

# **Service Manual**

## **Type MVTD**

### **Inverse Time Delayed Relays**

#### **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 GEC ALSTHOM T&D Protection & Control Limited products are completely safe from electrostatic discharge when housed in the case. 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 147-0F.

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.

GEC ALSTHOM T&D Protection & Control Limited 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 147-0F.

Types: MVTD11 Inverse Time Delayed Undervoltage Relay  
 MVTD12 Inverse Time Delayed Overvoltage Relay  
 MVTD13 Inverse Time Delayed Neutral Displacement Relay

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## 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.

	
<b>Caution:</b> refer to product documentation	<b>Caution:</b> 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.

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<sup>2</sup>, 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.

### **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.

### **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.

### **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.

### **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 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.

### **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.



## 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, GEC Red Spot type or equivalent, unless otherwise stated in the Technical Data section of the product documentation.

<b>Insulation class:</b>	IEC 1010-1: 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.
<b>Installation Category (Overvoltage):</b>	IEC 1010-1: 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.
<b>Environment:</b>	IEC 1010-1: 1990/A2: 1995 Pollution degree 2 EN 61010-1: 1993/A2: 1995 Pollution degree 2	Compliance is demonstrated by reference to generic safety standards.
<b>Product safety:</b>	73/23/EEC	Compliance with the European Commission Low Voltage Directive.
	EN 61010-1: 1993/A2: 1995 EN 60950: 1992/A3: 1995	Compliance is demonstrated by reference to generic safety standards.

## Section 1 DESCRIPTION OF SETTINGS

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### 1.1 Voltage settings

The setting voltage is determined by the positions of the bottom five dual-in-line switches. The sum of all the voltages shown by each respective switch position and the constant value as show on the relay nameplate, gives the required setting voltage.

### 1.2 Time multiplier setting switches

The TMS setting is determined by the top three dual-in-line switches. The sum of all the settings indicated by each switch position and the constant value 0.125, again as shown on the nameplate, gives the required TMS setting.

### 1.3 Setting example

An MVTD 11 with the switches set to the position shown corresponds to a voltage setting of 80V and a TMS setting of 0.375.

TMS switches	( 0.125	->	0	$x_t = (0.125 + \Sigma) \text{ TMS} = 0.125 + 0.25 = 0.375$
	( 0.25	<-	0	
	( 0.5	->	0	
<hr/>				
Voltage setting switches	( 1.5	->	0	$V_s = (62 + \Sigma) \text{ volt} = 62 + 6 + 12 = 80V$
	( 3	->	0	
	( 6	<-	0	
	( 12	<-	0	
	( 24	->	0	

For other versions the setting method is identical. Refer to the nameplate on each individual relay.

### 1.4 Trip indication

Earlier relays were fitted with hand reset mechanical flag indicators, later relays being fitted with non-volatile hand reset led trip indicators.

## Section 2 AUXILIARY EQUIPMENT

### 2.1 External series resistors

The following dropper resistors pre-mounted on an external assembly, marked with the relay serial number, are supplied with each relay when required.

### 2.2 MVTD 11 – Undervoltage

Relay ac rating (V) 50/60Hz	Relay dc rating (V)	Resistor assembly part number	Dropper resistor fitted	
			DC series resistor (ohm) Rext 1	AC series resistors (ohm) Rext 2
100/120	30/34	Not required	–	–
57/70	30/34	Not required	–	–
100/120	48/54	FJ0340 007	220Ω	–
57/70	48/54	FJ0340 007	220Ω	–
100/120	110/125	FJ0340 001	1.0kΩ	–
57/70	110/125	FJ0340 001	1.0kΩ	–
100/120	220/250	ZE0103 018	2 x 4.7kΩ in parallel	–
57/70	220/250	ZE0103 018	2 x 4.7kΩ in parallel	–

### 2.3 MVTD 12 – Overvoltage

Relay ac rating (V) 50/60Hz	Relay dc rating (V)	Resistor assembly part number	Dropper resistor fitted	
			DC series resistor (ohm) Rext 1	AC series resistors (ohm) Rext 2
100/120	30/34	None required	–	–
380/440	30/34	ZE0103 020	–	66kΩ
100/120	48/54	FJ0340 007	220Ω	–
380/440	48/54	ZE0103 021	220Ω	66kΩ
100/120	110/125	FJ0340 001	1.0kΩ	–
380/440	110/125	ZE0102 022	1.0kΩ	66kΩ
100/120	220/250	ZE0103 018	2 x 4.7kΩ in parallel	–
380/440	220/250	ZE0103 023	2 x 4.7kΩ in parallel	66kΩ

The 66kΩ external resistor, Rext 2, required only on the MVTD 12, is made up of two 15kΩ and two 18kΩ wirewound resistors, all connected in series.

The MVTD 12 is initially calibrated with this external resistor assembly and if the assembly or any of the resistors on it are changed, the relay must be recalibrated.

## 2.4 MVTD 13 Neutral Displacement

Relay ac rating (V) 50/60Hz	Relay dc rating (V)	Resistor assembly part number	Dropper resistor fitted	
			DC series resistor (ohm) Rext 1	AC series resistors (ohm) Rext 2
57/120	30/34	None required	–	–
57/120	48/54	FJ0340 007	220Ω	–
57/120	110/125	FJ0340 001	1.0kΩ	–
57/120	220/250	ZE0103 018	2 x 4.7kΩ in parallel	–

## Section 3 INSTALLATION

### 3.1 Precautions

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.

### 3.2 Packing

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

### 3.3 Inspection

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 immediately to the transport company concerned and the nearest GEC ALSTHOM T&D Protection & Control representative should be promptly notified. Relays which are supplied unmounted and not intended for immediate installation should be returned to their protective polythene bags.

### 3.4 Unpacking

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

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.

### 3.5 Storage

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 humid 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.

Storage temperature  $-25^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ .

### 3.6 Siting

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 R6051.

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## Section 4 COMMISSIONING

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Note: Earlier relays were fitted with hand reset mechanical flag indicators, later relays being fitted with non-volatile hand reset led trip indicators.

### 4.1 Relevant sections for testing of each relay

Test Description	Section	MVTD 11 Undervoltage	MVTD 12 Overvoltage	MVTD 13 N. displacement
Commissioning preliminaries	4.2	✓	✓	✓
DC auxiliary supply check	4.3.1	✓	✓	✓
Test block type MMLG	4.3.2	✓	✓	✓
Isolation of VT circuit	4.3.3	✓	✓	✓
Voltage setting check	4.3.4	4.3.4a	4.3.4b	4.3.4c
Operating time characteristic check	4.3.5	4.3.5a	4.3.5b	4.3.5c
TMS checks	4.3.6	4.3.6a	4.3.6b	4.3.6c
Final setting check	4.3.7	✓	✓	✓
Trip indicator and contact check	4.3.8	✓	✓	✓
Final checks	4.3.9	✓	✓	✓

## **4.2 Commissioning preliminaries**

### **4.2.1 Electrostatic discharge (ESD)**

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 the case for storage, the module should be placed in an electrically conducting anti-static bag. See full recommendations inside the front cover of this publication.

### **4.2.2 Inspection**

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

Check that the relay serial number of the module, case cover and resistor assembly (when required) are identical, and that the model number and rating information are correct.

**CAUTION:** If a mechanical flag indicator is fitted, damage is likely to be incurred if the flag indicator/armature assembly of a miniature relay is actuated manually with a screwdriver/probe. Flags should be reset with the cover in position by the facility provided.

### **4.2.3 Wiring**

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.

If a test block 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 with odd numbers (1, 3, 5, 7 etc.). The auxiliary supply voltage to the scheme should be routed via test block terminals 13 and 15.

### **4.2.4 Earthing**

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

### **4.2.5 Insulation**

The relay and its associated wiring may be insulation tested between:

- all electrically isolated circuits
- all circuits and earth

An electronic or brushless insulating 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, must subsequently be replaced.

### 4.3 Commissioning tests

Equipment required for all relays

- dc voltmeter to check nominal dc volts.
- ac voltmeter to cover setting range.
- resistance meter.
- electronic timer.
- double pole switch (except for MVTD 01).

MVTD 12 380/440V version only:

- step up transformer to cover range 0-800V.
- ac ammeter for use when no step up transformer is available (0-10mA).

MVTD 11 only:

- variable resistor (rheostat) 500Ω/0.5A.
- double pole changeover switch (break before make).

MVTD 13 only:

- wirewound resistor 6W/50kΩ.

Note: Measuring accuracy depends upon the accuracy of the instruments used.

#### 4.3.1 DC auxiliary supply check

Ensure that the correct series dropping resistor(s) are fitted if required. Remove the relay from its case and check that the incoming dc supply at the relay case terminals 13(+ve) and 14(-ve) is within the range specified below.

Rated dc voltage (V)	DC operative range (V)
30/34	24 – 37.5
48/54	37.5 – 66
110/125	87.5 – 150
220/250	175 – 300

#### 4.3.2 Test block type MMLG

If a test block is included in the scheme, it may also be associated with protection CT circuits. 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.

**DANGER: DO NOT OPEN CIRCUIT THE SECONDARY CIRCUIT OF A CURRENT TRANSFORMER SINCE THE HIGH VOLTAGE PRODUCED MAY BE LETHAL AND COULD DAMAGE INSULATION.**

The test plug isolates test block terminals 13 and 15 from 14 and 16 respectively removing the dc supply, making it necessary to add links between these terminals to restore the auxiliary supply to the relay.

#### 4.3.3 Isolation of VT circuit

Before any secondary injection tests are carried out, the voltage transformer supply to the relay should be isolated by removing the VT secondary link/fuses. This is to prevent any accidental back energisation of the system via the VT from the test supplies.

#### 4.3.4 Voltage setting check

Since the relay has very little hysteresis the pick-up and drop-off values of the relay are very close. This has the effect of causing the led to flicker as the setting is approached. The pick-up value should be taken as the value at which the green timer start led is fully illuminated without flickering.

The pick-up value of the relay should be measured with the voltage setting switches in each of the positions shown in Table 1.

Table 1

Switch positions						Pick up voltage (V rms)				
Switch	1	2	3	4	5	MVTD 11 57/70V	MVTD 11 100/120V	MVTD 12 100/120V	MVTD 12 380/440V	MVTD 13 57/120V
Test 1	0	0	0	0	0	32	62	105	400	5
Test 2	1	0	0	0	0	33	63.5	107.5	410	6
Test 3	0	1	0	0	0	34	65	110	420	7
Test 4	0	0	1	0	0	36	68	115	440	9
Test 5	0	0	0	1	0	40	74	125	480	13
Test 6	1	1	1	1	1	63	108.5	182.5	710	36

Key 1 = switch closed (in the left hand position)

0 = switch open (in the right hand position)

The ac voltage supply should be connected across terminals 27 and 28 via one pole of the switch (SW1) in Figures 1, 2, 3 and 4.

##### (a) MVTD11 undervoltage relay (See Figure 4)

The ac voltage should be increased to a value above the setting value and the trip indicator reset.

Slowly decrease the voltage until the relay picks up. This will be indicated by the illumination of the green timer start led on the relay frontplate. Record the pick-up value.

Repeat the test for each of the values in Table 1.

The allowable errors on the voltage settings are  $\pm 2\%$  on the lowest setting and  $\pm 4\%$  on all other settings. (No allowance has been made for instrument errors).

(b) MVTD 12 overvoltage relay

See Figures 1 and 2 for test circuits for the 100/120V and 380/440V versions respectively.

Note: If the 380/440V version is being commissioned, a step-up transformer is needed to allow the calibration of the settings to be checked. If no transformer is available, the alternative test method below should be used.

Check that the led trip indicator is reset and slowly increase the ac voltage until the led on the front plate is fully illuminated. This is the pick-up value and should be recorded.

The allowable errors on the voltage settings are  $\pm 2\%$  on the lowest setting and  $\pm 4\%$  on all other settings. (No allowance has been made for instrument errors).

Alternative test method for 380/440V version of MVTD 12

This method should be used only when no step-up transformer is available.

See Figure 3 for test circuit.

First, accurately measure the resistance of the dropper resistor assembly (REXT<sub>2</sub>).

With the relay on the lowest setting and the dropper resistor (REXT<sub>2</sub>) removed from the circuit, measure the pick-up voltage directly at the relay terminals (27 and 28) and the ac current into the relay at pick-up.

The effective pick-up value can now be calculated using the following formula:

$$V_{\text{eff}} = V_m + (I_m \times R_m)$$

Where:  $V_{\text{eff}}$  = the effective pick-up voltage

$V_m$  = the measured pick-up voltage with REXT<sub>2</sub> out of circuit

$I_m$  = the measured pick-up current with REXT<sub>2</sub> out of circuit

$R_m$  = the measured resistance of the dropper resistor assembly (REXT<sub>2</sub>)

The pick-up value should be within  $\pm 2\%$  of the setting value. (No allowance has been made for instrument errors).

This test has checked the calibration point of the relay and the other settings need only be checked to see that they are functioning. Refer to tests 2 – 6 in Table 1 for the appropriate switch positions.

With the dropper resistors (REXT<sub>2</sub>) still out of circuit, monitor the voltage at the relay terminals (27, 28). Slowly increase the voltage until the relay picks up (when the green timer start led is fully illuminated).

The measured pick-up values should be higher than the pick-up value on the lowest setting (400V) as indicated below.

Take the pick-up value at 400V as being X.

Table 2

Test No.	Voltage setting (V)	Pick up voltage at relay terminals (27, 28) (V)
1	400	X
2	410	$X + 2 \pm 1$
3	420	$X + 4 \pm 1$
4	440	$X + 9 \pm 2$
5	480	$X + 17 \pm 2$
6	710	$X + 66 \pm 4$

(c) MVTD 13 neutral displacement relay (See Figure 1 for test circuit)

A series dropper resistor of approximately  $50k\Omega$  is required to obtain sufficient accuracy in determining the pick-up value of the relay.

Check that the trip indicator is reset and slowly increase the ac voltage until the green timer start led on the frontplate is fully illuminated. Record the pick-up voltage.

Repeat the test for each of the settings shown in Table 1. The allowable errors on the voltage settings are  $\pm 2\%$  on the lowest setting and  $\pm 4\%$  on all other settings. (No allowance has been made for instrument errors).

#### 4.3.5 Operating time characteristic checks

It is recommended that the relays are timed at two points on the characteristic curve as given in the following relevant sections.

(a) MVTD 11 undervoltage relay (See Figure 4 for the test circuit)

One pole of the changeover switch (SW1) should be used to start the timer and one of the relay contacts used to stop the timer.

Note: If the changeover switch or variable resistor (rheostat) is not available, it is permissible to test the relay at only one point on the characteristic curve ie. switching from 120% of the setting to zero.

With the relay on the minimum voltage setting ( $32V_n = 57/70V$  or  $62V$  for  $V_n = 100/120V$ ) and the TMS = 1x, the variac and variable resistor should be adjusted to provide 120% and 70% of the setting voltage respectively.

Using the changeover switch (SW1 in Figure 4), change the applied voltage to the relay from 120% to 70% of the voltage setting. Measure and record the operating time.

The operating time should be  $16.67s \pm 7.5\%$  (within the range 15.42s to 17.92s). No allowance has been made for instrument errors.

Adjust the variable resistor to give zero volts from the wiper connection (ie. take the wiper to the beginning of the track). Switch the voltage applied to the relay from 120% of the setting to zero and measure and record the operating time.

The operating time should be  $5s \pm 5\%$  (within the range 4.75s to 5.25s). No allowance has been made for instrument errors.

(b) MVTD 12 overvoltage relay

Both of the test methods below should be carried out with the relay on the lowest voltage setting (105V for  $V_n = 100/120V$  or 400V for  $V_n = 380/440V$ ) and with the TMS = 1x.

Test Method 1

This is the method to be used when testing the 100/120V version (see Figure 1 for test circuit) and the 380/440V version with a step up transformer (see Figure 2 for test circuit).

One pole of the switch (SW1) should be used to start the timer and one of the relay contacts used to stop the timer.

Adjust the variac to give 130% of the setting voltage. Using switch SW1 change the voltage applied to the relay from zero to 130%. Measure and record the operating time.

The operating time for  $K = 40$  should be  $133.33s \pm 7.5\%$  (within the range 123.33s to 143.33s).

The operating time for  $K = 5$  should be  $16.67s \pm 7.5\%$  (within the range 15.42s to 17.92s). No allowance has been made for instrument errors.

Adjust the variac to give 200% of the setting voltage. Switch the voltage applied to the relay from zero to 200% and measure and record the operating time.

For  $K = 40$  the operating time should be  $40s \pm 5\%$  (within the range 38s to 42s).

For  $K = 5$  the operating time should be  $5s \pm 5\%$  (within the range 4.75s to 5.25s). No allowance has been made for instrument errors.

Test Method 2

This test method is for use when no step-up transformer is available for testing the 380/440V version.

The test procedure is the same as for Method 1 but the applied voltages should be from zero to 130% and from zero to 200% of the actual pick-up voltage measured at the relay terminals (27 and 28) without the external resistor assembly in circuit (see Figure 3). The operating times should be within the limits given in Test Method 1.

(c) MVTD 13 neutral displacement relay (see Figure 1 for the test circuit)

One pole of the switch SW1 should be used to start the timer and one of the relay contacts used to stop the timer.

With the relay on the minimum setting (5V) and the TMS = 1x, the variac should be adjusted to give 10V as measured at the relay terminals (27 and 28).

Using the switch (SW1) the voltage to the relay should be switched from 0V to 10V and the operating time measured and recorded.

The operating time should be  $40s \pm 11\%$  (within the range 35.6s to 44.4s).

Adjust the variac to give 100V at the relay terminals (27 and 28). Switch the voltage applied to the relay from 0V to 100V. Measure and record the operating time.

The operating time should be 2.11s at  $\pm 5\%$  (within the range 2.0s to 2.22s). No allowance has been made for instrument errors.

#### 4.3.6 Timer multiplier setting (TMS) checks

With the relay on the lowest setting, the multiple of the voltage setting shown in the relevant table below, should be applied to the relay. The operating time should be measured at each TMS shown, and checked to see that it lies within the range given.

(a) MVTD 11 undervoltage relay

Table 3

TMS switch position				TMS value (xt)	Applied voltage		Operating time range (seconds)
Switch	1	2	3		From (xVs)	To (xVs)	
Test 1	1	0	0	0.25	1.2	0	1.175 – 1.325
Test 2	0	1	0	0.375	1.2	0	1.781 – 1.969
Test 3	0	0	1	0.625	1.2	0	2.969 – 3.281

(b) MVTD12 overvoltage relay

Note: When testing the 380/440V version without a step-up transformer, the multiples of Vs referred to in Table 4 should be multiples of the actual pick-up voltage measured at the relay terminals (27 and 28), without the dropper resistor (REXT<sub>2</sub>) in circuit.

Table 4

TMS switch position				TMS value (xt)	Applied voltage		Operating time range (seconds)	
Switch	1	2	3		From (xVs)	To (xVs)	k = 40	k = 5
Test 1	1	0	0	0.25	0	2.0	9.4 – 10.6	1.175 – 1.325
Test 2	0	1	0	0.375	0	2.0	14.25 – 15.75	1.781 – 1.969
Test 3	0	0	1	0.625	0	2.0	23.75 – 26.25	2.969 – 3.281

Key 1 = switch closed (in the left hand position)

0 = switch open (in the right hand position)



(c) MVTD13 neutral displacement relay

Table 5

TMS switch position				TMS value (xt)	Applied voltage		Operating time range (seconds)
Switch	1	2	3		From (xVs)	To (xVs)	
Test 1	1	0	0	0.25	0	20.0	0.495 – 0.558
Test 2	0	1	0	0.375	0	20.0	0.750 – 0.829
Test 3	0	0	1	0.625	0	20.0	1.250 – 1.382

#### 4.3.7 Final setting check

Adjust the voltage to its functional setting and measure the pick-up voltage using the method described in previous sections. Also measure the drop-off value in the same way, taking the voltage at which the green timer start led goes out and stays out as being the drop-off voltage.

Check that the pick-up voltage is within the stated tolerance and that the drop-off is within 5% of the pick-up value.

Set the TMS to the setting required and apply the multiple of the voltage setting given in Table 6 for the relevant relay. Measure the operating time.

The operating time should be:

$$(t \times \text{TMS value}) \pm 8\%$$

Where t is the operating time given in Table 6.

Note: When testing the 380/440V version of the MVTD12 without a step up transformer, the applied voltage should be switched from zero to twice the actual pick-up value measured without REXT<sub>2</sub> in circuit, and NOT from zero to twice the voltage setting as given in the table.

Table 6

Relay	Applied voltage		Operating time t (seconds)
	From (xVs)	To (xVs)	
MVTD11	1.2	0	5
MVTD12	0	2	K = 40 : 40 K = 5 : 5
MVTD13	0	20	2.11

#### 4.3.8 Trip indicator and contact check

Check that the trip indicator and reset pushbutton operate satisfactorily. Also check that the contacts operate by carrying out continuity checks.

#### 4.3.9 Final checks

Operate the relay with the trip and alarm links restored to ensure that the the trip and alarm circuits are energised according to the relevant schematic diagram.

Remove all test leads, test switches, temporary shorting leads etc.

Replace any links that have been removed to facilitate testing. If a plug (MMLB) and test block (MMLG) have been used, remove the test plug.

Caution: Replace the test block cover to put the protection in service.

---

## **Section 5    MAINTENANCE**

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

### **5.1    Visual inspection**

Isolate all supplies and withdraw the module from the case using the two black handles on the relay. Inspect the printed circuit board for any sign of loose components or connections.

Note that when fitted, mechanical flag mechanisms should not be disturbed unless found to be operating incorrectly during the routine function tests.

Your attention is drawn to the fact that the relay can be damaged by electrostatic discharges. The PCB should not be touched unless precautions have been taken.

### **5.2    Functional checks**

Period function tests should be carried out using the test procedures shown in the commissioning section.

The operation of the trip indicator and the reset pushbutton should be checked during these functional tests.

---

## **Section 6    PROBLEM ANALYSIS**

---

These instructions enable a fault to be localised to sub-assembly level. Fault finding to component level is not recommended. The main reasons for this are as follows:

- fault finding on printed circuit boards requires the use of specialised knowledge and equipment.
- components used in manufacture are subject to strict quality control and in certain cases selected for particular characteristics. Complementary metal oxide (CMOS) components are used, which require extremely careful handling.
- damage can be caused to the printed circuit track unless extreme care is used in the replacement of components.
- replacement of some components will necessitate recalibration of the relay.
- the printed circuit boards are covered with a protective coating of polycoat which makes access to tracks and components very difficult.

### **6.1    Test equipment required for fault finding**

Equipment required for fault finding is minimal and consists of the following:

- digital multimeter with ranges of 0 - 1000V ac/dc and 0 – 1A ac/dc.
- dc voltage supply 30V 0.5A.
- ac voltage source 0 – 500V 50Hz at 10mA.
- oscilloscope (optional).
- relay tool kit.

## **6.2 General procedure and precautions**

Care must be taken when making test connections to printed circuit boards to avoid short circuiting or damaging the copper tracks. Before connecting or disconnecting any test equipment the relay must be isolated from the supply.

Relevant schematic diagrams.

MVTD11	–	Undervoltage	–	F10MVTD11 501
MVTD12	–	Overvoltage	–	F10MVTD12 501
MVTD13	–	Neutral displacement	–	F10MVTD13 501

## **6.3 Inspection – removal of module from case**

Unscrew the two front cover screws and remove the clear plastic front cover. Ensure that the dc supply is isolated and then withdraw the module assembly by the two black handles. A quick inspection of the relay may result in the detection of obvious faults, ie. loose components or connections. Otherwise proceed to the next section.

## **6.4 Connections for MVTD 11, MVTD 12 and MVTD 13**

The connections of the relay can be classified into two different types. Firstly, the external connections to the relay: these are the connections between the relay terminals and the rest of the systems. Secondly, the printed circuit board connections: these are the connections between the relay terminal block and the printed circuit board soldered connections.

Terminal connections: Terminals 13 and 14 are connected to the positive and negative dc supply. Terminals 1 to 6 are the tripping outputs of the relay. Terminals 27 and 28 are the ac input.

## **6.5 Checking voltage supplies to module**

The dc voltage ratings available are 30/34V, 48/54V, 110/125V and 220/250V. Where voltage sources which are higher than 30V are used, external dropper resistors are connected in series with the positive supply rail.

Check that the dc supply voltage is present and that the polarity is correct between terminals 13 and 14 on the relay case terminal block when the module is removed from the case. Note that when the module is in the case and the supply is connected, the voltage across the terminals may be less due to the voltage drop across the external dropper resistor  $R_D$  (if fitted).

Check that the ac is present between terminals 27 and 28. For the 380/440V ac version of the inverse time delayed overvoltage relay (MVTD 12), check that the series resistors are fitted in series with the ac supply terminals.

## **6.6 Printed circuit board tests**

If all the connections are intact and the supplies are of the correct voltage and polarity, it is likely that the fault will lie somewhere on the PCB. Proceed to the next two sections to try to confirm this.

### **6.6.1 Monitoring of the voltage across relay coil**

Set the time multiplier setting to 0.125. Connect an electronic voltmeter across the connectors leading to the trip indicator pcb to monitor the output signal. Adjust the ac input to an amplitude lower and then higher than the relay setting voltage, allowing sufficient time for the relay to time out. The output voltage should change from zero to

approximately 24V for the overvoltage (MVTD 12) and the neutral displacement (MVTD 13) version and from approximately 24V to zero for the undervoltage (MVTD 11) version.

#### 6.6.2 Measurements of the dc operating currents of the modules

By monitoring the dc operating current of a module, a good indication is provided that the module is connected correctly and that the dc power supply section is operating correctly if the current measured lies within about  $\pm 10\%$  of the specified value. Allowances must be made for supply voltages deviating from the lower rated voltage as this has a significant effect on the dc burden.

These dc burden tests should be carried out in the operated and non-operated state – that is with the ac input both above and below the voltage setting level.

An ammeter should be connected in the positive supply line to measure these burdens. Typical values for the dc burdens are shown in the following tables for the MVTD 11, 12 and 13.

Burdens – MVTD 11 inverse time delayed undervoltage relay

Nominal voltage range (V)		30/34	48/54	110/125	220/250
Series dropper resistor $R_D$ (ohm) Rext 1		None	220 $\Omega$	1k $\Omega$	4.7k $\Omega$ parallel 4.7k $\Omega$
DC voltage supplied for test (V)		30	48	110	220
Current drain for relays fitted with mechanical flag (mA)	Relay on standby $V_{in} > V$ setting	25	38	71	75
	Relay output energised $V_{in} < V$ setting	63	64	72	76
Current drain for relays fitted with led trip indicator (mA)	Relay on standby $V_{in} > V$ setting	25	38	71	75
	Relay output and led trip indicator operated	76	77	85	89
	LED trip indicator operated only	69	70	78	82

Burdens – MVT12 inverse time delayed overvoltage relay

Nominal voltage range (V)		30/34	48/54	110/125	220/250
Series dropper resistor RD (ohm) Rext 1		None	220Ω	1kΩ	4.7kΩ parallel 4.7kΩ
DC voltage supplied for test (V)		30	48	110	220
Current drain for relays fitted with mechanical flag (mA)	Relay on standby Vin < V setting	21	39	71	76
	Relay output energised Vin > V setting	59	60	72	76
Current drain for relays fitted with led trip indicator (mA)	Relay on standby Vin < V setting	21	39	71	76
	Relay output and led trip indicator operated	72	73	85	89
	LED trip indicator operated only	65	66	78	82

Burdens – MVT13 inverse time delayed neutral displacement relay

Nominal voltage range (V)		30/34	48/54	110/125	220/250
Series dropper resistor RD (ohm) Rext 1		None	220Ω	1kΩ	4.7kΩ parallel 4.7kΩ
DC voltage supplied for test (V)		30	48	110	220
Current drain for relays fitted with mechanical flag (mA)	Relay on standby Vin < V setting	39	41	70	76
	Relay output energised Vin > V setting	78	79	79	79
Current drain for relays fitted with LED trip indicator (mA)	Relay on standby Vin < V setting	39	41	70	76
	Relay output and LED trip indicator operated	91	92	92	92
	LED trip indicator operated only	84	85	85	85

### 6.6.3 Measurement of the ac operating currents of the modules

Monitor the ac input current by connecting an ammeter in series with one input terminal and the source. This test should be done at the following input voltages.

63.5V on 57/70V version of MVTD 11  
110V on 100/120V version of MVTD 11 & MVTD 12  
415V on 380/440V version of MVTD 12  
63.5V on 57/120V version of MVTD 13

The current through the transformer primary should be approximately 6mA.

If the measured current is zero, suspect an open circuit primary winding, series resistor or connection.

If the measured current exceeds 8mA, check that the external dropper resistors are correctly fitted (380/440V version only). Also check that the series resistor R11, fitted on the PCB is the correct value. If these are correctly fitted, then the primary windings may be shorted together – return the module for repair.

### 6.7 Calibration information

All relays are supplied precalibrated. The 380/440V ac version of the MVTD 12 is calibrated with the external series dropper resistors, Rext 2, fitted on the resistor assembly supplied with the module. If any external ac series resistor or the printed circuit board assembly itself is exchanged, the relay will require recalibration. The dc series dropper resistor Rext 1 may be exchanged without affecting the relay calibration.

### 6.8 Repairs and replacements

The instructions given enable the detection of faults to sub-assembly level. It is recommended that any fault on the pcb should be rectified by replacement of the complete board. However, if any component is replaced, then the relay must be recalibrated.

It is recommended that the module is returned to GEC ALSTHOM T&D Protection & Control Limited for recalibration.

Should the need arise for the equipment to be returned to GEC ALSTHOM T&D Protection & Control Limited for repair, then the form at the back of this manual should be completed and sent with the equipment together with a copy of any commissioning test results.

### 6.9 Repair of trip indicator

If the trip indication fails then it may be necessary to replace the mechanical flag unit or led indicator pcb depending on which is fitted.

### 6.10 Repair and replacement of miniature pcb mounted relay and flag mechanism (where fitted)

The miniature relay cannot be repaired. If it is proved to be operating incorrectly, it must be replaced. The flag assembly can be reset, or damaged parts replaced as required. If any part of the flag/relay assembly is disturbed, the settings of the assembly must be checked and adjustments made where necessary.

To gain access to the flag assembly, to replace parts or check the settings, it is necessary to dismantle the module. Once access to the flag assembly, mounted on the front plate of the relay, has been gained, adopt the following procedure:

- remove the screw holding the side plate to the top plate and remove the side plate. this will reveal the miniature relay and the flag spring. Access is possible through the side of the assembly unless impeded by other components.
- remove the 3 screws (2 at the top, 1 at the bottom) holding the printed circuit board to the top and bottom plates. The circuit board, with the miniature relay can not be withdrawn from the flag assembly.
- remove the 2 screws holding the flag spring and clamp plate to the bottom plate. The flag spring can now be extracted from the assembly.

Note that the top and bottom plates cannot be removed from the relay front plate without damaging the adhesive name plate, which covers the heads of the countersunk screws holding the top and bottom plates to the front plate.

Assembly is in the reverse order of dismantling.

Setting up procedure of flag assembly

Flag spring units are supplied pre-bent and should need no further adjustment before assembly.

With the flag spring and printed circuit board carrying the miniature relay assembled to the top and bottom plates check the settings:

- lift the flat spring to the latched position so that the tab on the flag spring rests on the catch on the relay.
  - a. with a gap of 0.4mm between the inside face of the armature and the core, the flag should remain latched.
  - b. with a gap of 0.15mm the flag should drop. If necessary, carefully bend the tab to fulfil these conditions.

These tests should be performed by positioning an appropriate feeler gauge between the armature and coil and then energising the coil with the appropriate voltage to pick up the relay.

- with the flag in the latched position the spring should exert a force of 10 – 12 grams on the catch. This is checked using a gram gauge, just lifting the flag off the catch.
- with the flag in the latched position the white stripes on the flag should show evenly through the slots in the nameplate. Adjustment is made by slackening the pcb fixing screws and moving the pcb assembly up or down as necessary, then re-tightening the screws. After adjustment of the pcb the catch engagement must be rechecked as in a. and b. above.
- allow the flag to drop (by energising the relay coil). The red stripes should show evenly through the slots in the nameplate. Adjustment is made by bending the tabs, one on each side of the bottom plate.

Flag replacement parts

Spring	GT7001 001
Flag	GT9009 001
Clamp plate	GT2007 001
Printed circuit board	ZG0859

### Armature clip

Several different makes of relay are used, which require different designs of armature clip. When ordering a replacement relay, state that it is for use in a flag assembly and it will be supplied with the correct armature clip.

The armature clip is marked by a number in the moulding to indicate which make of relay it fits:

Make of relay	Number on clip	Reference number
PASI	1	GT 6008 001
HALLER	2	GT 6007 002

## 6.11 Replacement parts – ordering information

When ordering any spares, please quote the relay model number and serial number as well as the printed circuit board part number.



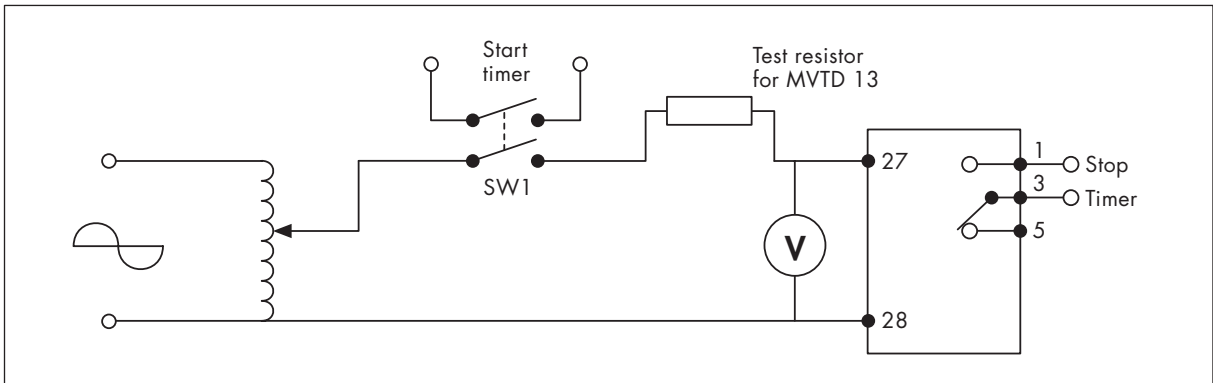


Figure 1 Test circuit for MVTD 13 and 100/120V MVTD 12

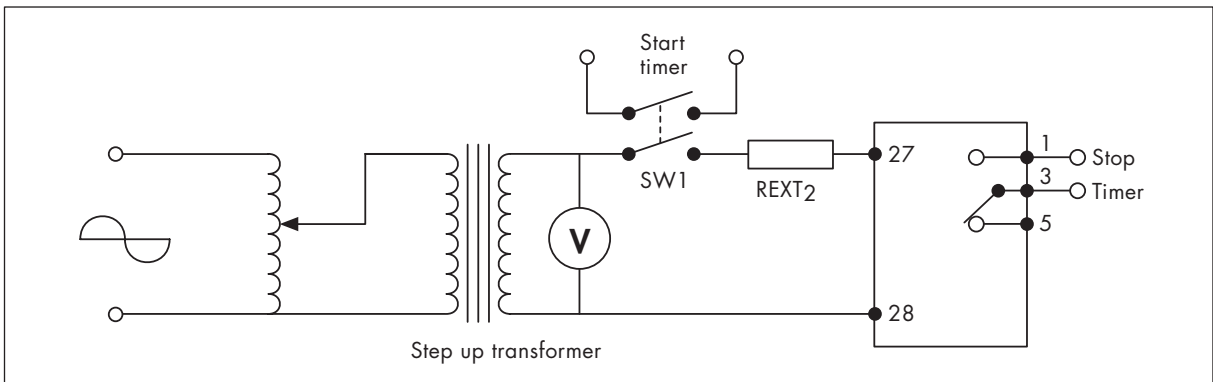


Figure 2 Test circuit for 380/440V MVTD 12

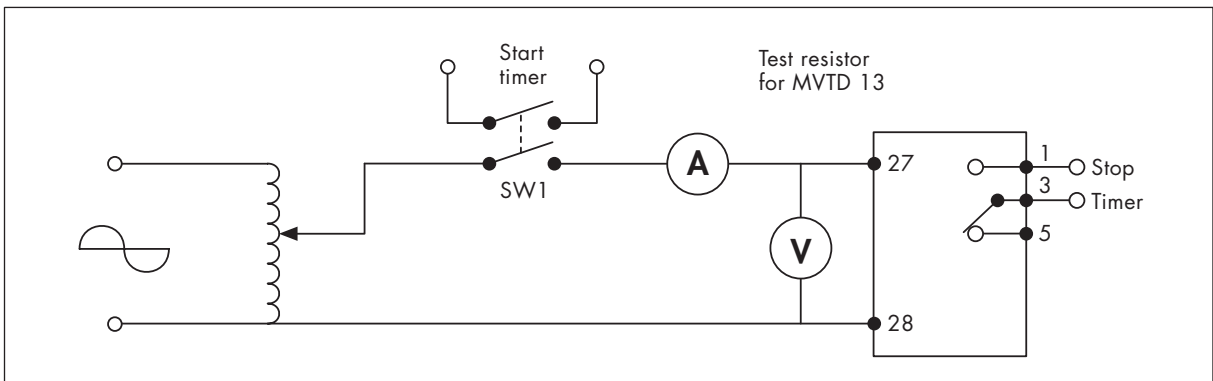


Figure 3 Test circuit for 380/440V MVTD 12 when no step up transformer is available

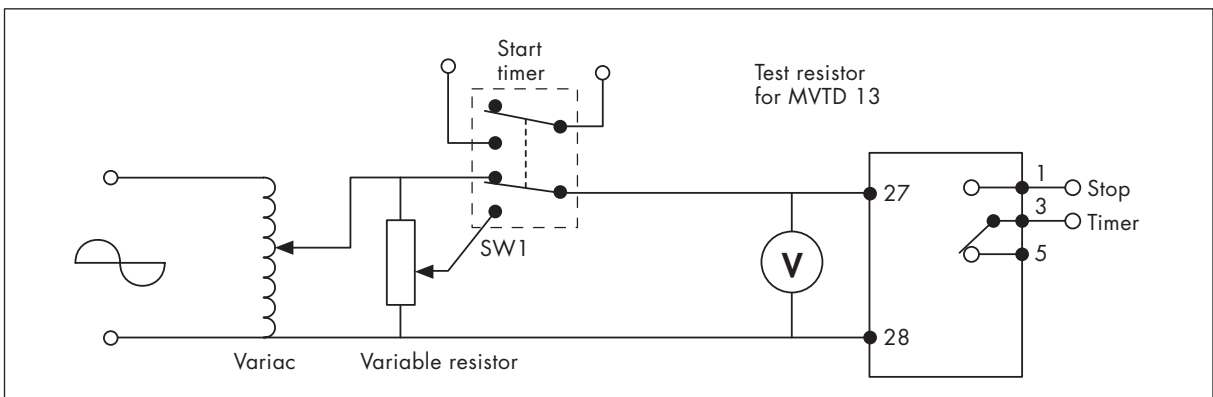


Figure 4 Test circuit for MVTD 11 undervoltage relay

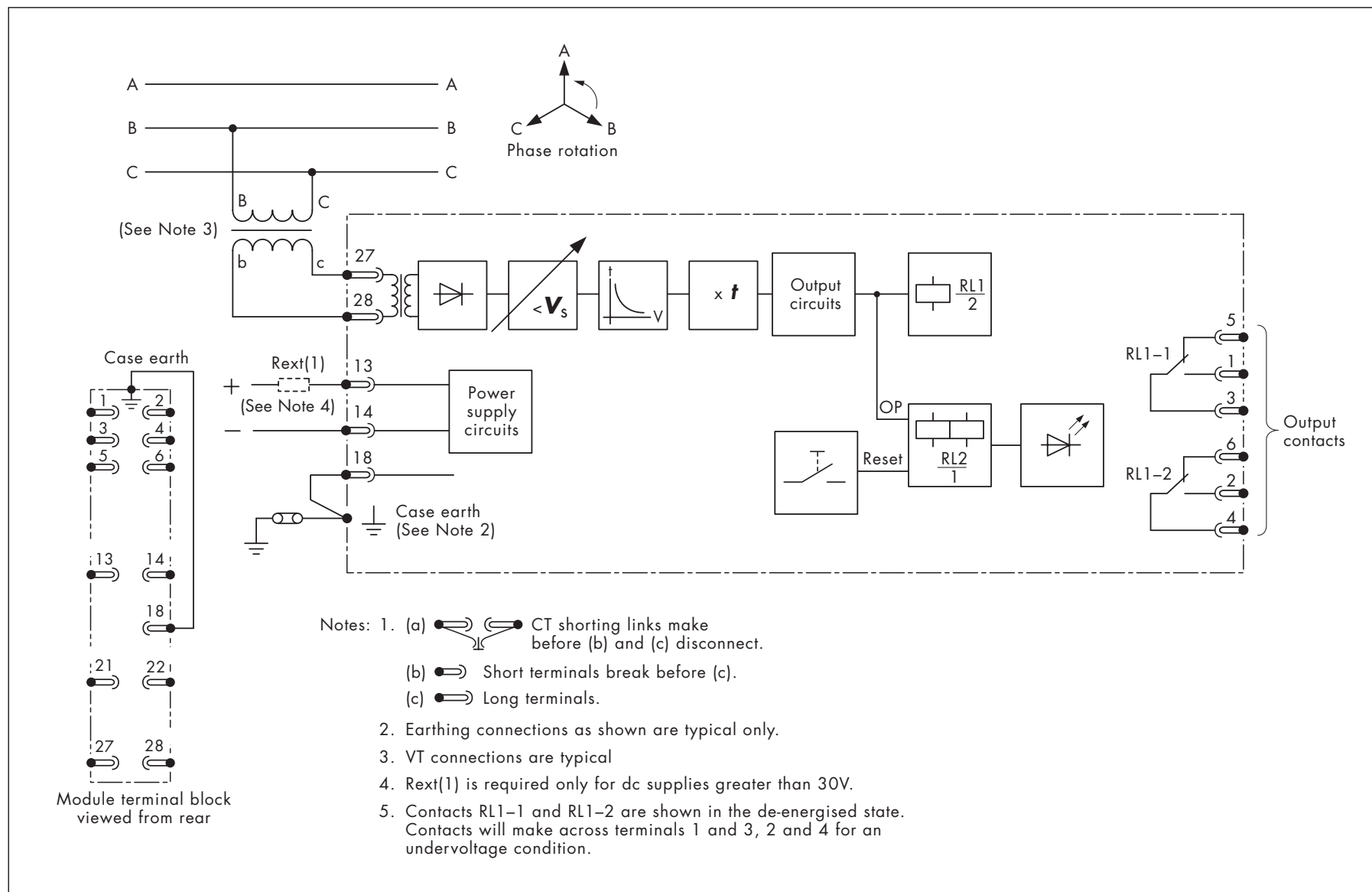


Figure 5 Application diagram: static modular inverse time delayed undervoltage relay – Type MVTD 11

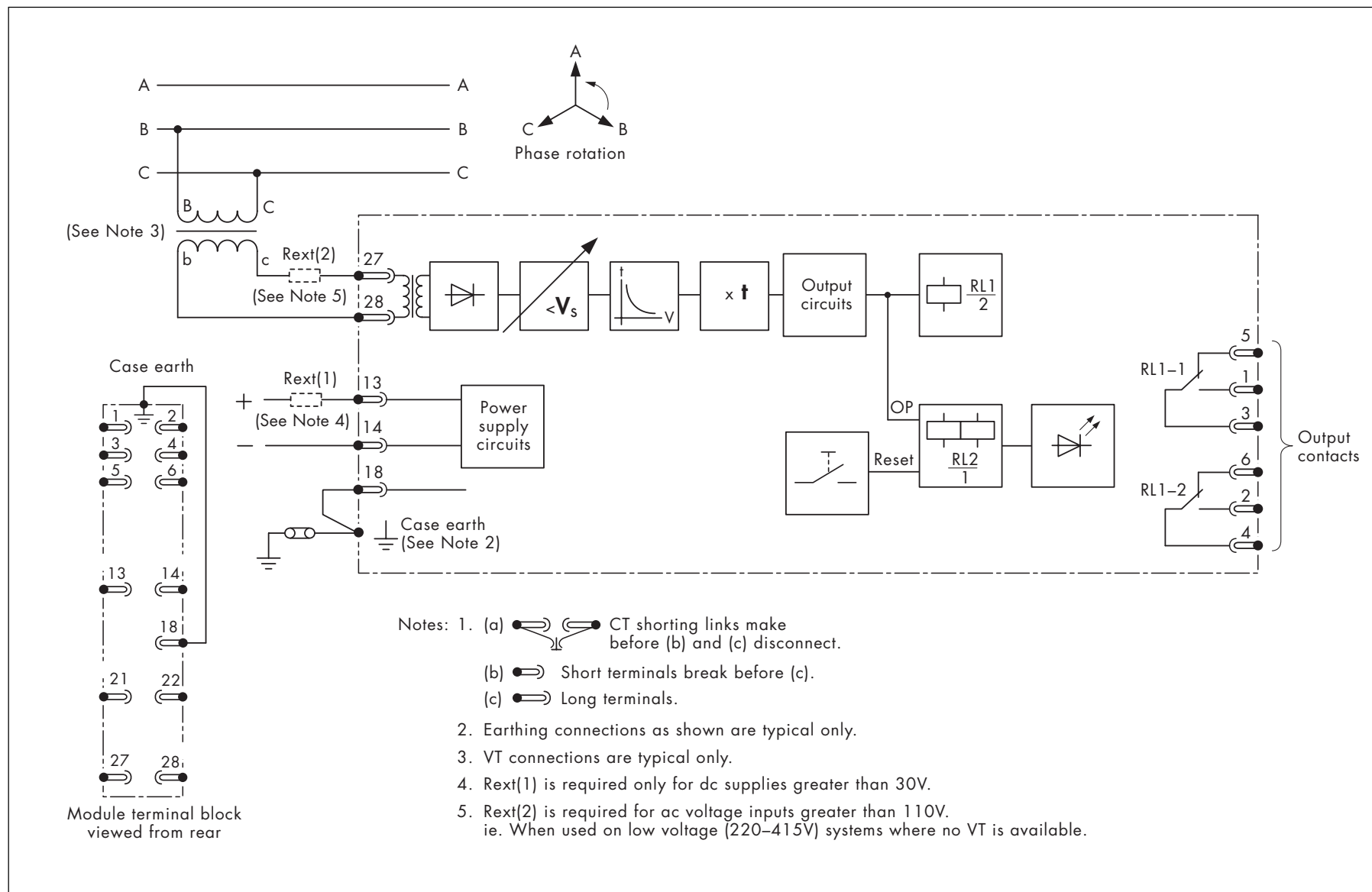


Figure 6 Application diagram: static modular inverse time delayed overvoltage relay – Type MVTD 12

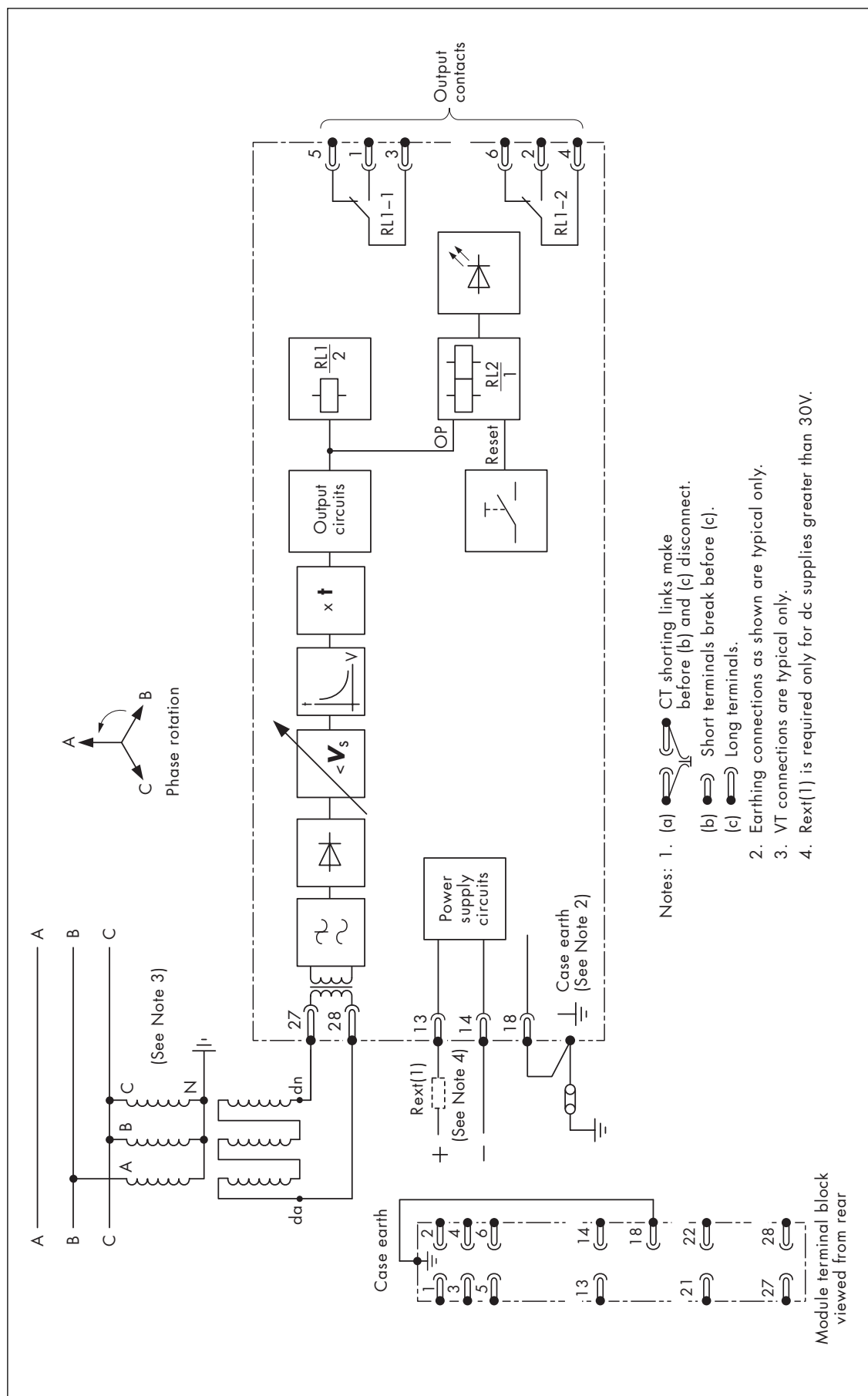


Figure 7 Application diagram: static modular inverse time delayed neutral displacement voltage relay – Type MVTD 13 (suitable for use with unearthed, solidly earthed or impedance earthed systems)

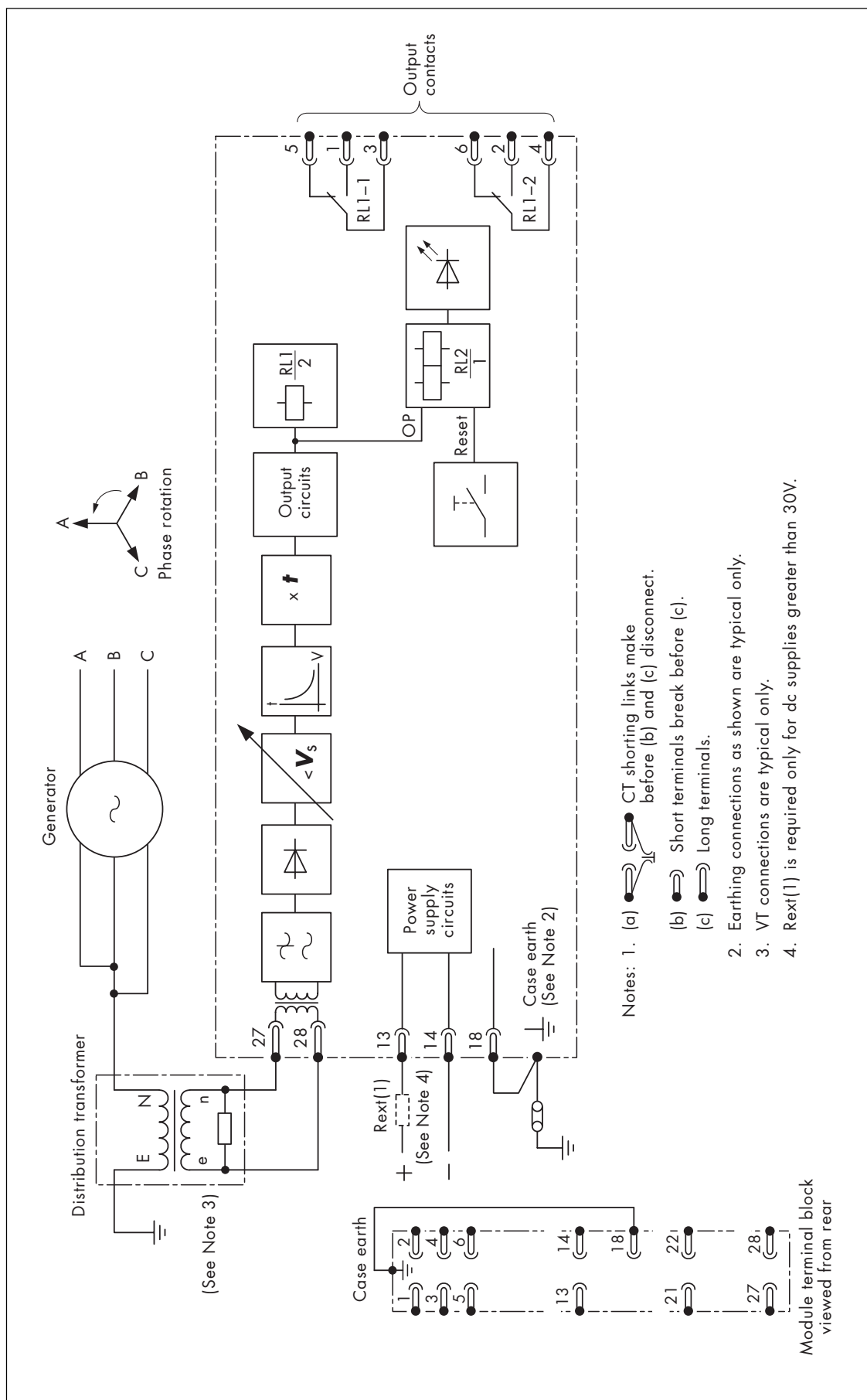


Figure 8 Application diagram: static modular inverse time delayed neutral displacement voltage relay – Type MVT D 13  
(for use with distribution earthed generators for stator earth faults)



## Section 7 COMMISSIONING TEST RECORD

Type MVTD inverse time voltage relays

Date \_\_\_\_\_

Station \_\_\_\_\_

Circuit \_\_\_\_\_

Relay Model No. MVTD \_\_\_\_\_

Serial No. \_\_\_\_\_

Rated AC Voltage  $V_n$  \_\_\_\_\_

REXT2 (If required) \_\_\_\_\_

DC Auxiliary Voltage  $V_x$  \_\_\_\_\_

REXT1 (If required) \_\_\_\_\_

DC supply check

$V_x$   Volts

Voltage Setting Check TMS = 1 X

	Voltage setting	Pick-up value		Voltage setting	Pick-up value
Test 1	<input type="text"/>	<input type="text"/>	Test 4	<input type="text"/>	<input type="text"/>
Test 2	<input type="text"/>	<input type="text"/>	Test 5	<input type="text"/>	<input type="text"/>
Test 3	<input type="text"/>	<input type="text"/>	Test 6	<input type="text"/>	<input type="text"/>

Operating time characteristic check

1st Op. time  2nd Op. time

TMS Check

TMS = 0.25  TMS = 0.375  TMS = 0.625

Final setting check

Voltage setting  Pick-up value   
Drop-off value   
TMS  Operating time

Contact check

Trip indicator check

1-3  3-5  Operate   
2-4  4-6  Reset

Commissioning Engineer

Customer Witness

Date

Date





## REPAIR FORM

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

GEC ALSTHOM T&D Protection & Control Limited  
St. Leonards Works  
Stafford  
ST17 4LX,  
England

For: After Sales Service Department

Customer Ref: \_\_\_\_\_

Model No: \_\_\_\_\_

GECA 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:

---

---

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\_\_\_\_\_  
Signature

\_\_\_\_\_  
Title

\_\_\_\_\_  
Name (in capitals)

\_\_\_\_\_  
Company name











GEC ALSTHOM T&D PROTECTION & CONTROL LIMITED  
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Email: [enquiries@pcs.gecalsthom.co.uk](mailto:enquiries@pcs.gecalsthom.co.uk) – Internet: [www.gecalsthomgpc.co.uk](http://www.gecalsthomgpc.co.uk)

Our policy is one of continuous product development and the right is reserved to supply equipment which may vary from that described.

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