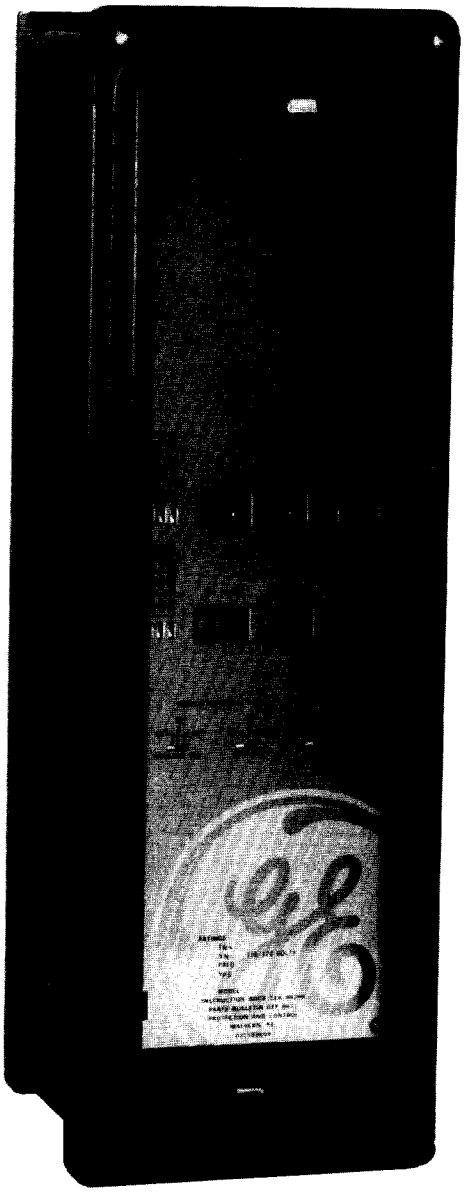
GEK-99290A

INSTRUCTIONS

MLCG

GROUND DIRECTIONAL OVERCURRENT RELAY



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These instructions do not purport to cover all details or variations in equipment nor provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the General Electric Company.

To the extent required the products described herein meet applicable ANSI, IEEE, and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

Contents

Since the last edition, the SOFTWARE section has received multiple revisions, and Group 4 has been added to the Renewal Parts List.

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PRODUCT DESCRIPTION

GENERAL

The MLCG201 relay is a microprocessor-based ground directional overcurrent relay that contains directional functions, and time and instantaneous-overcurrent functions. One of the following directional functions can be selected:

A. One zero-sequence directional function (ZD) that can be polarized from zero-sequence voltage and/or current.

B. One negative-sequence directional function (ND) that is polarized from negative-sequence voltage with negative-sequence current compensation.

The directional function selected above is used to control the following overcurrent functions:

A. A zero-sequence time-overcurrent function (TOC) with the following selectable time curves:

1. Inverse time characteristic (Figure 1).

2. Very Inverse time characteristic (Figure 2).

3. Extremely Inverse time characteristic (Figure 3).

5. BS142 time characteristic (Figure 4).

5. Definite time characteristic.

B. A zero-sequence instantaneous-overcurrent function (IOC) that can be used with or without positive-sequence current restraint. Figure 5 illustrates the characteristic curve for the directionally controlled IOC function.

C. A zero-sequence overcurrent function (IPT).

The MLCG relay is a low burden device that can be used to provide extremely sensitive ground fault protection.

A functional block diagram for the MLCG201 is shown in Figure 7 .

APPLICATION

The MLCG201 relay can be used on any grounded system to provide ground fault detection. The various functions can be used as follows.

DIRECTIONAL FUNCTIONS

Two directional functions are provided in the MLCG relay; a zero-sequence polarized function and a negative-sequence polarized function. Only one of the functions can be used at a given time. The directional function response time, as shown in Figure 6, must be taken into consideration when utilizing the time-overcurrent function selectable time curves, as well as when using the instantaneous-overcurrent functions. The following criteria can be used to select the function to be used for any given application.

Zero-Sequence Directional Function (ZD)

The zero-sequence directional function (ZD) can be polarized as follows:

1. Current Polarization - This method of polarization may be used at those points in the system where power transformers having suitable grounded neutrals are located. The polarizing current may be obtained in a number of different ways, among which are:

   - Current transformer in the power transformer neutral
   - Current transformer(s) in the tertiary of the power transformer
   - Various combinations of current transformers located in the high side, low side, or neutral of the power transformer

2. Voltage Polarization - This method of polarization may be used at those points where a suitable current polarizing source is not available. Voltage polarization can be obtained via the three phase-to-ground voltages or via the broken delta secondary connection of three potential transformers whose primary windings are connected grounded-wye (see Figure 9).

3. Dual (current/voltage) Polarization - This method of polarization may be used where suitable sources of polarizing current and voltage are both available. Dual polarization is preferred, because changing system conditions may favor current polarization at some times whereas voltage polarization might be favored at others.

Further information on polarizing sources can be found in GE publication, GET-6463, "Polarizing Sources for Ground Relays". Copies can be requested via the nearest General Electric Sales Office.

Negative-Sequence Directional Function (ND)

The negative-sequence directional function uses negative-sequence current and voltage to derive its characteristic. The function has a current-compensation feature that is used to provide the function with a reliable polarizing quantity even in those systems where low negative-sequence source to negative-sequence line impedance ratios (Z2S/Z2L) exist. In these applications, the negative-sequence voltage can be very small in magnitude. The current-compensation feature overcomes this deficiency. The negative-sequence directional function is beneficial in applications wherein strong zero-sequence mutual coupling exists and zero-sequence polarizing could prove unreliable, or when a suitable zero-sequence polarizing source is unavailable.

OVERCURRENT FUNCTIONS

Time-Overcurrent Function (TOC)

The time-overcurrent function (TOC) operates from zero-sequence (3I0) current and is used to provide time-delayed tripping for faults involving ground. The function is controlled by whichever directional function is selected. Any one (but only one) of the following time characteristics can be selected:

1. Inverse time characteristic (Figure 1).
2. Very Inverse time characteristic (Figure 2).
3. Extremely Inverse time characteristic (Figure 3).

4. BS142 time characteristic (Figure 4).

5. Definite time characteristic.

Select the characteristic that best fits the application.

Instantaneous-Overcurrent Function (IOC)

The instantaneous-overcurrent function (IOC) operates from zero-sequence current and may be applied with or without positive-sequence current restraint (3I0 – KD*I1) where KD can be set equal to zero or one. Positive-sequence current restraint (KD = 1) acts to de-sensitize the function for some system conditions while making it more sensitive for other conditions. The example given under CALCULATION OF SETTINGS will demonstrate this operation. The function is controlled by whichever directional function is selected.

Instantaneous-Overcurrent Function (IPT)

The instantaneous-overcurrent function (IPT) operates from zero-sequence current (3I0) alone. IPT may be used as the permissive tripping function in permissive overreaching and permissive underreaching transferred tripping schemes. However, it may be used anywhere its characteristic meets the application. The function is controlled by whichever directional function is selected.

FEATURES

Self Test

The MLCG includes extensive self-test features. Many of the self-tests are performed both at startup and in background mode with the MLCG in service. Some self-tests and actions that are made are indicated below:

CRC check of PROM
Write/Read test of RAM
Analog input reference voltage check
Spurious interrupt tests
CRC check of communications
Watchdog timer (if not updated) issuance of hardware restart

Remote Communications

A communication interface port (telephone-jack type), is located on the back of the MLCG relay. A user can remotely communicate with the MLCG relay by means of the interface port. A copy of MLCG-LINK software and a hardware link are required in order to communicate with the MLCG relay. Refer to the **SOFTWARE** section for additional information.

Some of the information reported by the MLCG relay, when requested through MLCG-LINK, is indicated below:

Rms values of 3I0, I1, I2, I0pol & V0
State of output relays
Pickup settings of the instantaneous units
Polarization setting & type selected
Curve type selected
Time Dial / Definite time setting
Status of KD factor
PROM version

Local Communications

Local Communications consists of a series of LED's located on the front of the MLCG relay. The following Led display is provided for indication purposes:

Instantaneous-Overcurrent Pickup	IOC	Amber
Instantaneous-Overcurrent Trip	IOC	Red*
Instantaneous-Overcurrent Trip	IPT	Red*
Instantaneous-Overcurrent Pickup	IPT	Amber
Time-Overcurrent Trip	TOC	Red*
Time-Overcurrent Pickup	TOC	Amber
MLCG Critical Failure/Protection Off	ALARM	Red
DC power ON	SYSTEM STATUS	Green

* Requires trip current in breaker trip coil

CONNECTION DIAGRAMS

An internal connection diagram for the MLCG is shown in Figure 8.

Typical external connections to the MLCG201 are shown in Figure 9 .

CALCULATION OF SETTINGS

DIRECTIONAL FUNCTION

Select the directional function to be used, based on the criteria described in the **PRODUCT DESCRIPTION** section. Next select a replica impedance angle, which can be set to 65° or 75° or 85° for the negative-sequence directional function, while the zero-sequence directional function can be set with an angle of 45° or 60° or 75°. The angle should be set as near as possible to the angle of the source impedance directly behind the function. For the system shown in Figure 10, set the angle to 85° if ND is selected, whereas a 75° angle should be used if ZD is selected.

TOC FUNCTION

Select a time-dial setting and curve type to meet the particular application.

IPT FUNCTION

Select a pickup setting to meet the application. If IPT is not used, any setting can be used.

IOC FUNCTION

This function requires a KD selection and a pickup setting. The pickup setting can be calculated as follows:

$$\text{IOC (pickup)} = |3I0| - |KD*I1| + |0.25*3I0|$$

The latter term in the above equation ($|0.25*3I0|$) is a margin factor. A KD setting of 1.0 is proposed, but the selection is up to the user. The following example describes the difference in performance with KD = 1 versus KD = 0.

Assume the simple system shown in Figure 10. For a Fault at F with both breakers closed, the following quantities apply:

$|3I0| = 2.4$

$|I1| = 3.7$

If 3I0 alone is used to operate IOC (KD = 0), IOC pickup is determined as follows:

IOC (pickup) = 2.4 – 0*3.7 + 0.25*2.4 = 3.0 amperes

Use a setting of 3.0 amperes.

If 3I0 – KD*I1 is used to operate IOC (KD = 1), IOC pickup is determined as follows:

IOC (pickup) = 2.4 – 1*3.7 + 0.25*2.4 = –0.7 amperes.

Since the calculation yields a negative number, the minimum pickup setting of 0.5 amperes can be used.

Note that the same settings can be used at each end of the line, since the system is symmetrical.

Now consider the same system with a resistive fault (F1) at the end of the line. The results shown in Table 1 are obtained.

With KD = 0:

For faults up to 17 ohms resistive, terminal B will trip immediately followed by sequential tripping of terminal A.

For faults up to 21 ohms, terminal B will trip instantly. Terminal A will have to rely on time-delayed tripping.

For faults greater than 21 ohms, both terminals will trip with time delay.

TABLE 1 Fault Results

SLG Fault	Station A		Station B		Brkr. B	Rf
	3I0	3I0 – KD*I1	3I0	3I0 – KD*I1		
F1	0.10	–0.06	**3.80**	**2.67**	C	17
F1	**3.10**	**2.10**	---	---	O	17
F1	0.08	–0.05	**3.10**	**2.20**	C	21
F1	2.70	**1.80**	---	---	O	21
F1	0.02	–0.01	0.77	**0.54**	C	85
F1	0.77	**0.51**	---	---	O	85

C = closed O = open

With KD = 1:

For faults up to 85 ohms, terminal B will trip immediately followed by sequential tripping of terminal A.

For faults greater than 85 ohms, both terminals will trip in time delay.

Thus, the function provides much more sensitive protection when positive-sequence restraint (KD = 1) is used. The difference in performance comes about because once breaker B opens, the positive-sequence current equals the zero-sequence current, thus reducing the I1 restraint significantly.

Although this example was chosen to show that the IOC function can be more effective when positive-sequence current restraint is used, other cases can probably be found where benefits would also be gained. Each application should be examined on an individual basis to determine the effects of the KD factor.

SETTINGS

The following settings, which must be set in each application, are made from the front of the relay. They are easily made by removing the front cover of the MLCG relay; refer to Figure 11.

DIRECTIONAL CONTROL/POLARIZATION

A three-section toggle switch is used in selecting the directional function, as well as the polarizing method. The available setting for the directional control function is either negative sequence (ND) or zero sequence (ZD). Voltage polarization is the only polarizing method available for the negative-sequence function. However, for the zero-sequence function, the relay can be voltage-, current- or both voltage- and current-polarized.

Refer to a chart located on the nameplate, immediately above the toggle switch, to determine the required switch positions in order to select the various settings.

IOC PICKUP

A three-section switch on the front panel allows the IOC PICKUP level to be set. Set the desired setting by pushing the + and – buttons of each switch section.

IPT PICKUP

A two-section switch on the front panel allows the IPT PICKUP level to be set. Set the desired setting by pushing the + and – buttons of each switch section.

CURVE SELECTION

A three-section toggle switch is used in selecting the TOC curves or a Definite Time Delay setting. The TOC curves that are available are inverse, very inverse, extremely inverse or the British Standard 142.

A chart located on the nameplate, immediately above the toggle switch, indicates the required switch position in order to select the desired curve or definite time. The relay will default to the very inverse curve if a non-recognized setting is applied prior to it being powered up.

TOC PICKUP

A three-section switch on the front panel allows the TOC PICKUP level to be set. Set the desired setting by pushing the + and – buttons of each switch section.

TIME DIAL OR DEFINITE TIME DELAY

A three-section switch on the front panel allows the Time Dial or the DEFINITE TIME to be set. Set the desired setting by pushing the + and – buttons of each switch section. If any of the TOC curves are chosen, this switch will set the TIME DIAL. However, if the DEFINITE TIME DELAY function is chosen, then this switch will set a definite time, in seconds.

REPLICA IMPEDANCE ANGLE

Negative Sequence

A three-position switch is used in selecting the negative-sequence replica impedance angle.

Zero Sequence

A three-position switch used in selecting the zero-sequence replica impedance angle.

KD

A three-position switch is used in selecting the multiplication factor for I1, which is the positive-sequence current restraint for the IOC function. With the switch set to the extreme left position, KD has a value of zero. However, with the switch set to the center or to the extreme right position, possible only with the nameplate removed, the value of KD is one. With the nameplate installed on the relay, the KD switch is limited to travel only between the extreme left and center positions.

APPLYING SETTINGS

Settings can be applied to the MLCG relay before the relay is powered up. Then, after the relay has powered up, those selected settings will automatically be accepted. Should any of the selected settings be out of range, by default the relay will take either the minimum or the maximum range value. The relay will default to the minimum range value if the selected setting is below the minimum value. However, the relay will default to the maximum range value if the selected setting is above the maximum value. In the case where one applies a non-recognized curve selection setting, the relay will default to the very inverse curve.

Settings can also be applied to the MLCG relay after it has been powered up. As the user makes his setting selection, the green SYSTEM STATUS LED will begin to flash. It will flash at a moderate rate if the settings are within the specified ranges; conversely, it will flash at a rapid rate if the selected settings are outside the specified ranges. After the settings have been made, the reset switch must be activated for a period of two seconds in order for the relay to accept the settings. Once the relay has accepted the new settings, the green SYSTEM STATUS LED will stop flashing and once again it will be fully lit.

CHANGING SETTINGS

Settings can be changed with the relay energized. The new settings will be accepted by the relay after the reset switch has been activated for a period of two seconds. The only time that the relay will not accept a setting change is between the pickup and trip time of the TOC function. The relay will either wait for the TOC function to trip and for the trip signal to be removed, or for the trip signal to fall below 0.25 Amp for the 5 Amp relay (0.05 Amp for the 1 Amp relay), before accepting the new settings.

HARDWARE DESCRIPTION

CONSTRUCTION

The components of the relay are mounted on a cradle assembly that can easily be removed from the relay case (refer to Figures 11 through 14). The cradle is locked in the case by latches at the top and bottom. The electrical connections between the case blocks and the cradle blocks are completed through removable connection plugs, as shown in Figure 16, to permit testing the relay in its case. The cover is attached to the front of the case and includes two interlocking arms that prevent the cover from being replaced until the connection plugs have been inserted.

The case is suitable for semi-flush mounting on panels. Hardware is available for all panel thicknesses up to two inches. A panel thickness of 1/8 inch will be assumed unless otherwise specified on the order. Outline and panel-drilling dimensions for the MLCG201 is shown in Figure 17.

The printed-circuit boards are mounted behind the nameplate and can be accessed by removing the four screws securing the nameplate. The boards are mounted horizontally in guides. Use GE part number 286A2847P1 card puller or other suitable means to remove the circuit boards. If you do not have a card puller, be careful not to damage or bend any components when removing the boards.

The output relays are mounted in sockets on a board fixed to the back of the cradle. If a relay requires replacement, unclip the retaining wire and pull the relay out of the socket.

The magnetics are mounted on the top and on the bottom of a metal plate that is found on the lower section of the relay cradle.

DISPLAYS

Trip

The trip indicators for the IOC, IPT & TOC functions are Red LED's that are supervised by the passage of trip current. One indicator is provided for each tripping function.

Pickup

The pickup indicators for the IOC, IPT & TOC functions are Amber LED's. They are not supervised and they light to indicate that the function has picked up. One indicator is provided for each tripping function.

The TOC pickup indicator also serves as a directional indicator. This indicator will flash, ON/OFF, whenever the relay is directional. It will continue to flash until the relay is no longer directional or until the TOC function has picked. When the relay is no longer directional, the TOC amber LED will no longer be lit. However, when the relay is directional and the TOC function is picked up, the TOC amber LED will be constantly lit.

System Status

The system status indicator is a Green LED. When lit, it not only indicates that DC power is applied to the MLCG relay but it also indicates that the relay is in a functional condition. The system status indicator is also used when a setting change is made to the relay. The indicator flashes at a moderate rate if the change is within the normal range. However, should the change be outside the normal range, the indicator will flash at a high rate.

Alarm

The alarm indicator is a Red LED. Under normal conditions, it is momentarily lit whenever the MLCG is powered up and the relay is going through the self check procedure. When lit by itself, the ALARM LED is used to indicate a critical failure of the MLCG relay. Relay protection is turned off and the alarm relay contacts will be closed when a critical failure has taken place.

The ALARM LED is also used to indicate a loss of potential. A loss of potential will be indicated by both the RED ALARM LED and the GREEN SYSTEM STATUS LED being lit. With this condition the alarm relay contacts will be closed. However, relay protection is active.

RECEIVING, HANDLING AND STORAGE

This relay contains electronic components that could be damaged by electrostatic discharge currents if those currents flow through certain terminals of the components. The main source of electrostatic discharge currents is the human body, and the conditions of low humidity, carpeted floors and isolating shoes are conducive to the generation of electrostatic discharge currents. Where these conditions exist, care should be exercised when removing and handling the modules. The persons handling the module should make sure that their body charge has been discharged, by touching some surface at ground potential, before touching any of the components on the modules.

These relays, when not included as part of a control panel, will be shipped in cartons designed to protect them against damage. Immediately upon receipt of a relay, examine it for any damage sustained in transit. If damage resulting from handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Sales Office.

If the relays are not to be installed immediately, they should be stored in their original cartons, and in a place that is free from moisture, dust and metallic chips.

INSTALLATION PROCEDURE

The relay should be installed in a clean, dry location, free from dust and excessive vibration. It should be mounted on a vertical surface. The outline and panel-drilling dimensions are shown in Figure 17.

Surge Ground

The case stud should be permanently connected to ground by a conductor not less than AWG No. 12 copper wire or equivalent. This connection is made to ground the relay case and the surge suppression networks in the relay. The surge ground lead should be as short as possible, preferably 10 inches or less, to provide maximum protection from surges. Figure 13 shows the rear view of an L2 case, illustrating the position of the case-grounding stud.

ACCEPTANCE TESTS

CAUTION

Power Down the relay by removing the test plugs before removing or inserting modules. Failure to do so can permanently damage the relay.

GENERAL

The relay should be examined to make sure that no damage has been sustained in shipment. Remove the relay from its case and check for signs of physical damage such as broken or cracked parts.

This section is a guide for testing the relay. It is not necessary that the tests be performed for incoming inspection. The relay has been tested at the factory with automated test equipment. The MLCG is a digital relay controlled by "self-checking" software. If a system failure is detected, it will be reported through the Red ALARM LED.

TEST EQUIPMENT

1. Dual-phase source of current at the rated frequency and with less than 5% harmonic distortion.
2. Single-phase source of voltage at the rated frequency and with less than 5% harmonic distortion.
3. AC ammeter and AC voltmeter.
4. Continuity tester or Ohm meter.
5. Precision timer for testing timed events.
6. Two phase angle meters.
7. DC power supply rated 48-250VDC, with less than 5% ripple.
8. Limiting resistor for target indicator test.

DRAWINGS

The following drawings should be used for reference during testing. The directional unit response time, as shown in Figure 6, must be taken into consideration when utilizing the time-overcurrent function selectable time curves, as well as when using the instantaneous-overcurrent functions.

1. The Functional Block Diagram	Figure 7
2. The Internal Connections Diagram	Figure 8
3. The TOC Curves	Figure 1-3
4. The BS142 Curve	Figure 4
5. Directional Unit Characteristic Curve	Figure 6

EQUIPMENT GROUNDING

All equipment used in testing the MLCG relay should be connected to a common grounding point to provide noise immunity. This includes the current source, as well as the MLCG itself.

The ground connection on the MLCG is terminal #21, the case-grounding stud, located on the rear of the case. Refer to Figure 13.

GENERAL RELAY TESTS

Power-Up Test

1. Connect the relay as shown in Figure 18. Apply rated DC power and wait for initialization to complete.

2. Only the green SYSTEM STATUS LED should be on.

LED Test

1. Connect the relay as shown in Figure 18. Apply rated DC power and wait for initialization to complete.

2. Activate the reset switch. Check that all LEDs are lit and remain lit as long as the reset switch is activated.

3. Release the reset switch. Check that the only LED lit is the green SYSTEM STATUS LED.

Alarm Test

1. Connect the relay as shown in Figure 19. Apply rated DC power and wait for initialization to complete.
2. Connect the phase lead of the voltage source to terminal 16 and the neutral lead to terminal 19. Apply 69 volts rms to the potential circuit VA.
3. Check that the red ALARM LED is lit. With the continuity tester, check that the alarm relay contacts, terminal 14 & 15, are closed.
4. Remove the voltage from the potential circuit VA. Check that the red ALARM LED is no longer lit and that the alarm contacts are open.

TOC Time-Dial Test

1. Connect the relay as shown in Figure 20.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD V&I POL.**
3. Set the IOC pickup to **10.0** for the 5A relay, and to **2.0** for the 1A relay.
4. Set the IPT pickup to **9.9** for the 5A relay, and to **1.9** for the 1A relay.
5. Set CURVE SELECTION to **INV.**
6. Set the TOC pickup to **5.0** for the 5A relay, and to **1.0** for the 1A relay.
7. Set the TIME DIAL to **0.5.**
8. Apply rated DC power and wait for initialization to complete.
9. Connect the phase lead of the polarizing current, Ipol, to terminal 8 and the neutral lead to terminal 9. Apply 1.5 Amps of polarizing current for the 5A relay, and 0.3 Amps of polarizing current for the 1A relay. Set the phase angle to 0°.
10. Connect the timer so that it starts when the operating current, Iop, is applied and it stops on the closure of the TOC output relay contacts, terminals 1 & 11.
11. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Apply 11.6 Amps rms of operating current for the 5A relay, and 2.31 Amps rms of operating current for the 1A relay. Set the phase angle to 0°.
12. The amber TOC Pickup LED should light when the operating current is applied. The time displayed by the timer should be between 0.368 and 0.407 seconds.

TOC Definite-Time Test

1. Connect the relay as shown in Figure 20.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD V&I POL.**
3. Set the IOC pickup to **10.0** for the 5A relay, and to **2.0** for the 1A relay.
4. Set the IPT pickup to **9.9** for the 5A relay, and to **1.9** for the 1A relay.
5. Set CURVE SELECTION to **DEF TIME.**

6. Set the TOC pickup to **5.0** for the 5A relay, and to **1.0** for the 1A relay.
7. Set the DEFINITE TIME DELAY to **0.5**.
8. Apply rated DC power and wait for initialization to complete.
9. Connect the phase lead of the polarizing current, Ipol, to terminal 8 and the neutral lead to terminal 9. Apply 1.5 Amps of polarizing current for the 5A relay, and 0.3 Amps of polarizing current for the 1A relay. Set the phase angle to 0°.
10. Connect the timer so that it starts when the operating current, Iop, is applied and it stops on the closure of the TOC output relay contacts, terminals 1 & 11.
11. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Apply 4.75 to 5.25 Amps rms of operating current for the 5A relay, and 0.95 to 1.05 Amps rms of operating current for the 1A relay. Set the phase angle to 0°.
12. The amber TOC Pickup LED should light when the operating current is applied. The time displayed by the timer should be between 0.450 and 0.550 seconds.

IOC Test, KD = 0

1. Connect the relay as shown in Figure 21.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD V&I POL.**
3. Set the IOC pickup to **4.5** for the 5A relay, and to **0.9** for the 1A relay.
4. Set the IPT pickup to **9.9** for the 5A relay, and to **1.9** for the 1A relay.
5. Set CURVE SELECTION to **DEF TIME.**
6. Set the TOC pickup to **10.0** for the 5A relay, and to **2.0** for the 1A relay.
7. Set the DEFINITE TIME DELAY to **0.5**.
8. Set the KD switch to **0.**
9. Apply rated DC power and wait for initialization to complete.
10. Connect the phase lead of the polarizing current, Ipol, to terminal 8 and the neutral lead to terminal 9. Apply 1.5 Amps of polarizing current for the 5A relay, and 0.3 Amps of polarizing current for the 1A relay. Set the phase angle to 0°.
11. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Apply 4.3 to 4.7 Amps rms of operating current for the 5A relay, and 0.86 to 0.95 Amps rms of operating current for the 1A relay. Set the phase angle to 0°.
12. The amber IOC Pickup LED and the red IOC Trip LED should light when the operating current is applied.
13. Remove the operating current, and check that the amber IOC LED is no longer lit. However, the red IOC LED should still be lit.
14. Activate the reset switch and check that the red IOC LED is no longer lit when the reset switch is released.

IOC Test, KD = 1

1. Connect the relay as shown in Figure 21.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD V&I POL.**
3. Set the IOC pickup to **4.5** for the 5A relay, and to **0.9** for the 1A relay.
4. Set the IPT pickup to **9.9** for the 5A relay, and to **1.9** for the 1A relay.
5. Set CURVE SELECTION to **DEF TIME.**
6. Set the TOC pickup to **10.0** for the 5A relay, and to **2.0** for the 1A relay.
7. Set the DEFINITE TIME DELAY to **0.5.**
8. Set the KD switch to **1.**
9. Apply rated DC power and wait for initialization to complete.
10. Connect the phase lead of the polarizing current, Ipol, to terminal 8 and the neutral lead to terminal 9. Apply 1.5 Amps of polarizing current for the 5A relay, and 0.3 Amps of polarizing current for the 1A relay. Set the phase angle to 0°.
11. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Apply 6.4 to 7.1 Amps rms of operating current for the 5A relay, and 1.3 to 1.4 Amps rms of operating current for the 1A relay. Set the phase angle to 0°.
12. The amber IOC Pickup LED and the red IOC Trip LED should light when the operating current is applied.
13. Remove the operating current and check that the amber IOC LED is no longer lit. However, the red IOC LED should still be lit.
14. Activate the reset switch and check that the red IOC LED is no longer lit when the reset switch is released.

IPT Test

1. Connect the relay as shown in Figure 21.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD V&I POL.**
3. Set the IOC pickup to **10.0** for the 5A relay, and to **5.0** for the 1A relay.
4. Set the IPT pickup to **4.0** for the 5A relay, and to **0.8** for the 1A relay.
5. Set CURVE SELECTION to **DEF TIME.**
6. Set the TOC pickup to **10.0** for the 5A relay, and to **2.0** for the 1A relay.
7. Set the DEFINITE TIME DELAY to **0.5.**
8. Set the KD switch to **0.**
9. Apply rated DC power and wait for initialization to complete.

10. Connect the phase lead of the polarizing current, Ipol, to terminal 8 and the neutral lead to terminal 9. Apply 1.5 Amps of polarizing current for the 5A relay, and 0.3 Amps of polarizing current for the 1A relay. Set the phase angle to 0°.

11. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Apply 3.8 to 4.2 Amps rms of operating current for the 5A relay, and 0.76 to 0.84 Amps rms of operating current for the 1A relay. Set the phase angle to 0°.

12. The amber IPT Pickup LED and the red IPT Trip LED should light when the operating current is applied.

13. Remove the operating current and check that the amber IPT LED is no longer lit. However, the red IPT LED should still be lit.

14. Activate the reset switch and check that the red IPT LED is no longer lit when the reset switch is released.

ZD Directional Test

CURRENT POLARIZED

1. Connect the relay as shown in Figure 22.

2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD IPOL**.

3. Set the IOC pickup to **10.0** for the 5A relay, and to **5.0** for the 1A relay.

4. Set the IPT pickup to **1.0** for the 5A relay, and to **0.2** for the 1A relay.

5. Set CURVE SELECTION to **DEF TIME**.

6. Set the TOC pickup to **10.0** for the 5A relay, and to **2.0** for the 1A relay.

7. Set the DEFINITE TIME DELAY to **0.5**.

8. Set the KD switch to **0**.

9. Apply rated DC power and wait for initialization to complete.

10. Connect the phase lead of the polarizing current, Ipol, to terminal 8 and the neutral lead to terminal 9. Apply 1.5 Amps of polarizing current for the 5A relay, and 0.3 Amps of polarizing current for the 1A relay. Use Ipol as the reference source; maintain its angle at 0°.

11. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Apply 1.5 Amps of operating current for the 5A relay, and 0.3 Amps rms of operating current for the 1A relay. Vary the phase angle of the operating current, as indicated below. The status of the amber IPT LED should agree with that shown below.

I0op PHASE ANGLE	IPT LED STATUS
+90°	OFF
+45°	ON
0°	ON
−45°	ON
−90°	OFF

VOLTAGE POLARIZED

1. Connect the relay as shown in Figure 22.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD VPOL.**
3. Set the IOC pickup to **10.0** for the 5A relay, and to **5.0** for the 1A relay.
4. Set the IPT pickup to **1.0** for the 5A relay, and to **0.2** for the 1A relay.
5. Set CURVE SELECTION to **DEF TIME.**
6. Set the TOC pickup to **10.0** for the 5A relay, and to **2.0** for the 1A relay.
7. Set the DEFINITE TIME DELAY to **0.5.**
8. Set the KD switch to **0.**
9. Set the ZERO SEQUENCE REPLICA IMPEDANCE ANGLE to **60°.**
10. Apply rated DC power and wait for initialization to complete.
11. Connect the phase lead of the polarizing voltage, Vpol, to terminal 19 and the neutral lead to terminal 16. Apply 9 Volts of polarizing voltage for both the 5A and 1A relay. Use Vpol as the reference source; maintain its angle at 0°.
12. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Apply 1.5 Amps of operating current for the 5A relay, and 0.3 Amps rms of operating current for the 1A relay. Vary the phase angle of the operating current, as indicated below. The status of the amber IPT LED should agree with that shown below.

I0op PHASE ANGLE	IPT LED STATUS
+30°	OFF
+8°	ON
−55°	ON
−120°	ON
−155°	OFF

ND Directional Test

VOLTAGE POLARIZED

1. Connect the relay as shown in Figure 22.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ND VPOL.**
3. Set the IOC pickup to **10.0** for the 5A relay, and to **5.0** for the 1A relay.
4. Set the IPT pickup to **1.0** for the 5A relay, and to **0.2** for the 1A relay.
5. Set CURVE SELECTION to **DEF TIME.**
6. Set the TOC pickup to **10.0** for the 5A relay, and to **2.0** for the 1A relay.
7. Set the DEFINITE TIME DELAY to **0.5.**
8. Set the KD switch to **0.**

9. Set the NEGATIVE SEQUENCE REPLICA IMPEDANCE ANGLE to 75°.

10. Apply rated DC power and wait for initialization to complete.

11. Connect the phase lead of the polarizing voltage, Vpol, to terminal 19 and the neutral lead to terminal 16. Apply 9 Volts of polarizing voltage for both the 5A and 1A relay. Use Vpol as the reference source; maintain its angle at 0°.

12. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Apply 1.5 Amps of operating current for the 5A relay, and 0.3 Amps rms of operating current for the 1A relay. Vary the phase angle of the operating current, as indicated below. The status of the amber IPT LED should agree with that shown below.

I0op PHASE ANGLE	IPT LED STATUS
+10°	OFF
−65°	ON
−120°	ON
−1600°	OFF

PERIODIC TESTS

CAUTION

Power Down the relay by removing the test plugs before removing or inserting modules. Failure to do so can permanently damage the relay.

A drawout-case relay may be tested without removing it from the panel, by using a 12XLA13A test plug. This plug makes connection to the relay only, and does not disturb any shorting bars in the case. The 12XLA12A test plug may also be used. Although this plug allows greater flexibility, it requires shorting jumpers, since connections are made to both the relay and the external circuits.

GENERAL

This section is a guide for testing the relay. The MLCG is a digital relay controlled by "self-checking" software. If a system failure is detected, it will be reported through the Red ALARM LED.

TEST EQUIPMENT

1. Dual-phase source of current at the rated frequency and with less than 5% harmonic distortion.
2. Single-phase source of voltage at the rated frequency and with less than 5% harmonic distortion.
3. AC ammeter and AC voltmeter.
4. Continuity tester or Ohm meter.
5. Precision timer for testing timed events.
6. Two phase-angle meters.
7. DC power supply rated 48-250VDC, with less than 5% ripple.
8. Limiting resistor for target indicator test.

DRAWINGS

The following drawings should be used for reference during testing. The directional unit response time, as shown in Figure 6, must be taken into consideration when utilizing the time-overcurrent function selectable time curves, as well as when using the instantaneous-overcurrent functions.

1. The Functional Block Diagram	Figure 7
2. The Internal Connections Diagram	Figure 8
3. The TOC Curves	Figure 1-3
4. The BS142 Curve	Figure 4
5. The Directional Unit Characteristic Curve	Figure 6
6. The External Connection Diagram	Figure 9

EQUIPMENT GROUNDING

All equipment used in testing the MLCG relay should be connected to a common grounding point to provide noise immunity. This includes the current source, as well as the MLCG itself.

The ground connection on the MLCG is terminal #21, the case-grounding stud, located on the rear of the case. Refer to Figure 13.

GENERAL RELAY TESTS

TOC Time-Dial Test

1. Connect the relay as shown in Figure 20.
2. Set DIRECTIONAL CONTROL / POLARIZATION to ZD I POL.
3. Set CURVE SELECTION, TOC PICKUP and TIME DIAL.
4. Connect the timer so that it starts when the operating current, Iop, is applied and it stops on the closure of the TOC output relay contacts, terminals 1 & 11.
5. Apply rated DC power and wait for initialization to complete.
6. Apply polarizing current, Ipol. Connect the phase lead to terminal 8 and the neutral lead to terminal 9. Set the phase angle to 0°.
7. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Set the phase angle to 0°.
8. Apply sufficient operating current, 5% above the TOC pickup, so that the TOC function operates. It should operate as per the settings selected in step #3.

TOC Definite-Time Test

1. Connect the relay as shown in Figure 20.
2. Set DIRECTIONAL CONTROL / POLARIZATION to ZD I POL.
3. Set CURVE SELECTION to Definite Time, TOC PICKUP and DEFINITE TIME DELAY.
4. Connect the timer so that it starts when the operating current, Iop, is applied and it stops on the closure of the TOC output relay contacts, terminals 1 & 11.
5. Apply rated DC power and wait for initialization to complete.

6. Apply polarizing current, Ipol. Connected the phase lead to terminal 8 and the neutral lead to terminal 9. Set the phase angle to 0°.
7. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Set the phase angle to 0°.
8. Apply sufficient operating current, 5% above the TOC pickup, so that the TOC function operates. It should operate as per the settings selected in step #3.

IOC Test, KD = 0

1. Connect the relay as shown in Figure 21.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD I POL.**
3. Set the IOC PICKUP.
4. Set the KD switch to **0.**
5. Apply rated DC power and wait for initialization to complete.
6. Apply polarizing current, Ipol. Connected the phase lead to terminal 8 and the neutral lead to terminal 9. Set the phase angle to 0°.
7. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Set the phase angle to 0°.
8. Apply sufficient operating current, 5% above the IOC pickup, so that the IOC function operates.

IOC Test, KD = 1

1. Connect the relay as shown in Figure 21.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD V&I POL.**
3. Set the IOC PICKUP.
4. Set the KD switch to **1.**
5. Apply rated DC power and wait for initialization to complete.
6. Apply polarizing current, Ipol. Connect the phase lead to terminal 8 and the neutral lead to terminal 9. Set the phase angle to 0°.
7. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Set the phase angle to 0°.
8. Apply sufficient operating current, 1.6 times the IOC pickup setting, so that the IOC function operates.

IPT Test

1. Connect the relay as shown in Figure 21.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD V&I POL.**
3. Set the IPT PICKUP.

4. Apply rated DC power and wait for initialization to complete.
5. Apply polarizing current, Ipol. Connect the phase lead to terminal 8 and the neutral lead to terminal 9. Set the phase angle to 0°.
6. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3. Set the phase angle to 0°.
7. Apply sufficient operating current, 5% above the IPT pickup, so that the IPT function operates.

ZD Directional Test

CURRENT POLARIZED

1. Connect the relay as shown in Figure 22.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD I POL.**
3. Set the IOC, IPT or TOC PICKUP.
4. Set CURVE SELECTION to **DEF TIME.**
5. Set the DEFINITE TIME DELAY.
6. Set the KD switch to **0.**
7. Apply rated DC power and wait for initialization to complete.
8. Apply polarizing current, Ipol. Connect the phase lead to terminal 8 and the neutral lead to terminal 9. Use Ipol as the reference source; maintain its angle at 0°.
9. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3.
10. Apply sufficient operating current, 15% above the function setting selected in step #3. Vary the phase angle of the operating current, ± 10° with respect to the polarizing current; check that the selected function operates.

VOLTAGE POLARIZED

1. Connect the relay as shown in Figure 22.
2. Set DIRECTIONAL CONTROL / POLARIZATION to **ZD V POL.**
3. Set the IOC, IPT or TOC PICKUP.
4. Set CURVE SELECTION to **DEF TIME.**
5. Set the DEFINITE TIME DELAY.
6. Set the KD switch to **0.**
7. Set the ZERO SEQUENCE REPLICA IMPEDANCE ANGLE.
8. Apply rated DC power and wait for initialization to complete.

9. Apply sufficient polarizing voltage, minimum 6 Vrms, for Vpol. Connect the phase lead to terminal 19 and the neutral lead to terminal 16. Use Vpol as the reference source; maintain its angle at 0°.

10. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3.

11. Apply sufficient operating current, 15% above the function setting selected in step #3. Vary the phase angle of the operating current, between −55° and −60° with respect to the polarizing voltage; check that the selected function operates.

    NOTE: The angles referenced above represent the worst case situation for minimum operating quantities and the selected Replica Impedance Angle.

ND Directional Test

VOLTAGE POLARIZED

1. Connect the relay as shown in Figure 22.

2. Set DIRECTIONAL CONTROL / POLARIZATION to **ND V POL.**

3. Set the IOC, IPT or TOC PICKUP.

4. Set CURVE SELECTION to **DEF TIME.**

5. Set the DEFINITE TIME DELAY.

6. Set the KD switch to **0.**

7. Set the NEGATIVE SEQUENCE REPLICA IMPEDANCE ANKLE.

8. Apply rated DC power and wait for initialization to complete.

9. Apply sufficient polarizing voltage, minimum 6 Vrms, for Vpol. Connect the phase lead to terminal 19 and the neutral lead to terminal 16. Use Vpol as the reference source; maintain its angle at 0°.

10. Connect the phase lead of the operating current, Iop, to terminal 2 and the neutral lead to terminal 3.

11. Apply sufficient operating current, 15% above the function setting selected in step #3. Vary the phase angle of the operating current, between −60° and −75°, with respect to the polarizing voltage; check that the selected function operates.

    NOTE: The angles referenced above represent the worst case situation for minimum operating quantities and the selected Replica Impedance Angle.

SERVICING

CAUTION

Power Down the relay by removing the test plugs before removing or inserting modules. Failure to do so can permanently damage the relay.

SPARES

There are two basic approaches that may be followed in servicing the MLCG relay. One approach is field service, where an attempt is made to replace defective components at the relay location. Generally, this will take the most time and require the highest degree of skill and understanding. It can also be expected to result in the longest system-outage time.

The preferred approach is board replacement, where a determination is made as to which printed-circuit board has failed, and that board is replaced with a spare board. The system can then be quickly returned to service. Considerable time is saved and there is much less pressure to make a decision about what to do with the defective part. This approach typically yields the shortest down time. It is recommended that a complete set of spare printed-circuit boards be kept at the main maintenance center.

For those who wish to repair at the component level, drawings are available from the factory. When requesting drawings, the following information must be supplied to the factory.

The assembly number of the p/c board. This is found on the component side of the printed-circuit board. It is an eight-digit number with a letter inserted between the fourth and fifth digit and suffixed with a group identification, e.g. 0215B8042G001 or G1.

Revision number of the p/c board. This is also found on the component side of the printed-circuit board, e.g. REV. 1.

The acceptance tests should be performed after a printed-circuit board has been repaired or replaced.

Whenever the nameplate is removed from the relay, care must be taken when restoring it to its place so that it does not interfere with the mechanical operation of any switches that protrude through the nameplate.

RENEWAL PARTS

It is recommended that sufficient quantities of renewal parts be carried in stock to enable the prompt replacement of any that are broken or damaged.

When ordering renewal parts, address the nearest Sales Office of the General Electric Company. Specify the quantity required, the name of the part wanted, the part number if known, and the complete model number of the relay for which the part is required. The table below lists the part numbers for the most common replacement parts.

It is recommended that renewal parts only be obtained from the General Electric Company. Should a printed-circuit card become inoperative, it is recommended that the card be replaced with a spare.

TABLE 2 RENEWAL PARTS

MODEL NUMBER	FUNCTION	PART NUMBER
MLCG201A01A	BACKPLANE BOARD	0215B8042G001
MLCG201A02A		"
MLCG201A03A		"
MLCG201A04A		0215B8042G002
MLCG201A05A		"
MLCG201A06A		"
MLCG201A07A		"
MLCG201A08A		"
MLCG201A09A		"
MLCG201A10A through MLCG201A12A		0215B8042G001
MLCG201A01A	CURRENT ANALOG BOARD	0215B8043G001
MLCG201A02A		"
MLCG201A03A		"
MLCG201A04A		0215B8043G002
MLCG201A05A		"
MLCG201A06A		"
MLCG201A07A		"
MLCG201A08A		"
MLCG201A09A		"
MLCG201A10A through MLCG201A12A		0215B8043G001
MLCG201A01A	TOC INTERFACE BOARD	0215B8044G001
MLCG201A02A		"
MLCG201A03A		"
MLCG201A04A		0215B8044G002
MLCG201A05A		"
MLCG201A06A		"
MLCG201A07A		0215B8044G003
MLCG201A08A		"
MLCG201A09A		"
MLCG201A10A through MLCG201A12A		0215B8044G004
MLCG201A01A	IOC INTERFACE BOARD	0215B8045G001
MLCG201A02A		"
MLCG201A03A		"
MLCG201A04A		"
MLCG201A05A		"
MLCG201A06A		"
MLCG201A07A		"
MLCG201A08A		"
MLCG201A09A		"
MLCG201A10A through MLCG201A12A		"
MLCG201A01A	VOLTAGE ANALOG BOARD	0215B8046G001
MLCG201A02A		"
MLCG201A03A		"
MLCG201A04A		0215B8046G002
MLCG201A05A		"
MLCG201A06A		"
MLCG201A07A		"
MLCG201A08A		"
MLCG201A09A		"
MLCG201A10A through MLCG201A12A		0215B8046G001

MLCG201A01A	CPU BOARD	0215B8027G021
MLCG201A02A		"
MLCG201A03A		"
MLCG201A04A		"
MLCG201A05A		"
MLCG201A06A		"
MLCG201A07A		"
MLCG201A08A		"
MLCG201A09A		"
MLCG201A10A through MLCG201A12A		"
MLCG201A01A	POWER SUPPLY	0215B5520G001
MLCG201A04A		"
MLCG201A07A		"
MLCG201A10A		"
MLCG201A02A		0215B5520G002
MLCG201A05A		"
MLCG201A08A		"
MLCG201A11A		"
MLCG201A03A		0215B5520G003
MLCG201A06A		"
MLCG201A09A		"
MLCG201A121A		"
MLCG201AXXA	EXTENDER BOARD	0215B8031G001
	CARD PULLER	207A5404P001
	UPPER CRADLE BLOCK	0184B8624G018
	LOWER CRADLE BLOCK	0184B8624G017
	UPPER CASE BLOCK	006418058G045
	LOWER CASE BLOCK	006418058G650
	FRONT COVER	P-6229807G061

SPECIFICATIONS

RATINGS

Rated Frequency	50 or 60 Hz
DC Control Voltage	48 VDC, Operating range 38.5-60 VDC 110/125 VDC, Operating range 88-150 VDC 220/250 VDC, Operating range 176-300 VDC
Input Circuit Current Ratings	
Nominal	In = (1 AMP & 5 AMPS)
Maximum Continuous Rating	5 AMPS for In = 1 AMP 10 AMPS for In = 5 AMPS
One Second Rating	100xIn
Input Circuit Voltage Ratings	
Nominal	110/120 VRMS PHASE-TO-PHASE 64/69 VRMS PHASE-TO-NEUTRAL
Environment	
Operating	−20° C to +65° C
Storage	−40° C to +85° C

Humidity	95% without condensation
Surge	ANSI C37.90 (SWC and Fast Transient)

BURDENS

	Ohms	VA @ 5A
Current Circuits		
ϕA, ϕB & ϕC	0.013 ohms, 3.3° @ 60Hz	0.33
ϕA, ϕB & ϕC	0.012 ohms, 2.5° @ 50Hz	0.30
Ipol	0.013 ohms, 3.3° @ 60Hz	0.33
	0.012 ohms, 2.5° @ 50Hz	0.30
	Ohms	**VA @ 1A**
ϕA, ϕB & ϕC	0.039 ohms, 26.5° @ 50Hz	0.039
Ipol	0.039 ohms, 26.5° @ 50Hz	0.039

	VA @ 69 VRMS
Voltage Circuits	
ϕA, ϕB & ϕC	0.13 @ 60Hz
ϕA, ϕB & ϕC	0.16 @ 50Hz

DC Battery (power supply)	20 Watts

CONTACT DATA

Trip Outputs		
Continuous Rating		3Amps
Make and carry for tripping duty		30Amps (per ANSI C37.90)
Interrupting:	Resistive	180 VA
	Inductive	60 VA (L/R = 40 msec. at 125/250 VDC)
Trip Monitor Sense Current		150 milliamperes

TIME-OVERCURRENT CURVES

INVERSE
VERY INVERSE
EXTREMELY INVERSE
BS142
DEFINITE

OVERCURRENT SETTINGS

	RANGE IN AMPS		RESOLUTION	
	1AMP	5AMPS	1AMP	5AMPS
TOC	0.1- 3.2	0.5-16.0	0.01	0.1
IOC	0.4-16.0	2.0-80.0	0.1	0.1
IPT	0.1- 1.9	0.5- 9.9	0.1	0.1

TOC TIME-DIAL SETTINGS

RANGE	RESOLUTION
0.5 - 10	0.1

DEFINITE-TIME SETTINGS

RANGE	RESOLUTION
0.5 - 30 (Sec)	0.1

REPLICA IMPEDANCE ANGLE

Negative Sequence	65° -75° -85°
Zero Sequence	45° -60° -75°

DIRECTIONAL CONTROL / POLARIZATION

Negative Sequence	Voltage polarized
Zero Sequence	Voltage polarized Current polarized Voltage & Current polarized

ACCURACY

Current:	5 Amp Relay	5% or 0.05 Amp, whichever is greater
	1 Amp Relay	5% or 0.01 Amp, whichever is greater
TOC Time:		7%
Repeatability:		3%, @ 25° C
Angles:		5°

CASE

GE L2

DIMENSIONS

HEIGHT:	20.312 inches	(516 millimeters)
WIDTH :	6.625 inches	(168 millimeters)
DEPTH :	8.06 inches	(205 millimeters, including front cover and terminals at back)

WEIGHT

RELAY:	27 pounds	(12.2 kilograms)
	Shipping weight 30 pounds	(13.6 kilograms)

SOFTWARE

OVERVIEW

A personal computer (PC) will provide a remote man-machine interface to the relay for operating personnel.

SYSTEM REQUIREMENTS

Hardware

The minimum PC hardware requirements consists of the following components. An IBM-AT or compatible (Compaq, Zenith, Tandy, etc...) with one parallel port, one serial port, a minimum of 400K bytes of free memory (RAM) to run the program in, 40MB hard drive, low density 3 1/2

inch floppy drive, EGA monitor, and one of the printers described below for plotting oscillography data.

Software

Requires MSDOS (PCDOS) 3.1 or above for the PC operating system.

INSTALLATION

View the file README.TXT for updated information and installation instructions for this program. This file is found on the 3.5" floppy disk located at the end of this section.

To run the program, change to the MLCG directory and type "MLCG-LNK.bat" at the DOS prompt.

GENERAL OPERATION

Mouse/Keyboard Usage

Either the mouse or the keyboard can be used to access all items in menus, dialog boxes and list boxes. For a description of how to use the mouse and keyboard in the various boxes and menus, refer to the following sections. For full manipulation of graphical data, the mouse is required.

The mouse is used to access items in menus and dialog boxes by moving the cursor to the item, followed by pressing and then releasing the left mouse button (clicking).

Main Horizontal Menu Bar

Items in the main horizontal menu are selected in one of three ways:

1. Position the mouse cursor on top of the menu item and click the left button.
2. Use a hot key. The hot key is the combination of the ALT key and the letter that is highlighted in the item description (blue).
3. Once either of the above methods has been used to select an item on the menu, indicated by one item being highlighted, the RIGHT and LEFT ARROW keys can be used to go to adjacent menu items. If the menu is not visible just below the highlighted item on the menu bar use the DOWN ARROW key to display the menu.

Pull-Down Menus

Pull-down menu items are selected in a number of ways:

Mouse

Position the mouse cursor on top of the menu item then press the left button once and release it (hereafter known as clicking on the mouse button) to display the pull-down menu. If the user wishes to select an item in the pull-down menu, position the mouse over the desired item and click on the left mouse button.

Both may be done at once by positioning the cursor over the menu item on the menu bar and holding the left mouse button down, moving the mouse cursor to the desired entry and then releasing the mouse button.

Keyboard

"Activating a hot key" is the combination of holding the ALT key and striking the highlighted key. Using a hot key will activate the associated menu or dialog box. If there is no hot key for a desired menu item, use the UP and DOWN ARROW keys to highlight the desired item, then press the ENTER key. Pressing the ENTER key will activate the associated menu or dialog box.

Dialog Boxes

Dialog boxes are generally characterized by a title bar, a grey box, and OK and CANCEL buttons. The dialog box cannot be moved, resized, or iconized. In addition, when a dialog box is displayed, the user can only access items in the dialog box, not any other items on the screen.

If an item in the dialog box has a title with a highlighted character (blue in the default color scheme), the user can access this item from the keyboard by using the ALT key with the highlighted character (the hot key). Items in a dialog box can also be accessed from the keyboard by using the cursor keys: UP/DOWN/LEFT/RIGHT ARROW keys, PAGE UP/DOWN keys and the TAB/SHIFT TAB keys. In any dialog box the TAB key will move sequentially in one direction, or the SHIFT TAB key in the opposite direction, selecting items in the dialog box with each keystroke. The other cursor keys will generally move within a selected item.

Buttons in the dialog box can be accessed from the keyboard by using the UP/DOWN ARROW keys, the TAB/SHIFT TAB keys, or if the button has a highlighted character, the hot key. If the buttons require the user to make a selection, the selection is made by using the ENTER key.

To exit from the dialog box and clear it from the screen, the user selects either the OK button or the CANCEL button. The mouse can be used to select these buttons by moving the mouse cursor over the button and clicking the left mouse button. In addition, the keyboard can be used to select these buttons by using their hot keys. The hot key for the OK button is ALT-O and the hot key for the CANCEL button is ALT-C.

The mouse can be used to select any item in a dialog box by moving the cursor with the mouse to the desired item and clicking on it with the left mouse button.

The OK button accepts the selection(s) made by the user and allows the program to use these selections. The CANCEL button does not accept the selections made by the user and thus the program uses the previous selections. Any highlighted button can be selected by striking the ENTER key.

List Boxes

A list box is another box within a dialog box that lists all choices for an item in the dialog box (for example, a list of file names). If the list of available entries is longer than the displayed list box, the list box has a vertical scroll bar, on the right side of the list box, that allows the user to scroll through the list.

To operate the scroll bar with the mouse, place the tip of the pointing arrow cursor in the gray hatched area, or on the arrows at the top and bottom of the scroll bar and click on the left mouse button. If the mouse arrow cursor is in the grey hatched area, then the contents of the list box will move a section at a time. If the mouse cursor is on one of the arrows at the top or bottom, the contents of the list box will move one line at a time. Holding down the mouse button will cause the movement to be repeated until the mouse button is released or the end of the list is reached.

Once the desired item can be seen, click on the item with the left mouse button to select it. Once an item has been selected it will be highlighted.

To operate the scrolling of the list box with the keyboard, use the PAGE UP/DOWN keys to move the contents of the list box a section at a time and the UP/DOWN ARROW keys to move the contents one line at a time. Holding down the keys will cause the movement in the list box to repeat until the key is released.

Once the desired item can be seen, use the UP/DOWN ARROW keys to select it. The selected item is the highlighted one.

The following table lists the valid keys and their functions for list boxes:

UP ARROW	Move up one selection.
DOWN ARROW	Move down one selection.
PAGE UP	Move up one page of selections.
PAGE DOWN	Move down one page of selections.
HOME	Move to the first selection.
END	Move to the last selection.
RETURN	Accept the current selection and exit the list box.
ALT-X	Exit the list box without making a selection.

Entering Text and Numbers

The following keys are used when entering and editing text and numbers.

LEFT ARROW	Move the cursor one character to the left.
RIGHT ARROW	Move the cursor one character to the right.
DELETE	Delete the character at the cursor.
BACKSPACE	Delete the character to the left of the cursor.
INSERT	Toggle between the insert and overwrite mode. -Overwrite mode is indicated by an underscore-character cursor. -Insert mode is indicated by a block-character cursor.
ENTER	Accept the text or number in the field/box
ESCAPE	Clear the text or number in the field/box.

The first keystroke other than the arrow keys will clear the field/box; this enables a new entry without having to clear the box first. If a minor change is desired and the user does not wish to clear the field/box, move the cursor first and then do the editing to the entry.

PROGRAM OPERATION

MAIN MENU

The main horizontal menu has the following items and hot keys.

Relay Functions	ALT-R
Setup	ALT-S
Help	ALT-H

Each item in the main horizontal menu has a pull-down menu associated with it.

RELAY FUNCTIONS

Relay functions has the following menu items and associated hot keys:

Login	ALT-L
lOgout	ALT-O
Hang up phone	ALT-H
request relay Data	ALT-D
request Status	ALT-S
request Versions	ALT-V

Login

Login is used to gain access to the relay. The **Login** dialog box contains a list of the currently configured MLCGs, a place to enter the password, a place to enter the unit ID, a button for adding a new MLCG to the configured MLCG list, an OK button and a CANCEL button.

The list of currently configured MLCGs contains the unit description, phone number, baud rate, and multiplexor switch code for each MLCG.

The NEW RELAY button in the dialog box allows the user to add a relay that has not been previously entered into the list of configured relays. The user enters the unit description, the phone number, the multiplexor switch code, and the phone number for the new relay. The new relay is added to the list of configured relays.

Once a relay is selected from the list of relays, the user is asked for a password and the unit ID. A password and Unit ID are not required to log in to this relay, and may be left blank.

lOgout

Logout disables access to the relay. A check is made to determine the status of protection at the MLCG (ON or OFF). The status is displayed in the dialog box. Selecting the OK button logs out of the relay. Selecting the CANCEL button, leaves the user logged in to the relay. If the status of protection is OFF due to a setting change that was not ended, pick the CANCEL button and choose **End settings change** under **Settings** in the **RELAY FUNCTIONS** menu.

Hang up phone

This selection will disconnect the phone line at the modem. If the user is logged in to the relay, The logout procedure will be completed before hanging up the phone. To pick this selection, use the hot key ALT-H or click on the menu item with the left mouse button.

request Data

This choice is used to request present values of the acquired data (RMS currents, protection status, input settings) and relay output information.

request Status

Relay status may be requested from this menu choice. This choice is used to view the results of the MLCG self tests.

request Version

This function requests the model number of the MLCG. The Firmware version number is also displayed.

SETUP

The **Setup** menu has the following items and hot keys.

Communication port number	ALT-C
Dial Type	ALT-D
Modem connection time	ALT-M
Relay parameters	ALT-R
Add relay to list	ALT-A
dElete relay from list	ALT-E
Memory available	no hot key

Communication port number

The communication port for the PC is chosen with this selection. To select this item, either click on it with the left mouse button or use the ALT-C hot key. Once this item is selected, a dialog box containing the port number and IRQ number will be displayed. The serial port that is connected to the MLCG, or the modem used to talk to the MLCG, must be entered before logging in to the relay. If the port chosen is not COM1(1) or COM2(2), the IRQ number for the port chosen must be entered. Use the TAB key to move between the port and IRQ fields and the buttons, or click on the desired field with the left mouse button.

Once a field has been selected, use the editing keys to change and/or enter data. When the port and IRQ numbers are correct, select the OK button to save the numbers. If the CANCEL button is selected, the **SETUP** menu will be redisplayed without any further action.

Dial type

To select this item, either click on it with the left mouse button or use the ALT-D hot key. Once this item is selected, a dialog box containing the dialing type will be displayed. Either tone or pulse dialing can be chosen. The UP and DOWN ARROW keys will toggle between the tone and pulse choices. The TAB key will move between the selected dialing type and the OK and CANCEL choices in the box. Once the dialing type has been chosen, selecting the OK button will store the change. Selecting the CANCEL button will exit Dial type without any further action.

Modem connection time

This item will change the time-out period for MLCG-LINK to wait for the modem to make a connection. To select this item, either click on it with the left mouse button or use the ALT-M hot key. The modem connection time can be set for any time up to 999 seconds, provided the modem being used will accommodate that long a time-out period. This setting is useful for applications where the modem is set to pickup after a large number of rings, or if the phone system has a lot of delay in making the initial connection. Once a connection time has been set, selecting the OK button with the left mouse button or the ALT-O hot key will store the new time-out period. Selecting the CANCEL button will exit this item without any further action.

Relay parameters

Relay parameters allows the communication parameters for a specific relay unit description to be changed or viewed. An entry in the list must be selected first, by clicking on it with the mouse or using the UP and DOWN ARROW keys to highlight the selection, and pressing the ENTER key.

Once a relay unit description has been picked, another window appears with the phone number, switch code, baud rate, number of stop bits and the parity for the selected relay unit description. Any of the entry values may be selected by clicking on it with the mouse or using the TAB key to move between the items, and then using the UP and DOWN ARROW keys to select the value for that item. To exit the dialog box for that unit description, select either the OK button or the CANCEL button. The OK button will accept the values in the dialog box and store them.

Selecting the CANCEL button will exit the dialog box and will use the values that were already present when the unit description was selected.

The user should note that once a unit description has been picked, there are no more hot keys available to select items. The TAB key may be used to move from item to item, or the mouse may be used to select a specific item at any time.

To enter or change the phone number, select it by clicking on it with the left mouse button or use the TAB key to move the cursor to the phone number box. The normal text-editing keys may be used to enter or modify the phone number. This is an optional item, and should only be filled in if MLCG-LINK is using a modem for the unit being described.

To enter or change the switch code, select it by clicking on it with the left mouse button or use the TAB key to move the cursor to the switch code box. The normal text-editing keys may be used to enter or modify the phone number. This is an optional item, and should only be filled in if a code-operated switch is being used.

The baud rate for this relay is fixed at 2400 baud only. The baud rate item can be selected by clicking on it with the left mouse button or using the TAB key until the selected item is highlighted. The UP and DOWN ARROW keys select the desired value. 2400 Baud can be selected by clicking on it directly with the left mouse button.

A choice of one stop bit must be made for communications to work properly. The stop bits item can be selected by clicking on it with the left mouse button or using the TAB key until the selected item is highlighted. The UP and DOWN ARROW keys select the desired value. A specific value can also be selected by clicking on it directly with the left mouse button.

Parity must be set to None for communications to work properly. The parity item can be selected by clicking on it with the left mouse button or using the TAB key until the selected item is highlighted. The UP and DOWN ARROW keys select the desired value. A specific value can also be selected by clicking on it directly with the left mouse button.

Add relay to list

Selecting this item will enable the user to add a unit description and the related values to the list of stored relay unit descriptions. The user can either move the mouse cursor to the entry in the menu and click on the left mouse button or use the hot key ALT-A to select this entry. Once the entry has been selected, the user is prompted for a unit description. The description is limited to 20 characters. After the description has been entered, the user can either click on the OK button with the left mouse button or use the ALT-O hot key to accept it. Selecting the CANCEL button will not add the new unit description and will exit the user from the menu entry.

After the new unit description has been accepted, a dialog box will appear with the phone number, switch code, baud rate, stop bits and parity items. Each item can be selected with the TAB or SHIFT TAB key and a value chosen with the UP and DOWN ARROW keys, or a value can be chosen by placing the mouse cursor over the desired value and clicking on the left mouse button.

dElete relay from list

This item allows the user to delete a relay unit description from the configuration file. To select this item, either click on it with the left mouse button or use the ALT-E hot key. Once this item has been selected, a dialog box will be displayed containing a list box with all the relay unit descriptions and the OK and CANCEL buttons.

The user selects the desired relay from a list box displaying the unit descriptions by using the UP and DOWN ARROW keys to highlight the desired relay and pressing the ENTER key, or moving the mouse cursor to the desired relay and clicking on it with the left mouse button. Selecting the OK button with the ALT-O hot key or clicking on it with the left mouse button will mark the unit

description for deletion. Selecting the CANCEL button will exit without deleting any relay unit descriptions. If the OK button is selected, the user is asked to confirm the deletion of the unit description. Selecting the OK button will delete the relay unit description. Selecting the CANCEL button will return to the list box without deleting any relay unit description. Selecting the CANCEL button in the dialog box will exit from the menu entry.

memory available

To display the amount of available memory while MLCG-LINK is running either click on this menu item with the left mouse button, or use the UP or DOWN ARROW keys to highlight the menu item, and hit the ENTER key. There is no hot key for this item.

Exiting MLCG-LINK

There are two ways to exit MLCG-LINK:

ALT-F4 will produce a dialog box with the exit message. Selecting the OK button with the mouse or using the ALT-O hot key will exit MLCG-LINK. Selecting the CANCEL button will return the program without exiting.

The ALT key combined with the space bar will produce the System Menu after all menus have been cleared from the screen. Choosing the CLOSE entry, with the mouse or the hot key ALT-C, will produce a dialog box with the exit message. Selecting the OK button with the mouse or using the ALT-O hot key will exit MLCG-LINK. Selecting the CANCEL button will return to the program without exiting.

NOTE: To exit MLCG-LINK, all dialog boxes and list boxes must be cleared from the screen. It is not necessary to clear all the menus from the screen.

HELP

This item displays a pull-down menu with a selection of topics for which help exists. This pull-down menu is different from the other pull-down menus in that the items do not have hot keys associated with them. The user must either click on the mouse or use the UP and DOWN ARROW keys followed by the ENTER key, to access the menu items.

COMMUNICATION WITH MULTIPLE MLCGs

MLCG-LINK software can be used to communicate with multiple MLCGs at a substation. Rather than requiring a dedicated line between a host PC and each MLCG, the PC can be connected to communicate with a multiplexer equipment (at the substation) to which the MLCGs are connected. GE does not provide the multiplexer at the present time, but it can be obtained from other vendors, for example Black Box Corporation's COS-8P or equivalent devices.

Code switches: These switches automatically select the channels requested by the host PC. The PC can communicate with one device at a time. At the PC the user must set up the configuration parameters once, with appropriate switch code for each of the MLCGs. It is beyond the scope of this instruction book to describe how to set up the various code switches. However, the following will be helpful.

1. Make sure the baud rate of the switch matches with that of the PC and each MLCG.

2. Serial data word format is: 8 data bits, 1 stop bit, and no parity.

3. Disable any auto device timeout on the code switch.

4. Make sure that the switch is set up for both text and binary data. Although D-link message formats are mostly ASCII, there are binary data for CRCs and oscillography.

5. Make sure the MLCG side of the switch is setup as DTE and the modem/PC side of the switch is setup as DCE.

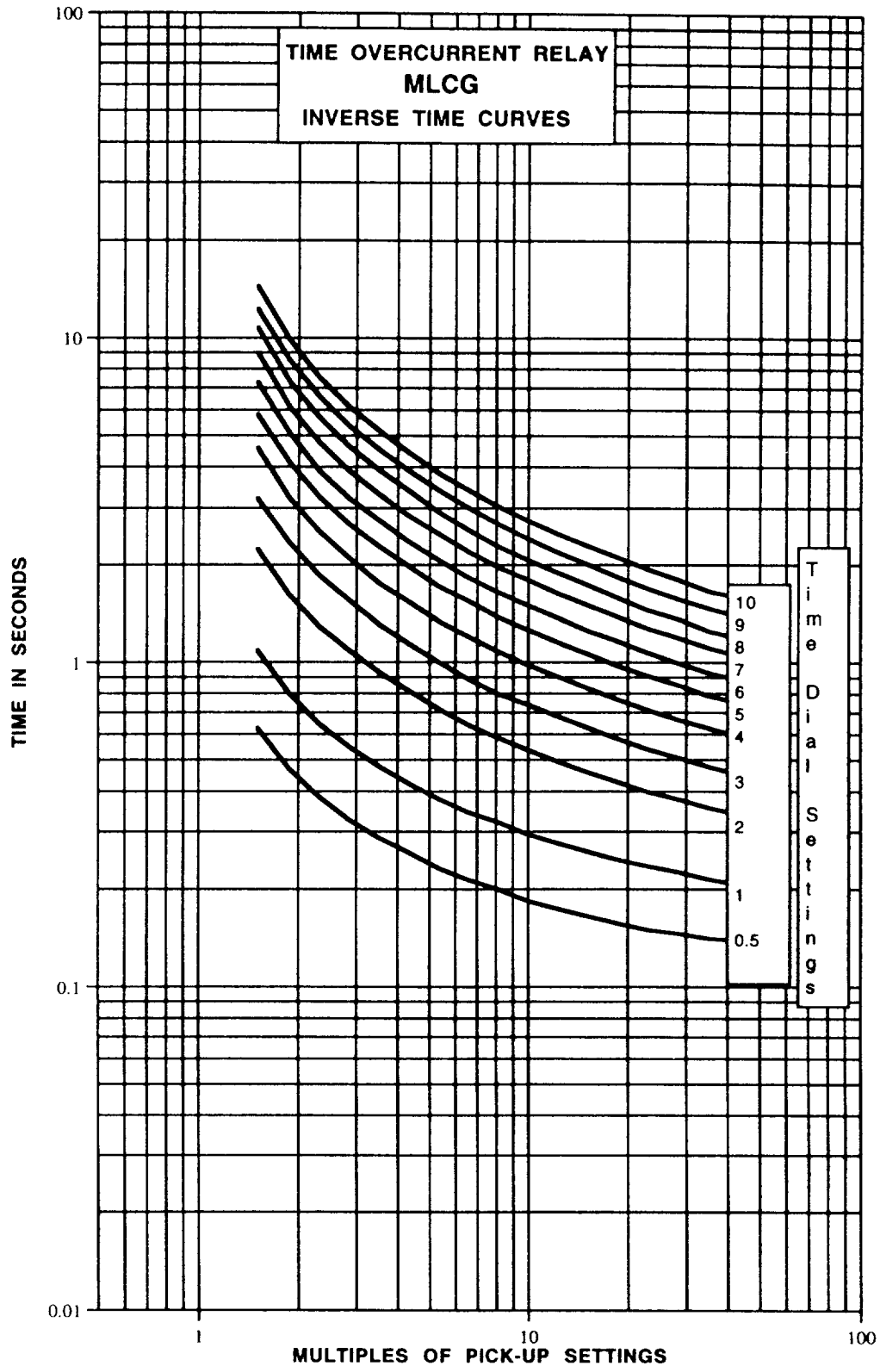


Figure 1 (GES-9873) TOC Inverse Time Characteristic Curve for the MLCG

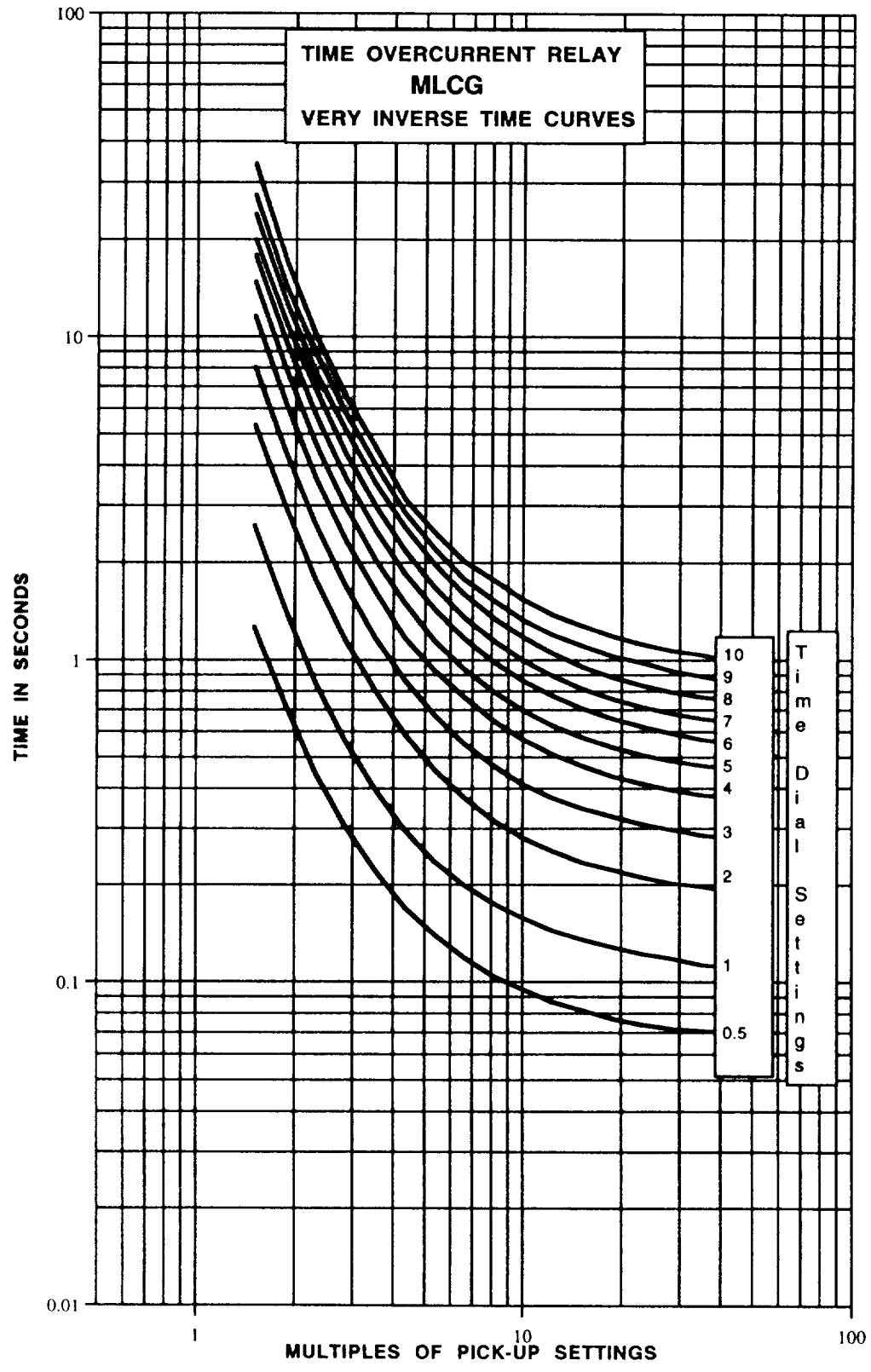


Figure 2 (GES-9874) TOC Very Inverse Time Characteristic Curve for the MLCG

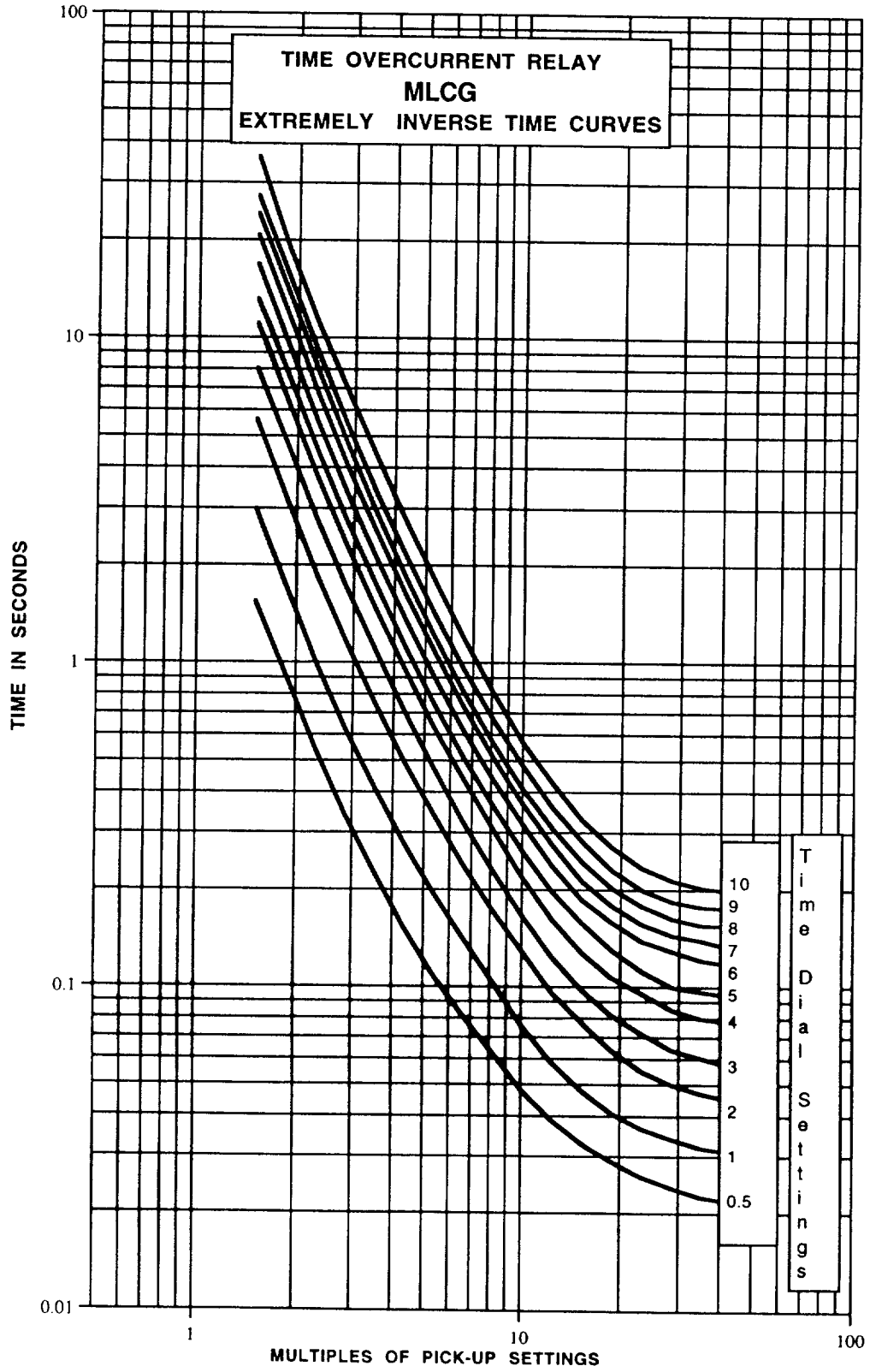


Figure 3 (GES-9875) TOC Extremely Inverse Time Characteristic Curve for the MLCG

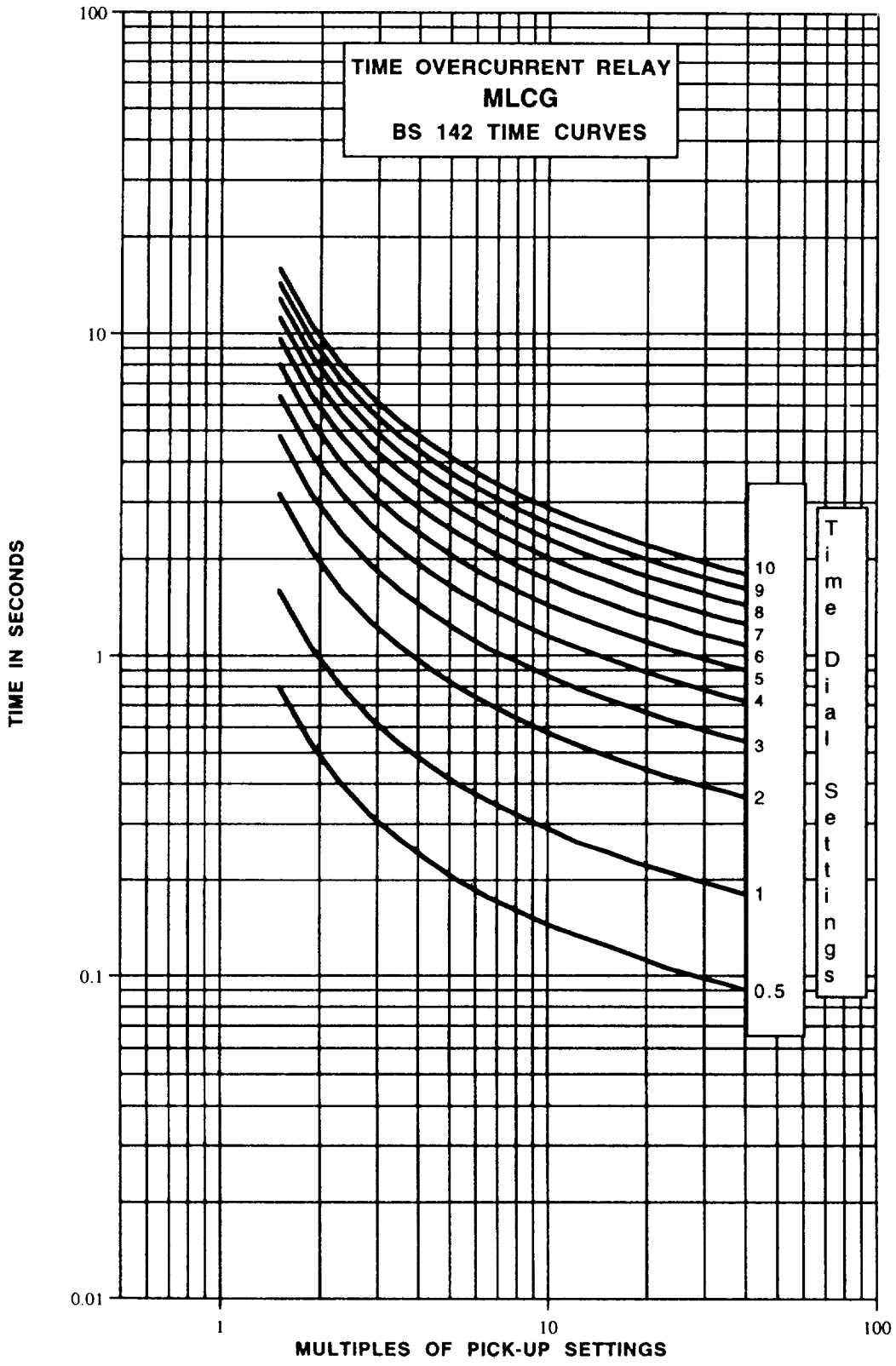


Figure 4 (GES-9876) BS142 Time Characteristic Curve for the MLCG

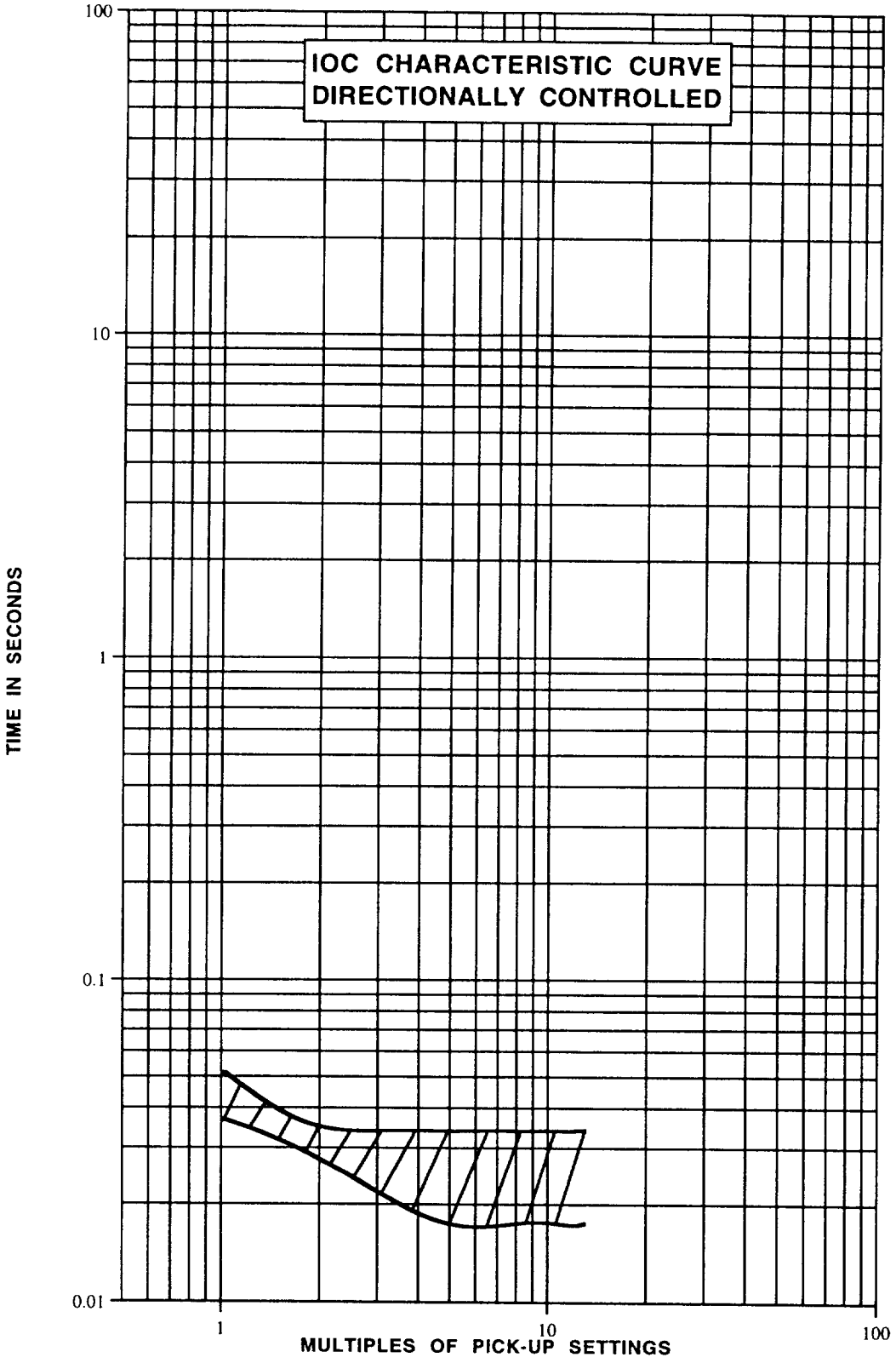
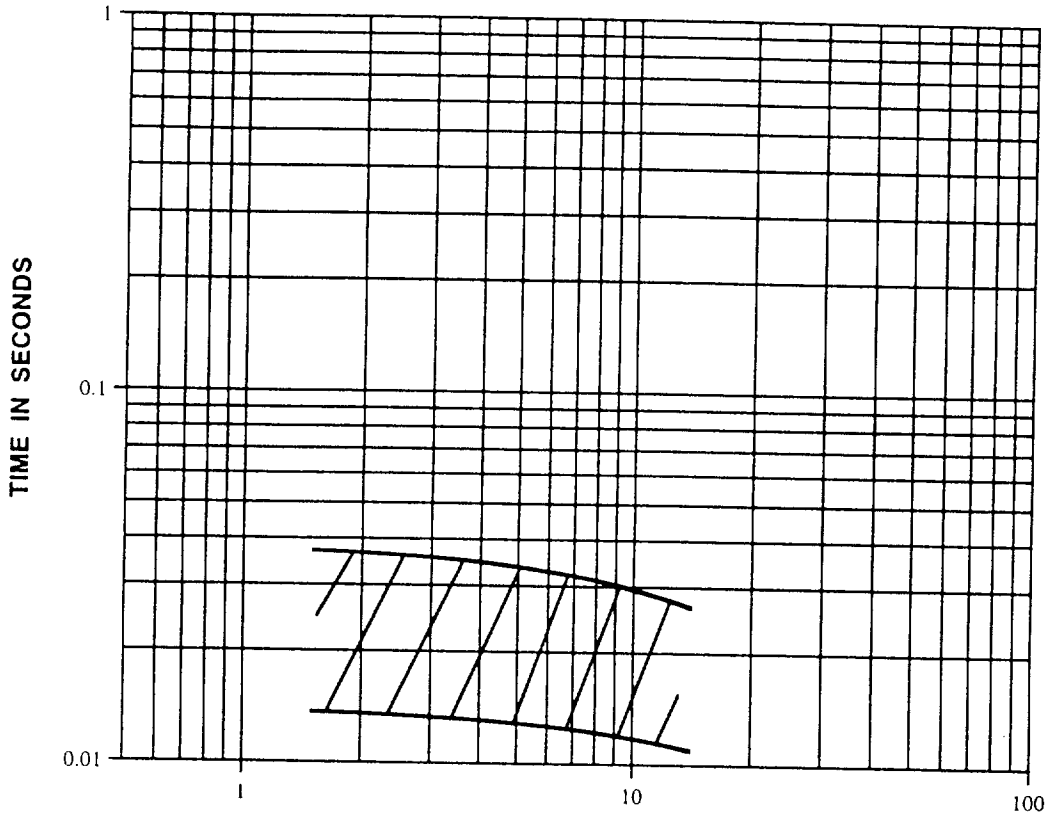


Figure 5 (GES-9877) IOC Characteristic Curve, Directionally Controlled, for the MLCG



MPU(IPOL) = (Iop x Ipol x cos∂)/(Iopmin x Ipolmin)

MPU(VPOL) = (Iop x Vpol x cos(ø-ß))/(Iopmin x Vpolmin)

∂(IPOL) = Angle by which Iop lags Ipol
Ø(VPOL) = Angle by which Iop lags Vpol
ß(VPOL) = Replica Impedance Angle Setting

	Iopmin	Ipolmin	Vpolmin
1AMP RELAY:	0.1 Amp	0.1 Amp	5.5 Volts
5AMPS RELAY:	0.5 Amp	0.5 Amp	5.5 Volts

Figure 6 (0286A5318) Directional Unit Characteristic

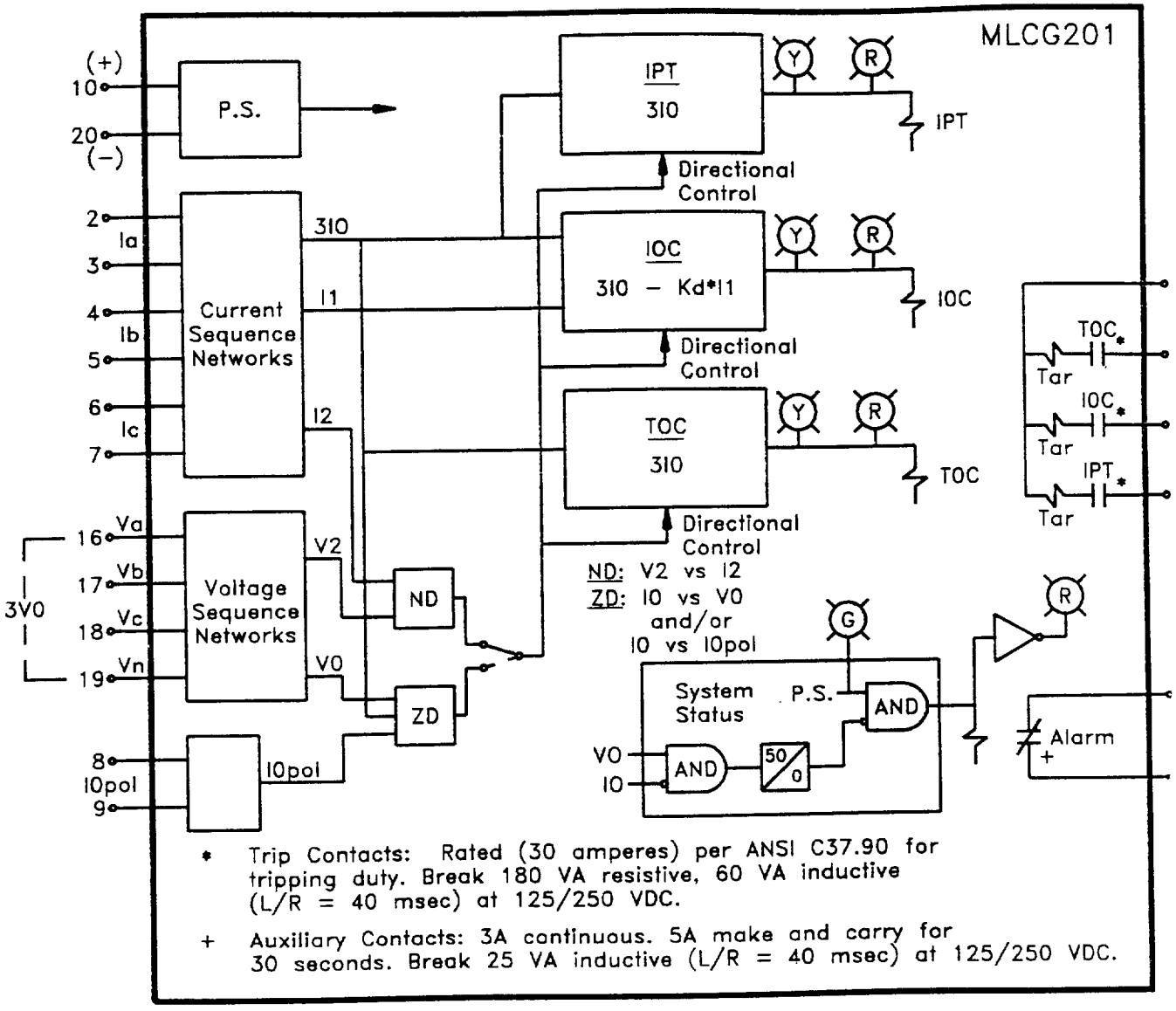


Figure 7 (0286A5303) Functional Block Diagram for MLCG

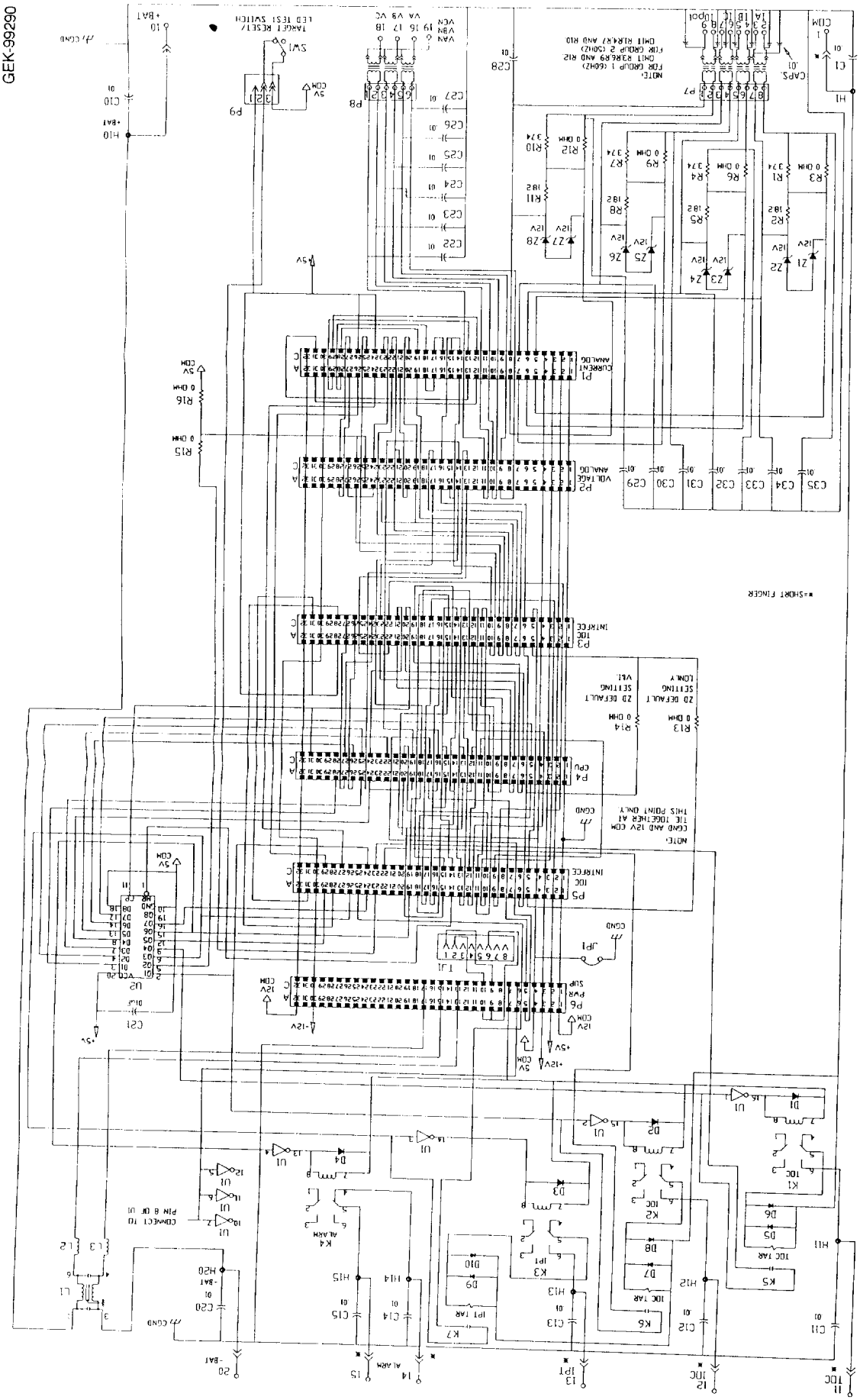


Figure 8 (0158D1773 [1]) Internal Connections for the MLCG

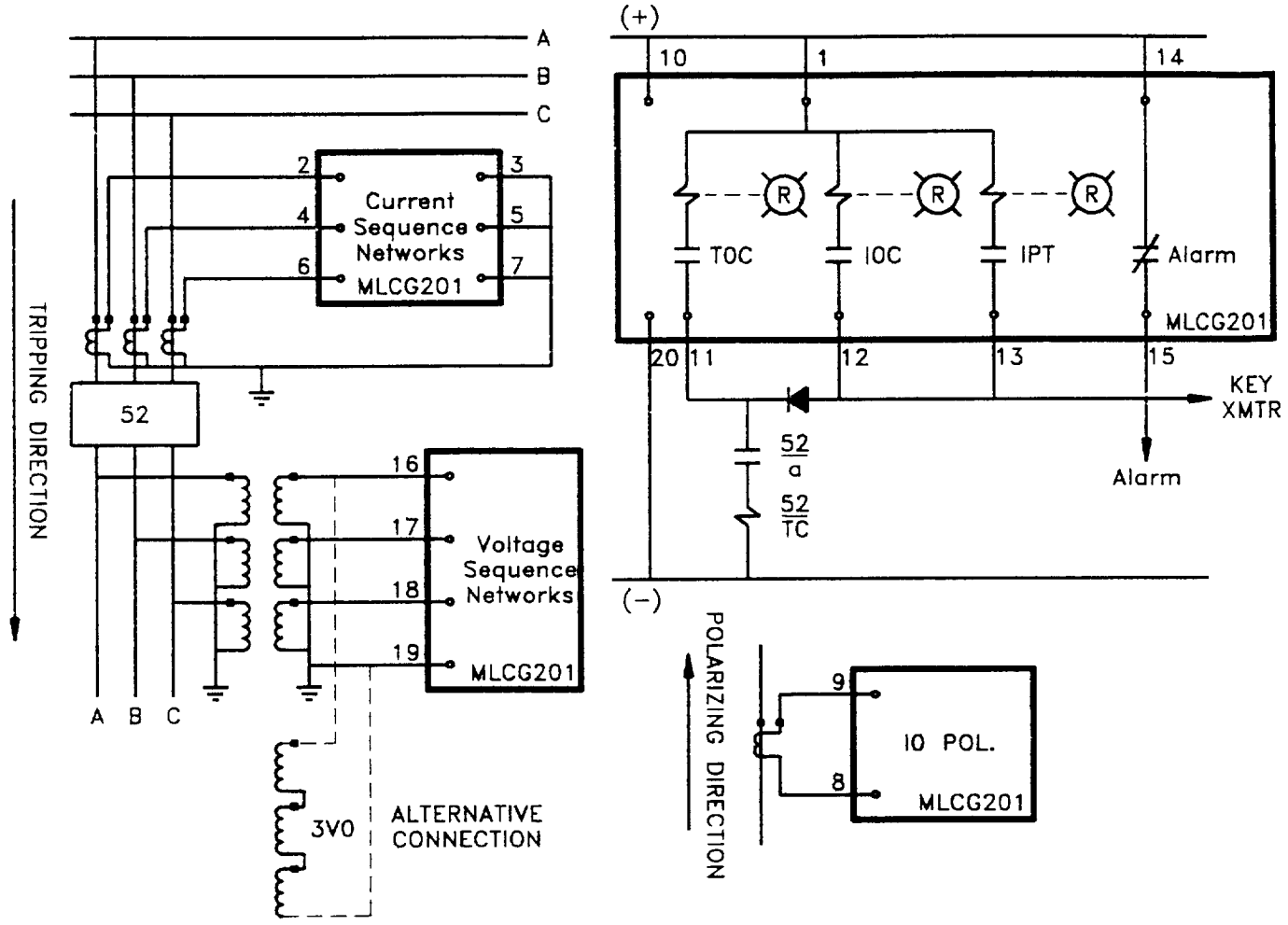


Figure 9 (0286A5304) Typical External Connections Diagram for MLCG

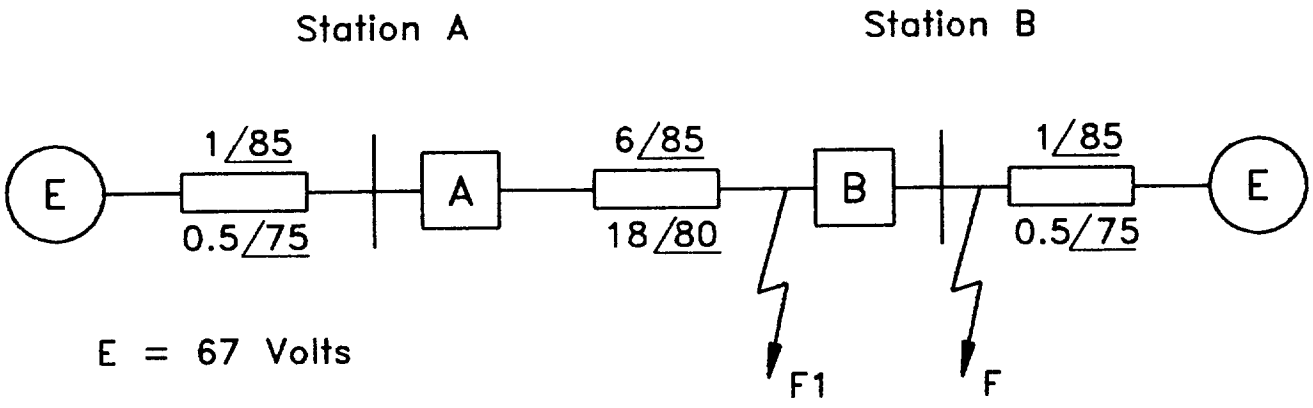


Figure 10 (0286A5305) Simple Power System

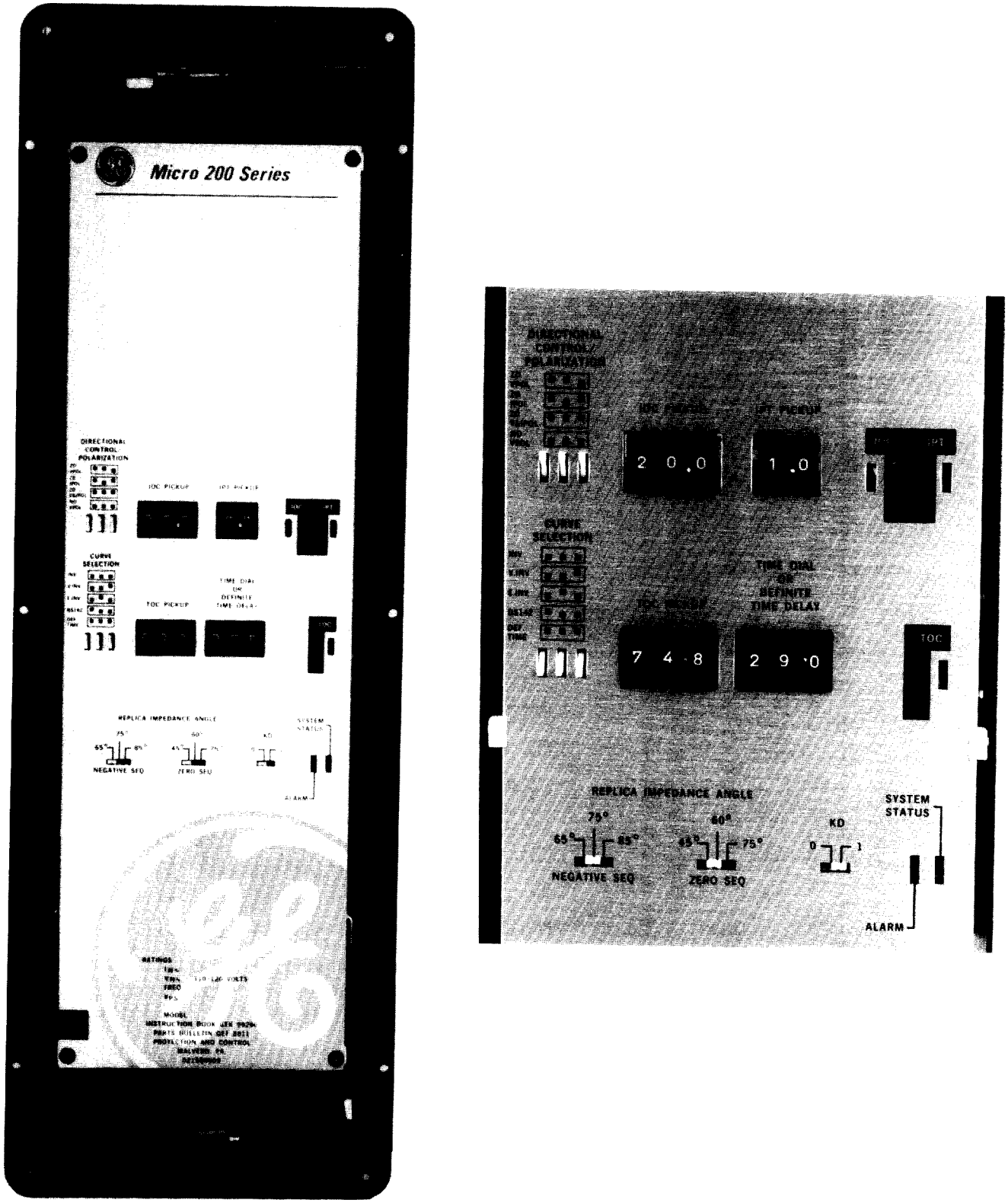


Figure 11 (8919486) MLCG with Front Cover Removed and (8919500) Detail

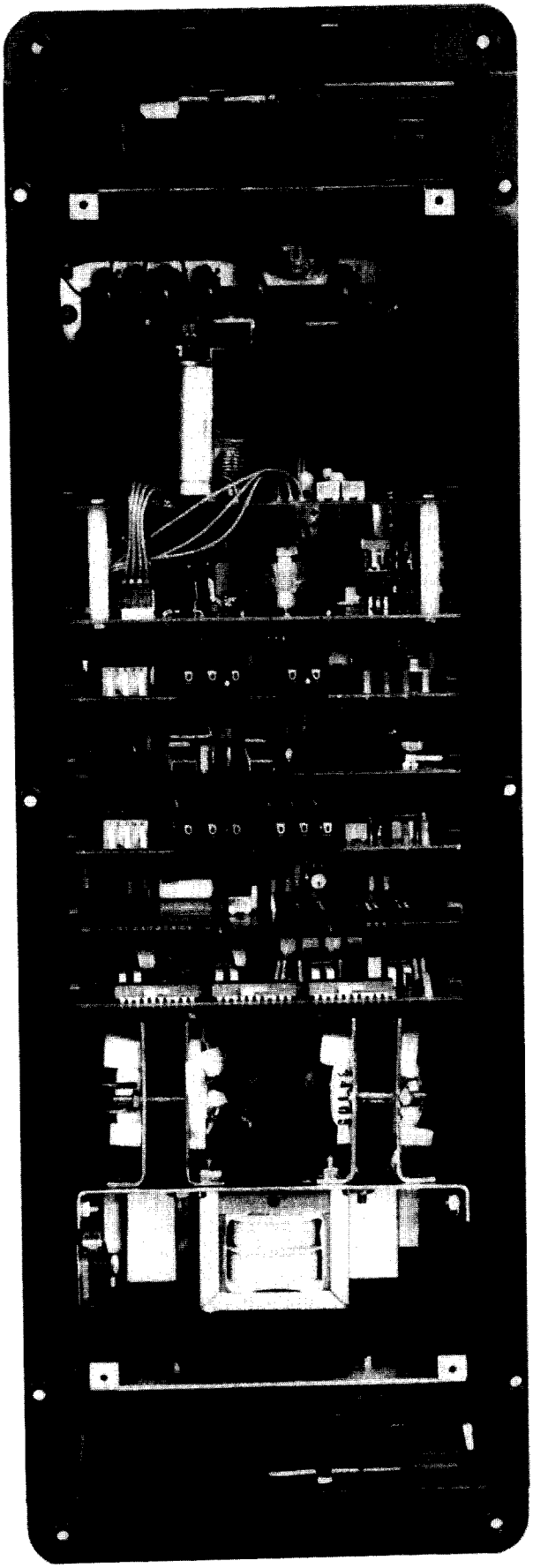


Figure 12 (8919481) MLCG Front View Without Nameplate

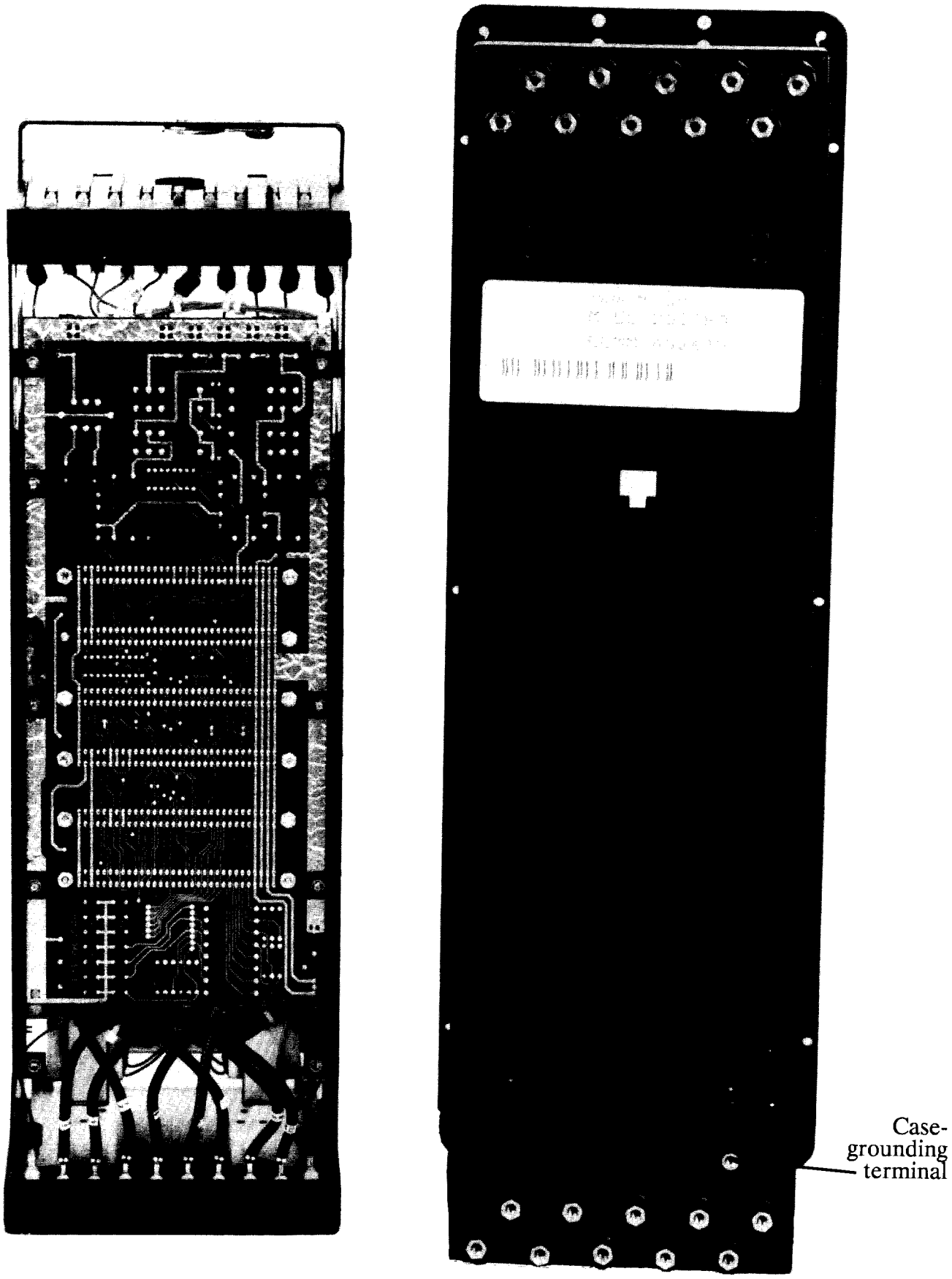


Figure 13 (8919480) Rear View of Relay Case and Cradle

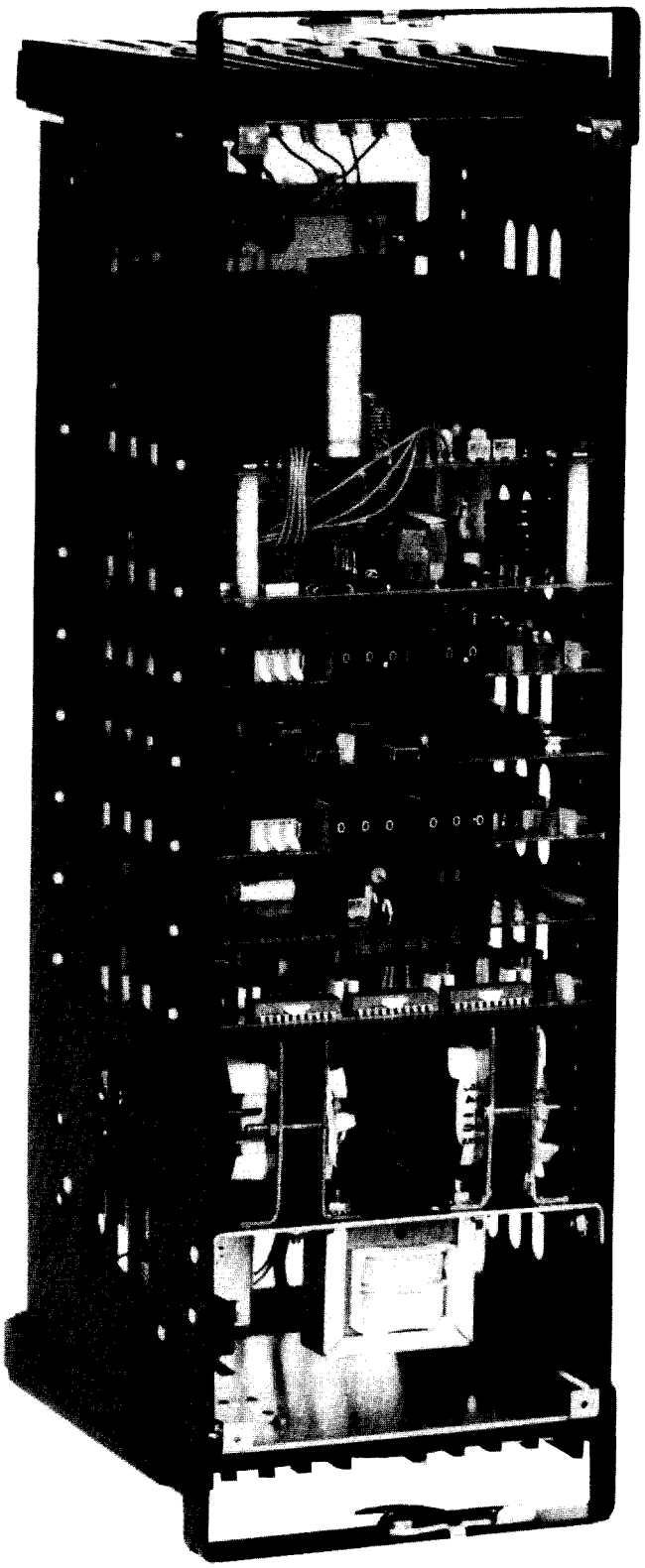


Figure 14 (8919483) View of Cradle Assembly with Nameplate Removed

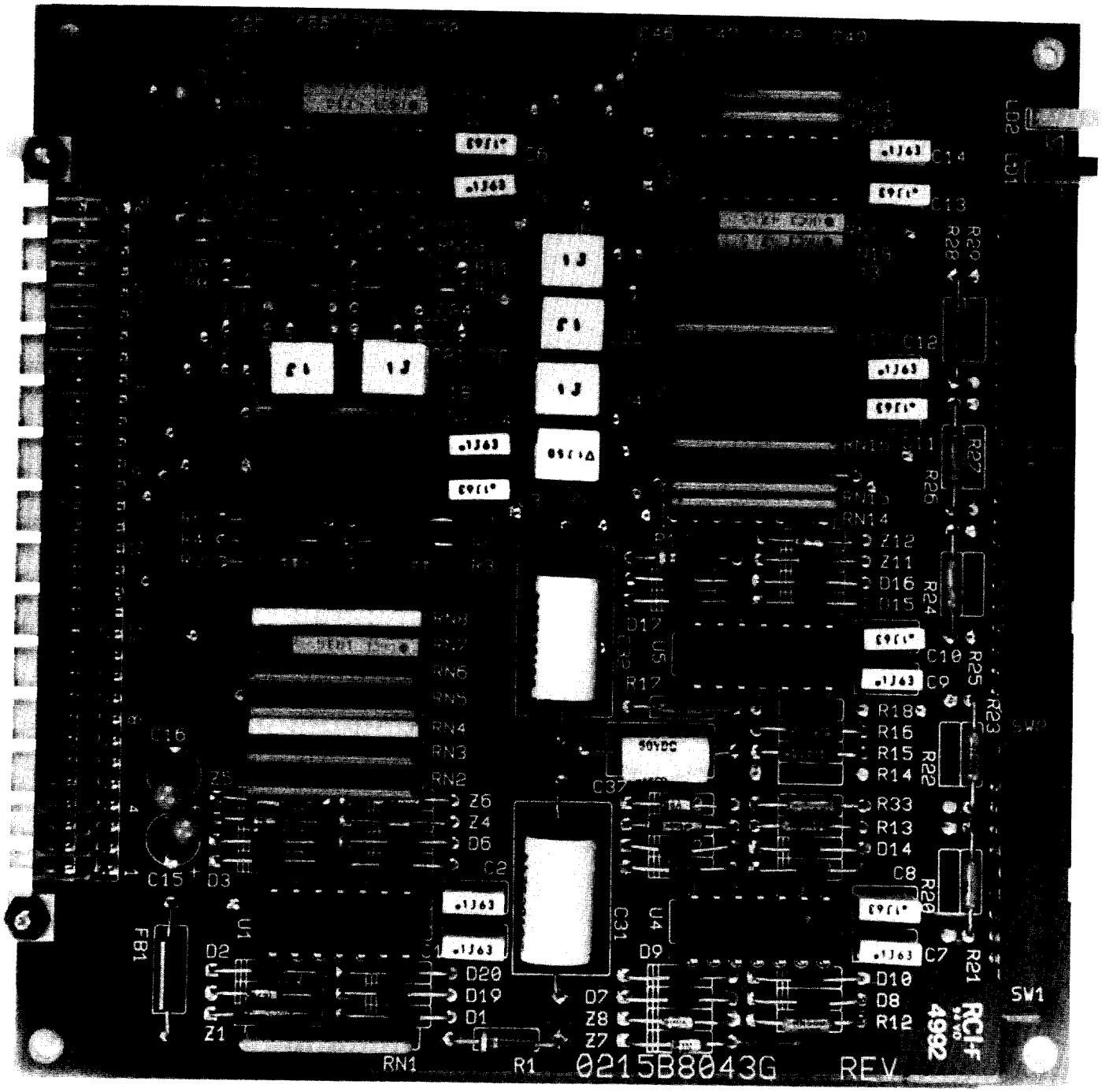
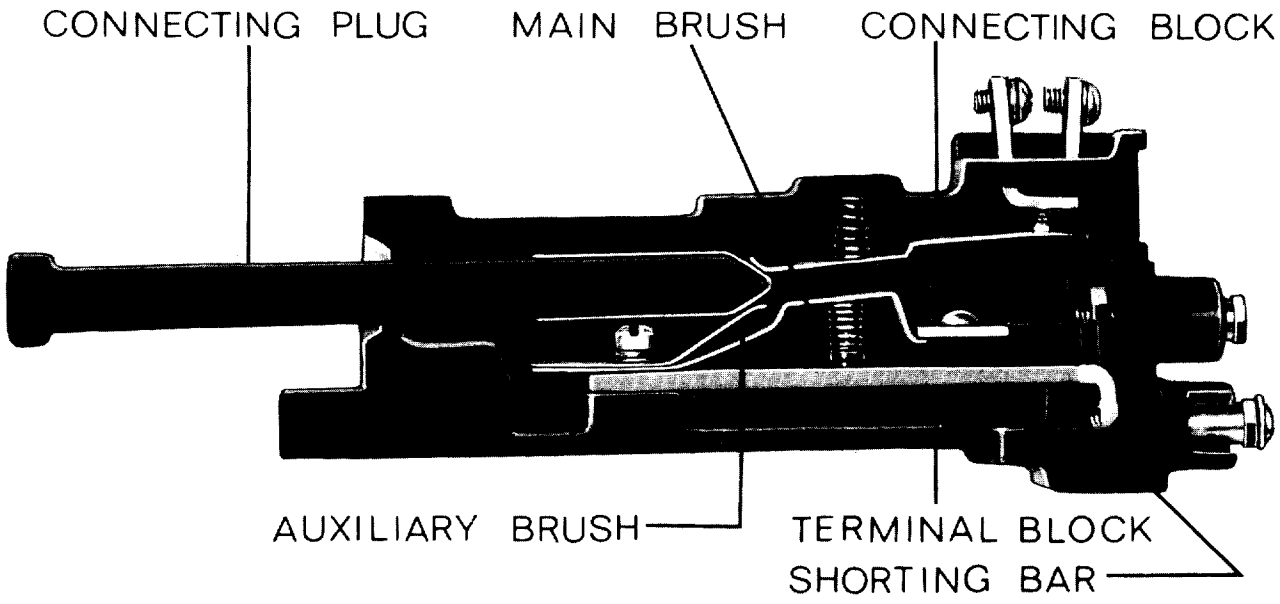


Figure 15 (8919479) View of Typical Removable Module



NOTE: AFTER ENGAGING AUXILIARY BRUSH CONNECTING PLUG TRAVELS 1/4 INCH BEFORE ENGAGING THE MAIN BRUSH ON THE TERMINAL BLOCK

Figure 16 (8025039) Drawout Case Contact Assembly

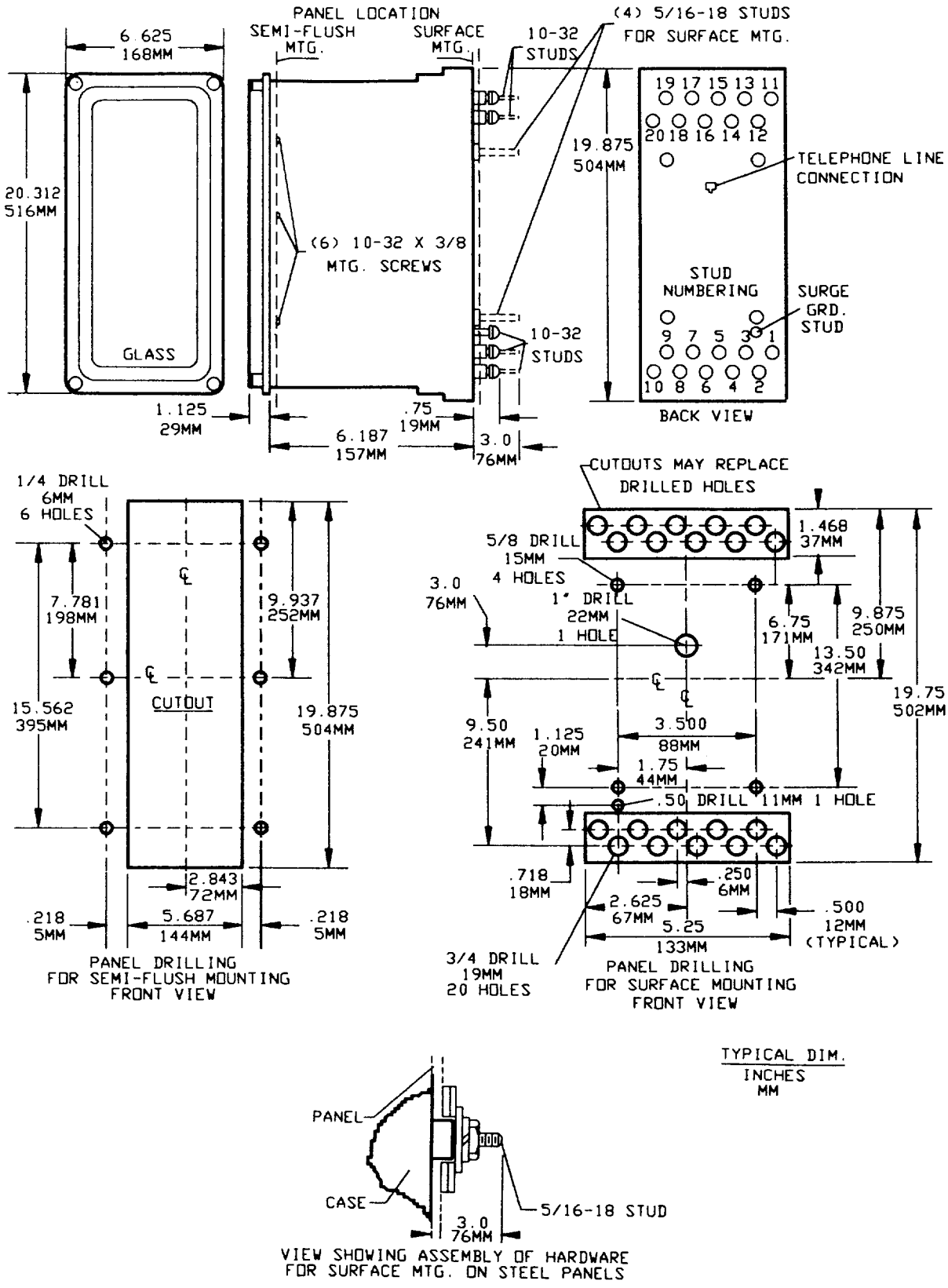


Figure 17 (0215B8430 [1]) Outline and Panel-Drilling Dimensions

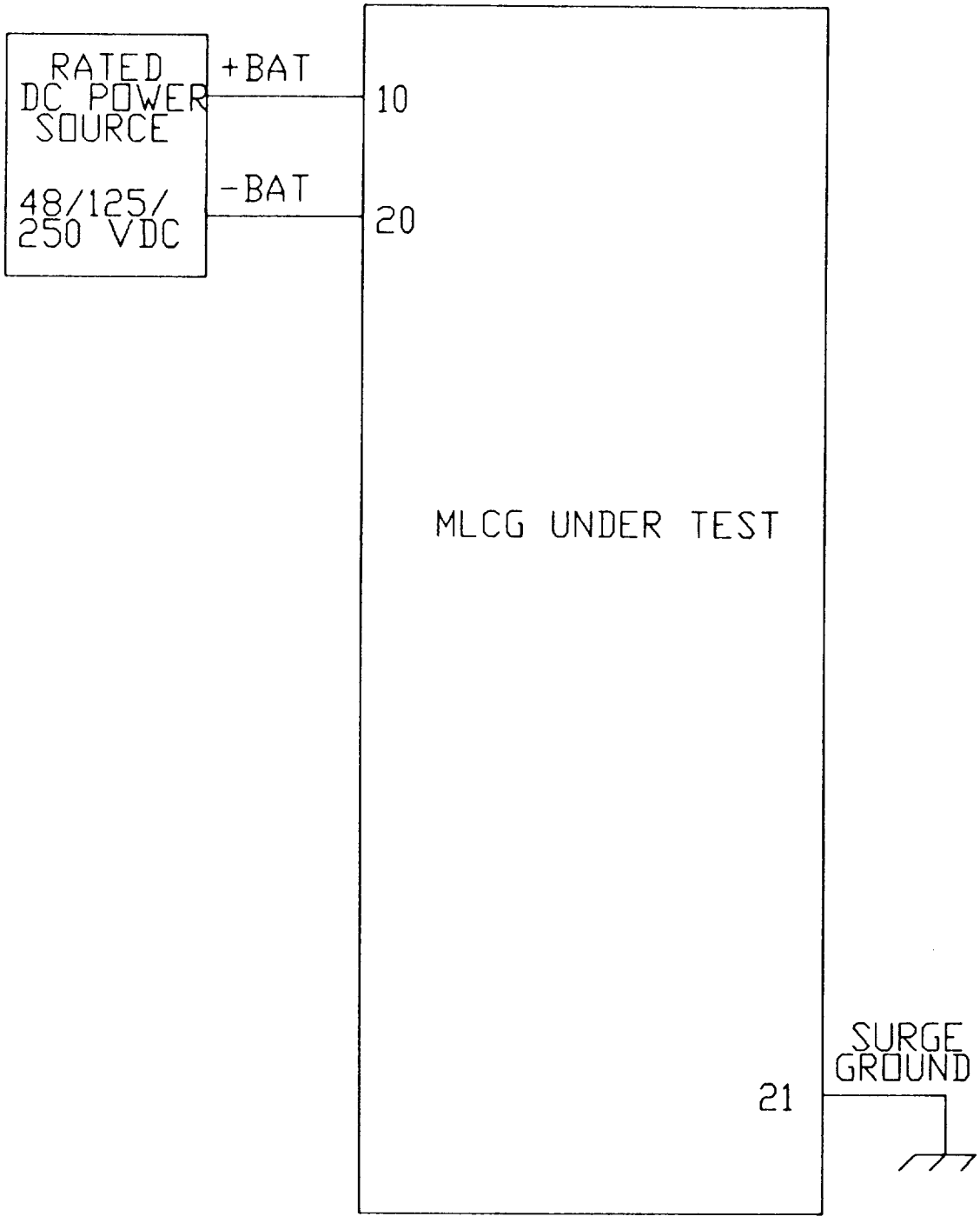


Figure 18 (0286A4931) Connections for Power Up Test and LED Test

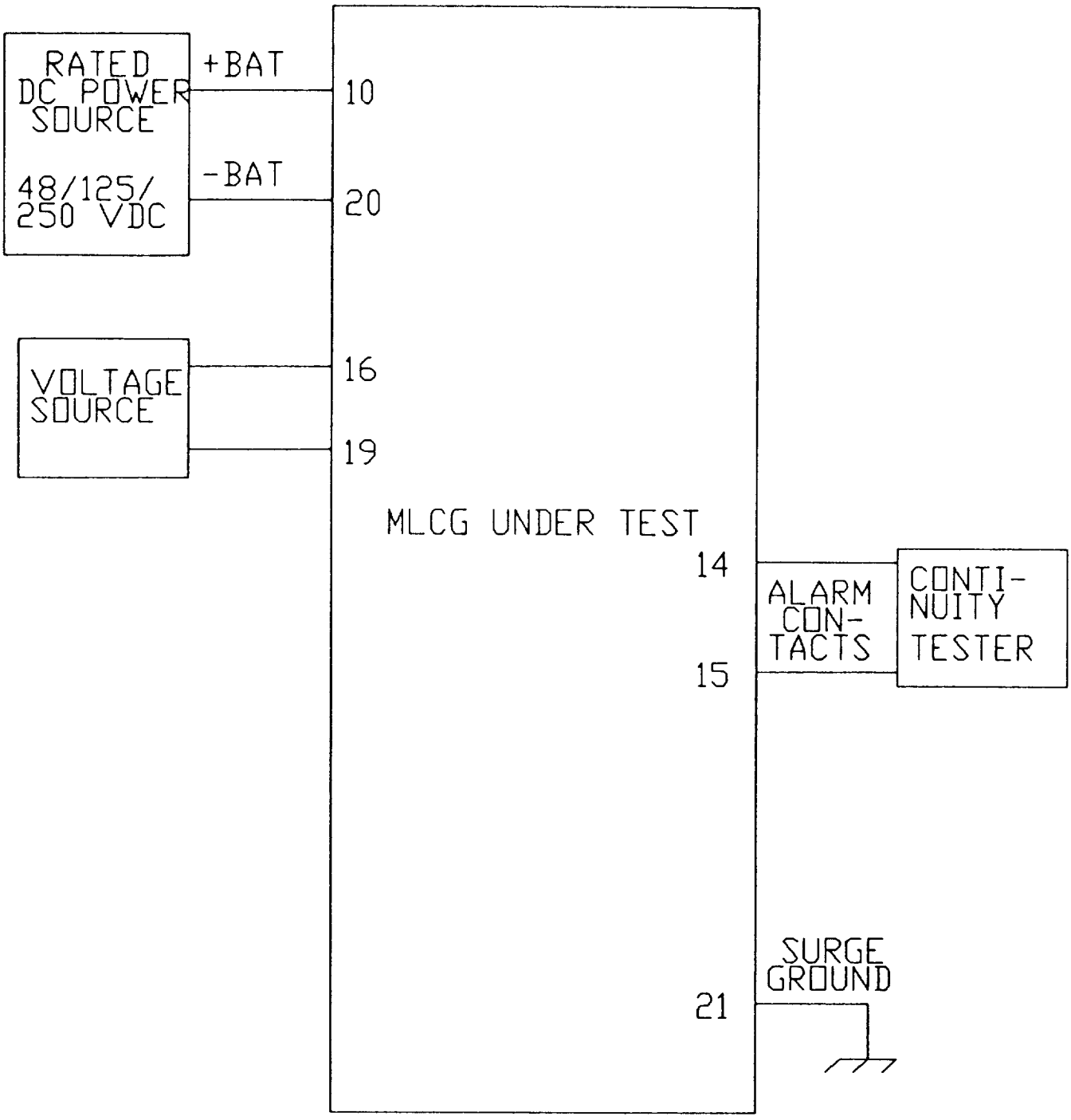


Figure 19 (0286A4932) Alarm Test Connections

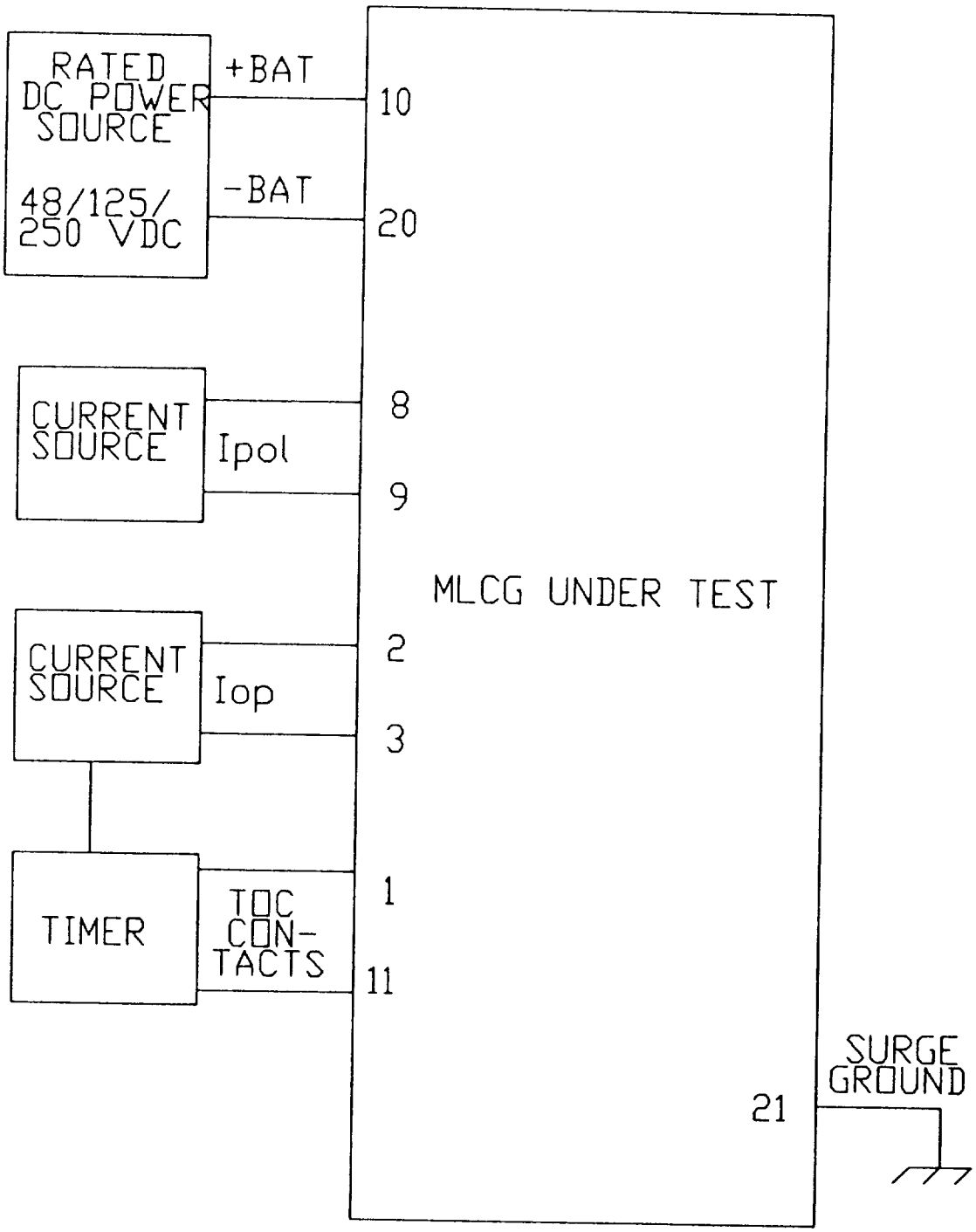


Figure 20 (0286A4933) Connections for TOC Time-Dial Test and TOC Definite-Time Test

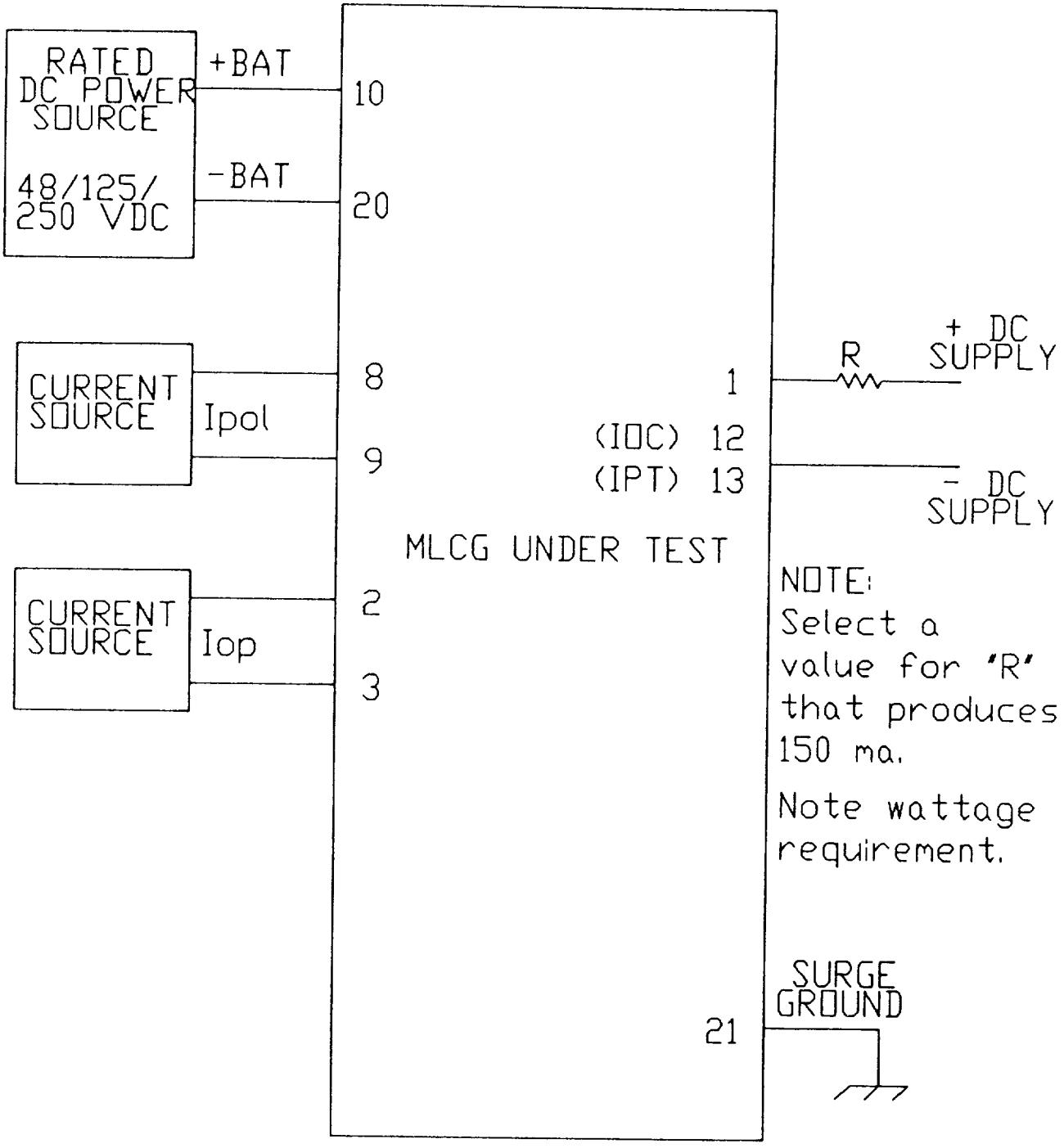


Figure 21 (0286A4934) Connections for IOC Tests and IPT Test

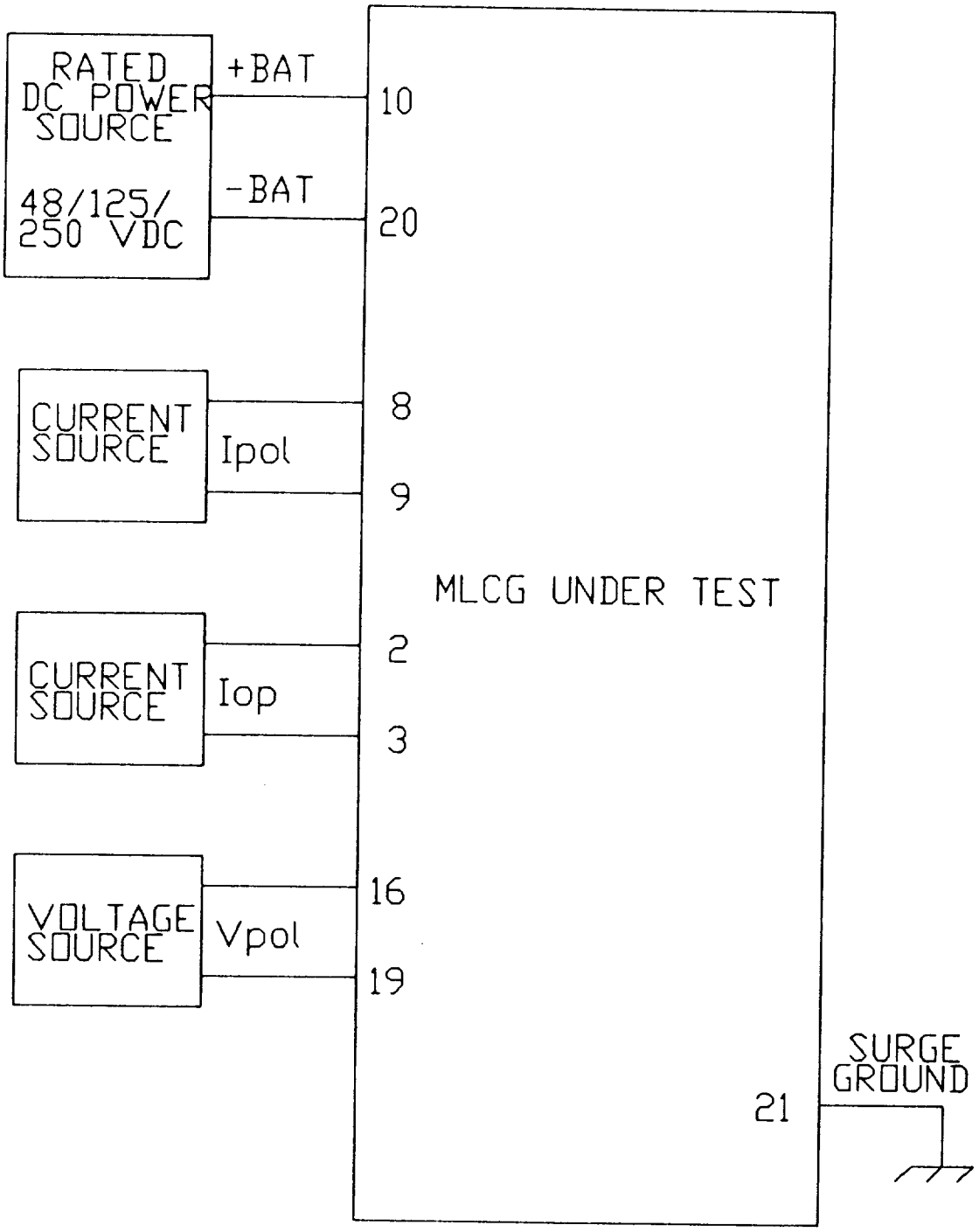
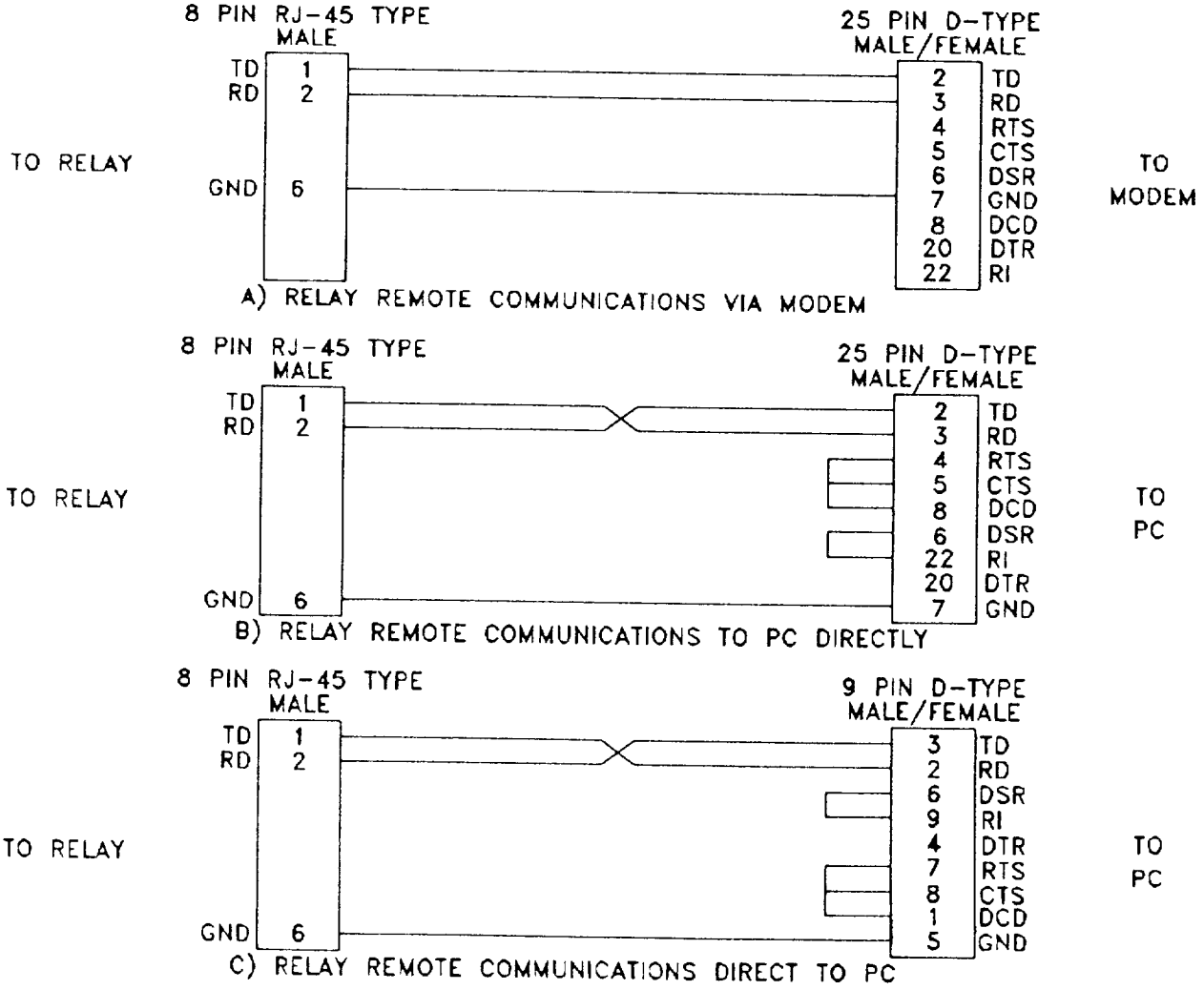


Figure 22 (0286A4935) Connections for Directional Tests, I and V Polarization



CABLES AVAILABLE UNDER GE PART NO. 0246A9866. SPECIFY CABLE TYPE AND CONNECTOR GENDER.

Figure 23 (0286A5315) Diagram of Cable Connections to PC and Modem

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