Remote Monitoring and Control Unit REC 523

Technical Reference Manual

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Technical Reference Manual

1. About this manual

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1.4. General

This manual provides a general technical description of the remote monitoring and control unit REC 523. This version of the Technical Reference Manual complies with REC 523 Release Q1/05. For information about the changes and additions included in this release compared to earlier releases, refer to Chapter 11. Revision history of REC 523.

For detailed information about the functions listed in Section 5.1. REC 523 functions, refer to the version 2.2 or later of the CD-ROM Technical Descriptions of Functions for REF, REM and REC. See Section 1.8. Related documents.

1.5. Use of symbols

This publication includes warning, caution, and information icons that point out safety related conditions or other important information. It also includes tip icons to point out useful information to the reader. The corresponding icons should be interpreted as follows:

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 to relevant 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, and caution hazards are associated with equipment or property damage, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.6. Terminology

The following is a list of terms associated with REC 523 that you should be familiar with. The list contains terms that are unique to ABB or have a usage or definition that is different from standard industry usage.

Term	Description
SPA	Data communication protocol developed by ABB
SPACOM	ABB product family

1.7. Abbreviations

AI	Analogue input
ASCII	American standard code for information interchange
CB	Circuit breaker
CBFP	Circuit-breaker failure protection
CPU	Central processing unit
CT	Current transformer
DI	Digital input
DLC	Digital line carrier
DO	Digital output
EMC	Electro-magnetic compatibility
HSPO	High-speed power output
I/O	Input/output
IRF	Internal relay fault
L/R	Local/remote
LED	Light-emitting diode
LNT	LON Network Tool
LON	Local Operating Network
LV	Low voltage
MIM	Matching transformer input module
MV	Medium voltage
NO/NC	Normally open/ normally closed
PCB	Printed circuit board
PLC	Programmable logic controller
PO	Power output
POD	Process object dictionary
PSC	Power supply and charger unit
RMU	Ring main unit
RTU	Remote terminal unit
SNVT	Standard network variable type
SO	Signal output
TCS	Trip circuit supervision
VT	Voltage transformer

1.8. Related documents

Name of the manual	**Document ID**
REC 523 manuals	
RE_ 5_ _, Protection, Monitoring and Control, Installation Manual	1MRS750526-MUM
REF 54_, REM 54_, RET 54_, REC 523, Configuration Guideline[a]	1MRS750745-MUM
Technical Descriptions of Functions	1MRS750889-MCD
Protocol descriptions	
DNP 3.0 Remote Communication Protocol for REC 523, Technical Description	1MRS750958-MUM
IEC 60870-5-101 Remote Communication Protocol for REC 523, Technical Description	1MRS750956-MUM

Name of the manual	Document ID
LonWorks Network in Protection and Control Systems, User's Manual and Technical Description	1MRS750035-MTD
MODBUS Remote Communication Protocol for REC 523, Technical Description	1MRS752015-MUM
SPA-Bus Communication Protocol V2.5, Technical Description	1MRS750076-MTD
Other manuals	
CAP 505 Protocol Editing Tool, User's Guide	1MRS751982-MUM
CAP 505 Protocol Mapping Tool, Operation Manual	1MRS755277
LIB, CAP and SMS, Tools for Relays and Terminals, User's Guide	1MRS752008-MUM
LNT 505, Operator's Manual	1MRS751706-MUM
Relay Configuration Tool, Quick Start Reference	1MRS751905-MEN
Relay Configuration Tool, Tutorial	1MRS751903-MEN
Echelon documents	
LonMark Application Layer Interoperability Guidelines	-
LonMark SNVT Master List	-

a. Included in the CD-ROM Technical Descriptions of Functions

1.9. Document revisions

Version	Date	History
F	26.04.2001	-
G	04.11.2002	-
H	21.10.2003	-Table 6.-6 Power output relay's breaking capacity value changed from 1 A/0.25 A /0.15 A to 5 A/3 A/1 A. -Customer feedback and Service Report forms deleted.
K	16.12.2004	-Release Q1/04 information added.
L	01.03.2005	-Communication protocol IEC 60870-5-101 now fully supported. -Protocol Mapping Tool additions. -New hardware variant (054/059) added. -New calculated analogue channel added.
M	31.10.2007	- Figure updated (Section 7.3.9. Application example)
N	19.12.2008	- New hardware variant (071/072) added.

2. Safety information

	Dangerous voltages can occur on the connectors, even though the auxiliary voltage has been disconnected.
	National and local electrical safety regulations must always be followed.
	The device contains components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.
	The frame of the device has to be carefully earthed.
	Only a competent electrician is allowed to carry out the electrical installation.
	Non-observance can result in death, personal injury or substantial property damage.
	Breaking the sealing tape on the upper handle of the device will result in loss of warranty and proper operation will no longer be guaranteed.

3. Introduction

3.1. General

The REC 523 Remote Monitoring and Control Unit (REC 523) is part of the ABB Distribution Automation system and extends the functionality and flexibility of the concept further. This is possible due to the modern technology applied both in hardware and software solutions.

Increased performance is achieved by utilizing the multiprocessor architecture. Digital signal processing combined with a powerful central processing unit (CPU) and distributed input/output (I/O) handling facilitates parallel operations and improves response times and accuracy. Moreover, highly developed function blocks that are used for protection in medium voltage (MV) substations are utilized in REC 523 to indicate faults at secondary substations.

Fig. 3.1.-1 REC 523 Remote Monitoring and Control Unit

3.2. Hardware versions

The REC 523 unit is available in several versions with varying hardware equipment corresponding to different uses in the distribution network (such as branch, normal open point, and so on) of the REC 523 unit. See the following table.

Table 3.2.-1 REC 523 hardware versions

HW versions	REC 523							
	032/037 AAA, CAA	033/038 AAA, CAA	034/039 AAA, CAA	054/059 AAA, CAA[a]	060/065 AAC, CAC[b]	061/066 AAA, CAA[b]	062/067 AAA, CAA[b]	071/072 AAB, CAB[a]
Analogue interface								
Sensor channels								
Current sensor	-	-	-	-	9	-	-	9
Voltage divider	-	-	-	-		-	-	
Transformers								
Current Transformer 0.2/1 A	-	-	-	1	-	-	-	1
Current Transformer 1/5 A	3	3	4	4	-	6	3	4
Voltage Transformer 100 V	-	3	-	4	-	3	6	4
Voltage Transformer 230 V	-	-	3	-	-	-	-	-
Digital inputs	15	15	15	15	15	15	15	15
Power outputs, double-pole	2	2	2	2	2	2	2	2
Signal outputs (NO)	3	3	3	3	3	3	3	3
Signal outputs (NO/NC)	4	4	4	4	4	4	4	4
IRF outputs	1	1	1	1	1	1	1	1

a. The HW versions 054/059 AAA, CAA and 071/072 AAB, CAB are only included in REC 523 revision F.

b. Not included in REC 523 revisions A and B. Note also that the HW versions 031/036 AAC, CAC were only included in REC 523 revisions A and B.

4. Instructions

4.1. Application

REC 523 is designed to be used for the control, measurement, supervision, protection and fault indication of secondary substations in medium voltage networks. The main area is remote control and monitoring of the medium voltage overhead line and underground networks:

- Pole and pad-mounted switches and disconnectors
- Ring main units (RMU)
- Small transformer kiosks
- Other primary and secondary substation automation

The functionality of REC 523 is tied to the hardware configuration.The desired functions can be activated from a wide range of protection, control, measurement, power quality, condition monitoring, general and communication functions within the scope of I/O connections, considering the total CPU load. Compared to the traditional use of separate products, the combination of desired functions provides cost-effective solutions and, together with the relay configuration (IEC 61131 standard), allows the REC 523 unit to be easily adapted to different kinds of applications.

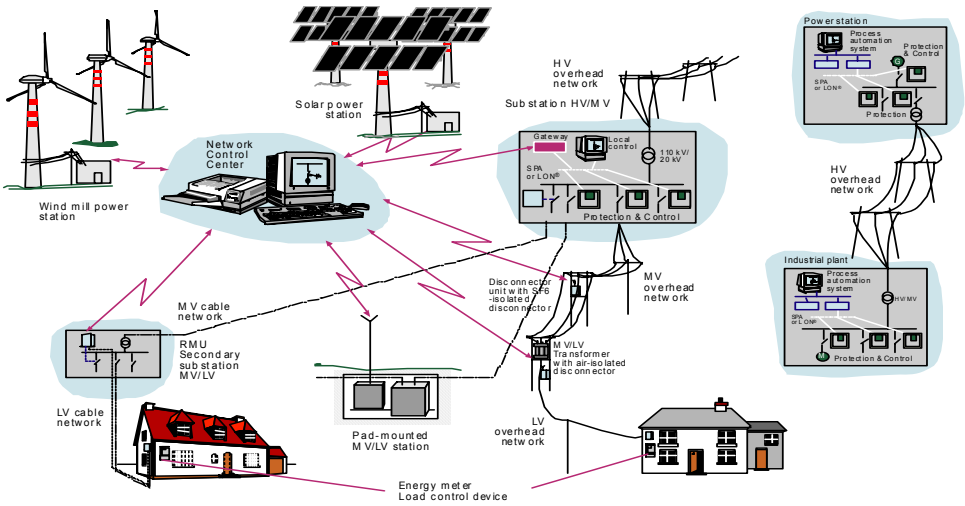


Fig. 4.1.-1 Remote Monitoring and Control Unit system based on REC 523

By means of a programmable LED display, the control functions of the REC 523 unit indicate the status of disconnectors and circuit breakers, faults, alarm limits, and so on. Further REC 523 allows status information to be transmitted to the remote control system. Controllable objects (such as circuit breakers) can be opened and closed over the remote control system or by using the local automation functions, such as reclosers and sectionalizers. Status information and control signals are transmitted over the serial bus.

The REC 523 unit measures, for example, phase currents, neutral currents, phase-to-phase or phase-to-earth voltages and residual voltages. The power factor, active and reactive power are calculated from measured currents and voltages. Energy can be calculated on the basis of the measured power. The measured values can be indicated remotely as scaled primary values.

In addition to measurement and control functions, the REC 523 units are provided with a large amount of programmable logic controller (PLC) functions allowing all the functions needed for secondary substation automation to be integrated into one unit. The data communication properties include communication over:

- SPA bus
- LON bus
- Modbus (RTU and ASCII)
- IEC 60870-5-101
- DNP 3.0 with higher-level equipment.

The flexibility of REC 523 makes it possible to use a wide range of communication methods such as switched line telephone, leased line, optical cable, digital and analogue mobile networks, radio modems, packet radio networks, radio links and TETRA network.

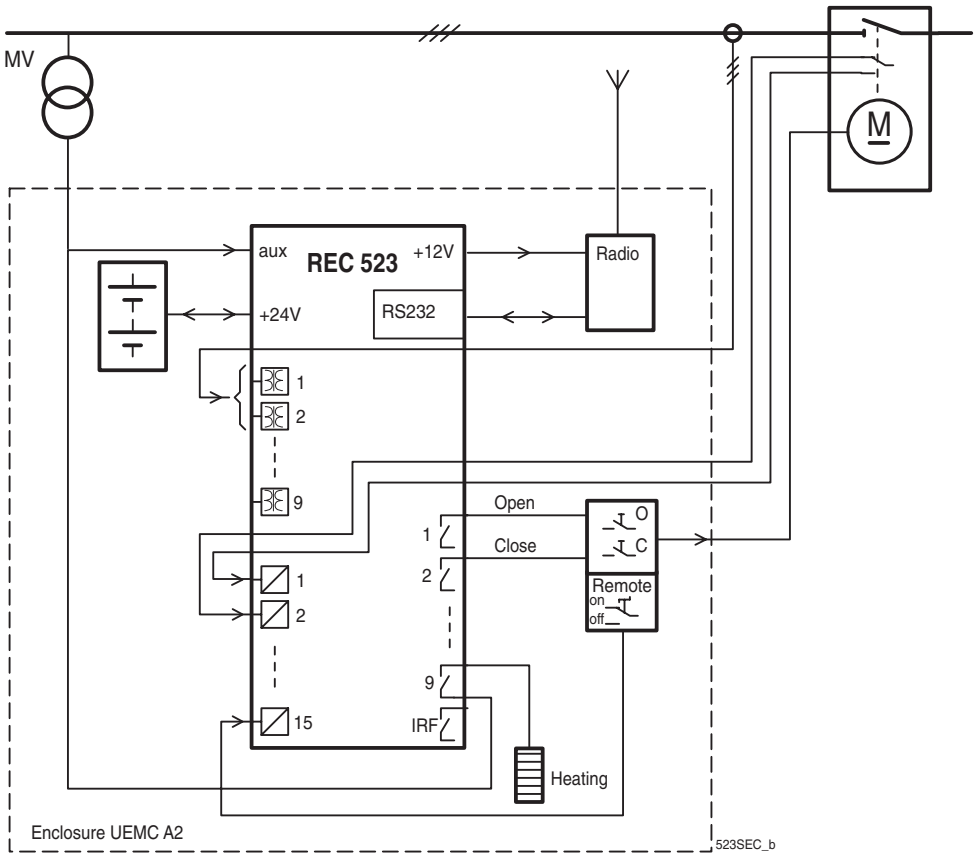


Fig. 4.1.-2 Application example of the REC 523 unit

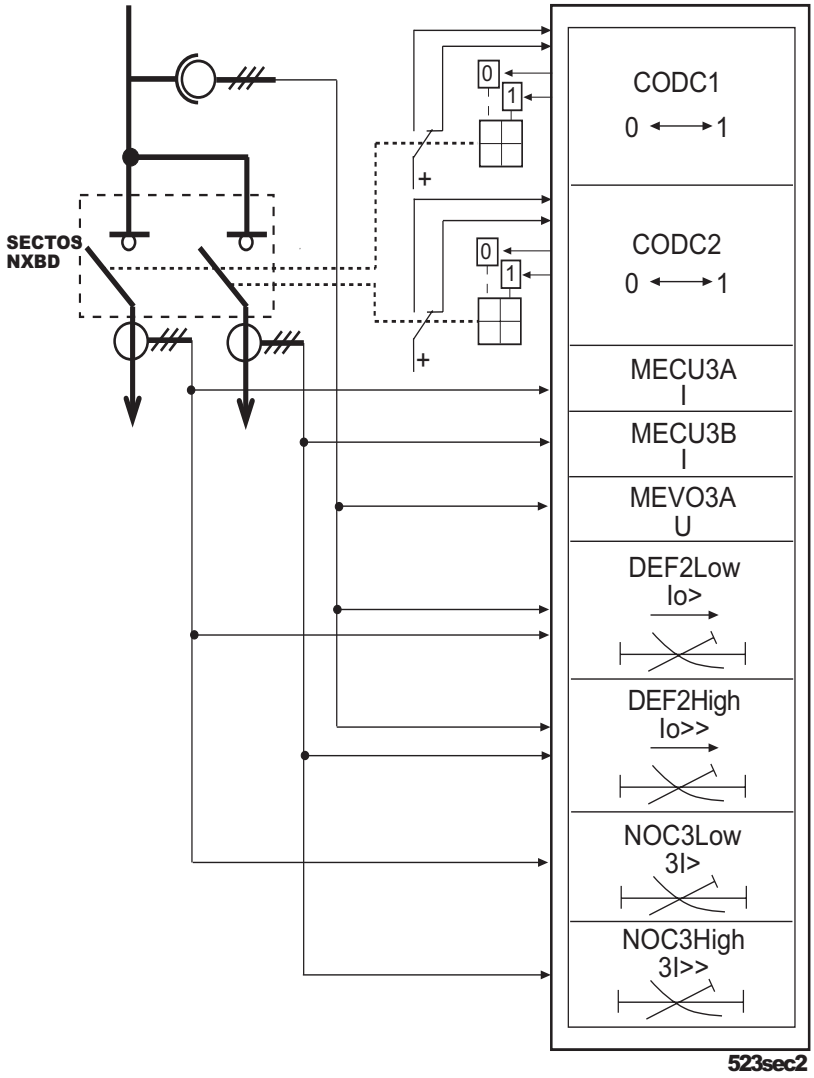


Fig. 4.1.-3 Basic functions of a REC 523 unit provided with NxBD type SF6 gas insulated double disconnectors

4.2. Requirements

If the environmental conditions differ from those specified in Chapter 7. Technical data, as to temperature and humidity, or if the atmosphere around the unit contains chemically active gases or dust, the device should be visually inspected in connection with the REC 523 secondary testing. The visual inspection should focus on:

- Signs of mechanical damage to device case and terminals.
- Dust inside the device cover or case; remove carefully with compressed air.
- Signs of corrosion on terminals, case or inside the device.

If any dust inside the device cover or case is found, remove it carefully with compressed air.

For information about the maintenance of REC 523, refer to Chapter 8. Service.

Remote control units are measuring instruments and should be handled with care and protected against moisture and mechanical stress, especially during transport.

4.3. Configuration

The REC 523 units are adapted to specific applications by using the Relay Configuration Tool included in CAP 505. The tool is used for configuring the basic terminal, protection and logic function blocks, control and measurement functions, timers and other functional elements included in the logic functions library. Refer to Section 5.8.1. REC 523 configuration.

The configuration of LON network is described in Section 5.8.2. LON network configuration. If LON communication is used without LON inputs and outputs (network variables), the section about LON network configuration is unnecessary.

The configuration procedure starts by configuring the functions of protection control, condition monitoring, measurement and logics with the Relay Configuration Tool.

For more detailed information about the configuration, refer to the tool-specific manuals (refer to Section 1.8. Related documents).

For the configuration of the remote communication protocols, refer to protocol descriptions (refer to Section 1.8. Related documents).

5. Functional description

5.1. REC 523 functions

The functions of REC 523 are categorized as:

- Measurement functions
- Control functions
- Protection and fault indication functions
- Condition monitoring functions
- Power quality functions
- Communication functions
- Standard functions
- General functions

5.1.1. Measurement functions

Current measurement can be based on Rogowski coils or conventional current transformers. Correspondingly, voltage dividers or voltage transformers are used for voltage-based measurement.

Measurement functions are available, for example, for three-phase currents, neutral current, three-phase voltages, residual voltage, frequency, and active and reactive power. One REC 523 device can be used to measure 2 feeders or branches by means of 9 analogue channels.

Furthermore, REC 523 incorporates environmental temperature and battery voltage measurements. The values measured can be forwarded to the control centre.

The measurement function blocks are documented on the CD-ROM Technical Descriptions of Functions (refer to Section 1.8. Related documents)

Table 5.1.1-1 Measurement functions available for REC 523

Function	Description
MEAI1...MEAI8[a]	General measurement 1...8/analogue input on RTD/analogue module
MECU1A	Neutral current measurement, stage A
MECU1B	Neutral current measurement, stage B
MECU3A	Three-phase current measurement, stage A
MECU3B[a]	Three-phase current measurement, stage B
MEVO1A	Residual voltage measurement, stage A
MEVO1B[a]	Residual voltage measurement, stage B
MEVO3A	Three-phase voltage measurement, stage A
MEVO3B[a]	Three-phase voltage measurement, stage B
MEPE7	Three-phase power and energy measurement
MEFR1	System frequency measurement
MEDREC16	Transient disturbance recorder

a. This function is supported in the REC 523 software revision C, or later.

5.1.2. Protection and fault indication functions

REC 523 provides a set of protection functions which also can be used for fault indication.

Before taking a protection function block into use, ensure that the function block operates correctly by checking the default values and by properly setting the parameter values.

The protection function blocks (for example NOC3Low) supported by REC 523 are independent of each other and have their own setting groups, data recording, and so on. For example, the non-directional overcurrent protection includes two different stages, NOC3Low and NOC3High, both with independent protection functions.

Either Rogowski coils or conventional current transformers can be used for protection functions based on current measurement. Correspondingly, voltage dividers or voltage transformers are used for protection functions based on voltage measurement.

The protection function blocks are documented on the CD-ROM, Technical Descriptions of Functions, refer to Section 1.8. Related documents.

Table 5.1.2-1 Protection and fault indication functions available for REC 523

Function	Description
AR5Func[a]	Auto-reclose function (5 shots)
CUB3Low	Phase discontinuity protection
DEF2Low	Directional earth-fault protection, low-set stage
DEF2High[b]	Directional earth-fault protection, high-set stage
DOC6Low	Three-phase directional overcurrent protection, low-set stage
DOC6High[b]	Three-phase directional overcurrent protection, high-set stage
Inrush3[b]	Three-phase transformer inrush and motor start-up current detector
NEF1Low	Non-directional earth-fault protection, low-set stage
NEF1High[b]	Non-directional earth-fault protection, high-set stage
NOC3Low	Three-phase non-directional overcurrent protection, low-set stage
NOC3High[b]	Three-phase non-directional overcurrent protection, high-set stage
UV3Low[b]	Three-phase undervoltage protection, low-set stage
UV3High[b]	Three-phase undervoltage protection, high-set stage

a. This function is only supported in the REC 523 software revision D, or later.
b. This function is only supported in the REC 523 software revision C, or later.

5.1.3. Control functions

The control functions are used to indicate the position of switching devices, that is, circuit breakers and disconnectors, and to execute open and close commands for controllable switching devices in the switchgear.

Furthermore, the control functions provide control objects for circuit breakers and disconnectors, indication objects for switching device indications, on/off switching objects for control logic purposes, miscellaneous objects for data monitoring, and so on.

The control function blocks are documented on the CD-ROM, Technical Descriptions of Functions, refer to Section 1.8. Related documents.

Table 5.1.3-1 Control functions available for REC 523

Function	Description
COCB1[a]	Circuit breaker 1 control with indication
COCB2[a]	Circuit breaker 2 control with indication
CODC1	Disconnector 1 control with indication
CODC2	Disconnector 2 control with indication
CODC3	Disconnector 3 control with indication
CODC4	Disconnector 4 control with indication
CODC5	Disconnector 5 control with indication
CO3DC1	Three-state disconnector (1) with indication
CO3DC2	Three-state disconnector (2) with indication
COIND1	Switching device 1 indication
COIND2	Switching device 2 indication
COIND3	Switching device 3 indication
COIND4	Switching device 4 indication
COIND5	Switching device 5 indication
COIND6	Switching device 6 indication
COIND7	Switching device 7 indication
COIND8	Switching device 8 indication
COLOCAT	Logic-controlled control position selector
COPFC[b]	Power factor controller

a. This function is only supported in the REC 523 software revision C, or later.
b. This function is only supported in the REC 523 software revision D, or later.

5.1.4. Condition monitoring functions

The condition monitoring function blocks are documented on the CD-ROM, Technical Descriptions of Functions, refer to Section 1.8. Related documents.

Table 5.1.4-1 Condition monitoring functions available for REC 523

Function	Description
CMBWEAR1	Supervision function of the cb 1 electric wear
CMBWEAR2	Supervision function of the cb 2 electric wear
CMCU3	Supervision function of the energizing current input circuit
GMGAS1	Supervision function of the gas density
CMGAS3[a]	Three-pole gas pressure monitoring
CMSCHED	Supervision function of the scheduled maintenance
CMSPRC1[b]	Spring charging control 1
CMTIME1[b]	Operation time counter 1 operate time used (motors)
CMTIME2[b]	Operation time counter 2 operate time used (motors)
CMTRAV1[b]	Breaker travel time 1
CMVO3	Supervision function of the energizing voltage input circuit

a. This function is only supported in the REC 523 Software revision D, or later.
b. This function is only supported in the REC 523 software revision C, or later.

5.1.5. Power quality functions

The power quality function blocks are documented on the CD-ROM, Technical Descriptions of Functions, refer to Section 1.8. Related documents.

Table 5.1.5-1 Power quality functions available for REC 523

Function	Description
PQCU3H[a]	Current waveform distortion measurement
PQVO3H[a]	Voltage waveform distortion measurement

a. This function is only supported in the REC 523 software revision D, or later.

5.1.6. General functions

The general function blocks are documented on the CD-ROM, Technical Descriptions of Functions, refer to Section 1.8. Related documents.

Table 5.1.6-1 General functions for REC 523

Function	Description
INDRESET	Resetting of operation indicators, latched output signals, registers and waveforms, that is, the disturbance recorder
SWGRP1... SWGRP20	Switchgroup SWGRP1...20

5.1.7. Standard functions

Standard functions are used for logics, such as interlocking, alarming and control sequencing. The use of logic functions is not limited and the functions can be interconnected with each other and with control, measurement, condition monitoring and other standard functions. In addition, the digital inputs and outputs as well as the LON inputs and outputs can be connected to standard functions by using the Relay Configuration Tool.

The standard functions are documented on the CD-ROM, Technical Descriptions of Functions, refer to Section 1.8. Related documents.

Table 5.1.7-1 Standard functions available for REC 523

Function	Description
ABS	Absolute value
ACOS	Principal arc cosine
ADD	Extensible adder
AND	Extensible AND connection
ASIN	Principal arc sine
ATAN	Principal arc tangent
BITGET	Get one bit
BITSET	Set one bit
BOOL_TO_*	Type conversion from BOOL to WORD / USINT / UINT / UDINT / SINT / REAL / INT / DWORD / DINT / BYTE
BOOL2INT	Type conversion from BOOL inputs to INT output
BYTE_TO_*	Type conversion from BYTE to WORD / DWORD
COMH	Hysteresis comparator
COS	Cosine in radians

Table 5.1.7-1 Standard functions available for REC 523 (Continued)

Function	Description
CTD	Down-counter
CTUD	Up-down counter
CTU	Up-counter
DATE_TO_UDINT	Type conversion from DATE to UDINT
DINT_TO_*	Type conversion from DINT to SINT / REAL / INT
DIV	Divider
DWORD_TO_*	Type conversion from DWORD to WORD / BYTE
EQ	Extensible comparison to equal
EXP	Natural exponential
EXPT	Exponentiation
F_TRIG	Falling edge detector
GE	Extensible comparison to greater or equal
GT	Extensible comparison to greater
INT_TO_*	Type conversion from INT to REAL / DINT
INT2BOOL	Type conversion from INT input to BOOL outputs
LE	Extensible comparison to less or equal
LIMIT	Limitation
LN	Natural logarithm
LOG	Logarithm base 10
LT	Extensible comparison to less
MAX	Extensible maximum
MIN	Extensible minimum
MOD	Modulo
MOVE	Move
MUL	Extensible multiplier
MUX	Extensible multiplexer
NE	Comparison to greater or less
NOT	Complement
OR	Extensible OR connection
R_TRIG	Rising edge detector
REAL_TO_*	Type conversion from REAL to USINT / UINT / UDINT / SINT / INT / DINT
ROL	Rotate to left
ROR	Rotate to right
RS	Reset dominant bistable function block
RS_D	Reset dominant bistable function block with data input
SEL	Digital selection
SHL	Bit-shift to left
SHR	Bit-shift to right
SIN	Sine in radians
SINT_TO_*	Type conversion from SINT to REAL / INT / DINT
SUB	Subtractor
SQRT	Square root
SR	Set dominant bistable function block
XOR	Extensible exclusive OR connection
TAN	Tangent in radians
TIME_TO_*	Type conversion from TIME to UDINT / TOD / REAL

Table 5.1.7-1 Standard functions available for REC 523 (Continued)

Function	Description
TOD_TO_*	Type conversion from TOD to UDINT / TIME / REAL
TOF	Off-delay timer
TON	On-delay timer
TP	Pulse
TRUNC_*	Truncation toward zero
UDINT_TO_*	Type conversion from UDINT to USINT / UINT / REAL
UINT_TO_*	Type conversion from UINT to USINT / UDINT / REAL / BOOL
USINT_TO_*	Type conversion from USINT to UINT / UDINT / REAL
WORD_TO_*	Type conversion from WORD to DWORD / BYTE

5.1.8. Communication

The remote communication protocols IEC 60870-5-101, Modbus (RTU and ASCII) and DNP 3.0 are available for REC 523.

The REC 523 includes SPA slave and LON serial communication protocols. In a customer-specific configuration, special events can be generated via an EVENT230 event function. EVENT230 is documented on the CD-ROM, Technical Descriptions of Functions, refer to Section 1.8. Related documents.

For more information about communication in REC 523 devices, Chapter 6.Communication.

5.2. Auxiliary voltage

For its operation REC 523 requires auxiliary voltage supply. The internal power supply and charger module of the device forms the voltages required by the REC 523 electronics. The power supply module is a galvanically isolated (flyback-type)
DC/DC converter. A green LED indicator on the front panel is lit when the power supply module is in operation.

When possible, the device should be supplied by an auxiliary supply voltage of the substation. Otherwise, a small MV auxiliary voltage transformer is recommended to be used for the supply of the device in secondary substation applications. National and local electrical safety regulations must always be followed when the device is connected to the electrical network.

5.2.1. Power supply versions

There are two power supply and charger unit (PSC) versions available REC 523:

- PSC1
- PSC2

The output voltages are identical, but the input voltages are different. The input voltage range of the power supply module is marked on the front panel of the device. The power supply version is specified by a letter combination in the hardware version number of REC 523.

The auxiliary voltages of the PSC versions are:

- PSC1:

  Operating range 80...265 V AC or DC.

- PSC2:

  Operating range 18...80 V DC.

The primary side of the power supply module is protected with a fuse located on the printed circuit board of the module.

The power supply also provides a 12 V DC output voltage to an external communication device, for example, a radio telephone. The maximum peak output current is 7A with batteries and 1A without batteries. This is sufficient for most conventional radio telephones or radio links.

For further technical data of the power supply, refer to Section 7.1. Technical data.

5.2.2. Power backup

Power backup for the station can be arranged by connecting 24 V (2 x 12 V) sealed lead acid batteries to the REC 523 device. The batteries supply the REC 523 device and the communication device 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 17 Ah or 24 Ah are normally used. Tests performed show an operation time of about 36 hours for a 17 Ah battery and 60 hours for a 24 Ah battery at an ambient temperature of +20 °C. The average consumption of the communication device during the test was 200 mA.

A low temperature reduces the capacity of the batteries and the operate time. The approximate maximum operate time versus temperature can be estimated as shown in the following figure.

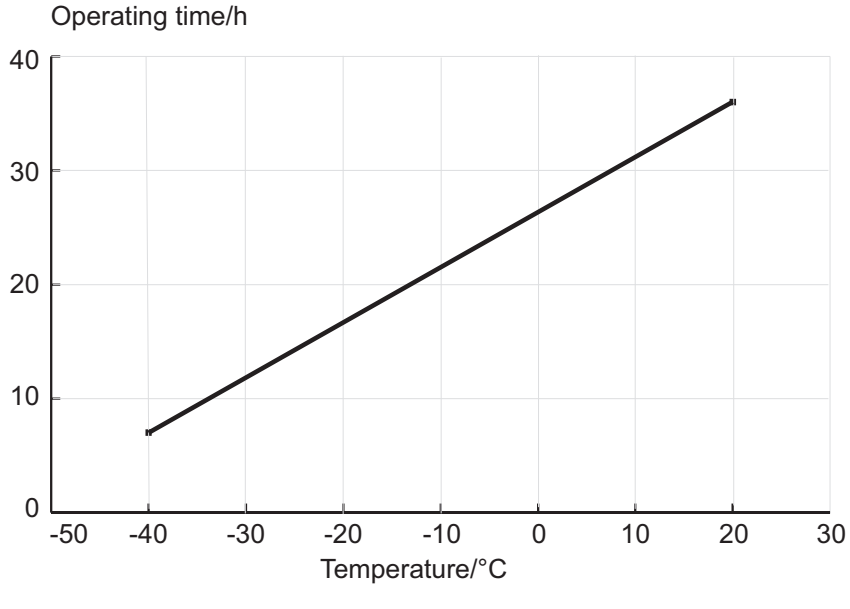


Fig. 5.2.2.-1 Operation time versus temperature with 17 Ah batteries

Batteries

Sealed lead-acid batteries, for example, Yuasa's NP 17-12, NPL 24-12 or equivalent are recommended to be used, refer to Section 7.1. Technical data.

Current limiter

A current limiter should be used when the battery capacity is less than 7 Ah. The current limiter is to be connected between the charger output (connector X7.1, pin 10) and the + pole of the battery to prevent the charging current from exceeding the specified maximum limit of about 0.6 A.

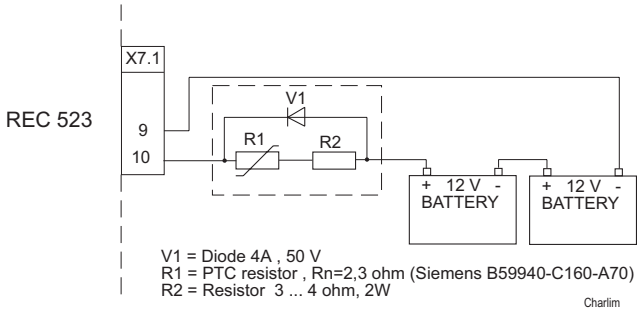


Fig. 5.2.2.-2 Circuit diagram for current limiter

The voltage of the batteries may vary in range of 19...32 V.

The batteries are charged by the battery charger of the REC 523 device.

5.2.3. Condition monitoring of batteries

The condition of the batteries is secured by a periodic ten second load test, which is performed twice an hour and always after the power up of the device. The test can also be activated remotely with the parameter `Battery test`.

The status of the battery test, that is, whether the test is active or not, can be read via remote communication with the parameter `BatteryTestSta`. The corresponding global variable in the Relay Configuration Tool is the following:

- REC 523: PSC_7_BattTest

During the battery load test, the voltage of the power supply charger is reduced to 20 V, which causes the electronics and communication to load the batteries. The automatic functions of the device measure the battery voltage continuously also during the test.

If the battery voltage drops to ~21...23 V during testing, the device generates an alarm to indicate that the lifetime of the batteries is ending or that an internal battery fault has occurred, which means that the battery must be changed in the near future. The status of the battery can also be read via remote communication with the parameter `Battery status`. The corresponding global variable in the Relay Configuration Tool is the following:

- REC 523: PSC_7_BattStatus

The parameter `Minimum battery voltage` indicates the lowest battery voltage recorded, which is usually the voltage during a control operation. The recorded voltage can be used to estimate the condition of the batteries. Note that the parameter must be set via remote communication to correspond to the present battery voltage when a new battery has been installed.

5.2.4. Battery charger

The power supply of the REC 523 device includes a temperature-compensated battery charger. The charger secures a suitable charging voltage in different environmental conditions. The batteries are also protected against too high or too low charging voltages.

The charger regulates the charging voltage for the batteries according to the temperature as illustrated in the figure below.

The output of the battery charger is protected by a fuse located on the printed circuit board of the module.

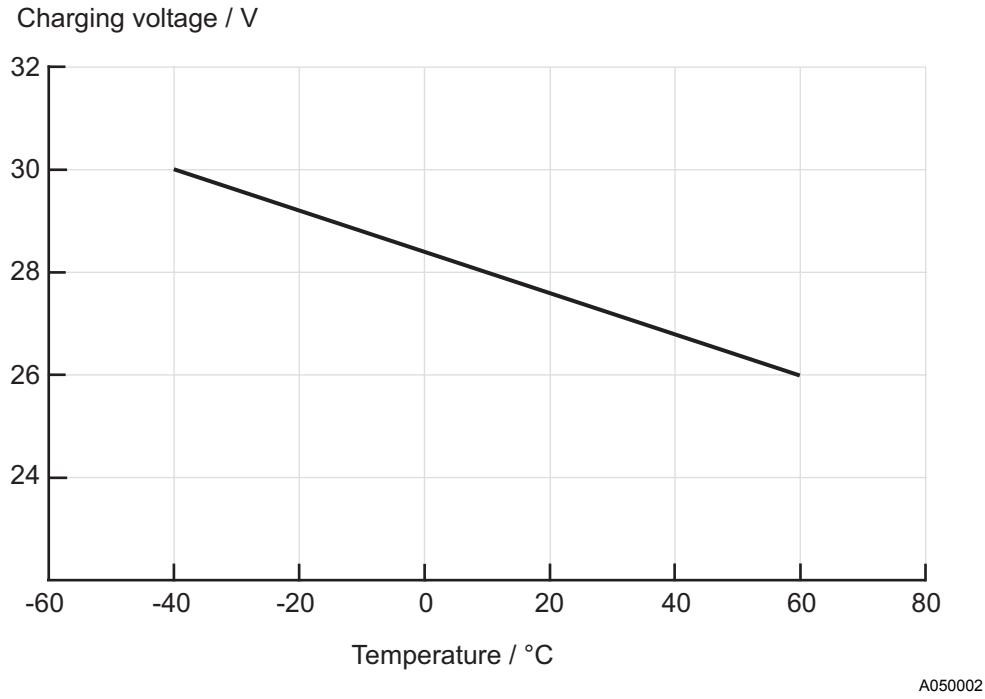


Fig. 5.2.4.-1 Charging voltage versus temperature

Deep-discharge protection

The charger also protects the batteries against deep-discharge during long periods of outages. It switches the power supply to stand-by mode as soon as the battery voltage drops below 19 V. The power supply is switched on again when the auxiliary voltage returns. After this, the batteries are charged at an interval of 1 second until the battery voltage exceeds 22 V.

5.2.5. Low auxiliary voltage indication

The REC 523 is provided with a low auxiliary voltage indication feature. The power supply module issues an internal alarm signal when a drop in the power supply voltage is detected (ACFail, active low).

The indication of a low auxiliary voltage (ACFail) is available in REC configuration environment and can be connected to any signal output of the REC 523 device. The auxiliary voltage indication in the REC configuration is as follows:

- REC 523: PSC_7_ACFail

5.2.6. Overtemperature indication

The REC 523 includes an internal temperature supervision function. The power supply module gives an internal alarm signal when overtemperature has been detected inside the enclosure. The alarm signal is activated when the temperature inside the enclosure increases to +78^{o}C (+75...+83^{o}C).

Overtemperature indication is available in the configuration and can be connected to any signal output of the device. The overtemperature indication input in the configuration is as follows:

- REC 523: PSC_7_TempAlarm

5.3. Analogue channels

5.3.1. Design

The REC 523 device measures the analogue signals needed, for example, for measuring, via sensors or galvanically separated matching transformers. REC 523 can be provided with the following matching transformers:

- 3 matching transformers; CT1, CT2, CT3
- 6 matching transformers; CT1, CT2, CT3, VT1, VT2, VT3
- 7 matching transformers; CT1, CT2, CT3, CT4, VT1, VT2, VT3
- 9 matching transformers; CT1, CT2, CT3, CT4, CT5, VT1, VT2, VT3, VT4
- 9 matching transformers; CT1, CT2, CT3, CT4, CT5, CT6, VT1, VT2, VT3
- 9 matching transformers; CT1, CT2, CT3, VT1, VT2, VT3, VT4, VT5, VT6
- 9 sensors; RS or VD

In addition to conventional matching transformers, current sensors and voltage dividers developed by ABB can be used. Depending on the hardware equipment, REC 523 has 9 sensor inputs. A current sensor (Rogowski coil) or a voltage divider can be used with the REC 523 device.

The number of channels used depends on the configuration and the kind of matching transformers or sensor inputs used. Furthermore, the device includes virtual analogue channels (refer to Section 5.3.3. Calculated analogue channels) for calculating the neutral current, phase-to-phase voltage and residual voltage from phase currents and voltages.

Each analogue channel is separately configured with the Relay Configuration Tool. Configure both the measuring unit for each analogue channel and the signal type to be measured.

The REC 523 versions have the following analogue channels:

Table 5.3.1-1 REC 523 versions and analogue channels

REC 523 version	Analogue channel
REC523F 032AAA (wall-mounted) **REC523F 037AAA (flush-mounted)**	3 current transformers 1/5 A U_{aux} = 80-265 V AC/DC
REC523F 032CAA (wall-mounted) **REC523F 037CAA (flush-mounted)**	3 current transformers 1/5 A U_{aux} = 18-80 V DC
REC523F 033AAA (wall-mounted) **REC523F 038AAA (flush-mounted)**	3 current transformers 1/5 A 3 voltage transformers 100 V U_{aux} = 80-265 V AC/DC
REC523F 033CAA (wall-mounted) **REC523F 038CAA (flush-mounted)**	3 current transformers 1/5 A 3 voltage transformers 100 V U_{aux} = 18-80 V DC

Table 5.3.1-1 REC 523 versions and analogue channels (Continued)

REC 523 version	Analogue channel
REC523F 034AAA (wall-mounted) **REC523F 039AAA (flush-mounted)**	4 current transformers 1/5 A 3 voltage transformers 230 V U_{aux} = 80-265 V AC/DC
REC523F 034CAA (wall-mounted) **REC523F 039CAA (flush-mounted)**	4 current transformers 1/5 A 3 voltage transformers 230 V U_{aux} = 18-80 V DC
REC523F 054AAA (wall-mounted) **REC523F 059AAA (flush-mounted)**	1 current transformer 0.2/1 A 4 current transformers 1/5 A 4 voltage transformers 100 V U_{aux} = 80-265 V AC/DC
REC523F 054CAA (wall-mounted) **REC523F 059CAA (flush-mounted**	1 current transformer 0.2/1 A 4 current transformers 1/5 A 4 voltage transformers 100 V U_{aux} = 18-80 V DC
REC523F 060AAC (wall-mounted) **REC523F 065AAC (flush-mounted)**	9 sensor channels (current sensor or voltage divider) U_{aux} = 80-265 V AC/DC
REC523F 060CAC (wall-mounted) **REC523F 065CAC (flush-mounted)**	9 sensor channels (current sensor or voltage divider) U_{aux} = 18-80 V DC
REC523F 061AAA (wall-mounted) **REC523F 066AAA (flush-mounted)**	6 current transformers 1/5 A 3 voltage transformers 100 V U_{aux} = 80-265 V AC/DC
REC523F 061CAA (wall-mounted) **REC523F 066CAA (flush-mounted)**	6 current transformers 1/5 A 3 voltage transformers 100 V U_{aux} = 18-80 V DC
REC523F 062AAA (wall-mounted) **REC523F 067AAA (flush-mounted)**	3 current transformers 1/5 A 6 voltage transformers 100 V U_{aux} = 80-265 V AC/DC
REC523F 062CAA (wall-mounted) **REC523F 067CAA (flush-mounted)**	3 current transformers 1/5 A 6 voltage transformers 100 V U_{aux} = 18-80 V DC
REC523F 071AAB (wall-mounted) **REC523F 072AAB (flush-mounted)**	1 current transformer 0.2/1 A 4 current transformers 1/5 A 4 voltage transformers 100 V 9 sensor channels (current sensor or voltage divider) U_{aux} = 80-265 V AC/DC
REC523F 071CAB (wall-mounted) **REC523F 072CAB (flush-mounted)**	1 current transformer 0.2/1 A 4 current transformers 1/5 A 4 voltage transformers 100 V 9 sensor channels (current sensor or voltage divider) U_{aux} = 18-80 V AC/DC

5.3.2. Technical data of measuring devices

When the REC 523 device is configured, the technical data of the measuring devices is set in separate dialogue boxes in the Relay Configuration Tool. The set values affect the measurements carried out by the REC 523 device.

When the values listed below for the measuring devices are changed via the Relay Setting Tool, the new values take effect only after they have been stored and the relay has been reset.

Values to be set for a current transformer:

- Rated primary current (1...6000 A)[1] of the primary current transformer
- Rated secondary current (5 A, 2 A, 1 A, 0.2 A) of the primary current transformer
- Rated current (5 A, 1 A, 0.2 A) of the current measuring input (= rated current of the matching transformer of REC 523)
- Amplitude correction factor (0.9000...1.1000) of the primary current transformer at rated current
- Correction parameter of the primary current transformer at rated current (-5.00°...0.00°)
- Amplitude correction factor of the primary current transformer at a signal level of 1% of the rated current (0.9000...1.1000)
- Correction parameter of the primary current transformer at a signal level of 1% of the rated current (-10.00°...0.00°)

Values to be set for a voltage transformer:

- Rated voltage of voltage input (same as the secondary rated voltage of the primary voltage transformer connected to the voltage input, that is, 100 V, 110 V, 115 V, 120 V, 230V)
- Rated voltage of primary voltage transformer (0.100...440.000 kV)[2]
- Amplitude correction factor of the primary voltage transformer voltage at rated voltage (0.9000...1.1000)
- Correction parameter of the primary transformer angle error at rated voltage (-2.00°...2.00°)

Values to be set for a current sensor (Rogowski coil):

- Secondary rated voltage of the current sensor used at the preset primary rated current (100...300 mV)[3]
- Primary rated current of the current sensor used (1...6000 A)[4]
- Amplitude correction factor of the current sensor used at rated current (0.9000...1.1000)

1. For releases prior to revision D, the current range is 0...6000 A.
2. For revision A, the voltage range is 0...150 kV. For revisions B, C, D and E, the range is 0...300 kV.
3. For releases prior to revision F, the voltage range is 0...300 mV.
4. For releases prior to revision F, the current range is 0...6000 A.

- Correction parameter for the phase displacement error of the current sensor (-1.0000°...1.0000°)[1]

Values to be set for a voltage divider:

- Division ratio of voltage divider primary and secondary voltage (1...20000)[2]
- Rated value of primary phase-to-phase voltage (0.100...440.000 kV)[1]
- Amplitude correction factor of the voltage divider (0.9000...1.1000)

The correction parameters/factors are calculated as follows:

Current transformers

Amplitude error at current I_n (e = error in per cent)	Amplitude correction factor 1 = 1 / (1+ e/100)
Amplitude error at current 0.01 x I_n (e = error in per cent)	Amplitude correction factor 2 = 1 / (1+ e/100)
Phase displacement error at current I_n (e = error in degrees)	Phase displacement error 1 = - e
Phase displacement error at current 0.01 x I_n (e = error in degrees)	Phase displacement error 2 = - e

Voltage transformers

Amplitude error at voltage U_n (e = error in per cent)	Amplitude correction factor = 1 / (1+ e/100)
Phase displacement error at voltage U_n (e = error in degrees)	Phase displacement error = - e

Rogowski coil

Amplitude error for the entire measuring range (e = error in per cent)	Amplitude correction factor = 1 / (1+ e/100)
Phase displacement error for the entire measuring range (e = error in degrees)	Phase displacement error = - e

Voltage divider

Amplitude error for the entire measuring range (e = error in per cent)	Amplitude correction factor = 1 / (1+ e/100)
Phase displacement error for the entire measuring range (e = error in degrees)	Phase displacement error = - e

5.3.3. Calculated analogue channels

REC 523 includes virtual channels to obtain phase-to-phase voltages, residual voltage and neutral current when sensors are used. Current sensors and voltage dividers are connected to the feeder terminal via coaxial cables. Therefore a phase-

1. Only included in revision D or later, refer to Section 11.1. Revision identification. Note that this parameter can only be set via the Relay Setting Tool.
2. For the releases prior to revision F, the division ratio is 0...20000.

to-phase voltage connection, an open-delta connection of phase voltages or a residual connection of phase currents cannot be made. Both the amplitude and the phase angle are calculated for the virtual channels.

The virtual channel voltages and currents are numerically derived from the phase voltages and phase currents according to Table 5.3.3-1. Though primarily meant to be used with sensors, the calculated analogue channels can also be used with conventional current and voltage transformers.

The virtual channels are numbered according to the priority numbers in the Table 5.3.3-1. The virtual channel used first is numbered as 11 and the following as 12, 13 and so on. For example, U_{0s} is numbered as 11 and U_{12s} as 12, if these virtual channels are selected for use.

When sensitive earth-fault protection is needed, core balance transformers are not recommended to be replaced with the numerically derived sum of phase currents. Normally, an earth-fault setting below 10% of the rated value requires the use of a core balance transformer.

Table 5.3.3-1 Virtual analogue channels

Virtual channel	Numeric derivation	Priority number
I_{0s}	$= -(I_{L1} + I_{L2} + I_{L1})$[a]	1
I_{0bs}[b]	$= -(I_{L1b} + I_{L2b} + I_{L1b})$[a]	2
U_{0s}	$= (U_1 + U_2 + U_3)/3$	3
U_{0bs}[b]	$= (U_{1b} + U_{2b} + U_{3b})/3$	4
U_{12s}[b]	$= (U_1 - U_2)$	5
U_{23s}[b]	$= (U_2 - U_3)$	6
U_{31s}[b]	$= (U_3 - U_1)$	7
U_{12bs}[b]	$= (U_{1b} - U_{2b})$	8
U_{23bs}[b]	$= (U_{2b} - U_{3b})$	9
U_{31bs}[b]	$= (U_{3b} - U_{1b})$	10

a. A minus in front of the parenthesis means that the default direction of neutral current is assumed to be from the line to the busbar, while the normal power flow is from the busbar to the line.
b. This virtual channel is supported in REC 523 revision F or later.

5.3.4. Temperature measurement

The temperature measurement is calibrated to measure the ambient temperature of the REC 523 device mounted in an enclosure. Furthermore, the temperature information is used to control the charging voltage of the batteries.

The measured ambient temperature values can be forwarded to the control center. The dead band of the temperature change report is defined by the temperature delta parameter of the PSC board.

Heating is needed if the REC 523 device is installed in a separate enclosure outdoors, where the ambient temperature may fall below -10...0°C. Heating is also required when the environment is very damp and dehumidifying is needed. The parameter `Heat limit` is used for selecting the limit value for the heater in the range of
-25°...+15°C. At lower values the cabinet heating is switched on and at upper values switched off. The hysteresis of heating is stable within 4°C. Indication of the heater status in REC 523 configuration is as follows:

- REC 523: PSC_7_HeatStat

The power supply and charger unit (PSC) has one output, PSC_7_SO1, which can be parametrized as a heater output. After this, the output is no more controllable from the application. The relay output is closed when the temperature falls below the heating limit. For more information about the parameters of the PSC board, refer to the CD-ROM Technical Descriptions of Functions (refer to Section 1.8. Related documents).

Cooling is needed if the environmental conditions may cause the temperature inside the cabinet to rise above the operation limit. The figure below shows an example of a CAP application used for controlling a cooler. In this example, the temperature measured by REC 523 is forwarded to the COMH_1 function via the input PSC_7_Temperature, the value of which is compared to the values of the parameters `Hlimit` and `Llimit`. If the value of the input is higher than or equal to the temperature defined with the `Hlimit` parameter, the PSC_7_SO1 output is switched on. Accordingly, if the temperature is lower than or equal to the value defined with the `Llimit` parameter, the output is switched off.

Note that the indications and parameters used for heater control should not be used when a cooler is controlled.

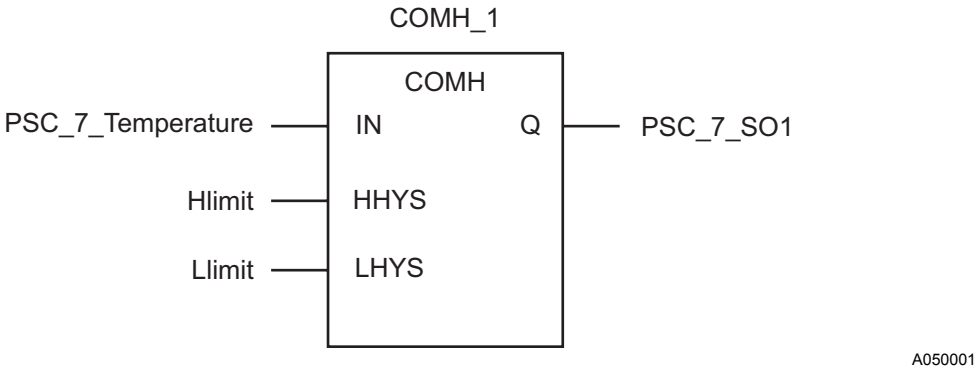


Fig. 5.3.4.-1 Example of a CAP application used for controlling a cooler

5.3.5. Battery voltage measurement

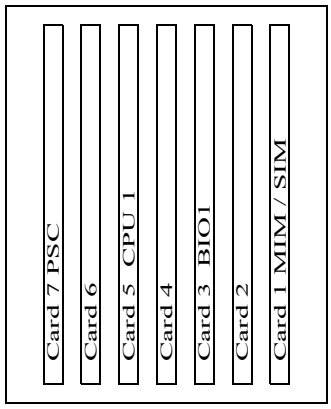
The REC 523 device incorporates measurement of the battery voltage. The measured value can be forwarded to the control centre. The dead band of the voltage change report is defined by the voltage delta parameter of the PSC board. For more information about the parameters of the PSC board, refer to the CD-ROM, Technical Descriptions of Functions, see Section 1.8. Related documents.

5.4. Digital inputs

5.4.1. General

The REC 523 device has the following digital inputs.

	REC 523
Digital inputs	PSC_7_BI1 *)
	PSC_7_BI2 *)
	PSC_7_BI3 *)
	BIO1_3_BI1
	BIO1_3_BI2
	BIO1_3_BI3
	BIO1_3_BI4
	BIO1_3_BI5
	BIO1_3_BI6
	BIO1_3_BI7
	BIO1_3_BI8
	BIO1_3_BI9
	BIO1_3_BI10
	BIO1_3_BI11
	BIO1_3_BI12
Digital inputs / total	15



*)This digital input can be programmed as either digital input or pulse counter.

Fig. 5.4.1.-1 REC 523 digital inputs

The digital inputs of REC 523 are voltage-controlled and optically isolated. For technical data of the digital inputs, refer to Section 7.1. Technical data.

The parameter for input filtering, input inversion and pulse counters can be set in the Configuration menu under each I/O card (for example Configuration/BI01/Input filtering).

The events and parameters of I/O cards are included in the event and parameter lists on the CD-ROM, Technical Descriptions of Functions, refer to Section 1.8. Related documents.

5.4.2. Configuration

5.4.2.1. Filter time of a digital input

The filter time eliminates debounces and short disturbances on a digital input. The filter time is set for each digital input of the REC 523 device. The operation of input filtering is illustrated below.

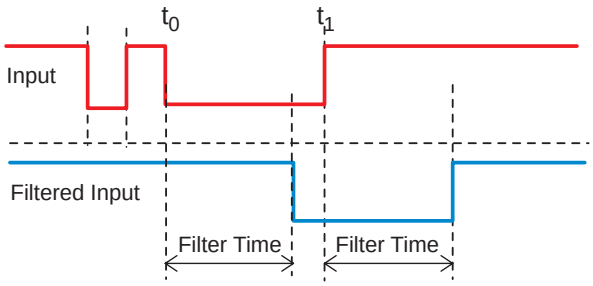


Fig. 5.4.2.1.-1 Filtering of a digital input

In the figure above, the input signal is named “Input”, the filter timer “Filter” and the filtered input signal “Filtered Input”. At the beginning, the input signal is at high state, the short low state is filtered and no input status change is detected. The low state starting from the time t_0 exceeds the filter time, which means that the change in the input status is detected and the time tag attached to the input change is t_0. The high state starting from t_1 is detected and the time tag t_1 is attached.

Each digital input has a filter time parameter `Input # filter`, where “#” is the number of the digital input of the module in question (for example Input 1 filter).

Parameter	Values	Default
Input # filter	1....15000 ms[a]	5 ms

a. In the REC 523 revision F or later. In earlier revisions the value is 1...65535 ms.

5.4.2.2. Inversion of a digital input

The parameter `Input # invert.` can be used to invert a digital input:

Control voltage	Input # invert.	Status of digital input
No	0	FALSE (0)
Yes	0	TRUE (1)
No	1	TRUE (1)
Yes	1	FALSE (0)

When the digital input is inverted, the status of the input is TRUE (1) when no control voltage is applied to its terminals. Accordingly, the input state is FALSE (0) when a control voltage is applied to the terminals of the digital input.

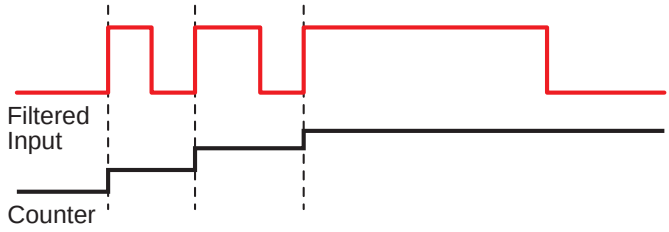
Parameter	Values	Default
Input # invert.	0 (not inverted)	0
	1 (inverted)	

5.4.2.3. Pulse counters

Some specific digital inputs (refer to Section 5.4. Digital inputs) of REC 523 can be programmed as digital inputs or as pulse counters. This programming is done via the parameter `Input # mode` (in this parameter as well as in others mentioned below, “#” denotes the input number).

When an input operates as a digital input, no counting is done but the pulse counter value remains at the present value.

When an input operates as a pulse counter, the positive input transitions (0 -> 1) of a filtered input are counted and the counter value of `Input # counter` parameter increases in the range 0... 2147483647. The pulse counters are updated with a period of 500 ms.The frequency range of a digital input parametrized to operate as a pulse counter is 0.....100 Hz.



Dipo_b

Fig. 5.4.2.3.-1 Principle of pulse counter function

Counter settings

The parameter `Input # preset` can be used to give a counter the start value.The start value is loaded into the counter by:

- Writing the desired start value to the parameter `Input # preset`
- Writing the value 1 to the parameter `Counter trigger`

All the updated values of the `Input # preset` parameters are then copied to the corresponding `Input # counter` parameters.

Writing the value 2 to the `Counter trigger` parameter copies all the `Input # preset` parameter values to the corresponding `Input # counter` parameters. Writing the value 0 clears all the counters.

Table 5.4.2.3-1 Counter setting parameters

Parameter	Values	Default
Input # preset	0..... 2147483647	0
Input # mode	1 = digital input 2 = counter	1

Counter trigger	0 = clear all counters
	1 = load updated `Input # preset` values
	2 = load all `Input # preset` values	

5.4.2.4. Oscillation suppression

Oscillation suppression is used to reduce the load from the system when, for some unrecognized reason, a digital input starts oscillating. A digital input is regarded as oscillating if the number of valid status changes (= number of events after filtering) during 1second is greater than the set value `Input osc. level` (Oscillation level). During oscillation, the digital input is blocked (status is invalid) and an event is generated. The state of the input does not change when it is blocked, that is, its state depends on the condition before blocking.

The digital input is regarded as non-oscillating if the number of valid status changes during 1 second is less than the set value of `Input osc. level` minus the set value of `Input osc. hyst.` (Oscillation hysteresis). Note that the oscillation hysteresis must be set lower than the oscillation level to enable the input to be restored from oscillation. When the input returns to a non-oscillating state, the digital input is deblocked (status is valid) and an event is generated.

Table 5.4.2.4-1 Oscillation suppression parameters

Parameter	Values	Default
Input osc. level	2...50 events/s	50 events/s
Input osc. hyst.	2...50 events/s	10 events/s

Unlike most parameters for digital I/O cards, the parameters `Input osc. level` and `Input osc. hyst.` can be found in the Relay Setting Tool: open the Configuration tab and select the General subtab.

5.4.2.5. Attributes of a digital input for device configuration

The validity of the digital input (invalidity), the status of the input (value) and the time tag for the status change (time) can be issued for each digital input by the attributes BI#IV, BI#, BI#Time and BI#Count, where "#" denotes the number of the input. The attributes are available in REC configuration and can be used for different purposes.

Invalidity (BI#IV)

When a digital input oscillates, the invalidity attribute IV changes to TRUE (1) and the input is blocked. The digital input is regarded as being blocked and oscillating if the number of status changes per second exceeds the set `Input osc. level` parameter value (events/s).

When a digital input does not oscillate, the invalidity attribute IV changes to FALSE (0) and the input becomes operative. The digital input is regarded as being operative and non-oscillating if the number of status changes per second is less than the set `Input osc. level` parameter value minus the set `Input osc. hyst.` parameter value (events/s).

Value (BI#)

Depending on the status of the digital input, the digital input value is TRUE (1) or FALSE (0). The attribute BI# value changes on the rising or falling edge of the input. To prevent undesired status changes of the digital input due to, for example, switch debouncing, the change of the attribute value is delayed by the filter time.

A counter attribute of a digital input is not handled when the input is programmed as a normal digital input.

Time (BI#Time)

Each change (rising or falling edge) detected in the status of a digital input is time-tagged at an accuracy of ±1 ms. The time tag represents the moment (time) of the latest input change of the value attribute. The time is not recorded until the filtering time of the status change has elapsed, which means that the filtering time does not affect the time tag value.

Count (BI#Count)

The count attribute indicates the number of positive input transitions of a filtered input. The frequency range of a digital input parameterized to operate as a pulse counter is 0...100 Hz. If a digital input is changed into a pulse counter, the attribute BI# is frozen at the value valid at the moment of the change.

The example below shows how the attributes of the digital input 1 (PSC_7_BI1 on PSC1 module) of REC 523 are named for the configuration:

PSC_7_BI1IV; digital input invalidity

PSC_7_BI1; digital input value

PSC_7_BI1Time; time tag

PSC_7_BT1Count; counter value

5.5. Digital outputs

5.5.1. General

The outputs of REC 523 are categorized as follows:

- HSPO High-speed power output, double-pole contact.
- SO Signal output, either NO (Normally Open) or NO/NC (Normally Open/ Normally Closed) contact.

Table 5.5.1-1 REC 523 digital outputs

	REC 523
Outputs	PSC_7_HSPO1
	PSC_7_HSPO2
	PSC_7_SO1 (Heater output)
	BIO1_3_SO1
	BIO1_3_SO2
	BIO1_3_SO3
	BIO1_3_SO4
	BIO1_3_SO5
	BIO1_3_SO6
Outputs / total	9

The events and parameters of I/O cards can be found in the event and parameter lists on the CD-ROM Technical Descriptions of Functions (refer to Section 1.8. Related documents).

For detailed information about terminal connections for the outputs, please refer to the terminal diagrams, where all the outputs and relay connector terminals are presented.

For detailed technical data of the outputs, refer to Section 7.1. Technical data.

5.5.2. Configuration

5.5.2.1. High speed double-pole power output (HSPO)

The high-speed power outputs PSC_7_HSPO1 and PSC_7_HSPO2 can be connected as double-pole outputs where the object to be controlled (for example a circuit breaker) is electrically connected between the two relay contacts, see figure below. The high-speed double-pole power output is preferred for the control of disconnectors.

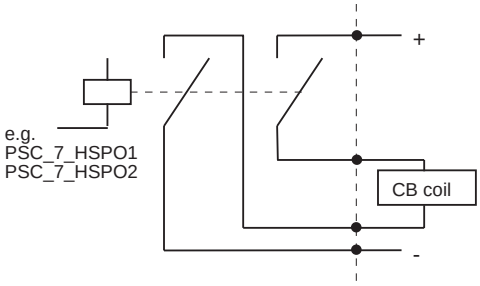


Fig. 5.5.2.1.-1 High-speed double-pole power outputs PSC_7_HSPO1 and PSC_7_HSPO2

The high-speed power outputs PSC_7_HSPO1 and PSC_7_HSPO2 can also be connected as single-pole power outputs where the object to be controlled (for example a circuit breaker) is electrically connected in series with the two relay contacts, see Fig. 5.5.2.1.-2 .

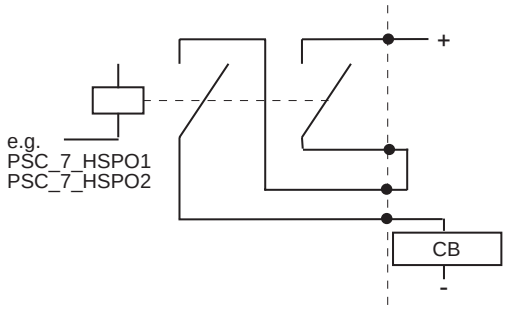


Fig. 5.5.2.1.-2 High-speed single-pole power output (HSPO)

5.5.2.2. Signalling output (SO)

The signalling output is not a heavy-duty output and thus it cannot be used for controlling a disconnector without external interpose relays. Available SO contacts are either Normally Open or Normally Open/Normally Closed type contacts (NO or NO/NC), see the figure below.

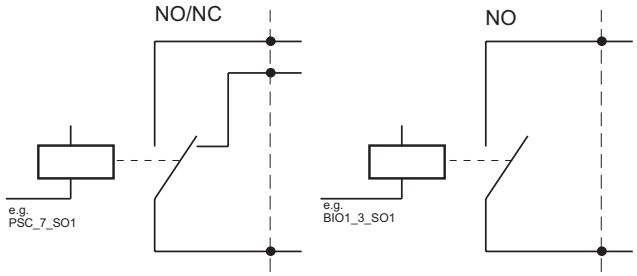


Fig. 5.5.2.2.-1 Signalling Output (SO)

5.6. LED panel and LED outputs

The LED panel is fully programmable through the Relay Configuration Tool (for an example configuration, see Fig. 5.6.-2). Each LED has four states: ON, OFF, fast blinking (2 Hz) and slow blinking (0.5Hz). The value field of each LED global variable is 16 bit and the consecutive bit pairs (0 and 1, 2 and 3, and so on) correspond to one LED state. The four states are illustrated in Fig. 5.6.-1 .

At power up, a test is run for the LED panel for its visual inspection. A testing sequence can also be initiated via the global variable PSC_7_LEDTEST in the Relay Configuration Tool.

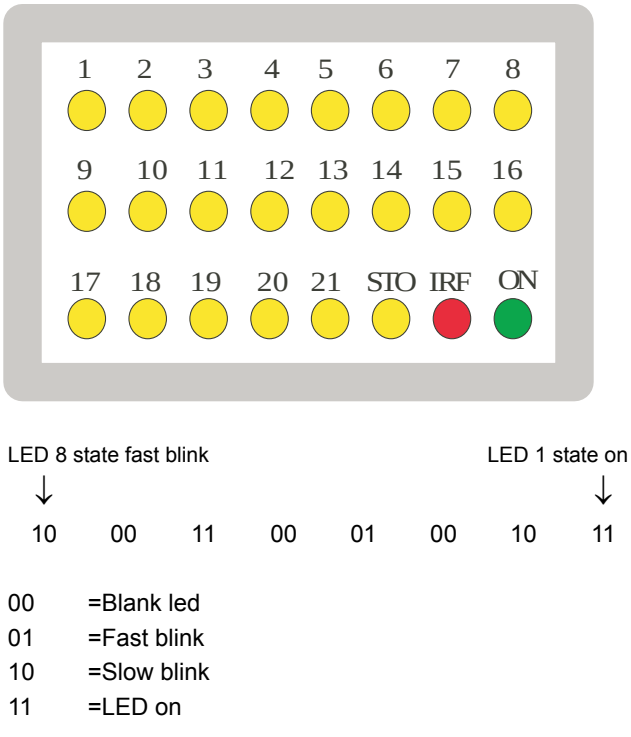


Fig. 5.6.-1 LED panel and different LED states

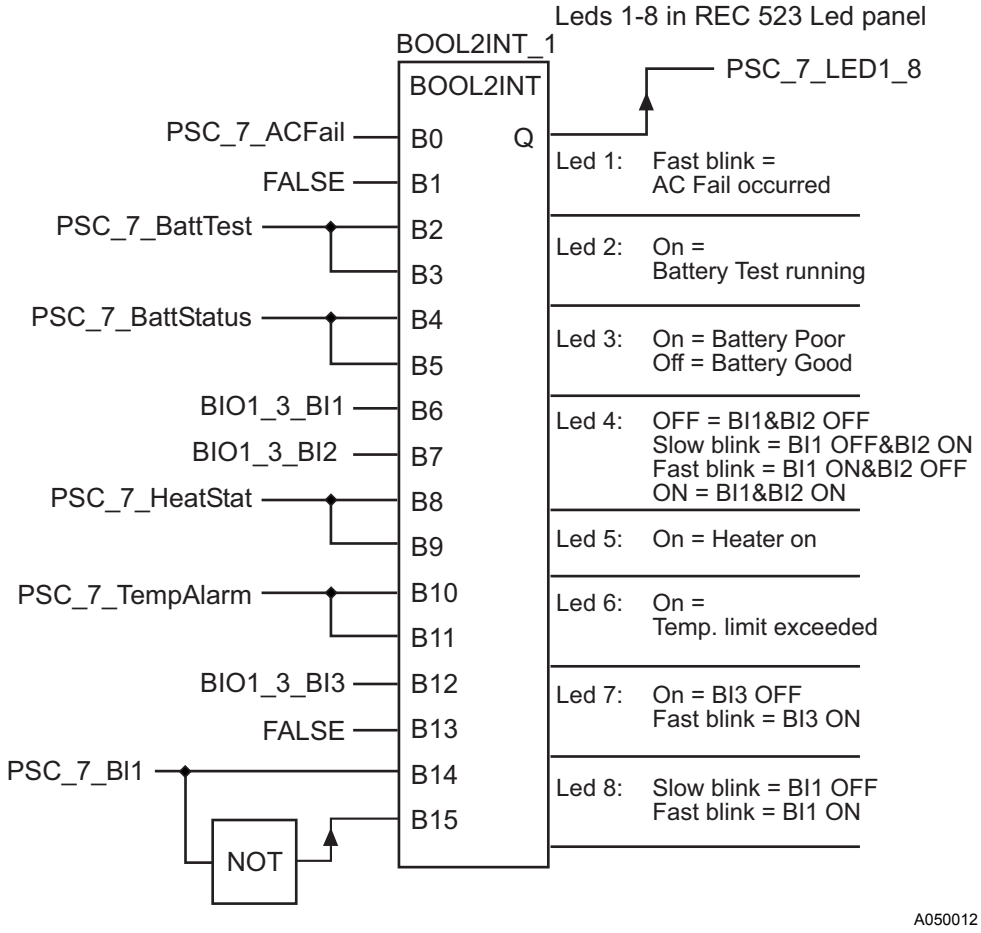


Fig. 5.6.-2 Example of LED configuration in the Relay Configuration Tool

LED outputs	LED global variable names in the Relay Configuration Tool
1 - 8	PSC_7_LED1_8
9 - 16	PSC_7_LED9_16
17 - 21	PSC_7_LED17_21
Total	21

In addition to the 21 freely configurable LEDs listed above, the LED panel includes three LEDs with fixed functionality: STO, IRF and ON.

- STO indicates when storing is in progress. When the LED is blinking, a store error has occurred.
- IRF indicates an internal device fault.
- ON indicates when the power is on.

5.7. Self-supervision (IRF)

The REC 523 device is provided with an extensive self-supervision system. The self-supervision system handles run-time fault situations and informs the user of faults through the LON/SPA and remote communication protocol.

5.7.1. Fault indication

The self-supervision signalling output operates on the closed circuit principle. Under normal operating conditions, the self-supervision output relay, that is, the IRF output relay, is energized and the contact gap X7.1/3-5 is closed. After a fault has been detected, the device delivers a fault signal to the IRF relay, which operates, that is, the relay drops off and the NO contact X7.1/4-5 closes.

The fault is indicated by the IRF LED on the LED panel and the PSC card of the REC 523 device. Additionally, an event E57 is generated over the serial communication.

If the internal fault disappears, event E56 is generated over the serial communication.

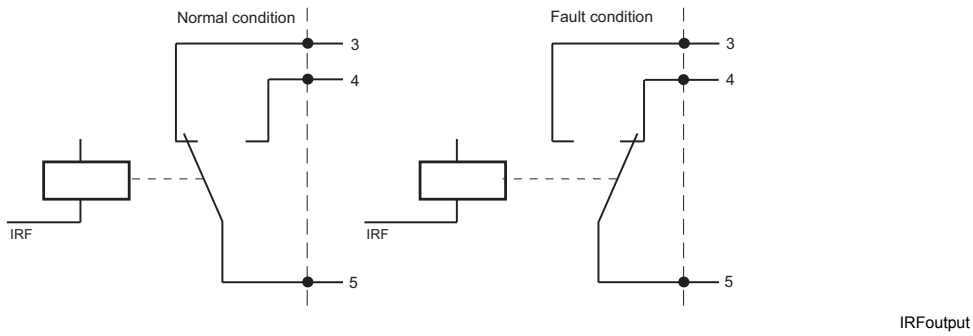


Fig. 5.7.1.-1 Self-supervision output (IRF)

5.7.2. Fault operation

When entering IRF state, the relay takes the following actions to ensure that a false trip can not be caused by the fault:

- All relay outputs are forced to zero (released), and subsequent changes blocked.
- All virtual outputs (COMM_OUT1...64) are written to zero, and subsequent changes blocked.
- Event transmission is blocked, except for IRF events E56/E57 and start-up event E50.

5.7.3. Fault recovery

This feature is supported in the REC 523 revision F or later.

The relay tries to recover from a fault either by restarting the module (I/O module) that reported the fault, or by restarting the whole relay. During a restart, the IRF state remains active until the internal self-supervision program has determined that the relay is operating normally. If the fault is still present after three restarts, the relay is in permanent IRF state.

When returning to normal operation, the IRF LED on the LED panel returns to blank state. In addition, an event 0/E56 is generated over the serial communication.

5.7.4. Fault codes

When an internal fault is indicated by REC 523, the self-supervision system generates an IRF code that indicates the type of the fault.The fault can be read in the Relay Setting Tool's menu Status/General/IRF code.

Do not reset REC 523 before reading the IRF code. The code should be noted in a service report when overhaul is ordered. In case of a repeating IRF, send the REC 523 device to the manufacturer.

Table 5.7.4-1 gives an overview of the fault origin.

Table 5.7.4-1 Fault origin overview

Codes	Explanation
0 →	Faults related to the module of the device, for example to BIO card
3000 →	Faults related to the parameter database
6000 →	Faults related to the analogue measurement inputs
7000 →	Software faults
15000 →	Faults related to testing

5.8. Configuration

5.8.1. REC 523 configuration

The Relay Configuration Tool is based on the IEC 61131-3 standard. The standard defines the programming language used for the configuration.

The programmable system of REC 523 allows the output contacts to be operated in accordance with the state of the logic inputs and the outputs of the protection, control, measurement and condition monitoring functions. The programmable logic controller (PLC) functions (for example interlocking and alarm logic) are programmed with Boolean functions, timers, counters, comparators and flip-flops. The program is written in a function block diagram language by using the configuration software.

After the configuration has been built and successfully compiled, the Relay Configuration Tool project (RCT project in CAP 505) including the relay configuration can be downloaded to the device with the Relay Download Tool. The project can also be uploaded from REC 523 with the same tool.

However, the relay configuration and the RCT project are saved in the non-volatile memory only after they have been stored via the parameter `Store`. To activate the new configurations, the REC 523 device should be reset via the parameter `Software reset`. The parameters can be found on the Relay Configuration Tool by opening the Configuration tab and clicking the General subtab. Likewise, the storing and the resetting can be done via the Relay Download Tool by using the relay command buttons **Store** and **Reset**.

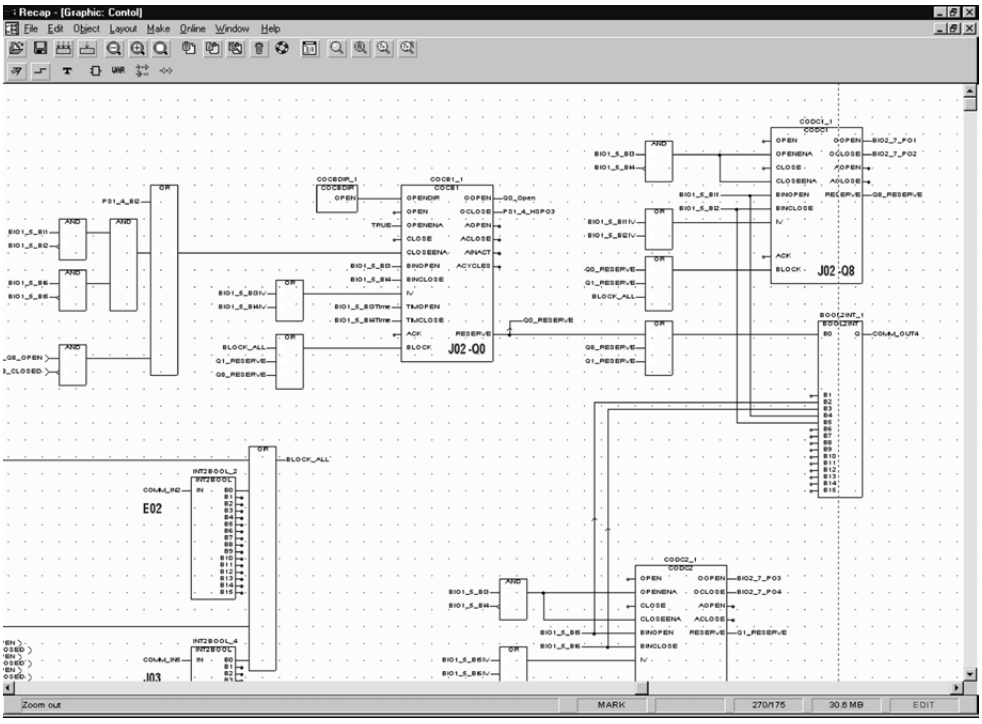


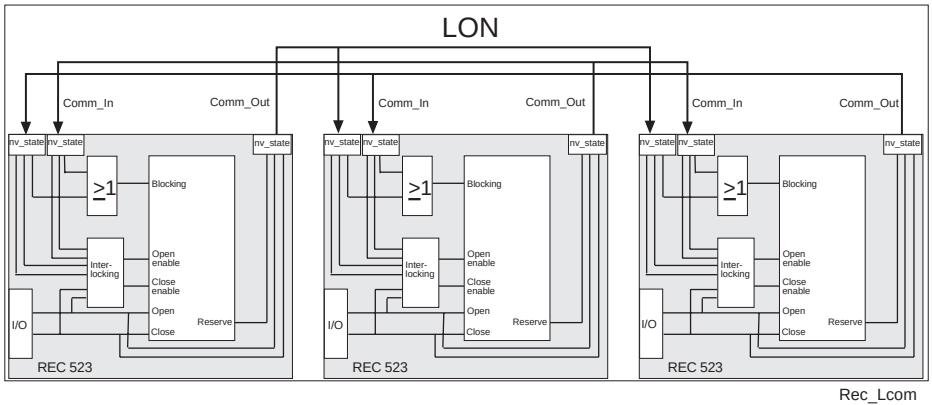
fig7_1_1bw

Fig. 5.8.1.-1 Configuration tool

For more information about the configuration and the Relay Configuration Tool, refer to the configuration guideline and the tool manuals (refer to Section 1.8. Related documents).

5.8.2. LON network configuration

The LON Network Tool is used for binding network variables between REC 523 units or other LON devices. Typically, LON is used for transferring status data between the REC units for the interlocking of the units, see Fig. 5.8.2.-1 .



Rec_Lcom

Fig. 5.8.2.-1 Communication between REC523 devices in station interlocking

For more information about the use of the tool, refer to the operator's manual for LNT 505 (refer to Section 1.8. Related documents).

5.8.3. Rated frequency

When configuring the REC 523 device, the rated frequency of the device is also set via the Relay Configuration Tool. The set rated frequency cannot be changed afterwards via serial communication but it can be read via the global control parameter `Rated frequency`.

5.9. Parameters and events

The function blocks and I/O cards include a large number of parameters and events. In addition, general parameters and events are provided, for example, parameters for control and communication as well as events for testing and self-supervision.

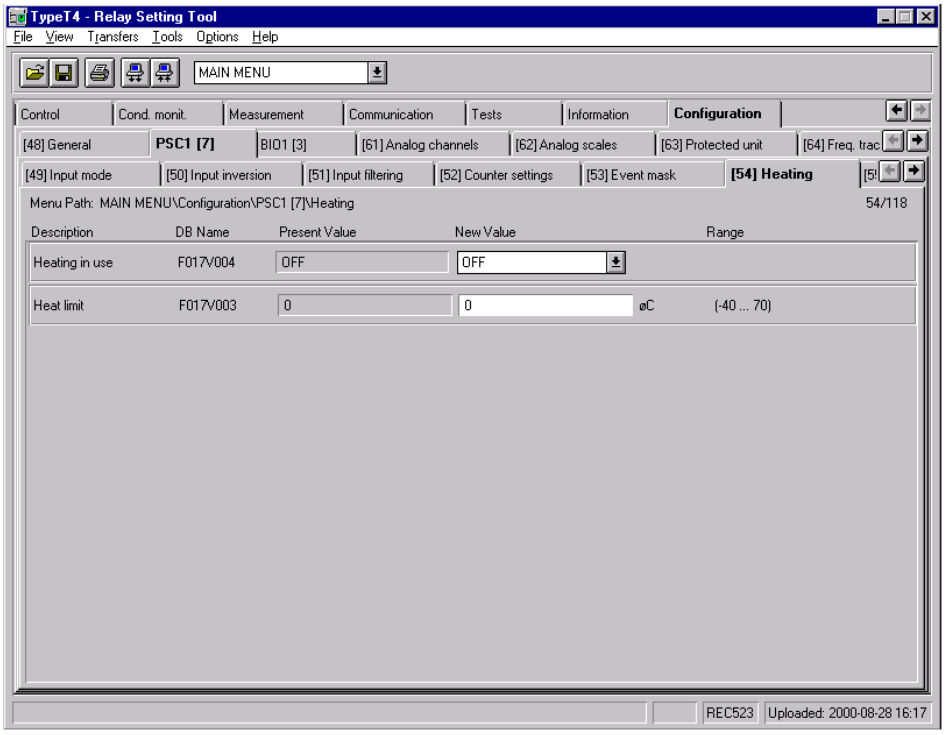
The function block specific parameters are listed in each function block description. Moreover, all parameters and events for REC 523 are listed in the parameter and event lists. The function block descriptions as well as the parameter and event lists are included in the CD-ROM Technical Descriptions of Functions (refer to Section 1.8. Related documents).

5.10. Parametrization

Before taking a protection function block into use, ensure that the function block operates correctly by checking the default values and by properly setting the parameter values.

The Relay Setting Tool is used for parametrizing and setting the REC 523 device. The parameters can be set off-line on a PC and downloaded to the relay over a communication port.

The use of the tool is explained in the user's guide for relay tools (refer to Section 1.8. Related documents).



psc

Fig. 5.10.-1 Main dialog of the Relay Setting Tool

5.11. Storing of parameters

When parameter values are changed, the new values take effect immediately. However, the new parameter values as well as the recorded data are saved in a non-volatile memory only after they have been stored.

Provided the storing was completed successfully, the information stored in the non-volatile memory is preserved in the memory also in case of a power interruption. During the storing procedure, it is not possible to perform software reset or to load a new project.

The parameters for measuring devices as well as the protocol and link parameters take effect only after they have been stored and the device has been reset. Store the parameters via the parameter `Store`, and reset the REC 523 device via the parameter `Software reset` by opening the Configuration tab and selecting General subtab. You can use the relay command buttons **Store** and **Reset** in the Relay Download Tool as well.

The same applies for some communication parameters, that is, the SPA baud rate, the protocol selection parameters (`Protocol 2` and `Protocol 3`) which can be found by opening the Communication tab and clicking the General subtab, and the `Command time-out` parameter which is found on the same subtab.

6. Communication

6.1. General

The REC 523 supports the most common remote communication protocols, such as:

- IEC 60870-5-101
- DNP 3.0
- Modbus

By using open and standard protocols in the REC 523 units, it is possible to connect to various SCADA systems.

The REC 523 has a default protocol interface that fits to modern SCADA systems as such. However, in case the existing SCADA system is inadaptable you can modify the protocol interface by using the Protocol Editing Tool. For IEC 60870-5-101 protocol, the REC 523 revision F provides support for the Protocol Mapping Tool (PMT). The Protocol Editing Tool and the Protocol Mapping Tool are included in CAP 505.

The REC 523 is also able to communicate with a modem by using freely programmable AT-Hayes commands. This function enables a sophisticated dial-up and re-dialling system, watchdog function and even entering the PIN code for cellular telephone modems.

The REC 523 has one RS 485 and two RS 232 serial communication ports.The 9-pole RS 485 connection X5.3 connects the REC 523 units to the distribution automation system via a SPA bus or a LON bus, LON being the default mode. The RS 232 port (X5.1) is used for the remote communication protocol, whereas the second RS 232 port (X5.2) is used for parametrization using the SPA bus protocol.

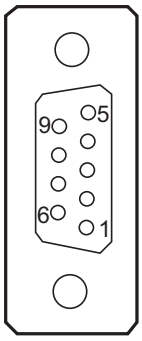
Note that a special parametrization cable of type 1MRS120520 is required to enter the SPA bus mode in port X5.2.

The fibre-optic interface module type RER 103 is used to connect the REC unit to the fibre-optic communication bus. This module supports both SPA-bus and LON-bus communication. To connect REC 523 to the free topology network, the free topology network interface (FTT-10) module should be used.

For communication port locations, refer to Fig. 7.2.-1, Fig. 7.2.-2 and Fig. 7.2.-3.

Note that the use of serial communication ports is not the same in different revisions of REC 523 (refer to Chapter 11. Revision history of REC 523).

Table 6.1.-1 9-pin communication port signal layout



Connector X5.1 F RS 232/ remote protocol[a]		Connector X5.2 M RS 232/ SPA parametrization[a]		Connector X5.3 F RS 485/ LON or SPA[a]	
1		1		1	DATA_A
2	RXD	2	RXD	2	DATA_B
3	TXD	3	TXD	3	RTS_A
4	(do not connect)	4	+15 V	4	RTS_B
5	GND	5	GND	5	LON_COL_A
6		6	DSRB[b]	6	LON_COL_B
7	RTS	7	RTS	7	GND
8	CTS	8		8	xLON_Switch
9		9		9	VCC

a. “F” after connector means female connector and “M” male connector.
b. When DSRB pin is set to +15 V, SPA bus protocol is in use (9600, even, 7 data bits, 1 stop bits, SPA bus address 1.

6.2. Communication interfaces

The REC 523 offers interface for various type of communication media used in distribution automation applications. The communication media includes:

- Public telephone lines
- Leased lines
- Digital line carrier (DLC)
- Digital cellular phones (GSM)
- Analogue or digital radio
- Optical cables
- Satellite communication

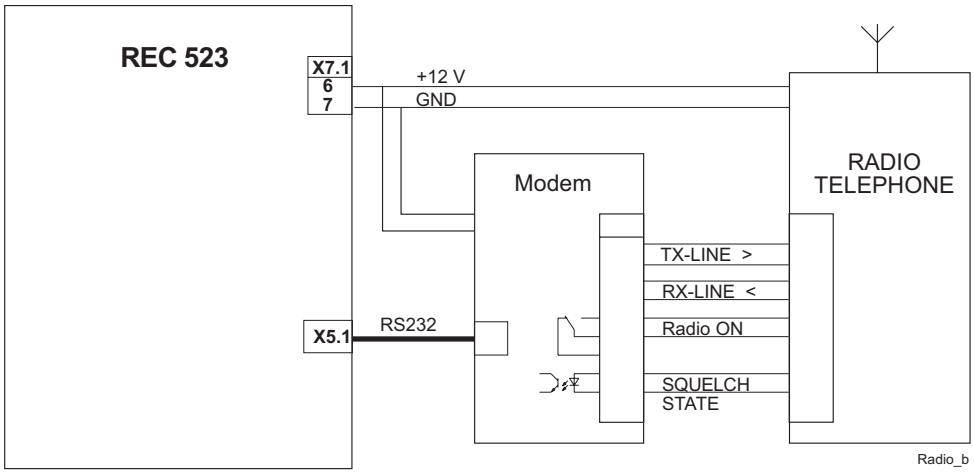


Fig. 6.2.-1 Radio telephone connection

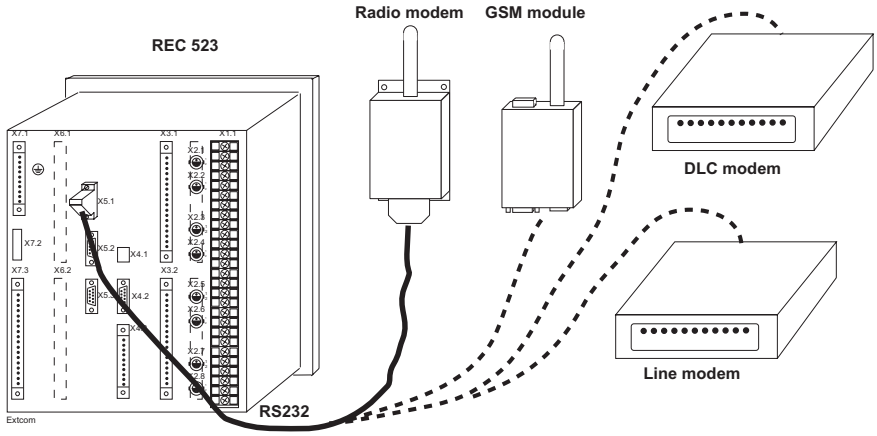
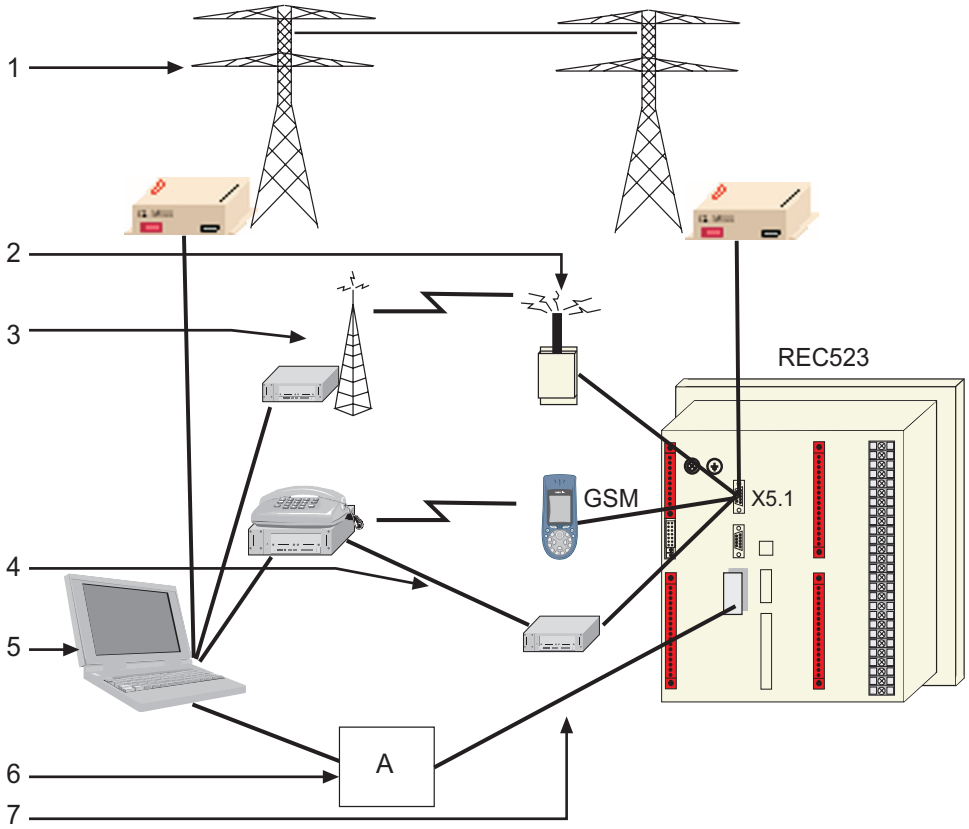


Fig. 6.2.-2 External communication devices



1 Power and distribution line carrier
2 Radio modem
3 Radio
4 Electrical telecommunication
5 Network control centre
6 Adapter
7 Fiber optic

comopt_a

Fig. 6.2.-3 Alternative communication methods

6.3. Communication overview

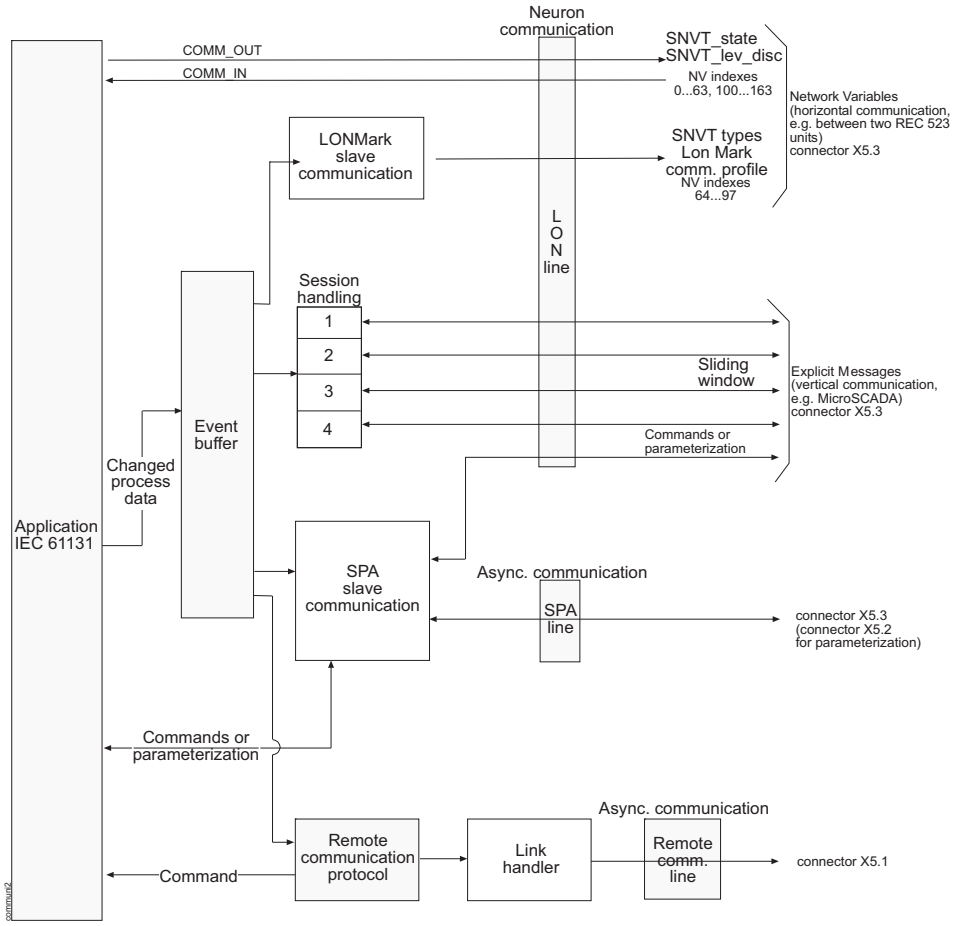


Fig. 6.3.-1 REC52_ Communication overview

6.4. LON communication

LON communication to/from REC 523 units falls into two categories:

- Communication based on network variables
- Communication based on explicit messages

Network variables are used when communication need to be interoperable with other commercially available LON devices. This is referred to as LonMark slave communication. For more information about interoperable communication, refer to the Echelon documents listed in Section 1.8. Related documents.

Explicit message communication falls into two main categories:

1) Standard LON messages (containing network management messages, router configuration messages, and so on)

2) Foreign messages

In REC 523, the ABB-specific solution for substation communication is supported by foreign messages. In short, the communication method consists of session control (REC 523 can maintain up to 4 sessions), a sliding window protocol for application acknowledgement and definition of data formats.

The REC 523 unit also supports explicit SPA messages which may be used for parametrization purposes. This method is also defined in the LON Application Guidelines document.

6.4.1. Network variable indexes of REC 523

Table 6.4.1-1 Network variable indexes

NV index	Dir.	SNVT_Type	SNVT number	Object Type	Comments
0...15	IN	SNVT_state	83	16 bit INT	Virtual IEC 61131 inputs (Relay Configuration Tool def. COMM_IN_1...16)
16...31	OUT	SNVT_state	83	16 bit INT	Virtual IEC 61131 outputs (Relay Configuration Tool def. COMM_OUT_1...16)
32... 47	IN	SNVT_state	83	16 bit INT	Virtual IEC 61131 inputs (Relay Configuration Tool def. COMM_IN_17...32)
48... 63	OUT	SNVT_state	83	16 bit INT	Virtual IEC 61131 outputs (Relay Configuration Tool def. COMM_OUT_17...32)
64	IN	SNVT_elapsed_tm	87	structure	Throttle input (see description in text)
65	IN	SNVT_elapsed_tm	87	structure	Timeout input (see description in text)
66	OUT	SNVT_alarm	88	structure	Alarms to receiver 1
67	OUT	SNVT_alarm	88	structure	Alarms to receiver 2
68... 77	OUT	SNVT_state	83	16 bit INT	User-definable outputs LM_STA_x (generated from internal process value types 1,2,3 or 16 bits)
78... 87	OUT	SNVT_count_inc_f	52	IEEE754 float	User-definable outputs LM_CNT_x (generated from internal process value type float)
88... 97	OUT	nv_32bit_analog	252	32 bit INT	User-definable outputs LM_ANA_x (generated from internal process value type 32 bit (=any type))
100... 115	IN	SNVT_state	83	16 bit INT	Virtual IEC 61131 inputs (Relay Configuration Tool def. COMM_IN_33...48)
116... 131	OUT	SNVT_state	83	16 bit INT	Virtual IEC 61131 outputs (Relay Configuration Tool def. COMM_OUT_33...48)

Table 6.4.1-1 Network variable indexes (Continued)

NV index	Dir.	SNVT_Type	SNVT number	Object Type	Comments
132... 147	IN	SNVT_lev_disc	22	8 bit INT	Virtual IEC 61131 inputs (Relay Configuration Tool def. COMM_IN_49...64)
148... 163	OUT	SNVT_lev_disc	22	8 bit INT	Virtual IEC 61131 outputs (Relay Configuration Tool def. COMM_OUT_49...64)

6.5. Virtual IEC 61131 inputs and outputs

The REC 523 unit offers up to 64 programmable LON inputs and 64 outputs on the LON bus, 128 in total. The inputs and outputs use the LonMark Standard Network Variables (NV type 83 = SNVT_state and NV type 22 = SNVT_lev_disc) for sending and receiving process data.

The LON inputs and outputs are accessible in the relay configuration and can be freely used for different types of data transfer between the REC units and other devices that are able to communicate using the network variable of type SNVT_state or SNVT_lev_disc.

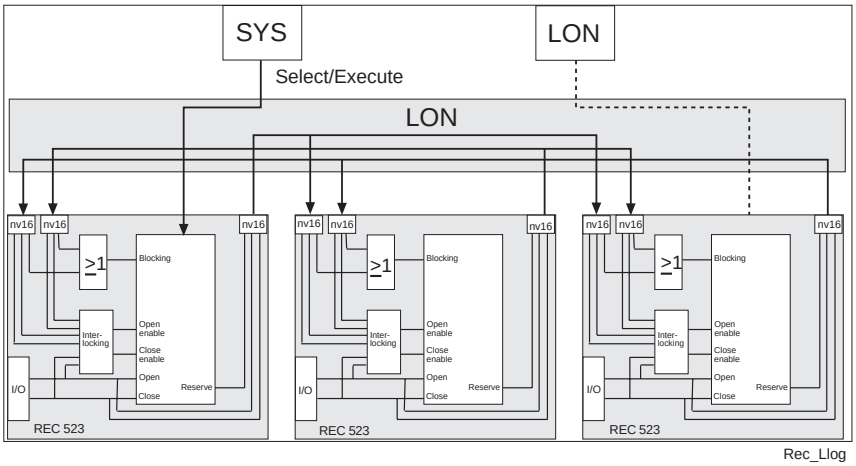


Fig. 6.5.-1 Principle of connecting LON inputs and outputs to logic functions of the device

NV type 83 = SNVT_state

The SNVT_state can be used to communicate the state of a set of 1 to 16 Boolean values. Each bit indicates the state of a Boolean value with, for example, the following interpretations:

0	1
off	on
inactive	active
disabled	enabled
low	high
false	true
normal	alarm

The value field shows the current value of the digital inputs or outputs at the time of reporting, or the last value reported from the concerned device.

The SNVT_state can be used to transfer the state of 1 to 16 digital inputs or it can be used to set the state of 1 to 16 output bits or digital set-points.

The SNVT_state inputs can also be used for controlling purposes.

6.5.1. LonMark Slave POD based network variables (NV indexes 64...97)

The communication application works as an event receiver using the event filter number 1, which is set with the Relay Setting Tool parameter `Event mask 1`. This means that all application events generated within REC 523 and enabled by the application-dependent filter 1, are received by the LonMark communication application.

The events received by the LonMark application are processed in two alternative ways:

- Events are converted into network variable data (analogue or digital) according to the LonMark slave POD (Process Object Dictionary), which works as a cross-coupling between REC 523 application events and LON network variables
- Events not defined in the LonMark slave POD are converted to alarms (SNVT_Alarm)

6.5.1.1. LonMark POD

To be able to parametrize the LonMark POD, you need the manuals from the CD-ROM Technical Descriptions of Functions (refer to Section 1.8. Related documents). The POD is structured as presented in Table 6.5.1.1-1.

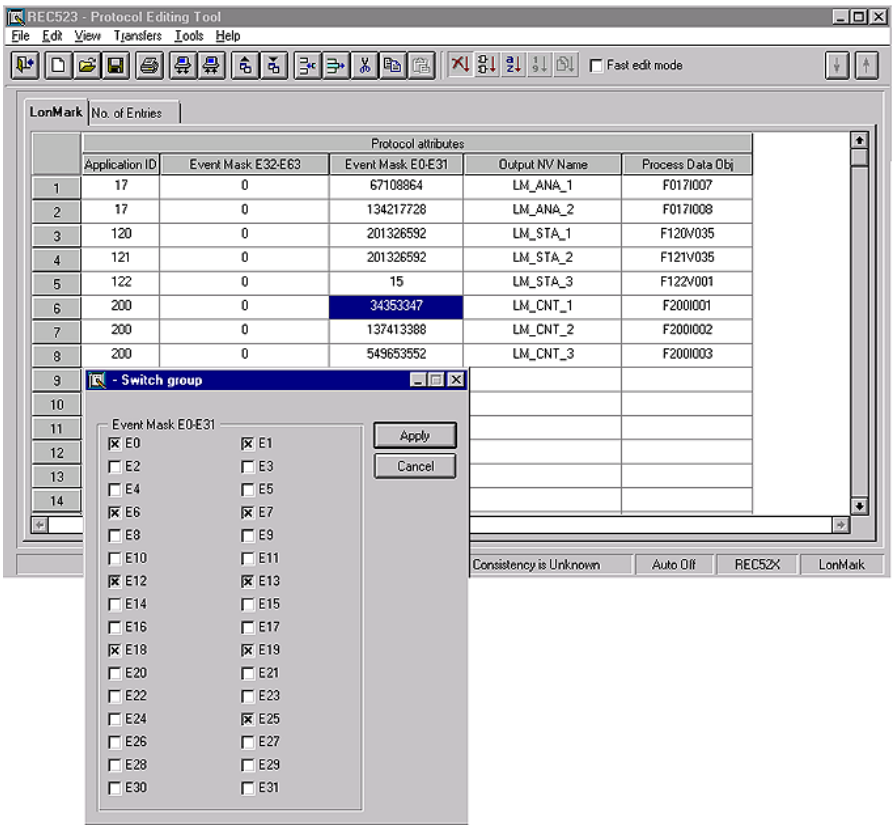
Table 6.5.1.1-1 POD structure

Table index	Application ID (channel, FblockID)	Event Mask1 (E32...E63)	Event Mask2 (E0...E31)	Output Network variable name	Process data object name
000[a]	122	0	15	LM_STA_1	F122V001
001[b]	200	0	34353347	LM_CNT_1	F200I001

Table 6.5.1.1-1 POD structure (Continued)

Table index	Application ID (channel, FblockID)	Event Mask1 (E32...E63)	Event Mask2 (E0...E31)	Output Network variable name	Process data object name
100					

a. The table index 000 illustrates the conversion of the disconnector position process data (CODC1) into a 16-bit network variable (index 68, two least significant bits). The Event Mask2 for the table index 000 means that the events E0, E1, E2 and E3 are set.
b. The table index 001 is an example of the conversion of the analogue measurement process data (MECU3A, phase current 1) into a float type of network variable (index 78). The Event Mask2 for the table index 000 means that the events E0, E1, E6, E7, E12, E13, E18, E19 and E25 are set.



LonMark3

Fig. 6.5.1.1.-1 Protocol Editing Tool with the LonMark POD

Application ID

Application ID is a number defining the source of the application event. When the application is an IEC 61131 function block, the ID equals the function block ID number, for example, MEVO3A has the ID number 204. In REC 523, there are also events coming from the non-IEC 61131 applications. These are the events related to the battery and heating monitoring. They are presented through the event channel 17. For more details about the channel 17 event profile, see CD-ROM Technical Descriptions of Functions (refer to Section 1.9. Document revisions).

Event Mask1 and Event Mask2

In addition to the application-dependent filter 1 mask, the event is reprocessed through the LonMark mask. The masks are defined so that the setting of the bit 2^(event number) enables the event to be processed as a data event and sent out on the network variable output defined in the next column. Several bits may be set in the masks.

If the Protocol Editing Tool is used for the creation of the LonMark POD, the selection of events to be processed as data events is done by selecting them from the Event Mask E0-E31 and Event Mask E32-E63 lists.

Output Network Variable name

The name is given in ASCII format and must be exactly as defined below.

Nv indexes 68...77 are defined as "LM_STA_1", "LM_STA_2",..."LM_STA10".

Nv indexes 78...87 are defined as "LM_CNT_1", "LM_CNT_2",..."LM_CNT10".

Nv indexes 88...97 are defined as "LM_ANA_1", "LM_ANA_2",..."LM_ANA10".

Conversion rules (see appropriate application documentation for event value types)

Event value types for output variables "LM_STA_1"..."LM_STA10" are the following:

EV_1BIT

EV_2BIT

EV_3BIT

EV_INT16

Event value type for output variables "LM_CNT_1"..."LM_CNT10" is:

EV_FLOAT

Event value types for output variables "LM_ANA_1"..."LM_ANA10" are the following:

EV_32BIT

EV_INT32

Process data object name

This is the definition of the internal source for momentary reading of process data. The data can be found in the user’s manual of the application. The name of the process data object is always of format "Fxxx<D>yyy", where:

- "xxx" is the application ID
- “<D>” is the data category
- "yyy" is the data number

The name is an ASCII string with the fixed length of 8 characters.

If, for example, the converted data is an analogue current value I3 and the application block is numbered 234, the name is “F234I003”.

The number of entries in the LonMark POD (index+1) should be stored into the 231M200000 parameter. In case the Protocol Editing Tool is used, the number of entries is defined in the No. of Entries tab. In such a case, the value is set to the index of the last row defined, neglecting the possible empty rows in the end of the POD.

6.5.2. Access to POD data

The POD can be read and written by using three principles:

1) LonTalk file transfer

File index is 48. The POD file is packed as presented in Table 6.5.2-1.

Table 6.5.2-1 POD file packing

Byte	Element	Comment
0	UINT16	Number of following POD entries
2	UINT16	ApplicationId (first entry)
4	UINT32	EventMask MSB
8	UINT32	EventMask LSB
12	UINT8	OutputNetworkVariableName (8)
20	UINT8	ProcessDataObjectName(8)
28	UINT16	ApplicationId (second entry)
:	:	:

The POD file must be packed, which means there must be no empty bytes between structures or elements. The POD file elements must be in Motorola byte order. The entries must be sorted based on the application ID, starting from the smallest application ID number.

2) Protocol Editing Tool

The Protocol Editing Tool available in the CAP 505 version 2.1.0. and later can be used for editing the LonMark POD.

The LonMark POD has two tabbed pages, LonMark and No. of Entries. The structure of the LonMark tab is introduced in the Fig. 6.5.1.1.-1. Refer to Section 6.5.1.1. LonMark POD for further definitions of the columns.

The second tab, No. of entries, has only one item: number of defined entries. The value for the No. of defined entries should be set to the same value as the index of the last row defined, for example to 8 in Fig. 6.5.1.1.-1.

The entries must be sorted on the basis of the application ID, starting from the smallest application ID number.

3) SPA table format

The SPA access can be used directly from the REC 523 SPA interface or any other protocol supporting the transparent SPA message transfer.

The LonMark application number is 231. Table is number 1. Data category is M. Entries are from 000 to 030.

Application Id is element 0.Value 0...65535

EventMaskMSB is element 1. Value 0...(2^{32}-1)

EventMaskLSB is element 2. Value 0...(2^{32}-1)

OutputNetworkVariableName is element 3.Value "LM_xxxxx"

ProcessDataObjectName is element 4.Value "FxxxDyyy"

The following syntax is used for reading or writing:

```
>nnnR231M<tableNo><entry><element>:CC
```

The reading of elements 3 and 4 of entry 18, for example:

Message form:

```
>nnnR231M101803/101804:CC
```

Reply form:

```
<nnnD:LM_ANA_2/F234I003:CC
```

The entries must be sorted on the basis of the application ID, starting from the smallest application ID number.

6.5.3. SNVT_alarm outputs

The events received by the LonMark application, but not defined in the POD, are converted into SNVT_alarm data. There are two separate asynchronous SNVT_alarm outputs which may be used by two different receivers. The network variable indexes are 66 and 67.

Table 6.5.3-1 SNVT alarm data

SNVT_alarm element	**REC 523 event data**
Location(6)	ASCII text “SPAxxx” xxx = SPA slave number
Object_id	Application id (channel number)
Alarm_type_t	128 + Event code
Priority_level	0
Index_to_SNVT	0, 83, 52 or 252 (SNVT_state, SNVT_count_inc, NV_32b_analog)
Value (4)	Value from internal event structure
Year Month Day Hour Minute Second Millisecond	Date and time from internal event structure
Alarm_limit(4)	0 0 0 0

Each SNVT_alarm output has its own event buffer. The size of each buffer is 50 events. Buffering contains local overflow, which means that overflow in LonMark event handling does not affect other event receivers in REC 523. The local overflow event is given with the location_id 231 (LonMark application's individual application number) and event code 51.

Sending and flow control of the SNVT_alarms

Two separate tasks within REC 523 handle the sending of events through two separate SNVT_alarm outputs. Alarms are sent with the minimum transfer rate defined by the throttle network variable input, NV index 64. The default setting 200 ms may be changed by writing a new value to the throttle input. The maximum throttle value is one minute.

If the sending of a SNVT_alarm fails, the same event is retransmitted at the rate defined in the timeout network variable input, NV index 65. The timeout setting is 1 second by default. If transmission fails 100 times in a row, the timeout is multiplied with 100. The max. written timeout setting value is one minute.

Both the throttle and timeout input variables are of the structured type SNVT_elapsed_tm.

Refer to SNVT documentation for more information.

7. Design description

7.1. Technical data

Table 7.1.-1 Energizing inputs

Rated frequency		50.0/60.0 Hz	
Current inputs	rated current		0.2 A/1 A/5 A
	Thermal withstand capability	continuously	1.5 A/4 A/20 A
		for 1 s	20 A/100 A/500 A
	dynamic current withstand, half-wave value		50 A/250 A/1250 A
	input impedance		<750mΩ/<100mΩ/ <20 mΩ
Voltage inputs	rated voltage		100 V/110 V/115 V/120V/ 230 V (parametrization)
	voltage withstand, continuous		2 x U_n (240 V)
	burden at rated voltage		<0.5 VA
Sensor inputs, max. 9	AC voltage range		9.4 V RMS
	DC voltage range		±13.3 V peak
	input impedance		>4.7 MΩ
	input capacitance		< 1 nF

Table 7.1.-2 Auxiliary power supplies

Type	**PSC1**	**PSC2**
Input voltage, AC	110/120/220/240 V	-
Input voltage, DC	110/125/220 V	24/48/60 V
Operating range	AC 85...110% of rated value DC 80...120% of rated value	DC 80...120% of rated value
Fuse	2 A slow	8 A slow
Normal power consumption	20...30 W	
Ripple in DC auxiliary voltage	max. 12% of the DC value	
Interruption time in auxiliary DC voltage without resetting	<50 ms, 110 V and <100 ms, 200 V	
Internal overtemperature indication	+78°C (+75…+83°C)	

Table 7.1.-3 Battery (recommended)

Type	**YUA NP 17-12**	**YUA NPL 24-12**
Rated voltage	12 V	12 V
Capacity	17 Ah	24 Ah, long life
Weight	5.6 kg	9.0 kg
Size	181x76x167 cm (L x W x H)	197x165x170 cm (L x W x H)

Table 7.1.-4 Supply for radios

With batteries	12 V DC, 7 A peak, 1A continuosly
Without batteries	12 V DC, 1 A peak

Table 7.1.-5 Temperature compensated charger for batteries

Rated charging voltage	27.6 V DC, at 20°C
Output power	15 W
Fuse (F2)	6 A
Temperature compensation	- 0.04 V / °C

Table 7.1.-6 Digital inputs

Number of inputs	15
Operating range	18…265 V DC (24/48/60/110/220 V DC)
Current drain	~2…25 mA
Power consumption/input	<0.8 W
Pulse counting (specific digital inputs), frequency range	0…100 Hz

Table 7.1.-7 Power outputs

Number of outputs	2
Max. system voltage	250 V AC/DC
Continuous carry	5 A
Make and carry for 0.5 s	30 A
Make and carry for 3 s	15 A
Breaking capacity when control circuit time constant L/R <40 ms, at 48/110/220 V DC	5 A / 3 A / 1 A
Contact material	$AgCdO_2$

Table 7.1.-8 Signal outputs

Number of outputs	7
Max. system voltage	250 V AC/DC
Continuous carry	5 A
Make and carry for 0.5 s	10 A
Make and carry for 3 s	8 A
Breaking capacity when control circuit time-constant L/R <40 ms, at 48/110/220 V DC	1 A/0.25 A/0.15 A
Contact material	$AgCdO_2$

Table 7.1.-9 Environmental conditions

Specified service temperature range		-10…+55°C
	with heated enclosure	-40...+55°C
Temperature range limit (short-term)		-40...+70°C
Transport and storage temperature range		-40…+70°C
Enclosure class (IEC 60529)	wall, flush and rackmounted	IP 20
	with UEMC-xx enclosure	IP 55
Dry heat test		according to IEC 60068-2-2
Dry cold test		according to IEC 60068-2-1

Table 7.1.-9 Environmental conditions (Continued)

Damp heat test, cyclic	according to IEC 60068-2-30 r.h. = 95%, T = 25°…55°C
Storage temperature tests	according to IEC 60068-2-48

Table 7.1.-10 Standard tests

Insulation tests	Dielectric test IEC 60255-5	Test voltage	2 kV, 50 Hz, 1 min.
	Impulse voltage test IEC 60255-5	Test voltage	5 kV, unipolar impulses, waveform 1,2/50 μs, source energy 0.5 J
	Insulation resistance measurements IEC 60255-5	Insulation resistance	> 100 MΩ, 500 V DC
Mechanical tests	Vibration tests (sinusoidal)		IEC 60255-21-1, class I
	Shock and bump test		IEC 60255-21-2, class I

Table 7.1.-11 Electromagnetical compatibility tests

The EMC immunity test level fulfills the requirements specified below			
1 MHz burst disturbance test, class III, IEC 60255-22-1	common mode		2.5 kV
	differential mode		1.0 kV
Electrostatic discharge test, class III, IEC 61000-4-2 and IEC60255-22-2	for contact discharge		6 kV
	for air discharge		8 kV
Radio frequency interference test	conducted, common mode IEC 61000-4-6 and IEC 60255-22-6		10 V (rms), f = 150 kHz…80 MHz
	radiated, amplitude-modulated IEC 61000-4-3 and IEC 60255-22-3		10 V/m (rms), f = 80…1000 MHz
	radiated, pulse-modulated ENV 50204		10 V/m, f = 900 MHz
Fast transient disturbance test IEC 60255-22-4 and IEC 61000-4-4	power supply		4 kV
	I/O ports		2 kV
Surge immunity test IEC 61000-4-5 and IEC 60255-22-5	power supply		4 kV, line to earth 2 kV, line to line
	I/O ports		2 kV, line to earth 1 kV, line to line
Power frequency (50 Hz) magnetic field IEC 61000-4-8	100 A/m		
Voltage dips and short interruptions IEC 61000-4-11	30%, 10 ms 60%, 100ms 60%, 1000ms >95%, 5000ms		

Table 7.1.-11 Electromagnetical compatibility tests (Continued)

Electromagnetic emission tests EN 55011 IEC 60255-25	conducted RF emission (mains terminal)	EN 55011, class A IEC 60255-25
	radiated RF emission	EN 55011, class A IEC 60255-25
CE approval EN 50263	Complies with the EMC directive 89/336/EEC and the LV directive 73/23/EEC	

Table 7.1.-12 Data communication

Front interface, connector X5.3	RS485 connection	
	LON bus or SPA bus, selectable	
	the fibre-optic interface module RER 103 is needed for galvanic isolation	
	data transfer rates	SPA bus: 4.8/9.6 kbps LON bus: 78.0 kbps/1.25 Mbps
Communication interface, connector X5.1	remote communication protocol	
Communication interface, connector X5.2	parametrization, SPA	
Communication protocols	Refer to Section 9.2. Software configuration and software number .	

Table 7.1.-13 General

Toolboxes	CAP 501 CAP 505	
Event recording	500 latest events are recorded	
	the events are recorded in higher level syntax: reason, time, date	
Data recording	records operate values	
Control functions	see “Technical Descriptions of Functions”, CD-ROM (1MRS750889-MCD)	
Condition monitoring functions		
Measurements	see “Technical Descriptions of Functions”, CD-ROM (1MRS750889-MCD)	
	temperature of enclosure	-40°...+60°C, ±3°C
	battery voltage	15...35 V DC, ±3%
Self-supervision	all analogue reference voltages	
	automatic test sequences for I/Os, batteries and flash memory	
Mechanical dimensions	Width: 261 mm Height: 265 mm Depth: 250 mm	
Weight of the unit	5...7.2 kg	

7.2. Terminal connections

All external circuits are connected to the terminal blocks on the rear panel. Terminal block X1.1 for the measuring transformers consists of fixed screw terminals fastened to the energizing input module. Each terminal is dimensioned for one max. 6 mm^2 or two max. 2.5 mm^2 wires.

ABB sensors (Rogowski coil or voltage divider) are connected to the connectors X2.1...X2.9. A special type of shielded twin BNC connector (for example type AMP 332225 or Amphenol 31-224) is used to improve reliability and protection against disturbances. The current sensor and/or voltage divider used must have a connector

that is compatible with the device. If the device is ordered without sensor inputs, the sensor connectors X2.1...X2.9 are missing. Short-circuit connectors (1MRS120515) must be connected to sensor inputs not in use.

The male parts of the multi-pole connector strips are fastened to the printed circuit boards. The female parts, including accessories, are delivered together with the device. The female connector part can be secured with fixing accessories and screws. One max. 1.5 mm^2 wire or two max. 0.75 mm^2 wires can be connected to one screw terminal.

The digital inputs and outputs (contacts) of the device are connected to the multi-pole connectors X3.1... X3.2, X7.1 and X7.3. The auxiliary power supply is connected to the terminals X7.1:1 (plus polarity) and X7.1:2 (minus polarity). The REC 523 self-supervision output IRF is linked to the terminals X7.1:3, X7.1:4 and X7.1:5.

Protective earth is connected to the screw marked with the earth symbol.

The serial interface RS 232 on the rear panel (connector X5.1) is used for connecting the REC 523 unit to the remote control system via the remote communication protocol. The connector X5.2, which is a 9-pole D-type subminiature connector, is used for parametrizing REC 523. When the parametrization cable 1MRS120520 is connected to the terminal, the SPA protocol is activated with the following communication parameters:

- Slave number = 1
- Communication speed = 9.6 kbps
- Parity = even
- Data bits = 7

The serial interface RS 485 on the rear panel (connector X5.3) is used for connecting the REC 523 unit to the SPA bus or the LON bus, the default mode being LON. The SPA/LON bus is connected via a connection module type RER 103 fitted to the 9-pole D-type subminiature connector and screwed to the rear panel.

The connectors are designated according to the module slot in REC 523.

Table 7.2.-1 Connector descriptions

Connector	Description
X1.1	connector for transformer inputs (current and voltage transformers)
X2.1	connector for sensor channel 10
X2.2	connector for sensor channel 9
X2.3	connector for sensor channel 8
X2.4	connector for sensor channel 7
X2.5	connector for sensor channel 5
X2.6	connector for sensor channel 4
X2.7	connector for sensor channel 3
X2.8	connector for sensor channel 2
X2.9	connector for sensor channel 1
X3.1	upper connector for I/O module BIO1 (slot 3)
X3.2	lower connector for I/O module BIO1 (slot 3)
X5.1	RS 232 for remote communication protocol

Table 7.2.-1 Connector descriptions (Continued)

Connector	Description
X5.2	RS 232 parametrization of the unit via a parametrization cable
X5.3	connector for RS 485 interface LON / SPA
X7.1	upper connector for the combined I/O, power supply and charger module PSC1/PSC2
X7.2	LED panel connector
X7.3	lower connector for the combined I/O, power supply and charger module PSC1/PSC2

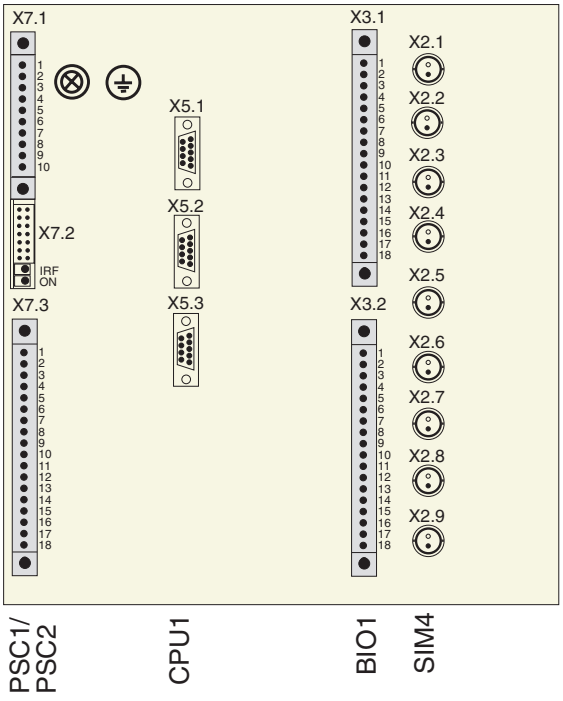


Fig. 7.2.-1 Terminal view of REC523F 060/065 AAC/CAC

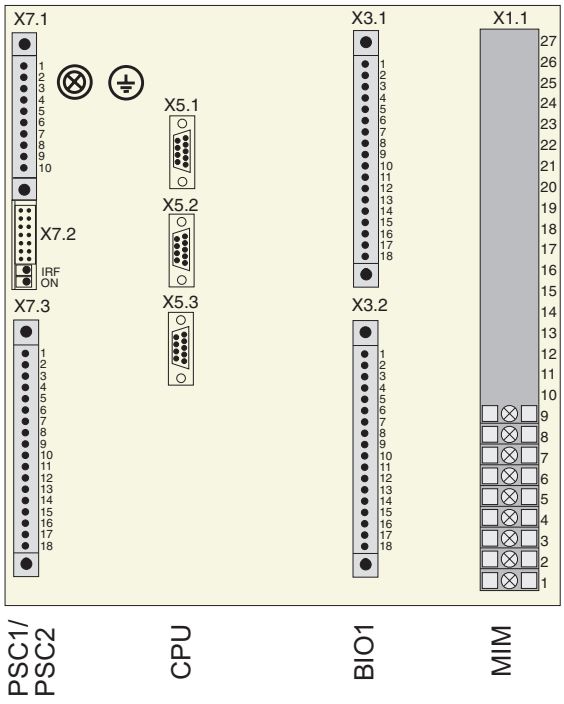


Fig. 7.2.-2 Terminal view of REC523F 032/037 AAA/CAA

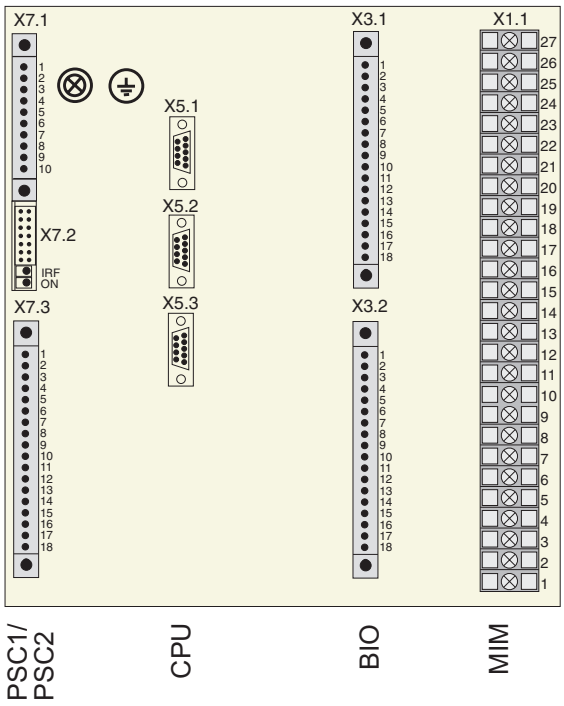
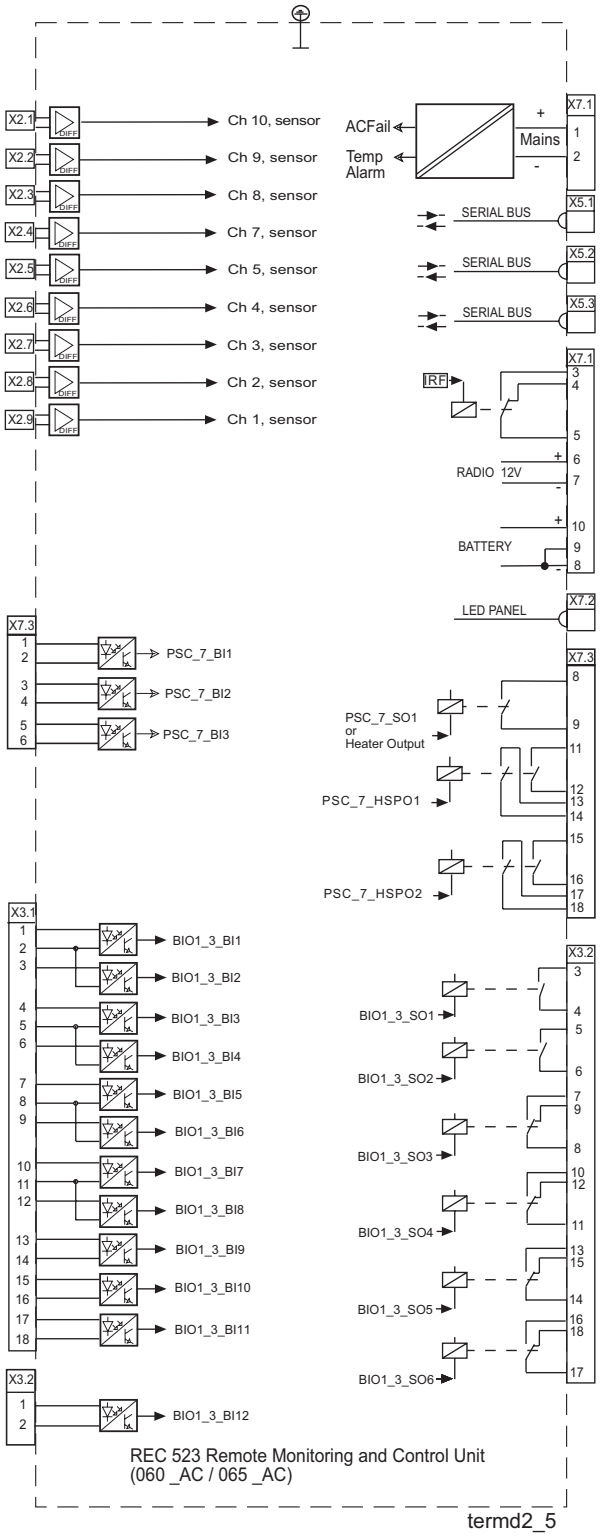


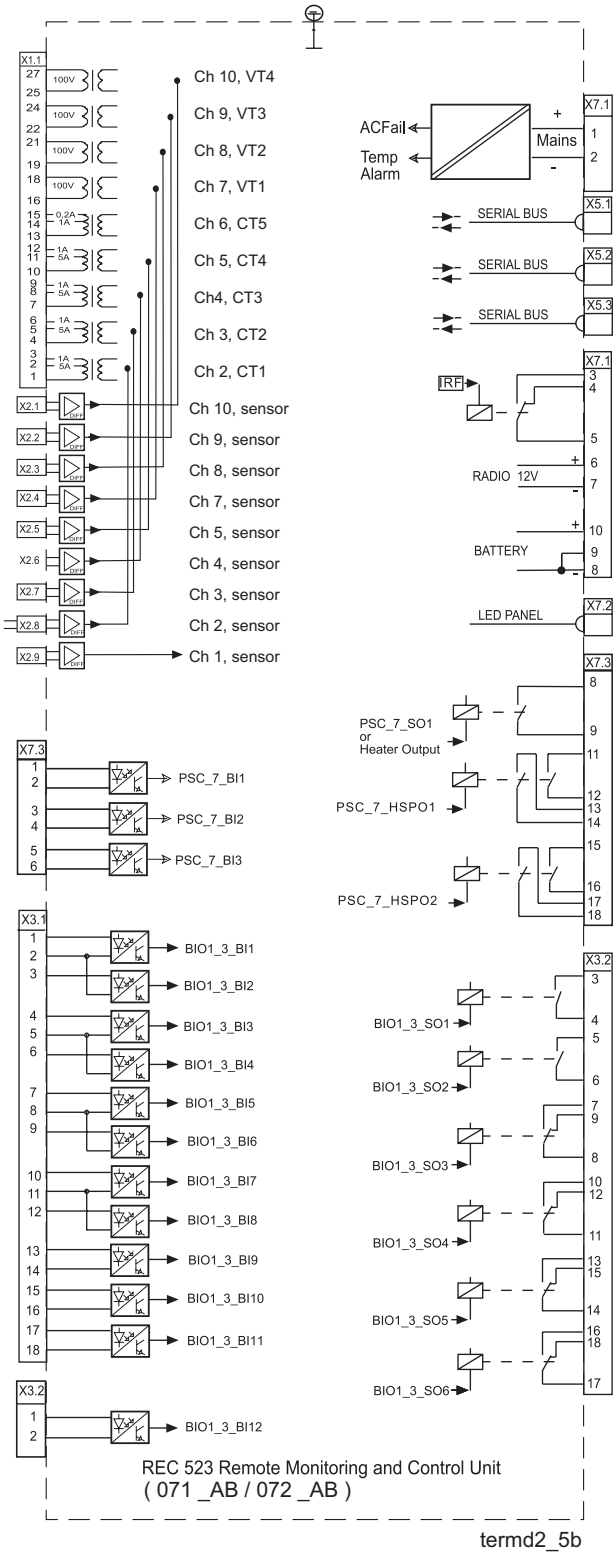
Fig. 7.2.-3 Terminal views of:
REC523F 033/038 AAA/CAA
REC523F 034/039 AAA/CAA
REC523F 054/059 AAA/CAA
REC523F 061/066 AAA/CAA
REC523F 062/067 AAA/CAA

7.3. Terminal diagrams

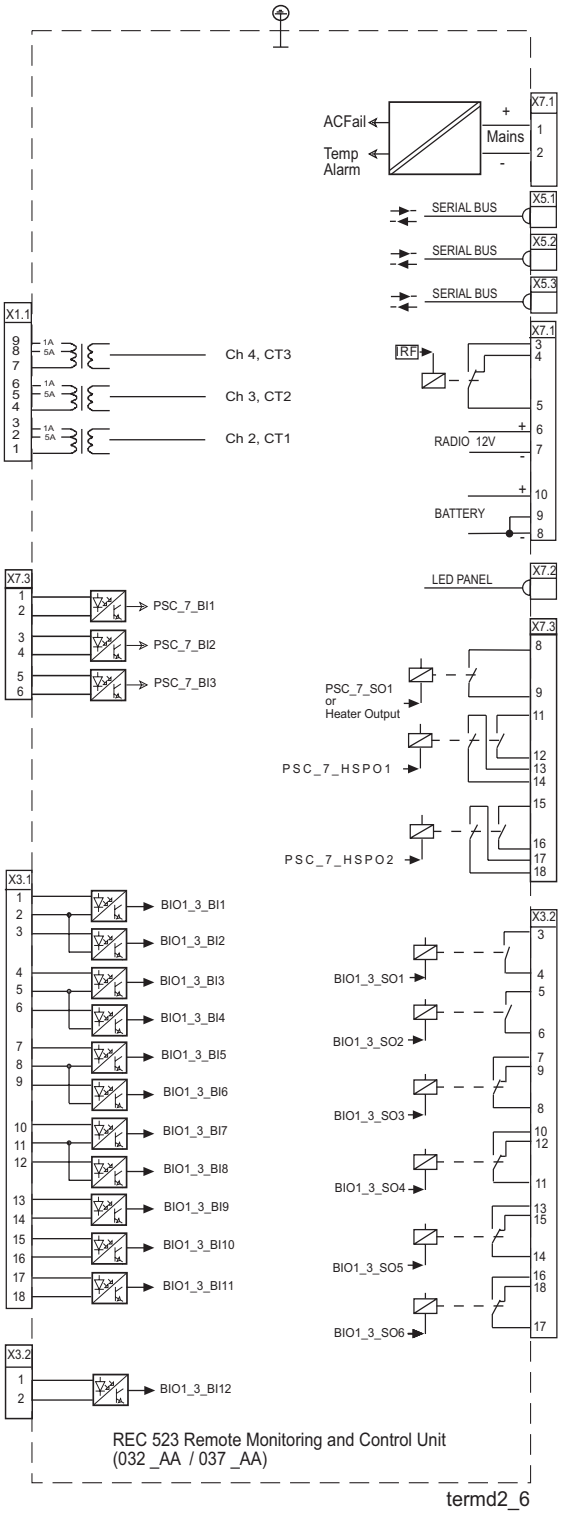
7.3.1. REC 523 with sensors



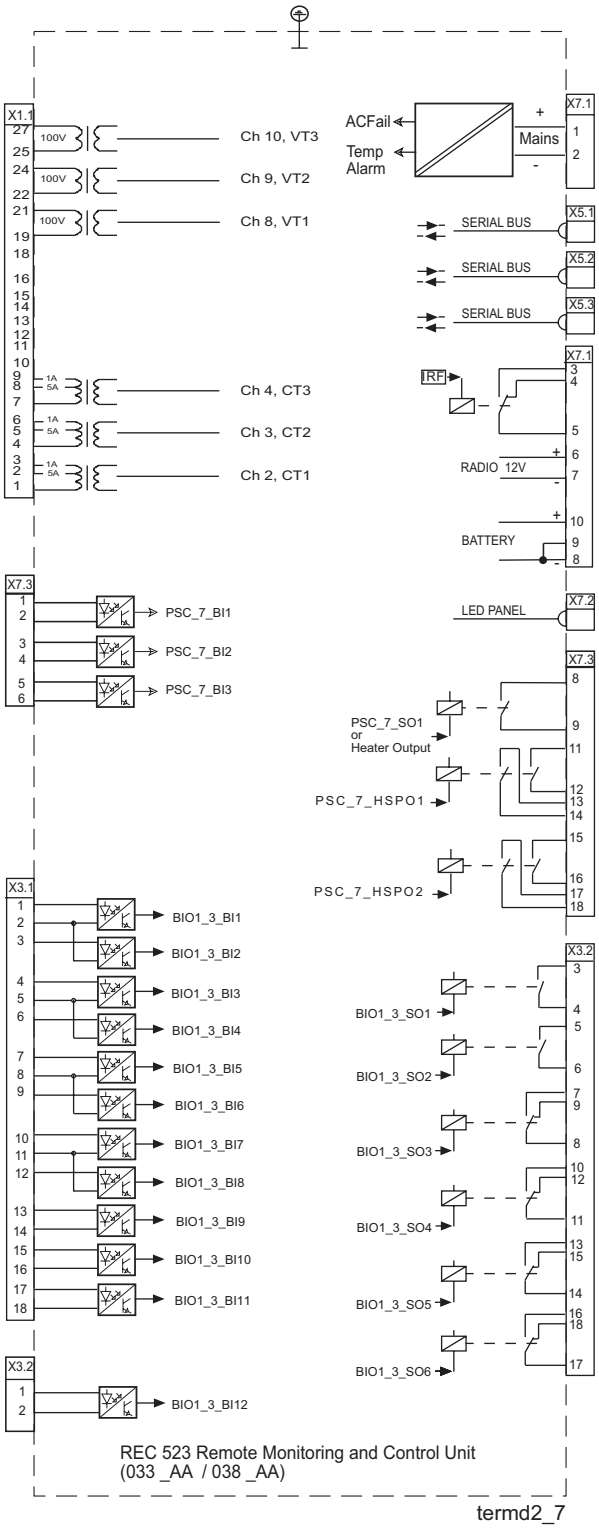
7.3.2. REC 523 with five current and four voltage transformers and sensors



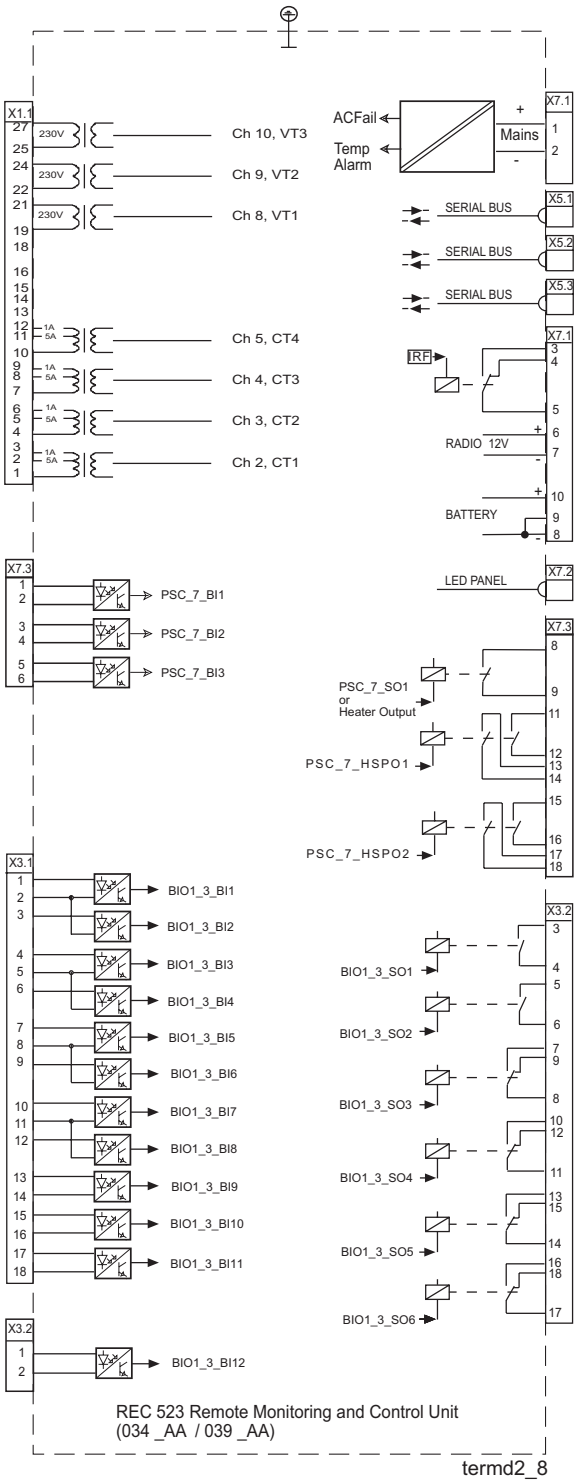
7.3.3. REC 523 with three current transformers



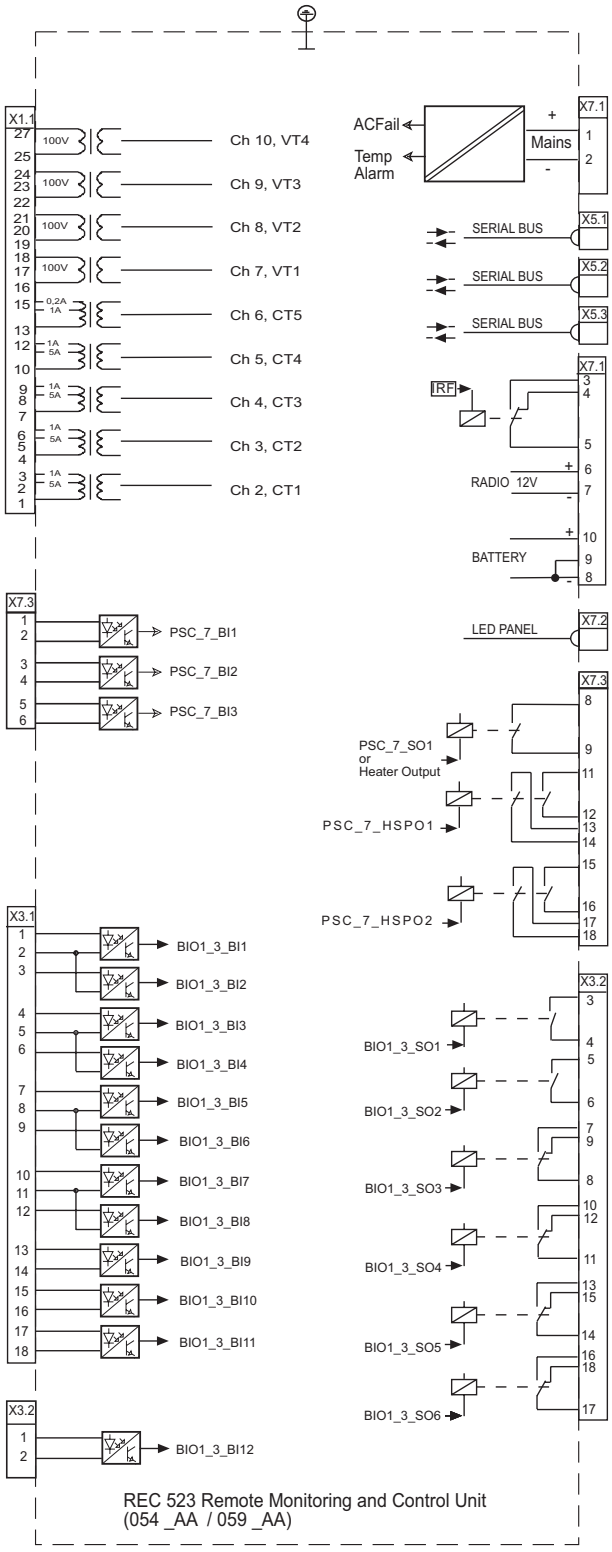
7.3.4. REC 523 with three current and three voltage transformers



7.3.5. REC 523 with four current and three voltage transformers



7.3.6. REC 523 with five current and four voltage transformers



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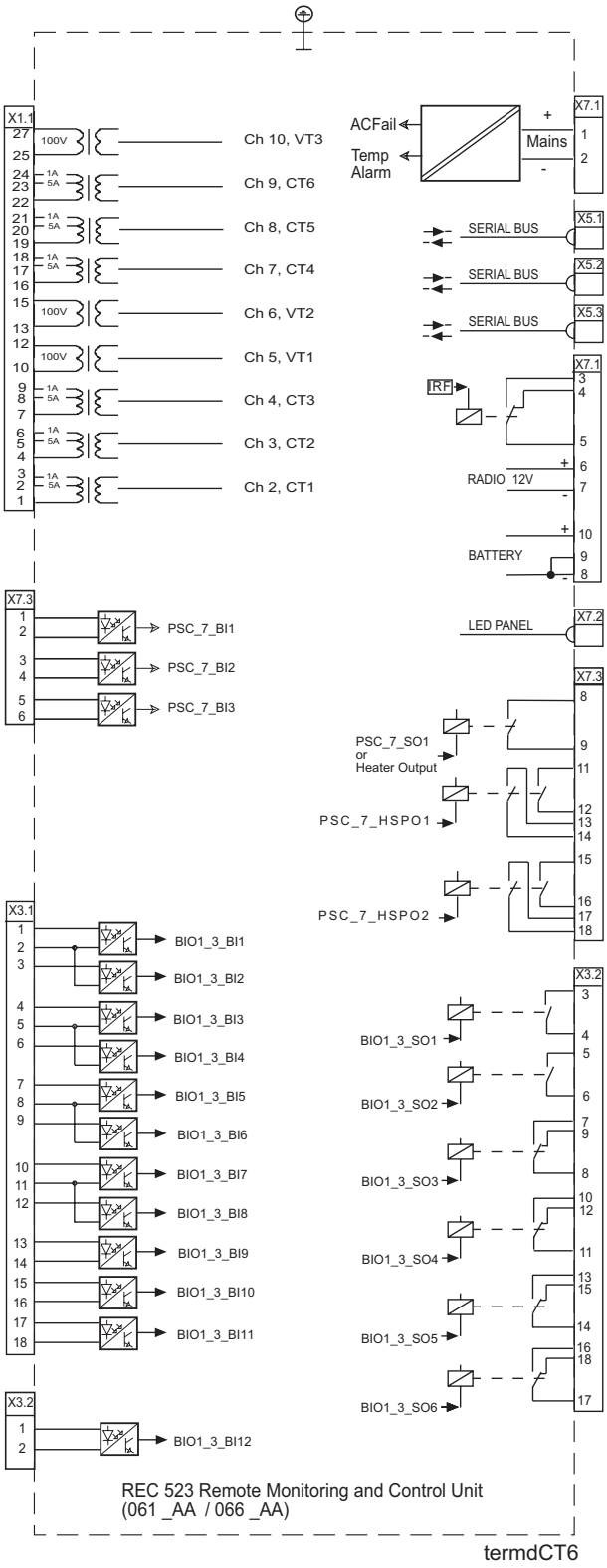
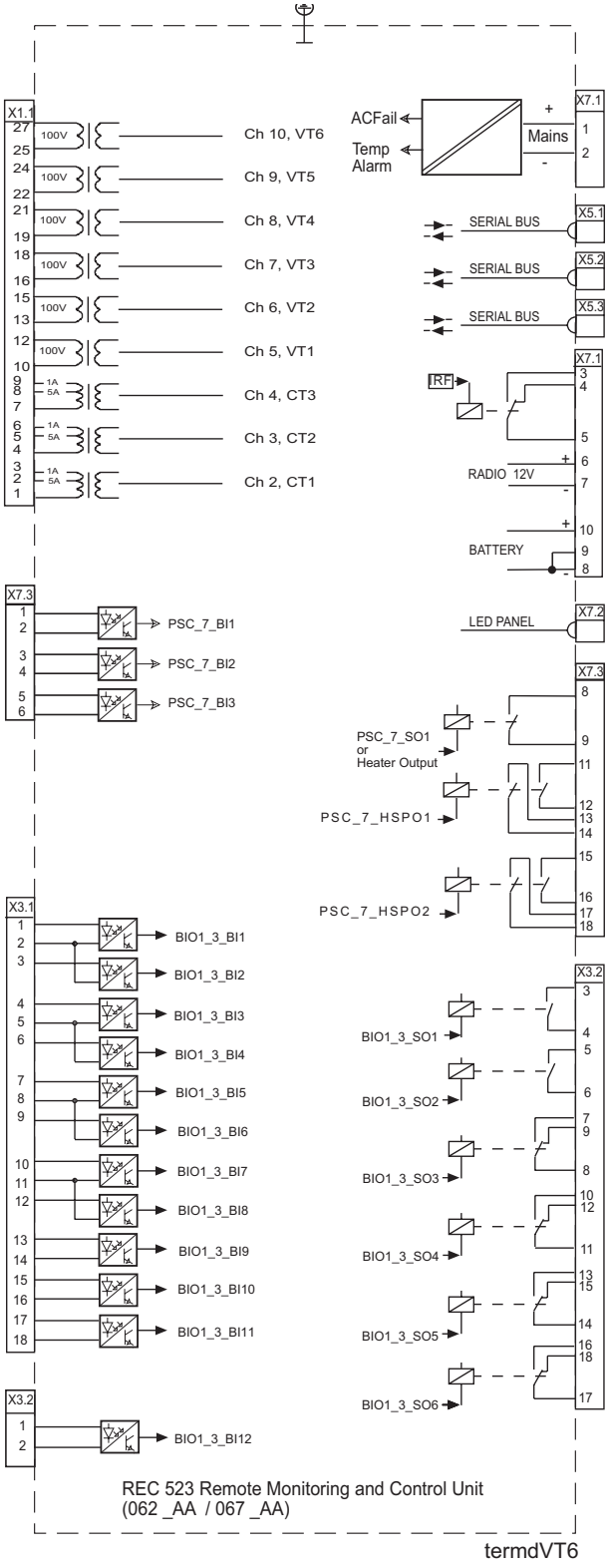
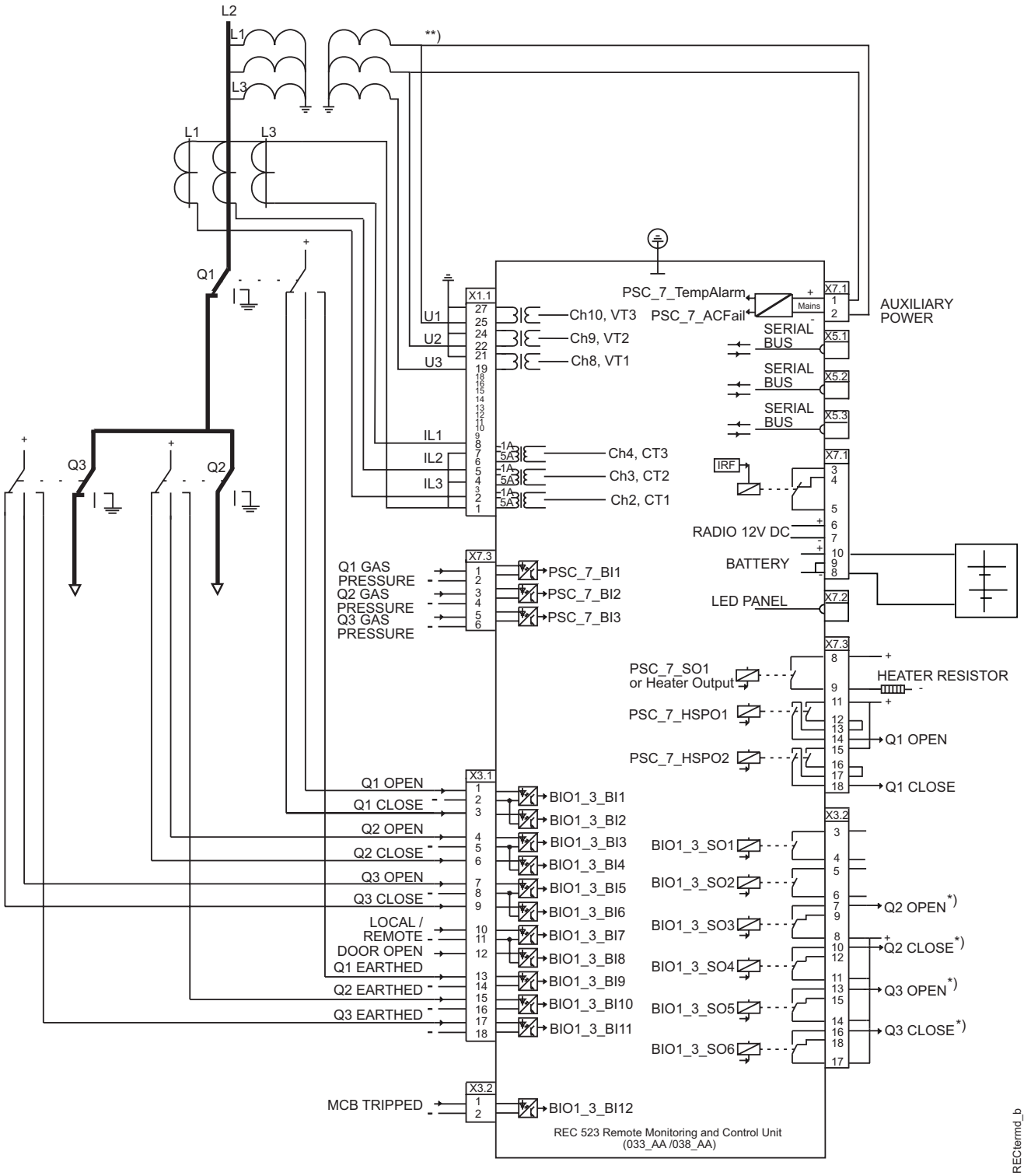
7.3.7. REC 523 with six current and three voltage transformers



7.3.8. REC 523 with three current and six voltage transformers



7.3.9. Application example



*) Auxiliary relays required

**)The secondary phase-to-ground voltage should not exeed the specified maximum auxliary pover supply voltage for the REC unit during opposite phase ground faults in the primary network.

8. Service

When the REC 523 device is used under the conditions specified in Section 7.1.Technical data, it is practically maintenance-free. The REC 523 electronics include no parts or components subject to abnormal physical or electrical wear under normal operating conditions.

To achieve the best possible operation accuracy, all parts of the REC 523 product have been calibrated together.

If the device fails in operation or if the operating values considerably differ from those mentioned in the device specifications, the device should be overhauled. All repairs are to be taken by the manufacturer. Contact the manufacturer or its nearest representative for further information about checking, overhaul and recalibration of the device.

The REC 523 device that is to be sent to the manufacturer has to be carefully packed to prevent further damage to the device.

In the event of malfunction, consult your device supplier.

9. Ordering information

9.1. Order number

The following data should be specified in the order:

- Order number (see Fig. 9.1.-1 below)
- Software number of protocol options (refer to Section 9.2. Software configuration and software number)
- Software number of function options (refer to Section 9.2. Software configuration and software number)
- Quantity of REC 523 units

Each REC 523 unit has a specific order number that identifies the unit type as well as the hardware and the software revision as described in Fig. 9.1.-1.

Item	Identifies	Options
1	Control unit type	-
2	Software revision	-
3	Hardware number	-
4	Auxiliary voltage range of a power supply module	A: U_r = 110/120/220/240 V AC; 110/125/220 V DC (PSC1) C: U_r =24/48/60 V DC (PSC2)
5	Digital input voltage range	A: U_r =24/48/60/110/220 V DC
6	Analogue interface type	A: Only matching transformers included (MIM) B: Matching transformers and sensor inputs included C: Only sensor inputs included (SIM)

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Fig. 9.1.-1 Order number of REC 523

The REC 523 units differ from each other as to the number and type of measuring inputs.

All the REC 523 hardware versions include the same number of digital inputs and outputs, whereas the number of matching transformers and sensor inputs as well as the auxiliary voltage range vary between the different hardware versions.

9.2. Software configuration and software number

Each REC 523 allows different software configurations based on separate functions that can be activated from comprehensive libraries (refer to Section 5.1. REC 523 functions) within the scope of the processing capacity as well as the I/O connections and analogue channels available, and considering the total CPU load of the selected functions.

There are two separate software numbers to be specified in the order, one for the protocol options as described in Table 9.2.-1 and the other for the function options as described in Table 9.2.-2.

Table 9.2.-1 Protocol options

Software No	Protocol options included
1MRS110006-001	SPA, LON and IEC 60870-5-101
1MRS110011-001	SPA, LON and DNP 3.0
1MRS110012-001	SPA, LON and Modbus (both the RTU and ASCII modes)

Table 9.2.-2 Function options

Software No	Function options for REC 523
1MRS100512	Current waveform distortion measurement
1MRS100513	Voltage waveform distortion measurement
1MRS100143	Power factor controller

9.3. Optional peripherals

Table 9.3.-1 Peripheral devices

Parametrization cable	1MRS 120520
Cable between REC 523 and a commercial modem	1MRS 120528
Cable between MicroSCADA and REC 523	1MRS 120523
Bus connection module RER 103	1MRS 090701-XX[a]
Semi-flush mounting kit	1MRS 050239
Rack mounting kit	1MRS 050242

a. XX receiver / transmitter; B = plastic fibre cable; M = Glass fibre cable

10. Parts and assembly description

Table 10.-1 Parts of REC 523

Main CPU module, type CPU1	1MRS 050433
Combined power supply and I/O module, 110…240 V AC/DC: - type PSC1 (80...265 V AC/DC) - type PSC2 (18...80 V DC)	 1MRS 050084 1MRS 050273
I/O module, input voltage range 24…220 V DC - type BIO1	 1MRS 050640
Transformer module (MIM): - with 3 transformers, 3*CT - with 6 transformers, 3*CT, 3*VT - with 7 transformers, 4*CT, 3*VT (U_n = 230V) - with 9 transformers, 5*CT, 4*VT - with 9 transformers, 6*CT, 3*VT - with 9 transformers, 3*CT, 6*VT - with 9 transformers, 5*CT, 4*VT and 9 sensors	 1MRS 050461 1MRS 050462 1MRS 050466 1MRS 050469 1MRS 050471 1MRS 050463 1MRS 050470
Sensor module (SIM): -with 9 sensors	 1MRS 050428
Mother board	1MRS 050003
Counter-contacts for multi-pole connectors including accessories (included in standard REC 523 delivery) 1x10 pin + 3 x18 pin If SIM card installed 1 x 10 pin + 5 x 18 pin	 1MRS 050334 1MRS 050335
Short-circuit connectors	1MRS 120515

Table 10.-2 Mounting kits available for REC 523

Flush mounting[a]	1MRS 050209
Semi-flush mounting	1MRS 050239
Rack mounting	1MRS 050242

a. The standard delivery includes a flush mounting kit

11. Revision history of REC 523

11.1. Revision identification

The main releases of REC 523 are differentiated with the software revision letter in the order number of the device printed on the marking strip on the front panel of REC 523, for example as follows:

Order No: REC523F 033AAA

The revisions of REC 523 are presented in Table 11.1.-1.

Table 11.1.-1 REC 523 software revisions

Revision	Release
A	Q4/98
B	Q1/99[a]
C	Q2/99
D	Q4/00
E	Q1/04
F	Q1/05

a. Includes the same function blocks as Release Q4/98.

The revision letter determines the main release which may involve functional additions and changes to the product. The changes included in each revision compared to the previous one are described in more detail below.

11.2. Changes and additions to earlier released revisions

11.2.1. Release Q1/99

General

- Software revision B (release 1.5)

Protocols and communication

- New protocols:

  IEC 60870-5-101 (unbalanced mode)

  DNP 3.0

- ANSI X.3.28 HD not included

Hardware and mechanics

- Revision of the CPU card

11.2.2. Release Q2/99

General

- Software revision C
- Revision (E) of the disturbance recorder function block MEDREC16
- New features:
  - LED test

- Indication of the battery test status
- Recording of the minimum battery voltage
- Store LED

Table 11.2.2-1 New fault indication functions

Function	Description
DOC6High	Indication for directional overcurrent (high-set stage)
DEF2High	Indication for directional earth-fault (high-set stage)
Inrush3	Indication for the three-phase transformer inrush and motor start-up current
NEF1High	Indication for non-directional earth-fault (high-set stage)
NOC3High	Indication for three-phase non-directional overcurrent (high-set stage)
UV3Low	Indication for three-phase undervoltage (low-set stage)
UV3High	Indication for three-phase undervoltage (high-set stage)

Table 11.2.2-2 New measurement functions

Function	Description
MEAI1...8	General measurement 1...8
MECU3B	Three-phase current measurement
MEVO1B	Residual voltage measurement
MEVO3B	Three-phase voltage measurement

Table 11.2.2-3 New control functions

Function	Description
COCB1	Circuit breaker 1 control with indication
COCB2	Circuit breaker 2 control with indication

Table 11.2.2-4 New condition monitoring functions

Function	Description
CMSPRC	Spring charging control 1
CMTIME1	Operation time counter 1 operate time used (motors)
CMTIME2	Operation time counter 2 operate time used (motors)
CMTRAV1	Breaker travel time 1

Protocols and communication

Table 11.2.2-5 Use of serial communication ports changed as follows:

Port	Revisions A, B	Revision C
X5.1	For internal use	Remote communication protocol
X5.2	Remote communication protocol / parametrization with a parametrization cable	Parametrization with a parametrization cable
X5.3	LON/SPA	LON/SPA

Hardware and mechanics

- Two new transformer modules, each with nine transformers
- 8-channel sensor card replaced by a new card with nine channels
- Revision of the CPU card
- Revision of the PSC card

Configuration, setting and SA system tools

Table 11.2.2-6 Release Q2/99 tool versions

CAP 501 Relay Setting Tool	v. 1.0.0.-1 or later
CAP 505 Relay Configuration Tool	v. 1.1.0.-1 or later
LIB 500/510 Library for MicroSCADA and REC 523	v. 4.0.2.-2 or later
LNT 505 LON Network Tool	v. 1.0.1 d or later

11.2.3. Release Q4/00

General

- Software revision D (release 2.0)
- Improved storing, shorter storing time

Function blocks

- Under voltage protection and fault indication function blocks UV3Low and UV3High
  - Phase-selective start outputs added
  - Control setting parameter `Oper.hysteresis` added for adjusting the level of comparator (for more information refer to CD-ROM Technical Descriptions of Functions, see Section 1.8. Related documents)
- EVENT230 function block: input interface changed
- Changes to input names in the following function blocks: UV3Low, UV3High, MEVO3A, CMVO3
- MEPE7, the function block for power and energy measurement:
  - Events for energy (E), apparent power (S), and cos φ added
  - Time-based delta event sending added
- New protection and fault indication function
  - AR5Func, auto reclosure function
- New control function
  - COPFC, power factor controller

- New condition monitoring function
  - CMGAS3, three-pole gas pressure monitoring
- New power quality functions
  - PQCU3H, current waveform distortion measurement
  - PQVO3H, voltage waveform distortion measurement

Protocols and communication

- New protocol
  - Modbus (both the RTU and ASCII modes)
- New LON virtual I/O's, NV indexes 100...163, 32 SNVT_state and 32 SNVT_lev_disc
- Modification to Modem support
  - Size of modem initialization string `Modem init. str.` increased from 40 to 75
  - Support for four additional phone numbers and the possibility to define an emergency number
- Customer defined events (EVENT230 function block) supported by all three remote protocols (DNP, IEC 60870-5-101 and Modbus)
- Remote protocol support for LON virtual I/O's, thus enabling Remote protocol–LON gateway functionality

Tools

- Uploading/downloading of the Relay Configuration Tool project (RCT in CAP 505) from/to the REC 523 unit via SPA or LON
- Uploading/downloading of settings (CAP 501/ CAP 505) from/to the REC 523 unit via SPA or LON

Configuration, setting and SA system tools

The following tool versions are needed to support the new functions and features of REC 523 D:

Table 11.2.3-1 Release Q4/00 tool versions

CAP 505 Relay Product Engineering Tools	v. 2.1.0 or later
LIB 510 Library for MicroSCADA v. 8.4.3	v. 4.0.3 or later
LNT 505 LON Network Tool	v. 1.1.1-1 or later

11.2.4. Release Q1/04

General

- Software revision E (release 2.5)
- Improved functionality
- Plug-in modem support no longer available

Protocols and communication

- Improved performance
- IEC 60870-5-101: support for new IEC ASDU types
  - ASDU 46
  - ASDU 9
  - ASDU 10

Configuration, setting and SA system tools

The following tool versions are needed to support the new functions and features of REC 523 E:

Table 11.2.4-1 Release Q1/04 tool versions

Engineer^{IT} Relay Setting Tools CAP 501	v. 2.3.0 or later
Engineer^{IT} Relay Product Engineering Tools CAP 505	v. 2.3.0 or later
Inform^{IT} Substation Monitoring System SMS 510	v. 1.1.0-1 or later
Engineer^{IT} Medium Voltage Process Application Library LIB 510	v. 4.0.4-3 or later
LNT 505 LON Network Tool	v. 1.1.1-1 or later

11.2.5. Release Q1/05

General

- Software revision F (release 3.0)
- Improved functionality
- New calculated analogue channel added

Protocols and communication

- IEC60870-5-101 balanced mode supported

Hardware and mechanics

- New hardware variant 054/059 consisting of 5 current transformer (CT) inputs and 4 voltage transformer (VT) inputs

Function blocks

- Updated function block revisions

Tools

- Protocol Mapping Tool support for IEC 60870-5-101

Configuration, setting and SA system tools

Table 11.2.5-1 Release Q1/2005 tool versions

Relay Setting Tools CAP 501	v. 2.3.0-5 or later
Relay Product Engineering Tools CAP 505	v. 2.3.0-5 or later
Substation Monitoring System SMS 510	v. 1.2.0-2 or later
Medium Voltage Process Application Library LIB 510	v. 4.0.5-3 or later
LNT 505 LON Network Tool	v. 1.1.1-1 or later

11.2.6. Release Q4/08

Hardware and mechanics

- New hardware variant 071/072 consisting of 5 current transformers (CT) inputs, 4 voltage transformer (VT) inputs and 9 sensor inputs

Configuration, setting and SA system tools

Table 11.2.6-1 Release Q4/08 tool versions

Engineer^{IT} Relay Setting Tools CAP 501	v. 2.3.0 or later
Engineer^{IT} Relay Product Engineering Tools CAP 505	v. 2.4.0-3 or later
Inform^{IT} Substation Monitoring System SMS 510	v. 1.1.0-1 or later
Engineer^{IT} Medium Voltage Process Application Library LIB 510	v. 4.0.4-3 or later
LNT 505 LON Network Tool	v. 1.1.1-1 or later

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