MANUAL

Professional Line | PROTECTION TECHNOLOGY
MADE SIMPLE

XE2 | DC CURRENT RELAY FOR LOSS OF EXCITATION PROTECTION


**DC CURRENT RELAY FOR LOSS OF EXCITATION PROTECTION**

Original document

English

Revision: B

# Inhalt

# 1. Applications and features

DC current relay XE2 is used for supervision of the ex-citer current. By the exciter current element the direct current of the excitation machine in brushless machines is supervised. The protection function includes detection of overcurrent and undercurrent as well as supervision of the ripple component of the exciter current and so faults of the rotating diodes would be revealed.

When compared to the conventional protection equipment all relays of the PROFESSIONAL LINE reflect the superiority of digital protection techniques with the following features:

- High measuring accuracy by digital data processing
- Fault indication via LEDs
- Extremely wide operating ranges of the supply voltage by universal wide-range power supply
- Very fine graded wide setting ranges
- Data exchange with process management system by serial interface adapter XRS1 which can be retrofitted
- Extremely short response time
- Compact design by SMD-technology

In addition to this the XE2 has the following special features:

- Galvanically decoupled measuring input of the exciter current 0.2 - 15 A
- Trip delay and limits for overcurrent and undercurrent can separately be set
- Supervision of rotating diodes by means of measuring the ripple component of the exciter current

# 2. Design

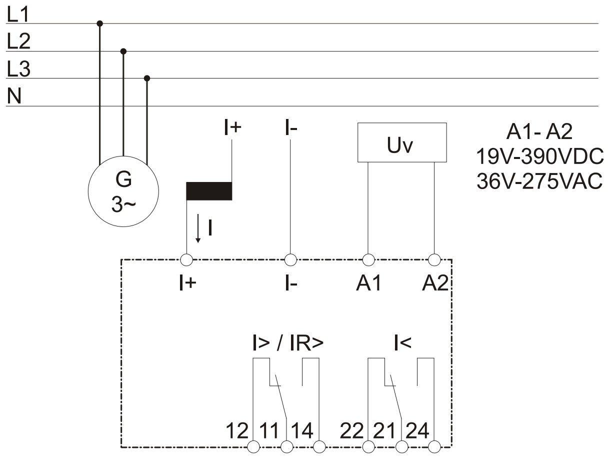


*Figure 2.1: Connections*

**Analog inputs**
The exciter current is fed to the protection relay via terminals I+ and I-.

**Auxiliary voltage supply**
The XE2 needs a separate auxiliary voltage supply. Therefore a DC or AC voltage must be used. The XE2 has an integrated wide range power supply. Voltages in the range from 19 - 390 V DC or 36 - 275 V AC can be applied at connection terminals A1 and A2. If a DC auxiliary voltage is used, the connection polarity at terminals A1-A2 is optional.

**Contact positions**

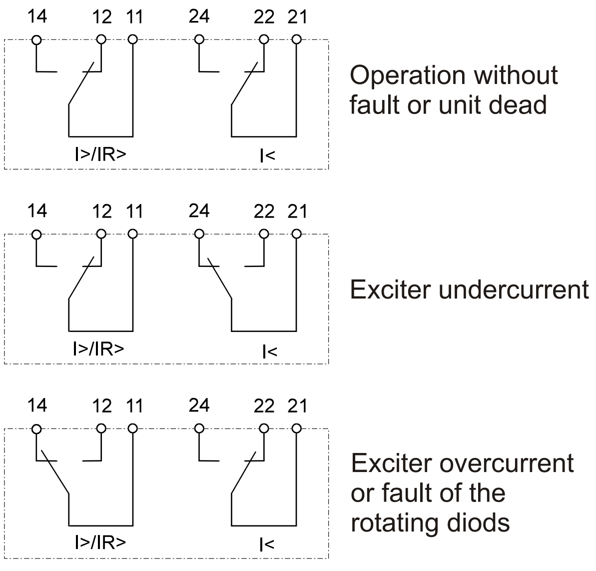


*Figure 2.2: Contact positions of the output relays*

# 3. Function

Failures in the excitation system of a synchronous generator may cause severe damage to the rotor of the generator as well as undesirable operating conditions:

| Failure | Effect |
|---|---|
| AVR failure; undercurrent in parallel operation | Excessive reactive current flow to the generator<br>=> System stability endangered (machine may slips, asynchronous torque) |
| AVR failure; undercurrent in single operation | System undervoltage if single operation<br>=> System stability endangered |
| AVR failure; overcurrent in parallel operation | Excessive reactive current flow to the system<br>=> Thermal overload of the exciter and stator winding |
| AVR failure; overcurrent in single operation | System overvoltage if in single operation<br>=> Thermal overload of the exciter and stator winding |
| Rotating diode open | Diodes overloaded<br>=> further diode faults |
| Rotating diode short | Excessive exciter current<br>=> severe overheating of the rotor system within a very short time. De-energizing and disconnection of the generator should be carried out within approx. 10 s. |

*Table 3.1: Effects of different failures*

**Exciter current supervision:**
The exciter current supervision comprises of three elements: under- and overcurrent and ripple component measurement. Those elements cover above mentioned failures of the generator excitation system.

**Undercurrent protection:**
If the exciter current $I_e$ falls below the set value I<, the relay trips after the set time delay tI<. The current setting $I_e$ should be chosen at about 70% of the no load exciter current of the generator. The corresponding time delay should be set to a value well above the AVR response time (e.g. 2 s), to allow transient deexcitation of the generator due to voltage regulator operation.

**Overcurrent protection:**
Function of the overcurrent protection is similar to that of the undercurrent protection. If the set value is exceeded, the relay trips after the set time delay. The current setting $I_e$ should be chosen at about 120% of the nominal exciter current of the generator. The time delay should be set to a value well above the AVR response time and required short circuit, to allow transient over-excitation of the generator due to voltage regulator operation.

**Diode failure protection:**
The diode failure protection is based on the measurement of the ripple component of the exciter current related to the mean value of the exciter current as per following formula:

$$I_r(\%) = \frac{I_{e,max} - I_{e,min}}{I_{e=}} \cdot 100$$

| **Condition of diodes** | $\mathbf{I_R}$ |
|---|---|
| All diodes all right: | $I_R \approx$ 15...20% |
| One diode open: | $I_R \approx$ 110% |
| One diode short: | $I_R \approx$ 200% |

*Table 3.2: Typical values for IR*

The setting of IR> should be chosen in the range from 40% to 50%. IR> trips with a fixed time delay of 4 s.

**Note!**
The required settings depend on various factors like:
- Required power factor of the generator
- Required minimum short circuit duration etc.

# 4. Operation and settings

All operating elements needed for setting parameters are located on the front plate of the XE2 as well as all display elements.
Because of this all adjustments of the unit can be made or changed without disconnecting the unit off the DIN-rail.

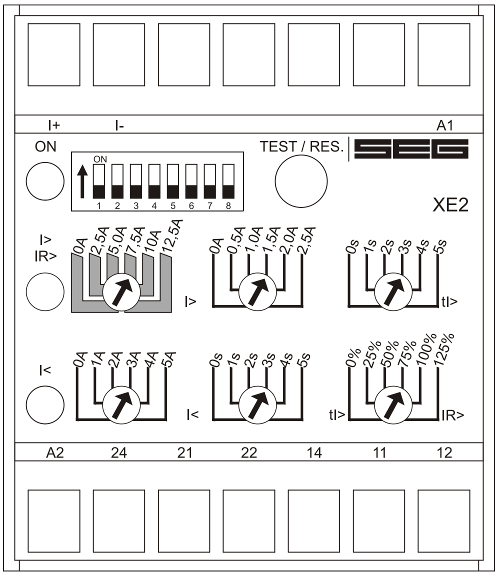


*Figure 4.1: Front plate*

For adjustment of the unit the transparent cover has to be opened as illustrated. Do not use force! The trans-parent cover has two inserts for labels.

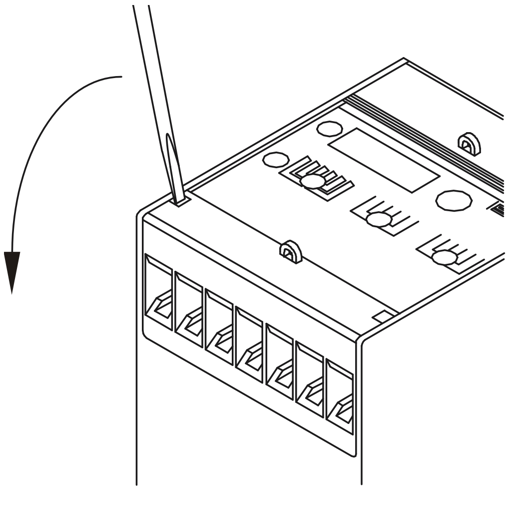

*Figure 4.2: How to open the transparent cover*

**LEDs**
LED „ON“ is used for display of the readiness for service (at applied auxiliary voltage Uv). LED I>, IR> and I< signal pickup (flashing) or tripping (steady light) of the corresponding function.

**Test push button**
This push button is used for test tripping of the unit and when pressed for 5 s a check-up of the hardware takes place. Both output relays are tripped and all tripping LEDs light up. If DIP-switch 1 is in ON position the TEST push button has an additional function. It then serves additionally for re-setting the I>/IR> output relay after tripping. For this purpose, briefly press push button (<5 s).

## 4.1 Setting of DIP-switches

The DIP-switch block on the front plate of the XE2 is used for adjustment of the nominal values and setting of function parameters:

| DIP-switch | OFF | ON | Function |
|---|---|---|---|
| 1 | OFF | ON | Relay latching I>/IR> |
| 2 | | | |
| 3 | | | |
| 4 | active | blocked | Exciter overcurrent element I> |
| 5 | active | blocked | Exciter undercurrent element I< |
| 6 | active | blocked | Ripple component supervision IR> |
| 7 | x 1 | x 10 | Multiplier for tI> |
| 8 | x 1 | x 10 | Multiplier for tI< |

*Table 4.1: Functions of DIP-switches*

**Blocking of overexcitation element**
When DIP switch 4 is in "ON" position, the overexcitation element is blocked.

**Blocking of underexcitation element**
When DIP switch 5 is in "ON" position, the underexcitation element is blocked.

**Blocking of ripple component supervision**
When DIP switch 6 is in "ON" position, the ripple component supervision is blocked.

**Relay latching**
If DIP-switch1 is in position "ON", the output relay I>/IR> will only return to is original position after tripping if the fault has been cleared and the TEST/RES. key is pressed.
The relay can also be reset electrically e. g. by a NC contact in the aux. voltage supply (interruption >2 s).

## 4.2 Setting of the tripping values

The PROFESSIONAL LINE units have the unique possibility of high accuracy fine adjustments. For this, two potentiometers are used. The coarse setting potentiometer can be set in discrete steps of 2.5 A. A second fine adjustment potentiometer is then used for continuously variable setting of the final 0 - 2.5 A. Adding of the two values results in the precise tripping value.

**Exciter overcurrent I>**
By using potentiometers shown on fig. 4.3, the over-excitation element I> can be adjusted in the range from 0 - 15 A (I> min. = 0.2 A). The dropout to pickup ratio (hysteresis) is 5 %.

**Example :**
The tripping value intended to be adjusted is 9 A. So the setting value of the right potentiometer is simply added to the value of the potentiometer for coarse adjustment.
(The arrow of the coarse setting potentiometer must be inside the marked bar, otherwise no defined setting value).

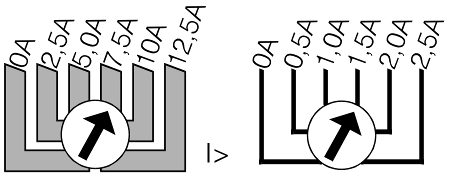


*Figure 4.3: Adjustment example*

**Supervision of exciter undercurrent I<**
By using potentiometer I<, the underexcitation element I< can be adjusted in the range from 0 - 5 A (I< min = 0.2 A). The dropout to pickup ratio (hysteresis) is 5 %.

**Ripple component supervision IR>**
By using potentiometer IR>, the ripple component supervision IR> can be adjusted in the range from 0 - 125 %. (IR> min = 10 %; hysteresis = 5 %).

**Time delay tI>**
By using DIP switch 7, time delay tI> for supervision of exciter overcurrent I> can be adjusted infinitely from 0 - 5 s or 0 - 50 s.

**Time delay tI<**
By using DIP switch 8, time delay tI< for supervision of exciter undercurrent I< can be adjusted infinitely from 0 - 5 s or 0 - 50 s.

## 4.3 Communication via serial interface adapter XRS1

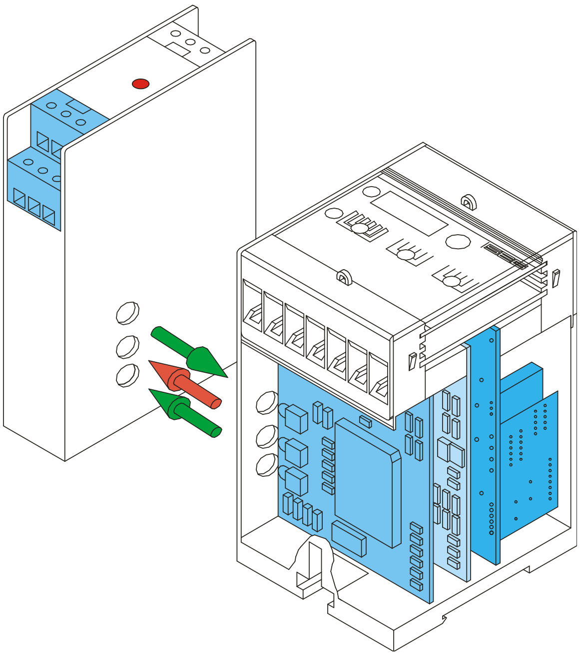

*Figure 4.4: Communication principle*

For communication of the units among each other and with a superior management system, the interface adapter XRS1 is available for data transmission, including operating software for our relays. This adapter can easily be retrofitted at the side of relay. Screw terminals simplify its installation. Optical transmission of this adapter makes galvanic isolation of the relay possible. Aided by the software, actual measured values can be processed, relay parameters set and protection functions programmed at the output relays. Information about unit XRS1 in detail can be taken from the description of this unit.

# 5. Relay case and technical data

## 5.1 Relay case

Relay XE2 is designed to be fastened onto a DIN-rail acc. to DIN EN 50022, the same as all units of the PROFESSIONAL LINE. The front plate of the relay is protected with a sealable transparent cover (IP40).

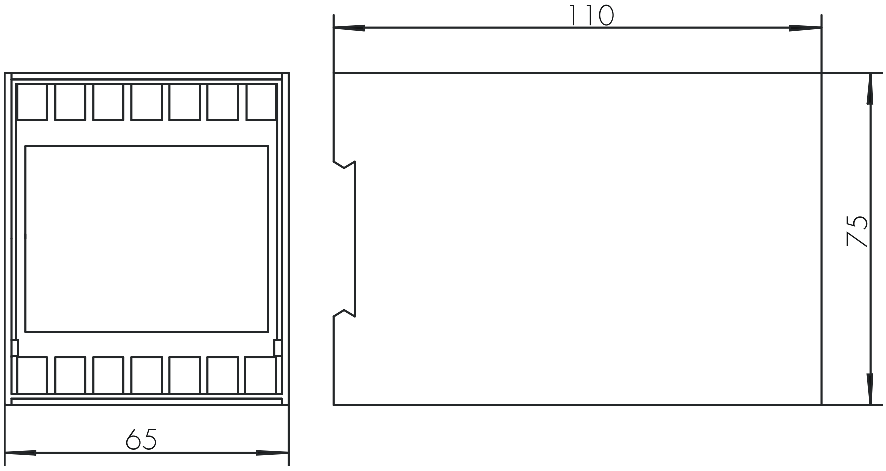


*Figure 5.1: Dimensional drawing*

**Connection terminals**
The connection of up to a maximum 2 x 2.5 $mm^2$ cross-section conductors is possible. For this the transparent cover of the unit has to be removed (see para. 4).

## 5.2 Technical data

**Measuring input circuits**

| | | |
|---|---|---|
| Rated frequency: | 0 - 300 Hz | |
| Thermal withstand capability in current circuit: | during 10 s | 5 x In |
| | continuously | 2 x In |
| Power consumption in current path: | at In = 10 A | 0,2 VA |

**Exciter current measuring:**

| | |
|---|---|
| Rated exciter current In: | 10 A DC (measuring range up to 17 A DC) |
| Power consumption in measuring path: | <1 VA |

**Auxiliary voltage**

| | |
|---|---|
| Rated auxiliary voltage Uv/ Power consumption: | 19 - 390 V DC or 36 - 275 V AC (f = 40 - 70 Hz) 4 W (terminals A1-A2) |
| Maximum interruption time of auxiliary voltage tU | UV = 24 V DC: tu = 8 ms, UV = 48 V DC: tu = 35 ms<br>UV > 60 V DC: tu = 50 ms |

**Common data**

| | |
|---|---|
| Dropout to pickup ratio: | >95 % |
| Resetting time from pickup: | <40 ms |
| Returning time from trip: | 500 ms |
| Minimum initialization time after supply voltage has applied: | 200 ms |
| Minimum response time when supply voltage is available: | <120 ms |

**Output relay**

| | |
|---|---|
| Number of relays: | 2 |
| Contacts: | 1 changeover contact for each trip relay |
| Maximum breaking capacity: | ohmic 1250 VA / AC resp. 120 W / DC<br>inductive 500VA / AC resp. 75 W / DC |
| Maximum rated voltage: | 250 V AC |
| 220 V DC | ohmic load $I_{max}$ = 0,2 A<br>inductive load $I_{max}$ = 0,1 A at L/R ≤ 50 ms |
| 24 V DC | inductive load $I_{max}$ = 5 A |
| Minimum load: | 1 W / 1 VA at $U_{min}$ ≤ 10 V |
| Maximum rated current: | 5 A |
| Making current (16ms): | 20 A |
| Contact life span: | $10^5$ operations at max. breaking capacity |
| Contact material: | AgCdO |

**System data**

| | |
|---|---|
| Design standard: | VDE 0435 T303; IEC 0801 part 1-4;<br>VDE 0160; IEC 255-4; BS142; VDE 0871 |
| Temperature range at storage and operation: | - 25°C to + 70°C |
| Constant climate class F acc. DIN 40040 and DIN IEC 68, part 2-3: | more than 56 days at 40°C and 95 % relative humidity |

**High voltage test acc. to VDE 0435, part 303**

| | |
|---|---|
| Voltage test: | 2.5 kV (eff.) / 50 Hz; 1 min |
| Surge voltage test: | 5 kV; 1.2/50 µs, 0.5 J |
| High frequency test: | 2.5 kV / 1 MHz |

| | |
|---|---|
| Electrostatic discharge (ESD) acc. to IEC 0801, part 2: | 8 kV |
| Radiated electromagnetic field test acc. to IEC 0801, part 3: | 10 V/m |
| Electrical fast transient (burst) acc. to IEC 0801, part 4: | 4 kV / 2.5kHz, 15 ms |
| Radio interference suppression test as per DIN 57871 and VDE 0871: | limit value class A |

| | |
|---|---|
| Accuracy of the specific rated values: | 3 % Repeat accuracy: 2 % |
| Basic time delay accuracy: | 0.5 % or □50 ms |
| Temperature effect: | 0.05 % per K |

**Mechanical test:**

| | |
|---|---|
| Shock: | class 1 acc. to DIN IEC 255-21-2 |
| Vibration: | class 1 acc. to DIN IEC 255-21-1 |

**Degree of protection**

| | |
|---|---|
| Front plate: | IP40 at closed front cover |
| Weight: | approx. 0.5 kg |
| Relay case material: | self-extinguishing |
| Mounting position: | any |

| **Parameter** | **Setting range** | **Graduation** |
|---|---|---|
| I> | 0 - 15 A (min 0,2 A) | continuously variable |
| I< | 0 - 5 A (min 0,2 A) | continuously variable |
| IR> | 0 - 125 % (min 10 %) | continuously variable |
| tI> | 0 - 5 s / 0 - 50 s | continuously variable |
| tI< | 0 - 5 s / 0 - 50 s | continuously variable |

*Table 5.1: Setting ranges and graduation*

Technical data subject to change without notice!

## Setting-list XE2

Project: ______________________________ Job.-no.: ____________________

Function group: = ______________ Location: + ___ Relay code: - ________________

Relay functions: _________________________ Date: ______________________

### Setting of parameters

| Function | | Unit | Default settings | Actual settings |
|---|---|---|---|---|
| I> | Exciter overcurrent | A | 0.2 | |
| I< | Exciter undercurrent | A | 0.2 | |
| IR> | Ripple component supervision | % | 10 | |
| tI> | Time delay for I> | s | 0 | |
| tI< | Time delay for I< | s | 0 | |

### DIP-switch settings

| DIP-switch | Function | Default settings | Actual settings |
|---|---|---|---|
| 1 | Relay latching I>/IR> | OFF | |
| 2 | | | |
| 3 | | | |
| 4 | Exciter overcurrent element I> | Active | |
| 5 | Exciter undercurrent element I< | Active | |
| 6 | Ripple component supervision IR> | Active | |
| 7 | Multiplier for tI> | x 1 | |
| 8 | Multiplier for tI< | x 1 | |

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