Type KAVR 100, 130: Multi-shot auto-reclose and check synchronising relay

KAVR 100 and 130 are multi-shot auto-reclose relays with integral check synchronising for application to feeders switched by a single circuit breaker. They are intended for use on transmission, sub-transmission and distribution systems

As a part of the K range of relays, the KAVR can be integrated into an overall protection and control system by utilising its integral serial communications facility

Features

- Number of reclosures selectable between 1 and 4
- Optional single phase reclosure on the first shot
- Integral synchronism check function for auto-reclose and manual circuit breaker closure
- Selectable undervoltage blocking and differential voltage blocking features
- Maintenance alarm and lockout
- Independently adjustable timers with wide setting ranges
- Flexible operating logic options via software function links
- Measurement of line and busbar voltage, system frequency, and phase angle slip frequency
- Remote communications via K-Bus
- Integral event recorder accessible from remote PC
- Comprehensive self-checking and alarms

Models available

- KAVR 100
  3 phase tripping only
- KAVR 130
  Single and 3 phase tripping

Application

The KAVR 100 provides 1, 2, 3 or 4 shot reclosure of a circuit breaker following a fault on an overhead line. The first shot can be selected to be either high speed or delayed three phase reclosure.

The KAVR 130 is specifically designed for transmission and sub-transmission lines where there is a need for single-phase auto-reclosure. In addition to the cycles available on the KAVR 100, it gives the option of high speed single-phase auto-reclose for the first shot.

The check synchronising function ensures that the two parts of the system are sufficiently in synchronism before being connected together. This function can also be used with manual switching and is operable even when the auto-reclose function is out of service.

Functions

Auto-reclose

The auto-reclose cycle is initiated by the operation of the associated protective relay. Flexible scheme logic is provided to allow the relay to be used for a wide range of applications.

The KAVR 130 can be set so that a single phase fault initiates a single phase auto-reclose cycle. If the fault evolves onto all three phases before the relay's dead time has elapsed, a three phase trip will result.

An integral maintenance alarm counts the number of operations of the circuit breaker. It provides an alarm and a subsequent lockout, if the preset thresholds are exceeded. Additional counters indicate the number of relosures which may be attempted before lockout occurs.

The KAVR 130 has separate counters for each phase and will also register the total number of single phase and three phase reclosures attempted.

Check synchronising

The relay checks that the two parts of the system are in synchronism by measuring the angle and the slip frequency between the line voltage and the bus voltage. Auto-reclose is blocked if these values exceed the phase angle and slip frequency settings.

Manual closure is blocked if these values exceed the system angle and system slip settings.

Selectable undervoltage and differential voltage measurements are available to block closure if the line and bus voltages are not compatible.

To allow the circuit breaker to be closed onto an uncharged line; live line/dead bus; dead line/dead bus and dead line/live bus detectors are included. These allow reclosure when the voltage on the line and/or the bus VT is below a preset value.

Scheme logic

The KAVR uses ladder logic (Figure 1) to implement the scheme. It presents this in the form of contacts, coils, counters and timers that are implemented in the software. In operation, the left side of the ladder is analogous to a positive supply rail, with the right side being negative. The program then acts as an imaginary current flowing left to right, acting upon the components on the rungs of the ladder as appropriate. Changes to the scheme can be made by the user, by opening or closing software function links, to match it to a particular application. Full details of the scheme logic used are included in the relevant logic diagram.
(See additional information.)

Inputs and outputs

KAVR has 8 opto-isolated inputs which may be assigned by the user to any of the available scheme inputs listed in the relevant scheme description.

There are 8 programmable outputs, each comprising a relay with 1 normally open contact, which may also be assigned by the user.

A dedicated watchdog contact with 1 normally open and 1 normally closed contact is also available.

Typical application diagrams (Figures 4 and 5) show the input and output functions assigned as factory default settings.

User controls

User controls are provided, via the user interface, to:

- switch auto reclosing in and out of service
- reset the relay from lockout
- reset 'Successful AR' or ' CB Failed to close' indication

In addition on the KAVR 130 they may be used to:

- select single phase, three phase or single/three phase reclosing

Ancillary Functions

Measurement

The relay can display the magnitude of the line and bus voltages, line voltage frequency and slip frequency. The measurements can be selected by the user to be displayed as either primary or secondary quantities.
Primary display quantities are based on the VT ratios set in the relay. These quantities can provide a default setting on the LCD situated on the relay frontplate.

Event records

Fifty events are stored in a non-volatile buffer. Software is available to enable the events to be downloaded to a PC.

Any change of state of a control input or output relay, local setting change or operation of a control function, is stored in the relay with a resolution of 1ms. Alarms are also stored as events.

Test features

A number of features are provided to enable the relay to be thoroughly tested during commissioning, routine maintenance and fault finding operations:

- The measurement functions allow the analogue input and its associate wiring to be checked.
- The on/off states of the digital inputs and relay outputs can be displayed.

Power-on diagnostics and self monitoring

Power-on diagnostic tests are carried out by the relay when it is energised.

These tests include checks on the timer, microprocessor, memory and the analogue input circuity.

Continuous self-monitoring, in the form of watchdog circuity, memory checks and analogue input module tests, is also performed. In the event of a failure, the relay will either lock out or attempt a recovery, depending on the type of failure detected.

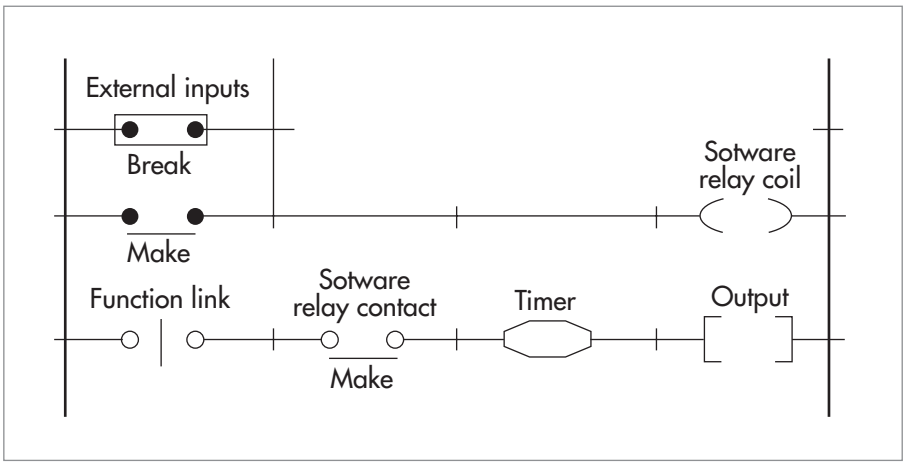


Figure 1 | Example of ladder logic

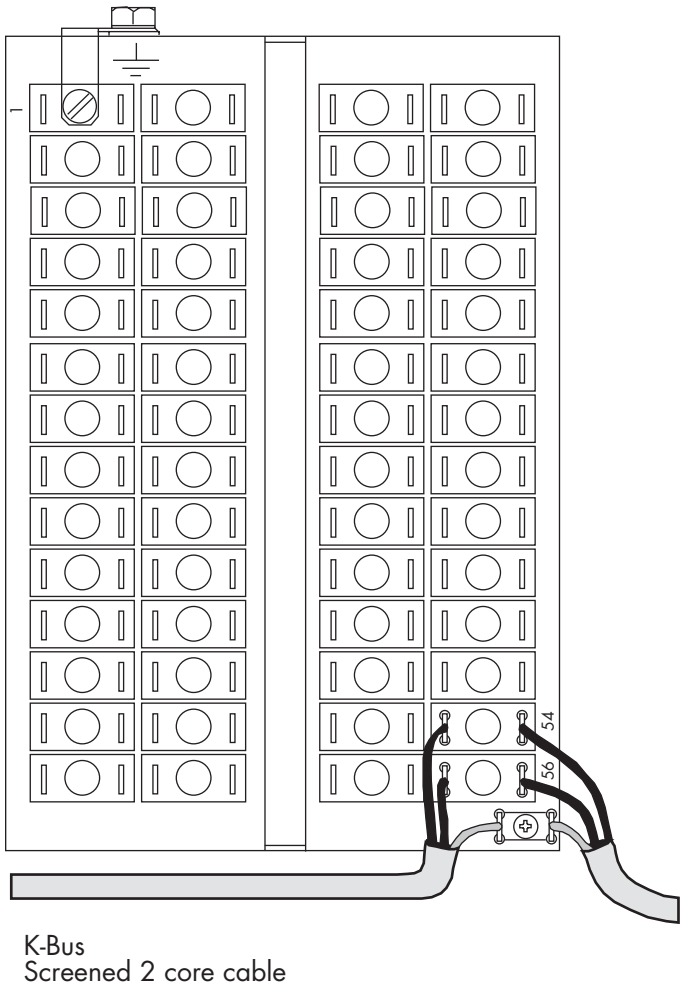


Figure 2

Communications terminal arrangement

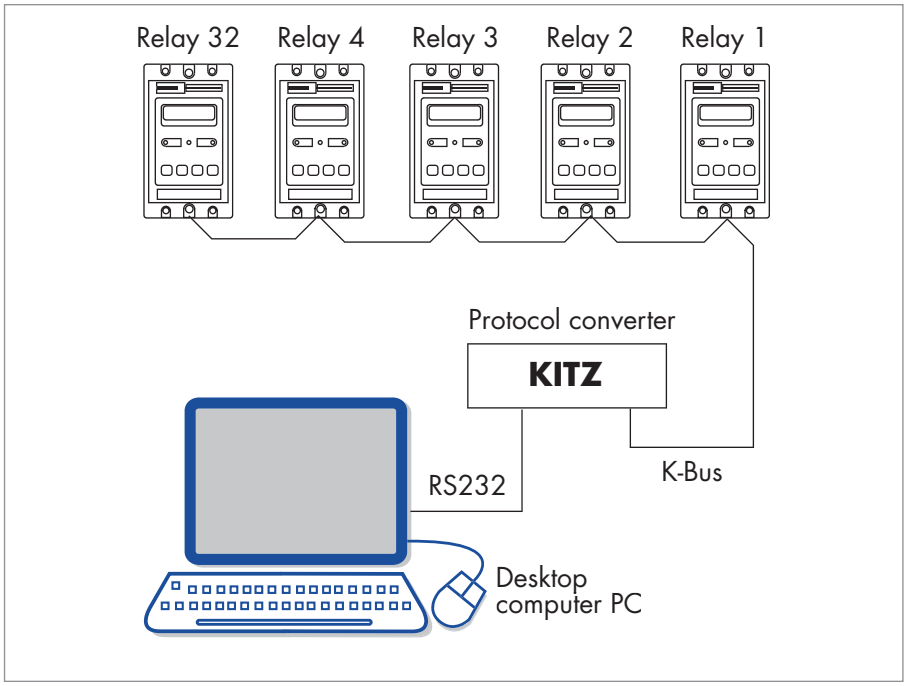


Figure 3

Basic communications system

Hardware Description

The relay is housed in a Midos size 4 case, suitable for either rack or panel mounting as shown in Figure 6.

A highly integrated 16-bit micro-controller uses digital signal processing techniques to analyse power system quantities and implement scheme logic. The micro-controller performs all of the major software functions such as input signal processing, scheme logic, output relay control and handling of the operator interface.

The relay has 2 analogue inputs and 8 opto-isolated digital inputs. The internal VTs are used to isolate, step-down and condition the input from the line VTs. Their output signals are then converted into digital data for further processing.

The front plate contains a 2 x 16 character, alphanumeric liquid crystal display (LCD) and 4 pushbuttons to provide local access to the relay's menu. There are also 3 light emitting diodes (LED) for visual indication of the relay's status.

Standard Midos terminal blocks are located at the rear of the relay providing connections for all input and output circuits such as dc supply, ac voltage and a K-Bus communications port.

User Interface

Front panel user interface

The features of the relay can be accessed through a menu-driven system. The menu is arranged in the form of a table, into each column of which related items (menu cells) are grouped.

The user can move around the menu by means of the keys on the frontplate. This can be done with the cover in place, but any change to the settings requires the cover to be removed.

Remote access user interface

The menu table can also be accessed via the remote communications facility. This allows all of the menu cells in a column to be displayed simultaneously on the screen of a PC. Changes to the menu cell can be made from the PC keyboard.

Relay interconnection

The relays are interconnected via a shielded, twisted wire pair known as K-Bus. Up to 32 relays may be connected in parallel across the bus.

The K-Bus is connected through a protocol converter known as KITZ, either directly or via a modem, to the RS-232 port of the PC. The KITZ provides signals over the bus which are RS-485 based and transmits at64 kbits/s. The K-Bus connection is shown in Figure 2.

This system allows up to 32 relays to be accessed through one RS-232 communications port.
A pictorial representation of this is shown in Figure 3.

Software is available with each KITZ to provide access to the relay to read and change settings. Additional software entitled 'Protection Access Software & Toolkit' which provides access to the event recorder, together with other additional functions, is also available.

Each relay is directly addressable over the bus to allow communication with the PC.

It should be noted that protection tripping and blocking signals are not routed via the K-Bus. Separate conventional cabling is used for these functions. Where appropriate, the isolated 48V dc supply available on each relay is used to energize its opto-isolators via external contacts.

Communications protocol

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 loaded to the PC.

The protocol includes extensive error checking routines to ensure that the system remains reliable and secure.

Password protection

Password protection is provided on settings which alter the configuration of the relay, any accidental change to which could seriously affect the ability of the relay to perform its intended function, ie. enable/disable settings, protection function characteristic selection, scheme logic settings and system VT ratios.

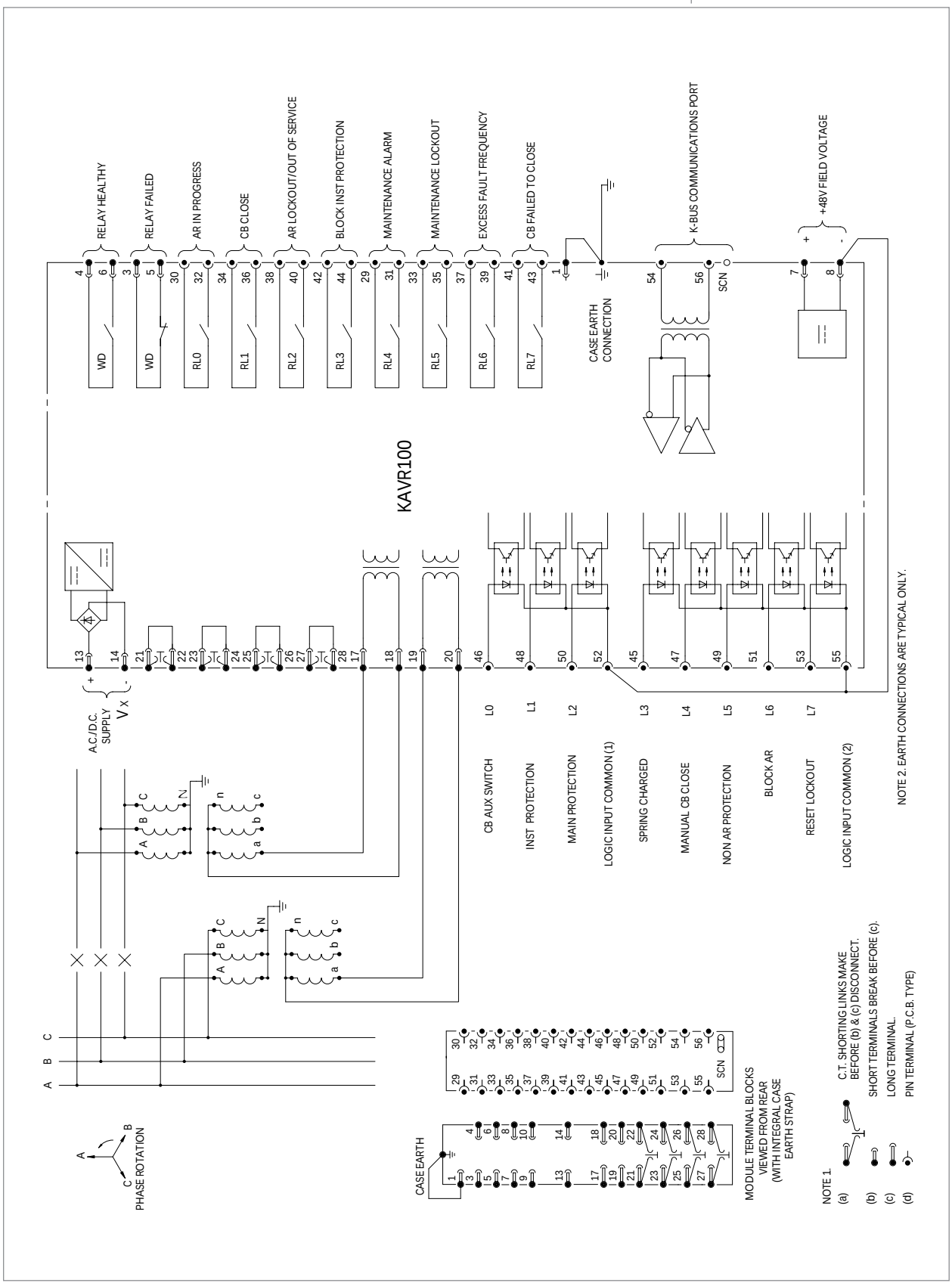
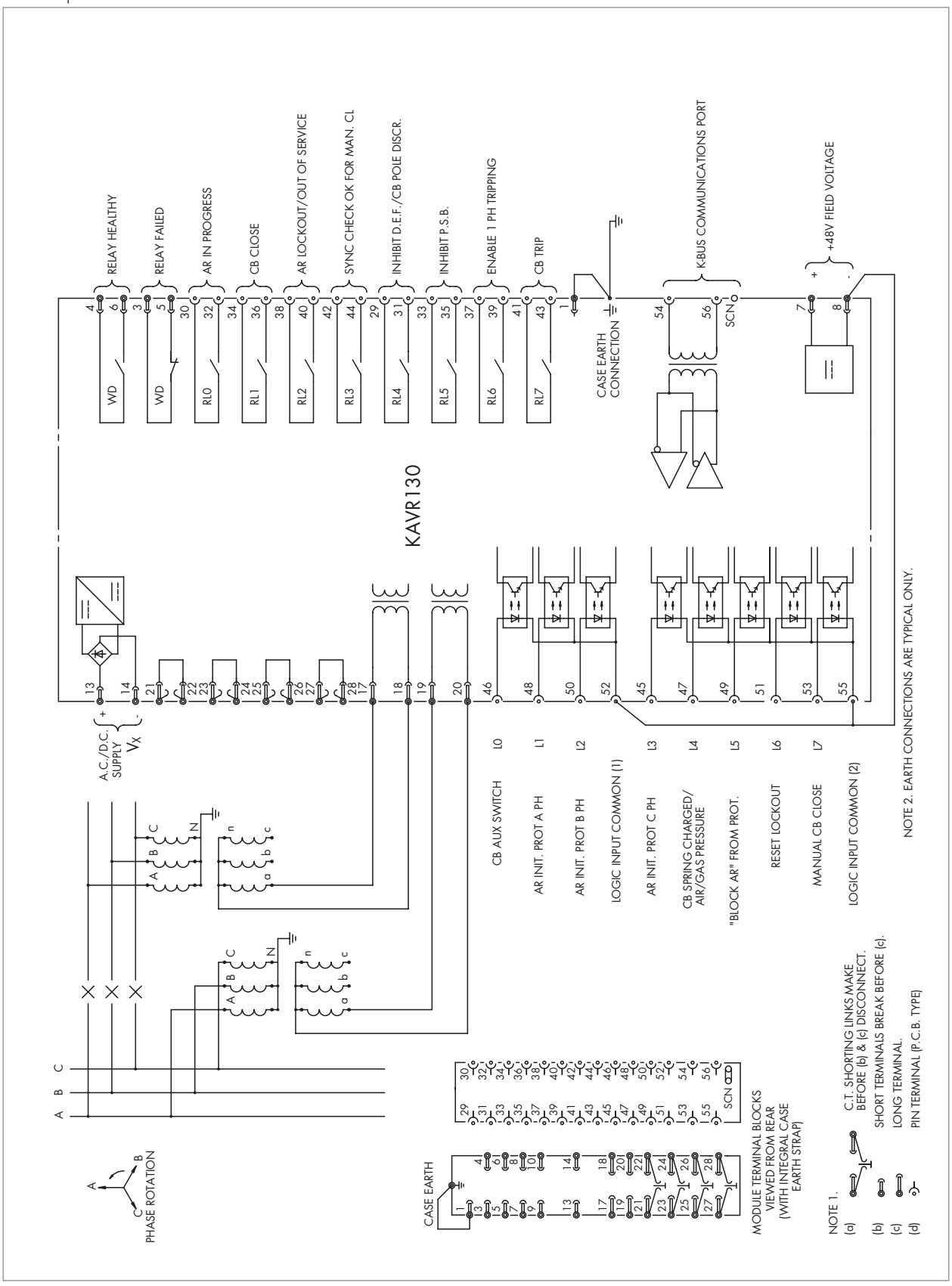

KAVR100
RELAY HEALTHY
RELAY FAILED
AR IN PROGRESS
CB CLOSE
AR LOCKOUT/OUT OF SERVICE
BLOCK INST PROTECTION
MAINTENANCE ALARM
MAINTENANCE LOCKOUT
EXCESS FAULT FREQUENCY
CB FAILED TO CLOSE
CASE EARTH CONNECTION
K-BUS COMMUNICATIONS PORT
SCN
+48V FIELD VOLTAGE
WD
RL0
RL1
RL2
RL3
RL4
RL5
RL6
RL7
A.C./D.C. SUPPLY
Vx
CB AUX SWITCH
INST PROTECTION
MAIN PROTECTION
LOGIC INPUT COMMON (1)
SPRING CHARGED
MANUAL CB CLOSE
NON AR PROTECTION
BLOCK AR
RESET LOCKOUT
LOGIC INPUT COMMON (2)
L0
L1
L2
L3
L4
L5
L6
L7
NOTE 2. EARTH CONNECTIONS ARE TYPICAL ONLY.
PHASE ROTATION
CASE EARTH
MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)
NOTE 1.
(a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
(b) SHORT TERMINALS BREAK BEFORE (c).
(c) LONG TERMINAL.
(d) PIN TERMINAL (P.C.B. TYPE)

Figure 5 | Typical application diagram KAVR130



Technical Data

Relay ratings

Inputs:

- AC voltage
- Vn (nominal)
  63.5/110V
- Operating range
  0 to 327V
- Maximum withstand
  375V
- Auxiliary voltage Vx
  24/125V or
  48/250V ac or dc
- Frequency
  50/60Hz
- Frequency range
  46Hz to 65Hz

Output:

- Field voltage
  48V dc (current limit: 60mA)

Burdens

- AC voltage
  0.02VA at 110V phase/neutral
- Auxiliary voltage
  The burden on the auxiliary supply depends upon the number of output relays and control inputs energised.

	No. of output relays	No. of control inputs	Typical burden
DC supply	0	0	2.5 – 6.0W
	2	2	4.0 – 8.0W
	8	8	5.5 – 12W
AC supply	0	0	6.0 – 12VA
	2	2	6.0 – 14VA
	8	8	13 – 23VA

Phase angle settings

- Check synchronism
  5° to 90°
- System synchronism
  5° to 90°

Slip frequency settings

- Check synchronism :
  0.001Hz to 2.0Hz
- System synchronism
  0.001Hz to 2.0Hz

Time settings

- KAVR100

Dead time 1	0.01s to 300s
Dead time 2	1.00s to 300s
Dead time 3	1.00s to 9999s
Dead time 4	1.00s to 9999s
Reclaim time	1.00s to 600s
Check synchronism delay	0.1s to 99s
System synchronism delay	0.1s to 99s
Check synchronism window	0.01s to 600s
Auto-reclose inhibit after manual close	0.01s to 300s
Close pulse	0.01s to 10s

- KAVR130

Dead time 1	0.01s to 300s
Dead time 2	1.00s to 9999s
Dead time 3	1.00s to 9999s
Dead time 4	1.00s to 9999s
Single phase dead time 1	0.01s to 5s
Reclaim time	1.00s to 600s
Check synchronism delay	0.10s to 99s
System synchronism delay	0.10s to 99s
Check synchronism window	0.01s to 9999s
Auto-reclose inhibit after manual close	0.01s to 600s
Close pulse	0.01s to 5s

Voltage settings

- Undervoltage 22V to 132V
- Differential voltage 0.5V to 22V
- Line/bus dead voltage
  5V to line/bus live voltage
- Line/bus live voltage
  Line/bus dead voltage to 132V

Transformer ratios

Voltage transformers
1:1 to 9999:1

Digital inputs

- Opto-isolated inputs
  Eight – energised from 48V field voltage
- Nominal rating 50V dc
- Off voltage ≤12V
- On voltage≥35V

Contacts

- Output relays Eight single make
- Contact ratings
  Make and carry for 0.2s 30A
  Carry continuously 5A
  Break 50W resistive
  25W inductive
  (L/R = 0.04s at 300V max)

Durability

- Loaded contact
  10,000 operations minimum.
- Unloaded contact
  1000,000 operations minimum

Communications port (K-Bus)

- Language Courier
- Transmission mode Synchronous
- Signal levels RS485
- Message format HDLC
- Data rate 64 kbits/s
- Connection Multidrop (32 units)
- Cable type Screened
  twisted pair of wires
- Cable length 1000m (maximum)
- Connector Screw terminals (M4)
- Isolation 2kV rms for 1 minute

High voltage withstand

- Dielectric withstand
  IEC 60255-5:1977

  2kV rms for 1 minute between all case terminals (except terminal 1) connected together and the case earth/terminal 1.

  2kV rms for 1 minute between terminals of independent circuits,including contact circuits.

  1.5kV rms for 1 minute across open contacts of output relays 0 to 8.

  1kV rms for 1 minute across the open contacts of the watchdog relay.

- High voltage impulse
  IEC 60255-5: 1977

  Three positive and three negative impulses of 5kV peak, 1.2/50µs, 0.5J between all terminals and all terminals (except terminal 1) and case earth/terminal 1.

Electrical environment

- High frequency disturbance
  IEC 60255-22-1:1988 Class III

  2.5kV peak between independent circuits.

  2.5kV peak between independent circuits and case earth.

  1.0kV peak across terminals of the same circuit.

- Fast transient disturbance
  IEC 60255-22-4:1992 Class III

  2kV, 5kHz applied directly to all inputs.

  IEC 60801-4: 1988 Level 4

  4kV, 2.5kHz applied directly to auxiliary voltage, watchdog and trip capacitor.

  4kV, 2.5kHz, via capacitor clamp to all inputs.

- Electrostatic discharge
  IEC 60255-22-2:1989 Class III

  8kV – discharge in air with cover in place.

  IEC 60801-2:1991 Level 2

  4kV – point contact discharge with cover removed.

- DC supply interruption
  IEC 60255-11:1979

  The unit will withstand a 10ms interruption in the auxiliary supply, under normal operating conditions, without de-energising.

- AC ripple on DC supply
  IEC 60255-11: 1979

  The unit will withstand 12% ac ripple on the dc supply.

- EMC Compliance

  CE 89/336/EEC

  Compliance with the EuropeanCommission Directive on EMC is claimed via the technical Construction File route.

  EN 50081-2:1994
  EN 50082-2:1995

  Generic Standards were used to establish conformity.

- Product Safety

  CE 72/23/EEC

  Compliance with the European Commission Low Voltage Directive.

  EN61010-1: 1993/A2:1995
  EN60950:1992/A3: 1995

  Compliance is demonstrated by reference to generic safety standards.

Atmospheric environment

- Temperature
  IEC 60255-6:1988

  Storage and transit –25°C to+70°C

  Operating –25°C to +55°C

  IEC 60068-2-1:1990 Cold

  IEC 60068-2-2:1974 Dry heat

- Humidity
  IEC 60068-2-3:1969
  56 days at 93% RH and 40°C

- Enclosure protection
  IEC 60529:1989
  IP50 (dust protected)

Mechanical environment

- Vibration
  IEC 60255-21-1:1988
  Response Class 1
  Endurance Class 1

- Shock and Bump
  IEC 60255-21:1988-2:1988
  Shock Response Class 1
  Shock Withstand Class 1
  Bump Class 1

- Seismic
  IEC255-21-3 1993 Class 1

Case

The relay is housed in a size 4 Midos case as shown in Figure 6.

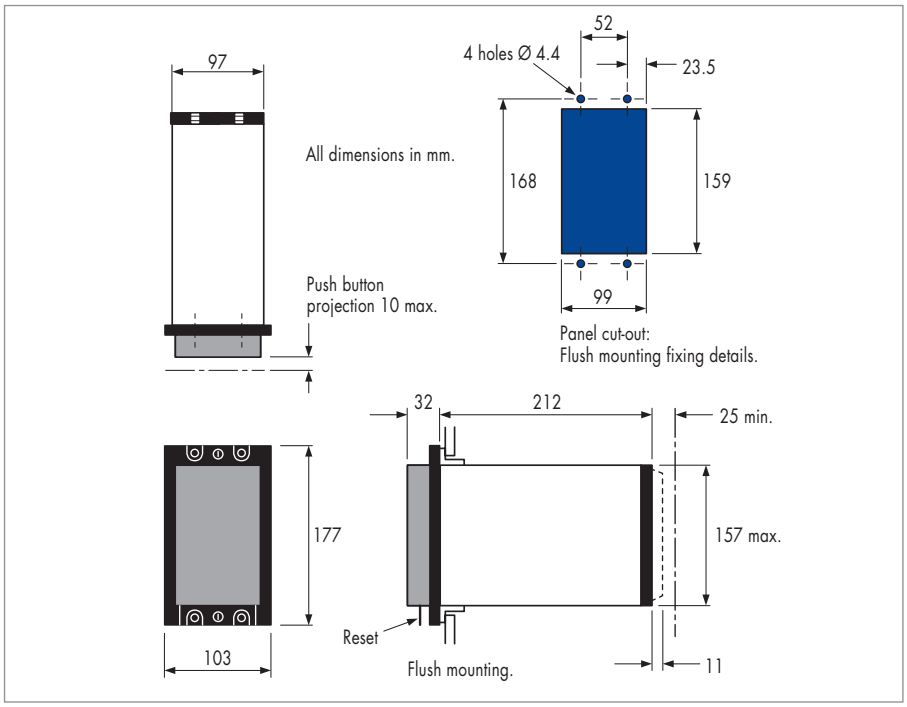


Figure 6 | Case outlines size 4

Additional Information

- KAVR/KAVS/KVTR service manual R8505
- KAVR100 scheme description R6523
- KAVR130 scheme description R6539
- KAVR100 logic diagram 08 KAVR100 01 (11 sheets)
- KAVR130 logic diagram 08 KAVR130 01 (12 sheets)
- KAVR130 service manual R8523

Glossary

- **Courier**
  A communications language developed to provide generic control, monitoring, data extraction and setting changes on remote devices (primarily on protective relays) within the substation environment.
- **K-Bus**
  The 64 kbps twisted pair cable used to connect Courier compatible devices and transfer Courier data.
- **KITZ**
  The interface unit which converts between K-Bus and IEC60870-5 FT1.2 format data, which is used to transfer Courier data over modems and RS232 connections.

Information required with order

Relay type	**K A V R**								
Models available:									
Three phase tripping		1	0	0					
Single and three phase tripping		1	3	0					
Configuration:									
Standard					0	1			
Case size:									
Size 4 MiDOS flush mounting							L	1	
Auxiliary voltage:									
24/125V								2	
48/250V								5	
Transformer ratings:									
Vn = 57.7 / 120V In = 0A									J
Language:									
English									E
Issue:									