Type MCAG 14, 34: High Stability Circulating Current Relay

Features

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

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. Because of the variations in the magnetising characteristics of the transformers a high unbalance current may result.

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

The MCAG 14 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. A typical circuit diagram is shown in Figure 2.

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.

Description

The relay is basically a standard 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.

The relay circuit, tuned to the supply frequency, rejects the harmonics produced by current transformer saturation. A slight time delay on operation helps to provide stability on heavy external faults and is obtained by allowing the auto-transformer to saturate above the relay setting. This limits the current supplied, and the attracted armature unit operates only on the slower part of its time-current curve.

Figure 1

Type MCAG 34 relay withdrawn from case

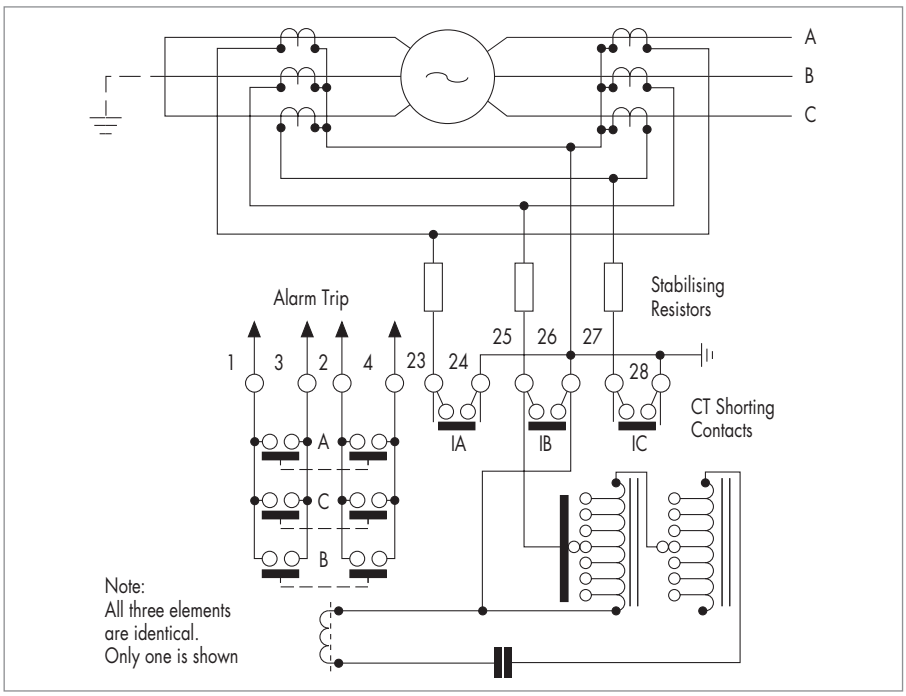


Figure 2 | Internal and external circuit diagram for unbiased differential protection of generators, reactors and synchronous motors using type MCAG 34 relay

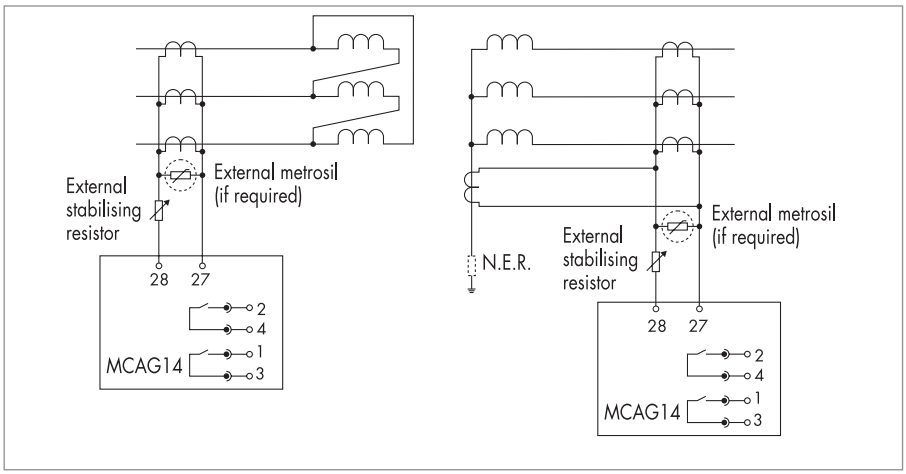


Figure 3 | Type MCAG14 relays applied to restricted earth fault protection of power transformer

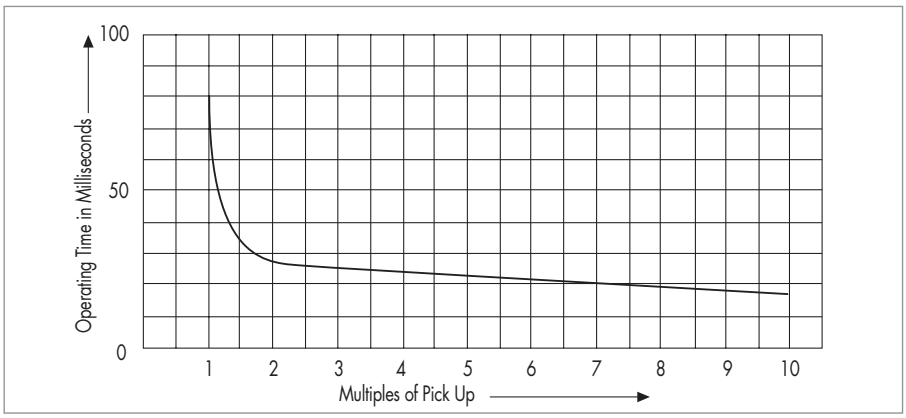


Figure 4 | Time/current characteristic

Technical Data

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

Rated frequency

50Hz or 60Hz

Operating time

25ms at 5 times current. See Figure 4.

Thermal withstand

- Relay

  5 times tap setting continuous
  20 times tap setting for 3s
- 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 2, or brought out to separate case terminals if required

Contact ratings

- 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

Operation indicator

A hand reset operation indicator is fitted as standard

Current transformer knee-point voltage

The knee-point voltage is defined as 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′) minimum knee-point voltage (Vk) and maximum excitation current (Ie) are calculated as follows:

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

$$V_{sA} = \frac{VA + Ir\,Rsr}{Ir}$$

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

$$Ie = \frac{Is-Ir}{n}$$

where

If = maximum secondary through fault current

Is = effective fault setting expressed in secondary amps

Ir = relay setting current

Rs = CT secondary winding resistance

Rp = maximum loop lead resistance between CTs and relay

n = 3 for restricted earth fault protection on delta windings (3CTs)

n = 4 for restricted earth fault protection on star windings (4CTs)

n = 2 for machine differential protection

n = number of CT groups forming the protected zone for bus-zone differential protection

V_{sA} = Actual voltage setting

Metrosil

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

$$Vp = 2\sqrt{2VkA\,(Vf-VkA)}$$

$$Vf = \frac{If_{int}\,(Rs+Rp+Rsr+VA)}{Ir^2}$$

Where:

If_{int} = maximum secondary internal fault current

VkA = actual CT knee - point voltage

Standard single disc metrosils suitable for $If_{int} \leq 50A$ (RMS)

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. Non-standard resistance values and non-linear voltage limiting devices are available.

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

In certain applications there is no need to utilise stabilising resistors in series with the MCAG14/34 (indicated by negative stabilising resistor value) the impedance of the relay elements alone will offer sufficient stabilising.

High voltage withstand

- Dielectric withstand
  IEC 60255-5:1977

  2kV rms for 1 minute between all terminals and case earth.

  2kV rms for 1 minute between terminals of independent circuits, with terminals on each independent circuit connected together.

  1kV 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 circuit.

  No additional tolerances are required for the operating time of the unit's thresholds.
- EMC compliance
  89/336/EEC

  Compliance to the European Commission Directive on EMC is claimed via the Technical Construction File route.

  EN 50081-2:1994
  EN 50082-2:1995

  Generic Standards were used to establish conformity.

Product safety

CE 73/23/EEC

Compliance with the European Commission Low Voltage Directive.

EN 61010-1: 1993/A2:1995
EN 60950: 1992/A11:1997
Compliance is demonstrated by reference to generic safety standards.

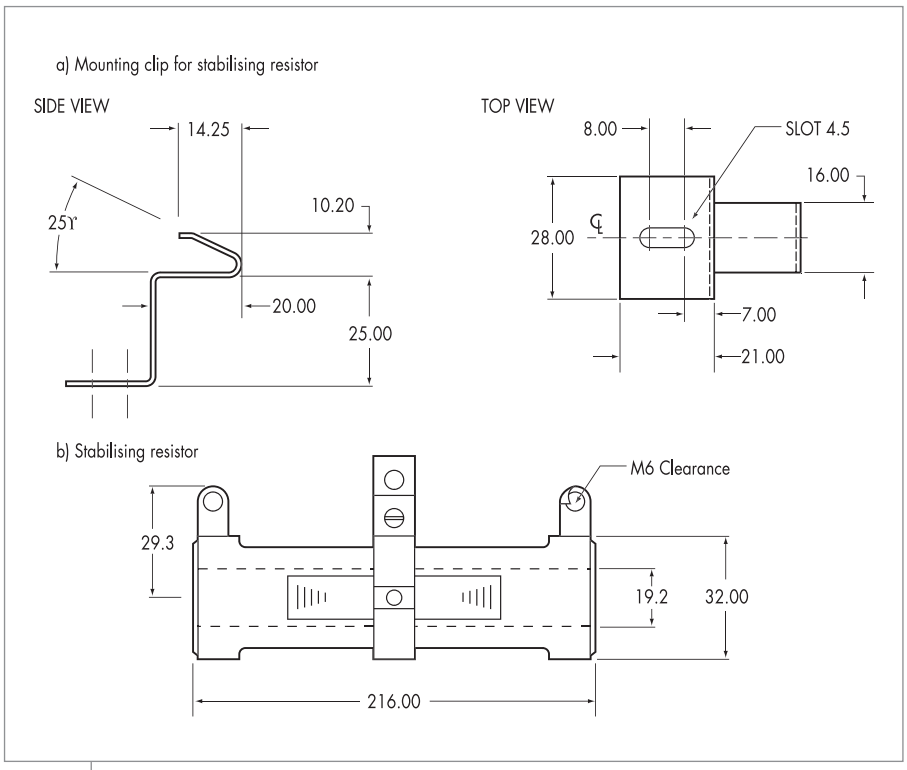
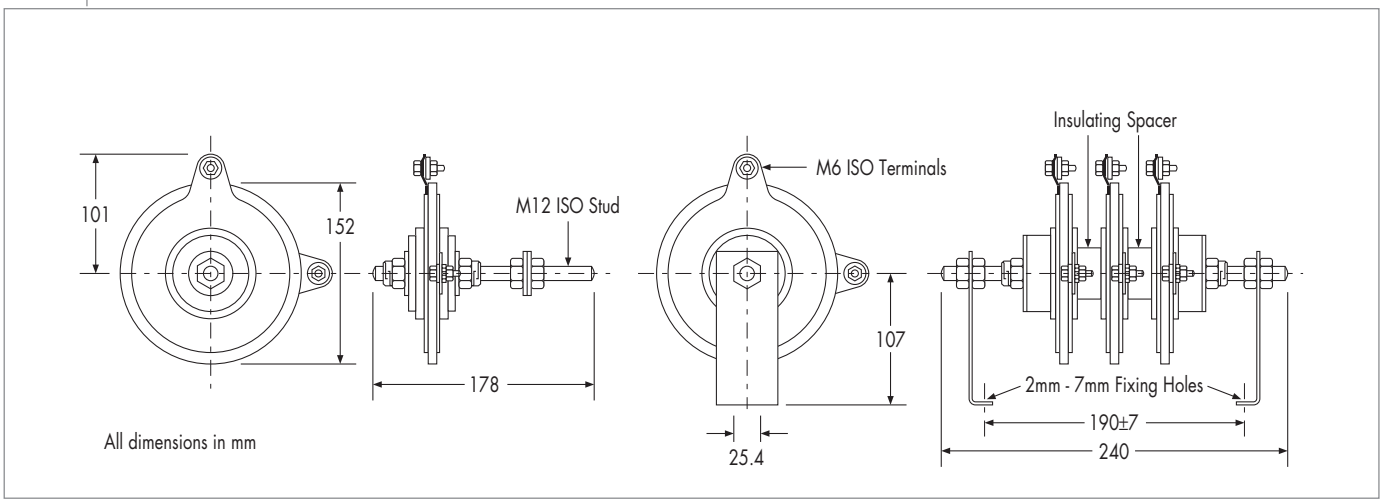


Figure 5 | External stabilising resistor assembly.

Figure 6 | Outlines and mounting arrangement for the standard single disc Metrosil units.



Atmospheric environment

- Temperature

  IEC 60255-6
  Storage and transit -25°C to +70°C
  Operating -25°C to +55°C

  IEC 60068-2-1 Cold

  IEC 60068-2-2 Dry Heat
- Humidity

  IEC 60068-2-3
  56 days at 93% RH and 40°C
- 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

Single pole relays are housed in size 3 cases and triple pole relays in size 6 cases. See Figures 7 and 8 respectively.

Information Required with Order

- Relay type (MCAG 14 or MCAG 34)
- Current transformer secondary rating
- Frequency
- Current setting range
- Stabilising resistor value, if non-standard

Additional Information

- Metrosil, if required:
- 1A relay:
  Voltage setting (V_{sA})
- 5A relay:
  Voltage setting (V_{sA})
  Secondary internal fault current (Ifint)

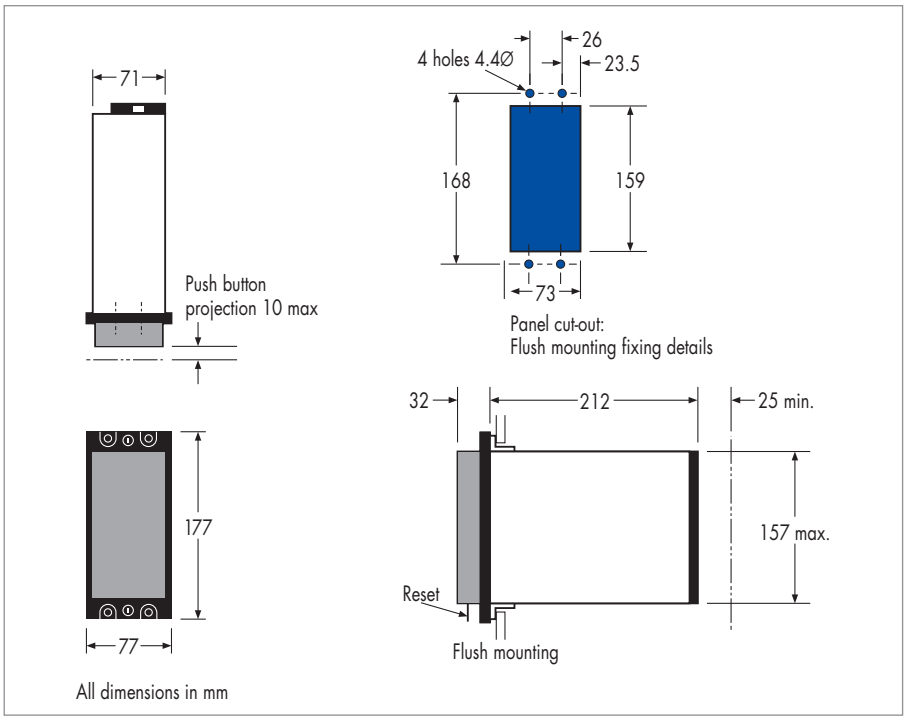


Figure 7 | Case outline size 3

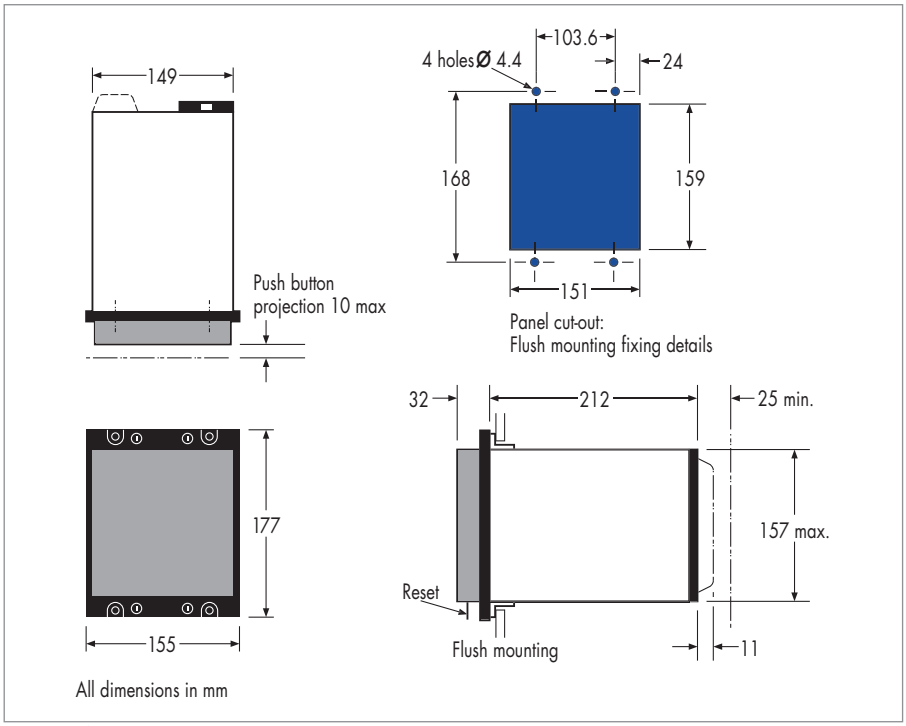


Figure 8 | Case outline size 6