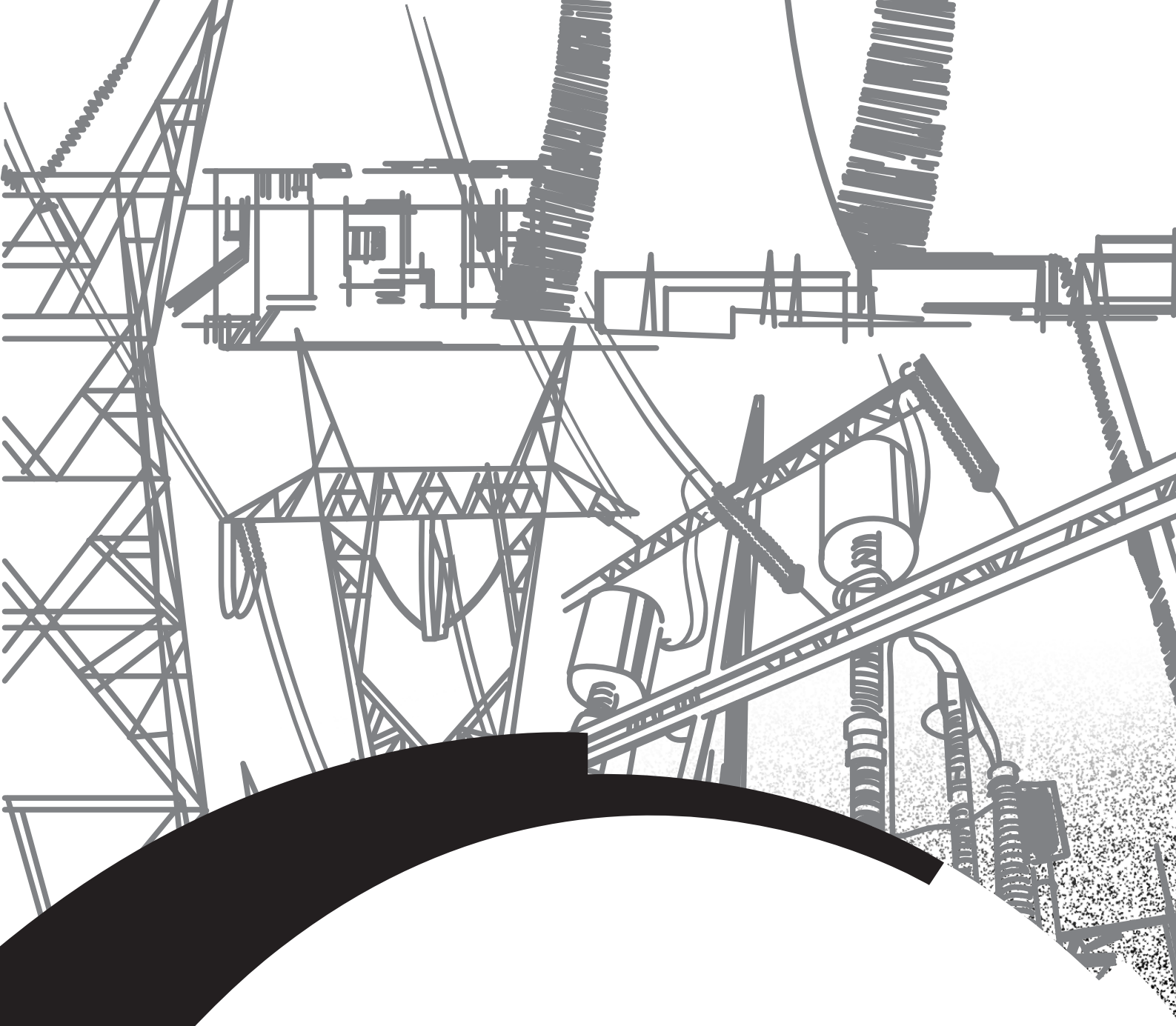


Service Manual
Type MYTU 04
Field Failure Relay

ALSTOM

Service Manual
Type MYTU 04
Field Failure Relay

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 electronic 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 ALSTOM T&D Protection & Control Ltd 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 at the 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 – 10MΩ. 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.

ALSTOM T&D Protection & Control Ltd 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.

ALSTOM

CONTENTS

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: 1990/A2: 1995 Class I EN 61010-1: 1993/A2: 1995 Class I	This equipment requires a protective (safety) earth connection to ensure user safety.
Installation Category (Overvoltage):	IEC 61010-1: 1990/A2: 1995 Category III EN 61010-1: 1993/A2: 1995 Category III	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.
Environment:	IEC 61010-1: 1990/A2: 1995 Pollution degree 2 EN 61010-1: 1993/A2: 1995 Pollution degree 2	Compliance is demonstrated by reference to generic safety standards.
Product safety: CE	73/23/EEC	Compliance with the European Commission Low Voltage Directive.
	EN 61010-1: 1993/A2: 1995 EN 60950: 1992/A11:	Compliance is demonstrated 1997 by reference to generic safety standards.

Section 1. DESCRIPTION

The MYTU 04 relay detects the loss of field supply or reduction in the field current of a synchronous generator beyond the machine stability limit.

It is basically a single phase mho relay with off-set adjustment (see Figure 1).
A built in timer enables the relay to be co-ordinated with other devices and to avoid the possibility of maloperation on synchronisation surges.

One changeover contact and one normally open contact are available, with the set time delay. An LED provides indication of operation of the time delayed contacts.

Pressing a test button causes the LED to light after the set time delay. No contacts should operate.

The contacts are self reset and the LED is made to reset via a push button.

Section 2. INSTALLATION

2.1 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.

2.2 The relays are despatched, either individually or as part of a panel/rack mounted 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 ALSTOM T&D Protection & Control should be promptly notified.
Relays which are supplied unmounted and not intended for immediate installation should be returned to their protective polythene bags.

2.3 Care must be taken when unpacking and installing the relays so that none of the parts are damaged or their settings altered and must only be handled by skilled persons.

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.

2.4 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°C.

2.5 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 centres. For individually mounted relays these dimensions will also be found in Publication R6115.

Publication R7012 Parts Catalogue and Assembly Instructions 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 Draw-out System of protective relays.

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

Section 3. APPLICATION AND SELECTION OF SETTINGS

The satisfactory application of the MYTU 04 field failure relay requires a full knowledge of the operating parameters of the machine during normal operating conditions. The maximum rotor angle at which the machine can operate within the stability limit, and whether the machine has been designed for operation under line charging conditions, that is leading power factors, are required. Once the operating conditions of the machine have been established, it is possible to determine the required offset and circle diameter for the circular characteristic of the relay from a knowledge of the machine transient and synchronous reactances.

The general practice is to use an offset setting Z1 (See Figure 1(a) equal to half the machine transient reactance (Xd')/2 and a circle diameter Z2 (See Figure 1(a)) equal to the synchronous reactance of the machine (Xs) for rotor angles up to 90°, and when the machine cannot be operated at leading power factors. Nevertheless when the machine has been designed to operate at leading power factors and it is provided with high speed, fast acting voltage regulators that permit the operation of the machine at rotor angles up to 120°, the above settings are modified to three quarters of the machine transient reactance 3(Xd')/4 for the offset and half the machine synchronous reactance (Xs)/2 for the circle diameter.

The following worked example indicates the method to be used in calculating the required relay settings. The characteristics of the machine to be used are as follows:

Voltage	:	11kV 3 phase 50Hz
Output	:	15 MVA 0.8 power factor
Machine transient reactance Xd'	:	19%
Machine synchronous reactance	:	200%
Current transformer ratio	:	1500/5
Voltage transformer ratio	:	11000/100

3.1 Typical relay settings

(i) For rotor angles up to 90° and no leading power factors

Offset = Xd'/2 Circle diameter = Xs

(ii) For rotor angles up to 120° and leading power factors

Offset = 3(Xd')/4 Circle diameter = Xs /2

Relay to be set for condition (i) above.

3.2 Offset setting

Machine transient reactance Xd' in secondary is

$$\frac{19 \times 11^2}{100 \times 15} \times \frac{1500/5}{11000/100} = 4.18\Omega$$

Required offset setting = Xd'/2 = 4.18/2 = 2.09Ω

Relay setting Z1 represents the required offset setting. This is set to the nearest available higher setting. Alternatively, the setting below can be used if this is within 10% of the required setting. In this case, the offset should be set to Z_1 = 2.0Ω.

3.3 Circle diameter setting

Machine synchronous reactance Xs in secondary ohms:

$$= \frac{200 \times 11^2}{100 \times 15} \times \frac{1500/5}{11000/100} = 44\Omega$$

Required circle diameter = Xs = 44Ω

Select the nearest setting below, ie. set Z_2 = 40Ω, unless the setting above is within 10%

3.4 Time delay setting

The relay is normally set to operate after a time delay (t) to avoid maloperation due to synchronous surges and transient conditions. The time delay must also be shorter than the thermal limits of the rotor and stator windings.

A typical setting of approximately 5 seconds is normally applied. This will vary with different applications depending on machine parameters and the nature of the external network.

Section 4. COMMISSIONING

4.1 Commissioning preliminaries

4.1.1 Electrostatic discharge

The relay uses components which are sensitive to electrostatic discharges.
When handling the withdrawn module, care should be taken to avoid contact with components and electrical connections. When removed from its case for storage the module should be placed in an electrically conducting anti-static bag.

4.1.2 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. Also check that the rating information is correct for the system.

4.1.3 Wiring

Check that the external wiring is correct to the relevant relay diagram and/or scheme diagram. The relay external connection diagram number is given on the rating label inside the case.

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 odd terminal numbers (1, 3, 5, 7 etc).

The auxiliary supply volts to the scheme are normally routed via test block terminals 13 and 15.

4.1.4 Earthing

Ensure that the case earthing connection, above the rear terminal block, is connected to the local earth bar.

4.1.5 Insulation tests

These tests may be done by the main plant contractor at an earlier date.

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 giving 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 must subsequently be replaced.

4.2 Commissioning tests

4.2.1 Equipment required

1 Double pole switch

1 Time interval meter

2 Variacs (1 suitable for 2x relay rated current)

1 Phase shifter giving 100 to 200V on the secondary side

1 Phase angle meter able to respond to currents from 0.2 to 2x rated current

1 Voltmeter

1 Ammeter

1 Variable resistor suitable for 2x rated current
(About 100Ω for 1A relay or 20Ω for 5A relay).

Note: For 5A relays a CT could be used to step up the current, with a 100Ω, 2A rated resistor being used.

4.2.2 Auxiliary supply

The auxiliary supply should be checked at terminals 13 (+ if dc) and 14 with the module removed. If a test block type MMLG is fitted the auxiliary supply may be routed through it. If the auxiliary supply is ac it should be checked at terminals 15 and 16.

Removal of the cover provides isolation of one connection. If the test plug type MMLB01 is to be used, the links to provide CT shorting must be in place before it is inserted. The CT shorting facility in the relay case should be checked with the relay removed.

Links can then be put on the test plug to restore auxiliary supplies to the relay.

The scheme connection diagram must be referred to.

For supplies greater than 125V dc an external resistor can be used giving about 110V dc at the relay.

For 24/30V dc supplies an MSTZ 02 is used in conjunction with a 48V relay.

4.2.3 Test feature

Set the time delay setting to about 1 second or the lowest available setting if higher than 1 second. Check that pressing the test push button causes the trip LED to light after the set time. Set the time delay to the minimum setting.

4.2.4 Secondary injection connections

The relay should now be connected to the test circuit, as shown in Figure 3, taking care to note the correct connections of the phase angle meter.

It should be noted that the relay has a characteristic as given in Figure 1 in terms of system primary impedances.

The required impedance settings should now be put on the relay as described in Section 3.

4.2.5 To check Z2 setting.

With the rated dc (or ac) auxiliary supply switched on, apply 50% rated volts to the relay. Adjust the phase shifting transformer as necessary to make the current lead the voltage by 90°. Reduce the current to zero and reset the relay. Slowly increase the current until the relay first operates, but do not exceed the current rating of the load resistor (2 x rated I) or the continuous rating of the relay (3 x rated I). At the point of operation of the relay, note the voltage and current.

The applied impedance $\frac{V}{I}$ represents $2(Z_1 + Z_2)$

$$\therefore \quad Z_2 = \frac{V}{2I} - Z_1$$

This should be within ±15% of the relay Z2 setting under commissioning test conditions. Check that when the current is reduced by 10% from that recorded, the relay can be reset. It should be noted that when the current is at a low value, the applied impedance is beyond the impedance setting of the relay.

See Publication R6115 for some areas where a greater error may be allowed.

If the relay cannot be made to operate, the voltage and current should be checked and the polarity of the phase angle meter and test connections affirmed. Applying an impedance of say 80% of the $Z_1 + Z_2$ setting, and rotating the phase shifting transformer through a full 360°, will help determine the position of the circle relative to the test circuit and phase angle measurement.

4.2.6 To check the relay characteristic angle (RCA)

Reduce the voltage approximately 10% less than that required for relay operation in Section 4.2.5. above. With the voltage and current kept constant, rotate the phase shifter transformer until the relay contacts open. Press the relay reset. Slowly rotate the phase-shifter back until the relay just re-operates. Note the phase angle between the current and voltage. Continue rotating the phase shifter in the same direction, passing through the 90° condition, until the relay contacts re-open and it can be reset. Creep back with the phase shifter until the relay once again just operates.

Note: The new phase angle. The mean of these two angles should be within ±5° of 90°.

4.2.7 To check the Z1 setting

Apply 50% rated volts. Increase the current until the relay just operates as in Section 4.2.5.

Increase the current up to the maximum of 2 x or 3 x rated I, as dictated by the load resistor or relay continuous rating, or until the relay contacts open and can be reset. If necessary, reduce the voltage, decreasing the impedance until the relay can be reset.

Note: The undervoltage cut off value may be 20% V_n or 40% V_n

Either increase the voltage slowly, or decrease the current, increasing the impedances, until the relay just operates. Note the voltage and the current.

The applied impedance $\frac{V}{I}$ represents $2Z_1$

$$\therefore\ Z_1 = \frac{V}{2I}$$

The calculated Z_1 should be within ±15% of the relay Z1 setting under commissioning test conditions.

From the point of pick up, decrease the voltage by 10%. The relay should now drop off and be capable of being reset.

4.2.8 Timing checks

Put the required time delay setting on the relay. Use one pole of the double pole switch to apply current and the other pole to start the time interval meter. Use the appropriate time delay contact to stop the timer. Apply a fault using rated current with the voltage of a value that gives a point well inside the characteristic. The times obtained should be within +5% (or +30ms if greater) of the set time. Take three timing shots to check for consistency. The reset time can be measured by arranging the time interval meter to start on removing the current and to stop when the relay contact opens. The time obtained should be less than 100ms.

Make sure the in service setting chart is completed.

4.2.9 System load checks

It is unlikely that selection of Z1 to its minimum and Z2 to its maximum setting together with adjustment of excitation to produce a leading power factor would result in a relay operation. It is thus recommended that the machine is run at unity power factor and a phase angle meter is used to measure the angle between A-B volts and A phase current as shown in Figure 4. This should be repeated using B phase current.

This test can only be done if the appropriate test block is provided.

Care is required to ensure that current transformers are not made open circuit at any time.

The angle measured using A phase current should be about 30° lagging.

The angle measured using B phase current should be about 150° lagging.

Section 5 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.

5.1 Repeat commissioning tests to prove correct operation or for more limited testing operate the test pushbutton.

Section 6 PROBLEM ANALYSIS

Should any problems be experienced with the relay, the commissioning tests should be repeated. If the relay is found to be faulty it should be returned to ALSTOM T&D Protection & Control for repair and recalibration since there are no user serviceable parts inside.

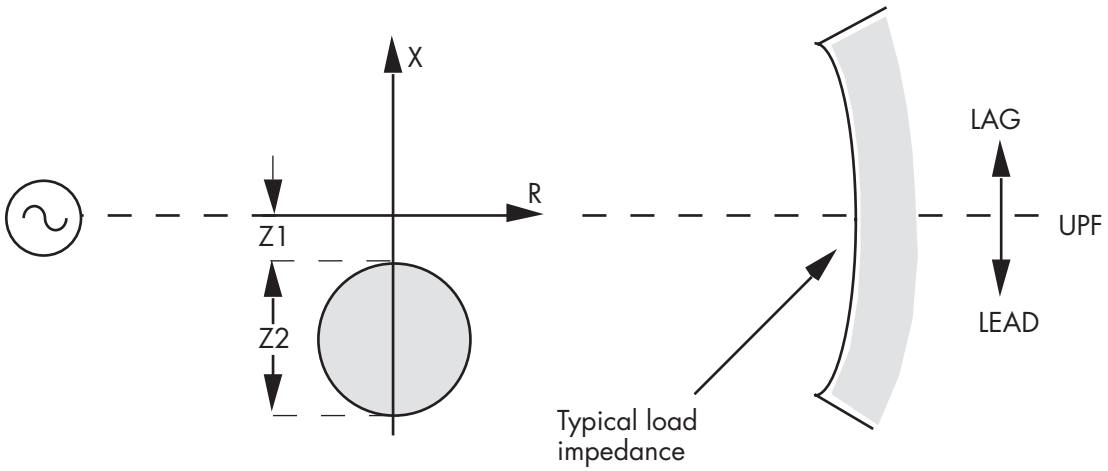


Figure 1 Normal field failure relay characteristics

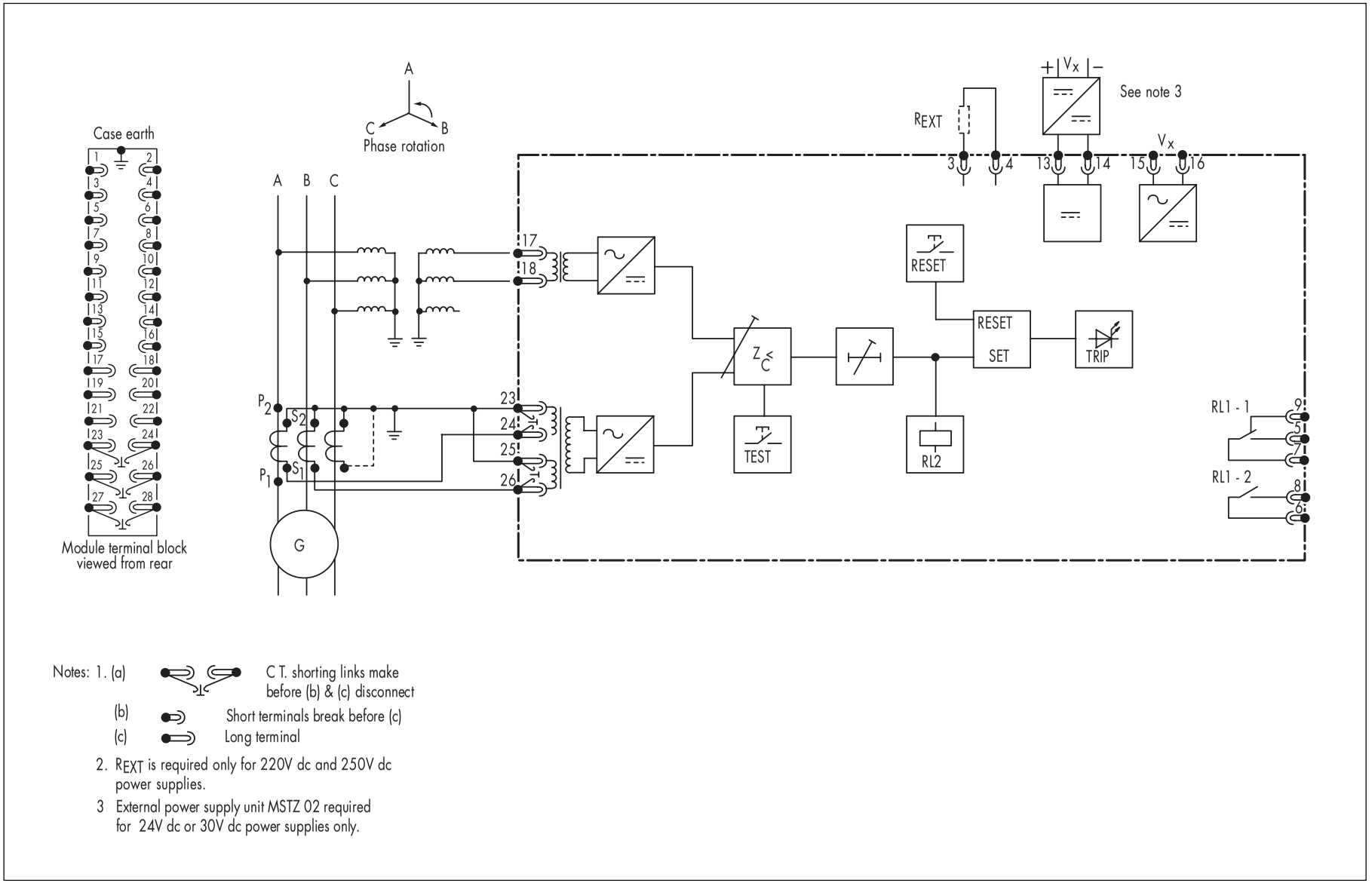
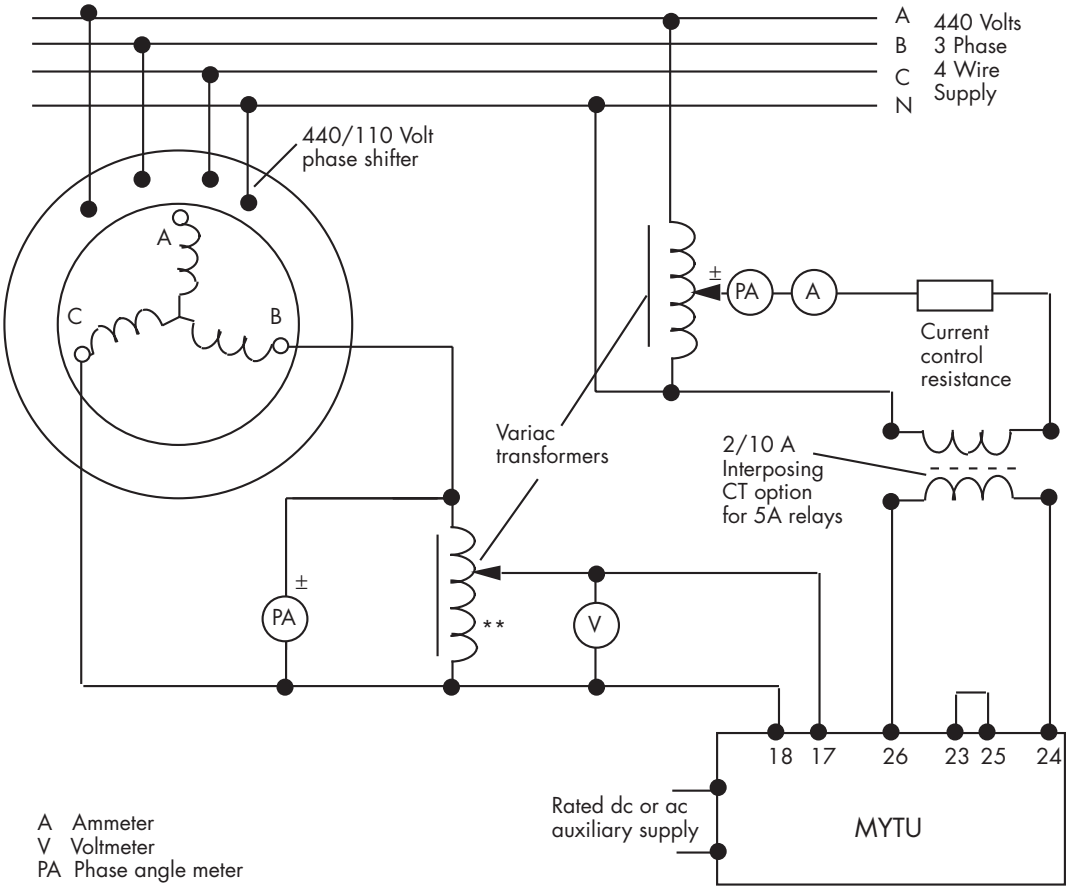


Figure 2 Block diagram: field failure relay



** This variac could be used to step up the voltage for relays with Vn = 220V or 380V.
50% Vn is satisfactory for tests.

Figure 3 Circuit diagram for secondary injection tests

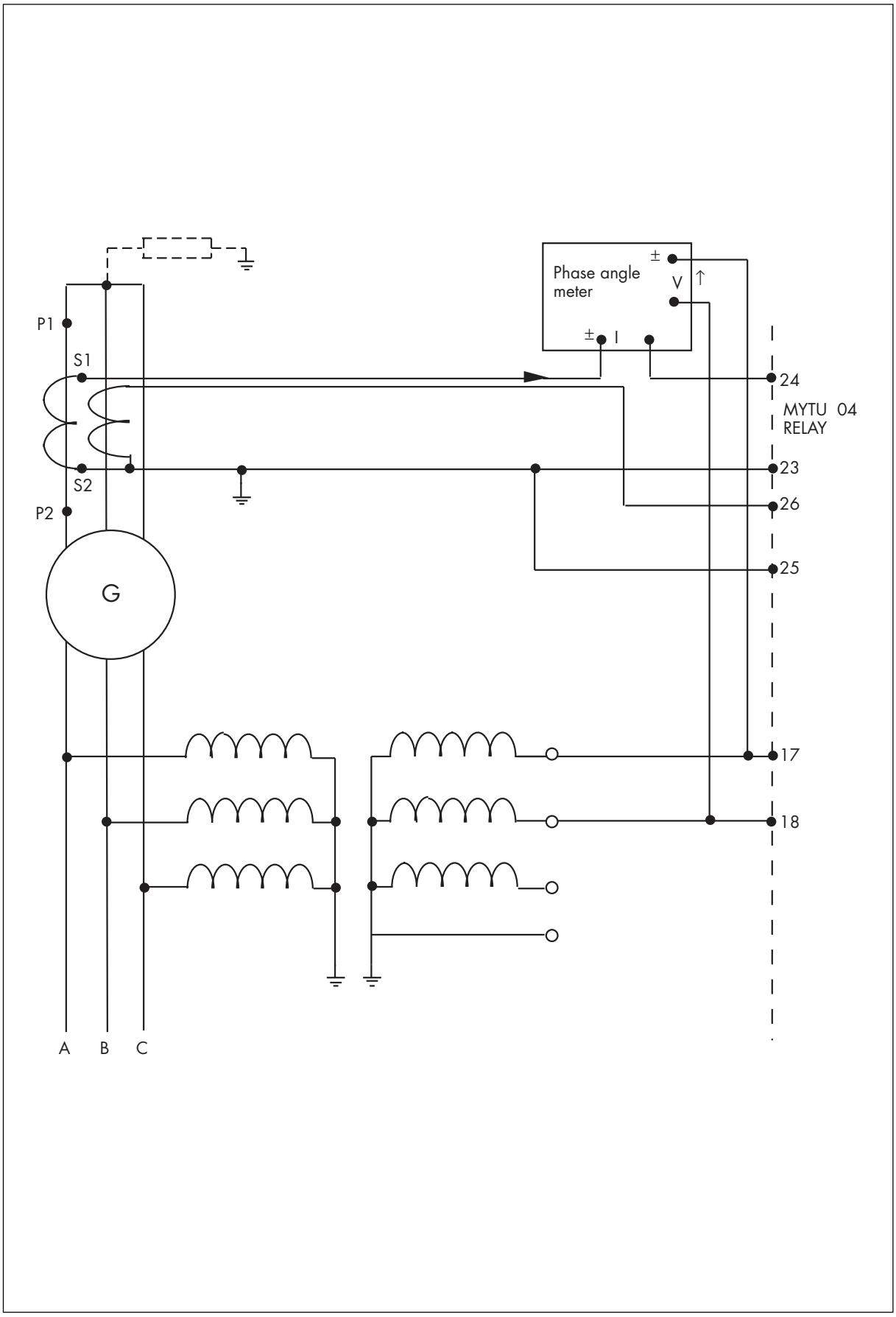


Figure 4 Circuit diagram for system load checks

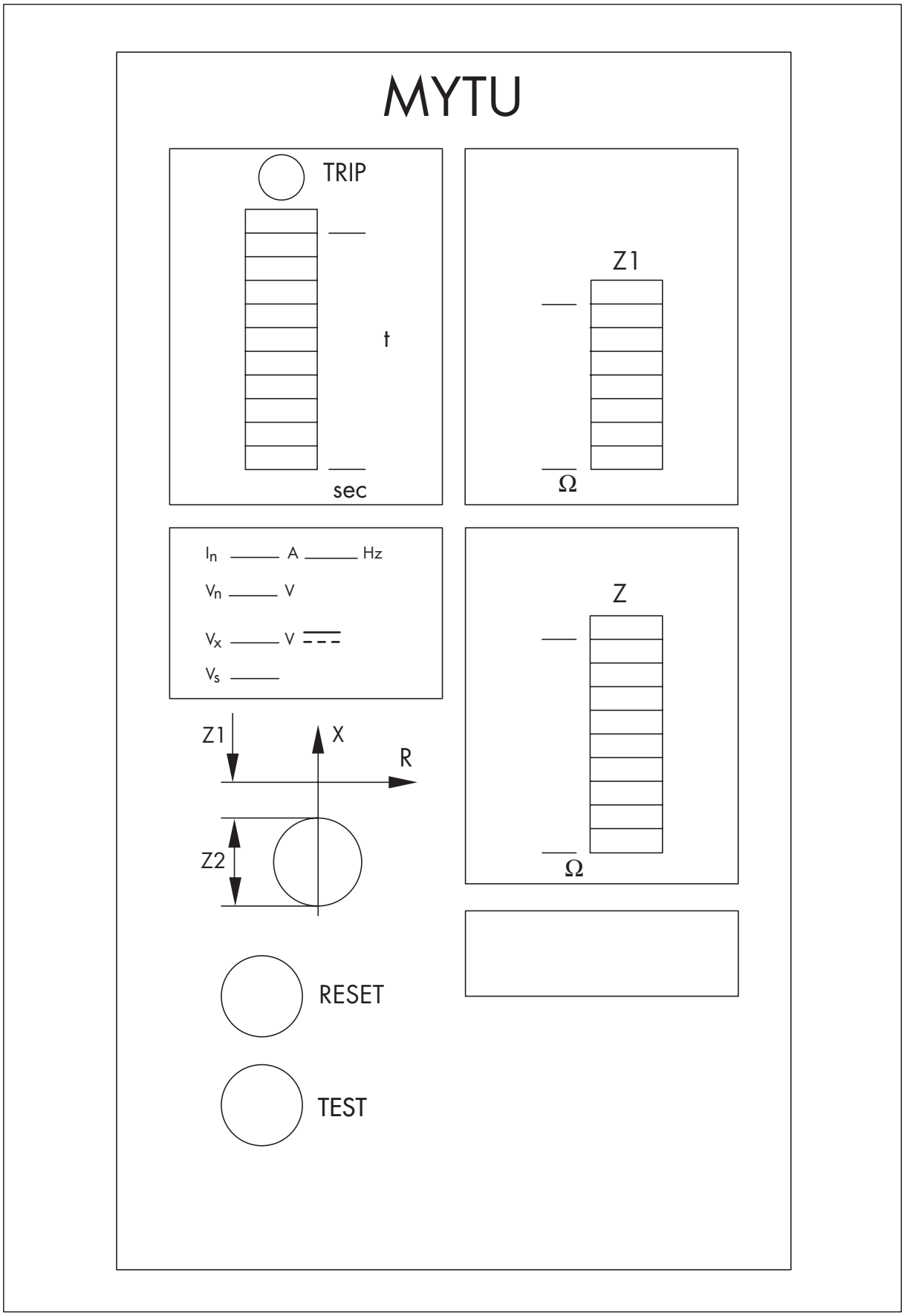


Figure 5 Chart of in service settings.

Section 7 COMMISSIONING TEST RECORD

Station _____ Circuit _____

Relay Model No _____ Serial No _____

Auxiliary Supply Vx _____ V AC ☐ DC ☐

Rated Current _____ A 50Hz ☐ 60Hz ☐

VT ratio _____ : _____ CT ratio _____ : _____

Machine transient reactance Xd = _____ %

Machine synchronous reactance Xs = _____ %

3.1 Required relay characteristics

(i) For rotor angles up to 90° and no leading power factors ☐

Offset = $\frac{Xd}{2}$ Circle diameter = Xs

(ii) For rotor angles up to 120° and leading power factors ☐

Offset = $\frac{3Xd}{4}$ Circle diameter = $\frac{Xs}{2}$

Calculated required relay secondary impedance settings

3.2 Offset Z1 _____ Ω

3.3 Circle diameter setting Z2 _____ Ω

Outer impedance _____ Ω

Chart of in service settings filled in Commissioning tests ☐

4.1.2 Visual inspection ☐

4.1.5 Insulation tests ☐

4.2.2 Auxiliary supply measured on terminals 17 & 18 _____ V _____

Relay CT shorting facility checked ☐

4.2.3 Test feature satisfactory ☐

4.2.5 Relay Z2 setting = _____ Ω

Measured Z2 boundary

I = _____ A V= _____ V

$Z1 + Z2 = \frac{V}{I}$ = _____ Ω Z2 =_____ Ω

With I reduced 10%, relay drops off ☐

4.2.6 Characteristic angle check

θ_1 measured = _____ °

θ_2 measured = _____ °

∴ characteristic angle = _____ ° I lead

4.2.7 Relay Z1 setting

_____ Ω

Measured Z1 boundary

I = _____ A V= _____ V

$Z1 = \frac{V}{2_I}$ = _____ Ω

4.2.8 Timing tests

Set time _____ s

Measured time = _____ _____ _____ s

Reset time = _____ _____ _____ ms

4.2.9 System load check

Angle between VAB and IA = _____ °

Angle between VAB and IB = _____ °

_____ _____

Commissioning Engineer Customer Witness

_____ _____

Date Date

REPAIR FORM

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

ALSTOM T&D Protection & Control Ltd
St. Leonards Works
Stafford
ST17 4LX,
England

For: After Sales Service Department

Customer Ref: _____ Model No: _____

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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