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Section 1. DESCRIPTION

The MCVG61 is a three pole voltage dependent overcurrent relay.

Each pole of the relay provides a choice of four IDMT characteristics, three definite time characteristics and a choice of either voltage control or voltage restrain characteristics.

In voltage control mode, the relay switches from an overload overcurrent characteristic to a fault overcurrent characteristic, when the input voltage falls below a set voltage level.

In voltage restrain mode, the relay gradually shifts from an overload overcurrent characteristic to a fault overcurrent characteristic, as the input voltage gradually decreases within fixed voltage limits.

The rated current of the relay (I_n) is either 1A or 5A and appears on the module rating label.

The rated voltage of the relay (V_n) is 63.5V or 110V and appears on the module rating label.

The relay comprises a case and single plug-in module, which utilizes two 28 way terminal blocks. The module is designed with ease of assembly and maintenance in mind, with a switch mode dc-dc converter on a mother-board at the back of the module. This board carries connectors so that three printed circuit boards carrying current measuring/timing circuits, which can derive IDMT and definite time characteristics, and three printed circuit boards carrying voltage measuring circuits, which can derive voltage control and voltage restrain characteristics, can be plugged in.

Section 2. INSTALLATION

2.1 General

Protective relays, although generally of robust construction, require careful treatment prior to installation on site. Relays should be examined immediately upon receipt to ensure that no damage has been sustained in transit.

If damage has been sustained in transit, a claim should be made to the transport contractors and the nearest branch of GEC ALSTHOM 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.

2.2 Electrostatic discharges (ESD)

The relay uses components which are sensitive to electrostatic discharges. When handling the 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.

2.3 Relay mounting

Relays are despatched either individually or as part of a panel/rack mounted assembly. If the relays are to be installed into a panel/rack assembly after receipt, then construction details can be found in Publication R7012.

2.3.1 When the MCVG61 is used in conjunction with other GEC ALSTHOM T&D Protection & Control relays, the following guidelines should be followed for positioning the relays in the modular assembly :

Test facilities	MMLG test block should be positioned at the right of the tier.
Current relays	MCGG and MCVG61 overcurrent relay should be adjacent to the test block.
Direction control	METI directional relay should be adjacent to, and to the left of, the MCGG relay it is controlling.
Other relays	Any other relays, required for the relay scheme, should be positioned to the left of the tier, as viewed from the front.

2.3.2 For individually mounted relays, an outline diagram is normally supplied showing panel cut-outs and hole centres. These dimensions will also be found in Publication R6054.

2.4 Unpacking

Care must be taken when unpacking and installing the relays so that none of the parts are damaged or their settings altered and they must only be handled by skilled persons. The installation should be clean, dry and reasonably free from dust and excessive vibration. The site should be well lit to facilitate inspection.

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

2.5 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 subjected to 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.

Storage temperature –25 to +70°C.

Section 3. COMMISSIONING

3.1 Commissioning preliminaries

3.1.1 Inspection

Carefully examine the module and case to see that no damage has occurred since installation. Visually check that any current transformer shorting switches are wired into the correct circuit and are closed with the module withdrawn. Check that the relay serial number on the module, case and cover are identical and that the model number or rating information is correct.

3.1.2 Wiring

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

3.1.3 Insulation

Isolate all wiring from earth and test the insulation of the external wiring with an electronic or brushless insulation tester at dc voltage not exceeding 1000V. Terminals of the same circuit should be temporarily strapped together.

3.1.4 Electrostatic discharges (ESD)

The relay uses components which are sensitive to electrostatic discharges. When handling the 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 front cover.

3.1.5 Earthing

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

3.1.6 Main current transformers

DANGER

DO NOT OPEN THE SECONDARY CIRCUIT OF A LIVE CT SINCE THE HIGH VOLTAGE PRODUCED MAY BE LETHAL AND COULD DAMAGE INSULATION.

3.1.7 Test block type MMLG

If test block type MMLG is provided, the connections should be checked to the scheme diagram, particularly that the supply connections are to the 'live' side of the test block (coloured orange) and with terminals allocated with odd numbers (1,3,5,7 etc.) and also that the dc connection is routed via test block terminals 13 (positive) and 14 (negative).

3.1.8 Terminal allocation

References should be made to the diagram supplied.

3.1.9 Test equipment required:

- Overcurrent test set with timing facilities.
- 0–250V variac.
- Multifinger test plug type MMLB01 for use with test block type MMLG when required.
- Calibrated multimeter 0–10A ac, 0–250V ac and dc.

3.1.10 General

Secondary injection commissioning tests should be carried out using portable single phase overcurrent test equipment, preferably test block type MMLG. It is most important that the test equipment is capable of injecting an undistorted sinusoidal current waveform.

3.1.11 DC supply

Remove the relay module from its case. The incoming supply should be checked at the relay case terminals. Relay case terminal 13 should be positive with respect to terminal 14 and the incoming voltage must be within the operative range specified below.

DC rating (volts)	Operative range (volts)
24/54	19 – 65
110/250	87.5 – 300

CAUTION:

The relay is designed to withstand an ac ripple component of up to ±12% of the nominal dc auxiliary supply voltage. However, in all cases the peak value of the dc supply must not exceed the maximum specified operating limit.

Operation of the supply battery charger with the batteries disconnected could cause damage due to overvoltage.

3.1.12 Relay CT shorting switches

With the relay removed from its case, check that each CT shorting switch is closed by injecting rated current into each phase circuit. The rated current of the relay (I_n) is either 1A or 5A and appears on the module rating label.

3.1.13 Energize relay

For secondary injection testing using test block type MMLG, insert test plug type MMLB01 with the required main CT shorting links fitted. It may then be necessary to link across the front of the test plug to restore the dc supply to the relay.

Isolate the relay trip contacts and insert the module. Ensure that the curve selection switches on each pole are set to any position except 111. Connect the dc supply to the relay. The relay has a non-volatile memory which remembers the state (ON or OFF) of the led trip indicators when the relay was last powered, and therefore some or all of the indicators may be illuminated.

Press the RESET button and check that the leds on all of the poles are illuminated. Release the RESET button and check that the leds reset.

Note: To commission the relay with the settings and curve required for the particular application, omit Section 3.2 and proceed directly to Section 3.3.

If the settings/curve will be altered by the user without recommissioning the relay, complete the tests in both Sections 3.2 and 3.3.

3.2 Instructions for commissioning the relay on any setting or curve

3.2.1 Current sensitivity switches ($I_S = \sum$ x I_n)

This test checks that the front panel current selector switches operate correctly. The green relay start led provided on the front panel gives indication when the input current exceeds the current setting of I_S.

Apply 0V ac to each voltage phase input. Inject single phase current into a convenient current phase circuit and slowly increase the current until the start led lights. Repeat the test for each switch position and check that the pick up current is within the range shown in Table 3.1

Switch selections				
	Current	$I_S = \sum$ x I_n	:	as shown
	Curve	( )	:	any
	TMS	$xt = \sum$	:	any
	Voltage mode	V_C or V_R	:	as shown
	VS setting	$V_S = (0.5 + \sum)$ x V_n	:	any
	ΔIS setting	$\Delta I_S = (0.5 + \sum)$ x I_n	:	2 x I_n

I_S (x I_n)	Voltage mode	AC current operate level (amps) I_n = 1A	I_n = 5A
0.05	VC	0.05 – 0.055	0.25 – 0.275
0.05	VR	0.05 – 0.055	0.25 – 0.275
0.10	VR	0.10 – 0.110	0.50 – 0.550
0.15	VR	0.15 – 0.165	0.75 – 0.825
0.25	VR	0.25 – 0.275	1.25 – 1.375
0.45	VR	0.45 – 0.495	2.25 – 2.475
0.85	VR	0.85 – 0.935	4.25 – 4.675

Table 3.1

Note 1: The measurements performed with a setting of 0.45 I_n should be repeated for each of the three 0.4 switch positions.

Note 2: The above current levels make no allowance for errors in measurement of the ac current amplitude.

These tests should be repeated for each pole of the relay.

3.2.2 Curve selection switches ( )

Connect the relay output contacts to both trip the test set, and to stop a timer. Apply 0V ac to each voltage phase input.

3.2.2.1 Inject single phase current into the pole under test at a current level of 10 x rated current.

Check that the operating time for the relay for each curve setting is within the range shown in Table 3.2.

Switch selections	Current	$I_S = \sum$ x I_n	:	1 x I_n
	Curve	( )	:	as shown
	TMS	$xt = \sum$	:	1 x t
	Voltage mode	V_C or V_R	:	any
	VS setting	$V_S = (0.5 + \sum)$ x V_n	:	any
	ΔIS setting	$\Delta I_S = (0.5 + \sum)$ x I_n	:	any

Selected curve	Operating time range at 10 x I_S (seconds) Nominal	Range
SI Standard inverse	2.97	2.82 – 3.12
VI Very inverse	1.50	1.42 – 1.58
EI Extremely inverse	0.808	0.747 – 0.869
LTI Long time inverse	13.3	12.6 – 14.0
D2 Definite time 2s	2.00	1.94 – 2.06
D4 Definite time 4s	4.00	3.88 – 4.12
D8 Definite time 8s	8.00	7.76 – 8.24

Table 3.2

3.2.2.2 Inject single phase current into the pole under test at a current level of 7 x rated current. Check that the operating time for SI curve setting is within the range shown in Table 3.3.

Switch selections	Current	$I_S = \Sigma \times I_n$	:	0.2 x I_n
	Curve	( )	:	SI
	TMS	$xt = \Sigma$	:	1 x t
	Voltage mode	V_C or V_R	:	any
	V_S setting	$V_S = (0.5 + \Sigma) \times V_n$	:	any
	ΔI_S setting	$\Delta I_S = (0.5 + \Sigma) \times I_n$	:	any

	Operating time range at 10 x I_S (seconds)	
Selected curve	Nominal	Range
SI Standard inverse	1.97	1.87 – 2.07

Table 3.3

Note: The above operating times make no allowance for errors in measurement of the ac current amplitude.

These tests should be repeated for each pole of the relay.

3.2.3 Time multiplier setting switches ($xt = \Sigma$)

Connect relay output contacts to both trip the test set and to stop a timer. Apply 0V ac to each voltage phase input. Inject single phase current into the pole under test at a current level of 10 x rated current.

Measure the operating time on the SI curve at the TMS switch positions shown in table 3.4.

Switch selections	Current	$I_S = \Sigma \times I_n$	:	1 x I_n
	curve	( )	:	SI
	TMS	$xt = \Sigma$	:	as shown
	Voltage mode	V_C or V_R	:	any
	V_S setting	$V_S = (0.5 + \Sigma) \times V_n$	:	any
	ΔI_S setting	$\Delta I_S = (0.5 + \Sigma) \times I_n$	:	any

	Operating time range at 10 x I_S (seconds)	
TMS value	Nominal	Range
0.125 x t	0.371	0.322 – 0.42
0.2 x t	0.594	0.534 – 0.654
0.9 x t	2.67	2.48 – 2.87

Table 3.4

Note: The above operating time ranges make no allowance for errors in measurement of the ac current amplitude.

These tests should be repeated for each pole of the relay.

3.2.4 ΔI_S setting $\Delta I_S = (0.5 + \Sigma) \times I_n$

This test checks that the front panel ΔI_S selector switches operate correctly, for both voltage control and voltage restrain characteristics. The green relay start led provided on the front panel gives indication when the input current exceeds the setting of $(\Delta I_S + I_S)$.

Apply rated ac voltage ($1 \times V_n$) to each voltage phase input. Inject single phase current into a convenient current phase circuit and slowly increase the current until the start led lights. Repeat the test for each switch position and check that the pick up current is within the range shown in Table 3.5.

Switch selections	Current	$I_S = \Sigma \times I_n$	:	as shown
	Curve	( )	:	any
	TMS	$xt = \Sigma$	:	any
	Voltage mode	V_C or V_R	:	as shown
	V_S setting	$V_S = (0.5 + \Sigma) \times V_n$	:	any
	ΔI_S setting	$\Delta I_S = (0.5 + \Sigma) \times I_n$	:	as shown

			AC Current operate level (Amps)	
ΔI_S (x I_n)	I_S (x I_n)	Voltage mode	I_n = 1A	I_n = 5A
0.5	0.25	V_C	0.725 – 0.800	3.625 – 4.000
0.5	0.25	V_R	0.725 – 0.800	3.625 – 4.000
0.6	0.3	V_C	0.870 – 0.960	4.350 – 4.800
0.6	0.3	V_R	0.870 – 0.960	4.350 – 4.800
0.7	0.35	V_C	1.015 – 1.120	5.075 – 5.600
0.7	0.35	V_R	1.015 – 1.120	5.075 – 5.600
0.9	0.45	V_C	1.305 – 1.440	6.525 – 7.200
0.9	0.45	V_R	1.305 – 1.440	6.525 – 7.200
1.3	0.65	V_C	1.885 – 2.080	9.425 – 10.400
1.3	0.65	V_R	1.885 – 2.080	9.425 – 10.400

Table 3.5

Note: The above current levels make no allowance for errors in measurement of the ac current amplitude.

These tests should be repeated for each pole of the relay.

3.2.5 Voltage control mode voltage setting $V_s = (0.5 + \Sigma) \times V_n$

This test ensures that the front panel V_s selector switches and the V_C position of the V_R/V_C selector switch operate correctly. For this test the green relay start led provided on the front panel will give indication when the input voltage falls below the setting of V_S.

Apply rated ac volts ($1 \times V_n$) to a convenient voltage phase input. Inject a single phase current of $2 \times I_n$ into the same phase current phase circuit. Slowly decrease the ac voltage until the start led lights. Repeat the test for each switch position and check that the setting voltage is within the range shown in Table 3.6.

Switch selections	Current	$I_S = \Sigma \times I_n$	:	$1 \times I_n$
	Curve	( )	:	any
	TMS	$xt = \Sigma$	:	any
	Voltage mode	V_C or V_R	:	V_C
	V_S setting	$V_S = (0.5 + \Sigma) \times V_n$	:	as shown
	ΔI_S setting	$\Delta I_S = (0.5 + \Sigma) \times I_n$	:	$2 \times I_n$

	AC voltage setting level (volts)	
V_S (x V_n)	V_n = 63.5V	V_n = 110V
0.55	33.18 – 36.67	57.48 – 63.53
0.60	36.20 – 40.01	62.70 – 69.30
0.65	39.21 – 43.34	67.93 – 75.08
0.75	45.24 – 50.01	78.38 – 86.63

Table 3.6

Note: The above voltage levels make no allowance for errors in measurement of the ac voltage amplitude.

These tests should be repeated for each pole of the relay.

3.2.6 Voltage restrain mode characteristic

This test ensures that the voltage restrain mode characteristic and the V_R position of the V_R/V_C selector switch operate correctly.

Apply an ac voltage of 0.9 x V_n to each voltage phase input. Inject single phase current into a convenient current phase circuit and slowly increase the current until the start led lights. Repeat the test for the different ac voltage phase input levels shown and check that the pick up current is within the range shown in Table 3.7.

Switch selections	Current	$I_S = \Sigma \times I_n$	:	$1 \times I_n$
	Curve	( )	:	any
	TMS	$xt = \Sigma$	:	any
	Voltage mode	V_C or V_R	:	V_R
	V_S setting	$V_S = (0.5 + \Sigma) \times V_n$	:	any
	ΔI_S setting	$\Delta I_S = (0.5 + \Sigma) \times I_n$	:	$2 \times I_n$

Input voltage (x V_n)	AC current operate level (Amps)	
	I_n = 1A	I_n = 5A
0.55	1.000 – 1.150	5.000 – 5.750
0.725	1.926 – 2.176	9.630 – 10.880
0.90	2.850 – 3.200	14.250 – 16.000

Table 3.7

Note: The above current levels make no allowance for errors in measurement of the ac current and voltage amplitudes.

These tests should be repeated for each pole of the relay.

3.2.7 Voltage control/restrain mode timing tests

Connect the relay output contacts to both trip the test set, and to stop a timer. With ac voltage applied, as indicated in Table 3.8, to each voltage phase input, inject single phase current into the pole under test at the indicated current levels. Check that the operating time for the relay is within the range shown in Table 3.8.

Switch selections	Current	$I_S = \sum x\ I_n$	:	$1 x I_n$
	Curve	(⌊‾)	:	SI
	TMS	$xt = \sum$	:	1 x t
	Voltage mode	V_C or V_R	:	as shown
	V_S setting	$V_S = (0.5 + \sum) x V_n$	:	any
	ΔI_S setting	$\Delta I_S = (0.5 + \sum) x I_n$	:	$2 x I_n$

Input voltage ($x V_n$)	Voltage mode	Injected current	Operating time (seconds) Nominal	Range
1.0	V_C	$12 x I_n$	2.97	2.81 – 3.13
1.0	V_R	$12 x I_n$	2.97	2.81 – 3.13
0.9	V_R	$12 x I_n$	2.97	2.81 – 3.13
0.725	V_R	$11 x I_n$	2.97	2.82 – 3.12
0.55	V_R	$10 x I_n$	2.97	2.82 – 3.12

Table 3.8

Note: The above operating time ranges make no allowance for errors in measurement of the ac current and voltage amplitudes.

These tests should be repeated for each pole of the relay.

3.3 Instructions for commissioning the relay at settings calculated for a particular application

3.3.1 General

If there is any possibility that the relay settings are to be changed during the life of the relay without re-commissioning, then the instructions in Section 3.2 should be completed initially.

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

3.3.2 Relay CT shorting switches

If not previously checked, and with the relay module removed from its case, check that each CT shorting switch is closed by injecting rated current into each phase circuit. The rated current of the relay (I_n) is either 1A or 5A and appears on the module rating label.

3.3.3 Energize relay

Connect the dc supply to the relay and record the dc voltage at terminals 13 (+ve) and 14 (–ve).

3.3.4 Trip test

Set the curve selection switches to 111 (test mode), on one pole of the relay. Check that the leds associated with that pole of the relay flash at a frequency of approximately once per second.

Press and hold the RESET button. The leds of the other poles of the relay should illuminate continuously, whilst those of the pole under test should continue to flash. After approximately 6 seconds, the output element should trip and at the same time the leds should illuminate continuously on that pole.

Release the RESET button. The output elements should reset.

Change the curve selection switches from 111 (test mode) to 101 (4s definite time), and repeat the test on the other poles of the relay.

3.3.5 Operating time test at 35 x multiplier

Connect the relay output contacts to both trip the test set, and to stop a timer. Apply 0V to each voltage phase input. Inject single phase current into the pole under test at the indicated current level and check that the operating time for the relay is within the range shown in Table 3.9

Switch selections	Current	$I_S = \Sigma \times I_n$	:	$0.2 \times I_n$
	Curve	( )	:	SI
	TMS	$xt = \Sigma$	:	1 x t
	Voltage mode	V_C or V_R	:	any
	V_S setting	$V_S = (0.5 + \Sigma) \times V_n$	:	any
	ΔI_S setting	$\Delta I_S = (0.5 + \Sigma) \times I_n$	:	any

Injected current	Operating time (seconds)	
	Nominal	Range
7 x In	1.97	1.87 – 2.07

Table 3.9

Note: The above operating times make no allowance for errors in measurement of the ac current amplitude.

These tests should be repeated for each pole of the relay.

3.3.6 Operational tests at final selected settings

With voltage control mode selected to be the final selected voltage characteristic, carry out tests 3.3.7 to 3.3.9. The voltage mode switch V_C/V_R should be set to V_C.

With voltage restrain mode selected to be the final selected voltage characteristic, carry out tests 3.3.10 to 3.3.11. The voltage mode switch VC/VR should be set to V_R.

3.3.7 Voltage control mode voltage setting test

The relay switches should be set to the specified settings for the application. For this test the green relay start led provided on the front panel will give indication when the input voltage falls below the setting of V_s.

Apply rated ac volts (1 x V_n) to a convenient voltage phase input. Inject a single phase current equal to (Is + 0.5ΔIs) x I_n into the same phase current phase circuit. Slowly decrease the ac voltage until the start led lights and record this value.

This voltage level should be within the range

(0.94 x V_s) to (1.04 x V_s)

Note: These levels make no allowance for errors in measurement of the ac voltage amplitude.

These tests should be repeated for each pole of the relay.

3.3.8 Voltage control mode overcurrent characteristic pick-up test

The relay switches should be set to the specified settings for the application. Apply rated ac voltage (1 x V_n) to each voltage phase input. Inject single phase current into a convenient current phase circuit and slowly increase the current until the start led lights and check that the pick up current is within the range shown in Table 3.10. Repeat the test with an applied ac voltage of 0V. Record the result of both tests.

Input voltage (x Vn)	Ratio of selected ΔIs:Is	K value	Overcurrent pick-up level	
			Lower limit	Upper limit
1.0	<2:1	1	I_S + 0.95 ΔI_S	1.1I_S + 1.05 ΔI_S
1.0	2:1 to 3:1	1	I_S + 0.90 ΔI_S	1.1I_S + 1.10 ΔI_S
1.0	3:1 to 5:1	1	I_S + 0.90 ΔI_S	1.1I_S + 1.20 ΔI_S
0.0	<5:1	0	IS	1.1IS

Table 3.10

Note 1: The above current limits make no allowance for errors in measurement of the ac current and voltage amplitude.

Note 2: At setting ratios of ΔI_S:I_S greater than 2:1, some chatter of the overcurrent level detector near the pick-up value will be apparent.

These tests should be repeated for each pole of the relay.

3.3.9 Voltage control mode timing tests

The following tests check the selected curve at specified points.

WARNING:

THE TEST EQUIPMENT'S THERMAL LIMIT MAY BE EXCEEDED IF THE LONG TIME INVERSE CURVE IS SELECTED

Connect the relay output contacts to both trip the test set, and to stop a timer. Apply rated ac voltage (1 x V_n) to each voltage phase input. Inject single phase current into a convenient current phase at the levels specified below in Table 3.11, for the particular curve selection specified for the application.

Check that the operating time for the relay is within the range of values given by multiplying the TMS setting with the operating time limits shown in Table 3.14 Repeat the test with an applied ac voltage of 0V. Record the result of both tests.

Input voltage (xV_n)	K value	Applied Current			
		2 x	5 x	10 x	20 x
1.0	1.0	$(2I_S + \Delta I_S)$	$(5I_S + \Delta I_S)$	$(10I_S + \Delta I_S)$	$(20I_S + \Delta I_S)$
0.0	0.0	$2I_S$	$5I_S$	$10I_S$	$20I_S$

Table 3.11

3.3.10 Voltage restrain mode overcurrent characteristic pick-up test

The relay switches should be set to the specified settings for the application. Apply rated ac voltage (1 x V_n) to each voltage phase input. Inject single phase current into a convenient current phase circuit and slowly increase the current until the start led lights and check that the pick up current is within the range shown in Table 3.12. Repeat the test with the applied ac voltages given below. Record the results.

Input voltage (x V_n)	Ratio of selected $\Delta I_S:I_S$	K value	Overcurrent pick-up level	
			Lower limit	Upper limit
1.0	<2:1	1	$I_S + 0.95\Delta I_S$	$1.1I_S + 1.05\Delta I_S$
1.0	2:1 to 3:1	1	$I_S + 0.90\Delta I_S$	$1.1I_S + 1.10\Delta I_S$
1.0	3:1 to 5:1	1	$I_S + 0.90\Delta I_S$	$1.1I_S + 1.20\Delta I_S$
0.9	<2:1	1	$I_S + 0.925\Delta I_S$	$1.1I_S + 1.05\Delta I_S$
0.9	2:1 to 3:1	1	$I_S + 0.88\Delta I_S$	$1.1I_S + 1.10\Delta I_S$
0.9	3:1 to 5:1	1	$I_S + 0.88\Delta I_S$	$1.1I_S + 1.20\Delta I_S$
0.725	<3:1	0.5	$I_S + 0.463\Delta I_S$	$1.1I_S + 0.538\Delta I_S$
0.725	3:1 to 5:1	0.5	$I_S + 0.439\Delta I_S$	$1.1I_S + 0.564\Delta I_S$
0.55	<5:1	0	I_S	$1.15I_S$
0.0	<5:1	0	I_S	$1.1I_S$

Table 3.12

Note 1: The above current limits make no allowance for errors in measurement of the ac current and voltage amplitude.

Note 2: At setting ratios of $\Delta I_S:I_S$ greater than 2:1, some chatter of the overcurrent level detector near the pick-up value will be apparent.

These tests should be repeated for each pole of the relay.

3.3.11 Voltage restrain mode timing tests

The following tests check the selected curve at specified points.

WARNING:

THE TEST EQUIPMENT'S THERMAL LIMIT MAY BE EXCEEDED IF THE LONG TIME INVERSE CURVE IS SELECTED

Connect the relay output contacts to both trip the test set, and to stop a timer. Apply rated ac voltage (1 x V_n) to each voltage phase input. Inject single phase current into a convenient current phase at the levels specified below in Table 3.13, for the particular curve selection specified for the application.

Input voltage (xV_n)	K value	Applied Current			
		2 x	5 x	10 x	20 x
1.0	1.0	$2I_S + \Delta I_S$	$5I_S + \Delta I_S$	$10I_S + \Delta I_S$	$20I_S + \Delta I_S$
0.9	1.0	$2I_S + \Delta I_S$	$5I_S + \Delta I_S$	$10I_S + \Delta I_S$	$20I_S + \Delta I_S$
0.725	0.5	$2I_S + 0.5\Delta I_S$	$5I_S + 0.5\Delta I_S$	$10I_S + 0.5\Delta I_S$	$20I_S + 0.5\Delta I_S$

Table 3.13

Check that the operating time for the relay is within the range of values given by multiplying the TMS setting with the operating time limits shown in Tables 3.14, 3.15 and 3.16. Repeat the test with the applied ac voltages shown in Table 3.13. Record the result of these tests.

Table 3.14, 3.15 and 3.16 detail the inverse operating time curves for different ratios of ΔI_S:I (with the TMS setting set to 1.0) at multipliers of 2, 5, 10 and 20.
It is recommended that results are recorded at multipliers of 10 followed by 2.
The others are listed in case they are specifically requested by the user.

Definite time characteristics should be checked at multiplier of 2 only.

Curve	Operating time range at specified applied current (seconds)with ratio of ΔI_S:I_S less than 2:1			
	2 x	5 x	10 x	20 x
SI	9.36 - 10.83	4.02 - 4.55	2.81 - 3.13	2.15 - 2.38
VI	12.2 - 15.0	3.13 - 3.63	1.41 - 1.59	0.671 - 0.750
EI	23.5 - 30.6	3.04 - 3.65	0.733 - 0.886	0.184 - 0.218
LTI	109 - 134	27.8 - 32.3	12.5 - 14.2	5.97 - 6.67
D2	1.90 - 2.10			
D4	3.80 - 4.20			
D8	7.60 - 8.40			

Table 3.14

Curve	Operating time range at specified applied current (seconds)with ratio of ΔI_S:I_S between 2:1 and 3:1			
	2 x	5 x	10 x	20 x
SI	9.07 - 11.31	3.99 - 4.58	2.80 - 3.14	2.15 - 2.39
VI	11.7 - 15.9	3.09 - 3.68	1.40 - 1.60	0.670 - 0.752
EI	22.1 - 33.0	2.98 - 3.73	0.725 - 0.896	0.183 - 0.219
LTI	104 - 141	27.5 - 32.7	12.4 - 14.2	5.95 - 6.68
D2	1.90 - 2.10			
D4	3.80 - 4.20			
D8	7.60 - 8.40			

Table 3.15

Curve	Operating time range at specified applied current (seconds)with ratio of ΔI_S:I_S between 3:1 and 5:1			
	2 x	5 x	10 x	20 x
SI	8.56 - 12.44	3.94 - 4.64	2.79 - 3.15	2.14 - 2.39
VI	10.8 - 18.0	3.02 - 3.78	1.39 - 1.62	0.666 - 0.756
EI	19.7 - 38.8	2.86 - 3.90	0.711 - 0.914	0.181 - 0.221
LTI	96 - 160	26.8 - 33.6	12.3 - 14.4	5.92 - 6.72
D2	1.90 - 2.10			
D4	3.80 - 4.20			
D8	7.60 - 8.40			

Table 3.16

Note: The above operating times make no allowance for errors in measurement of the ac current and voltage amplitude.

These tests should be repeated for each pole of the relay.

3.3.12 Final check

Carefully check that the led indicators and relay output contacts are all operating correctly and that with the relay front cover replaced, the reset button satisfactorily operates/resets the leds.

If required, check that the relay output contacts trip the circuit breaker.

Connect the relay through to the main CTs and VTs and remove the CT shorts.

Section 4. SETTINGS

These settings are determined by positioning miniature switches on the relay front panel. For each pole there are two printed circuit boards referred to as the current measuring board and the voltage measuring board, each with a single group of switches.

The printed circuit boards are arranged such that all three current measuring boards are positioned on the right hand side of the relay, and the three voltage measuring boards are positioned on the left.

4.1.1 Current setting, $I_s = \sum$ x I_n

The upper seven blue switches on the current measuring boards are used to set the required current sensitivity setting, which forms a part of the overcurrent characteristic. Each switch may be positioned to the left or right, the setting level being indicated at the same horizontal level as the switch, to the left or right of the switches or bank of switches.

The overall current setting is determined by adding the indicated values of the individual switch settings, and may be set in steps of 5% over the range 0.05 to 2.4 x I_n.

4.1.2 ΔIs setting $\Delta I_S = (0.5 + \sum)$ x I_n

The four lowest switches on the voltage measuring board are used to set the value of the ΔI_S function, which forms a part of the equation for the overcurrent characteristic. The ΔI_S setting is obtained by adding the indicated values of the

individual switch settings and is indicated by:

$\Delta I_s = (0.5 + \sum) \times I_n$

4.1.3 Voltage control mode voltage setting $V_s = (0.5 + \sum) \times V_n$

Three switches on the voltage measuring boards are used to set the voltage control mode voltage setting. The setting alters the voltage control characteristic and is obtained by adding the indicated values of the individual switch settings and is indicated by

$V_s = (0.5 + \sum) \times V_n$

Note: The V_S setting has no effect on the relay when the relay is set to voltage restrain mode.

4.1.4 Voltage control/voltage restrain mode switch

The top switch on the voltage measuring board is used to select the required voltage characteristic. The two characteristics and their associated equations and limits are as shown below

		Switch position
V_C Voltage control:		V_R ---> V_C
K = 0,	for $V < V_S$	
K = 1,	for $V > V_S$	
V_R Voltage restrain:		V_R <--- V_C
K = 0,	for $V < 0.55$	
$K = 1 - \frac{0.9 - V}{0.35}$	for $0.55 < V < 0.9$	
K = 1	for $V > 0.9$	

Where V is the ratio of applied voltage to rated voltage, and K is a variable whose value forms a part of the overcurrent characteristic.

4.1.5 Overcurrent characteristic current pick-up level

The formula for the pick up level for the overload characteristic is as shown below

Current pick up level = $(I_s + K\Delta I_s) \times I_n$

Note: The specified accuracy is only guaranteed when the setting ratio of ΔI_s:I_s is no greater than 5:1. At setting ratios of ΔI_S:I_S greater than 2:1, some chatter of the overcurrent level detector near the pick-up value will be apparent.

4.1.6 Curve selection switches

The three black switches on the current measuring board are used to select the required time curve from the choice of four inverse time and three definite time curves. The characteristic curve equations are listed below. The eighth switch combination sets the relay into the ‘trip test’ mode.

SI Standard inverse: $t = \frac{0.14}{\left(\frac{I - K\Delta I_S}{I_S}\right)^{0.02} - 1}$ s	0 0 0	<--- <--- <---		1 1 1
VI Very inverse: $t = \frac{13.5}{\left(\frac{I - K\Delta I_S}{I_S}\right) - 1}$ s	0 0 0	<--- <---	--->	1 1 1
EI Extremely inverse: $t = \frac{80}{\left(\frac{I - K\Delta I_S}{I_S}\right)^2 - 1}$ s	0 0 0	<--- <---	--->	1 1 1
LTI Long time inverse: $t = \frac{120}{\left(\frac{I - K\Delta I_S}{I_S}\right) - 1}$ s	0 0 0	<---	---> --->	1 1 1

Where I is the ratio of the applied current to the rated current.

Note: The specified accuracy is only guaranteed when the setting ratio of ΔI_S:I_S is no greater than 5:1

D2 Definite time 2s	0 0 0	<--- <---	 --->	1 1 1
D4 Definite time 4s	0 0 0	<---	---> --->	1 1 1
D8 Definite time 8s	0 0 0	<---	 ---> --->	1 1 1
Trip test	0 0 0		---> ---> --->	1 1 1

Note: It is recommended that visual indication of the curve selected is made on the relay front plate by marking the appropriate square(s) provided for each characteristic.

4.1.7 Time multiplier setting switches x t = ∑

The six lower blue switches on the current measuring boards are used to set the required time multiplier. The time given by each of the time delayed operating characteristics must be multiplied by the time multiplier to give the actual operating time of the relay pole. The setting is obtained by adding the indicated values of the individual switch settings and is indicated by:

x t = ∑.

Note: Although it is possible to set the switches to give a TMS of 0.025 x t, this setting cannot be guaranteed to give specified accuracy. Therefore only settings in the range 0.05 to 1.0 x t should be used.

4.1.8 Relay setting example

Current measuring board settings:

					Setting applied
	0.1	<---		0.05	$I_S = \sum x\ I_n$
Current	0.1	<---		0	
setting	0.2		--->	0	$= (0.1 + 0.1 + 0.4) x\ I_n$
switches	0.4	<---		0	
	0.4		--->	0	$= 0.6 x\ I_n$
	0.4		-->	0	
	0.8		--->	0	
Curve select	0	<---		1	
switches	0	<---		1	Standard inverse curve
	0	<---		1	
	0.025		--->	0.05	
TMS	0		--->	0.05	$xt = \sum$
switches	0	<---		0.1	$= 0.05 + 0.05 + 0.4$
	0	<---		0.2	$= 0.5$
	0	<---		0.2	
	0		--->	0.4	

Voltage measuring board settings:

Voltage mode	V_R		--->	V_C	Voltage control mode
	0.1		--->	0.05	$V_S = (0.5 + \sum) x\ V_n$
Voltage	0.1	<---		0	$V_S = (0.5 + 0.05 + 0.1 + 0.2) x\ V_n$
control	0.2	<---		0	$= 0.85 x\ V_n$
setting					
	0.1		--->	0	$\Delta I_S = (0.5 + \sum) x\ I_n$
ΔI_S setting	0.2	<---		0	$\Delta I_S = (0.5 + 0.2 + 0.4) x\ I_n$
	0.4	<---		0	$= 1.1 x\ I_n$
	0.8		--->	0	

If the above settings were applied to a 1A, 110V ac rated relay :

Current setting I_s	= 0.6A
Curve	= Standard Inverse
TMS	= 0.5
Voltage mode	= Voltage Control
Voltage setting V_s	= 93.5V
ΔI_s setting	= 1.1A

Section 5. MAINTENANCE

Periodic maintenance is not required; however, periodic inspection and test is advisable. It is recommended that the power supply healthy test outlined below is carried out at regular intervals.

5.1 Power supply healthy test

The availability of power to the measuring boards can be checked at any time without removing the protection provided by the relay. This is done by pressing the reset button on the front panel. All leds should illuminate if the relay power supply is performing satisfactorily. When the push button is released, all the leds should be extinguished.

Section 6. PROBLEM ANALYSIS

6.1 General

These instructions enable a fault to be located to sub-assembly level. Fault finding at component level is not recommended.

The major reasons for this are as follows:

– Fault finding on printed circuit boards requires specialized knowledge and equipment.

– Components used in manufacture are subjected to strict quality control procedures and in certain cases selected for particular characteristics. Metal oxide semiconductor (MOS) components are used which require very careful handling.

– Damage can be caused to printed circuit board track unless extreme care is used in replacement of components.

– Replacement of certain components will require recalibration of the relay.

In the event of a faulty sub-assembly being found, it is recommended that the relay is returned to GEC ALSTHOM T&D Protection & Control or sent to a competent service centre for the work to be carried out. However, replacement sub-assemblies can be made available from GEC ALSTHOM T&D Protection & Control upon request, provided the relay model number and serial number are quoted. Recalibration of the relay is not required after the replacement of a sub-assembly.

Note: Before fault finding on the relay is commenced, all external connections and supplies to the relay should be checked to ensure that the fault lies within the relay.

6.2 Procedure

The following tests should only be carried out under laboratory conditions, when a faulty relay has been identified and removed from its case.

6.2.1 Gaining access to the relay internal circuitry

The method for removing the front plate is to remove the six pozidrive screws from the black front plate which will then release the front plate from the relay module.

The voltage and current measuring pcbs can now be accessed as required.

Any measuring pcbs which have to be removed as part of the problem analysis

should be removed by gently pulling the pcb out from the mother board. When any measuring pcb is replaced, care should be taken to ensure that their connectors are correctly aligned with the rear socket.

Note: The C phase voltage measuring board has a screen pcb clipped to it and should always be replaced in the C phase position after problem analysis work.

6.2.2 DC internal power supply check

This can easily be done by pressing the reset button on the front panel. All leds should illuminate if all of the current measuring boards are operating satisfactorily. Upon releasing the push button, all leds should be extinguished.

Note: This test may be carried out at any time whilst the relay is in service without affecting its ability to measure or trip.

6.2.3 Output relay trip test

Set the curve selection switches on each measuring board, in turn, to the 111 position. This should result in the three leds on that measuring board flashing at a rate of one per second.

If the reset push button is then held pressed for approximately six seconds, the output relay should energize, the leds will stop flashing and remain in the on state until the push button is released.

In this way each current measuring board, the output relay and its associated output contacts can be checked individually without the need for any input current being applied.

The output miniature relay is an integral part of the module's mother board, so in the event of such a unit failing, the whole relay should be returned to GEC ALSTHOM T&D Protection & Control for repair.

Note: During this test, current transformer measurement is inhibited.

6.2.4 AC input tests

If one or more poles of the relay are inoperative, then the input transformers for that pole should be tested (For tests see Sections 6.2.5 and 6.2.6). These tests require a current source capable of delivering 2 x rated current to the relay; a voltage source capable of providing rated ac voltage to the relay; an ac ammeter and an ac voltmeter are required.

In order to test the transformers, the voltage measuring pcbs will have to be removed from the mother board as necessary so as to allow access to the connector plugs labelled PL8, PL9 and PL10 on the mother board ZJ0171/ZJ0298. Section 6.2.1 describes how to gain access to the measuring pcbs.

6.2.5 Current transformer test

To test the current transformers, a current of 2 x rated current should be applied to each current input of the relay in turn and the ammeter should be used to measure the current flowing into the appropriate terminals on the ZJ0171/ZJ0298 mother board connectors shown in the following table. This measured current should be 20mA ±10%.

Phase	Apply 2 x rated current to relay terminals	Measure 20mA ± 10% at connector terminal pins
A	21 and 22	PL8–8 and PL8–9
B	23 and 24	PL9–8 and PL9–9
C	25 and 26	PL10–8 and PL10–9

If 20mA is not obtained at the appropriate connector terminals, then firstly the relay wiring must be checked, both at the module contact moulding and at the pcb connectors. If these are sound, then the input current transformer of the faulty pole must be replaced.

Note: Care should be taken that no short circuits to other connector terminals are made inadvertently when connecting the ammeter to the required connector terminals, as this could result in damage to the relay.

6.2.6 Voltage transformer test

To test the voltage transformers, a voltage of 1 x rated voltage should be applied to each voltage phase input of the relay in turn and the voltmeter should be used to measure the voltage between the appropriate terminals on the ZJ0171/ZJ0298 mother board connectors shown in the following table.

Phase	Apply rated voltage to relay terminals	Measure voltage at connector terminal pins	Voltage (V) ±10%
A	21 and 22	PL8–1 and PL8–2	10.7
A	21 and 22	PL8–3 and PL8–4	4.1
B	23 and 24	PL9–1 and PL9–2	10.7
B	23 and 24	PL9–3 and PL9–4	4.1
C	25 and 26	PL10–1 and PL10–2	10.7
C	25 and 26	PL10–3 and PL10–4	4.1

If the required voltage is not obtained at the appropriate connector terminals, then firstly the relay wiring must be checked both at the module contact moulding and at the pcb connectors. If these are sound, then the input voltage transformer of the faulty pole must be replaced.

Note: Care should be taken that no short circuits to other connector terminals are made inadvertently when connecting the ammeter to the required connector terminals, as this could result in damage to the relay.

6.2.7 Measuring/timing circuitry tests

In the event that one or more poles of the relay is found to be inoperative or operating incorrectly, and the power supply and input transformers have been proved to be working correctly, then the voltage and/or current measuring pcbs, ZJ0172 and ZJ0161 respectively, must be suspected.

In order to establish which of these two pcbs is faulty, firstly a ‘known good’ current measuring pcb should be moved from another phase position in the module and tested in the faulty phase position. If this current pcb works satisfactorily in this position, it can be assumed that the suspect current measuring pcb is faulty and should be replaced.

If, however, this current measuring pcb does not work correctly then the voltage measuring pcb should be suspected. In order to establish if this is the case, then the original current measuring pcb should be replaced in the faulty phase and a ‘known good’ voltage measuring pcb should be moved from another phase position in the module and tested in the faulty phase position. If this voltage pcb works satisfactorily in this position, it can be assumed that the suspect voltage measuring pcb is faulty and should be replaced.

If, however this voltage measuring pcb does not work correctly then both of the original voltage and current measuring pcbs should be suspected. In order to establish if this is the case then ‘known good’ voltage and current measuring pcbs should be placed in the faulty phase position and tested. If this phase then works correctly. it can be assumed that the suspect voltage measuring pcb and current measuring pcb are faulty and should be replaced.

If, however, this phase still fails to work correctly, the mother-board should be suspected. The whole relay should be returned to GEC ALSTHOM T&D Protection & Control for repair.

Note 1: Under no circumstances should current be injected into any of the relay inputs when the corresponding current measuring pcb has been removed from the module.

Note 2: At least one of the current pcbs must be located in the module when the dc auxiliary supply is connected to the module or damage to the power supply circuitry may result.

6.3 Repairs

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.

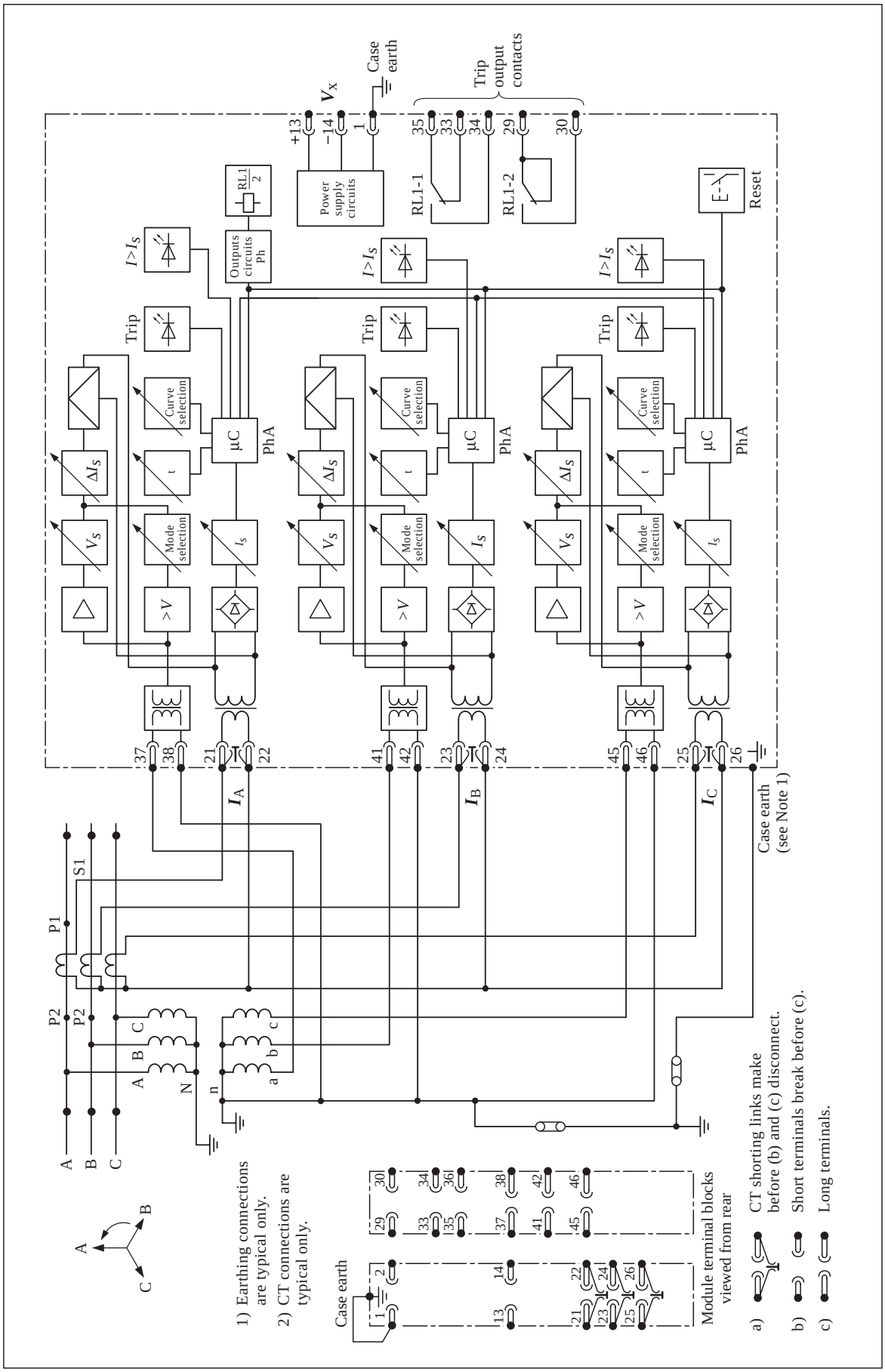

Figure 1 Application diagram: Static modular voltage restrained and controlled overcurrent relay Type MCVG 61 three phase (10 MCVG 61 02 issue A)

Section 7. COMMISSIONING TEST RECORD

Voltage Dependent Overcurrent Relay Type MCVG61

Serial no. _____ Date _____

Relay model no. MCVG61 _____

Station _____ Circuit _____

Rated current In

1A _____ 5A _____

DC voltage

24/54V _____ 110/250V _____

AC voltage

63.5V _____ 110V _____

Final switch settings

Phase A	Current sensitivity	I_S	_____	x I_n
	Curve		_____	
	TMS		_____	
	Voltage mode		_____	
	V_S voltage settings	V_S	_____	x V_n
	ΔI_S current setting	ΔI_S	_____	x I_n
Phase B	Current sensitivity	I_S	_____	x I_n
	Curve		_____	
	TMS		_____	
	Voltage mode		_____	
	V_S voltage settings	V_S	_____	x V_n
	ΔI_S current setting	ΔI_S	_____	x I_n

Phase C	Current sensitivity	I_S	_____	x I_n
	Curve		_____	
	TMS		_____	
	Voltage mode		_____	
	V_S voltage settings	V_S	_____	x V_n
	ΔI_S current setting	ΔI_S	_____	x I_n

Test results

3.1.13 Energization test _____

3.3.2 Relay CT shorting switches _____

3.3.3 DC supply voltage _____

3.3.4 Trip test _____

3.3.5 35 x multiplier timing test _____

Phase A	Phase B	Phase C
_____	_____	_____

3.3.7 V_C mode, operating voltage level at selected setting V_S (V)

V_S _____

Phase A	Phase B	Phase C
_____	_____	_____

3.3.8 V_C mode, current pick-up level at final selected settings

Input voltage (x Vn)	Phase A	Phase B	Phase C
1.0	_____	_____	_____
0.0	_____	_____	_____

4.3.9 V_C mode, operating times at final selected settings

Multiplier	Input voltage (x V_n)	Phase A	Phase B	Phase C
2x	1.0	_____	_____	_____
10x	1.0	_____	_____	_____
2x	0.0	_____	_____	_____
10x	0.0	_____	_____	_____

3.3.10 V_R mode, current pick-up level at final selected settings

Input voltage (x V_n)	Phase A	Phase B	Phase C
1.0	_____	_____	_____
0.9	_____	_____	_____
0.725	_____	_____	_____
0.55	_____	_____	_____
0.0	_____	_____	_____

3.3.11 V_R mode, operating times at final selected settings

Multiplier	Input voltage (x V_n)	Phase A	Phase B	Phase C
2x	1.0	_____	_____	_____
10x	1.0	_____	_____	_____
2x	0.9	_____	_____	_____
10x	0.9	_____	_____	_____
2x	0.725	_____	_____	_____
10x	0.725	_____	_____	_____

_____ _____

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:

_____

_____

_____

_____ _____

Signature Title

_____ _____

Name (in capitals) Company name