VAMP 260

Power monitoring unit

Publication version: V260/en M/B013

User Manual

Schneider Electric

Trace back information:
Workspace Main version a123
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Skribenta version 4.6.006

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1 General

1.1 Legal notice

Copyright

Disclaimer

No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this document. This document is not intended as an instruction manual for untrained persons. This document gives instructions on device installation, commissioning and operation. However, the manual cannot cover all conceivable circumstances or include detailed information on all topics. In the event of questions or specific problems, do not take any action without proper authorization. Contact Schneider Electric and request the necessary information.

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1.2 Safety information and password protection

Important Information

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service or maintain it. The following special messages may appear throughout this bulletin or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER
DANGER indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING
WARNING indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

⚠ CAUTION
CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

NOTICE
NOTICE is used to address practices not related to physical injury.

User qualification

Electrical equipment should be installed, operated, serviced, and maintained only by trained and qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material. A qualified person is one who has skills and knowledge related to the construction, installation, and operation of electrical equipment and has received safety training to recognize and avoid the hazards involved.

Password protection

Use IED's password protection feature in order to protect untrained person interacting this device.

⚠ WARNING

WORKING ON ENERGIZED EQUIPMENT

Do not choose lower Personal Protection Equipment while working on energized equipment.

Failure to follow these instructions can result in death or serious injury.

1.3 Unit features

The VAMP 260 power-monitoring unit is a compact multi-function monitoring device with extensive measuring and calculation functions. The unit is based on the same hardware and software as the protection relays. The setting and programming possibilities are comprehensive and versatile. The VAMP 260 is ideal for utility, industrial, marine and off-shore power distribution management.

The unit measures currents, voltages and frequencies and calculates following values:

- Active, reactive and apparent power
- Active and reactive energy
- Harmonics and THD of currents and voltages
- Programmable average value calculations
- Four energy pulse outputs

Further, the unit includes 6 freely configurable digital or analogue channels and a disturbance recorder.

The unit communicates with other systems using common protocols, such as the ModBus RTU, ModBus TCP, Profibus DP, IEC 61850, IEC 60870-5-101 , IEC 60870-5-103 and it can be connected to a fibre-optic SPA bus.

⚠ WARNING

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

A live current transformer secondary circuit must not be opened without turning off the primary side of the transformer and short circuiting transformer secondary circuits first

Failure to follow these instructions can result in death, serious injury, or equipment damage

1.4 Related documents

Document	Identification*)
VAMP Relay Mounting and Commissioning Instructions	VRELAY_MC_xxxx
VAMPSET Setting and Configuration Tool User Manual	VVAMPSET_EN_M_xxxx

**) xxxx = revision number*

Download the latest software and manual at www.schneider-electric.com/vamp-protection or m.vamp.fi.

1.5 Abbreviations

ANSI	American National Standards Institute. A standardization organisation.
cosφ	Active power divided by apparent power = P/S. (See power factor PF). Negative sign indicates reverse power.
CT	Current transformer
DI	Digital input
DO	Digital output, output relay
Document file	Stores information about the IED settings, events and fault logs.
DSR	Data set ready. An RS232 signal. Input in front panel port of VAMP relays to disable rear panel local port.
DST	Daylight saving time. Adjusting the official local time forward by one hour for summer time.
DTR	Data terminal ready. An RS232 signal. Output and always true (+8 Vdc) in front panel port of VAMP relays.
FFT	Fast Fourier transform. Algorithm to convert time domain signals to frequency domain or to phasors.
HMI	Human-machine interface
I_N	Nominal current. Rating of CT primary or secondary.
IEC	International Electrotechnical Commission. An international standardization organisation.
IEC-101	Abbreviation for communication protocol defined in standard IEC 60870-5-101
IEC-103	Abbreviation for communication protocol defined in standard IEC 60870-5-103
IED	Intelligent electronic device
IEEE	Institute of Electrical and Electronics Engineers
LAN	Local area network. Ethernet based network for computers and IEDs.
LCD	Liquid crystal display
LED	Light-emitting diode
Local HMI	IED front panel with display and push-buttons
NTP	Network Time Protocol for LAN and WWW
P	Active power. Unit = [W]
PF	Power factor. The absolute value is equal to cosφ, but the sign is '+' for inductive i.e. lagging current and '-' for capacitive i.e. leading current.
PT	See VT
pu	Per unit. Depending of the context the per unit refers to any nominal value. For example for overcurrent setting 1 pu = 1 x I_{GN}.
Q	Reactive power. Unit = [var] acc. IEC

RMS	Root mean square
S	Apparent power. Unit = [VA]
SF	IED status inoperative
SNTP	Simple Network Time Protocol for LAN and WWW
THD	Total harmonic distortion
U_A	Voltage input for U_{12} or U_{L1} depending of the voltage measurement mode
U_B	Voltage input for U_{23} or U_{L2} depending of the voltage measurement mode
U_C	Voltage input for U_{31} or U_0 depending of the voltage measurement mode
U_N	Nominal voltage. Rating of VT primary or secondary
UTC	Coordinated Universal Time (used to be called GMT = Greenwich Mean Time)
VAMPSET	Configuration tool for VAMP protection devices
Webset	http configuration interface
VT	Voltage transformer i.e. potential transformer PT
VT_{PRI}	Nominal primary value of voltage transformer
VT_{SEC}	Nominal secondary value of voltage transformer

1.6 Periodical testing

The protection IED, cabling and arc sensors must periodically be tested according to the end-user's safety instructions, national safety instructions or law. Manufacturer recommends functional testing being carried minimum every five (5) years.

It is proposed that the periodic testing is conducted with a secondary injection principle for those protection stages which are used in the IED.

1.7 EU directive compliance

EMC compliance

CE 2014/30/EU

Compliance with the European Commission's EMC Directive. Product Specific Standards were used to establish conformity:

- EN 60255-26: 2013

Product safety

CE 2014/35/EU

Compliance with the European Commission's Low Voltage Directive. Compliance is demonstrated by reference to generic safety standards:

- EN60255-27:2014

2 Local panel user interface

2.1 Relay front panel

The figure below shows, as an example, the front panel of the device and the location of the user interface elements used for local control.

1. Navigation push-buttons
2. LED indicators
3. LCD
4. RS 232 serial communication port for PC

Navigation push-button function

 CANCEL push-button for returning to the previous menu. To return to the first menu item in the main menu, press the button for at least three seconds.

 INFO push-button for viewing additional information, for entering the password view and for adjusting the LCD contrast.

ENTER push-button for activating or confirming a function.

 arrow UP navigation push-button for moving up in the menu or increasing a numerical value.

 arrow DOWN navigation push-button for moving down in the menu or decreasing a numerical value.

 arrow LEFT navigation push-button for moving backwards in a parallel menu or selecting a digit in a numerical value.

 arrow RIGHT navigation push-button for moving forwards in a parallel menu or selecting a digit in a numerical value.

LED indicators

The relay is provided with eight LED indicators:

LED indicator	Meaning	Measure/ Remarks
Power LED lit	The auxiliary power has been switched on	Normal operation state
Error LED lit	An internal unit fault has been detected	The relay attempts to reboot [REBOOT]. If the error LED remains lit, call for maintenance.
Com LED lit or flashing	The serial bus is in use and transferring information	Normal operation state
Alarm LED lit	Application related status indicators.	
Trip LED lit	Application related status indicators.	
A- C LED lit	Application-related status indicators.	

Adjusting LCD contrast

1. On the local HMI, push i and OK.
2. Enter the four-digit password and push OK.
3. Push i and adjust the contrast.
   - To increase the contrast, push △.
   - To decrease the contrast, push ▽.
4. To return to the main menu, push ⌂.

Resetting latched indicators and output relays

All the indicators and output relays can be given a latching function in the configuration.

There are several ways to reset latched indicators and relays:

- From the alarm list, move back to the initial display by pushing ⌂ for approx. 3s. Then reset the latched indicators and output relays by pushing OK.
- Acknowledge each event in the alarm list one by one by pushing OK equivalent times. Then, in the initial display, reset the latched indicators and output relays by pushing OK.

The latched indicators and relays can also be reset via a remote communication bus or via a digital input configured for that purpose.

2.1.1 Display

The VAMP 260 is provided with a backlit LCD dot matrix display. The display is divided into sections as shown in the next figure.

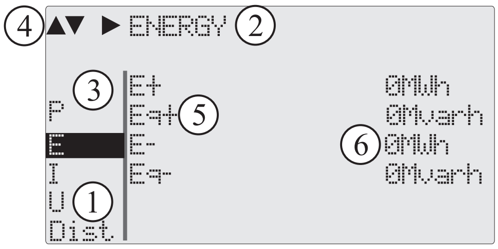


Figure 2.1: Sections of the LCD dot matrix display

1. Main menu column
2. The heading of the active menu
3. The cursor of the main menu
4. Possible navigating directions (push buttons)
5. Measured/setting parameter
6. Measured/set value

Backlight control

Display backlight can be switched on with a digital input, virtual input or virtual output. LOCALPANEL CONF/**Display backlight ctrl** setting is used for selecting trigger input for backlight control. When the selected input activates (rising edge), display backlight is set on for 60 minutes.

2.1.2 Adjusting display contrast

The readability of the LCD varies with the brightness and the temperature of the environment. The contrast of the display can be adjusted via the PC user interface, see Chapter 3 VAMPSET PC software.

2.2 Local panel operations

The local panel can be used to read measured values, to set parameters and to configure unit functions. Some parameters, however, can only be set by means of a PC connected to one of the local communication ports. Further some parameters are factory set.

Moving in the menus

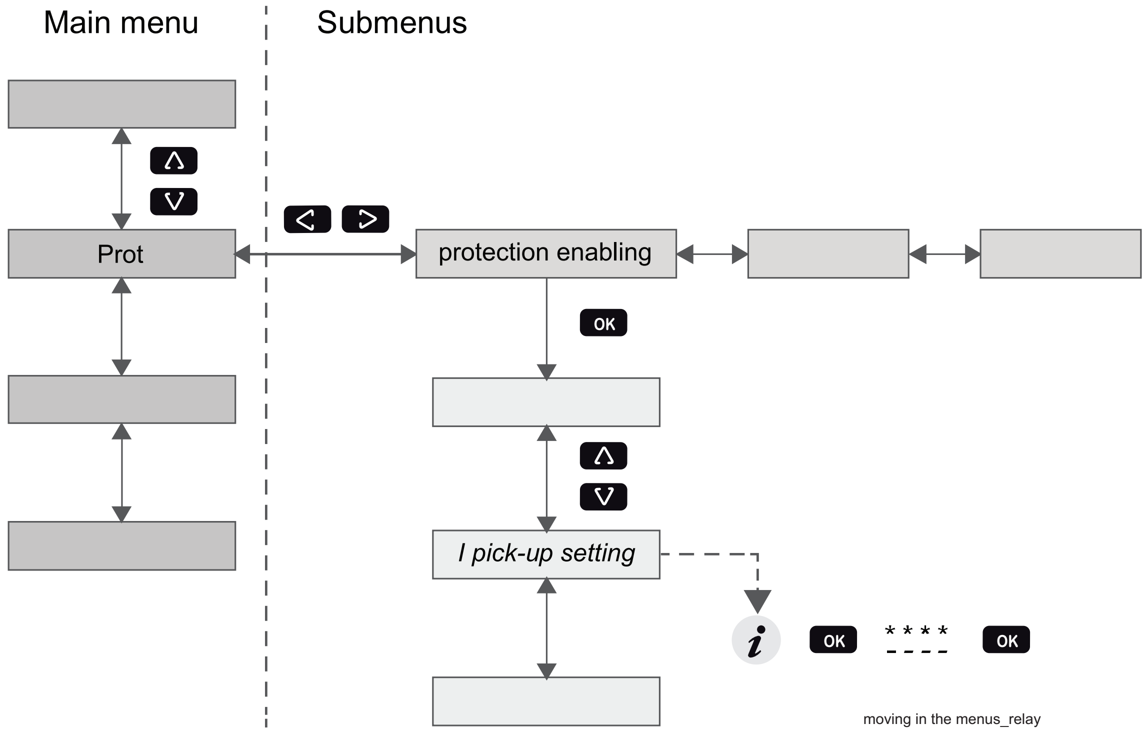


Figure 2.2: Moving in the menus using local HMI

- To move in the main menu, push ∧ or ∨.
- To move in submenus, push > or <.
- To enter a submenu, push OK and use ∨ or ∧ for moving down or up in the menu.
- To edit a parameter value, push *i* and OK .
- To go back to the previous menu, push .
- To go back to the first menu item in the main menu, push for at least three seconds.

NOTE: To enter the parameter edit mode, give the password. When the value is in edit mode, its background is dark.

Main menu

The menu is dependent on the user's configuration and the options according the order code. For example only the enabled protection stages will appear in the menu.

Table 2.1: A list of the local main menu

Main menu	Number of menus	Description	Note
	1	Interactive mimic display	1
	5	Double size measurements defined by the user	1
	1	Title screen with device name, time and firmware version.	
P	14	Power measurements	
E	5	Energy measurements	
I	14	Current measurements	
U	19	Voltage measurements	
Dema	15	Demand values	
Umax	8	Time stamped min & max of voltages	
Imax	7	Time stamped min & max of currents	
Pmax	5	Time stamped min & max of power and frequency	
Month	19	Maximum values of the last 31 days and the last twelve months	
Evnt	2	Events	
DR	3	Disturbance recorder	2
Runh	2	Running hour counter. Active time of a selected digital input and time stamps of the latest start and stop.	
TIMR	6	Day and week timers	
DI	5	Digital inputs including virtual inputs	
DO	4	Digital outputs (relays) and output matrix	
ExtAI	3	External analogue inputs	3
ExtAO	3	Externa analogue outputs	3
ExDI	3	External digital inputs	3
ExDO	3	External digital outputs	3
AO	5	Analogue outputs	
Alrm	5	Alarm stages	
Prg1	3	1st programmable stage	4
Prg2	3	2nd programmable stage	4
Prg3	3	3rd programmable stage	4
Prg4	3	4th programmable stage	4
Prg5	3	5th programmable stage	4
Prg6	3	6th programmable stage	4
Prg7	3	7th programmable stage	4
Prg8	3	8th programmable stage	4
OBJ	11	Object definitions	5
Lgic	2	Status and counters of user's logic	1
CONF	9+1	Device setup, scaling etc.	6
Bus	12	Serial port and protocol configuration	7

Main menu	Number of menus	Description	Note
Diag	8	Device selfdiagnosis	

Notes

1. Configuration is done with VAMPSET
2. Recording files are read with VAMPSET
3. The menu is visible only if protocol "ExternalIO" is selected for one of the serial ports. Serial ports are configured in menu "Bus".
4. The menu is visible only if the stage is enabled.
5. Objects are circuit breakers, disconnectors etc. Their position or status can be displayed and controlled in the interactive mimic display.
6. There are two extra menus, which are visible only if the access level "operator" or "configurator" has been opened with the corresponding password.
7. Detailed protocol configuration is done with VAMPSET.

2.2.1 Operating levels

The relay has three operating levels: **User level**, **Operator level** and **Configurator level**. The purpose of the access levels is to prevent accidental change of relay configurations, parameters or settings.

USER level

Use:	Possible to read e.g. parameter values, measurements and events
Opening:	Level permanently open
Closing:	Closing not possible

OPERATOR level

Use:	Possible to control objects and to change e.g. the settings of the protection stages
Opening:	Default password is 1
Setting state:	Push OK
Closing:	The level is automatically closed after 10 minutes idle time. Giving the password 9999 can also close the level.

CONFIGURATOR level

Use:	The configurator level is needed during the commissioning of the relay. E.g. the scaling of the voltage and current transformers can be set.
Opening:	Default password is 2
Setting state:	Push OK
Closing:	The level is automatically closed after 10 minutes idle time. Giving the password 9999 can also close the level.

Opening access

1. Push i and OK on the front panel

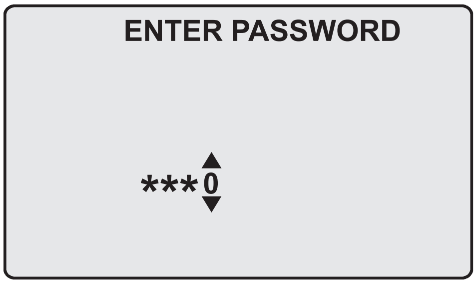


Figure 2.3: Opening the access level

2. Enter the password needed for the desired level: the password can contain four digits. The digits are supplied one by one by first moving to the position of the digit using ▷ and then setting the desired digit value using △.
3. Push OK.

Password handling

The passwords can only be changed using VAMPSET software connected to the local RS-232 port on the relay.

It is possible to restore the password(s) in case the password is lost or forgotten. In order to restore the password(s), a relay program is needed. The virtual serial port settings are 38400 bps, 8 data bits, no parity and one stop bit. The bit rate is configurable via the front panel.

Command	Description
get pwd_break	Get the break code (Example: 6569403)
get serno	Get the serial number of the relay (Example: 12345)

Send both the numbers to your nearest Schneider Electric Customer Care Centre and ask for a password break. A device specific break code is sent back to you. That code will be valid for the next two weeks.

Command	Description
set pwd_break=4435876	Restore the factory default passwords ("4435876" is just an example. The actual code should be asked from your nearest Schneider Electric Customer Care Centre.)

Now the passwords are restored to the default values (See Chapter 2.2.1 Operating levels).

2.3 Operating measures

2.3.1 Measured data

The measured values can be read from the P, E, I and U menus and their submenus. Furthermore, any measurement value in the following table can be displayed on the main view next to the single line diagram. Up to six measurements can be shown.

Value	Menu/Submenu	Description
P	P/POWER	Active power [kW]
Q	P/POWER	Reactive power [kvar]
S	P/POWER	Apparent power [kVA]
φ	P/POWER	Active power angle [°]
P.F.	P/POWER	Power factor
f	P/POWER	Frequency [Hz]
Prms	P/RMS POWER	Active power [kW] RMS value
Qrms	P/RMS POWER	Reactive power [kvar] RMS value
Srms	P/RMS POWER	Apparent power [kVA] RMS value
Pda	P/POWER DEMAND	Active power [kW] demand
Qda	P/POWER DEMAND	Reactive power [kvar] demand
Sda	P/POWER DEMAND	Apparent power [kVA] demand
Pfda	P/POWER DEMAND	Power factor demand
fda	P/POWER DEMAND	Frequency [Hz] demand
Prms	P/RMS POWER DEMAND	Active power [kW] demand RMS value
Qrms	P/RMS POWER DEMAND	Reactive power [kvar] demand RMS value
Srms	P/RMS POWER DEMAND	Apparent power [kVA] demand RMS value
PL1	P/POWER/PHASE 1	Active power of phase 1 [kW]
PL2	P/POWER/PHASE 1	Active power of phase 2 [kW]
PL3	P/POWER/PHASE 1	Active power of phase 3 [kW]
QL1	P/POWER/PHASE 1	Reactive power of phase 1 [kvar]
QL2	P/POWER/PHASE 1	Reactive power of phase 2 [kvar]
QL3	P/POWER/PHASE 1	Reactive power of phase 3 [kvar]
SL1	P/POWER/PHASE 2	Apparent power of phase 1 [kVA]
SL2	P/POWER/PHASE 2	Apparent power of phase 2 [kVA]
SL3	P/POWER/PHASE 2	Apparent power of phase 3 [kVA]
PF_L1	P/POWER/PHASE 2	Power factor of phase 1
PF_L2	P/POWER/PHASE 2	Power factor of phase 2
PF_L3	P/POWER/PHASE 2	Power factor of phase 3
CosFii	P/COS & TAN	Cosine phi
TanFii	P/COS & TAN	Tangent phi
cosL1	P/COS & TAN	Cosine phi of phase L1

Value	Menu/Submenu	Description
cosL2	P/COS & TAN	Cosine phi of phase L2
cosL3	P/COS & TAN	Cosine phi of phase L3
Iseq	P/PHASE SEQUENCIES	Actual current phase sequency [OK; Reverse; ??]
Useq	P/PHASE SEQUENCIES	Actual voltage phase sequency [OK; Reverse; ??]
fAdop	P/PHASE SEQUENCIES	Adapted network frequency [Hz]
E+	E/ENERGY	Exported energy [MWh]
Eq+	E/ENERGY	Exported reactive energy [Mvar]
E-	E/ENERGY	Imported energy [MWh]
Eq-	E/ENERGY	Imported reactive energy [Mvar]
RunH	E/ENERGY	Engine running hours [h]
E+.nn	E/DECIMAL COUNT	Decimals of imported energy
Eq.nn	E/DECIMAL COUNT	Decimals of imported energy
E-.nn	E/DECIMAL COUNT	Decimals of imported energy
Ewrap	E/DECIMAL COUNT	Maximum energy counter value
E+	E/E-PULSE SIZES	Pulse size of exported energy [kWh]
Eq+	E/E-PULSE SIZES	Pulse size of exported reactive energy [kvar]
E-	E/E-PULSE SIZES	Pulse size of imported energy [kWh]
Eq-	E/E-PULSE SIZES	Pulse duration of imported reactive energy [ms]
E+	E/E-PULSE DURATION	Pulse duration of exported energy [ms]
Eq+	E/E-PULSE DURATION	Pulse duration of exported reactive energy [ms]
E-	E/E-PULSE DURATION	Pulse duration of imported energy [ms]
Eq-	E/E-PULSE DURATION	Pulse duration of imported reactive energy [ms]
E+	E/ENERGY DOSE	Exported energy trip [MWh]
Timer	E/ENERGY DOSE	Remaining Etrip time [min]
Time	E/ENERGY DOSE	Etrip counting time [min]
P	E/ENERGY DOSE	Active power [kW]
IL1	I/PHASE CURRENTS	Phase current IL1 [A]
IL2	I/PHASE CURRENTS	Phase current IL2 [A]
IL3	I/PHASE CURRENTS	Phase current IL3 [A]
IL1da	I/PHASE CURRENTS	15 min average for IL1 [A]
IL2da	I/PHASE CURRENTS	15 min average for IL2 [A]
IL3da	I/PHASE CURRENTS	15 min average for IL3 [A]
ILRMS	I/RMS CURRENTS	Phase current RMS value
IL1RMS	I/RMS CURRENTS	IL1 current RMS value
IL2RMS	I/RMS CURRENTS	IL2 current RMS value
IL3RMS	I/RMS CURRENTS	IL3 current RMS value
IoCalc	I/SYMMETRIC CURRENTS	Calculated Io [A]
I1	I/SYMMETRIC CURRENTS	Positive sequence current [A]

Value	Menu/Submenu	Description
I2	I/SYMMETRIC CURRENTS	Negative sequence current [A]
I2/I1	I/SYMMETRIC CURRENTS	Negative sequence current related to positive sequence current (for unbalance protection) [%]
THDIL	I/HARM. DISTORTION	Total harmonic distortion of the mean value of phase currents [%]
THDIL1	I/HARM. DISTORTION	Total harmonic distortion of phase current IL1 [%]
THDIL2	I/HARM. DISTORTION	Total harmonic distortion of phase current IL2 [%]
THDIL3	I/HARM. DISTORTION	Total harmonic distortion of phase current IL3 [%]
Diagram	I/HARMONICS of IL1	Harmonics of phase current IL1 [%] (see Figure 2.4)
Diagram	I/HARMONICS of IL2	Harmonics of phase current IL2 [%] (see Figure 2.4)
Diagram	I/HARMONICS of IL3	Harmonics of phase current IL3 [%] (see Figure 2.4)
Uline	U/LINE VOLTAGES	Average value for the three line voltages [V]
U12	U/LINE VOLTAGES	Phase-to-phase voltage U12 [V]
U23	U/LINE VOLTAGES	Phase-to-phase voltage U23 [V]
U31	U/LINE VOLTAGES	Phase-to-phase voltage U31 [V]
UL	U/PHASE VOLTAGES	Average for the three phase voltages [V]
UL1	U/PHASE VOLTAGES	Phase-to-earth voltage UL1 [V]
UL2	U/PHASE VOLTAGES	Phase-to-earth voltage UL2 [V]
UL3	U/PHASE VOLTAGES	Phase-to-earth voltage UL3 [V]
URMS	U/RMS VOLTAGES	Average voltage RMS value [V]
UaRMS	U/RMS VOLTAGES	Voltage input a RMS value [V]
UbRMS	U/RMS VOLTAGES	Voltage input b RMS value [V]
UcRMS	U/RMS VOLTAGES	Voltage input c RMS value [V]
U1	U/SYMMETRIC VOLTAGES	Positive sequence voltage [%]
U2	U/SYMMETRIC VOLTAGES	Negative sequence voltage [%]
U2/U1	U/SYMMETRIC VOLTAGES	Negative sequence voltage related to positive sequence voltage [%]
THDU	U/HARM. DISTORTION	Total harmonic distortion of the mean value of voltages [%]
THDUa	U/HARM. DISTORTION	Total harmonic distortion of the voltage input a [%]
THDUb	U/HARM. DISTORTION	Total harmonic distortion of the voltage input b [%]
THDUc	U/HARM. DISTORTION	Total harmonic distortion of the voltage input c [%]
Diagram	U/HARMONICS of input Ua	Harmonics of voltage input Ua [%] (see Figure 2.4)
Diagram	U/HARMONICS of input Ub	Harmonics of voltage input Ub [%] (see Figure 2.4)

Value	Menu/Submenu	Description
Diagram	U/HARMONICS of input Uc	Harmonics of voltage input Uc [%] (see Figure 2.4)
Count	U/VOLT. INTERRUPTS	Voltage interrupt counter
Prev	U/VOLT. INTERRUPTS	Previous interruption
Total	U/VOLT. INTERRUPTS	Total duration of voltage interruptions [days, hours]
Prev	U/VOLT. INTERRUPTS	Duration of previous interruption
Status	U/VOLT. INTERRUPTS	Voltage status [LOW; NORMAL]

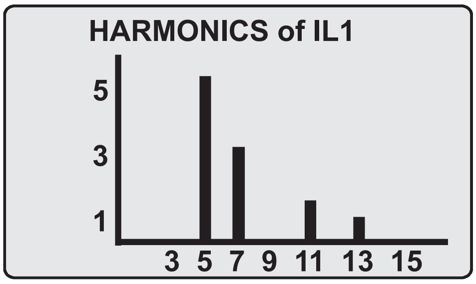


Figure 2.4: Example of harmonics bar display

2.3.2 Reading event register

The event register can be read from the Evnt submenu:

1. Push once.
2. The EVENT LIST appears. The display contains a list of all the events that have been configured to be included in the event register.

Figure 2.5: Example of an event register

3. Scroll through the event list with the and .
4. Exit the event list by pushing .

2.3.3 Forced control (Force)

In some menus it is possible to switch a function on and off by using a force function. This feature can be used, for instance, for testing a certain function. The force function can be activated as follows:

1. Open access level Configurator.
2. Move to the setting state of the desired function, for example DO (see Chapter 2.4 Configuration and parameter setting).
3. Select the Force function (the background color of the force text is black).

VAMP 260 force

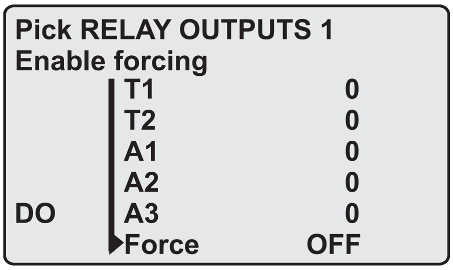


Figure 2.6: Selecting Force function

4. Push OK.
5. Push the △ or ▽ to change the "OFF" text to "ON", that is, to activate the Force function.
6. Push OK to return to the selection list. Choose the signal to be controlled by force with the △ and ▽, for instance the T1 signal.
7. Push OK to confirm the selection. Signal T1 can now be controlled by force.
8. Push the △ or ▽ to change the selection from "0" (not alert) to "1" (alert) or vice versa.
9. Push OK to execute the forced control operation of the selected function, e.g., making the output relay of T1 to pick up.
10. Repeat the steps 7 and 8 to alternate between the on and off state of the function.
11. Repeat the steps 1 – 4 to exit the Force function.
12. Push to return to the main menu.

NOTE: All the interlockings and blockings are bypassed when the force control is used.

2.4 Configuration and parameter setting

The minimum procedure to configure a device is

1. Open the access level "Configurator". The default password for configurator access level is 2.
2. Set the rated values in menu [CONF] including at least current transformers and voltage transformers ratings. Also the date and time settings are in this same main menu.
3. Configure the needed digital outputs in main menu [DO].
4. Configure the needed digital inputs in main menu [DI].
5. Configure the needed analog outputs in main menu [AO].
6. Choose and configure the alarm functions and configure the interlockings in main menu [Alrm].
7. Choose and configure the communication buses in main menu [Bus].

Some of the parameters can only be changed via the RS-232 serial port using the VAMPSET software. Such parameters, (for example passwords, blockings and mimic configuration) are normally set only during commissioning.

Some of the parameters require the restarting of the relay. This restarting is done automatically when necessary. If a parameter change requiresrestarting, the display will show as Figure 2.7

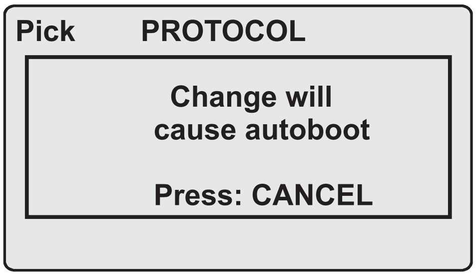


Figure 2.7: Example of auto-reset display

Press to return to the setting view. If a parameter must be changed, press OK again. The parameter can now be set. When the parameter change is confirmed with OK, a [RESTART]- text appears to the top-right corner of the display. This means that auto-resetting is pending. If no key is pressed, the auto-reset will be executed within few seconds.

2.4.1 Parameter setting

1. Move to the setting state of the desired menu (for example CONF/CURRENT SCALING) by pushing OK. The Pick text appears in the upper-left part of the display.
2. Enter the password associated with the configuration level by pushing i and then using the arrow keys and OK (default value is 0002).
3. Scroll through the parameters using the △ and ▽. A parameter can be set if the background color of the line is black. If the parameter cannot be set the parameter is framed.
4. Select the desired parameter (for example Inom) with OK.
5. Use the △ and ▽ keys to change a parameter value. If the value contains more than one digit, use the ▷ and ◁ keys to shift from digit to digit, and the △ and ▽ keys to change the digits.
6. Push OK to accept a new value. If you want to leave the parameter value unchanged, exit the edit state by pushing ⌂.

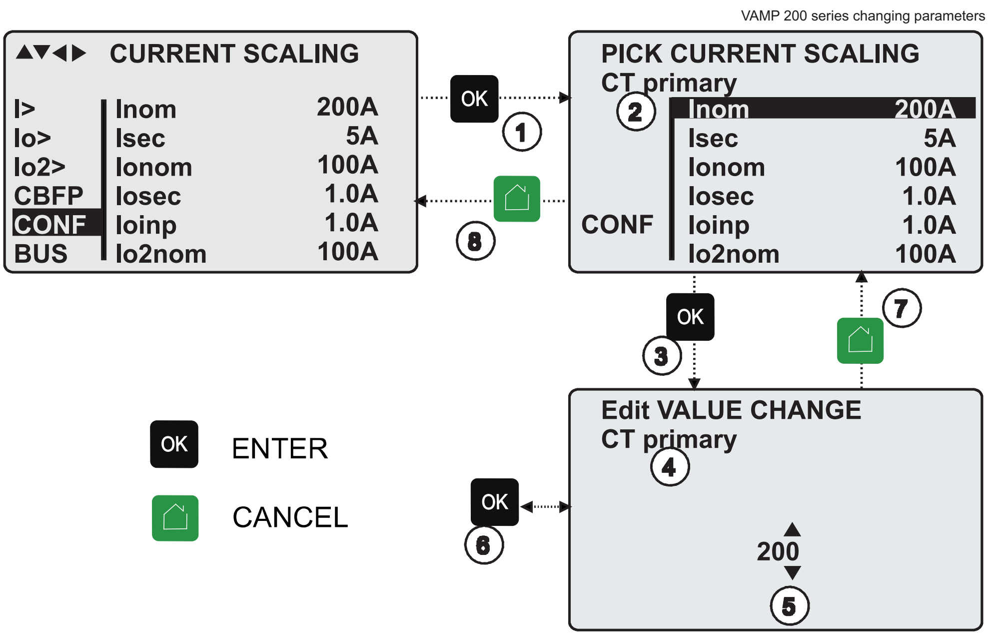


Figure 2.8: Changing parameters

2.4.2 Setting range limits

If the given parameter setting values are out-of-range values, a fault message will be shown when the setting is confirmed with OK. Adjust the setting to be within the allowed range.

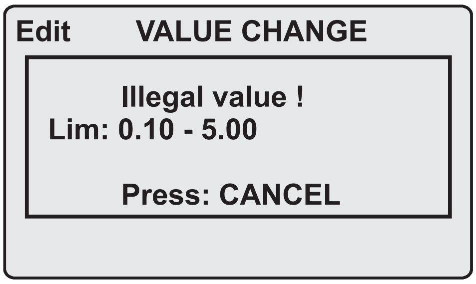


Figure 2.9: Example of a fault message

The allowed setting range is shown in the display in the setting mode. To view the range, push the info button. Push the home button to return to the setting mode.

infoset_I

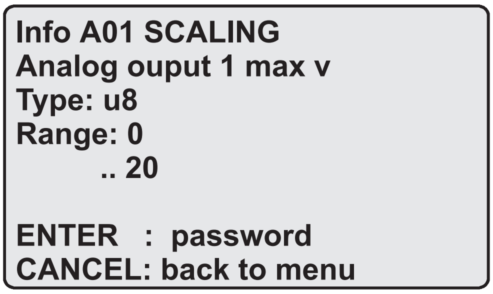


Figure 2.10: Allowed setting ranges show in the display

2.4.3 Disturbance recorder menu DR

Via the submenus of the disturbance recorder menu the following functions and features can be read and set:

Disturbance settings

- Recording mode (Mode)
- Sample rate (Rate)
- Recording time (Time)
- Pre trig time (PreTrig)
- Manual trigger (MnlTrig)
- Count of ready records (ReadyRe)

Rec. coupling

- Add a link to the recorder (AddLink)
- Clear all links (ClrLnks)

Available links

- DO, DI
- IL
- f
- I2/In, I2/I1, I2, I1, IoCalc
- IL3, IL2, IL1
- THDIL1, THDIL2, THDIL3
- IL1RMS, IL2RMS, IL3RMS
- Uo
- Uline, Uphase
- U2/U1, U2, U1
- UL3, UL2, UL1
- U31, U23, U12
- CosFii
- PF, S, Q, P
- Prms, Qrms, Srms
- Tanfii
- THDUa, THDUb, THDUc
- ILmin, ILmax, ULLmin, ULLmax, ULNmin, ULNmax

2.4.4 Configuring digital inputs DI

The following functions can be read and set via the submenus of the digital inputs menu:

1. Status of digital inputs (DIGITAL INPUTS)
2. Operation counters (DI COUNTERS)
3. Operation delay (DELAYs for DigIn)
4. The polarity of the input signal (INPUT POLARITY). Either normally open (NO) or normally closed (NC) circuit.
5. Selection to event register EVENT MASK1 and EVENT MASK2

2.4.5 Configuring digital outputs DO

The following functions can be read and set via the submenus of the digital outputs menu:

- The status of the output relays (RELAY OUTPUTS1 and 2)
- The forcing of the output relays (RELAY OUTPUTS1 and 2) (only if Force = ON):
  - Forced control (0 or 1) of the Trip relays
  - Forced control (0 or 1) of the Alarm relays
  - Forced control (0 or 1) of the SF relay
- The configuration of the output signals to the output relays. The configuration of the operation indicators (LED) Alarm and Trip and application specific alarm leds A, B and C (that is, the output relay matrix).

NOTE: The amount of Trip and Alarm relays depends on the relay type and optional hardware.

2.4.6 Configuring analogue outputs AO (Option)

Via the submenus of the analogue output menu the following functions can be read and set:

Analog output

- Value of AO1 (AO1)
- Value of AO2 (AO2)
- Value of AO3 (AO3)
- Value of AO4 (AO4)
- Forced control of analogue output (Force)

Analog output 1 – 4

- Value linked to the analogue output (Lnk1)
- (See list available links)
- Scaled minimum of linked value (Min)
- Scaled maximum of linked value (Max)
- Scaled minimum of analogue output (AOmin)
- Scaled maximum of analogue output (AOmax)
- Value of analogue output (AO1 - 4)

Available links:

- P, Q, S
- PF
- Cosφ
- IL1, IL2, IL2
- F
- IL
- U12, U23, U31
- UL1, UL2, UL3
- Uline, Uphase
- PrgVal
- Uo
- SagMin, SwellMax
- IoCalc

2.4.7 Setting alarm stage parameters

The settings of the selected alarm stages can be read and set separately in the Alrm submenus. There are 8 different alarm stages, which can be separately enabled or disabled. In any of the stages any one of the available variables can be chosen.

Available link variables

- P, Q, S
- f
- CosFii, TanFii
- IL1, IL2, IL3, IL, IoCalc, I1, I2, I2/I1, I2/In, ILmin, ILmax
- THDIL1, THDIL2, THDIL3
- U12, U23, U31, Uline, UL1, UL2, UL3, Uphase, U1, U2, U2/U1, ULLmin, ULLmax, ULNmin, ULNmax
- THDUa, THDUb, THDUc
- Prms, Qrms, Srms
- IL1rms, IL2rms, IL3rms
- Uo

2.4.8 Configuration menu CONF

The following functions and features can be read and set via the submenus of the configuration menu:

Device setup

- Bit rate for the command line interface in ports X4 and the front panel. The front panel is always using this setting. If SPABUS is selected for the rear panel local port X4, the bit rate is according SPABUS settings.
- Access level [Acc]
- PC access level [PCAcc]

Language

- List of available languages in the relay

Current scaling

- Rated phase CT primary current (Inom)
- Rated phase CT secondary current (Isec)
- Rated input of the relay [Iinput]. 5 A or 1 A. This is specified in the order code of the device.

Voltage scaling

- Rated VT primary voltage (Un)
- Rated VT secondary voltage (Usec)
- Voltage measuring mode (Umode)

Units for mimic display

- Unit for voltages (V). The choices are V (volt) or kV (kilovolt).
- Scaling for active, reactive and apparent power [Power]. The choices are k for kW, kvar and kVA or M for MW, Mvar and MVA.

Fundamental / RMS

- Energy calculation mode. The choices are Fundam and RMS.
- Display fundamental measurements. The choices are On and Off.

Display RMS measurements. The choices are On and Off.

Device info

- Relay type (Type VAMP 260)
- Serial number (SerN)
- Software version (PrgVer)
- Bootcode version (BootVer)

Date/time setup

- Day, month and year (Date)
- Time of day (Time)
- Date format (Style). The choices are "yyyy-mm-dd", "dd.nn.yyyy" and "mm/dd/yyyy".

Clock synchronisation

- Digital input for minute sync pulse (SyncDI). If any digital input is not used for synchronization, select "-".
- UTC time zone for SNTP synchronization (TZone)

NOTE: This is a decimal number. For example for state of Nepal the time zone 5:45 is given as 5.75

- Daylight saving time for NTP synchronization (DST).
- Detected source of synchronization (SyScr).
- Synchronization message counter (MsgCnt).
- Latest synchronization deviation (Dev).

The following parameters are visible only when the access level is higher than "User".

- Offset, i.e. constant error, of the synchronization source (SyOS).
- Auto adjust interval (AAIntv).
- Average drift direction (AvDrft): "Lead" or "lag".
- Average synchronization deviation (FilDev).

SW options

- External led module installed (Ledmodule)
- Mimic display selection (MIMIC)

2.4.9 Protocol menu Bus

In addition there is a connector in the front panel overruling the local port in the rear panel.

Remote port

- Communication protocol for remote port X5 [Protocol].
- Message counter [Msg#]. This can be used to verify that the device is receiving messages.
- Communication error counter [Errors]
- Communication time-out error counter [Tout].
- Information of bit rate/data bits/parity/stop bits. This value is not directly editable. Editing is done in the appropriate protocol setting menus.

The counters are useful when testing the communication.

Local port X4 (pins 2, 3 and 5)

This port is disabled, if a cable is connected to the front panel connector.

- Communication protocol for the local port X4 [Protocol]. For VAMPSET use "None" or "SPABUS".
- Message counter [Msg#]. This can be used to verify that the device is receiving messages.
- Communication error counter [Errors]
- Communication time-out error counter [Tout].
- Information of bit rate/data bits/parity/stop bits. This value is not directly editable. Editing is done in the appropriate protocol setting menus. For VAMPSET and protocol "None" the setting is done in menu CONF/DEVICE SETUP.

The counters are useful when testing the communication.

PC (Local/SPA-bus)

This is a second menu for local port X4. The VAMPSET communication status is showed.

- Bytes/size of the transmitter buffer [Tx].
- Message counter [Msg#]. This can be used to verify that the device is receiving messages.
- Communication error counter [Errors]
- Communication time-out error counter [Tout].
- Same information as in the previous menu.

Extension port (pins 7, 8 and 5)

- Communication protocol for extension port X4 [Protocol].
- Message counter [Msg#]. This can be used to verify that the device is receiving messages.
- Communication error counter [Errors]
- Communication time-out error counter [Tout].
- Information of bit rate/data bits/parity/stop bits. This value is not directly editable. Editing is done in the appropriate protocol setting menus.

Ethernet port

These parameters are used by the ethernet interface module. For changing the nnn.nnn.nnn.nnn style parameter values, VAMPSET is recommended.

- Ethernet port protocol [Protoc].
- IP Port for protocol [Port]
- IP address [IpAddr].
- Net mask [NetMsk].
- Gateway [Gatew].
- Name server [NameSw].
- Network time protocol (NTP) server [NTPSvr].
- TCP Keep alive interval [KeepAlive]
- MAC address [MAC]
- IP Port for VAMPSET [VS Port]
- Message counter [Msg#]
- Error counter [Errors]
- Timeout counter [Tout]

Modbus

- Modbus address for this slave device [Addr]. This address has to be unique within the system.
- Modbus bit rate [bit/s]. Default is "9600".
- Parity [Parity]. Default is ”Even”.

For details, see Chapter 8.2.2 Modbus TCP and Modbus RTU.

External I/O protocol

This is a Modbus master protocol to communicate with the extension I/O modules connected to the extension port. Only one instance of this protocol is possible.

- Bit rate [bit/s]. Default is "9600".
- Parity [Parity]. Default is "Even".

For details, see Chapter 8.2.8 External I/O (Modbus RTU master).

SPA-bus

Several instances of this protocol are possible.

- SPA-bus address for this device [Addr]. This address has to be unique within the system.
- Bit rate [bit/s]. Default is "9600".
- Event numbering style [Emode]. Default is "Channel".

For details, see Chapter 8.2.4 SPA-bus.

IEC 60870-5-103

Only one instance of this protocol is possible.

- Address for this device [Addr]. This address has to be unique within the system.
- Bit rate [bit/s]. Default is "9600".
- Minimum measurement response interval [MeasInt].
- ASDU6 response time mode [SyncRe].

For details, see Chapter 8.2.5 IEC 60870-5-103.

IEC 103 Disturbance recordings

For details, see Table 8.11.

Profibus

Only one instance of this protocol is possible.

- [Mode]
- Bit rate [bit/s]. Use 2400 bps. This parameter is the bit rate between the main CPU and the Profibus ASIC. The actual Profibus bit rate is automatically set by the Profibus master and can be up to 12 Mbit/s.
- Event numbering style [Emode].
- Size of the Profibus Tx buffer [InBuf].
- Size of the Profibus Rx buffer [OutBuf].
  When configuring the Profibus master system, the length of these buffers are needed. The size of the both buffers is set indirectly when configuring the data items for Profibus.
- Address for this slave device [Addr]. This address has to be unique within the system.
- Profibus converter type [Conv]. If the shown type is a dash “-“, either Profibus protocol has not been selected or the device has not restarted after protocol change or there is a communication problem between the main CPU and the Profibus ASIC.

For details, see Chapter 8.2.3 Profibus DP.

DNP3

Only one instance of this protocol is possible.

- Bit rate [bit/s]. Default is "9600".
- [Parity].
- Address for this device [SlvAddr]. This address has to be unique within the system.
- Master's address [MstrAddr].

For details, see Chapter 8.2.6 DNP 3.0.

IEC 60870-5-101

- Bit rate [bit/s]. Default is “9600”.
- [Parity].
- Link layer address for this device [LLAddr].
- ASDU address [ALAddr].

For details, see Chapter 8.2.7 IEC 60870-5-101.

DeviceNet

- Bit rate [bit/s]. Default is “125kbps”.
- Slave address [SlvAddr]

For details, see Chapter 8.2.12 DeviceNet.

3 VAMPSET PC software

The PC user interface can be used for:

- On-site parameterization of the relay
- Loading relay software from a computer
- Reading measured values, registered values and events to a computer
- Continuous monitoring of all values and events

Two RS 232 serial ports are available for connecting a local PC with VAMPSET to the relay; one on the front panel and one on the rear panel of the relay. These two serial ports are connected in parallel. However, if the connection cables are connected to both ports, only the port on the front panel will be active. To connect a PC to a serial port, use a connection cable of type VX 003-3.

The VAMPSET program can also use TCP/IP LAN connection. Optional hardware is required.

There is a free of charge PC program called VAMPSET available for configuration and setting of VAMP relays. Please download the latest VAMPSET.exe from our web page. For more information about the VAMPSET software, please refer to the user's manual with the code VVAMPSET/EN M/xxxx. Also the VAMPSET user's manual is available at our web site.

3.1 Folder view

In VAMPSET version 2.2.136, a feature called ”Folder view” was introduced.

The idea of folder view is to make it easier for the user to work with relay functions inside VAMPSET. When folder view is enabled, VAMPSET gathers similar functions together and places them appropriately under seven different folders (GENERAL, MEASUREMENTS, INPUTS/OUTPUTS, MATRIX, LOGS and COMMUNICATION). The contents (functions) of the folders depend on the relay type and currently selected application mode.

Folder view can be enabled in VAMPSET via Program Settings dialog (Settings -> Program Settings), see Figure 3.1.

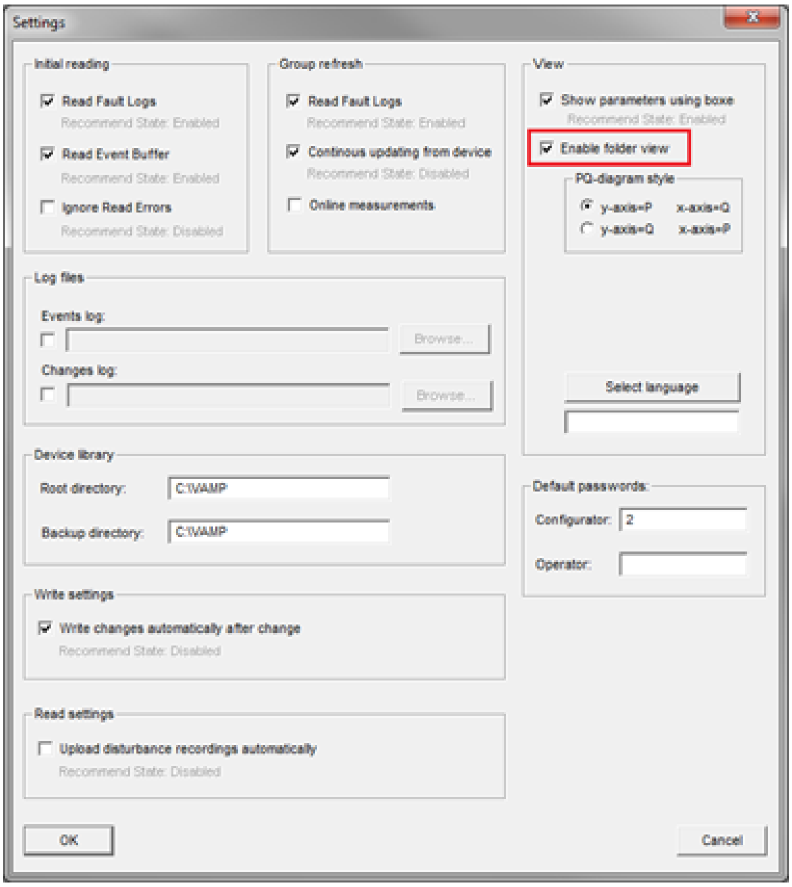


Figure 3.1: Enable folder view setting in Program Settings dialog

NOTE: It is possible to enable/ disable the folder view only when VAMPSET is disconnected from the relay and there is no configuration file opened.

When folder view is enabled, folder buttons become visible in VAMPSET, see Figure 3.2. Currently selected folder appears in bold.

Figure 3.2: Folder view buttons

4 Introduction

The power-monitoring unit VAMP 260 is an integrated monitoring device. Through numerical signal processing the device produces large amounts of important information. The device utilizes the latest technology and thus it offers many features, so far not found in corresponding devices.

The device measures the phase currents and the phase-to-phase voltages or phase-to-neutral voltages. Besides these directly measured data the VAMP 260 calculates much data about the state of the power network.

4.1 Main features

- Fully digital signal handling with a powerful 16-bit microprocessor and high measuring accuracy on all setting ranges due to an accurate 16-bit A/D conversion technique.
- Eight programmable alarm stages
- Wide setting ranges for the alarm stages.
- The unit can be matched to the requirements of the application by disabling functions not needed.
- Flexible control and blocking possibilities due to the six digital signal control inputs (DI).
- Easy adaptability of the unit to various substations and alarm systems due to a flexible signal-grouping matrix in the unit.
- Recording of events and fault values into an event register, from which data can be read via the key pad and the display or by means of the PC based VAMPSET user interface.
- Handy configuration, parameterization and reading of information via the user panel or with VAMPSET user interface.
- Easy connection to power plant automation system due to a versatile serial connection and several available communication protocols.
- Built-in self-regulating dc/dc converter for auxiliary power supply from any source within the range 40 to 260 V dc or ac, optionally 24 V dc.
- Built-in disturbance recorder
- Four programmable analog outputs (Option)

4.2 Principles of the numerical measuring technique

The power-monitoring unit VAMP 260 is fully designed using numerical technology. This means that all signal filtering, measuring and control functions are implemented through digital processing.

The numerical technique used in the unit is primarily based on an adapted fast Fourier transformation (FFT), in which the number of calculations (multiplications and additions) required to filter out the measuring quantities remains reasonable.

By using synchronized sampling of the measured signal (voltage or current) and a sample rate according to the 2^N series, the FFT technique leads to a solution, which can be realized with just a 16-bit microcontroller, without using a separate DSP (Digital Signal Processor).

The synchronized sampling means an even number of 2^N samples per period, e.g. 16 or 32 samples per period. This means that the frequency must be measured and the number of samples per period must be controlled accordingly, so that the number of samples per period remains constant, if the frequency changes.

5 Main functions

5.1 General features of protection stages

Setting groups

Setting groups are controlled by using digital inputs or other assigned inputs. When none of the assigned input/inputs is/are not active the active setting group is defined by parameter 'SetGrp no control state'. When controlled input activates the corresponding setting group is activated as well. If multiple inputs are active at the same time the active setting group is defined by 'SetGrp priority'. By using virtual I/O the active setting group can be controlled using the local panel display, any communication protocol or using the inbuilt programmable logic functions.

Set group 1 DI control	-			
Set group 2 DI control	-			
Set group 3 DI control	-			
Set group 4 DI control	-			
Group	1			
	Group 1	Group 2	Group 3	Group 4
Pick-up setting	480 A	480 A	480 A	480 A
Pick-up setting	1.20 xImot	1.20 xImot	1.20 xImot	1.20 xImot
Delay curve family	IEC	IEC	IEC	IEC
Delay type	NI	NI	NI	NI
Inv. time coefficient k	1.00	1.00	1.00	1.00
Inverse delay (20x)	2.26 s	2.26 s	2.26 s	2.26 s
Inverse delay (4x)	4.97 s	4.97 s	4.97 s	4.97 s
Inverse delay (1x)	600.02 s	600.02 s	600.02 s	600.02 s
	Common settings			
Include harmonics	Off			

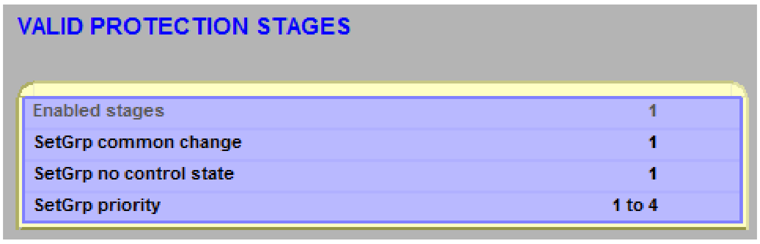
Example

Any digital input could be used to control setting groups but in this example DI1, DI2, DI3 and DI4 are chosen to control setting groups 1 to 4. This setting is done with a parameter "Set group x DI control" where x refers to the desired setting group.

Set group 1 DI control	DI1			
Set group 2 DI control	DI2			
Set group 3 DI control	DI3			
Set group 4 DI control	DI4			
Group	2			
	Group 1	Group 2	Group 3	Group 4
Pick-up setting	1500 A	3600 A	3600 A	3600 A
Pick-up setting	0.50 xIn	1.20 xIn	1.20 xIn	1.20 xIn
Delay curve family	DT	IEC	IEC	IEC
Delay type	DT	NI	NI	NI
Operation delay	0.30 s	0.30 s	0.30 s	0.30 s
Inv. time coefficient k	1.00	1.00	1.00	1.00
Inverse delay (20x)	- s	2.26 s	2.26 s	2.26 s
Inverse delay (4x)	- s	4.97 s	4.97 s	4.97 s
Inverse delay (1x)	- s	600.02 s	600.02 s	600.02 s

Figure 5.1: DI1, DI2, DI3, DI4 are configured to control Groups 1 to 4 respectively.

“SetGrp priority” is used to give a condition to a situation where two or more digital inputs, controlling setting groups, are active and at a same time . SetGrp priority could have vales “1 to 4” or “4 to 1”.



VALID PROTECTION STAGES

Enabled stages	1
SetGrp common change	1
SetGrp no control state	1
SetGrp priority	1 to 4

Figure 5.2: SetGrp priority setting is located in the Valid Protection stages view.

Assuming that DI2 and DI3 are active at a same time and SetGrp priority is set to “1 to 4” setting group 2 will become active. In case SetGrp priority is reversed i.e. it is set to “4 to 1” setting group 3 would be active.

Forcing start or trip condition for testing

The status of a protection stage can be one of the followings:

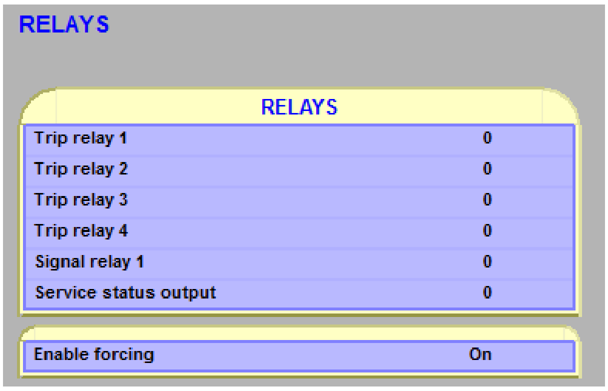
- **Ok = ‘-‘**
  The stage is idle and is measuring the analog quantity for the protection. No fault detected.
- **Blocked**
  The stage is detecting a fault but blocked by some reason.
- **Start**
  The stage is counting the operation delay.
- **Trip**
  The stage has tripped and the fault is still on.

Forcing start or trip condition for testing purposes

After testing the force flag will automatically reset 5-minute after the last local panel push button activity.

The force flag also enables forcing of the output relays and forcing the optional mA outputs.

Force flag can be found in relays menu.



Start and trip signals

Every protection stage has two internal binary output signals: start and trip. The start signal is issued when a fault has been detected. The trip signal is issued after the configured operation delay unless the fault disappears before the end of the delay time.

Output matrix

Using the output matrix the user connects the internal start and trip signals to the output relays and indicators. For more details, see Chapter 7.4 Output matrix.

Blocking

Any protection function, except arc protection, can be blocked with internal and external signals using the block matrix (Chapter 7.5 Blocking matrix). Internal signals are for example logic outputs and start and trip signals from other stages and external signals are for example digital and virtual inputs.

When a protection stage is blocked, it won't pick-up in case of a fault condition is detected. If blocking is activated during the operation delay, the delay counting is frozen until the blocking goes off or the pick-up reason, i.e. the fault condition, disappears. If the stage is already tripping, the blocking has no effect.

Retardation time

Retardation time is the time a protection relay needs to notice, that a fault has been cleared during the operation time delay. This parameter is important when grading the operation time delay settings between relays.

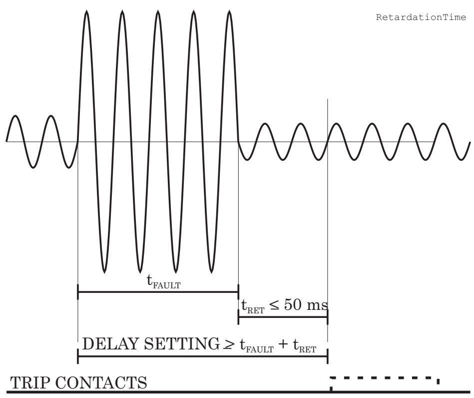


Figure 5.3: Definition for retardation time. If the delay setting would be slightly shorter, an unselective trip might occur (the dash line pulse).

For example when there is a big fault in an outgoing feeder, it might start i.e. pick-up both the incoming and outgoing feeder relay. However the fault must be cleared by the outgoing feeder relay and the incoming feeder relay must not trip. Although the operating delay setting of the incoming feeder is more than at the outgoing feeder, the incoming feeder might still trip, if the operation time difference is not big enough. The difference must be more than the retardation time of the incoming feeder relay plus the operating time of the outgoing feeder circuit breaker.

Figure 5.3 shows an overvoltage fault seen by the incoming feeder, when the outgoing feeder does clear the fault. If the operation delay setting would be slightly shorter or if the fault duration would be slightly longer than in the figure, an unselective trip might happen (the dashed 40 ms pulse in the figure). In VAMP devices the retardation time is less than 50 ms.

Reset time (release time)

Figure 5.4 shows an example of reset time i.e. release delay, when the relay is clearing an overcurrent fault. When the relay's trip contacts are closed the circuit breaker (CB) starts to open. After the CB contacts are open the fault current will still flow through an arc between the opened contacts. The current is finally cut off when the arc extinguishes at the next zero crossing of the current. This is the start moment of the reset delay. After the reset delay the trip contacts and start contact are opened unless latching is configured. The precise reset time depends on the fault size; after a big fault the reset time is longer. The reset time also depends on the specific protection stage.

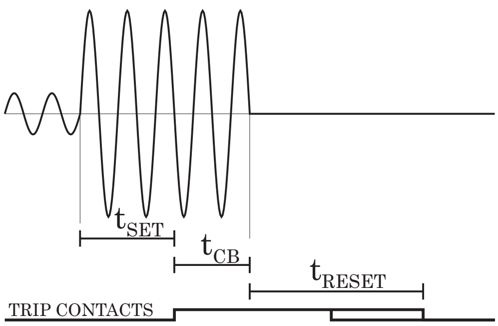


Figure 5.4: Reset time is the time it takes the trip or start relay contacts to open after the fault has been cleared.

Hysteresis or dead band

When comparing a measured value against a pick-up value, some amount of hysteresis is needed to avoid oscillation near equilibrium situation. With zero hysteresis any noise in the measured signal or any noise in the measurement itself would cause unwanted oscillation between fault-on and fault-off situations.

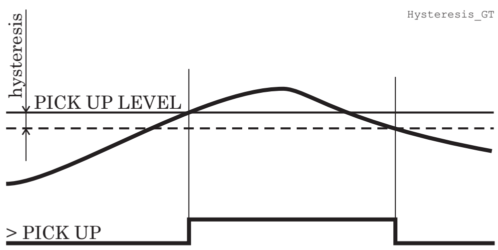


Figure 5.5: Behaviour of a greater than comparator. For example in overvoltage stages the hysteresis (dead band) acts according this figure.

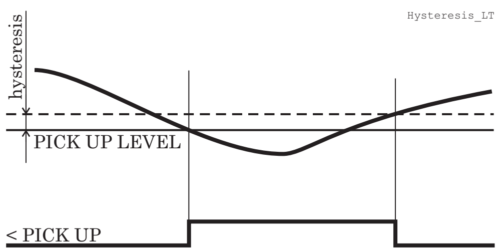


Figure 5.6: Behaviour of a less than comparator. For example in under-voltage and under frequency stages the hysteresis (dead band) acts according this figure.

5.2 Event log

Event log is a buffer of event codes and time stamps including date and time. For example each start-on, start-off, trip-on or trip-off of any alarm has a unique event number code. Such a code and the corresponding time stamp is called an event.

As an example of information included with a typical event an Programmable stage Trip.

EVENT	Description	Local panel	Communication protocols
Code: 46E2	Channel 46, event 2	Yes	Yes
Prg1 trip on	Event text	Yes	No
1.25 x In	Fault value	Yes	No
2007-01-31	Date	Yes	Yes
08:35:13.413	Time	Yes	Yes

Events are the major data for a SCADA system. SCADA systems are reading events using any of the available communication protocols. Event log can also be scanned using the front panel or using VAMPSET. With VAMPSET the events can be stored to a file especially in case the relay is not connected to any SCADA system.

Only the latest event can be read when using communication protocols or VAMPSET. Every reading increments the internal read pointer to the event buffer. (In case of communication interruptions, the latest event can be reread any number of times using another parameter.) On the local panel scanning the event buffer back and forth is possible.

Event enabling/masking

In case of an uninteresting event, it can be masked, which prevents the particular event(s) to be written in the event buffer. As a default there is room for 200 latest events in the buffer. Event buffer size can be modified from 50 to 2000.

Modification can be done in “Local panel conf” –menu.

Indication screen (popup screen) can also be enabled in this same menu when VAMPSET –setting tool is used. The oldest one will be overwritten, when a new event does occur. The shown resolution of a time stamp is one millisecond, but the actual resolution depends of the particular function creating the event. For example most protection stages create events with 5ms, 10 ms or 20 ms resolution. The absolute accuracy of all time stamps depends on the time synchronizing of the relay. See Chapter 5.7 System clock and synchronization for system clock synchronizing.

Event buffer overflow

The normal procedure is to poll events from the device all the time. If this is not done then the event buffer could reach its limits. In such case the oldest event is deleted and the newest displayed with OVF code in HMI.

Table 5.1: Setting parameters for events

Parameter	**Value**	**Description**	**Note**
Count		Number of events	
ClrEn	- Clear	Clear event buffer	Set
Order	Old-New New-Old	Order of the event buffer for local display	Set
FVSca		Scaling of event fault value	Set
	PU	Per unit scaling	
	Pri	Primary scaling	
Display Alarms	On Off	Indication dispaly is enabled No indication display	Set
FORMAT OF EVENTS ON THE LOCAL DISPLAY			
Code: CHENN		CH = event channel, NN=event code	
Event description		Event channel and code in plain text	
yyyy-mm-dd		Date (for available date formats, see Chapter 5.7 System clock and synchronization)	
hh:mm:ss.nnn		Time	

5.3 Disturbance recorder

The disturbance recorder can be used to record all the measured signals, that is, currents, voltage and the status information of digital inputs (DI) and digital outputs (DO).

The digital inputs include also the arc protection signals S1, S2, BI and BO, if the optional arc protection is available.

Triggering the recorder

The recorder can be triggered by any start or trip signal from any protection stage or by a digital input. The triggering signal is selected in the output matrix (vertical signal DR). The recording can also be triggered manually. All recordings are time stamped.

Reading recordings

The recordings can be uploaded, viewed and analysed with the VAMPSET program. The recording is in COMTRADE format. This also means that other programs can be used to view and analyse the recordings made by the relay.

For more details, please see a separate VAMPSET manual.

Number of channels

At the maximum, there can be 12 recordings, and the maximum selection of channels in one recording 12 (limited in wave form) and digital inputs reserve one channel (includes all the inputs). Also the digital outputs reserve one channel (includes all the outputs). If digital inputs and outputs are recorded, there will be still 10 channels left for analogue waveforms.

Table 5.2: Disturbance recorder parameters

Parameter	Value	Unit	Description	Note
Mode			Behavior in memory full situation:	Set
	Saturated		No more recordings are accepted	
	Overflow		The oldest recorder will be overwritten	
SR			Sample rate	Set
	32/cycle		Waveform	
	16/cycle		Waveform	
	8/cycle		Waveform	
	1/10ms		One cycle value *)	
	1/20ms		One cycle value **)	
	1/200ms		Average	
	1/1s		Average	
	1/5s		Average	
	1/10s		Average	
	1/15s		Average	
	1/30s		Average	
	1/1min		Average	
Time		s	Recording length	Set
PreTrig		%	Amount of recording data before the trig moment	Set
MaxLen		s	Maximum time setting. This value depends on sample rate, number and type of the selected channels and the configured recording length.	
Status			Status of recording	
	-		Not active	
	Run		Waiting a triggering	
	Trig		Recording	
	FULL		Memory is full in saturated mode	
ManTrig	-, Trig		Manual triggering	Set
ReadyRec	n/m		n = Available recordings / m = maximum number of recordings The value of 'm' depends on sample rate, number and type of the selected channels and the configured recording length.	

Parameter	Value	Unit	Description	Note
AddCh			Add one channel. Maximum simultaneous number of channels is 12.	Set
	IL1, IL2, IL3		Phase current	
	U12, U23, U31		Line-to-line voltage	
	Uo		Zero sequence voltage	
	f		Frequency	
	P, Q, S		Active, reactive, apparent power	
	P.F.		Power factor	
	CosFii		cosφ	
	IoCalc		Phasor sum Io = ($\underline{I}$L1+$\underline{I}$L2+$\underline{I}$L3)/3	
	I1		Positive sequence current	
	I2		Negative sequence current	
	I2/I1		Relative current unbalance	
	I2/In		Current unbalance [x I_N]	
	U1		Positive sequence voltage	
	U2		Negateive sequence voltage	
	U2/U1		Relative negative sequence voltage	
	IL		Average (IL1 + IL2 + IL3) / 3	
	Uphase		Average phase voltage	
	Uline		Average line-to-lines voltages	
	DI, DO		Digital inputs, Digital outputs	
	TanFii		tanφ	
	THDIL1, THDIL2, THDIL3		Total harmonic distortion of IL1, IL2 or IL3	
	THDUa, THDUb, THDUc		Total harmonic distortion of Ua, Ub or Uc	
	Prms		Active power rms value	
	Qrms		Reactive power rms value	
	Srms		Apparent power rms value	
	IL1RMS, IL2MRS, IL3RMS		IL1, IL2, IL3 RMS for average sampling	
	ILmin, ILmax		Min and max of phase currents	
	ULLmin, ULLmax		Min and max of line-to-line voltages	
	ULNmin, ULNmax		Min and max of phase voltages	
	Starts		Protection stage start signals	
	Trips		Protection stage trip signals	
Delete recorder channel			Delete selected channel	
ClrCh	-, Clear		Remove all channels	Set
(Ch)			List of selected channels	

Set = An editable parameter (password needed).

*) This is the fundamental frequency rms value of one cycle updated every 10 ms.

**) This is the fundamental frequency rms value of one cycle updated every 20 ms.

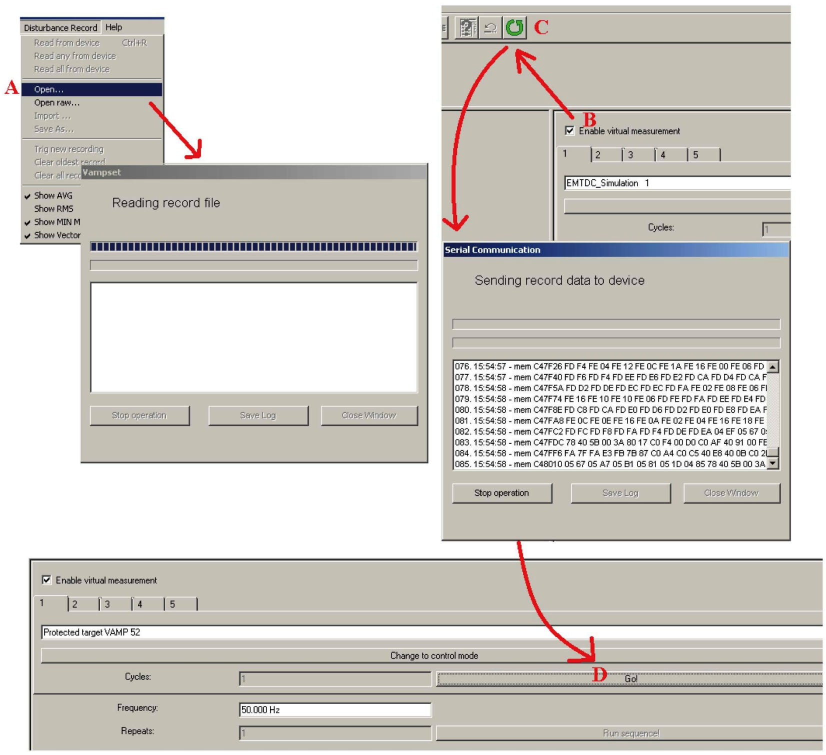
For details of setting ranges, see Table 11.17.

5.3.1 Running virtual comtrade files

Virtual comtrade files can be run with VAMP relays with the v.10.74 software or a later version. Relay behaviour can be analysed by playing the recorder data over and over again in the relay memory.

Steps of opening the VAMPSET setting tool:

1. Go to “Disturbance record” and select Open… (A).
2. Select the comtrade file from you hard disc or equivalent. VAMPSET is now ready to read the recording.
3. The virtual measurement has to be enabled (B) in order to send record data to the relay (C).
4. Sending the file to the device’s memory takes a few seconds. Initiate playback of the file by pressing the Go! button (D). The “Change to control mode” button takes you back to the virtual measurement.



5.4 Voltage sags and swells

The power quality of electrical networks has become increasingly important. The sophisticated loads (e.g. computers etc.) require uninterruptible supply of “clean” electricity. VAMP protection platform provides many power quality functions that can be used to evaluate, monitor and alarm on the basis of the quality. One of the most important power quality functions are voltage sag and swell monitoring.

VAMP provides separate monitoring logs for sags and swells. The voltage log is trigged, if any voltage input either goes under the sag limit (U<) or exceeds the swell limit (U>). There are four registers for both sags and swells in the fault log. Each register will have start time, phase information, duration, minimum, average, maximum voltage values of each sag and swell event. Furthermore, there are total number of sags and swells counters as well as total timers for sags and swells.

The voltage power quality functions are located under the submenu “U”.

Table 5.3: Setting parameters of sags and swells monitoring

Parameter	Value	Unit	Default	Description
U>	20 – 150	%	110	Setting value of swell limit
U<	10 – 120	%	90	Setting value of sag limit
Delay	0.04 – 1.00	s	0.06	Delay for sag and swell detection
SagOn	On; Off	-	On	Sag on event
SagOff	On; Off	-	On	Sag off event
SwelOn	On; Off	-	On	Swell on event
SwelOf	On; Off	-	On	Swell off event

Table 5.4: Recorded values of sags and swells monitoring

	Parameter	Value	Unit	Description
Recorded values	Count		-	Cumulative sag counter
	Total		-	Cumulative sag time counter
	Count		-	Cumulative swell counter
	Total		-	Cumulative swell time counter
Sag / swell logs 1 – 4	Date		-	Date of the sag/swell
	Time		-	Time stamp of the sag/swell
	Type		-	Voltage inputs that had the sag/swell
	Time		s	Duration of the sag/swell
	Min1		% Un	Minimum voltage value during the sag/swell in the input 1
	Min2		% Un	Minimum voltage value during the sag/swell in the input 2
	Min3		% Un	Minimum voltage value during the sag/swell in the input 3
	Ave1		% Un	Average voltage value during the sag/swell in the input 1
	Ave2		% Un	Average voltage value during the sag/swell in the input 2
	Ave3		% Un	Average voltage value during the sag/swell in the input 3
	Max1		% Un	Maximum voltage value during the sag/swell in the input 1
	Max2		% Un	Maximum voltage value during the sag/swell in the input 2
	Max3		% Un	Maximum voltage value during the sag/swell in the input 3

For details of setting ranges, see Table 11.18.

5.5 Voltage interruptions

The device includes a simple function to detect voltage interruptions. The function calculates the number of voltage interruptions and the total time of the voltage-off time within a given calendar period. The period is based on the real time clock of the device. The available periods are:

- 8 hours, 00:00 – 08:00, 08:00 – 16:00, 16:00 – 24:00
- one day, 00:00 – 24:00
- one week, Monday 00:00 – Sunday 24:00
- one month, the first day 00:00 – the last day 24:00
- one year, 1st January 00:00 – 31st December 24:00

After each period, the number of interruptions and the total interruption time are stored as previous values. The interruption counter and the total time are cleared for a new period. The old previous values are overwritten.

The voltage interruption is based on the value of the positive sequence voltage U_1 and a user given limit value. Whenever the measured U_1 goes below the limit, the interruption counter is increased, and the total time counter starts increasing.

Shortest recognized interruption time is 40 ms. If the voltage-off time is shorter it may be recognized depending on the relative depth of the voltage dip.

If the voltage has been significantly over the limit U_1< and then there is a small and short under-swing, it will not be recognized (Figure 5.7).

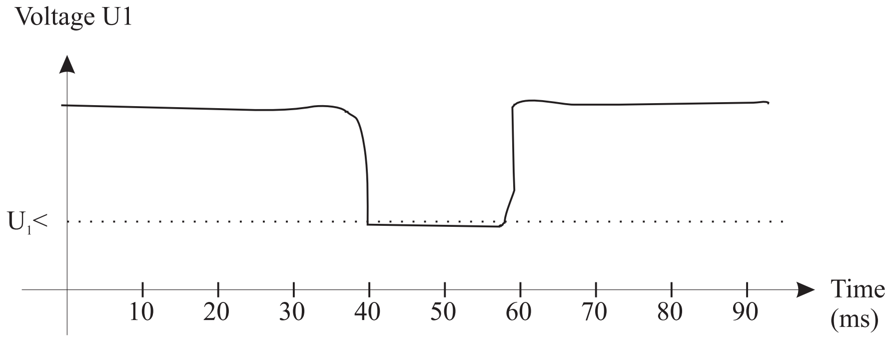


Figure 5.7: A short voltage interruption which is probably not recognized

On the other hand, if the limit U_1< is high and the voltage has been near this limit, and then there is a short but very deep dip, it will be recognized (Figure 5.8).

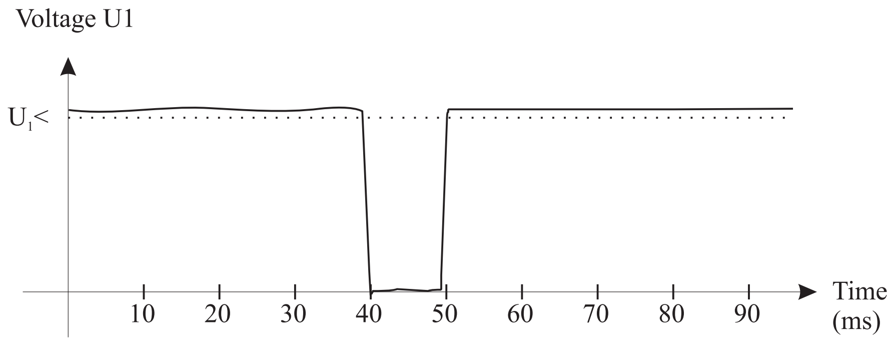


Figure 5.8: A short voltage interrupt that will be recognized

Table 5.5: Setting parameters of the voltage sag measurement function:

Parameter	Value	Unit	Default	Description
U1<	10.0 – 120.0	%	64	Setting value
Period	8h Day Week Month	-	Month	Length of the observation period
Date		-	-	Date
Time		-	-	Time

Table 5.6: Measured and recorded values of voltage sag measurement function:

	Parameter	Value	Unit	Description
Measured value	Voltage	LOW; OK	-	Current voltage status
	U1		%	Measured positive sequence voltage
Recorded values	Count		-	Number of voltage sags during the current observation period
	Prev		-	Number of voltage sags during the previous observation period
	Total		s	Total (summed) time of voltage sags during the current observation period
	Prev		s	Total (summed) time of voltage sags during the previous observation period

For details of setting ranges, see Table 11.19.

5.6 Energy pulse outputs

The device can be configured to send a pulse whenever certain amount of energy has been imported or exported. The principle is presented in Figure 5.9. Each time the energy level reaches the pulse size, an output relay is activated and the relay will be active as long as defined by a pulse duration setting.

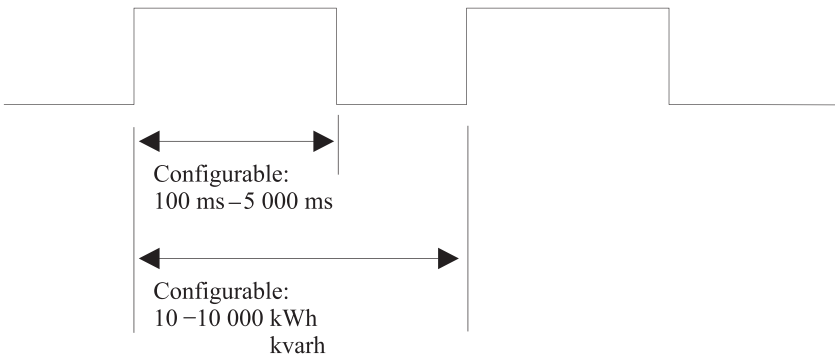


Figure 5.9: Principle of energy pulses

The relay has four energy pulse outputs. The output channels are:

- Active exported energy
- Reactive exported energy
- Active imported energy
- Reactive imported energy

Each channel can be connected to any combination of the output relays using output matrix. The parameters for the energy pulses can be found in the E menu under the submenus E-PULSE SIZES and E-PULSE DURATION.

Table 5.7: Energy pulse output parameters

	Parameter	Value	Unit	Description
E-PULSE SIZES	E+	10 – 10 000	kWh	Pulse size of active exported energy
	Eq+	10 – 10 000	kvarh	Pulse size of reactive exported energy
	E-	10 – 10 000	kWh	Pulse size of active imported energy
	Eq-	10 – 10 000	kvarh	Pulse size of reactive imported energy
E-PULSE DURATION	E+	100 – 5000	ms	Pulse length of active exported energy
	Eq+	100 – 5000	ms	Pulse length of reactive exported energy
	E-	100 – 5000	ms	Pulse length of active imported energy
	Eq-	100 – 5000	ms	Pulse length of reactive imported energy

Scaling examples

1. Average active exported power is 250 MW.
   Peak active exported power is 400 MW.
   Pulse size is 250 kWh.
   The average pulse frequency will be 250/0.250 = 1000 pulses/h.
   The peak pulse frequency will be 400/0.250 = 1600 pulses/h.
   Set pulse length to 3600/1600 - 0.2 = 2.0 s or less.
   The lifetime of the mechanical output relay will be
   $50x10^6/1000$ h = 6 a.
   This is not a practical scaling example unless an output relay lifetime of about six years is accepted.
2. Average active exported power is 100 MW.
   Peak active exported power is 800 MW.
   Pulse size is 400 kWh.
   The average pulse frequency will be 100/0.400 = 250 pulses/h.
   The peak pulse frequency will be 800/0.400 = 2000 pulses/h.
   Set pulse length to 3600/2000 - 0.2 = 1.6 s or less.
   The lifetime of the mechanical output relay will be
   $50x10^6/250$ h = 23 a.
3. Average active exported power is 20 MW.
   Peak active exported power is 70 MW.
   Pulse size is 60 kWh.
   The average pulse frequency will be 25/0.060 = 416.7 pulses/h.
   The peak pulse frequency will be 70/0.060 = 1166.7 pulses/h.
   Set pulse length to 3600/1167 - 0.2 = 2.8 s or less.
   The lifetime of the mechanical output relay will be
   $50x10^6/417$ h = 14 a.
4. Average active exported power is 1900 kW.
   Peak active exported power is 50 MW.
   Pulse size is 10 kWh.
   The average pulse frequency will be 1900/10 = 190 pulses/h.
   The peak pulse frequency will be 50000/10 = 5000 pulses/h.
   Set pulse length to 3600/5000 - 0.2 = 0.5 s or less.
   The lifetime of the mechanical output relay will be
   $50x10^6/190$ h = 30 a.

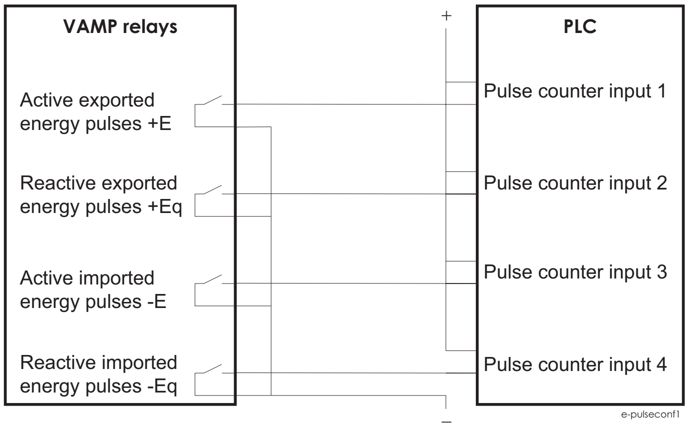


Figure 5.10: Application example of wiring the energy pulse outputs to a PLC having common plus and using an external wetting voltage

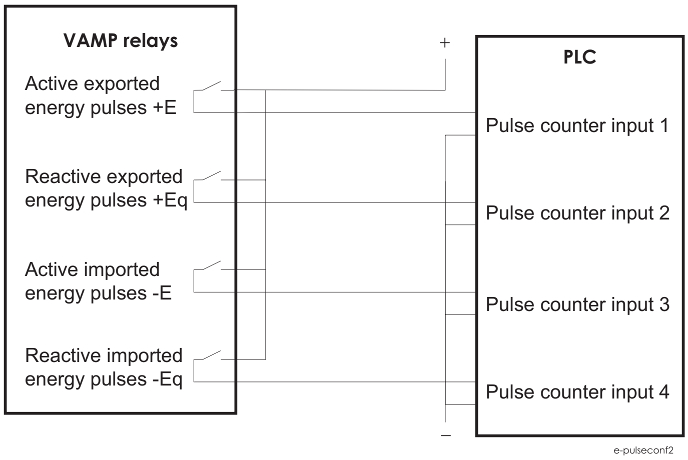


Figure 5.11: Application example of wiring the energy pulse outputs to a PLC having common minus and using an external wetting voltage

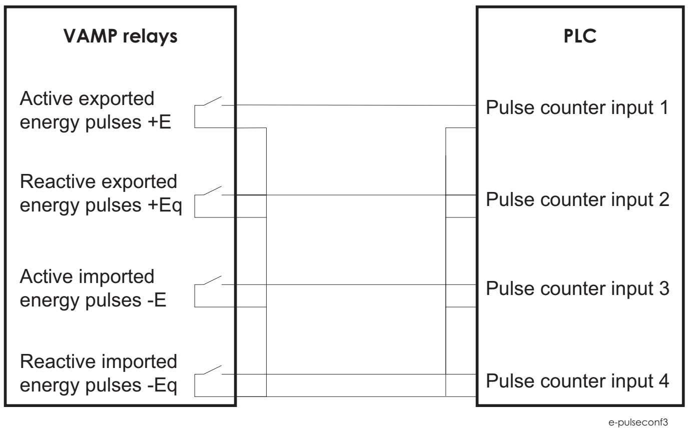


Figure 5.12: Application example of wiring the energy pulse outputs to a PLC having common minus and an internal wetting voltage.

5.7 System clock and synchronization

The internal clock of the relay is used to time stamp events and disturbance recordings.

The system clock should be externally synchronised to get comparable event time stamps for all the relays in the system.

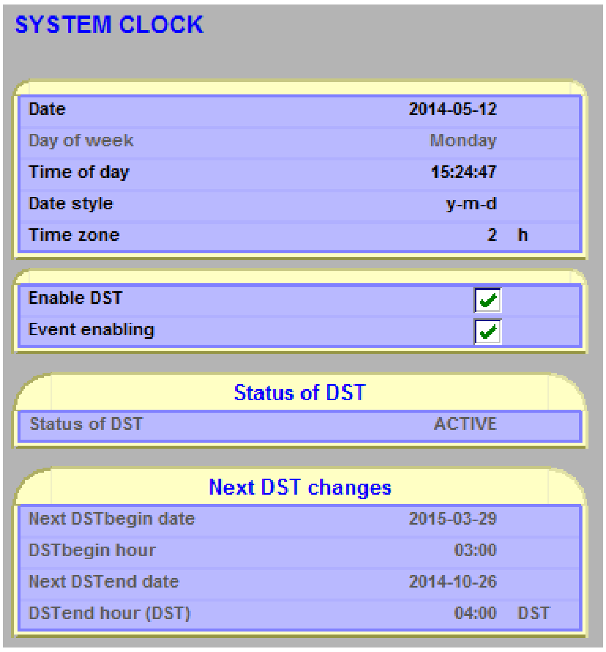
The synchronizing is based on the difference of the internal time and the synchronising message or pulse. This deviation is filtered and the internal time is corrected softly towards a zero deviation.

Time zone offsets

Time zone offset (or bias) can be provided to adjust the local time for IED. The Offset can be set as a Positive (+) or Negative (-) value within a range of -15.00 to +15.00 hours and a resolution of 0.01/h. Basically quarter hour resolution is enough.

Daylight saving time (DST)

IED provides automatic daylight saving adjustments when configured. A daylight savings time (summer time) adjustment can be configured separately and in addition to a time zone offset.



Daylight time standards vary widely throughout the world. Traditional daylight/summer time is configured as one (1) hour positive bias. The new US/Canada DST standard, adopted in the spring of 2007 is: one (1) hour positive bias, starting at 2:00am on the second Sunday in March, and ending at 2:00am on the first Sunday in November. In the European Union, daylight change times are defined relative to the UTC time of day instead of local time of day (as in U.S.) European customers, please carefully find out local country rules for DST.

The daylight saving rules for Finland are the IED defaults (24-hour clock):

- Daylight saving time start: Last Sunday of March at 03.00

- Daylight saving time end: Last Sunday of October at 04.00

DSTbegin rule		
DSTbegin month	Mar	
Ordinal of day of week	Last	
Day of week	Sunday	
DSTbegin hour	3	

DSTend rule		
DSTend month	Oct	
Ordinal of day of week	Last	
Day of week	Sunday	
DSTend hour (DST)	4	DST

To ensure proper hands-free year-around operation, automatic daylight time adjustments must be configured using the “Enable DST” and not with the time zone offset option.

Adapting auto adjust

During tens of hours of synchronizing the device will learn its average deviation and starts to make small corrections by itself. The target is that when the next synchronizing message is received, the deviation is already near zero. Parameters "AAIntv" and "AvDrft" will show the adapted correction time interval of this ±1 ms auto-adjust function.

Time drift correction without external sync

If any external synchronizing source is not available and the system clock has a known steady drift, it is possible to roughly correct the clock deviation by editing the parameters "AAIntv" and "AvDrft". The following equation can be used if the previous "AAIntv" value has been zero.

$$AAIntv = \frac{604.8}{DriftInOneWeek}$$

If the auto-adjust interval "AAIntv" has not been zero, but further trimming is still needed, the following equation can be used to calculate a new auto-adjust interval.

$$AAIntv_{NEW} = \frac{1}{\frac{1}{AAIntv_{PREVIOUS}} + \frac{DriftInOneWeek}{604.8}}$$

The term *DriftInOneWeek*/604.8 may be replaced with the relative drift multiplied by 1000, if some other period than one week has been used. For example if the drift has been 37 seconds in 14 days, the relative drift is 37*1000/(14*24*3600) = 0.0306 ms/s.

Example 1

If there has been no external sync and the relay's clock is leading sixty-one seconds a week and the parameter AAIntv has been zero, the parameters are set as

$$AvDrft = Lead$$

$$AAIntv = \frac{604.8}{61} = 9.9s$$

With these parameter values the system clock corrects itself with –1 ms every 9.9 seconds which equals –61.091 s/week.

Example 2

If there is no external sync and the relay's clock has been lagging five seconds in nine days and the AAIntv has been 9.9 s, leading, then the parameters are set as

$$AAIntv_{NEW} = \frac{1}{\frac{1}{9.9} - \frac{5000}{9 \cdot 24 \cdot 3600}} = 10.6$$

$$AvDrft = Lead$$

When the internal time is roughly correct – deviation is less than four seconds – any synchronizing or auto-adjust will never turn the clock backwards. Instead, in case the clock is leading, it is softly slowed down to maintain causality.

Table 5.8: System clock parameters

Parameter	Value	Unit	Description	Note
Date			Current date	Set
Time			Current time	Set
Style			Date format	Set
	y-d-m		Year-Month-Day	
	d.m.y		Day.Month.Year	
	m/d/y		Month/Day/Year	
SyncDI	-		DI not used for synchronizing	***)
	DI1 – DI6		Minute pulse input	
TZone	-15.00 – +15.00 *)		UTC time zone for SNTP synchronization. Note: This is a decimal number. For example for state of Nepal the time zone 5:45 is given as 5.75	Set
DST	No; Yes		Daylight saving time for SNTP	Set
SySrc			Clock synchronisation source	
	Internal		No sync recognized since 200s	
	DI		Digital input	
	SNTP		Protocol sync	
	SpaBus		Protocol sync	
	ModBus		Protocol sync	
	ModBus TCP		Protocol sync	
	ProfibusDP		Protocol sync	
	IEC101		Protocol sync	
	IEC103		Protocol sync	
	DNP3		Protocol sync	
	IRIG-B003		IRIG timecode B003 ****)	
MsgCnt	0 – 65535, 0 – etc.		The number of received synchronisation messages or pulses	
Dev	±32767	ms	Latest time deviation between the system clock and the received synchronization	
SyOS	±10000.000	s	Synchronisation correction for any constant deviation in the synchronizing source	Set
AAIntv	±1000	s	Adapted auto adjust interval for 1 ms correction	Set**)
AvDrft	Lead; Lag		Adapted average clock drift sign	Set**)
FilDev	±125	ms	Filtered synchronisation deviation	

Set = An editable parameter (password needed).

*) A range of -11 h – +12 h would cover the whole Earth but because the International Date Line does not follow the 180° meridian, a more wide range is needed.

**) If external synchronization is used this parameter will be set automatically.

***) Set the DI delay to its minimum and the polarity such that the leading edge is the synchronizing edge.

****) Relay needs to be equipped with suitable hardware option module to receive IRIG-B clock synchronization signal. (Chapter 13 Order information).

Synchronisation with DI

Clock can be synchronized by reading minute pulses from digital inputs, virtual inputs or virtual outputs. Sync source is selected with **SyncDI** setting. When rising edge is detected from the selected input, system clock is adjusted to the nearest minute. Length of digital input pulse should be at least 50 ms. Delay of the selected digital input should be set to zero.

Synchronisation correction

If the sync source has a known offset delay, it can be compensated with **SyOS** setting. This is useful for compensating hardware delays or transfer delays of communication protocols. A positive value will compensate a lagging external sync and communication delays. A negative value will compensate any leading offset of the external synch source.

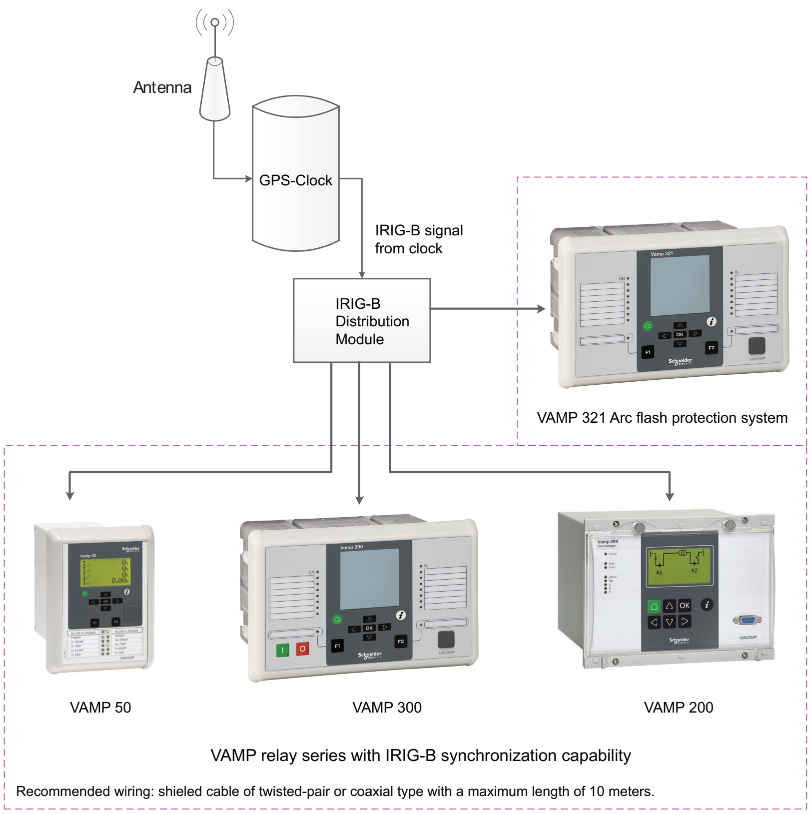
Sync source

When the device receives new sync message, the sync source display is updated. If no new sync messages are received within next 1.5 minutes, the device will change to internal sync mode.

Sync source: IRIG-B003

IRIG-B003 synchronization is supported with a dedicated communication option with either a two-pole or two pins in a D9 rear connector (See Chapter 13 Order information).

IRIG-B003 input clock signal voltage level is TLL. The input clock signal originated in the GPS receiver must be taken to multiple relays trough an IRIG-B distribution module. This module acts as a centralized unit for a point-to-multiple point connection. Note: Daisy chain connection of IRIG-B signal inputs in multiple relays must be avoided.



The recommended cable must be shielded and either of coaxial or twisted pair type. Its length should not exceed a maximum of 10 meters.

Deviation

The time deviation means how much system clock time differs from sync source time. Time deviation is calculated after receiving new sync message. The filtered deviation means how much the system clock was really adjusted. Filtering takes care of small deviation in sync messages.

Auto-lag/lead

The device synchronizes to the sync source, meaning it starts automatically leading or lagging to stay in perfect sync with the master. The learning process takes few days.

5.8 Running hour counter

This function calculates the total active time of the selected digital input, virtual I/O or output matrix output signal. The resolution is ten seconds.

Table 5.9: Running hour counter parameters

Parameter	Value	Unit	Description	Note
Runh	0 – 876000	h	Total active time, hours Note: The label text "Runh" can be edited with VAMPSET.	(Set)
Runs	0 – 3599	s	Total active time, seconds	(Set)
Starts	0 – 65535		Activation counter	(Set)
Status	Stop Run		Current status of the selected digital signal	
DI	 - DI1 – DI6, VI1 – VI4, LedAl, LedTr, LedA, LedB, LedC, LedDR, VO1 – VO6		Select the supervised signal None Physical inputs Virtual inputs Output matrix out signal Al Output matrix out signal Tr Output matrix out signal LA Output matrix out signal LB Output matrix out signal LC Output matrix out signal DR Virtual outputs	Set
Started at			Date and time of the last activation	
Stopped at			Date and time of the last inactivation	

Set = An editable parameter (password needed).

(Set) = An informative value which can be edited as well.

5.9 Timers

The VAMP protection platform includes four settable timers that can be used together with the user's programmable logic or to control setting groups and other applications that require actions based on calendar time. Each timer has its own settings. The selected on-time and off-time is set and then the activation of the timer can be set to be as daily or according the day of week (See the setting parameters for details). The timer outputs are available for logic functions and for the block and output matrix.

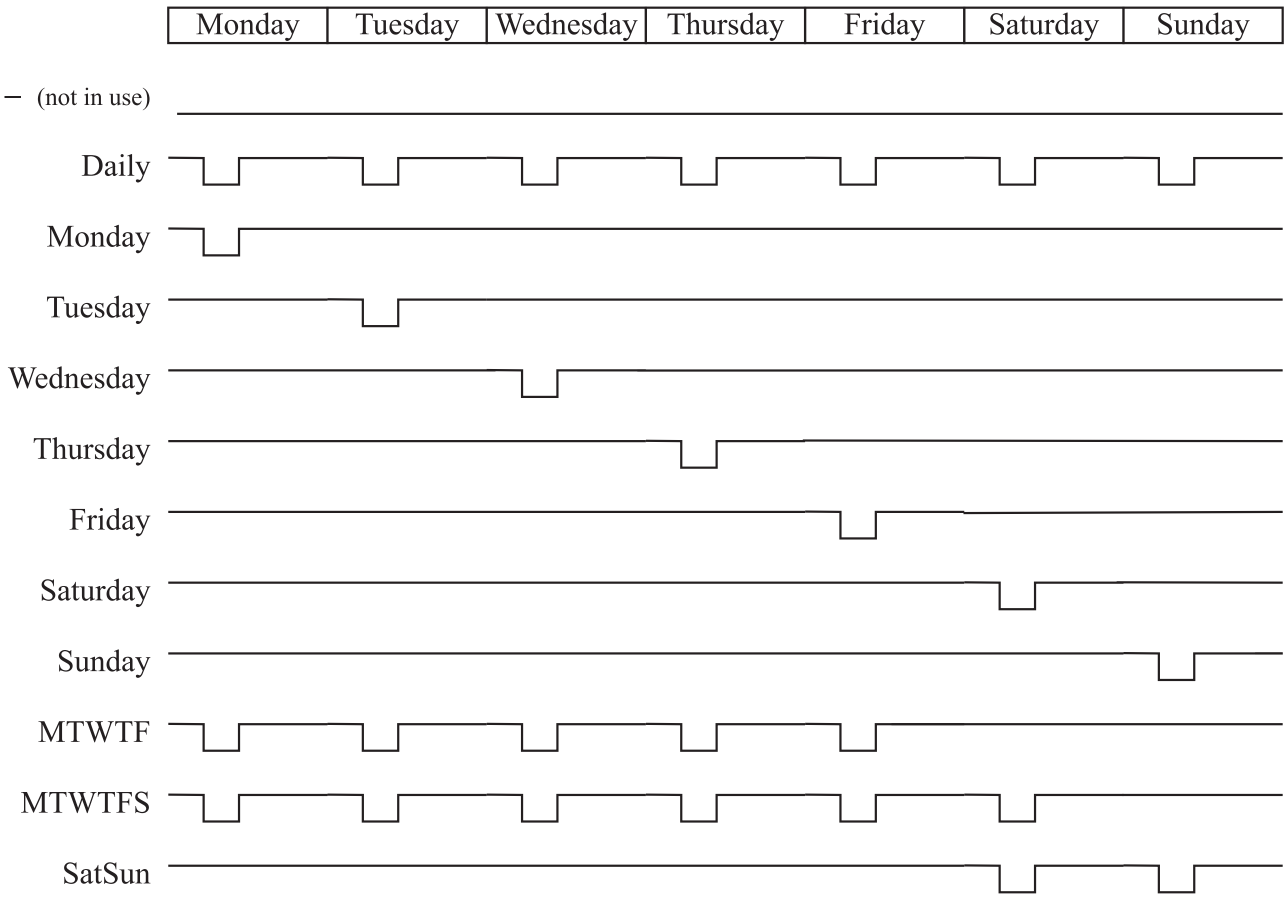


Figure 5.13: Timer output sequence in different modes.

The user can force any timer, which is in use, on or off. The forcing is done by writing a new status value. No forcing flag is needed as in forcing i.e. the output relays.

The forced time is valid until the next forcing or until the next reversing timed act from the timer itself.

The status of each timer is stored in non-volatile memory when the auxiliary power is switched off. At start up, the status of each timer is recovered.

Table 5.10: Setting parameters of timers

Parameter	Value	Description
TimerN		Timer status
	-	Not in use
	0	Output is inactive
	1	Output is active
On	hh:mm:ss	Activation time of the timer
Off	hh:mm:ss	De-activation time of the timer
Mode		For each four timers there are 12 different modes available:
	-	The timer is off and not running. The output is off i.e. 0 all the time.
	Daily	The timer switches on and off once every day.
	Monday	The timer switches on and off every Monday.
	Tuesday	The timer switches on and off every Tuesday.
	Wednesday	The timer switches on and off every Wednesday.
	Thursday	The timer switches on and off every Thursday.
	Friday	The timer switches on and off every Friday.
	Saturday	The timer switches on and off every Saturday.
	Sunday	The timer switches on and off every Sunday.
	MTWTF	The timer switches on and off every day except Saturdays and Sundays
	MTWTFS	The timer switches on and off every day except Sundays.
	SatSun	The timer switches on and off every Saturday and Sunday.

5.10 Programmable stages (99)

For special applications the user can built own protection stages by selecting the supervised signal and the comparison mode.

The following parameters are available:

- **Priority**
  If operation times less than 80 milliseconds are needed select 10 ms. For operation times under one second 20 ms is recommended. For longer operation times and THD signals 100 ms is recommended.
- **Coupling A**
  The name of the supervised signal in ">" and "<" modes (see table below). Also the name of the supervised signal 1 in "Diff" and "AbsDiff" modes.
- **Coupling B**
  The name of the supervised signal 2 in "Diff" and "AbsDiff" modes.
- **Compare condition**
  Compare mode. '>' for over or '<' for under comparison, "Diff" and "AbsDiff" for comparing Coupling A and Coupling B.
- **Pick-up**
  Limit of the stage. The available setting range and the unit depend on the selected signal.
- **Operation delay**
  Definite time operation delay
- **Hysteresis**
  Dead band (hysteresis)
- **No Compare limit for mode <**
  Only used with compare mode under ('<'). This is the limit to start the comparison. Signal values under NoCmp are not regarded as fault.

Table 5.11: Available signals to be supervised by the programmable stages

IL1, IL2, IL3	Phase currents
U12, U23, U31	Line-to-line voltages
UL1, UL2, UL3	Phase-to-ground voltages
Uo	Zero sequence voltage
f	Frequency
P	Active power
Q	Reactive power
S	Apparent power
Cos Fii	Cosine φ
IoCalc	Phasor sum $\underline{I}_{L1} + \underline{I}_{L2} + \underline{I}_{L3}$
I1	Positive sequence current

I2	Negative sequence current
I2/I1	Relative negative sequence current
I2/In	Negative sequence current in pu
U1	Positive sequence voltage
U2	Negative sequence voltage
U2/U1	Relative negative sequence voltage
IL	Average (I_{L1} + I_{L2} + $I_{L3)}$ / 3
TanFii	Tangent φ [= tan(arccosφ)]
Prms	Active power rms value
Qrms	Reactive power rms value
Srms	Apparent powre rms value
Uphase	Average of UL1, UL2, UL3
Uline	Average of U12, U23, U32
THDIL1	Total harmonic distortion of I_{L1}
THDIL2	Total harmonic distortion of I_{L2}
THDIL3	Total harmonic distortion of I_{L3}
THDUa	Total harmonic distortion of input U_A
THDUb	Total harmonic distortion of input U_B
THDUc	Total harmonic distortion of input U_C
IL1RMS	IL1 RMS for average sampling
IL2RMS	IL2 RMS for average sampling
IL3RMS	IL3 RMS for average sampling
ILmin, ILmax	Minimum and maximum of phase currents
ULLmin, ULLmax	Minimum and maximum of line voltages
ULNmin, ULNmax	Minimum and maximum of phase voltages
VAI1, VAI2, VAI3, VAI4, VAI5	Virtual analog inputs 1, 2, 3, 4, 5 (GOOSE)

Eight independent stages

The device has eight independent programmable stages. Each programmable stage can be enabled or disabled to fit the intended application.

Setting groups

There are four settings groups available. Switching between setting groups can be controlled by digital inputs, virtual inputs (mimic display, communication, logic) and manually.

There are four identical stages available with independent setting parameters.

See Chapter 5.1 General features of protection stages for more details.

Table 5.12: Parameters of the programmable stages PrgN (99)

Parameter	Value	Unit	Description	Note
Status	-		Current status of the stage	
	Blocked			
	Start			F
	Trip			F
SCntr			Cumulative start counter	C
TCntr			Cumulative trip counter	C
SetGrp	1 or 2		Active setting group	Set
SGrpDI			Digital signal to select the active setting group	Set
	-		None	
	DIx		Digital input	
	VIx		Virtual input	
	LEDx		LED indicator signal	
	VOx		Virtual output	
Force	Off On		Force flag for status forcing for test purposes. This is a common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set
Link	See Table 5.11		Name for the supervised signal	Set
See Table 5.11			Value of the supervised signal	
Cmp			Mode of comparison	Set
	>		Over protection	
	<		Under protection	
	Diff		Difference	
	AbsDiff		Absolut difference	
Pickup			Pick up value scaled to primary level	
Pickup		pu	Pick up setting in pu	Set
t		s	Definite operation time.	Set
Hyster		%	Dead band setting	Set
NoCmp		pu	Minimum value to start under comparison. (Mode='<')	Set

Set = An editable parameter (password needed). C = Can be cleared to zero. F = Editable when force flag is on.

Recorded values of the latest eight faults

There is detailed information available of the eight latest faults: Time stamp, fault value and elapsed delay.

Table 5.13: Recorded values of the programmable stages PrgN (99)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss.ms		Time stamp, time of day
Flt		pu	Fault value
EDly		%	Elapsed time of the operating time setting. 100% = trip
SetGrp	1, 2		Active setting group during fault

5.11 Self-supervision

The functions of the microcontroller and the associated circuitry, as well as the program execution are supervised by means of a separate watchdog circuit. Besides supervising the relay, the watchdog circuit attempts to restart the micro controller in an inoperable situation. If the micro controller does not resart, the watchdog issues a self-supervision signal indicating a permanent internal condition.

When the watchdog circuit detects a permanent fault it always blocks any control of the other output relays, except for the self-supervision output relay.

5.11.1 Diagnostics

The device runs self-diagnostic tests for hardware and software in boot sequence and also performs runtime checking.

Permanent inoperative state

If permanent inoperative state has been detected, the device releases SF relay contact and status LED is set on. Local panel will also display a detected fault message. Permanet inoperative state is entered when the device is not able to handle main functions.

Temporal inoperative state

When self-diagnostic function detects a temporal inoperative state, Selfdiag matrix signal is set and an event (E56) is generated. In case the inoperative state was only temporary, an off event is generated (E57). Self diagnostic state can be reset via local HMI.

Diagnostic registers

There are four 16-bit diagnostic registers which are readable through remote protocols. The following table shows the meaning of each diagnostic register and their bits.

Register	Bit	Code	Description
SelfDiag1	0 (LSB)	T1	Potential output relay problem
	1	T2	
	4	A1	
	5	A2	
	6	A3	
	7	A4	
	8	A5	
SelfDiag3	0 (LSB)	DAC	Potential mA-output problem
	1	STACK	Potential stack problem
	2	MemChk	Potential memory problem
	3	BGTask	Potential background task timeout
	4	DI	Potential input problem (Remove DI1, DI2)
	5		
	6	Arc	Potential arc card problem
	7	SecPulse	Potential hardware problem
	8	RangeChk	DB: Setting outside range
	9	CPULoad	Overload
	10	+24V	Potential internal voltage problem
	11	-15V	
	12	ITemp	Internal temperature too high
	13	ADChk1	Potential A/D converter problem
	14	ADChk2	Potential A/D converter problem
	15 (MSB)	E2prom	Potential E2prom problem
SelfDiag4	1	ComBuff	Potential BUS: buffer problem

The code is displayed in self diagnostic events and on the diagnostic menu on local panel and VAMPSET.

6 Measurement functions

All the direct measurements are based on fundamental frequency values.

The figure shows a current waveform and the corresponding fundamental frequency component f1, second harmonic f2 and rms value in a special case, when the current deviates significantly from a pure sine wave.

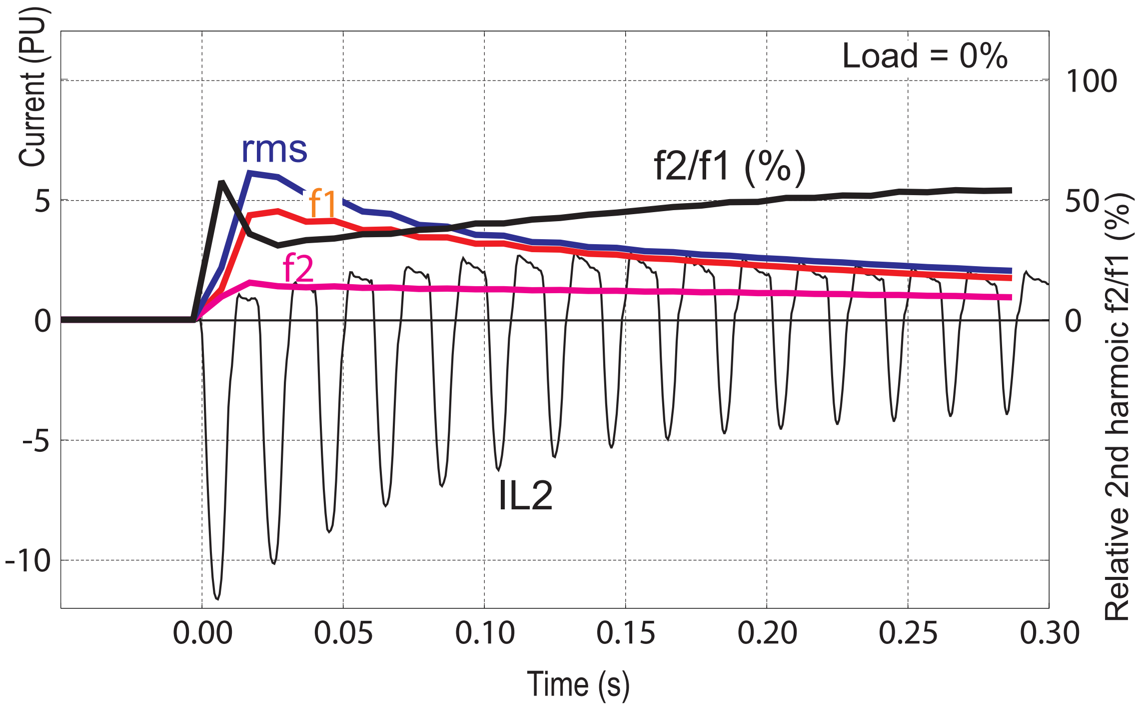


Figure 6.1: Example of various current values of a transformer inrush current

6.1 Measurement accuracy

The specified frequency range for all measurements except frequency is 45 Hz – 65 Hz.

Table 6.1: Phase current inputs I_{L1}, I_{L2}, I_{L3}

Measuring range	25mA – 250 A (5A) 5mA – 50 A (1A)
Inaccuracy: I ≤ 7.5 A I > 7.5 A	 ±0.5 % of value or ±15 mA ±3 % of value
The rated input I_N is 5 A or 1 A. It is specified in the order code of the relay. **Squelch limit:** Phase current inputs: 0.5% of I_{NOM} (tolerance ±0.05%) Residual current: 0.2% of I_{0NOM} (tolerance ±0.05%)	

Table 6.2: Voltage inputs U_A, U_B, U_C

Measuring range	0 – 260 V
Inaccuracy	±0.5 % or ±0.3 V
Squelch level	0.1 V
The usage of voltage inputs depends on the configuration parameter voltage measurement mode (see Chapter 6.9 Voltage measurement modes). For example, U_C is the input for U31 if the mode "3LL" is selected but in mode "3LN" the same input is used for phase-to-neutral voltage UL3.	

Table 6.3: Frequency

Measuring range	16 Hz – 75 Hz
Inaccuracy	±10 mHz
The frequency is measured from voltage inputs U_A and/or U_B.	

Table 6.4: Power measurements P, Q, S

Inaccuracy |PF|> 0.5	±1 % of value or ±3 VA_{SEC}

Table 6.5: Power factor cosφ, tanφ

Inaccuracy |PF|> 0.5	±2° or ±0.02

Table 6.6: Energy counters E+, Eq+, E-, Eq-

Inaccuracy |PF|> 0.5	±1 % of value or ±3 $Wh_{SECONDARY}$/1 h

Table 6.7: THD and harmonics

Inaccuracy I, U > 0.1 PU	±2 % units
Update rate	Once a second

6.2 Power calculations

The power calculation in VAMP devices are dependent on the voltage measurement mode, see Chapter 6.9 Voltage measurement modes. The formulas used for power calculations are described in this chapter.

The device is connected to line-to-line voltages

When the relay is connected to line-to-line voltages, the voltage measurement mode is set to equal to "3LL". The following Aron equation is used for power calculation.

$$\overline{S} = \overline{U}_{12} \cdot \overline{I}_{L1}^{*} - \overline{U}_{23} \cdot \overline{I}_{L3}^{*}$$

$\overline{S}$ = Three phase power phasor

$\overline{U}_{12}$ = Measured voltage phasor corresponding the fundamental frequency voltage between phases L1 and L2.

$\overline{I}_{L1}^{*}$ = Complex conjugate of the measured phase L1 fundamental frequency current phasor.

$\overline{U}_{23}$ = Measured voltage phasor corresponding the fundamental frequency voltage between phases L2 and L3.

$\overline{I}_{L3}^{*}$ = Complex conjugate of the measured phase L3 fundamental frequency current phasor.

Apparent power, active power and reactive power are calculated as follows

$$S = \left|\overline{S}\right|$$

$$P = real(\overline{S})$$

$$Q = imag(\overline{S})$$

$$\cos\varphi = \frac{P}{S}$$

The device is connected to line-to-neutral voltage

When the device is connected to line-to-neutral voltages, the voltage measurement mode is set to equal to "3LN". The following equation is used for power calculation.

$$\overline{S} = \overline{U}_{L1} \cdot \overline{I}_{L1}^{*} + \overline{U}_{L2} \cdot \overline{I}_{L2}^{*} + \overline{U}_{L3} \cdot \overline{I}_{L3}^{*}$$

$\overline{S}$ = Three phase power phasor

$\overline{U}_{L1}$ = Measured voltage phasor corresponding the fundamental frequency voltage of phase L1.

$\overline{I}_{L1}^{*}$ = Complex conjugate of the measured phase L1 fundamental frequency current phasor.

$\overline{U}_{L2}$ = Measured voltage phasor corresponding the fundamental frequency voltage of phase L2.

$\overline{I}_{L2}^{*}$ = Complex conjugate of the measured phase L2 fundamental frequency current phasor.

$\overline{U}_{L3}$ = Measured voltage phasor corresponding the fundamental frequency voltage of phase L3.

$\overline{I}_{L3}^{*}$ = Complex conjugate of the measured phase L3 fundamental frequency current phasor.

Apparent power, active power and reactive power are calculated similarly as with line-to-line voltages

$$S = \left|\overline{S}\right|$$

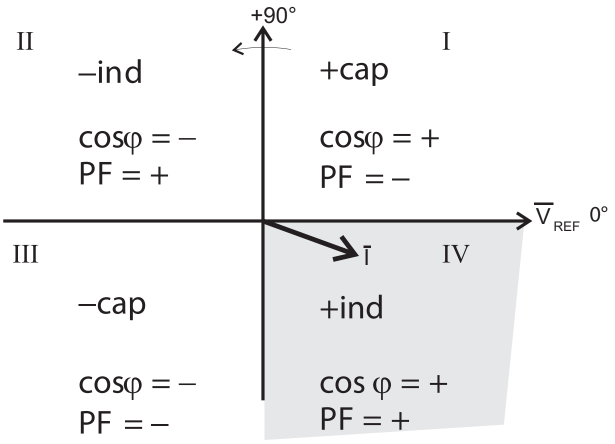
$$P = real(\overline{S})$$

$$Q = imag(\overline{S})$$

$$\cos\varphi = \frac{P}{S}$$

6.3 Direction of power and current

Figure 6.2 shows the concept of three phase current direction and sign of cosφ and power factor PF. Figure 6.3 shows the same concepts, but on a PQ-power plane.



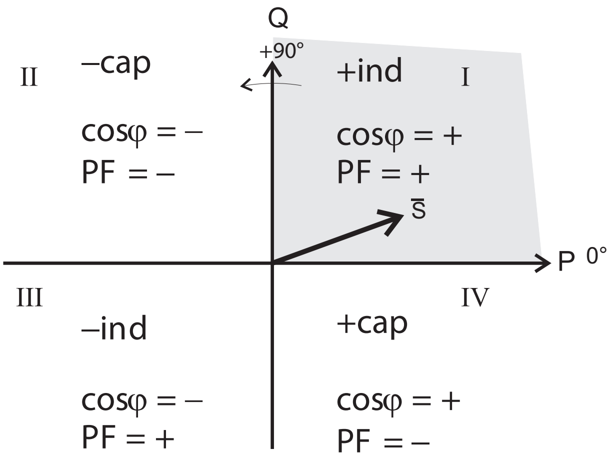
I: Forward capacitive power current is leading

II: Reverse inductive power current is leading

III: Reverse capacitive power current is lagging

IV: Forward inductive power current is lagging

Figure 6.2: Quadrants of voltage/current phasor plane



I: Forward inductive power current is lagging

II: Reverse capacitive power current is lagging

III: Reverse inductive power current is leading

IV: Forward capacitive power current is leading

Figure 6.3: Quadrants of power plane

Table 6.8: Power quadrants

Power quadrant	Current related to voltage	Power direction	cosφ	Power factor PF
+ inductive	Lagging	Forward	+	+
+ capacitive	Leading	Forward	+	-
- inductive	Leading	Reverse	-	+
- capacitive	Lagging	Reverse	-	-

6.4 Harmonics and Total Harmonic Distortion (THD)

The device calculates the THDs as percentage of the base frequency for currents and voltages. The device calculates the harmonics from the 2nd to the 15th of phase currents and voltages. (The 17th harmonic component will also be shown partly in the value of the 15th harmonic component. This is due to the nature of digital sampling.)

The harmonic distortion is calculated using equation

$$THD = \frac{\sqrt{\sum_{i=2}^{15} h_i^2}}{h_1}$$

h_1 = Fundamental value

h_{2-15} = Harmonics

Example

h_1 = 100 A, h_3 = 10 A, h_7 = 3 A, h_{11} = 8 A

$$THD = \frac{\sqrt{10^2 + 3^2 + 8^2}}{100} = 13.2\%$$

For reference the RMS value is

$$RMS = \sqrt{100^2 + 10^2 + 3^2 + 8^2} = 100.9A$$

Another way to calculate THD is to use the RMS value as reference instead of the fundamental frequency value. In the example above the result would then be 13.0 %.

6.5 RMS values

RMS currents

The device calculates the RMS value of each phase current. The minimum and the maximum of RMS values are recorded and stored (see Chapter 6.7 Minimum and maximum values).

$$I_{RMS} = \sqrt{I_{f1}^{\ 2} + I_{f2}^{\ 2} + ... + I_{f15}^{\ 2}}$$

RMS voltages

The device calculates the RMS value of each voltage input. The minimum and the maximum of RMS values are recorded and stored (see Chapter 6.7 Minimum and maximum values).

$$U_{RMS} = \sqrt{U_{f1}^{\ 2} + U_{f2}^{\ 2} + ... + U_{f15}^{\ 2}}$$

Apparent RMS power (S_{RMS})

PMU calculates the RMS value of apparent power (S). The minimum and the maximum of RMS values are recorded and stored (see Chapter 6.7 Minimum and maximum values).

$S_{RMS} = I_{RMS} \times U_{RMS}$

6.6 Demand values

The relay calculates average i.e. demand values of phase currents I_{L1}, I_{L2}, I_{L3} and power values S, P and Q.

The demand time is configurable from 10 minutes to 30 minutes with parameter "Demand time".

Table 6.9: Demand value parameters

Parameter	**Value**	**Unit**	**Description**	**Set**
Time	10 – 30	min	Demand time (averaging time)	Set
Fundamental frequency values				
IL1da		A	Demand of phase current IL1	
IL2da		A	Demand of phase current IL2	
IL3da		A	Demand of phase current IL3	
Pda		kW	Demand of active power P	
PFda			Demand of power factor PF	
Qda		Kvar	Demand of reactive power Q	
Sda		kVA	Demand of apparent power S	
RMS values				
IL1da		A	Demand of phase current IL1	
IL2da		A	Demand of phase current IL2	
IL3da		A	Demand of phase current IL3	

Set = An editable parameter (password needed).

6.7 Minimum and maximum values

Minimum and maximum values are registered with time stamps since the latest manual clearing or since the device has been restarted. The available registered min & max values are listed in the following table.

Min & Max measurement	Description
IL1, IL2, IL3	Phase current (fundamental frequency value)
IL1RMS, IL2RMS, IL3RMS	Phase current, rms value
U_ARMS, U_BRMS, U_CRMS	Line-to-neutral voltages, RMS value
U12, U23, U31	Line-to-line voltage
f	Frequency
P, Q, S	Active, reactive, apparent power
Prms, Qrms, Srms	Active, reactive, apparent power, rms values
IL1da, IL2da, IL3da	Demand values of phase currents
IL1da, IL2da, IL3da (rms value)	Demand values of phase currents, rms values
PFda	Power factor demand value

The clearing parameter "ClrMax" is common for all these values.

Table 6.10: Parameters

Parameter	Value	Description	Set
ClrMax	- Clear	Reset all minimum and maximum values	Set

Set = An editable parameter (password needed).

6.8 Maximum values of the last 31 days and 12 months

Maximum and minimum values of the last 31 days and the last twelve months are stored in the non-volatile memory of the relay. Corresponding time stamps are stored for the last 31 days. The registered values are listed in the following table.

Measurement	Max	Min	Description	31 days	12 months
IL1, IL2, IL3	X		Phase current (fundamental frequency value)		
S	X		Apparent power	X	X
P	X	X	Active power	X	X
Q	X	X	Reactive power	X	X

The value can be a one cycle value or an average based on the "Timebase" parameter.

Table 6.11: Parameters of the day and month registers

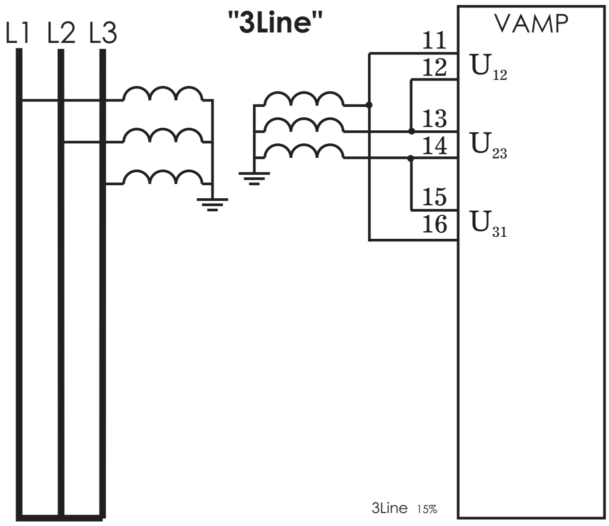
Parameter	Value	Description	Set
Timebase		Parameter to select the type of the registered values	Set
	20 ms	Collect min & max of one cycle values *	
	200 ms	Collect min & max of 200 ms average values	
	1 s	Collect min & max of 1 s average values	
	1 min	Collect min & max of 1 minute average values	
	demand	Collect min & max of demand values (Chapter 6.6 Demand values)	
ResetDays		Reset the 31 day registers	Set
ResetMon		Reset the 12 month registers	Set

Set = An editable parameter (password needed).

* This is the fundamental frequency rms value of one cycle updated every 20 ms.

6.9 Voltage measurement modes

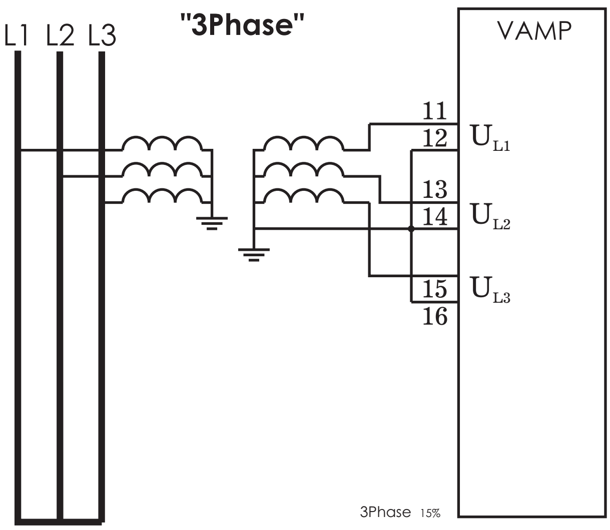
Depending on the application and available voltage transformers, the relay can be connected either to line-to-line voltages or phase-to-ground voltages. The configuration parameter "Voltage measurement mode" must be set according the used connection.



"3LL"

The device is connected to line-to-line voltages U12, U23 and U31. The phase-to-ground voltages are calculated. The network must use only three wires. Any neutral wire must not exist.

Figure 6.4: The device is connected to line-to-line voltages from three Y-connected voltage transformers. Voltage measurement mode is set to "3LL".



"3LN"

The device is connected to phase-to-ground voltages UL1, UL2 and UL3. The zero sequence voltage is calculated. There may exist a neutral wire.

Figure 6.5: The device is connected to phase-to-ground voltages from three Y-connected voltage transformers. The zero sequence is calculated internally. Voltage measurement mode is set to "3LN".

6.10 Symmetric components

In a three phase system, the voltage or current phasors may be divided in symmetric components according C. L. Fortescue (1918). The symmetric components are:

- Positive sequence 1
- Negative sequence 2
- Zero sequence 0

Symmetric components are calculated according the following equations:

$$\begin{bmatrix} \underline{S}_0 \\ \underline{S}_1 \\ \underline{S}_2 \end{bmatrix} = \frac{1}{3} \begin{bmatrix} 1 & 1 & 1 \\ 1 & \underline{a} & \underline{a}^2 \\ 1 & \underline{a}^2 & \underline{a} \end{bmatrix} \begin{bmatrix} \underline{U} \\ \underline{V} \\ \underline{W} \end{bmatrix}$$

$\underline{S}_0$ = zero sequence component

$\underline{S}_1$ = positive sequence component

$\underline{S}_2$ = negative sequence component

$\underline{a} = 1\angle 120° = -\frac{1}{2} + j\frac{\sqrt{3}}{2}$, a phasor rotating constant

$\underline{U}$ = phasor of phase L1 (phase current or line-to-neutral voltage)

$\underline{V}$ = phasor of phase L2

$\underline{W}$ = phasor of phase L3

In case the voltage measurement mode is "3LL" i.e. three line-to-line voltage are measured, the following equation is used instead.

$$\begin{bmatrix} \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3} \begin{bmatrix} 1 & -\underline{a}^2 \\ 1 & -\underline{a} \end{bmatrix} \begin{bmatrix} \underline{U}_{12} \\ \underline{U}_{23} \end{bmatrix}$$

U_{12} = Voltage between phases L1 and L2

U_{23} = Voltage between phases L2 and L3

When using line-to-line voltages, any zero sequence voltage can not be calculated.

The network must use only three wires. Any neutral wire must not exist.

Examples:

1. **Single phase injection**

   U_N = 100 V

   Voltage measurement mode is "3LL".

   Injection:

   $U_A = U_{12}$ = 100 V

   $U_B = U_{23}$ = 0

$$\begin{bmatrix} \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & -\underline{a}^2 \\ 1 & -\underline{a} \end{bmatrix}\begin{bmatrix} 100\angle 0^\circ \\ 0 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 100\angle 0^\circ \\ 100\angle 0^\circ \end{bmatrix} = \begin{bmatrix} 33 \\ 33 \end{bmatrix}$$

   U_1 = 33 %

   U_2 = 33 %

   U_2/U_1 = 100 %

   When using a single phase test device, the relative unbalance U_2/U_1 will always be 100 %.

2. **Two phase injection with adjustable phase angle**

   U_N = 100 V

   Voltage measurement mode is "3LL".

   Injection:

   $U_A = U_{12}$ = 100 V $\angle 0°$

   $U_B = U_{23} = 100/\sqrt{3}$ V $\angle$-150° = 57.7 V $\angle$-150°

$$\begin{bmatrix} \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & -\underline{a}^2 \\ 1 & -\underline{a} \end{bmatrix}\begin{bmatrix} 100\angle 0^\circ \\ 100/\sqrt{3}\angle -150^\circ \end{bmatrix} = \frac{100}{3}\begin{bmatrix} 1\angle 0^\circ - 1/\sqrt{3}\angle +90^\circ \\ 1\angle 0^\circ - 1/\sqrt{3}\angle -30^\circ \end{bmatrix} =$$

$$= \frac{100}{3}\begin{bmatrix} 2/\sqrt{3}\angle -30^\circ \\ 1/\sqrt{3}\angle +30^\circ \end{bmatrix} = \begin{bmatrix} 38.5\angle -30^\circ \\ 19.2\angle +30^\circ \end{bmatrix}$$

   U_1 = 38.5 %

   U_2 = 19.2 %

   U_2/U_1 = 50 %

   Figure 6.6 shows a geometric solution. The input values have been scaled with $\sqrt{3}$/100 to make the calculation easier.

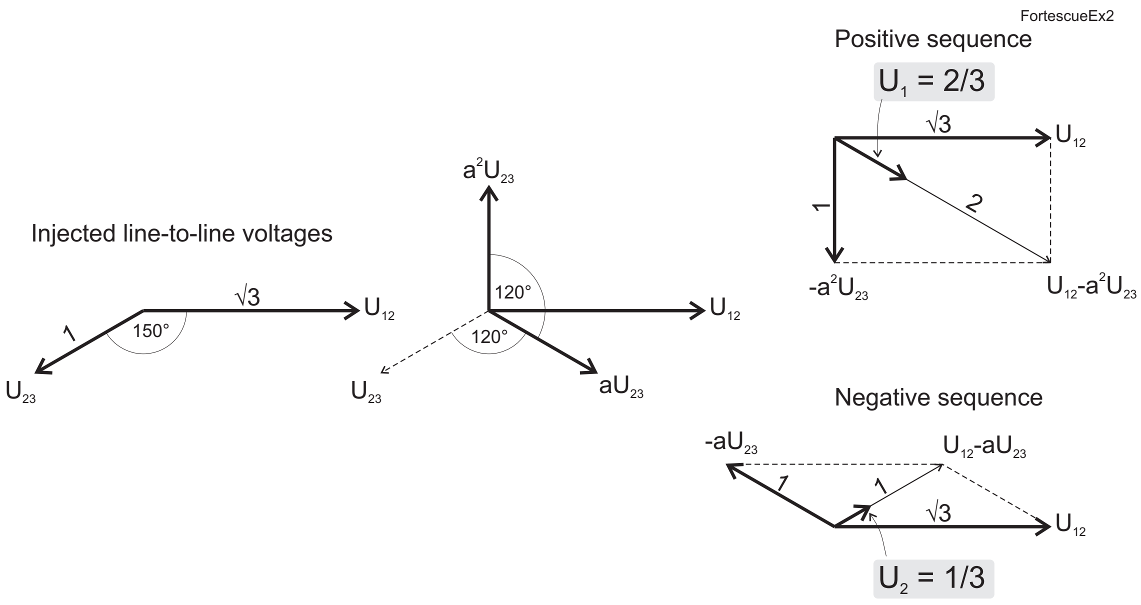


Figure 6.6: Example of symmetric component calculation using line-to-line voltages.

Unscaling the geometric results gives

$U_1 = 100/\sqrt{3}$ x 2/3 = 38.5 %

$U_2 = 100/\sqrt{3}$ x 1/3 = 19.2 %

U_2/U_1 = 1/3:2/3 = 50 %

3. **Two phase injection with adjustable phase angle**

U_N = 100 V

Voltage measurement mode is "3LN".

Injection:

$U_A = U_{L1} = 100/\sqrt{3}$ V $\angle$0° = 57.7 V $\angle$0°

$U_B = U_{L2} = 100/\sqrt{3}$ V $\angle$-120° = 57.7 V $\angle$-120°

$U_C = U_{L3}$ = 0 V

This is actually identical case with example 2 because the resulting line-to-line voltages $U_{12} = U_{L1} - U_{L2}$ = 100 V $\angle$30° and $U_{23} = U_{L2} - U_{L3} = U_{L2} = 100/\sqrt{3}$ V $\angle$-120° are the same as in example 2. The only difference is a +30° phase angle difference, but without any absolute angle reference this phase angle difference is not seen by the device.

$$\begin{bmatrix} \underline{U}_0 \\ \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \underline{a} & \underline{a}^2 \\ 1 & \underline{a}^2 & \underline{a} \end{bmatrix}\begin{bmatrix} \frac{100}{\sqrt{3}}\angle 0° \\ \frac{100}{\sqrt{3}}\angle -120° \\ 0 \end{bmatrix} = \frac{1}{3\sqrt{3}}\begin{bmatrix} 100\angle 0° + 100\angle -120° \\ 100\angle 0° + 100\angle 0° \\ 100\angle 0° + 100\angle +120° \end{bmatrix} =$$

$$= \frac{1}{3\sqrt{3}}\begin{bmatrix} 100\angle -60° \\ 200\angle 0° \\ 100\angle 60° \end{bmatrix} = \begin{bmatrix} 19.2\angle -60° \\ 38.5\angle 0° \\ 19.2\angle +60° \end{bmatrix}$$

U_0 = 19.2 %

U_1 = 38.5 %

U_2 = 19.2 %

U_2/U_1 = 50 %

Figure 6.7 shows a graphical solution. The input values have been scaled with $\sqrt{3}$/100 to make the calculation easier.

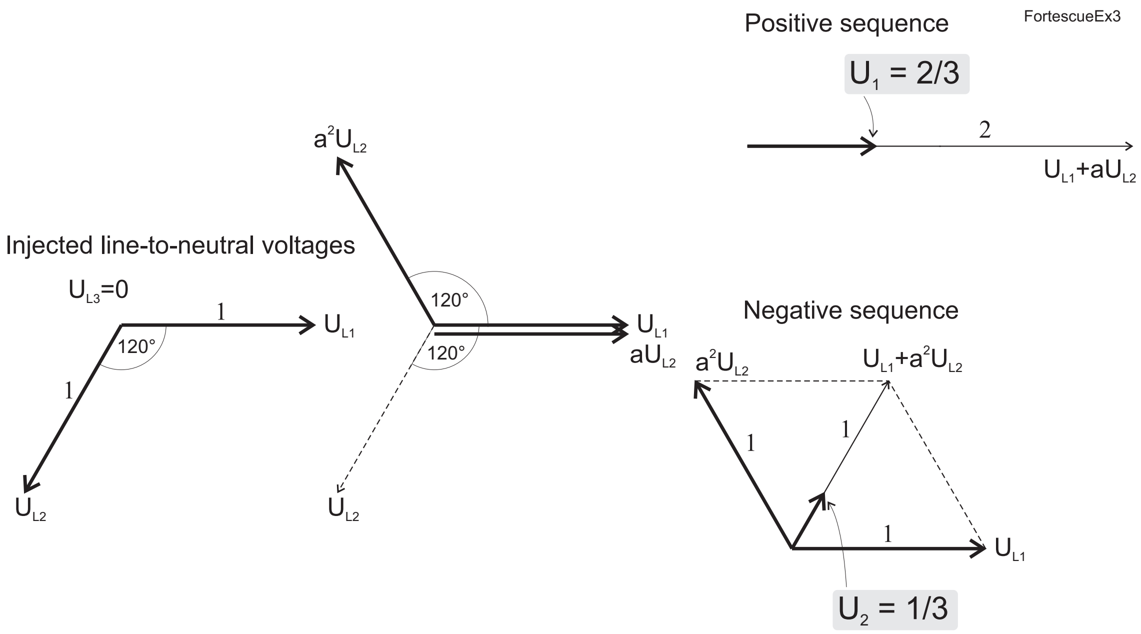


Figure 6.7: Example of symmetric component calculation using line-to-neutral voltages.

Unscaling the geometric results gives

U_1 = 100/$\sqrt{3}$ x 2/3 = 38.5 %

U_2 = 100/$\sqrt{3}$ x 1/3 = 19.2 %

U_2/U_1 = 1/3:2/3 = 50 %

6.11 Primary secondary and per unit scaling

Many measurement values are shown as primary values although the device is connected to secondary signals.

The scaling is done using the given CT and VT name plate values.

The following scaling equations are useful when doing secondary testing.

6.11.1 Current scaling

NOTE: The rated value of the device's current input, for example 5 A or 1A, does not have any effect in the scaling equations, but it defines the measurement range and the maximum allowed continuous current. See Table 11.1 for details.

Primary and secondary scaling

	Current scaling
secondary → primary	$I_{PRI} = I_{SEC} \cdot \frac{CT_{PRI}}{CT_{SEC}}$
primary → secondary	$I_{SEC} = I_{PRI} \cdot \frac{CT_{SEC}}{CT_{PRI}}$

Examples:

1. **Secondary to primary**
   CT = 500 / 5
   Current to the relay's input is 4 A.
   => Primary current is I_{PRI} = 4 x 500 / 5 = 400 A
2. **Primary to secondary**
   CT = 500 / 5
   The relay displays I_{PRI} = 400 A
   => Injected current is I_{SEC} = 400 x 5 / 500 = 4 A

6.11.2 Voltage scaling

Primary / secondary scaling of line-to-line voltages

	Line-to-line voltage scaling	
	Voltage measurement mode = "3LL"	Voltage measurement mode = "3LN"
secondary → primary	$U_{PRI} = U_{SEC} \cdot \frac{VT_{PRI}}{VT_{SEC}}$	$U_{PRI} = \sqrt{3} \cdot U_{SEC} \cdot \frac{VT_{PRI}}{VT_{SEC}}$
primary → secondary	$U_{SEC} = U_{PRI} \cdot \frac{VT_{SEC}}{VT_{PRI}}$	$U_{SEC} = \frac{U_{PRI}}{\sqrt{3}} \cdot \frac{VT_{SEC}}{VT_{PRI}}$

Examples:

1. **Secondary to primary. Voltage measurement mode is "3LL".**

   VT = 12000 / 110

   Voltage connected to the relay's input U_A, U_B or U_C is 100 V.

   Primary voltage is U_{PRI} = 100 x 12000 / 110 = 10909 V.

2. **Secondary to primary. Voltage measurement mode is "3LN".**

   VT = 12000 / 110

   Three phase symmetric voltages connected to the device's inputs U_A, U_B and U_C are 57.7 V.

   Primary voltage is U_{PRI} = $\sqrt{3}$ x 58 x 12000 / 110 = 10902 V

3. **Primary to secondary. Voltage measurement mode is "3LL".**

   VT = 12000 / 110

   The relay displays U_{PRI} = 10910 V.

   Secondary voltage is U_{SEC} = 10910 x 110 / 12000 = 100 V

4. **Primary to secondary. Voltage measurement mode is "3LN".**

   VT = 12000 / 110

   The relay displays $U_{12} = U_{23} = U_{31}$ = 10910 V.

   Symmetric secondary voltages at U_A, U_B and U_C are U_{SEC} = 10910 / $\sqrt{3}$ x 110 / 12000 = 57.7 V.

6.12 Analogue outputs (option)

A terminal with the mA option has four configurable analogue outputs that take up two of the output relays (A4 and A5). Thus, a relay with the mA option has two output relays less than the version without mA option.

The resolution of the analogue output is 12 bits resulting current steps less than 6 µA. The output current range is configurable allowing e.g. the following ranges: 0 – 20 mA and 4 – 20 mA. More exotic ranges like 0 – 5 mA or 10 – 2 mA can be configured freely as long as the boundary values are within 0 – 20 mA.

Connections:

X2: 1 AO1+	X2: 3 AO2+	X2: 5 AO3+	X2: 7 AO4+
X2: 2 AO1-	X2: 4 AO2-	X2: 6 AO3-	X2: 8 AO4-

NOTE: All positive poles (X2:1, -3, -5 and -7) are internally connected together.

6.12.1 mA scaling example

Examples of configuration of scaling the transducer (mA) output.

Example of mA scaling for IL

Coupling = IL

Scaled minimum = 0 A

Scaled maximum = 300 mA

Analogue output minimum value = 0 mA

Analogue output maximum value = 20 mA

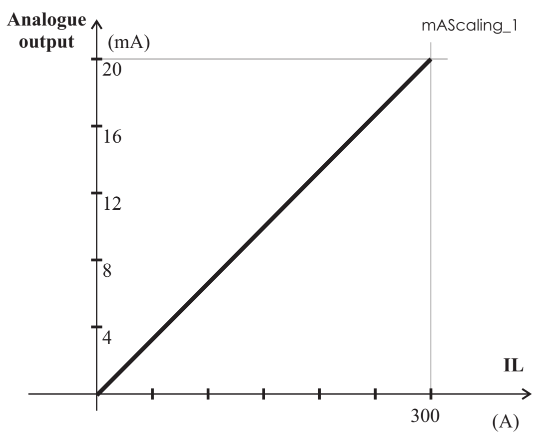


Figure 6.8: The average of the three phase currents. At 0 A the transducer ouput is 0 mA, at 300 A the output is 20 mA

Example of mA scaling for Uline

Coupling = Uline

Scaled minimum = 0 V

Scaled maximum = 15000 V

Analogue output minimum value = 4 mA

Analogue output maximum value = 20 mA

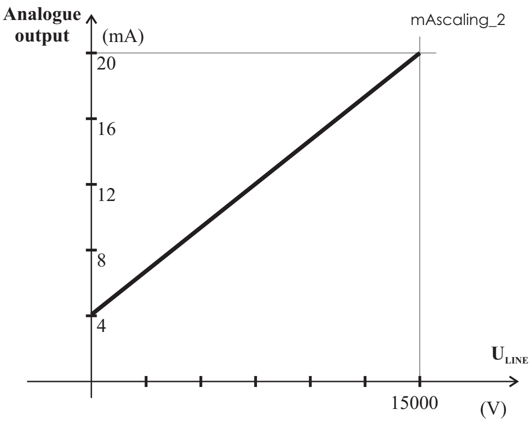


Figure 6.9: The average of the line-to-line voltages. At 0 V the transducer ouput is 4 mA, at 15000 V the output is 20 mA

Example of mA scaling for bi-directional power

Coupling = Q

Scaled minimum = -2000 kVar

Scaled maximum = 6000 kVar

Analogue output minimum value = 4 mA

Analogue output maximum value = 20 mA

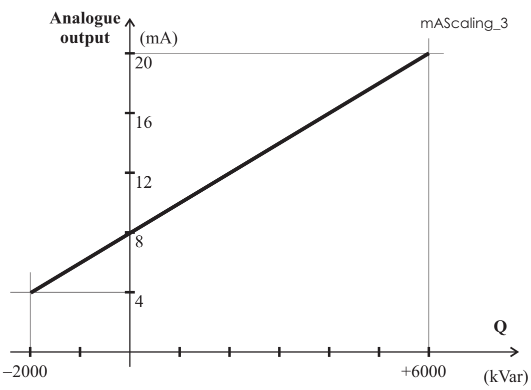


Figure 6.10: At -2000 kVar the transducer output is 4 mA, at 0 kVar it is 8 mA and at 6000 kVar the output is 20 mA

7 Control functions

7.1 Output relays

The output relays are also called digital outputs. Any internal signal can be connected to the output relays using output matrix. An output relay can be configured as latched or non-latched. See Chapter 7.4 Output matrix for more details.

NOTE: If the device has the mA option, it is equipped with only three alarm relays from A1 to A3.

The difference between trip contacts and signal contacts is the DC breaking capacity. See Table 11.4 and Table 11.5 for details. The contacts are SPST normal open type (NO), except alarm relays A1 – A3, which have change over contacts (SPDT).

Table 7.1: Parameters of output relays

Parameter	Value	Unit	Description	Note
T1 – T2	0 1		Status of trip output relay	F
A1 – A5	0 1		Status of alarm output relay	F
SF	0 1		Status of the SF relay In VAMPSET, it is called as "Service status output"	F
Force	On Off		Force flag for output relay forcing for test purposes. This is a common flag for all output relays and detection stage status, too. Any forced relay(s) and this flag are automatically reset by a 5-minute timeout.	Set
REMOTE PULSES				
A1 – A5	0.00 – 99.98 or 99.99	s	Pulse length for direct output relay control via communications protocols. 99.99 s = Infinite. Release by writing "0" to the direct control parameter	Set
NAMES for OUTPUT RELAYS (editable with VAMPSET only)				
Description	String of max. 32 characters		Names for DO on VAMPSET screens. Default is “Trip relay n”, n=1 – 2 or ”signal relay n”, n=1 – 5	Set

F = Editable when force flag is on. Set = An editable parameter (password needed).

7.2 Digital inputs

There are 6 digital inputs available for control purposes. The polarity - normal open (NO) / normal closed (NC) - and a delay can be configured according the application. The signals are available for the output matrix, block matrix, user's programmable logic etc.

The contacts connected to digital inputs DI1 – DI6 must be dry (potential free). These inputs use the common internal 48 Vdc wetting voltage from pin X3:1, only.

NOTE: These digital inputs must not be connected parallel with inputs of another device.

Label and description texts can be edited with VAMPSET according the application. Labels are the short parameter names used on the local panel and descriptions are the longer names used by VAMPSET.

Table 7.2: Parameters of digital inputs

Parameter	Value	Unit	Description	Note
DI1 – DI6	0; 1		Status of digital input	
DI COUNTERS				
DI1 – DI6	0 – 65535		Cumulative active edge counter	(Set)
DELAYS FOR DIGITAL INPUTS				
DI1 – DI6	0.00 – 60.00	s	Definite delay for both on and off transitions	Set
CONFIGURATION DI1 – DI6				
Inverted	no		For normal open contacts (NO). Active edge is 0 -> 1	Set
	yes		For normal closed contacts (NC). Active edge is 1 -> 0	
Indication display	no		No pop-up display	Set
	yes		Indication display is activated at active DI edge	
On event	On		Active edge event enabled	Set
	Off		Active edge event disabled	
Off event	On		Inactive edge event enabled	Set
	Off		Inactive edge event disabled	
NAMES for DIGITAL INPUTS (editable with VAMPSET only)				
Label	String of max. 10 characters		Short name for DIs on the local display. Default is "DIn", n = 1 – 6	Set
Description	String of max. 32 characters		Long name for DIs. Default is "Digital input n", n = 1 – 6	Set

Set = An editable parameter (password needed).

7.3 Virtual inputs and outputs

There are four virtual inputs and six virtual outputs. The four virtual inputs acts like normal digital inputs. The state of the virtual input can be changed from display, communication bus and from VAMPSET. For example setting groups can be changed using virtual inputs.

Table 7.3: Parameters of virtual inputs

Parameter	Value	Unit	Description	Note
VI1 – VI4	0; 1		Status of virtual input	
Events	On; Off		Event enabling	Set
NAMES for VIRTUAL INPUTS (editable with VAMPSET only)				
Label	String of max. 10 characters		Short name for VIs on the local display Default is "VIn", n = 1 – 4	Set
Description	String of max. 32 characters		Long name for VIs. Default is "Virtual input n", n = 1 – 4	Set

Set = An editable parameter (password needed).

The six virtual outputs do act like output relays, but there are no physical contacts. Virtual outputs are shown in the output matrix and the block matrix. Virtual outputs can be used with the user's programmable logic and to change the active setting group etc.

7.4 Output matrix

By means of the output matrix, the output signals of the various protection stages, digital inputs, logic outputs and other internal signals can be connected to the output relays, front panel indicators, virtual outputs etc.

There are two LED indicators named "Alarm" and "Trip" on the front panel. Furthermore there are three general purpose LED indicators - "A", "B" and "C" - available for customer-specific indications. In addition, the triggering of the disturbance recorder (DR) and virtual outputs are configurable in the output matrix. See an example in Figure 7.1.

An output relay or indicator LED can be configured as latched or non-latched. A non-latched relay follows the controlling signal. A latched relay remains activated although the controlling signal releases.

There is a common "release latched" signal to release all the latched relays. This release signal resets all the latched output relays and indicators. The reset signal can be given via a digital input, via a keypad or through communication. Any digital input can be used for resetting. The selection of the input is done with the VAMPSET software under the menu "Release output matrix latches". Under the same menu, the "Release latches" parameter can be used for resetting.

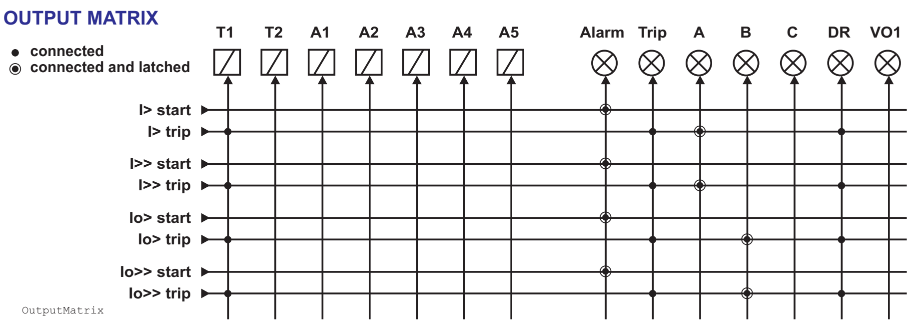


Figure 7.1: Output matrix.

7.5 Blocking matrix

By means of a blocking matrix, the operation of any protection stage can be blocked. The blocking signal can originate from the digital inputs DI1 to DI6, or it can be a start or trip signal from a programmable stage or an output signal from the user's programmable logic. In the block matrix Figure 7.2 an active blocking is indicated with a black dot (•) in the crossing point of a blocking signal and the signal to be blocked.

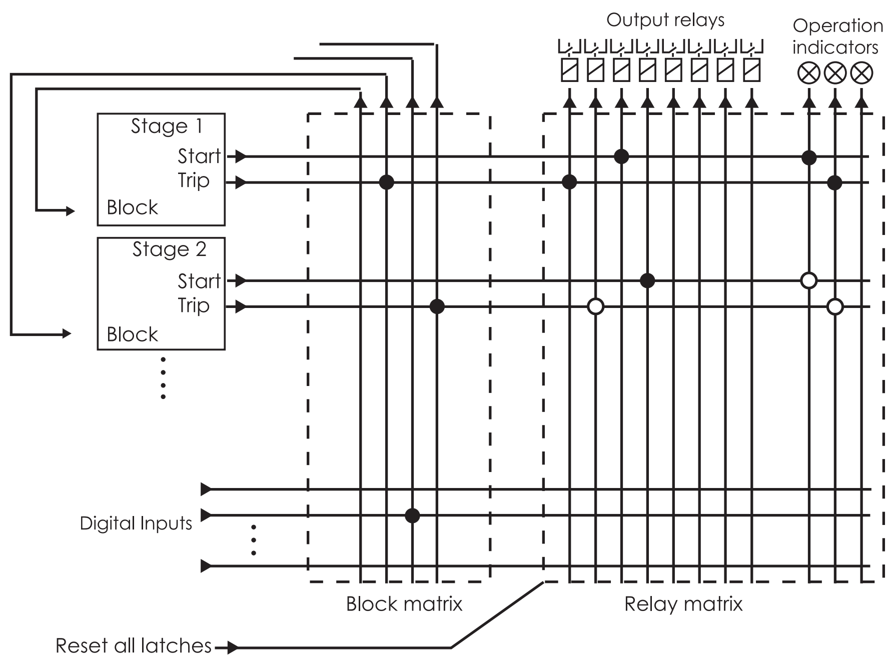


Figure 7.2: Blocking matrix and output matrix

7.6 Controllable objects

The device allows controlling of six objects, that is, circuit-breakers, disconnectors and earthing switches. Controlling can be done by "select-execute" or "direct control" principle.

The logic functions can be used to configure interlocking for a safe controlling before the output pulse is issued. The objects 1 – 6 are controllable while the objects 7 – 8 are only able to show the status.

Controlling is possible by the following ways:

- through the local HMI
- through a remote communication
- through a digital input

The connection of an object to specific output relays is done via an output matrix (object 1 – 6 open output, object 1 – 6 close output).

There is also an output signal “Object failed”, which is activated if the control of an object is not completed.

Object states

Each object has the following states:

Setting	Value	Description
Object state	Undefined (00)	Actual state of the object
	Open	
	Close	
	Undefined (11)	

Basic settings for controllable objects

Each controllable object has the following settings:

Setting	Value	Description
DI for ‘obj open’	None, any digital input, virtual input or virtual output	Open information
DI for ‘obj close’		Close information
DI for ‘obj ready’		Ready information
Max ctrl pulse length	0.02 – 600 s	Pulse length for open and close commands
Completion timeout	0.02 – 600 s	Timeout of ready indication
Object control	Open/Close	Direct object control

If changing states takes longer than the time defined by “Max ctrl pulse length” setting, object is inoperative and “Object failure” matrix signal is set. Also undefined-event is generated. “Completion timeout” is only used for the ready indication. If “DI for ‘obj ready’” is not set, completion timeout has no meaning.

Each controllable object has 2 control signals in matrix:

Output signal	Description
Object x Open	Open control signal for the object
Object x Close	Close control signal for the object

These signals send control pulse when an object is controlled by digital input, remote bus, etc.

Settings for read-only objects

Setting	Value	Description
DI for ‘obj open’	None, any digital input, virtual input or virtual output	Open information
DI for ‘obj close’		Close information
Object timeout	0.02 – 600 s	Timeout for state changes

If changing states takes longer than the time defined by “Object timeout” setting, and “Object failure” matrix signal is set. Also undefined-event is generated.

7.6.1 Controlling with DI

Objects can be controlled with digital input, virtual input or virtual output. There are four settings for each controllable object:

Setting	Active
DI for remote open / close control	In remote state
DI for local open / close control	In local state

If the device is in local control state, the remote control inputs are ignored and vice versa. Object is controlled when a rising edge is detected from the selected input. Length of digital input pulse should be at least 60 ms.

7.6.2 Local/Remote selection

In Local mode, the output relays can be controlled via a local HMI, but they cannot be controlled via a remote serial communication interface.

In Remote mode, the output relays cannot be controlled via a local HMI, but they can be controlled via a remote serial communication interface.

The selection of the Local/Remote mode is done by using a local HMI, or via one selectable digital input. The digital input is normally used to change a whole station to a local or remote mode. The selection of the L/R digital input is done in the “Objects” menu of the VAMPSET software.

NOTE: A password is not required for a remote control operation.

7.7 Logic functions

The device supports customer-defined programmable logic for boolean signals. The logic is designed by using the VAMPSET setting tool and downloaded to the device. Functions available are:

- AND
- OR
- XOR
- NOT
- COUNTERs
- RS & D flip-flops

Logic is made with VAMPSET setting tool. Consumed memory is dynamically shown on the configuration view in percentage. The first value indicates amount of used inputs, second amount of gates and third values shows amount of outputs consumed.

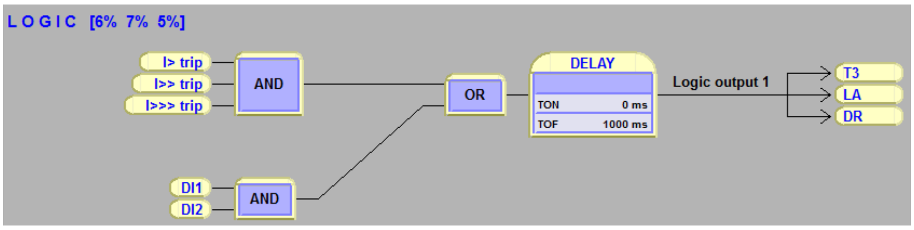


Figure 7.3: Logic can be found and modified in "logic" menu in VAMPSET setting tool

Percentages show used memory amount.

Inputs/Logical functions/Outputs- used. None of these is not allowed to exceed 100%. See guide below to learn basics of logic creation:

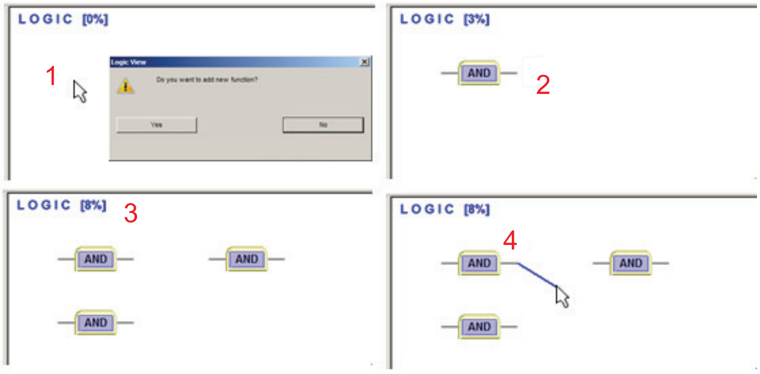


Figure 7.4: How to create logical nodes.

1. Press empty area to add a logic gate, confirm new function by pressing "Yes".
2. Logic function is always "AND" -gate as a default.
3. While logic increases the capacity is increasing as well.
4. To joint logic functions, go on top of the output line of gate and hold down mouse left -> make the connection to other logic functions input.

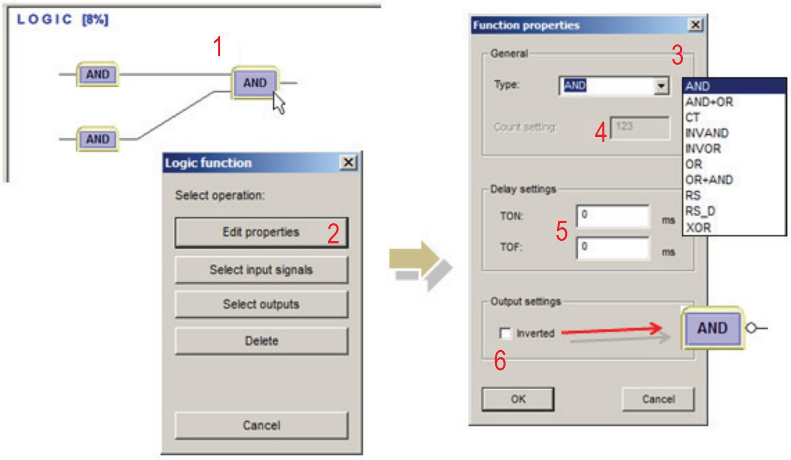


Figure 7.5: Logic creation

1. Left click on top of any logic function to activate the “Select operation” view.
2. Edit properties button opens the “Function properties” window.
3. Generally it is possible to choose the type of logic function between and/or/counter/swing -gate.
4. When counter is selected, count setting may be set here.
5. Separate delay setting for logic activation and dis-activation.
6. Possible to invert the output of logic. Inverted logic output is marked with circle.

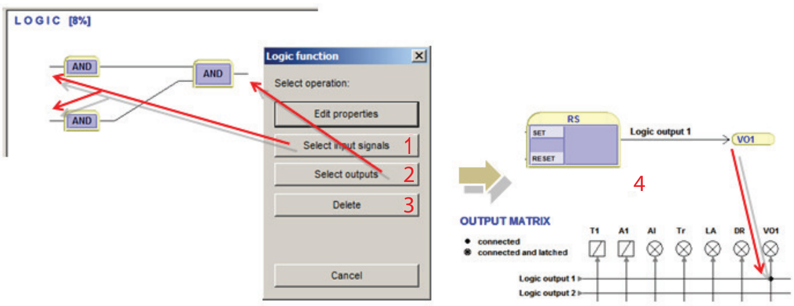


Figure 7.6: Logic creation

1. Select input signals can be done by pressing the following button or by clicking mouse left on top of the logic input line.
2. Select outputs can be done by pressing the following button or by clicking mouse left on top of the logic output line.
3. This deletes the logic function.
4. When logic is created and settings are written to the IED the unit requires a restart. After restarting the logic output is automatically assigned in output matrix as well.

NOTE: Whenever writing new logic to the IED the unit has to be restarted.

8 Communication

8.1 Communication ports

The device has three communication ports as standard. A fourth port, Ethernet, is available as option. See Figure 8.1.

There are three communication ports in the rear panel. The Ethernet port is optional. The X4 connector includes two ports: local port and extension port. The front panel RS-232 port will shut off the local port on the rear panel when a VX003 cable is inserted.

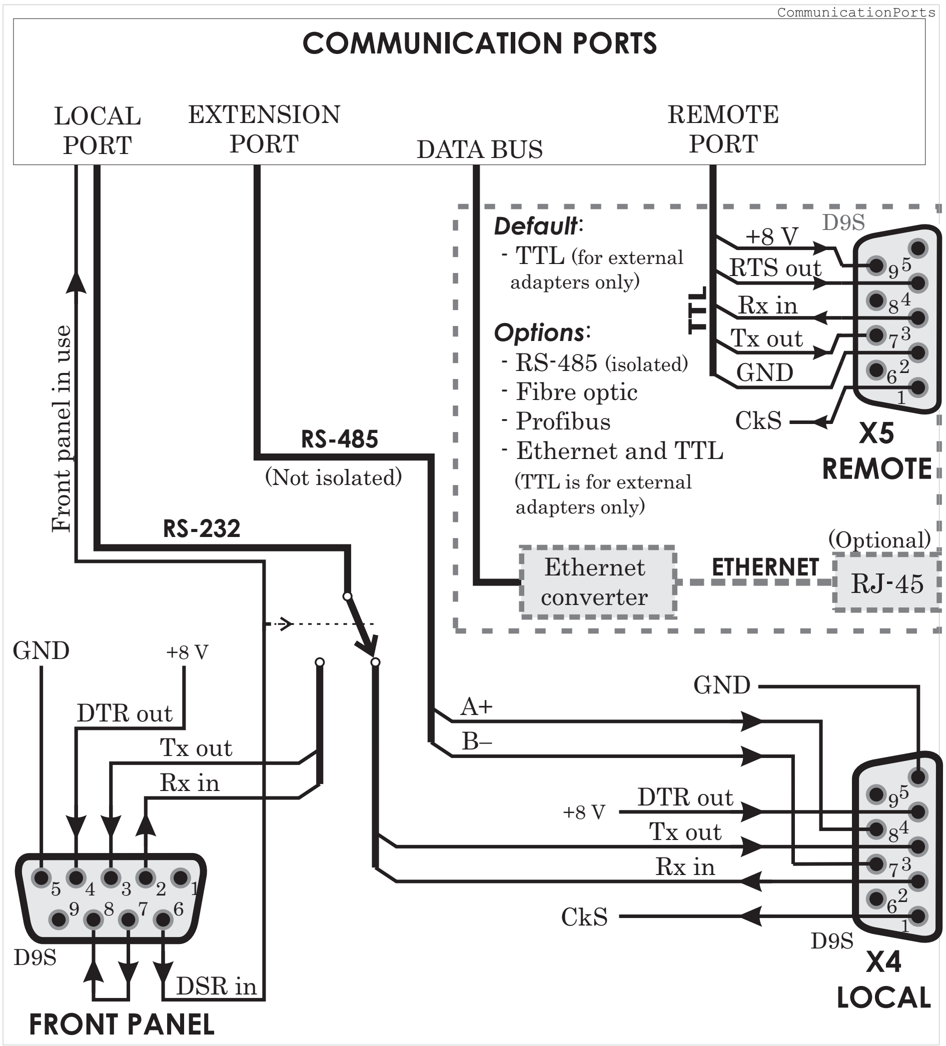


Figure 8.1: Communication ports and connectors. By default the X5 is a D9S type connector with TTL interface. The DSR signal from the front panel port selects the active connector for the RS232 local port.

By default the remote port has a TTL interface. It can only be used together with external converters or converting cables. Inbuilt options for RS-485, fibre optic (plastic/plastic, plastic/glass, glass/plastic or glass/glass), Profibus and Ethernet are available.

8.1.1 Local port X4

The local port has two connectors:

- On the front panel
- X4 the rear panel (D9S pins 2, 3 and 5)

Only one can be used at a time.

NOTE: The extension port is locating in the same X4 connector.

When the VX003 cable is inserted to the front panel connector it activates the front panel port and disables the rear panel local port by connecting the DTR pin 6 and DSR pin 4 together. See Figure 8.1.

Protocol for the local port

The front panel port is always using the command line protocol for VAMPSET regardless of the selected protocol for the rear panel local port.

If other than "None" protocol is selected for the rear panel local port, the front panel connector, when activated, is still using the plain command line interface with the original speed, parity etc. For example if the rear panel local port is used for remote VAMPSET communication using SPA-bus default 9600/7E1, it is possible to temporarily connect a PC with VAMPSET to the front panel connector with the default 38400/8N1. While the front panel connector is in use, the rear panel local port is disabled. The communication parameter display on the local display will show the active parameter values for the local port.

Physical interface

The physical interface of this port is RS-232.

Table 8.1: Parameters

Parameter	Value	Unit	Description	Note
Protocol			Protocol selection for the rear panel local port.	Set
	None		Command line interface for VAMPSET	
	SpaBus		SPA-bus (slave)	
	ProfibusDP		Profibus DB (slave)	
	ModbusSla		Modbus RTU slave	
	ModbusTCPs		Modbus TCP slave	
	IEC-103		IEC-60870-5-103 (slave)	
	ExternalIO		Modbus RTU master for external I/O-modules	
	DNP3		DNP 3.0	
Msg#	$0 – 2^{32}$-1		Message counter since the device has restarted or since last clearing	Clr
Errors	$0 – 2^{16}$-1		Protocol errors since the device has restarted or since last clearing	Clr
Tout	$0 – 2^{16}$-1		Timeout errors since the device has restarted or since last clearing	Clr
	speed/DPS Default = 38400/8N1 for VAMPSET		Display of actual communication parameters. Speed = bit/s D = number of data bits P = parity: none, even, odd S = number of stop bits	1)
VAMPSET communication (Direct or SPA-bus embedded command line interface)				
Tx	bytes/size		Unsent bytes in transmitter buffer/size of the buffer	
Msg#	$0 – 2^{32}$-1		Message counter since the device has restarted or since last clearing	Clr
Errors	$0 – 2^{16}$-1		Errors since the device has restarted or since last clearing	Clr
Tout	$0 – 2^{16}$-1		Timeout errors since the device has restarted or since last clearing	Clr

Set = An editable parameter (password needed). Clr = Clearing to zero is possible.

1) The communication parameters are set in the protocol specific menus. For the local port command line interface the parameters are set in configuration menu.

8.1.2 Remote port X5

Physical interface

The physical interface of this port depends of the communication letter in the order code. See Figure 8.1, Chapter 10.4.2 Rear panel connector X5 (REMOTE) and the table below. The TTL interface is for external converters and converter cables only. It is not suitable for direct connection to distances more than one meter.

Table 8.2: Parameters

Parameter	Value	Unit	Description	Note
Protocol			Protocol selection for remote port	Set
	None		-	
	SPA-bus		SPA-bus slave	
	ProfibusDP		Profibus DB slave	
	ModbusSla		Modbus RTU slave	
	ModbusTCPs		Modbus TCP slave	
	IEC-103		IEC-60870-5-103 slave	
	ExternalIO		Modbus RTU master for external I/O-modules	
	DNP3		DNP 3.0	
Msg#	$0 – 2^{32}-1$		Message counter since the device has restarted or since last clearing	Clr
Errors	$0 – 2^{16}-1$		Protocol errors since the device has restarted or since last clearing	Clr
Tout	$0 – 2^{16}-1$		Timeout errors since the device has restarted or since last clearing	Clr
			Display of current communication parameters.	1)
	speed/DPS		Speed = bit/s	
			D = number of data bits	
			P = parity: none, even, odd	
			S = number of stop bits	
Debug			Echo to local port	Set
	No		No echo	
	Binary		For binary protocols	
	ASCII		For SPA-bus protocol	

Set = An editable parameter (password needed). Clr = Clearing to zero is possible.

1) The communication parameters are set in the protocol specific menus. For the local port command line interface the parameters are set in configuration menu.

8.1.3 Extension port X4

This is a non-isolated RS-485 port for external I/O devices. The port is located in the same rear panel D9S connector X4 as the local port, but pins (7, 8, 5) are used instead of the standard RS-232 pins (2, 3, 5) used by the local port. See Figure 8.1.

Table 8.3: Parameters

Parameter	Value	Unit	Description	Note
Protocol			Protocol selection for extension port	Set
	None		Command line interface for VAMPSET	
	SPA-bus		SPA-bus slave	
	ProfibusDP		Profibus DB slave	
	ModbusSla		Modbus RTU slave	
	ModbusTCPs		Modbus TCP slave	
	IEC-103		IEC-60870-5-103 slave	
	ExternalIO		Modbus RTU master for external I/O-modules	
	DNP3		DNP 3.0	
Msg#	$0 – 2^{32}-1$		Message counter since the device has restarted or since last clearing	Clr
Errors	$0 – 2^{16}-1$		Protocol errors since the device has restarted or since last clearing	Clr
Tout	$0 – 2^{16}-1$		Timeout errors since the device has restarted or since last clearing	Clr
	speed/DPS Default = 38400/8N1 for VAMPSET		Display of current communication parameters. Speed = bit/s D = number of data bits P = parity: none, even, odd S = number of stop bits	1)

Set = An editable parameter (password needed). Clr = Clearing to zero is possible.

1) The communication parameters are set in the protocol specific menus. For the local port command line interface the parameters are set in configuration menu.

8.1.4 Ethernet port

TCP port 1st INST and TCP port 2nd INST are ports for ethernet communication protocols. Ethernet communication protocols can be selected to these ports when such hardware option is installed. The parameters for these ports are set via local HMI or with VAMPSET in menus TCP port 1st INST and TCP port 2nd INST. Two different protocols can be used simultaneously on one physical interface (both protocols use the same IP address and MAC address but different IP port).

Protocol configuration menu contains address and other related information for the ethernet port. TCP port 1st and 2nd instance include selection for the protocol, IP port settings and message/error/timeout counters. More information about the protocol configuration menu on table below.

Table 8.4: Main configuration parameters (local display), inbuilt Ethernet port

Parameter	Value	Unit	Description	Note
Protocol			Protocol selection for the extension port	Set
	None		Command line interface for VAMPSET	
	ModbusTCPs		Modbus TCP slave	
	IEC-101		IEC-101	
	IEC 61850		IEC-61850 protocol	
	EtherNet/IP		Ethernet/IP protocol	
	DNP3		DNP/TCP	
Port	nnn		Ip port for protocol, default 102	Set
IpAddr	n.n.n.n		Internet protocol address (set with VAMPSET)	Set
NetMsk	n.n.n.n		Net mask (set with VAMPSET)	Set
Gatew	default = 0.0.0.0		Gateway IP address (set with VAMPSET)	Set
NTPSvr	n.n.n.n		Network time protocol server (set with VAMPSET) 0.0.0.0 = no SNTP	Set
KeepAlive	nn		TCP keepalive interval	Set (1
FTP server	on/off		Enable FTP server	Set
FTP speed	4 Kb/s (default)		Maximum transmission speed for FTP	Set
FTP password	? (user) config (configurator)		FTP password	Set
MAC address	001ADnnnnnnn		MAC address	
VS Port	nn 23 (default)		IP port for Vampset	Set
Msg#	nnn		Message counter	
Errors	nnn		Error counter	
Tout	nnn		Timeout counter	

Parameter	Value	Unit	Description	Note
EthSffEn	on/off		Sniffer port enable	Set
SniffPort	Port2		Sniffer port	

Set = An editable parameter (password needed)

1) KeepAlive: The KeepAlive parameter sets in seconds the time between two keepalive packets are sent from the IED. The setting range for this parameter is between zero (0) and 20 seconds; with the exception that zero (0) means actually 120 seconds (2 minutes). A keep alive's packet purpose is for the VAMP IED to send a probe packet to a connected client for checking the status of the TCP-connection when no other packet is being sent e.g. client does not poll data from the IED. If the keepalive packet is not acknowledged, the IED will close the TCP connection. Connection must be resumed on the client side.

Table 8.5: TCP PORT 1st INST

Parameter	Value	Unit	Description	Note
Protocol			Protocol selection for the extension port.	Set
	None		Command line interface for VAMPSET	
	ModbusTCPs		Modbus TCP slave	
	IEC 61850		IEC-61850 protocol	
	EtherNet/IP		Ethernet/IP protocol	
	DNP3		DNP/TCP	
Port	nnn		Ip port for protocol, default 502	Set
Msg#	nnn		Message counter	
Errors	nnn		Error counter	
Tout	nnn		Timeout counter	

Table 8.6: CP PORT 2nd INST

Parameter	Value	Unit	Description	Note
Ethernet port protocol			Protocol selection for the extension port.	Set
(TCP PORT 2nd INST)	None		Command line interface for VAMPSET	
	ModbusTCPs		Modbus TCP slave	
	IEC 61850		IEC-61850 protocol	
	EtherNet/IP		Ethernet/IP protocol	
	DNP3		DNP/TCP	
Port	nnn		Ip port for protocol, default 502	Set
Msg#	nnn		Message counter	
Errors	nnn		Error counter	
Tout	nnn		Timeout counter	

Set = An editable parameter (password needed).

8.2 Communication protocols

The protocols enable the transfer of the following type of data:

- events
- status information
- measurements
- control commands.
- clock synchronizing
- Settings (SPA-bus and embedded SPA-bus only)

8.2.1 PC communication

PC communication is using a VAMP specified command line interface. The VAMPSET program can communicate using the local RS-232 port or using ethernet interface.

It is also possible to select SPA-bus protocol for the local port and configure the VAMPSET to embed the command line interface inside SPA-bus messages.

For Ethernet configuration, see Chapter 8.1.4 Ethernet port.

8.2.2 Modbus TCP and Modbus RTU

These Modbus protocols are often used in power plants and in industrial applications. The difference between these two protocols is the media. Modbus TCP uses Ethernet and Modbus RTU uses asynchronous communication (RS-485, optic fibre, RS-232).

VAMPSET will show the list of all available data items for Modbus.

The Modbus communication is activated usually for remote port via a menu selection with parameter "Protocol". See Chapter 8.1 Communication ports.

For Ethernet interface configuration, see Chapter 8.1.4 Ethernet port.

Table 8.7: Parameters

Parameter	Value	Unit	Description	Note
Addr	1 – 247		Modbus address for the device. Broadcast address 0 can be used for clock synchronizing. Modbus TCP uses also the TCP port settings.	Set
bit/s	1200 2400 4800 9600 19200	bps	Communication speed for Modbus RTU	Set
Parity	None Even Odd		Parity for Modbus RTU	Set

Set = An editable parameter (password needed)

8.2.3 Profibus DP

The Profibus DP protocol is widely used in industry. An inbuilt Profibus option card or external VPA 3CG is required.

Device profile "continuous mode"

In this mode, the device is sending a configured set of data parameters continuously to the Profibus DP master. The benefit of this mode is the speed and easy access to the data in the Profibus master. The drawback is the maximum buffer size of 128 bytes, which limits the number of data items transferred to the master. Some PLCs have their own limitation for the Profibus buffer size, which may further limit the number of transferred data items.

Device profile "Request mode"

Using the request mode it is possible to read all the available data from the VAMP device and still use only a very short buffer for Profibus data transfer. The drawback is the slower overall speed of the data transfer and the need of increased data processing at the Profibus master as every data item must be separately requested by the master.

NOTE: In request mode, it is not possible to read continuously only one single data item. At least two different data items must be read in turn to get updated data from the device.

There is a separate manual for VPA 3CG (VVPA3CG/EN M/xxxx) for the continuous mode and request mode. The manual is available to download from our website.

Available data

VAMPSET will show the list of all available data items for both modes. A separate document “Profibus parameters.pdf” is also available.

The Profibus DP communication is activated usually for remote port via a menu selection with parameter "Protocol". See Chapter 8.1 Communication ports.

Table 8.8: Parameters

Parameter	Value	Unit	Description	Note
Mode			Profile selection	Set
	Cont		Continuous mode	
	Reqst		Request mode	
bit/s	2400	bps	Communication speed from the main CPU to the Profibus converter. (The actual Profibus bit rate is automatically set by the Profibus master and can be up to 12 Mbit/s.)	
Emode			Event numbering style.	(Set)
	Channel		Use this for new installations.	
	(Limit60) (NoLimit)		(The other modes are for compatibility with old systems.)	
InBuf		bytes	Size of Profibus master's Rx buffer. (data to the master)	1. 3.
OutBuf		bytes	Size of Profibus master's Tx buffer. (data from the master)	2. 3.
Addr	1 – 247		This address has to be unique within the Profibus network system.	Set
Conv			Converter type	4.
	-		No converter recognized	
	VE		Converter type "VE" is recognized	

Set = An editable parameter (password needed)

Clr = Clearing to zero is possible

1. In continuous mode the size depends of the biggest configured data offset of a data item to be send to the master. In request mode the size is 8 bytes.
2. In continuous mode the size depends of the biggest configured data offset of a data to be read from the master. In request mode the size is 8 bytes.
3. When configuring the Profibus master system, the lengths of these buffers are needed. The device calculates the lengths according the Profibus data and profile configuration and the values define the in/out module to be configured for the Profibus master.
4. If the value is "-", Profibus protocol has not been selected or the device has not restarted after protocol change or there is a communication problem between the main CPU and the Profibus ASIC.

8.2.4 SPA-bus

The device has full support for the SPA-bus protocol including reading and writing the setting values. Also reading of multiple consecutive status data bits, measurement values or setting values with one message is supported.

Several simultaneous instances of this protocol, using different physical ports, are possible, but the events can be read by one single instance only.

There is a separate document “Spabus parameters.pdf” of SPA-bus data items available.

Table 8.9: Parameters

Parameter	Value	Unit	Description	Note
Addr	1 – 899		SPA-bus address. Must be unique in the system.	Set
bit/s	1200 2400 4800 9600 (default) 19200	bps	Communication speed	Set
Emode			Event numbering style.	(Set)
	Channel		Use this for new installations.	
	(Limit60) (NoLimit)		(The other modes are for compatibility with old systems.)	

Set = An editable parameter (password needed)

8.2.5 IEC 60870-5-103

The IEC standard 60870-5-103 "*Companion standard for the informative interface of protection equipment*" provides standardized communication interface to a primary system (master system).

The unbalanced transmission mode of the protocol is used, and the device functions as a secondary station (slave) in the communication. Data is transferred to the primary system using "data acquisition by polling"-principle.

The IEC functionality includes application functions:

- station initialization
- general interrogation
- clock synchronization and
- command transmission.

It is not possible to transfer parameter data or disturbance recordings via the IEC 103 protocol interface.

The following ASDU (Application Service Data Unit) types will be used in communication from the device:

- ASDU 1: time tagged message
- ASDU 3: Measurands I
- ASDU 5: Identification message
- ASDU 6: Time synchronization and
- ASDU 8: Termination of general interrogation.

The device will accept:

- ASDU 6: Time synchronization
- ASDU 7: Initiation of general interrogation and
- ASDU 20: General command.

The data in a message frame is identified by:

- type identification
- function type and
- information number.

These are fixed for data items in the compatible range of the protocol, for example, the trip of I> function is identified by: type identification = 1, function type = 160 and information number = 90. "Private range" function types are used for such data items, which are not defined by the standard (e.g. the status of the digital inputs and the control of the objects).

The function type and information number used in private range messages is configurable. This enables flexible interfacing to different master systems.

For more information on IEC 60870-5-103 in VAMP devices refer to the “IEC103 Interoperability List” document.

Table 8.10: Parameters

Parameter	Value	Unit	Description	Note
Addr	1 – 254		An unique address within the system	Set
bit/s	9600 19200	bps	Communication speed	Set
MeasInt	200 – 10000	ms	Minimum measurement response interval	Set
SyncRe	Sync Sync+Proc Msg Msg+Proc		ASDU6 response time mode	Set

Set = An editable parameter (password needed)

Table 8.11: Parameters for disturbance record reading

Parameter	Value	Unit	Description	Note
ASDU23	On Off		Enable record info message	Set
Smpls/msg	1 – 25		Record samples in one message	Set
Timeout	10 – 10000	s	Record reading timeout	Set
Fault			Fault identifier number for IEC-103. Starts + trips of all stages.	
TagPos			Position of read pointer	
Chn			Active channel	
ChnPos			Channel read position	
Fault numbering				
Faults			Total number of faults	
GridFlts			Fault burst identifier number	
Grid			Time window to classify faults together to the same burst.	Set

Set = An editable parameter (password needed)

8.2.6 DNP 3.0

The relay supports communication using DNP 3.0 protocol. The following DNP 3.0 data types are supported:

- binary input
- binary input change
- double-bit input
- binary output
- analog input
- counters

Additional information can be obtained from the “DNP 3.0 Device Profile Document” and “DNP 3.0 Parameters.pdf”. DNP 3.0 communication is activated via menu selection. RS-485 interface is often used but also RS-232 and fibre optic interfaces are possible.

Table 8.12: Parameters

Parameter	Value	Unit	Description	Set
bit/s	4800 9600 (default) 19200 38400	bps	Communication speed	Set
Parity	None (default) Even Odd		Parity	Set
SlvAddr	1 – 65519		An unique address for the device within the system	Set
MstrAddr	1 – 65519 255 = default		Address of master	Set
LLTout	0 – 65535	ms	Link layer confirmation timeout	Set
LLRetry	1 – 255 1 = default		Link layer retry count	Set
APLTout	0 – 65535 5000 = default	ms	Application layer confirmation timeout	Set
CnfMode	EvOnly (default); All		Application layer confirmation mode	Set
DBISup	No (default); Yes		Double-bit input support	Set
SyncMode	0 – 65535	s	Clock synchronization request interval. 0 = only at boot	Set

Set = An editable parameter (password needed)

8.2.7 IEC 60870-5-101

The IEC 60870-5-101 standard is derived from the IEC 60870-5 protocol standard definition. In VAMP devices, IEC 60870-5-101 communication protocol is available via menu selection. The VAMP unit works as a controlled outstation (slave) unit in unbalanced mode.

Supported application functions include process data transmission, event transmission, command transmission, general interrogation, clock synchronization, transmission of integrated totals, and acquisition of transmission delay.

For more information on IEC 60870-5-101 in VAMP devices, refer to the “IEC 101 Profile checklist & datalist.pdf” document.

Table 8.13: Parameters

Parameter	Value	Unit	Description	Note
bit/s	1200 2400 4800 9600	bps	Bitrate used for serial communication.	Set
Parity	None Even Odd		Parity used for serial communication	Set
LLAddr	1 – 65534		Link layer address	Set
LLAddrSize	1 – 2	Bytes	Size of Link layer address	Set
ALAddr	1 – 65534		ASDU address	Set
ALAddrSize	1 – 2	Bytes	Size of ASDU address	Set
IOAddrSize	2 – 3	Bytes	Information object address size. (3-octet addresses are created from 2-octet addresses by adding MSB with value 0.)	Set
COTsize	1	Bytes	Cause of transmission size	
TTFormat	Short Full		The parameter determines time tag format: 3-octet time tag or 7-octet time tag.	Set
MeasFormat	Scaled Normalized		The parameter determines measurement data format: normalized value or scaled value.	Set
DbandEna	No Yes		Dead-band calculation enable flag	Set
DbandCy	100 – 10000	ms	Dead-band calculation interval	Set

Set = An editable parameter (password needed)

8.2.8 External I/O (Modbus RTU master)

External Modbus I/O devices can be connected to the relay using this protocol. (See Chapter 10.5.2 Third-party external input / output modules module for more information).

8.2.9 IEC 61850

The relay supports communication using IEC 61850 protocol with native implementation. IEC 61850 protocol is available with the optional inbuilt Ethernet port. The protocol can be used to read / write static data from the relay or to receive events and to receive / send GOOSE messages to other relays.

IEC 61850 server interface is capable of

- Configurable data model: selection of logical nodes corresponding to active application functions
- Configurable pre-defined data sets
- Supported dynamic data sets created by clients
- Supported reporting function with buffered and unbuffered Report Control Blocks
- Sending analogue values over GOOSE
- Supported control modes:
    - direct with normal security
    - direct with enhanced security
    - select before operation with normal security
    - select before operation with enhanced security
- Supported horizontal communication with GOOSE: configurable GOOSE publisher data sets, configurable filters for GOOSE subscriber inputs, GOOSE inputs available in the application logic matrix

Additional information can be obtained from the separate documents “IEC 61850 conformance statement.pdf”, “IEC 61850 Protocol data.pdf” and “Configuration of IEC 61850 interface.pdf”.

8.2.10 EtherNet/IP

The device supports communication using EtherNet/IP protocol which is a part of CIP (Common Industrial Protocol) family. EtherNet/IP protocol is available with the optional inbuilt Ethernet port. The protocol can be used to read / write data from the device using request / response communication or via cyclic messages transporting data assigned to assemblies (sets of data).

For more detailed information and parameter lists for EtherNet/IP, refer to a separate application note “Application Note EtherNet/IP.pdf”.

For the complete data model of EtherNet/IP, refer to the document “Application Note DeviceNet and EtherNetIP Data Model.pdf”.

8.2.11 FTP server

The FTP server is available on VAMP IEDs equipped with an inbuilt or optional Ethernet card.

The server enables downloading of the following files from an IED:

- Disturbance recordings.
- The MasterICD and MasterICDEd2 files.

The MasterICD and MasterICDEd2 files are VAMP-specific reference files that can be used for offline IEC61850 configuration.

The inbuilt FTP client in Microsoft Windows or any other compatible FTP client may be used to download files from the device.

Parameter	**Value**	**Unit**	**Description**	**Note**
Enable FTP server	Yes No		Enable or disable the FTP server.	Set
FTP password	Max 33 characters		Required to access the FTP server with an FTP client. Default is “config”. The user name is always “vamp”.	Set
FTP max speed	1 – 10	KB/s	The maximum speed at which the FTP server will transfer data.	Set

8.2.12 DeviceNet

The device supports communication using DeviceNet protocol which is a part of CIP (Common Industrial Protocol) family. DeviceNet protocol is available with the optional external VSE009 module. The protocol can be used to read / write data from the device using request / response communication or via cyclic messages transporting data assigned to assemblies (sets of data).

For more detailed information about DeviceNet, refer to a separate application note “Application Note DeviceNet.pdf”.

For the complete data model of DeviceNet, refer to the document “Application Note DeviceNet and EtherNetIP Data Model.pdf”.

9 Applications

In a three-phase distribution network there are different needs for continuous measurements ranging from measurements for automation, control and supervision to energy measurements.

In the following applications several electrical quantities are typically measured for the same object:

Power plants

- Generator measurements
- Measurements of power plant transmission network connection

Industrial distribution networks

- Transforming station infeeder measurements
- Distribution feeder measurements
- High-voltage motor measurements
- Capacitor bank measurements

Power utilities

- Substation infeeder cubicle measurements

The above measurement needs can conveniently be fulfilled with VAMP 260, which also provides flexible connections to other systems utilizing the same measurement information:

- Serial bus connection to higher level logic systems or process automation systems
- Analogue outputs for meters or automation systems
- Contact outputs for energy pulses and alarms
- Digital inputs for collection of local position and alarm messages

9.1 Measurement and data acquisition system based on VAMP 260s and communication via Profibus

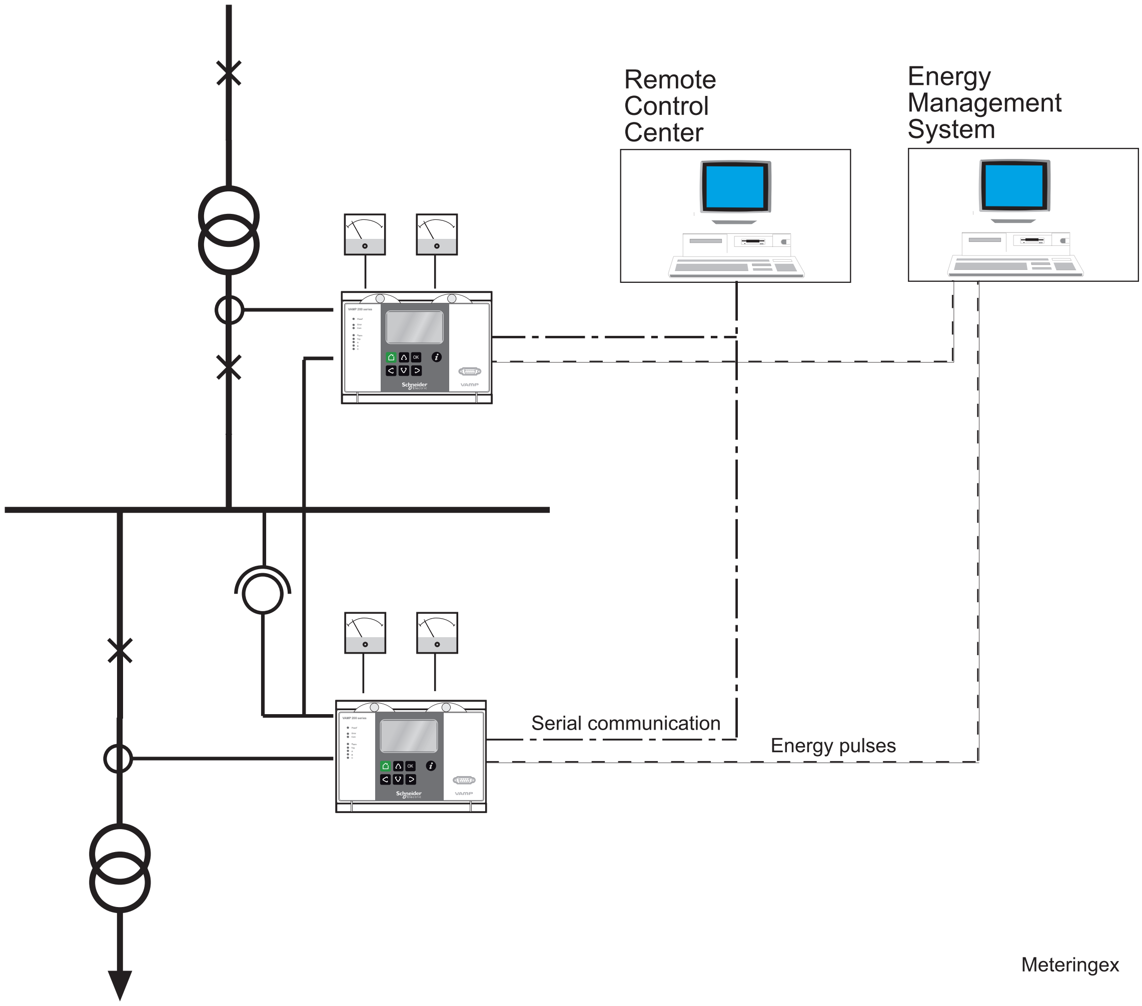


Figure 9.1: The measurement and data acquisition system of an industrial power network. The system is based on VAMP 260s and a PC control room, which are linked together via a serial bus. Energy pulses are available for Energy Management Systems.

9.2 Power Monitoring Unit in a 400 V network

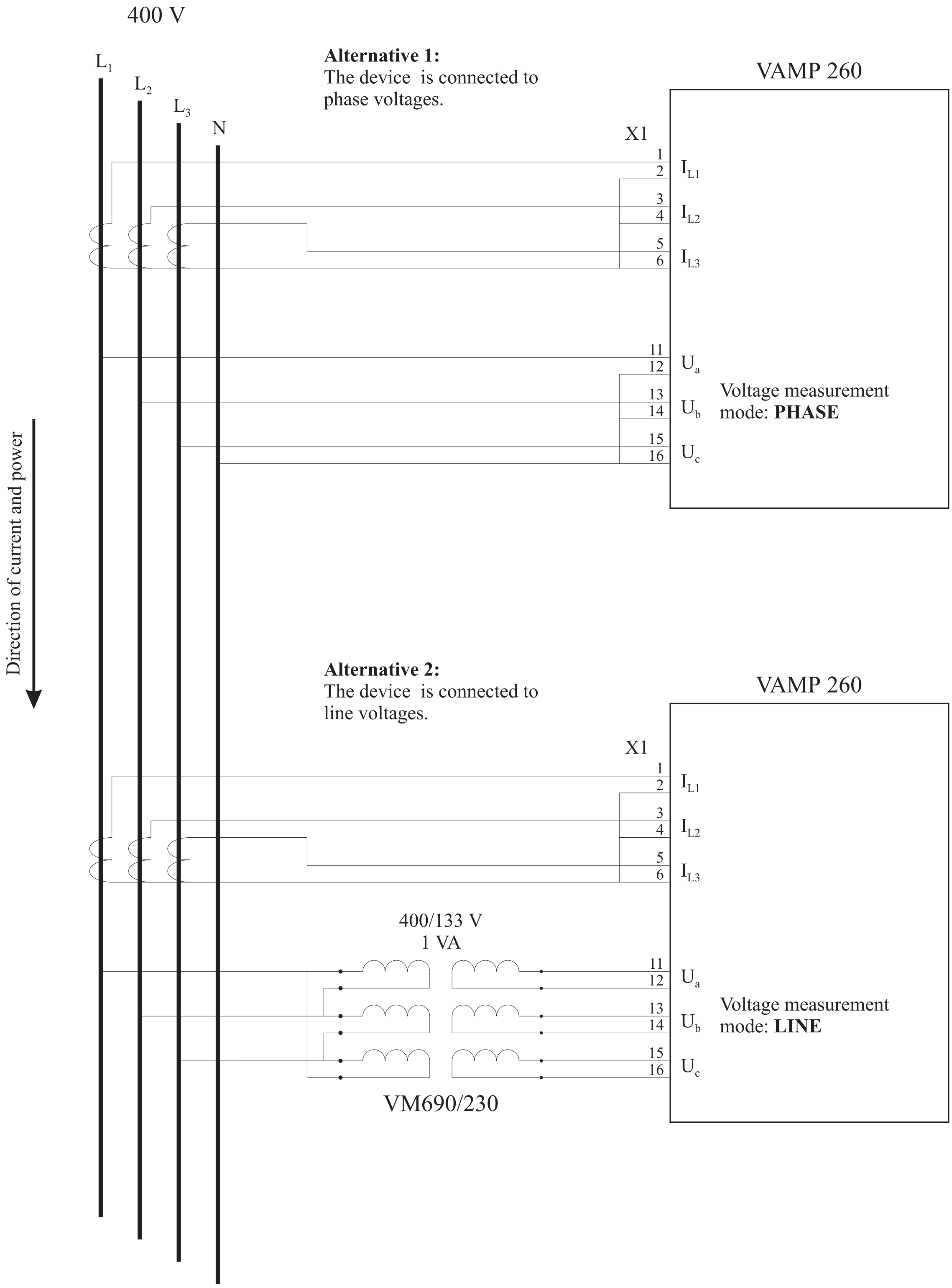


Figure 9.2: Example of VAMP 260 voltage measurement connection

10 Connections

10.1 Rear panel

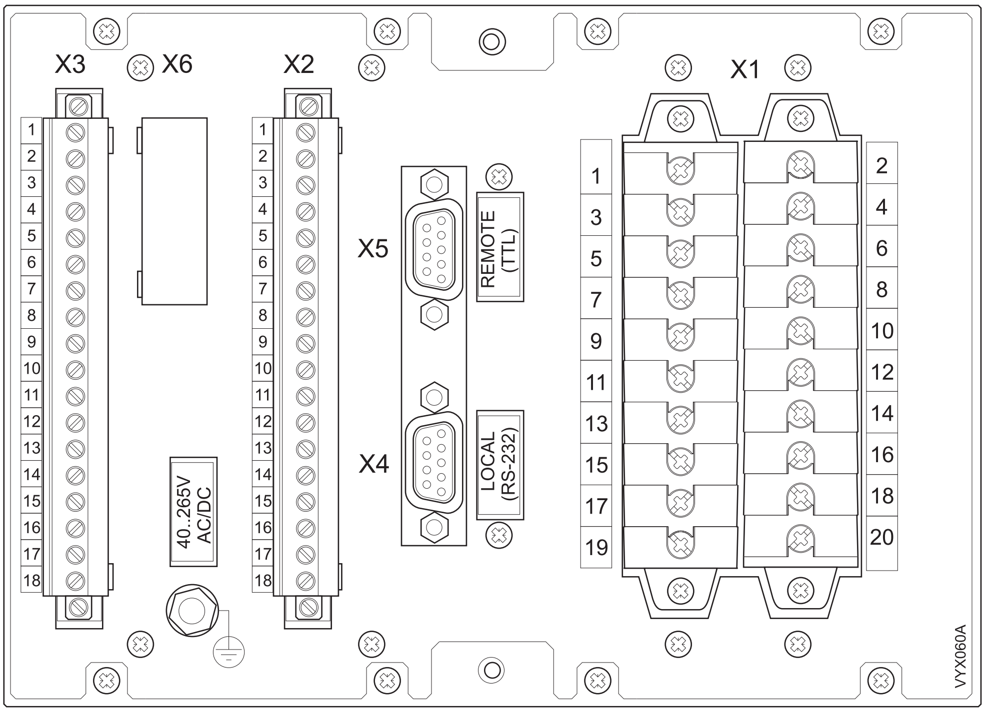
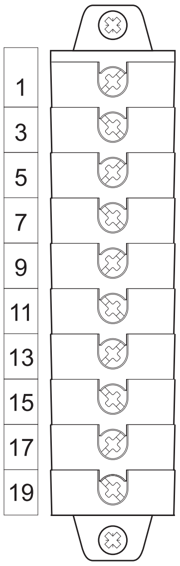


Figure 10.1: Connections on the rear panel of the VAMP 260

The VAMP 260 measuring unit is connected to the protected object through the following measuring and control connections:

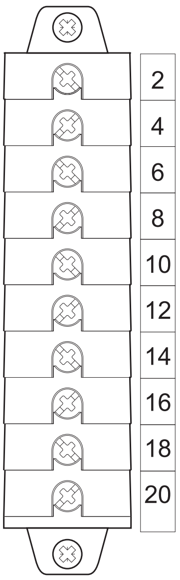
- Phase currents IL1, IL2 and IL3 (terminals X1: 1 – 6)
- Line-to-line voltages U12, U23 and U31 (terminals X1: 11 – 16)

Terminal X1 left side



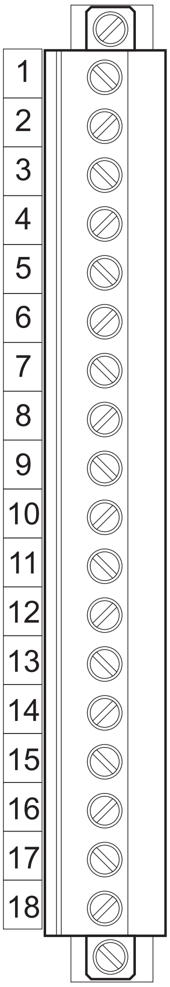
No	Symbol	Description
1	IL1 (S1)	Phase current L1 (S1)
3	IL2 (S1)	Phase current L2 (S1)
5	IL3 (S1)	Phase current L3 (S1)
7	--	--
9	--	--
11	Ua (a)	Line-to-line voltage U12 (a) or phase-to-neutral voltage UL1 (a)
13	Ub (a)	Line-to-line voltage U23 (a) or phase-to-neutral voltage UL2 (a)
15	Uc (da,a)	Line-to-line voltage U31 (a) or phase-to-neutral voltage UL3 (a)
17	--	--
19	--	--

Terminal X1 right side



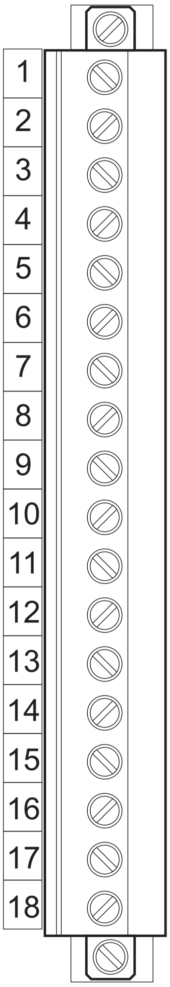
No	Symbol	Description
2	IL1 (S2)	Phase current L1 (S2)
4	IL2 (S2)	Phase current L2 (S2)
6	IL3 (S2)	Phase current L3 (S2)
8	--	--
10	--	--
12	Ua (b,n)	Line-to-line voltage U12 (b) or phase-to-neutral voltage UL1 (n)
14	Ub (b,n)	Line-to-line voltage U23 (b) or phase-to-neutral voltage UL2 (n)
16	Uc (dn,n)	Line-to-line voltage U31 (b) or phase-to-neutral voltage UL3 (n)
18	--	--
20	--	--

Terminal X2 without the analogue output



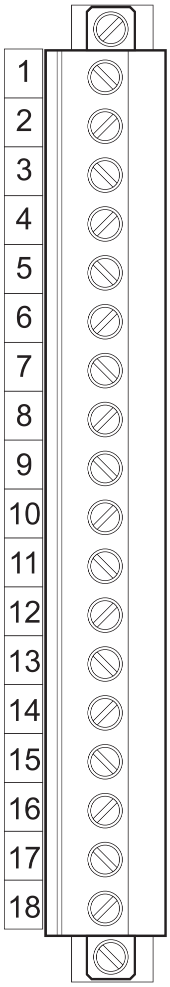
No	Symbol	Description
1	--	--
2	--	--
3	--	--
4	--	--
5	A5	Alarm relay 5
6	A5	Alarm relay 5
7	A4	Alarm relay 4
8	A4	Alarm relay 4
9	--	--
10	A3 COM	Alarm relay 3, common connector
11	A3 NC	Alarm relay 3, normal closed connector
12	A3 NO	Alarm relay 3, normal open connector
13	A2 COM	Alarm relay 2, common connector
14	A2 NC	Alarm relay 2, normal closed connector
15	A2 NO	Alarm relay 2, normal open connector
16	SF COM	Internal fault relay, common connector
17	SF NC	Internal fault relay, normal closed connector
18	SF NO	Internal fault relay, normal open connector

Terminal X2 with analog output



No	Symbol	Description
1	AO1+	Analogue output 1, common positive connector
2	AO1-	Analogue output 1, negative connector
3	AO2+	Analogue output 2, common positive connector
4	AO2-	Analogue output 2, negative connector
5	AO3+	Analogue output 3, common positive connector
6	AO3-	Analogue output 3, negative connector
7	AO4+	Analogue output 4, common positive connector
8	AO4-	Analogue output 4, negative connector
9	--	--
10	A3 COM	Alarm relay 3, common connector
11	A3 NC	Alarm relay 3, normal closed connector
12	A3 NO	Alarm relay 3, normal open connector
13	A2 COM	Alarm relay 2, common connector
14	A2 NC	Alarm relay 2, normal closed connector
15	A2 NO	Alarm relay 2, normal open connector
16	SF COM	Internal fault relay, common connector
17	SF NC	Internal fault relay, normal closed connector
18	SF NO	Internal fault relay, normal open connector

Terminal X3



No	Symbol	Description
1	+48V	Internal control voltage for digital inputs 1 – 6
2	DI1	Digital input 1
3	DI2	Digital input 2
4	DI3	Digital input 3
5	DI4	Digital input 4
6	DI5	Digital input 5
7	DI6	Digital input 6
8	--	--
9	A1 COM	Alarm relay 1, common connector
10	A1 NO	Alarm relay 1, normal open connector
11	A1 NC	Alarm relay 1, normal closed connector
12	T2	Trip relay 2
13	T2	Trip relay 2
14	T1	Trip relay 1
15	T1	Trip relay 1
16	--	--
17	Uaux -/~	Auxiliary voltage
18	Uaux +/~	Auxiliary voltage

10.2 Auxiliary voltage

The external auxiliary voltage U_{AUX} (standard 40 – 265 V ac/dc or optional 18 – 36 Vdc) for the pin is connected to the pins X3: 17 – 18.

NOTE: When optional 18 – 36 Vdc power module is used the polarity is as follows: X3:17 negative (+), X3:18 positive (-).

10.3 Output relays

The power-monitoring unit is equipped with seven (five) configurable output relays and a separate output relay for the self-supervision system.

- Trip relays T1 and T2 (terminals X3: 12 – 13 and 14 – 15)
- Alarm relays A1 – A5 (terminals X3: 9 – 11, X2: 5 – 6, 7 – 8, 10 – 12, 13 – 15)
  - In the mA version of the PMU the alarm relays A4 (X2:7 – 8) and A5 (X2:5 – 6) are excluded.
- Self-supervision system output relay SF (terminals X2: 16 – 18)

10.4 Serial communication connection

The pin assignments of communication connectors including internal communication converters are presented in the following figures and tables.

10.4.1 Front panel connector

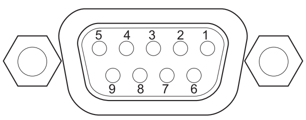


Figure 10.2: Pin numbering of the front panel D9S connector

Pin	RS232 signal
1	Not connected
2	Rx in
3	Tx out
4	DTR out (+8 V)
5	GND
6	DSR in (activates this port and disables the X4 RS232 port)
7	RTS in (Internally connected to pin 8)
8	CTS out (Internally connected to pin 7)
9	IRIG-B input

NOTE: DSR must be connected to DTR to activate the front panel connector and disable the rear panel X4 RS232 port. (The other port in the same X4 connector will not be disabled.)

10.4.2 Rear panel connector X5 (REMOTE)

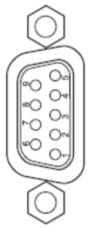
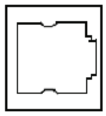
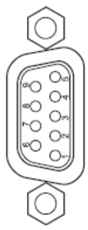
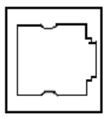
The X5 remote port communication connector options are shown in Figure 10.3. The connector types are listed in Table 10.1.

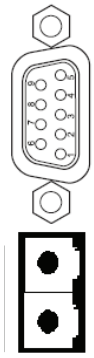
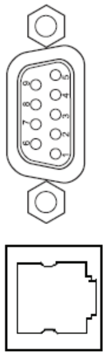
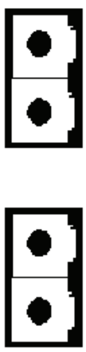
Without any internal options, X5 is a TTL port for external converters. Some external converters (VSE) are attached directly to the rear panel and X5. Some other types (VEA, VPA) need various TTL/RS-232 converter cables. The available accessories are listed in Chapter 13 Order information.

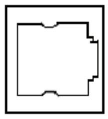
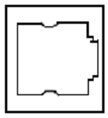
2 & 4-wire galvanically isolated RS-485 (Figure 10.4), internal options for fibre optic (Figure 10.5), and Profibus (Figure 10.6) are available. See ordering code in Chapter 13 Order information.

Table 10.1: Physical interface and connector types of remote port X5 with various options. Serial interface (A) is the default.

Order Code	Communication interface	Connector type	Pin usage
A	Serial interface for external converters only (REMOTE port)	D9S	1 = reserved 2 = TX_out / TTL 3 = RX_in /TTL 4 = RTS out /TTL 7 = GND 9 = +8V out
B	Plastic fibre interface (REMOTE port)	HFBR-0500	
C	Profibus interface (REMOTE port)	D9S	3=RXD/TXD+/P 4=RTS 5= GND 6=+5V 8= RXD/TXD-/N
D	RS-485, isolated (REMOTE port)	screw terminal	1= Signal ground 2= Reciever - 3= Reciever + 4= Transmitter - 5= Transmitter +
E	Glass fibre interface (62.5/125 μm) (REMOTE port)	ST	
F	Plastic / glass (62.5/125 μm) fibre interface (REMOTE port)	HFBR-0500/ST	Plastic Rx Glass Tx
G	Glass (62.5/125 μm) / plastic fibre interface (REMOTE port)	ST/HFBR-0500	Glass Rx Plastic Tx

Order Code	Communication interface	Connector type	Pin usage
H	Ethernet interface and Serial interface for external converters only (REMOTE port)	D9S and RJ-45  	D-connector: 1 = reserved 2 = TX_out / TTL 3 = RX_in /TTL 4 = RTS out /TTL 7 = GND 9 = +8V out RJ-45 connector: 1=Transmit+ 2=Transmit- 3=Receive+ 4=Reserved 5=Reserved 6=Receive- 7=Reserved 8=Reserved
M	10Mbps Ethernet interface with IEC 61850 and Serial interface for external converters only (REMOTE port)	D9S and RJ-45  	D-connector: 1 = reserved 2 = TX_out / TTL 3 = RX_in /TTL 4 = RTS out /TTL 7 = GND 9 = +8V out RJ-45 connector: 1=Transmit+ 2=Transmit- 3=Receive+ 4=Reserved 5=Reserved 6=Receive- 7=Reserved 8=Reserved

Order Code	Communication interface	Connector type	Pin usage
O	100 Mbps Ethernet fibre interface with IEC 61850 and Serial interface for external converters only (REMOTE port)	D9S and LC 	D-connector: 1 = reserved 2 = TX_out / TTL 3 = RX_in /TTL 4 = RTS out /TTL 7 = GND 9 = +8V out Fiber connector: TX=Upper LC-connector RX=Lower LC-connector
P	100Mbps Ethernet interface with IEC 61850 and Serial interface for external converters only (REMOTE port)	D9S and RJ-45 	D-connector: 1 = reserved 2 = TX_out / TTL 3 = RX_in /TTL 4 = RTS out /TTL 7 = GND 9 = +8V out RJ-45 connector: 1=Transmit+ 2=Transmit- 3=Receive+ 4=Reserved 5=Reserved 6=Receive- 7=Reserved 8=Reserved
R	100 Mbps Ethernet fibre interface with IEC 61850	2 x LC 	LC-connector from top: -Port 2 Tx -Port 2 Rx -Port 1 Tx -Port 1 Rx

Order Code	Communication interface	Connector type	Pin usage
S	100Mbps Ethernet interface with IEC 61850	2 x RJ-45  	1=Transmit+ 2=Transmit- 3=Receive+ 4=Reserved 5=Reserved 6=Receive- 7=Reserved 8=Reserved

NOTE: In VAMP device, RS485 interfaces a positive voltage from Tx+ to Tx- or Rx+ to Rx- does correspond to the bit value “1”. In X5 connector the optional RS485 is galvanically isolated.

In 2-wire mode the receiver and transmitter are internally connected in parallel. See the table below.

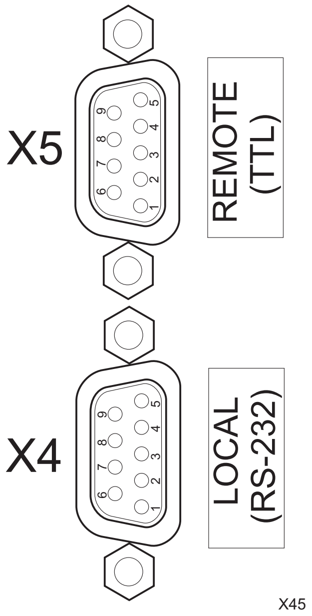


Figure 10.3: Pin numbering of the rear communication ports, REMOTE TTL

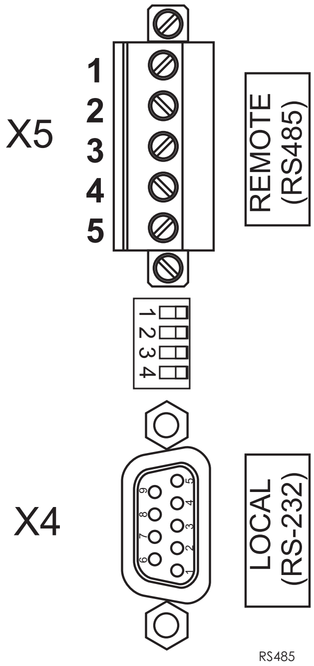


Figure 10.4: Pin numbering of the rear communication ports, REMOTE RS-485

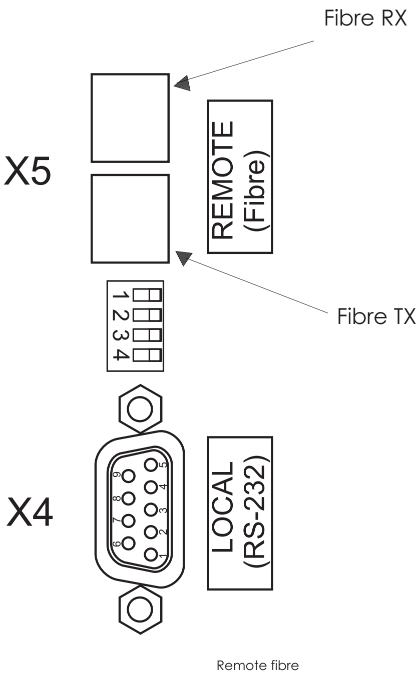


Figure 10.5: Picture of rear communication port, REMOTE FIBRE

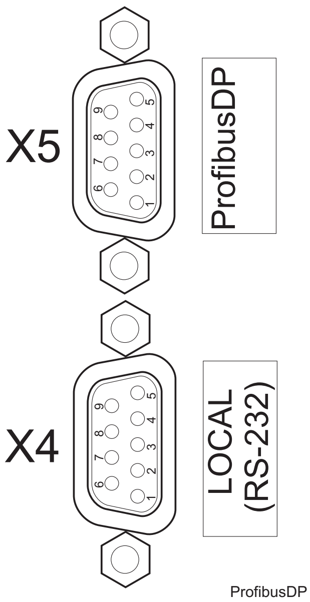


Figure 10.6: Pin numbering of the rear communication ports, Profibus DP

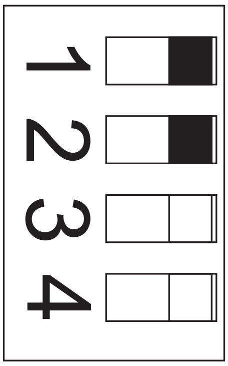


Figure 10.7: Dip switches in RS-485 and optic fibre options.

Dip switch number	Switch position	Function RS-485	Function Fibre optics
1	Left	2 wire connection	Echo off
1	Right	4 wire connection	Echo on
2	Left	2 wire connection	Light on in idle state
2	Right	4 wire connection	Light off in idle state
3	Left	Termination On	Not applicable
3	Right	Termination Off	Not applicable
4	Left	Termination On	Not applicable
4	Right	Termination Off	Not applicable

10.4.3 X4 rear panel connector (local RS232 and extension RS485 ports)

Rear panel port (LOCAL)	Pin	Signal
X4	1	No connection
	2	Rx in, RS232 local
	3	Tx out, RS232 local
	4	DTR out (+8 V)
	5	GND
	6	No connection
	7	B- RS485 extension port
	8	A+ RS485 extension port
	9	No connection

NOTE: In VAMP devices, a positive RS485 voltage from A+ to B- corresponds to bit value “1”. In X4 connector the RS485 extension port is not galvanically isolated.

10.5 External option modules

10.5.1 External LED module VAM 16D

The optional external VAM 16D led module provides 16 extra led-indicators in external casing. Module is connected to the serial port of the device's front panel. Please refer the User manual VAM 16D for details.

10.5.2 Third-party external input / output modules

The device supports optional external input/output modules used to extend the number of digital inputs and outputs. Also modules for analogue inputs and outputs are available.

The following types of devices are supported:

- Analog input modules (RTD)
- Analog output modules (mA-output)
- Binary input/output modules

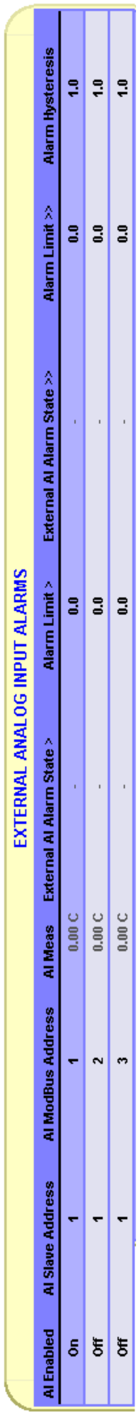
EXTENSION port is primarily designed for I/O modules. This port is found in the LOCAL connector of the device backplane and I/O devices should be connected to the port with VSE003 adapter.

NOTE: If External I/O protocol is not selected to any communication port, VAMPSET doesn't display the menus required for configuring the I/O devices. After changing EXTENSION port protocol to External I/O, restart the relay and read all settings with VAMPSET.

External analog inputs configuration (VAMPSET only)

Range	Description			
	Communication read errors			
X: -32000 – 32000 Y: -1000 – 1000	Scaling	**Y2**	Scaled value	Point 2
		X2	Modbus value	
		Y1	Scaled value	Point 1
		X1	Modbus value	
-32000 – 32000		**Offset**	Subtracted from Modbus value, before running XY scaling	
InputR or HoldingR	Modbus register type			
1 – 9999	Modbus register for the measurement			
1 – 247	Modbus address of the I/O device			
C, F, K, mA, Ohm or V/A	Unit selection			
	Active value			
On / Off	Enabling for measurement			

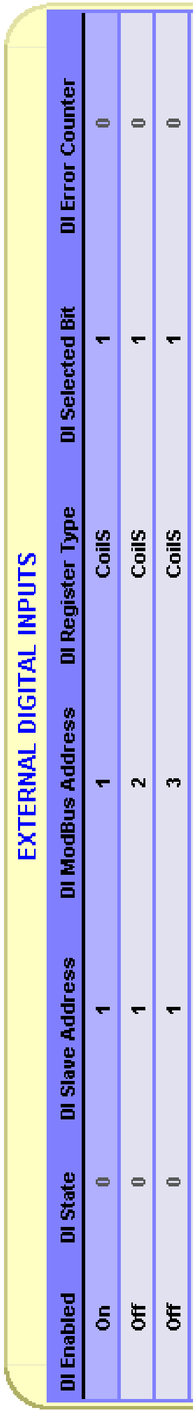
Alarms for external analog inputs



Range	Description	
0 – 10000	Hysteresis for alarm limits	
-21x107 – +21x107	**Alarm >>**	Limit setting
- / Alarm		Active state
-21x107 – +21x107	**Alarm >**	Limit setting
- / Alarm		Active state
	Active value	
1 – 9999	Modbus register for the measurement	
1 – 247	Modbus address of the I/O device	
On / Off	Enabling for measurement	

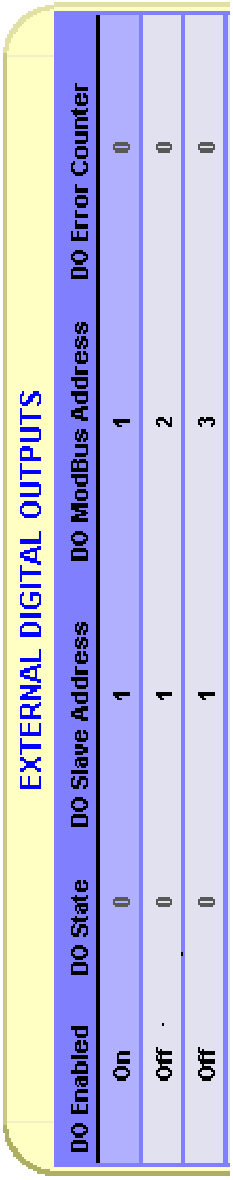
Analog input alarms have also matrix signals, “Ext. Aix Alarm1” and “Ext. Aix Alarm2”.

External digital inputs configuration (VAMPSET only)



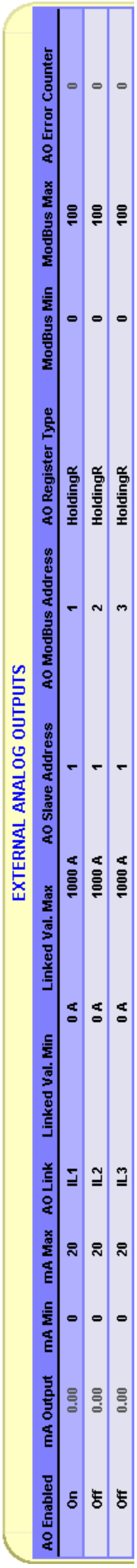
Range	Description
	Communication read errors
1 – 16	Bit number of Modbus register value
CoilS, InputS, InputR or HoldingR	Modbus register type
1 – 9999	Modbus register for the measurement
1 – 247	Modbus address of the I/O device
0 / 1	Active state
On / Off	Enabling for measurement

External digital outputs configuration (VAMPSET only)



	Range	Description
		Communication errors
	1 – 9999	Modbus register for the measurement
	1 – 247	Modbus address of the I/O device
	0 / 1	Output state
		Enabling for measurement

External analog outputs configuration (VAMPSET only)



Range	Description
	Communication errors
-32768 – +32767 (0 – 65535)	Modbus value corresponding Linked Val. Max
	Modbus value corresponding Linked Val. Min
InputR or HoldingR	Modbus register type
1 – 9999	Modbus register for the output
1 – 247	Modbus address of the I/O device
0 – 42x108, -21x108 – +21x108	Maximum limit for lined value, corresponding to "Modbus Max"
	Minimum limit for lined value, corresponding to "Modbus Min"
	Link selection
-21x107 – +21x107	Minimum & maximum output values
	Active value
On / Off	Enabling for measurement

10.6 Block optional diagrams

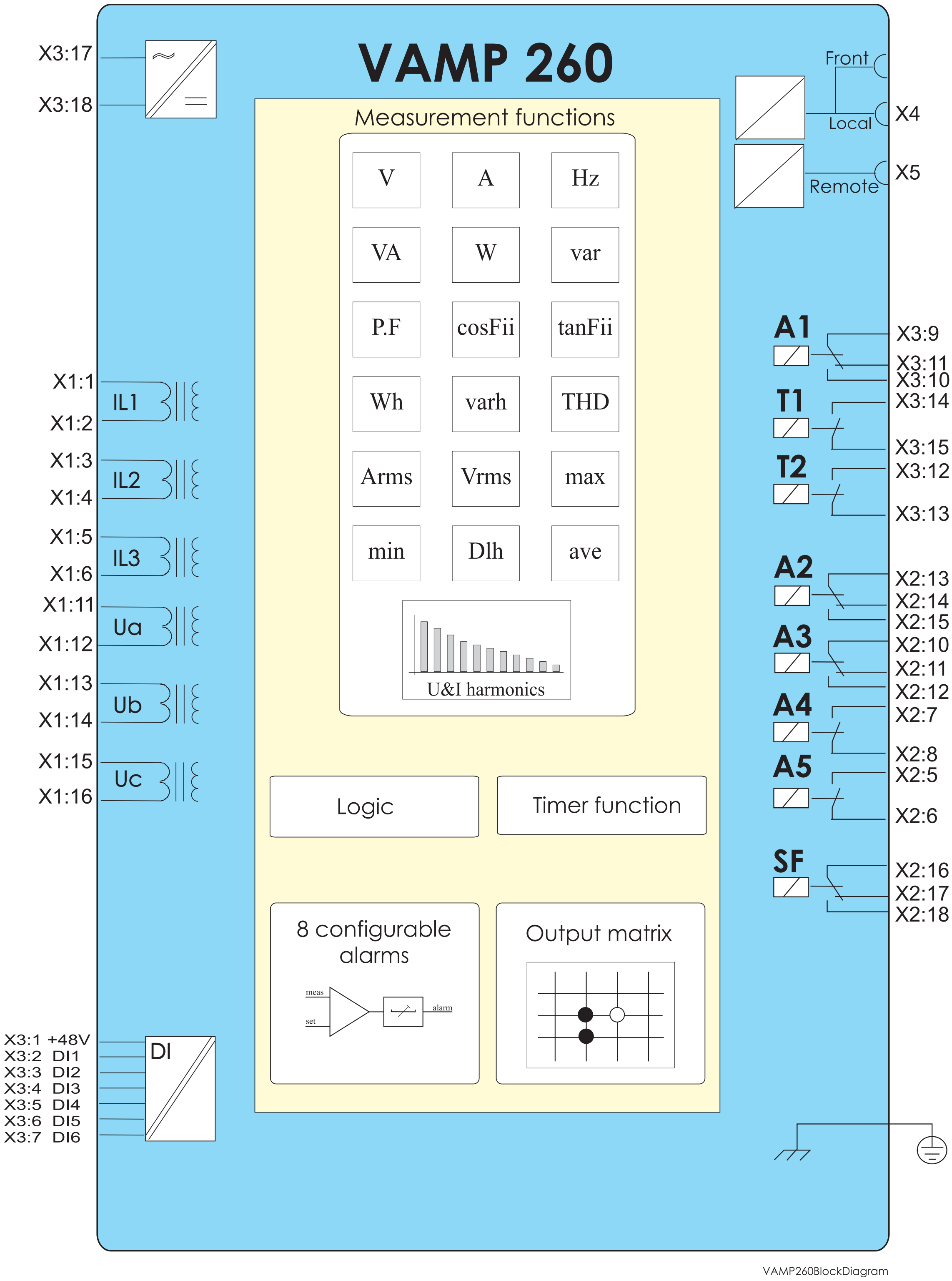


Figure 10.8: Block diagram of the power monitoring unit VAMP 260.

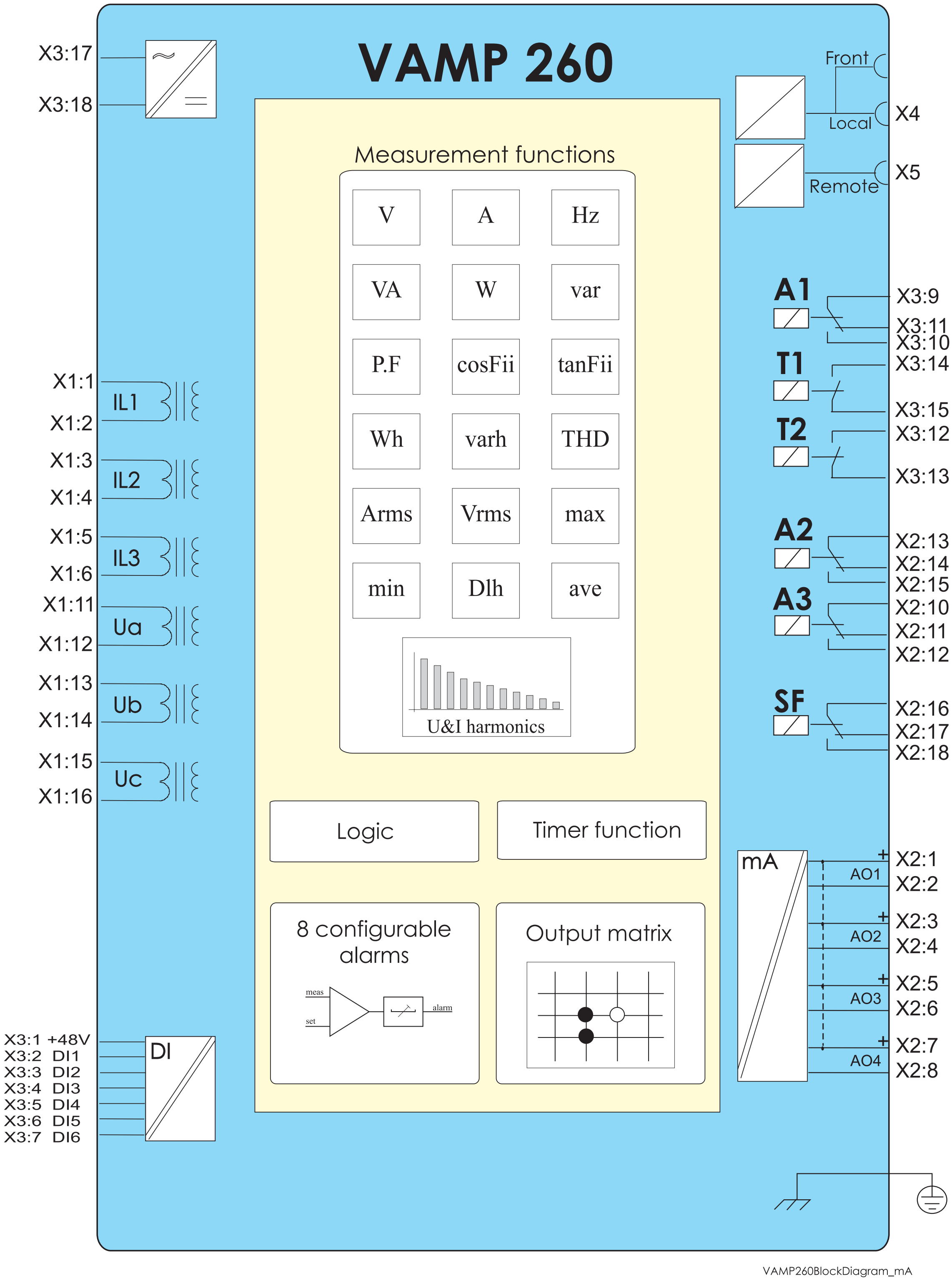


Figure 10.9: Block diagram of the power monitoring unit VAMP 260, with mA-option.

10.7 Connection examples

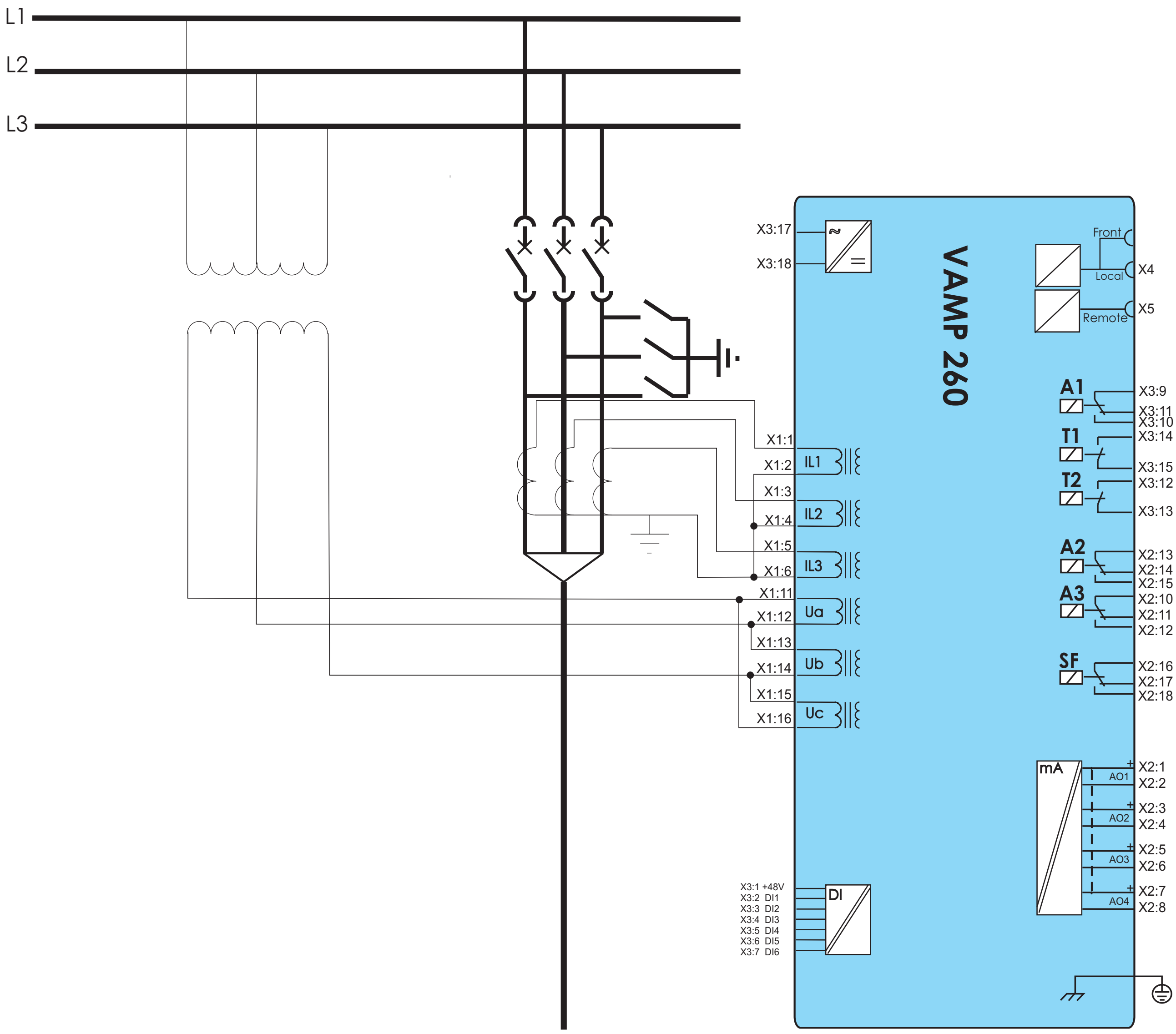


Figure 10.10: Connection example of power monitoring unit VAMP 260. The voltage measurement mode is set to “3LL”.

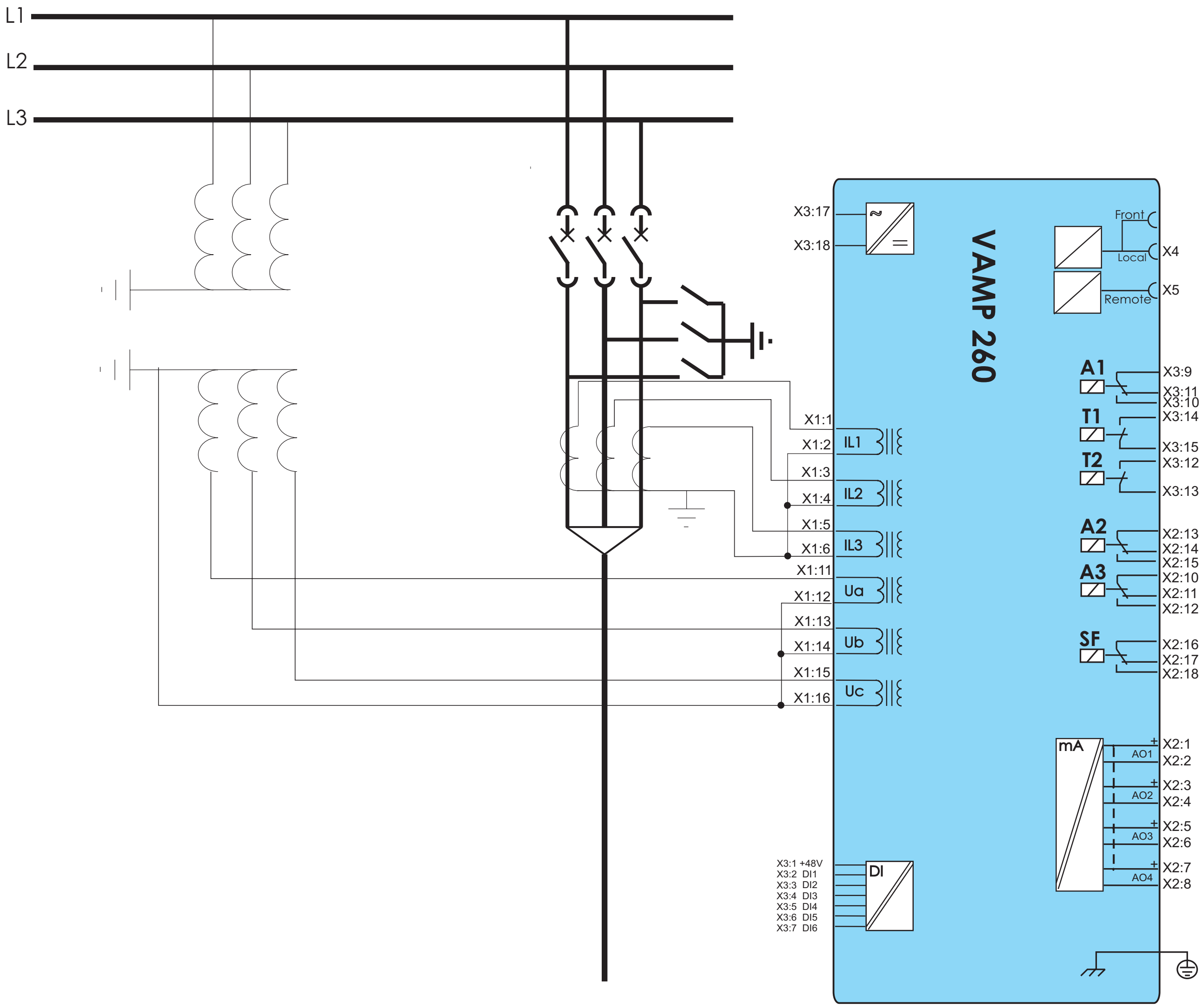


Figure 10.11: Connection example of power monitoring unit VAMP 260 with V-connected voltage transformers. The voltage measurement is set to “3LN”.

11 Technical data

11.1 Connections

Table 11.1: Measuring circuits

Rated current I_N	5 A or 1 A
- Current measuring range	0 - 5 x I_N
- Thermal withstand	4 x I_N (continuously)
	20 x I_N (for 10 s)
	100 x I_N (for 1 s)
- Burden / Impedance	0.125 VA / 0.005 ohm (I_N = 5 A)
	0.04 VA / 0.04 ohm (I_N = 1 A)
Rated voltage U_N	100 V (configurable for VT secondaries 50 – 120 V)
- Voltage measuring range	0 – 250 V (100 V/110 V)
- Continuous voltage withstan	250 V
- Burden	< 0.5V A
Rated frequency f_N	45 – 65 Hz
Terminal block:	Maximum wire dimension:
- Solid or stranded wire	4 mm^2 (10 – 12 AWG)

Table 11.2: Auxiliary voltage

	Type A (standard)	Type B (option)
Rated voltage U_{AUX}	40 – 265 V ac/dc	18 – 36 V dc **Note! Polarity** X3:17= negative (-) X3:18= positive (+)
Start-up peak (DC)		
110 V (Type A)	15 A with time constant of 1ms	
220 V (Type A)	25 A with time constant of 1ms	
Power consumption	< 15 W (normal conditions)	
	< 25 W (output relays activated)	
Max. permitted interruption time	< 50 ms (110 V dc)	
Terminal block:	Maximum wire dimension:	
- Phoenix MVSTBW or equivalent	2.5 mm^2 (13 – 14 AWG)	

Table 11.3: Digital inputs internal operating voltage

Number of inputs	6
Operation time	0.00 – 60.00 s (step 0.01 s)
Polarity	NO (normal open) or NC (normal closed)
Inaccuracy: - Operate time	 ±1% or ±10 ms
Internal operating voltage	48 V dc
Current drain when active (max.)	approx. 20 mA
Current drain, average value	< 1 mA
Terminal block: - Phoenix MVSTBW or equivalent	Maximum wire dimension: 2.5 mm^2 (13 – 14 AWG)

Table 11.4: Trip contact

Number of contacts	2 making contacts
Rated voltage	250 V ac/dc
Continuous carry	5 A
Make and carry, 0.5 s Make and carry, 3s	30 A 15 A
Breaking capacity, DC (L/R=40ms)	
at 48 V dc:	5 A
at 110 V dc:	3 A
at 220 V dc:	1 A
Contact material	AgNi 90/10
Terminal block: - MSTB2.5 - 5.08	Wire dimension: Maximum 2.5 mm^2 (13 – 14 AWG) Minimum 1.5 mm^2 (15 – 16 AWG)

Table 11.5: Signal contacts

Number of contacts:	3 change-over contacts (relays A1, A2 and A3) 2 making contacts (relays A4 and A5) (Not available with the mA option) 1 change-over contact (SF relay)
Rated voltage	250 V ac/dc
Max. making current	15 A
Continuous carry	5 A
Breaking capacity, AC	2 000 VA
Breaking capacity, DC (L/R=40ms)	
at 48 V dc:	1.3 A
at 110 V dc:	0.4 A
at 220 V dc:	0.2 A
Contact material	AgNi 90 / 10
Terminal block - MSTB2.5 - 5.08	Wire dimension Maximum 2.5 mm^2 (13 – 14 AWG) Minimum 1.5 mm^2 (15 – 16 AWG)

Table 11.6: Ethernet connection

Number of ports	1
Electrical connection	Ethernet RJ-45 (Ethernet 10-Base-T)
Protocols	VAMPSET Modbus TCP IEC 61850
Data transfer rate	10 Mb/s

Table 11.7: Ethernet fiber interface

Type	Multimode
Connector	LC
Physical layer	100 Base-Fx
Maximum cable distance	2 km
Optical wavelength	1300 nm
Cable core / cladding size	50/125 or 62.5/125 μm

Table 11.8: Local serial communication port

Number of ports	1 on front and 1 on rear panel
Electrical connection	RS 232
Data transfer rate	1 200 – 38 400 kb/s

Table 11.9: Remote control connection (option)

Number of ports	1 on rear panel
Electrical connection	TTL (standard) RS 485 (option) RS 232 (option) Plastic fibre connection (option) 100M Ethernet fiber 100M Ethernet copper (RJ 45)
Data transfer rate	1 200 – 38 400 kb/s
Protocols	Modbus, RTU master Modbus, RTU slave SPA-bus, slave IEC 60870-5-103 Profibus DP (option) Modbus TCP (internal / external optional module) IEC 60870-5-101 IEC 60870-5-101 TCP DNP 3.0 DNP 3.0 TCP IEC 61850

Table 11.10: Analogue output connection (option)

Number of analogue mA output channels	4
Maximum output current	1 – 20 mA, step 1 mA
Minimum output current	0 – 19 mA, step 1 mA
Resolution	12 bit
Current step	< 6 μA
Inaccuracy	±20 μA
Response time - normal mode - fast mode	 < 400 ms < 50 ms
Burden	< 600 Ω

11.2 Test and environmental conditions

Table 11.11: Disturbance tests

Test	Standard & Test class / level	Test value
Emission	EN 61000-6-4 / IEC 60255-26	
- Conducted	EN 55011, Class A / IEC 60255-25	0.15 – 30 MHz
- Emitted	EN 55011, Class A / IEC 60255-25 / CISPR 11	30 – 1000 MHz
Immunity	EN 61000-6-2 / IEC 60255-26	
- 1Mhz damped oscillatory wave	IEC 60255-22-1	±2.5kVp CM, ±1.0kVp DM
- Static discharge (ESD)	EN 61000-4-2 Level 4 / IEC 60255-22-2 Class 4	8 kV contact discharge 15 kV air discharge
- Emitted HF field	EN 61000-4-3 Level 3 / IEC 60255-22-3	80 - 1000 MHz, 10 V/m
- Fast transients (EFT)	EN 61000-4-4 Level 3 / IEC 60255-22-4 Class B	2 kV, 5/50 ns, 5 kHz
- Surge	EN 61000-4-5 Level 3 / IEC 60255-22-5	2 kV, 1.2/50 µs, CM 1 kV, 1.2/50 µs, DM
- Conducted HF field	EN 61000-4-6 Level 3 / IEC 60255-22-6	0.15 - 80 MHz, 10 Vemf
- Power-frequency magnetic field	EN 61000-4-8	300A/m (continuous)
- Pulse magnetic field	EN 61000-4-9 Level 5	1000A/m, 1.2/50 µs
- Voltage interruptions	IEC 60255-11	10ms / 100%
- Voltage dips and short interruptions	EN 61000-4-11	30%/10ms, 100%/10ms, 60%/100ms, >95%/5000ms
- Voltage alternative component	IEC 60255-11	12% of operating voltage (DC)

Table 11.12: Electrical safety tests

Test	Standard & Test class / level	Test value
- Impulse voltage withstand	EN 60255-5, Class III	5 kV, 1.2/50 ms, 0.5 J 1 kV, 1.2/50 ms, 0.5 J Communication
- Dielectric test	EN 60255-5, Class III	2 kV, 50 Hz 0.5 kV, 50 Hz Communication
- Insulation resistance	EN 60255-5	
- Protective bonding resistance	EN 60255-27	
- Power supply burden	IEC 60255-1	

Table 11.13: Mechanical tests

Vibration (IEC 60255-21-1) Class I	10 – 60 Hz, amplitude ±0.035 mm 60 – 150 Hz, acceleration 0.5g sweep rate 1 octave/min 20 periods in X-, Y- and Z axis direction
Shock (IEC 60255-21-1) Class I	half sine, acceleration 5 g, duration 11 ms 3 shocks in X-, Y- and Z axis direction

Table 11.14: Environmental conditions

Ambient temperature, in-service	-40 – 60°C (-40 – 140°F)
Ambient temperature, storage	-40 – 70°C (-40 – 158°F)
Relative air humidity	< 95%
Maximum operating altitude	2000 m (6561.68 ft)

Table 11.15: Casing

Degree of protection (IEC 60529)	Standard: IP30 front panel. IP20 rear panel Option: IP54 front panel, IP 20 rear panel
Dimensions (w x h x d):	208 x 155 x 225 mm / 8.19 x 6.10 x 8.86 in
Material	1 mm (0.039 in) steel plate
Weight	4.2 kg (9.272 lb)
Colour code	RAL 7032 (Casing) / RAL 7035 (Back plate)

Table 11.16: Package

Dimensions (W x H x D)	215 x 160 x 275 mm / 8.46 x 6.30 x 10.83 in
Weight (Terminal, Package and Manual)	5.2 kg (11.479 lb)

11.3 Main functions

Table 11.17: Disturbance recorder (DR)

Mode of recording	Saturated / Overflow
Sample rate:	
- Waveform recording	32/cycle, 16/cycle, 8/cycle
- Trend curve recording	10, 20, 200 ms 1, 5, 10, 15, 30 s 1 min
Recording time (one record)	0.1 s – 12 000 min (According recorder setting)
Pre-trigger rate	0 – 100%
Number of selected channels	0 – 12

The recording time and the number of records depend on the time setting and the number of selected channels.

Table 11.18: Voltage sag & swell

Voltage sag limit	10 – 120 %U_N (step 1%)
Voltage swell limit	20 – 150 %U_N (step 1%)
Definite time function: - Operating time	DT 0.08 – 1.00 s (step 0.02 s)
Low voltage blocking	0 – 50 %
Reset time	< 60 ms
Reset ration: - Sag - Swell	 1.03 0.97
Block limit	0.5 V or 1.03 (3 %)
Inaccuracy: - Activation - Activation (block limit) - Operating time at definite time function	 ±0.5 V or ±3% of the set value ±5% of the set value ±1% or ±30 ms

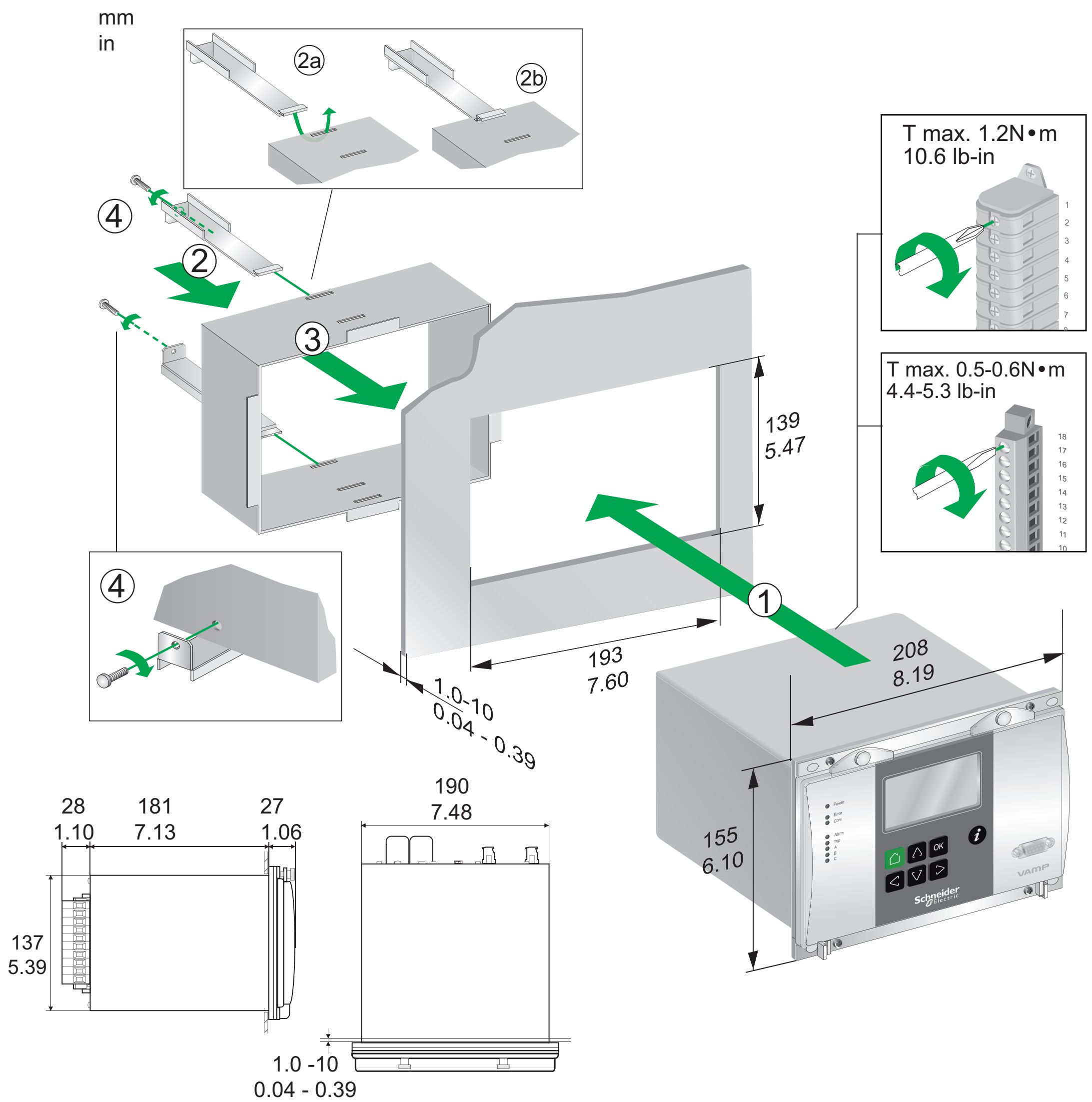
If one of the phase voltages is below sag limit and above block limit but another phase voltage drops below block limit, blocking is disabled.

Table 11.19: Voltage interruptions

Voltage low limit (U_1)	10 – 120 %U_N (step 1%)
Definite time function: - Operating time	DT <60 ms (Fixed)
Reset time	< 60 ms
Reset ratio:	1.03
Inaccuracy: - Activation	 3% of the set value

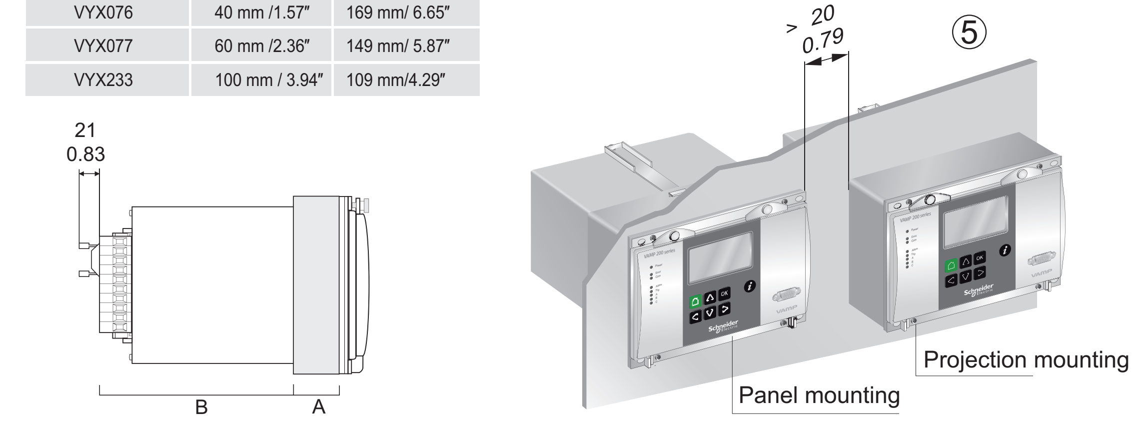
12 Mounting

VAMP 200 SERIES PANEL MOUNTING

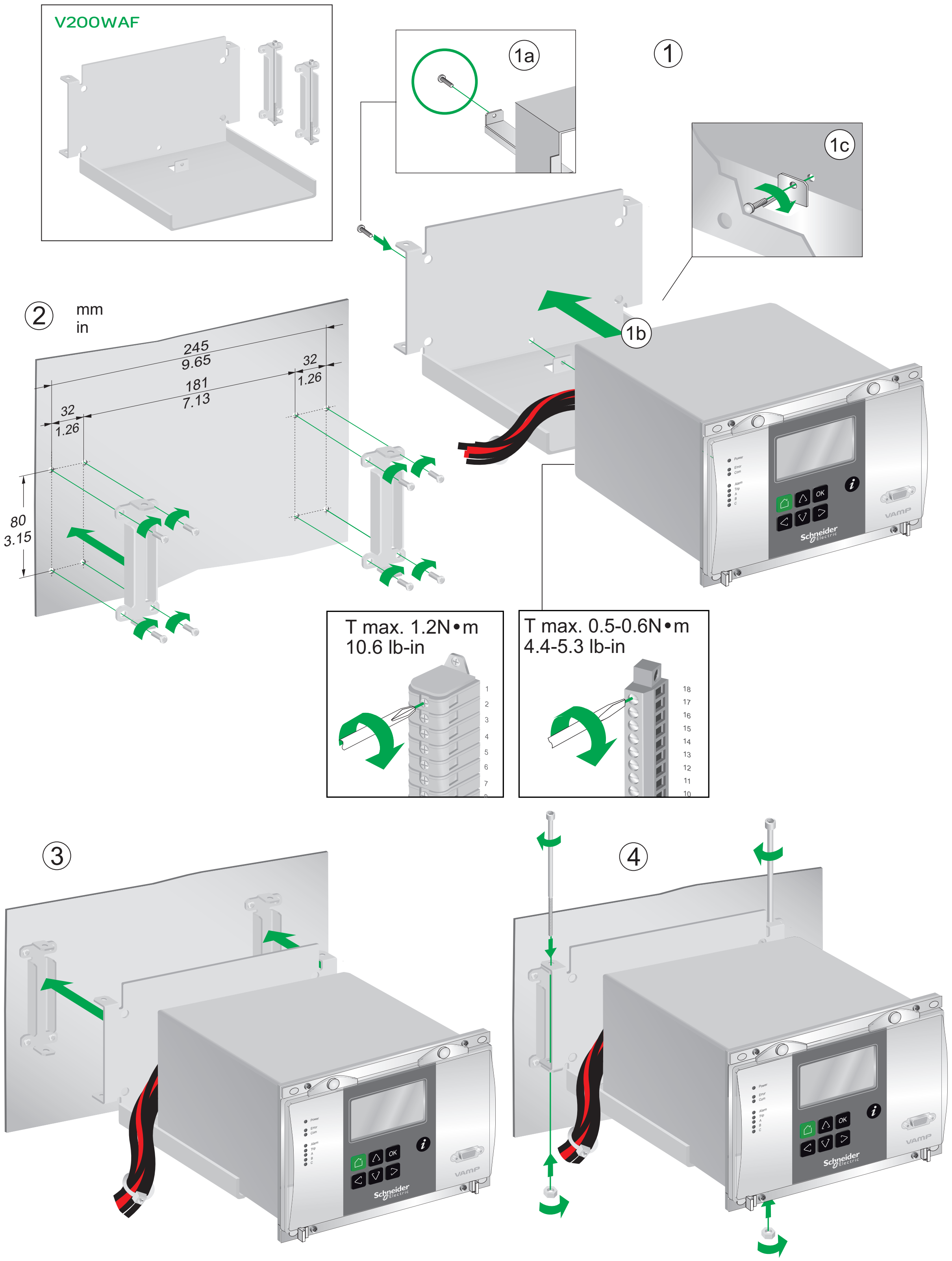


PROJECTION MOUNTING VAMP 200 SERIES

Projection	A	B
VYX076	40 mm /1.57″	169 mm/ 6.65″
VYX077	60 mm /2.36″	149 mm/ 5.87″
VYX233	100 mm / 3.94″	109 mm/4.29″



VAMP 200 SERIES WALL ASSEMBLY FRAME TYPE V200WAF



13 Order information

When ordering, please state:

- Type designation:
- Quantity:
- Options (see respective ordering code):

V260 - □□□□□□ - □ — **Measuring and Monitoring Unit**

Nominal current [A]
1 = 1A
5 = 5A

Nominal Voltage [V]
C = 100.. 240

Frequency [Hz]
7 = Standard relay

Nominal Supply Voltage [V]
A = Power A 48 - 230 V (40.. 265Vac/dc)
B = Power B 24 V (18.. 36Vdc)

Optional Hardware
A = None
B = Plastic/Plastic serial fibre interface
C = Profibus interface
D = RS 485 interface (4-wire)
E = Glass/Glass serial fibre interface
F = Rx Plastic/Tx Glass serial fibre interface
G = Rx Glass/Tx Plastic serial fibre interface
H = RJ-45 10Mbps ethernet interface
M = RJ-45 10Mbps ethernet inc. IEC 61850
O = LC 100 Mbps ethernet fibre interface inc. IEC 61850
P = RJ-45 100Mbps ethernet interface inc. IEC 61850
R = 2 x LC 100 Mbps ethernet fibre interface inc. IEC 61850
S = 2 x RJ-45 100 Mbps ethernet interface inc. IEC 61850

Analog Outputs & firmware
E = None, standard firmware
F = 4 pcs, standard firmware

HW options
= IP30 (default)
C = IP30 with conformal coating
I = IP54
K = IP54 with conformal coating

Note:
(* Optional hardw are, A-H available
(# Optional hardw are, A-G available

Accessories

Order code	Description	Note
VEA 3CGi	Ethernet adapter	
VPA 3CG	Profibus DP fieldbus option board	
VSE001PP	Fibre optic Interface Module (plastic - plastic)	Max. distance 30 m
VSE002	RS485 Interface Module	
VSE003	Local port RS-485 interface module,Ext I/O interface	
VSE009	External DeviceNet interface module	
VIO 12 AB	RTD Module, 12pcs RTD inputs, RS 485 Communication (24-230 Vac/dc)	
VIO 12 AC	RTD/mA Module, 12pcs RTD inputs, PTC, mA inputs/outputs, RS232, RS485 and Optical Tx/Rx Communication (24 Vdc)	
VIO 12 AD	RTD/mA Module, 12pcs RTD inputs, PTC, mA inputs/outputs, RS232, RS485 and Optical Tx/Rx Communication (48-230 Vac/dc)	
VX003-3	RS232 programming cable (VAMPSET, VEA 3CGi)	Cable length 3m
3P025	USB to RS232 adapter	
VX004-M3	TTL/RS232 converter cable (PLC, VEA 3CGi)	Cable length 3m
VX004-M10	TTL/RS232 converter cable (PLC, VEA 3CGi)	Cable length 10m
VX007-F3	TTL/RS232 converter cable (VPA 3CG)	Cable length 3m
VAM 16D	External LED module	Disables rear local communic- ation
VYX 076	Projection for 200 series	Height 40mm
VYX 077	Projection for 200 series	Height 60mm
VYX 233	Projection for 200 series	Height 100mm
V200WAF	V200 wall assembly frame	
VM690/230	3 Phase Nominal Voltage Matching Transformer	690V->230V , 400V->110V

14 Firmware revision history

10.58	New features in IEC 61850 added Outputs vef files with suomi & russian language packets
10.67	100 Mbps option card support
10.68	Default font sizes changed Popup window added for language packet init
10.74	I> and I_0> - I_0>>>> -stages with faster operation time Harmonic driver to 10 ms priority I_{0Calc} driver to 10 ms priority Logic outputs to GOOSE RSTP support
10.87	Maximum rated power increased to 400000 kVA from 200000 kVA Support for two instances of TCP protocols on Ethernet port Virtual output events added Ethernet/IP: mapping extensions (ExtDOs, ExtAOs and ExtAIs alarms) “get/set” added to communication ports’ protocol lists M-Bus added
10.106	GOOSE supervision signals added Automatic LED latch release added Disturbance recorder full event added
10.108	Use of recorder memory in percents added Various additions to IEC 61850
10.116	IP and other TCP parameters are able to change without reboot Logic output numbering is not changed when changes are made in the logic **NOTE! Vampset version 2.2.97 required**
10.118	Enable sending of analog data in GOOSE message Day light saving (DST) rules added for system clock HMI changes: • Order of the first displays changed, 1.measurement, 2. mimic, 3. title • timeout does not apply if the first 3 displays are active

10.161	- IEC 101 over Ethernet added - Possibility to compare two signals in programmable stages added - Alarms for ExtAI/RTD: RTD open/RTD shorted/RTD communication loss added - FTP file transfer passive mode added - Back-up SNTP server added - Support for HTTP server added - UDP mode for IEC 101 over Ethernet added - Support for folder view in VAMPSET added - Disturbance recorder memory doubled - More memory for MIMIC added - IEC 61850: file transfer added - IEC 61850: object inactivity alarms added - IEC 61850: new LN for EF trip indication EFPTRC2 including neutral component added - IEC 61850: new LN containing indications from DR and remote triggering of DR added - IEC 61850: parameter IEC 61850 file transfer added - IEC 61850: event COMTRADE file ready added - IEC 61850: new LNs with CT parameters added - IEC 61850: default value for every GOOSE NI - IEC 61850: support for bitstrings in GOOSE added - IEC 61850: setting GOOSE to test mode via DI/VI/local HMI added - IEC 61850: analog values received via GOOSE for display on MIMIC and MEASUREMENT DISPLAYS added - IEC 61850: all Data Sets and In Use Columns set to "NO" by default added - IEC 61850: LED reset command
10.175	I>: Pick-up limit setting minimum value changed from 0.10 to 0.05 Number of setting groups increased from 2 to 4 When accept zero delay enabled, stages' definite operation delay can be set to 0 Relay name can be 10 characters long

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