GE
Grid Solutions

# KAVS

## Check Synchronising Relay

The KAVS from GE is a check synchronising relay for feeders on transmission, sub-transmission and distribution systems.

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

The KAVS checks that the voltage, phase angle and frequency on either side of an open circuit breaker are such that it is safe to close. It provides the check synchronising or dead line/bus interlocks required for some auto-reclose applications. It also provides split system detection and check synchronising interlocks for manual reconnection following a system split.

Two voltage phase angle comparators are included, identical in operation, but having different angle, slip frequency and timer settings. This allows different check synchronising conditions to be selected for auto-reclosing and manual circuit breaker closing. The phase angle comparator is normally applied for auto-reclosing and the system angle comparator for manual circuit breaker closing.

### Key Features

- Selectable undervoltage blocking and differential voltage blocking features
- Flexible operating logic options via software function links
- Measurement of line and busbar voltage system frequency and phase angle slip frequency
- IEC 870-5 compatible communications via K-Bus
- Integral event recorder accessible from a remote PC
- Comprehensive self-checking and alarms
- Integral disturbance recorder accessible from a remote PC

## Models Available

- KAVS100

## Key Benefits

- Compact numeric relay
- User-friendly interface
- Flexible operating logic

Imagination at work

## Application

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## Functions

### Check Synchronisation

The relay checks that the two parts of the system are synchronised 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 KAVS 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 through a user interface by opening or closing software function links, to match the scheme to a particular application. Full details of the scheme logic used are included in the service manual (see Additional Information).

### Inputs and Outputs

KAVS has eight optically isolated inputs which may be reassigned by the user with any of the available functions from the settings menu. There are eight programmable outputs, each comprising a relay with one normally open contact which may also be reassigned by the user. A dedicated watchdog output with one normally open and one normally closed contact is also available.

The typical application diagram (Figure 4) shows the input and output functions assigned as a factory default setting.

## Ancilliary Features

### Measurements

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.

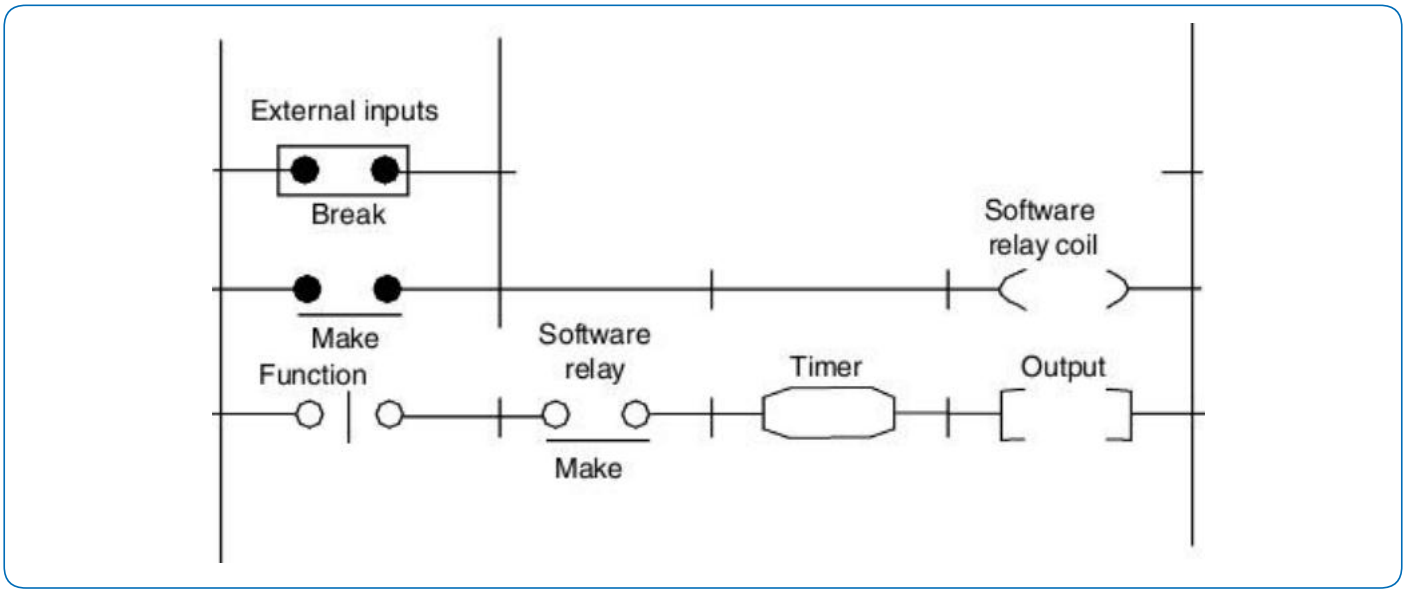



*Figure 1: Example of ladder logic*

## Event Records

Fifty events can be stored in a non-volatile buffer. Software is available to enable the events to be down-loaded 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 1 ms. Alarms are also stored as events.

## Disturbance Records

The internal disturbance recorder has up to two analog, 16 digital and one time channel. The recorder can be triggered from selectable software signals and can store one complete record. Data is sampled eight times per cycle and each channel can store up to 512 samples. Software is available to allow records to be accessed and displayed by a PC.

## 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 analog input and its associated wiring to be checked
- The on/off states of the digital inputs and relay outputs can be displayed

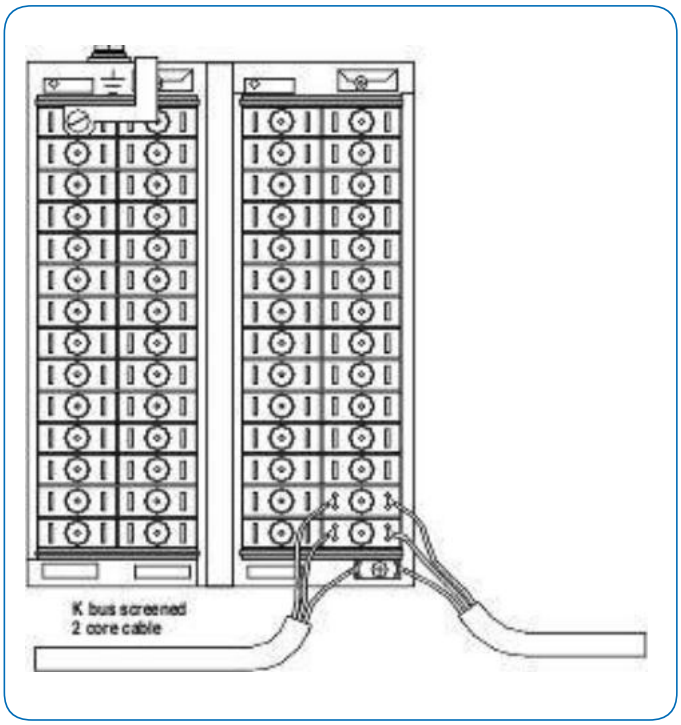



*Figure 2: Communications terminal arrangement*

## 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 analog input circuitry. Continuous self-monitoring, in the form of watchdog circuitry, memory checks and analog input module tests, is also performed. In the event of a failure, the relay will either stop operating, which resets the watchdog contact, or will attempt a recovery, depending on the type of failure detected.

## Hardware

The relay is housed in a Midos size 4 case, suitable for either rack or panel mounting as shown in Figure 5. A highly integrated 16-bit microcontroller uses digital signal processing techniques to analyse power system quantities and implement scheme logic. The microcontroller performs all of the major software functions such as input signal processing, scheme logic, output relay control and handling of the operator interface.

The front panel contains a 2 x 16 character alphanumeric back-lit liquid crystal display (LCD) and four push buttons to provide local access to the relay's menu. There are also three light emitting diodes (LED) for visual indication of the relay's status, i.e. relay healthy, trip, alarm.

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 via a menu system. The menu is arranged in the form of a table where related items (in cells) are grouped into columns.

The user can move around the menu by means of the keys on the front-plate. 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 a 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 RS232 port of the PC. The KITZ provides signals over the bus which are RS485 based and transmitted at 64 kbits/s. The K-Bus connection is shown in Fig. 3.

This system allows up to 32 relays to be accessed through one RS232 communications port. A pictorial representation of this is shown in Figure 3.

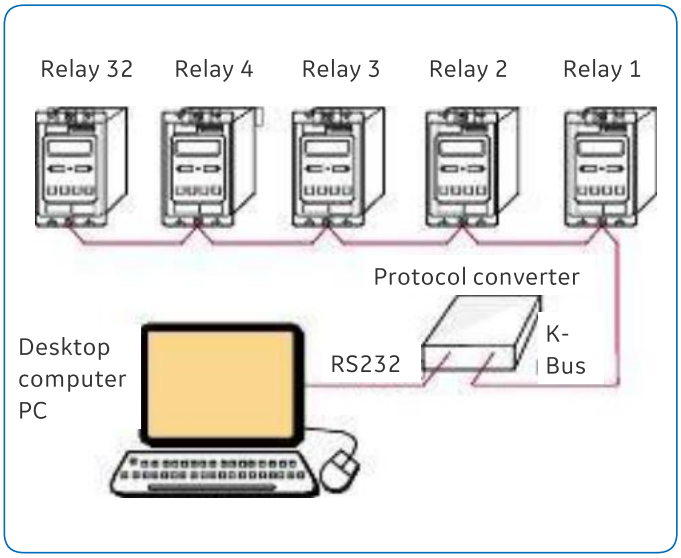



*Figure 3: Basic communications system*

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

Each relay is directly addressable over the bus to allow communication with any selected relay. Global commands may also be given to all relays on the network.

It should be noted that protection tripping and blocking signals are not routed via the K-Bus. Separate conventional cabling is used for this purpose. Where appropriate, the isolated 48 V dc supply available on each relay is used to energise the optically-isolated inputs via external contacts.

### Communications Protocol

The communications protocol used with K Range 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 within 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 the system remains reliable and secure.

### Password Protection

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

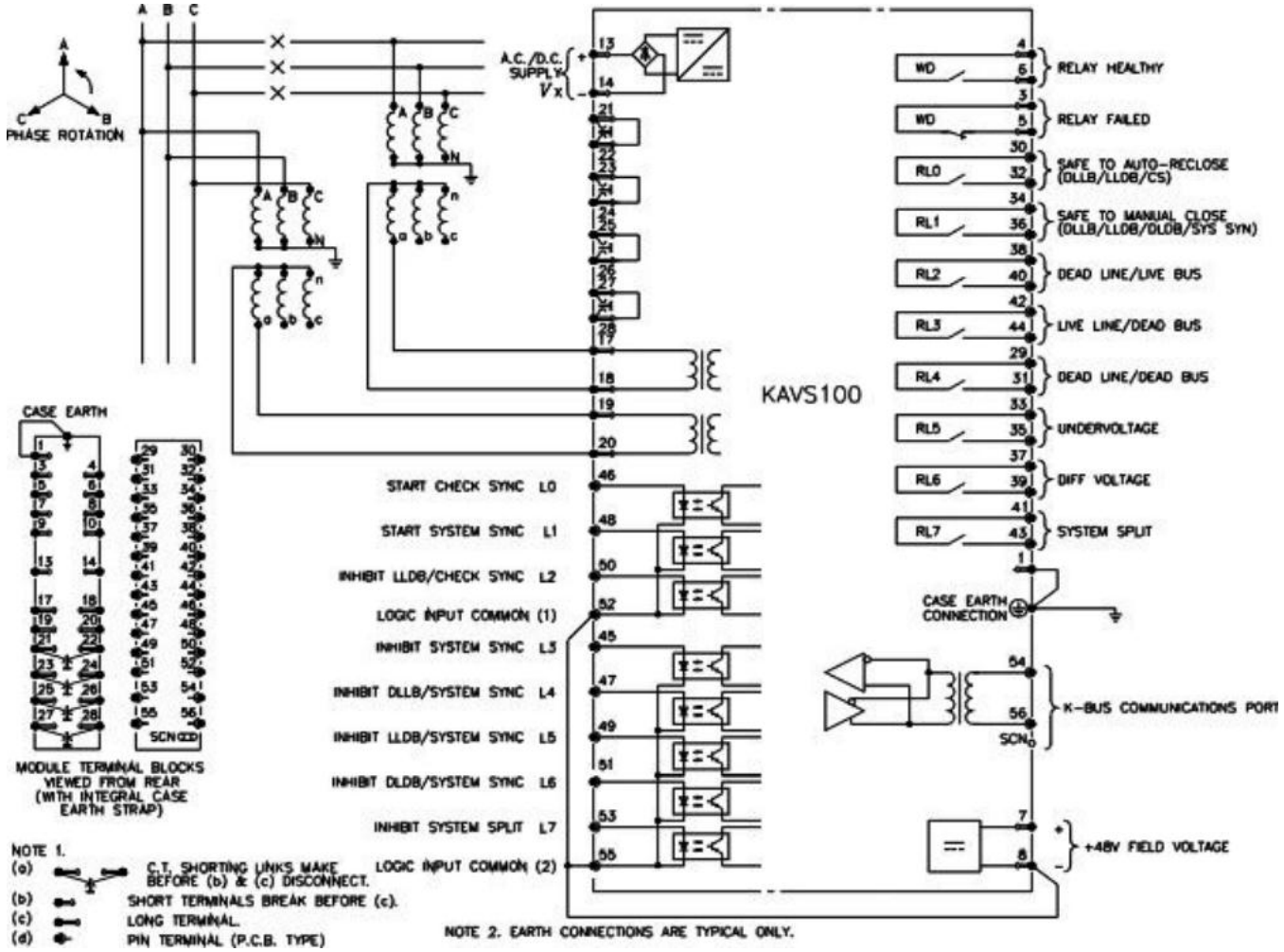



*Figure 4 Typical application diagram KAVS*

## Technical Data

### Ratings

| Inputs | |
|---|---|
| AC Voltage Vn (nominal) | 57 to 120 V |
| Operating range | 0 to 440 V |
| Auxiliary voltage Vx | 24/125 V or 48/250 V ac or dc |
| Frequency | 50/60 Hz |
| Frequency range | 45 Hz to 65 Hz |
| **Output:** | |
| Field Voltage | 48 Vdc (current limit: 60 mA) |

### Burdens

- AC Voltage 0.02 VA at 110 V phase/neutral
- Auxiliary voltage

  The burden on the auxiliary supply depends on the number of output relays and control inputs energised

Phase angle settings

- Phase angle 5° to 90°
- System angle 5° to 90°
- System split 90° to 175°

Slip frequency settings

- Phase angle check 0.005 Hz to 2.000 Hz
- System angle check 0.005 Hz to 2.000 Hz

| | No. of Output Relays | No. of Control Inputs | Typical Burden |
|---|---|---|---|
| DC Supply | 0 | 0 | 2.75 - 3 W |
| | 2 | 2 | 4.0 - 4.5 W |
| | 8 | 8 | 7.6 - 8.6 W |
| AC Supply | 0 | 0 | 4.5 - 9 VA |
| | 2 | 2 | 6.0 - 12 VA |
| | 8 | 8 | 7.5 - 20.0 VA |

### Time Settings

- Phase angle check delay 0.1 s to 99 s
- System angle check delay 0.1 s to 99 s
- System split time 0.01 s to 600 s
- Auto-reclose inhibit 0.01 s to 300 s after manual close

### Voltage Settings

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

### Transformer Ratios

- Voltage transformers 1 : 1 to 9999 : 1

### Digital Inputs

Opto isolated inputs

Eight energised from 48 V field voltage

- Nominal rating 50 V dc
- Off voltage 12 V
- On voltage 35 V

### Contacts

- Output relays eight single make
- Contact ratings

  Make: 30 A and carry for 0.2 s
  Carry: 5 A continuous
  Break: dc 50 W resistive
  25 W inductive
  (L/R = 0.04 s at 300 V max)

## Technical Data

### Durability

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

### Communications Port (K-Bus)

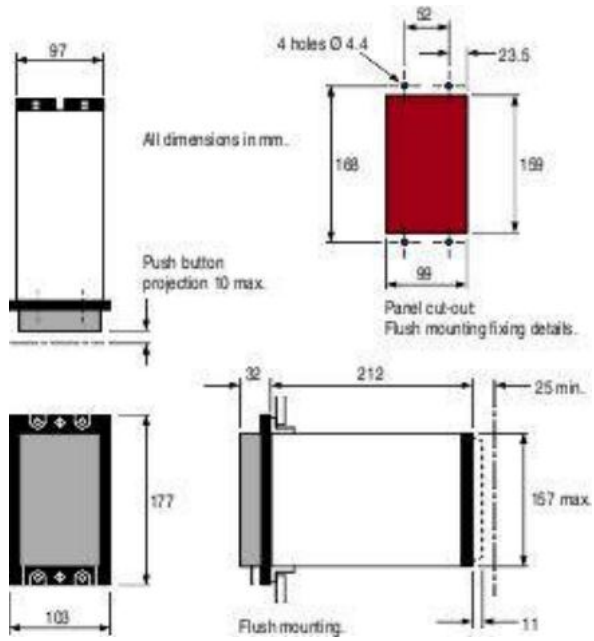
- Transmission mode synchronous
- Signal levels RS485
- Message format HDLC
- Data rate 64 kbits/s
- Connection Multidrop (32 units)
- K-Bus cable screened twisted pair
- K-Bus cable length 1000 m (maximum)
- K-Bus loading 32 units (multi-drop system)
- Connector screw terminals
- Isolation 2 kV rms for 1 minute
- For additional information, see the KAVS 100 service manual R8506

## Additional Information

KAVS 100 service manual R8506

## Case

The relay is housed in a size 4 Midos case as shown in Figure 5.




| Unit 100 | KAVS100 | 0 1 | T 1 | | J | E |
|---|---|---|---|---|---|---|
| **Configuration** | | | | | | |
| Standard | | 0 1 | | | | |
| **Case size** | | | | | | |
| Size 4 Midos flush mounting | | | T 1 | | | |
| **Auxiliary voltage** | | | | | | |
| 24/125V | | | | 2 | | |
| 48/250V | | | | 5 | | |
| **Ratings** | | | | | | |
| Vn = 57..7/120V | | | | | J | |
| **Language** | | | | | | |
| English | | | | | | E |

## Glossary

**Courier** A communications language developed to provide generic control, monitoring, data extraction and settings changes on remote devices (primarily on protective relays) within the substation environment.
**K-Bus** The 64 bit/s twisted pair cable used to connect Courier compatible devices and transfer Courier data.
**KITZ** The interface unit which converts between K-Bus and IEC 870 format data.
**PC** Personal computer

## Track Record - Check Synchronising Relays

| |
|---|
| MAVS relays launched in 1985. Over 16,000 MAVS relays delivered. |
| KAVR relays launched in 1993, offering additional features with numerical relay technology. Over 2,000 KAVS relays delivered. |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