



## **XUA1 – AC Voltage and phase balance relay**

**(August 1996)**

**Manual XUA1 (Revision New)**

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# 1. Applications and features

Relay XUA1 of the PROFESSIONAL LINE is a digital relay for voltage and phase balance supervision of 3-phase systems and provides protection for electrical power generators and general equipment against in-admissible undervoltage or overvoltage as well as voltage unbalance e.g. due to blown fuse or conductor break.

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

- High measuring accuracy by digital processing
- Fault indication via LEDs
- Extremely wide operating ranges of the supply voltage by universal wide range power supply unit
- Wide setting ranges very accurately graded
- Data exchange with process management system by serial interface adapter XRS1 which can be retrofitted
- RMS measurement
- Extremely short reaction times
- Adjustment of rated data
- Negative sequence measuring of voltage unbalance
- Compact design by SMD-technology

In addition to this relay XUA1 has the following special features:

- Different switching hysteresis adjustable
- Measurement phase-to-neutral or phase-to-phase voltage possible
- Tripping times for supervision  $U_{<U>/U_{2s}}$  adjustable

## 2. Design

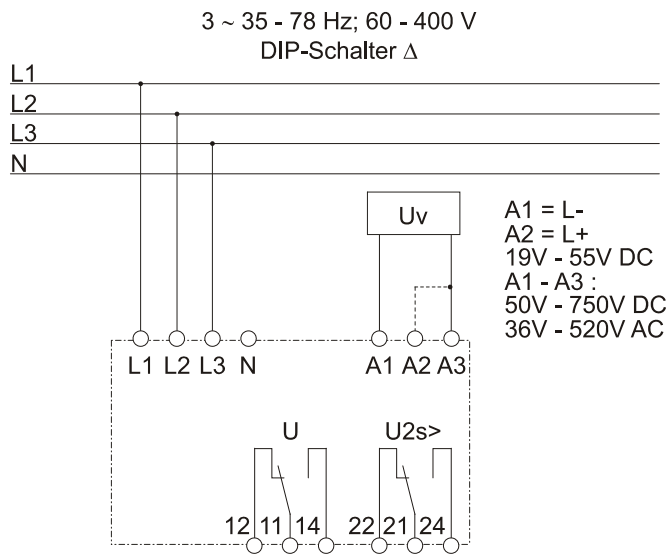


Figure 2.1: Connection three wire system

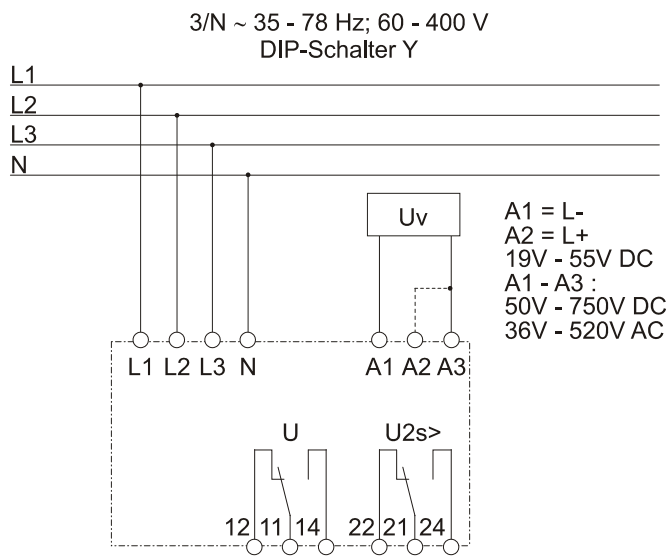


Figure 2.2: Connection four wire system

### Analog inputs

The analog voltage input signals are connected to the protection relay via terminals L1 - L3 and N.

### Auxiliary voltage supply

The XUA1 can be supplied directly from the measuring quantity itself or by a secured aux. supply. Therefore a DC or AC voltage must be used.

Unit XUA1 has an integrated wide range power supply. Voltages in the range from 19 - 55 V DC can be applied at connection terminals A1(L-) and A2(L+). Terminals A1/A3 are to be used for voltages from 50 - 750 V DC or from 36 - 520 V AC.

### Contact Positions

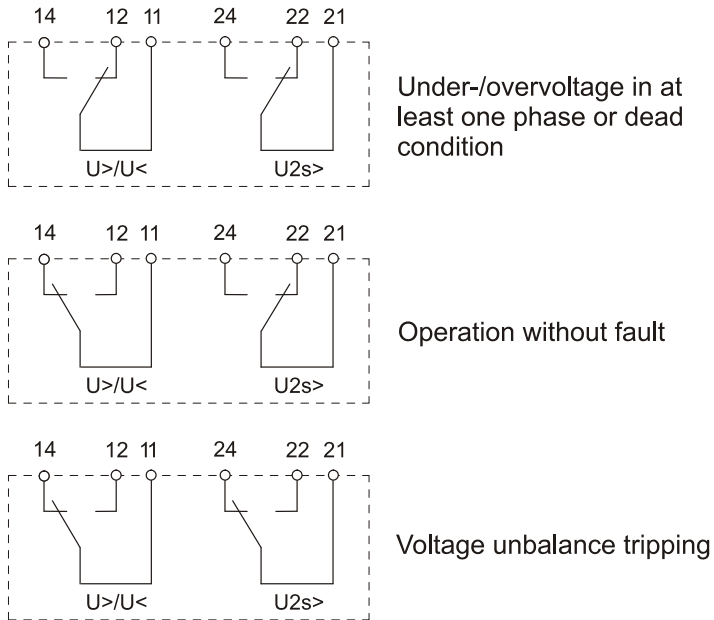


Figure 2.3: Contact positions of the output relays

## 3. Function

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### 3.1 Voltage supervision

Unit XUA1 has an independent overvoltage ( $U>$ ) and undervoltage supervision ( $U<$ ). The noise signals caused by inductive and capacitive coupling are suppressed by an analog RC-filter circuit.

The analog voltage signals are fed to the A/D-converter of the microprocessor and transformed to digital signals through sample-and-hold circuits. The analog signals are sampled with a sampling frequency of  $12 \times f_n$ , a sampling rate of 1.66 ms (1,39 ms) for every measuring quantity at 50 Hz (60 Hz).

### 3.2 Unbalanced voltage supervision

The XUA1 detects unbalanced voltages in terms of value and phase position. Such unsymmetric conditions can occur due to break of a conductor, blown fuses or unbalanced loading of the three phases system.

These conditions always result in displacement of the star point. The negative sequence voltage is measured by the XUA1 and so correct tripping after the adjusted tripping time is ensured.

**Measuring principle:**

A rotating three-phase system can be split according to the method of „Symmetrical Components“ into a positive-sequence system, a negative-sequence system and a zero sequence system.

The XUA1 calculates the negative-sequence system by rotating the voltage vector  $U_2$  by  $240^\circ$  and the voltage vector  $U_3$  by  $120^\circ$  and following addition of the voltage vectors.

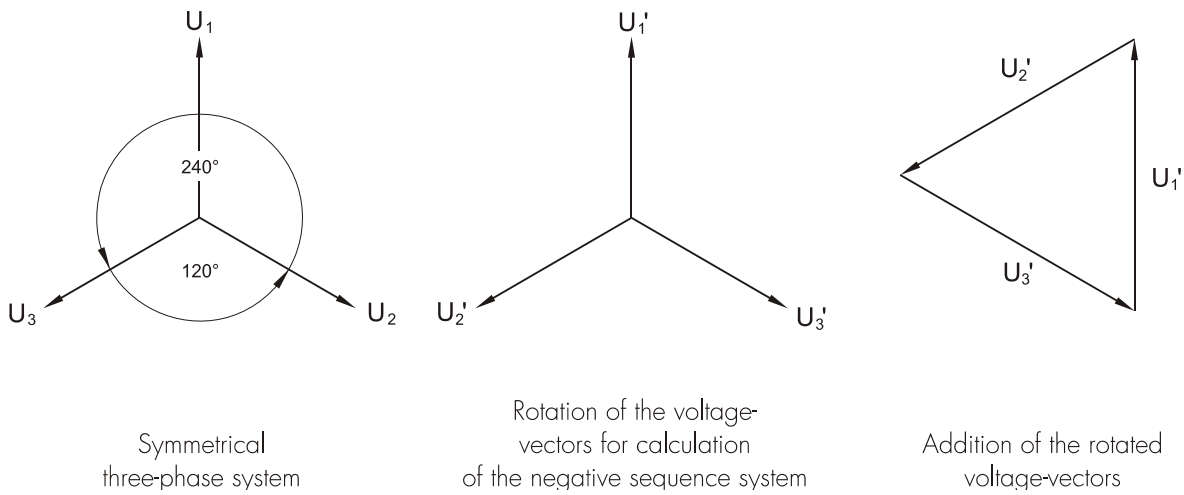


Figure 3.1: Symmetrical three-phase system

A rotating field is produced with opposite direction of rotating field. If the voltages of this negative-sequence system are added, the sum is zero in case of symmetrical voltages and angles.

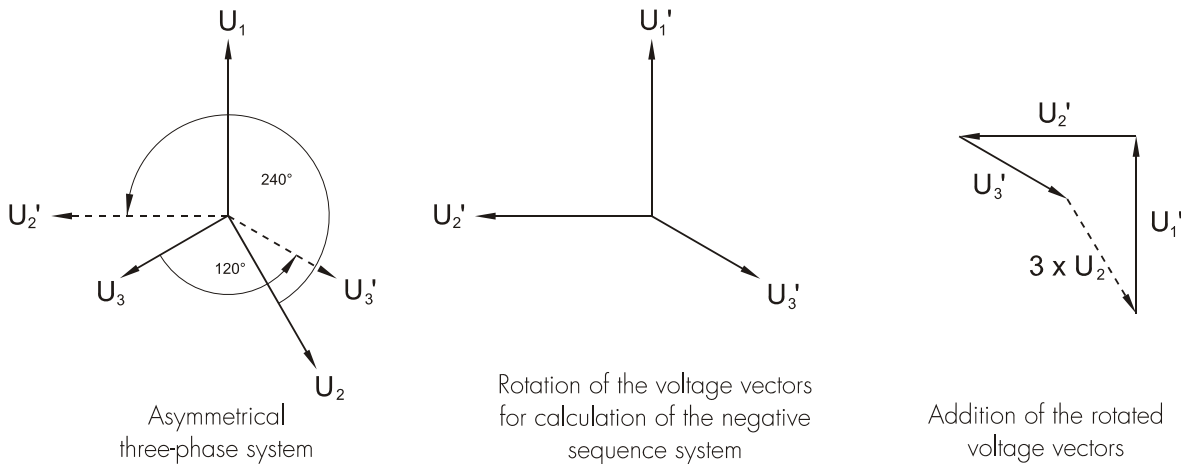


Figure 3.2: Asymmetrical three-phase system

In figure 3.2 voltages of an asymmetrical system are shown. The XUA1 calculates the negative-sequence system by rotating and following addition of the voltage vectors. The adjusting pickup value related to the rated voltage  $U_n$ . At phase loss (and correct phase angle) the asymmetrical voltage amounts to 33 %  $U_n$ .



## 4. Operation and settings

All operating elements needed for setting parameters are located on the front plate of unit XUA1 as well as all display elements.

Because of this all adjustments of the unit can be made or changed without disconnecting the unit from the DIN-rail.

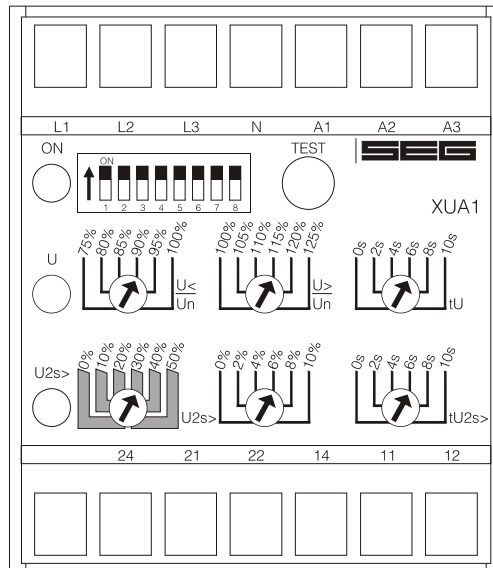


Figure 4.1: Front plate

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

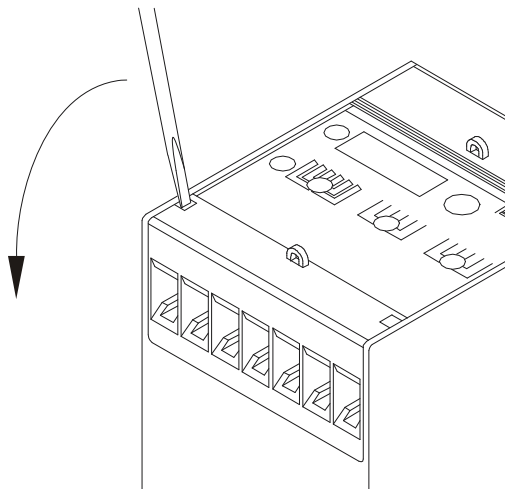


Figure 4.2: How to open the transparent cover

### LEDs

LED "ON" is used for display of the readiness for operation (at applied auxiliary voltage  $U_v$ ). LED U indicates undervoltage by flashing, at overvoltage the LED U is lit permanently. LED U2s> indicates tripping because of voltage unbalance.

### 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.

## 4.1 Setting of DIP-switches

The DIP-switch block on the front plate of unit XUA1 is used for adjustment of the nominal values and setting of function parameters:

DIP-switch	OFF	ON	Functions
1*	Un = 60 V	Un = 110 V	Setting of rated voltage
2*	Un = 60 V	Un = 230 V	
3*	Un = 60 V	Un = 400 V	
4			
5	Y	Δ	measurement phase-to-neutral/phase-to-phase voltage
6*	3 %	5 %	Switching hysteresis for U</U>
7*	3 %	10 %	
8	2 %	5 %	Switching hysteresis for U2s

Table 4.1: Function of DIP-switches

\* Only one of the DIP-switches 1 - 3 or 6 - 7 shall be in „ON“ position at the same time.

### Rated voltage

The required rated voltage Un (phase-to-phase voltage) can be set with the aid of DIP-switch 1 - 3 to 60, 110, 230 or 400 V AC. It has to be ensured that only one of the three DIP-switches is switched on.

The following DIP-switch configurations are permissible for adjustment of the rated voltage are allowed:

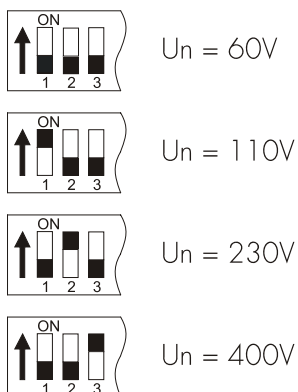


Figure 4.3: Adjustment of rated voltage

Rated voltage chosen too low, does not cause destruction of the unit but leads to wrong measuring results which may lead to false trippings.

### Measurement of phase-to-neutral / phase-to-phase voltage

The phase-to-neutral (position "OFF") or phase-to-phase voltage (position "ON") can be adjusted by means of switching over the DIP-switch 5. (See figure 2.1 and 2.2)

### Switching hysteresis for U</U>

The switching hysteresis for U> and U< can be set with the aid of DIP-switches 6 - 7 to 3, 5 or 10 % of the tripping value. As for the rated voltage, it has to be ensured that only one of the two DIP-switches is switched on.

### Switching hysteresis for U2s

The switching hysteresis for U2s (residual voltage) can be set with the aid of DIP-switch 8 to 2 or 5 % of the tripping value.

## 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 course setting potentiometer can be set in discrete steps of 10 %. A second fine adjustment potentiometer is then used for continuously variable setting of the final 0 - 10 %. Adding of the two values results in the precise tripping value.

### Undervoltage trip element

The undervoltage trip element can be set in the range from 75 - 100 %  $U_n$  with the aid of potentiometer  $U < / U_n$ .

### Overvoltage trip element

The overvoltage trip element can be set in the range from 100 - 125 %  $U_n$  with the aid of potentiometer  $U > / U_n$ .

### Asymmetry trip element

The trip element can be set in the range from 0 - 60 %  $U_n$  with the aid of the potentiometer illustrated in the following drawing.

#### Example:

A tripping value  $U_{2s>}$  for 36 %  $U_n$  is to be set. The set value of the right potentiometer is just added to the value of the coarse setting potentiometer. (The arrow of the coarse setting potentiometer must be in-side the marked bar, otherwise no defined setting value).

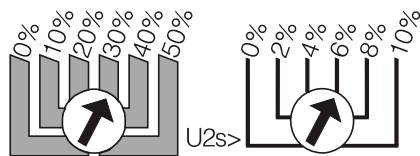


Figure 4.4: Adjustment example

### Time delay

The time delay  $t_U$  and  $t_{U_{2s>}}$  can be adjusted continuously variable in the range from 0 - 10 s.

### 4.3 Communication via serial interface adapter XRS1

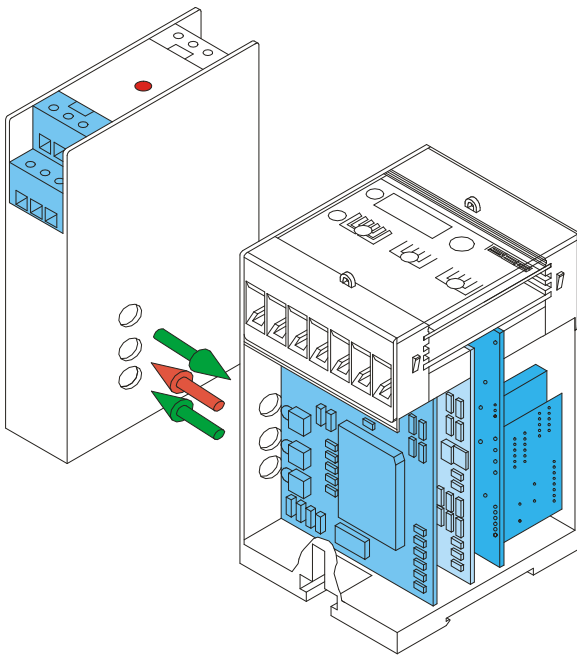


Figure 4.5: Communication principle

For communication of the units 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 the 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 XUA1 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).

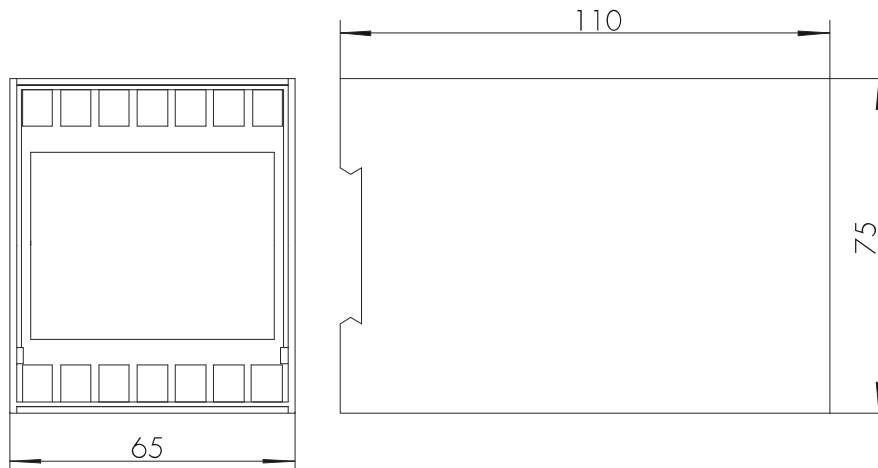


Figure 5.1: Dimensional drawing

#### Connection terminals

The connection of up to a maximum of 2 x 2.5 mm<sup>2</sup> cross-section conductors is possible. For this the transparent cover of the unit has to be removed (see chapter 4).

## 5.2 Technical data

### Measuring input circuits

Rated voltage  $U_n$ : 60, 110, 230, 400 V AC

Rated frequency range: 35 - 78 Hz

Power consumption in voltage circuit: 1 VA/per phase at  $U_n$

Thermal capacity of the voltage circuit: continuously 520 V AC

Auxiliary voltage

Rated auxiliary voltage  $U_v$ : 36 - 520 V AC ( $f = 35 - 78$  Hz) or 50 - 750 V DC / 4 W (terminals A1-A3)

Power consumption: 19 - 55 V DC / 3 W (terminals A1 (L-) - A2 (L+))

### Common data

Dropout to pickup ratio: depending on the adjusted hysteresis

Resetting time from pickup: <70 ms

Returning time from trip: 190 - 280 ms

Minimum initialization time after supply voltage has applied:  $U < U_0$  approx. 130 ms;  $U_{2S}$  approx. 290 ms

Minimum response time when supply voltage is available:  $U < U_0$  60 - 110 ms;  $U_{2S}$  70 - 130 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  
inductive 500 VA/AC resp. 75 W/DC

Max. rated voltage: 250 V AC

220 V DC ohmic load  $I_{max.} = 0,2$  A

24 V DC inductive load  $I_{max.} = 0.1$  A at  $L/R \leq 50$  ms

inductive load  $I_{max.} = 5$  A

Minimum load: 1 W / 1 VA at  $U_{min} \geq 10$  V

Maximum rated current: 5 A

Making current (16 ms): 20 A

Contact life span:  $10^5$  operations at max. breaking capacity

### System data

Design standard: VDE 0435 T303; IEC 0801 part 1-4,  
VDE 0160; IEC 255-4; BS 142; VDE 0871

Temperature range at storage and operation: - 25 °C to + 70 °C

Constant climate class F

acc. to 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  $\mu$ s, 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/2.5 kHz, 15 ms

Radio interference suppression  
 test acc. to DIN 57871 and VDE 0871: limit value class A  
 Repeat accuracy: 1 %  
 Basic time delay accuracy: 0.5 % or  $\pm$ 25 ms  
 Accuracy of the specific rated values: Un = 60 V U2s: 2 % U: 1.5 % U<sub>phase-to-neutral</sub>  
 2 % U<sub>phase-to-phase</sub>  
 1 %  
 Un = 110 V/230V/400 V  
 Temperature effect: 0.02 % per K  
 Frequency effect: 45 - 66 Hz no tolerance  
 35 - 45 Hz and 66 - 78 Hz 1 %

**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  
 Mounting position: any  
 Relay case material: self-extinguishing

Parameter	Setting range	Graduation
U<	75 - 100 % Un	continuously variable
U>	100 - 125 % Un	continuously variable
U2s>	0 - 60 % Un	continuously variable
tU/t $\Delta$ U	0 - 10 s	continuously variable
Hysteresis U</U>	3, 5, 10 %	
Hysteresis U2s	2, 5 %	

Table 5.1: Setting ranges and graduation

Technical data subject to change without notice!

**Setting-list XUA1**

Project: \_\_\_\_\_ SEG job.-no.: \_\_\_\_\_

Function group: = \_\_\_\_\_ Location: + \_\_\_\_\_ Relay code: - \_\_\_\_\_

Relay functions: \_\_\_\_\_ Date: \_\_\_\_\_

**Setting of parameters**

Function		Unit	Default settings	Actual settings
U<	Undervoltage	% Un	75	
U>	Overvoltage	% Un	100	
U2s>	Voltage asymmetry	% Un	0	
tU	Time delay for U< and U>	s	0	
tU2s>	Time delay for tU2s>	s	0	

DIP-switch	Function	Default settings	Actual settings
1*		60 V	
2*	Adjustment of rated voltage	60 V	
3*		60 V	
4			
5	Measuring phase-to-neutral / phase-to-phase voltage	Y	
6*	Hysteresis for U< and U>	3 %	
7*	Hysteresis for U< and U>	3 %	
8	Hysteresis for U2s	2 %	

\*Only one of the DIP-switches 1 - 3 or 6 - 7 shall be in „ON“-position at the same time.







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