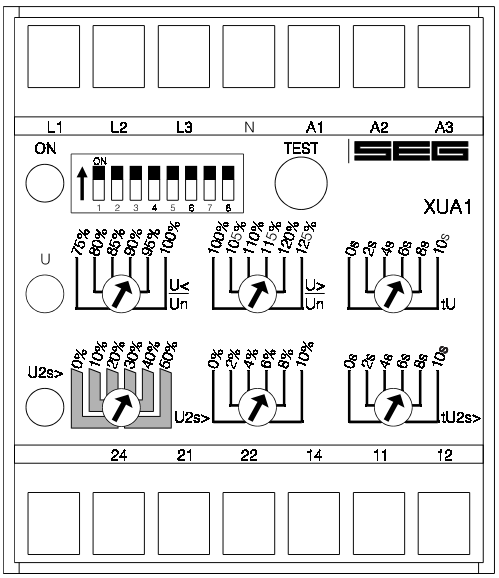
XUA1 - AC Voltage and phase balance relay



Contents

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 inadmissible 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>/U2s> adjustable

2. Design

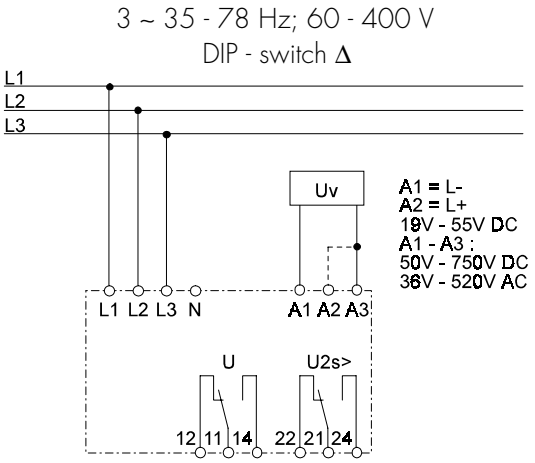


Fig. 2.1: Connection three wire system

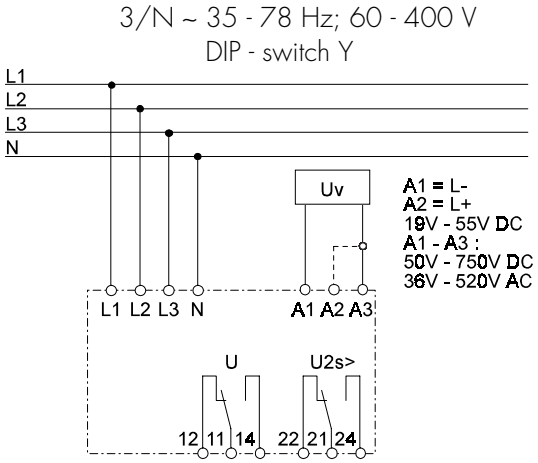


Fig. 2.2: Connection four wire system

Analog inputs

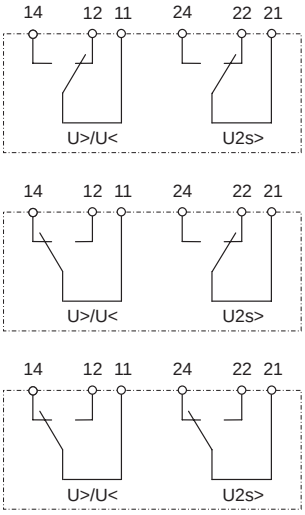
The analog voltage input signals are connected to the protection relay via terminals L1 - L3 and N.

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



Under-/overvoltage in at least one phase or dead condition

Operation without fault

Voltage unbalance tripping

Fig. 2.3: Contact positions of the output relays

3. Function

3.1 Voltage supervision

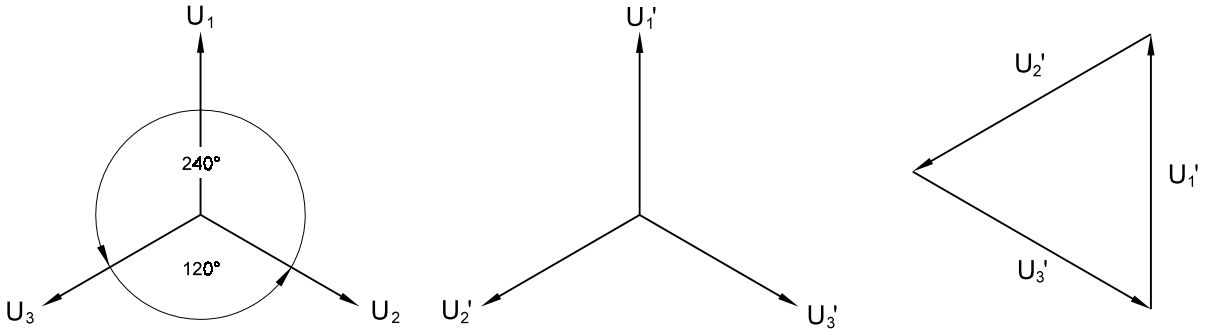
Unit *XUA1* has an independent overvoltage (U>) and undervoltage supervision (U<). The noise signals caused by inductive and capacitive coupling are supressed by an analog RC-filter circuit.

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 x fn, 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° and the voltage vector U_3 by 120° and following addition of the voltage vectors.



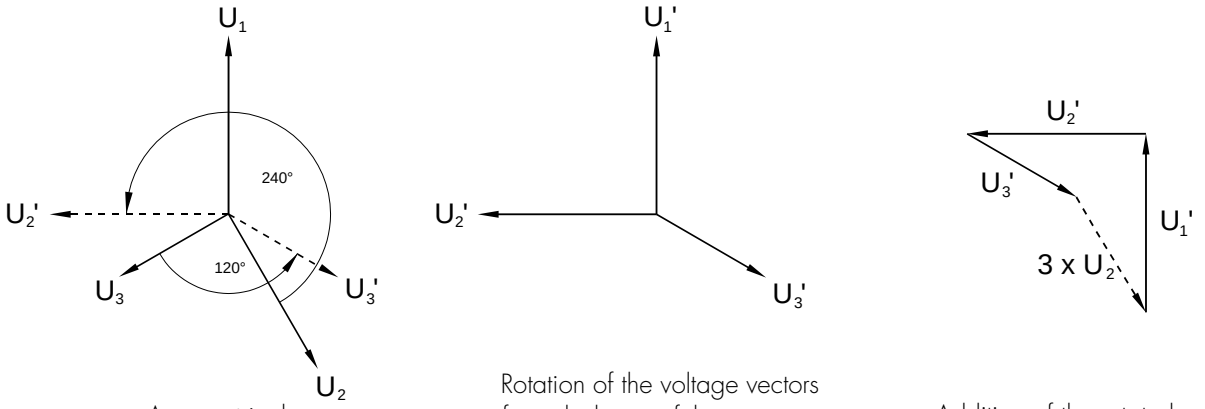
Symmetrical three-phase system

Rotation of the voltage-vectors for calculation of the negative sequence system

Addition of the rotated voltage-vectors

Fig. 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.



Asymmetrical three-phase system

Rotation of the voltage vectors for calculation of the negative sequence system

Addition of the rotated voltage vectors

Fig. 3.2: Asymmetrical three-phase system

In fig. 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 Un.
At phase loss (and correct phase angle) the asymmetrical voltage amounts to 33 % Un.

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.

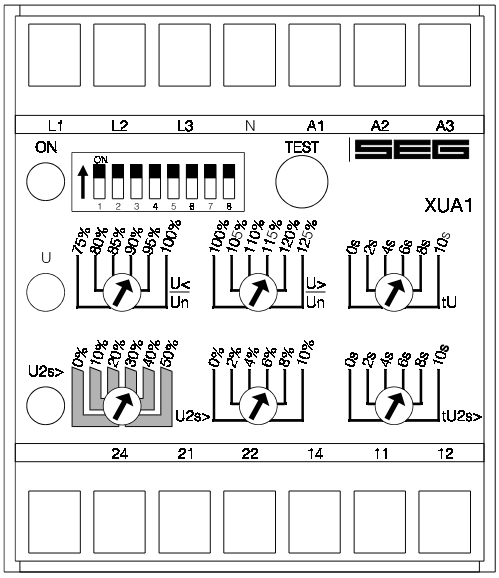


Fig. 4.1: Front plate

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

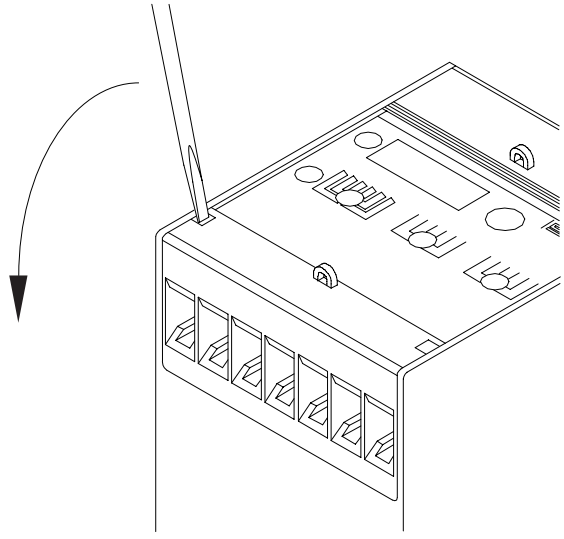


Fig. 4.2: How to open the transparent cover

LEDs

LED "ON" is used for display of the readiness for operation (at applied auxiliary voltage Uv). 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 4.3: 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:

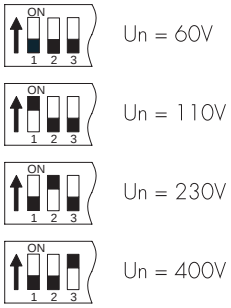


Fig. 4.3: Adjustment of rated voltage

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 descrete 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 % Un with the aid of potentiometer U</Un.

Overvoltage trip element

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

Asymmetry trip element

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

Example:
A tripping value U2s> for 36 % Un 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 inside the marked bar, otherwise no defined setting value).

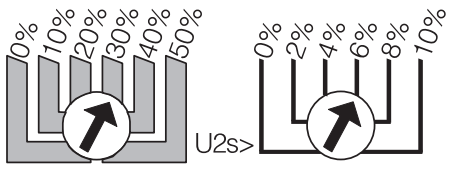


Fig. 4.4: Adjustment example

Time delay

The time delay tU and tU2s> can be adjusted continuously variable in the range from 0 - 10 s.

4.3 Communication via serial interface adapter XRS1

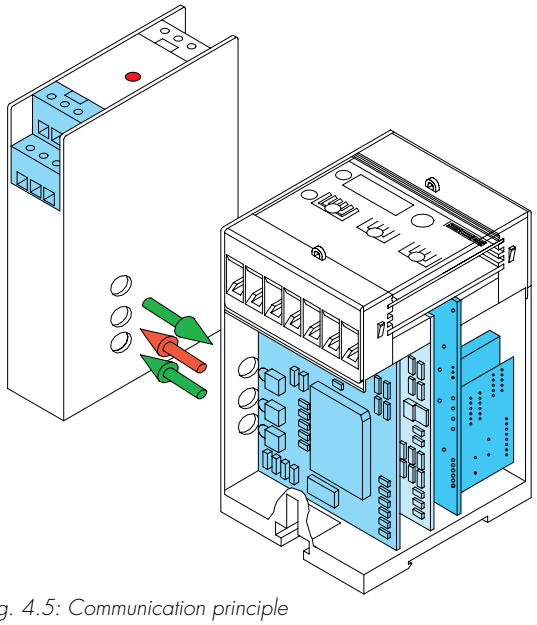


Fig. 4.5: Communication principle

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).

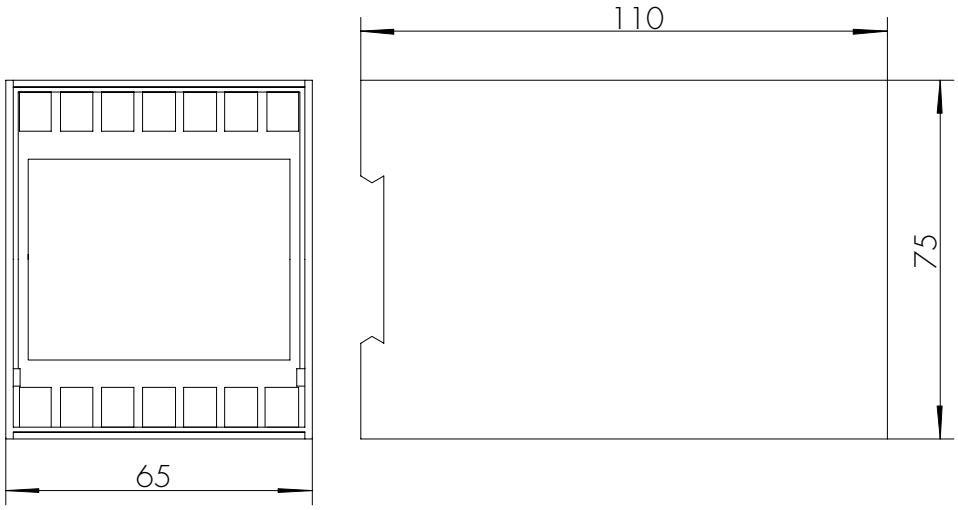


Fig. 5.1: Dimensional drawing

Connection terminals

The connection of up to a maximum of 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 voltage Un:	60, 110, 230, 400 V AC
Rated frequency range:	35 - 78 Hz
Power consumption in voltage circuit:	1 VA/per phase at Un
Thermal capacity of the voltage circuit:	continuously 520 V AC

Auxiliary voltage

Rated auxiliary voltage Uv/	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> approx. 130 ms; U_{2S} approx. 290 ms
Minimum response time when supply voltage is available:	U</U> 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 Imax. = 0,2 A inductive load Imax. = 0,1 A at L/R ≤ 50 ms 24 V DC inductive load Imax. = 5 A
Minimum load:	1 W / 1 VA at Umin ≥ 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 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/2.5 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 ±25 ms

Accuracy of the specific rated values: Un = 60 V U2s: 2 % U: 1.5 % $U_{\text{phase-to-neutral}}$
2 % $U_{\text{phase-to-phase}}$
Un = 110 V / 230 V / 400 V 1 %

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/tΔU	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*	Adjustment of rated voltage	60 V	
2*		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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