TYPE MHOA 04, MHOB 04, MHOC 04

Translay Feeder Protection Schemes

Service Manual

R8140B

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 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 AREVA T&D products are immune to the relevant levels of electrostatic discharge when housed in their cases. 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 a 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. Avoid touching the electronic components, printed circuit track or connectors.

3. Do not pass the module to any person without first ensuring that you are both at the same electrostatic potential. Shaking hands achieves equipotential.

4. Place the module on an antistatic surface, or on a conducting surface which is at the same potential as yourself.

5. Store or transport the module in a conductive bag.

More information on safe working procedures for all electronic equipment can be found in BS5783 and IEC 60147-0F.

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.

AREVA T&D strongly recommends that detailed investigations on the electronic circuitry, or modification work, should be carried out in a Special Handling Area such as described in BS5783 or IEC 60147-0F.

CONTENTS

SAFETY SECTION

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

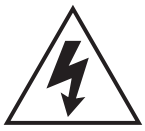
Health and safety

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 and 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 documentation



Caution: risk of electric shock

Protective/safety *earth terminal

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.

*Note: The term earth used throughout the product documentation is the direct equivalent of the North American term ground.

Installing, Commissioning and Servicing

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 a 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 2.5 mm^2, unless otherwise stated in the technical data section of the product documentation.

Before energising the equipment, the following should be checked:

Voltage rating and polarity;

CT circuit rating and integrity of connections;

Protective fuse rating;

Integrity of earth connection (*where applicable*)

Equipment operating conditions

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

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.

Battery replacement

Where internal batteries are fitted they should be replaced with the recommended type and be installed with the correct polarity, to avoid possible damage to the equipment.

Insulation and 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 and pcb cards

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

Fibre optic communication

Where fibre optic communication devices are fitted, these should not be viewed directly. Optical power meters should be used to determine the operation or signal level of the device.

Older Products

Electrical adjustments

Equipments 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 and withdrawal of extender cards

When using an extender card, this should not be inserted or withdrawn from the equipment whilst it is energised. This is to avoid possible shock or damage hazards. Hazardous live voltages may be accessible on the extender card.

Insertion and 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.

Decommissioning and 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. Any products containing batteries should have them removed before disposal, taking precautions to avoid short circuits. Particular regulations within the country of operation,may apply to the disposal of lithium batteries.

Technical Specifications

Protective fuse rating

The recommended maximum rating of the external protective fuse for this equipment is 16A, Red Spot type or equivalent, unless otherwise stated in the technical data section of the product documentation.

Insulation class:	IEC 61010-1: Class I	1990/A2:	1995	This equipment requires a protective (safety) earth connection to ensure user safety.
	EN 61010-1: Class I	1993/A2:	1995	
Installation Category (Overvoltage):	IEC 61010-1: Category III	1990/A2:	1995	Distribution level, fixed installation. Equipment in this category is qualification tested at 5kV peak, 1.2/50µs, 500Ω, 0.5J, between all supply circuits and earth and also between independent circuits.
	EN 61010-1: Category III	1993/A2:	1995	
Environment:	IEC 61010-1: Pollution degree 2	1990/A2:	1995	Compliance is demonstrated by reference to generic safety standards.
	EN 61010-1: Pollution degree 2	1993/A2:	1995	
Product safety: CE	73/23/EEC			Compliance with the European Commission Low Voltage Directive.
	EN 61010-1:	1993/A2:	1995	Compliance is demonstrated by reference to generic safety standards.
	EN 60950:	1992/A11:	1997	

Section 1. INTRODUCTION

Protective equipment is solely concerned with fault conditions, so it cannot readily be tested under actual operating conditions as can other forms of electrical plant. It is usually not feasible to reproduce actual fault conditions. Many forms of protective equipment remain stable when faults occur outside the zone of protection. Stability to external faults is equally as important as operation for internal faults but it is more difficult to test under actual operating conditions. Translay protection schemes have been well proven under the most arduous operating conditions in all parts of the world. Therefore elaborate site testing is unnecessary.

The object of commissioning tests is to ensure that all connections of the protection scheme are correct, the performance of current transformers and relays is capable of giving the expected results, and no components have been damaged in transit or during installation. Periodic routine tests are designed to verify the integrity of the relays to prove that they have not been damaged.

Under fault conditions considerable voltages may be induced in pilot wires, especially where the pilot wires are in close proximity to power conductors. The peak of these voltages may rise momentarily to some thousands of volts. These voltages are relative to earth. Translay relays are designed to withstand such voltages, however, to ensure satisfactory operation of the protection it is desirable to keep the pilots clear from earth and to avoid connecting them to auxiliary switches or other items that may have inadequate insulation strength.

Section 2. INSTALLATION

Before carrying out any work on the equipment the user should familiarise himself with the contents of the Safety Section. Particular attention should be given to the pilot wire circuits statement.

2.1 General

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.

The relays are either despatched individually or as part of a panel/rack mounted assembly in boxes 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 transit is evident, a claim should be made to the transport company concerned immediately, and the nearest AREVA T&D representative should be promptly notified.
Relays which are supplied unmounted and not intended for immediate installation should be returned to their protective polythene bags.

2.2 Unpacking

Care must be taken when unpacking and installing the relays so that none of the parts are damaged or settings altered. At all times handling must be 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. These should be removed after installation and before commissioning.

Relays which have been removed from their cases should be left in a dust and damp free environment. This particularly applies to installations which are being carried out at the same time as constructional work.

2.3 Storage

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

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

The storage temperature range is -25°C to +70°C.

2.4 Site

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 cutouts and hole centres. For individually mounted relays these dimensions will also be found in publication R6140.

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

Section 3. COMMISSIONING

Before carrying out any work on the equipment the user should familiarise himself with the contents of the Safety Section. Particular attention should be given to the pilot wire circuits statement.

3.1 Commissioning preliminaries

3.1.1 Inspection

Carefully examine the module and case to see that no damage has occurred during transit. Check that the 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.

3.1.2 Wiring

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

Note: The 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 the test block type MMLG is provided, the connections are made to the live side of the test block (coloured orange with odd terminal numbers).

The auxiliary supply voltage to the scheme should be routed via test block terminals 13 and 14.

3.1.4 Earthing

Ensure that the case safety earth connection at the top of the rear terminal block is used to connect the relay to a local earth bar.

3.1.5 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.

3.2 Electrical 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.

SUITABLE PRECAUTIONS SHOULD BE TAKEN BEFORE HANDLING PILOT WIRES. THESE CAN RISE TO A LETHAL HIGH VOLTAGE RELATIVE TO THE GROUND POTENTIAL UNDER LINE FAULT CONDITIONS. REFER TO THE SAFETY REQUIREMENTS OF THE COUNTRY OF INSTALLATION, FOR SAFE HANDLING OF PILOT WIRES.

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, an MMLB 02 single finger test plug must be terminated with an ammeter BEFORE IT IS INSERTED to monitor CT secondary currents.

The instructions have been written assuming that not all schemes are fitted with a test block. Where a test block is used, the procedure is generally correct, however, it will be necessary to determine the appropriate test block terminals for applying the voltages and monitoring relay operation from the scheme diagram.

3.3 Current transformer tests

3.3.1 Ratio test

Inject current into the primary of the A (red) phase current transformer and measure the current in the secondary winding. Refer to Figure 1. The ratio between the primary and secondary currents will be approximately equal to the turns ratio of the current transformer, the difference being equal to the magnetisation current taken by the current transformer. This should be repeated for the current transformers in the B (yellow) and C (blue) phases.

3.3.2 Magnetisation curve test

The magnetisation curve of all current transformers should be checked at the minimum number of points necessary to identify the current transformer and to determine its suitability for the intended duty. Refer to Figure 2.

3.3.3 Polarity test (dc flick test)

All current transformers should be tested to confirm that the primary and secondary polarity markings are correct. A dc milliammeter of the moving coil permanent magnet, centre zero pattern is connected across the secondary winding and a low voltage battery, in series with a single pole switch, is connected across the primary winding. Refer to Figure 3. Where a centre zero ammeter is not available a moving coil multi-meter should suffice eg. Avometer set to DC mA.

On closing the switch, the primary winding is energised and the dc milliammeter should give a momentary positive deflection. When the primary winding is de-energised, by opening the switch, the milliammeter should give a momentary negative deflection.

3.3.4 Phasing tests

Inject current into the primary of the A phase CT, refer to Figure 4a. For correct phasing the current reading of the A phase and neutral ammeters will be the same with negligible current in the B & C phase ammeters. This should be repeated for the B and C phases.

Inject primary current across A & B phases with a primary short on the other side of the CT, refer to Figure 4b. For correct phasing the current reading of the A & B phase ammeters will be the same with negligible current in the C phase and neutral ammeters. This test should be repeated by injecting across the A & C phase.

A more convenient method of phasing out is by using the primary balanced load current. For correct phasing, the A, B and C phase currents will be the same with negligible current flowing in the neutral ammeter. If one CT was reversed then approximately twice phase current will appear in the neutral ammeter.

3.4 Relay setting tests

The following tests are applicable for MHOA, MHOB and MHOC relays.

The arrangements for checking the relay settings are similar to those required for current transformer polarity tests using a primary injection test set. The tests are carried out by raising the test current until the relay operates. Refer to Figures 5a and 5b. This is equivalent to a single end feed condition. During these tests the torsion head on the relay should be set to the minimum setting mark.

Nominal relay settings are shown in Table 1 at the end of this publication but the effective settings will normally be 1.1 to 1.2 times higher than the nominal relay settings due to the current transformer magnetisation current.

In addition the torsion head settings should be checked by injecting on one phase, C-N and checking the current values. Secondary injection of current may be used to check the relay settings if insufficient current is available by primary injection.
If higher settings are required the torsion head may be rotated to achieve it at this time. Other checks which should be carried out are:

- check flag operate/reset
- check CT shorting switches
- check contact operation

3.5 Relay stability tests

These stability tests can be considered conclusive ONLY if the phasing tests at each end of the scheme have been performed beforehand.

The test procedure for the MHOA, MHOB and MHOC relays is given below. The tests for the MHOA are carried out in a slightly different manner.

3.5.1 MHOB and MHOC relays

3.5.1.1 Inject primary current at end A across A and B phases with a primary short circuit across the phases at end B after the current transformers. Refer to Figure 6.

Apply a test current equal to the rating of the current transformer and record the pilot voltage and current. The current reading should not exceed 10mA and the relay should remain stable. If a current equal to the primary rating of the current transformer cannot be obtained then the actual primary current should be recorded, noting that the relay restrains or tends to restrain.

This test is now repeated with the pilot wire reversed. From these tests definite pilot wire polarity may be proved. In the case where the test current is less than the effective relay setting, reversal of the pilots will be indicated by an increase in the current in the pilot wire ammeter and a tendency for the relay to operate.

The above test should be repeated for B and C phases.

Where these relays are applied to a long section of line, the increased line impedance may make it impossible to produce sufficient current for the above test. In such cases it will be necessary to perform the test described in Section 3.5.1.2.

3.5.1.2 The following tests should be carried out using primary load current. Refer to Figure 7.

With the A phase current transformers only connected in circuit and the B and C phase current transformers disconnected and shorted at each end of the feeder, energise the system and record the pilot voltage and current for future reference. Repeat this test with the pilot wires reversed and check that the current in the pilot millammeter increases and the relay operates or tends to operate depending upon the value of test current.

These tests should now be repeated for the B phase with the A and C phase current transformers disconnected and shorted and also for the C phase with the A and B phase current transformers disconnected and shorted.

3.5.2 MHOA relay

3.5.2.1 For a 3 ended system the stability tests should be carried out between ends A and B with test current injected at end A and the primary short circuit at end B only. These tests should then be repeated between ends B and C with test current injected at end B and the primary short circuit at end C only and again between C and A with test current injected at end C and the primary short circuit at end A only. The above test should be carried out between A and B phases as shown in Figure 6. The test should also be repeated for B and C phases.

3.5.2.2 With only A phase current transformers connected in circuit and B and C phase current transformers disconnected and shorted at all the ends of the scheme, apply load current between ends A and B only. This should be repeated for the B phase with A and C phase current transformers disconnected and shorted and also for the C phase with the A and B phase current transormers disconnected and shorted.

The above test should be repeated with load current applied between ends B and C, and again between ends C and A. For systems which have 4 ends or more the tests should be carried out in a similar manner.

3.6 Pilot loop resistance

Short out the pilot at the remote end of the line at the relay terminals and measure the pilot loop resistance at the local end of the line at the relay terminals, using a digital voltmeter. It is recommended that 250V grade pilot wires are used. For the MHOA 04 relay the maximum recommended loop resistance is 400Ω with a maximum intercore capacitance of 1mF. For the MHOB 04 and MHOC 04 relays the maximum recommended loop resistance is 1000Ω with a maximum intercore capacitance of 3μF.

3.7 Trip circuit

With primary load current flowing in the feeder and the pilots correctly connected, the relay should be restraining. Operate the disc manually using an insulated tool, a trip should be initiated and the circuit breaker should open. Reclose the circuit breaker after the test. This procedure should be repeated at the other end of the feeder.

The following tests are applicable if MRTP relays are used.

If pilot supervision is required with the MHOB or MHOC relay then MRTP01 and MRTP02 relays can be used. These relays are suitable for pilot isolation up to 4kVrms for 1 minute. If 15kV isolation is required then an MBCI translay scheme is recommended. The MRTP01 will provide supervision at the local end while an MRTP02 can be used at the remote end. When correctly connected and energised from the appropriate ac supply voltage the relay will inject a dc supervision supply across a capacitor in series with the pilots.

3.7.1 The commissioning instructions for the MRTP01 are given below:

Monitor the current which should flow in the pilot using a dc milliammeter.

Apply the appropriate ac supply for the supervision circuit and the normal dc supply.

Note the reading on the dc milliammeter. This current should be approximately 1.2mA dc, and is the current flowing in the pilots.

There are three red LED indicators and a green LED indicator. The latter is primarily intended as an aid during the setting of the adjustable resistor marked SET. The top red LED is to indicate failure of the ac supervision supply. The middle red LED indicator is to indicate pilot fail open circuit whilst the lower one is to indicate pilot fail short circuit. If any of these indicators are operated, resetting should be attempted by pressing the reset button.

Assuming that the ac and dc supplies are present, the ac supervision supply fail indicator should reset when the reset push button is pressed. Failure to reset is almost invariably due to the absence of correct ac or dc supplies.

The pilot fail indicators may be in the operated or reset state. In either case set the adjustable resistor as detailed in the following tests.

The adjustable resistor is changed by the use of a small screwdriver through a hole in the front plate marked SET. Adjustment is made by a worm drive screw which is connected directly to a resistor. This allows for a fine adjustment in the relay calibration. To facilitate the setting of the pilot supervision there is a test push button

which if depressed reduces the supervision band width inside which the pilots are considered healthy.

If it is considered desirable to monitor the position of the normally open contact of the pilot fail relay, connect a multimeter across terminals 1 & 3 or 2 & 4, whichever is more convenient. The meter must be suitably set either to measure volts, if the circuits are live, or ohms if there are no other connections to the terminals.

3.7.2 Adjust as follows:

With the screwdriver engaging the worm drive of the SET resistor, turn it clockwise for 30 complete turns. The green LED should illuminate, followed by the pilot fail open circuit red LED approximately 10s later. The contacts should also close. If the green LED is out and the contacts open, check that the dc and ac supplies are present.

Turn the screwdriver anticlockwise until either the green LED goes out and the contacts open or the worm drive has been turned 30 complete turns. In the latter case, where the contacts have not opened, check the reading on the dc milliammeter. This current should be approximately 1.2mA dc and is the current flowing in the pilots (a low dc current in the pilots indicates that the pilot resistance is much higher than the limit of 1000 ohms). The dc supply should also be checked. If both these checks are satisfactory, reference should be made to the fault finding instructions.

Reset the pilot fail circuit red LED.

Depress the test button (which closes the supervision zone); the green LED should come on. With the test button held depressed, slowly turn the screwdriver anticlockwise until the green LED extinguishes. Keeping the test button depressed, continue to turn the screwdriver anticlockwise, counting the number of turns until the green LED comes on again. Turn the screwdriver clockwise by half the number of turns counted previously. Release the test button.

Depress the test button again; the green LED should not illuminate. Release the test button. The pilot supervision is now correctly set.

Replace the relay cover and press the reset button.

It is advisable to check that if the pilots are open circuit, the green LED comes on instantaneously and the pilot fail open circuit indicator operates after approximately 10 seconds. After restoring the pilots to normal, reset the pilot fail open circuit indicator.

Check that if the pilots are short circuit, the green LED comes on instantaneously and the pilot fail short circuit indicator operates after approximately 10 seconds. After restoring the pilots to normal, reset the pilot fail short circuit indicator.

Confirm that removal of the ac supply operates the supervision supply indicator after a delay of approximately 10 seconds. Approximately 5 seconds after restoration of the ac supply it should be possible to reset the supervision supply fail indicator.

This completes the tests on the supervision module. Disconnect the milliammeter from the pilots and restore pilot connections.

On completing the tests all trip links should be restored, CT shorting links removed and tripping tests carried out on the circuit breakers from the relays.

Section 4. MAINTENANCE

Suitable precautions should be taken before handling pilot wires. These can rise to a lethal high voltage relative to the ground potential under line fault conditions. Refer to the safety requirements of the country of installation, for safe handling of pilot wires.

Periodic maintenance is not necessary, however, periodic inspection and test is recommended.

4.1 Routine tests

Routine tests should be carried out to confirm that the protection is still effective. This is necessary as under normal conditions protective gear is normally stable.

The frequency of such tests cannot be laid down since much depends upon local conditions. As a general guide, under favourable conditions, annual tests should be adequate. Also it is normally advisable to check protective equipment after operation due to a fault. Routine tests need not be as comprehensive as commissioning tests unless any relays, or associated equipment, have been removed from the panel and then refitted. The following tests are recommended for the MHOA, MHOB and MHOC relays, which may be carried out with the feeder on load.

- Remove the trip circuit isolating link of the translay relay, leaving the back up protection in service.
- Inspect the relay for foreign matter and clean out if necessary, especially the magnet gaps which should be cleaned with a feather. Inspect the contacts but do not disturb them unless badly pitted. (We recommend using a burnishing tool , available from ourselves, to refurbish badly pitted contacts. On no account should cleaning fluids, knives, files or abrasive materials be used). Check that the relay resets from the tripped position.

- Measure and record the pilot voltage and current and the corresponding load current, the results of which should show a close relationship to the previously recorded commissioning test results.

- Reverse the pilots and note that both relays close their contacts. If the load current is less than the three phase operating level of the relay there may be a small movement of the relay disc, and an increase in pilot current. If any doubt exists manually move the disc, noting the reduction in restraining torque compared to normal operating conditions.

- With the pilot connections restored to normal, place a short circuit across the pilot terminal of one relay. If the load current is less than the three phase operating level of the relay there may be a small movement of the relay disc.
- Check that all indicators operate satisfactorily.
- With all trip links restored and all connections normal check that the trip circuit is healthy. This check should preferably include tripping of the circuit breaker.

For the MRTP relay, during testing the LED indicators should be checked for operation. Operation of the relay contacts should coincide with the respective LED indicator illuminating. Check that operation is clean with no tendency to stick. Check also that the flag can be reset using the reset push button mounted in the relay cover.

Section 5. COMPATIBILITY

The MHOA04, MHOB04 and MHOC04 relays are compatible with the previous equivalents, HOA4, HO4 and HOC4 respectively. The circuit diagrams in Figures 8, 9 and 10 show the pilot wire connections between these different relays.

The capacitors within the MRTP supervision relay have identical injection filters to those used in the SJA static pilot supervision relay. The SJA was for use with protective schemes requiring a low impedance path for ac in the pilot circuit. This relay contained a capacitor bank which was connected across the input terminals to the relay. On the translay scheme an SJA relay would be used at one end with a cross pilot detection box at the other end. Now if an MHOB or MHOC protection scheme is in use and pilot supervision is required then MRTP relays would be necessary. For 4kVrms 1minute isolation an MRTP01 will be used at the local end with an MRTP02 at the remote end. Figure 11 shows how MRTP relays should be connected in a translay scheme.

Fault	MHOA (3 end)		MHOB	MHOC	
	13V	26V		N=2,25	N=6
A–N	46%	35%	22%	22%	11.5%
B–N	56%	45%	28%	28%	13%
C–N	80%	60%	40%	40%	15%
A–B	180%	140%	90%	90%	90%
B–C	180%	140%	90%	90%	90%
C–A	90%	70%	45%	45%	45%
A–B–C	104%	80%	52%	52%	52%

Table 1: Nominal relay settings

Notes:

1. The settings for all three types of relay are quoted for a pilot of negligible resistance. The fault settings will increase in proportion to any additional pilot resistance.
2. The settings in the above table for the MHOA are for a three ended system. For a four ended system these figures will have to be multiplied by 1.25.
3. For the MHOA the alternative sensitivities are available by the use of different taps on the quadrature CT (13V or 26V).
4. By adjusting the effective neutral turns between N=2.25 and N=6 on the MHOC relay, the earth fault sensitivity can be altered. Refer to the relay wiring diagram for the connections. The settings increase proportionally.

Relay type	Minimum secondary kneepoint voltage (V)	Secondary magnetising current limit (A) at the stated voltage (V)
MHOA 04	$\frac{350}{In} + I_F(R_{CT} + 2R_L)$	0.002In at $\frac{40}{In} + In(R_{CT} + 2R_L)$
MHOB 04	$\frac{I_F Q}{15}\left(\frac{7}{I^2} + R_{CT} + 2R_L\right)$	0.016In at $\frac{10}{In} + In(R_{CT} + 2R_L)$
MHOC 04	$\frac{I_{FP} Q}{15}\left(\frac{7}{I^2} + R_{CT} + 2R_L\right)$ $\frac{I_{FE} Q}{15}\left(\frac{12}{I^2} + R_{CT} + 2R_L\right)$	0.05In at $\frac{10}{In} + In(R_{CT} + 2R_L)$

Table 2: Current transformer requirements

where In = Rated current.

I_F = Maximum secondary through fault current.

I_{FP} = Maximum secondary through phase fault current.

I_{FE} = Maximum secondary through earth fault current.

R_{CT} = Resistance of the current transformer secondary winding.

R_L = Resistance per lead from current transformer to the relay.

Q = Reactance/resistance ratio (X/R) of the power system, including both the source impedance and the impedance of the feeder to be protected.

Notes

1. The impedance of other phase connected devices, such as instruments, must be added to the term in brackets when calculating the required voltage.
2. When two sets of current transformers are connected in parallel the allowable magnetisation current should be halved.
3. The kneepoint voltage of a CT is defined as that point of the magnetisation curve at which a 10% increase in voltage would cause a 50% increase in magnetisation current.
4. If the reactance/resistance ratio of the power system is not known assume that Q = 5.
5. The secondary magnetising current limit applies where the system minimum internal fault level is less than three times the current transformer rated primary current. Where the minimum internal fault level is greater than this value, the allowable magnetisation current may be increased.

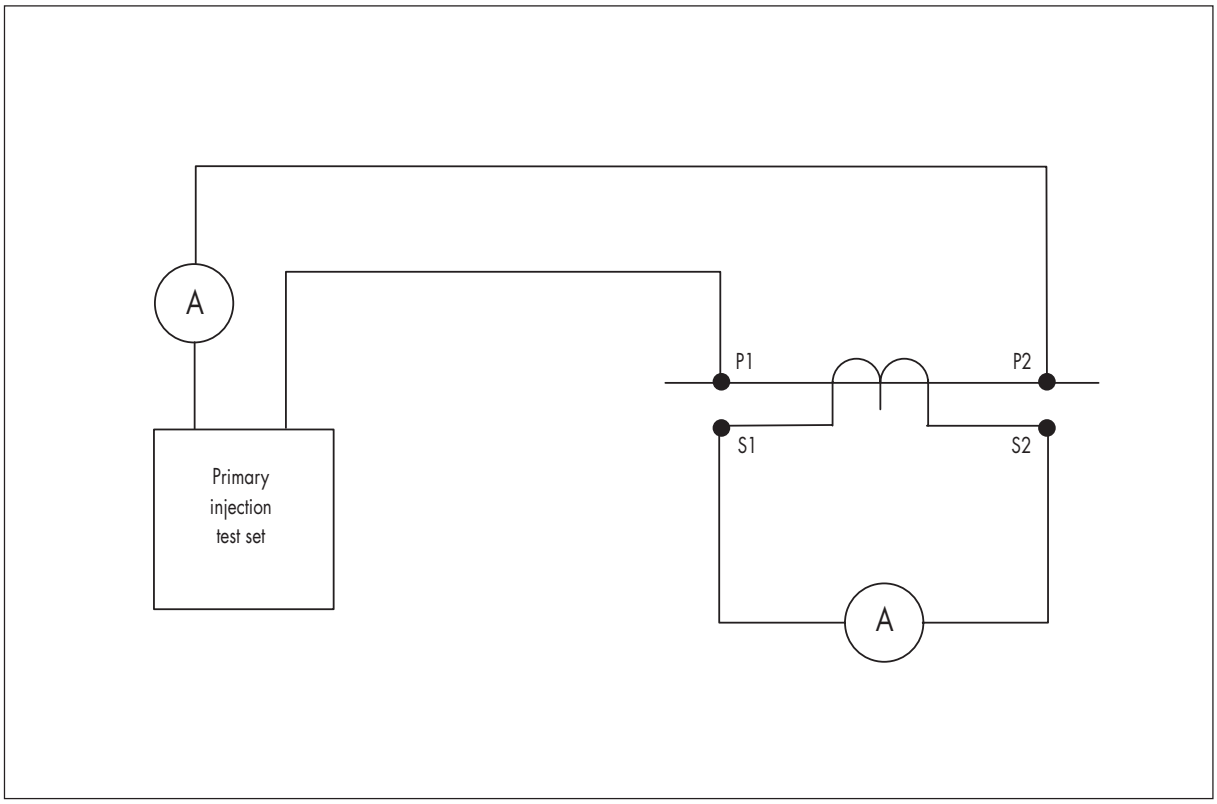


Figure 1: Current transformer ratio test

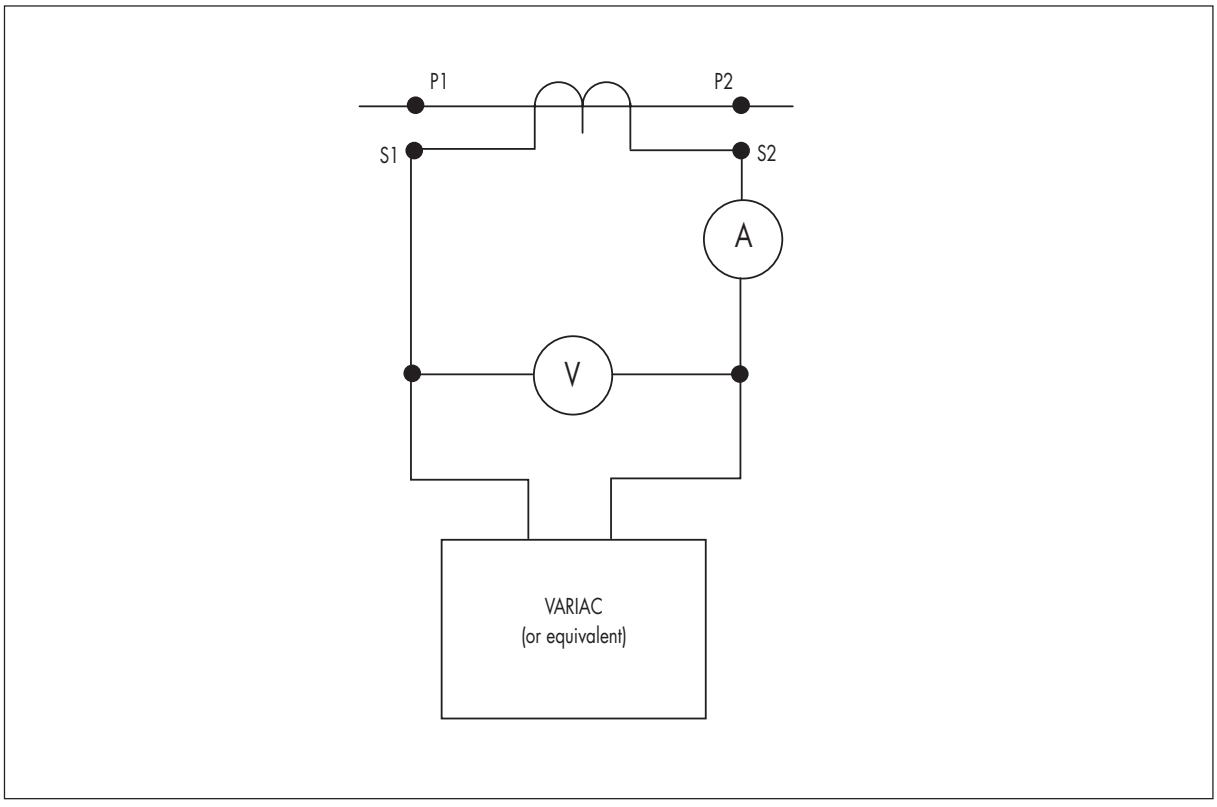


Figure 2: Current transformer magnetisation curve test

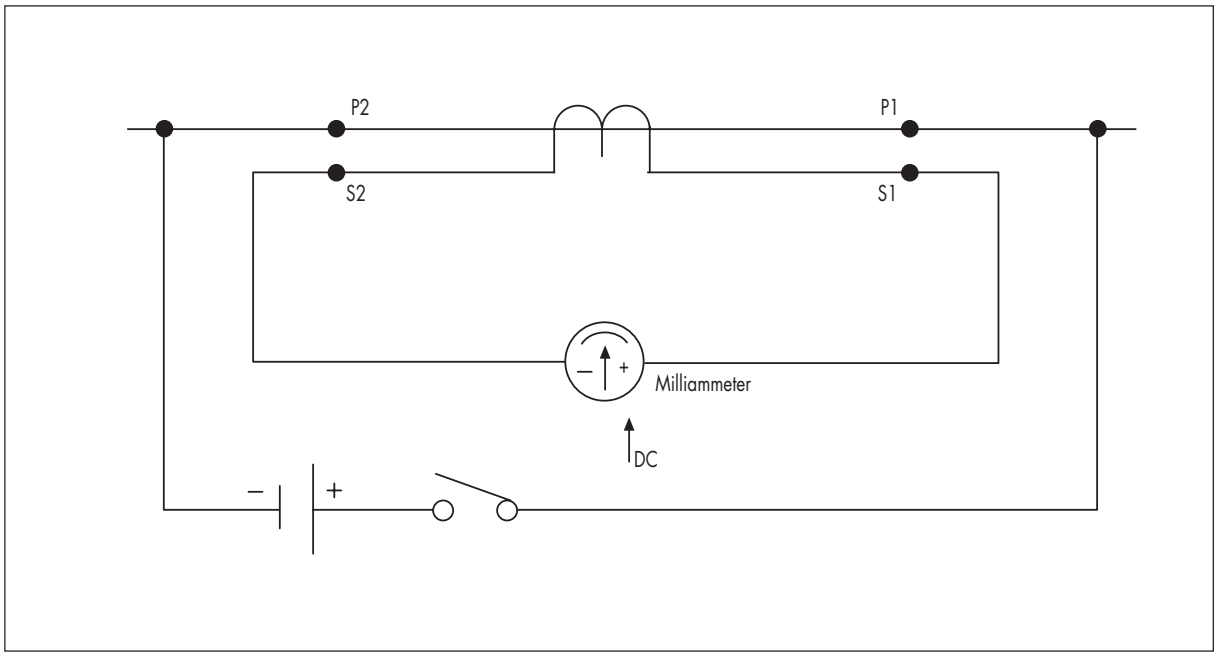


Figure 3: Current transformer dc flick test

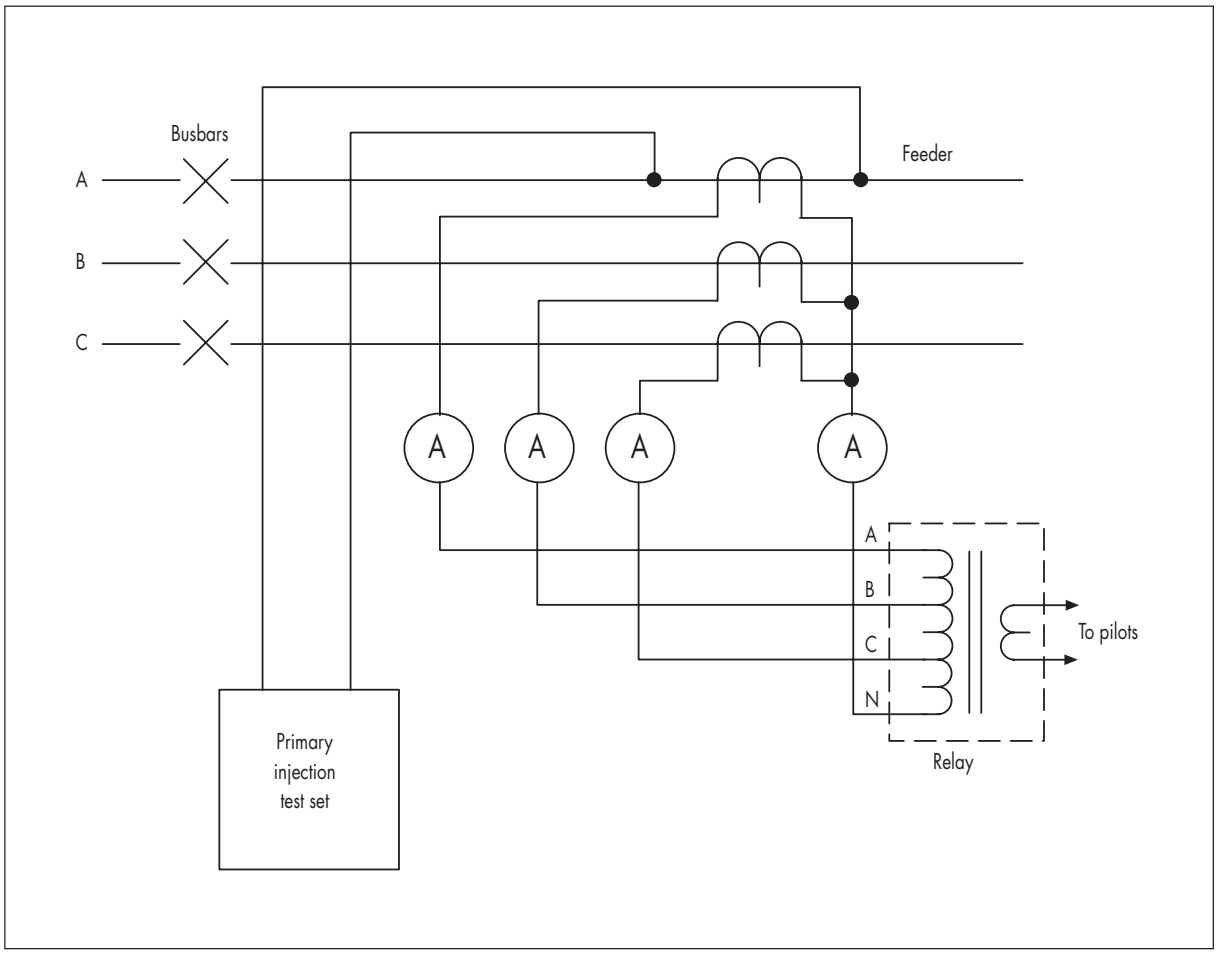


Figure 4a: Single phase injection

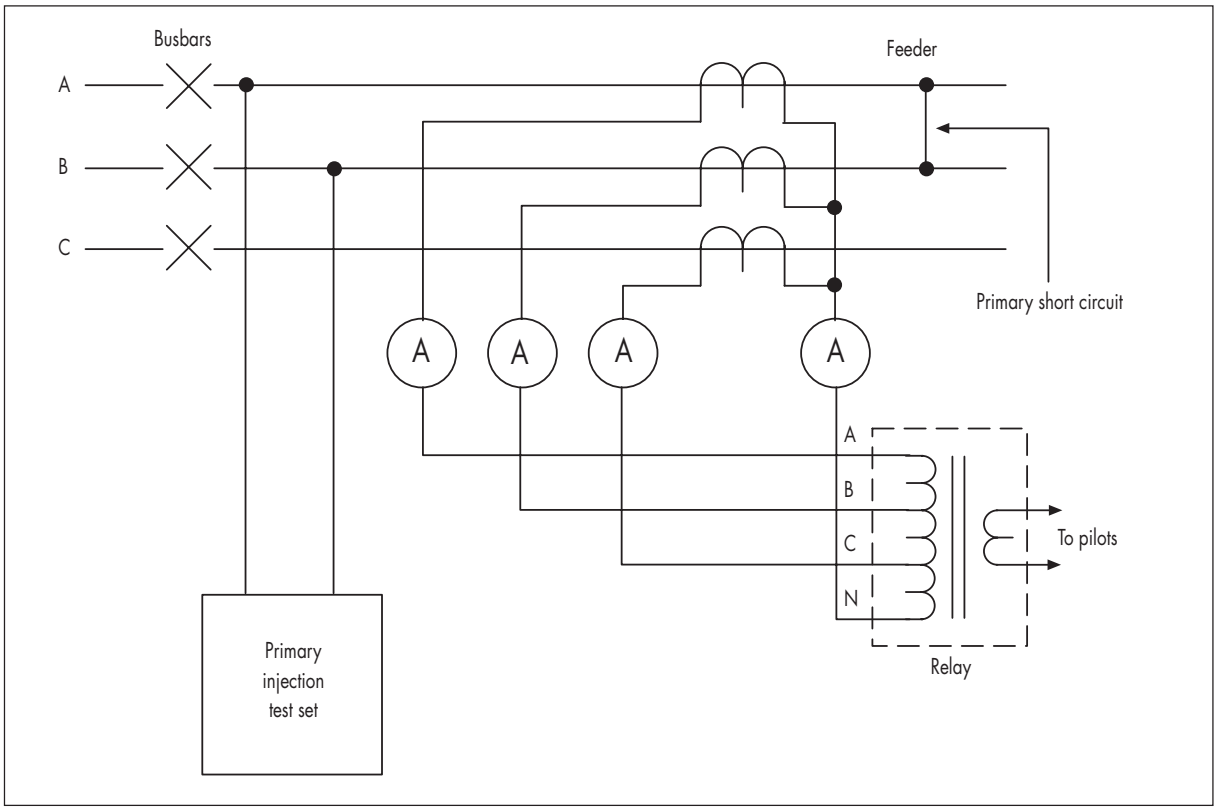


Figure 4b: Two phase injection

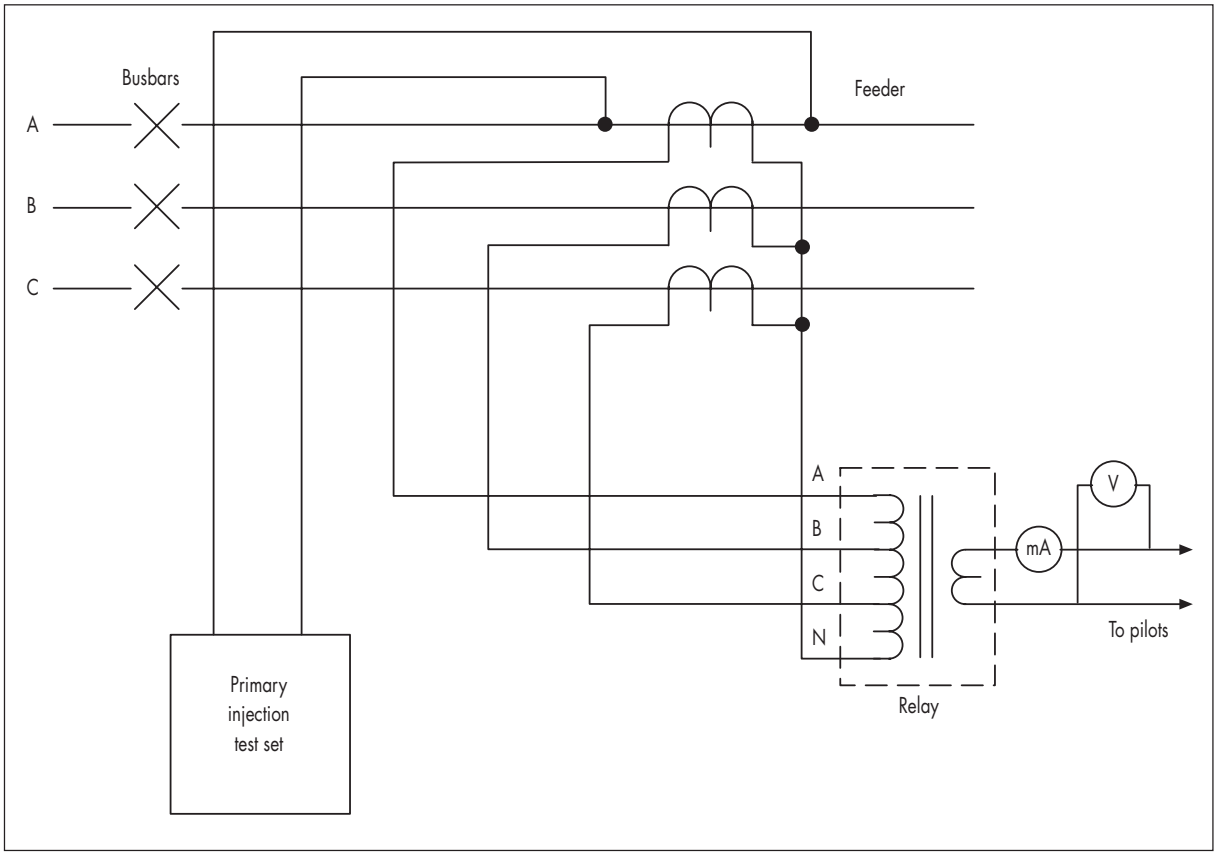


Figure 5a: Relay setting test using primary injection – earth fault A–N

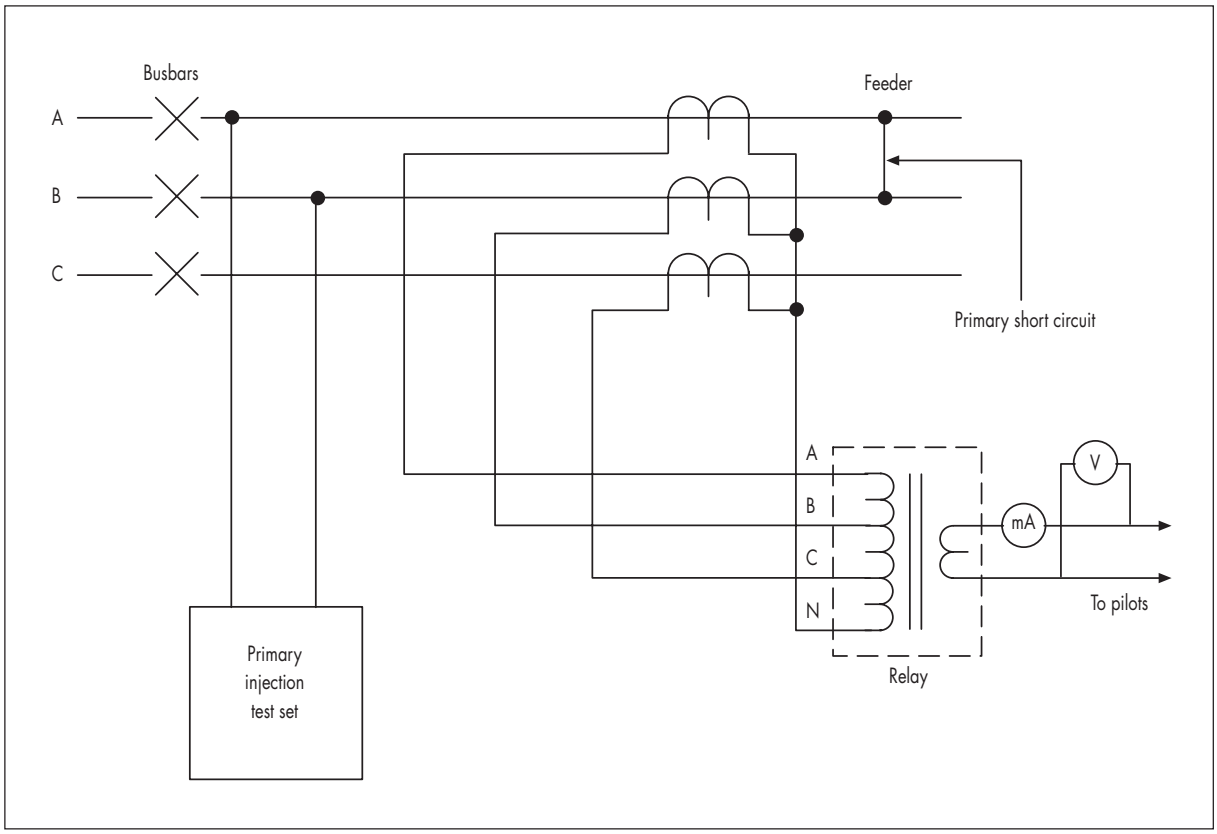


Figure 5b: Relay setting test using primary injection – phase fault A–B

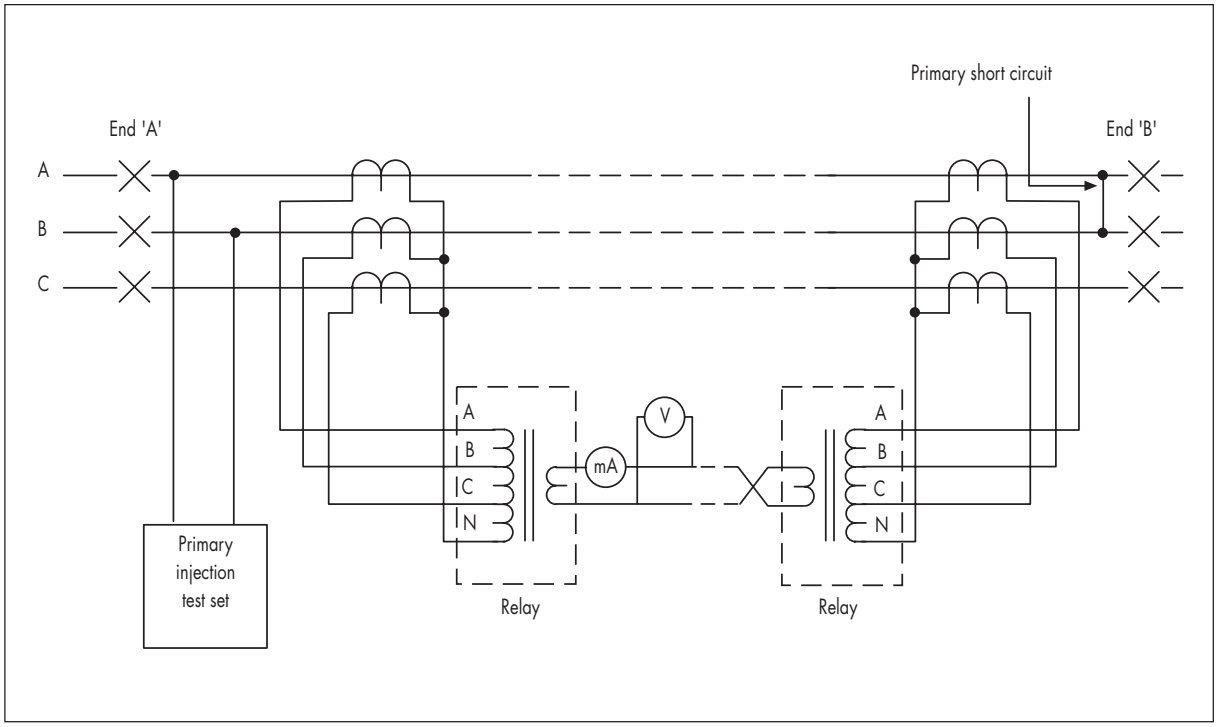


Figure 6: Stability test using primary injection test set through A–B phase fault

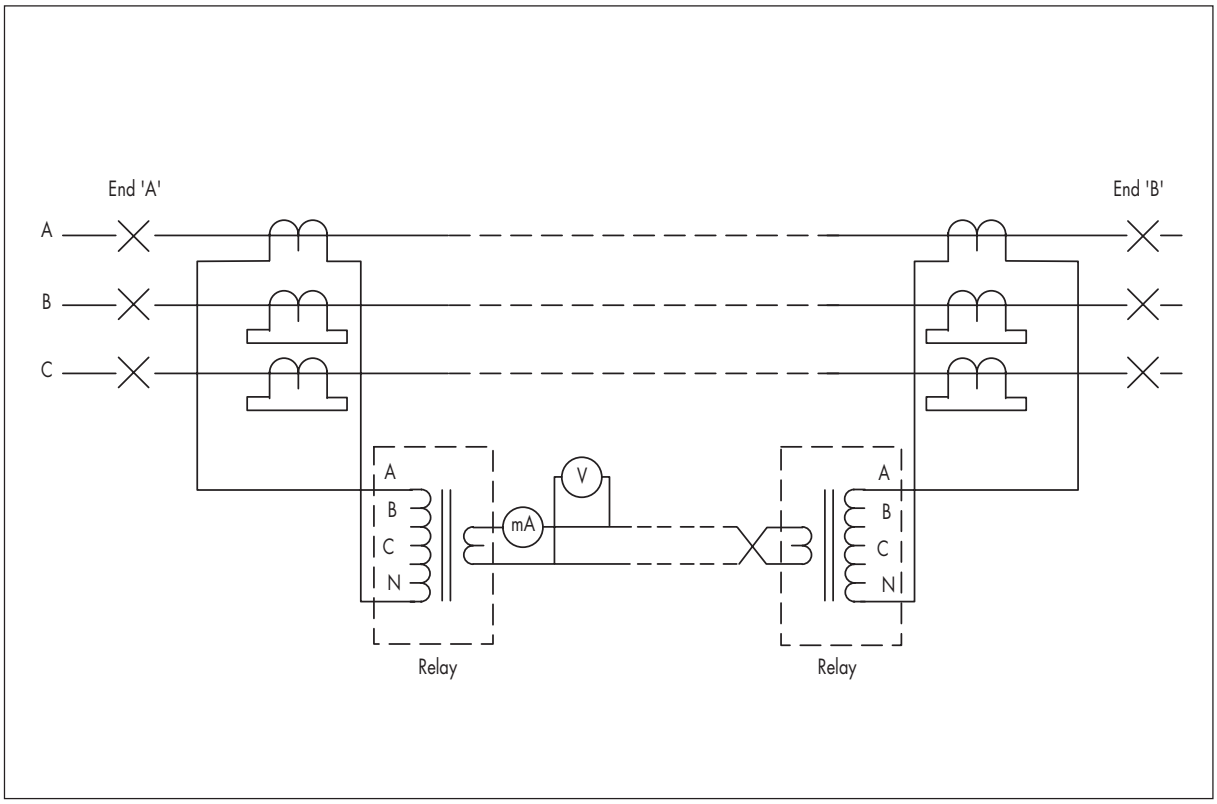


Figure 7: Stability test using phase load current – through A–N earth fault

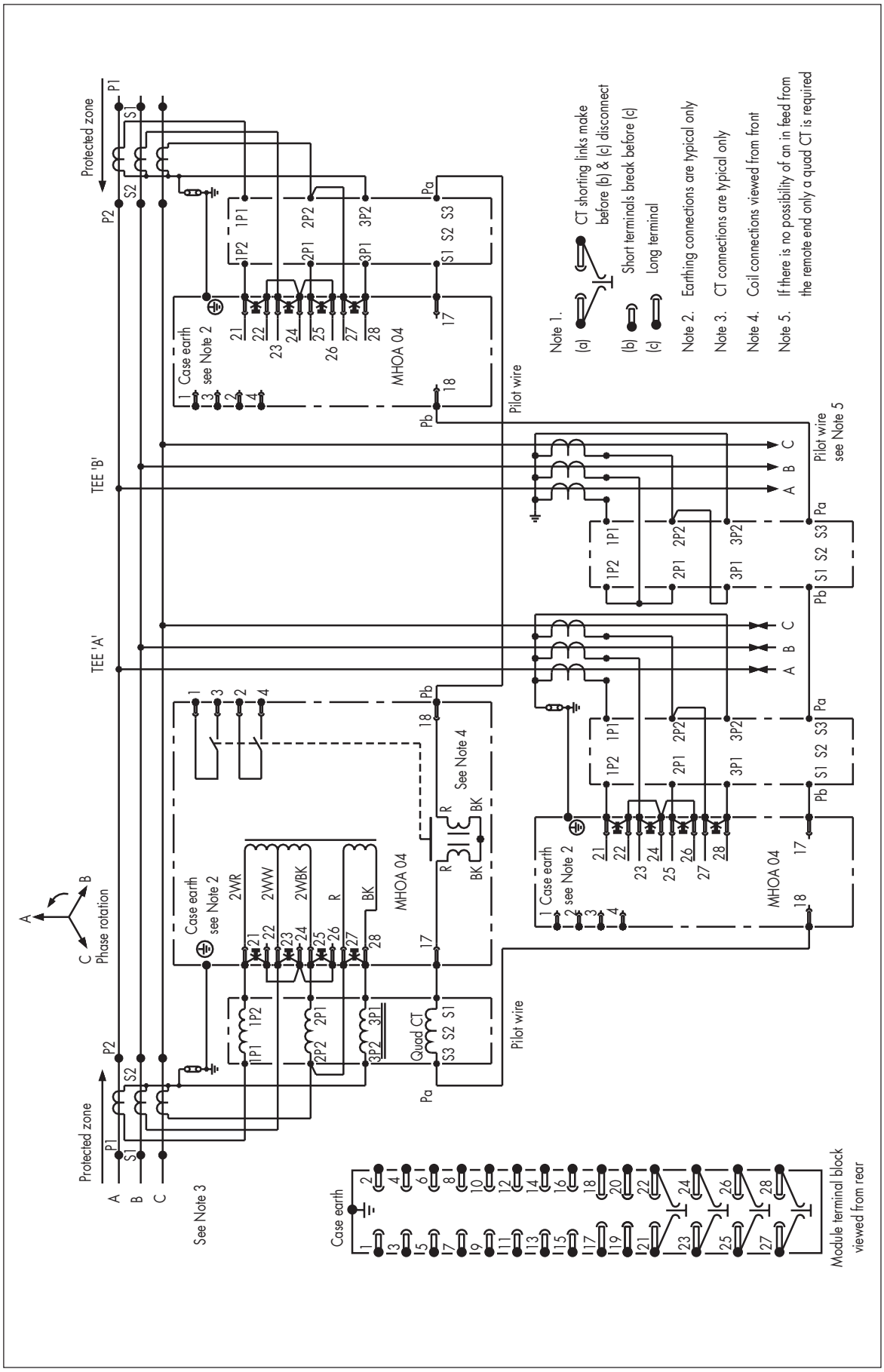


Figure 8: Type MHOA/HOA4 plain feeder protection

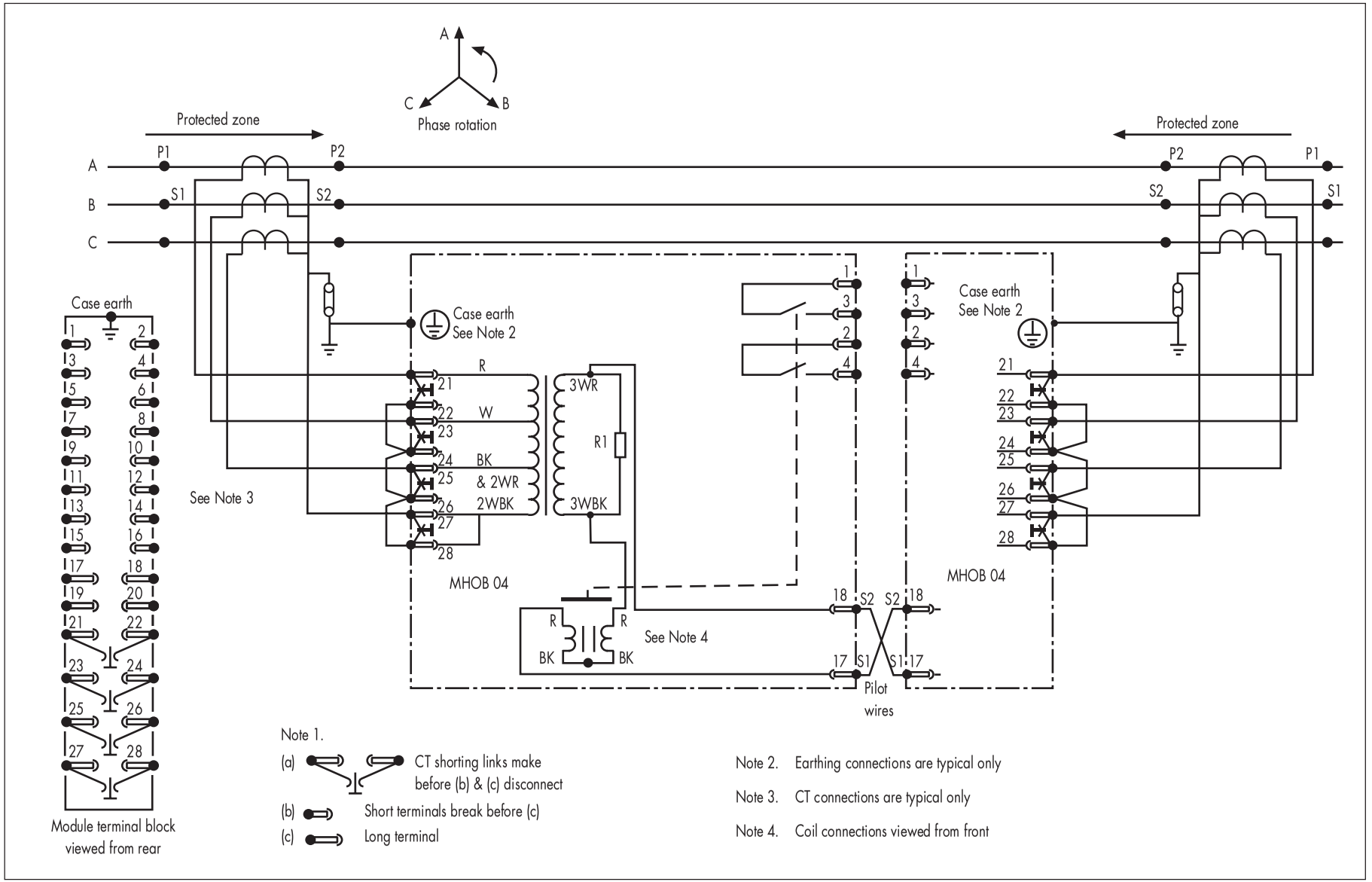


Figure 9: Type MHOB/HOB4 plain feeder protection

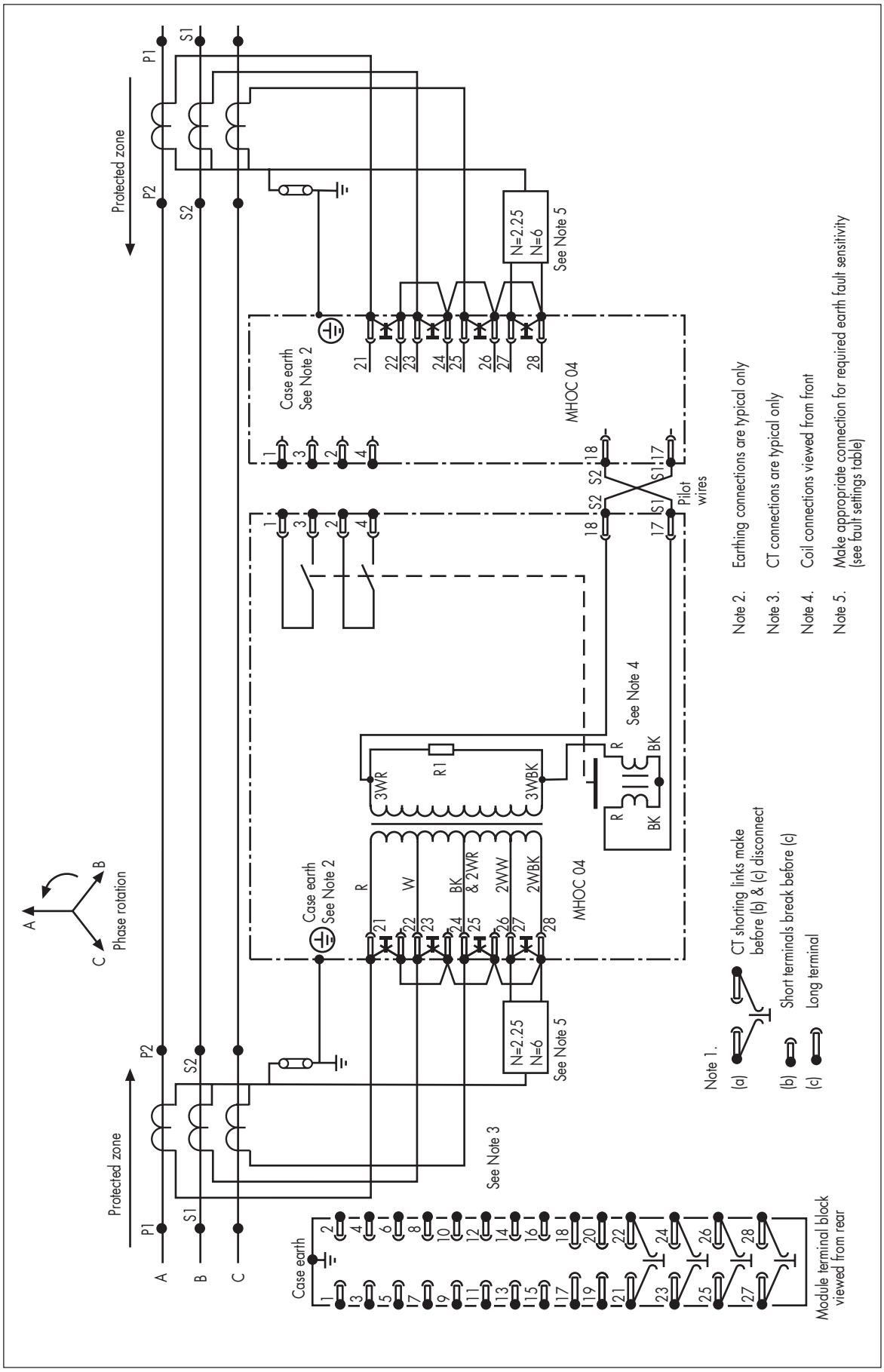


Figure 10: Type MHOC/HOC4 plain feeder protection

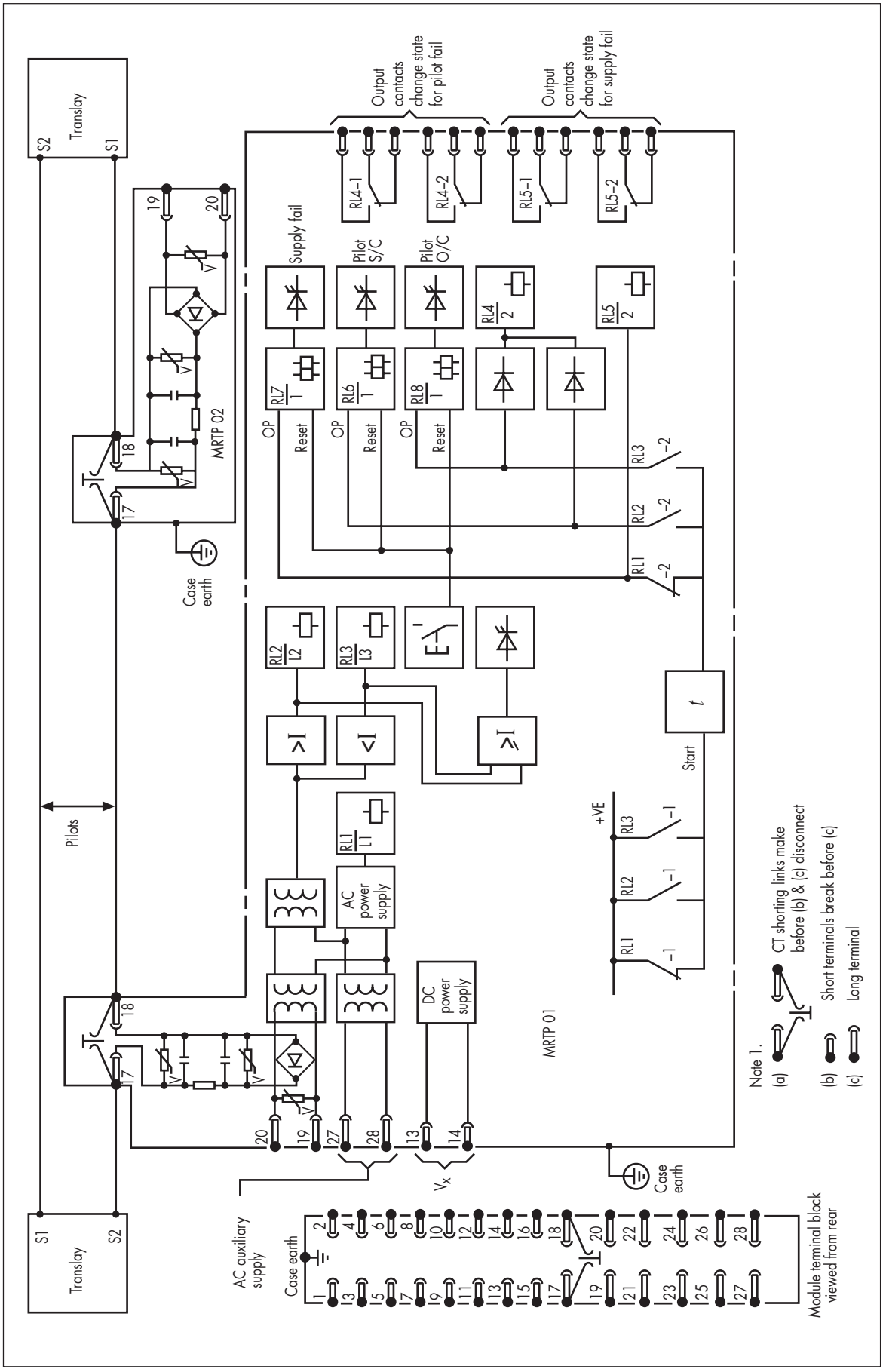


Figure 11: MRTP connections with a Translay scheme

Section 6. COMMISSIONING TEST RECORD

Suitable precautions should be taken before handling pilot wires. These can rise to a lethal high voltage relative to the ground potential under line fault conditions. Refer to the safety requirements of the country of installation, for safe handling of pilot wires.

Translay protection relay

Site: _____ Circuit: _____

Model No.: _____ Serial No.: _____

Rating: _____ Diagram: _____

Pilot Length: _____ Settings: _____

Current transformer tests

CT ratio test A _____ B _____ C_____

CT magnetisation test _____

CT polarity test _____

Phasing out tests A, B, C _____ N _____

Relay settings (at minimum setting mark)

Fault	MHOA (3 end)				MHOB		MHOC			
	13V		26V				N=2.25		N=6	
	Nominal	Actual	Nominal	Actual	Nominal	Actual	Nominal	Actual	Nominal	Actual
A-N	46%		35%		22%		22%		11.5%	
B-N	56%		45%		28%		28%		13%	
C-N	80%		60%		40%		40%		18%	
A-B	180%		140%		90%		90%		90%	
B-C	180%		140%		90%		90%		90%	
C-A	90%		70%		45%		45%		45%	
A-B-C	104%		80%		52%		52%		52%	

Other checks:

Flag operate/reset _____ Trip isolating switch _____

CT shorting switches _____ Contact operation _____

Relay stability tests

Test	Pilots normal			Pilots crossed		
	Pilot voltage	Pilot current	Relay restrains	Pilot voltage	Pilot current	Pilot operates
A-N						
B-N						
C-N						
A-B						
B-C						
C-A						
A-B-C						

Pilot loop resistance _____ Ω

Trip circuit test _____

MRTP ac pilot circuit supervision relay

Site: _____ Circuit: _____

Model No.: _____ Serial No.: _____

Rating AC V(n): _____ V Diagram: _____

DC V(x) _____ V

1. Check supplies – AC V(n) _____ V

   – DC V(x) _____ V

2. Monitor pilot current _____ mA

3. Set adjustable resistor _____

4. Monitor pilot fail contacts _____

5. Check indications _____

Pilot fail open circuit – instantaneous _____ (green LED)

– 10s delay _____ (red LED)

Pilot fail short circuit – instantaneous _____ (green LED)

– 10s delay _____ (red LED)

6. Check supervision supply fail _____ (redLED)

Remarks:

_____	_____
Commissioning Engineer	Customer Witness
_____	_____
Date	Date

REPAIR FORM

Please complete this form and return it to AREVA T&D with the equipment to be repaired. This form may also be used in the case of application queries.

AREVA T&D
St. Leonards Works
Stafford
ST17 4LX
England

For : After Sales Service Department

Customer Ref: _____ Model No: _____

AREVA Contract Ref: _____ Serial No: _____

Date: _____

1. What parameters were in use at the time the fault occurred?

   AC Volts _____ Main VT/Test set

   DC Volts _____ Battery/Power supply

   AC current _____ Main CT/Test set

   Frequency _____

2. Which type of test was being used? _____
3. Were all the external components fitted where required? Yes / No
   (Delete as appropriate)
4. List the relay settings being used

   _____

   _____

   _____

5. What did you expect to happen?

   _____

   _____

   _____

   _____

continued overleaf

6. What did happen?

_____

_____

_____

7. When did the fault occur?

Instant	Yes / No	Intermittent	Yes / No
Time delayed	Yes / No	(Delete as appropriate)	
By how long?	_____		

8. What indications if any did the relay show?

_____

_____

_____

_____

9. Was there any visual damage?

_____

_____

_____

10. Any other remarks which may be useful:

_____

_____

_____

_____	_____
Signature	Title
_____	_____
Name (in capitals)	Company name

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