



# REYROLLE

## *2C73 User Guide*

### *High Impedance Differential Relay*

relay monitoring systems Pty Ltd

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**Advanced Protection Devices**



User Guide



Test Manual

# 2C73 User Guide

## About This Manual

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This User Guide covers all 2C73 relays manufactured from May 2007. Earlier relays do not necessarily incorporate all the features described. Our policy of continuous may means that extra features & functionality may have been added.

The 2C73 User Guide is designed as a generic document to describe the common operating parameters for all relays built on this platform. Some relay applications are described but for specific model information the individual "K" number Product / Test manuals should be consulted.

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## Contact Us

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© Relay Monitoring Systems Pty Ltd 2001-2008  
6 Anzed Court • Mulgrave 3170 • AUSTRALIA  
Phone 61 3 9561 0266 • Fax 61 3 9561 0277  
Email [rms@rmspl.com.au](mailto:rms@rmspl.com.au) • Web [www.rmspl.com.au](http://www.rmspl.com.au)

To download a PDF version of this guide:  
[http://www.rmspl.com.au/userguide/2c73\\_user\\_guide.pdf](http://www.rmspl.com.au/userguide/2c73_user_guide.pdf)

To download the model specific Test Manual:  
<http://www.rmspl.com.au/search.asp>

# How this guide is organised

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*This guide is divided into five parts:*

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## Part 1 Overview

About this Manual

Contents

Test Manual

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## Part 2 Mechanical Configuration

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## Part 3 Technical Bulletin

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## Part 4 Installation

Handling of Electronic Equipment

Safety

Unpacking

Accessories

Storage & Handling

Equipment Operating Conditions

Relay Dimensions & Other Mounting Accessories

Equipment Connections

Commissioning

Decommissioning & Disposal

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## Part 5 Maintenance

Mechanical Inspection

Test Intervals

Defect Report Form

## Test Manual

This User Guide covers all 2C73 relay versions & describes the generic features & attributes common across all versions.

Different relay versions are required to cater for varying customer requirements such as auxiliary voltage range, I/O configuration, case style, relay functionality etc.

The product ordering code described in the Technical Bulletin is used to generate a unique version of the relay specification & is called a type number. The type number takes the form 2C73Kxx where the Kxx is the “K” or version number.

Refer to: [www.rmspl.com.au/handbook/parta3.pdf](http://www.rmspl.com.au/handbook/parta3.pdf)  
for a complete description of the RMS “K” number system.

Each 2C73 version has a specific Test Manual which provides details on the unique attributes of the relay. Each Test Manual includes the following information:

- Test Certificate
- Specific technical variations from the standard model if applicable
- Test & calibration record
- Wiring diagram

A Test Manual is provided with each relay shipped.

If you require a copy of the Test Manual for an RMS product the following options are available:

- Check the RMS web site at: [www.rmspl.com.au/search.asp](http://www.rmspl.com.au/search.asp)
- RMS CD catalogue select: [List all Product/Test Manuals](#) under [Technical Library](#)
- Contact RMS or a representative & request a hard copy or PDF by email.

## Mechanical Configuration

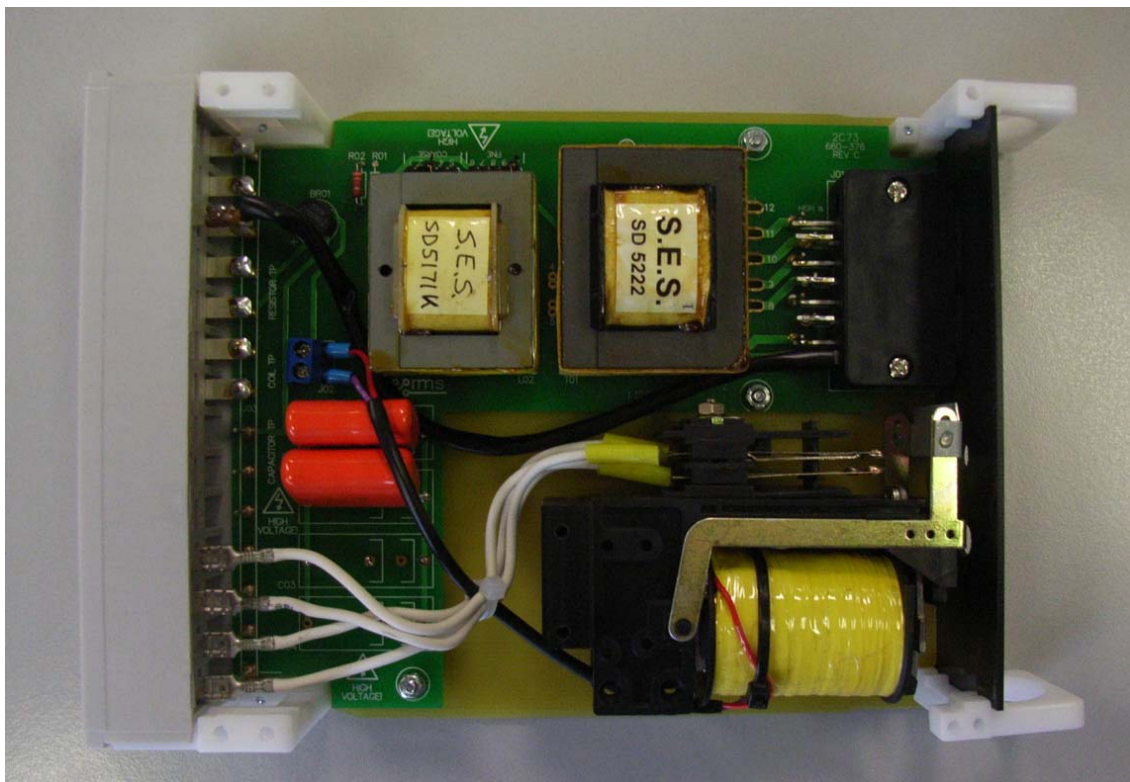
Great care has been taken to design a rugged, cost effective & flexible mechanical solution for the *MATRIX* range of RMS protection relays. The *MATRIX* range provides a compact draw out case solution with M4 screw terminals:

- 2M28 Size 2 with 28 terminals
- 4M28 Size 4 with 28 terminals
- 4M56 Size 4 with 56 terminals

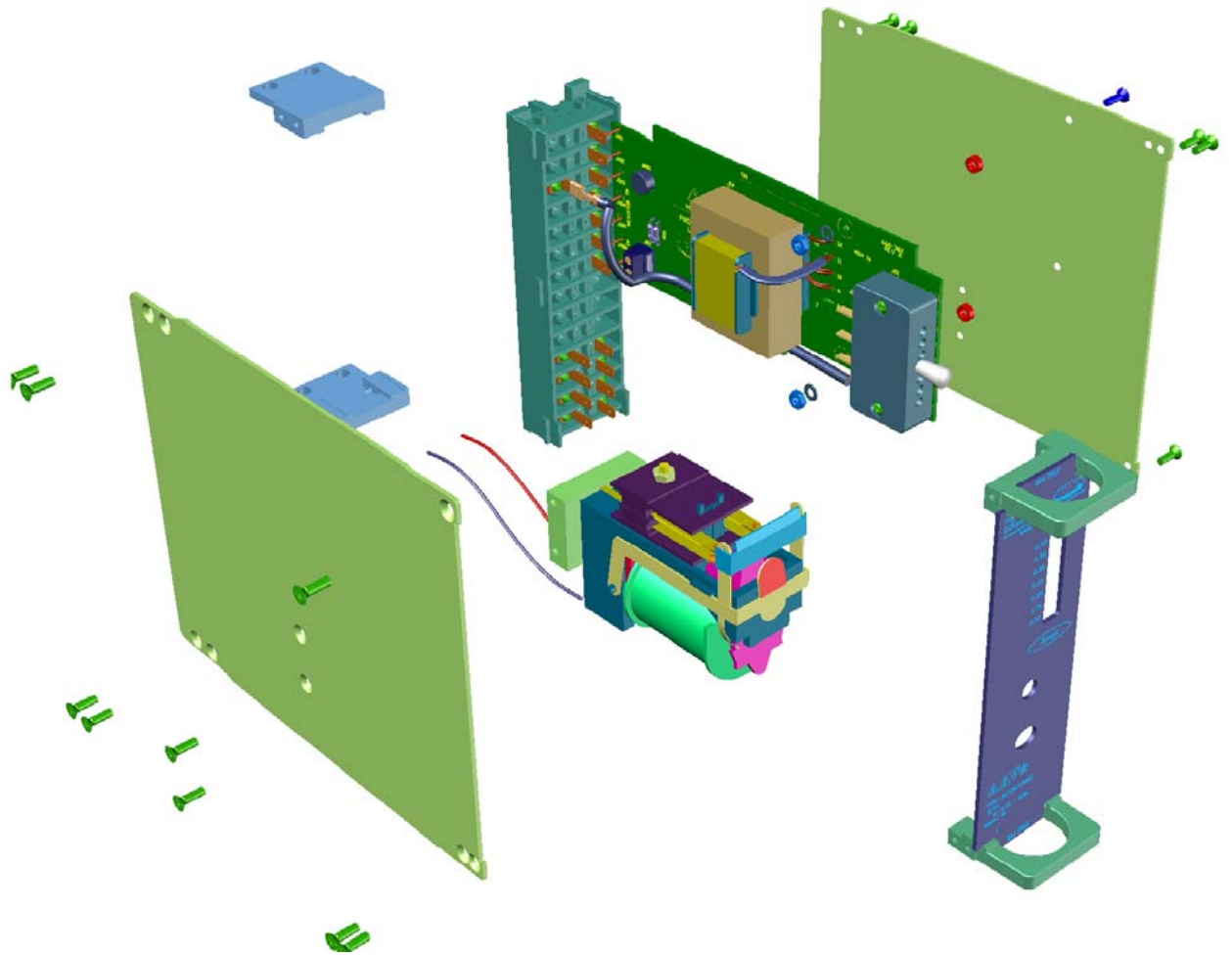
Complete details & attributes for the M (*MATRIX*) cases & accessories may be found at:

<http://www.rmspl.com.au/mseries.htm>

The 2C73 is configured in a 4M28 case & the following photographs depict the general mechanical configuration. It should be noted that re-usable JIS plastic threading (PT type) screws are used to bind the draw out relay module.



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2C73 relay assembly depicted in a 2M28 case

## Technical Bulletin

The detailed technical attributes, functional description & performance specifications for the 2C73 are described in the attached Technical Bulletin. For the most up to date version go to:

[www.rmspl.com.au/handbook/2c73.htm](http://www.rmspl.com.au/handbook/2c73.htm)

For any specific attributes of a particular version refer to the Test Manual for that type (K) number.

The order of precedence for technical information is as follows:

- Test Manual
- Fact Sheet
- User Guide

## Features

- High speed operation
- High sensitivity
- High stability for through faults
- Operating current set using 7 position plug bridge
- Optional 1A or 5A CT input
- Tuned to 50Hz or 60Hz
- 25ms operation at 5x setting
- Hand reset mechanical flag
- 2 heavy duty N/O trip contacts
- Rugged attracted armature sensing elements
- Use 3 independent units for 3 phase applications
- Size 2M draw out case

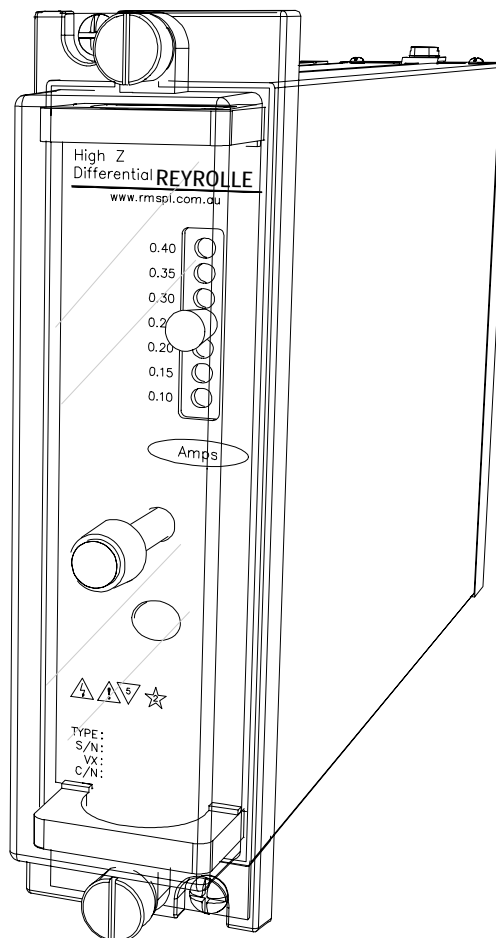
## Application

The 2C73 relay provides high speed differential protection for various items of power system plant including generators, busbars, motors & the individual windings of power transformers. It is also suitable for restricted earth fault protection applications.

When circulating current protection schemes are subjected to sudden & often asymmetrical growth in system currents due to through faults, the line current transformers can quickly reach saturation. In this condition, variation in transformer magnetizing characteristics can cause large ratio errors with a consequent circuit imbalance & false tripping of the protective relay scheme.

In order to ensure protection stability, a high impedance differential relay set to operate at a slightly higher voltage than that developed in the worst case of the above condition for a through fault current may be used. On a balanced earth fault system for example, this is when one CT of a group is saturated while the others remain unaffected. The saturated CT presents a low impedance path in parallel with the relay, which effectively limits the voltage applied to avoid operation. On internal faults however, this limitation does not exist & voltages of twice the relays pick up settings are easily reached.

The 2C73 relay is a single phase device built in a compact size 2M draw out case suitable for rack and flush mounting. Where 3 phase monitoring is required, 3 single phase units should be employed.



2C73 depicted in a 2M28 case

## Operation

The relay measuring element is basically an attracted armature unit of simple & rugged construction. The operating coil of this unit is connected in series with an inductor & capacitor forming a resonant circuit. These components are energised from a transformer which is tapped to provide current setting using the front panel mounted plug bridge. Removal of the setting plug bridge will result in the maximum current tap setting. The relay circuit is tuned to the supply frequency & rejects harmonics produced by current transformer saturation. A slight time delay on operation is provided to ensure stability on heavy external faults.

### RELATED EQUIPMENT

- ◆ Refer to the 2V75 Fact Sheets for details on the RMS Metrosil modules;
- ◆ Refer to the 1M123 & 1M124 Fact Sheets for details on complete BUS protection rack solutions;
- ◆ Refer to the 2V68 Fact Sheet for details on CT supervision applications;
- ◆ The 2C73 is a current operated relay. For a voltage operated version refer to the 2V73 Fact Sheet.



### RATED FREQUENCY

50Hz or 60Hz

### BURDEN

<1.2VA at pick up

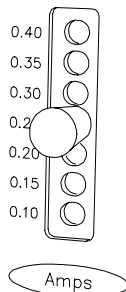
### STANDARD CURRENT SETTING RANGES

The 2C73 current setting range is determined by the setting range times the CT rating.

Current Setting		CT Rating	Front Label (Amps)	Setting Steps	
Order Code	Setting Range			%	Amps
AA#	10-40%	1	0.1-0.4*	7x 5%	0.05
AB#	10-40%	5	0.5-2.0	7x 5%	0.25
BA#	20-80%	1	0.2-0.8	7x 10%	0.1
CB#	20-80%	5	1.0-4.0	4x 20%	1.0
DA#	5-20%	1	0.05-0.2	7x 2.5%	0.025
DB#	5-20%	5	0.25-1.0	7x 2.5%	0.125
EA#	50-200%	1	0.5-2.0	7x 25%	0.25

Table 1

Adjustable via front panel plug bridge\*



### CT RATING

1A or 5A input rating

### PICK UP ACCURACY

+/-10% of setting at rated frequency

### HARMONIC REJECTION

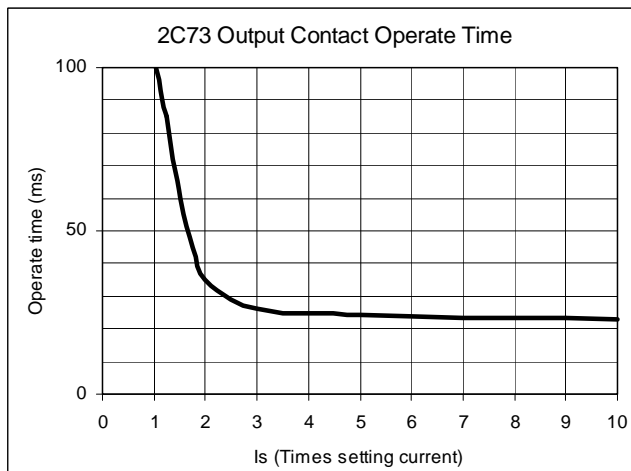
100Hz >10x setting required to pick up

150Hz >30x setting required to pick up

### OPERATE TIMES

Pick up: 25ms at 5x I<sub>s</sub>

The timing characteristic depicted below is intended to improve system security during transient conditions.



### THERMAL WITHSTAND – RELAY ALONE

5x tap setting to a maximum of 10A continuous  
20x tap setting for 3s

### AUTOMATIC CT SHORTING FACILITIES

While current setting changes would not normally be made with the relay energised, a CT shorting feature is incorporated. This automatically operates by shorting CT input terminal 5 to the maximum current tap setting when the front panel plug bridge is removed.

It should be noted that the CT input is also automatically shorted when the 2C73 module is withdrawn from the case. This feature may be used to take the 2C73 relay out of service.

### OUTPUT RELAY CONTACTS

2 N/O tripping duty contacts

### CONTACT RATINGS

#### Make & Carry Continuously

1,250 VA AC resistive with maximums of 300V & 5A

1,250 W DC resistive with maximums of 300V & 5A

#### Make & Carry for 3 Seconds

7,500 VA AC resistive with maximums of 300V & 30A

7,500 W DC resistive with maximums of 300V & 30A

#### AC Break Capacity

1,250VA AC resistive with maximums of 300V & 5A

#### DC Break Capacity

100W DC resistive with maximums of 300V & 5A

50W DC inductive with maximums of 300V & 5A

### OUTPUT RELAY OPERATION INDICATOR

Hand reset mechanical indicator

### TRANSIENT OVERVOLTAGE

Between all terminals & earth  
Between independent circuits without damage or flashover

### IEC60255-5 CLASS III

5kV 1.2/50us 0.5J

5kV 1.2/50us 0.5J

### INSULATION COORDINATION

Between all terminals & earth  
Between independent circuits  
Across normally open contacts

### IEC60255-5 CLASS III

2.0kV RMS for 1 minute

2.0kV RMS for 1 minute

1.0kV RMS for 1 minute

### HIGH FREQUENCY DISTURBANCE

2.5kV 1MHz common mode  
1.0kV 1MHz differential mode

### IEC60255-22-1 CLASS III

≤ 5% variation

### TEMPERATURE RANGE

Operating:

-5 to +55°C

Storage:

-25 to +75°C

### IEC68-2-1/2

### HUMIDITY

40°C & 95% RH non condensing

### IEC68-2-78

### CASE

Size 2M28-S draw out case

28 M4 screw terminals

Flush panel mount or 4U high 1/8 width 19 inch rack mount



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## CURRENT TRANSFORMERS (CT's)

The knee point voltage is defined as the point on the magnetization curve at which a 10% increase in excitation voltage produces a 50% increase in excitation current. The required stability voltage produces a 50% increase in excitation current. The required stability voltage setting ( $V_s$ ) minimum knee point voltage ( $V_k$ ) & maximum excitation current ( $I_e$ ) are calculated as follows:

$$V_{s'} \geq I_f (R_s + R_p)$$

$$V_{sA} = \frac{VA}{I_r} + I_r R_{sr}$$

$$V_k \geq 2V_{sA}$$

$$I_e = \frac{I_s - I_r}{n}$$

- $I_f$  = Max. secondary through fault current for which stability is required (RMS Amps)
- $I_s$  = effective fault setting expressed in secondary amps
- $I_r$  = relay setting current
- $R_s$  = CT secondary winding resistance
- $R_p$  = maximum loop lead resistance between CT's & relay
- $n$  = number of CT groups forming the protected zone for bus-zone differential protection
- $n$  = 2 for machine differential protection
- $n$  = 3 for restricted earth fault protection on delta windings
- $n$  = 4 for restricted earth fault protection on star windings
- $V_{sA}$  = Actual voltage setting

## Technical Data

### RECOMMENDED METROSIL's (Refer 2V75 Technical Bulletin)

An external Metrosil is required to limit the CT output voltage under an internal fault condition if  $V_p > 3kV$ . The voltage spike ( $V_p$ ) due to CT saturation is calculated from:

$$V_p = 2 \sqrt{2V k_a (V_f - V k_A)}$$

$$V_f = I_{f_{int}} (R_s + R_p + R_{sr} + \frac{VA}{I_r^2})$$

Where:

$I_{f_{int}}$  = maximum secondary internal fault current

$V k_A$  = actual CT knee – point voltage

Standard single disc Metrosils suitable for  $I_{f_{int}} < 50A$  RMS

### STABILISING RESISTORS (Refer 2V75 Technical Bulletin)

The appropriate value of series resistance ( $R_{sr}$ ) required to ensure stability is calculated as follows:

$$R_{sr} = \frac{V_{s'} - \frac{VA}{I_r}}{I_r}$$

Where:

$V_{s'}$  = minimum required stability voltage

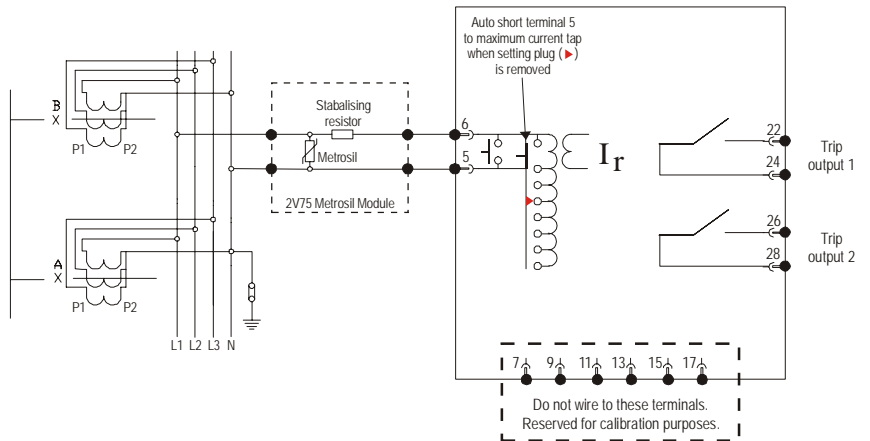
$VA$  = relay burden

$I_r$  = relay setting current

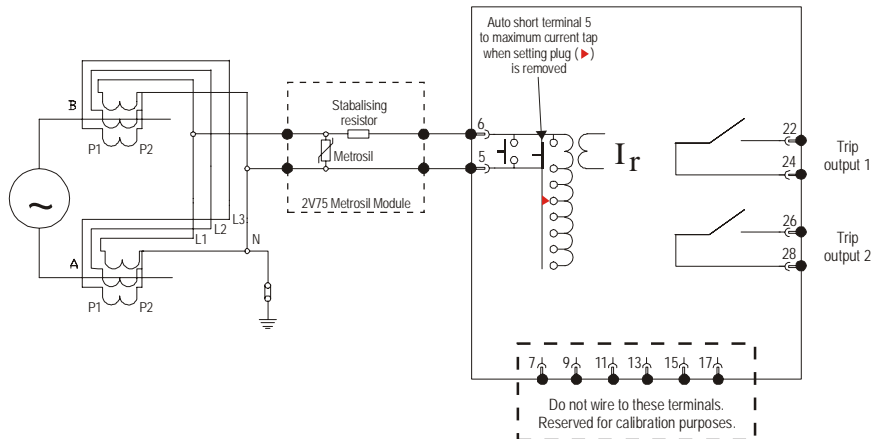
In certain applications there is no need to utilise stabilizing resistors in series with the 2C73 (Indicated by negative calculated stabilizing resistance value), the impedance of the relay element alone will offer adequate operational stability.



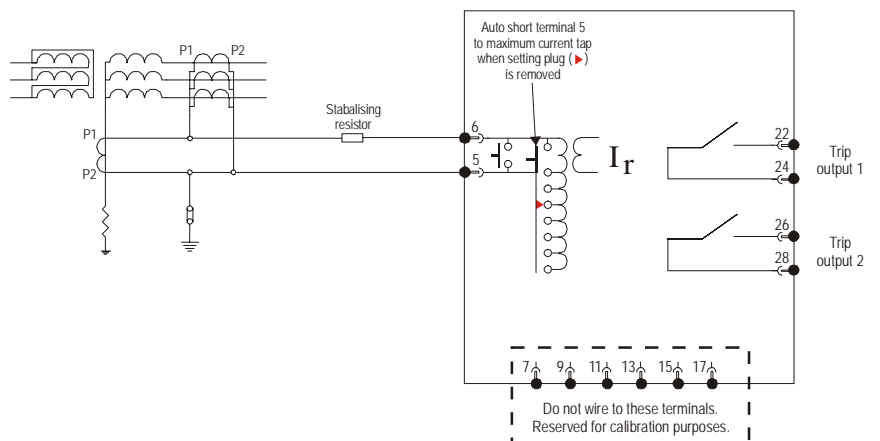
### High impedance differential BUS bar protection application (Use 3 units for 3 phase configuration)



### High impedance differential generator protection application (Use 3 units for 3 phase configuration)



### Restricted earth fault application

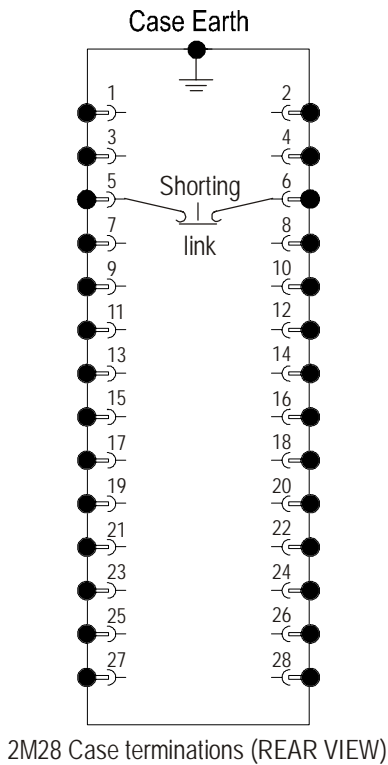


2C73 wiring diagrams - Relay shown in de-energised condition

## Ordering Information

Generate the required ordering code as follows: e.g. 2C73-ABA-R

General Type	Order Code			- R
	1	2	3	
2C73				



### 1 SETTING RANGE

- A 10 - 40% in 7x 5% steps
- B 20 - 80% in 7x 10% steps (1A CT only)
- C 20 - 80% in 4x 20% steps (5A CT only)
- D 5 - 20% in 7x 2.5% steps
- E 50 - 200% in 7x 25% steps (1A CT only)

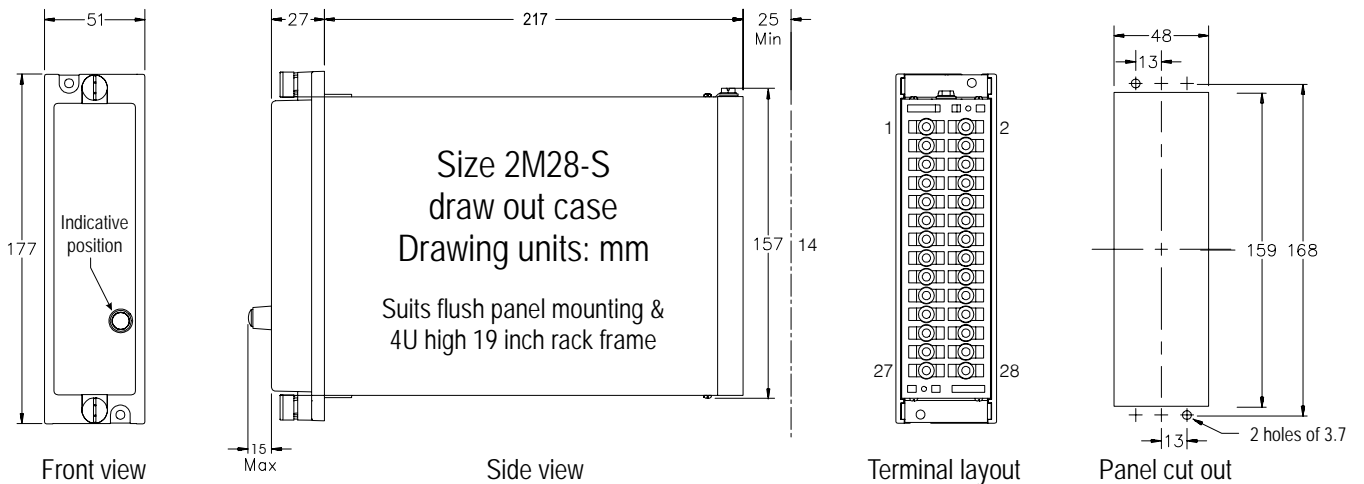
### 2 CT RATING

- A 1A
- B 5A

### 3 RATED FREQUENCY

- A 50Hz
- B 60Hz

Refer to the 2V75 Fact Sheet for details on combined Metrosil - resistor modules & loose components.



## Installation

### 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 of Relay Monitoring Systems Pty Ltd products are immune to the relevant levels of electrostatic discharge when housed in the case. Do not expose them to the 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 following 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 front-plate, frame, or edges of the printed circuit board.
3. Avoid touching the electronic components, printed circuit track or connectors.
4. Do not pass the module to any person without first ensuring that you are both at the same electrostatic potential. Shaking hands achieves equipotential.
5. Place the module on an antistatic surface, or on a conducting surface which is at the same potential as yourself.
6. 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 the build up of static.

Instrumentation which may be used for making measurements should be earthed to the case whenever possible.

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## Safety Section

**This Safety Section should be read before commencing any work on the equipment.**

The information in the Safety Section of the product documentation is intended to ensure that products are properly installed and handled in order to maintain them in a safe condition. It is assumed that everyone who will be associated with the equipment will be familiar with the contents of the Safety Section.

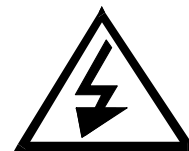
### Explanation of Symbols & Labels

The meaning of symbols and labels which may be used on the equipment or in the product documentation, is given below.

**Caution:** refer to product information

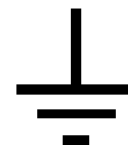


**Caution:** risk of electric shock



### Functional earth terminal

**Note:** this symbol may also be used for a protective/safety earth terminal if that terminal is part of a terminal block or sub-assembly eg. power supply.



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## Unpacking

Upon receipt inspect the outer shipping carton or pallet for obvious damage.

Remove the individually packaged relays and inspect the cartons for obvious damage.

To prevent the possible ingress of dirt the carton should not be opened until the relay is to be used. Refer to the following images for unpacking the relay:



Outer packing carton showing shipping documentation pouch.  
Address label on top of carton.



Inner packing carton showing front label detailing the customer name, order number, relay part number & description, the relay job number & packing date. (Size 2 inner packing carton depicted)

# REYROLLE

## Unpacking (Continued)



Inner packing carton with lid open showing protective foam insert.

CD depicted supplied with digital relay models or upon request at time of order.



Inner packing carton with protective foam insert removed showing relay location.



Where mechanical flags are fitted the yellow transit wedge must be removed before operation using a gentle twisting action. The wedge should be stored with the original packaging material.

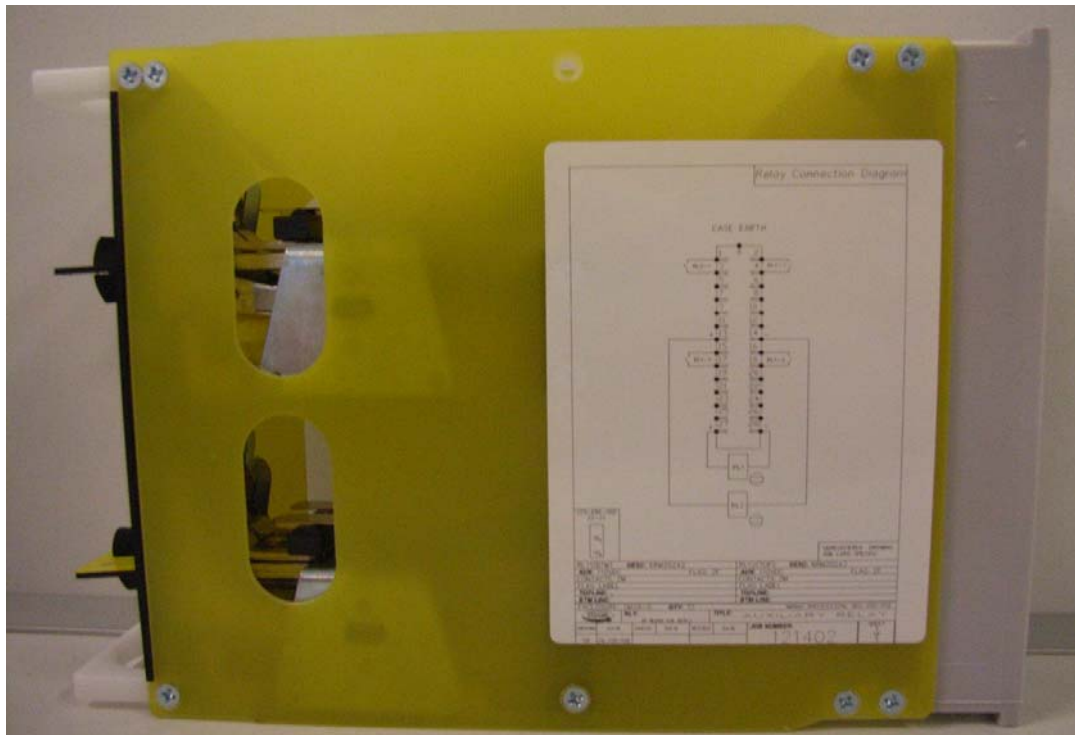


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## Relay Module Side Label Depicting Product Details



## Relay Module Side Label Depicting Wiring Diagram (6R MATRIX relays only)



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## Accessories Supplied With Each Relay



Self threading M4 mounting screws



M4 terminal screws with captured lock washers

## Storage & Handling

If damage has been sustained a claim should immediately be made against the carrier, also inform Relay Monitoring Systems Pty Ltd and the nearest RMS agent

When not required for immediate use, the relay should be returned to its original carton and stored in a clean, dry place.

Relays which 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 constructional work.

If relays are not installed immediately upon receipt they should be stored in a place free from dust and moisture in their original cartons.

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

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## Equipment Operating Conditions

The equipment should be operated within the specified electrical and environmental limits.

Protective relays, although generally of robust construction, require careful treatment prior to installation and a wise selection of site. By observing a few simple rules the possibility of premature failure is eliminated and a high degree of performance can be expected.

Care must be taken when unpacking and installing the relays so that none of the parts are damaged or their settings altered and must at all times be handled by skilled persons only.

Relays should be examined for any wedges, clamps, or rubber bands necessary to secure moving parts to prevent damage during transit and these should be removed after installation and before commissioning.

The relay should be mounted on the circuit breaker or panel to allow the operator the best access to the relay functions.

## Relay Dimensions & Other Mounting Accessories

Refer drawing in Technical Bulletin. Relevant Auto Cad files & details on other accessories such as 19 inch sub rack frames, semi projection mount kits & stud terminal kits may be down loaded from:

<http://www.rmspl.com.au/mseries.htm>

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## Equipment Connections

Personnel undertaking installation, commissioning or servicing work on this equipment should be aware of the correct working procedures to ensure safety. The product documentation should be consulted before installing, commissioning or servicing the equipment.

Terminals exposed during installation, commissioning and maintenance may present hazardous voltage unless the equipment is electrically isolated.

If there is unlocked access to the rear of the equipment, care should be taken by all personnel to avoid electric shock or energy hazards.

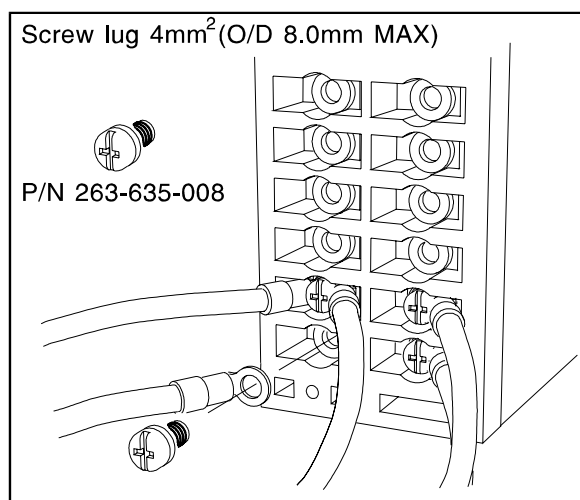
Voltage and current connections should be made using insulated crimp terminations to ensure that terminal block insulation requirements are maintained for safety. To ensure that wires are correctly terminated, the correct crimp terminal and tool for the wire size should be used.

Before energising the equipment it must be earthed using the protective earth terminal, or the appropriate termination of the supply plug in the case of plug connected equipment. Omitting or disconnecting the equipment earth may cause a safety hazard.

The recommended minimum earth wire size is 2.5mm<sup>2</sup>, unless otherwise stated in the technical data section of the product documentation.

Before energising the equipment, the following should be checked:

1. Voltage rating and polarity;
2. CT circuit rating and integrity of connections;
3. Protective fuse rating;
4. Integrity of earth connection (where applicable)



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## **Current Transformer Circuits**

Do not open the secondary circuit of a live CT since the high voltage produced may be lethal to personnel and could damage insulation.

## **External Resistors**

Where external resistors are fitted to relays, these may present a risk of electric shock or burns, if touched.

## **Insulation & Dielectric Strength Testing**

Insulation testing may leave capacitors charged up to a hazardous voltage. At the end of each part of the test, the voltage should be gradually reduced to zero, to discharge capacitors, before the test leads are disconnected.

## **Insertion of Modules**

These must not be inserted into or withdrawn from equipment whilst it is energised, since this may result in damage.

## **Electrical Adjustments**

Pieces of equipment which require direct physical adjustments to their operating mechanism to change current or voltage settings, should have the electrical power removed before making the change, to avoid any risk of electric shock.

## **Mechanical Adjustments**

The electrical power to the relay contacts should be removed before checking any mechanical settings, to avoid any risk of electric shock.

## **Draw Out Case Relays**

Removal of the cover on equipment incorporating electromechanical operating elements, may expose hazardous live parts such as relay contacts.

## **Insertion & Withdrawal of Heavy Current Test Plugs**

When using a heavy current test plug, CT shorting links must be in place before insertion or removal, to avoid potentially lethal voltages.

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## **Commissioning Preliminaries**

Carefully examine the module and case to see that no damage has occurred during transit. Check that the relay serial number on the module, case and cover are identical, and that the model number and rating information are correct.

Carefully remove any elastic bands/packing fitting for transportation purposes.

Check that the external wiring is correct to the relevant relay diagram or scheme diagram. The relay diagram number appears inside the case.

Particular attention should be paid to the correct wiring and value of any external resistors indicated on the wiring diagram/relay rating information.

Note that shorting switches shown on the relay diagram are fitted internally across the relevant case terminals and close when the module is withdrawn. It is essential that such switches are fitted across all CT circuits.

If a test block system is to be employed, the connections should be checked to the scheme diagram, particularly that the supply connections are to the 'live' side of the test block.

## Earthing

Ensure that the case earthing connection above the rear terminal block, is used to connect the relay to a local earth bar.

## Insulation

The relay, and its associated wiring, may be insulation tested between:

- all electrically isolated circuits
- all circuits and earth

An electronic or brushless insulation tester should be used, having a dc voltage not exceeding 1000V. Accessible terminals of the same circuit should first be strapped together. Deliberate circuit earthing links, removed for the tests, subsequently must be replaced.

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## **Commissioning Tests**

If the relay is wired through a test block it is recommended that all secondary injection tests should be carried out using this block.

Ensure that the main system current transformers are shorted before isolating the relay from the current transformers in preparation for secondary injection tests.

## **DANGER**

**DO NOT OPEN CIRCUIT THE SECONDARY CIRCUIT OF A CURRENT TRANSFORMER SINCE THE HIGH VOLTAGE PRODUCED MAY BE LETHAL AND COULD DAMAGE INSULATION.**

It is assumed that the initial preliminary checks have been carried out.

## **Relay CT shorting switches**

With the relay removed from its case, check electrically that the CT shorting switch is closed.

## **Primary injection testings**

It is essential that primary injection testing is carried out to prove the correct polarity of current transformers.

Before commencing any primary injection testing it is essential to ensure that the circuit is dead, isolated from the remainder of the system and that only those earth connections associated with the primary test equipment are in position.

## **Decommissioning & Disposal**

**Decommissioning:** The auxiliary supply circuit in the relay may include capacitors across the supply or to earth. To avoid electric shock or energy hazards, after completely isolating the supplies to the relay (both poles of any dc supply), the capacitors should be safely discharged via the external terminals prior to decommissioning.

**Disposal:** It is recommended that incineration and disposal to water courses is avoided. The product should be disposed of in a safe manner.



## Maintenance

### Mechanical Inspection

#### Relay Assembly

Inspect the relay for obvious signs of damage or ingress of moisture or other contamination.

#### Relay Module

Isolate the relay, remove the front cover & carefully withdraw the relay module from the case.

Care must be taken to avoid subjecting the relay element to static discharge which may damage or degrade sensitive electronic components.

Inspect the relay module for signs of any overheating or burn marks which may have been caused by overvoltage surge or transient conditions on the power supply or digital status inputs.

Inspect the VT & CT stages for degradation of insulation on the terminal wiring & transformer windings.



Remove cover by unscrewing black thumb screws & withdraw the relay module from the case.  
Image at right shows module with side plate removed.



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# REYROLLE

## Relay Case

Inspect the outer terminals checking insulation integrity & tightness.

Inspect inside the case and use a blower to remove dust.

Inspect the inner terminals for worn, distorted or tarnished contacts and if necessary clean the contacts using a brush dipped in a suitable substance.



Outer case terminal block showing CT shorting link across terminal 5-6.

## **Test Intervals**

The maintenance tests required will largely depend upon experience and site conditions, but as a general rule it is recommended that the following inspection and tests are performed every twelve months.

- ◆ Mechanical Inspection
- ◆ Check of Connections
- ◆ Insulation Resistance Test
- ◆ Fault Setting Tests by Secondary Injection
- ◆ Tests using Load Current
- ◆ Check the continuity of the neutral CT loop with a bell test set or an ohmmeter



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Due to RMS continuous product improvement policy this information is subject to change without notice. 2C73\_User\_Guide-5/lss E/30/10/08

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## Defect Report Form

Please copy this sheet and use it to report any defect which may occur.

Customers Name & Address:	Contact Name:
	Telephone No:
	Fax No:
Supplied by:	Date when installed:
Site:	Circuit:

### When Defect Found

Date:	Commissioning?	Maintenance?	Systems Fault?	Other, Please State:
Product Part No:			Serial Number:	
Copy any message displayed by the relay:				
Describe Defect:				
Describe any other action taken:				
Signature:		Please Print Name:		Date:

### For RMS use only

Date Received:	Contact Name:	Reference No:	Date Acknowledged:	Date of Reply:	Date Cleared:
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