VAMP 321

Arc Flash Protection System

Publication version: V321/en M/B011

User Manual

Trace back information:
Workspace VAMP Range version a5
Checked in 2018-04-09
Skribenta version 5.2.027

Table of Contents

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

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 the IED's password protection feature to protect untrained persons from interacting with 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 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

1.4 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. The manufacturer recommends that functional testing is carried out at the 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 and its related units.

1.5 Purpose

NOTE: For applications in the US, Canada and Mexico, use specific documents reviewed in line with the requirements of the relevant regulatory authorities. Please contact our local Schneider Electric office for assistance.

This document contains instructions on the installation, commissioning and operation of VAMP 321. This guide also contains an application example of configuring an arc flash protection system.

This document is intended for persons who are experts on electrical power engineering, and it covers the device models as described by the ordering code in Chapter 16 Order information.

Related documents

Document	Identification*)
VAMP Arc I/O units user manual	VIO_EN_M_xxxx
VAMP Arc Flash Protection Testing Manual	VARCTEST_EN_M_xxxx
VAMP Arc protection Mounting and Commissioning Instructions	VARC_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.

1.6 Abbreviations

ANSI	American National Standards Institute. A standardization organisation.
CB	Circuit breaker
CBFP	Circuit breaker failure protection
CT	Current transformer
CT_{PRI}	Nominal primary value of current transformer
CT_{SEC}	Nominal secondary value of current transformer
Dead band	See hysteresis.
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
Hysteresis	I.e. dead band. Used to avoid oscillation when comparing two near by values.
I_N	Nominal current. Rating of CT primary or secondary.
I_{SET}	Another name for pick up setting value I>
I_{0N}	Nominal current of I_0 input in general
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, refers to VAMP 321 in this document
IEEE	Institute of Electrical and Electronics Engineers
LAN	Local area network. Ethernet based network for computers and IEDs.
Latching	Output relays and indication LEDs can be latched, which means that they are not released when the control signal is releasing. Releasing of lathed devices is done with a separate action.
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
PT	See VT
RMS	Root mean square
SF	IED status inoperative
SNTP	Simple Network Time Protocol for LAN and WWW
SPST	Sigle pole single throw
SPDT	Sigle pole double throw
TCS	Trip circuit supervision
THD	Total harmonic distortion
VAMPSET	Configuration tool for VAMP protection devices

Webset	http configuration interface

2 Introduction

2.1 VAMP 321

The VAMP 321 IED includes the arc flash protection functions, such as overcurrent and arc supervision. VAMP 321 has a modular design, and it is optimised for use in arc protection systems. It can be used in various arc protection applications in low or medium voltage power distribution systems.

- Three-phase current
- Zero-sequence current
- One voltage channel for measurements and supporting functions
- Event logs, disturbance recording and real-time clock
- Operation on simultaneous current and light or on light only (I>&L>, I_0>&L> or L>)
- Informative LCD
- Output contact count, as per order code. See Chapter 16 Order information
- Two change-over signal contacts including SF
- Typically 7 ms operation time with a mechanical output relay, with optional 2IGBT card (HSO) operation time is typically 2ms
- Programmable operation zones
- System self-supervision
- Up to 8 normally-open trip contacts for fast arc flash detection
- LED indications of status, fault and trip indications
- Accommodations for up to 16 VAM I/O units
- Binary input/output (BI/O) bus for light and overcurrent information as per order code (Refer to Chapter 6.3 Binary inputs and outputs for additional information.)
- Two (2) high speed (HSO) outputs as per order code

The VAMP 321 is intended to be used as the main unit of an arc protection system, which includes also arc protection I/O units like VAM 10L and arc light sensors. The arc light sensors may be connected to the I/O units or to the main unit.

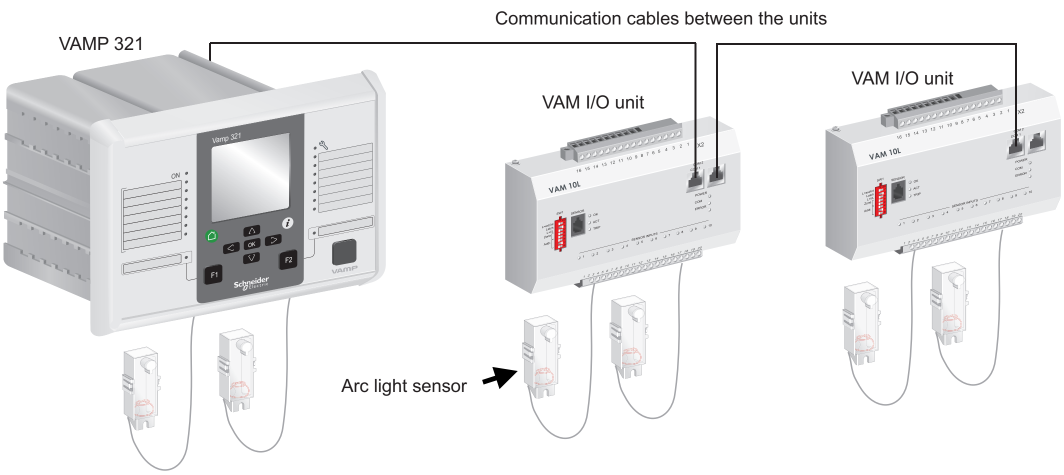


Figure 2.1: Arc protection system with VAMP 321 as central unit.

2.2 Local HMI

VAMP 321 has 128 x 128 LCD matrix display.

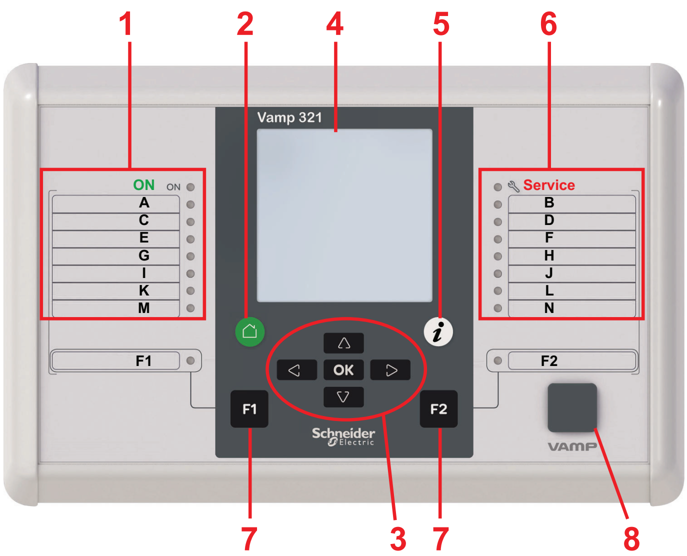


Figure 2.2: VAMP 321 local HMI

1	Power LED and seven programmable LEDs
2	CANCEL push-button
3	Navigation push-buttons
4	LCD
5	INFO push-button
6	Status LED and seven programmable LEDs
7	Function push-buttons and LEDs showing their status
8	Local port

2.2.1 Push-buttons

Symbol	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.
i	INFO push-button for viewing additional information, for entering the password view and for adjusting the LCD contrast.
F1	Programmable function push-button.
F2	Programmable function push-button.
OK	ENTER push-button for activating or confirming a function.
∧	UP navigation push-button for moving up in the menu or increasing a numerical value.
∨	DOWN navigation push-button for moving down in the menu or decreasing a numerical value.
<	LEFT navigation push-button for moving backwards in a parallel menu or selecting a digit in a numerical value.
>	RIGHT navigation push-button for moving forwards in a parallel menu or selecting a digit in a numerical value.

2.2.2 LEDs

VAMP 321 has 18 LEDs on front. Two LEDs represents units general status (On &), two LEDs for function buttons (F1 & F2) and 14 user configurable LEDs (A - N). When the device is powered the “ON” LED will lit as green. During normal use “Service” LED is not active, it activates only when error occurs or the device is not operating correctly. Should this happen contact your local representative for further guidance.

can lit either green or red. The LEDs on the local HMI can be configured in VAMPSET. To customise the LED texts on the local HMI, the texts can be written on a template and then printed on a transparency. The transparencies can be placed to the pockets beside the LEDs.

2.2.3 Enter password

1. On the local HMI, press i and OK.
2. Enter the four-digit password and press OK.

2.2.4 Adjusting LCD contrast (while correct password is enabled)

1. Press and adjust the contrast.
   - To increase the contrast, press .
   - To decrease the contrast, press .
2. To return to the main menu, press .

2.2.5 Release all latches (while correct password is enabled)

1. Press
   - To release the latches, press .
   - To release, choose “Release” parameter and press .

2.2.6 Moving in the menus

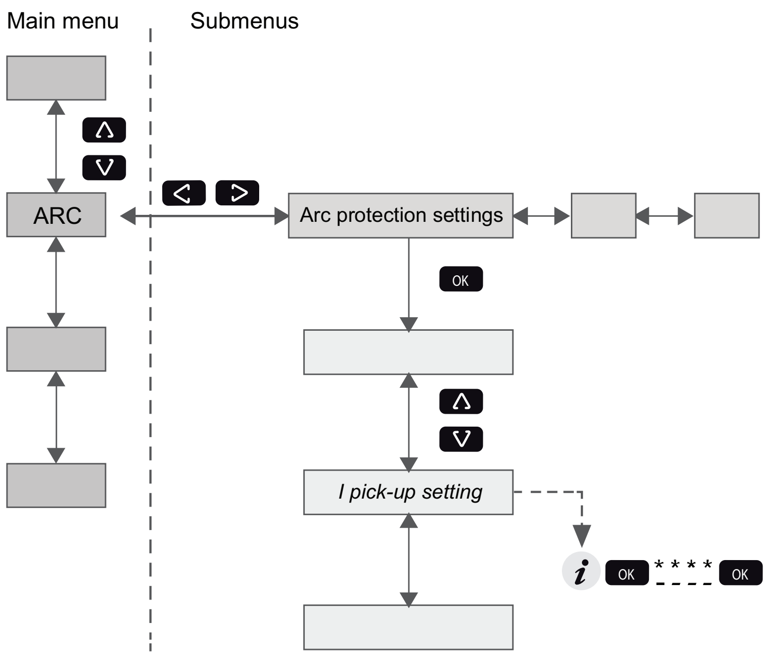


Figure 2.3: Moving in menus using local HMI

- To move in the main menu, press △ or ▽.
- To move in submenus, press ▷ or ◁.
- To enter a submenu, press OK and use ▽ or △ for moving down or up in the menu.
- To edit a parameter value, press i and OK. Key in four-digit password and press OK.
- To go back to the previous menu, press ⌂.
- To go back to the first menu item in the main menu, press ⌂ for at least three seconds.

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

2.3 VAMPSET setting and configuration tool

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Only qualified personnel should operate this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.

Failure to follow this instruction will result in death or serious injury.

VAMPSET is a software tool for setting and configuring the VAMP devices. VAMPSET has a graphical interface, and the created documents can be saved and printed out for later use.

To use VAMPSET, you need

- PC with Windows XP (or newer) operating system installed
- VX052 or equivalent USB cable for connecting the device to the PC (VX052 USB cable is recommended)
- Experience in using the Windows operating system
- USB drivers installed

NOTE: Download the latest VAMPSET version at www.schneider-electric.com/vamp-protection or m.vamp.fi.

2.3.1 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 2.4.

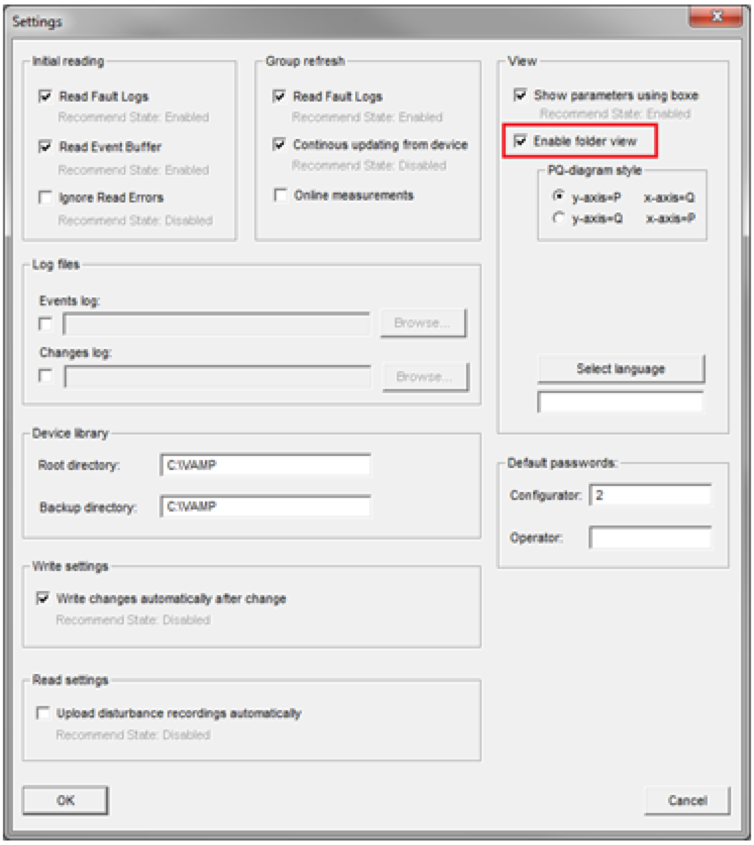


Figure 2.4: Enable folder view setting in Program Settings dialog

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 2.5. Currently selected folder appears in bold.

Figure 2.5: Folder view buttons

2.4 Configuring the system with VAMPSET

NOTICE

RISK OF SYSTEM SHUTDOWN

After writing new settings or configurations to a relay, perform a test to verify that the relay operates correctly with the new settings.

Failure to follow these instructions can result in unwanted shutdown of the electrical installation.

Before configuring the arc flash protection system, you need

- PC with adequate user rights
- VAMPSET setting and configuration tool downloaded to the PC
- USB cable (VX052) for connecting the device with the PC
- USB drivers installed

2.4.1 Setting up the communication

NOTE: If several devices are connected to a ARC I/O bus, set only one to master mode and the others to slave mode.

- Connect the USB cable between the PC and the local port of the device.

Defining the PC serial port settings

NOTE: Ensure that the communication port setting on the PC corresponds to the device setting.

1. Open the **Device Manager** on the PC and check the USB Serial Port number (COM) for the device.
2. Open the VAMPSET setting and configuration tool on the PC.
3. On the VAMPSET **Settings** menu, select **Communication Settings**.
4. Select the correct port under the **Port** area and click **Apply**.

Defining the VAMPSET communication settings

1. On the local HMI, go to the **CONF**/ **DEVICE SETUP** menu and check the local port bit rate.
2. On the VAMPSET **Settings** menu, select **Communication Settings**.
3. Under the **Local** area, select the corresponding speed (bps) from the drop-down list and click **Apply**.
4. In VAMPSET **Settings** menu, select **Program Settings**.

NOTE: If faster operation is needed, change the speed to 187500 bps both in VAMPSET and in the device.

Connecting the device

1. On the VAMPSET **Communication** menu, select **Connect Device**.
2. Enter the password and click **Apply**.

NOTE: The default password for the configurator is *2*.

2.4.2 Writing the settings to the device

- In the VAMPSET **Communication** menu, select **Write All Settings To Device** to download the configuration to the device.

NOTE: To save the device configuration information for later use, also save the VAMPSET document file on the PC.

2.4.3 Saving the VAMPSET document file

Save the device configuration information to the PC. The document file is helpful for instance if you need help in troubleshooting.

1. Connect the device to the PC with an USB cable.
2. Open the VAMPSET tool on the PC.
3. On the **Communication** menu, select **Connect device**.
4. Enter the configurator password. The device configuration opens.
5. On the **File** menu, click **Save as**.
6. Type a descriptive file name, select the location for the file and click **Save**.

NOTE: By default, the configuration file is saved in the VAMPSET folder.

2.5 Connecting the supply voltage

NOTE: Do not connect the supply voltage before the device connections and I/O unit configuration is done. If the settings of the VAM I/O units need to be changed, disconnect the supply voltage before configuring the devices.

- Ensure the device connections, protective grounding and I/O unit configurations are in order.
- Connect the auxiliary supply voltage to the IED's terminal block.

2.6 Disconnecting the supply voltage

The auxiliary supply power must be disconnected from IED and its extension unit in case following service action is required:

- replacement, add-on or removal of extension unit, cabling or sensors
- need to make settings to the I/O unit

3 Protection functions

3.1 Arc flash protection

3.1.1 Arc flash protection, general principle

The arc flash protection contains 8 arc stages, which may be used to trip e.g. the circuit breakers. Arc stages are activated with overcurrent and light signals (or light signal alone). The allocation of different current and light signals to arc stages is defined in arc flash protection matrices: current, light and output matrix. The matrices are programmed via the arc flash protection menus. Available matrix signals depends on order code (see Chapter 16 Order information).

3.1.2 Arc flash protection menus

The arc flash protection menus are located in the main menu under ARC. The ARC menu can be viewed either on the local HMI, or by using VAMPSET.

ARC PROTECTION

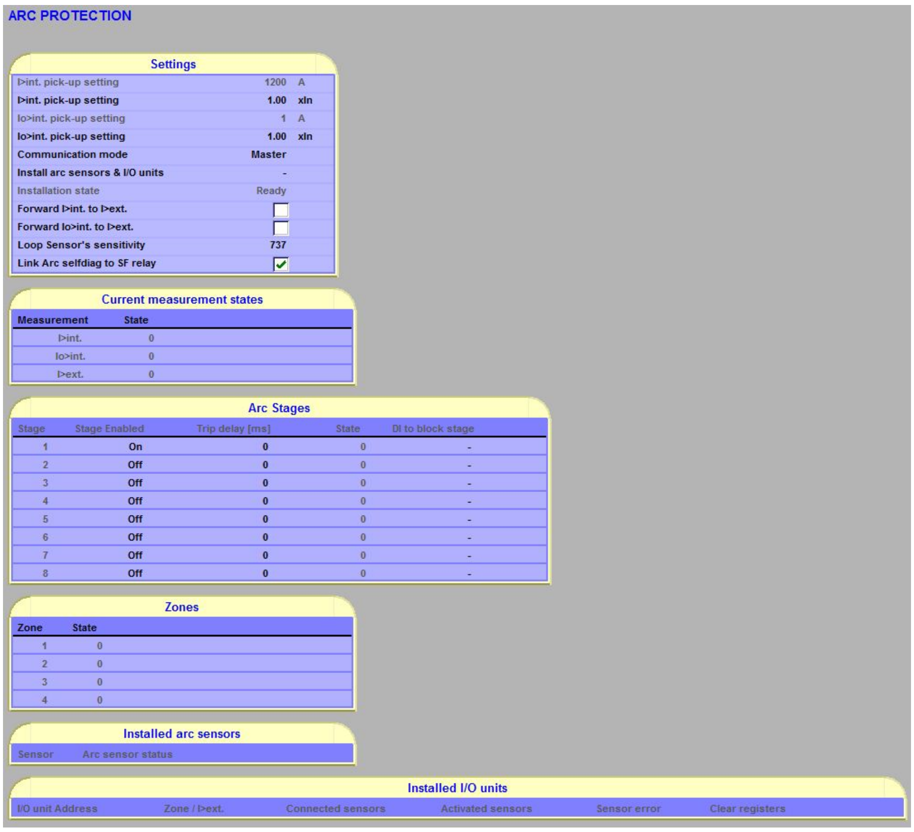


Figure 3.1: Example view of ARC PROTECTION menu

Table 3.1: ARC PROTECTION parameter group

Item	Default	Range	Description
I>int. pick-up setting	1.00 xIn	0.50 – 8.00 xIn	Phase L1, L2, L3 overcurrent pick-up level
Io>int. pick-up setting	1.00 xIn	0.10 – 5.00 xIn	Residual overcurrent pick-up level
Communication mode	Master	Slave, Master	Arc I/O communication mode
Install arc sensors & I/O units	-	-, Install	Installs all connected I/O units and sensors
Installation state	Ready	Installing, Ready	Installation state
Forward I>int. to I>ext	Off	On, Off	Forward I>int. signal to ARC I/O bus
Forward Io>int. to I>ext	Off	On, Off	Forward Io>int. signal to ARC I/O bus
Loop Sensor's sensitivity	737	100 - 900	Sensitivity setting for fibre loop sensor. C-option
Link Arc selfdiag to SF relay	On	On, Off	Links Arc protection selfsupervision signal to SF relay
Stage Enabled	On or Off	On, Off	Enables the Arc protection stage
Trip delay [ms]	0	0 – 255	Trip delay for the Arc protection stage
Min. hold time [10ms]	2	2 – 255	Minimum trip pulse lenght for the arc protection stage (Overshoot time <35ms)

NOTE: Use trip delay for separate arc stage as breaker failure protection (CBFP).

ARC MATRIX – CURRENT

In the ARC MATRIX - CURRENT setting view available current signals (left column) are linked to the appropriate Arc stages (1 – 8).

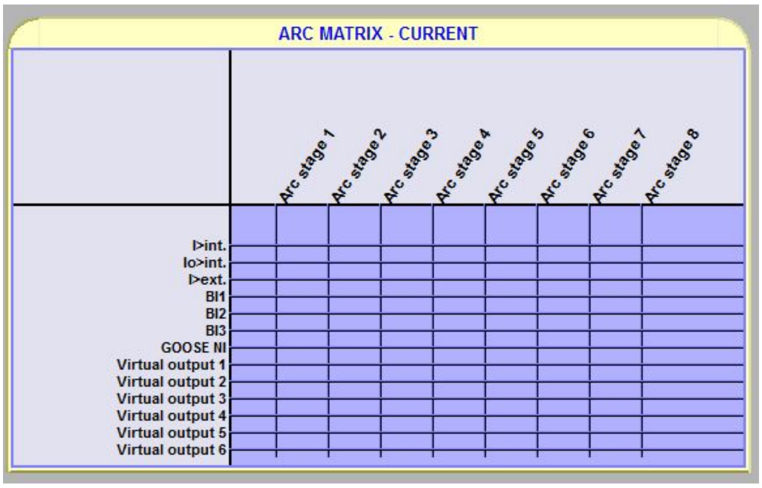


Figure 3.2: Example view of ARC MATRIX - CURRENT menu

Table 3.2: ARC MATRIX – CURRENT parameter group

Item	Default	Range	Description
I>int.	-	On, Off	Phase L1, L2, L3 internal overcurrent signal
Io>int.	-	On, Off	Residual overcurrent signal
I>ext.	-	On, Off	External overcurrent signal received from Arc I/O Bus
BI1-BI3	-	On, Off	Binary input 1 – 3 signals received from Arc I/O Bus
GOOSE NI	-	On, Off	Goose network input
Virtual output 1 – 6	-	On, Off	Virtual output
Arc stage 1 – 8	-	On, Off	Arc protection stage 1 – 8

ARC MATRIX – LIGHT

In the ARC MATRIX - LIGHT setting view available arc light signals are linked (left column) are linked to the appropriate Arc stages (1 – 8).

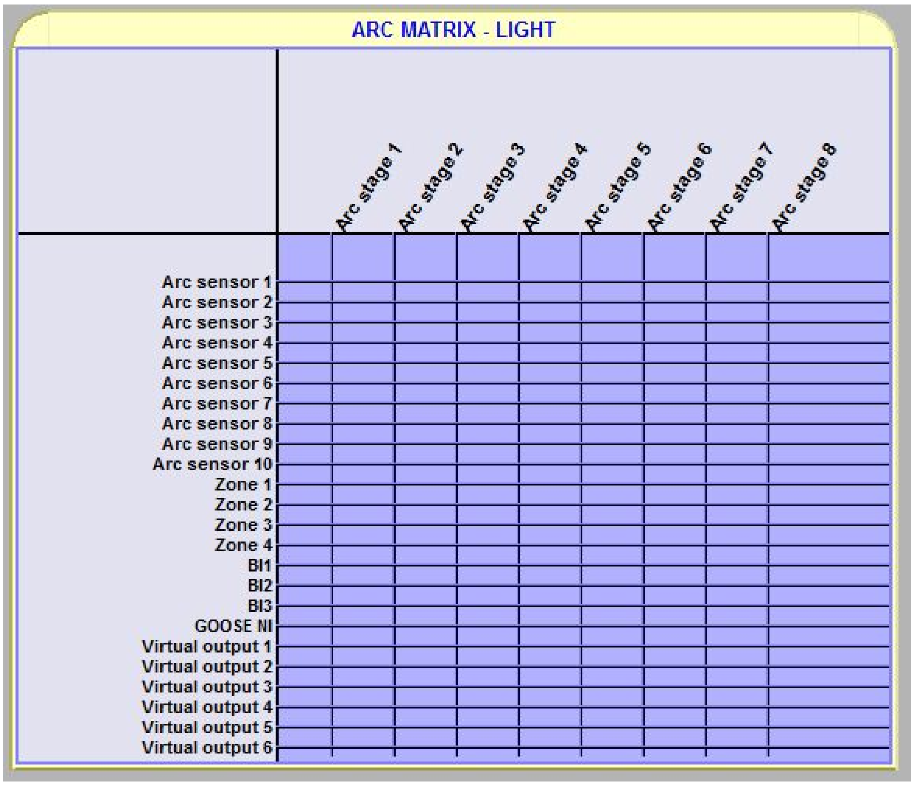


Figure 3.3: Example view of ARC MATRIX - LIGHT menu

Table 3.3: ARC MATRIX – LIGHT parameter group

Item	Default	Range	Description
Arc sensor 1 – 10	-	On, Off	Internal arc flash sensor 1 – 10
Zone 1 – 4	-	On, Off	Arc light zone 1 – 4
BI1 – 3	-	On, Off	Binary input 1 – 3 signal
GOOSE NI	-	On, Off	Goose network input
Virtual output 1 – 6	-	On, Off	Virtual output
Arc stage 1 – 8	-	On, Off	Arc protection stage 1 – 8

ARC MATRIX – OUTPUT

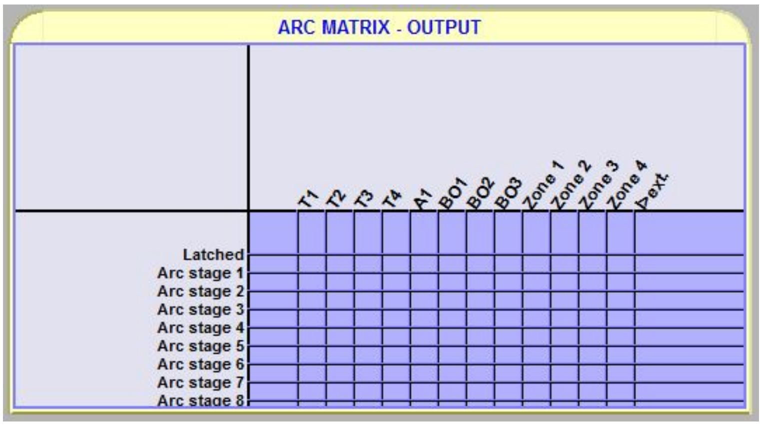


Figure 3.4: Example view of ARC MATRIX - OUTPUT menu

In the ARC MATRIX - OUTPUT setting view the used Arc stages (1 – 8) are connected to the required outputs. Possible latched function per output is also determined in this view. Available outputs depend on order code.

Table 3.4: ARC MATRIX – OUTPUT parameter group

Item	Default	Range	Description
Latched	-	On, Off	Output latch
Arc stage 1 – 8	-	On, Off	Arc protection stage 1 – 8
T1 – 4	-	On, Off	Trip output relay 1 – 4
A1	-	On, Off	Signal alarm relay 1
BO1 – 3	-	On, Off	Binary output 1 – 3
Zone 1 – 4	-	On, Off	Arc light zone 1 – 4
I>ext.	-	On, Off	External overcurrent signal received from ARC I/O Bus
HSO 1 – 2	-	On, Off	High speed output 1 – 2

MATRIX CORRELATION PRINCIPLE

When determining the activating conditions for a certain arc stage, a logical AND is made between the outputs from the arc light matrix and arc current matrix.

If an arc stage has selections in only one of the matrixes, the stage operates on light-only or on current-only principle.

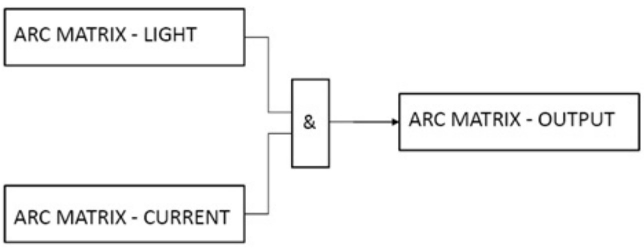


Figure 3.5: Matrix correlation principle with the logical AND operator

ARC EVENT ENABLING

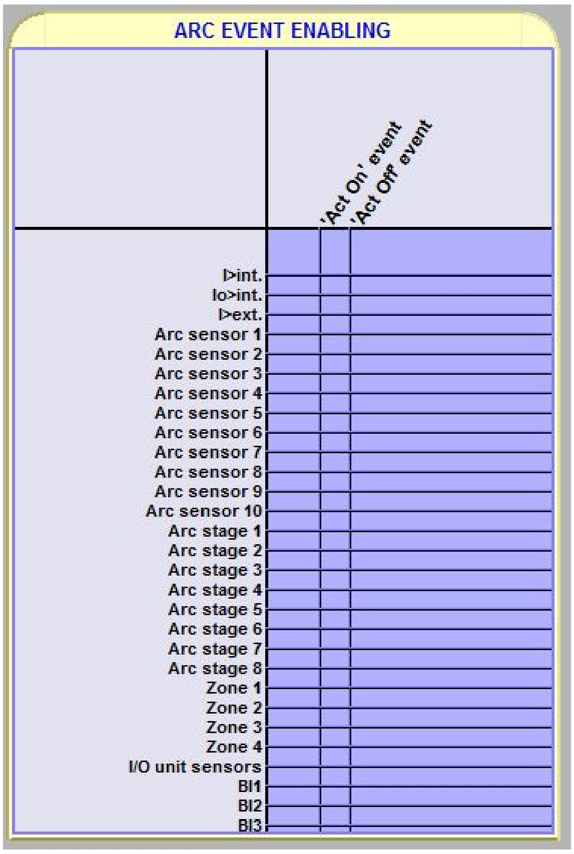


Figure 3.6: Example view of ARC EVENT ENABLING menu

Table 3.5: ARC EVENT ENABLING parameter group

Item	Default	Range	Description
I>int.	On	On, Off	Internal I overcurrent signal
Io>int.	On	On, Off	Internal Io overcurrent signal
I>ext.	On	On, Off	External overcurrent signal
Arc sensor 1-10	On	On, Off	Arc flash sensor 1 – 10
Arc stage 1-8	On	On, Off	Arc protection stage 1 – 8
Zone 1-4	On	On, Off	Arc light zone 1 – 4
I/O unit sensors	On	On, Off	External I/O unit Arc flash sensors
BI1	On	On, Off	Binary input 1
BI2	On	On, Off	Binary input 2
BI3	BI2	On, Off	Binary input 3
'Act On' event	On	On, Off	Event enabling
'Act Off" event	On	On, Off	Event enabling

3.1.3 Related VAM I/O units

NOTE: For more information on I/O units, such as panel and programming switch descriptions, see the separate documentation.

Table 3.6: VAM I/O units

I/O unit	Description
VAM 4C VAM 4CD VAM 4CRL	Current I/O unit serving as a link between the system's current inputs and the IED. Each I/O unit has connections for three current transformers and one trip output.
VAM 3L VAM 3LX	Fibre sensor I/O unit serving as a link between the system's fibre sensors and the IED. Each I/O unit has connections for three arc sensors, one pin sensor and one trip output.
VAM 10L VAM 10LD	Point sensor I/O unit serving as a link between the system's point sensors and the IED. Each I/O unit has connections for ten arc sensors, and one trip output.
VAM 12L VAM 12LD	Point sensor I/O unit serving as a link between the system's point sensors and the IED. Each I/O unit has connections for ten arc sensors, and three trip outputs.

3.2 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 operate times less than 80 milliseconds are needed select 10 ms. For operate times under one second 20 ms is recommended. For longer operate 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 3.7: Available signals to be supervised by the programmable stages

IL1, IL2, IL3	Phase currents
Io	Residual current input
U12	Line-to-line voltages
UL1	Phase-to-ground voltages
Uo	Zero sequence voltage
f	Frequency
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

IL	Average (I_{L1} + I_{L2} + $I_{L3)}$ / 3
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
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
Ucomm	Common mode voltage of Uo input
Io1RMS	RMS current of input Io
VAI1, VAI2, VAI3, VAI4, VAI5	Virtual analog inputs 1, 2, 3, 4, 5 (GOOSE)

The availability of voltage measurements depends on the selected voltage measurement mode of the device.

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.

Table 3.8: Parameters of the programmable stages PrgN (99)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Current status of the stage	 F F
SCntr			Cumulative start counter	C
TCntr			Cumulative trip counter	C
SetGrp	1, 2, 3, 4		Active setting group	Set

Parameter	Value	Unit	Description	Note
SGrpDI			Digital signal to select the active setting group	Set
	-		None	
	DIx		Digital input	
	VIx		Virtual input	
	LEDx		LED indicator signal	
	VOx		Virtual output	
	Fx		Function key	
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 3.7		Name for the supervised signal	Set
See Table 3.7			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 operate 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 3.9: 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 operate time setting. 100% = trip
SetGrp	1, 2, 3, 4		Active setting group during fault

4 Supporting functions

4.1 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 protection stage 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 a programmable stage trip event is shown in the following table.

EVENT	Description	Local panel	Communication protocols
Code: 46E2	Channel 46, event 2	Yes	Yes
Prg1 trip on	Event text	Yes	No
0.41 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 4.3 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 4.1: 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 4.3 System clock and synchronization)	
hh:mm:ss.nnn		Time	

4.2 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 also include the arc protection signals.

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 4.2: 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	
	Io		Measured residual current	
	U12		Line-to-line voltage	
	UL1		Phase-to-neutral voltage	
	Uo		Zero sequence voltage	
	f		Frequency	
	IoCalc		Phasor sum Io = (IL1+IL2+IL3)/3	
	I1		Positive sequence current	
	I2		Negative sequence current	
	I2/I1		Relative current unbalance	
	I2/In		Current unbalance [x I_N]	
	IL		Average (IL1 + IL2 + IL3) / 3	
	Uphase		Average phase voltage	
	Uline		Average line-to-lines voltages	
	DI, DO		Digital inputs, Digital outputs	
	THDIL1, THDIL2, THDIL3		Total harmonic distortion of IL1, IL2 or IL3	
	THDUa		Total harmonic distortion of Ua	
	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	
	Ucomm		Common mode voltage of Uo-input	
	Io1rms		RMS current of input Io1	
	Arc***)		Arc protection signals	
	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).

***) Arc events are polled in every 5 ms.

For details of setting ranges, see Chapter 11.2 Disturbance recorder

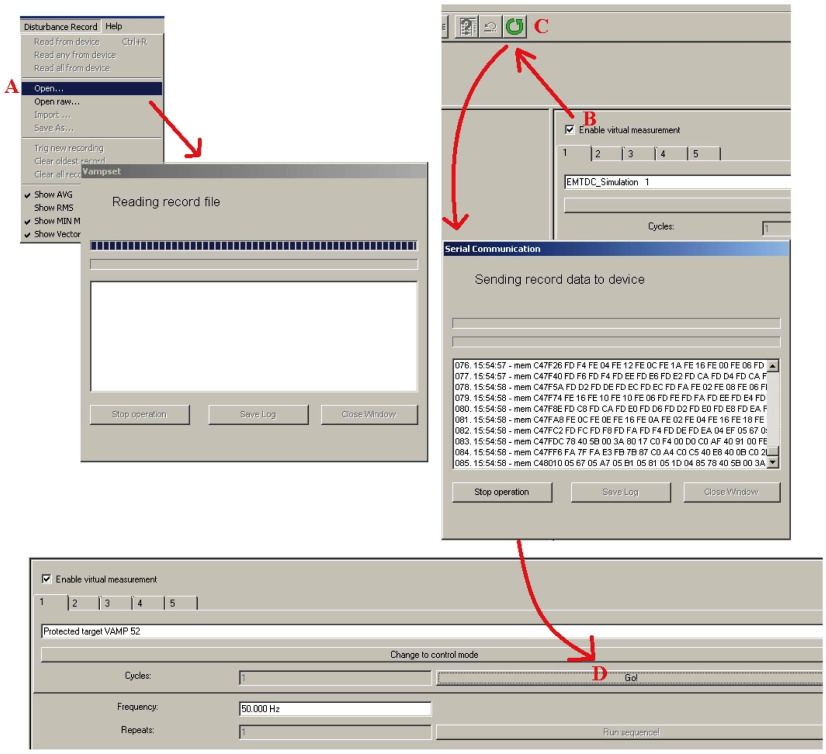
4.2.1 Running virtual comtrade files

Virtual comtrade files can be run with the device. Device behaviour can be analysed by playing the recorder data over and over again in the relay memory.

NOTE: This is not applicable to the arc protection functions of the device.

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.



NOTE: The sample rate of the comtrade file has to be 32/cycle (625 micro seconds when 50 Hz is used). The channel names have to correspond to the channel names in VAMP relays: I_{L1}, I_{L2}, I_{L3}, I_{01}, I_{02}, U_{12}, U_{23}, U_{L1}, U_{L2}, U_{L3} and U_0.

4.3 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.

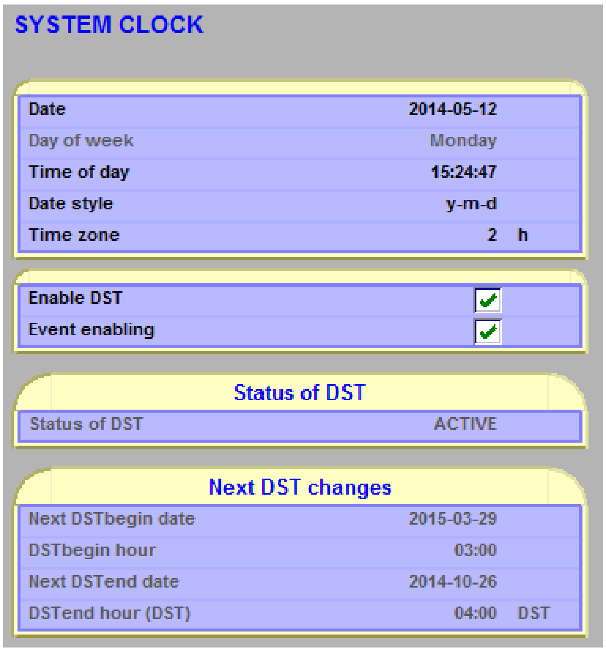
The synchronizing is based on the difference of the internal time and the synchronising message or pulse. This deviation is filtered and the internal time is corrected softly towards a zero deviation.

Time zone offsets

Time zone offset (or bias) can be provided to adjust the local time for the device. 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)

The device 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.

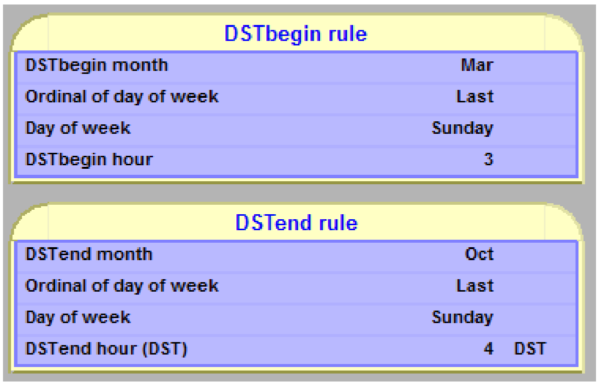


Daylight time standards vary widely throughout the world. Traditional daylight/summer time is configured as one (1) hour positive bias. The new US/Canada DST standard, adopted in the spring of 2007 is: one (1) hour positive bias, starting at 2:00am on the second Sunday in March, and ending at 2:00am 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 device 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



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 4.3: 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	Possible values depends on the types of I/O cards		The digital input used for clock synchronisation.	***)
	-		DI not used for synchronizing	
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

Parameter	Value	Unit	Description	Note
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 16 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.

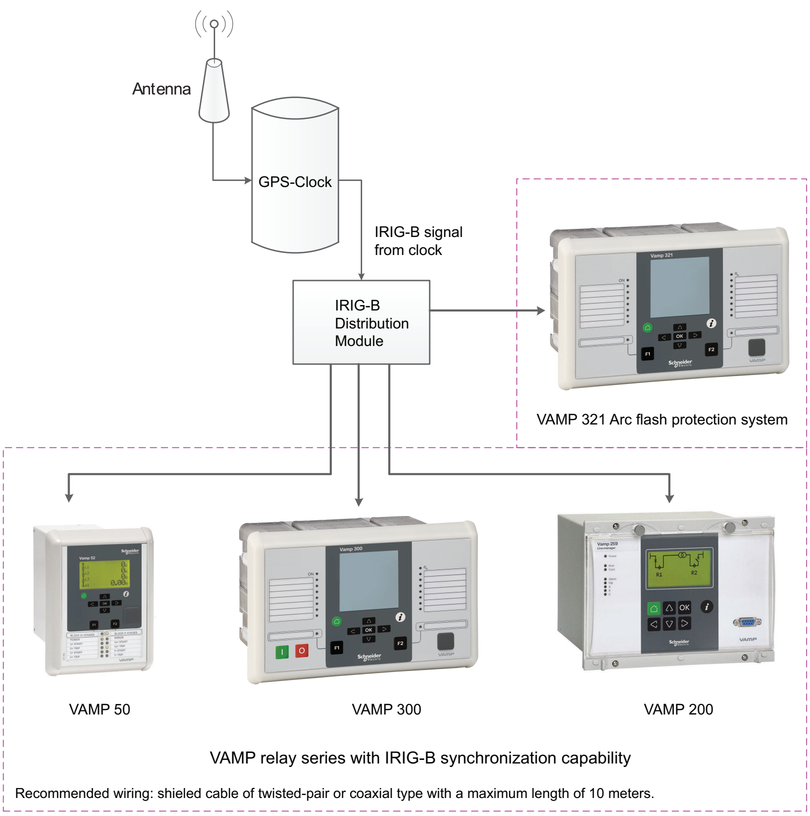
Sync source

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-B

IRIG standard time formats B003 and B004 are supported with a dedicated communication option with either a two-pole or two pins in a D9 rear connector (See Chapter 16 Order information).

IRIG-B 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.

4.4 Non-volatile RAM

The non-volatile RAM of the device is implemented using a super capacitor and a RAM memory with low power consumption.

When auxiliary power is on the super capacitor is charged from the internal power supply of the device and the non-volatile RAM memory also gets power from the same source. When auxiliary power is turned off the RAM memory is powered by the super capacitor. The memory will keep its contents as long as there is enough voltage in the super capacitor. This time is 7 days in +25°C room temperature – high humidity will decrease the time.

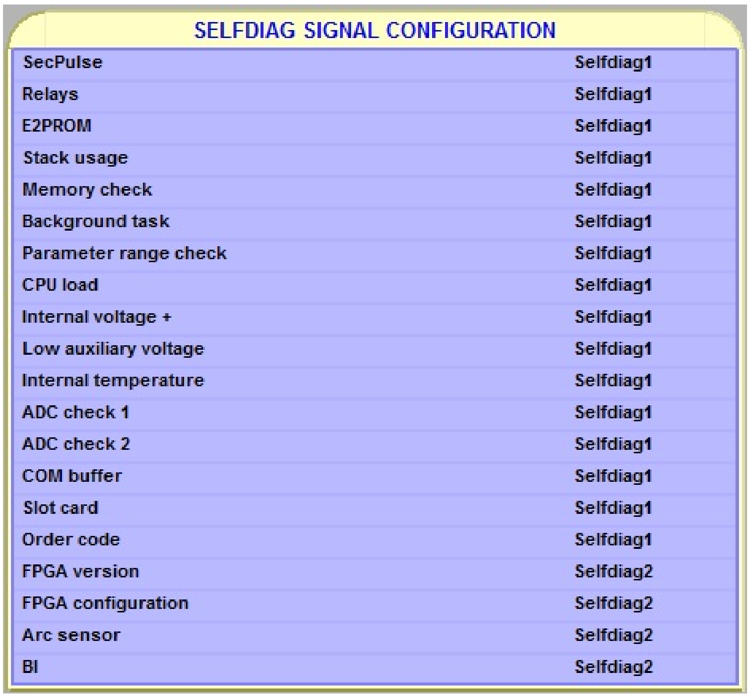
The non-volative RAM is used to store the disturbance recordings and the event-buffer.

4.5 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 other output relays (except for the self-supervision output relay and the output relays used in the arc protection function).

In order to get self-supervision alarms to SF output contact they must be linked in the DIAGNOSIS setting view's section SELFDIAG SIGNAL CONFIGURATION. Required alarms are first linked to a Selfdiag1, Selfdiag2 or Selfdiag3 group (Figure 4.1).



SELFDIAG SIGNAL CONFIGURATION	
SecPulse	Selfdiag1
Relays	Selfdiag1
E2PROM	Selfdiag1
Stack usage	Selfdiag1
Memory check	Selfdiag1
Background task	Selfdiag1
Parameter range check	Selfdiag1
CPU load	Selfdiag1
Internal voltage +	Selfdiag1
Low auxiliary voltage	Selfdiag1
Internal temperature	Selfdiag1
ADC check 1	Selfdiag1
ADC check 2	Selfdiag1
COM buffer	Selfdiag1
Slot card	Selfdiag1
Order code	Selfdiag1
FPGA version	Selfdiag2
FPGA configuration	Selfdiag2
Arc sensor	Selfdiag2
BI	Selfdiag2

Figure 4.1: Selfdiag alarm signal configuration

Having the Seldiag alarm grouping made then the appropriate alarms can be assigned to SF relay. By default, selfdiag alarm 2 is linked to SF relay (Figure 4.2). Function of this default setup is same as in the older systems where this configuration was not possible.

Figure 4.2: Linking Selfdiag alarm 1-3 to SF relay

It is possible to choose, what selfdiag alarms 1-3 does when activated. This option can be done through output matrix (Figure 4.3). This allows customer to categorize and prioritize actions for each selfdiag alarms individually. For example in this configuration selfdiag alarm 3 activates VO6.

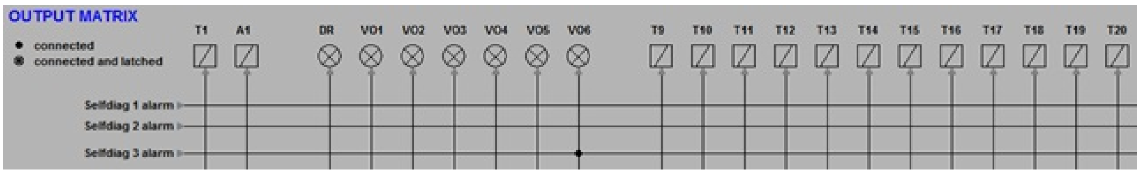


Figure 4.3: Selecting selfdiag 1-3 actions. Number of outputs varies depending of device and order code.

The condition of the VAMP 321 central unit, the I/O units and the sensors are supervised. Events are generated when possible problems occur or disappear. The events are stored in the device event buffer and they can be read on the local HMI or VAMPSET. Channel, events codes and situations where events are generated:

134E1 - 134E10:	Arc sensor 1 - 10 not conn. improper connection ON
134E11 - 134E20:	Arc sensor 1 - 10 not conn. improper connection OFF
134E21 - 134E30:	Arc sensor 1 - 10 short circuit ON
134E31 - 134E40:	Arc sensor 1 - 10 short circuit OFF
134E41 - 134E50:	Arc sensor 1 - 10 daylight detected ON
134E51 - 134E60:	Arc sensor 1 - 10 daylight detected OFF
135E1:	I/O unit sensor improper connection ON (I/O unit + sensor number also shown)
135E2:	I/O unit sensor improper connection OFF (I/O unit + sensor number also shown)
135E3:	I/O unit ArcI/O bus C interruption ON (I/O unit number also shown)
135E4:	I/O unit ArcI/O bus C interruption OFF (I/O unit number also shown)
135E9:	I/O unit ArcI/O bus R interruption ON (I/O unit number also shown)
135E10:	I/O unit ArcI/O bus R interruption OFF (I/O unit number also shown)

Communication interruption between the VAMP 321 and I/O units is also shown by “Arc I/O bus signal” in the output matrix and logics.

Only some of the communication protocols (IEC 61850, SPA-bus, Modbus and ModbusTCP) have capability to transfer all of these events. In some protocols only a selected subset can be left off or only status of "Arc I/O bus" is available with the help of logic programming.

4.5.1 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)	(Reserved)	(Reserved)
	1	(Reserved)	(Reserved)
	2	T1	Detected output relay faul
	3	T2	
	4	T3	
	5	T4	
	6	T5	
	7	T6	
	8	T7	
	9	T8	
	10	A1	
	11	A2	
	12	A3	
	13	A4	
	14	A5	
	15	T9	
SelfDiag2	0 (LSB)	T10	Detected output relay faul
	1	T11	
	2	T12	
	3	T13	
	4	T14	
	5	T15	
	6	T16	
	7	T17	
	8	T18	
	9	T19	
	10	T20	
	11	T21	
	12	T22	
	13	T23	
	14	T24	
SelfDiag4	0 (LSB)	+12V	Detected internal voltage fault
	1	ComBuff	BUS: detected buffer error
	2	Order Code	Detected order code error
	3	Slot card	Detected option card error
	4	FPGA conf.	Detected FPGA configuration error
	5	I/O unit	Detected ARC I/O unit error
	6	Arc sensor	Detected faulty arc sensor
	7	QD-card error	Detected QD-card error
	8	BI	Detected ARC BI error
	9	LowAux	Low auxiliary supply voltage

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

4.5.2 Binary input and binary output self supervision

Binary signal lines connected between VAMP 321 units are supervised for short circuit or broken connection. Binary output sends short pulse to the line and binary input receives this pulse but filters it away. Therefore this test pulse is not seen as activation of binary input. If pulse disappears, the VAMP 321 will issue an alarm of lost binary signal connection. Fiber optic BI/O signaling is straight forward as it is point to point connection. By using copper BI/O, there is possibility to connect multiple binary outputs from multiple VAMP 321 unit to same connection point when all VAMP 321 units will send binary output signal to one or multiple binary inputs.

NOTE: One binary output can be connected to maximum of 4 binary inputs.

When multiple binary outputs are connected to same connection point, only one binary output is allowed to have test pulse enabled.

5 Measurement functions

5.1 Measurements for arc protection function

The three phase current measurement and ground fault current measurement for arc protection is done with electronics (see Figure 5.1). The electronics compares the current levels to the pick-up settings - THRESHOLDs - and gives a binary signal "I>>" or "I_0>>" to the arc protection function if limit is exceeded. All the frequency components of the currents are taken into account.

Signals "I>>" or "I_0>>" are connected to a FPGA chip which implements the arc protection function. The pick-up settings are named "I> int" and "I_0> int" in the local LCD panel or VAMPSET views, these settings are used to set the THRESHOLD levels for the electronics.

The accuracy of the arc protection measurements is as follows:

- Under nominal current: 2.5% (1 of nominal
- Over nominal current: 2.5% (1 of measured/injected value

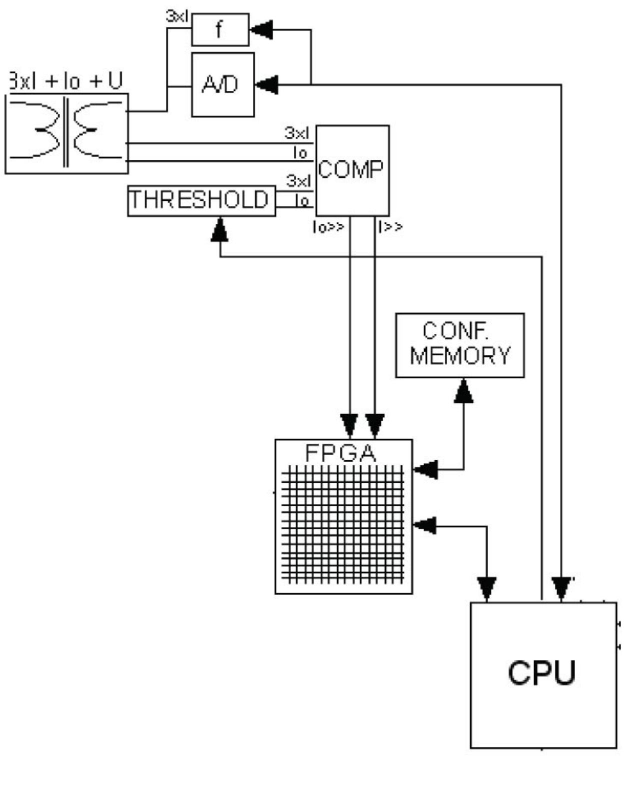


Figure 5.1: Measurement logic for the arc flash protection function

5.2 Measurements for protection functions

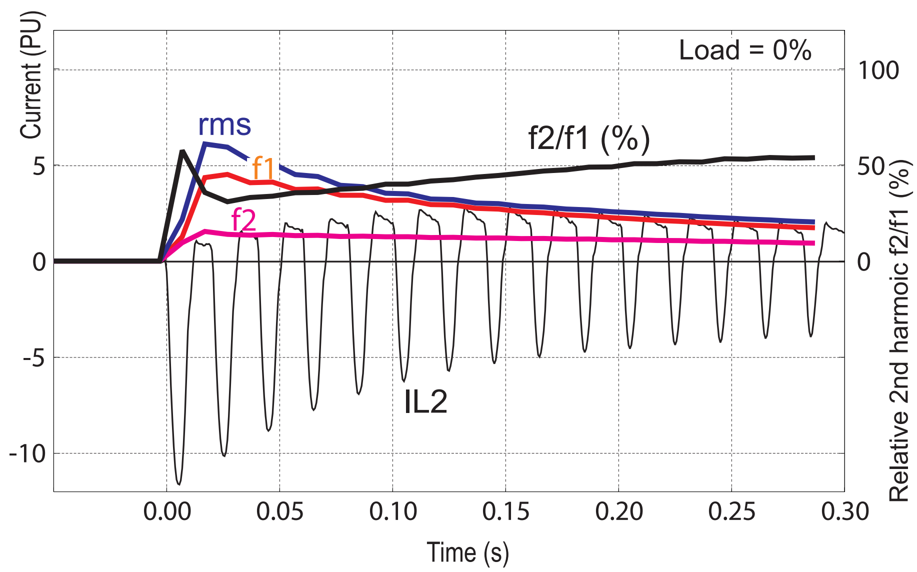


Figure 5.2: Example of various current values of a transformer inrush current

All the direct measurements are based on fundamental frequency values. The exceptions are frequency and instantaneous current for arc protection. Most protection functions are also based on the fundamental frequency values.

Figure 5.2 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.

5.3 Measurement accuracy

Table 5.1: Phase current inputs I_{L1}, I_{L2}, I_{L3}

Measuring range	0.025 – 250 A
Inaccuracy:	
I ≤ 7.5 A	±0.5 % of value or ±15 mA
I > 7.5 A	±3 % of value
The specified frequency range is 45 Hz – 65 Hz.	

Table 5.2: Voltage input U

Measuring range	0.5 – 190 V
Inaccuracy	±0.5 % or ±0.3 V
The usage of voltage inputs depends on the configuration parameter voltage measurement mode. For example, U is the zero sequence voltage input U_0 if the mode "U_0" is selected. The specified frequency range is 45 Hz – 65 Hz.	

Table 5.3: Residual current input I_{0N}

Measuring range	0.003 – 10 x I_{0N}
Inaccuracy: $I \le 1.5 xI_N$ $I > 1.5 xI_N$	 ±0.3 % of value or ±0.2 % of I_{0N} ±3 % of value
The rated input I_{0N} is 5A, 1 A or 0.2 A. It is specified in the order code of the relay. The specified frequency range is 45 Hz – 65 Hz.	

Table 5.4: Frequency

Measuring range	16 Hz – 75 Hz
Inaccuracy	±10 mHz
The frequency is measured from current signals.	

Table 5.5: THD and harmonics

Inaccuracy I, U > 0.1 PU	±2 % units
Update rate	Once a second
The specified frequency range is 45 Hz – 65 Hz.	

NOTE: These measurement accuracies are only valid for the user interface and communication.

5.4 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 5.7 Minimum and maximum values).

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

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 5.7 Minimum and maximum values).

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

5.5 Harmonics and Total Harmonic Distortion (THD)

The device calculates the THDs as a percentage of the currents and voltages values measured at the fundamental frequency. 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

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

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 %.

5.6 Demand values

The relay calculates average, i.e. demand values of phase currents I_{L1}, I_{L2}, I_{L3}.

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

Table 5.6: 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	
RMS values				
IL1RMSda		A	Demand of RMS phase current IL1	
IL2RMSda		A	Demand of RMS phase current IL2	
IL3RMSda		A	Demand of RMS phase current IL3	

Set = An editable parameter (password needed).

5.7 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
I_0	Residual current
U12	Line-to-line voltage
UL1RMS	Line-to-neutral voltage
Uo	Zero sequence voltage

NOTE: The availability of voltage measurements depends of the selected voltage measurement mode of the device.

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

Table 5.7: Parameters

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

Set = An editable parameter (password needed).

5.8 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)		
Io	X		Residual current		
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 5.8: 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 5.6 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.

5.9 Voltage measurement modes

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

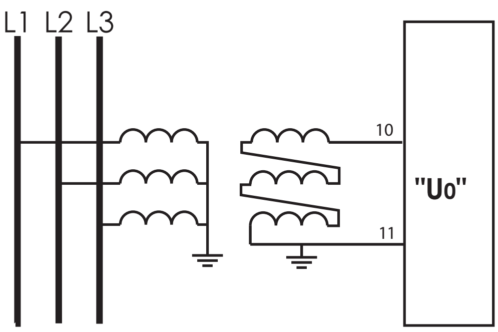


Figure 5.3: Broken delta connection "U_0".

U_0

The device is connected to zero sequence voltage. Directional ground fault protection is available. Line voltage measurement, energy measurement and over- and undervoltage protection are not possible.

The device is connected to zero sequence voltage. Line voltage measurement, energy measurement and over- and undervoltage protection are not possible.

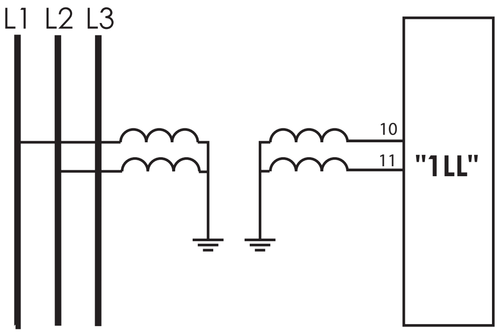
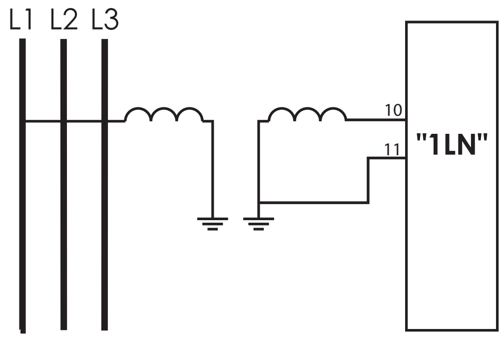


Figure 5.4: Line-to-line voltage "1LL".

1LL

The device is connected to one line-to-line voltage. Single phase voltage measurement and over- and undervoltage protection are available.



1LN

The device is connected to one phase-to-ground voltage. Single phase voltage measurement is available. In low impedance grounded networks over- and undervoltage protection are available.

Figure 5.5: Phase-to-neutral voltage “1LN”.

5.10 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)

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

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

5.11 Primary secondary and per unit scaling

Many measurement values are shown as primary values although the relay is connected to secondary signals. Some measurement values are shown as relative values - per unit or per cent. Almost all pick-up setting values are using relative scaling.

The scaling is done using the given CT, VT values.

The following scaling equations are useful when doing secondary testing.

5.11.1 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	$I_{SEC} = I_{PRI} \cdot \frac{CT_{SEC}}{CT_{PRI}}$

For residual current to input I_0 use the corresponding CT_{PRI} and CT_{SEC} values. For ground fault stages using I_{0Calc} signals use the phase current CT values for CT_{PRI} and CT_{SEC}.

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

Per unit [pu] scaling

For phase currents

1 pu = 1 x I_{MODE} = 100 %, where

I_{MODE} is the rated current.

For residual currents and ArcI> stage:

1 pu = 1 x CT_{SEC} for secondary side and 1 pu = 1 x CT_{PRI} for primary side.

	Phase current scaling excluding ArcI> stage	Residual current ($3I_0$) scaling and phase current scaling for ArcI> stage
secondary → per unit	$I_{PU} = \frac{I_{SEC} \cdot CT_{PRI}}{CT_{SEC} \cdot I_N}$	$I_{PU} = \frac{I_{SEC}}{CT_{SEC}}$
per unit → secondary	$I_{SEC} = I_{PU} \cdot CT_{SEC} \cdot \frac{I_N}{CT_{PRI}}$	$I_{SEC} = I_{PU} \cdot CT_{SEC}$

Examples:

1. **Secondary to per unit for ArcI>**

   CT = 750 / 5

   Current injected to the relay's inputs is 7 A.

   Per unit current is I_{PU} = 7 / 5 = 1.4 pu = 140 %

2. **Secondary to per unit for phase currents excluding ArcI>**

   CT = 750/5

   I_{MODE} = 525 A

   Current injected to the relay's inputs is 7 A.

   Per unit current is I_{PU} = 7 x 750 / (5 x 525) = 2.00 pu = 2.00 x I_{MODE} = 200 %

3. **Per unit to secondary for ArcI>**

   CT = 750 / 5

   The device setting is 2 pu = 200 %.

   Secondary current is I_{SEC} = 2 x 5 = 10 A

4. **Per unit to secondary for phase currents excluding ArcI>**

   CT = 750 / 5

   I_{MODE} = 525 A

   The relay setting is 2 x I_{MODE} = 2 pu = 200 %.

   Secondary current is I_{SEC} = 2 x 5 x 525 / 750 = 7 A

5. **Secondary to per unit for residual current**

   Input is I_{01}.

   CT_0 = 50 / 1

   Current injected to the relay's input is 30 mA.

   Per unit current is I_{PU} = 0.03 / 1 = 0.03 pu = 3 %

6. **Per unit to secondary for residual current**

   Input is I_{01}.

   CT_0 = 50 / 1

   The relay setting is 0.03 pu = 3 %.

   Secondary current is I_{SEC} = 0.03 x 1 = 30 mA

7. **Secondary to per unit for residual current**

   Input is I_{0Calc}.

   CT = 750 / 5

   Currents injected to the relay's I_{L1} input is 0.5 A.

   I_{L2} = I_{L3} = 0.

   Per unit current is I_{PU} = 0.5 / 5 = 0.1 pu = 10 %

8. **Per unit to secondary for residual current**

   Input is I_{0Calc}.

   CT = 750 / 5

   The relay setting is 0.1 pu = 10 %.

   If I_{L2} = I_{L3} = 0, then secondary current to I_{L1} is
   I_{SEC} = 0.1 x 5 = 0.5 A

5.11.2 Voltage scaling

Primary / secondary scaling of line-to-line voltages

	Line-to-line voltage scaling	
	Voltage measurement mode = "1LL"	Voltage measurement mode = "1LN"
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 "1LL".**

   VT = 12000 / 110

   Voltage connected to the relay's input is 100 V.

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

2. **Secondary to primary. Voltage measurement mode is "1LN".**

   VT = 12000 / 110

   The voltage connected to the relay's input is 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 "1LL".**

   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 "1LN".**

   VT = 12000 / 110

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

   Secondary voltage is U_{SEC} = 10910 / $\sqrt{3}$ x 110 / 12000 = 57.7 V.

Per unit [pu] scaling of line-to-line voltages

One per unit = 1 pu = 1xU_N = 100 %, where U_N = rated voltage of the VT.

	Line-to-line voltage scaling	
	Voltage measurement mode = "1LL"	Voltage measurement mode = "1LN"
secondary → per unit	$U_{PU} = \frac{U_{SEC}}{VT_{SEC}}$	$U_{PU} = \sqrt{3} \cdot \frac{U_{SEC}}{VT_{SEC}}$
per unit → secondary	$U_{SEC} = U_{PU} \cdot VT_{SEC}$	$U_{SEC} = U_{PU} \cdot \frac{VT_{SEC}}{\sqrt{3}}$

Examples:

1. **Secondary to per unit. Voltage measurement mode is "1LL".**

   VT = 12000 / 110,

   $U_N = VT_{PRI}$

   Voltage connected to the relay's input is 110 V.

   Per unit voltage is U_{PU} = 110 / 110 = 1.00 pu = 1.00 x U_{MODE} = 100 %

2. **Secondary to per unit. Voltage measurement mode is "1LN".**

   VT = 12000 / 110,

   Phase-to-neutral voltage connected to the relay's input is 63.5 V.

   Per unit voltage is U_{PU} = $\sqrt{3}$ x 63.5 / 110 x 12000 / 11000 = 1.00 pu = 1.00 x U_N = 100 %

3. **Per unit to secondary. Voltage measurement mode is "1LL".**

   VT = 12000/110,

   The relay displays 1.00 pu = 100 %.

   Secondary voltage is U_{SEC} = 1.00 x 110 x 11000 / 12000 = 100.8 V

4. **Per unit to secondary. Voltage measurement mode is "1LN".**

   VT = 12000 / 110,

   The relay displays 1.00 pu = 100 %.

   Phase-to-neutral voltage connected to the relay's input is

   U_{SEC} = 1.00 x 110 / $\sqrt{3}$ x 11000 / 12000 = 63.5 V

Per unit [pu] scaling of zero sequence voltage

	Zero-sequence voltage (U_0) scaling
	Voltage measurement mode = "U_0"
secondary ->per unit	$U_{PU} = \frac{U_{SEC}}{U_{0SEC}}$
per unit -> secondary	$U_{SEC} = U_{PU} \cdot U_{0SEC}$

Examples:

1. **Secondary to per unit. Voltage measurement mode is "U_0".**

   U_{0SEC} = 110 V (This is a configuration value corresponding to U_0 at full ground fault.)

   Voltage connected to the device's input U_C is 22 V.

   Per unit voltage is U_{PU} = 22 / 110 = 0.20 pu = 20 %

6 Control functions

6.1 Output relays

The output relays are also called digital outputs. Trip contacts can be controlled by using relay output matrix or logic function. Also forced control is possible. When using force controlling it has to be first enabled in the “relays” menu.

The output relays are also called digital outputs. Any internal signal can be connected to the output relays using "OUTPUT MATRIX" and/or "ARC MATRIX - OUTPUT". An output relay can be configured as latched or non-latched.

The "output matrix" and "relays" menus represents the state (de-energized / energized) of the output relay's coil. For example a bright green vertical line in "output matrix" and a logical "1" in "relays" menu represents the energized state of the coil. The same principle applies for both NO and NC type output relays. The actual position (open / closed) of the output relay's contacts in coil's de-energized and energized state depends on the type (NO/NC) of the output relay. De-energized state of the coil corresponds to the normal state of the contacts. An output relay can be configured as latched or non-latched. Latched relay contacts can be set free by pressing the “enter” key of the device or by releasing from VAMPSET setting tool.

The difference between trip contacts and signal contacts is the DC breaking capacity. The contacts are **single pole single throw (SPST)** normal open type (NO), except signal relay A1 which has change over contact **single pole double throw (SPDT)**.

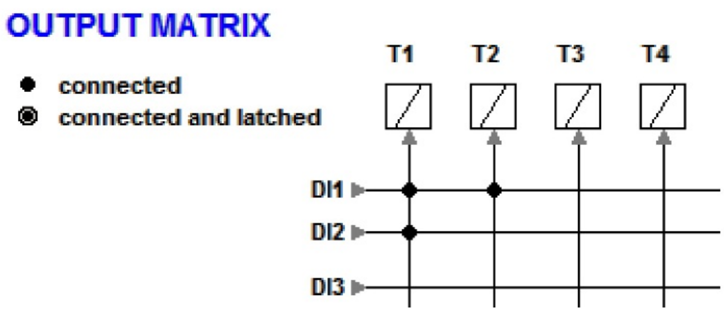


Figure 6.1: Trip contacts can be connected to protection stages or other similar purpose in “output matrix” menu.

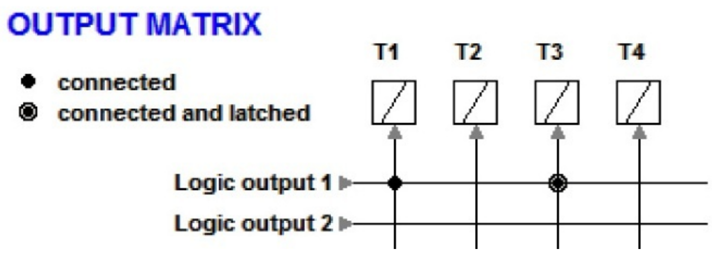


Figure 6.2: Trip contacts can be assigned directly to outputs of logical operators.

Notice the difference between latched and non-latched connection. Logic output will be assigned automatically in output matrix as well when logic is built.

Trip contacts can be controlled by using relay output matrix or logic function. Also forced control is possible. When using force controlling it has to be first enabled in the “relays” menu.

The position of the contact can be checked in “output matrix” and “relays” menu. An output relay can be configured as latched or non-latched. Latched relay contacts can be set free by by releasing from VAMPSET setting tool or pressing the “releasing all latches” on the device. See pictures or instructions below.

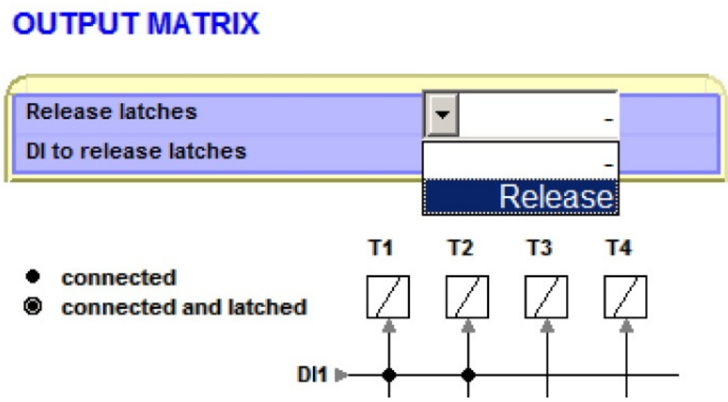


Figure 6.3: Latched output matrix signals released by using VAMPSET setting tool.

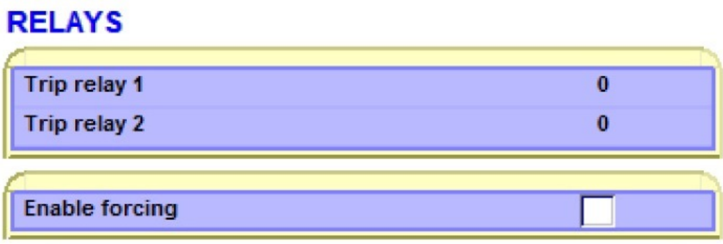


Figure 6.4: Trip contact can be viewed, forced to operate in “relays” menu. Logical "0" means that the output is not energized and logical "1" states that output is set active.

Release all latches (while correct password is enabled)

1. Press i.
   - To release the latches, press >.
   - To release, choose “Release” parameter and press OK.

Default numbering of DI / DO

Every option card and slot has default numbering. Below is an example of model VAMP 321 AGGII-AABAA-A1 showing default numbering of DO.

User can change numbering of the following option cards - slot 2, 3, 4, 5: G, I. More information in Chapter 6.5 Matrix.

Default digital output numbering is also shown in corresponding VAMPSET menus.

1. T1, A1, SF
2. T13 – 16
3. T17 – 20

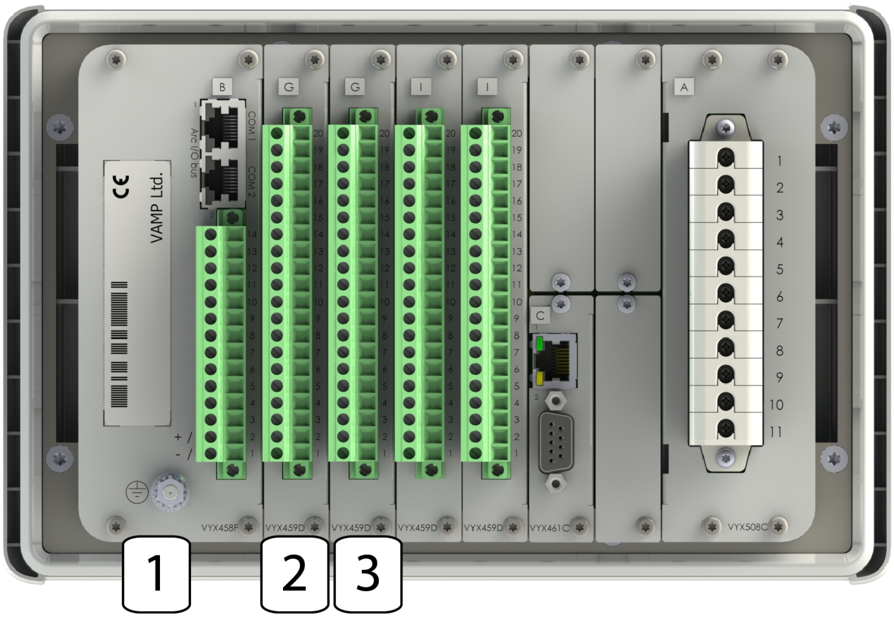
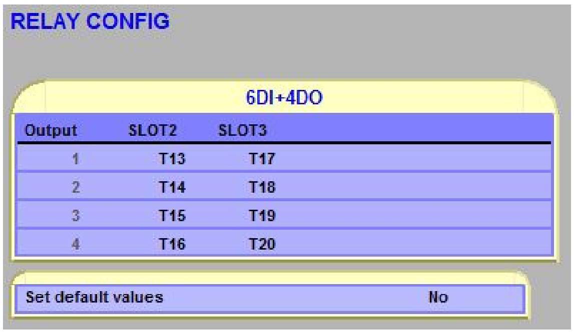


Figure 6.5: Default numbering of model VAMP 321-BGGII-AAACA-A1



Power supply card outputs are not visible in 'relay config' menu

Table 6.1: Parameters of output relays

Parameter	Value	Unit	Description	Note
T1 – Tx the available parameter list depends on the number and type of the I/O cards.	0 1		Status of trip output relay	F
A1	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	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 – x or "Signal relay n", n=1	Set

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

6.2 Digital inputs

Digital inputs are available for control purposes. The number of available inputs depends on the number and type of option cards.

The polarity –g normal open (NO) / normal closed (NC) – and a delay can be configured according the application by using the local HMI or VAMPSET.

Digital inputs can be used in many operations. The status of the input can be checked in relay “output matrix” and “digital inputs” menu. Digital inputs makes possible to change group, block/enable/disable functions, to program logics, indicate object status, etc.

The digital inputs do require an external control voltage (ac or dc). Digital input will be activated after activation voltage exceeds. Deactivation follows when the voltage drops below threshold limit. Activation voltage level of digital inputs can be selected in order code when such option cards are equipped.

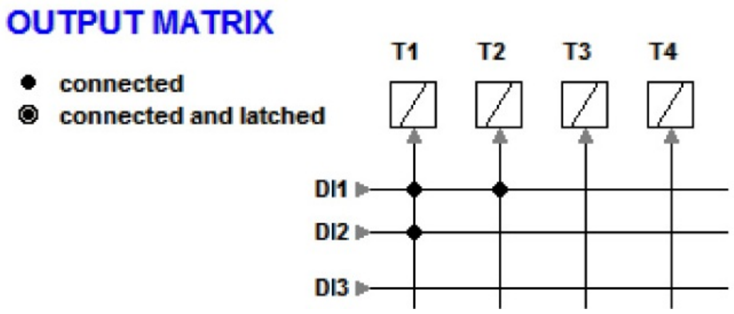


Figure 6.6: Digital inputs can be connected to trip contacts or other similar purpose in “output matrix” menu.

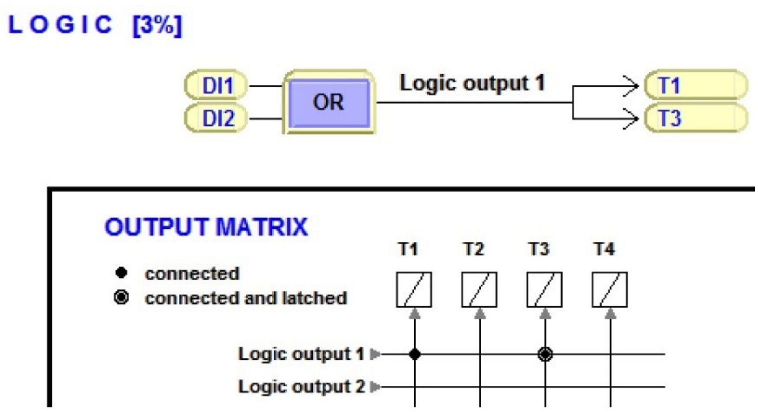


Figure 6.7: Digital inputs can be assigned directly to inputs/outputs of logical operators.

Notice the difference between latched and non-latched connection. Logic output will be assigned automatically in output matrix as well when logic is built.

NAMES for DIGITAL INPUTS

DIGITAL INPUTS

Input	Slot	Label	Description
1	2	DI1	Digital input 1
2	2	DI2	Digital input 2
3	2	DI3	Digital input 3
4	2	DI4	Digital input 4
5	2	DI5	Digital input 5
6	2	DI6	Digital input 6
7	3	DI7	Digital input 7
8	3	DI8	Digital input 8
9	3	DI9	Digital input 9
10	3	DI10	Digital input 10
11	3	DI11	Digital input 11
12	3	DI12	Digital input 12

Figure 6.8: Digital inputs can be viewed, named and changed between NO/NC in "Digital inputs" menu.

In case that inputs are energized by using AC voltage "mode" has to be selected as AC.

All essential information of digital inputs can be found from the same location "digital inputs" menu. DI on/off events and alarm display (pop-up) can be enabled and disabled in "digital inputs" menu. Individual operation counters are located in the same menu as well.

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.

Digital input activation thresholds are hardware selectable.

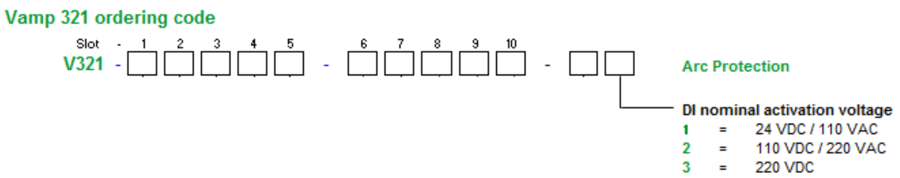


Figure 6.9: VAMP 321 order code.

Digital input delay determines the activation and de-activation delay for the input. See picture below to indicate how DI behaves when the delay is set to 1.0 seconds.

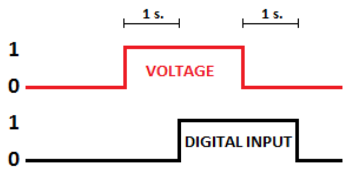


Figure 6.10: Digital inputs behaviour when delay is set to one second.

Table 6.2: Parameters of digital inputs

Parameter	**Value**	**Unit**	**Description**	**Note**
Mode	DC, AC		Used voltage of digital inputs	Set
Input	DI1 – DIx		Number of digital input. The available parameter list depends on the number and type of the I/O cards.	
Slot	2 – 6		Card slot number where option card is installed.	
State	0, 1		Status of digital input 1 – digital input x.	
Polarity	NO NC		For normal open contacts (NO). Active edge is 0 -> 1 For normal closed contacts (NC) Active edge is 1 -> 0	Set
Delay	0.00 – 60.00	s	Definite delay for both on and off transitions	Set
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	
Alarm display	no		No pop-up display	Set
	yes		Alarm pop-up display is activated at active DI edge	
Counters	0 – 65535		Cumulative active edge counter	(Set)
NAMES for DIGITAL INPUTS (editable with VAMPSET only)				
Label	String of max. 10 characters		Short name for DIs on the local display Default is "DI1 - DIx". x is the maximum number of the digital input.	Set
Description	String of max. 32 characters		Long name for DIs. Default is "Digital input 1 – Digital input x". x is the maximum number of the digital input.	Set

Set = An editable parameter (password needed).

Every option card and slot has default numbering. When making any changes to numbering, please read setting file after VAMP 321 has rebooted.

User can change numbering of the following option cards - slot 2, 3, 4, 5: G, I. More information in Chapter 6.5 Matrix.

Default digital input numbering is also shown in corresponding VAMPSET menus.

1. DI1 – 6
2. DI7 – 12
3. DI13 – 22
4. DI23 – 32

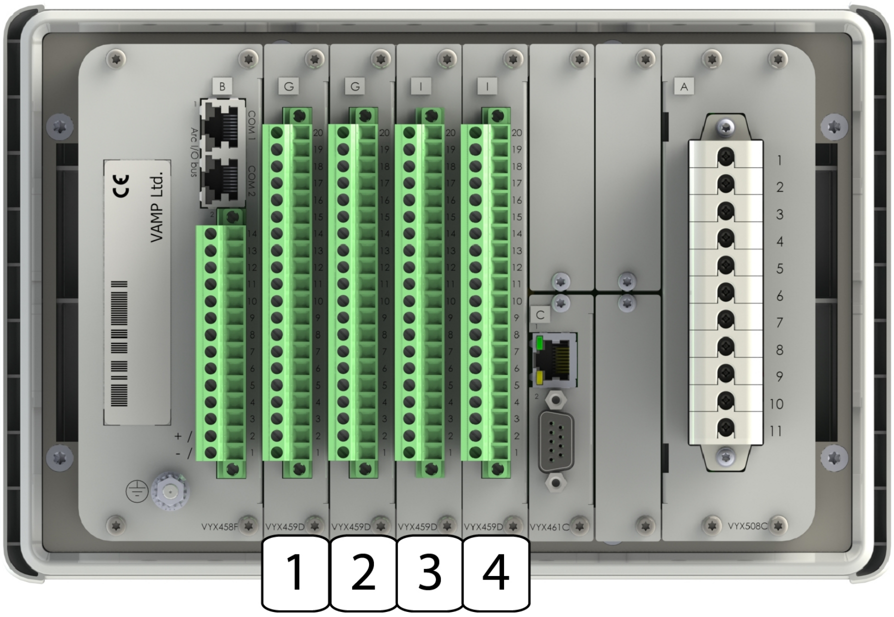


Figure 6.11: Default numbering of model VAMP321-BGGII-AAACA-A1

DIGITAL INPUTS CONFIG

6DI+4DO

Input	SLOT2	SLOT3
1	DI1	DI7
2	DI2	DI8
3	DI3	DI9
4	DI4	DI10
5	DI5	DI11
6	DI6	DI12

10DI

Input	SLOT4	SLOT5
1	DI13	DI23
2	DI14	DI24
3	DI15	DI25
4	DI16	DI26
5	DI17	DI27
6	DI18	DI28
7	DI19	DI29
8	DI20	DI30
9	DI21	DI31
10	DI22	DI32

Set default values	No

6.3 Binary inputs and outputs

Information from the arc protection function can be transmitted and/or received through binary inputs (BI) and outputs (BO). The rated voltage of these signals is 30 V dc when active. The input signal has to be 18 – 250 V dc to be activated.

Binary inputs

The binary inputs (BI) can be used to get the light indication from another IED to build selective arc protection systems. BI is a dry input for 18 – 250 V dc signal. The connection of BI signals is configured in the matrices of the arc flash protection function.

Binary output

The binary outputs (BO) can be used to give the light indication signal or any other signal or signals to another IED's binary input to build selective arc protection systems. BO is an internally driven (wetted) 30 Vdc signal. The connection of BO signals is configured in the matrices of the arc flash protection function.

6.4 Virtual inputs and outputs

There are virtual inputs and virtual outputs, which can in many places be used like their hardware equivalents except that they are only located in the memory of the device. The virtual inputs acts like normal digital inputs. The state of the virtual input can be changed from local display, communication bus and from VAMPSET. For example setting groups can be changed using virtual inputs.

Virtual inputs can be used in many operations. The status of the input can be checked in “output matrix” and “virtual inputs” menu. Status is also visible on local mimic display if so selected. Virtual inputs can be selected to be operated trough function buttons F1 and F2, trough local mimic or simply by using the virtual input menu. Virtual inputs makes possible to change group, block/enable/disable functions, to program logics and other similar to digital inputs.

Activation and reset delay of input is approximately 5ms. See specification below:

Table 6.3: Virtual input and output

Number of inputs	4
Number of outputs	6
Activation time / Reset time	< 5 ms

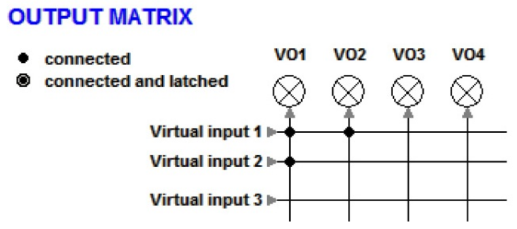


Figure 6.12: Virtual inputs and ouputs can be used for many purpose in “output matrix” -menu.

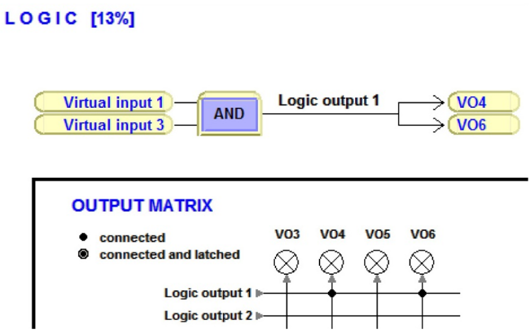


Figure 6.13: Virtual inputs and outputs can be assigned directly to inputs/outputs of logical operators.

Notice the difference between latched and non-latched connection.

INPUT SIGNALS > VIRTUAL INPUT

The virtual inputs do act like digital inputs, but there are no physical contacts. These can be controlled via the local HMI and communication protocols. Virtual inputs are shown in the output matrix and the block matrix. Virtual inputs can be used with the user's programmable logic and to change the active setting group etc.

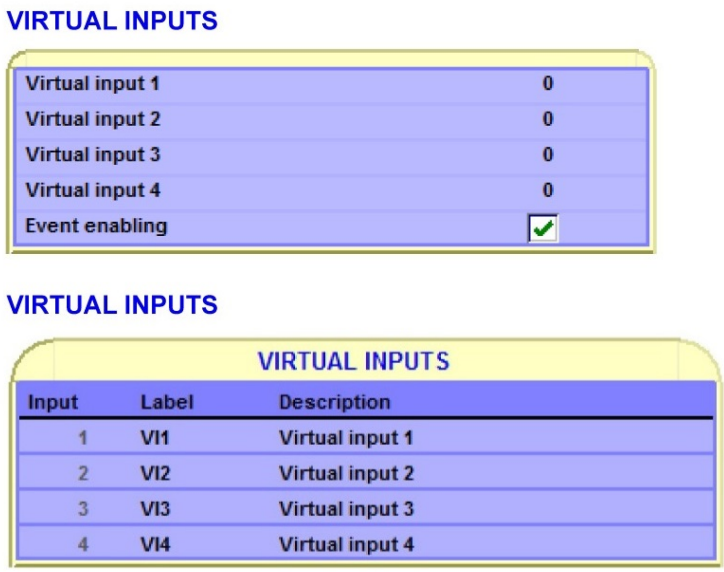


Figure 6.14: Virtual inputs can be viewed, named and controlled in “Virtual inputs” -menu.

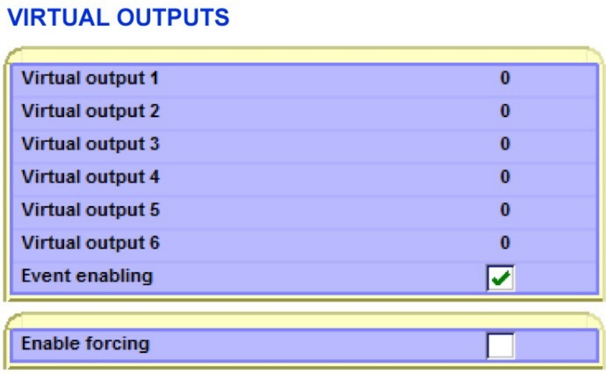
Table 6.4: Parameters of virtual inputs

Parameter	Value	Unit	Description	Set
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).

OUTPUT SIGNALS > VIRTUAL OUTPUT

The 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.



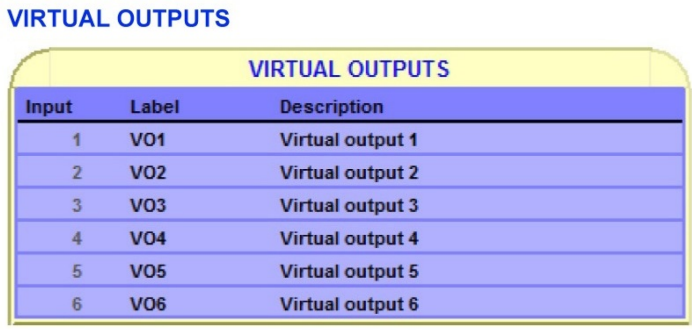


Figure 6.15: Virtual Outputs can be viewed, named and force controlled in “Virtual outputs” -menu. Virtual outputs menu is located under the “device menu” leaflet -> output signals. Virtual output contacts are in “DO” -menu when 64 x 128 LCD display is installed.

Table 6.5: Parameters of virtual outputs

Parameter	Value	Unit	Description	Set
VO1-VO6	0 1		Status of virtual output	F
Events	On Off		Event enabling	Set
NAMES for VIRTUAL OUTPUTS (editable with VAMPSET only)				
Label	String of max. 10 characters		Short name for VOs on the local display Default is "VOn", n=1 - 6	Set
Description	String of max. 32 characters		Long name for VOs. Default is "Virtual output n", n=1 - 6	Set

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

6.5 Matrix

6.5.1 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, virtual outputs, etc.

NOTE: For configuring the high-speed operations of the arc protection the “ARC MATRIX – OUTPUT” must be used.

There are general purpose LED indicators – "A", "B", "C" to ”N” – available for customer-specific indications on the front panel. Their usage is define in a separate LED MATRIX.

Furthermore there are two LED indicators specified for keys F1 and F2. In addition, the triggering of the disturbance recorder (DR) and virtual outputs are configurable in the output matrix.

See an example in Figure 6.16.

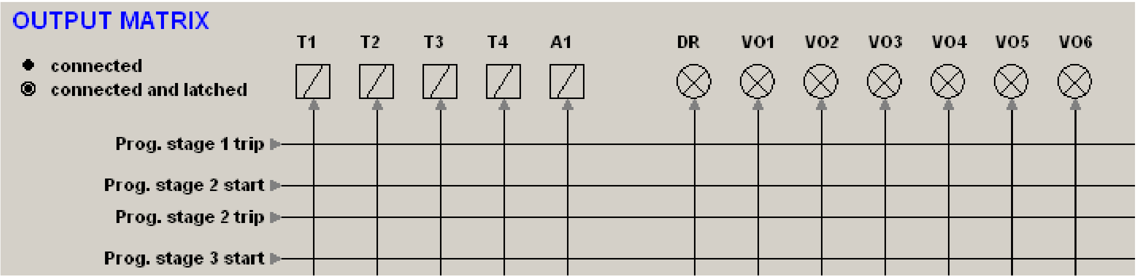


Figure 6.16: Output matrix

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.

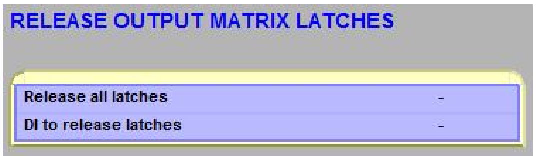


Figure 6.17: Release output matrix latches

There is a common "release all latches" signal to release all the latched relays. This release signal resets all the latched output relays and indicators with CPU and FPGA control. The reset signal can be given via a digital input, via HMI or through communication. The selection of the input is done with the VAMPSET software under the menu "Release output matrix latches". See an example in Figure 6.17.

NOTE: "Release all latches" signal clears and resets FPGA controlled latches.

6.5.2 Blocking matrix

By means of a blocking matrix, the operation of any protection stage (except the arc protection stages) can be blocked. The blocking signal can originate from the digital inputs or it can be a start or trip signal from a protection stage or an output signal from the user's programmable logic. In the Figure 6.18, an active blocking is indicated with a black dot (•) in the crossing point of a blocking signal and the signal to be blocked.

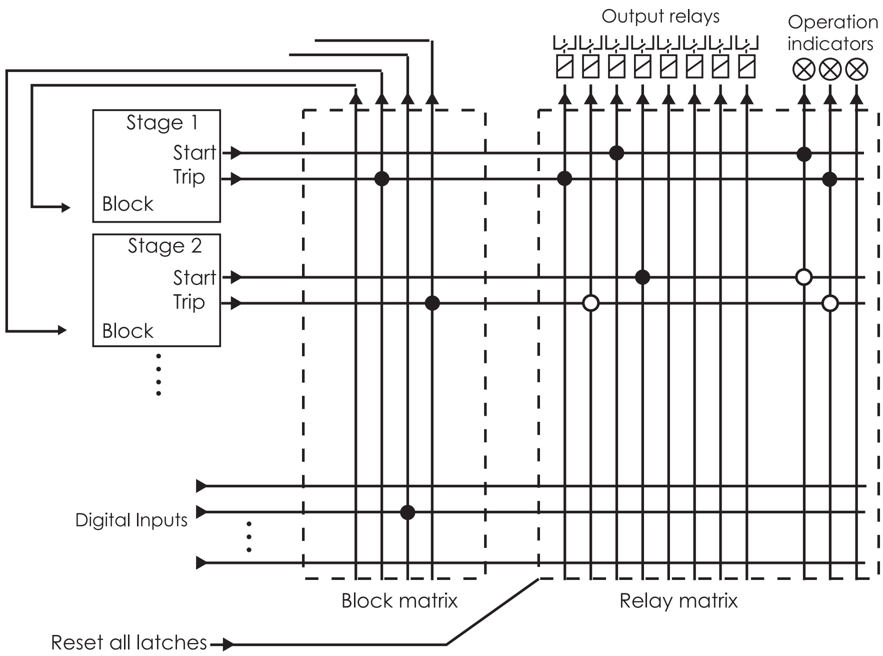


Figure 6.18: Blocking matrix and output matrix

NOTE: Blocking matrix can not be used to block the arc protection stages.

NOTICE

RISK OF NUISANCE TRIPPING

- The blocking matrix is dynamically controlled by selecting and deselecting protection stages.
- Activate the protection stages first, then store the settings in a relay. After that, refresh the blocking matrix before configuring it.

Failure to follow these instructions can result in unwanted shutdown of the electrical installation.

6.5.3 LED matrix

VAMP 321 has 18 LEDs on front. Two LEDs represents units general status (On & 🔧), two LEDs for function buttons (F1 & F2) and 14 user configurable LEDs (A - N). When the IED is powered the “ON” LED will light as green. During normal use “Service” LED is not active, it activates only when a detected error occurs or the IED is not operating correctly. Should this happen, contact your local representative for further guidance.

NOTE: When “Service LED” is lit, contact your local representative for further guidance.

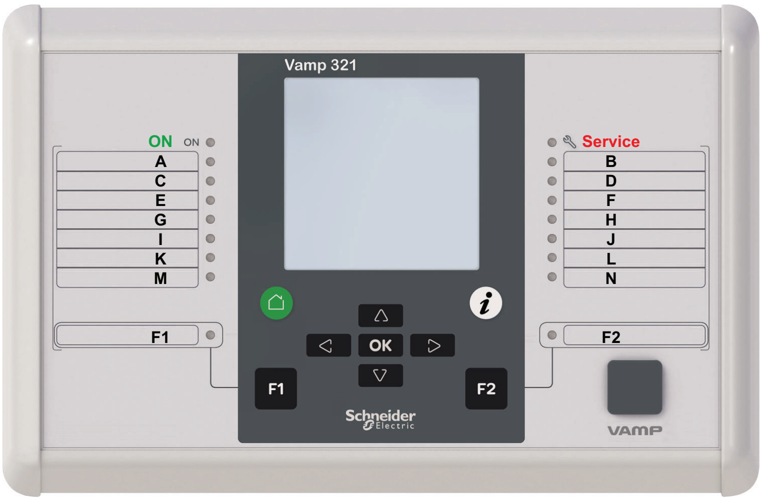


Figure 6.19: VAMP 321 local panel LEDs. 1. & 6.

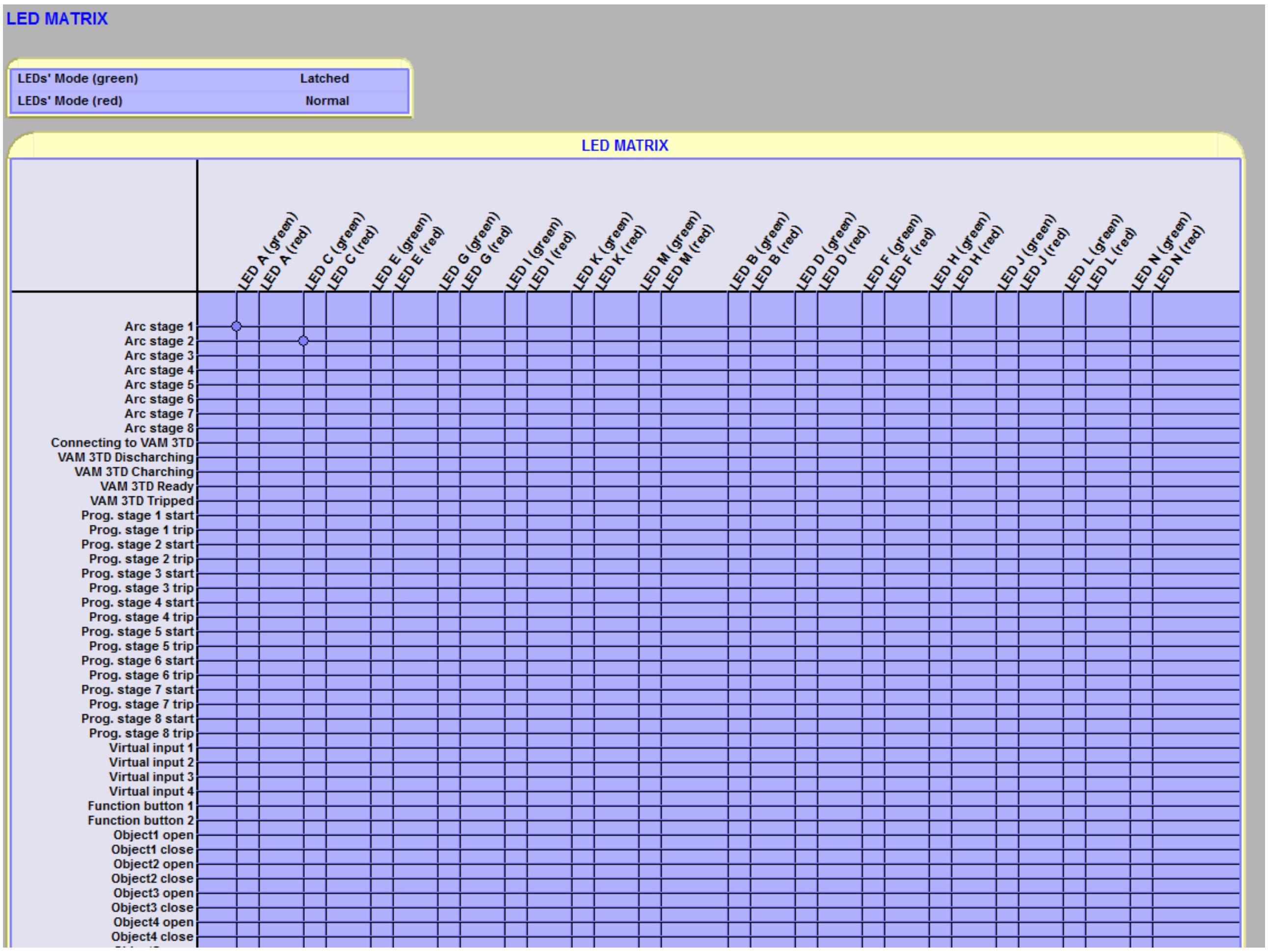


Figure 6.20: LEDs will be assigned in the "LED matrix" -menu. It is not possible to control LEDs directly with logics. Logic output has to be assigned in LED matrix.

Normal connection

When connection is normal the assigned LED will be active when the control signal is active. After deactivation, the LED will turn off. LED activation and deactivation delay when controlled is approximately 10ms.

Latched connection

Latched LED will activate when the control signal activates but will remain lit even when the control signal deactivates. Latched LEDs can be released by pressing enter key.

Blink Latched connection

When connection is "BlinkLatch" the assigned LED will be active and blinking as long as control signal is active. After deactivation the LED remains latched and blinking. Latch can be released by pressing OK (see Chapter 2.2 Local HMI).

When connection is normal the assigned LED will be active when the control signal is active. After deactivation, the LED will turn off.

LED activation and deactivation delay when controlled is approximately 10ms.

LED test sequence

In order to run LED test sequence, open user password first.

User can test the functionality of LEDs if needed. To start the test sequence, press "info" button and the "<" on the local HMI. The IED will test all the LEDs' functionality. The sequence can be started in all main menu windows, except the very first one.

Inputs for LEDs can be assigned in LED matrix. All 14 LEDs can be assigned as green or red. Connection can be normal, latched or blink latched. Instead of mere protection stages there are lots of functions which can be assigned to output LEDs. See the table below:

Table 6.6: Inputs for LEDs A - N

Input	LED mapping	Latch	Description	Note
Protection, Arc and programmable stages	LED A - N green or red	Normal/ Latched/ BlinkLatch	Different type of protection stages can be assigned to LEDs	Set
Digital/Virtual inputs and function buttons	LED A - N green or red	Normal/ Latched/ BlinkLatch	All different type of inputs can be assigned to LEDs	Set
Object open/close, object final trip and object failure information	LED A - N green or red	Normal/ Latched/ BlinkLatch	Information related to objects and object control	Set
Local control enabled	LED A - N green or red	Normal/ Latched/ BlinkLatch	While remote/local state is selected as local the “local control enabled” is active	Set
Logic output 1-20	LED A - N green or red	Normal/ Latched/ BlinkLatch	All logic outputs can be assigned to LEDs at the LED matrix	Set
Manual control indication	LED A - N green or red	Normal/ Latched/ BlinkLatch	When the user has controlled the objectives	Set
COM 1-5 comm.	LED A - N green or red	Normal/ Latched/ BlinkLatch	When the communication port 1 - 5 is active	Set
Setting error, seldiag alarm, pwd open and setting change	LED A - N green or red	Normal/ Latched/ BlinkLatch	Self diagnostic signal	Set
GOOSE NI1-64	LED A - N green or red	Normal/ Latched/ BlinkLatch	IEC 61850 goose communication signal	Set
GOOSEERR1-16	LED A - N green or red	Normal/ Latched/ BlinkLatch	IEC 61850 goose communication signal	Set

Set = an editable parameter (password needed)

6.6 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 object block matrix and 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
- through the function key

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, auto-reclose 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.

6.6.1 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.

6.6.2 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.

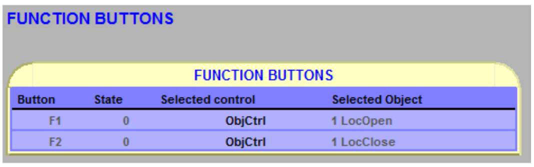
6.6.3 Controlling with F1 & F2

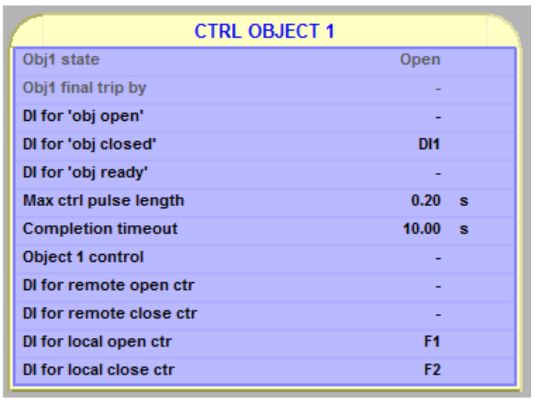
Objects can be controlled with F1 & F2.

As default these keys are programmed to toggle F1 and F2. It is possible to configure F1 & F2 to toggle VI1 – VI4 or act as object control. Selection of the F1 and F2 function is made with the VAMPSET software under the FUNCTION BUTTONS menu.

Table 6.7: Parameters of F1, F2

Parameter	Value	Unit	Description	Set
F1 – F2 VI1 – VI4	0		Function key toggles Virtual input 1 – 4 and Function button 1 – 2 between on (1) and off (0)	Set
ObjCtrl PrgFncs	1		When Object conrol in chosen F1 and F2 can be linked in OBJECTS to desired objects close/open command.	





Selected object and control is shown in VAMPSET software under the menu ”FUNCTION BUTTONS”. If no object with local control is selected ’-’ is shown. If multiple local controls are selected for one key ’?’ is shown.

6.7 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.

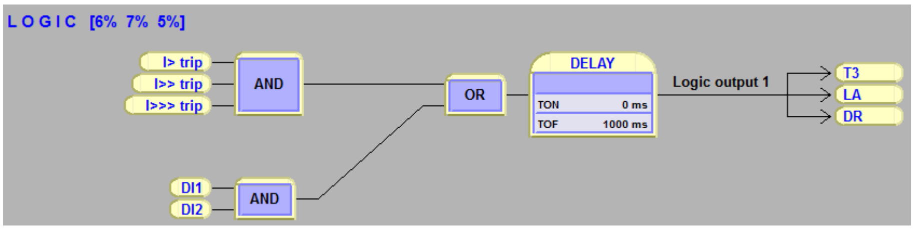


Figure 6.21: Logic can be found and modified in "logic" menu in VAMPSET setting tool

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:

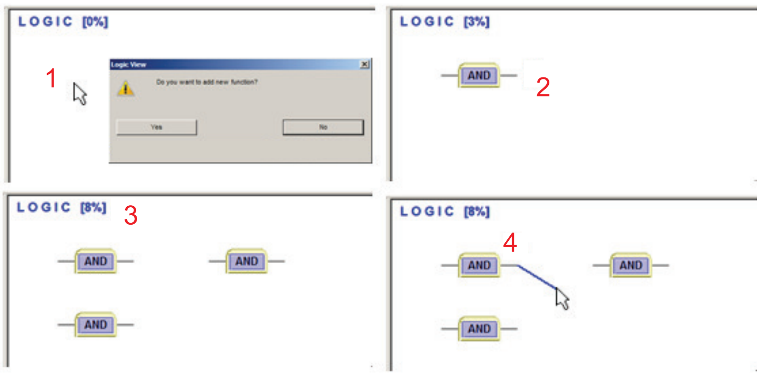


Figure 6.22: How to create logical nodes.

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.

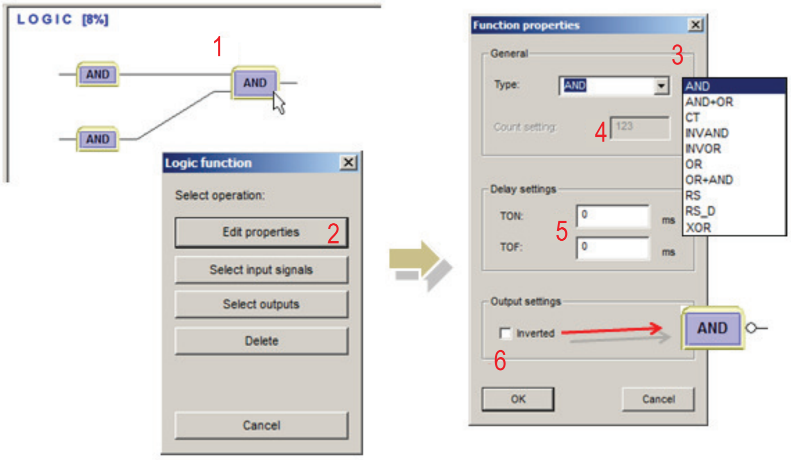


Figure 6.23: Logic creation

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.

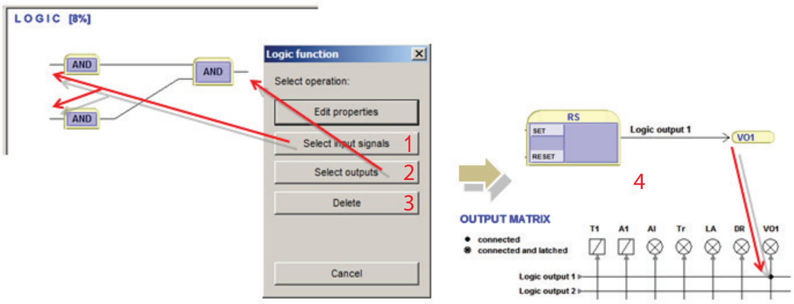


Figure 6.24: Logic creation

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 device 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 device the unit has to be restarted.

7 Communication

7.1 Communication ports

The device has two fixed communication ports: USB port for connection to VAMPSET setting and configuration tool and Arc I/O Bus for communication with the arc protection I/O-units.

Optionally the device may have up to to 4 serial ports COM 1, COM 2, COM 3 and COM 4 for serial protocols (for example IEC 103) and one ETHERNET port for Ethernet-based communication protocols (for example, IEC 61850).

The number of available serial ports depends on the type of the communication option cards in Slot 9 and Slot 10.

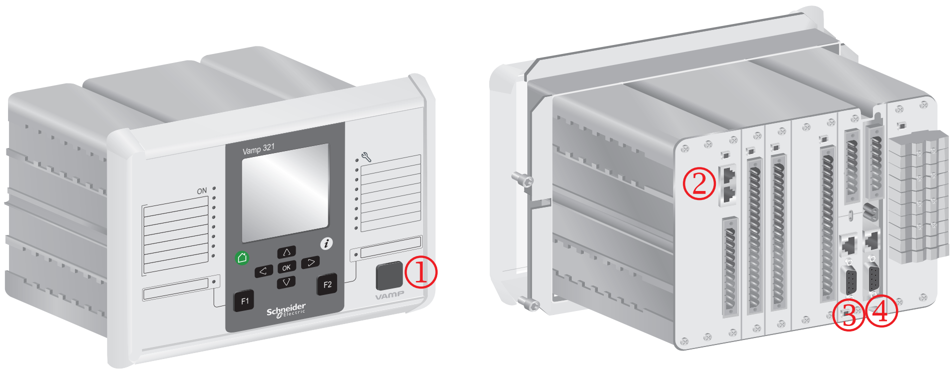


Figure 7.1: Communication ports and connectors.

1 USB interface for VAMPSET

2 Arc I/O Bus interface

3 Communication interface I (Slot 9)

4 Communication interface II (Slot 10)

NOTE: Arc I/O Bus is not an Ethernet interface.

7.1.1 Local port (Front panel)

The relay has a USB-connector in the front panel

Protocol for the USB port

The front panel USB port is always using the command line protocol for VAMPSET.

The protocol is an ASCII character protocol called “GetSet”. The speed of the interface is defined in CONF/DEVICE SETUP menu from the local HMI. The default settings for the relay are 38400/8N1.

Physical interface

The physical interface of this port is USB.

7.1.2 COM 1 – COM 4 ports

COM 1 – COM 4 PORT:s are ports for serial communication protocols. The type of the physical interface on these ports depends on the type of the selected communication option module. The use of some protocols may require a certain type of option module. The parameters for these ports are set via local HMI or with VAMPSET in menus COM 1 PORT – COM 4 PORT.

Communication information is normally sent to control system (SCADA) but it is also possible to use certain communication related notifications internally for example alarming. This is can be done for example via logic and different matrixes.

NOTE: It is possible to have up to 2 serial communication protocols simultaneously but restriction is that same protocol can be used only once.

Protocol configuration menu contains selection for the protocol, port settings and message/error/timeout counters.

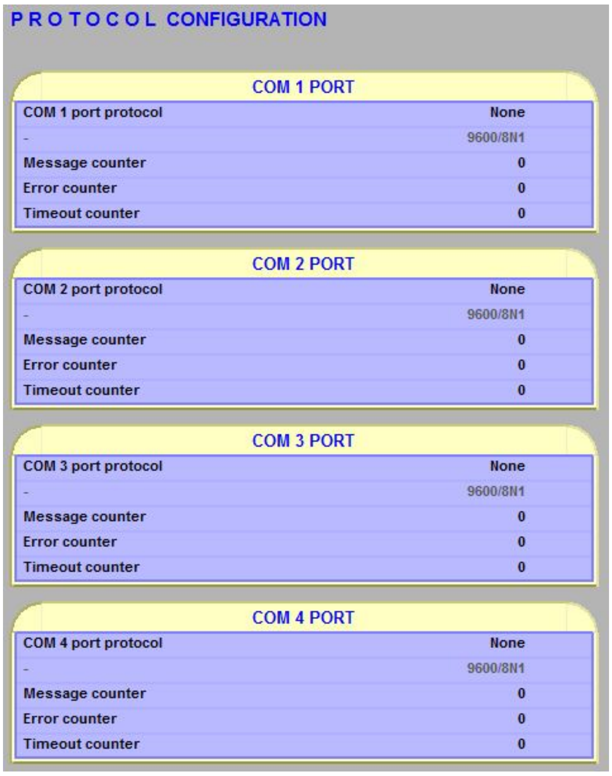


Figure 7.2: Protocols can be enabled in "protocol configuration" menu. Only serial communication protocols are valid with RS-232 interface.

Table 7.1: Parameters

Parameter	Value	Unit	Description	Note
Protocol			Protocol selection for COM port	Set
	None		-	
	SPA-bus		SPA-bus (slave)	
	ProfibusDP		Interface to Profibus DB module VPA 3CG (slave)	
	ModbusSlv		Modbus RTU slave	
	IEC-103		IEC-60870-5-103 (slave)	
	ExternalIO		Modbus RTU master for external I/O-modules	
	IEC 101		IEC-608670-5-101	
	DNP3		DNP 3.0	
	DeviceNet		Interface to DeviceNet module VSE 009	
	GetSet		Communicationi protocola for VAMPSET interface	
Msg#	$0 – 2^{32} - 1$		Message counter since the device has restarted or since last clearing	Clr
Errors	$0 – 2^{16} - 1$		Protocol interruption since the device has restarted or since last clearing	Clr
Tout	$0 – 2^{16} - 1$		Timeout interruption since the device has restarted or since last clearing	Clr
	speed/DPS		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.

7.1.3 Ethernet port

Ethernet port is used for Ethernet protocols like IEC61850 and Modbus TCP.

The physical interface is described in Chapter 9 Connections.

The parameters for the port can be set from the local HMI or using VAMPSET (see Table 7.2). Two different protocols can be used simultaneously - both protocols use the same IP address and MAC address (but different IP port number).

Table 7.2: Parameters of the Ethernet port

Parameter	Value	Unit	Description	Note
MAC address	001ADnnnnnnn		MAC address	
Enable DHCP service	Yes / No		If enabled the IP address of the device is defined by the DHCP server of the network.	
Enable IP verification service	Yes / No		If this option is enabled, device will send ARP packet to verify that the IP address given by the DHCP server is not duplicated in the network.	
NetMask	n.n.n.n		Net mask (set with VAMPSET)	Set
Gateway	default = 0.0.0.0		Gateway IP address	Set
NTP Server	n.n.n.n		Network time protocol server	Set
NTP server (BackUp)	n.n.n.n		Network time protocol server to be used if NPT server does not respond.	Set
IP port for setting tool	0 – 64000		IP port number to be used by VAMPSET (default = 23)	Set
TCP keepalive interval	0 – 20	s	TCP keepalive interval	Set 1)
Eth Port 1 status			Status of the physical Ethernet port 1	
Eth Port 2 status			Status of the physical Ethernet port 2	
Enable FTP server	Yes / No		Enable / Disable FTP	Set
FTP password	String		Password for FTP communication	Set
FTP max speek	1 – 10	KB/s	Max. amouth of data sent with FTP (this limited to give more time to other communicaitions)	Set
Enable HTTP server	Yes / No		Enable / Disable HTTP (Web) connection	Set
Storm protection limit	0.01 – 20	%	Percentage of broadcast messages, which is accepted	Set
Storm protection on port 1	Yes / No		Storm protection on/off on port 1	Set
Storm protection on port 2	Yes / No		Storm protection on/off on port 2	Set
Sniffer mode	Yes / No		Sniffer mode on/off.	Set
Sniffer port			Port which can be used to “sniff” the network traffic	
Disable Port 1 AugoNegotiation	Yes / No		Disable/enable automatic speed negotiation of the Ethernet port	Set
Disable Port 2 AugoNegotiation	Yes / No		Disable/enable automatic speed negotiation of the Ethernet port	Set
Send Gratuituous ARP	Yes / No		ARP Reply sent when no one requested. VAMP will send such reply in two cases: - when ethernet link goes up - when RSTP topology change occurs	Set

Parameter	Value	Unit	Description	Note
Ethernet Protocol 1				
Ethernet port protocol 1	None ModbusTCP DNP 3 IEC-101 IEC-61850 EthernetIP		Protocol 1 for Ethernet port	Set
IP port for protocol	0 – 64000		IP port number to be used by protocol 1	Set
Message counter	0 – 4200000000		Message counter since the device has restarted or since last clearing	
Error counter	0 – 64000		Protocol errors since the device has restarted or since last clearing	
Timeout counter	0 – 64000		Timeout errors since the device has restarted or since last clearing	
Ethernet Protocol 2				
Ethernet port protocol 2	None ModbusTCP DNP 3 IEC-101 IEC-61850 EthernetIP		Protocol 2 for Ethernet port	Set
IP port for protocol	0 – 64000		IP port number to be used by protocol 2	Set
Message counter	0 – 4200000000		Message counter since the device has restarted or since last clearing	
Error counter	0 – 64000		Protocol errors since the device has restarted or since last clearing	
Timeout counter	0 – 64000		Timeout errors since the device has restarted or since last clearing	
RSTP protocol for Ethernet				
Enable for RSTP	Yes / No		Enable / disable use of RSTP protocol on the Ethernet port	Set
Brige priority	Selection between 0 – 61440		Parameter used to define the RSTP root device for the network. If priorities of two or more devices are equal then the device with lowest MAC address is chosen as a root.	Set
Hello time	2 – 10	s	Setting defines how often RSTP frames (Hello BPDU) are sent	Set
Forward delay	4 – 30	s	Time needed for the port to change its state from blocking to forwarding	Set
Max Age	6 – 40	s	Time that every RSTP device should wait before starting to change the topology in case of not receiving Hello BPDU	Set
Bridge role			Rote of the device in the RSTP network	
Migrate time			Migrate time defines the initial delay needed only for backward compatibility with 802.1D switches.	

Parameter	Value	Unit	Description	Note
Protocol version			Version of the RSTP protocol	
Port 1				
Port priority			Port priority is important when both Ethernet ports are connected to the same network segment – in such a case the port with worse priority (higher value) is disabled as a backup path for that segment.	Set
Admin edge			Yes = port is connected to a device with single connection to the network and without RSTP protocol support	Set
Auto edge			Yes = enables automatic discovering of edge device	Set
Current state			State of the port	
Current role			Role of the port	
Root Path Cost			Port Cost is related to transfer speed. This is determined automatically according to RSTP specification.	
Port 2				
Port priority	Selection between 0 – 160		Port priority is important when both Ethernet ports are connected to the same network segment – in such a case the port with worse priority (higher value) is disabled as a backup path for that segment.	Set
Admin edge	Yes / No		Yes = port is connected to a device with single connection to the network and without RSTP protocol support	Set
Auto edge	Yes / No		Yes = enables automatic discovering of edge device	Set
Current state	Link down, blocked, listening, learning, forwarding		State of the port	
Current role	Root, designated, backup, alternate		Role of the port	
Root Path Cost			Port Cost is related to transfer speed. This is determined automatically according to RSTP specification.	

Set = An editable parameter (password needed)

1) KeepAlive: The KeepAlive parameter sets in seconds the time between two keepalive packets are sent from the device. 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 device 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 device. If the keepalive packet is not acknowledged, the device will close the TCP connection. Connection must be resumed on the client side.

7.2 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)

7.2.1 GetSet

This is and ASCII protocol used by VAMPSET. This protocol is the protocol used on the USB port. This can also be used on the COM ports, if VAMPSET interface via these ports is required.

7.2.2 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 7.1 Communication ports.

For Ethernet interface configuration, see Chapter 7.1.3 Ethernet port.

Table 7.3: 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)

7.2.3 Profibus DP

The Profibus DP protocol is widely used in industry. An external VPA 3CG and VX072 cables are 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 7.1 Communication ports.

Table 7.4: 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.

7.2.4 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 7.5: 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)

7.2.5 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 7.6: 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 7.7: 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)

7.2.6 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 7.8: 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)

7.2.7 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 device 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 7.9: 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)

7.2.8 External I/O (Modbus RTU master)

External Modbus I/O devices can be connected to the relay using this protocol.

7.2.9 IEC 61850

IEC 61850 protocol is available with the optional communication module. IEC 61850 protocol can be used to read / write static data from the relay 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”.

7.2.10 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”.

7.2.11 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

7.2.12 HTTP server – Webset

A subset of the features of VAMPSET is available in the Webset interface. The group list and group view from VAMPSET are provided, and most groups, except the LOGIC and the MIMIC groups are configurable.

Parameter	Value	Description	Note
Enable HTTP srvr	Yes; No	Enable or disable the HTTP server.	Set

8 Application example

8.1 VAMP 321 multizone arc flash protection system

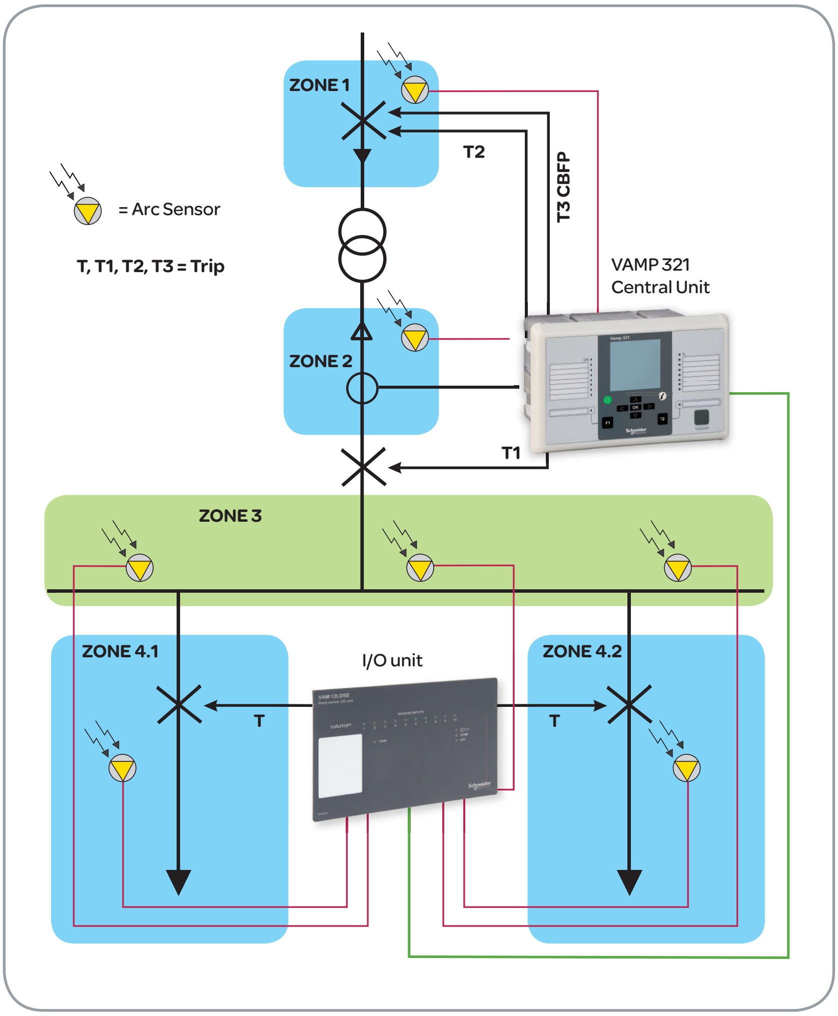


Figure 8.1: VAMP 321 application example.

Zone 1	Cable compartment of the incoming feeder
Zone 2	Circuit-breaker compartment
Zone 3	Busbar compartment
Zone 4.1 / Zone 4.2	Combined circuit-breaker and cable termination compartment

Functional description

In this application example, the arc flash sensor for zone 4.1 is connected to the I/O unit input number 1. If the arc flash sensor awakens and simultaneously VAMP 321 sends a current signal to the I/O unit, the zone 4.1 is isolated by the outgoing feeder breaker.

The arc flash sensor for zone 4.2 is connected to the I/O unit input number 2 or 3. If the arc flash sensor awakens and simultaneously VAMP 321 sends a current signal to the I/O unit, the zone 4.2 is isolated by the outgoing feeder breaker.

The arc flash sensors for zone 3 are connected to the I/O unit sensor channels 4 – 10. If a sensor awakens in zone 3, the light-only signal is transferred to VAMP 321 which then trips the main circuit breaker.

NOTE: For 12L and 12LD units, three sensor channels can trip independently their own zone, the other seven sensor channels can be allocated to another zone.

The sensor S2 connected to VAMP 321 in zone 2 overlaps zone 1. If the circuit breaker fails to isolate the failure in zone 2, the sensor (S2) generates a time-delayed circuit-breaker failure protection trip to the upstream breaker.

The incoming feeder circuit breaker has a CBFP backup trip to the upstream breaker. If zone 3 trip (T1) fails, the CBFP takes over and trips the upstream circuit breaker.

Zone 1 illustrates a typical medium voltage incoming feeder where the current transformers are located after the cable termination. In this case, an eventual arc flash fault in the cable termination does not activate the current element in VAMP 321. However, arc detection can be achieved by using the light-only principle. If an arc flash occurs in cable termination, zone 1 is tripped by an upstream circuit breaker. The sensor S1 in zone 1 overlaps the incoming circuit breaker.

Zone 1 operates on light-only principle as the currents are not available for current and light operation.

The circuit-breaker failure protection (CBFP) protects in case there is a detected failure in zone 3, or in sensor S2 in zone 2. The trip output (T2/CBFP) can function as a trip output, but also as a time-delayed circuit-breaker failure protection. To enable CBFP, an additional time-delayed stage needs to be created.

System components

- VAMP 321
- VAM 12LD I/O unit
- Seven VA1DA arc sensors
- VX001 modular cable for connecting the I/O unit to the IED

8.1.1 Connecting the devices

- Connect the arc sensors to the I/O unit's terminal block.
- Connect the I/O unit to the IED with a VX001 modular cable. Modular cable wiring shall be placed on the control cabling trays as far from the primary cable, bus bar and bus ducts as possible.
- Connect the arc sensors to the IED's terminal block.

⚠ DANGER

HAZARD OR ELECTRIC SHOCK OR EQUIPMENT DAMAGE

Before connecting the devices, disconnect the supply voltage to the unit

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

8.1.2 Configuring VAM 12LD

Each I/O unit connected to the communication bus has a unique address. Define the address by setting the I/O unit programming switches.

NOTICE

HAZARD OF EQUIPMENT DAMAGE

Before changing the programming switch positions, disconnect the supply voltage to the unit.

Failure to follow these instructions can result in equipment damage.

Table 8.1: SW1 switch settings for the application example

Switch	Name	Setting	Description
1	L> ext/int	ON	ON = Arc stage activates on the light information provided by the unit's own sensors. OFF = Arc stage activates on light information received from any unit in the same protection zone.
2	Latch	ON	Determines the trip relay operation after an arc flash. ON = Trip relay remains engaged until the fault is acknowledged on the IED's local HMI. OFF = Trip relay operation follows the arc flash fault.
3	L/L+I	OFF	Determines the arc trip criteria. ON = Trip is based on light information only. OFF = Trip requires both light information and fault current.
4	Zone	OFF	Address weighting coefficient 16
5	Zone	OFF	Address weighting coefficient 8
6	Addr.	OFF	Address weighting coefficient 4
7	Addr.	OFF	Address weighting coefficient 2
8	Addr.	OFF	Address weighting coefficient 1

8.2 Trip circuit supervision

Trip circuit supervision is used to ensure that the wiring from the protective device to a circuit-breaker is in order. This circuit is unused most of the time, but when a protection device detects a fault in the network, it is too late to notice that the circuit-breaker cannot be tripped because of a broken trip circuitry.

The digital inputs of the device can be used for trip circuit monitoring.

Also the closing circuit can be supervised, using the same principle.

8.2.1 Trip circuit supervision with one digital input

The benefits of this scheme is that only one digital inputs is needed and no extra wiring from the relay to the circuit breaker (CB) is needed. Also supervising a 24 Vdc trip circuit is possible.

The drawback is that an external resistor is needed to supervise the trip circuit on both CB positions. If supervising during the closed position only is enough, the resistor is not needed.

- The digital input is connected parallel with the trip contacts (Figure 8.2).
- The digital input is configured as Normal Closed (NC).

- The digital input delay is configured longer than maximum fault time to inhibit any superfluous trip circuit fault alarm when the trip contact is closed.
- The digital input is connected to a relay in the output matrix giving out any trip circuit alarm.
- The trip relay should be configured as non-latched. Otherwise, a superfluous trip circuit fault alarm will follow after the trip contact operates, and the relay remains closed because of latching.
- By utilizing an auxiliary contact of the CB for the external resistor, also the auxiliary contact in the trip circuit can be supervised.

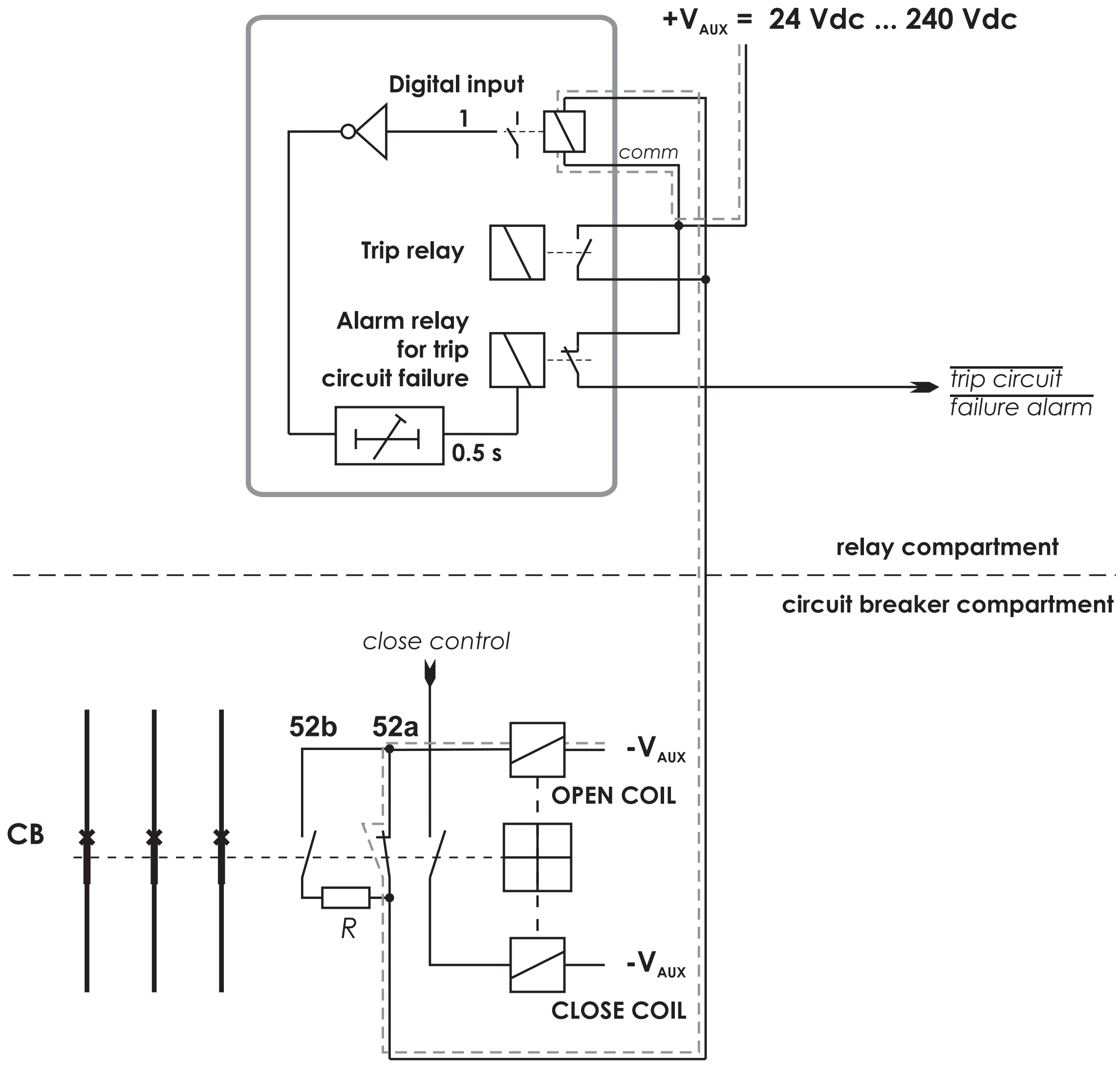


Figure 8.2: Trip circuit supervision using a single digital input and an external resistor R. The circuit-breaker is in the closed position. The supervised circuitry in this CB position is double-lined. The digital input is in active state when the trip circuit is complete. This is applicable for any digital inputs.

NOTE: The need for the external resistor R depends on the application and circuit breaker manufacturer's specifications.

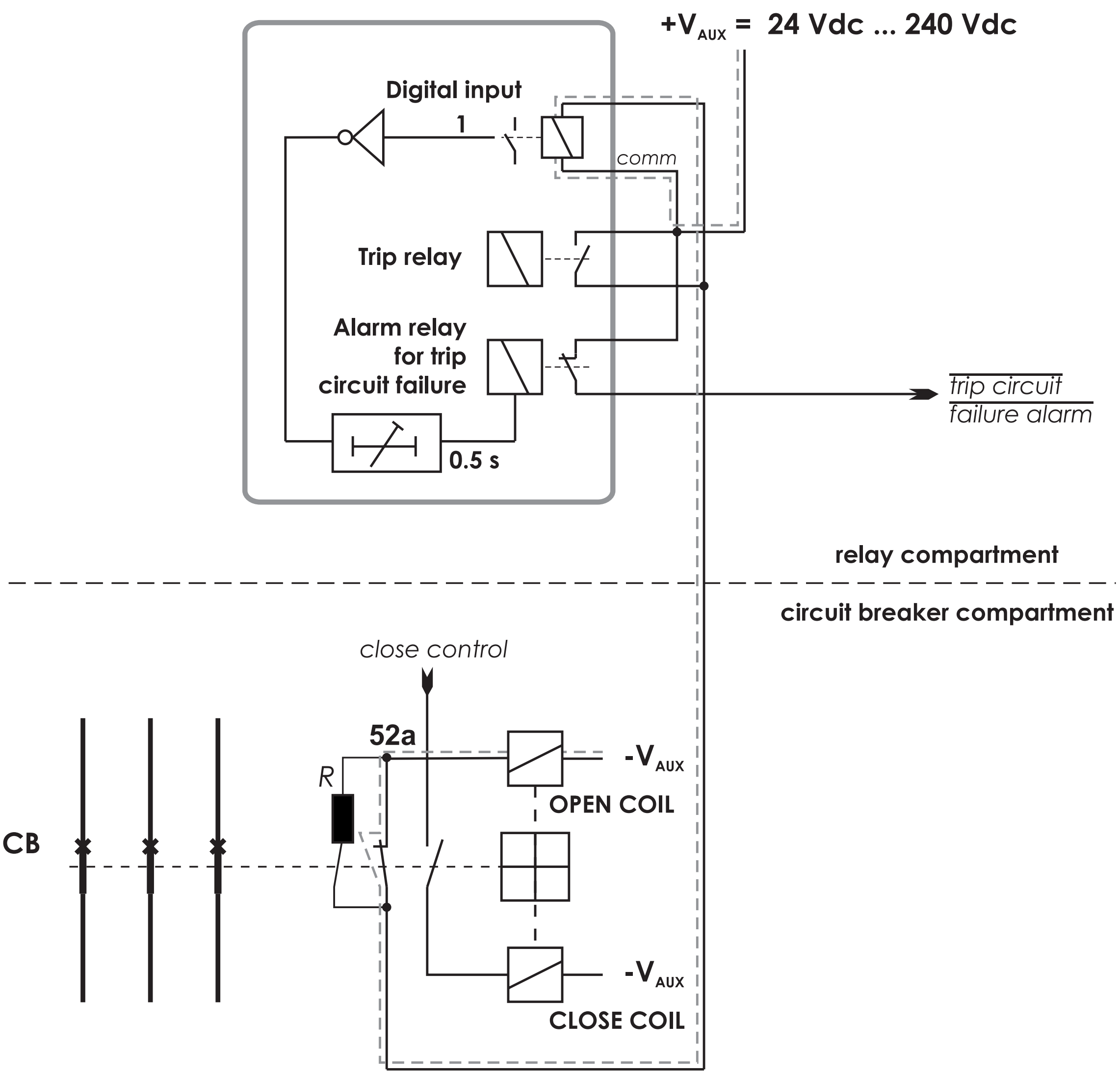


Figure 8.3: Alternative connection without using circuit breaker 52b auxiliary contacts. Trip circuit supervision using a single digital input and an external resistor R. The circuit-breaker is in the closed position. The supervised circuitry in this CB position is double-lined. The digital input is in active state when the trip circuit is complete. Alternative connection without using circuit breaker 52b auxiliary contacts. This is applicable for any digital inputs.

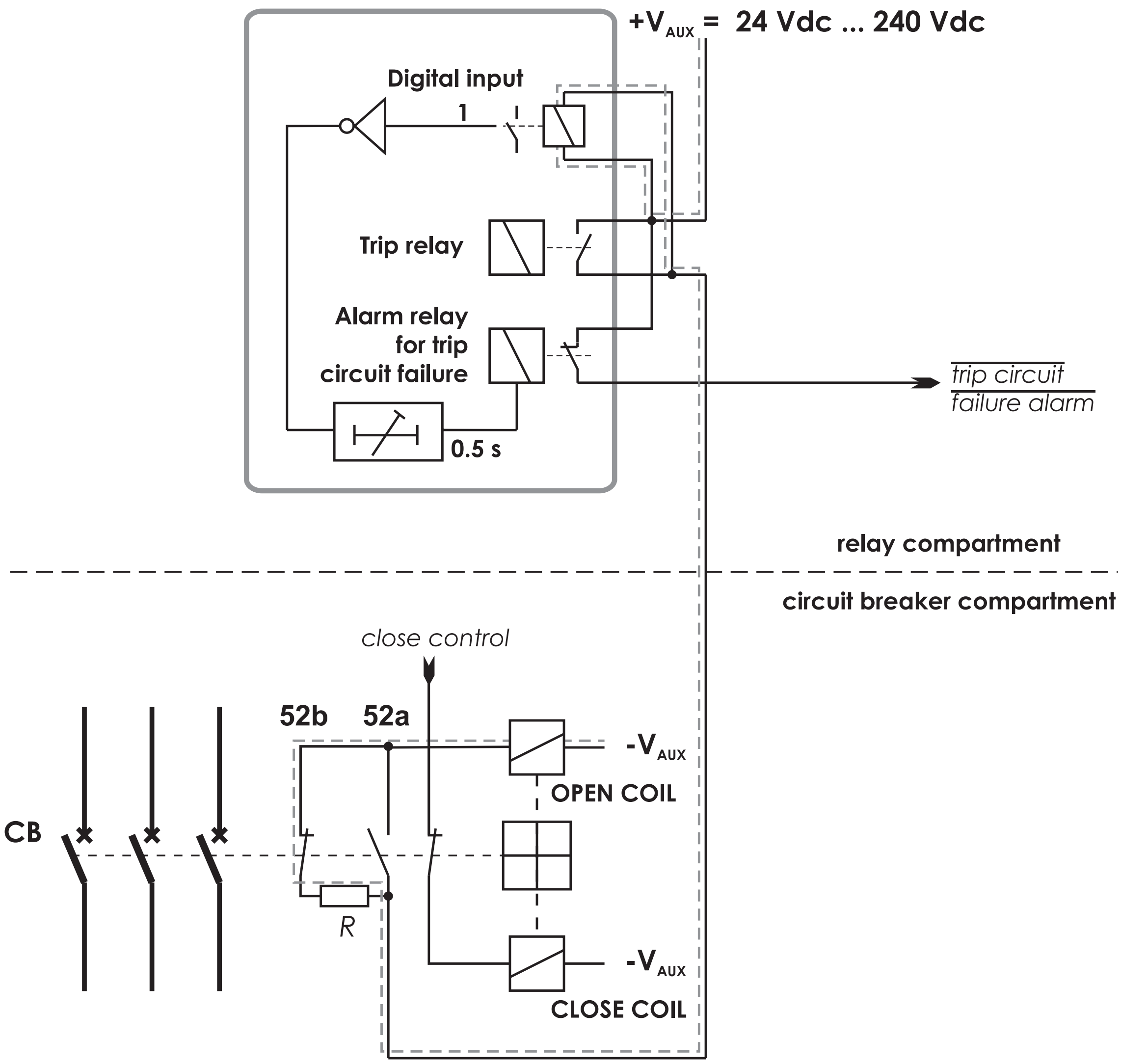


Figure 8.4: Trip circuit supervision using a single digital input, when the circuit breaker is in open position.

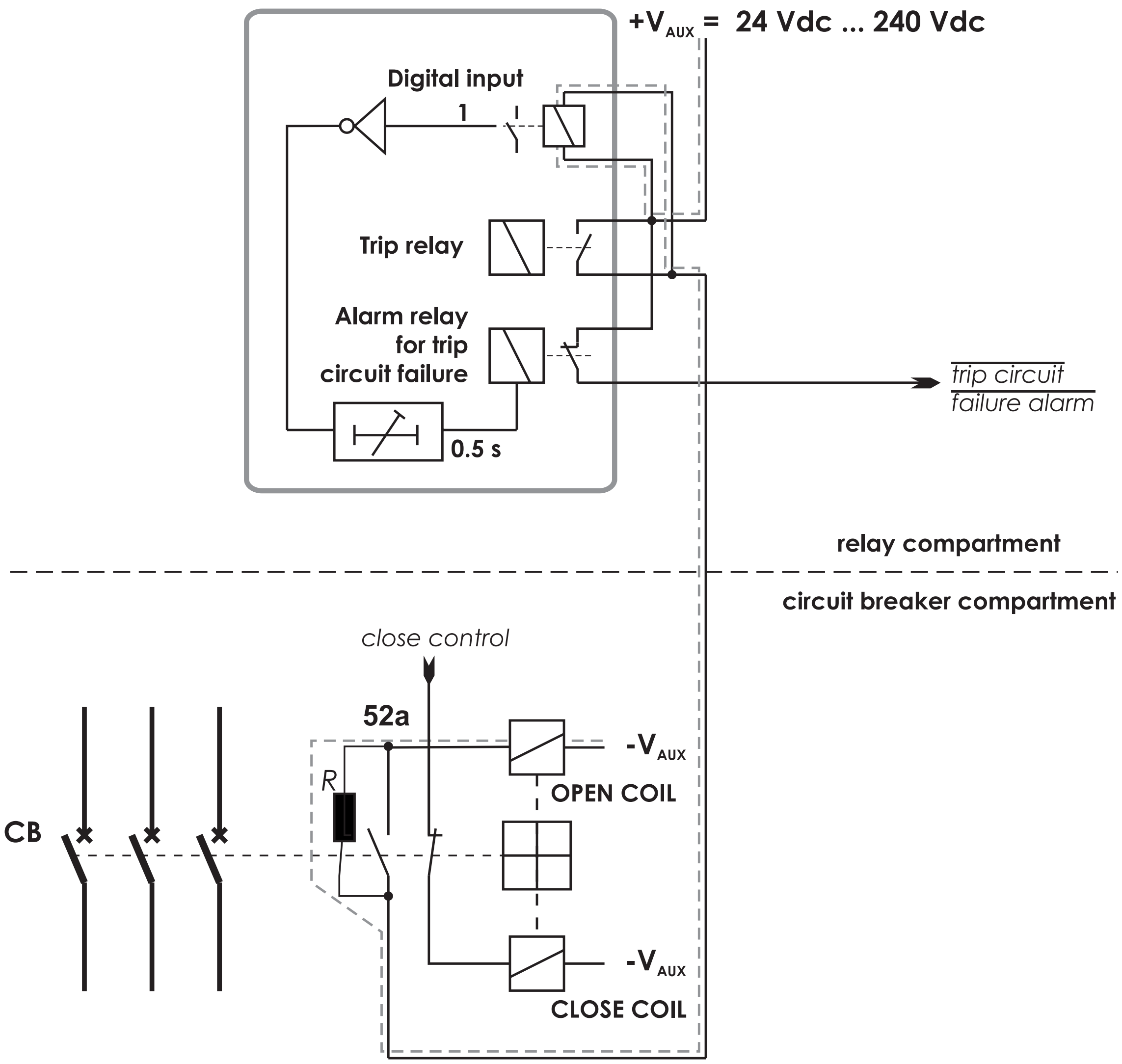


Figure 8.5: Alternative connection without using circuit breaker 52b auxiliary contacts. Trip circuit supervision using a single digital input, when the circuit breaker is in open position.

DIGITAL INPUTS

DIGITAL INPUTS

Input	State	Polarity	Delay	On Event	Off Event	Alarm display	Counters
1	0	NO	0.20 s	On	On	On	0
2	0	NO	0.00 s	On	On	On	0
3	0	NO	0.00 s	On	On	On	0
4	0	NO	0.00 s	On	On	On	0
5	0	NO	0.00 s	On	On	On	0
6	0	NO	0.00 s	On	On	On	0
7	0	NC	0.5 s	Off	Off	Off	0

Figure 8.6: An example of digital input DI7 configuration for trip circuit supervision with one digital input.

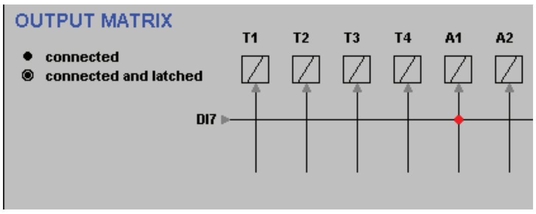


Figure 8.7: An example of output matrix configuration for trip circuit supervision with one digital input.

Example of dimensioning the external resistor R:

U_{AUX} =	110 Vdc - 20 % + 10%, Auxiliary voltage with tolerance
U_{DI} =	18 Vdc, Threshold voltage of the digital input
I_{DI} =	3 mA, Typical current needed to activate the digital input including a 1 mA safety margin.
P_{COIL} =	50 W, Rated power of the open coil of the circuit breaker. If this value is not known, 0 Ω can be used for the R_{COIL}.
U_{MIN} =	U_{AUX} - 20 % = 88 V
U_{MAX} =	U_{AUX} + 10 % = 121 V
R_{COIL} =	U^2_{AUX} / P_{COIL} = 242 Ω.

The external resistance value is calculated using Equation 8.1.

Equation 8.1:

$$R = \frac{U_{MIN} - U_{DI} - I_{DI} \cdot R_{Coil}}{I_{DI}}$$

R = (88 – 18 – 0.003 x 242)/0.003 = 23.1 kΩ

(In practice the coil resistance has no effect.)

By selecting the next smaller standard size we get **22 kΩ**.

The power rating for the external resistor is estimated using Equation 8.2 and Equation 8.3. The Equation 8.2 is for the CB open situation including a 100 % safety margin to limit the maximum temperature of the resistor.

Equation 8.2:

$$P = 2 \cdot I_{DI}^2 \cdot R$$

P = 2 x 0.003^2 x 22000 = 0.40 W

Select the next bigger standard size, for example **0.5 W**.

When the trip contacts are still closed and the CB is already open, the resistor has to withstand much higher power (Equation 8.3) for this short time.

Equation 8.3:

$$P = \frac{U_{MAX}^2}{R}$$

P = 121^2 / 22000 = 0.67 W

A 0.5 W resistor will be enough for this short time peak power, too. However, if the trip relay is closed for longer time than a few seconds, a 1 W resistor should be used.

8.2.2 Trip circuit supervision with two digital inputs

The benefits of this scheme is that no external resistor is needed.

The drawbacks are, that two digital inputs are needed and two extra wires from the relay to the CB compartment is needed. Additionally the minimum allowed auxiliary voltage is 48 Vdc, which is more than twice the threshold voltage of the digital input, because when the CB is in open position, the two digital inputs are in series.

- The first digital input is connected parallel with the auxiliary contact of the open coil of the circuit breaker.
- Another auxiliary contact is connected in series with the circuitry of the first digital input. This makes it possible to supervise also the auxiliary contact in the trip circuit.
- The second digital input is connected in parallel with the trip contacts.
- Both inputs are configured as normal closed (NC).
- The user’s programmable logic is used to combine the digital input signals with an AND port. The delay is configured longer than maximum fault time to inhibit any superfluous trip circuit fault alarm when the trip contact is closed.
- The output from the logic is connected to a relay in the output matrix giving out any trip circuit alarm.

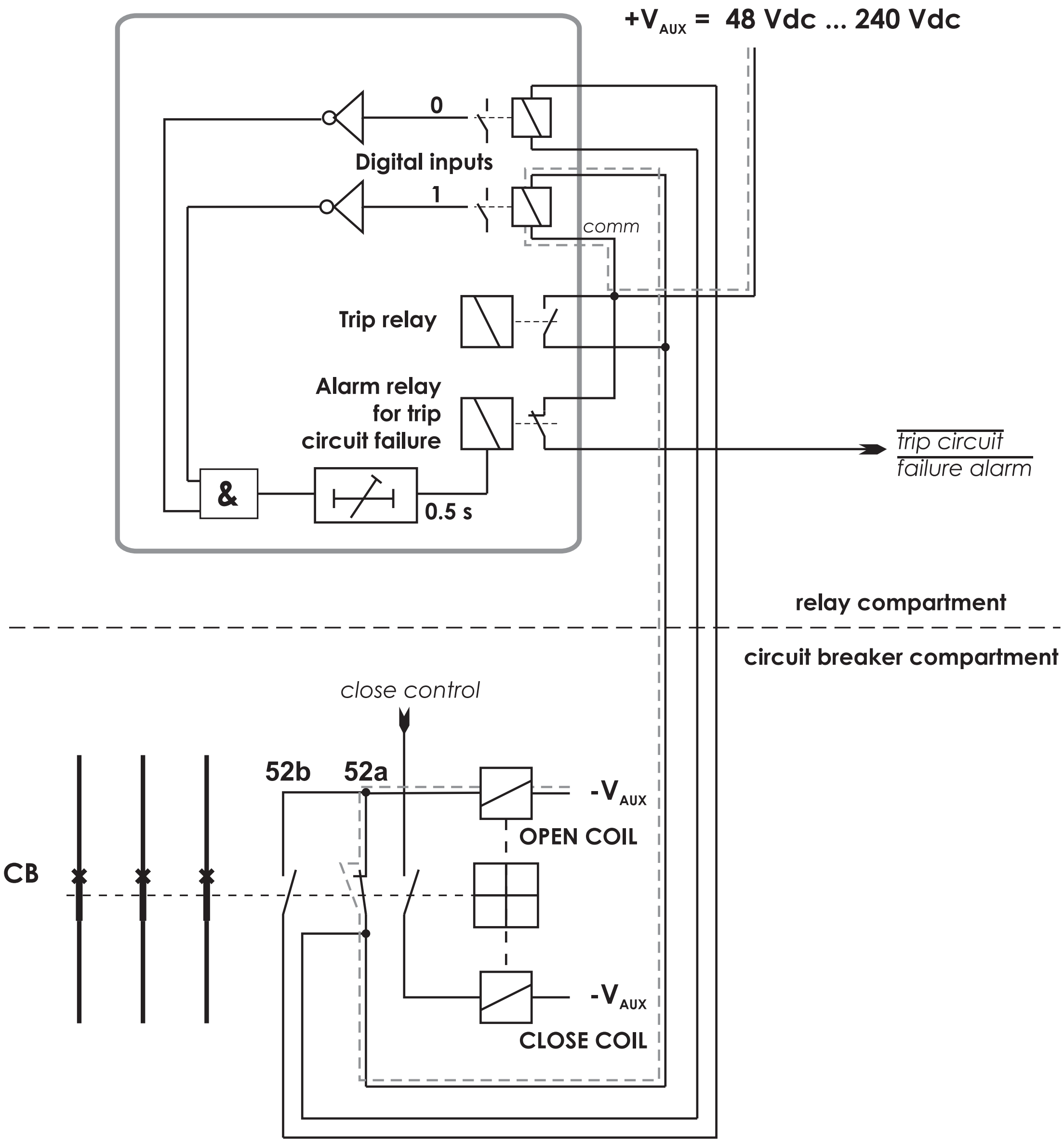


Figure 8.8: Trip circuit supervision with two digital inputs. The CB is closed. The supervised circuitry in this CB position is double-lined. The digital input is in active state when the trip circuit is complete. This is applicable for all digital inputs.

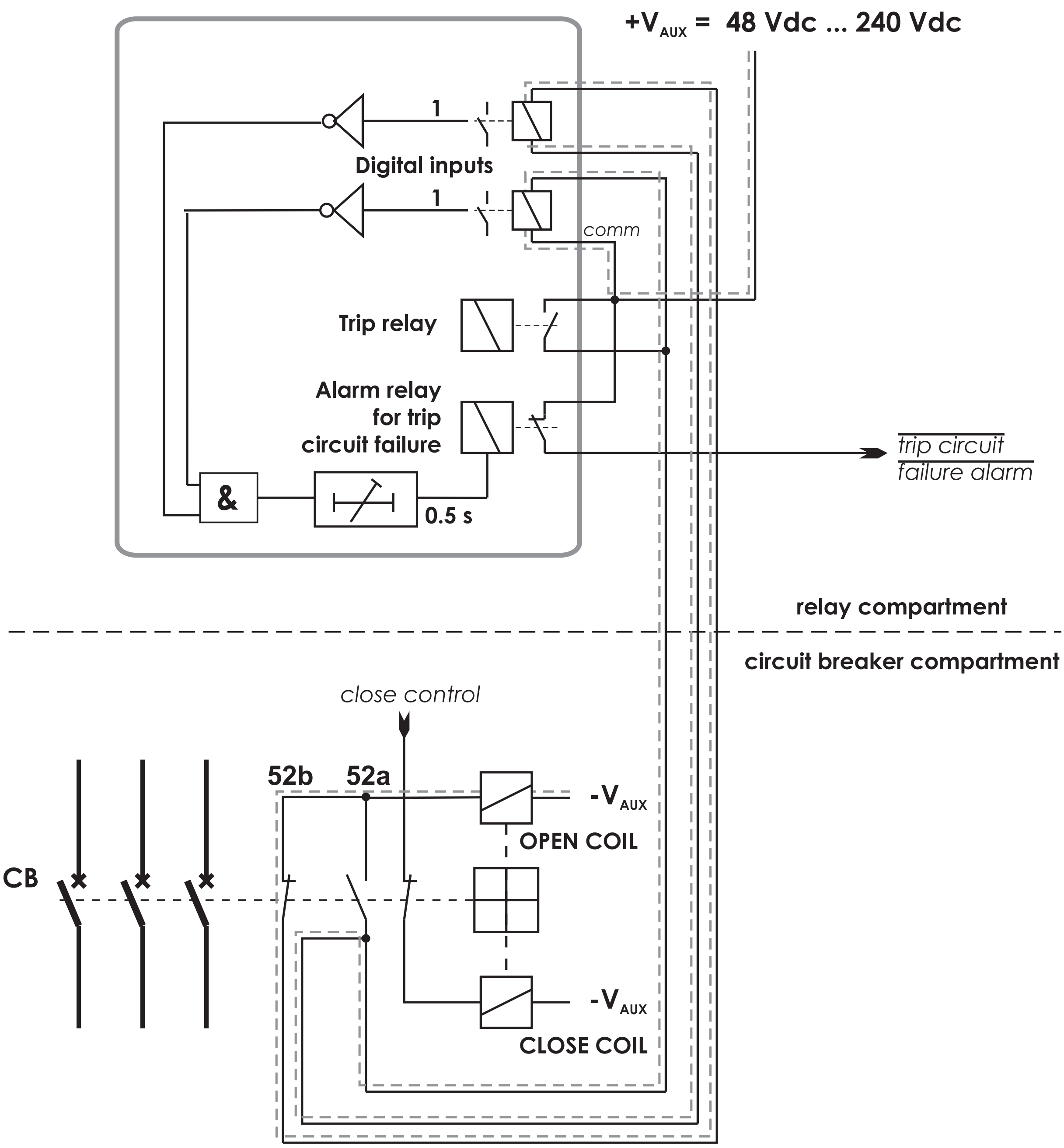


Figure 8.9: Trip circuit supervision with two digital inputs. The CB is in the open position. The two digital inputs are now in series.

DIGITAL INPUTS

DIGITAL INPUTS

Input	State	Polarity	Delay	On Event	Off Event	Alarm display	Counters
1	0	NO	0.00 s	On	On	On	0
2	0	NO	0.00 s	On	On	On	0
3	0	NO	0.00 s	On	On	On	0
4	0	NO	0.00 s	On	On	On	0
5	0	NO	0.00 s	On	On	On	0
6	0	NO	0.00 s	On	On	On	0
7	0	NC	0.00 s	Off	Off	Off	0
8	0	NO	0.00 s	On	On	On	0
9	0	NO	0.00 s	On	On	On	0
10	0	NO	0.00 s	On	On	On	0
11	0	NO	0.00 s	On	On	On	0
12	0	NO	0.00 s	On	On	On	0
13	0	NC	0.00 s	Off	Off	Off	0

Figure 8.10: An example of digital input configuration for trip circuit supervision with two digital inputs DI7 and DI13.

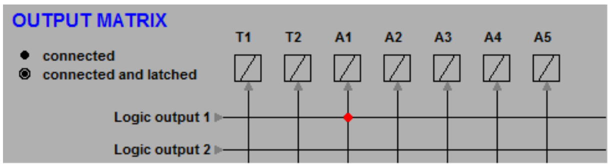
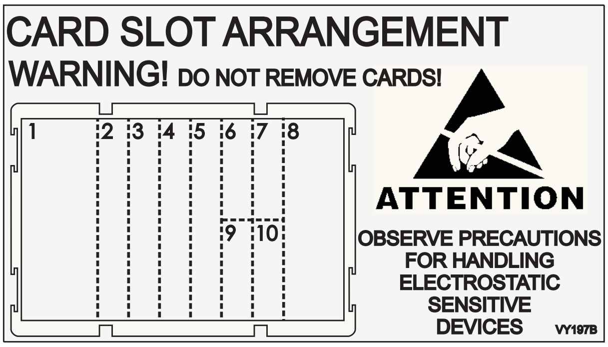


Figure 8.11: An example of output matrix configuration for trip circuit supervision with two digital inputs.

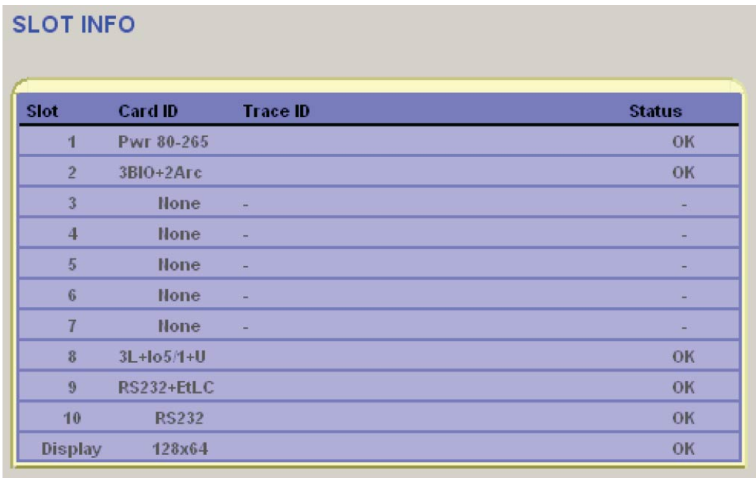
9 Connections

The VAMP 321 IED has fixed combination of analog interface, power supply, DI/DO, communication and arc flash protection cards as per chosen order code. Do not remove hardware from IED's card slot in any circumstances.



9.1 I/O cards and optional I/O cards

The configuration of the device can be checked from local HMI or VAMPSET menu called “Slot” or “SLOT INFO”. This contains “Card ID” which is the name of the card used by the device software.



SLOT INFO

Slot	Card ID	Trace ID	Status
1	Pwr 80-265		OK
2	3BIO+2Arc		OK
3	None	-	-
4	None	-	-
5	None	-	-
6	None	-	-
7	None	-	-
8	3L+Io5/1+U		OK
9	RS232+EtLC		OK
10	RS232		OK
Display	128x64		OK

Figure 9.1: An example of showing the hardware configuration by VAMPSET

9.2 Rear panel

The device has a modular structure. The device is built from hardware modules, which are installed into 10 different slots at the back of the device. The location of the slots in shown in the following figure.

The type of hardware modules is defined by the ordering code. A mimum configuration is that there is a supply voltage card in slot 1 and an analog measurement card in slot 8.

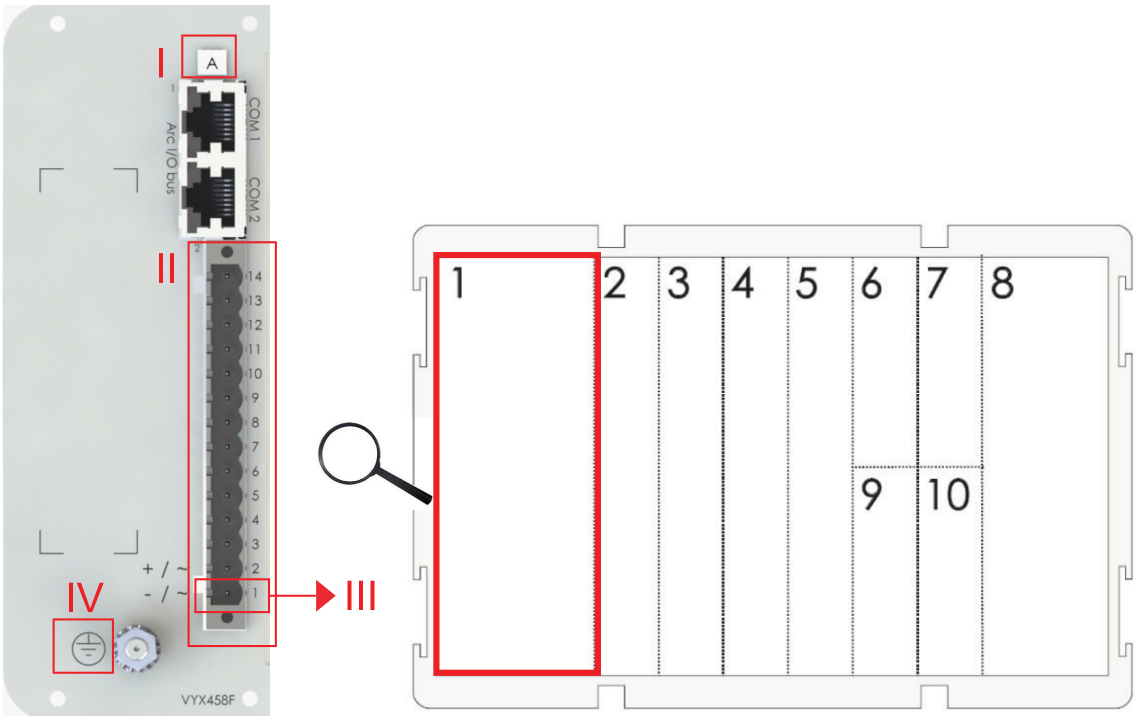


Figure 9.2: Slot numbering and card options in the VAMP 321 rear panel.

I	Option type for the card	1	Supply voltage [V]
II	Connector 2	2	I/O card I
III	Pin 1	3 – 5	I/O cards II – IV
IV	Protective grounding	6, 7	I/O option cards I and II
		8	Analog measurement card (I, U)
		9, 10	Communication interface I and II

The pin number is defined with a string 1/A/2:1, where "1" refers to slot numbering, "A" refers to chosen module type, "2" refers to connector and "1" refers to pin number of the connector.

9.3 Supply voltage card

Auxiliary voltage

The external auxiliary voltage U_{AUX} (110 – 240 V ac / dc, or optionally 24 – 48 V dc) for the device is connected to the pins 1/A/2: 1 – 2.

NOTE: When optional 24 – 48 Vdc power module is used the polarity is as follows: 1/A/2:2 positive (+), 1/A/2:1 negative (-).

Figure 9.3: Example of supply voltage card Power A 110-240

Table 9.1: Supply voltage card Power A 110-240 & Power B 24-48

Pin No.	Symbol	Description
14	+24V	I/O unit operating voltage
13	GND	I/O unit ground potential
12	SF NO	Service status output, normal open
11	SF NC	Service status output, normal closed
10	SF COMMMON	Service status output, common
9	A1 NO	Signal relay 1, normal open connector
8	A1 NC	Signal relay 1, normal closed connector
7	A1 COM	Signal relay 1, common connector
6	T1	Trip relay 1 for arc protection
5	T1	Trip relay 1 for arc protection
4		No connection
3		No connection
2	L / + / ~	Auxiliary voltage
1	N / - / ~	Auxiliary voltage

⚠ DANGER

HAZARD OF ELECTRICAL SHOCK

Always connect the protective grounding before connecting the power supply.

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

9.4 Analogue measurement cards

9.4.1 “A = 3L + U + I_0(5/1A)”

This card contains connections current measurement transformers for measuring of the phase currents L1, L2 and L3 and residual current I_0, and one voltage measurement transformer for measuring of the U_0, U_{LL} or U_{LN}.

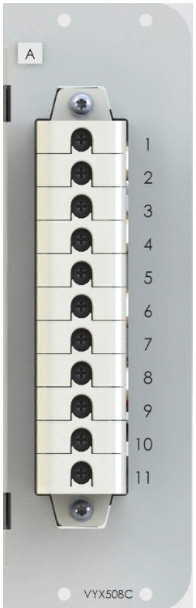


Figure 9.4: Analogue measurement card "A"

Table 9.2: Terminal pins 8/A/1:1 – 11

Pin No.	Symbol	Description
1	IL1 (S1)	Phase current L1 (S1)
2	IL1 (S2)	Phase current L1 (S2)
3	IL2 (S1)	Phase current L2 (S1)
4	IL2 (S2)	Phase current L2 (S2)
5	IL3 (S1)	Phase current L3 (S1)
6	IL3 (S2)	Phase current L3 (S2)
7	Io1	Residual current I_{01} common for 1A and 5A (S1)
8	Io1/5A	Residual current I_{01} 5A (S2)
9	Io1/1A	Residual current I_{01} 1A (S2)
10	Uo/ULL/ULN	U_0 (da)/ ULL (a)/ ULN (a)
11	Uo/ULL/ULN	U_0 (dn)/ ULL (b)/ ULN (n)

⚠ DANGER

HAZARD OF ELECTRICAL SHOCK

Do not open the secondary circuit of a live current transformer.

Disconnecting the secondary circuit of a live current transformer may cause dangerous overvoltages.

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

9.5 I/O cards

9.5.1 I/O card “B = 3BIO+2Arc”

This card contains connections to 2 arc light sensors (e.g. VA 1 DA), 3 binary inputs and 3 binary outputs.

The option card has also 3 normal open trip contacts that can be controlled either with the relay’s normal trip functions or using the fast arc matrix.

Table 9.3: Slots 2/B/1:1 – 20

Pin No.	Symbol	Description
20	T4	Trip relay 4 for arc protection (normal open)
19	T4	Trip relay 4 for arc protection (normal open)
18	T3	Trip relay 3 for arc protection (normal open)
17	T3	Trip relay 3 for arc protection (normal open)
16	T2	Trip relay 2 for arc protection (normal open)
15	T2	Trip relay 2 for arc protection (normal open)
14	BI3	Binary input 3
13	BI3	Binary input 3
12	BI2	Binary input 2
11	BI2	Binary input 2
10	BI1	Binary input 1
9	BI1	Binary input 1
8	BO COMMON	Binary output 1 – 3 common GND
7	BO3	Binary output 3, +30 V dc
6	BO2	Binary output 2, +30 V dc
5	BO1	Binary output 1, +30 V dc
4	Sen 2 -	Arc sensor channel 2 negative terminal
3	Sen 2 +	Arc sensor channel 2 positive terminal
2	Sen 1 -	Arc sensor channel 1 negative terminal
1	Sen 1 +	Arc sensor channel 1 positive terminal

NOTE: Binary inputs are polarity free which means that the user can freely choose "-" and "+" terminals to each binary input.

9.5.2 I/O card “C = F2BIO+1Arc”

This card contains connections to 1 arc fiber sensor, 2 fiber binary inputs, 2 fiber binary outputs and 3 fast trip relays.

Arc loop sensor input is used with Arc-SLm sensor. Sensor’s sensitivity can be set by using VAMPSET “ARC PROTECTION” menu.

Binary inputs and outputs are designed to be used with 50/125 µm, 62.5/125 µm, 100/140 µm, and 200 µm fiber sizes (Connector type: ST).

The option card has also 3 normal open trip contacts that can be controlled either with the relay’s normal trip functions or using the fast arc matrix.

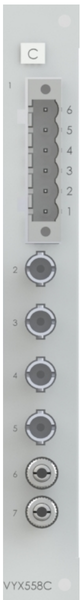
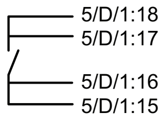
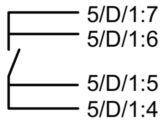


Table 9.4: VAMP 321 Fibre 2 x BI/BO, 1 x Arc loop sensor, T2, T3, T4 I/O card pins (slot 2)

Connector / Pin No.	Symbol	Description
1:6	T4	Trip relay 4 for arc protection (normal open)
1:5	T4	Trip relay 4 for arc protection (normal open)
1:4	T3	Trip relay 3 for arc protection (normal open)
1:3	T3	Trip relay 3 for arc protection (normal open)
1:2	T2	Trip relay 2 for arc protection (normal open)
1:1	T2	Trip relay 2 for arc protection (normal open)
2	BI2	Fibre binary input 2
3	BI1	Fibre binary input 1
4	BO2	Fibre binary output 2
5	BO1	Fibre binary output 1
6	Arc sensor 1	Arc sensor 1 Rx
7	Arc sensor 1	Arc sensor 1 Tx

9.5.3 I/O card “D = 2IGBT”

This card contains 2 semiconductor outputs.

Pin No.	Symbol	Description	
19 - 20	NC	No Connection	
18	HSO2	HSO output 2 terminal 2	
17			
16		HSO output 2 terminal 1	
15			
8 - 14	NC	No Connection	
7	HSO1	HSO output 1 terminal 2	
6			
5		HSO output 1 terminal 1	
4			
1 - 3	NC	No Connection	

9.5.4 I/O card “G = 6DI+4DO”

This card provides 6 digital inputs and 4 relays outputs. The threshold level is selectable by the last digit of the ordering code.

6xDI+4xDO option card is equipped with six dry digital inputs with hardware selectable activation/threshold voltage and four trip contacts. Input and output contacts are normally open.

Table 9.5: Slots 2 – 5/G/1:1 – 20

Pin No.	Symbol	Description
20	Tx	Trip relay
19		
18	Tx	Trip relay
17		
16	Tx	Trip relay
15		
14	Tx	Trip relay
13		
12	DIx	Digital input
11		
10	DIx	Digital input
9		
8	DIx	Digital input
7		
6	DIx	Digital input
5		
4	DIx	Digital input
3		
2	DIx	Digital input
1		

NOTE: Digital inputs are polarity free which means that the user can freely choose "-" and "+" terminals to each digital input.

9.5.5 I/O card “I = 10DI”

This card provides 10 digital inputs. The threshold level is selectable by the last digit of the ordering code.

Table 9.6: Slots 2 – 5/I/1:1 – 20

Pin No.	Symbol	Description
20	DIx	Digital input
19		
18	DIx	Digital input
17		
16	DIx	Digital input
15		
14	DIx	Digital input
13		
12	DIx	Digital input
11		
10	DIx	Digital input
9		
8	DIx	Digital input
7		
6	DIx	Digital input
5		
4	DIx	Digital input
3		
2	DIx	Digital input
1		

NOTE: Digital inputs are polarity free which means that the user can freely choose "-" and "+" terminals to each digital input.

9.6 I/O option card “D= 4Arc”

This card contains 4 arc point connections to 4 arc light sensors (e.g. VA 1 DA). If the card is in slot 6, it provides sensors 3 to 6 and in slot 7 sensors 7 to 10.

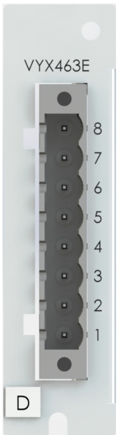


Table 9.7: Pins 6/D/1:1 – 8 (slot 6)

Pin No.	Symbol	Description
8	Sen 6 -	Arc sensor 6 negative terminal
7	Sen 6 +	Arc sensor 6 positive terminal
6	Sen 5 -	Arc sensor 5 negative terminal
5	Sen 5 +	Arc sensor 5 positive terminal
4	Sen 4 -	Arc sensor 4 negative terminal
3	Sen 4 +	Arc sensor 4 positive terminal
2	Sen 3 -	Arc sensor 3 negative terminal
1	Sen 3 +	Arc sensor 3 positive terminal

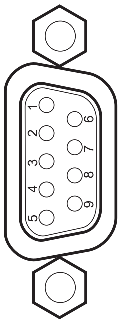
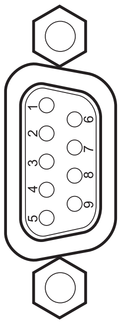
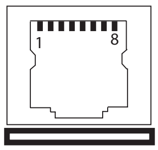
Table 9.8: 4xArc option card pins (slot 7)

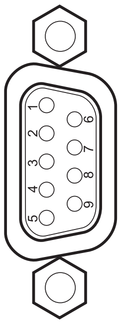
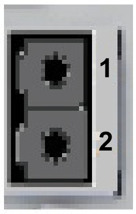
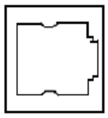
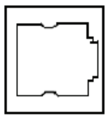
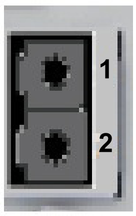
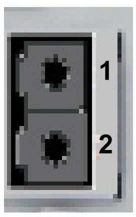
Pin No.	Symbol	Description
8	Sen 10 -	Arc sensor 10 negative terminal
7	Sen 10 +	Arc sensor 10 positive terminal
6	Sen 9 -	Arc sensor 9 negative terminal
5	Sen 9 +	Arc sensor 9 positive terminal
4	Sen 8 -	Arc sensor 8 negative terminal
3	Sen 8 +	Arc sensor 8 positive terminal
2	Sen 7 -	Arc sensor 7 negative terminal
1	Sen 7 +	Arc sensor 7 positive terminal

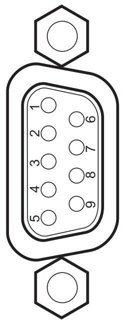
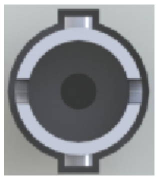
9.7 Communication cards

The communication card types and their pin assignments are introduced in the following table.

Table 9.9: Communication option modules and their pin numbering

Type	Communication ports	Signal levels	Connectors	Pin usage
232 (Slot 9)	COM 3 / COM 4	RS-232	D-connector 	1 = TX COM 4 2 = TX COM 3 3 = RX COM 3 4 = IRIG-B 5 = IRIG-B GND 6 = 7 = GND 8 = RX COM 4 9 = +12V
232+Eth RJ (Slot 9)	COM 3 / COM 4	RS-232	D-connector 	1 = TX COM 4 2 = TX COM 3 3 = RX COM 3 4 = IRIG-B 5 = IRIG-B GND 6 = 7 = GND 8 = RX COM 4 9 = +12V
	ETHERNET	ETHERNET 100Mbps	RJ-45 	1 = Transmit + 2 = Transmit - 3 = Receive + 4 = 5 = 6 = Receive - 7 = 8 =

Type	Communication ports	Signal levels	Connectors	Pin usage
232+Eth LC (Slot 9)	COM 3 / COM 4	RS-232	D-connector 	1 = TX COM 4 2 = TX COM 3 3 = RX COM 3 4 = IRIG-B 5 = IRIG-B GND 6 = 7 = GND 8 = RX COM 4 9 = +12V
	ETHERNET	Light 100Mbps	LC fiber connector 	1 = Receive 2 = Transmit
2EthRJ (Slot 9)	100Mbps Ethernet interface with IEC 61850	ETHERNET 100Mbps	2 x RJ-45  	1=Transmit+ 2=Transmit- 3=Receive+ 4= 5= 6=Receive- 7= 8=
2EthLC (Slot 9)	100 Mbps Ethernet fibre interface with IEC 61850	Light 100Mbps	2 x LC  	LC-connector from top: -Port 2 Tx -Port 2 Rx -Port 1 Tx -Port 1 Rx

Type	Communication ports	Signal levels	Connectors	Pin usage
232 (Slot 10)	COM 1 / COM 2	RS-232	D-connector 	1 = TX COM 2 2 = TX COM 1 3 = RX COM 1 4 = IRIG-B 5 = IRIG-B GND 6 = 7 = GND 8 = RX COM 2 9 = +12V
FibrePP (Slot 10)	COM 1	Light serial	2 x Versatile link fiber 	TX=Lower fiber connector RX=Upper fiber connector
FibreGG (Slot 10)	COM 1	Light serial (multimode)	2 x ST fiber 	TX=Lower fiber connector RX=Upper fiber connector

NOTE: When communication option module of type B, C or D is used in slot 9, serial ports COM 3 / COM 4 are available.

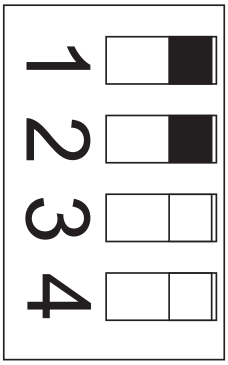


Figure 9.5: Dip switches in optic fibre options.

Dip switch number	Switch position	Function Fibre optics
1	Left	Echo off
1	Right	Echo on
2	Left	Light on in idle state
2	Right	Light off in idle state
3	Left	Not applicable
3	Right	Not applicable
4	Left	Not applicable
4	Right	Not applicable

9.8 Communication connections

9.8.1 Front panel USB connector

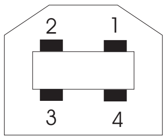
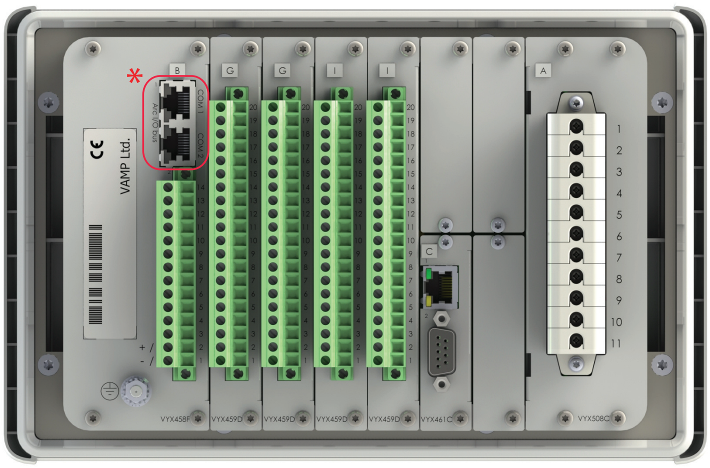


Figure 9.6: Pin numbering of the front panel USB type B connector

Pin	Signal name
1	VBUS
2	D-
3	D+
4	GND
Shell	Shield

9.8.2 Arc I/O Bus communication

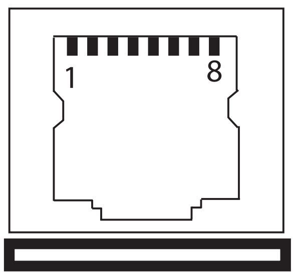


* Arc I/O Bus

Figure 9.7: Arc I/O Bus connectors at the back of the device

Arc I/O Bus interface contain two identical RJ-45 connectors. The pin numbering is:

RJ-45 connector



1= Arc comm A

2= +24V

3= RS485 A

4= GND

5= GND

6= RS485 B

7= +24V

8= Arc comm B

Modular cable wiring is described in separate VAM I/O units manual.

NOTICE
HAZARD OF EQUIPMENT DAMAGE Only VAMP communication cable type VX001 shall be used. Modular cable wiring shall be placed on the control cabling trays as far from the primary cable, bus bar and bus ducts as possible. Do not connect Ethernet to ARC I/O Bus! **Failure to follow these instructions can result in equipment damage.**

9.9 VAMP 321 block diagrams

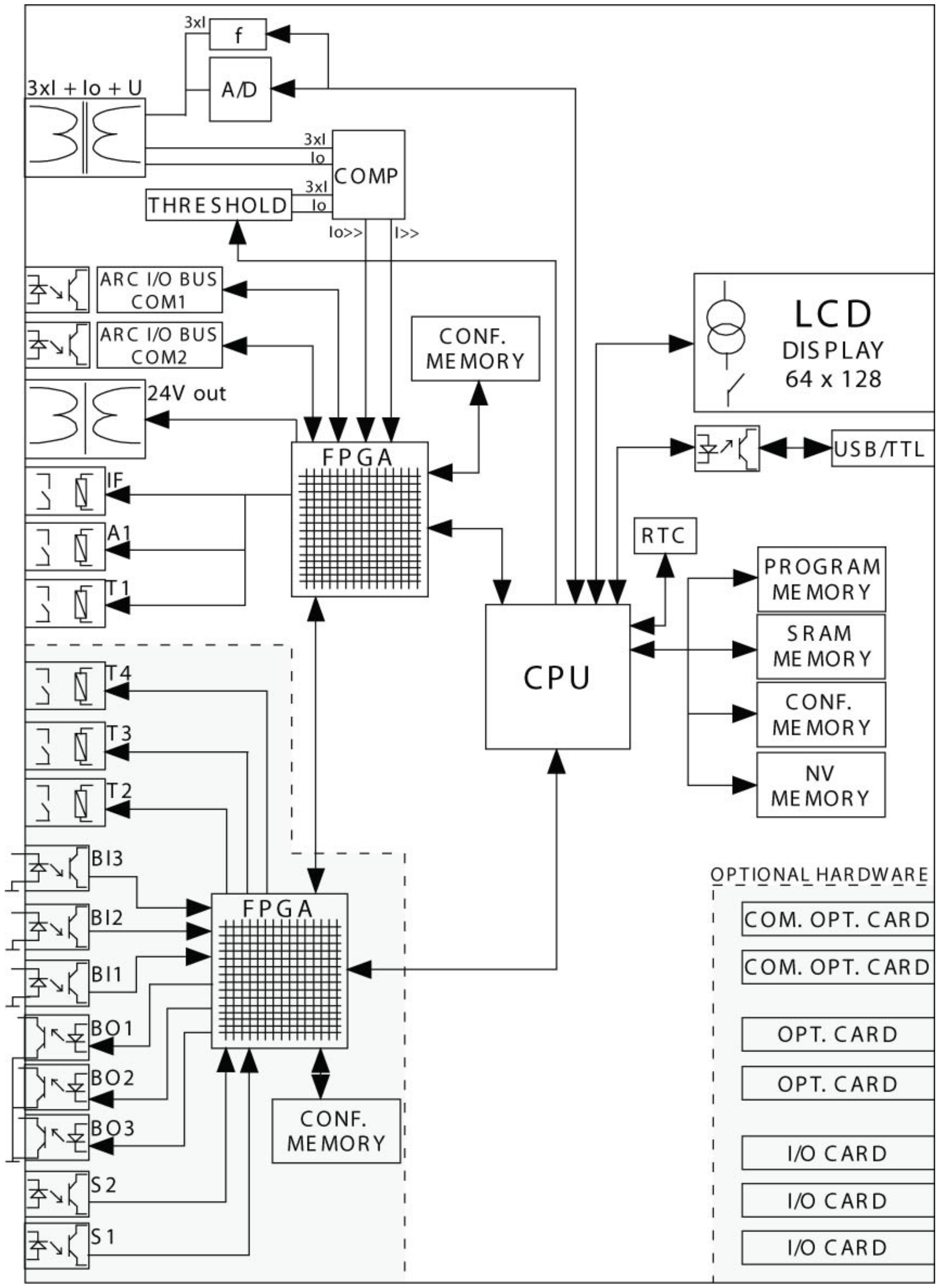


Figure 9.8: Functional block diagram for VAMP 321 AB AAA AAAAA A1

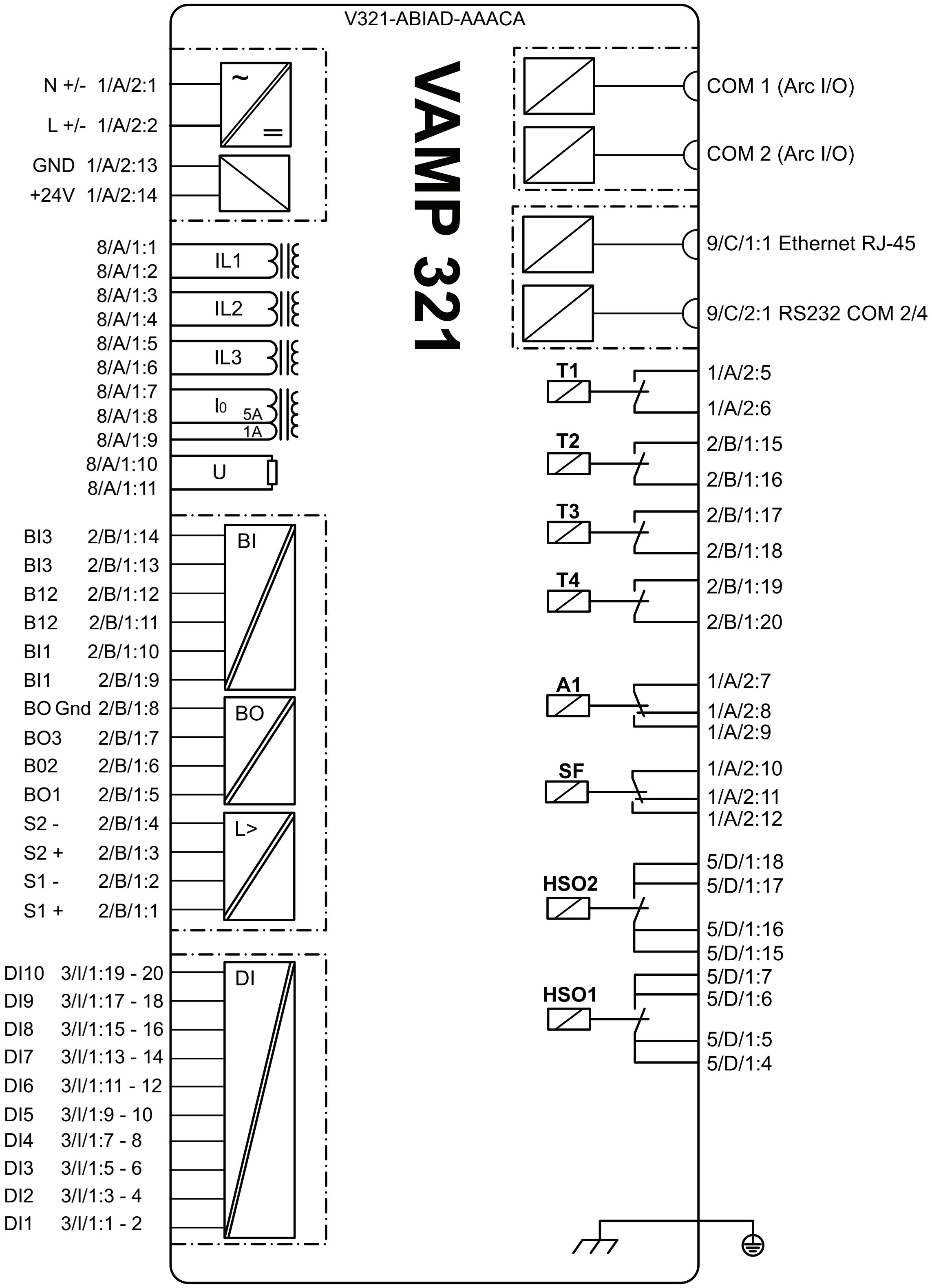


Figure 9.9: Block diagram of VAMP 321-ABIAD-AAACA

10 Configurations

10.1 Configuring the system with VAMPSET

Before configuring the arc flash protection system, you need

- PC with adequate user rights
- VAMPSET setting and configuration tool downloaded to the PC
- USB cable (VX052) for connecting the IED with the PC

10.1.1 Setting up the communication

NOTE: If several IEDs are connected to a communication bus, set only one to master mode and the others to slave mode.

- Connect the USB cable between the USB of the PC and the local port of the IED.

Defining the PC USB Serial port setting

NOTE: Ensure that the communication port setting on the PC corresponds to the IED setting.

1. Open the Device Manager on the PC and check the USB Serial Port number (COM) for the IED.
2. Open the VAMPSET setting and configuration tool on the PC.
3. On the VAMPSET Settings menu, select Communication Settings.
4. Select the correct port under the Port area and click Apply.

Defining the VAMPSET communication settings

1. On the local HMI, go to the CONF/ DEVICE SETUP menu and check the local port bit rate.
2. On the VAMPSET Settings menu, select Communication Settings.
3. Under the Local area, select the corresponding speed (bps) from the drop-down list and click Apply.
4. In VAMPSET Settings menu, select Program Settings.

NOTE: If faster operation is needed, change the speed to 187500 bps both in VAMPSET and in the IED.

Connecting the IED

1. On the VAMPSET Communication menu, select Connect Device.
2. Enter the password and click Apply.
   VAMPSET connects to the IED.

NOTE: The default password for the configurator is **2**.

10.1.2 Defining the current transformer and voltage scaling

The **SCALING** menu contains the primary and secondary values of the CT. However, the **ARC PROTECTION** menu calculates the I_N value only after the **I pick-up setting** value is given.

1. On the VAMPSET group list, select **SCALING**.
2. Click the **CT primary** value, set it to 1200 A and press **Enter**.
3. Click the **CT secondary** value, set it to 5 A and press **Enter**.

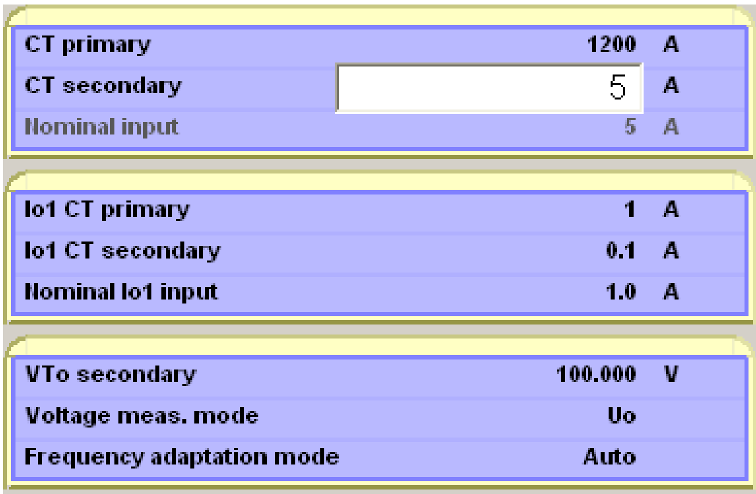


Figure 10.1: Setting the current transformer scaling values for the application example

4. On the VAMPSET group list, select **ARC PROTECTION**
5. Define the **I pick-up setting** value for the IED.
   Now the I_N value is calculated.

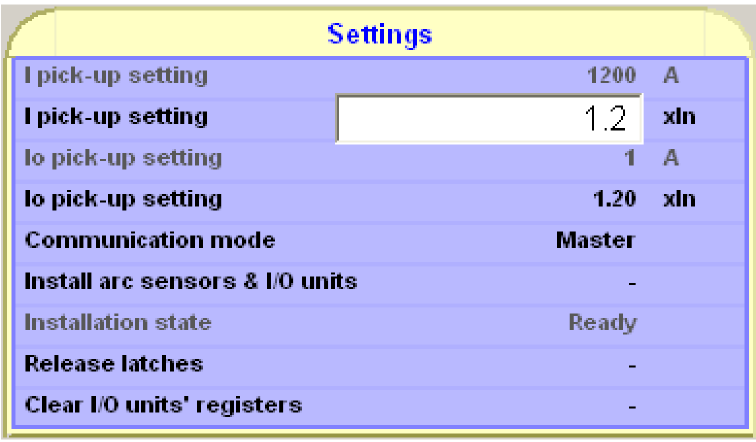


Figure 10.2: Defining the I pick-up setting value for the application example

In this application example, the residual current I0 is not connected to the IED, and the scaling can be ignored. Similarly, the voltage transformers are not available in this application and the voltage scaling can be ignored.

10.1.3 Installing the arc flash sensors and I/O units

1. On the VAMPSET group list, select **ARC PROTECTION**.
2. Under **Settings**, click the **Install arc sensors & I/O units** drop-down list and select **Install**.
3. Wait until the **Installation state** shows **Ready**. The communication between the system components is created.

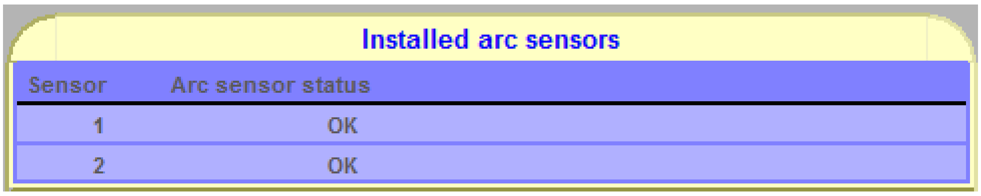
The installed sensors and units can be viewed at the bottom of the **ARC PROTECTION** group view.

10.2 Configuration example of arc flash protection

Installing the arc flash sensors and I/O units

1. On the VAMPSET group list, select **ARC PROTECTION**.
2. Under **Settings**, click the **Install arc sensors & I/O units** drop-down list and select **Install**.
3. Wait until the **Installation state** shows **Ready**. The communication between the system components is created.

The installed sensors and units can be viewed at the bottom of the **ARC PROTECTION** group view.



1. On the VAMPSET group list, select ARC PROTECTION
2. Click the Arc Stages 1, 2, select Stage 1 and 2 'On'
3. Click the Trip delay[ms] value, set it to e.g. '0' and press Enter.
4. Click the DI block value, set it to e.g. '-' and press Enter.

Configuring the current pick-up values

The **SCALING** menu contains the primary and secondary values of the CT. However, the **ARC PROTECTION** menu calculates the primary value only after the **I pick-up setting** value is given.

For example:

1. On the VAMPSET group list, select **SCALING**.
2. Click the **CT primary** value, set it to e.g. *1200 A* and press **Enter**.
3. Click the **CT secondary** value, set it to e.g. *5 A* and press **Enter**.
4. On the VAMPSET group list, select **ARC PROTECTION**
5. Define the **I pick-up setting** value for the IED.
6. Define the Io pick-up setting in similar manner.

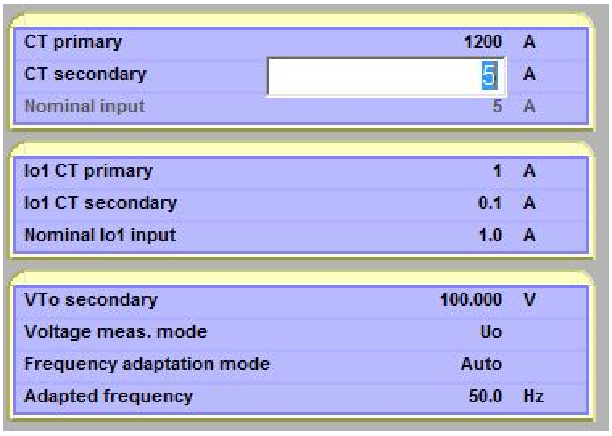


Figure 10.3: Example of setting the current transformer scaling values.

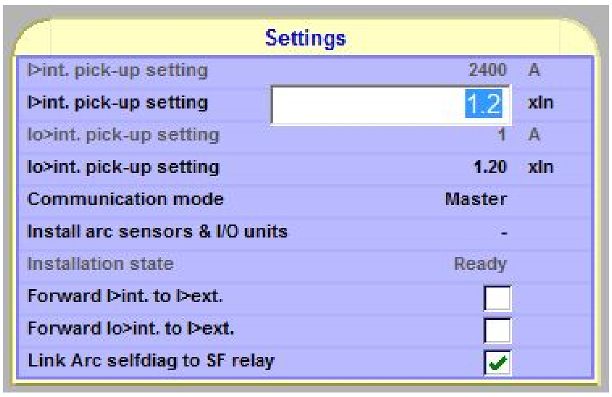


Figure 10.4: Example of defining the I pick-up setting value.

Configuring the current matrix

Define the current signals that are received in the arc flash protection system's IED. Connect currents to Arc stages in the matrix.

For example:

The arc flash fault current is measured from the incoming feeder, and the current signal is linked to **Arc stage 1** in the current matrix.

1. On the VAMPSET group list, select **ARC MATRIX – CURRENT**.
2. In the matrix, select the connection point of **Arc stage 1** and **I>int**.
3. On the **Communication** menu, select **Write Changed Settings To Device.**

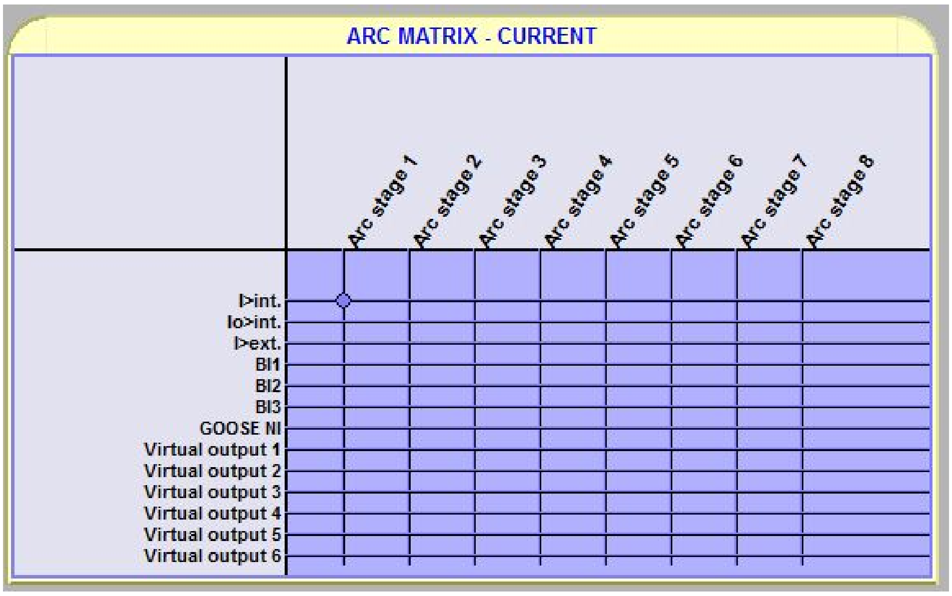


Figure 10.5: Configuring the current matrix – an example

Configuring the light matrix

Define what light sensor signals are received in the protection system. Connect light signals to arc stages in the matrix.

For example:

1. On the VAMPSET group list, select **ARC MATRIX – LIGHT**.
2. In the matrix, select the connection point of **Arc sensor 1** and **Arc stage 2**.
3. Select the connection point of **Arc sensor 2** and **Arc stage 2**.
4. Select the connection point of **Zone 1** and **Arc stage 1**.
5. On the **Communication** menu, select **Write Changed Settings To Device.**

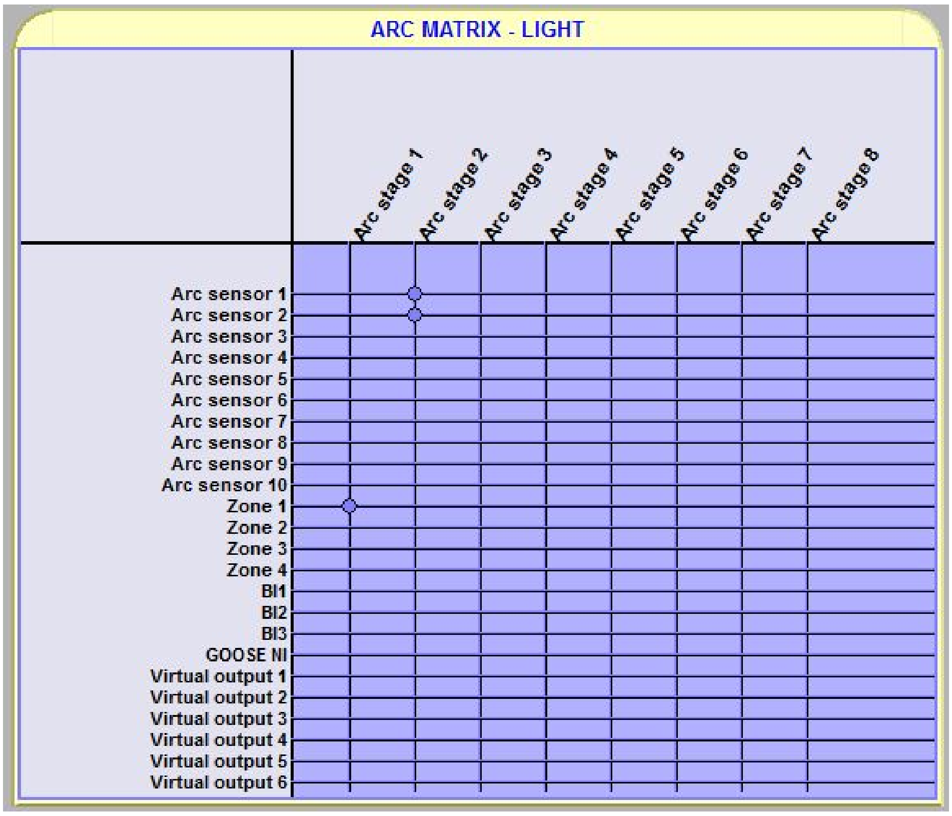


Figure 10.6: Configuring the light arc matrix

Configuring the output matrix

Define the trip relays that the current and light signals effect.

For example:

1. On the VAMPSET group list, select **ARC MATRIX – OUTPUT**.
2. In the matrix, select the connection point of **Arc stage 1** and **T1**.
3. Select the connection points of **Latched** and **T1** and **T2**.
4. Select the connection point of **Arc stage 2** and **T2**.
5. On the **Communication** menu, select **Write Changed Settings To Device.**

NOTE: It is recommended to use latched outputs for the trip outputs.

Arc output matrix includes only outputs which are directly controlled by FPGA.

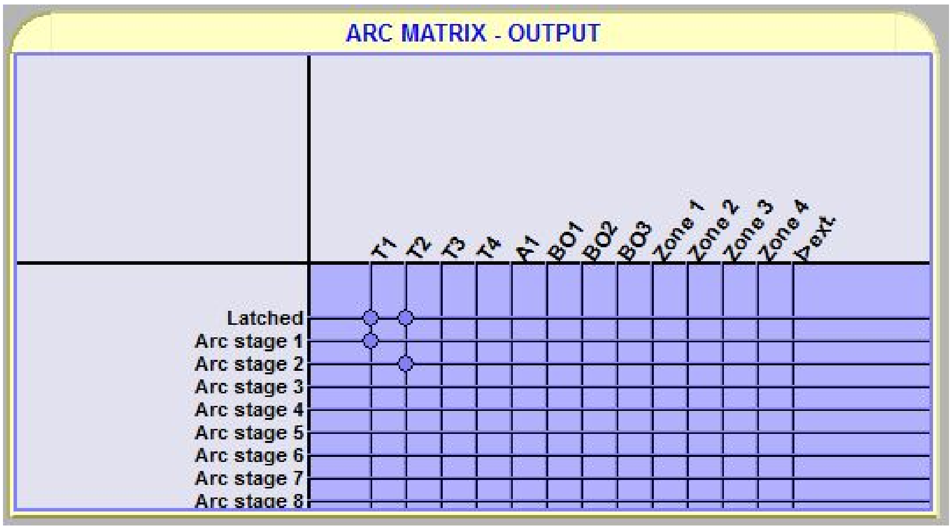


Figure 10.7: Configuring the output matrix - an example

Configuring the arc events

Define which arc events are written to the event list in this application.

For example:

1. On the VAMPSET group list, select **ARC EVENT ENABLING**.
2. In the matrix, enable both **'Act On' event** and **'Act Off" event** for **Arc sensor 1**, **Arc stage 1**, **Arc stage 2** and **Zone 1**.
3. On the **Communication** menu, select **Write Changed Settings To Device.**

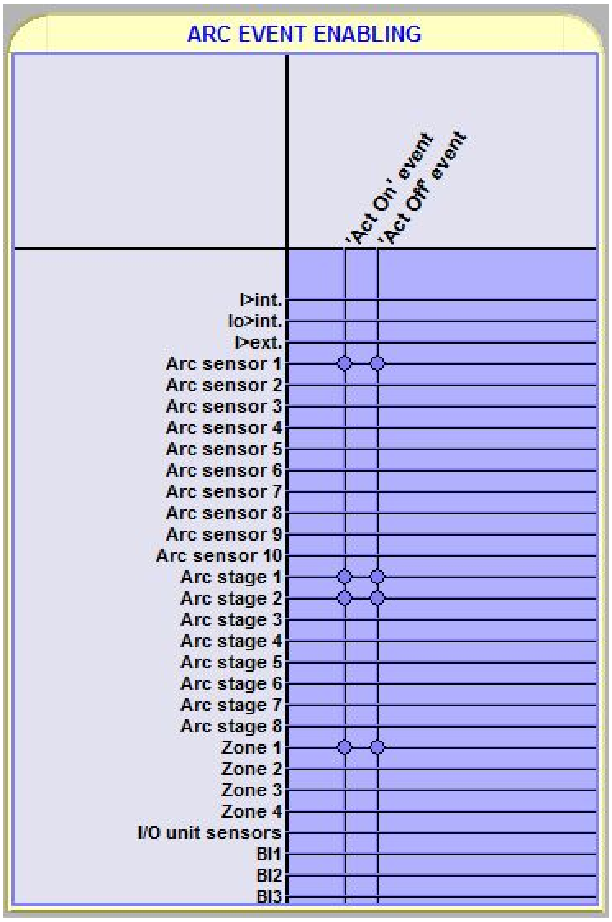


Figure 10.8: Configuring the arc events – an example

Configuring the LED names

1. On the VAMPSET group list, select **LED NAMES**.
2. To change a LED name, click the LED **Description** text and type a new name. Press **Enter**.

LED	Description	LED	Description
LED A (green)	LED A (green)	LED B (green)	LED B (green)
LED A (red)	LED A (red)	LED B (red)	LED B (red)
LED C (green)	LED C (green)	LED D (green)	LED D (green)
LED C (red)	LED C (red)	LED D (red)	LED D (red)
LED E (green)	LED E (green)	LED F (green)	LED F (green)
LED E (red)	LED E (red)	LED F (red)	LED F (red)
LED G (green)	LED G (green)	LED H (green)	LED H (green)
LED G (red)	LED G (red)	LED H (red)	LED H (red)
LED I (green)	LED I (green)	LED J (green)	LED J (green)
LED I (red)	LED I (red)	LED J (red)	LED J (red)
LED K (green)	LED K (green)	LED L (green)	LED L (green)
LED K (red)	LED K (red)	LED L (red)	LED L (red)
LED M (green)	LED M (green)	LED N (green)	LED N (green)
LED M (red)	LED M (red)	LED N (red)	LED N (red)

Figure 10.9: LED NAMES menu in VAMPSET for LED configuration

Configuring the disturbance recorder

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

For this application example, select the channels and sample rate for the disturbance recorder.

1. On the VAMPSET group view, click the **DISTURBANCE RECORDER** menu open.
2. Click the **Add recorder channel** drop-down list and select the channel IL1.
3. Similarly select the channels IL2, IL3, DO and Arc.
4. Click the **Sample rate** drop-down list and select the rate 1/20ms.

To upload, view or analyse the recordings, open VAMPSET and on the **View** menu click **Disturbance Record**.

NOTE: For more information about changing the disturbance recorder settings and evaluating the recordings, see the VAMPSET user manual.

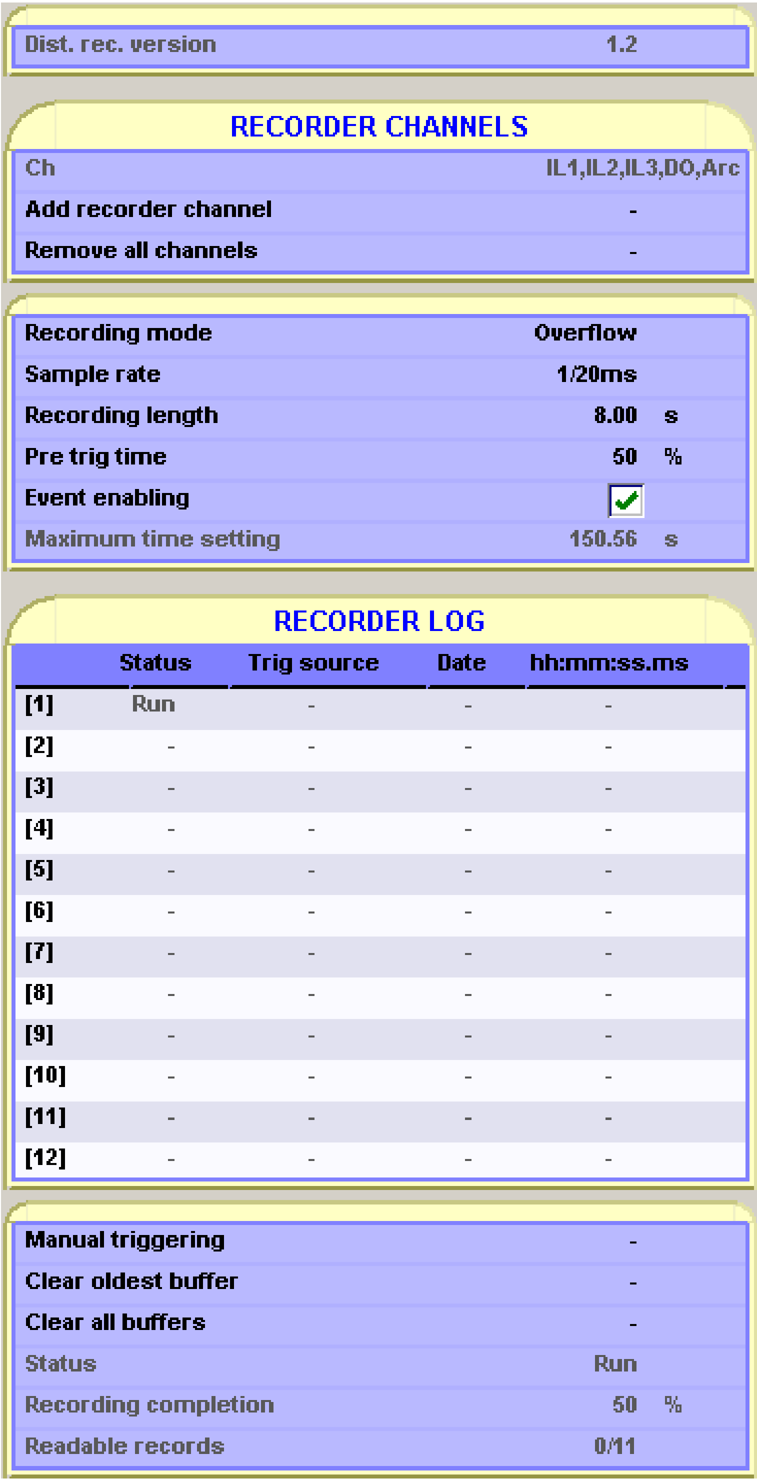


Figure 10.10: Configuring the disturbance recorder for the application example

Writing the setting to the IED

1. In the VAMPSET **Communication** menu, select **Write All Settings To Device** to download the configuration to the IED.

NOTE: To save the IED configuration information for later use, also save the VAMPSET document file on the PC.

Saving the VAMPSET document file

Save the IED configuration information to the PC. The document file is helpful for instance if you need help in troubleshooting.

1. Connect the IED to the PC with an USB cable.
2. Open the VAMPSET tool on the PC.
3. On the **Communication** menu, select **Connect device**.
4. Enter the configurator password.
   The IED configuration opens.
5. On the **File** menu, click **Save as**.
6. Type a descriptive file name, select the location for the file and click **Save**.

NOTE: By default, the configuration file is saved in the VAMPSET folder.

11 Technical data

Table 11.1: Measuring circuits

Rated current I_N	5 A (configurable for CT secondary 1 – 10 A)
- Current measuring range	0 – 250 A
- Thermal withstand	20 A (continuously)
	100 A (for 10 s)
	500 A (for 1 s)
- Burden	0.075 VA
- Impedance	0.003 Ohm
Rated current I	5 A / 1 A (optionally 1 A / 0.2 A)
- Current measuring range	0 – 50 A / 10 A
- Thermal withstand	4 x I_0 (continuously)
	20 x I_0 (for 10 s)
	100 x I_0 (for 1 s)
- Burden	0.075 VA (5A) / 0.02 VA (1A / 0.2A)
- Impedance	0.003 Ohm (5A) / 0.02 Ohm (1A / 0.2A)
Rated voltage U_N	100 V (configurable for VT secondary 50 – 120 V)
- Voltage measuring range	0.5 – 190 V
- Continuous voltage withstand	250 V
- Burden	< 0.5 VA
Rated frequency f_N	45 – 65 Hz
Terminal block: - Solid or stranded wire	Wire dimension: Maximum 4 mm^2 (11 – 12 AWG) Minimum 2.5 mm^2 (13 – 14 AWG)

Table 11.2: Auxiliary power supply

U_{AUX}	110 (-20%) – 240 (+10%) V ac/dc 110/120/220/240 V ac 110/125/220 V dc or 24 – 48 ±20% V dc 24/48 V dc
Power consumption (order code –ABAAA-AAAA-AA) Power consumption increases when more I/O cards or optional I/O or communication cards are used.	< 20 W (internal) max 65W (internal + I/O units)

Table 11.3: I/O unit voltage supply

Rated voltage	24 V dc
Rated power	36 W

Table 11.4: Trip contact, Tx

Number of contacts	As per ordering code
Rated voltage	250 V ac/dc
Continuous carry	5 A
Minimum making current	100 mA at 24 Vdc
Typical operate time (applies only to arc output matrix controlled outputs)	≤8 ms
Make and carry, 0.5 s Make and carry, 3 s	30 A 15 A
Breaking capacity, ac	2 000 VA
Breaking capacity, dc (L/R = 40ms)	
at 48 V dc:	1.15 A
at 110 V dc:	0.5 A
at 220 V dc:	0.25 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 contact, A1

Number of contacts:	1
Rated voltage	250 V ac/dc
Continuous carry	5 A
Minimum making current	100 mA at 24 V ac/dc
Breaking capacity, dc (L/R = 40ms)	
at 48 V dc:	1 A
at 110 V dc:	0.3 A
at 220 V dc:	0.15 A
Contact material	AgNi 0.15 gold plated
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: Solid state outputs, HSO

Number of contacts	As per order code
Rated voltage	250 V ac/dc
Continuous carry	5 A
Minimum making current	-
Make and carry, 0.5 s Make and carry, 3s	30 A 15 A
Typical operation time (applies only to arc output matrix controlled outputs)	2 ms
Breaking capacity, DC (L/R=40ms)	
at 48 V dc:	5 A
at 110 V dc:	3 A
at 220 V dc:	1 A
Solid state	IGBT
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 11.7: Digital inputs internal operating voltage

Number of inputs	As per ordering code
Voltage withstand	265 V ac/dc
Nominal operation voltage for DI inputs	A: 24 – 230 V ac/dc (max. 265 V ac/dc) B: 110 – 230 V ac/dc (max. 265 V ac/dc) C: 220 – 230 V ac/dc (max. 265 V ac/dc)
Typical switching threshold	A: 12 V dc B: 75 V dc C: 155 V dc
Current drain	< 4 mA (typical approx. 3mA)
Activation time dc/ac	< 11 ms / < 15 ms
Reset time dc/ac	< 11 ms / < 15 ms
Terminal block: - MSTB2.5 – 5.08	Maximum wire dimension: 2.5 mm^2 (13 – 14 AWG)

NOTE: set dc/ac mode according to the used voltage in VAMPSET.

Table 11.8: Ethernet communication port

Number of ports	0 – 2 on rear panel (option)
Electrical connection	RJ-45 100Mbps (option) LC 100Mbps (option)
Protocols	IEC 61850 Modbus TCP DNP 3.0 Ethernet IP IEC 61870-5-101

Table 11.9: Ethernet fiber interface

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

11.1 Arc protection interface

Table 11.10: BIO inputs/outputs, slot 2 option B

Rated output voltage	+30 V dc
Rated input voltage	+18 – 265 V dc
Rated current (BO)	20 mA
Rated current (BI)	5 mA
BI line (IN)	3 x BI inputs
BO lines (OUT)	3 x BO inputs
Connection cable	Twisted pair with shield. Shield shall be grounded.

Table 11.11: BIO inputs/outputs, slot 2 option C

Maximum number of Inputs	4 x inputs
Connector	ST
Fibre	50/125 μm, 62.5/125 μm, 100/140 μm, and 200 μm
Max link distance	2 km (62.5/125 μm)
Max link attenuation	7 db
BI line (IN)	2 pcs
BO lines (OUT)	2 pcs

Table 11.12: Arc I/O bus (RJ-45)

Multi drop	Max 16 I/O units, including central units in 'slave' mode
Supply to I/O units	Isolated 24 V dc
Arc RS485 communication (master-slave)	RS-485 information/self-supervision
Bus length	Max 100 m, single cable length 30 m
Additional power supply requirement	After 30m Arc I/O bus cable or after 4 I/O units
Arc I/O communication	4 zone light 1 zone I_{EXT}

NOTE: Please see I/O manual (VIO/EN M/xxxx).

Table 11.13: Arc sensor inputs

Number of inputs	As per ordering code
Supply to sensor	Isolated 12 V dc

Table 11.14: Arc flash protection stages 1 – 8

Pick-up current: Phase currents Zero-sequence current	 0.50 – 8.00 x I_N (step 0.01) 0.10 – 5.00 x I_N (step 0.01)
Operation time: Mechanical output (T1 – T8) Semiconductor output (HSO1 – HSO2)	 Typically 7 ms Typically 2 ms
Inaccuracy: Current Delayed operation time	 ±5% of the set value +≤10 ms of the set value

11.2 Disturbance recorder

The operation of disturbance recorder depends on the following settings. The recording time and the number of records depend on the time setting and the number of selected channels.

Table 11.15: 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

12 Test and environmental conditions

Table 12.1: 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	
- 1 Mhz damped oscillatory wave	IEC 60255-22-1	±2.5kVp CM, ±2.5kVp DM
- Static discharge (ESD)	EN 61000-4-2 Level 4 / IEC 60255-22-2 Class 4	8 kV contact, 15 kV air
- Emitted HF field	EN 61000-4-3 Level 3 / IEC 60255-22-3	80 - 2700 MHz, 10 V/m
- Fast transients (EFT)	EN 61000-4-4 Level 4 / IEC 60255-22-4 Class A	4 kV, 5/50 ns, 5 kHz
- Surge	EN 61000-4-5 Level 4 / IEC 60255-22-5	4 kV, 1.2/50 µs, CM 2 kV, 1.2/50 µs, DM
- Conducted HF field	EN 61000-4-6 Level 3 / IEC 60255-22-6	0.15 - 80 MHz, 10 Vrms
- Power-frequency magnetic field	EN 61000-4-8	300A/m (continuous), 1000A/m 1-3s
- Pulse magnetic field	EN 61000-4-9 Level 5	1000A/m, 1.2/50 µs
- Voltage dips	EN 61000-4-29 / IEC 60255-11	30%/1s, 60%/0.1s, 100%/0.01s
- Voltage short interruptions	EN 61000-4-11	30%/10ms, 100%/10ms, 60%/100ms >95%/5000ms
- Voltage alternative component	EN 61000-4-17 / IEC 60255-11	12% of operating voltage (DC) / 10min

Table 12.2: Electrical safety tests

Test	Standard & Test class / level	Test value
- Impulse voltage withstand	EN 60255-5, Class III	5 kV, 1.2/50 µs, 0.5 J 1 kV, 1.2/50 µs, 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	>100Mohm, 500V / 100V
- Protective bonding resistance	EN 60255-27	< 0,1 ohm
- Power supply burden	IEC 60255-1	> 20W internal

Table 12.3: Mechanical tests

Test	Standard & Test class / level	Test value
Device in operation		
- Vibrations	IEC 60255-21-1, Class II / IEC 60068-2-6, Fc	1Gn, 10Hz – 150 HZ
- Shocks	IEC 60255-21-2, Class II / IEC 60068-2-27, Ea	10Gn/11ms
Device de-energized		
- Vibrations	IEC 60255-21-1, Class II / IEC 60068-2-6, Fc	2Gn, 10Hz – 150 HZ
- Shocks	IEC 60255-21-2, Class II / IEC 60068-2-27, Ea	30Gn/11ms
- Bump	IEC 60255-21-2, Class II / IEC 60068-2-27, Ea	20Gn/16ms

Table 12.4: Environmental tests

Test	Standard & Test class / level	Test value
Device in operation		
- Dry heat	EN / IEC 60068-2-2, Bd	70°C (158°F)
- Cold	EN / IEC 60068-2-1, Ad	-40°C (-40°F)
- Damp heat, cyclic	EN / IEC 60068-2-30, Db	• From 25°C (77°F) to 55°C (131°F) • From 93% RH to 98% RH • Testing duration: 6 days
- Damp heat, static	EN / IEC 60068-2-78, Cab	• 40°C (104°F) • 93% RH • Testing duration: 10 days
Device in storage		
- Dry heat	EN / IEC 60068-2-2, Bb	70°C (158°F)
- Cold	EN / IEC 60068-2-1, Ab	-40°C (-40°F)

Table 12.5: Environmental conditions

Ambient temperature, in-service	-40 – 65°C (-40 – 149°F)*
Ambient temperature, storage	-40 – 70°C (-40 – 158°F)
Relative air humidity	< 95%
Maximum operating altitude	2000 m (6561.68 ft)

* Recommended values with VYX 695 projection mounting frame:

- VAMP 321 with 2 x raising frame -> maximum ambient temperature 50°C
- VAMP 321 with 1 x raising frame -> maximum ambient temperature 55°C

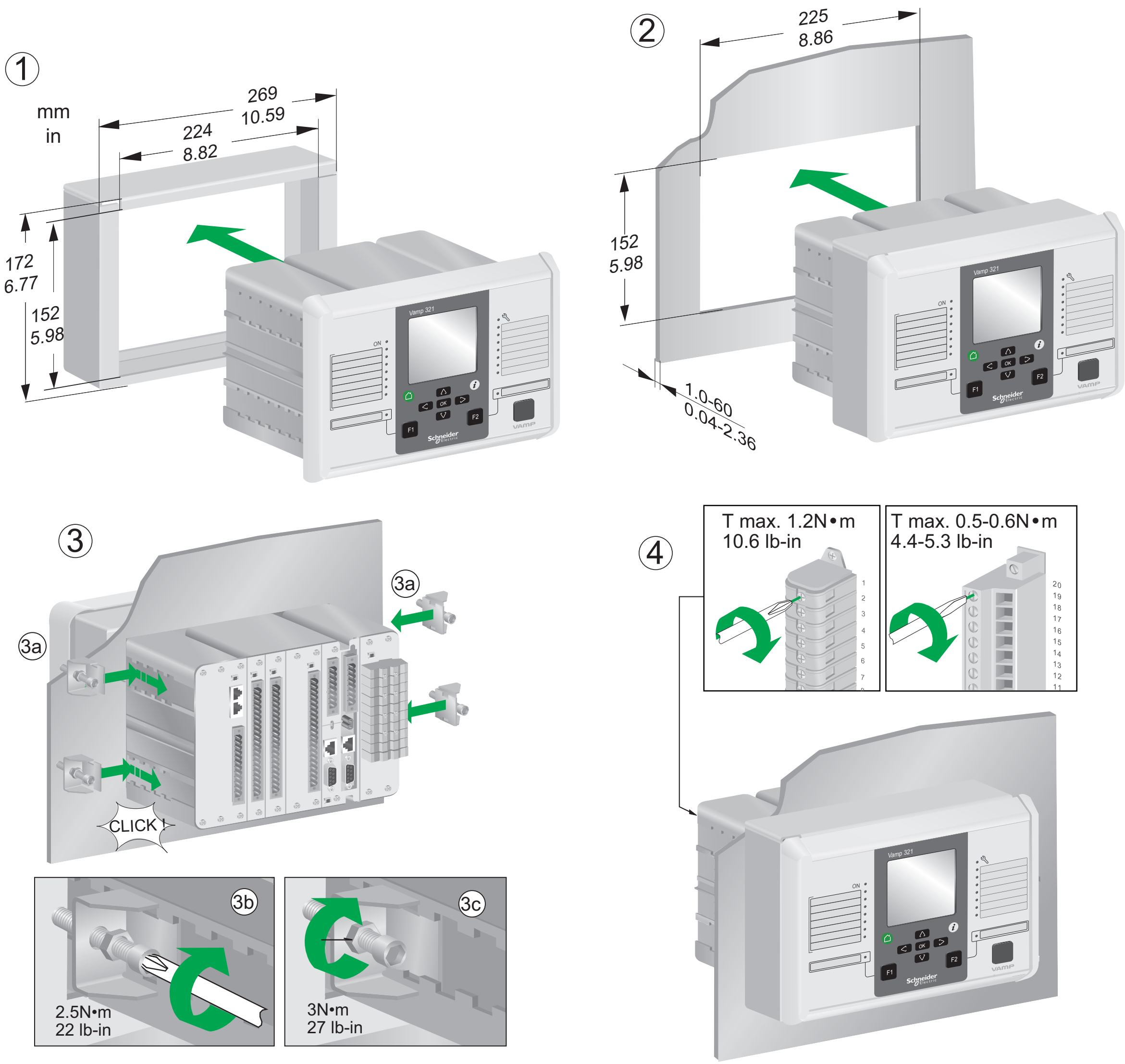
Table 12.6: Casing

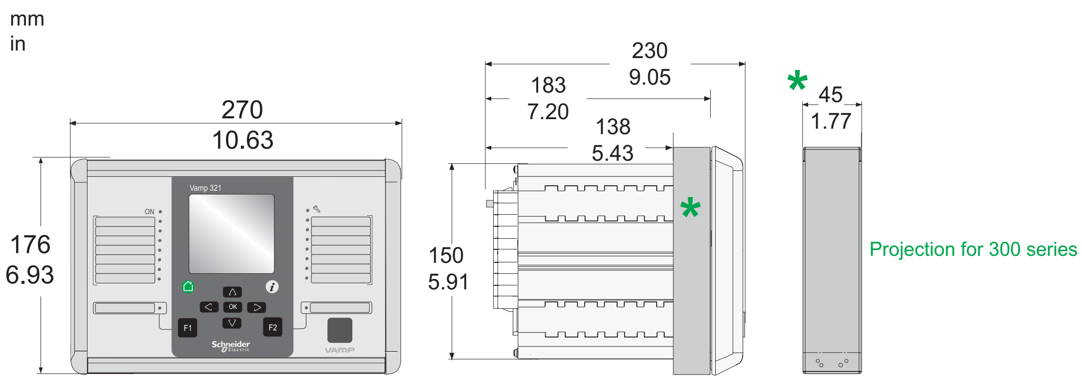
Degree of protection (IEC 60529)	IP54 front panel, IP 20 rear panel
Dimensions (W x H x D)	270 x 176 x 230 mm / 10.63 x 6.93 x 9.06 in
Weight	4.0 kg (8.830 lb)

13 Mounting

NOTE: See the mounting and commissioning instructions for more information.

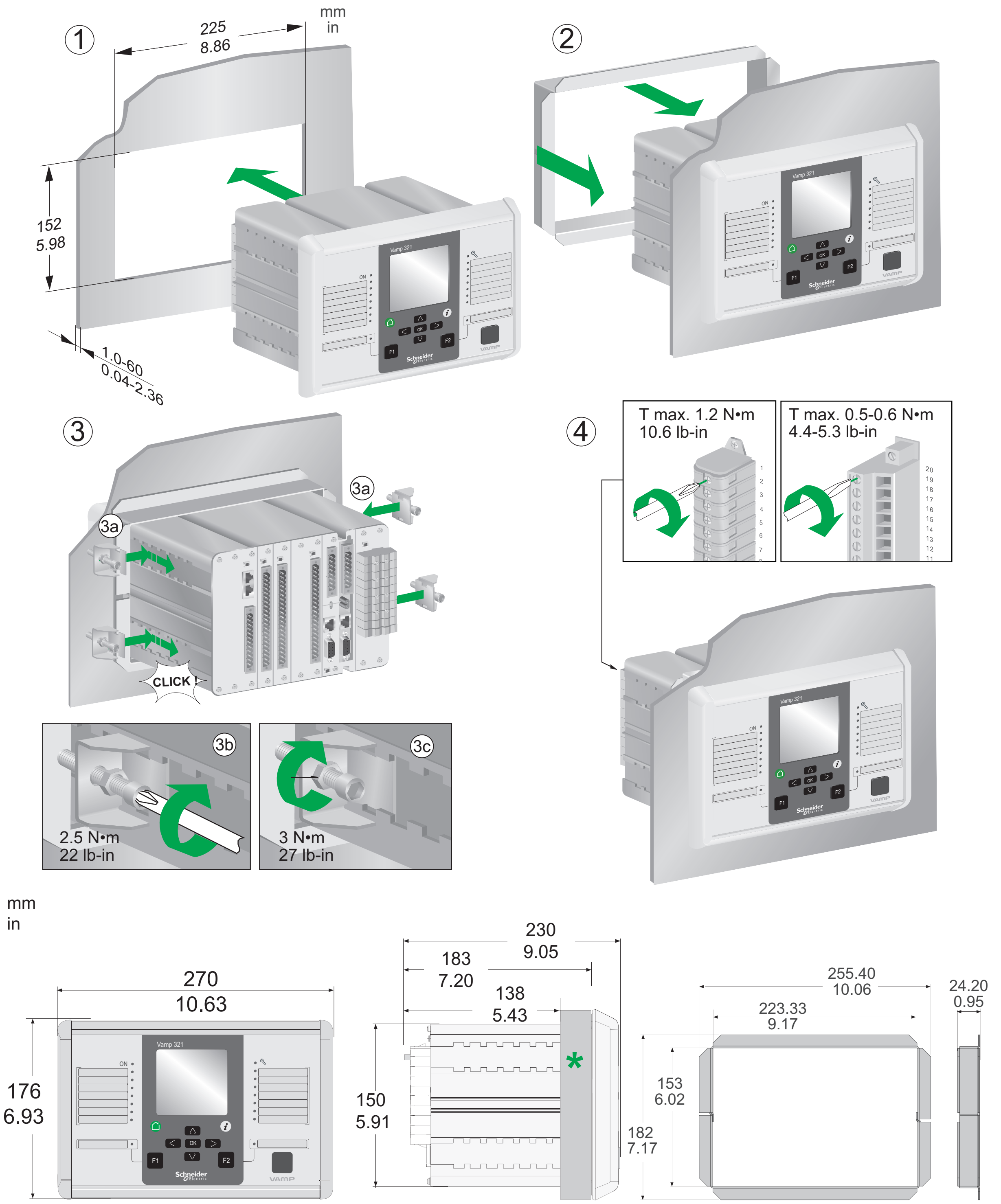
VAMP 321 PROJECTION MOUNTING





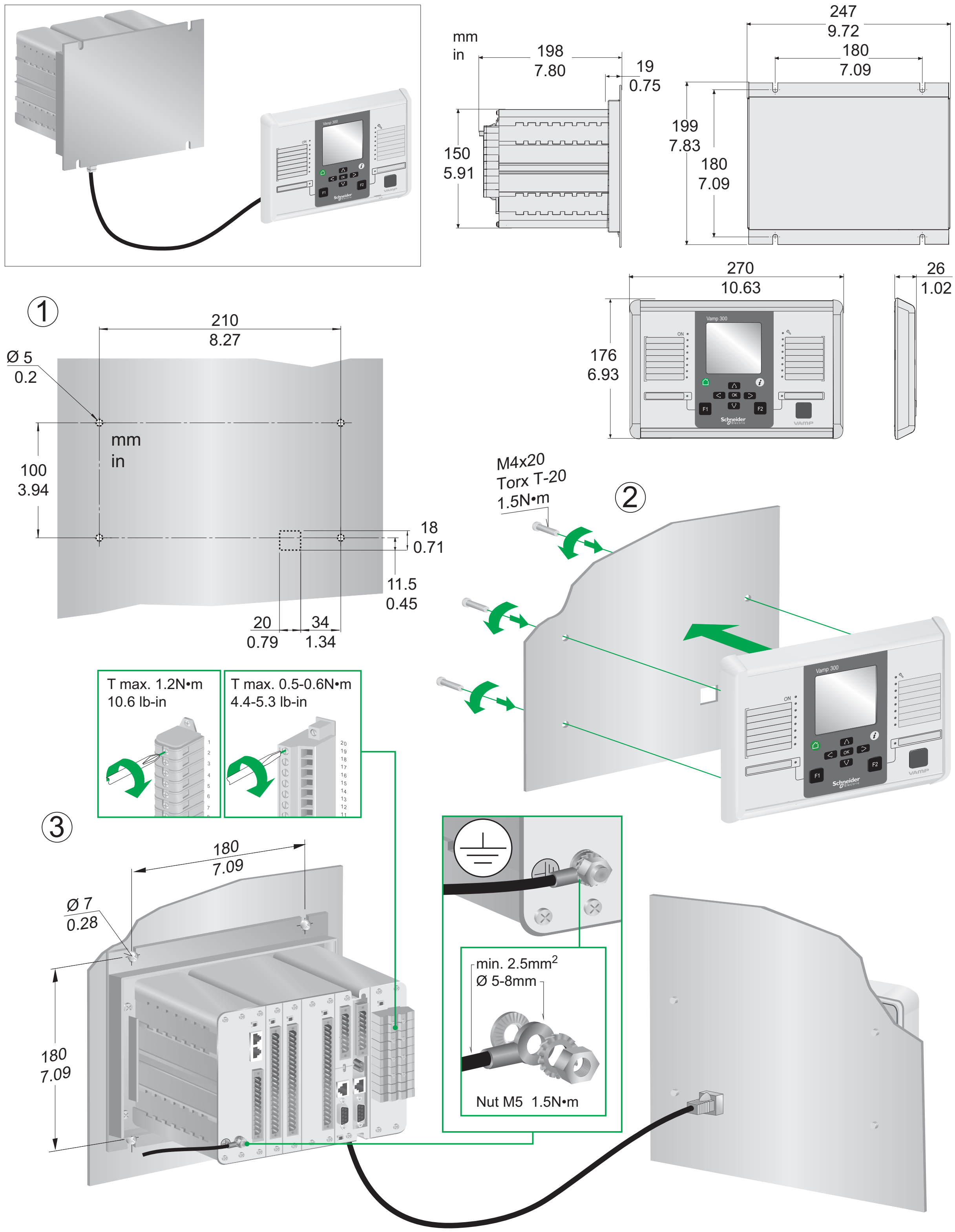
In case the depth dimension behind the compartment door is limited, the IED can be equipped with frame around the collar. This arrangement reduces depth inside compartment by 45 mm.

VAMP 321 PANEL MOUNTING



The conventional mounting technique has always been installing the IED on the secondary compartment's door. Limitation in this approach could be that the door construction is not strong enough for the IED's weight and suitability to wire large amount of secondary and communication cabling could be challenging.

VAMP 321 WALL MOUNTING WITH DETACHABLE HMI



This mounting technique allows door being lighter as the relays frame is installed in the back of the secondary compartment. Normally, the IED in this mounting principle is by the terminal blocks, hence the secondary wiring is short. Communication cabling is easier, too, as the door movement does not need to be considered. In this case, only the communication between IED base and display has to be wired.

14 Commissioning and Testing

The commissioning and testing procedure is introduced in separate Testing Manual VARCTEST/EN M/xxxx. Study the testing document before executing commissioning or testing.

By default the over current setting is set to 1.2 xI_N. Make sure that the over current setting is made in accordance to protection selectivity study to comply CT and other requirements.

During testing, pay attention and check that correct breakers trip in accordance with the zone selection.

14.1 Decommissioning

In case the commissioned system requires decommissioning where system components are changed or removed make sure that the switchgear to be protected is turned off.

⚠ WARNING

DECOMMISSIONING OF ARC PROTECTION SYSTEM

Turn off all power during decommissioning activities.

Use a properly rated measurement tool to confirm power is off.

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

Make sure that the switchgear is restored back to its original construction if arc protection components are removed from the gear. Pay attention that possible holes, and cut-outs are not left in the switchgear.

15 Maintenance

The VAMP arc products and its extension units require maintenance in order to work according to specification. Keep record of the maintenance actions performed for the system. The maintenance can include, but is not limited the following actions.

15.1 Preventative maintenance

The VAMP 321 IED and its extension units, sensor and cabling shall be visually checked when the switchgear is de-energized. During such inspection pay attention to

- possible dirty arc sensors
- loose wire connections
- damaged wiring
- indicator lights (see section LED test sequence) and
- other mechanical connections.

Visual inspection shall be made minimum every three (3) years.

15.2 Periodical testing

The VAMP 321 IED and its satellite extension units, cabling and sensors must periodically be tested according to the end-user's safety instructions, national safety instructions or law. Manufacturer recommend 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 and its extension units.

Follow separate testing manual (VARCTEST/EN/M_xxxx) for a test protocol.

15.3 Cleaning of hardware

Special attention must be paid that the IED, it's extension units and sensors do not become dirty. In case cleaning is required, wipe out dirt from the units.

15.4 Sensor condition and positioning check

After commissioning, sensor replacement, modification procedure, cleaning and periodical testing always check that the sensor positioning remains as it was originally designed.

15.5 System status messages

In case IED's self checking detects unindented system status it will in most of the cases provide alarm concerning this by activating the Service LED and indication status notification on the LCD screen. Should this happen store the possible message and contact your local representative for further guidance.

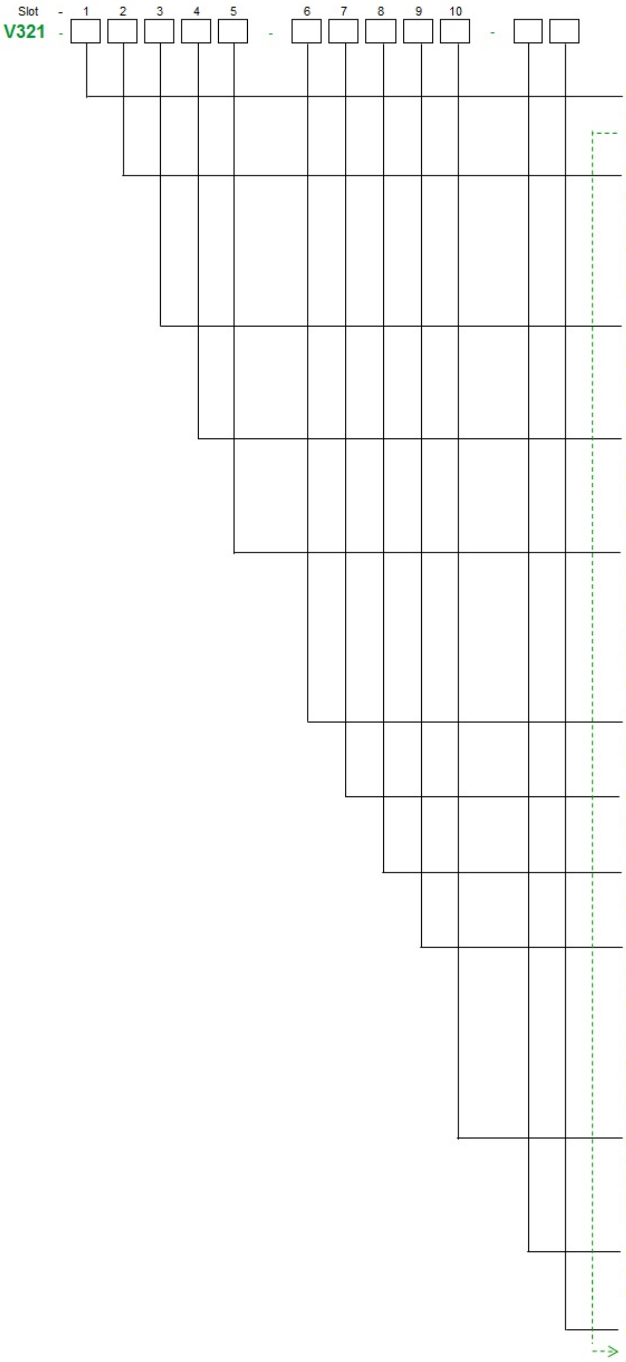
15.6 Spare parts

Use entire unit as a spare for the device to be replaced. Always store spare parts in storage areas that meet requirements stated in Chapter 12 Test and environmental conditions.

16 Order information

When ordering, please state:

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



Nominal Supply voltage [V]
- A = Power A 110 - 240 V (80 - 265Vac/dc, T1, A1, SF)
- B = Power B 24 - 48 V (18 - 60Vdc, T1, A1, SF) (1

I/O Card I
- A = None
- B = 3BIO+2Arc (3 x BI/BO, 2 x Arc sensor, T2, T3, T4)
- C = F2BIO+1Arc (Fibre 2 x BI/BO, 1 x Arc loop sensor, T2, T3, T4)
- G = 6DI+4DO (6 x DI, 4 x DO)
- H = 6DI+4DO (6 x DI, 4 x DO(NC))
- I = 10DI (10 x DI)

I/O Card II
- A = None
- G = 6DI+4DO (6 x DI, 4 x DO)
- H = 6DI+4DO (6 x DI, 4 x DO(NC))
- I = 10DI (10 x DI)

I/O Card III
- A = None
- G = 6DI+4DO (6 x DI, 4 x DO)
- H = 6DI+4DO (6 x DI, 4 x DO(NC))
- I = 10DI (10 x DI)

I/O Card IV
- A = None
- D = 2IGBT (2 x IGBT High speed outputs), excludes I/O Card III, slot 4
- E = QD (VAM 3QD control card)
- F = 3TD/3ED (VAM 3TD/3ED control interface)
- G = 6DI+4DO (6 x DI, 4 x DO)
- H = 6DI+4DO (6 x DI, 4 x DO(NC))
- I = 10DI (10 x DI)

I/O Option card I
- A = None
- D = 4Arc (4 x Arc sensor)

I/O Option card II
- A = None
- D = 4Arc (4 x Arc sensor)

Analog measurement card [A, V]
- A = 3L+U+Io (5/1A)
- G = 3L + Io (5/1A) + U, Ring lug terminals

Communication interface I
- A = None
- B = RS232 (RS232, IRIG-B)
- C = RS232+RJ (RS232, IRIG-B + Ethernet RJ-45 100 Mbs)
- D = RS232+LC (RS232, IRIG-B + Ethernet LC 100 Mbs)
- N = 2xRJ (Ethernet RJ 100 Mbs, RSTP)
- O = 2xLC (Ethernet LC 100 Mbs, RSTP)
- P = PP (Plastic / Plastic serial fibre)
- R = GG (Glass / Glass serial fibre)

Communication interface II
- A = None
- B = RS232
- P = PP (Plastic / Plastic serial fibre)
- R = GG (Glass / Glass serial fibre)

Display type
- B = 128x128 (128 x 128 LCD matrix)
- C = 128x128Ext (128 x 128 LCD matrix, detachable) (2

DI nominal activation voltage
- 1 = 24 VDC / 110 VAC
- 2 = 110 VDC / 220 VAC
- 3 = 220 VDC
- A = 24Vdc/ac, WITH conformal coating
- B = 110 Vdc/ac, WITHconformal coating
- C = 220 Vdc/ac, WITH conformal coating

Note
1) In case Auxiliary supply variant "D" is chosen then must use 24 Vdc/ac DI nominal voltage
2) By default cable lenght is 2 m. In case other leght is needed order separately VX001-1, Vx001-3 or VX001-5 for 1 m, 3 m and 5 m respectively.

Accessories

Order code	Description	Note
VAM 3L	Fibre sensor I/O unit (VAMP221 and 321)	3 fibre loops, 1 trip relay
VAM 3LX	Fibre sensor I/O unit (VAMP221 and 321)	3 fibre loops, 1 trip relay, adjustable sensitivity
VAM 4C	Current I/O unit (VAMP221 and 321)	3 current inputs, 1 trip relay
VAM 4CD	Current I/O unit (VAMP221 and 321)	3 current inputs, 1 trip relay, flush mounting
VAM 4CRL	Current I/O unit (VAMP221 and 321)	3 current inputs, 1 trip relay, ring-lug connector
VAM 10L	Point sensor I/O unit (VAMP221 and 321)	10 sensor inputs, 1 trip relay
VAM 10LD	Point sensor I/O unit (VAMP221 and 321)	10 sensor inputs, 1 trip relay, flush mounting
VAM 12L	Point sensor I/O unit (VAMP221 and 321)	10 sensor inputs, 3 trip relays
VAM 12LD	Point sensor I/O unit (VAMP221 and 321)	10 sensor inputs, 3 trip relays, flush mounting
VAMP 4R	Trip multiplier relay	4 x NO, 4 x NC, 2 groups
VA 1 DA-6	Arc sensor	Cable length 6 m (19.69 ft)
VA 1 DA-20	Arc sensor	Cable length 20 m (65.62 ft)
VA 1 DA-6s	Arc Sensor, shielded	Cable length 6 m (19.69 ft)
VA 1 DA-20s	Arc Sensor, shielded	Cable length 20 m (65.62 ft)
VA 1 DA-6-HF	Arc Sensor, halogen free	Cable length 6 m (19.69 ft)
VA 1 DA-20-HF	Arc Sensor, halogen free	Cable length 20 m (65.62 ft)
VA 1 EH-6	Arc Sensor (Pipe type)	Cable length 6 m (19.69 ft)
VA 1 EH-20	Arc Sensor (Pipe type)	Cable length 20 m (65.62 ft)
VA 1 EH-6S-IP	Arc Sensor, shielded (Pipe type, IP65)	Cable length 6 m (19.69 ft)
VA 1 EH-20S-IP	Arc Sensor, shielded (Pipe type, IP65)	Cable length 20 m (65.62 ft)
VA 1 EH-20-IP	Arc Sensor (Pipe type, IP65)	Cable length 20 m (65.62 ft)
VA 2 DV-5	Arc Sensor, shielded (metal pipe)	Cable length 5 m (16.41 ft)
VA 2 DV-11	Arc Sensor, shielded (metal pipe)	Cable length 11 m (36.09 ft)
VA 2 DV-15	Arc Sensor, shielded (metal pipe)	Cable length 15 m (49.22 ft)
VA 1 DP-5	Portable Arc Sensor	Cable length 5 m (16.41 ft)
VA 1 DP-5D	Portable Arc Sensor	Cable length 5 m (16.41 ft)
VA 1 GIS-1,5	Arc Sensor, shielded with GIS adapter	Cable length 1.5 m (4.93 ft)
VA 1 GIS-3	Arc Sensor, shielded with GIS adapter	Cable length 3 m (9.85 ft) Cable length 9.85 ft (3 m)
VA 1 GIS-5	Arc Sensor, shielded with GIS adapter	Cable length 5 m (16.41 ft)
VA 1 GIS-10	Arc Sensor, shielded with GIS adapter	Cable length 10 m (32.81 ft)
ARC SLm-x	Fibre sensor, 8 000 lx	x = fiber length (1
SLS-1	Fiber joint SLS-1	Max one joint per fiber
VX001-xx	Modular Cable VAM - VAM (xx = Cable length [m])	Preferred Cable Lengths (2
VX031-5	Extension cable for VA1DP-5D	Cable length 5 m (16.41 ft)
VX052-3	USB programming cable (VAMPSET)	Cable length 3 m (9.85 ft)
VX072	VAMP 300/321 profibus cable	Cable length 3 m (9.85 ft)

Order code	Description	Note
VYX 001	Surface Mounting Plate for Sensors	Z-shaped
VYX 002	Surface Mounting Plate for Sensors	L-shaped
VYX 628	Surface Mounting Plate for VA 1 DV Sensor	U-shaped
VYX 695	Projection for 300-series	Height 45 mm (1.78 in)
VSE001PP	Fibre optic Interface Module (plastic - plastic)	Max. distance 30 m (99 ft)
VSE002	RS485 Interface Module	
VPA 3CG	Profibus DP fieldbus option board	

Note 1. Fibre lengths: 1, 5, 10, 15, 20, 25, 30, 35, 40, 50, 60 or 70 m

Note 2. Cable lengths: 1, 3, 5, 7, 10, 15, 20, 25 & 30 m

17 Firmware history

Firmware version	Changes
10.85	First version
10.89	Support for IEC 61850
10.102	Support for “2xIGBT” card and “6DI/4DO” card
10.107	Support for Fibre I/O card
10.113	Arc sensor status on web browser / local LCD display
10.119	DHCP service implementation. CPU and FPGA latches, IO unit latches and regs. can be cleared from HMI by pressing i -> right arrow (password needs to be opened) New events from the following situations: - I/O unit installation ready - Release latches - Clear I/O unit registers More comprehensive DST functions
10.127	IEC 101 over Ethernet

10.145	Extended DI / DO support, RSTP, New release latches function IFTest fixed. ARC diag controls IF relay only when needed 61850 File Transfer added Difference of 2 signals compare mode in programmable stage added ExtAI/RTD enhancement: Open RTD sensor alarm added ExtAI/RTD enhancement: RTD shorted alarm added ExtAI/RTD enhancement: RTD communication loss alarm added Latch connection in Arc stages prohibited (in OUTPUT MATRIX) fixed FTP: Passive mode added Support for 10DI card added User can assign digital inputs to each card (if there are no DI's assigned to any card, defaults assignments are set automatically) added Latches from arc matrix - output also copied into CPU's output matrix added User can assign output relays to each card (T13...T30) added Max demand currents can be used in mimic and meas displays added Backup SNTP server added New "Webset" web server added Logic: added support for logic output events 17..20 added Possible to remove linked channels from disturbance recorder one by one added UDP mode for IEC 101 over Ethernet added QD: OUTPUT MATRIX lines added: QD-1 OK, QD-2 OK, QD-1 activated, QD-2 activated, QD-1 error, QD-2 error Support for BIOs added Support for folder view added Default sample rate is now 32/cycle in disturbance recorder Support for dual port ethernet cards 2EthRJ & 2EthLC added Support for arc stages' minimum hold time added IEC 61850: Enhanchements fixed

10.152	DNP3: enhancements fixed IRIG-B004: Year information taken from sync message IEC 101: enhancements fixed Option card recognition improvements Added support for editable output relays labels IEC61850: enhancements fixed Webset improvements 61850: Object inactivity alarm added Object6 added to block matrix Setting range changed to 2-250 for arc stages Min. Hold time. Default value for arc stages min. hold time changed to 2 (20ms).
10.157	Full support for 128x128 display Disturbance recorder memory size increased from 256kB to 512kB IEC61850: enhancements fixed Binary channels supervision signals added to output matrix
10.168	RSTP: Counters added for received and sent packets (per port) Event scroll order & event buffer clearing added to local panel conf in VAMPSET VAM4C L1 & L3 activation bits swapped to be correct DNP3 & IEC-101: internal temperature measurement added to analog input list FUNCTION BUTTONS: F1 & F2 pulse length can be defined IEC 61850: GOOSE messages can include quality attributes RELAYS: Relay name can be 10 characters long RELAYS: Object names are editable Arc I/O: V321 Several improvements to selfdiagnostic between master and slave units BI test enable removed from VAMPSET menu. User cannot turn it off anymore. IEC 61850: Improvements to object control
10.175 / 19.108	Number of setting groups increased from 2 to 4 When accept zero delay enabled, stages' definite operation delay can be set to 0 RELEASE OUTPUT MATRIX LATCHES renamed to RELEASE LATCHES Alarm logs for diagnosis
19.117	New virtual inputs and outputs - VI5-20 & VO7-VO20 USB auto-disabling (timer-based) FPGA register test Add "Arc I/O light sensor" matrix signal. On whenever any arc I/O light sensor is activated, including VAM12L channels 1..3

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