

REK 510

Current injection device for earth-fault protection of a synchronous machine rotor

User's Manual



We reserve the right to change data without prior notice.

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1. Application

The purpose of the rotor earth fault protection is to detect earth faults in the excitation circuit of synchronous machine.

The excitation field circuit is isolated during normal operating conditions. The field circuit can be exposed to abnormal mechanical or thermal stress due to vibrations, overcurrent, choked cooling medium flow, etc. This may result in the breakdown of the insulation between the field winding and the rotor iron at a point exposed to excessive stress. A single earth fault is not very dangerous and does not cause immediate damage, because the fault current is small due to the low voltage. More dangerous is a second earth fault that appears as a rotor winding interturn fault and causes severe magnetic imbalance and heavy rotor vibrations leading soon to severe damage.

Therefore, it is essential that any occurrence of an insulation failure is detected and that the machine is disconnected as soon as possible. Normally, the machine is tripped after a short time delay.

For generators with slip rings the rotor insulation resistance is sometimes reduced due to an accumulated carbon dust layer produced by the carbon brushes.

This product replaces the earlier version of current injection device type REK 510 and its predecessor type SPMK 1C40 C2.

The REK 510 ver. D introduced Q1/2007 has got following changes compared to the first version:

1. A new input for a 58 VAC supply voltage has been added. 100 VAC or 230 VAC can be alternatively used as before.
2. Injection voltage output level has been increased from 48 VAC to 100 VAC.
3. A suppression coil against field circuit harmonics is now integrated into unit.

2. Operating principle and connections

The injection device REK 510, supplied from a secured 58, 100 or 230 VAC 50/60Hz source, sets up a 100 VAC secondary voltage via its coupling capacitors to the rotor circuit towards earth.

This auxiliary AC voltage forms a small charging current I_1 to flow via coupling capacitors, resistances of the brushes and leakage capacitance between the field circuit and earth. The field to earth capacitance C_E somewhat affects the level of the resulting current, which is a few milliamperes during normal no-fault operating conditions.

If an earth fault arises somewhere in the field circuit, this current increases and may reach a level of 130 mA at fully developed earth fault (fault resistance $R_E = 0$, one coupling capacitor $C_1 = 2\mu\text{F}$ used). The integrated current transformer of the REK 510 then amplifies this current with the ratio 1:10 to a measurable level even with relays that have a 1 A rated current input.

A definite time earth-fault relay, e.g. REF 610 (or REJ 521) is connected to measure this current. The relay used should be insensitive to harmonics as considerable amount of harmonics (3rd and 6th) can occur in the current under normal no-fault operating conditions, especially with thyristor excitation and rotating diode rectifier systems.

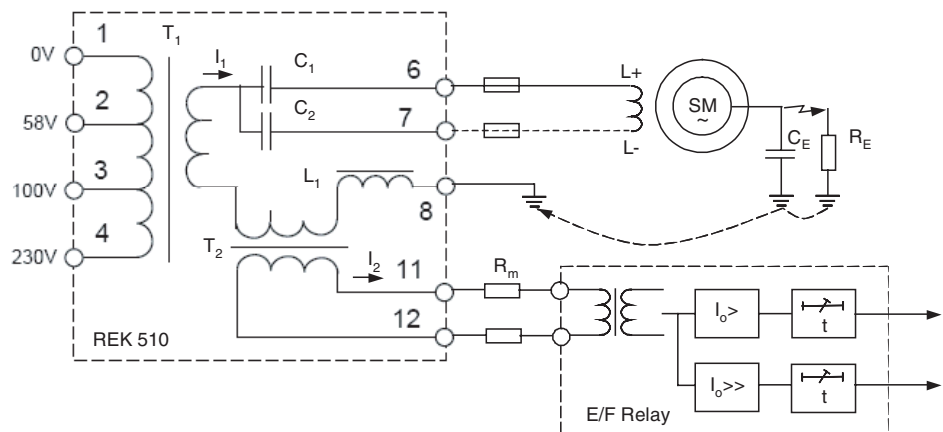


Fig. 2.-1 Principle of the rotor E/F protection with current injection device.

Machine terminal REM 543/5 can be also used, a dual stage rotor earth fault protection can be achieved with non-directional E/F protection function blocks NEF1Low and NEF1High, set to operate in a fundamental frequency mode. In this mode, digital filtering is used to filter out DC and harmonic components that could give false alarms/trips. For an example of measured curves with various field-to-earth leakage capacitance values, see Fig. 2.-2.

Typically an alarm level for weakly developed earth faults is set to the current pick-up level corresponding to 10 k Ω fault resistance, with a time delay of 10 sec. Tripping for fully developed earth faults is set to a current level corresponding to a 1-2 k Ω fault resistance with a 0.5 sec delay.

The current setting values corresponding to the required operating fault resistances can be tested by connecting an adjustable fault-simulating resistor between excitation winding poles and earth. Whether only one of the coupling capacitors or both of them should be used in a parallel connection should be determined on a case-by-case basis, taking into consideration the consequences of possibly excessive current at direct earth fault.

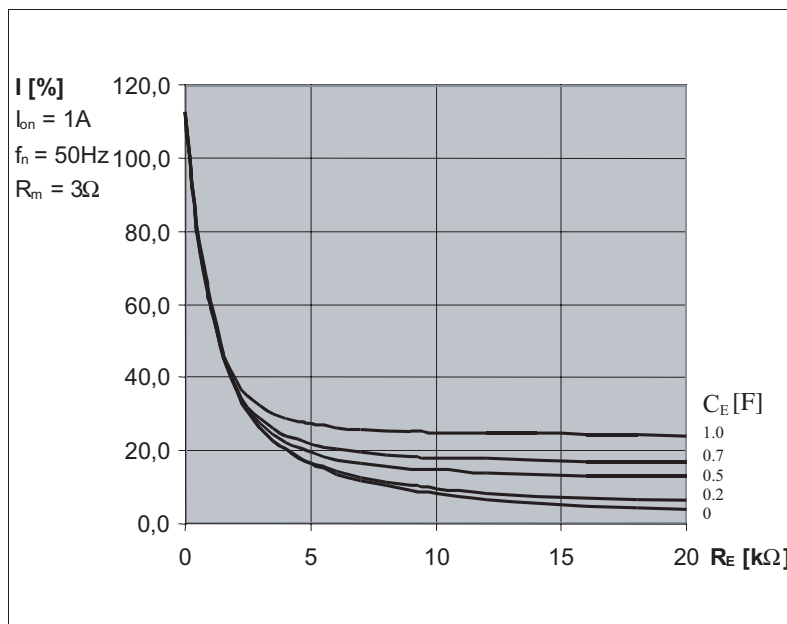


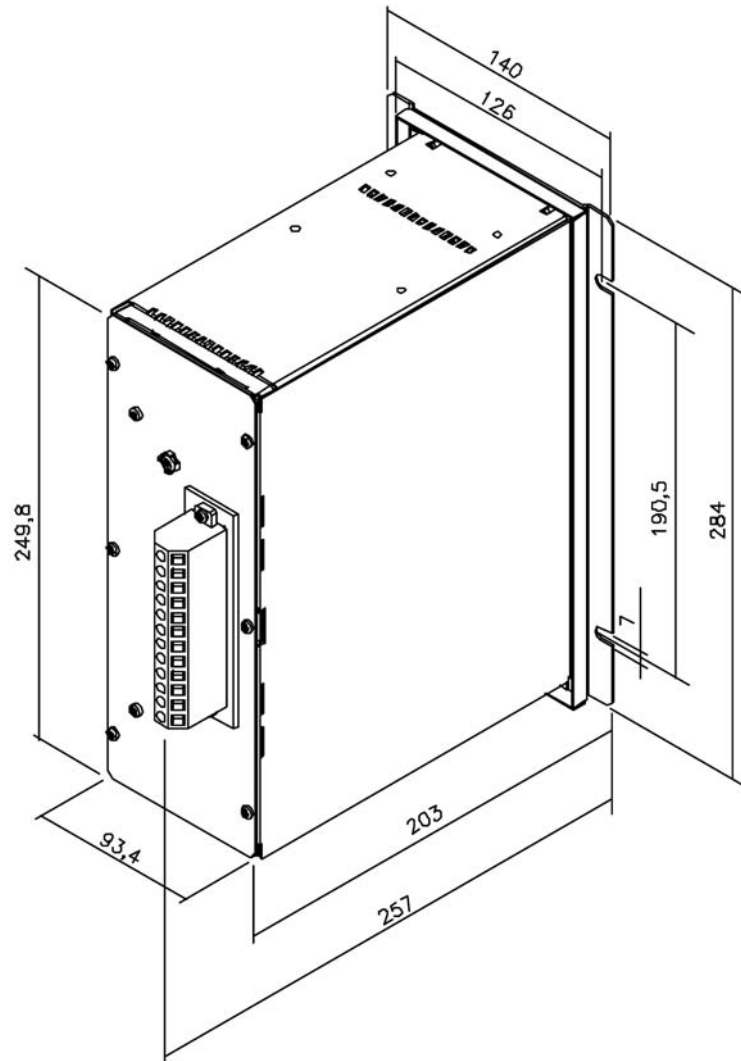
Fig. 2.-2 Measured current by REM 545 protection function NEF1Low as a function of rotor earth fault resistance with various field-to-earth capacitance values, measuring circuit resistance $R_m=3.0\Omega$, $f_n = 50Hz$. One of the coupling capacitors in use.

3. Technical data

Supply voltage, range according to IEC 60255-6	58, 100 or 230 V -20%...+10%, 50/60 Hz
Output voltage, nominal	100 V ac
Short circuit current between terminal 6 or 7 against terminal 8, when one of the coupling capacitors is used	$I_1 = 130 \text{ mA}$; withstands continuous short circuit
Excitation voltage withstand from terminals 6 and 7 to terminal 8	600 V dc
Maximum current to protection relay (terminals 11-12), when one of the coupling capacitors is used	$I_2 \leq 1.3 \text{ A}$
Maximum measuring circuit resistance (terminals 11-12)	$R_m \leq 3 \Omega$
Coupling capacitors	$2 \times 2 \mu\text{F}$
Power consumption	$\leq 15 \text{ W}$
Degree of protection provided by enclosure of the device according to IEC 529	IP 20
Environmental tests and conditions	
Service temperature range IEC 60255-6	-10°C ... +55°C
Transport and storage temperature IEC 60255-6	-40°C ... +70°C
Dry cold test according to IEC 60068-2-1	-10°C
Dry heat test according to IEC 60068-2-2	+55°C
Damp heat test, cyclic according to IEC 60068-2-2	+25°C ...55°C, RH > 93% 6 cycles (12+12 -hour cycle)
Storage temperature test according to IEC 60068-2-48	-40°C...+70°C
Dielectric tests	
Dielectric test according to IEC 60255-5 Input to outputs, output to output and all to earth	2.3 kV 50 Hz 1 min
Impulse test according to IEC 60255-5	7.3 kV 1.2 μs / 50 μs
Insulation resistance measurement according to IEC 60255-5	>100 M Ω , 500 V dc
Electromagnetic compatibility tests	
1 MHz burst disturbance test according to IEC 60255-22-1	2.5 kV common mode 1.0 kV differential mode
Electrostatic discharge test according to IEC 60255-22-2, IEC 61000-4-2	6 kV contact discharge 8 kV air discharge
Radio frequency interference tests:	
Conducted, according to IEC 60255-22-6, IEC 61000-4-6	10 V (rms) f = 150 kHz...80 MHz 80% amp. mod. with 1 kHz sinewave
Radiated, amplitude-modulated, according to IEC 60255-22-3, IEC 61000-4-3	10 V/m (rms) f = 30...1000 MHz 80% amp. mod. with 1 kHz sinewave
Radiated, pulse-modulated, according to ENV 50204, IEC 60255-22-3	10 V/m, f = 900 MHz f = 1.89 GHz Rep. frequency = 200 Hz, duty cycle 50%
Fast (5/50ns) transient disturbance test according to IEC 60255-22-4, IEC 61000-4-4	4 kV

Power frequency (50 Hz) magnetic field test according to IEC 61000-4-8	300A/m
Surge immunity test according to IEC 60255-22-5, IEC 61000-4-5	4kV common mode 2kV differential mode
Electromagnetic emission tests	
Conducted rf-emission EN 55011 (EN 55022), EN 60255-25	class A mains
Radiated rf -emission EN 55011 (EN 55022), EN 60255-25	class A enclosure
Mechanical tests	
Vibration tests IEC 60255-21-1	class 1
Shock and bump tests IEC 60255-21-2	class 1

4. Mechanical dimensions and mounting instructions



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Fig. 4.-1 Dimensions of the REK510.

Width 140 mm

Height 266 mm (6U)

Depth 257 mm, surface mounted

Weight of the unit 5.4 kg

The unit comes in a metal case and it is surface-mounted to the wall with four M6 size screws.

External connections have to be made according to the connection diagram. The numbering of the terminal block X1 connectors run from bottom to top. The screw-compression type connectors are dimensioned for one max. 6 mm² or two 0.2-1.0 mm² wires. A separate earth lead (2.5mm²) should be connected from the earth screw to the earth bar. No soldering is needed.

5.

References

Technical Reference Manual REF 610 1MRS755310

Technical Reference Manual REJ 521 1MRS750939

Technical Reference Manual REM 54_ 1MRS750915

6. Order information

Injection device REK 510 for rotor earth fault protection REK 510-AA



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