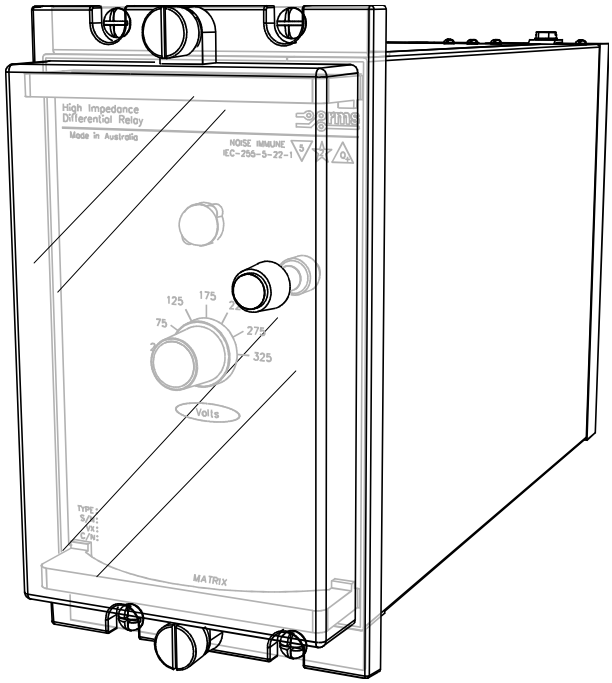
Technical bulletin

2V47

High Impedance Differential Relay

Features

- High speed operation
- High sensitivity
- Wide range of settings
- High stability
- 3 independent phase inputs
- Optional single phase relay
- 50Hz & 60Hz versions
- Insensitive to DC
- Common hand reset & separate magnetic disc flag (Permanent memory) for each phase
- Rugged attracted armature sensing elements
- Made in Australia



Single phase 2V47 in a size 4M rack mount case

Application

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 magnetising 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.

A block diagram of the relay is shown below:

Operation

Made in Australia

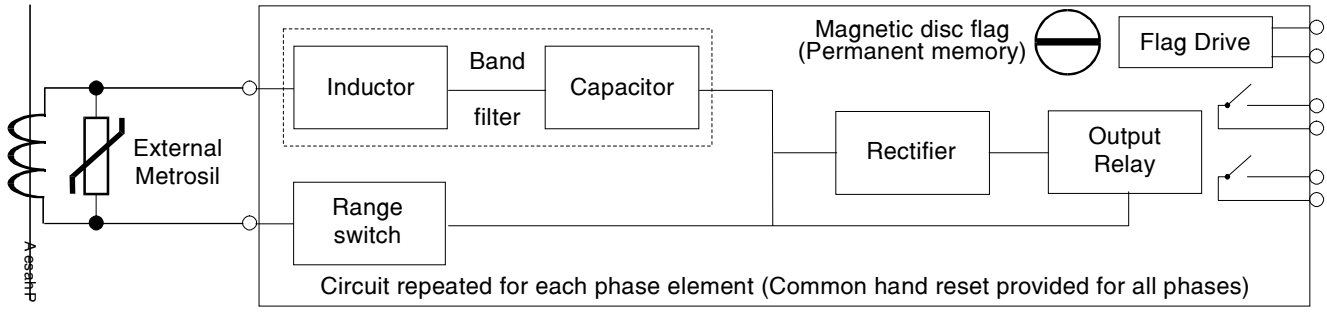
The 2V47 relay provides high speed differential protection for various items of power system plant including generators, busbars, motors & the individual windings of power transformers.

The relay measuring element is basically an attracted armature unit of simple & rugged construction powered from a bridge rectifier. Each phase of the relay can be set from 25 to 325V AC in 50V steps by using the front panel mounted selector switches. A capacitor is connected in series with the operating coil to make the relay insensitive to the DC component of fault current. The setting can thus be calculated in terms of RMS AC quantities without regard for the degree of offsets produced by the point on wave at which the fault occurs. An inductor connected in series with the capacitor forms a resonant circuit tuned to the relays rated frequency.

An external Metrosil unit having a non-linear resistance characteristic is required for each phase element to limit the peak voltage appearing across the secondary differential circuits under internal fault conditions. The type of Metrosil characteristic required is dependant on the relay setting range. For AC applications the following equation can be used to determine an approximate AC characteristic:

$$V = 0.84\ C\ (I)^{\beta}$$

V = RMS voltage, I = RMS Amps, C & β are fixed constants for the selected Metrosil.
For the setting range of 25 to 325V a Metrosil with C = 900 & β = 0.25 is suitable to provide a 400V continuous rating & current overload short time rating as follows: 22A for 3s, 30A for 2s & 39A for 1s.



AS/NZS ISO9001-94 REGISTRATION 6869

QUALITY MANAGEMENT SYSTEM ISO9001 NATA CERTIFIED

Technical Data

DERIVED RELAY POWER
During internal fault conditions, the relay & Metrosil current & the magnetising current of all the connected CT's is supplied from the fault current.

EFFECTIVE OPERATING CURRENT
The primary operating current is given by:

$$I_{op} = n (I_R + N I_\varnothing)$$

I_R = Relay operating current & Metrosil current at setting voltage as per the table below.
$I_\varnothing$ = CT magnetising current at setting voltage (A)
N = Number of connected CT's
n = CT turns ratio

Setting (V)	25	75	125	175	225	275	325
Nominal (A)	0.019	0.019	0.020	0.022	0.024	0.031	0.044
Limits (A)	0.018 to 0.020	0.018 to 0.020	0.018 to 0.022	0.019 to 0.025	0.019 to 0.033	0.022 to 0.048	0.028 to 0.076

Should the natural effective operating current after applying the above formula be lower that desired, it can be raised to the required level by adding a shunt resistor across the differential relay input circuit.

CURRENT TRANSFORMERS (CT's)
The 2V47 type relay is suitable for use with 0.5A,1A & 5A CT's at 50 or 60hZ. The CT's used in circulating current differential protection systems must be of equal turns ratio & have a reasonably low secondary winding resistance. The CT knee point voltage (Point on magnetisation curve at which a 10% increase in excitation voltage produces a 50% increase in excitation current) should be at least twice the voltage setting.

SELECTION OF OPTIMUM RELAY SETTING
The required relay setting (V_s) is calculated using the following formula:

$$V_s = \frac{I_f}{n}(R_{ct} + 2 R_w) \text{ Volts}$$

I_f = Max. primary through fault current for which stability is required (RMS Amps)
n = CT turns ratio
R_{ct} = CT secondary winding resistance (Ohms)
Rw = Resistance of each lead between the relay & CT (Ohms)

A value of Vs is calculated for each CT circuit in the differential system, & the relay setting finally chosen above the highest of these calculated values.

RECOMMENDED METROSIL's
6" 1 phase Type
6" 3 phase Type MT1-306 35KJ/s P/N 2105C58001
3" 1 phase Type
3" 3 phase Type MT1-303-REE198P 11KJ/s P/N 2105C58005

OPERATE TIME
20ms at 4 times I_s

RELEASE TIME
<50ms

AMBIENT OPERATING TEMPERATURE RANGE
-5 to 55 degrees C.

INSULATION WITHSTAND
In accordance with AS2481-1981 (clause 5-4), IEC 255-5: 2KV RMS between input & frame, output & frame, & output & input. 1.2/50 5KV impulse between each terminal & earth, between circuits not normally connected together & between terminals of the same circuit.

NOISE IMMUNITY
Withstands the high frequency interference test detailed in AS2481-1981 (clause 5-5 App. D), IEC 255-22-1.

OUTPUT RELAY CONTACTS
2 N/O per phase

6R RELAY CONTACT RATINGS
Make & Carry Continuously
3,000 VA AC resistive with maximums of 660V & 12A
3,000 VA DC resistive with maximums of 660V & 12A

Make & Carry for 0.5 Seconds
7,500 VA AC resistive with maximums of 660V & 30A
7,500 VA DC resistive with maximums of 660V & 30A

AC Break Capacity
3,000 VA AC resistive with maximums of 660V & 12A

DC Break Capacity (Amps)

Voltage			**24V**	**48V**	**125V**	**250V**
Resistive rating			12	1.5	0.5	0.25
L/R=40ms	Maximum break *		12	1	0.4	0.2

* As tested by Powernet Yarraville laboratories in Victoria.

OUTPUT RELAY OPERATION INDICATOR
Common hand reset with independent magnetic disc (permanent memory) per phase.

2V47 Options

Check the appropriate box under each section to accurately specify the relay configuration required & return with request for quotation:

2V47 Type Number if known: **K**____

RATED FREQUENCY
☐ 50Hz ☐ 60Hz

FLAG RESET VOLTAGE RANGE (Continuous burden)
☐ 24–150V DC (0.5W Max.) ☐ 140–250V DC (0.7W Max.)

ELEMENTS & ENCLOSURE STYLE (Refer Part B Section 6)
Single phase version
☐ Size 4 Case for rack mounting (4u high, 1/4 width)
☐ FSD Case for flush mounting in vertical format

Three phase version
☐ Size 8 Case for rack mounting (4u high, 1/4 width)
☐ FDD20 Case for flush mounting in horizontal format

CONNECTION TERMINALS
☐ 2BA studs
☐ 2BA screws

SPECIAL CUSTOMER LABELLING (* SPECIFY ANY 2)
☐ Not Required (Standard labelling)
☐ * Type No. _____
☐ * Order No. _____
☐ * Name: _____
☐ * Other: _____