

GE Vernova

MCAg

14, 34

Technical Manual
High Stability Circulating Relay

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TYPES MCAG 14 MCAG 34

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SAFETY SECTION

SECTION 1. INSTALLATION

1.1 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.

1.2 The relays are either despatched individually or as part of a panel/rack mounting assembly in cartons specifically designed to protect them from damage.

Relays should be examined immediately they are received to ensure that no damage has been sustained in transit. If damage due to rough handling is evident, a claim should be made to the transport company concerned immediately and the nearest GE Vernova representative should be promptly notified. Relays which are supplied unmounted and not intended for immediate installation should be returned to their protective polythene bags.

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

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.

1.4 If relays are not installed immediately upon receipt they should be stored in a place free from dust and moisture in their original cartons and where de-humidifier bags have been included in the packing they should be retained. The action of the de-humidifier crystals will be impaired if the bag has been exposed to damp ambient conditions and may be restored by gently heating the bag for about an hour, prior to replacing it in the carton.

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.

The storage temperature range is -25°C to $+70^{\circ}\text{C}$.

1.5 The installation should be clean, dry and reasonably free from dust and excessive vibration. The site should preferably be well illuminated to facilitate inspection.

An outline diagram is normally supplied showing panel cut-outs and hole centers. For individually mounted relays these dimensions will also be found in Publication R6008.

Publication R7012 is a Parts Catalogue and Assembly Instructions. This document will be useful when individual relays are to be assembled as a composite rack or panel mounted assembly.

Publication R6001 is a leaflet on the modular integrated drawout system of protective relays.

Publication R6014 is a list of recommended suppliers for the pre-insulated connectors.

SECTION 2. COMMISSIONING

2.1 Description of relay

This is a current operated relay having seven equally spaced settings. The setting ranges are given below.

0.025	–	0.1A
0.05	–	0.2A
0.1	–	0.4A
0.2	–	0.8A
0.25	–	1.0A
0.5	–	2.0A
1.0	–	4.0A

The relays may be used for any type of high impedance circulating current protection.

When used as a high impedance relay a stabilising resistor must be connected in series with the current circuit.

2.1.1 List of abbreviations

I_E	=	Current transformer exciting current at relay setting voltage, (referred to the CT secondary current).
I_F	=	Maximum value of primary through fault current for which protection must remain stable.
I_{FM}	=	Maximum value of primary fault current for internal fault.
I_P	=	Primary current for operation of protection.
I_R	=	Relay operating current.
N	=	Turns ratio of current transformer.
n	=	No. of current transformers in parallel with relay.
R_{CT}	=	Secondary resistance of current transformer.
R_L	=	Lead resistance between furthest current transformer and relay connection point.
R_R	=	Relay impedance.
R_{ST}	=	Value of stabilising resistor.
V_A	=	Relay burden at setting.
V_F	=	The theoretical voltage which would be produced across the relay circuit under internal fault conditions.
V_F	=	$\frac{I_{FM}}{N} (R_{CT} + 2R_L + R_{ST} + R_R)$
V_K	=	Knee point voltage of current transformer.

- V_P = Peak voltage across relay circuit under maximum internal fault conditions.
- V_S = Setting voltage (calculated).
- V_R = Setting voltage measured across relay and stabilising resistor (approximately equal to V_S).

2.2 Calculation of relay setting

The minimum setting voltage to ensure stability is:

$$V_S \geq \frac{I_F}{N} (R_{CT} + 2R_L)$$

The minimum knee point voltage (V_K) of the CT must be:

$$V_K \geq 2V_S$$

The relay is current calibrated and has settings chosen from the range given in 2.1.1. It has a burden of approximately 1VA at setting.

Having calculated V_S a suitable relay tap must be chosen to give the required primary operating current I_P .

$$I_P = N (I_R + nI_E)$$

When the value of I_R has been selected the value of stabilising resistor R_{ST} must be calculated.

$$R_{ST} = \frac{V_S}{I_R} - \frac{VA}{I_R^2}$$

2.3 External Metrosils

When the maximum voltage which appears across the relay circuit on internal faults exceeds 3000 volts peak a metrosil non-linear resistor must be fitted across the relay and the stabilizing resistor.

The peak voltage can be calculated from the formula:

$$V_P = 2\sqrt{2V_K(V_F - V_K)}$$

The metrosil should be chosen so that the current at the voltage setting of the relay is less than 30mA for a 1 amp and 100mA for 5 amp current transformers.

At the maximum secondary internal fault current the metrosil cut-off point should not be greater than 1500 volts rms or 2120 volts peak.

2.4 Commissioning preliminaries

2.4.1 Inspection

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 fitted for transportation purposes.

Carefully actuate the armature of each unit in turn with a small screwdriver/probe. Note that immediately after the point where any normally open contacts just make, there is a small further movement of the armature. This ensures that contact follow through and wiping action is present. On units fitted with hand reset flag indicators, check the flag is free to fall before, or just as, any normally open contacts touch.

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 type MMLG is provided, the connections should be checked to the scheme diagram, particularly that the supply connections are to the 'live' side of the test block (coloured orange) and with terminals allocated odd numbers (1, 3, 5, 7, etc.).

2.4.2 Earthing

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

2.4.3 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.

2.4.4 Terminal allocation

Terminals of the relay are normally allocated as below, but reference should always be made to the relevant diagram.

a) Single pole relays

Normally open contacts 1, 3 and 2, 4.

AC current input – 27, 28.

b) Triple pole relays

Normally open contacts 1, 3 and 2, 4.

The contacts are normally connected in parallel for the three phases but a version of the relay having contacts brought out separately is available.

AC current inputs – 23, 24 : 25, 26 : 27, 28.

2.4.5 Instructions to ensure that the relay can be commissioned at the specific settings for the application.

It is only necessary to check the relay at the setting on which it is to be used. The relay must not be used at any setting other than that for which the setting has been calculated.

2.4.6 Test equipment required

1 – Secondary injection test equipment capable of providing an ac voltage supply of at least 120% of the relay voltage setting, with sufficient output VA to exceed the current setting whilst maintaining the voltage output.

Note: Some modern digital test sets may have insufficient VA output to accurately test the relay.

1 – Multifinger test plug type MMLB 01 for use with test block type MMLG if fitted.

1 – Miniature split plug type MMLB 03 to fit relay plug bridge.

3 – Calibrated multimeters 0 – 10A ac, 0 – 400V ac

1 – Set primary injection testing equipment.

2.5 Commissioning tests

If the relay is wired through an MMLG 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.

When type MMLG test block facilities are installed, it is important that the sockets in the type MMLB 01 test plug, which correspond to the current transformer secondary windings, are LINKED BEFORE THE TEST PLUG IS INSERTED INTO THE TEST BLOCK. Similarly, a MMLB 02 single finger test plug must be terminated with an ammeter BEFORE IT IS INSERTED to monitor CT secondary currents.

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

2.5.1 Relay CT shorting switches

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

2.5.2 Secondary injection testing

2.5.2.1 Operating current test

Connect the circuit as shown in **Figure 1** and ensure that the current transformer primary is an open circuit and that if any earthing connections are fitted, they do not short out the primaries of any current transformers.

If a voltage source is used for the secondary injection test equipment to test the MCAG relay, a high value resistor should be connected in series with the operating coil of the relay to limit the distortion in the current.

All the operating current tests should be applied as step changes from zero amps, not by increasing the current in a gradual way. The relays should switch cleanly with one movement.

Apply a current 10% lower than the setting current, $(I_R - (10\% I_R))$ and check that the relay does not operate.

Apply a current 10% greater than the setting current, $(I_R + (10\% I_R))$, and check that the relay operates.

Note the current in the relay (this can be done using the miniature split plug inserted into the appropriate position of the plug bridge connected to an ammeter, A2). The current at which the relay operates should correspond to the setting of the relay with a tolerance of $\pm 10\%$.

Note also the voltage (V_R) at which the relay operates which should correspond to the setting V_R of the relay plus test equipment stabilizing resistor, R_{test} , with a tolerance of $\pm 10\%$. This test should be repeated for each pole of the relay.

2.5.2.2 Operating time test

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

Set the relay setting to the setting current, I_R , required. Inject a current of $5 \times I_R$ to the relay AC current inputs and check that the relay operating time is $< 40\text{ms}$, (typical operating time is 25ms at $5 \times$ setting).

2.5.2.3 Continuity test

With the relay operated check the continuity of the closed contacts. The contact continuity test should be done by applying 5A current through each closed contact & measuring the voltage across the output contact terminals.

2.5.3 Primary injection testing

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.

2.5.4 Primary fault setting

The primary fault setting of any balanced scheme can be checked using the circuit shown in Figure 2. The primary current is injected into each current transformer in turn and increased until the relay operates. The voltage at which the relay operates should be within $\pm 10\%$ of the relay setting voltage V_R . The primary current for operation and relay current should be noted.

In the case of machine protection, similar tests must be carried out by injecting first into each current transformer in turn to determine the primary fault setting.

For large machines, the machine itself can be used to provide the fault current to check the primary fault setting as shown in Figure 5. The machine should be run up to speed with no excitation. The excitation should then be increased until the relays have all operated.

The primary current, relay current and relay plus stabilising resistor voltage, should be noted as each relay operates.

2.5.5 Through fault stability

With any form of unbalanced protection it is necessary to check that the current transformers are correctly connected. For this purpose with a restricted earth fault scheme the circuit shown in Figure 3 may be used. During this test it is necessary to measure the spill current in the relay circuit and short out the relay and stabilising resistor (if fitted). The current is increased up to as near full load as possible and the spill current noted. The spill current should be very low, only a few milliamps if the connections are correct. A high reading (twice the injected current, referred through the current transformer ratio) indicates that one of the current transformers is reversed.

Injection should be carried out through each phase to neutral.

Where primary injection is not practicable in the case of restricted earth fault protection on a transformer it may be possible to check stability by means of back energising the transformer from a low voltage (415 volt) supply as shown in Figure 4.

In the case of machine protection, similar stability tests must be carried out by injecting into one and out of another current transformer connected on the same phase.

For large machines, the machine itself can be used to provide the fault current, but the short circuit must now be fitted as shown in Figure 6. The machine should be run up to normal speed and the excitation increased until the primary current is approximately full load, when the spill current should be checked.

All other types of balanced protection should be tested in a similar manner.

At the conclusion of the tests ensure that all connections are correctly restored and any shorting connections removed.

SECTION 3. MAINTENANCE

Periodic maintenance is not necessary. However, periodic inspection and test is recommended. This should be carried out every 12 months or more often if the relay is operated frequently or is mounted in poor environmental conditions.

Repeat secondary injection tests 2.5.2 to prove operation, with emphasis on contact wear and condition. Mechanical settings may be checked against those shown in Section 4.

SECTION 4. MECHANICAL SETTINGS

4.1 General

Armature gap measurements should be made with the top of the feeler gauge level with the centre line of the core.

Contact pressures are measured with a gramme gauge at the contact tips.

In general, contact gaps and follow through are defined by quoting an armature gap at which the tips should be just closed or just open.

The relay contact state is always defined with the relay in the unenergized position, unless otherwise specified on the appropriate circuit diagram.

4.1.1 With the armature closed the clearance between the back of the armature and the back stop should be 0.003"/0.008".

4.1.2 Nominal armature gap open 0.050"/0.060" for all types.

4.2 Contact settings

4.2.1 Normal duty make contacts

With the armature closed onto a 0.011" feeler gauge the make contacts should be closed, but should be open using a 0.013" feeler gauge.

Force to just close the make contacts 11/16 grammes.

4.3 Mechanical flag settings

4.3.1 Settings for self reset units

With the armature closed onto a 0.013" feeler gauge the flag should be free to fall, but should not fall using a 0.018" feeler gauge. Adjustment is made to the catch spring on the flag.

SECTION 5. PROBLEM ANALYSIS

5.1 Failure to operate

Check diagram for correct input connections.

Check tap current, this is marked above or below the plug bridge on the front of the module.

Flag spring may be jammed between armature and core face, preventing armature closure.

Check internal wiring.

Check continuity – result open circuit

– transformer open circuit

– internal wiring damaged

Check continuity – result short circuit

– transformer short circuit – relay takes excessive current

– shorting switch not opening

5.2 Excessive current taken by relay

Transformer damaged

Incorrect frequency of supply – this is marked on the front of the module

Shorting switch not opening

5.3 Output contacts not changing state

Operating push rods not in position

Check output terminals with reference to diagram

Internal wiring damaged

Contamination of contacts

Contacts should be cleaned with the burnishing tool, supplied in relay tool kits.

On no account should knives, files or abrasive materials be used.

Check mechanical settings as per Section 4.

SECTION 6. SPARES

When ordering spares, quote the full relay model number and any component reference numbers, or briefly describe the parts required.

Should the need arise for the equipment to be returned to GE Vernova for repair, please fill in the RMA form at the back of this manual.

A copy of any commissioning test results should also be sent.

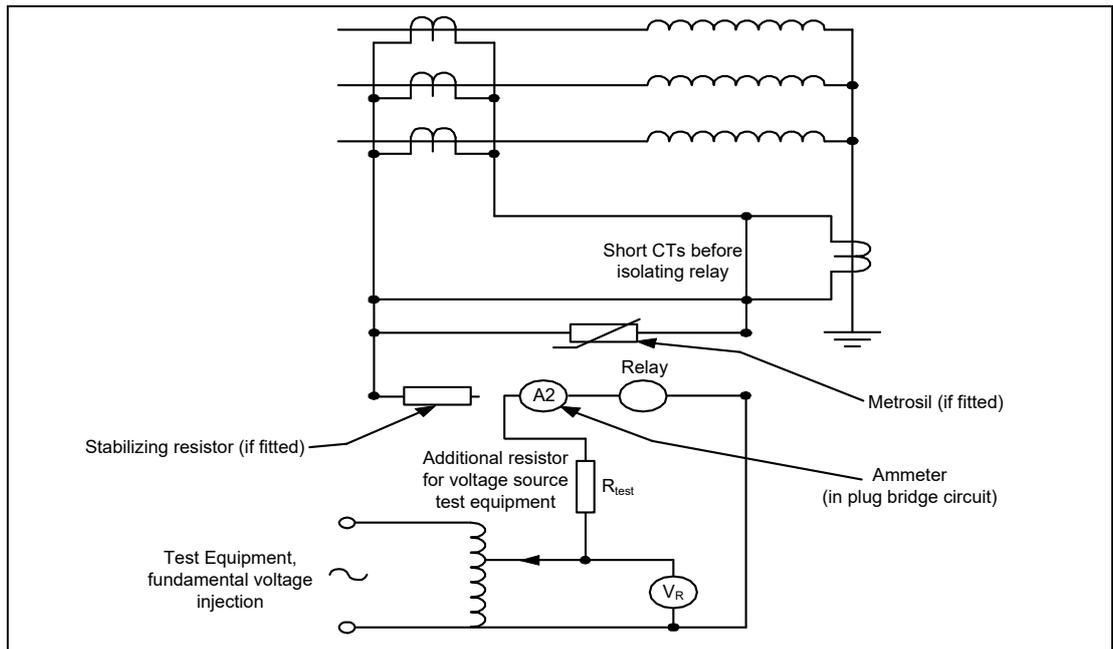


Figure 1 Secondary injection of relay to check secondary operating current, setting voltage and relay operating current

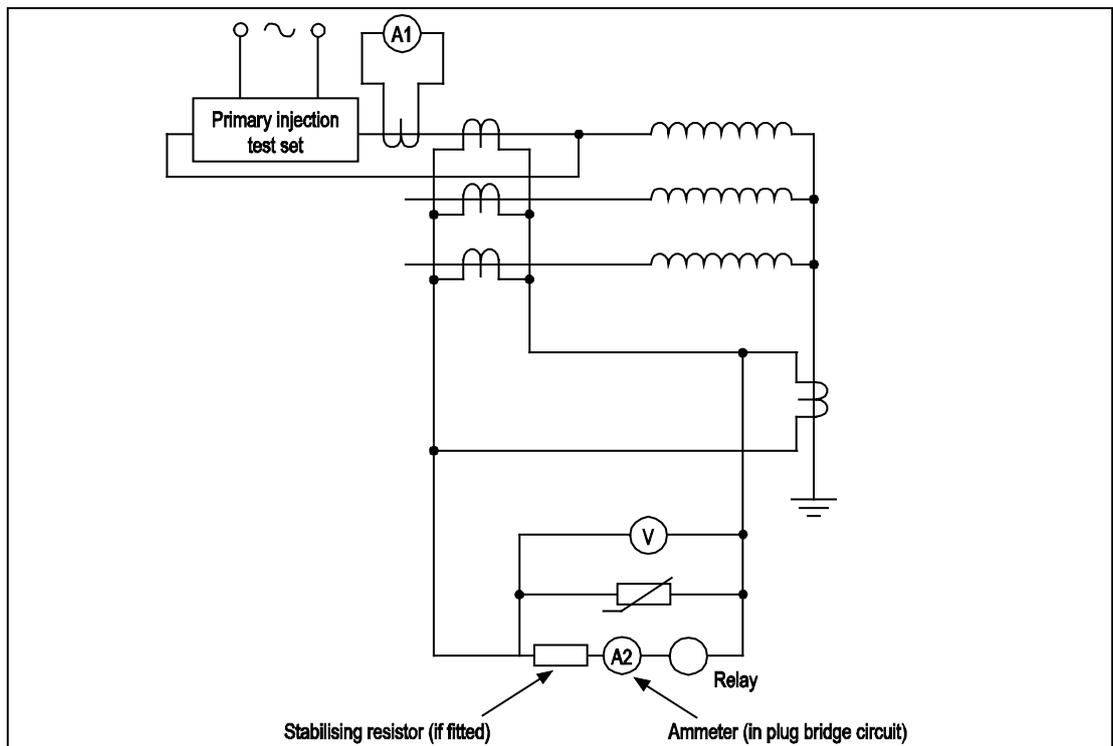


Figure 2 Sensitivity check of restricted earth fault scheme by primary injection

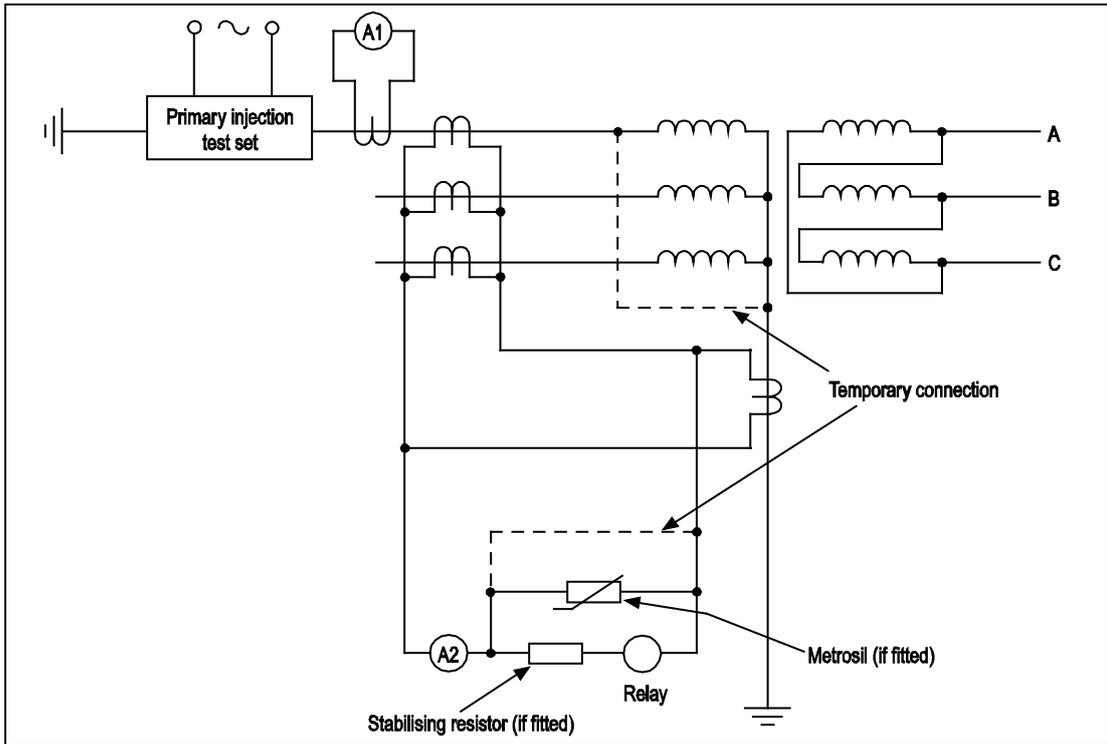


Figure 3 Stability check of restricted earth fault protection

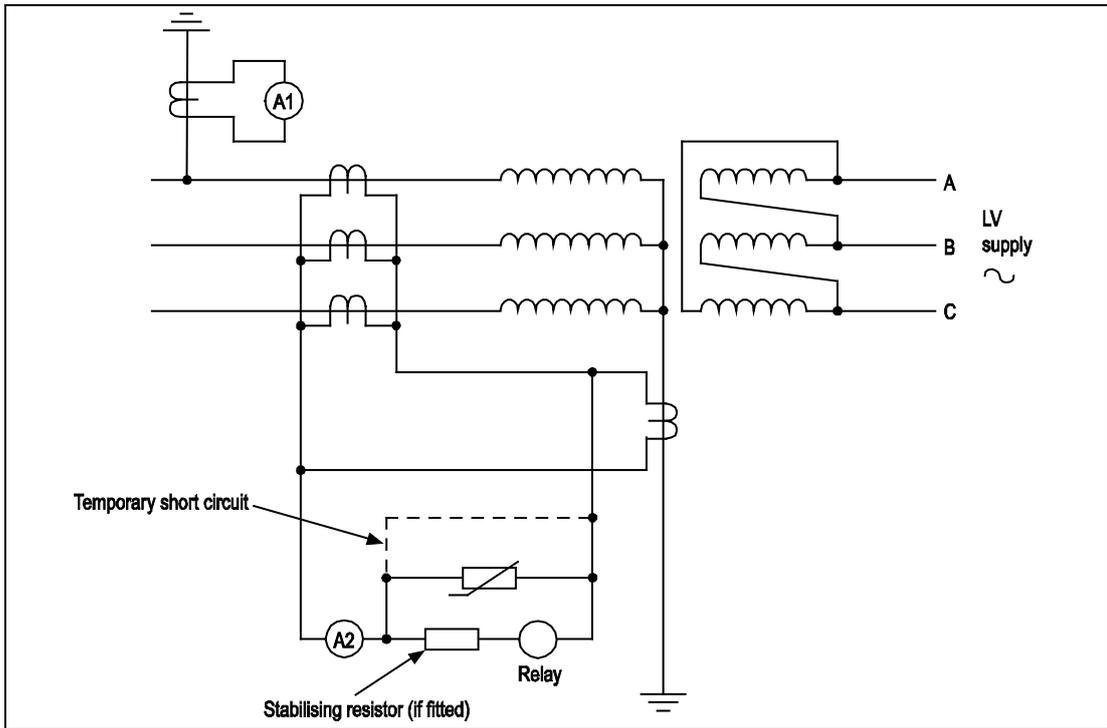


Figure 4 Stability check on restricted earth fault scheme by back energising with a low voltage supply

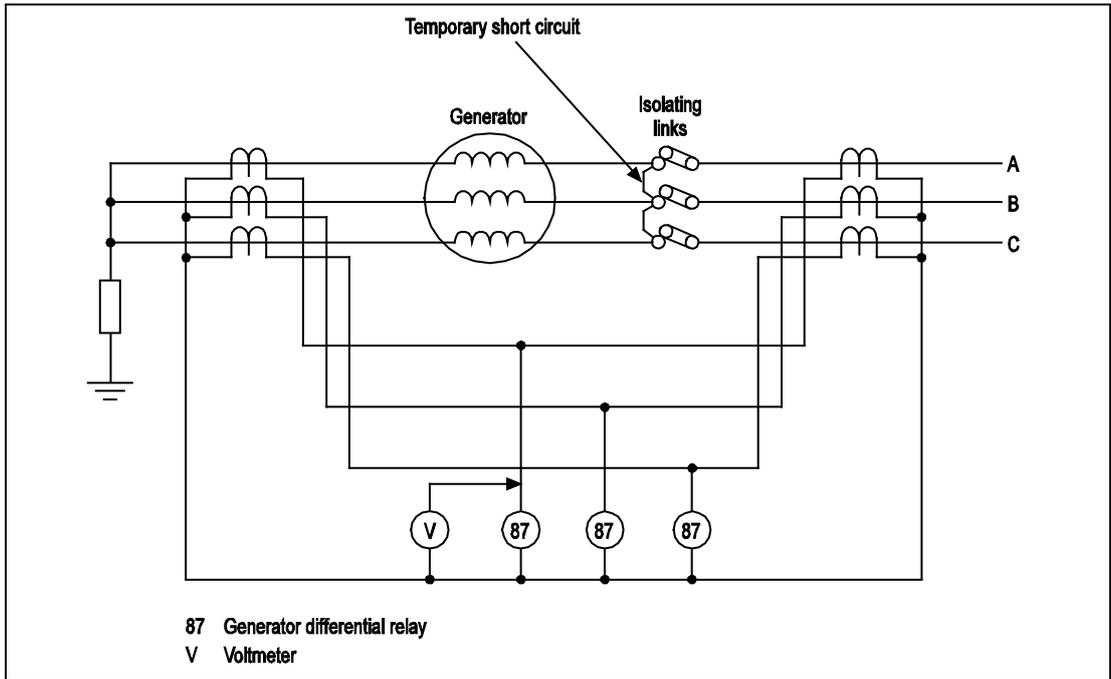


Figure 5 Testing sensitivity of generator differential protection using generator to supply primary current

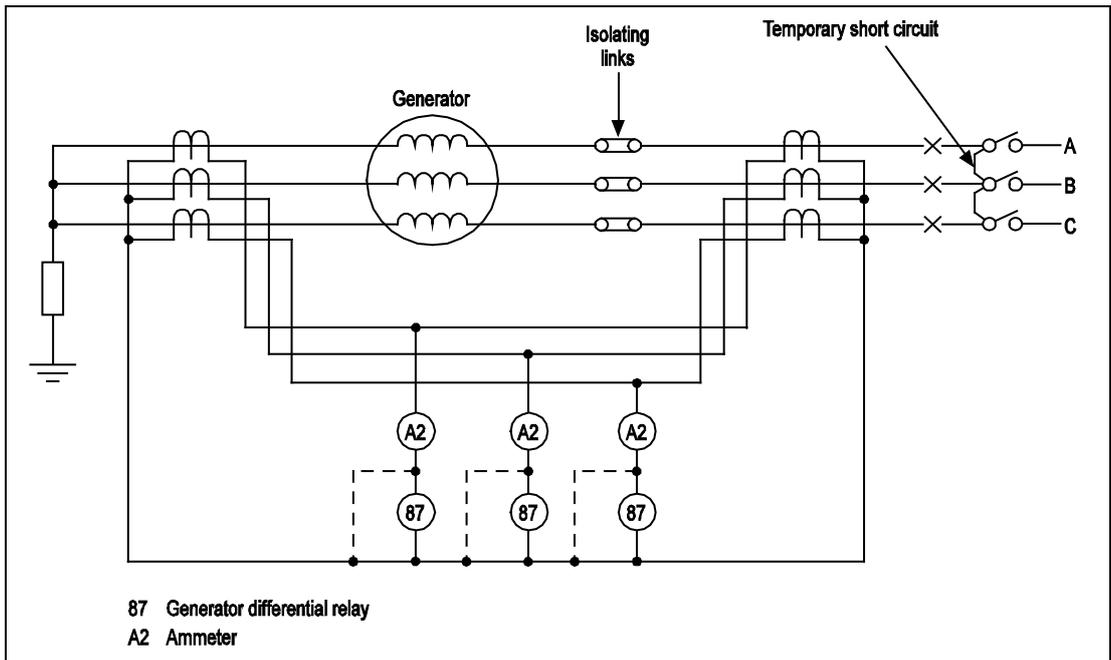


Figure 6 Checking stability of generator differential protection

SECTION 7. COMMISSIONING TEST RECORD

High Stability Circulating Current Relay Type MCAG 14, 34 Date _____

Station _____ Circuit _____

Relay model no. _____ Serial no. _____

Setting range _____ CT ratio _____

Setting voltage _____ Relay setting _____

Stabilizing resistor ohms _____ Shunt resistor ohms (if fitted) _____

Type of external Metrosil _____ Calculated primary OP current _____

Test results

2.5.1 Relay CT shorting switch

2.5.2 Secondary current to operate relay.

Phase	Total current (A1)	Relay current (A2)	Voltage
A			
B			
C			

2.5.4 Primary current to operate relay

Phase	Total current (A1)	Relay secondary current	Relay voltage
A			
B			
C			
N			

2.5.5 Stability check by primary injection

Restricted earth fault

Phase	Primary current A1	Spill current A2
A		
B		
C		
N		

Circulating current between two or more sets of current transformers.

Phase	Primary current A1	Spill current A2
A1 – A2		
B1 – B2		
C1 – C2		

Where more than two sets of current transformers are involved injection should be carried out between set 1 and each other set in turn.

Commissioning Engineer

Customer Witness

Date

Date



GE VERNOVA

Imagination at work

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