



(SE970178)

Features

- Percentage restrained differential relay for phase-to-phase and phase-to-earth faults
- Extremely rapid measurement of differential currents at all types of phase and earth faults
- Microprocessors in logic- and time-circuits with self-supervision
- Measuring time 1-3 ms and trip impulse from REB 101 within 6-9 ms
- Full stability for through-going fault currents even when current transformers are totally saturated
- Sensitivity of differential relay
 - in the range of 1-4% of rated current for the largest line
- Compact version with summation auxiliary transformer
- Line current transformers can be of standard design with very small requirements of saturation voltage and with different ratios both for 1 and 5 A
- Other relays can be connected to same core of current transformer
- Applicable with long distance between relay and current transformers

Application

REB 101 differential relay with summation transformer

The differential relay REB 101 is a very fast relay of the percentage stabilized type for phase and earth fault detection and can be used for busbars at all voltage levels. Internal faults are measured before saturation of the current transformer. Stability for external faults is guaranteed also at instantaneous saturation of the current transformer

In gas insulated switchgears the current transformer cores in the bushings can preferably be used. The total gas insulated switchgear will then be included in the measuring zone of the bus protection.

Intermediate summation current transformers are used for adjustment of the CT-ratios and to reduce the secondary current from 5, 2 or 1 A down to 0,5 A or lower. They are also used to galvanically separate the primary from the measuring circuit of the relay.

The intermediate summation current transformers are normally mounted close to REB 101 but can in special cases be mounted close to the line current transformers in order to reduce the resistance in the secondary circuit. In this way a line to or from the busbar can have its current transformer on a relatively long distance e.g. in the bushing in a power transformer close to a generator.

Application (cont'd)

Busbar arrangements

The arrangements of power system buses vary widely depending on the magnitude of the through going load current, the number of line circuits and the need for splitting up the station in several zones subsequent to an internal bus fault.

The normal rating of a bus conductor is from 1000-3000 A and a typical number of lines to a certain bus zone is 6-12 L. For the largest installations 2, 4 and 6 relay zones may be installed.

Single bus one-zone

The most simple and reliable installation is the single bus one-zone arrangement (Fig. 1). In this case it can also be permitted that a bus section switch (S) is opened at certain times to split the bus in two parts. As long as there is no internal fault the REB 101 differential relay remains stable. This applies even when the two bus sections are working asynchronously, e.g. at different frequencies; however, when an internal fault occurs, both sections will always be tripped simultaneously. When the bus selection switch is open, the two sections must then be supplied radially, i.e. internal fault currents to one section must not pass through to the other section.

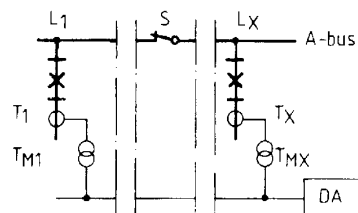


Fig. 1 Single-bus. one zone with bus section switch normally closed

Single bus two-zones with bus section switch

When the bus section switch (A12) in Fig. 2 is kept open during longer periods of time, it may be an advantage to include two differential relays. The two sections may then work independently and when a fault occurs only the affected section is tripped.

When the A12 switch is closed, all the input circuits will be connected to the DA1 relay and the DA2 relay is disconnected. The oper-

ating sensitivity is then determined only by the DA1 relay. If both relays should be kept in service at the same time the total relay operating current becomes twice as large.

The switching relay units are arranged to work in a special sequence so that the CT secondary circuits never become open-circuited.

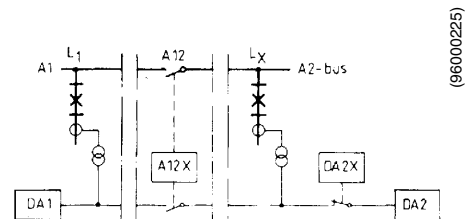


Fig. 2 Single-bus. one zone with bus section switch normally open

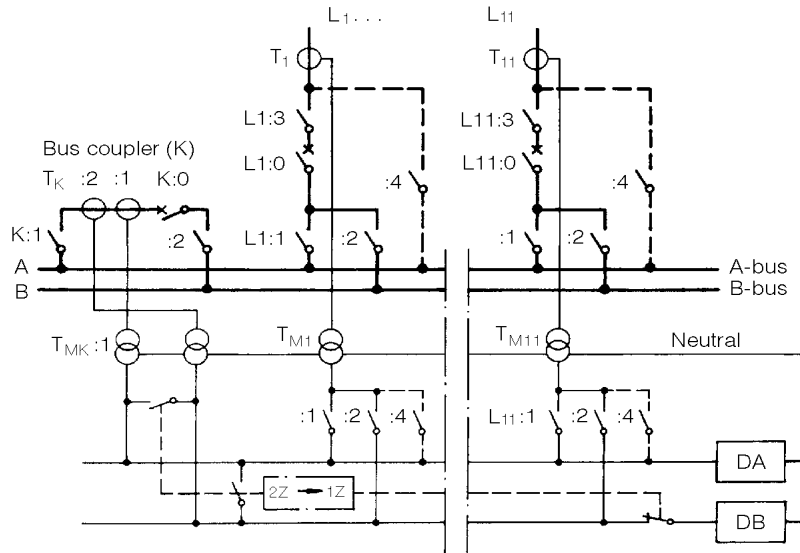
Double-bus with CT switching

One of the most common arrangements is the double-bus, with one bus coupler and one circuit-breaker per line (Fig. 3). When line L1, connected to the A-bus (L1:1 closed), is to be switched to the B-bus, the following sequence is used

- 1) The bus coupler circuit-breaker K:0 is closed.
- 2) The selector switch L1:2 is closed. Its corresponding auxiliary contact in the CT secondary is arranged to close earlier than the main (HV) contact.
- 3) Both selector switches (L1:1 and :2) are now closed and this situation activates a bus interconnection relay unit, which interconnects the CT circuits of the A- and B-zones and disconnects the DB-relay. The operating sensitivity then becomes controlled by only one relay, instead of two relays in parallel. Also, the two trip circuits are interconnected so that both buses are tripped for a fault on one bus.
- 4) The selector switch L1:1 is then opened and the bus interconnection unit brings the DB-relay back into service and separates both the CT and the trip circuit interconnection.

It should be noticed that during this switching operation the CT secondaries are never open-circuited so no dangerous voltages ever will occur; if a fault occurs, one or both buses will be tripped instantaneously. In the case of double-buses it is recommended that the main

bus coupler CT has two separate cores, one for each bus zone so as to avoid interference from one zone to the other. If only one core is available, its knee-point voltage should be higher than the knee-point voltage of the two auxiliary CT's put together.

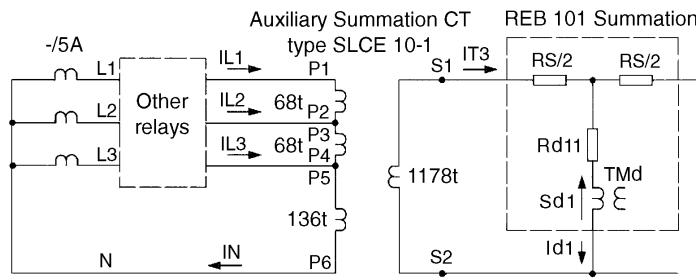


(96000226)

Fig. 3 Double-bus, two-zones with switching of CT secondary circuit. A bypass switch may be added.

The single-phase REB 101 bus differential relay including an auxiliary summation CT, which has a four-wire L1, L2, L3 - N input, and two-wire output, for every line. The protection thus obtained operates for all types of

internal phase and earth faults. The operating sensitivity, with the SR-starting relay set at 0,1 A, varies in the range 9-36% of the largest line CT rating.



(96000243)

Fig. 4 For each line, one auxiliary summation CT is used

Design

REB 101 summation type differential relay

The REB 101 differential relay measuring circuit is provided in modern microprocessor technology, enhancing the functionality and including self-supervision for high availability.

SR

The start relay is used as current detector and is normally set at 0,1 A. It can also be set at a lower value when maximum sensitivity is required. When setting the thumb-wheel to 0, the pick-up will be approximately the same as the differential relay.

DR

The differential relay is selective and operates only for internal faults. The sensitivity is around 1-4% of the largest current transformer.

The measuring elements of SR and DR operates within 1-3 ms and tripping of the busbar is not initiated until both elements have operated.

The stability (S) i.e. the relation between the differential current $ID1$ and the incoming current $IT3$ is applicable for external faults and is around 50%. At internal faults the relay has another characteristic with a larger operating area.

AR

The alarm relay operates for the differential current caused by an open CT-circuit and has a settable operating value. Five seconds after

operation of the AR-relay, the tripping circuit is opened and the differential circuit is short-circuited. This function is reset manually.

The total incoming current $IT3$ enters the relay at terminal K, and the total outgoing current leaves at terminal L. During normal service these currents are basically equal, and the different current is zero, or in practice less than 0,5 mA.

A restraint voltage US is obtained across the full stabilizing resistor RS , i.e. between the terminals K and L, and this voltage drives a current $IR2$ through the diode $D2$ and the resistor $RD3$, towards the output terminal L. The differential DR element is then securely restrained (blocked) and cannot operate.

When a differential (spill) current $ID1$ is produced, this passes a variable resistor $RD11$, the primary winding of an auxiliary CT (TMD) and the starting relay SR, which is used for selecting a suitable level of primary operating current. On the secondary side of TMD, the differential current is passed through a full wave rectifier and the resistor $RD3$ across which is developed an operating voltage $UD3$.

A comparison may then be made, between the operating and restraint voltages, $UD3$ and US . The output from this comparator circuit is fed to the high speed polarized differential relay element (DR). When the operating voltage is larger than the restraint voltage, the output current $IR1$ is regarded as positive and causes operation of the DR element.

Design (cont'd)

RLDA 101 measuring unit

All settings and indications are positioned in RLDA 101. Settings are made with thumb-wheels and indications given by LEDs.

Indication is given with yellow LEDs for:

- Start relay
- Differential relay
- Open CT Alarm

Indication for tripping is given with red LED.

Indication for blocked relay is given with yellow LED.

The settings of start and alarm relays are easily accessible in the front. The start relay can be set between: 0-1,5 A and the alarm relay between 2 and 30 V.

REB 101 is equipped with self-supervision for:

- low dc/dc-supply
- microprocessor fault

Faults detected by the self-supervision, blocks the relay and gives indication in the front.

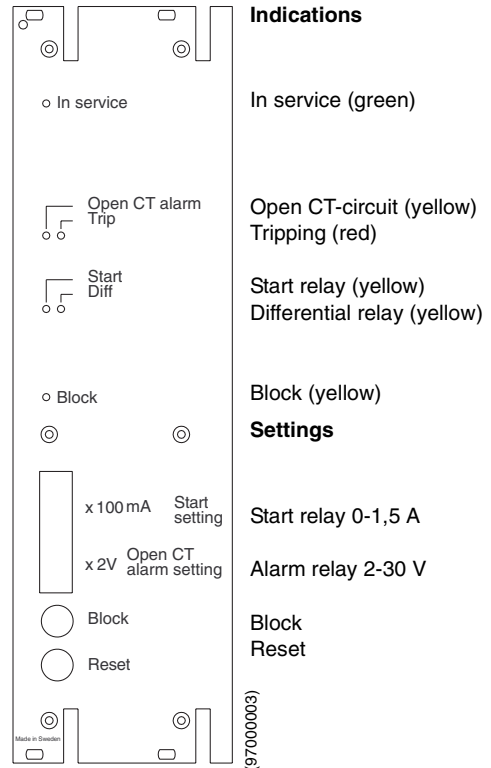
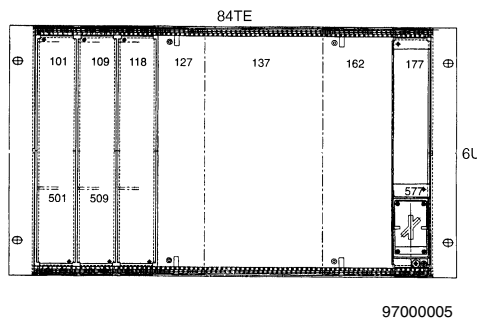


Fig. 6 RLDA 101 Measuring unit

REB 101 differential relay with summation auxiliary transformer



REB 101

Basic unit max. 36 lines RK 638 002-AA

| | | |
|-----|-----------|-----------------|
| 101 | RXTP 18 | Test unit |
| 109 | RXTP 18 | Test unit |
| 118 | RXTP 18 | Test unit |
| 127 | RLOE 100 | Diode unit |
| 137 | RLHE 100 | Comparator unit |
| 162 | RLDA 101 | Measuring unit |
| 177 | RXTUG 21H | Dc/dc converter |
| 501 | RXMD | Block relay |
| 509 | RXME | Trip relay |
| 577 | 577 | Switch |

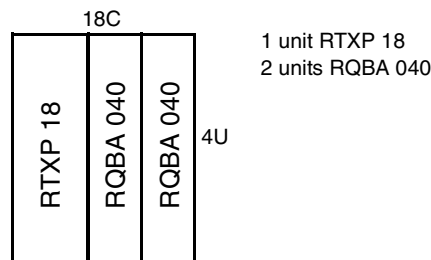
Extension units

The basic unit of REB 101 can be connected with up to 36 bays. If more bays are needed to be connected to the relay additional extension units must be added.

Extension unit for 12 bays

(12 additional bays)

Ordering No. 1MRK 001 428-AA



Auxiliary (intermediate, summation) current transformer

Summation transformers are always required for all circuits entering the relay.

Standard ABB aux. CTs are of C-core type (SLCE). They are used to create a summary of main CT secondary phase currents and to adapt to a suitable secondary level, before feeding the measuring circuits. The SLCE can have up to 4 secondary ratings.

The current from any input to the relay shall normally be 0.5 A or less, continuously, and the ratio shall be chosen so that the total through-going current (IT3) does not exceed 2 A continuously.

The calculation of aux. CTs for REB101 is relatively simple. The initial step is normally to calculate the current from the largest primary CT to give 0.5 A to the relay. This total ratio received shall be valid for all the other input circuits to the relay. All aux. CT ratios must be as exact as possible, thus without turn corrections, in order not to create unnecessary differential current, requiring alarms to be set on high levels.

For separate delivery

| | Rated primary current | Rated secondary current |
|-----------|------------------------------|--------------------------------|
| SLCE 10-1 | 1, 2 or 5 A | 0.025 to 0.250 |
| SLCE 10 | 1, 2 or 5 A | 0.025 to 0.500 |

The transformers can be delivered with up to 3 taps.

The delivered secondary values will depend on the last full secondary turn.

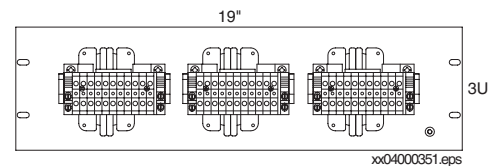


Fig. 7 Example of SLCE 10-1 mounted on a plate. (Only available as loose delivery of transformer and plate separately.)

Design (cont'd)

Protective panels with REB 101

Busbar protection of type REB 101 can also be supplied ready wired and tested in panels. In order to make a correct design, the following information is required as a base for a quotation for panel supply:

- Bus configuration
- One line diagram with protective zone requirements
- Voltage level
- Short-circuit current
- Continuous current through the station
- Number of lines plus bus couplers
- Current Transformer ratios and knee-point voltages
- Breaker failure protection included or not

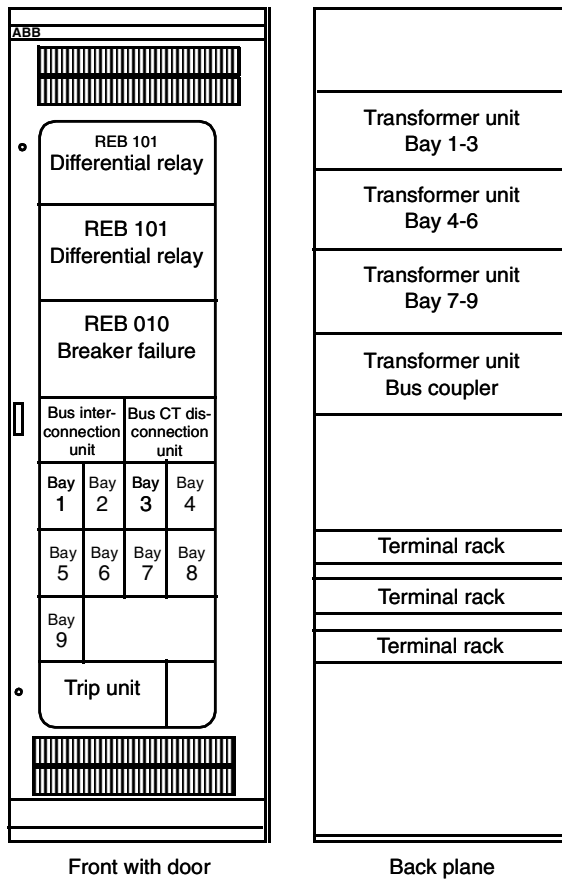
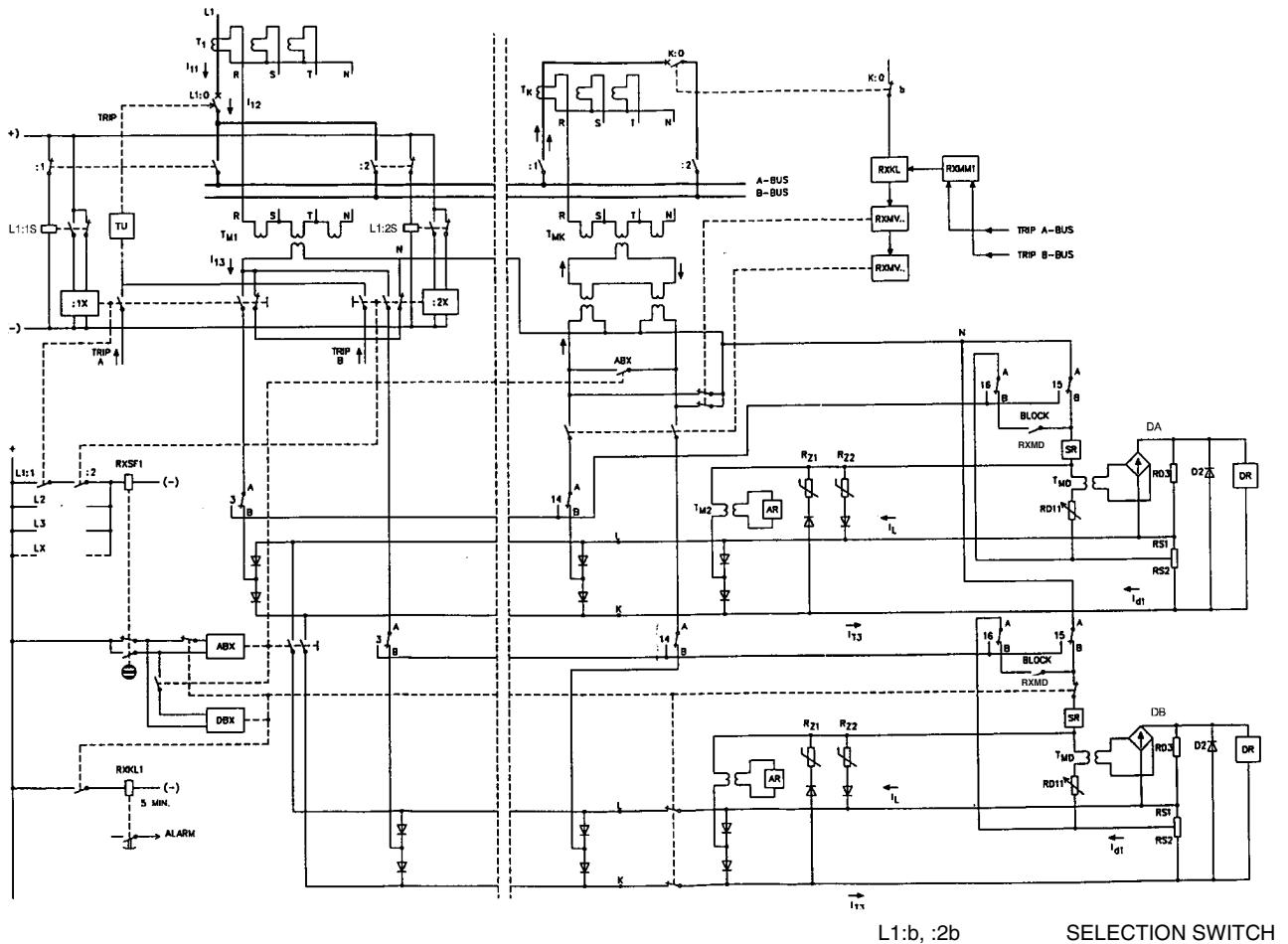


Fig. 8 Example of a REB 101 busbar protection terminal for double-bus with 9 lines and bus coupler with CT switching, including also REB 010 breaker failure relays.



- AUXILIARY CONTACT
- TM1, TMK AUXILIARY CT
- TU TRIP UNIT = RXMS 1
- L1: 1S, :2S SELF RESET MIRROR RELAY
- L1: 1X, :2X LATCHING RELAY
- RTXP 18 TEST SWITCH
- DR, SR, AR ELEMENTS FOR DIFF. START AND CT-OPEN CIRCUIT ALARM

| | | |
|-----------|--|--------|
| MAIN H.V. | OPEN | CLOSED |
| L1:1b | CLOSED | OPEN |
| | 0% K L 100% | |

Fig. 9 Bus differential relay for 11-lines, single bus coupler, two zones

The line CT's (T1) may be switched to the DA or DB differential relays. In most stations a mirror relay (L1:1S) is available and arranged to be energized when the (L1:1b) selector switch is open. The auxiliary contact (L1:1b) must open and close as shown in Fig. 9.

When both selector switches (L1:1 and :2) are closed simultaneously it is advantageous to interconnect the DA- and DB-line diodes and

disconnect the DB-measuring circuit. If the dc-supply to a mirror relay should be inadvertently interrupted, the two relay zones may be switched to one overall zone. This situation can be supervised by a time lag relay RXXL 1, sounding an alarm after five minutes. Switching a line from one bus to the other normally takes less than five minutes and no alarm will then be obtained.

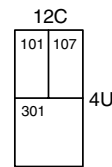
Design (cont'd)

The bus-coupler (BC) CT-disconnection scheme serves the following purpose:

- 1) When the BC breaker K:0 is open a fault which occurs between the CT's and the breaker will be disconnected instantaneously by the correct bus differential relay.
- 2) If this fault occurs when K:0 is closed the wrong bus will be tripped instantaneously and the faulty bus, approx. 150 ms later.
- 3) If the K:0 fails to open for a proper bus fault the adjacent bus will be tripped, approx. 150 ms later.

Relay units for protective systems

Switching line CT's to DA, DB
Ordering No. 1MRK 002 650-AA

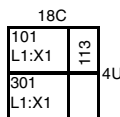


xx04000353.vsd

- 101: RXMB 1 aux. relay
- 107: RXMD 1 latching relay
- 301: RXMD 2 latching relay

Alternative:

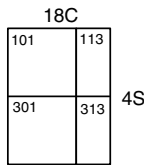
Ordering No. 5651 131-EA



- 101, 301: RXMVB 2 latching relay
- 113: RXMM aux. relay

Bus coupler CT disconnection

Ordering No. 1MRK 002 650-BA

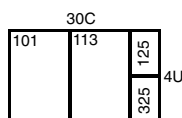


xx04000354.vsd

- 101, 301: RXMD 2 latching relay
- 113: RXMB 1 aux. relay
- 313: RXKL 1 time-lag relay

Alternative:

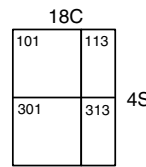
Ordering No. 5651 131-RA



- 101, 113: RXMVB 4 latching relay
- 125: RXKL 1 time-lag relay
- 325: RXMM aux. relay

Bus interconnection (two-zone to one zone)

Ordering No. 1MRK 002 650-CA

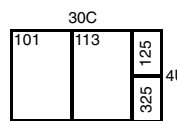


xx04000354.vsd

- 101, 301: RXMD 2 latching relay
- 113: RXMB 1 aux. relay
- 313: RXKL 1 time-lag relay

Alternative:

Ordering No. 5651 131-SA



- 101, 113: RXMVB 4 latching relay
- 125: RXSF 1 aux. flag relay
- 325: RXKL 1 delayed alarm relay

Trip relay units for high speed tripping

Trip relay

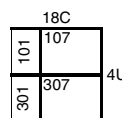
Ordering: See document 1MRK 508 015-BEN



- 101: RXMS 1 with 6 make contacts

Rapid operation, strong contacts

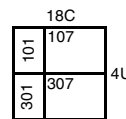
Ordering No. 5651 260-A



- 101, 301: RXMS 1 with 6 make contacts
- 107, 307: RXMH 2 with 8 make contacts

Rapid operation, strong contacts and latching relays

Ordering No. 5651 261-A



- 101, 301: RXMS 1 with 6 NO contacts
- 107, 307: RXMVB 2 latching relay with 8 make contacts

Technical data

Table 1: REB 101

| | |
|--|--|
| Rated frequency | 50-60 Hz |
| Rated current | 0,5 A per input |
| Maximal through-going current | 2 A |
| Operating differential current (ID1min) | 5 mA |
| Aux voltage | 48, 110, 125 or 250 V |
| Permitted ambient temperature | -5°C to +55°C |
| Operating time (S _R +d _R) | 1-3 ms |
| Trip impulse from diff. relay | 6-9 ms |
| Insulation tests: | |
| Dielectric tests | IEC 255-5 and ANSI C37.90 (2,5 kV and 2 kV) |
| Impulse voltage | IEC 255-5 (5 kV) |
| Disturbance tests: | |
| Power frequency test: | SS 436 15 03, section 3,3 |
| Transient test | SS 436 15 03, section 3,4 and |
| 1 MHz test | IEC 255-22-4 |
| ESD test | IEC 255-22-2 |
| Aux. voltage interruption | IEC 255-11 |
| Settings and estimated operating values (see Design) | |
| Stability factor S | $S = \frac{RS}{\left(n_d \cdot RD3 + \frac{RS}{2}\right)} = 0,5$ |
| RD3 | 2,2 ohm |
| RS/2 | 8 ohm |
| RD11 | 3, 6, 9 kohm |
| RDT | RD11 + 400 ohm |
| RLX | $RLX = \frac{S}{1-S} \cdot RDT \approx RDT$ |
| U _{T3} (DR) | 25-50 V |
| I _{d1} (SR) | 0,1-1,5 A |

Note:

When technical assistance is required to choose the most suitable design, please send us a simple one line diagram with the following information:

- 1 Rated current for the busbar
- 2 Number of lines
- 3 Current transformer ratios for all lines
- 4 Rated current for all lines
- 5 Required primary operate current

Ordering

Specify:

- Ordering No. RK 638 002-AA
- Quantity
- Number of lines (12/24/36)
- Auxiliary dc voltage
- Desired wording on the lower half of the test switch face plate max. 10 lines with 10 characters per line.

| Accessories | Ordering number | Quantity |
|--|------------------------|----------------------|
| REB 101 extension unit | 1MRK 001 428-AA | <input type="text"/> |
| State: 12 extra lines | | <input type="text"/> |
| 24 extra lines | | <input type="text"/> |
| 36 extra lines | | <input type="text"/> |
| Loose SLCE 10-1 line unit summation transformer 1 pc | 1MRK 000 646-AA | <input type="text"/> |
| State current ratio | | |
| Loose SLCE 10 line unit summation transformer 1 pc | 1MRK 000 646-CA | <input type="text"/> |
| State current ratio | | |
| Mounting plate for 3 transformers (pre-drilled) | | |
| for SLCE 10-1 3 U 19" | 2172 0615-44 | <input type="text"/> |
| for SLCE 10 4 U 19" | 2172 0615-45 | <input type="text"/> |
| Switching line CT relay unit | | |
| with RXMB 1, RXMD 1 and RXMD 2 | 1MRK 002 650-AA | <input type="text"/> |
| alternative | | |
| with RXMM 1 and RXMVB 2 | 5651 131-EA | <input type="text"/> |
| State auxiliary dc voltage in both cases | | |
| Bus coupler CT disconnection relay unit | | |
| with RXMD 2, RXMB 1 and RXKL 1 | 1MRK 002 650-BA | <input type="text"/> |
| alternative | | |
| with RXMVB 4, RXMM 1 and RXKL 1 | 5651 131-RA | <input type="text"/> |
| State auxiliary dc voltage in both cases | | |
| Bus interconnection unit | | |
| with RXMD 2, RXMB1 and RXKL 1 | 1MRK 002 650-CA | <input type="text"/> |
| alternative | | |
| with RXMVB 4, RXSF 1 and RXKL 1 | 5651 131-SA | <input type="text"/> |
| State delayed alarm relay or not | | |
| State auxiliary dc voltage in both cases | | |
| Trip relay unit with 2 RXMS 1 and 2 RXMH 2 | 5651 260-A | <input type="text"/> |
| State auxiliary voltage | | |
| State trip circuit (0/6/12) *see below | | |
| Trip relay unit with 2 RXMS 1 and 2 RXMVB 2 | 5651 261-A | <input type="text"/> |
| State auxiliary dc voltage | | |
| State trip circuits (0/6/12) *see below | | |

* 0 = No relays, only wired, 6 = One relay of each type, 12 = Two relays of each type

For our reference and statistics we would be pleased if we are provided with the following application data:

Country:

End user:

Station name:

Voltage level:

kV

References

| | |
|---|-------------------|
| COMBIFLEX Relay accessories and components | 1MRK 513 004-BEN |
| COMBITEST Test system | 1MRK 512 001-BEN |
| REB 101 User's Guide | On request |
| RXMS 1, RXMH 2 | 1 MRK 508 015-BEN |
| RXMVB 2 | 1 MRK 508 016-BEN |

Manufacturer

ABB Power Technologies AB
Substation Automation Products
SE-721 59 Västerås
Sweden
Tel: +46 (0) 21 34 20 00
Fax: +46 (0) 21 14 69 18
www.abb.com/substationautomation

