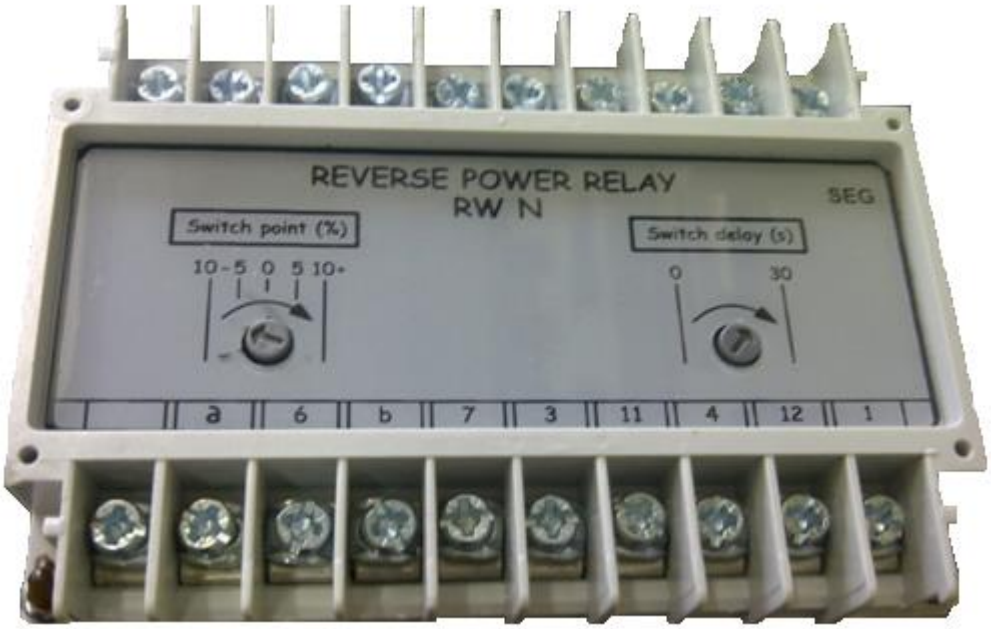
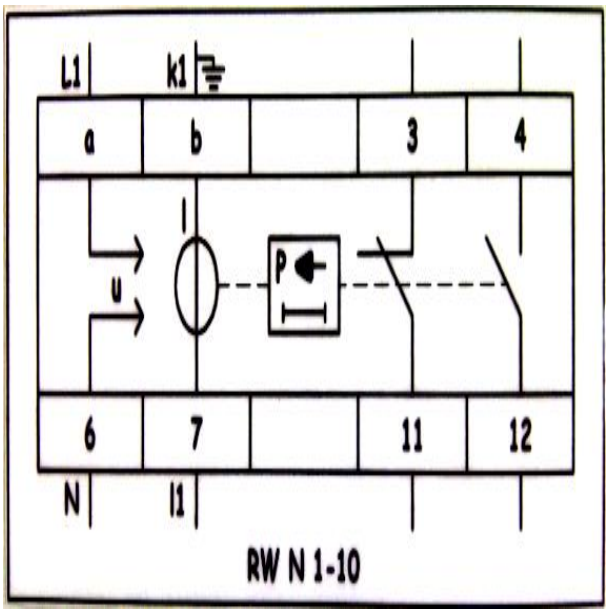
RW N - Reverse Power Relay



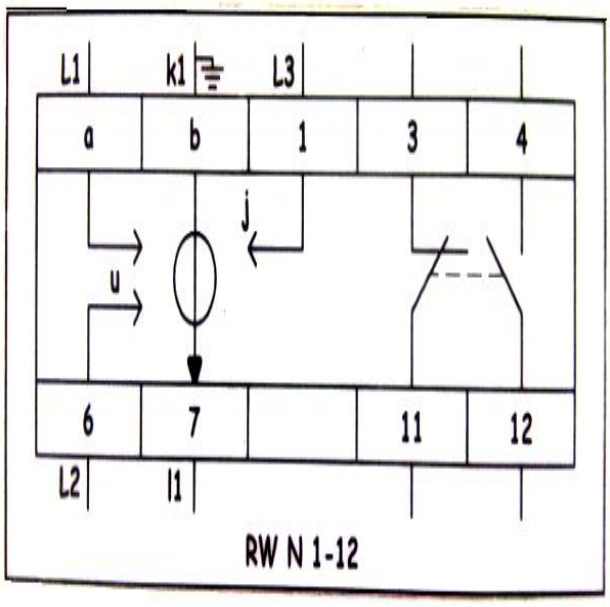
1. Applications

During parallel operation of a generator with a grid or with another generating system, it is necessary to supervise the power direction. Should, for instance, the driving unit fail, the generator acts as a motor by taking power from the grid and driving the unit. The reverse power relay RW N 1 detects the reversal of power direction and disconnects the generator in case of fault. By this power losses as well as dangerous conditions for the driving unit are prevented.
The unit RW1 is also suitable as a minimum load monitor.
Two variants of the appliance are available. Type RW N 1-10 is used in low-tension installations and type RW N1-12 in medium tension installations.

Front plate RW N 1-10



Front plate RW N 1-12



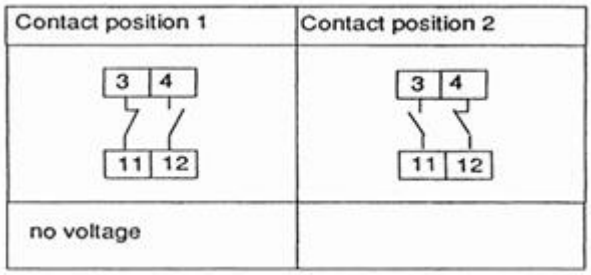
2. Mode of Operation

The reverse power relay RW N 1 consists of an electronic power-measuring circuit and a freely adjustable time circuit for a switching-delay and a time circuit for connection time lag. The latter is permanently set and suppresses the function of the power measuring circuit.

For about 8s after the application of the supply voltage. The power measuring circuit determines the magnitude and direction of the 3-phase power and causes a change-over of the relay from contact position 1 to the contact position 2 (see Fig. 1) in case of the percentage-value selected by the user.

If a negative percentage-value is adjusted, then the power monitor responds to the reverse power. By adjusting a positive value, ft can also be used as a minimum-load monitor. Diagram 1 illustrates as to when the reverse-power relay remains in contact position 1 or switches over to contact position 2.

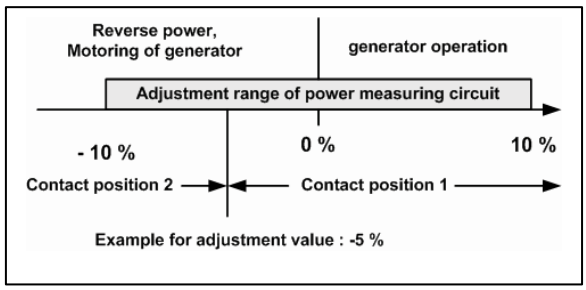
Fig. 1 Contact positions



Should, for instance, the setting be in the negative range (-10% to 0%), then the relay remains in the contact position 1 if
• The reverse power is smaller than the adjusted value,
• The power is equal to zero or positive.

A changeover to the contact position 2 takes place if the reverse power is greater than the adjusted value. Besides the adjustment value for the power-measuring circuit, a switching delay between Os and 30s can be selected in order to by-pass the dynamic reactions. This delay is required, for instance, in case of wind-drives where a feedback is caused by the customers at times

Diagram 1



3. Instructions for Adjustment

The reverse-power relay RW N 1 has a spindle potentiometer for the adjustment of the switching point (in %) and the switching delay (in seconds).

3.1 **Adjustment of the Switching Point of the Power-measuring Circuit**

Should the relay respond, for instance, at a generator reverse power of 10%, it does not (!) mean that the adjustment value of RW N 1 amounts to 10%. The adjustment value of the switching point must first be calculated because of the ratio of the transformers. Calculation of the adjustment value

Necessary data:

P_{GEN} [kW] Active power of the generator in kW It is calculated from the apparent power of the generator
S_{GEN} according to $P_{GEN} = SGEN \cos \phi$

PRW1 [kW] Reference power of the RW N 1 in kW It is
calculated from
I_N Nominal current of the relay
U_N Nominal voltage of the relay
ni Ratio of the current transformer
nu Ratio of the voltage transformer
for **4 wire system** (unit RW1-10) according to

$$\mathbf{P_{RW10} = (\sqrt{3}) \times I_N \times (\sqrt{3}) \times U_N \times ni \times nu}$$

For **3 wire system** (unit RW N 1-12) according to

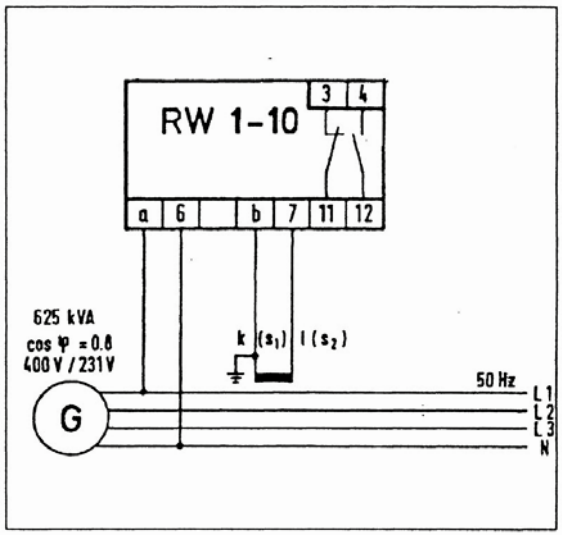
$$\mathbf{P_{RW12} = (\sqrt{3}) \times I_N \times U_N \times ni \times nu}$$

If P_{REV} [%] is the desired reverse-power value in % referring to the active power of the generator, then the value to be adjusted on the relay is calculated as per folllowing formula:

$$\text{Adjustment Value in \%} = \frac{P_{GEN}\,[kW]}{P_{RW1}\,[kW]} \times P_{REV}\,[\%]$$

Calculation-example 1

Low tension installation, unit RW N 1-10, diesel generator
Circuit example:
3 phase, 4 wire with current transformer



Note:

While connecting the relay it is to be observed that the current-transformer terminals k (S1) and l (S2) are connected as shown. Further the current and voltage measurement must be done on the same phase.

Active power of the generator
P_{GEN} = 625 kVA x 0.8 = 500 kW
nominal current of **RW N 1** I_N = 5 A
nominal voltage of RW N 1 U_N = 230 V
ratio of the current transformer ni = 1000 A/5 A = 200

=> reference power of the unit
P_{RW10} = (√3) x 5A x (√3) x 230V x 200 = 693 kW

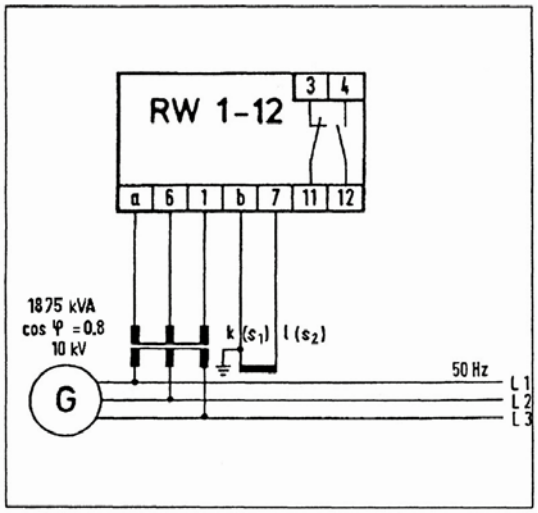
If the relay should respond at a reverse power of 5% (refered to the active power of the generator), then PREV = -5% and the adjustment value can be calculated in the following way:

$$\text{Adjustment Value in \%} = \frac{500\ KW}{693\ KW} \times (-5\ \%) = -3.6\ \%$$

In the foregoing example the relay RW1 is to be adjusted to - 3.6 %, so that it responds to a generator reverse-power of 5 % (corresponds to 25 kW in case of generator active-power of 500 kW).

Calculation-example 2

Medium tension installation, unit RW N 1-12, generator for turboset
Circuit example:
3 phase, 3 wire, current and voltage Transformer



Note:

- The proper connection of k(S1)and I(S2) is to be observed.
- L1, L2, and L3 are to be connected as shown.
- The current measurement must been done here in phase L1

Active power of the generator
P_{GEN} = 1875 kVA x 0.8 = 150 kW
nominal current of RW N 1 I_N = 5A
nominal voltage of RW U_N = 100V
Ratio
- the current transformer ni = 150 A/5 A 30
- the voltage transformer nu = 10KV/100V = 100

=> reference voltage of the unit
$\mathbf{P_{RW12}}$ = (√3) x 5A x 100V x 30 x 100 = 2598 kW

If the relay should respond at a reverse power of 3 % (refered to the active power of the generator), then PREV = -3 % and the adjustment value can be calculated in the following way:

$$\text{Adjustment Value in \%} = \frac{1500\ \text{KW}}{2598\ \text{KW}} \times (-3\ \%) = -2\ \%$$

In the foregoing example the relay RW N 1 is to be adjusted to -2 %, so that it responds to a generator reverse-power of 3 % (corresponds to 45 kW in case of generator active power of 1500 kW).

If the relay should respond at a reverse power of 5 %, for instance, the adjustment value on the RW1 can also be located by simulating a reverse power of 5 % and turning the setting element of the RW1 from the highest value down until the relay responds.

The simulation of reverse power of 5 % is achieved if k (s1) and l (s2) are interchanged at the current transformer and the generator to be monitored is operated at 5 % of its active power. The response of the relay can be noticed by disconnecting of the generator.

As soon as the switching point (i.e. the adjustment value) has been found, k (s_1) and I (s_2) must be properly connected again in order to operate the ***RW N 1*** as a reverse power relay.

3.3 Examples of reverse power values and switching delay
Examples of reverse-power values
- for turbines approx. 2 - 4 %
- for gas engines approx. 4 - 6 %
- for diesel generators approx. 6 - 8 %

Examples of the adjustments of time-delay
- generator in parallel operation with large grid approx. 5 -10 s
- generator in parallel operation with other generators in an isolated system approx. 10 - 20 s
- generator in parallel operation with other generators when reverse power is caused Occasionally by the consumer approx. 20 - 30 s

4. Functional Check

With the help of following functional check it can be tested whether the appliance ***RW N 1*** is properly connected.

The generator to be protected is operated at a small (positive) power. If the spindle potentiometer for the power-measuring circuit is now turned in the positive range, the relay must switch over from contact position 1 to contact position 2 at a specific positive adjustment value (see Fig. 1) and cause a disconnection of the generator. In this case the RW N 1 is properly connected. It is now adjusted to the desired adjustment value for use as a reverse-power relay.

If the relay does not respond, then the following questions are to be clarified:

- Are k (s1) and I (S2) properly connected on the secondary side of the current transformer?
- Are L_1 and N (in case of appliance RW1-10) or L_1, L_2 and L_3 (in case of appliance RW1-12) properly connected?
- Is the current and voltage measurement in the same phase L_1?

5. Technical Data

General Data

Type	:	RW N 1-10 for ac-current or 4 wire system RW N 1-12 for 3 wire system type suffix S for switchboards marine type
Design	:	static protection unit
Maintenance	:	none
Permissible operating time	:	continuous operation
Fitting position	:	operation independent on fitting position

Measuring circuit

Rated voltage	:	58 V, 127 V, 230 V, 3 x 110 V, 3 x 230 V, 3 x 400 V
Over voltage withstand50 % for approx 2 s		
Rated current	:	1 A, 5 A
Rated frequency	:	50 - 60 Hz
against extra charge	:	400 Hz
Own consumption in standstill condition	:	current measuring circuit 2 VA voltage measuring circuit 5 VA

Setting ranges

• power setting	:	-10% up to+10%
• switching delay Tripping	:	0 up to 30 s
• hysteresis	:	0.5 %

Auxiliary Voltage

Not Required

Output Circuit

Contacts	:	potential free, 1 NC, 1 NO
Contact capacity	:	660 VA at 250 V/AC or 2 A at 24 V/DC
Contact material	:	silver coated
Contact service life	:	10^6 switching operations
Terminals	:	M4, wire termination, max. 2.5 mm^2

Ambient Conditions

Ambient temperature limits

• for storage	:	-40°C up to +80°C
• for operating	:	-25°C up to + 60°C

Tests

Effect of temperature	:	< 1 % of adjusted value at 0°C to 60°C
Approvals	:	units with type suffix S are tested for ship-installations

Case, Dimensions, Weight and Fitting

Case	:	SEG standard case
Material	:	track-resistant moulded base and transparent cover
Heigth x width x depth	:	141 x 105x91 mm
Fitting positions	:	independent
Weight	:	approx. 0.78 kg
Mounting	:	screwed
Protection class	:	case IP20, terminals IP00

Measurement and Bore holes