Wireless Controller
REC601/603
Technical Manual

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Section 1 Introduction

1.1 This manual

The technical manual contains product overview, installation and mounting instructions, descriptions of physical connections, functionalities, Web configurator interface, IEC 60870-5-104 interoperability and controller configuration. The manual can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

1.2 Intended audience

This manual addresses system engineers and installation and commissioning personnel, who use technical data during engineering, installation and commissioning, and in normal service.

1.3 Product documentation

1.3.1 Document revision history

Document revision/date	Product series version	History
A/2011-09-14	1.0	First release
B/2013-02-15	1.1	Content updated
C/2014-08-18	1.2	Content updated

Download the latest documents from the ABB Website http://www.abb.com/substationautomation.

1.3.2 Related documentation

Product series- and product-specific manuals can be downloaded from the ABB Web site http://www.abb.com/substationautomation.

1.4 Symbols and conventions

1.4.1 Symbols

The electrical warning icon indicates the presence of a hazard which could result in electrical shock.

The warning icon indicates the presence of a hazard which could result in personal injury.

The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.

The information icon alerts the reader of important facts and conditions.

The tip icon indicates advice on, for example, how to design your project or how to use a certain function.

Although warning hazards are related to personal injury, it is necessary to understand that under certain operational conditions, operation of damaged equipment may result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.4.2 Manual conventions

Conventions used in manuals. A particular convention may not be used in this manual.

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Parameter names are shown in italics.
  The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks.
  The corresponding parameter values are “On“ and “Off”.

Section 2 REC601/603 overview

2.1 Overview

REC601 and REC603 are control and monitoring devices for secondary substations with integrated wireless communications. These devices are used for management of multiple disconnector or distribution transformer applications in distribution networks from a central control system (SCADA/DMS).

- Highly reliable control and monitoring of up to three objects (per REC603)
- Disconnector position indications with front LEDs
- Separate LED indicators for earthing status
- Overload protection of actuator motors
- Built-in battery charger with advanced battery control
- Fault Indicator support over Modbus for improved fault management
- IEC 104 (GPRS and wired) or IEC 101 (including dial-up) for host communication
- IEC 101 (router) and Modbus (pre-selected profiles) for sub-device communication
- Heater control to limit effects of ambient temperature variations
- General purpose I/O

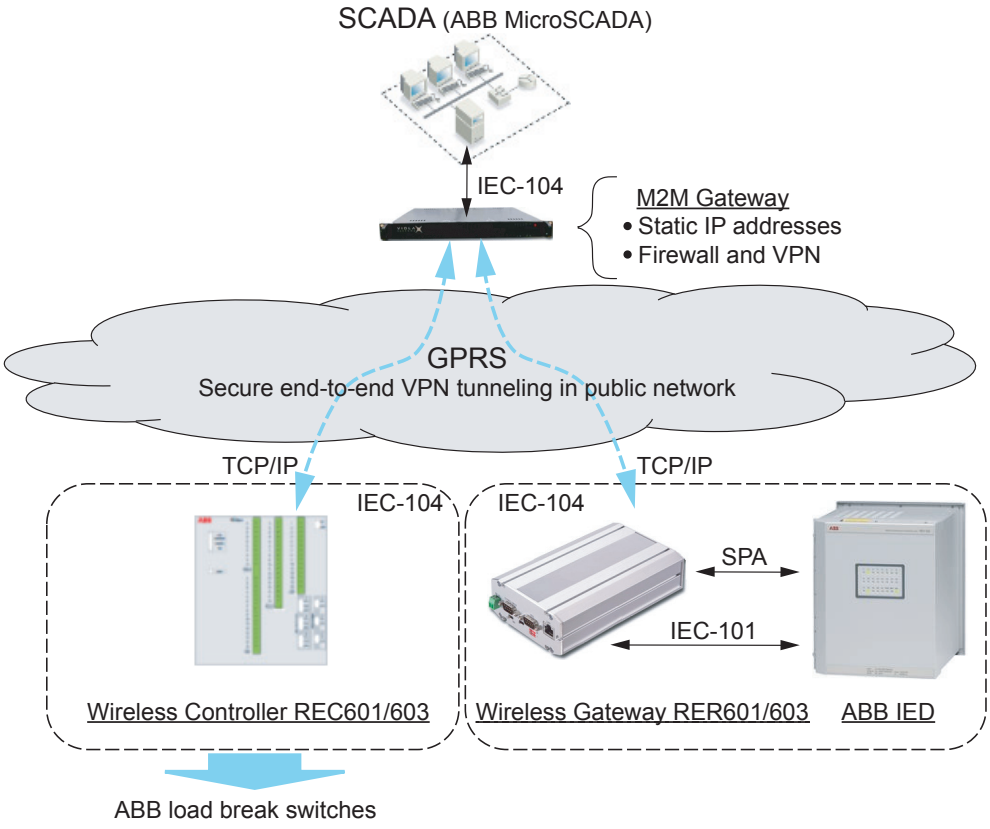

Figure 1: Typical communication system example

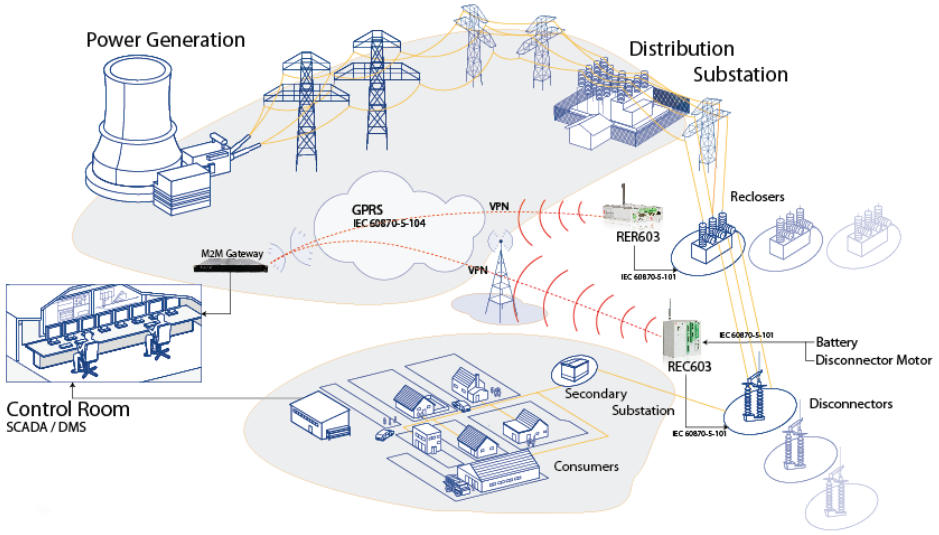

Figure 2: Distribution automation system overview

2.1.1 Product version history

Product version	Product history
1.0	First release
1.1	ComPass B node support
1.2	IEC-101 slave support with dial-up Kries IKI-50 support added Support for Viola Patrol remote device monitoring

2.2 Front panel

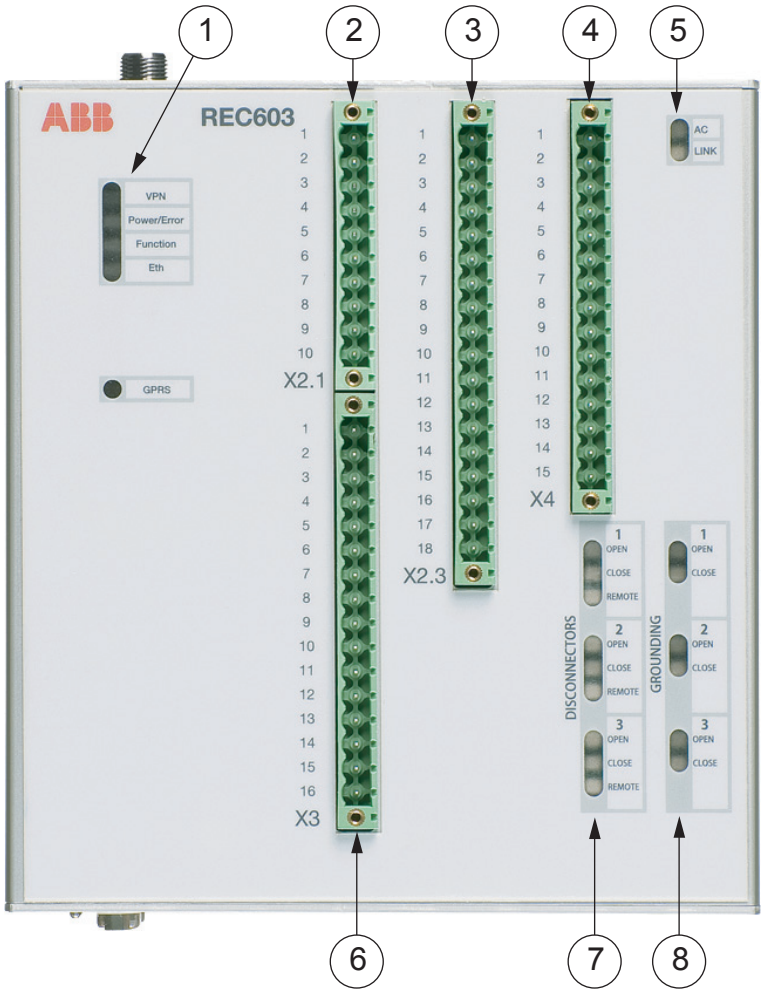

Figure 3: Front panel

1. System status LEDs
2. X2.1 connector
3. X2.3 connector
4. X4 connector
5. AC and LINK LEDs
6. X3 connector
7. Disconnector status LEDs
8. Grounding disconnector status LEDs

2.3 Serial panel

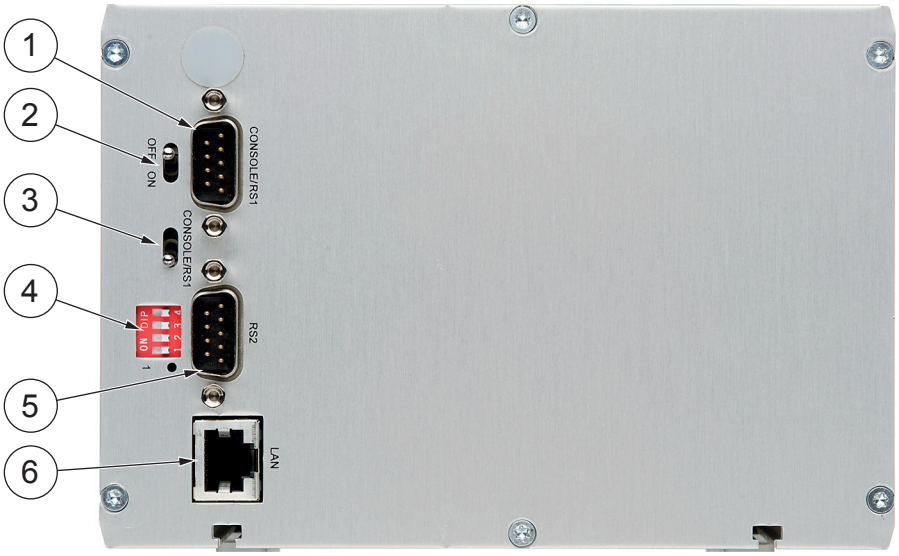

Figure 4: Serial panel

1. Serial port 1 (console or application port)
2. Power switch
3. Serial console switch
4. Serial port 2 configuration DIP switches
5. Serial port 2
6. Ethernet connector

2.4 Antenna panel

Figure 5: Antenna panel

1. SIM card tray connector
2. SIM card tray release button
3. Antenna FME connector (male)

2.5 System status LEDs

The device has eight LEDs indicating the system status. They are located on the front panel.

Table 1: System status LEDs

LED	State	Description
VPN	On	VPN connection is up
	Blink	VPN connection is starting
	Off	VPN connection is disabled
Power/Error	On	Operating power is turned on
	Off	Operating power is turned off
Function	On	Device is starting
	Blink	Device is operating normally

Table continues on next page

LED	State	Description
Eth	On	Ethernet link is up
	Blink	Ethernet link is transferring data
	Off	Ethernet link is down
GPRS	Blink	GPRS is starting or transferring data
	Off	GPRS is inactive

2.6 DIN rail mounting

The device has mounting holes for DIN rail mounting brackets.

2.7 Product label

The product label is located on the bottom of the device. It contains the basic information about the unit such as product name, serial number and Ethernet MAC address.

Figure 6: Product label

2.8 Firmware version

The device firmware version can be checked from the REC601/603 configurator start page (**System/Information**), or by executing the “firmware” command via the console.

This manual describes the REC601 and REC603 Ver.1.2 firmware 5.2.8.

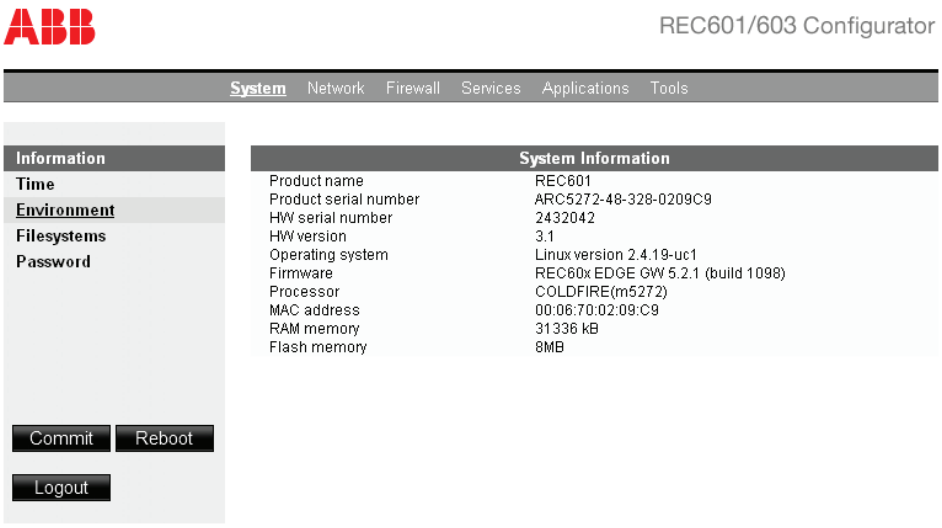

Figure 7: Firmware version

Section 3 Physical connections

3.1 Communication connections

REC601/603 uses the serial ports for console or application communication, the Ethernet port for network communication and GPRS for wireless applications.

3.1.1 Serial ports

The device has two application serial ports. Serial port 1 is configurable to either console or data mode and supports RS-232 only. Serial port 2 is configurable to multiple serial modes (RS-232/422/485). Serial port connectors are 9-pin D-sub male connectors. Serial ports function as DTE devices.

3.1.1.1 Console/serial port 1

The console switch enables or disables console access. When the switch is in the right position, serial port 1 is in the serial port mode, and when it is in the left position, serial port 1 is in the console mode.

The console switch is located below the serial port 1 connector. Turn off power from the device before toggling the console switch, as the switch position is read during the boot sequence only. The baud rate is fixed to 19200 when the port is configured in the serial console mode.

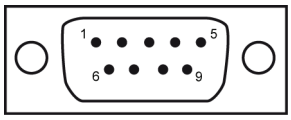

Figure 8: Console/RS1 port connector

Table 2: Console/RS1 port pinout

PIN	Function
1	DCD
2	RXD
3	TXD
4	DTR
5	GND
6	DSR
Table continues on next page	

PIN	Function
7	RTS
8	CTS
9	RI

Table 3: Console/RS1 port configuration

Parameter	Value
Baud rate	300...230400 (console 19200)
Data bits	8
Parity	No parity
Stop bits	1
Flow control	No flow control

3.1.1.2 Serial port 2

Serial port 2 can be configured to multiple serial formats (RS-232/422/485). The default is RS-232.

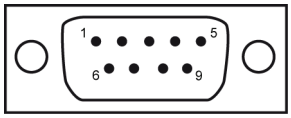

Figure 9: Application serial port

Table 4: Application serial port pinout (RS-232)

PIN	Function
1	DCD
2	RXD
3	TXD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

Table 5: Application serial port configuration

Parameter	Value
Baud rate	300...230400
Data bits	8
Parity	No parity
Stop bits	1
Flow control	CTS/RTS

By default, all DIP switches are set to the 0 position (RS-232 mode). DIP switches 2-4 apply only when the port is set in the RS-485 mode (DIP switch 1 in the 1 position).

Table 6: Application serial port DIP switches

DIP	Function	State	Description
1	RS-232 / RS-485	0 = RS-232, 1 = RS-485	Selects the serial port operation mode
2	DUPLEX	0 = FULL, 1 = HALF	Selects between half (2-wire) and full (4-wire) duplex
3	BIAS	0 = OFF, 1 = ON	RS-485 biasing
4	TERMINATION	0 = OFF, 1 = ON	RS-485 termination

Do not connect RS-422 or RS-485 cables to a serial port configured to the RS-232 mode. This could damage the port and the connected equipment.

Table 7: Application serial port pinouts in RS-422/485 modes

PIN	RS-485 full-duplex (4-wire)	RS-485 half-duplex (2-wire)
1	-	-
2	RXD positive (in)	-
3	TXD negative (out)	TXD/RXD negative (out/in)
4	-	-
5	GND	GND
6	-	-
7	TXD positive (out)	TXD/RXD positive (out/in)
8	RXD negative (in)	-
9	-	-

3.1.2 Ethernet

The device has an RJ-45 connector for 10/100 Mbps Ethernet connection. The maximum length of the Ethernet cable is 100 m.

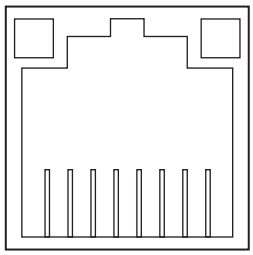

Figure 10: Ethernet connector

Table 8: Ethernet port configuration

Description	Value
Number of ports	1
Speed	10Base-T, 100Base-TX
Duplex	Half and full duplex
Auto-negotiation	No
Recommended cabling	Cat5e or better

The cross-connected cable is only used for connecting the device to the PC network interface. When connecting to a local network like a hub or switch, a direct Ethernet cable must be used.

3.1.3 GPRS

The device supports GPRS allowing the use of wireless applications. The device supports wireless data speed up to 86 kbit/s. The practical data transfer rates depend on the subscription details and wireless network capacity.

Table 9: Wireless specifications

Network	Frequencies	Maximum data rate
GPRS class 10	850/900/1800/1900 MHz	86 kbit/s

The device with GPRS includes an FME male type connector for an external antenna. Any kind of external 50 Ω dual-band antenna can be used intended for GSM900 (880–960 MHz) and GSM1800, also known as PCN, (1710–1880 MHz) frequency bands. The antenna is connected directly to the connector located on the device's back panel.

Commercially available antennas are usually provided with a flexible 50 Ω cable with a length of 2–3 meters and a female type FME connector.

The device's IEC 60870-5-104 gateway is tested with antennas from Hirschmann Rheinmetall Elektronik GmbH. Examples of tested external antennas include the sticker type and magnetic mount antennas.

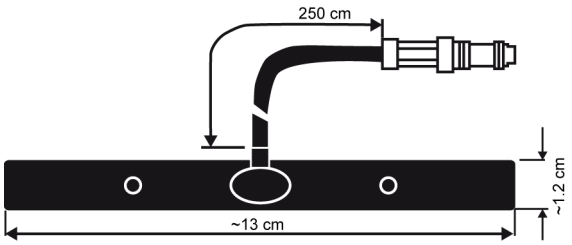

Figure 11: Sticker type patch antenna (MCA 18 90 STRIPE)

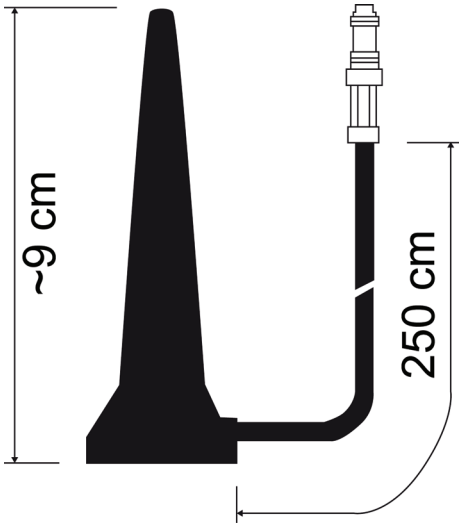

Figure 12: Magnetic mount antenna (MCA 18 90 MH)

Both antennas have an FME connector (female) and a 250 cm RG174 cable.

A SIM card with enabled data transfer is required for using the wireless connection. Standard 3 V SIM cards may be used with the IEC 60870-5-104 gateway. A SIM card holder is located on the back panel near the GPRS antenna connector.

If the PIN code query is enabled, check that the REC601/603 configurator has the correct PIN code entered in the GPRS submenu.

3.2 I/O connections

REC601/603 has four connectors in the front panel for power input and for control, condition monitoring, battery charging and measurement functions.

3.2.1 Power connector

Operating power for the device is supplied from connector X2.1. The device can use either an unregulated AC line input or a regulated DC input.

The power switch is located on the serial panel. It turns the unit on and off.

Table 10: Operating voltages of X2.1 connector pins

Input pins	Operating voltage range
1 and 2 (AC)	90...264 V AC or 85...200 V DC
6 and 7 (DC)	20...30 V DC

3.2.2 X2.1 connector

Table 11: X2.1 connector pinout

Pin	Symbol	Description
1	L	230 V AC
2	N	230 V AC
3	NTC_A	NTC resistor (battery temperature comp.)
4	PE	Protective earth
5	NTC_B	NTC resistor (battery temperature comp.)
6	24VDC	24 V DC output/input
7	GND	DC ground
8	GND	DC ground
9	GND	DC ground
10	BAT	Battery charging

Table 12: X2.1 connector types

Connector	Manufacturer	Connector type (part number)
Panel header	Phoenix Contact	MSTBV 2,5 HC/10–GF-5,08 (1924606)
Matching plug	Phoenix Contact	MSTB 2,5 HC/10–STF-5,08 (1912265)

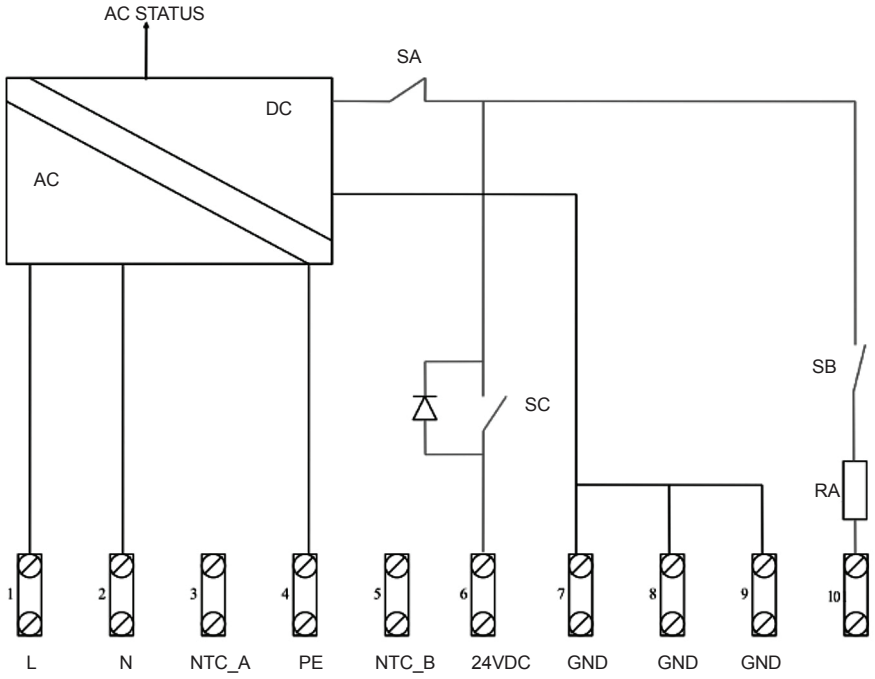

Figure 13: X2.1 connector schematics

3.2.3 X2.3 connector

Table 13: X2.3 connector pinout

PIN	Symbol	Description	Disconnector function
1	DI1	Digital input 1	Disconnector 1 opened
2	DI_C1	Common supply voltage for DI1 and DI2	
3	DI2	Digital input 2	Disconnector 1 closed
4	DI3	Digital input 3	Disconnector 2 opened
5	DI_C2	Common supply voltage for DI3 and DI4	
6	DI4	Digital input 4	Disconnector 2 closed
7	DI5_A	Digital input 5	Local/Remote switch for disconnector 1
8	DI5_B	Digital input 5	
9	DI6_A	Digital input 6	Local/Remote switch for disconnector 2
10	DI6_B	Digital input 6	
11	DO1_A	Relay output 1	Close disconnector 1
12	DO1_B	Relay output 1	
13	DO2_A	Relay output 2	Open disconnector 1
14	DO2_B	Relay output 2	

Table continues on next page

PIN	Symbol	Description	Disconnector function
15	DO3_A	Relay output 3	Close disconnector 2/ Heater
16	DO3_B	Relay output 3	
17	DO4_A	Relay output 4	Open disconnector 2
18	DO4_B	Relay output 4	

Table 14: X2.3 connector types

Connector	Manufacturer	Connector type (part number)
Panel header	Phoenix Contact	MSTBV 2,5/18–GF-5,08 (1777235)
Matching plug	Phoenix Contact	MSTB 2,5/18–STF-5,08 (1778140)

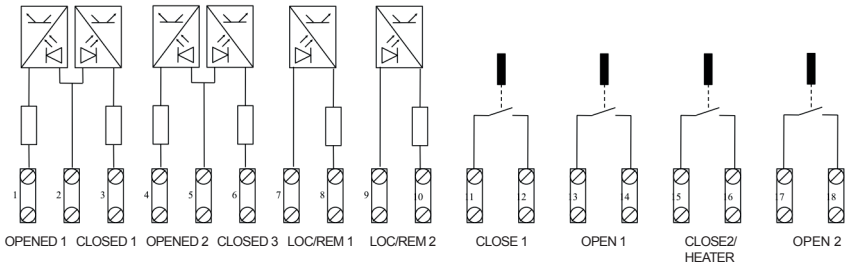

Figure 14: X2.3 connector schematics

3.2.4 X3 connector

Disconnector 3 and grounding disconnectors

Table 15: IO3 connector pinout

PIN	Symbol	Description	Disconnector function
1	DI7	Digital input 7	Disconnector 3 opened
2	DI_C3	Common supply voltage for DI7 and DI8	
3	DI8	Digital input 8	Disconnector 3 closed
4	DI9_A	Digital input 9	Local/Remote switch for disconnector 3
5	DI9_B	Digital input 9	
6	DO5_A	Relay output 5	Close disconnector 3
7	DO5_B	Relay output 5	
8	DO6_A	Relay output 6	
9	DO6_B	Relay output 6	Open disconnector 3

Table continues on next page

PIN	Symbol	Description	Disconnector function
10	DI_C4	Common supply voltage for DI10, DI11, DI12, DI13, DI14 and DI15	
11	DI10	Digital input 10	Grounding disconnector 1 open
12	DI11	Digital input 11	Grounding disconnector 1 closed
13	DI12	Digital input 12	Grounding disconnector 2 open
14	DI13	Digital input 13	Grounding disconnector 2 closed
15	DI14	Digital input 14	Grounding disconnector 3 open
16	DI15	Digital input 15	Grounding disconnector 3 closed

Table 16: X3 connector types

Connector	Manufacturer	Connector type (part number)
Panel header	Phoenix Contact	MSTBV 2,5/16–GF-5,08 (1777219)
Matching plug	Phoenix Contact	MSTB 2,5/16–STF-5,08 (1778124)

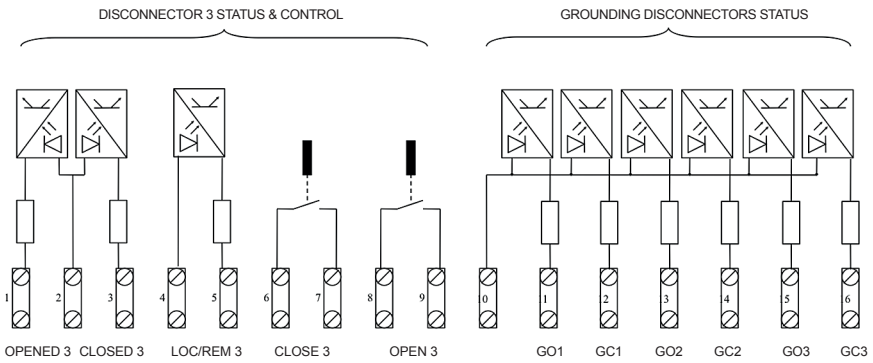

Figure 15: X3 connector schematics

3.2.5 X4 connector

Table 17: X4 connector pinout

PIN	Symbol	Description
1	LOADCUT_A	Load control relay
2	LOADCUT_B	Load control relay
3	AI1_A	Load measurement/-5...5 V[1)]
4	AI1_B	Load measurement/-5...5 V[1)]
5	TESTLOAD_A	Test load relay
6	TESTLOAD_B	Test load relay
7	HTR_A	Heater/Extra relay
8	HTR_B	Heater/Extra relay
9	AI2_A	-5...5 V/measurement[1)]
10	AI2_B	-5...5 V/measurement[1)]
11	DIC_5	Common supply voltage for DI16, DI17
12	DI16	Digital input 16
13	DI17	Digital input 17
14	DO7_A	Relay output 7
15	DO7_B	Relay output 7

1) Can be used as a 4...20 mA input using external resistor

Table 18: X4 connector types

Connector	Manufacturer	Connector type (part number)
Panel header	Phoenix Contact	MSTBV 2.5/15-GF-5.08 (1777206)
Matching plug	Phoenix Contact	MSTB 2.5/15-STF-5.08 (1778111)

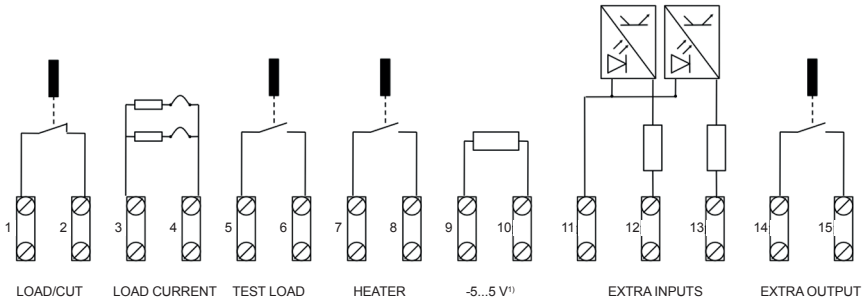

Figure 16: X4 connector schematics

1) Can be used as a 4...20 mA input using external resistor

3.2.6 I/O LEDs

The device has two LEDs indicating the AC and LINK status. REC601 has three LEDs and REC603 has nine LEDs to indicate the disconnector status. For indicating the grounding disconnector status, REC601 has two LEDs and REC603 has six LEDs.

3.2.6.1 AC and LINK LEDs

The device has two LEDs indicating the AC and LINK status.

Table 19: AC and LINK LEDs

LED	Description
AC	AC power is connected to connector X2.1 pins 1 and 2
LINK	The IEC control link to SCADA is active

3.2.6.2 Disconnector LEDs

REC601 has three LEDs and REC603 has nine LEDs to indicate the disconnector status. They are located on the device front panel. Each disconnector has three LEDs, which indicate the status of the disconnector.

Table 20: Disconnector LEDs

Disconnector LED	Description
Disconnector 1 open	Disconnector 1 is opened
Disconnector 1 close	Disconnector 1 is closed
Disconnector 1 remote	Disconnector 1 is on remote control
Disconnector 2 open	Disconnector 2 is opened
Table continues on next page	

Disconnector LED	Description
Disconnector 2 close	Disconnector 2 is closed
Disconnector 2 remote	Disconnector 2 is on remote control
Disconnector 3 open	Disconnector 3 is opened
Disconnector 3 close	Disconnector 3 is closed
Disconnector 3 remote	Disconnector 3 is on remote control

Disconnector LEDs can indicate two special cases.

Table 21: Disconnector LED special cases

Disconnector LED state	Description
Open and close LEDs are both OFF	Disconnector is changing state
Open and close LEDs are both ON	Disconnector error

3.2.6.3 Grounding LEDs

REC601 has two LEDs and REC603 has six LEDs indicating the grounding status. They are located on the device front panel. Each grounding disconnector has two LEDs, which indicate the status of the grounding disconnector.

Table 22: Grounding LEDs

Grounding LED	Description
Disconnector 1 open	Connector X3 digital input on pin 11 is active high
Disconnector 1 close	Connector X3 digital input on pin 12 is active high
Disconnector 2 open	Connector X3 digital input on pin 13 is active high
Disconnector 2 close	Connector X3 digital input on pin 14 is active high
Disconnector 3 open	Connector X3 digital input on pin 15 is active high
Disconnector 3 close	Connector X3 digital input on pin 16 is active high

All grounding disconnector digital input pins have connector X3 pin 10 as the common ground pin.

Section 4 Functional description

4.1 Control functions

The device is capable of controlling and monitoring an object, for example, a disconnector, and handling the object status information. The device can control and monitor up to three objects. The device can monitor the earthing switch position indications, with one function per disconnector object. Local/Remote indications are also a standard; each disconnector has its own Local/Remote position monitoring. In the Local position, control operations (open or close) can be performed at the site only. In the Remote position, control operations can be performed from the SCADA system in the network control center.

4.2 Condition monitoring functions

4.2.1 Communication diagnostics and watchdog

The device is provided with a self-supervision system, that is, a watchdog function. The self-supervision system handles run-time fault situations and informs the user of faults through the user HMI (function LED) on the front panel.

In addition to hardware supervision, the self-supervision system is able to re-establish the cellular connection and VPN connection (if applicable). Furthermore, it is able to restart the device as a last resort.

4.3 Disconnector control condition monitoring functions

4.3.1 Disconnector travel time monitoring

The OPEN and CLOSE indications are monitored. When a change occurs due to an activated control operation, the opening or closing travel time is measured. If the measured travel time is greater than or equal to the set limit values, an alarm is given. The settings define how the disconnector travel time duration (state change from open to close or vice versa) is reported.

Travel time is reported in seconds. The alarm signals remain active until the fault condition is acknowledged.

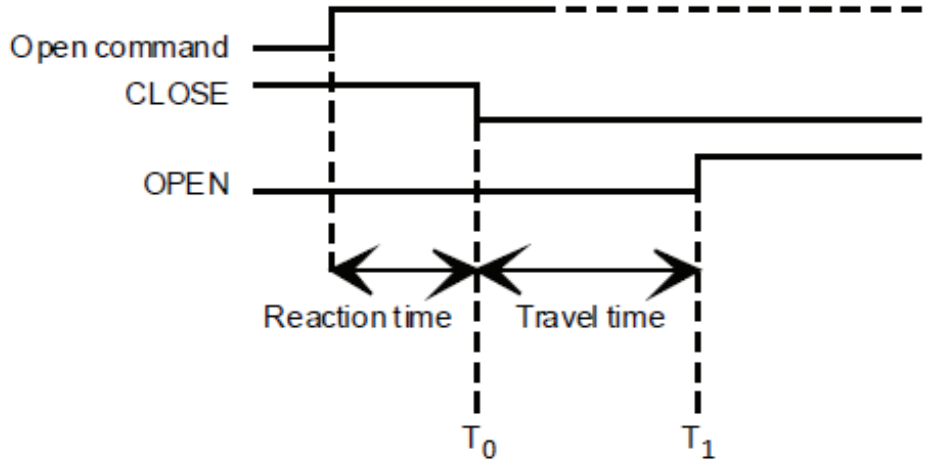

Figure 17: Travel time measurement for open operation

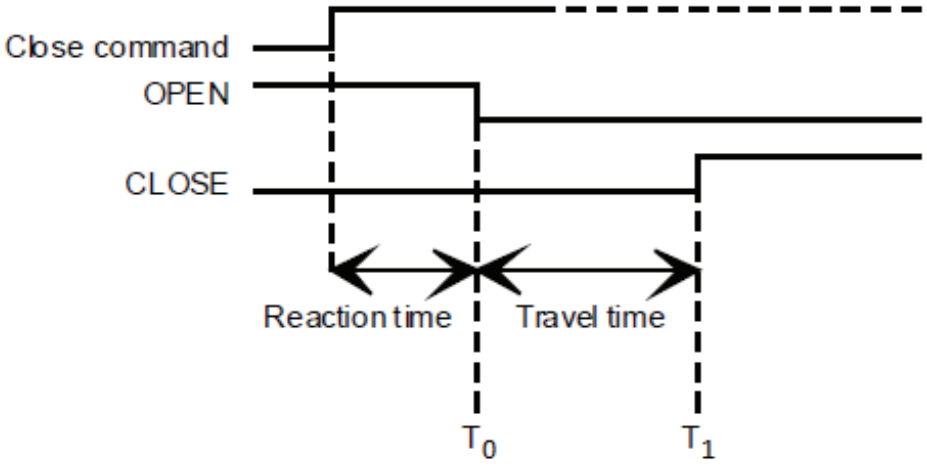

Figure 18: Travel time measurement for close operation

4.3.2 Disconnector actuator motor overload protection

With an optional Hall effect sensor, the device is able to measure the load current that flows through the actuator during the control operation of the disconnector. This current measurement is effectively used to detect an abnormality in the mechanical motion, when the lever that operates the disconnector moves from one end position to the other (for example, from Open to Close). A slip in the mechanical gear unit or a mechanically stiff operation, due to insufficient lubrication or deviation in operation tube positioning, can cause an overload situation which may be harmful to the actuator motor if no action is taken to prevent overloading.

Even if MCB's are used as an overload protection, they are not optimal from the maintenance point of view, as they require a site visit because the resetting is typically managed manually. The device's intelligent overload protection function, for example, the resetting and adjustment of the current pick-up level, is managed remotely from a utility dispatch center, using a system such as SCADA. The overload protection is coordinated with the possible MCB in the same circuit so that the current pick-up setting is lower than the MCB operational level to avoid unnecessary site visits.

4.3.3 Monitoring of the pressure of SF6 gas

The SF6 insulated primary equipment is arranged by wiring the pressure sensor contact to one input of the device, used for monitoring the SF6 gas pressure. When the gas pressure drops below the acceptable limit, the falling edge of the digital signal triggers and activates an alarm signal. This information can be obtained as an alarm event from the network control system.

4.4 Battery charging and monitoring functions

Power backup for the station can be arranged by connecting 24 V (2 x 12 V) sealed lead acid batteries to the device. The batteries supply power to both the device and the communication device during a mains failure. As the batteries are charged by the device, the communication between the unit and the network control center is always operating irrespective of distribution network faults or planned outages.

The battery condition is secured by a battery load and condition monitoring test, activated remotely via a command from the SCADA system. In the test, a discharge resistor is connected in parallel to the batteries. During the test, the battery capacity is measured and reported as an Ah value to indicate the remaining capacity, so that maintenance can be optimized. The battery load test is performed twice an hour and always after the power-up of the unit. During the battery load test, which takes 2-5 h, the voltage of the battery charger is shut off and the control functionality is blocked.

If the battery voltage drops to less than the set value, for example, 22 V, during the battery load test, the device generates an alarm event. This indicates that the lifetime of the batteries is ending or that an internal fault has occurred in the battery or its circuitry. In both cases, the battery must be replaced.

During normal control operations, the device makes condition measurements, such as the battery voltage minimum value and the maximum current. The battery condition and lifetime can be estimated based on these recorded values.

4.4.1 Power backup

Power backup for the station can be arranged by connecting 24 V (2 x 12 V) sealed lead acid batteries to the REC601/603 device. The batteries supply the device and keep the communication alive during a mains failure. Thus the communication between the device and a network control centre operates in any situation.

Depending on the application and the required maximum operation time, batteries of different capacity are used; the typical capacity is 17 Ah. With the 17 Ah battery, the maximum operation time is 48 hours (including safety coefficient) at ambient temperature of +20°C.

A low temperature reduces battery capacity and lifetime.

4.4.2 Heater control

The heater control is based on the environmental temperature. Heating is needed if the device is installed in a separate enclosure outdoors where the ambient temperature may be below 0°C. Heating is specifically required in very damp conditions when dehumidifying is needed. The heating control consists of switching on and off an output relay connected to an external heating resistor, which is located in the enclosure, preferably next to the batteries and the electronics components.

The device contains an internal thermostat for controlling the external heater. The heater element can be set to be constantly on, for example, if the element contains an internal thermostat, constantly off or to be controlled by the environmental temperature.

- For REC601 the heater output pins are X2.3 15 and 16. This is defined by giving the parameter *heater_output* value “3”.
- For REC603 the heater output pins are X4 7 and 8. This is defined by giving the parameter *heater_output* value “9”.

The settings are defined in the section [HEATER].

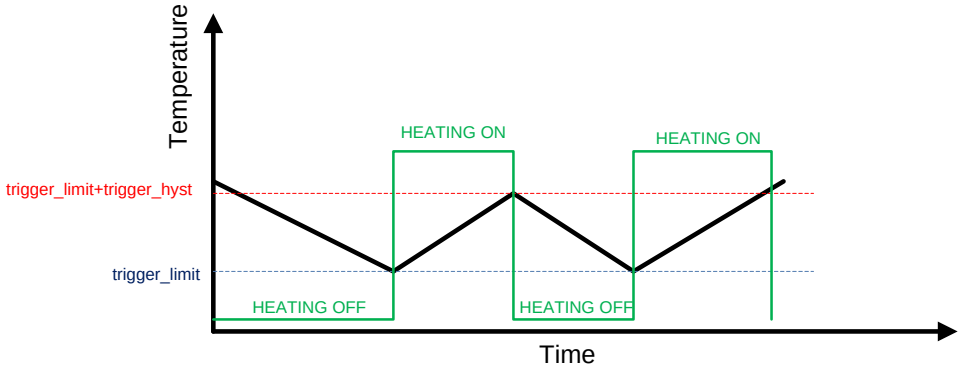

Figure 19: Heater control on auto-mode

4.4.3 Low auxiliary voltage indication

The power supply module gives an internal alarm signal when a drop in the power supply voltage is detected (AC Fail). The indication of a low auxiliary voltage can be reported to any available communication protocol supported by the device.

4.4.4 Over/undertemperature indication

The power supply module gives an internal alarm signal when over- or undertemperature is detected inside the enclosure. The alarm is activated when the temperature inside the enclosure surpasses a set limit or decreases below a set limit. Hysteresis can be set for both indication functions. The indication can be reported through any available communication protocol supported by the device.

4.4.5 Temperature compensation of battery charging voltage

The charging voltage of the internal battery charger of the device is temperature-compensated. The compensation factor is approximately -40 mV/°C. The data about the temperature is acquired with the help of a 2.2 kΩ NTC thermistor that is connected to pins 3 and 5 of the connector X2.1. If the battery charger is not used to charge the battery, the thermistor or the 2.2 kΩ resistor must still be installed between the pins 3 and 5 of the connector X2.1. Otherwise, the overvoltage protection of the charger may activate and prevent the device from starting.

It is recommended to install NTC thermistor between the batteries.

4.4.6 Battery deep discharge protection

When the battery voltage falls below a certain value, the battery is almost empty. To prevent battery damage, the battery should not be further discharged. The battery deep-discharge protection function disconnects the battery from the device REC60x in two cases.

- AC supply is not available to charge the battery.
- Battery voltage stays long enough below the defined limit.

Usually the deep-discharge protection causes the device to shutdown due to lack of power. The device recovers once the AC supply becomes available again or it is powered up with DC on the modem-supply pin (X2.1 pin 6). External loads such as a Hall sensor, additional DC-powered RECs or the supply for input circuits should not be connected directly to the battery but to the “master” REC modem supply pin (X2.1 pin 6). This way, the whole load can be removed at once when the deep-discharge protection is required. The settings are defined in the section [BATTERY_DISCHARGE_PROTECTION].

4.4.7 Battery capacity test

The device can test the capacity of the battery by disconnecting the charger and draining the battery to almost empty using an external loading resistor. The test is completed when the battery voltage reaches the defined voltage limit. The battery capacity can be returned by protocol communication in ampere-hours. The battery draining current is measured by external Hall sensor connected to analog input 1 (X4 3-4). The loading-resistor current should be routed through the relay contacts of X4 pins 5 and 6.

The test is started by protocol communication command. The information object is defined in the section [BATTERY_TEST_CONTROL_SC].

Certain conditions can be defined to abort the test.

- AC voltage is missing.
- Temperature is too high.
- Temperature is too low.
- Battery voltage does not reach the defined completion limit during timeout.
- Battery draining current too low.
- Battery draining current too high.
- Abortion command is issued by protocol communication.

The test is completed when the measured battery voltage stays below the defined voltage limit. This means the battery is almost empty and the available capacity can be estimated by multiplying the consumed charge by compensation factor. For example, if the defined target voltage means the battery to be 90% discharged, a multiplication factor 1.11 can be used to estimate the available total capacity. The device can compensate the cabling-loss voltage and include its internal charge consumption to the total capacity.

Usually, the disconnectors are internally blocked during the battery test and the test should be remotely stopped (information object [BATTERY_TEST_CONTROL_SC]) before the disconnectors can be operated. The blocked state can be indicated by configuring the local/remote status to double-point indication [DISCONNECTOR_LOCREM_xx].

The load limiter functionality and the heater are disabled during the test.

4.4.7.1 Settings

The battery capacity test settings are defined in the section [BATTERY_TEST].

4.4.7.2 Remote control of the battery test function

Once the battery test functionality is enabled on the configuration file, it can be remotely controlled by protocol communication. The information object is defined in the section [BATTERY_TEST_CONTROL_SC].

- 0 = Abort the battery test
- 1 = Start the battery test

4.4.7.3 Battery test status

The status of the battery testing is available for the protocol communication. The information object is defined in the configuration file section [BATTERY_TEST_STATUS_DPI].

- 0 = Idle (not testing the battery)
- 1 = Testing (discharging the battery by using external load)
- 2 = Test complete
- 3 = Test aborted

4.4.7.4 Battery capacity

The measured battery capacity can be reported as a short floating-point value. The reporting unit is ampere-hours Ah. For settings, see the general floating-point input settings. The measured capacity is always reported after the test is completed. The information object is defined in the configuration file section [BATTERY_TEST_CHARGE_FPI].

4.4.7.5 Measurement file

The device can generate the internal measurement file from the battery capacity testing. The measurement file is written every *averaging_interval_sec* and each line contains a time stamp, status, battery voltage, discharge current and the charge consumed so far. The file header contains the unloaded battery voltage before the load is applied. The last line of the file contains information whether the test was completed successfully or aborted for a specific reason.

4.5 Measurement functions

The device measures the battery voltage and the ambient temperature. The temperature measurement is calibrated to measure the ambient temperature of the device mounted in an enclosure. The temperature measurement is used to compensate for the charging voltage of the batteries and for activating or deactivating heating in cold environments. The battery voltage is measured as two values: the minimum battery voltage and the maximum current during control operation. The minimum battery voltage indicates the lowest voltage measured during a battery test or during an object's operation. The battery-charging voltage indicates the present voltage on the battery poles. The values can be read from the network control center via the supported communication protocols. The minimum battery voltage and the maximum current can be reset via the serial bus.

The device supports a general-purpose analog input that can be used as a transducer input. It supports voltage mode -5…5 V.

The input can be used as current mode 4...20 mA using an external resistor.

4.5.1 Temperature measurement

The device has four temperature sensors.

4.5.1.1 Processor temperature

The ambient temperature of the process is measured by a sensor whose measurement result is available on the System tab of the Web user interface and with the command line command temperature. The measurement data of the sensor is not available with protocol communication.

4.5.1.2 Communication module temperature

The internal temperature of the wireless communication module is available on the Web user interface under **Tools/Modem Info** and with the command line command modeminfo. The measurement data of the sensor is not available with protocol communication.

4.5.1.3 Sensor for the temperature compensation of the charging voltage

The internal sensor of the device adjusts the battery charging voltage based on the battery temperature. The data about the temperature is gained with the help of a 2.2 kΩ NTC thermistor that is connected to pins 3 and 5 of the connector X2.1. The thermistor is located between the batteries. The measurement data of the sensor is not available with protocol communication but it is only used for adjusting the charging voltage.

4.5.1.4 Ambient temperature

The temperature of the device casing is used for estimating the ambient temperature. Because the power consumption of the device affects the casing temperature, its effect is compensated based on calculations. The compensation parameters are defined in the setting file section [PHYSICAL_TEMP].

The ambient temperature calculated from the casing temperature is available with protocol communication. The temperature object is defined in the setting file section [TEMPERATURE_FPI]. This temperature is also used for temperature alarm ([TEMPERATURE_LOW_SPI], [TEMPERATURE_HI_SPI]), battery testing temperature guard ([BATTERY_TEST]) and heater control ([HEATER]).

Example

- Casing temperature 47 °C
- Fixed temperature difference -10 °C
- Charging current 2 A
- Charging current effect 3.5 °C/A
- Ambient temperature (47-10) °C - 2 A * 3.5 °C/A = 30 °C

4.6 Load limiter

The device can detect excessive loading of battery due to jammed disconnector switchgear and disconnect the load before the actual physical overcurrent fuse trips. The overload decision is based on both the consumed charge and duration of the loading. The current is measured usually by an external Hall sensor connected to analog input 1 (X4 3-4). The device uses a normally closed relay (X4 1-2) to break down the loading circuit by opening the relay contacts for a moment. Usually this is used to cut the holding circuit of motor contactors, not directly the motor current.

4.6.1 Overload detection settings

The overload detection settings are defined on section [LOAD_LIMITER]. The detection is based on the load current measurement by the external Hall sensor connected to X4 pins 3 and 4.

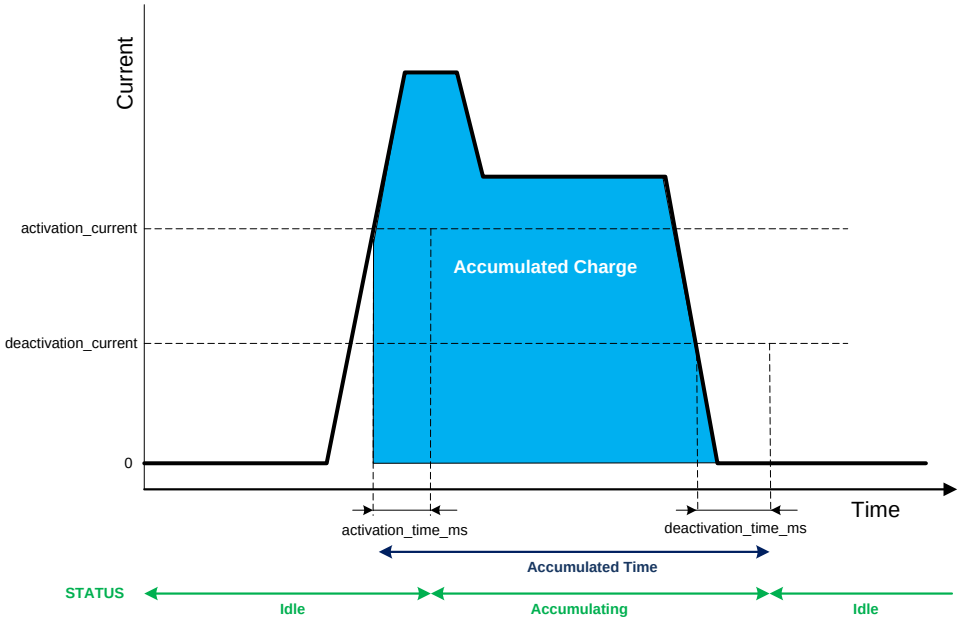

Figure 20: Load limiter measurements

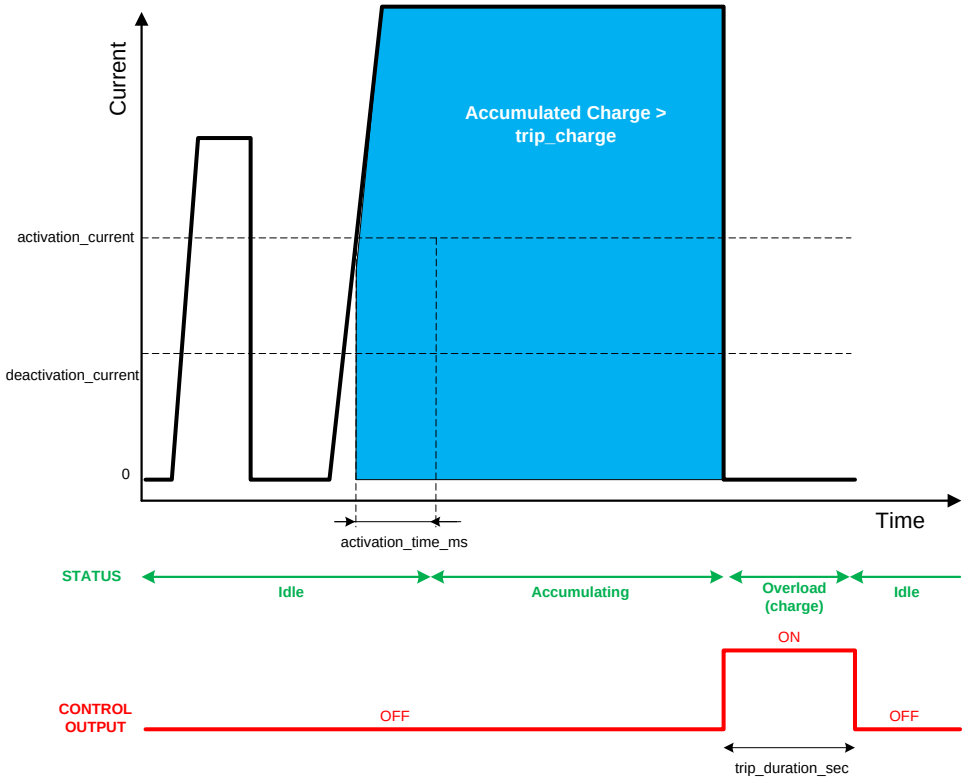

Figure 21: Overload caused by charge

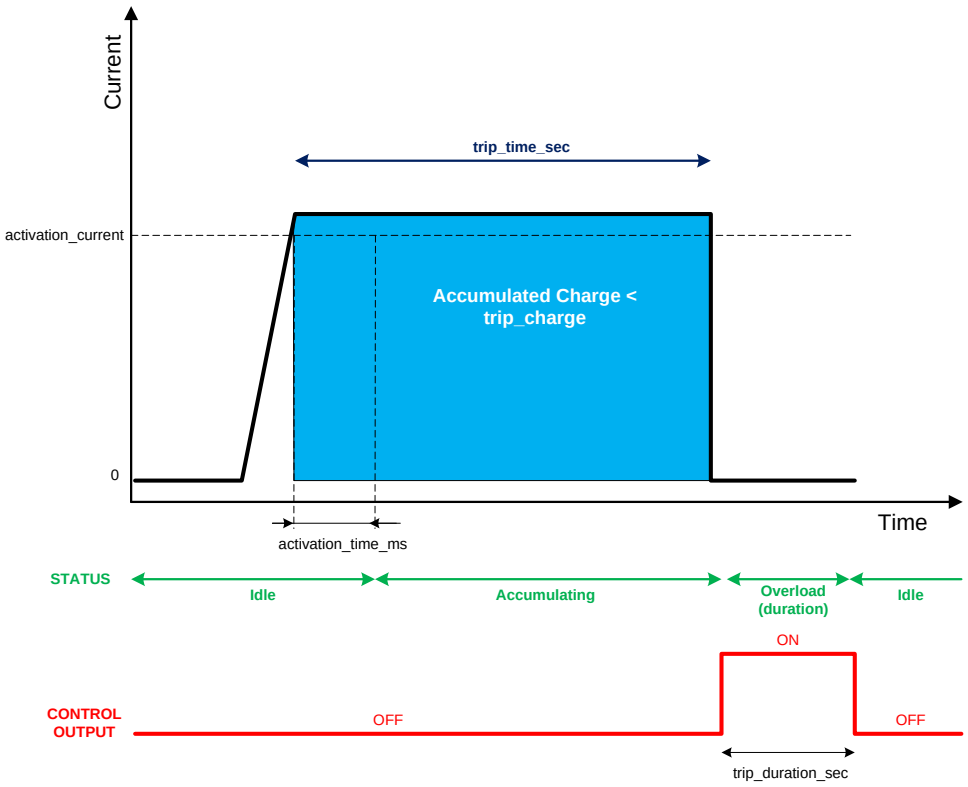

Figure 22: Overload caused by duration

4.6.2 Remote enabling and disabling of the load limiter

Once the load limiter functionality is enabled on the configuration file, it can be remotely controlled by the protocol communication. The information object is defined in the section [LOAD_LIMITER_CONTROL_SC].

- 0 = Disable load limiter
- 1 = Enable load limiter (if enabled on configuration file)

The issued value is not permanently stored and effects only until reboot or application restart.

4.6.3 Load limiter status

The current status of the load limiter function is available for protocol communication. The information object is defined in the section [LOAD_LIMITER_STATUS_DPI].

- 0 = Load limiter idle (waiting for the current to exceed the threshold)
- 1 = Load limiter disabled (does not monitor load)
- 2 = Loading detected, accumulating
- 3 = Overload, load disconnected

4.6.4 Reason for load limiter activity

The overload decision is based on both consumed charge and duration of the loading. Once the overload situation is detected, the reason can be reported as double-point input. The information object is defined in the section [LOAD_LIMITER_REASON_DPI].

- 0 = None, overload situation not detected
- 1 = Overload caused by consumed charge
- 2 = Overload caused by duration of loading
- 3 = Overload detected by manual command

4.6.5 Measured charge during overload

The overload decision is based on both consumed charge and duration of the loading. Once the overload situation is detected, the accumulated charge can be reported as a short floating-point value. The reporting unit is ampere-seconds. If no overload situation has been detected, the reported value is zero and has a non-topical NT flag set. The information object is defined in the section [LOAD_LIMITER_CHARGE_FPI]. This charge is reported only when the overload situation is detected. The consumed charge for normal operation is reported by [DISCONNECTOR_TRAVELCHARGE_N].

4.6.6 Measured time during overload

The overload decision is based on both consumed charge and duration of the loading. Once the overload situation is detected, the loading duration can be reported as a short floating-point value. The reporting unit is seconds. If no overload situation has been detected, the reported value is zero and has a non-topical NT flag set. The information object is defined in the section [LOAD_LIMITER_TIME_FPI]. This duration is reported only when the overload situation is detected. The travel time for normal operation is reported by [DISCONNECTOR_TRAVELTIME_N].

4.7 Support for fault indicators

The device contains a driver for the Horstmann ComPass-B and Kries IKI-50 fault indicators. The driver polls the fault indicator devices using Modbus and converts the values to IEC 60870-5-104. Up to four fault indicators can be connected.

Section 5 Cyber security

Cyber security aims to secure the properties of the organization against security risks. To strengthen the system and increase the security level towards any cyber security attacks from the Internet, certain actions are recommended while configuring the device.

- The device should be installed physically secure, for example, in a locked cabinet.
- The latest security updates need to be installed for all network devices.
- The network inventory needs to be documented and kept up to date.
- Unused services and interfaces should always be disabled.
- Only VPN connections should be used to access remote networks.

5.1 Enhancing operator and subscription security

Network subscription and SIM card must be stored safely and configured to prevent misuse of services.

- Disable unused services from SIM cards.
  - Voice calls
  - SMS
  - Paid services
  - Roaming
- Use pin code in SIM cards.
- Prefer a private APN service from the operator.
- Prefer M2M subscription SIM cards from the operator.
- Use private IP addressing from the operator for GPRS communications.
- If connected to a public IP network, do not use plain text protocols such as http, SNMP and telnet. Always use VPN to connect to the device.

5.2 Configuring firewall and services

Enable the firewall and disable the unused services and interfaces in the device. To start, disallow traffic and allow only the needed traffic. Use the default policy to drop connections.

- Check that the firewall is enabled.
- For incoming connections, always filter (drop) all unused ports which may include DNS, L2TP-VPN, SNMP and so on.
- Check that the default action is “drop” in firewalls and allow only the needed ports.
- Set unique passwords for each device.
- Keep passwords stored in a safe place, for example, Encrypted password management tool.
- Check that all unused services are disabled.
- If possible, allow IP connections only via VPN.
- Disable all unused services, for example, Dial-in, SMSconfig, serial and SNMP.
- Back up the configuration.

Section 6 REC601/603 Configurator

6.1 Overview

REC601/603 configurator is a tool which is used to manage the device properties via a user-friendly, Web-based interface.

To use the Web configurator, only a computer with an HTML browser and a connection to the device are needed. With the configurator, it is possible to receive status information and set parameters and variables that control which applications and processes are used with the device.

After a successful login, the main window is displayed. It consists of the main navigation menu on the top, the navigation bar on the left, and the content area that displays the currently active content and controls.

When the program starts for the first time, the System/Information window is displayed in the content area. The main navigation menu on the top of the window is used to navigate between the different subsets of the available settings. Selecting an item from the main menu displays the available items related to this subset in the navigation bar. The first of these is displayed in the content area by default.

The navigation bar on the left contains the parameter groups in the subset. Selecting an item from this menu displays the content related to the selected group in the content area.

Three buttons are always visible at the bottom of the navigation bar.

- The **Commit** button is used to save the memory-resident data for “soft” parameters permanently to the nonvolatile memory. The values for the previous parameters are not saved permanently unless this button is pressed.
- The **Reboot** button is used to reboot the device.
- The **Logout** button ends the current session and returns to the login window.

6.2 Login to the Web Configurator

1. Open the device from the URL where the device is located.
2. On the device main page, click the **Start Configurator** link.

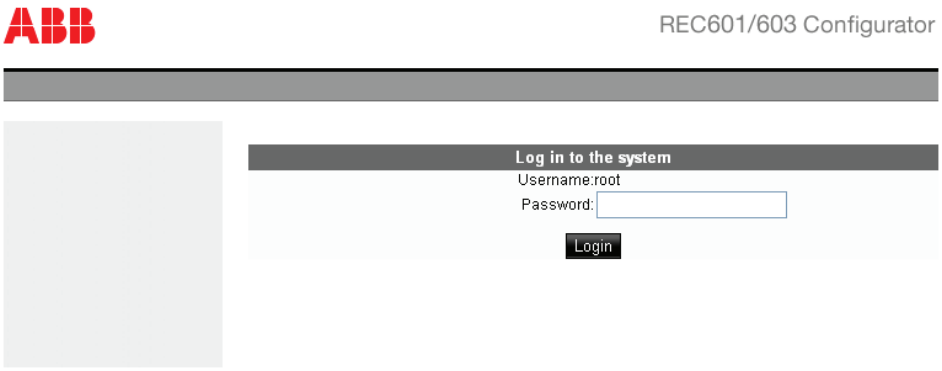

Figure 23: Start Configurator link

3. Enter the password for the device's root account and click the **Login** button to start the Web configurator tool.

The default password for the root is empty. Set the password before connecting the device to a public network. Change the password from the **System/Password** menu.

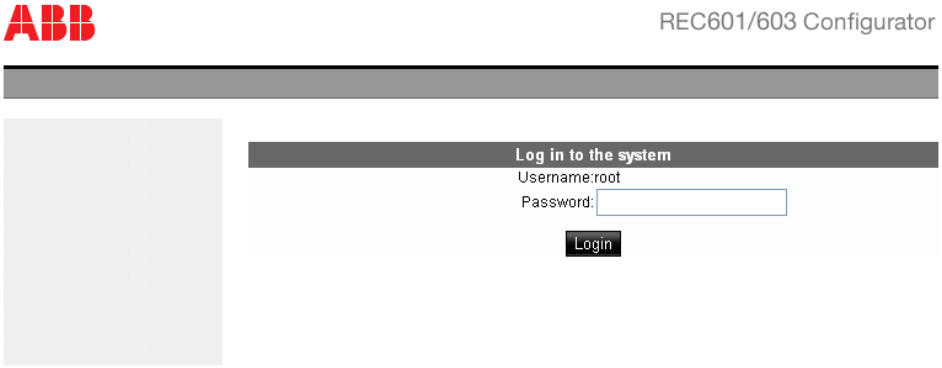

Figure 24: System login

6.3 System menu

The System menu can be used to view information about the system or the current executing environment and to set the date and time.

Updated time information is not saved permanently until the Commit button is pressed.

Information

Contains general information about the device. Information on this submenu should be provided, if possible, when contacting technical support.

Time

For adjusting time information. The device has a real-time clock with battery backup.

Environment

Contains information about the device's memory usage, uptime and inside temperature.

Password

For changing the password. The default password is blank.

6.3.1 Changing the password

It is recommended that the default password is changed before connecting the device to a public network. The default password for the root account is empty.

1. Click **Password**.
   - When changing the password for the first time, type the new password in all three fields, **Old password**, **Password** and **Retype password**.
   - When changing an old password, type the old password in the **Old password** field, type the new password in the **Password** field and retype the new password in the **Retype password** field.
2. Click **Apply** and then **Commit** to store the settings.
3. Click **Reboot** for the settings to take effect.

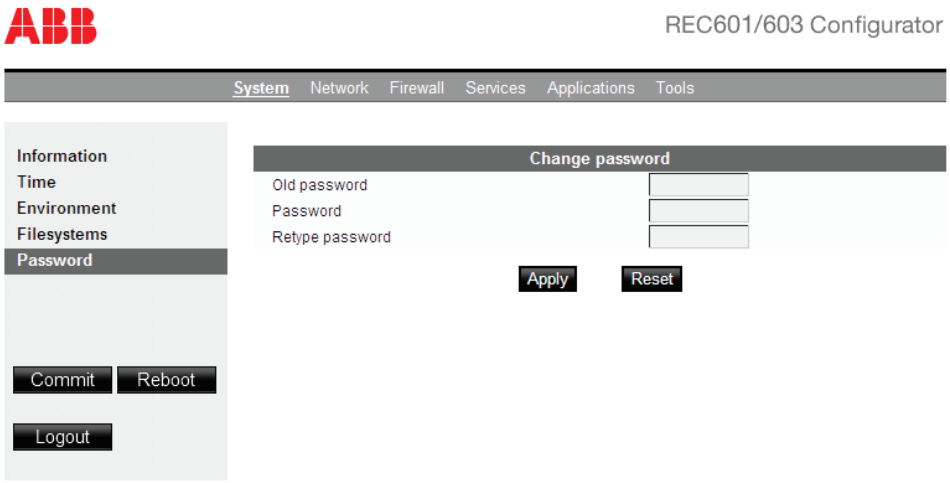

Figure 25: Changing the password

6.4 Network menu

The network interface properties are controlled through the Network menu. The menu contains items for the Ethernet, GPRS and VPN interfaces. The Network Interface Summary page shows the currently active interfaces and routing information.

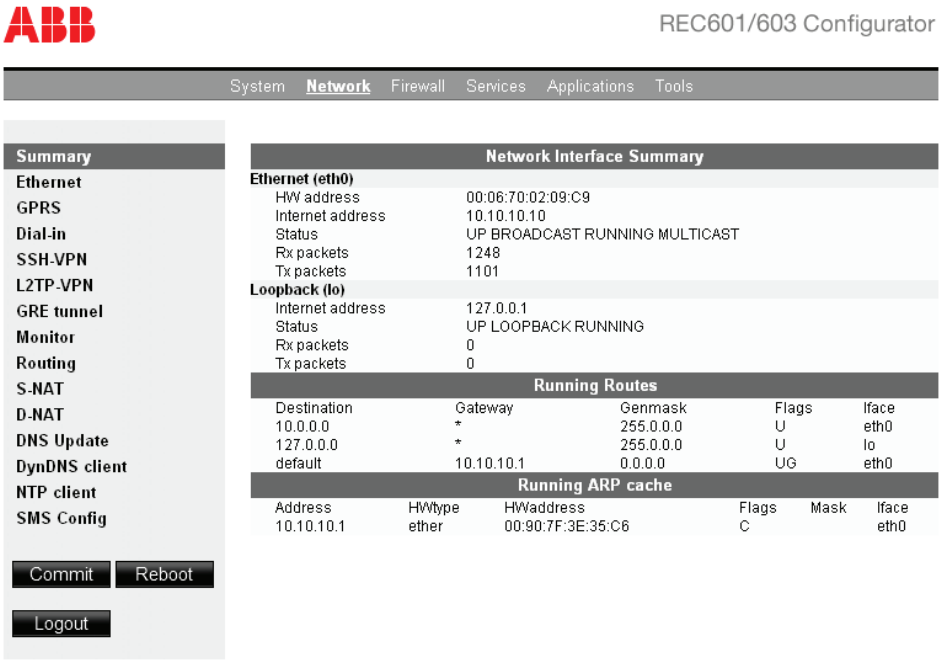

Figure 26: Network interface summary

6.4.1 Ethernet

The device's Ethernet interface is configured via the Ethernet command in the Network menu. Clicking this command displays the Ethernet settings in the content area.

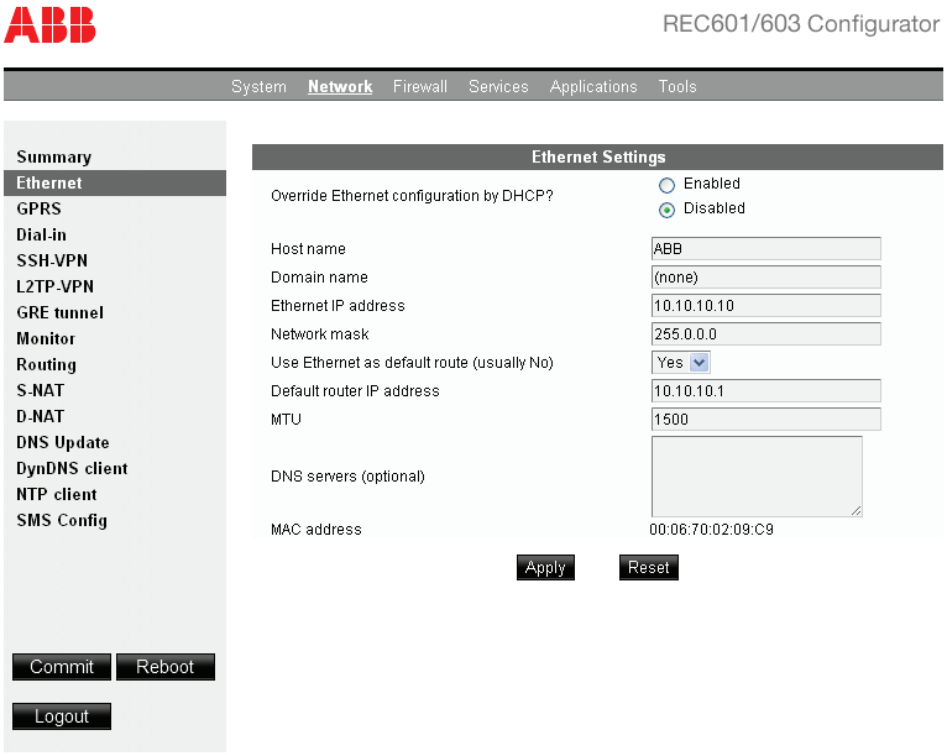

Figure 27: Ethernet settings

Override Ethernet configuration by DHCP? If enabled, the device gets the IP address and other related information from a local DHCP server. When enabled, all other settings are disabled on this page.

Host name sets the device host name. Each device connected to the gateway must have a unique host name. This is important to set up correctly when using the gateway and VPN.

Domain name determines the domain name for name resolution (optional).

Ethernet IP address determines the IP address used by the eth0 interface.

Network mask determines the network mask used by the eth0 interface.

Use Ethernet as default route should be set to “Yes” only if Ethernet is used as the default gateway or router. Usually this parameter is set to “No”, because either GPRS or VPN is used as the default route. This parameter overrides the next parameter *Default Route IP Address*, so that parameter has no effect if *Use Ethernet as default route* is set to “No“

Default Router IP address determines the default router or default gateway used when the direct route to the host or network is not known. Applies to the eth0 interface only. When GPRS or VPN is used as the default gateway, this parameter is set to “0”.

MTU determines the maximum transfer unit (MTU) for the Ethernet interface (usually 1500).

DNS servers (optional) determines the name server IP (DNS) address for resolving host names to the IP address and vice versa. Applicable when the GPRS parameter *DNS servers* is set to “User defined”.

6.4.2 GPRS

The GPRS settings include APN and other settings for the GPRS network connection.

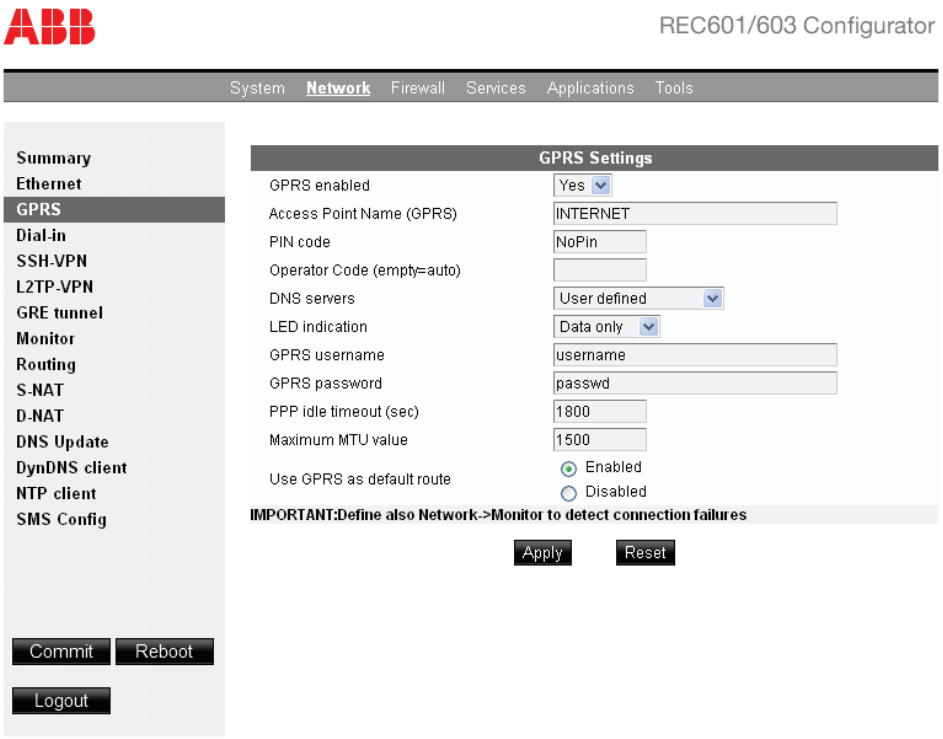

Figure 28: GPRS settings

GPRS enabled When set to ”Yes”, the GPRS interface is automatically connected to the GPRS network.

Access Point Name (GPRS) determines the GPRS Access Point Name (APN) for the connection.

PIN code determines the SIM card PIN code.

Operator Code (empty=auto) is a manually selected operator code. Leave empty for automatic network selection (default).

DNS servers When set to “User defined”, DNS servers defined on the Ethernet page are used. If set to “From GPRS network”, the device receives the DNS server IP addresses automatically from the GPRS network.

Led indication When set to “Data only”, the GPRS LED blinks green when transmitting data. When set to “Informative”, the LED blinks also when connected to the GPRS network without data transfer (GPRS context is active).

GPRS username determines the user name used for authentication, if APN requires it.

GPRS password determines the password used for authentication, if APN requires it.

PPP idle timeout determines the maximum idle time for the GPRS interface. If the GPRS interface has been idle (no traffic) for this period, the GPRS connection is restarted.

Maximum MTU value determines the maximum transfer unit (MTU) for GPRS.

Use GPRS as default route If enabled, GPRS is used as the default route. The Ethernet default gateway has to be disabled by setting the parameter *Use Ethernet as default route* to “No” in **Network/Ethernet**.

6.4.3 Dial-in

The device's PPP dial-in interface is configured via the Dial-in command in the Network menu. Clicking this command displays the Dial-in settings in the content area.

Dial-in enabled If enabled, PPP connections can be made to the device (GSM data).

Require authentication (PAP) determines if password authentication is used for incoming data calls.

Required username determines the PAP user name.

Required password determines the PAP password used for authentication.

Idle timeout determines the length of idle time before the PPP connection is terminated.

Local IP address determines the IP address used in the PPP peer.

Peer's IP address determines the IP address used in the PPP peer.

Maximum MTU value determines the maximum transfer unit (MTU) for dial-in connections.

6.4.4 SSH-VPN

The device has a VPN client that can be used with the gateway.

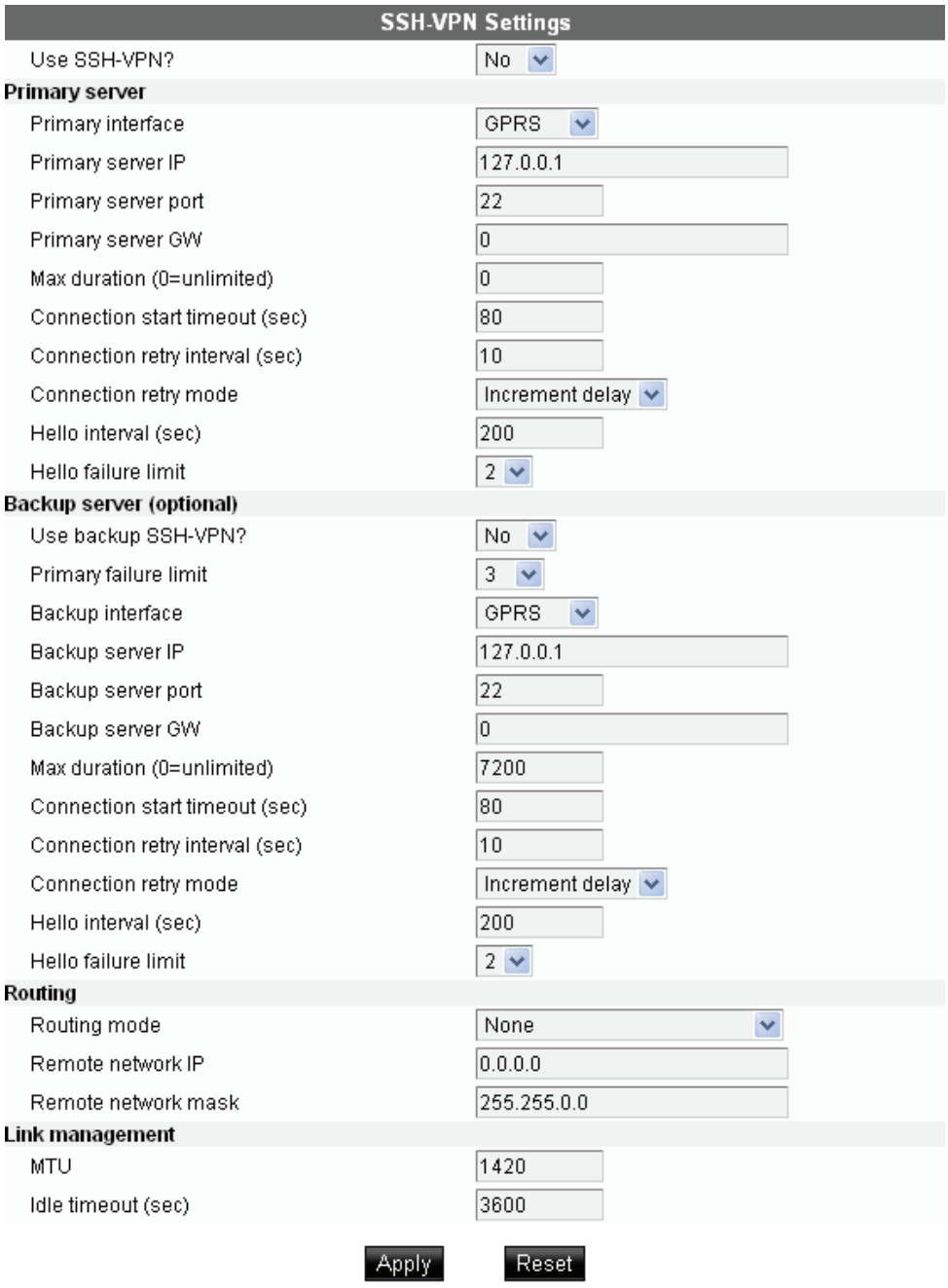

Figure 29: SSH-VPN settings

Primary server

Use SSH-VPN? When set to “Yes”, the device automatically establishes a SSH-VPN connection to the primary gateway.

Primary interface determines the interface used to reach the gateway server.

Primary server IP determines the IP address of the gateway SSH-VPN server.

Primary server port determines the SSH-VPN TCP port on the primary server. The default is 22.

Primary server GW is used if another gateway than the default route is needed to reach the gateway.

Max duration (0=unlimited) determines the maximum duration of the VPN connection. On the primary server, this should be set to zero. With the backup server, the primary server is tried again after this time-out.

Connection start timeout (sec) determines the time to wait until the connection is established.

Connection retry interval (sec) determines the time interval after which the connection is retried.

Connection retry mode increases incrementally the retry interval on each connection attempt. Constant delay always uses the same delay.

Hello interval (sec) determines the Hello packet interval for the VPN. This can be used as a keep-alive message on very critical links.

Hello failure limit determines the number of Hello packets that can be lost before restarting the connection.

Backup server (optional)

Use backup SSH-VPN? When set to “Yes”, the device tries to establish a VPN connection to back up the gateway, if the primary gateway cannot be reached.

Primary failure limit determines the number of times the primary must not be reached before changing to the secondary. The other parameters are same as in the primary server. The duration of the connection can be set, for example, to 3600 seconds, so after one hour's connection time to the backup server, the system tries to reach the secondary gateway.

Routing

Routing mode has three modes.

- Tunnel the following network. This adds the “Remote network IP” to be reached via the SSH-VPN. The parameters *Remote network IP* and *Remote network mask* must be set.
- Default route. The VPN interface is used as the default route.
- None. No routing is added when the VPN is established. The VPN peer IPs can be used for communications.

Remote network IP determines the remote network IP behind the VPN on the gateway side that the device needs to reach.

Remote network mask determines the network mask for the remote network IP.

Link management

MTU determines the maximum transfer unit (MTU) for the SSH-VPN interface.

Idle timeout (sec) determines the idle time-out for the SSH-VPN interface. If the time-out is reached, the VPN connection is restarted.

6.4.5 L2TP-VPN

The device has an L2TP client that can be used with an L2TP server.

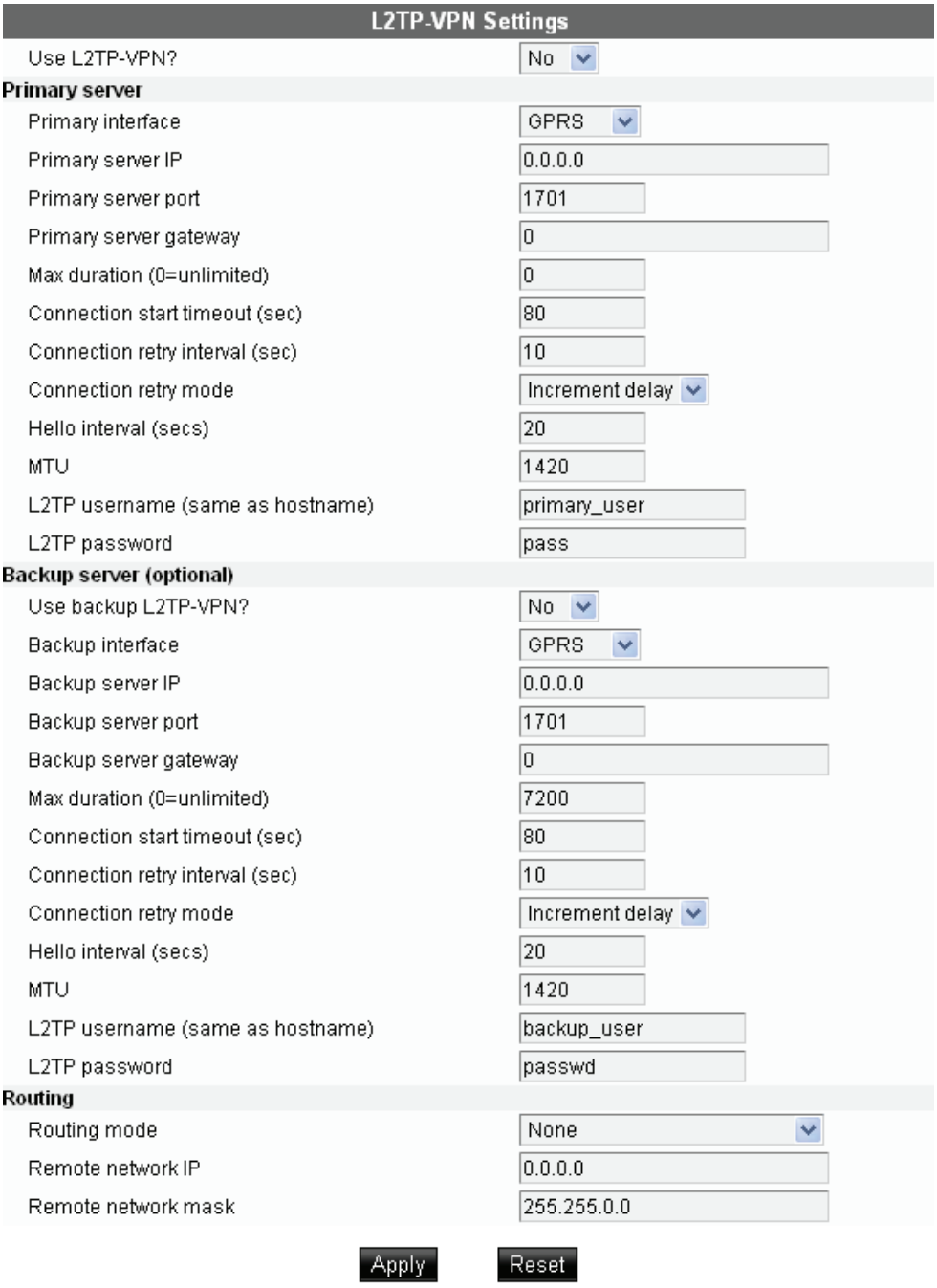

Figure 30: L2TP-VPN Settings

If the primary server cannot be reached, the L2TP VPN connection is established with a backup server.

Primary server

Use L2TP-VPN? When set to “Yes”, the device establishes an L2TP VPN connection with the primary gateway.

Primary interface determines the interface used to reach the gateway server.

Primary server IP determines the IP address of the gateway L2TP server.

Primary server port determines the L2TP VPN server port (UDP, default 1701).

Primary server gateway is used if another gateway than the default route is needed to reach the gateway.

Max duration (0=unlimited) determines the maximum duration of the VPN connection. On the primary server, this should be set to zero.

Hello interval (secs) determines the Hello interval for keeping the connection alive. The default is 20 seconds.

MTU determines the maximum transfer unit for the L2TP interface.

L2TP username (usually hostname) determines the user name for authentication.

L2TP password determines the L2TP password for authentication.

Routing

Routing mode is used if routing is needed with the L2TP interface. The parameters are the same as for SSH-VPN.

6.4.6 GRE

The GRE tunnel command in the Network menu is used to configure the GRE settings.

GRE tunnel enabled When set to “Yes”, the device establishes the GRE connection automatically.

Interface determines the interface used for the GRE server.

GRE server IP determines the IP address of the GRE server.

Gw to GRE server (Ethernet mode) (Optional) is used if another gateway than the default route is needed for the GRE server.

Local GRE interface IP (usually eth0 IP) determines the local IP address used in the GRE tunnel.

Remote GRE interface IP (Optional) determines the remote IP address used in the GRE tunnel.

TTL value determines the time to live value for the interface.

Checksum (Optional) determines the checksum value.

Incoming key determines the authentication key.

Outgoing key (Optional) determines the outgoing key for the server.

The optional routing parameters *Routing mode*, *Remote network* and *Remote network mask* are the same as in SSH-VPN and L2TP.

6.4.7 Monitor

The monitor settings are used for checking the GPRS and VPN connections. If the connection to the selected IP address is lost, the connection is restarted. The monitor uses ICMP echo (ping) packets to check the connection. The monitor also keeps the connection alive, so that idle time-out does not end the connection.

Figure 31: Monitor settings

ICMP Echo sending is used to enable the monitor. The monitor must always be enabled for the correct IP. When VPN is used, the remote VPN peer IP address (or other IP address reached only via VPN) must be used for checking the connection.

Interval (sec) determines how often the connection is checked by sending ICMP echo packets. The interval should be smaller than the GPRS idle time-out (typically maximum 2/3 of GPRS idle time-out) for uninterrupted communication.

Reply timeout (secs) determines the waiting time for reply packets.

Retries determines the number of retries before the connection is restarted.

Target IP address determines the host IP address to which the ICMP echo packets are sent.

Secondary target IP address determines the secondary host IP address to which ICMP echo packets are sent if sending to the primary target host IP address fails.

6.4.8 Routing

The routing settings of the device can be configured in the Routing menu.

6.4.8.1 S-NAT

These parameters are used to configure the S-NAT settings. When enabled, the private IP address used in the LAN is changed to the GPRS interface IP address.

From IP determines that only S-NAT connections from the defined IP address are allowed. If defined with wildcard (0/0), all IP addresses are handled in the same way.

6.4.8.2 D-NAT

These parameters are used to configure the D-NAT settings. When enabled, packets coming to the defined GPRS interface port are forwarded to the local IP address.

Source IP determines the D-NAT connections coming from the IP address. If defined with wildcard (0/0), all IP addresses are handled in the same way.

Protocol determines the protocol that is forwarded. If the value “Any” is selected, other parameters are ignored.

Dest.port determines the GPRS interface that is forwarded to the local Ethernet.

Redirect to IP determines the IP address used in the forwarding.

Redir. port determines the port used in the forwarding.

6.4.8.3 DNS Update

The DNS Update parameters are used to configure the dynamic DNS. The device can report its dynamic IP address to a DNS server. These settings are RFC2136 compliant, for example, for BIND DNS server.

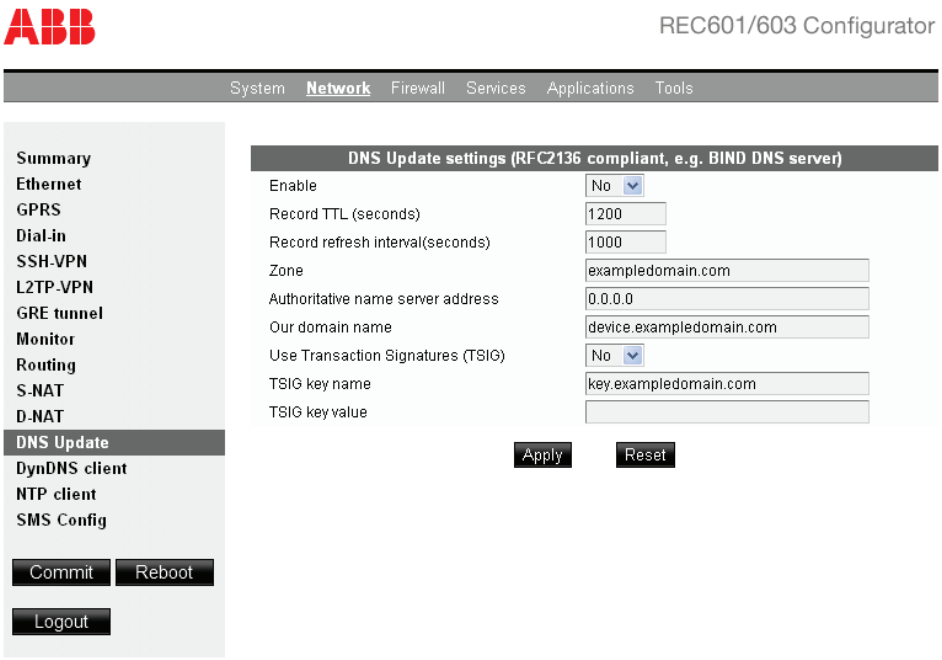

Figure 32: DNS Update settings

Authoritative name server determines the server that must be configured to accept the incoming DNS update messages, for example, the company's own DNS server, such as ISC BIND.

TSIG key name TSIG keys can be used for better security in DNS updates.

6.4.8.4 DynDNS client

These settings can be used with the DynDNS service available at http://www.dyndns.org.

The public IP address is required for GPRS and the user account from the DynDNS service operator.

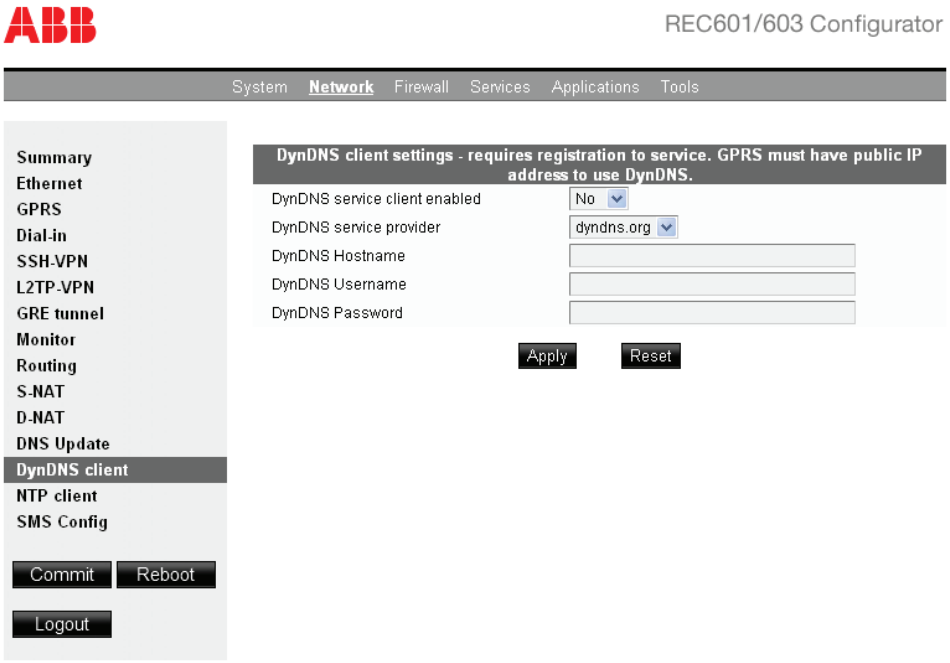

Figure 33: DynDNS client settings

DynDNS service client enabled disables or enables the DNS name update.

DynDNS service provider determines the service provider. Only dyndsn.org is currently supported.

DynDNS Hostname determines the service provider account host name.

DynDNS Username determines the service provider user name.

DynDNS Password determines the service provider password.

6.4.8.5 NTP client

The NTP client settings can be used to update the real-time clock of the device using the NTP protocol.

NTP server When enabled, the device updates the system clock from the NTP server.

Query interval determines the time interval for an NTP query.

Minimum time difference (seconds) determines the minimum time difference when the clock is updated.

Maximum time difference determines the maximum time difference between local system time and NTP time when the clock is updated.

Time adjust mode adds or subtracts time from the received NTP value.

Time adjust value (minutes) determines the value to add or substract from the NTP value.

6.4.8.6 SMS Config

The SMS Config settings can be used to monitor the device status and to issue simple commands remotely via SMS messages.

Enabled enables or disables the SMS configuration.

Get commands

Access determines if the get commands are allowed for everybody or only for the defined phone, or if they are disabled.

Allowed phone determines the phone number for get commands.

Require password determines if the system password is required for get commands.

Set commands

Access determines if the set commands are allowed for everybody or only for the defined phone, or if they are disabled.

Allowed phone determines the phone number for set commands.

Require password determines if the system password is required for set commands.

Allow execute commands determines if execute commands are allowed to be run on the device.

Other

Reply error to unknown commands If set to “No”, incorrect commands are silently disregarded. If set to “Yes“ the device sends an error message via SMS.

Reply error to unauthorized commands If set to “No“ unauthorized commands are silently disregarded. If set to “Yes”, the device sends an error message via SMS.

Factory reset command (8 chars min) resets the device to the factory settings. Does not require a system password. After an SMS command is sent, the factory settings are applied. The password is also set back to the factory default.

6.5 Firewall menu

The Firewall menu is used to configure the device's built-in firewall. The firewall can be disabled or enabled and separate rules may be created for the GPRS to the device, GRPS to the LAN, and LAN to the GPRS configurations.

Figure 34: GPRS to device firewall settings

The firewall rules are processed from top to bottom. If strict rules are wanted, the last rule should be DROP. The parameter *From IP* can be used to limit access based on the IP address. For example, “192.168.100.0/24” would limit access to packets coming from the 192.168.100.0 network only.

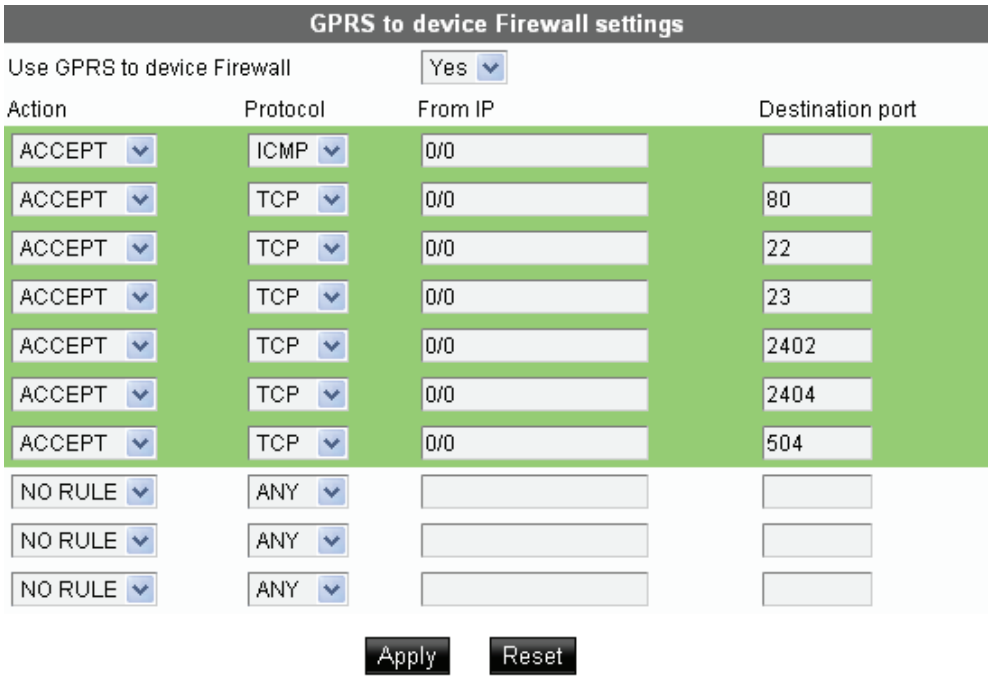

Figure 35: Example rules of the GPRS settings

These example rules would allow incoming connection to the GPRS interface: ICMP, Web (TCP port 80) and Telnet (TCP port 22) from any IP access.

6.6 Service menu

The Service menu contains the settings for the WWW, SSH, Telnet and DHCP servers.

6.6.1 WWW

These settings are used to enable or disable the WWW server.

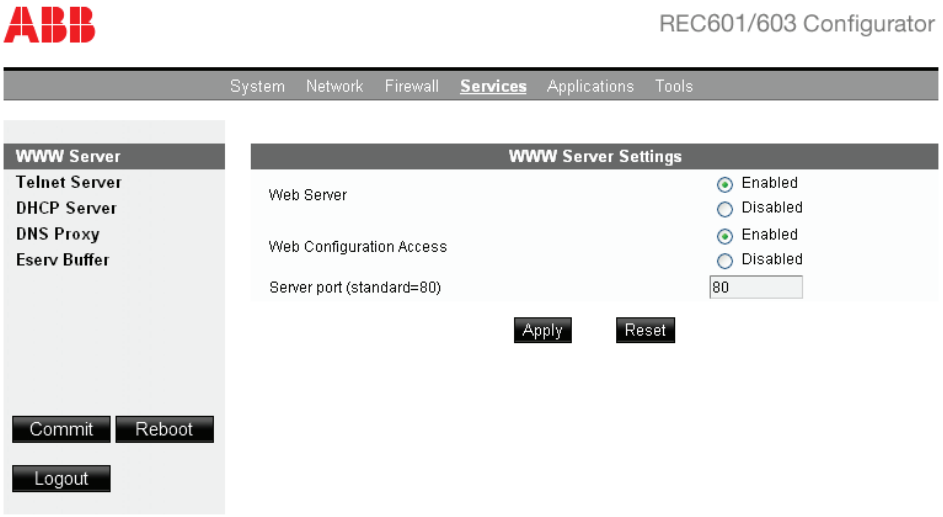

Figure 36: WWW server settings

Web Server enables or disables the WWW server.

Web Configuration Access enables or disables the Web configuration access.

If the Web access settings are disabled, the Web configurator stops functioning and it must be enabled via the console.

6.6.2 SSH

The SSH server is available in the device for secure connections. The configuration file is located at `/etc/sshd_config`. It can be edited manually.

SSH Server enables or disables the SSH server.

6.6.3 Telnet

A Telnet server can be used to make terminal connections to the device shell. A more secure way of performing remote management is based on the SSH.

Telnet server enables or disables the Telnet server.

6.6.4 DHCP

The DHCP server listens to broadcast DHCP queries and assigns an IP address for the host from the configured pool. If needed, the device can act as a DHCP server. This is suitable for small remote networks that have, for example, few laptops connected to the device via an Ethernet hub or a switch.

Configuring the DHCP server in an erroneous way may cause the network to function badly or may prevent functioning altogether. Consult the network administrator for the necessary information before setting up the service.

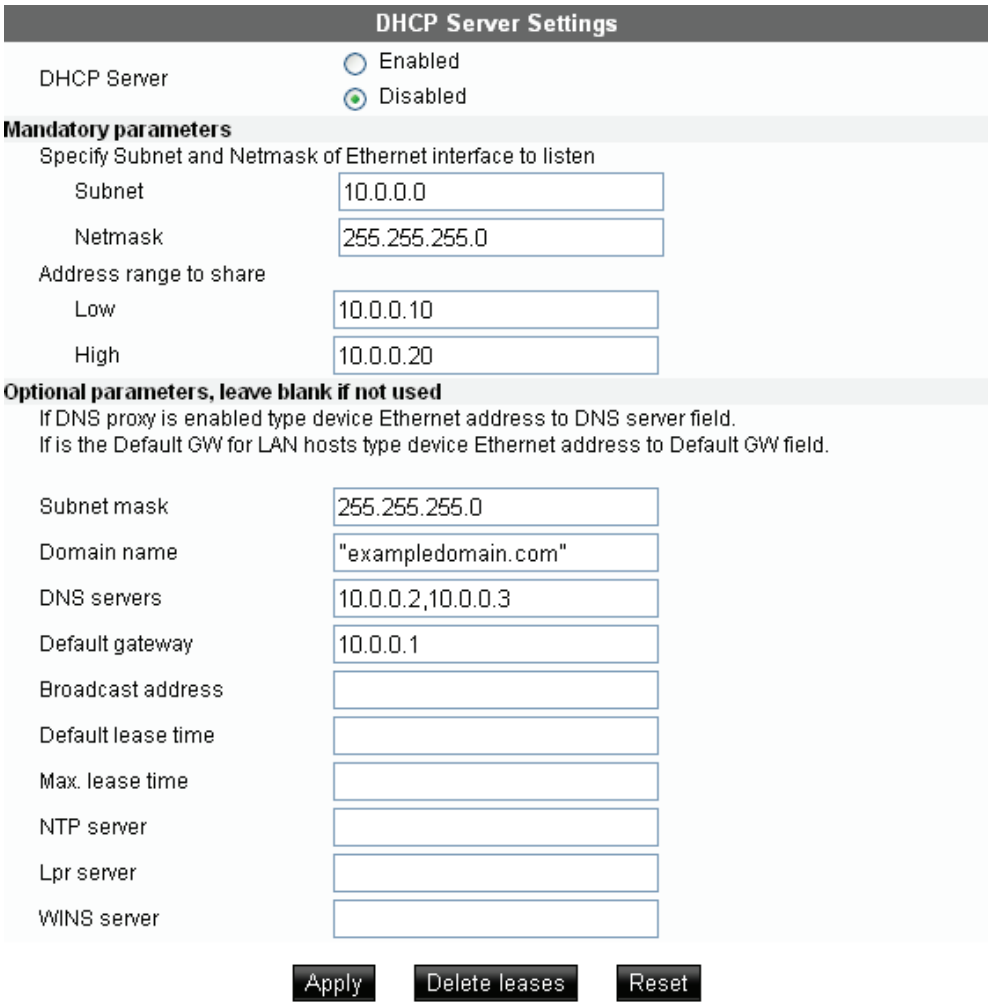

Figure 37: DHCP Server settings

DNS Proxy enables computers connected to the device's Ethernet interface to use the device as a DNS server. The device forwards DNS queries to the correct DSN server and there is no need to change the local computer's DNS settings. This can be used with the GPRS settings (**Network/GPRS**) parameter *DNS servers: From GPRS network*.

DNS Proxy/Forwarder enables the use of the device as a DNS server for local computers.

SNMP Agent enables the use of the SNMP Agent. The device supports the MIB-II SNMP Agent.

SNMP agent (SNMP Set/Get) enables or disables the SNMP agent.

Read only SNMP community determines that the community string is read-only.

Read and write SNMP community determines that both read and write properties are enabled for the community string.

Server port (standard=161) determines the SNMP Agent listening port (UDP).

Bind to interface determines that the interface is used as a source address.

6.7 Application menu

The Application menu contains the serial device server application. With this application, serial devices can be connected to the gateway and used over the TCP/IP network.

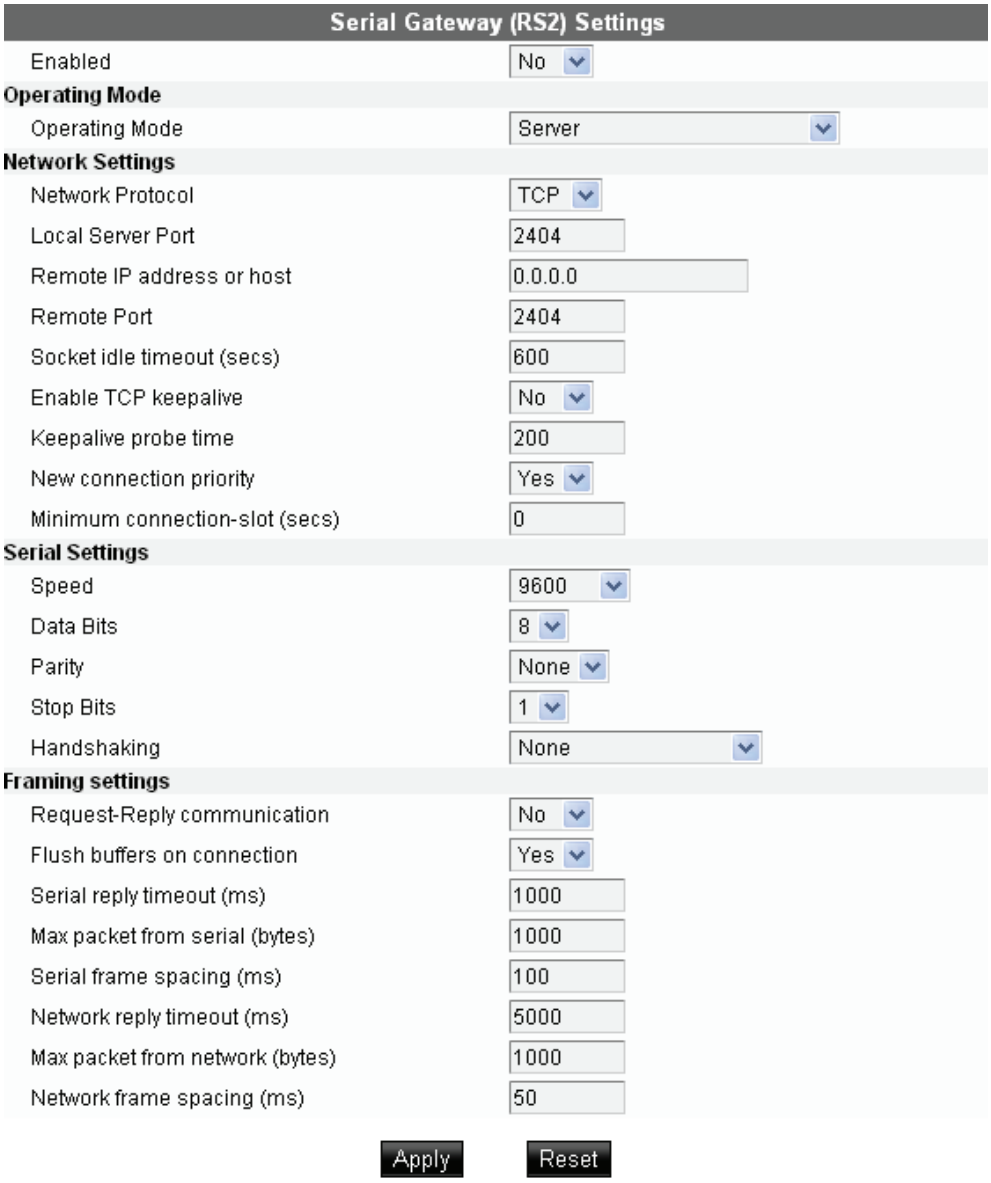

Figure 38: Serial Gateway settings

The serial gateway can be enabled from the Serial GW menu. When enabled with the *Server* operating mode, TCP/IP or UDP connections can be made to the device's local server port. In the *Client* operation mode, the gateway sends the received serial data via TCP/IP to the host (remote IP address or host) or to the remote host (remote port).

The IEC 60870-5-104 serial device can be connected to the RS1 or RS2 port. The RS2 serial port can be used either as an RS-232 or an RS-485 type port (IEC 60870-5-104). To enable the serial gateway on the console RS1 port, the console switch has to be set to “0”.

For example, in the *Server* operating mode a device connected to a gateway application serial port can be accessed with Telnet using `telnet<device IP address>2404`.

6.8 Tools menu

The Tools menu gives access to Web-based tools used for troubleshooting the device. It is possible to execute simple shell commands through the WHMI.

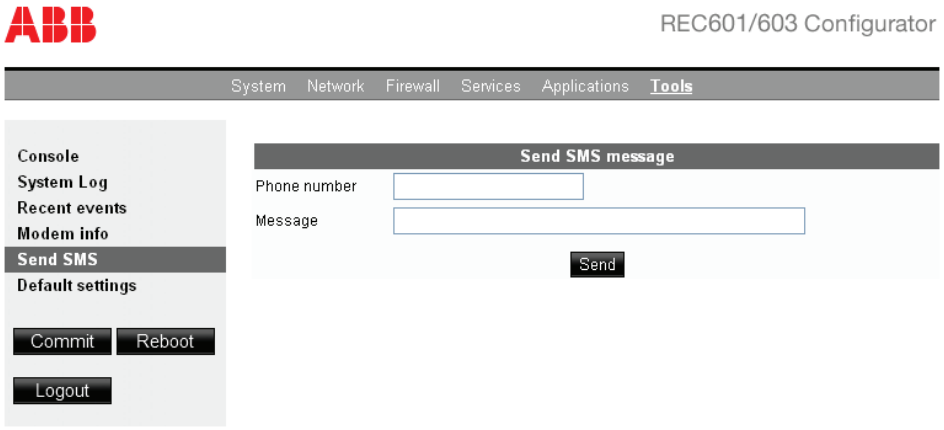

Figure 39: Tools menu

Console

The console settings can be used for running commands over the WHMI.

Example commands

```
ping –c 10 172.30.30.1
```

```
firmware
```

System Log and Recent events

The device's system log can be viewed as a system log and a recent events log. When support for the device is needed, for example in a fault situation, the log files can be copy-pasted from the system log.

Modem info

Displays information about the GPRS and GSM status. Also the signal strength is shown here. This can be used to solve GPRS connection problems on site.

Send SMS

The device can be used for sending test SMS messages. This is useful, for example, for checking the phone number of the current SIM card.

Default settings

The device can be reset to the factory default settings. When resetting to the factory settings, the network settings are excluded.

6.9 IEC-104 application settings

The IEC 60870-5-104 and IEC 60870-5-101 protocols share the same ASDU level messaging but differ on the link level. IEC 60870-5-104 is intended for packet-switched TCP/IP communication and IEC 60870-5-101 for serial communication. By using the device's IEC 60870-5-104 gateway, the IEC 60870-5-101 slaves, for example, RTUs, can be connected to an IEC 60870-5-104 master (for example, SCADA). The device requests events from the IEC 60870-5-101 slave locally and sends them to the IEC 60870-5-104 master. This eliminates the need to continuously poll the data remotely and also reduces the communication costs on a pay-per-use GPRS network. This approach also eliminates the IEC 60870-5-101 parameter problems caused by variable round-trip delays on the GPRS network and makes the information exchange faster and more reliable.

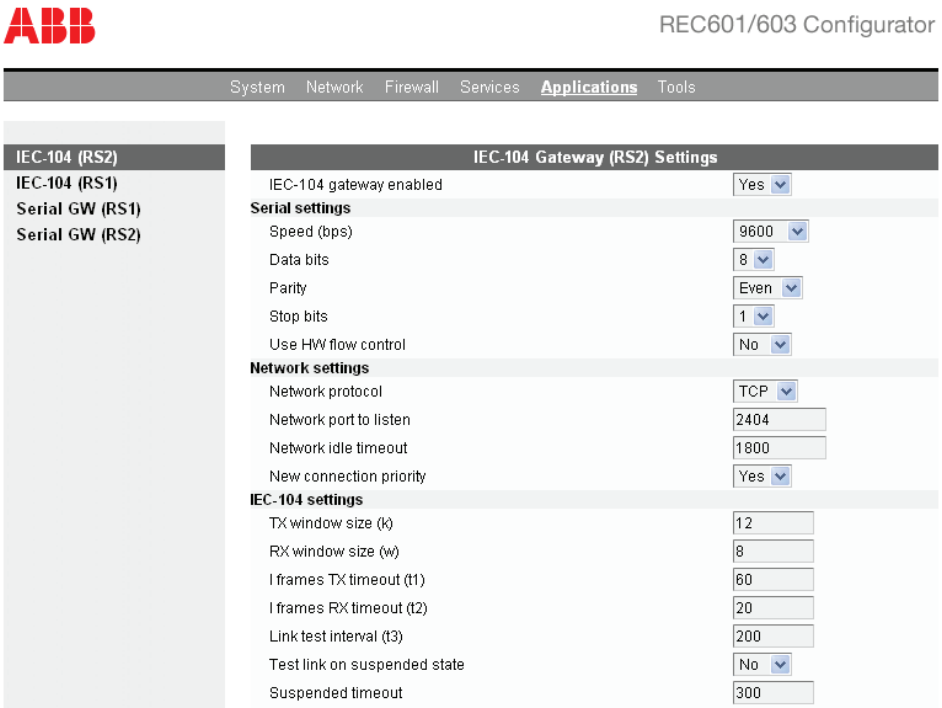

Figure 40: IEC-104 Application Settings

6.9.1 General settings

IEC-104 gateway enabled enables or disables the IEC 60870-5-104 to IEC 60870-5-101 gateway.

Table 23: IEC-104 gateway enabled

Description	Value
Type	Boolean
Units	N/A
Value range	No, Yes
Note	-

6.9.2 Serial settings

The serial settings define the physical serial communication properties between the device and an IEC 60870-5-101 slave. The selection between RS-232, RS-422 and RS-485 is made with the DIP switches located below the RS2 serial port.

The IEC-101 devices can be connected to the serial ports RS1 or RS2 (single device per port). When the serial port RS1 is used, the console switch below the RS1 should be in the “Data” position.

The settings for the IEC-104 gateway applications are available on WEB user interface applications IEC-104 (RS1) and IEC-104 (RS2).

Figure 41: Serial settings

Speed (bps) defines the IEC 60870-5-101 serial communication speed (bps).

Table 24: IEC 60870-5-101 serial communication speed (bps)

Description	Value
Type	Serial speed
Units	Bits per second
Value range	1200, 2400, 4800, 9600, 19200, 38400, 57600
Note	-

Data bits defines the number of data bits used in the IEC-101 serial communication.

Table 25: Number of data bits used in the IEC 60870-5-101 serial communication

Description	Value
Type	Serial data bits
Units	Bits
Value range	5, 6, 7, 8
Note	-

Parity defines the parity method used in the IEC 60870-5-101 serial communication.

Table 26: Parity method used in the IEC 60870-5-101 serial communication

Description	Value
Type	Serial data parity
Units	Bits
Value range	None, Even, Odd
Note	-

Stop bits defines the number of stop bits used in the IEC 60870-5-101 serial communication.

Table 27: Number of stop bits used in the IEC 60870-5-101 serial communication

Description	Value
Type	Serial data stop bits
Units	Bits
Value range	1, 2
Note	-

Use HW flow control defines if the HW flow control mechanism is used.

Table 28: HW flow control mechanism (RTS/CTS) in the IEC 60870-5-101 serial communication

Description	Value
Type	Boolean
Units	N/A
Value range	Yes, No
Note	The HW handshaking is available only in the RS-232 mode

6.9.3 Network settings

The Network settings define the general TCP/IP networking properties between the device and the IEC 60870-5-104 master.

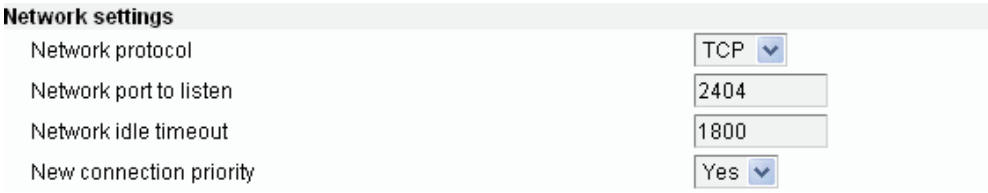

Figure 42: Network settings

Network protocol defines the network transmission layer protocol (either TCP or UDP) used with IEC 60870-5-104 network communication. The IEC 60870-5-104 standard protocol uses TCP, but for reliable slow-speed packet-switched networks the UDP protocol can be used to minimize the packets transmitted over network.

Table 29: Network protocol in IEC 60870-5-104 communication

Description	Value
Type	Network transmission layer protocol
Units	N/A
Value range	UDP, TCP
Note	The IEC 60870-5-104 standard specifies only the TCP protocol

Network port to listen defines the network port to listen for incoming IEC 60870-5-104 connections.

Table 30: TCP or UDP port to listen for incoming IEC 60870-5-104 connections

Description	Value
Type	Network port
Units	Port number
Value range	0...65000
Note	The IEC 60870-5-104 standard specifies TCP port 2404

Network idle timeout defines the idle time-out of the network connection in seconds. If there is no network data received during the specified interval, the device closes the connection. This parameter is required to detect partially closed connections and to release the resources for new connections, especially if the *New connection priority* parameter is disabled. The value “0” disables the network idle time-out detection.

Table 31: Network idle time-out for IEC 60870-5-104 connections

Description	Value
Type	Time-out
Units	Seconds
Value range	0...65000
Note	The network idle time-out must be longer than the IEC 60870-5-104 link test interval (t3)

New connection priority defines the action when a new connection request arrives while a connection is already active. If the set value is ”No”, the new connection is rejected. If the set value is ”Yes”, the present connection is terminated and the new connection is accepted.

Table 32: New connection priority for IEC 60870-5-104 connections

Description	Value
Type	Boolean
Units	N/A
Value range	No, Yes
Note	This value must be set to “Yes” in normal configurations with only one IEC 60870-5-104 master

6.9.4 IEC-104 settings

The IEC-104 settings define the properties of the IEC 60870-5-104 link layer and application layer parameters as described in the IEC 60870-5-104 standard. The IEC 60870-5-104 communication is carried out between the device and the IEC 60870-5-104 master over the TCP/IP network.

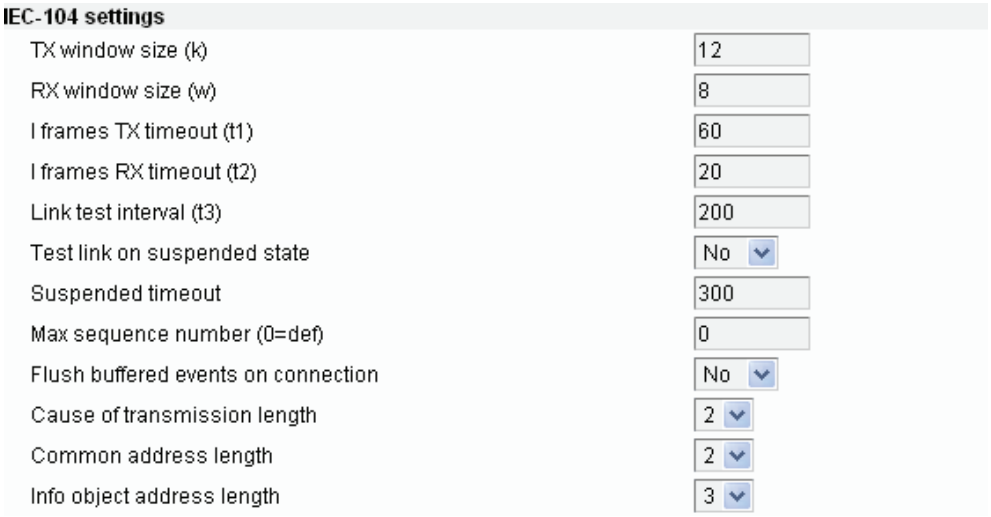

Figure 43: IEC-104 Settings

TX window size (k) defines the maximum number of I format APDUs the device may send before requiring the IEC 60870-5-104 master to acknowledge them. If there are unacknowledged “k” size frames sent, the device stops polling the IEC 60870-5-101 slave for events until acknowledgement is received.

Table 33: IEC 60870-5-104 TX window size (k)

Description	Value
Type	Window size
Units	Packets
Value range	1...20
Note	The value “k” must always be less than the maximum sequence number defined below. The IEC 60870-5-104 standard suggests k = 12.

RX window size (w) defines the maximum number of I format APDUs the device may receive before sending an acknowledgement to the IEC 60870-5-104 master.

Table 34: IEC 60870-5-104 RX window size (w)

Description	Value
Type	Window size
Units	Packets
Valule range	1...20
Note	The value “w” should not exceed two-thirds of the TX window size “k”. The IEC 60870-5-104 standard suggests w = 8.

I frames TX timeout (t1) defines the time-out in seconds the device waits for an acknowledgement from the IEC 60870-5-104 master after sending the last I format APDU or a control frame, such as a link test. If no acknowledgement is received during the defined time, the device closes the network connection and the IEC 60870-5-101 link.

Table 35: IEC 60870-5-104 I frames TX time-out (t1)

Description	Value
Type	Timeout
Units	Seconds
Value range	1...255
Note	The value ”t1” must be longer than the network round-trip time. The IEC 60870-5-104 standard suggests t1 = 15 seconds.

I frames RX timeout (t2) defines the time-out in seconds from the last received I format APDU before sending an acknowledgement.

Table 36: IEC 60870-5-104 I frames RX time-out (t2)

Description	Value
Type	Timeout
Units	Seconds
Value range	1...255
Note	The value “t2” must be smaller than “t1”. The IEC 60870-5-104 standard suggests t2 = 10 seconds.

Link test interval (t3) defines the interval in seconds how often the IEC 60870-5-104 link is tested if there is no other activity.

Table 37: IEC 60870-5-104 link test interval (t3)

Description	Value
Type	Timeout
Units	Seconds
Value range	1...65000
Note	This parameter must be adjusted according to the criticality of the link. The IEC 60870-5-104 standard suggests 20 seconds but the practical value may be substantially longer for pay-per-use GPRS connections.

Suspended timeout defines the time in seconds how long a connected IEC 60870-5-104 link can be in the suspended state (STOPD) before the device closes the connection.

Table 38: IEC 60870-5-104 suspended time-out

Description	Value
Type	Timeout
Units	Seconds
Value range	1...65000
Note	Using this parameter makes it easier to detect partially closed network connections, especially in the UDP mode

Max sequence number defines the maximum sequence number used in IEC 60870-5-104 communication. The value “0” selects the standard value “32767”.

Table 39: Max sequence number

Description	Value
Type	Sequence number
Units	Packets
Value range	1...32767
Note	0 = 32767 as suggested by the IEC 60870-5-104 standard

Cause of transmission length defines the length of the IEC 60870-5-104 Cause of transmission ASDU header field in bytes.

Table 40: IEC 60870-5-104 ASDU cause of transmission length

Description	Value
Type	Field length
Units	Bytes
Value range	1...3
Note	The IEC 60870-5-104 standard defines the value “2”

Common address length defines the length of the IEC 60870-5-104 Common address ASDU header field in bytes.

Table 41: IEC 60870-5-104 ASDU common address length

Description	Value
Type	Field length
Units	Bytes
Value range	1...3
Note	The IEC 60870-5-104 standard defines the value “2”

Info object address length defines the length of the IEC 60870-5-104 Information object address ASDU header field in bytes.

Table 42: IEC 60870-5-104 ASDU information object address length

Description	Value
Type	Field length
Units	Bytes
Value range	1...3
Note	The IEC 60870-5-104 standard defines the value “3”

6.9.5 IEC-101 settings

The IEC-101 settings define the properties of the IEC 60870-5-101 link layer and application layer parameters as described in the IEC 60870-5-101 standard. The communication is carried out between the device and the IEC 60870-5-101 slave. Only unbalanced IEC 60870-5-101 communication is supported.

Figure 44: IEC-101 settings

Slave link address defines the link-level address of the IEC 60870-5-101 slave.

Table 43: IEC 60870-5-101 slave link address

Description	Value
Type	Link address
Units	N/A
Value range	1...65000
Note	The link-level address of the IEC 60870-5-101 slave

Link address field length defines the length of the IEC 60870-5-101 link-level address field in bytes.

Table 44: IEC 60870-5-101 slave link address field length

Description	Value
Type	Field length
Units	Bytes
Value range	1, 2
Note	The link-level address of the IEC 60870-5-101 slave

Event poll interval defines the IEC 60870-5-101 event-polling interval in 0.1-second increments (class 1 or 2 poll).

Table 45: IEC 60870-5-101 event poll interval

Description	Value
Type	Interval
Units	0.1 seconds
Value range	1...65000
Note	The events are polled only when the IEC 60870-5-104 connection is active

Link test interval defines the IEC 60870-5-101 link test interval in 0.1-second increments. The link test is performed if there is no other activity.

Table 46: IEC 60870-5-101 link test interval

Description	Value
Type	Interval
Units	0.1 seconds
Value range	1...65000
Note	The link test is performed if there is no other activity during the defined interval

Keep link open defines that the IEC 60870-5-101 link is always kept open even when there is no active IEC 60870-5-104 connection. If this parameter is enabled, the device sends link test frames and restarts the IEC 60870-5-101 link if the test fails. The events are still not polled before the IEC 60870-5-104 connection is active.

Table 47: IEC 60870-5-101 keep link open

Description	Value
Type	Boolean
Units	N/A
Value range	No, Yes
Note	Some IEC 60870-5-101 slaves require the link to be continuously open to operate

Reply header timeout defines the time-out the device waits for the reply to start from the IEC 60870-5-101 slave after a command or request.

Table 48: IEC 60870-5-101 reply start time-out

Description	Value
Type	Timeout
Units	Milliseconds
Value range	1...65000
Note	-

Reply end timeout defines the maximum duration of the IEC 60870-5-101 slave response.

Table 49: IEC 60870-5-101 reply end time-out

Description	Value
Type	Timeout
Units	Seconds
Value range	1...65000
Note	-

Retry limit defines the number of retries sent to an IEC 60870-5-101 slave in case of no reply. If no reply is received after this limit, the device closes the IEC 60870-5-101 and IEC 60870-5-104 connections.

Table 50: IEC 60870-5-101 retry limit

Description	Value
Type	Retry limit
Units	Retries
Value range	0...65000
Note	-

Cause of transmission length defines the length of the IEC 60870-5-101 Cause of transmission ASDU header field in bytes.

Table 51: IEC 60870-5-101 ASDU cause of transmission length

Description	Value
Type	Field length
Units	Bytes
Value range	1...3
Note	The IEC 60870-5-101 standard defines the value “1”

Common address length defines the length of the IEC 60870-5-101 Common address ASDU header field in bytes.

Table 52: IEC 60870-5-101 ASDU common address length

Description	Value
Type	Field length
Units	Bytes
Value range	1...3
Note	The IEC 60870-5-101 standard defines the value “2”

Info object address length defines the length of the IEC 60870-5-101 Information object address ASDU header field in bytes.

Table 53: IEC 60870-5-101 ASDU information object address length

Description	Value
Type	Field length
Units	Bytes
Value range	1...3
Note	The IEC 60870-5-101 standard defines the value “2”

6.9.6 ASDU converter

The ASDU converter can be used to convert the ASDU header field lengths between the IEC 60870-5-101 and IEC 60870-5-104 protocols.

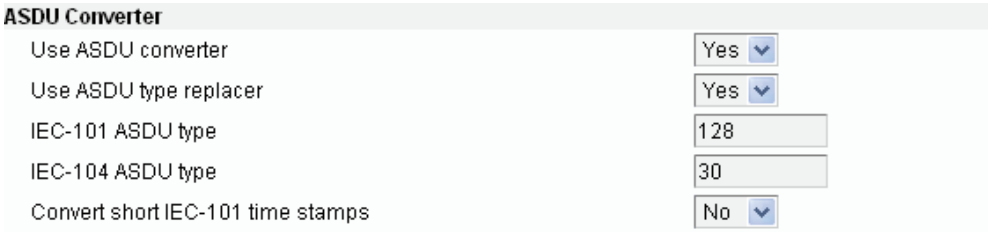

Figure 45: ASDU Converter

Use ASDU converter defines if the ASDU header field length conversion is in use. This parameter must be enabled if the ASDU header field lengths differ between IEC 60870-5-101 and IEC 60870-5-104.

Table 54: Use ASDU converter

Description	Value
Type	Boolean
Units	N/A
Value range	No, Yes
Note	The information in the field must fit in the shorter one of the two. It is not possible to convert, for example, the value “12000” to a one byte field.

Use ASDU type replacer can be used to convert an ASDU type (original type) to another type (applied type), for example, in cases when the IEC implementation differs between the master and the slaves.

Table 55: Use ASDU type replacer

Description	Value
Type	Boolean
Units	N/A
Value range	No, Yes
Note	-

Original type defines the original ASDU type searched by the ASDU type replacer.

Applied type defines the new ASDU that replaces the original type.

6.9.7 Packet collector

The packet collector can be used to collect a number of IEC 60870-5-101 messages or events to a single network packet instead of sending every message separately. This is useful in a slow packet-switched communication network for speeding up the general interrogation response.

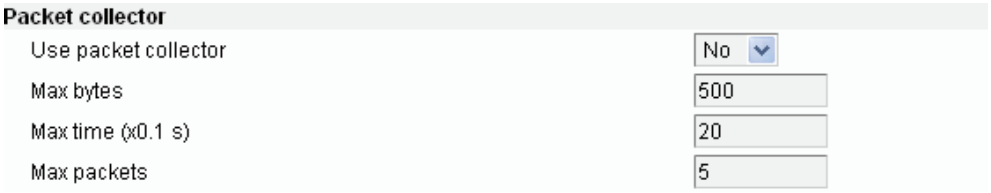

Figure 46: Packet collector

Use packet collector defines if the packet collector is in use.

Table 56: Use packet collector

Description	Value
Type	Boolean
Units	N/A
Value range	No, Yes
Note	-

Max bytes defines the number of maximum bytes for the packet collector. Before a new packet is inserted into the packet collector buffer, the amount of bytes is checked. If the number of bytes in the new packet exceeds the value defined by this parameter, the old content is sent to the network before inserting the new one.

Table 57: Maximum collected bytes

Description	Value
Type	Packet size
Units	Bytes
Value range	1...1500
Note	The value should be smaller than the MTU/MRU of the network used

Max time defines the maximum time collected for the packet collector in 0.1 second increments. If there has been data in the packet collector for longer than the value defined by this parameter, the data is sent to the network.

Table 58: Maximum collected time

Description	Value
Type	Timeout
Units	0.1 seconds
Value range	1...255
Note	The value must be smaller than t1

Max packets defines the maximum amount of IEC 60870-5-101 packets stored into the packet collector before sending the data to the network.

Table 59: Maximum collected packets

Description	Value
Type	Packet count
Units	Packets
Value range	1...255
Note	-

6.9.8 Other settings

Write syslog defines if error messages are stored to the system log file.

Table 60: Write system log

Description	Value
Type	Boolean
Units	N/A
Value range	No, Yes
Note	The system log is available by using the WHMI

6.10 Support for remote monitoring

The device has a Patrol client to communicate with Viola Systems M2M server to send communication diagnostics. Viola Patrol is an application within the M2M gateway solution. Patrol functionality offers a graphical user interface for monitoring the remote devices. The Patrol can be used to see the connection quality or locate faults. For more information on configuring the Patrol functionality, see M2M gateway documentation.

Section 7 Technical data

Table 61: Dimensions

Description	Value
Width x Height x Depth	150 x 177 x 135 mm (without antenna)

Table 62: Power Supply

Description	Value
Input voltage	85...200 VDC/ 90...264 VAC
Frequency range	45...65 Hz
Input current, 100% load, 230 VAC	0.8 A
Efficiency, typical (230 VAC, 100% load)	>83%
Isolation	Input / ground 1500 VAC RMS 50 Hz 1 min Input / output 3000 VAC RMS 50 Hz 1 min Output / ground 500 VDC
Inrush current 25C°, 230 VAC	<25 A <5 ms
Input fuse	T3.15 A high breaking
Overvoltage transient protection	VDR 275 VAC 72 J
Holdup time (230 V, 100% load)	>50 ms
Power consumption	10 W (not charging) … 60 W (full charging)

Table 63: Battery recommendations

Description	Yasa NP 17-12	Yasa NPL 24-12
Rated voltage	12 V	12 V
Capacity	17 Ah	24 Ah long life
Weight	6.1 kg	9 kg
Size (LxWxH)	181 x 76 x 167 mm	166 x 175 x 125 mm

Table 64: Supply for external devices and input circuits (X2.1 pin 6)

Description	Value
Output voltage	21...29 V
Output current	1 A continuous, 3 A peak
Output overvoltage protection level	30.5 V

Table 65: Temperature-compensated charger for batteries

Description	Value
Rated charging voltage	27.4 V at 20 °C
Output power	60 W
Fuse	4 A
Temperature compensation	-40 mV/°C
Output overvoltage protection level	30.5 V

Table 66: Hardware

Description		Value
Processor Environment	Processor	32 bit RISC
	Memory	8 MB FLASH
		32 MB SDRAM
Other	Sensor	Temperature
	Internal clock	Real time
Approvals		CE
Environmental conditions	Temperature ranges	-40...+70 °C (operation)
		-40...+85 °C (transport and storage)
	Relative Humidity	5 to 85 % RH

Table 67: Software

Description	Value
Network protocols	PPP, IP, ICMP, UDP, TCP, ARP, DNS, DHCP, FTP, TFTP, HTTP, POP3, SMTP
Tunneling (VPN)	SSH-VPN client (requires M2M Gateway)
	L2TP-VPN client (requires M2M Gateway)
	SSH client
Management	WWW, SSH, Telnet and console FTP, TFTP and HTTP software update
Routing and firewall	Static routing, proxy ARP, port forwarding, IP masquerading/NAT, firewall
Serial device connectivity	Device server application (IEC 60870-5-104 GW)
	Simultaneous GPRS, CSD and SMS
	SMS configuration and status reporting
IEC 60870-5-104 and IEC 60870-5-101	IEC 60870-5-104 over TCP or UDP
	IEC 60870-5-101 FT 1.2 framing
	Local IEC 60870-5-101 polling
	ASDU replacer
	Packet compressor

Table 68: Physical interfaces

Description	REC601				REC603			
	Binary		Analog		Binary		Analog	
Inputs/Outputs	I	O	I	NTC	I	O	I	NTC
Physical signals	17	10	2	1	17	10	2	-
Application	**RTU default configuration**							
Disconnector control	-	2	-	-	-	6	-	-
Disconnector status	2	-	-	-	6	-	-	-
Grounding disconnector status	2	-	-	-	6	-	-	-
L/R status	1	-	-	-	3	-	-	-
Load control	-	1	-	-	-	1	-	-
Test load	-	1	-	-	-	1	-	-
Heater	-	1	-	-	-	1	-	-
Load measurement	-	-	1	-	-	-	1	-
Temperature measurement	-	-	-	1	-	-	-	1
General purpose input	12	-	1	-	2	-	1	-
General purpose output	-	5	-	-	-	1	-	-

Table 69: Digital inputs

Description	Value
Number of digital inputs	17
Operating range	18…60 VDC
Current drain	3.5…12.5 mA
Power consumption / input	< 0.8 W
Input polarity	Bipolar
Isolation	3 kV

Table 70: Digital outputs

Description	Value
Number of digital outputs	10
Max system voltage	110 VDC
Continuous carry 30 VDC	1 A
Continuous carry 110 VDC	0.3 A
Contact material	$AgSnO_2$

Table 71: Network interfaces

Description	Value	
Ethernet	10/100 Base-T. Shielded RJ-45	
	1.5 kV isolation transformer	
	Ethernet IEEE 802-3, 802-2	
CSD (GSM data)	Up to 14.4 kbps	
	V.110	
	Non-transparent mode	
	USSD support	
	FME external antenna connector (50Ω) (Stub antenna included)	
GPRS	Bandwidth	Quad band (850/900/1800/1900 MHz)
	Module	Internal module and SIM card socket
	Class	Multi-slot class 20
		Mobile station class B
	Downlink speed	Max. 85.6 kbps
	Uplink speed	Max. 85.6 kbps
	Coding schemes	CS1...4
	Antenna connector	FME (50 Ω)
	Security	Via encrypted VPN
Serial Ports	Serial 1 / Console	RS-232
		IEC 60870-5-101 protocol support
	Serial 2	RS-232/422/485 (selectable)
		IEC 60870-5-101 protocol support

Table 72: Communication protocols

Master protocol	Slave protocol (RS1/RS2)
IEC 60870-5-104	IEC 60870-5-101
	Modbus profile for Kries IKI-50
	Modbus profile for Horstmann Compass B
	Serial gateway[1)]
IEC 60870-5-101	Modbus profile for Kries IKI-50
	Modbus profile for Horstmann Compass B

1) Serial port data stream is sent over TCP/IP

Table 73: Electromagnetic compatibility tests

Description	Type test value	Reference
Electrostatic discharge test:		EN 61000-4-2
• Contact discharge:	4 kV	
• Indirect contact discharge:	4 kV	
Conducted RF Immunity test:		EN 61000-4-6
• 150 kHz...80 MHz	3 V (rms)	
Radiated RF Immunity test:		EN 61000-4-3
• 80...2700 MHz	3 V/m (rms)	
Fast transient disturbance tests:		EN 61000-4-4
• All ports	1 kV	
Surge immunity test:		EN 61000-4-5
• AC power input ports	2 kV, line-to-earth	
	1 kV, line-to-line	
Voltage dips and short interruptions	0 % / 1 cycle	EN 61000-4-11
	40 % / 10 cycles	
	70 % / 25 cycles	
Emission tests:		CISPR 22 (EN 55022), Class B
• Conducted		
0.15...0.50 MHz	< 66 dB(µV) quasi peak	
	< 56 dB(µV) average	
0.5...5 MHz	< 56 dB(µV) quasi peak	
	< 46 dB(µV) average	
5...30 MHz	< 60 dB(µV) quasi peak	
	< 50 dB(µV) average	
• Radiated		
30...230 Mhz	< 35 dB(µV/m) quasi peak,	
	measured at 3 m distance	
230...1000 MHz	< 42 dB(µV/m) quasi peak,	
	measured at 3 m distance	
1000...3000 MHz	< 70 dB(µV/m) quasi peak,	
	< 50 dB(µV/m) average,	
	measured at 3 m distance	
3000...6000 MHz	< 74 dB(µV/m) quasi peak,	
	< 54 dB(µV/m) average,	
	measured at 3 m distance	

Table 74: EMC compliance

Description	Reference
Standard	ETSI EN 301489-1 (V1.8.1 2008-04) IEC 61000-6-1 (Second edition 2005–01) IEC 61000-6-3 (2006–07)

Table 75: RoHS and REACH compliance

Description
Complies with RoHS directive 2002/95/EC
Complies with REACH directive 2006/1907/EC

Section 8 Ordering data

Product label is found on the top of the device and it contains the basic information about the product (for example product name) as well as unique data regarding the unit such as serial number and Ethernet MAC address.

The order number consists of a string of codes generated from the device's hardware and software modules.

Use the ABB Library to access the selection and ordering information and to generate the order number.

Section 9 Appendix 1 Installation and mounting instructions

9.1 Unpacking the device

The device is delivered in a package containing the device itself, a short antenna, an NTC thermistor sensor cable and four connectors. Accessories such as null-modem cables, hall-effect current transducers, test load resistors and roof antennas can be ordered separately.

1. Remove the transport packing carefully without force.

   

   All packaging materials are recyclable. Follow the environmental regulations regarding the disposal of materials.

2. Examine the delivered products to ensure that they were not damaged during the transport. If any of the items is missing or damaged, inform the nearest ABB office or representative. ABB should be notified immediately if there are any discrepancies in relation to the delivery documents.

   

   Handle the device carefully before installation on site.

9.2 Installing the device

- Install the device horizontally on a flat surface on a desk or on a rack.
- As the device has the GPRS option, consider the high-frequency radio waves it uses for data transmission and choose the installation site accordingly.
  - If the device with antenna is mounted directly to the antenna connector, avoid placing the device where nearby obstacles might disturb the radio signal.
  - In case of metal racks or surfaces, use an external antenna with an appropriate cable.

Walls with metallic structures, such as cabling or concrete iron, may degrade the antenna performance.

- Use mounting tools to mount the device on a wall. Select the optimum mounting direction using the rails on the device's aluminium casing.

The protective earth screw terminal is located next to the DIN-rail mounting clips. The earth lead must always be properly connected, at least 6.0 mm^2 and as short as possible.

9.3 Installing the SIM card

Standard 3 V SIM cards can be used with the device's IEC 60870-5-104 gateway. A SIM card holder is located on the back panel near the GPRS antenna connector.

If the PIN code query is enabled, check that the correct PIN code is entered in the REC601/603 configurator GPRS submenu.

1. Switch off power from the device.
2. Ensure that the GSM module is in the shutdown mode.

The SIM card holder has a card detection circuit that allows hot insertion and removal of the card. This is not recommended, as the SIM card content may become corrupted if the card is removed while the GSM module is writing data to it.

3. Eject the SIM card holder by pushing the **Eject** button.
4. Remove the tray from the holder and place the SIM card onto the tray.
5. Insert the tray carefully back to the holder and press the tray until it is locked.

9.4 Setting the IP address via a Web browser

1. Connect to the device using the Web browser.

The default IP address is “10.10.10.10” (netmask “255.0.0.0”). A computer connected to the device may use, for example, the IP address “10.10.10.11”.

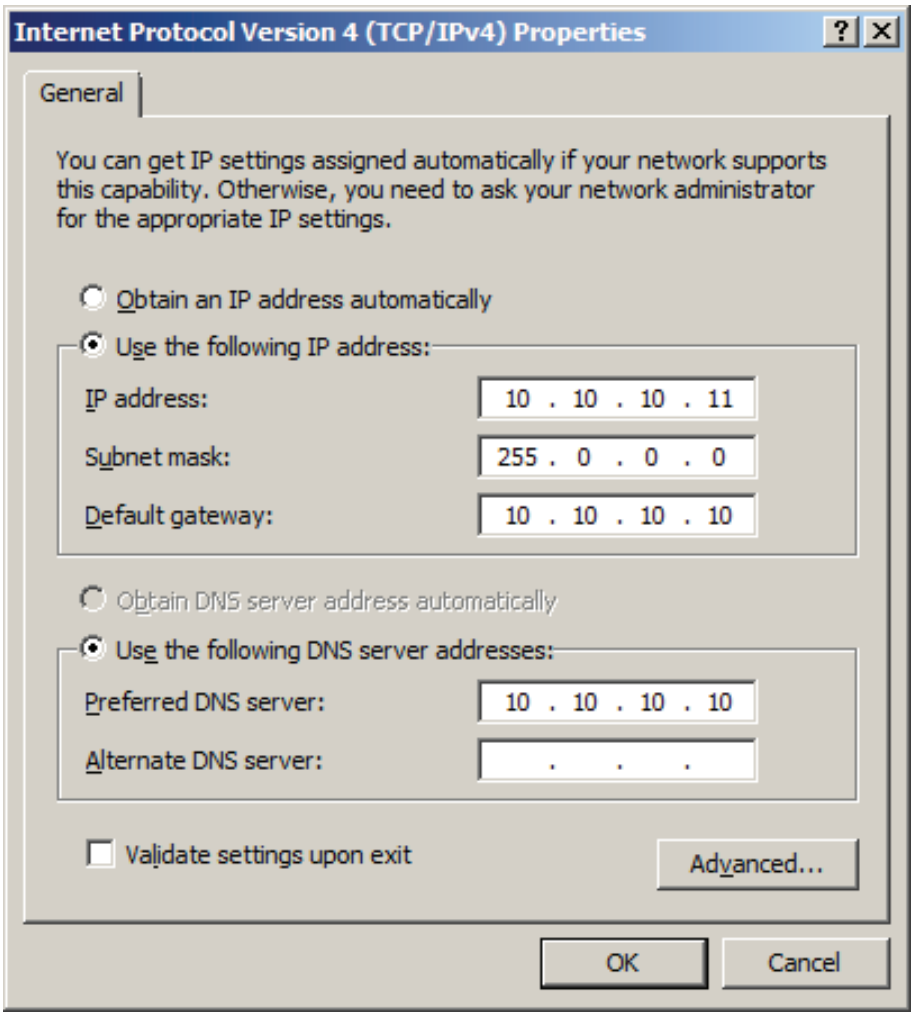

Figure 47: IP Properties

2. On the start page, click the **Start Configurator** link.
3. Enter the login information.
   3.1. Type the user name as “root”.
   3.2. Leave the password box empty.
4. Select **Network/Ethernet**.

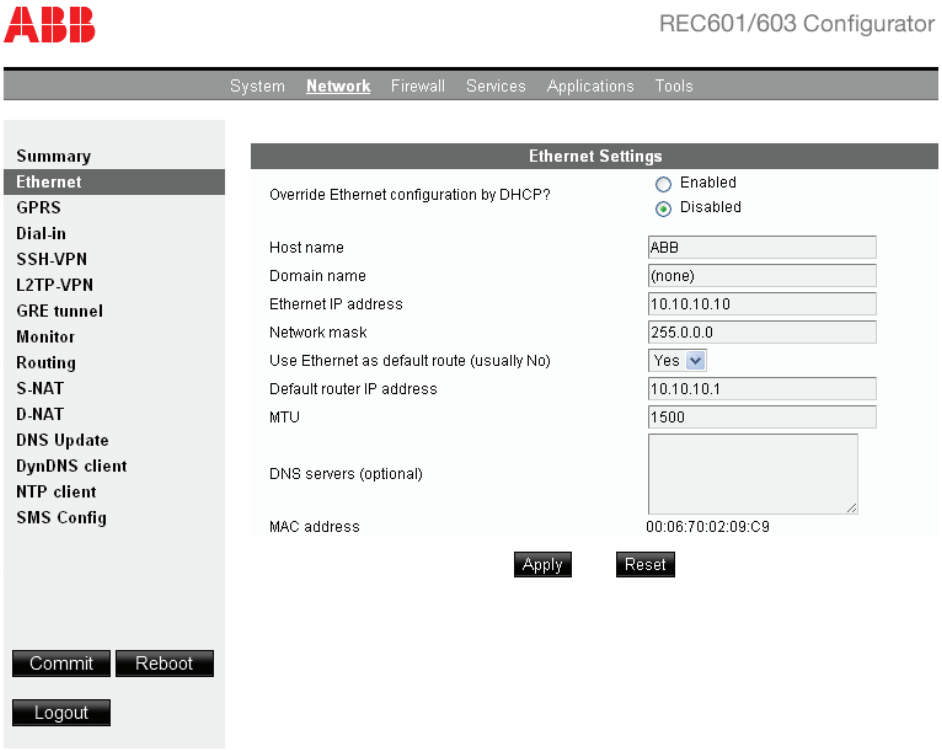

Figure 48: Ethernet Settings

5. Type the Ethernet IP address and the required network settings in the boxes. Click **Apply** and **Commit** at the bottom of the page to save the settings.
6. Restart the device for the settings to take effect.

The default password is empty. Set the password before connecting the device to a public network.

9.5 Configuring the GPRS settings

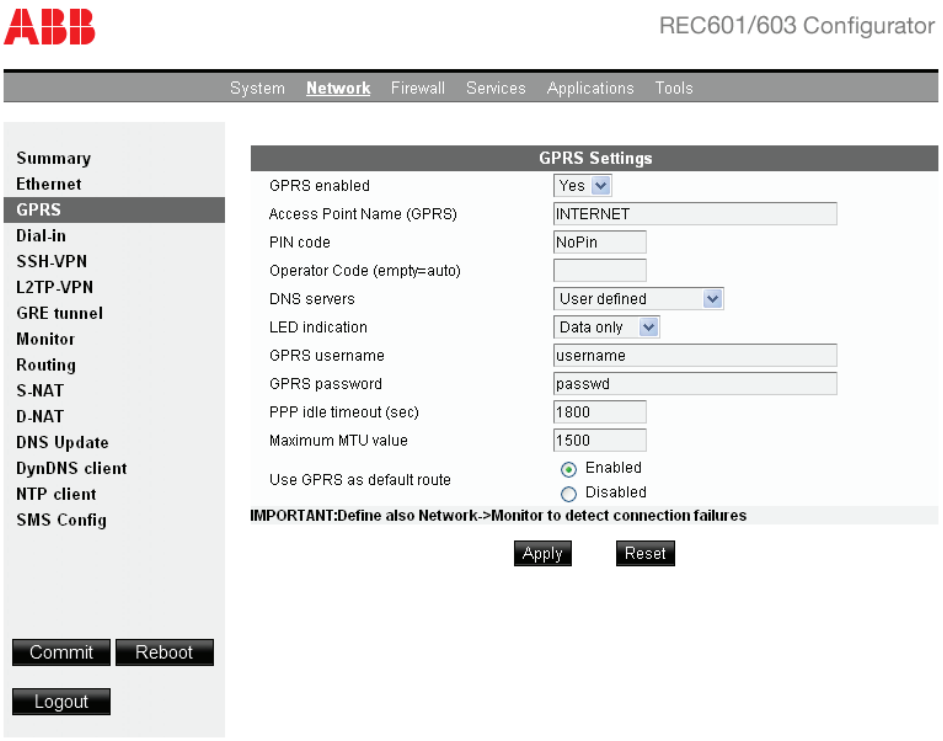

Figure 49: GPRS settings

See **Tools/Modem info** for GSM/GPRS information.

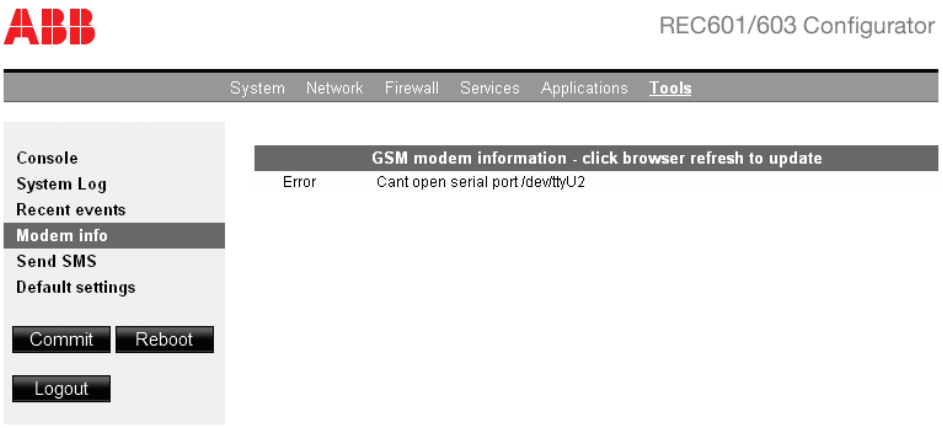

Figure 50: GSM modem information

1. If the SIM card has the PIN code querying enabled, configure the PIN code before inserting the card in the card holder.
2. Connect to the device and log in to the REC601/603 configurator.
3. Navigate to **Network/GPRS**.
4. Type the access point name in the **Access Point Name (GPRS)** box. Usually, the access point name is “INTERNET“
5. Set the GPRS network user name and password if the GPRS service requires authentication.
6. Set the default route to “Enabled”.
7. The parameters *PIN code* and *PPP idle timeout (sec)* are optional.
   - If the SIM card has the PIN code set, type the code in the **PIN code** box.

     

     Set the correct PIN code with the REC601/603 configurator before plugging in the SIM card. If an incorrect PIN code is set and the PIN code is required by the SIM card, the device does not retry with the wrong PIN code, thus avoiding a SIM card lock-up. In such a case, insert the SIM card to a mobile phone and enter the correct PIN code before continuing.

   - **PPP idle timeout (sec)** defines the interval in seconds when the device resets the GPRS connection if the connection is idle.
   - **ICMP Echo** is used to monitor the GPRS connection between the device and the remote host. If the host cannot be reached, the GPRS connection is reset. This feature should always be enabled from **Network/Monitor**.
8. Click **Apply**. After confirmation, click **Commit** to save the settings.
9. Restart the device for the settings to take effect. Check the GPRS status from **Network/Summary**.

Section 10 Appendix 2 Controller configuration reference

10.1 Introduction

This document describes the structure of the configuration file used to setup the operational and communication parameters of the internal RTU application.

This guide defines configuration of the RTU application itself. For general networking configuration and IEC 60870-5-101 gateway or IEC 60870-5-101 converter application configuration refer to separate guides.

10.2 Physical pins

The physical pins are referred frequently on setup chapters. The same physical pins are used by G-P and for disconnector-specific functionality.

10.2.1 Digital inputs

Each digital input has two pins. One pin is used for common potential and the other pin for signal. The common potential may be shared between multiple signal pins. The pins are bi-directional meaning the current can flow either from signal pin to common potential or vice-versa. The digital inputs table the signal pin is mentioned before the common pin.

Table 76: Digital inputs

Index	Physical	Single point (G-P)	Double point (G-P)	Disconnector	Note
DI1	X2.3 1-2	[DIGITAL_INPUT_SPI_1]	[DIGITAL_INPUT_DPI_1] (open status input)	[DISCONNECTOR_STATUS_1] (open status input)	Controls the Open LED of Disconnector 1
DI2	X2.3 2-3	[DIGITAL_INPUT_SPI_2]	[DIGITAL_INPUT_DPI_1] (closed status input)	[DISCONNECTOR_STATUS_1] (closed status input)	Controls the Close LED of Disconnector 1
DI3	X2.3 4-5	[DIGITAL_INPUT_SPI_3]	[DIGITAL_INPUT_DPI_2] (open status input)	[DISCONNECTOR_STATUS_2] (open status input)	Controls the Open LED of Disconnector 2
DI4	X2.3 5-6	[DIGITAL_INPUT_SPI_4]	[DIGITAL_INPUT_DPI_2] (closed status input)	[DISCONNECTOR_STATUS_2] (closed status input)	Controls the Close LED of Disconnector 2

Table continues on next page

Index	Physical	Single point (G-P)	Double point (G-P)	Disconnector	Note
DI5	X2.3 7-8	[DIGITAL_INPUT_SPI_5]		[DISCONNECTOR_LOCREM_1]	Controls the Local/Remote LED of Disconnector 1
DI6	X2.3 9-10	[DIGITAL_INPUT_SPI_6]		[DISCONNECTOR_LOCREM_2]	Controls the Local/Remote LED of Disconnector 2
DI7	X3 1-2	[DIGITAL_INPUT_SPI_7]	[DIGITAL_INPUT_DPI_3] (open status input)	[DISCONNECTOR_STATUS_3] (open status input)	Controls the Open LED of Disconnector 3
DI8	X3 2-3	[DIGITAL_INPUT_SPI_8]	[DIGITAL_INPUT_DPI_3] (closed status input)	[DISCONNECTOR_STATUS_3] (closed status input)	Controls the Close LED of Disconnector 3
DI9	X3 4-5	[DIGITAL_INPUT_SPI_9]		[DISCONNECTOR_LOCREM_3]	Controls the Local/Remote LED of Disconnector 3
DI10	X3 11-10	[DIGITAL_INPUT_SPI_10]	[DIGITAL_INPUT_DPI_4] (open status input)		Controls the Open LED of Grounding 1
DI11	X3 12-10	[DIGITAL_INPUT_SPI_11]	[DIGITAL_INPUT_DPI_4] (closed status input)		Controls the Close LED of Grounding 1
DI12	X3 13-10	[DIGITAL_INPUT_SPI_12]	[DIGITAL_INPUT_DPI_5] (open status input)		Controls the Open LED of Grounding 2
DI13	X3 14-10	[DIGITAL_INPUT_SPI_13]	[DIGITAL_INPUT_DPI_5] (closed status input)		Controls the Close LED of Grounding 2
DI14	X3 15-10	[DIGITAL_INPUT_SPI_14]	[DIGITAL_INPUT_DPI_6] (open status input)		Controls the Open LED of Grounding 3
DI15	X3 16-10	[DIGITAL_INPUT_SPI_15]	[DIGITAL_INPUT_DPI_6] (closed status input)		Controls the Close LED of Grounding 3
DI16	X4 12-11	[DIGITAL_INPUT_SPI_16]	[DIGITAL_INPUT_DPI_7] (open status input)		Extra DI
DI17	X4 13-11	[DIGITAL_INPUT_SPI_17]	[DIGITAL_INPUT_DPI_7] (closed status input)		Extra DI

10.2.2 Analog inputs

Each analog input has two pins. One pin is used for positive potential (+/A) and the other pin for negative potential (-/B). The inputs are bidirectional. This means that the value can be positive or negative. If the positive pin has a higher potential than the negative pin, the result is positive. If the positive pin has a lower potential than the negative pin, the result is negative. The inputs can be configured for voltage mode (-5...5 V, input impedance 2.2 kΩ) or current mode (4…20 mA, with external resistor). The mode needs to be entered in the configuration file for the

application to use the correct calibration and scaling data. In Table 77 the positive pin is mentioned before the negative pin.

Table 77: Analog input

Index	Physical	General-Purpose	Shared Function	Note
AI1	X4 3-4	[ANALOG_INPUT_FPI_1]	Load current measurement for load limiter and battery testing	Usually connected to the Hall sensor measuring motor current having output of 0...5 V
AI2	X4 9-10	[ANALOG_INPUT_FPI_2]		

10.2.2.1 Current measurement with analog input AI2

The analog input AI2 (X4 pins 9 and 10) has the voltage mode input range -5…+5 VDC and input impedance 2.2 kΩ. For measuring 0...20 mA currents, an external 250 Ω (or smaller) resistor should be connected in parallel to the input.

The AI2 value is available for the protocol communication. The information object is defined in the section [ANALOG_INPUT_FPI_2]. To report the measured value in milliamperes, the *scaling_multiple* parameter should be modified. The required value can be calculated with the equation

$$scaling\_multiple = 1000 \times \frac{2200 + R}{2200 \times R}$$

(Equation 1)

For example, if the connected external resistor has value 250 Ω, the *scaling_multiple* should have value 4.45.

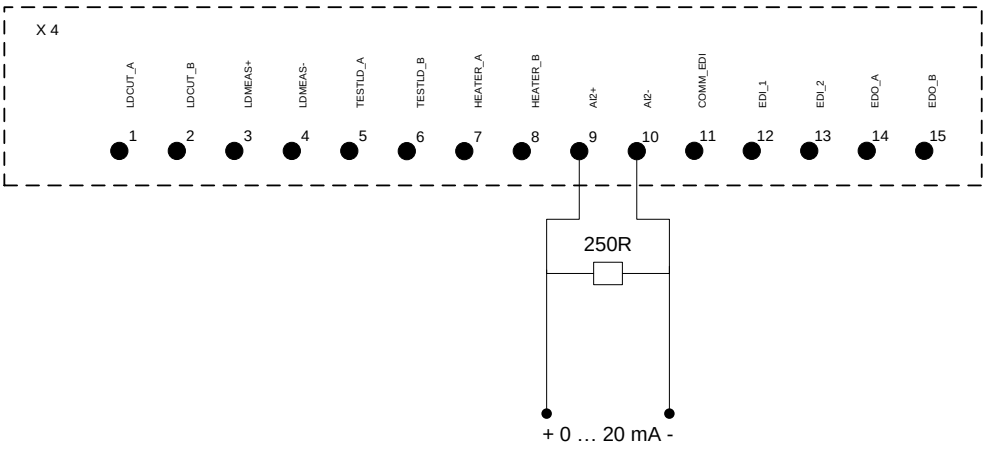

Figure 51: Principle for converting the AI2 input for milliamp measurement

10.2.3 Digital outputs

Digital outputs are implemented with relays. Each digital output has two pins connected to the relay contacts. Outputs are bi-directional due to the galvanic contact.

Table 78: Digital outputs

Index	Physical	Single point (G-P)	Double point (G-P)	Disconnector	Other	Note
DO1	X2.3 11-12	[DIGITAL_OUTPUT_SC_1]	DIGITAL_OUTPUT_DC_1] (drive to close)	[DISCONNECTOR_CONTROL_1] (drive to close)		
DO2	X2.3 13-14	[DIGITAL_OUTPUT_SC_2]	DIGITAL_OUTPUT_DC_1] (drive to open)	[DISCONNECTOR_CONTROL_1] (drive to open)		
DO3	X2.3 15-16	[DIGITAL_OUTPUT_SC_3]	DIGITAL_OUTPUT_DC_2] (drive to close)	[DISCONNECTOR_CONTROL_2] (drive to close)	Heater ACO1	
DO4	X2.3 17-18	[DIGITAL_OUTPUT_SC_4]	DIGITAL_OUTPUT_DC_2] (drive to open)	[DISCONNECTOR_CONTROL_2] (drive to open)		
DO5	X3 6-7	[DIGITAL_OUTPUT_SC_5]	DIGITAL_OUTPUT_DC_3] (drive to close)	[DISCONNECTOR_CONTROL_3] (drive to close)		
DO6	X3 8-9	[DIGITAL_OUTPUT_SC_6]	DIGITAL_OUTPUT_DC_3] (drive to open)	[DISCONNECTOR_CONTROL_3] (drive to open)		
DO7	X4 1-2	[DIGITAL_OUTPUT_SC_7]			Load limiter load cut	Normally closed
DO8	X4 5-6	[DIGITAL_OUTPUT_SC_8]			Battery test load	
DO9	X4 7-8	[DIGITAL_OUTPUT_SC_9]			Heater ACO3	
DO10	X4 14-15	[DIGITAL_OUTPUT_SC_10]				Extra DO

10.3 Configuration file syntax

The configuration file follows common INI-file format, see http://en.wikipedia.org/wiki/INI_file where sections are used to group parameters.

10.3.1 Sections

Parameters are grouped into logically-named sections. A section starts from section declaration and ends to a blank line or another section declaration. The section name appears on a line by itself, in square brackets ([and]). All parameters after the section declaration are associated with that section. Sections may not be nested. Section names are case-sensitive and must be entered on uppercase letters.

Example

```
[MY_SECTION]
my_parameter_a = my_value_a
my_parameter_b = my_value_b
```

10.3.2 Parameters

The basic element contained in a configuration file is the parameter. Every parameter has a name and a value, delimited by an equals sign (=). The name appears to the left of the equals sign. Parameter names and values are case-sensitive and must be entered on small letters. There may be whitespaces before and after the delimiter (=).

Example

```
name=value
name = value
```

10.3.3 Comments

Semicolons (;) or number signs (#) indicate the start of a comment. The comments continue to the end of the line. Everything between the semicolon or number sign and the End of Line is ignored. The comment character must be the first character on the line (no white spaces).

Example

```
;comment text
#comment text
```

10.3.4 Duplicate section names

Duplicate section names are used to define multiple instances of the same object. For example, duplicate section names can be used to define multiple cyclic transmission groups with different intervals. If the object does not support multiple instances, the first section is used and the other sections are ignored.

Example

```
[IEC_CYCLIC_GROUP]
onoff = on
group_index = 1
name = cyclic_fast
cause_of_transmission = 1
interval_sec = 120
sense_linkstatus = yes

[IEC_CYCLIC_GROUP]
onoff = on
group_index = 2
name = cyclic_slow
cause_of_transmission = 1
interval_sec = 7200
sense_linkstatus = yes
```

10.3.5 Duplicate parameter values

Some parameters accept multiple values. Typically the values are supplied to a single parameter as a comma-separated list. Certain parameters (where comma-separation is not practically possible) require that multiple instances are defined.

Example

```
name=value1,value2,value3
name = value1
name = value2
```

10.4 [GLOBAL]

The [GLOBAL] section parameters affect the whole application.

Table 79: Settings for global parameters

Setting	Units	Range	Description	Parameter name
Enable RTU application	binary	on,off	Should the RTU application run	onoff
Syslog enable	binary	on,off	Should the application write system log	syslog_onoff
Syslog identifier	text		System log identifier string	syslog_id

Example

```
[GLOBAL]
onoff = on
syslog_onoff = yes
syslog_id = rtu
```

10.5 Low-level I/O settings

The low-level I/O settings define communication bus properties between the application processor and I/O processor. The default values are normally correct.

10.5.1 [PHYSICAL_DI]

Table 80: Settings for physical digital inputs

Setting	Units	Range	Description	Parameter name
Query interval	ms	1...5000 (int)	How often to query I/O processor for digital input values	query_interval_ms
Invalid timeout	ms	1...60000 (int)	If no successful update during time-out mark the values invalid	invalid_timeout_ms
Reply timeout	ms	1...5000 (int)	How long to wait for I/O processor response	reply_timeout_ms
Retry limit	times	0...10 (int)	How many times to retry within query	reply_retries
Debounce filter	ms	0...5000 (int)	Tell I/O processor to use this glitch/ debounce filtering window	debounce_filter_ms

Example

```
[PHYSICAL_DI]
query_interval_ms = 200
invalid_timeout_ms = 2000
reply_timeout_ms = 500
reply_retries = 2
debounce_filter_ms = 100
```

10.5.2 [PHYSICAL_AI]

Table 81: Settings for physical analog inputs

Setting	Units	Range	Description	Parameter name
Query interval	ms	1...5000 (int)	How often to query I/O processor for analog input values	query_interval_ms
Invalid timeout	ms	1...60000 (int)	If no successful update during time-out mark the values invalid	invalid_timeout_ms
Reply timeout	ms	1...5000 (int)	How long to wait for I/O processor response	reply_timeout_ms
Retry limit	times	0...10 (int)	How many times to retry within query	reply_retries
Averaging	times	0...50 (int)	How many samples to average	averaging

Example

```
[PHYSICAL_AI]
query_interval_ms = 500
invalid_timeout_ms = 5000
reply_timeout_ms = 500
reply_retries = 2
averaging = 8
```

10.5.3 [PHYSICAL_TEMP]

Table 82: Settings for physical temperature measurements

Setting	Units	Range	Description	Parameter name
Query interval	ms	1...5000 (int)	Time interval for I/O processor queries for temperature values	query_interval_ms
Invalid timeout	ms	1...60000 (int)	In case of unsuccessful update during time out, values are marked invalid	invalid_timeout_ms
Reply timeout	ms	1...5000 (int)	Waiting period for I/O processor response	reply_timeout_ms
Retry limit	times	0...10 (int)	Number of retries within query	reply_retries
Offset	Degrees C	float	Value added to temperature measurement	scaling_add
Gain		float	Temperature multiplication factor	scaling_multiple
Compensation factor		float	Charging current affecting temperature	chargecur_heating
Averaging	samples	float	Averaging window for charging current	chargecur_averaging

Example

```
[PHYSICAL_TEMP]
query_interval_ms = 2000
invalid_timeout_ms = 10000
reply_timeout_ms = 500
reply_retries = 2
scaling_add = -10
scaling_multiple = 1
chargecur_heating = 3.5
chargecur_averaging = 1200
```

10.5.4 [PHYSICAL_DO]

Table 83: Settings for physical digital outputs

Setting	Units	Range	Description	Parameter Name
Query interval	ms	1...5000 (int)	How often to refresh digital output values (after first write)	query_interval_ms
Reply timeout	ms	1...5000 (int)	How long to wait for I/O processor response	reply_timeout_ms
Retry limit	times	0...10 (int)	How many times to retry within query	reply_retries

Example

```
[PHYSICAL_DO]
query_interval_ms = 200
reply_timeout_ms = 500
reply_retries = 2
```

10.6 Analog scaling settings

The analog inputs (X4 3-4 and X4 9-10) can be used on voltage (-5...5 V) or current (4…20 mA) mode. These modes have different scaling and calibration properties and therefore the application should know the required mode. The physical measurement circuit itself needs to be configured to the required mode with the internal DIP switches (selection per channel).

10.6.1 [PHYSICAL_EXTAIMODE_1]

Defines the measurement mode of the analog input 1 (X4 pins 3-4). Usually this channel is used for a Hall-sensor having 0...5 V voltage output.

Table 84: Measurement mode for physical_extaimode_1

Setting	Units	Range	Description	Parameter name
Measurement mode		volt, cur	Use voltage or current mode scaling and calibration.	mode

Example

```
[PHYSICAL_EXTAIMODE_1]
mode = volt
```

10.6.2 [PHYSICAL_EXTAIMODE_2]

Defines the measurement mode of analog input 1 (X4 pins 9-10).

Table 85: Measurement mode for physical_extaimode_2

Setting	Units	Range	Description	Parameter name
Measurement mode		volt,cur	Use voltage or current mode scaling and calibration.	mode

Example

```
[PHYSICAL_EXTAIMODE_2]
mode = cur
```

10.6.3 [CURRENT_SENSOR]

The motor load current is usually measured by using a Hall-sensor connected to the analog input 1 (X4 3-4). The typical Hall-sensor output voltage is 0...5 V, being directly related to the measured current. For example, if the measurement range is 0...10 A and output voltage is 0...5 V, the transfer ratio is 2 A/V.

Table 86: Settings for current_sensor

Setting	Units	Range	Description	Configuration parameter
Offsett	V	0...5 (float)	Add offsett amount to value	scaling_add
Gain	A/V	0...10 (float)	Multiply value with gain (after offsetting)	scaling_multiple

Example

```
[CURRENT_SENSOR]
scaling_add = 0
scaling_multiple = 2
```

10.7 Protocol communication settings

The protocol communication settings define the properties of remote monitoring and control. The device acts as a protocol slave whereas the controlling system, such as SCADA or NFE acts as a protocol master.

10.7.1 Selection between IEC-104 and IEC-101 slave protocols

The communication to NCC is supported using the IEC-101 or IEC-104 protocols. The IEC-104 protocol selection has priority over IEC-101 selection. The protocols cannot be used simultaneously. If both IEC_104_SLAVE_LINK and IEC_101_SLAVE_LINK are enabled, IEC_104_SLAVE_LINK is started.

10.7.2 [IEC_104_SLAVE_LINK]

Table 87: Link level settings of IEC 60870-5-104 protocol communication

Setting	Units	Range	Description	Parameter name
Use IEC 60870-5-104 link layer	binary	off,on		onoff
Listening port	TCP port	1...65535 (int)	TCP port to listen for incoming connections	tcp_port
Listening IP	IP address	IP address, none	Listen only on given IP address	bind_ip
Allowed clients	IP address	IP address, any	Accept connections only from this IP address (max 10 configuration parameters, each on own line)	remote_ip
Connection backlog		1...20 (int)	Allow operating system to have this many unfinished connection attempts	con_backlog
Idle timeout	s		Close connection if no IEC 60870-5-104 communication during the time-out (0=never)	idle_timeout
Tx window	packets	1...32767 (int)	IEC 60870-5-104 transmit window (k)	k
Rx window	packets	1...32767 (int)	IEC 60870-5-104 receive window (w)	w
Tx timeout	s	1...255 (int)	IEC 60870-5-104 transmit time-out (t1)	t1

Table continues on next page

Setting	Units	Range	Description	Parameter name
RX timeout	s	1...255 (int)	IEC 60870-5-104 receive time-out (t2)	t2
Test interval	s	1...65535 (int)	IEC 60870-5-104 link test interval (t3)	t3
Maximum sequence number		1...32767 (int)	IEC 60870-5-104 maximum sequence number (0=max)	max_seqno
ASDU max length	bytes	20...249 (int)	IEC 60870-5-104 ASDU maximum length	max_framelen
Test stopped connections	binary	off,on	Link-test connected but stopped IEC 60870-5-104 connections	test_closed
ASDU packing	binary	off,on	Pack multiple ASDUs of same type to IEC 60870-5-104 link frame	pack_asdus
Low-priority interval	packets	1...100 (int)	Force sending low-priority data (cyclic responses) after set packet interval is reached.	fifo_lowpri_int
Low-priority amount	packets	1...100 (int)	Number of lower-priority packets to add between higher-priority data	fifo_lowpri_amount
FIFO full watermark	packets	(int)	Internal notification is generated when FIFO has less than this amount of free spaces	fifo_hi_watermark
FIFO full hysteresis	packets	(int)	Internal notification is generated when FIFO has watermark plus hysteresis amount of free spaces	fifo_watermark_hysteresis
FIFO size	packets	1...200 (int)	Size of each FIFO (commands, events, cyclic, responses, pulse counters)	fifo_size
Event FIFO policy		new,old	Policy to take when event FIFO is full. "New" overwrites oldest packet with new one. "Old" keeps the oldest and rejects the new one.	fifo_event_policy
Synhroneous FIFO Policy	new,old		Policy to take when synch FIFO is full. "New" overwrites oldest packet with new one. "Old" keeps the oldest and rejects the new one.	fifo_synch_policy
Pulsecounter FIFO policy		new,old	Policy to take when pulsecount FIFO is full. "New" overwrites oldest packet with new one. "Old" keeps the oldest and rejects the new one.	fifo_pulsec_policy
Link version		1,2	IEC-60870-5-104 link version used (default 1)	link_version
Disable redundancy	binary	off,on	Disable redundant connections and allow only one master to be connected simultaneously (default off)	Disable_redundancy
Status file name			Full path and name of IEC 60870-5-104 link status file	statusfile_name
Status file interval	s	(int)	Interval of status file writing	statusfile_interval_sec

Example

```
[IEC_104_SLAVE_LINK]
onoff = on
tcp_port = 2404
bind_ip = none
remote_ip = any
con_backlog = 5
```

```
idle_timeout = 1800
k = 12
w = 8
t1 = 60
t2 = 20
t3 = 250
max_seqno = 0
max_framelen = 249
test_closed = yes
pack_asdus = yes
link_version = 1
disable_redundancy = no
fifo_lowpri_int = 10
fifo_lowpri_amount = 2
fifo_hi_watermark = 10
fifo_watermark_hysteresis = 5
fifo_size = 300
fifo_event_policy = new
fifo_synch_policy = new
fifo_pulsec_policy = old
statusfile_name = /var/run/iec104_sl.status
run/iec104_sl.status
statusfile_interval_sec = 20
```

10.7.3 [IEC_104_SLAVE_APP]

Table 88: Application level settings of IEC 60870-5-104 protocol communication

Setting	Units	Range	Description	Parameter name
Common address length	bytes	1...3 (int)	Length of IEC 60870-5-104 common Address field	common_address_length
Cause of transmission length	bytes	1...3 (int)	Length of IEC 60870-5-104 cause of transmission field	cause_of_transmission_length
Information object address length	bytes	1...3 (int)	Length of IEC 60870-5-104 information object address field	information_object_address_length
Common address		(int)	IEC 60870-5-104 common address of the station (structured/unstructured)	common_address
Reply broadcasts	binary	off,on	Reply to broadcast common address	reply_broadcast
Atomic control	binary	off,on	Allow only one selection or unfinished execution per station simultaneously	atomic_control
Status file name			Full path and name of IEC 60870-5-104 station status file	statusfile_name
Status file interval	s		How often to write status file	statusfile_interval_sec

Example

```
[IEC_104_SLAVE_APP]
common_address_length = 2
cause_of_transmission_length = 2
information_object_address_length = 3
common_address = 1
reply_broadcast = 1
atomic_control = yes
statusfile_name = /var/run/iec104_ss.status
statusfile_interval_sec = 20
```

10.7.4 [IEC_101_SLAVE_LINK]

The IEC 60870-5-101 protocol operation mode is an unbalanced slave.

IEC-101 is started only when IEC_104_SLAVE_LINK is disabled.

Table 89: Link level settings of IEC 60870-5-101 protocol communication

Setting	Units	Range	Description	Parameter Name
Use IEC-101 Link Layer	binary	off,on		onoff
Connection mode		direct, dialup	Use direct serial connection or modem connection (default direct)	Connection_mode
Direct serial port	RS port	RS1, RS2	Serial port to be used on direct connection mode	physical
Direct serial speed	bps	300-115200	Serial speed used on direct connection mode	speed
Direct serial data bits	bits	7,8	Serial data bits used on direct connection mode	databits
Direct serial stop bits	bits	1,2	Serial stop bits used on direct connection mode	stopbits
Direct serial parity		N,E,O	Serial parity used on direct connection mode	parity
Direct serial handshaking		None (N), Hardware (H)	Serial handshaking used on direct connection mode	handshaking
Dial on startup		off,on	Initiate dial-out process on startup on dial-up connection mode	dialup_on_startup
Dial on event		off,on	Initiate dial-out process on event occurrence on dial-up connection mode	dialup_on_event
Dial trigger information object address		(int)	Structured or unstructured information object address enabled to start dial-out process. Maximum 10 instances can be specified. If not defined, every event is able to trigger.	Dialup_trigger_ioa
Dial duration extension for received command	secs	(int)	Extend allowed dial duration when command is received in order to allow command reply to be returned.	dialup_cmd_extratime
Link address		(int)	IEC-101 link address	link_address
Link address length		1,2	IEC-101 link address length	link_address_len
Reply link broadcast		yes,no	Accept broadcast link messages	link_reply_broadcast
Idle Timeout	s		Close connection if no IEC-101 communication during the timeout (0=never)	idle_timeout
ASDU Max Length	bytes	20-255 (int)	IEC-101 ASDU maximum length	max_framelen
ASDU Packing	binary	off,on	Pack multiple ASDUs of same type to IEC-101 link frame	pack_asdus
Low-Priority Interval	packets	1-100 (int)	Force sending low-priority data (cyclic responses) after set packet interval is reached	fifo_lowpri_int

Table continues on next page

Setting	Units	Range	Description	Parameter Name
Low-Priority Amount	packets	1-100 (int)	Number of lower-priority packets to be added between higher-priority data	fifo_lowpri_amount
FIFO Full Watermark	packets	(int)	When FIFO has less than this amount of free space, generate internal notification.	fifo_hi_watermark
FIFO Full Hysteresis	packets	(int)	When FIFO has watermark + hysteresis amount of free space, generate internal notification.	fifo_watermark_hysteresis
FIFO Size	packets	1-300 (int)	Size of each FIFO (commands, events, cyclic, responses, pulse counters)	fifo_size
Event FIFO Policy		new,old	Policy to take when event FIFO is full. “New” overwrites oldest packet with new one. “Old” keeps the oldest and rejects the new one.	Fifo_event_policy
Synchronous FIFO Policy		new,old	Policy to take when synch FIFO is full. “New” overwrites oldest packet with new one. “Old” keeps the oldest and rejects the new one.	Fifo_synch_policy
Pulsecounter FIFO Policy		new,old	Policy to take when pulsecount FIFO is full. “New” overwrites oldest packet with new one. “Old” keeps the oldest and rejects the new one.	Fifo_pulsec_policy
Status File Name			Full path and name of IEC-101 link status file	statusfile_name
Status File Interval	s	(int)	How often the status file is written	statusfile_interval_sec

For information on modem settings for dial-up connection mode, see the MODEM_DIALUP section.

Example

```
[IEC_101_SLAVE_LINK]
onoff =  on
connection_mode = dialup
physical = RS2
speed = 9600
databits = 8
stopbits = 1
parity = N
handshaking = N
dialup_on_startup = yes
dialup_on_event = yes
dialup_cmd_extratime = 30
dialup_trigger_ioa = 100
dialup_trigger_ioa = 200
link_address = 9
link_address_len = 2
link_reply_broadcast = no
idle_timeout = 60
max_framelen = 255
pack_asdus = yes
fifo_lowpri_int = 10
fifo_lowpri_amount = 2
fifo_hi_watermark = 10
fifo_watermark_hysteresis = 5
fifo_size = 300
```

```
fifo_event_policy = new
fifo_synch_policy = new
fifo_pulsec_policy = old
statusfile_name = /var/run/iec101_sl.status
statusfile_interval_sec = 20
```

10.7.5 [IEC_TIME]

Table 90: Time synchronization settings of IEC 60870-5-104 protocol communication

Setting	Units	Range	Description	Parameter name
Use IEC-104 Time Synch	binary	off,on		onoff
Time source		none,ntp,iec	Station time synchronization method	update_source
Time storage		system,internal, rtc	System clock changed according to IC time or internal difference information kept	storage
Interval for refreshing system time from RTC chip	s	(int)	Interval of refreshed system time from RTC chip on rtc storage mode.	Rtc_readback_interval
Transmission delay	ms	(int)	Estimation of transmission delay from source to station. Used for compensation.	transmission_delay_ms

Example

```
[IEC_TIME]
onoff = on
update_source = iec
storage = system
transmission_delay_ms = 800
time_adjust_dir = none
time_adjust_amount = 0
ntp_interval_sec = 600
ntp_response_timeout_sec = 30
ntp_retries = 2
ntp_retry_interval_sec = 5
adjust_mindiff_sec = 1
adjust_maxdiff_sec = 0
invalid_timeout_sec = 10800
rtc_readback_interval = 0
```

10.7.6 [IEC_CYCLIC_GROUP]

Up to 50 cyclic group sections are available, each defining an independent instance. Typical use of the multiple cyclic groups is to transmit important information more frequently than the lower priority information.

Table 91: Settings for IEC_cyclic_group

Setting	Units	Range	Description	Parameter name
Use this cyclic group	binary	off,on		onoff
Name			Descriptive name for the group (logging)	name
Group index		1...50 (int)	Group index where information objects can bind to. Must be unique for each group.	group_index

Table continues on next page

Setting	Units	Range	Description	Parameter name
Cause of transmission		1...127 (int)	Cause of transmission generated by this group	cause_of_transmission
Cyclic interval	s	1...65535 (int)	How often to cause cyclic transmission	interval_sec
Sense link status	binary	off,on	Generate cyclic transmission only when IEC 60870-5-104link is up	sense_linkstatus

Example

```
[IEC_CYCLIC_GROUP]
onoff = on
group_index = 1
name = cyclic_fast
cause_of_transmission = 1
interval_sec = 120
sense_linkstatus = yes

[IEC_CYCLIC_GROUP]
onoff = on
group_index = 2
name = cyclic_slow
cause_of_transmission = 1
interval_sec = 7200
sense_linkstatus = yes
```

10.7.7 [MODEM_DIALUP]

The REC601/603 RTU can be connected to a control center by using an IEC-101 protocol and a dial-up modem over PSTN, radio or satellite link. External modem is connected to the serial port RS1 or RS2.

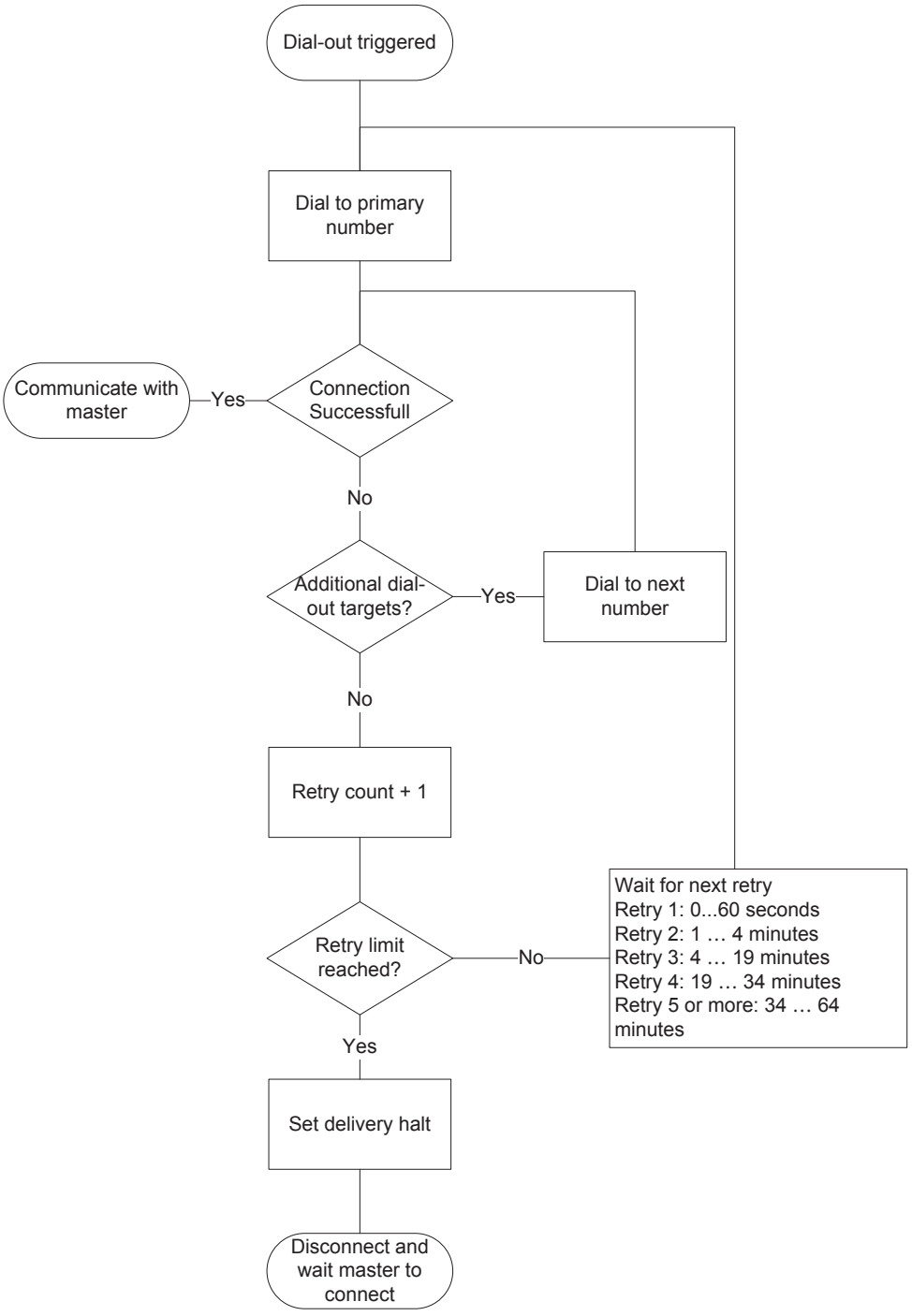

Figure 52: Dialing logic of REC601 and REC603

10.7.7.1 Dial-out

The dial-out sequence is initiated when one of the following trigger conditions is met.

- RTU application is started (for example, power-up, application restart)
- Asynchronous event occurs for an information object, whose IOA has matching entry on trigger-IOA list and the dial-out/dial-in logic has not started.
- Event buffer contains class 1 events when dial-in ends.

When one of the above condition triggers a dial-out, REC601/603 dials to the primary target number. When a connection is established, it remains active until master closes the connection or one of the timeouts is reached. Active connection has two adjustable timeouts; duration timeout and inactivity timeout. Duration timeout is the maximum length of connection and the connection is closed when duration timeout is reached. When a command is executed, the duration timeout is extended to ensure that all indications are reported to master. Inactivity timeout may close the connection before the duration timeout is reached, if any data is received from modem or application during set time period.

REC601/603 has extensive re-dial logic in case the dial-out fails. Up to five dial-out targets can be set and tried, if the previous target responds BUSY, NO CARRIER, NO ANSWER, ERROR, NO DIALTONE codes or if the connection is not established in set time. When all the dial-out targets are tried once, re-dial logic waits until adjustable retry delay is elapsed and starts redial-sequence from the first dial-out target. Retry wait delay is incremental. It consists of constant and random part with the appropriate values.

- Retry 1: 0...60 seconds
- Retry 2: 1…4 minutes
- Retry 3: 4…19 minutes
- Retry 4: 19…34 minutes
- Retry 5 or more: 34…64 minutes

Parameter *retry_max_steps* limits the incremental steps for retry delay. If *retry_max_steps* is set to “2”, the delay is limited to 1...4 minutes even when *retry_max_tries* is set greater than “2”.

In addition to the actual retry delay above, there is configurable modem hang-up delay (for example, 30 seconds). This hang-up delay is to ensure the modem is ready for the next call.

Re-dial sequence is stopped when defined retry limit is reached. Further dial-outs are not allowed, even if new events occur. This delivery halt condition is cleared only after successful dial-in which is able to empty the event buffer.

10.7.7.2 Dial-in

There is no filter for allowed dial-in numbers. The modem automatically answers to any incoming call. There are two adjustable timeouts for dial-in.

- Idle timeout - if the established call does not send or receive data during the timeout, the call is terminated.
- Duration timeout - if the call duration exceeds the timeout, the call is terminated.

If the event queue contains unacknowledged class 1 messages when the dial-in ends, the dial-out trigger is set, which initiates a new dial-out sequence. If all dial-out retries are used, no dial-out sequence is started. If the event queue does not contain unacknowledged class 1 messages when the dial-in ends, the delivery halt situation is cleared, which enables a new dial-out sequences for new dial-out triggers.

10.7.7.3 IEC-101 link level broadcast

The IEC-101 link layer broadcast messages are handled differently for dial-out and dial-in situations. Link function Request for access demand <8> having broadcast link-layer destination address is accepted for dial-out connections, otherwise rejected. Link function Send no reply expected <4> having broadcast link-layer destination address is always accepted. This is used for example, for clock synchronization.

10.7.7.4 Modem dial-up settings

Dial-up modem can be used for IEC-60870-5-101 communication.

Table 92: Modem dial-up settings

Setting	Units	Range	Description	Parameter Name
Control modem	binary	off,on		onoff
Serial port		RS1, RS2	Serial port used for modem communication	physical
Serial speed	bps	300 - 115200	Serial speed used for modem communication	speed
Serial data bits		7,8	Serial data bits used for modem communication	databits
Serial stop bits		1,2	Serial stop bits used for modem communication	stopbits
Serial parity		N,E,O	Serial parity used for modem communication	parity
Serial handshaking		None (N), Hardware (H)	Serial port handshaking used for modem communication	handshaking
Modem init string		text	AT command used for modem initialization	Init_string
PIN query command		text	AT command used for querying whether modem requires PIN code	pinquery_string
PIN input command		text	AT command used for inputting PIN code to modem	pincode_string
Escape string		text	Escape string for entering from data mode to command mode	escape_string
Hang-up command		text	AT command used for hanging up a call	hangup_string
Dial-out command		text	AT command used for dialing Maximum 5 instances can be specified	Dial_string
Inactivity timeout	secs	(int)	Hang-up call if inactive over defined timeout (0=never)	inactivity_timeout_sec

Table continues on next page

Setting	Units	Range	Description	Parameter Name
Duration timeout	secs	(int)	Hang-up call if connected over defined timeout (0=never)	duration_timeout_sec
Modem answer timeout	secs	(int)	Modem command reply timeout	modem_timeout_sec
Dial answer timeout	secs	(int)	Timeout for waiting outgoing dial to be answered	dial_timeout_sec
Use modem control signals		on,off	Use CD for detecting incoming calls and DTR for hang-up	modem_hw_control
Delay after hangup	secs	(int)	Waiting period after hang-up before issuing next command	hangup_delay
Dial-out retry loop limit		(int)	The number of redials for every dial-out target before giving up	retry_max_tries
Dial-out delay step limit		1-5	Incrementation of retry delay level 1=0-60 s, 2=1-4 min, 3=4-19 min, 4=19-34 min, 5=34-64 min	retry_max_steps
Modem restart interval	secs	(int)	Modem restart frequency (0=never)	restart_interval_sec
Dial-out halt		on,off	If enabled and maximum dial-out retries is reached, no new dial-out is performed before successful incoming call.	halt_on_failure

Example

```
[MODEM_DIALUP]
onoff = on
physical = RS1
speed = 115200
databits = 8
stopbits = 1
parity = N
handshaking = H
init_string = AT&FE0V0X0Q0S0=1&C1&D2
pinquery_string = AT+CPIN?
Pincode_string = AT+CPIN=0000
escape_string = +++
hangup_string = ATH
dial_string = 123456
dial_string = 789012
dial_string = 345678
inactivity_timeout_sec = 60
duration_timeout_sec = 120
modem_timeout_sec = 5
dial_timeout_sec = 60
modem_hw_control = yes
retry_max_tries = 6
retry_max_steps = 5
restart_interval_sec = 0
hangup_delay = 30
halt_on_failure = yes
```

10.8 Common objects

Most of the remote communication is implemented with the object data types.

- Single-point information (SPI)
- Double-point information (DPI)
- Measured value, short floating-point information (FPI)
- Single command (SC)
- Double command (DC)

10.8.1 Single-point information settings

The single-point information data value is single bit and contains either 0 or 1.

Table 93: Single-point information settings

Setting	Units	Range	Description	Parameter name
Enable data point	binary	off, on		onoff
Information object address	address	(int)	Structured or unstructured IOA of this data point	object_address
Name	text	20 chars	Descriptive name for this data point (logging)	name
Generate events	binary	off, on	Should this data point generate events	event_generation
Send event when invalid	binary	off, on	Should event be generated when this data point becomes invalid	event_invalid
Event interval	s	(int)	Minimum delay between events generated by this data point	event_interval_sec
Event filtering delay	ms	(int)	How long the value must be changed before sending event	event_filter_ms
Event timestamp format		none, short, long	Timestamp format of asynchroneous events for this data point	event_timestamp
GI group		1...20 (int)	Which GI group this data point belongs (maximum 10 groups on comma-separated list). 20=Global	gi_group
GI timestamp format		none, short, long	Timestamp format of GI responses for this data point	gi_timestamp
Cyclic group		1...100 (int)	Which Cyclic groups this data point belongs (maximum 10 groups on comma-separated list)	cyclic_group
Cyclic timestamp format		none, short, long	Timestamp format of cyclic transmissions for this data point	cyclic_timestamp
Invert value	binary	off, on	Invert value for transmission (bit-level inversion)	invert_value

10.8.2 Double-point information settings

The double-point information data field is two bits and contains values 0...3. Typically, it is used for reporting the disconnector status having two level switches (open, closed).

Table 94: Double-point information settings

Setting	Units	Range	Description	Parameter name
Enable data point	binary	off,on		onoff
Information object address	address	(int)	Structured or unstructured IOA of this data point	object_address
Name	text	20 chars	Descriptive name for this data point (logging)	name
Generate events	binary	off,on	Should this data point generate events	event_generation
Send event when invalid	binary	off,on	Should event be generated when this data point becomes invalid	event_invalid
Event interval	s	(int)	Minimum delay between events generated by this data point	event_interval_sec
Event filtering delay	ms	(int)	How long the value must be changed before sending event	event_filter_ms
Event timestamp format		none,short,long	Timestamp format of asynchroneous events for this data point	event_timestamp
GI group		1...20 (int)	Which GI group this data point belongs (maximum 10 groups on comma-separated list). 20=Global	gi_group
GI timestamp format		none,short,long	Timestamp format of GI responses for this data point	gi_timestamp
Cyclic group		1...100 (int)	Which Cyclic groups this data point belongs (maximum 10 groups on comma-separated list)	cyclic_group
Cyclic timestamp format		none,short,long	Timestamp format of cyclic transmissions for this data point	cyclic_timestamp
Invert value	binary	off,on	Invert value for transmission (bit-level inversion)	invert_value
Map value	index	0...23	Map the transmitted value to a different value	value_map_index

10.8.2.1 Double-point information value mapping

The transmitted value of a double-point information object can be mapped to a different value in order to enable flexible value integration with SCADA screens. The original values mapped to different values are shown in the table.

Table 95: Information value mapping

Map Index	Original Value 0 (00)	Original Value 1 (01)	Original Value 2 (10)	Original Value 3 (11)
0	0	1	2	3
1	0	1	3	2
2	0	2	1	3
3	0	2	3	1
4	0	3	1	2
5	0	3	2	1
6	1	0	2	3
7	1	0	3	2
8	1	2	0	3

Table continues on next page

Map Index	Original Value 0 (00)	Original Value 1 (01)	Original Value 2 (10)	Original Value 3 (11)
9	1	2	3	0
10	1	3	0	2
11	1	3	2	0
12	2	0	1	3
13	2	0	3	1
14	2	1	0	3
15 (default)	2	1	3	0
16	2	3	0	1
17	2	3	1	0
18	3	0	1	3
19	3	0	2	1
20	3	1	0	2
21	3	1	2	0
22	3	2	0	1
23	3	2	1	0

10.8.3 Measured value, short floating-point information

The measured value is used for reporting analog values, that is measurements in IEEE 754 floating-point format.

Table 96: Settings for floating point

Setting	Units	Range	Description	Parameter name
Enable data point	binary	off,on		onoff
Information object address	address	(int)	Structured or unstructured IOA of this data point	object_address
Name	text	20 chars	Descriptive name for this data point (logging)	name
Generate events	binary	off,on	Does this data point generate events	event_generation
Send event when invalid	binary	off,on	Is an event generated when this data point becomes invalid	event_invalid
Event interval	s	(int)	Minimum delay between events generated by this data point	event_interval_sec
Event filtering delay	ms	(int)	Time period for changing the value before sending an event	event_filter_ms
Event timestamp format		none,short,long	Timestamp format of asynchronous events for this data point	event_timestamp
GI group		1..20 (int)	The GI group this data point belongs (maximum 10 groups on comma-separated list). 20=Global.	gi_group
GI timestamp format		none,short,long	Timestamp format of GI responses for this data point	gi_timestamp
Cyclic group		1...100 (int)	The cyclic group the data point belongs (maximum 10 groups on comma-separated list)	cyclic_group

Table continues on next page

Setting	Units	Range	Description	Parameter name
Cyclic timestamp format		none,short,long	Timestamp format of cyclic transmissions for this data point	cyclic_timestamp
Event high treshold		analog (float)	Send (refresh) event when the value is above threshold	event_hilimit
Event low treshold		analog (float)	Send (refresh) event when the value is below threshold	event_lolimit
Event hysteresis		analog (float)	Send (refresh) event when the value returns hysteresis amount from high or low threshold	event_limit_hyst
Event window treshold		analog (float)	Send (refresh) event when the value differs threshold amount of last sent value	event_window
Overflow hilimit		analog (float)	Set overflow flag when the value is above limit	overflow_hilimit
Overflow lolimit		analog (float)	Set overflow flag when the value is below limit	overflow_lolimit
Scaling offset		analog (float)	Add offset amount to the value	scaling_add
Scaling gain		analog (float)	Multiply value with gain (after offsetting)	scaling_multiple
Noisegate threshold		analog (float)	When the absolute value is smaller than threshold, detect as zero	noisegate

10.8.4 Single-command settings

The single command can control a value to be on or off.

Table 97: Single-command settings

Setting	Units	Range	Description	Parameter name
Enable data point	binary	off,on		onoff
Information object address	address		Structured or unstructured IOA of this data point	object_address
Name	text	20 chars	Descriptive name for this data point (logging)	name
Intial state	binary	off,on	Initial state of this data point. Off sets all bit to 0, On sets all bits to 1	initial_state
Select pluse execute	binary	off,on	Allow only two-phase commands	require_select
Selection time-out	binary	(int)	Release selection if no further command after select during this time-out	select_timeout_sec
Timestamped commands	s	off,on	Require commands to contain timestamps	require_timestamp
Timestamp allowed difference	s	(int)	Maximum difference between command time and internal time	timestamp_maxage_sec
Short pulse duration	ms	(int)		short_pulse_ms
Long pulse duration	ms	(int)		long_pulse_ms
Termination timeout	ms	(int)	Force pulse termination after this time-out if lower layer does not return termination	termination_timeout_ms
Disable persistent commands	binary	off,on	Allow only pulse commands	disable_persistent

Table continues on next page

Setting	Units	Range	Description	Parameter name
Application-level I/O	binary	off,on	Handle I/O timings on application level rather than on physical/lower layer	application_io
Default output function		short,long,persistent	I/O function to execute when command does not contain additional specification	default_operation
Disable select and execute state match	binary	off,on	Allow value field to differ between select and execute commands	disable_se_match
Allow unusual states	binary	off,on	Allow commands to contain "00" and "11" states	enable_notpermit_cmd
Refresh interval	ms	(int)	How often to refresh lower layer for value	refresh_interval_ms
Invert value	binary	off,on	Invert value for transmission (bit-level inversion)	invert_value

10.8.5 Double-command settings

The double-command value field is two bits and can contain values 0...3. Usually it is used to drive disconnector open and close relays.

Table 98: Single-command settings

Setting	Units	Range	Description	Parameter name
Enable data point	binary	off,on		onoff
Information object address	address		Structured or unstructured IOA of this data point	object_address
Name	text	20 chars	Descriptive name for this data point (logging)	name
Intial state	binary	off,on	Initial state of this data point. Off sets all bit to 0, On sets all bits to 1	initial_state
Select pluse execute	binary	off,on	Allow only two-phase commands	require_select
Selection time-out	s	(int)	Release selection if no further command after select during this time-out	select_timeout_sec
Timestamped commands		off,on	Require commands to contain timestamps	require_timestamp
Timestamp allowed difference	s	(int)	Maximum difference between command time and internal time	timestamp_maxage_sec
Short pulse duration	ms	(int)		short_pulse_ms
Long pulse duration	ms	(int)		long_pulse_ms
Termination timeout	ms	(int)	Force pulse termination after this time-out if lower layer does not return termination	termination_timeout_ms
Disable persistent commands	binary	off,on	Allow only pulse commands	disable_persistent
Application-level I/O	binary	off,on	Handle I/O timings on application level rather than on physical/lower layer	application_io
Default output function		short,long,persistent	I/O function to execute when command does not contain additional specification	default_operation
Disable select and execute state match	binary	off,on	Allow value field to differ between select and execute commands	disable_se_match

Table continues on next page

Setting	Units	Range	Description	Parameter name
Allow unusual states	binary	off,on	Allow commands to contain “00“ and “11“ states	enable_notpermit_cmd
Refresh interval	ms	(int)	How often to refresh lower layer for value	refresh_interval_ms
Invert value	binary	off,on	Invert value for transmission (bit-level inversion)	invert_value

10.9 Disconnector settings

REC601 can control and monitor one disconnector. REC603 is able to control and monitor up to three disconnectors. One disconnector interface forms a disconnector object group which consists of three parts.

- Disconnector status input (double point, open and close level switches)
- Local or remote control switch input (single point)
- Disconnector control output (double point, drive open, drive close)

When the local or remote switch is on “Local” position, the remote control of the disconnector is denied. For the condition monitoring, each disconnector control block has the internal measurements and calculations available.

- Travel-time measurement (the time the disconnector state change takes from closed-to-open or vice-versa)
- Minimum battery voltage during the disconnector state change
- Charge consumed during the disconnector state change.

10.9.1 [DISCONNECTOR_CONTROL_N] (where N=1, 2, 3)

These settings define the remote control properties of the disconnector control outputs. The settings follow the structure of general double-point output but contain an additional *disable_blocking* parameter which defines whether the internal functions (particularly battery testing) can block disconnector remote control.

Table 99: Settings for disconnector control

Setting	Units	Range	Description	Parameter name
Enable data point	binary	off,on	Enable disconnector control by double commands	onoff
Information object address	address	(int)	Structured or unstructured IOA of this data point	object_address
Name			Descriptive name for this data point (logging)	name
Intial state	binary	off,on	Intial state of this data point. Off sets all bit to 0, On sets all bits to 1	initial_state
Select pluse execute	binary	off,on	Allow only two-phase commands	require_select
Selection time-out	s	(int)	Release selection if no further command after select during this time-out	select_timeout_sec

Table continues on next page

Setting	Units	Range	Description	Parameter name
Timestamp commands		off,on	Require commands to contain timestamps	require_timestamp
Timestamp allowed difference	s	(int)	Maximum difference between command time and internal time	timestamp_maxage_sec
Short pulse duration	ms	(int)	Pulse duration when short pulse command executed	short_pulse_ms
Long pulse duration	ms	(int)	Pulse duration when long pulse command executed	long_pulse_ms
Termination timeout	ms	(int)	Force pulse termination after this time-out if lower layer does not return termination	termination_timeout_ms
Disable persistent commands	binary	off,on	Allow only pulse commands	disable_persistent
Application-level I/O	binary	off,on	Handle I/O timings on application level rather than on physical/lower (I/O processor) layer	application_io
Default output function		short,long, persistent	I/O function to execute when command does not contain additional specification. Short or long pulse or persistent.	default_operation
Disable select and execute state match	binary	off,on	Allow value field to differ between select and execute commands	disable_se_match
Allow unusual states	binary	off,on	Allow commands to contain "00" and "11" states	enable_notpermit_cmd
Refresh interval	ms	(int)	How often to rewrite lower layer for value	refresh_interval_ms
Disable blocking	binary	off,on	Disable blocking caused by local functions (for example battery test)	disable_blocking
Invert value	binary	off,on	Invert value for transmission (bit-level inversion)	invert_value

Example

```
[DISCONNECTOR_CONTROL_1]
onoff = on
name = disc1_control
object_address = 1.144.1
disable_blocking = no
initial_state = off
require_select = no
select_timeout_sec = 60
require_timestamp = yes
timestamp_maxage_sec = 30
short_pulse_ms = 800
long_pulse_ms = 2000
termination_timeout_ms = 5000
disable_persistent = no
application_io = no
default_operation = short_pulse
disable_se_match = no
enable_notpermit_cmd = no
application_io = no
refresh_interval_ms = 2000
```

10.9.2 [DISCONNECTOR_STATUS_N] (where N=1, 2, 3)

These settings define how the disconnector status inputs are reported and treated internally. The settings follow the structure of general double-point inputs.

Table 100: Settings for disconnector status

Setting	Units	Range	Description	Configuration parameter
Enable data point	binary	off,on	Enable object data ganeration from disconnector status	onoff
Information object address	address	(int)	Structured or unstructured IOA of this data point	object_address
Name			Descriptive name for this data point (logging)	name
Generate events	binary	off,on	Should this data point generate events	event_generation
Send event when invalid	binary	off,on	Should event be generated when this data point becomes invalid	event_invalid
Event interval	s	(int)	Minimum delay between events generated by this data point	event_interval_sec
Event filtering delay	ms	(int)	How long the value must be changed before sending event	event_filter_ms
Event timestamp format		none,short,long	Timestamp format of asynchroneous events for this data point	event_timestamp
GI group		1...20 (int)	Which GI group this data point belongs (maximum 10 groups on comma-separated list). 20=Global.	gi_group
GI timestamp format		none,short,long	Timestamp format of GI responses for this data point	gi_timestamp
Cyclic group		1...100 (int)	Which cyclic groups this data point belongs (maximum 10 groups on comma-separated list)	cyclic_group
Cyclic timestamp format		none,short,long	Timestamp format of cyclic transmissions for this data point	cyclic_timestamp
Invert value	binary	off,on	Invert value for transmission (bit-level inversion)	invert_value

Example

```
[DISCONNECTOR_STATUS_1]
onoff = on
name = disc1_status
object_address = 1.16.1
event_generation = yes
event_invalid = yes
event_interval_sec = 1
event_filter_ms = 500
event_timestamp = long
gi_group = 20
gi_timestamp = none
cyclic_group = 1
cyclic_timestamp = none
```

10.9.3 [DISCONNECTOR_LOCREM_N] (where N=1, 2, 3)

These settings define how the status of the local or remote switch is reported. Regardless of these settings the physical status of the switch always defines whether the disconnector can be controlled remotely or not. Each disconnector has its own local or remote input. The settings follow the structure of general single-point or double-point inputs.

The selection between single-point or double-point information is done via the *report_blocking_dpi* parameter. When enabled, the reporting is double point where the most significant bit indicates if the disconnector is locally blocked, for example during battery testing, and the least significant bit indicates the actual local or remote switch status.

Table 101: Settings for disconnector local or remote

Setting	Units	Range	Description	Configuration parameter
Enable data point	binary	off,on	Enable object data ganeration from local or remote status	onoff
Information object address	address	(int)	Structured or unstructured IOA of this data point	object_address
Name			Descriptive name for this data point (logging)	name
Generate events	binary	off,on	Should this data point generate events	event_generation
Send event when invalid	binary	off,on	Should event be generated when this data point becomes invalid	event_invalid
Event interval	s	(int)	Minimum delay between events generated by this data point	event_interval_sec
Event filtering delay	ms	(int)	How long the value must be changed before sending event	event_filter_ms
Event timestamp format		none,short,long	Timestamp format of asynchroneous events for this data point	event_timestamp
GI group		1...20 (int)	Which GI group this data point belongs (maximum 10 groups on comma-separated list). 20=Global.	gi_group
GI timestamp format		none,short,long	Timestamp format of GI responses for this data point	gi_timestamp
Cyclic group		1...100 (int)	Which cyclic groups this data point belongs (maximum 10 groups on comma-separated list)	cyclic_group
Cyclic timestamp format		none,short,long	Timestamp format of cyclic transmissions for this data point	cyclic_timestamp
Invert value	binary	off,on	Invert value for transmission (bit-level inversion)	invert_value
Report blocking	binary	off,on	Send local or remote status as DPI and use msb for indicating blocking status. Blocking means the being locally disabled, for example due to battery testing.	report_blocking_dpi

Example

```
[DISCONNECTOR_LOCREM_1]
onoff = on
```

```
name = disc1_locrem
object_address = 1.16.2
report_blocking_dpi = yes
event_generation = yes
event_invalid = yes
event_interval_sec = 1
event_filter_ms = 100
event_timestamp = long
gi_group = 20
gi_timestamp = none
cyclic_group = 1
cyclic_timestamp = none
```

10.9.4 [DISCONNECTOR_TRAVELTIME_N] (where N=1, 2, 3)

These settings define how the disconnector travel time duration (state change from open to close or vice versa) is reported. The settings follow the structure of general floating-point inputs. Additional *travel_** parameters detect and report state transaction time-out, for example, a jammed disconnector preventing the state change to complete. Transaction time is reported in seconds. If no disconnector state change has happened, the reported value is zero and has a non-topical NT flag set.

Table 102: Settings for disconnector travel time

Setting	Units	Range	Description	Parameter name
Enable data point	binary	off,on	Enable object data generation from disconnector state change duration	onoff
Information object address	address	(int)	Structured or unstructured IOA of this data point	object_address
Name			Descriptive name for this data point (logging)	name
Generate events	binary	off,on	Does this data point generate events	event_generation
Send event when invalid	binary	off,on	Is an event generated when this data point becomes invalid	event_invalid
Event interval	s	(int)	Minimum delay between events generated by this data point	event_interval_sec
Event filtering delay	ms	(int)	Time period for changing the value before sending an event	event_filter_ms
Event timestamp format		none,short,long	Timestamp format of asynchronous events for this data point	event_timestamp
GI group		1...20 (int)	The GI group this data point belongs (maximum 10 groups on comma-separated list). 20=Global.	gi_group
GI timestamp format		none,short,long	Timestamp format of GI responses for this data point	gi_timestamp
Cyclic group		1...100 (int)	The Cyclic group the data point belongs (maximum 10 groups on comma-separated list)	cyclic_group
Cyclic timestamp format		none,short,long	Timestamp format of cyclic transmissions for this data point	cyclic_timestamp
Event high treshold		analog (float)	Send (refresh) event when the value is above threshold	event_hilimit

Table continues on next page

Setting	Units	Range	Description	Parameter name
Event low treshold		analog (float)	Send (refresh) event when the value is below threshold	event_lolimit
Event hysteresis		analog (float)	Send (refresh) event when the value returns hysteresis amount from high or low threshold	event_limit_hyst
Event window treshold		analog (float)	Send (refresh) event when the value differs threshold amount of last sent value	event_window
Overflow hilimit		analog (float)	Set overflow flag when the value is above limit	overflow_hilimit
Overflow lolimit		analog (float)	Set overflow flag when the value is below limit	overflow_lolimit
Scaling offset		analog (float)	Add offset amount to the value	scaling_add
Scaling gain		analog (float)	Multiply value with gain (after offsetting)	scaling_multiple
Noisegate threshold		analog (float)	When the absolute value is smaller than threshold, detect as zero	noisegate
Detect travel timeout	binary	off, on	Detect disconnector state change time-out	travel_report_timeout
Travel timeout	ms	(int)	Travel (state change) time-out	travel_timeout_ms
Use OV flag	binary	off, on	Use overflow flag to indicate time-out	travel_use_ovflag
Report travel start	binary	off, on	Send zero value when travel triggered	travel_report_start

Example

```
[DISCONNECTOR_TRAVELTIME_1]
onoff = on
name = disc1_time
object_address = 1.68.1
event_generation = yes
event_invalid = yes
event_interval_sec = 1
event_filter_ms = 2000
event_timestamp = long
gi_group = 20
gi_timestamp = none
travel_timeout_ms = 10000
travel_report_timeout = yes
travel_report_start = no
travel_use_ovflag = yes
```

10.9.5 [DISCONNECTOR_TRAVELVOLT_N] (where N=1, 2, 3)

These settings define how the minimum battery voltage during the disconnector state change (from open to close or vice versa) is reported. This information may be used for estimating the battery or switchgear condition. The settings follow the structure of general floating-point inputs. The voltage is reported in volts. If no disconnector state change has happened, the reported value is zero and has non-topical NT flag set.

Table 103: Settings for disconnector travel volt

Setting	Units	Range	Description	Parameter name
Enable data point	binary	off,on	Enable object data generation from minimum voltage during state change	onoff
Information object address	address	(int)	Structured or unstructured IOA of this data point	object_address
Name			Descriptive name for this data point (logging)	name
Generate events	binary	off,on	Does this data point generate events	event_generation
Send event when invalid	binary	off,on	Is an event generated when this data point becomes invalid	event_invalid
Event interval	s	(int)	Minimum delay between events generated by this data point	event_interval_sec
Event filtering delay	ms	(int)	Time period for changing the value before sending an event	event_filter_ms
Event timestamp format		none,short,long	Timestamp format of asynchronous events for this data point	event_timestamp
GI group		1...20 (int)	The GI group this data point belongs (maximum 10 groups on comma-separated list). 20=Global.	gi_group
GI timestamp format		none,short,long	Timestamp format of GI responses for this data point	gi_timestamp
Cyclic group		1...100 (int)	The cyclic group the data point belongs (maximum 10 groups on comma-separated list)	cyclic_group
Cyclic timestamp format		none,short,long	Timestamp format of cyclic transmissions for this data point	cyclic_timestamp
Event high treshold		analog (float)	Send (refresh) event when the value is above threshold	event_hilimit
Event low treshold		analog (float)	Send (refresh) event when the value is below threshold	event_lolimit
Event hysteresis		analog (float)	Send (refresh) event when the value returns hysteresis amount from high or low threshold	event_limit_hyst
Event window treshold		analog (float)	Send (refresh) event when the value differs threshold amount of last sent value	event_window
Overflow hilimit		analog (float)	Set overflow flag when the value is above limit	overflow_hilimit
Overflow lolimit		analog (float)	Set overflow flag when the value is below limit	overflow_lolimit
Scaling offset		analog (float)	Add offset amount to the value	scaling_add
Scaling gain		analog (float)	Multiply value with gain (after offsetting)	scaling_multiple
Noisegate threshold		analog (float)	When the absolute value is smaller than threshold, detect as zero	noisegate

Example

```
[DISCONNECTOR_TRAVELVOLT_1]
onoff = on
name = disc1_volt
object_address = 1.68.3
event_generation = yes
```

```
event_invalid = yes
event_interval_sec = 1
event_filter_ms = 2000
event_timestamp = long
gi_group = 20
```

10.9.6 [DISCONNECTOR_TRAVELCURRENT_N] (where N=1, 2, 3)

These settings define how the maximum motor current during the disconnector state change (from open to close or vice versa) is reported. This information may be used for estimating the battery or switchgear condition. The settings follow the structure of general floating-point inputs. The current is reported in amperes. If no disconnector state change has happened, the reported value is zero and has a non-topical NT flag set.

Table 104: Settings for disconnector travel current

Setting	Units	Range	Description	Parameter name
Enable data point	binary	off,on	Enable object data generation from minimum voltage during state change	onoff
Information object address	address	(int)	Structured or unstructured IOA of this data point	object_address
Name			Descriptive name for this data point (logging)	name
Generate events	binary	off,on	Does this data point generate events	event_generation
Send event when invalid	binary	off,on	Is an event generated when this data point becomes invalid	event_invalid
Event interval	s	(int)	Minimum delay between events generated by this data point	event_interval_sec
Event filtering delay	ms	(int)	Time period for changing the value before sending an event	event_filter_ms
Event timestamp format		none,short,long	Timestamp format of asynchronous events for this data point	event_timestamp
GI group		1...20 (int)	The GI group this data point belongs (maximum 10 groups on comma-separated list). 20=Global.	gi_group
GI timestamp format		none,short,long	Timestamp format of GI responses for this data point	gi_timestamp
Cyclic group		1...100 (int)	The cyclic group the data point belongs (maximum 10 groups on comma-separated list)	cyclic_group
Cyclic timestamp format		none,short,long	Timestamp format of cyclic transmissions for this data point	cyclic_timestamp
Event high treshold		analog (float)	Send (refresh) event when the value is above threshold	event_hilimit
Event low treshold		analog (float)	Send (refresh) event when the value is below threshold	event_lolimit
Event hysteresis		analog (float)	Send (refresh) event when the value returns hysteresis amount from high or low threshold	event_limit_hyst
Event window treshold		analog (float)	Send (refresh) event when the value differs threshold amount of last sent value	event_window

Table continues on next page

Setting	Units	Range	Description	Parameter name
Overflow hilimit		analog (float)	Set overflow flag when the value is above limit	overflow_hilimit
Overflow lolimit		analog (float)	Set overflow flag when the value is below limit	overflow_lolImit
Scaling offset		analog (float)	Add offset amount to the value	scaling_add
Scaling gain		analog (float)	Multiply value with gain (after offsetting)	scaling_multiple
Noisegate threshold		analog (float)	When the absolute value is smaller than threshold, detect as zero	noisegate

Example

```
[DISCONNECTOR_TRAVELCURRENT_1]
onoff = on
name = disc1_cur
object_address = 1.68.4
event_generation = yes
event_invalid = yes
event_interval_sec = 1
event_filter_ms = 2000
event_timestamp = long
gi_group = 20
```

10.9.7 [DISCONNECTOR_TRAVELCHARGE_N] (where N=1, 2, 3)

These settings define how the charge required for disconnector state change (from open to close or vice versa) is reported. This information may be used for estimating the battery or switchgear condition. The settings follow the structure of general floating-point inputs. The charge is reported in ampere-seconds. If no disconnector state change has happened, the reported value is zero and has a non-topical NT flag set.

Table 105: Settings for disconnector travel charge

Setting	Units	Range	Description	Parameter name
Enable data point	binary	off,on	Enable object data generation from minimum voltage during state change	onoff
Information object address	address	(int)	Structured or unstructured IOA of this data point	object_address
Name			Descriptive name for this data point (logging)	name
Generate events	binary	off,on	Does this data point generate events	event_generation
Send event when invalid	binary	off,on	Is an event generated when this data point becomes invalid	event_invalid
Event interval	s	(int)	Minimum delay between events generated by this data point	event_interval_sec
Event filtering delay	ms	(int)	Time period for changing the value before sending an event	event_filter_ms
Event timestamp format		none,short,long	Timestamp format of asynchronous events for this data point	event_timestamp

Table continues on next page

Setting	Units	Range	Description	Parameter name
GI group		1...20 (int)	The GI group this data point belongs (maximum 10 groups on comma-separated list). 20=Global.	gi_group
GI timestamp format		none,short,long	Timestamp format of GI responses for this data point	gi_timestamp
Cyclic group		1...100 (int)	The cyclic group the data point belongs (maximum 10 groups on comma-separated list)	cyclic_group
Cyclic timestamp format		none,short,long	Timestamp format of cyclic transmissions for this data point	cyclic_timestamp
Event high treshold		analog (float)	Send (refresh) event when the value is above threshold	event_hilimit
Event low treshold		analog (float)	Send (refresh) event when the value is below threshold	event_lolimit
Event hysteresis		analog (float)	Send (refresh) event when the value returns hysteresis amount from high or low threshold	event_limit_hyst
Event window treshold		analog (float)	Send (refresh) event when the value differs threshold amount of last sent value	event_window
Overflow hilimit		analog (float)	Set overflow flag when the value is above limit	overflow_hilimit
Overflow lolimit		analog (float)	Set overflow flag when the value is below limit	overflow_lolimit
Scaling offset		analog (float)	Add offset amount to the value	scaling_add
Scaling gain		analog (float)	Multiply value with gain (after offsetting)	scaling_multiple
Noisegate threshold		analog (float)	When the absolute value is smaller than threshold, detect as zero	noisegate

Example

```
[DISCONNECTOR_TRAVELCHARGE_1]
onoff = on
name = disc1_charge
object_address = 1.68.2
event_generation = yes
event_invalid = yes
event_interval_sec = 1
event_filter_ms = 2000
event_timestamp = long
gi_group = 20
```

10.9.8 Default sections

Each of the three disconnectors often share the same common settings and only the unique settings, such as *onoff*, *name*, *object address* vary. It is possible to define default settings and copy them to each of the disconnector. Every default parameter can still be overridden in disconnector-specific sections. The *onoff*, *name* and *object_address* parameters are not copied and must be defined per disconnector. The [DISCONNECTOR_N] section defining whether the individual disconnector

is enabled at all must be defined separately for each disconnector. There are seven default sections.

- [DISCONNECTOR_CONTROL_DEFAULT]
- [DISCONNECTOR_LOCREM_DEFAULT]
- [DISCONNECTOR_STATUS_DEFAULT]
- [DISCONNECTOR_TRAVELTIME_DEFAULT]
- [DISCONNECTOR_TRAVELVOLT_DEFAULT]
- [DISCONNECTOR_TRAVELCURRENT_DEFAULT]
- [DISCONNECTOR_TRAVELCHARGE_DEFAULT]

Example

```
[DISCONNECTOR_TRAVELCHARGE_DEFAULT]
event_generation = yes
event_invalid = yes
event_interval_sec = 1
event_filter_ms = 2000
event_timestamp = long
gi_group = 20

[DISCONNECTOR_TRAVELCHARGE_1]
onoff = on
name = disc1_charge
object_address = 1.68.2

[DISCONNECTOR_TRAVELCHARGE_2]
onoff = on
name = disc2_charge
object_address = 2.68.2

[DISCONNECTOR_TRAVELCHARGE_3]
onoff = on
name = disc3_charge
object_address = 3.68.2
```

10.10 Internal inputs

The device has various internal data sources like temperature measurement and voltage alarms which can be reported. Internal data sources are not available on external I/O connectors.

10.10.1 [POWER_SUPPLY_STATUS_SPI]

Defines how the AC supply status is reported.

- 0 = AC power not available, running on batteries or external DC supply
- 1 = AC power available

10.10.2 [MODEM_RELAY_STATUS_SPI]

The device has a 24 V DC power output on the X2.1 pin 6. Usually, the power output is used for external modems and other external components like a Hall current sensor. An internal relay controls whether power is supplied out from this pin or not. Due to the internal connection, DC power can always be fed to the device through this pin regardless of the relay status. The settings define how the modem relay status is reported.

- 0 = Relay contacts open (power output disabled)
- 1 = Relay contacts closed (power output available)

10.10.3 [BATTERY_RELAY_STATUS_SPI]

The device has a built-in 24 V DC battery charger. The charging is available on the X2.1 pin 10. The battery is disconnected from the device in case of deep-discharge protection. The settings define how the battery connection status is reported

- 0 = Battery relay contacts open (battery disconnected from the device)
- 1 = Battery relay contacts closed (battery connected to the device)

10.10.4 [CHARGER_RELAY_STATUS_SPI]

The device has a built-in 24 V DC battery charger. Charging is available on the X2.1 pin 10. The charger is disconnected from the battery in case of battery testing. The settings define how the charger connection status is reported

- 0 = Charger relay contacts open (charger disconnected from the battery and the device)
- 1 = Charger relay contacts closed (charger connected to the battery and the device)

10.10.5 [BATTERY_LOW_SPI]

The device can detect low battery voltage and send alarm of the situation. The settings define how the low battery voltage status is reported.

- 0 = Battery voltage above the low voltage limit (alarm inactive)
- 1 = Battery voltage below the low voltage limit (alarm active)

10.10.6 [BATTERY_PROTECT_SPI]

The device can detect if the battery voltage is below the deep-discharge limit and send an alarm of the situation. Additionally all the load, including the device itself,

is disconnected from the battery to prevent battery failure due deep discharge. The settings define how the battery deep-discharge protection status is reported.

- 0 = Normal operation
- 1 = Protection active (battery is disconnected)

10.10.7 [TEMPERATURE_LOW_SPI]

The device can detect low temperature and send an alarm of the situation. The settings define how the low temperature status is reported.

- 0 = Temperature above the low limit (alarm inactive)
- 1 = Temperature below the low limit (alarm active)

10.10.8 [TEMPERATURE_HI_SPI]

The device can detect low temperature and send an alarm of the situation. The settings define how the low temperature status is reported.

- 0 = Temperature below the high limit (alarm inactive)
- 1 = Temperature above the high limit (alarm active)

10.10.9 [HEATER_RELAY_STATUS_SPI]

The device contains an internal thermostat for controlling the external heater. The settings define how the heating status is reported.

- 0 = Heating off
- 1 = Heating on

10.10.10 [BATTERY_CHARGEVOLTAGE_FPI]

The device measures the voltage used to charge the external battery. This voltage can be reported as short a floating-point value. The reporting unit is volts.

10.10.11 [BATTERY_CHARGECURRENT_FPI]

The device measures the current used to charge the external battery. This current can be reported as a short floating-point value. The reporting unit is amperes. The negative current indicates that the device is consuming the battery instead of charging.

10.10.12 [TEMPERATURE_FPI]

The device measures the internal case temperature. This temperature can be reported as a short floating-point value. The reporting unit is degrees Celsius.

10.10.13 [LOAD_LIMITER_STATUS_DPI]

The device can detect excessive loading of the battery, for example resulting from a jammed disconnector switchgear, and disconnect the load before the actual physical overcurrent fuse trips. The settings define how the load limiter status is reported.

- 0 = Load limiter idle (monitoring load)
- 1 = Load limiter disabled (does not monitor load)
- 2 = Loading detected, accumulating
- 3 = Overload, load disconnected

10.10.14 [LOAD_LIMITER_REASON_DPI]

The device can detect excessive loading of the battery, for example resulting from a jammed disconnector switchgear, and disconnect the load before the actual physical overcurrent fuse trips. The overload decision is based on both consumed charge and duration of the loading. Once the overload situation is detected, the reason can be reported as a double-point input. The settings define how the load limiter reason is reported.

- 0 = None, overload situation never detected
- 1 = Overload caused by consumed charge
- 2 = Overload caused by duration of loading
- 3 = Overload detected by manual command.

10.10.15 [LOAD_LIMITER_CHARGE_FPI]

The device can detect excessive loading of the battery, for example resulting from a jammed disconnector switchgear, and disconnect the load before the actual physical overcurrent fuse trips. The overload decision is based on both consumed charge and duration of the loading. Once the overload situation is detected, the accumulated charge can be reported as a short floating-point value. The reporting unit is ampere-seconds. If no overload situation is detected, the reported value is zero and has a non-topical NT flag set.

10.10.16 [LOAD_LIMITER_TIME_FPI]

The device can detect excessive loading of the battery, for example resulting from a jammed disconnector switchgear, and disconnect the load before the actual physical overcurrent fuse trips. The overload decision is based on both consumed

charge and duration of the loading. Once the overload situation is detected the loading duration can be reported as a short floating-point value. The reporting unit is seconds. If no overload situation is detected, the reported value is zero and has non-topical NT flag set.

10.10.17 [BATTERY_TEST_STATUS_DPI]

The device can test the real capacity of the battery by disconnecting the charger and draining the battery to a certain voltage level by using an external loading resistor.

The settings define how the battery test status is reported.

- 0 = Idle (not testing the battery)
- 1 = Testing (discharging the battery by using external load)
- 2 = Test complete
- 3 = Test aborted

10.10.18 [BATTERY_TEST_CHARGE_FPI]

The device can test the real capacity of the battery by disconnecting the charger and draining the battery to a certain voltage level by using an external loading resistor. The measured battery capacity can be reported as a short floating-point value. The reporting unit is ampere-hours. The measured capacity is always reported after the test is completed regardless of the *event_window* or *event_filter* settings that control the reporting frequency during the testing phase.

10.11 Physical general-purpose inputs

Most of the physical inputs are shared between the general-purpose usage and the device functionality. For example, when disconnector 1 is enabled, DI1, DI2 and DI5 cannot be used as general purpose inputs. If both disconnector and general-purpose inputs are configured to the same pins, the device application refuses to start.

10.11.1 [DIGITAL_INPUT_SPI_N] (where N=1 … 17)

When the pin is configured as a general purpose single-point input, its value can be reported as a single-point input object.

- 0 = Off (no current flows through the input)
- 1 = On (current flows through the input)

The internal circuits of inputs are bi-directional and current can flow to either direction.

10.11.2 [DIGITAL_INPUT_DPI_N] (where N=1 … 6)

When the pin is configured as a general purpose double-point input, then its value can be reported as a double-point input object.

- 0 = Intermediate state (no current flows through either input)
- 1 = Open state (current flows between “open” pin and common)
- 2 = Closed state (current flows between “closed” pin and common)
- 3 = Fail state (current flows between both “open” and “closed” pins and common)

The internal circuits of inputs are bi-directional and current can flow to either direction. One double-point input consumes two physical inputs.

10.11.3 [ANALOG_INPUT_FPI_N] (where N=1, 2)

The analog inputs can operate either on voltage mode (measurement range -5...5 V, input impedance 2.2 kΩ) or current mode (measurement range 4…20 mA, with external resistor). The measurement result can be reported as a short floating-point value. The reporting unit is volts or milliamperes, depending on the mode selection. The mode is selected with the internal DIP switches and the *[PHYSICAL_EXTAIMODE_N]* section. The internal DIP switches change the measurement circuit, and the *[PHYSICAL_EXTAIMODE_N]* section changes the internal calibration and scaling.

10.11.4 Default sections

The general-purpose inputs often share the same common settings and only the unique settings such as *onoff*, *name*, *object address* vary. It is possible to define default settings and copy them to each general-purpose input of the same type. Every default parameter can still be overridden in the input-specific sections. The *onoff*, *name* and *object_address* parameters are not copied and must be defined per input. There are three default sections.

- [DIGITAL_INPUT_SPI_DEFAULT]
- [DIGITAL_INPUT_DPI_DEFAULT]
- [ANALOG_INPUT_FPI_DEFAULT]

Example

```
[DIGITAL_INPUT_SPI_DEFAULT]
event_generation = yes
event_invalid = yes
event_interval_sec = 3
event_filter_ms = 100
event_timestamp = long
gi_group = 20
gi_timestamp = none
cyclic_group = none
```

```
cyclic_timestamp = long

#extradi1 (X4-12)
[DIGITAL_INPUT_SPI_16]
onoff = on
object_address = 1116
name = extradi_1
```

10.12 Internal outputs

The device has internal data points which can be controlled remotely. Internal data points are not available on external I/O connectors.

10.12.1 [LOAD_LIMITER_CONTROL_SC]

The device can detect excessive loading of the battery, for example resulting from a jammed disconnector switchgear, and disconnect the load before the actual physical overcurrent fuse trips. This overloading detection can be enabled or disabled remotely by using a single-command value.

- 0 = Disable load limiter
- 1 = Enable load limiter (if enabled on configuration file)

10.12.2 [BATTERY_TEST_CONTROL_SC]

The device can test the real capacity of the battery by disconnecting the charger and draining the battery to a certain voltage level by using an external loading resistor. This testing can be started or stopped remotely by using a single-command value

- 0 = Manually stop the battery test
- 1 = Start the battery test (if enabled on configuration file)

10.13 General-purpose outputs

Most of the physical outputs are shared between the general-purpose usage and the device functionality. For example, when the disconnector 1 is enabled, DO1 and DO2 cannot be used as general purpose outputs. If both the disconnector and general-purpose outputs are configured to the same pins, the device application refuses to start.

10.13.1 [DIGITAL_OUTPUT_SC_N] (where N=1 … 10)

When the pin is configured as a general-purpose single-point output, its value can be remotely controlled with a single command

- 0 = Off (output relay de-energized)
- 1 = On (output relay energized)

Most relays are normally open type, meaning that the contacts are open (non-conducting) when the relay is de-energized. However, the load-cut relay (DO7, X4 pins 1-2) however is normally closed.

10.13.2 [DIGITAL_OUTPUT_DC_N] (where N=1, 2, 3)

When the pin is configured as a general purpose double-point output, its value can be remotely controlled with a double command.

- 0 = Off (both output relays de-energized)
- 1 = Open (output relay “open” energized)
- 2 = Close (output relay “close” energized)
- 3 = Fail (both output relays energized)

Relays are normally open type,meaning that the contacts are open (non-conducting) when the relay is de-energized. One double output consumes two physical outputs.

10.13.3 Default sections

The general-purpose outputs often share the same common settings and only the unique settings (such as *onoff*, *name*, *object address*) vary. It is possible to define default settings and copy them to each general-purpose output of same type. Every default parameter can still be overridden in the output-specific sections. The *onoff*, *name* and *object_address* parameters are not copied and must be defined per output. There are two default sections.

- [DIGITAL_OUTPUT_SC_DEFAULT]
- [DIGITAL_OUTPUT_DC_DEFAULT]

Example

```
[DIGITAL_OUTPUT_SC_DEFAULT]
initial_state = off
require_select = yes
select_timeout_sec = 30
require_timestamp = yes
timestamp_maxage_sec = 120
short_pulse_ms = 500
long_pulse_ms = 2000
termination_timeout_ms = 5000
disable_persistent = no
application_io = no
default_operation = short_pulse
```

```
disable_se_match = no
enable_notpermit_cmd = no
application_io = no
refresh_interval_ms = 2000

#extrado (X4 14-15)
[DIGITAL_OUTPUT_SC_10]
onoff = on
object_address = 2110
name = extrado
```

10.14 Functions

The device contains internal function blocks implementing common tasks required at the disconnector station. These functions include, for example, heater-thermostat, temperature alarms, battery deep-discharge protection and overload limiter. The settings above configured show how the status of these functions can be remotely monitored and controlled. The settings control the operational parameters of these functions.

10.14.1 [POWER_MONITOR]

The power monitor settings define how the device monitors the internal inputs and controls the internal relays related to the power supply.

Table 106: Settings for power monitor

Setting	Units	Range	Description	Parameter name
Control internal power-related outputs/inputs	binary	off,on	Control internal power-related outputs/inputs	onoff
Monitor AC supply status	binary	off,on	Monitor internal input telling whether AC supply is available or not.	monitor_ac
Control battery relay	binary	off,on	Connect battery to charger on normal situation, disconnect battery on deep-discharge situation	control_battery
Control modem supply	binary	off,on	Power up modem supply (X2.1 pin 6) on normal situation	control_modem
Control charger	binary	off,on	Connect charger output to REC601/603 internal power on normal situation	control_charger
Update interval	ms	(int)	How often to check input status or rewrite output status	update_interval_ms

Example

```
[POWER_MONITOR]
onoff = on
monitor_ac = yes
control_battery = yes
control_modem = yes
control_charger = yes
update_interval_ms = 200
```

10.14.2 [BATTERY_MONITOR]

The battery voltage monitor generates an alarm when the battery voltage falls below a defined limit. The reporting of this situation can be delayed on [BATTERY_LOW_SPI] by *event_filter_ms* parameter.

Table 107: Settings for battery monitor

Setting	Units	Range	Description	Parameter name
Monitor battery low voltage	binary	off,on	Detect battery low voltage situation	onoff
Battery low voltage alarm threshold	V	(float)	When voltage below threshold, alarm is generated	loalarm_limit
Battery low voltage alarm hysteresis	V	(float)	When voltage above threshold+hysteresis, alarm is cleared	alarm_hyst

Example

```
[BATTERY_MONITOR]
onoff = yes
loalarm_limit = 22
alarm_hyst = 1
```

10.14.3 [BATTERY_DISCHARGE_PROTECTION]

When the battery voltage falls below a certain value, the battery is almost empty. To prevent battery damage, the battery should not be further discharged. The battery deep-discharge protection function disconnects the battery from the device in two cases.

- AC supply is not available to charge the battery
- Battery voltage is long enough below the defined limit

Usually the deep-discharge protection causes the device to shut down due lack of power. The device recovers from the situation once the AC supply comes available again or it is powered up with the DC on modem-supply pin. All the external loads such as a Hall sensor or an additional DC powered device should not be connected directly to the battery but to the modem supply pin (X2.1 pin 6) of the master device. In this way all the load can be removed at once when deep-discharge protection is required.

Table 108: Settings for battery discharge protection

Setting	Units	Range	Description	Parameter name
Enable deep discharge protection	binary	off,on	Disconnect all load from battery to prevent deep discharge	onoff
Battery deep discharge protection threshold	V	(float)	When voltage below threshold, time accumulation is started	trigger_limit
Battery deep discharge porotection hysteresis	V	(float)	When voltage above threshold plus hysteresis, accumulation is stopped	trigger_hyst
Battery deep discharge protection filtering delay	s	(int)	When accumulation duration exceeds delay, disconnect battery	trigger_filter_sec

Example

```
[BATTERY_DISCHARGE_PROTECTION]
onoff = on
trigger_limit = 20
trigger_hyst = 2
trigger_filter_sec = 100
```

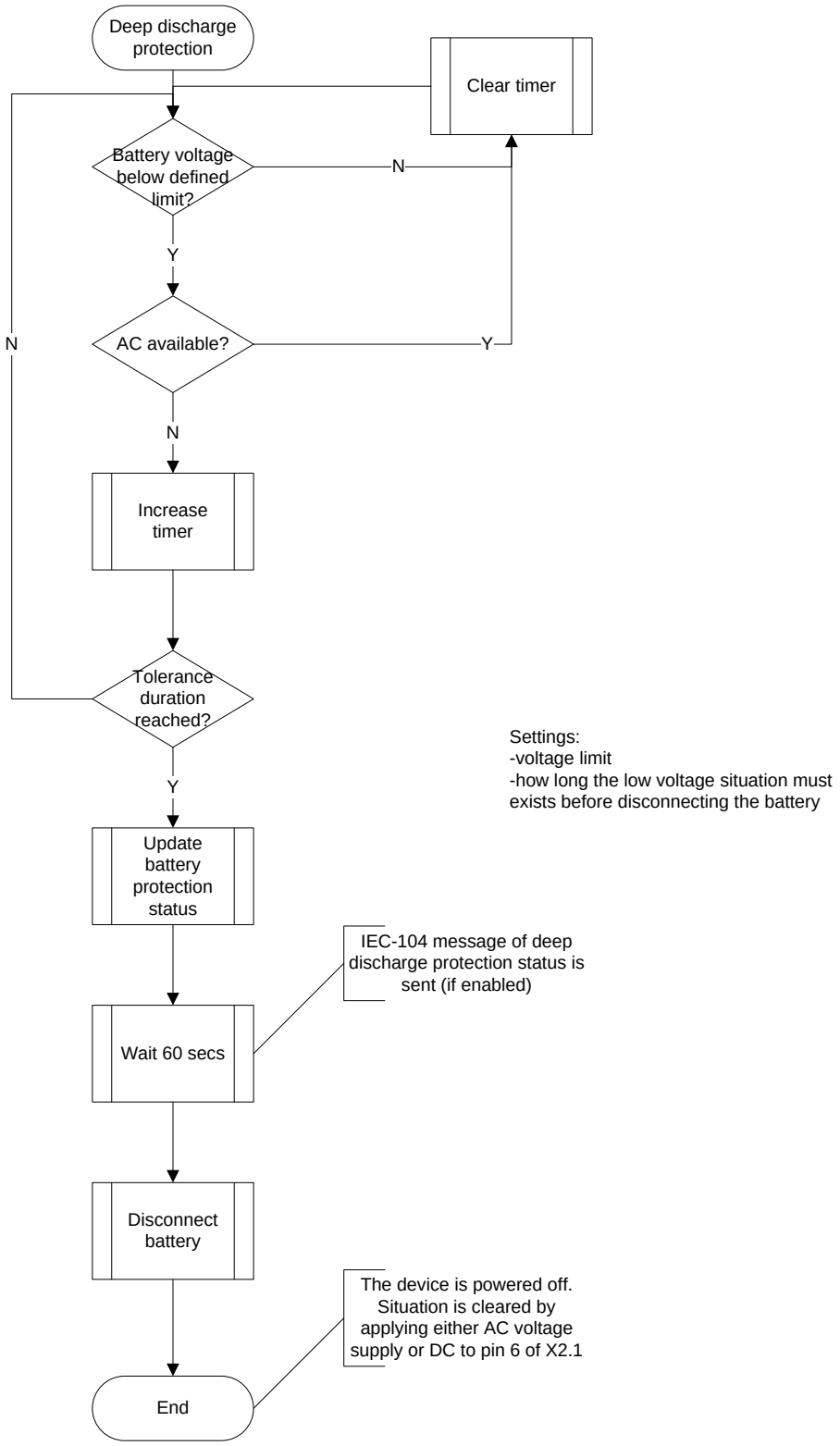

Figure 53: Deep discharge protection

10.14.4 [LOTEMP_MONITOR]

The low temperature monitor generates an alarm when the temperature falls below a defined limit. The reporting of this situation can be delayed on [TEMPERATURE_LOW_SPI] by *event_filter_ms* parameter.

Table 109: Settings for low temperature monitor

Setting	Units	Range	Description	Parameter name
Monitor low temperature	binary	off,on	Detect low temperature situation	onoff
Temperature low alarm threshold	C	(float)	When temperature below threshold, alarm is generated	loalarm_limit
Temperature low alarm hysteresis	C	(float)	When temperature above threshold plus hysteresis, alarm is cleared	alarm_hyst

Example

```
[LOTEMP_MONITOR]
onoff = yes
loalarm_limit = -5
alarm_hyst = 2
```

10.14.5 [HITEMP_MONITOR]

The high temperature monitor generates an alarm when the temperature rises above a defined limit. The reporting of this situation can be delayed on [TEMPERATURE_HI_SPI] by *event_filter_ms* parameter.

Table 110: Settings for high temperature monitor

Setting	Units	Range	Description	Parameter name
Monitor High Temperature	binary	off,on	Detect high temperature situation	onoff
Temperature High Alarm Threshold	C	(float)	When temperature above treshold, alarm is generated	hialarm_limit
Temperature High Alarm Hysteresis	C	(float)	When temperature below treshold minus hysteresis, alarm is cleared	alarm_hyst

Example

```
[HITEMP_MONITOR]
onoff = yes
hialarm_limit = 80
alarm_hyst = 2
```

10.14.6 [LOAD_LIMITER]

The device can detect excessive loading of the battery, for example resulting from a jammed disconnector switchgear, and disconnect the load before actual physical overcurrent fuse trips. The overload decision is based on both consumed charge

and duration of the loading. The current is measured usually by an external Hall-sensor which is connected to an analog input 1 (X4 3-4). The device uses a normally-closed relay (X4 1-2) to break down the loading circuit by opening the relay contacts for a moment. Usually this cuts the holding circuit of the motor contactors and not the motor current directly.

Table 111: Settings for load limiter

Setting	Units	Range	Description	Parameter name
Enable load limiter	binary	off,on	Detect and cut excessive load (jammed disconnector)	onoff
Query interval	ms	1...5000	How often to query I/O processor for load limiter status	query_interval_ms
Reply timeout	ms	1...5000	How long to wait for I/O processor response	reply_timeout_ms
Retry limit		0...10	How many times to retry	reply_retries
Offset	raw_ad	0...10000	Internal a/d offset (automatic)	offsett
Load limiter activation threshold	A	(float)	When current above threshold, accumulation is started	activation_current
Load limiter activation filtering delay	ms	(int)	How long current must be above threshold before starting to accumulate	activation_time_ms
Load limiter deactivation threshold	A	(float)	When current below threshold, accumulation is stopped	deactivation_current
Load limiter deactivation filtering delay	ms	(int)	How long current must be below threshold before accumulation is stopped	deactivation_time_ms
Load limiter charge threshold	As	(float)	When accumulated charge exceeds threshold, trip action is performed	trip_charge
Load limiter time threshold	s	(int)	When accumulated time exceeds threshold, trip action is performed	trip_time_sec
Load limiter trip duration	s	(int)	Duration of trip operation (auto-reset)	trip_duration_sec

Example

```
[LOAD_LIMITER]
onoff = on
activation_current = 5
activation_time_ms = 200
deactivation_current = 0.5
deactivation_time_ms = 500
trip_charge = 40
trip_time_sec = 10
trip_duration_sec = 5
```

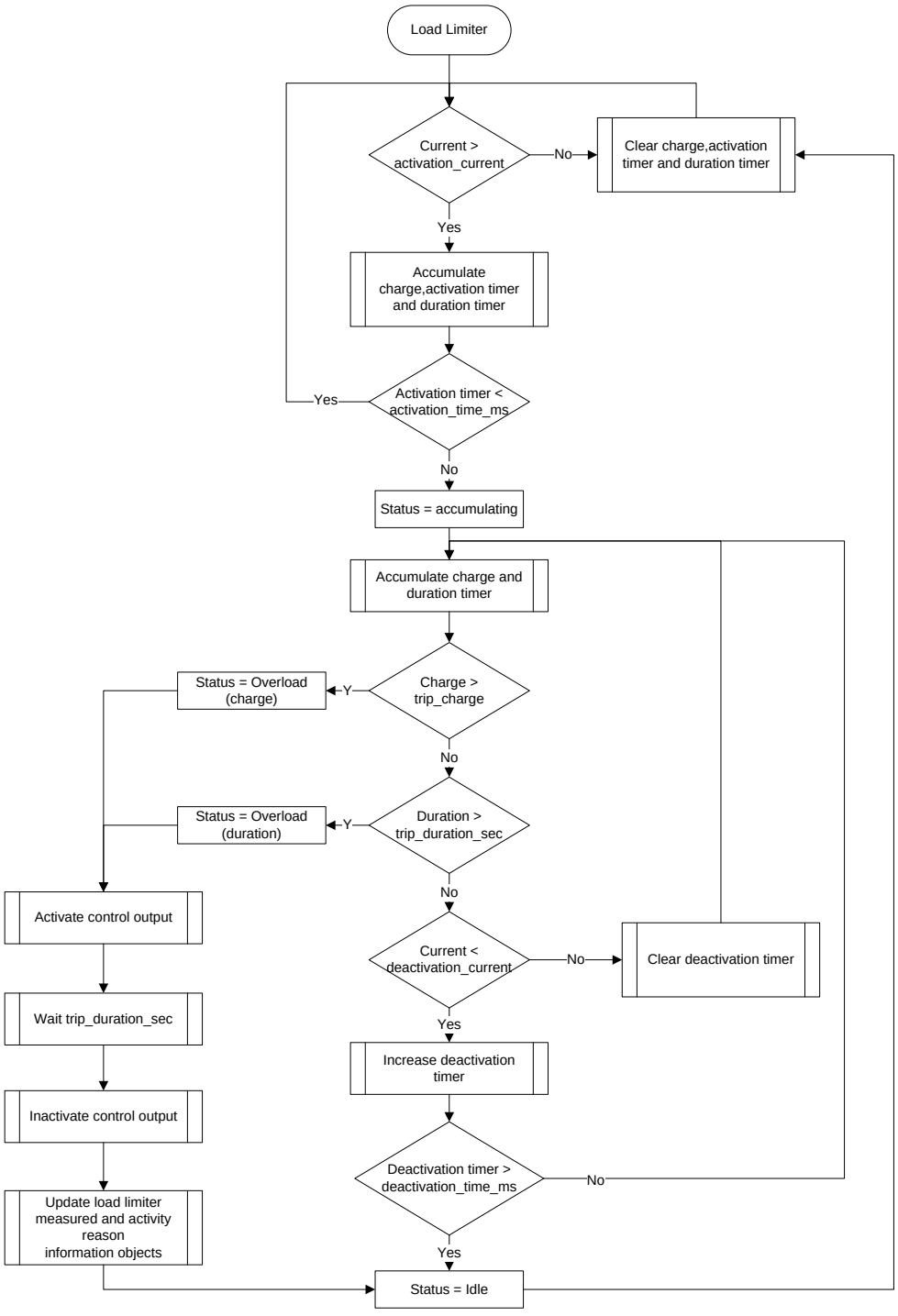

Figure 54: Load limiter logic

10.14.7 [HEATER]

The device contains an internal thermostat for controlling an external heater.

Table 112: Settings for heater

Setting	Units	Range	Description	Parameter name
Enable heater	binary	off,on	Control heater	onoff
Heater output	pin	1...7	Which DO pin to use as heater output	heater_output
Heater mode	binary	off,on,auto	Heater always off, always on or thermostat controlled	heater_mode
Heater thermostat treshold	C		When temperature below threshold, start heating	trigger_limit
Heater thermostat hysteresis	C		When temperature above threshold plus hysteresis, heating is stopped	trigger_hyst
Heater thermostat AC detect	binary	no, yes	When enabled the AC must be available for heating	detect_ac

Example

```
[HEATER]
onoff = on
heater_output = 9
heater_mode = auto
trigger_limit = 5
trigger_hyst = 4
detect_ac = yes
```

10.14.8 [BATTERY_TEST]

The device can test the real capacity of the battery by disconnecting the charger and draining the battery to a certain voltage level by using an external loading resistor.

Table 113: Settings for battery test

Setting	Units	Range	Description	Description
Enable battery test	binary	off, on	Allow battery test functionality	onoff
Disable disconnector control during battery test	binary	off, on	Locally block disconnectors when battery test is active	block_disconnectors
Include own current consumption	binary	off, on	Add product's own current consumption to the actual test current drained out from the battery	add_own_consumption
Abort test if no AC available	binary	off, on	Abort the battery test if AC supply not available	abort_no_ac
Abort if temperature too high	binary	off, on	Abort the battery test if the internal temperature is too high	abort_hitemp
Abort if temperature too low	binary	off, on	Abort the battery test if the internal temperature is too low	abort_lotemp
Abort if test takes too long	binary	off, on	Abort the battery test if the target voltage level is not reached during certain time	abort_duration
Abort if test current too low	binary	off, on	Abort the battery test if the measured discharge current is too low	abort_lowcur
Abort if test current too high	binary	off, on	Abort the battery test if the measured discharge current is too high	abort_hicur

Table continues on next page

Setting	Units	Range	Description	Description
Hi-Temperature limit	C	(float)	Limit for hi-temperature abortion	hitemp_limit
Lo-Temperature limit	C	(float)	Limit for low-temperature abortion	lotemp_limit
Duration limit	seconds	(int)	Limit for test duration abortion	duration_limit_sec
Hi-Current limit	A	(float)	Limit for hi-current abortion	hicur_limit
Lo-Current limit	A	(float)	Limit for low-current abortion	locur_limit
Sampling interval	seconds	(int)	How often to sample the discharge current	sample_interval_sec
Abortion tolerance filter	samples	(int)	How many samples the abortion condition must exist before actually aborting the test	abort_filter_samples
Abortion tolerance filter	seconds	(int)	How long to integrate samples for averaging the discharge current	averaging_interval_sec
Target voltage	V	(float)	Target battery voltage for test completion	target_voltage
Target voltage filter	samples	(int)	How many samples the battery voltage must be below the target limit before completion	target_filter_samples
Cabling loss	mV	(float)	Add cabling loss to the measured battery voltage	cabling_loss_mv
Charge multiplier		(float)	Scaling constant for multiplying consumed charge (e.g. if battery will be 90% discharged the multiplier would be 1.1)	charge_multiplier
Generate measurement file	binary	off, on	Write test results to a file	write_measurement_fille
Measurement file name	filename		Where to write the measurement file	measurement_file

Usually the disconnectors are internally blocked during the battery test and the test should be remotely stopped before the disconnectors can be operated. The blocked state can be indicated by configuring the local or remote status to double-point indication.

The load-limiter functionality and the heater are disabled during the test.

The measurement file is written in intervals defined by the *averaging_interval_sec* parameter and each line contains a timestamp, status, battery voltage, discharge current and the charge consumed so far. The file header contains the unloaded battery voltage before the load is applied. The last line of the file contains information on whether the test was completed successfully or aborted by a specific reason.

Example

```
[BATTERY_TEST]
onoff = on
block_disconnectors = yes
add_own_consumption = yes
abort_no_ac = yes
abort_hitemp = yes
abort_lotemp = yes
abort_duration = yes
abort_lowcur = yes
abort_hicur = yes
hitemp_limit = 80
lotemp_limit = -20
duration_limit_sec = 36000
```

```
lowcur_limit = 0.5
hicur_limit = 3.5
sample_interval_sec = 10
abort_filter_samples = 10
averaging_interval_sec = 60
target_voltage = 21
cabling_loss_mv = 0
charge_multiplier = 1.1
target_filter_samples = 10
write_measurement_file = yes
measurement_file = /var/batterytest.meas
```

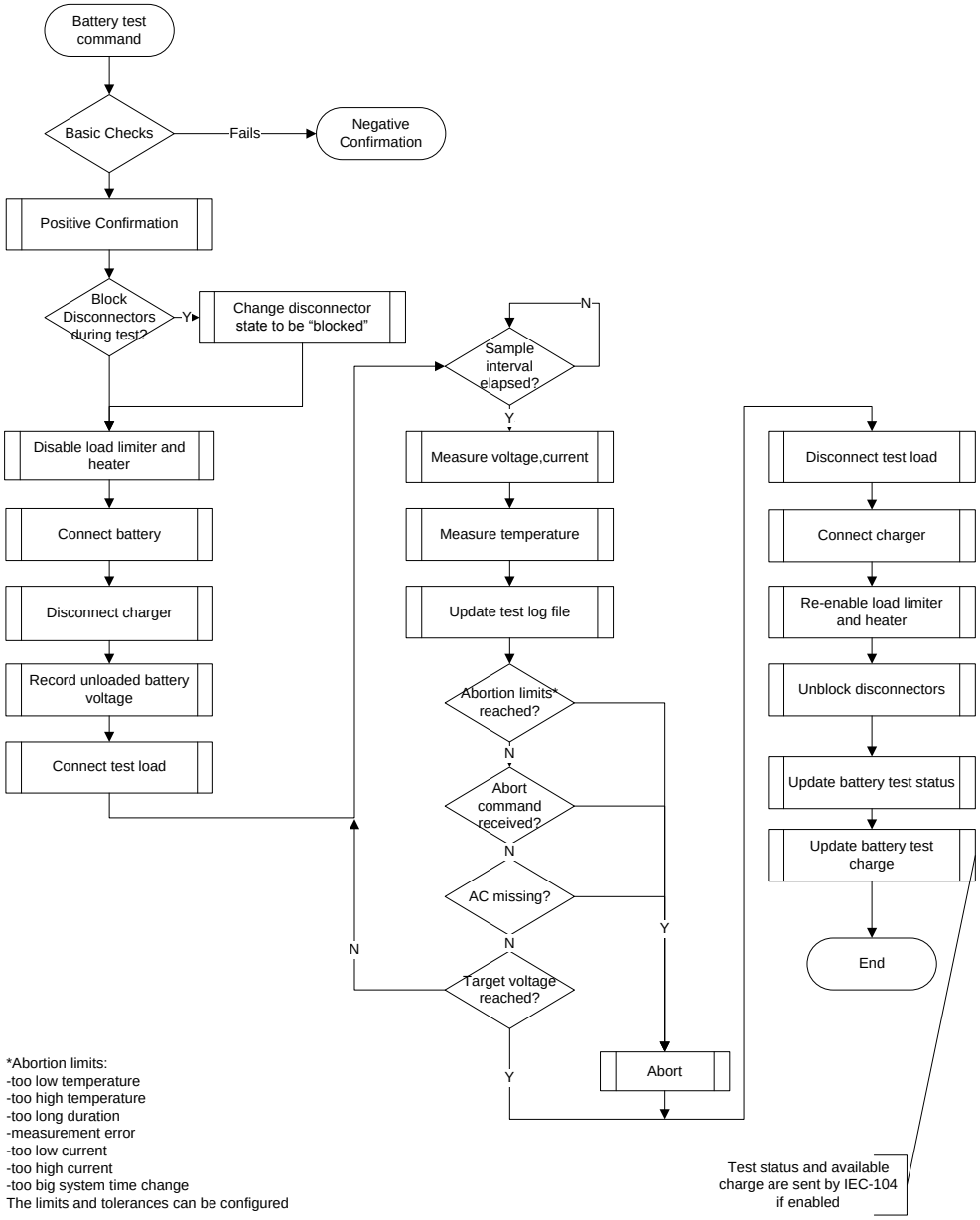

Figure 55: Battery test

10.14.9 [PWM_CHARGER]

The device normally float-charges the battery and has an internal method for limiting the charging current by adjusting the charging voltage. For charging larger than 25 Ah batteries, the internal (secondary protection) PTC fuses can activate. The pulse-mode charging can be used in these situations to reduce the average current and prevent the charger overloading. In this mode the charger relay is used to periodically connect and disconnect the charger from the battery. With the batteries less than 25 Ah the pulse-mode charging is not required.

Table 114: Settings for PWM charger

Setting	Units	Range	Description	Parameter name
Enable pulse-mode charging	binary	off,on	Use pulse-mode charging mode	onoff
Activation current	A	(float)	Activate pulse-mode when the charging current exceeds this limit	activation_current
De-Activation current	A	(float)	Stop using pulse-mode charging (and start using constant charging) when the charging current is below this limit	deactivation_current
Activation filter	seconds	(int)	How many seconds the charging current must exceed the limit before activating the pulse-mode	activation_time_sec
De-Activation filter	seconds	(int)	How many seconds the charging current must be below the limit before falling back to constant mode	deactivation_time_sec
On-cycle duration	seconds	(int)	The duration when the charger is connected	on_duty_sec
Off-cycle duration	seconds	(int)	The duration when the charger is disconnected	off_duty_sec
Minimum cycle count	cycles	(int)	Once pulse-mode is activated perform at least this many cycles even if the charging current is below the deactivation current	min_cycles
Background testing interval	seconds	(int)	Periodically disconnect the charger for certain time to cool down the PTC fuses and after that test the charging current	test_interval_sec
Cooling-down time	seconds	(int)	How many seconds to keep the charger connected from battery before performing the background testing	test_off_sec

When the pulse-mode charging is active, the charging current and charging voltage vary between on-cycle and off-cycle. Similarly the charger relay status changes on the every cycle. If the events are not required on each cycle the *event_filter_ms* of the affected input objects should be set little longer than the *off_duty_sec* but still shorter than the *on_duty_sec*.

Example

```
[PWM_CHARGER]
onoff = on
activation_current = 1.8
deactivation_current = 1.3
```

```
activation_time_sec = 30
deactivation_time_sec = 10
on_duty_sec = 30
off_duty_sec = 20
min_cycles = 5
test_off_sec = 240
test_interval_sec = 86400
```

10.15 Updating the configuration file on command prompt

The device web user interface (applications RTU) contains the configuration file which can be modified and saved. It is also possible to download the configuration file directly to the device from a configuration server. The server serving the configuration files must support HTTP or FTP protocol.

The configuration file is located at `/home/rtu/rtu.conf`.

Commands can be given through a serial console or a telnet console but not through the WEB-UI command-line tool.

1. Type **#cd/home/rtu** to go to the correct directory.
2. Type **#pwd** to see the directory is correct.
3. Type **#cp rtu.conf rtu.old** to make a copy of the old configuration.
   The old configuration file becomes **rtu.old**
4. Type **#wget http://ip_of_the_server/my_rtu_filename** to download a new configuration file by using HTTP.
   Here ip_of_the_server is the IP address of the configuration server and the my_rtu_filename is the file name of the new configuration to be downloaded.
5. Type **#mv my_rtu_filename rtu.conf** to overwrite the existing configuration file with the new one.
   This step is possible when the download is 100% complete.
6. Type **#killall rtu** to restart the rtu application.

To switch back to the old configuration type (on the correct directory) **#mv rtu.old rtu.conf**

10.16 Expansion devices

The device contains a driver for the Horstmann ComPass-B and Kries IKI-50 fault indicators. The driver polls the fault indicator devices by using Modbus and converts the values to IEC 60870-5-104. Up to four fault indicators can be connected.

The fault indicators are connected to serial port RS2 using RS-485 cabling. If serial port RS1 is used, an external RS-232 to RS-485 converter is required. It is recommended to use the external optical isolators.

REC601/603 device supports pre-selected Modbus register range based on the most common grid automation application.

10.16.1 Common settings for expansion devices

The common settings for the supported 3rd party devices are defined in the section [EXPANSION_LINE].

Table 115: EXPANSION LINE settings

Setting	Units	Range	Description	Parameter Name
Enable this expansion line	binary	off,on		onoff
Name		text	Descriptive name for this expansion line for logging	name
Startup script		text	System command or script to be executed before line startup	start_script
Expansion bus identification		(int)	Defines unique identification for this expansion line. This identification will be used by module drivers for directing the communication to correct expansion line.	line_index
Line type		serial,tcp	Whether the line uses serial or TCP/IP communication	type
Serial port	RS port	RS1, RS2	The serial port to be used on serial communication mode	physical
Serial speed	bps	300 - 115200	Serial speed used on serial communication mode	speed
Serial data bits	bits	7,8	Serial data bits used on serial communication mode	databits
Serial stop bits	bits	1,2	Serial stop bits used on serial communication mode	stopbits
Serial parity		N,E,O	Serial parity used on serial communication mode	parity
Serial handshaking		None (N), Hardware (H)	Serial handshaking used on serial communication mode	handshaking

Example

```
[EXPANSION_LINE]
onoff=off
line_index=1
name=serial1
type=serial
start_script=
physical=RS2
```

```
speed=9600
databits=8
stopbits=1
parity=E
handshaking=N
```

10.16.2 Horstmann ComPass B fault indicator

The common settings for the fault indicator connection are defined in the section [COMPASS_POLLER]. When the serial port is used for ComPass communication, it cannot be used for other purposes.

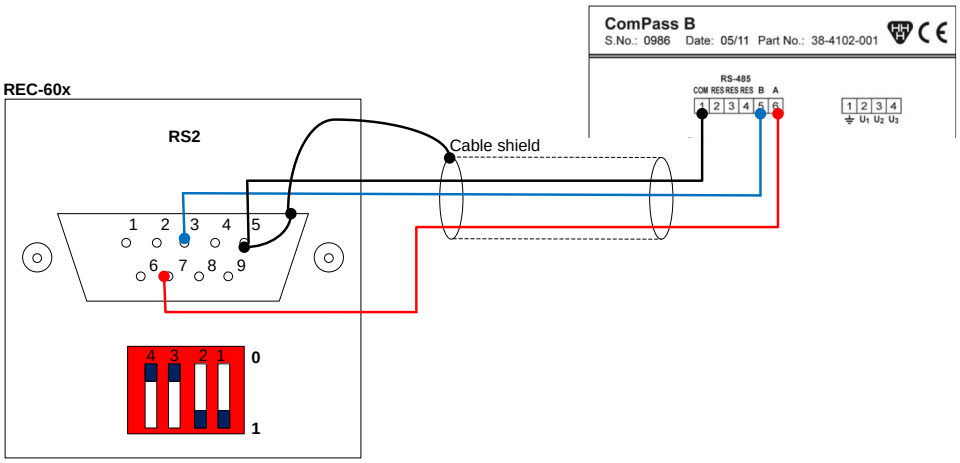

Figure 56: Physical connection between ComPass and REC601/REC603

Table 116: Main settings of ComPass B

Setting	Units	Range	Description	Parameter Name
Enable ComPass poller	binary	off,on		onoff
Run interval	ms	1-5000 (int)	How often to run the ComPass poller. This is not the polling frequency but internal scheduling parameter.	run_interval_ms

Example

```
[COMPASS_POLLER]
onoff = off
run_interval_ms = 100
```

Each individual ComPass device is defined as a node. A default section can be used to define the common settings for each node. The common settings for the fault indicator connection are defined in the sections [COMPASS_NODE_N] (where N=1,2,3,4 or DEFAULT).

Table 117: Fault indicator settings

Setting	Unit	Range	Description	Parameter name
Enable ComPass node	binary	off,on		onoff
Name			Descriptive name for this node (logging)	Name
Poll interval	ms	1...50000 (int)	Indicates how often the ComPass device is polled for data	query_interval_ms
Modbus frame gap	ms	1...5000 (int)	Modbus frame-ending time gap	frame_spacing_ms
Modbus address		1...255	The Modbus address of the ComPass device	modbus_address
Invalid Timeout	ms	1...60000 (int)	If no successful update during the timeout mark the values invalid	nvalid_timeout_ms
Reply Timeout	ms	1...5000 (int)	How long to wait for ComPass response	reply_timeout_ms
Retry Limit	times	0...10 (int)	How many times to retry within query	reply_retries
Clock synchronization interval	s	0...50000 (int)	How often to synchronize the ComPass clock (0=never). Requires REC603 own clock to be valid.	clock_synch_interval_sec
Generate Events	binary	off,on	Should this node generate events	event_generation
Send Event When Invalid	binary	off,on	Should event be generated when data becomes invalid	event_invalid
Event Interval	s	(int)	Minimum delay between events generated by this node for individual data point	event_interval_sec
Event Filtering Delay for SPI	ms	(int)	How long the value of single-point information object must be changed before sending event	event_filter_spi_ms
Event Filtering Delay for FPI	ms	(int)	How long the value of analog information object must be changed before sending event	event_filter_fpi_ms
Event Threshold for Currents	A	analog (float)	Send (refresh) event when value differs from the threshold amount of last sent value	event_window_currents
Event Threshold for Voltages	V	analog (float)	Send (refresh) event when value differs from the threshold amount of last sent value	event_window_voltages
Event Threshold for Powers	KW	analog (float)	Send (refresh) event when value differs from the threshold amount of last sent value	event_window_powers
Event Threshold for Frequency	Hz	analog (float)	Send (refresh) event when value differs from the threshold amount of last sent value	event_window_frequency

Table continues on next page

Setting	Unit	Range	Description	Parameter name
Event Threshold for power factor		analog (float)	Send (refresh) event when value differs from the threshold amount of last sent value	event_window_pf
Event Timestamp Format		none,long	Timestamp format of asynchronous events for this data point	event_timestamp
GI Group		1...20 (int)	Which GI groups the data points of this node belong to (max. 10 groups on comma-separated list). 20=Global	gi_group
GI Timestamp Format		none,short,long	Timestamp format of GI responses for this node	gi_timestamp
Cyclic Group		1...100 (int)	Which Cyclic groups the data points of this node belong to (max 10 groups on comma-separated list)	cyclic_group
Cyclic Timestamp Format		none,short,long	Timestamp format of cyclic transmissions for this node	cyclic_timestamp
Select+Execute	binary	off,on	Allow only two-phase commands	sc_require_select
Selection Time-Out	s	(int)	Release selection if no further command after select during this timeout	sc_select_timeout_sec
Timestamp Commands		off,on	Require commands to contain timestamps	sc_require_timestamp
Timestamp Allowed Difference	s	(int)	Maximum difference between command time and internal time	sc_timestamp_maxage_sec

The ComPass information object addresses are defined individually for each data object. If no address is defined, the data object is not used. SC means single command type, SPI single-point indication and FPI analog short-floating point value. Each enabled information object must have a unique information object address.

Table 118: Information object addresses

Parameter name	Description
object_address_reset_sc	When “1” is written, the ComPass device is reset
object_address_dispreset_sc	When “1” is written, the ComPass device display is reset (clears event flags)
object_address_deverror_spi	ComPass Modbus address 8 internal device error flag
object_address_overcurrent_spi	ComPass Modbus address 9 overcurrent flag
object_address_earthfault_spi	ComPass Modbus address 10 earth fault tripping
object_address_ph1event_spi	ComPass Modbus address 11 event in phase 1
Table continues on next page	

Parameter name	Description
object_address_ph2event_spi	ComPass Modbus address 12 event in phase 2
object_address_ph3event_spi	ComPass Modbus address 13 event in phase 3
object_address_overvoltage_spi	ComPass Modbus address 14 overvoltage flag
object_address_undervoltage_spi	ComPass Modbus address 15 undervoltage flag
object_address_idira_spi	ComPass Modbus address 16 current direction a
object_address_idirb_spi	ComPass Modbus address 17 current direction b
object_address_iedira_spi	ComPass Modbus address 18 earth current direction a
object_address_iedirb_spi	ComPass Modbus address 19 earth current direction b
object_address_loaddira_spi	ComPass Modbus address 21 load flow direction a
object_address_loaddirb_spi	ComPass Modbus address 22 load flow direction b
object_address_ph1current_fpi	ComPass Modbus address 1000 phase 1 current
object_address_ph2current_fpi	ComPass Modbus address 1001 phase 2 current
object_address_ph3current_fpi	ComPass Modbus address 1002 phase 3 current
object_address_phecurrent_fpi	ComPass Modbus address 1003 earth current
object_address_v12voltage_fpi	ComPass Modbus address 1004 voltage between phases 1, 2
object_address_v23voltage_fpi	ComPass Modbus address 1005 voltage between phases 2, 3
object_address_v31voltage_fpi	ComPass Modbus address 1006 voltage between phases 3, 1
object_address_ph1voltage_fpi	ComPass Modbus address 1007 phase 1 voltage
object_address_ph2voltage_fpi	ComPass Modbus address 1008 phase 2 voltage
object_address_ph3voltage_fpi	ComPass Modbus address 1009 phase 3 voltage
object_address_phevoltage_fpi	ComPass Modbus address 1010 displacement voltage
object_address_kva_fpi	ComPass Modbus address 1022 apparent power in kva
object_address_kw_fpi	ComPass Modbus address 1023 active power in kw
object_address_kvar_fpi	ComPass Modbus address 1024 reactive power in kvar

Table continues on next page

Parameter name	Description
object_address_pf_fpi	ComPass address 1025 power factor
object_address_frequency_fpi	ComPass Modbus address 1026 frequency
object_address_ph1avgcurrent_fpi	ComPass Modbus address 1027 phase 1 average current 15 min
object_address_ph2avgcurrent_fpi	ComPass Modbus address 1028 phase 2 average current 15 min
object_address_ph3avgcurrent_fpi	ComPass Modbus address 1029 phase 3 average current 15 min
object_address_pheavgcurrent_fpi	ComPass Modbus address 1030 average earth current 15 min
object_address_ph1maxcurrent24h_fpi	ComPass Modbus address 1031 phase 1 max current 24h
object_address_ph2maxcurrent24h_fpi	ComPass Modbus address 1032 phase 2 max current 24h
object_address_ph3maxcurrent24h_fpi	ComPass Modbus address 1033 phase 3 max current 24h
object_address_ph1maxcurrent7d_fpi	ComPass Modbus address 1034 phase 1 max current 7 days
object_address_ph2maxcurrent7d_fpi	ComPass Modbus address 1035 phase 2 max current 7 days
object_address_ph3maxcurrent7d_fpi	ComPass Modbus address 1036 phase 3 max current 7 days
object_address_ph1maxcurrent1y_fpi	ComPass Modbus address 1037 phase 1 max current 1 year
object_address_ph2maxcurrent1y_fpi	ComPass Modbus address 1038 phase 2 max current 1 year
object_address_ph3maxcurrent1y_fpi	ComPass Modbus address 1039 phase 3 max current 1 year
object_address_latestevent_fpi	ComPass Modbus address 6000 (event type) and 6009-6012 (event time). This object comes always with long timestamp when enabled.

Example

```
#the compass nodes
[COMPASS_NODE_DEFAULT]
onoff = on
query_interval_ms = 5000
invalid_timeout_ms = 180000
reply_timeout_ms = 1000
reply_retries = 2
frame_spacing_ms = 600
clock_synch_interval_sec = 600
gi_group = 20
gi_timestamp = none
cyclic_group = none
cyclic_timestamp = long
event_timestamp = long
event_generation = yes
event_invalid = yes
event_interval_sec = 3
event_filter_spi_ms = 500
```

```
event_filter_fpi_ms = 500
event_window_currents = 2
event_window_voltages = 5
event_window_powers = 0.2
event_window_frequency = 2
event_window_pf = 0.1
sc_require_select = no
sc_select_timeout_sec = 30
sc_require_timestamp = no
sc_timestamp_maxage_sec = 30
```

```
[COMPASS_NODE_1]
onoff=on
name=compass_1
modbus_address = 1
object_address_reset_sc    = 10100
object_address_dispreset_sc = 10101
object_address_deverror_spi    = 10001
object_address_overcurrent_spi = 10002
object_address_earthfault_spi = 10003
object_address_ph1event_spi = 10004
object_address_ph2event_spi = 10005
object_address_ph3event_spi = 10006
object_address_overvoltage_spi = 10007
object_address_undervoltage_spi = 10008
object_address_idira_spi = 10009
object_address_idirb_spi = 10010
object_address_iedira_spi = 10011
object_address_iedirb_spi = 10012
object_address_loaddira_spi = 10013
object_address_loaddirb_spi = 10014
object_address_ph1current_fpi = 10020
object_address_ph2current_fpi = 10021
object_address_ph3current_fpi = 10022
object_address_phecurrent_fpi = 10023
object_address_v12voltage_fpi = 10031
object_address_v23voltage_fpi = 10032
object_address_v31voltage_fpi = 10033
object_address_ph1voltage_fpi = 10034
object_address_ph2voltage_fpi = 10035
object_address_ph3voltage_fpi = 10036
object_address_phevoltage_fpi = 10037
object_address_kva_fpi = 10041
object_address_kw_fpi = 10042
object_address_kvar_fpi = 10043
object_address_pf_fpi = 10044
object_address_frequency_fpi = 10045
object_address_ph1avgcurrent_fpi = 10051
object_address_ph2avgcurrent_fpi = 10052
object_address_ph3avgcurrent_fpi = 10053
object_address_pheavgcurrent_fpi = 10054
object_address_ph1maxcurrent24h_fpi = 10055
object_address_ph2maxcurrent24h_fpi = 10056
object_address_ph3maxcurrent24h_fpi = 10057
object_address_ph1maxcurrent7d_fpi = 10058
object_address_ph2maxcurrent7d_fpi = 10059
object_address_ph3maxcurrent7d_fpi = 10060
object_address_ph1maxcurrent1y_fpi = 10061
object_address_ph2maxcurrent1y_fpi = 10062
object_address_ph3maxcurrent1y_fpi = 10063
object_address_latestevent_fpi = 10071
```

10.16.3 Kries IKI-50 grid-inspector

The main settings for the fault indicator connection are defined in the section [IKI50_POLLER]. When the serial port is used for Kries IKI-50 communication, it cannot be used for other purposes.

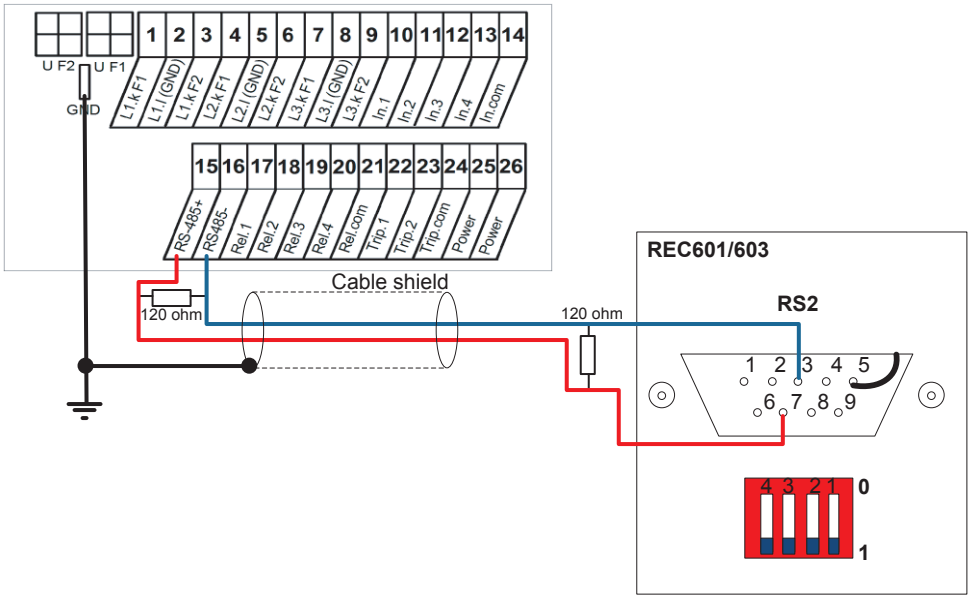

Figure 57: Physical connection between Kries IKI-50 and REC601/603

Table 119: Main settings of Kries IKI 50

Setting	Unit	Range	Description	Parameter name
Enable IKI-50 poller	binary	off,on		onoff
Run interval	ms	1-5000 (int)	How often to run the IKI-50 poller. This is not the polling frequency but internal scheduling parameter.	run_interval_ms

Example

```
#IKI50 poller
[IKI50_POLLER]
onoff = on
run_interval_ms = 100
```

Each individual Kries IKI-50 device is defined as a node. A default section can be used to define the settings common for each node. The individual settings for the fault indicator connection are defined in the sections [IKI50_NODE_N] (where N=1,2,3,4 or DEFAULT).

Table 120: Grid-inspector settings

Setting	Units	Range	Description	Parameter Name
Enable IKI-50 node	binary	off,on		onoff
Expansion line used		(int)	The line index of the expansion line used	line_index
Line access timeout	ms	(int)	How long to wait the expansion line to become available	line_access_timeout_ms
Name			Descriptive name for this node (logging)	Name
Poll interval	ms	1-50000 (int)	How often to poll the IKI-50 device for data	query_interval_ms
Modbus frame gap	ms	1-5000 (int)	Modbus frame-ending time gap	frame_spacing_ms
Modbus address		1-255	The Modbus address of the IKI-50 device	modbus_address
Invalid Timeout	ms	1-60000 (int)	If no succesfull update during the timeout mark the values invalid	invalid_timeout_ms
Reply Timeout	ms	1-5000 (int)	How long to wait for IKI-50 response	reply_timeout_ms
Retry Limit	times	0-10 (int)	How many times to retry within query	reply_retries
Clock synchronization interval	sec	0-50000 (int)	How often to synchronize the IKI-50 clock (0=never). Requires Arctic Contol own clock to be valid.	clock_synch_interval_sec
Generate Events	binary	off,on	Should this node generate events	event_generation
Send Event When Invalid	binary	off,on	Should event be generated when data becomes invalid	event_invalid
Event Interval	s	(int)	Minimum delay between events generated by this node for individual data point	event_interval_sec
Event Filtering Delay for SPI	ms	(int)	How long the value of single-point information object must be changed before sending event	event_filter_spi_ms
Event Filtering Delay for FPI	ms	(int)	How long the value of analog information object must be changed before sending event	event_filter_fpi_ms
Event Threshold for Currents	A	analog (float)	Send (refresh) event when value differs threshold amount of last sent value	event_window_currents
Event Threshold for Voltages	kV	analog (float)	Send (refresh) event when value differs threshold amount of last sent value	event_window_voltages
Event Threshold for Powers	kW	analog (float)	Send (refresh) event when value differs threshold amount of last sent value	event_window_powers

Table continues on next page

Setting	Units	Range	Description	Parameter Name
Event Threshold for Energies	MWh	analog (float)	Send (refresh) event when value differs threshold amount of last sent value	event_window_energies
Event Threshold for Frequency	Hz	analog (float)	Send (refresh) event when value differs threshold amount of last sent value	event_window_frequency
Event Threshold for power factor		analog (float)	Send (refresh) event when value differs threshold amount of last sent value	event_window_pf
Event Timestamp Format		none,long	Timestamp format of asynchroneous events for this data point	event_timestamp
GI Group		1-20 (int)	Which GI groups the data points of this node belongs (max. 10 groups on comma-separated list). 20=Global	gi_group
GI Timestamp Format		none,short,long	Timestamp format of GI responses for this node	gi_timestamp
Cyclic Group		1-100 (int)	Which Cyclic groups the data points of this node belongs (max 10 groups on comma-separated list)	cyclic_group
Cyclic Timestamp Format		none,short,long	Timestamp format of cyclic transmissions for this node	cyclic_timestamp
Select+Execute	binary	off,on	Allow only two-phase commands	sc_require_select
Selection Time-Out	s	(int)	Release selection if no further command after select during this timeout	sc_select_timeout_sec
Timestamp Commands		off,on	Require commands to contain timestamps	sc_require_timestamp
Timestamp Allowed Difference	s	(int)	Maximum difference between command time and internal time	sc_timestamp_maxage_sec

Example

```
[IKI50_NODE_DEFAULT]
onoff = on
line_index=1
line_access_timeout_ms=20000
query_interval_ms = 10000
invalid_timeout_ms = 60000
reply_timeout_ms = 1000
reply_retries = 2
frame_spacing_ms = 10
clock_synch_interval_sec = 180
gi_group = 20
gi_timestamp = none
cyclic_group = none
cyclic_timestamp = long
event_timestamp = long
event_generation = yes
event_invalid = yes
event_interval_sec = 3
event_filter_fpi_ms = 2000
event_filter_spi_ms = 2000
```

```
event_window_currents = 2
event_window_voltages = 5
event_window_powers = 0.2
event_window_energies = 100
event_window_frequency = 2
event_window_pf = 0.1
sc_require_select = no
sc_select_timeout_sec = 30
sc_require_timestamp = no
sc_timestamp_maxage_sec = 30
```

```
[IKI50_NODE_1]
onoff=off
name=iki50_1
modbus_address = 50
line_index = 1
object_address_resetfault_sc =
object_address_resetminmax_sc =
object_address_resettrip1_sc =
object_address_resettrip2_sc =
object_address_ph1current_fpi=
object_address_ph1tdacurrent_fpi=
object_address_ph1maxtdacurrent_fpi=
object_address_ph1tdtcurrent_fpi=
object_address_ph1maxtdtcurrent_fpi=
object_address_ph1frequency_fpi=
object_address_ph1voltage_fpi=
object_address_ph2current_fpi=
object_address_ph2tdacurrent_fpi=
object_address_ph2maxtdacurrent_fpi=
object_address_ph2tdtcurrent_fpi=
object_address_ph2maxtdtcurrent_fpi=
object_address_ph2frequency_fpi=
object_address_ph2voltage_fpi=
object_address_ph3current_fpi=
object_address_ph3tdacurrent_fpi=
object_address_ph3maxtdacurrent_fpi=
object_address_ph3tdtcurrent_fpi=
object_address_ph3maxtdtcurrent_fpi=
object_address_ph3frequency_fpi=
object_address_ph3voltage_fpi=
object_address_sumcurrent_fpi=
object_address_sumvoltage_fpi=
object_address_sumpowerw_fpi=
object_address_sumpowervar_fpi=
object_address_sumpowerva_fpi=
object_address_sumenergyawh_fpi=
object_address_sumenergytwh_fpi=
object_address_sumenergyavarh_fpi=
object_address_sumenergytvarh_fpi=
object_address_sumenergyavah_fpi=
object_address_sumenergytvah_fpi=
object_address_sumpf_fpi=
object_address_sumdtacurrent_fpi=
object_address_v12voltage_fpi=
object_address_v23voltage_fpi=
object_address_v31voltage_fpi=
object_address_ph1short_spi=
object_address_ph2short_spi=
object_address_ph3short_spi=
object_address_shorttoward_spi=
object_address_shortaway_spi=
object_address_shortunknowndir_spi=
object_address_eshort_spi=
object_address_etransfault_spi=
object_address_estaticfault_spi=
object_address_pulsecurrent_spi=
object_address_efaulttoward_spi=
```

object_address_efaultaway_spi=
object_address_efaultunknowndir_spi=
object_address_limitgtu_spi=
object_address_limitgtgtu_spi=
object_address_limitstu_spi=
object_address_limitststu_spi=
object_address_limitgtf_spi=
object_address_limitstf_spi=
object_address_limitqu_spi=
object_address_limitgtu0_spi=
object_address_intefault_spi=
object_address_intefaultwarn_spi=
object_address_intefaulttoward_spi=
object_address_intefaultaway_spi=
object_address_intefaultunknowndir_spi=

IKI-50 data point addresses are defined individually for each data point. The data point is not used if no address is defined. SC means single command type, SPI single-point indication and FPI analog short-floating point value. For detailed IKI-50 register content definitions, see manufacturer's (Kries-Energietechnik GmbH & Co. KG) documentation.

Table 121: Data point addresses

Parameter Name	IKI-50 Modbus address	Description
object_address_resetfault_sc	5000	Reset faults (all faults)
object_address_resetminmax_sc	5003	Reset min-/max-values
object_address_resettrip1_sc	5012	Tripping1 accept fault / reset
object_address_resettrip2_sc	5013	Tripping2 accept fault / reset
object_address_shortdetect_sc	4000	Short-circuit detection [On <> 0 ; Off = 0]
object_address_eshortdetect_sc	4006	Earth short-circuit detection [On <> 0 ; Off = 0]
object_address_sefaultdetect_sc	4011	Static earth fault detection [On <> 0 ; Off = 0]
object_address_tefaultdetect_sc	4016	Transient earth fault detection [On <> 0 ; Off = 0]
Analog Measurements		
object_address_ph1current_fpi	0	Current L1 Feeder1
object_address_ph1tdacurrent_fpi	1	Dt Current L1 Feeder1 away from busbar
object_address_ph1maxtdacurrent_fpi	3	Max Dt Current L1 Feeder1 away from busbar
object_address_ph1tdtcurrent_fpi	6	Dt Current L1 Feeder1 toward busbar
object_address_ph1maxtdtcurrent_fpi	8	Max Dt Current L1 Feeder1 toward busbar
object_address_ph1frequency_fpi	11	Frequency Voltage L1 Feeder1
object_address_ph1voltage_fpi	12	Voltage L1-GND Feeder1
object_address_ph2current_fpi	70	Current L2 Feeder1
object_address_ph2tdacurrent_fpi	71	Dt Current L2 Feeder1 away from busbar
object_address_ph2maxtdacurrent_fpi	73	Max Dt Current L2 Feeder1 away from busbar
object_address_ph2tdtcurrent_fpi	76	Dt Current L2 Feeder1 toward busbar

Table continues on next page

Parameter Name	IKI-50 Modbus address	Description
object_address_ph2maxtdtcurrent_fpi	78	Max Dt Current L2 Feeder1 toward busbar
object_address_ph2frequency_fpi	81	Frequency Voltage L2 Feeder1
object_address_ph2voltage_fpi	82	Voltage L2-GND Feeder1
object_address_ph3current_fpi	140	Current L3 Feeder1
object_address_ph3tdacurrent_fpi	141	Dt Current L3 Feeder1 away from busbar
object_address_ph3maxtdacurrent_fpi	143	Max Dt Current L3 Feeder1 away from busbar
object_address_ph3tdtcurrent_fpi	146	Dt Current L3 Feeder1 toward busbar
object_address_ph3maxtdtcurrent_fpi	148	Max Dt Current L3 Feeder1 toward busbar
object_address_ph3frequency_fpi	151	Frequency Voltage L3 Feeder1
object_address_ph3voltage_fpi	152	Voltage L3-GND Feeder1
object_address_sumcurrent_fpi	216	Sum I1 – I3 Feeder1
object_address_sumvoltage_fpi	217	Sum U1 – U3 Feeder1
object_address_sumpowerw_fpi	221	Sum Effective Power Feeder1
object_address_sumpowervar_fpi	223	Sum Reactive Power Feeder1
object_address_sumpowerva_fpi	225	Sum Apparent Power Feeder1
object_address_sumenergyawh_fpi	227	Sum Effective Energy away from busbar Feeder1
object_address_sumenergytwh_fpi	228	Sum Effective Energy toward busbar Feeder1
object_address_sumenergyavarh_fpi	229	Sum Reactive Energy away from busbar Feeder1
object_address_sumenergytvarh_fpi	230	Sum Reactive Energy toward busbar Feeder1
object_address_sumenergyavah_fpi	231	Sum Apparent Energy away from busbar Feeder1
object_address_sumenergytvah_fpi	232	Sum Apparent Energy toward busbar Feeder1
object_address_sumpf_fpi	263	Cos φ Sum U1-U3, I1-I3 Feeder1
object_address_sumdtacurrent_fpi	280	Dt Sum I1 – I3 away from busbar Feeder1
object_address_v12voltage_fpi	218	Voltage L1-L2 Feeder1
object_address_v23voltage_fpi	219	Voltage L2-L3 Feeder1
object_address_v31voltage_fpi	220	Voltage L3-L1 Feeder1
Single-point indications		
object_address_ph1short_spi	2003	Short-circuit L1 feeder1
object_address_ph2short_spi	2004	Short-circuit L2 feeder1
object_address_ph3short_spi	2005	Short-circuit L3 feeder1
object_address_shorttoward_spi	2006	Short-circuit towards busbar feeder1
object_address_shortaway_spi	2007	Short-circuit away from busbar feeder1
object_address_shortunknowndir_spi	2008	Fault direction short-circuit unknown feeder1

Table continues on next page

Parameter Name	IKI-50 Modbus address	Description
object_address_eshort_spi	2009	Earth short-circuit feeder1
object_address_etransfault_spi	2010	Earth fault with transient earth fault feeder1
object_address_estaticfault_spi	2011	Earth fault with static earth fault feeder1
object_address_pulsecurrent_spi	2012	Pulse current detected feeder1
object_address_efaulttoward_spi	2013	Earth fault towards busbar feeder1
object_address_efaultaway_spi	2014	Earth fault away from busbar feeder1
object_address_efaultunknowndir_spi	2015	Fault direction earth fault unknown feeder1
object_address_limitgtu_spi	2017	Limit monitoring feeder1 U>
object_address_limitgtgtu_spi	2018	Limit monitoring feeder1 U>>
object_address_limitstu_spi	2019	Limit monitoring feeder1 U<
object_address_limitststu_spi	2020	Limit monitoring feeder1 U<<
object_address_limitgtf_spi	2021	Limit monitoring feeder1 f>
object_address_limitstf_spi	2022	Limit monitoring feeder1 f<
object_address_limitqu_spi	2023	Limit monitoring feeder1 Q&U
object_address_limitgtu0_spi	2027	Limit monitoring feeder1 U0>
object_address_intefault_spi	2082	Intermittent earth fault detected feeder1
object_address_intefaultwarn_spi	2083	Intermittent earth fault Warning feeder1
object_address_intefaulttoward_spi	2084	Intermittent earth fault towards busbar feeder1
object_address_intefaultaway_spi	2085	Intermittent earth fault away from busbar feeder1
object_address_intefaultunknowndir_spi	2086	Intermittent earth fault unknown direction feeder1
Settings read		
object_address_shortdetect_spi	3000	Short-circuit detection [On <> 0 ; Off = 0]
object_address_eshortdetect_spi	3006	Earth short-circuit detection [On <> 0 ; Off = 0]
object_address_sefaultdetect_spi	3011	Static earth fault detection [On <> 0 ; Off = 0]
object_address_tefaultdetect_spi	3016	Transient earth fault detection [On <> 0 ; Off = 0]

Section 11 Appendix 3 IEC 60870-5-104 and IEC 60870-5-101 interoperability

11.1 Interoperability IEC 60870-5-104

This interoperability document does not specify the behavior of IEC 60870-5-101 to IEC 60870-5-104 gateway (protocol converter) application available on the device, but the RTU application itself.

This companion standard presents a set of parameters and alternatives from which subsets must be selected to implement particular telecontrol systems. Certain parameter values, such as the “structured“ or the “unstructured“ fields of the INFORMATION OBJECT ADDRESS of ASDUs represents mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction, allow the specification of the complete set or subset, as appropriate for given applications. This clause summarizes the parameter of the previous clause to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all the partners agree on the selected parameters.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in this standard. The text descriptions of parameters which are not applicable to this companion standard are strike through (corresponding check box is marked black).

The full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The selected parameters should be marked in the white boxes.

☐ Function or ASDU is not used

☒ Function or ASDU is used as standardized (default)

R Function or ASDU is used in reverse mode

B Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter.

A black check box indicates that the option cannot be selected in this companion standard.

11.1.1 System or device

(System-specific parameter, select one definition of a system or a device by marking it with “X“.)

☐ System definition

☐ Controlling station definition (Master)

☒ Controlled station definition (Slave)

11.1.2 Network configuration

(Network-specific parameter, mark all used configurations with an “X“.)

■ ~~Point-to-point~~ ■ ~~Multipoint~~

■ ~~Multiple point-to-point~~ ■ ~~Multipoint-star~~

11.1.3 Physical layer

(Network-specific parameter, mark all used interfaces and data rates with an “X“.)

Transmission speed (control direction)

Unbalanced interchange Circuit V. 24/V.28 Standard	Unbalanced interchange Circuit V. 24/V.28 Recommended if >1 200 bit/s	Balanced interchange Circuit X. 24/X.27	
~~100 bit/s~~	~~2400 bit/s~~	~~2400 bit/s~~	~~56000 bit/s~~
~~200 bit/s~~	~~4800 bit/s~~	~~4800 bit/s~~	~~64000 bit/s~~
~~300 bit/s~~	~~9600 bit/s~~	~~9600 bit/s~~	
~~600 bit/s~~		~~19200 bit/s~~	
~~1200 bit/s~~		~~38400 bit/s~~	

Transmission speed (monitor direction)

Unbalanced interchange Circuit V. 24/V.28 Standard	Unbalanced interchange Circuit V. 24/V.28 Recommended if >1 200 bit/s	Balanced interchange Circuit X. 24/X.27	
~~100 bit/s~~	~~2400 bit/s~~	~~2400 bit/s~~	~~56000 bit/s~~
~~200 bit/s~~	~~4800 bit/s~~	~~4800 bit/s~~	~~64000 bit/s~~
~~300 bit/s~~	~~9600 bit/s~~	~~9600 bit/s~~	
~~600 bit/s~~		~~19200 bit/s~~	
~~1200 bit/s~~		~~38400 bit/s~~	

11.1.4 Link layer

(Network-specific parameter, mark all used options with an “X“. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the Type ID and COTof all messages assigned to class 2.)

~~Frame format FT 1.2, single character 1 and the fixed time-out interval are used exclusively in this companion standard.~~

Link transmission	Address field of the link
~~Balanced transmission~~	~~not present (balanced transmission only)~~
~~Unbalanced transmission~~	~~One octet~~

Table continues on next page

■ ~~Two octets~~

Frame length

■ ~~Maximum length L (number of octets)~~

■ ~~Structured~~

■ ~~Unstructured~~

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

■ ~~The standard assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission
9, 11, 13, 21	<1>

■ ~~A special assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission

~~(In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available)~~

11.1.5 Application layer

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

(System-specific parameter, mark all used configurations with an “X“.)

■ ~~One octet~~

[X] Two octets

Information object address

(System-specific parameter, mark all used configurations with an “X“.)

■	~~One octet~~	X	Structured
■	~~Two octets~~	X	Unstructured
X	Three octets		

Cause of transmission

(System-specific parameter, mark all used configurations with an “X“.)

■	~~One octet~~	X	Two octets (with originator address). Originator address is set to zero if not used

Length of APDU

(System-specific parameter, specify the maximum length of the APDU per system.)

The maximum length of APDU for both directions is 253. It is a fixed system parameter.

■	Maximum length of APDU per system in control direction
■	Maximum length of APDU per system in monitor direction

Selection of standard ASDUs

Process information in monitor direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

X	<1>:= Single-point information	M_SP_NA_1
■	~~<2>:= Single-point information with time tag~~	M_SP_TA_1
X	<3>:= Double-point information	M_DP_NA_1
■	~~<4>:= Double-point information with time tag~~	M_DP_TA_1
	<5>:= Step position information	M_ST_NA_1
■	~~<6>:= Step position information with time tag~~	M_ST_TA_1
	<7>Bitstring of 32 bit	M_BO_NA_1

Table continues on next page

■	~~<8>:= Bitstring of 32 bit with time tag~~	M_BO_TA_1
☐	<9>:= Measured value, normalized value	M_ME_NA_1
■	~~<10>:= Measured value, normalized value with time tag~~	M_ME_TA_1
☐	<11>:= Measured value, scaled value	M_ME_NB_1
■	~~<12>:= Measured value, scaled value with time tag~~	M_ME_TB_1
☒	<13>:= Measured value, short floating point value	M_ME_NC_1
■	~~<14> := Measured value, short floating point value with time tag~~	M_ME_TC_1
☐	<15>:= Integrated totals	M_IT_NA_1
■	~~<16>:= Integrated totals with time tag~~	M_IT_TA_1
■	~~<17>:= Event of protection equipment with time tag~~	M_EP_TA_1
■	~~<18>:= Packed start events of protection equipment with time tag~~	M_EP_TB_1
■	~~<19>:= Packed output circuit information of protection equipment with time tag~~	M_EP_TC_1
☐	<20>:= Packed single-point information with status change detection	M_SP_NA_1
☐	<21>:= Measured value, normalized value without quality descriptor	M_ME_ND_1
☒	<30>:= Single-point information with time tag CP56Time2a	M_SP_TB_1
☒	<31>:= Double-point information with time tag CP56Time2a	M_DP_TB_1
☐	<32>:= Step position information with time tag CP56Time2a	M_ST_TB_1
☐	<33>:= Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☐	<34>:= Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☐	<35>:= Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☒	<36>:= Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☐	<37>:= Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐	<38>:= Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐	<39>:= Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐	<40>:= Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

In this companion standard only the use of the set <30> – <40> for ASDUs with time tag is permitted.

Process information in control direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[X]	<45>:= Single command	C_SC_NA_1
[X]	<46>:= Double command	C_DC_NA_1
[ ]	<47>:= Regulating step command	C_RC_NA_1
[ ]	<48>:= Set point command, normalized value	C_SE_NA_1
[ ]	<49>:= Set point command, scaled value	C_SE_NB_1
[ ]	<50>:= Set point command, short floating point value	C_SE_NC_1
[ ]	<51> := Bitstring of 32 bit	C_BO_NA_1
[X]	<58> := Single command with time tag CP56Time2a	C_SC_TA_1
[X]	<59>:= Double command with time tag CP56Time2a	C_DC_TA_1
[ ]	<60>:= Regulating step command with time tag CP56Time2a	C_RC_TA_1
[ ]	<61>:= Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
[ ]	<62>:= Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
[ ]	<63> := Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1
[ ]	<64> := Bitstring of 32 bit with time tag CP56Time2a	C_BO_TA_1

Either the ASDUs of the set <45> – <51> or of the set <58> – <64> are used.

System information in monitor direction

(Station-specific parameter, mark with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[X]	<70> := End of initialization	M_EI_NA_1

System information in control direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

X	<100>:= Interrogation command	C_IC_NA_1
	<101>:= Counter interrogation command	C_CI_NA_1
	<102>:= Read command	C_RD_NA_1
X	<103>:= Clock synchronization command (option see 7.6)	C_CS_NA_1
■	~~<104>:= Test command~~	C_TS_NA_1
X	<105>:= Reset process command	C_RP_NA_1
■	~~<106>:= Delay acquisition command~~	C_CD_NA_1
X	<107>:= Test command with time tag CP56Time2a	C_TS_TA_1

Parameter in control direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

	<110>:= Parameter of measured value, normalized value	P_ME_NA_1
	<111>:= Parameter of measured value, scaled value	P_ME_NB_1
	<112>:= Parameter of measured value, short floating point value	P_ME_NC_1
	<113>:= Parameter activation	P_AC_NA_1

File transfer

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

	<120>:= File ready	F_FR_NA_1
	<121>:= Section ready	F_SR_NA_1
	<122>:= Call directory, select file, call file, call section	F_SC_NA_1
	<123>:= Last section, last segment	F_LS_NA_1
	<124>:= Ack file, ack section	F_AF_NA_1
	<125>:= Segment	F_SG_NA_1
	<126>:= Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1
	<127>:= Query Log – Request archive file	F_SC_NB_1

Type identifier and cause of transmission assignments

(Station-specific parameters)

Shaded boxes: option not required.

Black boxes: option not permitted in this companion standard

Blank: functions or ASDU not used.

Mark the Type Identification/Cause of transmission combinations.

"X" if only used in the standard direction

"R" if only used in the reverse direction

"B" if used in both directions

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1			X											X					
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1			X											X					
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1																			
~~<6>~~	~~M_ST_TA_1~~																			
<7>	M_BO_NA_1																			
~~<8>~~	~~M_BO_TA_1~~																			
<9>	M_ME_NA_1																			
~~<10>~~	~~M_ME_TA_1~~																			
<11>	M_ME_NB_1																			
~~<12>~~	~~M_ME_TB_1~~																			
<13>	M_ME_NC_1	X		X											X					
~~<14>~~	~~M_ME_TC_1~~																			
<15>	M_IT_NA_1																			
~~<16>~~	~~M_IT_TA_1~~																			
~~<17>~~	~~M_EP_TA_1~~																			
~~<18>~~	~~M_EP_TB_1~~																			
~~<19>~~	~~M_EP_TC_1~~																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X																
<31>	M_DP_TB_1			X																
<32>	M_ST_TB_1																			

Table continues on next page

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1																			
<35>	M_ME_TE_1																			
<36>	M_ME_TF_1			X																
<37>	M_IT_TB_1																			
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X						X	X	X	X
<46>	C_DC_NA_1						X	X	X	X	X						X	X	X	X
<47>	C_RC_NA_1																			
<48>	C_SE_NA_1																			
<49>	C_SE_NB_1																			
<50>	C_SE_NC_1																			
<51>	C_BO_NA_1																			
<58>	C_SC_TA_1						X	X	X	X	X						X	X	X	X
<59>	C_DC_TA_1						X	X	X	X	X						X	X	X	X
<60>	C_RC_TA_1																			
<61>	C_SE_TA_1																			
<62>	C_SE_TB_1																			
<63>	C_SE_TC_1																			
<64>	C_BO_TA_1																			
<70>	M_EI_NA_1*				X															
<100>	C_IC_NA_1						X	X			X						X	X	X	X
<101>	C_CI_NA_1																			
<102>	C_RD_NA_1																			
<103>	C_CS_NA_1						X	X									X	X	X	X
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1*						X	X									X	X	X	X
~~<106>~~	~~C_CD_NA_1~~																			
<107>	C_TS_TA_1						X	X									X	X	X	X
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1																			
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			

Table continues on next page

Type identification		Cause of transmission																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1*																			
<127>	F_SC_NB_1*																			
* Blank or X only																				

11.1.6 Basic application functions

Station initialization

(Station-specific parameter, mark with an “X“ if the function is used.)

☒ Remote initialization

Cyclic data transmission

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

☒ Cyclic data transmission

Read procedure

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

☐ Read procedure

Spontaneous transmission

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

☒ Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

(Station-specific parameter, mark each information type with an “X“ where both a Type ID without time and a corresponding Type ID with time are issued in response to a single spontaneous change of a monitored object.)

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

- ☐ Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1
- ☐ Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
- ☐ Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
- ☐ Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)
- ☐ Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1
- ☐ Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
- ☐ Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- ☒ global

☒ group 1	☒ group 7	☒ group 13
☒ group 2	☒ group 8	☒ group 14
☒ group 3	☒ group 9	☒ group 15
☒ group 4	☒ group 10	☒ group 16
☒ group 5	☒ group 11	Information object addresses assigned to each group must be shown in a separate table.
☒ group 6	☒ group 12	

Clock synchronization

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- [X] Clock synchronization
- [ ] Day of week used
- [ ] RES1, GEN (time tag substituted/ not substituted) used
- [ ] SU-bit (summertime) used

Command transmission

(Object-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- [X] Direct command transmission
- [ ] Direct set point command transmission
- [X] Select and execute command
- [ ] Select and execute set point command
- [ ] C_SE ACTTERM used
- [X] No additional definition
- [X] Short-pulse duration (duration determined by a system parameter in the outstation)
- [X] Long-pulse duration (duration determined by a system parameter in the outstation)
- [X] Persistent output
- [X] Supervision of maximum delay in command direction of commands and set point commands

0 – 600 sec	Maximum allowable delay of commands and set point commands

Transmission of integrated totals

(Station- or object-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- [ ] Mode A: Local freeze with spontaneous transmission
- [ ] Mode B: Local freeze with counter interrogation
- [ ] Mode C: Freeze and transmit by counter-interrogation commands
- [ ] Mode D: Freeze by counter-interrogation command, frozen values reported

Table continues on next page

- ☐ Counter read
- ☐ Counter freeze without reset
- ☐ Counter freeze with reset
- ☐ Counter reset

- ☐ General request
- ☐ Request counter group 1
- ☐ Request counter group
- ☐ Request counter group 3
- ☐ Request counter group 4

Parameter loading

(Object-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- ☐ Threshold value
- ☐ Smoothing factor
- ☐ Low limit for transmission of measured values
- ☐ High limit for transmission of measured values

Parameter activation

(Object-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- ☐ Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- ☒ Test procedure

File transfer

(Station-specific parameter, mark with an “X“ if the function is used.)

Compare with “File transfer in control direction“.

☐ Transparent file

☐ Transmission of disturbance data of protection equipment

☐ Transmission of sequences of events

☐ Transmission of sequences of recorded analogue values

File transfer in control direction

☐ Transparent file

Background scan

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

☐ Background scan

Acquisition of transmission delay

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

■ ~~Acquisition of transmission delay~~

Definition of time-outs

Parameter	Default value	Remarks	Selected value
t_0	30 s	Time-out of connection establishment	
t_1	15 s	Time-out of send or test APDUs	Adjustable, GPRSdefault 60
t_2	10 s	Time-out for acknowledges in case of no data messages $t_2 < t_1$	Adjustable, GPRS default 20
t_3	20 s	Time-out for sending test frames in case of a long idle state	Adjustable, allows up to 65535

Maximum range for time-outs t_0 to t_2: 1 s to 255 s, accuracy 1 s.

Recommended range for time-out t_3: 1 s to 48 h, resolution 1 s.

Long time-outs for t_3 may be needed in special cases where satellite links or dial-up connections are used for instance to establish connection and collect values only once per day or week.

Maximum number of outstanding I format APDUs k and latest acknowledge APDUs (w)

Parameter	Default value	Remarks	Selected value
k	12 APDUs	Maximum difference receive sequence number to send state variable	12 (Adjustable)
w	8 APDUs	Latest acknowledge after receiving w I format APDUs	8 (Adjustable)

Maximum range of values *k*: 1 to 32767 (2^{15} –1) APDUs, accuracy 1 APDU

Maximum range of values *w*: 1 to 32767 APDUs, accuracy 1 APDU
(Recommendation: w should not exceed two-thirds of *k*).

Portnumber

Parameter	Value	Remarks
Portnumber	2404	Adjustable 1...65535

Redundant connections

5	Number N of redundancy 1 group connections used

RFC 2200 suite

RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for given projects has to be chosen by the user of this standard.

- [X] Ethernet 802.3
- [ ] Serial X.21 interface
- [ ] Other selection from RFC 2200:

List of valid documents from RFC 2200

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. etc.

11.2 Interoperability IEC 60870-5-101

This interoperability document does not specify the behavior of IEC 60870-5-101 to IEC 60870-5-104 gateway (protocol converter) application available on the device, but the RTU application itself.

This companion standard presents a set of parameters and alternatives from which subsets must be selected to implement particular telecontrol systems. Certain parameter values, such as the “structured“ or the “unstructured“ fields of the INFORMATION OBJECT ADDRESS of ASDUs represents mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction, allow the specification of the complete set or subset, as appropriate for given applications. This clause summarizes the parameter of the previous clause to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all the partners agree on the selected parameters.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in this standard. The text descriptions of parameters which are not applicable to this companion standard are strike through (corresponding check box is marked black).

The full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The selected parameters should be marked in the white boxes.

- ☐ Function or ASDU is not used
- ☒ Function or ASDU is used as standardized (default)
- ☒ R Function or ASDU is used in reverse mode
- ☒ B Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter.

A black check box indicates that the option cannot be selected in this companion standard.

11.2.1 System or device

(System-specific parameter, select one definition of a system or a device by marking it with “X“.)

- ☐ System definition
- ☐ Controlling station definition (Master)
- ☒ Controlled station definition (Slave)

11.2.2 Network configuration

(Network-specific parameter, mark all used configurations with an “X“.)

☒ Point-to-point	■ ~~Multipoint~~
■ ~~Multiple point-to-point~~	☐ Multipoint-star

11.2.3 Physical layer

(Network-specific parameter, mark all used interfaces and data rates with an “X“.)

Transmission speed (control direction)

Unbalanced interchange Circuit V. 24/V.28 Standard		Unbalanced interchange Circuit V. 24/V.28 Recommended if >1 200 bit/s		Balanced interchange Circuit X. 24/X.27			
■	~~100 bit/s~~	X	2400 bit/s	☐	2400 bit/s	■	~~56000 bit/s~~
■	~~200 bit/s~~	X	4800 bit/s	☐	4800 bit/s	■	~~64000 bit/s~~
■	~~300 bit/s~~	X	9600 bit/s	☐	9600 bit/s		
■	~~600 bit/s~~			☐	19200 bit/s		
X	1200 bit/s			☐	38400 bit/s		

Transmission speed (monitor direction)

Unbalanced interchange Circuit V. 24/V.28 Standard		Unbalanced interchange Circuit V. 24/V.28 Recommended if >1 200 bit/s		Balanced interchange Circuit X. 24/X.27			
■	~~100 bit/s~~	X	2400 bit/s	☐	2400 bit/s	■	~~56000 bit/s~~
■	~~200 bit/s~~	X	4800 bit/s	☐	4800 bit/s	■	~~64000 bit/s~~
■	~~300 bit/s~~	X	9600 bit/s	☐	9600 bit/s		
■	~~600 bit/s~~			☐	19200 bit/s		
X	1200 bit/s			☐	38400 bit/s		

11.2.4 Link layer

(Network-specific parameter, mark all used options with an “X“. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the Type ID and COTof all messages assigned to class 2.)

Frame format FT 1.2, single character 1 and the fixed time-out interval are used exclusively in this companion standard.

Link transmission		Address field of the link	
■	~~Balanced transmission~~	■	~~not present (balanced transmission only)~~
X	Unbalanced transmission	X	One octet

Table continues on next page

[X] Two octets

Frame length

[X] Maximum length 255 (number of octets)

[ ] Structured

[X] Unstructured

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

[X] The standard assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of transmission
9, 11, 13, 21	<1>

[X] A special assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of transmission
1,3,13	<2>

In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available.

11.2.5 Application layer

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

(System-specific parameter, mark all used configurations with an “X“.)

[X] One octet

[X] Two octets

Information object address

(System-specific parameter, mark all used configurations with an “X“.)

[X]	One octet	[X]	Structured
[X]	Two octets	[X]	Unstructured
[X]	Three octets		

Cause of transmission

(System-specific parameter, mark all used configurations with an “X“.)

[■]	~~One octet~~	[X]	Two octets (with originator address). Originator address is set to zero if not used

Length of APDU

(System-specific parameter, specify the maximum length of the APDU per system.)

The maximum length of APDU for both directions is 253. It is a fixed system parameter.

[■]	Maximum length of APDU per system in control direction
[■]	Maximum length of APDU per system in monitor direction

Selection of standard ASDUs

Process information in monitor direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[X]	<1>:= Single-point information	M_SP_NA_1
[■]	~~<2>:= Single-point information with time tag~~	M_SP_TA_1
[X]	<3>:= Double-point information	M_DP_NA_1
[■]	~~<4>:= Double-point information with time tag~~	M_DP_TA_1
[ ]	<5>:= Step position information	M_ST_NA_1
[■]	~~<6>:= Step position information with time tag~~	M_ST_TA_1
[ ]	<7>Bitstring of 32 bit	M_BO_NA_1
[■]	~~<8>:= Bitstring of 32 bit with time tag~~	M_BO_TA_1

Table continues on next page

☐	<9>:= Measured value, normalized value	M_ME_NA_1
■	~~<10>:= Measured value, normalized value with time tag~~	M_ME_TA_1
☐	<11>:= Measured value, scaled value	M_ME_NB_1
■	~~<12>:= Measured value, scaled value with time tag~~	M_ME_TB_1
☒	<13>:= Measured value, short floating point value	M_ME_NC_1
■	~~<14> := Measured value, short floating point value with time tag~~	M_ME_TC_1
☐	<15>:= Integrated totals	M_IT_NA_1
■	~~<16>:= Integrated totals with time tag~~	M_IT_TA_1
■	~~<17>:= Event of protection equipment with time tag~~	M_EP_TA_1
■	~~<18>:= Packed start events of protection equipment with time tag~~	M_EP_TB_1
■	~~<19>:= Packed output circuit information of protection equipment with time tag~~	M_EP_TC_1
☐	<20>:= Packed single-point information with status change detection	M_SP_NA_1
☐	<21>:= Measured value, normalized value without quality descriptor	M_ME_ND_1
☒	<30>:= Single-point information with time tag CP56Time2a	M_SP_TB_1
☒	<31>:= Double-point information with time tag CP56Time2a	M_DP_TB_1
☐	<32>:= Step position information with time tag CP56Time2a	M_ST_TB_1
☐	<33>:= Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☐	<34>:= Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☐	<35>:= Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☒	<36>:= Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☐	<37>:= Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐	<38>:= Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐	<39>:= Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐	<40>:= Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

In this companion standard only the use of the set <30> – <40> for ASDUs with time tag is permitted.

Process information in control direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[X]	<45>:= Single command	C_SC_NA_1
[X]	<46>:= Double command	C_DC_NA_1
[ ]	<47>:= Regulating step command	C_RC_NA_1
[ ]	<48>:= Set point command, normalized value	C_SE_NA_1
[ ]	<49>:= Set point command, scaled value	C_SE_NB_1
[ ]	<50>:= Set point command, short floating point value	C_SE_NC_1
[ ]	<51> := Bitstring of 32 bit	C_BO_NA_1
[X]	<58> := Single command with time tag CP56Time2a	C_SC_TA_1
[X]	<59>:= Double command with time tag CP56Time2a	C_DC_TA_1
[ ]	<60>:= Regulating step command with time tag CP56Time2a	C_RC_TA_1
[ ]	<61>:= Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
[ ]	<62>:= Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
[ ]	<63> := Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1
[ ]	<64> := Bitstring of 32 bit with time tag CP56Time2a	C_BO_TA_1

Either the ASDUs of the set <45> – <51> or of the set <58> – <64> are used.

System information in monitor direction

(Station-specific parameter, mark with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[X]	<70> := End of initialization	M_EI_NA_1

System information in control direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

X	<100>:= Interrogation command	C_IC_NA_1
	<101>:= Counter interrogation command	C_CI_NA_1
	<102>:= Read command	C_RD_NA_1
X	<103>:= Clock synchronization command (option see 7.6)	C_CS_NA_1
■	~~<104>:= Test command~~	C_TS_NA_1
X	<105>:= Reset process command	C_RP_NA_1
■	~~<106>:= Delay acquisition command~~	C_CD_NA_1
X	<107>:= Test command with time tag CP56Time2a	C_TS_TA_1

Parameter in control direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

	<110>:= Parameter of measured value, normalized value	P_ME_NA_1
	<111>:= Parameter of measured value, scaled value	P_ME_NB_1
	<112>:= Parameter of measured value, short floating point value	P_ME_NC_1
	<113>:= Parameter activation	P_AC_NA_1

File transfer

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

	<120>:= File ready	F_FR_NA_1
	<121>:= Section ready	F_SR_NA_1
	<122>:= Call directory, select file, call file, call section	F_SC_NA_1
	<123>:= Last section, last segment	F_LS_NA_1
	<124>:= Ack file, ack section	F_AF_NA_1
	<125>:= Segment	F_SG_NA_1
	<126>:= Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1
	<127>:= Query Log – Request archive file	F_SC_NB_1

Type identifier and cause of transmission assignments

(Station-specific parameters)

Shaded boxes: option not required.

Black boxes: option not permitted in this companion standard

Blank: functions or ASDU not used.

Mark the Type Identification/Cause of transmission combinations.

"X" if only used in the standard direction

"R" if only used in the reverse direction

"B" if used in both directions

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1			X											X					
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1			X											X					
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1																			
~~<6>~~	~~M_ST_TA_1~~																			
<7>	M_BO_NA_1																			
~~<8>~~	~~M_BO_TA_1~~																			
<9>	M_ME_NA_1																			
~~<10>~~	~~M_ME_TA_1~~																			
<11>	M_ME_NB_1																			
~~<12>~~	~~M_ME_TB_1~~																			
<13>	M_ME_NC_1	X		X											X					
~~<14>~~	~~M_ME_TC_1~~																			
<15>	M_IT_NA_1																			
~~<16>~~	~~M_IT_TA_1~~																			
~~<17>~~	~~M_EP_TA_1~~																			
~~<18>~~	~~M_EP_TB_1~~																			
~~<19>~~	~~M_EP_TC_1~~																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X																
<31>	M_DP_TB_1			X																
<32>	M_ST_TB_1																			

Table continues on next page

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1																			
<35>	M_ME_TE_1																			
<36>	M_ME_TF_1			X																
<37>	M_IT_TB_1																			
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X						X	X	X	X
<46>	C_DC_NA_1						X	X	X	X	X						X	X	X	X
<47>	C_RC_NA_1																			
<48>	C_SE_NA_1																			
<49>	C_SE_NB_1																			
<50>	C_SE_NC_1																			
<51>	C_BO_NA_1																			
<58>	C_SC_TA_1						X	X	X	X	X						X	X	X	X
<59>	C_DC_TA_1						X	X	X	X	X						X	X	X	X
<60>	C_RC_TA_1																			
<61>	C_SE_TA_1																			
<62>	C_SE_TB_1																			
<63>	C_SE_TC_1																			
<64>	C_BO_TA_1																			
<70>	M_EI_NA_1*				X															
<100>	C_IC_NA_1						X	X			X						X	X	X	X
<101>	C_CI_NA_1																			
<102>	C_RD_NA_1																			
<103>	C_CS_NA_1						X	X									X	X	X	X
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1*						X	X									X	X	X	X
~~<106>~~	~~C_CD_NA_1~~																			
<107>	C_TS_TA_1						X	X									X	X	X	X
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1																			
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			

Table continues on next page

Type identification		Cause of transmission																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1*																			
<127>	F_SC_NB_1*																			
* Blank or X only																				

11.2.6 Basic application functions

Station initialization

(Station-specific parameter, mark with an “X“ if the function is used.)

[X] Remote initialization

Cyclic data transmission

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[X] Cyclic data transmission

Read procedure

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[ ] Read procedure

Spontaneous transmission

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[X] Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

(Station-specific parameter, mark each information type with an “X“ where both a Type ID without time and a corresponding Type ID with time are issued in response to a single spontaneous change of a monitored object.)

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

- ☐ Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1
- ☐ Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
- ☐ Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
- ☐ Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)
- ☐ Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1
- ☐ Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
- ☐ Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- ☒ global
- ☒ group 1
- ☒ group 2
- ☒ group 3
- ☒ group 4
- ☒ group 5
- ☒ group 6
- ☒ group 7
- ☒ group 8
- ☒ group 9
- ☒ group 10
- ☒ group 11
- ☒ group 12
- ☒ group 13
- ☒ group 14
- ☒ group 15
- ☒ group 16

Information object addresses assigned to each group must be shown in a separate table.

Clock synchronization

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- [X] Clock synchronization
- [ ] Day of week used
- [ ] RES1, GEN (time tag substituted/ not substituted) used
- [ ] SU-bit (summertime) used

Command transmission

(Object-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- [X] Direct command transmission
- [ ] Direct set point command transmission
- [X] Select and execute command
- [ ] Select and execute set point command
- [ ] C_SE ACTTERM used
- [X] No additional definition
- [X] Short-pulse duration (duration determined by a system parameter in the outstation)
- [X] Long-pulse duration (duration determined by a system parameter in the outstation)
- [X] Persistent output
- [X] Supervision of maximum delay in command direction of commands and set point commands

0 – 600 sec Maximum allowable delay of commands and set point commands

Transmission of integrated totals

(Station- or object-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- [ ] Mode A: Local freeze with spontaneous transmission
- [ ] Mode B: Local freeze with counter interrogation
- [ ] Mode C: Freeze and transmit by counter-interrogation commands
- [ ] Mode D: Freeze by counter-interrogation command, frozen values reported

Table continues on next page

- ☐ Counter read
- ☐ Counter freeze without reset
- ☐ Counter freeze with reset
- ☐ Counter reset

- ☐ General request
- ☐ Request counter group 1
- ☐ Request counter group
- ☐ Request counter group 3
- ☐ Request counter group 4

Parameter loading

(Object-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- ☐ Threshold value
- ☐ Smoothing factor
- ☐ Low limit for transmission of measured values
- ☐ High limit for transmission of measured values

Parameter activation

(Object-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- ☐ Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- ☒ Test procedure

File transfer

(Station-specific parameter, mark with an “X“ if the function is used.)

Compare with “File transfer in control direction“.

☐ Transparent file

☐ Transmission of disturbance data of protection equipment

☐ Transmission of sequences of events

☐ Transmission of sequences of recorded analogue values

File transfer in control direction

☐ Transparent file

Background scan

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

☐ Background scan

Acquisition of transmission delay

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

■ ~~Acquisition of transmission delay~~

11.3 Default signal mapping

11.3.1 Disconnector 1

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Control output	DISCONNECTOR_CONTROL_1	150	C_DC_NA_1	Select Cancel Execute		No	1=Open 2=Close
•	•	Local / Remote switch	DISCONNECTOR_LOCREM_1	101	M_DP_TB_1	Spontaneous		Yes	0=Local (blocked) 1=Local 2=Remote 3=Remote (blocked)
•	•	Status	DISCONNECTOR_STATUS_1	100	M_DP_TB_1	Spontaneous		Yes	0=Intermediate 1=Open 2=Closed 3=Invalid
•	•	Travel time	DISCONNECTOR_TRAVELTIME_1	103	M_ME_TF_1	Spontaneous		Yes	
•	•	Minimum voltage during control	DISCONNECTOR_TRAVELVOLT_1	104	M_ME_TF_1	Spontaneous		Yes	
•	•	Maximum current during control	DISCONNECTOR_TRAVELCURRENT_1	105	M_ME_TF_1	Spontaneous		Yes	
•	•	Consumed charge for control	DISCONNECTOR_TRAVELCHARGE_1	106	M_ME_TF_1	Spontaneous		Yes	

11.3.2 Disconnector 2

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
	•	Control output	DISCONNECTOR_CONTROL_2	250	C_DC_NA_1	Select Cancel Execute		No	1=Open 2=Close
	•	Local / Remote switch	DISCONNECTOR_LOCREM_2	201	M_DP_TB_1	Spontaneous		Yes	0=Local (blocked) 1=Local 2=Remote 3=Remote (blocked)
	•	Status	DISCONNECTOR_STATUS_2	200	M_DP_TB_1	Spontaneous		Yes	0=Intermediate 1=Open 2=Closed 3=Invalid
	•	Travel time	DISCONNECTOR_TRAVELTIME_2	203	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
	•	Minimum voltage during control	DISCONNECTOR_TRAVELVOLT_2	204	M_ME_TF_1	Spontaneous		Yes	
	•	Maximum current during control	DISCONNECTOR_TRAVELCURRENT_2	205	M_ME_TF_1	Spontaneous		Yes	
	•	Consumed charge for control	DISCONNECTOR_TRAVELCHARGE_2	206	M_ME_TF_1	Spontaneous		Yes	

11.3.3 Disconnector 3

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Control output	DISCONNECTOR_CONTROL_3	350	C_DC_NA_1	Select Cancel Execute		No	1=Open 2=Close
•	•	Local / Remote switch	DISCONNECTOR_LOCREM_3	301	M_DP_TB_1	Spontaneous		Yes	0=Local (blocked) 1=Local 2=Remote 3=Remote (blocked)
•	•	Status	DISCONNECTOR_STATUS_3	300	M_DP_TB_1	Spontaneous		Yes	0=Intermediate 1=Open 2=Closed 3=Invalid
•	•	Travel time	DISCONNECTOR_TRAVELTIME_3	303	M_ME_TF_1	Spontaneous		Yes	
•	•	Minimum voltage during control	DISCONNECTOR_TRAVELVOLT_3	304	M_ME_TF_1	Spontaneous		Yes	
•	•	Maximum current during control	DISCONNECTOR_TRAVELCURRENT_3	305	M_ME_TF_1	Spontaneous		Yes	
•	•	Consumed charge for control	DISCONNECTOR_TRAVELCHARGE_3	306	M_ME_TF_1	Spontaneous		Yes	

11.3.4 Internal inputs

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	AC supply status	POWER_SUPPLY_STATUS_SPI	400	M_SP_TB_1	Spontaneous		Yes	0=AC available 1=AC not available
•	•	24VDC output relay status	MODEM_RELAY_STATUS_SPI	410	M_SP_TB_1	Spontaneous		Yes	0=DC output disabled 1=DC output enabled
•	•	Battery relay status	BATTERY_RELAY_STATUS_SPI	440	M_SP_TB_1	Spontaneous		Yes	0=Battery disconnected 1=Battery connected
•	•	Charger relay status	CHARGER_RELAY_STATUS_SPI	420	M_SP_TB_1	Spontaneous		Yes	0=Charging allowed 1=Charging disabled
•	•	Battery low voltage alarm	BATTERY_LOW_SPI	441	M_SP_TB_1	Spontaneous		Yes	0=Alarm off (voltage ok) 1=Alarm on (voltage low)
•	•	Battery deep-discharge protection status	BATTERY_PROTECT_SPI	442	M_SP_TB_1	Spontaneous		Yes	0=Normal operation 1=Protection active
•	•	Low temperature alarm	TEMPERATURE_LOW_SPI	460	M_SP_TB_1	Spontaneous		Yes	0=Alarm off 1=Alarm active
•	•	High temperature alarm	TEMPERATURE_HI_SPI	461	M_SP_TB_1	Spontaneous		Yes	0=Alarm off 1=Alarm active
•	•	Heater relay status	HEATER_RELAY_STATUS_SPI	430	M_SP_TB_1	Spontaneous		Yes	0=Heating off 1=Heating on
•	•	Battery charging voltage	BATTERY_CHARGEVOLTAGE_FPI	443	M_ME_TF_1	Spontaneous		Yes	
•	•	Battery charging current	BATTERY_CHARGECURRENT_FPI	444	M_ME_TF_1	Spontaneous		Yes	< 0=Consuming battery > 0=Charging battery
•	•	Temperature	TEMPERATURE_FPI	462	M_ME_TF_1	Spontaneous		Yes	
•	•	Load limiter status	LOAD_LIMITER_STATUS_DPI	480	M_DP_TB_1	Spontaneous		Yes	0=Idle (monitoring) 1=Disabled 2=Accumulating 3=Tripped
•	•	Load limiter trip reason	LOAD_LIMITER_REASON_DPI	481	M_DP_TB_1	Spontaneous		Yes	0=None 1=Charge 2=Duration 3=Manual

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Load limiter accumulated charge	LOAD_LIMITER_CHARGE_FPI	482	M_ME_TF_1	Spontaneous		Yes	
•	•	Load limiter accumulated duration	LOAD_LIMITER_TIME_FPI	483	M_ME_TF_1	Spontaneous		Yes	
•	•	Battery capacity test status	BATTERY_TEST_STATUS_DPI	445	M_DP_TB_1	Spontaneous		Yes	0=Idle 1=Testing 2=Test complete 3=Test aborted
•	•	Battery capacity test charge	BATTERY_TEST_CHARGE_FPI	446	M_ME_TF_1	Spontaneous		Yes	

11.3.5 Internal outputs

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Load limiter control	LOAD_LIMITER_CONTROL_SC	580	C_SC_NA_1	Execute		No	0=Disabled 1=Enabled
•	•	Battery capacity test control	BATTERY_TEST_CONTROL_SC	540	C_SC_NA_1	Execute		No	0=Stop test 1=Start test

11.3.6 General purpose inputs

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•		DI3 (X2.3 4-5)	DIGITAL_INPUT_SPI_3	703	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active
•		DI4 (X2.3 5-6)	DIGITAL_INPUT_SPI_4	704	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active
•		DI6 (X2.3 9-10)	DIGITAL_INPUT_SPI_6	706	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active
•		DI7 (X3 1-2)	DIGITAL_INPUT_SPI_7	707	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active
•		DI8 (X3 2-3)	DIGITAL_INPUT_SPI_8	708	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active
•		DI9 (X3 4-5)	DIGITAL_INPUT_SPI_9	709	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active
•		DI12 (X3 13-10)	DIGITAL_INPUT_SPI_12	712	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active
•		DI13 (X3 14-10)	DIGITAL_INPUT_SPI_13	713	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active
•		DI14 (X3 15-10)	DIGITAL_INPUT_SPI_14	714	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active
•		DI15 (X3 16-10)	DIGITAL_INPUT_SPI_15	715	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	DI16 (X4 12-11)	DIGITAL_INPUT_SPI_16	716	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active
•	•	DI17 (X4 13-11)	DIGITAL_INPUT_SPI_17	717	M_SP_TB_1	Spontaneous		Yes	0=Inactive 1=Active
•	•	Grounding disconnector 1 status	DIGITAL_INPUT_DPI_4	102	M_DP_TB_1	Spontaneous		Yes	0=Intermediate 1=Open 2=Closed 3=Invalid
	•	Grounding disconnector 2 status	DIGITAL_INPUT_DPI_5	202	M_DP_TB_1	Spontaneous		Yes	0=Intermediate 1=Open 2=Closed 3=Invalid
	•	Grounding disconnector 3 status	DIGITAL_INPUT_DPI_6	302	M_DP_TB_1	Spontaneous		Yes	0=Intermediate 1=Open 2=Closed 3=Invalid

11.3.7 Analog inputs

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	AI 1 (X4 3-4)	ANALOG_INPUT_FPI_1	601	M_ME_TF_1	Spontaneous		Yes	
•	•	AI 2 (X4 9-10)	ANALOG_INPUT_FPI_2	602	M_ME_TF_1	Spontaneous		Yes	

11.3.8 General purpose outputs

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•		DO4 (X2.3 17-18)	DIGITAL_OUTPUT_SC_4	804	C_SC_TA_1	Execute		No	0=Contacts open 1=Contacts closed
•		DO5 (X3 6-7)	DIGITAL_OUTPUT_SC_5	805	C_SC_TA_1	Execute		No	0=Contacts open 1=Contacts closed
•		DO_6 (X3 8-9)	DIGITAL_OUTPUT_SC_6	806	C_SC_TA_1	Execute		No	0=Contacts open 1=Contacts closed
•		DO9 (X4 7-8)	DIGITAL_OUTPUT_SC_9	809	C_SC_TA_1	Execute		No	0=Contacts open 1=Contacts closed
•	•	DO10 (X4 14-15)	DIGITAL_OUTPUT_SC_10	810	C_SC_TA_1	Execute		No	0=Contacts open 1=Contacts closed

11.3.9 ComPass fault passage indicator node1

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Reset ComPass		10100	C_SC_NA_1	Execute		No	1=Reset ComPass device
•	•	Clear ComPass events		10101	C_SC_NA_1	Execute		No	1=Clear ComPass events
•	•	Internal device error flag		10001	M_SP_TB_1	Spontaneous		Yes	0=No error 1=Internal device error
•	•	Overcurrent flag		10002	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent detected 1=Overcurrent detected
•	•	Earth fault tripping flag		10003	M_SP_TB_1	Spontaneous		Yes	0=No earth tripping occurred 1=Earth tripping occurred
•	•	Event in phase 1 flag		10004	M_SP_TB_1	Spontaneous		Yes	0=Phase 1 not event-affected 1=Phase 1 event-affected
•	•	Event in phase 2 flag		10005	M_SP_TB_1	Spontaneous		Yes	0=Phase 2 not event-affected 1=Phase 2 event-affected
•	•	Event in phase 3 flag		10006	M_SP_TB_1	Spontaneous		Yes	0=Phase 3 not event-affected 1=Phase 3 event-affected
•	•	Overvoltage flag		10007	M_SP_TB_1	Spontaneous		Yes	0=No overvoltage detected 1=Overvoltage detected
•	•	Undervoltage flag		10008	M_SP_TB_1	Spontaneous		Yes	0=No undervoltage detected 1=Undervoltage detected
•	•	Overcurrent direction A flag		10009	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent direction A detected 1=Overcurrent direction A detected

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Overcurrent direction B flag		10010	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent direction B detected 1=Overcurrent direction B detected
•	•	Earth current direction A flag		10011	M_SP_TB_1	Spontaneous		Yes	0=No eath current direction A detected 1=Earth current direction A detected
•	•	Earth current direction B flag		10012	M_SP_TB_1	Spontaneous		Yes	0=No eath current direction B detected 1=Earth current direction B detected
•	•	Load flow to direction A flag		10013	M_SP_TB_1	Spontaneous		Yes	0=Load flow direction is not A 1=Load flow direction is A
•	•	Load flow to direction B flag		10014	M_SP_TB_1	Spontaneous		Yes	0=Load flow direction is not B 1=Load flow direction is B
•	•	Phase current 1		10020	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase current 2		10021	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase current 3		10022	M_ME_TF_1	Spontaneous		Yes	
•	•	Earth current		10023	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 1-2		10031	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 2-3		10032	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 3-1		10033	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 1		10034	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 2		10035	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 3		10036	M_ME_TF_1	Spontaneous		Yes	
•	•	Displacement voltage		10037	M_ME_TF_1	Spontaneous		Yes	
•	•	Apparent power		10041	M_ME_TF_1	Spontaneous		Yes	
•	•	Active power		10042	M_ME_TF_1	Spontaneous		Yes	
•	•	Reactive power		10043	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Power factor		10044	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency		10045	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 average current 15 min		10051	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 average current 15 min		10052	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 average current 15 min		10053	M_ME_TF_1	Spontaneous		Yes	
•	•	Average earth current 15 min		10054	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 max current 24h		10055	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 24h		10056	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 24h		10057	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 max current 7d		10058	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 7d		10059	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 7d		10060	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 max current 1y		10061	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 1y		10062	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 1y		10063	M_ME_TF_1	Spontaneous		Yes	
•	•	Latest event type and time		10071	M_ME_TF_1	Spontaneous		No	

11.3.10 ComPass fault passage indicator node2

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Reset ComPass		20100	C_SC_NA_1	Execute		No	1=Reset ComPass device
•	•	Clear ComPass events		20101	C_SC_NA_1	Execute		No	1=Clear ComPass events
•	•	Internal device error flag		20001	M_SP_TB_1	Spontaneous		Yes	0=No error 1=Internal device error

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Overcurrent flag		20002	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent detected 1=Overcurrent detected
•	•	Earth fault tripping flag		20003	M_SP_TB_1	Spontaneous		Yes	0=No earth tripping occurred 1=Earth tripping occurred
•	•	Event in phase 1 flag		20004	M_SP_TB_1	Spontaneous		Yes	0=Phase 1 not event-affected 1=Phase 1 event-affected
•	•	Event in phase 2 flag		20005	M_SP_TB_1	Spontaneous		Yes	0=Phase 2 not event-affected 1=Phase 2 event-affected
•	•	Event in phase 3 flag		20006	M_SP_TB_1	Spontaneous		Yes	0=Phase 3 not event-affected 1=Phase 3 event-affected
•	•	Overvoltage flag		20007	M_SP_TB_1	Spontaneous		Yes	0=No overvoltage detected 1=Overvoltage detected
•	•	Undervoltage flag		20008	M_SP_TB_1	Spontaneous		Yes	0=No undervoltage detected 1=Undervoltage detected
•	•	Overcurrent direction A flag		20009	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent direction A detected 1=Overcurrent direction A detected
•	•	Overcurrent direction B flag		20010	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent direction B detected 1=Overcurrent direction B detected
•	•	Earth current direction A flag		20011	M_SP_TB_1	Spontaneous		Yes	0=No eath current direction A detected 1=Earth current direction A detected

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Earth current direction B flag		20012	M_SP_TB_1	Spontaneous		Yes	0=No eath current direction B detected 1=Earth current direction B detected
•	•	Load flow to direction A flag		20013	M_SP_TB_1	Spontaneous		Yes	0=Load flow direction is not A 1=Load flow direction is A
•	•	Load flow to direction B flag		20014	M_SP_TB_1	Spontaneous		Yes	0=Load flow direction is not B 1=Load flow direction is B
•	•	Phase current 1		20020	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase current 2		20021	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase current 3		20022	M_ME_TF_1	Spontaneous		Yes	
•	•	Earth current		20023	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 1-2		20031	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 2-3		20032	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 3-1		20033	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 1		20034	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 2		20035	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 3		20036	M_ME_TF_1	Spontaneous		Yes	
•	•	Displacement voltage		20037	M_ME_TF_1	Spontaneous		Yes	
•	•	Apparent power		20041	M_ME_TF_1	Spontaneous		Yes	
•	•	Active power		20042	M_ME_TF_1	Spontaneous		Yes	
•	•	Reactive power		20043	M_ME_TF_1	Spontaneous		Yes	
•	•	Power factor		20044	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency		20045	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 average current 15 min		20051	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 average current 15 min		20052	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 average current 15 min		20053	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Average earth current 15 min		20054	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 max current 24h		20055	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 24h		20056	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 24h		20057	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 max current 7d		20058	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 7d		20059	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 7d		20060	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 max current 1y		20061	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 1y		20062	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 1y		20063	M_ME_TF_1	Spontaneous		Yes	
•	•	Latest event type and time		20071	M_ME_TF_1	Spontaneous		No	

11.3.11 ComPass fault passage indicator node3

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Reset ComPass		30100	C_SC_NA_1	Execute		No	1=Reset ComPass device
•	•	Clear ComPass events		30101	C_SC_NA_1	Execute		No	1=Clear ComPass events
•	•	Internal device error flag		30001	M_SP_TB_1	Spontaneous		Yes	0=No error 1=Internal device error
•	•	Overcurrent flag		30002	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent detected 1=Overcurrent detected
•	•	Earth fault tripping flag		30003	M_SP_TB_1	Spontaneous		Yes	0=No earth tripping occurred 1=Earth tripping occurred
•	•	Event in phase 1 flag		30004	M_SP_TB_1	Spontaneous		Yes	0=Phase 1 not event-affected 1=Phase 1 event-affected

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Event in phase 2 flag		30005	M_SP_TB_1	Spontaneous		Yes	0=Phase 2 not event-affected 1=Phase 2 event-affected
•	•	Event in phase 3 flag		30006	M_SP_TB_1	Spontaneous		Yes	0=Phase 3 not event-affected 1=Phase 3 event-affected
•	•	Overvoltage flag		30007	M_SP_TB_1	Spontaneous		Yes	0=No overvoltage detected 1=Overvoltage detected
•	•	Undervoltage flag		30008	M_SP_TB_1	Spontaneous		Yes	0=No undervoltage detected 1=Undervoltage detected
•	•	Overcurrent direction A flag		30009	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent direction A detected 1=Overcurrent direction A detected
•	•	Overcurrent direction B flag		30010	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent direction B detected 1=Overcurrent direction B detected
•	•	Earth current direction A flag		30011	M_SP_TB_1	Spontaneous		Yes	0=No eath current direction A detected 1=Earth current direction A detected
•	•	Earth current direction B flag		30012	M_SP_TB_1	Spontaneous		Yes	0=No eath current direction B detected 1=Earth current direction B detected
•	•	Load flow to direction A flag		30013	M_SP_TB_1	Spontaneous		Yes	0=Load flow direction is not A 1=Load flow direction is A
•	•	Load flow to direction B flag		30014	M_SP_TB_1	Spontaneous		Yes	0=Load flow direction is not B 1=Load flow direction is B
•	•	Phase current 1		30020	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Phase current 2		30021	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase current 3		30022	M_ME_TF_1	Spontaneous		Yes	
•	•	Earth current		30023	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 1-2		30031	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 2-3		30032	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 3-1		30033	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 1		30034	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 2		30035	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 3		30036	M_ME_TF_1	Spontaneous		Yes	
•	•	Displacement voltage		30037	M_ME_TF_1	Spontaneous		Yes	
•	•	Apparent power		30041	M_ME_TF_1	Spontaneous		Yes	
•	•	Active power		30042	M_ME_TF_1	Spontaneous		Yes	
•	•	Reactive power		30043	M_ME_TF_1	Spontaneous		Yes	
•	•	Power factor		30044	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency		30045	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 average current 15 min		30051	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 average current 15 min		30052	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 average current 15 min		30053	M_ME_TF_1	Spontaneous		Yes	
•	•	Average earth current 15 min		30054	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 max current 24h		30055	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 24h		30056	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 24h		30057	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 max current 7d		30058	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 7d		30059	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 7d		30060	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Phase 1 max current 1y		30061	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 1y		30062	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 1y		30063	M_ME_TF_1	Spontaneous		Yes	
•	•	Latest event type and time		30071	M_ME_TF_1	Spontaneous		No	

11.3.12 ComPass fault passage indicator node4

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Reset ComPass		40100	C_SC_NA_1	Execute		No	1=Reset ComPass device
•	•	Clear ComPass events		40101	C_SC_NA_1	Execute		No	1=Clear ComPass events
•	•	Internal device error flag		40001	M_SP_TB_1	Spontaneous		Yes	0=No error 1=Internal device error
•	•	Overcurrent flag		40002	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent detected 1=Overcurrent detected
•	•	Earth fault tripping flag		40003	M_SP_TB_1	Spontaneous		Yes	0=No earth tripping occurred 1=Earth tripping occurred
•	•	Event in phase 1 flag		40004	M_SP_TB_1	Spontaneous		Yes	0=Phase 1 not event-affected 1=Phase 1 event-affected
•	•	Event in phase 2 flag		40005	M_SP_TB_1	Spontaneous		Yes	0=Phase 2 not event-affected 1=Phase 2 event-affected
•	•	Event in phase 3 flag		40006	M_SP_TB_1	Spontaneous		Yes	0=Phase 3 not event-affected 1=Phase 3 event-affected
•	•	Overvoltage flag		40007	M_SP_TB_1	Spontaneous		Yes	0=No overvoltage detected 1=Overvoltage detected
•	•	Undervoltage flag		40008	M_SP_TB_1	Spontaneous		Yes	0=No undervoltage detected 1=Undervoltage detected

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Overcurrent direction A flag		40009	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent direction A detected 1=Overcurrent direction A detected
•	•	Overcurrent direction B flag		40010	M_SP_TB_1	Spontaneous		Yes	0=No overcurrent direction B detected 1=Overcurrent direction B detected
•	•	Earth current direction A flag		40011	M_SP_TB_1	Spontaneous		Yes	0=No eath current direction A detected 1=Earth current direction A detected
•	•	Earth current direction B flag		40012	M_SP_TB_1	Spontaneous		Yes	0=No eath current direction B detected 1=Earth current direction B detected
•	•	Load flow to direction A flag		40013	M_SP_TB_1	Spontaneous		Yes	0=Load flow direction is not A 1=Load flow direction is A
•	•	Load flow to direction B flag		40014	M_SP_TB_1	Spontaneous		Yes	0=Load flow direction is not B 1=Load flow direction is B
•	•	Phase current 1		40020	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase current 2		40021	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase current 3		40022	M_ME_TF_1	Spontaneous		Yes	
•	•	Earth current		40023	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 1-2		40031	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 2-3		40032	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage 3-1		40033	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 1		40034	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 2		40035	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase voltage 3		40036	M_ME_TF_1	Spontaneous		Yes	
•	•	Displacement voltage		40037	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Apparent power		40041	M_ME_TF_1	Spontaneous		Yes	
•	•	Active power		40042	M_ME_TF_1	Spontaneous		Yes	
•	•	Reactive power		40043	M_ME_TF_1	Spontaneous		Yes	
•	•	Power factor		40044	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency		40045	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 average current 15 min		40051	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 average current 15 min		40052	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 average current 15 min		40053	M_ME_TF_1	Spontaneous		Yes	
•	•	Average earth current 15 min		40054	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 max current 24h		40055	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 24h		40056	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 24h		40057	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 max current 7d		40058	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 7d		40059	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 7d		40060	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 1 max current 1y		40061	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 2 max current 1y		40062	M_ME_TF_1	Spontaneous		Yes	
•	•	Phase 3 max current 1y		40063	M_ME_TF_1	Spontaneous		Yes	
•	•	Latest event type and time		40071	M_ME_TF_1	Spontaneous		Yes	

11.3.13 Kries IKI-50 fault passage indicator node 1

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Reset faults (all faults)		11100	C_SC_NA_1	Execute		No	1=Reset
•	•	Reset min-/ max-values		11101	C_SC_NA_1	Execute		No	1=Reset
•	•	Tripping1 accept fault / reset		11102	C_SC_NA_1	Execute		No	1=Reset
•	•	Tripping2 accept fault / reset		11103	C_SC_NA_1	Execute		No	1=Reset
•	•	Enable or disable short-circuit detection		11104	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Enable or disable earth short-circuit detection		11105	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Enable or disable static earth fault detection		11106	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Enable or disable transient earth fault detection		11107	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Current L1 Feeder1		11020	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L1 Feeder1 away from busbar		11021	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L1 Feeder1 away from busbar		11022	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L1 Feeder1 toward busbar		11023	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L1 Feeder1 toward busbar		11024	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency Voltage L1 Feeder1		11025	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Voltage L1-GND Feeder1		11026	M_ME_TF_1	Spontaneous		Yes	
•	•	Current L2 Feeder1		11027	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L2 Feeder1 away from busbar		11028	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L2 Feeder1 away from busbar		11029	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L2 Feeder1 toward busbar		11030	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L2 Feeder1 toward busbar		11031	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency Voltage L2 Feeder1		11032	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L2-GND Feeder1		11033	M_ME_TF_1	Spontaneous		Yes	
•	•	Current L3 Feeder1		11034	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L3 Feeder1 away from busbar		11035	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L3 Feeder1 away from busbar		11036	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L3 Feeder1 toward busbar		11037	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L3 Feeder1 toward busbar		11038	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency Voltage L3 Feeder1		11039	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L3-GND Feeder1		11040	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Sum I1 – I3 Feeder1		11041	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum U1 – U3 Feeder1		11042	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Effective Power Feeder1		11043	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Reactive Power Feeder1		11044	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Apparent Power Feeder1		11045	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Effective Energy away from busbar Feeder1		11046	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Effective Energy toward busbar Feeder1		11047	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Reactive Energy away from busbar Feeder1		11048	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Reactive Energy toward busbar Feeder1		11049	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Apparent Energy away from busbar Feeder1		11050	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Apparent Energy toward busbar Feeder1		11051	M_ME_TF_1	Spontaneous		Yes	
•	•	Cos φ Sum U1-U3, I1-I3 Feeder1		11052	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Sum I1 – I3 away from busbar Feeder1		11053	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Voltage L1-L2 Feeder1		11054	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L2-L3 Feeder1		11055	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L3-L1 Feeder1		11056	M_ME_TF_1	Spontaneous		Yes	
•	•	Short-circuit L1 feeder1		11200	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit L2 feeder1		11201	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit L3 feeder1		11202	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit towards busbar feeder1		11203	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit away from busbar feeder1		11204	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Fault direction short-circuit unknown feeder1		11205	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth short-circuit feeder1		11206	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault with transient earth fault feeder1		11207	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault with static earth fault feeder1		11208	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Pulse current detected feeder1		11209	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault towards busbar feeder1		11210	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault away from busbar feeder1		11211	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Fault direction earth fault unknown feeder1		11212	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Limit monitoring feeder1 U>		11213	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U>>		11214	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U<		11215	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U<<		11216	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 f>		11217	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 f<		11218	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 Q&U		11219	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U0>		11220	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault detected feeder1		11221	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault Warning feeder1		11222	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault towards busbar feeder1		11223	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault away from busbar feeder1		11224	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault unknown direction feeder1		11225	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit detection		11300	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Earth short-circuit detection		11301	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Static earth fault detection		11302	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Transient earth fault detection		11303	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

11.3.14 Kries IKI-50 fault passage indicator node 2

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Reset faults (all faults)		21100	C_SC_NA_1	Execute		No	1=Reset
•	•	Reset min-/ max-values		21101	C_SC_NA_1	Execute		No	1=Reset
•	•	Tripping1 accept fault / reset		21102	C_SC_NA_1	Execute		No	1=Reset
•	•	Tripping2 accept fault / reset		21103	C_SC_NA_1	Execute		No	1=Reset
•	•	Enable or disable short-circuit detection		21104	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Enable or disable earth short-circuit detection		21105	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Enable or disable static earth fault detection		21106	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Enable or disable transient earth fault detection		21107	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Current L1 Feeder1		21020	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L1 Feeder1 away from busbar		21021	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L1 Feeder1 away from busbar		21022	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Dt Current L1 Feeder1 toward busbar		21023	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L1 Feeder1 toward busbar		21024	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency Voltage L1 Feeder1		21025	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L1-GND Feeder1		21026	M_ME_TF_1	Spontaneous		Yes	
•	•	Current L2 Feeder1		21027	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L2 Feeder1 away from busbar		21028	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L2 Feeder1 away from busbar		21029	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L2 Feeder1 toward busbar		21030	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L2 Feeder1 toward busbar		21031	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency Voltage L2 Feeder1		21032	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L2-GND Feeder1		21033	M_ME_TF_1	Spontaneous		Yes	
•	•	Current L3 Feeder1		21034	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L3 Feeder1 away from busbar		21035	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L3 Feeder1 away from busbar		21036	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Dt Current L3 Feeder1 toward busbar		21037	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L3 Feeder1 toward busbar		21038	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency Voltage L3 Feeder1		21039	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L3-GND Feeder1		21040	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum I1 – I3 Feeder1		21041	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum U1 – U3 Feeder1		21042	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Effective Power Feeder1		21043	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Reactive Power Feeder1		21044	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Apparent Power Feeder1		21045	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Effective Energy away from busbar Feeder1		21046	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Effective Energy toward busbar Feeder1		21047	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Reactive Energy away from busbar Feeder1		21048	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Reactive Energy toward busbar Feeder1		21049	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Sum Apparent Energy away from busbar Feeder1		21050	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Apparent Energy toward busbar Feeder1		21051	M_ME_TF_1	Spontaneous		Yes	
•	•	Cos φ Sum U1-U3, I1-I3 Feeder1		21052	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Sum I1 – I3 away from busbar Feeder1		21053	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L1-L2 Feeder1		21054	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L2-L3 Feeder1		21055	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L3-L1 Feeder1		21056	M_ME_TF_1	Spontaneous		Yes	
•	•	Short-circuit L1 feeder1		21200	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit L2 feeder1		21201	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit L3 feeder1		21202	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit towards busbar feeder1		21203	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit away from busbar feeder1		21204	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Fault direction short-circuit unknown feeder1		21205	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth short-circuit feeder1		21206	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault with transient earth fault feeder1		21207	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault with static earth fault feeder1		21208	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Pulse current detected feeder1		21209	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault towards busbar feeder1		21210	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault away from busbar feeder1		21211	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Fault direction earth fault unknown feeder1		21212	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U>		21213	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U>>		21214	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U<		21215	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U<<		21216	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 f>		21217	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 f<		21218	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 Q&U		21219	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U0>		21220	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault detected feeder1		21221	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault Warning feeder1		21222	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault towards busbar feeder1		21223	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Intermittent earth fault away from busbar feeder1		21224	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault unknown direction feeder1		21225	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit detection		21300	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth short-circuit detection		21301	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Static earth fault detection		21302	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Transient earth fault detection		21303	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

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REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Reset faults (all faults)		31100	C_SC_NA_1	Execute		No	1=Reset
•	•	Reset min-/ max-values		31101	C_SC_NA_1	Execute		No	1=Reset
•	•	Tripping1 accept fault / reset		31102	C_SC_NA_1	Execute		No	1=Reset
•	•	Tripping2 accept fault / reset		31103	C_SC_NA_1	Execute		No	1=Reset
•	•	Enable or disable short-circuit detection		31104	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Enable or disable earth short-circuit detection		31105	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Enable or disable static earth fault detection		31106	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Enable or disable transient earth fault detection		31107	C_SC_NA_1	Execute		No	1=On 0=Off

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Current L1 Feeder1		31020	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L1 Feeder1 away from busbar		31021	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L1 Feeder1 away from busbar		31022	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L1 Feeder1 toward busbar		31023	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L1 Feeder1 toward busbar		31024	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency Voltage L1 Feeder1		31025	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L1-GND Feeder1		31026	M_ME_TF_1	Spontaneous		Yes	
•	•	Current L2 Feeder1		31027	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L2 Feeder1 away from busbar		31028	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L2 Feeder1 away from busbar		31029	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L2 Feeder1 toward busbar		31030	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L2 Feeder1 toward busbar		31031	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency Voltage L2 Feeder1		31032	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L2-GND Feeder1		31033	M_ME_TF_1	Spontaneous		Yes	
•	•	Current L3 Feeder1		31034	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Dt Current L3 Feeder1 away from busbar		31035	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L3 Feeder1 away from busbar		31036	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L3 Feeder1 toward busbar		31037	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L3 Feeder1 toward busbar		31038	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency Voltage L3 Feeder1		31039	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L3-GND Feeder1		31040	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum I1 – I3 Feeder1		31041	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum U1 – U3 Feeder1		31042	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Effective Power Feeder1		31043	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Reactive Power Feeder1		31044	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Apparent Power Feeder1		31045	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Effective Energy away from busbar Feeder1		31046	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Effective Energy toward busbar Feeder1		31047	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Reactive Energy away from busbar Feeder1		31048	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Sum Reactive Energy toward busbar Feeder1		31049	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Apparent Energy away from busbar Feeder1		31050	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Apparent Energy toward busbar Feeder1		31051	M_ME_TF_1	Spontaneous		Yes	
•	•	Cos φ Sum U1-U3, I1-I3 Feeder1		31052	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Sum I1 – I3 away from busbar Feeder1		31053	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L1-L2 Feeder1		31054	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L2-L3 Feeder1		31055	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L3-L1 Feeder1		31056	M_ME_TF_1	Spontaneous		Yes	
•	•	Short-circuit L1 feeder1		31200	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit L2 feeder1		31201	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit L3 feeder1		31202	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit towards busbar feeder1		31203	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit away from busbar feeder1		31204	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Fault direction short-circuit unknown feeder1		31205	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth short-circuit feeder1		31206	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Earth fault with transient earth fault feeder1		31207	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault with static earth fault feeder1		31208	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Pulse current detected feeder1		31209	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault towards busbar feeder1		31210	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault away from busbar feeder1		31211	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Fault direction earth fault unknown feeder1		31212	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U>		31213	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U>>		31214	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U<		31215	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U<<		31216	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 f>		31217	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 f<		31218	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 Q&U		31219	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U0>		31220	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault detected feeder1		31221	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Intermittent earth fault Warning feeder1		31222	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault towards busbar feeder1		31223	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault away from busbar feeder1		31224	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault unknown direction feeder1		31225	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit detection		31300	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth short-circuit detection		31301	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Static earth fault detection		31302	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Transient earth fault detection		31303	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

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REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Reset faults (all faults)		41100	C_SC_NA_1	Execute		No	1=Reset
•	•	Reset min-/ max-values		41101	C_SC_NA_1	Execute		No	1=Reset
•	•	Tripping1 accept fault / reset		41102	C_SC_NA_1	Execute		No	1=Reset
•	•	Tripping2 accept fault / reset		41103	C_SC_NA_1	Execute		No	1=Reset
•	•	Enable or disable short-circuit detection		41104	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Enable or disable earth short-circuit detection		41105	C_SC_NA_1	Execute		No	1=On 0=Off

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Enable or disable static earth fault detection		41106	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Enable or disable transient earth fault detection		41107	C_SC_NA_1	Execute		No	1=On 0=Off
•	•	Current L1 Feeder1		41020	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L1 Feeder1 away from busbar		41021	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L1 Feeder1 away from busbar		41022	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L1 Feeder1 toward busbar		41023	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L1 Feeder1 toward busbar		41024	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency Voltage L1 Feeder1		41025	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L1-GND Feeder1		41026	M_ME_TF_1	Spontaneous		Yes	
•	•	Current L2 Feeder1		41027	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L2 Feeder1 away from busbar		41028	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L2 Feeder1 away from busbar		41029	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L2 Feeder1 toward busbar		41030	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L2 Feeder1 toward busbar		41031	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Frequency Voltage L2 Feeder1		41032	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L2-GND Feeder1		41033	M_ME_TF_1	Spontaneous		Yes	
•	•	Current L3 Feeder1		41034	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L3 Feeder1 away from busbar		41035	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L3 Feeder1 away from busbar		41036	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Current L3 Feeder1 toward busbar		41037	M_ME_TF_1	Spontaneous		Yes	
•	•	Max Dt Current L3 Feeder1 toward busbar		41038	M_ME_TF_1	Spontaneous		Yes	
•	•	Frequency Voltage L3 Feeder1		41039	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L3-GND Feeder1		41040	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum I1 – I3 Feeder1		41041	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum U1 – U3 Feeder1		41042	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Effective Power Feeder1		41043	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Reactive Power Feeder1		41044	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Apparent Power Feeder1		41045	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Effective Energy away from busbar Feeder1		41046	M_ME_TF_1	Spontaneous		Yes	

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Sum Effective Energy toward busbar Feeder1		41047	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Reactive Energy away from busbar Feeder1		41048	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Reactive Energy toward busbar Feeder1		41049	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Apparent Energy away from busbar Feeder1		41050	M_ME_TF_1	Spontaneous		Yes	
•	•	Sum Apparent Energy toward busbar Feeder1		41051	M_ME_TF_1	Spontaneous		Yes	
•	•	Cos φ Sum U1-U3, I1-I3 Feeder1		41052	M_ME_TF_1	Spontaneous		Yes	
•	•	Dt Sum I1 – I3 away from busbar Feeder1		41053	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L1-L2 Feeder1		41054	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L2-L3 Feeder1		41055	M_ME_TF_1	Spontaneous		Yes	
•	•	Voltage L3-L1 Feeder1		41056	M_ME_TF_1	Spontaneous		Yes	
•	•	Short-circuit L1 feeder1		41200	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit L2 feeder1		41201	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit L3 feeder1		41202	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit towards busbar feeder1		41203	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit away from busbar feeder1		41204	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Fault direction short-circuit unknown feeder1		41205	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth short-circuit feeder1		41206	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault with transient earth fault feeder1		41207	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault with static earth fault feeder1		41208	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Pulse current detected feeder1		41209	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault towards busbar feeder1		41210	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth fault away from busbar feeder1		41211	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Fault direction earth fault unknown feeder1		41212	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U>		41213	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U>>		41214	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U<		41215	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 U<<		41216	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 f>		41217	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 f<		41218	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Limit monitoring feeder1 Q&U		41219	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

Table continues on next page

REC601	REC603	Description	Name	IEC address	ASDU type	Access type	Class	IA	Values
•	•	Limit monitoring feeder1 U0>		41220	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault detected feeder1		41221	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault Warning feeder1		41222	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault towards busbar feeder1		41223	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault away from busbar feeder1		41224	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Intermittent earth fault unknown direction feeder1		41225	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Short-circuit detection		41300	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Earth short-circuit detection		41301	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Static earth fault detection		41302	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off
•	•	Transient earth fault detection		41303	M_SP_TB_1	Spontaneous		Yes	1=On 0=Off

Section 12 Glossary

AC	Alternating current
APDU	Application protocol data unit
APN	Access Point Name
ARP	Address Resolution Protocol
ASDU	Application-layer service data unit
BIND	Berkeley Internet Name Domain
COT	Cause of transmission
CTS	Clear to send
D-NAT	Destination network address translation
DC	1. Direct current 2. Disconnector 3. Double command
DCD	Data carrier detect
DHCP	Dynamic Host Configuration Protocol
DI	Digital input
DIN rail	A standardized 35 mm wide metal rail with a hat-shaped cross section
DIP	Dual in-line package
DIP switch	A set of on-off switches arranged in a standard dual in-line package
DMS	Distribution Management System
DNS	Domain Name System
DPI	Double-point information
DSR	Data set ready
DTE	Data Terminal Equipment
DTR	Data terminal ready
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
FIFO	First in, first out
FME	For Mobile Equipment

FPI	Measured value, short floating point information
FTP	File transfer protocol
G-P	General-purpose
GI	General interrogation
GND	Ground/earth
GPRS	General Packet Radio Service
GRE	Generic Routing Encapsulation. Network tunneling protocol.
GSM	Global system for mobile communications
HMI	Human-machine interface
HTML	Hypertext markup language
HW	Hardware
I/O	Input/output
IAB	Internet Architecture Board
IC	Integrated circuit
ICMP	Internet Control Message Protocol
IEC	International Electrotechnical Commission
IEC 60870-5-101	Companion standard for basic telecontrol tasks
IEC 60870-5-104	Network access for IEC 60870-5-101
IEC 60870-5-4	
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IP	Internet protocol
IP address	A set of four numbers between 0 and 255, separated by periods. Each server connected to the Internet is assigned a unique IP address that specifies the location for the TCP/IP protocol.
LAN	Local area network
LED	Light-emitting diode
MAC	Media access control
MCB	Miniature circuit breaker
Modbus	A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.
MRU	Maximum Receive Unit
MTU	Maximum Transfer Unit
NT	Non-topical

NTC	Negative Temperature Coefficient
NTP	Network time protocol
PC	1. Personal computer 2. Polycarbonate
PIN	Personal Identification Number
PPP	Point-to-point protocol
REC601	Wireless controller
REC603	Wireless controller
RF	Radio frequency
RI	Ring Indicator
RJ-45	Galvanic connector type
RoHS	Restriction of the use of certain hazardous substances in electrical and electronic equipment
RS-232	Serial interface standard
RS-422	Serial communication standard (EIA–422)
RS-485	Serial link according to EIA standard RS485
RTS	Ready to send
RTU	Remote terminal unit
Rx	Receive/Received
RXD	Received exchange data
S-NAT	Source network address translation
SC	Single command
SCADA	Supervision, control and data acquisition
SIM	Subscriber Identity Module
SMS	1. Short Message Service 2. Station monitoring system
SNMP	Simple Network Management Protocol
SPI	Single-point information
SSH	Secure shell
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
Telnet	An Internet protocol that allows logging on to a remote computer using a user name and password
TSIG	Transaction signature
Tx	Transmit/Transmitted

TXD	Transmit exchange data
UDP	User datagram protocol
UI	User interface
URL	Uniform Resource Locator
VPN	Virtual Private Network
WHMI	Web human-machine interface
WWW	World Wide Web

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