

# MANUAL

Professional Line | PROTECTION TECHNOLOGY  
MADE SIMPLE

**XRW14** | MAINS DECOUPLING RELAY FOR WIND POWER SYSTEMS



## MAINS DECOUPLING RELAY FOR WIND POWER SYSTEMS

Original document

English

Revision: D

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# 1. Introduction and application

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The XRW1-4 is a universal mains decoupling device and covers the protection requirements from VDEW and most other utilities for the mains parallel operation of power stations.

- Over/ and undervoltage protection
- Over/ and underfrequency protection
- Rate of change of frequency  $df/dt$

Because of combination of three protectional functions in one device the XRW1-4 is a very compact mains decoupling device. Compared to the standardly used single devices it has a very good price/performance ratio.

## 2. Features and characteristics

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- Microprocessor technology with watchdog
- Effective analogue low pass filter for suppressing harmonics when measuring frequency
- Digital filtering of the measured values by using discrete Fourier analysis to suppress higher harmonics and d.c. components induced by faults or system operations
- Integrated functions for voltage and frequency super-vision in one device.
- Voltage supervision each with four step under-/ and overvoltage detection
- Frequency supervision with three step under-/ or overfrequency (user setting)
- Completely independent time settings for voltage and frequency supervision
- Adjustable voltage threshold value for blocking frequency measuring.
- Display of all measuring values and setting parameters for normal operation as well as tripping via a alphanumerical display and LEDs
- Storage and indication of the tripping values
- In compliance with VDE 0435, part 303 and IEC 255
- For blocking the individual functions by the external blocking input, parameters can be set according to requirement
- Direct connection 690 V (linked)

## 3. Design

### 3.1 Connections

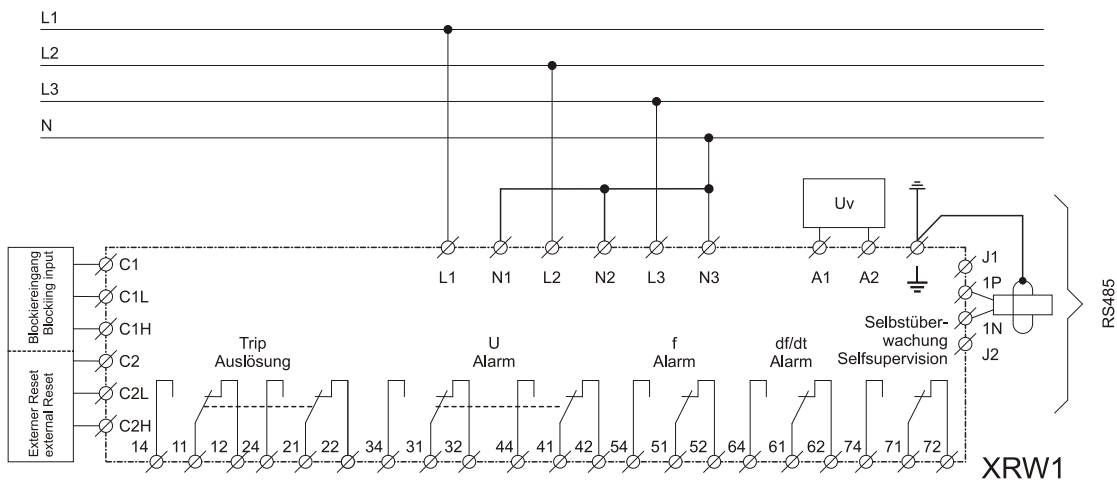


Figure 3.1: Connection diagram XRW1-4

#### 3.1.1 Analog input circuits

The analog input voltages are galvanically decoupled by the input transformers of the device, then filtered and finally fed to the analog digital converter. The measuring circuits can be applied in star or delta connection (refer to chapter 4.3.1).

#### 3.1.2 Blocking input

The blocking function can be set according to requirement. By applying the auxiliary voltage to C1/C1L or C1/C1H, the previously set relay functions are blocked (refer to 4.7).

#### 3.1.3 Reset input

Please refer to chapter 6.4.1.

#### 3.1.4 Low/High range of functions blocking and reset

The XRW1-4 relay has a wide-range power supply unit allowing to choose a suitable supply voltage. The operating threshold of the blocking and reset inputs, however, has to be defined by taking the supply voltage into account. The following two different operating thresholds can be adjusted:

- Low-range threshold  $U_{ON} \geq 10 \text{ V}$ ;  $U_{OFF} \leq 8 \text{ V}$   
Terminals C1/C1L for blocking input and C2/C2L for resetting input are assigned
- High-range threshold  $U_{ON} \geq 70 \text{ V}$ ;  $U_{OFF} = < 60 \text{ V}$   
Terminals C1/C1H for blocking input and C2/C2H for resetting input are assigned

### 3.1.5 Output relays

The XRW1-4 has 5 output relays. One trip relay with two changeover contacts. One alarm relay with two changeover contacts and three alarm relays with one changeover contact.

- Tripping 11, 12, 14 and 21, 22, 24
- Indication of over-/ and undervoltage alarm 31, 32, 34 and 41, 42, 44
- Indication of over-/ and underfrequency alarm 51, 52, 54
- Indication 61, 62, 64, df/dt-alarm
- Indication self supervision (internal fault of the unit) 71, 72, 74

All trip and alarm relays are normally-off relays, the re-lay for self supervision is a normally-on relay.

### 3.1.6 Data communication

For data communication with a central control system the XRW1-4 relay is provided with a serial interface RS485. Simplified and fast reading and changing of parameters and measuring values can be achieved by HTL/PL-Soft4.

The XRW1-4 can be connected to other units of the PROFESSIONAL LINE or the HIGH TECH LINE via interface. If there are more than one relay in the system, the last relay of the chain has to be provided with a line termination resistor.

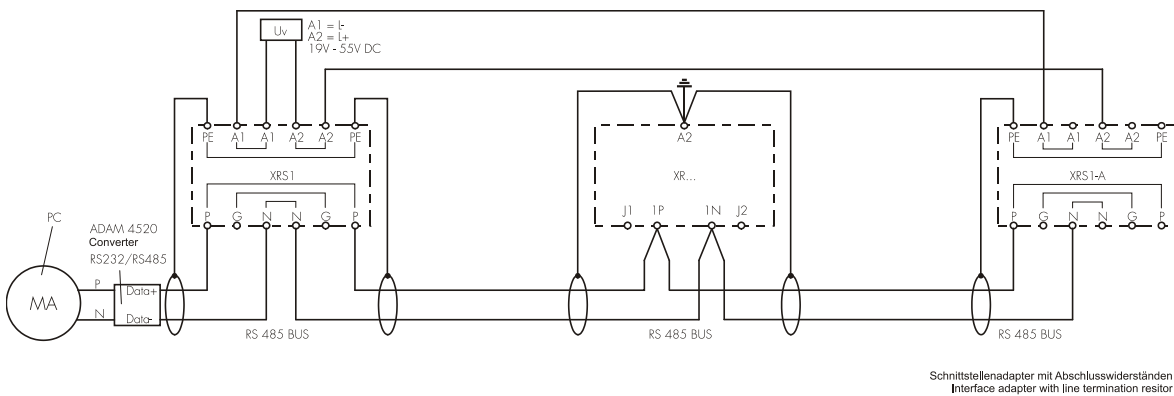


Figure 3.2: Connection example with 3 users, XR ... as linked device

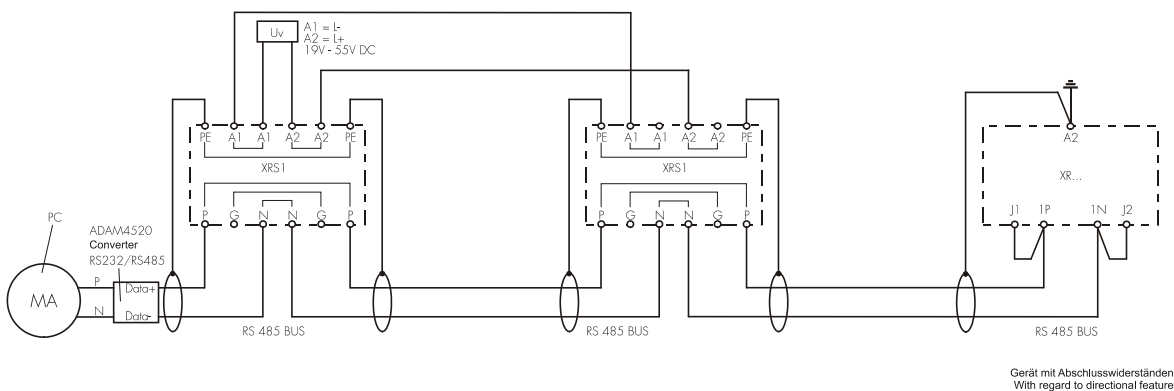


Figure 3.3: Connection example with 3 users, XR ... as last device



### 3.2 Front plate

#### 3.2.1 Indication- and operation elements

The front plate of the XRW1-4-protection relay comprises the following operation and indication elements:

- Alphanumerical display (4 Digits)
- Push buttons for setting and other operations
- LEDs for measured value indication and setting

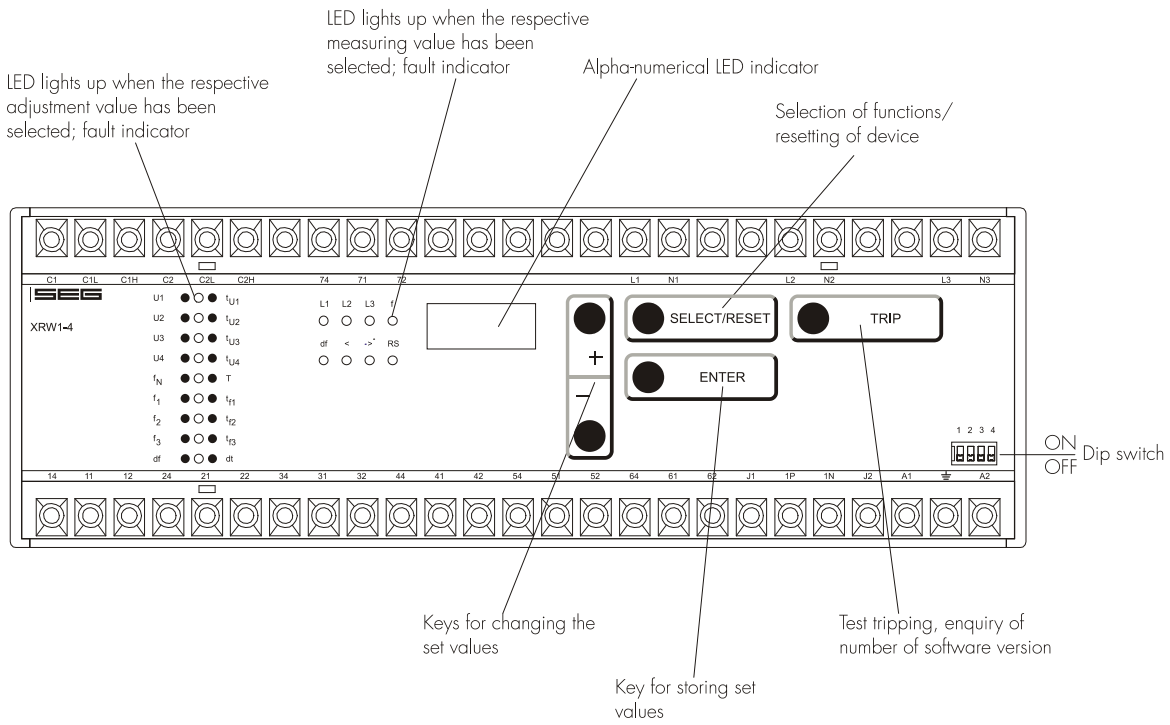


Figure 3.4: Front plate XRW1-4

### 3.2.2 Display

Function	Display shows	Pressed pushbutton	Corresponding LED
Normal operation	WW		
Measured operating values	Actual measured value Min. and max. values of voltage and frequency	<SELECT/RESET> one time for each value	L1, L2, L3, f, min, max df
Undervoltage U1< tripping time delay tU1< reverse run of the time delay tU1<	Setting value in Volt Setting value in seconds YES/NO	<SELECT/RESET> <+> <-> one time for each value	U1; < tU1; < tU1; <
Undervoltage U2< tripping time delay tU2< reverse run of the time delay tU2<	Setting value in Volt Setting value in seconds YES/NO	<SELECT/RESET> <+> <-> one time for each value	U2; < tU2; < tU2; <
Undervoltage U3< tripping time delay tU3< reverse run of the time delay tU3<	Setting value in Volt Setting value in seconds YES/NO	<SELECT/RESET> <+> <-> one time for each value	U3; < tU3; < tU3; <
Undervoltage U4< tripping time delay tU4< reverse run of the time delay tU4<	Setting value in Volt Setting value in seconds YES/NO	<SELECT/RESET> <+> <-> one time for each value	U4; < tU4; < tU4; <
Overvoltage U1> tripping time delay tU1> reverse run of the time delay tU1>	Setting value in Volt Setting value in seconds YES/NO	<SELECT/RESET> <+> <-> one time for each value	U1; > tU1; > tU1; >
Overvoltage U2> tripping time delay tU2> reverse run of the time delay tU2>	Setting value in Volt Setting value in seconds YES/NO	<SELECT/RESET> <+> <-> one time for each value	U2; > tU2; > tU2; >
Overvoltage U3> tripping time delay tU3> reverse run of the time delay tU3>	Setting value in Volt Setting value in seconds YES/NO	<SELECT/RESET> <+> <-> one time for each value	U3; > tU3; > tU3; >
Overvoltage U4> tripping time delay tU4> reverse run of the time delay tU4>	Setting value in Volt Setting value in seconds YES/NO	<SELECT/RESET> <+> <-> one time for each value	U4; > tU4; > tU4; >
rated frequency	Setting value in Hz	<SELECT/RESET><+><->	f <sub>N</sub>
frequency measuring repetition	Setting value in periods	<SELECT/RESET><+><->	T
frequency element f1 tripping delay of frequency element f1	Setting value in Hz Setting value in seconds	<SELECT/RESET><+><-> one time for each value	f <sub>1</sub> t <sub>f1</sub>
frequency element f2 tripping delay of frequency element f2	Setting value in Hz Setting value in seconds	<SELECT/RESET><+><-> one time for each value	f <sub>2</sub> t <sub>f2</sub>
frequency element f3 tripping delay of frequency element f3	Setting value in Hz Setting value in seconds	<SELECT/RESET><+><-> one time for each value	f <sub>3</sub> t <sub>f3</sub>
setting value df/dt measuring repetition df/dt	Setting value in Hz/s Setting value in periods	<SELECT/RESET><+><-> one time for each value	df dt
Blocking	EXIT	<+> until max. setting value <-> until min. setting value	LED of blocked parameter
Undervoltage blocking of frequency and df/dt measuring	Setting value in Volt	<SELECT/RESET><+><->	f, df
Slave address of serial interface	1 - 32	<SELECT/RESET><+><->	RS
<b>Recorded fault data:</b> Star-connection: U1, U2, U3 delta-connection: U12, U23, U31 frequency	tripping values in Volt	<SELECT/RESET><+><-> one time for each phase	L1, L2, L3,
	tripping values in Volt	<SELECT/RESET><+><-> one time for each phase	L1, L2, L3
	tripping values in Hz	<SELECT/RESET><+><-> one time for each phase	f, f <sub>min</sub> , f <sub>max</sub>
rate of change of frequency	tripping value in Hz/s	<SELECT/RESET><+><->	df
Save parameter?	SAV?	<ENTER>	
Save parameter!	SAV!	<ENTER> for about 3 s	
Software version	First part (e.g. D02-) Sec. part (e.g. 6.01)	<TRIP> one time for each part	
Manual trip	TRI?	<TRIP> three times	
Inquire password	PSW?	<SELECT/RESET><+><->/<ENTER>	
Relay tripped	TRIP	<TRIP> or fault tripping	
Secret password input	XXXX	<SELECT/RESET><+><->/<ENTER>	

Function	Display shows	Pressed pushbutton	Corre- sponding LED
LED blinking after excitation	NOFL/FLSH	<SELECT/RESET><+><->	
System reset	WW	<SELECT/RESET> for about 3 s	

Table 3.1: possible indication messages on the display

### 3.2.3 LEDs

All LEDs (except LED RS, min and max) are two-colored. The LEDs on the left side, next to the alpha-numerical display light up green during measuring and red after tripping.

The LEDs at the left on of the front are lit green during setting and inquiry procedure of the setting values which are printed on the left side next to the LEDs. The LEDs will light up red after activation of the setting values next to their right side.

The LED marked with letters RS lights up during setting of the slave address of the device for serial data communication.

### 3.2.4 Front plate XRW1-4

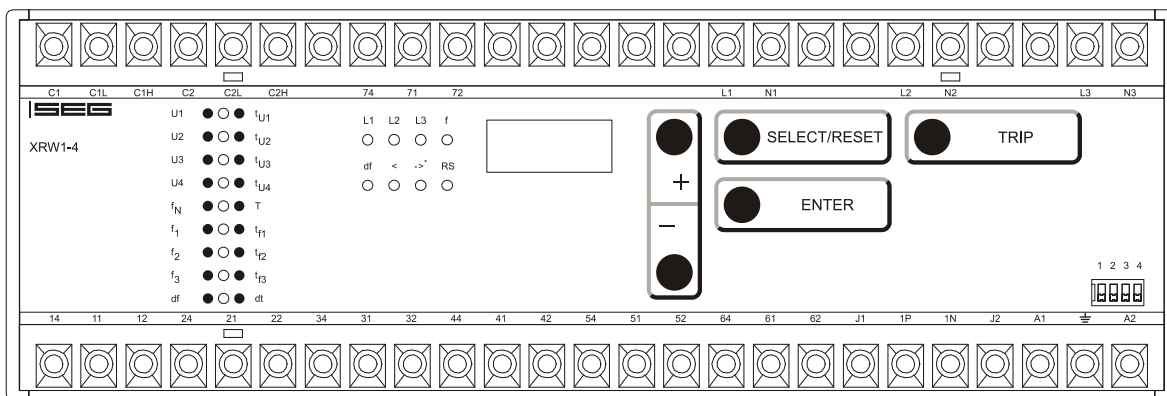


Figure 3.5: Front plate XRW1-4

### 3.2.5 Parameter settings

Setting parameters		Unit	Range
$\Delta/Y$	input transformer connection		Y = star DELTA = Delta
U1<	Pick-up value for the 1st undervoltage step	V	1 - 100 /4 - 800*
tU1<	Tripping time for the 1st undervoltage step	s	0.2 - 1500
tU1< back	Reverse run of the 1st tripping time is active		YES/NO
U2<	Pick-up value for the 2nd undervoltage step	V	1 - 100 /4 - 800*
tU2<	Tripping time for the 2nd undervoltage step	s	0.2 - 1500
tU2< back	Reverse run of the 2nd tripping time is active		YES/NO
U3<	Pick-up value for the 3rd undervoltage step	V	1 - 100 /4 - 800*
tU3<	Tripping time for the 3rd undervoltage step	s	0.04 - 300
tU3< back	Reverse run of the 3rd tripping time is active		YES/NO
U4<	Pick-up value for the 4th undervoltage step	V	1 - 100 /4 - 800*
tU4<	Tripping time for the 4th undervoltage step	s	0.04 - 300
tU4< back	Reverse run of the 4th tripping time is active		YES/NO
U1>	Pick-up value for the 1st overvoltage step	V	4 - 800
tU1>	Tripping time for the 1st overvoltage step	s	0.2 - 1500
tU1> back	Reverse run of the 1st tripping time is active		YES/NO
U2>	Pick-up value for the 2nd overvoltage step	V	4 - 800
tU2>	Tripping time for the 2nd overvoltage step	s	0.2 - 1500
tU2> back	Reverse run of the 2nd tripping time is active		YES/NO
U3>	Pick-up value for the 3rd overvoltage step	V	4 - 800
tU3>	Tripping time for the 3rd overvoltage step	s	0.04 - 300
tU3> back	Reverse run of the 3rd tripping time is active		YES/NO
U4>	Pick-up value for the 4th overvoltage step	V	4 - 800
tU4>	Tripping time for the 4th overvoltage step	s	0.04 - 300
tU4> back	Reverse run of the 4th tripping time is active		YES/NO
f <sub>N</sub>	rated frequency	Hz	50/60
T	frequency measuring repetition in periods	periods	2 - 99
f <sub>1</sub>	pickup value for frequency element 1	Hz	30 - 70 or
40 - 80			
t <sub>1</sub>	tripping delay for frequency element 1	s	t <sub>min</sub> -50
f <sub>2</sub>	pickup value for frequency element 2	Hz	30 - 70 or
40 - 80			
t <sub>2</sub>	tripping delay for frequency element 2	s	t <sub>min</sub> -50
f <sub>3</sub>	pickup value for frequency element 3	Hz	30 - 70 or
40 - 80			
t <sub>3</sub>	tripping delay for frequency element 3	s	t <sub>min</sub> -50
df	pickup value for rate of frequency (dt/dt) in	Hz/s	0.2 - 10
dt	measuring repetition for df/dt	periods	2 - 64
UB<	voltage threshold value for frequency and df/dt element	V	20 - 400
	LED blinking after excitation		NOFL/FLSH
RS	Slave address of the serial interface		1 - 32

\*According to the rated voltage UN=100V /UN=690V

Table 3.2: Sequence of parameter setting

## 4. Working principle

---

### 4.1 Analog circuits

The input voltages are galvanically insulated by the input transformers. The noise signals caused by inductive and capacitive coupling are suppressed by an analog R-C 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  $16 \times f_N$ , namely, a sampling rate of 1.25 ms for every measuring quantity, at 50 Hz.

### 4.2 Digital circuits

The essential part of the XRW1-4 relay is a powerful microcontroller. All of the operations, from the analog digital conversion to the relay trip decision, are carried out by the microcontroller digitally. The relay program is located in an EPROM (Electrically-Programmable-Read-Only-Memory). With this program the CPU of the microcontroller calculates the three phase voltage in order to detect a possible fault situation in the protected object.

For the calculation of the voltage value an efficient digital filter based on the Fourier Transformation (DFFT - Discrete Fast Fourier Transformation) is applied to suppress high frequency harmonics and dc components caused by fault-induced transients or other system disturbances. The microprocessor continuously compares the measured values with the preset thresholds stored in the parameter memory (EEPROM). If a fault occurs an alarm is given and after the set tripping delay has elapsed, the corresponding trip relay is activated.

The relay setting values for all parameters are stored in a parameter memory (EEPROM - Electrically Erasable Programmable Read Only Memory), so that the actual relay settings cannot be lost, even if the power supply is interrupted.

The microprocessor is supervised by a built-in "watch-dog" timer. In case of a failure the watchdog gives an alarm signal via the output relay "self supervision".

### 4.3 Voltage supervision

The voltage element of XRW1-4 has the application in protection of generators, consumers and other electrical equipment against over/and undervoltage.

The relay is equipped with a four step independent three-phase overvoltage ( $U1 > \dots U4 >$ ) and undervoltage ( $U1 < \dots U4 <$ ) function with completely separate time and voltage settings.

In delta connection the phase-to-phase voltages and in star connection the phase-to-neutral voltages are continuously compared with the preset thresholds.

For the overvoltage supervision the highest, for the undervoltage supervision of the lowest voltage of the three phases are decisive for energizing.

Basic for this elements is the RMS of the voltage fundamental.

### 4.3.1 Selection of star or delta connection

All connections of the input voltage transformers are led to screw terminals. The nominal voltage of the device is equal to the nominal voltage of the input transformers. Dependent on the application the input transformers can be connected in either delta or star. The connection for the phase-to-phase voltage is the delta connection. In star connection the measuring voltage is reduced by  $1/\sqrt{3}$ . During parameter setting the connection configuration either Y or  $\Delta$  has to be adjusted.

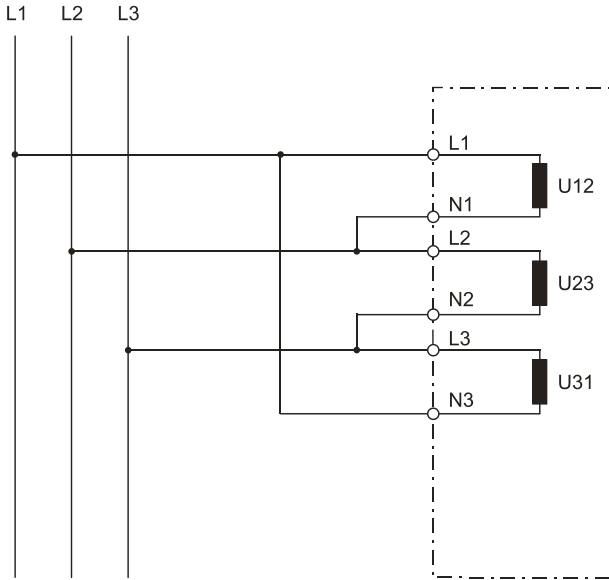


Figure 4.1: Input v.t.s in delta connection ( $\Delta$ )

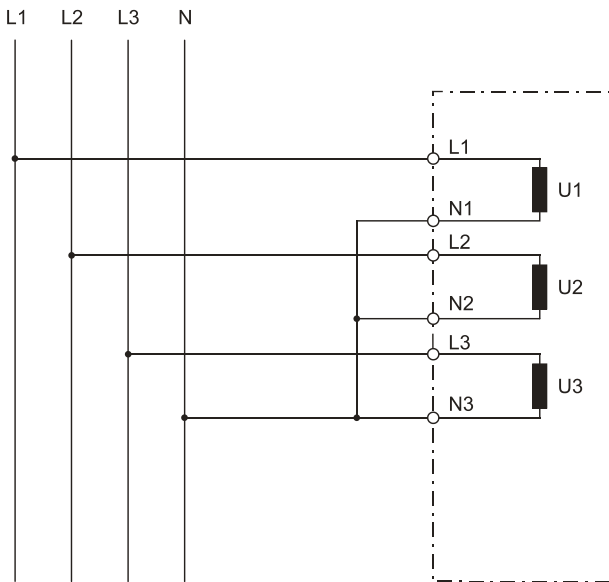


Figure 4.2: Input v.t.s in star connection (Y)

## 4.4 Principle of frequency supervision

The frequency element of XRW1-4 protects electrical generators, consumers or electrical operating equipment in general against over- or underfrequency. The relay has independent three frequency elements  $f_1 - f_3$  with a free choice of parameters, with separate adjustable pickup values and delay times.

The measuring principle of the frequency supervision is based in general on the time measurement of complete cycles, whereby a new measurement is started at each voltage zero passage. The influence of harmonics on the measuring result is thus minimized.

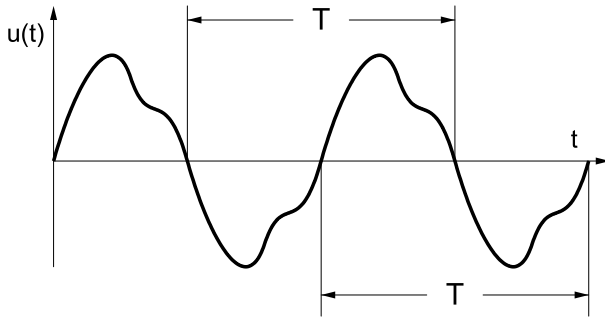


Figure 4.3: Determination of cycle duration by means of zero passages.

In order to avoid false tripping during occurrence of interference voltages and phase shifts the relay works with an adjustable measuring repetition (see chapter 6.2.3)

Frequency tripping is sometimes not desired by low measured voltages which for instance occur during alternator acceleration. All frequency supervision functions can be blocked with the aid of an adjustable voltage threshold UB in case the measured voltage value is below this value.

## 4.5 Measuring of frequency gradient

Electrical generators running in parallel with the mains, e.g. industrial internal power supply plants, should be separated from the mains when failure in the intra-system occurs for the following reasons:

- It must be prevented that the electrical generators are damaged when mains voltage recovering asynchrone, e.g. after a short interruption.
- In order to prevent uncontrollable islands, users generating their own power must decouple from the remaining faulty grid.

A reliable criterion of detecting mains failure is the measurement of the rate of change of frequency  $df/dt$ . Precondition for this is a load flow via the mains coupling point. At mains failure the load flow changing then spontaneously leads to an increasing or decreasing frequency in the grid island. At active power deficit of the internal power station a linear drop of the frequency occurs and a linear increase occurs at power excess this assumption is valid within a time window of some 100 milliseconds, because regulator effects become here not marked out yet. Typical frequency gradients during application of "mains decoupling" are in the range of 0.5 Hz/s up to over 2 Hz/s. The XRW1-4 detects the instantaneous frequency gradient  $df/dt$  of each mains voltage period in an interval of one half period each. Through multiple evaluation of the frequency gradient in sequence the continuity of the directional change (sign of the frequency gradient) is determined. Because of this special measuring procedure a high safety in tripping and thus a high stability against transient processes, e.g. switching procedure are reached. The total switching off time at mains failure is usually approx. 100 ms ( $T = 4$ ) depending on the setting.

## 4.6 Voltage threshold value for frequency measuring

At low measuring voltages, e.g. during generator start-up, frequency and  $df/dt$ -measuring is perhaps not desired.

By means of the adjustable voltage threshold value  $U_{B<}$ , functions  $f_1 - f_3$  and  $df/dt$  are blocked if the measured voltage falls below the set value.

## 4.7 Blocking function

No.	Dynamic Behaviour	$U1< - U4<$	$U1> - U4>$	$f_1, f_2, f_3$	$df/dt$
1	voltage to external blocking input is applied	free programmable	free programmable	free programmable	free programmable
2	blocking input is released	released instantaneously	released instantaneously	released after 1 s	released after 5 s
3	supply voltage is switched on	blocked for 200 ms	blocked for 200 ms	blocked for 1 s	blocked for 1 s
4	3-phase measuring voltage is suddenly applied	released	released	blocked for 1 s	blocked for 5 s
5	one or several measuring voltages are switched off suddenly (phase failure)	released	released	blocked	blocked
6	measuring voltage smaller $U_{B<}$ (adjustable voltage threshold value)	released	released	blocked	blocked

Table 4.1: Dynamic behaviour of XRW1-4 functions

### Blocking function set in compliance with requirements:

The XRW1-4 has an external blocking input. By applying the auxiliary voltage to input C1/C1L or C1/C1H, the requested protection functions of the relay are blocked.



## 5. Operation and setting

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.

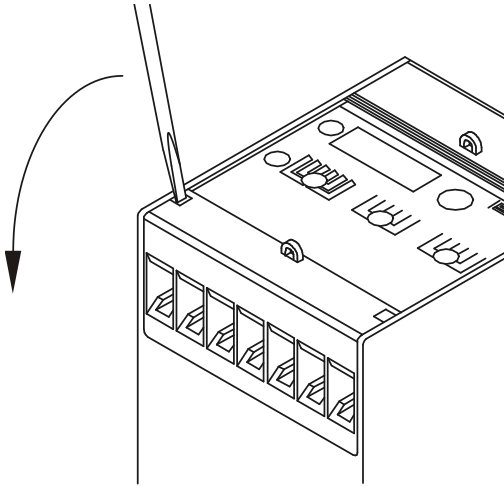


Figure 5.1: How to open the transparent cover

### 5.1 Push buttons

Push buttons are used for calling up the parameters to be processed, for selection of measuring parameters to be indicated and for changing and storing the parameters.

The individual setting and measuring values can be selected one after another by pressing push button <SELECT/RESET>. This push button is also used for re-setting the display by pressing approx. 3s.

Push buttons <+> <-> are used for in-/decrementing of the parameter indicated on the display. They can be pressed step-by-step or continuously.

After the selected parameter is set by the <+> <-> push button it may be stored using the <ENTER> push button.

Through the push button <ENTER> the set value indicated on the display will be transferred to the internal parameter memory. An unintended or unauthorized change of the selected parameter is avoided by means of a password identification (see 5.4.2).

The <TRIP>-push button is used to test the output relay circuits both for tripping and signalling. During normal operation it is also interlocked by means of the pass-word identification.

### 5.1.1 Indication of measuring values and fault data

#### Indication in faultless condition

In normal operation the display always shows |WW. After pressing the push button <SELECT/RESET> the display switches cyclically to the next measuring value. After the measuring values had been indicated the setting parameters are displayed. Hereby the LEDs left to the display section signalize which measured value is indicated, the LEDs in the left end of the front section signalize which setting parameter is indicated on the display. Longer actuating the push button resets the re-lay and the display changes into normal operation (WW).

#### Indication after pickup/tripping

All of the faults detected by the relay are indicated on the front plate optically. Here not only the faults are indicated but also the faulty phase(s) and the protection function in operation. During pick-up LEDs are flashing, after tripping this changes to continuous light.

In tripped condition "TRIP" appears on the display and the LEDs of the operating measuring data light up red together with the LEDs of the tripping parameter. All operating data, which were measured at the moment of tripping, can now be called one after another by pressing push button <SELECT/RESET>. If in this condition setting parameters are to be indicated, push button <ENTER> has to be pressed.

The graphic below shows again the difference between the different display modes.

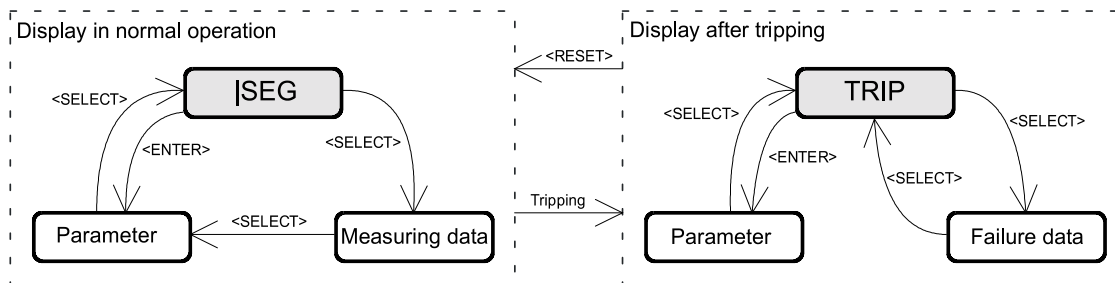


Figure 5.2: Switching over of the display in dependence of the operating mode.

## 5.2 DIP switches

On the front plate of the XRW1-4-relay there are DIP switches to preset the following functions:

- Password programming
- Output relay functions

### 5.2.1 Function of the output relays

The following functions of the output relays can be preset:

- Alarm relay activation at pickup or after tripping of the relay
- Reset of the output relays manually or automatically

The alarm relays are activated according to the preset-ting:

#### Dip switch 2 OFF:

The alarm relays pickup directly with energizing of the corresponding measuring circuit. Thus, an alarm signaling can be given before the relay trips.

#### Dip switch 2 ON:

The alarm relays pickup only after relay trip. That means: the trip relay and the corresponding alarm relay pickup at the same time after the time delay elapsed.

#### Dip switch 3 OFF:

All output relays will be reset automatically after the fault has been rectified, (e.g. when the fault current is interrupted).

#### Dip switch 3 ON:

All output relays remains activated and must be reset after fault clearance.

- Manually: By pressing push button <SELECT/RESET>
- External: By connecting aux. voltage to C2/C2L or C2/C2H
- Via RS 485 interface

#### Note:

To let the parameter change take effect, the auxiliary voltage has to be switched off and on again after the dip switches are plugged or unplugged.

Dip switch	Function	Dip switch position	Operation mode
1	Password	OFF	Normal position
		ON	Password selection
2	Alarm relays	OFF	Alarm relays will be activated at pickup
		ON	Alarm relay will be activated at tripping
3	Reset	OFF	Output relays will be reset automatically
		ON	Output relays will be reset manual/external/via software
4	none		

Table 5.1: Summary of coding possibilities

## 5.3 Reset

### Manual reset

By pressing push button <RESET/SELECT> for some time (about 3 s).

### External reset-input C2/C2L or C2/C2H

The external reset input has the same function as the <SELECT/RESET> push button on the front plate. Connecting auxiliary voltage to this input, the unit can be reset, provided that the fault is removed.

### Software reset via serial interface RS 485

Software reset has the same function as push button <SELECT/RESET>. Please refer to open data protocol of RS 485 interface named RS485-PRO.

## 5.4 Password

### 5.4.1 Password programming

The XRW1-4-relay is delivered with the preset pass-word "++++", it can be programmed new with dip switch 1: Apply dip switch 1. After power on and pressing any push button, the relay XRW1-4 inquires for a new password. The text "PSW?" appears on the display. The new password is entered by any combination of the push buttons <SELECT> <-> <+> <ENTER>. After the new password is given, the dip switch 1 has to be set off and aux. power must be switched off and on.

### 5.4.2 Using the password

Step by step, a new relay setting is made according to the following sequence:

- After the present setting value is changed with <+><-> push button, <ENTER>-push button should be pressed.
- A message "SAV?" appears on the display to inquire if the new setting value is really wanted to be stored.
- After pressing the <ENTER>-push button again, the password will be inquired by means of the message "PSW?" on the display.
- After the password is given correctly, which is prompted by message "SAV!" on the display, the new setting value can be stored by pressing the <ENTER>-push button for about 3 seconds.
- The new setting value for the selected parameter appears on the display again.

A password consists of four push button operations. The pressed push buttons and their sequences define the password.

<SELECT>	=	S
<->	=	-
<+>	=	+
<ENTER>	=	E

then a password "-E+S" means pressing push buttons according to the following sequence:

<-> <ENTER> <+> <SELECT>

After the password is given correctly, parameter setting is permitted for five minutes. This means: For a subsequent parameter setting, as long as it is made within five minutes after the password input, a renewed password input is not required. Moreover, the valid period for parameter setting is automatically extended to further 5 minutes after each new push button operation.

If no push button operation follows within the five minute period after password input, the validity for parameter setting will be suspended.

For entering further parameters the password is then called up again. During the validity for parameter setting a new set value, after having acknowledged "SAV" two times, is stored by just pressing push button <ENTER> for some time.

As to parameter setting via RS 485 interface: see open data protocol.

## 5.5 Relay setting principle

By pressing push button <ENTER>, the parameter menu can be called up. By pressing push button <SELECT/RESET> the parameter to be set is reached. The corresponding LED lights up. The actual set value of the selected parameter is indicated on the display. The indicated set value can then be changed by pressing push buttons <+><-> (in-/decrementing). The selected set value is stored by pressing push button <ENTER> and by input of the authority code (password) which means the adjustment of the unit is only possible after the password had been put in.  
(see 5.4.2)

After a trip the push button <SELECT/RESET> is re-served for the indication of fault data. Now new parameter setting by means of push button <SELECT/RESET> is only possible by pressing <ENTER> first.

### 5.5.1 Setting of default parameters

Setting of the XRW1-4 default parameters can be done as follows:

- switch off the auxiliary voltage supply
- press simultaneously push buttons <+><-> and <SELECT/RESET> and
- switch on the auxiliary voltage supply again.

### 5.5.2 Blocking the protection functions

The blocking function of the XRW1-4-relays can be set according to requirement. When pressing push buttons <ENTER> and <TRIP> at the same time the blocking menu is entered.

## 5.6 Display of software version and test-TRIP

By pressing push button <TRIP> the first part of the software version is displayed, the second part appears when this push button is pressed again. When push button <TRIP> is pressed repeatedly, the test trip routine starts.

By entering the password the display shows "TRI?". After pressing <TRIP> again all output relays will be energized one after the other with a time delay of 1 s.

All relays stay energized until manual reset.

## 5.7 Low/High range of functions block-ing and reset

All relays of the PROFESSIONAL LINE have a wide-range power supply unit allowing to choose a suitable supply voltage. The operating threshold of the blocking and reset inputs, however, has to be defined by taking the supply voltage into account. The following two different operating thresholds are available:

- Low-range threshold  $U_{AN} \geq 10 \text{ V}$ ;  $U_{AB} \leq 8 \text{ V}$
- High-range threshold  $U_{AN} \geq 70 \text{ V}$ ;  $U_{AB} \leq 60 \text{ V}$

### Connection terminals

- Low-range blockage input terminal C1/C1L
- Low-range reset input terminal C2/C2L
- High-range blockage input terminal C1/C1H
- High-range reset input terminal C2/C2H

## 6. Parameter settings

### 6.1 Adjustable parameters

The following parameters can be set by the user him-self:

$\Delta Y$	-	changing of input transformer connection
U1<	-	Pick-up value for the 1st undervoltage step
tU1<	-	Tripping time for the 1st undervoltage step
tU1 back	-	Reverse run of the 1st tripping time
U2<	-	Pick-up value for the 2nd undervoltage step
tU2<	-	Tripping time for the 2nd undervoltage step
tU2 back	-	Reverse run of the 2nd tripping time
U3<	-	Pick-up value for the 3rd undervoltage step
tU3<	-	Tripping time for the 3rd undervoltage step
tU3 back	-	Reverse run of the 3rd tripping time
U4<	-	Pick-up value for the 4th undervoltage step
tU4<	-	Tripping time for the 4th undervoltage step
tU4 back	-	Reverse run of the 4th tripping time
U1>	-	Pick-up value for the 1st overvoltage step
tU1>	-	Tripping time for the 1st overvoltage step
tU1 back	-	Reverse run of the 1st tripping time
U2>	-	Pick-up value for the 2nd overvoltage step
tU2>	-	Tripping time for the 2nd overvoltage step
tU2 back	-	Reverse run of the 2nd tripping time
U3>	-	Pick-up value for the 3rd overvoltage step
tU3>	-	Tripping time for the 3rd overvoltage step
tU3 back	-	Reverse run of the 3rd tripping time
U4>	-	Pick-up value for the 4th overvoltage step
tU4>	-	Tripping time for the 4th overvoltage step
tU4 back	-	Reverse run of the 4th tripping time
f <sub>N</sub>	-	rated frequency
T	-	frequency measuring repetition in periods
f <sub>1</sub>	-	threshold for frequency element 1
t <sub>f1</sub>	-	tripping delay for frequency element 1
f <sub>2</sub>	-	threshold for frequency element 2
t <sub>f2</sub>	-	tripping delay for frequency element 2
f <sub>3</sub>	-	threshold for frequency element 3
t <sub>f3</sub>	-	tripping delay for frequency element 3
U <sub>B&lt;</sub>	-	voltage threshold value for frequency and vector surge measuring (or df/dt) LED blinking after excitation
RS	-	Slave address of the serial interface
df	-	threshold for rate of frequency (df/dt) in Hz/s
dt	-	measuring repetition for df/dt in periods

## 6.2 Setting procedure

In this paragraph the settings for all relay parameters are described in detail. For parameter saving a pass-word has to be entered (please refer to 5.4).

### 6.2.1 Parameter setting of over- and undervoltage supervision

The setting procedure is guided by two colored LEDs. During setting of the voltage thresholds the LEDs U1, U2, U3 and U4 are light green. During setting of the trip delays tU1, tU2, tU3 and tU4 the according LEDs light up red. The LED's „<“ or „>“ light up yellow. They indicate whether it is an undervoltage or overvoltage parameter.

#### Thresholds of the voltage supervision

During setting of the threshold U1<, U2<, U3<, U4<, U1>, U2>, U3> and U4> the displays shows the value directly in volt.

The undervoltage supervision as well as the overvoltage supervision can be de-activated by setting the threshold to "EXIT".

#### Tripping delay of voltage supervision

When the tripping delays  $t_{U1<}$  -  $t_{U4<}$  and  $t_{U1>}$  -  $t_{U4>}$  are adjusted, the display shows a value in units of seconds. The tripping delay can be adjusted by means of the <+> and <-> keys, for the stages  $t_{U3<}$ ,  $t_{U4<}$ ,  $t_{U3>}$ ,  $t_{U4>}$  from 0.04s to 300s and for the stages  $t_{U1<}$ ,  $t_{U2<}$ ,  $t_{U1>}$ ,  $t_{U2>}$  from 0.2s to 1500s. The set values can be stored by means of the <ENTER> key.

When setting the tripping delay to "EXIT" the value is infinity meaning only warning, no tripping.

#### Reversal of delay time

After the pickup point has been passed, the delay time starts to run. If the pickup point is fallen short of again during the excitation phase, it is possible to choose whether the expired delay time is reset complete (setting „no“) or whether the delay timer runs reversed to zero (setting „yes“). This is useful at very long delay times to prevent resetting the complete timer with only a few measurements in good range. The setting can be separately adjusted for the tripping stages  $t_{U1<}$  -  $t_{U4<}$  and  $t_{U1>}$  -  $t_{U4>}$ , using the <+> and <-> keys.

### 6.2.2 Setting of nominal frequency

First the nominal frequency (50 or 60 Hz) has to be correctly set before unit XRW1-4 is put into operation. All frequency functions are determined by setting the nominal frequency, i.e. whether the set frequency thresholds are evaluated as over- or underfrequency (see also chapter 6.2.4). Also the cycle duration (20 ms at 50 Hz and 16.67 ms at 60 Hz) derives from this setting which determines the minimum tripping delay for frequency elements f1 - f3 with an adjustable multiplier (see also chapter 6.2.5). During setting of the nominal frequency a value in Hz is shown on the display.



### 6.2.3 Number of measuring repetitions (T) for frequency functions

In order to avoid false tripping of the unit at short voltage drops of the system voltage or interference voltages, XRW1-4 works with an adjustable measuring repetition. When the instantaneous frequency measuring value exceeds (at overfrequency) or falls below (at underfrequency) the set reference value, the counter is incremented, otherwise the counter is decremented down to the minimum value of 0. Only when the counter exceeds the value adjusted at T, alarm is given and after the tripping delay of the frequency element has elapsed the tripping command is given.

The setting range for T is between 2 - 99.

#### Recommendation for setting:

For short tripping times, e.g. for machine protection or for mains decoupling T should be set in the range from 2 - 5.

At precision measurements, e.g. exact measurement of the system frequency a setting of T in the range from 5 - 10 is recommended.

### 6.2.4 Threshold of frequency supervision

The frequency supervision of XRW1-4 has three frequency elements independent from each other. Acc. to setting the pickup value above or below the nominal frequency, these elements can be used for over- or under frequency supervision.

Dependent on the preset nominal frequency  $f_N$  the pickup values from 30 Hz up to 70 Hz at  $f_N = 50$  Hz and from 40 Hz to 80 Hz at  $f_N = 60$  Hz can be set.

During setting of the pickup values  $f_1 - f_3$  the display shows the values in 1/100 Hz. A value of for instance 49,8 Hz is indicated with "4980".

The function of the individual frequency elements can be deactivated by setting the pickup values to "EXIT". The setting value "EXIT" corresponds to the rated frequency.

### 6.2.5 Tripping delays for the frequency elements

Tripping delays  $t_{f1} - t_{f3}$  of the four frequency elements can be set independently from  $t_{f1min} - 50$  s. The minimum tripping delay  $t_{f1min}$  of the relay depends upon the number of set measuring repetitions T (periods) and amounts to:

T	$t_{f,min}$
2...49	$(T+1) \cdot 20$ ms
50...69	$(T - 49) \cdot 50$ ms + 1 s
70...99	$(T - 69) \cdot 100$ ms + 2 s

When setting the tripping delay to "EXIT" by pressing push button <+> up to the maximum setting value, the corresponding tripping relay is blocked. Pickup of the frequency element is however displayed on the front plate by the corresponding LED, an assigned alarm re-lay is also activated. This setting applies to 50 Hz and 60 Hz.

## 6.2.6 Parameter setting of frequency gradient

The pickup value of frequency gradient (parameter df) can be set between 0.2 to 10 Hz/s. The number of measuring repetitions (parameter dt) can be set between 2 - 64 cycles. This parameter defines the number of df/dt measurements, which have to exceed the set value, before tripping.

### Setting information:

The power difference after mains failure causes a change in frequency, which can approximately be calculated as follows:

$$\frac{df}{dt} = -\frac{f_N}{T_A} \cdot \Delta P$$

with  $f_N$  = rated frequency in Hz  
 $T_A$  = inertia time constant of the generators  
 $\Delta P$  = per unit power deficit with reference to the rated active power of the generators

If the inertia time constant is known and a power difference given, the frequency gradient can be estimated by the a.m. equation. At a supposed power difference of 20% and an inertia time constant of 10 s, the frequency gradient is 1 Hz/s.

To prevent false trippings at loading, deloading or failure signals, we would recommend a setting value for dt of minimum 4 cycles.

## 6.2.7 Voltage threshold value for frequency and df/dt measuring

Correct frequency measuring or vector surge measuring cannot be obtained if the system voltage is very low, for instance during generator start up or voltage failure. False tripping of the XRW1-4 in such cases is prevented by an adjustable voltage threshold  $U_B$ . If the system voltage is below this threshold, these functions of the relay are blocked.

During adjustment of  $U_B$  LEDs f and df light up in the right display part.

## 6.2.8 Display of the activation storage (FLSH/NOFL)

If after an activation the existing voltage drops again below the pickup value, e.g.  $U1>$ , without a trip has been initiated, LED  $U1>$  signals that an activation has occurred by flashing fast. The LED keeps flashing until it is re-set again (push button <RESET>). Flashing can be suppressed when the parameter is set to NOFL.

## 6.2.9 Adjustment of the slave address

The slave address can be set in the range of 1 - 32. During this adjustment the LED RS lights up.

## 6.2.10 Setting procedure for blocking the protection functions

The blocking function of the XRW1-4 can be set according to requirement. By applying the aux. voltage to C1/C1L or C1/C1H, the functions chosen by the user are blocked. Setting of the parameter should be done as follows:

- When pressing push buttons <ENTER> and <TRIP> at the same time, message "BLOC" is displayed (i.e. the respective function is blocked) or "NO\_B" (i.e. the respective function is not blocked). The LEDs allocated to the first protection function U1 and ">" lights red.
- By pressing push buttons <+> <-> the value displayed can be changed.
- The changed value is stored by pressing <ENTER> and entering the password.
- By pressing the <SELECT/RESET> push button, any further protection function which can be blocked is displayed.
- Thereafter the menu is left by pressing <SELECT/RESET> again.

Function	Description	Display	LED
U1<	Undervoltage step 1	BLOC	red
U2<	Undervoltage step 2	BLOC	red
U3<	Undervoltage step 1	BLOC	red
U4<	Undervoltage step 2	BLOC	red
U1>	Overvoltage step 1	NO_B	red
U2>	Overvoltage step 2	NO_B	red
U3>	Overvoltage step 1	NO_B	red
U4>	Overvoltage step 2	NO_B	red
f1	Frequency step 1	BLOC	red
f2	Frequency step 2	BLOC	red
f3	Frequency step 3	NO_B	red
df/dt	Fravient frequency	BLOC	red

Table 6.1: Blockage function for two parameter sets

## 6.3 Indication of measuring values

In normal operation the following measuring values can be displayed:

Voltages (LED L1, L2, L3 green)

- In star connection all phase-to-neutral voltages
- In delta connection all phase-to-phase voltages
- Frequency (LED f green + L1, L2 or L3 green;
- Frequency gradient  $df/dt$  (LED df green)

Min. and max. values since the last reset :

- Frequency (LED f + min or f + max)
- Frequency gradient (LED df + min or df + max)

### 6.3.1 Min./Max.- values

The XRW1-4 offers a minimum/maximum storage for the measuring values of the frequency gradient. These min./max. values are mainly used to appraise the system quality. Always the highest and lowest values of each cycle are measured and stored until the next re-set.

#### **Min./max. frequency measuring :**

The XRW1-4 ascertains the actual frequency from each cycle of the system voltage. These measuring values are entered into the min./max. storage. The latest entered min./max. values replace the previously stored values.

Dependent on the adjustment of dt and tripping delay, it is possible that the stored min./max. values are higher than the tripping threshold without causing a trip. The reason for this is storage of instantaneous values.

#### **Min./Max. measuring of the frequency gradient :**

The procedure described above applies also to storage of min./max. values of  $df/dt$  measurement. Since each instantaneous  $df/dt$  value is stored, high values can occur which, however, do not cause any tripping.

This can for instance happen during switching procedures where high positive and negative  $df/dt$  values occur, but they do not cause any tripping due to the special measuring method.

#### **As to operation:**

After each reset (ref. 6.4) the min./max. storages are cleared. As from this instant there is no time limit for the min./max. storage until the next reset.

By repeatedly pressing the <SELECT/RESET> push but-ton, the measuring values of the min./max. storage can be queried. The respective LEDs light up at the same time; e.g. during minimum frequency is displayed, LEDs "f" and "<" light up.

## 6.4 Fault memory

When the relay is energized or is energized or trips, all fault data and times are stored in a non-volatile memory manner. The XRW1-4 is provided with a fault value recorder for max. five fault occurrences. In the event of additional trippings always the oldest data set is written over. The momentary values are stored in the moment the relay decides to trip.

For fault indication not only the trip values are recorded but also the status of LEDs. Fault values are indicated when push buttons <-> or <+> are pressed during normal measuring value indication.

- Normal measuring values are selected by pressing the <SELECT/RESET> button.
- When then the <-> button is pressed, the latest fault data set is shown. By repeated pressing the <-> button the last but one fault data set is shown etc. For indication of fault data sets abbreviations FLT1, FLT2, FLT3, ... are displayed (FLT1 means the latest fault data set recorded). At the same time the parameter set active at the occurrence is shown.
- By pressing <SELECT/RESET> the fault measuring values can be scrolled.
- By pressing <+> it can be scrolled back to a more recent fault data set. At first FLT8, FLT7, ... are al-ways displayed. When fault recording is indicated (FLT1 etc), the LEDs flash in compliance with the stored trip information, i.e. those LEDs which showed a continuous light when the fault occurred are now blinking to indicate that it is not a current fault. LEDs which were blinking during trip conditions, (element had picked up) just briefly flash.
- If the relay is still in trip condition and not yet reset (TRIP is still displayed), no measuring values can be shown.
- To delete the trip store, the push button combination <SELECT/RESET> and <->, has to be pressed for about 3s. The display shows "wait".

### Recorded fault data:

Measuring	Displayed value	Corresponding LED
Voltage	L1; L2; L3; L1/L2; L2/L3; L3/L1	L1; L2; L3
Frequency	f; f min f max	f; min; max
Frequency changing rate	df	df

### 6.4.1 Reset

All relays have the following three possibilities to reset the display of the unit as well as the output relay at switch position 3=ON.

#### Manual Reset

- Pressing the push button <SELECT/RESET> for some time (about 3 s)

#### Electrical Reset

- Through applying auxiliary voltage to C2/C2L or C2/C2H

#### Software Reset

- The software reset has the same effect as the <SELECT/RESET> push button (see also communication protocol of RS485 interface)

The display can only be reset when the pickup is not present anymore (otherwise "TRIP" remains in display). During resetting of the display the parameters are not affected.

### 6.4.2 Erasure of fault storage

To delete the trip store, the push button combination <SELECT/RESET> and <->, has to be pressed for about 3s. The display shows "wait" during the clearing process.

## 7. Relay testing and commissioning

The following test instructions should help to verify the protection relay performance before or during commissioning of the protection system. To avoid a relay damage and to ensure a correct relay operation, be sure that:

- the auxiliary power supply rating corresponds to the auxiliary voltage on site.
- the rated frequency and rated voltage of the relay correspond to the plant data on site.
- the voltage input circuits are connected to the relay correctly.
- all signal circuits and output relay circuits are connected correctly.

### 7.1 Power-On

#### NOTE!

Prior to switch on the auxiliary power supply, be sure that the auxiliary supply voltage corresponds to the rated data on the type plate.

Switch on the auxiliary power supply to the relay and check that the message "IWW" appears on the display and the self supervision alarm relay (watchdog) is energized (terminals 71 and 74 closed).

It may happen that the relay is tripped because of under voltage condition after power-on. (The message "TRIP" on the display and LED L1, L2, L3 and U< light up red). An undervoltage condition has been detected after power-on, because no input voltages are applied to the relay. In this case:

- Press the push button <ENTER>, thus entering into the setting mode. Now set the parameters U1< to U4< to "EXIT" to block the undervoltage functions. After that, press the <SELECT/RESET> for app. 3 s to reset the LEDs and "TRIP" message.
- The undervoltage tripping after power on can also be eliminated by applying three phase rated voltages after power-on and reset the LED and "TRIP" message.
- Apply auxiliary voltage to the external blocking input (Terminals C1/C1L or C1/C1H) to inhibit the undervoltage functions (refer to 6.2.10) and press the <SELECT/RESET> for app. 3 s to reset the LEDs and "TRIP" message.

### 7.2 Testing the output relays

#### NOTE!

Prior to commencing this test, interrupt the trip circuit to the circuit breaker if tripping is not desired.

By pressing the push button <TRIP> once, the display shows the first part of the software version of the relay (e.g. „D08-“). By pressing the push button <TRIP> twice, the display shows the second part of the software version of the relay (e.g. „4.01“). The software version should be quoted in all correspondence. Pressing the <TRIP> button once more, the display shows "PSW?". Please enter the correct password to proceed with the test. The message "TRI?" will follow. Confirm this message by pressing the push button <TRIP> again. All output relays should then be activated and the self supervision alarm relay (watchdog) be deenergized one after another with a time interval of 1 second. Thereafter, reset all output relays back to their normal positions by pressing the push button <SELECT/RESET>.

### 7.3 Checking the set values

By repeatedly pressing the push button <SELECT>, all relay set values may be checked. Set value modification can be done with the push button <+><-> and <ENTER>.

As relay input energizing quantities, three phase volt-ages should be applied to XRW1-4 relay input circuits. Depending on the system conditions and the voltage transformer used, three voltages can be connected to the relay input circuits with either star or delta connection. In case of a star connection the phase-to-neutral voltage will be applied to the voltage input circuits, while the phase-to-phase voltages will be connected to the voltage input circuits in case of a delta connection. The voltage input connection must be set as a parameter, and should correspond with the actual voltage input connection:

- Star connection: Phase-to-neutral voltages will be measured and evaluated.
- Delta connection: Phase-to-phase voltages will be measured and evaluated.

### 7.4 Secondary injection test

#### 7.4.1 Test equipment

- Voltmeter and frequency meter with class 1 or better
- Auxiliary power supply with the voltage corresponding to the rated data on the type plate
- Three-phase voltage supply unit with frequency regulation (Voltage: adjustable from 0 to  $\geq 1.15 \times U_N$ ; Frequency: adjustable from 40 - 70 Hz)
- Timer to measure the operating time (Accuracy class  $\pm 10$  ms)
- Switching device
- Test leads and tools

#### 7.4.2 Example of test circuit

For testing of the XRW1-4 relay, a three phase voltage source with adjustable voltage and frequency is required. Figure 7.1 shows an example of a three-phase test circuit energizing the XRW1-4 relay during test. The three phase voltages are applied to the relay in Y-connection.

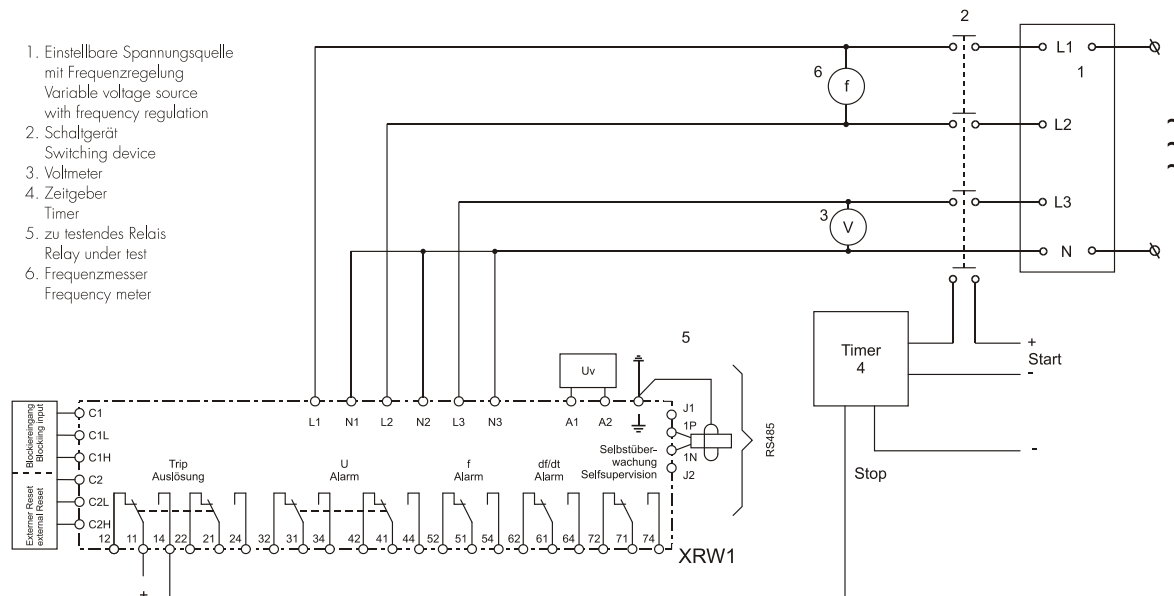


Figure 7.1: Test circuit

For testing the df/dt function of the relay, a special test equipment is required, which produces a constant rate of change of frequency (linear of f-ramp).

### 7.4.3 Checking the input circuits and measuring functions

Apply three voltages of rated value to the voltage input circuits (terminals L1, L2, L3, N1, N2, N3) of the relay. Check the measured voltages, frequency and the rate of change of frequency on the display by pressing the push button <SELECT/RESET> repeatedly.

The voltages are indicated on the display in volts

At Y-connection:

- Phase-to-neutral voltages: LED L1, L2, L3

At Delta-connection:

- Phase-to-phase voltages: LED L1+L2, L2+L3, L3+L1

The frequency is indicated on the display in Hz: LED f (system frequency = 50.01Hz, Indication = 5001). The rate of change of frequency (LED df) is indicated on the display in Hz/s.

Change the voltages around the rated value and check the measured voltages on the display.

Change the system frequency around the rated frequency and check the measured frequency on the display.

Compare the voltage and frequency on display with the signal on voltmeter and frequency meter. The deviation for the voltage must not exceed 1% and for frequency <0.05 Hz.

By using an RMS-metering instrument, a greater deviation may be observed if the test voltage contains harmonics. Because the XRW1-4 relay measures only the fundamental component of the input signals, the harmonics will be rejected by the internal DFFT-digital filter. Whereas the RMS-metering instrument measures the RMS-value of the input signals.

### 7.4.4 Checking the operating and reset-ting values of the over/undervoltage functions

#### Note:

When the measuring voltage is connected or disconnected, df/dt tripping can occur. In order to ensure a trouble-free test procedure, the df/dt function of the relay have to be blocked before tests are started.

Apply three voltages with the rated value and gradually increase (decrease) the voltages until the relay starts, i.e. at the moment when the LED U> (or U<) lights up or the voltage alarm output relay (contact terminals 31/34 and 41/44) is activated. Read the operating voltage indicated by the voltmeter. The deviation must not exceed 1% of the set operating value.

Furthermore, gradually decrease (increase) the voltages until the relay resets, i.e. the voltage alarm output relay is disengaged. Check that the dropout to pickup ratio for voltage is greater than 0.97 (for overvoltage function) or smaller than 1.03 (for undervoltage).

### 7.4.5 Checking the relay operating time of the over/undervoltage functions

To check the relay's operating time, a timer must be connected to the trip output relay contact. The timer should be started simultaneously with the voltage change from sound condition to a faulty condition and stopped by the trip relay contact. The operating time measured by timer should have a deviation about 3% of the set value or <30 ms.



## 7.4.6 Checking the operating and reset-ting values of the over/underfrequency functions

### Note:

Due to frequency changes  $df/dt$  tripping can occur during frequency tests. In order to ensure a trouble-free test procedure, the  $df/dt$  function of the relay has to be blocked before tests are started.

During frequency tests, each of the frequency elements should be tested separately. This makes it necessary that the other frequency elements of the relay have to be blocked by setting the frequency pickup values  $f1 - f3$  to "EXIT". For testing the pickup and dropout to pickup values, the test frequency has to be increased (decreased) until the relay is energized. This is indicated by lighting up of LEDs  $f1 - f3$ .

When comparing the values displayed with those of the frequency meter, the deviation must not exceed 0.05 Hz. The dropout to pickup values are ascertained by increasing (decreasing) the test frequency slowly until the output relay releases.

The dropout to pickup value for overfrequency must be  $>0.98$ , and for underfrequency  $<1.02$ .

## 7.4.7 Checking the relay operating time of the over/underfrequency functions

The operating time of the over/underfrequency functions can be tested in the similar manner as in chapter 7.4.5 for over/undervoltage functions.

## 7.4.8 Checking the tripping and reset values of the $df/dt$ stages

The  $df/dt$  function can only be tested with a frequency generator which is capable of producing a defined linear frequency gradient. The step speed of the frequency generator must be  $< 10$  ms. The tripping value of the frequency gradient can be tested with the following setting values.

Set all frequency stages to "EXIT"  
 $df = 0.5$  Hz/s,  $dt = 10$ ,  $f_N = 50$  Hz,  
 $U_B = 40$  % of  $U_n$

First of all a measuring voltage is applied the value of which must be higher than the voltage threshold for frequency measuring and the  $df/dt$  measuring. After 5 s the  $df/dt$  supervision is released (refer to Chapter 4.7). The frequency generator should now run through a frequency ramp from 50 Hz to 48.6 Hz within 2.0 s which corresponds to a frequency-change speed of  $-0.7$  Hz/s. If the frequency change during the set time  $dt = (T+1) \times 20$  ms is greater than the set trip value  $df$ , tripping will take place. In this case that means after 120 ms with a permissible tolerance of  $\pm 20$  ms. Tripping will also take place if the frequency ramp from 50 Hz to 51.4 Hz within 2 s ( $+0.7$  Hz/s). If the frequency ramp is set from 50 Hz to 49.4 Hz within 2 s ( $0.3$  Hz/s), there must not be any tripping.

## 7.4.9 Checking the external blocking and reset functions

The external blocking input is free programmable by the user.

To test the blocking function apply auxiliary supply voltage to the external blocking input of the relay (terminals C1/C1L or C1/C1H). Inject a test voltage which could cause tripping for the tested functions. Observe that there is no trip and alarm for those functions.

Remove the auxiliary supply voltage from the blocking input. Return the test voltages to the same condition. The display should show "TRIP" now. Remove the test voltages and apply auxiliary supply voltage to the external reset input of the relay (terminals C2/C2L or C2/C2H). The display and LED indications should be reset immediately.

## 7.5 Primary injection test

Generally, a primary injection test could be carried out in the similar manner as the secondary injection test described above. With the difference that the protected power system should be, in this case, connected to the installed relays under test „on line“, and the test voltages should be injected to the relay through the voltage transformers with the primary side energized. Since the cost and potential hazards are very high for such a test, primary injection tests are usually limited to very important protective relays in the power system.

Because of its powerful combined indicating and measuring functions, the XRW1-4 relay may be tested in the manner of a primary injection test without extra expenditure and time consumption.

In actual service, for example, the measured voltage and frequency values on the XRW1-4 relay display may be compared phase by phase with the concerned indications of the instruments of the switchboard to verify that the relay works and measures correctly.

## 7.6 Maintenance

Maintenance testing is generally done on site at regular intervals. These intervals vary among users depending on many factors: e.g. the type of protective relays employed; the importance of the primary equipment being protected; the user's past experience with the relay, etc.

For electromechanical or static relays, maintenance testing will be performed at least once a year according to the experiences. For digital relays like XRW1-4, this interval can be substantially longer. This is because:

- the XRW1-4 relays are equipped with very wide self-supervision functions, so that many faults in the relay can be detected and signalized during service. Important: The self-supervision output relay must be connected to a central alarm panel!
- the combined measuring functions of the XRW1-4 relay enable supervision the relay functions during service.
- the combined TRIP test function of the XRW1-4 relay allows to test the relay output circuits.

A testing interval of two years for maintenance will, therefore, be recommended.

During a maintenance test, the relay functions including the operating values and relay tripping times should be tested.

## 8. Technical data

### 8.1 Measuring input circuits

Rated data:	Nominal voltage	$U_N$	100 V
		$U_N$	690 V
	Nominal frequency $f_N$		50/60 Hz
	Frequency range		40 - 70 Hz
Power consumption in voltage circuit:		<1 VA per channel at rated	
Thermal rating: continuously		2.00 x $U_N$ at $U_N= 100V$ 1.15 x $U_N$ at $U_N= 690V$	
Undervoltage lockout for frequency and df/dt measurement:		adjustable (5%...100% $U_N$ )	

### 8.2 Common data

Dropout to pickup ratio:	for $U>/U>>$ : >99%;	for $U</U<<$ : <101%
	for $f>/f>>$ : >99.98%;	for $f</f<<$ : <100.02%
Dropout time:	60 ms	
Time lag error class E:	$\pm 10$ ms	
Minimum operating time:	$U = 40$ ms	
	$f = 60$ ms	
	$df/dt = 60$ ms	

#### Influences on voltage measuring

Aux. voltage:	in the range $0.8 <U_H/U_{HN} <1.2$ no additional influences to be measured
Frequency:	in the range $0.8 <f/f_N <1.4$ (for $f_N = 50$ Hz) <0.15% / Hz
Harmonics:	up to 20% of the 3rd harmonic <0.1% per percent of the 3rd harmonic up to 20% of the 5th harmonic <0.05% per percent of the 5th harmonic

#### Influences on frequency measuring

Aux. voltage:	in the range $0.8 <U_N/U_{HN} <1.2$ no additional influences to be measured
Frequency:	no influences
Influences on delay time:	no additional influences to be measured

### 8.3 Setting ranges and steps

Function	Parameter	Setting range	Steps	tolerance
Voltage stages U1 – U2	U1< U2< U1> U2>	U <sub>n</sub> = 100V 1...200V (EXIT) U <sub>n</sub> = 690V 4...800V (EXIT)	1V 2V	±1% from setting value or 0.3% of U <sub>N</sub>
	tU1< tU2< tU1> tU2>	0.2...1500s (EXIT)	0,2; 0,5; 1; 2; 5; 10; 20; 50	±1% or 30ms
Voltage stages U3 – U4	U3< U4< U3> U4>	U <sub>n</sub> = 100V 1...200V (EXIT) U <sub>n</sub> = 690V 4...800V (EXIT)	1V 2V	±1% from setting value or 0.3% of U <sub>N</sub>
	tU3< tU4< tU3> tU4>	0.04...300s (EXIT)	0.02; 0.05; 0.1; 0.2; 0.5; 1; 2; 5; 10	±1% or 30ms
Rated frequency	f <sub>N</sub>	f = 50 Hz / f = 60 Hz		
Frequency measuring repetition	T	2...99 (periods)	1	
Frequency element 1 - 3	f <sub>1</sub> - f <sub>3</sub>	30...49,99; EXIT; 50.01...70 Hz <sup>1</sup> 40...59,99; EXIT; 60.01...80 Hz <sup>2</sup>	0.1; 0.01 Hz	0,05 Hz±1% or ±40 ms
	t <sub>f1</sub> - t <sub>f3</sub>	t <sub>f,min</sub> <sup>3</sup> ...50 s; EXIT	0.01, 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0 s	
df/dt-Step	dfdt	0,2...10 Hz/s (EXIT)	0.1; 0.2; 0.5 Hz/s	0.1 Hz/s
df/dt-Measuring repetition		2 64 periods	1	
Voltage threshold for frequency measuring	UB< (LED f+ df)	U <sub>N</sub> = 690 V: 20...400 V	2 V	±1% from setting value or <0.3% U <sub>N</sub>
Serial interface	RS	1 - 32	1	

Table 8.1: Setting ranges and steps

<sup>1</sup> At 50 Hz rated frequency

<sup>2</sup> At 60 Hz rated frequency

<sup>3</sup> t<sub>f,min</sub> min. time delay; see chapter 6.2.5



## 8.7 System data and test specifications

### Design standards:

Generic standard:	EN 50082-2, EN 50081-1
Product standard:	EN 60255-6, IEC 255-4, BS142

### Specified ambient service

temperature limits in operation:	- 25°C to +70°C
storage:	- 25°C to +70°C

Moisture-carrying capacity class F as per DIN 40040 and per DIN IEC 68, part 2-3:	rel. humidity <95% at 40°C for 56 days
---	--

Insulation test voltage, inputs and outputs between themselves and to the relay frame as per EN 60255-6, IEC 255-5:	2.5 kV (eff.)/50 Hz.; 1 min.
---	------------------------------

Impulse test voltage, inputs and outputs between themselves and to the relay frame as per EN 60255-6, IEC 255-5:	5 kV; 1.2/50 µs, 0.5 J
--	------------------------

High frequency interference test voltage, inputs and outputs between themselves and to the relay frame as per EN 60255-6, IEC 255-6:	2.5 kV/1 MHz
--	--------------

Electrical discharge (ESD) test as per EN 61000-4-2, IEC 255-22-1:	8 kV air discharge, 6 kV contact discharge
--	--

Electrical fast transient (Burst) test as per EN 61000-4-8, IEC 255-22-1:	4 kV/2.5 kHz, 15 ms
---	---------------------

### Power frequency magnetic

field immunity test:	100 A/m continuously 1000 A/m for 3 s
----------------------	--

Radiated electromagnetic field disturbance test as per ENV 50140, IEC 255-22-3: electric field strength:	10 V/m
Guided radiated electromagnetic field disturbance test as per ENV 50141:	electric field strength: 10 V/m

Surge immunity test as per EN 61000-4-5: EN 61000-4-5:	2 kV
--	------

Radio interference suppression test as per EN 55011:	limit value class B
--	---------------------

Radio interference radiation test as per EN 55011:	limit value class B
--	---------------------

### Mechanical test:

Shock:	Class 1 as per DIN IEC 255 T 21-2
Vibration:	Class 1 as per DIN IEC 255 T 21-1
Degree of protection:	IP40
Overvoltage class:	III
Weight:	1.6 kg
Relay case material:	self-extinguishing

Technical data subject to change without notice!

## 8.8 Relay case

Relay XRW1-4 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).

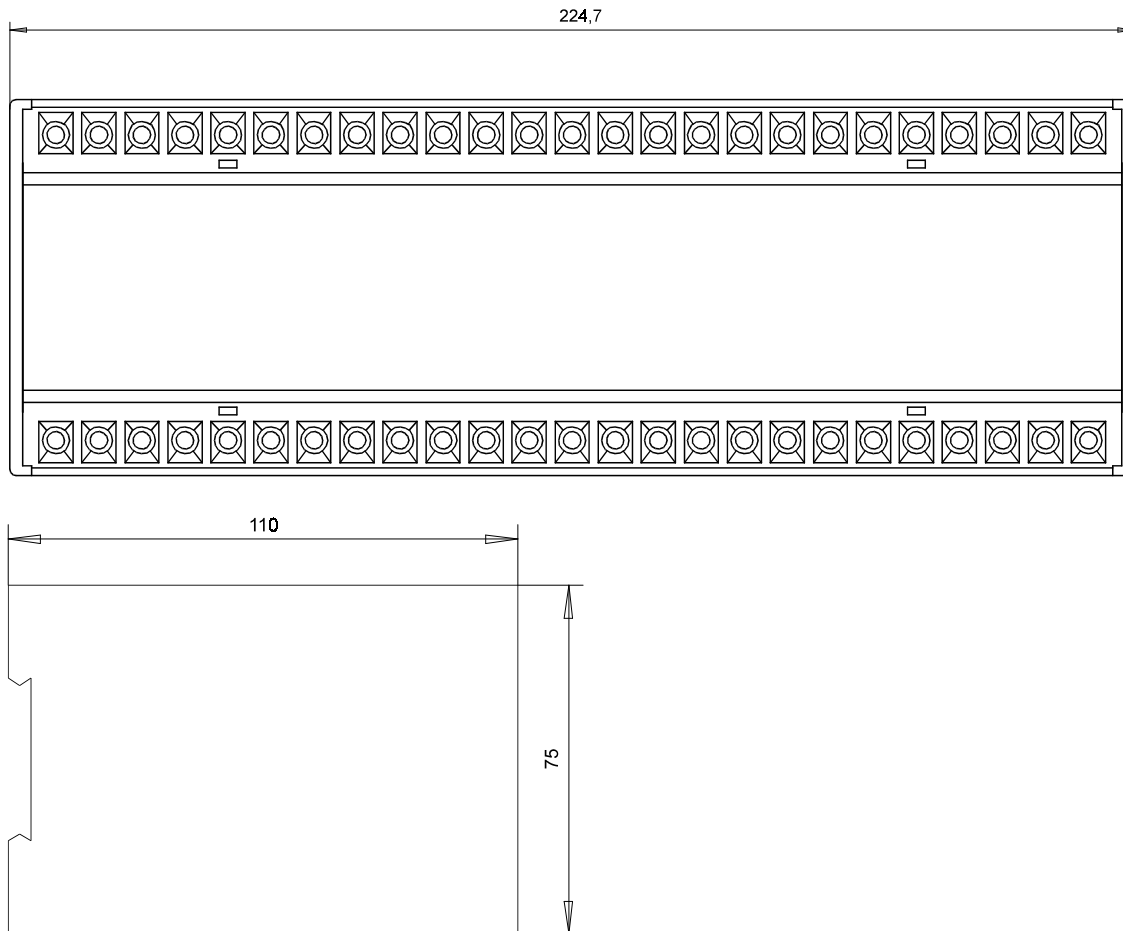


Figure 8.1: Dimensional drawing, dimensions in mm

### Connection terminals

The connection of up to a maximum  $2 \times 2.5 \text{ mm}^2$  cross-section conductors is possible. For this the transparent cover of the unit has to be removed.

# 9. Order form

<b>Mains decoupling relay</b>	<b>XRW1-</b>	<b>4</b>	
Voltage, frequency and df/dt-supervision			
Rated voltage:	100 V		<b>1</b>
	690 V		<b>7</b>

<b>Interface adapter</b>	<b>RSC2-485-232-1</b>	yes	no
Interface adapter RS232 and RS485 (with galvanical decoupling)			

**Important:** For supplying the interface adapter needed:

<b>Plug-in power supply for interface transformer</b>	<b>RSC2-NT1-230</b>	yes	no
230 V 50/60 Hz with german safety plug			

Diagnosis- and parameterizing software	<b>HTL/PL-Soft4</b>	yes	no



## Setting list XRW1-4

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

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

Relay functions: \_\_\_\_\_ Password: \_\_\_\_\_

Function		Unit	Default settings	Actual settings
$\Delta/Y$	input transformer connection		Y	
U1<	Pick-up value for the 1st undervoltage step	V	95/654	
tU1<	Tripping time for the 1st undervoltage step	s	0.20	
tU1< back	Reverse run of the 1st tripping time is active		YES	
U2<	Pick-up value for the 2nd undervoltage step	V	90/620	
tU2<	Tripping time for the 2nd undervoltage step	s	0.20	
tU2< back	Reverse run of the 2nd tripping time is active		YES	
U3<	Pick-up value for the 3rd undervoltage step	V	85/586	
tU3<	Tripping time for the 3rd undervoltage step	s	0.04	
tU3< back	Reverse run of the 3rd tripping time is active		NO	
U4<	Pick-up value for the 4th undervoltage step	V	80/552	
tU4<	Tripping time for the 4th undervoltage step	s	0.04	
tU4< back	Reverse run of the 4th tripping time is active		NO	
U1>	Pick-up value for the 1st overvoltage step	V	105/724	
tU1>	Tripping time for the 1st overvoltage step	s	0.20	
tU1> back	Reverse run of the 1st tripping time is active		YES	
U2>	Pick-up value for the 2nd overvoltage step	V	110/760	
tU2>	Tripping time for the 2nd overvoltage step	s	0.20	
tU2> back	Reverse run of the 2nd tripping time is active		YES	
U3>	Pick-up value for the 3rd overvoltage step	V	115/792	
tU3>	Tripping time for the 3rd overvoltage step	s	0.04	
tU3> back	Reverse run of the 3rd tripping time is active		NO	
U4>	Pick-up value for the 4th overvoltage step	V	120/800	
tU4>	Tripping time for the 4th overvoltage step	s	0.04	
tU4> back	Reverse run of the 4th tripping time is active		NO	
fN	rated frequency	Hz	50	
T	frequency measuring repetition in periods	periods	4	
f <sub>1</sub>	pickup value for frequency element 1	Hz	4800	
t <sub>f1</sub>	tripping delay for frequency element 1	s	0.1	
f <sub>2</sub>	pickup value for frequency element 2	Hz	4900	
t <sub>f2</sub>	tripping delay for frequency element 2	s	0.1	
f <sub>3</sub>	pickup value for frequency element 3	Hz	5100	
t <sub>f3</sub>	tripping delay for frequency element 3	s	0.1	
df	pickup value for rate of change of frequency (dt/dt) in	Hz/s	0.2	
dt	measuring repetition for df/dt	periods	4	
U <sub>B</sub> <	voltage threshold value for frequency or df/dt)	V	40	
	LED blinking after excitation		FLSH	
RS	Slave address of the serial interface		1	

\* Setting dependent on rated voltage 100V or 690 V

**Blockage function**

	Default setting		Actual setting	
	Blocked	Not blocked	Blocked	Not blocked
U1<	X			
U2<	X			
U3<	X			
U4<	X			
U1>			X	
U2>			X	
U3>			X	
U4>			X	
f1	X			
f2	X			
f3			X	
df/dt	X			

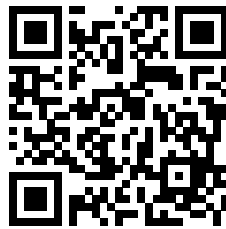
**Setting of dip switches**

Dip switch	1 (PSW)		2		3		4	
	Default setting	Actual setting	Default setting	Actual setting	Default setting	Actual setting	Default setting	Actual setting
ON							no function	
OFF	X		X		X		X	

This technical manual is valid for software version number: D04-7.40

# Professional Line

[https://docs.SEGelectronics.de/xrw1\\_4](https://docs.SEGelectronics.de/xrw1_4)



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