VAMP 140

Overcurrent and earth-fault relay

Operation and configuration instructions

Technical description

Table of Content

1. General

This part of the manual describes the general functions of the combined overcurrent and earth-fault relay VAMP 140 and includes the relay operation instructions. It also includes instructions on parameterisation and configuration of the relay and instructions on changing of settings.

The second part of the publication includes detailed protection function descriptions as well as application examples and technical data sheets.

The Mounting and Operation Instructions are published in a separate publication, code named VMMC.EN0xx.

1.1. Relay features

The combined overcurrent and earth-fault relay VAMP 140 is a non-directional current measuring protection relay for overcurrent, short-circuit and earth-fault protection. It features the following protection functions:

- Three overcurrent stages
- Three earth fault stages
- One sensitive earth fault stage
- Current unbalance stage
- Circuit breaker failure protection

Further the relay includes a disturbance recorder and is optionally available with an arc supervision unit. It is also equipped with a current measuring transducer, the output signal of which can be wired to an external meter or a SCADA system.

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

1.2. Operating safety

The terminals on the rear panel of the relay may carry dangerous voltages, although the auxiliary voltage is switched off. A live current transformer secondary circuit must not be opened.

Disconnecting a live circuit may cause dangerous voltages! Any operational measure must be carried out according to national and local handling directives and instructions.

Carefully read through the relay operation instructions before any relay operational measures are carried out.

2. User interface

2.1. General

The VAMP 140 relay can be controlled in three ways:

- Locally with the push-buttons on the relay front panel
- Locally with a PC connected to the serial port on the relay front panel
- Via the remote control port on the relay rear panel.

2.2. Local panel

Figure 2.2-1 below shows the location of the components of the local user interface on the front panel of the relay.

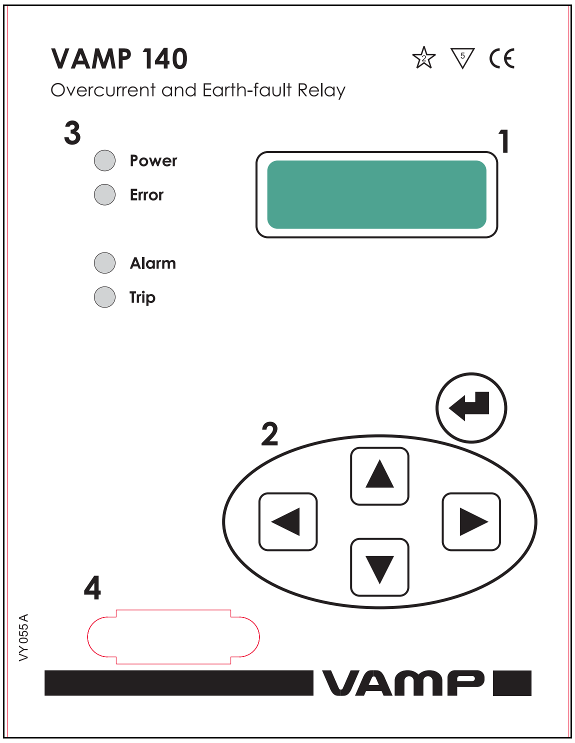


Figure 2.2-1 Relay front panel.

1. Alpha-numerical LED display
2. Key pad
3. LED indicators
4. RS 232 serial communication port for a PC

2.2.1. Display

The VAMP 140 relay is provided with a clear 10 character alphanumerical LED display, which normally shows a scrolling text.

Use the SERVICE/Setup/Bright menu to set the brightness of the display. The display is dimmed after a preset time.

Use the SERVICE/Setup/ScrolDelay menu to set the scrolling speed of the display text.

2.2.2. Key pad

Use the key pad and the display to navigate through the menus and to set the required parameters. The keypad comprises the following keys:

LEFT, RIGHT, UP, DOWN and the ENTER key.

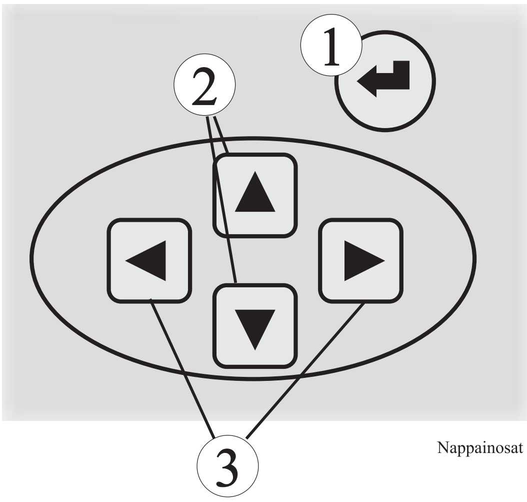


Figure 2.2.2-1 Components of the key pad.

1. Enter and confirmation key (ENTER)
2. UP/DOWN [INCREASE/DECREASE] arrow keys (UP/DOWN)
3. LEFT/RIGHT arrow keys [for selection of digit position] (LEFT/RIGHT)

2.2.3. Indicators

The relay front panel holds 4 LED indicators:

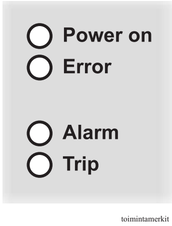


Figure 2.2.3-1 Relay operation indicators.

Relay operation indicators:

Power on	auxiliary voltage indicator
Error	self-supervision fault, the self-supervision output relay operates in parallel with the indicator
Alarm	starting of protection stage
Trip	tripping of protection stage

3. Local panel operations

The local panel can be used to read measured values, set parameters and configure relay functions. However, please note that some of the parameters can only be set by means of a PC connected to the local communication port. Further, some parameters are factory set.

3.1. Navigation in the menus

All setting, resetting, etc. functions are carried out via menu functions, see Figure 3.1-1:

1. Use UP and DOWN arrow keys to move up and down in the main menu. The active menu is the one seen in the display. The menu names are shown with their full length or abbreviated, e.g. IL STATUS = status display for the different current stages.
2. Use the RIGHT key to move to the function level of the required menu, e.g. I> Stat.

   Use the LEFT key to cancel the selection.
3. Use the RIGHT key to move to the parameter level of the selected function, e.g. SCntr.

   Use the UP and DOWN keys to scroll through the other parameters on the same function level.
4. Confirm the selection of setting state of the requested parameter by pushing ENTER and by entering the password corresponding to the setting level.
5. Push LEFT for at least 2 s to exit from the setting state of a parameter without changing the setting value or,
6. Push ENTER to confirm and store the parameter setting.

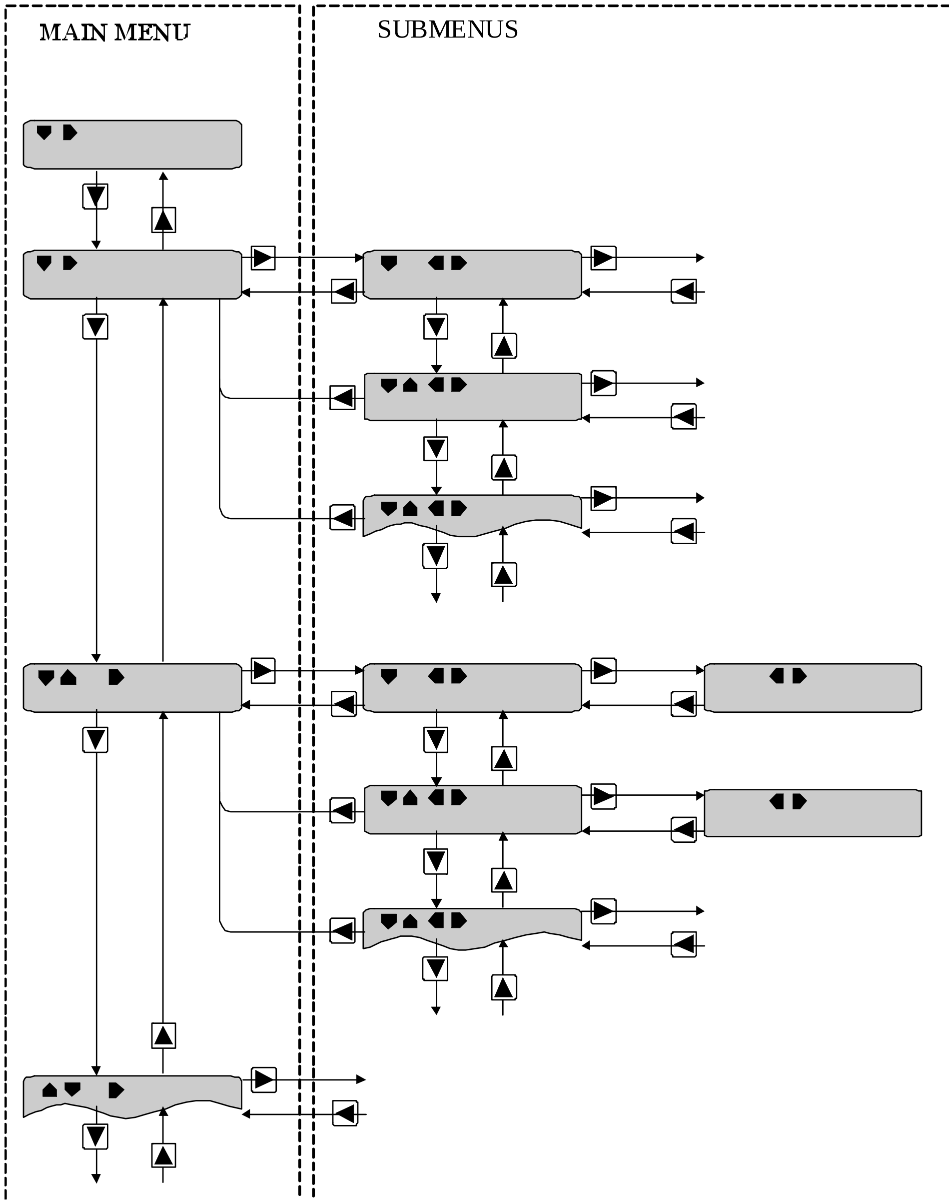
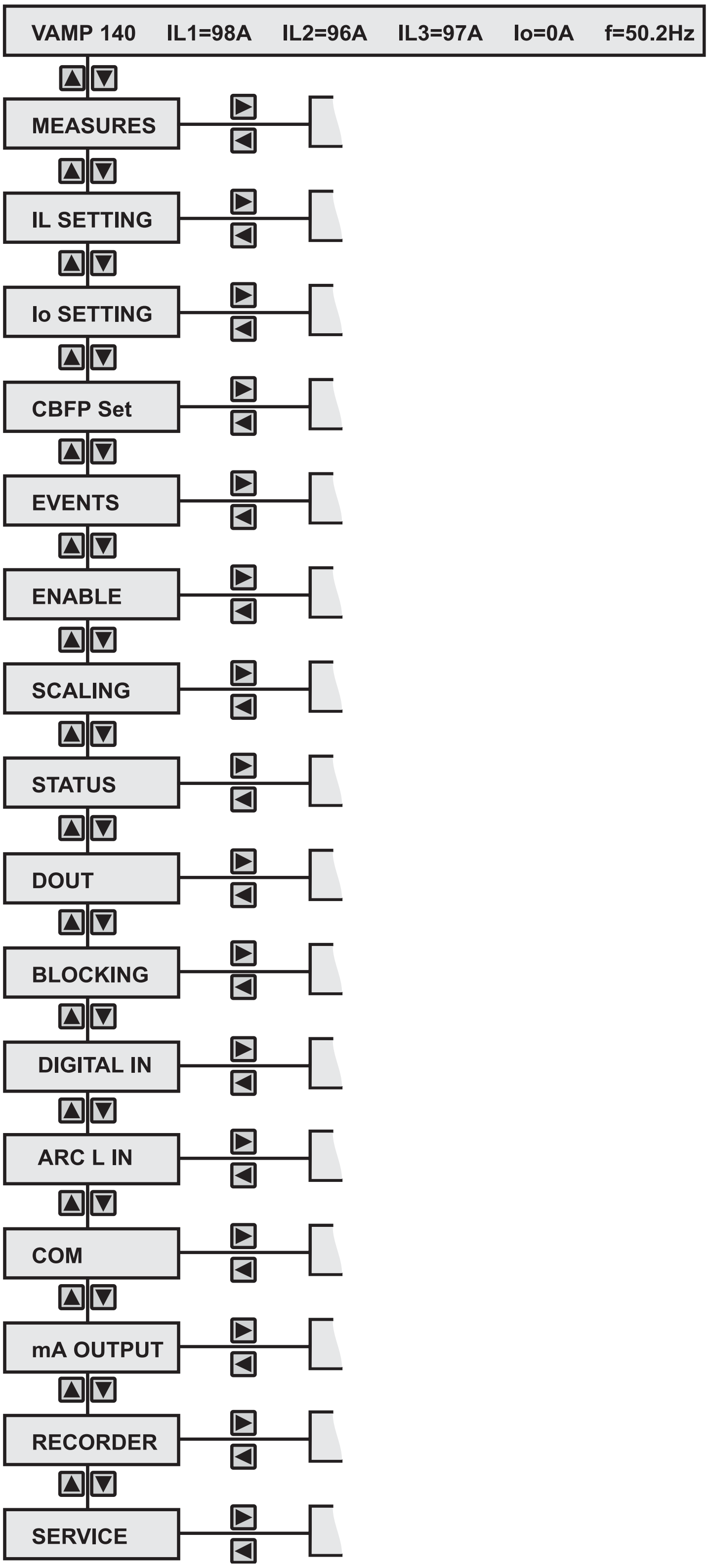


Figure 3.1-1 The principle of the menu structure and navigation in the menus.

3.1.1. Function menu table



mainmenu.cdr

Figure 3.1.1-1 Main menu of the VAMP 140 relay.

3.1.2. Basic menu structure of protection functions

Example I>:

IL SETTING / I> SET:

I>	110A	Set value of protection function [A]
I>	1.10pu	Set value of protection function [pu]
curve	DT	Selection of delay characteristic (DT, NI, VI, EI, LTI)
t>	0.30s	

STATUS I> stat:

SCntr	-	Start counter
TCntr	-	Trip counter
Force	-	Forced operation of state (ON/OFF)
Status	-	-, Start, Trip, Blocked

3.2. Operating levels

The relay features three operating levels, i.e. the User, the Operator and the Configuration level. The purpose of the operating levels is to prevent accidental change of relay configurations, parameterizations or settings.

USER level

Use: Parameter values can be read
Opening: Level permanently open
Closing: Closing not possible

OPERATOR level

Use:	Settings of protection stages can be changed.
Opening:	The default password is 0001.
Setting state:	On entering the parameter setting state a password must be given, see 3.2.1.
Closing:	The level is automatically closed when 10 minutes has elapsed since a key was pushed or a setting was done via the local port. The level can also be closed by giving the password 9999.

CONFIGURATION level

Use:	The configuration level is needed during the commissioning of the relay. E.g. the turn ratios of the current transformers, for example, can be set.
Opening:	The default password is 0002
Configure state:	On entering the parameter setting state a password must be given, see 3.2.1.
Closing:	The level is automatically closed when 10 minutes has elapsed since a key was pushed or a setting was done via the local port. The level can also be closed by giving the password 9999

3.2.1. Opening operating levels

1. Move to the item to be changed, e.g. IL SETTING/I>Set/ I>: 1.20 pu. Push the ENTER key twice on the front panel.

```
Give OPERATOR password
```

```
                  +++0
```

Figure 3.2.1-1 Opening an operating level

2. Enter the password needed for the desired level: The password may contain four digits. The digits are supplied one by one by first moving to the position of the digit using the RIGHT key and then setting the desired digit value using the UP key.
3. Push ENTER.

3.2.2. Changing passwords

The set passwords can only be changed using a PC connected to the local RS 232 port on the relay.

4. Operating measures

General

Carefully study the operating instructions in Chapters 1 through 3 of this manual before any operating measures are taken or before any relay settings or functions are changed.

The relay can be controlled by means of the MMI on the relay front panel, a PC running the VAMPSET software, a PC running suitable terminal software or a remote control system.

4.1. Measured data

The measured values can be read from the main menu MEASURES menu and its submenus shown in the figure below.

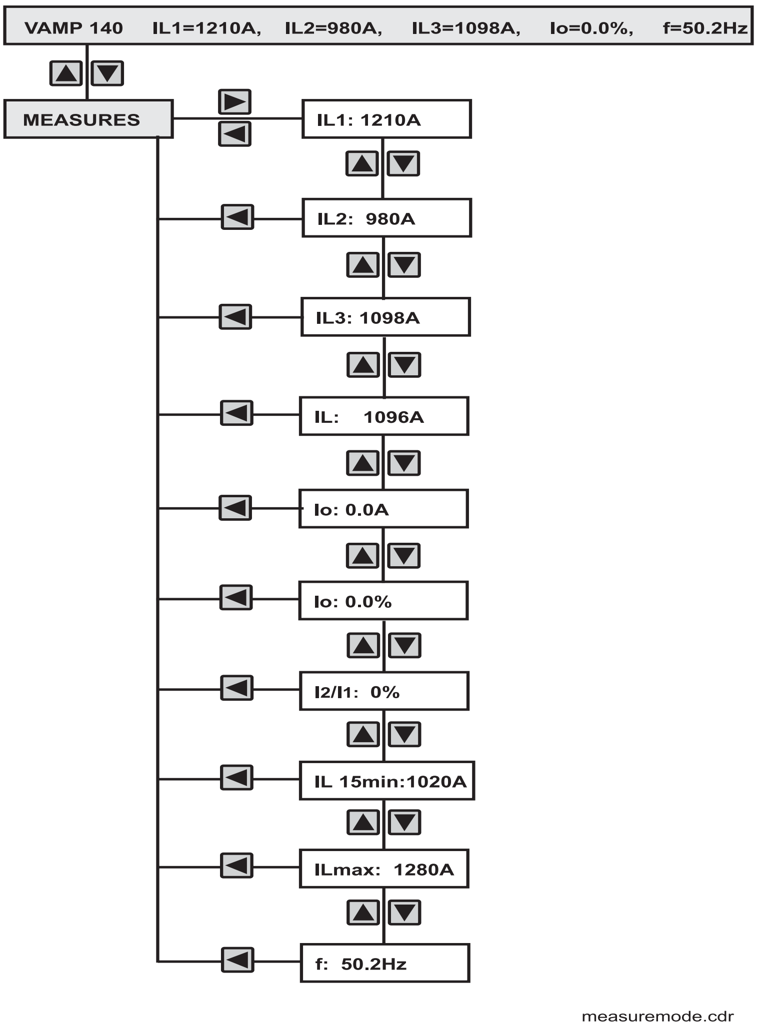


Figure 4.1-1 Measures menu of VAMP 140 relay.

4.2. Operation indicators

LED indicators	Explanation	Measure/ remarks
Power LED lit	The auxiliary power switched on	Normal operating state
Error LED lit	An internal relay fault has been detected	The relay attempts to reboot. If the error LED remains lit, call for maintenance
Alarm LED lit	One or several signals of the output relay matrix have been assigned to output Alarm and the output has been activated by one of the signals. (see Chapter 5.5)	The LED is switched off, when the signal that caused output Alarm to activate, e.g. the START signal, resets. The resetting depends on the type of configuration; Connected or Latched.
TRIP LED lit	One or several signals of the output relay matrix have been assigned to output Trip and the output has been activated by one of the signals. (see Chapter 5.5)	The LED is switched off, when the signal that caused output Trip to activate, e.g. the TRIP signal, resets. The resetting depends on the type of configuration; Connected or Latched.

Resetting latched indicators and output relays

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

There are several ways to reset latched indicators and relays:

1. Move to the initial display, from the alarm list, by pushing the CANCEL key for approx. 3 s. Then reset the latched indicators and output relays by pushing the ENTER key.
2. Acknowledge each event in the alarm list one by one, by pushing ENTER the equivalent times. Then, in the initial display, reset the latched indicators and output relays by pushing the ENTER key.

The latchings can also be reset via the communications bus or via a DI input configured for that purpose.

4.3. Reading of event register

The event register can be read from the Events item of the main menu:

1. Push the RIGHT key once, the displays shows the Event info text
2. Push the RIGHT key once, the displays shows Count: x, where x = the number of recorded events
3. Push the DOWN key once, the display shows the ClrEv text. The event register can now be reset.
4. Push the LEFT key to return to the Event info menu (by pressing twice you can return to the main menu)
5. Push the DOWN key to return to the Event list menu:

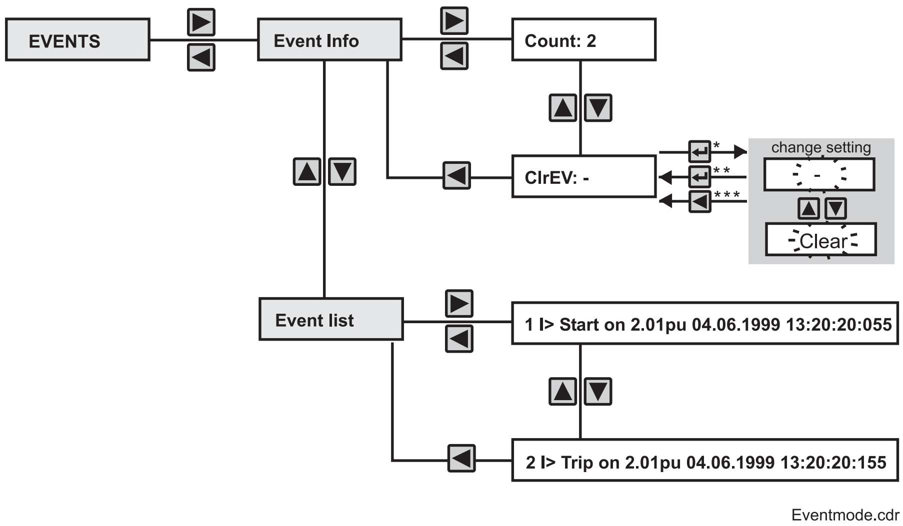


Figure 4.3-1 Event register, example.

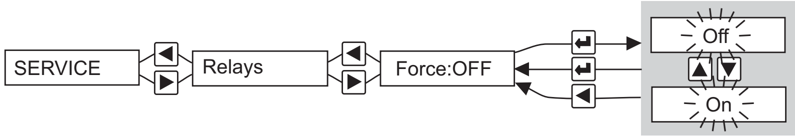
6. Push the RIGHT key once to enter the event list, the display shows the last Event list text. Scroll the event list by pushing the UP and DOWN keys.
7. Push the LEFT key twice to move from the event list to the main menu.

4.4. Forced control (Force)

In the SERVICE menu it is possible to use forced control of the output relays, e.g. for testing purposes.

To activate the forced control function:

1. Open access level CONFIGURATION, see chapter 3.2.1.
2. Move to the SERVICE level of the main menu.
3. Push the RIGHT key once to move to the submenu Relays
4. Push the RIGHT key once to move to the output relays' force setting parameter Force:



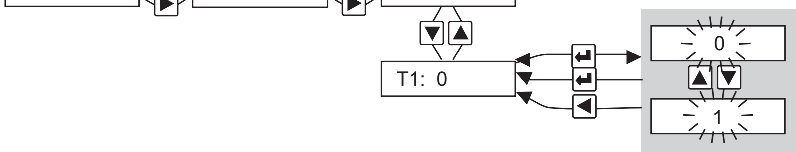


Figure 4.4-1 Activation of the Force function.

5. Push the ENTER key while on the Force: level to be able to change the setting (the parameter to be set is blinking)
6. Push the UP and DOWN keys to change the OFF text to the ON text in the display (Force function activated).
7. Push the ENTER key to confirm the setting and to move back to the Force: level
8. The Force: level has a selection list. Push the UP and DOWN keys to select the desired output relay, which is controlled on and off by forced control:
9. Push the ENTER key to obtain the setting state, e.g. Relays/T1.
10. Push the UP or DOWN key to change the selection 0 -> 1.
11. Push the ENTER key to perform a controlled operation of the output relay (e.g. the T1 is activated) and to return to the Force: level.
12. Push the LEFT key for more than 2 s to return from the Force: setting state to the normal Force: state without changing the control state.
13. Push the LEFT key to return from the Force: setting state to the Relays submenu.
14. Push the LEFT key to return to the main menu.

4.5. Setting range limits

Note!

If parameters requiring a setting value are given out-of-range settings, a fault message will be obtained when the setting is confirmed with the ENTER key. Adjust the setting to within the allowed setting range.

4.6. Adjusting display contrast and scroll speed

The readability of the LCD varies with the brightness of the surrounding. When needed the brightness can be adjusted in the SERVICE/Setup/Bright: menu.

The scroll speed of the text in the display can be adjusted in the SERVICE/Setup/ScrolDelay: menu.

4.7. Setting date and time

Date, time and style is set in the SERVICE/Setup/Date, Time and Style menus.

5. Configuration and parameter setting

User level: CONFIGURATION

- Choose the protection functions in the ENABLE position of the main menu, see chapter 5.2. NOTE! Protection functions not enabled will not be shown in the submenus.
- Change the parameters of overcurrent, unbalance and arc protection functions in the IL SETTING position of the main menu, see chapter 5.3.

  Change the parameters of residual current protection functions in the Io SETTING position of the main menu, see chapter 5.3.
- Change the parameters of Circuit Breaker Failure Protection function in the CBFP Set position of the main menu, see chapter 5.3.
- Set the current transformer scaling and residual current scaling (e.g. CTprim, CTsec, CToprim, etc.) in the SCALING position of the main menu, see chapter 5.4.
- Configure the digital outputs in the DOUT position of the main menu, see chapter 5.5.
- Configure the interlockings in the BLOCKING position of the main menu, see chapter 5.6.
- Configure the digital input in the DIGITAL IN position of the main menu, see chapter 5.7.
- Choose and configure the communication buses in the COM position of the main menu, see chapter 5.8.
- Configure the analog output in the mA OUTPUT position of the main menu, see chapter 5.9.
- Set the Date and time in the SERVICE position of the main menu, see chapter 5.11.

NOTE!

Some of the parameters, for instance the password, can only be altered via the RS 232 serial communication port using a PC.

5.1. Principle of parameter setting

This example shows how to change the scaling of the current transformers. Same principle is used to change other parameters, see Figure 5.1-1.

1. Use the DOWN key of the front panel to move to item SCALING of the main menu.
2. Use the RIGHT key to move one step to the right, the text CTprim: 100 A appears in the display. Use the DOWN key to select the CTsec.
3. Use the ENTER key twice to move to give the operator password. Use the ENTER key to confirm the password.
4. Use the UP and DOWN key to change the setting value and use the RIGHT and LEFT key to move from digit to digit.
5. Use the ENTER key to confirm the function or push the LEFT key for >2 s to cancel the function.
6. Push the LEFT key twice to return to the main menu.

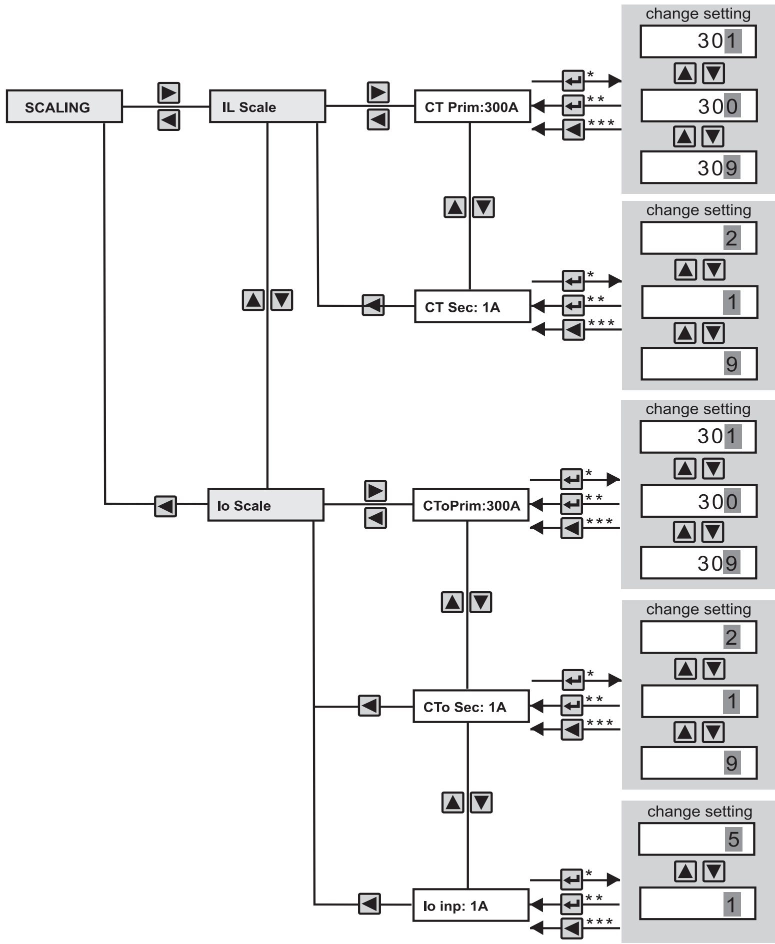


Figure 5.1-1 Changing parameters.

5.2. Enabling and disabling protection functions (ENABLE)

Via the submenus of the ENABLE menu, all the protection functions can be enabled (ON) or disabled (OFF):

ENABLE I

- Overcurrent, unbalance and arc protection stages (I> I>>, I>>>, I2> and ArcI>)

ENABLE Io

- Residual current stages and residual arc protection (Io>, Io>>, Io>>> and ArcIo>)

Ena CBFP

- Circuit Breaker Failure Protection stage (CBFP)

RESET

- Reset the software of the VAMP 140 relay and reset latches (Reset and Latch)

NOTE!

Disabling a protection function will remove the item from the menu.

5.3. Setting protection function parameters

The settings of the selected protection functions can be read and set separately in the submenus of each function.

Available protection stages

- I>, I>>, I>>>, I2>, ArcI> (IL SETTING)
- Io>, Io>>, Io>>>, ArcIo> (Io SETTING)
- CBFP (CBFP Set)

5.4. Scaling of measuring transformers

Via the submenus of the SCALING menu the following can be read and set:

IL SCALING

- Current transformer primary value (CTprim)
- Current transformer secondary value (CTsec)

Via the submenus of the Io SCALING menu the following can be read and set:

Io SCALING

- Residual current transformer primary value (CToprim)
- Residual current transformer secondary value (CTosec)
- Residual current input channel 1A or 5A (Ioinp)

5.5. Configuring digital outputs DOUT

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

Configuration of the output signals to the output relays T1 and T2, A1 – A3 and the operation indicators (LED). Operation indicators, only VAMPSET.

5.6. Configuring blocking matrix BLOCKING

Configuration of the blockings is done under the BLOCKING menu. Any start or trip signal can be used to block the operation of any wanted protection stage.

5.7. Configuring digital input DIGITAL IN

Via the submenus of the DIGITAL IN menu the following functions can be read and set:

- Status of the digital input (DI1)
- Operation delay (D1 dly)
- Polarity of the input signal (DI1pol), either normally open (NO) or normally closed (NC) circuit.
- Remote release of latches using digital input (RemRel)
- Selection to event register (OnEvent and OffEvent)

5.8. Configuring communication protocols COM

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

Active

- Communication protocol of REMOTE port (Protocol)
- Message counter (Msg#)
- Communication error counter (ERRORS)
- Communication time-out counter (Tout)

Profibus

- Profibus profile (Mode)
- Transfer rate of converter
- Profibus Tx Buf lentgh (InBuf)
- Profibus Rx Buf lentgh (OutBuf)
- ProfiBus address (Addr)
- Type of the ProfiBus converter (Conv)

ModBus

- Device slave number at ModBus Slave Protocol or target slave number at ModBus Master protocol (Addr)
- ModBus transfer rate (bit/s)
- ModBus parity check (Parity)

SpaBus

- Slave number (Addr) when relay connected to SPA-Bus
- SPA-Bus transfer rate (bit/s)
- Event mode (Emode)

IEC-103

- Slave address (Addr)
- Transfer rate (bit/s)

TCP/IP (ModBus TCP, only in VAMPSET)

- IP address of the relay (IPAddr)
- Subnet mask (NetMsk)
- IP address of the Name Server (NameSv)
- IP address of the SNTP Server (NTPSvr)
- IP address of the Gateway (Gatew)
- IP port number for Protocol (Port)

Local Port

- Transfer rate of local serial bus (bit/s)

5.9. Analog output mA OUTPUT

Via the submenus of the mA OUTPUT menu the following functions can be read and set:

- Analog output reading / editing a forced value (AO)
- Enabling / disabling of forced control of the analog output (FORCE)
- Choosing the coupling of analog output (Link)
- Setting the coupling minimum value (Min)
- Setting the coupling maximum value (Max)
- Setting the analog output minimum value (AOmin)
- Setting the analog output maximum value (AOmax)

Available links:

- IL1, IL2, IL3, IL
- Io
- f
- I2/I1
- I_fault

5.10. Disturbance recorder menu RECORDER

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

- Recording mode (Mode)
- Sample rate (Rate)
- Recording time (Time)
- Pre trig time (PreTrig)
- Scroll list of active links (Links)
- Add a link to the recorder (AddLink)
- Clear all links (ClrLink)
- Manual trigger (MnlTrig)
- Count of ready records (ReadyRec)

For list on available links see chapter 2.6 in the technical description.

5.11. Service menu SERVICE

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

Relays

- Enabling / disabling of forced control of the output relays (FORCE)
- The status of the output relays (T1 and T2, A1 – A3 and IF)
- The forced control of the output relays (T1 and T2, A1 – A3 and IF)

Setup

- Setup of screen brightness (Bright)
- Setup of screen scroll delay (ScrlDelay)
- Changing of password (ChgPwd)
- Changing of date, time and date style (Date, Time, Style)

DeviceInfo

- Serial number of the device (SerN)
- Software version (Prgver)

6. PC software

6.1. PC user interface

The PC interface is intended to be used for onsite parameterization of the relay and for reading of measured values to a computer or loading of the relay software from a computer.

The RS 232 serial port is available for the connection of a local PC on the front panel of the relay. To connect a PC to the serial port use a connection cable of type VX 003-3.

6.1.1. Using the VAMPSET program

See separate user's manual for the VAMPSET software, VMV.EN0xx. If the VAMPSET software is not available please download it from www.vamp.fi.

6.2. Remote control connections

The protection relay communicates with higher-level systems, e.g. remote control systems, via the serial port (REMOTE) on the rear panel of the relay.

ModBus, SPA-Bus, IEC 60870-5-103, ProfiBus or ModBus TCP can be used as REMOTE communication protocols (see details in Chapter 2.5.2. in technical description).

Additional operation instructions for various bus types are to be found in their respective manual.

7. Commissioning configuration

7.1. Factory settings

When delivered from the factory, the relay has been given factory default settings or settings defined by the customer. The actual configuration can be read from the workshop test report or from the final test report

7.1.1. Configuration during commissioning

The configuration and settings of the overcurrent and earthfault relay VAMP 140 is defined and checked during commissioning in accordance with the instructions given in Chapter 5 of this manual, for example in the following order:

1. Scaling of the rated values of the current transformer in menu IL SCALING
2. Scaling of the rated values of the residual current transformer Io SCALING

The scaling is done in the software block of the measured signals, Figure 7.1.1-1. Thus the scaling affects all the protection functions.

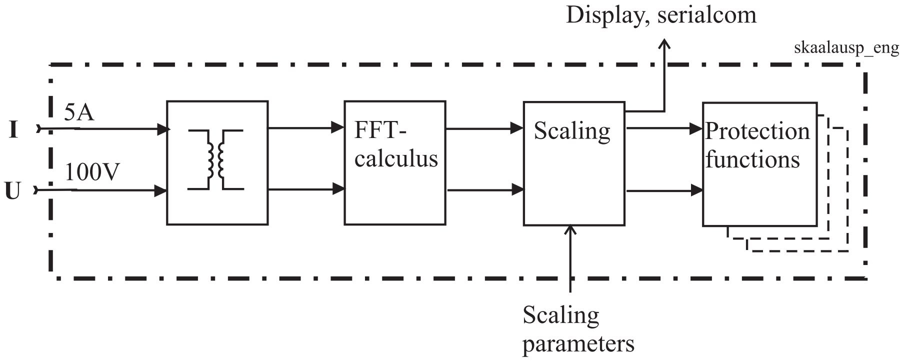


Figure 7.1.1-1 Principle for scaling the measured values of the VAMP 140 relay.

3. Activation of the desired protection functions, ENABLE menu, see Chapter 5.2.
4. Setting values of the protection functions, see Chapter 2 in the Technical description.
5. Configuration of the starting and tripping signals of the protection stages to the desired output relays and the LED indicators (DOUT menu), see Chapter 5.5.
6. Configuration of the blocking matrix (BLOCKING menu), see Chapter 5.6.

7. Selection of the communication protocol and setting of the communication parameters (COM menu), see Chapter 5.8.
8. Other required parameters, for example the DI input, mA output and circuit breaker failure protection.

7.1.2. Configuration example

The following example illustrates the calculation and scaling of setting values and the grouping of output relays in a typical protection configuration. The values given in the example are to be regarded as guidelines only.

Example:

The example is based on the technical application drawing of Chapter 3, Figure 3.1-1 in the technical description.

In the application the following functions and stages are used:

- Three-stage overcurrent protection (I>, t>; I>>, t>> and I>>>, t>>>)
- Three-stage residual current protection (Io>, t>, Io>, t>> and Io>>>, t>>>)

The above functions are enabled via the ENABLE menu by selecting the "On" in the ENABLE menu, see Chapter 5.2. the functions not to be included are disabled by selecting the “Off” value.

1 Output data:

Given within the parenthesis are the configuration menus where the settings are done.

Transforming ratios of measurement transformers

Current transformer (CT) (SCALING)	CTprim CTsec	600 A 5 A
Residual current transformer (CTo) (SCALING)	CToprim CTosec Ioinp	100 A 5 A 5 A

2 Selection of setting values:

Protection stage:	Parameter:	Setting:
Overcurrent stage I>	I> Curve t>	1.20pu DT 0.50 s
Overcurrent stage I>>	I>> t>>	1.50pu 0.20 s
Overcurrent stage I>>>	I>>> t>>>	2.00pu 0.08 s
Residual current stage Io>	Io> t>	0.10pu 0.40 s
Residual current stage Io>>	Io>> Curve t>>	0.20pu DT 0.20 s
Residual current stage Io>>>	Io>>> t>>>	0.30pu 0.10 s

3 Blocking matrix

The required blocking of the protection functions are configured in the BLOCKING menu, see Chapter 5.6.

4 Output relay configuration

The required grouping of output relays and output signals are configured in the DOUT menu, see Chapter 5.5.

In the example, relay T1 is programmed to open the circuit breaker with a trip signal (for example I>>) selected in the DOUT menu.

Table of Content

1. Introduction

This part of the manual describes the protection functions, provides a few application examples and contains technical data. This part of the manual also includes the operating instructions.

Mounting and Commissioning Instructions are provided in a separate mounting and commissioning manual (VMMC.EN0xx).

1.1. Application

The versatile basic protection functions, the wide variety of additional functions and several available communication protocols render the overcurrent and earthfault relay VAMP 140 an ideal protection relay for power plants and substations as well as for industry, marine and off-shore applications.

The modern technology in association with an extensive self-supervision system and a reliable construction ensures an extremely high availability for the VAMP 140 protection relay.

The relay is used for overcurrent and earthfault feeder protection. The relay can also be used in other applications where a single-, two- or three-phase protection relay is needed.

1.2. Main features

- Fully digital signal handling with a powerful 16 bit micro processor and high measuring accuracy on all setting ranges due to an accurate 12 bit A/D conversion technique.
- Easy enabling and disabling of protection functions according to the needs of the intended application.
- Wide setting ranges for the protection functions.
- Flexible external control and blocking possibilities due to the digital signal control input (DI).
- Easy adaptation of the relay to various substations and alarm systems due to a flexible signal-grouping matrix in the relay.
- Recording of events and fault values into an event register, from which data can be read via the key pad and the display or by means of the PC based VAMPSET user interface.
- Signals from the relay's current measurement transducer can be wired to an external meter or a SCADA system.

- Handy configuration, parameterization and reading of information via the user panel or by means of the PC based VAMPSET user interface.
- Easy to connect to power plant automation systems due to versatile serial connection and several available communication protocols.
- Latest events and indications are in non-volatile memory
- Reliable built-in self-regulating dc/dc converter for auxiliary power supply from any source within the range 40 - 265 V dc/ac, optionally 24 V dc.
- Built-in disturbance recorder for evaluating primary and secondary, as well as neutral currents of the protected object.

2. Functions

The individual protection functions of the VAMP 140 overcurrent and earthfault relay can independently of each other be enabled or disabled according to the requirements of the application. See the configuration instructions, Chapter 5 and 7, in the Operation and configuration instructions.

2.1. Principles of the numerical protection technique

The VAMP 140 relay is designed using numerical technology. This means that all signal filtering, protection and control functions are made by digital processing.

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

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

The synchronized sampling means an even number of 2^n samples per period, e.g. 16 samples/period. This means that the frequency must be measured and the number of samples per period must be controlled accordingly, so that the number of samples per period remains constant should the frequency change.

Figure 2.1-1shows the main components of a relay using numerical technology; i.e. the relay comprises input transformers, digital input adapters, output relays, A/D converter and a micro controller including memory circuits. Further the relay needs a power supply and a user interface.

Figure 2.1-2 shows the heart of the numerical technology or the main block diagram of the calculated functions.

Figure 2.1-3 shows a functional principle diagram of a single-phase overcurrent function.

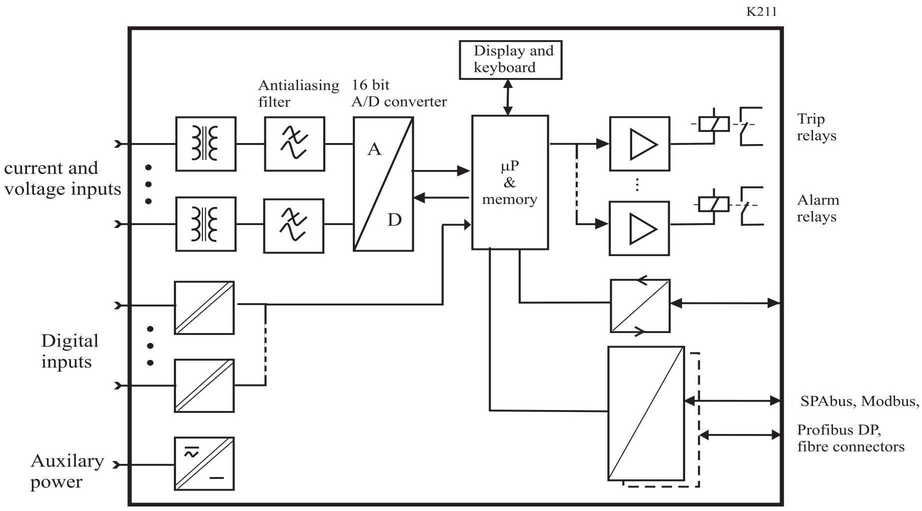


Figure 2.1-1 Principle block diagram of a numerical protection relay.

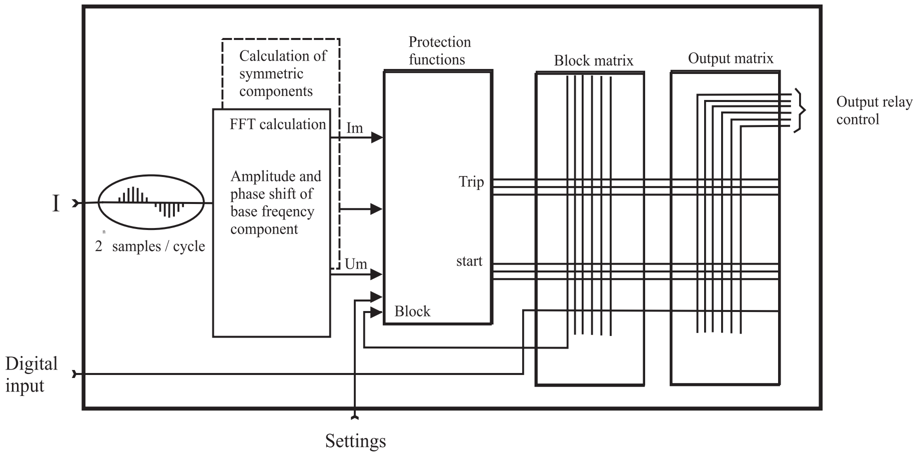


Figure 2.1-2 Block diagram of a software based function.

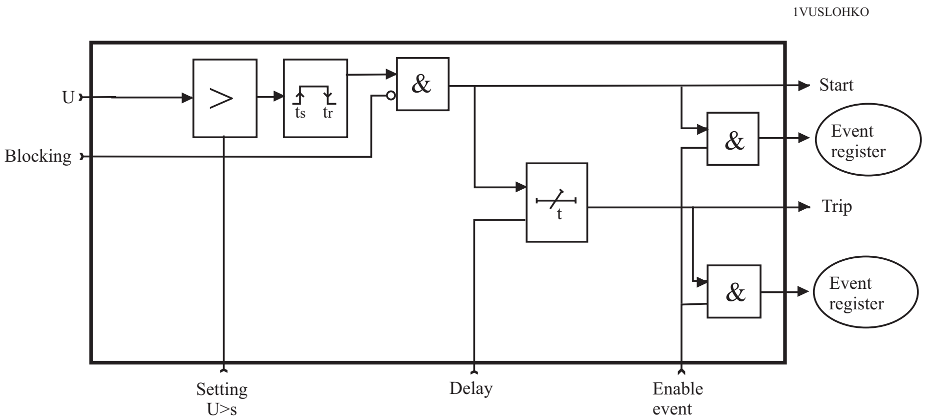


Figure 2.1-3 Block diagram of a single-phase protection function.

2.2. Relay protection functions

2.2.1. Overcurrent protection I>, I>>, I>>> (50/51)

The three-phase overcurrent unit comprises three separately adjustable overcurrent stages, i.e. stage I>, I>> and I>>>.

The overcurrent unit measures the fundamental frequency component of the phase currents.

Stage I> can be configured for definite time or inverse time operation characteristic. Stage I>> and stage I>>> have definite time characteristic.

Figure 2.2.1-1 shows the functional block diagram of stage I>.

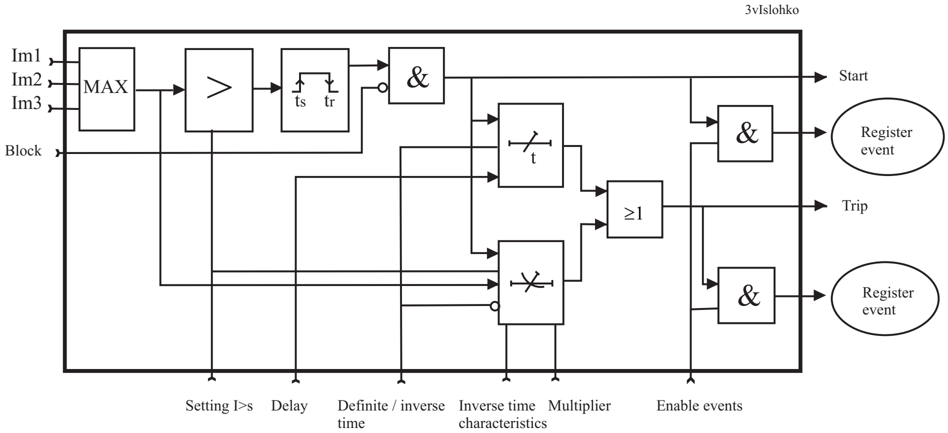


Figure 2.2.1-1 Block diagram of the three-phase overcurrent stage I>.

Parameters of the overcurrent stages:

I>, I>>, I>>> (50/51)

	Parameter:	Value/unit:	
Measured value	ILmax	A	Max. value of phase currents IL1, IL2, IL3 primary values
Setting values	I>, I>>, I>>>	A	Setting value in primary current units
	I>, I>>, I>>>	pu	Setting value as per unit value. Setting done in xIn
	Curve	DT	Operation charact./ definite time (I>)
		NI, VI EI, LTI	Operation charact./ inverse time (I>)
	t>, t>>, t>>>	s	Operation time
	k		Time multiplier at inverse time (I>)

Recorded values	SCntr		Start counter (Start) reading
	TCntr		Trip counter (Trip) reading
	Type	1-N, 2-N 3-N	Fault type/single-phase fault e.g.: 1-N = fault on phase L1
		1-2, 2-3 1-3	Fault type/two-phase fault e.g.: 2-3 = fault between L2 and L3
		1-2-3	Fault type/three-phase fault
	Flt	pu	Max. value of fault current as compared to In
	Load	pu	1 s mean value of pre-fault phase currents IL1…IL3
	EDly	%	Elapsed time as compared to the set operate time, 100% = tripping

The low-set stage (I>) of the overcurrent unit can be configured for inverse time characteristic. Four sets of characteristic curves according to IEC 60255-3 are available for the low-set stage, i.e.: Normal Inverse (NI), Very Inverse (VI), Extremely Inverse (EI) and Long Time Inverse (LTI). The mathematical expressions and the curve sets are given in Figs. 2.2.1.-3, -4, -5 and -6.

Limitations:

1. The maximum measured current is 50 x I_n. This limits the scope of inverse curves when the setting is more than 2.5 x I_n. E.g. at setting 4 x I_n the maximum setting relative current is 12.5 x I_{set}/I_n although the curves are defined up to 20 x I_{set}/I_n
2. The fastes possible operating time is about 60 ms at inverse time characteristic according to curve types VI and EI.

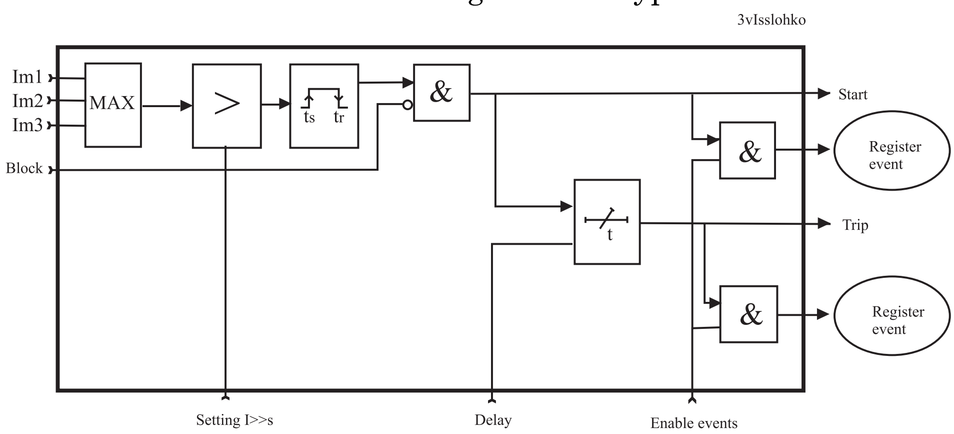


Figure 2.2.1-2 Block diagram of the three-phase overcurrent stage I>>.

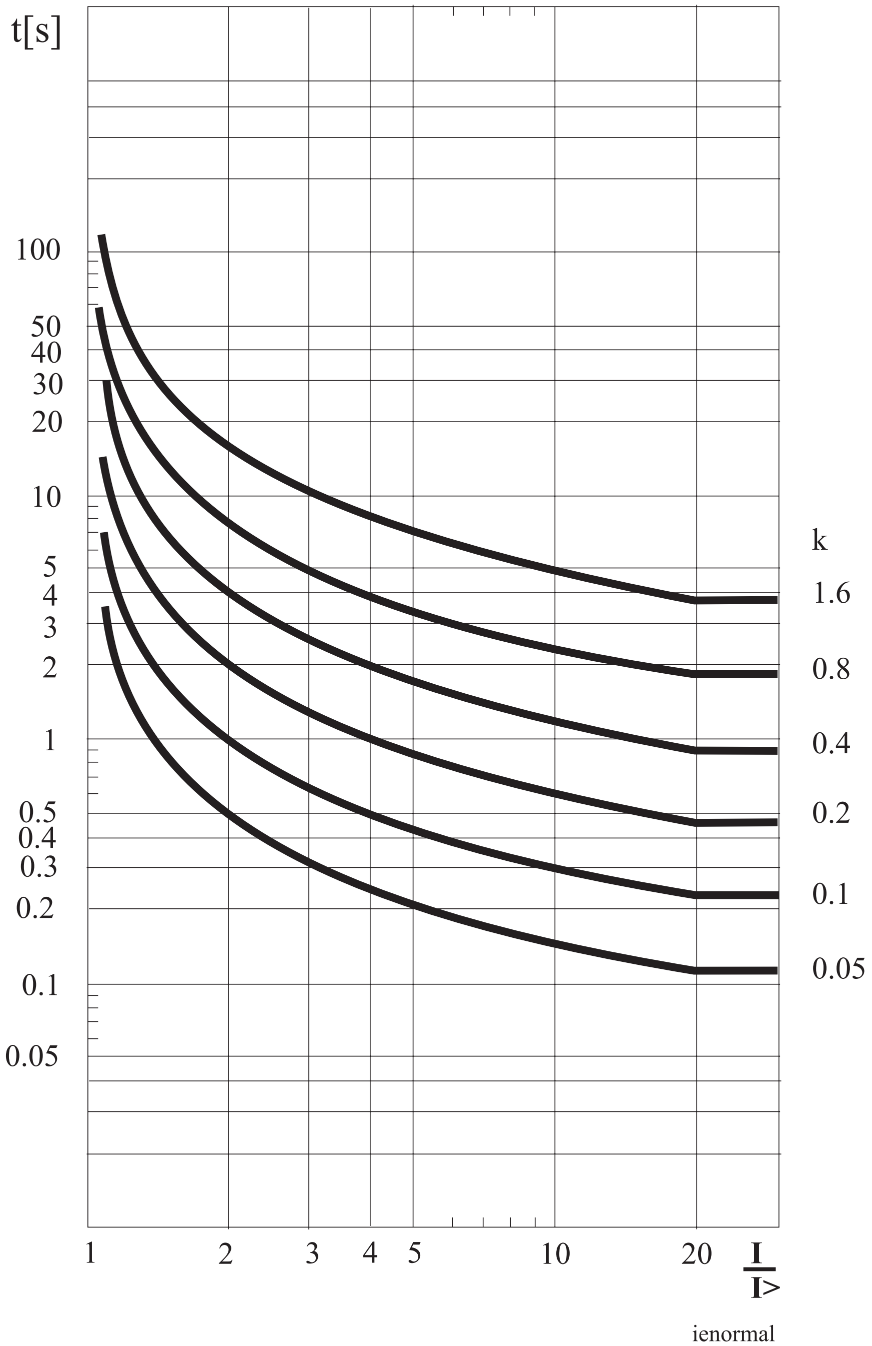


Figure 2.2.1-3 Normal Inverse (IEC 60255-3) characteristic.

$$t[s] = 0{,}14 \cdot \frac{k}{\left(\frac{I}{I>}\right)^{0{,}02} - 1}$$

t[s] = Trip time
k = Time multiplier
I = Measured current
I> = I set current

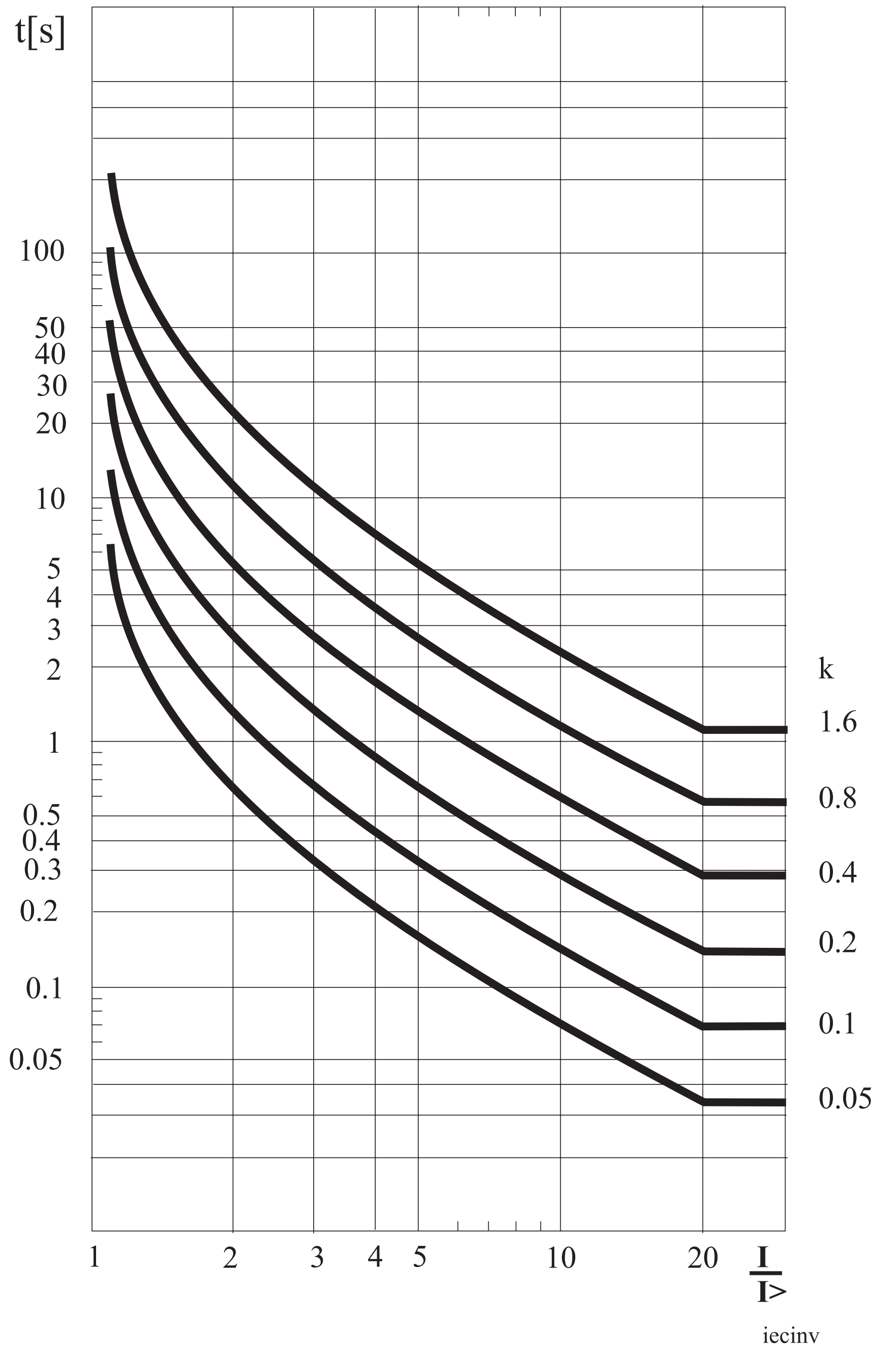


Figure 2.2.1-4 Very Inverse (IEC 60255-3) characteristic.

$$t[s] = 13{,}5 \cdot \frac{k}{\frac{I}{I>} - 1}$$

(See explanation for symbols under Figure 2.2.1-3)

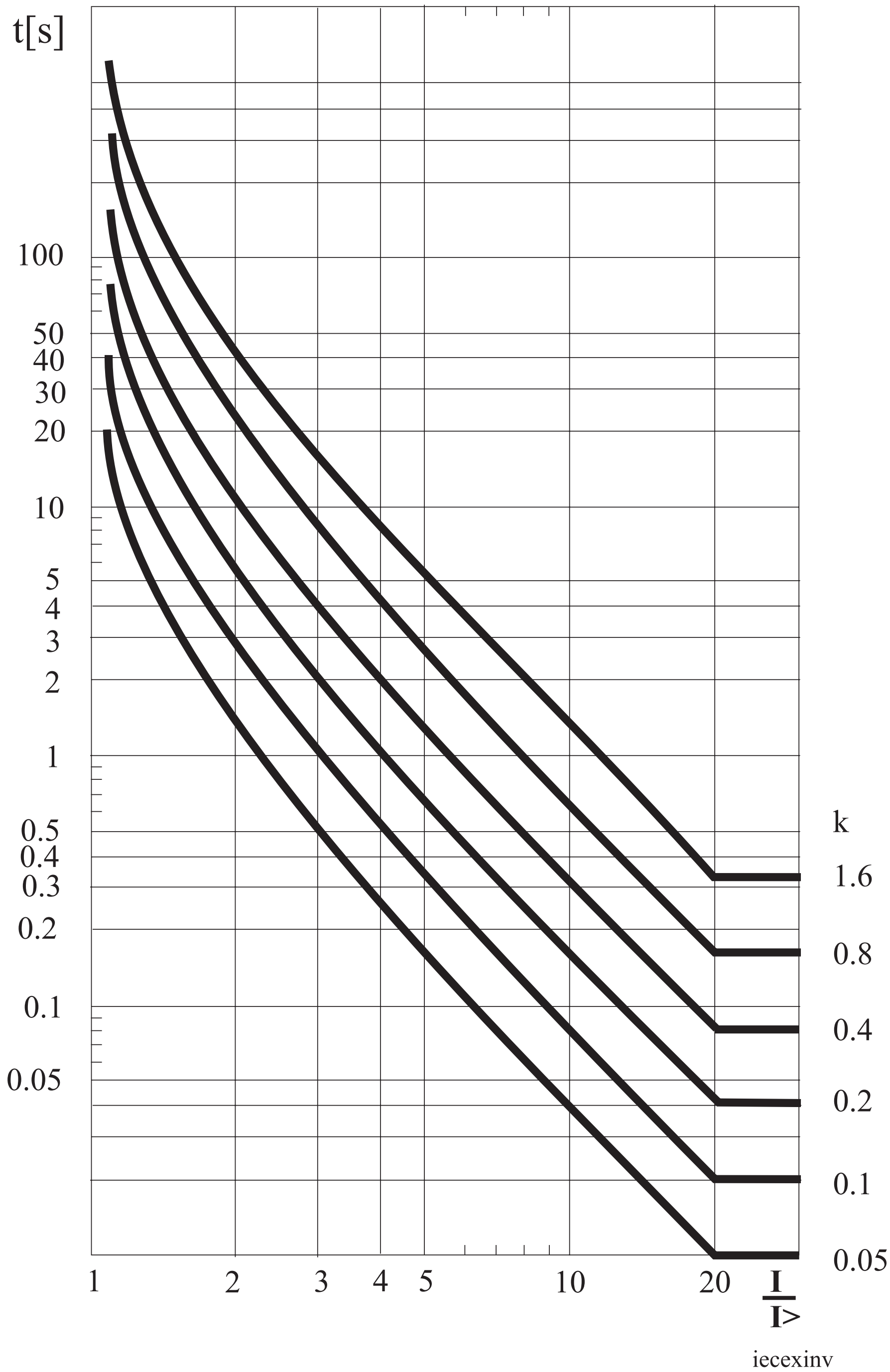


Figure 2.2.1-5 Extremely Inverse (IEC 60255-3) characteristic.

$$t[s] = 80 \cdot \frac{k}{\left(\frac{I}{I>}\right)^2 - 1}$$

(See explanation for symbols under Figure 2.2.1-3)

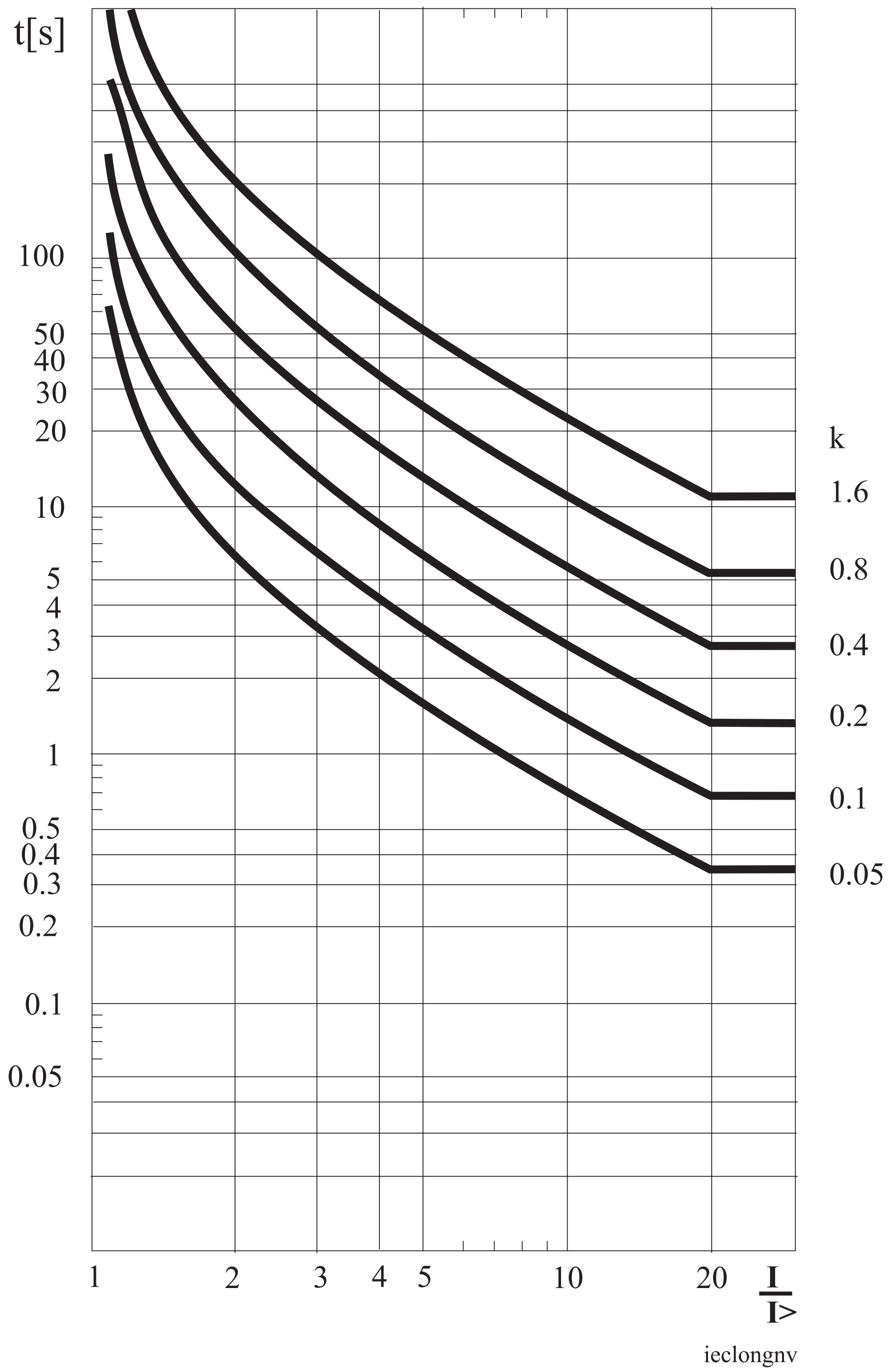


Figure 2.2.1-6 Long Time Inverse (IEC 60255-3) characteristic.

$$t[s] = 120 \cdot \frac{k}{\frac{I}{I>} - 1}$$

(See explanation for symbols under Figure 2.2.1-3)

2.2.2. Non-directional earth-fault protection (50/51N)

The earth-fault unit of the combined overcurrent and earth-fault relay VAMP 140 is provided with two energizing inputs rated 5 A and 1 A, software selection.

The earth-fault unit measures the fundamental frequency component Io. In the VAMP 140 relay this means that the degree of attenuation of the third harmonic is at least 60 dB, which contributes to the extremely high accuracy of the earth-fault protection.

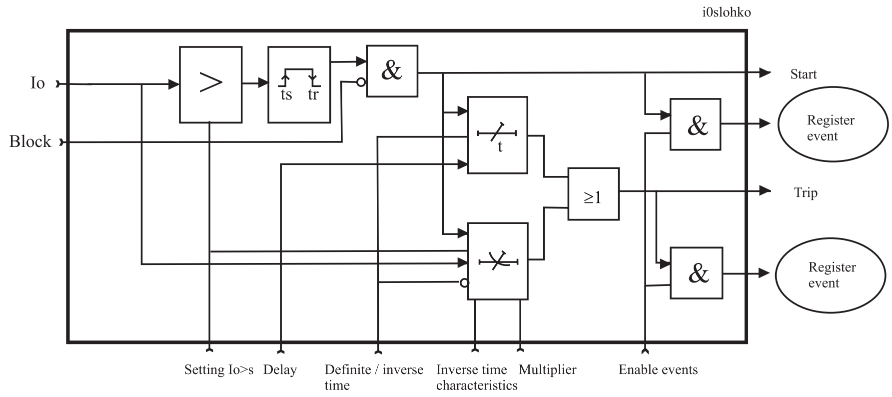


Figure 2.2.2-1 Block diagram of the earth-fault stage I_0>.

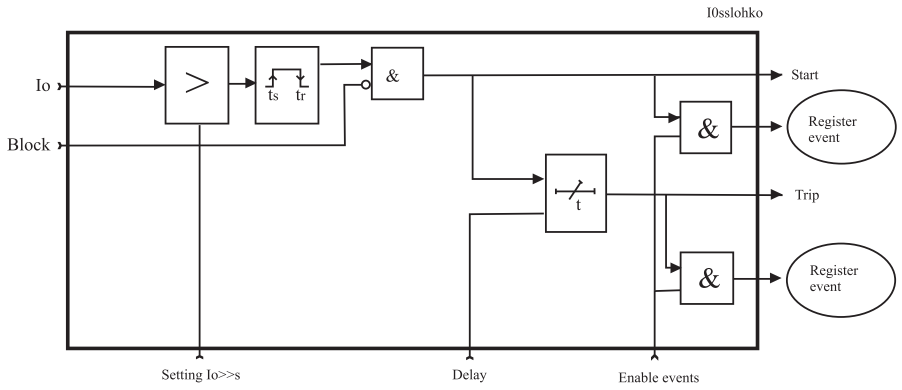


Figure 2.2.2-2 Block diagram of the earth-fault stage I_0>>.

Parameters of the earth-fault stages:

I_0>, I_0>>, I_0>>> (50/51N)

	Parameter:	Value/unit:	
Measured value	I_0	A	Earth-fault current in primary value
Setting values	I_0>, I_0>>, I_0>>>	A	Setting value in primary current units
	I_0>, I_0>>, I_0>>>	pu	Setting value as per unit value
	Curve	DT	Operation charact./ definite time (Io>, Io>>)
		NI, VI EI, LTI	Operation charact./ inverse time (Io>, Io>>)
	t>, t>>, t>>>	s	Operation time
	k		Time multiplier at inverse time (Io>, Io>>)
Recorded values	SCntr		Start counter (Start) reading
	TCntr		Trip counter (Trip) reading
	Flt	pu	Max. value of fault current as compared to I_{0n}
	EDly	%	Elapsed time as compared to the set operate time, 100% = tripping

2.2.3. Phase unbalance protection I_2> (46)

The purpose of the phase unbalance protection is to detect phase discontinuity and abnormal unbalance of the power system.

The operation of the unbalanced load function is based on the relation between the negative phase sequence I_2 and the positive phase sequence I_1. For the relay to be able to measure the correct unsymmetry, it is important that the phase order of the energizing currents is correct.

The phase unbalance protection operates with definite time characteristic and it is mainly used for signalling.

The setting of the phase unbalance protection is performed in the menu called IL SETTING/I2> Set.

Parameters of the unbalance protection stage:

I_2> (46)

	Parameter:	Value/unit:	
Measured value	I2/I1	%	Negative phase sequence current I2/I1
Setting values	I2>	%	Setting value
	t>	s	Operation time
Recorded values	SCntr		Start counter (Start) reading
	TCntr		Trip counter (Trip) reading
	Flt	%	Max. fault current
	Edly	%	Elapsed time as compared to the set operate time, 100% = tripping

2.2.4. Second harmonic stage / inrush (68)

This stage is mainly used to block other stages. The ratio between the second harmonic component and the fundamental frequency component is measured on all the phase currents. When the ratio in any phase exceeds the setting value, the stage gives a start signal. After a settable delay, the stage gives a trip signal.

The start and trip signals can be used for blocking the other stages. The trip delay is irrelevant if only the start signal is used for blocking.

The trip delay of the stages to be blocked must be more than 60 ms to ensure a proper blocking.

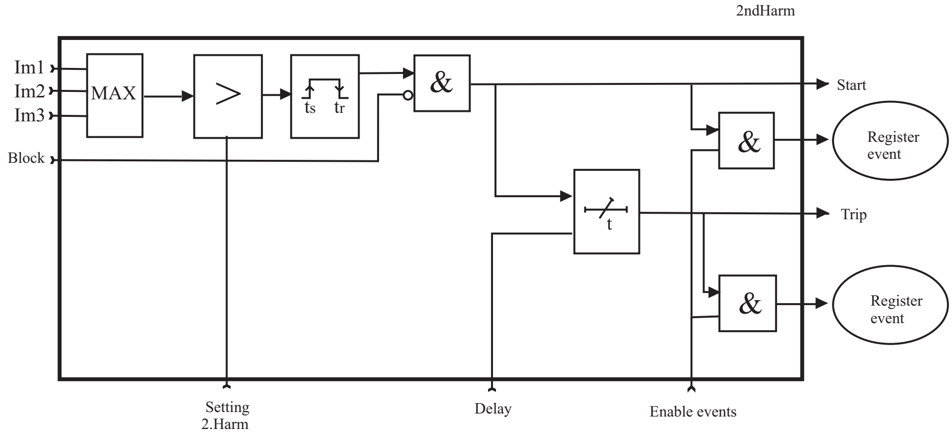


Figure 2.2.4-1. Block diagram of the second harmonic stage.

Setting parameters of second harmonic blocking:

2.Ha (68)

Parameter:	Value:	Unit:	Default:	Description:
If2>	10...100	%	10	Setting value If2/Ifund
t_f2	0.05...300.0	s	0.05	Definite operating time
S_On	Enabled; Disabled	-	Enabled	Start on event
S_Off	Enabled; Disabled	-	Enabled	Start off event
T_On	Enabled; Disabled	-	Enabled	Trip on event
T_Off	Enabled; Disabled	-	Enabled	Trip off event

Measured and recorded values of second harm. blocking:

2.Ha (68)

	Parameter:	Value:	Unit:	Description:
Measured values	IL1H2.		%	2. harmonic of IL1, proportional to the fundamental value of IL1
	IL2H2.		%	2. harmonic of IL2
	IL3H2.		%	2. harmonic of IL3
Recorded values	Flt		%	The max. fault value
	EDly		%	Elapsed time as compared to the set operating time; 100% = tripping

2.2.5. Thermal overload protection T> (49F)

The overload function protects the line against thermal overload. The thermal stress can be supervised by means of a thermal image, which can be calculated from the standard heating expression according to IEC 60255-8:

$$t = \tau \cdot \ln \frac{I^2 - I_p^2}{I^2 - (k * I_n)^2}$$

where:

t	=	trip time
τ	=	thermal time constant of cable
I	=	average RMS value of three measured phase currents
ln	=	natural logarithm
Ip	=	preload current (corresponds to the heating level reached)
k	=	factor for allowed continuous overload
I_n	=	rated current

The heating time constant (τ) and the load current factor (k) corresponding to the maximum thermal load are adjustable. Factor k defines the load current value, which, when exceeded, results in a thermal trip.

The cooling time constant of the thermal overload protection is the same as the heating time constant.

The thermal overload stage is provided with a separately adjustable alarm function, the setting range of which is 60...99% of the thermal trip level.

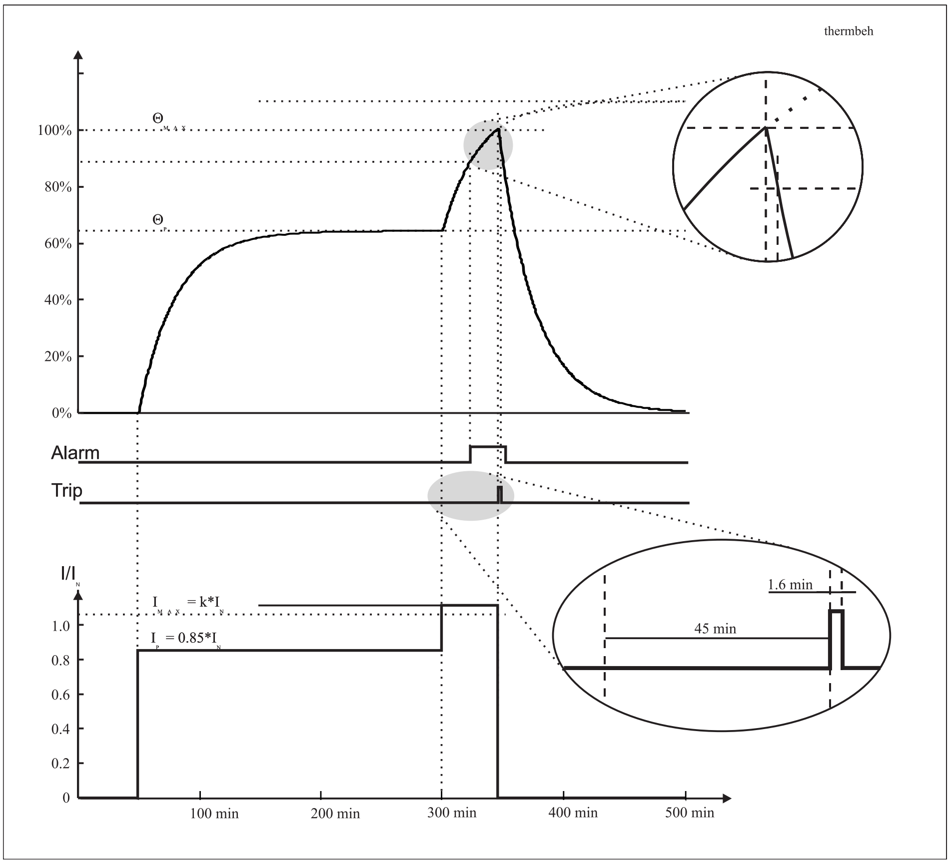


Figure 2.2.5-1 Principle of thermal overload protection.

Parameters of the thermal overload protection:

T> (49)

	Parameter:	Value/unit:	
Measured value	Temp	%	Calculated thermal load (100% = tripping)
Setting values	T>	A	Permitted max. cont. current primary value
	T>	x In	Perm. max. cont. current as compared to In
	Alarm	%	Start level set value
	tau (τ)	min	Heating time constant
Fixed value	tau2 (τ)	x In	Cooling time constant
Recorded values	SCntr		Start counter (Start) reading
	TCntr		Trip counter (Trip) reading

	Pre-Flt	A	Pre-fault current
	Flt current	A	Fault current
	Flt temp.	%	Fault temperature
	Edly	%	Elapsed time as compared to the set operate time, 100% = tripping

2.2.6. Arc fault protection (option) ArcI> (51 L>), ArcI$_0$> (51N L>)

The arc fault protection has been realized with an arc sensor (or sensors) and an extremely fast overcurrent function Iarc and Ioarc using the arc optional card.

The arc protection unit operates, when the arc sensor detects an arc fault or the binary input (BI) of the arc option card is activated and the fast overcurrent stage ArcI> measures overcurrent simultaneously.

The earth-fault arc protection unit operates, when the arc sensor detects an arc fault or the binary input (BI) of the arc option card is activated and the earth-fault function ArcIo> measures earth-fault simultaneously.

The sensor connections (S1, S2) and binary input (BI) can be set, individually or any combination of these, to operate the ArcI> and ArcIo> protection stages.

The operating time of the arc protection stages are approximately 15 ms.

The sensor connections and binary input can be set to activate the binary output (BO) in the output matrix, DO menu. The binary output can be used to forward light information to another relay, e.g. VAMP 140. The binary output can be connected to a maximum of three binary inputs of other relays.

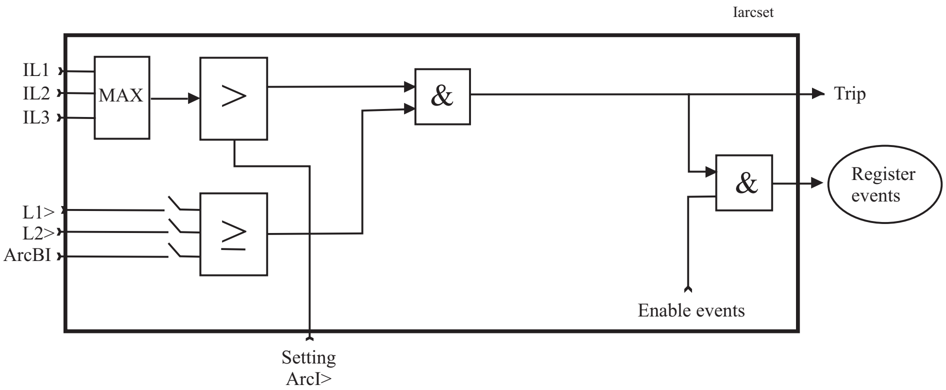


Figure 2.2.6-1 Block diagram of the arc protection stage ArcI>. The symbol of the starting of the arc sensor is L> and that of the fast overcurrent stage is ArcI.

The setting of the arc protection stage is performed in the menu called IL SETTING/ArcI Set.

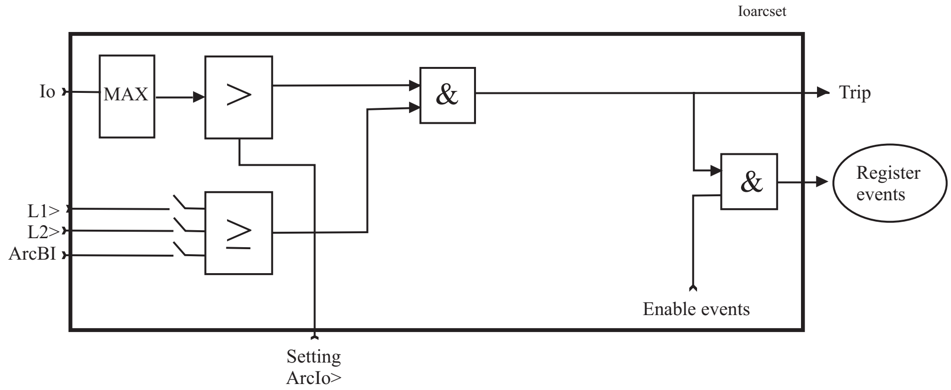


Figure 2.2.6-2 Block diagram of the arc protection stage ArcIo>. The symbol of the starting of the arc sensor is L> and that of the fast earth-fault stage is ArcIo.

The setting of the earth-fault arc protection stage is performed in the menu called Io SETTING/ArcIo Set.

Delayed Arc S>

A delay function can be triggered with one or more of the S1>, S2> or Arc BI signals. The output of the function is activated after the specified delay and deactivated when the trigger signal is deactivated.

The function can be used e.g. to implement back up for the arc-protection function.

Parameters of the arc protection stage ArcI> (51L>):

	Parameter:	Value/unit:	
Measured value	IL max	A	Max. value of phase currents IL1, IL2, IL3 primary values
Setting values	ArcI>	pu	Setting value as per times In
	ArcI> sensor		Selection of the arc sensor channel(s) and/or arc binary input
Recorded values	SCntr		Cumulative start counter, only selected ArcCn arc activations
	TCntr		Cumulative trip counter, only selected ArcCn arc activations
	Flt	%	Maximum value of fault current as per times In

Parameters of the arc protection stages ArcIo> (51NL>):

	Parameter:	Value/unit:	
Measured value	Io	A	Max. value of earth-fault current Io primary value
Setting values	ArcI>	pu	Setting value as per times Ion
	ArcI> sensor		Selection of the arc sensor channel(s) and/or arc binary input
Recorded values	SCntr		Cumulative start counter, only selected ArcCn arc activations
	TCntr		Cumulative trip counter, only selected ArcCn arc activations

	Flt	%	Maximum value of fault current as per times Ion

2.2.7. Circuit-breaker failure protection CBFP (50BF)

The operation of the circuit-breaker failure protection is based on the supervision of the operating time, from the pick-up of the configured trip relay to the dropout of the same relay. If that time is longer than the operating time of the CBFP stage, the CBFP stage activates another output relay, which will remain activated, until the primary trip relay resets.

The CBFP stage functions also in earth-fault situations, because its function is merely based on supervision of the function of the output relay T1.

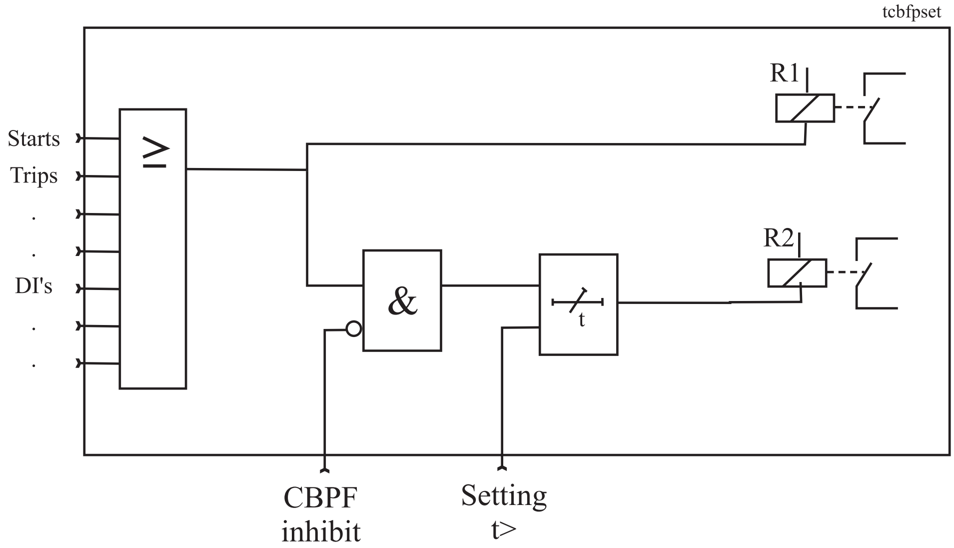


Figure 2.2.7-1 Block diagram of the circuit-breaker failure protection

The CBFP blocking signal prevents the CBFP stage from operating, when the output relays or any other protection function is operated by forced control.

Parameters of the circuit-breaker failure protection

CBFP (50BF)

	Parameter:	Value/unit:	
Setting values	CBRel		Relay to be supervised
	t>	s	Operation time
Recorded values	SCntr		Start counter (Start) reading
	TCntr		Trip counter (Trip) reading

2.3. Measurement functions of the relay

Measured values

Phase currents I_{L1}, I_{L2}, I_{L3}

Measuring range	0 – 50 x In	In = 1A or 5A

Residual current I_0

Measuring range	0 – 5 I_{0n}	I_{0n} = 1A or 5A

Frequency f

Measuring range	16 - 65 Hz

Calculated values

From the measured values the relay calculates the following:

- IL
- I2/I1, I2/In
- IL1rms, IL2rms, IL3rms, Ilrms

2.4. Output relay and blocking functions

In the VAMP 140 relay all start and trip signals of the protection stages can be freely routed to the output relays and operation indicators according to the requirements of the application. The functions can also be blocked and for this purpose both internal relay signals and external control signals can be used. Figure 2.4-1 shows the operating principle of the grouping and blocking matrix.

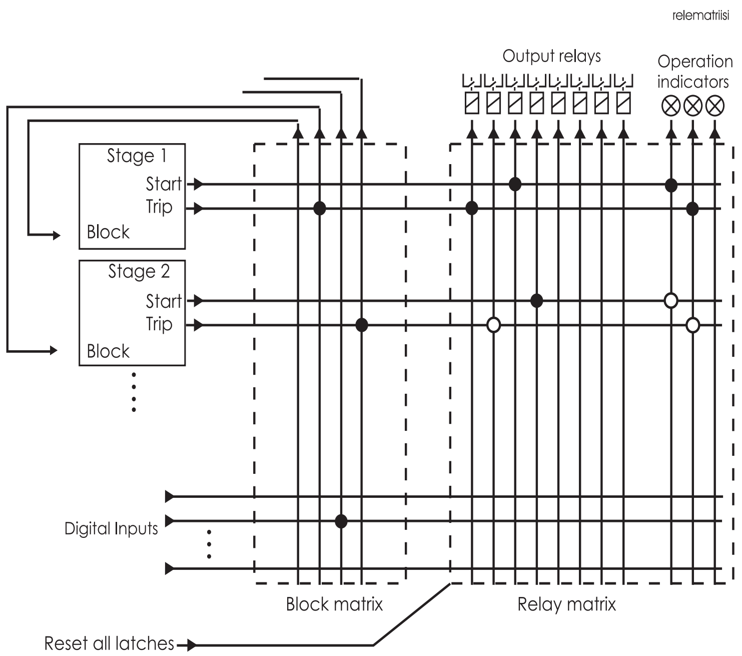


Figure 2.4-1 Operating principle of the grouping and blocking matrices.

2.4.1. Output relay matrix

By means of the relay matrix the output signals of the various protection stages can be combined with the trip relay T1 and T2, alarm relays A1...A3 and the operation indicator L1 (Alarm) and L2 (Trip).

When a connection is made, two functions can be selected, the signal follower function (•) or the latching function (o), see Figure 2.4-1.

The "Reset all latches" function resets all latched output relays and operation indicators. The reset signal can be given via a digital input, the key pad or the serial port. If the reset signal is to be given via the digital input DI1, the Remote Release ("RemRel") input DI1 must be configured to function as a reset input from DIGITAL IN/RemRel menu.

2.4.2. Blocking matrix

By means of the block matrix the operation of a protection stage can be blocked. During blocking, a stage will not start or if already started the delay counter is halted, thus preventing tripping. The blocking signal can originate from the digital input DI1, or it can be a start or trip signal from a protection stage. In Figure 2.4-1, a blocking connection is indicated with a black dot (•) in the crossing point of a blocking signal and a signal to be blocked.

2.5. Communication

2.5.1. PC port

The PC port is used for on-site parameterization of the relay, for downloading of the program and for reading relay parameters to a PC.

For connection to a PC, one RS 232 serial port is available on the front panel of the relay. Any connection to the port is done with the connection cable type VX 003.

2.5.2. Remote control connection

The relay can be connected to higher level systems, e.g. network control systems via the serial port named REMOTE on the rear panel. To the port a SPABus, ModBus, ProfiBus or IEC-103 connection can be made using a special internal or external bus connection module. The bus type selection and the parameterisation of the bus are carried out as the relay is configured.

Optional accessories are available for RS485 connection (VMA 3CG), Ethernet connection with TCP/IP protocol (VEA 3CG) and Profibus connection (VPA 3CG). Please see the corresponding documentation for more details.

Table 2.5.2-1 Communication protocols and physical interfaces on REMOTE serial port.

	Standard interface	Internal option cards	External option modules		
Protocol	RS232: VX004-M3 or VX008-4	Plastic	RS485: VMA3CG + VX007-F3	ProfiBus: VPA3CG + VX007-F3	Ethernet: VEA3CG + VX015-3
ModBus	X	X	X		
SPA-Bus	X	X	X		
ProfiBus				X	
IEC-60870-5-103	X	X	X		
ModBus/ TCP					X
Transparent TCP/IP					X

2.6. Disturbance recorder

The disturbance recorder can be used to record all measured signals i.e. currents and voltages, status information of digital inputs (DI) and digital outputs (DO). The digital inputs include also the Arc light information (S1, S2 and Arc binary input BI). The digital outputs include the Arc binary output information (BO).

Recorder capacity is 48 000 bytes. There can be a maximum of 5 recordings and the maximum selection of channels in one recording is 12 (limited in waveform recording).

The recorder can be triggered by any protection stage start or trip signal, Arc sensors (S1, S2, BI) and digital input. The trig signal is selected in the output matrix. The recording can also be triggered manually. When recording is made also the time stamp will be memorized.

The recordings can be viewed by VAMPSET program, version 8.x or newer. The recording is in COMTRADE format so also other programs can be used to view the recordings.

For more detailed information, see separate Disturbance Recorder manual VMDR.EN0xx.

Available links

The following channels can be linked to Disturbance Recorder:

- IL1, IL2, IL3, IL
- IL1rms, IL2rms, IL3rms, ILrms
- Io
- f
- I2/I1, I2/In
- DI, DO

Parameters of the Disturbance Recorder

	Parameter:	Value/unit:	
Setting values	Mode		Mode of the recording
	Rate		Sample rate
	Time	s	Recording time
	PreTrig	%	Pre-trigger time
	MnlTrig		Manual trig
	Size		Size of one recording
	MAX time	s	Maximum time of recordings
	MAX size		Maximum size of recordings
Recorder links	Links		Connected links
	AddLink		Add links
	ClrLnks		Clear links
Recorded values	Status		Status of the recorder
	Time status	%	Status of the pre-triggering
	ReadyRec		Number of ready records

2.7. Self-supervision

The functions of the micro controller 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 a fault situation. If the restarting fails the watchdog issues a self-supervision alarm because of a permanent relay fault.

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

Also the internal supply voltage is supervised. Should the auxiliary supply of the relay disappear, an IF alarm is automatically given. The IF relay contact is normally closed type of contact. This means that the IF relay contact is closed, when there is an internal fault or there is no auxiliary power supply. If the relay is fully operational with the auxiliary power supply, the IF contact is on the open position.

3. Application examples

3.1. Overcurrent, earth-fault and phase discontinuity protection of an overhead line feeder

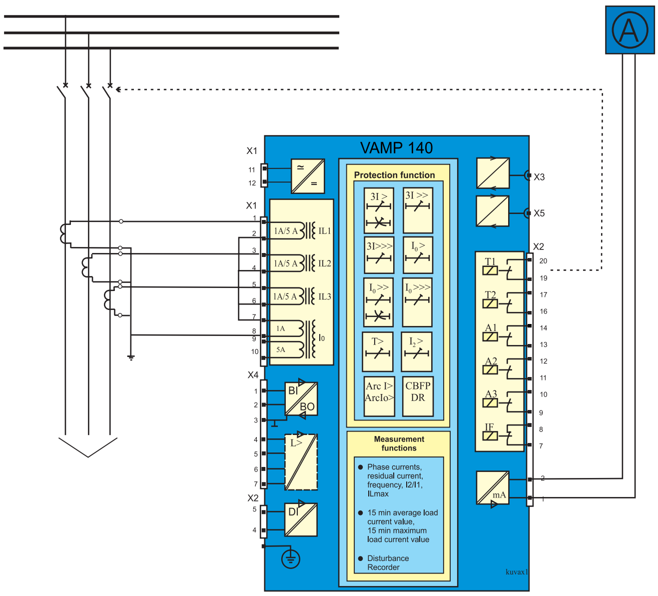


Figure 3.1-1 Three-phase overcurrent protection, earth-fault protection and phase discontinuity protection of an overhead line feeder. The earth-fault current is measured with a residual current connection of the current transformers. The analog mA output can be used to show the load current of one of the phases. The signal can be wired to a local meter or to an automation system

3.2. Overcurrent and earth-fault protection of an overhead line feeder

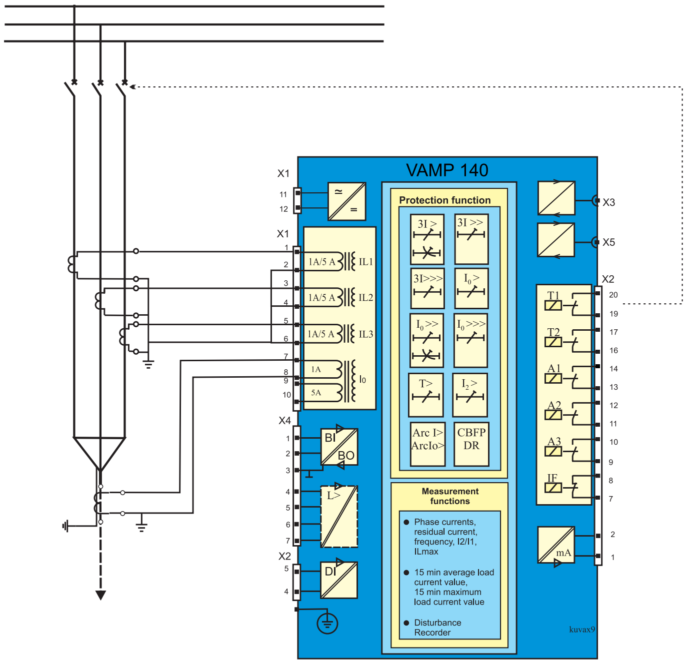


Figure 3.2-1 Three-phase overcurrent protection and earth-fault protection of an overhead line feeder. The earth-fault current is measured with a residual current connection of the current transformers.

3.3. Overcurrent, earth-fault and arc protection of a distribution transformer feeder

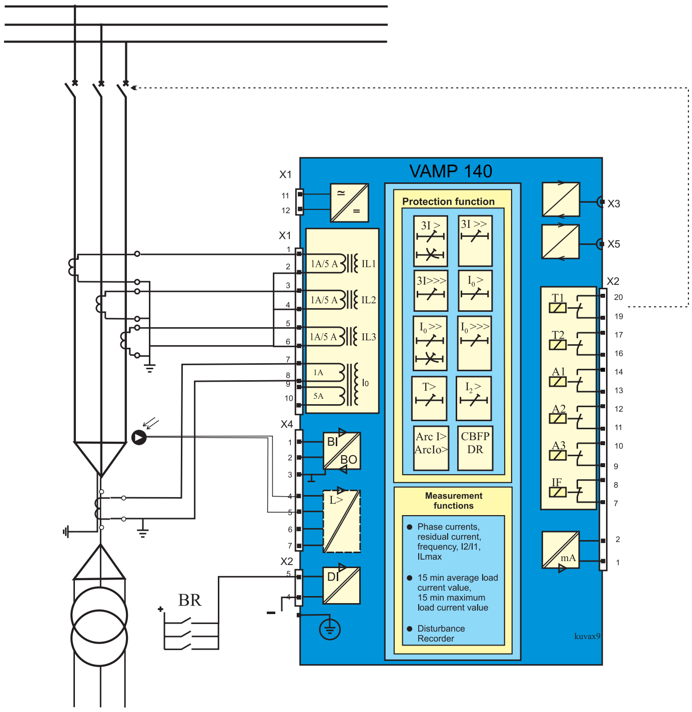


Figure 3.3-1 Overcurrent, earth-fault and arc protection of a distribution transformer feeder. The relay is provided with the optional arc protection card. The binary input of the relay is used for collecting contact alarm signals from, e.g. the distribution transformer Buchholz relay (gas relay) and/or oil level supervision device or the oil temperature alarm contact.

3.4. Power transformer HV side overcurrent and earth-fault protection

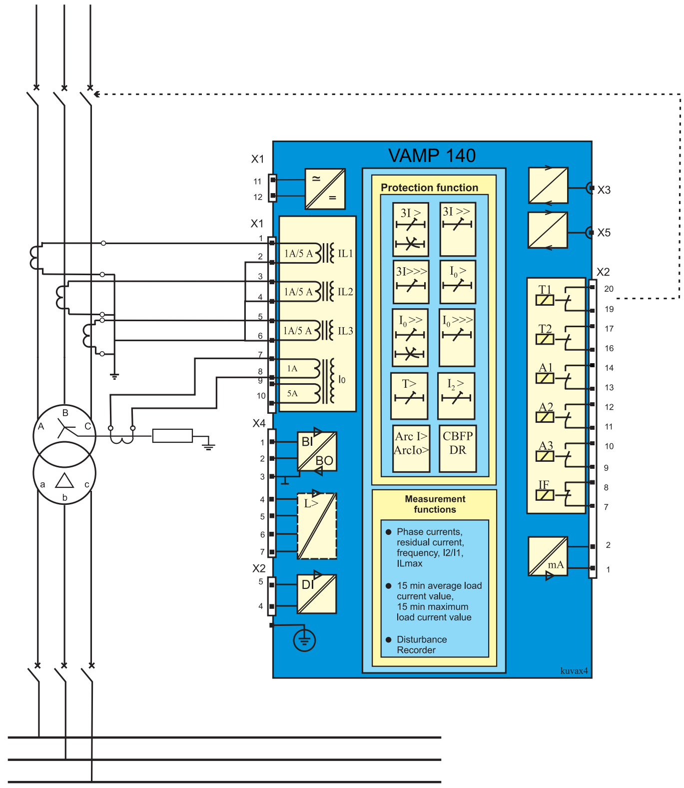


Figure 3.4-1 The VAMP 140 relay used for overcurrent and earth-fault protection of the HV side of a power transformer.

3.5. Fast busbar short-circuit protection based on blockings

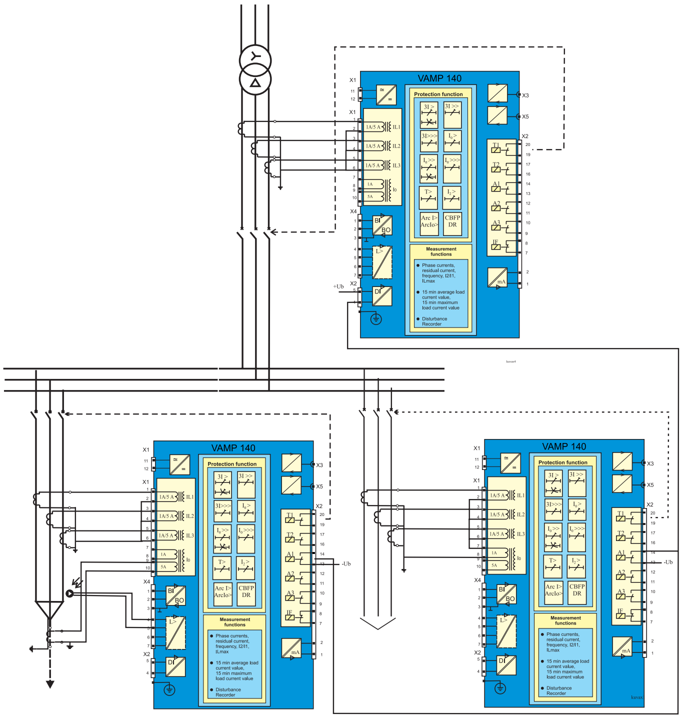


Figure 3.5-1 A fast busbar short-circuit protection based on blocking of overcurrent relays. A blocking signal is issued, if one of the overcurrent relays on the outgoing feeders starts. The blocking signal is configured to block the high-set stage I>> of the overcurrent relay on the infeeder. The operating time t>> of the high-set stage of the infeeder can be set as low as 70 ms, because the operating time of the start contacts of the overcurrent relays of the outgoing feeders is well under 50 ms.

3.6. Circuit-breaker failure protection via the output relay T2

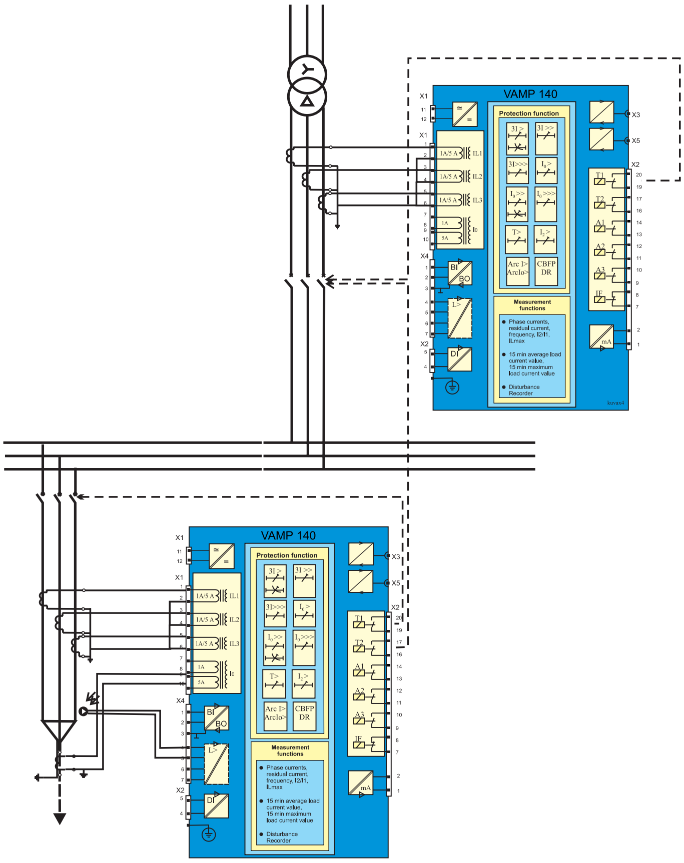


Figure 3.6-1 When the circuit-breaker failure protection is used it is configured to control the output relay T2, which usually controls the following upstreams circuit breaker.

3.7. Trip circuit supervision

Trip circuit supervision is used to ensure that the wiring from protective relay to the circuit breaker is in order. This circuit is most of the time unused but when the protection relay 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.

A digital input of the relay can be used for trip circuit monitoring.

- The digital input is connected in parallel with the trip contacts (Figure 3.7-1).
- A resistor module VR10CB enables supervision also when the circuit breaker is open. The module consist resistor for

110 Vdc and 220 Vdc and is connected according the auxiliary voltage.

- 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 trip relay should be configured as non-latched. Otherwise a superfluous trip circuit fault alarm will follow after the trip contact operates and remains closed because of latching.

Figure 3.7-1 shows the situation when the circuit breaker is closed. If the digital input is not in active state it indicates that there is something wrong in the trip circuitry.

Figure 3.7-2 shows the situation when the circuit breaker is open. The resistor module VR10CB ensures that the digital input is in active state also in this situation. If the digital input is not in active state it indicates that there is something wrong in the trip circuitry.

If a communication protocol is in use the digital input event will tell the control system that there is a circuit breaker failure.

If serial communication is not in use, any of the unused output relays can be configured to follow the state of the inverted and delayed digital input. This relay will then give a "trip circuit failure" alarm to the control system if there is a failure.

The user may also configure a dedicated digital input event text, e.g. "TRIP CIRCUIT FAILURE", to be displayed on the local display of the protective relay whenever there is a trip circuit failure.

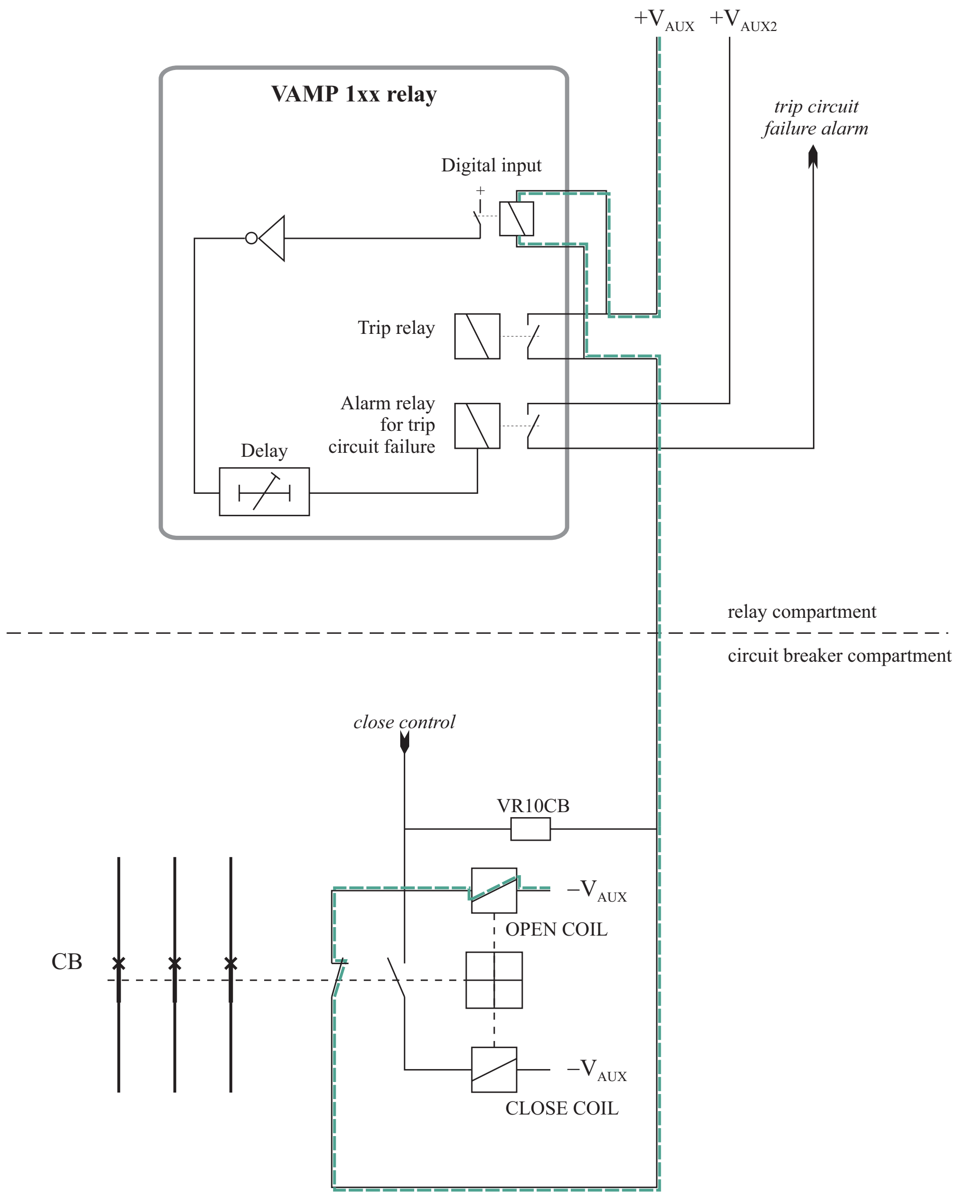


Figure 3.7-1 Trip circuit supervision when the circuit breaker is closed. The supervised circuitry in this CB position is marked with an extra parallel line. The digital input is in active state.

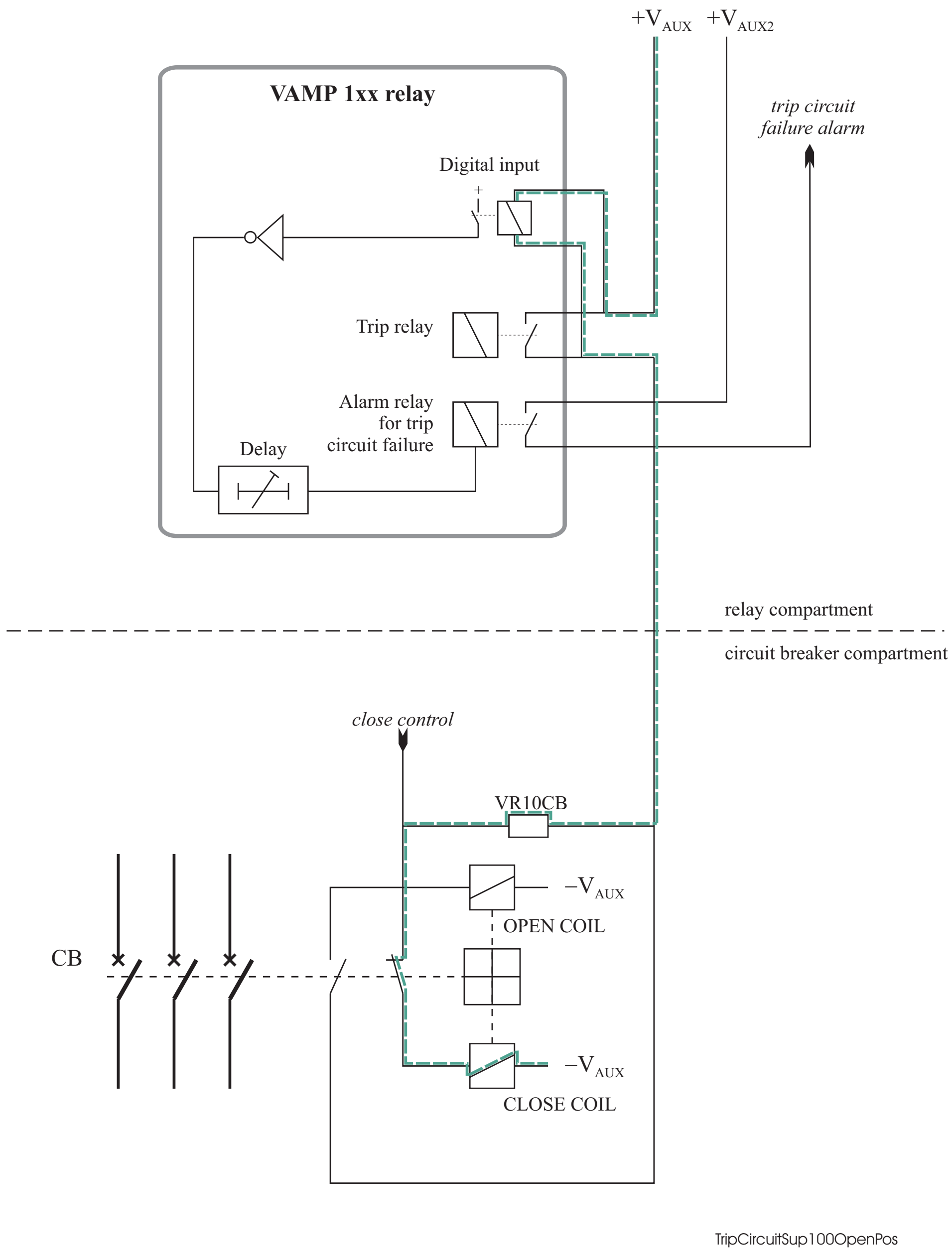


Figure 3.7-2 Trip circuit supervision when the circuit breaker is open. The supervised circuitry in this CB position is marked with an extra parallel line. The resistor device VR10CB offers an active input state for the digital input although the open coil auxiliary contact is open.

3.8. Complete protection of a HV capacitor bank

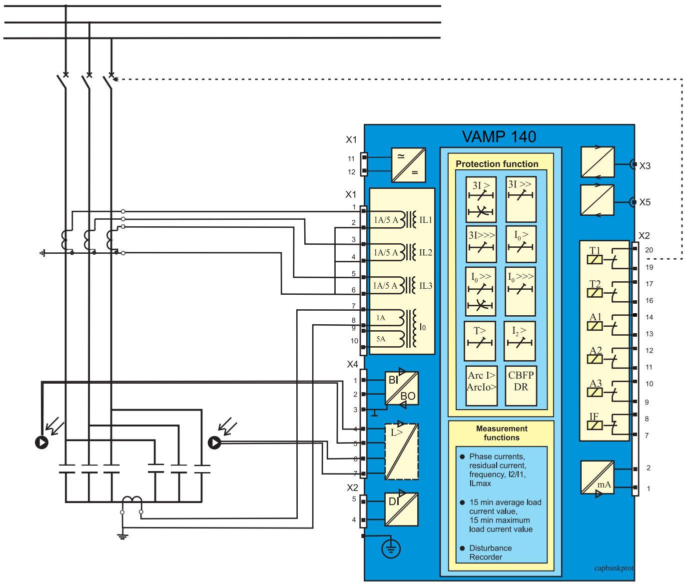


Figure 3.8-1 The VAMP 140 relay is well suited for the complete protection of HV capacitor banks. The three-phase overcurrent stage provides capacitor short-circuit protection (and overload protection). The sensitive earth-fault stage is connected to measure the unbalance current. By utilizing the arc protection features of the relay the capacitor bank can be given selective arc protection.

3.9. Three-phase overcurrent protection with two current transformers

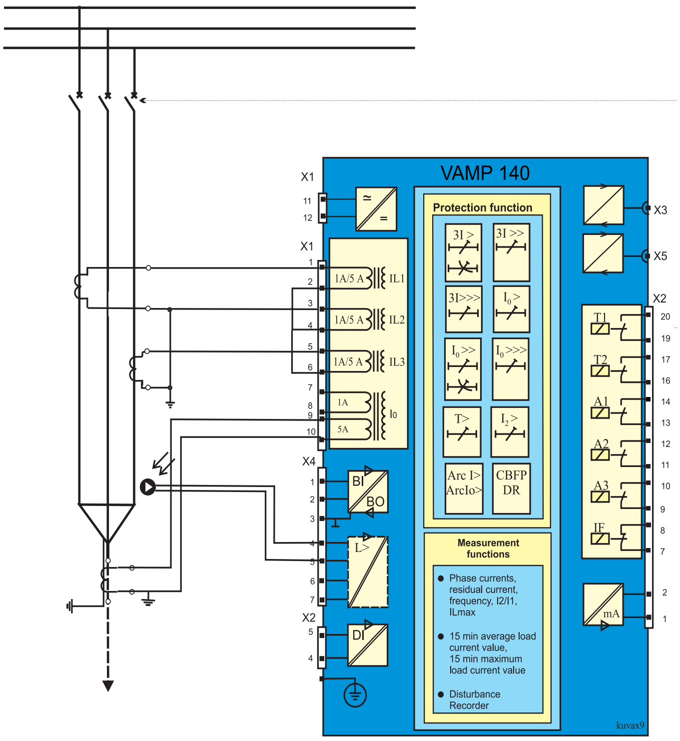


Figure 3.9-1 When current transformers are available on only two phases, the three-phase overcurrent protection can be carried out by connecting the current transformers as shown in the above figure.

3.10. DI controlled overcurrent scaling

The setting of the three overcurrent stages can also be controlled by the digital input. In this case only two scaling coefficients are possible: 100% (DI is inactive) and any configured value between 20% - 100% (DI is active).

If you want to use this feature, it must be first enabled using VAMPSET, or from the local panel using the following procedure:

- Go to main menu "ENABLE" using the UP/DOWN keys.
- Press RIGHT key to enter submenu "Enable I".
- Press RIGHT key again to enter this menu.
- Go to line "Isca: Off" by pressing the UP/DOWN keys.
- Press ENTER. The device will ask for an operator password:

- Press ENTER again, press ENTER once more to start editing. The device will inform that editing this value will cause an autoboot.
- Select value "On" with the UP/DOWN keys and confirm with ENTER key.
- Wait about 30 seconds until the device restarts.

The setting range is for the DI-active scaling factor is 20% - 100%. To change the factor use VAMPSET or the local panel. The procedure from the local panel is:

- Go to main menu "IL SETTING" using the UP/DOWN keys.
- Press RIGHT key to enter this menu.
- Go to the line "DI1 I Set" by pressing the UP/DOWN keys.
- Press RIGHT key to enter this menu. The display will show "Isca: 100%".
- Press ENTER. The device will ask for an operator password:
- Press ENTER again, give the password 1 (use UP/DOWN keys) and confirm with ENTER key.
- Set the value with the UP/DOWN/LEFT/RIGHT keys and confirm with ENTER key.

Please note that the polarity (i.e. whether the input is active with closed or open contact) of the digital input is configurable, too. See menu "DIGITAL IN/DI1pol: NO". 'NO'=Normal Open for a closed-active contact and 'NC'=Normal Closed for an open-active contact.

Note!

If the digital input is used for setting control, it should not be used for other purposes like blocking the protection stages.

This feature is available starting from software version 2.70

4. Connections

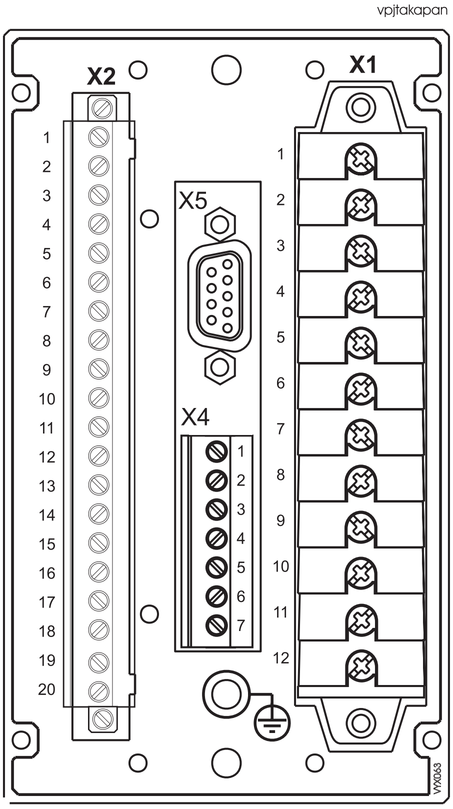


Figure 2.5.2-1 Connections on the rear panel of the VAMP 140 relay.

The VAMP 140 relay is connected to the protected object through the following measuring and control connections:

- Phase currents IL1, IL2 and IL3 (terminals X1: 1-6)
- Residual current I0 (5 A input: terminals X1: 9-10, 1 A input: terminals X1: 7-8)

4.1. Digital input

Further the relay can collect position information and alarm signals via the digital input (terminals X2: 4-5) and store the information in the event register.

The digital input can be used to:

- Block protection stages under certain conditions.
- Get time stamped event code from any auxiliary contact.
- Control the output relays.
- Supervise the trip circuit.

Potential-free contacts for position indication must be available in the protected application.

4.2. Auxiliary voltage

The external auxiliary voltage Uaux (standard 40 to 265 V ac/dc or 24 V dc, option B) for the relay is connected to the terminals X1: 11 - 12

Note!

Polarity of the auxiliary voltage U_{aux} (24 V dc, option B):

+ = X1:11 and - = X1:12.

4.3. Output relays

The VAMP 140 relay is equipped with five configurable output relays and a separate output relay for the self-supervision system

- Trip relays T1 and T2 (terminals X2: 19 - 20 and 16 - 17)
- Alarm relays A1 - A3 (terminals X2: 13 - 14, 11 - 12 and 9 - 10)
- Self-supervision system output relay IF (terminals X2: 7 - 8)
- The trip relay T2 can also be used for alarm purposes.

4.4. Serial communication connections

- RS 232 serial communication connection for computers, connector LOCAL (RS 232) on the front panel of the relay
- Remote control connection, connector REMOTE (TTL) on the rear panel of the relay (terminal X5). See also Table 2.5.2-1.

4.5. Current transducer

- The output signal, i.e. 0 - 20 mA or 4 - 20 mA, of the integrated mA transducer is available on terminal X2: 1 - 2.

Available couplings to the analog output

- I_{L1}, I_{L2}, I_{L3}, I_L
- I_0
- f
- I2/I1
- I_{Fault}

4.6. Arc protection

The optional arc protection card includes two arc sensor channels. The arc sensors are connected to terminals X4: 4-5 and 6-7.

The arc information can be transmitted and/or received through the binary input and output channels. This is a 48 Vdc signal.

Connections:

X4: 1 Binary input (BI)

X4: 2 Binary output (BO)

X4: 3 GND (connect between relays)

X4: 4 Arc sensor 1 +

X4: 5 Arc sensor 1 -

X4: 6 Arc sensor 2 +

X4: 7 Arc sensor 2 -

4.7. Block diagram

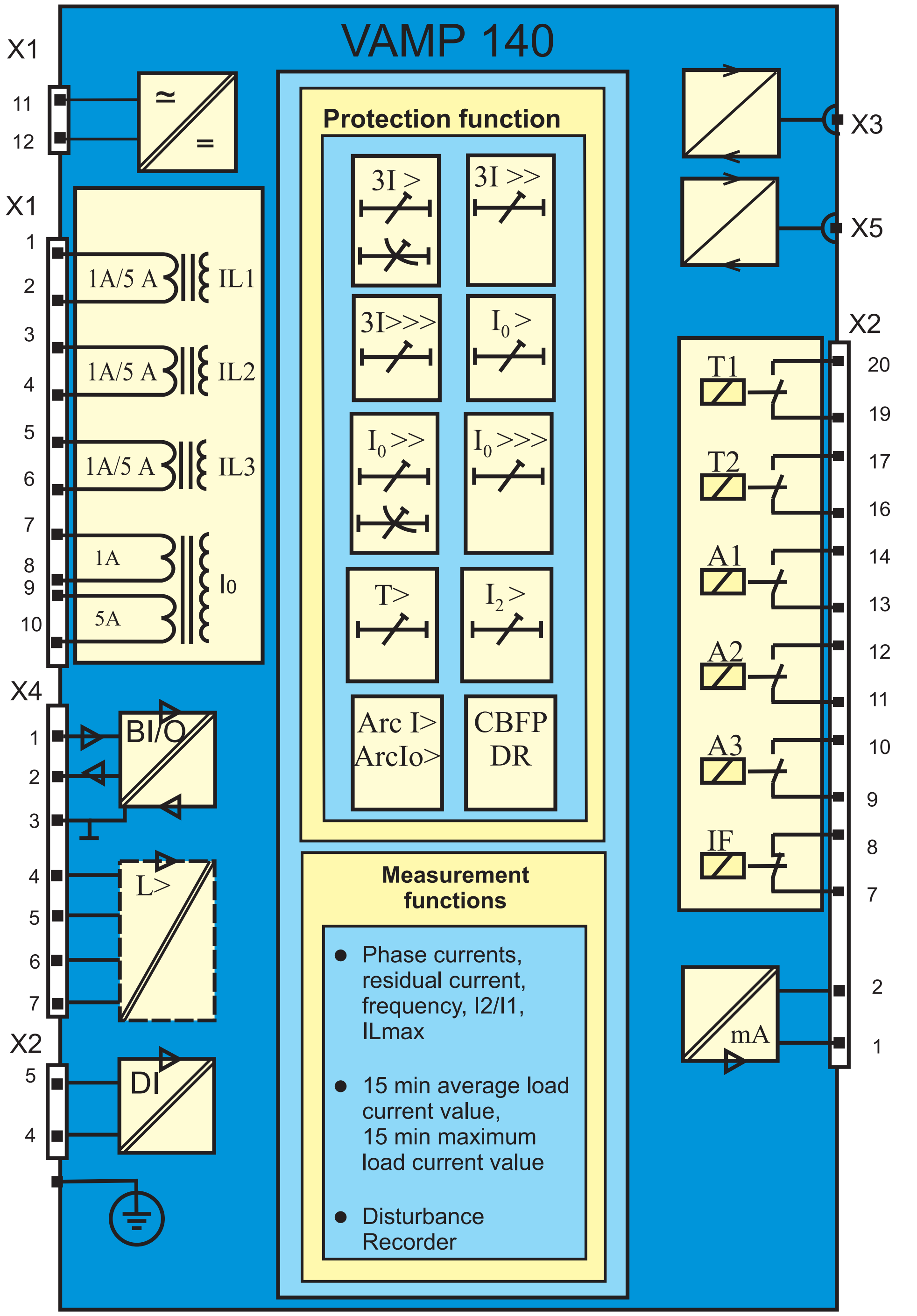


Figure 4.7-1 Block diagram of the overcurrent and earthfault relay VAMP 140.

4.8. Connection diagram

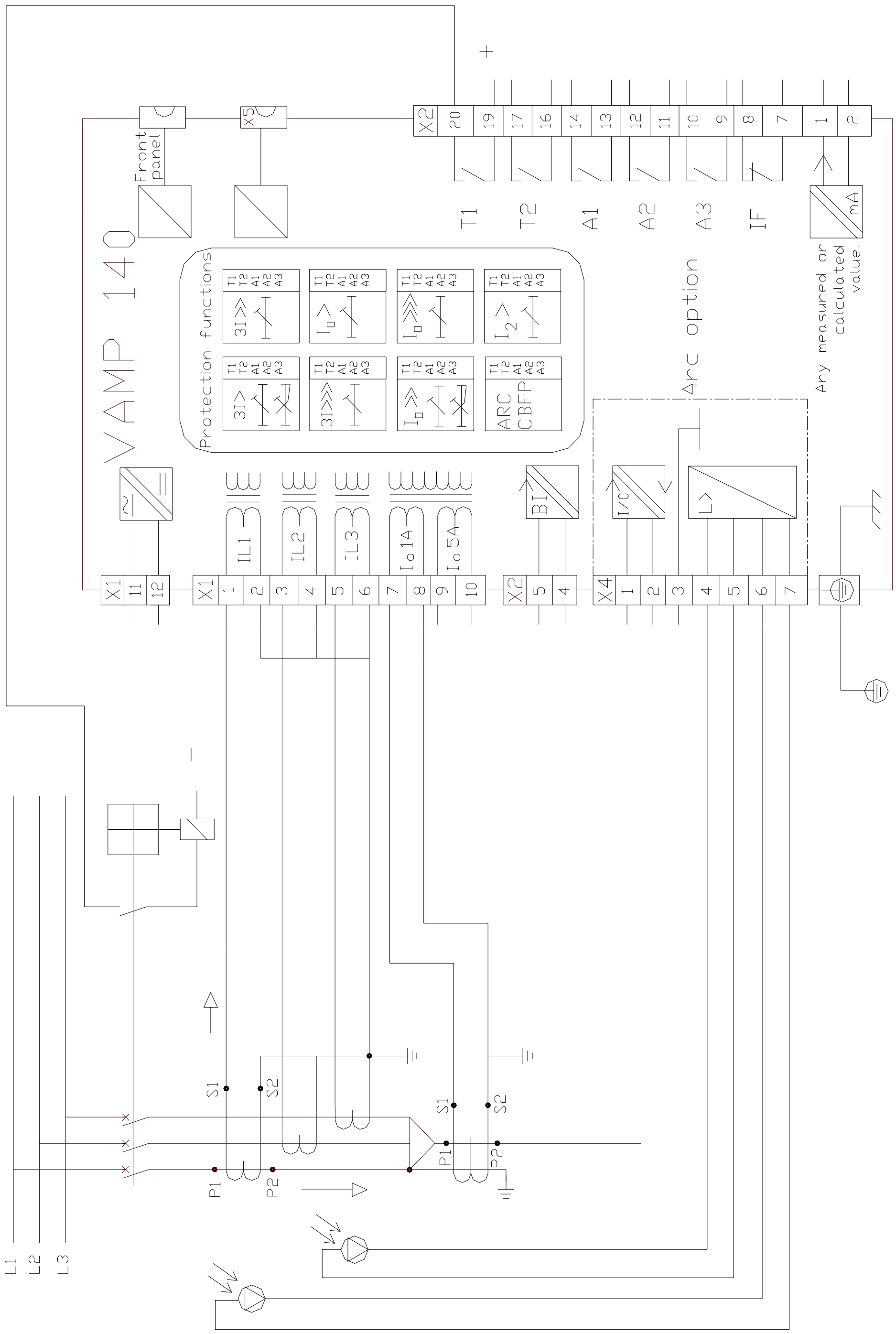


Figure 4.8-1 VAMP 140 connection diagram. Relay contact positions when no auxiliary power supply connected.

5. Technical data

5.1. Connections

5.1.1. Measuring circuitry

Rated current In - Current measuring range - Thermal withstand - Power consumption - Inaccuracy I ≤ 1.5 x In I > 1.5 x In	1 A or 5 A 0 – 50 x In 4 x In (continuous) 20 x In (for 10 s) 100 x In (for 1 s) < 0.1 VA (In = 1A) < 0.2 VA (In = 5A) ±0.5% of value or ±0.3% of rated value ±3% of value
Residual current I_{0n} - Current measuring range - Thermal withstand - Power consumption - Inaccuracy I_0 ≤ 1.5 x I_0n I_0 > 1.5 x I_0n	1 A or 5 A 0 – 5 x I_{0n} 4 x I_{0n} (continuous) 20 x I_{0n} (for 10 s) 100 x I_{0n} (for 1 s) < 0.1 VA (I_{0n} = 1A) < 0.2 VA (I_{0n} = 5A) ±0.5% of value or ±0.3% of rated value ±3% of value
Rated frequency fn - Frequency measuring range - Inaccuracy	50/60 Hz 16 - 65 Hz ±10 mHz

5.1.2. Auxiliary voltage

	Type A (standard)	Type B (option)
Rated voltage Uaux	40 - 265 V ac/dc 110/120/220/240 V ac 48/60/110/125/220 V dc	18 - 36 V dc 24 V dc
Power consumption	< 7 W (under normal conditions) < 15 W (as the relay has started)	
Max. permitted ac component of dc supply, point-to-point	<= 12% of rated voltage <= 6% near the limits of the voltage range	
Max. permitted interruption time	< 50 ms (110 V dc)	

5.1.3. Digital input

Number of inputs	1
External control voltage	18 - 265 V ac/dc
Burden	< 2 mA

5.1.4. Trip contacts (T1 and T2)

Number of contacts	2 making contacts
Rated voltage	250 V ac
Continuous carry	5 A
Max. making current	15 A
Breaking capacity, AC	2 000 W/VA
Breaking capacity, DC (L/R=40ms)	50 W
Contact material	AgNi 90/10

5.1.5. Alarm contacts (A1...A3) and IF

Number of contacts	3 making contacts (relays A1...A3) 1 making contact (relay IF)
Rated voltage	250 V ac
Continuous carry	5 A
Breaking capacity	1 500 W/VA
Contact material	$AgSnO_2$

5.1.6. Local serial communication port

Number of ports	1 on front panel
Electrical connection	RS 232
Data transfer rate	2 400…38 400 b/s

5.1.7. Remote control port

Number of ports	1 on rear panel
Electrical connection	TTL (standard) RS 485 (option) RS 232 (option) Plastic fibre connection (option)
Data transfer rate	1 200...38 400 b/s
Protocols	ModBus,, RTU master ModBus,, RTU slave SPA Bus, slave Profibus DP (option) ModBus TCP (option) Transparent TCP/IP (option) IEC-6870-5-103

5.1.8. mA output

Number of outputs	1
Output signal	0/1 - 5 mA or 0/4 - 20 mA or any between 0...20mA
Load resistance	RL < 600 W
Accuracy	Class 1

5.1.9. Arc option card

Binary input - operationg voltage	+48 Vdc (optically isolated input)
Binary output - Output voltage level	+48 Vdc (transistor controlled output) Max three binary inputs can be connected to one uotput. More inputs can be connected if an external amplifier is used.
Arc sensor inputs - Number of inputs - Operating voltage level	2 12 Vdc (optically isolated inputs) Arc sensor draws > 11.9 mA current from the 12 Vdc line, when arc has been detected. Sensor and sensor wiring is OK, when current is 1.3 mA..31 mA, otherwise sensor line is broken or short-circuited.

5.1.10. Connectors

Connector X1

Max. torque	1.2 Nm
AWG	14 - 10

Connectors X2 and X4

Max. torque	0.5 – 0.6 Nm
AWG	24 - 12

5.2. Tests and environmental conditions

5.2.1. Disturbance tests (EN 50263)

Emission - Conducted (EN 55022) - Emitted (EN 55022)	 0.15 - 30 MHz 30 - 1 000 MHz
Immunity - Static discharge (ESD) - Fast transients (EFT) - Surge - Conducted RF field - Emitted RF field - GSM test	 EN 61000-4-2, class III 6 kV contact discharge 8 kV air discharge EN 61000-4-4, class III 2 kV, 5/50 ns, 5 kHz, +/- EN 61000-4-5, class III 1 kV, 1.2/50 µs, common mode 2 kV, 1.2/50 µs, differential mode EN 61000-4-6 0.15 - 80 MHz, 10 V/m, 80% AM (1 kHz) EN 61000-4-3 80 - 1000 MHz, 10 V/m, 80% AM (1 kHz) EN 61000-4-3 900 MHz, 10 V/m, pulse modulated
1 MHz burst	IEC 60255-22-1 1 kV, differential mode 2,5 kV, common mode
Voltage interruption	IEC 60255-11

5.2.2. Test voltages

Insulation test voltage (IEC 60255-5)	2 kV, 50 Hz, 1 min
Surge voltage (IEC 60255-5)	5 kV, 1,2/50 μs, 0,5 J

5.2.3. Mechanical tests

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

5.2.4. Environmental conditions

Operating temperature	-10 to +55 ×C
Transport and storage temperature	-40 to +70 ×C
Relative humidity	< 75% (1 year, average value) < 90% (30 days per year, no condensation permitted)

5.2.5. Casing

Degree of protection (IEC 60529)	IP20
Dimensions (W x H x D)	99 x 155 x 225 mm
Weight	2.3 kg

5.3. Protection stages

5.3.1. Overcurrent protection

Overcurrent stage I> (50/51)

Current setting range:	0.10 – 5.00 pu
Definite time characteristic:	
- Operating time	0.08 - 300.00 s (step 0.02)
Inverse time characteristic:	
- 4 characteristic curve sets: (IEC60255-3)	EI, VI, NI, LTI *)
- Time multiplier k	0.05 – 3.20
Starting time	<60 ms
Resetting time	<80 ms
Resetting ratio	0.97
Inaccuracy:	
- Starting	±2% of set value
- Operating time definite time	±1% or ±30 ms
- Operating time inverse time	±5% or at least ±30 ms (I< 50 x In)

*) EI = Extremely Inverse, VI = Very Inverse, NI = Normal inverse, LTI = Long Time Inverse

Overcurrent stages I>> and I>>> (50/51)

Current setting range	0.10 – 40.00 pu
Definite time characteristic:	
- Operating time	0.05 - 300.00 s (step 0.01)
Starting time	<50 ms
Resetting time	<80 ms
Resetting ratio	0.97
Inaccuracy:	
- Starting	±2% of set value
- Operate time	±1% or ±30 ms

Phase unbalance stage I2> (46)

Current setting range	5 – 70% I2/I1
Definite time characteristic:	
- Operating time	1.0 – 600.0s s (step 0.1)
Starting time	<300 ms
Resetting time	<300 ms
Resetting ratio	0.95
Inaccuracy:	
- Starting	±3% of set value or
	±0.5% of rated value
- Operate time	±5% or ±300 ms

Thermal overload stage T> (46)

Settings:	
- Max. continuous load current k x In	0.50 - 1.20 x In
(□trip = thermal trip level)	
- Thermal alarm level	60 – 99%
- Heating time constant □	2 – 60 min
- Cooling time constant □	1.0 x tau

5.3.2. Residual current protection

Residual current stage I_0> (50/51N)

Residual current setting range	0.005 - 2.000 pu
Definite time characteristic:	
- Operating time	0.08 - 300.0 s (step 0.02 s)
Starting time	<60 ms
Resetting time	<80 ms
Resetting ratio	0.97
Inaccuracy:	
- Starting	±2% of set value or
	±0.3% of rated value
- Operate time	±1% or ±30 ms

Residual current stage I_0>> (50/51N)

Current setting range:	0.02 – 2.00 pu
Definite time characteristic:	
- Operating time	0.05 - 300.00 s (step 0.01)
Inverse time characteristic:	
- 4 characteristic curve sets: (IEC60255-3)	EI, VI, NI, LTI *)
- Time multiplier k	0.05 – 3.20
Starting time	<60 ms
Resetting time	<80 ms
Resetting ratio	0.97

Inaccuracy:	
- Starting	±2% of set value or ±0.3% of rated value
- Operating time definite time	±1% or ±30 ms
- Operating time inverse time	±5% or at least ±30 ms ($I_0 < 5 \times I_{0n}$)

*) EI = Extremely Inverse, VI = Very Inverse, NI = Normal inverse, LTI = Long Time Inverse

Residual current stage I_0>>> (50/51N)

Residual current setting range	0.05 - 4.00 pu
Definite time characteristic:	
- Operating time	0.05 - 300.0 s (step 0.01 s)
Starting time	<60 ms
Resetting time	<80 ms
Resetting ratio	0.97
Inaccuracy:	
- Starting	±2% of set value or ±0.3% of rated value
- Operate time	±1% or ±30 ms

5.3.3. Second harmonic function

2. Harmonic stage / Inrush (68)

Settings:	
- Setting range 2.Harmonic	10 – 100 %
- Operating time	0.05* – 300.00 s (step 0.01 s)

*) This is the instantaneous time i.e. the minimum total operational time including the fault detection time and operation time of the trip contacts.

5.3.4. Arc protection (option)

The operation of the arc protection depends on the setting value of the ArcI> current limit. The current limit cannot be set, unless the relay is provided with the optional arc protection card.

Arc protection stage ArcI> (51L>)

Current setting range	0.5 – 10.0 pu
Operating time	~ 15 ms
Arc sensor channel selection	S1, S2, BI, S1/S2, S1/BI, S2/BI, S1/S2/BI

The operation of the earth-fault arc protection depends on the setting value of the ArcIo> earth-fault limit. The earth-fault limit cannot be set, unless the relay is provided with the optional arc protection card.

Arc protection stage Arc I_0> (51NL>)

Current setting range	0.05 – 10.0 pu
Operating time	~ 15 ms
Arc sensor channel selection	S1, S2, BI, S1/S2, S1/BI, S2/BI, S1/S2/BI

Delayed Arc S>

Delay time	0.01 – 0.15
Arc sensor channel selection	S1, S2, BI, S1/S2, S1/BI, S2/BI, S1/S2/BI

5.4. Disturbance Recorder (DR)

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

Disturbance recorder (DR)

Mode of recording:	Saturated / Overflow
Sample rate:	
- Waveform recording	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 (must be shorter than MAX time)
Pre trigger rate	0 – 100%
Number of selected channels	0 – 12

6. Construction

6.1. Dimensional drawing

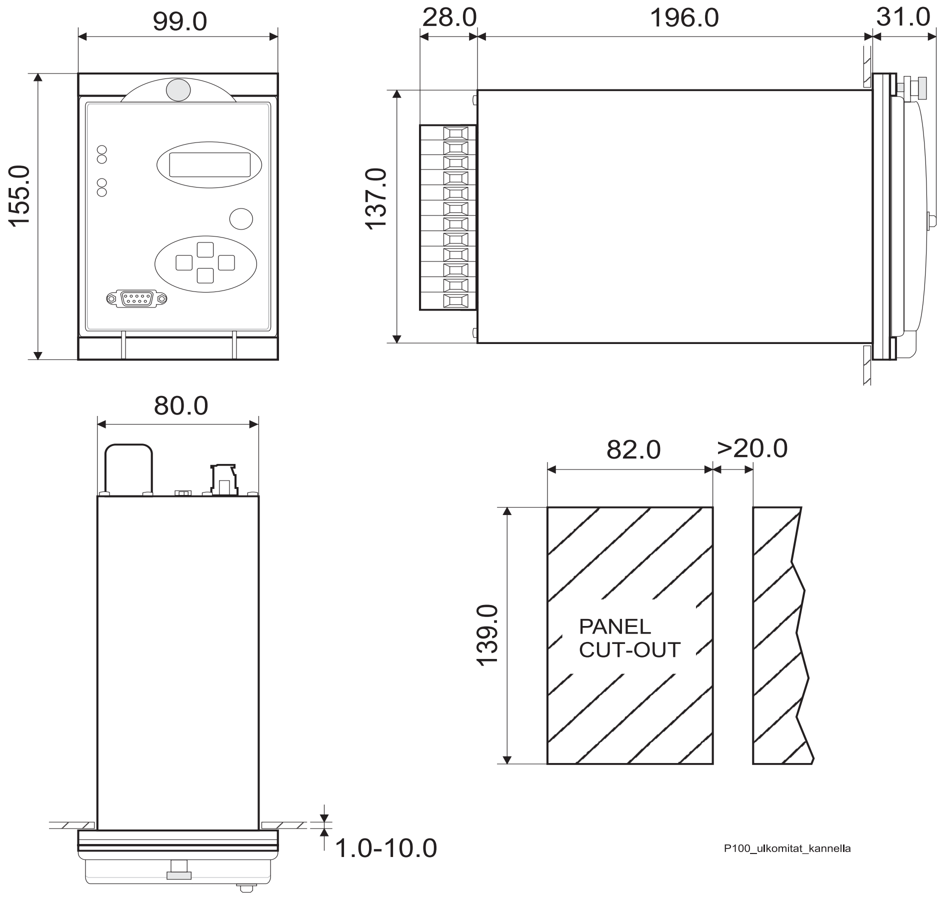


Figure 6.1-1 Dimensional drawing and panel cut-out dimensions

6.2. Panel mounting

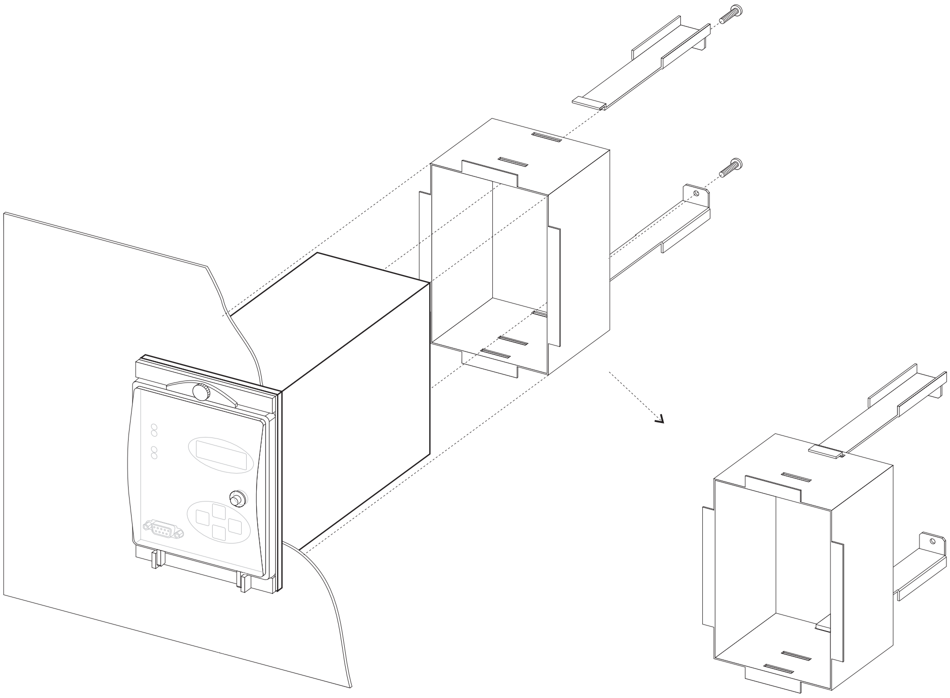


Figure 6.2-1 Panel mounting

6.3. Semi-flush mounting

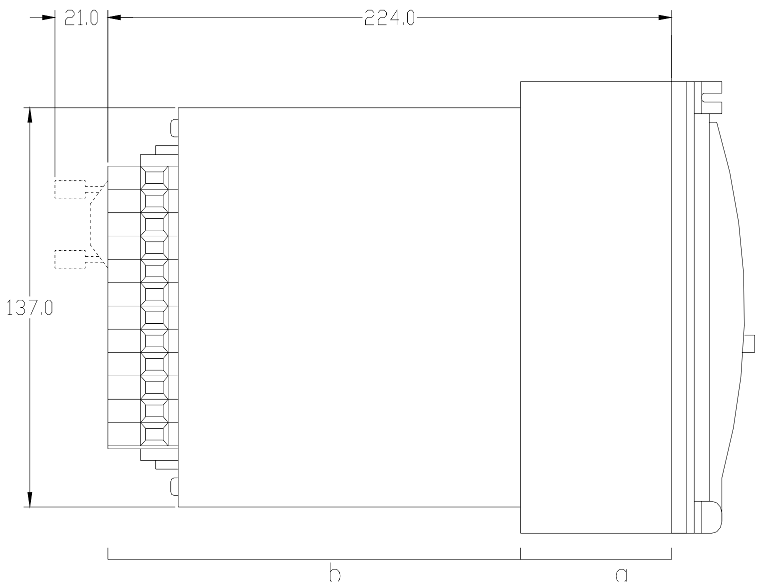


Figure 6.3-1 Semi-flush mounting

Depth with raising frames

Type designation	a	b
VYX078	40 mm	184.0 mm
VYX079	60 mm	164.0 mm

7. Order information

When asking for quotations or when ordering, please, state:

The ordering code:

Quantity:

Auxiliary voltage:

Options:

VAMP 140 ORDERING CODE

VAMP 140 - 3 A 7 ☐ ☐ ☐

Nominal current [A]
3 = 1A / 5A

Nominal Earth Current [A]
A = 1A / 5A / SEF 1A

Frequency [Hz]
7 = 50/60Hz

Supply Voltage [V]
A = 40.. 265Vac/dc
B = 18.. 36Vdc

Optional Hardware
A = None
B = Plastic Optic Interface & Arc
C = Arc Protection
D = Plastic Optic Interface
E = Combined PC & protocol port
F = Combined PC & protocol port & .

Optional Software
A = None

Accessories :

Order Code	Explanation	Note
VEA 3 CG	Ethernet Interface Module	VAMP Ltd
VPA 3 CG	Profibus Interface Module	VAMP Ltd
VSE001	Fiber optic Interface Module	VAMP Ltd
VSE002	RS485 Interface Module	VAMP Ltd
VX003-3	Programming Cable (VAMPSet, VEA 3 CG+200serie)	Cable length 3m
VX004-M3	TTL/RS232 Converter Cable (for PLC, VEA3CG+200serie)	Cable length 3m
VX007-F3	TTL/RS232 Converter Cable (for VPA 3 CG or VMA 3 CG)	Cable length 3m
VX015-3	TTL/RS232 Converter Cable (for 100serie+VEA3CG)	Cable length 3m
VX008-4	TTL/RS232 Converter Cable (for Modem MD42, ILPH, ..)	Cable length 4m
VA 1 DA-6	Arc Sensor	Cable length 6m

8. Reference information

Technical documentation:
Mounting and Commissioning Instructions VMMC.EN0xx
VAMPSET Operating Instructions VMV.EN0xx

Manufacturer:
VAMP Ltd.
P.O. Box 5
FIN-65381 Vaasa, Finland
Street address: Runsorintie 7
Tel. Int.+358 (0)6-2121 100
Fax. Int.+358 (0)6-2121 105
URL: http://www.vamp.fi

Service:
VAMP Ltd.
P.O. Box 5
FIN-65381 Vaasa, Finland
Street address: Runsorintie 7
Tel. Int.+358 (0)6-2121 100
Fax. Int.+358 (0)6-2121 105
URL: http://www.vamp.fi

24h support phone:
Tel . +358 (0)40 573 6316

Email: vampsupport@vamp.fi

During office hours 6.00 - 14.00 GMT, please use the following telephone number +358 (0)6-2121 100.

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