GEK-105189A

MCP1000

CAPACITOR BANK PROTECTION & CONTROL

MULTILIN

GE Power Management

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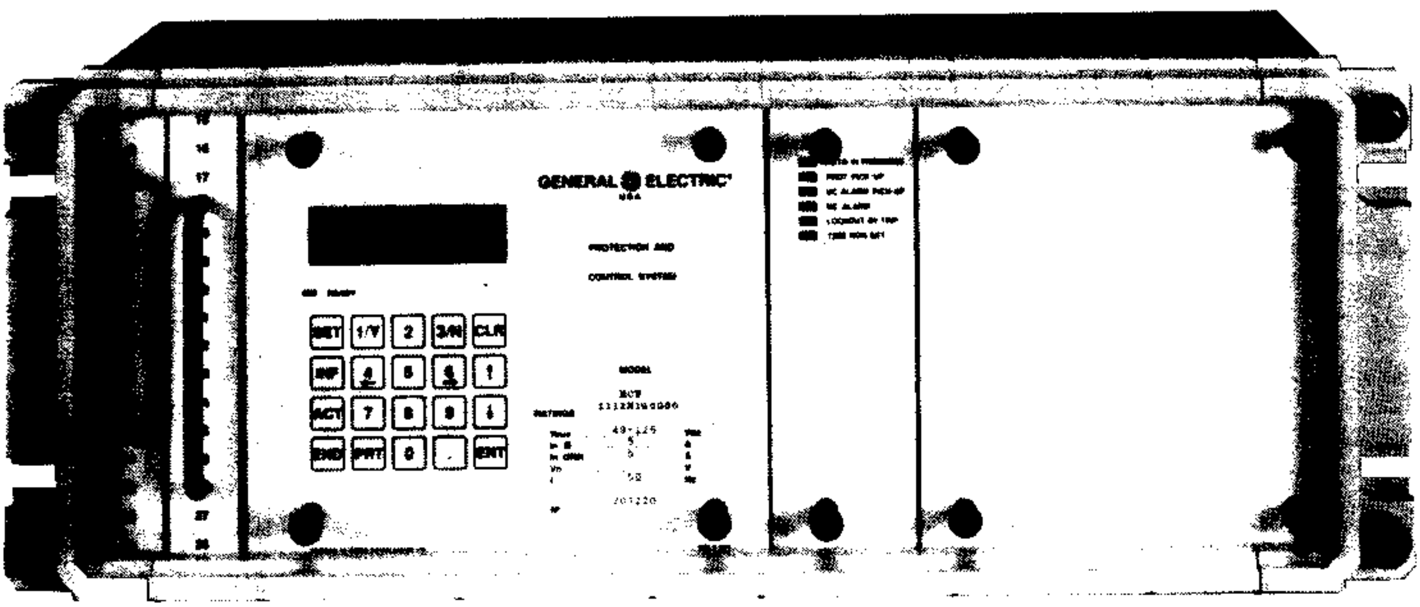

MULTILIN

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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 purposes, 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.

Table of Contents

LIST OF FIGURES

Model Selection Guide

MCP1 * * * * * * * * * *

	Test Plugs
0	No
1	Yes
	Range
0	Phase: 1-8A Grnd: 0.2-1.6A
1	1.5-12A 0.5-4A
2	0.3-2.4 A 0.1-0.8A
	Communication Port
1	RS232
2	Fiber Optic (1 mm Plastic)
3	Fiber Optic (100/140 Glass)
4	Fiber Optic (50/125 Glass)
	Unbalance Protection
M	Unbalance Current #
D	Unbalance Voltage ##
	Frequency
1	50 Hz
2	60 Hz
	Vaux: Contact Converter Voltage
0	48 Vdc
1	125 Vdc
2	220 Vdc
	Outputs
1	Standard Input/Output
S	Special Models
	Vaux: DC Supply Voltage
G	48-125 Vdc
H	110-250 Vdc
	Other
* *	Special Models

 # Ranges: Alarm: 0.5-2A Time: 1-10 seconds
Trip: 1-5A Time: 0.1-1 seconds
##Ranges: Trip: 2-18 V Time: 1-20 seconds

DESCRIPTION

The MCP1000 is a microprocessor based system that can be used for the protection and control of shunt connected capacitor banks. It includes overcurrent functions with instantaneous and time delayed characteristics for phase and ground fault protection, and over/under voltage functions with inverse and definite time characteristics for protection and control. Time-of-day programming , which can be set differently for weekdays versus weekends, is also included.

COMMUNICATIONS AND CONFIGURATION

The MCP contains a serial port , for either RS232 or fiber optic communication, which permits its utilization as an integral part of a complete protection and control system in substations as shown in Figure 1. The other components of the system are:

a) Remote controller:

Personal computer with modem

b) Communications concentrator unit:

Broadcast device (FAC for fiber optics) and modem for connecting to the MCP relays

The *Mlink Program*, supplied with the relay, is required to communicate with the relay through the personal computer.

The MCP system contains a configuration setting group that is accessed exclusively through the keypad. It is used to select how the MCP will interact with the external world. The configuration settings and their default values are as follows:

Setting	Default
Unit Number	255
Baud Rate	4800
Stop Bits	1
Open/close breaker via keypad	Prohibited
Open/close breaker remotely	Prohibited
Change settings via keypad	Prohibited
Change settings remotely	Prohibited
Language	English

Any or all of these settings can be changed to suit the particular application. To change any of these settings refer to the **Configuration Settings** section on page 19 in the **KEYPAD AND DISPLAY** section of this book.

FUNCTIONS

The following functions are included in the MCP system:

Phase and ground instantaneous and time overcurrent functions

Inverse, very inverse, extremely inverse and a user defined curve are included for use with the time overcurrent functions. Time curves can be independently selected for phase and ground protection. The instantaneous functions are provided with independent time delay for use if required.

Voltage functions for both protection and control

Definite time and inverse time characteristics are included with the overvoltage functions. Definite time characteristics are provided with the undervoltage functions.

Unbalanced current or voltage function

The MCP can be provided with one or the other of the following functions:

1. An overcurrent function for sensing the neutral current produced as a result of unbalances in the individual phases of the capacitor bank.

2. An overvoltage function that senses the unbalanced voltage that is produced as a result of unbalances in the individual phases of the capacitor bank.

Check the specific model to determine which function is provided in the MCP.

Programmable timing functions

The MCP system can be time programmed to insert and remove the capacitors from service at specific times during the day. Separate programs are available wherein different timing sequences can be used during the weekdays versus weekends. The time programs are supervised by the voltage functions so that insertion/removal can only be performed under favorable voltage conditions.

Breaker control and monitoring

Breaker conditions (opened/closed) are monitored in the MCP via breaker auxiliary switches. If desired, the MCP can be set so that remote and/or local control of the breaker can be performed via the MCP.

The MCP relay monitors the current during each breaker opening and determines the maximum of the three phase currents that are interrupted (rated current is used if all currents are less than rated). This maximum value is squared and added to the previous maximum value and the total is stored in memory and compared to a set value (user setting). When this value is exceeded, it may be used as an indication that the breaker requires maintenance. A user settable sum can be entered if the MCP is applied with a breaker having previous operations.

EVENT RECORDING

The MCP system has the capability to store up to 255 time-tagged and dated events. Events include pickup of the protection functions, trip orders, breaker status changes,. etc.

PACKAGING

The MCP system is packaged in a 19 inch case for horizontal mounting. Outline and mounting dimensions are shown in Figure 8. External connections for the MCP are shown in Figures 12 and 13.

APPLICATION

The MCP1000 system is used for the protection and control of a capacitor bank.

PROTECTION

Overcurrent Functions

Included for the protection of the capacitor bank are phase and ground overcurrent functions for both time-delayed and instantaneous tripping. The following time curves are available for use with the phase and ground time overcurrent functions:

1. Inverse
2. Very Inverse
3. Extremely Inverse
4. User defined

Any one of these curves can be selected and the phase and ground functions can use different types. The different curves are shown in Figures 2 through 5. The user defined curve shown in Figure 5 is the default set of curves. The MORCALC program included with the Mlink software provided with the MCP can be used to modify the curve to fit any particular application.

Voltage Functions

The following voltage functions are provided for use in the protection of the bank:

1. Time overvoltage with characteristic time curves shown in Figure 6
2. Instantaneous overvoltage, no intentional time delay

Neutral Overcurrent or Overvoltage Function for Bank Unbalance

Depending on the model of the MCP, protection for capacitor bank unbalance can be provided via:

1. an overcurrent function that senses the unbalance via current flow in the neutral of the bank. Separate alarm level and trip level functions are included. Each function can be separately set with user selectable time delay.
2. an overvoltage function that senses the unbalance via voltage that is produced in the neutral of the bank The function can be set with user selectable time delay.

CONTROL

Manual

The capacitor bank can be controlled manually via the keypad or through the communications interface (local or remote via a personal computer). Manual control (local and /or remote) can be turned off if desired. This is done via the **Configuration Settings** which are described in more detail in the **COMMUNICATIONS** section of this book. Manual control is permitted only when the MCP relay is set in the manual mode.

Automatic

Automatic control can be implemented in one or both of the following ways:

1. Voltage control with settable time delay. In this mode of operation, the bank will be connected when the voltage is less than a set value for a set time delay. The bank will be disconnected either instantly or with time delay when the voltage exceeds set values.
2. Time control with voltage supervision. In this mode of operation, the bank will be connected at a set time and disconnected at a set time provided the voltage conditions are correct at the time connection/disconnection is set to occur. Different opening and closing times can be set for weekday versus weekend operation.

When the MCP is set to the automatic mode of operation, manual control is not permitted. Control can be shifted between manual and automatic via external contacts, through the keypad or through the communications port via a personal computer.

OPERATING PRINCIPLES

INPUTS

The current transformers for the capacitor bank provide a secondary current with is supplied to the relay inputs which are then further reduced by internal current transformers. The internal secondary current is applied to resistor networks which provide a voltage for use in the relay. This voltage is passed through low-pass filters and applied to analog/digital converters which act to provide amplification and a variable gain.

A similar process is followed for the input voltage.

MEASUREMENT PRINCIPLES

Current Measurement

The internal microprocessor timer generates an interrupt every millisecond (50 Hz) or every 0.833 milliseconds (60 Hz) thus producing 20 interrupts per cycle. The interrupts are divided into groups of five in such a manner that the first four interrupts are used to measure the phase and ground currents and the fifth is reserved for the event recorder. Each phase and ground is therefore measured 4 times per cycle with 5 milliseconds (50 Hz) or 4.33 milliseconds (60 Hz) between each measurement. With these four instantaneous current measurements, the RMS current can be calculated as follows:

$$Irms = \sqrt{\frac{I1^2 + I2^2 + I3^3 + I4^2}{4}}$$

To increase the precision of the measurement, range changing techniques are used within the system to take better advantage of the dynamic range of the analog to digital converter. This results in the use of the following three zones within the overall range of setting of the time overcurrent function.

Zone	Range
1	**1K** to **2K** (included)
2	**2K** (excluded) to **4K** (included)
3	**4K** (excluded) to **8K** (included)

The constant **K**, represents the minimum setting that can be made on the time overcurrent function (**TOC**) and, as shown below, is dependent on the range of the time overcurrent functions in the specific model of the MCP:

TOC Range	**K (In = 5)**	**K (In = 1)**

(0.1 to 0.8)x**In**	0.5	0.1
(0.2 to 1.6)x**In**	1.0	0.2
(0.3 to 2.4)x**In**	1.5	0.3

For example, if an MCP rated 5 amperes (**In** = 5) with a range of (0.2 to 1.6)x**In** is selected for the phase **TOC** functions, the corresponding range in amperes is 1 to 8. In this example, **K** = 1. It is important to know into which zone the setting of the **TOC** function falls, because this determines the maximum setting that can be made on the respective instantaneous overcurrent function (**IOC**). The minimum setting of **IOC** is always equal to **K** (1.0 ampere in this example) whereas the maximum setting for **IOC** is equal to 20 times the maximum setting that can be made on **TOC** in the zone that the **TOC** setting falls. For example, if **TOC** is set at 2.5 amperes, this setting falls into Zone 2 thus the maximum setting that can be made on **IOC** is 20 times 4 (the maximum setting of **TOC** in zone 2), or 80 amperes. If **TOC** was set at 1.5 amperes, then 40 amperes (2*20) would be the maximum setting that could be made on **IOC**.

Voltage and Unbalance Id/Vd Measurement

The voltage and unbalance current measurement uses the same algorithm as the current measurement. In this case, two of the five interrupts are used for the voltage and unbalance measurements with the remaining three used for inputs/outputs and the event recorder. Because the range of voltage and unbalance measurement is much less than the ranges involved in the current measurements, only one zone is required to cover the complete range.

Inverse Time Overcurrent Function, TOC

The currents are measured independently for each phase and ground and compared to the pickup setting. If the pickup is exceeded, the "PROT. PICK-UP" LED on the front panel of the relay will turn on and the function will start timing in accordance with one of the following selectable characteristic time curves provided in the MCP system

1. Inverse
2. Very Inverse
3. Extremely inverse
4. User Defined

Within each family, the curves are defined by a coefficient (time Index) that runs from 0.05, the lowest curve to 1.0, the highest curve. The time index is another way of referring to the "Time Dial" setting commonly referred to in many relays. The corresponding "Time Dial" settings are 0.5, lowest curve and 10, the highest curve. Characteristic curves can be selected independently for the phase and ground functions. Either, or both the phase and ground time overcurrent functions can be turned off by setting the respective pickup to zero (0).

The respective **TOC** function will operate within the following limits relative to the pickup setting, Is:

1.0*Is < Ioperate < 1.1*Is

The dropout of **TOC** will be greater than 95 percent of Ioperate, the current required to produce operation of the function.

Instantaneous Overcurrent Function IOC

The currents are measured independently for each phase and ground and compared to the pickup setting. If the pickup is exceeded, the "PROT. PICK-UP" LED on the front panel of the relay will turn on. Pickup of **IOC** phase or ground will start independently settable timers which on expiration of the set time delay will allow tripping to be initiated. The respective **IOC** function will operate within the following limits relative to the pickup setting, Is:

0.95*Is < Ioperate < 1.05*Is

The **IOC** functions follow the time curve shown in Figure 7. Note that he **IOC** functions will be very fast once the current exceeds twice the multiple of pickup. This time characteristic is intentionally designed to recognize that there might be DC offset in the current and thus has the characteristic shown below twice the multiple of pickup to allow time for the DC transient to subside.

IOC phase and/or **IOC** ground may be disabled by setting the respective pickup to zero (0).

Inverse Time Overvoltage Function, TOV

The voltage measurement is made on one of the phase-pair voltages and compared to the pickup setting. If the pickup setting Vs, is exceeded, the "PROT. PICK-UP" LED on the front panel of the relay will turn on and the function will start timing as shown in the time curves of Figure 6. The **TOV** function will operate within the following limits relative to the pickup setting, Vs:

1.0*Vs < Voperate < 1.1*Vs

The dropout of **TOV** will be greater than 95 percent of Voperate, the voltage required to produce operation of the function.

The characteristic time curves for **TOV** are shown in Figure 6. Here too, Time Index and Time Dial are interchangeable taking into account the factor of ten (10) associated with the Time Dial Setting.

The **TOV** function can be disabled by setting the pickup to zero (0

Instantaneous Overvoltage Function, IOV

The voltage measurement is made on one of the phase-pair voltages and compared to the pickup setting. If the pickup setting Vs, is exceeded, the "PROT. PICK-UP" LED on the front panel of the relay will turn on. The **IOV** function will operate within the following limits relative to the pickup setting, Vs:

0.95*Vs < Voperate < 1.05*Vs

The dropout of **IOV** will be greater than 95 percent of Voperate, the voltage required to produce operation of the function.

The **IOV** function can be disabled by setting the pickup to zero (0).

Unbalanced Current, Id (Model M)

The **Id** function is used to detect the current in the neutral of the capacitor bank (wye connected) that may be caused by unbalances in the capacitance of the individual phases of the bank. An alarm level and trip level are provided with each level having separately adjustable time delays.

When the current reaches the set value for the alarm level, the "UC ALARM PICK-UP" LED on the front panel will light. If the current is maintained for the alarm level set time delay, the "UC ALARM" LED on the front panel will light and the corresponding auxiliary relay will be activated.

When the current reaches the set value for the trip level, the "PROT PICK-UP" LED on the front panel will light. If the current is maintained for the trip level set time delay, the OPEN (trip) relay will be activated.

The **Id** function (alarm or trip) will operate within the following limits relative to the pickup setting, Is:

0.95*Is < Ioperate < 1.05*Is

The dropout of **Id** will be greater than 95 percent of Ioperate, the current required to produce operation of the function.

The **Id** function (trip level only) can be disabled by setting the pickup to zero (0).

Unbalanced Voltage, Vd (Model D)

The **Vd** function is used to detect the unbalance voltage in the capacitor bank (wye connected) that may be caused by unbalances in the capacitance of the individual phases of the bank. A trip level only is provided with adjustable time delay. When the voltage reaches the set tripping value, the LED display on the relay shows "**Vd** pick-up". If the voltage condition is maintained for the set time delay, the LED display will then show "**Vd** trip", and the OPEN (trip) relay will be activated.

The **Vd** function will operate within the following limits relative to the pickup setting, Vs:

0.95*Vs < Voperate < 1.05*Vs

The dropout of **Vd** will be greater than 95 percent of Voperate, the voltage required to produce operation of the function.

The **Vd** function can be disabled by setting the pickup to zero (0).

Zero Voltage

When the voltage at the capacitor bank drops below 50 percent of rated and remains there for a user settable time delay, it is considered to be a zero voltage condition and the capacitor bank will be disconnected. The "AUTO PICK-UP" LED on the front panel of the relay will be illuminated at that time, and the "Inhibit Operation" auxiliary relay will pick up . The relay will remain picked up until voltage returns to normal and control is enabled.

AUTOMATIC CONTROL

The purpose of the automatic control mode is to allow the capacitor bank to be inserted and removed from service automatically. To accomplish this, the relay must be set to the automatic mode. It can be placed in this mode by any of the following methods:

1. Through the communications port via the Mlink program and a personal computer (locally connected or remotely connected via a modem)
2. Through the keypad and display as explained in section under SINGLE KEY OPERATIONS.
3. Through an external contact connected to the "AUTO" input (terminal F6) of the relay. This contact when used must be held closed for at least 200 milliseconds for the command to be accepted.

Note that the relay will revert to the "Manual" mode of operation if the DC control voltage to the MCP is lost. One of the above steps must be taken to return it to the "Automatic" mode when the DC control voltage is returned.

Undervoltage/Overvoltage Control

Undervoltage - If the voltage at the capacitor bank falls below a set voltage and remains for a set time (both level and time are user settable), the MCP relay will issue a CLOSE order to insert the capacitor bank in service. The "AUTO IN PROGRESS" LED on the front panel will turn on when the voltage level is exceeded and will stay picked up until the timer setting is exceeded and the CLOSE order is issued.

This feature can be disabled by setting the pickup value of the undervoltage function to zero (0).

Overvoltage - When the voltage at the capacitor bank exceeds a set voltage and remains there for a set time (level and time are user settable), the MCP will issue an OPEN order to disconnect the capacitor bank. The "AUTO IN PROGRESS" LED on the front panel will light when the set voltage level is exceeded and will stay lit until the set time is exceeded and the OPEN order is issued.

This feature can be disabled by setting the pickup of the overvoltage function to zero (0).

Time-of-Day Control

The MCP can be programmed to provide time-of-day insertion and removal of the capacitor bank. Two separate programs can be provided: one for weekdays and one for weekends. Both programs are supervised by the instantaneous voltage functions in the following manner:

1. A CLOSE command will be issued only if instantaneous voltage is below the set value and there has not been a timed overvoltage trip. If a timed overvoltage trip has been started, but the timer has not timed out, a CLOSE command will be issued.
2. An OPEN command will be issued if voltage is above the set level of the instantaneous undervoltage function and there has not been a time undervoltage trip. If a timed undervoltage trip has been started, but the set time has not been reached, an OPEN command will be issued.

The MCP must be set in the "automatic" mode for time-of-day control to operate. One, or both, programs can be defeated by setting the insertion time equal to the removal time. This feature can be used if weekend control is not required.

The open/close time-of-day breaker logic is shown in Figures 11a and 11b.

DIGITAL INPUTS

The MCP has provisions for the following contact (digital) inputs:

1. Capacitor Bank Breaker (52 CAP/b) - This input is used to indicate the status of the breaker (open or closed).
2. Transformer Bank Breaker (52 BANK/b) - This input (when used) is used to indicate the status of the transformer bank breaker (see Figure 12 and 13). If the capacitor bank breaker is closed, and the transformer bank breaker is tripped, the MCP will issue an OPEN (trip) order to the capacitor bank breaker to disconnect the capacitor bank. At the same time, the trip contacts will seal-in, and the inhibit operation auxiliary relay will be energized and it can be used to block operation of the capacitor bank breaker until the transformer breaker is returned to service.
3. Manual - This input is used to put the MCP into the manual mode of operation. The input must be 200 milliseconds or greater in duration for the change to take effect.

4. Automatic - This input is used to put the MCP into the automatic mode of operation. The input must be 200 milliseconds or greater in duration for the change to take effect.

TRIP BLOCK

If the capacitor bank is tripped by any one of the overcurrent protection functions or the unbalance (current or voltage) functions, the MCP relay will revert to the manual mode of operation and closing of the capacitor bank breaker will be blocked until the MCP is manually reset. To indicate this condition, the "LOCKOUT BY TRIP" LED on the front panel of the relay will light and the operation disabled auxiliary output relay will be energized. If, for some reason, DC control power is lost to the MCP during a lockout by trip condition, the MCP will remember this and it will return to that state when power is returned.

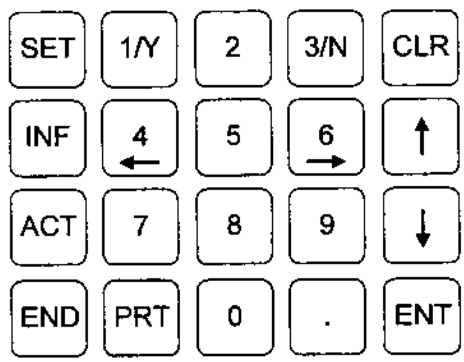
The lockout by trip condition may be reset through the keypad by following the instructions given under **Resetting A Trip Block** in the **KEYPAD AND DISPLAY** section of this book. The lockout by trip condition may also be reset through the MLINK communications program.

KEYPAD AND DISPLAY

GENERAL

The MCP is provided with a 20 key keypad and 32 character liquid crystal display divided into 2 lines of 16 characters each. The layout of the keypad and the LCD display is shown below:

```
      MCP
GENERAL ELECTRIC
```



Note that the 1/Y key serves to enter the number 1 or to answer **Yes** to questions that are asked when performing certain actions. Similarly, the 3/N key serves to enter the number 3 or to answer **No** to certain questions. The keypad allows the user to perform certain actions and to obtain information from the MCP through the following keys:

- **SET** - This key allows settings to be read or be modified
- **INF** - Information about the relay status, alarms, currents, etc., can be accessed through this key
- **ACT** - Opening and closing of the breaker can be performed (if enabled) and the time and date can be set.

When the MCP is in the standby mode, the following message is displayed.

```
      MCP
GENERAL ELECTRIC
```

This message must be displayed to enter into any one of the modes described above. Once one of the modes is entered, the **ENT**, **CLR** and the ↑ and ↓ keys are used to move within that mode. The use is of these keys is as follows:

- **ENT** - Accepts the action currently displayed. It is equivalent to descending one level in the menu tree.
- **CLR** - Clears the display and returns to the previous display. It is equivalent to ascending one level in the tree. Continue pressing the **CLR** key to return to the standby display described above.
- ↑/↓ - Changes the option. When the desired option appears in the display, use the **ENT** to select it.

The use of these keys will become clear as each distinct group is described.

SINGLE-KEY OPERATIONS

The MCP allows information to be obtained through the use of the <**ENT**> key. The following information can be obtained by starting from the standby screen:

```
MCP
GENERAL ELECTRIC
```

<**ENT**>

```
A = 3.52      B = 3.46
C = 3.50      N =
```

The phase and neutral currents are displayed and then are continually updated.

<**ENT**>

```
V = 119.6
Id = 0.21
```

The phase voltage (V) and unbalance current (**Id**) are displayed and are then continually updated. The unbalance voltage (**Vd**) will be displayed in place of **Id** if the MCP includes the unbalance voltage function.

<**ENT**>

```
MANUAL
```

This display indicates that the MCP is in the manual mode of operation. Pressing <**ENT**> produces the following:

<**ENT**>

```
KEEP PRESSED
TO AUTOMATIC
```

To change the mode of operation to AUTOMATIC, release the **<ENT>** key and then press it and keep it pressed. The display will momentarily change to AUTOMATIC and then will change to the screen shown below. If the MCP was in the AUTOMATIC mode then releasing and holding the **<ENT>** key will change the MCP to the MANUAL mode of operation.

<ENT>

```
■ PROT PICKUP
□ AUTO IN PROG
```

<ENT>

This display and the following displays indicated the status of the LED targets. The block to the left of the text indicates the status of the LED. ■ Indicates that the LED is on whereas □ indicates that the LED is inactive.

```
□ Id ALARM
□ Id ALARM PICKUP
```

<ENT>

This display shows the alarm and the alarm pickup for the unbalanced current function. For the model with the unbalance voltage function, the pickup and trip values of **Vd** would be displayed.

```
□ TIME NOT SET
□ LOCK OUT BY TRIP
```

<CLR>

This display shows whether or not the time is set and the lock out by trip status. The lockout by trip indicator will be present if the overcurrent or the unbalance protection functions operated to trip the capacitor bank breaker.

```
       MCP
GENERAL ELECTRIC
```

The <**CLR**> key can be pressed at any time during the sequence to return to the standby display.

INTERACTION OF THE KEYPAD WITH REMOTE COMMUNICATIONS

The keypad has priority over remote communications in the MCP. When the keypad is active, all messages specifically directed to the unit from a remote location are responded to with the error message "RELAY BUSY".

The keypad becomes active when pressing either the **SET**, **INF** or **ACT** keys. It is also activated by pressing the <**ENT**> key for single key operations or when one of the numeric keys is pressed for entry into the configuration unit. If, when pressing one of these keys, remote communication is active, the following message will be displayed:

```
BREAKING REMOTE
PLEASE WAIT
```

This message will last until the remote connection is broken. To ensure transmission integrity, the MCP is designed so that remote communications cannot be interrupted if a message is being transmitted. For this reason, the previous message may remain displayed noticeably longer at lower transmission rates (300 - 600 baud).

When the <**CLR**> key is pressed while in the **SET**, **INF** or **ACT** modes, the following display will appear:

```
(*)        MCP
 GENERAL ELECTRIC
```

The (*) indicates that the keypad is still busy. The (*) can be cleared immediately by pressing the <**END**> key, or it will be cleared after a time delay of two minutes and eleven seconds.

If the keypad is being used in the **SET**, **INF** or **ACT** modes, and no key is pressed for two minutes and eleven seconds, the keypad will be deactivated and the screen will return to the standby mode (without the (*)).

If the keypad is being used in the single key mode then the display will remain active indefinitely until the <**CLR**> key is depressed or until remote communications is established (the keypad does not take priority over remote in single key operations). The keypad will be deactivated when <**CLR**> is pressed or remote communications is established and the display will return to the standby mode.

CONFIGURATION SETTINGS

To change any of the configuration settings, make sure that the standby screen is being displayed as shown below:

```
       MCP
GENERAL ELECTRIC
```

Now enter the following four digit code: 7169. As each number is entered, an asterisk (*) will appear in the display. After the fourth digit (9) is entered, the display will appear as follows:

```
      ****
```

Now press the <**ENT**> key: <**ENT**>

```
UNIT NUMBER
1              ---------
```

<1> <5>

This screen shows the unit number which is used to provide a unique identification to the relay. It can be set to any number from 1 to 255. The number to the lower left of the display shows the present unit number and the series of dashes (---------) is the placeholder to enter a new number, if desired. To change the unit number, simply type in the new number when the above screen is displayed. For example if a unit number of 15 is desired, enter the numbers 1 and 5 through the keypad which will then yield the following display.

```
UNIT NUMBER
1              15-------
```

<**ENT**>

```
UNIT NUMBER
1              15
```

<↑>

Note that the dashes following the number disappear when the <**ENT**> key is depressed, indicating that the number was accepted. To actually implement the change, the <**END**> key must be pressed. Before this is done, however, scroll through the rest of the configuration settings by pressing the <↑> key:

```
SPEED (BAUDS)
9600           ---------
```

<↑>

The baud rate can be changed at this time. Available settings are: 300, 600, 2400, 4800 and 9600.

```
STOP BITS
1              ---------
```

<↑>

Sets the number of bits (0, 1 OR 2) added to each byte transmitted across the serial line. The MCP always transmits eight bits without parity. Set stop bits to meet the communications link requirements.

```
MAN. FROM KBD
PERMIT         ---------
```

<↑>

This setting can be used to allow or block manual control of the breaker via the keypad. The message (PERMIT) displayed above allows manual control. To block control, press the <1/N> key which will produce the following display:

```
MAN. FROM KBD
PERMIT          prohib
```

Pressing **<ENT>** at this time will change prohib to PROHIB indicating that the change was accepted. To actually enter the setting, the **<END>** key must be used as will be demonstrated later.

<ENT>

```
MAN. FROM KBD
PERMIT          PROHIB
```

<↑>

```
SET. FROM KBD
PERMIT          ---------
```

In a like manner, this setting can be used to allow or block changes in settings via the keypad. Follow the same procedure described under MAN. FROM KBD to change the setting from PERMIT to PROHIB.

<↑>

```
MAN. REMOTE
PERMIT          ---------
```

This setting allows or blocks remote control of the breaker via the serial port. Follow the same procedure described under MAN. FROM KBD to change the setting from PERMIT to PROHIB.

<↑>

```
SET. REMOTE
PERMIT          ---------
```

This setting allows or blocks changes in settings to be made via the serial port.. Follow the same procedure described under MAN. FROM KBD to change the setting from PERMIT to PROHIB.

<↑>

```
LANGUAGE
ENG.            ---------
```

<END>

This setting allows presentation of the display messages in either the English (ENG.) or Spanish (ESPA.) language. Enter <0> for Spanish or <1> for English.

Now that all of the Configuration Settings have been scrolled through and the necessary changes made. It is necessary to enter the settings into the relay by pressing the <**END**> key. The following display will appear:

```
MODIFY SETTINGS
(Y/N)
```

<1/Y>

```
MODIFY SETTINGS
(Y/N) YES
```

<ENT>

```
  (*)        MCP
 GENERAL ELECTRIC
```

Pressing <**ENT**> causes the display to return to the standby mode indicating that the new settings have been entered into the relay. As a final check, it is advisable to scroll through the Configuration Settings group at this time.

The configuration settings are stored in permanent EEPROM memory. If the memory were to deteriorate (not likely) the relay would lose the settings and not be configured. If this were to occur, the default configuration will be loaded, the NO CONFIGURATION alarm will appear in the display under relay status and remote communications will be disabled. The relay must then be reconfigured to remove the alarm and to establish remote communications.

INFORMATION GROUP

GENERAL

This group provides information related to the MCP.:

```
MCP
GENERAL ELECTRIC
```

<INF>

To access this group, press the **INF** key when the standby screen is displayed. The following should appear

```
MODEL
```

<ENT>

The model number of the relay can be accessed at this time. By pressing <<**ENT**>>.

```
MCP1111N21G00
60 HZ
```

<CLR>

Press <**CLR**> to return to the previous display.

```
MODEL
```

<↑>

Use the <↑> to scroll through the remaining screens that can be viewed under the information group. As each new option is displayed press <**ENT**> to view the information

```
CURRENTS
```

<ENT>

The currents will be displayed and will then be continually updated

```
A = 0.00     B = 0.00
C = 0.00     D = 0.00
```

<CLR>

```
CURRENTS
```

<↑>

```
VOLTAGE
```

<ENT>

```
V =  0.00
Id =  0.00
```

<CLR>

The display shows the input voltage (V) to the relay and the unbalance current (**Id**) at that moment and then is continuously updated. If an MCP with the unbalance voltage option is chosen (Model D), the unbalance voltage (**Vd**) would be shown instead of **Id**.

```
VOLTAGE
```

<↑>

```
STATUS OF
RELAY
```

<ENT>

```
RELAY IN SERVICE
[ALARMS]
```

<CLR>

Pressing of the ↑/↓ key will display all alarms that are stored in the MCP. If [ALARMS] is not shown in the display, there are no alarms stored. The available alarm messages are:

NO CONFIGURATION
BREAKER ACCUMULATE LIMIT
INPUTS DISABLED
INTERNAL COMMUNICATIONS FAILURE
CLOCK STOPPED
NO USER CURVE

```
STATUS OF
RELAY
```

<↑>

```
STATUS OF
BREAKER
```

<ENT>

CLOSED
MANUAL

The capacitor bank breaker status appears on the first line (closed in this example). The message on the second line indicates whether the MCP is in the manual mode (MANUAL) or automatic mode (AUTOM.) of operation. If the transformer bank breaker input (terminal F7) is energized (b switch closed indicating transformer bank breaker is open) the screen will appear as follows:

OPEN
MANUAL BREAKER

<CLR>

DATE AND TIME

<ENT>

28-JUN-95
12:00:00

<CLR>

DATE AND TIME

<↑>

EVENTS

<ENT>

PROCESSING
EVENT [NN]

Selection of this option will extract the stored events from the system memory. During the extraction, the above message will appear on the display (NN is the number of the event extracted). On completion of the extraction, the most recent event will be displayed as typified in the screen shown below.

```
29JUN  15:08:5236
52 FAIL TO OPEN
```

<CLR>

The 49 most recent events can be scrolled through on the display by pressing the <↑> <↓ > keys. Pressing <↑ > will progress through the events from the most recent to the oldest. If <↓> is pressed, the order of events displayed will be from the oldest to the most recent. Note that all events will be extracted (up to 255) but only the 49 most recent can be viewed on the display. The possible event messages, and instructions on how to obtain more information relative to a specific event, are given below under DETAILS OF AN EVENT.

```
(*)      MCP
 GENERAL ELECTRIC
```

Note that the last display is very similar to the standby display except for the appearance of the (*) which simply means that the keypad is busy. The significance of the (*) will be explained in the section **Interaction of the Keypad with Remote Communications.** For now, its presence does not affect the use of the keypad. If desired, it can be cleared by pressing <**END**>.

DETAILS OF AN EVENT

The following details can be obtained for a specific event by pressing <**ENT**>.

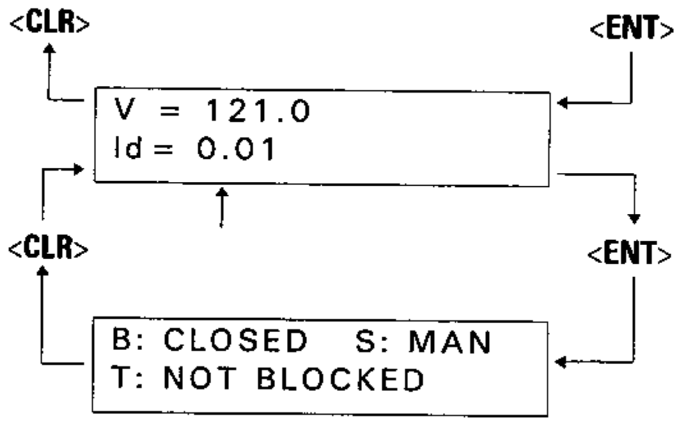
- Currents at the time of the event
- Value of the voltage and the unbalance current or voltage (depending on model) at the time of the event
- The breaker state and blocked by trip state at the time of the event

For the event shown above, the additional information relative to that event will appear as follows:

```
29JUN  15:08:5236
52 FAIL TO OPEN
```

<CLR> **<ENT>**

```
A =  3.56      B =  3.61
C =  3.52      N =  0.01
```



TYPES OF EVENTS

CPU Protection Functions

PU TOC PHASE:	Timed phase pickup
PU IOC PHASE:	Instantaneous phase pickup
PU TOC GROUND:	Timed neutral pickup
PU IOC GROUND:	Instantaneous neutral pickup
TRIP TOC PHASE:	Timed phase trip
TRIP IOC PHASE:	Instantaneous trip
TRIP TOC GROUND:	Timed neutral trip
TRIP IOC GROUND:	Instantaneous neutral trip

CPU Voltage and Control Functions

PU UNDERV AUTO:	Undervoltage pickup
PU OVERV AUTO:	Overvoltage pickup
PU ZERO VOLTAGE:	Zero voltage pickup
PU TOV:	Timed overvoltage pickup
PU UC CURRENT:	UC (unbalance current) pickup
PU UC ALARM:	UV (unbalance current) alarm pickup
TRIP UNDERV AUTO:	Undervoltage trip
TRIP OVERV AUTO:	Overvoltage trip
TRIP ZERO VOLT:	Zero voltage trip
TRIP TOV	Timed overvoltage trip
TRIP OVERV PROT	Instantaneous overvoltage trip
TRIP UC CURRENT	UC (unbalance current) trip

Breaker Operations

BREAKER OPEN:	Breaker opened
BREAKER CLOSE:	Breaker closed

EXT OPEN COMM:	External open order
EXT CLOSE COMM:	External close order
52 FAIL TO CLOSE:	Close order failed
52 FAIL TO OPEN:	Open order failed
OPEN BY TIME ST:	Opened by time-of-day control
CLOSE BY TIME ST:	Closed by time-of-day control

Inputs

MANUAL:	Manual input activated
AUTOMATIC:	Automatic input activated
BREAKER BANK:	Breaker bank input activated
DISAB 52 INPUTS::	"Relay status" disabled
DISAB BANK 52:	"Breaker bank" disabled

Miscellaneous

SETTINGS CHANGED:	Settings changed
PROGRAM START:	Program initiated
RESET BLOCK:	Trip block reset
USR CURVE:	User curve changed
TIME/DATE SET:	Date and time set
ADC. I FAILURE:	Reference voltage failure - CPU protection
ADC. I CORRECT:	Reference voltage recovery - CPU protection
ADC. U FAILURE:	Reference voltage failure - CPU voltage
ADC. U CORRECT:	Reference voltage recovery - CPU voltage

ACTION GROUP

The Action Group allows the following to be performed:

1. Open the capacitor bank circuit breaker
2. Close the capacitor bank circuit breaker
3. Set the date and time

The following displays can be found under the action group:

MCP
GENERAL ELECTRIC

<ACT>

OPEN
BREAKER

<↑>

CLOSE
BREAKER

<↑>

SET DATE & TIME

<CLR>

(*) MCP
GENERAL ELECTRIC

To initiate any of the actions, press <**ENT**> after the appropriate screen is displayed.

OPEN BREAKER

For example, to initiate opening of the breaker, do the following:

MCP
GENERAL ELECTRIC

<**ACT**>

OPEN
BREAKER

<ENT>

```
CONFIRM
(Y/N)
```

<Y>

```
CONFIRM
(Y/N) YES
```

<ENT>

```
OPENING
SUCCESSFUL
```

<ENT>

```
BREAKER
OPENED
```

<CLR>

```
(*)     MCP
GENERAL ELECTRIC
```

Note that once an action is selected, it must be confirmed before it will be performed. This confirmation procedure is used to prevent unnecessary operations from taking place. If the breaker opening had been unsuccessful, the following screen would have appeared:

```
OPENING
UNSUCCESSFUL
```

CLOSE BREAKER

A similar procedure can be followed if closing of the breaker is required.

SET DATE AND TIME

To set the time and date, use the following procedure:

MCP
GENERAL ELECTRIC

<ACT>

OPEN
BREAKER

<↑>

CLOSE
BREAKER

<↑>

SET TIME & DATE

<ENT>

DATE
dd:mm:yy

Enter the date, month and then the year as shown below (the dashes shown separating the quantities will be placed automatically by the relay.

DATE
17-06-95

<ENT>

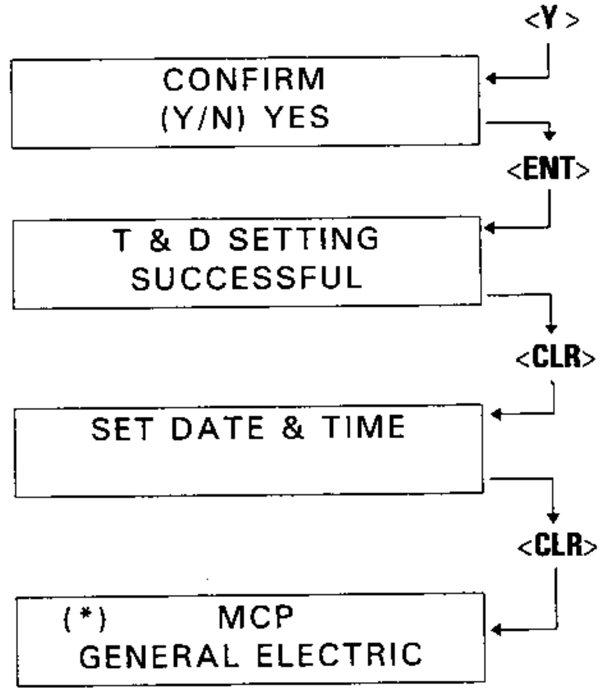
TIME
hh mm ss

Enter the hours. Minutes and seconds as shown below (the colons separating the quantities will be entered automatically).

TIME
10:15:25

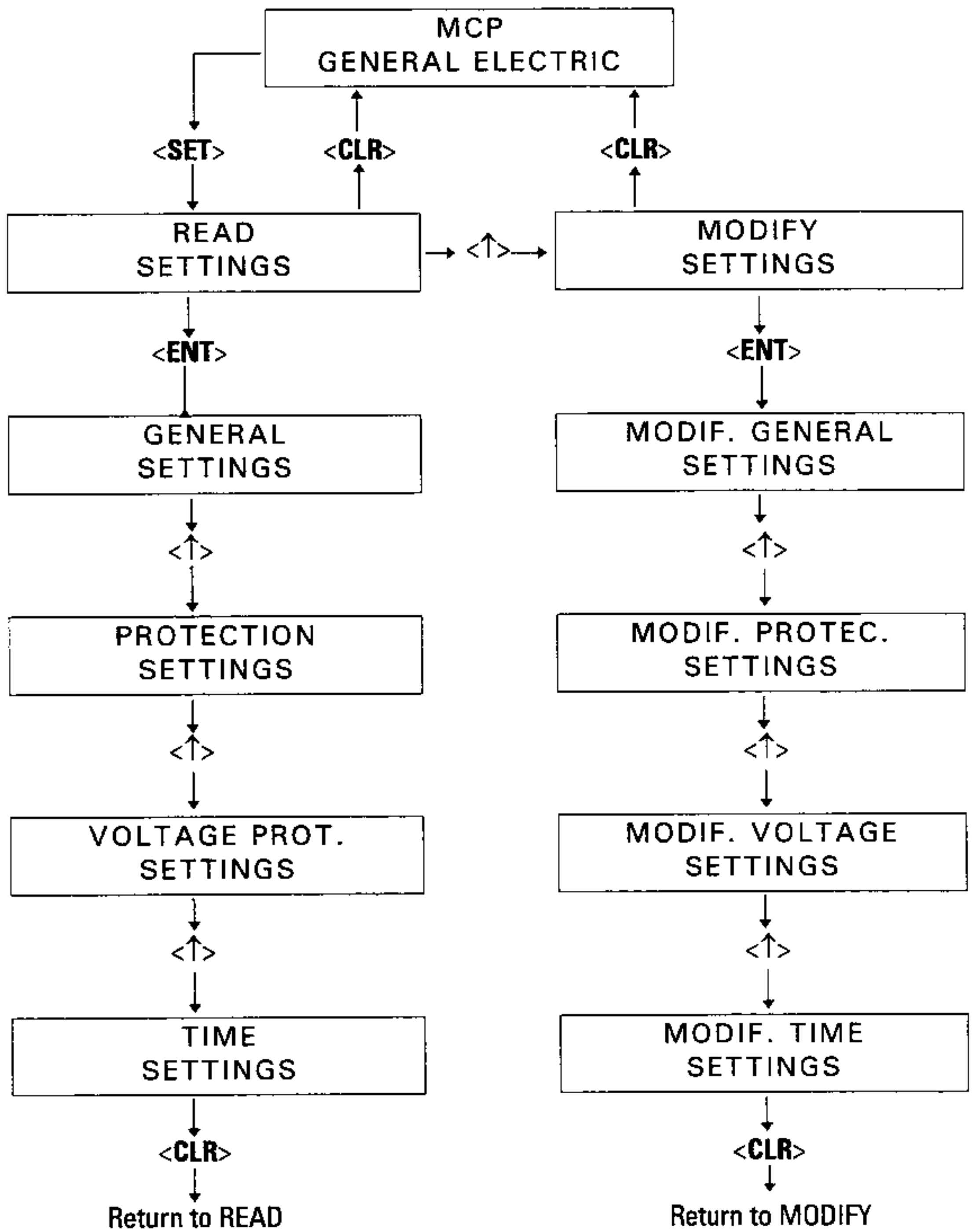
<ENT>

CONFIRM
(Y/N)


<Y>
CONFIRM
(Y/N) YES
<ENT>
T & D SETTING
SUCCESSFUL
<CLR>
SET DATE & TIME
<CLR>
(*) MCP
GENERAL ELECTRIC

SETTINGS GROUP

The **SET** key on the keypad allows the user to either read or modify the settings in the various settings groups. Starting with the display screen, the read or modify option can be selected as follows:



To read or modify the settings in any specific group, go to the desired display, and then press <**ENT**> to access the settings for that group. Following is a list of the settings by group along with a brief description of each of the settings: The settings are given as they appear on the LED display and in the order in which they appear when the <↑> key is pressed.

GENERAL SETTINGS GROUP

PHASE CT RATIO

The ratio of the phase CT's entered as a single number. If the phase CT ratio is 1200/5, enter 240 for this setting. Range: 0 to 4000, step = 1.

GROUND CT RATIO

The ratio of the ground CT (if separate) - enter as a single number. If a separate ground CT is not use, enter same number as for phase CT's. Range: 0 to 4000, step = 1.

VOLTAGE VT RATIO

The voltage ratio of the potential transformer from which the input voltage is obtained, entered as a single number. If the PT is rated 69,000/115, enter 600 for this setting.. Range: 0 to 4000, step = 1.

UC CT RATIO (Unbalanced Current CT)

The ratio of the CT used in the unbalanced current circuit entered as a single number. If the CT ratio is 120/5, enter 24 for this setting. Range: 0 to 4000, step = 1.

MAX OPENING TIME

The maximum opening time for the breaker entered in seconds. Range: 0.1 to 1.0 seconds, step = 0.1 seconds.

MAX CLOSING TIME

The maximum closing time expected for the breaker entered in seconds. Range: 0.5 to 99.9 seconds, step = 0.1 seconds.

LIMIT

The breaker total interrupting capability - enter in kilo-amperes squared (kA^2). Range: 1 to 99999 kA^2.

ACCUMULATED

The accumulated breaker duty in kilo-amperes squared (kA^2).. Enter the accumulated duty for the breaker in use. Range: 0 to 99999 kA^2.

BREAKER NUMBER

The breaker identification number entered as a single number. Range: 0 to 255.

TIME TO CLOSE

The time delay for which closing is prohibited following opening of the capacitor bank breaker - entered in minutes. Range: 0 to 15 minutes, step = 1 minute.

PROTECTION SETTINGS GROUP

PH INST PU

The pickup in amperes of the phase instantaneous overcurrent function - entered in amperes. Range: See **Current Measurement** section (Page 9) under **OPERATING PRINCIPLES**.

Set to zero to disable this function.

PH INST DELAY T

The time to delay the phase instantaneous overcurrent function - entered in seconds. Range: 0 to 9.99 seconds, step = 0.01 seconds.

PH TIME OC PU

The pickup in amperes of the phase time overcurrent function - entered in amperes

Range: (0.1 to 0.8)xIn, step = 0.01 amperes
(0.2 to 1.6)xIn, step = 0.01 amperes
(0.3 to 2.4)xIn, step = 0.01 amperes

} see specific model

Set to zero to disable time overcurrent function.

PH TIME INDEX

This setting corresponds to the time dial setting and is set per selected time curve. Range: .05 to 1.0, step =0.01.

PHASE CURVE

Selects the curve to be used by the phase time overcurrent functions.

Selection:
0. User curve - see Figure 5
1. Extremely Inverse - see Figure 4
2. Very Inverse - see Figure 3
3. Inverse - see Figure 2

The curve fitting program, MORCALC, can be used to generate any curve to be used as the user curve.

GRN INST PU

The pickup of the ground instantaneous overcurrent function entered in amperes. Range: See Current Measurement section (Page 4) under **OPERATING PRINCIPLES.**

Set to zero to disable this function.

GRN INST DELAY T

The time to delay the ground instantaneous overcurrent function - entered in seconds. Range: 0 to 9.99 seconds, step = 0.01 seconds.

GRN TIME OC PU

The pickup in amperes of the ground time overcurrent function - entered in amperes.

Range: (0.1 to 0.8)xIn, step = 0.01 amperes
(0.2 to 1.6)xIn, step = 0.01 amperes
(0.3 to 2.4)xIn, step = 0.01 amperes
} see specific model

Set to zero to disable time overcurrent function.

GRN TIME INDEX

This setting corresponds to the time dial setting and is set per selected time curve. Range: .05 to 1.0, step =0.01.

GROUND CURVE

Selects the curve to be used by the ground time overcurrent functions - enter number for desired curve as listed below:

0 = User curve - see Figure 5

1 = Extremely Inverse - see Figure 4
2 = Very Inverse - see Figure 3
3 = Inverse - see Figure 2

The curve fitting program, MORCALC, can be used to generate any curve for use as the user curve.

PROTECTION SETTING EXAMPLE

The PROTECTION SETTINGS group will be used to demonstrate how the settings can be changed via the keypad. Follow a similar procedure the change settings in any of the other settings groups.

MCP
GENERAL ELECTRIC

<SET>

READ
SETTINGS

<↑>

MODIFY
SETTINGS

<↑>

MODIF. GENERAL
SETTINGS

<↑>

MODIF. PROTEC.
SETTINGS

<ENT>

PH INST PU
10.00A ---------

<↑>

The present setting (10.00A) is shown to the left in the display. The dashed line (----------) indicates the place where the changed setting would be entered if a change is desired. If no change is desired, use the <↑> key to scroll to the next display.

PH INST DELAY T.
0.05 s ---------

Assume that the delay time is to be changed to 0.1 seconds. To do this, enter 0.1 via the keypad (if a mistake is made, press the <**CLR**> key to start over) and the display will then appear as follows:

<0><.><1>

```
PH INST DELAY T.
0.05 s          0.1------
```

To have this value accepted, press the <**ENT**> key which will remove the dashes (--------) to show that the entry has indeed been accepted. To clear the value, press <**CLR**> key. Follow the same procedure to change any of the remaining protection.

<**ENT**>

```
PH INST DELAY T.
0.05 s          0.1
```

Press the <↑> to move to the next display.

<↑>

```
PH TIME OC PU
1.5 A           ---------
```

<↑>

```
PHASE TIME INDEX.
1.0             ---------
```

<↑>

```
PHASE CURVE.
EX INV          ---------
```

<↑>

```
GRN INST PU.
1.0 A           ---------
```

<↑>

```
GRN INST DELAY T.
0.1 s           ---------
```

<↑>

```
GRN TIME OC PU.
1.0 A           ---------
```

<↑>

```
GRN TIME INDEX.
0.2            ---------
```

<↑>

```
GROUND CURVE.
EX INV         ---------
```

After all of the settings have been entered, all of the screens should be scrolled through by pressing either the <↑> or <↓> to assure that the correct settings have been entered. After verification, press the <**END**> key to implement the changes. The following display will appear.

<**END**>

```
CHANGE SETTINGS.
(Y/N)
```

To make the changes, press the <**1/Y**> key and then the <**ENT**> key which will produce the following screen:

<1/Y><**ENT**>

```
CHANGE SETTINGS.
(Y/N)  YES
```

Press <**ENT**> once more to verify that the changes should be made. This will produce the following screen:

<**ENT**>

```
SETTINGS CHANGED.
```

Note that if any of the settings were entered in error (an incorrect number), the above display would not have appeared. The following screen will appear instead:

```
ERR. IN SETTINGS.
```

If this message appears, press <**ENT**> and then scroll through the protection setting screens (or whatever group being worked in) to determine where the error was made. Any setting that was made in error will be marked with an R> whereas correctly entered settings will be marked with an A>as in the screens shown below:

Correctly entered setting:

```
PH INST PU
45.00    A>   55.00.
```

Incorrectly entered setting:

```
PH INST PU
45.00     R>   65.02.
```

To correct the error, simply enter the correct number and then press <**END**> to complete the settings procedure.

VOLTAGE PROTECTION & CONTROL SETTINGS

UNDERVOLTAGE AUTOM

Sets the voltage in the automatic mode to initiate connection of the capacitor bank when the voltage falls below a set level for a set amount of time delay - entered in volts. Range: 85 to 110 volts, step = 1.0 volts.

Set to zero to disable function.

UNDERVOLT TIME

Sets the time delay to use with the UNDERVOLTAGE AUTOM function described above - enter in minutes and seconds. Range: 3 to 5 minutes, step = 1.0 second.

NOTE: To enter this setting, enter the number of minutes, then press the decimal point key, then enter the number of seconds. For example to enter 3 minutes and 59 seconds, use the following key strokes: <3><.><5><9><<**ENT**>.

OVERVOLT AUTOM

Sets the voltage to be used in the automatic time mode to disconnect the capacitors from the system or to prevent connection of the capacitors when the voltage exceeds the set voltage for the set time delay - enter in volts. Range: 110 to 130 volts, step = 1.0 volt.

Set to zero to disable function.

OVERVOLT TIME

Sets the time delay to be used with the OVERVOLT AUTOM function described above - enter in minutes and seconds. Range: 3 to 5 minutes, step = 1.0 seconds

NOTE: To enter this setting, enter the number of minutes, then press the decimal point key, then enter the number of seconds. For example to enter 3 minutes and 59 seconds, use the following key strokes: <3><.><5><9><<**ENT**>.

OVERVOLT AUTO INST

Sets the value of the instantaneous overvoltage function that is used in the automatic time mode to prevent connection of the capacitors when the voltage exceeds the setting - enter in volts. Range: 110 to 130 volts, step = 1.0 volt.

ZERO VOLT TIME

Sets the time delay to use to disconnect the capacitor from the system when the voltage falls below 50 percent of the rated value - enter in seconds. Range: 1 to 60 seconds, step = 0.01 seconds.

OVERVOLT PROT INST

Sets the voltage in the protection that will instantly initiate disconnecting of the capacitor bank when the voltage exceeds the set value - enter in per unit. Range: (1.5 to 2.0)xVn, step = .01.

OVERVOLT TIME OV

Sets the voltage in the protection that will initiate disconnecting of the capacitor bank when the voltage exceeds the set value for a time delay determined by the selected timing index curve - enter in volts. Range: 100 to 140 volts, step = 1.0 volt.

OVERVOLT TIME INDEX

Sets the curve (see Figure 6) that the OVERVOLT TIME OV function will use to add time delay before initiating disconnection of the capacitor bank. Range: 0,05 to 1.0, step = 0.01.

CURRENT Id (Model M)

ALARM CURRENT Id

Sets the level at which the unbalance current will initiate an alarm following a set delay when the level is exceeded - enter in amperes. Range: 0.5 to 2.0 amperes, step = 0.01

ALARM Id TIME

Sets the time to wait before initiating the unbalance current alarm - enter in seconds. Range: 1 to 10 seconds, step = 0.01.

CURRENT Id

Sets the level at which the unbalance current will initiate a trip following a set time delay - enter in seconds. Range: 1 to 5 amperes, step = 0.01 amperes.

Set to zero to disable this function.

CURRENT Id TIME

Sets the time to wait before initiating an unbalance current trip - enter in seconds. Range: 0.1 to 1.0 seconds, step = 0.01 seconds.

VOLTAGE Vd (Model D)

VOLTAGE Vd

Sets the level at which the unbalance voltage will initiate a trip following a set time delay - enter in volts. Range: 2 to 18 volts, step = 1.0 volts.

Set to zero to disable this function.

VOLTAGE Vd TIME

Sets the time to wait before initiating an unbalance voltage trip - enter in seconds. Range: 1 to 20 seconds, step = 1.0 seconds.

TIME SETTINGS GROUP

OPEN WORK DAY

Sets the time in the automatic mode of operation to connect the capacitor bank to the system - enter in Hours:Minutes:Seconds (a twenty four hour military clock is used; for example 1:30 pm = 13:30:00 in twenty four hour time))

CLOSE WORK DAY

Sets the time in the automatic mode of operation to disconnect the capacitor bank from the system - enter in Hours:Minutes:Seconds (a twenty four hour military clock is used; for example 2:40 pm = 14:40:00 in twenty four hour time)

Note that the above times (work day) refer to the WORK DAYs of the week - Monday through Friday. If automatic time operation is not required on work days, set the open time equal to the close time. If this is done, both times will appear as 00:00:00 once the setting is implemented by pressing <**END**>.

OPEN HOLIDAY

Sets the time in the automatic mode of operation to connect the capacitor bank to the system - enter in Hours:Minutes:Seconds (a twenty four hour military clock is used; for example 11:30 Am = 11:30:00 in twenty four hour time))

CLOSE HOLIDAY

Sets the time in the automatic mode of operation to disconnect the capacitor bank from the system - enter in Hours:Minutes:Seconds (a twenty four hour military clock is used; for example 5:15 pm = 17:15:00 in twenty four hour time)

Note that the above times (HOLIDAY) refer to the weekend days - Saturday and Sunday. If automatic time operation is not required on weekends, set the open time equal to the close time. If this is done, both times will appear as 00:00:00 once the setting is implemented by pressing <**END**>.

RECEIVING, HANDLING AND STORAGE

Immediately after receiving the relay, it should be checked for any signs of damage due to transportation. If it is apparent that the relay has been damaged due to inappropriate handling, it should be immediately reported in writing to the transportation carrier and also to the factory.

If the relay is not to be installed immediately, it is recommended that it be stored in it's original package and kept in a dry, dust-free place.

It is important to check that the name plate data coincides with the data from the original order.

ACCEPTANCE TESTS

Immediately after receiving the relay, visually check the relay to assure that it has not suffered transportation damage. The acceptance tests described below should be run to verify that the relay is functioning normally and that the factory calibration has not been altered. Verify that the model number and data on the nameplate coincide with that of the order. Visually inspect the relay and check that nothing has been broken or damaged during transport.

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

GENERAL CONSIDERATIONS

All devices operating on alternating current are affected by the frequency. Because non-sinusoidal waveforms can be analyzed as a fundamental frequency plus harmonics of the fundamental, it follows that relays operating on alternating current are affected by non-sinusoidal waveforms. To properly test relays that operate on alternating current it is necessary to use a current waveform that is sinusoidal. The MCP relay incorporates a set of analog and digital filters that are frequency sensitive. Consequently measurements will be affected by non-sinusoidal waveforms.

Additionally, the MCP incorporates a switched DC power supply that must be energized from a pure DC source and not from rectified alternating current that is not filtered. If there is excessive ripple in the DC source, it is possible that the relay and the measuring functions will not operate correctly. When using a DC source with an elevated ripple (AC component) the absolute minimum value of DC voltage must greater than the minimum DC auxiliary voltage specified for the relay. For example, in the 48/125 volts DC model it is necessary to supply a voltage that will never be less than 80 percent of 48 volts DC. As a rule, the applied auxiliary voltage should not have a ripple greater than 5 percent.

The MCP relay calculates the current based on the fundamental component only. For this reason, using an ammeter that does not measure fundamental values (for example, one that measures average value or does not filter out the harmonics), causes the relay readings and the ammeter readings to be different. This does not mean that the relay is not measuring correctly. The test equipment used to perform the trip tests and operating time tests must be calibrated and have a precision better than that of the relay. If the applied AC test quantities are derived directly from the power system, they must remain stable in magnitude, when testing near pickup levels.

The relays are calibrated in the factory using frequency-synthesized, programmable test equipment. When testing the relay, an AC source should be used that does not contain harmonics. It is important to stress that test precision depends on the precision of the test source and the instruments used.

PROTECTION FUNCTIONS

TIME OVERCURRENT FUNCTIONS (TOC)

Pickup Calibration

Connect the MCP as shown in Figure 9. Set the phase and ground time overcurrent functions to the minimum pickup. Set the instantaneous functions to pick up with a value higher than the time functions, or turn them off by setting their pickup to zero. Apply current to the relay that is less than the pickup and then slowly increase it and check that the PROT PICK-UP LED lights and that the trip relay contact closes between 100 and 110 percent of the pickup setting. With the relay still picked up, slowly reduce the current and check that the PROT PICK-UP LED goes out and that the output relay contact opens between 95 and 105 percent of the pickup setting.

Operating Time

Choose one of the pickup settings shown in Tables 1-4, and set the Index Time (IT) setting to 0.5. Apply currents of 2.0, 5.0 and 10.0 times the pickup setting and, for the specific curve type, check that the operating time is within the values indicated in the respective Table.

Table 1 - Inverse Characteristic

Multiples of PU	PU = 0.5 Test I	PU = 1.0 Test I	PU = 1.5 Test I	Operating Time
2.0	1.0	2.0	3.0	4.14 - 5.32
5.0	2.5	5.0	7.5	1.89 - 2.19
10.0	5.0	10.0	15.0	1.36 - 1.50

Table 2 - Very Inverse Characteristic

Multiples of PU	PU = 0.5 Test I	PU = 1.0 Test I	PU = 1.5 Test I	Operating Time
2.0	1.0	2.0	3.0	7.03 - 9.04
5.0	2.5	5.0	7.5	1.89 - 2.19
10.0	5.0	10.0	15.0	0.88 - 0.98

Table 3 - Extremely Inverse Characteristic

Multiples of PU	PU = 0.5 Test I	PU = 1.0 Test I	PU = 1.5 Test I	Operating Time
2.0	1.0	2.0	3.0	14.03 - 18.04
5.0	2.5	5.0	7.5	1.89 - 2.19
10.0	5.0	10.0	15.0	0.50 - 0.55

Table 4 - User Characteristic

Multiples of PU	PU = 0.5 Test I	PU = 1.0 Test I	PU = 1.5 Test I	Operating Time
2.0	1.0	2.0	3.0	5.59 - 7.19
5.0	2.5	5.0	7.5	1.89 - 2.19
10.0	5.0	10.0	15.0	1.08 - 1.20

If pickup settings other than those listed in the tables are to be used, apply tests currents in multiples of 2.0, 5.0 and 10.0 relative to those settings and check that the operating times correspond to those given in the respective table for the curve selected.

Set the time overcurrent functions to minimum pickup and apply a current equal to 5 times the pickup setting. Check that operation occurs within the limits for the Index Time settings shown in Table 5.

Table 5 - Operating Time Vs Index Time

Index Time	Operating Time - All Curve Types
1.0	3.76 - 4.37
0.7	2.64 - 3.07
0.3	1.15 - 1.34
0.1	0.41 - 0.48

INSTANTANEOUS OVERCURRENT FUNCTIONS (IOC)

Pickup Calibration

Connect the relay as shown in Figure 9. Disable the time overcurrent functions by setting the pickup to zero and set the instantaneous functions to pickup at 1.0 amperes. Set the instantaneous delay time to zero seconds. Apply current to the relay and check that the "PROT PICK-UP" LED lights and that the trip output closes between 0.95 and 1.05 amperes. With the function still picked up, reduce the current and check that the "PROT PICK-UP" LED turns off and that the trip output resets between 95 and 100 percent of the pick-up value.

Operating Time

Using the previous setup, apply a current of 5.0 amperes (5x pickup) and check that the operating time is less than 0.025 seconds. Set the instantaneous delay time to 0.10 seconds and apply 5.0 amperes to the relay. Check that the total operating time is 0.10 seconds plus the previously measured operating time.

VOLTAGE PROTECTION SETTINGS

INVERSE TIME OVERVOLTAGE FUNCTION (TOV)

Pickup Calibration

Connect the relay as shown in Figure 10. Set the pickup of the TOV function to the minimum of 100 volts, and the instantaneous function with a somewhat higher pickup (120 volts for example). Apply voltage to the relay and check that the "PROT PICK-UP" LED lights and that the output relay contact closes between 100 and 110 percent of the set pickup value. With the function still picked up, reduce the voltage and check that the "PROT PICK-UP" LED turns off and that the output relay resets between 95 and 100 percent of the pickup value.

Operating Time

With the relay connected as for the previous tests, set the time index to 0.5 and maintain the pickup at 100 volts. Apply the voltages shown in Table 6 and check that the operating time is within the limits given in the Table.

Table 6- TOV Operating Time Vs Time Index

Multiples of PU	Test V	Operating Time (Sec)
1.25	125	60 - 70
1.75	175	0.49 - 0.55
2.0	200	0.17 - 0.19

With the TOV function set to pick up at 100 volts, apply a voltage of 150 volts (1.5x pickup) and with the Time Index setting given in Table 7, check that the function operates within the time limits given in the Table.,

Table 7 - Operating Time Vs Index Time

Index Time	Test V	Operating Time(Seconds)
1.0	150	3.76 - 4.37
0.7	150	2.64 - 3.07
0.3	150	1.15 - 1.34
0.1	150	0.41 - 0.48

INSTANTANEOUS OVERVOLTAGE FUNCTION (IOV)

Pickup Calibration

With the relay connected as shown in Figure 10, set the IOV function to the minimum pickup setting to 1.5 times the rated voltage. Apply voltage to the relay and check that the output relay closes between 95 and 105 percent of the set pickup. With the function still picked up, reduce the voltage and check that the output relay resets between 95 and 105 percent of the pickup value.

UNBALANCE FUNCTION SETTINGS

UNBALANCE CURRENT FUNCTIONS (Id - Model M)

Pickup Calibration - Alarm Function

Connect the relay as shown in Figure 9. Set the unbalance trip function to pickup at 0.5 amperes. Apply current to the relay and check that the "UC ALARM PICK-UP" LED lights and that the corresponding auxiliary relay contact closes between 95 and 105 percent of the set pickup value.. The "UC ALARM" LED should also light. With the Id function still picked up, reduce the current and check that the auxiliary relay resets and that both of the LED's go out between 95 and 105 percent of the pickup value.

Operating Time - Trip Function

With the function set to pick up as for the previous test, set the pickup time to any setting within the range. Apply a current greater than 0.5 amperes and check that the auxiliary contacts close in the set time.

Pickup Calibration - Trip Function

With the relay connected as shown in Figure 9, set the alarm function to pick up at 1.0 amperes. Apply current to the relay and check that the "PROT PICK-UP" LED lights and that the trip contacts close within 95 and 105 percent of the set pickup value. The "UC ALARM" and "UC ALARM PICK-UP" LED's may also light for this test. With the trip function picked up, slowly reduce the current and check that the "PROT PICK-UP" LED goes out and that the trip relay contacts close within 95 to 105 percent of the pickup value.

Operating Time - Trip Function

With the function set to pick up as for the previous test, set the pickup time to any setting within the range. Apply a current greater than 1.0 amperes and check that the auxiliary contacts close in the set time.

UNBALANCE VOLTAGE FUNCTIONS (Vd - Model D)

Pickup Calibration

With the relay connected as shown in Figure 10, set the voltage function (Vd) to pick up at 10.0 volts. Apply voltage to the relay and check that the "Vd PICKUP" LED lights within 95 and 105 percent of the set pickup value. With the "Vd PICKUP" LED still on. slowly reduce the voltage and check that the LED goes out within 95 to 105 percent of the pickup value.

Operating Time

With the function set to pick up as for the previous test, set the pickup time to any setting within the range. Apply a voltage greater than the pickup setting and check that the auxiliary contacts close in the set time.

REGULATION FUNCTIONS

To run the regulation function tests, it is necessary to operate the breaker, or to mimic operation of the breaker. It is therefore necessary to have a breaker "b" switch input connected to the relay (terminal F4) or to simulate a breaker "b" switch input through switch SW1 (see Figure 10). Breaker closed is simulated with SW1 open and breaker open is simulated with SW1 closed.

Zero Voltage Function

Connect the relay as shown in Figure 10, apply rated voltage and set the relay to the automatic mode (AUTO) of operation. Set the zero voltage time to 10 seconds and close the breaker or simulate closing by opening SW1. Set the hourly opening and closing times equal so as to disable hourly control. Slowly reduce the voltage until the "AUTO IN PROGRESS" LED lights. This should occur at 50 percent or less of rated voltage. The OPEN contacts should close 10 seconds after the "AUTO IN PROGRESS" LED lights. With the OPEN relay still activated, slowly increase the voltage until the "AUTO IN PROGRESS" LED goes out and the OPEN relay resets. This should occur at 50 percent or greater of rated voltage.

Undervoltage Function

With the relay connected as shown in Figure 10 and in the automatic mode of operation, set the undervoltage function to operate at 85 volts and with a time delay of 3 minutes. Set the hourly open and close times equal so that hourly control is disabled. Make sure that the breaker is open, or simulate the open condition by closing switch SW1. Slowly reduce the voltage until the "AUTO IN PROGRESS" LED lights. This should occur between 95 and 105 percent of the undervoltage setting. Check that the CLOSE relay contacts close three minutes after the "AUTO IN PROGRESS" LED comes on. With the CLOSE relay still activated, slowly increase the voltage until the "AUTO IN PROGRESS" LED goes out and the close contacts open. This should occur within 100 to 105 percent of the undervoltage setting value.

Overvoltage Function

With the relay connected as shown in Figure 10 and in the automatic mode of operation, set the overvoltage function to operate at 130 volts and with a time delay of 3 minutes. Set the hourly open and close times equal so that hourly control is disabled. Make sure that the breaker is closed, or simulate the closed condition by opening switch SW1. Slowly increase the voltage until the "AUTO IN PROGRESS" LED lights. This should occur between 95 and 105 percent of the undervoltage setting. Check that the OPEN relay contacts close three minutes after the "AUTO IN PROGRESS" LED comes on. With the OPEN relay still activated, slowly decrease the voltage until the "AUTO IN PROGRESS" LED goes out and the OPEN contacts open. This should occur within 100 to 105 percent of the overvoltage setting value.

Hourly Control Functions

Connect the relay as shown in Figure 10 and apply rated voltage. Check that the relay is in the manual mode of operation. Close switch SW1 to simulate an open breaker, or open the breaker if a "b" switch is connected to the relay.

Set the date and time to the present date and time.

Set the hourly control times to times that are slightly later than the present time. For example, set the breaker closing time 10 minutes after the present time and then set the opening time two minutes later than that.

Set the relay to the automatic mode of operation (use the <**ENT**> key as described under single-key operations).

Monitor the CLOSE contacts and check that they close at the set closing time. Check that the breaker is closed after the CLOSE contacts close - open SW1 to simulate a closed breaker or close the breaker.

Monitor the OPEN contacts and check that they close at the set opening time.

INSTALLATION

INTRODUCTION

The place where the relay is to be installed must be clean, dry, free of dust and vibration, and well illuminated to facilitate inspection and tests. The relay must be mounted on a vertical surface. Figure 8 shows dimensions and panel drilling diagram for the MCP.

SURGE GROUND CONNECTION

The A6 terminal of the relay must be connected directly to station ground so that the surge suppression circuits included in the relay function correctly. This connection must be as short as possible to assure the maximum protection (preferably 10 inches or shorter). Proper surge grounding assures that the internal capacitors shunt the high frequency surges directly to ground without passing through the electronic circuits. It also guarantees the physical safety of test personnel since the chassis is then grounded.

INSTALLATION TESTS

Given that the majority of users utilize different procedures for installation tests, the tests described in the acceptance tests section of this book can be used as a guide in testing the various units included in the MCP relay.

PERIODIC TESTS AND MAINTENANCE

Given the primary role that protection relays have in any installation, it is suggested that a periodic test program be followed. Since the tests vary for different types of relays and installations as well as the experience of the user in performing the tests, a test interval based on experience should be established.

TECHNICAL SPECIFICATIONS

Frequency:	50 Hz or 60 Hz
Rated Current:	In = 1a In = 5A
Rated Voltage:	Vn = 110V
Control Voltage:	24-48 Vdc 48-125 Vdc 110-250 Vdc
Auxiliary Voltage: (Cont. Converter)	24 Vdc 48 Vdc 110 Vdc
Thermal Capacity:	Continuous: 2 x In 3 seconds: 50 x In 1 second: 100 x In
Temperature:	Operation: -4°F to 131° F (-20° C to 55° C) Storage: -40° F to 149° F (-40° C to 65° C)
Ambient Humidity:	Up to 95% without condensation
Trip Contacts:	Maximum Voltage: 300 Vdc Make and Carry: 30A Carry Continuously: 5A Operating Capacity: 3000 W resistive for 0.2 seconds with a maximum of 30A and 300 Vdc Break: 50W resistive, with a maximum of 2A and 300 Vdc
Auxiliary Contacts:	Maximum Voltage: 250 Vdc Make and Carry: 5A Carry Continuously: 3A Operating Capacity: 5A dc for 30 seconds with a maximum voltage of 250 Vdc Break: 25W resistive, with a maximum of 300 Vdc
Type Tests:	Insulation: 2 kV 50/60 Hz for 1 minute (IEC 255-5) Impulse: 5 kV peak, 1.2/50 μs, 0.5J (IEC 255-5) 1 Mhz Noise: 2.5 kV common mode, 1 kV differential mode, Class III (IEC 255-22-1) Electrostatic discharge: Class III (IEC 255-22-2) Radio Interference: Class III (IEC 255-22-3)

Fast Transient: Class III (IEC 255-22-4)

SETTINGS, RANGES AND VALUES

PROTECTION:

Overcurrent Functions

Time Overcurrent (phase and ground):

Range: 0.1 to 0.8 x In
0.2 to 1.6 x In
0.3 to 2.4 x In
Setting to zero disables function

Characteristic Curves (independent for phase and ground)

ANSI Inverse
ANSI Very Inverse
ANSI Extremely Inverse
User Defined

Instantaneous Overcurrent Range (independent for phase and ground)

1 to 160 times minimum setting of time overcurrent function (dependent on setting of TOC)
Setting to zero disables function

Timing: 0.0 to 9.9 seconds

Voltage Functions:

Timed Overvoltage Function (TOV):

Range: 100 to 140 volts
Setting to zero disables function
Timing: See characteristic curves of Figure 6

Instantaneous Overvoltage Function (IOV):

Range: 1.5 to 2 x Vn
Setting to zero disables function

Unbalance Functions:

Unbalance Current (Model M)

Alarm: 0.5 to 2A
Timing: 1 to 10 seconds

Trip: 1 to 5 a
Time: 0.1 to 1.0 seconds

Setting to zero disables trip level

Unbalance Voltage (Model D)

Trip: 2 to 18 volts
Time: 1 to 20 seconds
Setting to zero disables this function

AUTOMATION:

Time Undervoltage:

Range: 85 to 110 volts
Time: 3 to 5 minutes
Setting to zero disables function

Instantaneous Undervoltage:

Range: 110 to 130 volts

Time Overvoltage:

Range: 110 to 130 volts
Time: 3 to 5 minutes
Setting to zero disables function

Instantaneous Overvoltage:

Range: 110 to 130 volts

Breaker Opening Time:

Time: 01. To 1.0 seconds

Breaker Closing Time:

Time: .5 to 99.9 seconds

Time-of-day Settings:

Weekday opening: hh:mm:ss
Weekday closing: hh:mm:ss

Weekend opening: hh:mm:ss
Weekend closing: hh:mm:ss

Closing block time, after an opening:

Time: 1 to 15 minutes
Setting to zero disables function

COMMUNICATIONS

Baud Rates:

300, 600, 1200, 2400, 4800, or 9600

Mode:

Half Duplex

Medium:

Fiber Optics or RS232 (optional)

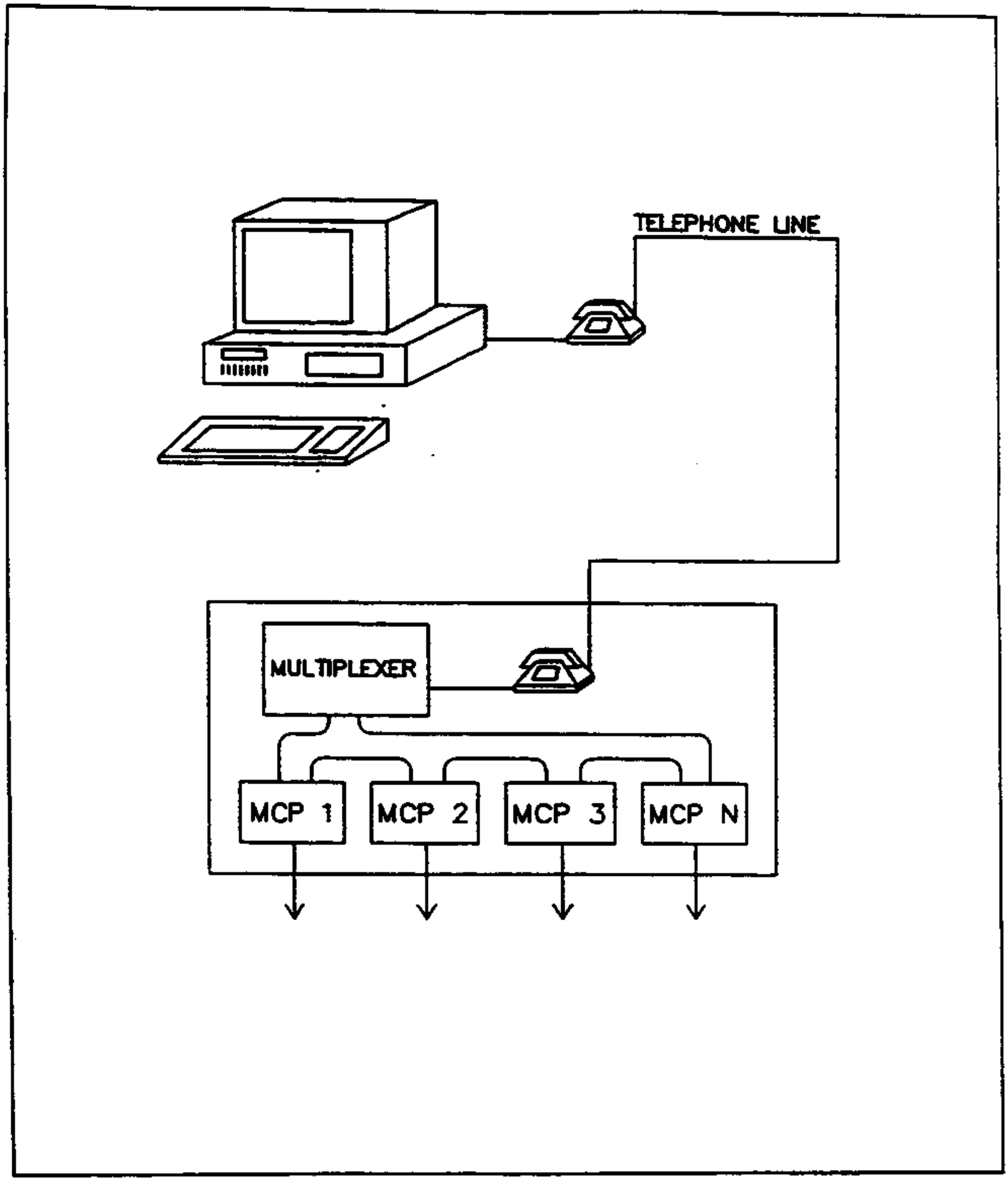


Figure 1 - System Diagram

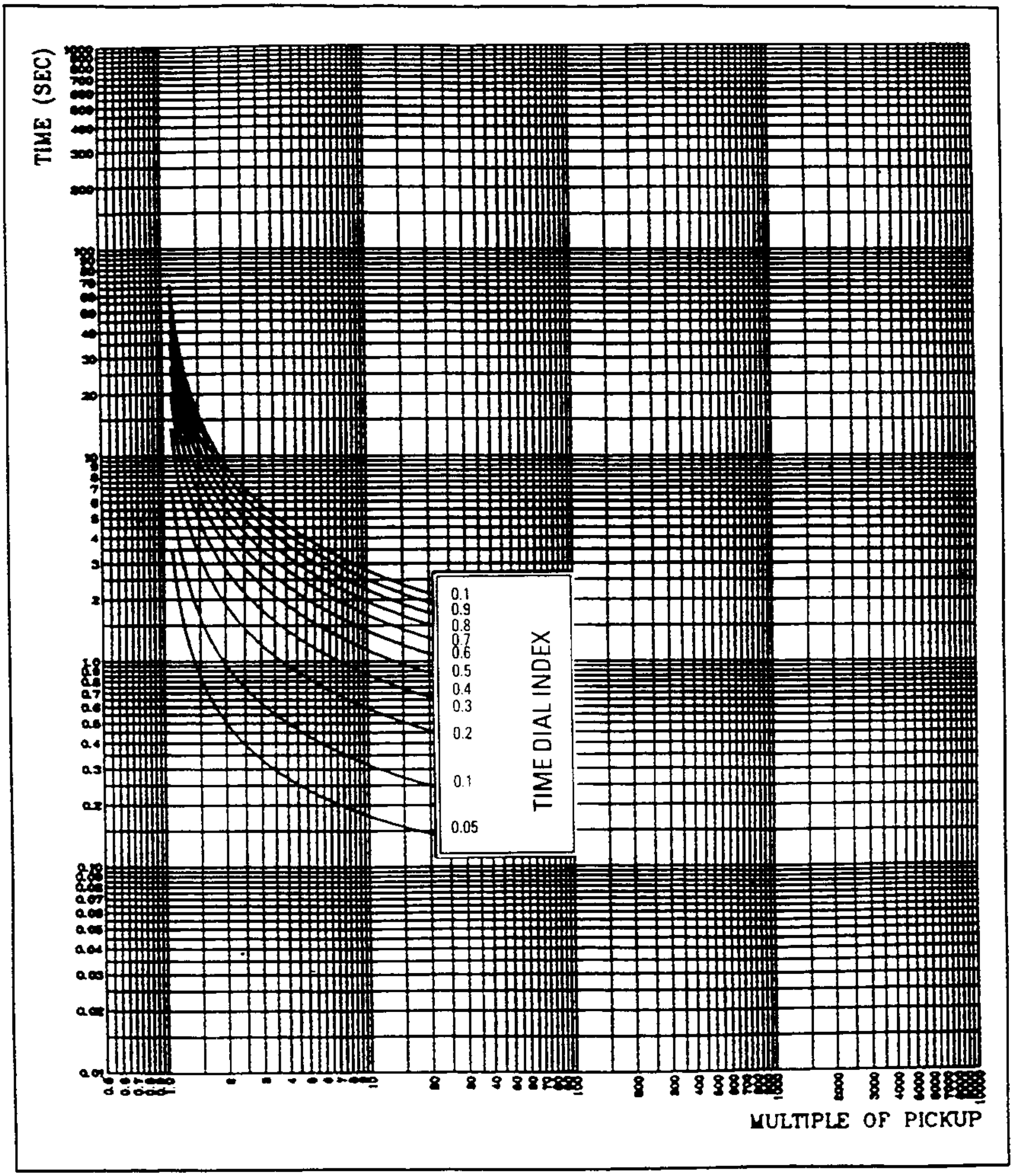


Figure 2- Inverse Time Characteristic

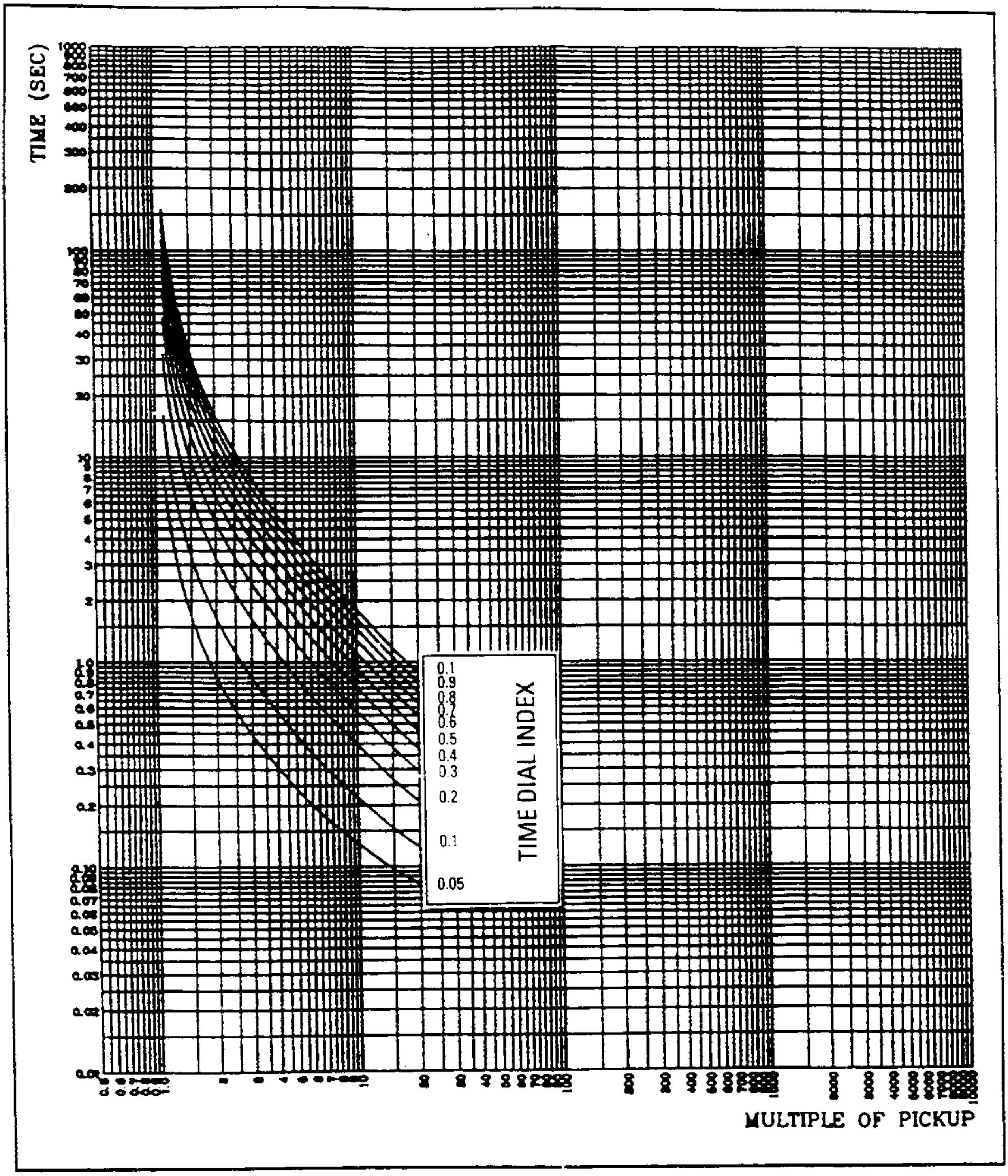


Figure 3- Very Inverse Time Characteristic

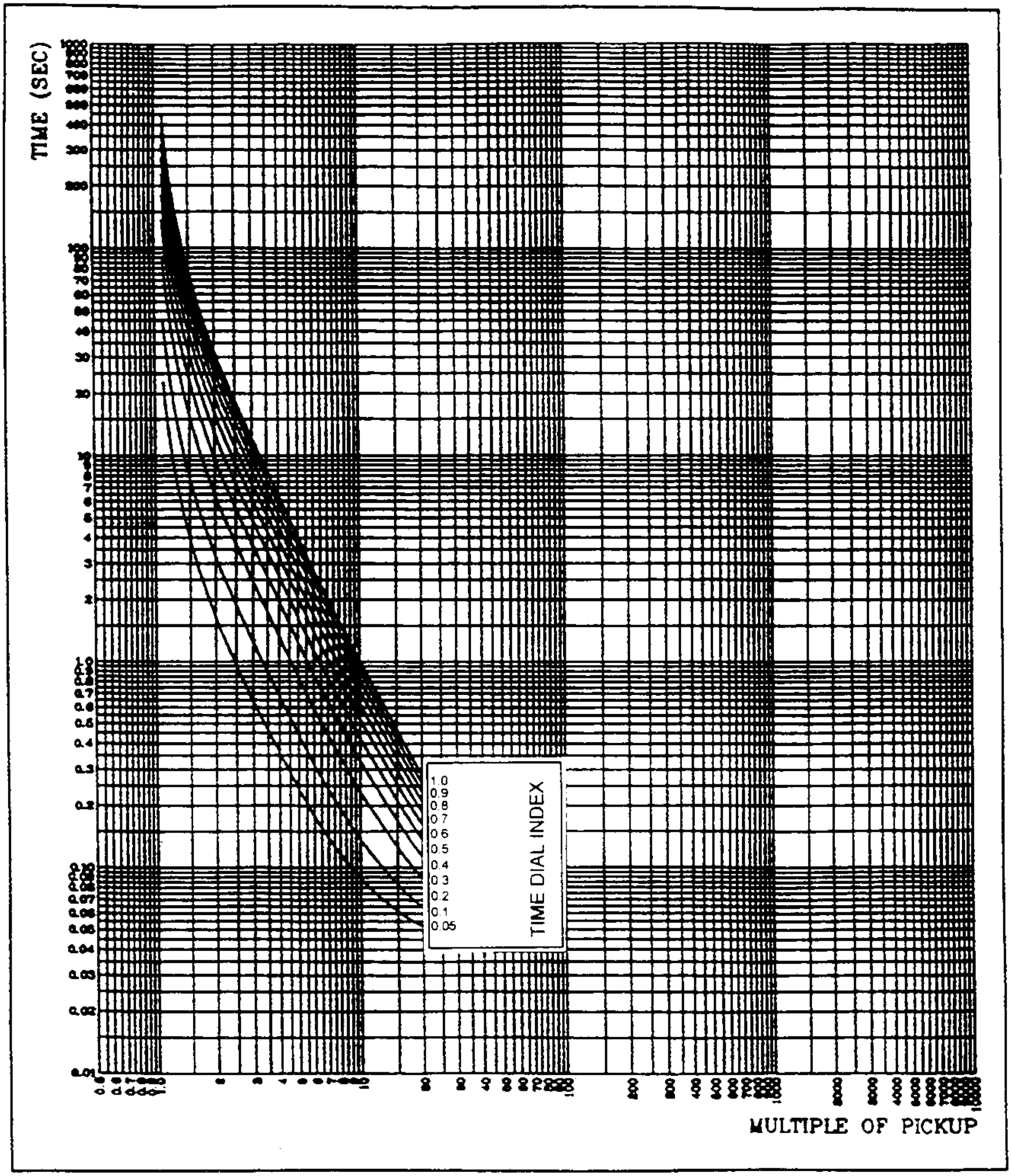


Figure 4- Extermely Inverse Time Characteristic

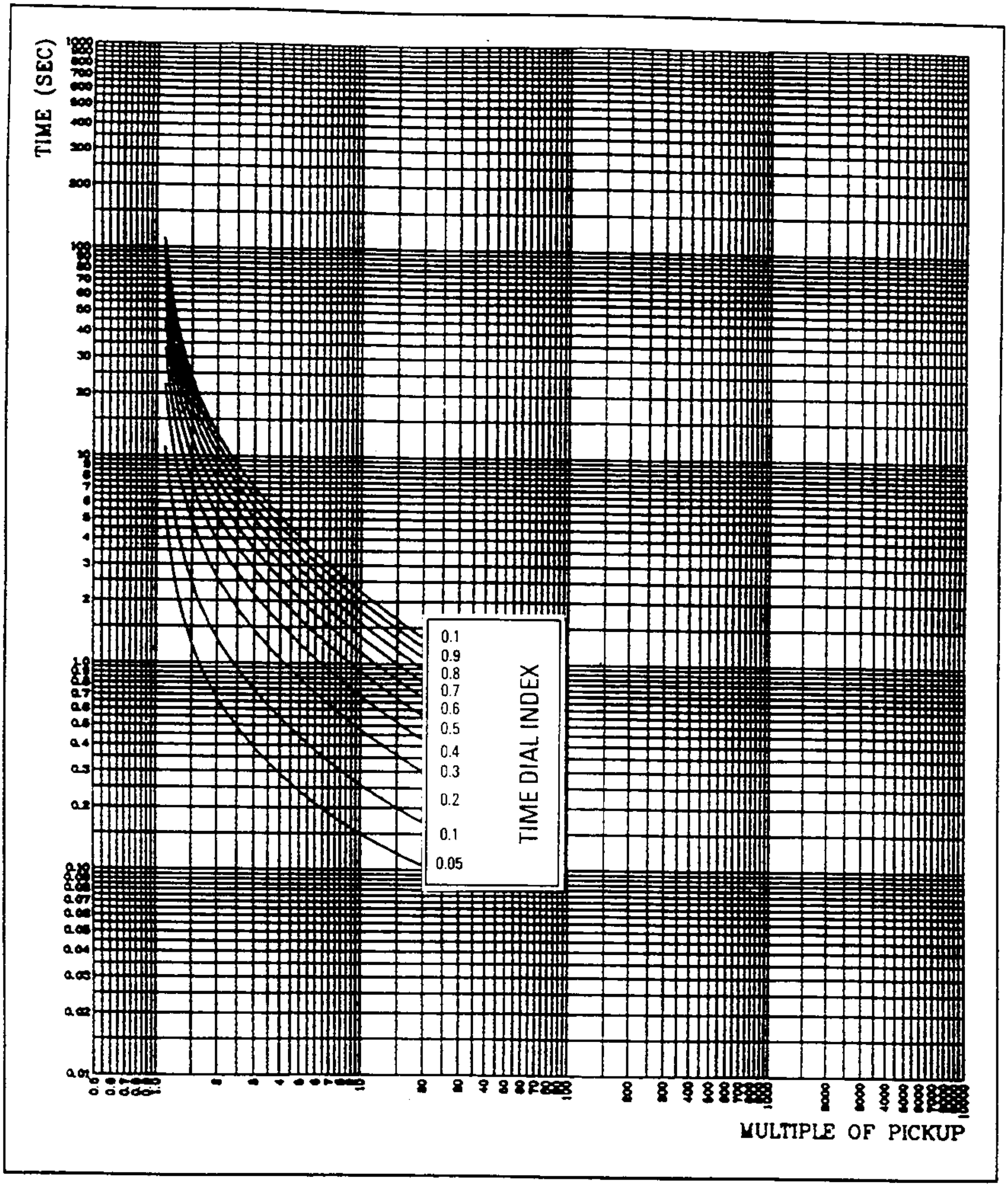


Figure 5- User Defined Time Characteristic

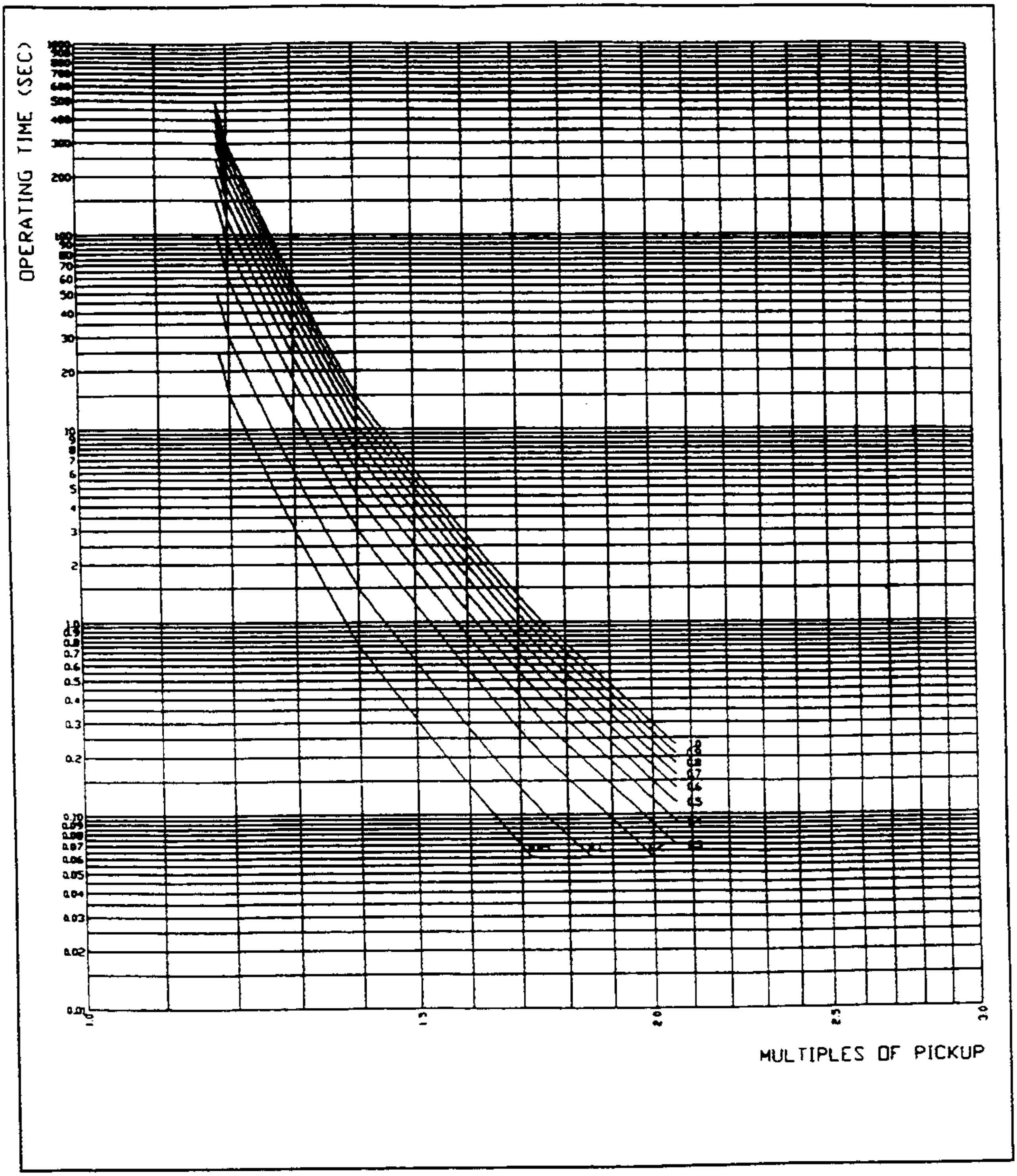


Figure 6- Overvoltage Time Characteristic

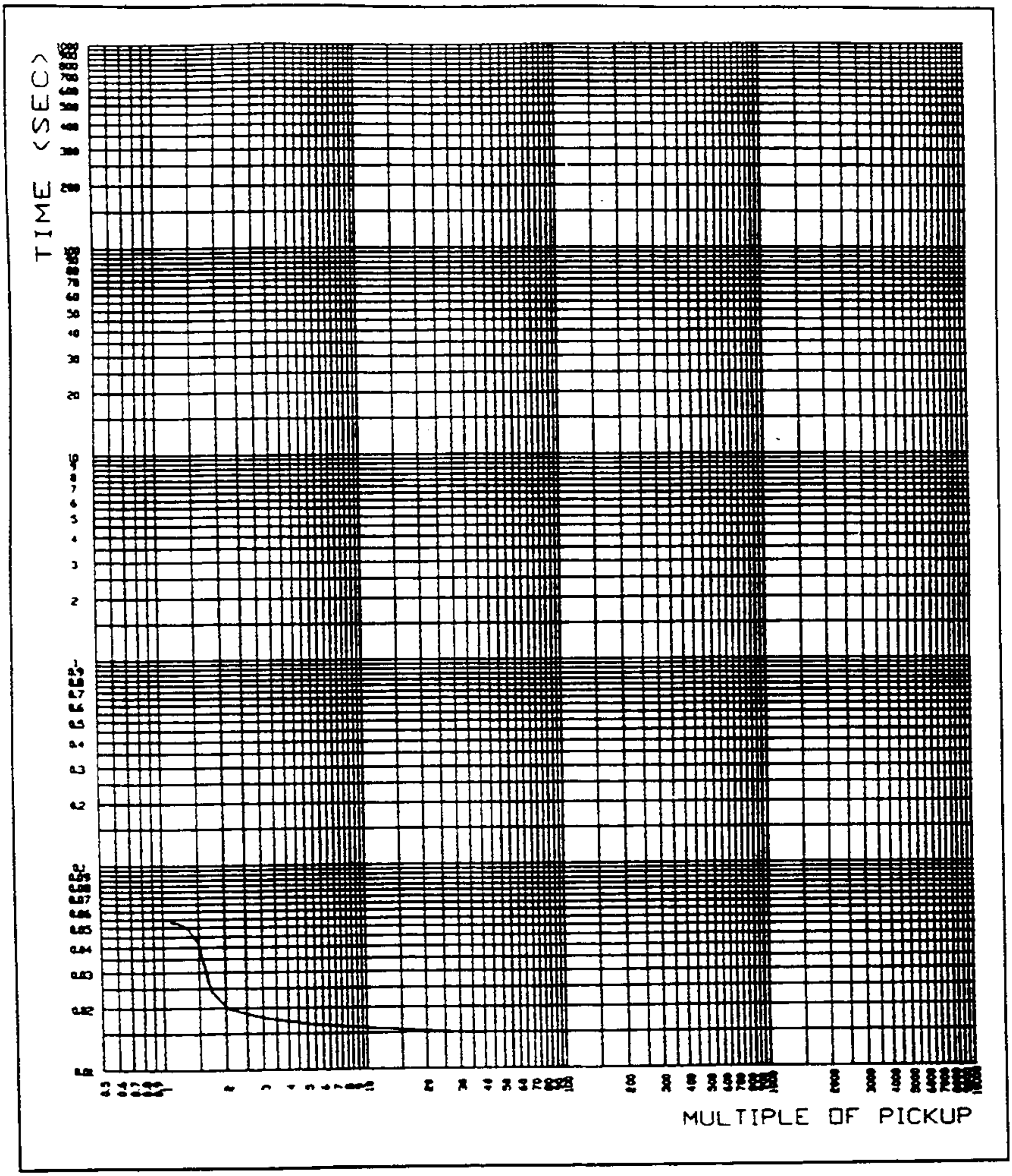


Figure 7- Instantaneous Overcurrent Time Characteristic

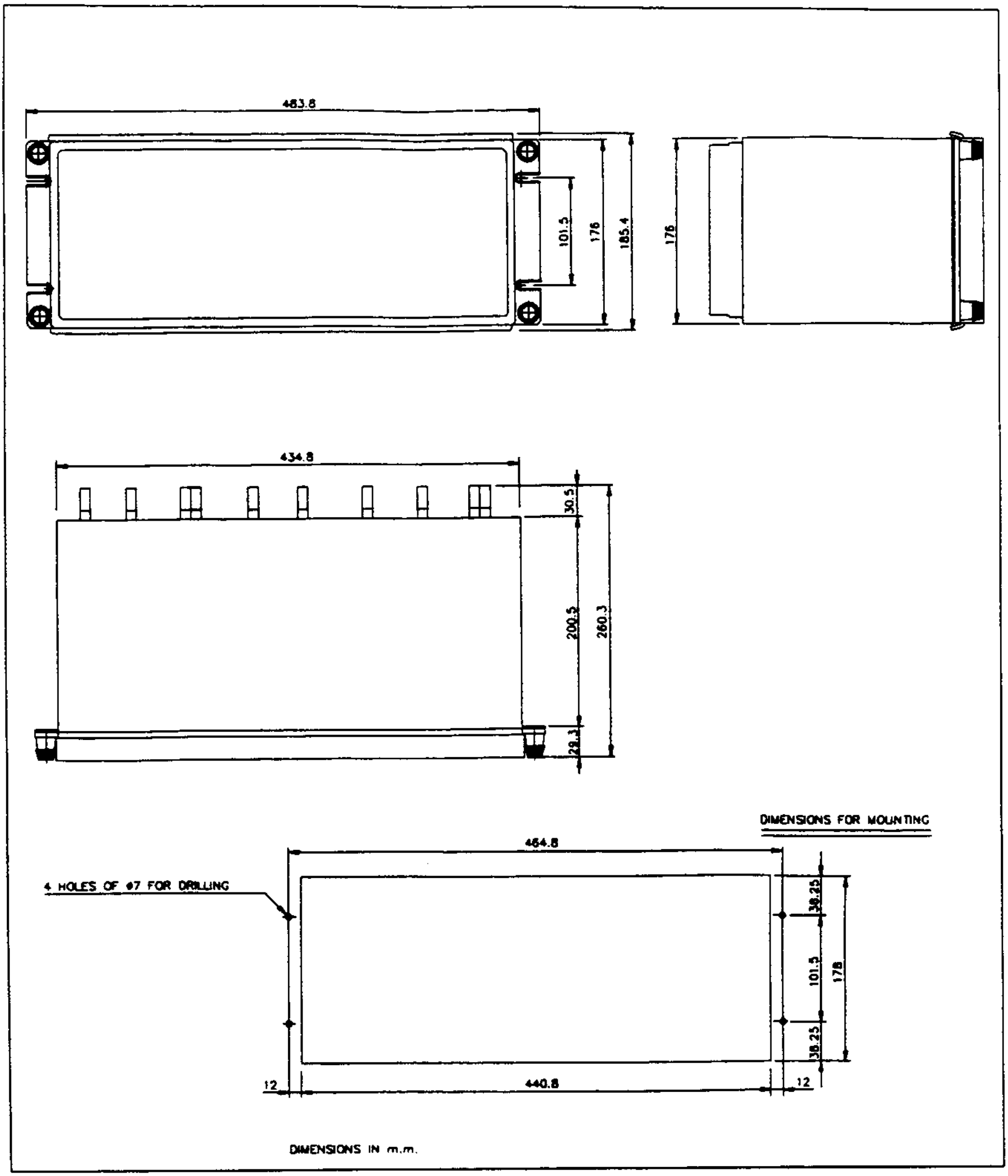
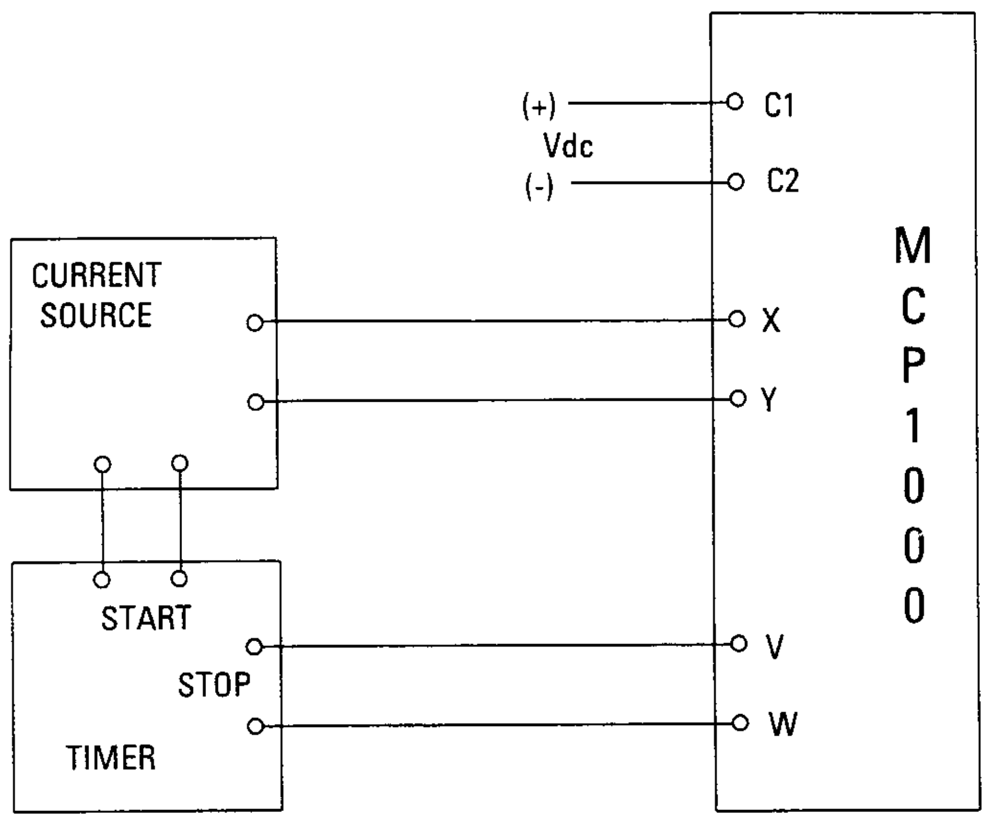
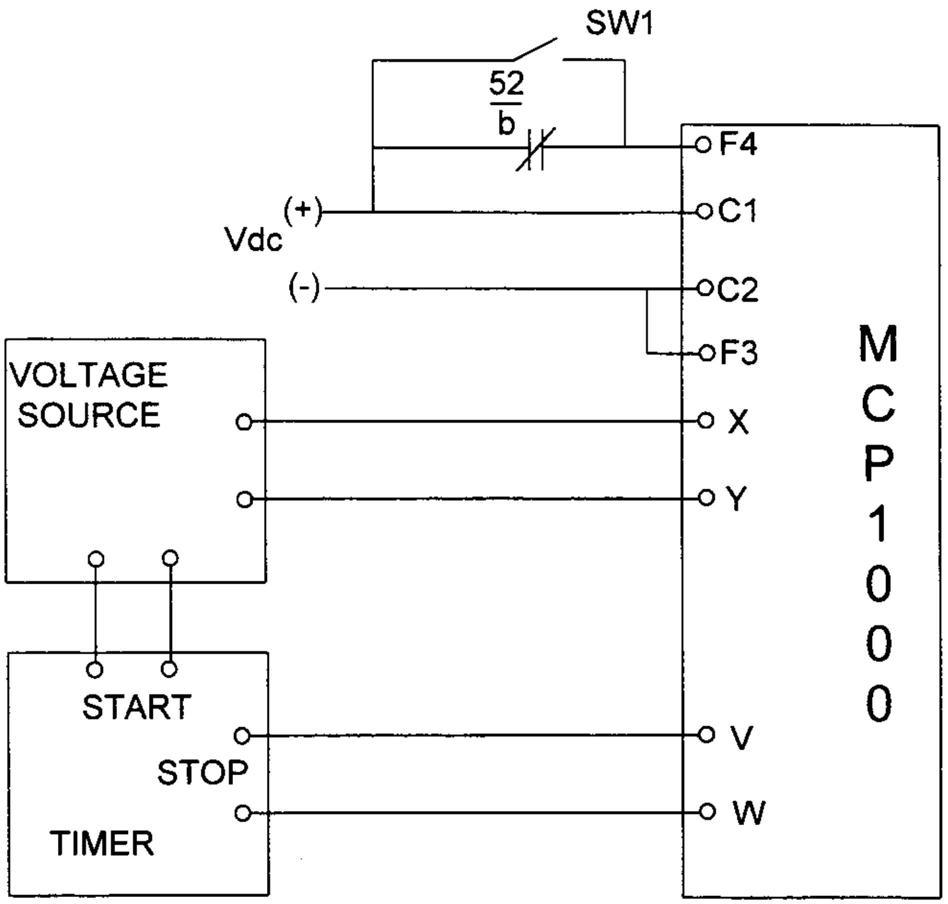


Figure 8 - Oultine and Panel Drilling



	X	Y	V	W
PH1	B11	B12	C5	C6
PH2	B9	B10	C5	C6
PH3	B7	B8	C5	C6
GRD	B5	B6	C5	C6
Id AL	B3	B4	D9	D12
Id	B3	B4	C5	C6

Figure 9 - Test Setup (Currents)



	X	Y	V	W
TOV	A2	A3	C5	C6
IOV	A2	A3	C5	C6
UNDERVOLTAGE	A2	A3	C9	C10
OVERVOLTAGE	A2	A3	C5	C6
ZERO VOLTAGE	A2	A3	C5	C6
UNBAL. VOLTAGE	E4	E6	A6	A7

Figure 10 - Test Setup (Voltages)

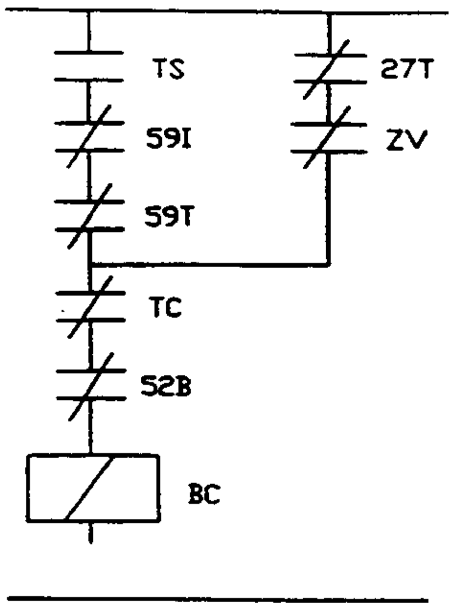


Figure 11a : Closing Logic

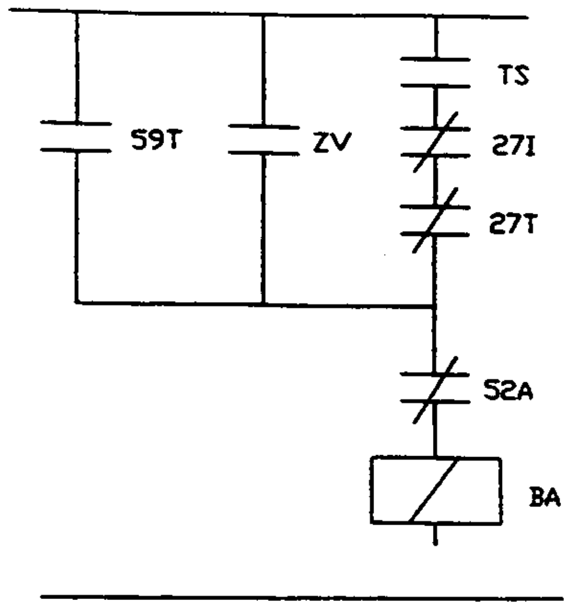


Figure 11b : Opening Logic

Where:

TS	**CLOCK**
ZV	**ZERO VOLTAGE**
TC	**BLOCKING OF THE CLOSING LOGIC FOLLOWING OPENING**

Figure 11 - Control Function Logic

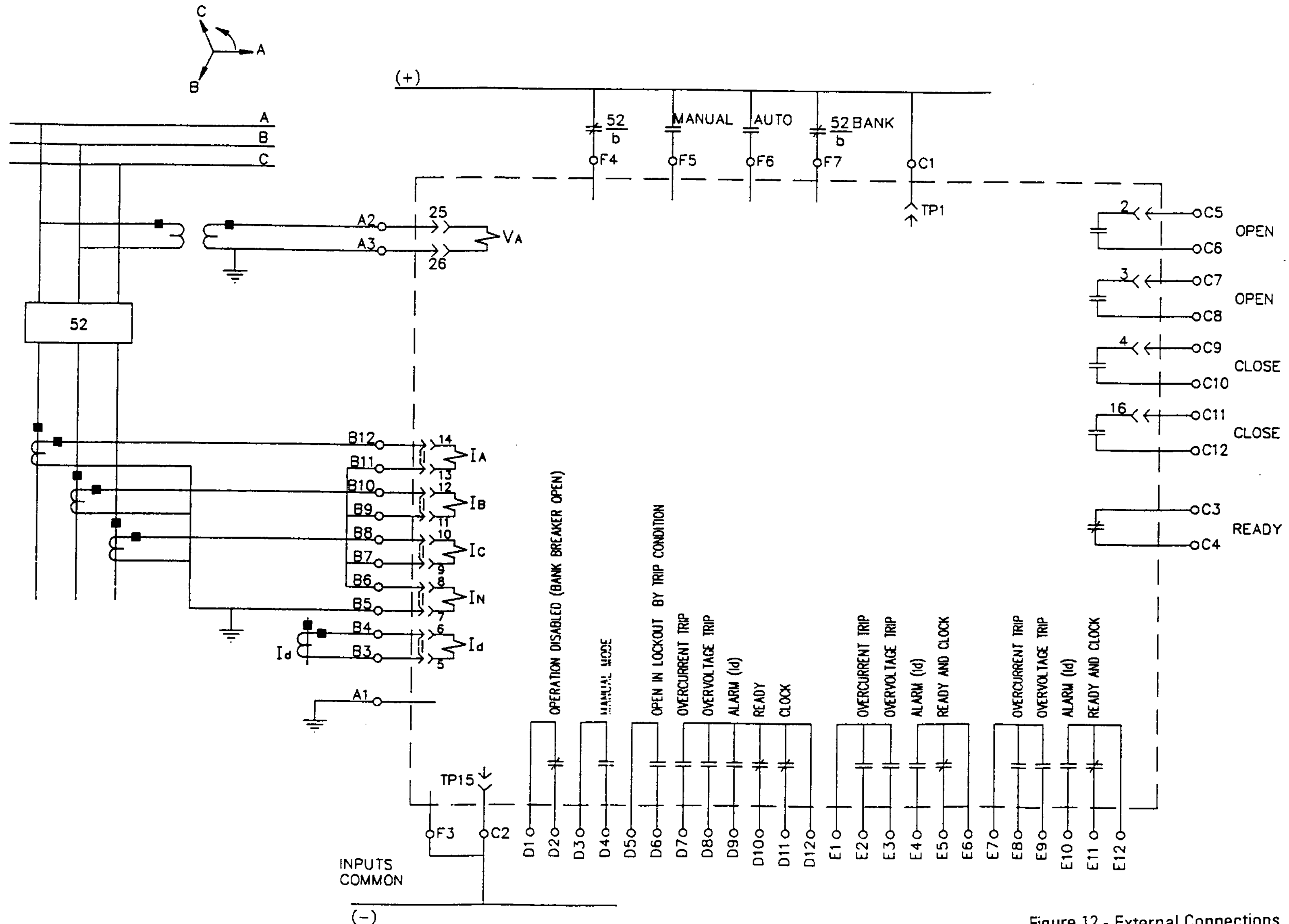


Figure 12 - External Connections, Model M

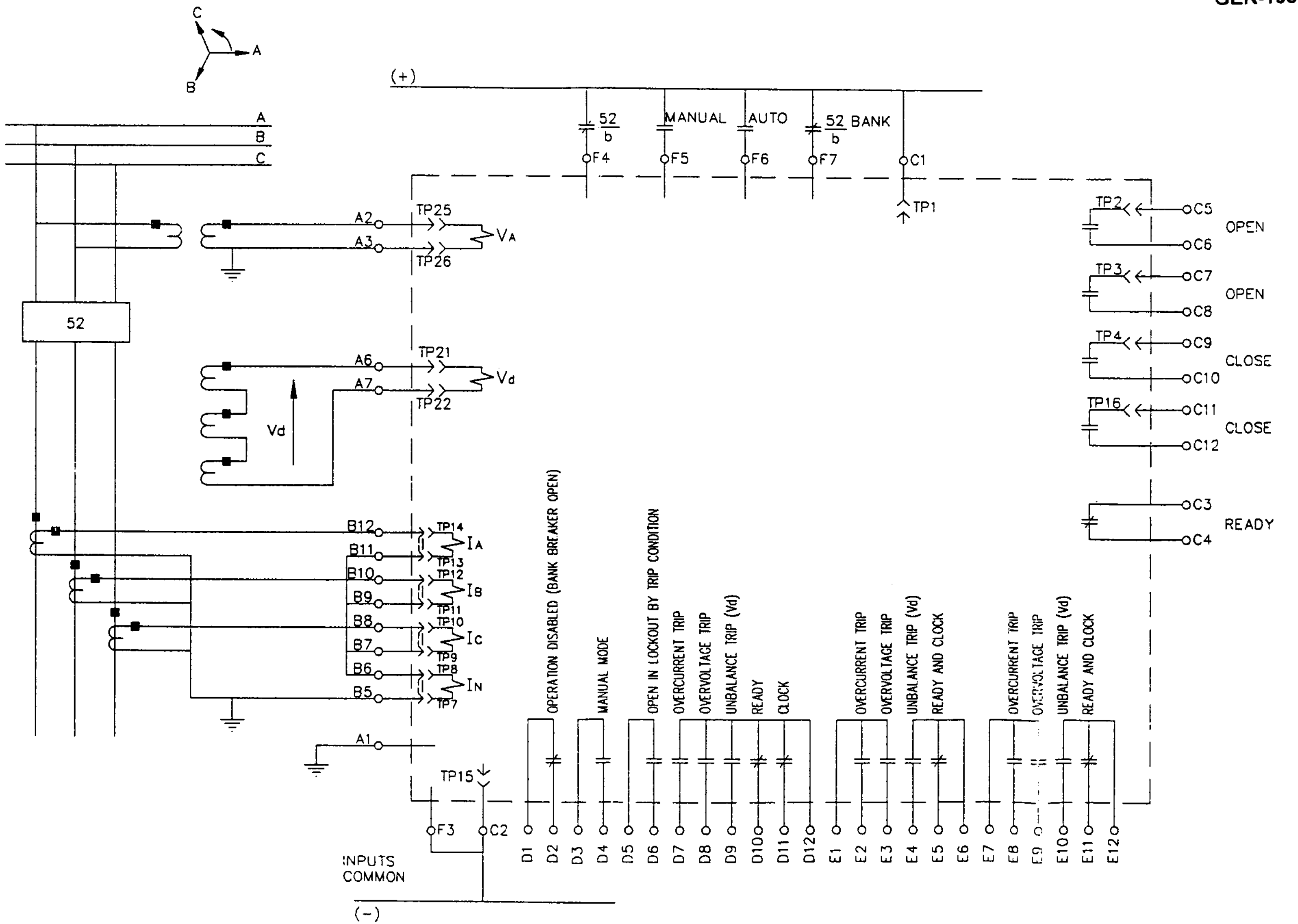


Figure 13 - External Connections, Model D

GEK-105189A

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