EPAC 3100/3500
Numerical distance relay

EPAC 3100/3500

Numerical distance relay with integrated automatic and control functions

Features

- Fully numerical distance relay designed to protect overhead lines and underground cables.
- Typical operating time 1.25 cycles
- Up to six independent zones of protection.
- Dual distance protection algorithms.
- Independent directional overcurrent element for additional (back-up) protection.
- Quadrilateral characteristic used for all type of faults.
- Comprehensive range of protection schemes.
- Single and three pole tripping.
- Comprehensive directional earth fault (DEF) protection with back-up IDMT element for high resistance earth faults.
- Additional overload, overvoltage and undervoltage protection functions.
- Power swing blocking.
- Switch-on-to-fault protection.
- Parallel line compensation.
- Weak-infeed and echo operation.
- Check synchronising function.
- Automatic single and/or three-pole auto-reclose function.
- Four independent, user selectable setting groups.
- Fault location and instrumentation.
- Ten fault reports stored in non volatile mass memory with automatic down-loading to a printer.
- Oscillography stored in non volatile memory. Average capacity of 40 5-second records through data compression.
- Real time calendar clock of fault reports and oscillography.
- IRIG-B port for real-time clock synchronisation.
- Substation communications via K-bus or VDEW (IEC 870-5-103 protocol).
- Comprehensive self-checking and alarms.

User's tools

- Front panel display,
- WinEPAC software (off-line setting),
- WinTPE software (oscillography),
- Courier™ communication: PAS&T or CAS:W software (on-line setting).

Figure 1.
EPAC 3100 relay

Introduction

EPAC is a fully numerical protection equipment designed for distribution and/or transmission networks that are solidly earthed, impedance earthed or earthed via a Petersen coil.

The relay is fully compatible with the ALSTOM K-range of relays and can be integrated into an overall protection and control system utilising its integral serial communications facility.

Models available

There are 12 different models according to the features required.

These models are described in a table, page 16 of this publication: *Recapitulation of features per models.*

Applications

EPAC is suitable for the protection of overhead lines and underground cables and can be used as the main or back-up distance protection for networks whether they are solidly earthed, impedance earthed or earthed via a Petersen coil. The resistance reach coverage value per zone is perfectly adapted to short line and cable protection.

Two independent earth fault factors, K01 used for zone 1 and K02 for the other zones are particularly beneficial to hybrid line applications.

Its protection scheme simultaneously employs fast algorithms, using superimposed values in order to eliminate load current, which respond only to fault related phase values, and conventional algorithms using values measured during the fault in the same way as conventional protection.

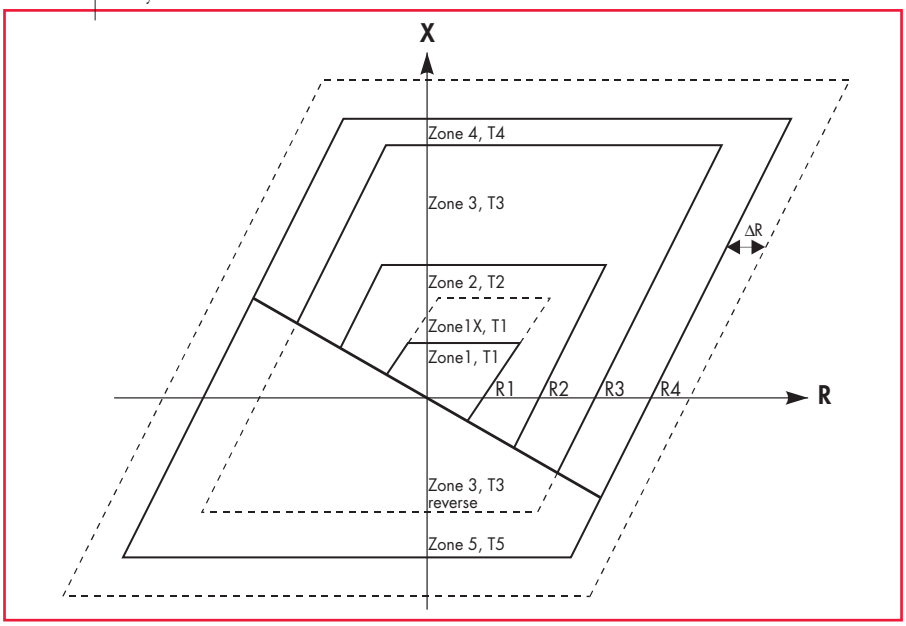
This dual algorithm principle allows the relays to detect all types of faults occurring in the network.

VT's or CVT's may be on a line or on busbar side.

There is a comprehensive selection of protection schemes allowing single or three pole tripping with or without a signalling channel.

Additional protection functions such as DEF, overload, under and over voltage protection, complement the distance protection and allow single or three-pole tripping when the impedance point relative to the fault is outside the quadrilateral characteristic.

Figure 2.
Relay characteristic



Functions

Phase selector

Fast algorithms compare superimposed currents.

Conventional algorithms use overcurrent or impedance criteria.

Fault direction

The fault direction is obtained by calculating the sign of the superimposed energy for the fast algorithms or measuring the phase shift between the pre-fault voltage (10 s memory voltage) and the fault current for the conventional algorithms.

Distance-to-fault measurement

Distance to the fault is measured by discriminating between the voltage drop on the line and that caused by the fault. This removes the error due to the fault resistance irrespective of the load current. A least squares method is used to get the algorithms to converge rapidly.

Distance protection

Six zones of protection for all types of faults are provided as shown in Figure 2.

They are:

- Zone 1 forward directional instantaneous or time-delayed trip zone.
  and
  Zone 1X forward directional used for zone reach control scheme, instantaneous or time-delayed trip zone.

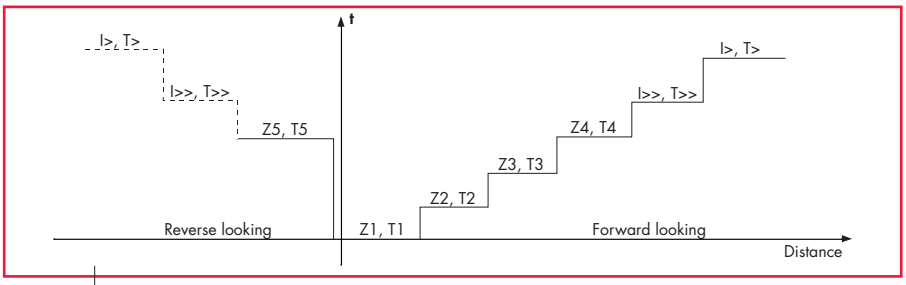


Figure 3.
Current start-up

- Zone 2 forward directional time-delayed trip zone.
- Zone 3 forward or reverse directional time delayed trip zone.
- Zone 4 forward directional time delayed trip zone.
- Zone 5 reverse directional time delayed trip zone.

The back-up overcurrent protection permits the clearance of faults beyond zones 4 and 5 using two directional or non-directional time delayed thresholds as shown in Figure 3.

Busbar isolation

Busbar isolation mode is used to isolate busbars if there is a fault near them in order to reduce the fault current quickly. This 4-zone mode is non-directional as the link must be broken quickly since the fault may originate from a busbar situated in the forward or reverse direction of the protection device as shown in Figure 4.

Earth fault direction in isolated or Petersen coil earthed networks

The RNI module allows the EPAC to protect overhead lines and underground cables when the neutral of the network is isolated or earthed by an impedance or by a Petersen coil. The PWH function (wattmetric element) in the RNI module determines the direction of permanent or intermittent phase-to-earth faults.

Scheme functions

The relay is fitted with a comprehensive selection of scheme functions.

Single-ended schemes include:

- Basic scheme logic for stand alone operation (without signalling channel),
- Zone 1 extention scheme to permit high speed reclosure when no signalling channel is available (zone reach extention).

Carrier aided schemes for two and three terminal feeders:

- Permissive underreach transfer tripping scheme (PUTT or PUP forward),
- Permissive overreach transfer tripping scheme (POTT or POR1),
- Accelerated underreach scheme (AUP or PUR),
- Blocking underreach scheme (BOR1),
- Blocking overreach scheme (BOR2).

Tee-line applications may use two different schemes.

Additional features

- Switch-on-to-fault (SOTF), using overcurrent and distance element fault detection.
- Power Swing Blocking, based on measuring the time necessary for the three single loops to cross the power swing band (R surrounding the start-up characteristic (Figure 2).
- Voltage Transformer Supervision for the detection of the VT fuse failure or miniature circuit breaker operation.
- Detection of the 2nd harmonic current (inrush current) to protect against maloperation due to transformer inrush conditions.
- Fault detection and clearance during a single-phase cycle in progress.
- The Weak Infeed mode of the relay is used when the infeed to a line end is too low to detect a fault. In this mode the relay is able to trip single- or three-pole.

Protection against high resistance earth fault

The role of this protection is to detect resistive earth faults which resistance is outside the quadrilateral characteristic of the distance protection.

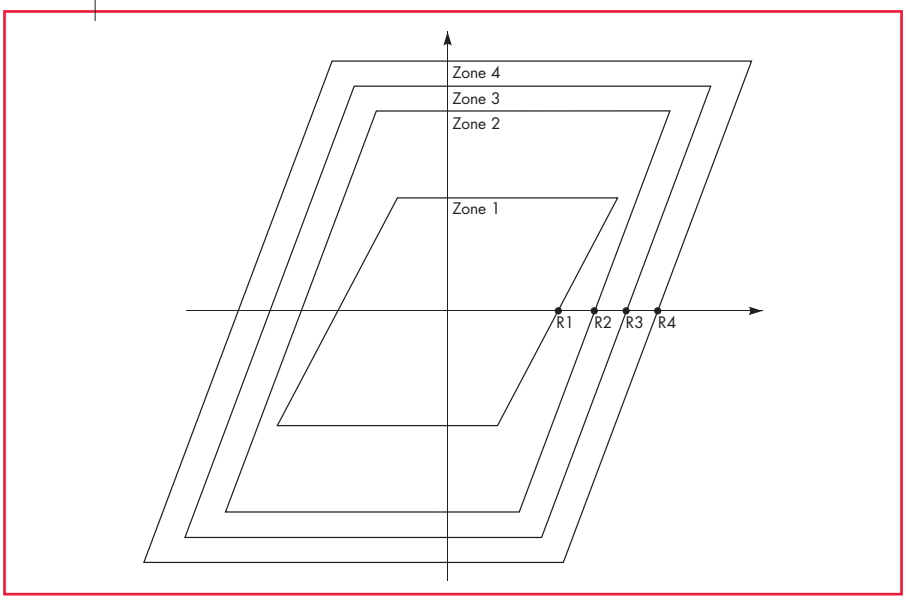
The main protection is realised by a directional comparison element using zero sequence quantities. Its back-up earth fault protection is provided by an inverse definite minimum time (IDMT) delayed element using the zero-sequence directional current or the zero-sequence directional power.

Directional earth fault comparison protection (DEF) for 2 or 3 terminals

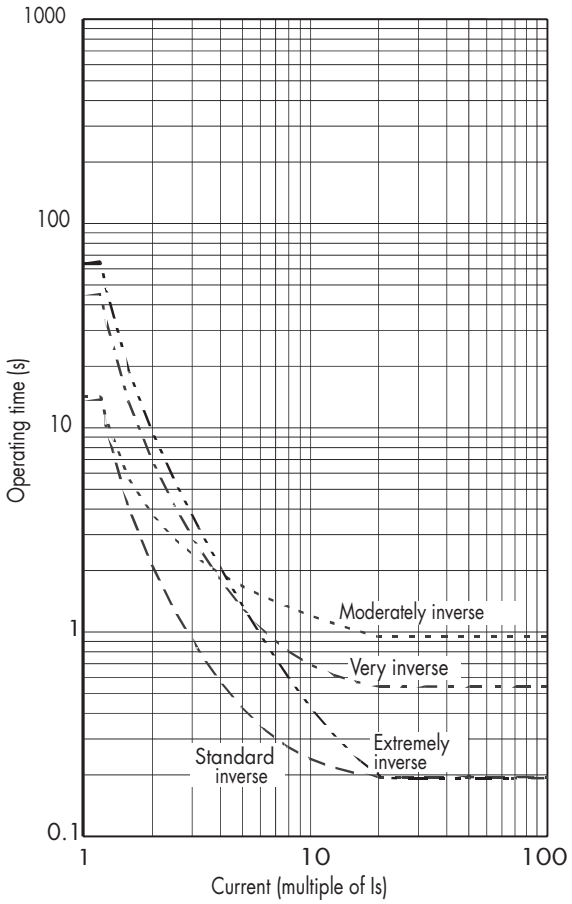
Directional comparison protection operates in conjunction with one or two remote end relays. The DEF protection is able to trip single- or three-pole using permissive or blocking scheme logic. The transmission channels may be the same as those used by the distance protection or may be independent.

Tee-line applications may use two different schemes.

Figure 4.
Busbar isolation

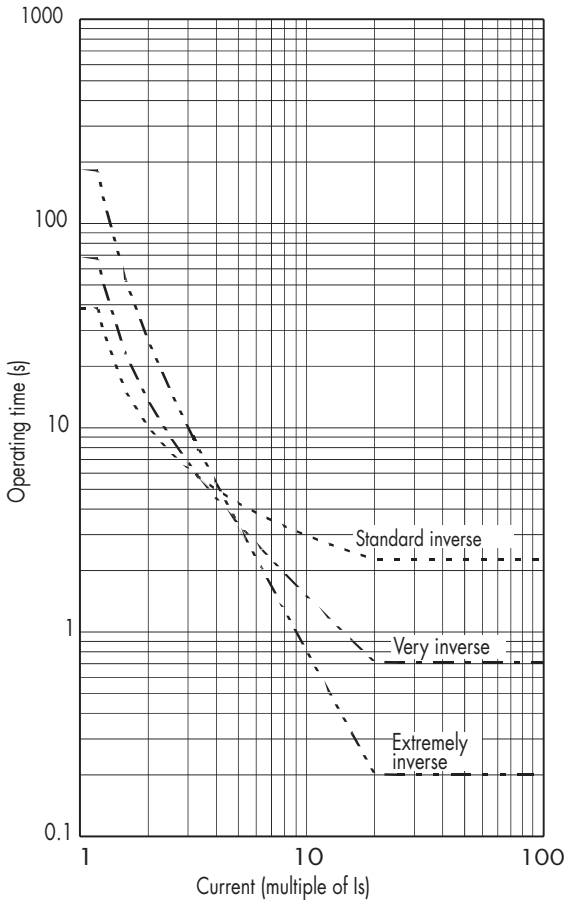


ANSI/IEE curves



Moderately inverse	$\left(0.114 + \frac{0.0515}{(I/I_E)^{0.02} - 1}\right) \cdot TM$
Standard inverse	$\left(0.18 + \frac{5.95}{(I/I_E)^{2} - 1}\right) \cdot TM$
Very inverse	$\left(0.491 + \frac{19.61}{(I/I_E)^{2} - 1}\right) \cdot TM$
Extremely inverse	$\left(0.1217 + \frac{28.2}{(I/I_E)^{2} - 1}\right) \cdot TM$

IEC curves



Standard inverse	$\left(\frac{0.14}{(I/I_E)^{0.02} - 1}\right) \cdot TM$
Very inverse	$\left(\frac{13.5}{(I/I_E) - 1}\right) \cdot TM$
Extremely inverse	$\left(\frac{80}{(I/I_E)^{2} - 1}\right) \cdot TM$

I = earth fault current
I_E = set earth fault pick-up value

Zero-sequence power protection with inverse definite time:

$$\text{Operating time} = \frac{0.2 \cdot P \cdot So}{Sr}$$

So = 10 VA; Sr = Ur . Ir; P = programmable factor
Ir = measured residual current; Ur = measured residual voltage

Figure 5.
IDMT curves

IDMT earth fault protection

The IDMT directional overcurrent or zero sequence power elements are used as back-up protection:

- The IDMT directional overcurrent protection trips the three poles of the associated circuit breaker if a high resistance earth fault remains after a fixed time delay.

  The value of this time delay varies in relation with the value of the fault current and the type of the inverse time curve selected, see Figure 5.

- Inverse time delayed directional zero sequence: the value of its time delay varies in relation with the values of the zero sequence current and voltage and the equation described in Figure 5.

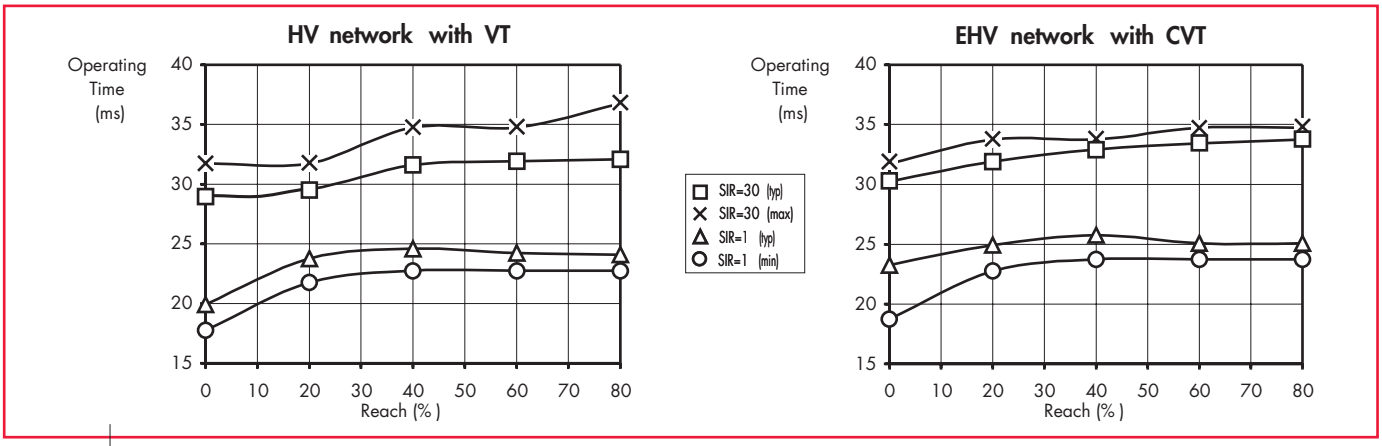


Figure 6.
Zone 1 50 Hz operating times for phase to neutral faults

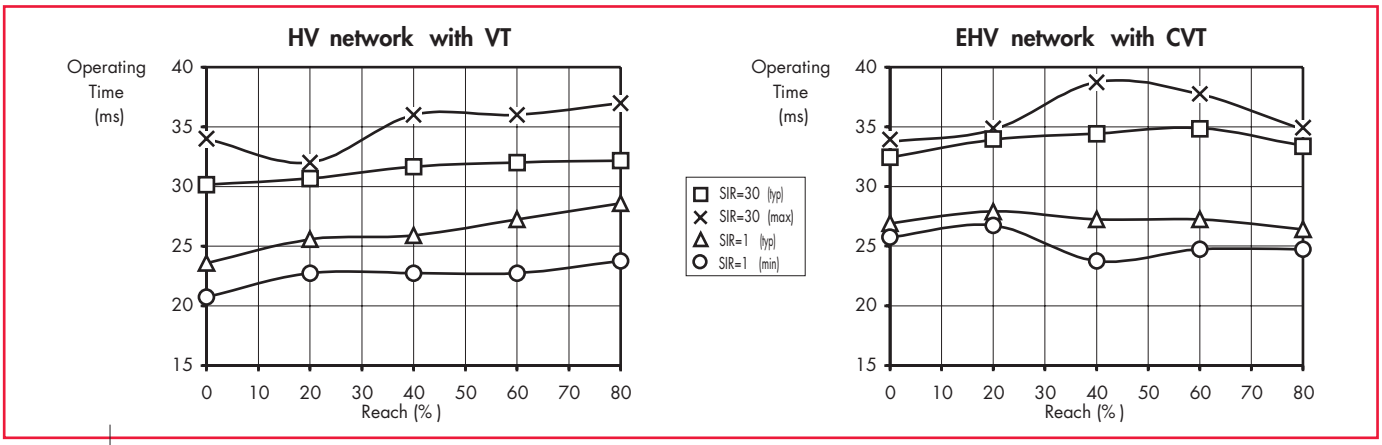


Figure 7.
Zone 1 50 Hz operating times for phase to phase faults

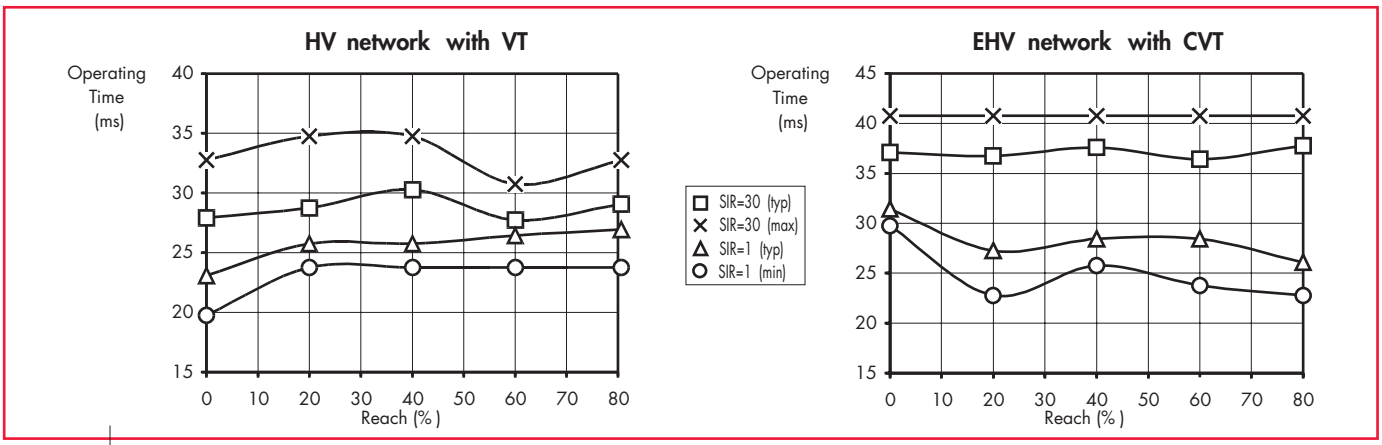


Figure 8.
Zone 1 50 Hz operating times for phase-phase-neutral faults

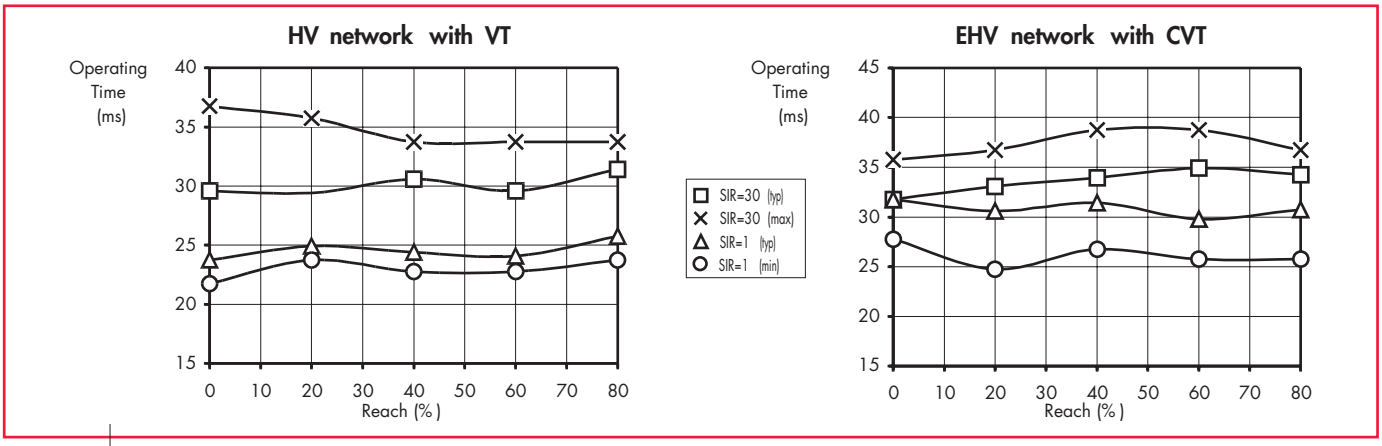


Figure 9.
Zone 1 50 Hz operating times for 3-phase faults

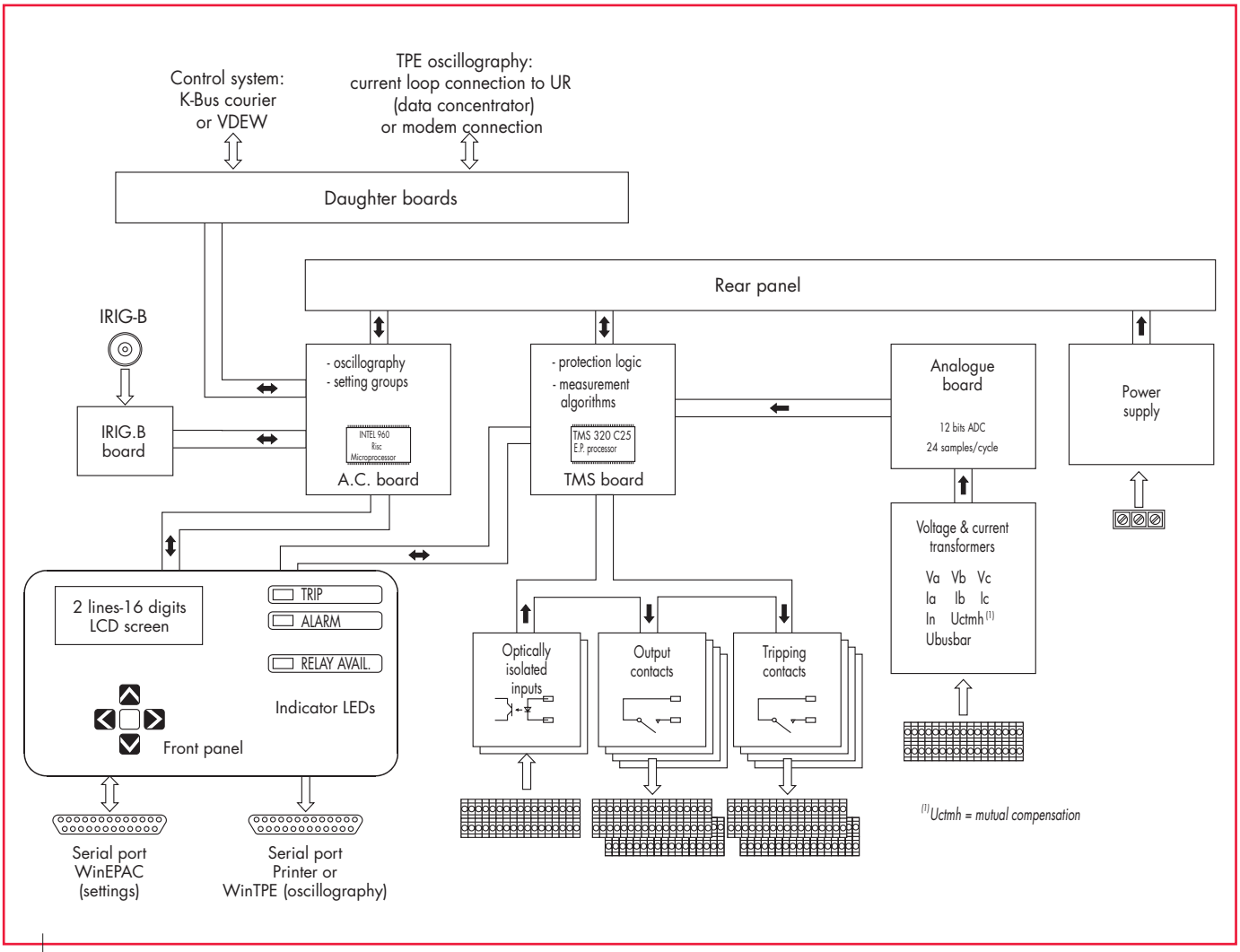


Figure 10.
Block diagram

Additional protection functions

The following additional protection is included in the distance relay.

Overload protection

The overload protection trips three-phase if at least one of the measured currents is higher than a settable threshold for a fixed or inverse time delay.

Undervoltage protection

The undervoltage protection trips three-phase if at least one of the measured voltages is lower than a settable threshold for a fixed time.

Overvoltage protection

The overvoltage protection trips three-phase if at least one of the measured voltages is higher than a settable threshold during a fixed time.

Auto-recloser

The reclose cycle is initiated by the operation of the associated protective function (distance, DEF or back-up) or through opto-isolated inputs (external protection relay). It provides one 1- or 3-pole high speed reclosure and up to three 3-pole delayed auto-reclosures.

Check synchronising function

The check synchronising function allows reclosure when the voltage on the line and/or the busbar is below a preset value and when the two parts of the system are in synchronism by measuring the angle and the slip frequency between the line voltage and the busbar voltage:

- Live busbar and dead line,
- Dead busbar and live line,
- Live busbar and live line,
- OR logic of the three preceeding mode.

Configuration

Inputs and outputs

- 8 or 16 user programmable, optically isolated inputs depending on the model selected.
- 13, 16, 26 or 32 user programmable normally open output contacts depending on the model selected.
- 3, 6 or 12 normally open trip contacts depending on the model selected. These contacts may be connected directly to the coil of the circuit breaker.
- 1 or 2 normally open reclose contacts depending on the model selected. These contacts may be connected directly to the coil of the circuit breaker.
- 1 or 2 normally closed contacts, depending on the model selected, for watchdog alarm.

Alternative setting groups

Four sets of setting groups are provided and stored in a non-volatile memory. They can be used to change the relay's setting to cover abnormal operating conditions. The setting groups can be selected locally via the front panel display or WinEPAC software, or remotely via the relay's communication system. Two inputs can be allocated to the selection of setting groups allowing them to be changed by means of an external system.

Ancillary Functions

The ancillary functions allow the equipment to be used in specific applications.

Instrumentation

The instrumentation functions of the equipment can be accessed locally via the relay's front panel display or the WinEPAC software, or remotely via its communication system. Values of frequency, phase currents and voltages, active and reactive power, the direction of the load current, and the status of the relay's inputs and outputs are displayed.

Fault reports

When a fault occurs, causing a relay to trip, a fault report is created and stored in non-volatile memory. It is possible to view via the relay's front panel or the WinEPAC software, or print out, any or all of the last ten fault reports.

Each fault report includes time tagged details of the faulted phases, trip type and fault location (fault distance and apparent resistance). Additionally, information on the system frequency, fault currents and voltages values.

Disturbance records

The internal disturbance recorder has 8 analogue channels to record current and voltage inputs to the relay and up to 32 digital channels to record the status of the input/output relays. Data compression allows the recording and storage in non-volatile memory of an average of forty 5-second events. The information in the disturbance recorder is accessed on a personal computer connected to the relay's front panel or via the communication system to provide a graphical display and to conduct in-depth fault analysis, using WinTPE software.

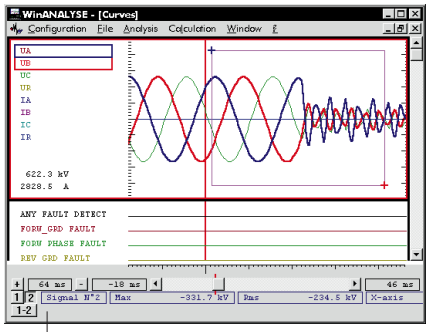


Figure 11.
WinTPE software (WinANALYSE)

Fault location

The fault location report provides information about the distance to the fault and the fault resistance. The distance to the fault is in miles, kilometres, ohms or as a percentage of line length.

Fault location can be calculated both for single and parallel lines.

Power-on diagnostics and self monitoring

The relay continuously runs self-checks. In the event of a failure of a device, an alarm is triggered and a self-diagnostics system enables quick and easy trouble-shooting.

Hardware description

The EPAC is a fully numerical relay providing:

- input circuit with anti-aliasing filters.
- acquisition of residual quantities allowing constant monitoring of sampled values.
- 16-bit sampling of current values and 12-bit sampling of voltage values.
- filtering and computing of derived quantities and protection algorithms by a real-time signal processor.
- tripping logic, management of logic acquisitions and signals.

The oscillography, communication and user interface dialogue are managed by a special board having a RISC microprocessor INTEL 960.

User interface

The EPAC is programmed and operated through its key-pad and display, or through its RS-232 link on the front panel of the unit, or via the communications unit from a personal computer running the programming software WinEPAC.

User interface with WinEPAC

WinEPAC software is run on the Windows™ interface of which it uses the graphic capabilities to their fullest. All the functions are clearly labelled and grouped by theme screens. WinEPAC is a very intuitive application and it is quick and easy to learn.

Figure 12.
WinEPAC software

Front panel user interface

Dialogue through the front panel display offers the same features as with the WinEPAC software.

Functions are selected using six keys on the key-pad. The display is a 2 line, 16 character back-lit LCD screen.

Figure 13.
Front panel display

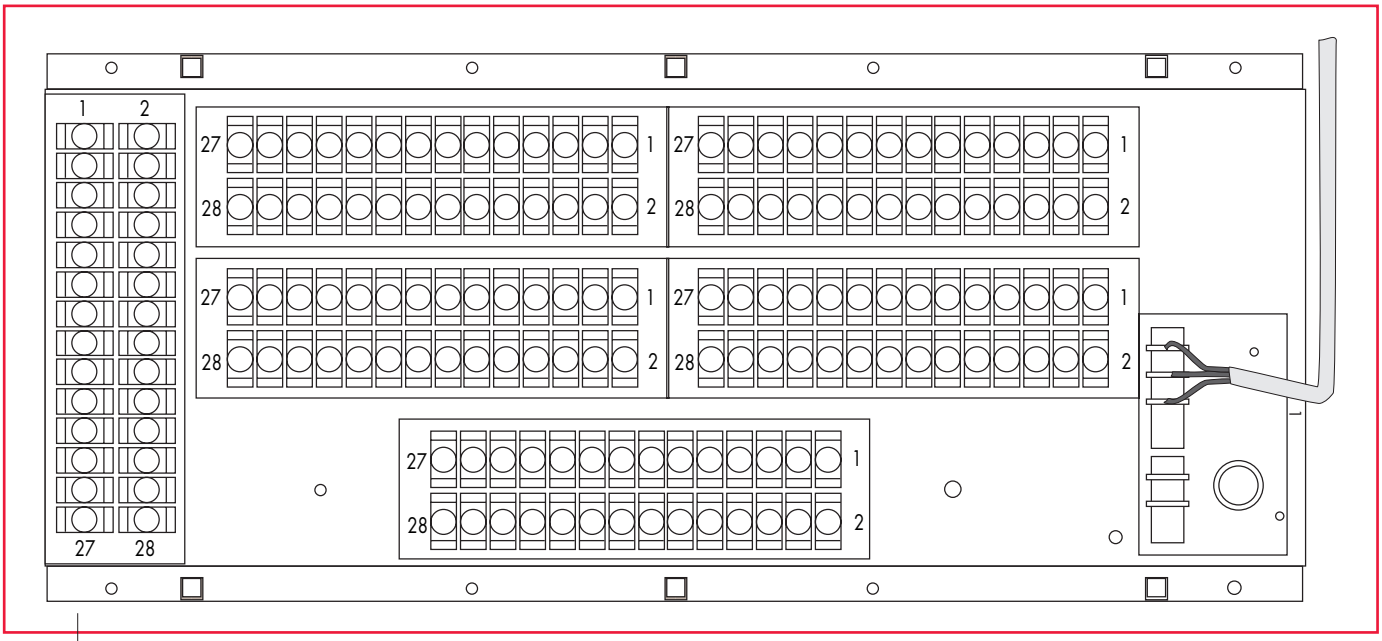


Figure 14.
Rear panel and K-bus connection to the terminal block

Maintenance software

WinEPAC software also includes a commissioning and maintenance program to facilitate commissioning tests and providing guidance for maintenance personnel.

Communication protocol

- Communication with the master station comforms to application standard 'VDEW' - IEC 870-5/103. The EPAC can therefore be interfaced with any product compliant with that standard.
- The communications protocol used with K Series relays is designated Courier. The Courier language has been developed specifically for the purpose of developing generic PC programs that will, without modification, communicate with any device using the Courier language. In the Courier system, all information resides in the relay. Each time communication is established with the relay, the requested information is sent to the PC. The protocol includes extensive error checking routines to ensure that the system remains reliable and secure.

Relay interconnection

- The VDEW IEC 870-5/103 interface enables the relays to be connected to the master station using fibre optic link. The speed of this link is 9600 or 19200 bits/s depending on the configuration.
- The relay's communication can be connected via a shielded, twisted

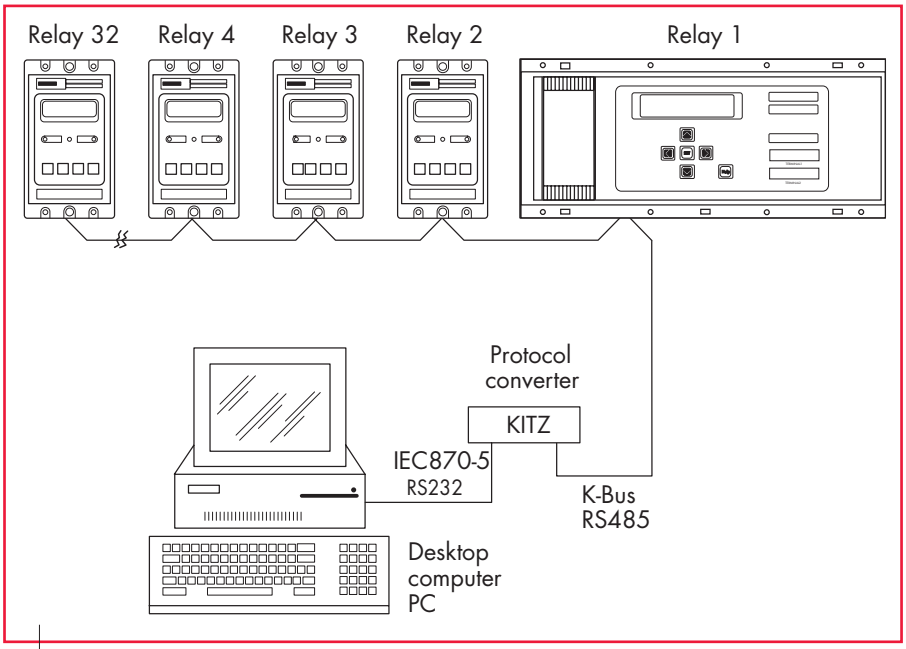


Figure 15.
Connection to K-bus

wire pair known as K-Bus. Up to 32 relays may be connected in parallel across the bus. The K-Bus can be connected through a protocol converter known as KITZ, either directly or via a modem, to the RS-232 port of the PC. The K-Bus is RS-485 based and runs at 64 kbits/s. The K-Bus connection to the relay is shown in Figure 14 . This system allows up to 32 relays to be accessed through one RS-232 communication port (Figure 15). Software is available with each KITZ to provide access to the relays to read and change settings.

Password protection

Password protection is provided for all remote or local setting changes which alter the configuration of the relay. This prevents any accidental change which could seriously affect the ability of the relay to perform its intended functions. The setting, fault report and disturbance record consultations are not protected by password: a password is needed for resetting only.

Languages

The EPAC user interface may be configured in one of four languages; these are:

- English,
- French,
- German,
- Spanish.

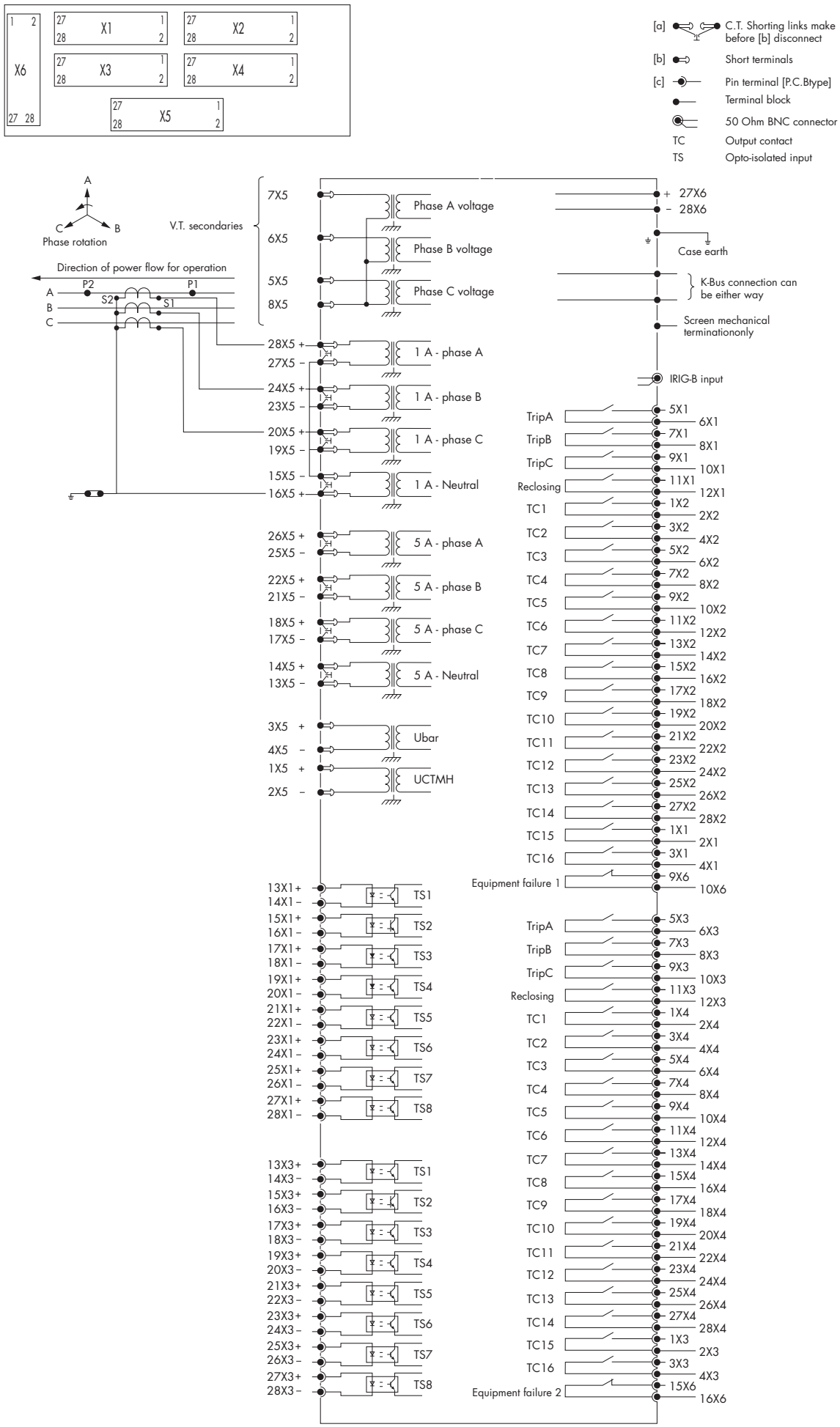


Figure 16.
Example of case connection diagram (EPAC 3132)

Technical Data

Ratings

Inputs		
AC current (In)	1 A and 5 A	
AC voltage (Vn)	100 V to 120 V in steps of 1V	
DC auxiliary voltage	Nominal (V)	Operative range (V)
	48	38.4 - 57.6
	60	48 - 72
	110	88 - 132
	125	100 - 150
	220	176 - 264
	250	200 - 275
DC opto-isolated input voltage supply	48 V, 60 V, 110 V, 125 V, 220 V, 250 V	
Frequency	50/60 Hz	
Permitted ripple	12% superimposed on nominal frequency	

Burdens

AC current	0.1 VA at In = 1 A; 0.5 VA at In = 5 A
AC voltage	0.1 VA
DC auxiliary voltage	25 W under healthy live line conditions, 35 W max.
Optically isolated inputs	10 mA per input

Thermal withstand

AC current inputs	4 In continuous 100 In for 1 s; 30 In for 5 s
AC voltage inputs	2.2 Vn continuous 2.6 Vn for 10 s

Reference conditions

Temperature	20 °C
Auxiliary voltage	Nominal DC voltage range
Frequency	50/60 Hz

Transformers turns ratios

CT ratios (Ki)	1 to 20,000 in steps of 1
VT ratios (Ku)	1 to 20,000 in steps of 1

Contact ratings

Tripping and Closing Contacts	
Maximum operating voltage	250 Vdc
Make	30 A and carry for 500 ms 250 A and carry for 30 ms
Permitted overload	250 A, 30 ms
Carry	5 A continuous
Breaking capacity (L/R < 40 ms)	0.75 A with 48 Vdc 0.3 A with 125 Vdc 0.25 A with 220-250 Vdc
Signalling Contacts	
Maximum operating voltage	250 Vdc
Permitted overload	100 A, 30 ms
Carry	5 A continuous
Breaking capacity (L/R < 40 ms)	0.75 A with 48 Vdc 0.3 A with 125 Vdc 0.25 A with 220-250 Vdc

Contact durability

Loaded contact	10,000 operations minimum
Unloaded contact	100,000 operations minimum

IRIG.B

All versions 3X3X have a BNC type connector to carry IRIG-B format data for automatic setting and synchronising the relay's calendar clock.

Settings

Line parameters

Neutral earthing	direct isolated or Petersen coil earthed network
Length of line in km or miles	0.3 to 999.99 km or 0.18 to 621.49 miles in steps of 0.01

Range of settings in secondary values. Parameters can be entered in Cartesian co-ordinates, Polar Co-ordinates or Positive sequence impedance/earth ratios.

Polar Co-ordinates

Positive sequence impedance module, Z1	0.001 to 999 Ω in steps of 0.001 Ω
Positive sequence impedance argument	0° to 90° in steps of 1°
Zero sequence impedance modules Z01 and Z02	0.001 to +999 Ω in steps of 0.001 Ω
Zero sequence impedance argument	– 90° to +90° in steps of 1°

Monitoring Parameters of the Protection Function

	1A rating	5A rating
Impedance Zone 1, Zone 1X, Zone 2, Zone 3, Zone 4, Zone 5	0.1 to 200 Ω in steps of 0.01	0,02 to 40 Ω in steps of 0.01
Phase-phase resistance reach (zone 1)	0 to 200 Ω in steps of 0.01	0 to 40 Ω in steps of 0.01
Phase-earth resistance reach (zone 1)	0 to 200 Ω in steps of 0.01	0 to 40 Ω in steps of 0.01
Resistance reach zone 2	0 to 200 Ω in steps of 0.01	0 to 40 Ω in steps of 0.01
Resistance reach zone 3	0 to 200 Ω in steps of 0.01	0 to 40 Ω in steps of 0.01
Start resistance zones 4 and 5	0 to 200 Ω in steps of 0.01	0 to 40 Ω in steps of 0.01
Zone 3 direction	forward/reverse	
Step 1 timer, T1	0 to 10 s in steps of 5 ms	
Steps 2, 3, 4 and 5 timers: T2, T3, T4, T5	0 to 10 s in steps of 10 ms	
Overcurrent thresholds I> and I>>	0.2 In to 9.99 In in steps of 0.01 In	
Directionality of I> and I>>	without/forward/reverse	
Step timers T> and T>>	0 to 10 s in steps of 10 ms	

Scheme functions

Tripping type	single-phase for zones 1 and 2 single-phase for zone 1 ordinary three-phase tripping all zones
Scheme logic	basic scheme logic accelerated underreach protection (AUP) permissive overreach protection (POP or POTT) blocking overreach protection (BOP or BDCP) blocking underreach protection (BUP) permissive underreach protection (PUB or PUTT) zone reach control busbar isolation
HF acceptance or unblocking	none, unblocking, HF acceptance
Carrier send transmission	carrier send transmission in zone 1 carrier send transmission in zone 2 carrier send transmission in reverse zone 5

Tee Line

The teleaction possibilities for the second teleprotection channel of the Tee line are the same as those for the first channel.

Weak-infeed and echo

Weak-Infeed and echo configuration	yes/no
Function locking on power swing	yes/no
Tripping authorisation	none/1 pole/3 poles
Confirmation by insufficient voltage	yes/no
If yes, under voltage threshold	0.2 Vn to Vn in steps of 0.1 Vn
Open pole detection threshold	0/0.05 In
Time-delay for tripping	0 to 1 s in steps of 1 ms
Blocking time if start-up drop off	0 to 500 ms in steps of 1 ms

Power-swing

Power swing detection boundary	0 to 25 Ω in steps of 0.01 Ω
Unblocking timer	0 to 30 s in steps of 100 ms
First zone independent on power swing	yes/no
Carrier send blocking on power swing	yes/no
Carrier receive blocking on power swing	yes/no

Unblocking on residual current Ir	yes/no
Unblocking percentage threshold kr	10 to 100% in steps of 1 % of Ir
Unblocking on overcurrent Imax	yes/no
Unblocking threshold Imax	In to 20 In in steps of 0.01 In
Unblocking on negative sequence current	yes/no
Unblocking percentage threshold	10 to 100% in steps of 1% of I2
Tripping mode	1 pole/3 poles
Blocking type	none
	blocking all zones
	zone 1 blocking
	zones 1 and 2 blocking
	zones 1, 2 and 3 blocking
	zone 1 unblocking
	zones 1 and 2 unblocking
	zones 1, 2 and 3 unblocking

Fuse failure and emergency overcurrent protection

I0 and I2 threshold detection	0 to In in steps of 0.01 In
Timer for fuse failure indication	1 to 20 s in steps of 1 s
Ifus> threshold unblocking	yes/no
Ifus> threshold	0.2 In to 9.99 In in steps of 0.01 In
Tfus> timer	0 to 10 s in steps of 10 ms
Ifus>> threshold unblocking	yes/no
Ifus>> threshold	0.2 In to 9.99 In in steps of 0.01 In
Tfus>> timer	0 to 10 s in steps of 10 ms
Ifr> threshold unblocking	yes/no
Ifr> threshold	0.2 In to 9.99 In in steps of 0.01 In
Tfr> timer	0 to 10 s in steps of 10 ms
Auto-recloser blocking by fuse failure tripping	yes/no

Timer for auto-recloser blocking by the distance protection

Timer for auto-recloser blocking	no/to T2/to T3/to T4/to T5/to T>/to T>>

Seal-in

Enabled/disabled	yes/no
Holding threshold	0.1 In to In in steps of 0.1 In

Auto-recloser

Reclosing mode on 1 pole trip	None, 1, 1/3, 1/3/3, 1/3/3/3
Reclosing mode on 3 pole trip	None, 3, 3/3, 3/3/3, 3/3/3/3
Reclosing mode on trip by backup protection	None, 3, 3/3, 3/3/3, 3/3/3/3
High-speed 1 pole dead time	0.1 to 5 s in steps of 0.01 s
High-speed 3 pole dead time	0.1·k to 500 s in steps of 0.01 s
Low-speed dead time	0.1·k to 500 s in steps of 0.01 s
	where k=1 if no synchro-check
	where k=2 if voltage check
	where k=4 if synchro-check
Reclaim time	0.1 to 500 s in steps of 0.1 s
Backup protection reclaim time	0.1 to 500 s in steps of 0.1 s
Duration of closing command	0.1 to 10 s in steps of 10 ms

Check synchronising function

The following types of synchro-check are possible:

none	
live line / dead bus	UL> / UB<
dead line / live bus	UL< / UB>
live line / live bus	UL> / UB>
Check synchronism on high-speed three-phase cycle	yes/no
Confirmation time for the live-line and live bus mode	0.2 to 2.0 s in steps of 0.1 s
Voltage difference	0.1 Vn to Vn in steps of 0.05 Vn
Frequency difference	0.05 to 5 Hz in steps of 0.01 Hz
Angle difference	10° to 70° in steps of 5°
UL> (line voltage presence threshold)	0.5 Vn to Vn in steps of 0.05 Vn
UB> (bus voltage presence threshold)	0.5 Vn to Vn in steps of 0.05 Vn
UL< (line voltage absence threshold)	0.1 Vn to 0.4 Vn in steps of 0.05 Vn
UB< (bus voltage absence threshold)	0.1 Vn to 0.4 Vn in steps of 0.05 Vn

Switch on-to-fault

Switch on to fault threshold	In to 9.9 In in steps of 0.1 In

Reversal guard extension

Reverse locking extension time-delay	0 to 150 ms in steps of 10 ms

Fault locator

Fault locating unit	in km or in miles,
Accuracy	± 3% of the line length

Disturbance recording

Disturbance recording enabled	yes/no
Disturbance recording triggered when analogue thresholds are exceeded	yes/no (IA, IB, IC, Ir, UA, UB, UC, UR, F)
Min and max voltage thresholds	0 to 250% Vn in steps of 1% Vn
Min and max current thresholds	0 to 7,000% In in steps of 1% Vn
Min frequency threshold	
If freq. = 50 Hz	45 ≤ Fmin ≤ 50; 50 ≤ Fmax ≤ 55
If freq. = 60 Hz	55 ≤ Fmin ≤ 60; 60 ≤ Fmax ≤ 65
Pre-fault time	0.1 to 0.5 s in steps of 100 ms
Post-fault time	0.1 to 4.5 s in steps of 100 ms

Overload protection

Type of protection	none
	fixed thresholds
	inverse curves
Fixed threshold I1	0.5 In to 2 In in steps of 0.01 In
Fixed threshold I2	In to 3 In in steps of 0.01 In
Fixed threshold I3	1.3 In to 3 In in steps of 0.01 In
Threshold I1 tripping timer	1 to 100 min in steps of 1 min
Threshold I2 tripping timer	1 to 100 min in steps of 1 min
Threshold I3 tripping timer	1 to 100 s in steps of 1 s
Type of inverse curve	IEC, ANSI (US)
Choice of IEC curve	inverse/very inverse/extremely inverse
Choice of ANSI curve	moderately inverse/inverse/very inverse/extremely inverse
Threshold line current	0.5 In to 2 In in steps of 0.05 In
Multiplier factor	0 to 3.2 In in steps of 0.01 In

Over and under voltage protection

Minimum voltage threshold	0.1 Vn to 0.6 Vn in steps of 0.1 In
Timer for minimum voltage tripping	0 to 20 s in steps of 0.1 s
Maximum voltage threshold	1.1 to 1.4 Vn in steps of 0.1 Vn
Timer for maximum voltage alarm	0 to 20 s in steps of 0.1 s
Tripping on maximum voltage	yes/no

Resistant earth fault protection

Directional comparison protection	yes/no
Residual voltage threshold	0.01 Vn to 0.2 Vn in steps of 0.01 Vn
Residual forward current threshold	0.1 In to 4 In in steps of 0.01 In
Tripping type	1 pole/3 poles
Independent teleaction channel	yes/no
Type of tripping scheme	permissive/blocking
Transmission time-delay for teleaction	0 to 1 s in steps of 5 ms
Tee line present	yes/no
Type of scheme for tee line	permissive/blocking
Transmission time-delay for tee line application	0 to 1 s in steps of 5 ms
Operation timer	0 to 10 s in steps 100 ms
Activation of back-up protection	no, power, current
Residual current threshold	0.1 In to 4 In in steps of 0.01 In
Multiplier factor	0 to 3.2 in steps of 0.01
Type of curve	IEC, ANSI (US)
IEC curve type	inverse/very inverse/extremely inverse
ANSI curve type	moderately inverse/inverse/very inverse/extremely inverse
Coefficient of multiplication P (power)	1 to 9 in steps of 1
Auto-recloser of backup protection locked	yes/no

Isolated neutral protection (Peterson coil)

Network with isolated neutral or impedance	yes/no
Selection criteria for loop	Acyclic C(A), A(C), B(A), A(B), C(B), B(C)/Cyclic C(A), A(C)
Residual current threshold	0.2 In to 5 In steps of 0.1 In
Residual voltage threshold	0.1 Vn to Vn in steps of 0.05 Vn
Tripping on maximum residual voltage	yes/no
Time-delay for tripping on maximum residual voltage	1 to 360 s in steps of 1 s

Zero sequence active power protection

Zero sequence active power	yes/no
Secondary current for max. angle error of current transformer	1 mA to 4 A in steps of 1 mA
Angle error of current transformer at I1	-30° à +30° in steps of 1°
Secondary current above which the angle error is practically constant	1 mA to 4 A in steps of 1 mA
Angle error of current transformer at I2	-30° to +30° in steps of 1°
Residual current threshold for the start-up	1 mA to 4 A in steps of 1 mA
Angle of the start-up characteristic	-180° to +180° in steps of 1°
K power factor	1 to 10 in steps of 1
CT core balance ratio (Kir)	1 to 20000 in steps of 1
Duration of transient earth fault	100 to 500 ms in steps of 10 ms

Sensitivity of the distance protection function

Current threshold	0.2 In
Directional sensitivity	unlimited for all types of faults unlimited for 10 s for close faults (memory voltage)

Accuracy of the distance protection function

For an SIR < 30 and a current of 0.2 to 30 In (zone 1)	5% of adjusted value
Other zones	10 % of adjusted value

Operating Time

Fastest tripping time	18 ms
Typical operating time	60 Hz: 22 ms 50 Hz: 25 ms ≤ 30 ms for SIR =1 ≤ 40 ms for SIR = 30

Electro-magnetic compatibility	IEC 255-22
High frequency disturbance (255-22-1)	2.5 kV peak between independent circuits and case 1.0 kV peak across terminals of the same circuit
Electrostatic discharge (255-22-1)	8.0 kV point contact discharge with cover removed 15 kV discharge in air with cover in place
Electromagnetic interference (immunity)	27 MHz - 1000 MHz 10 V/M, 80% modulation at 1 kHz
Fast transient disturbance	4.0 kV, 5.0 kHz 1 min. applied to all inputs
Electromagnetic interference on logic channel (transmission)	NF for 55011 and 55022 Group 1, Class A
Electrical environment	IEC 255-5
Impulse voltage withstand	5 kV 1.2 / 50 microseconds; 0.5 J
Insulation resistance	> 100 MΩ at 500 VDC
Dielectric withstand	2 kV 50 Hz 1 min.
Protection index	IP52
Atmospheric environment	IEC 68-2
Operating temperature	-10° to +55°C
Storage temperature	-40° to +70°C
Relative humidity with no condensation	93 %
Mechanical environment	IEC 255-21
Vibration	category 1
Shock and bump	category 1
Free fall with packing	2 falls of 0.5 m

Recapitulation of features / models

Specifications	3111 3511	3112 3512	3113 3513	3116 3516	3121 3521	3122 3522	3123 3523	3126 3526	3131 3531	3132 3532	3133 3533	3136 3536
Distance protection Six zones of protection Directional overcurrent Scheme functions	●	●	●	●	●	●	●	●	●	●	●	●
Power-swing tripping	●	●	●	●	●	●	●	●	●	●	●	●
Single or three pole tripping	●	●	●	●	●	●	●	●	●	●	●	●
Directional earth fault (DEF)	●	●	●	●	●	●	●	●	●	●	●	●
Additional overload, overvoltage and undervoltage protection	●	●	●	●	●	●	●	●	●	●	●	●
Check synchronising function		●	●	●		●	●	●		●	●	●
Automatic single and/or three-pole autoreclose function		●	●	●		●	●	●		●	●	●
Four independent user selectable setting groups	●	●	●	●	●	●	●	●	●	●	●	●
Fault location	●	●	●	●	●	●	●	●	●	●	●	●
Ten fault reports stored in non-volatile mass memory	●	●	●	●	●	●	●	●	●	●	●	●
Automatic down-loading of fault reports to a printer					●	●	●	●	●	●	●	●
Oscillography stored in non volatile memory					●	●	●	●	●	●	●	●
IRIG-B input for real-time clock synchronisation									●	●	●	●
Substation communications via K-Bus, VDEW ou TPE					●	●	●	●	●	●	●	●
Front panel LCD display	●	●	●	●	●	●	●	●	●	●	●	●
Programmable inputs	8	16	8	16	8	16	8	16	8	16	8	16
Programmable output contacts	16	32	13	26	16	32	13	26	16	32	13	26
Tripping contacts	3	6	6	12	3	6	6	12	3	6	6	12
Circuit breaker reclosing contacts	0	2	1	2	0	2	1	2	0	2	1	2
Watchdog contacts	1	2	1	2	1	2	1	2	1	2	1	2

Information required with order

EPAC 3111/3511	E	P	3						B	A	A			D	B
EPAC 3112/3512	E	P	3						E	A	A			H	B
EPAC 3113/3513	E	P	3						G	A	A			H	B
EPAC 3116/3516	E	P	3						H	A	A			H	B
EPAC 3121/3521	E	P	3						B		C			D	
EPAC 3122/3522	E	P	3						E		C			H	
EPAC 3123/3523	E	P	3						G		C			H	
EPAC 3126/3526	E	P	3						H		C			H	
EPAC 3131/3531	E	P	3						B		D			D	
EPAC 3132/3532	E	P	3						E		D			H	
EPAC 3133/3533	E	P	3						G		D			H	
EPAC 3136/3536	E	P	3						H		D			H	

Case:

Flush panel	1
Rack	5

Language:

French	0
English	1
German	2
Spanish	3

Auxiliary voltage:

48 Vdc	1
60 Vdc	2
110 Vdc	3
125 Vdc	4
220 Vdc	5
250 Vdc	6

Acquisition:

1A, 100V/√3 to 120V/√3, 50 Hz	1
5A, 100V/√3 to 120V/√3, 50 Hz	2
1A, 100V/√3 to 120V/√3, 60 Hz	3
5A, 100V/√3 to 120V/√3, 60 Hz	4

Input supply for the teleprotection:

48 Vdc	1
60 Vdc	2
110 Vdc	3
125 Vdc	4
220 Vdc	5
250 Vdc	6

Communication:

VDEW protocol	B
K-Bus/Courier protocol	C

Network environment:

Network directly earthed	C	D
Isolated or with Petersen coil without DEF protection	D	C
Isolated or with Petersen coil and zero-sequence active power protection without DEF	F	C

Oscillography:

TPE current loop oscillography	F
VDEW oscillography	G
K-Bus/Courier oscillography	H
TPE/Modem oscillography	J

Glossary

Courier: A communication language developed to provide generic control, monitoring, data extraction and setting changes on remote devices (primarily on protective relays) within the substation evironment.

PAS&T: MS Dos interface of the Courier language.

CAS:W: MS Windows interface of the Courier language.

WinEPAC: MS Windows application enabling the EPAC to be configured and information uploaded.

WinTPE: Group of Windows applications allowing communication with the TPE 2000 disturbance recorder and analysis of fault reports issued by the TPE 000 and the EPAC.

K-Bus: The 64 kbit/s twitsted pair cable used to connect courrier compatible devices and transffer Courier data.

KITZ: The interface unit which converts between K-Bus and IEC 870 format data.

IEC 870: An abbreviated term for the communication standard IEC 870-5 FT1.2 which is used to transfer Courier data over modems and RS232 connections.

Case

The relay is housed in a multi-module MIDOS case suitable for rack or panel mounting, as shown in Figure 17.

Additional information

MS/M 1.6882-B Commissioning and Maintenance Guide.

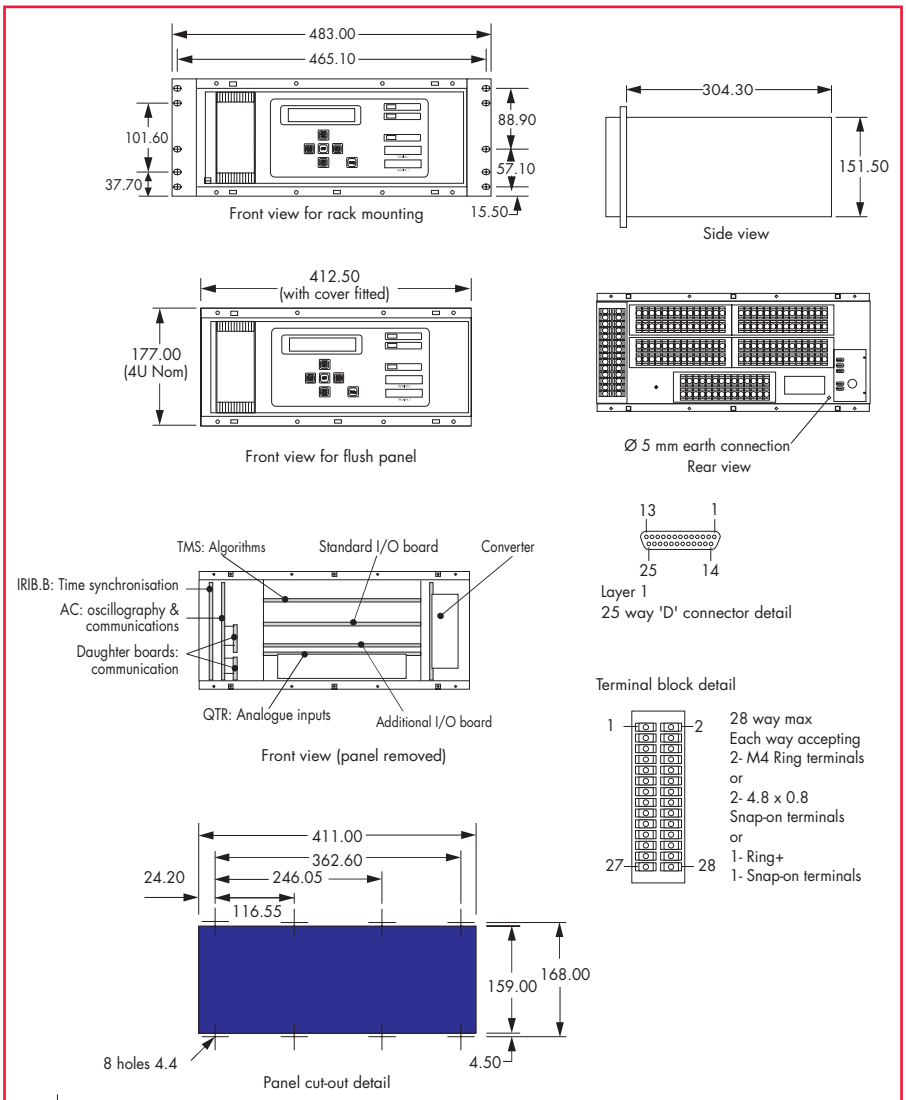


Figure 17.
Arrangement and outline :
EPAC panel and rack mounting details

Quality assurance : ISO 9001

DESIGN, DEVELOPMENT, PRODUCTION, SALES AND SERVICING (SELECTIVITY STUDYING, CUSTOMER TRAINING, SITE INTERVENTIONS, REPAIR OF SPARE PARTS) OF PROTECTION AND CONTROL EQUIPMENT FOR ELECTRICAL NETWORKS.

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