AREVA

Type KMPC130

Measurement Centre

Technical Manual

R8520G

PURPOSE OF THIS MANUAL

This manual is intended to guide the user through the procedures for negotiating the menu system of the Measurement Centre to read selected data, apply settings to the available protection and control functions and provide guidance on the terminal connections. It describes the optional functions and how they may be selected.

Some options require the use of the serial communication channel, but only the settings associated with these functions are covered in this document, together with some notes on their operation.

The remainder of the manual deals with installation, commissioning and maintenance.

Equipment covered by this manual:

KMPC130 Measurement Centre

Contents

Section 1. HANDLING AND INSTALLATION

1.1 General considerations

1.1.1 Receipt of product

Although the product is generally of robust construction, careful treatment is required prior to installation on site. Upon receipt, the product should be examined immediately, to ensure no damage has been sustained in transit. If damage has been sustained during transit, a claim should be made to the transport contractor, and a GEC ALSTHOM T&D Protection & Control representative should be promptly notified. Products that are supplied unmounted and not intended for immediate installation should be returned to their protective polythene bags.

1.1.2 Electrostatic discharge (ESD)

The product uses components that are sensitive to electrostatic discharges.
The electronic circuits are well protected by the metal case and the internal module should not be withdrawn unnecessarily. When handling the module outside its case, care should be taken to avoid contact with components and electrical connections. If removed from the case for storage, the module should be placed in an electrically conducting antistatic bag.

There are no setting adjustments within the module and it is advised that it is not unnecessarily disassembled. Although the printed circuit boards are plugged together, the connectors are a manufacturing aid and not intended for frequent dismantling; in fact considerable effort may be required to separate them. Touching the printed circuit board should be avoided, since complementary metal oxide semiconductors (CMOS) are used, which can be damaged by static electricity discharged from the body.

1.2 Handling of electronic equipment

A person’s normal movements can easily generate electrostatic potentials of several thousand volts. Discharge of these voltages into semiconductor devices when handling electronic circuits can cause serious damage, which often may not be immediately apparent but the reliability of the circuit will have been reduced.

The electronic circuits are completely safe from electrostatic discharge when housed in the case. Do not expose them to risk of damage by withdrawing modules unnecessarily.

Each module incorporates the highest practicable protection for its semiconductor devices. However, if it becomes necessary to withdraw a module, the precautions should be taken to preserve the high reliability and long life for which the equipment has been designed and manufactured.

1. Before removing a module, ensure that you are at the same electrostatic potential as the equipment by touching the case.
2. Handle the module by its frontplate, frame or edges of the printed circuit board. Avoid touching the electronic components, printed circuit track or connectors.
3. Do not pass the module to another person without first ensuring you are both at the same electrostatic potential. Shaking hands achieves equipotential.
4. Place the module on an antistatic surface, or on a conducting surface which is at the same potential as yourself.
5. Store or transport the module in a conductive bag.

If you are making measurements on the internal electronic circuitry of an equipment in service, it is preferable that you are earthed to the case with a conductive wrist strap. Wrist straps should have a resistance to ground between 500k–10M ohms. If a wrist strap is not available, you should maintain regular contact with the case to prevent a build-up of static. Instrumentation which may be used for making measurements should be earthed to the case whenever possible.

More information on safe working procedures for all electronic equipment can be found in BS5783 and IEC 147–OF. It is strongly recommended that detailed investigations on electronic circuitry, or modification work, should be carried out in a Special Handling Area such as described in the above-mentioned BS and IEC documents.

1.3 Mounting

Products are dispatched, either individually, or as part of a panel/rack assembly. If loose products are to be assembled into a scheme, then construction details can be found in Publication R7012. If an MMLG test block is to be included it should be positioned at the right hand side of the assembly (viewed from the front). Modules should remain protected by their metal case during assembly into a panel or rack. The design of the relay is such that the fixing holes are accessible without removal of the cover. For individually mounted units, an outline diagram is normally supplied showing the panel cut-outs and hole centres. These dimensions will also be found in Publication R6520.

1.4 Unpacking

Care must be taken when unpacking and installing the products so that none of the parts are damaged, or the settings altered and they must only be handled by skilled persons. The installation should be clean, dry and reasonably free from dust and excessive vibration. The site should be well lit to facilitate inspection. Modules that have been removed from their cases should not be left in situations where they are exposed to dust or damp. This particularly applies to installations which are being carried out at the same time as construction work.

1.5 Storage

If products are not to be installed immediately upon receipt they should be stored in a place free from dust and moisture in their original cartons. Where de-humidifier bags have been included in the packing they should be retained. The action of the de-humidifier crystals will be impaired if the bag has been exposed to ambient conditions and may be restored by gently heating the bag for about an hour, prior to replacing it in the carton.

Dust which collects on a carton may, on subsequent unpacking, find its way into the product; in damp conditions the carton and packing may become impregnated with moisture and the de-humidifier will lose its efficiency.

Storage temperature –25°C to +70°C.

Section 2. DESCRIPTION

The KMPC130 Measurement Centre provides measurement, protection, control and recording functions for the circuit to which it is connected. Some 30 to 40 individual measurements are provided which include voltage, current, power, peak demand and energy values. Protection features include definite time overcurrent with start and timer blocking facilities; circuit breaker failure protection and undercurrent detection. The control features include remote closing/tripping of the circuit breaker and load shedding/restoration. In addition records can be generated for fault information, time tagged events and disturbances on the circuit to which it is connected. These records can be triggered by the internal protection functions and also by the operation of external protection if required. Some of the data recorded will assist with establishing circuit breaker maintenance requirements.

Eight opto-isolated inputs are used in the control logic and when any of these are not required for this purpose they may be used to indicate the status of primary plant, or the operation of external protective relays. Eight output relays provide for remote control of the circuit breaker, control of voltage regulating relays, such as the MVGC 01 relay, back tripping from the breaker fail circuit, undercurrent and the outputs of auxiliary time delays.

Serial communication via K-Bus, based on the Courier language and protocol, provides means of remotely accessing the measurement centre for measured values, records, control of plant, load shedding and setting changes.

2.1 Measurement functions

2.1.1 Frequency response

Measurement is based on the Fourier derived value of the power frequency component of current. Harmonics up to and including the 6th are suppressed.
The 7th harmonic is the first predominant harmonic and this is attenuated by a factor of 3; also higher harmonics are further progressively attenuated by the anti-aliasing filter.

The frequency response is further enhanced by frequency tracking the measured signal over a range of 45Hz to 65Hz. The sampling rate of the analogue/digital conversion is automatically adjusted to match the frequency of the tracked signal. In the absence of a signal to track, the sampling rate settles to that determined from the set rated frequency (Fn) and this will be the displayed default value for the frequency. In the presence of a signal within the tracking range the KMPC will lock-on to the signal and track any changes in frequency.

Frequency measurement is a by-product of the frequency tracking and maintains its accuracy from 45Hz to 65Hz. In the absence of any signal to track the display will change to the selected default value of 50Hz or 60Hz.

2.1.2 Measured quantities

Measurements are divided into three groups: those that are directly measured; those that are calculated from the directly measured quantities and demand values.
All measurement values can be displayed on the front of the relay. Measured values will be displayed in primary system quantities if the current and voltage transformer ratios are entered in the PHASE FAULT SETTINGS column of the menu.

The default setting for these ratios is 1:1; the displayed settings and measured values then being in terms of the secondary quantities from the primary transducers.

2.1.3 Measurement refresh interval

Measurement	Refresh interval	Used for
Samples	8 per cycle	Fourier calculations and disturbance records
Values (peak)	2 per cycle	Undercurrent protection
Values (Fourier)	1 cycle	Overcurrent protection, fault records
Rolling average	As value	Demand and displayed values
Displayed values	1 cycle	Va, Vb, Vc, Vab, Vbc, Vca, Vave, %Vnps, F
	1 cycle	Ia, Ib, Ic, Io, Iave, %Inps
	1 second	Power measurements
	5s	Demand values and energy measurement
Display refresh	0.5 second	All displayed values

2.1.4 Rolling average value

A rolling average calculation is used to provide a stable reading of the measured values obtained from the sampled waveforms and to improve the accuracy. It is achieved by averaging the last eight measured or calculated values and is applied to all values that can be read or displayed, except for the half and one cycle values used for protection and fault records. The display will therefore settle to the final value in eight times the refresh interval given in the table in section 2.1.3.

2.1.5 Directly measured

2.1.5.1 Current

The phase currents (Ia, Ib, Ic) shall be measured. These measurements are corrected during calibration for both phase and amplitude and then used to calculate other values such as negative phase sequence current, and power.

Accuracy:

Amplitude – Better than 1% of rated current at any value of applied current from 0.2In to 2In.

Phase – Better than 0.5 degree between any two phase currents over the range 0.2In to 2In.

Range:

The first gain change takes place at 0.225In and the second range change at approximately 1.8In to obtain suitable negative sequence sensitivity and this will give an overall range of 0 to 16In. Above 16In the values will have an increasing error and the maximum value of the samples will be clipped at (√2 x 16)In.

2.1.5.2 Voltage

The three phase voltages (Va, Vb, Vc) are measured. These measurements are corrected during calibration for both phase and amplitude and then used to calculate other values such as Line Voltage, Negative Phase Sequence Voltage and Power. Accuracy:

Amplitude – Better than 1% of rated phase to neutral voltage at any value of applied voltage from 0.5Vn to 1.5 Vn.

Note: Vn = 110V phase/phase (63.5V phase/neutral).

Phase – Better than 0.5 degree between any two phase voltages over the range 0.5Vn to 1.5Vn.

Range:

The first gain change takes place at 11.25V and the second range change at 90V to obtain suitable negative sequence sensitivity. The overall voltage range is limited by the rating of the input VTs as given in section 7.1.1.

2.1.5.3 Frequency

Frequency is displayed to two decimal places and the displayed value is averaged over the last 8 measurements to ensure an accurate and stable measurement. Default = Fn, the set rated frequency, with no signal.

Range: 45Hz to 65 Hz

Accuracy: ±0.05% or better

2.1.6 Calculated from measured values

2.1.6.1 Line voltages

The three line voltages (Vab, Vbc, Vca) are calculated from the phase to neutral voltages. The displayed values are the average of the last 8 calculated values to ensure an accurate and stable display.

2.1.6.2 Average line voltage

The average line voltage (Vave) is the average value of the three line voltages and is averaged over 8 measurements. This is one of the main values to be extracted by SCADA type systems to give busbar voltage on mimic diagrams etc.

2.1.6.3 Line and neutral currents

The residual current (Io) is calculated as the vector sum of the currents in the three phases. Two line currents (Iab, Ibc) are also calculated but they are only used in the calculation of negative phase sequence currents and cannot be displayed.

2.1.6.4 Average phase current

The average value of the three phase currents (Iave) is calculated and made available via the menu. This value is a rolling average value to ensure an accurate and stable display. This replaces the maximum phase current value in the menu of some relays in the K-series. This is one of the main values to be extracted by SCADA type systems to give values for feeder current on mimic diagrams etc.

2.1.6.5 Negative sequence voltage

The negative sequence voltage is calculated from the line voltages and expressed as a percentage of the average phase voltage. Incremental changes are displayed over the range 0 to 100%. The sensitivity of measurement will be highest at rated values of voltage and the error will be greatest at low voltages.

Full scale (100%) is displayed when a balanced three phase negative phase sequence voltage is applied. With a balanced positive phase sequence voltage applied the reading will be close to 0%.

Accuracy: ±2%Vn or better – for voltages in the range 0.5Vn to 1.5Vn

2.1.6.6 Negative sequence current

The negative sequence is calculated from the line currents and expressed as a percentage of the average phase current. The measurement will be satisfactory with current as low as 0.1In, with smaller incremental changes being displayed.

Full scale (100%) will be achieved when a balanced three phase current is applied with a reversed phase sequence, when the negative sequence value is equal to the average phase current. Balanced load current will produce a reading close to 0%.

Accuracy: ±2%In or better – for currents in the range 0.1In to 2In

2.1.7 Power

2.1.7.1 Signing direction of power flow

The standard current and voltage connections, shown on connection diagrams and listed in the table in Section 3 of this manual, are the convention that forward current flow is from the busbar to the feeder. This will correspond to positive values of active power flowing from the busbar to the feeder. However, alternative methods of signing the direction of power flow are provided and may be selected to suit a particular application, or user's standards. The mode for signing the direction of active and reactive power are provided in menu cell 041E in the MEASUREMENTS 2 column of the menu. The following options are provided:

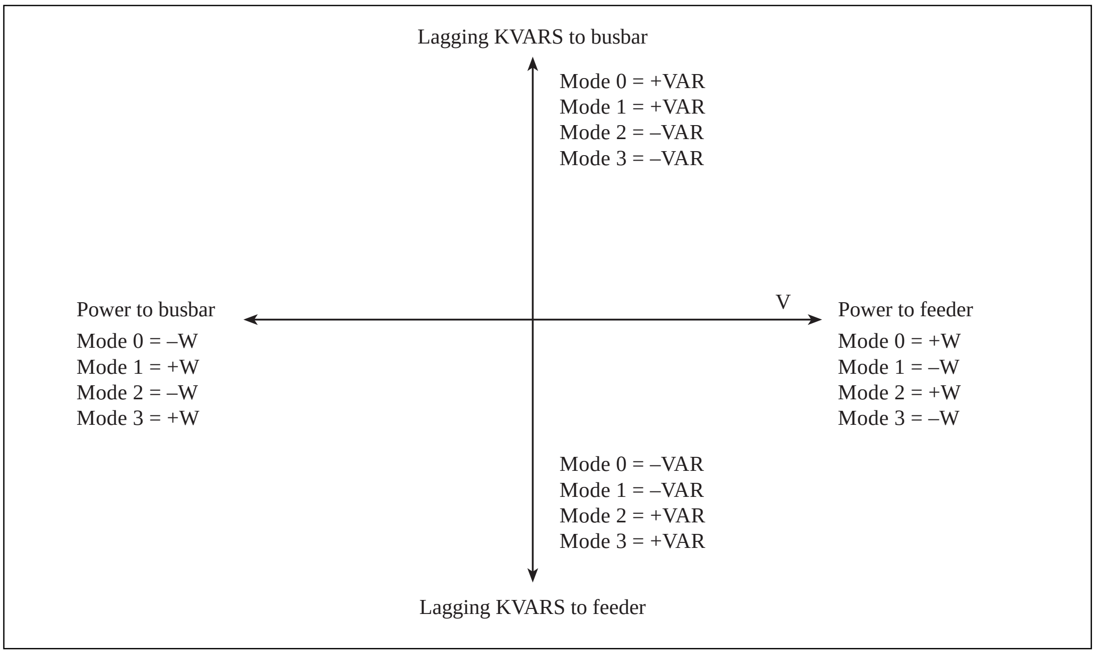

Figure 1

Mode 0 in the above diagram is for conventional connection for power flow to feeder.

Mode 0 – Normal direction	: power flow towards feeder (a+jb)
Mode 1 – Nett import signing	: + = import; – = export
Mode 2 – Nett export signing	: + = export; – = import
Mode 3 – Reversed direction	: power flow towards busbar (a+jb)

Note: The selected mode of signing will apply to all values of power and energy measurement including the demand values. If the setting of this cell is changed after the KMPC has been put into service the demand and energy registers should be first read and then reset to zero. As a safeguard against accidental change the mode cell is password protected.

2.1.7.2 Apparent power per phase

The apparent power (VA) is calculated separately for each phase as the phase to neutral voltage times the phase current. This is calculated from the average value of eight consecutive voltage and current measurements to give a stable and accurate indication. These values are not displayed, they are used in the calculation of three phase VA.

2.1.7.3 Active power per phase

The active power (W) is calculated separately for each phase as $VI\cos\phi$, where V is the phase to neutral voltage. This is calculated from the average value of eight consecutive voltage and current measurements to give a stable and accurate indication. (See Note 1 in Section 3).

2.1.7.4 Reactive power per phase

The reactive power (VAR) is calculated separately for each phase as $VI\sin\phi$, where V is the phase to neutral voltage. This is calculated from the average value of eight consecutive voltage and current measurements to give a stable and accurate indication. (See note 1 in section 3).

2.1.7.5 Three phase power

The three phase power is derived from the sum of the three single phase power measurements for each of the following:

Three phase apparent power

Three phase active power

Three phase reactive power

These values will often be required by SCADA. The displayed values are the average of 8 separate measurements per phase to improve accuracy of measurement and the settling time is eight times the refresh rate (= 8s).

Range: (0 to 2) x [Rated VA]

Rated VA = $\sqrt{3}$.Vn .In .[CT Ratio] . [VT Ratio]

where Vn is the rated line voltage

and In is the rated CT secondary current.

Accuracy: 2% of rated VA

2.1.7.6 Three phase power factor

The three phase power factor is calculated after taking the selected signing mode into account as:

pf = [active power]/[apparent power]

Range: $-1 < 0 < +1$ [the sign (–/+) indicates reverse/forward and not lag/lead]

Accuracy: 4% for input power up to 2.25Pn

where Pn is rated power ($\sqrt{3}$Vn.In)

2.1.8 Demand values

$$\frac{\text{[The sum of equally spaced measurements over the demand period]}}{\text{[number of measurements]}}$$

At the end of the demand period this value will be equal to the average demand value over the set time period.

2.1.8.1 Demand for last period

At the end of the demand period, each demand value is stored in its own unique menu cell for local display and remote retrieval. For the current demand period these cells will hold the demand values for the demand for the last (previous) period. These cells cannot be manually reset to zero; they are continually updated by overwriting with new data at the end of each demand period. If the value of these cells is remotely logged once in each demand period, the variation in demand can be plotted over any period of time.

2.1.8.2 Peak demand value

The peak demand is the highest value reached in any demand period. The peak demand values are recorded in a separate menu cell for each type of measurement. These cells can be reset to zero either manually, via the user interface on the front of the measuring centre, or remotely via the serial communication port. Resetting any one of the demand registers will reset all the demand registers to zero. Accidental resetting of these cells is prevented by password protection. As a further safeguard the peak demand values have been made non volatile and they will retain their values if the auxiliary power supply to the KMPC is lost, but they will not be incremented during this time.

2.1.8.3 Demand time period

The demand time period shall be adjustable to the following settings:

Settings: 1 minute, 15 minutes, 30 minutes, 1 hour

The demand period timer can be reset to zero by energising an opto-isolated logic input of the KMPC, or by a global command to synchronise the demand periods of all KMPC units. This action also resets the integrating registers to zero.

2.1.8.4 Demand values required

Per phase amps

3 phase active forward power	3 phase active reverse power
3 phase reactive forward power	3 phase reactive reverse power

2.1.9 Energy

Accumulated energy is calculated for both active and reactive power. This will essentially be a three phase value and will be the signed net value of the imported and exported power. The signing will be as decided by the mode selected (Section 2.1.7.1).

MWh = [MW (imported) + MW (exported)] x [time]
= [Calculated 3Phase MW] x [time]

MAVRh = [MVAR (imported) + MVAR (exported)] x [time]
= [Calculated 3Phase MVAR] x [time]

Menu cells accommodate values up to ±999999.99MWh before they overflow back to zero. The value is incremented every 5s. For security, manual reset of these values is under password control.

2.2 Protection functions

2.2.1 Definite time overcurrent element

This element provides an instantaneous START output when the current exceeds the set threshold value (I>). If the current persists a second output will be given after a set time delay (t>) to initiate tripping of a circuit breaker. The timer for the second stage output can be blocked by energisation of a selected opto-isolated input.
This element of the KMPC can be incorporated in schemes of blocked overcurrent protection, by association with similar elements in overcurrent protection on other feeders. Thus in many instances the addition of the KMPC to a circuit will sufficiently upgrade the protection, without the need to replace the existing protective relay.

A separate element is provided for earth faults so that an earth fault threshold (Io>) of less than load current can be applied. However, the gain range for the input amplifier in the current input circuit is automatically selected to suit the value of the phase current and hence the minimum operation current for earth faults may be higher than the set value if the phase currents are large. This should only be a problem when very low settings are selected and settings much less than load current will still be obtainable. The earth fault element is provided with an independent definite time delay (to>).

The current signals are software filtered to reduce their sensitivity to the third harmonic in the current waveform. Overrun time, which is important for time co-ordination, is very low at typically 25ms or less. The type of fault detected is displayed by a series of fault flags.

A reset time delay, which may be set between 0 and 60s, provides these definite time elements with the ability to detect recurring intermittent faults to give earlier clearance.

2.2.2 Undercurrent elements

An undercurrent element is provided for each of the three phases, but no separate undercurrrent element is provided for earth faults. The phase elements respond when the measured current reaches a set threshold (I<). They require the peak value of at least one half cycle to be below the set threshold to indicate an undercurrent condition and since the peak values are measured every 10ms the fast response necessary for the breaker fail applications can be obtained. However, before an output is given, an undercurrent condition has to be detected by each of the three phase elements. An undercurrent condition is assumed not to exist (or an overcurrent condition exists) when both the positive and negative peaks of the waveform, on any one phase, exceed the threshold (I<). No separate undercurrent element is provided for earth faults because the phase fault elements can be set to a low current value.

The undercurrent element can be selectively used for breaker failure protection, or to give a time delayed undercurrent output to indicate loss of critical load etc.

2.2.3 Breaker fail/backtrip

The breaker fail logic can be energised by an external input to one of the auxiliary timers; this timer being set to the required breaker fail delay. Additionally, breaker fail protection can be initiated by the integral definite time overcurrent protection. In either case the backtrip relay and breaker fail timer will be reset by a current check as soon as an undercurrent condition is detected on all three phases.

2.2.4 Additional overcurrent stage

When the undercurrent element is not being used for an undercurrent function it can be given a higher current setting and an inverted output used to initiate an auxiliary time delay to provide another definite time overcurrent stage. The requirement for both positive and negative peaks to exceed the threshold reduces over-reach that would be caused by the exponential component of fault current. This element has no software filtering and will be responsive to harmonics, but the higher frequencies will receive some attenuation from the anti-aliasing filter. Section 6 describes setting of these functions.

2.3 Control

All the settings for the auxiliary timing functions that are used in the logic are located under the LOGIC heading of the menu. The setting of the logic function links, together with the setting of the input and output masks, controls the way in which the optional features are used, thus maximising the use of the available functions. All function links and input/output masks are password protected to prevent accidental changes being made during the course of minor setting adjustments.

2.3.1 Input masks

Eight opto-isolated inputs are provided and they can be assigned to control various functions, or indicate plant status, by setting input masks.

2.3.2 Output relays

Eight programmable output relays are provided, arranged to operate in response to any of the available functions by setting the OUTPUT MASKS. In addition there is a watchdog relay for external indication of equipment failure/healthy status.

2.3.3 Auxiliary timers

There are three auxiliary timers in the relays that are used in the internal scheme logic. When they are not used internally they may be used as discrete time delays for external functions. For this they may be initiated via any of the opto-isolated control inputs and their outputs directed to any of the output relays by setting the associated INPUT and OUTPUT MASKS.

2.3.4 Load shedding by tripping less essential loads

Load shedding is possible in response to commands via the communication port. An indication is required that the circuit breaker was closed before the trip command was received, otherwise the circuit breaker will not close to restore load when the appropriate command level is received. The circuit breaker position is indicated via one of the opto- isolated inputs.

2.3.5 Load restoration

Where load restoration is being used it will be necessary to provide for both tripping and closing of the circuit breaker via the relay. A restoration time delay may be set to different values for each circuit so that the reclosures of the circuit breakers in the substation are staggered. For safety reasons, if the auxiliary supply to the relay is removed for a short period of time the relay will no longer remember that it tripped for a load shed command. This will result in the relay not responding to a subsequent restoration command and thus prevent the possibility of an unexpected closure of the circuit breaker.

2.3.6 Load shedding by voltage reduction

Three of the output relays respond separately to a three stage load shedding command via the serial communication port. Typically these outputs would be used to control the load shedding settings of a voltage regulating relay, such as the MVGC, to give up to three levels of voltage reduction. Restoration is achieved by load shedding to a lower degree.

2.3.7 Remote control of circuit breaker

Remote close/trip of the circuit breaker is possible by a command over the serial communication port. This is described in detail in Section 6.

2.4 Records

Several types of record can be stored by the KMPC and in many cases these records can be triggered by the contacts of an external device such as a protective relay.

2.4.1 Fault records

A fault record is generated whenever a particular output relay (RLY3) operates. Fault values include voltages and currents recorded for the last fault, but the fault flags are recorded for the last five triggered events. The fault values are stored in non-volatile memory and can be accessed via the user interface. There is provision for resetting these records to zero. In addition the time taken for the circuit breaker to interrupt the last fault is recorded under this heading. This value is not resettable as it may need to be accessed at any time as part of a maintenance routine.

A copy of the fault record is also stored in the event records and up to 50 of these records can be held at any one time, provided no other types of record are logged.

2.4.2 Time tagged event records

An event may be an alarm, a fault record, a change of state of a control input or an output relay, a setting that has been changed locally, or a control function that has performed its intended function. A total of 50 events may be stored in a buffer, each with an associated time tag. This time tag is the value of a timer counter that is incremented every 1 millisecond.

The event records can only be accessed via the serial communication port when connected to a suitable master station. When the equipment is not connected to a master station the event records can still be extracted within certain limitations:

– the event records can only be read via the serial communication port and a K-Bus/IEC870-5 interface unit will be required to enable the serial port to be connected to an IBM or compatible PC. Suitable software (eg. Protection Access Software & Toolkit) will be required to run on the PC so that the records can be extracted.

– when the event buffer becomes full the oldest record is overwritten by the next event.

– event records are deleted when the auxiliary supply to the relay is removed, to ensure that the buffer does not contain invalid data.

– the time tag will be valid for 49 days assuming that the auxiliary supply has not been lost within that time. However, there may be an error of ±4.3 seconds in every 24 hour period due to the accuracy limits of the crystal. This is not a problem when a master station is on line as polling will take place once every second or so.

Events that are recorded include :

– change in state of logic inputs.
– change in state of relay outputs.
– change to settings made locally.
– fault records as defined in the FAULT RECORD column of the menu.
– alarm messages.

Items 1 and 2 may be deleted from the events by setting one of the System Data Links in the menu, so that up to 50 fault records may be stored.

2.4.3 Disturbance records

The internal disturbance recorder has one channel allocated to each of the directly measured analogue quantities; one to record the eight control inputs and one to record the eight relay outputs. As with the event recorder, when the buffer is full the oldest record is overwritten and records are deleted if the auxiliary supply to the relay is removed. This ensures that when the buffer is read the contents will all be valid.

The disturbance recorder is stopped and the record frozen, a set time after a selected trigger has been activated. For example a particular output relay could be the selected trigger and the delay would then set the duration of the trace after the fault.

Each sample has a time tag attached to it so that when the waveform is reconstituted it can be plotted at the correct point against the time scale, thus ensuring that the time base is correct and independent of the frequency. Each waveform and opto-input is sampled eight times per cycle, but the method of recording allows the analysis program to perform with records that may have a different sample rate.

The disturbance records can only be accessed via the serial communication port. Only one record can be stored at a time and this may be overwritten by the next record, or retained until read.

Note: In order to improve measurement accuracy the operational range of the current input has been reduced by a factor of 4 compared with the protective relays in the K-series. Therefore the current measurement will saturate at approximately 16In and this will lead to clipping of the waveform when the instantaneous value of the current exceeds $\sqrt{2}$ x 16In.

2.4.4 Circuit breaker maintenance records

The information recorded can be of assistance in determining the need for circuit breaker maintenance. The circuit breaker opening time is recorded under FAULT RECORDS. If this value is monitored, any significant increase may be used as an indication that circuit breaker maintenance is required.

Additionally the number of circuit breaker operations is recorded under MEASUREMENTS (2).

2.5 Serial communication

Serial communication is supported over K-Bus, a multidrop network that readily interfaces to IEC870-5 FT1.2 standards. The language and protocol used for communication is Courier. It has been especially developed to enable generic master station programs to access many different types of equipment without the need to continually modify the master station program. The items of equipment connected to the network form a distributed data base for the master station and are polled for information as required.

The data includes:

– menu text
– measured values
– settings and setting limits
– fault records
– event records
– disturbance records
– plant status
– status – an eight bit word that identifies specific data available

In addition remote control features offer:

– close circuit breaker
– open circuit breaker
– load shed to level (0 to 7)
– change protection and control settings
– change I/O allocation
– change selected options (logic)

An essential requirement is that the performance of equipment must not be degraded by connection to the communication bus. Hence error checking and noise rejection was a major consideration in the design.

The communication port is based on RS485 voltage transmission and reception levels with galvanic isolation provided by a transformer. A polled protocol in a master/slave arrangement is used and no slave unit is allowed to transmit unless a valid message is received, without a detected error, addressed to it. Transmission is synchronous over a pair of screened wires with the data FM0 coded with the clock signal to remove any dc component, so that the signal will pass through transformers. This method of data encoding results in the polarity of the connection to the bus wiring being unimportant.

With the exception of the master units, each node in the network is passive and any failed unit on the system will not interfere with communication to the other units. The frame format is HDLC and the data rate is 64kbits/s. Up to 32 units may be connected to any bus at any point over a maximum length of 1000 metres.

2.6 Security and reliability

2.6.1 Self monitoring and equipment alarms

The internal monitoring circuits continuously perform a self test routine.
Any detected loss of operation in the first instance initiates a reset sequence to return the equipment to a serviceable state. The voltage rails are also supervised and the processor is reset if the voltage falls outside their working range. Should the processor fail and not restart, the watchdog relay will provide an alarm. This relay will also signal an alarm on loss of the auxiliary energising supply.

In addition the internal memory of the relay is checked for possible corruption of data and any detected errors will result in an alarm being generated. An ALARM led indicates several alarm states which can be identified by viewing the alarm flags. These are found towards the end of the SYSTEM DATA column of the menu and consist of a number of characters that may be either “1” or “0” to indicate the set and reset states of the alarm respectively.

The flags offer the following indications:

000001	Unconfig	– non operational – needs to be configured
000010	Uncalib	– running uncalibrated – calibration error
000100	Setting	– running – possible setting error
001000	No Service	– out of service
010000	No Samples	– not sampling
100000	No Fourier	– not performing Fourier

For the above listed alarms the ALARM led will be continuously lit, the alarm bit will be set in the STATUS word as a remote alarm and the watchdog relay will operate. However, there is another form of alarm that causes the ALARM led to flash; this indicates that the password has been entered to allow access to change protected settings within the relay and this is not generally available as a remote alarm.

Note: No control will be possible via the keypad if the "Unconfigured" alarm is raised because the equipment is locked in a non-operate state.

2.6.2 Password protection

Password protection is provided for the configuration settings including the selection of CT and VT ratios, function link settings, opto-input and relay output allocation.

2.6.3 Remote control functions

The measuring centre has function links that can be set to block remote control of selected functions. These can be used to select the commands to which the measuring centre will respond. This will include change of individual settings; remote control of the circuit breaker position and load shedding by either voltage reduction or by load rejection, see Section 5.

Access to internal memory is restricted to that addressed via the menu system of the unit. In addition all setting changes are reflexed back to the master station for verification and this must be followed by an EXECUTE command. On reception of the EXECUTE command the new setting is checked against the limits stored in the unit before they are entered. Only then does the unit respond to the new setting.

All remote commands are reflexed back to the master station for verification and followed by an execute command before they are actioned. Any command left set is automatically rejected if not executed within the time-out period. No replies are permitted for global commands as this would cause contention on the bus; instead a double send is used for verification purposes with this type of command.

Remote control is restricted to those functions that have been selected in the menu table and the selection cannot be changed without entering the password. CRC and message length checks are used on each message received. No response is given for received messages with a detected error. The master station can be set to resend a command a set number of times if it does not receive a reply or receives a reply with a detected error.

Section 3. EXTERNAL CONNECTIONS

Standard connection table					
Function	Terminal				Function
Earth terminal	–	1	2	–	Not used
Watchdog relay (Break contact)	b –	3 5	4 6	m –	Watchdog relay (Make contact)
48V field voltage	[+]	7	8	[–]	48V field voltage
Not used	–	9	10	–	Not used
Not used	–	11	12	–	Not used
Auxiliary voltage input	(+)	13	14	(–)	Auxiliary voltage input
Not used	–	15	16	–	Not used
A phase voltage	In	17	18	In	B phase voltage
C phase voltage	In	19	20	Out	Common voltage neutral
A phase current	In	21	22	Out	A phase current
B phase current	In	23	24	Out	B phase current
C phase current	In	25	26	Out	C phase current
Not used	–	27	28	–	Not used
Output relay 4	–	29 31	30 32	–	Output relay 0
Output relay 5	–	33 35	34 36	–	Output relay 1
Output relay 6	–	37 39	38 40	–	Output relay 2
Output relay 7	–	41 43	42 44	–	Output relay 3
Opto control input L3	(+)	45	46	(+)	Opto control input L0
Opto control input L4	(+)	47	48	(+)	Opto control input L1
Opto control input L5	(+)	49	50	(+)	Opto control input L2
Opto control input L6	(+)	51	52	(–)	Common L0/L1/L2
Opto control input L7	(+)	53	54	–	K-BUS serial port
Common L3/L4/L5/L6/L7	(–)	55	56	–	K-BUS serial port

Key to connection tables

[+] & [–] indicates the polarity of the dc output from these terminals.

(+) & (–) indicate the polarity for the applied dc supply.

In / Out indicate the signal direction for forward operation.

Note 1: The voltage transformers may be star, delta, or V connected; however, the single phase wattmetric measurements will not take account of the zero sequence voltages unless the VTs are star connected. Instead the neutral point of the voltage input circuit will take up a mean neutral position based on the phase imbalance and the impedances of the phase inputs of the relay. Phase/phase measurements will be unaffected by these alternative VT connections.

Note 2: All units have standard Midos terminal blocks to which connections can be made with either 4mm screws or 4.8mm pre-insulated snap-on connectors. Two connections can be made to each terminal.

3.1 Auxiliary supply

The auxiliary voltage may be ac or dc provided it is within the limiting voltages given in the Technical Data (see Section 7). The nominal voltage range will be found on the frontplate of the measurement centre; it is marked (Vx = (24V–125V) or (48V–250V). An ideal supply to use for testing the relays will be 50V dc or 110V ac because these values fall within both of the auxiliary voltage ranges.

The supply should be connected to terminals 13 and 14 only. To avoid any confusion it is recommended that the polarity of any applied voltage is kept to the Midos standard:

– for dc supplies the positive lead connected to terminal 13 and the negative to terminal 14.

– for ac supplies the live lead is connected to terminal 13 and the neutral lead to terminal 14.

Note: To avoid damage do not connect any auxiliary supplies directly in parallel with terminals 7 and 8.

3.2. Analogue inputs

The six analogue inputs on the expansion board are used for the three phase voltage and current inputs. Each is fed via an input transducer, a low pass filter and a three range scaling amplifier. The analogue signals are sampled eight times per cycle on each channel as the sampling rate tracks the frequency of the input signal.

The terminals to use and the connection polarities for forward power flow can be found from the table at the start of Section 3.

3.3 Opto-isolated control inputs

The opto-isolated control inputs are rated for 48V and energised from the isolated 48V field voltage provided on terminals 7 and 8 of the relay. Terminal 8 (–) must be connected to terminal 52 and on three and four pole relays terminal 8 must also be connected to terminal 55. The opto-isolated control inputs can then be energised by connecting a volt free contact between terminal 7 (+) and the terminal associated with the required input, L0 to L7, given in the above table.

The circuit for each opto-isolated input contains a blocking diode to protect it from any damage that may result from the application of voltage with incorrect polarity.

Where the opto-isolated input of more than one relay is to be controlled by the same contact it will be necessary to connect terminal 7 of each relay together to form a common line. In the example, shown in Figure 2, contact X operates L1 of relay 1 and contact Y operates L0 of relay 1 as well as L0 and L1 of relay 2. L2 is not used on either relay and has no connections made to it.

The opto-inputs may be energised from an external 50V dc supply if required but it is not advisable to connect the external and internal sources together.
The opto-inputs are in two separate groups of three and five, as shown in the table, page 23. It would be acceptable to energise one group from the internal source and the other from the internally derived field voltage.

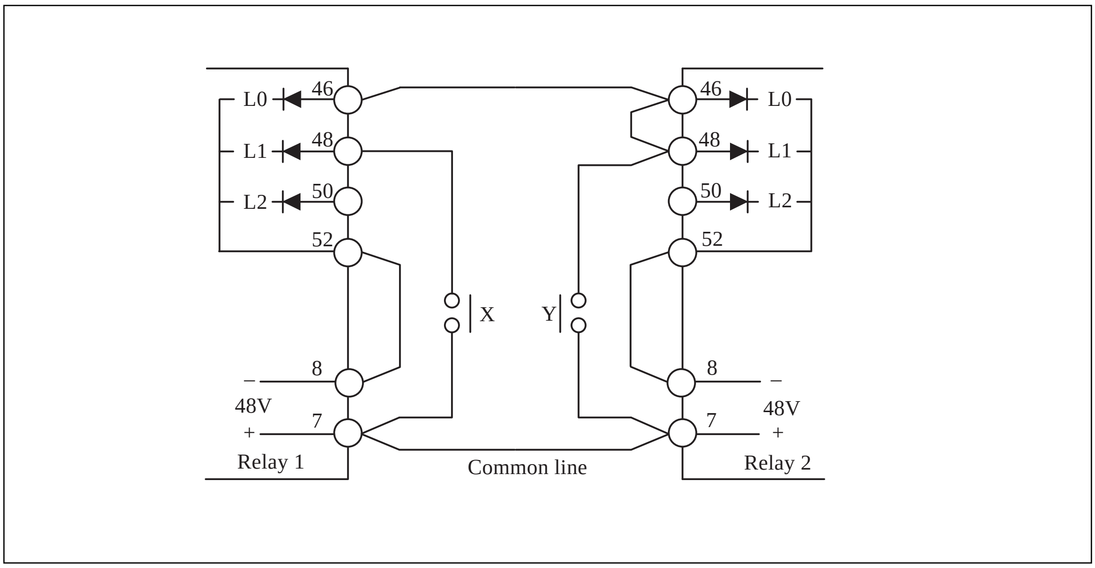

Figure 2

3.4 Output relays

There are eight programmable output relays available. Some of these output relays have special significance in their control of flag and recorded logic (see Section 6.8).

In addition there is a watchdog relay which has one make and one break contact. Thus it can indicate both healthy and failed conditions. As these contacts are mainly used for alarm purposes single contacts are used and their rating is therefore not as high as that of the programmable outputs.

3.5 Trip arrangements

An auxiliary supply will be required to trip the circuit breakers. This will normally be a dc supply which is generally considered to be more secure than an ac supply. It would be usual to use a shunt trip coil for dc energised trip circuits. The trip circuit current must be broken by an auxiliary contact on the circuit breaker once the circuit breaker has opened. If this is not the case then a trip relay with heavy duty contacts must be interposed between the contact of RLY3 and the trip coil.

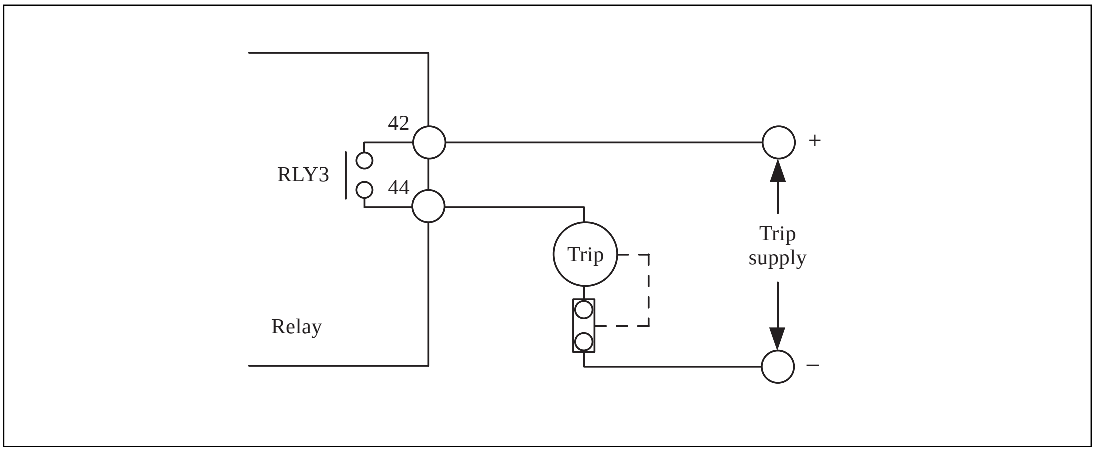

Figure 3

3.6 Serial communication port

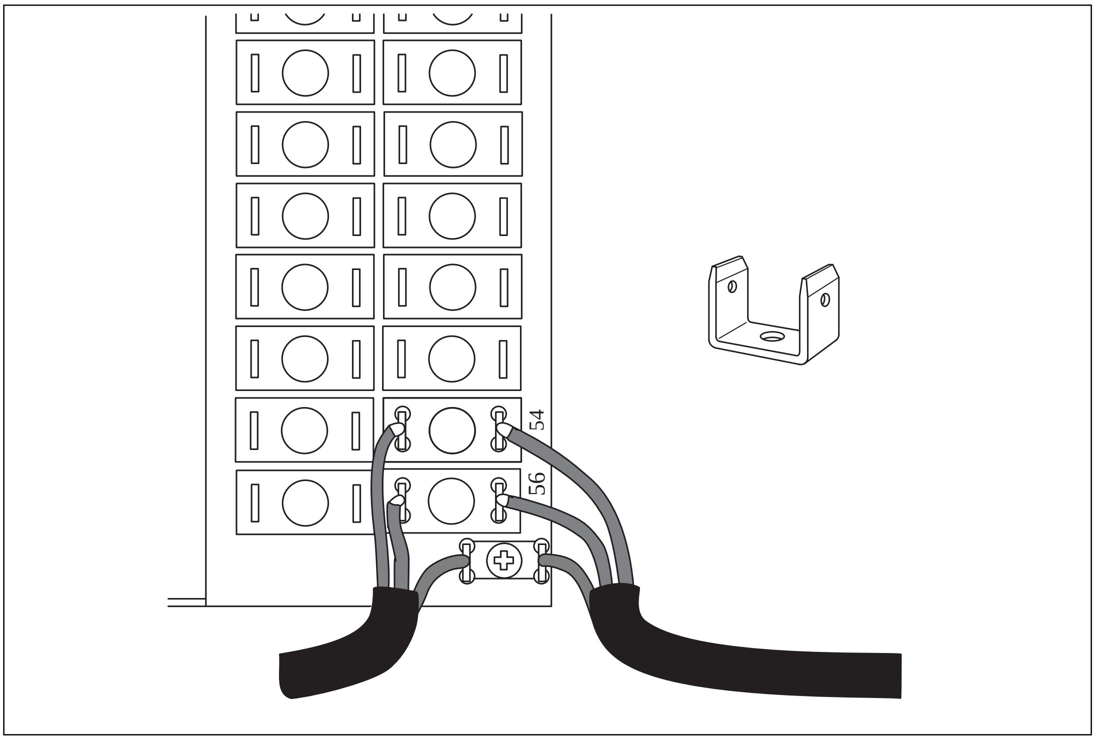

Figure 4

Connection to the K-BUS Port is by standard Midos 4mm screw terminals or snap-on connectors. A twisted pair of wires is all that is required; the polarity of connection is not important. It is recommended that an outer screen is used with an earth connected to the screen at the master station end only. Termination of the screen is effected with the “U” shaped terminal supplied, which must be secured with a self tapping screw in the hole in the terminal block just below terminal 56. Operation has been tested up to 1,000 metres with cable to:

DEF standard 16–2–2c

16/0.2mm diameter

40mΩ/M per core

171pF/M core/core

288pF/M core/screen

The minimum requirement to communicate with the relay is a K-Bus/IEC870-5 converter box Type KITZ 101 and suitable software to run on an IBM or compatible personal computer.

Note: K-Bus must be terminated with a 150Ω resistor at each end of the bus. The master station can drive the bus from either end, but the bus should only be driven from one end at a time.

3.7 Watchdog contacts

The watchdog relay will pick-up when the relay is operational to indicate an healthy state, with its “make” contact closed. When an alarm condition that requires some action to be taken is detected the watch-dog relay resets and its “break” contact will close to give an alarm.

Section 4. USER INTERFACE

This interface provides the user with a means of entering settings and reading data.

4.1 Frontplate layout

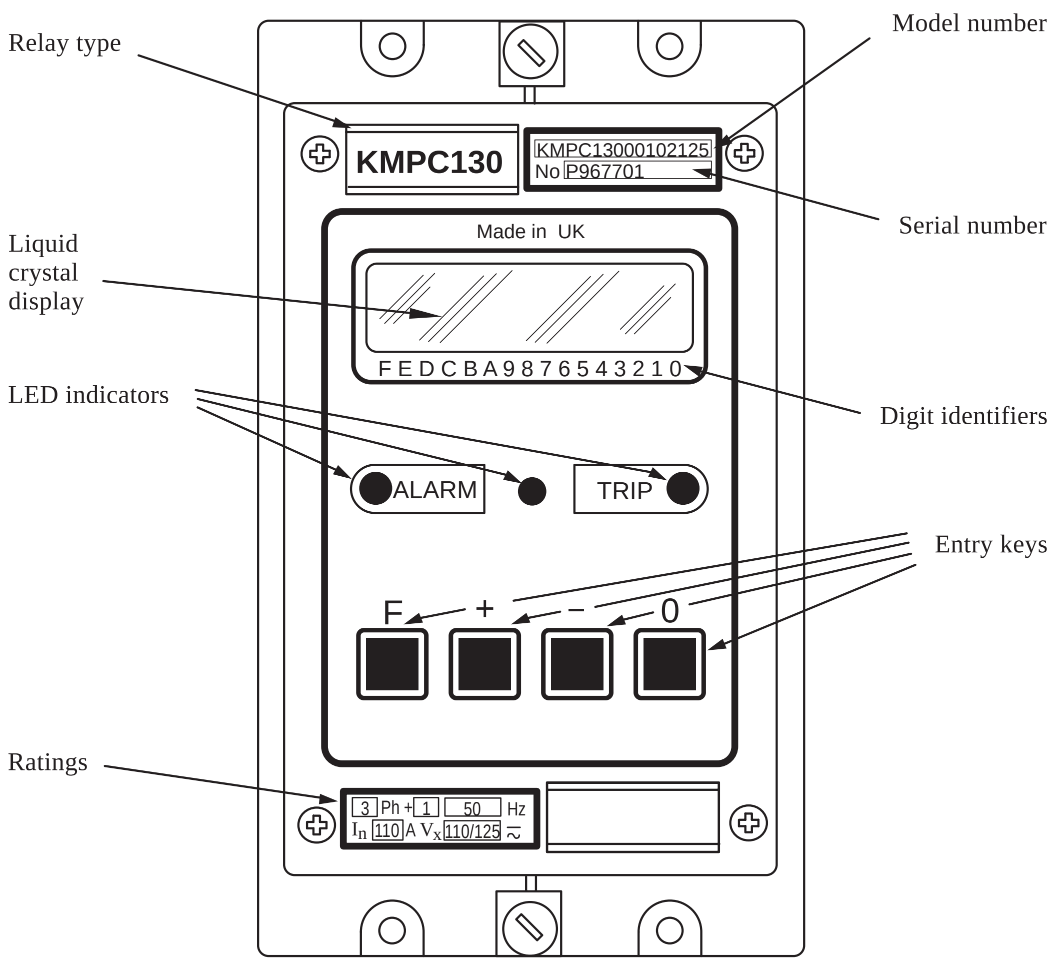

Figure 5

The frontplate of the module carries an identification label at the top corner.
This identifies the product by both its model number and serial number.
This information is required when making any enquiry to the factory about a particular equipment because it uniquely specifies the product. In addition there is a rating label in the bottom corner which gives details of the auxiliary voltage, reference voltage and current ratings.

Two handles, one at the top and one at the bottom of the frontplate, will assist in removing the module from the case. Three light emitting diodes (leds) provide status indication and in addition a liquid crystal display and a four key pad provide access to settings and other readable data.

4.2 LED indications

The three leds provide the following functions:

Green led	indicates the equipment is powered up and running. In most cases it follows the watchdog relay and it will operate for loss of auxiliary supply.
Yellow led	indicates alarm conditions that have been detected during its self checking routine. The alarm lamp flashes when the password is entered (password inhibition temporarily overridden).
Red led	indicates a trip that has been issued by the relay. This may be an externally initiated trip or result from a remote trip command; the trip flags have to be viewed to decide which.

4.3 Keypad

Four keys on the frontplate enable the user to select the data to be displayed and settings to be changed. The keys perform the following functions:

[F] – FUNCTION SELECT KEY

[+] – INCREMENT VALUE KEY

[–] – DECREMENT VALUE KEY

[0] – RESET/ESCAPE KEY

4.4 Liquid crystal display

The liquid crystal display (lcd) has two lines, each of sixteen characters, that are used to display settings, measured values and records which are extracted from the internal data bank. A backlight is activated when any of the keys on the frontplate is momentarily pressed. This enables the display to be read in all conditions of ambient lighting.

The numbers printed on the frontplate just below the display, identify the individual digits that are displayed for some of the settings, ie. function links, relay masks etc.

Section 5. MENU SYSTEM

Internal data is accessed via a MENU table. The table is divided into columns and rows to form cells, rather like a spreadsheet. Each cell may contain text, values, limits and functions. The first cell in a column contains a heading which identifies the data grouped on that column.

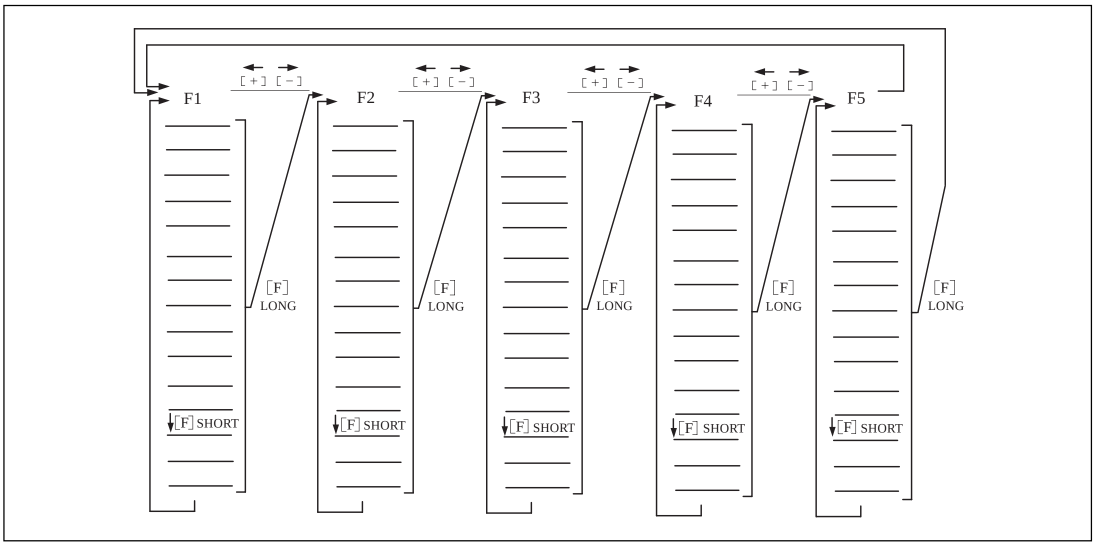

Figure 6

Four keys on the frontplate allow the menu to be scanned and the contents displayed on the liquid crystal display (lcd). The act of depressing any key will result in the lcd backlight being switched on. The backlight will turn off again if a key is not pressed again within one minute.

The display will normally be the selected default setting and a momentary press of the function key **[F]** will change the display to the heading for the first column, SYSTEM DATA. Further momentary presses of the **[F]** key will step down the column, row by row, so that data may be read. If at any time the **[F]** key is pressed and held for one second the cursor will be moved to the top of the next column and the heading for that column will be displayed. Further momentary presses of the **[F]** key will then move down the new column, row by row. In this way the full menu of the relay may be scanned with just one key and this key is accessible with the cover in place on the relay.

The other key that is accessible with the cover in place is the reset key **[0]**.
A momentary press of this key will switch on the back light for the lcd without changing the display in any way. Following a trip the display will change automatically from the default display to that of the fault flags for that fault and the red trip led will be lit to draw attention to the fact. The trip led can be reset by holding down the reset key **[0]** for at least one second.

The fault information is not lost by this action, it is only cleared from the display. The fault flags can be read by selecting FAULT RECORDS from the column headings and stepping down until the flag data (Fn), the flags for the last fault, are displayed. The red trip led can be reset by holding the reset key **[0]** depressed for 1 second whilst this cell is being displayed. The next cell down contains the flags for the previous fault (Fn–1) and so on to (Fn–4); enough for a full four shot autoreclose cycle.

The currents and voltages measured during the last fault are also recorded on this page of the menu together with the circuit breaker opening time. To delete all fault records the next cell after (Fn–4) must be selected. This cell will read “FLT clear records = **[0]**” and to complete the reset action the **[0]** key must be held depressed for more than 1 second.

The only setting change that can be made with the cover in place is to reset a cell to zero or a preset value. Resetting any one cell of a similar group will reset all the values in that group. For example, if any demand value is displayed and the reset key **[0]** is held down for 1 second then all the demand registers will be reset to zero. Password protected cells such as those containing energy values cannot be reset to zero unless the password is first entered. To enter the password, or make any other type of change, the cover has to be removed from the case to gain access to the **[+]** and **[–]** keys that are used to increment or decrement a value.

When a column heading is displayed the **[–]** key will change the display to the next column and the **[+]** key will change the display to the previous column, giving a faster selection. When a cell containing a setting is displayed the action of pressing either the **[+]** or **[–]** keys will indicate to the processor that a value is to be changed and a flashing cursor will appear on the display. To escape from the setting mode without making any change, the **[0]** key should be depressed for one second.

For instruction on how to change the various types of settings refer to Section 6.2.

5.1 Menu contents

Related data and settings are grouped together in separate columns of the menu. Each column has a text heading that identifies the data contained in that column. Each cell may contain text, values, limits and/or a function. The cells are referenced by the column number/row number. For example 0201 is column 02, row 01.

The full menu is given in the following notes.

The menu cells that are read only are marked **[READ]** .

Cells that can be set are marked **[SET]**.

Cells that can be reset are marked **[RESET]**.

Cells that are password protected are marked **[PWP]**.

5.1.1 System data

0002 SYS Password — Password **[PWP]**

0003 SYS Fn Links — Function Links **[PWP]**

- LINK 0 [SYS Rem ChgStg] — 1 = Enable remote setting changes
- LINK 1 [SYS Load Shed T] — 1 = Enable global load shed tripping
- LINK 2 [SYS Rem CB Ctrl] — 1 = Enable remote circuit breaker control
- LINK 5 [SYS Auto Reset] — 1 = Enable automatic reset of trip flags
- LINK 6 [SYS Auto Rec] — 1 = Enable automatic reset of recorder
- LINK 7 [SYS En Log Evts] — 1 = Enable all event records to be stored

0004 SYS Description — Description or user scheme identifier **[PWP]**

0005 SYS Plant Ref. — User plant/location identifier **[PWP]**

0006 SYS Model No. — Model number **[READ]**

0007 SYS Firmware No. — Firmware number **[READ]**

0008 SYS Serial No. — Serial number **[READ]**

0009 SYS Frequency — Frequency **[SET]**

000A	SYS Comms Level	Communication level **[READ]**
000B	SYS Rly Address	Communication address **[SET]**
000C	SYS Plant Status	CB and isolator positions **[READ]**
000D	SYS Ctrl Status	Not used **[READ]**
000F	SYS LS Stage	Current state of load shedding (0–7) **[READ]**
0010	SYS CB Control	CB control NO OPERATION/TRIP/CLOSE **[SET]**
0011	SYS Software Ref	Software reference number
0020	SYS Logic Stat	Current state of logic control inputs **[READ]**
0021	SYS Relay Stat	Current state of output relays **[READ]**
0022	SYS Alarms	State of alarms **[READ]**

0002 SYS password [PWP]

This password must be entered before the relay configuration is changed. Provision has been made for the user to change the password, which may consist of four upper case letters in any combination. In the event of the password becoming lost a recovery password can be obtained on request, but the request must be accompanied by a note of the model and serial number of the relay. The recovery password will be unique to one relay and will not work on any other unless the user set password is the same.

0003 SYS function links [PWP]

These software function links in the System Data column enable the system options to be selected, eg. the commands that are responded to over the serial link.

0004 SYS description [PWP]

This is text that describes the relay type, for example “MEASUREMENT CNTR”. It is password protected and can be changed by the user to a name which may describe the scheme configuration of the relay if the relay is changed from the factory configuration.

0005 SYS plant reference [SET]

The plant reference can be entered by the user, but it is limited to 16 characters. This reference is used to identify the primary plant with which the relay is associated.

0006 SYS model number [READ]

The mechanical assembly ratings and configuration of the relay are encoded in the model number which is entered during manufacture. This model number is printed on the frontplate and should be quoted in any correspondence concerning the product.

0007 SYS firmware number [READ]

The version of software and memory components is coded into this number. It cannot be changed.

0008 SYS serial number [READ]

The serial number is the relay identity and encodes also the year of manufacture. It cannot be changed from the menu.

0009 SYS frequency [SET]

The set frequency from which the relay starts tracking on power-up.

000A SYS communication level [READ]

This cell will contain the communication level that the relay will support. It is used by master station programs to decide what type of commands to send to the relay.

000B SYS relay address [SET]

An address between 1 and 254 that identifies the relay when interconnected by a communication bus. These addresses may be shared between several communication buses and therefore not all these addresses will necessarily be available on the bus to which the relay is connected. The address can be manually set. Address 0 is reserved for the automatic address allocation feature and 255 is reserved for global messages. The factory set address is 255.

000C SYS plant status [READ]

Plant status is a 16 bit word which is used to transport plant status information over the communication network. The word can be tested for changes to plant status. The various bit pairs are pre-allocated to specific items of plant.

000D SYS control status [READ]

The control status is not used in this product.

000E SYS setting group [READ]

Not used in this product.

000F SYS LS stage [READ]

If link SD1 = 0 this cell will indicate the current state for load shedding by voltage reduction. The command levels received are latched and displayed in this cell.

<Level 0> = "No load shed" – All stages reset
<Level 1> = "Volt reduction 1" – Relay for stage 1 only picked-up
<Level 2> = "Volt reduction 2" – Relay for stage 2 only picked-up
<Level 3> = "Volt reduction 3" – Relay for stage 3 only picked-up

When the auxiliary supply to the relay is interrupted the states of the relays that initiate voltage reduction are remembered. This ensures that the level of load shedding is not caused to change by momentary interruptions of the auxiliary supply.

The master station is expected to take care of any operational changes to the load shed level that may have taken place whilst a relay has been out of service, by resending the last global load shed command.

If link SD1=1 then this display will be the last global load shed trip level that the relay received and the state of the relay. Example relay set to level 2:

Typical load shedding sequence

"<0> No load shed"
"<1> No load shed"
"<2> LS Trip"
"<3> LS Trip"
"<1> Restoring"
"<1> No load shed"

On loss of the auxiliary supply the memory of having tripped due to a load shed trip command is erased. This ensures that a relay that has been out of service for some time will not close a circuit breaker in response to a subsequent load shed command, as this could be dangerous.

0010 SYS CB control [SET]

This cell contains the functions for control of the circuit breaker. Via this cell the circuit breaker can be closed and tripped either from the user interface or over a communication network. To be able to do this the relay must have output relays allocated to circuit breaker control.

0020 SYS logic stat

Current state of opto-isolated logic control inputs. “1” = energised;
“0” = de-energised.

0021 SYS relay stat

Current state of relay outputs. “1” = set; “0” = reset.

0022 Alarms

Current state of alarm flags (see Section 5.2.11).

5.1.2 Fault records [READ]

0101 FLT Ia	Fault current for last trip
0102 FLT Ib	Fault current for last trip
0103 FLT Ic	Fault current for last trip
0105 FLT Vab	Fault line voltage for last trip
0106 FLT Vbc	Fault line voltage for last trip
0107 FLT Vca	Fault line voltage for last trip
0108 FLT Vo	Fault zero sequence voltage for last fault
0109 FLT CB trip time	Circuit breaker operation time for last trip
010A Fnow	Current state of flags (not latched)
010B Fn	Flags for last fault (n) **[RESET trip led only]**
010C Fn–1	Flags for fault (n–1) – previous fault
010D Fn–2	Flags for fault (n–2)
010E Fn–3	Flags for fault (n–3)
010F Fn–4	Flags for fault (n–4)
0110 FLT clear record = [0]	Clear fault records (except CB trip time) **[RESET]**

5.1.3 Measurement (1) [READ]

0201 MS1 Ia	Current in phase A
0202 MS1 Ib	Current in phase B
0203 MS1 Ic	Current in phase C
0204 MS1 Io	Current in neutral
0205 MS1 Vab	Line voltage A–B
0206 MS1 Vbc	Line voltage B–C
0207 MS1 Vca	Line voltage C–A
0208 MS1 Va	Phase voltage A
0209 MS1 Vb	Phase voltage B
020A MS1 Vc	Phase voltage C
020C MS1 F	Frequency

5.1.4 Measurement (2) [READ]

0301	MS2 W	Three phase power
0302	MS2 VA	Three phase VoltAmps
0303	MS2 VAr	Three phase reactive power
0304	MS2 Iave	Average of the three phase currents
0305	MS2 Vave	Average of the three line voltages
0306	MS2 Inps (%)	Negative sequence current (%Iave)
0307	MS2 Vnps (%)	Negative sequence voltage (%Vave)
0309	MS2 Wa	Active power for phase A
030A	MS2 Wb	Active power for phase B
030B	MS2 Wc	Active power for phase C
030C	MS2 Power Factor	Three phase power factor
030D	MS2 VARa	Reactive power for phase A
030E	MS2 VARb	Reactive power for phase B
030F	MS2 VARc	Reactive power for phase C
0310	MS2 Sum (OPS)	Sum of circuit breaker operations **[RESET to 0]**
031A	MS2 MWh	Nett active energy
031B	MS2 MVARh	Nett reactive energy
031E	MS2 Power Mode	Mode 0, 1, 2, 3 :sign convention for power flow **[PWP]**

5.1.5 Measurement (3) [READ]

0401	MS3 tD>	Demand period 1 minute, 15 minutes, 30 minutes, 1 hour
0402	MS3 tD	Current value of demand timer tD
0404	MS3 D Ia	Demand current for last period phase A
0405	MS3 D Ib	Demand current for last period phase B
0406	MS3 D Ic	Demand current for last period phase C
040A	MS3 PDIa	Peak demand current – phase A **[RESET]**
040B	MS3 PDIb	Peak demand current – phase B **[RESET]**
040C	MS3 PDIc	Peak demand current – phase C **[RESET]**
0411	MS3 D +3ph W	Demand active power for last period
0412	MS3 D – 3ph W	Demand active power for last period
0413	MS3 D +3ph VAR	Demand reactive power for last period
0414	MS3 D – 3ph VAR	Demand reactive power for last period
0416	MS3 PD +3ph W	Peak demand active power since last reset **[RESET]**
0417	MS3 PD – 3ph W	Peak demand active power since last reset **[RESET]**
0418	MS3 PD +3ph VAR	Peak demand reactive power since last reset **[RESET]**
0413	MS3 PD – 3ph VAR	Peak demand reactive power since last reset **[RESET]**

5.1.6 Earth fault (1) [SET]

0505	EF1 Io>	Earth fault current setting
0506	EF1 to>	Earth fault definite time delay

5.1.7 Phase fault (1) [SET]

0601	PF1 Fn. Links	Phase fault function links **[PWP]**
	Link 7 [PF1 Aux2=I<]	1 = enable delayed undercurrent
0602	PF1 CT Ratio	Line CT ratio **[PWP]**

0603	PF1 VT Ratio	Line VT ratio **[PWP]**
0605	PF1 I>	Overcurrent threshold
0606	PF1 t>	Time delay for overcurrent element
060D	PF1 I<	Undercurrent threshold

5.1.8 Logic functions [SET]

0901	LOG Fn Links	Function links for miscellaneous logic **[PWP]**
	Link2 [LOG Backtrip]	1 = Enable backtrip circuit via Aux1
	Link3 [LOG Aux3=not I<]	1 = Enable I< to trip via Aux3 and tAUX3
0903	LOG tAUX1	Time delay associated with Aux1 output **[SET]**
0904	LOG tAUX2	Time delay associated with Aux2 output **[SET]**
0905	LOG tAUX3	Time delay associated with Aux3 output **[SET]**
0907	LOG tTRIP	Circuit breaker trip pulse setting SET]
0908	LOG tCLOSE	Circuit breaker close pulse setting **[SET]**
0909	LOG LS Group	Load shed trip level 0–7 **[SET]**
090A	LOG tRESTORE	Load restoration time delay **[SET]**
090F	LOG Default Display	Selected display for default **[SET]**

Default display **[SET]**

1. Manufacturers Name
2. Product description
3. Plant reference
4. Ia, Ib,
   Ic, Io
5. Vave, Iave,
   (V2)% (%I2)

6a. Vave,
VA

6b. W
VAR

(6a / 6b) Alternating between 6a and 6b every 5s when display (6) is selected

7. F(now)

5.1.9 Input masks [PWP]

0A01	INP Blk to>	Input to block to>
0A05	INP Blk t>	* Input to block t>
0A08	INP Aux1	Input to initiate tAUX1
0A09	INP Aux2	Input to initiate tAUX2
0A0A	INP Aux3	Input to initiate tAUX3
0A0C	INP CB Open	Input to indicate circuit breaker open
0A0D	INP CB Closed	Input to indicate circuit breaker closed
0A0E	INP CB to Bus2	Input to circuit breaker connected to bus 2
0A0F	INP LTrip CB	Input to initiate CB trip pulse timer
0A10	INP LClose CB	Input to initiate CB close pulse timer
0A15	INP Reset tD>	Input to reset demand period timer tD>

5.1.10 Relay mask [PWP]

0B01	RLY Io>Start		Relay to be operated by Io> START
0B04	RLY to>	*	Relay to be operated by to>
0B06	RLY I>Start		Relay to be operated by I> START
0B09	RLY t>	*	Relay to be operated by t>
0B0C	RLY Aux1		Relay to be operated by Aux1
0B0D	RLY Aux2		Relay to be operated by Aux2
0B0E	RLY Aux3		Relay to be operated by Aux3
0B0F	RLY V Reduct 1		Relay to cause stage 1 voltage reduction
0B10	RLY V Reduct 2		Relay to cause stage 2 voltage reduction
0B11	RLY V Reduct 3		Relay to cause stage 3 voltage reduction
0B12	RLY CB Trip		Relay to provide remote trip of circuit breaker
0B13	RLY CB Close		Relay to provide remote close of circuit breaker

5.1.11 Recorder [SET]

0C01	REC Control	RUNNING/TRIGGERED/STOPPED **[SET]**
0C02	REC Capture	SAMPLES/MAGNITUDE/PHASE **[SET]**
0C03	REC Post Trigger	Trace length after trigger **[SET]**
0C05	REC Relay Trig	Select relay output to trigger **[SET]**

Note: The functions marked * do not have identical cell locations to those used in the type KCGG/KCGU overcurrent and type KCEG/KCEU directional overcurrent relays.

5.2 Changing text and settings

To enter the setting mode

Settings and text in certain cells of the menu can be changed via the user interface. To do this the cover must be removed from the case to gain access to the **[+]** and **[–]** keys. Give the **[F]** key a momentary press to change from the selected default display and switch on the backlight; the heading SYSTEM DATA will be displayed. Use the **[+]** and **[–]** keys, or a long **[F]** key press, to select the column containing the setting or text cell that is to be changed. Then with the **[F]** key step down the column until the contents of the cell are displayed. Press the **[+]** or **[–]** key to put the unit into the setting mode, which will be indicated by a flashing cursor on the bottom line of the display. If the cell is a read-only cell then the cursor will not appear and the setting mode will not be accessible.

TO ESCAPE FROM THE SETTING PROCEDURE WITHOUT EFFECTING ANY CHANGE: HOLD THE [0] KEY DEPRESSED FOR ONE SECOND, THE ORIGINAL SETTING WILL BE RETAINED.

To accept the new setting

Press the **[F]** key until the display reads:

Are you sure?
+ = YES – = NO

1. Press the **[0]** key if you decide not to make any change.
2. Press the **[–]** key if you want to further modify the data before entry.
3. Press the **[+]** to accept the change. This will terminate the setting mode.

5.2.1 Entering passwords

The **[+]** and **[–]** keys can be used to select a character at the position of the cursor. When the desired character has been set the **[F]** key can be given a momentary press to move the cursor to the position for the next character. The process can then be repeated to enter all four characters that make up the password. When the fourth character is acknowledged by a momentary press of the **[F]** key the display will read:

Are you sure?

+ = YES – = NO

1. Press the **[0]** key if you decide not to enter the password.
2. Press the **[–]** key if you want to modify the entry.
3. Press the **[+]** to enter the password. The display will then show four stars **** and if the password was accepted the alarm led will flash. If the password is not accepted a further attempt can be made to enter it, or the **[0]** key used to escape. Password protection is reinstated when the alarm led stops flashing, fifteen minutes after the last key press, or by selecting the PASSWORD cell, or any column heading, and pressing the **[0]** key for more than one second.

5.2.2 Changing passwords

After entering the current password and it is accepted, as indicated by the alarm led flashing, the **[F]** key is pressed momentarily to move to the next menu cell.
If instead, it is required to enter a new password, the **[+]** key must be pressed to select the setting mode. A new password can be entered with the same procedure described in Section 5.2.1. Only capital (upper case) letters may be used for the password.

BE SURE TO MAKE A NOTE OF THE PASSWORD BEFORE ENTERING IT ACCESS WILL BE DENIED WITHOUT THE CORRECT PASSWORD.

5.2.3 Entering text

Enter the setting mode as described in Section 5.2 and move the cursor with the [F] key to where the text is to be entered or changed. Then using the **[+]** and **[–]** key select the character to be displayed. The **[F]** key may then be used to move the cursor to the position of the next character and so on. Follow the instructions in Section 5.2 to exit from the setting change.

5.2.4 Changing function links

Select the page heading required and step down one line to FUNCTION LINKS and press either the **[+]** or **[–]** to put the unit in a setting change mode. A cursor will flash on the bottom line at the extreme left position. This is link “F”; as indicated by the character printed on the frontplate under the display.

Press the **[F]** key to step along the row of links, one link at a time, until some text appears on the top line that describes the function of a link. The **[+]** key will change the link to a “1” to select the function and the **[–]** key will change it to a “0” to deselect it. Not all links can be set, some being factory selected and locked. The links that are locked in this way are usually those for functions that are not supported by a particular product, when they will be set to “0”. Merely moving the cursor past a link position does not change it in any way.

5.2.5 Changing setting values

Move through the menu until the cell that is to be edited is displayed. Press the **[+]** or **[–]** key to select the setting change mode. A cursor will flash in the extreme left hand position on the bottom line of the display to indicate that the setting mode has been selected. The value will be incremented in single steps by each momentary press of the **[+]** key, or if the **[+]** key is held down the value will be incremented with increasing rapidity until the key is released. Similarly, the **[–]** key can be used to decrement the value. Follow the instructions in Section 5.2 to exit from the setting change.

Note: When entering CT RATIO or VT RATIO the overall ratio should be entered, ie. 2000/5A CT has an overall ratio of 400:1. With rated current applied the displayed value will be 5A when CT RATIO has the default value of 1:1 and when the RATIO is set to 400:1 the displayed value will be 400 x 5 = 2000A.

To determine the overall VT ratio to enter under PHASE FAULT use phase/phase values for both the primary and secondary windings.

5.2.6 Setting communication address

The communication address will normally be set to 255, the global address on the network, to which all products will be set when first supplied. Reply messages are not issued in response to a global command to prevent all slave units responding at the same time with resulting contention on the bus. Setting the address to 255 will ensure that when first connected to the network they will not interfere with communications on existing installations. The communication address can be manually set by selecting the appropriate cell for the SYSTEM DATA column, entering the setting mode and then decrementing or incrementing the address.

It is recommended that the user enters the plant reference in the appropriate cell and then, if using a Courier master station, sets the address manually to “0”. The master station will then detect that a new node has been added to the network and automatically allocate the next available address on the bus and communications will then be fully established.

5.2.7 Setting control input masks

An eight bit mask is allocated to each function that can be influenced by an external input applied to one or more of the opto-isolated control inputs. When an input mask is selected the text on the top line of the display indicates the associated control function and the bottom line of the display shows a series of “1”s and “0”s for the selected mask. The numbers printed on the frontplate under the display indicate the number of the control input (L7 to L0) that is being displayed. A “1” indicates that a particular input will effect the displayed control function and a “0” indicates that it will not. The same input may be used to control more than one function.

5.2.8 Setting relay output masks

An eight bit mask is allocated to each protection and control function. When a mask is selected the text on the top line of the display indicates the associated function and the bottom line of the display shows a series of “1”s and “0”s for the selected mask. The numbers printed on the frontplate under the display indicates the number of the output relay (RLY7 to RLY0) that each bit controls. A “1” indicates that the output relay will respond to the displayed function and a “0” indicates that it will not.

The mask acts like an “OR” function so that more than one relay may be allocated to the same function. An output mask may be set to operate the same relay as another mask so that, for example, one output relay may be arranged to operate for all the functions required to trip the circuit breaker and another for the functions that are to initiate autoreclose.

5.2.9 Resetting values and records

Some values and records can be reset to zero or to some predefined value.
To achieve this the menu cell must be displayed, then the **[0]** key must be held depressed for at least one second to effect the reset. The fault records are slightly different because they are a group of settings and to reset these the last cell under FAULT RECORDS must be selected. This will display:

FLT records

Clear = [0]

To reset the fault records hold the **[0]** key depressed for more than 1 second.

5.2.10 Resetting TRIP led indication

The trip led can be reset when the flags for the last fault are displayed. They are displayed automatically after a trip occurs, or can be selected in the fault record column. The reset is effected by depressing the **[0]** key for 1 second. Resetting the fault records will also reset the trip led indication. Set function link SD5 to “1” for automatic reset of trip led.

5.2.11 Alarm records

The alarm flags are towards the end of the SYSTEM DATA column of the menu and consist of six characters that may be either “1” or “0” to indicate the set and reset states of the alarm. The control keys perform for this menu cell in the same way as they do for Function Links. The cell is selected with the function key **[F]** and the setting mode selected by pressing the [+] key to display the cursor. The cursor will then be stepped through the alarm word from left to right by with each press of the [F] key and text will be displayed identifying the alarm bit selected.

000001	Unconfig	–not operational – needs to be configured
000010	Uncalib	–running uncalibrated – calibration error
000100	Setting	–running – possible setting error
001000	No service	–out of service
010000	No samples	–not sampling but not out of service
100000	No Fourier	–not performing fourier on the data but not out of service

For the above listed alarms the ALARM led will be continuously lit. However, there is another form of alarm that causes the ALARM led to flash and this indicates that the password has been entered to allow access to change protected settings. This is not generally available as a remote alarm and the alarm flags do not change.

No control will be possible via the key pad if the “Unconfigured” alarm is raised because the product will be locked in a non-operate state.

5.2.12 Default display (lcd)

The lcd changes to a default display if no key presses are made for fifteen minutes. The display can be returned to the default value, without waiting the full time out delay, by selecting any column heading and then holding the **[0]** reset key depressed for 1 second, but note that this will also reset the password protection. The default display can be selected to any of the options listed under LOGIC FUNCTIONS location 090F by following the change of setting procedure.

When the protection trips the display changes automatically to display the fault flags. The trip led indication must be reset by pressing the **[0]** key for 1 second before the selected default display is returned.

5.3 Disturbance recorders

5.3.1 Recorder control

This cell displays the state of the recorder :

a) RUNNING – recorder storing data (overwriting oldest data)

b) TRIGGERED – recorder stop delay triggered

c) STOPPED – recorder stopped and record ready for retrieval

When this cell is selected, manual control is possible and to achieve this the setting mode must be selected by pressing the **[+]** key. A flashing cursor will then appear on the bottom line of the display at the left-hand side. The [**+]** key will then select “RUNNING” and the **[–]** key will select triggered. When the appropriate function has been selected the **[F]** key is pressed to accept the selection and the selected function will take effect when the **[+]** key is pressed to confirm the selection.
To abort the selection at any stage press the reset key **[0]**.

5.3.2 Recorder capture

The recorder can capture:

a) SAMPLES – the individual calibrated samples

b) MAGNITUDES – the Fourier derived amplitudes

c) PHASES – the Fourier derived phase angles

No electro-mechanical calibration adjustments are provided, all calibration is effected in software and all three of the above options are used in the calibration process. SAMPLES will be the normal choice when used as a disturbance recorder.

5.3.3 Recorder post trigger

The post trigger setting determines the length of the trace that occurs after the stop trigger is received. This may be set to any value between 1 and 511 samples. When recording samples the total trace duration is 512/8 = 64 cycles because the interval between the samples is equivalent to one eighth of a cycle. However, the Fourier derived values are calculated once per cycle and so the total trace length when recording these calculated phase or amplitude values is 512 cycles.

5.3.4 Recorder relay trigger

Any, or all, of the output relays may be used as a stop trigger and the trigger may be taken from either the energisation or the de-energisation of these outputs. The bottom line of the display for this cell will show a series of 16 characters, each of which may be set to “1” or “0”. A “1” will select the input and a “0” will deselect it.

The selection is made using the instructions for setting links in Section 5.2.4. The output relays (RLY0 to RLY7) associated with each digit underlined by the cursor is shown on the top line of the display. A + preceding it will indicate that the trigger will occur for energisation and a – will indicate the trigger will occur for de-energisation.

5.3.5 Notes on recorded times

The times recorded for the opto-isolated inputs is the time at which the relay accepted them as valid and responded to their selected control function. This will be 12.5 ± 2.5ms at 50Hz (10.4 ± 2.1ms at 60Hz) after the opto-input was energised. The time recorded for the output relays is the time at which the coil of the relay was energised and the contacts will close approximately 5ms later. Otherwise the time tags are generally to a resolution of 1ms for events and to a resolution of 1µs for the samples values.

Section 6. SELECTIVE LOGIC

In this section the scheme logic is broken down into groups which are described individually. The logic is represented in a ladder diagram format and the key to the symbols used is shown in the diagram below.

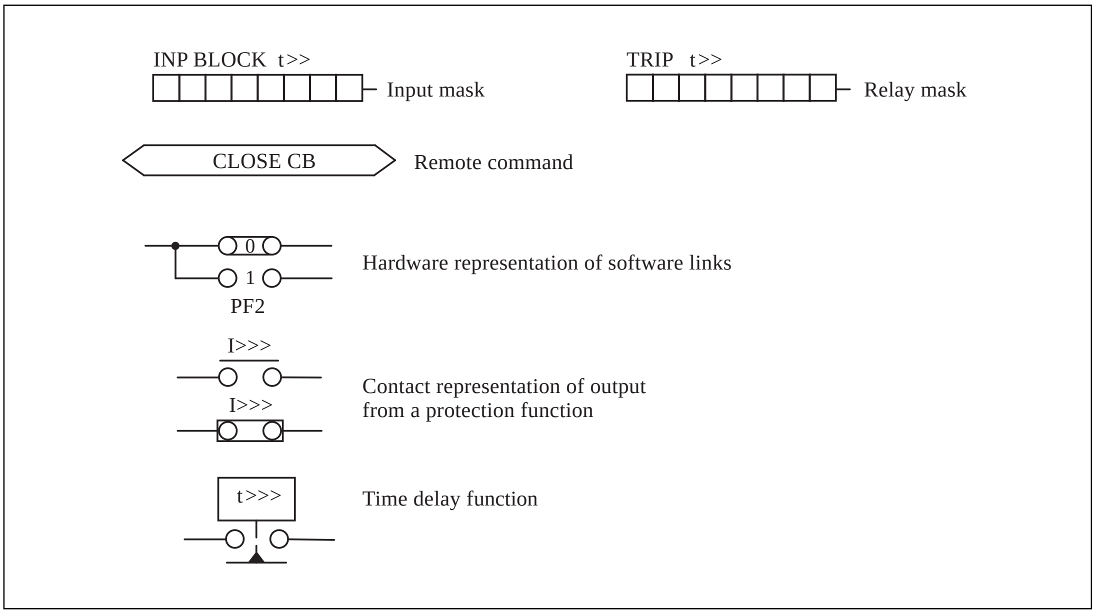

Figure 7

Contacts have been used to represent the output of the various protection and control functions, even though they are actually implemented in software. The contacts are all shown in the state they would take up with no inputs applied to the protective relay.

The function links are also implemented in software but have been drawn as mechanical links. They are shown in the factory default position for the basic factory configuration. In position “0” the function is deselected and “1” the function is selected.

Opto-isolated control inputs L7–L0, are represented by an eight bit mask with a thicker line at the top and left hand side of the mask. The control asserted by the input is stated above the mask and the position of the “1”s within the mask will determine the input(s) that asserts the control. More than one control input may be assigned by the mask and the same control inputs may be used in several masks.

The output relays RLY7 – RLY0 are represented by an eight bit mask with a thicker line at the bottom and right hand side. A mask is allocated to each protection and control function that can be assigned to an output relay. The function asserted on the mask is stated by the text above it and the position of the “1”s in the mask determines which relay(s) operate in response. More than one output relay may be assigned by a mask and the same relay may be assigned by several masks.

Figure 8 below shows by example how the input and output masks may be used.

Function 1 is initiated by L0 as indicated by the position of the “1” in the input mask.

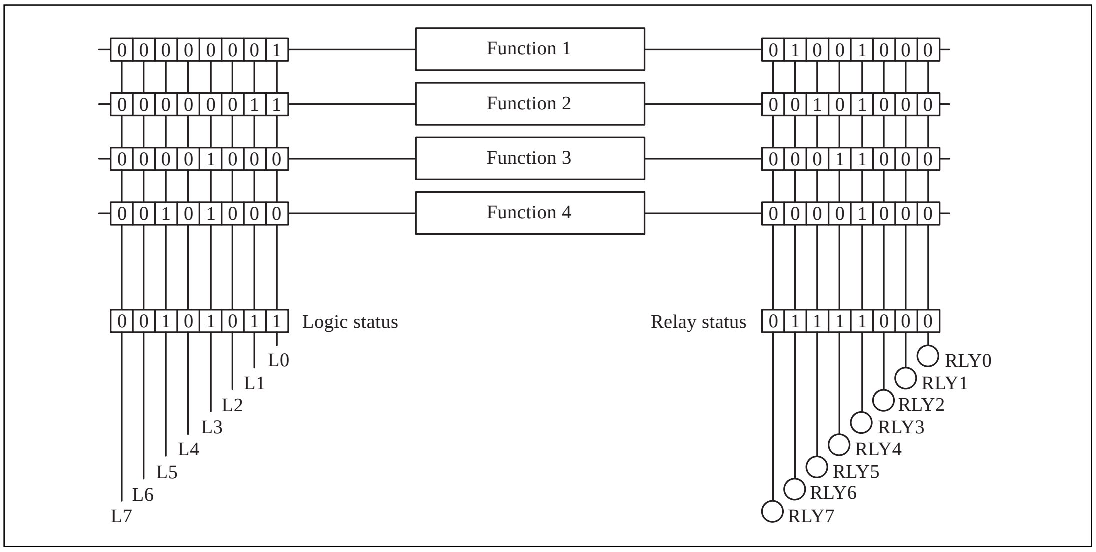

Figure 8

The input masks act as an “OR” gate such that function 2 is initiated by either, or both, L0 and L1, but L1 will not initiate function 1.

Both functions 3 and 4 can be initiated by L3, but only function 4 is initiated by L5. Similarly the output masks can be used to direct the output of a function to any relay.

The relay masks also act as “OR” gates so that several functions can be directed to a particular output relay. In the example function 1 operates relays 3 and 6, however, relay 3 is also operated by functions 2, 3, and 4.

6.1 Definite time overcurrent stage

The overcurrent logic provides for a start output when the current threshold (I>) is exceeded and provides for a trip output if the current threshold (I>) is exceeded for a time in excess of a set limit (t>). Output relays can be assigned to the start and trip by means of the relay masks shown in the diagram. The time delay can be blocked by energising an opto-isolated input to the unit; the selected input must be assigned in the input mask [Blk t>].

The earth fault element is provided with identical logic but in this case the current threshold in indicated by Io> and the associated time delay by to>.

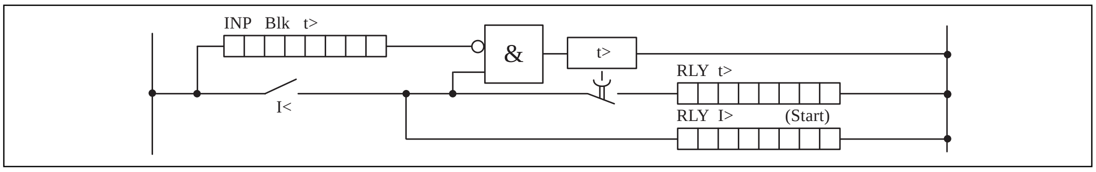

Figure 9

6.2 Auxiliary timers

The three auxiliary timers shown in Figure 10 may be initiated from external inputs assigned in the respective input masks and which, after the set time delay, operate the relays assigned in the relay masks.

Setting link PH7 to “1”, timer tAUX2 will be initiated when the currents for all three phases and earth/ground elements are below the respective undercurrent settings (I<) to give a time delayed undercurrent output.

Setting link LOG3 to “1”, timer tAUX3 will be initiated when any of the three phase currents rise above their respective undercurrent threshold (I<). This can be used to provide a fourth time delayed overcurrent and earth/ground fault stage.

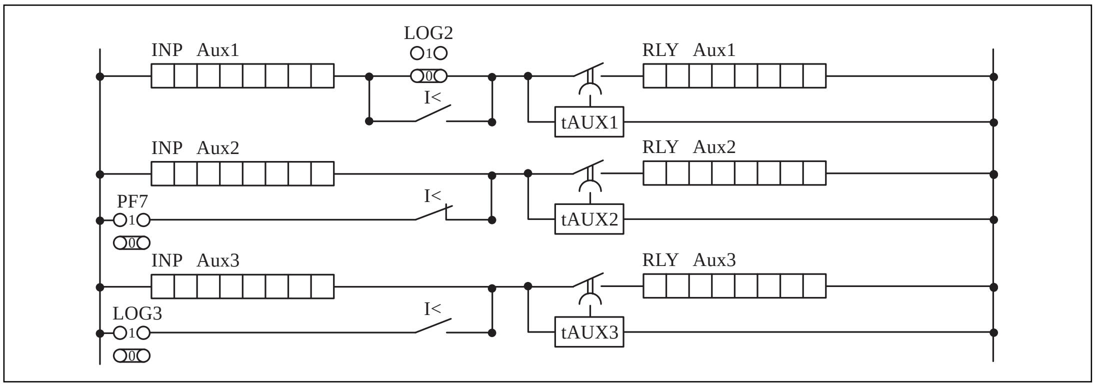

Figure 10

6.3 Breaker fail and backtripping

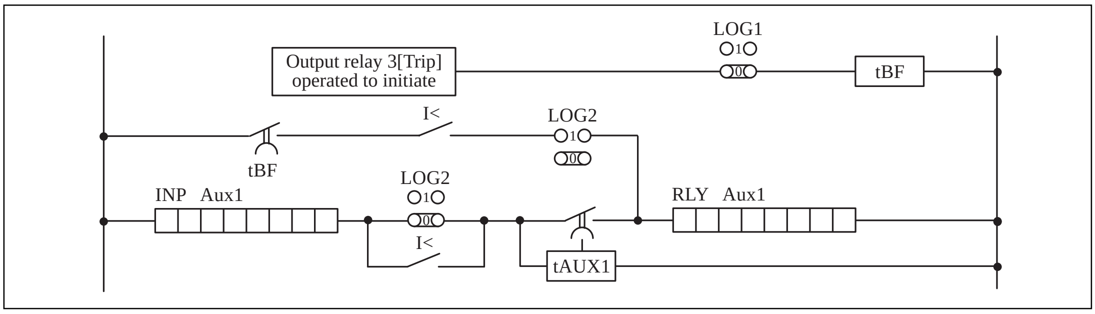

Figure 11

The [RLY Aux 1] input mask can be used to assign one of the control inputs to initiate the time delay tAUX1. By this means an externally initiated breaker fail function can be set up. Time delay tAUX1 will be set to the required circuit breaker fail time setting and a backtrip output will be given via the [RLY Aux1] output mask. The backtrip output and the breaker fail timers are checked by the undercurrent element if function link LOG2 has been set to ‘1’.

When the backtrip feature is selected the output relay is assigned via the output mask [Aux1] and will be recorded in the fault flags as Aux1. The time delay (tAUX1) will have a typical setting of 200 to 400ms.

Internal initiation of the breaker logic can be obtained by setting the link LOG1 to ‘1’. The breaker fail timer tBF will be started when output relay RLY3 operates. When the set time delay expires the start relay will first be reset to inhibit any blocking signals that it generated and the output relay Aux1, if one is selected, will pick up to backtrip.

6.4 Circuit breaker control

6.4.1 Local and remote control of circuit breaker

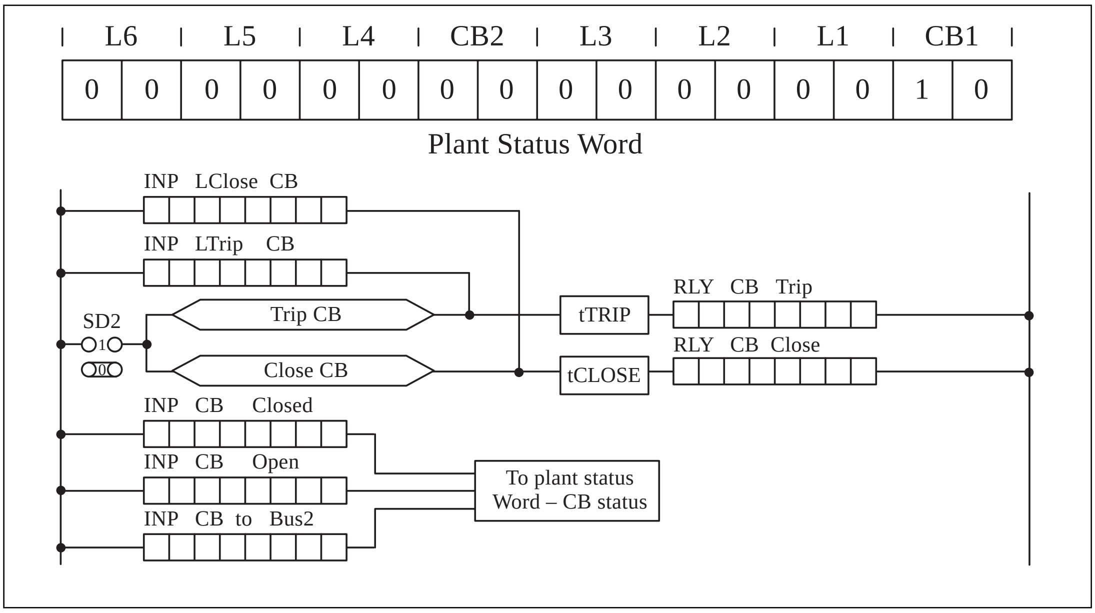

Figure 12

For the relay to respond to remote close and trip commands for the circuit breaker, it is necessary to set link SD2 to “1” and allocate output relays via both the [RLY CB Close] and [RLY CB Trip] masks. The commands are not sustained for the closing time of the breaker and so time delays assert the close and trip commands to the circuit breaker for a set period of time (a pulse output of duration set by time delays tTRIP and tCLOSE).

RLY 7 is usually allocated to [RLY CB Trip] and RLY 6 would be used for [RLY CB Close].

Two circuit breaker auxiliary contacts, to indicate the circuit breaker position, must be connected to the control inputs of the relay. The inputs, assigned by the input masks [INP CB Closed] and [INP CB Open], are directed to the appropriate two bits in the plant status word for CB1. The plant status word is used by the master station to determine where there are circuit breakers on the system which can be controlled and if they are in the open or closed position. A third opto-input may be used to indicate when the circuit breaker is connected to the second busbar in a two busbar system and is assigned by the [INP CB to Bus2] input mask. When this input is energised the circuit breaker positional information is directed to the two bits in the plant status word for CB2.

The two input masks [INP LClose CB] and [INP LOpen CB] assign control inputs for local initiation of the close and trip pulse timers for the circuit breaker. The only slight disadvantage of tripping the circuit breaker via this path is that a remote trip indication (RT) will be recorded.

6.4.2 Improving reliability of trip and closing contacts

In the event of the circuit breaker failing to trip, the relay contacts are called upon to break the trip coil current. The majority of protective relays are not rated for this duty and their contacts may be damaged as a result. This problem can be eliminated if a relay with heavy duty contacts is interposed between the output contacts of the protective relay and the circuit breaker trip circuit. This can be more economic than the repair costs and the overall fault clearance time need not be increased as a result. If the interposed relay is connected as a shunt repeat relay, the protection will trip the circuit breaker directly and then be backed-up by the contacts of the interposing relay. On breaking, the protective relay will reset first so that the interposing relay performs the actual circuit interruption.

Similarly the breaking duty of the relay contacts may not be rated for the circuit breaker closing current and in such cases an interposing relay will be necessary.

6.5 Trip and close test facility

If configured for remote control of the circuit breaker, then a trip or close test can be carried out from the SYSTEM DATA column of the menu. The control buttons on the front of the relay provide an input to the trip and close pulse timers in parallel with the [INP LClose CB] and [INP LTrip CB] masks. If link SD2 is set to ‘0’ the remote control of the circuit breaker is blocked but local control is still possible.

6.6 Load shedding by tripping less essential loads

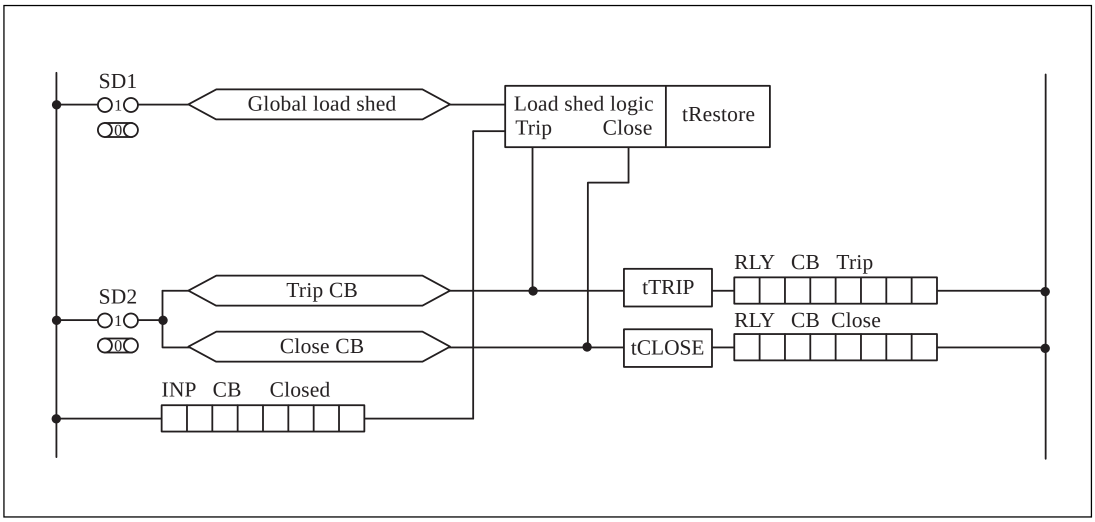

Figure 13

Global load shedding is possible in response to commands via the communication port. To select this option link SD1 must be set to “1” and to deselect it link SD1 must be set to “0”. Output relays must be selected via the [RLY CB Trip] and [RLY CB Close] masks to perform the circuit breaker control duty.

An indication is required that the circuit breaker was closed before the trip command was received, otherwise the circuit breaker will not close to restore load when the appropriate command level is received. A control input must therefore be assigned via [INP CB Closed] input mask.

Load shedding by tripping less important loads can also benefit from the control connections shown in the remote control diagram. Where load restoration is being used it will be necessary to provide for both trip and closing of the circuit breaker via the relay. The time delay (tRESTORE) may be set to different values for each circuit so that the reclosures of the circuit breakers are staggered.

Note: If the auxiliary supply to the relay is removed for a short period of time, the relay will not remember that it tripped for a load shed command. This will result in the relay not responding to a restoration command.

6.7 Load shedding by voltage reduction

Three of the output relays can be allocated via the [RLY V Reduct 1][RLY V Reduct 2][RLY V Reduct 3] output masks to give three stages of load shedding. Typically these outputs would be used to control the load shedding settings of a voltage regulating relay such as a type MVGC. The relays allocated via these masks will respond to load shedding commands received via the serial communication port and the stage of load shedding to which the relay is responding can be viewed under the SYSTEM DATA heading of the menu. Only the relays selected in one of the three masks can operate at any one time.

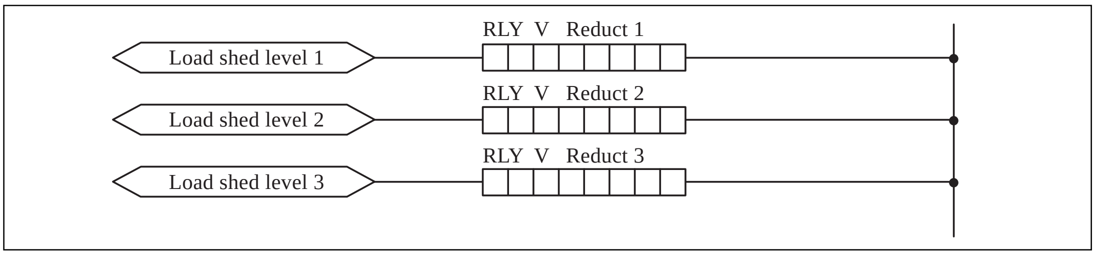

Figure 14

6.8 Trip and flag logic

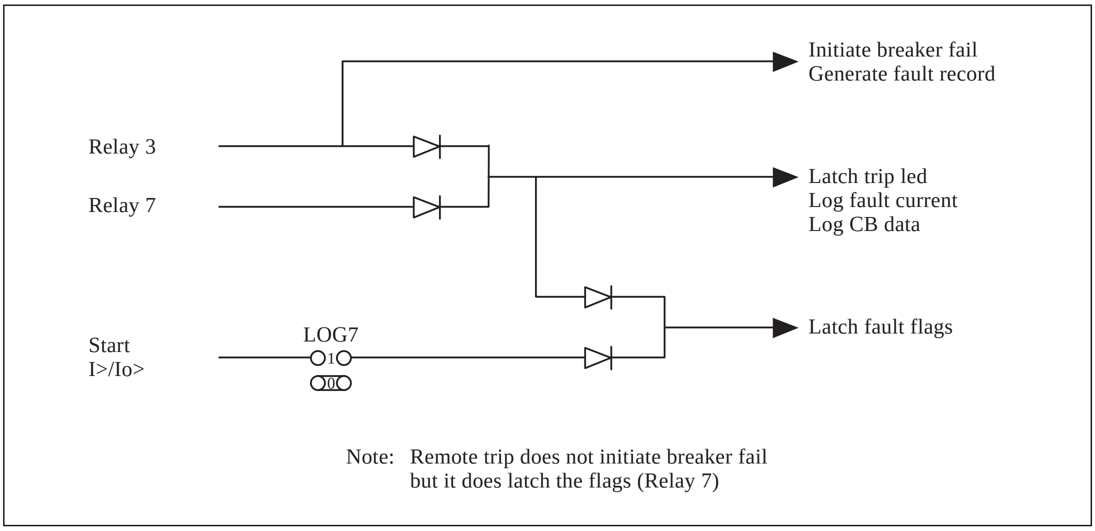

Figure 15

Not all functions will be used for tripping purposes; some may be used for control or alarm. The flag latching has been made programmable so that it can be set to suit the application. The trip led and the flags are latched for operation of relays RLY3 and RLY7, but the fault records are only initiated by the operation of relay RLY3.

To ensure correct flagging RLY3 should not be used for alarm or control functions. RLY7 is used for remote tripping of the circuit breaker and when it is not required for this purpose it may be used as an additional trip relay to provide an extra trip contact.

6.9 Flag display format

F	n	–	1	G	2	A	*			B	*			R	T
A	U	X	1	2	3	C	*			N	*				
F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0

Fn	Flags for last fault
Fn – 1	Flags for previous fault
A B C N	Start indication of phases
*	Element that tripped
RT	Remote trip
AUX123	Indicates which of the auxiliary outputs operated

Figure 16

Note: To trigger a fault record from an external event an external signal will need to be routed to RLY3 via an opto-input in mask [INP Aux1],[INP Aux2] or [INP Aux3] with the respective auxiliary time delay set to zero.
The disturbance recorder may be initiated by the same route if required, when the selected trigger should be RLY3. There will be a delay of approximately 15ms before the records are triggered and this must be taken into account. If the fault is removed before the trigger is accepted the record will not be stored.

Operation of relay RLY3 or RLY7 will automatically update the circuit breaker trip counter.

Section 7. TECHNICAL DATA

7.1 Ratings

7.1.1 Inputs

Reference current (In)	Nominal rating	Continuous	3 seconds	1 Second
Auxiliary powered	In = 1A	3.2In	30In	100A
	In = 5A	3.2In	30In	400A

Reference voltage (Vn)	Nominal rating	Maximum rating
Vn = 110V	110 / 440V phase/phase	560V phase/phase

Auxiliary voltage (Vx)	Nominal rating	Operative range DC supply	Operative range AC 50/60Hz	Absolute maximum
Auxiliary powered	24–125V ac/dc	19–150V	50–133V	190V crest
	48–250V ac/dc	33–300V	87–265V	380V crest

Frequency (Fn)	Nominal rating	Reference range
Frequency tracking	50 Hz or 60 Hz	45–65Hz

Opto–isolated inputs	Nominal rating	Reference range
Supply	50V dc only	25–60V dc only

7.1.2 Outputs

Field voltage 48V dc (current limited to 60mA)

7.2 Burdens

7.2.1 Reference current circuit

0.09	ohms for In = 1A
0.007	ohms for In = 5A

7.2.2 Reference voltage circuit

Reference voltage	0.02 VA at 110V	phase/neutral
	0.15 VA at 327V	phase/neutral

7.2.3 Auxiliary Voltage

DC supply	2.75 –3.0 W	at Vx max with no output relays or logic inputs energised
	4.0–4.5 W	at Vx max with 2 output relays and 2 logic inputs energised
	7.6–8.6 W	at Vx max with all output relays and logic inputs energised
AC supply	4.5–9.0 VA	at Vx max with no output relays or logic inputs energised
	6.0–12.0 VA	at Vx max with 2 output relays and 2 logic inputs energised
	7.5–20.0 VA	at Vx max with all output relays and logic inputs energised

7.2.4 Opto-isolated inputs

DC supply 0.25W per input (50V 10kΩ)

7.3 Current setting range

		Setting range	Step
Setting	I<	0.02–3.2In	0.01In
	I>/Io>	0.08–3.2In	0.01In
Reset	General	0.95Is	

7.4 Time setting range

		Setting range	Step size
t>/to>	Definite time	0 to 100s	0.01s
tBF	Definite time	0 to 10s	0.01s
tAUX1	Definite time	0 to 14.4ks (4Hrs)	30.01 to 100s
tAUX2	Definite time	0 to 14.4ks (4Hrs)	30.1 to 1,000s
tAUX3	Definite time	0 to 14.4ks (4Hrs)	31 to 10,000s
tTRIP	Definite time	0.5 to 5s	0.1s
tCLOSE	Definite time	0.5 to 5s	0.1s
tRESTORE	Definite time	0 to 100s	0.01s
tD>	Demand interval	1 minute, 15minutes, 30 minutes, 1 hour	

7.5 Measurement (displayed)

Voltage	(0–327) x VT Ratio	volts phase/neutral
Current	(0–64)In x CT Ratio	amps per phase
Power	(0–9999)x1021	Watts
VAr	(0–9999)x1021	VAr
VA	(0–9999)x1021	VA
Energy	(0–999999.99)	MWh
CB operations	(0–65535)	
Current^2 broken	(0–9999)x1021	
Frequency	45–65	Hz

7.6 Ratios

CT ratios	9999 : 1	Default = 1.000 : 1
VT ratios	9999 : 1	Default = 1.000 : 1

7.7 Accuracy

7.7.1 General for reference conditions

Ambient temperature	20°C
Frequency	50Hz or 60Hz (whichever set)
Auxiliary voltage	24V to 125V (aux powered)
	48V to 250V (aux powered)

Current

Undercurrent	Minimum operation	±10%
	Reset	±5%
	Repeatability	±2.5%

Auxiliary timers

Operating time	Set time ±0.5%(set time)+(15 to 30)ms
Disengage time	0 to 10ms (for timers alone) 15 to 30ms (including output relays and opto-inputs)

Measurements

Voltage	±1%Vn (typical)
Current	±1%In (typical)
Power	±2%Pn (typical)
Frequency	±1%Fn (typical over range 45–65Hz)

7.7.2 Influencing quantities

Ambient temperature	Operative range –25 to +55°C	
Current settings	1%	
Voltage settings	0.03% per °C	
Operation times	1%	
Angle measurement	2°	
Frequency	Operative range 46 to 65 Hz	
Current settings	1%	
Voltage settings	1%	
Operation times	1%	
Angle measurement	<1°	
Auxiliary supply	Nominal	Operative range
	24/125V	19 to 150V dc (aux powered) 50 to 133V ac (aux powered)
	48/250V	33 to 300V dc (aux powered) 87 to 265V ac (aux powered)
Current settings	0.5%	
Voltage settings	0.5%	
Operation times	0.5%	

7.8 Opto-isolated inputs

Capture time	12.5 ±2.5ms at 50Hz 10.4 ± 2.1ms at 60Hz
Release time	12.5 ±2.5ms at 50Hz 10.4 ± 2.1ms at 60Hz
Maximum series lead resistance	10kΩ (1 opto)
Maximum series lead resistance	5kΩ (2 optos in parallel)
Maximum series lead resistance	2.5kΩ (4 optos in parallel)
Maximum ac induced loop voltage	>50Vrms (thermal limit)
Maximum capacitance coupled ac voltage	>250Vrms via 0.1µF

7.9 Contacts

Output relays 0 to 7

Type		2 make contacts connected in series	
Rating	Make	30A and carry for 0.2s	
	Carry	5A continuous	Subject to a maxima of 5A and 300V
	Break	dc–50W resistive	
		25W inductive (L/R = 0.04s)	
		ac–1250VA (maxima of 5A)	

Watchdog

Type		1 make + 1 break	
Rating	Make	10A and carry for 0.2s	
	Carry	5A continuous	Subject to a maxima of 5A and 300V
	Break	dc–30W resistive	
		dc–15W inductive (L/R = 0.04s)	
		ac–1250VA (maxima of 5A)	

7.10 Operation indicator

3 light emitting diodes–internally powered.

16 character by 2 line liquid crystal display (with backlight).

7.11 Communication port

Language	COURIER
Transmission	Synchronous–RS485 voltage levels
Format	HDLC
Baud rate	64kbit per second
K-Bus cable	Screened twisted pair
K-Bus cable length	1000M of cable.
K-Bus loading	32 units (multidrop system)

7.12 Current transformer requirements

For general application

Vk = 30In(Rct + 2Rl + B) volts for fault recording
Vk = 5In(Rct + 2Rl + B) volts for measurement only

In addition

Im < 0.05In at In(Rct+2Rl+B) volts.

where Vk = Minimum knee point voltage required from the CT secondary winding.
In = Rated CT secondary current.
Im = Magnetising current
Rct = CT secondary winding resistance (at 75°C).
Rl = Resistance of a single lead from the CT to the relay.
B = Resistive burden of the relay at 30In
Is = Setting current for the relay

7.13 High voltage withstand

7.13.1 Insulation

2.0kVrms for one minute between all terminals and case earth, except terminal 1.

2.0kVrms for one minute between terminals of independent circuits, including contact circuits.

1.5kVrms across open contacts of output relays 0 to 7.

1.0kVrms for 1 minute across open contacts of the watch-dog relay.

7.13.2 Impulse IEC255-5

5kV peak, 1.2/50s, 0.5J between all terminals and all terminals to case earth.

7.13.3 High frequency disturbance IEC255-22-1/2

2.5kV peak between independent circuits and case.

7.13.4 Fast transient IEC255-22-4

Class 3 (2kV) – all circuits to case.

7.13.5 Static discharge test IEC801-2(1991)

Level 4 (15kV) – discharge in air with cover in place

Level 2 (4kV) – point contact discharge with cover removed

7.14 Environmental

7.14.1 Temperature IEC68-2-3

Storage and transit	–40°C to +70°C
Operating	–25°C to +55°C

7.14.2 Humidity IEC68-2-3

56 days at 93% relative humidity and 40°C

7.14.3 Enclosure protection IEC529

IP50 (dust protected)

7.14.4 Vibration IEC255-21-1

0.5g between 60Hz and 150Hz

0.07mm peak to peak between 10Hz and 60Hz.

7.14.5 Mechanical durability

10,000 operations, minimum.

7.15 Model numbers

KMPC130 CO CS RTG A

- KMPC130 – Relay type
- CO (with KMPC130) – Configuration (ie. settings as supplied) and connection diagram (Sht No. varies with external connection arrangement).
- CS – Case details
- RTG – Rating
- A – Issue

Case details and Rating – Mechanical Assembly

KMPC 1XX

- 0 – First version
- 3 – Three phase
- 1 – Auxiliary powered (V)
- C – Control
- P – Protection
- M – Measurement
- K – K-Series Midos

CO

- 01 – Standard configuration

CS

- 1 – Back connected flush mounting (standard mounting)
  May be used as an additional digit for configuration later
- F – Midos case size 6

RTG

- E – English text
- L – Vn = 57–120V In = 1A 50/60Hz
  M – Vn = 57–120V In = 5A 50/60Hz
- 2 – Vx = 24–125V ac/dc (auxiliary powered version)

Section 8. COMMISSIONING

8.1 Commissioning preliminaries

When commissioning for the first time the engineers should allow an hour to get familiar with the menu. Please read Section 9.1.1 which provides simple instructions for negotiating the menu using the push buttons **[F] [+] [–]** and **[0]** on the frontplate. Individual cells can be viewed and the settable values can be changed by this method.

If a portable PC is available together with a K-Bus interface unit and the Protection Access Software, then the menu can be viewed a page at a time to display a full column of data and text. Settings are also more easily entered and the final settings can be saved to a file on a disk for future reference, printing a permanent record, or for downloading to other similar relays. The software and instructions for its use are provided with the communication interfaces.

8.1.1 Quick guide to local menu control

With the cover in place only the **[F]** and **[0]** push button are accessible, so data can only be read or flag and counter functions reset. No protection or configuration settings can be changed. In the table **[F]** long indicates that the key is pressed for 1 second and **[F]** short for less than 0.5 second. This allows the same key to perform more than one function.

8.1.1.1 With the cover fitted to the case

Current display	Key press	Effect of action
Default display or fault flags after a trip	[F]short or [F]long	Display changes to first menu column heading “SYSTEM DATA”.
	[0]short	Backlight turns ON.
	[0]long	If the fault flags are displayed the trip led will be reset and the display will return to the selected default display.
Column heading	[F]short	Backlight turned ON and steps down to the next cell in the column.
	[0long	Returns to the selected default display and re-establishes the password protection, without waiting for the 15 minute delay.
Anywhere in menu	[F]short	Displays the next item of data in the column.
	[F]long	Displays the heading for the next column.
	[0]short	Turns the backlight ON.
	[0]long	If a resettable cell is displayed it will be reset.

8.1.1.2 With the cover removed from the case

The key presses listed in 9.1.1.1 still apply and in addition the **[+]** and **[–]** keys are accessible. This allows other functions to be performed such as changing the protection and control settings and, where necessary, the configuration of the relay by setting function links and reallocating opto-input and relay outputs.

Current display	Key press	Effect of action
Column heading	[+]	Move to next column heading.
	[–]	Move to previous column heading
A settable cell	[+] or [–]	Puts relay in the setting mode (flashing cursor on bottom line of display) if the cell is not password protected.
Setting mode	[+]	Increments value.
	[–]	Decrements value.
	[F]	Changes to the confirmation display, or if function links, relay or input masks are displayed then the [F] key will step through them from left to right. The final key press will change to the confirmation display.
	[0]	Escapes from the setting mode and the original setting is retained.
Confirmation display	[+]	Confirms setting and enters new value.
	[–]	Returns prospective value of setting for checking and further modification.
	[0]	Escapes from the setting mode without the setting being changed, original setting retained.

8.1.2 Terminal allocation

Reference should be made to the diagram supplied with every relay.
The diagram number will be found on the label fixed inside the case on the left-hand side. Section 3 of this document provides useful notes on connections to the relay.

8.1.3 Electrostatic discharge (ESD)

See recommendations in Section 1 of this user manual before handling module.

8.1.4 Inspection

Carefully examine the module and case to see that no damage has occurred since installation and visually check that the current transformer shorting switches in the case are wired into the correct circuit and that they are closed when the module is withdrawn. Check the serial number on the module, case and cover are identical and that the model number and rating information is correct.

Check that the external wiring is correct to the relevant relay diagram or scheme diagram. The relay diagram number appears inside the case on a label at the left hand side. This diagram shows the functions to which the opto-inputs and output relays have been allocated and gives the associated terminal numbers. If the user has reallocated the inputs and outputs a new diagram can be constructed by taking a copy of the schematic diagram given in this service manual and marking it up as appropriate to show the I/O allocation and function link positions.

The serial number of the relay appears on the label fitted the inside the case. It is also marked on the inside of the cover and on the front plate of the relay module. The serial numbers marked on these three items should match; the only time that they may not match is when a failed relay module has been replaced for continuity of protection.

With the relay removed from its case, ensure that the shorting switches between terminals listed below are closed by checking with a continuity tester between:

Terminals: 21 and 22; 23 and 24; 25 and 26; 27 and 28.

Check also that with the module fitted in its case there is no open circuit between:

Terminals: 21 and 22; 23 and 24; 25 and 26; 27 and 28.

8.1.5 Earthing

Ensure that terminal 1 is solidly connected to the case earthing connection, above the rear terminal block, and that there is a low resistance connection to earth. Where several relays are assembled in a tier, check that the earth terminal of each case in the same tier is interconnected by a copper earth bar.

8.1.6 Main current transformers

DO NOT OPEN CIRCUIT THE SECONDARY CIRCUIT OF A LIVE CT SINCE THE HIGH VOLTAGE PRODUCED MAY BE LETHAL TO PERSONNEL AND COULD DAMAGE INSULATION.

8.1.7 Test block

If the MMLG test block is provided, the connections should be checked to the scheme diagram, particularly that the supply connections are to the live side of the test block (coloured orange) and with the terminals allocated odd numbers (1, 3, 5, 7 etc.). The auxiliary supply is normally routed via terminals 13 (+) and 14 (–), but check against the schematic diagram for the installation.

8.1.8 Insulation

Insulation tests only need to be done when required.

Isolate all wiring from the earth and test the insulation with an electronic or brushless insulation tester at a dc voltage not exceeding 1000V. Terminals of the same circuits should be temporarily strapped together.

The main groups on the relays are given below but they may be modified by external connection as can be determined from the scheme diagram.

a) Current transformer circuits

b) Voltage transformer circuits

c) Auxiliary voltage supply

d) Field voltage output and opto-isolated control inputs

e) Relay contacts

f) Communication port

g) Case earth

8.2 Equipment required

The following equipment is required :

Secondary injection test set.

Multifinger test plug type MMLB01 for use with test block type MMLG.

Continuity tester.

AC voltmeter 0–440V

DC voltmeter 0–250V

AC multi-range ammeter

Phase angle meter or transducer. If necessary suitable current shunt(s) for use with the phase angle meter.

8.3 Auxiliary supply tests

8.3.1 Auxiliary supply

The relay can be operated from either an ac or a dc auxiliary supply but the incoming voltage must be within the operating range specified below.

Relay rating (V)	DC operating range (V)	AC operating range (VAC)	Maximum crest voltage (V)
24/125	19 – 150	50 – 133	190
48/250	33 – 300	87 – 265	380

For secondary injection testing using the test block type MMLG, insert test plug type MMLB01 with CT shorting links fitted. It may be necessary to link across the front of the test plug to restore the auxiliary supply to the relay. Isolate the relay trip contacts and insert the module.

Monitor the state of the watchdog contacts with a continuity checker before and after the auxiliary voltage is applied. Compare the action of the contacts against the following table.

Terminals	With relay de-energised	With relay energised
3 and 5	contact closed	contact open
4 and 6	contact open	contact closed

With the auxiliary supply connected the power supply should start up, the liquid crystal display should show the default display and the centre green led should be illuminated to indicate the relay is healthy. The relay has a non-volatile memory which remembers the state (ON or OFF) of the led trip indicator when the relay was last powered and therefore the indicator may be illuminated.

8.3.2 Field voltage

The power supply of the relay generates a field voltage that should be used to energise the opto-isolated inputs. With the relay energised, measure the field voltage across terminals 7 and 8. Terminal 7 is positive with respect to terminal 8 and should be within the range 45V to 60V when no load is connected.

8.4 Settings

The commissioning engineer should be supplied with all the required settings for the application. The settings should be entered via the front keypad or using a portable PC with a K-Bus connection.

SYSTEM DATA	SYS Fn Links
PHASE FAULT (1)	PF1 Fn Links
LOGIC FUNCTIONS	LOG Fn Links
INPUT MASKS	An eight bit mask is allocated to each protection and control function that can be influenced by an external input applied to one or more opto-isolated inputs.
RELAY MASK	An eight bit mask is allocated to each protection and control function that can operate one or more outputs.

It is necessary to enter the password before the functions link, I/O masks, VT and CT ratios can be changed.

For each control function input required, at least one opto-input must be allocated in the INPUT MASK menu.

For each control function output required, at least one output relay must be allocated in the RELAY MASK menu.

When a product leaves the factory it is configured with a set of default relay masks, input masks and function link settings. Any of these settings can be left at the default values if required.

When the settings have been entered they should be noted down on the commissioning test record sheet. If the K-Bus communications are being used then the master station can download the settings to its memory from which they can be downloaded to other units requiring the same set-up.

8.5 Measurement checks

8.5.1 Current and voltage measurement check

To test the measurement functions a known current, or voltage as appropriate, should be injected into each phase input. Refer to Section 3 for the appropriate terminal numbers and relative polarity. The injected voltage or current should be measured and compared with the value displayed on the measurement centre and the accuracy checked. Due allowance should be made for instrumentation error of the portable test equipment when examining the results of the measurement.

With the CT and VT ratio settings under the PHASE FAULT heading of the menu, set to the overall ratios of the CTs and VTs the displayed measured values and settings will be in the equivalent primary quantities.

Accuracy should be better than ±5% for voltage of Vn±10% and ±5% for current from 0.1In to 1.5In for on site measurements.

8.5.2 Power measurement check

Power measurements are the product of voltage and current and will be correct if the current and voltage measurements are within the accuracy limits. Hence the direction for power flow is the main feature that should be checked.

With the polarity for voltage and current connections as shown in the table in section 3 and the signing power flow set to Mode 0, power flow from the busbar to the feeder will be (+) and for the reactive power a (+) sign will indicate a leading power factor. For other modes of signing power flow refer to Section 2.1.7.1.

For this test the load current may be used if the direction of power flow and power factor is known.

8.5.3 Power factor

Power Factor is derived from the calculation (VIcos)/(VI) = cos and will therefore have the same sign as the power and hence indicate the direction of power flow; not a leading or lagging power factor.

8.6 Undercurrent measurement check

Check the undercurrent elements pick-up (ie. no longer indicate an undercurrent condition) at the applied setting (I< ± 10%). The elements are more easily tested by injecting into one phase at a time for this test. The actual accuracy is improved for settings greater than 0.1In.

8.7 Definite time overcurrent check

Set the default display for the lcd to (Fnow) then check the overcurrent elements pick-up at the applied setting (I>/Io> ± 5%) and that a start output is given in the flags, indicated by the display of the letter for the phase that operates.

Check that if the current is held on for a time in excess of the time delay setting t>/ to> an * appears in the display after the phase indication letter. The actual operation time should be the (set time) ±5%(set time) +(10 to 30ms) for on site measurements.

8.8 Selective logic

For the selective logic checks only the features that are to be used in the application should be tested. Relay settings must not be changed to enable unused functions to be tested. For detailed descriptions of the selective logic please refer to Section 6 of this manual.

8.8.1 Opto-input checks

This test is to check that all the opto-inputs are functioning correctly. To enable energisation of the opto-inputs terminal 8 should be linked to terminals 52 and 55. The opto-inputs can then be individually energised by connecting terminal 7 to the appropriate opto-input listed in the following table.

Opto-input number	terminal
L0	46
L1	48
L2	50
L3	45
L4	47
L5	49
L6	51
L7	53

The status of each opto-input can be viewed by displaying [SYS Logic Stat], which will be found towards the end of the SYSTEM DATA column of the menu.
When each opto is energised one of the characters on the bottom line of the display will change to indicate the new state of the inputs. The number printed on the

frontplate under the display will identify which opto each character represents. A “1” indicates an energised state and a “0” indicates a de-energised state.

Note: The opto-isolated inputs may be energised from an external 50V battery in some installations. Check that this is not the case before connecting the field voltage otherwise damage to the relay may result.

8.8.2 Auxiliary timers

The auxiliary timers present in the relay should only be tested if they are to be used in the intended application and if the timer settings are not so high that testing is impractical.

8.8.2.1 Timer AUX1

To test the tAUX1 time delay an external switch must be connected to start an external timer interval meter and energise the opto input that activates tAUX1. The time interval meter must be stopped by the contacts of the relay allocated in relay mask [RLY tAUX1] when it operates.

If the LOGIC function link LOG2 is set to “1” then current must be injected into the relay above the undercurrent threshold I< during the test, otherwise the timer will be blocked from operating. If LOGIC function link LOG2 is set to “0” the current does not need to be injected into the relay during the test.

The measured time delay should be within the set time tAUX1 ±5% + (0.02 to 0.05)s for on site measurements.

8.8.2.2 Timer AUX2

If the PHASE FAULT function link PH7 is set to “1” or the input mask [INP Aux2] has been allocated an input, then auxiliary timer 2 should be tested. There are two ways of testing the timer depending on the relay’s settings.

If the input mask [INP Aux2] has been allocated then an external time interval meter must be connected so that it starts when the opto-isolated input is energised and stops when the relay allocated by the relay mask [RLY tAUX2] operates.

If the PHASE FAULT function link PH7 is set to “1” then the timer will be energised via the undercurrent element when an undercurrent condition exists. The time interval meter must therefore be started when the current is removed and it must be stopped when the relay selected by the mask [RLY Aux2] operates.

The measured time delay should be within the set time tAUX1 ±5% + (0.02 to 0.05)s for on site measurements.

8.8.2.3 Timer AUX3

If the LOGIC function link LOG3 is set to “1” or the input mask [INP Aux3] has been allocated an input, then auxiliary timer 3 should be tested. There are two ways of testing the timer depending on the relays settings.

If the input mask [INP Aux3] has been allocated then an external time interval meter must be connected so that it starts when the opto-isolated input is energised and stops when the relay allocated by the relay mask [RLY tAUX3] operates.

If the LOGIC function link LOG3 is set to “1” then the timer tAUX3 will be energised via the undercurrent element when the undercurrent threshold is exceeded (ie. an overcurrent condition). The time interval meter must therefore be started when the current is applied and it must be stopped when the relay selected by the mask [RLY Aux2] operates.

The measured time delay should be within the set time tAUX1 ±5% + (0.02 to 0.05)s for on site measurements.

8.8.3 Breaker fail

When LOGIC function link LOG2 is set to “1” the time delay tAUX1 is initiated via an opto-input and checked by the undercurrent element to provide a backtrip output to trip an up-stream circuit breaker. This constitutes the breaker fail function.
It should be tested by energising the undercurrent element of any one phase with a current above its setting threshold I<. The output relay allocated to initiate the backtripping via output mask RLY AUX1 should operate after the delay set for tAUX1 + (15 to 30)ms.

8.8.4 Circuit breaker control

Provided the relay is wired to control a circuit breaker a manual test can be performed via the user interface of the relay as a check that the connection is functioning correctly.

8.8.4.1 CB trip test

The relay mask [CB Trip] must be assigned to the output relays that are to trip the circuit breaker. This will not enable the remote control of the circuit breaker provided system data links 1 and 2 are set to “0”. The circuit breaker trip time delay (tTRIP) under the LOGIC heading, should be set to a value appropriate to the application.

Select the SYSTEM DATA heading from the menu.

Step down the column with short [F] key presses until the display reads :

SYS CB control

No operation

Press the [+] key and the cursor will flash on the bottom line of the display.

Press the [+] key once again and the bottom line of the display will change to TRIP.

Press the [F] key and the prompt will be displayed :

Are you sure?

+ = YES – = NO

Press the [0] key to abort.

[–] key to change option.

[+] key to execute command.

After executing the open command the output relay assigned to trip the circuit breaker by the [CB Open] relay mask, will operate for the trip time (tTRIP). During the trip test the status of this relay should be monitored to ensure it operates correctly.

8.8.4.2 CB close test

The relay mask [CB Close] must be assigned to the output relays that are to trip the circuit breaker. This will not enable the remote control of the circuit breaker provided the System Data Link 2 is set to “0”. The circuit breaker close time delay (tCLOSE), under the LOGIC heading, should be set to a value appropriate to the particular application.

Select the SYSTEM DATA heading from the menu.

Step down the column with short [F] key presses until the display reads :

SYS CB control

No Operation

Press the [+] key and the cursor will flash on the bottom line of the display.

Press the [+] key once again and the bottom line of the display will change to TRIP and press again to display CLOSE.

Press the [F] key and the prompt will be displayed :

Are you sure?

+ = YES   – = NO

Press the [0] key to abort.
[–] key to change option.
[+] key to execute command.

After executing the close command the output relay assigned to close the circuit breaker by the [CB Close] relay mask, will operate for the close time delay (tCLOSE). During the close test the status of this relay should be monitored to ensure it operates correctly.

8.9 On load measurement tests

Measure the secondary CT currents and if applicable, the secondary VT voltages. Compare the values of the secondary quantities with the relays measured values, which can be found in MEASUREMENTS (1). If the CT and VT ratios are set to 1:1 then the values will be within ±5% of the secondary quantities, if the CT and VT ratios are not set to 1:1, then the measurement values will be equal to the secondary values multiplied by the appropriate transformer ratios.

Section 9. PROBLEM SOLVING

9.1 Password lost or not accepted

Relays are supplied with the password set to AAAA.

Only uppercase letters are accepted.

Password can be changed by the user see Section 5.2.2

There is an additional unique recovery password associated with the unit which can be supplied by the factory, or service agent, if given details of its serial number. The password will be found in the system data column of the menu and should correspond to the number on the label at the top right hand corner of the frontplate of the unit. If they differ, quote the one in the system data column.

9.2 Function links cannot be changed

Enter the password as these menu cells are protected.

Links are not selectable if associated text is not displayed.

9.3 Alarms

If the watchdog relay operates, first check that the relay is energised from the auxiliary supply. If it is, then try to determine the cause of the problem by examining the alarm flags towards the bottom of the LOGIC column of the menu. This will not be possible if the display is not responding to key presses.

Having attempted to determine the cause of the alarm it may be possible to return the unit to an operable state by resetting it. To do this, remove the auxiliary power supply for 10s, or so. Then re-establish the supplies and the unit should in most cases return to an operating state.

Recheck the alarm status if the alarm led is still indicating an alarm state.
The following notes will give further guidance.

9.3.1 Watchdog alarm

The green led will usually follow the operation of the watchdog relay in either of the above two cases.

There is no shorting contact across the case terminals connected to the “break” contact of the watchdog relay. Therefore, the indication for a failed/healthy relay will be cancelled when the relay is removed from its case.

If the relay is still functioning, the actual problem causing the alarm can be found from the alarm records in the LOGIC column of the menu.

9.3.2 Unconfigured or uncalibrated alarm

For a CONFIGURATION alarm the protection is stopped and no longer performing its intended function. For an UNCALIBRATED alarm the protection will still be operational but there will be an error in its calibration that will require attention.
It may be left running provided the error does not cause any grading problems.

To return the unit to a serviceable state the initial factory configuration will have to be reloaded and recalibrated. It is recommended that the work be carried out at the factory, or entrusted to a recognised service centre.

9.3.3 Setting error alarm

A SETTING alarm indicates that the area of non-volatile memory where the selected protection settings are stored, has been corrupted. The current settings should be checked against those applied at the commissioning stage or any later changes that have been made.

If a personal computer (PC) is used during commissioning then it is recommended that the final settings applied are copied to a floppy disc with the serial number of the relay used as the file name. The setting can then be readily loaded back into the relay if necessary, or to a replacement relay.

9.3.4 “No service” alarm

This alarm flag can only be observed when the relay is in the calibration or configuration mode when the protection program will be stopped.

9.3.5 Fault flags will not reset

These flags can only be reset when the flags Fn are being displayed or by resetting the fault records, see Section 5.2.10.

9.4 Records

9.4.1 Problems with event records

Fault records will only be generated if RLY3 is operated as this relay is the trigger to store the records.

Fault records can be generated in response to another protection operating if RLY3 is operated by one of its trip contacts via an auxiliary input. This will result in the fault values, as measured by the KMPC, being stored at the instant RLY3 resets. The flag display will include a flag to identify the auxiliary input that initiated the record.

Fault currents recorded are lower than actual values: as the fault is interrupted before measurement was completed.

Few fault records can be stored when changes in state of logic inputs and relay outputs are stored in the event records. These inputs and outputs can generate a lot of events for each fault occurrence and limit the total number of faults that can be stored. Setting System Data Link 7 to “0” will turn off this feature and allow the maximum number of fault records to be stored.

The event records are erased if the auxiliary supply to the KMPC is lost for a period exceeding the hold-up time of the internal power supply.

Events can only be read via the serial communication port and are not available on the lcd.

Any spare opto-inputs may be used to log changes of state of external contacts in the event record buffer. The opto-input does not have to be assigned to a particular function in order to achieve this.

The oldest event is overwritten by the next event to be stored when the buffer becomes full.

When a master station has successfully read a record it usually clears it automatically and when all records have been read the event bit in the status byte is set to “0” to indicate that there are no longer any records to be retrieved.

9.4.2 Problems with disturbance records

Only one record can be held in the buffer and the recorder must be reset before another record can be stored. Automatic reset can be achieved by setting function link SD6 to 1. It will then reset the recorder 3s after current, above the undercurrent setting, has been restored to the protected circuit.

The disturbance records are erased if the auxiliary supply to the relay is lost for a period exceeding the hold-up time of the internal power supply.

Disturbance records can only be read via the serial communication port. It is not possible to display them on the lcd.

No trigger selected to initiate the storing of a disturbance record.

Disturbance recorder automatically reset on restoration of current above the undercurrent setting for greater than 3s. Change function link SD6 to 0 to select manual reset.

Post trigger set to maximum value and so missing the fault.

When a master station has successfully read a record it will clear it automatically and the disturbance record bit in the status byte will then be set to “0” to indicate that there is no longer a record to be retrieved.

9.5 Circuit breaker maintenance records

When a replacement relay is fitted it may be desirable to increment the CB maintenance counters to the values of that on the old unit. The counter for the number of circuit breaker operations can be incremented manually by pulsing an opto-input, that operates relay RLY3, the required number of times.

The circuit breaker trip time for the last fault cannot be cleared to zero. This is to enable the master station to interrogate the relay for this value as a supervisory function.

The circuit breaker maintenance counters are not incremented when another protection trips the circuit breaker. Add a trip input from the protection to an auxiliary input of the KMPC and arrange for relay RLY3 or RLY7 to operate instantaneously in response to the input.

9.6 Communications

Address cannot be automatically allocated if the remote change of setting has been inhibited by function link SD0. This must be first set to “1”, alternatively the address must be entered manually via the user interface of the KMPC.

Address cannot be allocated automatically unless the address is first manually set to 0. This can also be achieved by a global command including the serial number of the relay.

Communication address set to 255, the global address for which no replies are permitted.

9.6.1 Measured values do not change

Values in the MEASUREMENTS (1) and MEASUREMENTS (2) columns are snap shots of the values at the time they were requested. To obtain a value that varies with the measured quantity it should be added to the poll list as described in the communication manual.

9.6.2 Relay no longer responding

Check if other devices further along the bus are responding and if so power down the KMPC for 10s and then re-energise to reset the communication processor. This should not be necessary as the reset operation occurs automatically when the relay detects a loss of communication.

If relays further along the bus are not communicating, check to find out which are responding towards the master station. If some are responding then the position of the break in the bus can be determined by deduction. If none are responding then check for data on the bus or reset the communication port driving the bus with requests.

Check there are not two devices with the same address on the bus.

9.6.3 No response to remote control commands

Check that the relay is not inhibited from responding to remote commands by observing the system data function link settings. If so reset as necessary; a password will be required.

System data function links can not be set over the communication link if the remote change of settings has been inhibited by setting system data function link SD0 to 0. First reset SD0 to 1 manually via the user interface on the KMPC.

KMPC is not identified in the circuit breaker control menu of the Courier master station if two auxiliary circuit breaker contacts have not been connected to opto-inputs of the relay to indicate its position via the plant status word. Check input mask settings and the connections to the auxiliary contacts of the circuit breaker.

Section 10. MAINTENANCE

10.1 Remote testing

The KMPC is self-supervising and so will require less maintenance. Most problems will result in an alarm so that remedial action can be taken. However, some periodic tests could be done to ensure that the relay is functioning correctly. If the relay can be communicated with from a remote point, via its serial port, then some testing can be carried out without actually visiting the site.

10.1.1 Measurement accuracy

The values measured can be compared with known system values to check that they are in the approximate range that is expected. If they are, then the analogue/digital conversion and calculations are being performed correctly.

10.1.2 Trip test

If the relay is configured to provide remote control of the circuit breaker then a trip test can be performed remotely in two ways:

1. Measure the load current in each phase and reduce the phase fault setting of the relay to a known value that is less than the load current. The relay should trip in the appropriate time for the given multiple of setting current.

   The settings can then be returned to their usual value and the circuit breaker reclosed.

Note: If the second group of settings are not being used for any other purpose they could be used for this test by having a lower setting selected and issuing a command to change the setting group that is in use to initiate the tripping sequence.

2. If the KMPC is connected for remote control of the circuit breaker then a trip/close cycle can be performed. This method will not check as much of the functional circuit of the unit as the previous one but it will not need the settings of the relay to be changed.

If a failure to trip occurs the relay status word can be viewed, whilst the test is repeated, to check that the output relay is being commanded to operate. If it is not responding then an output relay allocated to a less essential function may be reallocated to the trip function to effect a temporary repair, but a visit to site may be needed to effect a wiring change.

10.1.3 CB maintenance

Maintenance records for the circuit breaker can be obtained at this time by reading the appropriate data in the MEASUREMENT(2) and the FAULT RECORDS columns.

10.2 Local testing

When testing locally similar tests may be carried out to check for correct functioning of the relay.

10.2.1 Alarms

The alarm status led should first be checked to identify if any alarm conditions exist. The alarm records can then be read to identify the nature of any alarm that may exist.

10.2.2 Measurement accuracy

The values measured can be checked against known values injected into the KMPC via the test block, if fitted, or injected directly into the relay terminals. Suitable test methods will be found in the Section 8 of this manual. These tests will prove the calibration accuracy is being maintained.

10.2.3 Trip test

If the KMPC is configured to provide a “trip test” via the user interface of the relay then this should be performed to test the output trip relays. If the KMPC is configured for remote control of the circuit breaker the “trip test” will initiate the remote CB trip relay and not the main trip relay that the protection uses. In which case the main trip relay should be tested by injecting a current above the protection setting so that operation occurs.

If an output relay is found to have failed, an alternative relay can be reallocated until such times as a replacement can be fitted.

10.2.4 CB maintenance

Maintenance records for the circuit breaker can be obtained at this time by reading the appropriate data in the MEASUREMENT(2) and the FAULT RECORDS columns.

10.2.5 Additional tests

Additional tests can be selected from the commissioning instructions Section 8 as required.

10.3 Method of repair

Please read the handling instructions in Section 1 before proceeding with this work. This will ensure that no further damage is caused by incorrect handling of the electronic components.

10.3.1 Replacing a pcb

a) Replacement of user interface

Withdraw the module from its case.

Remove the four screws that are placed one at each corner of the frontplate.

Remove the frontplate.

Lever the top edge of the user interface board forwards to unclip it from its mounting.

Then pull the pcb upwards to unplug it from the connector at its lower edge.

Replace with a new interface board and assemble in the reverse order.

b) Replacement of main processor board

This is the pcb at the extreme left of the module, when viewed from the front. To replace this board:

First remove the screws holding the side screen in place. There are two screws through the top plate of the module and two more through the base plate.

Remove screen to expose the pcb.

Remove the two retaining screws, one at the top edge and the other directly below it on the lower edge of the pcb.

Separate the pcb from the sockets at the front edge of the board. Note that they are a tight fit and will require levering apart, taking care to ease the connectors apart gradually so as not to crack the front pcb card. The connectors are designed for ease of assembly in manufacture and not for continual disassembly of the unit.

Reassemble in the reverse of this sequence, making sure that the screen plate is replaced with all four screws securing it.

c) Replacement of auxiliary expansion board

This is the second board in from the left hand side of the module.

Remove the processor board as described above in b).

Remove the two securing screws that hold the auxiliary expansion board in place.

Unplug the pcb from the front bus as described for the processor board and withdraw.

Replace in the reverse of this sequence, making sure that the screen plate is replaced with all four screws securing it.

10.3.2 Replacing output relays and opto-isolators

PCBs are removed as described in 11.3.1 b and c. Replaced in the reverse order. Calibration is not usually required when a pcb is replaced unless either of the two boards that plug directly on to the left hand terminal block are replaced, as these directly affect the calibration.

Note that this pcb is a through hole plated board and care must be taken not to damage it when removing a relay for replacement, otherwise solder may not flow through the hole and make a good connection to the tracks on the component side of the pcb.

10.3.3 Replacing the power supply board

Remove the two screws securing the right hand terminal block to the top plate of the module.

Remove the two screws securing the right hand terminal block to the bottom plate of the module.

Unplug the back plane from the power supply pcb.

Remove the securing screw at the top and bottom of the power supply board.

Withdraw the power supply board from the rear, unplugging it from the front bus.

Reassemble in the reverse of this sequence.

10.3.4 Replacing the back plane (size 6 case)

Remove the two screws securing the right hand terminal block to the top plate of the module.

Remove the two screws securing the right hand terminal block to the bottom plate of the module.

Unplug the back plane from the power supply pcb.

Twist outwards and around to the side of the module.

Replace the pcb and terminal block assembly.

Reassemble in the reverse of this sequence.

10.4 Recalibration

Whilst recalibration is not usually necessary it is possible to carry it out on site, but it requires test equipment with suitable accuracy and a special calibration program to run on a PC. This work is not within the capabilities of most people and it is recommended that the work is carried out by an authorised agency.

After calibration settings for the application will need to be re-entered and so it is useful if a copy of the settings are available on a floppy disk. Although this is not essential it can reduce the down time of the system.

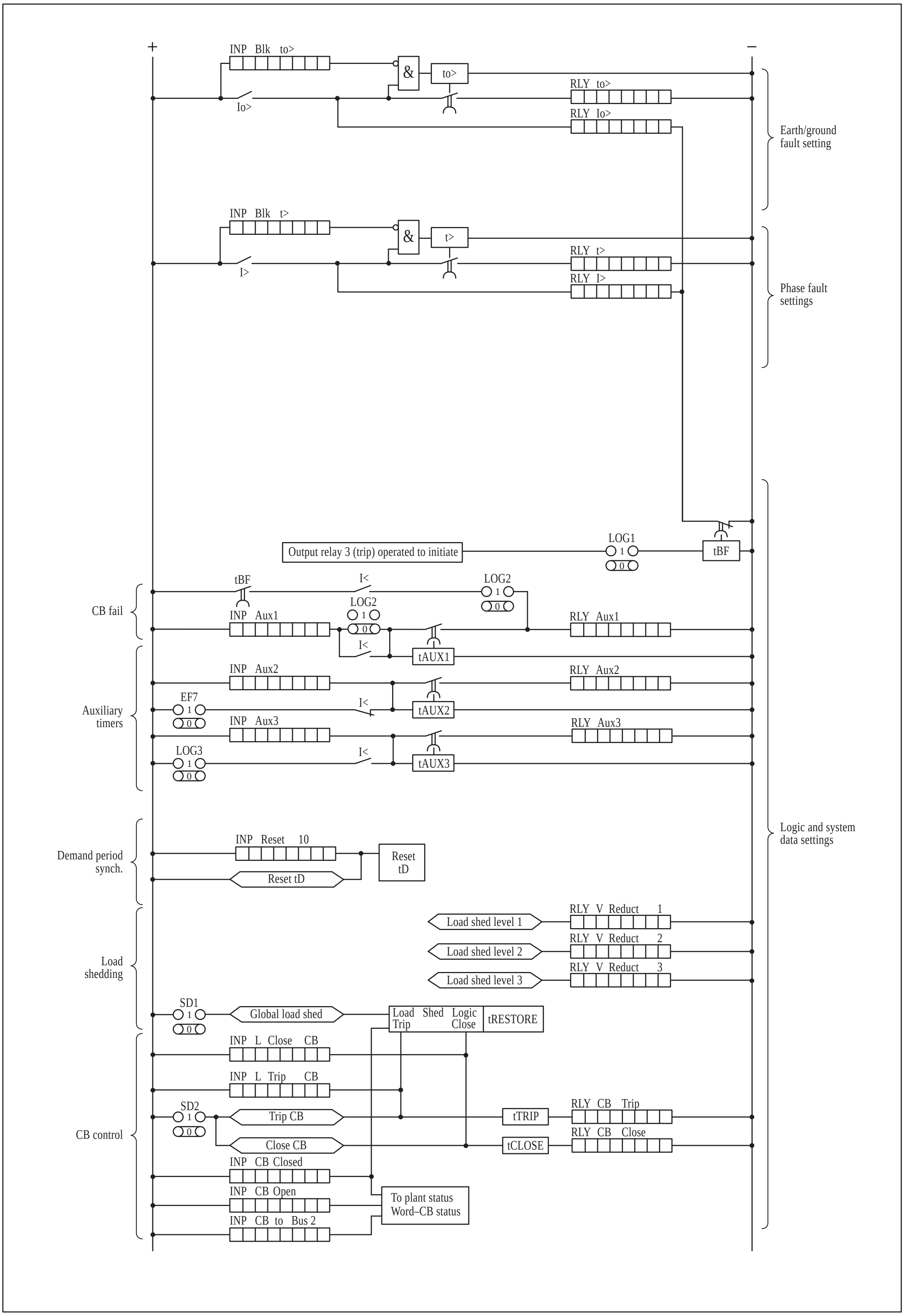

Figure 17. Scheme logic diagram: Midos measurement centre Type KMPC 130

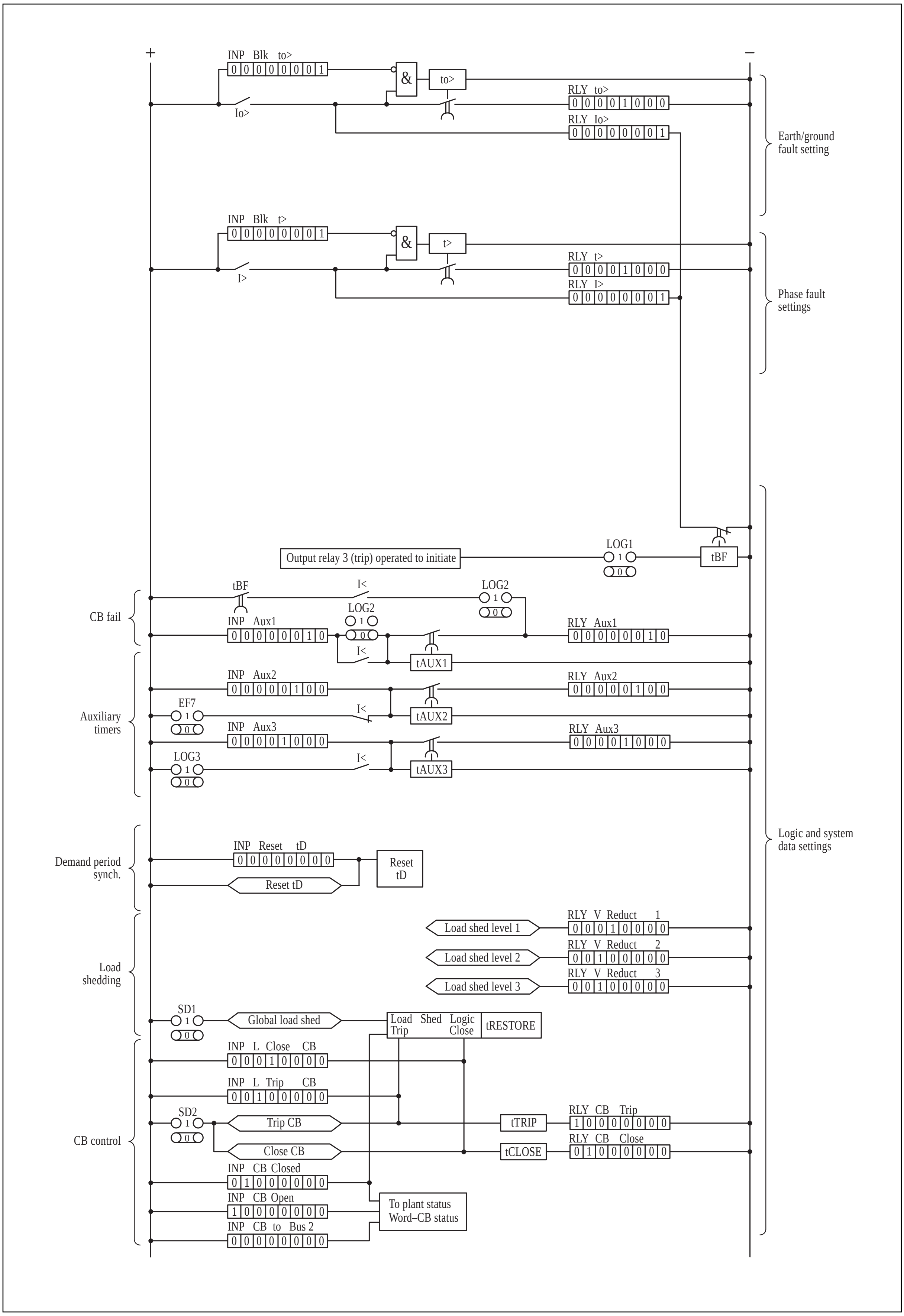

Figure 18. Scheme logic diagram: Midos measurement centre Type KMPC 130

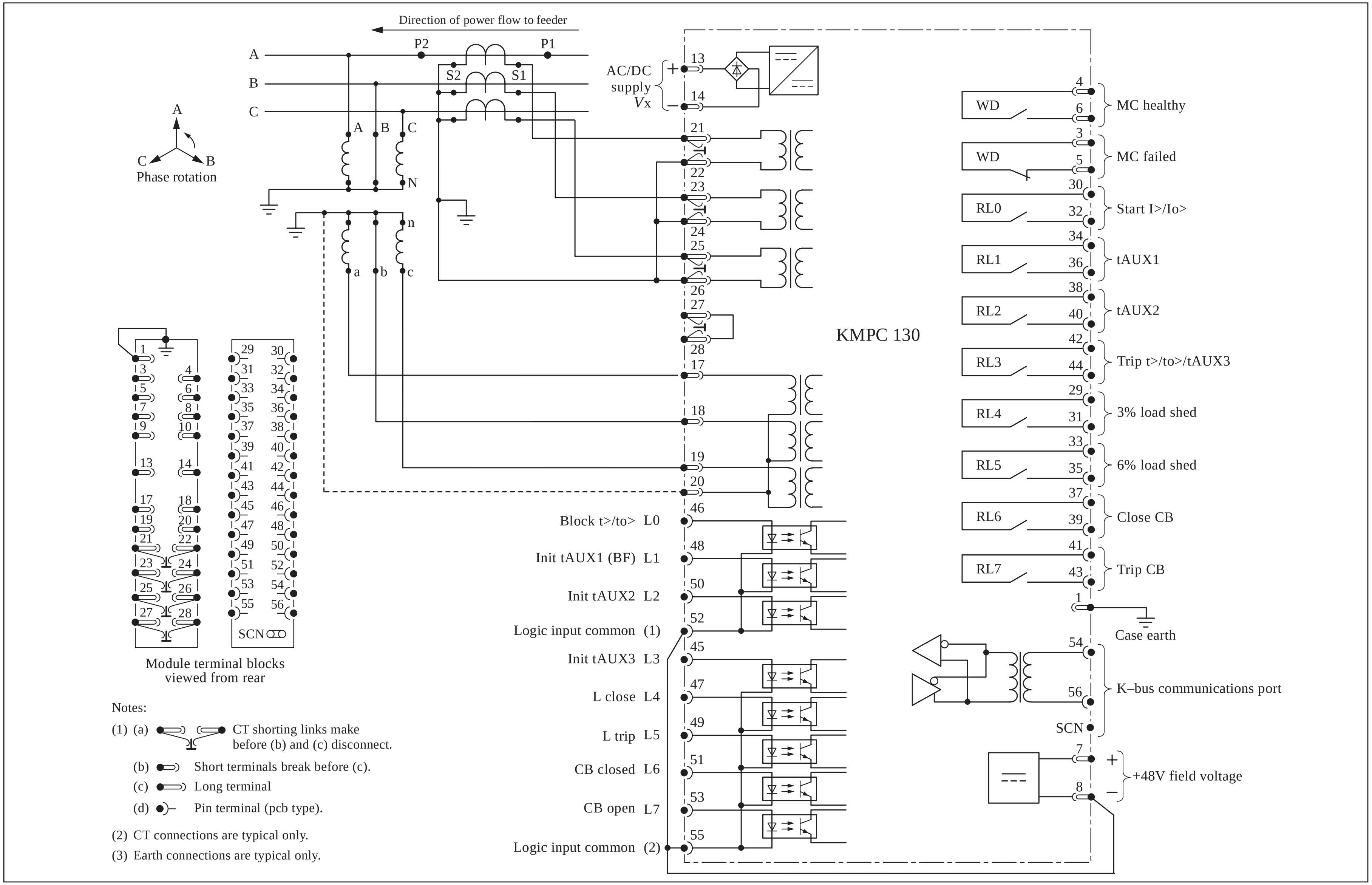

Figure 19. Application diagram: Midos measurement centre Type KMPC 130 3 CT and 3VT connection.

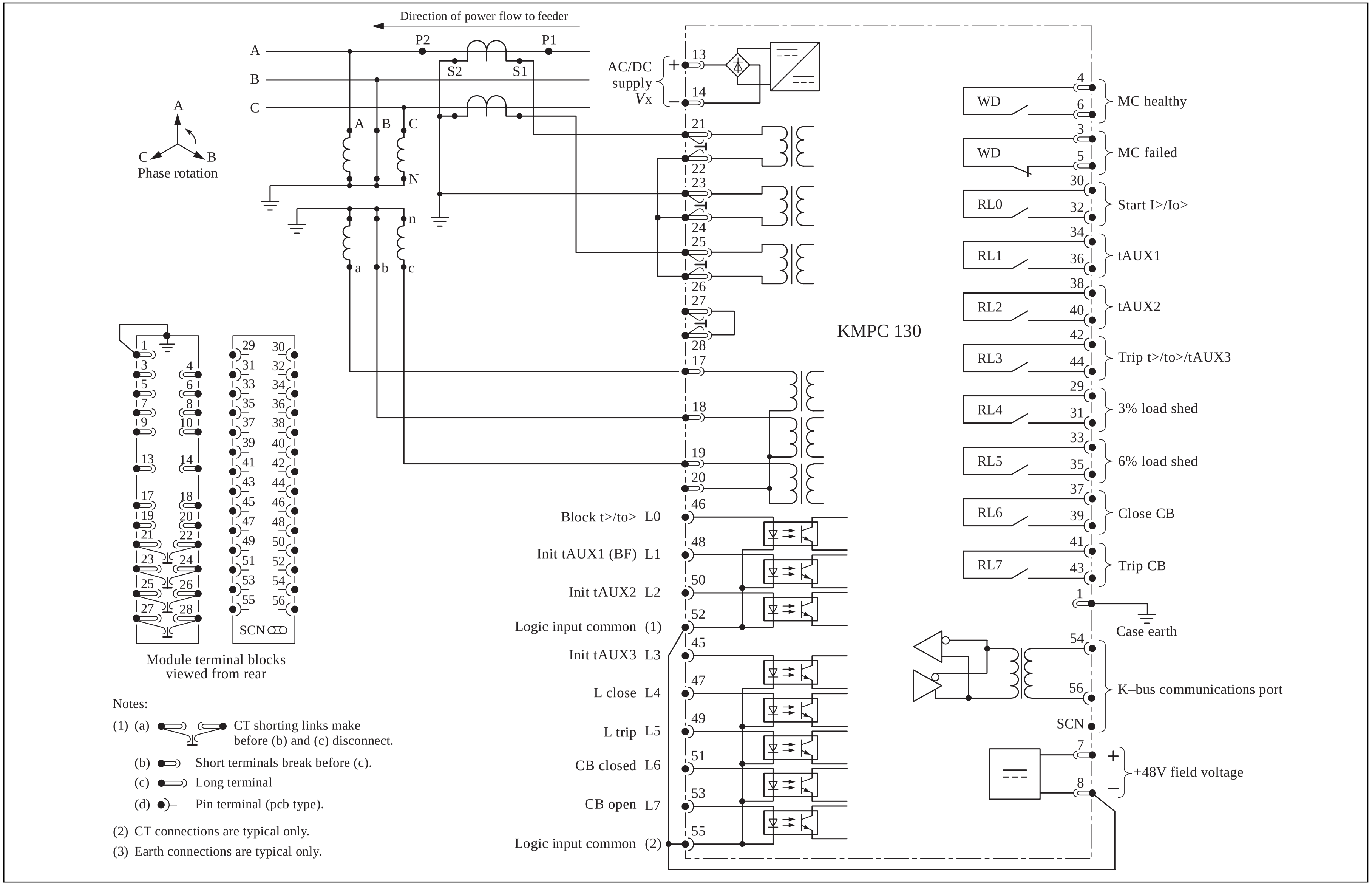

Figure 20. Application diagram: Midos measurement centre Type KMPC 130 2 CT and 2VT connection.

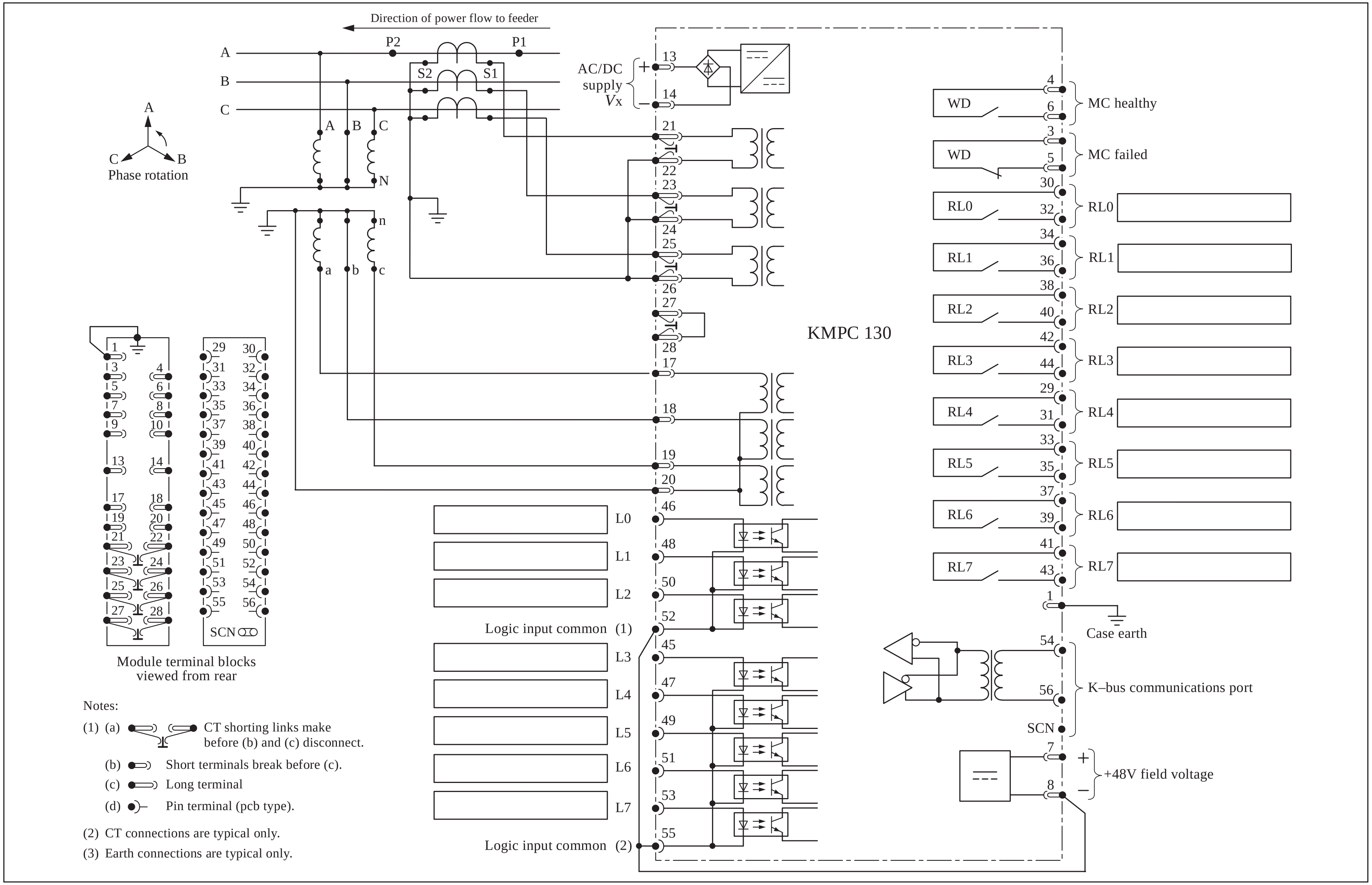

Figure 21. Application diagram: Midos 3 phase measurement centre Type KMPC 130.

REPAIR FORM

Please complete this form and return it to GEC ALSTHOM T&D PROTECTION & CONTROL LIMITED with the equipment to be repaired. This form may also be used in the case of application queries.

GEC ALSTHOM T&D PROTECTION & CONTROL LIMITED
St. Leonards Works
Stafford
ST17 4LX,
England

For: After Sales Service Department

Customer Ref: ____________________ Model No: ____________________

GECA Contract Ref: ____________________ Serial No: ____________________

Date: ____________________

1. What parameters were in use at the time the fault occurred?

   AC volts ______________ Main VT/Test set

   DC volts ______________ Battery/Power supply

   AC current ______________ Main CT/Test set

   Frequency ______________

2. Which type of test was being used? ____

3. Were all the external components fitted where required? Yes/No
   (Delete as appropriate.)

4. List the relay settings being used

   ____

   ____

   ____

5. What did you expect to happen?

   ____

   ____

   ____

   ____

continued overleaf

6. What did happen?

____

____

____

____

7. When did the fault occur?

Instant	Yes/No	Intermittent	Yes/No
Time delayed	Yes/No	(Delete as appropriate).	

By how long? ___________

8. What indications if any did the relay show?

____

____

____

9. Was there any visual damage?

____

____

____

10. Any other remarks which may be useful:

____

____

____

Signature	Title
Name (in capitals)	Company name

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