SEL-RTS
RELAY TEST SYSTEM

SEL-AMS ADAPTIVE MULTICHANNEL SOURCE
SELTEST™ SOFTWARE (MS DOS)
SEL-5401 TEST SYSTEM SOFTWARE (WINDOWS®95, WINDOWS®NT)

INSTRUCTION MANUAL

FEBRUARY 3, 1997

SEL-RTS INSTRUCTION MANUAL
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SEL ® | # SEL-RTS Relay Test System

SEL-AMS Adaptive Multichannel Source
SELTEST™ Software (DOS)
SEL-5401 Test System Software (Windows®95, Windows®NT)

DATA SHEET

The SEL-RTS Relay Test System is designed for testing protective relays having low-level test capabilities. The system consists of the SEL-AMS Adaptive Multichannel Source and either the SEL-5401 or SELTEST™ software.

SEL-AMS ADAPTIVE MULTICHANNEL SOURCE

- Twelve analog output channels (±5 volts peak)

- Replays downloaded waveforms or generates sinusoids with 16-bit precision

- Six sense inputs for monitoring relay contacts

- Ten contact outputs for driving relay logic inputs

- Includes 50 VA source of 24, 48, 125, 250 Vdc

- Buffered outputs for monitoring analog and digital signals

SEL-5401 AND SELTEST SOFTWARE

- SELTEST for DOS and SEL-5401 for Windows 95 and Windows NT

- Multistate capability supports simulating power system changes

- Amplitude ramping allows relay element threshold tests

- Programmable inputs and outputs simulate circuit breakers, communications, etc.

- COMTRADE file support for signal definition, including EMTP simulations

- System frequency ramping

GENERAL FEATURE DESCRIPTION

Overall System

The SEL-RTS consists of the SEL-AMS Adaptive Multichannel Source, PC-based SEL-5401 or SELTEST software, and a personal computer supplied by the user.

Low-Level Test Philosophy

The SEL-RTS bypasses digital relay input transformers (Figure 1). Testing from the secondary side of the relay input transformers eliminates large amplifiers.
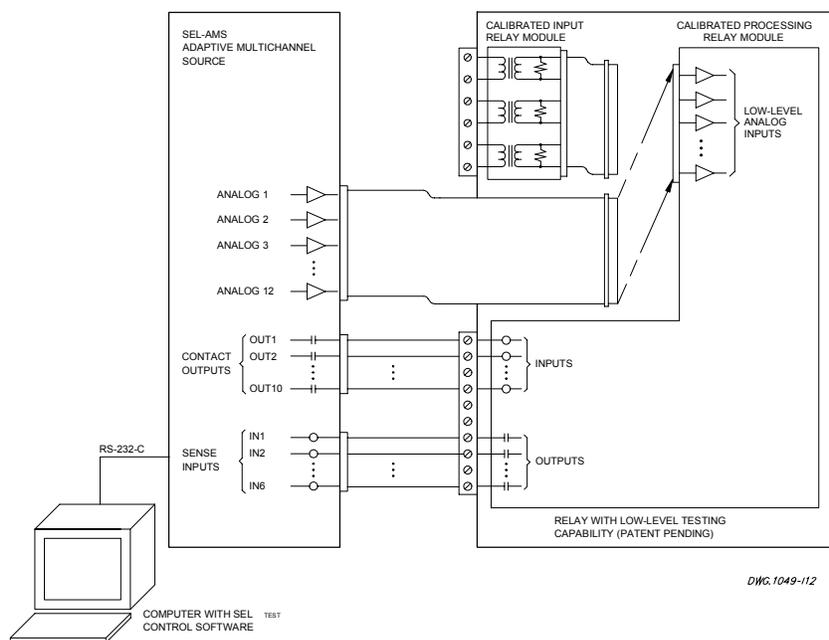
Figure 1: Low-Level Digital Relay Test

SEL-AMS Features

Analog Outputs. Twelve analog outputs can simulate voltages and/or currents. Test one or more simple relays or two distance relays simultaneously.

Sense Inputs and Contact Outputs. The six sense inputs, ten contact outputs, and programmable logic are available to measure operating times and to simulate circuit breaker and communications schemes.

Front-Panel LEDs. These LEDs indicate the state of each sense input and contact output.

Front-Panel Monitor Points. Two 25-pin connectors on the front panel make the 12 analog outputs and 16 contact I/O points available for monitoring and recording.

2

Serial Port. One EIA-232 serial port provides computer communications.

DC Power Source. Two 125 Vdc outputs and two 24 Vdc outputs are available for wetting sense inputs and powering relays. These may be connected for 24, 48, 125, or 250 Vdc, and can supply up to 50 VA.

SEL-5401 AND SELTEST SOFTWARE FEATURES

Testing with States. Define a test as a sequence of up to 255 states (three shown in Figure 2). Link states together to create a test file. Run the tests from a menu or directly from the operating system prompt. View test results through a Results window, or examine the tests results by reading automatically created ASCII files.

STATE #01   STATE #02   STATE #03
PRE-FAULT   FAULT   POST-FAULT
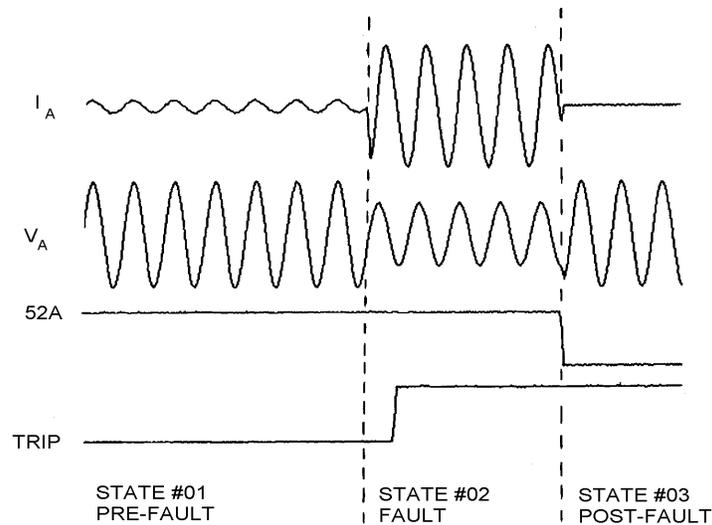
Figure 2: Example of Pre-Fault, Fault, and Post-Fault States

Programmable Test Lengths. Run tests of virtually any length. Select time periods in individual test states from 0.5 ms to days. Test states may loop to repeat indefinitely.

Programmable States. Design test sequences using menus and windows. State changes and terminations can occur at selected times or when selected inputs assert.

The Standard State window (Figure 3 and Figure 4) defines or shows the most important information for three states, simultaneously.

The Extended State window (Figure 5 and Figure 6) adds more choices to state definition, including selection of next state to run, ramping of analog signals, and ramping of system frequency.

Figure 3: SELTEST Software (DOS) Standard State Window Handles Most Important Information for Three States
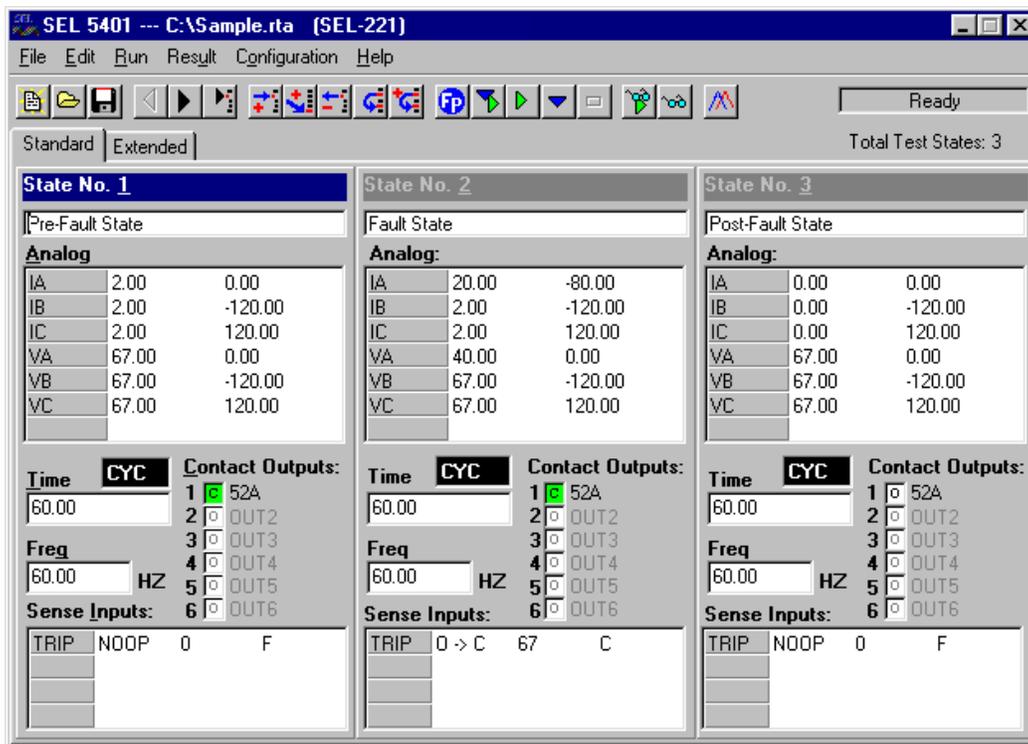
Figure 4: SEL-5401 (Windows 95, Windows NT) Standard State Window Handles Most Important Information for Three States
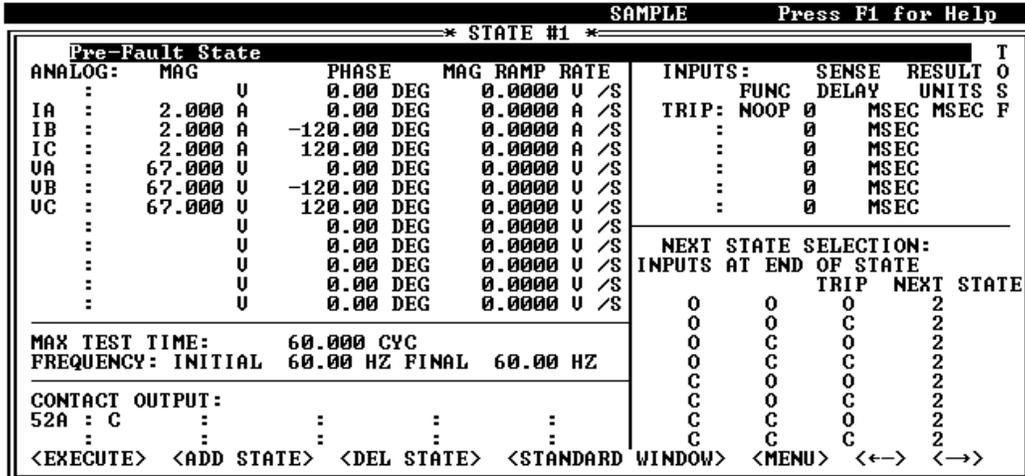
Figure 5: SELTEST **Software (DOS) Extended State Window Includes Amplitude and Frequency Ramping and Next-State Programming**
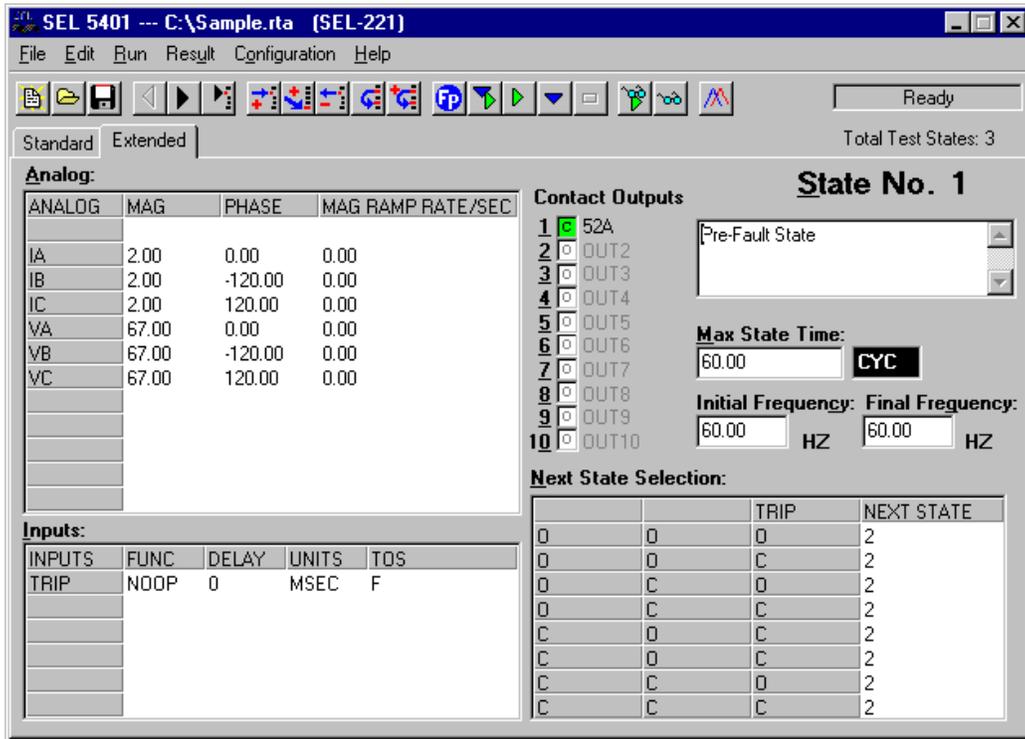
Figure 6: SEL-5401 (Windows 95, Windows NT) Extended State Window Includes Amplitude and Frequency Ramping and Next-State Programming

Automatic Scaling. Automatically scales analog signals for relay types you select, or you can provide your own scaling.

Frequencies. Select frequencies from 10.0 Hz to 300.0 Hz.

Frequency Ramping. Ramp frequencies between -100.0 and 100.0 Hz/sec in approximately 0.1 Hz/second resolution.

Ramp Analog Outputs. Ramp the signal on each analog output channel individually.

COMTRADE Files. Use COMTRADE format files within test states to define transient analog waveforms. Replay fault data from event recorder or EMTP simulations.

FACTORY ASSISTANCE

The employee-owners of Schweitzer Engineering Laboratories, Inc. are dedicated to making electric power safer, more reliable, and more economical.

We appreciate your interest in SEL products, and we are committed to making sure you are satisfied. If you have any questions, please contact us at:

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2350 NE Hopkins Court
Pullman, WA USA 99163-5603
Tel: (509) 332-1890
Fax: (509) 332-7990

We guarantee prompt, courteous, and professional service.

We appreciate receiving any comments and suggestions about new products or product improvements that would help us make your job easier.

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SECTION 2: INSTALLATION AND CHECKOUT

GETTING STARTED

This instruction manual provides descriptive information and operating instructions for the SEL-RTS. The SEL-RTS consists of the SEL-5401 Test System Software or SELTEST™ Software, the SEL-AMS Adaptive Multichannel Source, and a personal computer supplied by the user. These instructions are designed for personnel with a background in power systems or experience in protective relay testing.

How to Use This Manual

Section 4 of this manual describes the SELTEST Software, and *Section 5* describes the SEL-5401 Test System Software. If you are not familiar with the SEL-RTS, we suggest the following:

1. Read the data sheet preceding this section.
2. Perform the installation in *Section 4: SELTEST Software Reference* or *Section 5: SEL-5401 Installation and Configuration*.
3. Examine the *Creating a Test File* paragraphs in *Section 4* or *Section 5*.
4. Build and execute your own test.

Experienced users may want to refer to the detailed explanations of program functions in *Section 4: SELTEST Software Reference* or *Section 5: SEL-5401 Test System Software Reference* and the appendices at the end of the manual.

UNPACKING SEL-RTS EQUIPMENT

Inspect the equipment for physical damage. Make sure the following equipment is enclosed in the shipping container:

- RTS Technical Manual
- SEL-5401 Test System Software or SELTEST Software Disks
- SEL-AMS Chassis
- Terminal Block Adapter
- 10-Position Terminal Block Plug (2 ea.)
- 12-Position Terminal Block Plug (1 ea.)
- Line Cord
- 12 Jumper Wires (SEL-C956)

- Ribbon Cable Number SEL-C710
- Ribbon Cable Number SEL-C720
- Ribbon Cable Number SEL-C721
- Ribbon Cable Number SEL-C731
- Ribbon Cable Number SEL-C740 (DB25 to DB25)
- Ribbon Cable Number SEL-C750
- EIA-232 Data Cable, SEL-C234A

MOUNTING

You can mount the SEL-AMS by its front vertical flanges in a 19" vertical relay rack, or you can use the SEL-AMS as a bench-top instrument. Removable feet are provided to make rack mounting easy. Use four #10 screws for rack mounting. Front and rear panels, relay dimensions, and drill plan are shown in Figure 2.1 and Figure 2.2.
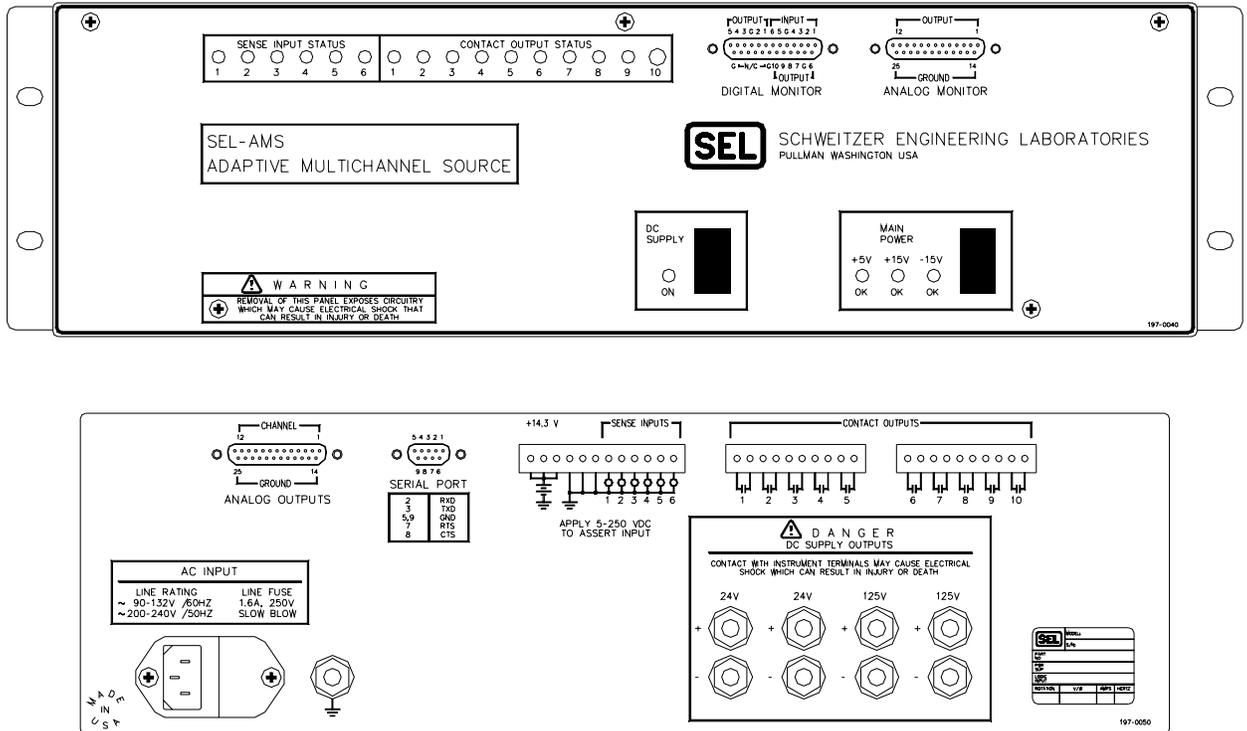
Figure 2.1: SEL-AMS Front and Rear Panels
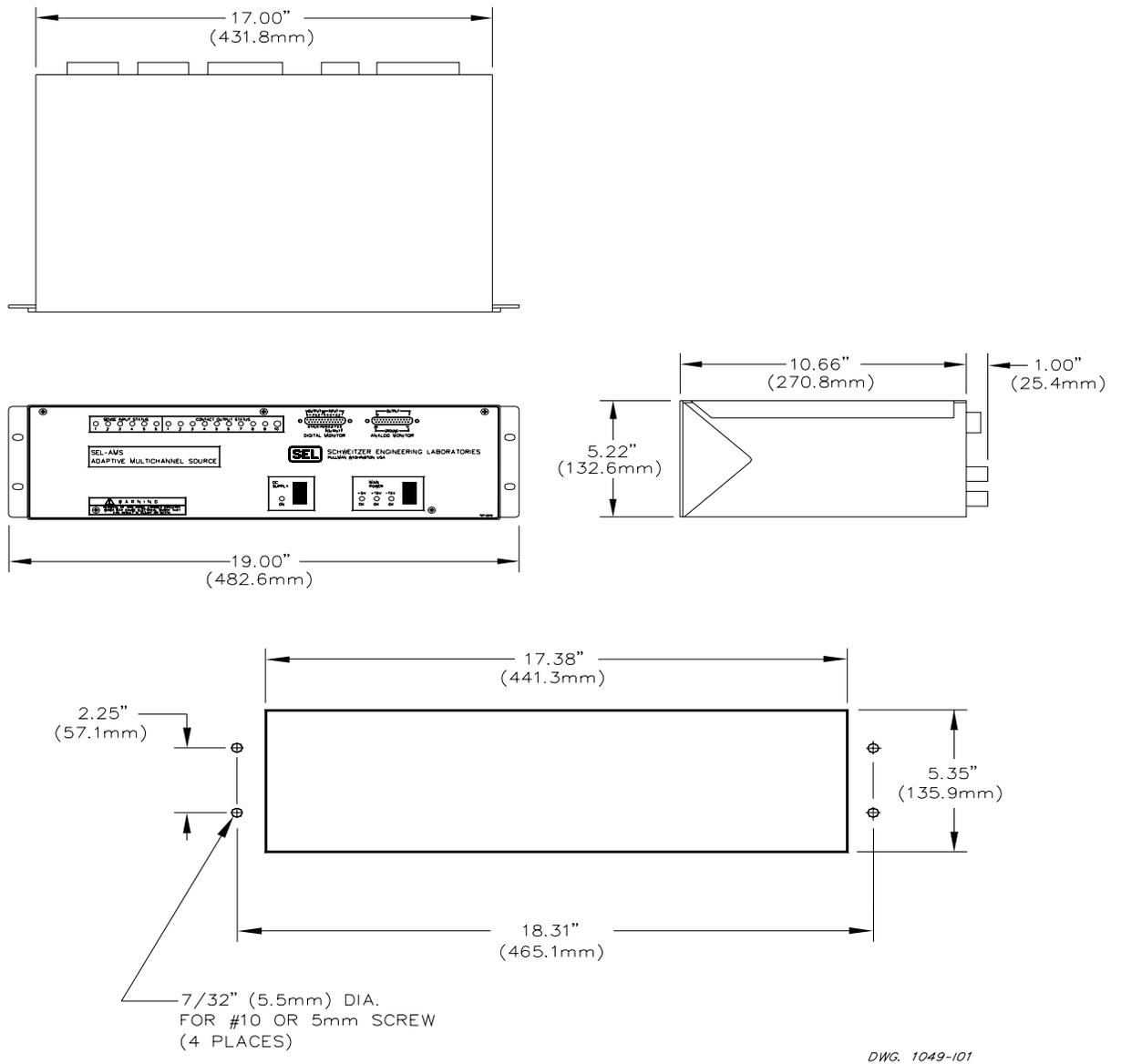
Figure 2.2: SEL-AMS Dimensions, Panel Cutout, and Drill Plan

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SECTION 3: USER'S GUIDE

INTRODUCTION

This section gives general suggestions to help you get started creating a test with the SEL-5401 Test System Software or SEL TEST^{TM} Software.

TEST SETUP

Use the following procedure as a guide, modifying it to accommodate your own test conditions for testing SEL relays.

1. Choose an appropriate test setup. Figure 3.1 shows a typical setup to test a single relay; Figure 3.2 shows two relays under test. If you want to download event reports, you must supply a second EIA-232 cable between the relay and the computer. When testing two relays consecutively, you must provide an external port switch box and any additional cables. Table 3.1 shows the SEL relays you can test with the SEL-RTS. Some older series relays do not support low-level testing with the SEL-RTS.

Table 3.1: Compatible SEL Relays

SEL-Relay Model	Includes
200 Series	All Shallow Low Profile
300 Series	Relays with firmware version numbers of R400 and above
500 Series	All

CABLE**

CABLE**

SENSE   CONTACTS
INPUTS   OUTPUTS

INPUTS OUTPUTS

RIBBON
CABLE

RELAY 1

ANALOG OUTPUT
CHANNELS

OPTIONAL
OSCILLOGRAPH*   CABLE*

DIGITAL OUTPUT
MONITOR

OPTIONAL
OSCILLOSCOPE*   CABLE*

ANALOG OUTPUT
MONITOR

SEL-AMS

IBM PC

SEL-234A

SERIAL PORT
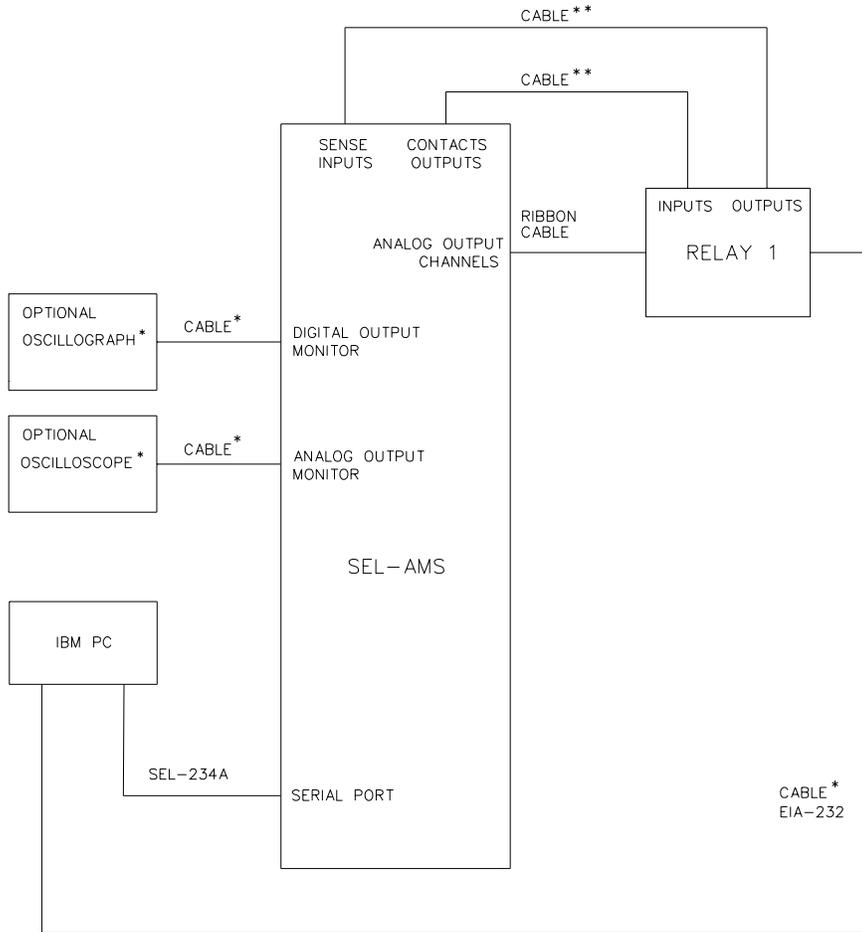
CABLE*
EIA-232

* NOT SUPPLIED WITH SEL-RTS SYSTEM

** CONNECTOR AND JUMPER WIRES SUPPLIED — NO CABLE SUPPLIED

DWG. 1049-I09

Figure 3.1: SEL-RTS to Relay Interconnection Diagram - Single Relay Test

CABLE**

CABLE**

SENSE   CONTACTS
INPUTS   OUTPUTS

ANALOG***
RIBBON
CABLE

INPUTS   OUTPUTS

RELAY 1

ANALOG OUTPUT
CHANNELS

OPTIONAL
OSCILLOGRAPH*

CABLE*

DIGITAL OUTPUT
MONITOR

OPTIONAL
OSCILLOSCOPE*

CABLE*

ANALOG OUTPUT
MONITOR

SEL-AMS

RELAY 2

INPUTS   OUTPUTS

IBM PC*

CONTACT OUTPUTS

CABLE**

SENSE INPUTS

CABLE**

CABLE*

SEL-234A

SERIAL PORT

CABLE*

EIA-232 *

EXTERNAL
PORT
SWITCH BOX*

* NOT SUPPLIED WITH SEL-RTS

** CONNECTOR AND JUMPER WIRES SUPPLIED — NO CABLE SUPPLIED

*** NOT SUPPLIED WITH SEL-RTS, CONTACT FACTORY
    FOR INSTRUCTIONS ON BACK-TO-BACK TESTING

DWG. 1049-I03

Figure 3.2: SEL-RTS to Relay Interconnection Diagram - Back-to-Back Test

Note: If you use an input wetting voltage other than the +14.3 Vdc provided on the input connector, it must be grounded to the SEL-AMS chassis for proper ground reference. Higher wetting voltages may cause crosstalk between inputs resulting in improper input sensing if you do not place wires carefully.

2. Wire the ground connection, inputs and outputs between the SEL-RTS and the relay using the SEL-supplied pluggable terminal blocks. Figure 3.3 shows typical sense input and contact output connections with supply voltage connections. Table 3.2 shows sources for terminal blocks for replacement purposes.
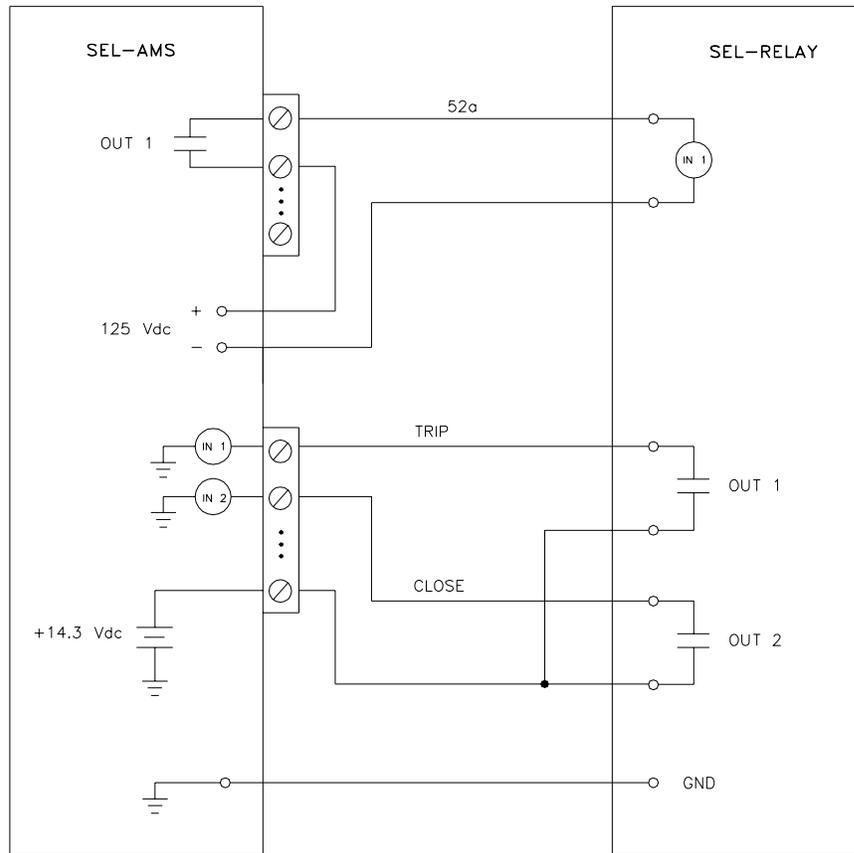
DWG: MIN_OUT

Figure 3.3: Example of Sense Input and Contact Output Connection

Figure 3.4 shows how each SEL-AMS sense input circuit is configured inside the SEL-AMS. The circuit can sense μA of current at 3.5 Vdc.
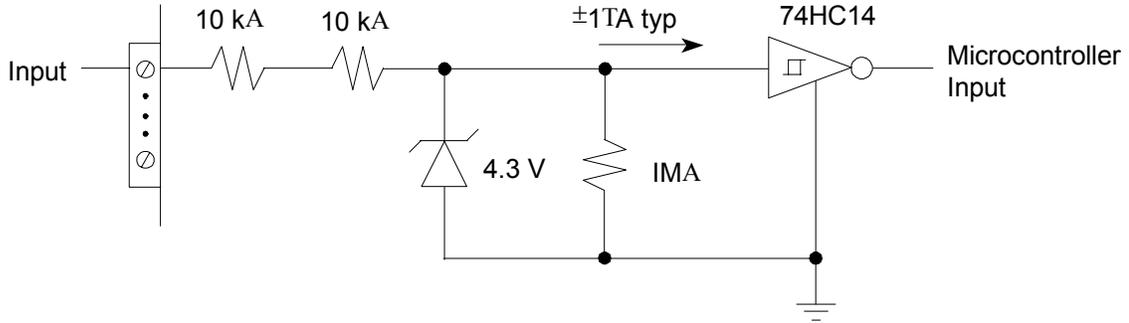
Figure 3.4: SEL-AMS Sense Input Circuit

Table 3.2: Pluggable Terminal Blocks

Terminal Block	Source/PN
Sense Input - 12 Position 0.200 in. (5.08 mm) Spacing	PCD ELFP 12210 Phoenix 17 57 11 6
Sense Output - 10 Position 0.200 in. (5.08 mm) Spacing	PCD ELFP 10210 Phoenix 17 57 09 3

3. If you require a monitoring circuit, connect the digital monitor and/or analog monitor outputs to the monitoring instruments. Use the terminal block adapter, Figure 3.5, and the DB25 to DB25 ribbon cable (SEL-C740) to connect to an oscilloscope for monitoring analog output signals via the analog monitor connector.
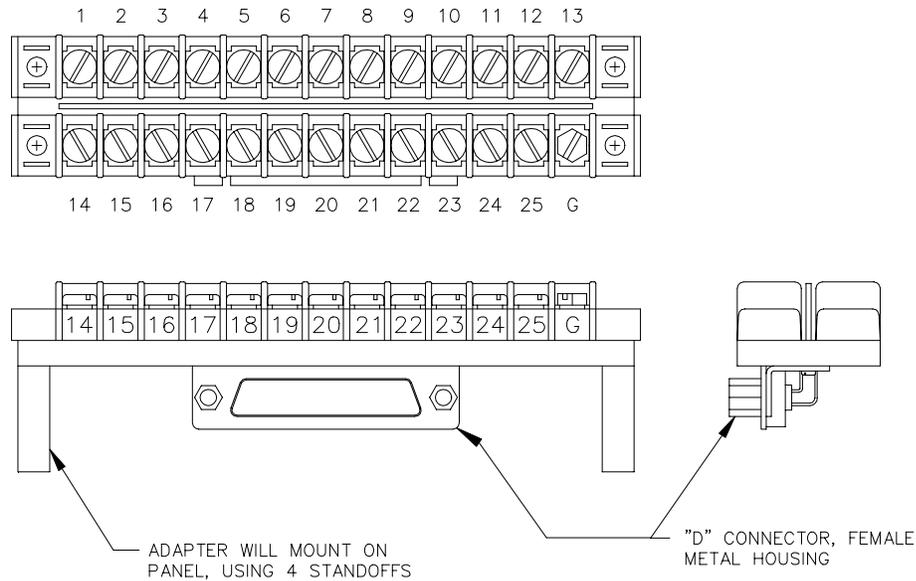
DWG. 1098-102

Figure 3.5: DB25 to Terminal Block Adapter

4. Select the analog ribbon cable (from Table 3.3) appropriate for the SEL relay being tested.

Table 3.3: Analog Ribbon Cables

Cable Number	Relay Type
C710, C750	SEL-200 Series
C750	SEL-300 Series (except SEL-321)
C720	SEL-321 Series
C731, C750	SEL-500 Series

⚠ **WARNING**   Removal of the front cover exposes circuitry which may cause electrical shock that can result in injury or death.

⚠ **CAUTION**   The relay contains devices sensitive to electrostatic discharge (ESD). When working on the relay with front or top cover removed, work surfaces and personnel must be properly grounded or equipment damage may result.

5. Remove the front cover of the relay. All SEL relays with a built-in low-level test interface have a sticker attached to the inside of the front cover showing the low-level interface connection for that relay. The relay has a calibrated input module and a separately calibrated processing module. The panel sticker shows the ribbon jumper cable that joins these modules. Disconnect the ribbon jumper cable and plug the SEL-AMS analog cable, from Table 3.3, into the processing module of the relay.

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SECTION 4: SELTEST^{TM} SOFTWARE REFERENCE

This section describes SELTEST^{TM} software and its operation in detail.

SECTION 4 CONVENTIONS

In this section, commands you type appear in bold/uppercase: **C:\SELTEST.** Keys you press appear in bold/uppercase/brackets: **<ESC>**. Selections you make at the bottom of windows are described in text with bold/uppercase brackets and followed by the word "button": **<NEW TEST>** button. Menu selections are referred to as menu selections and are bold/upper case.

ONLINE CONTEXT-SENSITIVE HELP

Select HELP from the Main Menu bar to display a general help window. Within menus and windows, press **<F1>** to display a help screen that describes the menu option or field the cursor is in.

SCREEN PRINTING

Press **<F3>** at any time to print the currently displayed screen to your printer. All graphics characters are converted to ASCII characters to be compatible with almost any printer.

FILE EXTENSIONS

SELTEST software uses three file extensions for three types of data files that describe tests and test results. The extensions are explained below.

.RTA Extension

This extension is used with SELTEST software test files. These files contain ASCII test descriptions with the same data you enter interactively. These files are in an easily readable format and can be modified with a text editor. When creating a new test in the interactive mode, SELTEST software loads a file with this extension named RTA.RTA, which you then modify to produce a new file. *Appendix B* describes the format of this file.

.RTR Extension

This extension is used with results data files, which are in a readable ASCII format. They are created by the program as a result of test execution. The results correspond to data displayed in the Results window. *Appendix C* describes the format of this file in detail.

.RTP Extension

This extension is used with primitive test files. These files are created when SELTEST software runs a test from the Interactive Mode or SELTEST File Execution Mode. This file format is directly compatible with the SEL-AMS and is not easily read.

SYSTEM REQUIREMENTS

One megabyte of memory is the minimum requirement to run SELTEST software. If you use this program concurrently with another application, at least two megabytes of memory are required. If you use this program with Microsoft Windows, at least four megabytes of memory are required. An AT class machine (286) or better is required. This program will work with MS-DOS/PC-DOS 3.0 and above, Windows 3.1, and DESQview.

The following memory managers are compatible with this version of SELTEST software:

QEMM 4.1 or later (Quarterdeck)
386MAX 4.02 or later (Qualitas)
CEMM 4.02 or later (Compaq)
EMM386 (Microsoft Windows 3.0, MS DOS 5.0)

SOFTWARE INSTALLATION AND CONFIGURATION

Note: If you intend to use SELTEST software within Microsoft Windows, see *Appendix H* for additional information.

1. Place the SELTEST software installation diskette in drive A (or B) and type **A:INSTALL** (or **B:INSTALL**) **<ENTER>**. At the prompt, press **<ENTER>** again.

2. Enter the name of the directory where you want SELTEST software files installed, then press **<ENTER>** at the create directory prompt. If the directory does not exist, press **Y** and **<ENTER>**.

3. Following the prompts on the screen, enter the directory where data will be stored, the directory where COMTRADE files will be stored, the communications port number that connects the SEL-AMS to the PC, the Quiet (PC speaker) option, and 1 A or 5 A relay configuration. (The same list of relays is presented whether you select 1 A or 5 A, but not all relays are available in the 1 A configuration.) When you are finished, press **<CTRL-ENTER>**. After installation is complete, you should see the DOS prompt and your current directory will be the SELTEST subdirectory.

Customization

After you are familiar with the program, you may want to consider items 1 and 2 below.

1. The file RTA.RTA is the default test that the program loads when initiated and when you select CREATE. The factory default is set for an SEL-251 single-state, one-second test with nominal currents and voltages. To customize this default, use SELTEST software to build the desired default. Then, save it as RTA in the SELTEST directory to overwrite the existing RTA.RTA file.

SELTEST Software Reference
SEL-RTS Instruction Manual

2. The file SELTEST.UUT contains the information the software uses for relay type selection within the Configuration window. This can be edited to customize the selections. The first part of the file lists the possible relay types and assigns a reference number to each. OTHER must be the last item in this list and must have a reference of "0". The second part of the file defines the analog channel configurations for each reference number.

3. If you intend to use SELTEST software within Microsoft Windows, see *Appendix H* for additional information.

SELTEST SOFTWARE FILES

The following is a list of SELTEST files that are included on your software disk:

SELTEST.EXE	Executable file
*.DLL	Run-time libraries
PHARLAP.386	Floating-point math support
RTA_ERRS.TXT	Error message file
SELTEST.HLP	Command line help file
SELTEST.CFG	Configuration file
*.UUT	Unit-under-test description files
SELTEST.PIF	Program information file for Windows
RTA.RTA	Default test
*.FRM	Screen definition files
*.WIN	Online help screen files
SAMPLE.RTA	Example of a ground fault test
PICKUP.RTA	Example of an element pickup test
COMTRADE.RTA	Example of a COMTRADE test
CHECKOUT.RTA	Used for initial checkout
BREAKER.RTA	Example of a simple breaker simulation
INSTALL.EXE	SELTEST installation program

SELTRADE™ CONVERSION SOFTWARE FILES

The following is a list of SELTRADE files that are included on your software disk. These are installed in the COMTRADE directory during SELTEST software installation:

SELTRADE.EXE	COMTRADE conversion program (see *Appendix G*)
EXAMPLE.EVE	Example of an SEL event report

CHECKOUT PROCEDURE

Use the procedure below to checkout the SEL-RTS or combine it with your normal practice.

Step 1   Connect the SEL-AMS EIA-232 serial communications port to the computer via cable SEL-234A.

Low-energy, low-voltage MOVs and passive RC filters protect the communication circuits. Minimize communication circuit difficulties by keeping the lengths of the EIA-232 cables as

short as possible. We recommend lengths of 12 feet or less. The cable length should <u>never</u> exceed 100 feet. Use shielded communications cable for lengths greater than 10 feet.
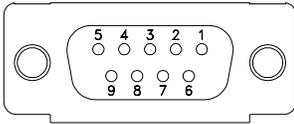
(female chassis connector, viewed from outside panel)

Figure 4.1: 9-Pin Connector Pin Number Convention

Table 4.1: EIA-232 Port Pin Assignments

SEL-AMS Connector Pin	Signal
2	RXD
3	TXD
5	GND
7	RTS
8	CTS
9	GND

Step 2   Connect the PC and the SEL-AMS to line power, and turn on the main power to both. Verify the +5 V, +15 V, and -15 V LED indicators on the SEL-AMS illuminate. Verify that the 16 I/O LEDs light briefly when the power is turned on.

Step 3   Turn the DC SUPPLY switch on the SEL-AMS to ON. Verify the ON LED indicator illuminates.

Step 4   Using a voltmeter, verify the +24 V and +125 V dc supply outputs and the +14.3 V supply on the sense input connector. All are located on the SEL-AMS back panel.

Step 5   Check each SEL-AMS sense input by connecting +14.3 V with each sense input pin and verify that the appropriate front-panel LED illuminates.

Step 6   If SELTEST software has not been loaded on your PC, load the software using the procedure in ***Software Installation*** at the beginning of this section.

Step 7   At the DOS prompt type: **CD\SELTEST <ENTER>**. If you installed SELTEST SOMEWHERE else, make that directory the current directory.

Step 8   From the SELTEST directory type: **SELTEST <ENTER>**. The Startup window will be displayed.

Step 9   In the Startup window, select the <**LOAD TEST**> button.

Step 10   From the list of tests, select **CHECKOUT**. You will see the screen displayed in Figure 4.2.

Step 11   This test consists of 10 states of 5 seconds each. The analog outputs are driven to full scale (10 V$_{pk-pk}$ or 3.5355 Vrms), and an individual contact output is asserted in each state. To allow ample time for you to check individual contact outputs and the analog outputs, the test is looped indefinitely.

Step 12   Execute this file by placing the cursor in the <**EXECUTE**> button at the bottom of the screen and press <**ENTER**>. Use an oscilloscope or DMM to verify the output on each analog channel.

```
════* STATE #1 *════     ════STATE #2════     ════STATE #3════
RTS CHECKOUT             RTS CHECKOUT             RTS CHECKOUT
───ANALOG OUTPUTS───     ───ANALOG OUTPUTS───     ───ANALOG OUTPUTS───
ch1 :   353.55U    0.00D  ch1 :   353.55U    0.00D  ch1 :   353.55U    0.00D
ch2 :   353.55U -120.00D  ch2 :   353.55U -120.00D  ch2 :   353.55U -120.00D
ch3 :   353.55U  120.00D  ch3 :   353.55U  120.00D  ch3 :   353.55U  120.00D
ch4 :   353.55U    0.00D  ch4 :   353.55U    0.00D  ch4 :   353.55U    0.00D
ch5 :   353.55U -120.00D  ch5 :   353.55U -120.00D  ch5 :   353.55U -120.00D
ch6 :   353.55U  120.00D  ch6 :   353.55U  120.00D  ch6 :   353.55U  120.00D
ch7 :   353.55U    0.00D  ch7 :   353.55U    0.00D  ch7 :   353.55U    0.00D
ch8 :   353.55U -120.00D  ch8 :   353.55U -120.00D  ch8 :   353.55U -120.00D
──────MISC──────         ──────MISC──────         ──────MISC──────
TIME:    5.000 SEC       TIME:    5.000 SEC       TIME:    5.000 SEC
FREQ:    60.00 HZ        FREQ:    60.00 HZ        FREQ:    60.00 HZ
───CONTACT OUTPUTS───    ───CONTACT OUTPUTS───    ───CONTACT OUTPUTS───
OUT1 C  OUT2 O  OUT3 O   OUT1 O  OUT2 C  OUT3 O   OUT1 O  OUT2 O  OUT3 C
───SENSE INPUTS───       ───SENSE INPUTS───       ───SENSE INPUTS───
IN1 : NOOP   0      F     IN1 : NOOP   0      F     IN1 : NOOP   0      F
IN2 : NOOP   0      F     IN2 : NOOP   0      F     IN2 : NOOP   0      F
              *MORE*                   *MORE*                   *MORE*
<EXECUTE>  <EXTENDED>     <EXECUTE>  <EXTENDED>     <EXECUTE>  <EXTENDED>
<MENU>     <ADD STATE>    <MENU>     <ADD STATE>    <MENU>     <ADD STATE>
<←─> <─→>  <DEL STATE>    <←─> <─→>  <DEL STATE>    <←─> <─→>  <DEL STATE>
```

Figure 4.2: Checkout Test Displayed in Standard State Window

CREATING A TEST FILE

SEL TEST software allows you to create, modify, and run computer-controlled protective relay test programs for SEL relays. SEL TEST software is a state-dependent program. Test conditions are created with test states that you define by invoking state definition windows. The following procedure is meant to be used as a general guide to creating a simple test. If you need additional information on individual windows, keyboard functions, or software features, see ***Section 4: SEL TEST Software Reference***.

Start SEL TEST Software

1. At the DOS prompt type: **CD\SELTEST <ENTER>** (if you installed SEL TEST software somewhere else, make that directory the current directory).

2. From the SELTEST directory type: **SELTEST <ENTER>**.

<u>**Create a Test**</u>

We suggest using this procedure to create a test to simulate a phase-to-ground fault, like the one provided on the software distribution disk under the name "SAMPLE." This test has the following three states:

- State #1 defines the pre-fault conditions.

- State #2 defines the fault condition - a ground fault on ΦA just in front of the relay. The fault terminates when an O → C condition is sensed on an input and a 67 ms time delay expires.

- State #3 commences just after the breaker operates. It defines the post-fault condition. State #3 assumes a three-pole trip.

Procedure for Creating Test

When the program is initialized, select the **<NEW TEST>** button from the Startup window (the **<LOAD TEST>** button loads an existing test). Select the relay you are testing from the list of relays presented and press **<ENTER>**. If you were not testing an SEL relay, or you didn't want the default configuration, you would select OTHER from the list.

If you select a relay from the list, the Standard State window, Figure 4.3, is displayed ready for you to define the first test state. Figure 4.3 shows all three states in our example test as we defined them. If you select OTHER from the list, the Configuration window is displayed. To create our example, we selected OTHER from the list to adjust the configuration. Figure 4.4. shows the Configuration window with our modified configuration.

```
                                         SAMPLE      Press F1 for Help
  ═══* STATE #1 *═══      ═══STATE #2═══            ═══STATE #3═══
 Pre-Fault State         Fault State              Post-Fault State
     ─ANALOG OUTPUTS─         ─ANALOG OUTPUTS─         ─ANALOG OUTPUTS─
        0.00V    0.00D          0.00V    0.00D          0.00V    0.00D
 IA  :  2.00A    0.00D    IA  : 20.00A  -80.00D    IA  :  0.00A    0.00D
 IB  :  2.00A -120.00D    IB  :  2.00A -120.00D    IB  :  0.00A -120.00D
 IC  :  2.00A  120.00D    IC  :  2.00A  120.00D    IC  :  0.00A  120.00D
 VA  : 67.00V    0.00D    VA  : 40.00V    0.00D    VA  : 67.00V    0.00D
 VB  : 67.00V -120.00D    VB  : 67.00V -120.00D    VB  : 67.00V -120.00D
 VC  : 67.00V  120.00D    VC  : 67.00V  120.00D    VC  : 67.00V  120.00D
     :  0.00V    0.00D        :  0.00V    0.00D        :  0.00V    0.00D
     ─MISC─                   ─MISC─                   ─MISC─
 TIME:     60.000 CYC     TIME:     60.000 CYC     TIME:     60.000 CYC
 FREQ:     60.00 HZ       FREQ:     60.00 HZ       FREQ:     60.00 HZ
    ─CONTACT OUTPUTS─        ─CONTACT OUTPUTS─        ─CONTACT OUTPUTS─
 52A  C                  52A  C                   52A  O
     ─SENSE INPUTS─          ─SENSE INPUTS─           ─SENSE INPUTS─
 TRIP: NOOP  0      F     TRIP: O->C  67     C     TRIP: NOOP  0      F
     :       0              :       0               :       0

 <EXECUTE>  <EXTENDED>    <EXECUTE>  <EXTENDED>    <EXECUTE>  <EXTENDED>
 <MENU>     <ADD STATE>   <MENU>     <ADD STATE>   <MENU>     <ADD STATE>
 <←─> <─→>  <DEL STATE>   <←─> <─→>  <DEL STATE>   <←─> <─→>  <DEL STATE>
```

Figure 4.3: Standard State Window Showing State #1 through State #3 of Sample Test

The following steps explain editing of both windows.

Configuration Window Editing. Selecting OTHER allows you to assign input labels, output labels, analog channel labels, and scale factors using the Configuration window. If you selected OTHER, use the following steps to modify the configuration.

1. In the first field, enter a test name to identify the test. Press **<ENTER>** to move to the next field (press **<TAB>** to move to the next field without entering data).

2. In the Relay Type field, enter the relay type by pressing the **<SPACE BAR>** until the desired relay type appears or pressing **<F2>** for a list to choose from. If you wish to select scale factors, you would leave OTHER in this field.

Because we entered SEL-221 as the RELAY TYPE, scale factors are automatically assigned. If you selected OTHER, you would next enter a scale factor for each channel.

3. Place the cursor in the Test Information field. The Test Information screen, Figure 4.5, is overlayed on the Configuration window. Use this screen as a memo pad to record information about the test that you may want to refer to later. Exit the Test Information screen.

```
 FILE▼  EDIT▼  VIEW▼  EXECUTE   QUIT   HELP    52B_279       Press F1 for Help
╔═══════════════════════════════* CONFIGURATION *═══════════════════════════╗
║ The 279 Logic test setup                                                   ║
║ RELAY TYPE:   SEL-279                                                       ║
║ Test Information                                                           ║
║                                                                            ║
║ CHANNEL LABELS & SCALE FACTORS      OUTPUT LABELS       INPUT LABELS       ║
║                                                                            ║
║  1:           1.000 V              1: 52a             1: CLOS              ║
║  2: V1      100.000 V              2: HSRI            2: OUT1              ║
║  3: V3      100.000 V              3: HSRB            3: OUT2              ║
║  4: V5      100.000 V              4: DTL             4:                   ║
║  5: V2      100.000 V              5: EMT             5:                   ║
║  6: V4      100.000 V              6: HLD1            6:                   ║
║  7: V6      100.000 V              7: HLD2                                 ║
║  8:           1.000 V              8: DLH1                                 ║
║  9:           1.000 V              9: DLH2                                 ║
║ 10:           1.000 V             10: HLHB                                 ║
║ 11:           1.000 V                                                      ║
║ 12:           1.000 V                            <EDIT TEST>  <MENU>       ║
╚════════════════════════════════════════════════════════════════════════════╝
```

Figure 4.4: Configuration Window Showing Data for Sample Test

```
                                          52B_279       Press F1 for Help
╔═══════════════════════════════* CONFIGURATION *═══════════════════════════╗
║ The 279 Logic test setup                                                   ║
║ RELAY TYPE:   SEL-279                                                       ║
║                       ┌─────────Test Information─────────┐                  ║
║                       │ RS1D = 30                        │                  ║
║                       │ MT1D = 30                        │                  ║
║                       │ MTPD = 200                       │                  ║
║                       │                                  │                  ║
║                       │ MT1 = HLHB                       │                  ║
║                       │ MTR = HLHB                       │                  ║
║                       │ OUT1 = 52B                       │                  ║
║                       │                                  │                  ║
║                       │                                  │                  ║
║                       │                                  │                  ║
║                       │                                  │                  ║
║                       │                                  │                  ║
║                       └─Press <TAB> or <SHIFT><TAB> to exit this window─┘    ║
╚════════════════════════════════════════════════════════════════════════════╝
```

Figure 4.5: Test Information Screen Called From Configuration Window

4. In the first field under OUTPUT LABELS, we entered 52A to label the signal we desired on that output. For other outputs, we deleted the default labels for clarity.

5. In the first field under INPUT LABELS, we entered TRIP to label our only input signal. We deleted the remaining default label for clarity.

6. Cursor down to the **<EDIT TEST>** button at the bottom of the window, and press enter. The Standard State window will be displayed showing labels copied from the Configuration window.

Standard State Window Editing. If a state is too complex to be defined by the Standard State window (e.g., more than two sense inputs need to be defined), you would select the **<EXTENDED>** button at the bottom of the window to display the test state in the Extended State window. The Extended State window is described in *Section 4: SELTEST Software Reference*.

1. In the Standard State window, enter a description of the state in the first field the cursor comes to (Pre-Fault State in the example), and press **<ENTER>**.

2. Next, fill in the currents, voltages, and phase angles for each channel under the ANALOG OUTPUTS portion of the window. (If you are testing delta relays, see *Appendix I* for special test information.)

3. In the next two fields, enter the length of time you want the state to run (in the Time field) and the units that time is expressed in. The state will run for this length of time unless interrupted by a terminate on sense condition first.

4. In the FREQ field, enter the system frequency.

5. In the Contact Outputs fields, toggle to O or C (open or closed) for each output used by pressing the **<SPACE BAR>**. In the field after the first contact output, for example, we selected C to represent a closed condition during this state for the output we labeled 52A.

6. Toggle O → C (open to close), C → O (close to open), or NOOP (no operation) in the Sense Inputs fields using the **<SPACE BAR>**. We selected NOOP for the input labeled TRIP to indicate that this input will not be used for timing functions during this state.

7. The next field the cursor moves to is used for time delay information. The program allows this time to expire after an input condition is sensed before assuming the condition is stable. The next field is the Terminate-On-Sense field. We entered F to indicate no operation, no matter what condition is sensed during this state. Note that in State #2, we entered C in this field to indicate that the state should terminate when a closed condition is sensed on this sense input, and we entered 67 in the Time Delay field so the program will wait 67 milliseconds before terminating the state after sensing the close condition.

8. Cursor down to the **<ADD STATE>** button, and press **<ENTER>**. A copy of State #1 is displayed but is labeled State #2. You edit this state to define State #2 in the test. Repeat steps 8 through 14 to define as many states as the test requires. If you want to edit a previous state or next state, use the **<←> <→>** buttons at the bottom of the window. Figure 4.3 shows all three state definitions for our example test in the Standard State window.

9. Cursor down to the **<EXECUTE>** button, and press **<ENTER>** to execute the test. Figure 4.6 is a plot of the SEL-AMS outputs and input from the sample test. For simplicity, only the current and voltage on the faulted phase, the trip output from the relay, and the 52A output to the relay are shown.

Figure 4.6: Plot of the Three State Sequence Input and Outputs

Viewing Test Results

When a test completes execution, the program prompts you for the next operation to perform. View results as follows:

1. Select **<VIEW RESULTS>** button to view the results of a test. A Results window, Figure 4.7, will be displayed showing test results. The first state in which an input is used is the one displayed in the Results window. If there was no input used, the last state in the test is displayed.

2. Figure 4.7 shows the Results window displayed for the example test. Select the arrow keys at the bottom of the window to view results of other states in the test. Test results can also be examined by viewing the results (.RTR) file directly.

Figure 4.7: Results Window for Example Test

Additional Test Examples

Your software distribution disk contains several examples of short tests you may examine:

PICKUP.RTA is a simple element pickup test that illustrates ramping an output signal with the Extended State window.

COMTRADE.RTA shows the use of COMTRADE files for analog signal definition within the Extended State window.

CHECKOUT.RTA is the file used to perform initial checkout of the SEL-RTS. It illustrates looping states to produce a continuous output.

BREAKER.RTA is a simple breaker simulation.

STARTUP OPTIONS

SELTEST software operates in one of four modes: Interactive Mode, SELTEST File Execution Mode, Primitive File Execution Mode, or Direct SEL-AMS Execution Mode. Select operating modes or help from the command line when starting the program. Table 4.2 lists the program's startup options. Where "FILENAME" appears in italics, you supply the name of the file you want to run. The command line options are mutually exclusive: only one may be used.

Table 4.2: SELTEST Control Software Program Startup Options

Option	Comment
No Option Selected	**Note**: Files are searched for in the default data path defined at installation. SELTEST software automatically reverts to the interactive mode of operation if you start the program with no command line option specified. (See Interactive Mode.)
/R=FILENAME	Executes a test with an .RTA extension specified by the given filename. (See SELTEST File Execution Mode.)
/P=FILENAME	Executes a test with an .RTP extension specified by the given filename. (See Primitive File Execution Mode.)
/D=FILENAME	Downloads a test with an .RTA extension specified by the given filename. (See File Download Mode.)
/Q=FILENAME	Downloads a test with an .RTP extension specified by the given filename. (See File Download Mode.)
/E=FILENAME	Executes a test that has already been downloaded to the SEL-AMS, and the results are stored to the specified filename.
/T=FILENAME	Translates a test with the given filename from an .RTA file to an .RTP file. (See File Translate Mode.)
/H	Prints a brief help statement, describing the program and listing all startup options, to the window.

OPERATING MODES

The interactive mode is the normal mode of execution. The other modes are provided for automated testing and for faster test execution under special conditions.

Interactive Mode

Use this mode to create and execute test files using SELTEST software menus and windows.

Start the program without any command-line options to use the interactive operating mode. You control selection, creation, editing, and execution of tests by selecting menus and modifying windows using the editing and function keys described in this section.

SELTEST File Execution Mode

Use this mode to run existing tests automatically.

In this mode, SELTEST software runs test files with the .RTA extension. These test files may be created using the software in the interactive mode or with a text editor. The program stores complete test results in files with the .RTR extension for later analysis. Execute a test in this

mode by starting the software with the /R option from the command line as follows (assuming the software program is in the current directory on the C drive.):

>**SELTEST /R=**_FILENAME_ **<ENTER>**

Use **<ESC>** while the test is running to abort execution.

Primitive File Execution Mode

Tests run with greater speed in this mode than any other except the Direct SEL-AMS Execution Mode, but complete test results are not available. This mode requires the existence of an .RTP file, which is created when a test is run from the Interactive Mode or SELTEST File Execution Mode. Files with the .RTP extension are in a format directly compatible with the SEL-AMS. Use this mode when speed is required, and test results are secondary.

Note the following peculiarities of results (.RTR) files generated by primitive file execution:

- Time is reported in milliseconds.
- All inputs and outputs are considered enabled. You may see data (such as NOOP) for unused inputs in the .RTR (results) file.
- The frequency in all states is reported as 60 Hz.
- All channels are assumed not to be ramped: no channel results are reported.

Run an existing primitive test file (with the .RTP extension) directly, by starting the program with the /P option at the DOS prompt as follows (assuming the SELTEST software program is in the current directory on the C drive.):

>SELTEST /P=_FILENAME_ <**ENTER**>

Use **<ESC>** while the test is running to abort execution.

File Download Mode

This mode allows you to download a test without executing it. You can then directly execute it as described below.

To download files with the .RTA extension, use the /D option:

>**SELTEST /D=*FILENAME* <ENTER>**

To download files with the .RTP extension, use the /Q option:

>**SELTEST /Q=*FILENAME* <ENTER>**

Direct SEL-AMS Execution Mode

This mode executes the test currently in SEL-AMS memory. The test must already have been run or downloaded in one of the other modes. This mode is useful when you want to repeat execution of a test. The advantage of using this mode is speed; there is no translation nor download time involved. The same limitations exist in the results files generated as for the Primitive File Execution Mode (complete test results are not available). Use this mode by starting the program with the /E option at the DOS prompt as follows (assuming the software program is in the current directory on the C drive.):

>**SELTEST /E=*FILENAME* <ENTER>**

Use **<ESC>** while the test is running to abort execution.

Saving Previous Test Results

If you want to save results of previous test runs, change the filename when you enter the command. Otherwise, any previous .RTR file with the same name will be overwritten.

File Translate Mode

This mode translates a user test file (file with .RTA extension) to a primitive test file (file with .RTP extension). Use this mode by starting the program with a /T option:

>**SELTEST /T=*FILENAME* <ENTER>**

FUNCTION KEYS AND EDITING

Mouse Operation

Use SELTEST software with or without a mouse. Access any field or function with the mouse then edit fields from the keyboard.

Editing and Function Keys

Editing and function keys are used with the windows while in the interactive mode. Table 4.3 provides a list of editing and function keys:

Table 4.3: Editing and Function Keys

Key	Function
<ALT-FUNCTION LETTER>	**<ALT>** and highlighted letter of function button selects a new function from the buttons at the bottom of windows.
<ALT-RIGHT>	Moves one character right within a field.
<ALT-LEFT>	Moves one character left within a field.
<CTRL-PGDN>	Moves cursor to the last field.
<CTRL-PGUP>	Moves cursor to the first field.
<DOWN>	Moves cursor down a field.
<UP>	Moves cursor up a field.
<RIGHT>	Moves cursor right a field.
<LEFT>	Moves cursor left a field.
<TAB>	Moves cursor to the next field.
<SHIFT-TAB>	Moves cursor to the previous field.
<ENTER>	Accepts contents of current field and moves cursor to next field.
<SPACE BAR>	Toggles to next available selection in a list (only in fields with small set of choices).
<F2>	Displays list of selections for a field (only available in fields with small set of choices).
<DELETE>	Deletes the character at the cursor.
<BACKSPACE>	Deletes the character to the left of the cursor.
<INSERT>	Toggles between insert and typeover mode.
<F1>	Displays help information about current field.
<F3>	Prints contents of the screen.
<CTRL-ENTER>	Exits window, saving current changes. Same as selecting <**MENU**> button.
<ESC>	Exits window, <u>without saving</u> current changes.

WINDOWS

There are six windows used to define test states, configure tests, set hardware options, or select specific signal options. The figures and tables that follow describe every function available in each window.

SELTEST Software Reference
SEL-RTS Instruction Manual

Color Monitor

If you are using a color monitor, windows appear in blue, data you enter appear in black, and fields that are not editable appear in red. SELTEST software will also operate on monochrome monitors.

Startup Window

The startup window gives you the option of creating a new test or loading an existing test file. Figure 4.8 and Table 4.4 describe the Startup window and its function.


```
Welcome to the SELTEST program.  This program allows
you to create tests to execute with the SEL-AMS.

Within SELTEST, press <F1> for context-sensitive
help, press <F3> to print the screen, and press
<ESC> to abort the current operation.

Do you wish to create a new test or load a previously
defined test?

            <NEW TEST>   <LOAD TEST>
```
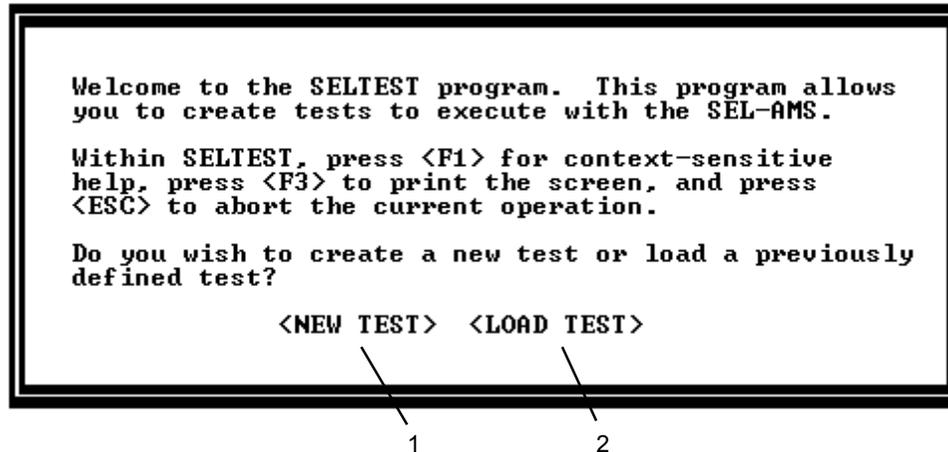
Figure 4.8: Startup Window

Table 4.4: Startup Window Description

Item	Comment
1	New Test button. Select this if you want to create a new test. A list of relays is presented. After you select a relay, the Standard State window with State #1 will be presented for editing. If you select OTHER from the list, the Configuration window will be displayed for editing.
2	Load Test button. Select this to load an existing test file. A directory of existing files will be displayed for you to select from. The selected file will then be displayed in the Standard State window for editing or execution.

Configuration Window

Figure 4.9 and Table 4.5 describe the Configuration window. Use the Configuration window to define scale factors and unit definitions for the analog channels, labels for analog channels, sense inputs, and contact outputs. Tests are automatically given a default configuration when the relay type is selected. However, you may change this configuration using the Configuration window. This window is accessed by selecting OTHER as the relay type for a new test on program startup or by selecting CONFIGURATION from the VIEW menu.
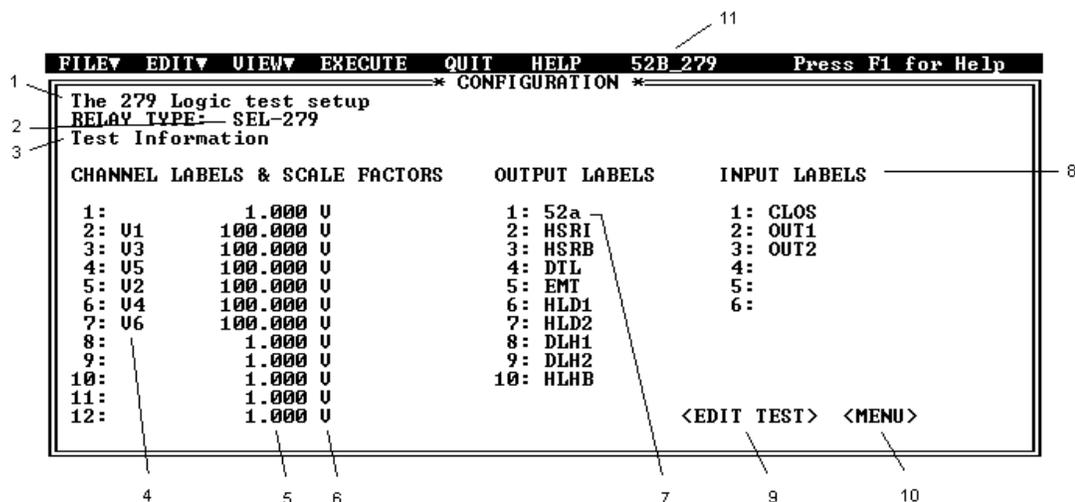
Figure 4.9: Configuration Window

Table 4.5: Configuration Window Description

Item	Comment
1	Test Description field. A descriptive phrase identifying the test being configured.
2	Relay Type field. Press the **<SPACE BAR>** until the SEL relay model you want to test is displayed in this field, or press **<F2>** to display a selection menu. SELTEST software uses this to assign channel labels, scale factors, and units designators for each of the 12 analog channels. To assign the scale factor yourself, for a device not listed in SELTEST software for example, select OTHER in this field, and type the scale factor in the Scale Factor field.
3	Test Information field. Displays the Test Information window when the cursor is placed in this field. Use this window as a note pad to record information about the test.
4	Analog Output Channel Label field. A label (up to 4 characters) identifying the Analog Output Channel. If this field is left blank, the channel remains unused. This label is copied to all windows where the Analog Output Channel appears. Labels are automatically selected based on the relay type unless OTHER is entered in Relay Type field.
5	Scale Factor field. Identifies the Analog Output Channel scale factor. SELTEST software applies the scale factor to the analog magnitude entered for the channel, so you can work in natural units while designing a test. The scale factor is determined by SELTEST software based upon the entry in Relay Type field unless OTHER is entered there. In that case, you may enter the scale factor in this field yourself. With a scale factor of 1, a magnitude entry of 1 produces 1 Vrms output from the SEL-AMS. To work in secondary units, set the scale factor equal to the relay's internal transformer ratio (typically 50). Then a magnitude setting of 50 yields a 1.0 Vrms output, which looks like 50 V to the relay. Acceptable scale factor range is 1.000 to 999999.999. This field is not accessible if the Channel Label field is left blank or the relay type is not OTHER.

Item	Comment
6	Unit Designator field. Defines units for Analog Output Channel. Options are A (amperes), V (volts), KV (kilovolts), and KA (kiloamperes). Units are automatically selected unless OTHER is entered in Relay Type field. Press the **<SPACE BAR>** to step through the options. You may also press **<F2>** to display a selection menu. Units displayed in this field are automatically copied to all windows where the Analog Output Channel appears. These units are for your convenience and do not affect the operation of the test.
7	Output Label field. A label (up to four characters) identifying the contact output. This label is copied to all windows where the contact outputs appear. If a label is left blank, that output will not be used in the test.
8	Sense Input Label field. Enter a label (up to four characters) identifying the sense input. This label is copied to all windows where the sense input appears. If this label is left blank, this input is not used for this test.
9	**<EDIT TEST>** button. Selects the state editing mode in the Standard or Extended State window (depending on last edits performed). If you have not edited a state yet, the Standard State window is the default.
10	**<MENU>** button. Selects the Main Menu bar and exits the edit mode. After selecting this option, you must select EDIT and EDIT WINDOW from the Main Menu bar or press **<ESC>** to reenter the edit mode.
11	Test Name field. Shows the name of the test that this configuration is for.

Using Test States

What is a State?

A test state is a set of static output conditions and static input handling specifications that exists for a defined period of time. You define states using state definition windows in SELTEST software. This definition tells the SEL-AMS what signals to send to a relay under test and what to do with signals that return from the relay. If any test output condition changes, a new state is required.

How Many States?

A test must consist of at least one state but may have up to 255 states. A simple test may have a single state that repeats itself. PC memory constraints may not allow 255 states.

State Flexibility

A state normally executes for a period of time you specify in the state description. However, you may program a state to conclude its operation when sensing an input condition you define. States normally run in the sequence they appear in the test file, but you may also program a state to select the next state to run, out of the numerical sequence, based on input conditions. The number of states, their complexity, and their sequence of operation depends on the object of the test. Using these tools, virtually any test condition may be achieved.

State Window Differences

For comparison, Table 4.6 lists the functions available with each of the two state definition windows. Generally, use the Standard State window if it meets your needs.

Table 4.6: State Window

Function	Standard	Extended
Number of analog channels available to edit or view	8	12
Number of sense inputs available to edit or view	2	6
Number of contact outputs available to edit or view	3	10
Maximum number of states displayed at one time	3	1
Terminate state operation on input condition sensed	YES	YES
Next-state-to-run selection available	NO	YES
Analog-output-signal ramping available	NO	YES
Event timing available	YES	YES
System-frequency ramping available	NO	YES
COMTRADE definitions available for analog channels	NO	YES

Standard State Window

The Standard State window, Figure 4.10 and Table 4.7, displays up to three states at a time in the window, sometimes in an abbreviated format. The information displayed or edited is only the minimum required to define a state. Only eight analog channels, two sense inputs, and three contact outputs are available. If more data is available than can be viewed (the state was created using the Extended State window), a *MORE* prompt is displayed near the bottom of the window.
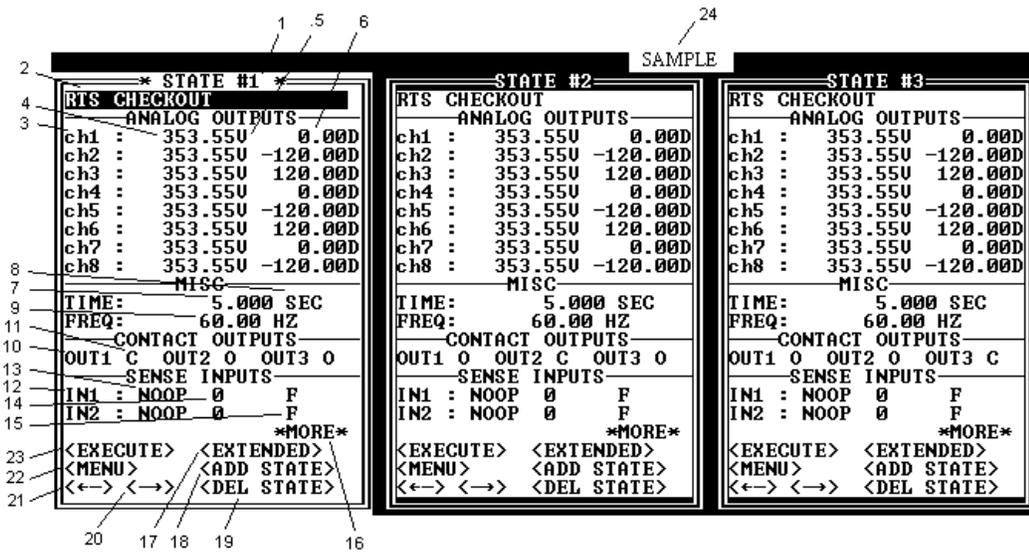
Figure 4.10: Standard State Window

Table 4.7: Standard State Window Description

Item	Comment
1	State Number field. Number of the state currently displayed.
2	State Description field. Descriptive phrase (up to 70 characters) identifies the state.
3	Analog Output Label field. Descriptive label from Configuration window. If blank, channel remains unused.
4	Magnitude field. Signal amplitude on the analog output channel. Range is 0.0 to 3.535 times the channel's scale factor. Only eight channels are accessed from this window. If you need to view or edit more channels, use the Extended State window. If more than eight channels have already been defined in this state, *MORE* is displayed at the bottom of the window. Voltages for delta relays must be phase to phase values, ($V_{ab} = V_a - V_b$). See *Appendix I* for details.
5	Units field. Units Magnitude field is expressed in, copied from Configuration window. Will be V (volts), A (amperes), KV (kilovolts), or KA (kiloamperes). Blank if the Analog Output Channel Label field is blank.
6	Phase field. Enter the relative phase angle (in degrees) for this channel. The range is -360.0° to 360.0°. If this channel is defined by a COMTRADE file, you cannot edit this field. If the Analog Output Channel Label field is blank, this field is inaccessible. Only eight analog output channels are shown in this window. If you need to view or edit more channels, use the Extended State window.
7	Maximum Test Time field. Enter the maximum time you want this state to run. State terminates when time elapses, if a terminate-on-sense condition doesn't terminate the state first. Range is 0.5 to 400000000.0 milliseconds, 0.001 to 400000.0 seconds, 0.001 to 7000.0 minutes, or 0.05 to 10000000.0 cycles.
8	Units field. Units the Maximum Test Time field is expressed in. Use the **<SPACE BAR>** to select from MSEC (milliseconds), SEC (seconds), MIN (minutes), and CYC (cycles).
9	Frequency field. In this field, enter the system frequency for this state. Range is 10.0 to 300.0 Hz.
10	Output Contact Label field. Descriptive label from Configuration window, identifies contact output. If this field is left blank, the output is unused.
11	Output Contact field. Use the **<SPACE BAR>** to select between O (open), or C (closed) condition that you want on the output contacts during this test state. If the Output Contact Label field is blank, this field is inaccessible.
12	Sense Input Label field. Descriptive label from Configuration window identifies input channel. If blank, channel is unused. Only two inputs are shown. If you need to view or edit more inputs, use the Extended State window. If more inputs exist for this state than are shown, *MORE* is displayed at the bottom of the window.

Item	Comment
13	Function field. This field describes the input transition that SELTEST software looks for on this channel. Press the **<SPACE BAR>** to select from NOOP (no operation required), O → C (open to close), C → O (close to open). This field is inaccessible if the Sense Input Label Field is blank. Only two inputs are shown. If you need to view or edit more inputs, use the Extended State window. If more inputs exist for this state than are shown, *MORE* is displayed at the bottom of the window.
14	Delay Time field. Time in milliseconds (0 - 255) allowed to transpire before software assumes transition state in the Function field is stable. This field is inaccessible if the Sense Input Label field is blank. This would normally be used to ignore transient switches and to allow for switch debounce. It can also be used to delay state transitions after an input condition is sensed.
15	Terminate-On-Sense field. The SEL-AMS concludes operation of this state when it senses the condition shown in this field. Press the <**SPACE BAR**> to select from: F (do not terminate based on this input), O (terminate when open), and C (terminate when closed). This field is inaccessible if the Sense Input Label field is blank. Only two inputs are shown. If more inputs need to be viewed or edited, use the Extended State window. If more inputs exist for this state than are shown, *MORE* is displayed at the bottom of the window.
16	*MORE* Prompt. When displayed, indicates that parameters have been defined that cannot be shown in this window type. Use the Extended State window to view remaining state settings.
17	<**EXTENDED**> button. Switches the editing mode to the Extended State window.
18	**<ADD STATE>** button. Causes the currently selected state to be copied and inserted as the next state and displays it for edit.
19	**<DEL STATE>** button. Causes the currently selected state to be deleted. The next state in the test is then displayed as the current state. If the state displayed is the only state, this button is inoperative.
20	<→> button. Causes the next state in the test to be displayed as the currently selected state. If the currently selected state is the last state in the test, this button in inoperative.
21	<←> button. Causes the previous state in the test to be displayed as the currently selected state. If the currently selected state is the first state in the test, this button is inoperative.
22	**<MENU>** button. Selects the Main Menu bar and exits the edit mode. You must select EDIT and EDIT WINDOW from the Main Menu bar or press **<ESC>** to reenter the edit mode.
23	**<EXECUTE>** button. Causes the currently selected test to execute.
24	Test Name field. Shows the name of the test that this state is a part of.

Extended State Window

Figure 4.11 and Table 4.8 describe the Extended State window. Use the Extended State window when you need to control the order in which states execute, ramp system frequency or analog channel outputs, or use COMTRADE data sets.
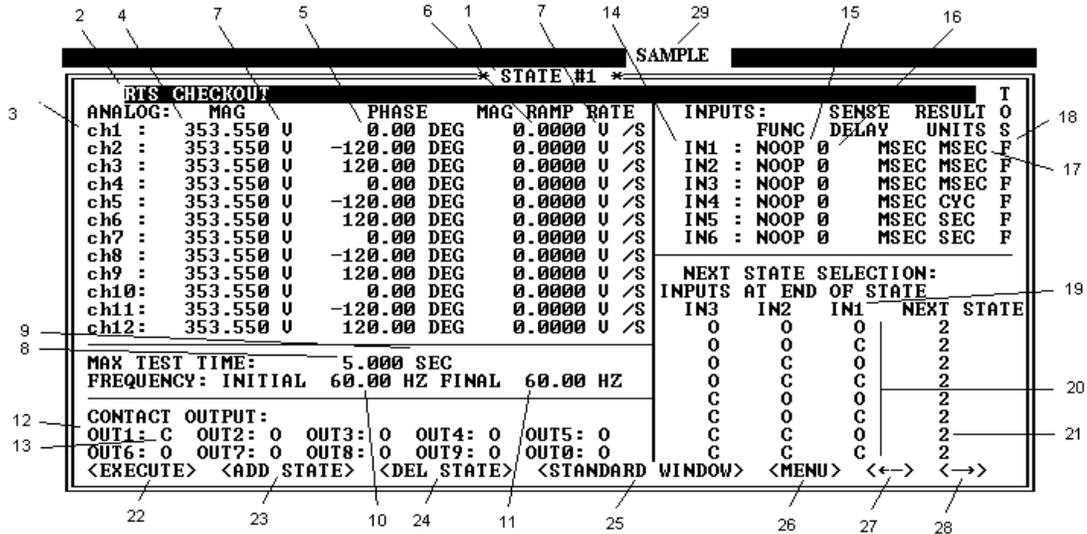
Figure 4.11: Extended State Window

Table 4.8: Extended State Window Description

Item	Comment
1	State Number field. Shows the number of the state currently displayed.
2	State Description field. Enter a phrase that identifies the state displayed.
3	Analog Output Channel Label field. Descriptive label copied from the Configuration window. If blank, the channel remains unused.
4	Magnitude field. Number represents analog output channel signal amplitude. Range is 0.000 to 3.535 times the channel's scale factor. If you desire a COMTRADE signal, press **<F2>** or **<SPACE BAR>** to display a COMTRADE/SINE selection menu. Select COMTRADE to display the COMTRADE window (Figure 4.11 and Table 4.8). If the Analog Output Channel Label field is blank, this field is inaccessible. Voltages for delta relays must be phase to phase values, ($V_{ab} = V_a$-V_b). See ***Appendix I*** for details.
5	Phase field. Enter the relative phase angle (in degrees) for this channel. Range is -360.0 to 360.0☞. If the Magnitude field is defined by a COMTRADE file, you cannot edit this field. If the Analog Output Channel Label field is blank, this field is inaccessible.

Item	Comment
6	Ramp rate. The rate, in units per second, the signal on this channel is to be ramped. Increment may not exceed maximum frequency/256 * scale factor * 3.5355. Leave 0.0 if you desire no ramping. Both positive and negative ramps are allowed. If the Analog Output Channel Label field is blank, this field is inaccessible. If the Magnitude field is defined by a COMTRADE file, you cannot edit this field.
7	Units field. Units the Magnitude field or Magnitude Ramp field are expressed in, copied from the Configuration window. Units are: V (volts), A (amperes), KV (kilovolts), or KA (kiloamperes). This field is blank if Analog Output Channel Label field is blank.
8	Maximum Test Time field. Enter the maximum time you want this state to run. State terminates when time elapses, if a terminate-on-sense condition doesn't terminate the state first. Range is 0.5 to 400000000.0 milliseconds, 0.001 to 400000.0 seconds, 0.001 to 7000.0 minutes, or 0.05 to 10000000.0 cycles.
9	Test Time Units field. Units the test time is expressed in. Use the **<SPACE BAR>** to select from: SEC (seconds), MIN (minutes), CYC (cycles), or MSEC (milliseconds).
10	Initial Frequency field. Enter the system frequency for this state in this field. Range is 10.0 to 300.0 Hz.
11	Final Frequency field. Enter the final frequency for this state. Set it the same as the initial frequency for no frequency ramping. It may not differ from the initial frequency by more than a factor of two.
12	Contact Output Label field. Label identifying contact output. This label is picked from the Configuration window. If blank, the output is unused.
13	Contact Output field. Use the **<SPACE BAR>** to select between O (open) or C (closed) condition you want on the output contacts during this test state. If the Output Contact Label field is blank, this field is inaccessible.
14	Sense Input Label field. Label identifying input channel. This label is picked up from the Configuration window. If blank, the input is unused.
15	Function field. Describes the transition on this input SELTEST software looks for. The time this transition takes place, measured from the beginning of the state, is recorded during test execution and may be viewed in the Results window. Available options are: NOOP (no operation required), O → C (open to close), and C → O (close to open). Press the **<SPACE BAR>** to toggle to the desired entry. This field is inaccessible if the Sense Input Label field is blank.
16	Delay Time field. Time in milliseconds (0 - 255) that the input must be stable before software assumes transition state in the Function field has occurred. This field is inaccessible if the Sense Input Label field is blank. This would normally be used to ignore transient switches and to allow for switch debounce.
17	Result Units field. Shows the units of measure the FUNCTION FIELD results are expressed in. Press the **<SPACE BAR>** to select from SEC (seconds), MSEC (milliseconds), CYC (cycles), or MIN (minutes). This field is inaccessible if the Sense Input Label field is blank, or the function is NOOP.

Item	Comment
18	Terminate-On-Sense field. Defines condition on input channel that concludes the operation of this state when sensed. Press the **<SPACE BAR>** to select from F (do not terminate based on this input), O (terminate when open), or C (terminate when close). This field is inaccessible if the Sense Input Label field is blank.
19	Sense Input Label fields. Labels of first three inputs (copied from Configuration window). The condition of these inputs is used to determine the next state to execute upon conclusion of this state's operation.
20	Selection matrix. Matrix of open and closed conditions on first three inputs that determine the next state to execute. To the right of each row, enter the state number to run if the conditions in that row exist when the state terminates. If all three input labels are present, you may edit eight of these next states. If two input labels are present, you may edit four states. If one label is present, you may edit two states. If no labels are present, you may edit the first state number.
21	Next State Number field. Enter state number to be transitioned to if conditions in that row of Selection matrix exist when the state concludes operation. If any of the first three inputs are not defined, the number of next-state selections is reduced.
22	**<EXECUTE>** button. Causes the currently selected test to execute.
23	**<ADD STATE>** button. Causes the currently selected state to be copied and added as the next state and then be displayed as the currently selected state.
24	**<DEL STATE>** button. Causes the currently selected state to be deleted. The next state in the test is then displayed as the current state. If the state displayed is the only state, this button is inoperative.
25	**<STANDARD WINDOW>** button. Selects the Standard State window for editing this state.
26	**<MENU>** button. Selects the Main Menu bar and exits the edit mode. You must select EDIT and EDIT WINDOW from the Main Menu bar or press <**ESC**> to reenter the edit mode.
27	<←> button. Causes the previous state in the test to be displayed as the currently selected state. If the currently selected state is the first state, this button is inoperative.
28	<→> button. Causes the next state in the test to be displayed as the currently selected state. If the currently selected state is the last state in the test, this button is inoperative.
29	Test Name field. Shows the name of the test that this state is a part of.

COMTRADE Specification Window

The COMTRADE Specification window, Figure 4.12 and Table 4.9, is displayed when selected from a Magnitude field of the Extended State window. It allows you to specify what COMTRADE data to use for a channel and how it should be scaled.
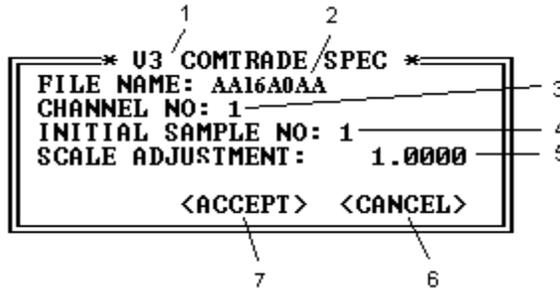
Figure 4.12: COMTRADE Specification Window

Table 4.9: COMTRADE Specification Window Description

Item	Comment
1	Analog Channel Label field. Descriptive label, from the Configuration window, identifies the analog channel for which this COMTRADE file is effective.
2	COMTRADE File Set name. The name of the COMTRADE file set (no extension) within the COMTRADE directory specified in the Options window. Press **<SPACE BAR>** or **<F2>** to get a list of files to select from.
3	Channel Number field. Channel number within the COMTRADE file that specifies the column of data used for this analog channel.
4	Initial Sample Number field. Sample number (data row) in the COMTRADE data file to use as the beginning of the waveform definition.
5	Scale Adjustment field. Data values are divided by this number before SELTEST scaling (from Configuration window) is applied. Use this field to adjust scaling if COMTRADE data is scaled differently from SELTEST data. For example, if the data is expressed in primary units, but SELTEST software is set to operate in secondary units, you place the PT or CT ratio in this field.
6	**<CANCEL>** button. Select to cancel editing session without saving changes made.
7	**<ACCEPT>** button. Select to terminate editing session and save all changes made.

Post-Execution Window

The Post-Execution window, Figure 4.13 and Table 4.10, is displayed after a test executes. It shows the options you have to choose from at the end of test execution.
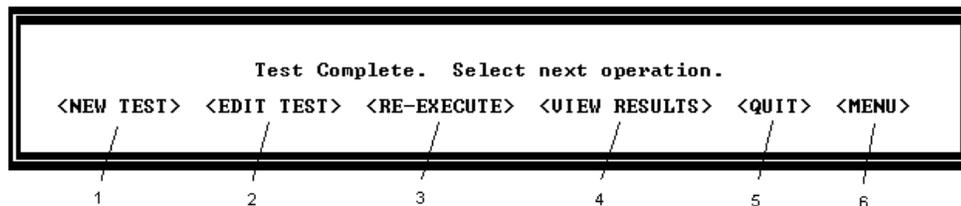
Figure 4.13: Post-Execution Window

Table 4.10: Post-Execution Window Description

Item	Comment
1	**<NEW TEST>** button. Select this button to create a new test. Displays the Standard State window for you to begin editing a new test.
2	**<EDIT TEST>** button. Returns you to the test just executed so you may edit the test.
3	**<RE-EXECUTE>** button. Repeats execution of the same test that just executed.
4	**<VIEW RESULTS>** button. Displays the results window with test results of the test just executed.
5	**<QUIT>** button. Select this button to exit the SELTEST program.
6	**<MENU>** button. Displays the Main Menu bar at the top of the window so you may select menu options.

Results Window

With the Results window, Figure 4.14 and Table 4.11, you view the result of a test state's execution. The final state of the inputs and the time a transition was sensed on each input, is displayed. For all channels, the signal level at the end of the state is indicated. The window shows the elapsed time the state executed and the number of the next state transitioned to. If this is the last state in a test, the next state number is zero. You cannot edit this window.
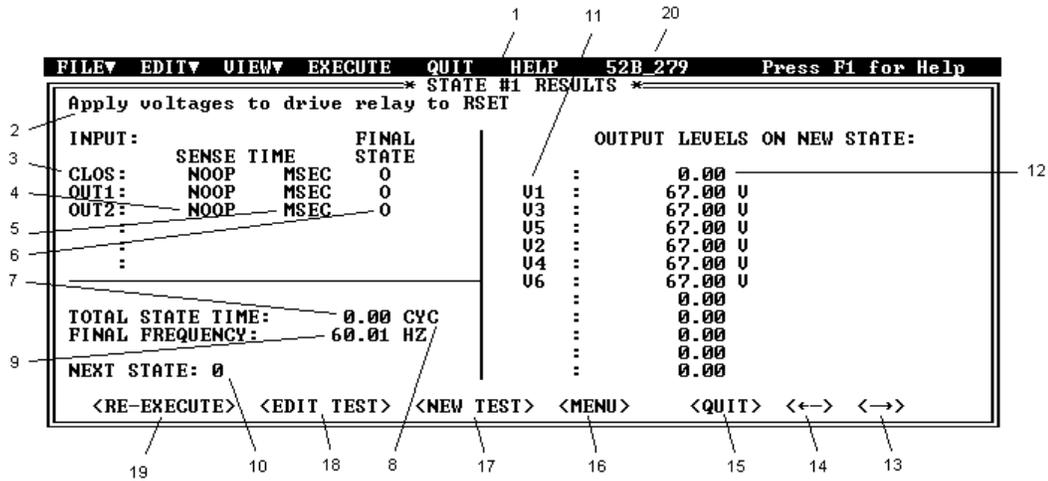
Figure 4.14: Results Window

Table 4.11: Results Window Description

Item	Comment
	NOTE: You cannot modify data in this window. Data are imported from the Configuration window or are a result of test execution.
1	State Number field. Number of the state whose results are currently displayed.
2	State Description field. Descriptive phrase identifying the state for which results are displayed. Comes from State window.
3	Input Channel Label field. Descriptive label, from the Configuration window, that identifies the input channel.
4	Sense Time field. The time a signal was sensed on this input channel, measured from the beginning of state. Sense delay time is not included in this value. Will be NOOP if function was NOOP or desired transition was not detected. Will be SENSE if desired transition had already occurred at the beginning of the state. SEL-AMS inputs are not edge triggered; they are sampled at 1 kHz. If contact bounce lasts more than one millisecond, input timing will be less accurate.
5	Units field. Units the Sense Time field is expressed in. May be MIN (minutes), SEC (seconds), MSEC (milliseconds), or CYC (cycles).
6	Final State field. Final state O (open) or C (closed) of the input channel when the state concluded operation.
7	Total State Time field. Elapsed time that this state executed within the test. If the test was aborted during this state, the reported time will be "0".
8	Time Units field. Units the Total State Time field is expressed in. May be MIN (minutes), SEC (seconds) , MSEC (milliseconds), or CYC (cycles).
9	Final Frequency field. Frequency at the termination of the state.
10	Next State field. Next state run at the conclusion of the displayed state. Contains zero if this was the last state executed.
11	Analog Channel Label field. Descriptive label, from the Configuration window, identifying analog output channel.
12	Analog Output Channel Results field. Signal amplitude on the analog output channel at the end of the state.
13	<→> button. Causes the next state in the results to be displayed as the currently selected state. If the currently selected state is the last state in the results, this button is inoperative.
14	<←> button. Causes the previous state in the results to be displayed as the currently selected state. If the currently selected state is the first state in the results, this button is inoperative.
15	**<QUIT>** button. Terminates the program. If you have not saved the currently selected test, you are prompted to save it.

Item	Comment
16	**<MENU>** button. Selects the Main Menu bar and exits the edit mode. You must select **EDIT** then **EDIT WINDOW** from the Main Menu bar or press **<ESC>** to reenter the edit mode.
17	**<NEW TEST>** button. Clears the currently selected test from memory. Loads a default test for editing. Displays the last editing window selected and the configuration for last relay selected.
18	**<EDIT TEST>** button. Selects the state editing mode last used.
19	**<RE-EXECUTE>** button. Causes the currently selected test to execute.
20	Test Name field. Shows the name of the test that this results state is a part of.

Options Window

Use the Options window to change PC terminal settings. Figure 4.15 and Table 4.12 describe the Options window and its function. These settings are initially loaded from the SEL TEST.CFG file. To access the Options window, select **OPTIONS** under **FILE** on the Main Menu bar.
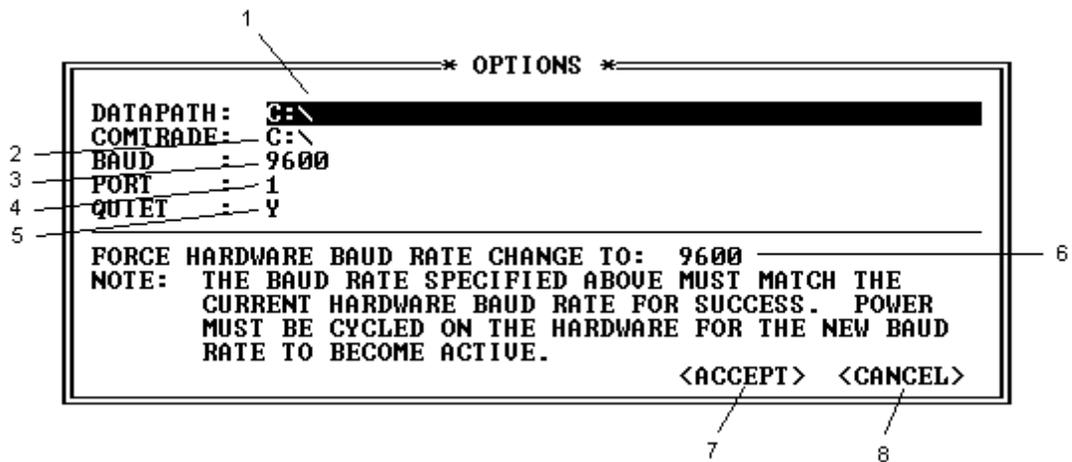
Figure 4.15: Options Window

Table 4.12: Options Window Description

Item	Comment
1	Datapath field. Enter the file path where you want to look for test files.
2	COMTRADE Path field. Enter the file path where COMTRADE files are located.
3	Baud field. Shows the current communications baud rate for the personal computer for communication with the SEL-AMS. Use the **<SPACE BAR>** to step through the valid choices or use **<F2>** to get a list to select from. This baud rate should always match the current SEL-AMS baud rate.
4	Port field. Enter the personal computer's communications port used to talk to the SEL-AMS. Use the **<SPACE BAR>** to toggle between the options. Currently, only COM1 and COM2 are allowed.
5	Quiet field. Press the **<SPACE BAR>** to toggle between Y and N selections. Use N for audio enabled, Y for disabled.
6	Baud Rate Change field. Use the **<SPACE BAR>** to step through valid selections or use **<F2>** to get a list to select from. Normally, this is set the same as the PC baud rate. To change the SEL-AMS baud rate, set this baud rate to the desired baud rate. Upon exiting the Options window, the PC will command the SEL-AMS to set this new baud rate. Cycle power on the SEL-AMS to make the new baud rate effective.
7	**<ACCEPT>** button. Select to terminate editing the Options window, and accept all changes made. You will then be prompted to save changes. Saving will place changes in the SELTEST.CFG file, and they will be effective in subsequent program executions. Whether or not they are saved, they will still be effective for the current editing session.
8	**<CANCEL>** button. Cancels editing session and does not save changes made.

MENU OPERATIONS

Using the menu structure shown in Figure 4.16, you access and modify test files. Access all SELTEST software functions by selecting operations from these menus. To get to the menu, select **<MENU>** button from the current window. To return to window editing, select **EDIT WINDOW** from the **EDIT** menu or press **<ESC>** from the Main Menu bar.

The left and light arrow keys move between Main Menu bar options. **<ENTER>** selects the currently displayed option. **<UP>** and **<DOWN>** arrow keys move between choices within a menu. **<F1>** may be used from any menu selection for help on that selection.

Menu Structure

Access interactive windows through a Main Menu bar with menus as shown in Figure 4.16 and Table 4.13. The Main Menu bar appears when selected with **<MENU>** button at the bottom of most windows.

```
`FILE    EDIT    VIEW      EXECUTE     QUIT      HELP      SAMPLE      Press F1 for Help
```

```
┌─────────────────────────┐   ┌──────────────────────────────────────┐   ┌────────────────────────┐
│  CREATE                 │   │  EDIT WINDOW            Alt E          │   │  √CONFIGURATION        │
│  LOAD          Alt L    │   │  GO TO NEXT STATE       Alt >          │   │   STANDARD STATE       │
│  DELETE        Alt D    │   │  GO TO PREV STATE       Alt <          │   │   EXTENDED STATE       │
│  SAVE AS . . . Alt S    │   │  GO TO A STATE          Alt End        │   │   RESULTS              │
│  OPTIONS       Alt O    │   │  INSERT STATE                          │   │                        │
│                         │   │  APPEND STATE                          │   └────────────────────────┘
└─────────────────────────┘   │  COPY STATE                            │
                              │  MOVE STATE                            │
                              │  DELETE STATE                          │
                              └────────────────────────────────────────┘
```
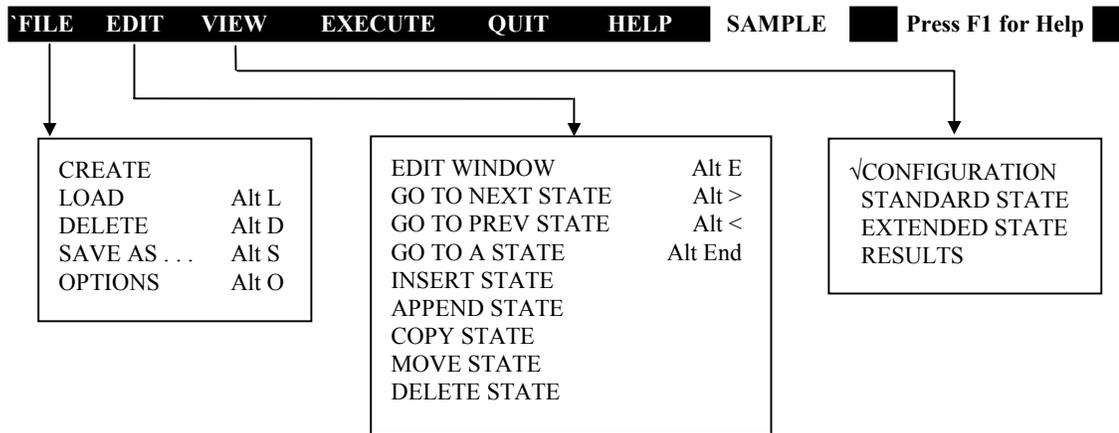
Figure 4.16: Menu Structure

Table 4.13: Menu Bar Functions

Menu Bar Selection	Menu	Comment
FILE		Activates a menu with file handling selections.
	CREATE	Use to create a new test. Loads a default initial test (RTA.RTA).
	LOAD	Loads an existing test file. Select file from a directory list.
	DELETE	Deletes a test. Select the test from a directory list.
	SAVE AS	Saves current file to a filename you select. If a previous .RTA file exists by the same name, the program asks if you want to overwrite it.
	OPTIONS	Allows you to change PC terminal settings by opening Options window, Figure 4.15 and Table 4.12.
EDIT		Activates menu with window editing selections.
	EDIT WINDOW	Allows you to edit currently displayed window.
	GO TO NEXT STATE	Displays next state in numerical order in the test or results.
	GO TO PREV STATE	Displays previous state in numerical order in the test or results.
	GO TO A STATE	Activates a list of states in the test. Cursor up/down to a state and press <**ENTER**> to select a state to be displayed.
	INSERT STATE	Inserts a state before the currently displayed position within the test.

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Menu Bar Selection	Menu	Comment
VIEW	APPEND STATE	Adds a state after the currently displayed state.
	COPY STATE	Activates a list of states in the test. The current state is copied and inserted at the selected location.
	MOVE STATE	Activates a list of states in the test. The current state is removed from its current location and inserted at the selected location.
	DELETE STATE	Deletes the current state from the test.
	CONFIGURATION	Displays the Configuration window.
	STANDARD STATES	Displays the current state and two others (if they exist) in Standard State window.
	EXTENDED STATES	Displays the current state in the Extended State window.
	RESULTS	Displays a state's results (from test execution) in a Results window.
EXECUTE	--	Executes the test. Use <**ESC**> while the test is running to abort execution.
QUIT	--	Quits the SELTEST software program.
HELP	--	Displays a general help window.

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SECTION 5: SEL-5401 TEST SYSTEM SOFTWARE REFERENCE

SYSTEM REQUIREMENTS FOR THE SEL-5401

Windows®95 / Windows®NT3.51 or higher
8 MB RAM
3 MB Disk Space
3½-inch Disk Drive for software installation
Mouse or other pointing device

SEL-5401 INSTALLATION AND CONFIGURATION

1.   Start Windows.

2.   Place the SEL-5401 installation disk into your disk drive and run setup.exe. Follow the installation instructions displayed on your monitor.

   Below is a list of files that will be installed on your PC

   - SEL5401.EXE - Application Executable File
   - SEL5401.HLP - Help File
   - SEL5401.CNT - Help Contents File
   - SEL5401.LIC - Application License Information
   - SELTESTx.UUT - Relay Configuration Files (contains channel scaling and default labels)
   - DATA - Example Test Description Files in a Data Subdirectory

ONLINE HELP

Select **Help** from the Main menu to open the help file for the SEL-5401. Help can also be accessed on each form by pressing **F1**. When pressing **F1**, the help relating to that form will be opened.

CHECKOUT PROCEDURE

Use the procedure below to checkout the SEL-RTS or combine it with your normal practice.

Step 1   Connect the SEL-AMS EIA-232 serial communications port to the computer via cable SEL-C234A.

   Low-energy, low-voltage MOVs and passive RC filters protect the communication circuits. Minimize communication circuit difficulties by keeping the lengths of the EIA-232 cables as short as possible. We recommend lengths of 12 feet or less. The cable length should never exceed 100 feet. Use shielded communications cables for lengths greater than 10 feet.

Step 2   Connect the SEL-AMS to line power and turn on the main power. Verify the main power indicators illuminate on the SEL-AMS. Also verify the 16 input/output indicators illuminate briefly when the power is turned on.

Step 3   Switch on the SEL-AMS DC Supply switch. Verify the On indicator illuminates.

Step 4   Using a voltmeter, verify the +24 V and +125 Vdc supply outputs and the +14.3 V supply on the Sense Input connector. All are located on the SEL-AMS back panel.

Step 5   Check each SEL-AMS sense input by applying +14.3 V to each input and verifying that the appropriate front-panel indicator illuminates.

Step 6   If the SEL-5401 has not been installed on your PC, install the software now by running setup.exe.

Step 7   To start the SEL-5401, double click on the SEL-5401 icon. Open the CHECKOUT.RTA test using the **File|Open** menu. This test consists of 10 states of 5 seconds each. The analog outputs are driven to full scale (10 V p-p or 3.5355 Vrms), and an individual output contact is asserted in each state. This test is looped indefinitely.

Step 8   To execute the test, click on the **Download** and **Run** speedbutton or select **Run|Download Test and Run it** from the Main Form menu. To abort the test, click on the **Abort** speedbutton or select **Run|Stop Test** or **Download** from the menu.

CREATING A TEST FILE

The SEL-5401 allows you to create, modify, and run computer controlled protective relay test programs for SEL relays. The SEL-5401 is a state-dependent program. Test conditions are created with the test states that you define in the state definition windows. The following procedure is meant to be used as a general guide to creating a simple test. Additional information on the application is available within the SEL-5401 Help file.

Start SEL-5401

Double click on the SEL-5401 icon.

Create a Test

This procedure is used to create a test that simulates a phase to ground fault. This test will be similar to the SAMPLE.RTA test provided with the installation. This test has the following three states.

State 1 Pre-fault conditions.
State 2 Fault condition - a Phase A fault just in front of the relay. The fault terminates when an Open to Close (O→C) condition is sensed on an input and a 67 ms time delay expires.
State 3 Post-fault condition - the breaker opens all three phases.

Procedure for Creating Test

Start the SEL-5401 and select **File|New** from the Main menu. After selecting **New** the configuration form will open. Select the relay you are using for this test from the relay type list box. You can also assign meaningful labels to the inputs and outputs from this form.
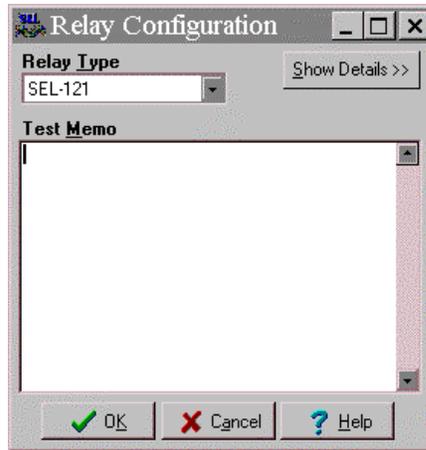
Figure 5.1: Configuration Form

After selecting a relay from the relay type list box, the main form will contain a one-state default test for the relay.

State Editing Window

The state editing window can be displayed in either the Standard or Extended view. The Extended view is used for more complex states and displays all of the available inputs and outputs, plus the next state table. Both views use the same editing conventions described below. Refer to Figure 5.2.

1. **Description.** Enter a description for the active state in this field.

2. **Analog Values.** Enter the analog magnitudes and phase angles in this grid. If using magnitude ramping, the Extended State view will be required. To display/edit COMTRADE descriptions, click on the right mouse button while one of the analog channels has focus.

3. **State Time.** Enter the time for this state and the units of time. To modify the units of time, type in the first letter or press the space bar to toggle through the available selections.

4. **Frequency.** Enter the final frequency for this state. If the final frequency of the state is different than the initial value, the Extended State view will be required to enter the initial frequency.
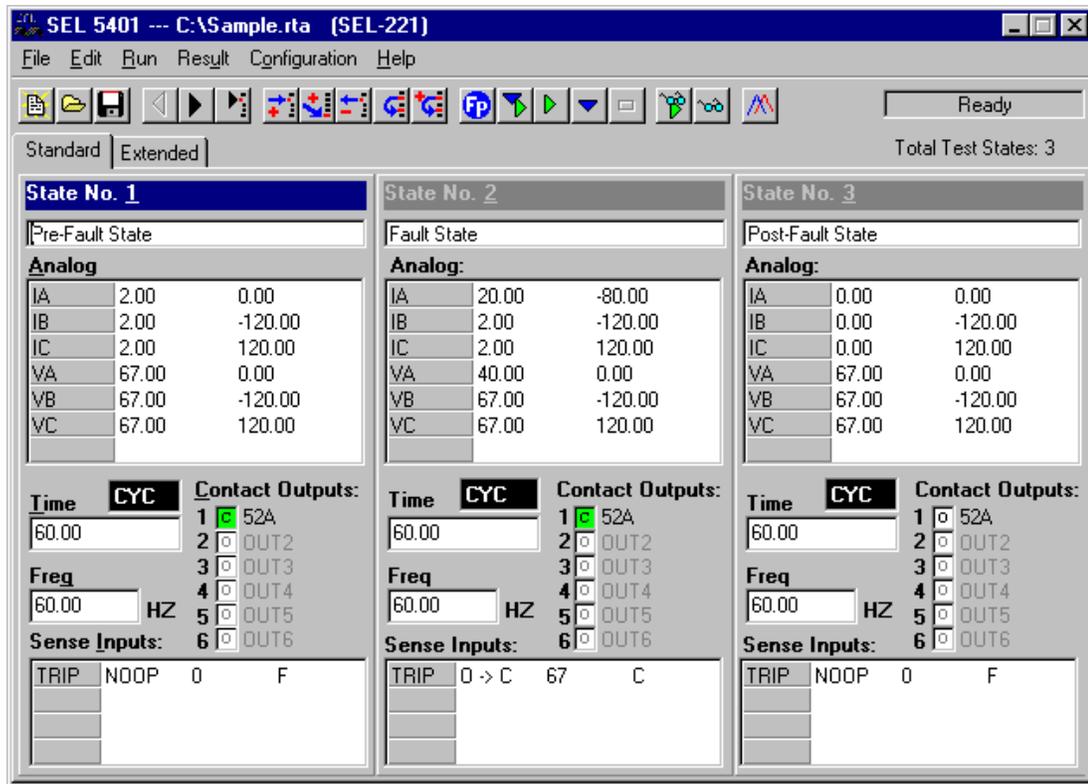
Figure 5.2: Standard View of a Test

5. **Outputs.** Enter the output contact condition for this state (O - open, C - closed). To toggle the condition, double click with the left mouse button, press the space bar or type the character O or C. Set the 52A input as closed for States 1 and 2 and Open for State 3.

6. **Input Sense.** Enter the Sense condition for the inputs: Open to Close (O→C), Close to Open (C←O), or No Operation (NOOP). To toggle the state, press the space bar or type the first letter of the sense condition. For the TRIP input, set the sense function as NOOP.

7. **Input Delay.** Enter the time delay for the input before the sensed condition is accepted. The program allows this time to expire after an input condition is sensed before assuming the condition is stable. The time delay is in the units specified in the Units field.

8. **Input Terminate on Sense (TOS).** Enter whether this input will be used to terminate the state. Use "C" to terminate the state when the input is sensed as Closed, "O" for Open, or "F" to ignore this input for state termination.   Note: If a time delay is specified for an input with a TOS condition, the state will terminate after the time delay.

9. **Adding States.** To add a state to the test, use the **Edit** menu or the Insert, Append, or Copy speedbuttons. The **Edit** menu, or Left and Right Arrow speedbuttons, can also be used to move the display between states.

10. **Executing Test.** Execute the test using the **Run|Download Test and Run it** from the menu or the Download and Run speedbutton. This converts the test to a primitive form and sends the primitive file to the SEL-AMS hardware.

Viewing Test Results

After the test is complete, the test results can be viewed on the Results form. Results can also be viewed for tests that were completed earlier by opening the appropriate results file (*.RTR).

The results will be displayed in the order the states were run. For example, if the states in a test ran 1, 2, 5, 4 and 3, then the results would also be viewed in that order.

PRINTING TESTS AND RESULTS

To print a test or the test results, select **File|Print** from the Main menu. From the Print form, you may select specific states to print or the entire test can be printed. The same actions can be done for printing results. In some cases, results may not exist for a given state and no results will be printed for that state.

FILE EXTENSIONS

The SEL-5401 uses three file extensions for the three types of files used to describe tests, results, and primitive tests.

RTA Extensions

This extension is used with the SEL-5401 test description files. These files contain ASCII test descriptions with the same data that you enter using the forms. These files are in an easily readable format and can be modified with a text editor. When the SEL-5401 opens a test, it opens a test with an RTA extension. See *Appendix B* for a description of the format.

RTR Extensions

This extension is used for the SEL-5401 results data files. This file is created by the SEL-5401 as a result of the execution of a test. See *Appendix C* for a description of the format.

RTP Extensions

This extension is used with the SEL-AMS primitive test file. The SEL-5401 creates the RTP file in a combination ASCII and binary format. This format is used by the SEL-AMS hardware.

TEST STATES

What is a State?

A test state is a set of static output conditions and static input handling specifications that exist for a defined period of time. You define states using the SEL-5401. This definition tells the SEL-AMS what signals to send to the relay under test and what to do with signals returned from the relay. If any test output conditions change, a new state is required.

How Many States?

A test must consist of at least one state, but may have up to 255 states. A simple test may have a single state that repeats itself.

State Flexibility

A state normally executes for a period of time specified in the state description. However, you may program a state to conclude its operation when sensing an input condition you define. States normally run in the sequence they appear in the test file, but you may also program a state to select the next state to run, out of numerical sequence, based on the input conditions. The number of states, their complexity, and their sequence of operation depends on the object of the test. Using these tools, virtually any test condition may be achieved.

FORMS IN THE SEL-5401

Main Form

The Extended State view on the Main form shows one state of the active test. Up to three states can be viewed for the test in the Standard State View of the Main form, but some of the functionality is not shown due to space limitations. Refer to Figure 5.3.

State Description

Enter a phrase in this field that describes this state.
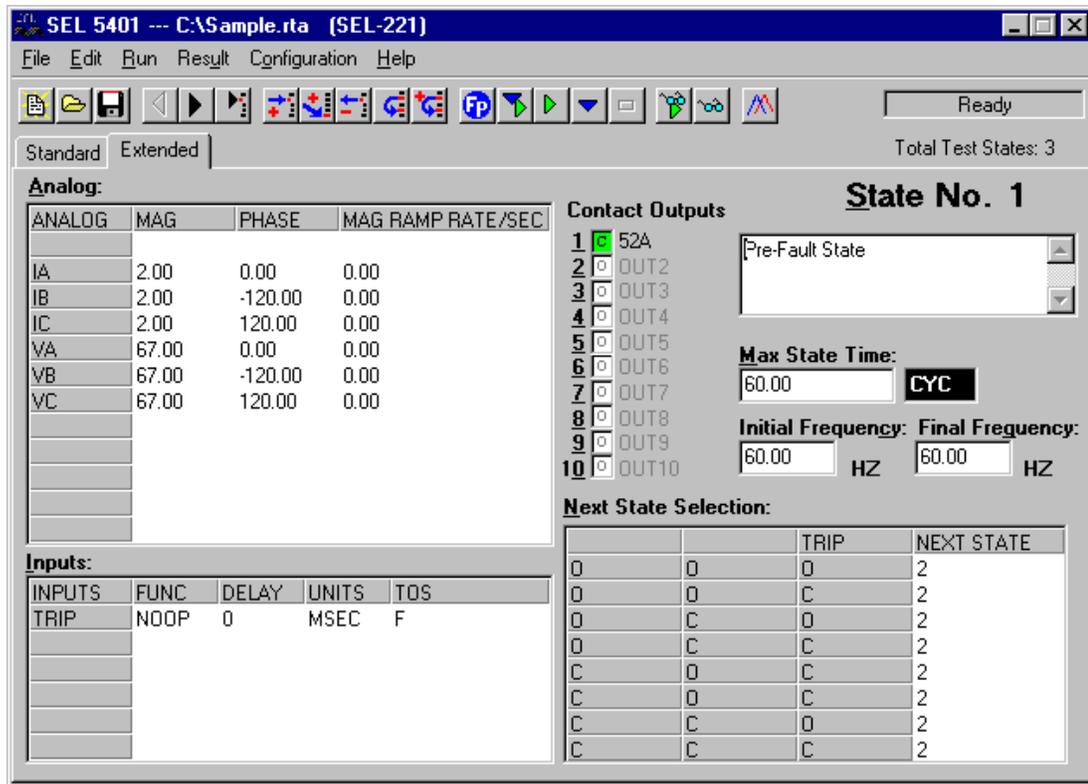
Figure 5.3: Extended View of a Test

Analog

Enter the magnitude and phase for each channel.

Magnitude. The number in this field represents the signal amplitude on this Analog Output Channel. The range is 0.000 to 3.535 times the channel's scale factor. To specify a transient signal (from a COMTRADE format file set), click the right mouse button. The magnitude field will contain "COMTRADE" when a transient selection has been made and the channel's phase will contain the name of the COMTRADE file.

Phase. Enter the phase angle (in degrees) of the signal on this channel. The acceptable range is -360.0 to 360.0°.

Magnitude Ramp Rate. Enter the rate, in units/second (units as defined by the Channel Units field), you want the signal on this Analog Output Channel to be ramped. Both positive and negative ramps are allowed. The maximum magnitude of the ramp corresponds to 1/256 of the maximum amplitude setting per cycle (as determined by the frequency setting). This is not visible on the Standard State View.

Contact Outputs

Set the state of the contact outputs. To toggle the state of the contacts, double click on the field or press the spacebar when the control is active. When the control is active you can also type

"C" or "O" to change the state. Only six of the ten outputs are visible on the Standard State View.

Sense Inputs

Set the functionality of the sense inputs. To toggle the functionality, press the spacebar or type the first letter of the function. Only four inputs are visible on the Standard State View.

Function Field. This field describes the input transition that the SEL-5401 looks for on this channel. This field describes the input transition that the SEL-5401 times on this channel. Press the space bar to select from NOOP (no operation), O→C (open to close), or C→O (close to open). This field remains blank if the Sense Input Label field is blank (the input is unused). The time this transition takes place, measured from the beginning of the state, is recorded during test execution and may be viewed in the Results window.

Sense Input Delay. Enter a time in milliseconds that an input must be stable before the SEL-5401 treats it as a changed input. Setting this to a non-zero value allows glitches and chatter to be ignored. The recorded sense time will correspond to the time at the beginning of the detected stable condition. The range is 0 to 255 milliseconds. If the sense condition exists at the beginning of the state, then this sense delay is not used.

Terminate on Sense Field. The SEL-5401 concludes operation of this state when it senses the condition shown in this field. Press the space bar to select from O (terminate when open), C (terminate when closed), F (do not terminate based on this input). This field remains blank if the Sense Input Label field is blank. The input's sense delay will be applied to this operation for de-bounce and glitch ignoring purposes.

State Time

Enter the maximum time for this state to run. The state concludes execution when this time elapses unless a terminate-on-sense condition concludes execution first. Four time options are available. Their ranges are 0.5 to 210000000 milliseconds, 0.01 to 210000 seconds, 0.01 to 3500 minutes, or 0.05 to 12600000 cycles. The units field shows the units of measure the Maximum State Time field is expressed in. Press the space bar to step through the selections. The available selections are: MSEC, CYC, SEC, and MIN

State Frequency

Initial. Enter the system frequency for this state in this field. The range is 10.0 Hz to 300.0 Hz.

Final. Enter the final frequency for this state. The system will ramp between the initial frequency and this frequency during the state. Set this the same as the initial frequency to disable frequency ramping. This is not available on the Standard State View.

Next State Selection

Enter the number of the next state to run when the open/ close conditions in this row of the truth table are true at state conclusion. This is not available on the Standard State View.

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Print Options Form

The Print Options form is used to identify which states from a test are to be printed and whether to print both the test and the results. Refer to Figure 5.4.
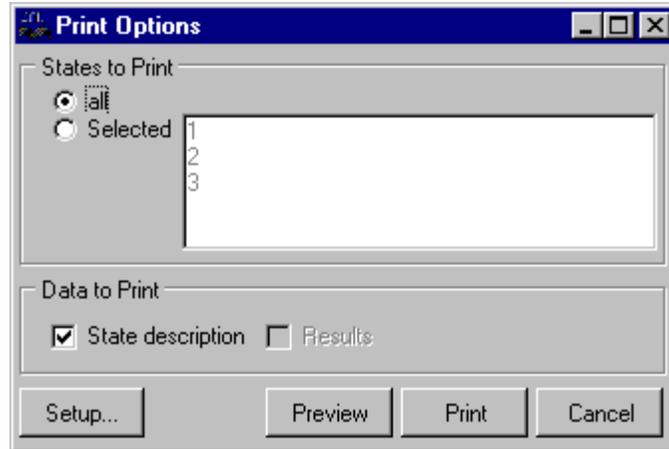
Figure 5.4: Print Options Form

States to Print

All. Select this option to print all of the states from a test or result file.

Selected. Select this option if you want to print only selected states from a test or result file. When selected, the list box will be enabled and states may be selected.

Data to Print

State Description. Prints the state descriptions as given in the RTA file and shown on the Main form.

Results. Prints the results descriptions as given in the RTR file and shown on the Results form

Buttons

Setup. Opens the Printer Setup dialog.

Preview. Displays the printout on your screen. From the preview form, you can print the document.

Print. Prints the document to your default printer.

Cancel. Closes this form and cancels the print options.

Test Options Form

This form is used to set general options for your test. Refer to Figure 5.5.
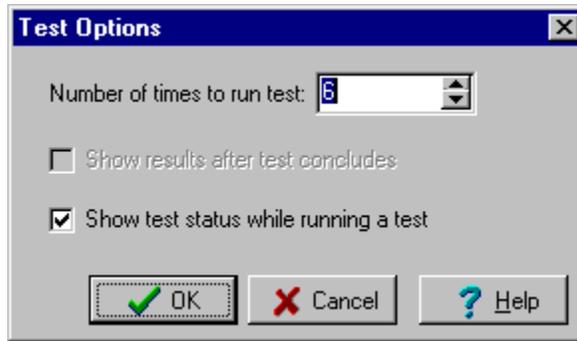
Figure 5.5: Test Option Form

Number of Times to Run Test. Specify the number of times to run this test. The first time the test will be converted and downloaded to the SEL-AMS. Subsequent tests will only require sending "ET" (execute test) to the SEL-AMS.

Show Results After Test Concludes. Mark this box to have the Results form open at the completion of the test. If this option is not selected, you may view the results manually by selecting **Result|View Result** from the Main Form menu.

Show Test Status While Running a Test. Mark this box to have the Test Status form open while a test is executing. With this option, you can watch the status of your test as it runs. This is especially useful when your test is not operating as you expected and may be stuck in one state.

Configuration Form

This form is used to specify the relay configuration for the active test. Refer to Figure 5.6.
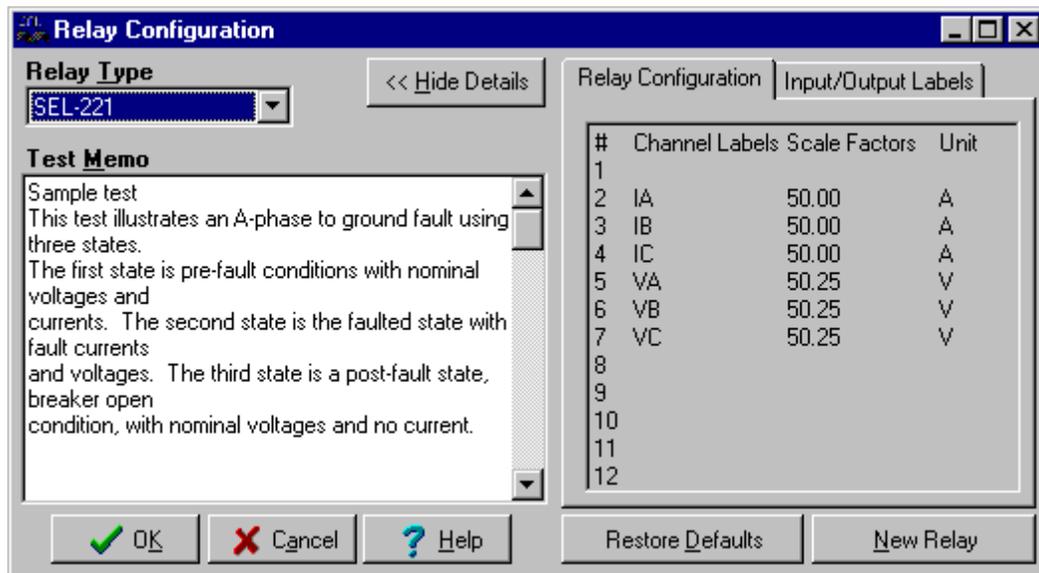
Figure 5.6: Configuration Form

Test Memo Field. Enter a description of the test. This description is used in addition to the state descriptions.

Relay Type. Select the relay type for the test. If you want a relay that is not listed in the combo box, then go to the **Configuration|UUT** database on the Main Form menu to create a new relay type.

Configuration. This is a read only field that displays the relay channel label, scale factor and units. To modify these values, use the UUT database.

Output Labels. Enter a label for the outputs. These labels will be shown on the Main form.

Input Labels. Enter a label for the inputs. These labels will be shown on the Main form. If this label is left blank, this input is not used for this test.

Restore Default Button. Click on this button to restore the configuration of the Input and Output labels to their default values.

Results Form

This form displays the results after a test has executed. Results are viewed state by state. For a given state, the final condition of the inputs, the time events were sensed, the ramped output levels, the total time the state ran, and the next state run when a state completes are shown. You cannot edit any of the fields within the Results form. Refer to Figure 5.7.

Figure 5.7: Results Form

The units of measure for the time are the same as the units specified in the test.

Output Levels. Displays the channel magnitude at the end of the state.

Input. Displays the input status during the state. The sense of the input, time of the change and the final state of the input are displayed.

Total State Time. Displays the total time the test was in this state.

Final Frequency. Displays the frequency of the channels at the end of this state.

Next State. Displays the next state the test went to at the completion of this state.

State Selection buttons. Click on the previous or next button to display the results of an adjacent state or select a state from the combo box.

Communication Options Form

This form sets the communication parameters between the PC and the SEL-AMS.
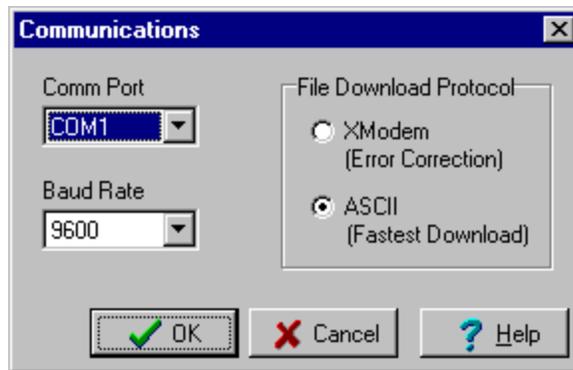
Figure 5.8: Communications Options Form

Communication Options

Select the communication parameters for the PC. The options include port and baud rate. The other communications parameters are fixed in the SEL-AMS hardware(Data bits = 8, Parity = none, Stop Bits = 1).

When changing the baud rate, use the following procedure:

1. Verify jumper JMP8 is installed on the SEL-AMS (forces baud rate to 9600).

2. Using a terminal program (at 9600 baud), send the SBxxxxx (uppercase) command to the SEL-AMS where xxxxx is between 00300 and 38400. Note: The command is not echoed back to your monitor. If the new baud rate is accepted, the SEL-AMS responds with "TC" otherwise an error code is returned.

3. Remove power from the SEL-AMS and remove jumper JMP8. Removing jumper JMP8 allows the SEL-AMS hardware to use baud rates other than 9600.

4. Restore power to the SEL-AMS. The SEL-AMS is now configured to the new baud rate.

5. Set the SEL-5401 baud rate to match the SEL-AMS rate using the Communications Options form.

File Download Protocol Options

Select whether the download protocol is ASCII or XMODEM. The ASCII protocol is faster, but does not provide any error checking. The XMODEM protocol provides error checking by creating a CRC checksum for each packet of data and the SEL-AMS verifies the received data has the same checksum.

Test Status Form

This form shows the status of a test as it is running and you can view the data as it streams out of the SEL-AMS. Refer to Figure 5.9.
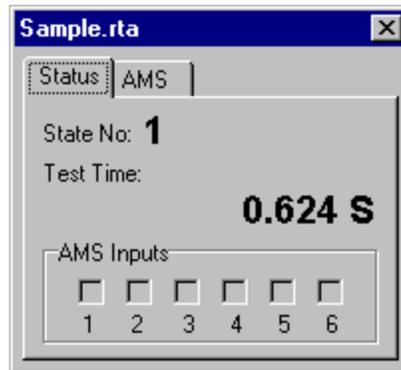
Figure 5.9: Test Status Form

Status Tab

State Number. Displays the active state in the test. This feature is especially useful when your test does not seem to be operating as expected.

Test Time. Displays the cumulated time, in ms, that the test has been running.

AMS Inputs. Displays the status of the SEL-AMS inputs as reported in the AMS Output Stream.

AMS Output Stream. Displays stream of data coming out of the SEL-AMS. Refer to the on-line help for a description of the data from the SEL-AMS.

Front Panel Form

The Front Panel form is used to simulate a front panel on the SEL-AMS and run steady state tests. Refer to Figure 5.10.
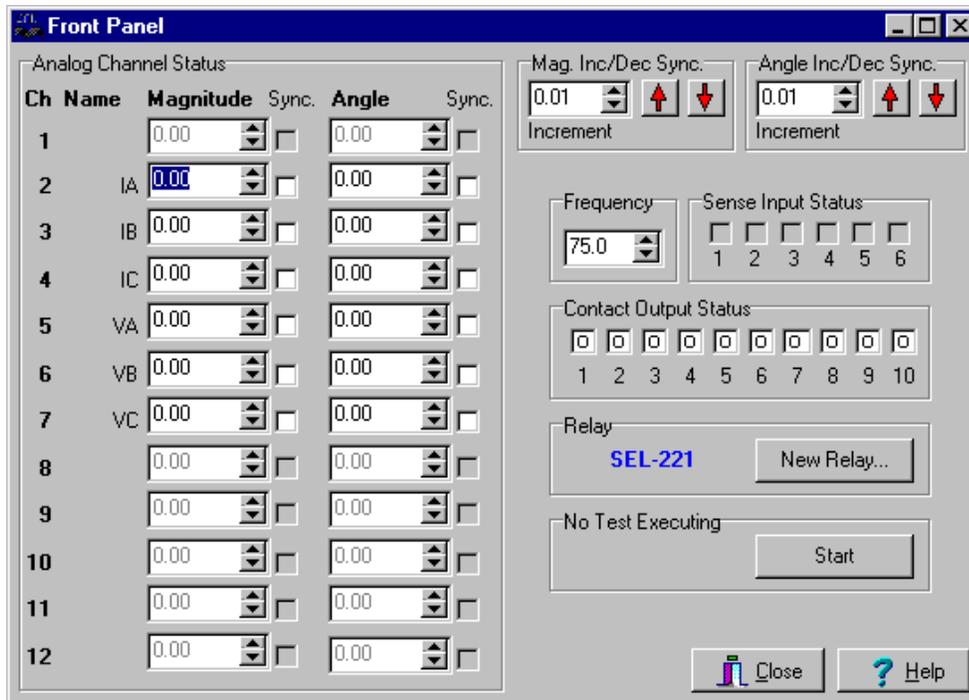
Figure 5.10: Front Panel Form

Channel Magnitude and Angle. Type or click on the associated buttons to modify the value for that channel. Each channel's magnitude and angle may be modified.

Input Status. This displays the status of the SEL-AMS inputs while the test is running.

Frequency. Type or click on the associated buttons to modify the frequency for the test.

Output Contacts. Double click to toggle the output contact state between open and closed. The state can also be changed with the keyboard using the "C", "O", or spacebar.

Start/Stop Button. Click on this button to start or stop the test signals. If a test is not running, click on the Start button to download and run the test. While a test is running, click on the Stop button to disable the test signals and open all of the output contacts.

New Relay Button. The SEL-AMS analog channels are configured for particular relays. To change the configuration to another relay type, click on the New Relay button to open the Configuration form.

UUT Database Form

This form is used to create, modify or delete relay configurations. Refer to Figure 5.11.

Figure 5.11: UUT Database Form

Relay Name

Select the relay name from the list box.

Channel Configuration

Label. Enter a label, up to four characters, identifying the Analog Output Channel. If this field is left blank, the channel is unused. This label is used on all other forms where the analog channel appears.

Scale Factor. Identifies the scale factor for the Analog Output Channel. The SEL-5401 assigns a scale factor based on the device shown in the Relay Name field. The scale factor field is read only unless the New Relay Configuration or Update speedbuttons have been pressed. The SEL-5401 uses this entry to apply scaling to the analog magnitude for this channel so you may work in natural units. With a scale factor of 1, a magnitude entry of 1 produces 1 Vrms output from the AMS. To work in secondary units, set the scale factor equal to the relay's internal transformer ratio (typically 50). With a scale factor of 50, a magnitude setting of 50 V will produce a 1 Vrms output from the SEL-AMS, which will be interpreted as 50 V by the relay. Setting range is 1.000 to 999999.999.

Units. Defines units for Analog Output Channel. Choices are: A (Amperes), V (Volts), kV (Kilovolts), KA (Kiloamperes). Press the space bar "K", "V" or "A" to toggle the unit labels until desired units appear. Units displayed in this field are used on all forms Analog Output Channels appear. These units are for convenience and have no affect on the operation of the test.

Buttons

New. Click on the new button to create a new relay configuration. The new relay can be based on an existing relay configuration or the entire configuration can be user defined. The new configuration will be compared with other relays in the database and the user will be notified if the new configuration already matches an existing relay. To add a new relay that matches an existing configuration, simply specify the new relay name and select an existing relay and click on the OK button.

UUT File Selection. Select either the 5 A relay scaling or 1 A relay scaling file. All changes made on this form will apply to the selected UUT file.

Update. Click on update button to modify/update an existing relay configuration. If the configuration is used for more than one relay, you will be prompted with a list of all relays using that configuration.

Delete. Click on delete button to delete the selected relay from the database. This action will be confirmed with a dialog box.

New Relay Configuration Options

Use Existing Relay's Configuration: Mark the check box to enable a list box that displays existing relays. The new relay will have a configuration that is exactly like the relay selected from the list box. You may not edit the configuration values with this option selected.

Use Existing Relay's Configuration as Starting Point: Mark the check box to enable a list box that displays existing relays. The new relay will use the existing relay configuration as a template. This configuration can be edited and saved into the relay configuration file. This option is useful for creating a new relay without requiring you to re-enter configuration data that is similar to an exiting relay.

COMTRADE Configuration Form

This form is used to identify and configure COMTRADE data that is to be used in the test. Refer to Figure 5.12.

Channels

Select the channel for the COMTRADE values.

Default Comtrade File

Enter the name of the default COMTRADE file to use for all channels. The name is displayed without the DAT extension. You can also browse for the file by pressing the file open speedbutton. Select the file from the Open File Dialog and the file will be displayed in this field.

Comtrade Channel Definition

Comtrade File. Enter the name of the COMTRADE file for the selected channel. This file will be applied only to the selected channel. The name is displayed without the DAT extension. You

can also browse for the file by pressing the file open speedbutton. Select the file from the Open File Dialog and the file will be displayed in this field.

Figure 5.12: COMTRADE Configuration Form

Comtrade Channel. Select the desired channel from the COMTRADE file you wish to use on this analog channel. The list box show the channel data from the COMTRADE configuration file.

Initial Sample Number. Enter the sample number (specified as a data line in the COMTRADE data file) you want to be the starting sample for the test.

Scale Correction Factor. Enter a scale factor if the units of measure specified for the analog channel are different than those specified in the COMTRADE file. The COMTRADE data entries will be divided by this value. For example, if COMTRADE data is in primary quantities, but the SEL-5401 configuration is set for secondary quantities (the default), set this scale adjustment factor to the transformer ratio. NOTE: If you are using a COMTRADE file generated by SELTRADE, your scale adjustment factor will need to be divided by the square-root of 2. This will correct for the RMS scaling present in SEL event reports. For example, if your transformer ratio for a channel is 1000, then set the scale adjustment to 707.1.

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SECTION 6: MAINTENANCE AND TESTING

CALIBRATION

Schweitzer Engineering Laboratories (SEL) performs a software calibration of the SEL-AMS at the factory. Periodic calibration by maintenance personnel is not required.

FUSE REPLACEMENT

Line Fuse

The 2-amp line fuse is located in the power entry module's fuse drawer on the rear panel of the SEL-AMS. To replace it, compress the fuse drawer's side tab and pull out the fuse drawer. Replace the fuse, and snap the fuse drawer back in place.

Wetting Voltage Fuse

Perform the following procedure if +14.3 Vdc cannot be measured between any of pins 1 through 3 and GND on the Sense Inputs connector. The 1/4-amp wetting voltage fuse is located on the SEL-AMS main board. Perform the following to replace the fuse:

Note: The +24 Vdc and +125 Vdc power sources are protected by the line fuse in the power entry module.

Step 1.   Remove power from the SEL-AMS.

Step 2.   Remove any cables connected to the SEL-AMS.

Step 3.   Remove the front panel screws and remove the front panel.

⚠	**CAUTION**

The relay contains devices sensitive to Electrostatic Discharge (ESD). When working on the relay with front or top cover removed, work surfaces and personnel must be properly grounded or equipment damage may result.

Step 4.   Pull the SEL-AMS main board out of the chassis or remove the top cover.

Step 5.   Remove the fuse which is located at the middle rear of the main board and replace it with a 1/4-amp fuse (See *Appendix D*).

Step 6.   Insert the SEL-AMS main board in the chassis and slide back until it is firmly seated.

Step 7.   Replace the front panel and front panel screws and tighten securely.

Step 8.   Replace any cables removed from the SEL-AMS. Reconnect power and verify the presence of +14.3 Vdc between pins 1 through 3 and GND on the Sense Input connector.

TROUBLESHOOTING

Power System Problems

See Table 6.1 for troubleshooting problems involving the SEL-AMS power system.

Table 6.1: Power System Problems

Symptom	Probable Cause	Corrective Action
All MAIN POWER LEDs Dark	Line cord not installed.	Install line cord.
	Blown fuse.	Replace fuse as described in Line Fuse paragraph above.
	MAIN POWER switch is off.	Turn power switch on.
Some MAIN POWER LEDs Dark	The supply(s) with the dark LED is out of tolerance.	Turn power off at once and contact the factory.
DC Supply LED Dark	MAIN POWER switch is off.	Turn on.
	DC Supply switch is off.	Turn on.
	Outputs are shorted.	Check connections.
	Line fuse is blown.	Replace per Line Fuse paragraph above.

Communications Problems

See Table 6.2 for troubleshooting communications SEL-AMS problems.

Table 6.2: Communications Problems

Symptom	Probable Cause	Corrective Action
SEL-AMS does not communicate with PC.	Serial cable damaged or incorrectly connected.	1. Inspect the cabling for damage. 2. Make sure cable is connected to proper communications port.
	Baud rate default jumper installed.	1. Access the main board using Steps 1 through 3 in Wetting Voltage Fuse paragraph above. 2. Using instructions in Table 4.12 set the desired baud rate. 3. Remove jumper JMP8. Place the jumper on one pin of the connector for safe keeping.

Table 6.2: Communications Problems (continued)

Symptom	Probable Cause	Corrective Action
Relay does not respond to faults.	Port and baud rate settings of PC may be incorrect.	Check port and baud rate settings of SEL-AMS under test.
	SEL-AMS baud rate may be set wrong.	1. Access the main board using Steps 1 through 3 in Wetting Voltage Fuse paragraph above. 2. Install jumper JMP 8. 3. Set PC baud rate to 9600 baud to match the SEL-AMS. 4. Change the baud rate to desired rate on SEL-AMS and PC per the instructions in Table 4.12, then remove JMP 8.
	IRQ problem in PC.	Check PC IRQ set-up to make sure there are no conflicts.
	Power-saver feature of laptop is disabling serial communications.	Check PC power-saver settings and make sure they are compatible with high-speed serial port operation.
	Test setup may be incorrect.	Make sure analog ribbon cable is properly connected to relay under test and the cable is not loose or defective.
	Output voltages and currents are at improper levels.	Perform checkout procedure per *Section 4: SELTEST Software Reference.*
	Wrong UUT has been selected.	On the Configuration window, enter the proper device type in the UUT TYPE Field.
	Error in software test state.	Make sure all software test states have been properly constructed.

FIRMWARE OR SOFTWARE UPGRADE INSTRUCTIONS

SEL may occasionally offer upgrades to improve the performance of this device. These instructions explain how to implement an upgrade.

Firmware upgrades require that you power-down the SEL-AMS, remove the front panel, pull out the main board, exchange IC chips, and reassemble the hardware. If you do not wish to perform this modification yourself, return the SEL-AMS and IC chips to us and we will install the new chips and return the unit within a few days.

EPROM Upgrade Instructions

Step 1. If the SEL-AMS is in service, remove power to the device. Disconnect all cables from the rear panel.

Step 2. Remove the SEL-AMS front panel by removing the attaching screws.

| ⚠ CAUTION | The relay contains devices sensitive to Electrostatic Discharge (ESD). When working on the relay with front or top cover removed, work surfaces and personnel must be properly grounded or equipment damage may result. |

Step 3. Disconnect the power supply cable and remove the main board from the chassis.

Step 4. Note the orientation of the ICs to be replaced. Use an IC removal tool or a small screwdriver to pry the indicated ICs from their sockets. Do not bend the IC pins or damage adjacent components.

Step 5. Carefully place the new ICs in the appropriate sockets. Check the orientation of the ICs, and make sure each is in its appropriate socket. Make sure no pins are bent under or broken.

Step 6. Slide the main board into the chassis. Push the board in until the front of the board is flush with the front of the SEL-AMS chassis.

Step 7. Reconnect the power supply cable to the connector on the front of the main board and replace the front panel.

Step 8. Perform the initial checkout procedures in *Section 2: Installation and Checkout*.

FACTORY ASSISTANCE

The employee-owners of Schweitzer Engineering Laboratories, Inc. are dedicated to making electric power safer, more reliable, and more economical.

We appreciate your interest in SEL products, and we are committed to making sure you are satisfied. If you have any questions, please contact us at:

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We guarantee prompt, courteous, and professional service.

We appreciate receiving any comments and suggestions about new products or product improvements that would help us make your job easier.

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APPENDIX A: SELTEST^{TM} ERROR MESSAGES

Table A.1 lists the error messages generated by SELTEST software and gives a brief explanation or corrective action for each.

Table A.1: SELTEST Software Error Messages

Error Code	Message	Description
1	Program terminated due to errors in SELTEST.CFG.	Errors occurred while reading configuration file. Correct configuration file and re-run program.
2	Program terminated due to errors in command line arguments.	Either a nonexisting argument was entered or the wrong syntax was used (see Table 4.2).
3	Error message file RTA_ERRS.TXT is missing. Complete error messages will not be generated.	The file RTA_ERRS.TXT does not exist in the directory with SELTEST.EXE. The program will still run, but all error messages will consist of an error number only; text error messages will be unavailable.
10	Cannot find SELTEST.CFG.	DOS cannot find the file SELTEST.CFG in the current directory. This file is required for the program to operate.
11	Baud rate must be specified within SELTEST.CFG.	The baud rate was not specified within the configuration file.
12	This is an invalid baud rate setting: baud.	You entered a baud rate setting that is not allowed within SELTEST.CFG.
13	Duplicate baud rate settings within SELTEST.CFG not allowed.	The baud rate setting may be specified only once within the configuration file.
14	Com port must be specified within SELTEST.CFG.	The communications port must be specified within the configuration file.
15	This is an illegal com port setting: port.	You entered a com port setting that is not allowed within SELTEST.CFG. Only COM1 and COM2 are allowed.
16	Duplicate com port settings within SELTEST.CFG not allowed.	The communications port setting may be specified only once within the configuration file.
17	Data directory must be specified within SELTEST.CFG.	You did not specify the data directory in the configuration file.
18	Specified data directory does not exist: *path*.	DOS cannot access the directory you specified within SELTEST.CFG.

Error Code	Message	Description
19	Duplicate data directory settings within SELTEST.CFG not allowed.	More than one data directory is found in the configuration file. The data directory setting may be specified only once within the configuration file.
20	Specified EMTP directory does not exist: *path*.	DOS cannot access this directory as specified within SELTEST.CFG.
21	Duplicate EMTP directory settings within SELTEST.CFG not allowed.	The EMTP directory setting may be specified only once within the configuration file.
22	Specified quiet settings is invalid: setting.	The specified quiet setting within SELTEST.CFG is not valid. Only Y and N are allowed.
23	Error closing SELTEST.CFG.	DOS reported an error closing the configuration file.
30	Command line options must begin with '/' or '-'.	See Table 4.2.
32	/r, /p, and /e option must be immediately followed by '='.	The syntax for the r, p, and e options are: /r=filename, /p=filename, and /e=filename. The equals sign was missing from your specification.
33	/p, /r, /e, and /h options are mutually exclusive.	The four command line options p, r, e, and h are mutually exclusive. Only one of them may be used at a time, and each may only be used once.
34	Specified file is not accessible: *filename*.	The specified .RTA file could not be found.
35	Specified file is not accessible: *filename*.	The specified .RTP file could not be found.
37	Unrecognized command line option: option.	Only four command line options are allowed: h, r, p, and e.
50	Specified directory does not exist: *path*.	DOS cannot access the specified directory.
60	SELTEST.HLP is missing. No command line help available.	Command line help is unavailable because the help file, SELTEST.HLP, is missing.
61	Error closing file SELTEST.HLP.	DOS reported an error while closing SELTEST.HLP.
70	Out-Of-Memory. Cannot complete program initialization.	The program detected an out-of-memory condition while initializing program variables. Try removing any TSRs to help gain space, or simplify your test to reduce memory requirements.

Error Code	Message	Description
80	Error opening file SELTEST.UUT.	DOS could not open SELTEST.UUT. Make sure it exists and is accessible within the local directory.
81	Could not find UUT keyword in file SELTEST.UUT.	The file SELTEST.UUT is missing the keyword UUT. This keyword indicates the start of data. Check SELTEST.UUT to verify that it is of the correct format.
82	Error reading UUT description in SELTEST.UUT at line *n.*	An error occurred while reading a UUT description from the specified line of SELTEST.UUT. This could be due to a premature end-of-file, a device name exceeding 10 characters, or a type number less than 0 or greater than 20.
83	TYPE keyword not in expected location in SELTEST.UUT.	The keyword TYPE is missing from SELTEST.UUT. It should occur immediately after the uut specification of OTHER. Check the format of SELTEST.UUT and make sure it is correct.
84	Error reading type number in SELTEST.UUT at line *n.*	An error occurred while reading a type number. This could be due to a premature end-of-file or an entry occurring out-of-order.
85	Error reading channel configuration in SELTEST.UUT at line *n.*	An error occurred while reading channel configuration data. This could be caused by a premature end-of-file, insufficient data items, or a poorly formatted label field.
86	Attempt to define type with no channels in SELTEST.UUT for type number *n.*	A relay type was specified with all twelve channels having blank labels. At least one channel must be defined.
87	Invalid scale factor in SELTEST.UUT at line *n.*	A scale factor defined in SELTEST.UUT is out-of-range. Scale factors must be at least 1.0 and less than 1,000,000.0.
88	Invalid channel units in SELTEST.UUT at line *n.*	The specified channel units are inappropriate. Only V, A, KV, and KA are allowed.
89	In SELTEST.UUT, a type was referenced but not defined: *n.*	In SELTEST.UUT, the specified type number was assigned to a relay label, but the type was not subsequently defined. Verify that SELTEST.UUT has a type definition for every referenced relay type.
90	Error closing file SELTEST.UUT.	DOS reported an error while closing the file SELTEST.UUT.

Error Code	Message	Description
91	An error occurred while reading SELTEST.UUT. UUT type selections will be unavailable.	An error was detected while reading SEL-TEST.UUT. To prevent further errors from bad data, the only allowed UUT type selection will be OTHER.
92	More UUT Types are specified in SELTEST.UUT than are allowed.	Only 20 UUT types may be specified in SELTEST.UUT. Edit SELTEST.UUT to stay within this limit.
100	Form files are missing. Program aborted.	A .FRM file, required to display data, is missing. Make sure all .FRM files are properly installed in the SELTEST directory.
101	Help file is missing: *filename*.	Missing file is one of those required for on-line help to work. To use on-line help, make sure all help files are installed in the SELTEST directory.
110	Help files are missing. On-line help will be unavailable.	Context - sensitive help is unavailable because one or more help files could not be opened.
111	Program aborted.	Execution was aborted because the user pressed <ESC> from the start-up window or because the default test file RTA.RTA could not be read. Without this file the program will not be able to operate. Make sure this file is properly installed in the SELTEST directory.
112	Error displaying forms. Program aborted.	There is an error displaying default data. Program cannot run until data problem is resolved.
201	Error reading .RTA file. Default test will be used.	The program could not read selected .RTA file. The default test, RTA.RTA, will be used instead.
210	Invalid disk selected.	You selected a disk that does not exist.
215	Error reading RTA.RTA. Unable to create default test.	An error occurred while reading RTA.RTA. This file must have already been read successfully, so something happened to the file while the program was running. Exit the program and resolve the problem; an improperly read file may create unexpected test editing problems.
221	Error storing .RTA file. File may not have been stored.	An error occurred while storing a test. Resolve and restore to save the test.

Error Code	Message	Description
250	Unable to open SELTEST.CFG.	The program could not open the configuration file. Configuration data cannot be saved.
251	Error closing file SELTEST.CFG.	An error occurred closing the configuration file.
275	Magnitudes will saturate if amplitude ramp is applied for stated test time.	If magnitude ramps are applied too long, the SEL-AMS may reach full-scale. When full-scale is reached, further ramping will be disabled.
277	Frequency may not vary by more than a factor of 2 during a test.	Over a state's maximum test time, the frequency may not vary by more than a factor of two. Modify the final frequency to be within a factor of two of the initial frequency to eliminate this problem.
279	The specified COMTRADE file data will repeat unless test time is reduced.	The amount of data provided in the COMTRADE file is insufficient to complete the currently specified test time. The specified COMTRADE data will repeat unless the test time is reduced to less than the time allowed within the COMTRADE file.
282	Test time may not be expressed in cycles if frequency is ramped.	If the frequency is ramped, the test time must be expressed in something other than cycles.
283	Result's units may not be expressed in cycles if frequency is ramped.	If the frequency is ramped, the result units must be expressed in something other than cycles.
285	When input function is O→C or C→O, terminate-on-sense may not be O or C, respectively.	If the input function is O→C, then a setting of O for terminate-on-sense is not allowed. Similarly, if the input function is C→O, a terminate-on-sense setting of C is not allowed.
286	Insufficient channels in new COMTRADE file. COMTRADE channel number set to 1 on analog channel.	This warning occurs when you have selected to update the COMTRADE filenames within a state. On the specified channel, a COMTRADE channel was selected within the old COMTRADE data set which does not exist in the new COMTRADE data set. It has been set to 1 to avoid problems. Go edit it if some other channel is desired.

Error Code	Message	Description
287	Insufficient samples in new COMTRADE file. Initial sample number set to 1 on analog channel.	This warning occurs when you have selected to update the COMTRADE filenames within a state. On the specified channel, the initial sample number is greater than the total number of samples within the new COMTRADE data set. It has been set to 1 to avoid any potential problems. Go edit it if some other initial sample is desired.
290	Out-Of-Memory. Cannot create COMTRADE data description.	The program ran out of memory while attempting to create a COMTRADE data description.
291	Out-Of-Memory. Cannot create sinusoidal data description.	The program ran out of memory while attempting to create a simple sinusoidal data description.
302	Scale factor may not be less than 1.0	The specified scale factor is too small.
303	Out-Of-Memory. Cannot support requested change.	Out-of-memory condition occurred while updating the test for new analog channel. The program cannot complete the change. The test data may have been left in an odd configuration.
310	Magnitude may not exceed 3.535 times the channel's scale factor.	You specified a magnitude too large. Reduce it to less than 3.535 times the channel's scale factor.
311	Magnitude may not be negative	You must specify a positive amplitude. Shift the phase by 180° to achieve an effective negation of the amplitude.
312	Phase must be between -360.0 and +360.0 degrees.	You have entered a phase angle out of range.
313	Test time may not be less than 0.5 milliseconds.	You have entered a test time less than 0.5 milliseconds.
314	Test time may not be less than 0.05 cycles.	You have entered a test time less than 0.05 cycles.
315	Test time may not be less than 0.001 seconds nor exceed 400,000.00 seconds.	You have entered a test time that is less than 0.001 or exceeds 400,000.00 seconds.
316	Test time may not be less than 0.001 minute nor exceed 7000.00 minutes.	You have entered a test time that is less than 0.001 minute or exceeds 7000.00 minutes.
317	Frequency must be between 10.0 and 300.0 Hertz.	You have entered a frequency that is not between 10.0 and 300.0 Hertz.

Error Code	Message	Description
318	Input delay time may not exceed 255 milliseconds and must be positive.	You have entered an input delay time that exceeds 255 milliseconds, or is negative, or is both.
340	Magnitude may not exceed 3.535 times the channel's scale factor or 99999.999	The specified magnitude is too big. Reduce it to less than 3.535 times the channel's scale factor. It must also be less than 100,000.000 to make it fit within the field.
341	Magnitude may not be negative.	The specified amplitude must be positive. Shift the phase by 180° to achieve an effective negation of the amplitude.
342	Magnitude increment too fast.	The magnitude increment may not exceed 1/256th of full-scale per cycle.
343	Magnitude decrement too fast.	The magnitude decrement may not exceed 1/256th of full-scale per cycle.
344	Phase must be between -360.0 and +360.0 degrees.	Specify a phase within limits.
345	Test time may not be less than 0.5 milliseconds.	Specify a time greater than 0.5 milliseconds.
346	Test time may not be less than 0.05 cycles.	Specify a time greater than 0.05 cycles.
347	Test time may not be less than 0.001 seconds nor exceed 400,000.00 seconds.	Specify a time within limits.
348	Test time may not be less then 0.001 minutes nor exceed 7000.00 minutes.	Specify a time within limits.
349	Frequency must be between 10.0 and 300.0 Hertz.	Specify a frequency within limits.
350	Frequency may not differ by more than a factor of 2 during state.	When using frequency ramping, the frequency may not vary by more than a factor of two during a state to prevent the sample rate from becoming excessively long.
351	Input delay time may not exceed 255 milliseconds and must be positive.	Enter a delay time within acceptable parameters.
352	Requested next-state does not exist.	When specifying next-states, the specified state must exist, or it must be set to 0 to indicate the end of the test.
353	Test time may not be expressed in cycles if using frequency incrementing.	Specify a test time that is not in cycles.

Error Code	Message	Description
354	Result's units may not be expressed in cycles if frequency is incremented.	Specify units of measure that is not in cycles.
355	Frequency may not ramp out of 10 to 300 Hz range.	The final frequency is outside the allowed frequency range of 10 to 300 Hz.
360	Cannot find directory *path*.	DOS cannot access the directory path you specified. Enter a correct directory path.
361	Cannot find COMTRADE file *filename*.	Make sure the COMTRADE data path is properly set and that a valid COMTRADE filename has been entered.
362	The COMTRADE channel number must be at least 1 and not greater than 255.	Enter a channel number within the acceptable parameters.
363	The initial sample number must be greater than zero.	Enter a sample number that is greater than zero.
364	The gain adjustment factor may not be zero.	Enter a gain adjustment factor that is not zero.
425	Insufficient memory to append state.	Memory was exhausted appending the state. Test results may not be properly linked.
426	Insufficient memory to append state.	Not enough memory to append the state.
427	Attempt to exceed maximum number of states. No more than 255 states are allowed.	Once 255 states are defined, you cannot add states to the test.
430	Insufficient memory to insert state.	The program ran out of memory inserting a state. Test states may not be properly linked.
431	Insufficient memory to insert state.	You cannot insert a state because there is insufficient memory.
432	Attempt to exceed maximum number of states. No more than 255 states are allowed.	Once 255 states are defined, you cannot add states to the test.
435	Insufficient memory to copy state.	The program ran out of memory copying a state. Test states may not be properly linked.
436	Insufficient memory to copy state.	Not enough memory to copy a state.
437	Attempt to exceed maximum number of states. No more than 255 states are allowed.	Once 255 states are defined, you cannot add states to the test.
440	Insufficient memory to move state.	The program ran out of memory moving a state. Test states may not be properly linked.

Error Code	Message	Description
441	Insufficient memory to move state.	You cannot move the state because there is insufficient memory.
445	Attempt to delete last state. A test must contain at least one state.	You cannot reduce a test to zero states. There must be at least one defined state in a test.
446	Insufficient memory to delete state.	The program ran out of memory deleting a state. Test states may not be properly linked.
575	Error preparing test; test execution aborted.	An error occurred somewhere in the translate and store process. Test execution cannot proceed.
576	Error during test execution.	An error occurred during test execution. There will be no results data from this test.
577	Error translating test results; no results will be available.	An error occurred while translating the test results.
578	Error storing test results.	An error occurred while storing the test results. The results may be viewed, but they have not been stored to a .RTR file.
585	Test execution aborted due to error storing test.	An error occurred while storing an .RTA file. Test execution cannot proceed without first storing this file.
600	Sample rates between COMTRADE data files do not match.	COMTRADE files were specified for use within a state which do not have matching data sample rates. Since the program does not re-sample the data, the sample rates must match.
601	Out-Of-Memory. Cannot complete test translation.	Out-of-memory condition occurred during test translation. Try removing any TSRs to help gain space, or simplify your test to reduce memory requirements.
602	Frequency ramp is too slow for SEL-AMS to support.	A frequency ramp was specified that rounded to zero during the quantization process. Specify a shorter time or make the initial and final frequencies further apart to overcome this.
610	Out-Of-Memory. Cannot complete test results translation.	Out-of-memory condition occurred while translating results. Try removing any TSRs to help gain space, or simplify your test to reduce memory requirements.

Error Code	Message	Description
615	Error reading COMTRADE file at line number.	The program was unable to read data as expected at the specified line number within a COMTRADE file. This could be due to a premature end-of-file or insufficient number of data columns. Make sure the specifications in the .CFG file match the data supplied in the .DAT file. Also confirm that the rows in the .DAT file are properly numbered.
616	Error opening COMTRADE file: *filename*.	The program was unable to open the specified file. Make sure it exists and is readable. Make sure the EMTP data path established in SELTEST.CFG or specified in the OPTIONS window is correct.
617	Error closing file: *filename*.	DOS reported an error while closing the specified file.
618	Error opening temporary file: *filename*.	The program was unable to open the specified file. Make sure the desired directory exists and is accessible.
625	Cannot open file *filename*.	Cannot open specified .RTP file for writing. Either the directory cannot be found or writes have been disabled.
626	Error closing file *filename*.	DOS detected an error while closing the specified .RTP file. It may not have been successfully stored.
627	Error opening temporary file: *filename*.	The specified file could not be opened for reading. Either it is missing or an access error occurred.
628	Error closing temporary file: *filename*.	DOS reported an error while closing the specified temporary file.
629	Error deleting temporary file: *filename*.	DOS reported an error while attempting to delete the specified temporary file.
630	Error reading data from temporary file.	An error occurred while reading a temporary file. This could be due to a premature end-of-file, or it could be caused by a bad COMTRADE data file leading to an improper number of data items in the temporary file.
635	Cannot open file *filename*.	Cannot open specified .RTA file for writing. Either the directory cannot be found or writes have been disabled.

Error Code	Message	Description
636	Error closing file *filename*.	DOS detected an error while closing the specified .RTA file. It may not have been successfully stored.
650	Unexpected End-Of-File in file *filename*.	The TEST keyword is missing from the specified .RTA file.
651	Error reading number of states in RTA file at line *n*.	Number of states in a file must be between 1 and 255. May also be caused by a premature end-of-file.
652	Error reading scale factor in RTA file at line *n*.	Either an invalid scale factor was specified or a premature end-of-file condition was detected.
653	Error reading channel units in RTA file at line *n*.	Error occurred while reading a channel's units specification. Either an invalid entry was specified (only V, A, KV, and KA are allowed) or a premature end-of-file was detected.
654	Error reading SET keyword in RTA file at line *n*.	The keyword may be missing, may include an invalid state specification, or a premature end-of-file condition may have been detected.
655	Error reading test time in RTA file at line *n*.	Error occurred while reading a state's maximum test time or test time units from an .RTA file. The file may contain bad data or be prematurely ended.
656	Error reading initial frequency in RTA file at line *n*.	Error occurred while reading state frequency specification. Either an invalid frequency is specified, or a premature end-of-file condition was detected.
657	Error reading final frequency in RTA file at line *n*.	Error occurred while reading state final frequency specification. Either, an invalid final frequency was specified, or a premature end-of-file condition was detected.
658	Error reading output contact state in RTA file at line *n*.	Either an invalid state was specified (only 'O' or 'C' are allowed) or a premature end-of file condition was detected.
659	Error reading amplitude in RTA file at line *n*.	Either an out-of-range amplitude was specified or a premature end-of-file condition occurred.
660	Error reading amplitude increment in RTA file at line *n*.	Either an out-of-range amplitude increment was specified or a premature end-of-file condition occurred.

Error Code	Message	Description
661	Error reading phase in RTA file at line *n.*	Either an out-of-range phase was specified or a premature end-of-file condition occurred.
662	Error reading COMTRADE filename at line *n.*	Error occurred while reading a COMTRADE filename. This is probably due to a premature end-of-file.
663	Error reading COMTRADE data description at line *n.*	Error occurred while reading a COMTRADE data description. Either insufficient or improperly formatted data was supplied or a premature end-of-file was detected.
668	Error reading input function in RTA file at line *n.*	Either an invalid entry was specified (only 0, 1, and 2 are allowed) or a premature end-of-file condition was detected.
669	Error reading input sense delay in RTA file at line *n.*	Either an out-of-range value was specified (must be in the range 0-255) or a premature end-of-file condition was detected.
670	Error reading result's units in RTA file at line *n.*	Either an invalid entry was present (only MSEC, CYC, SEC, and MIN are allowed) or a premature end-of-file condition was detected.
671	Error reading term-on-sense flag in RTA file at line *n.*	Error occurred while reading an input's terminate-on-sense specification. Either an invalid entry was present (only F, O, and C allowed), the entry conflicts with the input function (when input function is O→C, O is not allowed; when function is C→O, C is not allowed), or a premature end-of-file was detected.
672	Error reading next-state number in RTA file at line *n.*	Either an invalid next state is specified (must lie in the range 0-255), or a premature end-of-file was detected.
673	END keyword missing in RTA file.	Expected END keyword is missing from .RTA file.
674	Referenced state not defined in RTA file.	A state was referenced by a next-state specification that has not been defined.
675	Error closing file *filename.*	A DOS error occurred while closing the specified .RTA file.
676	Cannot open file *filename.*	DOS cannot open the specified .RTA file. Most likely, it cannot be found.

Error Code	Message	Description
677	Error reading description in RTA file at line *n*.	Error occurred while reading a test description. This was probably caused by a premature end-of-file.
678	Error reading label in RTA file at line *n*.	Error occurred while reading an analog channel, output contact, or input sense label. This is probably caused by a premature end-of-file.
679	Out-Of-Memory. Cannot complete test file read.	An out-of-memory condition occurred while reading a .RTA file. Try removing any TSRs to help gain space, or simplify your test to reduce memory requirements.
680	Error in RTA file. At least one channel must be defined.	No analog channels were labeled in the .RTA file. At least one must be labeled in order to specify a test.
681	Error reading UUT-type in RTA file at line *n*.	Error occurred while reading uut-type specification. This was probably caused by a premature end-of-file.
682	Frequency ramping not allowed while using COMTRADE data sets. Frequency ramp will be ignored.	A state of a test was specified to use a COMTRADE data set and to ramp frequency. These two operations are incompatible, so frequency ramping will be disabled during this state.
683	UUT Type set to OTHER because of unknown UUT Type specification in RTA file: *filename*.	A UUT Type was specified in the specified file, which is not defined in SELTEST.UUT. As such, it will be treated as type OTHER.
684	Error reading memo field at line *n*.	DOS reported an error while reading the .RTA file at the specified line. Most likely, a premature end-of-file was detected. Make sure your .RTA file is complete are properly formatted.
700	Unable to open file *filename*.	Could not open specified .RTR file for writing. Make sure a valid path has been specified and that the media is available and writable.
701	Unable to close file *filename*.	DOS error occurred while closing .RTR file. Data may not have been properly stored.
710	Unexpected EOF in file *filename*.	While searching for beginning of data in this .RTR file, the program found the end-of-file. This .RTR file does not contain any data, or, at least, does contain the keyword indicating the beginning of data.

Error Code	Message	Description
711	Error reading state time in RTR file at line *n.*	Could not read the state time at line n. Could be caused by bad data or by a premature end-of-file.
712	Error reading state time units in RTR file at line *n.*	Error could be caused by a premature end-of-file or by the units not matching those specified in the .RTA file for that state.
713	Error reading frequency in RTR file at line *n.*	Error could be caused by bad data or by a premature end-of-file.
714	Error reading number-of-channels in RTR file at line *n.*	Error could be caused by an unreasonable data value or by a premature end-of-file.
715	Error reading channel number in RTR file at line *n.*	Could not read channel number for a ramped channel. Could be caused by an invalid data item, repeated information on the channel, or a premature end-of-file.
716	Error reading channel label in RTR file at line *n.*	Could not read channel label for a ramped channel. Could be caused by the label not matching the label specified in the .RTA file or by a premature end-of-file.
717	Error reading harmonic number in RTR file at line *n.*	Could not read the harmonic number of a ramped channel. In the current revision of the software, only a value of 1 is allowed here. This error could also be due to a premature end-of-file.
718	Error reading final amplitude in RTR file at line *n.*	Could not read the final amplitude of a ramped channel from a .RTR file. This could be because the value is out-of-range, not-a-number, or because of a premature end-of-file.
719	Error reading results data in RTR file at line *n.*	Error could be caused by a premature end-of-file or by a bad input test time.
720	Error reading results' units in RTR file at line *n.*	Error could be caused by units not matching those specified in the .RTR file, or by a premature end-of-file.
721	Error reading input state in RTR file at line *n.*	Error could be caused by a bad data item or a premature end-of-file.
722	Error reading SET or END keyword in RTR file at line *n.*	Expected keyword is missing. The .RTR file has been corrupted or prematurely ended.
723	Invalid SET message in RTR file at line *n.*	SET keyword at line n does not indicate a valid state number. May be caused by bad data or a premature end-of-file.

Error Code	Message	Description
724	Unable to close file *filename*.	An error occurred while closing a .RTR file. Make sure media has not been removed during read operation.
725	Out-Of-Memory. Cannot complete results file read.	Out-of-memory condition occurred while reading a .RTR file. Try removing any TSRs to help gain space, or simplify your test to reduce memory requirements.
726	Error reading state description in RTR file at line *n*.	Could not read state description from .RTR file. Probably caused by a premature end-of-file.
727	Error reading channel ramp units in RTR file at line *n*.	Could not read the units of a channel's ramp from the .RTR file. Could be due to the units not matching those specified in the .RTA file, or it could be due to a premature end-of-file.
750	Unable to open file *filename*.	DOS could not open the specified .RTP file.
751	Error initializing serial port.	The communications handler reported an error initializing the serial port. Make sure a valid port has been selected. This could also be due to insufficient memory to initialize the serial port data structure.
752	Error initializing serial port.	The communications handler reported an error initializing the serial port.
753	Error initializing serial port.	The communications handler reported an error initializing the XON/XOFF functions of the serial port.
754	Error issuing self-test request to SEL-AMS.	The SEL-AMS and the PC are probably not properly connected.
755	Error reading self-test results from SEL-AMS.	The SEL-AMS and the PC are probably not communicating. Make sure the SEL-AMS is properly connected and baud rates on the SEL-AMS and in the SELTEST software are properly set.
756	SEL-AMS improper self-test response.	An unexpected response received when self-test status was requested. Make sure baud rates on the SEL-AMS and in SELTEST software are properly set and that the devices are properly connected.
757	SEL-AMS self-test failure: type.	SEL-AMS internal diagnostics detected a self-test error. Have the SEL-AMS serviced before attempting to use it again.

Error Code	Message	Description
758	Serial port time-out during data transmittal.	Data is not being transmitted properly. Verify the serial port connection.
759	SEL-AMS error #n.	The SEL-AMS reported an error n. This is most likely due to bad data within the downloaded .RTP file. Error may be due to I/O overrun. SEL-AMS requires hardware handshake from PC to avoid overrun. Use cable SEL-C234A, or make sure cable includes RTS/CTS hardware handshaking signals.
760	SEL-AMS did not properly respond to start-test instruction.	The SEL-AMS did not issue a test initiating message when an execute test command was issued. This is probably due to a bad .RTP file.
761	Unable to close file *filename*.	DOS reported an error while closing the specified .RTP file.
762	Unexpected SEL-AMS message message.	The SEL-AMS issued an unexpected message while the .RTP file was being downloaded. Error may be due to I/O overrun. SEL-AMS requires hardware handshake from PC to avoid overrun. Use cable SEL-C234A, or make sure cable includes RTS/CTS hardware handshaking signals.
764	Error issuing firmware revision request to SEL-AMS.	The communications handler reported an error issuing the request for firmware revision to the SEL-AMS.
765	Error reading firmware revision response from SEL-AMS.	A response was not received to a firmware revision request. Check PC to SEL-AMS communications.
766	Improper SEL-AMS firmware revision response.	The SEL-AMS issued an unexpected response to a request for firmware revision.
767	Error transmitting .RTP file to SEL-AMS while using XMODEM transfer.	An unrecoverable error occurred while downloading a test to the SEL-AMS.
768	Unexpected SEL-AMS message message.	The SEL-AMS issued an unexpected message while downloading the .RTP file. Make sure the .RTP file is valid.
769	SEL-AMS error #n.	The SEL-AMS reported an error in response to the downloaded .RTP file. Make sure the .RTP file is valid.

Error Code	Message	Description
770	Unexpected SEL-AMS response to abort-test command: message.	The SEL-AMS did not properly respond to an abort test message. Error may be due to I/O overrun. SEL-AMS requires hardware handshake from PC to avoid overrun. Use cable SEL-C234A, or make sure cable includes RTS/CTS hardware handshaking signals.
780	Error initializing serial port.	The communications handler reported an error initializing the serial port. Make sure a valid port has been selected. This error may also indicate insufficient memory to create port data structure.
781	Error initializing serial port.	The communications handler reported an error initializing the serial port.
782	Error initializing serial port.	The communications handler reported an error initializing the XON/XOFF functions of the serial port for baud rate setting.
783	Error issuing self-test request to SEL-AMS.	The SEL-AMS and the PC are probably not properly connected.
785	Error issuing baud-set command to SEL-AMS.	The communications handler reported an error issuing a set baud rate message out the serial port.
786	Error in SEL-AMS response to baud- set command.	The SEL-AMS did not properly respond to the baud-set command.
790	Unexpected SEL-AMS message: message.	The SEL-AMS issued an unexpected status message while a test was running. Error may be due to I/O overrun. SEL-AMS requires hardware handshake from PC to avoid overrun. Use cable SEL-C234A, or make sure cable includes RTS/CTS hardware handshaking signals.
791	Out-Of-Memory. Unable to save results from SEL-AMS.	Out-of-memory condition occurred while handling test results. Results for the current test will not be available.
800	Error opening form file *filename*.	Either the file is missing or corrupted.
801	Out-Of-Memory. Unable to load form.	An out-of-memory condition occurred while trying to load a new form specification file. Try removing any TSRs to help gain space, or simplify your test to reduce memory requirements.

Error Code	Message	Description
802	Error creating new window.	An error occurred while trying to create a data entry window.
825	Error opening help window file *filename*.	The specified help window file could not be opened. This window file must have been accessible when the SELTEST program started, so something has happened during execution to make it inaccessible.
850	Error opening COMTRADE configuration file *filename*.	Unable to open specified COMTRADE configuration file. Make sure COMTRADE port is properly selected within SELTEST.CFG, the proper COMTRADE file is selected from the .RTA file, and the file exists and is accessible.
851	Error reading data in COMTRADE file at line *n*.	An error occurred while reading data at the indicated line. Either the data is improperly formatted or an unexpected end-of-file was detected.
852	Requested COMTRADE channel does not exist in COMTRADE data set.	The requested COMTRADE channel, specified in the .RTA file, does not exist within the COMTRADE data set, as indicated by the COMTRADE configuration file.
853	Error closing COMTRADE configuration file *filename*.	DOS reported an error while closing the indicated file.
854	Maximum or minimum COMTRADE data item exceeds SEL-AMS full-scale output. Output will be clipped.	The maximum and minimum data items reported in the COMTRADE configuration file exceed full-scale output of the SEL-AMS. Data items which exceed full-scale will be clipped. If this is not acceptable, modify the data or scaling to prevent the overflow.
855	COMTRADE configuration file specifies more than one sample rate; SELTEST software supports one sample rate per file only.	Although standard COMTRADE format allows the sample rate to change within the data set, SELTEST software does not support this. Modify the COMTRADE data set so only one sample rate exists in each data file.
856	COMTRADE sample rate exceeds SEL-AMS maximum output update rate.	The program will set the SEL-AMS output sample rate to match the COMTRADE data. This sample rate must not exceed the maximum supported rate of 4000 Hz.

Error Code	Message	Description
857	Requested initial COMTRADE sample does not exist in COMTRADE data.	The number of samples indicated by the COMTRADE configuration file is less than the initial sample requested in the .RTA file.
858	SELTEST software supports ASCII format COMTRADE data files only.	Something other than ASCII format is specified in the COMTRADE configuration file.
900	Unable to open file for reading: *filename*.	File copy routine unable to open specified file to copy from.
901	Unable to open file for writing: *filename*.	File copy routine unable to open specified file to copy to. Make sure path settings are proper and all disks are in place.
902	Unable to close file: *filename*.	DOS reported an error while closing the file.
903	Error reading from file: *filename*.	DOS reported an error occurred while reading from the file.
904	Error writing to file: *filename*.	DOS reported an error occurred while writing to the file.
925	Unable to print. Cannot open temporary file: TEMP.PRN.	Print routine was unable to open temporary file for printing.
926	Unable to print. Cannot close temporary file: TEMP.PRN.	DOS reported an error while attempting to close temporary file. No output to printer will be generated.
927	Error occurred while printing.	DOS reported an error while copying the temporary printer file to the printer.
950	Error in menu handler. Program aborted.	Error within menu system. This is most likely caused by insufficient memory for the menu handler to run.
999	Internal error. Attempt to access partial state code.	An attempt was made to execute code which is no longer enabled. This should never happen. If it does, contact the factory immediately to report it.

MEMORY HANDLING

This program can use a great deal of memory, so care must be taken when using it to avoid memory problems. If SELTEST software detects an out-of-memory condition, it will notify you. If this occurs, try removing any TSRs to help gain memory space. You can also simplify your test to reduce memory requirements.

APPENDIX B: RTA TEST FILES

RTA TEST FILE DESCRIPTION

Use this test file description to interpret an .RTA file. The data in this file correspond to the items entered in the configuration and state windows.

An RTA test description data file must have a filename with a .RTA extension. Each line of the file contains an ASCII data item with no preceding spaces, unless the spaces are desired as part of a text field. No blank lines are allowed between the TEST and the END keywords unless the corresponding data item is blank. Items that occur on a line after the requested data are ignored. All indicated labels (i.e., A, SEC,...) are in upper case, as indicated.

The file must be in the format described below. Lowercase letters indicate where values are to be replaced; uppercase letters are keywords and must be entered exactly as shown. Comments are allowed prior to the TEST keyword and after the END keyword. Comments are allowed on any line following the data. Additional key words used by the SEL-5401 Test System Software are shown below.

Keyword	Description
NEW	SEL-5401 keyword indicating new format
TEST	Beginning of test
ds	Description String; 0-80 characters
nn	Number of sets in test; 1-255
uut	UUT Label - specifies type of relay being tested. Must be valid relay type or OTHER.
CHANNEL	SEL-5401 keyword identifying start of channel data
chn	Channel number
lbl1	Label for channel 1; 0-4 characters; if blank, channel is unused
sf1	Scale Factor for channel 1; range 1.0 to 999999.999; may be 0 if label is blank
u1	Units for channel 1 scale factor; A, V, KA, or KV; may be blank if label is blank
chn	Channel number
lbl2	Label for channel 2; 0-4 characters; if blank, channel is unused
sf2	Scale Factor for channel 2; range 1.0 to 999999.999; may be 0 if label is blank
u2	Units for channel 2 scale factor; A, V, KA, or KV; may be blank if label is blank
.	.
.	.
.	.

Keyword	Description
lbl12	Label for channel 12; 0-4 characters; if blank, channel is unused
sf12	
u12	Units for channel 12 scale factor; A, V, KA, or KV; may be blank if label is blank
CONTACTS	SEL-5401 keyword identifying start of output contact data
contactn	Contact number
olbl1	Label for contact 1; 0-4 characters; if blank, channel is unused
contact n	Contact number
olbl2	Label for contact 2; 0-4 characters; if blank, channel is unused.
.	.
.	.
.	.
olbl10	Label for contact 10; 0-4 characters; if blank, channel is unused.
INPUT	SEL-5401 keyword indicating start of input data
in n	Input number
ilbl1	Label for input 1; 0-4 characters; if blank, channel is unused
.	.
.	.
.	.
inn	Input number
ilbl6	Label for input 6; 0-4 characters; if blank, channel is unused
MEMO	Beginning of test memo information
memo1	First line of memo data; up to 70 characters
memo2	Second line of memo data; up to 70 characters
.	.
.	.
.	.
memo70	Seventieth line of memo data; up to 70 characters
SET001	Beginning of first set
setdesc	Set descriptive comment; the comment may be 0-70 characters
tt	Test time for set; decimal number in the range 0.5-10000000.0 milliseconds, 0.001-429000.0 seconds, 0.001-7000.0 minutes, or 0.05-10000000.0 cycles.
tu	Units for test time; allowable options are MSEC, SEC, MIN, and CYC.
fff	Initial frequency of operation; in range 10.0 - 300.0
fi	Final frequency; in range 10.0 - 3000; must be within factor of two of initial frequency.

Keyword	Description
ocs	Output Contact State; 3-digit hex in range 000-3FF
CHANNELVAL	SEL-5401 keyword indicating start of channel data
chn	Channel number
amp1	Amplitude of channel 1 relative to scale factor; may not exceed 3.535 times the scale factor. Set to -1 to use COMTRADE data.
ampincr1	Amplitude increment of channel 1; may not exceed (maximum frequency/256)*(scale factor)*3.535 in magnitude; if for COMTRADE file, then will be filename.
pha1	Relative phase of channel 1 in degrees; -360.0 to 360.0. If COMTRADE file, will contain channel number, initial sample number, and scale correction factor, separated by commas.
chn	Channel number
amp2	Amplitude of channel 2 relative to scale factor; may not exceed 3.535 times the scale factor. Set to -1 to use COMTRADE data.
ampincr2	Amplitude increment of channel 2; may not exceed (maximum frequency /256)*(scale factor)*3.535. If for COMTRADE file, then will be filename.
pha2	Relative phase of channel 2 in degrees; -360.0 to 360.0
.	.
.	.
.	.
chn	Channel number
amp12	Amplitude of channel 12 relative to scale factor; may not exceed 3.535 time the scale factor.
ampincr12	Amplitude increment of channel 12; may not exceed (maximum frequency /256)*(scale factor)*3.535.
pha12	Relative phase of channel 12 in degrees; -360.0 to 360.0
FUNCTION	SEL-5401 keyword indicating start of input function data
input n	Input number
ftn1	Function of input 1: 0 for none, 1 for sense on O->C (L->H), 2 for sense on C->O (H->L)
dly1	Delay time for input 1 in milliseconds; may not exceed 255 milliseconds
u1	Units for measurement on input 1; MSEC, SEC, MIN, or CYC
ts1	Terminate on sense flag for input 6; may be O, C, or F
.	.
.	.
.	.
input n	Input number

Keyword	Description
ftn6	Function of input 6: 0 for none, 1 for sense on O->C (L->H), 2 for sense on C->O (H->L)
dly6	Delay time for input 6 in milliseconds; may not exceed 255 milliseconds
u6	Units for measurement on input 6; MSEC, SEC, MIN, or CYC
ts6	Terminate on sense flag for input 6; may be O, C, or F
STATE	SEL-5401 keyword indicating start of next state data
ns0	Number of set to go to if three least-significant inputs are open
ns1	Number of set to go to if least-significant input is closed and the next two least-significant inputs are open
.	.
.	.
.	.
ns7	Number of set to go to if three least-significant inputs are closed
SET002	Beginning of second set
.	.
.	.
.	.
SET003	Beginning of third set
.	.
.	.
.	.
SETnnn	Beginning of set nnn
.	.
.	.
.	.
END	End of test description

APPENDIX C: RTR RESULTS FILES

Use this explanation to interpret data in .RTR files. This data corresponds to the data shown in the results window.

The RTR results file (.RTR file) is an ASCII file containing the results of a test. It consists of a sequence of statements in the following format. This data corresponds to the data displayed in results windows. Additional keywords used by the SEL-5401 are shown below.

Keyword	Description
NEW	SEL-5401 keyword indicating new file format
TEST	Keyword indicating beginning of file
desc	Test description (same as in .RTA file)
SETnnn	Number of first state executed
setdesc	Description of this state (same as in .RTA file)
tt	Length of time this state ran
tu	Units for test time: MSEC, CYC, SEC, or MIN (MSEC assured of SELTEST run in primitive mode)
fre	Frequency at the end of the state (60 assumed if SELTEST run in primitive mode)
nr	Number of used channels in this state (0 to 12) (0 assumed if SELTEST run in primitive mode)
CHANNEL	SEL-5401 keyword indicating start of channel data
num1	Channel number of first used channel
chn	Label of first used channel (1 to 12)
har1	Harmonic number of first used channel
val1	Value of channel at end of state
units1	Units this channel is being measured in: A, V, KA, KV, %, or DEG
.	.
.	.
.	.
num12	Channel number of last used channel
chn	Label of last used channel (1 to 12)
har12	Harmonic number of last used channel
val12	Value of channel at end of state
units12	Units this channel is being measured in: A, V, KA, KV, %, or DEG
INPUT	SEL-5401 keyword indicating start of input data

Keyword	Description
input n	input number
rslt1	Time of pick-up of first input, 0 if already picked-up, -1 if never picked-up or input function is NOOP.
ru1	Units of time for results: MSEC, SEC, CYC, or MIN (MSEC assumed if SEL TEST runs in primitive mode.
sta1	State of input 1 at the end of the state: O or C
.	.
.	.
.	.
input n	input number
rslt6	Time of pick-up of sixth input, 0 if already picked-up, -1 if never picked-up or input function is NOOP
ru6	Units of time for results: MSEC, SEC, CYC, or MIN (MSEC assumed if run in primitive mode)
sta6	State of input 6 at the end of the state: O or C
SETnnn	Number of second state executed
.	.
.	.
.	.
END	Keyword indicating end of results

APPENDIX D: SEL-RTS MAIN BOARD JUMPER AND SOCKET LOCATIONS

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AMS MAIN BOARD REV. B
DWG P/N 1049BC01
ASSY P/N
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F1

J3

J2

J1

JMP8

U18

U19

U20   U21

U5   U6   U7   U8   U9   U10   U11   U12   U13   U14
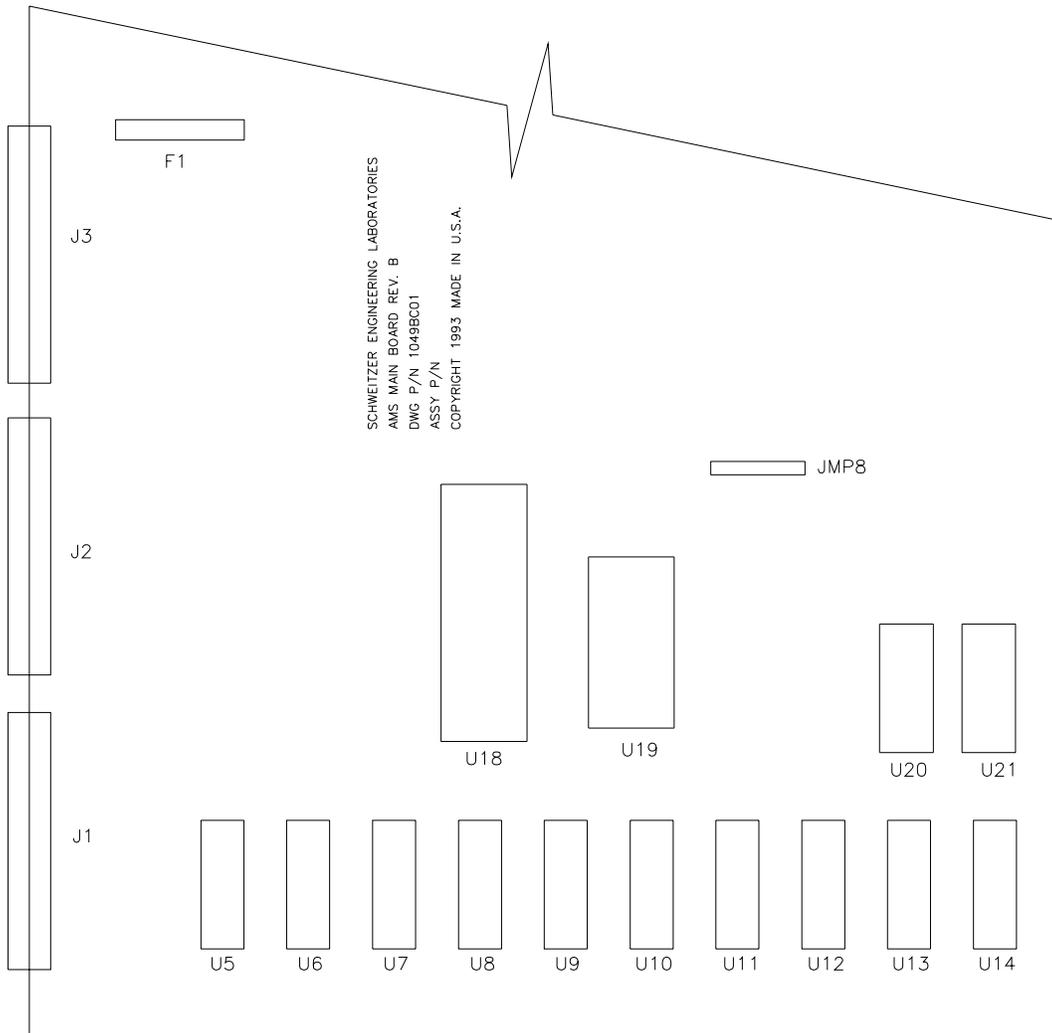
DWG: MBJMP

APPENDIX E: FIRMWARE VERSIONS IN THIS MANUAL/ SOFTWARE VERSIONS IN THIS MANUAL

This manual covers SEL-AMS chassis that contain firmware bearing the following part numbers and revision numbers:

SEL-AMS Firmware Revision No.	Description of Firmware
R102	XMODEM file transfer support added
R101	Initial firmware release

This manual also covers SELTEST™ Control Software and SELTRADE™ Conversion Software that bear the following revision numbers:

SELTEST Software Revision No.	Description of Software
R102	Adds /T command line option

SELTRADE Software Revision No.	Description of Software
Version 1.01	Improved line frequency selection
Version 1.00	Initial software release

The following table shows software versions that do not precisely match this manual:

SELTEST Software Revision No.	Description of Software
R101	Adds /D and /Q command line options
R100	Initial software release

APPENDIX F: COMTRADE FILE FORMAT SUPPORT

SELTEST^{TM} software supports the IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for power systems (IEEE C37.111-1991). This appendix lists limitations and extensions to standard COMTRADE data.

LIMITATIONS TO COMTRADE SUPPORT

Data Rates and Channel Skew

The SEL-RTS will replay the COMTRADE data at the given sample rate; the SEL-RTS will not re-sample the data. This means channel skew is not supported and only one data rate is allowed within a COMTRADE data set. The data rate may not exceed 4000 Hz.

Data File Limitations

Only a single data file is allowed and it must be in ASCII format. Missing data values, as indicated by a 999999 data value are not supported.

Digital Channels

Digital channels may be included, but they will be ignored.

Unused COMTRADE Parameters

There are a number of COMTRADE parameters that SELTEST software does not use, so the user need not worry about what they are set to.

- The header file is not used and need not be present.
- The station name and identification are not used.
- The channel name, phase identification, monitored component, and channel units are not used.
- Channel maximum and minimum are only used to warn the operator of possible data overflow.
- Digital channel information is not used.
- The date and time stamps are not used.
- Within the data file, the time column is not used and only the selected data columns are evaluated.

EXTENSIONS TO COMTRADE

SELTEST software allows these extensions to COMTRADE to allow you to more easily format data:

Data Values

Data values, both in the data file and in the maximum and minimum settings, may be signed real numbers.

Data Format

Within the data file, the data need only be comma-delimited; fixed-size columns are not required.

APPENDIX G: SEL<small>TRADE</small>^{TM} CONVERSION SOFTWARE

Use SEL<small>TRADE</small> Conversion Software to translate a file containing an SEL event report[1] to a set of COMTRADE[2] files. These files can then be used in data analysis by many devices.

From the DOS prompt, invoke SEL<small>TRADE</small> Conversion Software with the SELTRADE command, specify the file to be translated, and the frequency:

C:\SELTRADE>SELTRADE TEST.EVE frequency <ENTER>

If you type the command line without the frequency parameter:

C:\SELTRADE>SELTRADE TEST.EVE <ENTER>

Then SEL<small>TRADE</small> uses the default frequency from the file SELTRADE.CFG. If the file SELTRADE.CFG does not exist, SEL<small>TRADE</small> uses a default frequency of 60 Hz.

In this example, the program converts the file TEST.EVE to COMTRADE format and generates three files with the following formats and uses:

COMTRADE Files and Uses

File Use	Filename
Header File	test.hdr
Configuration File	test.cfg
Data File	test.dat

Analog channel data from event reports are assigned to COMTRADE channels in the order they appear. So the first column of analog data is COMTRADE channel 1, the second column is channel 2, etc.

SEL event reports are scaled to RMS quantities (sampled quantities are divided by $\sqrt{2}$ before being reported).   SEL<small>TRADE</small> Conversion Software does not compensate for this scale factor. To play back event reports, converted with SEL<small>TRADE</small> software, you may need to correct for this $\sqrt{2}$ factor. The following example procedure shows using SEL<small>TEST</small> software to playback an event report converted with SEL<small>TRADE</small> software:

EXAMPLE TEST

The following example uses a COMTRADE format file which you convert from a relay event report by SEL<small>TRADE</small> software.

1. Capture the event report to a disk file, for this example TEST.EVE.

---

[1] Supports event reports retrieved from all currently available SEL relays except SEL-279 and SEL-279H.
[2] For a detailed description of the COMTRADE format, see: IEEE C37.111-1991, *IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems*.

2. From the COMTRADE directory, run SELTRADE specifying TEST.EVE as the input file as follows (assuming SELTEST is installed on the C drive):

\SELTEST>SELTRADE TEST.EVE <ENTER>

SELTRADE software generates 3 output files: TEST.HDR
                                                           TEST.CFG
                                                           TEST.DAT

3. From the SELTEST directory start the SELTEST program.

4. Select **<NEW TEST>** then select the appropriate relay type.

5. At the bottom of the Standard State window, select **<EXTENDED>** to display the Extended State window.

6. Place the cursor in the desired Analog Channel Magnitude field and press the **<SPACE BAR>** to display the COMTRADE menu.

7. Select COMTRADE and press **<ENTER>**.

8. Press **<SPACE BAR>** to get a list of COMTRADE files. Select the TEST file, for this example.

9. Enter the number of the COMTRADE Analog Channel in the next field. (See the TEST.CFG file for a reference of channel numbers to labels.)

10. Enter the initial sample number in the next field (normally 1).

11. Enter a scale adjustment in the next field. The scale adjustment = the CTR or PTR setting of relay divided by $\sqrt{2}$. This compensates for primary scaling of the relay versus secondary scaling of SELTEST and for relays RMS amplitude scaling.

12. Select **<ACCEPT>** at the bottom of the window.

13. Repeat Steps 7 through 13 for each analog channel used.

APPENDIX H: WINDOWS 3 APPLICATIONS

WINDOWS INSTALLATION OF SELTEST SOFTWARE

SELTEST software can run in the DOS box of all three modes of Microsoft Windows 3.0 and higher. This includes 386 Enhanced mode.

Select "About Program Manager..." from the Program Manager Help menu to show which mode you are in.

Perform the following steps to install SELTEST software in Windows.

- Perform normal SELTEST software installation
- From Windows, open the group you want to add the item to
- Select the New command from the File menu in Program Manager
- Select the Program Item from the New Program Object dialog box, then select OK
- Provide the information requested in the Program Item Properties dialog box and select OK. The command line should be the complete path and filename for SELTEST.PIF (i.e., C:\SELTEST\SELTEST.PIF). The working directory must be the directory in which SELTEST was installed (i.e., C:\SELTEST).

If you will be running SELTEST software under Windows 3.0 Enhanced mode, and do not have an 80287 or 80387 numerics coprocessor or an 80486 processor (with built-in numerics), you will need to install PHARLAP.386. This 32-bit virtual device driver allows floating-point emulation to work properly under Windows 3.0 enhanced mode.

PHARLAP.386 should be copied to your Windows subdirectory, and the following line should be added to the [386enh] section of your Windows SYSTEM.INI file:

DEVICE=PHARLAP.386

The SYSTEM.INI file is a standard text file located in your Windows 3.0 subdirectory.

SELTEST software should now be ready to use.

WINDOWS MODES

In Windows 3 Real and Standard mode, SELTEST software can get extended (XMS) memory from the HIMEM.SYS device driver that comes with Windows. In Enhanced mode, SELTEST uses the DOS Protected-Mode Interface (DPMI) services provided by Windows. You don't need to change any .PIF file settings. SELTEST software automatically gets virtual memory when running under Windows 3 enhanced mode.

NESTED DOS EXTENDERS

The DPMI server in Windows 3.0 only allows one DOS extender to be running at a time in a given DOS "box" (virtual machine). That is, DOS extenders cannot be "nested" under Windows 3.0 Enhanced mode.

Consequently, you cannot run SELTEST software from inside the DOS shell of a DOS-extended application like Lotus 1-2-3 Release 3.1.

If SELTEST software is started under the DOS shell of a DOS-extended application under Windows 3.0 Enhanced mode, it will issue an error message:

> Fatal Error 286.1090: Nested DOS Extenders cannot be run in Windows 3.0 enhanced mode.

QEMM 4.1 AND 386MAX

All popular expanded-memory managers, including 386MAX and QEMM, are compatible with the Virtual Control Program Interface (VCPI), used by SELTEST software.

If you find a compatibility problem between SELTEST software and one of these memory managers, it is because an old version of the memory manager is being used. Use one of the following versions:

QEMM 4.1 or later (Quarterdeck)
386MAX 4.02 or later (Qualitas)
CEMM 4.02 or later (Compaq)
EMM386 (Microsoft Windows 3.0, MS DOS 5.0)

APPENDIX I: DELTA RELAY TESTING

When testing any delta relay (such as SEL-221D, SEL-267D, SEL-251D, and SEL-251CD) with the low-level test interface, you must enter phase-phase values for voltages in the Analog Output Channel fields in the Standard State window or the Extended State window.

SEL delta relays use the low-level test voltages in a manner that is distinct from all other SEL relays. Instead of using phase voltages (VA, BC, and VC) as with other relays, the delta relays expect phase-to-phase voltages (VAB, VBC, and VCA) at the low-level test connector.

To calculate phase-phase voltages from phase voltages, find the vector differences between them (i.e., $\mathbf{V}_{ab} = \mathbf{V}_a\text{-}\mathbf{V}_b$).

Failure to enter phase-phase voltages for delta relays will result in an erroneous test.