Type MCAG 14, 34

High Stability Circulating Current Relay

The MCAG relay, used with a stabilising resistor, is designed for applications where sensitive settings with stability on heavy through faults are required, and is recommended for balanced and restricted earth fault, bus-zone and certain forms of differential protection for generators, auto-transformers, reactors and motors. The relay operates as a high impedance unit protection scheme.

The relay is an attracted armature unit of simple and robust construction. The operating coil of this unit is connected in series with a small choke and capacitor, forming a series resonant circuit. These components are energised from an auto-transformer which is tapped to provide seven current settings.

Due to the simple electromechanical construction, the detection element, and the output contacts are one and the same device. Operation is therefore fast, and highly reliable.

The relay circuit, tuned to the supply frequency, rejects the harmonics produced by current transformer saturation.

The total impedance of the relay and series stabilising resistor is usually low enough to prevent the current transformers developing voltages over 2kV during maximum internal faults, but in some applications a non-linear resistor is required to limit this voltage.

Types MCAG 14 and MCAG 34 relays are single and triple pole, respectively.

Customer Benefits

- High stability with through faults
- Tuned to rated frequency
- Operates in 25ms at 5 times setting

T&D

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APPLICATION

When circulating current protection schemes are subjected to heavy through faults, the sudden, and often asymmetrical growth in the system current can cause the protective current transformers to approach or even reach saturation level. This may result in a high unbalancing current due to the variations in the magnetising characteristics of the current transformers.

To ensure stability under these conditions, it is common practice to use a high impedance relay, set to operate at a voltage slightly higher than that developed by the current transformers under maximum external fault conditions.

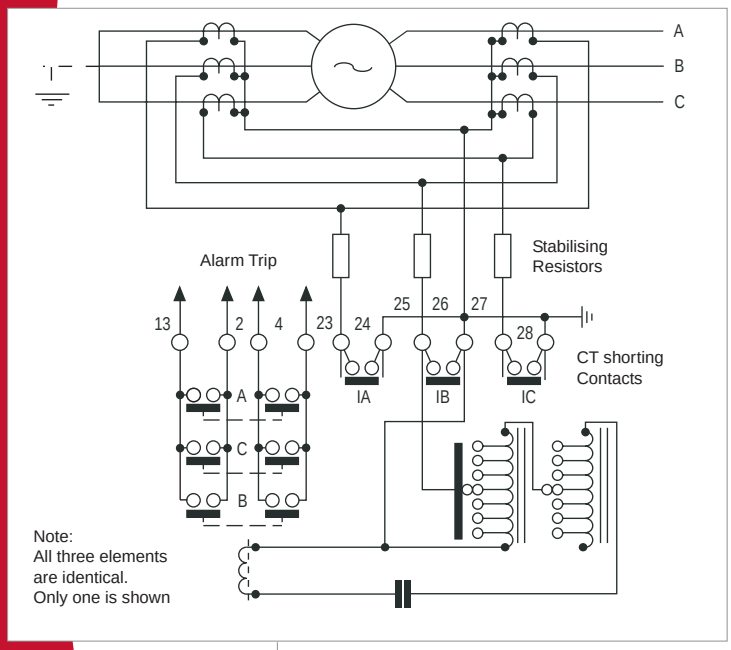
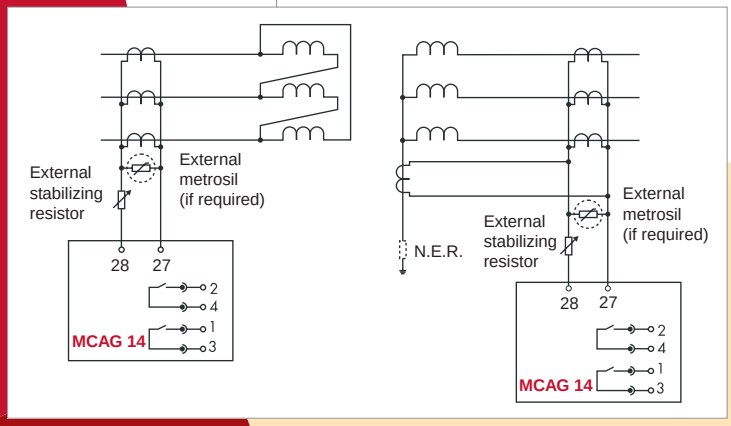


Figure 1 Internal and external circuit diagram for unbiased differential protection of generators, reactors and synchronous motors using type MCAG 34 relay

Figure 2 Type MCAG14 relays applied to restricted earth fault protection of power transformer



CURRENT TRANSFORMER REQUIREMENTS

MCAG relays are suitable for use with 0.5A, 1A and 5A current transformers, at 50Hz or 60Hz. Since selection of the optimum relay setting is based on the loop resistance of the secondary circuit, there are advantages in using current transformers with either of the lower secondary ratings.

The current transformers used in high impedance circulating current differential protection systems must be equal turns ratio and have reasonably low secondary winding resistance. Current transformers of similar magnetising characteristic with low reactance construction such as IEC60044 Class PX, or similar, are preferred. The relay requirements are based upon a calculation of the required knee-point voltage with the IEC definition of the knee-point voltage being the point on the magnetisation curve at which a 10% increase in excitation voltage produces a 50% increase in excitation current. The required stability voltage setting (Vs') and minimum knee-point voltage (Vk) are calculated as follows:

$$Vs' \geq If\,(Rs+Rp)$$

$$VsA = \frac{VA}{Ir} + Ir\,Rsr$$

$$Vk \geq 2VsA$$

Where

If	=	maximum secondary through fault current
Ir	=	relay setting current
Rct	=	CT secondary winding resistance
RP	=	maximum loop lead resistance between CTs and relay
Rsr	=	external stabilising resistance
VA	=	relay burden at setting
VsA	=	Actual voltage setting

Simple, reliable and secure unit protection

STABILISING RESISTANCE

Externally mounted, continuously variable resistors of 470Ω, 220Ω and 47Ω for 0.5A, 1A and 5A CT secondaries respectively are supplied as standard.

The appropriate value of series resistance (Rsr) required to ensure stability is calculated as follows:

$$Rsr = \frac{Vs' - VA / Ir}{Ir}$$

Where

Vs' = minimum required stability voltage
VA = relay burden
Ir = relay setting current

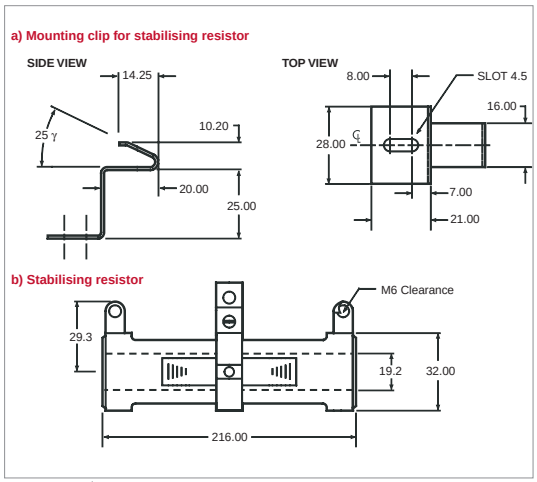


Figure 3 | External stabilising resistor assembly

To ensure that the thermal rating of the stabilising resistor is not exceeded, it is recommended that the resistor is not set to a value less than 65% of its maximum rated value. For example, a 220Ω variable resistor should not be used when the required stabilising resistance is less than 140Ω.
In certain applications there is no need to utilise stabilising resistors in series with the MCAG14/34 (indicated by negative stabilising resistor value) because the impedance of the relay elements alone will offer sufficient stabilisation.

The outline and mounting arrangement drawing for the external stabilising resistor is shown in Figure 3.

EFFECTIVE PRIMARY OPERATING CURRENT

During internal fault conditions, the relay and Metrosil current and the magnetising current of all connected current transformers are supplied from fault current. The primary operating current is given by:

$$I_{op} = n (I_R + NI_m)$$

Where

I_R = relay setting current (plus Metrosil current at setting voltage if used)
I_μ = current transformer magnetising current at setting voltage (A)
N = number of connected current transformers
n = current transformer turns ratio

METROSIL (NON-LINEAR RESISTORS)

A Metrosil is required to limit the CT output voltage under an internal fault condition if the peak voltage developed (Vp) is greater than 3kV. The voltage spike (Vp) due to CT saturation is calculated from:

$$Vp = \sqrt{2VkA (Vf-VkA)}$$
$$Vf = If_{int} (Rs+Rp+Rsr+ \frac{VA}{Ir^2})$$

Where

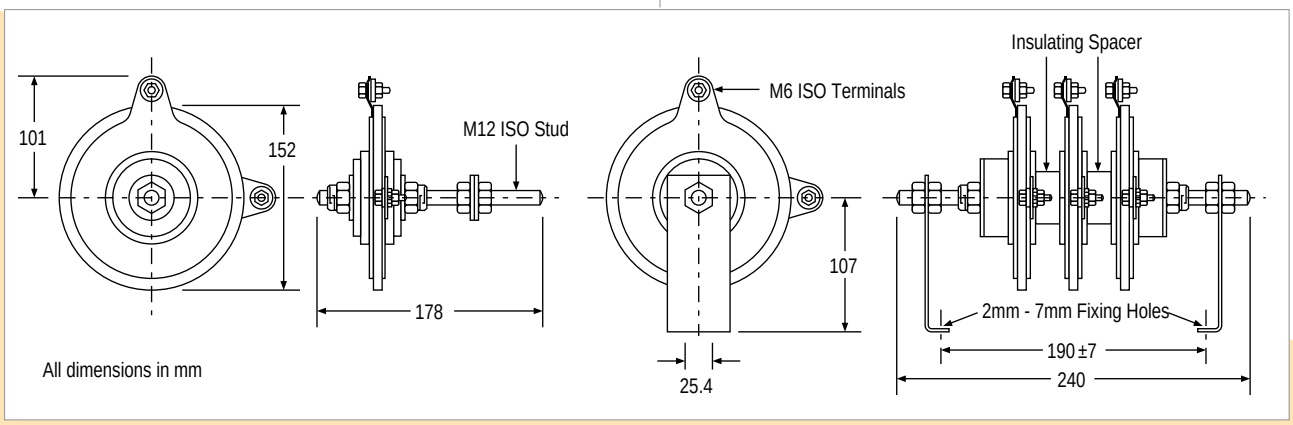
Ifint = maximum secondary internal fault current
VkA = actual CT knee-point voltage

The exact Metrosil rating will depend upon the application and is based upon the following details:

- CT secondary current rating
- Relay stability voltage (VsA)
- Maximum secondary internal fault current in Amps (Ifint)

The outline and mounting arrangement drawing for the external Metrosil units is shown in Figure 4.

Figure 4 | Outlines external Metrosil units



TECHNICAL DATA

> Rated frequency

50Hz and 60Hz

> Burdens

1 VA at setting

> Standard current settings

5% - 20%, 10% - 40% or 20% - 80% of 0.5A, 1A or 5A (CT secondary), adjustable by plug setting bridge in seven equal steps.

> Operating time

25ms at 5 times setting current. See figure 5.

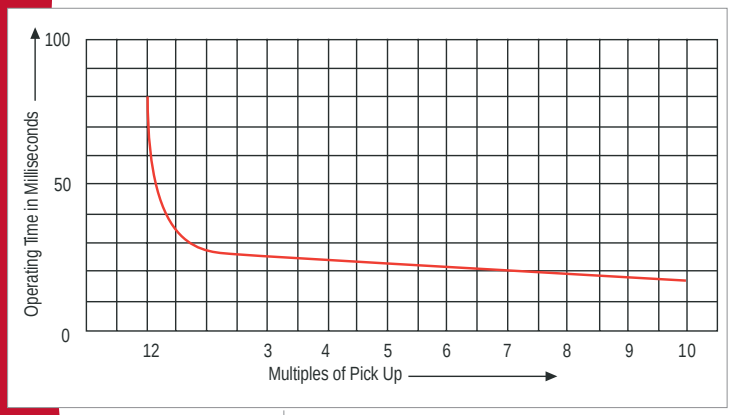


Figure 5 | Time/current characteristic

> Thermal withstand

- Relay
  - 5 times tap setting continuous
  - 20 times tap setting for 3s
- Stabilising Resistor

Resistor Value (O) (1)	Maximum Current Withstand (A)		
	Continuous	3 second (2)	1 second (2)
24	2.45	9.00	11.50
47	1.76	7.70	10.00
100	1.20	5.30	6.90
150	0.98	4.30	5.60
220	0.81	3.60	4.60
270	0.73	3.20	4.20
470	0.56	2.40	3.20
820	0.42	1.80	2.40
1000	0.38	1.67	2.20
1500	0.31	1.36	1.80
2700	0.23	1.00	1.30
5600	0.16	0.71	0.92

(1) - The resistance tolerance is ±10%

(2) - The 3 second & 1 second rating values are AREVA calculated values

> Contacts

Two pairs of make self-resetting contacts are provided on single element relays and two on three element relays. In three element relays the contacts are connected in parallel, as shown in Figure 1, or brought out to separate case terminals if required.

- Contact Rating
  - Make and carry continuously
    ac 1250VA with maxima of 5A or 300V
    dc 1250W with maxima of 5A or 300V
  - Make and carry for 3s
    ac 7500VA with maxima of 30A or 300V
    dc 7500W with maxima of 30A or 300V
  - Break
    ac 1250VA with maxima of 5A or 300V
    dc 100W (resistive)50W (inductive) with maxima of 5A or 300V

> High voltage withstand

- Dielectric withstand
  IEC 60255-5:1977

  2kV rms for 1 minute between all terminals and case earth2kV rms for 1 minute between terminals of independent circuits, with terminals on each independent circuit connected together1kV rms for 1 minute across open contacts of output relays.
- High voltage impulse
  IEC 60255-5:1977

  Three positive and three negative impulses of 5kV peak, 1.2/50µs, 0.5J between all terminals of the same circuit (except output contacts) between independent circuits, and between all terminals connected together and case earth.

> Electrical environment

- High frequency disturbance
  IEC 60255-22-1
  Class III

  2.5kV peak between independent circuits and case.1.0kV peak across terminals of the same circuitNo additional tolerances are required for the operating time of the unit's thresholds.

- EMC Compliance

  CE 89/336/EEC

  Compliance to the European Commission Directive on EMC is claimed via the Technical Construction File route.Generic Standards were used to establish conformity.

  EN 50081-2:1994
  EN50082-2:1995

> Product safety

CE 73/23/EEC
Compliance with the European Commission Low voltage directive

EN61010-1:1993/A2:1995
EN60950:1992/A11:1997
Compliance is demonstrated by reference to generic safety standards

> Atmospheric environment

- Temperature
  IEC 60255-6

Storage and transit	-25ºC to +70ºC
Operating	-25ºC to +55ºC
IEC 60068-2-1	Cold
IEC 60068-2-2	Dry heat

- Humidity

IEC 60068-2-3	56 days at 93% RH and +40ºC

- Enclosure protection

IEC 60529	IP50 (dust protected)

> Mechanical environment

- Vibration

IEC 60255-21-1	0.5g between 10Hz and 150Hz

- Mechanical durability

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

> Cases

Type MCAG 14 (single element) and MCAG 34 (three element) relays are supplied in 15TE (size 3) and 30TE (size 6) cases respectively. These are shown in Figures 6 and 7.

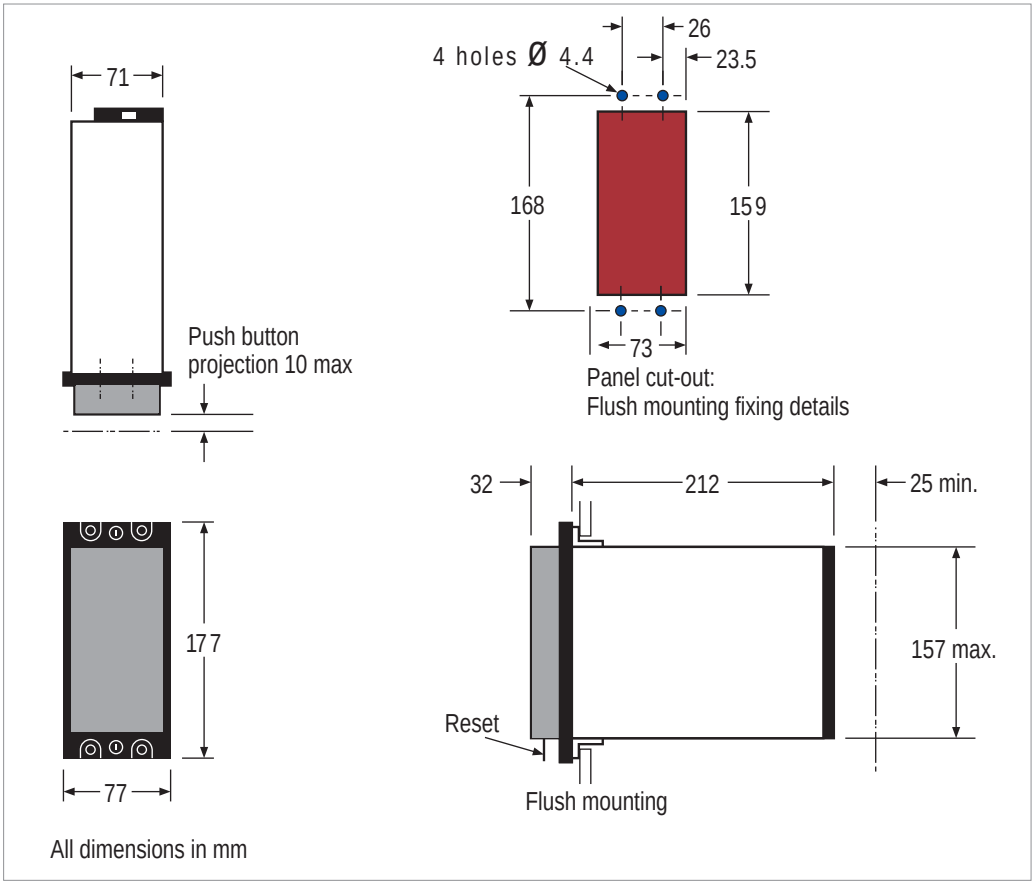
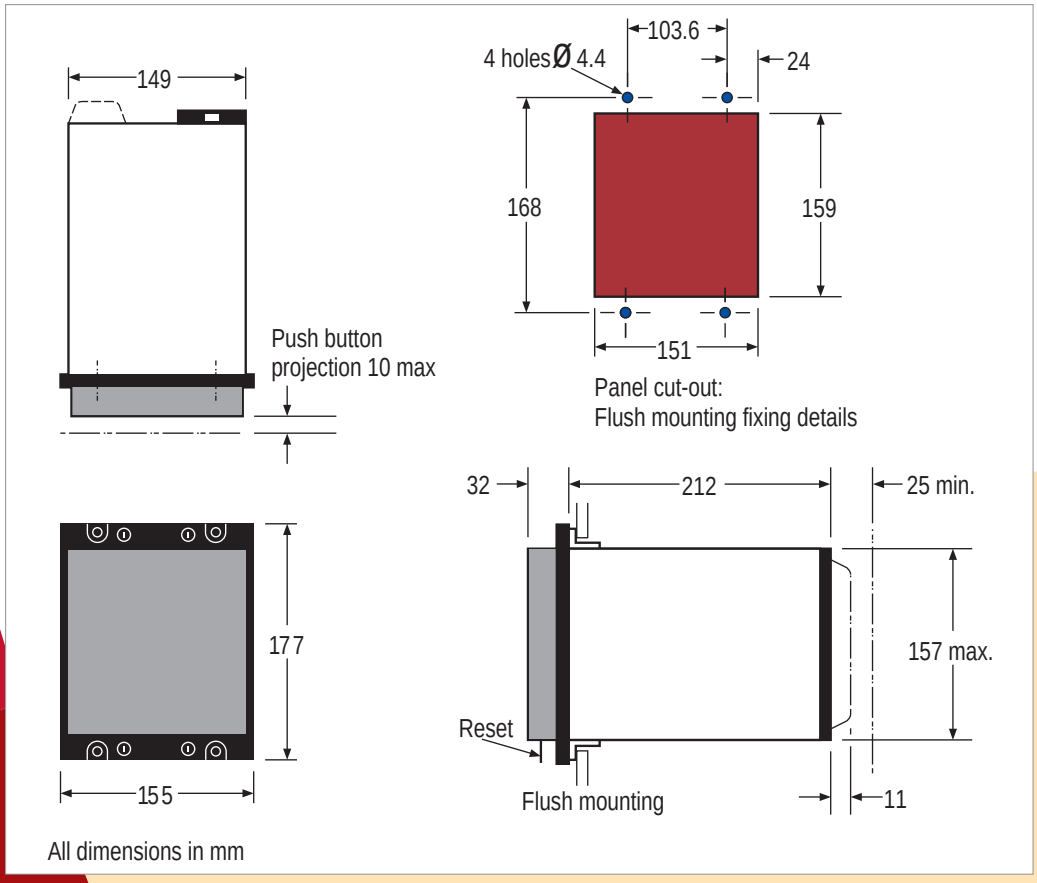


Figure 6 | Case outline 15TE (size 3)

Figure 7 | Case outline 30TE (size 6)



INFORMATION REQUIRED WITH ORDER

Information Required with Order Relay Type MCAG

	4											

Number of Elements

One	1
Three	3

Case Size

15TE (Size 3) Case for MCAG14 only	S
30TE (Size 6) Case for MCAG34 only	V

Contact Wiring

Segregated contacts	S
Common contacts (MCAG34 only)	C

Frequency & Flagging

	50Hz	60Hz	
Without Flag	●		A
With Hand Reset Flag	●		B
Without Flag		●	C
With Hand Reset Flag		●	D

CT Secondary & Setting Range

	0.5A	1A	5A	
5 - 20% Setting	●			A
10 - 40% Setting	●			B
20 - 80% Setting	●			C
50 - 200% Setting	●			D
5 - 20% Setting		●		B
10 - 40% Setting		●		C
20 - 80% Setting		●		E
50 - 200% Setting		●		F
20 - 80% (A & C) / 10 - 40% (B)		●		J
50 - 200% (A & C) / 20 - 80% (B)		●		K
5 - 20% Setting			●	D
10 - 40% Setting			●	F
20 - 80% Setting			●	G

Stabilising Resistor

No Resistor Supplied	0	0	0	0
Standard Resistor for 0.5A CT Rating	0	4	7	0
Standard Resistor for 1A CT Rating	0	2	2	0
Standard Resistor for 5A CT Rating	0	0	4	7
Non-standard Resistor (24 ohms)	0	0	2	4
Non-standard Resistor (47 ohms)	0	0	4	7
Non-standard Resistor (100 ohms)	0	1	0	0
Non-standard Resistor (150 ohms)	0	1	5	0
Non-standard Resistor (220 ohms)	0	2	2	0
Non-standard Resistor (270 ohms)	0	2	7	0
Non-standard Resistor (470 ohms)	0	4	7	0
Non-standard Resistor (820 ohms)	0	8	2	0
Non-standard Resistor (1000 ohms)	1	0	0	0
Non-standard Resistor (1500 ohms)	1	5	0	0
Non-standard Resistor (2700 ohms)	2	7	0	0
Non-standard Resistor (5600 ohms)	5	6	0	0

Hardware Issue Suffix

Factory Defined

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