Click here to get to our homepage:
http://www.ge.com/indsys/pm/

GE Power Management

Modular Directional Power Relay

TCW series 1000

Instructions
GEK 105188A

TABLE OF CONTENTS

1. DESCRIPTION

The TCW relays are directional current relays. They are definite time and single phase to avoid motor operation in alternating current generators. The customer can select the model depending on phase to ground polarization or quadrature polarization (phase to phase).

For applications in three phase systems, only one relay is needed in the majority of the cases as the current flow is generally the same in the three phases.

The TCW relays are solid state modular relays with a DC/DC converter as a power supply. The relay is supplied in a 1/8 rack case.

MODEL LIST

TCW	5	0	0	D	A	*	*	*	*	00C	DESCRIPTION
						1					50 Hz
						2					60 Hz
							1				Vn = Phase to Ground (single phase)
							2				Vn = Phase to phase (three phases)
								1			In = 1A
								2			In = 5A
									F		24/48 VDC
									G		48/125 VDC
									H		110/240 VDC

	50 Hz	60 Hz
Vn Phase to Ground	63	69
Vn Phase to phase	110	120

The information provided herein does not intend to cover all details of variations of the described equipment nor does it take into account the circumstances that be present in your installation, operating or maintenance activities.

Should you wish to receive additional information, or for any particular problem which cannot be solved by referring to the information contained herein, please write to: GENERAL ELECTRIC POWER MANAGEMENT, S.A.

2. APPLICATION

The TCW relay has been specifically designed for applications related with the management of the current in alternating current generators .The operation of these relays depends on the phase angle, the voltage quantity, and the applied current. They operate when the current quality in one direction is greater than a preset value.

These relays are adequate in applications where the three phase load is balanced. The selection of the type of relay depends on whether the voltage is between phases or between phase and ground.

For models in which the polarization voltage is between phase and ground, the trip characteristic is represented in figure 12. For models in which the polarization voltage is the quadrature voltage (phase to phase), the trip characteristic is represented in figure 11.

In small generation stations the TCW type relays are used as protection against an excessive flow of power from the station to system. The relay trips the interconnection breaker if the power supply exceeds a predetermined value for a set period of time.

3. TECHNICAL CHARACTERISTICS

Temperature Range:

Operation: 14ºF to 131ºF (-10º-c to +55ºC)
Storage: -40ºF to 149ºF (-40ºC to +65ºC)

Insulation:

Between any terminal and ground: 2000 VAC during 1 min. At industrial frequency (50 Hz or 60 Hz).

Between independent circuits: 2000 VAC during 1 min. At industrial frequency (50 Hz or 60 Hz).

Between each end of an open contact: 1000 VAC during 1 min. At industrial frequency (50 Hz or 60 Hz).

Operation range:

1 - 40% of In in 1% steps.

Auxiliary voltage circuit:

If the power supply drops by more than 20% of the lower rated value, the relay will shut down automatically and produce a voltage presence auxiliary contact operation.

The consumption of the relay is less than 3 W at any voltage

Trip contacts:

Carry Continuously: 3 A,
Make and Carry: 30 A.
Open 180 VA resistive at 125 /250 VDC.
Open 60 VA inductive at 125 /250 VDC.

Auxiliary contacts:

Make and Carry: 5 A DC during 30 seconds with a maximum 250 VDC.

Break: 25 W inductive, with a maximum of 250 VDC.

Carry Continuously: 3 A.

Accuracy:

Operation value: ±5%
Operation time: ±5% or 30 ms (whichever is greater).

Ambient humidity:

Up to 95 % without condensation

Frequency Range

Rated Frequency:	50 or 60 Hz
Effective Range:	48 – 51 or 57 – 63 Hz
Operational Range:	46 – 53 or 56 – 64 Hz

Alternate consumption:

By the current circuit

Rated Current: In = 1A

Current	Consumption
1A	0.170 VA
2A	0.680 VA

Rated Current: In = 5 A

Current	Consumption
5A	2.30 VA
10A	9.30 VA

By the voltage circuit:

Vpol = 110 V
Consumption = 0.25 VA

Type Tests:

Impulse test:
5 kV peak 1.2/50 µsec, 0.5 J (IEC 255-4).

1 MHz noise test:
2.5 kV common mode, 1 kV differential mode,
Class III (IEC 255-4).

Electrostatic discharge:

Class III (IEC 801-3).

Radio Interference:
Class III (IEC 801-3).

Fast Transient:
Class III (IEC 801-4).

Timing:

Instantaneous unit: less than 40 ms.
Timed Unit: 100 ms – 1 s in 100 ms steps.
1 – 10 s in 1 s steps.

4. PRINCIPLES OF OPERATION

4.1 Input

Figures 2 and 3 represent the block diagrams of a TCW relay which differentiate the operation between a relay polarized by the voltage between phase and ground, and a relay polarized by the voltage between phases (in quadrature).

The current transformers of the protected circuit supply a secondary current which is applied to the relay input and later reduced by internal current transformers.

For a TCW relay to produce a trip, the overcurrent unit and the directional unit must give permission for the trip. IF one of these two units does not permit the trip, it will not occur. This condition is represented through the AND3 gate.

Understanding that this important condition must always be met, we can continue with the study of the principles of operation for the TCW relay separating the two functional units.

4.2. Overcurrent Unit

Once the current has been reduced in the current transformer secondary, it is connected to a full wave rectifier and is compared to a reference voltage which can be set by the user.

If the voltage measured in the secondary transformer is greater than the reference voltage set by the user, the first trip condition is produced in the AND3 gate input.

Through the P1 potentiometer (see figure 13) it proceeds to the calibration of the overcurrent unit.

4.3. Directional Unit

The operation of the directional unit depends on the polarized voltage applied to the relay in accordance with figures 2 and 3. If the polarization voltage is between phase and ground the representative block diagram is that which is given in figure 3. If the polarization voltage is between phases, the representative diagram is that which is given in figure 3.

4.3.1. POLARIZATION VOLTAGE BETWEEN PHASES

The time diagram for this directional unit is represented in figure 4. The input polarization voltage is reduced to lower values by a voltage transformer. The voltage produced in this secondary is inverted, and wave squares generate the Vpol (+) signal and the Vpol (-) signal which correspond to the positive half-waves and negative half-waves respectively.

The same is done to the secondary current of the current transformer, generating the IL(+) and the IL (-) signals. A 90º lag is applied to these signals to obtain the trip characteristic represented in figure 11.

A pulse train which is generated through the AND1, AND2, and OR1 gates is introduced in the T/T timer which detects the width of the pulses. If the width of these pulses is greater than 5ms (or 4.16 ms if the frequency is 60 Hz) the directionality condition for producing a trip has been met.

4 3 2 POLARIZATION VOLTAGE BETWEEN PHASE AND GROUND

The time diagram for this directional unit is represented in figure 5.

The operation of the directional unit corresponding to this mode is similar to the previous section except that in this case the line current will not lag by 90º to set the trip characteristic represented in figure 12.

4.4 Trip

Once the two necessary conditions for a trip have been met, the output of the AND3 gate will contain the adequate signal which produces the pick-up of the timing unit and signaling of the Is LED.

The timing can be set through the micro-switches on the front panel of the relay, making possible an instantaneous or timed trip. Once the set time has terminated, a trip will be produced in the main relay and the auxiliary tripping relay as long as the origin of the trip has not disappeared.

As the relays trip, the TRIP LED on the front panel is illuminated simultaneously. Once the cause of the trip has disappeared, an auxiliary trip memory circuit will maintain the LED lit to indicate that a trip occurred. The relay contains a button on the front panel for resetting this indicator.

5. CONSTRUCTION

5.1. Case

The TCW case is made of plated steel. The case and mounting dimensions are provided in figures 9 and 10.

The front cover is made of plastic and can be fitted to the relay in a way that produces a dust-proof scal.

The module is mounted vertically and contains a connector on the rear panel which serves as a mechanical support and electrical connection element, maintaining the module firmly in the correct position. This connector permits that the module outputs go directly to the relay panel allowing it to be disconnectable. When extracting the module from the case, the connector short-circuits the protected circuit current transformer secondary with the purpose of not leaving the transformer with an open circuit due to the disconnection of the module.

The case contains two plastic guides, one on top and one on the bottom, to ensure an exact alignment.

5.2. Identification

The complete relay model is indicated on the nameplate. To correctly identify the relay, compare the model with the table on page 3.

5.3. External Connections

The relay external connections are represented in figures 7 and 8, differentiating between models with polarization voltage between phase and ground, and models with polarization voltage between phases (in quadrature).

5.4. Printed Circuit Board

The TCW relay is formed by a single printed circuit which is connected, through the use of separators, to a card which supports the current and voltage transformers. The secondaries of these transformers are soldered directly to the printed circuit, while the primaries directly access the short-circuitable connector.

Handles are screwed onto the support card which permits disconnection of the module. It is important to remember that a mechanical device in the connector will short-circuit the transformer secondary of the protected device so that it is not left with an open circuit.

5.5. Location of External Controls and Signals

Figure 6 displays front panel of the TCW relay indicating the following points:

1. **Model**: Next to TCW, the model number of the relay is indicated.

2. **Voltage Present**: This green LED indicates that the internal supply to the relay is correct. If a failure occurs in the power supply, the relay is automatically turned off to prevent incorrect operation. This way, the TCW contains a switched contact which changes its state when the power supply is incorrect.

3. **Pick-up indicator**: Whenever a trip condition is produced, this red LED lights up.

4. **Tap selection**: This block of microswitches allows the user to select the tap as a percentage of the relay's rated current.

5. **Time selection**: This block of microswitches allows the user to select the timing mode.

6. **Trip indicator**: This red LED lights up whenever a trip has been produced.

7. **Reset**: This button allows the user to reset the trip indicator once the cause of the trip has disappeared.

5.6. Location of Internal Controls and Test Points

The TCW relays leave the factory calibrated so there is no need for further calibration by the customer. However, should it become necessary to calibrate the relay, the identification of the internal settings is listed below.

Figure 13 shows the location of the following controls on the card:

P1: Current Level Setting
P2: Timing Setting 0.1 – 1.0s.
P3: Timing Setting 1 – 10 s.
P4: 90º lag setting (If included)
P5: Supervision Time setting.
P6: Characteristic Opening Calibration.

6. RECEPTION, HANDLING AND STORAGE

This relay is supplied to the customer in a special package, which adequately protects it during transportation, as long as this is performed under normal conditions.

Immediately after receiving the relay, the customer should check whether it shows any sign of transportation damage. If it is apparent that the relay has been damaged due to inappropriate handling, it must be immediately reported in writing to the transportation carrier, and the damage must be reported to the manufacturer.

For unpacking the relay, care should be taken not to lose the screws also supplied in the box.

If you do not intend to install the relay immediately, it is recommended that the relay is stored in its original package and kept in a dry, dust-free place.

It is important to check that the data on the identification plate coincides with the data from the order.

7. ACCEPTANCE TESTS

Immediately after receiving the relay, the customer should perform a visual check and the acceptance tests in this section to ensure the relay has not suffered transportation damage and that the factory calibration has not been altered. If the tests performed indicate that it is necessary to reset the relay, refer to the RELAY CALIBRATION section.

These tests can be performed as installation or acceptance tests in accordance with the user's criteria. Given that the majority of the users have different procedures for installation and acceptance tests, this section contains all of the necessary tests that may be performed with these relays.

7.1. Visual Inspection

Verify that the data on the nameplate coincides with the data from the order. Disassemble the relay and check that the parts have not been broken or damaged during transportation.

7.2. Electrical Tests

7.2.1. GENERAL CONSIDERATIONS ABOUT THE NETWORK

All devices powered by alternating current are affected by the frequency. Because a non-sine wave is the result of a fundamental wave and a series of harmonics belonging to this fundamental wave, the devices that are powered by alternating current are affected by the form of the wave applied

To correctly test relays that operate on alternating current it is necessary to use a voltage and/or current sine wave. The purity of a sine wave (absence of harmonics) cannot be expressed specifically for any given relay However, in any relay that includes tuned circuits, circuits R-L and R-C or non-linear elements (such as inverse time overcurrent relays) are affected by the non-sine waves.

These relays respond to the voltage wave form in a different way than the majority of alternating current voltmeters. If the AC source used for the test contains many harmonics, the voltmeter and relay readings will be different.

The relays are calibrated in the factory using a network of 50 or 60 Hz containing a minimum amount of harmonics. When testing the relay, you should use an AC source whose waveform does not contain harmonics.

The voltmeters and stop watches used to perform the trip tests and operating time tests must be calibrated and their precision should be better than that of the relay.

The network power used in the tests must remain stable, mainly in the levels near the pick-up voltage.

It is important to stress that the precision used in the tests depends on the network power and the instruments used. Operating tests performed with inadequate power and instruments are useful to test that the relay operates correctly and that its characteristics arc verified approximately. However, if the relay is calibrated under these conditions, its operating characteristics may be outside the tolerance levels.

7.3. Checking the Current Setting

Perform the connections as indicated in figure 14.

Apply power to the relay.

Set all the microswitches to the left except switch 2 on the lower block (instantaneous trip)

Apply an alternate voltage in such a way that the voltage measured by voltmeter V coincides with the relay's rated voltage.

Using the shifter set the phase angle to 120º. (Current delay in respect to the voltage).

Apply current and check that the relay trips and complies with the values in the following table as related to the microswitch on the upper block which is at the right (units in amperes):

Switch to the right	**In=1A**		**In=5A**	
	Imin	**Imax**	**Imin**	**Imax**
None	0,009	0.011	0.048	0.052
6	0.019	0.021	0.095	0.105
5	0.029	0.031	0.143	0.157
4	0.048	0.052	0.238	0.262
3	0.086	0.094	0.428	0.472
2	0.086	0.094	0.428	0.472
1	0.162	0.178	0.808	0.892

7.4. Checking the Opening Characteristic and the Trip Direction

Perform the connections as indicated in figure 14.

Apply power to the relay.

Set all the microswitches to the left except switch 2 on the lower block (instantaneous trip)

Apply sufficient current to cause the relay to trip. Vary the phase through the shifter and check that the relay trips when the phase is between 100 - 103º in the case of phase to ground polarization. In the case of polarization between phases, check that the relay trips between 162 - 170º.

In the same way, check that the relay trips within the same limits when varying the current module.

7.5. Checking the Instantaneous Unit and Correct Contact Operation

7.5.1. CHECKING THE VOLTAGE PRESENT CONTACTS

Check the resistance between the following terminals with no power applied to the relay:

B9 - B10	0
B9 - B 11	infinite

Apply power to the relay.

Check the resistance between the following terminals:

B9 - B10	infinite
B9 - B11	0

7.5.2. CHECKING THE INSTANTANEOUS UNIT AND THE TRIP CONTACTS

Set the corresponding timing microswitches for an instantaneous trip and check the resistance between the following terminals:

A6 - A7	0
A7 - A8	infinite
B5 - B6	0
B5 - B4	infinite

Provoke a fault in accordance with the previous section and check the resistance between the following terminals:

A6 - A7	infinite
A7 - A8	0
B5 - B6	infinite
B5 - B4	0

Check that the time measured by the stopwatch moves between 25 and 30 ms.

7.5.3. CHECKING THE TIMING

Perform the connections as indicated in figure 14.

Set the microswitches 1 and 2 of the lower block to the right. Provoke a fault and check that the time measured by the stopwatch complies with the values in the following table as related to the microswitch which is at the right:

Switch to the right	Tmin ms	Tmax ms
None	95	105
1	190	210
2	285	315
3	285	315
4	457	525

Set the microswitch 2 of the lower block to the left. Provoke a fault and check that the time measured by the stopwatch complies with the values in the following table as related to the microswitch which is at the right:

Switch to the right	Tmin ms	Tmax ms
None	0.95	1.05
1	1.90	2.10
2	2.85	3.15
3	2.85	3.15
4	4.57	5.25

8. INSTALLATION

8.1. Introduction

The place where the relay is to be installed must be clean, dry, free of dust and vibrations, and well illuminated to facilitate inspection and tests.

The relay must be mounted on a vertical surface. Figures 9 and 10 represent the dimensions and drilling diagrams of the TCW. The external connection schemes are represented in figures 7 and 8 depending on the voltage polarization.

If the inspection or tests performed indicate that the relay requires resetting, see the section RELAY CALIBRATION.

8.2. Setting the Current Level

This setting is performed using the microswitches on the upper microswitch block which has inscribed below:

Is[1+()] x In/100

The setting is in percentage of rated current. Therefore, to set the current trip level you simply have to move the corresponding microswitch to the right. (Assuming that the directionality condition has been met).

For example, if we have a relay with a rated current of 5 A and we want it to trip when the current exceeds 1.35 A (27% of In), the microswitches would be set to the following positions:

—		1
	—	2
—		4
—		8
	—	8
	—	16

Is={1+(2+8+16)} x 5/100 = 1.35 A

8.3. Setting the Timing

8.3.1. SETTING THE INSTANTANEOUS

For the trip to be instantaneous, the microswitches on the lower block must be set in following positions:

	—		0.1
		—	0.2
	—		0.2
x10	—		0.4
		—	x1
1>>	—		T

T = 0.1 + ( )

This set of microswitches does not affect the instantaneous.

8.3.2. SETTING THE TIMING 0.1 - 1s

The following is inscribed below the lower block of microswitches: T = 0.1 + ( ). To select this timing mode, switch 1 must be in the T position and switch 2 must be in the x1 position. If we wanted to set the timing to 600 ms, the switches would be set in the following positions:

	—		0.1
		—	0.2
	—		0.2
x10	—		0.4
		—	x1
1>>	—		T

T = 0.1 + ( )

T = 0.1 + (0.1 + 0.4) = 600 ms

8.3.3. SETTING THE TIMING 1 - 10s

To select this timing mode, switch 1 must be in the T position and switch 2 must be in the x10 position. If we wanted to set the timing to 6 s, the switches would be set in the following positions:

	—		0.1
	—		0.2
	—		0.2
x10		—	0.4
	—		x1
1>>		—	T

T = 0.1 + ( )

T = 0.1 + (0.1 + 0.4) = 0.6s
T x 10 = 0.6 x 10 = 6s

8.3.4. TESTS

Given that the majority of users have different procedures for installation tests, the section ACCEPTANCE TESTS includes all of the necessary tests that may be performed as installation tests in accordance with the user's criteria.

9. RELAY CALIBRATION

If during the tests the relay is determined to be outside the established tolerance levels (first ensure that the power supply and test instruments used meet the prerequisites specified in the section ACCEPTANCE TESTS), it can be calibrated as follows:

9.1. Calibrating the Current Level

Perform the connections as indicated in figure 14. Using the shifter, delay the voltage 120º to obtain the directional permission.

Set the timing so that the trip will be instantaneous. Set the current level to 1%. Apply 1% of the rated current through the variable resistance. Adjust the potentiometer P1 (see figure 13) until the Is LED remains lit.

9.2. Calibrating the Characteristic Opening

Through the variable resistance, apply a current enough to cause the directional unit to provoke a trip. Adjust the potentiometer P6 until the relay trips in accordance with the trip characteristic in figure 11 or 12.

9.3. Calibrating the timing 0.1 - 1s

Perform the connections as indicated in figure 14. Set the timing to 500 ms. Provoke a fault and adjust the potentiometer P2 until the measured time is 500 ms.

9.4. Calibrating the timing 1 - 10 s

Perform the connections as indicated in figure 14. Set the timing to 5s. Provoke a fault and adjust the potentiometer P3 until the measured time is 5s.

NOTE: Whenever the 0.1 - 1s timing has been calibrated, it is necessary to calibrate the 1-10 s timing

10. PERIODIC TEST AND MAINTENANCE

Given the primary role that protection relays have in any installation, it is recommended that a periodic test program is followed. Given that the intervals between these tests vary for different types of relays and installations as well as the experience of the user performing the tests, it is recommended that the points described in the section INSTALLATION are checked at intervals of 1 to 2 years.

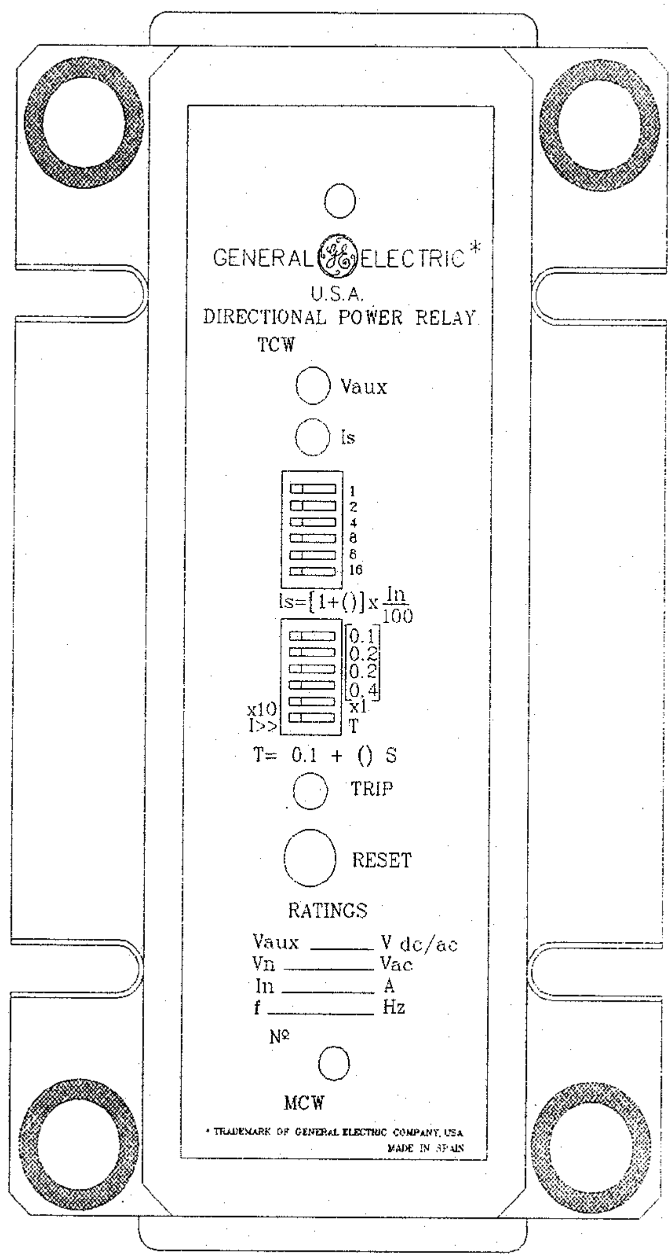


Figure 1*. Front view of the relay*

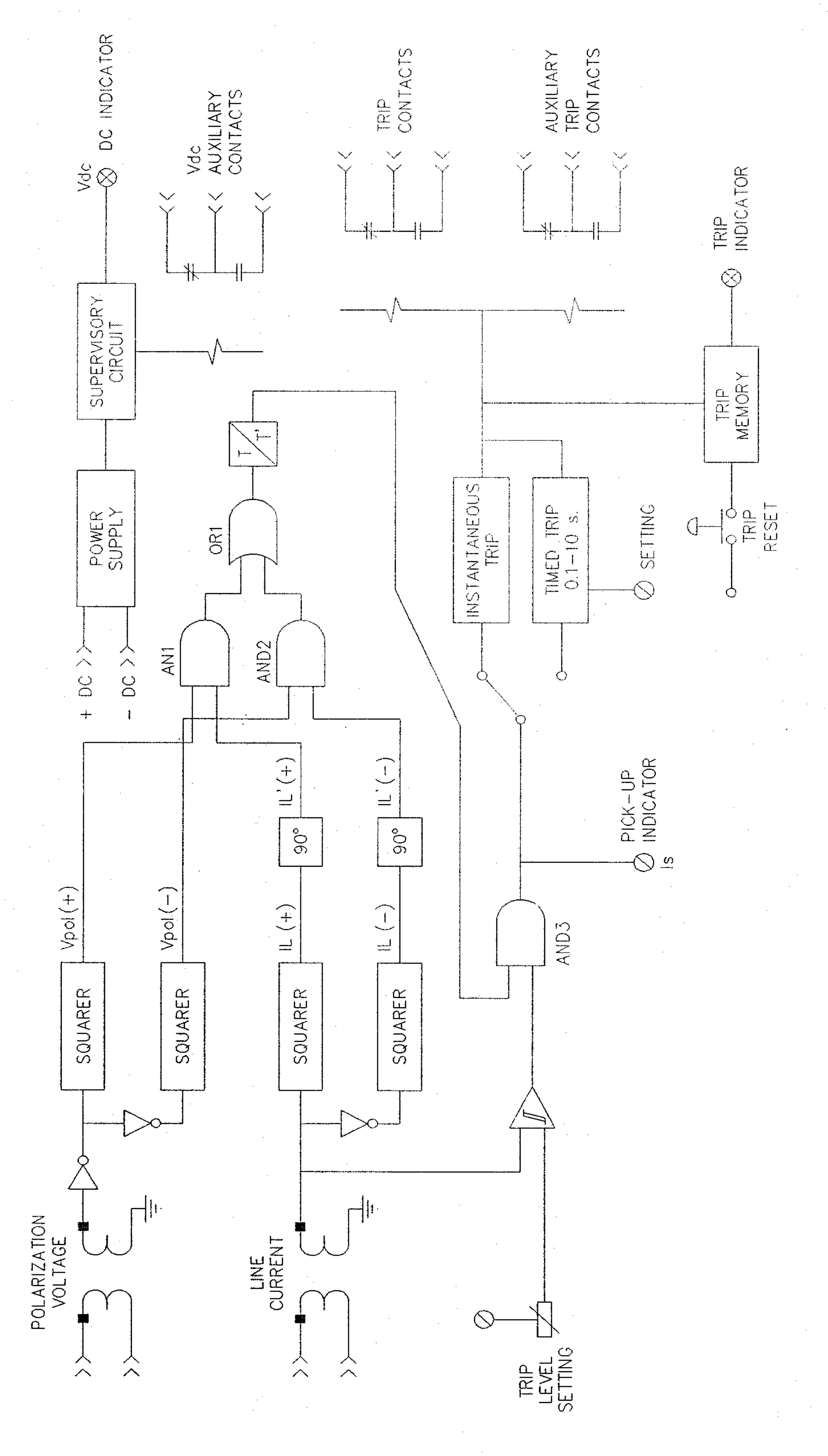


***Figure 2**. Phase to phase polarization block diagram*

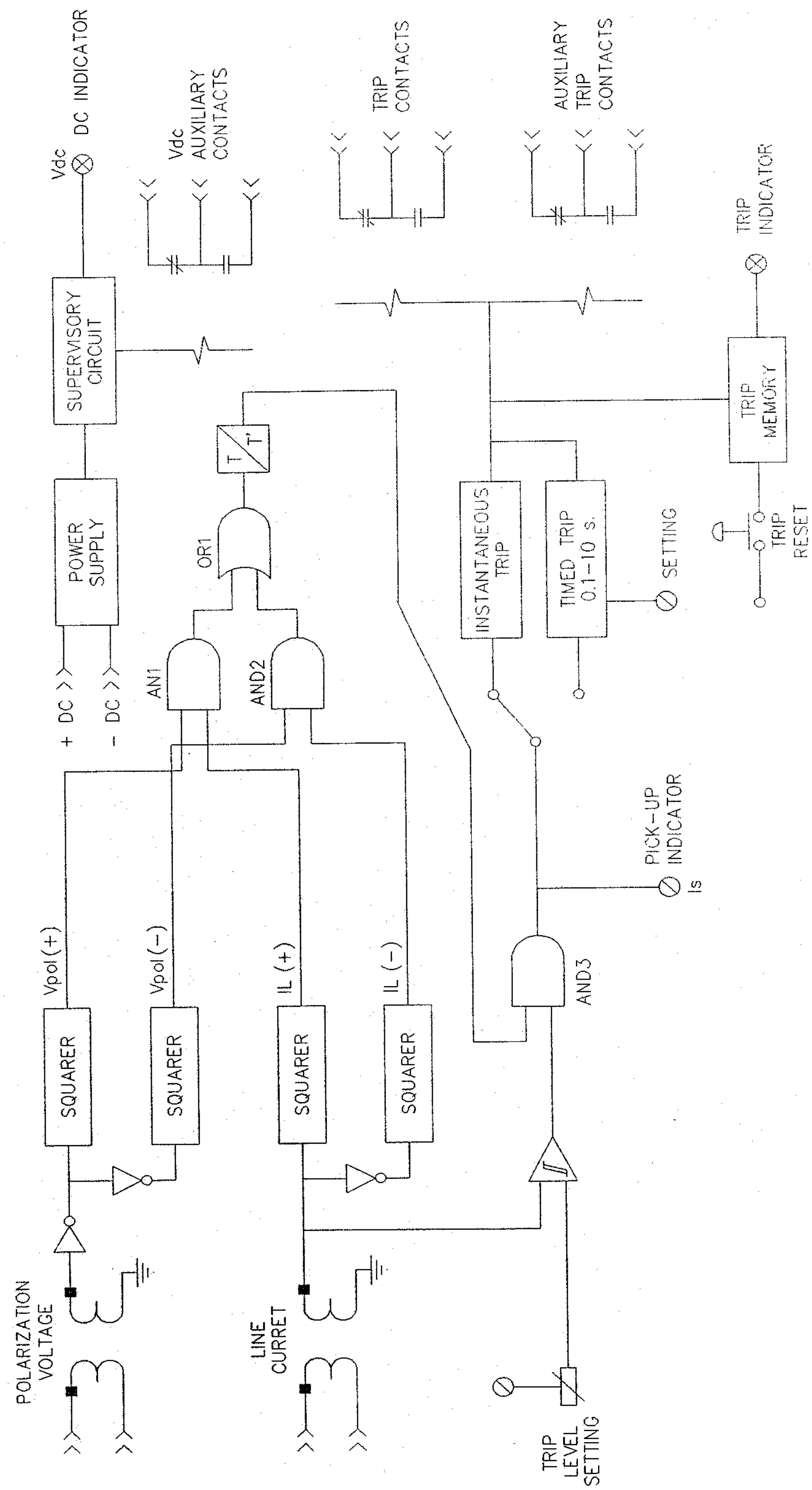


***Figure 3**. Phase to ground polarization block diagram*

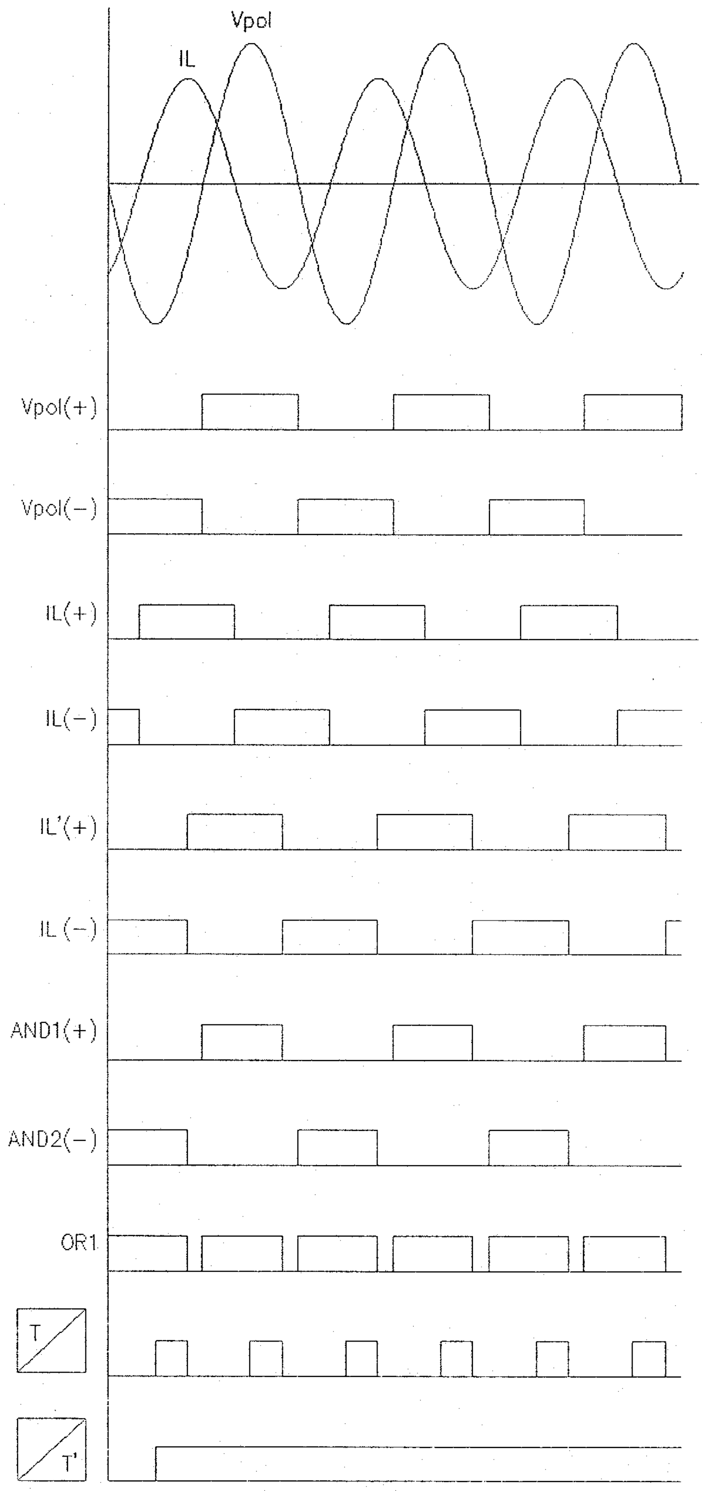


Figure 4. *Phase to phase polarization time diagram*

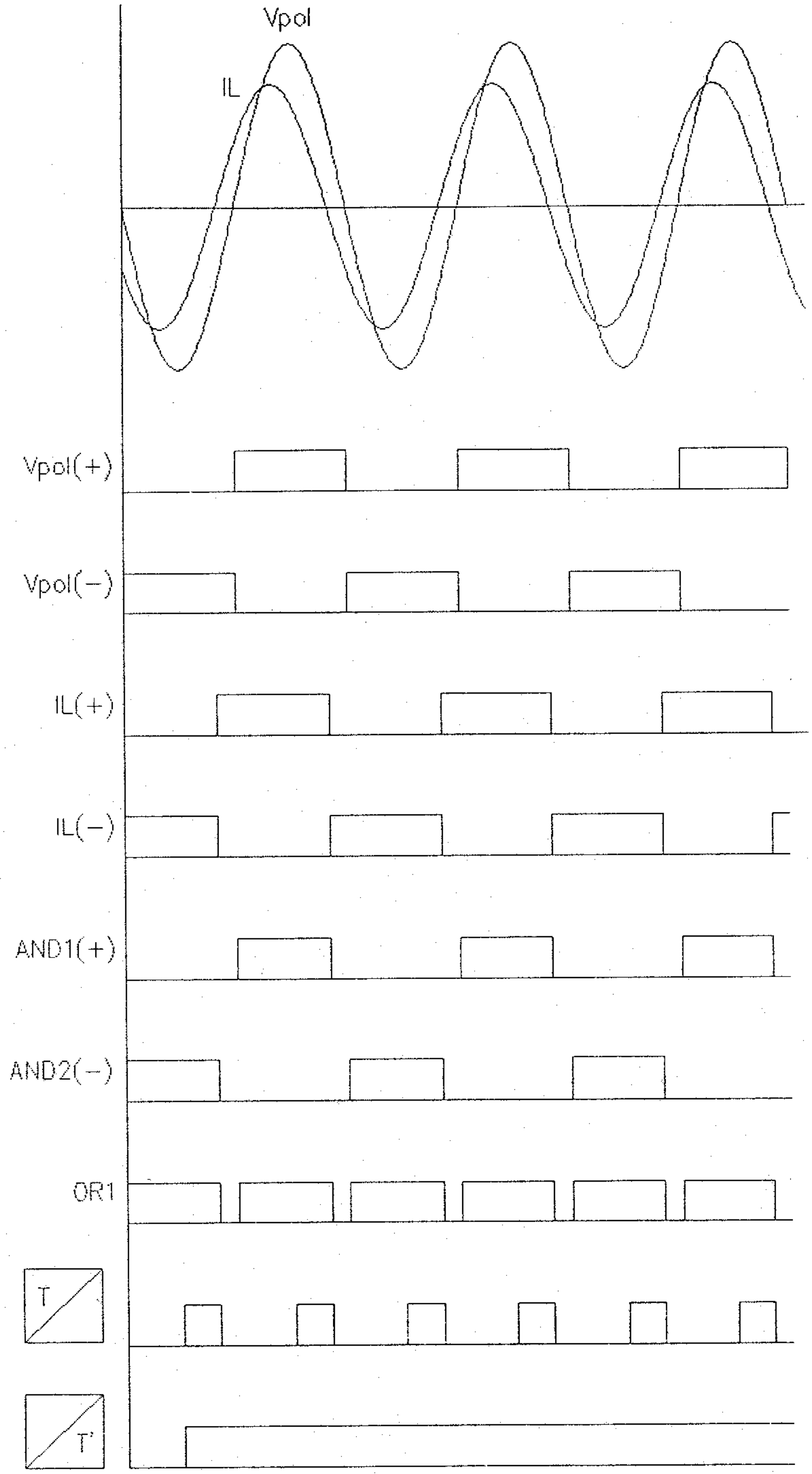
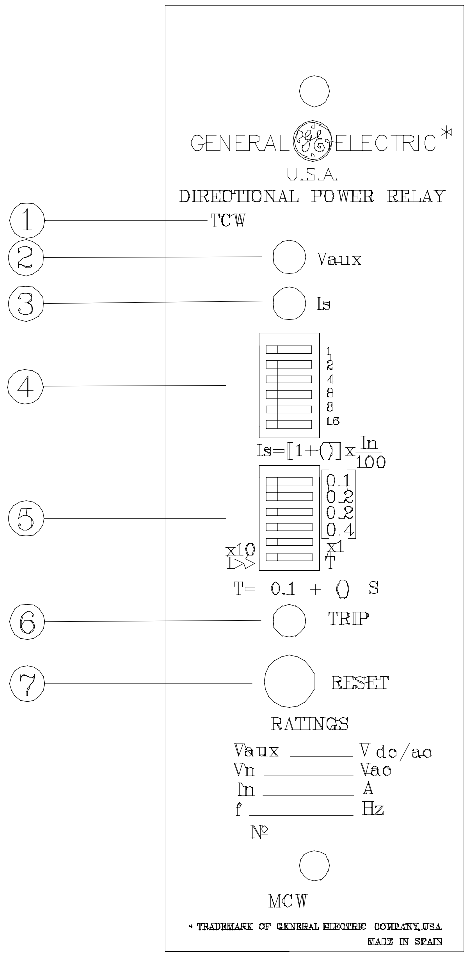


Figure 5. *Phase to ground polarization time diagram.*



1 Model
2 Vaux presence (Green LED)
3 Pick-up indicator (Red LED)
4 Current level selector
5 Time selector
6 Trip indicator (Red LED)
7 Trip reset

Figure 6. *Name plate*

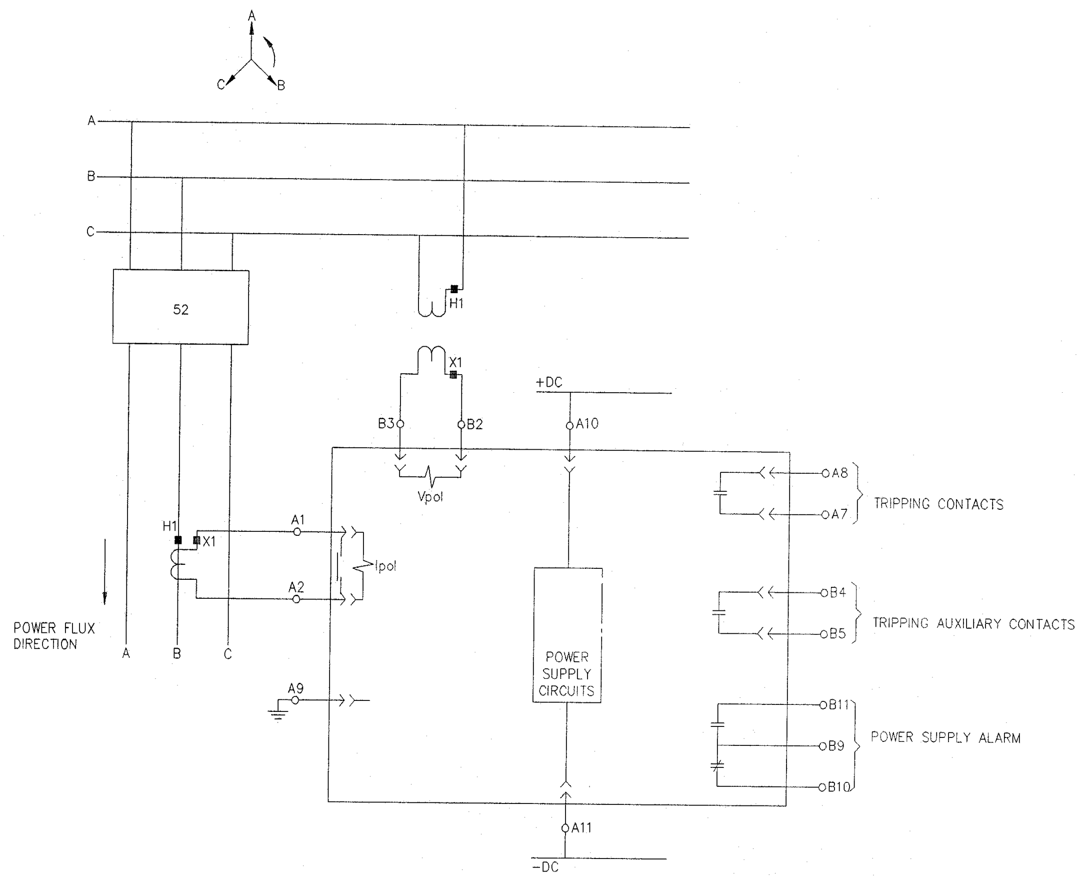


Figure 7*. Phase to phase polarization external connections*

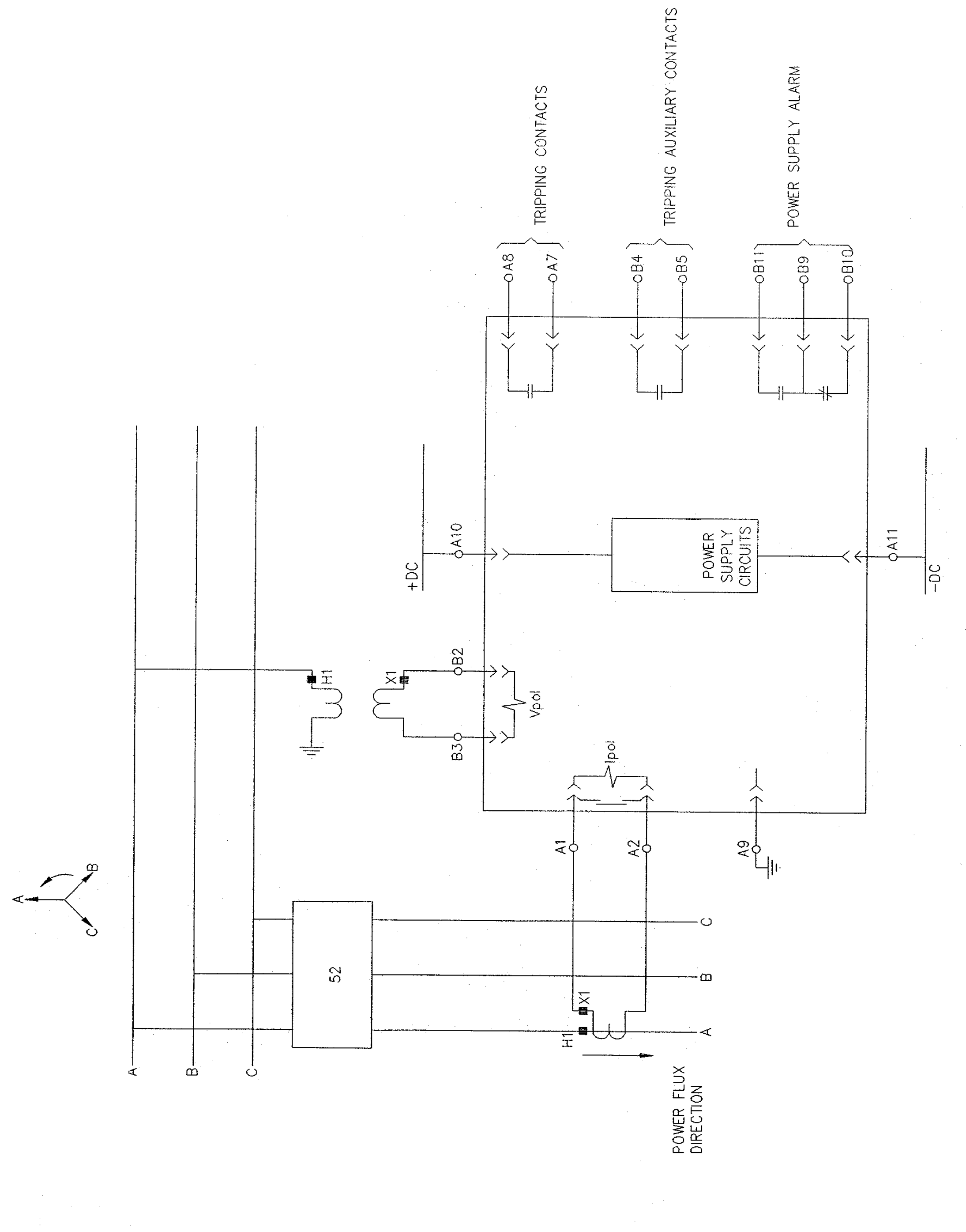


Figure 8. *Phase to ground polarization external connections*

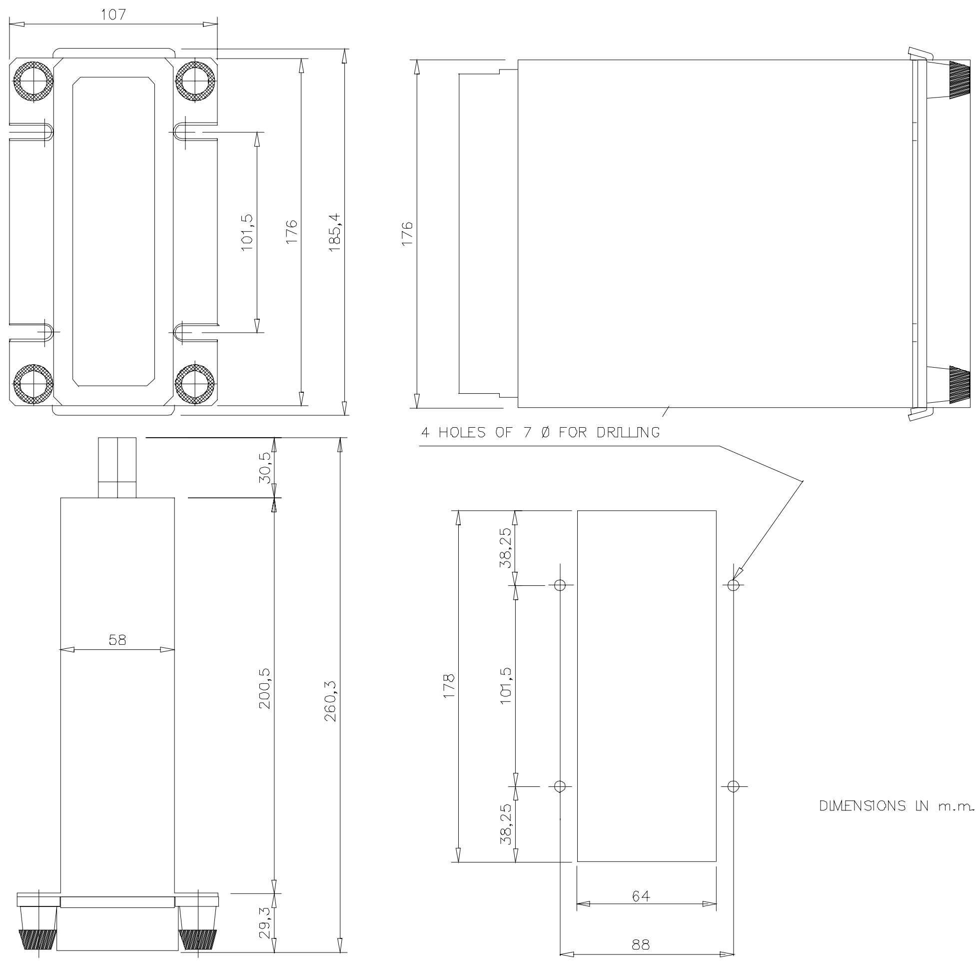


***Figure 9**. Dimensions and drilling diagram*

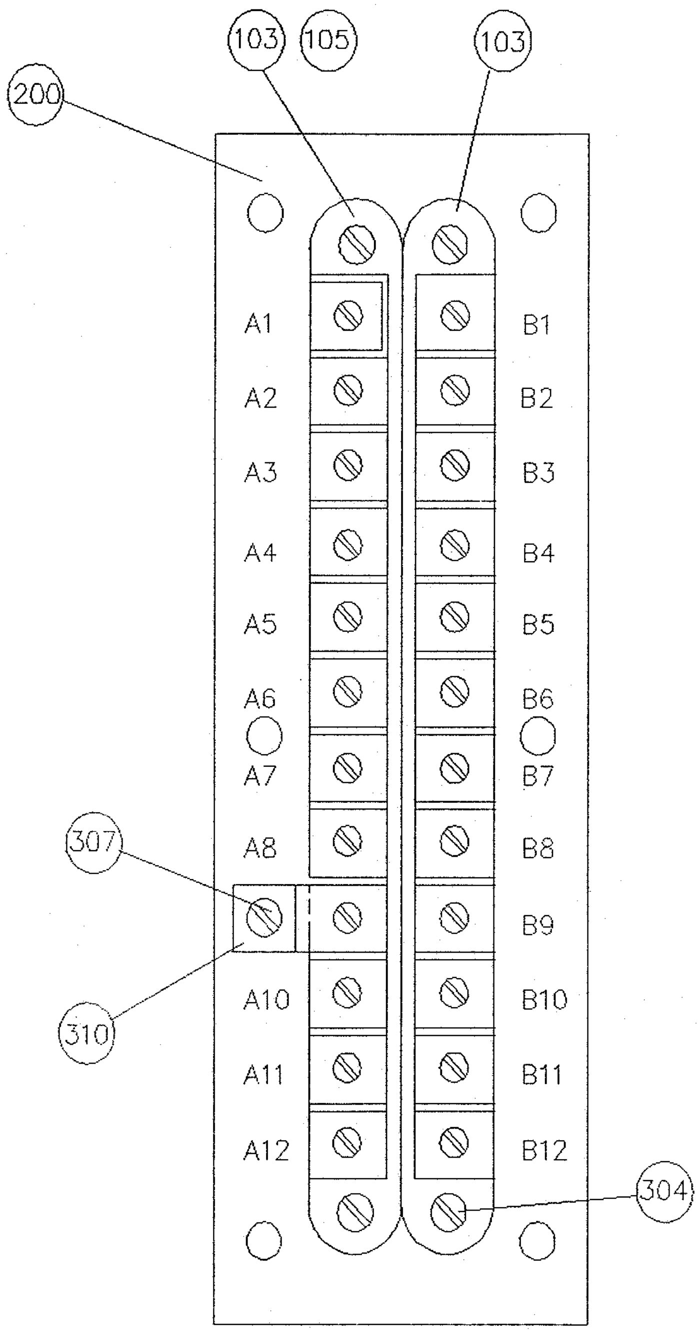


Figure 10. *Rear Panel*

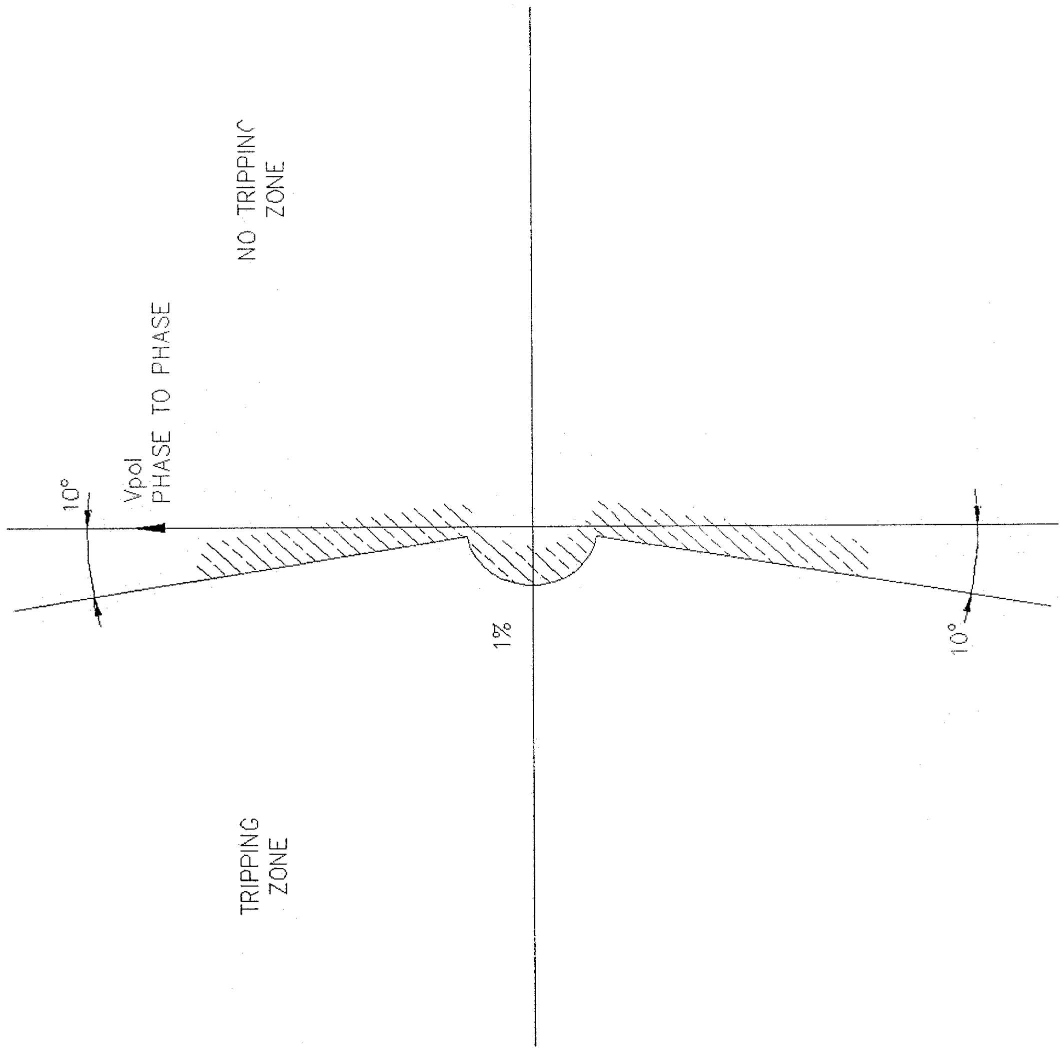


Figure 11. *Phase to phase polarization characteristic curve*

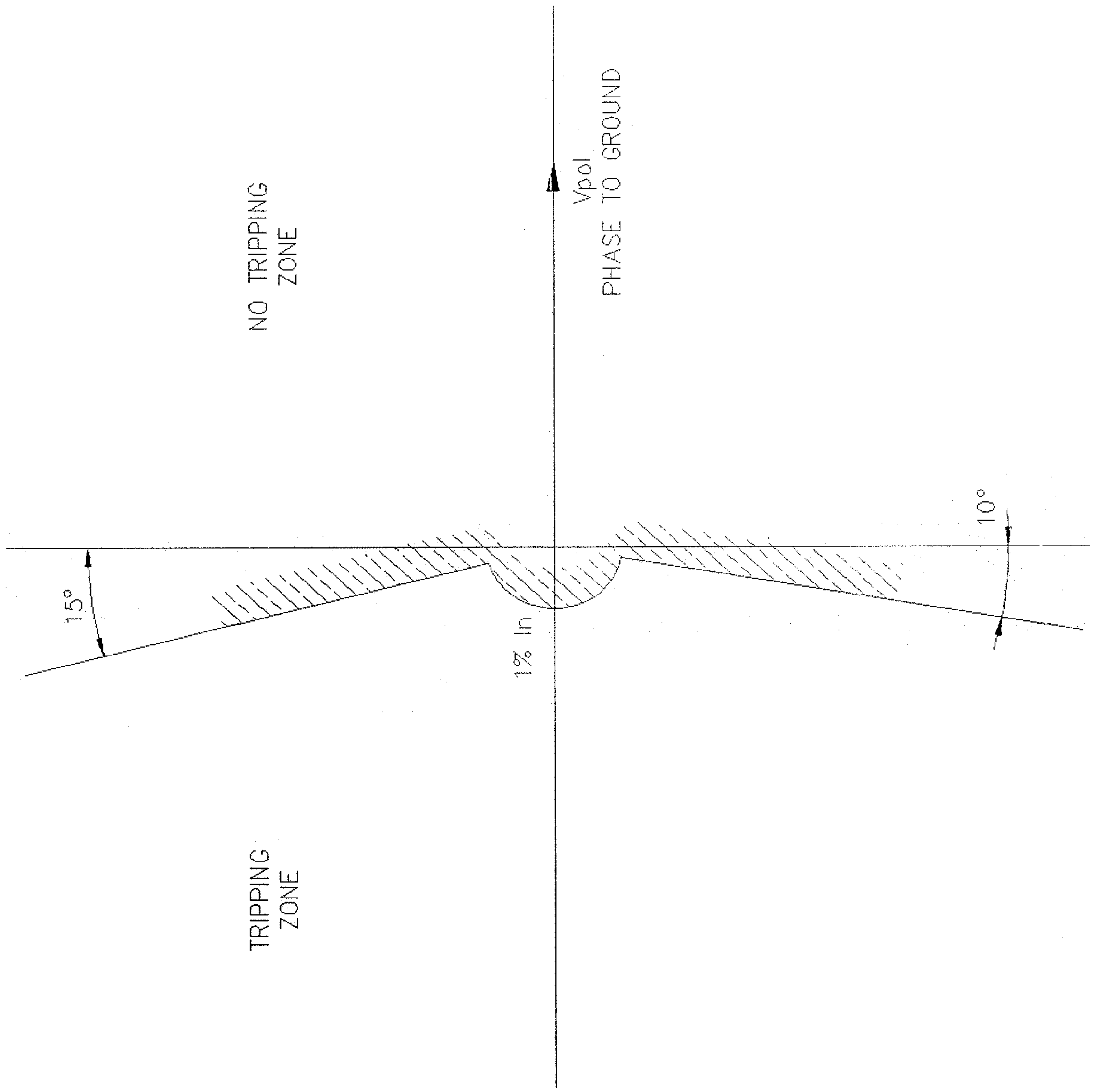


Figure 12. *Phase to ground polarization characteristic curve*

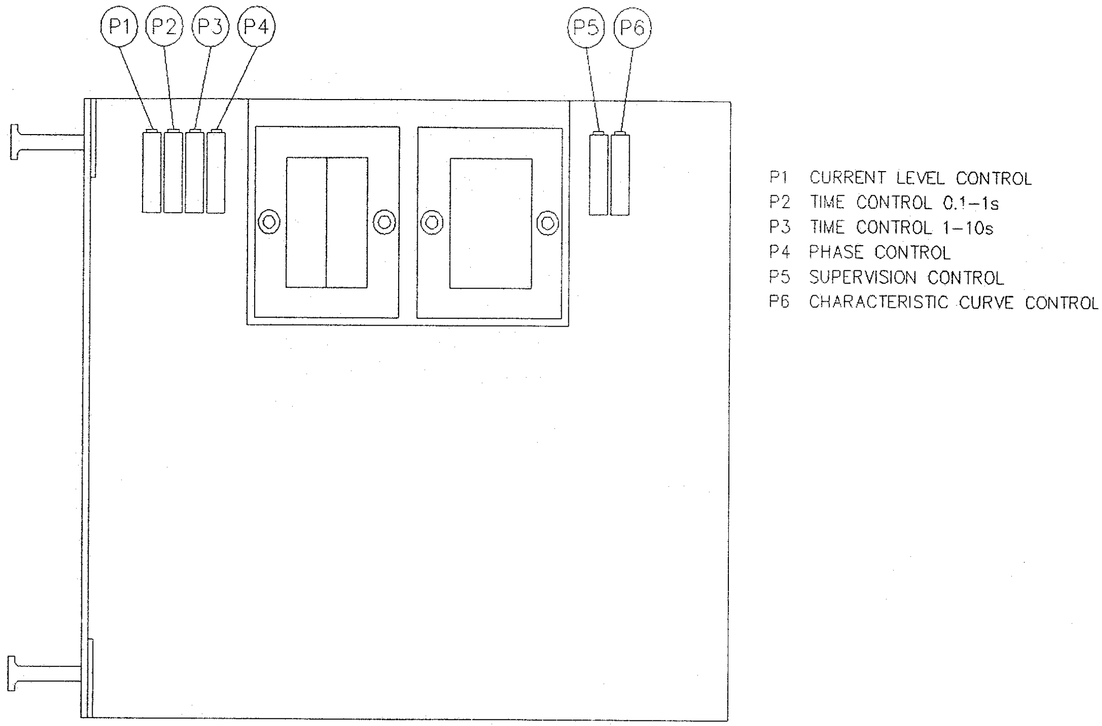


Figure 13. *Internal controls*

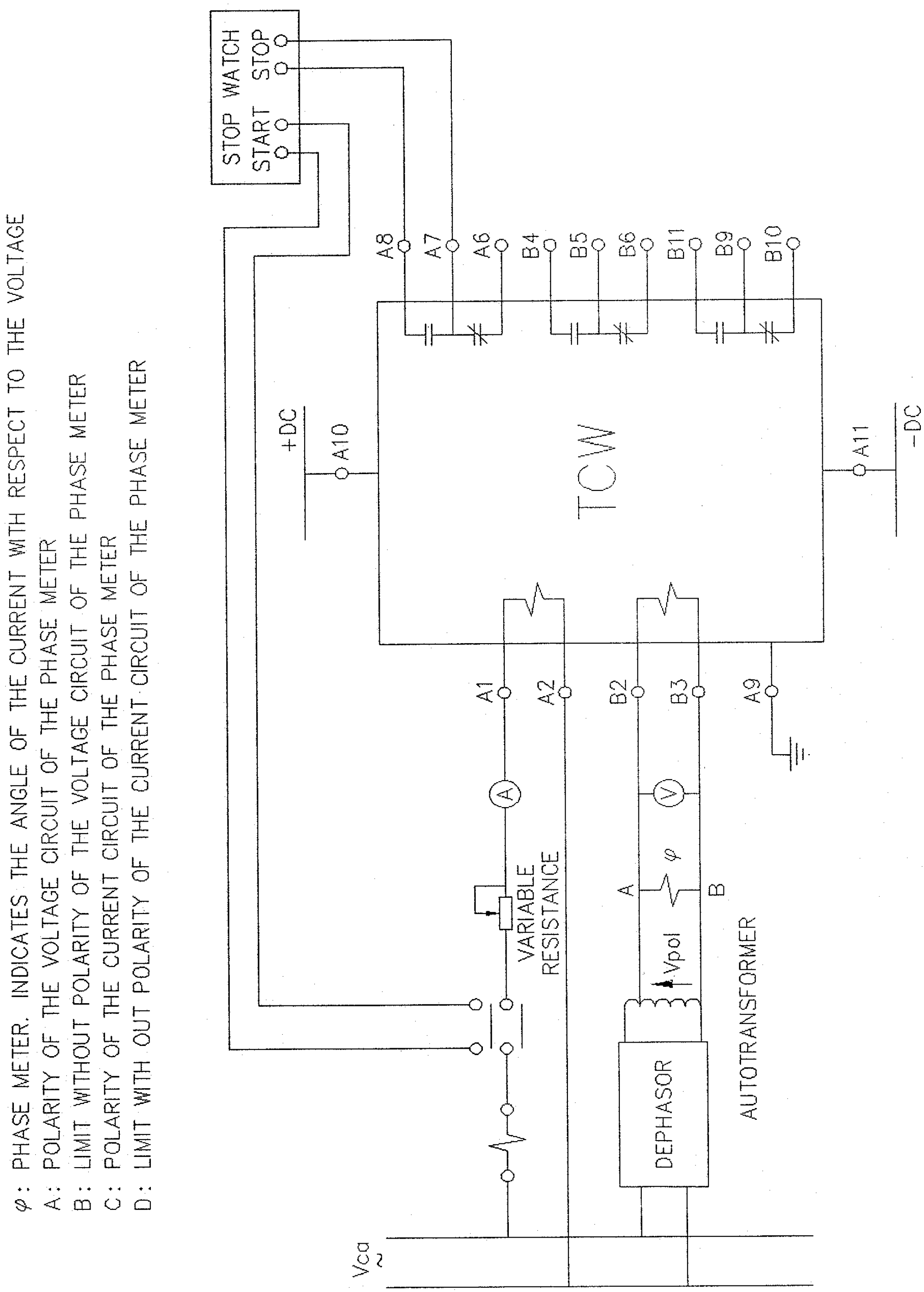


Figure 14*. Test connections*