Reverse power relay and protection assemblies

RXPPK 2H and RAPPK

1MRK 509 042-BEN
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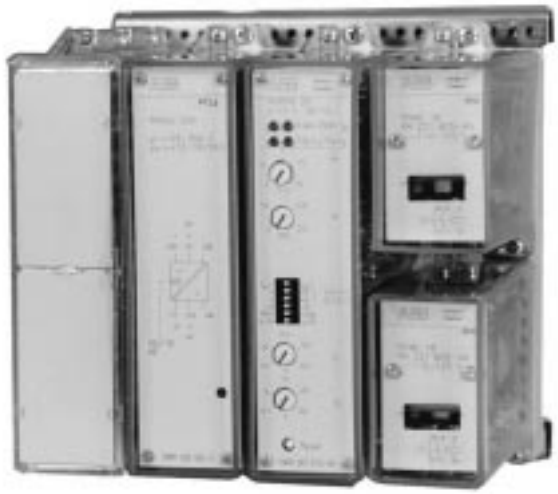
(SE980053)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Features

- Micro-processor based time directional-current relay/protection with continuous settings for operate values and time delays.
- RXPPK 2H is used to detect reverse power or low forward power to prevent damage of the prime mover.
- Setting range I_α = 0,3 - 15 % of rated current.
- Two variants, with wide setting ranges.
  - Scale constant
  I_s = 0,1, 0,4, 0,7, 1,0 A or
  I_s = 0,5, 2,0, 3,5, 5,0 A
- Two different definite time delay stages.
  - Trip t_1 = 0 - 4 s or Trip t_2 = 0 - 30 s
- Trip t_2 function is supported with a stand by time-hold function, with the settings 0 or 5 s. When a Start I_s has occurred, the t_2 timer will not reset until the hold time has expired, regardless if the Start I_s has been reset.
- Block functions:
  - Undervoltage block: blocking all the functions if the voltage is less than 40 V
  - Undercurrent block: blocking all the functions if the current is less than 0,25 % of the rated current

Application

The purpose of the reverse power relay is basically to prevent damage of the prime mover (turbine or motor) upon a reverse power condition. If the driving torque becomes less than the total losses in the generator and the prime mover, the generator starts to work as a synchronous compensator, taking necessary active power from the network.

In case of steam turbines, a reduction of the steam flow reduces the cooling effect of the turbines blades and overheating may occur. Hydro turbines of the Kaplan type and bulb type may also be damaged due to the fact that the turbine blade surf on the water and set up an axial pressure on the bearing. Diesel engines may be damaged due to insufficient lubrication.

Application (cont'd)

The total losses at rated speed, as a percentage of the rated power of the generator, are approximately:

Type	Total loss
Steam turbine	1 - 3%
Hydraulic turbine	1 - 3%
Gas turbine	5%
Diesel engine	25%

These table values apply to the case when the power input to the prime mover is completely cut off. Thus, in the case when the total power losses of a unit are covered partly by the prime mover and partly by electrical power from the system, the actual power drawn by a generator, during certain motoring conditions, may be much less than the above percentage values.

The generator currents remains balanced when the machine is working as a motor, hence, a single-pole relay is fully sufficient if the sensitivity is high. For large turbo units, an additional relay may be connected to a different phase in order to obtain redundancy.

When the generator is working as a motor, the small active current to the machine may be combined with a substantial reactive current delivered by the machine. Hence, the angular error of voltage and current transformers feeding low set reverse power relays should be small.

For large turbo-generators, where the reverse power may be substantially less than one percent, reverse power protection is obtained by a minimum power relay, which normally is set to trip the machine when the active power output is less than one percent of rated value, low forward power principle (see Fig. 2)

The time step t_1 is mainly arranged to trip the field and the generator breaker with a short time delay, typically 2 - 3 seconds after operation of the reverse power measuring function.

The reverse power function with time step t_1 can be used in the normal decommissioning routine to avoid excessive overspeeding when taking steam powered generators off service. The function can also be used to interlock the generator breaker tripping for non-urgent faults.

The purpose of the second stage is to prevent excessively high temperature and possible mechanical damage to the prime mover. The time delay can be longer in this case, typically 10 - 15 seconds. A reset delay, of 5 seconds can be activated to ensure operation, even if power swing makes the current function pick up and reset during the measuring period.

A rather common arrangement in older power plants is the use of V-connected voltage transformers. The VT's then have no neutral point available. Polarizing voltage to a RXPPK 2H relay, measuring the current in L1, can be arranged with two 2200 Ω, 2 W resistors shown in Fig. 1. E.g. two RTXE can be used, each with 2200 Ω, ordering number RK 741 225-DG.

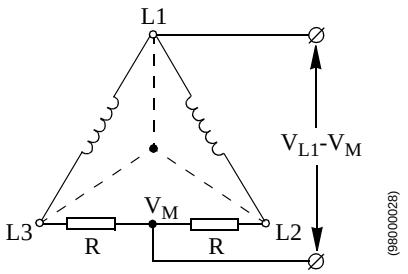


Fig. 1 Voltage V_{L1} - V_M is obtained using resistors for polarizing RXPPK 2H when measuring current in L1. The figure shows V-connected voltage transformers connected between L1 and L2 and L3 and L1 respectively.

The difference in resistance value between the two resistors should be kept as low as 10 ohms in order not to introduce appreciable angular errors if the operate value of RXPPK 2H is set to 1% of rated generator current or lower.

Design

The reverse power relay protection assemblies with RXPPK 2H can be delivered with different output circuits.

The RXPPK 2H relay requires a separate dc-dc converter for auxiliary supply (±24 V). One RXTUG converter can supply up to nine relays.

Note: Before the RXPPK 2H relay or the dc-dc converter RXTUG is plugged into or withdrawn from a terminal base, the auxiliary voltage supply must be interrupted. It is not allowed to disconnect the wiring on the plus or minus supply with the unit in service, since this may result in an unwanted relay operation.

RXPPK 2H measuring relay
RXPPK 2H is a microprocessor based relay with one measuring stage and two different definite time delay stages. The relay has two input transformers for current and voltages, filter circuits, HMI, LEDs for start, trip indications and three output units which provide separate change-over contacts for start and trip functions. The relay has also two binary inputs, one for reset of LED's and the other to block or enable the trip t_1 function.

Operate values are set with the potentiometers and programming switches. Both time delay stages can independently be programmed for the different times.

The start function output is energized immediately after the measured value exceeds or falls below the set start level, depending on setting for reverse (over) power or low forward (under) power operation.

Technical data

Below data is for measuring relay RXPPK 2H. Technical data for the total assemblies please refer to the catalogues for other included relays

Table 1: Current input

Rated voltage U_r	120 V
Rated current I_r	1A or 5A
Scale constant I_s for 1A variant 5A variant	 0,1, 0,4, 0,7 and 1,0 A 0,5, 2, 3,5 and 5A
Effective voltage range	(0,4 - 2,5) x U_r
Effective current range	(0,003 - 1,70) x I_r
Voltage block level	U < 0,4 x U_r
The function is blocked and the start is reset when the current is:	0,3% of I_r
Rated frequency f_r Operating frequency range	50 Hz or 60 Hz 45 - 66 Hz
Power consumption for: U = U_r = 100 V 1A variant I = I_r 5A variant I = I_r	 0,2 VA 100 mVA 150 mVA
Overload capacity voltage circuit: continuously during 10 s Overload capacity current circuit: 1A variant continuously during 1 s 5A variant continuously during 1 s	 250 V 300 V 4 A 100 A 20 A 350 A

Technical data (cont'd)

Table 2: Power functions

Function	**Power functions I_α> / I_α<**
Function characteristic selectable in the front between: I_α>: Reverse power function I_α<: Low forward power function	 I x cos(φ-β-α) ≥ set I_α> see Fig. 2 (α = 180°) I x cos(φ-β–α) ≤ set I_α<(α = 0°)
Setting range I_α	0,3 - 15% of I_r
Setting range β (adjustment for correction of system angle inaccuracy)	±3°
Consistency of set operate value	<5% for current <0,02 x I_r <2% for current >0,02 x I_r
Phase angle φ consistency	<0,5°
Angle φ between U and I	Positive if I lags U
Typical operate time I = 0 => 2 x set operate value	100 ms
Typical reset time I = 2 => 0 x set operate value	100 ms
Typical reset ratio	80%
Frequency dependence within frequency ±5% of rated frequency ±10% of rated frequency	 <0,8° <1,5°
Temperature dependence within range -5°C to +55°C	<0,5°
Binary input 1, selectable in the front between: Block Enable	 Active signal blocking Trip t_1 function Active signal enables Trip t_1 function

Table 3: Time functions

Time function	**Trip t_1**	**Trip t_2**
Time delay	Definite time	
Setting range	0 - 4 s	0 - 30 s
Accuracy	1% and ±20 ms	
Reset delay, t_h (for function at power swing)	-	0 - 5 s

Table 4: Auxiliary DC voltage supply

Auxiliary voltage EL for RXTUG 22H Auxiliary voltage for the relay	24 - 250 V DC, ±20% ±24 V (from RXTUG 22H)
Power consumption at RXTUG 22H input 24-250 V before operation after operation without RXTUG 22H ±24 V before operation after operation	 max. 5,5 W max. 6,5 W max. 3,0 W max. 4,0 W

Table 5: Binary input

Binary input voltage RL	48-60 V and 110-220 V DC, -20% to +10%
Power consumption 48-60 V 110-220 V	 Max. 0,3 W / input Max. 1,5 W / input

Table 6: Output relays

Contacts	3 change-over
Maximum system voltage	250 V AC / DC
Current carrying capacity continuous during 1 s	 5 A 15 A
Making capacity at inductive load with L/R >10 ms during 200 ms during 1 s	 30 A 10 A
Breaking capacity AC, max. 250 V, cos φ > 0,4 DC, with L/R < 40 ms 48 V 110 V 220 V 250 V	 8 A 1 A 0,4 A 0,2 A 0,15 A

Table 7: Electromagnetic compatibility (EMC), immunity tests

All tests are performed together with the DC/DC-converter, RXTUG 22H

Test	**Severity**	**Standard**
Surge	1 and 2 kV, normal service 2 and 4 kV, withstand test	IEC 61000-4-5, class 3 IEC 61000-4-5, class 4
AC injection	500 V, AC	SS 436 15 03, PL 4
Power frequency magnetic field	1000 A/m	IEC 61000-4-8
1 MHz burst	2,5 kV	IEC 60255-22-1, class 3
Spark	4-8 kV	SS 436 15 03, PL 4
Fast transient	4 kV	IEC 60255-22-4, class 4
Electrostatic discharge In normal service with cover on	 8 kV (contact) 15 kV (air) 8 kV, indirect application	 IEC 60255-22-2, class 4 IEC 60255-22-2, class 4 IEC 61000-4-2, class 4
Radiated electromagnetic field	10 V/m, 80-1000 MHz	IEC 61000-4-3, Level 3
Radiated pulse electromagnetic field test	10 V/m, 900 MHz	ENV 50204
Conducted electromagnetic	10 V, 0,15-80 MHz	IEC 61000-4-6, Level 3
Interruptions in auxiliary voltage 24 V DC, no resetting for interruptions 110 V DC, no resetting for interruptions 250 V DC, no resetting for interruptions	2 - 200 ms < 20 ms < 50 ms < 250 ms	IEC 60255-11

Technical data (cont'd)

Table 8: Electromagnetic compatibility (EMC), emission tests

Test	Severity	Standard
Conducted	0,15-30 MHz, class A	EN 50081- 2
Radiated	30-1000 MHz, class A	EN 50081- 2

Table 9: Insulation tests

Test	Severity	Standard
Dielectric Current circuit to circuit and current circuit to earth Circuit to circuit and circuit to earth Over open contact	 2,5 kV AC, 1 min 2,0 kV AC, 1 min 1,0 kV AC, 1 min	IEC 60255-5
Impulse voltage	5 kV, 1,2/50 µs, 0,5 J	IEC 60255-5
Insulation resistance	> 100 MΩ at 500 V DC	IEC 60255-5

Table 10: Mechanical tests

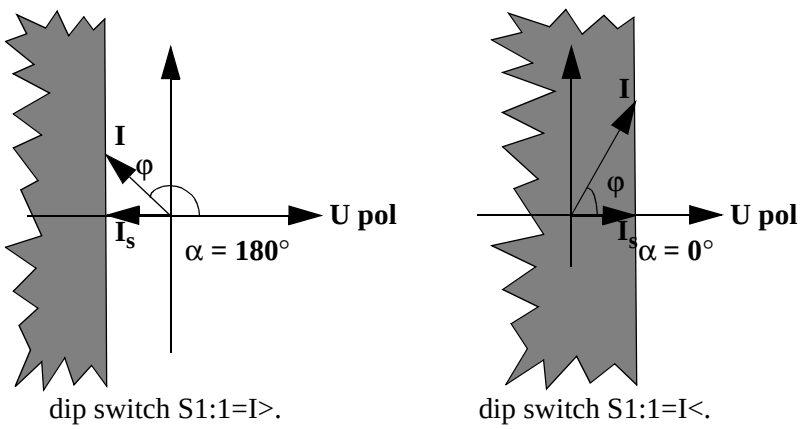
Test	Severity		Standard
Vibration	Response: Endurance:	2,0 g, 10-150-10 Hz 2,0 g, 10-150-10 Hz, 20 sweeps	IEC 60255-21-1, class 2
Shock	Response: Withstand:	5 g, 11 ms, 3 pulses 15 g, 11 ms, 3 pulses	IEC 60255-21-2, class 1
Bump	Withstand:	10 g, 16 ms, 1000 pulses	IEC 60255-21-2, class 1
Seismic	X axis: Y axis: Z axis:	3,0 g, 1-35-1 Hz 3,0 g, 1-35-1 Hz 2,0 g, 1-35-1 Hz	IEC 60255-21-3, class 2, extended (Method A)

Table 11: Temperature range

Storage	-20°C to +70°C
Permitted ambient temperature	-5°C to +55°C

Table 12: Weight and dimensions

Equipment	Weight	Height	Width
RXPPK 2H without RXTUG 22H	0,7 kg	4U	6C



dip switch S1:1=I>. dip switch S1:1=I<.

Fig. 2 Functional characteristics for the RXPPK 2H relay

Diagrams

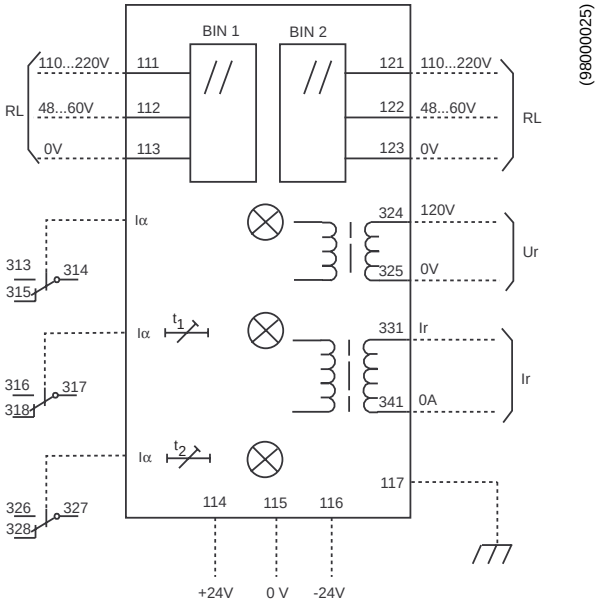


Fig. 3 Terminal diagram RXPPK 2H

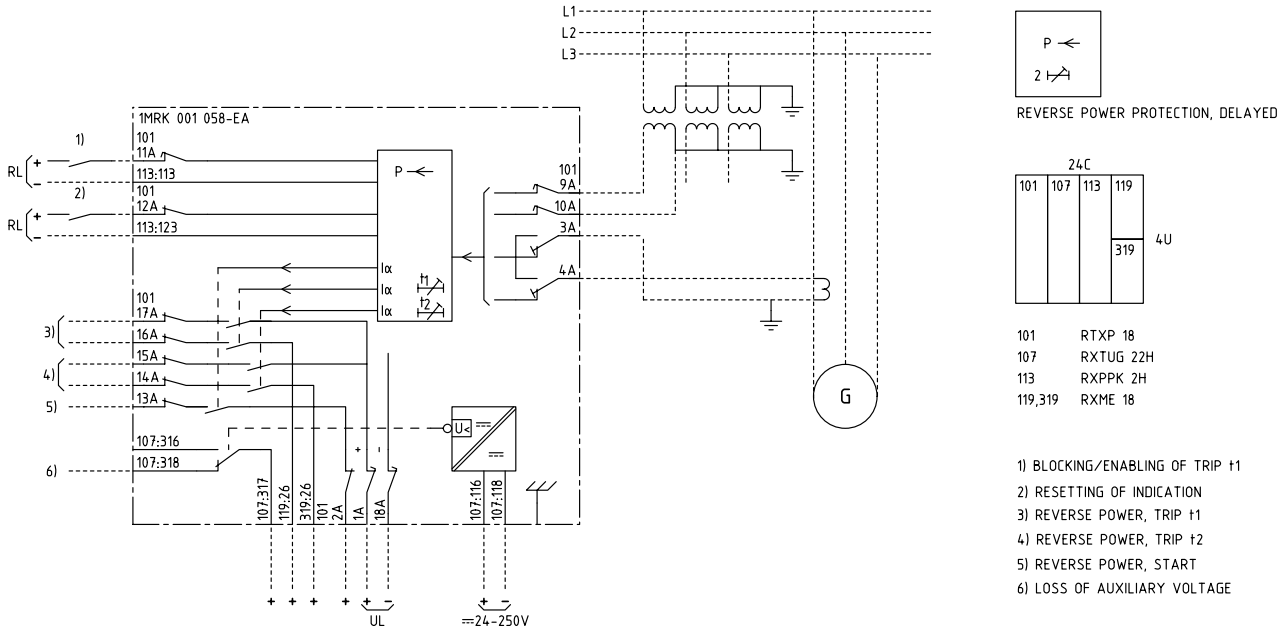


Fig. 4 Terminal diagram 1MRK 001 058-EAA

Protection assemblies

RAPPK protection assemblies are built up based upon reverse power relay RXPPK 2H. Test device RXTP 18 and dc/dc-converter RXTUG 22H can also be included for specific application requirements. Test device RTXP is a tool for relay testing.

DC/DC-converter RXTUG 22H can be used either separately for a single protection or to feed also other protections with up to 9 units of the same relay family. With RXTUG 22H all requirements concerning disturbance emission and immunity with this protection assembly will be met.

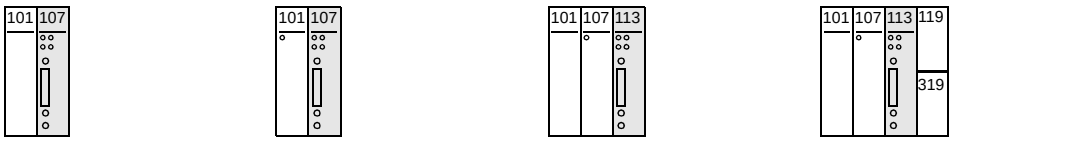
The assemblies have output contacts as specified for the relay RXPPK 2H, which in most cases are fully sufficient even for trip duty.

Protection assemblies are also available with heavy duty output relay RXME 18 (RK 221 825-XX) with indicating flag and can upon request be completed with an output logic of free choice. Output relays are connected to separate auxiliary voltage.

The extremely flexible mounting system COMBIFLEX together with a modern CAD-system enables us to present a unique flexibility for designing assemblies upon the customers requests.

The interface voltage for enable or block impulses can be connected to either 48-60 V dc or 110-220 V dc by connecting the voltage circuit to separate terminals. At delivery all relays are connected for 110-220 V dc.

RAPPK 1 Reverse Power Protection



101 RTXP 18 107 RXPPK 2H		101 RXTUG 22H 107 RXPPK 2H		101 RTXP 18 107 RXTUG 22H 113 RXPPK 2H		101 RTXP 18 107 RXTUG 22H 113 RXPPK 2H 119 RXME 18 319 RXME 18	
Order No.	Circuit diagram	Order No.	Circuit diagram	Order No.	Circuit diagram	Order No.	Circuit diagram
1MRK 001 057-BA	1MRK 001 058-BA	1MRK 001 057-CA	1MRK 001 058-CA	1MRK 001 057-DA	1MRK 001 058-DA	1MRK 001 057-EA	1MRK 001 058-EA

Mounting alternatives

All assemblies can be delivered in the following mounting alternatives:

- on apparatus bar
- in equipment frame 60C
- in RHGS
- in RHGX

Ordering

Specify RAPPK (Protection):

- Quantity
- Ordering number
- Code A, H, M
- Desired wording on the lower half of the test switch face plate max. 13 lines with 14 characters per line

Specify RXPPK (Loose Relay):

- Quantity
- Ordering number

Reverse Power Relay

Type	Voltage	Frequency	Article No.	Code
RXPPK 2H	1 A	50 Hz	1MRK 001 615-AA	☐A1
RXPPK 2H	5 A	50 Hz	1MRK 001 615-BA	☐A3
RXPPK 2H	1 A	60 Hz	1MRK 001 615-CA	☐A2
RXPPK 2H	5 A	60 Hz	1MRK 001 615-DA	☐A4

Auxiliary voltage
For included auxiliary relays

	Code
24 V dc	☐H5
48-55 V dc	☐H6
110-125 V dc	☐H7
220-250 V dc	☐H8

Mounting

Mounting alternatives	Size	Article No.	Code
Apparatus bars			☐M10
Equipment frame without door	4U 19”	1MRK 000 137-GA	☐M11
Equipment frame with door	4U 19”	1MRK 000 137-KA	☐M12
RHGX 4	4U 12C	RK 927 001-AB	☐M71
RHGX 8	4U 24C	RK 927 002-AB	☐M72
RHGX 12	4U 36C	RK 927 003-AB	☐M73
RHGX 20	4U 60C	RK 927 004-AB	☐M74
RHGS 30	6U x 1/1 19” rack	1MRK 000 315-A	☐M81
RHGS 12	6U x 1/2 19” rack	1MRK 000 315-B	☐M82
RHGS 6	6U x 1/4 19” rack	1MRK 000 315-C	☐M83

References

Connection and installation components in COMBIFLEX	1MRK 513 003-BEN
Relay accessories COMBIFLEX	1MRK 513 004-BEN
User’s Guide RXPPK 2H	1MRK 509 042-UEN

Manufacturer

ABB Automation Products AB
Substation Automation Division
SE-721 59 Västerås
Sweden
Tel: +46 (0) 21 34 20 00
Fax: +46 (0) 21 14 69 18