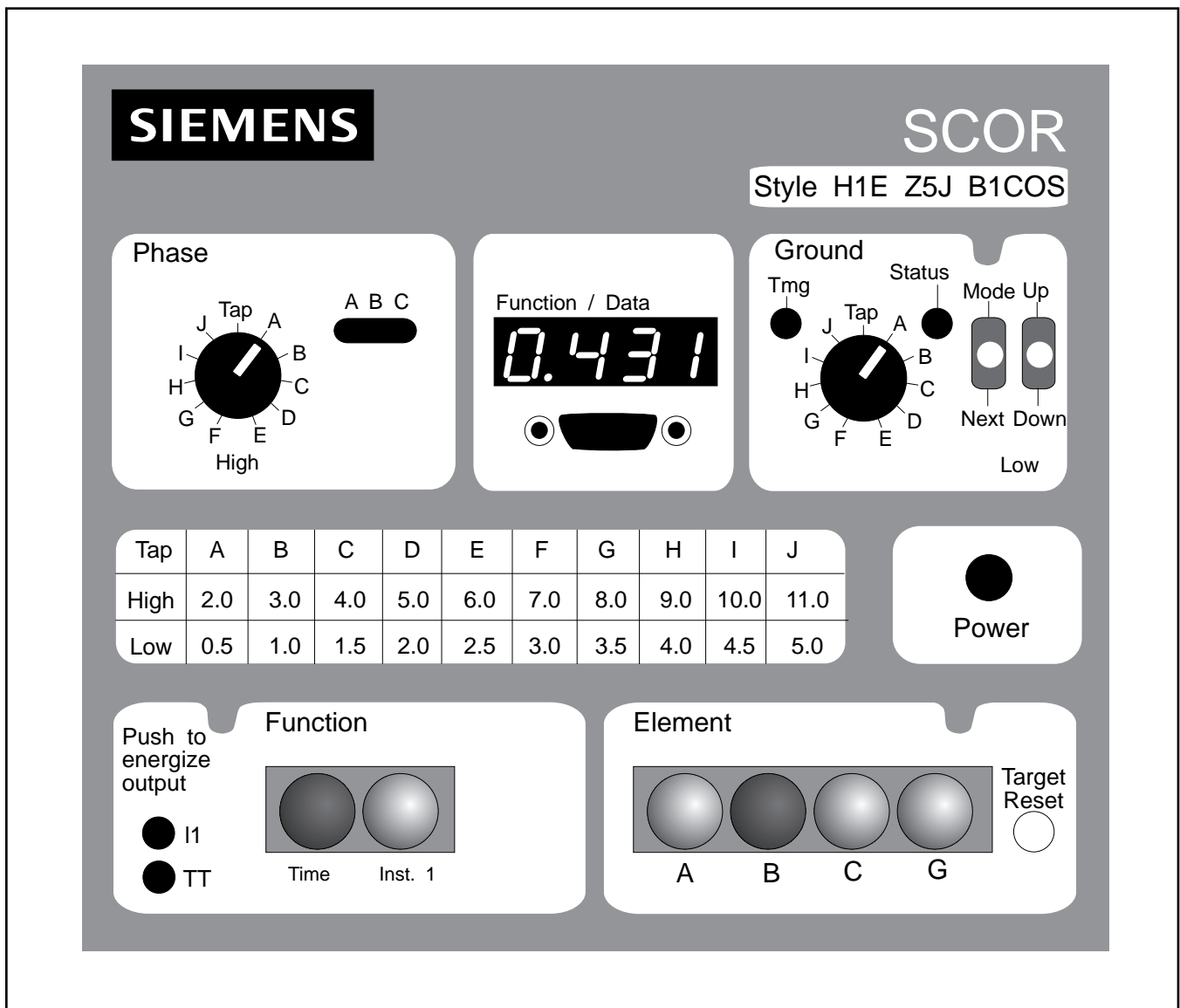


SCOR Overcurrent Protective Relay

Instruction
Installation
Operation
Maintenance

Hardware 3.11
Software 3.40





! DANGER

Electrical equipment contains hazardous voltages and high speed moving parts.

Will cause death, serious personal injury or equipment damage.

Always de-energize and ground the equipment before maintenance. Maintenance should be performed only by qualified personnel.

The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which will cause severe personal injury or equipment damage. Follow all safety instructions contained herein.

IMPORTANT

The information contained herein is general in nature and not intended for specific application purposes. It does not relieve the user of responsibility to use sound practices in application, installation, operation, and maintenance of the equipment purchased. Siemens reserves the right to make changes in the specifications shown herein or to make improvements at any time without notice or obligations. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material or both, the latter shall take precedence.

QUALIFIED PERSON

For the purpose of this manual a qualified person is one who is familiar with the installation, construction or operation of the equipment and the hazards involved. In addition, he has the following qualifications:

- (a) **is trained and authorized** to de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.
- (b) **is trained** in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.
- (c) **is trained** in rendering first aid.

SUMMARY

These instructions do not purport to cover all details or variations in equipment, nor to 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 local sales office.

The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens Energy & Automation, Inc. The warranty contained in the contract between the parties is the sole warranty of Siemens Energy & Automation, Inc. Any statements contained herein do not create new warranties or modify the existing warranty.

Table of Contents

1. General	1		
1.1 Description	1		
1.2 Application	1		
1.3 The Time Overcurrent Function	1		
1.3.1 Pickup	1		
1.3.2 Timing	1		
1.3.3 Trip and Reset	1		
1.4 RMS Sensing	1		
1.5 The Instantaneous Overcurrent Function (Option 1-1)	2		
1.6 The Ground Time Overcurrent and Instantaneous Functions	2		
1.7 Ground Trip Selectivity	2		
1.8 Auxiliary Output Relay (Option 1-2)	3		
1.9 Communications Option	3		
1.9.1 The Ports	3		
1.9.2 Communications	3		
1.10 Breaker Failure	4		
1.11 Style Number (Figure 2)	4		
1.12 Time Overcurrent Characteristic Curves	5		
1.13 Instantaneous Overcurrent Characteristic Curves	5		
2. Controls and Indicators	6		
2.1 General	6		
3. Operation by Front Panel	10		
3.1 General	10		
3.2 The Configuration Mode	10		
3.2.1 Defined	10		
3.2.2 Entering the Configuration Mode	10		
3.2.3 Stepping Through the Read/Write Registers	10		
3.2.4 Loading the Read/Write Registers	10		
3.2.5 Programming Note	10		
3.2.6 Programming the Address	12		
3.2.7 Setting the Baud Rate	12		
3.2.8 Setting the Time Dial	13		
3.2.9 Setting Tap Calibration	13		
3.2.10 Setting Instantaneous Overcurrent Pickup	13		
3.2.11 Selecting the Time Overcurrent Characteristic	13		
3.2.12 Selecting the CT Ratios	13		
3.2.13 Current Sensing Range	13		
3.2.14 Demand Period	13		
3.3 The DATA Mode	13		
3.3.1 Defined	13		
3.3.2 Entering the DATA Mode	13		
3.3.3 Scrolling	13		
3.3.4 Instrumentation Display	14		
3.3.5 Error Code	14		
3.4 Setting the Relay (Example)	15		
3.4.1 Example Defined	15		
3.4.2 Calculating the Settings	15		
3.4.3 Entering the Settings	15		
4. Installation and Testing	17		
4.1 General	17		
4.2 Relay Operating Precautions	17		
4.3 Dielectric Test	17		
4.4 Mounting	17		
4.5 Connections	17		
4.6 Verification Testing	20		
4.6.1 General	20		
4.6.2 Scope	20		
4.7 Operational Test	20		
4.7.1 Equipment Required	20		
4.7.2 Preliminary Steps	21		
4.7.3 Time Overcurrent Pickup Test	21		
4.7.4 Timing Test	23		
4.7.5 Instantaneous Overcurrent Pickup Test	24		
4.7.6 Testing of Option 1-2 Command Close Function ..	24		
5. Maintenance	25		
5.1 General	25		
5.2 Storage	25		
5.3 Timekeeping	25		
6. References	26		

Table of Contents

Appendix A Time Overcurrent Characteristic Curves 27

Appendix B Functional Description of Operation 37

B.1 General	37
B.2 Current Sensing	37
B.3 Power Supply	37
B.3.1 General	37
B.3.2 Loss-of-Power Sensing	37
B.4 Multiplexer	37
B.5 Internal Microcomputer	37
B.5.1 Analog-to-Digital Converter	37
B.5.2 RMS Sensing	37
B.5.3 Time Overcurrent Calculations	38

B.5.4 High/Low Range Register	38
B.5.5 Watchdog Circuitry	39
B.6 Outputs	39
B.6.1 General	39
B.6.2 Relay Disabled Output	39
B.6.3 Instantaneous and Command Close Options	39
B.7 Target Indicators	39
B.8 Communications Option	39
B.8.1 Local RS-232 Port	40
B.8.2 Local or Remote with Siemens Power Monitor Unit	40
B.8.3 Local or Remote by Owner's Computer	40
Appendix C Specifications	41

List of Tables and Figures

Table 1. Available Characteristics	5
Table 2. Controls and Indicators	7
Table 3. Configuration Mode Display Sequence	11
Table 4. List of Devices	12
Table 5. The Data Mode Display Sequence	14
Table C.1. Specifications	41
Figure 1. Relay Construction	2
Figure 2. Style Number Identification Chart	4
Figure 3. Controls and Indicators	6
Figure 4. Outline Dimensions	18
Figure 5. Panel Drilling and Cutout Dimensions (For Semi-Flush Mounting)	18
Figure 6. Relay Connections	19
Figure 7. Control Circuits	19
Figure 8. Single-Phase Current Sensing Connections	21
Figure 9. Three-Phase Current Sensing Connections	21
Figure 10. Three-Phase with Residually Connected Ground, Current Sensing Connections	22
Figure 11. Three-Phase with Independent Ground, Current Sensing Connections	22

Figure 12. Two-Phase with Residually Connected Ground, Current Sensing Connections	23
Figure A.1 Timing Type b1: Short Inverse Time	28
Figure A.2 Timing Type b2: Long Inverse Time	28
Figure A.3 Timing Type b3: Definite Time	29
Figure A.4 Timing Type b4: Moderately Inverse	29
Figure A.5 Timing Type b5: Inverse Time	30
Figure A.6 Timing Type b6: Very Inverse Time	30
Figure A.7 Timing Type b7: Extremely Inverse	31
Figure A.8 Timing Type b8: I ² T	31
Figure A.9 Timing Type c1: I ² T with Limit 1	32
Figure A.10 Timing Type c2: I ² T with Limit 2	32
Figure A.11 Timing Type c3: I ² T with Limit 3	33
Figure A.12 Timing Type c4: I ² T with Limit 4	33
Figure A.13 Timing Type c5: I ² T with Limit 5	34
Figure A.14 Timing Type c6: I ² T with Limit 6	34
Figure A.15 Timing Type c7: I ² T with Limit 7	35
Figure A.16 Timing Type c8: I ² T with Limit 8	35
Figure A.17 SCOR Instantaneous Time Curve, Phase Timings	36
Figure A.18 SCOR Instantaneous Time Curve, Ground Timings	36
Figure B.1 Functional Block Diagram	38

1.1 Description

The Siemens Communicating Overcurrent Relay (SCOR) is a microprocessor-based, time overcurrent relay designed for easy incorporation into a computer-monitored power system. It is available in a number of styles to supply single-phase, two-phase-with-ground, three-phase, and three-phase-with-ground protection for 60 Hz power systems.

The relay provides for the incorporation of an optional plug-in communications board to interface with the Siemens Power Monitor™ display and monitoring unit and the Siemens ACCESS™ system. The communications interface, when fully implemented, allows remote monitoring of real-time system and circuit breaker information and the transmission of event and historical data, as well as remote configuration of operating parameters.

1.2 Application

The SCOR relay is utility grade and is provided in a draw-out case with built-in test facilities. It is used for the protection of medium voltage electrical power systems. It is designed to monitor the outputs of standard (5 A secondary) current transformers and, when it operates, to close an output contact that may be used to trip a circuit breaker.

The relay requires control power for its internal circuits. A number of ac and dc voltage options are available for this purpose that match the usual ac or dc control power used for tripping the circuit breaker.

1.3 The Time Overcurrent Function

1.3.1 Pickup

A coarse incremental selection of overcurrent pickup tap is provided by front panel rotary switches. One switch simultaneously sets the pickup tap for all the monitored phases. If ground is also monitored, a second rotary switch independently sets the ground overcurrent pickup tap.

A fine incremental adjustment that provides 99 intermediate pickup points between adjacent positions of the rotary switches is provided by entering data into the memory of the internal microcomputer tap calibration registers.

1.3.2 Timing

A time delay is initiated when a pickup point is exceeded. When the current drops below pickup, the timing circuit is reset immediately. The amount of delay required before trip is a function of the overcurrent magnitude.

One of 16 families of time overcurrent characteristics may be selected for the monitored phases. These families are graphically illustrated in **Figures A.1** through **A.16** in **Appendix A**. If ground current is monitored, its timing characteristic is independently selected from the 16 families.

Selection of the timing characteristics is made at the front panel or via one of the two communications links. After a characteristic is selected, it is adjusted to specific requirements by choosing the TIME DIAL number. (These are the numbers in a vertical row along the right hand margin of **Figures A.1** through **A.16**.) This TIME DIAL number (0 to 99) selects one of the 100 characteristic curves available for each characteristic. (Only 14 of the 100 curves in the relay's memory are shown on each graph because of space limitations.)

The selected TIME DIAL number is entered into the relay's memory, again using either the front panel data entry controls, or one of the two communications links. The available characteristic curves include one definite time, six inverse time, and nine I²T curves. (Refer to **Table 4**.)

1.3.3 Trip and Reset

When the monitored current exceeds the overcurrent pickup point, the TMG LED illuminates as timing begins. The timing process continues until the interval calculated by the selected time overcurrent characteristic is completed (thereby tripping the associated output contact and target indicators), or until the sensed overcurrent drops below the pickup setting (which causes the timer to reset). In either case (trip or reset), the timing process is terminated. The TMG LED extinguishes at reset, but remains on at trip as an indication of contact closure.

If a relay output is closed, it is immediately reset when the monitored current drops below the pickup setting. Targets, however, remain tripped until manually reset at the front panel. (Control power is required to reset the targets.)

1.4 RMS Sensing

The SCOR protective relay uses RMS Sensing, a technology first introduced by Siemens in 1985, to sample the current wave shape and quickly calculate the effective heating value of the current. SCOR relays evaluate the impact of harmonics and provide accurate circuit protection. The SCOR relay uses a sum of squares algorithm for both determining trip level and for calculating metered values of the relay current level. The input waveform is sampled several times to determine instantaneous values. These instantaneous values are processed to obtain the true RMS value of the input current.



Figure 1. Relay Construction

1.5 The Instantaneous Overcurrent Function (Option 1-1)

One or two instantaneous overcurrent outputs are available, Options 1-1 and 1-2. Normally one is selected. The instantaneous pickup point is adjustable from 0.50 times to 20 times the time overcurrent tap setting. When the sensed input current exceeds an instantaneous overcurrent pickup setting, an instantaneous output relay is energized. Also a target indicator is set to show that an instantaneous output was tripped. (On multi-phase relays, an additional indicator denotes the phase or ground element which initiated the tripping.)

If an instantaneous option is selected for a relay which includes both phase and ground sensing, then an instantaneous output is supplied which operates for both phase protection and ground protection. The instantaneous phase and ground pickup points are independent of each other.

The desired instantaneous overcurrent pickup values for phase and for ground are entered via the data entry controls at the front panel. (This can also be done remotely by the data link if the communications option is present.)

1.6 The Ground Time Overcurrent and Instantaneous Functions

When the sensing input type includes ground current sensing, the relay is supplied with a separate and independent time overcurrent function for ground, as previously described for the phases. When instantaneous is selected, it is supplied for both phase and ground.

The signal for the ground function can be obtained by connecting the ground element in the residual circuit of three current transformers connected in the phases (51N or 50N/51N), from a current transformer in series with the connection from the power transformer neutral to ground (51G), or from a core balance current transformer encircling all phase conductors, often called a zero sequence CT (51GS or 50GS/51GS). Refer to **Figures 8** through **12**.

1.7 Ground Trip Selectivity

This standard feature of the SCOR relay allows the ground element to be enabled or disabled on the timed and INST 1 output.

Some applications require that the instantaneous element be active for phase, but not for ground, and vice versa. Other applications may require instantaneous tripping with no time overcurrent function. When the time or instantaneous function is not desired, this may be achieved by disabling either when configuring the relay at Display Sequence 20 of the Configuration Menu (see **Page 11**).

For some applications, the ground element may be present, but not desired. It may be disabled completely at Display Sequence 20 of the Configuration Menu (see **Page 11**).

Alternatively, ground trip functions can be shifted to the auxiliary output relay if this option is installed. This option is configured at Display Sequence 20 of the Configuration Menu (see **Page 11**).

1.8 Auxiliary Output Relay (Option 1-2)

This option includes an additional target identified as "INST 2/ CLOSE". The option can be used in any one of three ways:

- a. INST 2. This provides a second instantaneous trip contact, which can be set independently of INST 1, and the contact can be used in a different circuit. This is for application in reclosing schemes to block reclosing for high magnitude faults. It can also be used to block tripping of an interrupting device above its interrupting rating.
- b. COMMAND ACTUATED CLOSE. This selection is only available if the SCOR relay is equipped with a communications card (Option 2-C). This is used to permit remote closing of the circuit breaker. A remote close signal may be transmitted over the communications link to initiate closure of this output relay if the breaker is open. The relay contact must be wired into the circuit-breaker close circuit in this application.
- c. Separate GROUND TRIP. It is necessary in some applications to trip a separate lockout relay for ground faults. This can be achieved by selecting Option 1-2, and configuring the relay to cause tripping through this separate relay contact for ground faults. The ground tripping can be for operation of both the time and instantaneous elements, but either can be configured to be disabled if desired.

1.9 Communications Option

1.9.1 The Ports

The communications interface (a plug-in board, Option 2-C) supports an RS-232 port on the front panel and an RS-485 port on the back of the relay's case. (These are also known by the designations EIA-232 and EIA-485.) Both ports have equal access to the relay's registers. When connection is made to the RS-232 port, the RS-485 port is disabled.

The RS-232 port is for relatively short range communication (under 50 feet). Its intended purposes are for initial configuration, local testing and maintenance when the relay is not connected to a Power Monitor unit.

The RS-485 port provides for intercommunication between the relay and a Siemens Power Monitor unit or a computer running the Power Monitor PC™ software, WinPM™ power monitoring and control software, or SIEServe™ software. Communication is provided over a shielded twisted pair cable at distances of up to 4000 feet. This feature allows configuration, measurement, and protection functions to be performed or reviewed from a remote location.

1.9.2 Communications

The data and configuration capability of the communications link includes:

Real-time data for amperes (each phase and ground), and amperes demand (each phase). The monitored current is expressed in primary kiloamperes:

$$I_{\text{monitored}} = I_{\text{relay}} (CT \text{ ratio})$$

Relay status (normal/timing/tripped), and breaker position (open/closed).

Event record, with amperes prior to trip, time stamp, element which caused trip, and fault accumulation.

Trip log, including status changes, RMS current, and time stamp. The last 20 events are stored in the relay's nonvolatile memory.

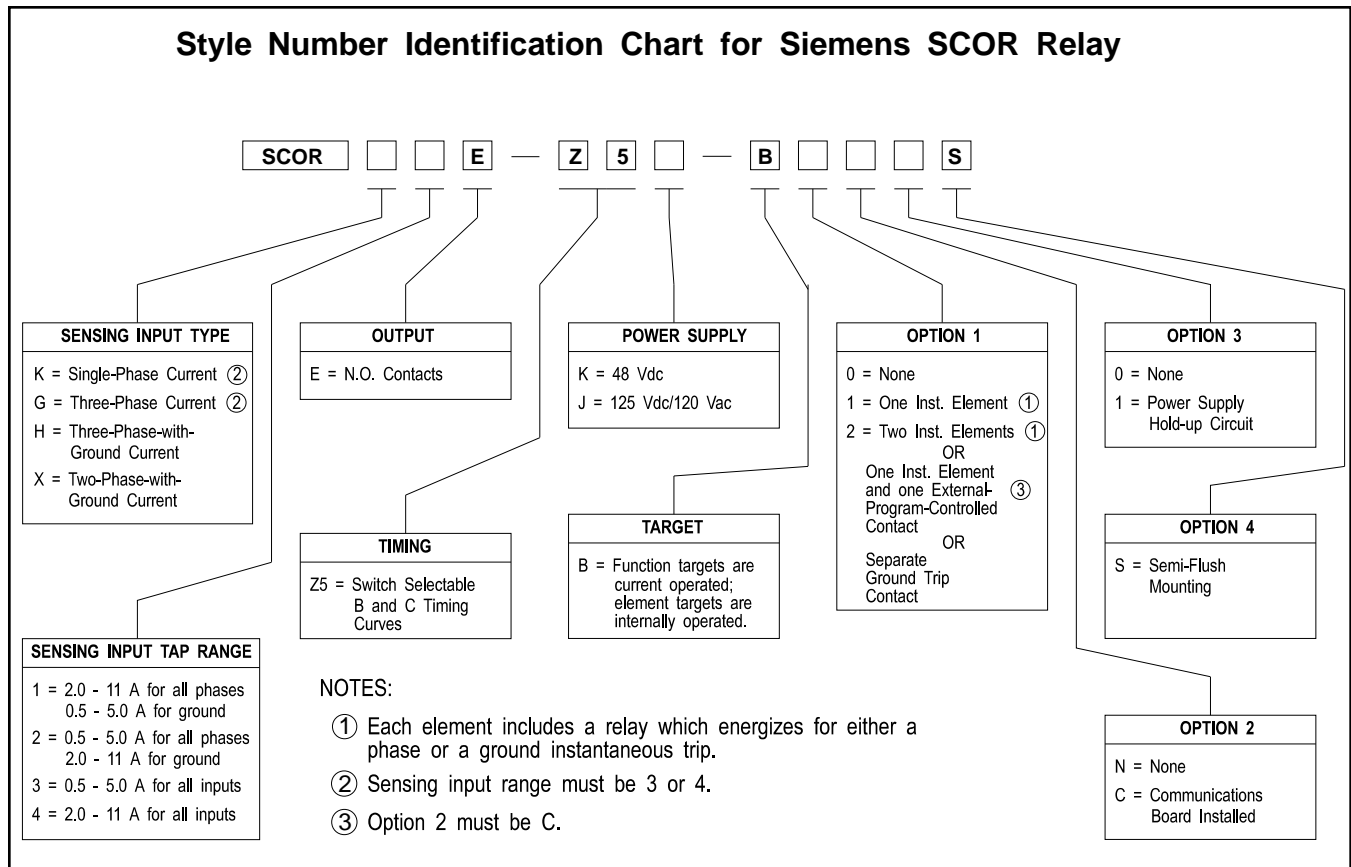


Figure 2 Style Number Identification Chart

MIN/MAX log, which contains the minimum and maximum current and demand values which have occurred since last cleared.

Configuration data for all registers listed in Table 3 (Page 11), including time overcurrent function and curve selected, pickup settings, and current transformer ratios.

Whichever port is used, all communications must be initiated by the Power Monitor unit or computer. When addressed, all of the relay's storage registers may be read by the Power Monitor unit, and many of them can be altered. (Password protected.)

1.10 Breaker Failure

When the relay includes the Communications Option, a "Breaker Failure" feature is provided. This functions to signal if the circuit breaker does not open immediately after operation of a time and/or instantaneous output relay.

The breaker failure function involves a 1-second timer. When a trip occurs, the timer starts. At time-out, two checks are made; one, that the breaker properly changed state (opened), and two, that the current is below approximately 10% of the tap value. If the result of either check is not correct, then it is assumed that the circuit breaker has failed to open and/or failed to interrupt the current.

If a breaker failure is detected, a time-stamped message "Breaker Failure" is sent to the Power Monitor unit Event Log. This feature may be disabled at Display Sequence 21 of the Configuration Menu (see Page 11).

1.11 Style Number (Figure 2)

The style number of the relay determines the features to be included (or ordered) for a particular application. Each available option is represented by a character as shown in Figure 2 Style Number Identification Chart.

For example, if it is decided that three-phase-with-ground monitoring is required for an application, then the first character of the style number is H.

The second character of the style number determines the range for overcurrent pickup. For example, Sensing Input Tap Range 1 would provide a range of 2.0 to 11.0 A for each phase, and a range of 0.5 to 5.0 A for ground current. Normally open (NO) output contacts for tripping the breaker are standard, so output Option E is the third character. The fourth and fifth characters are Timing Option Z5, which is standard on the SCOR relay. This feature allows the timing to be selected from any of the sixteen overcurrent timing functions illustrated in **Figures A.1** through **A.16**. The sixth character represents the voltage of the source of operating power for the relay. If J, the internal power for the relay is derived from an external source of (a nominal) 125 VDC or 120 VAC.

Since only one target configuration is offered, the seventh character is B. Note that all of the FUNCTION targets are current operated. Current operated targets are advantageous because they confirm that a current flowed in the output circuit as the result of a trip. (Since the ELEMENT targets are not associated with any output contacts, they are internally operated.)

If one instantaneous overcurrent element is needed, the eighth character of the style number is 1. If any one of the three features provided by Option 1-2 is desired, the eighth character of the style number is 2. The ninth character must be C to specify the communications board option. This would allow communication with a Power Monitor unit or a local terminal.

The tenth character of the style number is 0 if the control power for the power supply is DC. However, if 120 volt AC control power is to be used, then this character must be 1. The last character is always S. (These relays are always supplied in a draw-out case for semi-flush mounting.)

1.12 Time Overcurrent Characteristic Curves

Table 1 lists the types of Time Overcurrent Characteristic Curves available and the Number entered into the appropriate register during configuration. The curves are presented in **Figure A.1** through **A.16** in **Appendix A**.

1.13 Instantaneous Overcurrent Characteristic Curves

The characteristic curves for the instantaneous relay functions are also presented in **Appendix A**. **Figure A.17** shows the curve for the Phase Instantaneous function, and **Figure A.18** shows the curve for the Ground Instantaneous function.

Table 1. Available Characteristics

Number	Time Overcurrent Characteristic	Figure
b1	Short Inverse Time	A.1
b2	Long Inverse Time	A.2
b3	Definite Time	A.3
b4	Moderately Inverse Time	A.4
b5	Inverse Time	A.5
b6	Very Inverse Time	A.6
b7	Extremely Inverse Time	A.7
b8	I ² T	A.8
c1	I ² T with limit 1	A.9
c2	I ² T with limit 2	A.10
c3	I ² T with limit 3	A.11
c4	I ² T with limit 4	A.12
c5	I ² T with limit 5	A.13
c6	I ² T with limit 6	A.14
c7	I ² T with limit 7	A.15
c8	I ² T with limit 8	A.16

2.1 General

Figure 3 shows the front panel of the SCOR relay with all the options installed except Option 1-2. All of the front panel controls and indicators are called out and assigned a locator letter. **Table 2** supplies a description for each. Data is displayed in primary kilo

amperes. The Time Target and Element B Target are shaded darker, indicating that the relay caused an overcurrent timed trip due to a fault on Phase B, and the targets have not been reset.

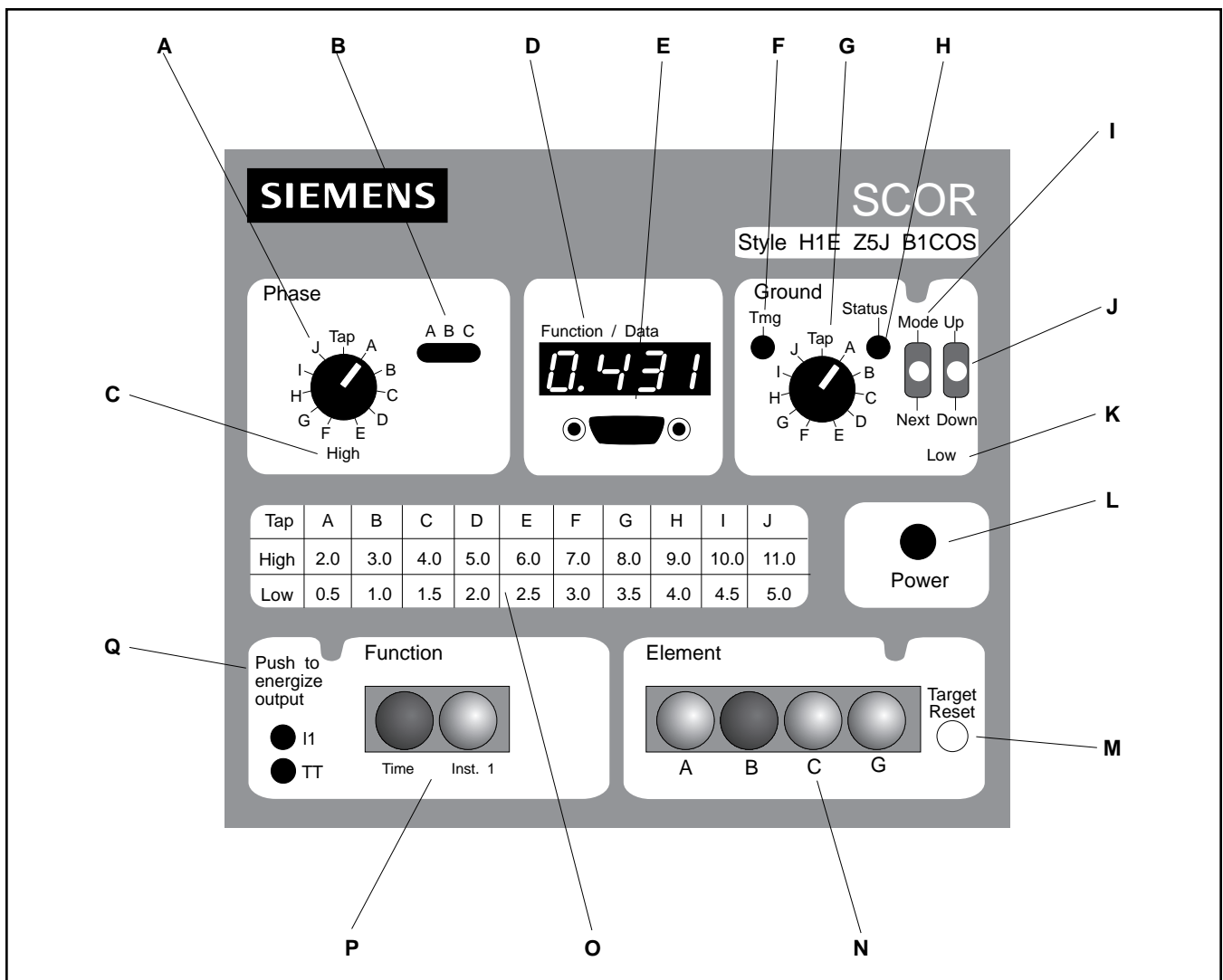


Figure 3. Controls and Indicators

Table 2. Controls and Indicators

Locator	Name	Function
A	PHASE TAP selector	A ten-position switch that provides an incremental adjustment of the current pickup tap for all of the phases (simultaneously). The switch positions are defined for both HIGH and LOW range in a table printed on the front panel (locator O of Figure 3). (Intermediate settings between the switch positions may be established by the Tap Cal register.)
B	Timing indicators, phase	LEDs that illuminate when the preset overcurrent pickup point for the corresponding phase is exceeded, to indicate that timing is underway.
C	Range plate, phase	Indicates the current tap range that applies to the internal scaling of all the phase inputs of the relay. The range is either HIGH or LOW. (Reference the TAP value table, locator O.) Note that the range is determined (during manufacture) by the style number of the relay. The position of this plate serves only a documentary purpose.
D	FUNCTION/DATA display ⁷	<p>This four-character, seven-segment LED display (with a right-hand decimal point for each digit) has two modes of operation: (1) the DATA mode which permits reading the information registers in primary kilo amperes, and (2) the CONFIGuration mode that permits reading and writing into those registers that control operation of the relay.</p> <p>The instrumentation registers monitor the input current and the demand current in kilo amperes. A row of dashes indicates an out-of-range condition. (Dashes along the bottom of the display indicate that the current is somewhere below 10% of TAP; dashes along the top indicate a current above 150% of TAP.)</p> <p>When the relay is powered up, the display will default to the DATA mode. Crossing from one mode to the other, and entering/modifying the data is described briefly below (locators I, J), and in detail in Operation by Front Panel.</p> <p>When the display exhibits the word "dAtA" for 60 seconds, the display will begin scrolling through the instrumentation registers in a fixed sequence. After stepping through all of the DATA registers, the display wraps around to repeat the sequence until instructed otherwise. This process is covered in detail beginning on Page 10.</p> <p>A front-panel switch (locator I) can cause the display to exhibit a particular register of interest in either mode. If, while in the CONFIGuration mode, neither the UP/DWN nor the MODE/NEXT switches have been actuated for one minute, the display will revert to the DATA mode. (This protects the settings by requiring the deliberate action of loading to effect a change. In the DATA mode, however, a specifically selected register can be displayed indefinitely.) Note that when in the CONFIGuration mode, the relay is inoperative.</p>

Table 2. Controls and Indicators (continued)

Locator	Name	Function
E	RS232 PORT (Supplied with the communications option)	Provides interconnection for any RS-232 device that is to be used for reading and/or changing data in the relay registers when the communication option is supplied.
F	TMG indicator, ground	An LED that illuminates when the preset ground overcurrent pickup point is exceeded, to indicate that timing is underway.
G	GROUND TAP selector	A ten-position switch that provides an incremental adjustment of the ground current pickup point. The switch positions are defined for both HIGH and LOW range in a table printed on the front panel (locator O). (Intermediate settings between the switch positions may be established by the Tap Cal register.)
H	STATUS indicator	An LED that illuminates whenever the relay is in the CONFIguration mode
I	MODE/NEXT switch	<p>Holding this switch in the MODE position (up) for approximately 5 seconds when the word "dAtA" is exhibited on the FUNCTION/DATA display (locator D), selects the CONFIguration mode. Holding the switch in the MODE position for 5 seconds when "ConF" is displayed selects the DATA mode, and also loads data changes (if any) into memory.</p> <p>When neither "dAtA" nor "ConF" is on the display, holding the switch up in the MODE position identifies the register whose contents were on display immediately before the switch was operated.</p> <p>Each time the switch is toggled to the NEXT position (down), the display advances to the next function in the sequence (if the DATA mode was selected) or to the next operating parameter (if CONF was selected).</p>
J	UP/DOWN switch	Active in the CONFIguration mode only: Increments (if raised) or decrements (if depressed) the value of the displayed register.
K	Tap range, ground	Indicates the current tap range (HIGH or LOW) that applies to the relay's internal scaling of the ground current input. (Reference the front panel TAP value table, locator O.) Note that the range is determined (during manufacture) by the style number of the relay. The position of this plate serves only a documentary purpose.

Table 2. Controls and Indicators (continued)

Locator	Name	Function
L	POWER indicator	Red LED that illuminates when relay power supply is functioning.
M	TARGET RESET switch	Raising this switch simultaneously resets all of the targets (locators N and P) if relay is powered up.
N	ELEMENT targets	Magnetically latched indicators that change from black to orange when tripping occurs to indicate the phase (A, B, or C) or ground (N) that caused the trip. Depending on the relay's style number, some of these targets may not be present. Reset by Target Reset Switch (M).
O	TAP scaling chart	Defines the settings of the TAP switches (locators A and G).
P	FUNCTION targets	Magnetically latched indicators that change from black to orange when a relay output has tripped. Note that the current through the associated output contact must exceed 0.2 A to actuate the target. For reset see M. Depending upon the style number, some of the illustrated targets may not be present.
	TIME	Indicates that a trip was caused by a TIME overcurrent function.
	INST 1	INST 1 Indicates a trip initiated by the INSTantaneous-1 function.
	INST 2/CLOSE (not illustrated)	Only provided if Option 1-2 is selected. Indicates a trip initiated by the INSTantaneous-2 function or, that a CLOSE contact output was initiated by an external computer-controlled command, or that a ground trip occurred.
Q	PUSH TO ENERGIZE OUTPUT	Momentary pushbuttons that provide the means to test the functioning of the output contacts without having to apply current to the sensing inputs. Buttons are depressed by inserting a 1/8" diameter non-conducting rod through holes in the front panel.
	I2/CLS (not illustrated)	Closes the INSTantaneous-2 or the CLOSE output contact (depending upon the option present).
	I1	Closes the Instantaneous-1 output contact.
	TT	Closes the Timed Trip output contact.

3.1 General

Once installed, and with its operating parameters established in internal memory, the relay functions automatically to protect the system from overcurrent conditions. Front panel operation of the relay permits configuring the registers that define the relay's automatic operation. These parameters are entered into the relay's memory by using the controls and indicators that were introduced in the Controls and Indicators section, and are further explained below.

The memory registers accessible from the front panel fall into two basic categories: read-only registers which are accessible when the relay is in the DATA mode (the normal or working mode), and the read/write registers which may be accessed only when the relay is in the CONFIguration mode.

Note that all the registers accessible at the front panel (plus many others that aren't) are also accessible by remote computer and by local terminal. For more information on controlling the SCOR relay from a remote computer, see **Section B.8** in **Appendix B**. For information about controlling the SCOR relay from a Siemens Power Monitor unit, see the *Siemens Power Monitor™ Display and Monitoring Unit*, (Manual No. SG-4018-01).

3.2 The Configuration Mode

3.2.1 Defined

Configuring the relay means loading the operating parameters into the relay's internal registers and setting the PHASE TAP and GROUND TAP switches. The CONFIguration registers are accessible (and alterable) whenever the relay is in the configuration mode, i.e., when the letters "ConF" appear in the front-panel display and the STATUS LED is illuminated. (These registers may also be read or altered remotely by computer.)

3.2.2 Entering the Configuration Mode

IMPORTANT NOTE

It is recommended that the Circuit Breaker be in the open position while the SCOR relay is being configured from the front panel. The SCOR relay is inoperative in the CONFIguration mode.

To leave the DATA mode and enter the CONFIguration mode, depress the MODE/NEXT switch repeatedly until the word "dAtA" is in view on the front-panel display. Then hold the switch up for approximately five seconds, during which time the display

becomes blank. Release the switch after "ConF" appears in the display.

Upon release of the MODE switch, the STATUS LED will be lit, and "ConF" will be in view on the FUNCTION/DATA display. (Releasing the MODE switch before 5 seconds has expired returns the unit and display to the DATA mode.)

3.2.3 Stepping Through the Read/Write Registers

Starting with the display reading "ConF," you may step through the configuration registers by depressing and releasing the NEXT switch. The registers will appear in the sequence given in **Table 3**. Alternately, the register abbreviation will be displayed, followed by the value or choice for that register. If you stop, the value is displayed. If you forget what register is being displayed, lift up on the switch again to display the register abbreviation.

After the 22nd register is reached, one more depression of the NEXT switch brings the display back (full circle) to the "ConF" position. At this point, you have the option of stepping through the configuration registers again, or returning to the DATA mode. To effect the latter, raise the MODE switch up and hold it there until the word "dAtA" appears in the display. (This requires about 5 seconds.)

3.2.4 Loading the Read/Write Registers

As the MODE switch is held raised (in the procedure just described for returning to the DATA mode), the display should become blank, and then, after about 5 seconds, the message "PEE" should appear. This indicates that the data changes made while in the CONFIguration mode have now replaced the former contents of the registers in the nonvolatile memory. After a brief interval, the display changes again to read "dAtA." The relay is now returned to its normal operating mode.

3.2.5 Programming Note

SCOR relays supplied on Siemens switchgear products are normally configured at the factory with the following settings:

Register 1	Address...Addr
Register 2	Baud Rate...bAud...4800
Register 13	Phase CT Primary Amps...PPri
Register 15	Ground CT Secondary Amps...nPri

Table 3. Configuration Mode Display Sequence

Register Display Sequence	Register Display Abbreviation	Register Function	Register Range
	<i>CONF</i>	Mode selection window	--
1	<i>Addr</i>	Indicates the present <u>Address</u> of the relay	0001 to 0254
2	<i>bAUD</i>	Selected <u>bAUd</u> rate	See text
3	<i>P_td</i>	<u>Phase time dial</u> setting	0000 to 0099
4	<i>n_td</i>	<u>Ground time dial</u> setting	0000 to 0099
5	<i>P_tAP</i>	<u>Phase tAP</u> calibrate	0000 to 0099
6	<i>n_tAP</i>	<u>Ground tAP</u> calibrate	0000 to 0099
7	<i>P_{in}1</i>	<u>Phase instantaneous #1</u>	00.75 to 020.0
8	<i>P_{in}2</i>	<u>Phase instantaneous #2</u>	00.75 to 020.0
9	<i>n_{in}1</i>	<u>Ground instantaneous #1</u>	00.75 to 020.0
10	<i>n_{in}2</i>	<u>Ground instantaneous #2</u>	00.75 to 020.0
11	<i>P_{cur}</i>	<u>Phase time overcurrent curve</u> type	b1 through c8
12	<i>n_{cur}</i>	<u>Ground time overcurrent curve</u> type	b1 through c8
13	<i>P_{P_r}1</i>	<u>Phase CT Primary</u> Amps	5 through 5000
14	<i>P_{S_Ec}</i>	<u>Phase CT SEcondary</u> Amps	5 always
15	<i>n_{P_r}1</i>	<u>Ground CT Primary</u> Amps	5 through 5000
16	<i>n_{S_Ec}</i>	<u>Ground CT SEcondary</u> Amps	5 always
17	<i>P_rAN</i>	<u>Phase rAnge</u>	HI or LO
18	<i>n_rAN</i>	<u>Ground rAnge</u>	HI or LO
19	<i>dP_rd</i>	<u>demand Period</u>	1 to 30
20	<i>g En</i>	ground trip <u>Enable?</u> If 20 is YES, the following options are provided	YES or no
20A	<i>50 g</i>	Ground instantaneous trip (<u>50 g</u>)	YES or no
20B	<i>51 g</i>	Ground time trip (<u>51 g</u>) If the relay includes the auxiliary output relay, 20C is provided	YES or no
20C	<i>out</i>	<u>output relay</u> to be tripped by the ground function	in2 or tin1*
21	<i>bF</i>	<u>breaker Failure</u> enable?	YES or no
22	<i>CONF</i>	Wraps to the top (i.e., to the Mode selection window)	--

* 20C permits option 1-2 to be configured as a dedicated ground trip output relay (see Page 3).
If this is desired, select " in2 ", if not, select " tin1 ".

Register 19 Demand Period Length...dPrd

Registers 14 and 16, the phase and ground secondaries, are always 5.

Registers 17 and 18, the Tap Ranges, are pre-programmed based on the style number ordered.

Registers 7, 8, 9 and 10, the Instantaneous #1 and #2 Functions, are options only supplied when ordered.

Thus, you normally only need to program registers 3 through 12 in the field. These are the protective settings. The values are established by a time-current coordination study. You may also need to make the choices for registers 19, 20 and 21. Values which have been entered can be viewed by entering the CONFIguration mode, and scrolling through all items.

3.2.6 Programming the Address

Skip this item if the relay is not equipped with the communications option.

Enter the configuration mode (described above) and advance to the Addr register by depressing and releasing the NEXT switch. The SCOR unit address is displayed. This number which ranges from 1 to 254 is a unique address used for communicating to this SCOR via its RS-485 port on the back of the case. The number must be selected such that it is unique among all devices connected on the same RS-485 loop (multiple devices may be daisy-chained together on a single communication bus). When configuring the SCOR to communicate to a Siemens Power Monitor unit, the address will be used to identify the particular SCOR.

Relays initially are configured with the address 222. If this has not been changed, it must be done prior to accessing from the Power Monitor unit. It is suggested that a list of devices be made with the information shown in **Table 4**.

3.2.7 Setting the Baud Rate

Using the procedures described above for entering the CONFIguration mode, display "bAUd" by advancing to the second register. (Reference **Table 3**.) The baud rate may now be adjusted by raising or depressing the UP/DOWN switch as required.

Table 4. List of Devices

Device Type	Serial Number	Circuit Name	Address	Location in Swgr	New Address/Date
SCOR 4700	325 2092	Main #1 Main #1	223 323	Cell 1B Cell 1B	
SCOR 4700	333 2105	Feeder #1 Feeder #1	224 324	Cell 2A Cell 2A	
Use key assignment "A" to change an address					

The baud rates available and their sequence are listed below. Note that the displayed value requires a multiplier of 1000 to arrive at the actual rate.

Baud Rate	Displayed Value
19,200	19.20
9,600	9.600
4,800	4.800 (standard for Power Monitor)
2,400	2.400
1,200	1.200
600	0.600
300	0.300 (The next advance wraps to 19.20.)

The selected baud rate is loaded into the relay's nonvolatile memory with the return to DATA mode. The message "P EE" will appear briefly on the display to indicate that the new data is stored in nonvolatile memory

NOTE: The Power Monitor System uses a baud rate of 4800.

IMPORTANT NOTE

If the installation is equipped with a Power Monitor unit, the remaining registers can be more easily configured using the Power Monitor unit. Refer to Siemens *Power Monitor™ Display and Monitoring Unit* (Manual SG-4018-01).

3.2.8 Setting the Time Dial

There are two Time Dial registers, one for the phases, one for ground (the 3rd and 4th registers, respectively, in the stepping sequence). (Some relays do not monitor the ground current. Check the style number.)

The Time Dial registers may contain any integer from 0 to 99. Each integer designates one of the hundred characteristic curves available for each overcurrent function as illustrated in **Figures A.1** through **A.16**.

3.2.9 Setting Tap Calibration

The Tap Cal registers (5th and 6th of the sequence listed in **Table 3**) may hold any integer from 0 to 99. Each integer represents a one-percent increment between adjacent taps. Refer to the example at the end of this section to calculate the required integer.

3.2.10 Setting Instantaneous Overcurrent Pickup

The "pin1" and "pin2" registers (7th and 8th of the CONFIguration sequence) hold the phase trip values for the INST 1 and the INST 2 output contacts. These instantaneous overcurrent registers may contain any number in the range 0.50 to 20, representing 0.50 to 20 times the phase TAP position.

Ground current instantaneous trip values are similarly entered (as multiples of the GROUND TAP position) into registers "nin1" and "nin2" (9th and 10th of the configuration sequence) for the INST 1 and INST 2 contacts.

3.2.11 Selecting the Time Overcurrent Characteristic

The time overcurrent curve type registers (11th and 12th in the sequence of **Table 3**) may contain any of 16 codes, b1 through b8 and c1 through c8, representing the curve types listed in **Table 1**. Refer to **Figures A.1** through **A.16** in **Appendix A** for graphic representations of these curves.

3.2.12 Selecting the CT Ratios

Registers 13 through 16 provide a multiplier that allows the microprocessor to match the relay's response to the turns ratio of the external CTs. The relative turns ratio of the CTs is expressed as a fraction whose denominator is 5.

3.2.13 Current Sensing Range

The 17th and 18th registers in the sequence display the current sensing range to which the relay is configured (either HI or LO) in accordance with the style chart. This is a factory setting.

3.2.14 Demand Period

Register 19 (**Table 3**) indicates the number of minutes in a demand period. This figure is used to calculate the demand current. For further information, look under "Instrumentation Display," **Page 14**.

3.3 The DATA Mode

3.3.1 Defined

The DATA mode is the normal operating state of the relay. When in this mode, all the read-only registers which are accessible from the front panel may be viewed by stepping the MODE switch, or by automatic scrolling (described later).

In DATA mode, the STATUS LED is off.

3.3.2 Entering the DATA Mode

If the STATUS LED is on, the relay is in the CONFIguration mode.

To leave the CONFIguration mode and enter the DATA mode, depress the MODE/NEXT switch repeatedly until "ConF" is displayed on the front panel display. Then hold the switch up for approximately five seconds until the word "dAtA" appears. At this time the STATUS LED will extinguish. (Releasing the MODE switch before five seconds has expired will return the display to the CONFIguration mode.)

3.3.3 Scrolling

When the display is left at "dAtA" for 60 seconds, the display will automatically step through all of the read-only registers (will "scroll") in the sequence of **Table 5**, then wrap around and repeat. This scrolling process first presents the name of the next register of the sequence (for 0.4 seconds), then presents the data of that register (for 0.4 seconds). This process will repeat

endlessly while the relay remains in the DATA mode unless deliberately halted as described below.

To stop the display at a particular register, step the display to the desired read-only register using the NEXT switch. (The registers will appear in the sequence of **Table 5**). Raising the MODE/NEXT switch (above center) displays the name of the register arrived at, and this register will be displayed until manually advanced (except when "dAtA" is displayed).

Holding the MODE switch up for five seconds or more when the word "dAtA" is displayed puts the relay into the CONFIGURATION mode. Leaving the display at "dAtA" for 60 seconds will cause it to scroll again.

3.3.4 Instrumentation Display

The first seven registers of the Data Mode Display Sequence (**Table 5**) comprise the instrumentation display. The first four registers indicate the current at the CT primaries of each phase in kiloamperes. Registers 5, 6, and 7 of the sequence indicate the demand current (at the primaries in kiloamperes).

The Demand Registers show average kiloampere demand for each monitored phase over a time period that is set into the Demand Period register. (The latter is not accessible from the front-panel display.) The displayed average is recalculated each

minute for each phase by adding the Demand Period samplings which have accumulated for a given phase, then dividing this sum by the Demand Period number to obtain the average demand value. The latter is then displayed in the Demand Current register for the appropriate phase. (The demand current values may also be read over the data link.)

All of the instrumentation registers (registers 1 through 7) display their data in real time. Note that if the amperes are over or under the operational scale of the ammeter, the display will show a row of four dashes. The position of these dashes (high or low) indicate which way the parameter is out-of-range:

If current is below the 10% of TAP level, the row of dashes are along the bottom of the display.

If current is above 150% of TAP, the row of dashes are along the top of the display.

3.3.5 Error Code

The error code display is the last register of the sequence described in **Table 5**. In the event of a malfunction, the Error Code register can narrow the search for possible causes. When this register is at 0000, there is no error message. If not at 0000, advise the Siemens Customer Service representative of the reading. The relay will probably require repair at the factory.

Table 5. The Data Mode Display Sequence

Display Sequence	Display Abbreviation	Register Function	Register Range
	<i>dAtA</i>	Mode selection window	--
1	<i>Ph. A</i>	Phase <u>A</u> kiloamperes	0 to 50 kA
2	<i>Ph. b</i>	Phase <u>b</u> kiloamperes	0 to 50 kA
3	<i>Ph. c</i>	Phase <u>c</u> kiloamperes	0 to 50 kA
4	<i>Gnd</i>	<u>G</u> round kiloamperes	0 to 50 kA
5	<i>Ph.Ad</i>	Phase <u>A</u> demand kiloamperes	0 to 50 kA
6	<i>Ph.bd</i>	Phase <u>b</u> demand kiloamperes	0 to 50 kA
7	<i>Ph.cd</i>	Phase <u>c</u> demand kiloamperes	0 to 50 kA
8	<i>Err</i>	<u>E</u> rror code (see text below)	--
9	<i>dAtA</i>	Wraps to the top (i.e., to the Mode selection window)	--

3.4 Setting the Relay (Example)

3.4.1 Example Defined

This hypothetical example has the following requirements:

Parameter	For Phase	For Ground
Time overcurrent pickup:	4.7A	1.6A
Pickup Range:	High	Low
Curve shape:	Very Inverse	Inverse
Time delay setting:	0.38 sec. @ 6 x pickup	0.37 sec @ 6 x pickup
Instantaneous overcurrent pickup:	14.4A	6.4A

The following style number describes an appropriate relay for this hypothetical application.

Model: SCOR Style: H1E Z5J B1NOS.

The second style digit indicates that HIGH range was chosen for phase monitoring, and LOW range for ground current monitoring.

3.4.2 Calculating the Settings

1. The time overcurrent characteristic must be selected such that it will coordinate with the other relays in the system to meet the protective needs of the application. Assume that a Very Inverse function is suitable for phase protection, and Inverse for ground protection. From **Table 1** we see that these two characteristics are designated b6 and b5 respectively. The table also provides the figure numbers that illustrate the desired curve sets.
2. Note that the phase time overcurrent pickup, 4.7 A, falls between tap C and tap D of the HIGH range (as shown on the front-panel chart illustrated in **Figure 3**). The phase Tap Cal value (which interpolates between TAP switch positions) is then calculated as follows:

Given:

Pickup value	= 4.7 A
Tap C (HIGH)	= 4.0 A
Tap D (HIGH)	= 5.0 A

$$\begin{aligned}
 \text{Then: Set Phase Tap Switch (Front Panel) on C} \\
 \text{Span} &= \text{Tap D} - \text{Tap C} &&= 1.00 \\
 \text{Difference} &= \text{Pickup value} - \text{Tap C} &&= 0.70 \\
 \text{Tap Cal value (phase)} &= \text{Difference} / \text{Span} \times 100 &&= \\
 &&&0.70 / 1.00 \times 100 = 70
 \end{aligned}$$

3. The ground time overcurrent pickup, 1.6 A, falls between tap C and tap D of the LOW range (**Figure 3**). The ground Tap Cal value is:

$$\begin{aligned}
 \text{Pickup value} &= 1.6A \\
 \text{Tap C (LOW)} &= 1.5A \\
 \text{Tap D (LOW)} &= 2.0A
 \end{aligned}$$

$$\begin{aligned}
 \text{Then: Set Ground Tap Switch (Front Panel) on C} \\
 \text{Span} &= \text{Tap D} - \text{Tap C} &&= 0.5 \\
 \text{Difference} &= \text{Pickup value} - \text{Tap C} &&= 0.1 \\
 \text{Tap Cal value (ground)} &= \text{Difference} / \text{Span} \times 100 &&= \\
 &&&0.10 / 0.50 \times 100 = 20
 \end{aligned}$$

4. The ratio of the phase Instantaneous Overcurrent pickup to the phase Time Overcurrent Tap is calculated as follows:

$$\begin{aligned}
 \text{Phase Instantaneous Overcurrent} &= 14.4A \\
 \text{Phase Time Overcurrent Tap} &= 4.0 \\
 \text{Ratio} &= 14.4 / 4.0 &&= 3.6 \\
 \text{Set Pin1 to 3.6}
 \end{aligned}$$

5. The ratio of the ground Instantaneous Overcurrent pickup to the ground Time Overcurrent Tap is calculated as follows:

$$\begin{aligned}
 \text{Ground Instantaneous Overcurrent} &= 6.4A \\
 \text{Ground Time Overcurrent Tap} &= 1.5A \\
 \text{Ratio} &= 6.4 / 1.5 &&= 4.27 \\
 \text{Set nin1 to 4.27}
 \end{aligned}$$

6. From Curve b6 **Figure A.6**, find the phase TIME DIAL setting that corresponds to a delay of 0.38 seconds at 6 times the pickup setting.

Answer: A TIME DIAL setting of 07.

7. From Curve b5 **Figure A.5**, find the ground TIME DIAL setting that corresponds to a delay of 0.37 seconds at 6 times the pickup setting.

Answer: A TIME DIAL setting of 05.

3.4.3 Entering the Settings

1. Set PHASE TAP Switch (Front Panel) on C, and GROUND TAP Switch (Front Panel) on C.

2. Load b6 into the phase Curve Type register, and b5 into the ground Curve Type register.
3. Enter 70 into the phase Tap Cal register, and 20 into the ground Tap Cal register.
4. Enter 3.6 into the phase instantaneous #1 overcurrent register, and 4.27 into the ground Instantaneous #1 Overcurrent register.
5. Enter 07 into the phase TIME DIAL register, and 05 into the ground TIME DIAL register.

4.1 General

When not shipped as part of switchgear, relay panel, circuit breaker or control, the relay is shipped in a sturdy carton to prevent damage during transit. Immediately upon receipt of a relay, check the style number against the requisition and packing list to see that they agree. Visually inspect the relay for damage that may have occurred during shipment. If there is evident damage, immediately file a claim with the carrier and notify the Siemens Sales Office, or contact Electrical Apparatus Division, Customer Service. In the event the relay is not to be installed immediately, store the relay in its original shipping carton in a moisture and dust free environment. When the relay is to be placed in service, it is recommended that the verification tests (given later in this section) be performed prior to installation.

4.2 Relay Operating Precautions

Before installation or operation of the relay, note the following precautions.

1. A minimum of 0.2 A in the output circuit is required to ensure operation of the FUNCTION targets.
2. Always reset targets by means of the target reset switch.
3. The relay is a solid state device and has been tested in accordance with the requirements defined below under DIELECTRIC TEST. If a wiring insulation test is required on the panel assembly where this relay is to be installed, it is suggested that the connecting plugs (or "paddles") of the relay be removed and the cradle withdrawn from the case so as not to produce false readings during the wiring insulation test.
4. When the connecting plugs are removed, the relay is disconnected from the operating circuit and will not provide system protection. Always be sure that external operating (monitored) conditions are stable before removing a relay for inspection, test, or service. Be sure that connecting plugs are in place before replacing the front cover.
5. Be sure that the relay case is hard wired to earth ground using no smaller than 12 AWG copper wire to the ground terminal on the rear of the unit. It is desirable to use a separate ground wire to the ground bus for each relay. If this is not practical, the number of relays sharing a ground wire should be kept to a minimum.

4.3 Dielectric Test

In accordance with ANSI/IEEE C37.90-1989 and IEC 255-5, one-minute dielectric (high potential) tests may be performed up to 1500 VAC (45-65 Hz). This applies to all terminals, including the ports. Note that this device employs decoupling capacitors to ground from terminals 3, 4, 9, A, and B. Accordingly, a leakage current of 100 mA (max.) is to be expected at these terminals.

4.4 Mounting

The SCOR relay is supplied in a standard S1 size drawout case. **Figure 4** provides the outline dimensions for this case. The panel drilling and cutout dimensions for this case are provided in **Figure 5**.

The relay does not have to be mounted vertically. Any convenient mounting angle may be chosen.

4.5 Connections

The connections for the relay are shown in **Figure 6** and **Figure 7**. Incorrect wiring may result in damage to the relay. Be sure to check the model and style number of the relay with the Style Number Identification Chart (**Figure 2**) before connecting and energizing the relay.

The terminals along the top and bottom of the back of the case are suitable for use with wiring terminals and wire sizes of 14 AWG or larger. The RS-485 port terminals A, B, and C (back of case, center) require a shielded, twisted pair.

Be sure the relay case is hard-wired to earth ground with no smaller than 12 AWG copper wire. A ground terminal on the rear of the case is provided for this purpose. Ideally, each relay should have a separate ground wire to the ground bus. If this is not practical, the number of relays sharing a ground wire should be kept to a minimum.

The connections to the current transformers are shown in **Figures 8** through **12**. Diagrams are presented for single-phase, two-phase, and three-phase operation.

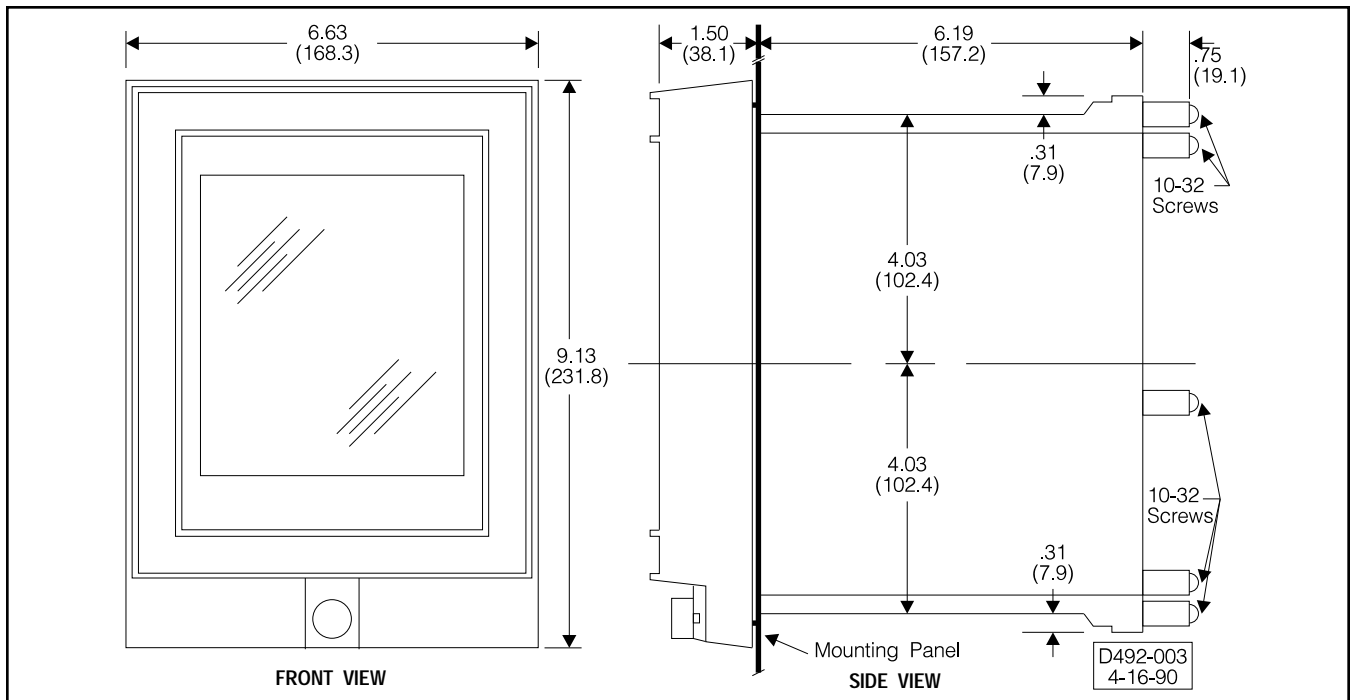


Figure 4. Outline Dimensions

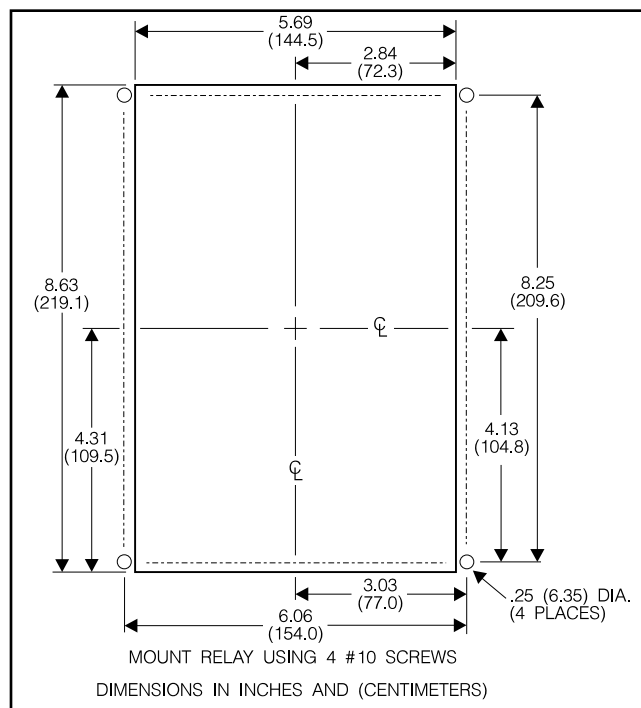


Figure 5. Panel Drilling and Cutout Dimensions (For Semi-Flush Mounting)

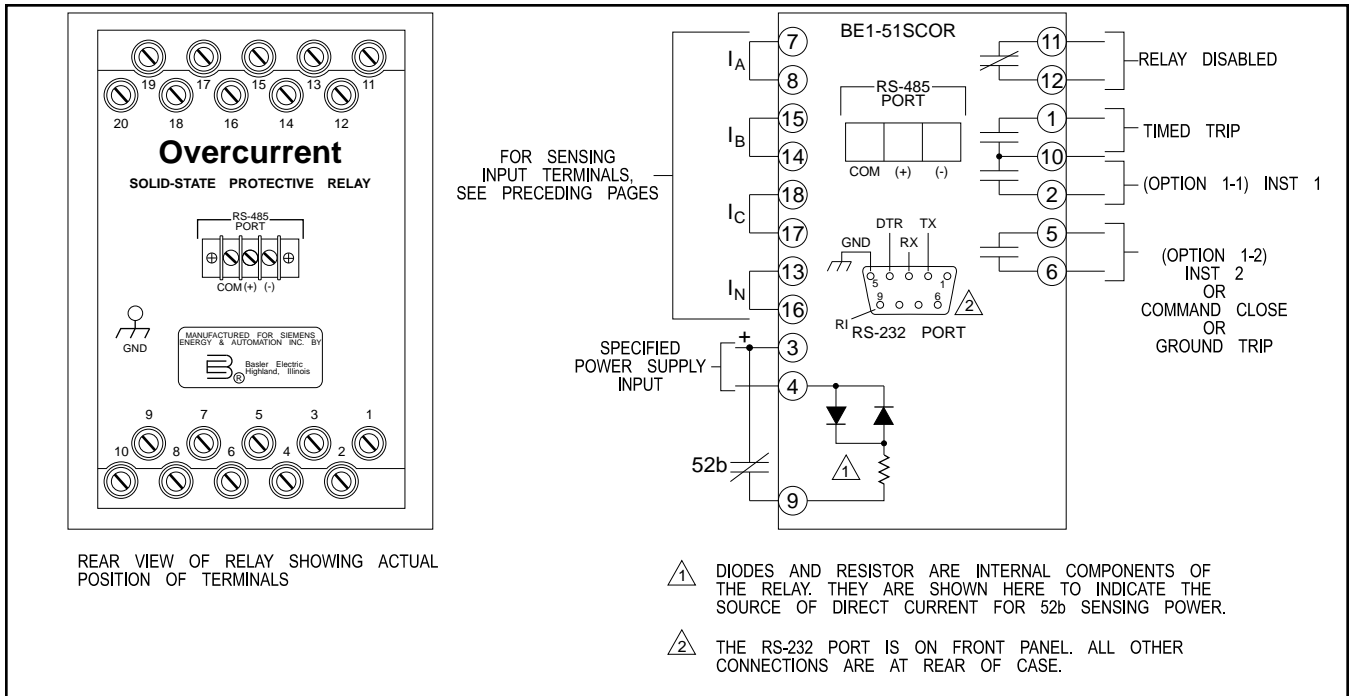


Figure 6. Relay Connections

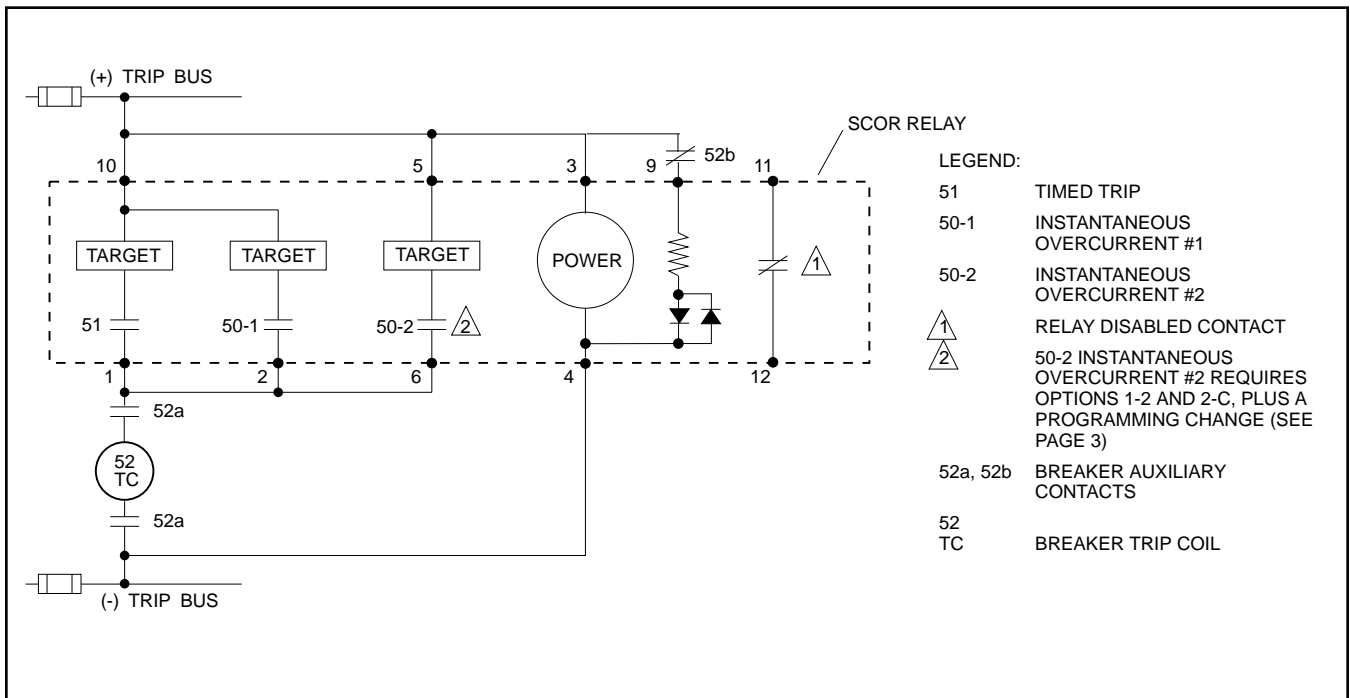


Figure 7. Control Circuits

4.6 Verification Testing

4.6.1 General

The various test procedures which follow are intended to verify operation of the relay, and to set the various controls for a specific application. Each phase of a two-or three-phase relay may be tested as a single-phase device using the procedures given. Check the Style Number Identification Chart (**Figure 2**) with the style number of the relay to identify the options included within the specific relay to be tested.

All LED and target indicators should be checked in the course of carrying out these test procedures. Reminder: The FUNCTION targets require at least 0.2 A in the output circuit to operate.

When test results do not fall within the specified tolerances, the following should be evaluated.

1. The tolerances of the test equipment;
2. Cycle-to-cycle phase stability of the test equipment;
3. The tolerances of any external components used in the test setup.

4.6.2 Scope

A complete checkout of the relay (or "verification" test) confirms that the following are within the published specifications.

1. Time overcurrent pickup;
2. Instantaneous pickup;
3. Time overcurrent timing;
4. Communications option. (The testing procedure for this option is covered in Siemens *Power Monitor™ Display and Monitoring Unit* (Manual SG-4018-01).

While every comprehensive test program should cover all of the above items, the amount of testing within any category can vary over a great range. The operational test defined below illustrates an appropriate lower limit for this range.

4.7 Operational Test

Confirmation of every parameter within the capability of this relay is usually not practical nor necessary except as an

acceptance procedure for a newly delivered relay. Succeeding tests can be reduced in scope to conserve time (and thereby permit more frequent tests). Such an operational test may be accomplished by scaling down the verification tests of this subsection as follows:

1. By concentrating on the parameters actually required in the assigned application;
2. By using spot tests that check (for example) only one or two multiples of applied TAP current at only one or two TAP positions.

Accordingly, the procedures described below can serve as the basis for both verification and operational testing.

This procedure verifies the operation of the unit. Check the Style Number Identification Chart (**Figure 2**) with the style number of the relay to identify the options included within the specific relay to be tested.

4.7.1 Equipment Required

1. The current source used in the following tests should have the following capabilities.
 - a. Current output should be switchable so that the test current can be set before it is applied to the relay. The selected operating current can then be switched to the relay's sensing inputs.
 - b. The current source needs to be capable of delivering at least 20 A. This is necessary to test the full capability of the instantaneous overcurrent element.
 - c. Because the current levels used to verify operation of the instantaneous overcurrent element(s) may exceed the continuous current rating of the relay, it is suggested that the current source include a provision for automatic removal of the test current following a trip.
2. A timer accurate to within 0.001 seconds.
3. Two test plugs, Siemens p/n 00-871-854-001, Basler p/n 10095, or GE p/n XLA12A. (Replaces the "paddles" when testing an installed relay.)
4. For bench testing: An appropriate AC or DC power source for relay operation.

NOTE

Several proprietary test sets are marketed which combine the current source and timer, and include other features to simplify setup.

4.7.2 Preliminary Steps

1. With the connecting plugs removed, connect the unit as shown in the following figure numbers:

1st Digit of Style Number	Sensing Input Configuration	Figure Number
K	Single-phase	8
G	Three-phase	9
H	Three-phase-with-ground	10, 11
X	Two-phase-with-ground	12

2. Insert the relay connecting plugs if bench testing. If relay is installed, insert test plugs instead. Before applying power, check that the Relay Fail contact is closed (terminals 11 and 12).
3. Apply operating power at terminals 3 and 4. Verify that the POWER LED is lit, and that the relay disabled contact is open.
4. Load 00 into the Phase Tap Cal register.
5. Load 99 into the Time Dial register.

4.7.3 Time Overcurrent Pickup Test

The phase current pickup of the relay will be set at the factory to operate on one of the two available ranges: HIGH or LOW. If ground current is monitored, it will also be set for one of the two ranges. Determine which range applies by noting the indication of the tap range on the front panel. (One for phase and one for ground.)

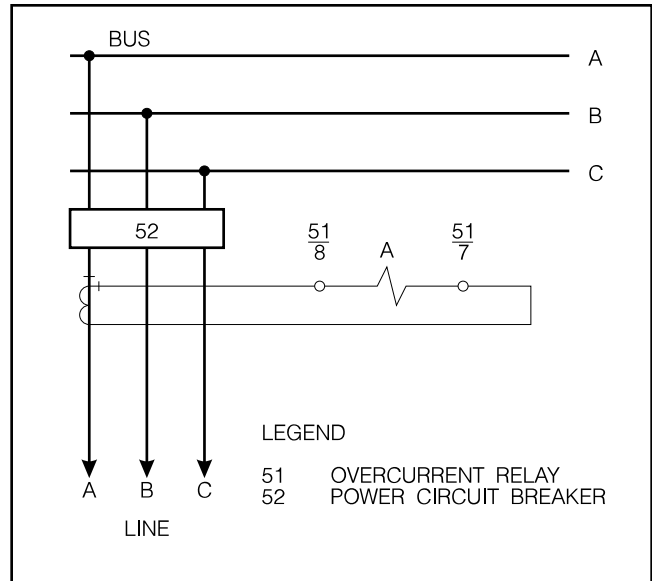


Figure 8. Single-Phase Current Sensing Connections

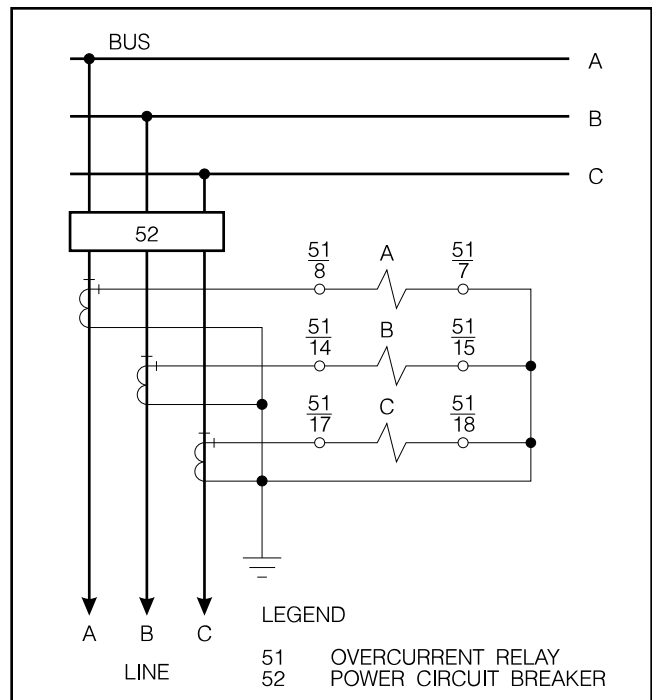


Figure 9. Three-Phase Current Sensing Connections

4.7.3 Time Overcurrent Pickup Test (Continued)

Verify time overcurrent pickup as follows:

1. After performing the above preliminary steps, connect the input current source to terminals 7 and 8 on the relay case (Phase A).
2. Set the PHASE TAP switch to position A.
3. Adjust the input current source to 110% of the value shown on the front panel table for TAP A (HIGH or LOW range as indicated by the second digit of the style number). Observe that the PHASE A TMG LED illuminates.
4. Adjust the current source so that the PHASE A TMG LED goes dark. The current applied when the LED extinguishes should be between the pickup point (from the table) and .90 times the pickup point.
5. Repeat steps 3 and 4 with the PHASE TAP switch set to B, C, D, E, F, G, H, I, and J successively.

NOTE

If this is a single-phase relay, this completes the Time Overcurrent Pickup Test. If this is a three-phase relay, perform steps 6, 7, 8, and 9 below. If two-phase-with-ground relay, perform steps 6, 7, 10, and 11 below. If three-phase-with-ground, perform all of the following steps.

6. Disconnect the input current source from terminals 7 and 8 (Phase A) and connect it to terminals 14 and 15 (Phase B).
7. Repeat steps 2 through 5 above for Phase B.
8. Disconnect the input current source from terminals 14 and 15 (Phase B) and connect it to terminals 17 and 18 (Phase C).
9. Repeat steps 2 through 5 above for Phase C.
10. Disconnect the input current source from terminals 17 and 18 (Phase C) and connect it to terminals 13 and 16 (Ground).
11. Repeat steps 2 through 5 above for ground current.

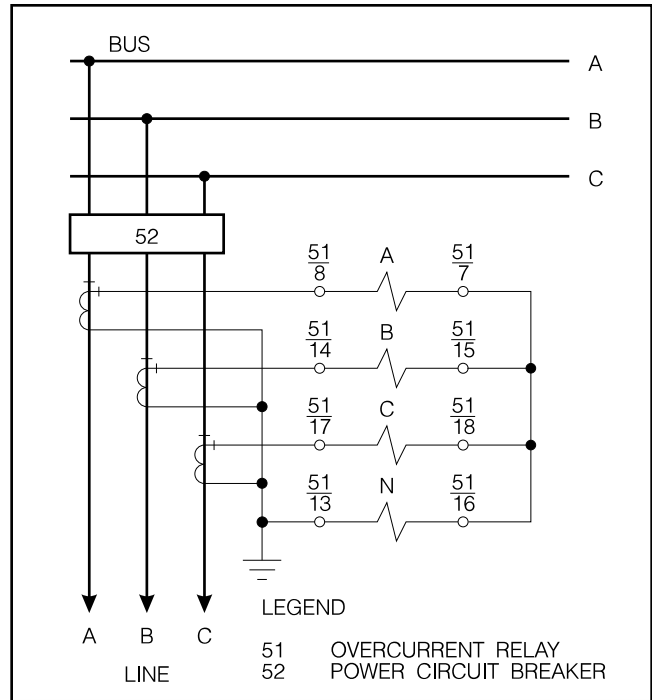


Figure 10. Three-Phase with Residually Connected Ground, Current Sensing Connections

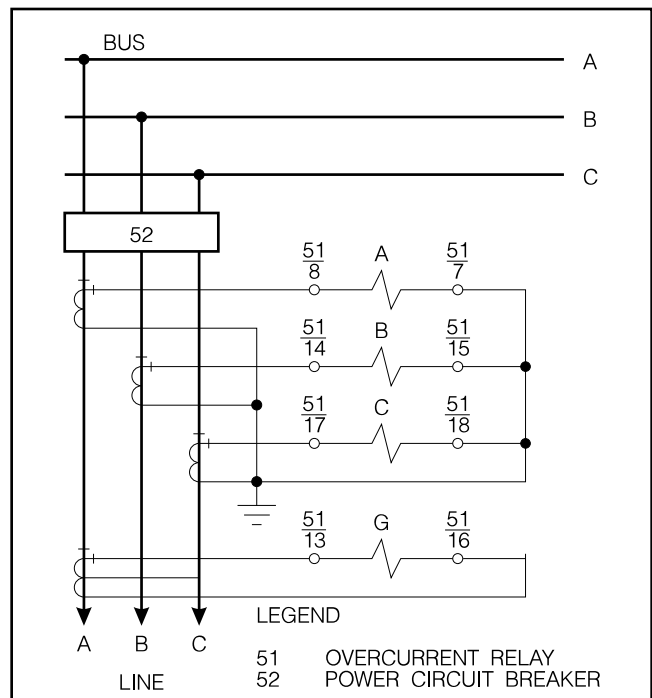


Figure 11. Three-Phase with Independent Ground, Current Sensing Connections

4.7.4 Timing Test

The timing characteristics available by programming the relay are illustrated in **Figures A.1** through **A.16**. Output trip should occur as shown for any given TIME DIAL setting, to within 10% or 20 milliseconds (whichever is greater). Verification of timing accuracy can be limited to low current levels for convenience.

Verify timing accuracy as follows:

1. After performing the "Preliminary Steps" (**Page 19**), connect the input current source to terminals 7 and 8 on the relay case (Phase A).
2. Select the time overcurrent characteristic of choice by entering its identifying code number into the Phase curve (Pcur) register. (Reference **Table 3**.) Similarly load the Ground curve register with the characteristic of choice (if ground current monitoring is a relay option).
3. Set the PHASE TAP switch to position A. Load 99 into the Time Dial register. (The Phase tAP calibrate register is still at the 00 setting given in "Preliminary Steps.")
4. Measure the timing from the application of input current to output contact closure for currents that are adjusted to the following multiples of TAP:
 - a. 2.0 x TAP, and
 - b. 5.0 x TAP

Check the results against the graphed values.
5. Adjust the TIME DIAL to 20 and repeat step 4.

NOTE

If this is a single-phase relay, this concludes a minimal Timing Test. Other TAP switch positions may be tried within the limitations of the current source. If this is a three-phase relay with ground, perform the following steps.

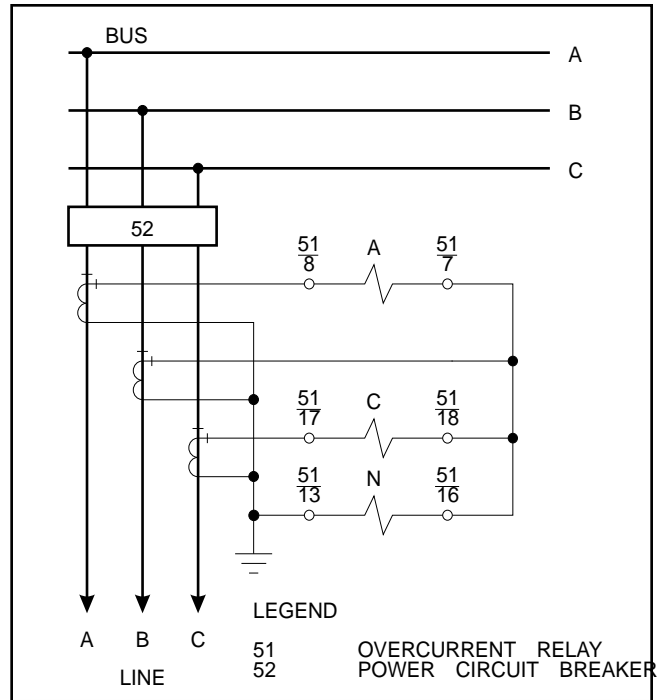


Figure 12. Two-Phase with Residually Connected Ground, Current Sensing Connections

6. Disconnect the input current source from terminals 7 and 8 (Phase A) and connect it to terminals 14 and 15 (Phase B).
7. Repeat steps 2 through 5 above for Phase B.
8. Disconnect the input current source from terminals 14 and 15 (Phase B) and connect it to terminals 17 and 18 (Phase C).
9. Repeat steps 2 through 5 above for Phase C.
10. Disconnect the input current source from terminals 17 and 18 (Phase C) and connect it to terminals 13 and 16 (Ground).
11. Repeat steps 2 through 5 above for ground current.

4.7.5 Instantaneous Overcurrent Pickup Test

The phase current pickup of the relay will be set at the factory to operate on one of the two available ranges: HIGH or LOW. If ground current is monitored, it will also be set for one of the two ranges. Determine which range your relay is set for by the indication of the tap range on the front panel. (One for phase and one for ground.)

NOTE

When testing the instantaneous element, the thermal rating of the relay must not be exceeded. The maximum continuous current rating for each input is five times tap or 20 A, whichever is less. The one-second current rating for each input is 50 times tap or 500 A, whichever is less. For ratings at less than one second, refer to formula on **Page 41**.

Verify instantaneous overcurrent pickup as follows:

1. After performing the "Preliminary Steps" (**Page 19**), connect the input current source to terminals 7 and 8 on the relay case (Phase A).
2. Load .50 into the Phase Instantaneous #1 register. (Appears as Pin1 in the display, and in **Table 3**, on **Page 11**.)
3. Set the PHASE TAP switch to position A.
4. Starting from 0 A, slowly increase the input current source until the INST 1 output contact closes. This should occur at 0.5 the value shown on the front panel table for TAP A.
5. Adjust the current source so that the INST 1 relay opens. The current applied should be above 71.25% of the TAP value (reference the front panel table).
6. Repeat steps 3 through 5 above with the PHASE TAP switch set to B, C, D, E, F, G, H, I, and J successively.
7. If Option 1-2 is present and is used as Inst 2, follow the procedures of steps 2 through 6 for testing the Instantaneous 2 pickup and output.

NOTE

If this is a single-phase relay, this completes the Instantaneous Overcurrent Pickup Test. If this is a three-phase relay, perform steps 8 through 12 below. If a two-phase-with-ground relay, perform steps 8, 9, 12, and 13. If three-phase-with-ground, perform all of the following steps.

8. Disconnect the input current source from terminals 7 and 8 (Phase A) and connect it to terminals 14 and 15 (Phase B).
9. Repeat steps 2 through 7 above for Phase B.
10. Disconnect the input current source from terminals 14 and 15 (Phase B) and connect it to terminals 17 and 18 (Phase C).
11. Repeat steps 2 through 7 above for phase C.
12. Disconnect the input current source from terminals 17 and 18 (Phase C) and connect it to terminals 13 and 16 (Ground).
13. Repeat steps 2 through 7 above for ground.

4.7.6 Testing of Option 1-2 Command Close Function

This function can only be used and tested if the Communications Option is present, and a Power Monitor unit or Power Monitor PC unit is present.

1. Close the 52b contact input on the relay (terminals 3 and 9) which simulates the open breaker.
2. Select the "Command Close" command in the Power Monitor. For detailed instructions refer to the Siemens *Power Monitor™ Display and Monitoring Unit* (Manual SG-4018-01).
3. You should observe the closure of the programmable output contact (terminals 5 and 6).
4. Open the 52b contact input. You should observe the programmable output contact open.
5. Repeat step 2. Terminals 5 and 6 should not close.

5.1 General

Static devices require no preventive maintenance other than a periodic operational test (see **Page 20**). If the relay fails to function properly, contact Siemens Customer Service. When returning the relay to the factory, ship the entire relay cradle assembly, preferably in its case.

5.2 Storage

This protective relay contains aluminum electrolytic capacitors which generally have a storage life expectancy in excess of ten years at storage temperatures less than 40°C. Typically, the life expectancy of the capacitor is cut in half for every 10°C rise in temperature. Storage life can be extended if, at one-year intervals, power is applied to the relay for a period of 30 minutes.

5.3 Timekeeping

The real-time clock within the relay, once set by the Power Monitor unit after power up, maintains time to a resolution of 0.01 second; however, drift within the clock can be as much as 0.5 seconds per day. In order to keep all of the clocks in the system in proper synchronization, the Power Monitor periodically broadcasts the correct time.

Note that changing the time within a relay by seconds or minutes can upset instrumentation functions such as demand calculations.

1. *EIA Standard: EIA 485*. (Also known as the RS-485 Standard.) Published by Electronic Industries Association (April 1983).
2. Siemens *Power Monitor™ Display and Monitoring Unit* (Manual No. SG-4018-01).
3. Siemens *SCOR Protocol*.
4. Siemens *Isolated Multi-Drop™ RS-232 to RS-485 Converter* (Manual No. SG-6048).
5. Siemens *Power Monitor PC™ User's Guide* (Manual No. SG-4028).
6. Siemens *SIEServe™ Electrical Distribution Communication Software User's Manual* (Manual No. SG-6058).
7. Siemens *WinPM™ Power Monitoring and Control for Windows User's Manual* (Manual No. SG-6118).
8. Siemens *PC32F Power Monitor Data Sheet* (Bulletin No. SG-3211).

Figure A.1 through **Figure A.16** illustrate the characteristic curves that are programmed into the nonvolatile memory of this relay.

Refer to **Table 1** on **Page 5** for a listing of the 16 characteristic curves.

Note that a drawing number is given under each caption. Use this number to order a full-size (10" x 12") Characteristic Curve set.

The Phase and Ground Instantaneous Time Curves are presented in **Figures A.17** and **A.18** respectively.

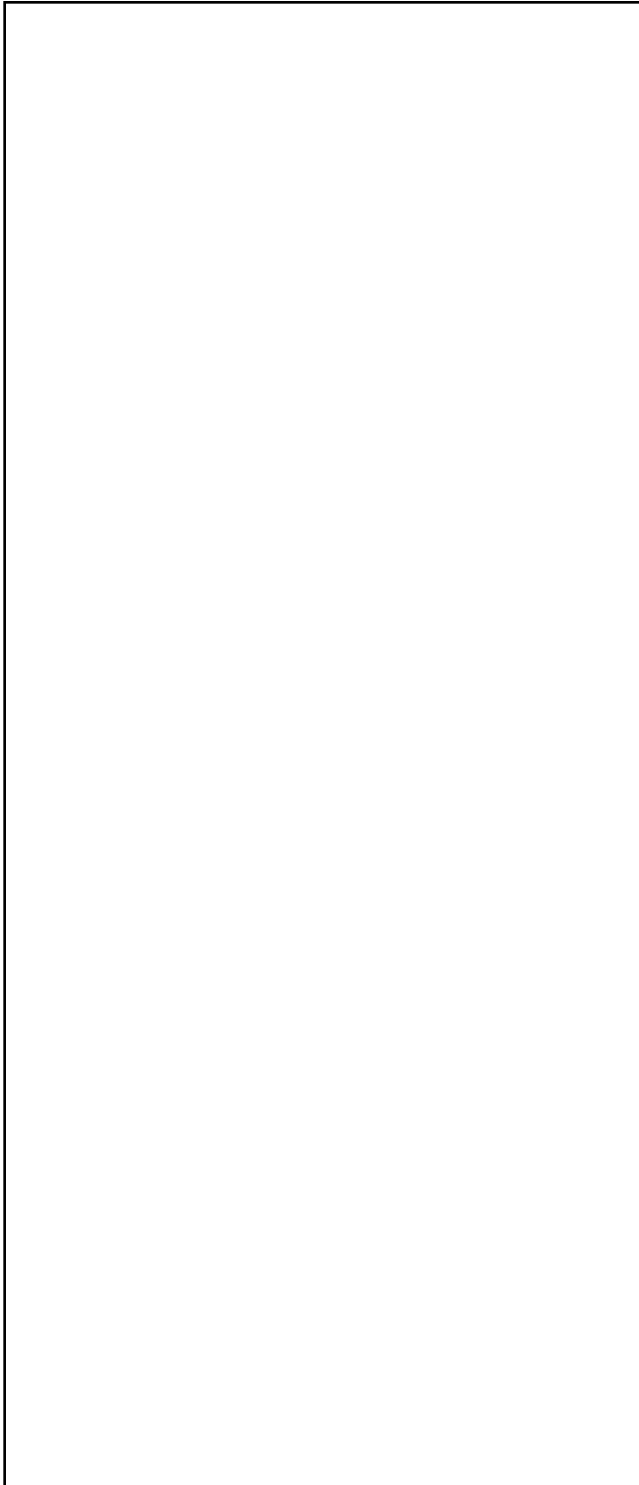


Figure A.1 Timing Type b1: Short Inverse Time
(Dwg. No. 18-752-294-001)

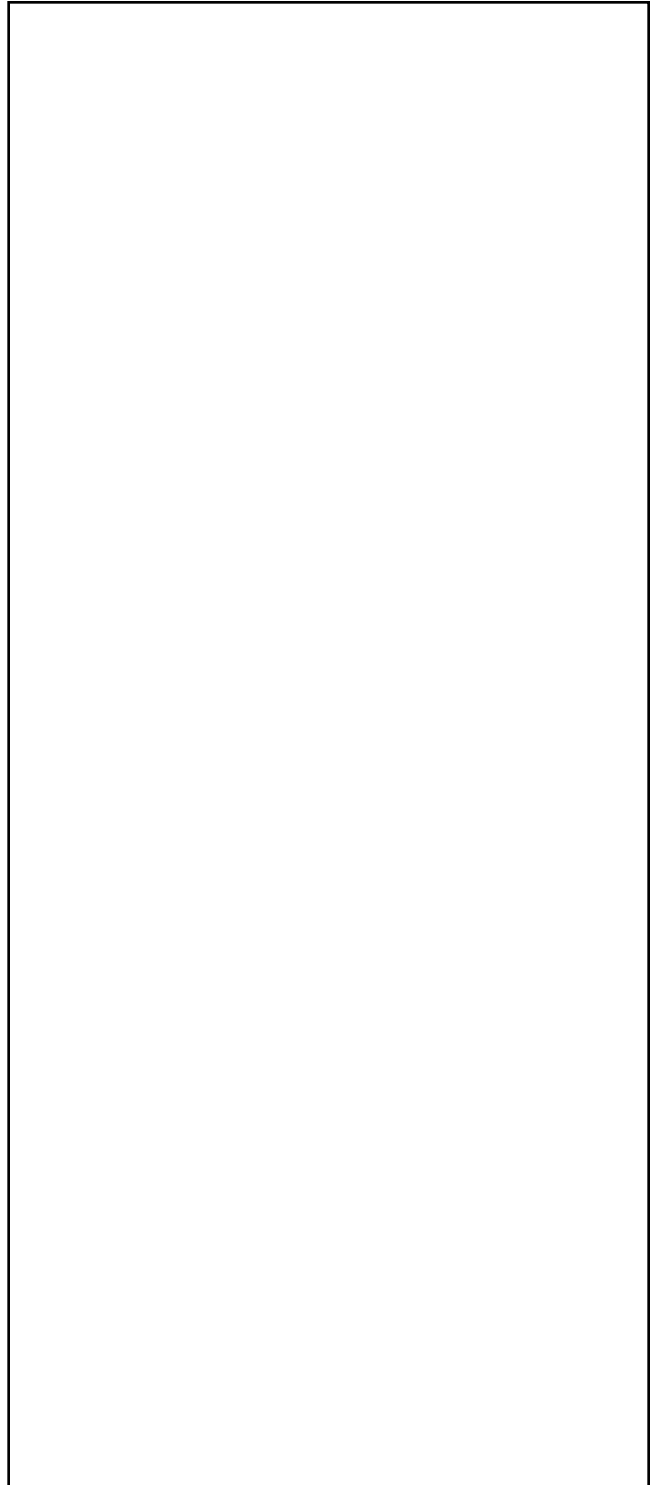


Figure A.2 Timing Type b2: Long Inverse Time
(Dwg. No. 18-752-294-002)

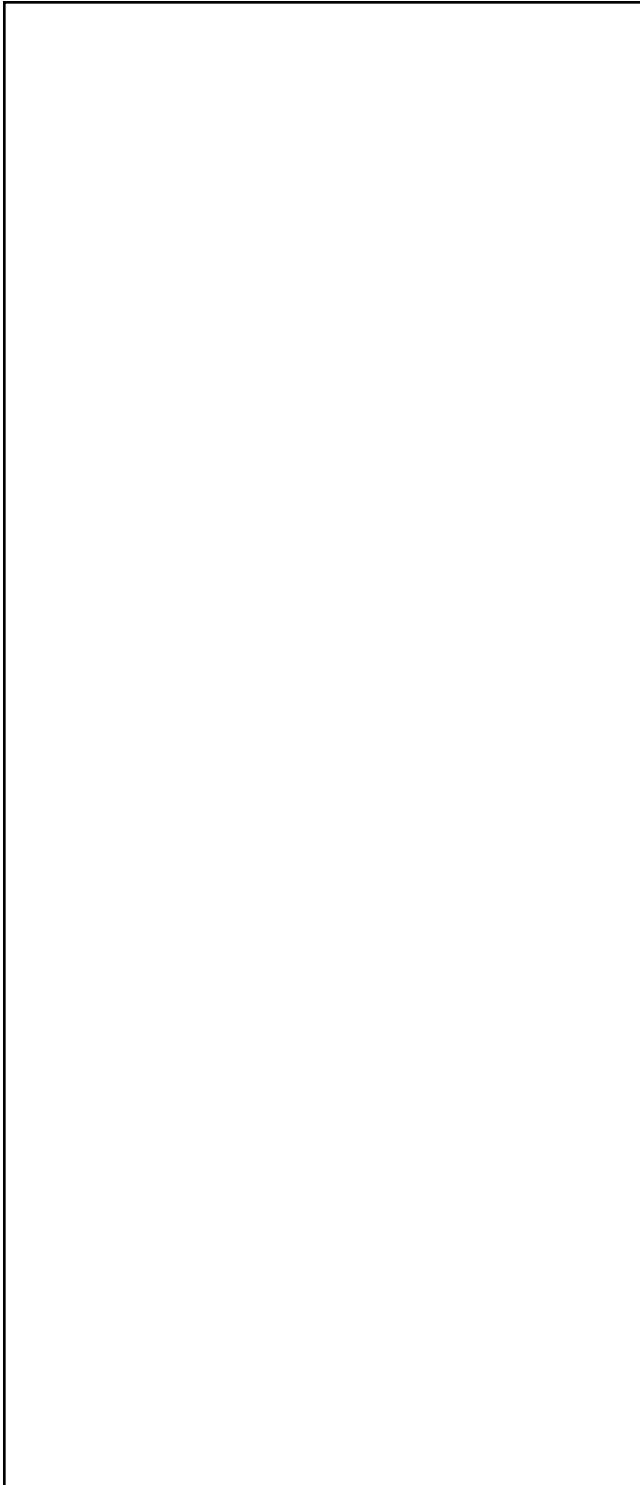


Figure A.3 Timing Type b3: Definite Time
(Dwg. No. 18-752-294-003)

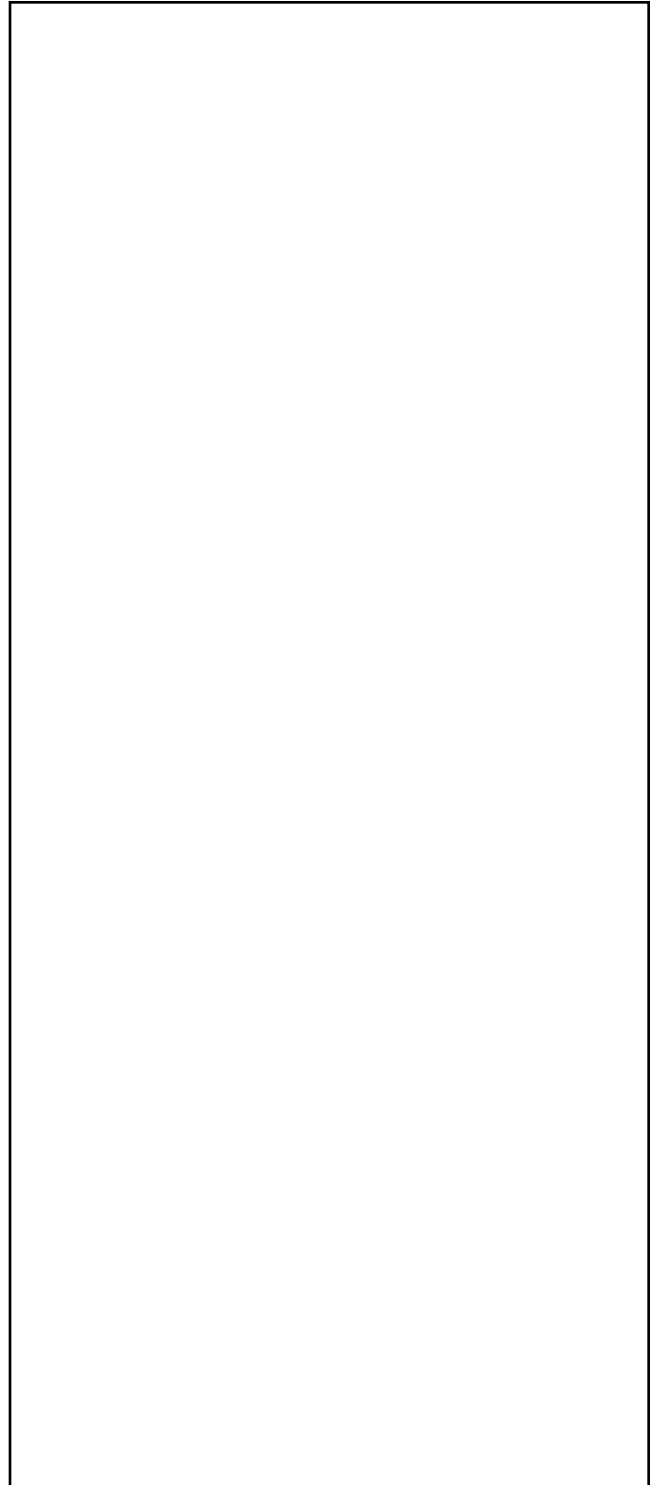


Figure A.4 Timing Type b4: Moderately Inverse
(Dwg. No. 18-752-294-004)

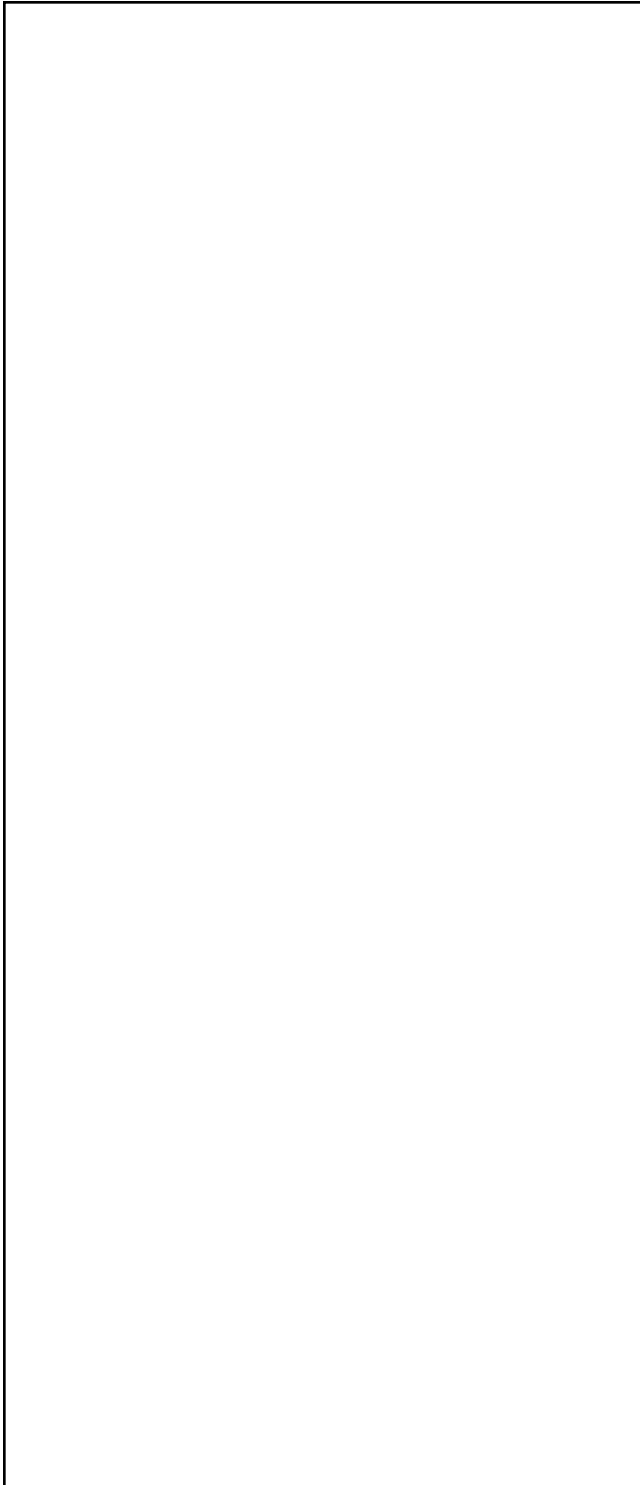


Figure A.5 Timing Type b5: Inverse Time
(Dwg. No. 18-752-294-005)

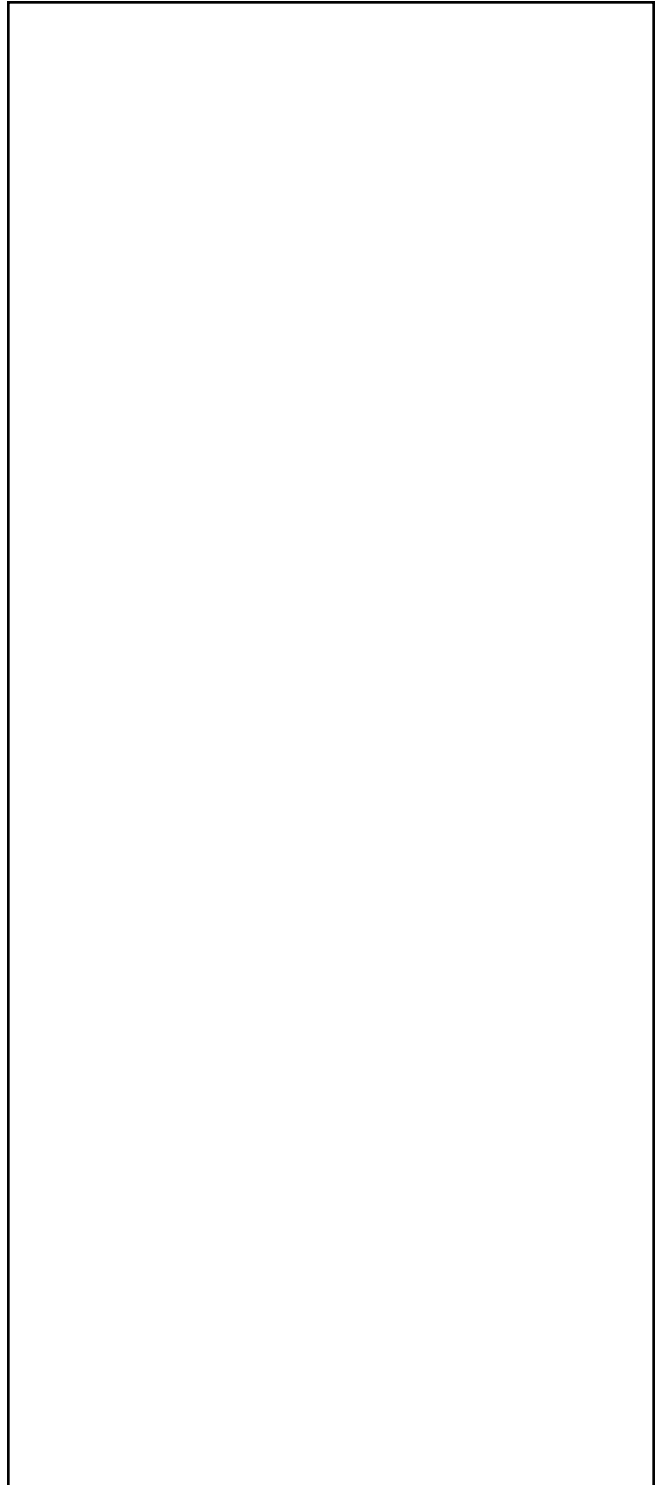


Figure A.6 Timing Type b6: Very Inverse Time
(Dwg. No. 18-752-294-006)

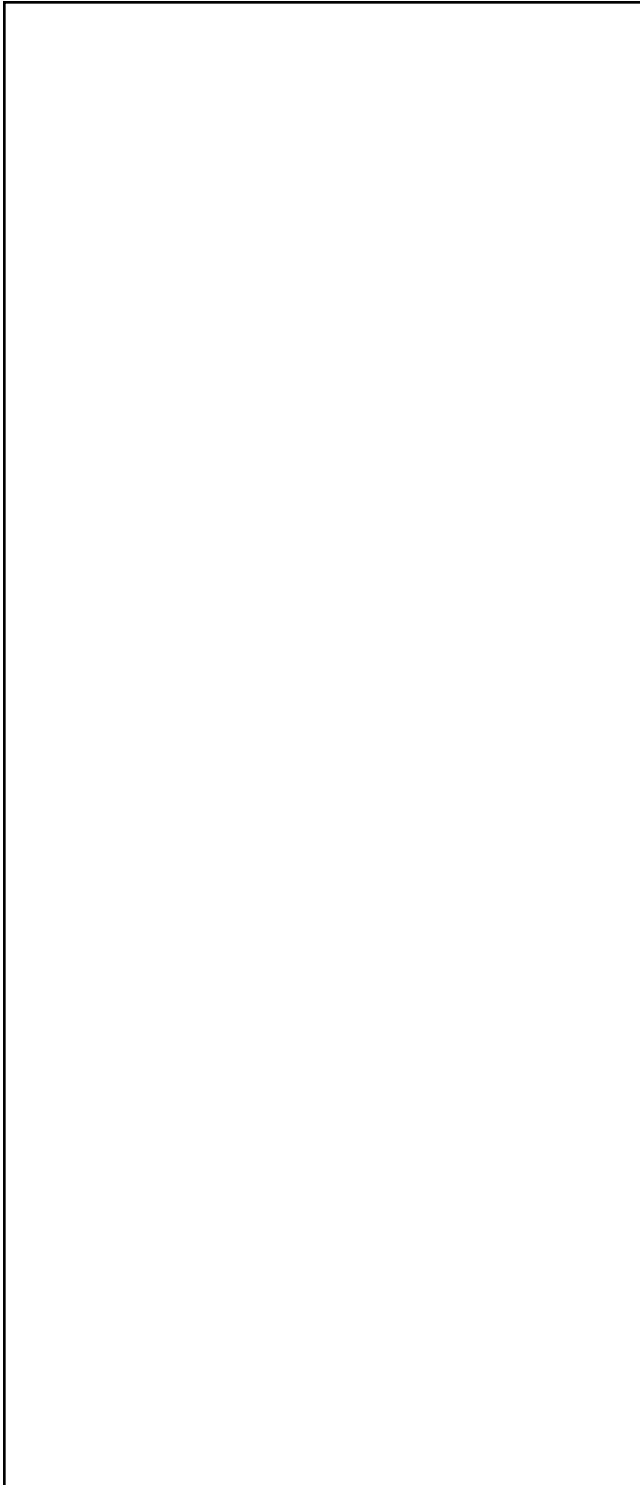


Figure A.7 Timing Type b7: Extremely Inverse
(Dwg. No. 18-752-294-007)

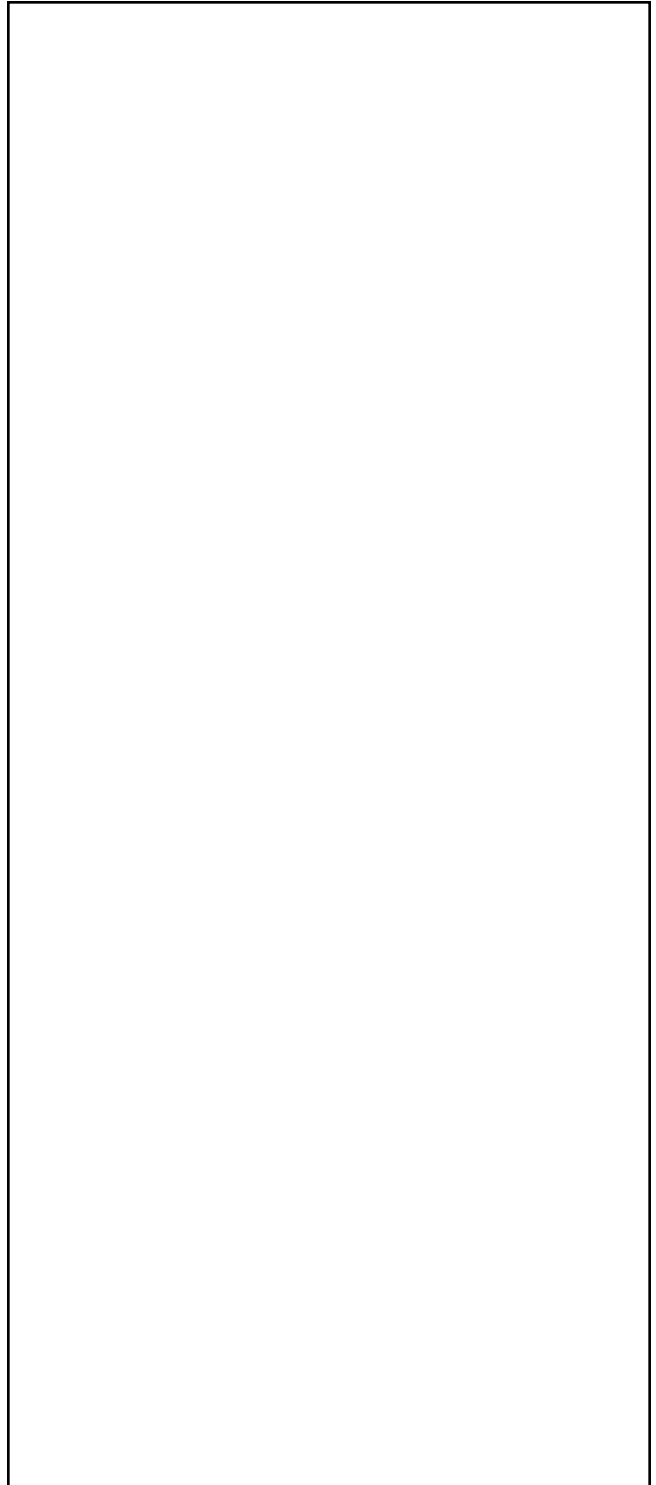


Figure A.8 Timing Type b8: I²T
(Dwg. No. 18-752-294-008)

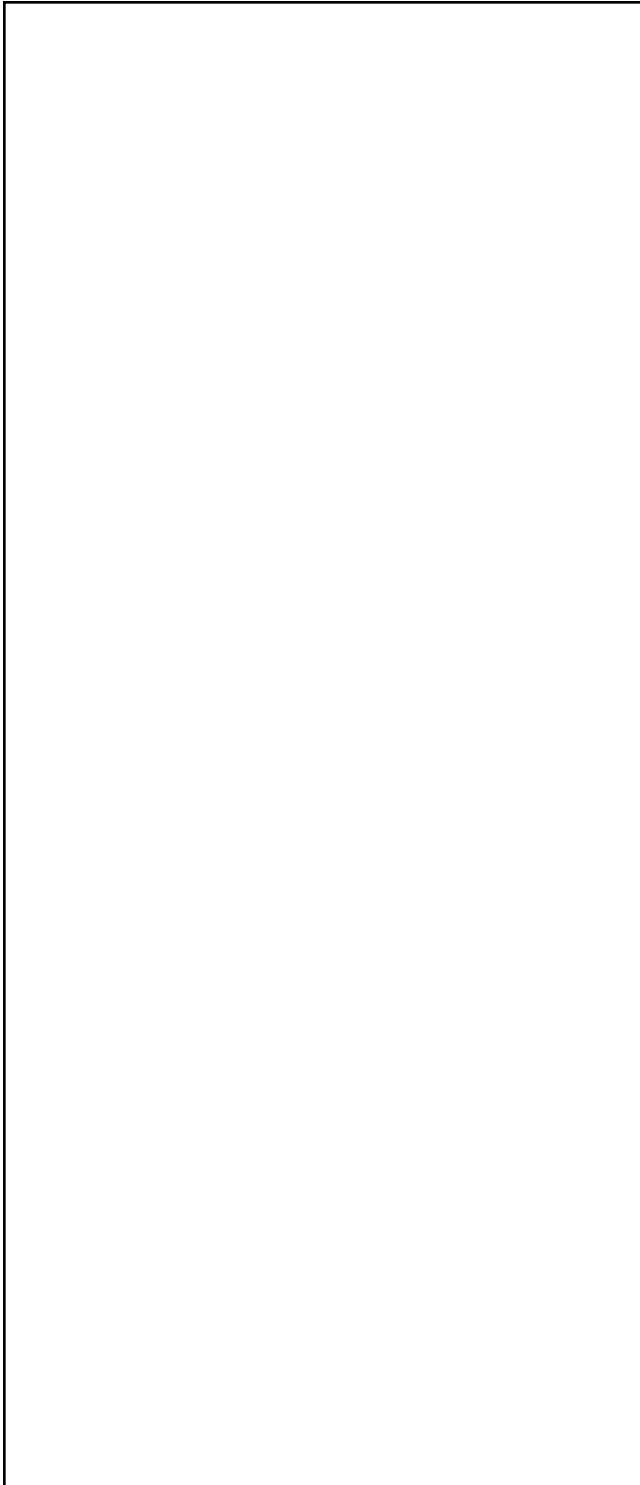


Figure A.9 Timing Type c1: I²T w/Limit 1
(Dwg. No. 18-752-294-009)

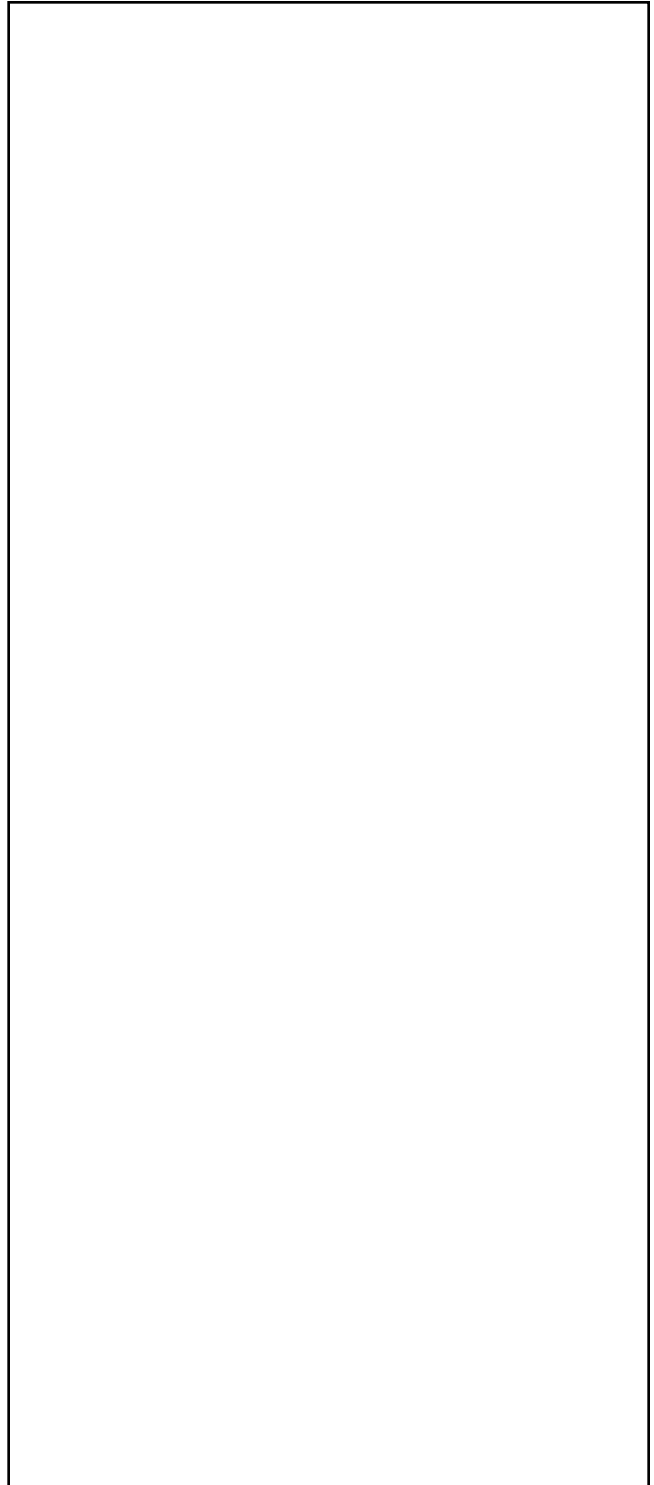


Figure A.10 Timing Type c2: I²T w/Limit 2
(Dwg. No. 18-752-294-010)

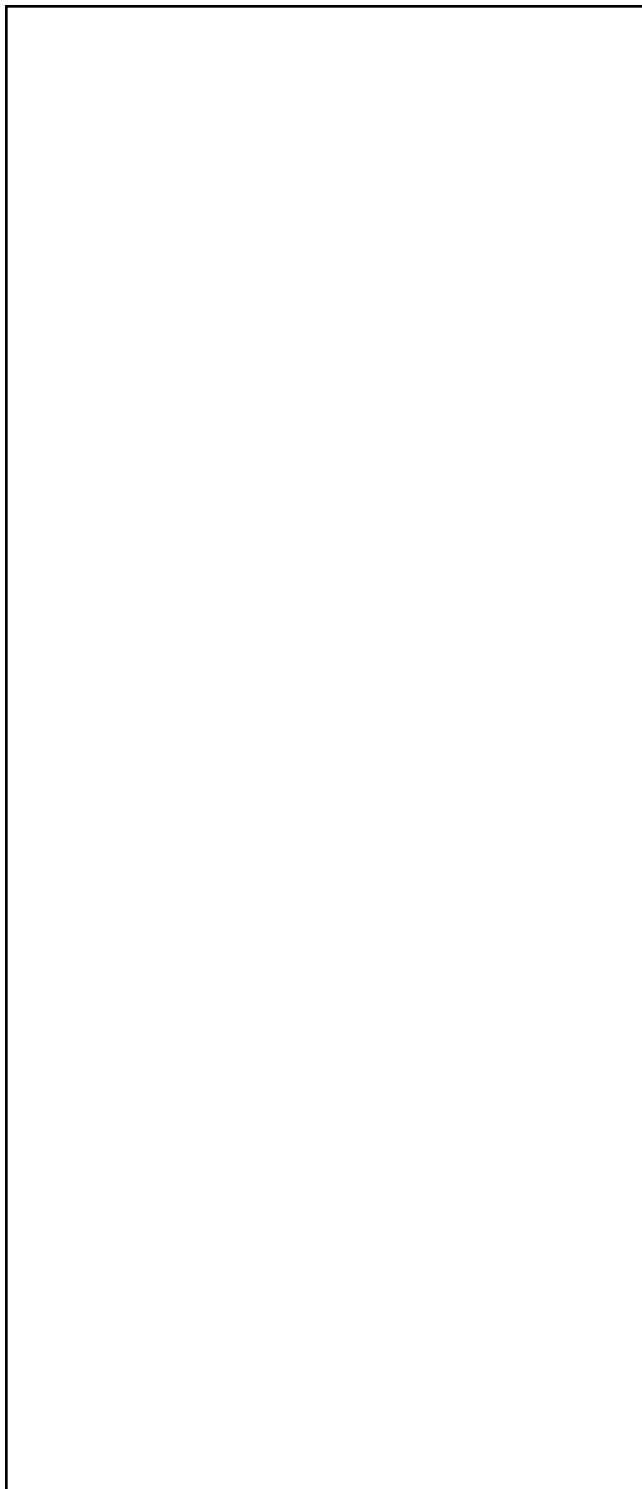


Figure A.11 Timing Type c3: I^2T w/Limit 3
(Dwg. No. 18-752-294-011)

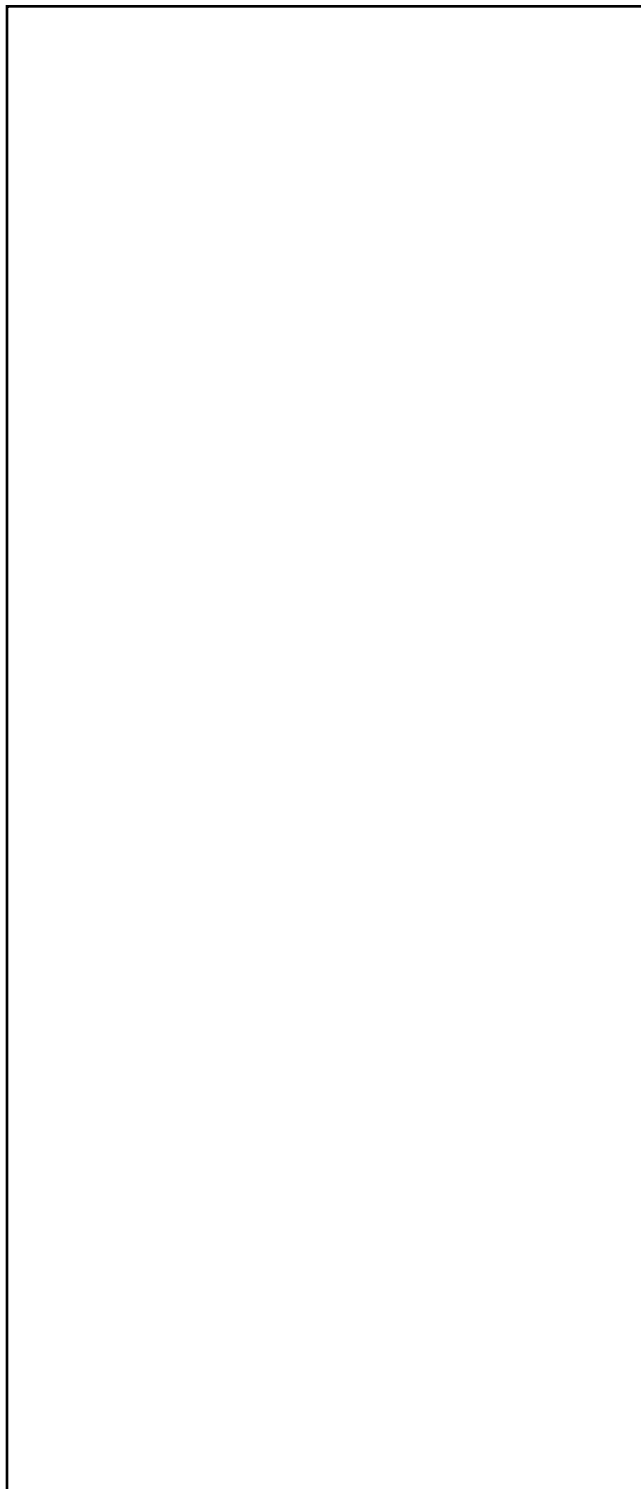


Figure A.12 Timing Type c4: I^2T w/Limit 4
(Dwg. No. 18-752-294-012)

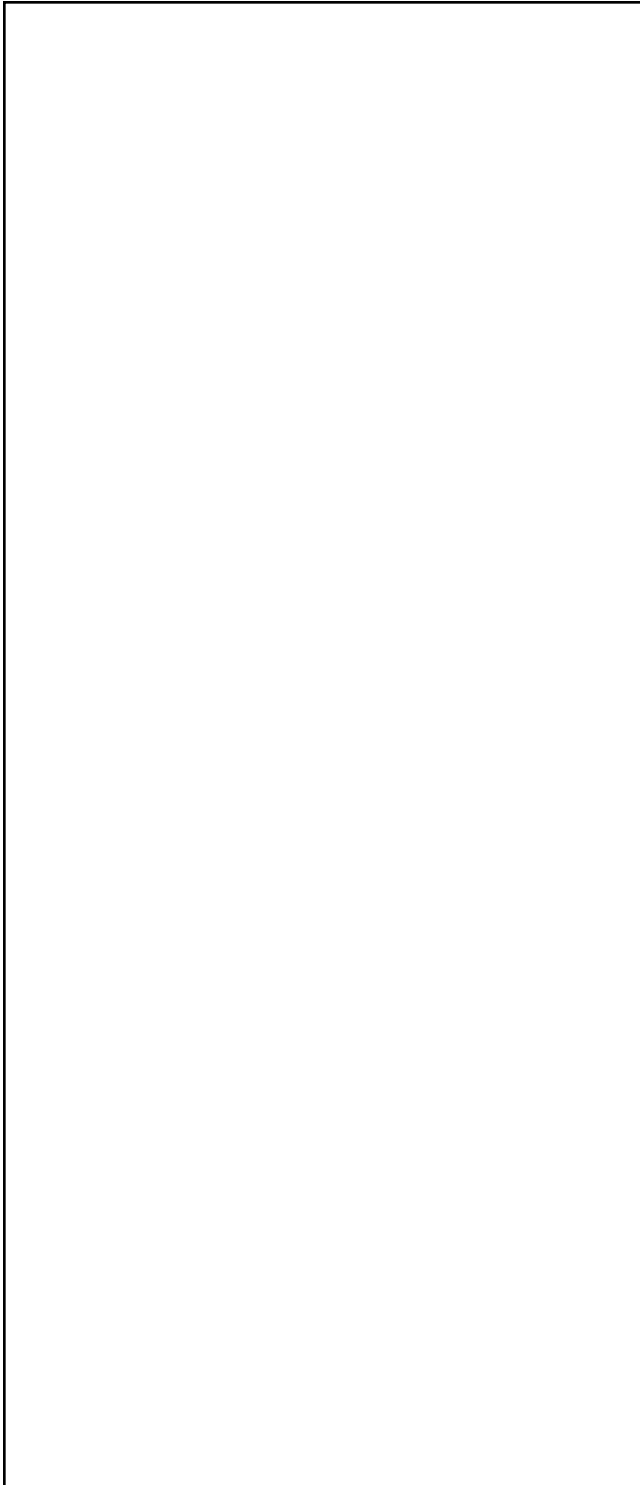


Figure A.13 Timing Type c5: I²T w/Limit 5
(Dwg. No. 18-752-294-013)

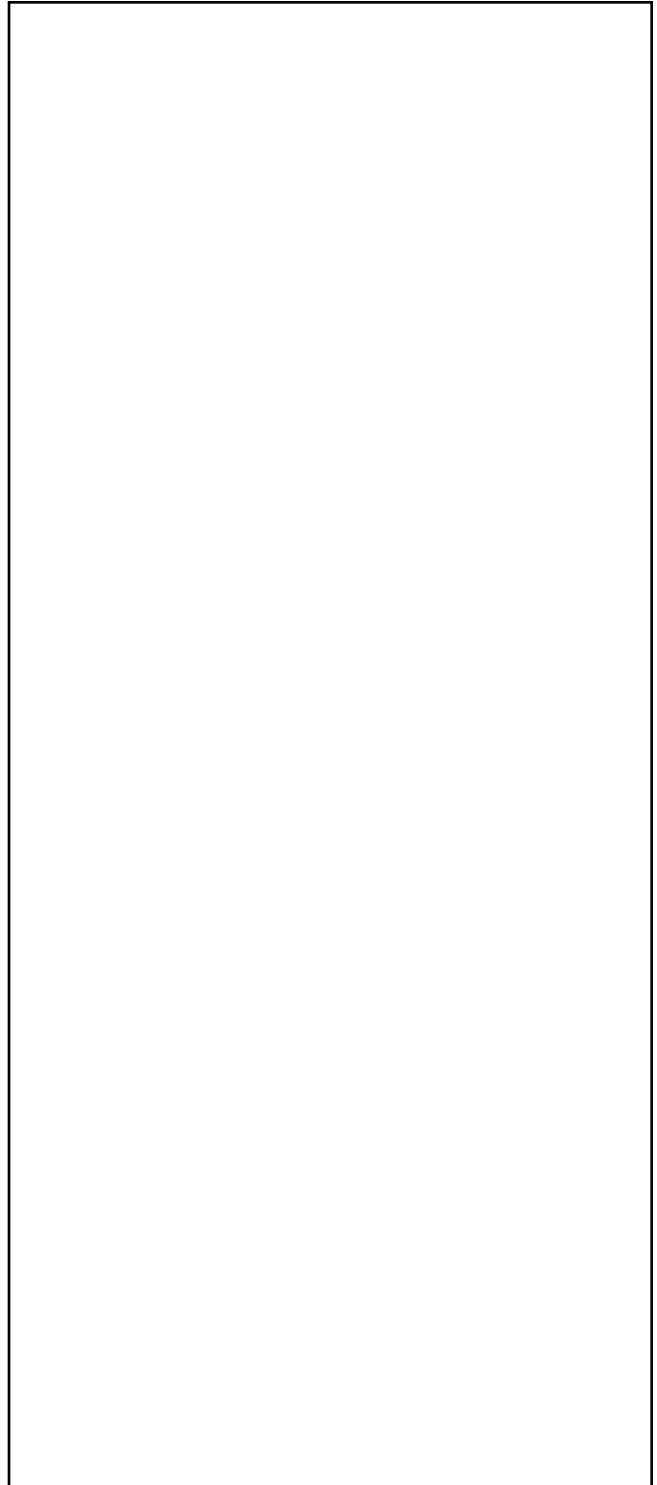


Figure A.14 Timing Type c6: I²T w/Limit 6
(Dwg. No. 18-752-294-014)

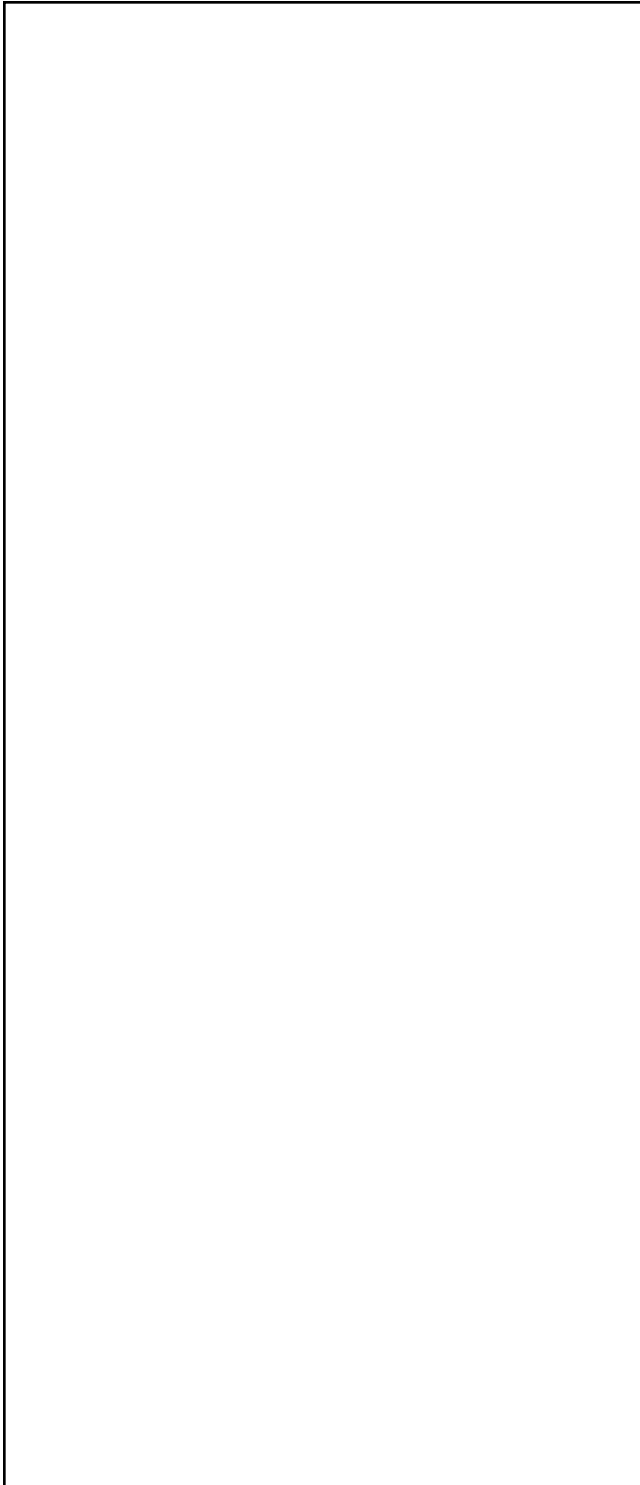


Figure A.15 Timing Type c7: I²T w/Limit 7
(Dwg. No. 18-752-294-015)

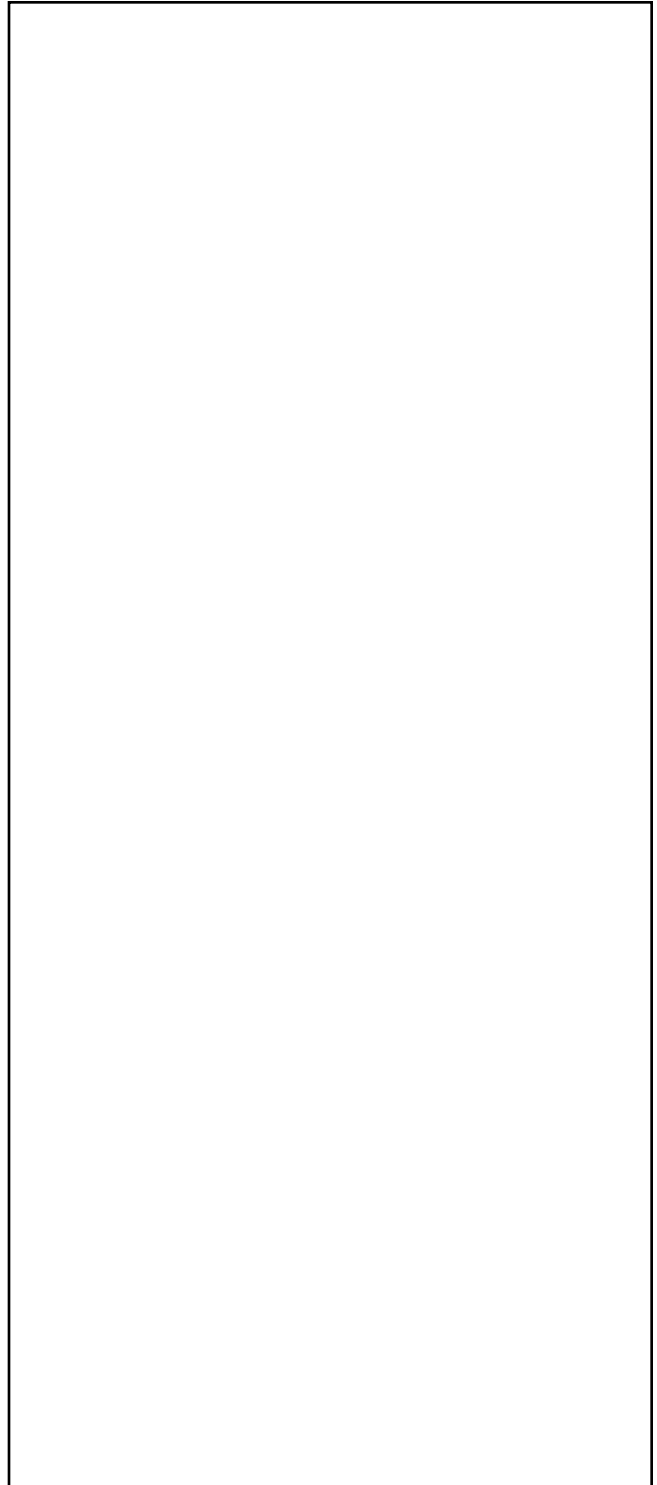


Figure A.16 Timing Type c8: I²T w/Limit 8
(Dwg. No. 18-752-294-016)

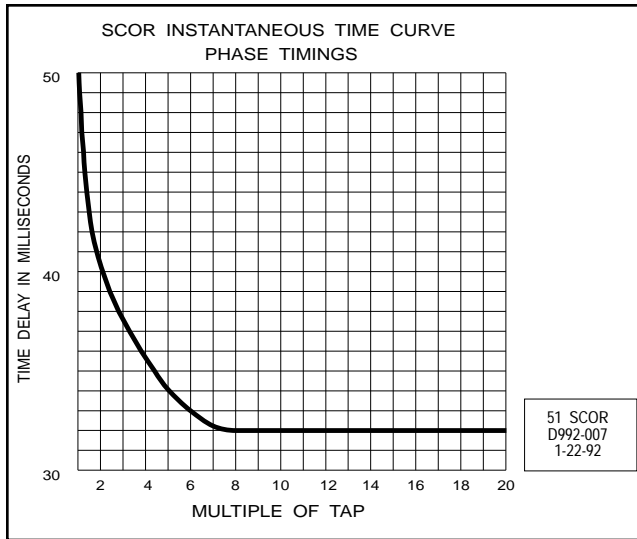


Figure A.17 SCOR Instantaneous Time Curve Phase Timings

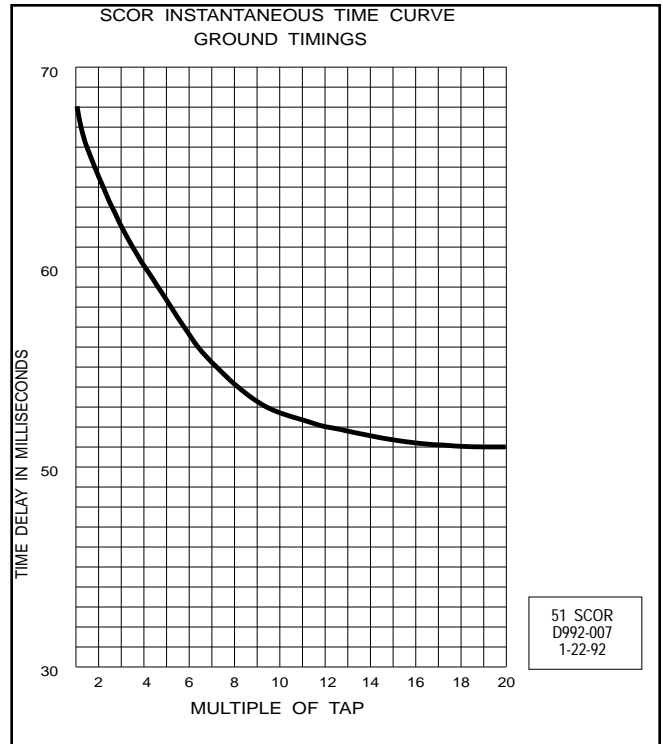


Figure A.18 SCOR Instantaneous Time Curve Ground Timings

B.1 General

The SCOR relay is a microprocessor-based overcurrent relay that can optionally be equipped to communicate with a remote computer. The following text is referenced to **Figure B.1**, which is a functional block diagram that illustrates the overall operation of a fully implemented version of the relay.

B.2 Current Sensing

The SCOR relay can be provided for single-phase, two-phase-with-ground, three-phase, or three-phase-with-ground current monitoring. The illustrated relay is of the three-phase-with-ground style.

The internal current sensing transformers are designed to receive their input from the 5 A nominal secondaries of standard current transformers (CTs). Note the dual primaries of the internal transformers. One or the other is connected by the factory to obtain a LOW or a HIGH current sensing range (0.50 to 5.0 A, or 2.00 to 11.00 A) in accordance with the specified Style Number of the relay.

The outputs of the internal transformers are applied to scaling circuits (one for each of the phases, one for ground) that convert each of the input currents to a voltage level that can be utilized within the relay.

A "coarse" incremental adjustment for the current pickup setting is provided by the TAP switches. These are front-panel rotary switches; one for the phases, and another for ground, if ground current is monitored. The current setting represented by each of the 10 switch positions is given for each range (HIGH and LOW) in the table printed on the front panel. (Reference **Figure 3**.)

The "fine" adjustment of the current pickup point is determined by the value (0 to 99) stored in the relay's Tap Cal registers (again, one setting for the phases, one for ground). When the Tap Cal register contains the value 0, the pickup setting of the relay is the indicated TAP setting.

The Tap Cal registers provide a means of adjusting the timed trip pickup between the selected position of the TAP switch and the next higher position. For example, when the TAP switch is set to position A, the Tap Cal register provides an adjustment from 0.50 to 1.00 A for the LOW range, and from 2.00 to 3.00 A for the HIGH range. EXCEPTION: At the highest TAP position (i.e., J), the setting of the Tap Cal register is ignored. Therefore the J values of 5.0 and 11.00 represent the upper limits of the LOW and HIGH ranges, respectively.

B.3 Power Supply

B.3.1 General

The solid state power supply is a low burden, flyback switching design which delivers a nominal +5 and +/-12 VDC to the relay's internal circuits; also an isolated +5 Vdc for the communications circuits.

The input terminals of the power supply are not polarity sensitive. A red POWER LED illuminates to indicate that the power supply is functioning.

B.3.2 Loss-of-Power Sensing

A loss-of-power circuit monitors the power supply. If power is interrupted, a Power Fail signal is delivered to the computer in time for it to store all vital information in non-volatile registers. Also at this time, the Relay Disabled output contact closes as explained below under "Outputs."

B.4 Multiplexer

A multiplexer is utilized to select each current sensing input. These inputs are then supplied to the sample-and-hold circuit, and then to the level shifter. The level of each input sample is strobed into the microprocessor, where analog-to-digital conversion is implemented.

B.5 Internal Microcomputer

The onboard computer fulfills many of the logic and signal processing functions described in the following paragraphs, and performs the time delay computations.

B.5.1 Analog-to-Digital Converter

The voltage representing a component of the actual sensed current is presented to the analog-to-digital (A/D) converter. The A/D converter supplies the equivalent binary value of the sensed current. The accumulator stores a number of these squared samples and presents this sum to the trip computer. The microcomputer then calculates the true RMS value of the current at each input.

B.5.2 RMS Sensing

The SCOR protective relay uses RMS Sensing, a technology first introduced by Siemens in 1985, to sample the current wave shape and quickly calculate the effective heating value of the current. SCOR relays evaluate the impact of harmonics and provide accurate circuit protection. The SCOR relay uses a sum

of squares algorithm for both determining trip level and for calculating metered values of the relay current level. The input waveform is sampled several times to determine instantaneous values. These instantaneous values are processed to obtain the true RMS value of the input current.

B.5.3 Time Overcurrent Calculations

If the magnitude of the current exceeds the pickup setting, the microprocessor calculates the required time delay by evaluating the magnitude of the overcurrent in the context of the desired time overcurrent response curve. (All of the time overcurrent functions that are graphically illustrated in **Figures A.1** through **A.16** are in the computer's memory.)

The current inputs are continuously polled and the calculations updated once for every 60 Hz (line) cycle. As long as the sensed current is above the pickup point, the elapsed time is accumulated toward trip. However, once the sensed current falls below pickup, the relay is reset and all accumulated time is cancelled.

When the value of a sensed current exceeds the pickup setting, the TIMING LED for that phase will light. The LED will stay lit as long as the sensed current exceeds the selected pickup level.

B.5.4 High/Low Range Register

It was noted earlier in this section that the input transformers must be wired for one of two sensing ranges: HIGH or LOW. This information is recorded (at the factory) into the HI/LO Range

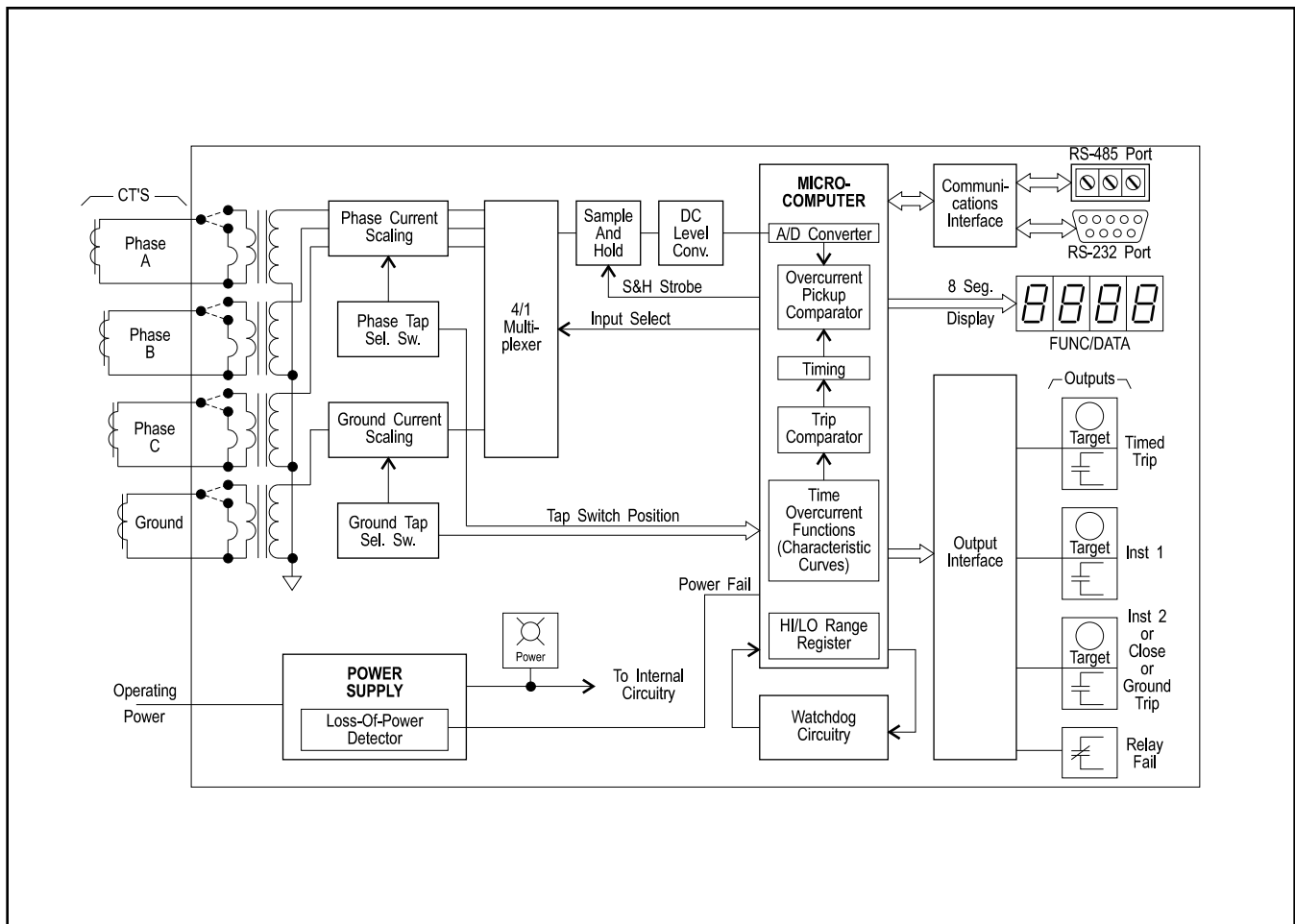


Figure B.1 Functional Block Diagram

Registers; one register for the phases, one for ground. All current sensing and pickup data is weighted by the computer accordingly.

B.5.5 Watchdog Circuitry

The watchdog circuit checks that the microcomputer is operational. If some transient condition has disrupted its normal pattern of operation, the watchdog will momentarily close the relay disabled output contact, reset the computer, and reinitialize the program. The computer is then restarted, and the relay resumes its monitoring function (without human input).

B.6 Outputs

B.6.1 General

Although the output relays are controlled by the microcomputer, the output interface contains the transistors that energize them. With the exception of the Relay Disabled contact (described below), all of the output contacts are of the normally open type and have targets associated with them.

B.6.2 Relay Disabled Output

The Relay Disabled output contact is of the normally closed (NC) type. It is held open (by the output relay's energized coil) at all times after power-up unless a malfunction is detected as noted below. (This arrangement provides for a fail-safe output signal, since the contact is able to close an external alarm circuit even in the absence of power.)

The Relay Disabled output contact will close if:

1. The power supply voltage falls below requirements; or
2. The upper connecting plug ("paddle") is removed.

Additionally, the Relay Disabled output contact will momentarily close if the watchdog circuit detects abnormal operation of the computer. (Actually, detection of abnormal operation leads to microcomputer reset in an effort to correct the problem, and the reset operation causes the contact closure.)

B.6.3 Instantaneous and Command Close Options

One or two instantaneous outputs are available as options. The trip points for these options are selected by a programming method described in **Section 3**, Operation by Front Panel.

When two instantaneous outputs are selected, one of them can be programmed to operate directly from the system computer

(assuming that the Communications Option is also present). The programming information is supplied in the Siemens *Power Monitor™ Display and Monitoring Unit* (Manual SG-4018-01). (The second output relay, when controlled by the computer, cannot simultaneously serve as an instantaneous output.)

Optionally, this extra output relay can be programmed as a dedicated ground trip contact.

B.7 Target Indicators

Targets are provided for each function (TIME, INST 1, and INST 2/CLOSE or GROUND), and for each phase and ground that is monitored on multiphase relays. Each target indicator is visible on the front panel of the relay with the cover in place. When operated, the disk in the target changes from black to orange, and is magnetically latched in this position.

The FUNCTION targets only operate when a minimum of 0.2 A flows through the associated relay's output circuit. This is to provide confirmation that the contact actually did close and that a signal was delivered. The ELEMENT targets, i.e., phase and ground are internally operated.

To monitor output current, the coil of a special reed relay is placed in series with the output contacts. The reed relay signals the target. (The series impedance of the reed relay coil is less than 0.1 ohm.)

To reset the target(s) after an abnormal system condition has been cleared, manually raise the target reset switch on the front of the relay, or its extension bar that protrudes through the bottom of the cover. (The relay must be under power to reset a target.)

NOTE

Resetting the targets in this manner will not reset the alarm messages provided on the communication link.

B.8 Communications Option

The SCOR relay includes provision for the future addition of the optional communication board as standard. If the communications option 2-C is selected initially, the relay is provided with an RS-232 port on the front panel, and an RS-485 port on the back of the case.

B.8.1 Local RS-232 Port

A 9-pin RS-232 communication port is provided on the front of the relay for local data readout and programming when the communication option is installed.

Use of this port is restricted to Siemens field service and factory personnel, and connection to this port automatically disables remote RS-485 communications.

B.8.2 Local or Remote with Siemens Power Monitor Unit

The RS-485 port permits interconnecting multiple SCOR relays, 4700 power meters, Static Trip IIC trip units, and other compatible devices via an industry standard shielded twisted-pair EIA RS-485 communication bus to a Siemens Power Monitor display and monitoring unit. A Power Monitor unit can accommodate up to 64 devices. The bus length can be up to 4000 feet. The Power Monitor unit is intended to be a "factory floor" tool, and can be mounted on medium-voltage or low-voltage switchgear, serving all circuit breakers within a substation or control room, or it may be located remotely at a central maintenance/control area.

The Power Monitor unit works intimately with SCOR relays to provide comprehensive displays, monitoring, and logging of all the data from all devices on the bus. It is a dedicated computer which constantly monitors each device on the communications bus. Every data item available from the front of the relay is also available at the Power Monitor unit. The Power Monitor unit also provides information not available on the SCOR display, such as

system diagrams with real-time amperes and circuit breaker position; detailed data for all phases and ground simultaneously which changes to a trip log with time stamped currents at the time of trip, relay target operation plus watchdog status; a MIN/MAX log; and an event log with a time stamped chronological listing of events of all devices on the bus. The event log is a powerful tool for operating and maintenance personnel.

Configuration of the SCOR relay is read and stored by the Power Monitor unit, and the relay can be configured or changed remotely from the Power Monitor unit (except for the tap switches which must be set manually on the front panel). Configuration and changes from the Power Monitor unit is password protected.

For complete operation of the SCOR relay with a Power Monitor unit, see the Siemens *Power Monitor™ Display and Monitoring Unit* (Manual No. SG-4018-01).

B.8.3 Local or Remote by Owner's Computer

Installations which do not have a Power Monitor unit can use a computer equipped with Siemens Power Monitor-PC program connected through a Siemens Isolated Multidrop RS-485/RS-232 converter. If the SCOR relays and other devices are interconnected by the communication bus described above, the computer can access all devices, and display the same data as described for the Power Monitor unit. This can be helpful when initially configuring a system which has multiple devices, and for periodic downloading of event and MIN/MAX data. For information about operation with the Power Monitor PC, refer to the Siemens *Power Monitor PC™ User's Guide* (Manual No. SG-4028).

The SCOR relay is available in single-phase, three-phase, two-phase-with-ground, and three-phase-with-ground configurations, and with the features and capabilities described in **Table C.1**.

Table C.1 Specifications

Current Sensing Inputs	<p>The unit is designed to operate from the secondary of a standard current transformer rated at 5 A. The maximum continuous current rating for each input is five times tap or 20 A, whichever is less.</p> <p>The one-second current rating for each input is 50 times tap or 500 A, whichever is less. Ratings at less than one second are calculated as:</p> $I = \sqrt{K/T} \text{ where}$ $K = (500 \text{ A or } 50 \text{ times TAP})^2$ $T = \text{Time that current flows (in seconds)}$
Current Sensing Burden	Less than 0.025 ohms per phase at nominal 60 Hz. (see Table 3)
Frequency (nominal)	60 Hz.
Time Overcurrent	
Pickup Ranges:	Two ranges are available: HIGH (2.0 - 11.0 A), and LOW (0.5 - 5.0 A). Range is independently specified for phase and ground by the second digit of the Style Number. The TAP range windows on the front panel indicate which range (HIGH or LOW) is specified. Selection of the desired tap is made using the rotary selector switch(s) on the front panel. Refer to the table on the front panel for the various tap ratings in secondary amps.
Pickup Adjustment:	Incrementally adjustable over the selected range by a front-panel (TAP) selector switch ("coarse"), and by numerical data entered into the Tap Cal register ("fine").
Pickup Setting Accuracy:	The accuracy of the pickup setting is +/- 2% of the programmed setting over the full specified range of the relay at 60 Hz.
Pickup Repeatability:	Within 2%.
Dropout Ratio:	Better than 80% of the established pickup level within 50 milliseconds.
Instantaneous Overcurrent	
Pickup Range:	0.5 to 20 times the value of the time overcurrent tap setting.
Pickup Setting Accuracy:	The accuracy of the instantaneous pickup setting is +/- 2% of the programmed setting over the full specified range of the relay at 60 Hz.
Dropout Ratio:	Better than 80% of the established pickup level within 50 milliseconds.

Table C.1 Specifications (continued)

Overcurrent Timing Characteristics	
Characteristic:	The relay incorporates all of the time overcurrent characteristics shown in Figures A.1 through A.16 in Appendix A. Selection of a specific timing characteristic is accomplished by programmed instructions. Separate selections can be made for phase current and for ground current.
Time Dial:	Refer to Figures A.1 through A.16 in Appendix A, which show 14 of the 100 available curves for each type.
Time Delay Accuracy	The time overcurrent delay shall be within 5% or 20 milliseconds (whichever is greater) of the characteristic curves shown in Figures A.1 through A.16 in Appendix A for any combination of TIME DIAL and pickup setting at 25°C. The time delay shall not vary more than +/- 5% over the temperature range of -40° to 70°C (-40° to 158.°°F).
Instrumentation Feature	Provision is made to monitor primary current on a real-time basis. Accuracy is within +/- 2%. Range is from 10% of TAP (at the low end) to 150% of TAP (at the high end).
Communications Option	Includes an RS-232 port on the front panel for local testing and configuration, and an RS-485 port at rear of unit for operation by a Siemens Power Monitor unit at distances up to 4000 feet using baud rates up to 19,200.
Power Supply	Power for the internal circuitry may be derived from ac or dc external power sources as indicated in Table C.2. If ac control power is used, a separate power supply hold-up circuit is required. (Option 3-1.)
Target Indicators	The targets are magnetically latched type.
Single-Phase Units:	<p>Current-operated targets are furnished for each of the tripping outputs included within the relay (e.g., TIME and INSTantaneous overcurrent functions).</p> <p>To trip, a current-operated target requires a minimum of 0.2 A in the output circuit of its associated output contact. This confirms that current has flowed through the relay output contacts and the external trip circuit.</p>
Multi-Phase Units:	Includes the above plus an internally-operated target for each phase element (A, B, C, and/or ground) which may initiate a trip.

Table C.1 Specifications (continued)

Outputs	Output contacts are rated as follows:
Resistive:	120/240 VAC - Make 30 A for 0.2 seconds, carry 7 A continuously, break 7 A. 250 VDC - Make and carry 30 A for 0.2 seconds, carry 7 A continuously, break 0.3 A. 500 VDC - Make and carry 15A for 0.2 seconds, carry 7 A continuously, break 0.1 A.
Inductive:	120/240 VAC, 125/250 VDC - Break 0.3 A (L/R = 0.04).
Shock	In standard tests the relay has withstood 15 g in each of three mutually perpendicular axes, without structural damage or degradation of performance.
Vibration	In standard tests the relay has withstood 2 g in each of three mutually perpendicular axes, swept over the range of 10 to 500 Hz for a total of six sweeps, 15 minutes each sweep, without structural damage or degradation of performance.
Isolation	1500 VAC at 60 Hz for one minute, in accordance with IEC 255-5 and ANSI/IEEE C37.90-1989 (Dielectric Test).
Surge Withstand Capability	Qualified to ANSI/IEEE C37.90.1-1989 Standard Surge Withstand Capability Test and Fast Transient Test, and IEC 255-5 Impulse Test and Dielectric Test.
Radio Frequency Interference (RFI)	Maintains proper operation when tested in accordance with ANSI/IEEE C37.90.2-1987.
Temperature (Operating)	-40° to 70°C (-40° to 158°F).
Temperature (Storage)	-65° to 100°C (-85° to 212°F).
Weight	14.8 pounds net.
Case Size	S1. (Dimensions are given in Figure 4.)
Certification	UL

Table C.2 Power Supplies

Type	Nominal Input Voltage	Input Voltage Range	Burden at Nominal (Maximum)
K	48 VDC	24 to 60 VDC	7.0 W
J	125 VDC 120 VAC	62 to 150 VDC 90 to 132 VAC	8.0 W 19.0 VA

Table C.3 Current Sensing Burden, R and L (R in milliohms, L in microhenries)

TAP	RANGE	1 x TAP	2 x TAP	5 x TAP
A	LOW	12.37 (2.46)	11.66 (2.33)	11.17 (2.22)
B		11.86 (2.36)	11.29 (2.25)	10.97 (2.18)
C		11.53 (2.30)	11.10 (2.20)	10.71 (5.41)
D		11.33 (2.25)	10.82 (5.46)	10.87 (5.46)
E		10.94 (5.54)	10.69 (5.41)	11.57 (5.86)
F		10.71 (5.41)	10.86 (5.49)	10.70 (5.41)
G		10.88 (5.52)	10.70 (5.41)	10.69 (5.41)
H		10.87 (5.49)	10.70 (5.41)	10.64 (5.38)
I		10.84 (5.49)	10.69 (5.41)	10.66 (5.38)
J		10.83 (5.49)	10.69 (5.41)	10.67 (5.41)
A	HIGH	5.78 (1.14)	5.50 (2.79)	5.61 (1.11)
B		5.70 (1.14)	5.57 (1.11)	5.58 (1.11)
C		5.66 (1.14)	5.49 (1.09)	*
D		5.69 (1.14)	5.50 (1.09)	*
E		5.68 (1.14)	5.52 (1.11)	*
F		5.59 (1.11)	5.54 (1.11)	*
G		5.60 (1.11)	5.56 (1.11)	*
H		5.61 (1.11)	5.56 (1.11)	*
I		5.61 (1.11)	*	*
J		5.63 (1.11)	*	*

* Exceeds maximum continuous current

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