MSCDN – MP2A

Capacitor unbalance protection

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

2010/02	Document reformat due to rebrand
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Software Revision History

26/02/2006	2621H80002R9	

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1 Introduction

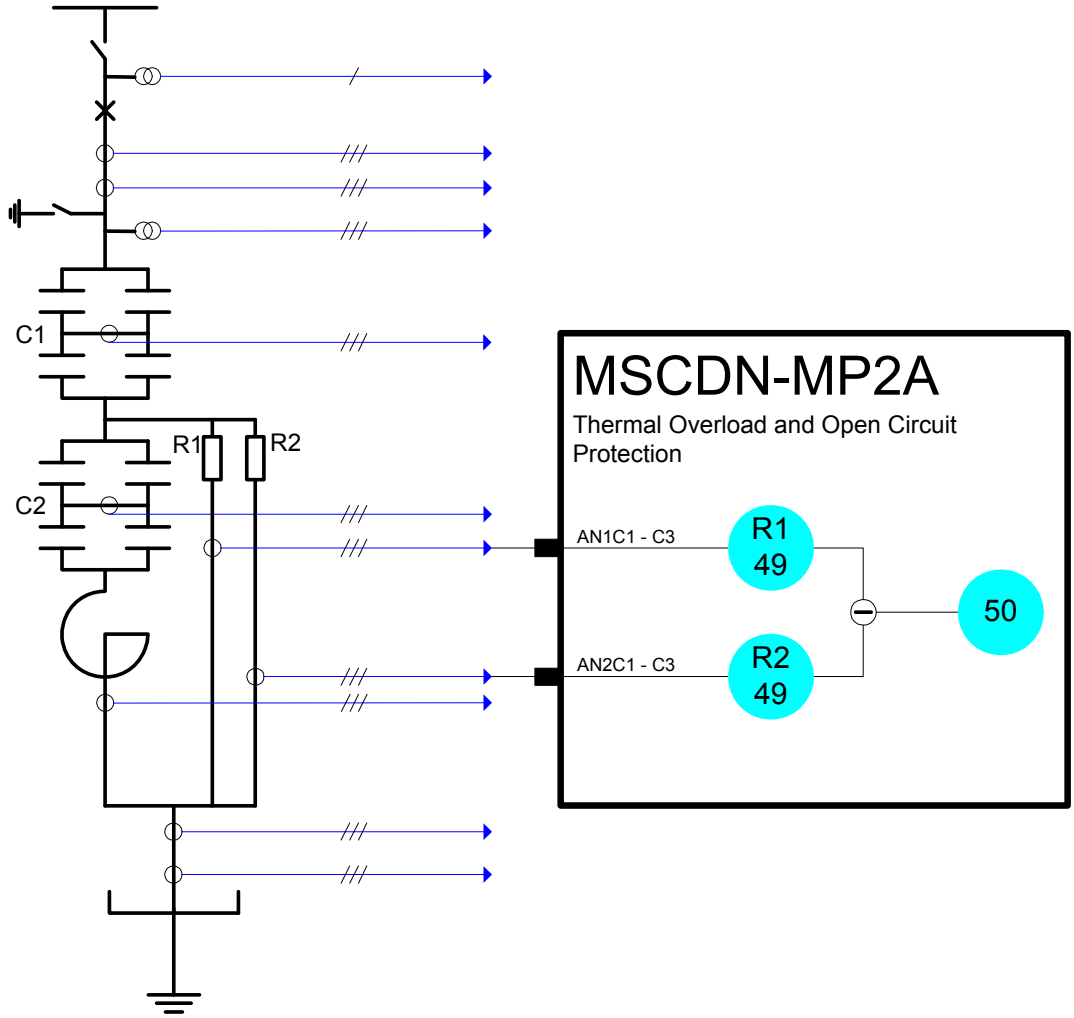

Figure 1 – MSCDN-MP2A Overview

The MSCDN-MP2A relay provides wide bandwidth, true RMS phase by phase thermal Overcurrent protection and open circuit protection for the damping resistors in a mechanically switched capacitor bank. Together with its sister units MSCDN-MP1 and MP2B, this protection unit offers a complete solution for Main 1 and Main 2 protection of EHV capacitor banks.

2 Hardware Description

2.1 General

The structure of the relay is based upon the Modular II hardware and software platform illustrated in Figure 2 where the required cards plug in from the front after opening the front fascia. Modules are interconnected by means of ribbon cable. The relay can be supplied in standard Epsilon case size E12 or E16. The Modular II design provides commonality between products and spare parts across a range of protection and control relays including Duobias, Ohmega, Delta, Tau and Iota.

Typical Configuration :

Analogue Inputs	Status Inputs	Output Relays	Case
8	11	13	E12

Each analogue module requires three inputs; for measuring the CT secondary line currents from each of the three phases A, B and C.

The unit consists of the following modules:

1) Two Wide Bandwidth Analogue Input modules (4 x I per module)

2) One Controller CPU module

3) One Power Supply and Basic I/O module

4) One Output relay/Status Input Module

5) One Front Fascia

2.2 Analogue Inputs

Two analogue modules are used in the case style E16. Each module consists of up to 4 channels of current.

In order to ensure high accuracy true RMS measurements over a wide bandwidth and accurate phase and slip frequency calculations, the current signals are sampled at 32 samples per cycle.

2.3 Status Inputs

The relay may be fitted with up to 27 status inputs. The user can program the relay to use any status input for any function. A timer is associated with each input and a pickup time setting may be applied to each input. In addition each input may be logically inverted to allow easy integration of the relay within the user scheme. Each input may be mapped to any front Fascia LED and/or to any Output Relay contact. This allows the Relay to act as panel indication for alarms and scheme status without having to use additional external flagging elements.

2.4 Output Relays

The relay is fitted with up to 29 output relays, all of which are capable of handling circuit breaker tripping duty. All relays are fully user configurable and can be programmed to operate from any or all of the control functions. There are three relays on the Power Supply/Basic I/O module that have C/O contacts and 2 with N/O contacts. Additional modules are fitted with 8 N/O contacts although N/C contacts are available as an option.

In their normal mode of operation output relays remain energised for a minimum of 100msec and a maximum dependent on the energising condition duration. If required, however, outputs can be programmed to operate as latching relays. These latched outputs can be reset by either pressing the TEST/RESET button, or by sending an appropriate communications command.

The operation of the contacts can be simply checked by using the Protection Healthy setting on the Output Relay Menu to energise each relay in turn. Do not forget to reset this setting back to its correct value.

The output relays can be used to operate the trip coils of the circuit breaker directly if the circuit breaker auxiliary contacts are used to break the trip coil current and the contact rating of the relay output contacts is not exceeded for 'make and carry' currents.

With a failed breaker condition the current 'break' may be transferred to the relay output contacts and where this level is above the break rating of the contacts an auxiliary relay with heavy-duty contacts should be utilised.

2.5 Fascia LEDS

In the E12 and E16 case there are 32 user programmable LED flag indicators. By opening the front panel it is possible to insert a strip into a slip in pocket, which provides legend information about the meaning of each LED. The legend may be specified when ordering the relay or alternatively the user can create a customized legend. The user can customise which LED is used for which purpose as well as being able to program each LED as being latching or self –resetting.

2.6 Self Monitoring

The relay incorporates a number of self-monitoring features. Each of these features can initiate a controlled reset recovery sequence, which can be used to generate an alarm output. In addition, the Protection Healthy LED will give visual indication.

A watchdog timer continuously monitors the microprocessor. If the software fails to service the watchdog timer the watchdog will time out and cause a reset.

The Output Relay modules are blocked in hardware if the watchdog timer expires.

Guard areas to intercept unintentional access surround the memory locations that control the Output Relays.

Additionally the Output Relay modules incorporate an operational timeout feature, which prevents output contacts from being held energised if the microprocessor fails to service them.

The voltage rails are also continuously supervised and the microprocessor is reset if any of the rails falls outside of their working ranges. Any failure is detected in sufficient time so that the micro can be shut down in a safe and controlled manner.

The program memory is supervised by a CRC check which runs continuously to verify its contents.

2.6.1 Protection Healthy/Defective

The normally closed contacts of relay 1 are used to signal protection defective, whilst the normally open contacts are used to signal protection healthy. When the DC supply is not applied to the relay or a problem is detected with the operation of the relay then this relay is de-energised and the normally closed contacts make to provide an external alarm. When the relay has DC supply and it has successfully passed its self-checking procedure then the Protection Healthy contacts are made and the Protection Defective contacts are opened.

3 Protection Functions

3.1 Resistor R1 and R2 Thermal Overload (R1 49, R2 49)

The relay provides thermal overload protection for resistors R1 and R2. The elements, one per phase, use 32 samples/cycle to provide a flat frequency response up to 550 Hz and beyond. The elements are by default disabled by a setting. An external status input may also be programmed to inhibit the elements. The temperature of the protected equipment is not measured directly. Instead, thermal overload conditions are detected by calculating the RMS of the current flowing in each phase of the resistor.

Should the RMS current rise above a defined level (the Overload Setting) for a defined time (the operating time t), the system will be tripped to prevent damage.

Time to trip

$$t = \tau \times \ln\left\{\frac{\mathrm{I}^2 - \mathrm{I}_\mathrm{p}^2}{\mathrm{I}^2 - \left(k \times I_B\right)^2}\right\}$$

Where

I_P = Previous steady state current level

I_B = Basic current of resistor, typically the same as In

k = Multiplier resulting in the overload pickup setting k.IB

I = The measured resistor current

τ = Thermal time constant

Additionally, an alarm can be given if the thermal state of the system exceeds a specified percentage of the protected equipment's thermal capacity (Capacity Alarm).

The thermal state may be reset via an external status input.

3.2 Resistor R1 and R2 Open Circuit (50OC)

The resistor open circuit protection works by comparing the current in resistor R1 and resistor R2 on a phase-by-phase basis. Because the resistors are the same value then the current through each resistor should be equal. An instantaneous/time delayed Overcurrent element monitors the difference between the currents on a phase-by-phase basis. If the element operates then the resistor, which has the LOWEST current, is indicated on the Fascia leds. For an open circuit condition then this will be the faulty resistor. However if there has been a short circuit in a resistor then this will not be true. The waveform records should be downloaded to confirm the actual fault condition that has occurred.

An external status input may also be programmed to inhibit the element.

3.3 Trip Circuit Supervision

Status inputs on the relay can be used to supervise trip circuits while the associated circuit breakers (CB) are either open or closed. Since the status inputs can be programmed to operate output contacts and LED's, alarms can be also generated from this feature.

To use the function set 'Trip Cct Pickup Delay to the required value in the Reylogic Elements Menu and then map the 'Trip Circuit Fail' settings in the Output Relay Menu and LED Menu as required.

See the Applications Guide for more details on the trip circuit supervision scheme.

4 Other Features

4.1 Metering

The metering feature provides real-time data available from the relay fascia in the 'Instruments Mode' or via the communications interface.

The following displays are available:

RMS Resistor currents (primary and nominal)

RMS Resistor Open Circuit currents (nominal difference between R1 & R2)

Digital input status

Output relay status

Time and Date

4.2 Data Storage

4.2.1 General

Details of relay operation are recorded in three forms, namely Waveform records, Event records and Fault Data records. All records are time and date stamped with a resolution of one millisecond.

4.2.2 Waveform Records.

The waveform record feature stores analogue and digital information for the current inputs, status inputs and output relays and LED's.

The waveforms are stored with a sampling resolution of 16 samples per cycle. The waveform recorder has the ability to store records for the previous four trip operations of the relay. These are labelled 1-4 with 1 being the most recent record. This however, can be altered using the 'Record Duration' setting, which offers the following selection:

- Four records of one-second duration.
- Two records of two seconds duration.
- One record of five seconds duration.

The waveform recorder will be triggered automatically when any protection element operates. It can also be triggered by any of the following means:

- The 'Trigger Storage" status input signal.
- The IEC870-5-103 communications interface.

The waveform recorder has a settable pre-fault triggering capability.

4.2.3 Event Records

The event recorder feature allows the time tagging of any change of state (Event) of the relay. As an event occurs the actual event condition is logged as a record along with a time and date stamp to a resolution of 1 millisecond. There is capacity for a maximum of 500 event records that can be stored in the relay and when the event buffer is full any new record will over-write the oldest. The following events are logged:

- Change of state of Output Relays.
- Change of state of Status Inputs.
- Change of Settings and Settings Group
- Change of state of any of the control functions of the relay.

4.2.4 Fault Recording

The led flag configuration, date and time of the last five faults are recorded for display via the Fascia LCD.

Note: the real-time clock, waveform records and event records are all maintained, in the event of loss of auxiliary D.C. supply voltage, by the backup storage capacitor. This capacitor has the ability to maintain the charges on the real-time clock IC and the SRAM memory device for typically 2-3 weeks time duration. This time, however, is influenced by factors such as temperature and the age of the capacitor and could be shorter.

4.3 Time Synchronisation

Time and date can be set either via the relay fascia using appropriate commands in the System Config menu or via an IRIG-B input or via the communications interface

4.3.1 IRIG-B Time Synchronisation

A BNC connector on the relay rear provides an isolated IRIG-B GPS time synchronisation port. The IRIG-B input expects an modulated 3-6 Volt signal and provides time synchronisation to the nearest millisecond.

4.3.2 IEC 60870-5-103 Time Synchronisation

Relays connected individually or in a ring or star configuration can be directly time synchronised using the IEC 60870-5-103 global time synchronisation. This can be from a dedicated substation automation system or from Reydisp Evolution Communications Support Software.

4.3.3 Real Time Clock Time Synchronisation

In the absence of IRIG-B and IEC60870 time synchronisation the relay contains a year 2000 compatible real time clock circuit which maintains real time in the absence of DC supply (See Note).

4.4 Communications

Two fibre optic communication ports, COM 1 and COM 2b are provided at the rear of the relay, which give superior EMC performance. An isolated RS232 port, COM 2a is provided at the front of the relay for local access using a PC.

Communication is compatible with the IEC870-5-103 FT 1.2 transmission and application standards. For communication with the relay via a PC (personal computer) a user-friendly software package, REYDISP EVOLUTION, is available to allow transfer of the following:

Relay Settings

Waveform Records

Event Records

Fault Data Records

Instrument and meters

Control Functions

Communications operation is described in detail in Section 4 of this manual. For information about all aspects of the communications protocol used in the Modular II range of relays see [2].

4.5 Settings Groups

Depending upon the relay model then up to four alternative setting groups are provided, making it possible to edit one group while the relay protection algorithms operate using another ‘active’ group. An indication of which group is being viewed is given by the ‘Gn’ character in the top left of the display. Settings that do not indicate Gn in the top left corner of the LCD are common to all groups.

A change of group can be achieved either locally at the relay fascia or remotely via a communication interface command.

4.6 Password Feature

The programmable password feature enables the user to enter a 4 character alpha code to secure access to the relay settings. The relay is supplied with the password set to 'NOT ACTIVE', which means that the password feature is disabled. The password must be entered twice as a security measure against accident changes. Once a password has been entered then it will be required thereafter to change settings. It can, however, be de-activated by using the password to gain access and by entering the password 'NONE'. Again this must be entered twice to de-activate the security system.

As soon as the user attempts to change a setting the password is requested before any setting alterations are allowed. Once the password has been validated, the user is 'logged on' and any further changes can be made without re-entering the password. If no more changes are made within 1 hour then the user will automatically be 'logged off', re-enabling the password feature.

Note that the password validation screen also displays a numerical code. If the password is lost or forgotten, this code should be communicated to Siemens and the password can be retrieved.

If the code is 1966067850 then 4 spaces have been entered as the password. This is caused by ENTER being pressed three times on the Change Password setting screen. De-activate password using 'NOT ACTIVE' as described above if this was set un-intentionally.

5 User Interface

The user interface is designed to provide a user-friendly method of entering settings and retrieving data from the relay. The relay fascia includes a 20 character by 2 line, backlit, liquid crystal display (LCD), 32 light emitting diodes (LED) and 5 push buttons.

5.1 Liquid Crystal Display

The liquid crystal display is used to present settings, instrumentation and fault data in a textual format on a 2 lines by 20-character interface.

5.2 Back light Control

To conserve power the display backlighting is turned off if no push buttons are pressed for 5 minutes. After an hour the whole display is de-activated. A setting within the "SYSTEM CONFIG MENU" allows the timeout to be adjusted from 1 to 60 minutes and "OFF", which means the backlight is always on.

5.3 LED Indications

The following indications are provided:

Protection Healthy – Green LED.

This LED is solidly illuminated to indicate that DC volts have been applied to the relay and that the relay is operating correctly. If the internal relay watchdog detects a protection relay unhealthy condition then this LED will continuously flash.

Programmable – Red LED.

An LED MENU is provided to map any output to any LED.

5.4 Keypad

Five pushbuttons are used to control the functions of the relay. They are labelled ⇧, ⇩,⇨ **ENTER** and **CANCEL**. Note that the ⇨ button is also labelled **TEST/RESET**.

When the relay front cover is in place only the ⇩ and ⇨ buttons are accessible. This allows only read access to all the menu displays.

5.5 Relay Identifier

The Relay Identifier setting in the SYSTEM CONFIG MENU may be used to place a circuit identifier of up to 16 alphanumeric characters onto the relay fascia e.g. BOLDON SGT1. This information is also returned as part of the System Information command from Reydisp Evolution Communications Support Software.

5.6 Settings Mode

5.6.1 Settings Adjustment

The push buttons on the fascia are used to display the relay settings, display the operating signals, e.g. currents, on the LCD and to reset the fault records and flag indication on the LCDs. There are five push buttons marked read-up, read-down, enter, cancel, and right/test/reset only two of which are accessible when the relay cover is on, namely read-down and right/rest/reset.

⇩ READ DOWN / DECREMENT

In the Settings Display this push-button is used for scrolling down through a list of settings or signals.

In Settings Modification mode it is used for selecting the next value of (or decreasing) the displayed setting or for deselecting a bit position in a particular control setting.

⇧ READ UP / INCREMENT

In Settings Display or Signal Displays this push-button is used for scrolling back up through a list of settings or signals.

In Settings Modification mode it is used for selecting the previous value of (or increasing) the displayed setting or for selecting a bit position in a particular control setting.

ENTER

This push-button is used when the cover is removed to select between two modes of operation namely Settings Display or Settings Modification.

When this push-button is pressed and a relay setting is being displayed part of the display will flash to indicate that the setting being displayed can be modified by using the ⇧ **INCREMENT** or ⇩ **DECREMENT** keys on the facia.

When the required value of the setting has been established, it may be entered into the relay and acted upon by pressing the **ENTER** key again.

CANCEL

This push-button is used when the cover is removed to return the relay display to its initial status. It can be used to reject any alterations to the setting being modified provided the **ENTER** key has not been pressed to accept the changes.

⇨ TEST/RETEST

This push-button is used to reset the fault indication on the LEDs on the fascia it also acts as a lamp test button because when pressed all of the LEDs will momentarily light up to indicate their correct operation.

The ⇩ **READ DOWN** and ⇧ **READ UP** push-buttons may then be used to scroll through the various signals.

5.6.2 Settings And Displays

The display menu structure is shown in Figure 4. This diagram shows the three main modes of display, which are the Settings Mode, Instruments Mode and the Fault Data Mode.

When the relay is first energised the user is presented with the following message,

SETTINGS DEFAULTED PRESS ENTER

Which shows that the relay has been set with the standard factory default settings. If this message is displayed ENTER must be pressed to acknowledge this initial condition, the display will then indicate the relay software variant. e.g.

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Pressing the ⇨**TEST/RESET** key on this display initiates an LED test. Pressing ⇩ **READ DOWN** at this display allows access to the three display modes, which are accessed in turn by pressing the ⇨ **TEST/RESET** key.

The Settings Mode contains 15 setting sub-menu's. These hold all of the programmable settings of the relay in separate logical groups. The sub menus are accessed by pressing the key. This enters the sub menu and presents a list of all the settings within that sub menu. Pressing ⇩ **READ DOWN** scrolls through the settings until after the last setting in the group the next sub menu is presented. Access to this group is via the same method as before. Pressing ⇩ **READ DOWN** will skip past a menu and present the next one in the list. Note that all screens can be viewed even if the password is not known. The password only protects against unauthorised changes to settings.

While viewing an editable screen pressing the **ENTER** key allows the user to change the displayed data. A flashing character(s) will indicate the editable field. Pressing ⇧ **INCREMENT** or ⇩ **DECREMENT** scrolls through the available setting values or, pressing ⇨**TEST/RESET** moves right through the edit fields. Note that all settings can be incremented or decremented using the ⇧ **INCREMENT** or ⇩ **DECREMENT** keys and they all wraparound so that to go from a setting minimum value to the maximum value it is quicker to press the ⇩ **DECREMENT** key, rather than scroll through every setting. Also, to facilitate quicker setting changes an acceleration feature is available which if ⇧ **INCREMENT** or ⇩ **DECREMENT** are depressed and held, then the rate of scrolling through the setting values increases.

If **ESCAPE/CANCEL** is pressed during a setting change operation the original setting value is restored and the display is returned to the normal view mode.

If changes are made to the setting value then pressing **ENTER** disables the flashing character mode and displays the new setting value. This is immediately stored in non-volatile memory.

The next sections give a description of each setting in the relay. The actual setting ranges and default values can be found in the Relay Settings section of this manual.

5.7 Instruments Mode

In INSTRUMENT MODE metering points can be displayed to aid with commissioning, the following meters are available

INSTRUMENT	DESCRIPTION
[R1 METERS] --> press down <--	Start of resistor 1 meters
R1 Primary Currents 0.0 0.0 0.0 kA	Resistor 1 primary currents
R1 Nom Currents 0.00 0.00 0.00 xIn	Resistor 1 secondary nominal currents
R1 Thermal Status 0.0 0.0 0.0 %	Resistor 1 thermal status
[R2 METERS] --> press down <--	Start of resistor 2 meters
R2 Primary Currents 0.0 0.0 0.0 kA	Resistor 2 primary currents
R2 Nom Currents 0.00 0.00 0.00 xIn	Resistor 2 secondary nominal currents
R2 Thermal Status 0.0 0.0 0.0 %	Resistor 2 thermal status
[OPEN CCT METERS] --> press down <--	Start of resistor open circuit meters
Open Cct Currents 0.00 0.00 0.00 xIn	Resistor open circuit nominal currents
[MISC METERS] --> press down <--	Start of miscellaneous meters
Status Inputs 1-16 ---- ---- ---- ----	Displays the state of DC status inputs 1 to 16[1]
Status Inputs 17-27 ---- ---- ---	Displays the state of DC status inputs 17 to 27[1]
Output Relays 1-16 ---- ---- ---- ----	Displays the state of output relays 1 to 16[2]
Output Relays 17-29 ---- ---- ---- -	Displays the state of output relays 17 to 29[2]
Time & Date 13/08/2002 10:16:11	Time and Date

1) Display is different when fewer status inputs are fitted

2) Display is different when fewer output relays are fitted

Note that meters not designated as primary or secondary values are usually displayed as multiples of nominal

i.e. x In, 1 Amp or 5 Amp.

5.7.1 Hidden Instruments

At the “INSRUMENTS MODE” title screen, pressing ENTER and DOWN simultaneously reveals some additional metering for calibration purposes. The reference channels as well as DC offsets may be displayed along with the RMS values in raw ADC counts. The relationship between current and ADC counts is 1.0 xIn = 600 counts.

5.8 Fault Data Mode

In “FAULT DATA MODE”, the time and date of relay operations are recorded together with a record of the LED flag states.

6 Diagrams

Figure 2 – Modular II Relay in E16 case with front panel open

Figure 3 – Modular II Relay Rear View

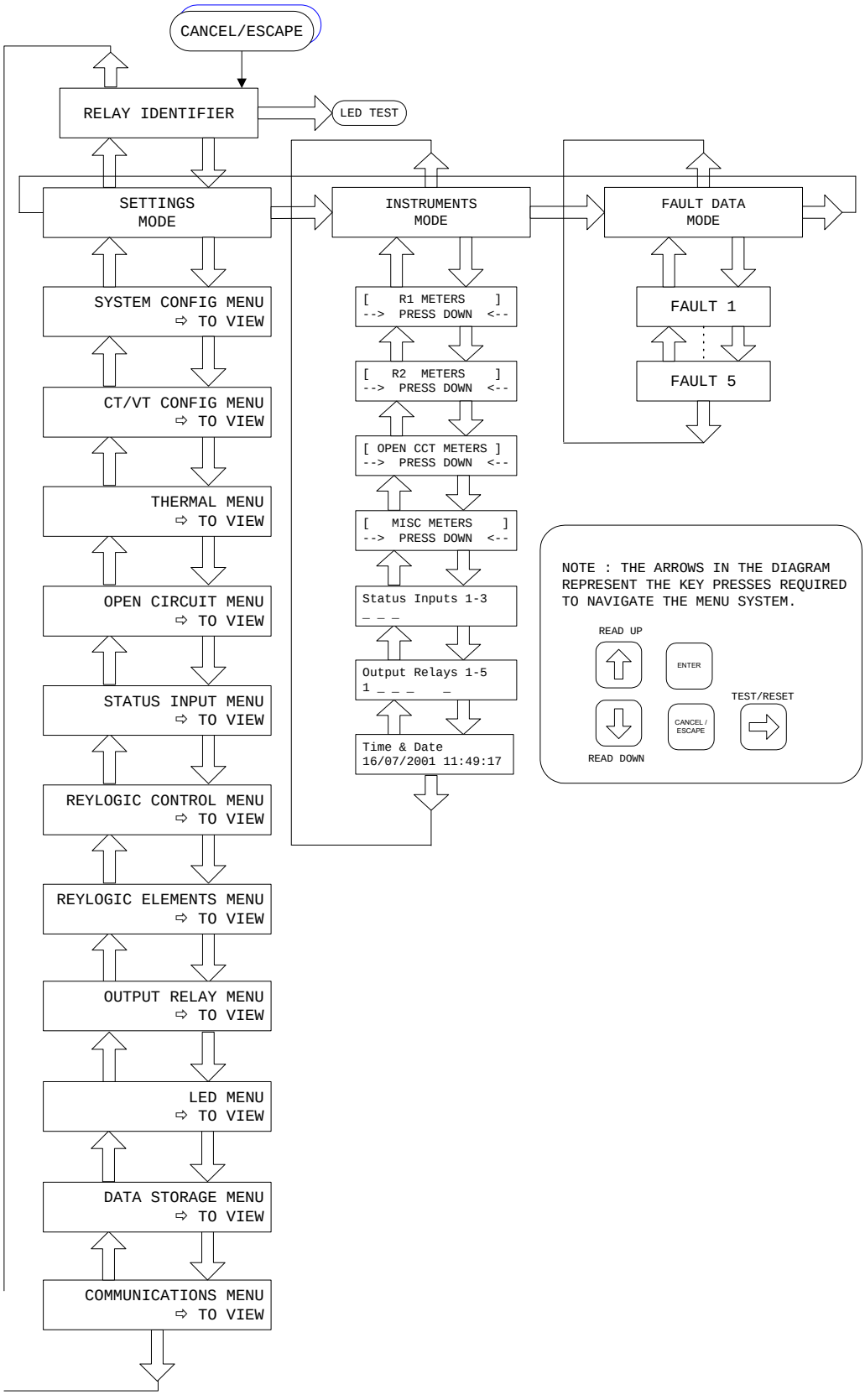

Figure 4 – Menu Structure