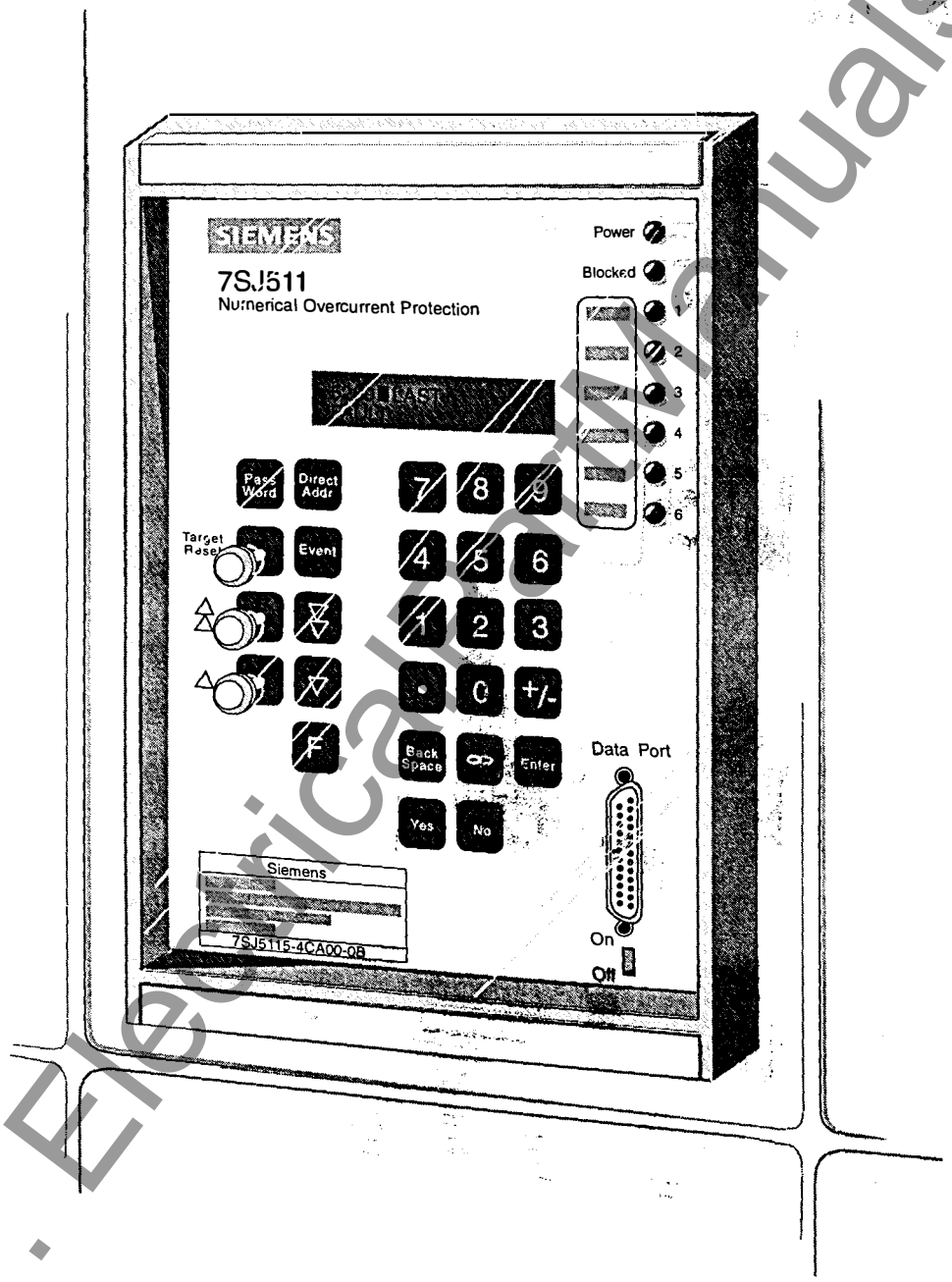
SIEMENS

7SJ511 Numerical Overcurrent Protection Relay



Manual No. SG-8028-01

Table of Contents

List of Figures

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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 your local sales office.

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1. Introduction

1.1 Using This Manual

This operator's manual is intended to provide you with all the information you need to install and operate the Siemens 7SJ511 Numerical Overcurrent Protection Relay. In addition to describing how to interface with the relay, the manual offers general information about the functions and features.

This manual is divided into two parts:

- The *User Guide* describes how to install, program, operate, and maintain the 7SJ511 relay. You will need to read this part if you are to perform any of these tasks. General information about the relay's features and functions is also in this part of the manual.

- The *Reference Guide* includes the relay specifications, theory of operation, information on how to calculate the relay settings, and other supporting information for installing and configuring the relay. If you are responsible for application and developing relay settings, you will need to read this part of the manual.

Refer to Table 1-1 for help in finding the information you need in this manual.

This manual assumes you are using the 7SJ511 relay's operator panel to program, maintain, and operate the relay. If you are using DIGSI® software or some other application to control the relay, refer to the appropriate user guide when instructions in this manual are insufficient.

Table 1-1. Using the Manual

If you want to ...	**then read ...**
learn more about the relay,	• Product Description • Method of Operation
install the relay,	• Acceptance Tests • Installation • Commissioning the Relay
program the relay,	• Programming the Relay • Setting Calculations • Setting Worksheets • Input/Output Functions
check relay status, target history, and event log,	• Displaying System and Relay Information
perform maintenance,	• Maintenance
review relay specifications,	• Specifications

1.2 Glossary of Terms and Abbreviations

Following are definitions and descriptions of terms and abbreviations used in this manual that are unique to power systems and Siemens relay technology in particular.

Abbreviations and Acronyms

A/D	analog-to-digital
B/F	breaker failure
C/O	changeover
CT	current transformer
CW	codeword
EEPROM	electrically erasable, programmable, read-only memory
EPROM	erasable, programmable, read-only memory
I>>	IEC identifier - high-set overcurrent protection element for phases
I_E>>	IEC identifier - high-set overcurrent protection element for neutral
I>	IEC identifier - definite time overcurrent protection element for phases
I_E>	IEC identifier - definite time overcurrent protection element for neutral
I_p	IEC identifier - inverse time overcurrent protection element for phases
I_{Ep}	IEC identifier - inverse time overcurrent protection element for neutral
LCD	liquid crystal display
LED	light emitting diode
LSA	local substation automation
NC	normally closed
NO	normally open
PC	personal computer
O/C	overcurrent
RAM	random access memory
ROM	read only memory

Terms

annunciation 1. activating outputs (LCD, LEDs, output relays) when events occur
2. event message in the LCD

binary input a relay input terminal that responds to presence or absence of voltage on the terminal in a digital (on/off) manner

block 1. prevent normal operation or function
2. group of memory addresses

drop-off drop-out (used in the operator panel LCD text)

drop-out return to a normal or no-fault state

earth	electrical ground
high-set	an overcurrent protection element that operates independently of the definite time or inverse time elements and typically has a high pickup value and a small or zero time delay
marshalling	configuring the I/O devices
numerical relay	relay in which the measured AC quantities are sequentially sampled and converted into numerical data that is mathematically and/or logically processed to make trip decisions.
pickup	activation of a protection function either through detection of a fault or as a result of a binary input. The current and voltage levels or ratios that cause a protection element to pick up are called *pickup values*.
stage	protection element; a group of protection parameters that, at a minimum, include pickup and time delay values
starpoint	common connection point in Y-connected electrical equipment; the neutral connection
trip	activate a trip relay or open a circuit breaker

1.3 Reading the Relay Model Number

The model number for your 7SJ511 relay is printed on the relay's nameplate, which is located on the operator panel. As illustrated in Figure 1-1, you can read your relay's model number and determine the rated input current, DC supply voltage, installed options, and mounting configuration. Using the model number in this manner allows you to verify that you have the correct relay.

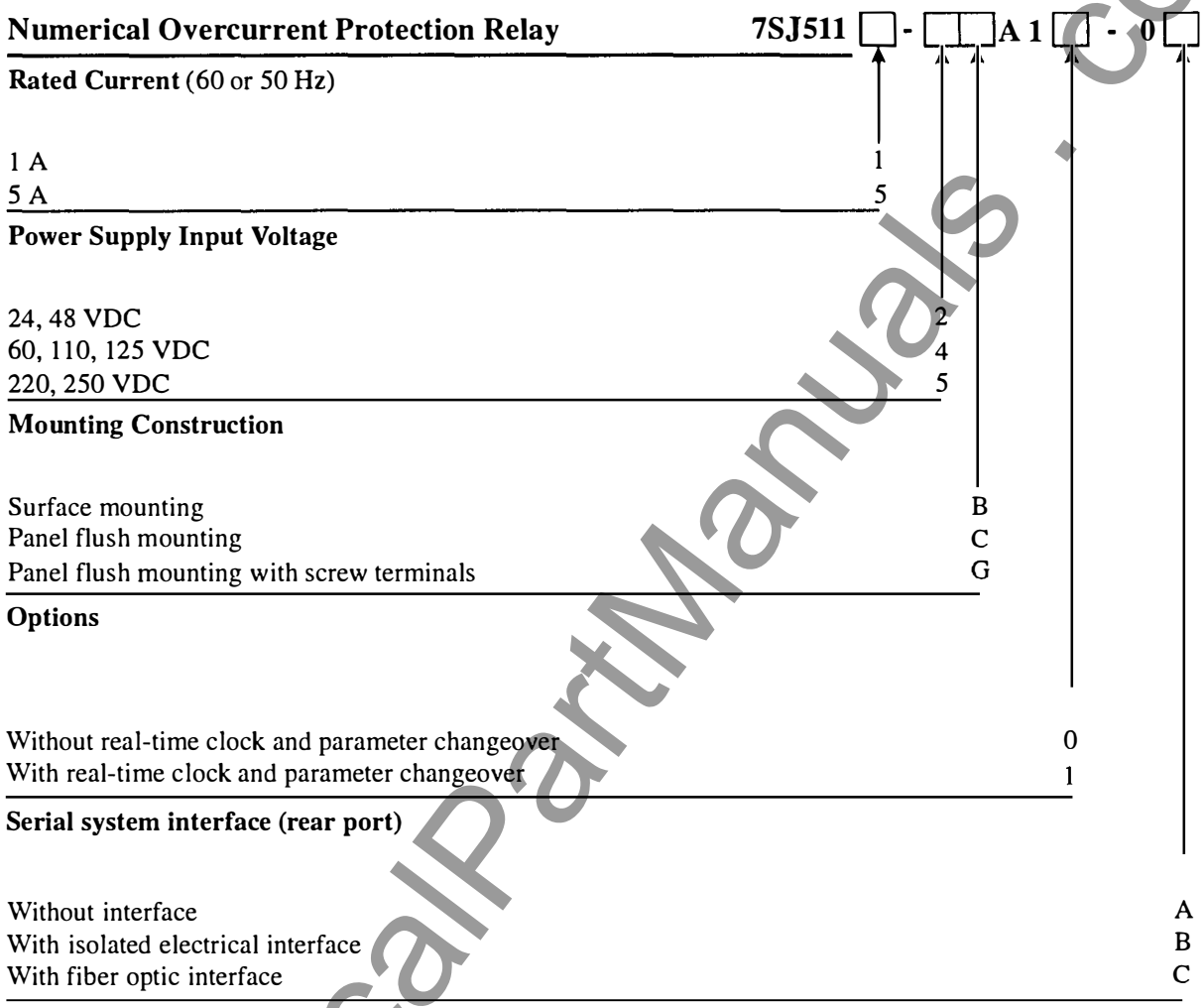


Figure 1-1. Interpreting the Relay Model Number

2. Product Description

2.1 About the Relay

The 7SJ511 numerical overcurrent protection relay is a microprocessor-based, three-phase and neutral relay designed to provide fast, secure, and highly reliable overcurrent protection for high voltage distribution lines. It can also provide breaker failure protection and bus protection. It can be used as primary or backup protection on lines, power transformers, generators, motors, and buses. The relay can be mounted in several types of housing and is easily programmed and operated using the keypad and alphanumeric liquid crystal display (LCD) on the operator panel. The light emitting diodes (LEDs) on the integral operator panel continuously display relay status and target indications. When prompted, the LCD can show operational information such as the relay settings, system conditions, and event data.

The relay can be connected to a PC or to a substation control system, enabling the user to analyze data stored in the relay's memory and to monitor the relay's failure (alarm) and status signals.

Inputs
The available inputs consist of two binary inputs and four analog current inputs. The binary inputs can be used to receive input such as blocking or breaker failure initiation signals from other protection devices or supervisory control systems. The four analog inputs provide a pair of connection points for each of the three power phases and neutral.

Outputs
The outputs consist of three sets of output contacts (relays), two serial data interfaces (one standard, one optional), and a set of eight LED indicators.

The first set of output contacts is comprised of four signal relays, each with both normally open and normally closed contacts. The second set of output contacts is comprised of two command relays intended for tripping protective circuit breakers, each having two sets of normally open contacts. The third set is a device failure relay with both normally open and normally closed contacts.

The first of the serial data interfaces is available through a connector on the front of the operator panel and is intended to be connected to a local personal computer. The second optional serial port is available through the back of the relay housing and is intended for remote communications.

The eight LEDs consist of two dedicated indicators and six programmable indicators. The process of activating the various outputs (LCD, LEDs, output relays) when events occur is referred to as *annunciation*.

Operator Panel
The operator panel consists of a 28 key membrane keypad and a 32 character alphanumeric display. This panel is used to program the relay and to access stored system data. The keypad provides a standard 10 key numeric section and 18 other control keys. The display is a liquid crystal type (LCD) that provides two lines of 16 characters each.

Internal Monitoring and Self-Diagnostics
The relay continuously monitors the operation of its internal hardware and software along with the external CT circuits. Detected failures are logged and the relay is automatically taken out of service. A relay failure signal is available to notify the other parts of the system of this condition.

Measured Values and Event Logging
Measured system current values are available through both the LCD and the serial ports. Operational and fault events are recorded in logs that can be displayed in the LCD or retrieved through the serial ports.

2.2 Relay Features

- Microprocessor-Based Technology
- Fully Numerical Design
- Three-Phase and Ground Overcurrent Protection
  – Instantaneous (50/50N)
  – Definite Time (51/51N)
  – Inverse Time (51/51N)
- Breaker Failure Protection (50BF)
- Reverse Interlock Bus Protection
- Nonvolatile Memory for Settings and Targets
- Programmable Binary Inputs, LEDs, Signal and Trip Relays
- Four Independent Setting Groups
- Real-Time Clock (optional)
- Circuit Breaker Operations Counter
- Accumulated Circuit Breaker Interrupted Current (per pole)
- Circuit Breaker Trip Test
- Two (2) Serial Ports (front port standard, rear port optional)
- IEC 870-5 Communication Standard
- Fault Waveform Capture (20 samples per cycle)
- Fault Target Data
- Operations Event Log
- Current Metering Function (on-line)
- Isolated DC to DC Power Supply
- Self-Monitoring
- Draw Out Construction

2.3 Relay Setting Types

The relay has four types of settings. These settings, described below, determine how the relay recognizes and responds to abnormal operating conditions to protect the power system. Each relay is delivered with a set of parameters that are preprogrammed at the factory. With the exception of the optional rear port communications, the relay is fully functional with these

settings. It is only necessary to alter those settings that must be changed to meet your specific system requirements.

- The **operating settings** define the conditions under which the relay will function. These include the setting of the real-time clock (time and date), choice of display language, and choice of the data transmission rate for the serial communication ports. In addition, the operating settings identify what information is to be displayed in each of the two lines of the display, whether or not waveform capture is enabled, and if the relay is a component of a substation control system.

- The **system settings** provide information about the power system that the relay is to protect. This includes CT primary current, frequency, and measured value monitoring parameters.

- The **protection settings** specify the current and time values that are used to identify fault conditions. These settings include the overcurrent limits and the choice of either definite time or one of three standard inverse time characteristics for each of the three phases and neutral. In addition, various combinations of protection can be turned on or off and one of four different sets of parameters may be selected (provided real-time clock option is installed).

- The **configuration settings** tell the relay how to process the input information and logically associate it with the output devices. *Configuring* the relay is also referred to as *programming* or *marshalling* the relay.

Each setting is assigned to an **address number** that you must access if you wish to display or change the setting. The 4-digit address number, made up of a **block number** and a **sequence number**, appears in the display as shown below.

12 = block number
34 = sequence number.
1234 = address number.

Similar settings or operations are grouped together in the same address block. The following table shows the address blocks used in the 7SJ511 relay.

Table 2-1. Relay Address Blocks

Block	Function
0000	**Relay Type, Software Version, and Order Designation**
1000	**Functional Parameters**
1100	Power System Data
1200	Overcurrent Protection - Phases
1500	Overcurrent Protection - Neutral
2800	Waveform Capture
2900	Measured Value Supervision
3900	Circuit Breaker Failure Protection
4000	**Tests**
4400	Trip Circuit Breaker
5000	**Event Data**
5100	Operational Events
5200	Last Fault Event
5300	2nd to Last Fault Event
5400	3rd to Last Fault Event
5600	Circuit Breaker Operation Statistics
5700	Operational Measured Values
6000	**Programming (Marshalling)**
6100	Programming (Marshalling) Binary Inputs
6200	Programming (Marshalling) Signal Relays
6300	Programming (Marshalling) LED Indicators
6400	Programming (Marshalling) Trip Relays
6900	Rear Port Configuration (optional)
7000	**Operating Parameters**
7800	Scope of Functions
7900	Device Configuration
8000	**Device Control**
8100	Setting the Real-Time Clock (optional)
8200	Resetting Stored Data
8500	Parameter Changeover (optional)

2.4 Overview of the Protection Functions

The 7SJ511 is a *numerical protection* relay. Numerical protection describes the process of reading analog signals, digitizing them, and then performing all of the measurements, protection functions, comparisons, and trip decision logic mathematically through software or algorithms in the microprocessor.

Siemens numerical protection allows the same hardware and software components to be used in many different relays. The advantages to the user include:

- Common repair parts
- Consistent user interface
- Field proven software

This section describes the protection functions of the 7SJ511 relay, as listed below:

- Overcurrent protection
- Circuit breaker failure protection

2.4.1 Overcurrent Protection

Overcurrent protection monitors the current levels in the protected power system and compares them with limit values that have been programmed into the relay. When the current levels exceed the programmed limits, appropriate annunciation signals are generated, trip commands are issued, and fault data is recorded.

Either of two types of time overcurrent processing can be selected:

- **Definite time** (ANSI 51, IEC I>) protection specifies a time delay between the detection of a fault and the output of the trip command. The overcurrent limit and time delay can be specified separately for phases and neutral. Both normal and *high-set* protection functions are available. The magnitude of the fundamental frequency is evaluated for this measurement. The time delays can be set to infinity, effectively disabling the function. When the time delay is set to zero, instantaneous overcurrent protection (ANSI 50, IEC I>>) is implemented.

- **Inverse time** (ANSI 51, IEC I_p) protection calculates the time delay between fault detection and the trip command as a function of the magnitude of the current. There are three standard IEC inverse time characteristics available for both phase and neutral currents:

  1. Normal Inverse
  2. Very Inverse
  3. Extremely Inverse

  When using inverse time protection, either the magnitude of the fundamental frequency or the true rms value can be evaluated for the measurement.

2.4.2 Breaker Failure Protection

When a fault is detected and a trip command is issued, the relay will continue to monitor the currents anticipating removal of the fault. If, after a specified time delay, the circuit breaker that was the target of the trip command fails to remove the fault, the relay can signal another part of the system to attempt fault removal. The timeout for this protection can be programmed. Breaker failure protection may also be initiated externally by means of a binary input signal.

2.5 Additional Functions and Features of the Relay

2.5.1 Serial Data Ports

As described earlier, a serial data port through which the relay can be configured, controlled, and interrogated is available on the operator panel. A second optional port, used for data retrieval only, is available on the rear panel. In both cases, the data transmission protocol is in compliance with IEC 870-5.

Front Panel Port

The port on the operator panel is intended to be used with a locally attached personal computer. It is accessible through the 25 pin connector on the operator panel. The attached PC can run DIGSI® or other appropriate software to communicate and exchange information with the relay. This interface is not electrically isolated from the monitored system and conforms to the EIA RS-232-C specification.

Rear Port

The optional port on the rear panel of the relay is intended for remote data retrieval by a substation control system. It is available as either an isolated wired interface (RS-232-C subset) or an optical fiber interface. (Consult the factory for details on the use of this feature.)

2.5.2 Multiple Parameter Sets

An optional feature available with the 7SJ511 relay allows up to four uniquely different sets of functional parameters (relay setting addresses between 1000 and 3999) to be defined. The active set of parameters can be changed during relay operation (provided no protection functions are picked up) using the operator panel, the front serial port, or by means of binary inputs.

2.5.3 Real-Time Clock

An optional real-time clock feature is available that allows time stamping of events to be in *real* rather than *relative* time.

2.5.4 User Definable Functions

The relay provides two logical functions, **>Annunc.1** and **>Annunc.2**, that can be activated through binary inputs and allocated to the outputs as the user wishes.

3. Acceptance Tests

This section provides acceptance test procedures. Follow these procedures carefully to help prevent possible injury and equipment damage. When testing the 7SJ511 relay, you should be familiar with all applicable safety regulations from ANSI, IEC, NEC, and other pertinent standards.

In the following chapters, the various forms of protection provided by the relay are referenced with the IEC designations shown in the list below. This nomenclature is used in the text, the tables and the LCD. The corresponding ANSI designations are also indicated.

IEC	ANSI	
I>>	50 HS/51 HS	High-set overcurrent protection element for phases
I_E>>	50G HS/51G HS	High-set overcurrent protection element for neutral
I>	50/51	Definite time overcurrent protection element for phases
I_E>	50G/51G	Definite time overcurrent protection element for neutral
I_p	51	Inverse time overcurrent protection element for phases
I_{Ep}	51G	Inverse time overcurrent protection element for neutral

Note: The 50G and 51G protection elements are also applicable to the 50N and 51N functions

For information on relay mounting and connection options refer to the "Installation" section.

Acceptance tests are intended to verify, with commonly available test equipment, that the relay will work properly. The acceptance tests described in this section verify that the following relay subsystems are functioning correctly:

- Power supply
- Metering function
- Overcurrent and breaker failure protection functions
- Binary inputs
- LEDs
- Output relays

3.1 Test Equipment

At a minimum, you will need the following items to perform the required acceptance tests:

- DC power supply, 20W minimum (voltage depends on the relay's model number on the operator's panel). The required peak current capability is shown in the chart below:

Relay Model Number	Rated Voltage	I_{peak} (1 ms)
7SJ511*-**2***A0*-0*	24/48 V	100 A
7SJ511*-**4***A0*-0*	60/110/125 V	50 A
7SJ511*-**5***A0*-0*	220/250 V	25 A

- Timer with electrical start/stop contacts
- Multimeter
- DC voltage source adjustable between 0 V and 30 V
- Single-phase 60 Hz current source adjustable between 0 A and 20 A

Note: Commercial test sets that include some or all of the above test tools are available and can be used in the following tests.

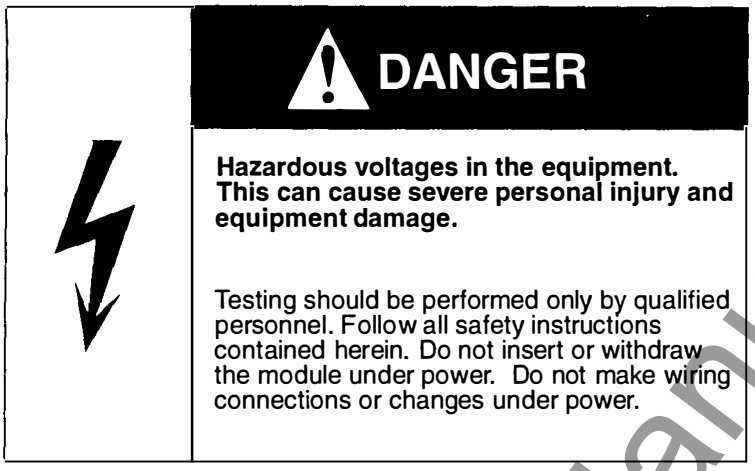
Test accuracy is directly dependent on the test environment and the equipment used. The accuracy indicated in the "Specifications" section can only be achieved by testing under conditions specified in IEC 255 using precision test equipment.

When tests are run using a single-phase input, the current symmetry and summation monitors will pick up if the test current is applied for a sufficient time. Testing of the measured value monitoring function requires a three-phase current source with individually adjustable currents.

If the user wishes to make the setting changes required by some of the tests through the front port, a PC with DIGSI® software will be required.

You will also need to know the relay model number and how to interpret it. Refer to the "Introduction" section, which describes how to read the model number to determine the relay's rated current, DC supply voltage, installed options, and type of mounting.

3.2 Energizing the Relay



1. Connect the relay as indicated in Table 3-1 on page 3-6 to a DC power source that provides the rated relay voltage (see Table 3-2 on page 3-6).

   Important: Voltage is present in the primary side of the relay power supply even with the **On/Off** switch on the front panel of the relay in the "Off" position. The DC power source should be set to the relay's rated DC voltage *before* connecting the source to the relay terminals.

2. To gain access to the operator panel, remove the protective cover from the front of the relay (see "Installation" chapter for proper procedure).

3. Position the **On/Off** switch on the operator's panel to the "On" position (because this switch is recessed in the panel, a tool such as a 1/8 inch flat blade screw driver will be required to operate the switch). The green **Power** LED should light, and the red **Blocked** LED will illuminate briefly then go out indicating successful completion of the self-diagnostic tests. The LCD will read as shown below:

   ```
   0000■7SJ511Vx.xx
   7SJ511***A0*0***
   ```

   Note: Instead of "x.xx" appearing on your display, the relay software version (e.g. 2.10) will appear. The second line of the LCD shows the complete ordering number with appropriate characters replacing the asterisks (*) corresponding to the relay configuration.

4. To determine the present language setting, press the △ key to advance to the next address block. If the relay is programmed for English the LCD should display "1000 ▮ Parameters."

IF the LCD text . . .	THEN . . .
is in English,	go to step 4.
is NOT in English,	follow these steps to change the language parameter. a. Press the **Direct Addr** key. b. Key in 7001 and press **Enter**. "7001 ▮ SPRACHE DEUTSCH" will appear on the display. c. Press the **Password** key. "CODEWORTEINGABE:" appears in the display. Key in password '000000'. Each character ('0') you type appears as the @ symbol on the display. d. Press **Enter**. e. If your entry is correct, the message "CW AKZEPTIERT" appears on the display. Press **Enter** again. You will return to address 7001 and the relay is in Programming mode. Go to step g. f. If your entry is not valid, the message " CODEWORT FALSCH" appears on the display. Begin again with step c. g. Press the **No** key. "ENGLISH" will appear on line 2 of the display. h. Press **Enter** to select the setting "English." i. Press the **F** key followed by the **Enter** key. The message "EINSTELLUNGEN UEBERNEHMEN ?" will appear on the display. j. Press the **Yes** key in response to the message to save the language parameter. The confirmation message "NEW SETTINGS SAVED" will appear on the LCD. k. Press **Enter** to clear the message from the LCD and return to the 7001 address display.

5. When making wiring changes during any of the following tests, turn off all supplies,

6. Unless otherwise noted, the default factory program settings will be used for all of the tests in this chapter. The factory presets are identified in Chapter 5, "Programming the Relay," and Reference F, "Setting Worksheets."

7. Some of the tests in this section require changes to the factory settings. If you wish to preserve the original factory settings, record any factory setting before changing it. After testing is complete, you can restore the original settings or program the relay for your application. "Programming the Relay" provides detailed instructions on how to change relay settings.

Note: Test failures may be the result of incorrect relay settings. Always verify the relay settings before beginning each test. If you continue to have test failures with correct settings, contact your Siemens representative immediately.

8. Check the system frequency setting, f_N, at address 7899. Ensure that it is set for 60 Hz. If necessary, use the programming procedures in "Programming the Relay" to change it.

9. Check the CT ratio matching factor, I_E/I_{ph}, at address 1112. Ensure that it is set to 1.000. If necessary, use the programming procedures in "Programming the Relay" to change it.

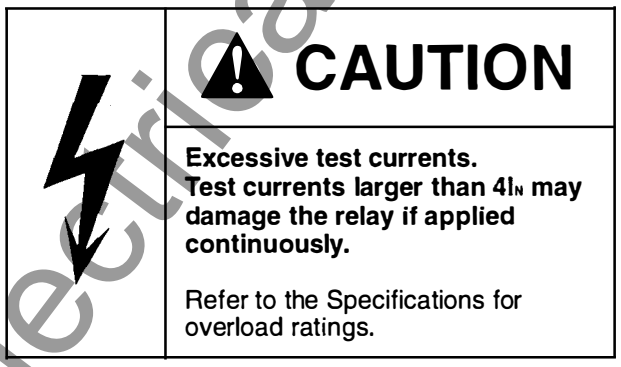
3.3 Test Procedures

Each of the test procedures in the following sections will use a common format:

1. Brief description of the test and its objectives
2. Test equipment connections to the relay
3. Procedure steps and supporting comments
4. Action/Results table

The test connections should be made using the charts and diagram in the "Installation" section of this manual. The test connection terminals are indicated in each test procedure. It is expected that both commercially available multifunction test sets (e.g., a DC power supply with built in meters and power switch) and/or user-assembled test beds will be employed.

Note: The terminal numbers used in the following tests are for the flush mount configuration only.



Important: All test cases use single-phase current input. With the factory settings, this will cause the current summation and symmetry monitors to pickup. This, in turn, causes LED 1 to light. Except where indicated otherwise, LED 1 should be ignored.

3.3.1 Power Supply Test

These procedures will verify the power consumption of the 7SJ511 and the operation of the failure alarm contacts.

1. Connect test equipment to the relay as indicated in Table 3-1.

Table 3-1. Power Supply Test Connections

	Relay Terminal Connections	
Test Equipment - Relay	**+** (where applicable)	**-** (where applicable)
DC Power supply - Power input	4D1	4D2

Power Consumption Test

A DC power supply is connected to the relay power input terminals. The input voltage is then varied over the allowed range and the current draw by the relay is checked to ensure that it is within the specified limits.

Test Procedure

1. Measure the input current while varying the input voltage between the limits indicated in the Table 3-2. The values should be within the "Measured Current" range for the corresponding entry in the table.

Table 3-2. Power Consumption Test

Relay Model Number	Rated Voltage V_H	Test Voltage (V)		Measured Current (A)	
		Min.	Max.	Min.	Max.
7SJ511*-**2***A0*-0*	24/48 V	19.2 V	56.0 V	.20 A	.35 A
7SJ511*-**4***A0*-0*	60/110/125 V	48.0 V	144.0 V	.06 A	.15 A
7SJ511*-**5***A0*-0*	220/250 V	176.0 V	288.0 V	.04 A	.05 A

Failure Alarm Contact Test

The failure alarm contacts are tested for correct operation in both normal and failure modes. The failure mode is simulated by removing relay power.

Test Procedure

1. Connect ohmmeters or other appropriate continuity checking devices to the relay terminals as indicated in Table 3-3.
2. For the Power On/Off switch settings shown in the table (supply or relay), the continuity reading should be as indicated.

Table 3-3. Failure Alarm Relay Contact Test

Power On/Off	Terminals 6D4-8D4	Terminals 7D4-8D4
Off	Ω =0	Ω=∞
On	Ω=∞	Ω=0

3.3.2 Metering Test

This procedure verifies operation of the analog input channels. Known values of current are injected into the current inputs and the accuracy of the relay measurement is checked.

Test Procedure

1. Connect test equipment to the relay as indicated in Table 3-4.

Table 3-4. Metering Test Connections

	Relay Terminal Connections	
Test Equipment - Relay	**+** (where applicable)	**-** (where applicable)
DC Power supply - Power input	4D1	4D2
1-phase current source - I_{L1}	4C2	4C1

Notes: *The frequency of the test current must be the same as the relay's rated frequency, f_N, as defined at address 7899.*

2. Using the operator panel, display the address corresponding to the terminal pair that has the current source connected (see Table 3-5). Increase the test current to 15% of the relay's rated current I_N as indicated in the following chart.

Model No.	I_N
7SJ5111-**A0*-0*	1 A
7SJ5115-**A0*-0*	5 A

3. Ensure that the displayed value is within the tolerance indicated in Table 3-5.
4. Reduce the test current to zero.
5. Move the current source to the next pair of terminals indicated in Table 3-5.
6. Repeat steps 2 through 5. Continue testing until all four pairs of current input terminals have been tested.

Table 3-5. Metering Test

			Tolerance	
Current Input Connections	**Addr. No.**	**LCD Text**	**Min. Value**	**Max. Value**
4C1 - 4C2 (I_{L1})	5710	IL1 = 15.0%	13%	17%
3C1 - 3C2 (I_{L2})	5711	IL2 = 15.0%	13%	17%
2C1 - 2C2 (I_{L3})	5712	IL3 = 15.0%	13%	17%
1C1 - 1C2 (I_E)	5713	IE = 15.0%	13%	17%

3.3.3 Binary Input Test

This test verifies operation of the binary inputs. A voltage below the minimum value required for an active level (approximately 11 volts) is applied to the binary inputs. The event log is then checked to ensure that no events are logged. A voltage at or above the minimum value required for an active level is applied to the binary inputs. The event log is then checked to see that the preset functions assigned to the binary inputs are correctly logged.

Test Procedure

1. Connect test equipment to the relay as indicated in the Table 3-6.

Table 3-6 Binary Input Test Connections

	Relay Terminal Connections	
Test Equipment - Relay	**+** (where applicable)	**-** (where applicable)
DC Power supply - Power input	4D1	4D2
DC Voltage - Binary Input 1	1D2	1D1

2. Set the voltage source to zero.

   Note: The binary input voltage must never exceed the upper relay specification limit defined in the "Specifications" section.

3. Power on the relay.
4. Using the programming procedures described in "Programming the Relay,"verify or program the settings shown in Table 3-7.

Table 3-7. Binary Input Test Settings

Addr.	Index	LCD Text
6101	001	INPUT 1 >LED reset NO
6102	001	INPUT 2 >Block I>> NO

5. Refer to the "Erasing Stored Data" section in the "Maintenance" chapter to reset the event log (Operational Annunciations, address 5100). All other relay settings should be factory presets.
6. Using the operator panel, display address 5100. "OPERATIONAL ANNUNCIATIONS" appears in the display. Press △ to display the first entry in the log.
7. Ensure that the displayed message is "Table empty."
8. Exit display of the 5100 block. Increase the binary input voltage to 20 volts. Repeat step 6. Ensure that the displayed text matches that shown in Table 3-8. Reduce the binary input voltage to zero.
9. Move the voltage source to the next pair of terminals indicated in Table 3-8. Repeat steps 5 through 8 then exit the test procedure.

Table 3-8. Binary Input Test

	Binary Input Connections		
Binary Input No.	**Plus (+)**	**Minus (-)**	**LCD Text** (2nd line)
1	1D2	1D1	LED reset :C
2	1D4	1D3	>Block I>> :C

3.3.4 LED Test

This test verifies the operation of the 6 programmable LEDs on the operator panel. The factory presets are used for this test. A current large enough to cause the I>> element to pick up is applied to each of the three phase inputs. These fault conditions ultimately cause all of the LEDs to illuminate. The final step in this procedure tests the relay function that allows the LEDs to be reset by means of a binary input.

Test Procedure

1. Connect test equipment to the relay as indicated in Table 3-9.

Table 3-9. LED Test Connections

	Relay Terminal Connections	
Test Equipment - Relay	+ (where applicable)	- (where applicable)
DC Power supply - Power input	4D1	4D2
1-phase current source - I_{L1}	4C2	4C1
DC Voltage - Binary Input 1	1D2	1D1

Note: *The frequency of the test current must be the same as the relay's rated frequency, f_N, as defined at address 7899.*

2. Set the current and voltage sources to zero.
3. Power on the relay and press the **Target Reset** key. All six programmable LEDs should be off.
4. Using the programming procedures described in "Programming the Relay,"verify or program the settings shown in Table 3-10.

Table 3-10. LED Test Settings

Addr.	Index	LCD Text
6301	002	LED 1 Failure Isymm nm
6302	001	LED 2 Fault L1 m
6303	001	LED 3 Fault L2 m
6304	001	LED 4 Fault L3 m
6305	001	LED 5 Flt I>> Ie>> m
6306	001	LED 6 Gen. Trip m
1201		O/C PHASES ON
1202		I>> 2.00 I/In
1203		T-I>> 0.10 s

5. Gradually increase the input current until it reaches $2.5I_N$. Wait at least 1 second after completing all input adjustments to ensure that all time delays have expired before examining the results. Verify the state of the LEDs as indicated in Table 3-11. Reduce the current input to zero. Move the current source to the next set of terminals in the table and press the **Target Reset** key. Repeat this step until all three pairs of current input terminals have been tested.

Table 3-11. LED Test

Current Input Connections	LED 1	LED 2	LED 3	LED 4	LED 5	LED 6
4C2 - 4C1	On	On	Off	Off	On	On
3C2 - 3C1	On	Off	On	Off	On	On
2C2 - 2C1	On	Off	Off	On	On	On

6. Increase the input current until it reaches $2.5I_N$. Wait at least 1 second after completing all input adjustments to ensure that all time delays have expired before examining the results. Verify that the LEDs as indicated in Table 3-11 are on. Reduce the current input to zero. Except for LED 1, the LEDs should be unchanged. Momentarily increase the voltage source to 15 volts or more. All of the LEDs should turn off. This completes the test.

3.3.5 Signal and Trip Relay Contact Test

This test verifies the operation of the four signal relays and the two trip relays. The factory presets are used for this test. A current large enough to cause the I>> element to pick up is applied to the phase 1 (I_{L1}) input. This fault condition ultimately causes all of the relays to close.

Test Procedure

1. Connect test equipment to the relay as indicated in the Table 3-12.

Table 3-12. Signal and Trip Relay Test Connections

	Relay Terminal Connections	
Test Equipment - Relay	**+** (where applicable)	**-** (where applicable)
DC Power supply - Power input	4D1	4D2
1-phase current source - I_{L1}	4C2	4C1
Continuity indicator - Signal Relay 1	8D3	8D2
Continuity indicator - Signal Relay 2	7D3	7D2
Continuity indicator - Signal Relay 3	6D3	6D2
Continuity indicator - Signal Relay 4	5D3	5D2
Continuity indicator - Trip Relay 1A	8C2	8C1
Continuity indicator - Trip Relay 1B	8C4	8C3
Continuity indicator - Trip Relay 2A	7C2	7C1
Continuity indicator - Trip Relay 2B	7C4	7C3

Note: *The frequency of the test current must be the same as the relay's rated frequency, f_N, as defined at address 7899.*

2. Set the input current to zero.

3. Power on the relay. All relay contacts should be open.
4. Using the programming procedures described in "Programming the Relay,"verify or program the settings shown in Table 3-13.

Table 3-13. Signal and Trip Relay Test Settings

Addr.	Index	LCD Text
6201	001	RELAY 1 Gen. Fault
6202	002	RELAY 2 Failure Isymm
6203	001	RELAY 3 Fault L1 I>>
6204	001	RELAY 4 Gen. Trip
6401	001	TRIP REL. 1 Gen. Trip
6402	001	TRIP REL. 2 Trip I>> Ie>>
1201		O/C PHASES ON
1202		I>> 2.00 I/In
1203		T-I>> 0.10 s

5. Gradually increase the input current until it reaches $2.5I_N$. Wait at least 1 second after completing all input adjustments to ensure that all time delays have expired before examining the results. Verify that all relay contacts are closed.
6. Reduce the input current to zero. Wait at least 1 second after completing all input adjustments to ensure that all time delays have expired before examining the results. Verify that all relay contacts are open.

3.3.6 High-Set Overcurrent Protection Test

This test verifies the operation of the high-set definite time overcurrent protection element. A single phase test current is connected sequentially to each of the four current inputs. The test current is increased until the protection picks up and is then maintained until the trip time delay expires. The pickup current value and the time delay are then verified against the programmed settings.

1. Connect test equipment to the relay as indicated in Table 3-14.

Table 3-14. High-Set Overcurrent Test Connections

	Relay Terminal Connections	
Test Equipment - Relay	+ (where applicable)	- (where applicable)
DC Power supply - Power input	4D1	4D2
1-phase current source - I_{L1}	4C2	4C1
Timer start - Signal Relay 1	8D3	8D2
Timer stop - Signal Relay 4	5D3	5D2

Note: *The frequency of the test current must be the same as the relay's rated frequency, f_N, as defined at address 7899.*

2. Set the input current to zero.
3. Power on the relay.

4. Using programming procedures described in "Programming the Relay" and "Setting Calculations," assign logical functions to the I/O units as indicated in Table 3-15. All other relay settings should be factory presets. The indicated functions should be assigned to index 001. All other indexes should be unassigned.

Table 3-15. I/O Assignments for High-Set Overcurrent Test

Addr.	I/O Unit	FNo	Function
6201	Signal Relay 1	311	Flt I>> I_E>> nm
6204	Signal Relay 4	321	Trip I>> I_E>> nm
6302	LED 2	312	Fault L1 I>> nm
6303	LED 3	313	Fault L2 I>> nm
6304	LED 4	314	Fault L3 I>> nm
6305	LED 5	315	Fault E I_E>> nm

5. Using the programming procedures described in "Programming the Relay,"verify or program the settings shown in Table 3-16.

Table 3-16. High-Set Overcurrent Test Settings

Addr.	LCD Text
1201	O/C PHASES ON
1202	I>> 2.00 I/In
1203	T-I>> 0.10 s
1501	O/C EARTH ON
1502	Ie>> 0.50 I/In
1503	T-Ie>> 0.50 s

6. Press the **Target Reset** key and reset the timer. Increase the input current until the LED indicated in Table 3-17 illuminates. Maintain this current for at least one second to ensure that all time delays expire.
7. Verify that the pickup current value and the time delay match the values shown in Table 3-17 for this set of input current connections.
8. Reduce the input current until the LED turns off. Verify that the input current level at which the LED turns off is 95% of the value at which it turned on. Reduce the input current to zero.
9. Move the current source to the next pair of terminals indicated in Table 3-17. Repeat steps 6 through 9 until all four of the current input connections shown in the table have been tested.

Table 3-17. High-Set Overcurrent Test

Current Input Connections	Pickup Current	Trip Delay	LED
4C2 - 4C1	$2.00I_N \pm 3\%$	0.10 s ± 10 ms	2
3C2 - 3C1	$2.00I_N \pm 3\%$	0.10 s ± 10 ms	3
2C2 - 2C1	$2.00I_N \pm 3\%$	0.10 s ± 10 ms	4
1C2 - 1C1	$0.50I_N \pm 3\%$	0.50 s ± 10 ms	5

3.3.7 Definite Time Overcurrent Protection Test

This test verifies the operation of the definite time overcurrent protection element. A single phase test current is connected sequentially to each of the four current inputs. The test current is increased until the protection picks up and is then maintained until the trip time delay expires. The pickup current value and the time delay are then verified against the programmed settings.

1. Connect test equipment to the relay as indicated in Table 3-18.

Table 3-18. Definite Time Overcurrent Test Connections

	Relay Terminal Connections	
Test Equipment - Relay	+ (where applicable)	- (where applicable)
DC Power supply - Power input	4D1	4D2
1-phase current source - I_{L1}	4C2	4C1
Timer start - Signal Relay 1	8D3	8D2
Timer stop - Signal Relay 4	5D3	5D2

Note: The frequency of the test current must be the same as the relay's rated frequency, f_N, as defined at address 7899.

2. Set the input current to zero.
3. Power on the relay.
4. Using programming procedures described in "Programming the Relay" and "Setting Calculations," assign logical functions to the I/O units as indicated in Table 3-19. All other relay settings should be factory presets. The indicated functions should be assigned to index 001. All other indexes should be unassigned.

Table 3-19. I/O Assignments for Definite Time Overcurrent Test

Addr.	I/O Unit	FNo	Function
6201	Signal Relay 1	341	Flt I> I_E> nm
6204	Signal Relay 4	351	Trip I> I_E> nm
6302	LED 2	342	Fault L1 I> nm
6303	LED 3	343	Fault L2 I> nm
6304	LED 4	344	Fault L3 I> nm
6305	LED 5	345	Fault E I_E> nm

5. Using the programming procedures described in "Programming the Relay,"verify or program the settings shown in Table 3-20.

Table 3-20. Definite Time Overcurrent Test Settings

Addr.	LCD Text
7812	CHARAC. PH DEFINITE TIME
7815	CHARAC. E DEFINITE TIME
1201	O/C PHASES ON
1212	I> 1.00 I/In
1213	T-I> 0.50 s
1501	O/C EARTH ON
1512	Ie> 0.20 I/In
1513	T-Ie> 0.50 s

6. Press the **Target Reset** key and reset the timer. Increase the input current until the LED indicated in the Table 3-21 illuminates. Maintain this current for at least one second to ensure that all time delays expire.
7. Verify that the pickup current value and the time delay match the values shown in Table 3-21 for this set of input current connections.
8. Reduce the input current until the LED turns off. Verify that the input current level at which the LED turns off is 95% of the value at which it turned on. Reduce the input current to zero.
9. Move the current source to the next pair of terminals indicated in Table 3-21. Repeat steps 6 through 9 until all four of the current input connections shown in the table have been tested.

Table 3-21. Definite Time Overcurrent Test

Current Input Connections	Pickup Current	Trip Delay	LED
4C2 - 4C1	$1.00I_N \pm 3\%$	0.50 s ± 10 ms	2
3C2 - 3C1	$1.00I_N \pm 3\%$	0.50 s ± 10 ms	3
2C2 - 2C1	$1.00I_N \pm 3\%$	0.50 s ± 10 ms	4
1C2 - 1C1	$0.20I_N \pm 3\%$	0.50 s ± 10 ms	5

3.3.8 Inverse Time Overcurrent Protection Test

This test verifies the operation of the inverse time overcurrent protection element. A single phase test current is connected sequentially to each of the four current inputs. The test current is increased until the protection picks up and is then maintained until the trip time delay expires. The pickup current value and the time delay are then verified against the programmed settings.

1. Connect test equipment to the relay as indicated in Table 3-22.

Table 3-22. Inverse Time Overcurrent Test Connections

	Relay Terminal Connections	
Test Equipment - Relay	+ (where applicable)	- (where applicable)
DC Power supply - Power input	4D1	4D2
1-phase current source - I_{L1}	4C2	4C1
Timer start - Signal Relay 1	8D3	8D2
Timer stop - Signal Relay 4	5D3	5D2

Note: *The frequency of the test current must be the same as the relay's rated frequency, f_N, as defined at address 7899.*

2. Set the input current to zero.
3. Power on the relay.
4. Using programming procedures described in "Programming the Relay" and "Setting Calculations," assign logical functions to the I/O units as indicated in Table 3-23. All other relay settings should be factory presets. The indicated functions should be assigned to index 001. All other indexes should be unassigned.

Table 3-23. I/O Assignments for Inverse Time Overcurrent Test

Addr.	I/O Unit	FNo	Function
6201	Signal Relay 1	371	Flt I_p I_{Ep} nm
6204	Signal Relay 4	381	Trip I_p I_{Ep} nm
6302	LED 2	372	Fault L1 I_p nm
6303	LED 3	373	Fault L2 I_p nm
6304	LED 4	374	Fault L3 I_p nm
6305	LED 5	375	Fault E I_{Ep} nm

5. Using the programming procedures described in "Programming the Relay," *program* the following parameters to the settings shown in Table 3-24.

Table 3-24. Inverse Time Overcurrent Test Settings

Addr.	LCD Text
7812	CHARAC. PH INVERSE TIME
7815	CHARAC. E INVERSE TIME
1214	Ip 0.50 I/In
1502	Ie>> 2.00 I/In
1514	Iep 0.50 I/In

6. Using the programming procedures described in "Programming the Relay," verify or program the settings shown in Table 3-25.

Table 3-25. Inverse Time Overcurrent Test Settings

Addr.	LCD Text
1201	O/C PHASES ON
1211	CHARACTER. NORMAL INVERSE
1215	T-Ip 0.50 s
1511	CHARACTER. NORMAL INVERSE
1515	T-Iep 0.50 s

7. Press the **Target Reset** key and reset the timer. Gradually increase the input current until the LED indicated in Table 3-26 illuminates. Maintain this current for at least 50 seconds to ensure that all time delays expire.
8. Verify that the pickup current value and the time delay match the values shown in Table 3-26 for this set of input current connections.
9. Reduce the input current to zero.
10. Move the current source to the next pair of terminals indicated in Table 3-26. Repeat steps 7 through 10 until all four of the current input connections shown in the table have been tested.

Table 3-26. Inverse Time Overcurrent Test

Current Input Connections	Pickup Current (1.1 set value)	Trip Delay	LED
4C2 - 4C1	$0.55I_N \pm 5\%$	36.69 s ± 7%	2
3C2 - 3C1	$0.55I_N \pm 5\%$	36.69 s ± 7%	3
2C2 - 2C1	$0.55I_N \pm 5\%$	36.69 s ± 7%	4
1C2 - 1C1	$0.55I_N \pm 5\%$	36.69 s ± 7%	5

3.3.9 Breaker Failure Protection Test

The following procedures will verify operation of the breaker failure (B/F) protection element. The functions tested include the following:

- On/Off control - control of B/F protection by programming
- Start/Start control - initiation of B/F protection timeout by internal overcurrent pickup or by external command (binary input)
- $I_{B/F}>$ protection threshold - current level above which a breaker failure is assumed
- $T_{B/F}$ time delay - time allowed after B/F protection is initiated for the fault current to drop below the protection threshold
- Logical function FNo 471 (B/F Off) - activated when B/F protection is turned off
- Logical function FNo 473 (Fault B/F) - activated when B/F protection time delay starts
- Logical function FNo 475 (Trip B/F) - activated when the B/F protection time delay ends

Test Procedure

1. Connect test equipment to the relay as indicated in Table 3-27.

Table 3-27. Breaker Failure Test Connections

	Relay Terminal Connections	
Test Equipment - Relay	+ (where applicable)	- (where applicable)
DC Power supply - Power input	4D1	4D2
1-phase current source - I_{L1}	4C2	4C1
DC Voltage - Binary Input 2	1D4	1D3
Timer start - Signal Relay 3	6D3	6D2
Timer stop - Signal Relay 4	5D3	5D2

2. Set the current and voltage sources to zero.
3. Power on the relay.
4. Using programming procedures described in "Programming the Relay" and "Setting Calculations," assign logical functions to the I/O units as indicated in Table 3-28. All other relay settings should be factory presets. The indicated functions should be assigned to index 001. All other indexes should be unassigned.

Table 3-28. I/O Assignments for Breaker Failure Test

Addr.	I/O Unit	FNo	Function
6102	Binary Input 2	075	>Start B/F NO
6203	Signal Relay 3	473	Fault B/F
6204	Signal Relay 4	475	Trip B/F
6302	LED 2	401	Fault L1 m
6304	LED 4	471	B/F Off nm
6305	LED 5	473	Fault B/F nm
6306	LED 6	475	Trip B/F nm

5. Using programming procedures described in "Programming the Relay,"verify or program the settings indicated in Table 3-29.

Table 3-29. Initial B/F Protection Test Settings

Addr.	LCD Text
1201	O/C PHASES ON
7812	CHARAC. PH DEFINITE TIME
1212	I> 1.00 I/In
1213	T-I> 0.50 s
3901	B/F PROT. OFF
3902	I> B/F 0.20 I/In
3903	T-B/F 0.25 s

6. Proceed with the test steps indicated in the table below. For each step, set the program parameters and the signal inputs as indicated, then verify that the outputs are as specified. At the conclusion of each step, reduce the current and voltage inputs to zero , reset the timer, and press the **Target Reset** key before proceeding to the next step. Wait at least 1 second after completing all input adjustments to ensure that all time delays have expired before examining the results.

Table 3-30. Breaker Failure Protection Test Steps

Step	Addr. 3901	I_{L1}	Binary Input 2	LED 2	LED 4	LED 5	LED 6	Timer
7	OFF	1.50I_N	0 V	On	On	Off	Off	0 s
8	ON INTERN. START	1.50I_N	0 V	On	Off	On	On	0.25 s ± 20 ms
9	ON EXTERN START	0.210I_N See Note	0 V	Off	Off	Off	Off	0 s
10	ON EXTERN START	0.210I_N See Note	V_H V	Off	Off	On	On	0.25 s ± 20 ms
11	ON EXTERN START	0.190I_N See Note	V_H V	Off	Off	Off	Off	0 s
12	OFF	0.210I_N See Note	V_H V	Off	On	Off	Off	0 s

Note: *I_{BF}> tolerance is ± 3%. B/F protection will pick up for any current value within the range of 0.194I_N to 0.206I_N*

4. Installation

When installing the 7SJ511 relay, you should be familiar with all applicable safety regulations from ANSI, IEC, NEC, and other pertinent standards. You will also need to refer to the mounting and connection diagrams at the end of this chapter.

The relay is completely tested at the factory prior to shipment and is designed to eliminate the need for any special testing, calibration, or maintenance. Figure 4-1 shows the three main components that make up the relay assembly.

4.1 Receiving and Handling the Relay

The relay is packed to protect against mechanical shock. *Carefully remove the relay from the package and visually check it for external damage. If the relay is physically damaged, return it to Siemens immediately*. Please include a short description of the damage.

Keep the original packing material. Should you need to transport the relay again, use the original packaging to avoid damaging the relay.

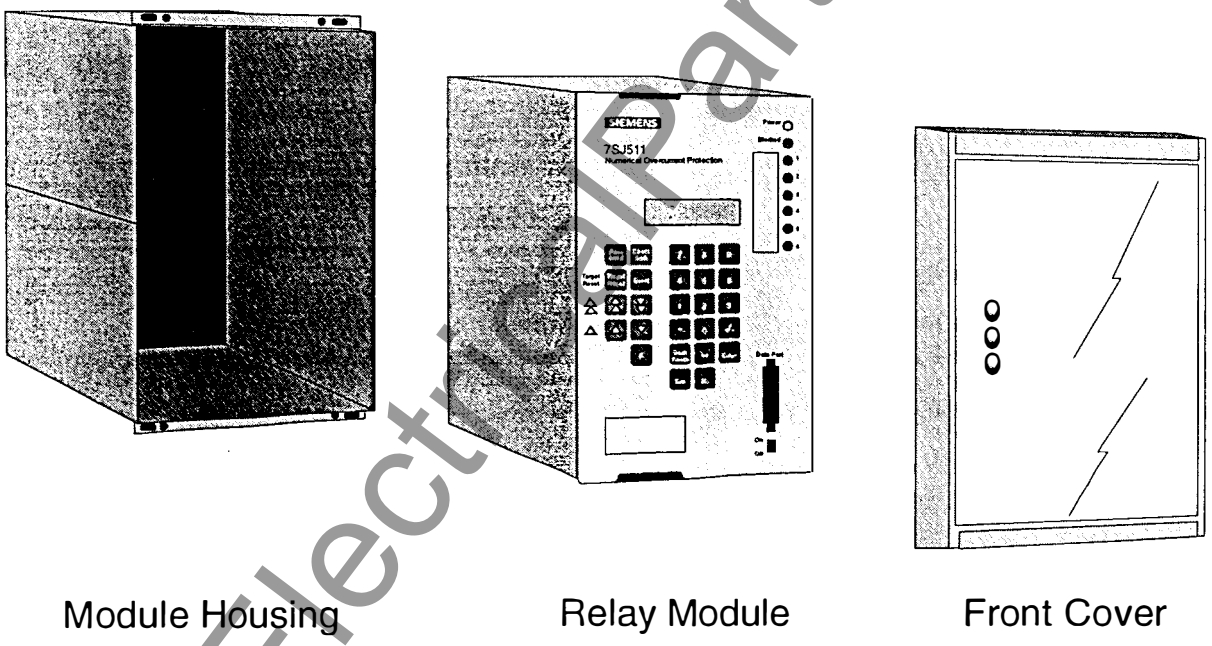


Figure 4-1. Exploded View of the Relay Components

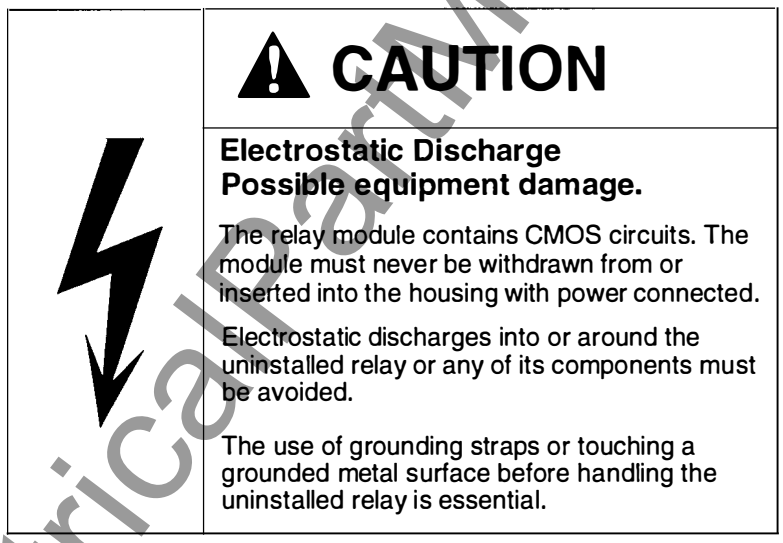
4.2 Storing the Relay

Store the relay in a dry, clean room. The temperature range for storage is -13° F to +131° F (-25° C to +55° C). Refer to the "Specifications" section of this manual for additional storage information.

If the relay is stored with no power input for an extended time period, proper voltage should be applied to the power input for one or two days prior to placing the relay into service.

4.3 Removing and Inserting the Relay Module

Some of the maintenance procedures described in this manual require removal of the relay module from its housing. Refer to the following instructions for the proper removal and insertion procedure.



⚠ CAUTION

Electrostatic Discharge
Possible equipment damage.

The relay module contains CMOS circuits. The module must never be withdrawn from or inserted into the housing with power connected.

Electrostatic discharges into or around the uninstalled relay or any of its components must be avoided.

The use of grounding straps or touching a grounded metal surface before handling the uninstalled relay is essential.

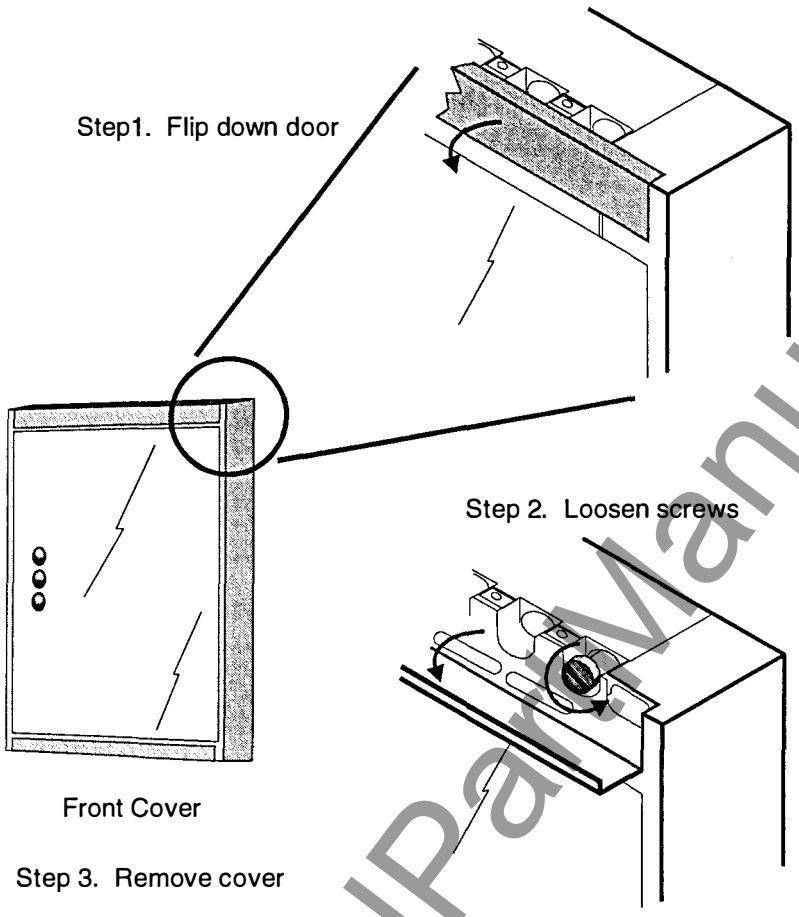


Figure 4-2. Removing the Protective Cover

Removing and Installing the Protective Cover

The relay is provided with a protective plastic cover that mounts on the front of the housing. In order to have full use of the key pad or to connect to the front data port, it is necessary to remove the cover.

The cover is mounted to the housing by four screws in the cover. Access to the screws is obtained by opening the door panels located at the top and bottom of the cover. As shown in Figure 4-2, the doors snap open and rotate on hinges. The top door rotates down and the bottom door rotates up.

To remove the cover, open both doors, then loosen all four screws until the cover is free. The screws are held captive in the cover.

To install the cover, position it properly on the housing, engage and tighten the four mounting screws, then close the doors.

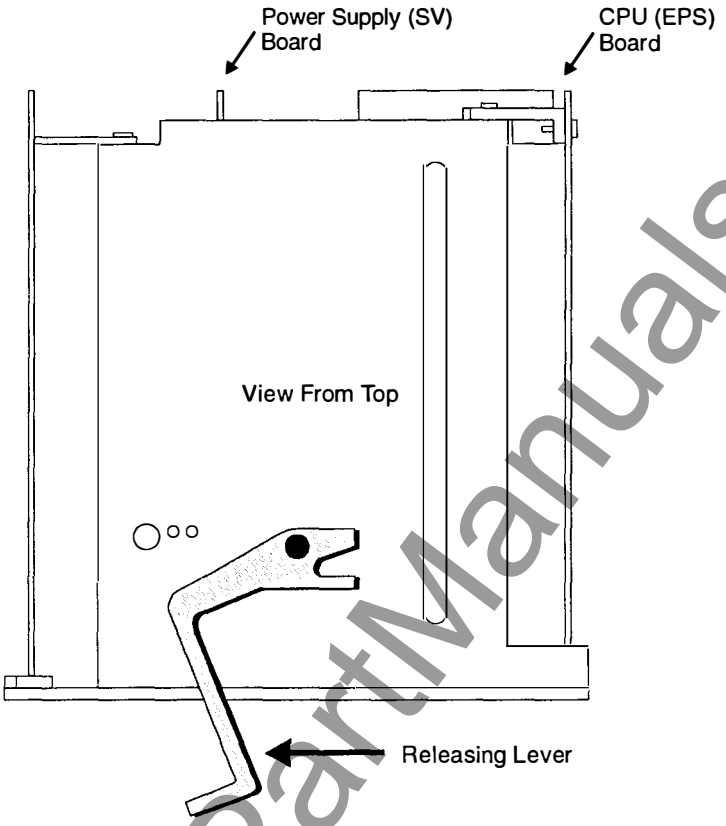


Figure 4-3. Removing the Relay Module

Removing the module:

- If necessary, remove the protective cover.
- Loosen the module by pulling the top and bottom releasing levers to the right.
- Grasp the module by the edges of the front panel and pull it out of the housing.
- Place the module on a conductive surface.
- Take all necessary precautions to avoid electrostatic discharges into or around the module.

Inserting the module:

- Position the top and bottom releasing levers fully to the right.
- Holding the module by the edges of the front panel, insert the module into the housing.
- Push the module into the housing as far as it will go.
- Push the top and bottom releasing levers fully to the left. This will pull the module into the housing and properly engage the internal connectors.
- Ensure that the module is fully inserted. One indication that the module is not fully inserted occurs when current is applied and the measured values in the LCD display are not as expected.

4.4 Printed Circuit Board Locations

The 7SJ511 relay module contains two printed circuit boards:

1. the power supply board, identified as the SV board
2. the system board containing the microprocessor (CPU), communication circuits, and basic I/O, identified as the EPS board

The location of each board is shown in Figure 4-3. Please refer to this illustration when you are required to locate components for any of the installation or maintenance procedures.

4.5 Mounting the Relay

Mounting diagrams for the *flush* mounted relay are provided in Figure 4-4. The relay model number includes the mounting construction of the relay. The flush mount configuration is the recommended alternative.

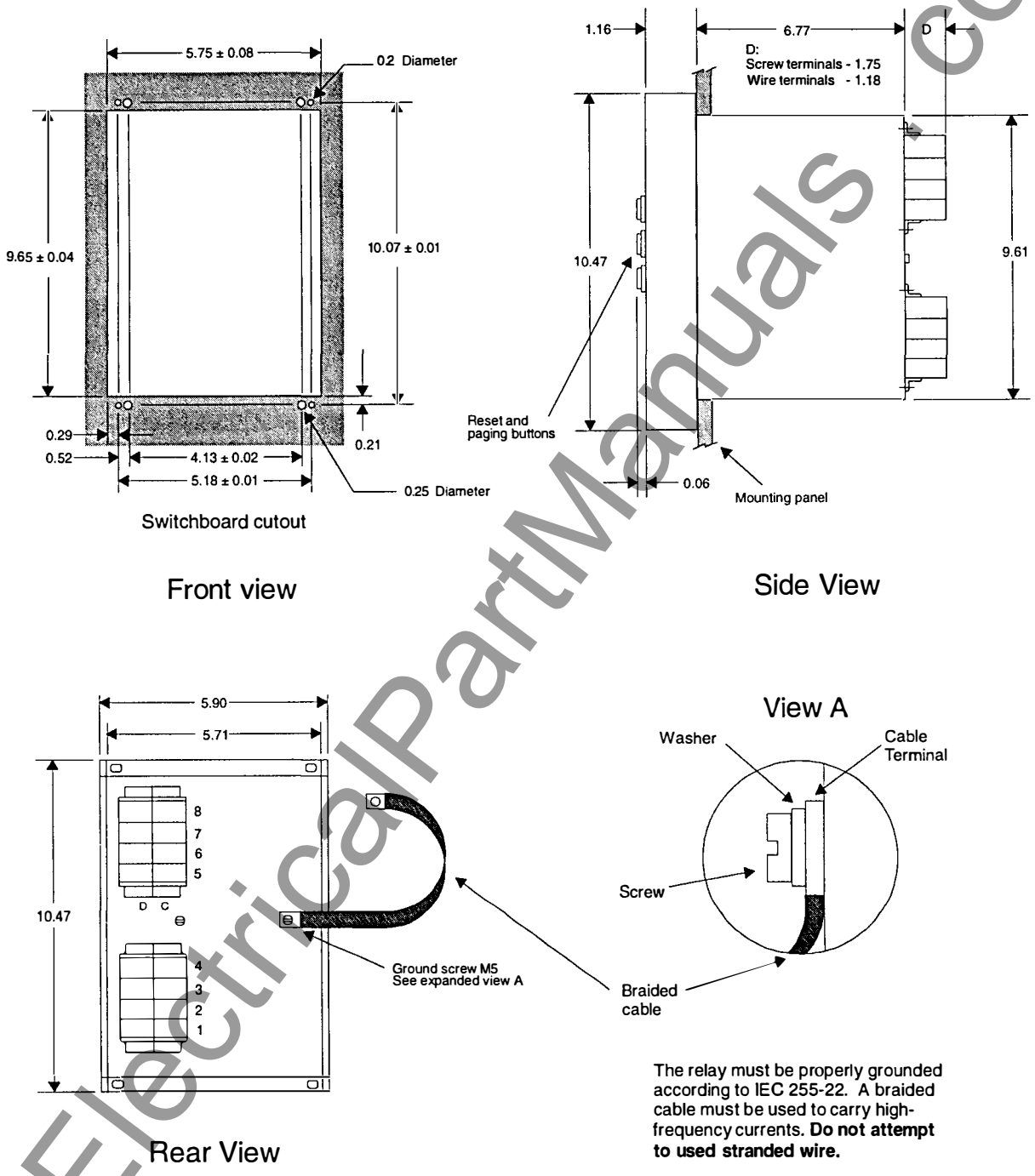


Figure 4-4. Flush Mounting Diagram (Dimensions in inches)

4.6 Connecting the Relay To Your System

This section provides diagrams for making connections to the relay terminals and to the system to be protected.

4.6.1 Relay Connection Diagrams

The following diagrams provide information on the function and location of the relay I/O and power connections. The terminal numbers are for the flush mount configuration.

Figure 4-5. Flush Mount Connection Diagram (See Figure 4-6 for communication connections)

Figure 4-6. Rear Panel Serial Interface Connections

Figure 4-7. Terminal Block Detail on the Rear Panel - Ring Lugs

Figure 4-8. Terminal Block Detail on the Rear Panel - Wire Compression

Figure 4-9. Terminal Function Assignment on the Rear Panel

Figure 4-10. Screw Terminal Detail

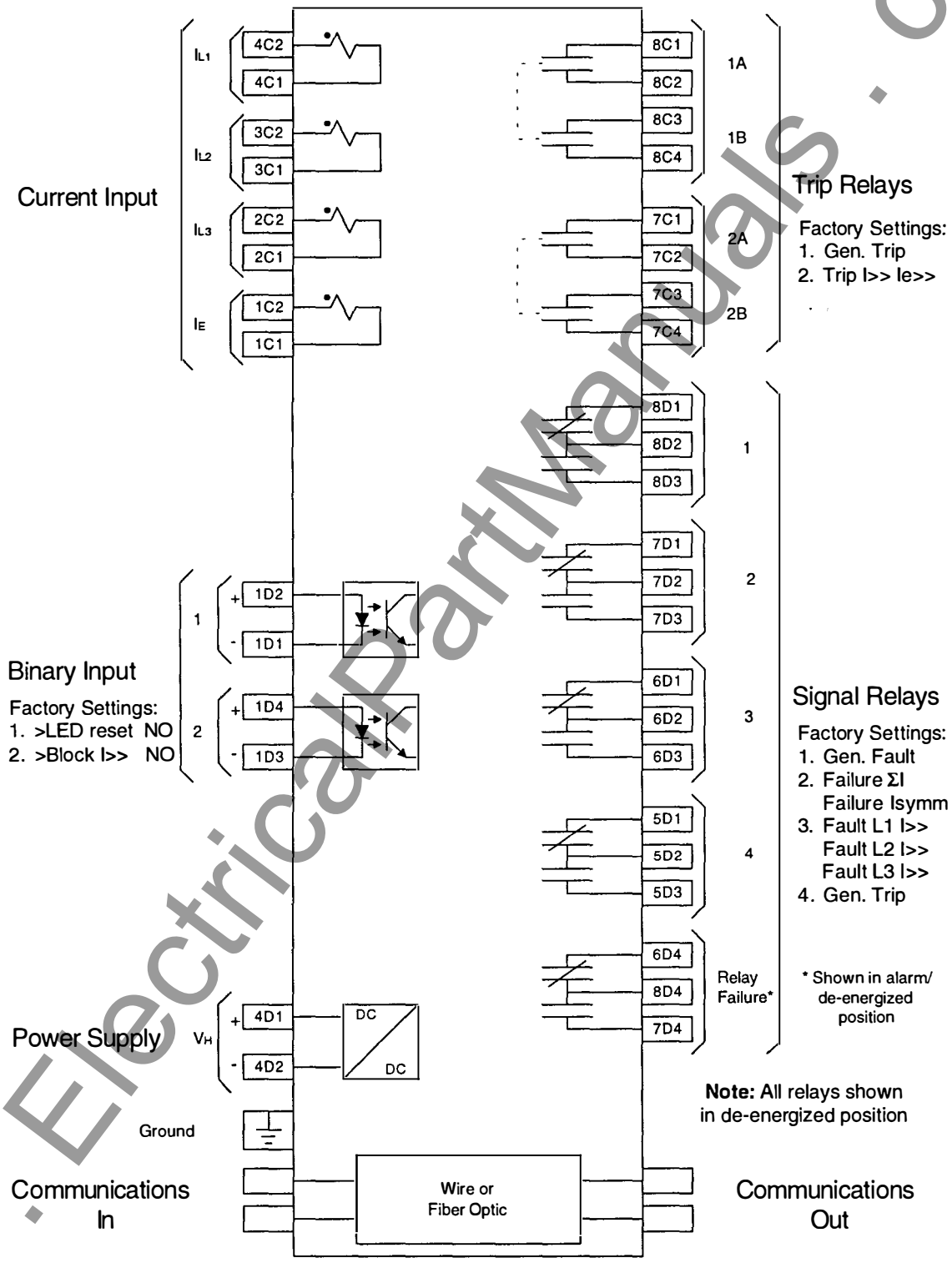


Figure 4-5. Flush Mount Connection Diagram (See Figure 4-6 for communication connections)

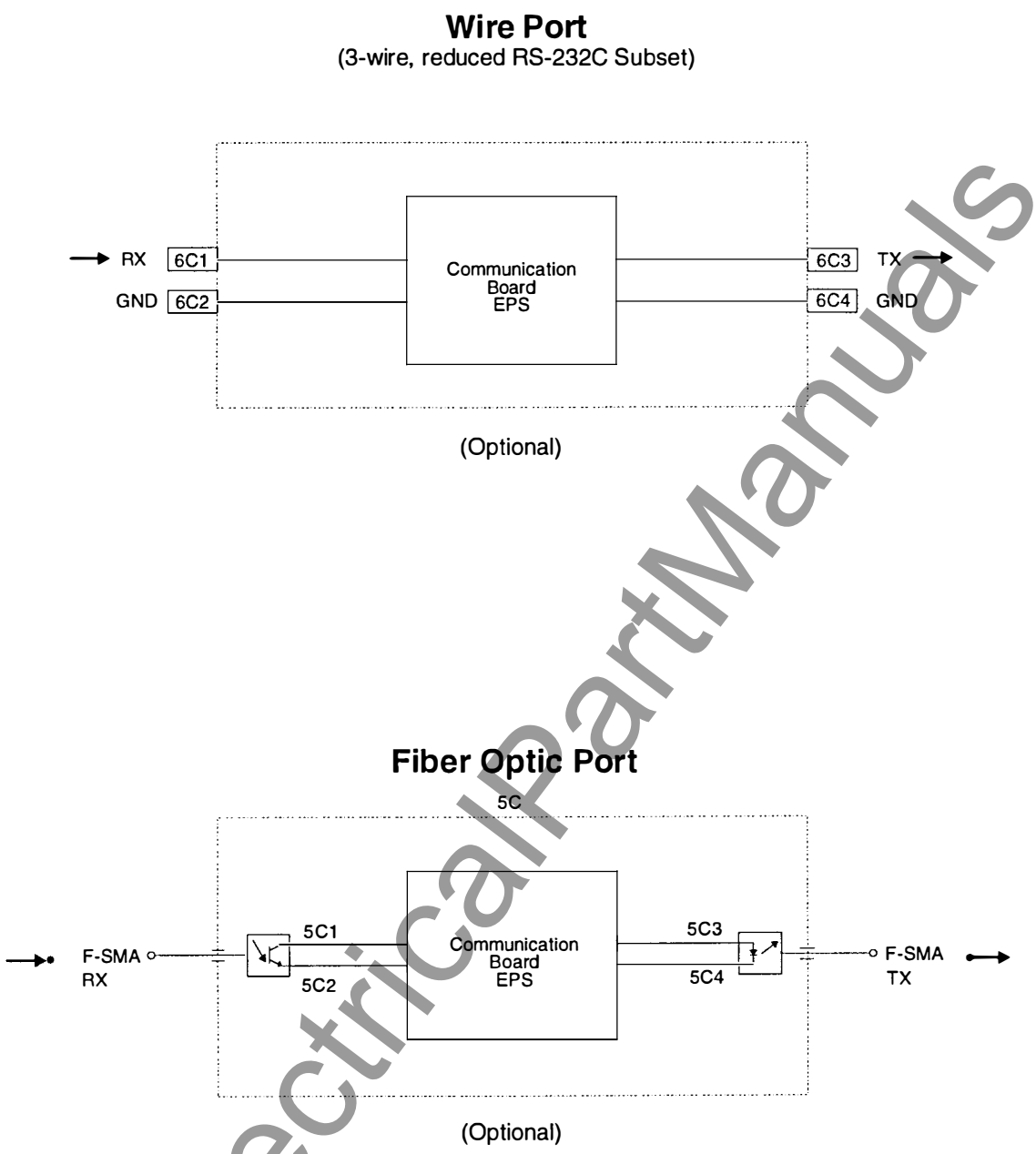


Figure 4-6. Rear Panel Serial Interface Connections

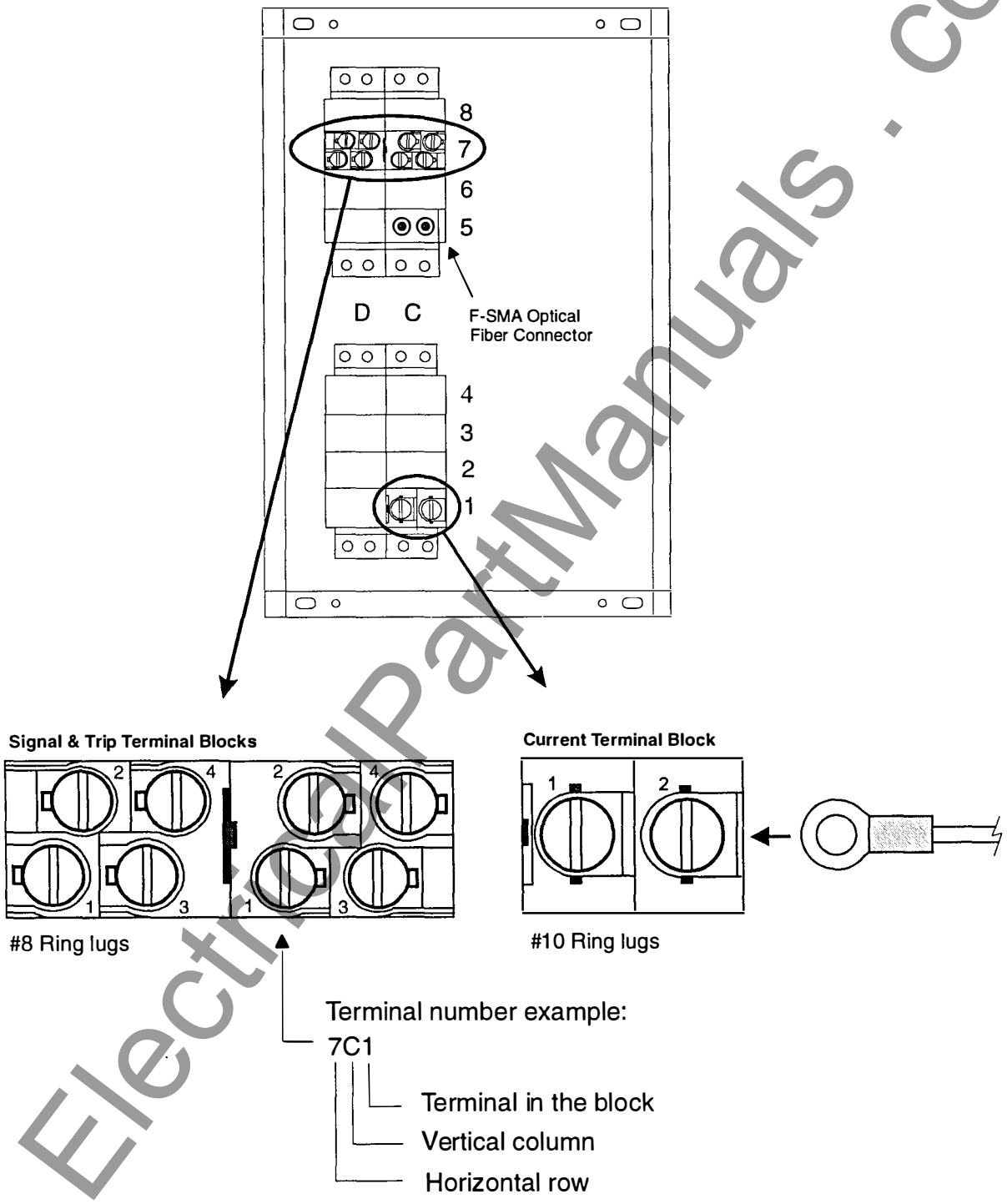


Figure 4-7. Terminal Block Detail on the Rear Panel - Ring Lugs

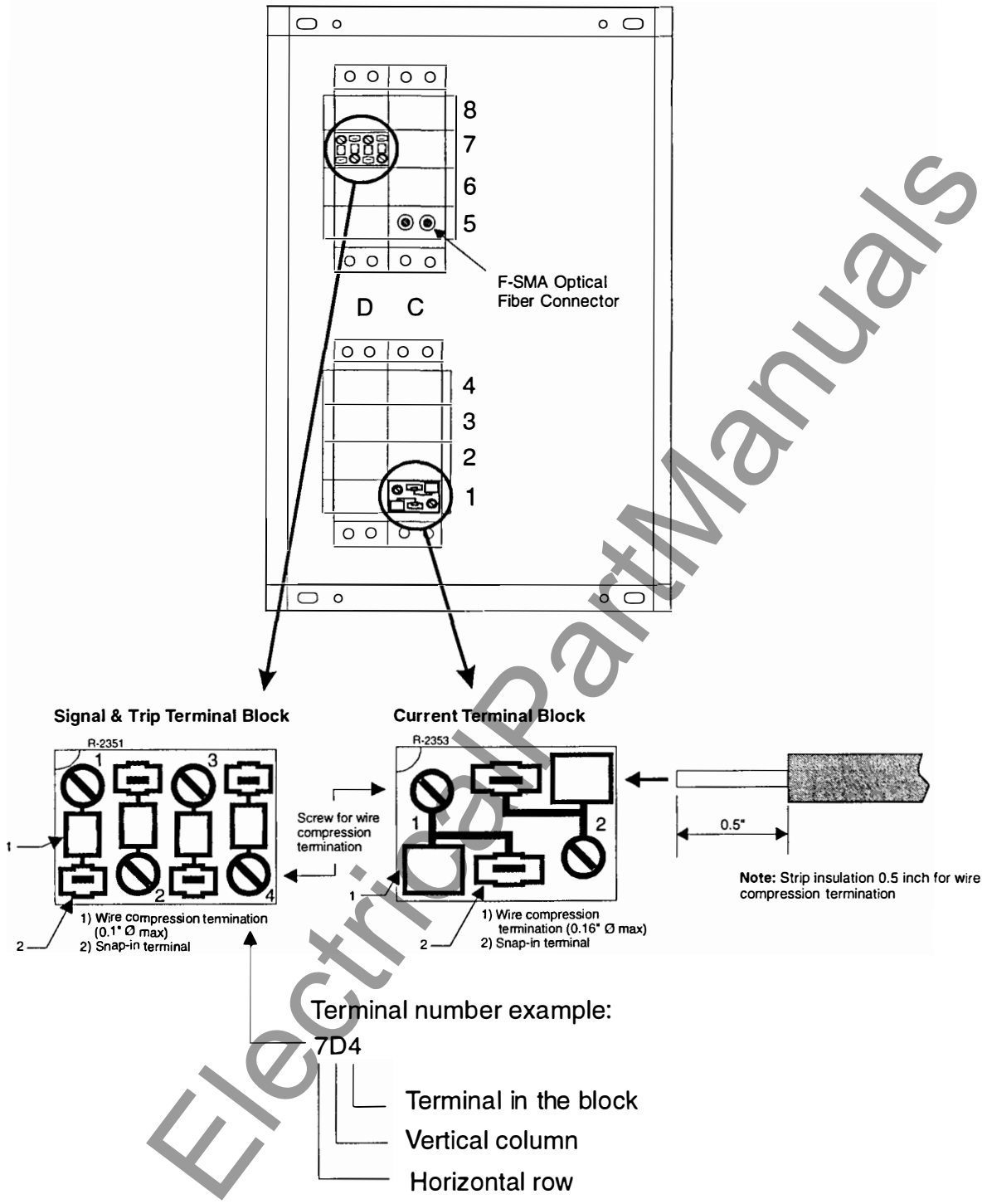


Figure 4-8. Terminal Block Detail on the Rear Panel - Wire Compression

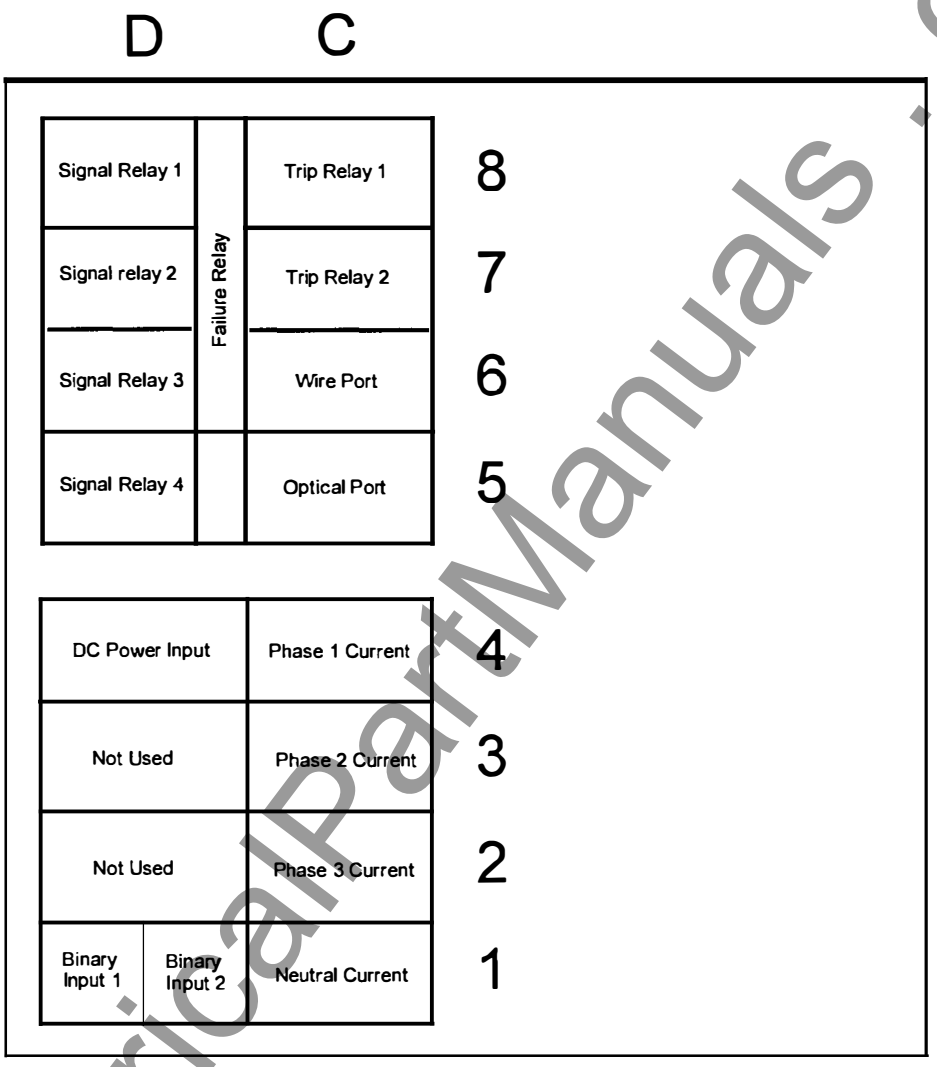


Figure 4-9. Terminal Function Assignment on the Rear Panel

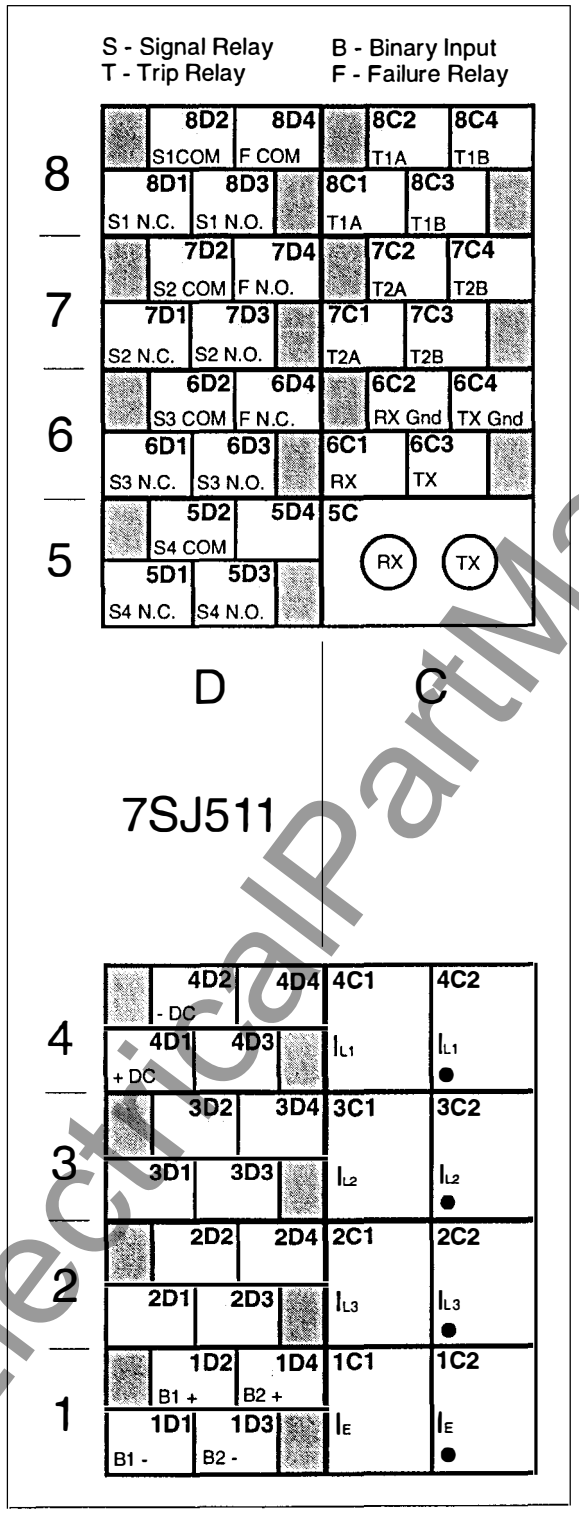


Figure 4-10. Screw Terminal Detail

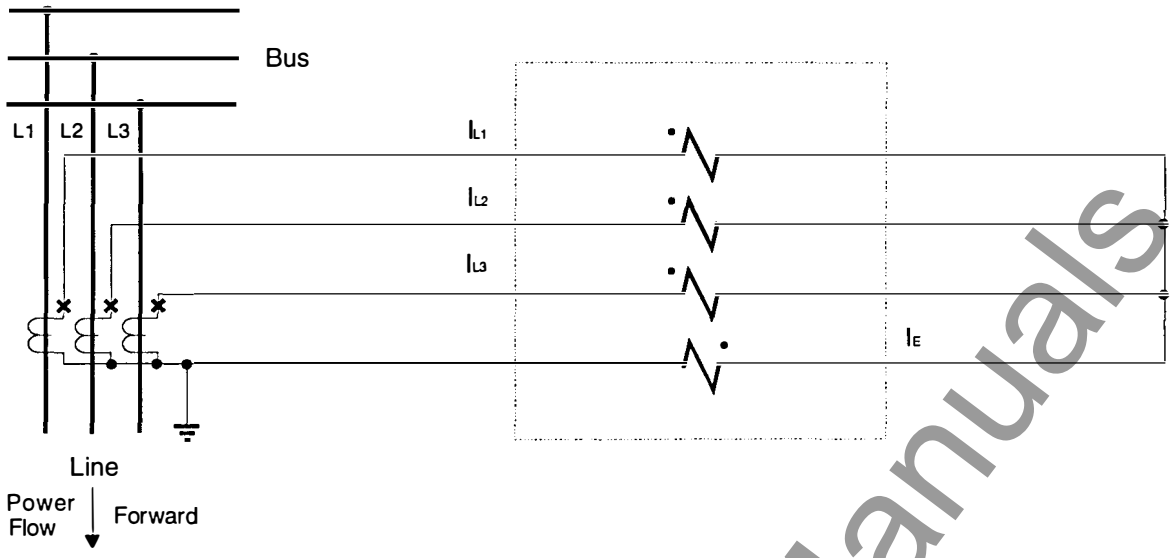
4.6.2 Current Transformer Connection Examples

The following diagrams provide examples of how the relay and the external measurement transformers might be connected to the system that is being protected.

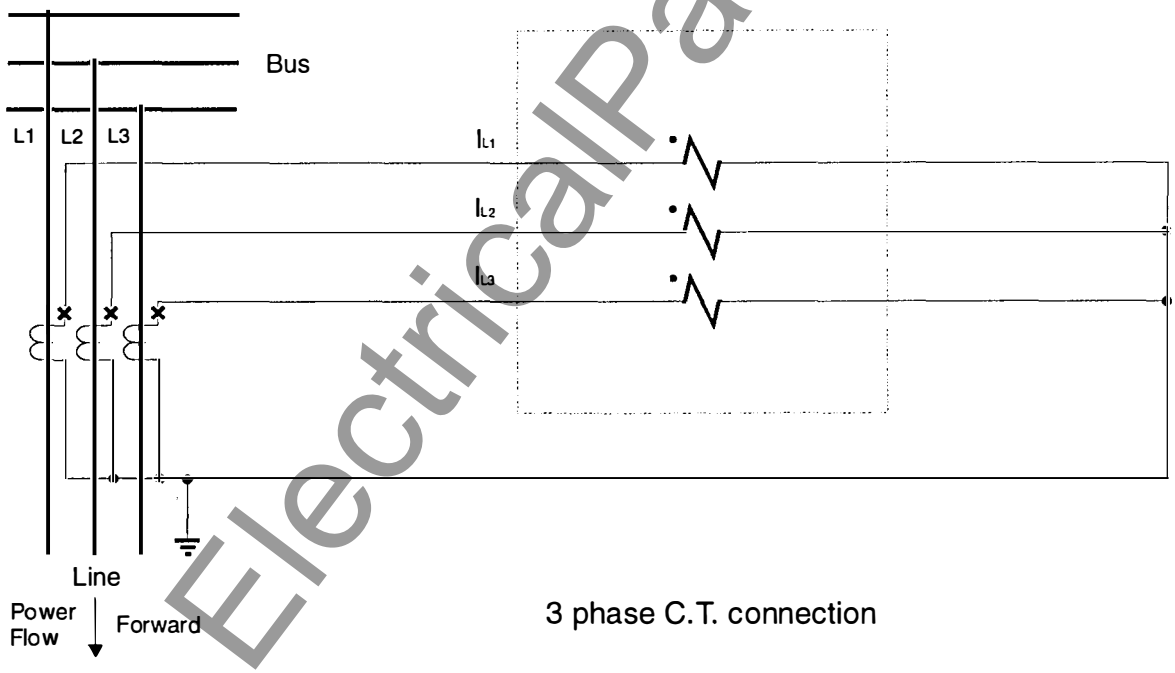
Figure 4-11. Current Transformer Connection Examples (Sheet 1 of 3)

Figure 4-12. Current Transformer Connection Examples (Sheet 2 of 3)

Figure 4-13. Current Transformer Connection Examples (Sheet 3 of 3)

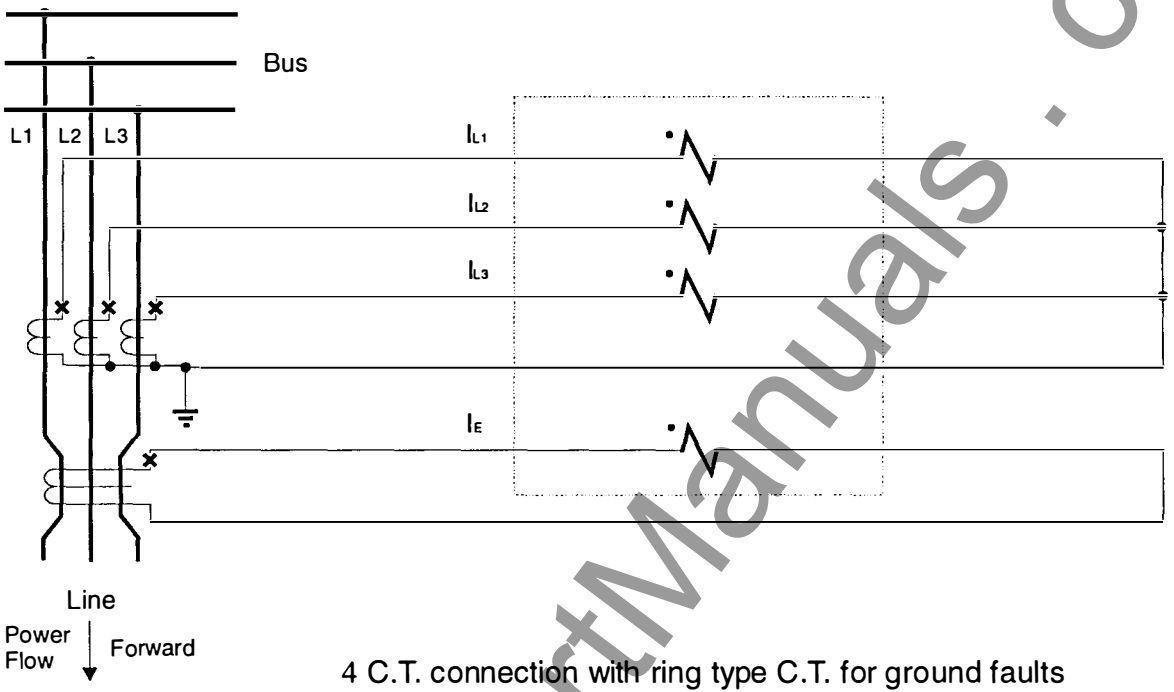


3 phase C.T. connection with residual connection for neutral faults

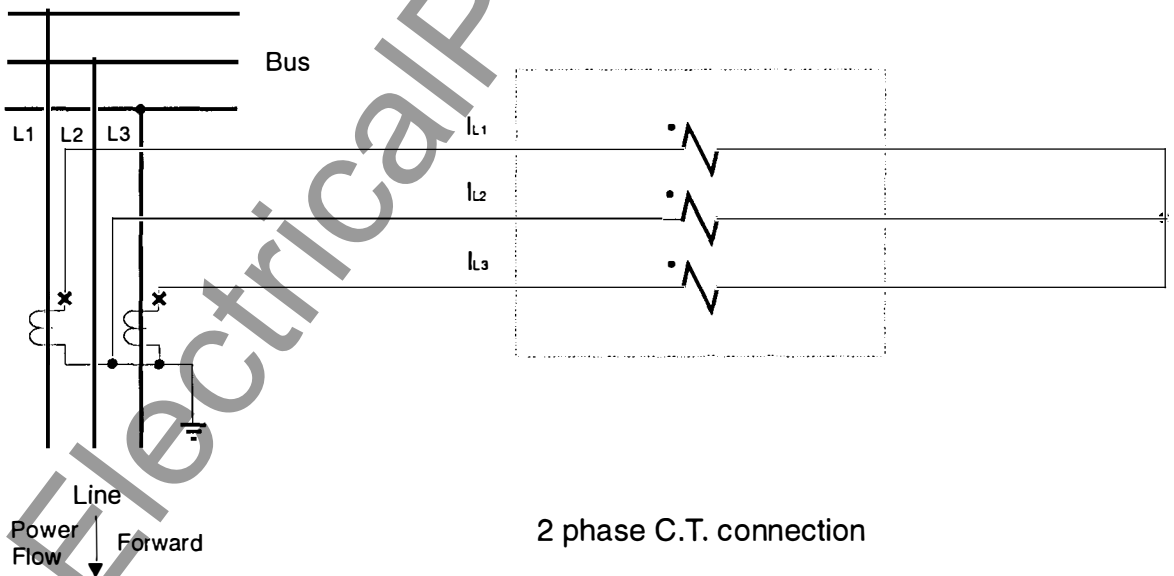


3 phase C.T. connection

Figure 4-11. Current Transformer Connection Examples (Sheet 1 of 3)

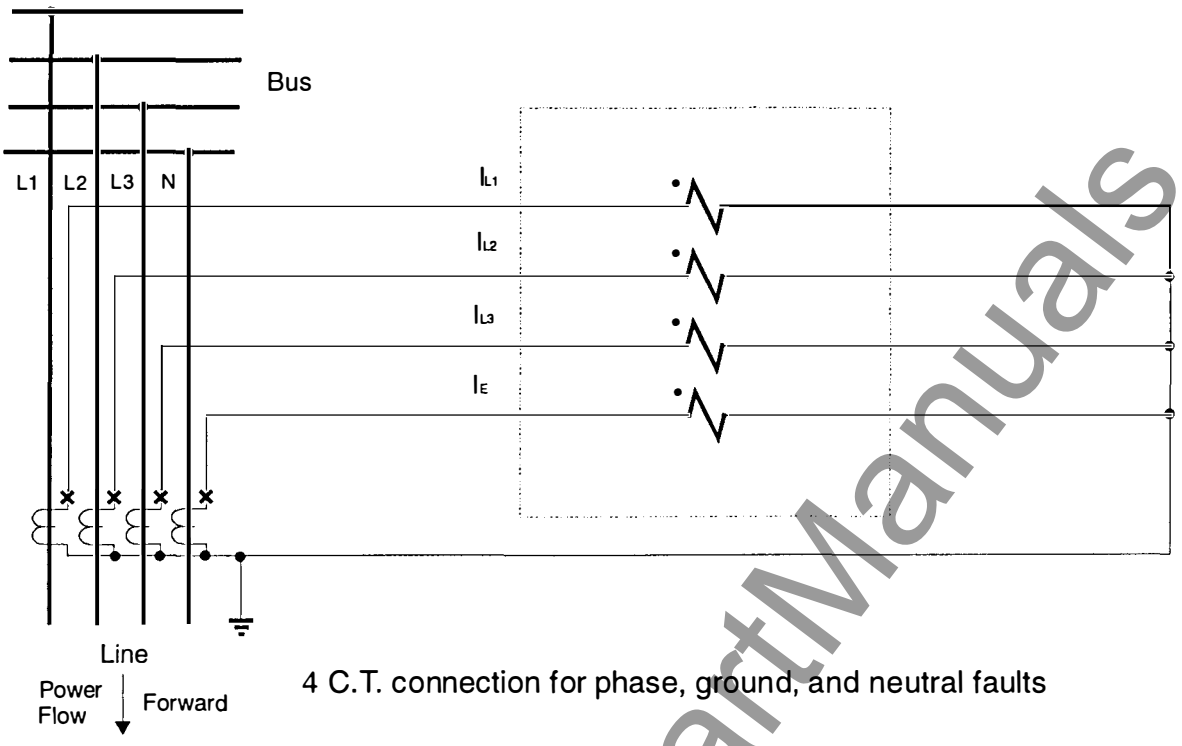


4 C.T. connection with ring type C.T. for ground faults

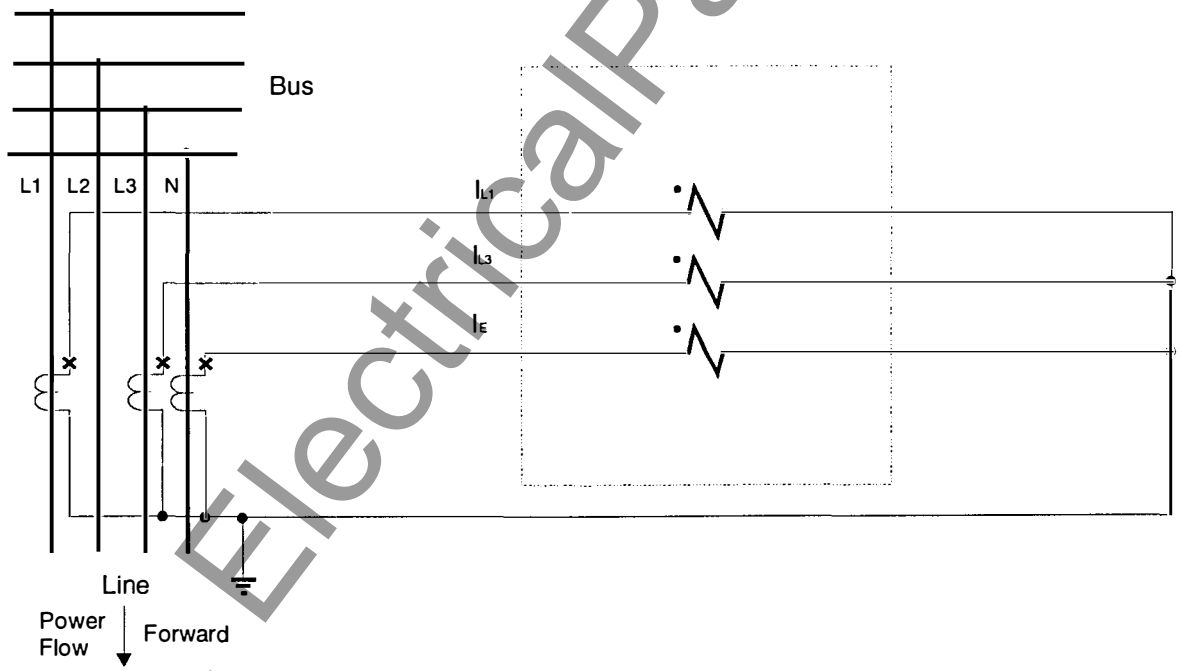


2 phase C.T. connection

Figure 4-12. Current Transformer Connection Examples (Sheet 2 of 3)



4 C.T. connection for phase, ground, and neutral faults



3 C.T. connection when neutral fault current is less than rated current

Figure 4-13. Current Transformer Connection Examples (Sheet 3 of 3)

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5. Programming the Relay

Before operating the 7SJ511 relay, you must program it specifically for your system. This chapter tells you how to:

- Use the operator panel
- Place the relay in programming mode
- Program the relay
- Save new settings

This chapter also identifies the factory presetting for the system, protection, and relay configuration settings. Setting options and ranges are included.

Before you begin any procedure in this chapter, either fill out the worksheets provided in the "Setting Worksheets" section of this manual or get a copy of the worksheets as completed by a relay engineer. To avoid operating problems due to incorrect parameters, the relay should be configured as soon as possible after the installation procedures are completed.

⚠ CAUTION

Possible configuration errors. May result in incorrect protection settings.

Only authorized personnel should program the relay. Do not attempt to program the relay if you are not certain of the information you are changing.

If present, remove the protective cover to access the operator panel (see section 4.3 in the "Installation" chapter). Be sure that the **On/Off** power switch is in the "On" position and the **Power** LED is on.

5.1 The Operator Panel

Before programming and operating the relay, you need to be familiar with the keypad and other features of the operator panel. Figure 5-1 provides an illustration of the operator panel for the 7SJ511 relay. The features, listed below, are described in the rest of this section:

- Keypad
- Display panel
- On/Off switch
- Nameplate
- Light Emitting Diodes (LEDs)
- Reserved area for LED labels
- Serial data port

Keypad

The keys on the operator panel keypad have four basic functions: data entry, navigation, control, and confirmation. The numeric keys are used specifically for data entry or address selection. The navigation keys are used to move around within the address space. The control, and confirmation keys are used to accept, reject, or modify configuration options. See Figure 5-1.

Display Panel

This 32-character liquid crystal display (LCD) is made up of two lines of text, 16 characters each. There are two modes of operation for the display.

- The **display** mode is the normal operating mode. You can read information, but you cannot change it. The information that is displayed during normal (i.e., no fault) system conditions is user-selectable through the configuration process. Stored event data can be recalled and analyzed in this mode.

- The **programming** mode is activated by the relay password. The information displayed in this case is configuration data. The relay stays in programming mode until you change and save at least one setting. The normal protective functions of the relay continue to be operational while in programming mode. New settings do not take affect until you exit programming mode.

Note: The LCD is not capable of displaying subscript characters. As a result, lowercase characters, in some cases, are substituted for the subscripts (e.g., I_N becomes **In** and I_{Ep} becomes **Iep)**. In other cases, the subscript is indicated by a dash (e.g., T_{REC} becomes **T-REC**). In this manual, specific references to the LCD text will show the symbols as they appear in the display. Otherwise, symbols with correct case and subscripts are used.

On/Off Switch

This switch controls the operational state of the relay. When the switch is in the "Off" position, the microprocessor is reset and processing stops. Secondary (DC) power output from the power supply module is turned off. The relay is effectively disabled or blocked in this state. This switch

should stay in the "On" position after the relay has been properly installed, programmed, and commissioned. The relay may be turned off for certain maintenance and testing procedures. Refer to the "Maintenance" section for more information on the use of this switch during maintenance. Anytime the **On/Off** switch is moved from "Off" to "On", the internal microprocessor is restarted. When turned off, the relay failure contact closes.

Nameplate

The nameplate identifies several things about your relay such as rated current and DC supply voltage. The relay model number is printed at the top of the nameplate. The section "Reading the Relay Model Number" in the "Introduction" chapter describes how to interpret the model number.

LEDs

The 7SJ511 relay has eight LEDs, six of which can be programmed (see Figure 5-1). The LEDs that cannot be changed are as follows:

- **Power** - Lights up GREEN to indicate the relay is operating properly. Normally this indicator will always be on. This indicator will be off if the **On/Off** switch is in the "Off" position or if power to the relay is interrupted. It will also be off if the microprocessor monitor function detects a failure.

- **Blocked** - Lights up RED to indicate that the relay has detected an internal problem and has "blocked" itself from operation. This indicator will also light briefly during initial power-on and after some settings are changed and saved.

The remaining LEDs (1 through 6) will light up RED to indicate that the event or function assigned to this LED indicator during the configuration process has occurred. These indicators will remain on until reset and the relay will retain this data even if power is lost. Whether or not the indications are retained in the nonvolatile memory is a configuration option. If the indications are not retained, they will be reset when the fault condition is removed. If they are retained, they can be reset locally by the **Target Reset** key on the operator panel, via a binary input, or automatically when a new fault is detected.

Reserved Area for LED Labels

The 7SJ511 relay provides a space on the operator panel to label the six LEDs indicating how they are programmed. Labels for the preprogrammed annunciations are provided with the relay.

Serial Data Port

The serial data port allows you to connect a personal computer (PC) directly to the relay. This port conforms to the EIA RS-232-C standard. This feature is typically used in conjunction with DIGSI® software to quickly retrieve and view event data, program the settings, monitor measured values, and analyze captured waveforms.

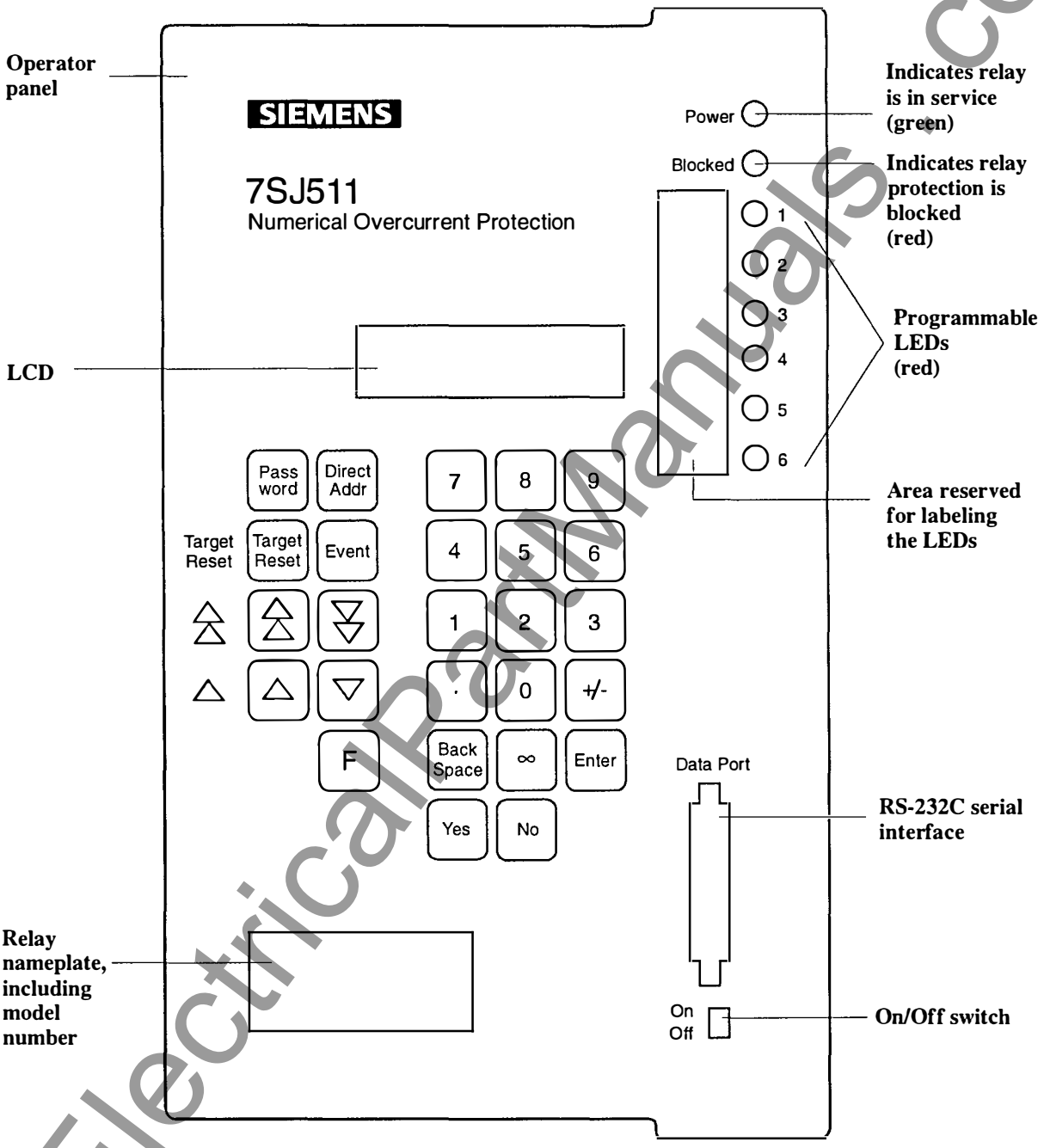

Figure 5-1. Illustration of the 7SJ511 Operator Panel

5.2 General Procedures for Programming the Relay

To program the relay, you must first change the relay from **display** to **programming** mode and choose the address block or number having the setting(s) you need to change. Once you are in programming mode, you can change any settings in any address block. The procedures and tables given throughout this chapter identify the settings that require a numeric value within a specified range and the settings that are chosen from a pre-defined list of options.

This section tells you how to do the following operations as part of the programming process:

- Change to programming mode
- Select an address block
- Program a *selectable* setting option
- Program a *numeric* setting

Keypad Functions

The functions of the keys on the operator panel are described below:

Press this key to ...	
Pass word	Enter the relay password.
Direct Addr	Directly access an address.
Event	Directly access address 5000 (Annunciations).
Target Reset	Test and reset the stored LEDs.
⏫ ⏬	Scroll through address blocks.
▲ ▼	Scroll through addresses or index numbers.
F	Modify the function of the key that follows.
0 – 9	Enter numeric data (addresses, values, etc.).
.	Enter (1) a decimal point in numeric data or (2) a separator between hours, minutes, month, day, etc., for date and time setting.
+/-	Indicate (1) a negative value or (2) a difference time.
Back Space	(1) Delete one character to the left or (2) scroll backward through the function selection (index) levels.
∞	Enter the program setting value "infinite."
Enter	(1) Confirm the address or value that has been keyed in or selected, or (2) clear error or operational messages from the LCD.
Yes	(1) Accept the displayed setting or (2) respond "Yes" to the displayed question.
No	(1) Reject the displayed setting or (2) respond "No" to the displayed question.

5.2.1 Selecting an Address

There are two ways to select an address. You can use (1) the **Direct Addr** (direct address) shortcut key or (2) the navigation keys. Two of the navigation keys are accessible with the protective cover installed over the relay. The cover must be removed to access the **Direct Addr** key.

Note: The direct address method is used in the procedures in this manual.

Using the Direct Address Key

1. Press the **Direct Addr** key.
2. Type the 4-digit address number.
3. Press **Enter**. The address number, description, and the setting appear on the display.

Note: If you enter

- an invalid address, you get the message "ADDRESS UNKNOWN."
- no address, you get the message "ENTRY ERROR."
- an address for a function configured as NON EXIST, you get the message "NOT AUTHORIZED."

Using the Navigation Keys

Repeatedly press either of the navigation keys described below until the **address block** that contains the setting you want to review is displayed.

- Press the ⏫ key to go to the NEXT BLOCK. *
- Press the ⏬ key to go to the PREVIOUS BLOCK.

With the correct address block number displayed, press either of the navigation keys described below until the **address number** and setting you want is displayed.

- Press the △ key to go to the NEXT ADDRESS. *
- Press the ▽ key to go to the PREVIOUS ADDRESS.

** This key is accessible with the protective cover installed.*

5.2.2 Placing the Relay in Programming Mode

The 7SJ511 relay requires a password (codeword) which must be entered to place the relay in programming mode. The factory-set password is six zeroes ('000000') and cannot be changed. While the relay is in programming mode, the solid bar following the address number in the LCD will flash on and off. The relay remains in programming mode until you save the settings as discussed in section 5.2.4

To place the relay in programming mode, follow this procedure:

1. Press the **Direct Addr** key, type the address number for the setting to be programmed, and press **Enter**. The requested address, description, and presetting appear on the display (refer to section 5.2.1 for instructions on how to use the navigation keys to access an address).
2. Press the **Password** key and enter password '000000'. Each character ('0') you type appears as the @ symbol on the display.
3. Press **Enter**.
4. If your entry is correct, the message "CW ACCEPTED" appears on the display. Press **Enter** again. You return to the address where you started in step 1, and the relay is in programming mode. The bar following the address number will now blink on and off. Go to section 5.2.3.
5. If your entry is not valid, the message "CODEWORD WRONG" appears on the display. Begin again with step 2.

To take the relay out of programming mode, follow this procedure:

1. Press the **F** key followed by the **Enter** key.
2. If programming changes have been made, the "SAVE NEW SETTINGS?" message will be displayed. Refer to section 5.2.4 where the correct response to this message is covered.
3. If no programming changes have been made, the message "CW OPERATION TERMINATED" will appear in the display. Press **Enter** to clear the message and return to a display of the last address that was accessed. The bar following the address number will no longer blink on and off.

5.2.3 Changing a Setting

The relay must be in programming mode to change a setting.

There are two types of relay settings:

1. **selectable** - parameters or options that are selected from a list
2. **numeric** - values that are entered using the numeric keys of the keypad

To change a **selectable** setting:

1. When the setting displayed is not the one you want, press the **No** key. The next setting from the list appears on the second line of the LCD. Continue to press the **No** key until the setting you want is displayed on the LCD.
2. Press **Enter**. Go to section 5.2.4.

To change a **numeric** setting:

1. With the existing setting displayed, type in the new value and press **Enter**.
2. If the new value is invalid, an appropriate error message will be displayed. Press **Enter** to clear the message and re-enter a correct value. Continue with section 5.2.4.

5.2.4 Saving New Settings

Before new settings are saved, all configuration and programming changes are stored in the volatile working memory (RAM). To save new relay settings and store them in nonvolatile EEPROM memory, you must press the **Yes** key in response to the "SAVE NEW SETTINGS?" message. There are two ways to reach this message:

(1) By use of the F key.			
Step	**Action**		**Result**
1.	Press function key **F.**		An "F" replaces the solid bar following the address number in the display.
2.	Press **Enter**.		The message "SAVE NEW SETTINGS?" appears on the display.
3.	To respond to this message:		
	a.	Press the **Yes** key to save the settings and exit programming mode.	The "NEW SETTINGS SAVED" message appears on the display.* Press **Enter** to clear the message and return the relay to display mode.
	b.	Press the **No** key to cancel saving the settings.	The "SAVING PROCEDURE ABORTED" message appears on the display. Press **Enter** to clear the message and return the relay to display mode. Any changes made while in programming mode are erased.
(2) When leaving address blocks 10 to 39 or 60 to 85.			
1.	Use the **Direct Addr** key or the navigation keys to leave address blocks 10 to 39 or 60 to 85.		The message "END OF CODEWORD OPERATION?" appears on the display.
2.	To respond to this message:		
	a.	Press the **Yes** key to save the settings and exit programming mode.	The "SAVE NEW SETTINGS ?" message appears on the display. Respond to this message as described in Step 3 above.
	b.	Press the **No** key to continue configuration.	The message "PRESS ANY KEY TO CONTINUE" is displayed. When a key is pressed, the relay returns to the last address that was accessed and stays in programming mode.

** When changing the Scope of Functions parameters in address block 7800 or the configuration parameters in address block 6000, the display blanks out and the microprocessor automatically resets and restarts. The programmable LEDs will light briefly then go out and the display returns to address 0000. The relay failure contact will close briefly during the reset operation.*

5.3 Enabling the Relay for Substation Control (optional)

If the 7SJ511 relay is connected to a substation control system through the rear port, you must change several presettings. These presettings include activating the rear communication port, selecting the data transmission rate, and specifying system addresses.

Note: If the rear port is enabled (address 7814 set to EXIST), waveform capture data will not be available at the front port.

Table 5-1 lists the relay presettings, the optional settings and the setting ranges available for the rear port. Compare these presettings to the information on a completed set of worksheets, and determine which settings you need to change to match your operating environment. After all settings have been verified or changed appropriately, follow the procedure described in section 5.2.4 to save the new settings.

Table 5-1. Substation Control System Settings

Addr.	LCD Text (1st line)	Description	Preset	Options/Ranges
7814	LSA	Enable rear communications port	NON-EXIST (disable)	EXIST (enable)
6902	BAUDRATE	Data transmission speed	9600 BAUD	• 4800 BAUD • 19200 BAUD
7009	DEVICE ADD.	Device address	0	0 - 255
7010	FEEDER ADD.	Feeder address	0	0 - 255

The "Input/Output Functions" section of this manual identifies the relay functions that can be accessed by the substation control system.

5.4 Waveform Capture Settings

Waveform capture continuously stores the phase and neutral current waveforms. If FAULT RECRD at address 7806 is set to NON-EXIST, the waveform capture function will not be available and the remaining waveform capture parameters cannot be programmed. The stored waveform data may be retrieved through either of the serial ports for later analysis. However, if address 7814 is set to EXIST, the waveform capture data will be available only at the rear port.

Table 5-2 lists the preset waveform capture settings and setting options. Compare these presettings to the information on the completed worksheets and determine which settings, if any, you need to change to match your operating environment.

Table 5-2. Waveform Capture Settings

Addr.	LCD Text (1st line)	Description	Preset	Options/Ranges
7806	FAULT RECRD	Waveform capture existence	EXIST (enable)	NON-EXIST (disable)
2801	FAULT REC.	Waveform capture on or off	ON	OFF
2802	INITIATION	Waveform capture start	BY FAULT DETEC. (pickup)	BY TRIP <T-REC
2803	FAULT REC.	Fault record destination	TO PC/PD (front port)	TO LSA (rear port)
2804	T-REC	Time allowed following pickup for trip command to start recording (see address 2802)	0.30 s	0.01 - 2.50 s
7002	OPER. BAUDR.	Front port data rate	1200 BAUD	• 2400 BAUD • 4800 BAUD • 9600 BAUD • 19200 BAUD

The following procedure enables the waveform capture function via the front serial port for the 7SJ511 relay. It is a good example of how to use the operator panel to change settings, verify predefined settings, enter new data, and save the new settings.

1. To verify the presettings for the waveform capture function, press the **Direct Addr** key and type address number 7806.

2. Press **Enter**. With the factory presettings, the display should appear as shown below:

```
7806 FAULT RECRD
EXIST
```

3. Press the **Direct Addr** key, type address number 2801, and press **Enter**. With the factory presettings, the display should appear as shown below:

```
 2801 FAULT REC.
ON
```

4. Press the △ key to go to address number 2802. With the factory presettings, the display should appear as shown below:

```
2802▮INITIATION
BY FAULT DETEC.
```

5.

If you want waveform capture initiated by . . .	then . . .
fault detection (pickup),	Press the △ key to go to address number 2803.
trip command,	1. Change to programming mode. 2. With "2802 ▮ INITIATION BY FAULT DETEC." displayed on the LCD, press the **No** key. "BY TRIP <T-REC" will appear on line 2 of the display. 3. Press **Enter** to have waveform capture initiated by trip command. 4. Press the △ key to go to address number 2803.

6. The factory presetting "2803 ▮ FAULT REC. : TO PC/PD" appears on the display. Since this example procedure is to set the waveform capture function for the front port, the presetting is the correct setting. Press the △ key.

7.

If address 2802 setting is . . .	then . . .
BY FAULT DETEC.,	Address 2804 is not available, so address 2801 appears on the display. Go to the next step of this procedure.
BY TRIP <T-REC,	1. Press the △ key. "2804 ▮ T- REC 0.30 s" appears on the display. This setting indicates the time allowed, after a trip command, before waveform capture recording is started. 2. To *accept* the T-REC presetting of 0.30 seconds, press the △ key. Go to Step 8. 3. To *change* the time delay T-REC, place the relay in programming mode if you have not done so in a previous step. Type in the new value using the decimal point and numeric keys, and press **Enter**. Verify the value you entered on the display.

8. To change the data rate for communication via the front port, press the **Direct Addr** key and type in address number 7002. The display appears as shown below:

```
7002 OPER. BAUDR.
1200 BAUD
```

9.

If . . .	then . . .
1200 is the correct data transmission speed for the front serial port,	continue with the next step of this procedure.
1200 bps is NOT correct,	press the **No** key. The setting options are: • 2400 BAUD • 4800 BAUD • 9600 BAUD • 19200 BAUD When the setting you want to select is displayed, press **Enter**.

10. To save the settings, press function key **F** then press **Enter**. Press the **Yes** key in response to the "SAVE NEW SETTINGS?" message. The "NEW SETTINGS SAVED" confirmation message will appear on the display. See section 5.2.4 for more detailed instructions on saving relay settings.

5.5 Operating Settings

Table 5-3 lists the factory settings and setting options. Compare these presettings to the information on the completed worksheets and determine which settings, if any, you need to change to match your operating environment. After all settings have been verified or changed appropriately, follow the procedure described in section 5.2.4 to save the new settings.

Table 5-3. Operating Parameter Settings

Addr.	LCD Text (1st line)	Description	Preset	Options/Range
7001	LANGUAGE	Display language	ENGLISH	DEUTSCH (German)
7002	OPER.BAUDR.	Front port data rate	1200 BAUD	• 2400 BAUD • 4800 BAUD • 9600 BAUD • 19200 BAUD
7003	DATE FORMAT	Date format for real-time clock	DD.MM.YYYY	MM/DD/YYYY
7004	FAULT INDIC	Initiation of fault indication in LCD	BY FAULT DETEC (pickup)	BY TRIP COMM.
7005	OPER. 1st L	1st line of display - normal conditions	not allocated	• IL1 = nnnnn A • IL2 = nnnnn A • IL3 = nnnnn A • IE = nnnnn A • IL1 = nnn.n % • IL2 = nnn.n % • IL3 = nnn.n % • IE = nnn.n % (where "n" is a numeric digit)
7006	OPER. 2nd L	2nd line of display - normal conditions	not allocated	(same as address 7005)
7007	FAULT 1st L	1st line of display - fault conditions	not allocated	• Fault Type • Trip Type • Prot.Pickup • Prot.Trip • Time-to-Drop • Time-to-Trip
7008	FAULT 2nd L	2nd line of display - fault conditions	not allocated	(same as address 7007)

5.6 Real-Time Clock

The real-time clock is an optional feature on the 7SJ511 relay. If your relay model number is 7SJ511*-**A01-0*, the feature is present.

When the operator first accesses the 8100 block, the block title is displayed as shown below.

```
8100 SETTING
REAL TIME CLOCK
```

Pressing the △ key (or direct access to address 8101) causes the present date and time to be displayed as shown below. The date appears in the first line in the format (American or European) selected at address 7003. The time appears in the second line in 24-hour format.

```
08/14/1993
15:54:42
```

The relay must be in programming mode to change the date or time. The "T.CLOCK ADJUSTED" message will display after the date or time is changed.

Note: To properly save the new time or date, use the navigation keys to leave the 8100 address block. When you do this you will get the "SAVE NEW SETTINGS" message.

Date

A date can be entered at address 8102. When entering the date, the period (.) key is used as the separator between days, months and years. The entry must be made using two digits for the month, two digits for the day, and four digits for the year ; i.e., **MM.DD.YYYY** or **DD.MM.YYYY**. The date format is selected at address 7003.

Set Time

The clock can be *set* by entering a time at address 8103. Enter the time in 24 hour format using two digits each for hours, minutes, and seconds (i.e., **HH.MM.SS**). The period (.) key is used as the separator between hours, minutes, and seconds. The time entered takes effect at the moment the **Enter** key is pressed.

Difference Time

The clock can be *adjusted* by specifying a *difference* time at address 8104. In this case, the clock is adjusted forward or backward by the amount of time entered. To adjust the clock forward, enter the difference time, then press the **Enter** key. To adjust the clock backward, enter the difference time, press the **+/-** key, then press the **Enter** key. The format for the difference time is the same as for the set time as described above.

Synchronizing the Clock

There are two ways to precisely synchronize the relay clock with another reference:

1. via the operator panel
2. via a binary input signal

Operator Panel Entry

Synchronizing the clock through the operator panel can be done with either a *set* time entry or a *difference* time entry.

To synchronize with a *set* time entry, enter a time in advance of the reference time, then press the **ENTER** key precisely when the reference clock reaches the entered time. This method can never be extremely precise since it is dependent on operator reaction time.

To synchronize with a *difference* time entry, enter a *difference* time equal to the time difference between the relay clock and the reference clock. The difference time method has the advantage of being independent of the operator reaction time. It does, however, have the disadvantage of having to know the exact difference between the relay clock and the reference clock.

Binary Input Signal

The relay clock may also be synchronized by means of an external signal on a binary input. In order to use this method, the logical function "Time Synchro" (FNo 005) must be assigned to a binary input (see section 5.11.3). When "Time Synchro" is assigned to a binary input, a transition of the input signal to the active state causes the seconds counter of the internal clock to reset to zero. The minutes counter will advance to the next minute if the seconds counter is at 30 seconds or more when the transition occurs. Otherwise, the minutes counter will remain unchanged. Worst case delay between the synchronizing transition and the reset to zero seconds is 20 milliseconds.

The internal clock accuracy allows a maximum deviation of 8.64 seconds per 24 hour period. It is, therefore, recommended that elapse-time between synchronizing signals not exceed 3 days (72 hours).

5.7 Parameter Changeover Feature

The Parameter Changeover (C/O) feature is an option that is provided along with the real-time clock option. If your relay model number is 7SJ511*-**A0**1**-0*, the feature is present.

This optional feature allows up to four uniquely different sets of functional parameters (addresses between 1000 and 3999) to be defined. The active set of parameters can be changed during relay operation using either the operator panel, through the front serial port, or by means of the binary inputs.

Table 5-4 lists the preset parameter changeover parameter settings and setting options. Compare these presettings to the information on the completed worksheets and determine which settings, if any, you need to change to match your operating environment. After all settings have been

verified or changed appropriately, follow the procedure described in section 5.2.4 to save the new settings.

If the parameter set changeover feature will be used, make additional copies of the worksheets (one for each of the four parameter sets) to record the unique settings for each set.

Table 5-4. Parameter Changeover Settings

Addr.	LCD Text (1st line)	Description	Preset	Options
7885	PARAM. C/O	Activating the Parameter C/O feature	NON-EXIST	EXIST
8501	ACTIV PARAM	Displays presently active parameter set in 2nd line		
8503	ACTIVATION	Selecting the active parameter set	SET A	1. SET B 2. SET C 3. SET D 4. SET BY BINARY INPUT

5.7.1 Programming Parameter Changeover

There are three primary programming steps associated with this feature:

- Activating the function
- Configuring the four parameter sets
- Selecting the active parameter set

Activating Parameter Changeover - Address 7885

In order to use this feature, the Scope of Functions parameter at address 7885 must be set to EXIST.

```
7885 PARAM. C/O
EXIST
```

Configuring a Parameter Set

Each of the four sets of parameters is identified by the letters A, B, C, and D. The parameter sets can be configured directly by specifying each parameter in each set. Or, the parameters from a set that has already been configured can be copied and then modified. When address 7885 is set to EXIST, access to a particular set is accomplished by the following key sequences:

- **F1** accesses Set A
- **F2** accesses Set B
- **F3** accesses Set C
- **F4** accesses Set D

Note: When the above key sequence is used to access a parameter set, the message "COPY TERMINATED" appears in the display. Ignore this message and press **Enter** to clear it.

When one of these key sequences is used while the relay is in display mode, the parameters for the selected set can be displayed. The parameter address number in the display will be preceded by the parameter set ID letter (A - D). For example, the parameter at address 1105 in Set B appears as:

```
B1105 In PRIMARY
1000  A
```

The same key sequence is used when the relay is in programming mode to access and change a particular parameter set. However, the relay always operates with the active set of parameters (as indicated at address 8503) regardless of which set is being displayed or configured.

Prior to activating the parameter changeover feature, the parameter values are display without a parameter set ID prefix. In reality, the relay is operating with parameter Set A and any changes made to the settings will be made to Set A. The factory preset for the active parameter set when parameter changeover is activated is Set A. Therefore, if programming changes are made prior to activating parameter changeover, there will be no undesirable changes in the operation of the relay when parameter changeover is initially activated.

All four of the available parameters sets are initialized at the factory the same set of default parameters identified as the "ORIG.SET." This set of parameters is permanently stored in the read-only memory of the relay. If, after making setting changes, it is necessary to restore the relay to the factory default settings, this can be done by copying the ORIG.SET to any or all of the four parameter sets.

A selectable set may also be initialized by copying another selectable set. Table 5-5 contains a list of the available copy options. To perform a copy, access the address corresponding to the desired copy function. For example:

```
8512 Copy ?
ORIG.SET->SET C
```

Press the **YES** key. The second line of the display will indicate "IN PROGRESS" followed by "SUCCESSFUL" after a successful copy operation. Press **Enter** to clear the message. The relay remains in programming mode. (To exit programming mode see the Note below.)

Note: To properly save the copied parameter set, use the navigation keys to leave the 8500 address block. When you do this you will get the "SAVE NEW SETTINGS" message.

Table 5-5. Parameter Set Copy Options

Addr. No.	Copy Action
8510	Copy ORIG.SET to Set A
8511	Copy ORIG.SET to Set B
8512	Copy ORIG.SET to Set C
8513	Copy ORIG.SET to Set D
8514	Copy Set A to Set B
8515	Copy Set A to Set C
8516	Copy Set A to Set D
8517	Copy Set B to Set A
8518	Copy Set B to Set C
8519	Copy Set B to Set D
8520	Copy Set C to Set A
8521	Copy Set C to Set B
8522	Copy Set C to Set D
8523	Copy Set D to Set A
8524	Copy Set D to Set B
8525	Copy Set D to Set C

Selecting the Active Parameter Set - Addresses 8501 and 8503

As shown in the illustration below, the presently active parameter set can be determined by displaying address 8501.

Specifying which parameter set is to be the active set is done at address 8503. The preset option is Set A.

You may cycle through each of the available options by pressing the **No** key as each option is displayed. When the option you want is displayed, press the **Enter** key.

One of the options available at address 8503 is to allow selection of the active parameter set by means of the binary inputs (SET BY BIN.INPUT). See "Parameter Changeover" in the "Setting Calculations" section for programming prerequisites associated with this option.

Selection of the active parameter set may also be done through the front port.

Important: After a new parameter set has been selected as the active set, the parameter set ID prefix displayed for addresses 1000 to 3999 will not change until the relay has been through a reset and restart cycle (see "On/Off Switch" in the "Product Description" chapter). Therefore, you cannot count on the prefix to indicate the correct active parameter set at all times. Only the value at address 8501 is always an accurate indication of the active set.

5.7.2 Deactivating Parameter Changeover

If you change the parameter at address 7885 to NON-EXIST, parameter changeover is deactivated. The parameters between addresses 1000 and 3999 will no longer display an address number with the parameter set ID (A - D) preceding it. However, the active parameters will remain those of the last active set. If, when deactivating parameter changeover, you wish to restore the relay to the ORIG.SET, you must first copy the ORIG.SET to one of the four sets, A, B, C, or D, activate that set (address 8503), and then deactivate parameter changeover.

5.8 System Settings

System settings provide information to the relay about the characteristics of the power system to which the relay is connected and intended to protect. If you change the system frequency setting at address 7899, the relay will automatically reset and restart after the "NEW SETTINGS SAVED" message is displayed.

Table 5-6 identifies the system presettings and the available options. Compare these presettings to the information on the completed worksheets and determine which settings you need to change to match your operating environment. After all settings have been verified or changed appropriately, follow the procedure described in section 5.2.4 to save the new settings.

Table 5-6. System Settings

Addr.	LCD Text (1st line)	Description	Preset	Options/Range
1105 *	In PRIMARY	Phase CT primary rated current	400 A	10 - 50000 A
1112 *	Ie/Iph	CT ratio matching factor	1.000	0.000 - 20.000
2903	SYM.Ithres	Current threshold for symmetry monitoring	0.50 I/In	0.10 - 1.00 I/In
2904	SYM.Fact.I	Current symmetry factor	0.50	0.10 - 0.95
2905	SUM.Ithres	Current threshold for summation monitoring	0.10 I/In	0.05 - 2.00 I/In
2906	SUM.Fact.I	Current summation factor	0.10	0.00 - 0.95
7899 *	FREQUENCY	System frequency	60 Hz	50 Hz

** **Note:** In order for measured value monitoring to function correctly, it is very important that the system parameters at addresses 1105 (CT primary current), 1112 (CT ratio matching factor), and 7899 (frequency) be set properly.*

5.9 Overcurrent Protection Settings

Overcurrent protection settings are made in address blocks 1200 and 1500, and addresses 7812 and 7815. The settings made in these blocks turn the protection on and off, establish current levels for fault detection, and set time delays before issuing a trip command. The settings in address block 1200 are for phase currents and those in block 1500 are for the neutral current. Phase current settings are common for all three phases.

The protection mode (definite or inverse time) is selectable with separate choices available for phases (address 7812) and neutral (address 7815).

In addition to the protection modes identified above, a *high-set* group of parameters that provide *definite time* protection independently of the choices at addresses 7812 or 7815 are available.

Table 5-7 identifies the overcurrent protection presettings and the available options. Compare these presettings to the information on the completed worksheets and determine which settings you need to change to match your operating environment. After all settings have been verified or changed appropriately, follow the procedure described in section 5.2.4 to save the new settings.

Table 5-7. Overcurrent Protection Settings

Addr.	LCD Text (1st line)	Description	Preset	Options/Range
7812	CHARAC. PH	Time protection mode for phases	DEFINITE TIME	INVERSE TIME
7815	CHARAC. E	Time protection mode for neutral	DEFINITE TIME	INVERSE TIME
1201	O/C PHASES	Overcurrent protection for phases	ON	OFF
1202	I>>	Pickup value for I>>	2.00 I/In	0.10 - 25.00 I/In
1203	T-I>>	Trip delay for I>>	0.10 s	0.00 - 60.00 s or ∞
1206	MEAS.REPET	Measurement repetition for I>>	NO	YES
1211	CHARACTER.	Inverse time characteristic for phases	NORMAL INVERSE	1. VERY INVERSE 2. EXTREMELY INVERS
1212	I>	Pickup value for I>	1.00 I/In	0.10 - 25.00 I/In
1213	T-I>	Trip delay for I>	0.50 s	0.00 - 60.00 s or ∞
1214	Ip	Pickup value for I_p	1.00 I/In	0.10 - 4.00 I/In
1215	T-Ip	Trip delay time dial (multiplier) for I_p	0.50 s	0.05 - 3.20 s or ∞
1216	RMS FORMAT	Measured phase current evaluation method for I_p	I1 FOURIER (fundamental only)	I TRUE (rms)

Addr.	LCD Text (1st line)	Description	Preset	Options/Range
1221	MAN. CLOSE	Phase overcurrent element with zero time delay effective during manual closing of the circuit breaker	I>> NO DELAY	1. I>/Ip NO DELAY 2. INEFFECTIVE
1501	O/C EARTH	Overcurrent protection for neutral	ON	OFF
1502	Ie>>	Pickup value for I_E>>	0.50 I/In	0.10 - 25.00 I/In
1503	T-Ie>>	Trip delay for I_E>>	0.50 s	0.00 - 60.00 s or ∞
1506	MEAS.REPET	Measurement repetition for I_E>>	NO	YES
1511	CHARACTER.	Inverse time characteristic for neutral	NORMAL INVERSE	1. VERY INVERSE 2. EXTREMELY INVERS
1512	Ie>	Pickup value for I_E>	0.20 I/In	0.10 - 25.00 I/In
1513	T-Ie>	Trip delay for I_E>	0.50 s	0.00 - 60.00 s or∞
1514	Iep	Pickup value for I_{ep}	0.10 I/In	0.10 - 4.00 I/In
1515	T-Iep	Trip delay time dial (multiplier) for I_{Ep}	0.50 s	0.05 - 3.20 s or ∞
1516	RMS FORMAT	Measured neutral current evaluation method for I_{Ep}	I1 FOURIER	I TRUE
1521	MAN. CLOSE	Neutral overcurrent element with zero time delay effective during manual closing of the circuit breaker	IE>> NO DELAY	1. IE> NO DELAY 2. INEFFECTIVE

5.10 Breaker Failure Protection Settings

In order to ensure that the circuit breaker functions correctly, the relay checks to see that the current flow stops when the circuit breaker trip command is issued. When the trip command is issued, the T_{BF} timer starts and runs as long as the trip command is active and the current continues to flow. If current flow continues until the timer expires, the circuit breaker failure protection function can issue additional trip commands to upstream breakers.

Table 5-8 identifies the breaker failure protection presettings and the available options. Compare these presettings to the information on the completed worksheets and determine which settings you need to change to match your operating environment. After all settings have been verified or changed appropriately, follow the procedure described in section 5.2.4 to save the new settings.

Table 5-8. Breaker Failure Protection Settings

Addr.	LCD Text (1st line)	Description	Preset	Options/Range
3901	B/F PROT.	Breaker failure on/off control	OFF	1. ON, internal 2. ON, external 3. ON, int. or ext.
3902	I> B/F	Breaker failure current threshold	0.20 I/In	0.10 - 4.00 I/In
3903	T-B/F	Breaker failure time delay	0.25 s	0.06 - 60.00 s or ∞

5.11 Configuration Settings

The configuration settings tell the relay what action to take and how. Configuration is the process of assigning one or more logical functions to each of the physical input/output (I/O) units. The relay has a large number of predefined logical functions. Each logical function has a unique 3 digit function number (FNo) assigned to it. A complete list of logical functions that can be configured is provided in the "Input/Output Functions" section.

5.11.1 Assigning Logical Functions to the I/O Units

The relay must be placed in programming mode using the password in order to assign logical functions. Each of the configurable I/O units has a unique address number as shown in the example below.

```
6101▮ INPUT 1
```

After accessing the address of the I/O unit of interest, the present function assignment can be displayed by pressing the key sequence **F**△. This takes the operator into the function selection level for the I/O unit. The address number in the display is replaced with a 3 digit *index number* (see example display below).

The index number is associated with the number of logical functions assigned to the I/O unit. For example, if the I/O unit has three functions assigned, the display will show the first function with index number 001, the second function with index number 002 and the third function with index number 003.

Initially upon entering the selection level, the index number 001 is displayed. The second line of the display contains an abbreviated description of the assigned function. If an index number is accessed for which no function has been assigned, the second line displays "not allocated." All of the functions assigned to that I/O unit can be displayed by paging up and down in the index number sequence using the △ and ▽ keys.

For example, with factory preset parameters and address 6101 displayed, pressing **F△** results in the display shown below:

```
001■INPUT 1
>LED reset NO
```

Pressing the △ key again results in this display:

```
002■INPUT 1
not allocated
```

There are two ways to change or add an assignment:

1. After accessing the desired input and index, display the different functions available for the I/O unit by pressing the **No** key (to page forward) or the **Back Space** key (to page backward). When the desired function is displayed, press the **Enter** key to assign that function.

   Note: If you attempt to assign a function to an I/O unit that has already been assigned to that unit, the message "ALREADY ALLOCATD" will be displayed. Press the **Enter** key to clear the message and continue with function assignments.

2. Alternatively, a function can be assigned directly by entering the function number (FNo) on the numeric key pad. For example, to change the function for input 1, index 001 to function 081, access "001 Input 1" then key in 81. The display appears as follows:

```
001■INPUT 1
81
```

   Note: When entering a function number directly, it is not necessary to enter leading zeros.

   Press the **Enter** key to assign the function. The display appears as follows:

```
001■INPUT 1
>Block I>>
```

   Note: If you enter a function number that cannot be assigned to the I/O unit, the message "NON-EXISTING" will be displayed instead of the function.

To exit the selection level, press the **F△** key sequence or use the **Direct Addr** key to go to another address.

5.11.2 Presettings

Table 5-9 identifies the configuration presettings for each of the I/O units. Compare these settings to the data on the completed worksheets to see which settings, if any, you need to change. The available settings for each type of I/O unit are described in "Setting Calculations."

Table 5-9. Configuration Presettings

Address No.	I/O Unit	Index No.	FNo	LCD Text (2nd Line)
6101	Binary Input 1	001	006	> LED reset NO
6102	Binary Input 2	001	081	>Block I>> NO
6201	Signal Relay 1	001	400	Gen. Fault
6202	Signal Relay 2	001 002	151 154	Failure ∑I Failure Isymm
6203	Signal Relay 3	001 002 003	312 313 314	Fault L1 I>> Fault L2 I>> Fault L3 I>>
6204	Signal Relay 4	001	451	Gen. Trip
6301	LED 1	001 002	151 154	Failure ∑I nm Failure Isymm nm
6302	LED 2	001	401	Fault L1 m
6303	LED 3	001	402	Fault L2 m
6304	LED 4	001	403	Fault L3 m
6305	LED 5	001	311	Flt I>> Ie>> m
6306	LED 6	001	451	Gen. Trip m
6401	Trip Relay 1	001	451	Gen. Trip
6402	Trip Relay 2	001	321	Trip I>> Ie>>

5.11.3 Binary Inputs

The relay configuration settings for the binary inputs are in address block 6100. The 7SJ511 relay has two binary inputs.

Normally Open/Normally Closed Mode

For each input function, you can specify whether the function will operate in the NO (*Normally Open)* or NC *(Normally Closed)* mode. All preset input assignments are set to operate in NO mode.

- NO - means a voltage *applied to* the input terminals *turns on* the function.
- NC - means a normally present voltage *removed from* the input terminals *turns on* the function.

When paging through the available functions in the selection level using the **No** or **Back Space** keys, the abbreviated description shown in the LCD will be accompanied by an **NO** or **NC**

indication that changes from one to the other when the **No** or **Back Space** key is pressed. In this way, the desired mode can be selected when the paging method is used. When entering the function number directly, the function number can be extended by a decimal point followed by a 0 or 1 where

.0 indicates normally open (**NO**) mode

.1 indicates normally closed (**NC**) mode

If the extension is omitted, the function display defaults to **NO**. This can be changed to **NC** by pressing the **No** key.

5.11.4 Output Signal Relays

The output signal relays have relay functions assigned in address block 6200. The 7SJ511 relay has four programmable signal relays.

5.11.5 LED Indicators

The LED indicators have relay functions assigned in address block 6300. The 7SJ511 relay has, six programmable LEDs. The functions that have preassigned at the factory are provided on a preprinted label that is shipped with the relay. This label, or another showing the new function assignments, is intended for insertion into the LED label window on the operator panel.

Latched/Unlatched Mode

For each LED function, you can specify whether the function will operate in the *latched* or *unlatched* mode.

When paging through the available functions in the selection level using the **No** or **Back Space** keys, the abbreviated description shown in the LCD will be accompanied by an **m** (for **m**emorized; i.e., latched) or **nm** (for **n**ot **m**emorized; i.e., not latched) indication that changes from one to the other when the **No** or **Back Space** key is pressed. In this way, the desired mode can be selected when the paging method is used. When entering the function number directly, the function number can be extended by a decimal point (.) followed by a 0 or 1 where:

.0 indicates unlatched (**nm**) mode

.1 indicates latched (**m**) mode

If the extension is omitted, the function display defaults to **nm**. This can be changed to **m** by pressing the **No** key.

5.11.6 Trip Relays

The trip relays have relay functions assigned in address blocks 6400. The 7SJ511 relay has two programmable trip relays.

Displaying Information

6. Displaying System and Relay Information

This chapter describes the available system and relay information and tells you how to use the operator panel to display information. When prompted, the operator panel LCD can display the following information:

- Event log for the relay during normal and fault conditions
- Target log for the last three faults
- Circuit breaker operation statistics
- Measured values of the protected system

The system and relay information is also accessible using analysis software if the relay is connected to a PC through the front port. See section 6.6 for additional details.

Table 6-1 lists the address blocks and descriptions that are used to display the system and relay information. It is not necessary to enter a password to display relay data.

Table 6-1. Address Blocks Used to Display the System and Relay Information

Addr. Block	Description
5100	Event log
5200	Target history for the last (most recent) fault
5300	Target history for the second to last fault
5400	Target history for the third to last fault
5600	Circuit breaker operation statistics
5700	Measured phase and neutral currents of the protected system

The tables in this chapter identify, by address block, all of the messages and values available for display on the LCD. Whether or not some information can be displayed is dependent on the model and configuration of the individual relay.

6.1 Using the Operator Panel to Display Information

Using the operator panel, there are two ways to select an address to display information. You can use the **Direct Addr** (direct address) key or the navigation keys. The following procedure uses the direct address method to access information. Refer to "Programming the Relay" for instructions on using the navigation keys to access and display information. Note that in the LCD text, event messages are often referred to as *annunciations*.

To display the information you want to review, follow this procedure:

1. Press the **Direct Addr** key and enter the address block for the information you want to display.

2. Press **Enter**. The requested address number and description appears in the LCD as shown in the example display below:

```
5100 OPERATIONAL
ANNUNCIATIONS
```

Note: Display of messages beginning at address 5000 may be done by pressing the **Event** key.

3. Press the △ key to display the first entry in the list you are viewing. The example below shows how the annunciation for turning off the circuit breaker failure protection could appear. The first line contains the date and time with the message text in the second line.

```
03/19/92  17:02
B/F OFF :C
```

Note: If the relay is not equipped with the optional real time clock, the date will be replaced with "**.**.**". The time will be given as the elapsed time from the last restart of the microprocessor.

4. Press the ▽ or △ key to move up or down in the list you are viewing.

5. When you are finished reading the information, press the ⏫ or ⏬ key to go to another address block. Information is not updated when the address block is active.

6.2 Event Log

The event log consists of operational and status messages chronologically listed under address 5100, starting with the most recent message. Information on available messages is listed in Table 6-2. Operational messages include pickup and/or drop-out of enabled protections and alarms, pick up and/or drop out of binary inputs, signal outputs, trips, relay diagnostics, and other relay operational information.

Up to 50 event log messages can be stored. After all 50 memory locations are filled, additional messages replace the oldest messages in sequence. When paging through the stored messages, if more than 50 messages have been stored, "Table overflow" is displayed in the last message slot. Otherwise, "End of table" will appear as the last valid message.

The event log message display format always gives the date and time of the event in the first line (see **Note** above concerning models without the real-time clock option). The time is displayed to the nearest minute, but the events are sorted (placed in the correct order of occurrence) with 1 millisecond resolution. The second line gives a description of the event. Each event described in

an event log message may be followed by a C (Coming) or a G (Going) tag (see the previous section for examples of the display content). The C tag indicates the message was logged at pickup. The G tag indicates the message was logged at drop-out. In the following table "C/G" indicates that the message could be logged with either a C or a G tag on separate log entries, but not both C and G on the same log entry. Table 6-2 lists each possible event log message for the relay with a brief description.

The operational messages fall into four different categories:

1. Binary Inputs - events associated with changes on the binary inputs
2. General - operational events not associated with another specific category
3. Monitoring function - events associated with the internal relay monitoring functions (see the "Product Description" chapter)
4. Protection functions

Only messages consistent with your relay configuration and options will appear in the display. See the "Maintenance" chapter for information on how to erase the event log.

Table 6-2. Possible Event Log Messages, Address Block 5100

LCD Text (2nd Line)	**Description**	**Tags**
Binary Inputs		
>Annunc. 1	User defined display message 1	C/G
>Annunc. 2	User defined display message 2	C/G
>Block I>>	Block I>>	C
>Block Ie>>	Block I_E>>	C
>Block I>	Block I>	C
>Block Ie>	Block I_E>	C
>Block Ip	Block I_p	C
>Block Iep	Block I_{Ep}	C
General		
Re-start	Microprocessor has been reset and restarted	C
System Fault	Fault in power system	C
LED reset	Stored LED indications have been reset	C
Flt.Rec. off	Waveform capture is turned off	C/G
Param. Running	Parameters are being set	C/G
Manual Close	Manual close indication received via binary input	C
CB in Test	Circuit breaker test is in progress	C/G
Param. Set A	Parameter set A is active	C/G
Param. Set B	Parameter set B is active	C/G
Param. Set C	Parameter set C is active	C/G
Param. Set D	Parameter set D is active	C/G
Monitoring Function		
Failure 12V	Failure in 12 volt internal power supply	C/G
Failure 15V	Failure in 15 volt internal power supply	C/G

LCD Text (2nd Line)	**Description**	**Tags**
Failure 5V	Failure in 5 volt internal power supply	C/G
Failure 0V	Failure in 0 volt internal offset for A/D converters	C/G
Failure RKA	Failure in trip relay circuits on base I/O board RKA	C/G
Failure ∑I	Failure detected by measured current sum monitor	C/G
Failure Isymm	Failure detected by measured current symmetry monitor	C/G
Annunc. Lost	A message table has overflowed	C
Flt.Buff.Over	Fault message table has overflowed	C
Oper.Ann.Inva	Operational messages are invalid	C
Flt.Ann.Inva	Fault messages are invalid	C
Stat.Buff.Inv	Circuit breaker operation statistics are invalid	C/G
LED Buff.Inva	Stored LED indications are invalid	C/G
Chs.Error	Check sum error in memory	C/G
Chs.S1 Error	Check sum error in parameter set A	C/G
Chs.S2 Error	Check sum error in parameter set B	C/G
Chs.S3 Error	Check sum error in parameter set C	C/G
Chs.S4 Error	Check sum error in parameter set D	C/G
Overcurrent Protection		
O/C I>> off	I>> is turned off	C/G
O/C Ie>> off	I_E>> is turned off	C/G
O/C I> off	I> is turned off	C/G
O/C Ie> off	I_E> is turned off	C/G
O/C Ip off	I_p is turned off	C/G
O/C Iep off	I_{Ep} is turned off	C/G
Breaker Failure Protection		
B/F off	Circuit breaker failure protection is turned off	C/G
Table Status		
End of table	Follows last stored message if the table is not full	
Table overflow	Last valid message if more than 50 messages stored	
Table empty	No event recorded	

6.3 Target Log

Addresses 5200, 5300, and 5400 contain the target log for the last three faults. This record is called a target log because all of these faults can potentially result in a trip command being issued to a *target* circuit breaker. Fault information is recorded sequentially from the most recent fault (5200) to the "oldest" fault (5400)--the oldest fault data is erased when the next fault occurs.

```
5300■2nd TO LAST
FAULT
```

```
5400■3rd TO LAST
FAULT
```

Beginning at addresses 5200, 5300 or 5400, a sequence of messages provides a chronological review of all the events that occur from the initial detection of the fault until the fault is cleared and the relay returns to a normal no-fault condition (drop out).

By definition, the term *system fault* includes the time period from fault detection up to final clearance. Within a system fault, any number of fault events can occur. Each system fault is counted and assigned a consecutive *fault number*. The count indicates the number of system faults that have occurred since the relay memory was last cleared. Up to 80 messages can be stored for each of the three recorded faults. If more than 80 annunciations occur, the messages for those beyond 80 are not stored and the annunciations are lost.

Each message is identified by a *sequence number* in the first three character positions of the LCD. The first message, 001, displays the *date* of the fault in the first line of the LCD. The second line displays the message "System Fault" followed by the consecutive fault number.

```
001■03/19/93
System Fault 89
```

The second message, 002, displays the *time* of the beginning of the fault event with *millisecond* precision. The second line contains the message "Fault."

```
002■17:38:31,227
Fault          :C
```

Note: If the relay is not equipped with the optional real time clock, the date will be replaced with "**.**.**". The time will be given as the elapsed time from pickup of any protection function.

Subsequent display messages will indicate all relay events that occur after initial detection of the fault until drop-out (drop-off). Each message includes the elapsed time from initial detection (message 002) in milliseconds. In the following display examples, the fault is identified as an overcurrent fault in both phase 1 and neutral resulting in a general trip command being issued 302 milliseconds after the fault was detected. At 398 milliseconds after the fault was detected, the

breaker opened and successfully cleared the fault. The interrupted fault current was 12.7 times the rated primary current.

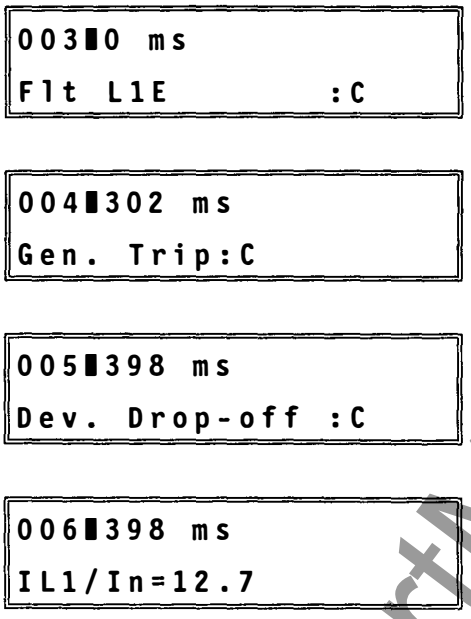

Table 6-3 lists all the available fault messages. These messages fall into three different categories:

1. General - associated with any and all system fault conditions including those not caused by overcurrent detection
2. Overcurrent
3. Circuit breaker failure

Each event described in an target log message may be followed by a "C" (message logged at pickup) or "G" (message logged at drop-out) tag. In the following table "C/G" indicates that the message could be logged with either a C or a G tag on separate log entries, but not both C and G on the same log entry. Only messages consistent with your relay configuration and options will appear in the display. See the "Maintenance" chapter for information on how to erase the target log.

In the following table, "n" represents a numeric digit.

Table 6-3. Possible Target Log Messages, Address Blocks 5200, 5300, and 5400

LCD Text (2nd Line)	**Description**	**Tag**
General		
System Fault nn	System fault with consecutive number nn	C
Fault	A fault has occurred	C
IL1/In=nnn.nn	Interrupted fault current ratio on phase 1	C
IL2/In=nnn.nn	Interrupted fault current ratio on phase 2	C
IL3/In=nnn.nn	Interrupted fault current ratio on phase 3	C

LCD Text (2nd Line)	**Description**	**Tag**
Dev. Drop-off	Return to no-fault conditions	C
Overcurrent		
Fault L1	Fault on phase 1	C
Flt L2	Fault on phase 2	C
Flt L3	Fault on phase 3	C
Flt E	Fault on neutral	C
Flt L12	Fault on phase 1 and phase 2	C
Flt L13	Fault on phase 1 and phase 3	C
Flt L1E	Fault on phase 1 and neutral	C
Flt L23	Fault on phase 2 and phase 3	C
Flt L2E	Fault on phase 2 and neutral	C
Flt L3E	Fault on phase 3 and neutral	C
Flt L123	Fault on phase 1, phase 2 and phase 3	C
Flt L12E	Fault on phase 1, phase 2, and neutral	C
Flt L13E	Fault on phase 1, phase 3, and neutral	C
Flt L23E	Fault on phase 2, phase 3, and neutral	C
Flt L123E	Fault on phases 1, 2, 3, and neutral	C
Flt I>> Ie>>	Fault detected by high-set overcurrent element	C
T-I>> expired	I>> trip delay has expired	C
T-Ie>> expired	I_E>> trip delay has expired	C
T-I> expired	I> trip delay has expired	C
T-Ie> expired	I_E> trip delay has expired	C
T-Ip expired	I_P trip delay has expired	C
T-Iep expired	I_{EP} trip delay has expired	C
Gen. Trip	Trip command issued by overcurrent protection	C
Breaker Failure		
Fault B/F	Breaker failure protection fault	C/G
Trip B/F	Trip command issued by breaker failure protection	C
Table Status		
End of table	Follows last stored message if the table is not full	
Table empty	No event recorded (displayed in all unused locations)	
Table overflow	Additional messages could not be stored; memory is full	
Table superseded	A new fault occurred during read-out of data *	

** Following display of this message, pressing either the △ or ▽ keys will cause the first message for the new fault to be displayed.*

6.4 Circuit Breaker Operation Statistics

Circuit breaker operation statistics are available in address block 5600.

```
5600 OPERAT.
STATISTICS
```

The display format has the statistic identified in the first line of the LCD with the value in the second line as shown below:

```
5604 TRIP No =
23
```

Interrupted current values are expressed as a ratio to the rated relay current I_N.

Table 6-4 shows the location of all the circuit breaker operation statistics. Each of the statistics can be accessed by scrolling from block 5600, or by direct addressing to the indicated address number. See the "Maintenance" chapter for information on how to reset the circuit breaker statistics.

In the following table, "n" represents a numeric digit.

Table 6-4. Circuit Breaker Operation Statistics

Addr.	LCD text	Description	Range
5604	Trip No= nnnnn	Number of trip commands issued	0 - 65535
5607	ΣIL1/In= nnn.nn	Accumulated interrupted currents for phase 1	0 - 655.35
5608	ΣIL2/In= nnn.nn	Accumulated interrupted currents for phase 2	0 - 655.35
5609	ΣIL3/In= nnn.nn	Accumulated interrupted currents for phase 3	0 - 655.35
5610	LAST IL1/In IL1/In = nnn.nn	Last interrupted current on phase 1	0 - 655.35
5611	LAST IL2/In IL1/In = nnn.nn	Last interrupted current on phase 2	0 - 655.35
5612	LAST IL3/In IL1/In = nnn.nn	Last interrupted current on phase 3	0 - 655.35

6.5 Reading the Measured Values

This section describes the measured values you can display in address block 5700 using the operator panel. The ability to check the relay's measured values is helpful during commissioning, normal operation, and troubleshooting. Measured values are calculated based on the system settings programmed in the relay. They are available as primary values and as a percentage of the relay's rated value. The displayed values are updated once every 5 seconds. In addition, these measured values may be selected to be displayed on the LCD during normal (no-fault) operating conditions (see "Programming the Relay").

There are eight measured values that can be displayed in address block 5700.

```
5700 OPERATIONAL
MEASURED VALUES
```

The measured value appears in the second line of the LCD as shown in the example below.

```
5701 MEAS.VALUE
IL1   = 1060 A
```

Table 6-5 describes the measured values you can view in address block 5700. Values outside the operational range of the relay are indicated by ****.

In the following table, "n" represents a numeric digit.

Table 6-5. Operational Measured Values, Address Block 5700

Addr.	**LCD text** (2nd line)	**Description**
5701	IL1 = nnnnn A	I_{L1} - the system primary current in phase 1 in amperes
5702	IL2 = nnnnn A	I_{L2} - the system primary current in phase 2 in amperes
5703	IL3 = nnnnn A	I_{L3} - the system primary current in phase 3 in amperes
5704	IE = nnnnn A	I_E - the system primary current in the neutral circuit in amperes
5710	IL1 =nnn.n %	I_{L1} as a percentage of the rated primary current specified at address 1105 ($I_{N\ PRIMARY}$)
5711	IL2 = nnn.n %	I_{L2} as a percentage of the rated primary current specified at address 1105 ($I_{N\ PRIMARY}$)
5712	IL3 = nnn.n %	I_{L3} as a percentage of the rated primary current specified at address 1105 ($I_{N\ PRIMARY}$)
5713	IE = nnn.n %	I_E as a percentage of the rated primary current specified at address 1105 ($I_{N\ PRIMARY}$)

6.6 Normal/Fault Data Display

As indicated in "Programming the Relay," two lines of operational data may be displayed during normal and fault conditions. The choice of data to be displayed is made at addresses 7005 and 7006 for normal conditions , and 7007 and 7008 for fault conditions.

The relay will automatically display the fault data following drop-out if address 0000 or any address in block 5000 is being displayed at the time. Otherwise, to force display of this data, display address 0000 or any address in block 5000 and depress the **Target Reset** key.

6.7 Waveform Capture

In addition to the event and target logs described in the preceding sections, actual waveforms of the last fault are recorded. The sampling rate is 20 samples per power cycle. The starting point, ending point, and maximum recording time after pickup is a function of the port being used to access the data. Table 6-6 provides the details.

Table 6-6. Waveform Capture Specifications

Access Port	**Start** (prior to pickup)	**End** (after trip)	**Max. Rec. Time After Pickup**	**Total Maximum Recording Time**
Front	5 cycles	5 cycles	145 cycles	150 cycles
Rear	3 cycles	3 cycles	30 cycles	33 cycles

When the data is accessed and processed by appropriate software it can be displayed in graphical format. An example of the waveform data and the way it may be displayed using DIGSI® software is shown in Figure 6-1. The display shows the actual current waveforms on each phase and ground with markers for pickup (FD), trip (Trip), and drop-out (Reset). The points at which the fault occurred and the circuit breaker opened are also visible. The horizontal time line is in milliseconds.

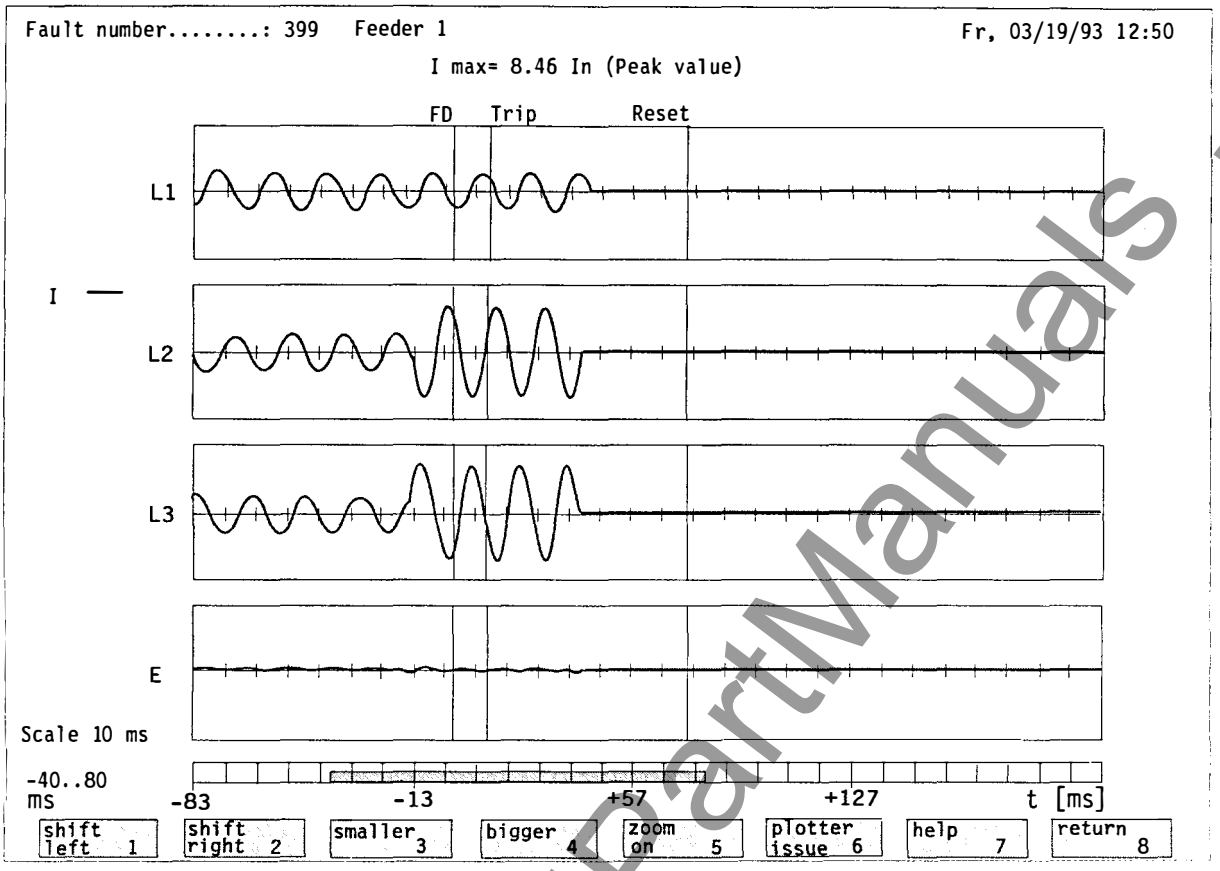

Figure 6-1. Waveform Capture Display Example

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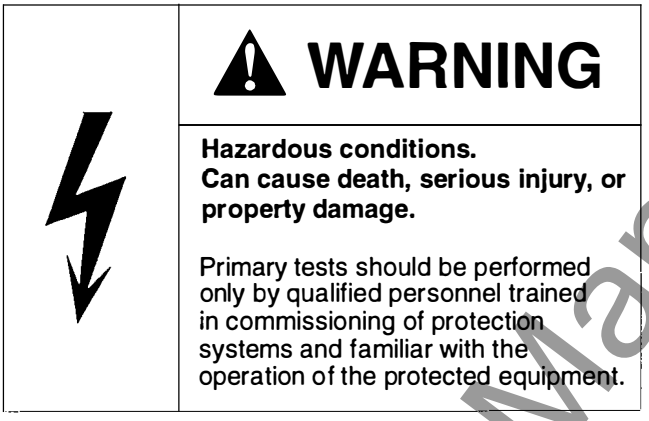
7. Commissioning the Relay

This chapter describes the commissioning procedures you should perform after the relay is installed, programmed for your system, and is operating. These tests and procedures assume that the relay is operating in its intended environment and has been correctly set and configured.



The following precautions must strictly observed at all times:

- The relay must be solidly grounded before any other connections are made. This includes both power and measurement connections.
- Hazardous voltages can be present on any circuits or components attached to the relay.
- Hazardous voltages can be present inside the relay even with power removed due to storage capacitors.
- Current transformer secondary connections must be short circuited before any current leads to the relay are interrupted.

7.1 Relay Commissioning Tests

Commissioning tests are intended to verify correct operation of the relay connected to and operating in a normal manner with the system it is intended to protect. Some cautions and recommended procedures associated with these tests are as follows:

- The limit values given in the Specifications must not be exceeded.
- The actual system settings for the relay should be used for the test procedures. If these settings are not yet available, test the relay with the factory settings. In the following tests the factory settings are assumed unless otherwise noted.

Check for the following DURING testing.

- Be sure that the correct command (trip) contacts close.
- Read the LCD and verify the proper information appears when testing output relays and remote signaling.
- If the relay is connected to a subsystem control system, ensure correct communication through the rear serial port.

Always press the **Target Reset** key to reset the relay after tests which cause LED indications.

7.1.1 Current Circuit Checks

For the purpose of these tests, the relay should be connected to a normal, correctly operating, three-phase power system with a load at least 10% of the rated value (address 1105). Under these conditions there should be no fault indications from either the internal monitors or the overcurrent protection elements. In addition, the measured values displayed in the LCD at address block 5700 should indicate phase and neutral currents that closely match the expected values. If these values are not as expected or some type of fault is indicated, the following checks should be made.

Incorrect Measured Values

A substantial deviation from expected current values, or a significant ground current indication can result from incorrectly wired current transformers. Check these connections and make corrections if necessary.

Current Symmetry Error

If a current symmetry error, **Failure Isymm**, is indicated in the event log (address block 5100) the current transformers and their connections should be checked for interruptions or short circuits. If there are no problems in these areas, then it is likely that the currents are, in fact, asymmetrical. If this is a normal operating condition for the system, the current symmetry parameters (addresses 2903 and 2904) should be adjusted appropriately. "Setting Calculations" provides information on how to correctly set these parameters.

Current Summation Error

If a current summation error, **Failure ΣI**, is indicated in the event log (address block 5100), the CT ratio matching factor (I_E/I_{ph}) at address 1112 should be checked. "Setting Calculations" provides information on how to correctly set this parameter. The residual current must be fed to the ground current input of the relay for the current summation check to function properly.

If the CT ratio matching factor and the ground current connections are correct, it may be necessary to adjust the current summation parameters (addresses 2905 and 2906). "Setting Calculations" provides information on how to correctly set these parameters.

Pickup by Overcurrent Protection

If one or more of the overcurrent protection elements are in pickup while there are no other error indications, and the system currents are nominal, then it is likely that one or more of the pickup

threshold values is set too low. An indication of what type of pickup has occurred is available in the target log beginning at address 5200. Check the setting of the appropriate pickup value(s) and correct as necessary (refer to "Setting Calculations").

7.1.2 Reverse Interlock Test

If the relay is connected in a reverse interlock configuration, it should be tested for correct operation of the high-set overcurrent element (I>>) blocking function. Refer to the "Reverse Interlocking" section in the "Method of Operation" chapter for an illustration of the typical reverse interlock wiring configuration.

In order for the relay to function as the supply feeder protection in the reverse interlock connection, one of the binary inputs must be assigned the logical function **>Block I>>** (FNo 081). This function assignment is preset at the factory in normally open (NO) mode to Binary input 2 (address 6102, index 001).

To perform the test, the load feeder relay(s) should be programmed for pick up by the I> or I_p element on the available test current. The supply feeder relay under test should be programmed for pick up by the I>> element for the same test current. Initially the pickup signal from the load feeder relay should be disconnected from the supply feeder binary input. Now, raise the test current until both relays pick up and trip. The factory preset for LED 6 is **Gen. Trip** (FNo 451) which can provide a convenient indication of the trip if the setting has not been altered. After verifying that both relays trip with no reverse interlock, reconnect the blocking signal to the binary input of the supply feeder relay. Repeat the test and verify that only the load feeder relay trips.

7.1.3 Circuit Breaker Trip Test

A test to verify the operation of the circuit breaker tripping function and the operation of the circuit breaker is available through the operator panel. The test may be initiated at address 4404. The relay must be in programming mode. Prerequisites to starting the test are:

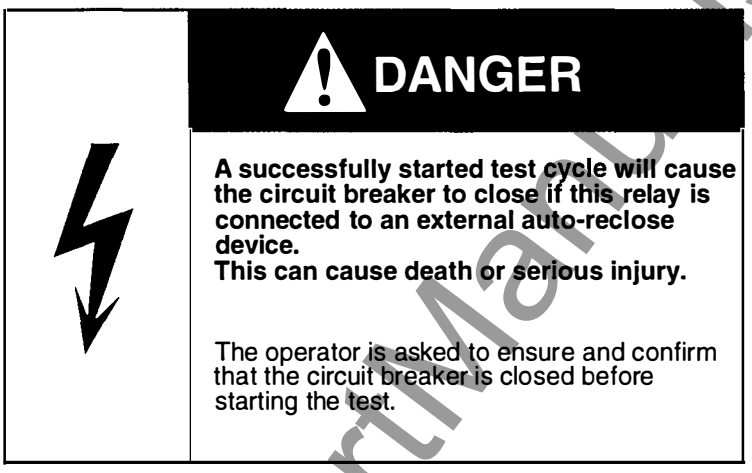
1. No protection function is picked up
2. The circuit breaker is closed
3. FNo 880, **CB Test Trip**, is assigned to the output relay that trips the circuit breaker under test.

To perform the test, put the relay in programming mode by entering the password then access address 4404.

```
4404 TRIP
CB THREE-POLE ?
```

Depress the **Yes** key. The LCD will then show:

```
4404■TRIP
CB CLOSED ?
```



If the circuit breaker is closed, depress the **Yes** key. Otherwise, abort the test by depressing the △ key. If you press the **Yes** key, verify that the circuit breaker opens. The test is now complete.

As a safety precaution, delete the assignment of FNo 880 to the output relay controlling the circuit breaker before returning the relay to service.

This test may also be initiated through the front serial port.

7.2 Returning the Relay to Operating Status

After completing all commissioning tests, return the relay to normal operating status by performing the following steps:

- Verify that the green **Power** LED is on.
- Verify that the red **Blocked** LED is *not* on.
- Verify that the relay protection and configuration settings are correct.
- Press the **Target Reset** key to clear any indications.
- If a test switch was used, return the switch to the normal position.

8. Maintenance

This chapter describes maintenance and problem isolation procedures that may be required after the relay is installed and operating. These procedures assume that the relay is operating in its intended environment and has been correctly set and configured.

8.1 Tracing Hardware and Software Faults

Siemens digital protection relays are designed to require no special maintenance. All measurement and signal processing circuits are fully solid state and therefore completely maintenance free. Only the optional clock module (see section 8.2) requires periodic attention.

As the protection is almost completely self-monitored, hardware and software faults are automatically announced. With detected hardware faults the relay blocks itself. Recognized software faults cause the processor to reset and restart. If the software fault is still present after three restart attempts, the relay will take itself out of service and indicate this condition by the red **Blocked** LED on the operator panel.

The event log is under address block 5100, and the target log for the last three faults is under address blocks 5200, 5300, and 5400.

If the relay appears to have a defect and none of the LEDs on the operator panel of the module are on, then perform the following checks:

- Have the modules been properly pushed-in and locked?
- Is the **On/Off** switch on the operator panel in the **On** position?
- Does the input power have correct polarity and voltage?
- Is the input power connected to the proper relay terminals?
- Is the fuse in the power supply section open?

If the red **Blocked** LED is lit and the green **Power** LED remains dark, the device has recognized an internal fault. Reinitialization of the protection system can be attempted by turning the DC auxiliary voltage off and on again (operator panel **On/Off** switch). However, if a configuration process has not yet been completed, all parameters that have not been saved will be lost.

8.2 Replacing the Clock Module

If the relay has the optional real-time clock (model 7SJ511*-**A01-0*), it contains an integrated circuit module that provides the clock, the fault recording memory, and the backup battery to power the clock and fault memory during power outages. The internal lithium battery has a long life, but it should be replaced at least once every 5 years to avoid unexpected loss of fault data.

The module is located in a multipin socket on the CPU circuit board (see Figure 8-1). The location of the CPU board is shown in Figure 4-3. The relay module must be removed from its housing in order to replace the module. Fault data is stored in a memory in the clock module. If the currently stored fault data is to be retrieved, it must be done before beginning this clock

module replacement procedure (configuration data is stored in a different memory and is not affected by this process). The data may be retrieved through either of the serial ports or by readout through the LCD on the operator panel.

Following all recommended procedures, replace the clock module in the following manner:

- Remove the relay module from the housing as described in section 4.3
- Remove the CPU board from the relay module to gain access to the clock module.
- Replace the clock module with the same or equivalent type.
  Recommended replacements are:
  DALLAS
  DS 1386 - 32K
  RAMified TIMEKEEPER

  Caution: Do not place clock modules on conductive surfaces.

- Reinstall the CPU board in the relay module.
- Reinstall the relay module in the housing as described in section 4.3
- Set the clock to the correct date and time either by means of the procedures described in "Programming the Relay" or through one of the serial ports.
- Return the relay to service.

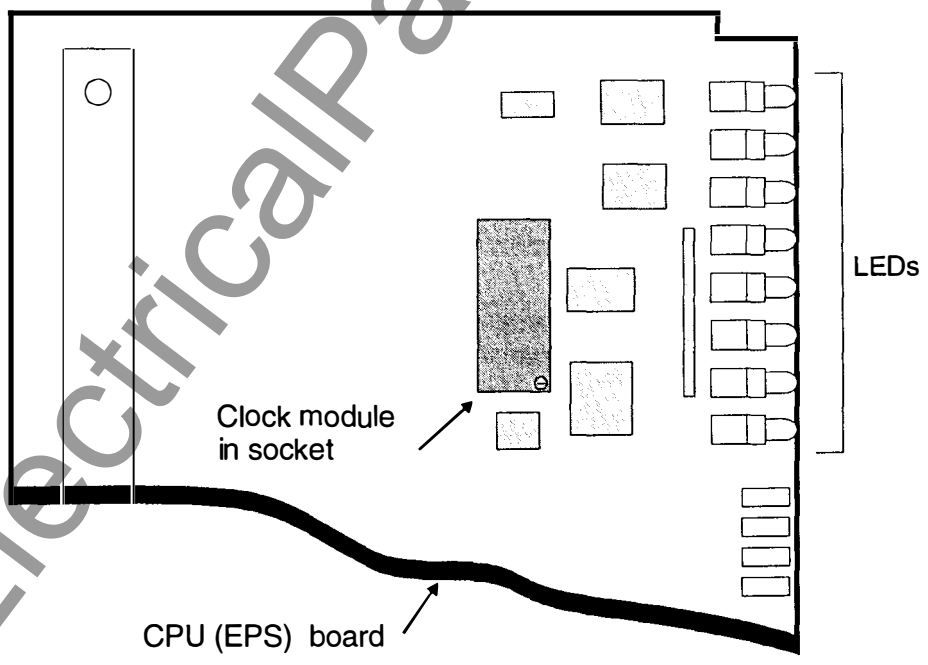
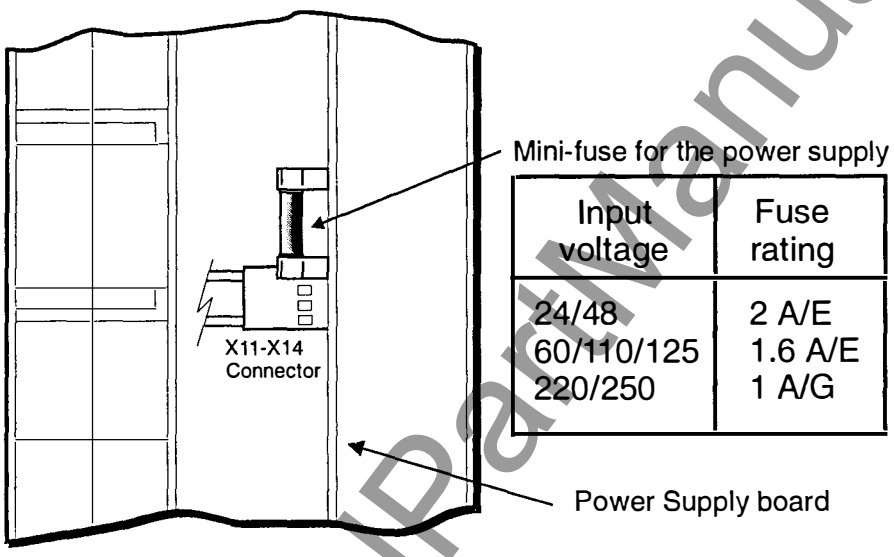


Figure 8-1. Location of the Clock Module

8.3 Inspecting the Power Supply Fuse

The relay's internal power supply is protected by a fuse. In the event of a blown fuse, you must remove the relay module from its housing to inspect the fuse. The fuse holder is located at the rear of the relay module on the power supply (SV) board as shown in Figure 8-2. Refer to the "Installation" chapter for proper module removal and reinstallation procedures.

If the fuse is blown, there is very likely a problem in the internal power supply and the relay should be returned to the factory for repair.



Input voltage	Fuse rating
24/48	2 A/E
60/110/125	1.6 A/E
220/250	1 A/G

Figure 8-2. Location of the Power Supply Fuse

8.4 Erasing Stored Data

The data stored in the non-volatile memory can be erased using the control functions at address block 8200. With the exception of address 8201 (LED memory), the relay must be placed in programming mode using the password to perform a reset. The RESET block at 8200 allows the stored data to be cleared in five separate groups using addresses 8201 through 8205. In each case, a question asking whether or not to reset a particular data group is displayed. If clearing of that group is desired, the operator responds to the question with the **Yes** key. During the clearing operation, the message "RESET IN PROGRESS" is displayed. When the clearing operation is complete, the address of the group (8201 - 8205) that was reset is displayed along with the message "RESET SUCCESSFUL."

For example, to reset the LED memory:

1. Direct access address 8201.

2. Press the **Yes** key.

Table 8-1. Reset Data Options

Addr.	**LCD text** (2nd line)	**Description**
8201	LED ?	Reset the LED memory?
8202	COUNTERS ?	Reset CB trip command count?
8203	TOTAL Isc ?	Reset interrupted current statistics?
8204	OPERAT.ANNUNC. ?	Reset event log?
8205	FAULT ANNUNC. ?	Reset target log?

8.5 What To Do With Defective Relays

If you cannot correct a problem with the relay using the procedures described in this manual, then return the complete relay to the manufacturer. If it is available, use the original packaging for shipping. Otherwise, provide appropriate packaging to ensure that there will be no damage during shipping.

8.6 Storing Relays That Are Taken Out of Service

Solid state protective relays should be stored in dry and clean rooms. The temperature range for storage of the relays or associated spare parts is -13°F to +131°F (-25°C to +55°C). See the "Specifications" section of this manual for more information.

If the relay is stored with no power input for an extended time period, proper voltage should be applied to the power input for one or two days prior to placing the relay into service.

A. Method of Operation

The 7SJ511 relay is a microprocessor-based, high speed, three-phase and neutral, numerical, overcurrent unit used to protect high voltage distribution systems and as backup protection for transformers, generators, and motors. The relay provides full digital processing of all functions, from data acquisition of measured values to the trip signals for the circuit breakers. Figure A-1 shows the basic structure of the unit.

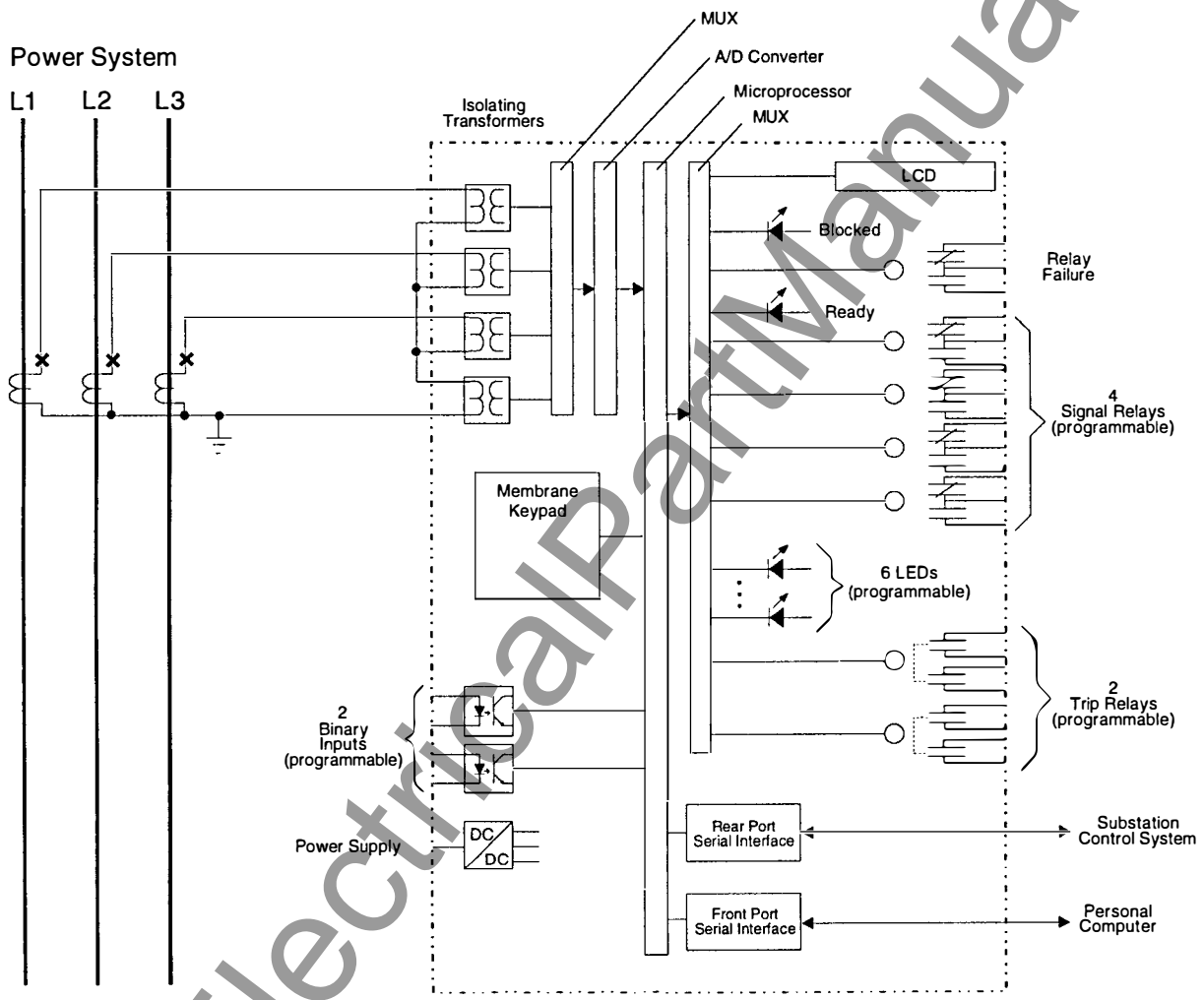


Figure A-1. Hardware Structure

The analog input module (see Figure A-1) contains input amplifiers, sample and hold elements for each input, a multiplexer, and an analog/digital converter. Analog current input signals enter into the relay isolating transformers and then pass through anti-aliasing filters to the analog input module. The anti-aliasing filters' bandwidth and processing speed are optimized to match the protection algorithms. The input signals are sampled 20 times per power cycle and converted to digital signals.

For overcurrent protection, the input currents are converted in relation to the distribution system rated current. This is achieved by programming data, such as the rated primary current of the current transformers into the protection unit. Once the rating specification has been entered, the protection unit is capable of performing the current comparison according to fixed formula.

Binary inputs are isolated through optical couplers. Outputs are performed via output relays, and output contacts are provided for trip and signaling functions. Outputs include trip commands to the circuit breakers, signals for remote notification of important events and conditions, as well as the LEDs and alphanumeric LCD on the operator panel. You can program the binary inputs, outputs, and LEDs as discussed in "Programming the Relay".

Using the operator panel keypad and LCD, you can read or change the system, protection, and relay configuration settings, you can access and read the relay's measured values, and you can review the data recorded for the last three faults. This interaction with the relay can also be accomplished using a personal computer connected to the serial interface port on the operator panel.

The microprocessor also processes the following functions:

- Formation of the measured values in accordance with the rated primary current and the CT ratios
- Calculation of rms values for overcurrent detection
- Scanning of limit values and time sequences
- Decision for trip commands
- Storage and issue of messages and fault data for fault analysis

An integrated DC-to-DC converter supplies multiple voltages to the relay subsystems as follows:

Voltage	Subsystem
+18 V	Output relays
±15 V	A/D converters
+12 V	EEPROMs
+ 5 V	CPU and associated logic

For $V_H \geq 110$ V, the relay can tolerate a loss of the input voltage for 50 milliseconds or less.

A.1 Overcurrent Protection

Overcurrent protection monitors the current levels in the protected power system and compares them with limit values that have been programmed into the relay. When the measured current levels exceed the programmed limits, appropriate annunciation signals are generated, trip commands are issued, and fault data is recorded.

The four analog inputs allow for monitoring of all three phases of the distribution system plus the neutral circuit. The currents are sensed and fed to the relay by current transformers (CTs). The inputs are electrically isolated from the electronic circuits and from each other. As a result, a

starpoint of the three phase currents can be formed outside the relay, and additional protection or supervision devices can be included in the CT circuits. For the neutral current input, either the residual current of the phase CTs can be used, or a separate summation CT can be connected. The instantaneous current values are sampled at a rate of 20 times per cycle.

The secondary windings of the relay input transformers are terminated by shunt resistors which transform the currents to proportional voltages. These voltages are converted to numeric values by the analog-to-digital converter.

All of the overcurrent protection options discussed in the following sections can be activated or blocked by both programming and/or binary input signals.

A.1.1 Definite Time Protection

Definite time (I>, I>>) protection *specifies* a time period between the detection of a fault and the output of the trip command. The overcurrent limit and time delay can be specified separately for phases and neutral. The overcurrent limit and time delay for phases is common to all three phases. The magnitude of the fundamental wave is evaluated for this measurement. All DC and harmonic components are suppressed. The time delay to trip may be set to 0 (instantaneous trip) or ∞ (no trip).

There are two overcurrent protection elements that operate in the definite time mode:

- Definite time element (I>)
- High-set element (I>>)

Overcurrent limits and time delays can be specified separately for each element. The high-set element can be used in concert with either the definite time element or the inverse time element described below.

The logic diagrams for the definite time and the high-set elements are shown in Figure A-2 and Figure A-3 respectively.

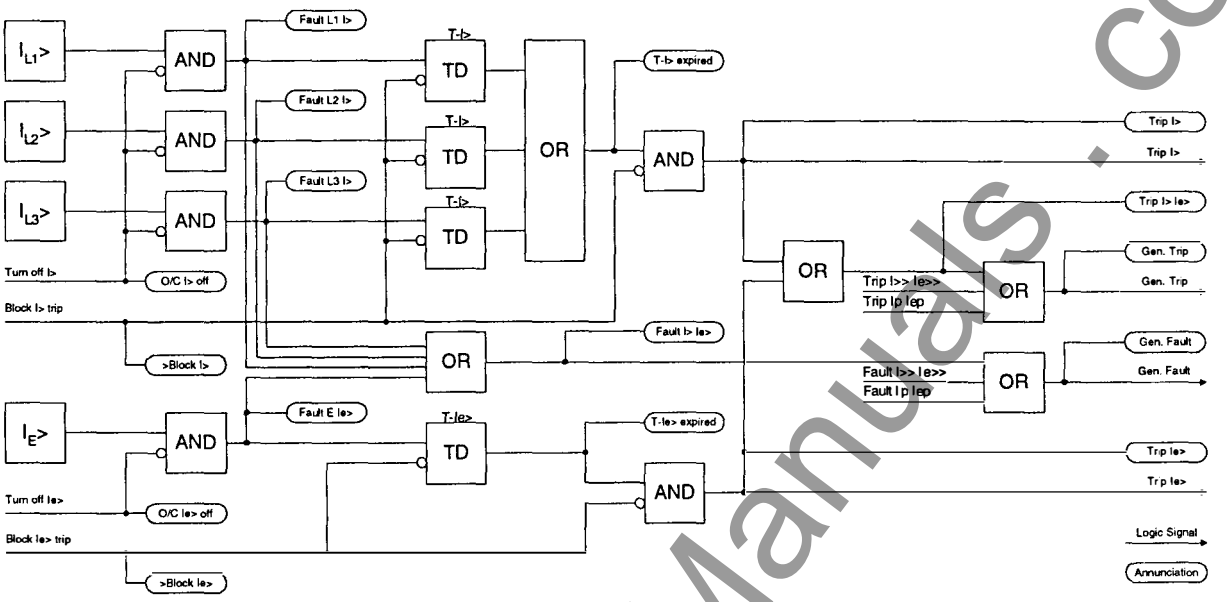


Figure A-2. Definite Time Overcurrent Protection Logic (50/50G/51/51G)

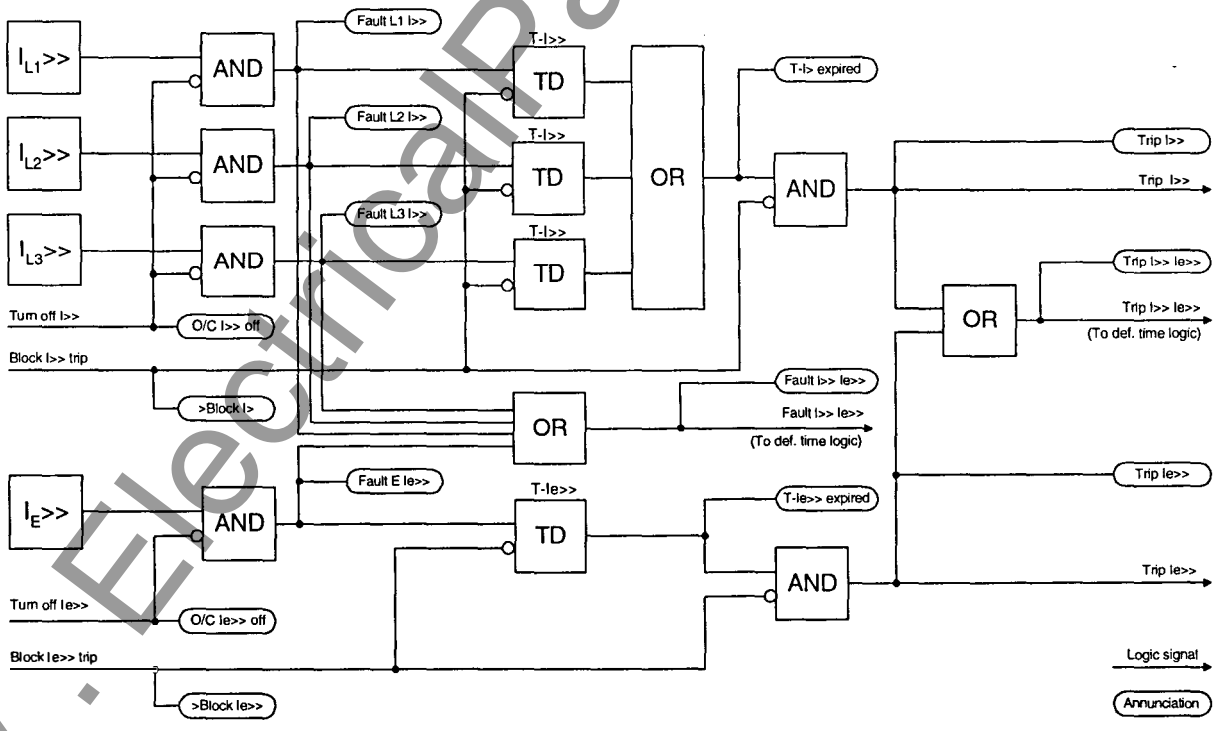


Figure A-3. High-set Overcurrent Protection Logic (50 HS/50G HS/51 HS/51G HS)

A.1.2 Inverse Time Protection

Inverse time protection (I_p) *calculates* the time period between fault detection and the trip command as a function of the magnitude of the current. As is the case with definite time protection, the overcurrent limit and time delay can be set independently for phases and neutral, but the phase settings are common for all three phases. Three standard inverse time characteristics are available:

1. Normal Inverse
2. Very Inverse
3. Extremely Inverse

When using inverse time protection, either the magnitude of the fundamental wave or the true rms value can be evaluated for the measurement. The time delay in this case is controlled by specifying a multiplier factor for the normalized inverse time characteristic.

The logic diagram for the inverse time element is shown in Figure A-4.

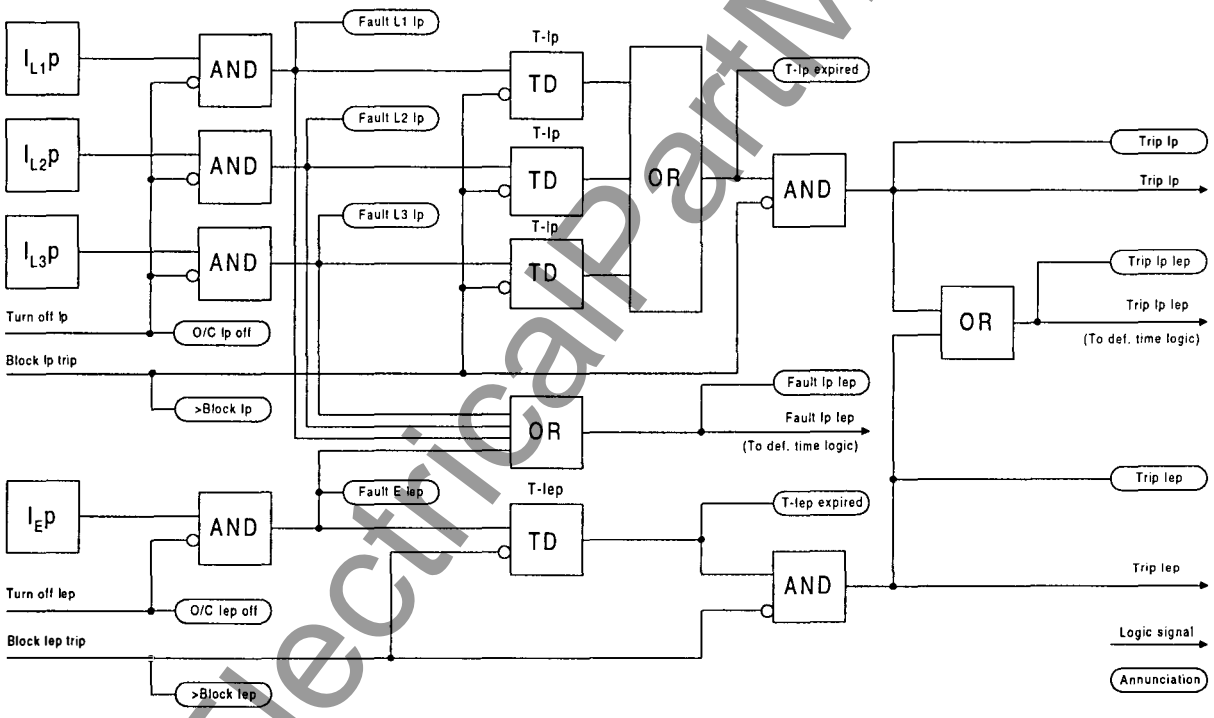


Figure A-4. Inverse Time Overcurrent Protection Logic (51/51G)

A.2 Breaker Failure Protection

In order to ensure that the circuit breaker functions correctly, the relay checks to see that the current flow stops when the circuit breaker trip command is issued. When the trip command is issued, a timer starts and runs as long as the trip command is active and the current continues to flow. If current flow continues until the timer expires, the circuit breaker failure protection

function can issue additional trip commands to upstream breakers. The circuit breaker failure protection function can also be initiated by means of a binary input signal.

The circuit breaker failure protection function can be assigned to either the trip relays or to the signal relays. If it is assigned to a signal relay, an external interposing relay will normally be required to provide adequate switching capacity.

Activation of this protection function can be controlled by programming and/or binary input signals.

A.2.1 Breaker Failure Protection Threshold

The current threshold, $I_{BF}>$, above which a breaker failure is indicated can be programmed. If after the circuit breaker failure timer is started, the current drops below the threshold value, the circuit breaker is assumed to have operated successfully. This setting applies to all three phases of the protected system. The setting should be at least 10% below the smallest expected fault current, including neutral faults. However, the threshold should not be more sensitive than necessary to avoid extended timeouts due to transient phenomena in the current transformers after interruption of high short-circuit currents.

A.2.2 Breaker Failure Protection Time Delay

The time delay, T_{BF}, should be equal to the maximum tripping time of the circuit breaker plus the reset time of the current detectors plus a safety margin:

$$T_{BF} = \text{CB trip time} + I_{BF}> \text{ reset} + \text{safety margin}$$

The logic diagram for the breaker failure protection element is shown in Figure A-5.

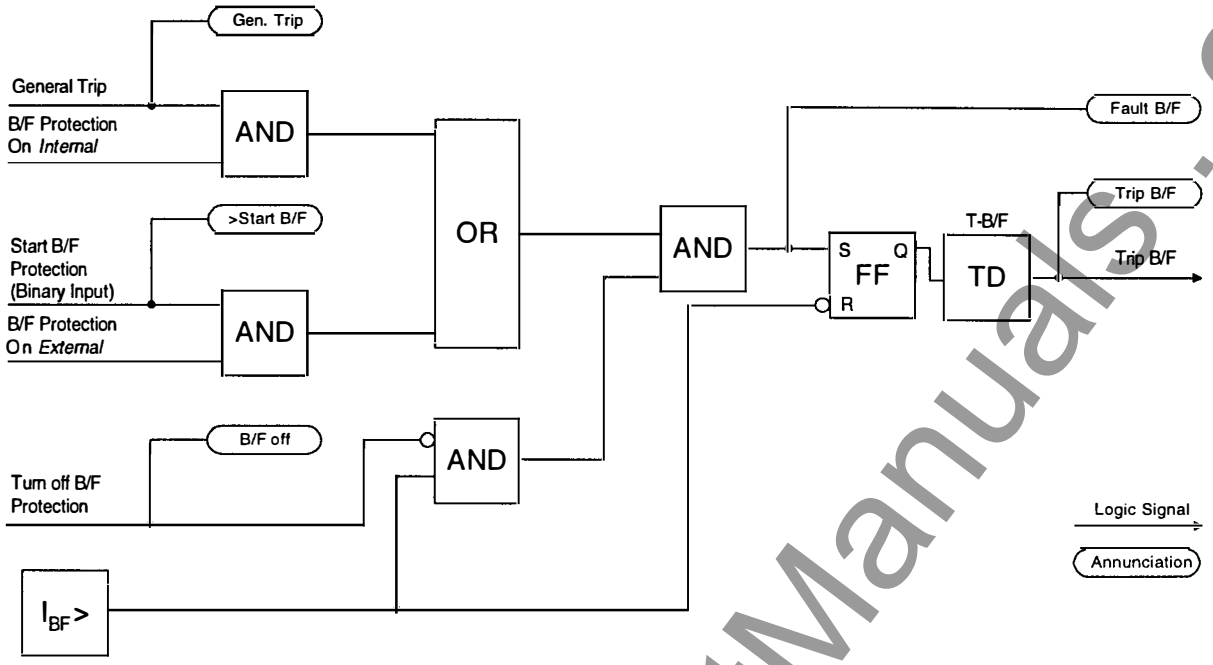


Figure A-5. Breaker Failure Protection Logic

A.3 Reverse Interlocking

Each of the overcurrent elements can be blocked by means of a binary input. This allows the relay to provide fast bus protection in radial networks or open ring networks, using the *reverse interlock* principal.

Reverse interlocking means that a downstream relay, via binary inputs, can block the overcurrent protection on an upstream relay. In a configuration of this type, the high-set element of the relay closest to the fault picks up first and can then block the upstream relays. The definite time (I>) or inverse time (I_p) element provide backup protection.

An example of bus protection using reverse interlocking appears in Figure A-6. In this case, the reverse interlock blocks high-speed overcurrent protection on the supply feeder to the bus if any of the load feeder overcurrent relays are in pick up. If a fault is not present on any of the associated load feeders on the bus, the supply feeder's high-speed overcurrent protection is not blocked, providing reliable protection for bus faults.

In this manner, *selective high-speed overcurrent* relaying can provide supply feeder, bus, and load feeder protection. The relays, through contact input and output communication with each other, can discriminate and operate selectively for various types of faults within the substation - tripping only the affected parts of the system.

The interlock is formed by blocking the high-speed overcurrent protection I>> (ANSI 50) on the supply feeder overcurrent relay with a contact closure from any of the load feeder overcurrent relays when they pick up on their inverse (I_p) or definite time (I>) protection (ANSI 51). The supply feeder overcurrent relay uses one binary input; each load feeder relay uses a contact output.

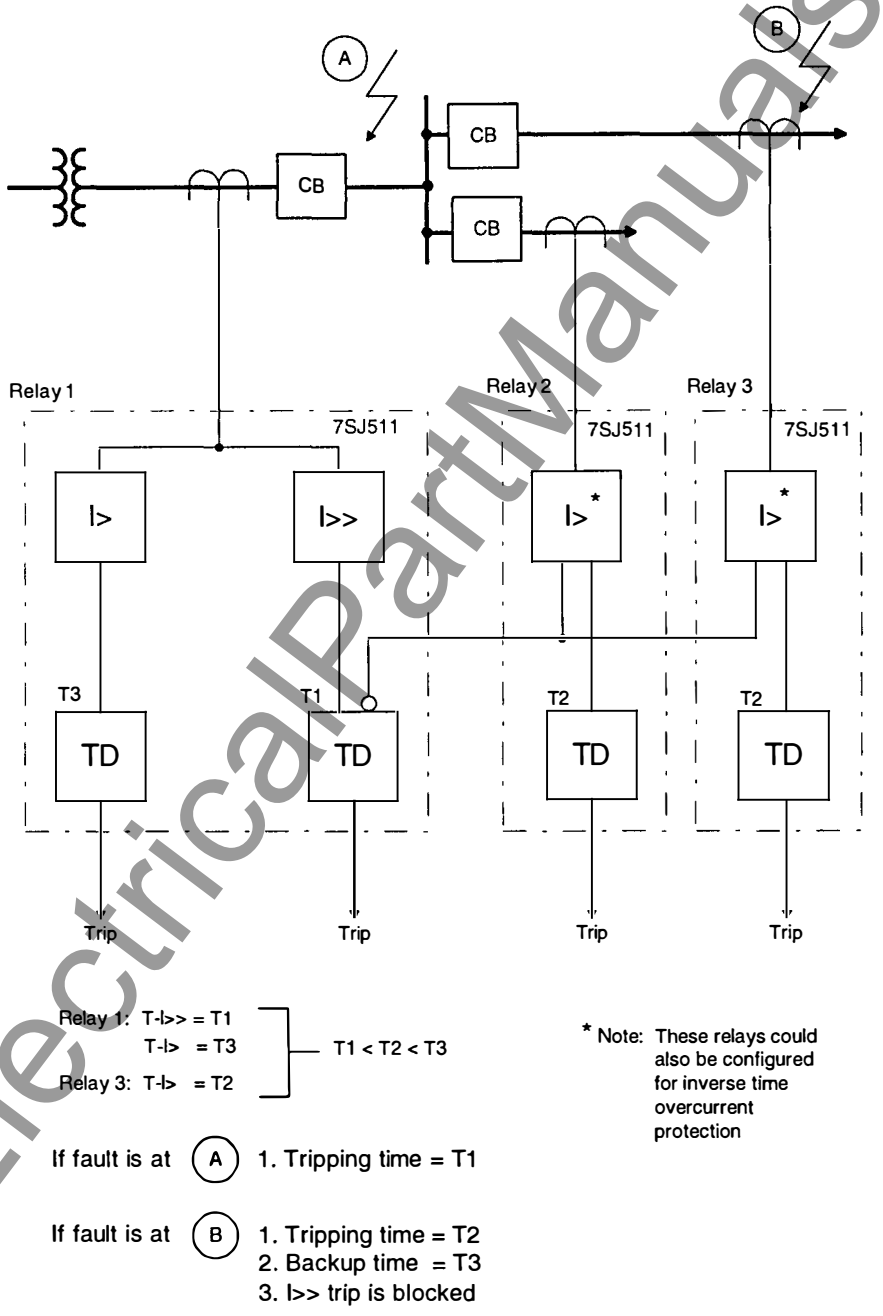


Figure A-6. Bus Protection Using Reverse Interlocking

A.4 Trip Matrix

The relay includes an integrated trip matrix, which allows flexibility in programming the trip logic with regard to inputs, protections, alarms, and various output relays.

The trip signals of the various protection functions, as described in sections A-1 and A-2, can be programmed to the two trip relays of the unit as required. External inputs such as blocking signals may be used as binary inputs to the 7SJ511 and configured to the trip relays via the trip matrix. Each trip relay is assigned to a switching element such as a circuit breaker, de-excitation circuit breaker, trip valve, or other control gear.

The procedure for programming the trip matrix and the presettings as delivered from the factory are described in detail in "Programming the Relay."

A.5 Ancillary Functions

The ancillary functions of the relay include:

- LEDs and output contacts
- Digital communications
- Operational current measurements
  - Waveform capture
  - Measured values
- Self-diagnostics

A.5.1 LEDs and Signal Relays

Important events and conditions are indicated by LEDs on the operator panel. The unit also contains signal relays for remote indication. Most of the signals and indications can be programmed and assigned meanings other than the presetting. "Programming the Relay" describes in detail the presettings and the configuration options.

The signal relays operate in a non-latching mode and reset after the indicated condition is no longer present. The LED indicators can be operated in latched or unlatched mode. The memories of the indicators are reset:

- locally using the **Reset** key on the operator panel
- remotely by energizing the binary remote reset input
- automatically when a new general fault is detected

The green **Power** LED indicates the relay is powered and functioning correctly. This LED cannot be reset. The LED turns off when the self-monitoring function of the microprocessor detects a fault or when the power supply voltage is absent.

With the auxiliary voltage present but with an existing internal fault in the unit, a red **Blocked** LED illuminates and blocks the unit from operating. All output relays are in the de-energized state when an internal relay failure is detected.

A.5.2 Digital Communications

A personal computer can be connected to the front port of the relay via the RS-232-C serial interface. This ability provides enhanced viewing on a CRT screen and menu-guided operation from DIGSI® software. Additionally, the data can be documented on a printer or stored on disk for evaluation elsewhere. After a fault, for example, important information concerning its history, such as pickup and tripping, can be called up on a CRT via the front interface connection. The events are tagged with a relative time, referred to the moment of fault detection. Thus, the elapsed time until tripping is initiated and until the trip signal is reset can be read out.

A.5.3 Target Log

The protection device stores the data of the last three faults; if a fourth fault occurs the oldest event is overwritten in the fault event memory. A fault event begins with recognition of the fault by pick up of the relay and ends with the reset of the pickup (drop-out).

A.5.4 Waveform Capture

Waveform capture can be initiated by a pickup. This enables, for example, the recording of the short circuit current level.

The instantaneous values of the measured currents, I_{L1}, I_{L2}, I_{L3}, and I_E, of the power system are sampled at 20 times per power cycle and converted to digital signals. In case of a fault, the data from before the occurrence of the fault and after the trip command is stored. This data is then available for fault analysis.

You can access and review the relay's fault data via a serial interface to a computer using DIGSI® software. The currents are referred to their maximum value, normalized to their rated values, and prepared for graphic visualization. Pick-up, trip, and drop-off are marked on the waveform record. The relay is ready to record new data as soon as the most recent data has been read out or the "holding time" (which can be set up to 30 minutes) has elapsed.

A.5.5 Measured Values and Load Data

Using the operator panel or via a personal computer connected to the relay, the following information is constantly available for you to view:

- I_{L1}, I_{L2}, I_{L3}, and I_E primary rms values
- I_{L1}, I_{L2}, I_{L3}, and I_E in percent of rated primary current

A.5.6 Self-Diagnostics

This digital protective relay incorporates comprehensive monitoring functions which cover both hardware and software. The relay continuously self-monitors its hardware including the DC/DC converter reference voltages. For $V_H \geq 110$ V, the relay can tolerate a loss of the input voltage for 50 milliseconds or less. The relay monitors its control circuits for discontinuities and short circuits. The command circuits are controlled by two command channels and one additional release channel. The relay regularly checks its memory (EPROM, EEPROM, and general purpose RAM). The checksum of EEPROMs is calculated each time new parameters are assigned.

For software monitoring, the relay has an internal watchdog timer so that its program sequences, occurrences, and fault events are continuously monitored and time-stamped. If a program falls out of step or if the processor fails, the relay will automatically reset and restart the processor. The relay will reset and restart itself three times, then if the error is still present, it is considered a failure.

In summary, if a failure is detected in power, hardware, or software, the following occurs:

- All protection functions are blocked to prevent nuisance tripping (the relay fails in a secure manner)
- The relay failure (alarm relay) contacts close
- The **Blocked** LED will illuminate if power is still available to the relay

The relay also continuously monitors load currents. You can access and analyze this information using the operator panel. This ability to check the relay's measured values is helpful during commissioning, normal operation, and troubleshooting.

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B. Hardware & Software

B.1 Hardware

Electronic Subsystem
The 7SJ511 electronic subsystem is based on the latest in large scale CMOS integrated circuitry. The microprocessor is the powerful Siemens 80C166 16-bit device whose architecture is specifically designed for high speed industrial control applications. This sophisticated digital processing system is packaged in surface-mount technology (SMT).

Analog Inputs
The transducers of the measured value input section transform the currents from the external measurement transformers and match them to the internal processing level of the relay electronics. In addition to low capacitance isolation, filters are provided for the suppression of interference. The bandwidth and processing speed of the filters have been optimized to suit the measured value processing.

Binary Inputs
The digital inputs are optically isolated to provide low-load signal sensing for control by other parts of the network.

Outputs
All outputs from the relay are in the form of simple, highly reliable, relay contact closures. This provides the user a maximum amount of flexibility and convenience in interfacing with other system components.

LED Indicators
The eight LED indicators on the operator panel provide a highly visible, fail-safe, warning and event announcement capability. In addition, six of the indicators are programmable with easily altered labels.

Operator Display
The operator display is a dot matrix LCD with two lines of 16 characters each. This large 32-character display capacity allows for the presentation of a maximum amount of information with minimum confusion.

Keyboard
The operator keyboard provides 26 keys for the entry of data and control of the relay. The keyboard uses membrane technology to provide maximum reliability, longevity, and resistance to wear and environmental contamination.

Data Communications
Two data communication ports are available. An RS-232-C serial port is a standard feature on the operator panel. This port is accessible through a standard 25-pin D-shell connector and is intended for attachment of a local personal computer.

An optional serial port, intended for remote communications, is available on the rear panel. This interface is available in either wire or optical interfaces. The wire interface is a reduced 3 wire (transmit, receive, and ground) RS-232-C subset with a maximum transmission distance of 0.6 miles (1 kilometer). The optical interface is accessible through F-SMA fiber optic connectors. There are separate transmit and receive optical signal paths with a maximum transmission distance of 1.24 miles (2 kilometers). In either case, the interface meets isolation and interference suppression as defined in ANSI and IEC standards.

B.2 Software

The reliable field-proven software provided with the 7SJ511 relay is developed and maintained in efficient, highly functional C language. The software version is displayed at relay address 0000.

B.3 Monitoring Features

The 7SJ511 relay contains extensive internal monitoring capabilities including:

- Self-diagnostics for both hardware and software
- Display of both measured and calculated values of the protected system
- Reading of operation and fault annunciations

B.3.1 Self-Diagnostics

This section describes the relay's diagnostic capabilities. They are provided to ensure the operational integrity of the relay itself and its associated input sources. The self-diagnostics include monitoring of:

- Internal hardware
- Internal software
- External transformer circuits

In any case where a failure is detected, the relay is securely taken out of service (blocked), the **Power** LED is turned off, the relay failure contact is closed, and, if the DC power supply is still functional, the **Blocked** LED is lit.

Internal Hardware

Internal hardware monitoring checks for faults in four major internal subsystems:

1. Internal power supply output voltages
2. Measured value acquisition circuits
3. Trip relay control channels
4. Microprocessor memory modules

Power for the relay subsystems (electronics, signal relays, etc.) is provided by an internal DC-to DC converter. This unit provides operating voltages for all of the subsystems and reference voltages used by the analog-to-digital (A/D) converters. All of these voltages are continuously

monitored for unacceptable deviations. For $V_H \geq 110$ V, the relay can withstand a loss of input supply voltage for up to 50 milliseconds without going out of service.

The measured value acquisition circuits include the input transformers, the measured value matching circuits, and the A/D converter. Monitoring of these circuits is accomplished by plausibility checks of the measured values.

The tripping relays are controlled by two set channels and one release channel. These three channels and the relay coils are, in the absence of a fault condition, periodically tested for availability.

The microprocessor memory modules include the general purpose memory (RAM), the program memory (EPROM), and the nonvolatile memory (EEPROM) used to store configuration parameters and fault data. The RAM is checked by periodically writing, then reading a specified bit pattern to all memory locations. The EPROM and EEPROM memories are checked by periodically doing a modulus check on the memory contents and comparing it against a stored value.

Internal Software
For software monitoring, the relay has an internal watchdog timer so that its program sequences, occurrences, and fault events are continuously monitored and time-stamped. If a program falls out of step or if the processor fails, the relay will automatically reset and restart the processor. The relay will attempt the reset and restart three times. If the error is still present, a device failure is assumed.

External Transformer Circuits
The relay periodically checks for open or short circuits in the external measuring transformer circuits. This check is done for the current transformers by testing for approximately symmetrical phase currents. The check is made as long as no fault conditions are being processed by the relay.

B.3.2 Measured and Calculated Value Display
Load current values are accessible through the LCD or serial ports to aid in data collection, commissioning and troubleshooting.

B.3.3 Operational and Fault Annunciation
Event Log (Operational Annunciations)
Up to 50 operational events can be time stamped and stored for readout through the LCD or the serial ports. These events include response from the binary inputs, diagnostic failures, setting parameters, and on/off control of the protection functions. Refer to "Displaying System and Relay Information" for a complete list of all possible event log messages.

Target Log (Fault Annunciations)
The relay has a non-volatile memory (EEPROM). Through the configuration process, the relay can be programmed to store and time stamp fault event data that includes interrupted fault currents, operator messages, protection pickup and drop off, and the state of both input and output signals. Data for the last three fault events is retained. This data can be readout either as

messages on the LCD or through a serial port. The three events are identified as last, second-to-last and third-to-last. The data for the oldest (third-to-last) event is discarded each time a new event occurs. Refer to "Displaying System and Relay Information" for a complete list of all possible target log messages.

Circuit Breaker Operation Statistics

Data concerning the operation of the circuit breakers controlled by the relay is also stored. This data includes the number of trip commands issued, the last interrupted current value, and accumulated interrupted current values.

Waveform Capture

The relay will also capture and store the waveforms for the last fault. The instantaneous values of the system phase and neutral currents are sampled 20 times per cycle and stored in a circulating shift register. When a fault is detected, data is stored for a time period beginning before the event and ending after a trip command is issued.

C. Communications

The 7SJ511 relay provides extensive external data communication facilities. There are two serial data communications ports available. The first port is standard and is located on the front operator panel. The second port is optional and is located on the rear panel of the relay housing.

C.1 Front Port

The front port is a standard RS-232-C serial interface that is intended to be used with a locally attached personal computer. The connector on the operator panel is a 25 pin D-shell type to which a standard personal computer serial interface cable may be attached. With appropriate hardware and software, it is possible to access all of the data and perform all of the functions normally available through the operator panel, through the front port. In addition, the waveform capture data is accessible. The communications speed is user-programmable to run at any of six different rates between 1200 bps and 38400 bps.

The functions available through this port include:

- Programming - readout and setting of all configuration parameters
- Target reset
- Retrieval of:
  - Measured values
  - Event log
  - Target log
  - Circuit breaker operation statistics
  - Waveform capture data

The Siemens DIGSI® software package can be used in the attached PC to accomplish the above functions.

Note: The front port is *not* electrically isolated from the protected system.

C.2 Rear Port

The optional rear port is intended for remote communications with a substation control facility. The primary function of this interface is to send fault data to the substation control station. However, as long as the relay is not in pickup, measured values may also be transmitted. Availability of the waveform capture data at either the front or rear port is a configuration option. Unlike the front port, the relay cannot be controlled or configured through the rear port.

The rear port is available in either a wired or an optically coupled form. In either case, the interface meets isolation and interference suppression as defined in ANSI and IEC standards. The communications speed is user programmable to run at any of three different rates between 4800 bps and 19200 bps. Communications protocol is DIN 19244. When the relay is part of a network, device and feeder addresses may be specified.

C.3 DIGSI® Software

The DIGSI® software package can be used in a PC attached to the front panel serial port to program the relay and interpret fault event data in various forms including:

- A Target Log with 1 millisecond resolution
- An Event Log with 1 minute display resolution (1 millisecond. sorting resolution)
- Captured waveforms showing the phase and ground current behavior in each relay element before, during, and after a fault

D. Specifications

D.1 Symbols

General	
I	Measured system current
f	Measured system frequency
I_N	Rated current
f_N	Rated frequency (60 or 50 Hz)
V_H	Auxiliary (power supply) voltage
V_{HN}	Rated auxiliary (power supply) voltage
Θ	Temperature
T	Time
τ	Time constant
Definite time overcurrent protection	
I> (50/51)	Pickup value - phase current
I_E> (50G/51G)	Pickup value - neutral current
I>> (50 HS/51 HS)	High-set pickup value - phase current
I_E>> (50G HS/51G HS)	High-set pickup value - neutral current
I_{BF}>	Breaker failure pickup value - phase current
Inverse time overcurrent protection	
I_p (51)	Pickup value - phase current
I_{Ep} (51G)	Pickup value - neutral current

D.2 Relay Specifications

Measuring circuits

Rated relay current I_N	1 A or 5 A
Rated relay frequency f_N	60 Hz/50 Hz (programmable)
Burden at:	
I_N = 1 A	< 0.1 VA per phase
I_N = 5 A	< 0.5 VA per phase
Overload capability:	
Thermal (rms)	100 x I_N for ≤ 1 s 10 x I_N for ≤ 10 s 4 x I_N continuous
Dynamic (impulse)	250 x I_N for one half cycle (peak value)

Auxiliary Voltage

Auxiliary DC supply via integrated DC/DC converter

Rated auxiliary voltage V_{HN} (VDC)	Operating range V_H (VDC)
24/48	19 to 56
60/110/125	48 to 144
220/250	176 to 288

Ripple, peak-to-peak	≤ 12% at rated voltage ≤ 6% at the limits of the voltage ranges
Power consumption	
Quiescent	approx. 7 W
Energized	approx. 11 W
Loss-of-input-supply ride through	≥ 50 ms at V_H ≥ 110 VDC

Trip relays

Number of relays	2
Contacts per relays	2 form A (DPST)

Switching capacity	MAKE BREAK	1000 W/VA 30 W/VA
Switching voltage		250 V
Carry current		5 A continuous 30 A for 0.5 s

Signal/Failure relays

Number of signal relays		4
Number of failure relays		1
Contacts per relay		1 form C (SPDT)
Switching capacity	MAKE BREAK	20 W/VA 20 W/VA
Switching voltage		250 V
Carry current		1 A

Binary inputs

Number of inputs	2
Operating voltage	24 VDC to 250 VDC
Current consumption	approx. 2.5 mA, independent of operating voltage

Serial interfaces

Operator interface (front port)	non-isolated
- Connection	25-pin connector on the front panel providing an EIA RS-232-C (ISO 2110) interface for connection to a personal computer

- Transmission speed	1200 bps as delivered max. - 19200 bps min. - 1200 bps
Rear port interface	isolated
- Standards	similar to CCITT V.24/V.28, EIA RS-232 C, or IEC 870-5 Protocol DIN 19244
- Transmission speed	9600 bps as delivered max. - 19200 bps min. - 4800 bps
- Hamming distance	d = 4
- Connection - Wire	for flush mounted housing: 4-pole module connector; for surface mounted housing: 4 terminals 2 core pairs, with individual and common shields
Transmission distance	max. approx. 0.6 mi. (3280 ft.) (1000 m)
Test voltage	2 kV with rated frequency for 1 min
- Connection - Fiber Optic	integrated F-SMA connector for direct fiber optic connection; (e.g., glass fiber, 62.5/125 µm)
Optical wave length	820 nm
Permissible line attenuation	max. 8 db
Transmission distance	max. 1.24 mi (6547 ft) (2 km)
Inactive optical signal	field settable; factory setting: "light off"

Design

Housing	refer to "Installation"
Dimensions	refer to "Installation"
Weight in housing for:	
surface mounting	approx. 17.5 lb (8.0 kg)
flush mounting	approx. 14.5 lb (6.5 kg)

D.3 System Specifications

Standards	ANSI C37.90.0, C37.90.1, and C37.90.2 or IEC 255-5 and IEC 255-6
Insulation tests:	
- High voltage test (routine test) ANSI C37.90.0/IEC 255-5	2 kV (rms), 50/60 Hz, 1 min; alt. 2.8 kVDC, 1 min
- Impulse voltage test (type test) IEC 255-5	5 kV (peak); 1.2/50 µs; 0.5 J; 3 positive and 3 negative shots at intervals of 5 s
Disturbance tests:	
- High frequency (type test) IEC 255-22-1 class III ANSI C37.90.1	2.5 kV (peak); 1 MHz; τ = 15 µs; 400 shots per s for 2 s
- Electrostatic discharge (type test) IEC 255-22-2 class III	8 kV (peak); 5/30 ns; 10 positive discharges
- Radiated electromagnetic fields (type test) IEC 255-22-3 (report) class III	test with walkie-talkie; 68 MHz; 151 MHz; 450 MHz
ANSI C37.90.2	25 MHz - 1 GHz, 10 V/m
- Fast transients (type test) IEC 255-22-4 class III	2 kV (peak); 5/50 ns; 5 kHz; 4 mJ per shot
ANSI C37.90.1	5 kV; 10/150 ns
Mechanical stress tests	
During service	10 Hz to 60 Hz: 0.035 mm amplitude; 60 Hz to 500 Hz: 0.5 g acceleration
During transport	5 Hz to 8 Hz: 7.5 mm amplitude; 8 Hz to 500 Hz: 2 g acceleration

Climatic tests

Permissible ambient temperature during:	
service	-4°F to +131°F (-20°C to +55°C)
storage	-13°F to +131°F (-25°C to +55°C)
transport	-13°F to +158°F (-25°C to +70°C)
Humidity class	95% non-condensing

D.4 Definite Time Overcurrent Protection (50/51/50 HS/51 HS/50G/50G HS/51G/51G HS

Setting range/steps

Overcurrent pickup I> (phases)	I/I_N	0.10 to 25.00 (steps 0.01)
Overcurrent pickup I_E> (neutral)	I/I_N	0.10 to 25.00 (steps 0.01)
Overcurrent pickup I>> (phases)	I/I_N	0.10 to 25.00 (steps 0.01)
Overcurrent pickup I_E>> (neutral)	I/I_N	0.10 to 25.00 (steps 0.01)
Delay times	T	0.00 s to 60.00 s (steps 0.01 s) or infinite

Times

Pickup times for I>, I>>, I_E>, and I_E>> with:	
2 x setting value, w/o meas. repetition	approx. 33 ms
2 x setting value, with meas. repetition	approx. 50 ms
5 x setting value, w/o meas. repetition	approx. 25 ms
5 x setting value, with meas. repetition	approx. 40 ms
Reset times for I>, I>>, I_E>, I_E>>	approx. 50 ms
Overshot time	approx. 35 ms
Reset ratio	approx. 0.95

Tolerances

Pickup values I>, I>>, I_E>, I_E>>	± 3% of setting value
Delay times T	± 1% of setting value or 10 ms

Influence variables

Auxiliary voltage in range $0.8 \leq V_H/V_{HN} \leq 1.15$	≤ 1%
Temperature in range $0°C \leq \Theta_{AMB} \leq 40°C$	≤ 0.5%/10°C
Frequency in range $0.98 \leq f/f_N \leq 1.02$	≤ 1%
Frequency in range $0.95 \leq f/f_N \leq 1.05$	≤ 2.5%
Harmonics:	
Up to 10% of 3rd harmonic	≤ 1%
Up to 10% of 5th harmonic	≤ 1%

D.5 Inverse Time Overcurrent Protection (51/51G)

Setting range/steps

Overcurrent pickup I_p (phases)	I/I_N	0.10 to 4.00 (steps 0.01)
Overcurrent pickup I_{Ep} (neutral)	I/I_N	0.10 to 4.00 (steps 0.01)
Time multiplier for I_p, I_{Ep}	T_p	0.05 s to 3.20 s (steps 0.01 s) or infinite

Trip time characteristics

IEC 255-3

Normal inverse

$$t = \frac{0.14}{(I/I_p)^{0.02} - 1} \cdot T_p$$ (Figure D-1)

Very inverse

$$t = \frac{13.5}{(I/I_p) - 1} \cdot T_p$$ (Figure D-2)

Extremely inverse

$$t = \frac{80}{(I/I_p)^2 - 1} \cdot T_p$$ (Figure D-3)

where:
t = tripping time
T_p = set time multiplier
I = fault current
I_p = set pickup value

Pickup threshold $1.1I_p$

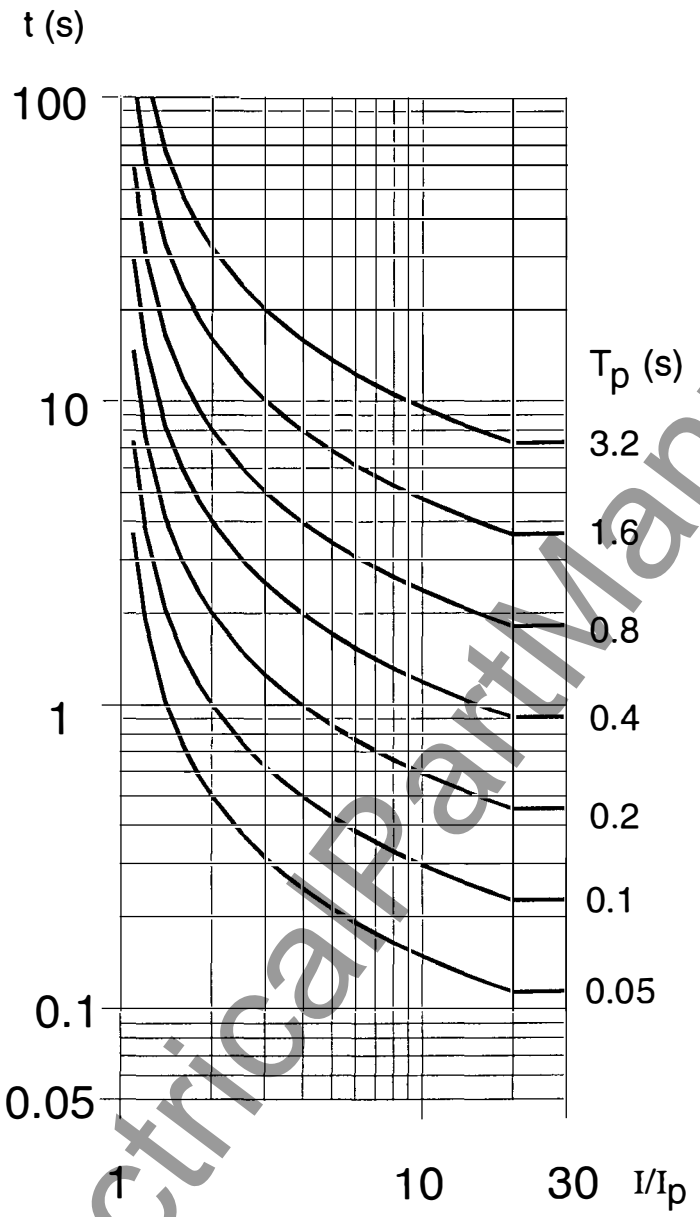
Note: For neutral faults substitute I_{Ep} for I_p and T_{Ep} for T_p.

Tolerances

Pickup value I_p, I_{Ep}	± 5% of setting value
Delay time for $2 \leq I/I_p \leq 20$	
$T_p = 1$	± 5% of setting value
$T_p \neq 1$	additional ± 2% or at least ± 30 ms

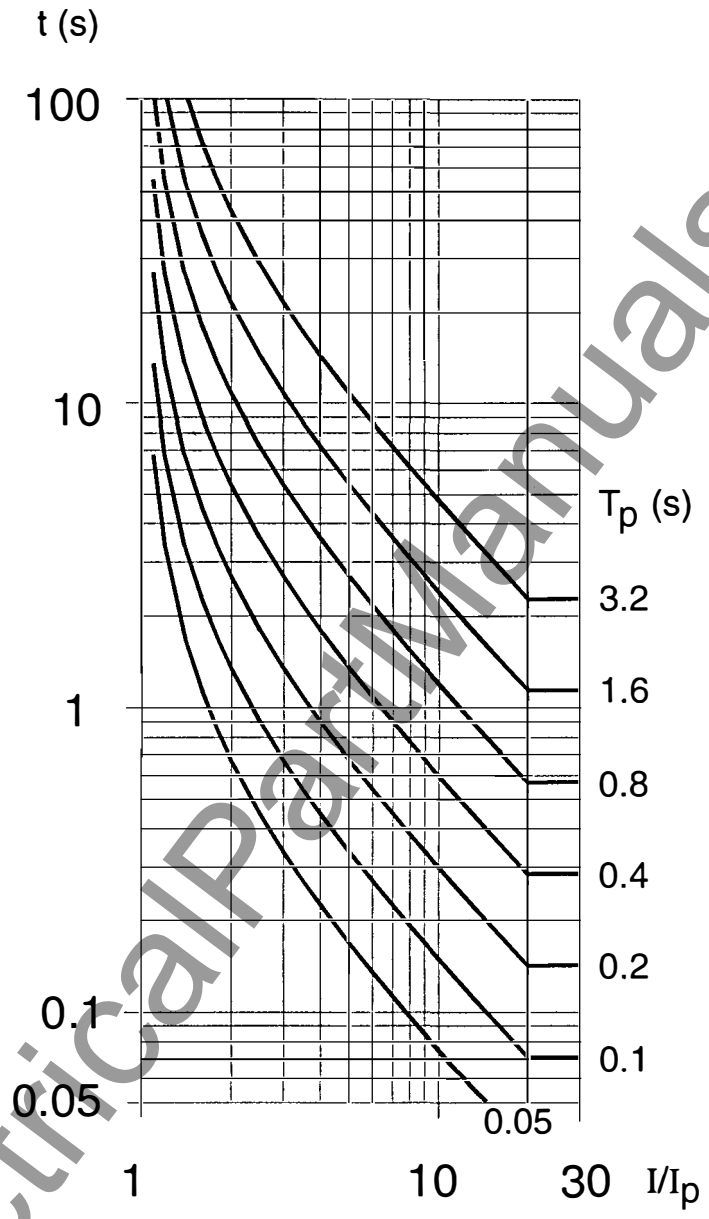
Influence variables

Auxiliary voltage in range $0.8 \leq V_H/V_{HN} \leq 1.15$	≤ 1%
Temperature in range $0°C \leq \Theta_{AMB} \leq 40°C$	≤ 0.5%/10°C
Frequency in range $0.95 \leq f/f_N \leq 1.05$	≤ 8%



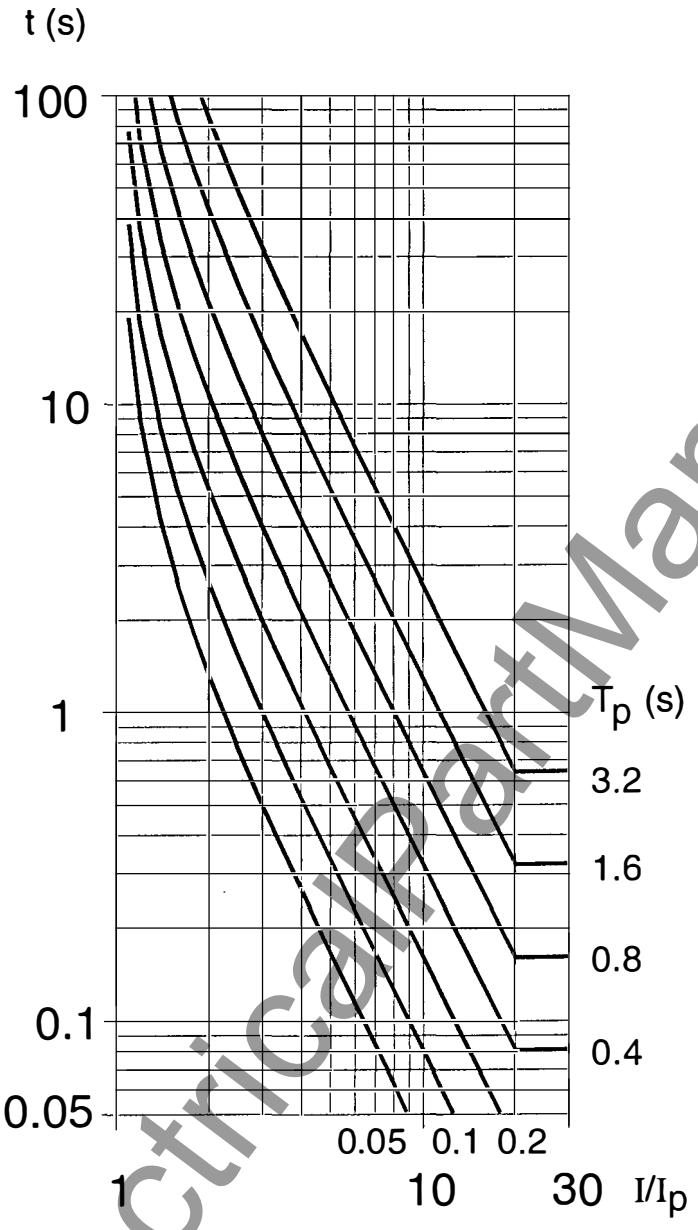
$$\text{Normal inverse: } t = \frac{0.14}{(I/I_p)^{0.02} - 1} \bullet Tp$$

Figure D-1. Trip Time Characteristics of *Normal Inverse* Overcurrent Protection



$$\text{Very inverse: } t = \frac{13.5}{(I/I_p) - 1} \bullet Tp$$

Figure D-2. Trip Time Characteristics of *Very Inverse* Overcurrent Protection



$$\text{Extremely inverse: } t = \frac{80}{(I/I_p)^2 - 1} \bullet Tp$$

Figure D-3. Trip Time Characteristics of *Extremely Inverse* Overcurrent Protection

D.6 Breaker Failure Protection

Setting ranges/steps

Pickup value of element $I_{BF}>$	I/I_N	0.10 to 4.00 (steps 0.01)
Time delay	T_{BF}	0.06 s to 60.00 s (steps 0.01 s) or infinite

Times

Pickup time with:	
internal start	included in overcurrent time
external start	approx. 50 ms
Reset time	approx. 50 ms

Tolerances

Pickup value	± 3% of setting value
Delay time T	± 1% of setting value or at least 20 ms

D.7 Ancillary Functions

Operational value measurements

Operational current values	I_{L1}; I_{L2}; I_{L3}; I_E
- Measurement range	0% to 240% of I_N
- Tolerance	≤ 2% of I_N

Measured values plausibility checks

Sum of currents	phases and neutral

Steady-state measured value supervision

Current unbalance	I_{max}/I_{min} > symmetry factor as long as $I > I_{limit}$

Data storage for waveform capture (fault recording)

Storage period (fault detection = 0 ms), max. for:	
operating interface (front port)	-100 ms to +2900 ms at 50 Hz -83 ms to +2416 ms at 60 Hz
rear port	-60 ms to +600 ms at 50 Hz -50 ms to +500 ms at 60 Hz
Sampling rate	1 instantaneous value per 1.00 ms at 50 Hz 1 instantaneous value per 0.83 ms at 60 Hz

Target log storage

Storage of annunciations of the last three faults

Real-time clock

Display resolution for event log annunciations	1 min
Order (sorting) resolution	1 ms
Resolution for target log annunciations	1 ms
Maximum time deviation	± 0.01%

E. Setting Calculations

E.1 Introduction

This section provides detailed information for determining the programming settings of the relay. As you go through this section, use the "Method of Operation" section for reference and the Setting Worksheets for recording the relay settings. Once you have entered all of the required data in the worksheets, Siemens recommends that you make at least one photocopy of the worksheets to distribute to personnel responsible for programming the settings into the relay. Refer to "Programming the Relay" for step-by-step instructions on programming the relay settings as well as configuring the binary inputs, LEDs, and output contacts.

In the following sections the programming parameters are documented primarily in ascending numerical order by address. In each case, the section begins with a description of the parameter group followed by a detailed discussion of each parameter.

Exist/Non-Exist, On/Off, and Blocking Control
Many of the features and functions of the relay can be made active or inactive by program settings. This control is accomplished by programming a function as:

- Exist or Non-Exist.
- On or Off.
- Blocked.

Exist/Non-Exist
For major functions such as waveform capture or substation control connections, the programming parameters are EXIST or NON-EXIST. Functions which are configured as non-exist will not be processed. There will be no annunciations and the associated setting parameters will not be requested during a programming operation. Exist/Non-Exist control is programmed under the Scope of Functions parameter group at address block 7800 and can only be set through the operator panel or serial port.

On/Off
In other cases, a function, such as circuit breaker failure protection may be programmed ON or OFF. A function that has been programmed off will be processed, but protective actions such as lighting operator panel LEDs or activating trip relays will not occur. On/Off control may be accomplished through the operator panel, the front serial port, and the binary inputs.

If on/off control for a function has been assigned to binary inputs, the function may be turned on only if the command comes from *both* the binary input *and* either the operator panel or the front port. A function may be turned off by a command from *either* the binary input *or* the operator panel or front port. This ensures that the protection element can only turned on from the same source which previously turned it off.

These control functions, unlike most of the other binary input functions, are stored in the non-volatile memory of the relay (latched) and can, therefore, be activated by momentary input

signals. This characteristic, however, requires that *two* binary inputs be assigned to control the function -one to command turn on and one to command turn off.

Turning off a function will generate an operational message (see "Displaying System and Relay Information").

Blocked

Any of the six overcurrent protection elements may be blocked through a binary input. A protection element that has been programmed but is blocked by a binary input will not pickup on the associated fault.

The blocking functions, unlike the on/off control functions, are not latched. Therefore, a continuous signal on a *single* binary input is required to maintain the blocking function.

Blocking of an overcurrent protection element will generate an operational message (see "Displaying System and Relay Information").

E.2 Power System Data (1100)

The Power System Data parameters are in address block 1100. These parameters include the primary current rating and matching factor for the external CTs.

1105 CT Primary Rated Current

The parameter at address 1105 is set to the rated current for the primary of the attached current transformers. For example, if the CT rating is 800:5 then address 1105 is set to 800 A.

1112 CT Ratio Matching Factor

The CT ratio matching factor, k_I, is set as a parameter at address 1112. This factor is used to correct for differences in the phase and neutral CT ratios. If the neutral current input is the common connection of the phase CTs wired in a starpoint, then $k_I = 1.000$. If a separate neutral current transformer is used to feed the neutral current input

then $$k_I = \frac{I_E}{I_{ph}},$$

where I_E is the neutral CT ratio
and I_{ph} is the phase CT ratio.

For example,

if $$I_E = \frac{60\ \text{A}}{1\ \text{A}} = 60$$

and $$I_{ph} = \frac{400\ \text{A}}{5\ \text{A}} = 80$$

then $k_I = \frac{60}{80} = 0.75.$

E.3 Overcurrent Protection (1200, 1500)

Overcurrent protection settings are made in address blocks 1200 and 1500, and addresses 7812 and 7815. The settings made in these blocks turn the protection on and off, establish current levels for fault detection, and set time delays before issuing a trip command. The settings in address block 1200 are for phase currents and those in block 1500 are for the neutral current. Phase current settings are common for all three phases.

The 7SJ511 relay provides overcurrent protection in either of two modes:

- **Definite time** protection (I>) *specifies* a time period between the detection of a fault and the output of the trip command. The overcurrent limit and time delay can be specified separately for phases and neutral. The magnitude of the fundamental wave is evaluated for this measurement.

- **Inverse time** protection (I_p) *calculates* the time period between fault detection and the trip command as a function of the magnitude of the current. There are three standard inverse time characteristics available. The overcurrent limit and time multiplier for the selected characteristic can be specified separately for phases and neutral. The magnitude of the fundamental wave or the true rms value can be selected for evaluation for this measurement.

The protection mode is selectable with separate choices available for phases (address 7812) and neutral (address 7815). See section E.11 for details.

High-Set Parameters

In addition to the protection modes identified above, you can specify a *high-set* (I>>)group of parameters that provide definite time protection independently of the choice made at addresses 7812 or 7815. This protection element is often used for current grading before high impedances such as transformers, motors, and generators.

Use of the High-Set Element with Auto-Reclose Devices

When used with an auto-reclose device, the high-set element can function as a rapid tripping element before auto-reclosure. As long as the auto-reclose device is ready, reclosure with a short or zero time delay for the high-set element will be successful. If the auto-reclose device is not ready or the reclosure is unsuccessful, the high-set element should be blocked by a binary input. The delayed definite time or inverse time elements can then clear the fault in accordance with the time grading plan of the network. In this case, the pickup value of the high-set element need not be different from either the definite time or inverse elements since the high-set time delay is very short.

E.3.1 Overcurrent Protection On/Off Control

1201, 1501 Internal On/Off Control

Overcurrent protection may be turned on or off by means of the parameters at addresses 1201 and 1501. Address 1201 controls protection for phases while address 1501 controls protection for neutral.

External On/Off Control

Overcurrent protection functions may also be controlled by means of commands through the binary inputs. The following logical functions are available to control overcurrent protection externally:

- FNo 031 Turn on overcurrent protection for phases
- FNo 032 Turn off overcurrent protection for phases
- FNo 033 Turn on overcurrent protection for neutral
- FNo 034 Turn off overcurrent protection for neutral

If on/off control by means of the binary inputs is configured, the parameters at 1201 and 1501 must be set to ON.

External Blocking

While on/off control for overcurrent protection is common for all variations of the function (definite time, inverse time, high-set, etc.), the activation (pickup) of the variations when a fault is detected may be blocked independently. The following logical functions may be assigned to the binary inputs to provide this control:

- FNo 081 Block the high-set element for phase faults (I>>)
- FNo 082 Block the high-set element for neutral faults (I_E>>)
- FNo 083 Block the definite time element for phase faults (I>)
- FNo 084 Block the definite time element for neutral faults (I_E>)
- FNo 085 Block the inverse time element for phase faults (I_p)
- FNo 086 Block the inverse time element for neutral faults (I_{Ep})

E.3.2 Overcurrent Protection Status

There are six logical functions indicating overcurrent protection status that can be assigned to the relay outputs:

- FNo 301 The high-set element, I>>, for phase faults is turned off
- FNo 302 The high-set element, I_E>>, for neutral faults is turned off
- FNo 331 The definite time element, I>, for phase faults is turned off
- FNo 332 The definite time element, I_E>, for neutral faults is turned off
- FNo 361 The inverse time element, I_p, for phase faults is off turned
- FNo 362 The inverse time element, I_{Ep}, for neutral faults is turned off

E.3.3 Definite Time Overcurrent Protection

There are two overcurrent protection elements that operate in the definite time mode.

1202, 1203, 1206, 1502, 1503, 1506 High-Set Element

The high-set parameters consist of an overcurrent pickup value, a trip time delay, and a request for measurement repetition. All of these parameters can be set separately for phases and neutral. All measurements for the high-set element are based on the fundamental component.

1202, 1502

I>>, I_E>>

The high-set pickup value as a ratio of the fault current to the rated relay current.

For example, if a secondary current level that is twice the rated value should be considered a fault, then I>> would be set to 2.00.

When used for current grading before high impedances such as transformers, motors, and generators, I>> is normally set to pick up on short circuits in these impedances.

For example, if the impedance is a transformer, I>> would be set to

$$1.5\left(\frac{1}{Z_{K\,transf}}\right)\left(\frac{I_{N\,transf}}{R_{CT.}}\right)$$

where $Z_{Ktransf}$ = P.U. winding impedance
$I_{Ntransf}$ = nominal primary winding current
R_{CT} = ratio of rated primary and secondary currents

1203, 1503

T>>, T_E>>

The high-set time delay between fault detection and issuing a trip command. The fault must continue to exist from the time it is detected until the time delay expires for a trip command to be issued.

This parameter is a pure time delay that does not include the operating time of the protection function. This protection element can effectively be disabled by setting the time delay to infinity. The effect of inrush currents is reduced in the 7SJ511 by numerical filters. However, because inrush currents contain high fundamental wave components, it may be advisable to set short time delays. Normally, 50 to 100 milliseconds is a typical value.

1206, 1506
MEAS.REPET

Request for measurement repetition when the high-set element detects a fault.

When the parameters at addresses 1206 and/or 1506 are set to YES, an additional AC cycle is evaluated after the fault is initially detected before a fault condition is recorded and the protection function picks up. This capability is helpful in avoiding false pickups in difficult measuring conditions. This would include systems with high harmonic content, frequent transients, and/or unbalanced load conditions.

1212, 1213, 1512, 1513 Definite Time Element

Definite time parameters consist of a pickup value and trip time delay. Both of these parameters can be set separately for phases and neutral.

1212, 1512
I>, I_E>

The definite time pickup value as a ratio of the fault current to the rated relay current.

For example, if a secondary current level that is twice the rated value should be considered a fault, then I> would be set to 2.00.

The maximum load current determines the setting for I>. Pickup on overload must be excluded since the relay operates in this mode for short circuit protection. The setting should be 120% for feeder lines and 150% for transformers or motors, of the maximum load current. The maximum neutral current determines the setting for I_E>.

1213, 1513
T>, T_E>

Time delay between fault detection and issuing a trip command for the definite time element. The fault must continue to exist from the time it is detected until the time delay expires for a trip command to be issued.

This parameter is a pure time delay that does not include the operating time of the protection function. This protection element can effectively be disabled by setting the time delay to infinity. The time delay depends on the coordination plan of the network.

E.3.4 Inverse Time Overcurrent Protection

1211, 1214, 1215, 1216, 1511, 1514, 1515, 1516

Inverse time protection parameters consist of a selection of one of three delay time characteristics, specification of a pickup value, specification of a time multiplier, and selection of the type of waveform evaluation. All of these parameters can be set separately for phases and neutral.

1211, 1511
CHARACTER.

Selection of the trip time delay characteristic for the inverse time element.

The choices are:

- Normally inverse
- Very inverse
- Extremely inverse

Each of these three characteristics is an industry standard. Refer to the "Specifications" sections for details.

1214, 1514
I_p, I_{Ep}

The inverse time pickup value as a ratio of the fault current to the rated relay current.

For example, if a secondary current level that is twice the rated value should be considered a fault, then I_p would be set to 2.00.

Note: According to IEC 255-3, the protection should pick up only if the I/I_N ratio exceeds 1.05 times the set value. For the 7SJ511, the ratio must exceed 1.1 times the set value

1215, 1515
T_p, T_{Ep}

Multiplier for the normalized time delays of the selected inverse time characteristic (shifts the curve in time). This protection element can effectively be disabled by setting the time multiplier to infinity.

1216, 1516
RMS FORMAT

Selection of the waveform evaluation method for the inverse time element. Either the fundamental component of the current waveform or the true rms value can be selected.

E.3.5 Manual Closing of the Circuit Breaker Detected

1221, 1521

In cases where a tripped circuit breaker is closed manually, it may be desirable to temporarily use a modified form of the normally specified overcurrent protection. Parameters at addresses 1221 for phases and 1521 for neutral allow either the high-set element or the definite/inverse (depending on the setting of addresses 7812 and 7815) time element *with no time delay* to be effective during manual reclose. Alternatively, normal protection may be specified (INEFFECTIVE). In order for this parameter to be effective, it is required that logical function FNo 011, **>Manual Close**, be assigned to a binary input so that the relay is notified of the manual closing of the circuit breaker by a signal on the binary input (e.g., a momentary contact closure).

When activated, the modified trip delay is effective for a period of 300 milliseconds.

E.4 Waveform Capture (2800)

The Waveform Capture parameters are in address block 2800. These parameters include on/off control, what initiates recording, and the fault record destination.

E.4.1 Waveform Capture On/Off Control

2801 Internal Control

If access to waveform capture data is desired, two configuration parameters must be set appropriately. The Scope of Functions parameter at address 7806 (see section E.11) must be set to EXIST, and the Control parameter at address 2801 must be set ON. If address 7806 is set to NON-EXIST, waveform capture processing will not occur. If address 7806 is set to EXIST and address 2801 is set to OFF, the data will be recorded but will not be available at the LCD or the serial ports.

External Control

Waveform capture can also be controlled by external commands through the binary inputs. The following logical functions are available for this purpose:

- FNo 007 Initiate waveform capture
- FNo 049 Turn on waveform capture function
- FNo 050 Turn off waveform capture function

If on/off control of the waveform capture feature by means of the binary inputs is configured, it is required that the parameter at address 2801 be set to ON.

E.4.2 Waveform Capture Status

There are two logical functions indicating waveform capture that can be assigned to the relay outputs:

- FNo 107 Waveform capture is active (data present or being transmitted)
- FNo 108 Waveform capture is turned off

E.4.3 Waveform Capture Parameters

2802 Initiating Waveform Capture

Waveform capture can be initiated either by pickup or by trip within the specified time period T_{REC} (address 2804).

2803 Destination of Recorded Fault Data

The captured waveforms can be directed to either the front (personal computer/programming device) or rear (substation control system) panel serial ports but not to both.

2804 Allowed Time to Trip Command (T_{REC})

You can specify a time period between fault detection and the trip command, within which waveform capture will be initiated. This timeout is applicable only if recording is initiated by Trip < T_{REC} (see address 2802). If the timeout expires with no trip command having been issued, no recording takes place. Adjustment of this timeout allows selective waveform capture based on protection element. Figure E-1 illustrates this graphically.

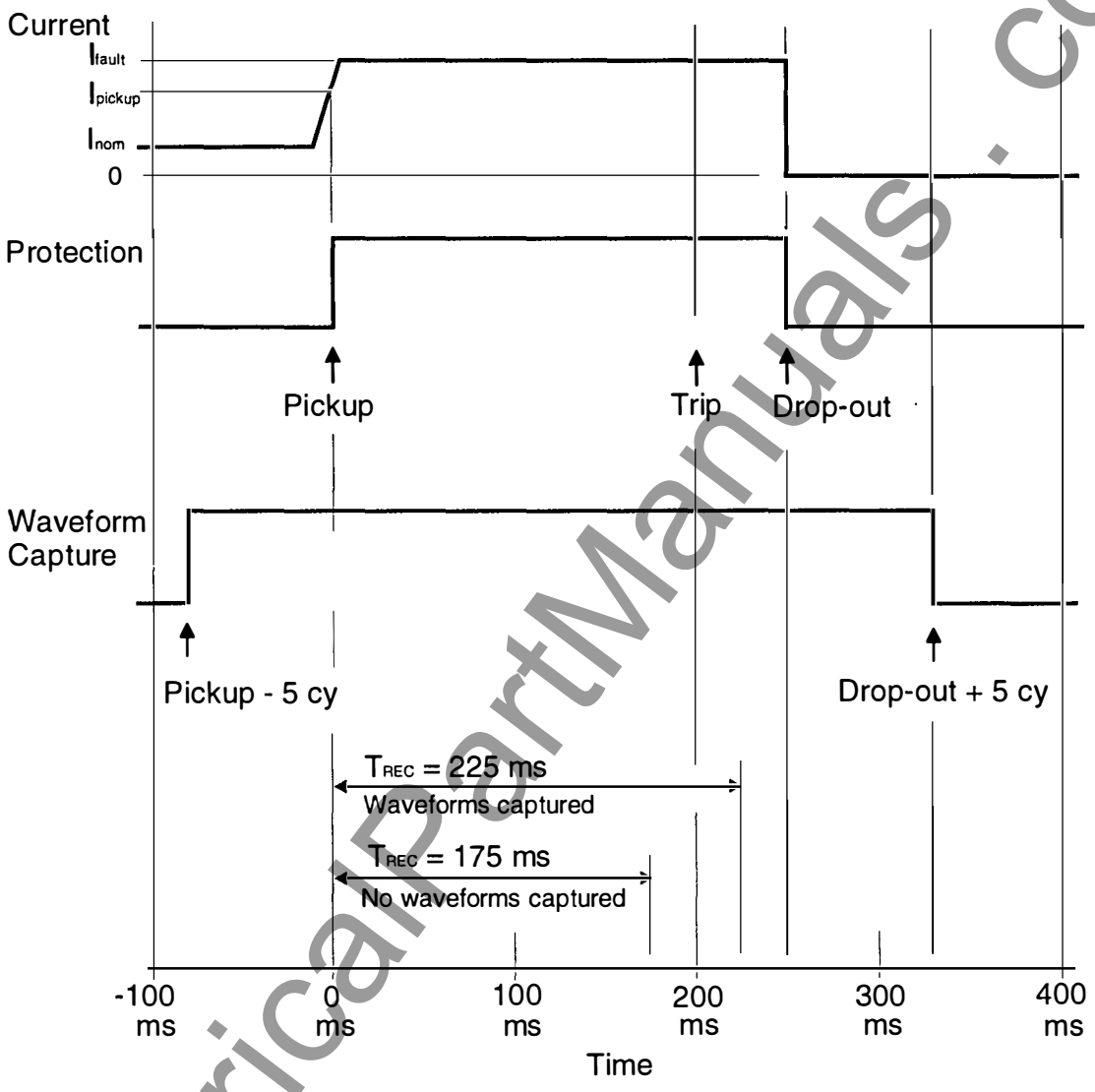


Figure E-1. Waveform Capture Event Sequence

E.5 Measured Value Supervision (2900)

The relay monitors the current measuring functions for faults. The complete chain, from input transformers up to and including the A/D converter, is monitored by a plausibility check on the measured values. To detect open or short circuits in the external measuring transformers and their connections, a current symmetry check is performed. Parameters for these checks are in address block 2900 and at address 1112.

E.5.1 Current Symmetry Check

The current symmetry check assumes that the phase currents are approximately symmetrical (of equal magnitude). Therefore:

for $$\frac{I_{max}}{I_N} > \frac{SYM.Ithres}{I_N},$$

the symmetry check function is defined by the equation:

$$\frac{|I_{min}|}{|I_{max}|} < SYM.Fact.I,$$

where I_{max} is always the largest of the three phase currents,
I_{min} is always the smallest of the three phase currents,
SYM.Ithres is the lower limit of the processing area of the monitoring function,
and *SYM.Fact.I* is the magnitude of asymmetry of the phase currents.

The above relationship is illustrated graphically in Figure E-2.

2903 SYM.Ithres Parameter

This parameter should be set to the current value above which you want the current symmetry check to be effective; i.e., the checking threshold. It is specified as a ratio of the desired current threshold to I_N (i.e., I/I_N). The permissible range of values is 0.10 to 1.00.

2904 SYM.Fact.I

This parameter is the magnitude of asymmetry of the phase currents for operation of current symmetry monitoring. It is equal to the slope of the symmetry characteristic. The permissible range of values is 0.10 to 0.95.

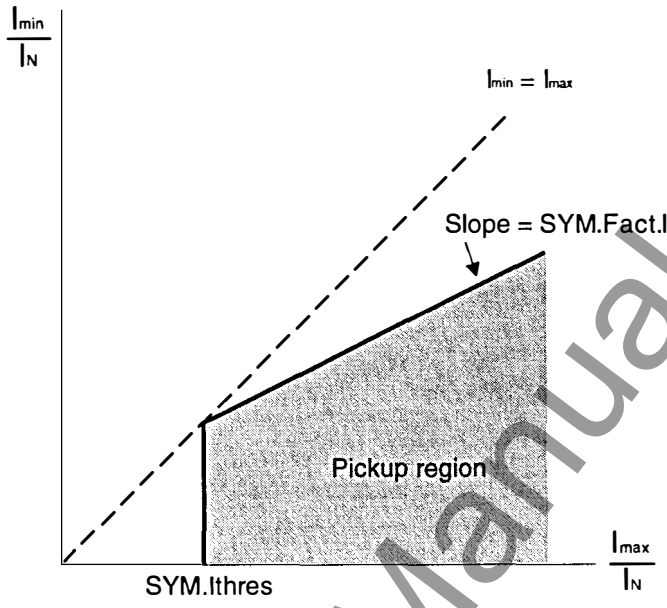


Figure E-2. Current Symmetry Monitoring

E.5.2 Current Summation Check

The plausibility check is on the instantaneous samples of the A/D converter (this check is applicable only if the residual current of the protected line is fed to the ground current input of the relay). The check is based on the assumption that in a *healthy* system

$$\left|i_{L1} + i_{L2} + i_{L3} + k_I i_E\right| \leq SUM.Ithres \cdot I_N + SUM.Fact.I \cdot I_{\max},$$

where k_I is the matching factor I_E / I_{ph} for the CT ratios,
SUM.Ithres and *SUM.Fact.I* are setting parameters,
and I_{max} is always the largest of the three phase currents.

Note: By definition *positive* current is current flowing *into* the relay terminals.

The CT ratio matching factor, k_I, is set as a parameter at address 1112. See section E.2.

The above relationship is illustrated graphically in Figure E-3.

2905 SUM.Ithres Parameter

This parameter should be set to the current value above which you want the current summation check to be effective; i.e. the checking threshold. It is specified as a ratio of the desired current threshold to I_N (i.e., I/I_N).The permissible range of values is 0.05 to 2.00.

2906 SUM.Fact.I

This parameter is the relative content (related to the maximum conductor current) for operation of current summation monitoring. The component *SUM.Fact.I* x I_{max} takes into account the permissible current proportional transformation errors in the input converters which can occur

under conditions of high short circuit current. The permissible range of values is 0.00 to 0.95. Graphically, this parameter is equivalent to the slope of the characteristic.

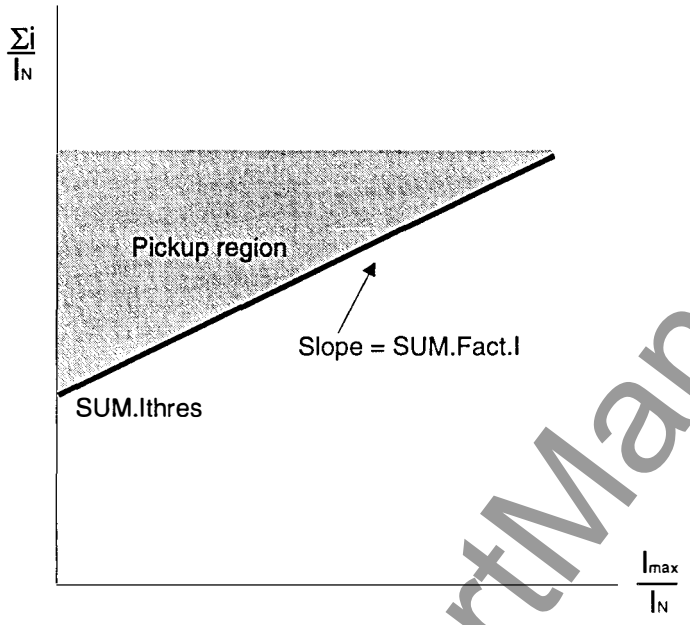


Figure E-3. Current Sum Monitoring

E.6 Breaker Failure Protection (3900)

To ensure that the circuit breaker functions correctly, the breaker failure protection element verifies that current flow is interrupted following a trip command. When the trip command is issued, a timer starts and runs as long as the trip command is active and the current continues to flow. If current flow continues until the timer expires, the breaker failure protection element can issue additional trip commands to upstream breakers. Breaker failure protection settings are in address block 3900.

E.6.1 Breaker Failure Protection On/Off Control

3901 Internal Control

The setting at address 3901 controls whether or not this protection function is active or not (on or off). When the function is active, processing (i.e., starting the timer and monitoring the current) can be initiated three ways:

1. Overcurrent fault detection
2. Binary input
3. Either overcurrent fault detection or binary input

External Control

Breaker failure protection can also be controlled by external commands through the binary inputs. The following logical functions are available to control breaker failure protection externally:

- FNo 075 Start breaker failure protection
- FNo 076 Turn on breaker failure protection
- FNo 077 Turn off breaker failure protection

If on/off control by means of the binary inputs is configured, it is required that both binary inputs be assigned to control the breaker failure protection feature - one to command turn-on and one to command turn-off. It is also necessary that the parameter at 3901 be set to ON.

E.6.2 Breaker Failure Protection Status

There are two logical functions indicating breaker failure protection status that can be assigned to the relay outputs. They provide an indication of the status and actions of the function:

- FNo 471 Breaker failure protection has been turned off
- FNo 473 Breaker failure protection timeout and current monitoring has started

E.6.3 Breaker Failure Protection Parameters

3902 Breaker Failure Protection Threshold

The current threshold, $I_{BF}>$, above which a breaker failure is indicated can be set at address 3902. If after the circuit breaker failure timer is started, the current drops below the threshold value, the circuit breaker is assumed to have operated successfully. This setting applies to all three phases of the protected system. The setting should be at least 10% below the smallest expected fault current, including neutral faults. However, the threshold should not be more sensitive than necessary to avoid extended timeouts due to transient phenomena in the current transformers after interruption of high short circuit currents.

3903 Breaker Failure Protection Time Delay

The time delay, T_{BF}, is set at address 3903. This parameter should be equal to the maximum tripping time of the circuit breaker plus the reset time of the current detectors plus a safety margin:

$$T_{BF} = \text{CB trip time} + I_{BF}> \text{reset} + \text{safety margin.}$$

The complete fault clearance timing sequence is illustrated in Figure E-4.

The breaker failure protection function can be assigned to either the trip relays or to the signal relays. If it is assigned to a signal relay, an external relay will normally be required to provide adequate switching capacity.

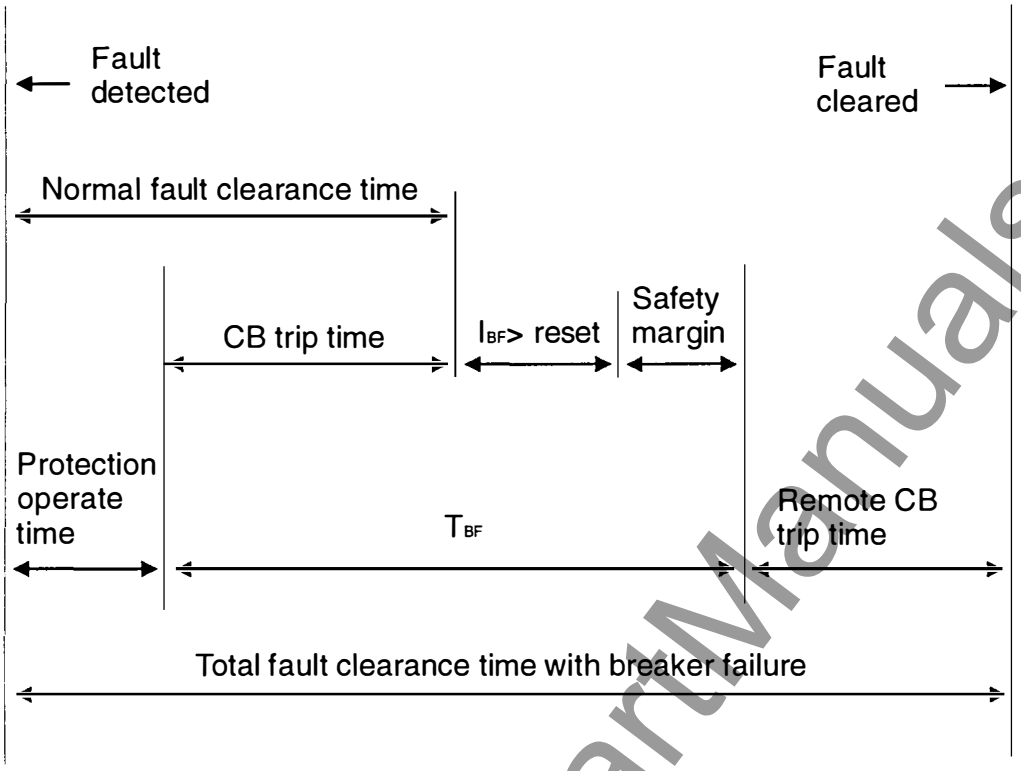


Figure E-4. Fault Clearance Time Sequence (with/without Breaker Failure)

E.7 Circuit Breaker Trip Test (4000)

A single test function that determines whether the relay can successfully trip the associated circuit breaker can be initiated from the operator panel. This test is initiated using address 4404. See the "Commissioning the Relay" chapter.

E.8 Configuration (Marshalling) (6000)

Configuration is the process of assigning one or more logical functions to each of the physical input/output (I/O) units. The relay has a large number of predefined logical functions. Each logical function has a unique three digit function number (FNo) assigned to it. A complete list of logical functions that can be configured is provided in Table E-3.

The configuration settings in address block 6000 tell the relay what action to take and how. You can configure each of the relay functions listed below:

1. Input
   - Fault Detection
   - Binary Inputs
2. Processing
   - Logical Functions
3. Output
   - Signal Relays
   - LED Indicators
   - Trip (Command) Relays

The relationship of the three main function groups in the configuration process is the traditional case of input being processed to generate output.

Input → Processing → Output

In operation, an input can activate one or more logical functions. Fault detection inputs are incorporated into the definition of the logical function. Each of the activated logical functions can then activate one or more of the output devices. Each binary input can activate up to 10 logical functions. Signal relays, LEDs, and trip relays can be activated by up to 20 logical functions. Each logical function can activate multiple output units (signal relays, LEDs, etc.) and can be activated by multiple binary inputs. The total number of binary inputs and physical output units associated with each logical function may not exceed 10.

An Example

As an example, assume that an overcurrent fault on phase 1 of the system is detected by the relay's high-set overcurrent element (I>>). It is required that this event send a signal to another part of the system by means of Signal Relay 4 and the circuit breaker be tripped by Trip Relay 2. In addition, the relay should turn on LED 2 and be prepared to start breaker failure protection if signaled to do so on Binary Input 2.

To program the relay for these requirements, the following assignments could be made:

Assign logical function ...	**to I/O address ...**
FNo 312 (Fault L1 I>>)	6204 (Signal Relay 4)
FNo 322 (Trip I>>)	6402 (Trip Relay 2)
FNo 312 (Fault L1 I>>)	6302 (LED 2)
FNo 075 (>Start B/F)	6102 (Binary Input 2)

Be aware that these are not the only assignments that could be made to accomplish the results described above. The same results in combination with other requirements can be achieved with other assignments. For example, substituting FNo 451, **Gen. Trip**, for FNo 322 above meets the described requirements, but additionally activates Trip Relay 2 on any overcurrent fault.

Table E-1 lists all of the programmable I/O addresses along with the factory presettings.

Table E-1. Configuration Factory Presettings

Address No.	**I/O Unit**	**Index No.**	**FNo**	**LCD Text** (2nd Line)
6101	Binary Input 1	001	006	>LED reset NO
6102	Binary Input 2	001	081	>Block I>> NO
6201	Signal Relay 1	001	400	Gen. Fault
6202	Signal Relay 2	001 002	151 154	Failure ∑I Failure Isymm
6203	Signal Relay 3	001 002 003	312 313 314	Fault L1 I>> Fault L2 I>> Fault L3 I>>
6204	Signal Relay 4	001	451	Gen. Trip
6301	LED 1	001 002	151 154	Failure ∑I nm Failure Isymm nm
6302	LED 2	001	401	Fault L1 m
6303	LED 3	001	402	Fault L2 m
6304	LED 4	001	403	Fault L3 m
6305	LED 5	001	311	Flt I>> Ie>> m
6306	LED 6	001	451	Gen. Trip m
6401	Trip Relay 1	001	451	Gen. Trip
6402	Trip Relay 2	001	321	Trip I>> Ie>>

E.8.1 Binary Inputs (6100)

Table E-2 lists the logical functions that can be assigned to the binary inputs. Any logical function involving a protective function that has not been configured or has been blocked will not be effective. Up to 10 logical functions can be assigned to a single binary input. Binary input functions are assigned at address block 6100.

Normally Open/Normally Closed Mode

For each input function, you can specify whether the function will operate in the *Normally Open* (NO) or *Normally Closed* (NC) mode. All preset input assignments are set to operate in NO mode.

- NO - means a voltage *applied to* the input terminals *turns on* the function.
- NC - means a normally present voltage *removed from* the input terminals *turns on* the function.

Except for the on/off control functions, the voltage level must be present at the binary input as long as the state of the function is to be maintained. The on/off control functions are latched in the relay memory and can be activated by a momentary signal on the binary input.

User Defined Functions

The relay provides two user defined functions (FNo 21, **>Annunc. 1** and FNo 22, **>Annunc. 2**) that can be assigned to binary inputs These functions, when activated will generate an entry in the Event log and can be assigned to any of the output devices. These functions are not latched and require continuous signal input to maintain an active state.

Table E-2. Binary Input Functions

FNo	**LCD Text** (2nd Line)	**Description**
001	not allocated	No function assigned
005	>Time Synchro	Synchronize internal real-time clock
006	> LED reset	Reset stored LED indicators
007	>Start FltRec	Start waveform capture
011	>Manual Close	Circuit breaker manual close indication
013	>CB Test	Initiate circuit breaker test
021	>Annunc. 1	User-defined display message 1
022	>Annunc. 2	User-defined display message 2
031	>O/C ph on	Turn on overcurrent protection for phase currents *
032	>O/C ph off	Turn off overcurrent protection for phase currents *
033	>O/C e on	Turn on overcurrent protection for neutral current *
034	>O/C e off	Turn off overcurrent protection for neutral current *
049	>Flt.Rec on	Turn on waveform capture *
050	>Flt.Rec off	Turn off waveform capture *
059	>ParamSelec.1	Parameter set select 1
060	>ParamSelec.2	Parameter set select 2
075	>Start B/F	Start breaker failure protection
076	>B/F on	Turn on breaker failure protection *
077	>B/F off	Turn off breaker failure protection *
081	>Block I>>	Block I>>
082	>Block Ie>>	Block I_E>>
083	>Block I>	Block I>
084	>Block Ie>	Block I_E>
085	>Block Ip	Block I_p
086	>Block Iep	Block I_{Ep}

** These inputs are latched in the relay memory.*

E.8.2 Signal Relays (6200)

Table E-3 lists the logical functions that can be assigned to the output signal relays. Any logical function involving a protective function that has not been configured or has been blocked will not be effective. Signal relay functions are assigned in address block 6200. Up to 20 logical functions can be assigned to a single signal relay.

Note: Output signal relay functions with numbers below 100 are identical to those for the binary inputs. They can be used as a confirmation of the binary input and are available as long as the binary input is active. This capability for these functions is flagged in the LCD text by the leading ">" character.

Table E-3. Signal Relay and LED Functions

FNo	**LCD Text** (2nd Line)	**Description**
001	not allocated	No function assigned
005	>Time Synchro	Synchronize internal real-time clock
006	> LED reset	Reset stored LED indicators
007	>Start FltRec	Start waveform capture
011	>Manual Close	Circuit breaker manual-close indication
013	>CB Test	Initiate circuit breaker test
021	>Annunc. 1	User defined annunciation 1
022	>Annunc. 2	User defined annunciation 2
031	>O/C ph on	Turn on overcurrent protection for phases
032	>O/C ph off	Turn off overcurrent protection for phases
033	>O/C e on	Turn on overcurrent protection for neutral
034	>O/C e off	Turn off overcurrent protection for neutral
049	>Flt.Rec on	Turn on waveform capture function
050	>Flt.Rec off	Turn off waveform capture function
059	>ParamSelec.1	Parameter set selection 1
060	>ParamSelec.2	Parameter set selection 2
075	>Start B/F	Start breaker failure protection
076	>B/F on	Turn on breaker failure protection
077	>B/F off	Turn off breaker failure protection
081	>Block I>>	Block I>>
082	>Block Ie>>	Block I_E>>
083	>Block I>	Block I>
084	>Block Ie>	Block I_E>
085	>Block Ip	Block I_p
086	>Block Iep	Block I_{Ep}
101	Dev.Operative	Protection relay operational
106	LED reset	Stored LED indications have been reset
107	Flt.Rec.Activ	Waveform capture data is available or being transmitted
108	Flt.Rec. OFF	Waveform capture is turned off
110	Param.Running	Parameters are being set
111	Manual Close	Manual close indication received via binary input
113	CB in Test	Circuit breaker test is in progress
116	Param. Set A	Parameter set A is active
117	Param. Set B	Parameter set B is active
118	Param. Set C	Parameter set C is active
119	Param. Set D	Parameter set D is active
121	Failure 12V	Failure in 12 V internal power supply circuit
122	Failure 15V	Failure in 15 V internal power supply circuit
123	Failure 5V	Failure in 5 V internal power supply circuit
124	Failure 0V	Failure in 0 V internal offset for analog-digital converters
125	Failure RKA	Failure in trip relay circuits on base I/O board RKA

FNo	**LCD Text** (2nd Line)	**Description**
151	Failure ∑I	Failure detected by measured current sum monitor
154	Failure Isymm	Failure detected by measured current symmetry monitor
221	Device FltDet	General fault detection
251	Device Trip	General trip signal
301	O/C I>> off	I>> is turned off
302	O/C Ie>> off	I_E>> is turned off
311	Flt I>> Ie>>	Fault detected by high-set element
312	Fault L1 I>>	Fault detected by I>> in phase 1
313	Fault L2 I>>	Fault detected by I>> in phase 2
314	Fault L3 I>>	Fault detected by I>> in phase 3
315	Fault E Ie>>	Fault detected by I>> in neutral
316	T-I>> expired	I>> trip delay has expired
317	T-Ie>> expird	I_E>> trip delay has expired
321	Trip I>> Ie>>	Trip command issued by I>>or I_E>>
322	Trip I>>	Trip command issued by I>>
323	Trip Ie>>	Trip command issued by I_E>>
331	O/C I> off	I> is turned off
332	O/C Ie> off	I_E> is turned off
341	Flt I> Ie>	Fault detected by I> or I_E>
342	Fault L1 I>	Fault detected by I> in phase 1
343	Fault L2 I>	Fault detected by I> in phase 2
344	Fault L3 I>	Fault detected by I> in phase 3
345	Fault E Ie>	Fault detected by I_E> in neutral
346	T-I> expired	I> trip delay has expired
347	T-Ie> expird	I_E> trip delay has expired
351	Trip I> Ie>	Trip command issued by I>or I_E>
352	Trip I>	Trip command issued by I>
353	Trip Ie>	Trip command issued by I_E>
361	O/C Ip off	I_p is turned off
362	O/C Iep off	I_{Ep} is turned off
371	Flt Ip Iep	Fault detected by I_p or I_{Ep}
372	Fault L1 Ip	Fault detected by I_p in phase 1
373	Fault L2 Ip	Fault detected by I_p in phase 2
374	Fault L3 Ip	Fault detected by I_p in phase 3
375	Fault E Iep	Fault detected by I_p in neutral
376	T-Ip expired	I_p trip delay has expired
377	T-Iep expird	I_{Ep} trip delay has expired
381	Trip Ip Iep	Trip command issued by I_p or I_{Ep}
382	Trip Ip	Trip command issued by I_p
383	Trip Iep	Trip command issued by I_{Ep}
400	Gen. Fault	General fault detection by overcurrent protection
401	Fault L1	Overcurrent fault on phase 1

FNo	**LCD Text** (2nd Line)	**Description**
402	Fault L2	Overcurrent fault on phase 2
403	Fault L3	Overcurrent fault on phase 3
404	Fault E	Overcurrent fault on neutral
451	Gen. Trip	Trip command issued by overcurrent protection
471	B/F OFF	Breaker failure protection has been turned off
473	Fault B/F	Breaker failure protection fault
475	Trip B/F	Trip command issued by breaker failure protection
880	CB Test Trip	Trip command issued by circuit breaker test function

E.8.3 LEDs (6300)

The LED indicators are assigned to relay functions in address block 6300. The 7SJ511 relay has six programmable LEDs. The logical functions that can be assigned to the six programmable LEDs are the same as for the output signal relays as shown in Table E-3. Up to 20 logical functions can be assigned to a single LED.

Latched/Unlatched Mode

For each LED function, you can specify whether the function will operate in the *latched* (m) or *unlatched* (nm) mode. If an LED operating in latched mode is turned on, this event will be stored (**m**emorized) in the nonvolatile memory and the LED will remain on as long as the stored indication has not been reset by commands through the serial ports or binary inputs, or use of the **`Target Reset`** key. Otherwise, an unlatched LED will not be stored (**n**ot **m**emorized) and the LED will turn off when the condition that turned it on no longer exists.

E.8.4 Trip Relays (6400)

The trip relays are assigned to functions in address blocks 6400. The 7SJ511 relay has two trip relays. Although all of the logical functions that can be assigned to the output signal relays can also be assigned to the trip relays, the list of functions in the table below are particularly suitable and are recommended for assignment to the trip relays. Any logical function involving a protective function that has not be configured or has been blocked will not be effective. Up to 20 logical functions can be assigned to a single trip relay.

Table E-4. Trip (Command) Relay Recommended Functions

FNo	**LCD Text** (2nd Line)	**Description**
001	not allocated	No function assigned
221	Device FltDet	General fault detection
251	Device Trip	General trip signal
321	Trip I>> Ie>>	Trip command issued by I>>or I_E>>
322	Trip I>>	Trip command issued by I>>
323	Trip Ie>>	Trip command issued by I_E>>
351	Trip I> Ie>	Trip command issued by I>or I_E>
352	Trip I>	Trip command issued by I>
353	Trip Ie>	Trip command issued by I_E>
381	Trip Ip Iep	Trip command issued by I_p or I_{Ep}
382	Trip Ip	Trip command issued by I_p
383	Trip Iep	Trip command issued by I_{Ep}
400	Gen. Fault	General fault detection by overcurrent protection
451	Gen. Trip	Trip command issued by overcurrent protection
475	Trip B/F	Trip command issued by breaker failure protection
880	CB Test Trip	Trip command issued by circuit breaker test function

E.9 Substation Control System Configuration (6900)

6902 Rear Port Transmission Rate

One of three data transmission speeds for the rear serial port can be selected at address 6902. The choices are 4800, 9600, and 19200 bps.

E.10 Operating Parameters (7000)

The operating parameters in address block 7000 include a language specification, selecting the data transmission rate for the front serial port, selecting the date format for the real time clock, and choice of what data to display in the LCD during normal operation.

7001 Language Setting

The language in which information is displayed in the LCD can be either English or German.

7002 Front Serial Port Data Rate

The data transmission rate for the front serial port can be selected from one of six different speeds ranging from 1200 to 38400 bps (baud).

7003 Date Format for the Real-Time Clock

One of two formats for the date setting of the real-time clock must be specified. You may select either the American *Month/Day/Year* or the European *Day.Month.Year* formats.

7004 Fault Indication Condition

LED indications and the fault event messages can be initiated either by fault detection or after a trip command has been issued.

7005, 7006 Data Display for Normal Operating Conditions
During normal operation when there are no fault conditions present, the relay will display system data. This data can be any of the measured system values. There are four measured system values - three phase currents and one neutral current. The data can be displayed as either primary values or a percentage of the rated CT primary current specified at address 1105. A different value can be displayed on each of the two lines of the LCD.

7007, 7008 Data Display for Fault Conditions
When fault conditions occur, the display changes to a display of fault messages. Any one of six different fault messages can be selected to display in the first line of the LCD. Another of the same six messages can be selected to display in the second line of the LCD. The fault messages can be acknowledged either by the operator pressing the **Target Reset** key or by commands received through the serial ports. When the messages are acknowledged, the relay automatically resumes display of the normal condition data.

7009 Device Address
If the relay is attached to a subsystem control network through the rear port, address 7009 is set to the address of the relay in the subsystem control communication network.

7010 Feeder Address
The identifying number of the power system feeder that the relay is protecting is set at address 7010.

E.11 Scope of Functions (7800)

The Scope of Function parameters in address block 7800 include a variety of on/off controls, the time characteristic for overcurrent protection, and the frequency of the power system being protected.

7806 Activating Waveform Capture
If access to captured waveforms is desired, two configuration parameters must be set appropriately. The Scope of Functions parameter at address 7806 must be set to EXIST, and the Control parameter at address 2801 must be set ON. If address 7806 is set to NON-EXIST, no fault recording processing will occur. If address 7806 is set to EXIST and address 2801 is set to OFF, the data will be recorded but will not be available at the LCD or the serial ports. On/off control of fault recording can also be done through the binary inputs.

7812, 7815 Protection Mode
These parameters select the protection mode, either definite time or inverse time, for phase and neutral overcurrent protection.

7814 Substation Control System Connection
The parameter at address 7814 is set according to whether or not the relay is connected to a substation control system through the rear port.

7885 Activating Parameter Changeover
In order to use this feature, the optional real-time clock feature must be installed and the parameter at address 7885 must be set to EXIST.

7899 System Frequency
The parameter at address 7899 identifies the system frequency as either 60 or 50 Hz.

E.12 Device Configuration (7900)

Address block 7900 contains a single device configuration parameter at address 7910. This parameter indicates what kind of circuit breaker test will be performed and is preset to THREE-POLE TRIP. This parameter cannot be changed.

E.13 Setting the Real-Time Clock (8100)

The parameters at address block 8100 are used in setting the optional real-time clock feature. There are no factory presets. See "Programming the Relay" for details.

E.14 Reset (8200)

The parameters at address block 8200 are used to erase stored data. There are no factory presets. See the "Maintenance" section for details.

E.15 Parameter Changeover (8500)

The Parameter Changeover (C/O) feature is an option that is provided along with the real-time clock option. If your relay model number is 7SJ511*-**A01-0*, the feature is present.

This feature allows up to four uniquely different sets of functional parameters (addresses between 1000 and 3999) to be defined. The active set of parameters can be changed during relay operation using either the operator panel, through a serial port, or by means of the binary inputs. In order to use this feature, the Scope of Functions parameter at address 7885 must be set to EXIST. The preprogrammed setting is NON-EXIST (see section E.11).

The presently active parameter set can be determined by displaying address 8501. Specifying which parameter set is to be the active set is done at address 8503. The preprogrammed option is SET A. This can be changed to SET B, SET C, or SET D. If you want to allow the parameter set to be selected by the binary inputs, set address 8503 to the last option, SET BY BINARY INPUT.

Selecting the Active Parameter Set with Binary Inputs
One of the options available for specifying the active parameter set is to allow the selection to be controlled by the binary inputs. When this option is selected, both of the available binary inputs must be assigned to this control function. The two inputs must be assigned to logical functions **ParamSelec.1** (FNo 059) and **ParamSelec.2** (FNo 060). Selection of the active parameter set may then be made as shown in the following table:

Table E-5. Controlling Parameter Changeover with Binary Inputs

Binary Input		
ParamSelec.1	**ParamSelec.2**	**Selects**
Off	Off	Set A
On	Off	Set B
Off	On	Set C
On	On	Set D

The binary input signals must be declared as normally open (NO) and must be continuously present to maintain the selected parameter set.

F. Setting Worksheets

These worksheets should be completed as you go through "Setting Calculations" to determine the system, protection, and relay configuration settings. Once you have completed the worksheets, Siemens recommends that you make at least one photocopy of the worksheets to distribute to personnel responsible for programming these settings in the relay. If the Parameter Changeover feature is used, a separate set of worksheets for each parameter set will be required.

Refer to "Programming the Relay" for step-by-step instructions on programming the relay settings. A copy of the worksheets is also provided in the "7SJ511 Quick reference Guide"

For parameters where a selection is to be made, the **Preset** column contains [x] beside the preprogrammed selection.

The text used in the worksheets is the exact text as displayed on the operator panel LCD. The following list provides the meaning of non-standard abbreviations used in the LCD:

LCD Text	Meaning
ADD	Address
BAUDR	Baud Rate
B/F	Breaker Failure
BI or BIN	Binary
C/O	Changeover
COMM	Command
CW	Codeword
DETEC	Detection
E or e or EAR or EARTH	Ground
ext	external
FNo	Function Number
INDIC	Indication
I>>	High-set element - phases
Ie>>	High-set element - neutral
I>	Definite time element - phases
Ie>	Definite time element - neutral
Iep	Inverse time element - neutral
Ip	Inverse time element - phases

LCD Text	Meaning
In	I_N - rated relay current
int	internal
Iph	Phase current, CT ratio
L	Line (Power or LCD)
MAN	Manual
MEAS	Measurement
O/C	Overcurrent
OPER	Operation
p or PH or ph	Phase
PARAM	Parameter
PD	Programming Device
PROT	Protection
REC or RECRD	Recording
REPET	Repetition
sc	short circuit
SUM	Summation
SYM	Symmetry

Parameter set : [ ] A [ ] B [ ] C [ ] D (if applicable)

1000 PARAMETERS

1100 POWERSYSTEM DATA

Addr.	LCD Text	Options/Range	Selection/Value	Preset
1105	In PRIMARY	10 - 50000	_____ A	400 A
1112	Ie/Iph	0.000 - 20.000	_____	1.000

1200 O/C PROT. PHASES

Addr.	LCD Text	Options/Range	Selection/Value	Preset
1201	O/C PHASES	ON	[ ]	[x]
		OFF	[ ]	
1202	I>>	0.10 - 25.00	_____ I/In	2.00 I/In
1203	T-I>>	0.00 - 60.00 / ∞	_____ s	0.10 s
1206	MEAS.REPET	NO	[ ]	[x]
		YES	[ ]	
1211	CHARACTER.	NORMAL INVERSE	[ ]	[x]
		VERY INVERSE	[ ]	
		EXTREMELY INVERS	[ ]	
1212	I>	0.10 - 25.00	_____ I/In	1.00 I/In
1213	T-I>	0.00 - 60.00 / ∞	_____ s	0.50 s
1214	Ip	0.10 - 4.00	_____ I/In	1.00 I/In
1215	T-Ip	0.05 - 3.20 / ∞	_____ s	0.50 s
1216	RMS FORMAT	I1 FOURIER	[ ]	[x]
		I TRUE	[ ]	
1221	MAN. CLOSE	I>> NO DELAY	[ ]	[x]
		I>/Ip NO DELAY	[ ]	
		INEFFECTIVE	[ ]	

1500 O/C PROT. EARTH

Addr.	LCD Text	Options/Range	Selection/Value	Preset
1501	O/C EARTH	ON	[ ]	[x]
		OFF	[ ]	
1502	Ie>>	0.10 - 25.00	_____ I/In	0.50 I/In
1503	T-Ie>>	0.00 - 60.00 / ∞	_____ s	0.50 s
1506	MEAS.REPET	NO	[ ]	[x]
		YES	[ ]	
1511	CHARACTER.	NORMAL INVERSE	[ ]	[x]
		VERY INVERSE	[ ]	
		EXTREMELY INVERS	[ ]	
1512	Ie>	0.10 - 25.00	_____ I/In	0.20 I/In
1513	T-Ie>	0.00 - 60.00 / ∞	_____ s	0.50 s
1514	Iep	0.10 - 4.00	_____ I/In	0.10 I/In
1515	T-Iep	0.05 - 3.20 / ∞	_____ s	0.50 s

Addr.	LCD Text	Options/Range	Selection/Value	Preset
1516	RMS FORMAT	I1 FOURIER	[ ]	[x]
		I TRUE	[ ]	
1521	MAN. CLOSE	IE>> NO DELAY	[ ]	[x]
		IE> NO DELAY	[ ]	
		INEFFECTIVE	[ ]	

2800 FAULT RECORDINGS

Addr.	LCD Text	Options/Range	Selection/Value	Preset
2801	FAULT REC.	ON	[ ]	[x]
		OFF	[ ]	
2802	INITIATION	BY FAULT DETEC.	[ ]	[x]
		BY TRIP <T-REC	[ ]	
2803	FAULT REC.	TO PC/PD	[ ]	[x]
		TO LSA	[ ]	
2804	T-REC	0.01 - 2.50	_____ s	0.30 s

2900 MEAS.VALUE SUPERVISION

Addr.	LCD Text	Options/Range	Selection/Value	Preset
2903	SYM.Ithres	0.10 - 1.00	_____ I/In	0.50 I/In
2904	SYM.Fact.I	0.10 - 0.95	_____	0.50
2905	SUM.Ithres	0.05 - 2.00	_____ I/In	0.10 I/In
2906	SUM.Fact.I	0.00 - 0.95	_____	0.10

3900 BREAKER FAILURE PROT.

Addr.	LCD Text	Options/Range	Selection/Value	Preset
3901	B/F PROT.	OFF	[ ]	[x]
		ON, internal	[ ]	
		ON, external	[ ]	
		ON, int. or ext.	[ ]	
3902	I> B/F	0.10 - 4.00	_____ I/In	0.20 I/In
3903	T-B/F	0.06 - 60.00 / ∞	_____ s	0.25 s

6000 MARSHALLING

6100 MARSHALLING BINARY INPUTS

(Note: Up to 10 logical functions may be assigned to each Binary Input)

Addr.	LCD Text	Preset Index	FNo	NO	NC
6101	INPUT 1	001	006	[x]	[ ]

Index	FNo	NO	NC	Index	FNo	NO	NC
001	_____	[ ]	[ ]	006	_____	[ ]	[ ]
002	_____	[ ]	[ ]	007	_____	[ ]	[ ]
003	_____	[ ]	[ ]	008	_____	[ ]	[ ]
004	_____	[ ]	[ ]	009	_____	[ ]	[ ]
005	_____	[ ]	[ ]	010	_____	[ ]	[ ]

Addr.	LCD Text	Preset Index	FNo	NO	NC
6102	INPUT 2	001	081	[x]	[ ]

Index	FNo	NO	NC	Index	FNo	NO	NC
001	_____	[ ]	[ ]	006	_____	[ ]	[ ]
002	_____	[ ]	[ ]	007	_____	[ ]	[ ]
003	_____	[ ]	[ ]	008	_____	[ ]	[ ]
004	_____	[ ]	[ ]	009	_____	[ ]	[ ]
005	_____	[ ]	[ ]	010	_____	[ ]	[ ]

6200 MARSHALLING SIGNAL RELAYS

(Note: Up to 20 logical functions may be assigned to each Signal Relay)

Addr.	LCD Text	Preset Index	Preset FNo
6201	RELAY 1	001	400

Index	FNo	Index	FNo	Index	FNo	Index	FNo
001		006		011		016	
002		007		012		017	
003		008		013		018	
004		009		014		019	
005		010		015		020	

Addr.	LCD Text	Preset Index	Preset FNo
6202	RELAY 2	001	151
		002	154

Index	FNo	Index	FNo	Index	FNo	Index	FNo
001		006		011		016	
002		007		012		017	
003		008		013		018	
004		009		014		019	
005		010		015		020	

Addr.	LCD Text	Preset	
		Index	FNo
6203	RELAY 3	001	312
		002	313
		003	314

Index	FNo	Index	FNo	Index	FNo	Index	FNo
001		006		011		016	
002		007		012		017	
003		008		013		018	
004		009		014		019	
005		010		015		020	

Addr.	LCD Text	Preset	
		Index	FNo
6204	RELAY 4	001	451

Index	FNo	Index	FNo	Index	FNo	Index	FNo
001		006		011		016	
002		007		012		017	
003		008		013		018	
004		009		014		019	
005		010		015		020	

6300 MARSHALLING LED INDICATORS

(Note: Up to 20 logical functions may be assigned to each LED)

Addr.	LCD Text	Preset			
		Index	FNo	nm	m
6301	LED 1	001	151	[x]	[ ]
		002	154	[x]	[ ]

Index	FNo	nm	m	Index	FNo	nm	m
001		[ ]	[ ]	011		[ ]	[ ]
002		[ ]	[ ]	012		[ ]	[ ]
003		[ ]	[ ]	013		[ ]	[ ]
004		[ ]	[ ]	014		[ ]	[ ]
005		[ ]	[ ]	015		[ ]	[ ]
006		[ ]	[ ]	016		[ ]	[ ]
007		[ ]	[ ]	017		[ ]	[ ]
008		[ ]	[ ]	018		[ ]	[ ]
009		[ ]	[ ]	019		[ ]	[ ]
010		[ ]	[ ]	020		[ ]	[ ]

Addr.	LCD Text	Preset			
		Index	FNo	nm	m
6302	LED 2	001	401	[ ]	[x]

Index	FNo	nm	m	Index	FNo	nm	m
001		[ ]	[ ]	011		[ ]	[ ]
002		[ ]	[ ]	012		[ ]	[ ]
003		[ ]	[ ]	013		[ ]	[ ]
004		[ ]	[ ]	014		[ ]	[ ]
005		[ ]	[ ]	015		[ ]	[ ]
006		[ ]	[ ]	016		[ ]	[ ]
007		[ ]	[ ]	017		[ ]	[ ]
008		[ ]	[ ]	018		[ ]	[ ]
009		[ ]	[ ]	019		[ ]	[ ]
010		[ ]	[ ]	020		[ ]	[ ]

Addr.	LCD Text	Preset			
		Index	FNo	nm	m
6303	LED 3	001	402	[ ]	[x]

Index	FNo	nm	m	Index	FNo	nm	m
001		[ ]	[ ]	011		[ ]	[ ]
002		[ ]	[ ]	012		[ ]	[ ]
003		[ ]	[ ]	013		[ ]	[ ]
004		[ ]	[ ]	014		[ ]	[ ]
005		[ ]	[ ]	015		[ ]	[ ]
006		[ ]	[ ]	016		[ ]	[ ]
007		[ ]	[ ]	017		[ ]	[ ]
008		[ ]	[ ]	018		[ ]	[ ]
009		[ ]	[ ]	019		[ ]	[ ]
010		[ ]	[ ]	020		[ ]	[ ]

Addr.	LCD Text	Preset			
		Index	FNo	nm	m
6304	LED 4	001	403	[ ]	[x]

Index	FNo	nm	m	Index	FNo	nm	m
001		[ ]	[ ]	011		[ ]	[ ]
002		[ ]	[ ]	012		[ ]	[ ]
003		[ ]	[ ]	013		[ ]	[ ]
004		[ ]	[ ]	014		[ ]	[ ]
005		[ ]	[ ]	015		[ ]	[ ]
006		[ ]	[ ]	016		[ ]	[ ]
007		[ ]	[ ]	017		[ ]	[ ]
008		[ ]	[ ]	018		[ ]	[ ]
009		[ ]	[ ]	019		[ ]	[ ]
010		[ ]	[ ]	020		[ ]	[ ]

Addr.	LCD Text	Preset Index	FNo	nm	m
6305	LED 5	001	311	[ ]	[x]

Index	FNo	nm	m	Index	FNo	nm	m
001		[ ]	[ ]	011		[ ]	[ ]
002		[ ]	[ ]	012		[ ]	[ ]
003		[ ]	[ ]	013		[ ]	[ ]
004		[ ]	[ ]	014		[ ]	[ ]
005		[ ]	[ ]	015		[ ]	[ ]
006		[ ]	[ ]	016		[ ]	[ ]
007		[ ]	[ ]	017		[ ]	[ ]
008		[ ]	[ ]	018		[ ]	[ ]
009		[ ]	[ ]	019		[ ]	[ ]
010		[ ]	[ ]	020		[ ]	[ ]

Addr.	LCD Text	Preset Index	FNo	nm	m
6306	LED 6	001	451	[ ]	[x]

Index	FNo	nm	m	Index	FNo	nm	m
001		[ ]	[ ]	011		[ ]	[ ]
002		[ ]	[ ]	012		[ ]	[ ]
003		[ ]	[ ]	013		[ ]	[ ]
004		[ ]	[ ]	014		[ ]	[ ]
005		[ ]	[ ]	015		[ ]	[ ]
006		[ ]	[ ]	016		[ ]	[ ]
007		[ ]	[ ]	017		[ ]	[ ]
008		[ ]	[ ]	018		[ ]	[ ]
009		[ ]	[ ]	019		[ ]	[ ]
010		[ ]	[ ]	020		[ ]	[ ]

6400 MARSHALLING TRIP RELAYS

(Note: Up to 20 logical functions may be assigned to each Trip Relay)

Addr.	LCD Text	Preset Index	Preset FNo
6401	TRIP RELAY 1	001	451

Index	FNo	Index	FNo	Index	FNo	Index	FNo
001		006		011		016	
002		007		012		017	
003		008		013		018	
004		009		014		019	
005		010		015		020	

Addr.	LCD Text	Preset Index	Preset FNo
6402	TRIP RELAY 2	001	321

Index	FNo	Index	FNo	Index	FNo	Index	FNo
001		006		011		016	
002		007		012		017	
003		008		013		018	
004		009		014		019	
005		010		015		020	

6900 LSA-CONFIGURATION

Addr.	LCD Text	Options/Range	Selection/Value	Preset
6902	BAUDRATE	9600 BAUD	[ ]	[x]
		4800 BAUD	[ ]	
		19200 BAUD	[ ]	

7000 OPERATING PARAMETERS

Addr.	LCD Text	Options/Range	Selection/Value	Preset
7001	LANGUAGE	ENGLISH	[ ]	[x]
		DEUTSCH (German)	[ ]	
		ITALIANO (Italian)	[ ]	
7002	OPER.BAUDR.	1200 BAUD	[ ]	[x]
		2400 BAUD	[ ]	
		4800 BAUD	[ ]	
		9600 BAUD	[ ]	
		19200 BAUD	[ ]	
		38400 BAUD	[ ]	
7003	DATE FORMAT	DD.MM.YYYY	[ ]	[x]
		MM/DD/YYYY	[ ]	
7004	FAULT INDIC	BY FAULT DETEC	[ ]	[x]
		BY TRIP COMM.	[ ]	
7005	OPER. 1st L	not allocated	[ ]	[x]
		IL1 = nnnnn A	[ ]	
		IL2 = nnnnn A	[ ]	
		IL3 = nnnnn A	[ ]	
		IE = nnnnn A	[ ]	
		IL1 = nnn.n %	[ ]	
		IL2 = nnn.n %	[ ]	
		IL3 = nnn.n %	[ ]	
		IE = nnn.n %	[ ]	
7006	OPER. 2nd L	not allocated	[ ]	[x]
		IL1 = nnnnn A	[ ]	
		IL2 = nnnnn A	[ ]	
		IL3 = nnnnn A	[ ]	
		IE = nnnnn A	[ ]	
		IL1 = nnn.n %	[ ]	
		IL2 = nnn.n %	[ ]	
		IL3 = nnn.n %	[ ]	
		IE = nnn.n %	[ ]	

Addr.	LCD Text	Options/Range	Selection/Value	Preset
7007	FAULT 1st L	not allocated	[ ]	[x]
		Fault Type	[ ]	
		Trip Type	[ ]	
		Prot.Pick-up	[ ]	
		Prot.Trip	[ ]	
		Time-to-Drop	[ ]	
		Time-to-Trip	[ ]	
7008	FAULT 2nd L	not allocated	[ ]	[x]
		Fault Type	[ ]	
		Trip Type	[ ]	
		Prot.Pick-up	[ ]	
		Prot.Trip	[ ]	
		Time-to-Drop	[ ]	
		Time-to-Trip	[ ]	
7009	DEVICE ADD.	0 - 255	_____	0
7010	FEEDER ADD.	0 - 255	_____	0

7800 SCOPE OF FUNCTIONS

Addr.	LCD Text	Options/Range	Selection/Value	Preset
7806	FAULT RECRD	EXIST	[ ]	[x]
		NON-EXIST	[ ]	
7812	CHARAC. PH	DEFINITE TIME	[ ]	[x]
		INVERSE TIME	[ ]	
7814	LSA	NON-EXIST	[ ]	[x]
		EXIST	[ ]	
7815	CHARAC. E	DEFINITE TIME	[ ]	[x]
		INVERSE TIME	[ ]	
7885	PARAM. C/O	NON-EXIST	[ ]	[x]
		EXIST	[ ]	
7899	FREQUENCY	fN 60 Hz	[ ]	[x]
		fN 50 Hz	[ ]	

7900 DEVICE CONFIGURATION

Addr.	LCD Text	Options/Range	Selection/Value	Preset
7910	CB TEST PRG	THREE-POLE TRIP	(no options)	[x]

8000 DEVICE CONTROL

Addr. No.	LCD Text	Selection/Value
8100	**SETTING REAL TIME CLOCK**	See "Programming the Relay" in this manual
8200	**RESET**	See "Erasing Stored Data" in the "Maintenance" chapter of this manual

8500 PARAMETER CHANGE-OVER

Addr.	LCD Text	Options/Range	Selection/Value	Preset
8501			See "Programming the Relay" in this manual	
8503	ACTIVATION	SET A	[ ]	[x]
		SET B	[ ]	
		SET C	[ ]	
		SET D	[ ]	
		SET BY BINARY INPUT	[ ]	

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G. Input/Output Functions

The following table lists, in Function Number (FNo) order, all logical functions that can be configured to physical input/output (I/O) units in the 7SJ511 relay. Refer to "Programming the Relay" for instructions on configuring the I/O units and for information on the presettings for logical functions.

Regarding the table headings:

- "X" in the "Binary Input" column indicates the function can be programmed to a binary input. Notice that only function numbers 001 through 099 fit into this category.
- "X" in the "Relay/LED" column indicates the function can be programmed to an output relay and/or an LED.
- "C" or "C/G" in the "OP/Front Port" column means the function (event) can be read out using the relay operator panel or a PC, with DIGSI® software, connected to the relay at the front port.
- "C" or "C/G" in the "Rear Port" column means the function (event) can be read out from a substation control system when the rear port of the relay is enabled.

The "C" tag indicates the event is logged at pickup. The "G" tag indicates that the message is logged at drop-out. "C/G" indicates that the event is logged at both pickup and drop-out.

FNo	LCD Text	Function	Binary Input	Relay/ LED	OP/ Front Port	Rear Port
353	Trip Ie>	Trip command issued by IE>		X		C
361	O/C Ip off	Ip is turned off		X	C/G	C/G
362	O/C Iep off	IEp is turned off		X	C/G	C/G
371	Fault Ip Iep	Fault detected by Ip or IEp		X		C/G
372	Fault L1 Ip	Fault detected by Ip on phase 1		X		C/G
373	Fault L2 Ip	Fault detected by Ip on phase 2		X		C/G
374	Fault L3 Ip	Fault detected by Ip on phase 3		X		C/G
375	Fault E Iep	Fault detected by Ip on neutral		X		C/G
376	T-Ip expired	Ip trip delay has expired		X	C	C
377	T-Iep expird	IEp trip delay has expired		X	C	C
381	Trip Ip Iep	Trip command issued by Ip or IEp		X		C
382	Trip Ip	Trip command issued by Ip		X		C
383	Trip Iep	Trip command issued by IEp		X		C
400	Gen. Fault	General fault detected by overcurrent protect.		X		C/G
401	Fault L1	Overcurrent fault on phase 1		X		C/G
402	Fault L2	Overcurrent fault on phase 2		X		C/G
403	Fault L3	Overcurrent fault on phase 3		X		C/G
404	Fault E	Overcurrent fault on neutral		X		C/G
451	Gen. Trip	Trip command by overcurrent protection		X	C	C
471	B/F off	Breaker failure protection is turned off		X	C/G	C/G
473	Fault B/F	Breaker failure protection fault		X	C/G	C/G
475	Trip B/F	Trip command by breaker failure protection		X	C	C
481	Flt L1	Fault on phase 1			C	C
482	Flt L1E	Fault on phase 1 and neutral			C	C
483	Flt L2	Fault on phase 2			C	C
484	Flt L2E	Fault on phase 2 and neutral			C	C
485	Flt L12	Fault on phase 1 and phase 2			C	C
486	Flt L12E	Fault on phase 1, phase 2, and neutral			C	C
487	Flt L3	Fault on phase 3			C	C
488	Flt L3E	Fault on phase 3 and neutral			C	C
489	Flt L13	Fault on phase 1 and phase 3			C	C
490	Flt L13E	Fault on phase 1, phase 3, and neutral			C	C
491	Flt L23	Fault on phase 2 and phase 3			C	C
492	Flt L23E	Fault on phase 2, phase 3, and neutral			C	C
493	Flt L123	Fault on phase 1, phase 2 and phase 3			C	C
494	Flt L123E	Fault on phases 1, 2, 3, and neutral			C	C
495	Flt E	Fault on neutral			C	C
880	CB Test Trip	Trip command by circuit breaker test function		X		
900	Dev. Drop-off	Return to no-fault conditions			C	C

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