ProTesT User Guide

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PN 500-0220

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Preface

This manual describes how to use Doble Engineering's ProTesT™ Software. The purpose of this guide is to assist engineers and technicians in performing relay tests using ProTesT with Doble's F2000 and F6000 Families of Power System Simulators.

Structure of this Manual

This manual consists of six chapters and three appendices:

Chapter 1 ″Introducing ProTesT″

Chapter 1 introduces you to ProTesT, including features and benefits, and discusses architecture, location tree, Test Plans and ProTesT Macros.

Chapter 2 ″Getting Started″

Chapter 2 provides information needed to get started with ProTesT: hardware and software requirements, and instructions for installing, configuring, and running the application.

Chapter 3 ″ProTesT Menu Commands″

Chapter 3 describes how to use the ProTesT Menus and Database.

Chapter 4 ″Creating a Relay Test Plan″

Chapter 4 describes how to create a database of Relay Test Plans and further describes ProTesT Macros.

Chapter 5 ″Running a Test″

Chapter 5 describes how to set up and run a test.

Chapter 6 ″Sense Input″

Chapter 6 describes Sense Assignments and Sense Input Filtering.

Appendix A ″ProTesT Error Messages″
Appendix A describes ProTesT Run Time Errors, Macro Errors, Macro Execution Errors, and other related error messages.

Appendix B ″F6000 Control Panel″
Appendix B describes the features and functions of the F6000 Control Panel.

Appendix C ″ProTesT Macro Reference Guide″
Appendix C lists specifications for each test macro included in the various ProTesT Plans.

Document Conventions

The following font conventions serve to distinguish various references in the text:

- Button labels, menu selections, and items on pick lists (items in a display that the user can click) are shown in bold type.
- The names of displays are shown in bold type.
- Section names on the Control Panel, labels on the instrument front panel, and other labels are shown in italics.

The following definitions distinguish the software controls in ProTesT from the hardware on the instrument:

- Control Panel refers to the F6000 Control Panel option of the ProTesT Tools menu.
- Instrument Front Panel refers to the front panel of the F2000 or the F6000 Instrument.

Notes, Cautions, and Warnings

Note, Caution, and Warning icons denote information of special interest. The icons appear in the column to the left of the text and are reproduced below with explanations of their meanings. Failure to observe a Caution or Warning could cause a dangerous condition.

COMPLIANCE The **CE** icon signifies that the equipment complies with CE requirements.

WARNING The **WARNING** icon signifies information that denotes a potentially hazardous situation, which, if not avoided, may result in death or serious injury.

GROUND Protective Earth Ground Symbol.

NOTE The **Note** icon signifies a cautionary statement, an operating tip or maintenance suggestion. Instrument damage may occur if not followed.

VOLTAGE-HIGH The Voltage-High icon indicates a situation involving hazardous voltage levels with risks of shock or injury.

Safety

WARNING

To eliminate the potential of dangerous electrical shock from the test instrument, verify the safety ground before turning it on or using it. Always turn the source output off and disable the unit before connecting, removing, or touching any output terminal or cable.

DO NOT defeat the AC power input source ground connection and verify that the power connections have proper hot and neutral polarity.

VOLTAGE-HIGH

Dangerous and potentially fatal voltages can be developed across the output terminals of any Power System Simulator. **USE EXTREME CAUTION** when turning on or using the instrument. Always turn the source output off and disable the unit before connecting, removing, or touching any output terminal or cable. Never ground any instrument output source connection.

The high intensity yellow LED flashes to indicate that dangerous and potentially fatal voltages may be present. Flashing occurs when the Battery Simulator is on, or when other sources are enabled or on.

1. Introducing ProTesT

This chapter introduces ProTesT, explains the features and benefits of ProTesT, and discusses architecture, location tree, test plans, and ProTesT macros.

About ProTesT

ProTesT is an interactive software system for automated relay testing. It can be used with Doble's F2000 series or F6000 series of power system simulators (Figure 1.1 on page 1-2).

ProTesT runs on Microsoft Windows 9X/ME, Windows NT 4.0, or Windows 2000 operating systems.

ProTesT give the user control of relay testing including:

- Creating and editing test plans for any type of relay
- Using ProTesT macros to test relay functions
- Running tests automatically
- Logging date and time stamped results
- Plotting characteristics
- Generating test reports
- Using relay settings to define test parameters and expected values
- Replaying records
- Providing fault parameters studies
- Using either F6000 or F2000 to run the same Test Plan, subject to source capabilities
- Storing test plans and results in an ODBC-compliant client-server database

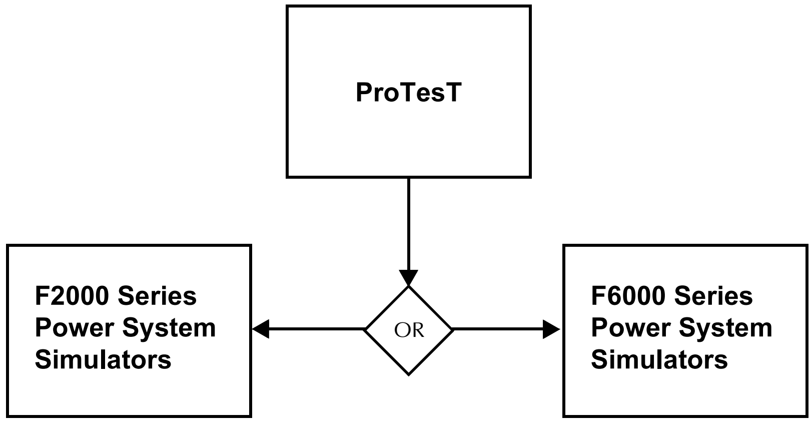


Figure 1.1 Automated Relay Testing with ProTesT

The ProTesT Starter Kit is required for each test instrument to run ProTesT macros where the:

- F2000 Instrument uses the F2910 ProTesT Starter Kit
- F6000 Instrument uses the F6910 Simulator Control and Automation Module

Refer to Table 1.1 for the items ProTesT requires to communicate with the F2000 and F6000 Instruments:

Table 1.1 Communication Between ProTesT and the Test Instrument

F2000 Test Instruments:	**F6000 Test Instruments:**
RS-232 interface, 9600 baud, 25-pin connector, full duplex	RS-232 or an Ethernet interface: • RS-232, 57600 baud, 9-pin connector • Ethernet, 10 base 2, BNC coaxial connector

ProTesT Macros

ProTesT provides macros to test relay functions. These macros offer the following features:

- Pickup and dropout
- Time characteristics
- Ohmic reach and plot
- Differential relay testing
- Frequency relay testing
- Synchronizer relay testing
- SSIMUL Macro for dynamic testing
- TRANS Macro for transient testing

ProTesT Plans

ProTesT macros are bundled in ProTesTPlans™ licensed for company-wide use. Each ProTesTPlan includes macros to conduct tests for a family of relays. Each of the seven plans corresponds to a type of relay: A, F, I, P, T, V, and Z. The seven plans contain macros for these types of tests:

A Plan	Autosynchronizing Relay Test (ASYNC Macro)
F Plan	Frequency (under/over frequency, time characteristic)
I Plan	Current (overcurrent, pickup and dropout, instantaneous, time characteristic)
P Plan	Power System Model (calculate test values to be used in SSIMUL dynamic tests)
T Plan	TRANS Macro for replaying COMTRADE waveform files (does not support the F2000 Series at this time)
V	PlanVoltage (under/overvoltage, time characteristic)
Z Plan	Distance (reach, maximum torque angle, characteristic)
TRANS	TRANS macro for replaying COMTRADE waveform files for the F2000 Series

To use a macro in ProTesT, specify macro parameters in standard engineering units of voltage and current amplitude, phase angle, and frequency. For more information, see Table 1.2 on page 1-9.

Benefits

ProTesT provides:

- Automated relay calibration tests
- Standardized test plans with repeatable results, a quality system requirement
- Ability to test complete protection schemes under simulated power system conditions
- Better test results with less time and fewer people

ProTesT Function Menus

ProTesT functions are accessed from the menu bar on the ProTesT main menu. Access a menu or toolbar selection with a single-click or use shortcut keys to access the most frequently used menu functions.

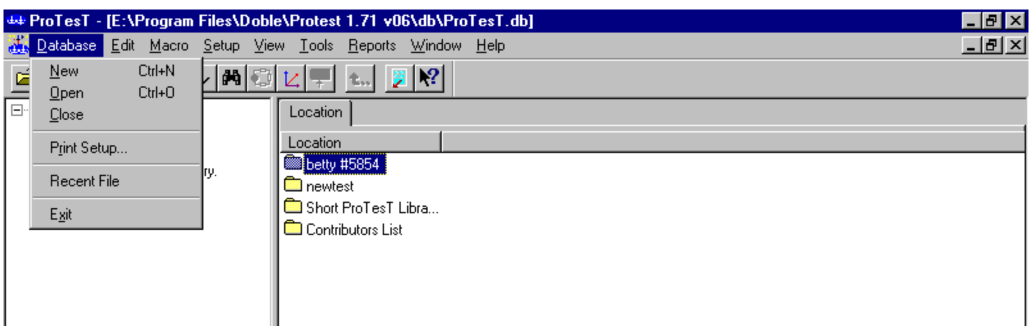


Figure 1.2 ProTesT Menu Bar with Database Drop-down Menu Displayed

The menu functions of ProTesT are:

Database	Create a new database, open an existing database, close the current database, Print Setup, or Exit.

Edit — *Cut*, *Copy*, and *Paste* apply to one or more selected records, using standard Windows conventions.

Insert and *Append* add a new record to the selected list view of a location, relay, or Test Plan.

Delete removes one or more selected records.

Move Up and *Move Down* adjust the order of records shown in the list view.

Find searches for and locates records that match the search criteria.

Macro — Opens a selected test in a Test Plan. Closes an open test Macro, or Saves it while it is still open. *Run* executes the selected Macro either at the test view or at the Test Plan list view. *Autorun* executes a sequence of macros automatically. Refer to Chapter 5 for details.

Setup — Opens a dialog to configure ProTesT.

View — Controls whether the toolbar and the status bar appear in the main display.

Tools

F6000 Control Panel

The Control Panel is a virtual front panel for the F6000 Instrument.

F6000 Configuration

Before running the F6000, it is necessary to set up the desired source configuration. Up to 8 sources can be configured, in various combinations of voltage and current sources. Refer to "F6000 Configuration" on page 3-11 for details.

F6000 Flash Loader

Installs firmware.

F6000 Key Code

Installs F6000 options.

F6000 IP Set

Changes the F6000 Instrument's IP address for Ethernet communications.

Power System Model

Invokes optional power system model for SSIMUL Macro. This selection is available only at the SSIMUL Macro screen.

Vector Calculator

Calculates Doble source values for phase-to-phase tests.

Graph

Plots Test Results from one or more characteristic test Macros.

Export/Import

Not implemented.

Import SS1 files

Imports simulation tests from DOS SSIMUL.EXE stored in .SS1 files. Multiple simulations from one file are imported as individual SSIMUL Macros in the currently selected Test Plan.

Convert ProTesT Database

Updates the SQL database from a previous release of ProTesT, if necessary. This feature copies from the old database to a newly created one.

Change Password

Opens dialog to change the password on the open database.

Enter Password

If a database is opened with the incorrect password or without a password, use Enter Password to open the database for full access.

Reports	Opens a display to select a Doble standard test report.
Window	Arrange windows to view more than one database record; e.g., to compare or to copy and paste.
Help	Access Help. Select **About ProTesT** to see the software version, the product code number, and the installed ProTesT Plans.

ProTesT Architecture

ProTesT organizes relay test data in a tree view hierarchy like folders in Microsoft Windows Explorer. In ProTesT, the folders are location records that can represent substations in a utility.

Location Tree

The Location tree organizes user-defined Relays and Test Plans. When a new database is created, the Location tree is empty.

Click **Edit | Append** to create a new location. Then, type a descriptive name and press **Enter** to confirm. Single-click a tree view record to select, or double-click a record in the list to view the contents.

Relay

Relay identifies relays by name and number.

Test Plan

The Test Plan is a list of user-defined macros for a relay. Steady state macros in a Test Plan test individual relay functions, such as reach, instantaneous overcurrent, reverse current response, and timing. Dynamic tests can be added using the SSIMUL Macro. Transient tests can be added using the TRANS Macro.

Macros are added to the List View by selecting **Edit | Insert** to insert a new test in front of the currently selected record, or **Edit | Append** to append a new test at the end. Fill in a name, select the macro, and enter optional comments. Other fields on the list show the time stamp of the last Macro edit, and the last test date. The ***Eval*** column shows the last Test status, if there are Test Results.

NOTE ! **Doble recommends that standardized nomenclature be used for easier access to relay records. Settings and test data for all relays in a protection system can be stored in the ProTesT database and arranged in the location tree.**

ProTesT Macros

ProTesT Macros are spreadsheet forms that specify Doble Instrument test sources, action parameters, and expected results.

When the RUN button is clicked, a Macro performs precisely timed, standard actions with one or more F2000/F6000 Instrument sources that include:

- Setting initial Amplitude, Phase, Frequency, and Timer Sense mode
- Doing Source Action; e.g., Linear Ramp, Pulsed Ramp, or Binary Search with one or more Action sources
- Recording Operate Value or Operate Time

A ProTesT Macro applies action to a specific source parameter, such as current amplitude or voltage amplitude. The Macro name in the examples below indicates the source action:

- PRAMPV for pulsed ramp voltage
- BSRHOI for binary search current
- LRAMPF for linear ramp frequency
- PHROTI/PHROTV for linear ramp phase (or phase rotate)
- RCHLRI is a linear ramp reach test in the Z ProTesTPlans, which performs the same action as LRAMPI in the I ProTesTPlans

Table 1.2 lists the available Test Macros by ProTesTPlans. See Appendix C ″ProTesT Macro Reference Guide″ for a detailed explanation of each macro.

Table 1.2 Test Plans and Macros

Special Macros (included in all Plans)		
EXTERN (Execute External Program)		
NOTEBK (User Notes)		
POWER (dc power to relay)		
SSIMUL (Dynamic State Simulator)		
A Plan: Autosynchronizing Relay Test		
ASYNCH		
Z Plan: Distance Relays		
GONGOI	RCHLRV	ZPLLRI
GONGOV	RCHPRI	ZPLLRV
MAXTAI	RCHPRV	ZPLPRI
MAXTAV	TIMEI	ZPLPRV
RCHBOI	TIMEV	ZPXBOI
RCHBOV	ZPLBOI	ZPXBOV
RCHLRI	ZPLBOV	
I Plan: Overcurrent and Differential Relays		
BSRHOI	LRAMPI	PRAMPI
CREEPI	PHROTI	TIMEI
DRAMPI	PHSFTI	TIMEPH
GONGOI	PLOTII	TOCPLT
INDPUI		

Table 1.2 Test Plans and Macros (Continued)

V Plan: Over/Undervoltage Relays		
BSRHOV	INDPUV	PHSFTV
CLOSEA	LRAMPF	TFRPLT
CREEPV	LRAMPV	TIMEPH
DRAMPV	PLOTVV	TIMEV
GONGOF	PRAMPV	TOVPLT
GONGOV	PHROTV	TPHPLT
F Plan: Frequency Relays		
CREEPF	GONGOF	TIMEF
FRDRMP	LRAMPF	TPHPLT
FRRMPT		
P Plan: Power System Model		
Exports Test States to SSIMUL		
T Plan: Transient Waveform Testing		
TRANS: Playback of COMTRADE Waveform Data		

2. Getting Started

This chapter provides information needed to get started with ProTesT: hardware and software requirements, and instructions for installing, configuring, and running the application.

Hardware and Software Requirements

ProTesT requires the following computer hardware and software:

- A personal computer with a Pentium-class processor
- Microsoft Windows 98/ME, Windows NT 4.0, or Windows 2000
- An 800 by 600 VGA, 256 color monitor
- A pointing device such as a Windows compatible mouse
- 100 MB or more of free disk space
- 64 MB or more of RAM (random access memory)
- CD-ROM Drive

Installation Procedure

To install ProTesT:

WARNING

For F6000 Instruments, install ProTesT version 1.7 or higher.

1. Insert the ProTesT CD into the CD-ROM drive.
2. From the Windows task bar, select **Start | Run**.

   If *E:* is the CD-ROM drive letter type **E:\Disk1\Setup.exe**,
   or use the **Browse** button to manually locate the Setup.exe file.
3. Press **ENTER** or click **OK** to launch the ProTesT Installation Wizard.
4. Follow the prompts to install both the Sybase SQL Anywhere Desktop Runtime Engine and ProTesT.

For the installation of the Sybase SQL Anywhere Desktop Runtime Engine:

- Follow the dialog instructions.

NOTE

Answering OK to all dialog instructions sets the default parameters and is recommended.

- If the Sybase SQL Anywhere Desktop Runtime Engine is already installed on the machine, the Sybase SQL Anywhere Desktop Runtime Engine Install Wizard can be cancelled.
- When installing on Windows NT 4.0, the installation procedure deletes any earlier version of Sybase SQL Anywhere Desktop Runtime Engine before installing the new version, ensuring that the new version installs correctly.

NOTE

Installing ProTesT overwrites any earlier version of ProTesT stored in the same installation directory.

- At the User Information window:
  - Verify your name and company.
  - Be sure to enter a Product Code in the serial number field. The product code is affixed to the Software Registration Certificate enclosed with the installation package. This code enables operation of the ProTesT macros purchased by your company as ProTesTPlans™. The product code may contain an alphabetic ***o***; it never contains a numeric ***0***. Entering the wrong character invalidates the code. If an incorrect code is entered, ProTesT will run as a demo, and no macros can run. To correct the product code within ProTesT, select **Tools | Change Product Code** from the menu bar. Then, enter the correct code.
- The default directory displayed at installation is c:\Program Files\Doble\ProTesT. To change the drive or directory, click the Browse button and enter a path name. The directory is created if it does not already exist.

Log In

At startup, a login window appears with a default *User Name*. Refer to Figure 2.1. Change the name and Click **OK** to continue. The default *User Name* is from the last login. Click the drop down arrow to see a list of previous logins.

Figure 2.1 Login Display

Password

The ProTesT startup screen asks for a Password. The default shown is DOBLE in clear text. All ProTesT databases have the default password DOBLE, until a user changes the password for a selected database.

If a special Password has been assigned to a database, and that password is not used at Login, the user is limited to read-only access; changes and deletions are not allowed. However, the user can still run tests and save Test Results, copy test plans for pasting in another database, and enter comments on the User side of Notebooks.

Changing the Password

After opening a database, the password can be changed.

To change the password:

1. Select **Tools | Change Password**.
2. Enter the old password first to authorize the change.
3. Enter the new password twice for verification.

NOTE

The password is not case sensitive.

ProTesT Main Screen

After Login, the ProTesT main screen appears (Figure 2.2).

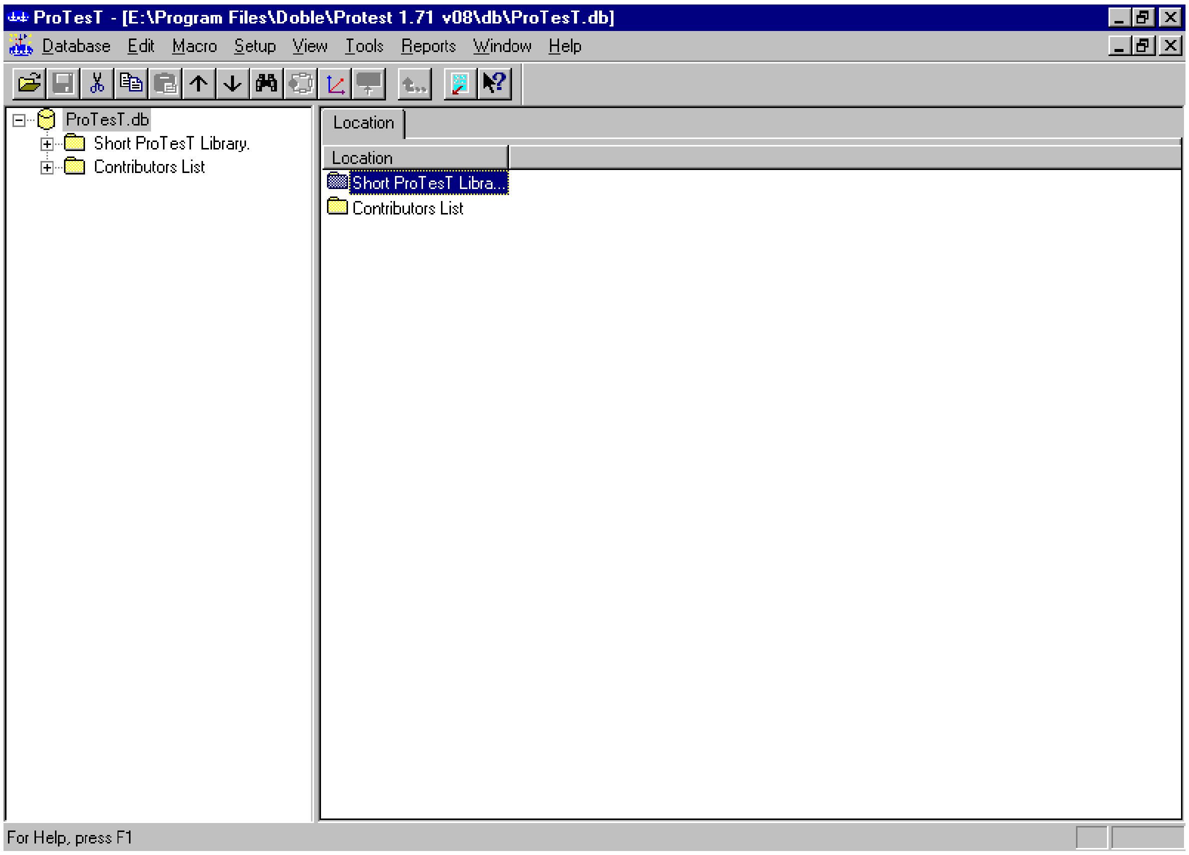


Figure 2.2 ProTesT Main Window

Setup

To open the **Setup** dialog box, click **Setup** in the ProTesT menu bar (Figure 2.3).

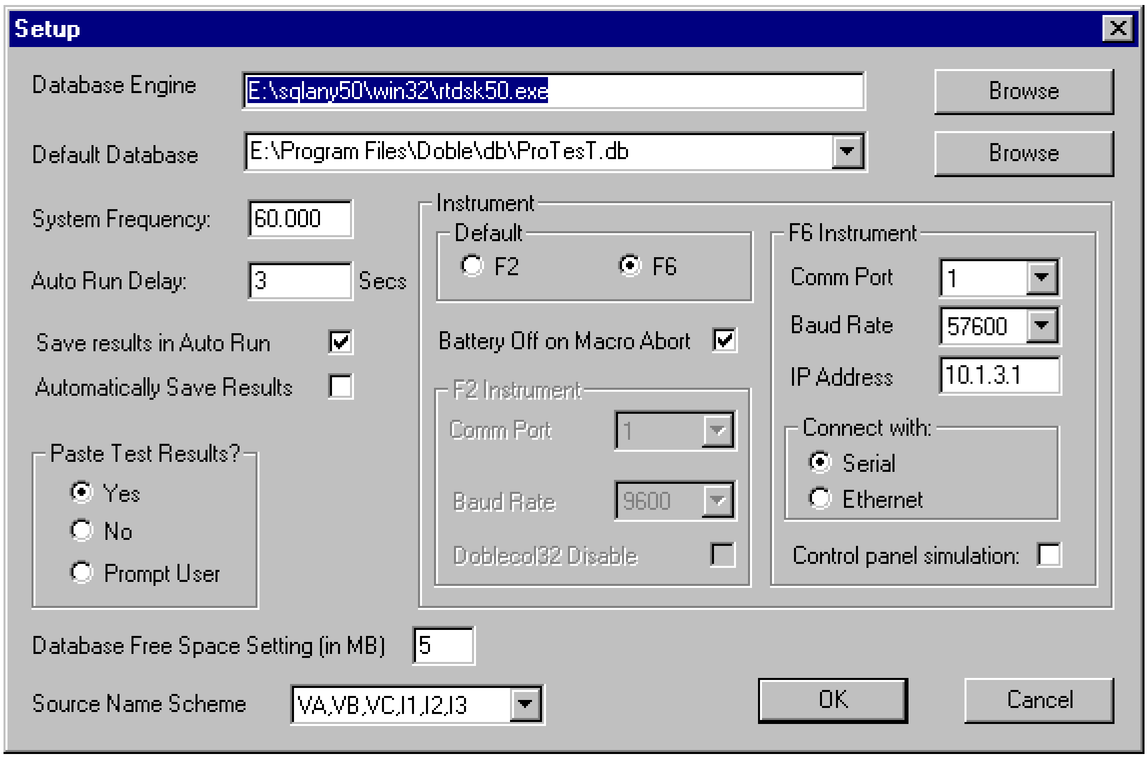


Figure 2.3 Setup Dialog Box

The **Setup** dialog contains the following fields and sections:

Database Engine — The Path for the Database Engine is the installation path for the SQL Anywhere Desktop Runtime Engine, normally:

c:\SQLANY50\WIN32\rtdsk50.exe

Verify that this path is correct.

Default Database — The path for default database is usually the *db* subdirectory under the ProTesT home directory, for example:

c:\Program Files\Doble\ProTesT\db\ProTesT.db

NOTE

If only the path to the database directory is specified, ProTesT opens a browse window at startup that allows the user to select a database, for example, *c:\Program Files\Doble\ProTesT\db.*

System Frequency — Enter the default system frequency: 50 or 60 Hz. This is used as the default for sources added to a test macro.

AutoRun Delay — The delay time between tests in a Test Plan when AutoRun is selected. This delay allows the relay to reset fully between macros permitting visual inspection of the test results. The recommended value is 3-5 seconds. Refer to "Autorun" on page 5-5.

Save Results in AutoRun

Check this box to save all test results when AutoRun is used. This box should always be selected.

Automatically Save Results

Check this box to automatically save all test results. If this box is not checked, a message appears prompting you to save your results.

Paste Test Results — When copying test plans or tests, select whether test results are to be copied:

- Yes means always copy Test Results.
- No means do not copy Test Results.
- Prompt User every time for the choice (recommended choice).

Instrument (Default) In the *Instrument* section, click the *F2* or the *F6* radio button to select the default instrument.

Battery Off on Macro Abort

Set this only if the battery is always to be turned off when a test is aborted. For example, if a POWER Macro has been run to turn on the battery source, it may be desirable to leave the battery on if a test is aborted.

Database Free Space Setting (in MB)

Type in the amount of space needed on the hard drive for the ProTesT database. The default setting is 5 MB. Unless disk space is very limited, this setting should be a large number. If ProTesT finds insufficient space, it prompts the user to repack the database. Repacking is a time consuming operation that cannot be interrupted.

Source Name Scheme

Select the source name scheme to be used for the Power System Model. These source names are used when source values are inserted in a SSIMUL Macro after modeling a fault.

F2 Instrument

The *Instrument* section of the **Setup** display contains these settings for the F2000:

Baud Rate

The default baud rate of 9600 is recommended to match factory default of instruments. Refer to Table 2.1, and to the F2000 User Guide or F2250 Family of Power System Simulators.

Comm Port

The default is 1.

Doblecol32 Disable

Check this box only if setup errors occur with F2000 Instruments.

The F2000 Communications Port Settings are set by switches SW2 and SW3 on the F2000 CPU board, which can be viewed after removing the F2000 top cover. Use Table 2.1 to check your port settings on the F2000.

Table 2.1 SW 3 Switch Positions and Baud Rates

Baud Rate	**SW3 - Switch 1**	**SW3 - Switch 2**	**SW3 - Switch 3**	**SW3 - Switch 4**
300	On	On	Off	On
1200	On	Off	Off	On
2400	On	On	On	Off
4800	Off	On	On	Off
9600	Off	Off	On	Off
19.2k	On	On	Off	Off

F6 Instrument

The *Instrument* section of the **Setup** display contains these settings for the F6000:

Comm Port	If communication is through the serial port, set the *Comm Port* and the *Baud Rate* in the **Setup** display. The default is *1*.
Baud Rate	The baud rate for serial port communications must be 57,600.
IP Address	If communication in through the Ethernet port, the IP address in the *IP Address* must match the instrument IP address. The IP address appears in the **Instrument** Display on the front panel when the instrument is turned on and the F6000 firmware boots up.
Connect with	Radio buttons to select serial or Ethernet communication.
Control panel simulation	If the computer is not connected to an instrument, or if the instrument is switched off, operate the Control Panel in simulator mode. Simulator mode is useful for training and for configuring tests that will be conducted at a later time. To choose this mode, check the box for *Control panel simulation*.

NOTE

If the computer is not connected to an instrument or if the instrument is switched off when the F6000 Control Panel is opened, an error message appears. Acknowledge the error message. Then specify *Control panel simulation* in the Setup display, or switch the instrument on.

After all the settings in the **Setup** display are changed or confirmed, click **OK** to accept the modifications and close the display, or **Cancel** to close without change.

Database Conversion

A new release of ProTesT may include changes to the database schema. See "Convert ProTesT Database" on page 3-27.

Change Alert

When attempting to open a database created by an earlier version of ProTesT, a change alert dialog box may appear (Figure 2.4). Click **Yes** to proceed with conversion of the old database. During conversion, ProTesT creates a new database and copies records from the old database into the new one. Click **No** in the dialog box to cancel the conversion.

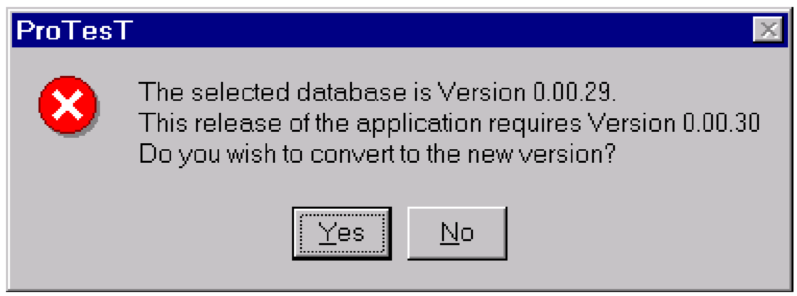


Figure 2.4 Change Alert Dialog Box

ProTesT III Databases

ProTesT can copy and convert ProTesT III data into a selected database. A conversion program for ProTesT III databases exists in the Protest folder. In Windows Explorer, open the Protest folder and double-click on Protest_III_Convert.exe (default directory c:\Program Files\Doble\ProTesT). Refer to "Convert ProTesT III Database" on page 3-28.

3. ProTesT Menu Commands

Chapter 3 describes how to use the ProTesT menus and database.

Database Explorer

The ProTesT Database Explorer displays a tree view on the left and a list view on the right (Figure 3.1).

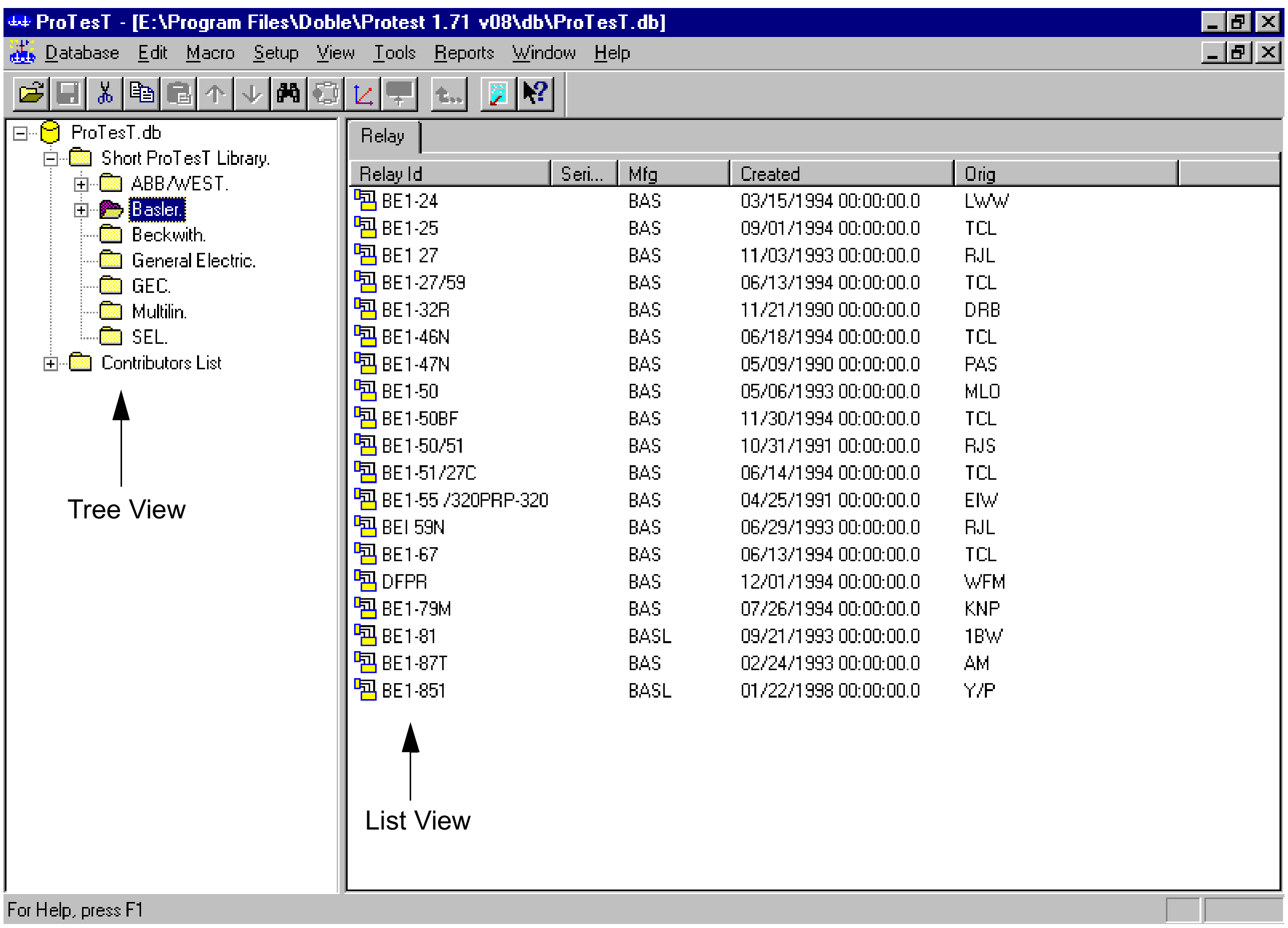


Figure 3.1 ProTesT Database Explorer

Click a folder in the tree view (Figure 3.2) to select it and see the contents in the list view. Click the [+] box to expand lower level branches of the folder, as in Windows Explorer.

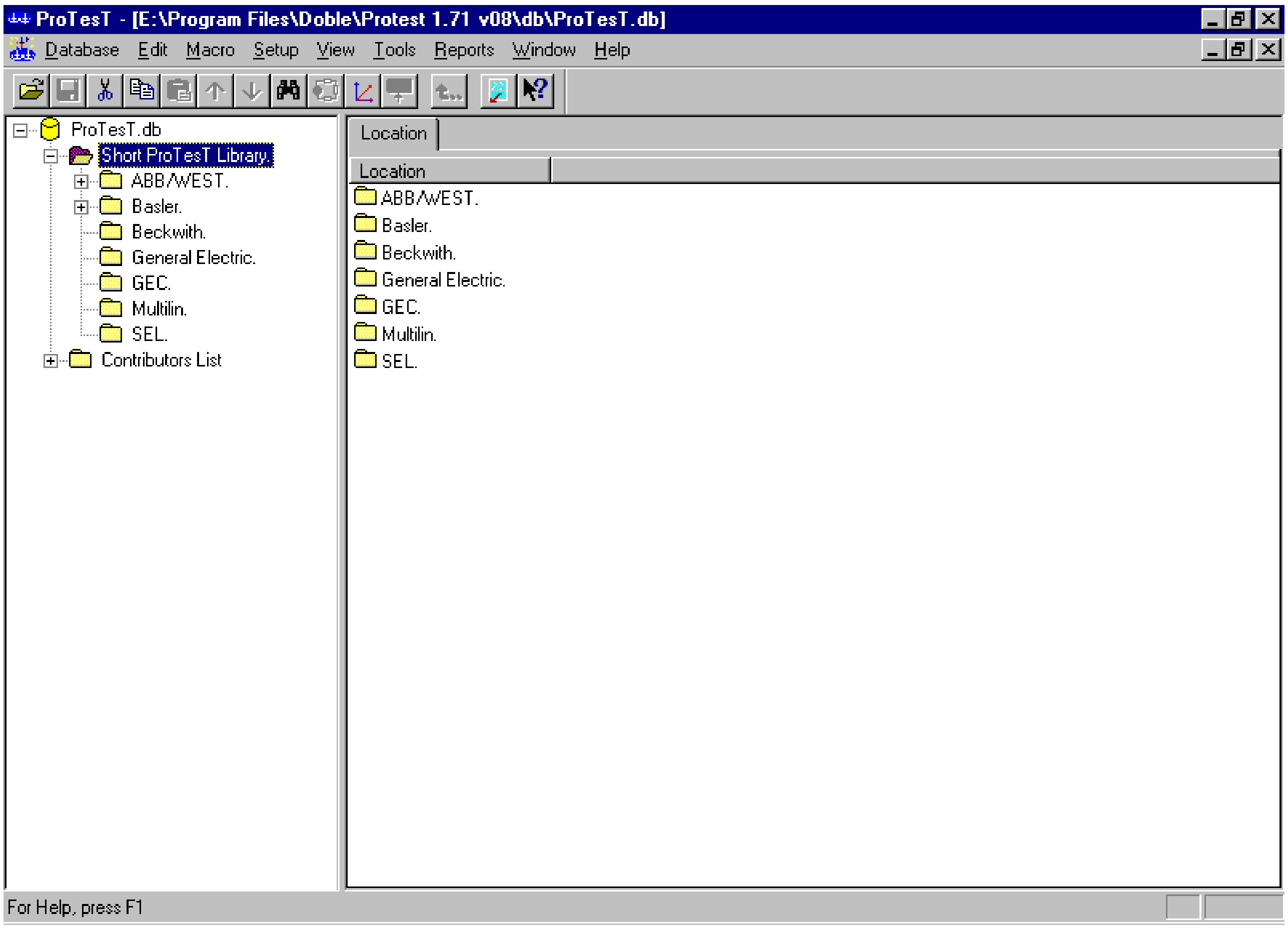


Figure 3.2 Expanded Tree View

Double-click a record in the list view to open it and view its contents.

How to Select ProTesT Data

- To select a record from the list view, click the desired record.
- To select a set of consecutive records in the list view, hold down the Shift key and click the first and last records in the list to be selected. Alternately, hold down the Shift key and use the Down Arrow or Up Arrow keys to select the desired records.
- To select non-consecutive records from the list view, hold down the Ctrl key and click the desired records.

How to Edit List View Data

- To edit the record name, click a second time on the record name.

  An edit box appears.
- To edit any field other than the record name, single-click to select.

NOTE

Some fields cannot be edited, for example, Macro Type.

To change the name of a record:

1. Select the name in either the tree view or the list view, and click a second time (two single-clicks rather than a double-click).

   An edit line opens.
2. Use the navigation keys – the Home, End, Left and Right arrows, not the Up or Down arrows – to position the bar cursor.
3. Type in the desired changes.

Menu Commands

Commands on the ProTesT Database Explorer menu bar (Figure 3.2 on page 3-2) are explained in the remainder of this chapter. A context-sensitive menu is available by clicking the right mouse button.

Database Menu

From the Database Menu:

New

1. To create a new database, select **New** from the Database Menu.
2. In the new database dialog box at File name, enter a database name and press **Save**.

   A new, empty database is created and is ready to be populated with data.

NOTE

Database names cannot contain any spaces. Certain characters are also not valid, such as '.' and '/'.

Open

1. To open an existing database, select **Open** from the Database Menu.
2. From the list of databases, select the appropriate database and press **Enter**.

Close

To close an open database, select **Close** from the Database Menu.

Printer Setup

1. To change your Windows printer setup, select **Print Setup** from the Database Menu.
2. Select the appropriate print parameters to use in ProTesT and press **Enter**.

Recent File

Used for access to recently opened database files.

Exit

To exit ProTesT, select **Exit** from the Database Menu.

Edit Menu

From the Edit Menu, choose:

Cut — To cut information:

1. Select one or more records in the list view by highlighting with the mouse.
2. Select **Cut** from the Edit Menu or use the Toolbar icon, which temporarily stores the data in the clipboard and removes the data from its location.

   A second cut or copy operation overwrites the previous contents of the clipboard.

Copy — To copy information:

1. Select one or more records list view by highlighting with the mouse.
2. Select **Copy** from the Edit Menu or use the Toolbar icon, which temporarily stores the data in a clipboard and leaves the original data intact at its location.

   A second cut or copy operation overwrites the previous contents of the buffer.

Paste — To paste information:

1. Position the cursor at the paste location.
2. Select **Paste** from the Edit Menu or use the Toolbar icon.

   Multiple paste operations are possible for multiple copies.

Insert — To add a new record to the list view above a selected location relay, or Test Plan:

1. Select Insert from the Edit Menu, or use the Toolbar icon.
2. Type the new record name into the box, and press **Enter**.
3. Fill in any remaining data fields.

Append To add a new record at the end of the list view of a location, relay, or Test Plan:

1. Select **Append** from the Edit Menu, or use the Toolbar icon.
2. Type the new record name into the box, and press **Enter**.
3. Fill in any remaining data fields.

Delete To delete one or more selected records from the list view of a selected location, relay, or Test Plan:

• Select **Delete** from the Edit Menu, or use the Delete key.

NOTE

Edit commands can be applied only to a single item in the tree view.

Find

1. To find a record in the open database, select **Find** from the Edit Menu, or use the Toolbar icon. The **Find** display appears (Figure 3.3).
2. In the *Find what* field, enter part of the name to be located.
3. Select the database table to be searched (e.g., Relay or Test macro).
4. Select the field to be searched (e.g., Label or Macro type). All matching records are listed.
5. Select **Go To** to open one of the records.

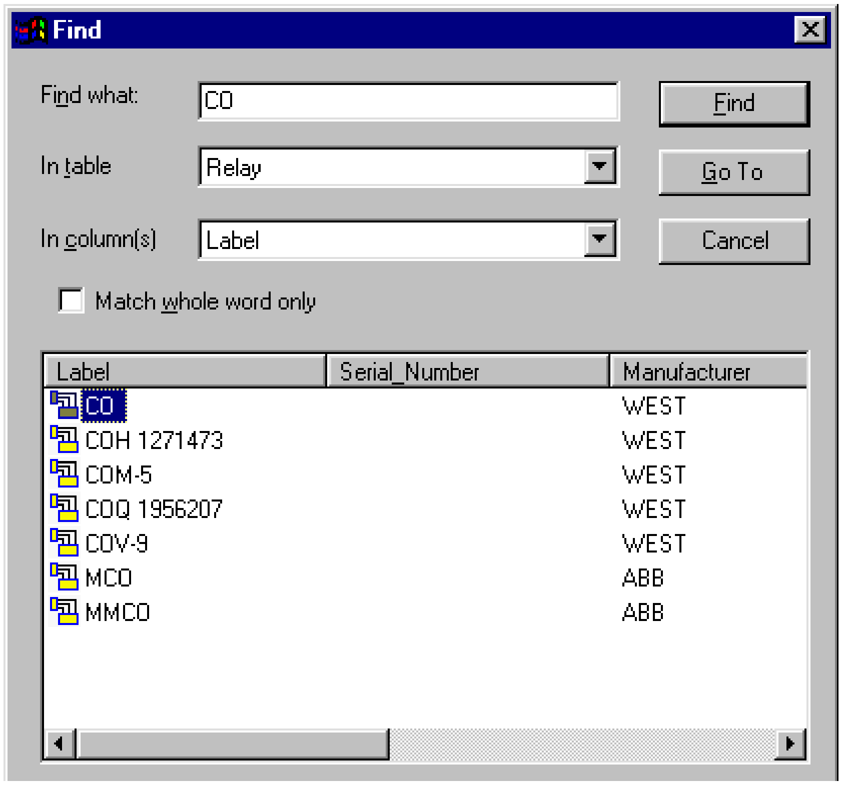


Figure 3.3 Find Display

Move Down Select a record from the list view, and select **Move Down** from the Edit Menu or click the Move Down icon on the Toolbar. The record is moved one position downward.

Move Up Select a record from the list view, and select **Move Up** from the Edit Menu or click the Move Up icon on the Toolbar. The record is moved one position upward.

Macro Menu

From the Macro Menu:

Open To open a Macro, select the macro in the list view, then select **Open** from the Macro Menu. Alternately, select the macro and press **Enter**, or double-click the macro in the list view. ProTesT displays the **Test** tab view.

NOTE **The Navigation window stays open when a Macro is opened.**

Close To close an open Test, select **Close** from the Macro Menu, or click the Go Back icon on the toolbar. ProTesT closes the Test tab view.

Save To save changes to a Test with the Test view open, select **Save** from the Macro Menu. Alternately, click the Save icon on the Toolbar. ProTesT saves the Test, and the Test view remains open.

Run To run a Test, select **Run** from the Macro Menu, click the Run icon on the toolbar, or press the **F12** key. If more than one test is selected on the list view, the Run function performs an AutoRun sequence on just the selected tests. Refer to Chapter 5 ″Running a Test″.

AutoRun To start an AutoRun sequence:

1. Select a test on the Test Plan, or open a Test view.
2. Select **AutoRun** from the Macro Menu or press **Al+F12**.

   AutoRun begins with the currently selected Macro and proceeds non-stop through all following Macros until it encounters a Notebook or until the end of the Test Plan. Refer to Chapter 5 ″Running a Test″.

Setup Menu

For details on the **Setup** display and the configuration process, see Chapter 2 ”Getting Started”.

View Menu

From the View Menu, toggle the toolbar and the status bar on and off.

Tools Menu

The Tools Menu (Figure 3.4) provides access to several utilities.

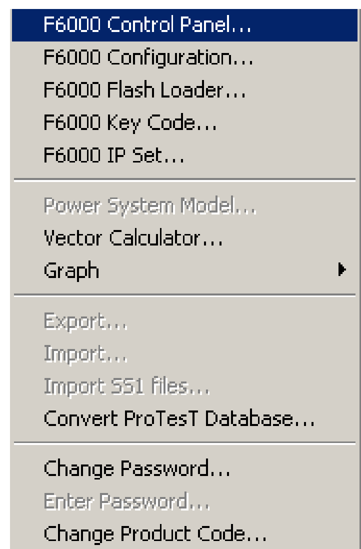


Figure 3.4 Tools Menu

F6000 Control Panel

The F6000 Control Panel (Figure 3.5) contains all of the functions and controls needed to conduct manual tests with the F6000 Instrument. To open the F6000 Control Panel, click **Tools | F6000 Control Panel** in the ProTesT menu bar. See Appendix B "F6000 Control Panel" for more information on Control Panel settings.

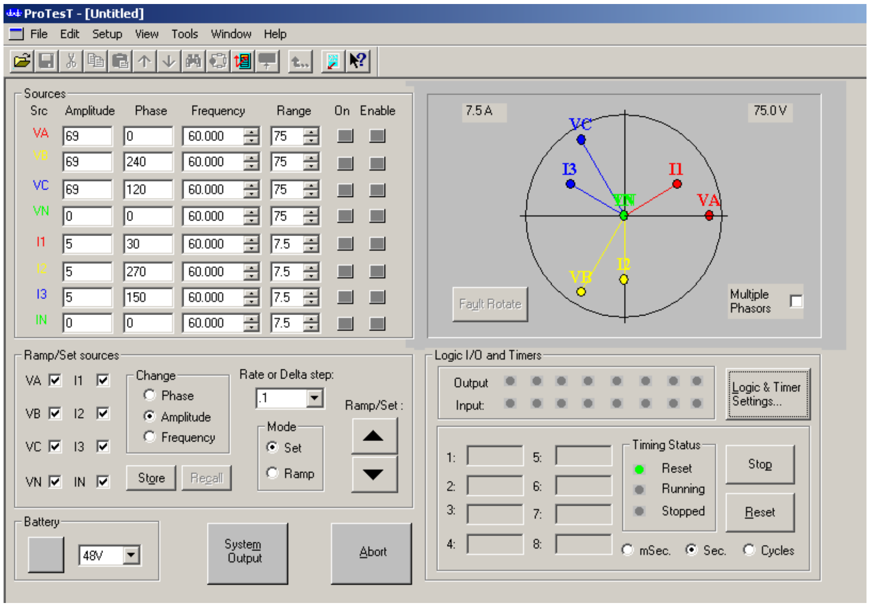


Figure 3.5 F6000 Control Panel

F6000 Configuration

The F6000 sources can be configured to suit test requirements.

1. Click **Tools | F6000 Configuration** in the ProTesT menu bar to open the **F6000 Configuration** display (Figure 3.6).

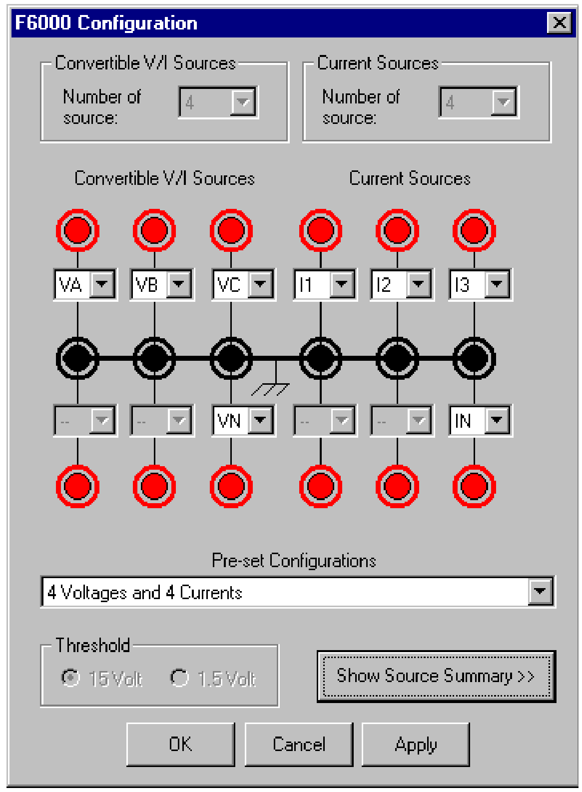


Figure 3.6 Configuration Display

2. Click **Show Source Summary** to show the VA rating and the range settings for each configured source (Figure 3.7).

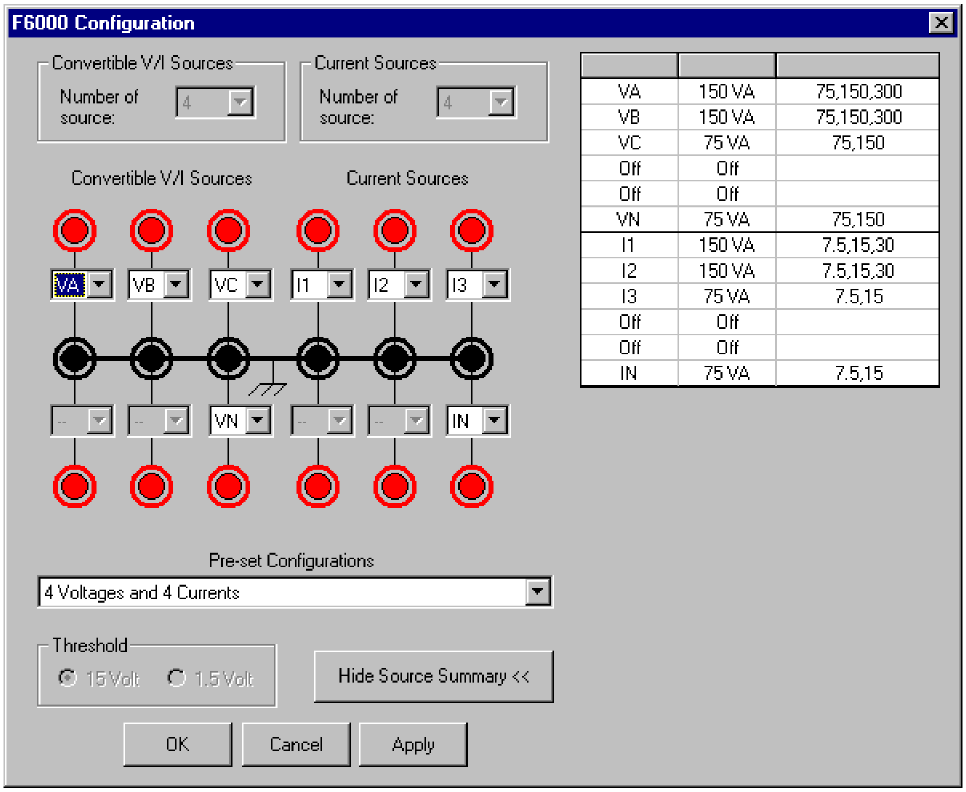


Figure 3.7 Configuration Display with Source Summary

To configure the sources manually:

1. Select **User defined** in the *Pre-set Configurations* pick list.
2. Select the number of convertible sources and the number of current sources in the two pick lists at the top of the display.

NOTE

If the F6150 Instrument does not have the F6810 convertible source option installed, the sources on the left side of the Configuration display can be used only as voltage sources.

The two pick lists correspond to the two types of sources available:

Convertible V/I Sources
: If Option 6810 is installed, the sources on the left side of the display can be used as voltage sources or as low range current sources. Use the *Convertible V/I Sources* pick list in the **F6000 Configuration** dialog to specify the number of convertible sources (Figure 3.7).

Current Sources
: The sources in the right half of the display are configurable only as current sources. Use the *Current Sources* pick list in the **F6000 Configuration** dialog to specify the number of current sources (Figure 3.7).

The **F6000 Configuration** dialog box has a graphic display which represents the voltage and current source output terminals on the F6000 Front Panel. When a preset configuration is selected, the source names and layout are displayed in this graphic. For user defined configurations, the required number of convertible V/I sources and current sources can be selected. Moreover, the source names can be chosen from the available options for each source shown in the graphic.

Once the number of convertible and current sources is specified, assign a name to each one. Name the sources by choosing from active pick lists in the middle of the display.

- Voltage sources are typically designated VA, VB, and VC.
- Current sources are typically designated I1, I2, and I3.
- VN is a general label for a fourth voltage source.
- IN is a general label for a fourth current source.

NOTE

Current sources are selected on the basis of 150 VA output. To create a 300 VA source, select 2 current sources. To create a 450 VA source, select 3 current sources. Then assign each source the same source name.

To use a pre-set configuration, select one of the options from the *Pre-set Configurations* pick list at the bottom of the display:

- User Defined
- 3 Voltages and 3 Currents
- 3 Voltages and 3 Transient Currents
- 4 Voltages and 4 Currents
- 6 Currents (right bank)
- 1 Voltage and 2 Low Range Currents
- 1 Voltage 150 VA and 1 Current 450 VA
- 4 Voltages and 4 Transient Currents
- 6 Voltages
- 6 Low Range Currents
- 6 Low Range Transients
- 6 Transient Currents
- 1 Voltage and 2 Low Range Transients

3. To finish configuring the sources, click one of the three buttons at the bottom of the display (Figure 3.7 on page 3-12):
   - Click OK to configure the sources on the F6000 Instrument and close the F6000 Configuration dialog.
   - Click Cancel to ignore changes to the source configuration and close the F6000 Configuration dialog.
   - Click Apply to configure the sources on the F6000 Instrument without closing the F6000 Configuration dialog.

F6000 Flash Loader

The F6000 Flash Loader updates F6000 instrument firmware. Refer to the *F6000 User Guide* for details on operation.

F6000 Key Code

The F6000 Key Code updates F6000 Instrument options by downloading a software key. Key codes can be obtained from Doble to update options in the F6000.

Power System Model

The Power System Model is enabled when the ProTesTPlan is installed and an SSIMUL Macro is displayed.

It contains three tabbed views:

- Primary Ohms
- Secondary Ohms
- Results

When using the Power System Model, the primary impedance values are entered for the near end source, line, and far end source. Impedance can be entered in rectangular, polar, or per unit terms. Current and Potential Transformer ratios are entered to compute secondary values for fault calculations.

The Power System Model calculates amplitude and phase angle quantities to simulate power system events in an SSIMUL Macro.
This form of test is called a dynamic test. It can be used to test entire protection schemes.

The Power System Model represents a two-machine equivalent with lumped impedance parameters for line and source values. Faults are simulated on the model with varied fault locations, resistance, and load flows. Test Plans are created to model power system events such that the complete relay system is tested for each case modeled. Relay reach and direction (faults behind and in front) for the various zones and combinations of zones are tested for each case, and classified as *op* or *no-op*, depending on whether zone protection was enabled. For a Zone 1 relay with ± 5% accuracy, an operation should always occur at 95% of setting (*op* case). For a fault at 106% of setting, there should be no operation (*no-op* case). These two cases confirm the accuracy of the relay.

Other dynamic relay tests that can be performed are operating time tests at different system impedance ratios – the ratio of the source impedance behind the relay to the set impedance of the relay.

Other application tests include:

- Switch onto fault
- Blown fuse, memory, adaptive characteristics
- Programmable logic tests

With dynamic relay testing, these events can be very quickly modeled and played back using the SSIMUL Macro.

Primary Ohms

To work with the Power System Model, obtain the source impedance and the line impedance for both ends of the line. The impedance is entered only in primary quantities. Secondary impedance quantities are calculated automatically by the program from the PT and CT ratios.

Impedances are entered as positive, negative, and zero sequence components. If the negative sequence impedance is not available, set it to the positive sequence impedance. If the source impedance is not available, use these rules:

- Set the positive sequence impedance, negative sequence, and zero sequence equal to each other.
- For a strong source, set the source impedance to line impedance ratio (ZS/ZL) between one and five. For example, for a ZS/ZL ratio of two, set the source impedance equal to two times the line impedance.
- For a weak source, set the source impedance to line impedance ratio (ZS/ZL) between five and ten. For example, for a ZS/ZL ratio of six, set the source impedance equal to six times the line impedance.

To access Primary Ohms or the Power System Model:

1. At the **SSIMUL Test** tab, click the **Power System Model** icon in the toolbar. Alternately, select **Power System Model** from the Tools Menu.

   The Power System Model defaults to the Primary Ohms tab (Figure 3.8).

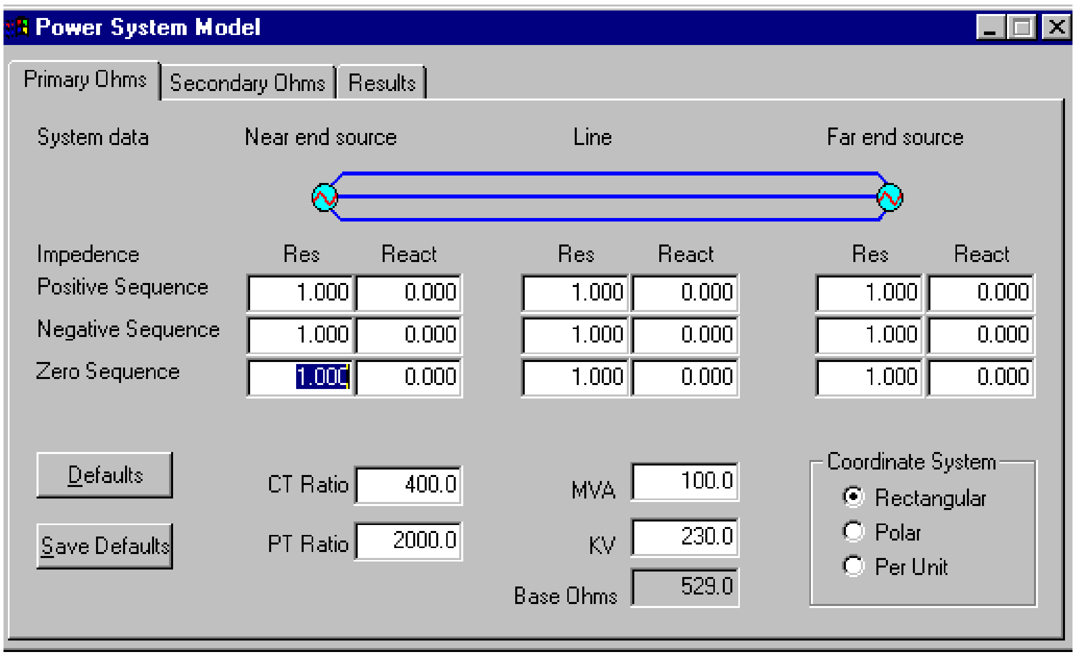


Figure 3.8 Primary Ohms

2. Enter the Base MVA and the voltage level of the line (in kilovolts).

   The base MVA and voltage is required only when using Per Unit impedance quantities. The Base Ohms is recalculated only when switching from one coordinate system to another system.

3. Choose the correct coordinate system for the primary impedance to be entered by clicking on the appropriate coordinate system button.

   The Power System Model converts the impedances to the desired coordinate system. Changing the coordinate system of the Primary Ohms does not change the coordinate system of the Secondary Ohms.

4. Enter the near end source impedance, the line impedance, and the far end source impedance.

   Use the Tab key to advance the cursor or click with the left mouse button.

   - For polar coordinates, enter the magnitude and angle in primary Ohms.
   - For rectangular coordinates, enter the resistance and reactance in primary Ohms.
   - For Per Unit coordinates enter the resistance and reactance in per unit quantities.

5. Enter the CT and PT ratios.

   Enter the ratio as a primary quantity to one secondary quantity. For example, a 2000/5 CT has a ratio of 400. The CT and PT ratios are used to calculate the secondary impedance and fault voltages and currents seen by the relay.

NOTE

If only secondary data is available, use CT Ratio = PT Ratio = 1.

Secondary Ohms

To access Secondary Ohms from the Power System Model:

1. Select the Secondary Ohms tab to see calculated secondary quantities (Figure 3-13).

   Nothing can be entered in the Secondary Ohms tab (Figure 3.9); these are calculated quantities only.

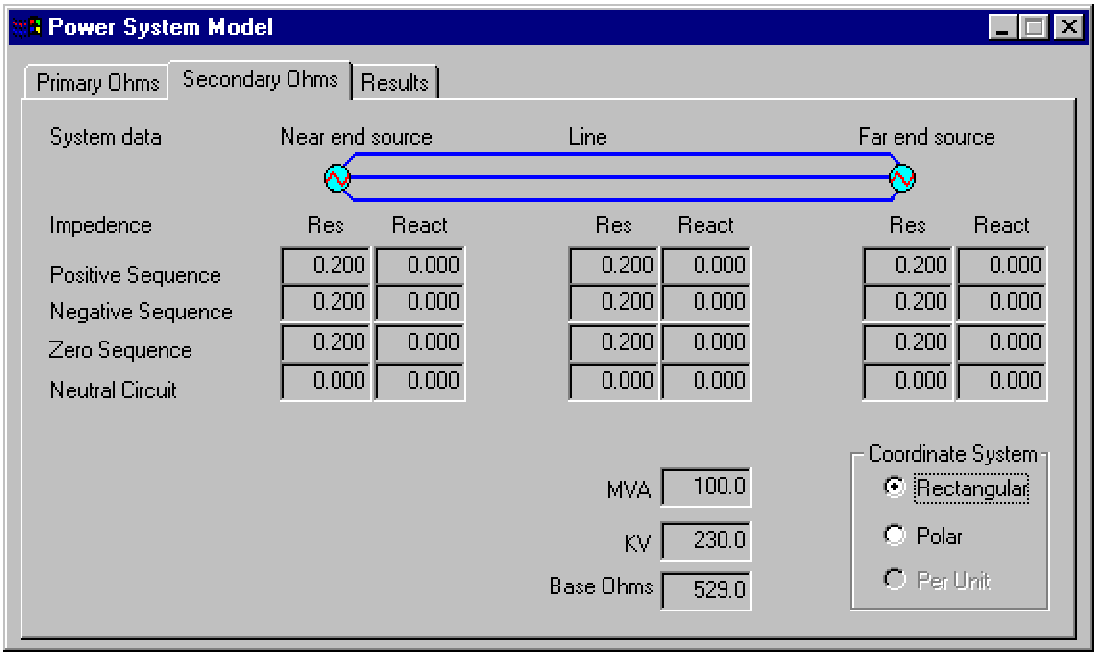


Figure 3.9 Secondary Ohms

2. To choose the coordinate system for the secondary impedance, click the appropriate coordinate system button.

   The Power System Model converts the impedances to the desired coordinate system. Changing the coordinate system of the Secondary Ohms does not change the coordinate system of the Primary Ohms.

Results   To specify the type of fault and fault location, select the **Results** tab (Figure 3.10).

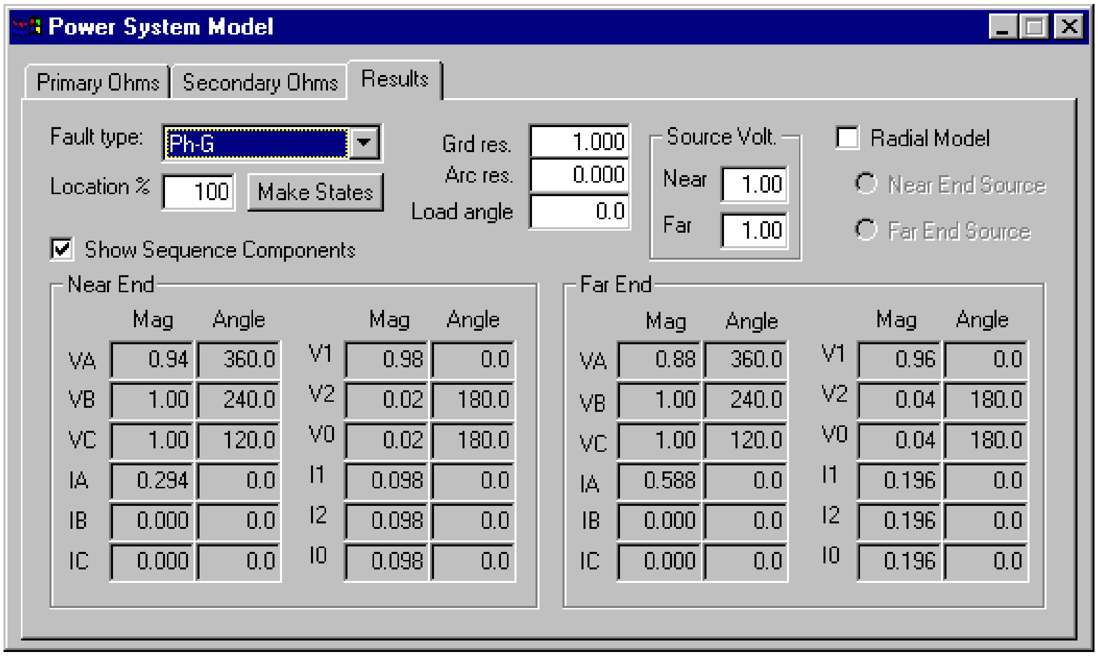


Figure 3.10 Results Tab: Calculated Fault Quantities

The Results tab contains the following fields:

- Fault type: Provides the following options:
    - Load Flow
    - Phase-to-Ground = Ph-G (A-G fault)
    - Phase-to-Phase = Ph-Ph (B-C fault)
    - Three Phase = 3 Ph (A-B-C fault)
    - Phase-to-Phase-to-Ground = Ph-Ph-G (B-C-G fault)
- Location %: Allows moving the fault on the line.

  The percentage is the distance from the near end to the fault. For example, entering 60 in this field places the fault 60 percent of the line length from the near end or 40 percent from the far end. The Power System Model also allows percentages to be entered up to 999% to test different zones of protection. To create a fault at more than 100% of the line, set the far end source equal to 0 for realistic values.
- Gnd res.: Allows entering the total ground fault resistance in secondary Ohms.
- Arc res.: Allows entering the fault arcing resistance for phase-to-phase faults in secondary Ohms.
- Load Angle: Allows entering the load angle in degrees.

  This is the angle between the voltages at terminals of the machines of the near source and the far source. Positive angle provides load flow from the near source to the far source (that is, into the line), and negative angle provides load flow from the far source to the near source (that is, into the bus).
- Source Voltage: Allows entering the terminal voltage for the near and far end sources.
- Radial Model: Creates a radial model from the data entered in the Primary Ohms control folder.

  The check box has a toggle action. Clicking on the box enters a check mark and creates the Radial Model; clicking again unchecks the box and restores a double-ended model.

  Choosing ***Radial Model*** requires a decision about whether the line is to be radial from the near end or the far end. Select the correct radial model by clicking the correct selection box.
- Show Sequence Components: Shows the sequence components for the fault values shown. Uncheck the box to remove the sequence components.

Make States for SSIMUL Macro

The Make States button creates a three-state fault: Pre-fault, Fault and Post-fault. The states are automatically appended to the open SSIMUL Macro. Only the fault data from the near end is inserted in the fault state. The load flow voltage and current data is inserted into the pre-fault state. The load flow voltage is inserted into the post-fault state.

More than one fault can be added to a SSIMUL Macro, creating a dynamic test that tests several fault conditions in one macro.

Once states have been added to SSIMUL from the Power System Model, they can be edited at the SSIMUL test screen.

NOTE

The Power System Model uses the source name scheme selected in Setup; the default scheme is VA, VB, VC, I1, I2, and I3. If the source names are not present in the SSIMUL test, a prompt asks whether to add new sources if required.

Vector Calculator

To access the Doble Vector Calculator, choose **Reports > Vector Calculator...**

The Vector Calculator consists of a Vector Table and Keypad (Figure 3.11). Vectors are displayed graphically in the Vector View area. A user-entered vector formula is displayed in the Formula Box, with a result shown in the Answer Box.

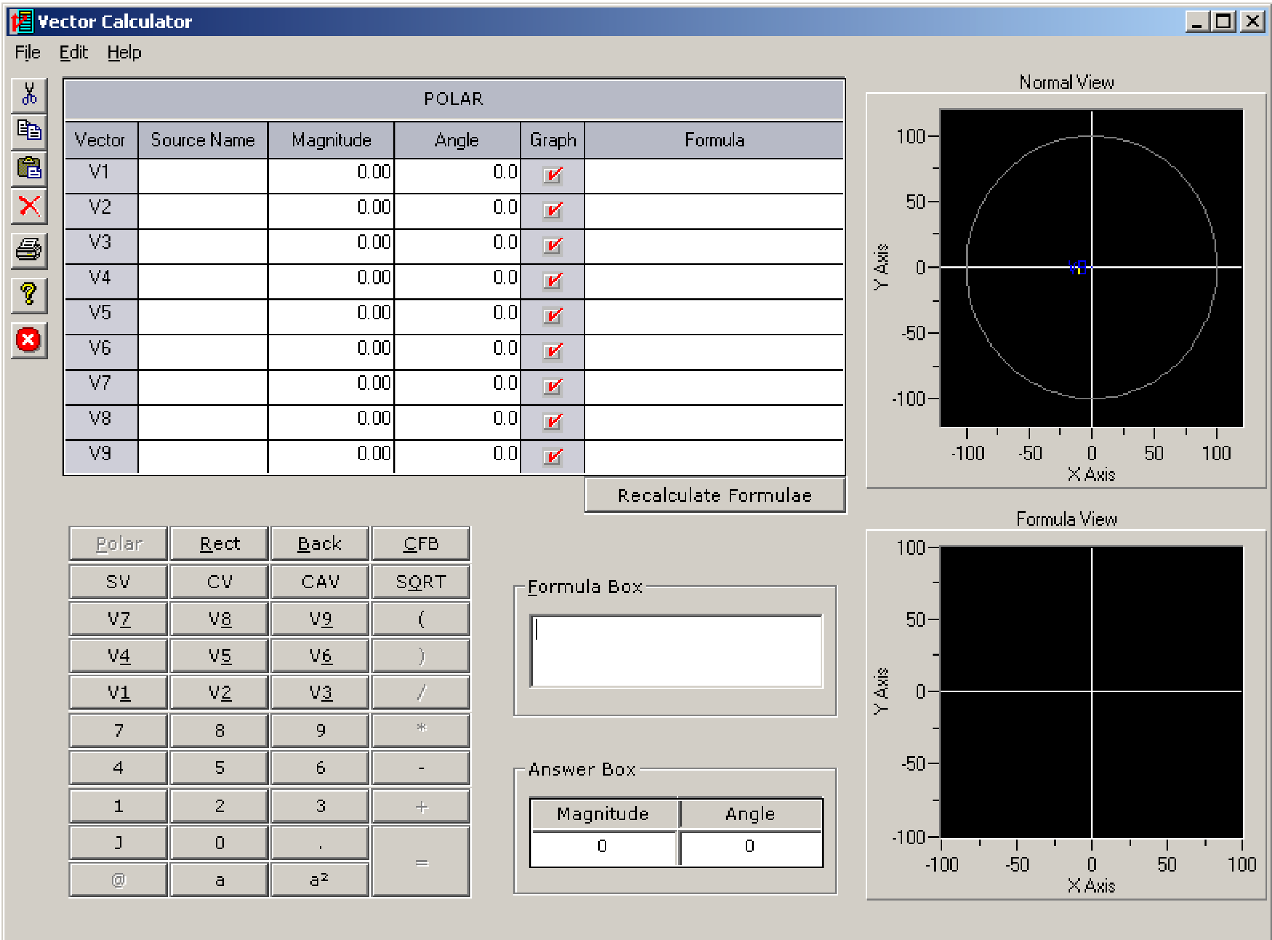


Figure 3.11 Vector Calculator

To enter vector values to the Vector Calculator:

1. Select **Polar** on the function keypad to enter magnitude and angle or select **Rect** to enter real and imaginary values.
2. Enter values directly into cells of the Vector Table using the keyboard or the numeric keypad of the calculator.
3. Press the Enter key to complete the entry or use the mouse to select another cell.
4. Click on the Graph check box to see the vector displayed in the Normal View area.

See Help for more details.

Export / Import This function is not implemented. It is intended to export to and import from a foreign database.

Graph To see characteristic Test Results plotted on a graph, select **Tools | Graph**. A Test Result must be selected before any graph can be viewed.

To Plot a Single Result on a graph:

1. Select **Tools | Graph | Display Graph**.

This opens the graph window (Figure 3.12). If a macro **Test** tab is open and a result is displayed, the values will appear on the graph.

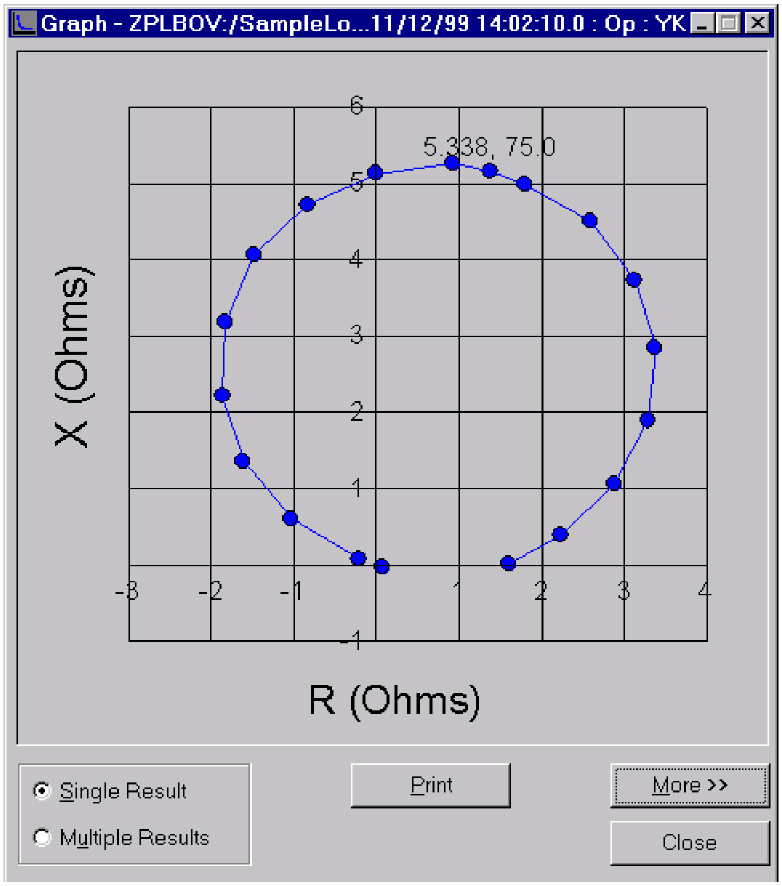


Figure 3.12 Display Single Result

2. Move the graph window out of the way by dragging it with the mouse, or minimize it.

   The graph window stays open and displays currently selected results.

3. Click **More >>** to see additional controls (Figure 3.13).

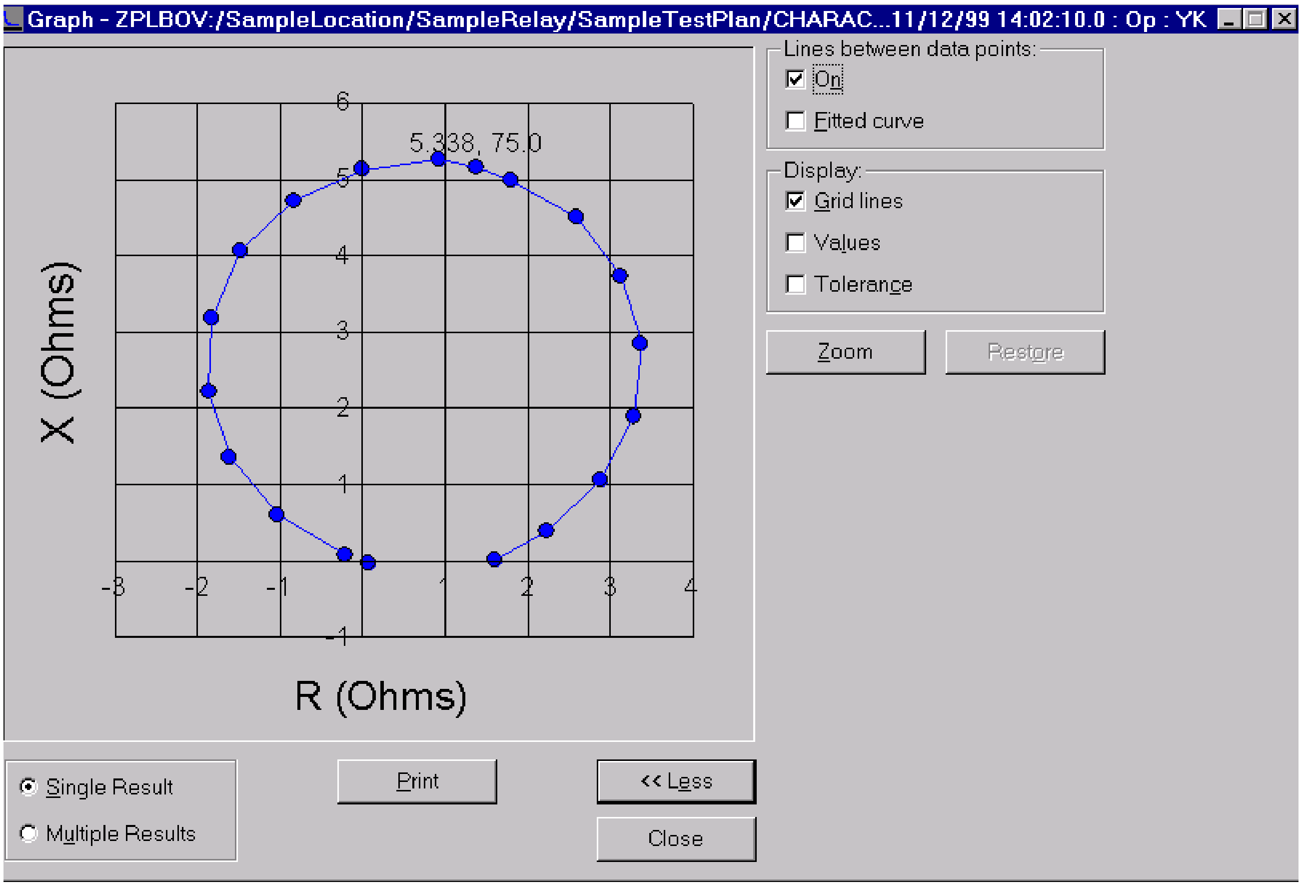


Figure 3.13 Display Single Result with* More *Selected

4. When finished, close the graph window.

To Overlay Multiple Results:

1. Open a characteristic test and from the Menu bar, select **Tools | Graph | Add Results to Graph List**.
2. To add results to the graph list, check the Test Results and press **OK**.

   Open other tests and repeat as needed. Up to ten results can be overlaid.
3. From the Menu bar, select **Tools | Graph | Display Graph**.
4. Click the *Multiple Results* radio button in the lower left-hand corner of the graph window.

   A graph list appears on the right side of the full graph window. The graph window can be moved, minimized or closed.

NOTE

To clear overlaid results, select Tools | Graph | Add Results to Graph List, then click Empty Graph List or Remove All.

Import SS1 files

Imports data from DOS SSIMUL.EXE stored in .SS1 files. A Test Plan must be selected before using Import SS1 Files. Multiple simulations can be imported from a single .SS1 file. Each simulation is converted as a single SSIMUL Macro in the currently selected Test Plan.

Convert ProTesT Database

To open an old ProTesT database in a new release of ProTesT, it may be necessary to convert the old database. Use **Convert Database** to copy the old database to a database that is compatible with the new ProTesT release (Figure 3.14).

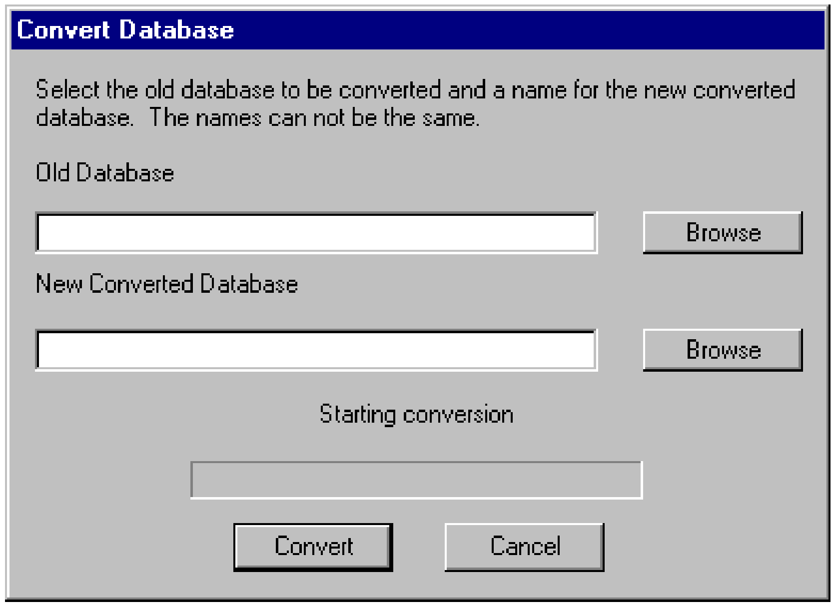


Figure 3.14 Convert Database

To convert a database:

1. Select **Convert ProTesT Database** in the Tools Menu.

2. Enter the path to the old ProTesT database, or use the Browse window.

3. Enter the name of the new converted ProTesT database.

If the path is not the same as that for the old database, enter the new path or locate it using the Browse window.

NOTE

Confirm that the previous ProTesT database is located on the local hard drive.

4. Click **Convert**.

When the conversion is complete, the new database can be opened.

Convert ProTesT III Database

In Windows Explorer, open the Protest folder and double-click on Protest_III_Convert.exe to open the **Select Databases** display (Figure 3.15). Use the display to convert a ProTesT III database and create new records in the selected ProTesT database file.

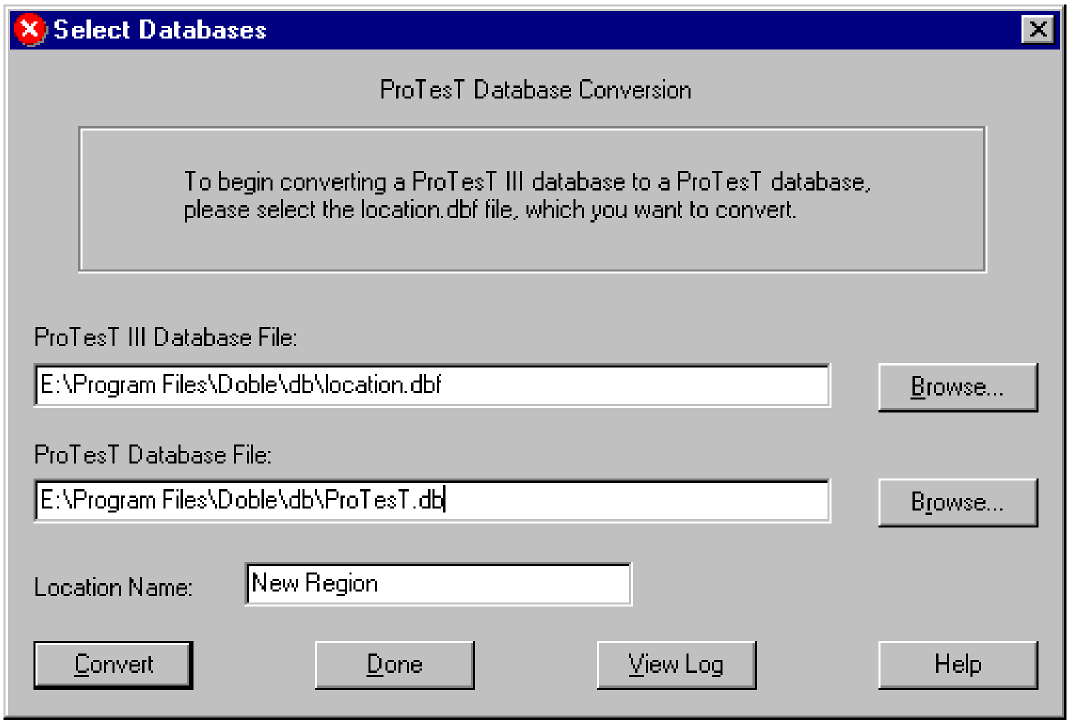


Figure 3.15 Convert ProTesT III Database

NOTE

The target database must be a non-existing database name.

To convert a database:

1. In Windows Explorer, go to the **C:\Program Files\Doble\ProTesT folder**.
2. Find and double-click the file called **ProTesT_III_Convert.exe**.
3. This starts the conversion program.
4. In the Protest Database box, browse till you find the path of the database that you wish to convert, for example: **C:\ProTesT3\db\location.dbf**

NOTE

Be sure to select the location.dbf file.

5. In the ProTesT Database box, enter a new database name.

   Do not use spaces or ./ - in the DB name

Click **Convert** to begin the Database conversion.

Change/Enter Password

Click **Change Password** in the Tools Menu to change an existing password.

Doble Reports

Click **Reports** in the top menu bar to open the **Reports** dialog (Figure 3.16). Use the **Reports** dialog box to select and print standard test reports.

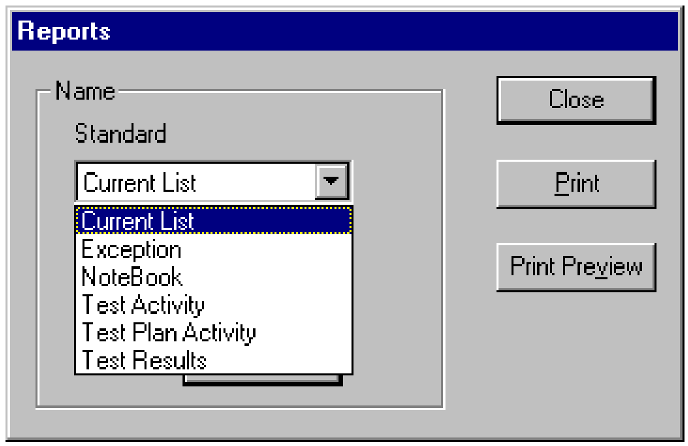


Figure 3.16 Reports Dialog

The scope of a report is limited to what is selected in the tree view of the Doble Explorer. For example, if a relay is selected in the tree view, the report includes only test plans and test results for that relay.

The following standard reports are available in the **Reports** dialog box:

Current List	Shows the contents of the current list view, where the last test date and test result are shown.
Exception	This is a Test Activity report, but only for those tests whose last result was *Fail*.
NoteBook	Lists contents of all NOTEBK Macros within the scope of the report.
Test Activity	Lists all the tests and test plans within the scope of the report, including the date the relay was last tested and the evaluation summary (Pass or Fail).
Test Plan Activity	Lists all test plans within the scope of the report, and the latest date of any test result.

Test Results — Shows detailed results for all tests within the scope of the report. Use the **Test Results Date Parameters** dialog to specify the results to include (Figure 3.17). The default is to report only the last test result. If *Query By Date* is selected, enter a date range. All the test results within that range are reported. Note, however, that NOTEBK Macros have no results and are not included.

To generate a report:

1. Click **Report** in the ProTesT menu bar.
2. Select a standard report from the pick list.
3. Select **Print Preview** to see the report on screen.

   If the Test Results report is selected, the **Test Results Date Parameters** dialog box appears (Figure 3.17). Use the dialog box to select results within a specified date range.

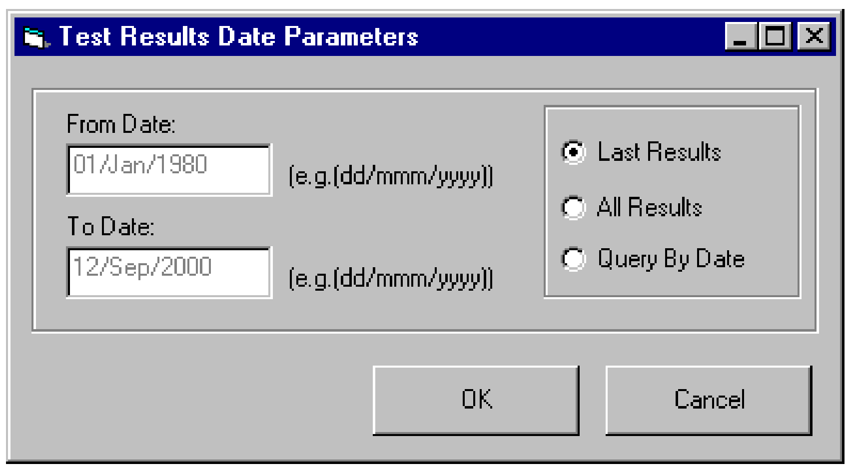


Figure 3.17 Test Results Date Parameters

4. Enter the date, month, and year in the ***From Date*** and ***To Date*** fields.
5. Click the *Query By Date* radio button.

6. Click **OK**.

   The **Doble Reports** display appears with a preview of the selected test results (Figure 3.18).

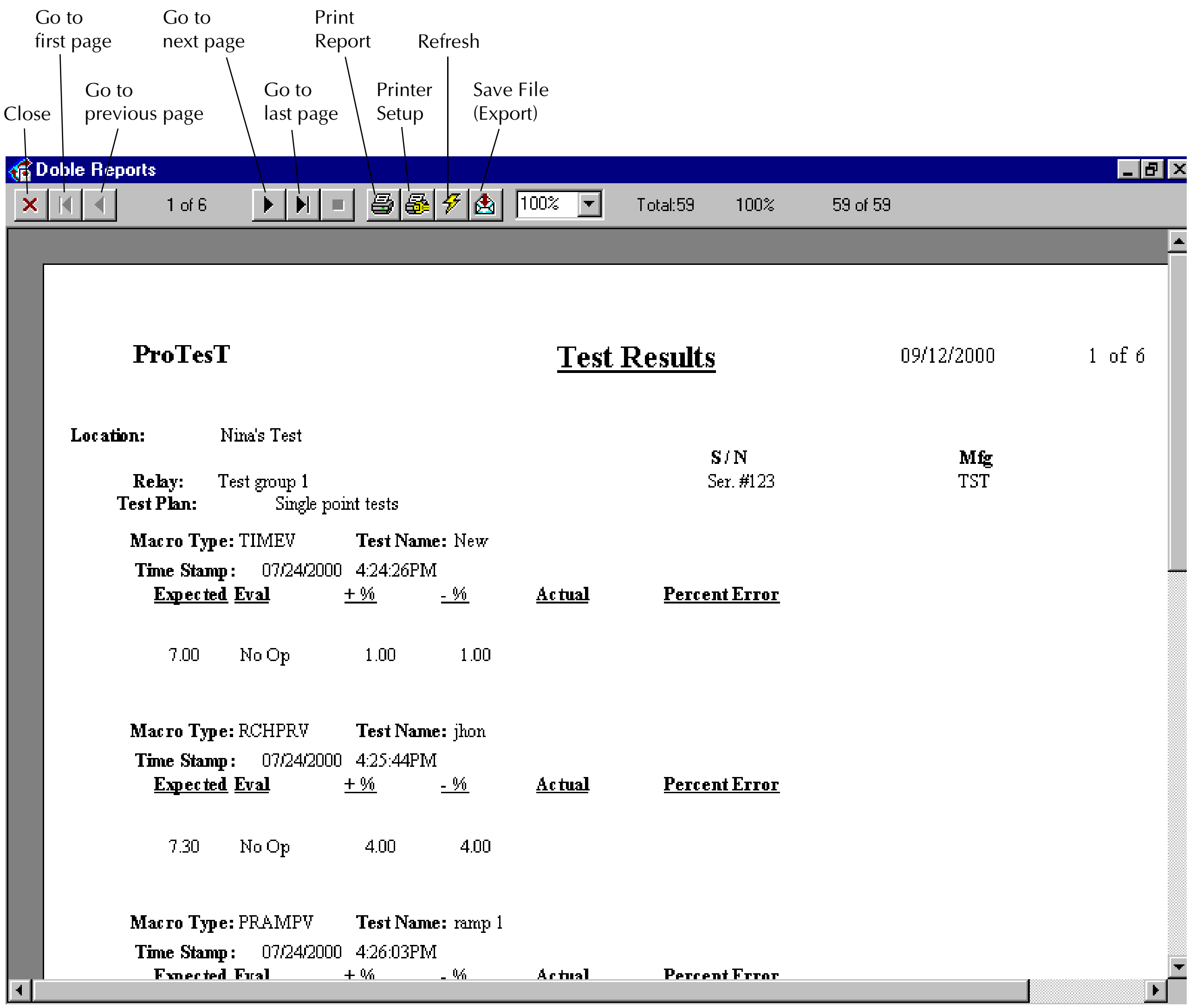


Figure 3.18 Report Document: On-Screen Preview

For the best view of the report, select full screen and *Page Width* magnification.

NOTE

When previewing a document on the screen, the scroll bar and Page Down/Page Up buttons access only the current page.

Click the **Page Forward** button in the toolbar at the top of the preview display to turn the page.

- A black Page button indicates more pages exist.
- A gray Page button indicates no more pages exist.

Use the **Last Page** button to go to the last page. Similar control buttons go to the previous page and first page of the report.

To select a printer, single-click the **Printer Setup** icon in the reports toolbar.

To save the report as a file:

1. Click the **Save File** icon located on the toolbar.

The Export display appears (Figure 3.19).

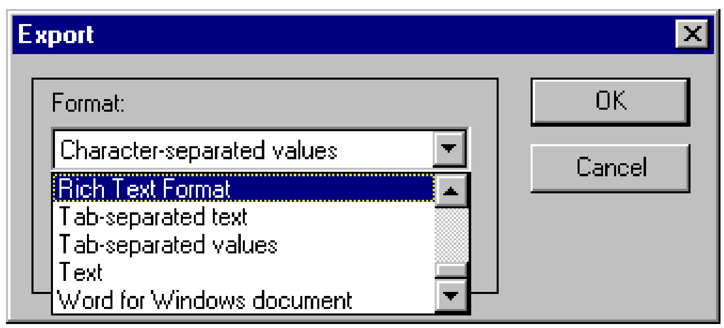


Figure 3.19 Export Drop Down List

2. Select the appropriate file format for the report from the *Format* pick list.

To edit the report in Word, for example, select *Word for Windows document*.

3. Select the location for the saved report from the *Destination* pick list.

4. Click **OK**.

The report is saved in the format and location specified.

Window Menu

Arranges ProTesT windows for viewing, comparing, copying, and pasting Test Plan and test data.

Cascade Arranges all open windows in an overlapping format with the title bars displayed, such as Navigation window and Macro tab.

Tile Arranges all open windows in a tile format with the title bars displayed.

Arrange Icons This function is not implemented.

Help Menu

Click **Help** in the top menu bar to open ProTesT help.

Index Opens the table of contents to online help. Help includes much of the information in this User Guide.

Using Help Provides basic information about how to navigate and use a Windows Help System.

About ProTesT Provides the following information about ProTesT:

- Version number
- Product Code or serial number, which determines what ProTesTPlan Macros are available

NOTE

When looking at a Test, press the F1 key, and Help opens to the test macro, showing how the macro action works.

Toolbar Summary

Toolbar icons are shortcuts to menu bar functions. Place the cursor on an icon to see a tool tip description. Standard Windows icons are used for Open, Save, Cut, Copy, and Paste. When a Macro is in view, the Go Back icon closes the Macro and restores the tree and list view. Table 3.1 explains each icon.

Table 3.1 Toolbar Command Description

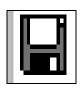
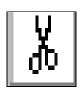
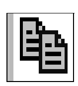
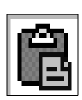
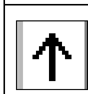
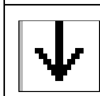
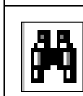
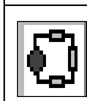
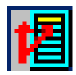
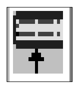
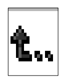
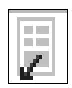
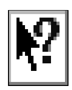
Icon	Command	Description
	Open	Opens a database.
	Save	Saves modified records to the open database.
	Cut	Cuts information from a Test Plan or a record. Places the information on the clipboard for pasting into another database.
	Copy	Copies information from a Test Plan, or a record for pasting in the open database or to another database.
	Paste	Pastes information to the open database.
	Move Up	Moves the selected record in a list view upwards.
	Move Down	Moves the selected record in a list view downwards.
	Find	Searches for a record by name and type.
	Power System Model	Quick access to the Power System Model when an SSIMUL Macro is open.

Table 3.1 Toolbar Command Description (Continued)

	Vector Calculator	Calculates phase-to-phase values.
	Run	Runs the currently selected Test.
	Go Back	Closes the view of a test macro and return to the navigation view of the database.
	Exit	Exits from ProTesT.
	Help	Opens Help for ProTesT.

4. Creating a Relay Test Plan

This chapter describes how to create a database of relay test plans and introduces ProTesT macros.

Organizing Databases

Since ProTesT starts by opening a database, the first step is to create your own database. Create ProTesT Location folders to identify relays and test plans for specific substations. A Location folder can be used for every substation in a geographic or business unit region or as a library to contain sample relay test plans for common relays found in each substation.

Creating Test Plans

To create a Test Plan for a specific substation using the ProTesT library:

1. Copy an appropriate Test Plan from the library.
2. Paste the plan into a Location folder.
3. Adjust the test parameters to the specific relay settings required.

Keep the following three key issues in mind when creating test plans:

- Create standard test plans.

  Since a standard test sequence runs the same every time under ProTesT, results can be compared exactly.

- Use standard names.

  A standard format for Relay IDs and serial numbers is also important, as well as for substation folders and test names. This makes it possible to do a meaningful database search using **Edit | Find**.

- Create a standard test setup.

  Creating a standard configuration of test equipment makes it possible to have a standard test procedure, using a common set of voltages and currents, with common wye or delta connections to the relay or test panel. This simplifies technician training and run time operation.

Adding Relays

To add relays to a Test Plan:

1. From the menu bar, select **Edit | Append** to add a new Location and open it.

   For a large substation, it may be convenient to add sub-folders to represent terminals. A Location folder can contain either all sub-folders or all Relay records, but not both.

2. Add Relay records, using a meaningful Relay ID, since this can be used later as a search key.

   Serial number, manufacturer abbreviation, and function description are optional.

For the first time ProTesT user, it may be helpful to start by adding only a few relays, especially when adding more complex numerical relays which are more difficult to test manually, or older relays in critical applications requiring coordination tests.

Adding Test Plans

Each Relay record can have more than one Test Plan. Often, only one Test Plan per relay is needed, however it may be useful to have different test procedures for acceptance or commissioning vs. routine calibration.

Consider the following when determining how many test plans to create:

- Test equipment to be used
- The number of voltage and current sources available
- VA power the sources have

Even testing a numeric relay can require high power, if high overcurrent multiples are being used. Therefore, creating separate test plans for different Doble test set configurations may be helpful.

Finding Test Plans

The Doble ProTesT library, provided with the software, contains sample test plans for a large number of relays. Many of these are ready to run, but most require tuning for the specific application. Other resources include instructions from the relay manufacturer and existing company procedures for manual testing.

Since ProTesT macros let the user select voltage and current sources and their values, it is easy to transcribe manual test procedures into an automated macro. Most macros do simple source operations like an A-to-B step test or a linear ramp. If a test can be done manually, a ProTesT macro can be created to obtain the same result. Once the macro is coded, it runs faster and is exactly repeatable.

NOTE

Remember, if a test result from an automated test is a "Fail", manual testing can help determine the cause.

Verifying and Improving Test Plans

After a Test Plan is created, it must be verified to prove that it works as expected. Later, the Test Plan can be improved to make it run in less time or to avoid excessive current load on the relay. Also, macros can be added to obtain more complete time, distance, or differential characteristics, since little extra time is needed using ProTesT.

Managing Test Data

The easiest way to manage data with ProTesT is to treat substation test plans in a database like books in a lending library. An office computer may act as a library, where one or more databases contain test plans and accumulated test results for all substations.

When it is time to test relays, a copy of the database or the substation test plans is borrowed to go to the field. For example, data can be copied from a desktop office computer to a technician's laptop. The laptop is then used to run the tests and add new test results in the same way that a handwritten journal is updated. The borrowed data, augmented with new test results, is returned to the office library.

Copy ProTesT Data

To copy data from one ProTesT database to another:

1. Select one or more records in the open database.
    - A single Location folder or Relay can be selected in the tree view
    - Multiple records can be selected in the list view
2. Click the **Copy** icon on the toolbar, or select **Edit | Copy**, or press **Ctrl+C**.

Paste and Transfer

To create a database to receive the copy:

1. Select **Database | New**.

    Alternatively, open an existing target database. The target should reside on a hard drive or other high capacity drive.

    A dialog box asks whether ProTesT data in the copy clipboard should be saved.
2. Click **Yes** to open the new database.
3. To insert the copied data, click the **Paste** icon on the toolbar, or select **Edit | Paste**, or press **Ctrl+V**.

    The data is then copied to the target database.
4. Use Windows Explorer to transfer the target file to the laptop, via networking, Internet, or high capacity media.

    For a large database, file compression may be desirable for the transfer.

Update and Return

Use the copied data to test relays. Reverse the above procedure (”Paste and Transfer”) to update the master copy in the office. For a large database, it may be necessary to have a database administrator manage the updates.

ProTesT Macros

A ProTesT macro controls Doble voltage and current sources. Each macro type follows a particular algorithm for changing one or more source values, called Action values. The user identifies the sources to use, their amplitude, phase, and frequency, and which values are Action values.

Macro Tables

Each macro consists of tables that define Doble sources, values, and Action parameters. The tables are shown on several tabs beginning with the Test tab (Figure 4.1).

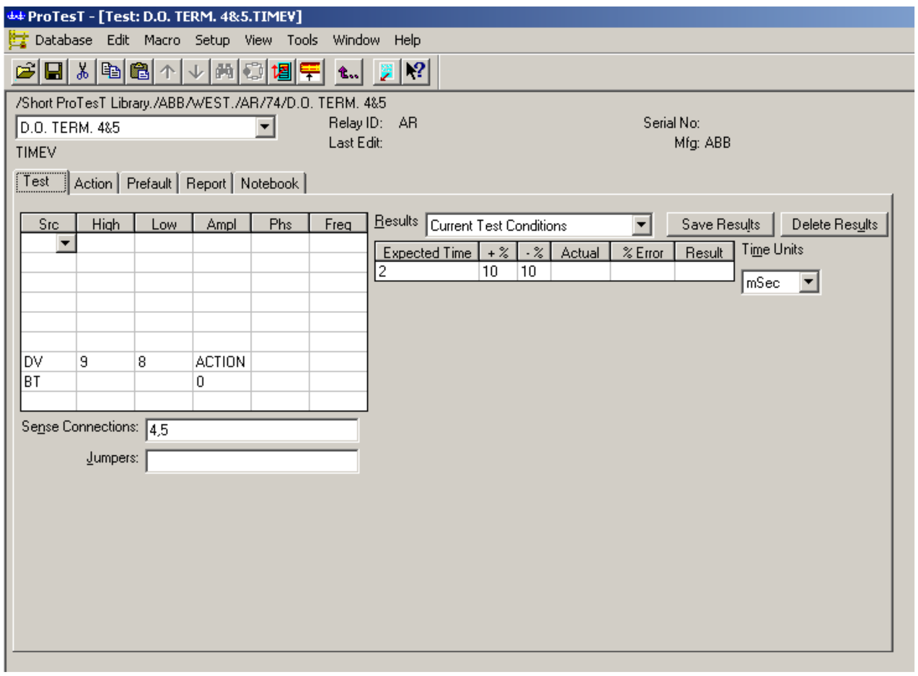


Figure 4.1 Test Tab

Test Tab

To enter data to the Test tab:

1. Select source names in the Src column from the drop-down list or by typing the two-character name.

   Default frequency (Freq), inserted automatically from Setup, can be changed if necessary.

2. Enter amplitude and phase values in the *Ampl* and *Phs* columns.

   At least one source parameter must be labeled “Action”.

   Most macros use only one parameter as Action. For example, one current amplitude or voltage amplitude may be used, but not both, although more than one source can have the same Action parameter.

3. Enter the expected test result and pass/fail tolerance values under Results.

   When a test is opened, the Results field shows Current Conditions. These are the expected result and tolerances and they can be changed. The Results drop-down list shows prior test results, including expected results, % errors, and pass/fail indications. Although these results can be seen in the table entry, they cannot be changed.

4. To set new expected or tolerance values, select **Current Conditions**.

Pass/Fail

If no expected value or tolerance is entered, the test result is recorded simply as “Op” (operate) or “No Op” (no operation). If an expected value is entered, the error is calculated and reported, but the test result is “Op”. Otherwise, pass/fail is determined by applying the tolerances. A one-sided tolerance is indicated by entering only one tolerance value.

The second tab, the Action tab, is shown in Figure 4.2.

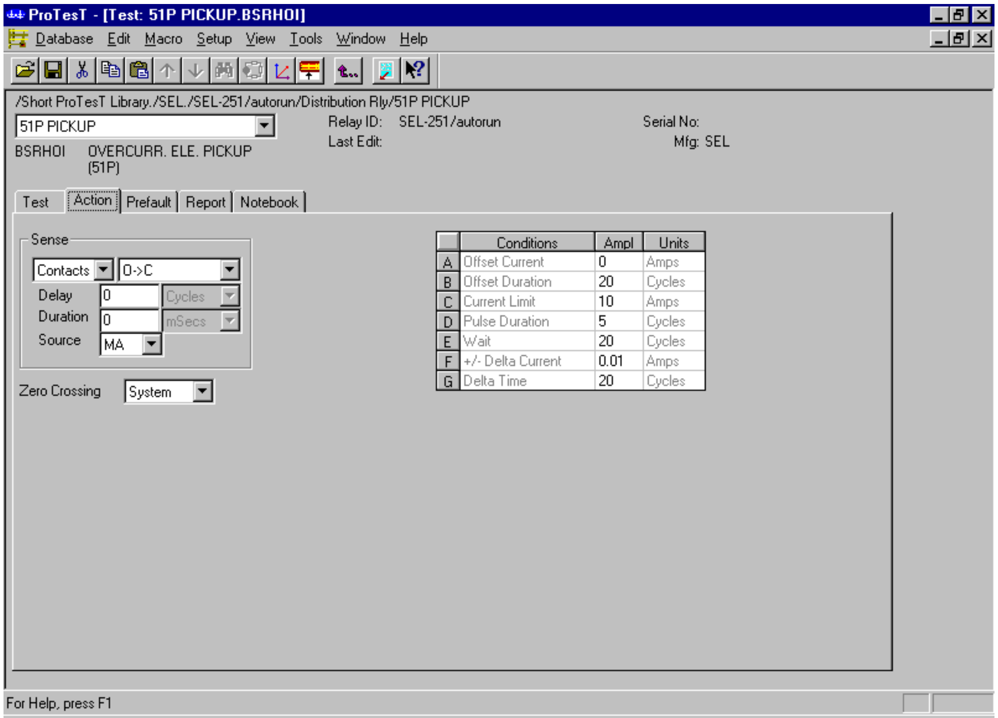


Figure 4.2 Action Tab

Action Tab

The Sense section on the Action tab defines the relay operate signal to the Doble instrument and the Action table supplies parameters for the macro.

1. For Sense, select contacts or voltage as the operate signal and the transition from the drop-down menus.

   As an example, contacts would be open to close (O→C) for pickup, while dropout would be C→O.

2. From the drop-down menu, identify by source name the sense input terminals that are to receive the operate signal.

   The default, “MA” (Master), identifies either the F2000 instrument with the green Master LED lit or Input 1 on the F6000.

   Refer to Chapter 6 ”Sense Input” for details on Sense Delay and Sense Duration.

3. Select zero crossing from the drop-down menu.

   Zero crossing is normally System; that is, Action changes occur when the Doble reference frequency (50 or 60 Hz internal crystal or line synch) has a positive zero crossing.

   Source means that changes occur at the positive zero crossing of each source. Therefore, if a phase offset exists between Action sources with Source zero crossing, they change value in phase delay order rather than at the same time, which is not usually desirable.

4. Fill in the Action table for each macro.

   Refer to the specific descriptions provided in Appendix C ”ProTesT Macro Reference Guide”.

The Prefault tab is shown in Figure 4.3.

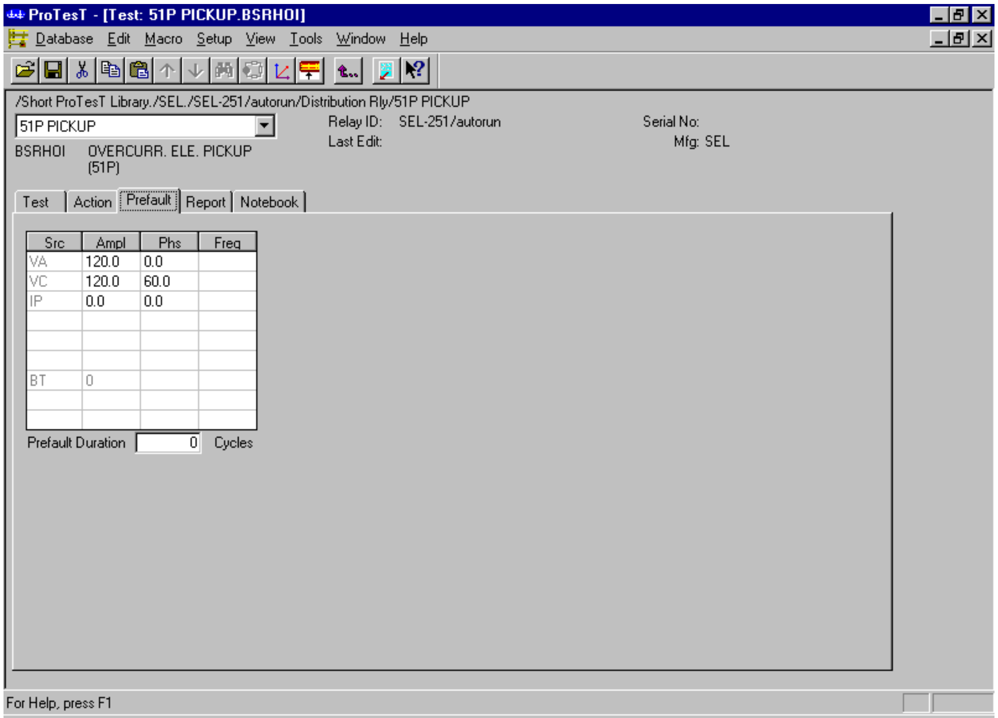


Figure 4.3 Prefault Tab

Prefault Tab

Many macros have a Prefault tab. This allows an initial state of normal voltage and current to be applied to a relay before the Action begins. The sources previously entered to the Test tab are displayed in this tab.

To enter data to the Prefault tab:

1. Modify the amplitude and phase, if necessary.

2. Enter the prefault duration.

The duration should be long enough for the relay to initialize before the fault condition is applied by the Action.

The next tab, the Notebook tab, is displayed in Figure 4.4.

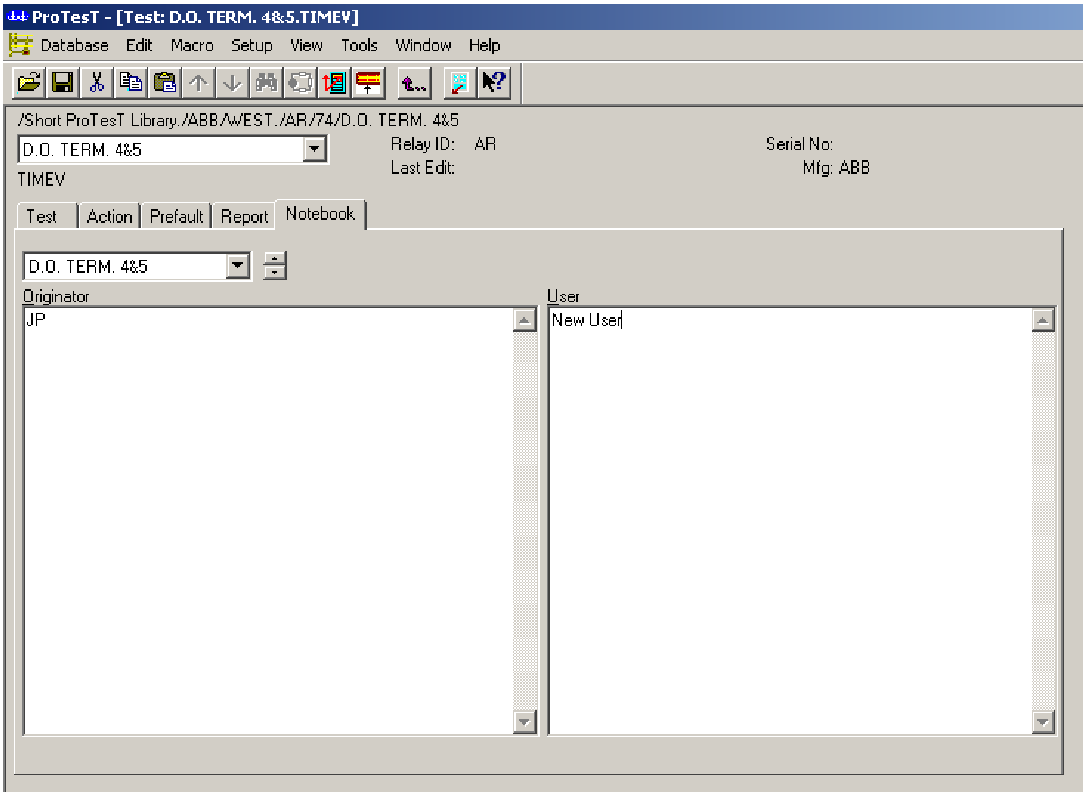


Figure 4.4 Notebook Tab

Notebook Tab

This is a two-column area for free-format text. The columns are labeled *Originator* for notes to guide the tester, and *User* for comments from the tester. For example, Originator notes can indicate when to change test leads while User comments can record the results of visual inspection. A page selection box allows the user to scroll through all the Notebook pages in the Test Plan without losing position in the Test Plan.

NOTE

If notes are present for a macro, a Notebook icon appears on the status bar below the Test tab.

Report Tab

The Report tab presents a print format report of test parameters and notes. A test result can optionally be selected for inclusion in the report.

Selecting a Macro

ProTesT macros perform steady state, dynamic state, or transient tests.

Steady State Test

Most ProTesT macros perform steady state calibration tests, such as those recommended by the relay manufacturer. These automate common manual tests that verify relay settings.

Amplitude and Phase

In a simple test, amplitude and phase for current and voltage are set close to fault values, and the current (Action) may be changed until the relay operates, which stops the test. The Action value, whether amplitude or phase, is stepped by increments and held for the specified number of cycles, just as a tester would do manually from a control panel.

A user-configured ProTesT macro automatically downloads the preset values to the instrument, which executes the Action precisely every time the macro is run. This is both accurate and repeatable. If more than one source is being stepped, all step together, synchronized to a common clock. Typically, the internal instrument crystal is the reference frequency (50 or 60 Hz), but sometimes it is useful to designate line frequency reference (FL), from the wall socket.

Frequency

Entering source frequency as a number implies using the instrument crystal reference in Variable Frequency mode. Any frequency within the capability of the Doble instrument can be entered, such as 59.77 or 1000 Hz, but if different sources are assigned different frequencies, the frequencies must be harmonics of a common base. ProTesT calculates a common base from the numeric values entered and reports an error if no common base exists. Alternatively, base frequency and harmonics can be explicitly entered as: FX (crystal base) and FX*2 (second harmonic), or FL (line frequency) and FL*2.

A frequency Action ramp shifts frequency in a continuous, Hz/sec, manner, rather than in large steps. It is also possible to identify one source to be at instrument base frequency (FX), while another source frequency is Action. In F2000, the FX frequency must be assigned to source 1 (the top source) of the Master instrument, if the other sources have Action frequency.

Macro Name

The macro name is a mnemonic that identifies the Action algorithm and the source parameter used. For example, LRAMPI is a linear ramp of current amplitude; LRAMPV is a ramp of voltage amplitude; and LRAMPF is a ramp of frequency. PHROTV and PHROTI rotate (ramp) phase.

Dynamic State Test

The SSIMUL macro performs a dynamic test. Amplitude and phase of voltage and current sources are changed simultaneously in a sequence of sine wave values that approximate a fault condition. Unlike a steady state macro, which stops as soon as the relay operates, the SSIMUL state playback continues to the end. When it is over, ProTesT checks timer values to determine whether relay operation occurred.

The advantage of dynamic testing is that it presents a realistic fault to a relay, and the test can do more than verify set points of individual relay elements. A fault can be applied to a single relay or to a larger protection scheme. The source values used are derived from fault studies for the relaying point, and these can be used to test reclosing actions, blocking schemes, and the effect of evolving faults.

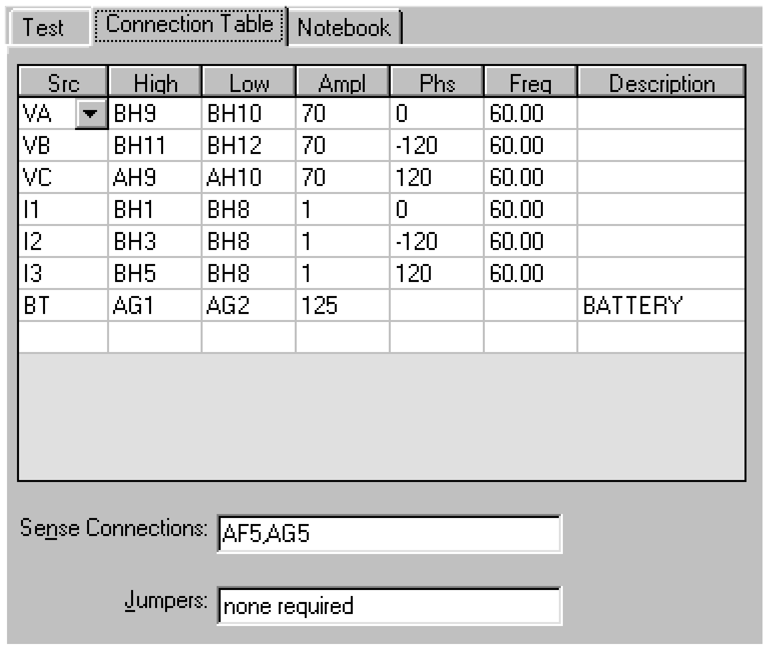
Transient Test

Like SSIMUL, the TRANS macro plays a realistic fault through Doble sources, but unlike SSIMUL, TRANS plays point-by-point transient waveforms.

The TRANS macro allows the user to import waveform data from industry standard COMTRADE files, select channels and a time frame of interest, and save these for playback with ProTesT. For F2000 instruments, digital source names are any valid source name with an L1 or L2 suffix, such as VAL1, VBL2, or I2L2. For F6150 instruments, digital source names are any valid source name with an L1 suffix, such as VAL1, VBL1, or I2L1. As with SSIMUL, timers can be set up to record relay response. TRANS is particularly useful for testing the effect of dc offset, harmonic content, and l/r delay in a fault.

Constructing A Test Plan

Opening a ProTesT Test Plan displays a list of macros on a Test tab, along with two other tabs: Connection Table and Notebook. The Connection Table tab is displayed in Figure 4.5.



Src	High	Low	Ampl	Phs	Freq	Description
VA	BH9	BH10	70	0	60.00	
VB	BH11	BH12	70	-120	60.00	
VC	AH9	AH10	70	120	60.00	
I1	BH1	BH8	1	0	60.00	
I2	BH3	BH8	1	-120	60.00	
I3	BH5	BH8	1	120	60.00	
BT	AG1	AG2	125			BATTERY

Figure 4.5 Connection Table tab

Connection Table

To fill in the Connection Table for identifying the Doble sources and default values to be used in individual tests:

- Enter source names, normal amplitude and phase, and the initial relay terminals to which the source leads are to be connected. Source names and values entered in the Connection Table are automatically filled in whenever a new test is added to the Test Plan. Values in the new test can then be modified as needed, and sources added or removed.

The discipline of creating a Connection Table can lead to designing a better test procedure by focusing attention on the use of source connections in a way that minimizes the number of lead changes during the Test Plan. The number of sources available, and the order in which tests are executed, can often be configured to simplify wiring changes during the Test Plan.

Changing leads can be the source of operator error, particularly if tests are re-run or run out of order. Lead changes take time away from running tests. Where possible, it is best to set up all source connections and sense leads one time at the beginning. Manual setups take more time and are more error prone; running ProTesT is the easy part.

Notebook

The Test Plan and each test macro have a Notebook tab (similar to Figure 4.4 on page 4-10), to record setup instructions, relay settings, and run time observations. Notebook text can be copied and pasted from one Windows application to another using standard Copy/Paste commands.

A NOTEBK macro is a pure Notebook that is often inserted into a Test Plan to advise the operator to change leads or relay settings before the next test can be run. A good Test Plan usually begins with a NOTEBK macro to explain the test procedure that follows.

POWER Macro and BT Source

For a solid state or numerical relay, the Doble battery simulator (source BT) can be controlled by ProTesT to supply dc logic power to the relay. In that case, a POWER macro should be added at the start of the Test Plan. When it is run, BT is turned on to power the relay, and BT remains on continuously while the Test Plan is open. Without the POWER macro, BT would turn on and off with other sources as each test is run. Another POWER macro can be run later in the test sequence if it is necessary to turn off BT for the following test.

Alternatively, it is possible to turn the BT source on manually with a switch on the F2000, or with the Control Panel on the F6000. ProTesT recognizes that BT is on, but will not touch the source. Thus, if BT is turned on manually, BT must be turned off manually.

NOTE

If a test is manually aborted, all sources are turned off for safety. To keep BT on after an abort, open ProTesT Setup on the menu bar, and verify that “Battery Off on Macro Abort” is not checked.

Selecting a Test Macro

For further details on the following macros, refer to the detailed descriptions found in Appendix C ”ProTesT Macro Reference Guide”.

CREEP

The CREEP macro can reproduce the manual minimum pickup test. The computer keyboard or mouse is used to step the current up or down. CREEP also allows the user to indicate pickup from the keyboard, which is useful if relay response is only a visual indicator such as a target drop. Although this is a manual test, source setup is automatic and the result is recorded in the ProTesT database.

CREEP action can be applied to current (CREEPI), voltage (CREEPV), and frequency (CREEPF).

GO/NOGO

GO/NOGO is a simple A-to-B test. For pickup, GONGOI sets current amplitude to an initial value (A) and after the offset duration, the test value (B) is applied and held for a maximum on time. As soon as the relay operates, the test ends and sources turn off, as is true for all steady state macros.

Expected Value

Steady state macros have expected values to determine Pass/Fail. Although this is optional, a good test record normally requires it. For GONGOI, as the name implies, the result is either Operate (Op) or No Operation (No Op).

GO/NOGO action can be applied to current (GONGOI), voltage (GONGOV), and frequency (GONGOF). Go/NoGo for phase is a phase shift, done with PHSFTI and PHSFTV.

Time Test

A time test, like TIMEI, is an A-to-B test that adds a timer to record operating time. In this case, expected value is an operate time, whether the Action parameter is current (TIMEI), voltage (TIMEV), phase (TIMEPH), or frequency (TIMEF). TOCPLT (Time Overcurrent Plot) runs a sequence of time tests at specified multiples of tap, which can be displayed as a time curve. There are similar time plot tests for voltage, phase, and frequency.

Linear Ramp

Linear ramp of current or voltage amplitude is one of the most common test methods. For example, LRAMPI can be used to test minimum pickup of a definite time relay, such as a winding on an HU or STD differential relay. However, LRAMPI is not the best option for a variable time relay, such as with inductive disk overcurrent. The INDPUI macro is better suited for this situation. However, linear ramp is simple, and everything important about all other macros can be learned from using the linear ramp.

Linear Ramp Algorithm

LRAMPI begins at an offset (A) and ramps toward a limit (E), as shown in Figure 4.6 on page 4-17. The amplitude proceeds in a series of steps, incrementing by a fixed delta value (C), and waiting a delta time (D) to allow the relay to pick up at that value. As soon as pickup is sensed, the macro stops and the amplitude is recorded. If no pickup occurs after the limit is reached, the macro ends with a No Op.

Figure 4.6 shows the ramp starting at a low value and ramping to a higher limit, however LRAMPI can start at a high offset and ramp down toward a lower limit as in a dropout test or in the related macro LRAMPV, for an undervoltage test. The offset or offset duration can be 0.

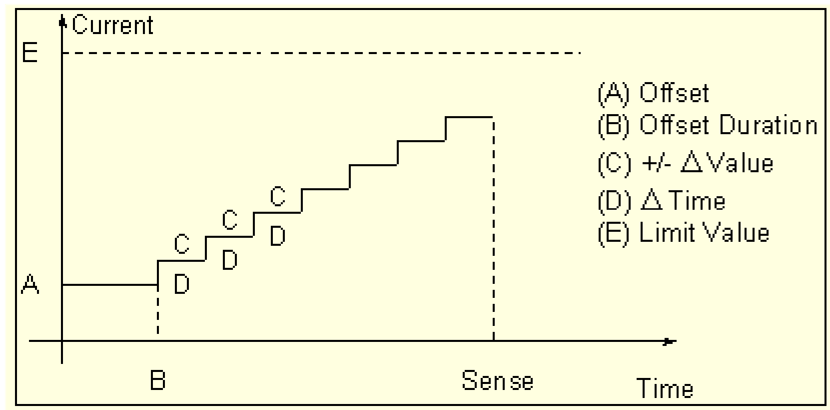


Figure 4.6 Linear Ramp Staircase Algorithm

LRAMPI Rules

LRAMPI rules are listed below. Refer to Figure 4.7.

1. The largest current, whether limit (E) or offset (A), determines the range of the Doble current source.

This limit must be higher than the expected operate value, but low enough to select the lowest current range that can make the relay operate. This ensures that the maximum source power is applied. Otherwise, the source compliance voltage may not be able to drive the load, causing a “Source Error” that shuts down the test. This is especially true for high burden electromechanical relays.

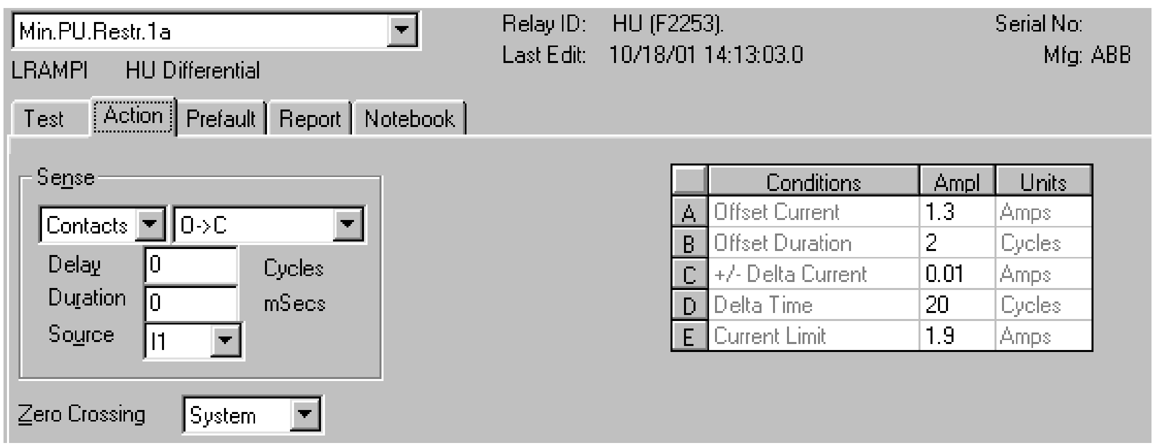


Figure 4.7 LRAMPI Action Parameters

2. In a pickup test, make the Offset Current close to the expected value.

   This makes the test run faster and avoids applying high current to the relay longer than necessary.

3. The delta current (C) should be a meaningful value, perhaps 10% of the tolerance.

   If the expected = 1.5, and the pass/fail tolerance is 10% or 0.15 amp, a delta current of 0.01 or 0.02 is good. Although the source allows milliamp resolution, it may not be useful.

   If the delta current is too large, the result may easily exceed the pass/fail tolerance, even if the relay is working fine.

4. The delta time (D) must be long enough for the relay to notice.

   Numeric relays respond very quickly to input changes, but electromechanical relays take longer. If the delta time is too short, the ramp races ahead of the relay's ability to respond, and the recorded pickup amplitude is too large (or too small).

   A good approach when first designing a test is to make the delta time long enough for the tester to see the relay start to respond at each step (if a response can be seen), similar to running a manual test. Then shorten the delta time until relay response becomes erratic. A good starting delta time is often 10 cycles.

5. Near the pickup point, relays have an inverse operating time.

   Since the relays may or may not respond, the delta time should be much longer than the nominal relay operate time.

Inductive Pickup

To test inductive disk overcurrent relays, INDPUI is a better choice than LRAMPI. INDPUI begins by applying a multiple of tap to make the relay operate right away. Then, a linear ramp begins just above the tap value and steps downward until the relay drops out. A second ramp turns back upward looking for pickup. This algorithm is similar to a common form of manual test. The dropout and pickup values are recorded, and the average taken as the result. The rules for linear ramp (See page 4-18) apply here also. Refer to Appendix C ”ProTesT Macro Reference Guide” for further details.

INDPUI Rules

1. To make the relay operate initially, make the initial amplitude as small as possible.

   This minimizes the impact when the induction disk swings around to make contact. At a high multiple, the impact is large and there is a lot of contact bounce. The macro may interpret the bounce as pickup-dropout-pickup before the downward ramp has barely moved.

2. On long time constant relays, a high multiple may be necessary for initial pickup.

   To compensate for contact bounce, use Sense Duration as a filter. Refer to Chapter 5, Sense Input for details on Sense Duration and Sense Delay.

3. The primary cause of sense instability in INDPUI is contact bounce, for which Sense Duration is the best filter.

   It may also be useful, however, to apply Sense Delay. Whenever source amplitude is set or changed, Sense Delay causes the Doble sense input to shut off momentarily. This is useful when high initial current is applied because it sets a minimum time initial current and a minimum time the initial ramp step is held, thus allowing the induction disk to stabilize.

Pulsed Ramp and Double Ramp

Variations on linear ramp are pulsed ramp (PRAMPI, PRAMPV) and double ramp (DRAMPI, DRAMPV). There is also a frequency double ramp (FRDRMP).

Pulsed Ramp

Pulsed ramp is the same as linear ramp, except that between each ramp step, the amplitude returns to the offset. This is useful when testing at high current to allow the relay to cool off between pulses.

Double Ramp

Double ramp consists of a ramp to pickup followed by a ramp to dropout. The offset can, however, be held as long as desired before the ramp begins.

Binary Search

Binary search combines a high-low pulsed search with a linear or pulse ramp at the end. It is a fast and accurate test method that cannot be duplicated by manual testing. In most cases, if linear ramp or pulsed ramp work, binary search works also with the following added advantages:

- Using pulses, current load on the relay is minimized.
- Regardless of offset and limit, binary search quickly finds the pickup if it is in the search range.
- If the desired result is No Op, binary search takes only 2 pulses to determine No Op: one pulse at the midrange, and one at the limit.

  If the relay does not operate at the limit, the test is over.
- There is audible feedback that the test is working.

  Beeps indicate that test pulses are causing a pickup. Lack of audible feedback may indicate that the test setup is incorrect.

NOTE

For binary search to work, the relay must reset between test pulses that cause it to operate. For example, breaker fail detection might have to be disabled.

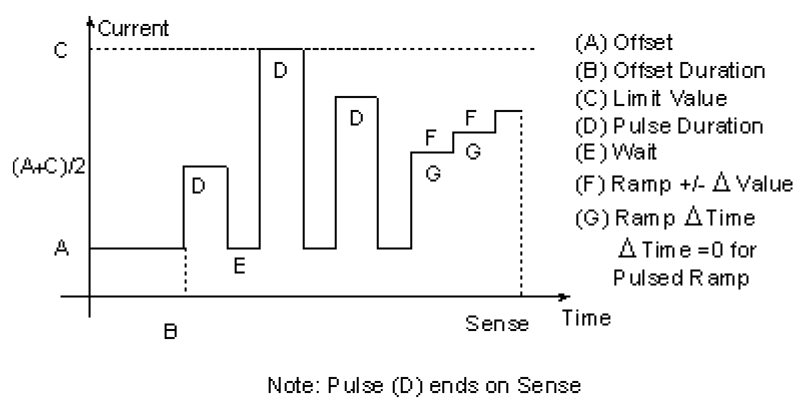


Figure 4.8 Binary Search Algorithm

Binary Search Algorithm

Like pulsed ramp and linear ramp, binary search uses an offset (A) and a limit (C). Although Figure 4.8 shows the macro searching between a low offset and a high limit, it can start from a high offset and search toward a low limit. For BSRHOI, the offset can be normal load current with the limit higher than the expected pickup.

The search starts halfway between offset and limit. Each test pulse is halfway between the last No Op value and the last operate value (or the limit). When test values differ by less than 3 “clicks” (ramp delta value), the macro switches to a linear or pulse ramp for the actual operate value. Note that if (G) ramp delta time = 0, a pulsed ramp is used, with pulse and wait the same as for the search. For details, refer to the description of BSRHOI in Appendix C ”ProTesT Macro Reference Guide”.

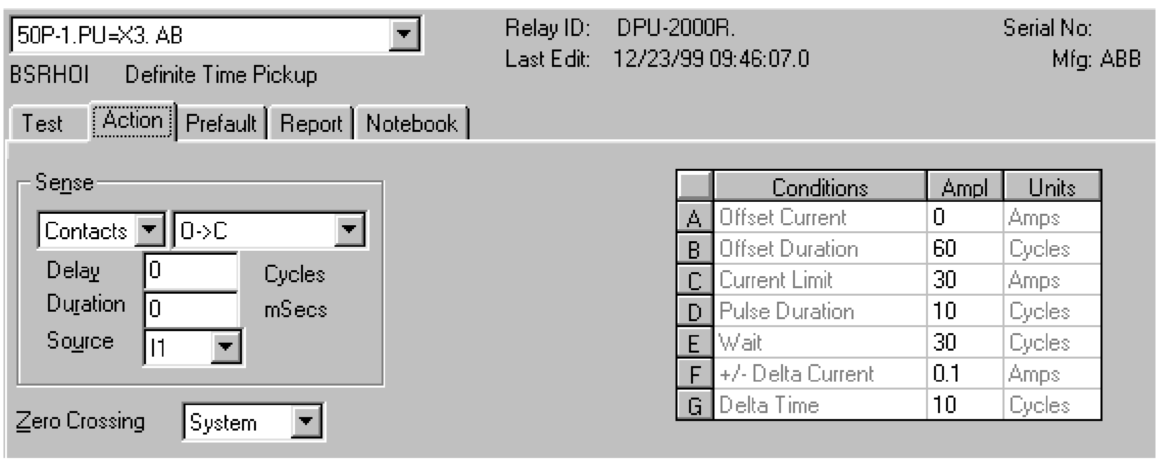


Figure 4.9 BSRHOI Action Parameters

Binary Search Rules

Use the rules for linear ramp listed in page 4-18. In addition, the following rules apply:

1. The offset can affect the result, since the first test pulse is determined by the difference between offset and limit.

   Depending on the algorithm of the relay, the linear or pulse ramp should be used.

2. The wait time must be long enough for the relay to reset or cool down.

3. Related relay elements not being tested may have to be disabled, if the test pulse can cause them to operate and to report incorrect results.

4. If a search finds a pickup point, but the linear ramp at the end fails resulting in No Op, increase the ramp delta value.

   This happens because the ramp takes no more than 15 steps. If the ramp delta value is too small, however, 15 steps may be undetectable to the relay.

   The electromechanical distance relays are also subject to transient overreach when pulsed current is applied, whereas a ramp returns the steady state response. Therefore, Action parameters may require more tuning to produce desirable results.

   To smooth out unwanted response to test pulses, Sense Delay may be required. For more information, refer to Chapter 6, Sense Input.

5. When creating a new test, start with generous values for pulse duration and wait.

   If the test works, try reducing these values until the test no longer returns consistent results. This optimizes the test to run faster.

5. Running a Test

This chapter describes how to set up and run a test.

Test Setup

When a test opens, the Test tab (Figure 5.1) is displayed.

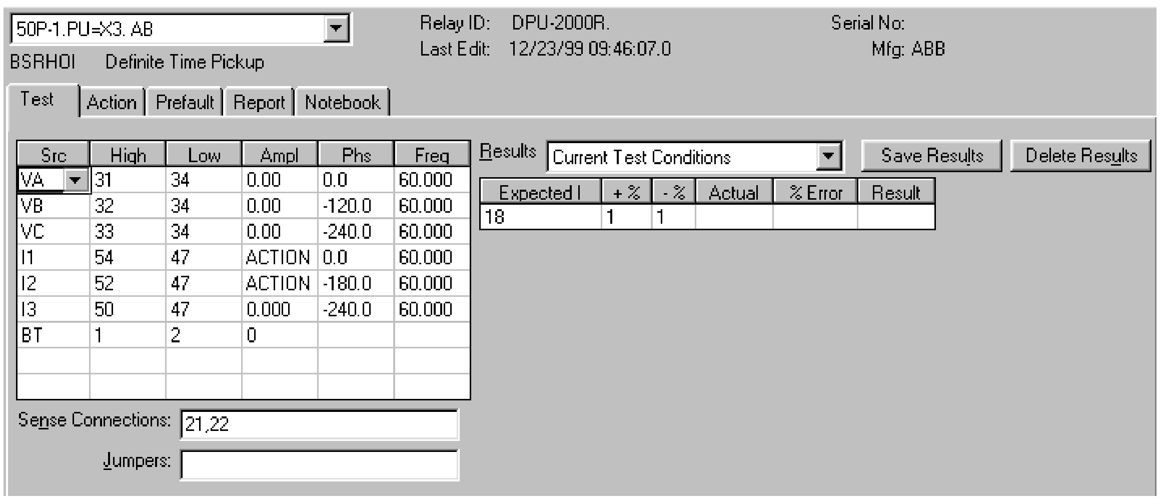


Figure 5.1 Sample Test Tab

Connecting to the Relay

The Test tab documents everything needed to connect Doble sources to the relay.

Source Names

The Test tab identifies the voltage and current sources required to run the test. The tester must configure the Doble instrument sources to match these names. This is because only the tester knows where the source leads are connected, such as which voltage source is “VA” to the relay. By manually naming the Doble sources, the tester determines which source terminals to connect to the relay voltage and current inputs.

Source Connections

The Test tab documents the relay terminals where Doble sources are connected. “High” is used for red polarity and “Low” is used for black ground.

BT Source

If the Doble Battery Simulator is used, only an allowable dc voltage can be selected; Phase and Frequency do not apply. If BT is used in more than one test, insert a POWER Macro to turn BT on and leave it on throughout the test sequence. Otherwise, BT turns on and off with each test, forcing the relay to re-initialize. Note, however, that after POWER runs, its amplitude overrides the BT amplitude in tests that follow.

Sense Connections

Sense Connections, a free-format text window that holds up to 25 characters, is used to document where the sense leads connect at the relay.

Jumpers

Like Sense Connections, Jumpers is a 25 character free-format text field that can be used to note any relay jumpers that must be inserted.

Notebook Tab

Further instructions can be documented on the Notebook tab. If notes exist on the Notebook tab, this icon appears on the right side of the ProTesT status bar.

How to Connect Sense Leads

F2000

If the test setup has more than one F2000, it is likely that in a sequence of tests the Action source will move from one F2000 to another, such as from one phase source to another. The Action tab identifies the sensing source, which must be an Action and must be on the Master F2000. The default, “MA”, identifies the Master F2000, whose sense terminals are armed to respond to relay pickup. If a sense source like “I1” is assigned, ProTesT ensures that the F2000 containing “I1” is the Master, and its sense terminals are armed.

If only one output relay contact is used, to eliminate the need to switch sense leads when the Master changes, connect all F2000 sense terminals in parallel, with only one set of sense leads connected to the relay. When the test is run, ProTesT arms only one sense input and the others remain idle.

F6000

The Action tab sense source “MA” identifies Input 1 on the front panel; otherwise, the input corresponding to the designated sense source is used.

Run a Test

When setup is complete, the test can be run. To run the test:

- Click the **Run** button on the toolbar, press **F12**, or select **Macro | Run** from the menu bar.

A test can be run from the test view or from the list view.

Steady state macros execute the following sequence of steps described below:

- Connect to Doble instrument
- Verify Test parameters
- Indicate a Test is in progress
- Check Sense
- Action algorithm proceeds

Connect to the Doble Instrument

ProTesT attempts to communicate to the Doble instrument using the connection properties defined in Setup. If there is a problem, a read failure or communication error is reported. This occurs, for example, if there is not an instrument connected or the wrong COMM port is specified.

Verify Test Parameters

ProTesT verifies that all specified test sources are present and that no duplicate source names exist. Also, ProTesT verifies that source capabilities can supply the required test values. Any error stops the test.

Test in Progress

A Test in Progress window appears, and initial values for amplitude, phase, and frequency are set. If a Prefault is specified, those values are set. Sources turn on and the Offset Duration begins.

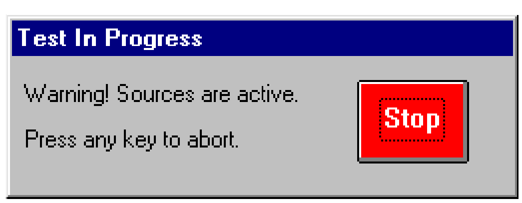


Figure 5.2 Test in Progress Window

Sense Check

At the end of the Offset Duration, ProTesT determines whether sense input, indicating relay operation, has already occurred. If so, the test terminates with a Sense Check error. This can happen in a dropout test, for example, if the Offset Duration is not long enough, or the initial conditions are not severe enough for the relay to pick up. Another cause is incorrect sense settings on the Action tab, such as a setting of O→C instead of C→O. Sense must be clear for the Action to start.

Action

The macro action algorithm proceeds until relay operation is detected. The test value is recorded and time stamped.

Abort

Tests can be aborted manually or automatically.

Manual Abort

To abort a test manually, click **Stop** on the Test in Progress window, or press the spacebar or Enter key. On the F2000, pressing any red key on the front panel aborts the test also.

Automatic Abort

A Sense Check error automatically aborts a test.

A Source Error also aborts a test, except in the following cases.

- In a Binary Search, the search range can include a value that the source is unable to drive into the relay load, while the actual operate point of the relay is much lower value that does not cause a source error. The macro ignores source errors during the search phase, but aborts with a source error if the error persists during the final ramp.
- In multipoint tests, such as time or distance plots, source errors on individual points are merely recorded as “Source” and the test continues with the next point. For example, in TOCPLT, if a high tap multiple causes a source error, other test points may work with no problem.

Autorun

Tests in a Test Plan can be run in a non-stop sequence using Autorun.

1. Select any test on the list view or open a test window.
2. Select **Macro | Autorun** or press **Alt+F12**.

   After the selected test opens, runs, and posts the results to the screen, the next test automatically opens and runs. The sequence continues until either a NOTEBK Macro is encountered, or until the end of the Test Plan. When a NOTEBK Macro is opened, it may advise changing source leads or relay parameters.

   A ProTesT dialog asks the user whether to continue the Autorun or to cancel.

If a test is manually aborted or if an error occurs, such as a Sense Check, Autorun is terminated.

Autorun Delay

In Setup, there is a field called Autorun Delay. This adds a delay time (seconds) between tests in Autorun to allow the user to view the results of the preceding test or to allow the relay to reset. If a test fails, there may be no point in continuing the Autorun. An Autorun delay of 3 to 5 seconds is recommended.

Multi-run

A block of selected tests in a Test Plan can be run nonstop.

1. Select a test.
   - To select sequential tests, hold the Shift key and use the Down Arrow key or hold the Ctrl key and click the mouse.
   - To select non-contiguous tests, use Ctrl and click the mouse.
2. Click the **Run** icon or press **F12**.

   The selected tests will be run in order, just like with Autorun. If a NOTEBK Macro is included, the sequence pauses, allowing the user to continue or cancel further tests.

New Test Results

New test results are displayed on the Test tab of all steady state macros. SSIMUL and TRANS have separate Results tabs that display automatically when the macro is run. If an expected value and tolerance have been entered, Pass/Fail evaluation is reported.

Table 5.1 Test Result Messages

Summary	Meaning
Pass/Fail	Result lies within ± tolerance range of expected value.
No Op	Relay did not operate. This may be the desired result.
Op	Relay operated, but no tolerance or no expected value was specified.
Source	Source error occurred for one point of multipoint test. Check source connections, use lower current range, or use thicker test leads.

Prior Test Results

When a test is opened, the Test tab shows Current Test Conditions in the Results area. This allows values to be edited.

To see prior results:

1. Click the drop-down Results window and a result list appears in timestamp order with the most recent results first.
2. Select a result, and its values replace the current conditions.

   Expected value and tolerance are saved with the actual test value, to show how pass/fail was determined. Although, these values cannot be edited and the record is sealed, the result values can be copied.
3. Select Current Test Conditions to change values.

NOTE

If expected value and tolerance were not defined when a test was run, ‘they do not appear in the test result, even though Current Test Conditions may now show expected value and tolerance.

There is no reason to compare the test results if the test conditions are changed. If it is necessary to change test conditions, create a new test plan.

6. Sense Input

This chapter describes Sense Assignment and Sense Input Filtering.

Sense Assignment

On the Action tab of a macro, the *Sense* section identifies the Action source whose timer/sense input records relay pickup. The default assignment is *MA. This maps to the* F2000 Master Instrument or Input 1 for the F6000. The Master F2000 provides reference signals for source output, and is identified by the green LED on the Instrument front panel. The Action source must be on the Master F2000.

Use the Sense source name to identify where to connect the sense leads. ProTesT automatically makes that F2000 the Master and arms the sense input. With F6000, ProTesT arms the sense input associated with the source name.

Successive Tests in a Test Plan can specify a different sense source. With F2000, the sense source must be an Action source. If all sense terminals are connected in parallel, sense leads do not have to be changed between tests. This saves time, since switching the Master manually or changing sense lead connections at the instrument during the Test Plan are not necessary.

Sense Input Filtering

The Doble F2000/F6000 Instruments can filter the sense input signal, when acting under ProTesT control. In a time test, however, no filtering is possible, since first strike stops the timer hardware. Not doing so would skew the time value.

There are two kinds of sense input filtering:

- Sense Delay
- Sense Duration

These are two independent filters executed by the Instrument firmware.

Sense Delay

Every time the Action Source changes state, the firmware ignores sense input for N cycles – a user defined number. At every step in the Action, when source amplitude, phase, or frequency changes, the sense input signal is ignored until the user specified Sense Delay interval has expired.

Use Sense Delay for filtering relay transient response to a step change (as in LRAMP) or to an amplitude pulse (as in PRAMP or Binary Search) to suppress transient overreach in a distance relay.

NOTE

Relay transient response may lead the search pulses to converge to an incorrect value. Then during the subsequent ramp, the relay may fail to operate (the ramp takes a maximum of 15 steps, which are typically small). Use Sense Delay to prevent faulty search convergence.

Sense Duration

Whenever a sense signal is detected, a Sense Duration timer is set by the Doble instrument. If the sense signal drops out before the timer has expired, the momentary pickup is ignored. If sense occurs again, the timer is started afresh. Not until the sense signal has persisted for the entire Sense Duration interval is it accepted as a sense.

Use Sense Duration to filter relay sense contact chatter such as the unstable bouncing of an induction disk. Sense Duration is also useful if relay output is unstable near the operation point.

NOTE

Sense Duration is useful for the INDPUI (Inductive Pickup Current) and INDPUV (Inductive Pickup Voltage) Macros, when testing an induction disk relay. Sense output is typically very unstable when the initial amplitude is applied to make the relay operate. A large Sense Duration may be needed to get meaningful results.

Should I Use Sense Delay or Sense Duration?

When developing a test, set Sense Delay and Sense Duration equal to zero at the outset. Adjusting the result of a test macro is not typically good practice; however, to obtain repeatable, stable results that are acceptable, adding Sense Delay or Sense Duration may be appropriate. This is especially true for electromechanical relays, where the purpose of a test is to detect physical deterioration of components. A standardized test that is repeated over a period of years should obtain the same result, within an allowable limit, before adjustment or repair are needed.

Rules for Sense Delay and Sense Duration

Sense filtering is applied to each and every ramp step or pulse duration of a test macro. At the end of every step the filters are reset, and begin anew on the next step of the macro.

1. If either Sense Delay or Sense Duration is used, make the initial settings large to determine whether it has any effect on the result. Taking away 50% of the duration of a ramp step or pulse duration for sense filtering is not unusual. Once the effect has been determined, reduce the amount until results become unstable in repeated tests.
2. Do not use too much filtering or no sense result will be detected. ProTesT issues a warning in this case. F2000 Instruments require a window of at least two cycles to reliably detect a sense event. To be safe, leave at least two or three cycles of ramp step or pulse duration free from sense filtering.
3. Both Sense Delay and Sense Duration can be used together. Therefore, the combined length of Sense Delay and Sense Duration must be less than the pulse or step duration of the macro. Otherwise, no sense will be detected.

Appendix A. ProTesT Error Messages

Appendix A defines the error messages that can occur during ProTesT operations. Some ProtTesT software errors (e.g., Invalid Password) are considered self-explanatory and do not appear here. Obscure errors and those that relate to running a test are documented here.

For F2000 Instruments, refer to the F2000 Troubleshooting Guide in the *F2000 Instruction Manual*, for F2000 Instrument error codes displayed on the front panel, or to the *F2250 User's Guide* Error Message section. For F6000 Instruments, refer to the Troubleshooting Guide in Chapter 6 of the *F6000 User Guide*.

ProTesT Run Time Errors

When a macro is run or on exit from a macro screen, Test and Action values are verified for consistency and accuracy. Messages are preceded by the word *Error*.

Missing Data	Required data field is missing. Selection moves to highlight field in error.
Source xx Appears More Than Once	Source name xx appears more than once on the Test screen. Change or delete the source name.
Invalid Action Source xx, Must be (Current/Voltage)	Attempt to label a source Action that is incompatible with the macro; e.g., designating current amplitude Action in LRAMPV Macro. Only voltage amplitude can be Action.
Incompatible Action	Attempt to specify Action for a parameter not compatible with the macro; e.g., making phase Action in LRAMPI or LRAMPV.
Action Not Defined	No Action source parameter has been specified.
Preset Not Defined	PLOTII,PLOTVV: One amplitude must be labeled Preset, another Action.

Phase must be Action	ZPX/ZPL Macros: Action amplitude must have accompanying phase Action.
Sense Source is not an Action	Action tab sense assignment specifies a source name that is not an Action.

Macro Execution Errors

When a macro is run, ProTesT sends a Request Configuration message to the test instrument and starts a timer. If there is no reply before the timer runs out, an error message appears.

From the test instrument configuration, ProTesT verifies that the source names required by the macro are available and are uniquely defined. Then a burst of commands representing the entire test sequence is downloaded to the test instrument.

The following errors may occur:

Communication Error, Com n	No reply came to the initial Request Configuration message; the com port is identified. Make sure the right com port is selected in ProTesT Setup, check RS-232C cable connection, and make sure that Setup baud rate and parity match Instrument setting. Be sure cable is a straight through connection, with no null modem crossover. Refer to possible F2000 Error Codes listed in the following section to clarify the cause.
Missing Source: xx	The macro uses a source name that does not appear in the test instrument.
Multiple Sources with Same Name: xx	Source names must be uniquely identified, so that ProTesT knows which VA, for example, to address. When instruments are powered up, they default to the same source names; e.g., VA and I1. Be sure unused sources are given different source names.

Test aborted by user	This message appears a test is aborted by pressing a key on the computer keyboard, or by pressing a red rocker switch on the front panel of the F2000.
F2000 Setup Error Source: xx (nnnn)	Source sending error is identified and the code number identifies the DobleCol command that caused the error. If contacting Doble, please report the code.
Action Source is not the Master: xx	Unless a source name is selected on the Action tab as Sense, ProTesT assumes that the active Timer Sense is the Master Instrument. At least one Action source must be on the Master. To avoid this error, enter a source Sense name on the Action tab, or manually switch the Master at the F2000 front panel.
Sense Check Detected	After Action Offset, ProTesT verifies that the relay has not already operated before macro continues; pickup at offset invalidates the test result. Sense check aborts the test. Change the test parameters or relay connections as needed.
Source Error xx	A test instrument source error has occurred. Verify by turning the sources on manually. Adjust source amplitudes to meet the relay burden.
No Relay Operation	INDPU Macro: At initial amplitude, the relay is supposed to trip, before the macro continues with ramp to drop out and pick up again. An error is reported if a relay does not operate at initial current. This is different from Noop.
ProTesT Option Missing	An F2000 Instrument does not have the F2910 ProTesT option installed. Call Doble Engineering.
Source Amplitude too high: IP	When using IP or F2000, maximum amplitude is 26 amps times the number of IP sources, up to 65 amps.

F2000 Front Panel Diagnostic Codes

When the F2000 Instrument firmware detects a serious problem, all instruments halt and display a diagnostic code on the front panel. In most cases, one instrument has detected a problem and halts; the *keep-alive* signal on the synch bus drops out and remaining Instruments in the network halt in sympathy, displaying *SY nEt Err* in Source 1 phase and amplitude displays.

Find the instrument that does not display *SY nEt Err* – the SY code reveals the cause of the crash. The *At* code that appears below it is a memory address that is not particularly helpful for diagnosis.

The following error codes are grouped by number, class, and function.

Internal F2000 Errors

If any of these occur, call Doble. Be prepared to report the instrument configuration and ROM revision numbers.

0001	WATCHDOG TIMEOUT ERROR
10XX	VRTX ERROR (VRTXR is the firmware executive in F2000 ROM.)
2004	TIMER NOT RUNNING.
3000	RAM TEST ERROR IN 16K LOW RAM SPACE
3001	RAM TEST ERROR IN 64K CONTIGUOUS RAM SPACE
3002	RAM TEST ERROR IN SOURCE 2 WAVEFORM RAM
3003	RAM TEST ERROR IN SOURCE 1 WAVEFORM RAM

Computer Communication Errors

The following errors occur most often because baud rate and parity are set incorrectly on the Setup menu. The PROTEST.INI file contains baud rate and parity settings for ProTesT; the default, if not explicitly set, is

BAUD = 9600 (F2000)

Use the DIP switches on the CPU board to change F2000 baud rate (Table A.1). (Refer to the F2000 DobleCoL Manual, p. 1-2.) Baud rate and parity affect only the instrument connected to the computer, however, Doble recommends setting all instruments to the same baud rate and parity.

Table A.1 SW 3 Switch Positions and Baud Rates

Baud Rate	SW3 - Switch 1	SW3 - Switch 2	SW3 - Switch 3	SW3 - Switch 4
300	On	On	Off	On
1200	On	Off	Off	On
2400	On	On	On	Off
4800	Off	On	On	Off
9600	Off	Off	On	Off
19.2k	On	On	Off	Off

The factory setting is BAUD = 9600.

The following errors are related to communications via the RS-232 serial port:

4001	RS-232 TRANSMITTER NOT READY
4002	RS-232 RECEIVER NOT READY
4003	RS-232 RECEIVE BUFFER OVERFLOW
4004	RS-232 TRANSMIT BUFFER OVERFLOW
4010	RS-232 OVERRUN ERROR
4020	RS-232 PARITY ERROR
4030	RS-232 OVERRUN ERROR AND PARITY ERROR
4040	RS-232 FRAMING ERROR
4050	RS-232 FRAMING ERROR AND OVERRUN ERROR
4060	RS-232 FRAMING ERROR AND PARITY ERROR
4070	RS-232 FRAMING ERROR, OVERRUN ERROR, AND PARITY ERROR

The following errors are related to communications with the satellite interface board.

4101	STG RS-232 TRANSMITTER NOT READY
4102	STG RS-232 RECEIVER NOT READY
4103	STG RS-232 RECEIVE BUFFER OVERFLOW
4104	STG RS-232 TRANSMIT BUFFER OVERFLOW
4110	STG RS-232 OVERRUN ERROR
4120	STG RS-232 PARITY ERROR
4130	STG RS-232 OVERRUN ERROR AND PARITY ERROR
4140	STG RS-232 FRAMING ERROR
4150	STG RS-232 FRAMING ERROR AND OVERRUN ERROR
4160	STG RS-232 FRAMING ERROR AND PARITY ERROR
4170	STG RS-232 FRAMING ERROR, OVERRUN ERROR, AND PARITY ERROR
D001	RS-232 OUTPUT STATE INACTIVE

Waveform Control Diagnostics

Contact Doble. The last two codes apply to synchronized end-to-end testing via satellite time signal.

5001 FREQUENCY RAMP ERROR

5002 REFERENCE ZERO INTERRUPT ERROR
(NO RAMPS OR DELAYS ACTIVE)

5003 INVALID LOCAL ZERO INTERRUPT FOR SOURCE 1

5004 INVALID LOCAL ZERO INTERRUPT FOR SOURCE 2

500A SATELLITE INTERRUPT ERROR
(NO RAMPS OR DELAYS ACTIVE)

500B NO SATELLITE BOARD DETECTED

IEEE 488 Bus Communication Errors

Make sure all IEEE 488 cable connectors are firmly attached. Contact Doble if a problem persists.

6000 TIMEOUT OF REQUEST TO TALK TIMER

6001 488 ERROR DETECTED

6002 TIMEOUT OF TALK TIMER

6003 TIMEOUT OF LISTEN TIMER

6004 F2000 NOT READY TO TALK OVER 488 NETWORK

6005 TOO MANY DEVICES ON 488 NETWORK

6006 ERROR CHANGING NETWORK ADDRESS

6007 BAD NETWORK ADDRESS

F2000 Network Errors

Verify that IEEE 488 and synch bus cables are properly connected. If the problem persists, contact Doble.

7000 488 SYNC BUS ERROR
Displayed as 'nEt' by the F2000)

GPS Satellite Errors

7002	CLKGEN GATE ARRAY NOT READY FOR CONFIGURATION
7004	IRIG GATE ARRAY NOT READY FOR CONFIGURATION
7005	GPS TIME SEQUENCE ERROR
700B	NO STG BOARD DETECTED
8001	MORE THAN ONE MASTER
8002	MISSING MASTER
8003	INCOMPLETE NETWORK CONFIGURATION TABLE
8004	INHIBIT REFERENCE ERROR (F2000 IS NOT SYNC BUS MASTER)
8005	PHASE LOCK LOOP FAILURE
FFFF	BUS TIMEOUT ERROR (Displayed as 'bUs' by the F2000)

The following occur only when an F2000 Instrument is slaved to a different Doble instrument.

8006	ERROR DETECTING F3S CLOCK SOURCE
8007	ERROR DETECTING F3S
8008	ERROR DETECTING FDF CLOCK SOURCE
8009	ERROR DETECTING FDF
800A	ERROR DETECTING F2

The following are satellite interface errors.

8010	SATELLITE INTERFACE II IRIG ERROR
8040	SATELLITE INTERFACE II 1 PPS TOO HIGH ERROR
8080	SATELLITE INTERFACE II 1 PPS ERROR
9000	ERROR DETECTING F2350 AMPLIFIER

Transient Waveform Board Errors

9001	POWER LOST ON TWG BOARD
9002	SOURCE 1 DRAMC GATE ARRAY NOT READY FOR CONFIGURATION
9003	SOURCE 2 DRAMC GATE ARRAY NOT READY FOR CONFIGURATION
9004	SOURCE 1 WAVEC GATE ARRAY NOT READY FOR CONFIGURATION
9005	SOURCE 2 WAVEC GATE ARRAY NOT READY FOR CONFIGURATION
9006	ERROR CONFIGURING SOURCE 1 DRAMC GATE ARRAY
9007	ERROR CONFIGURING SOURCE 2 DRAMC GATE ARRAY
9008	ERROR CONFIGURING SOURCE 1 WAVEC GATE ARRAY
9009	ERROR CONFIGURING SOURCE 2 WAVEC GATE ARRAY
900A	BOTH WAVEFORM AND TWG BOARD DETECTED
900B	RAM TEST ERROR IN SOURCE 1 TWG DATA RAM
900C	RAM TEST ERROR IN SOURCE 2 TWG DATA RAM
900D	RAM TEST ERROR IN SOURCE 1 TWG CONTROL BITS RAM
900E	RAM TEST ERROR IN SOURCE 2 TWG CONTROL BITS RAM

DobleCol Command and Execution Errors

If these errors occur under ProTesT control, contact Doble.

A000	LOGICAL SWITCH TRANSLATION ERROR
A001	INVALID SWITCH NUMBER
A002	INVALID MESSAGE HEADER
A003	MESSAGE LENGTH IS TOO LONG
A004	MESSAGE ABORT CODES DO NOT MATCH
A005	INVALID MESSAGE HEADER
A007	INVALID SWITCH OPERATION
A008	INVALID SWITCH GROUP
B000	ERROR CHANGING SOURCE TYPE
B00A	SOURCE DESIGNATION ERROR
B00E	INVALID STATE
B00F	ERROR SETTING AMPLIFIER STATE
B010	UNDEFINED COMMAND INTERPRET SEMAPHORE
B011	INVALID TIMER START CONDITION
B100	ERROR SETTING EVENT CONDITION
C000	UNDEFINED COMMAND ERROR
C001	COMMAND OUT OF RANGE ERROR
C002	MESSAGE TYPE ERROR
C003	NULL DATA ERROR
C005	EXTENDED TYPE OUT OF RANGE ERROR
C006	BAD DATA ERROR
C007	NULL ADDRESSER ERROR
C008	NULL ADDRESSEE ERROR
C010	ERROR RUNNING PHASE RAMP TEST
D001	RSK-232 OUTPUT STATE INACTIVE
E001	INVALID DISPLAY NUMBER
E002	INVALID LED NUMBER
E003	INVALID SEVEN SEGMENT DISPLAY GROUP NUMBER
E004	SOURCE NUMBER GREATER THAN THE NUMBER OF SOURCES
E005	HARMONIC = 0 OR GREATER THAN 10

E006	TAP GREATER THAN MAXIMUM
E007	PHASE GREATER THAN 360.0 DEGREES
E008	SOURCE STATUS ERROR
E009	SOURCE TYPE ERROR
E00A	RAMP TYPE ERROR
E00B	FREQUENCY RAMP RATE ERROR
E00C	WAVEFORM CRYSTAL SPEED ERROR
E00D	FREQUENCY ERROR
E00E	EVENT SETTING ERROR
E00F	SYSTEM ERROR
E010	TABLE LOOKUP ERROR

F6000 System Errors

Use Table A.2 to diagnose and correct system errors that occur during operation of the F6000 Instrument.

Table A.2 F6000 System Errors

Name	Explanation
Current monitor (Power supply high amps)	Input line current is too large. The total of all amplifier outputs exceeds system specifications. Reduce the source amplitude or the load. Hardware detects that the instrument is drawing too much current from the wall.
Voltage monitor (Power supply high volts)	Either the AC input line voltage is too high, or power is being fed back into the F6000 through the amplifier outputs.
Open ground detector (Power supply)	Hardware problem that needs to be addressed before it is safe to use the F6000. When the F6000 clears the error, it should occur again if the hardware problem has not been fixed.
Logic Output (Logic I/O)	Hardware detects an overcurrent condition on a logic output. The F6000 software shuts down all amplifiers. The F6000 hardware latches all logic outputs open.
+12 Volt fail monitor (DC power supply)	Hardware disables amplifiers to prevent damage to relays on the amplifier assemblies if output from the DC power supply falls below +5 volts.
High voltage heart beat	Five-second software timeout on lack of communication while hazardous voltages may be present on the front panel terminals. The F6000 software shuts down the amplifiers. Can occur if a communication cable is removed. The PC gets a communication timeout and displays it to the user. The system error is only displayed when communication is re-established.

Table A.2 F6000 System Errors (Continued)

Fan flow monitor error	Fans blocked or inoperative.
Lost pulse per second	Software shuts down the amplifiers because it detects lost external synchronization. This only occurs in an external synchronization mode.
Waveform Under-run	System error in waveform generation and I/O.
Unknown Command	Unknown command.
Source Disabled	One or more sources were disabled by hardware.
Over Temperature or fuse error (I AMP#0) SLOT 5	Current amplifier in slot 5 is overheated or has a blown fuse. Software shuts down the amplifiers if the temperature is too high.
Over Temperature or fuse error (I AMP#1) SLOT 6	Current amplifier in slot 6 is overheated or has a blown fuse. Software shuts down the amplifiers if the temperature is too high.
Over Temperature or fuse error (I AMP#2) SLOT 7	Current amplifier in slot 7 is overheated or has a blown fuse. Software shuts down the amplifiers if the temperature is too high.
Over Temperature or fuse error (V AMP#0) SLOT 8	Voltage amplifier in slot 8 is overheated or has a blown fuse. Software shuts down the amplifiers if the temperature is too high.
Over Temperature or fuse error (V AMP#1) SLOT 9	Voltage amplifier in slot 9 is overheated or has a blown fuse. Software shuts down the amplifiers if the temperature is too high.
Over Temperature or fuse error (V AMP#2) SLOT 10	Voltage amplifier in slot 10 is overheated or has a blown fuse. Software shuts down the amplifiers if the temperature is too high.
Missing analog I/O board	Hardware is missing or not communicating with CPU properly.
Missing digital I/O board	Hardware is missing or not communicating with CPU properly.
Control Panel Mode	Option F6909 is required.
Macro Mode	Option F6910 is required.
No convertible sources	Option F6810 is required.

NOTE

Some system errors cannot be cleared. For example, if the instrument has no analog I/O board, then the error condition remains until the board is supplied.

Appendix B. F6000 Control Panel

Appendix B describes the settings and controls in the F6000 Control Panel. The F6000 Control Panel is a virtual front panel used for manual control of F6000 sources. To open the Control Panel, click **Tools | F6000 Control Panel** in the ProTesT menu bar (Figure B.1).

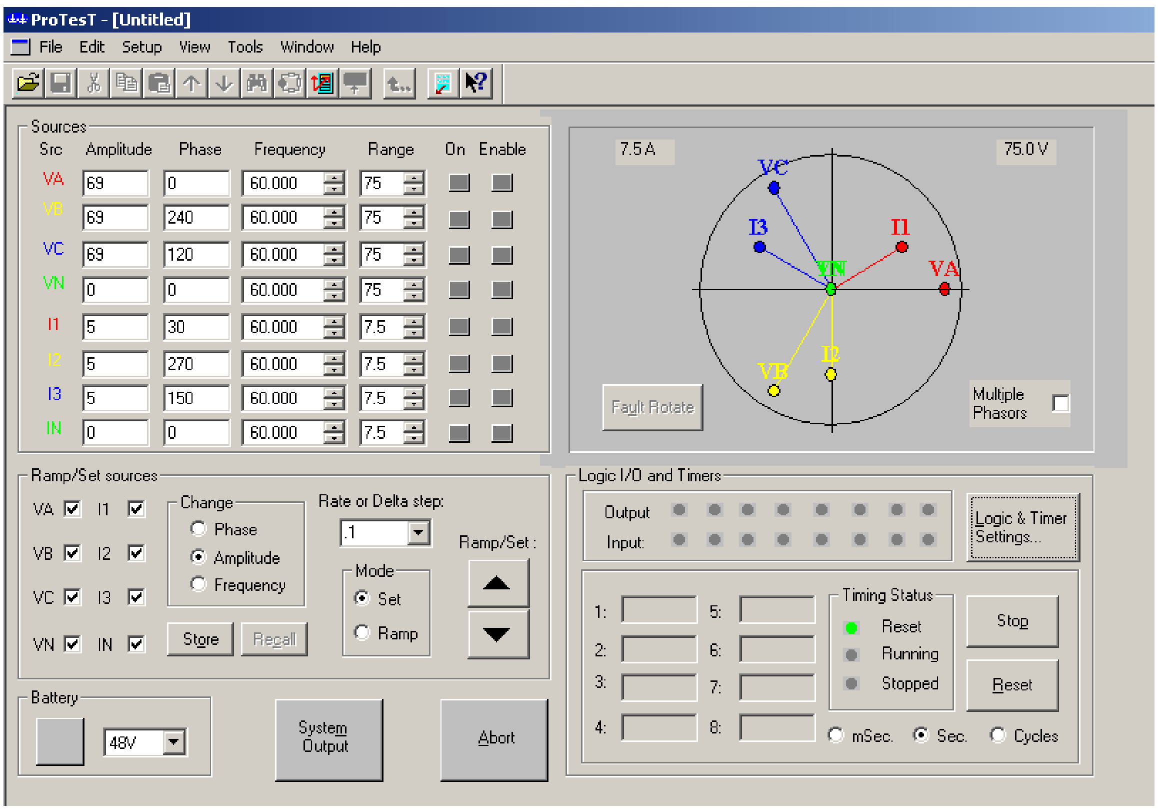


Figure B.1 F6000 Control Panel

NOTE

For computers with screen resolution of 640x480 pixels, disable the toolbar and the status bar from the View menu to display all of the F6000 controls on one screen.

The Control Panel contains eight sections. The functions in these sections control the instrument's source outputs, logic inputs, logic outputs, and timers. A listing of these sections and controls follows:

- Source table
- Ramp/Set sources
- Phasor diagram
- Logic and timer settings button
- Timers
- Logic output and logic input indicators
- Battery simulator
- System Output
- Abort

Source Table

The source table in the upper left-hand portion of the Control Panel contains seven columns (Figure B.2). The column headings are:

- Source
- Amplitude
- Phase
- Frequency
- Range
- On
- Enable

Src	Amplitude	Phase	Frequency	Range	On	Enable
VA	69	0	60.000	75		
VB	69	240	60.000	75		
VC	69	120	60.000	75		
VN	0	0	60.000	75		
I1	5	30	60.000	7.5		
I2	5	270	60.000	7.5		
I3	5	150	60.000	7.5		
IN	0	0	60.000	7.5		

Figure B.2 Source Table

NOTE

If a source error occurs, the alarm is visible in the source table. The name of the source affected changes to ER and blinks. The Amplitude and Phase fields for that source also blink, and an audible alarm sounds from the speakers of the control PC.

The first five columns contain the settings for each source:

Source — The source column in Figure B.2 contains eight entries for eight sources. The default naming scheme for the voltage sources is *VA*, *VB*, *VC*, and *VN*; the default naming scheme for the current sources is *I1*, *I2*, *I3*, and *IN*.

Amplitude — Amplitude indicates the voltage or current value of a source. The range sets the maximum value for the amplitude. If the amplitude entered exceeds the maximum range value, an error message appears. To correct the error, reduce the amplitude or increase the range.

Phase — The phase indicates the phase angle in degrees. Enter a phase angle from –359.9° to 0° to +359.9°.

Frequency — The default system frequency is 50/60 Hz. Use the **Setup** display (Figure 3.3 on page 3-7) to change the default frequency. Use the spinner arrows in the *Frequency* column to select the AC harmonic or to select a DC '+' or a DC '–' range.

Range — The range setting determines the maximum value for the amplitude of a particular source. For maximum compliance voltage, use the lowest current range that can produce the desired test current.

The last two columns in the source table contain On and Enable buttons for each source.

On	Click the **On** button to activate a source. The button turns red, and the System Output button blinks red. Click the **On** button again to turn a source off, the button turns gray. The System Output button stops blinking when all the sources have been turned off.
Enable	Click the **Enable** button to place selected sources in standby status. The Enable button for each source to be activated turns green. When **System Output** is selected, all of the enabled sources turn on. The System Output button turns red, and the On buttons for the individual sources stay gray. Clicking **System Output** again turns the enabled sources off.

The default color for System Output, On, and Enable buttons is gray. Table B.1 summarizes the panel indications associated with all three indicators.

WARNING

The high intensity yellow LED flashes when the battery simulator or any output source is enabled or on to indicate the potential for dangerous or fatal voltages.

Table B.1 Indications for Activated Sources

	Method of Source Activation	
	Click *On*	**Click *Enable*, then click *System Output***
On Button Color	Red	Gray
Enable Button Color	Gray	Green
System Output Color	Blinking Red	Steady Red
Abort Button Color	Red	Red

NOTE

To turn off all active sources during a test, click Abort. Clicking Abort in the Control Panel does not turn off the battery simulator.

Ramp/Set Sources

The *Ramp/Set sources* section (Figure B.3) contains five fields for varying the values in the source table:

- Mode setting: Ramp or Set (default mode)
- Rate or Delta step pick list (or user entered value field)
- Variable to change: Phase, Amplitude (default variable), and Frequency
- Check boxes to designate sources to change
- Up and down control arrows
- Store and Recall buttons

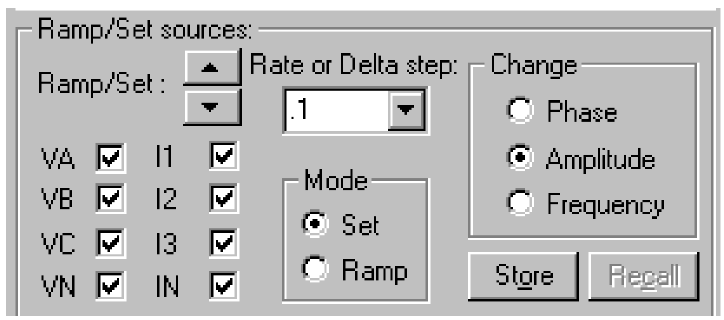


Figure B.3 Ramp/Set Sources Section

NOTE

Use the source table and the *Ramp/Set* section to control the amplitude, phase angle, and frequency of each source during tests.

Sources to Change

The *Ramp/Set* section has eight check boxes, one for each source. To change the selected variable (amplitude, phase angle, or frequency) for a given source, click the checkbox for that source.

NOTE

To avoid altering the values for a source during a test, make sure the checkbox for that source is not selected.

Variable to Change

Under *Change*, select a variable to increase or decrease:

- Click the radio button for Phase to vary the phase angle of the selected sources by clicking either the up or down control arrow.
- Click the radio button for Amplitude to vary the voltage or the current of the selected sources by clicking either the up or down control arrow.
- Click the radio button for Frequency to vary the frequency of the selected sources by clicking either the up or down control arrow.

NOTE

The frequency of the first source in the source table varies independently of the other seven sources. The frequencies of sources 2 through 7 vary together, and are harmonically related to each other.

If VA is the only source checked in the ***Ramp/Set sources*** section, the frequency for VA is the only variable that changes when the up or down arrow is pressed. When VB is the only source checked, however, the frequencies for VB, VC, VN, I1, I2, I3 and IN all change at the same time.

Control Arrows

The up and down arrows to the right of *Ramp/Set* on the Control Panel permit the change of selected source variables. The up arrow increments and the down arrow decrements the selected source variables. The type of change depends on the mode selected (see "Mode and Ramp/Delta Step" on page B-7).

All eight sources in Figure B.3 on page B-5 are checked. When the up arrow is pressed, the sources increase at the rate on step up by the amount specified in the *Rate or Delta Step* field. Amplitude settings cannot increase beyond the limit set in the *Range* column of the source table. The setting stops at the last valid value and remains there.

Mode and Ramp/Delta Step

The settings in the source table can be varied continuously when in *Ramp* mode or in discrete steps when in *Set* mode.

Ramp Mode	Select a value from the pick list or enter the Rate = value/second manually. The selected source variables increment or decrement at this rate when the up or down arrows are respectively clicked.
Set Mode	Select a value from the pick list or enter the Delta step manually. The selected source variables increment or decrement by this amount when the up or down arrows are respectively clicked.

For both the *Ramp* and *Set* modes, the values in the *Rate or Delta step* pick list are 0.1, 1, 10, and 100.

NOTE

In *Ramp* mode, the Rate = value/second.

AutoSensE is a *Ramp* mode feature (see ″Inputs Tab″ on page B-12). The timers are a *Set* mode feature (see ″Timers Tab″ on page B-15 and ″Timers″ on page B-23).

Store and Recall

To save the values displayed in the source table, click **Store** at any time. The source table values can then be altered manually or using step/ramp tests. To reinstate the stored values, click **Recall**.

Phasor Diagram

The **phasor diagram** in the upper right-hand portion of the Control Panel is based on polar coordinates. Each phasor represents the amplitude and phase angle of a source. The distance from the origin to the endpoint of the phasor represents the amplitude of a source. The angle formed by the phasor and the positive half of the horizontal axis represents the phase angle of a source. The phasor in Figure B.4 shows current source I3 with an amplitude of 10 A and a phase angle of 45°.

The **phasor diagram** gives a visual representation of the amplitude and phase values in the source table. The source table and **phasor diagram** interact with each other. Source table values are continuously updated as phasors are dragged to new locations in the diagram using the mouse. The change is not sent to the F6000 Instrument until the phasor is dropped.

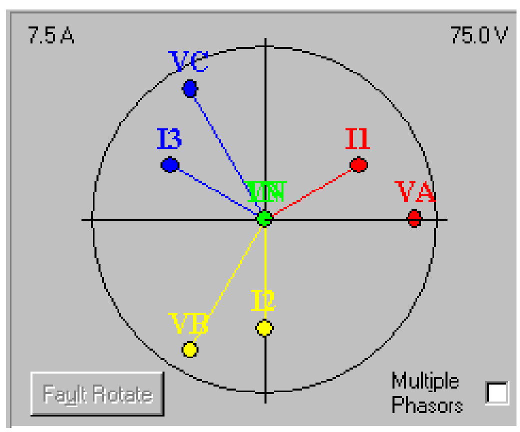


Figure B.4 Phasor Diagram

Range Settings

The upper left-hand corner of the **phasor diagram** contains the highest current setting from the *Range* column of the source table. The upper right-hand corner of the **phasor diagram** contains the highest voltage setting from the *Range* column of the source table.

These settings determine the scale of the **phasor diagram**. For example, if the amplitude for current source I1 is 15 A and the range setting for that source is 15 A, the I1 phasor reaches to the perimeter of the circle in the **phasor diagram**. Similarly, if the potential for voltage source VA is 50 V and the range setting for that source is 75 V, the length of the VA phasor is two-thirds the radius of the circle in the **phasor diagram**.

Fault Rotate

Click **Fault Rotate** to rotate a fault from phase to phase without rewiring the instrument front panel or relay under test.

Fault Rotate works only if the following conditions are met:

- The source configuration must be 3 Voltages and 3 Currents, or 3 Voltages and 1 Current.
- All voltage sources must be on the same range.
- All current sources must be on the same range.

The Fault Rotate button in the phasor diagram is grayed out if one or more of these conditions is not met.

Use a simple A-to-ground fault to try the Fault Rotate procedure. To simulate the fault, the voltage VA drops and the current I1 goes up. For this example, VA = 40 V and I1 = 10 A (Table B.2).

When the fault is rotated, the fault in A goes to B, the settings in phase B go to C, and the settings in C go to A:

A →B

B →C

C →A

When the fault is rotated, VB = 40 V and I2 = 10 A. Rotated again, VC = 40 V and I3 = 10 A (Table B.2). Both the source table and the **phasor** diagram reflect these changes.

Table B.2 Rotation of a Phase-to-Ground Fault

Source	Initial Setup: Fault in Phase A		Fault Rotated to Phase B		Fault Rotated to Phase C	
VA	40 V	0°	69 V	120°	69 V	240°
VB	69 V	240°	40 V	0°	69 V	120°
VC	69 V	120°	69 V	240°	40 V	0°
I1	10 A	330°	0 A	90°	0 A	210°
I2	0 A	210°	10 A	330°	0 A	90°
I3	0 A	90°	0 A	210°	10 A	330°

Multiple Phasors

When *Multiple Phasors* is checked, all the phasors for a set of voltage or current sources can be moved by dragging and dropping any one of them. Each phasor maintains its position relative to the other two. When dragging the phasors, the source table is continuously updated, but the new amplitude and phase angle values are not sent to the F6000 Instrument until the phasor selected is dropped. Figure B.5, Figure B.6, and Figure B.7 show a configuration with three voltage sources and no current sources. The three figures illustrate how the phase angles for VA, VB, and VC change when the phasor for VA is shifted ~45° with *Multiple Phasors* checked.

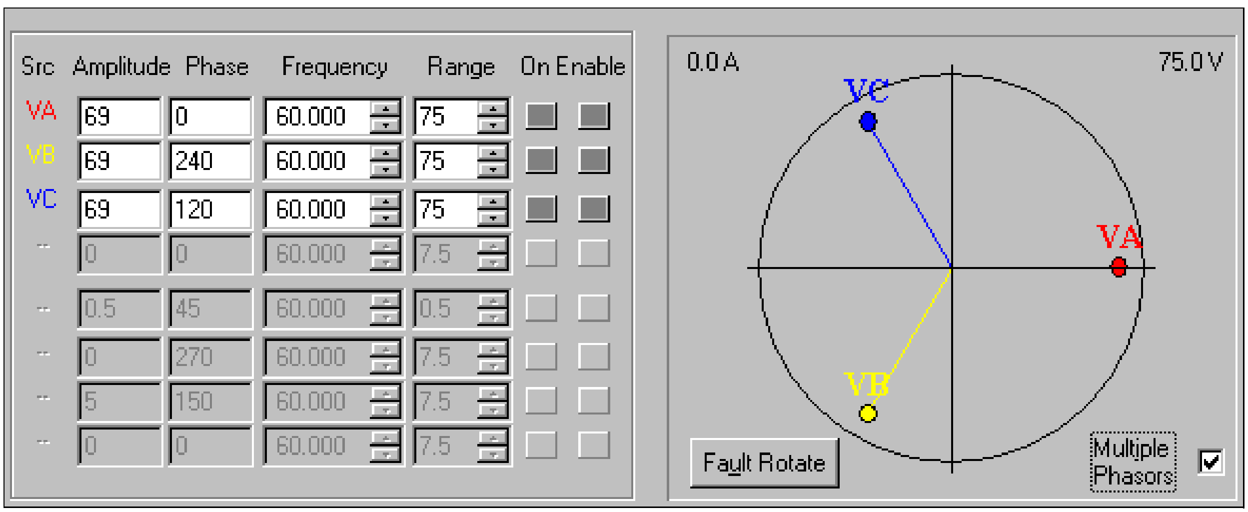


Figure B.5 Phasors for Three Voltage Sources Separated 120°

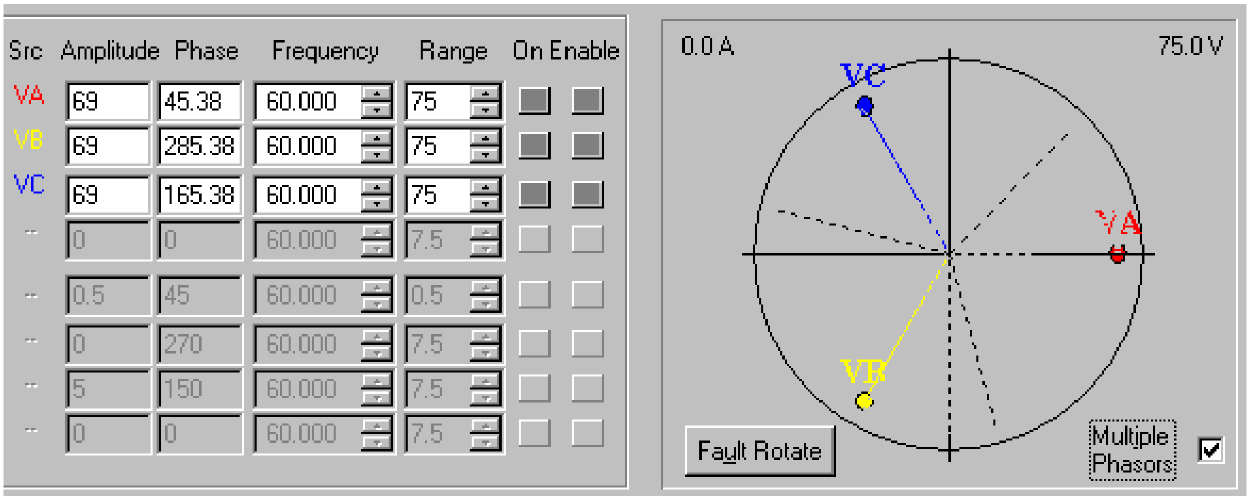


Figure B.6 Dotted Lines Show New Position of Phasors Before Release

See Figures 4.5 and 4.6 on page 4-11 of Rev. A.

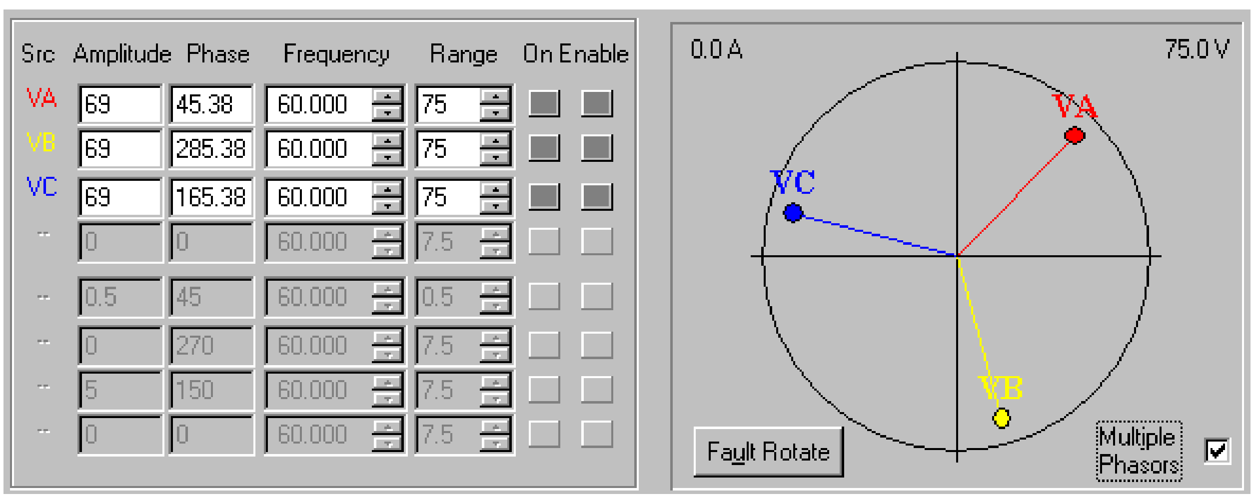


Figure B.7 Phasors for Three Voltage Sources Shifted ~45°

Logic and Timer Settings

Click **Logic & Timer settings...** to bring up the **Settings** display (Figure B.8). The **Settings** display has four tabs:

- Inputs
- Outputs
- Timers
- Notes

Inputs Tab

The Inputs tab (Figure B.8) contains settings for eight logic inputs, one for each input terminal on the instrument front panel. The Inputs tab also contains controls for the AutoSensE and Threshold options.

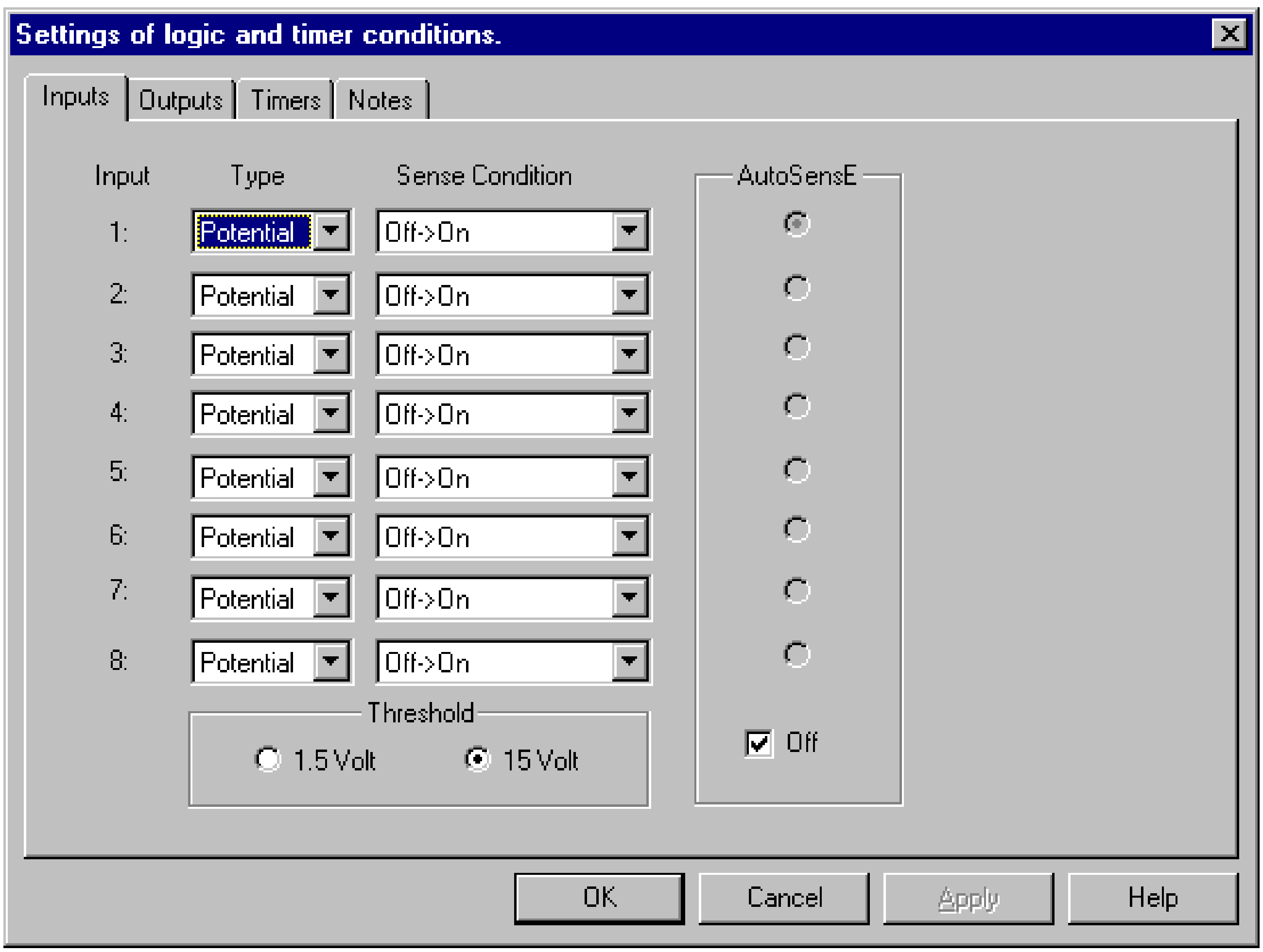


Figure B.8 Inputs Tab

For each input, choose the *Type* of input and the *Sense Condition*:

Type	Select **Potential** or **Contact** from the pick list.
Sense Condition	Select the transition that must occur for the input to be true.

Each input type, Potential or Contact, has two selectable sense conditions. Table B.3 summarizes these selections for a relay with normally open contacts. For normally closed output contacts, use inverse logic (i.e., instead of Off to On, use On to Off).

Table B.3 Sense Conditions for Each Type of Input

Type of Input	Sense Conditions	Description
Potential	Off →On	Relay responds
	On →Off	Relay drops out
Contact	Open →Close	Relay responds
	Close →Open	Relay drops out

The *AutoSensE* column lies to the right of the pick lists. Each logic input has an AutoSensE radio button. Selecting AutoSensE for an input freezes the ramping variable or variables when the required input condition is sensed.

NOTE

The default setting for the AutoSensE feature is ON. To disable the AutoSensE radio buttons, click the Off check box at the bottom of the AutoSensE column.

Locate the *Threshold* section beneath the *Type* and *Sense Condition* columns. The *Threshold* section applies to inputs that have potential present at their terminals.

The threshold setting of 15 V is provided to reduce sensitivity to circuit noise. Use the 1.5 V setting when the circuit does not have noise present, or greater sensitivity to circuit noise is required.

Outputs Tab

The Outputs tab (Figure B.9) sets the default contact status for each of the eight logic outputs on the instrument front panel. *Normally open* is the default contact status for all eight logic outputs in the Outputs tab. Click the desired radio button for each output.

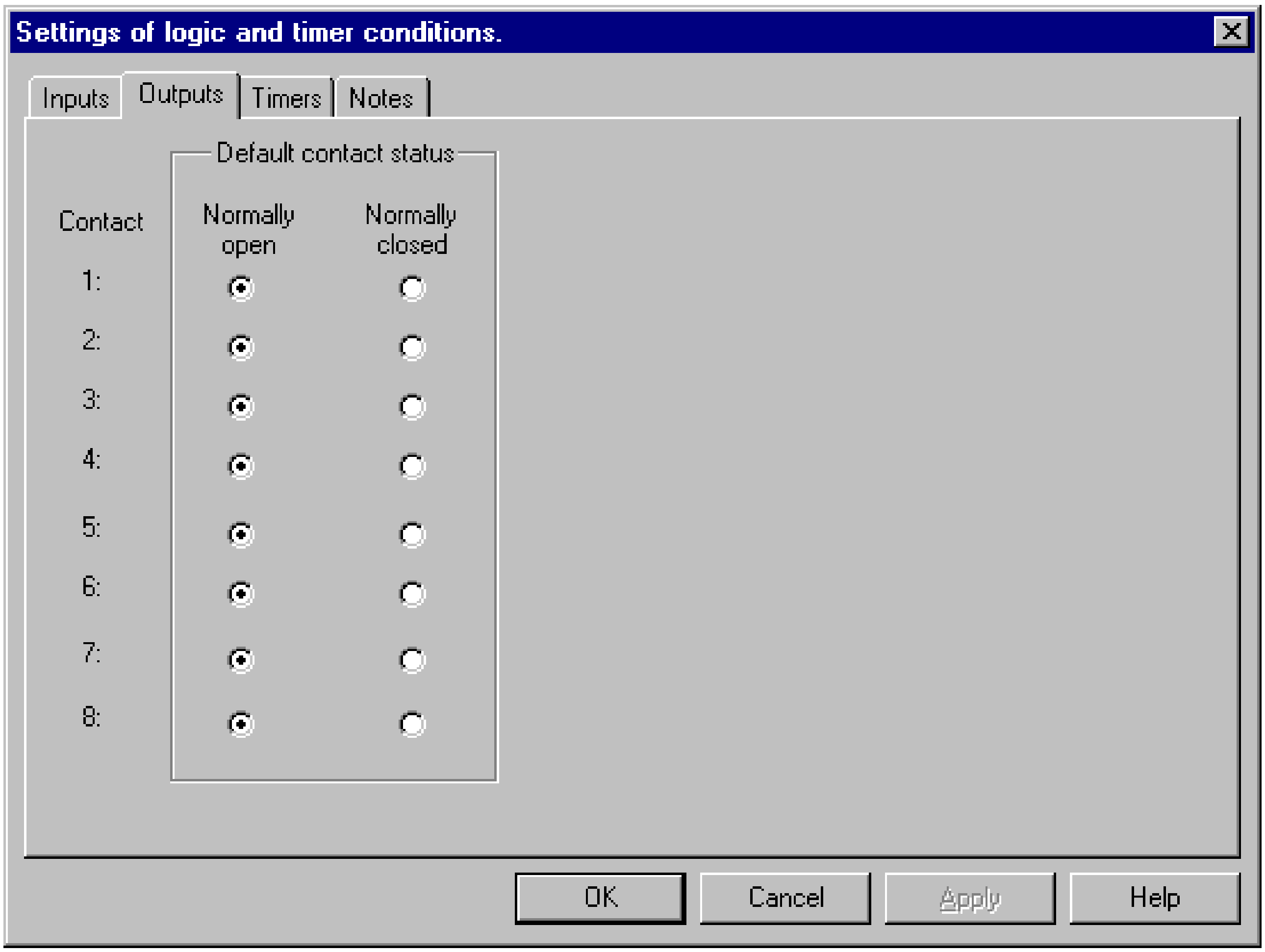


Figure B.9 Outputs Tab

NOTE

The logic outputs change state with the status of their mapped output sources. See "Input and Output Indicators" on page B-25.

Timers Tab

The Timers tab (Figure B.10) contains functions that define the start and stop conditions for a particular timer. To set Timer 1, select the first radio button under *Set timer*. The start and stop conditions for each timer are set individually.

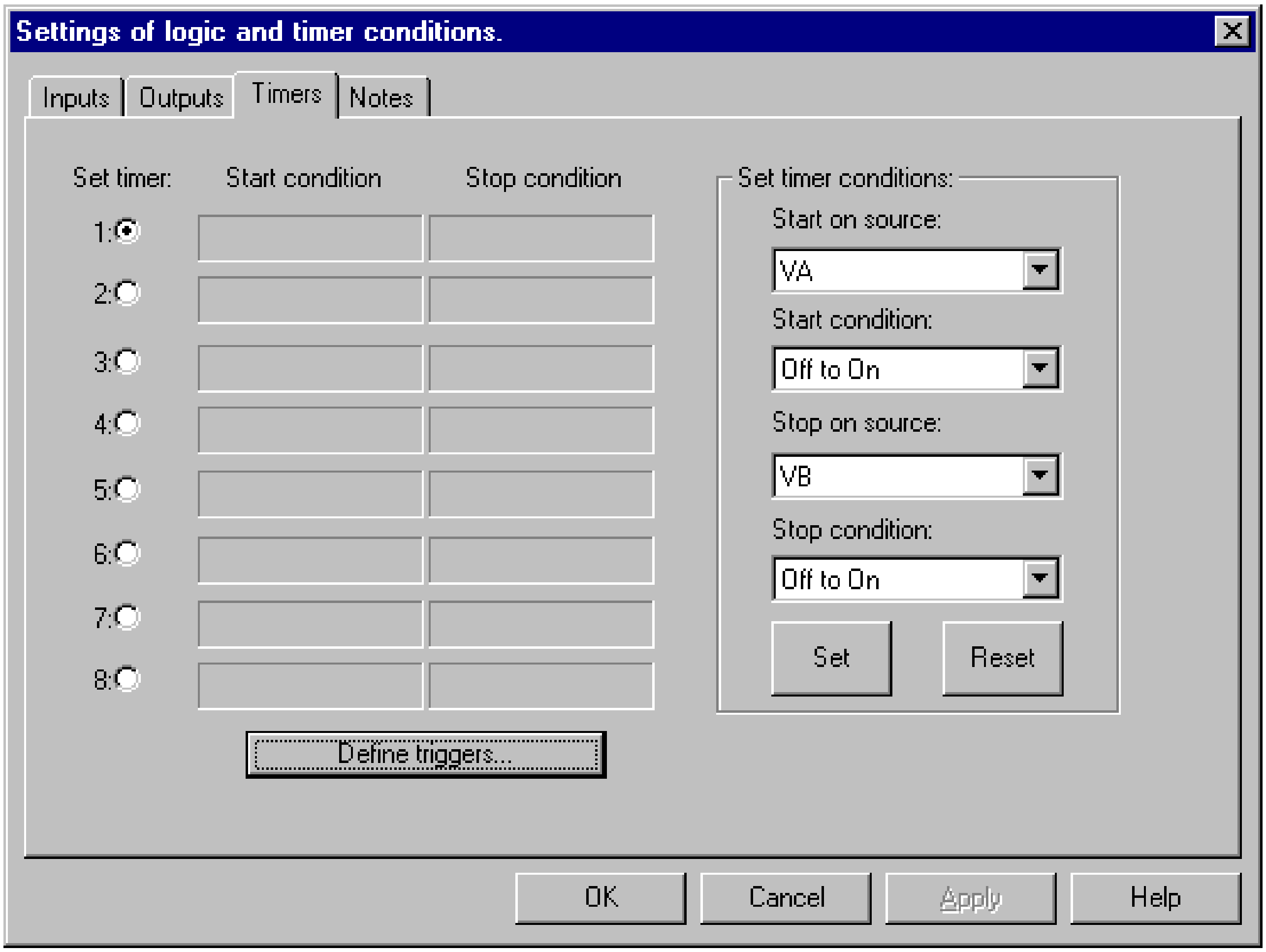


Figure B.10 Timers Tab

Define Triggers

If a start condition or a stop condition requires an input signal from the relay under test or from any other source, specify the input via the **Triggers** display (Figure B.11). To open the **Triggers** display, click **Define triggers...** in the Timers tab.

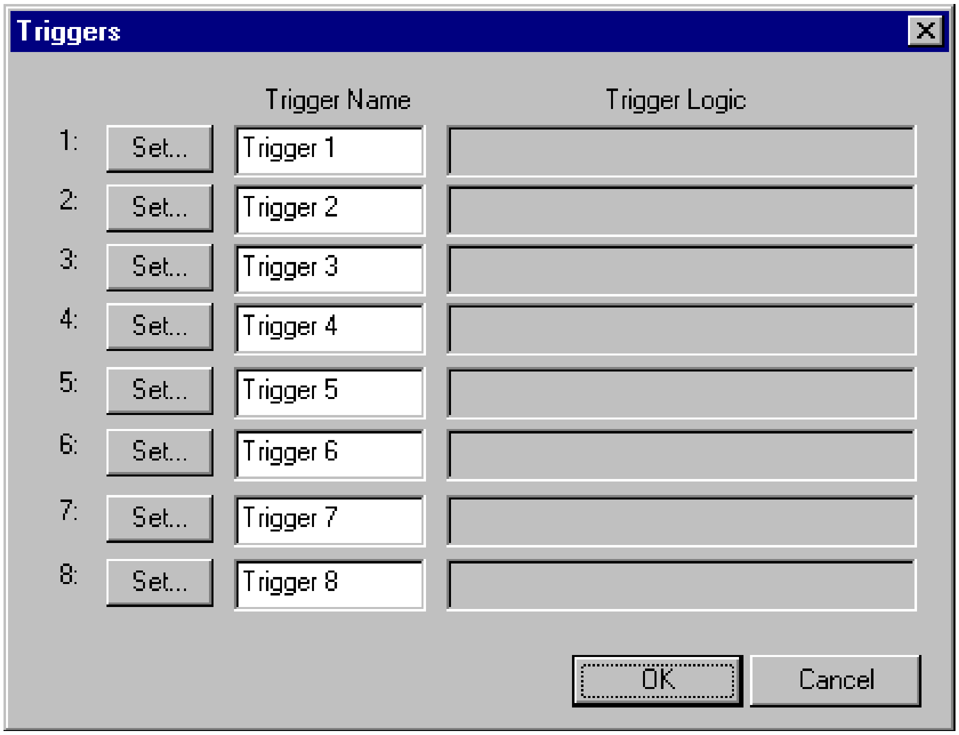


Figure B.11 Triggers Display

Click **Set...** for Trigger 1 in the **Triggers** display to open **Set Trigger Logic** (Figure B.12). Use the **Set Trigger Logic** display to select the inputs needed to make the trigger true. For instance, click **1** under *Choose input* to put In1 in the *Logic* field.

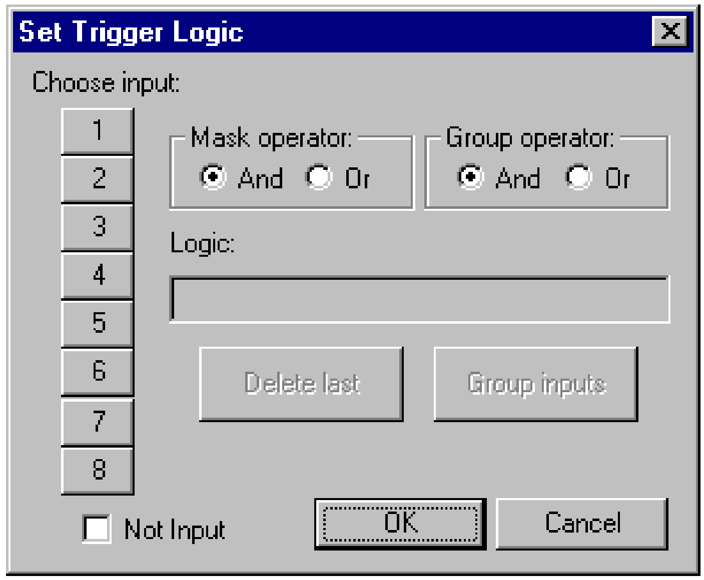


Figure B.12 Set Trigger Logic

Multiple inputs can be configured as a trigger logic setting by using Boolean operators with the inputs. The Boolean operators used are And (*), Or (+), and Not (~). To put more than one input in the *Logic* field, select *And* or *Or* under *Mask Operator* to connect them logically.

- Connecting the logic inputs with the And operator requires that all the inputs be true to assert the trigger.
- Connecting the logic inputs with the Or operator requires that any of the inputs be true to assert the trigger.

Click the *Not Input* check box to place a tilde (~) before a logic input. In this case, the trigger is asserted when the logic input is *not* true.

In the **Set Trigger Logic** display, select the *And* operator (*) or the *Or* operator (+) under *Mask Operator* to set the logical relationship for two or more inputs. These three examples illustrate the logic for three distinct triggers:

In1*In2	The trigger is asserted when both Input 1 and Input 2 are true.
In1+In2	The trigger is asserted when either Input 1 or Input 2 is true.
In1*~In2	The trigger is asserted when Input 1 is true and Input 2 is not true.

Click **Group inputs** to place parentheses around a series of inputs in the *Logic* field. Then select a group operator to set the logical relationship between the group and another input. For example:

(In1*In2*In3*In4*In5*In6*In7)+In8

The trigger is asserted when Inputs 1 through 7 are true, *or* when Input 8 is true.

(In1+In2+In3+In4+In5+In6+In7)*In8

The trigger is asserted when *one* of the first seven inputs is true, *and* Input 8 is true.

Three restrictions govern the formation of logical expressions that use a group operator:

- The mask operator for all of the inputs inside the parentheses must be the same.
- The group operator outside the parentheses must be the opposite of the mask operator inside the parentheses.
- Only one input can follow the group operator outside the parentheses.

Click **Delete last** to delete the last input entered in the *Logic* field. To clear all the inputs from the *Logic* field, click **Delete last** until all the inputs are deleted.

Set Timer Conditions

Click **OK** to close the **Set Trigger Logic** display. The text in the *Logic* field of the **Set Trigger Logic** display appears in the *Trigger Logic* field of the **Triggers** display (Figure B.13).

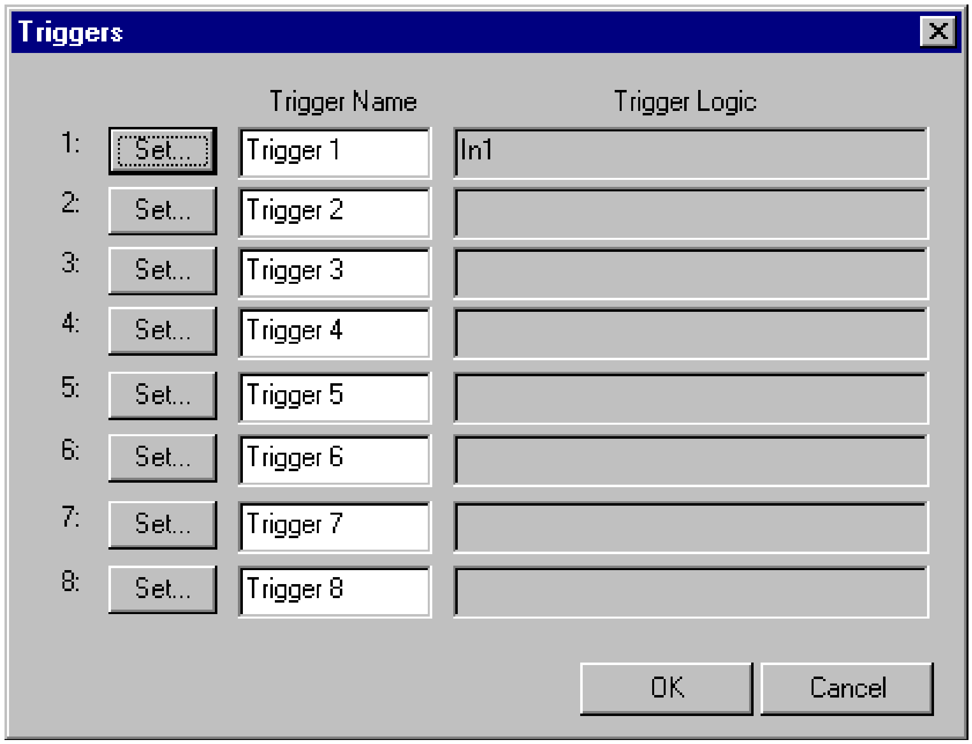


Figure B.13 Trigger Logic Set for Trigger 1

Click **OK** to close the **Triggers** display and return to the Timers tab (Figure B.10 on page B-15). The trigger named Trigger 1 appears in both the *Start on source* and the *Stop on source* pick lists.

Start on source	The *Start on source* pick list contains the voltage and current sources from the source table, plus the defined triggers. Click the source or trigger in the list required by the test protocol.
Start condition	The *Start condition* pick list contains three events or transitions: Off to On, On to Off, and On Change. The *On Change* option permits time tests that are initiated when there is a step change in the selected source variables. Click the start condition required by the test protocol. When the source or trigger selected in *Start on source* meets the specified start condition, the timer starts.
Stop on source	The *Stop on source* pick list contains the voltage and current sources from the source table, plus the defined triggers. Select the source or trigger from the list required by the test protocol.
Stop condition	The *Stop condition* pick list contains two events or transitions – Off to On, and On to Off. Click the stop condition required by the test protocol. When the source or trigger selected in *Stop on source* meets the specified stop condition, the timer stops.

NOTE

The timer start and stop conditions apply only to the voltage and current sources. If a trigger is selected in *Start on source*, the *Start condition* pick list is grayed out. Similarly, if a trigger is selected in *Stop on source*, the *Stop condition* pick list is grayed out.

Set and Reset

After selecting the desired entries from all four pick lists in the Timers tab, click **Set**. The start condition defined in the first two pick lists appears in the *Start condition* field in Figure B.14. The stop condition defined in the third and fourth pick lists appears in the *Stop condition* field in Figure B.14.

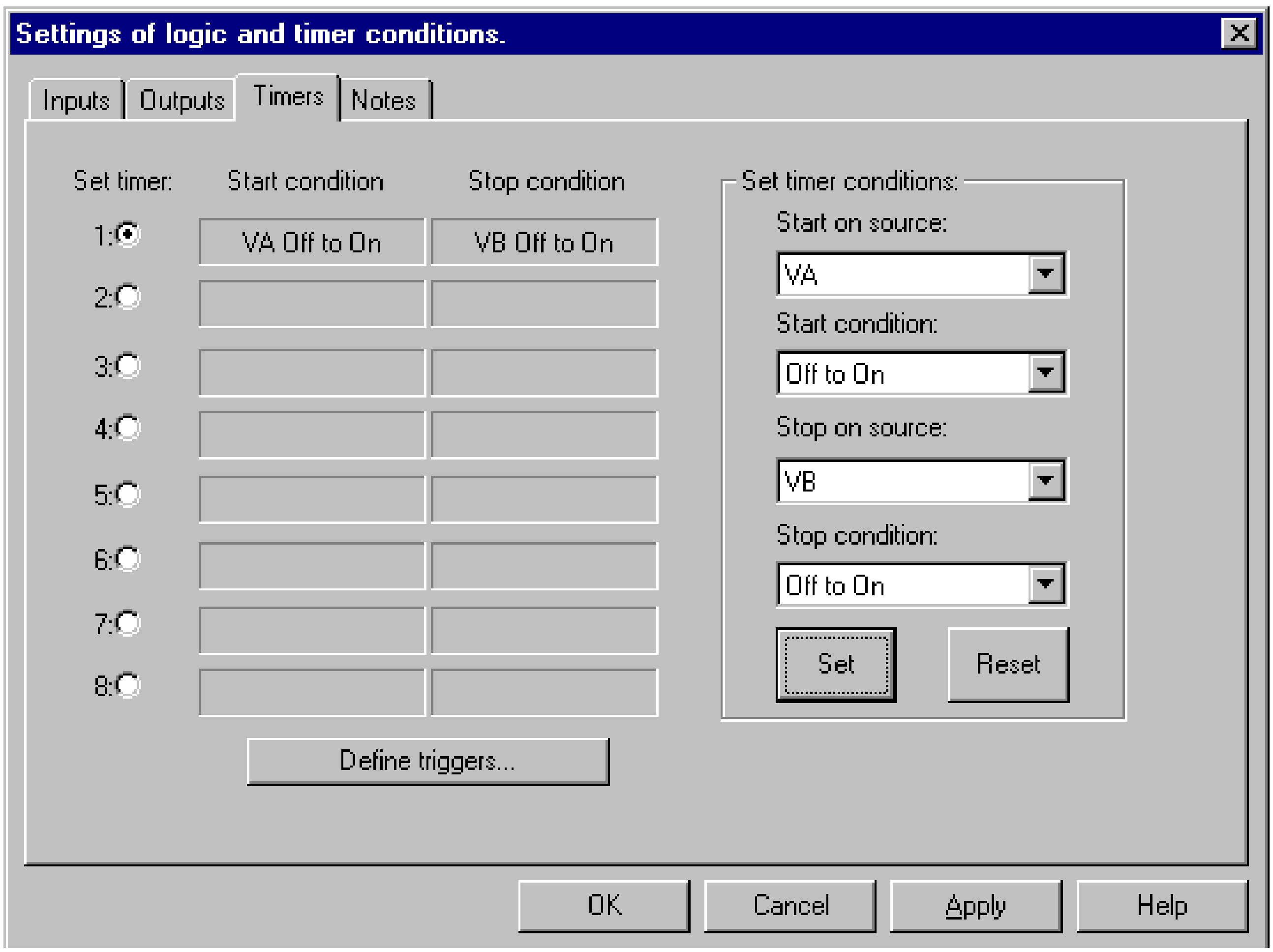


Figure B.14 Start and Stop Conditions Set in the Timers Tab

To redefine the start and stop conditions for a timer, click the radio button for that timer. Then click **Reset** in the *Set timer conditions* section. The *Start condition* and *Stop condition* fields for that timer go blank, and new conditions from the pick lists can be selected.

Notes Tab

Use the Notes tab (Figure B.15) to document any part of a test setup or test procedure by typing in text. For example, the Notes tab can be used to record timer conditions in the Timers tab, triggers defined in the **Triggers** display, or the reasons for key settings. When in simulator mode, the settings for a test can be entered, saved, and sent to a technician in the field. The field technician can then use the information in the Notes tab to set up and conduct the test.

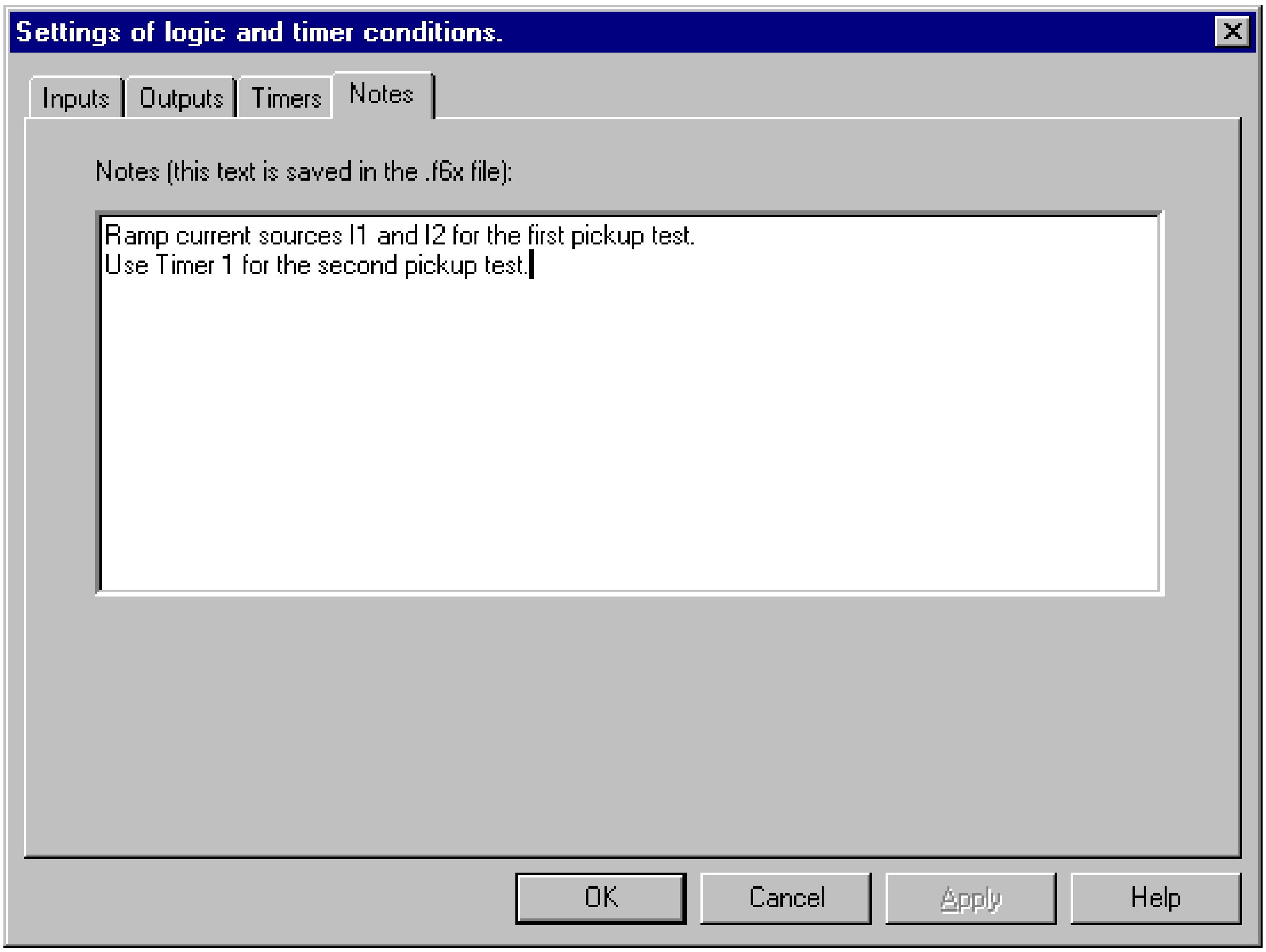


Figure B.15 Notes Tab

Timers

The *Timers* section contains readouts for eight timers (Figure B.16). Using logic inputs and logic outputs, time tests are possible for up to eight separate events. The timers allow configuration of the logic inputs and outputs for specific relays or for an entire protection scheme. For example, use the timers to measure pickup and dropout times for relay under tests. Use any timer with any source, any input or output, and any trigger.

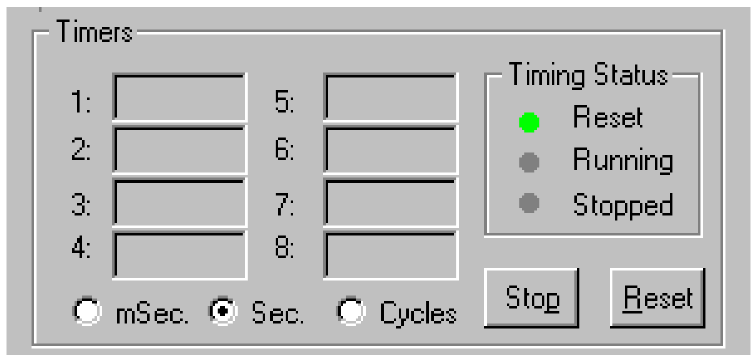


Figure B.16 Timers Section

During a simple test of an overcurrent relay, the timer starts when the source turns on and stops when the relay responds. The timer therefore measures the response time of the relay.

NOTE

Active timers have white fields. The initial reading for an active timer is 0.00 seconds. If the settings for a timer have not been defined in the Timers tab, the readout for that timer is gray. All of the timers are inactive when *Ramp* mode is selected.

Timing Status

The *Timers* section contains three *Timing Status* lights that function for any and all timers:

Reset	Active timers are reset to 0.00.
Running	Time test is in progress.
Stopped	Relay has responded. Timer shows elapsed time in milliseconds, seconds, or cycles.

When **System Output** is clicked, the enabled sources turn on and the enabled timers start. If the timer **Stop** button is then clicked, these sources are switched off and the **System Output** button returns to its previous status.

Timer Controls

Click **Stop** to stop timers that have not stopped due to a pre-defined stop condition. Click **Reset** to return all the active timers to 0.00.

If **Stop** is clicked while the timer is running, *NO-OP* appears in the field for that timer. *NO-OP* means No Operation. It appears in the timer readout after an unsuccessful or an interrupted test. For example, when a timer is started and then stopped manually during a test, *NO-OP* appears in the timer field because the relay being tested did not respond.

Measurement Units

Set the measurement units for the timers with the radio buttons located along the bottom of the Timers section. The options are milliseconds, seconds, and cycles. The default selection is Seconds (*Sec.*).

To measure the elapsed time in milliseconds, click the radio button for ***mSec***. To measure the number of cycles that elapse during a test, click the ***Cycles*** radio button. For example, if the default system frequency of 60 Hz is set, the timer shows 90 cycles for a time test that lasts 1.5 seconds.

Input and Output Indicators

The Control Panel contains a status indicator for each logic output and each logic input. The status indicators are numbered 1 through 8 from left to right (Figure B.17).

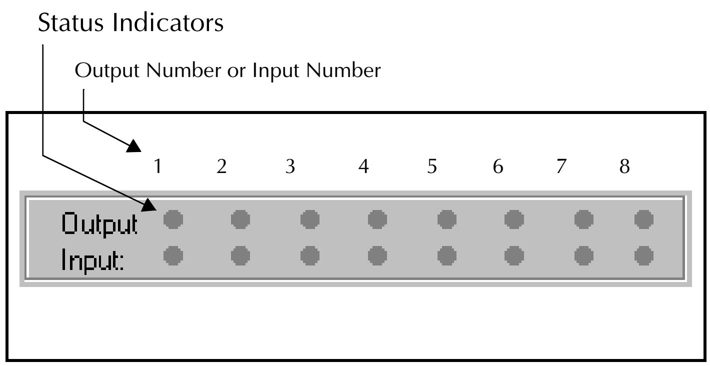


Figure B.17 Output and Input Status Indicators

Each power source maps to one logic output and one logic input. The mapping of sources to inputs and outputs depends on the source configuration in effect. The mapping rule assigns the inputs and outputs to voltage and current sources in ascending order first from left to right, then from top to bottom. Figure B.18, Figure B.19 on page B-26, and Figure B.20 on page B-26 illustrate how the rule works for three common source configurations.

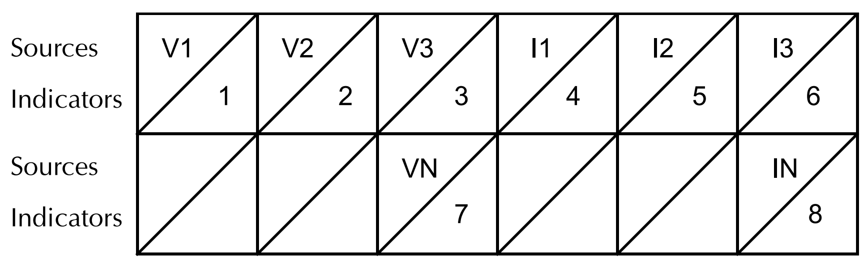


Figure B.18 Input and Output Indicators for Four Voltage Sources and Four Current Sources

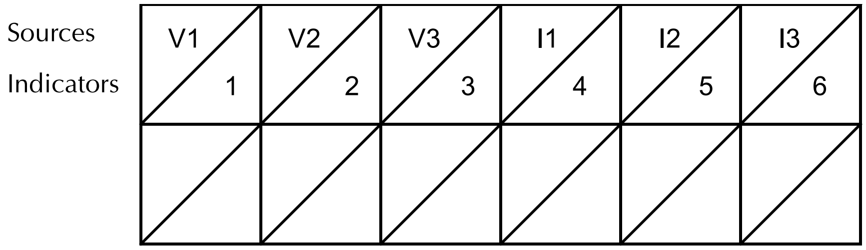


Figure B.19 Input and Output Indicators for Three Voltage Sources and Three Current Sources

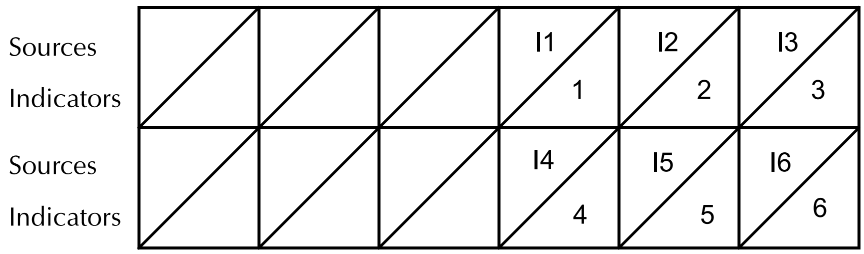


Figure B.20 Input and Output Indicators for Six Current Sources

NOTE

If a ProTesT macro specifies source MA, the macro uses Input 1 and Output 1.

A logic output gives the F6000 the ability to send out its own signal. It is a logical relay that opens or closes its contacts when its associated source goes on. The output is in its normal state when the source is off. A normally open output contact closes when the source is turned on and its corresponding status indicator illuminates.

A logic input is a signal that originates with the relay under test and is sent to the instrument. Any trigger necessary to run a test can be programmed as a logic input. See ″Define Triggers″ on page B-16 for examples of how to use logic inputs in actual tests.

Battery Simulator

Locate the *Battery* section (Figure B.21) in the lower left-hand corner of the Control Panel. If the test protocol requires a DC voltage supply, use the pick list under *Battery* to set the voltage of the source. The options on the list are: 48 V, 125 V, and 250 V DC.

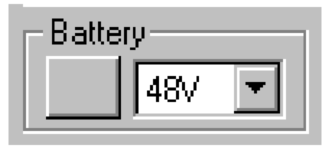


Figure B.21 Battery Section

Click the button to the left of the pick list to toggle the battery simulator on and off. The battery simulator has the following operating characteristics:

- When using the F6000 Control Panel, the battery simulator provides continuous output while the user conducts tests or changes logic and timer configurations.
- When using ProTesT test plans, the battery simulator provides continuous output when either the F6000 Control Panel or the F6000 Configuration display is selected, or when a third party application external to ProTesT is run.
- The battery simulator switches off if ProTesT is shut down or if communication with the F6000 Instrument is lost.

WARNING

Care should be taken when using the battery simulator as it is capable of up to 250 V DC at 60 Watts.

Saving the F6000 Control Panel Configuration

To save a setup on the Control Panel, click **File | Save** in the ProTesT menu bar. To save a setup under a new name, click **File | Save As**. ProTesT saves the new information on the Control Panel in an .f6x file. The default settings for the Control panel are saved in a file named *default.f6x*. The Control Panel uses the settings in this file when it first opens.

Summary

The Control Panel provides full control over each voltage and current source, and maximum flexibility in preparing for and conducting tests of protective relays:

- Pre-programmed and user-defined ramp values eliminate manual errors in testing. The AutoSensE feature simplifies testing and eliminates errors.
- The phasor diagram shows source table settings in real time and allows the dragging and dropping of phasors to reset source table values.
- The Fault Rotate feature makes efficient testing of three-phase relays possible.
- The eight individual timers enable measurements of eight different timed events.

Appendix C. ProTesT Macro Reference Guide

ASYNCH - Testing of Autosynchronizing Relay - A ProTesTPLAN

Description

The autosynchronizer relay is designed to control the closing of a circuit breaker connecting two electrical systems. A typical application is the connection of an incoming line or generator to a station bus.

The relay can be applied to directly close the circuit breaker or to supervise the operator-initiated manual closing. Closing is allowed only when the two sources are almost synchronous and in phase.

The typical autosynchronizer relay has controls for setting the frequency and maximum voltage difference at which operation is allowed. Relays also have a setting for circuit breaker closing time, and other settings.

Operation

Two voltage sources, both fixed at 120 V, are used to test the relay. One source, used to represent the bus side voltage, is fixed at 60/50 Hz. The other source is used to represent generator voltage at the system frequency, plus or minus the slip frequency. The example shown in Figure C.1 illustrates 60.02 Hz for a 0.02 Hz slip frequency.

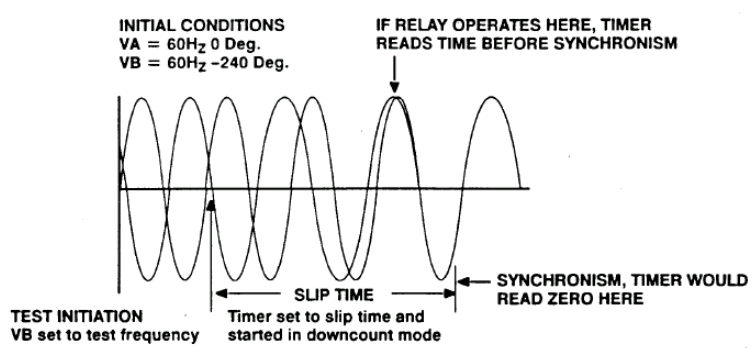


Figure C.1 Slip Frequency Example

The relay is configured to respond with a close signal in advance of synchronism that is dependant on the circuit breaker advance time setting on the relay. The output from the relay is applied to the test instrument to record the close command issued by the relay.

Use

The main goal of testing is to compare the circuit breaker allowed Closing Angle to the Actual circuit breaker Closing Angle. The difference between these is the Close Angle Error (CAE), which is reported by the macro in degrees. This result must fall within the range of the allowed tolerance. This angle is actually derived, however, from a comparison of the difference in mSecs, or cycles, between the expected value and the test result value.

The Expected Time in Figure C.2 is the Advance Time plus the Output Operating Time. In Figure C.3, the Advance Time is the circuit breaker closing time. The Output Operate Time is the Relay Operate Time which is sometimes published by relay manufacturers and should be considered when calculating the Expected Time.

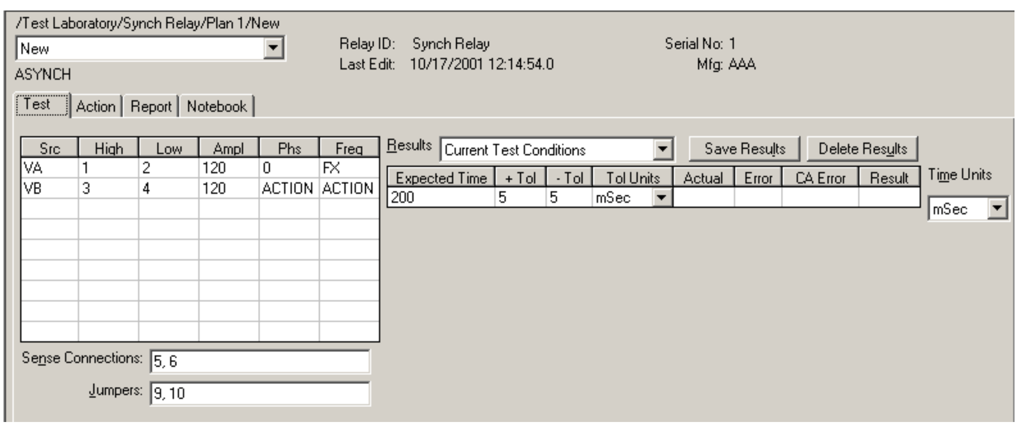


Figure C.2 Asynch Test Tab Screen

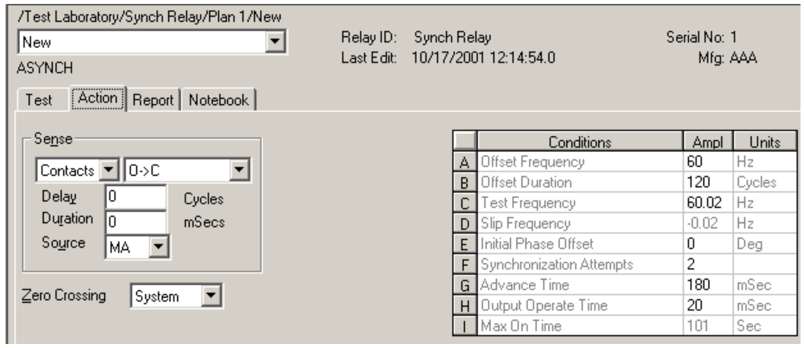


Figure C.3 Asynch Action Tab Screen

The test sequence is:

1. Voltages VA and VB are applied to the relay for the offset time and at the offset frequency of 60 Hz.
2. The voltage VB frequency shifts to the test frequency of 60.02 Hz.
3. The instrument starts a timer and waits for the relay sense signal.
4. The timer is stopped when the sense signal occurs and ProTesT receives the timing information.

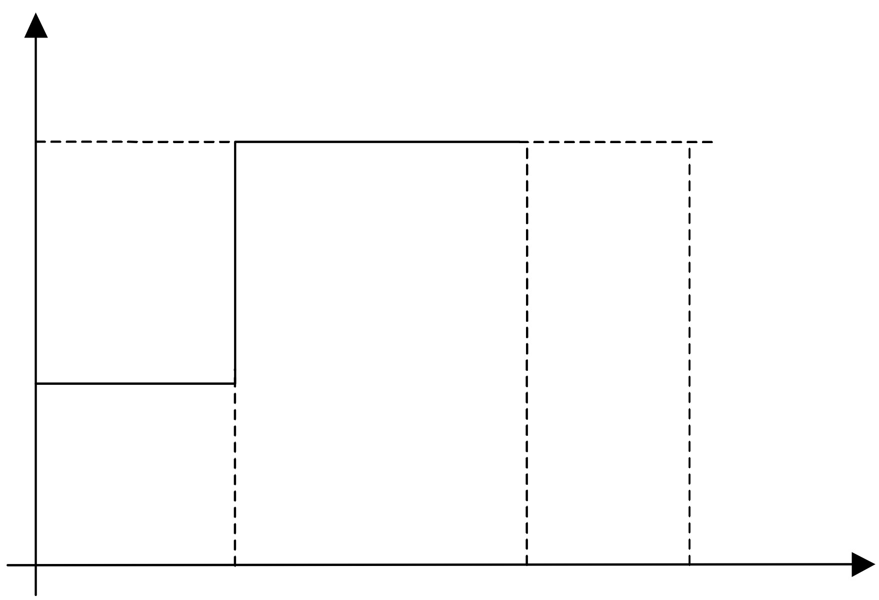


Figure C.4 Timer Starts and Stops

5. ProTesT calculates the breaker advance time using the timing value measured by the instrument, according to:

   Breaker advance time =
   [(1/Slip frequency) * initial offset/360 °] - instrument measured time.

   For a slip frequency setting of 0.02 and an initial offset of 0° (360°), the time required for two voltages in synchronism is:

   (1/Slip frequency * Initial offset/360°).

   The time calculated is 50 seconds. This calculated time is compared with the set time of the relay. The instrument measured time is subtracted from the synchronization time.

6. The CAE is calculated as follows:

   Error in Close Angle = [Tm – (Ts + Ti)] x (F1 - F2) x 360/1000]

   where:

   - Tm = Measured Circuit Breaker advance time in milliseconds.
   - Ts = Selected circuit breaker advance time (Action tab item G).
   - Ti = Output relay operation time (Action tab item H).
   - F1 = Source 1 Frequency Hz (= 60 Hz). Use FX in Frequency.
   - F2 = Source 2 Frequency Hz (= 60.02). Use Action for Phase and Frequency.
   - 360 converts Hz to degrees/second.
   - 1000 converts milliseconds to seconds.

   For instance, if 190 milliseconds had been measured, then:

   Error in Close Angle = [(Tm – (Ts + Ti)] x (F1 –F2) x 360/1000] =
   [190 – (180+20)] x (60 –60.02) x 0.36 = –10 x (–0.02) x 0.36 =
   0.07 degrees

NOTE

The error in Advance time for 1° close angle error can be calculated as: Time for 1° closing angle = 1/(Slip frequency * 360) = 1/(0.02*360) = 0.1389 seconds or 138.9 milliseconds.

From the allowable closing angle error, the tolerance on the circuit breaker advance time can be calculated.

Test Tab

The ASYNCH Test Tab screen is shown in Table C.1.

Table C.1 ASYNCH Test Tab Results Fields

Field	Explanation
Expected Time	= Advance Time + Output Operating Time (Action Tab Items G & H).
+ Tol/-Tol	Plus/minus tolerance used for Pass/Fail calculation.
Tol Units	Units for use with Tolerances: %, Sec, mSec, or Cycles.
Actual	Recorded test result.
Error	Calculated difference between the actual and expected results shown in the selected units.
CA Error	The difference between Actual and Expected Time expressed in degrees.
Result	Pass/fail determination.
Time Units	For Expected Time units: Sec, mSec, or Cycles.

The ASYNCH Test Tab screen is shown in Figure C.2 on page C-2.

Action Tab

The ***ASYNCH Action Tab Conditions Fields are explained in*** Table C.2***.***

Table C.2 ASYNCH Action Tab Conditions Fields

Field	Explanation
Offset Frequency	Frequency that the Action source will be set to for the Offset Duration. NOTE: This is a mandatory field. This value must be the same as your System Frequency, i.e., 50Hz or 60Hz. See ProTesT | Setup Menu.
Offset Duration	Time for which the Offset Frequency is applied to the Action source.
Test Frequency	Test frequency required for the test. This value is intended to calculate the Slip Frequency.
Slip Frequency	Calculated value: Slip Freq. = Non-Action Source Freq. - Test Freq.
Initial Phase Offset	Initial setting of the phase angle.
Synchronization Attempt	Enter the number of attempts the relay is permitted to attempt a Circuit Breaker Close Signal. This field was left as a user entry field to account for future relay developments that may provide this functionality.
Advance Time	Circuit Breaker Closing Time.
Output Operate Time	Output relay operation time after the relay measuring circuit makes a decision to close the circuit breaker.

Table C.2 ASYNCH Action Tab Conditions Fields (Continued)

Field	Explanation
Max On Time	Maximum time for the test to run. This is a calculated field and depends upon the settings in Slip Frequency, Initial Phase Offset and Synchronization attempts. This is provided to end the test after the time for a successful relay operation has lapsed.
Source	Identifies the Action source associated with the timer/sense input. For the F2000, this source must be in the Master Instrument. The default of MA indicates to look for a timer/sense input at the Master Instrument.
Zero Crossing	Two options, System or Source System (default) cause changes to the sources to occur on the positive zero crossing of the reference sine wave. All sources change at the same time. • For the F6150, Source setting does not apply. • For the F225x, Source settings cause each source in the system to change on the first positive zero crossing of its sine wave. • For the F2000, Source settings cause each source in the system to change on the first positive or negative zero crossing of its sine wave. All sources change at their respective zero crossing. For example, if VA is at 0°, VB is 120°, and VC is at 240°, the system changes all sources at the same time. For Source, VA changes at time T0, VB changes at time T0+1/3 of a cycle, and VC changes at time T0+2/3 of a cycle

BSRHOI - Binary Search, Current - I ProTesTPLAN

Description

This macro is a fast, high-low pulsed search used to bracket a relay operate point, followed by either a linear ramp or pulsed ramp for a high resolution result. RCHBOI and BSRHOI are identical (see page C-171). If you have both Z and I ProTesTPLANS, use the name you prefer.

A search begins by testing midway between the Action Offset and Limit Current. If the relay does not operate, the limit current is applied. If the relay still does not operate, the test is over (recorded as No Op, No Operation). Successive pulses are calculated based on the results of the last pulse; i.e., the next pulse is halfway between the last operate value and the last No Op value. When the difference between pulse amplitudes is less than three times the ramp delta current, the search stops and either a Linear Ramp or a Pulsed Ramp begins.

The ramp backs off twice the delta current, then ramps for a maximum of 15 steps. If the test is properly tuned, three or four steps should be sufficient.

Operation

One or more current sources can be ramped simultaneously, using the same Action conditions. One or more voltage presets can be applied.

Use

This macro ramps current sources. Use Binary Search wherever Linear Ramp or Pulsed Ramp can be used; however, there are cases where it cannot be used successfully, such as long reset times in induction disk relays. When properly used, binary search is faster for determining the Ohmic reach of current-operated distance relays or measuring the pickup/dropout of overcurrent relays.

Notes

- Binary Search requires more tuning than a Linear Ramp or Pulsed Ramp. The relay may respond differently to search pulses vs. linear ramp steps. Sensing may be heard during the search, but the ramp concludes with No Op – relay operation not detected. Use sense delay to filter the relay transient response on the pulses, so that the search converges to the correct value.
- If memory action is important to the relay, allow adequate wait time for reset and a long enough pulse time to operate.
- Some relays require the use of pulsed ramp for testing. If so, select the Pulsed Ramp option by setting Ramp Delta Time = 0.
- Search can be done either from low offset to high limit, or high offset to low limit. When searching from a high offset, Ramp Delta Current must be negative.
- Use Offset Current = 0, and non-zero Offset Duration Action Delay if the polarizing voltage must be applied before the Action.
- Use sense delay to ensure that the search converges to a value that can be detected with the ramp. A large delay may be required, for example, 25 to 50% of the pulse duration. This filters the transient response to the leading edge of the pulse. If contact instability is also present, use sense delay as well.

Test Tab

On the BSRHOI Test Tab screen (Figure C.5 on page C-12):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The BSRHOI Test Tab Results fields are explained in Table C.3.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

Table C.3 BSRHOI Test Tab Results Fields

Field	**Explanation**
Expected I	Expected operate value, in Amps.
+ %/ – %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The BSRHOI Test Tab screen is shown in Figure C.5.

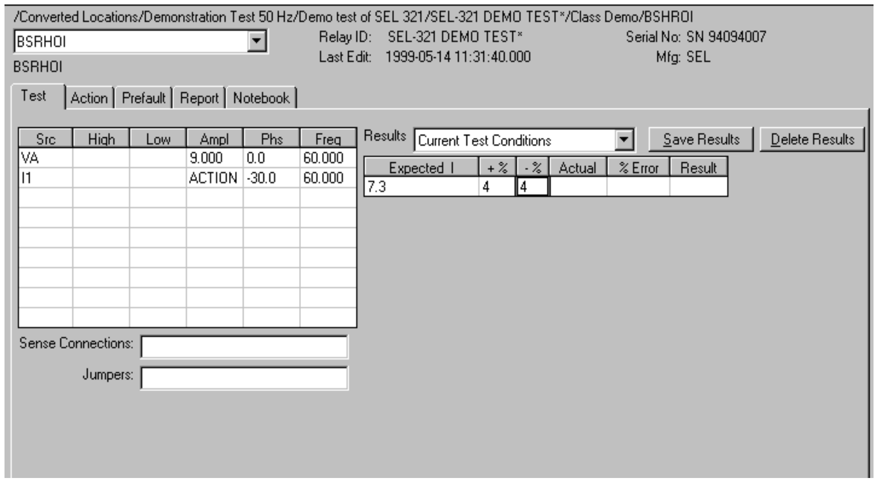


Figure C.5 BSRHOI Test Tab Screen

Action Tab

The BSRHOI Action Tab Conditions fields are explained in Table C.4.

Table C.4 BSRHOI Action Tab Conditions Fields

Field	Explanation
Offset Current	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Current Limit	The amplitude that stops the search, if the relay does not operate. The limit also determines the source range for a positive Delta Current.
Pulse Duration	The maximum length of each search pulse; pulse terminates as soon as a sense is detected.
Wait	How long to wait between pulses; wait is at offset current.
Delta Current	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	Duration of each ramp step. A non-zero value selects a linear ramp; setting Delta Time = 0 selects a pulsed ramp, using the same pulse duration and wait as the search.

The BSRHOI Action Test Tab screen is shown in Figure C.6.

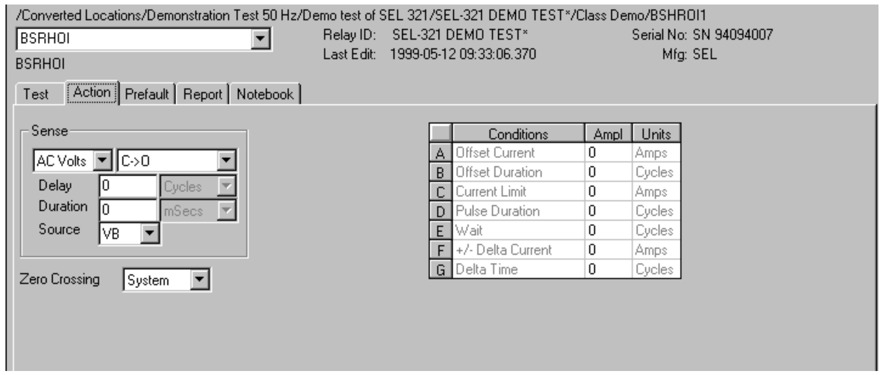


Figure C.6 BSRHOI Action Tab Screen

Sense

The BSRHOI Sense fields are explained in Table C.5.

Table C.5 BSRHOI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

After a small number of search pulses, the ramp begins. The test stops as soon as the ramp detects relay operation, normally after three or four steps, and the amplitude is recorded. If the relay does not operate after 15 ramp steps are taken, a No Op is recorded. No Op may be desired, if the relay is not supposed to operate.

Operation Graph

The BSRHOI Operation graph is shown in Figure C.7.

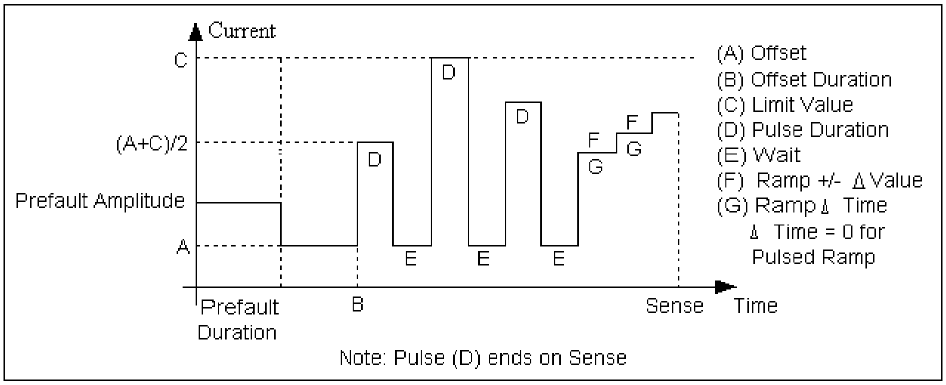


Figure C.7 BSRHOI Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins using faulted voltage and increasing current. The BSRHOI Prefault Tab fields are explained in Table C.6.

Operation	When the test is run, the Prefault is applied as indicated in Figure C.7. This allows an intelligent relay to see normal conditions before responding to the fault condition that is generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.6 BSRHOI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

BSRHOV- Binary Search, Voltage - V ProTesTPLAN

Description

A fast, high-low pulsed search to bracket a relay operate point, followed by either a linear ramp or pulsed ramp for a high resolution result. RCHBOV and BSRHOV are identical. If you have both the V and Z ProTesTPLANS, use the name you prefer.

The search begins by testing midway between the Action Offset and Limit Voltage. If the relay does not operate, limit voltage is applied. If the relay still does not operate, the test is over (recorded as No Op, No Operation). Successive pulses are calculated based on the results of the last pulse; i.e., the next pulse is halfway between the last operate value and the last No Op value. When the difference between pulse amplitudes is less than three times the ramp delta voltage, the search stops and either a Linear Ramp or a Pulsed Ramp begins.

The ramp backs off twice the delta voltage, then ramps for a maximum of 15 steps. If the test is properly tuned, three or four steps should be sufficient.

Operation

One or more voltage sources are ramped simultaneously, using the same Action conditions. One or more voltage presets can be applied.

Use

This macro ramps voltage sources. Use Binary Search wherever Linear Ramp or Pulsed Ramp can be used; however, there are cases where it cannot be used successfully. When used properly, Binary Search has faster performance for determining Ohmic reach of voltage-operated distance relays or pickup/dropout of overvoltage or undervoltage relays.

Notes

- Binary Search requires more tuning than Linear Ramp or Pulsed Ramp. The relay may respond differently to search pulses vs. linear ramp steps. Sensing may be heard during the search, but the ramp concludes with No Op – relay operation not detected. Use sense delay to filter relay transient response on the pulses, so that the search converges to the correct value.
- If memory action is important to the relay, allow adequate wait time for reset and a long enough pulse time to operate.
- Some relays require the use of pulsed ramp for testing. If so, select the Pulsed Ramp option by setting Ramp Delta Time = 0.
- The search can be done either from low offset to high limit, or high offset to low limit. When searching from a high offset, Ramp Delta Voltage must be negative.

Test Tab

On the BSRHOV Test Tab Screen (Figure C.8 on page C-18):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The BSRHOV Test Tab Results fields are explained in Table C.7 on page C-18.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.

Delete Results — Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

The BSRHOV Results fields are explained in Table C.7.

Table C.7 BSRHOV Test Tab Results Fields

Field	Explanation
Expected V	Expected operate value, in Amps.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The BSRHOV Test Tab Screen is shown in Figure C.8.

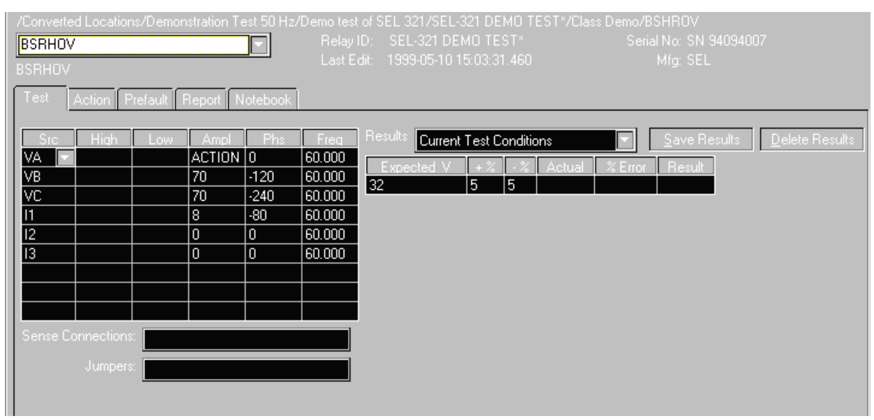


Figure C.8 BSRHOV Test Tab Screen

Action Tab

The BSRHOV Action Tab Conditions fields are explained in Table C.8.

Table C.8 BSRHOV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial amplitude of the Action source. Action offset turns on at the same time as the Preset sources.
Offset Duration	How long to maintain the offset. If no offset is wanted, enter 0 Volts and 0 Cycles.
Voltage Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum offset and limit determines the source range.
Pulse Duration	The maximum length of each search pulse; pulse terminates as soon as a sense is detected.
Wait	How long to wait between pulses; wait is at offset voltage.
Delta Voltage	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each Linear Ramp step is held; set Delta Time = 0 for Pulsed Ramp, using the same pulse duration and wait as the search.

The BSRHOV Action Tab screen is shown in Figure C.9.

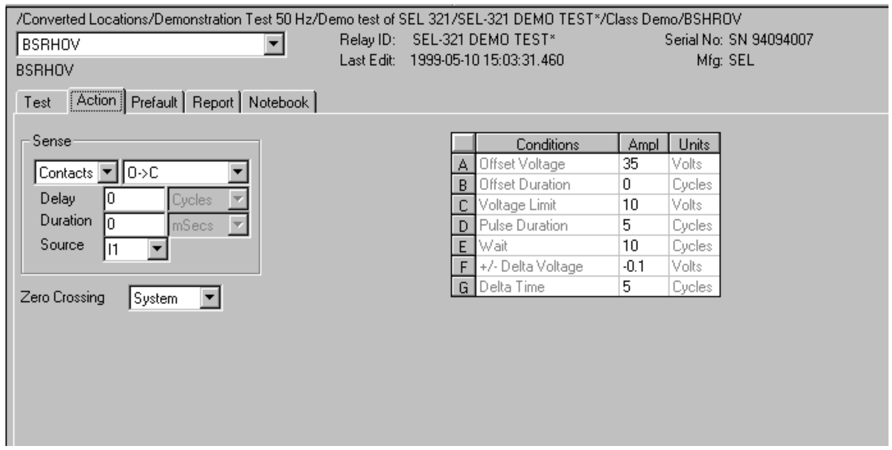


Figure C.9 BSRHOV Action Tab Screen

Sense

The BSRHOV Sense fields are explained in Table C.9.

Table C.9 BSRHOV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

After a small number of search pulses, the ramp begins. The test stops as soon as the ramp detects relay operation, normally after three or four steps, and the amplitude is recorded. If the relay does not operate after 15 ramp steps are taken, a No Op is recorded. No Op may be desired, if the relay is not supposed to operate.

Hints

- Use Offset Voltage = 0, and non-zero Offset Duration Action Delay if polarizing current must be applied before the Action.
- Use sense delay to ensure that the search converges to a value that can be detected with the ramp. A large amount may be required, for example, 25 to 50% of the pulse duration. This filters transient response to the leading edge of the pulse. If contact instability is also present, use sense duration as well.

Operation Graph

The BSRHOV Operation graph is shown in Figure C.10.

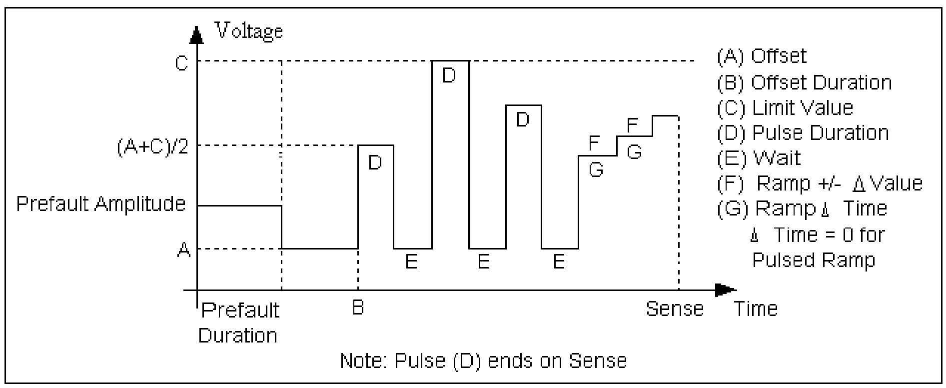


Figure C.10 BSRHOV Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins using faulted voltage and increasing current. The BSRHOV Prefault Tab fields are explained in Table C.10 on page C-22.

Operation

When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.10 BSRHOV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

CLOSEA - Close Angle, Voltage or Current - V ProTesTPLAN

Description

The phase angle of one or more sources rotates in one direction from an initial line angle offset, looking for lead dropout. Phase then returns to the offset and rotates in the other direction, looking for lag dropout. Lead and Lag are recorded. CLOSEA is a dropout test, very much the same as MAXTAV, Maximum Torque Angle test, but allows the user to specify a closing angle at which dropout is expected. CLOSEA can also be used as a pickup test.

Operation

The phase of all sources is ramped at the specified rate. Mark AC source phases *ACTION*, or *A–120* or *A+120* for phase offset, and enter values for amplitude and frequency.

Use

This macro tests phase and power swing relays.

NOTE

Both voltage and current phase action can be used.

Test Tab

On the CLOSEA Test Tab screen (Figure C.11 on page C-25):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Specify phase as *ACTION*, *A–120*, *A+120*, for example, and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The CLOSEA Test Tab Results fields are explained in Table C.11.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

Table C.11 CLOSEA Test Tab Results Fields

Field	Explanation
Close Angle	Specified angle where relay is expected to drop out.
Tolerance +/–	Angle tolerance for dropout.
Lead Dropout Angle	Recorded operate angle of relay in lead direction.
Lag Dropout Angle	Recorded operate angle of relay in lag direction.
Lead Error	Recorded difference between lead dropout angle value and the actual recorded value.
Lag Error	Recorded difference between lag dropout angle value and the actual recorded value.
Result	Pass/Fail.

The CLOSEA Test Tab screen is shown in Figure C.11.

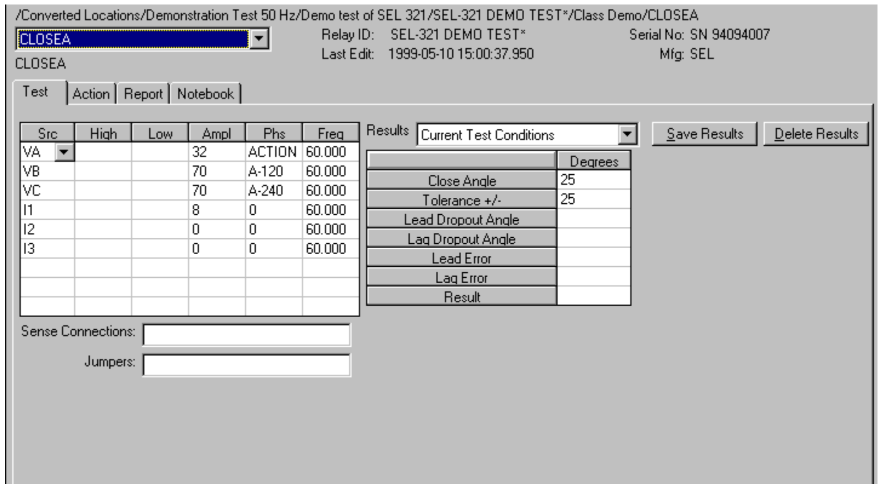


Figure C.11 CLOSEA Test Tab Screen

Action Tab

The CLOSEA Action Tab Conditions fields are explained in Table C.12.

Table C.12 CLOSEA Action Conditions Tab Fields

Field	Explanation
Line Angle	The initial phase for Action sources.
Line Angle Duration	How long to maintain the initial phase angle. Be sure it is long enough for the relay to pick up.
Delta Angle	The increment of phase rotation, in degrees.
Delta Time	How long to hold each phase step during rotation – measured in cycles.
Angle Limit	How far to go before stopping ramp if the relay does not operate – must be positive. The same limit is used in each direction.

The CLOSEA Action tab is shown in Figure C.12.

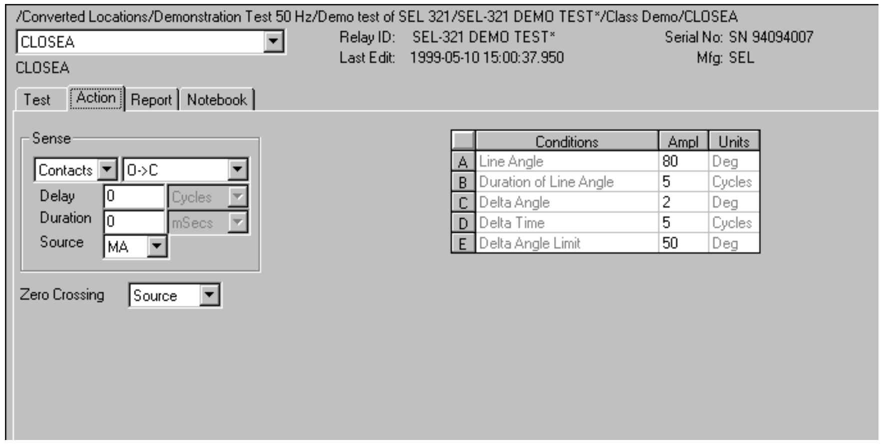


Figure C.12 CLOSEA Action Tab Screen

Sense

The CLOSEA Sense fields are explained in Table C.13.

Table C.13 CLOSEA Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

The test stops as soon as the relay operates and the phase is recorded. Phase returns to offset, waits, and begins ramping in the other direction. If the relay does not operate, a No Op is recorded.

Hints

Note that Angle Limit is the maximum displacement from the line angle that is allowed before a No Op is recorded.

Operation Graph

The CLOSEA Operation graph is shown in Figure C.13.

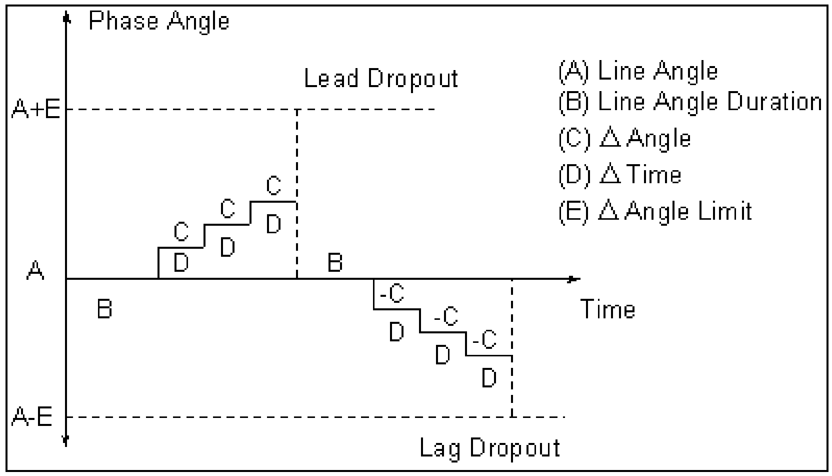


Figure C.13 CLOSEA Operation Graph

CREEPF - Manual Frequency Ramp - F ProTesTPLAN

Description

CREEPF allows the user to step the frequency up or down.

Operation

Test sources are initialized at the offset frequency. The next step requires the user to increment or decrement the frequency. Click the up or down spinner control on the Test in Progress Window, or use the Up arrow or Down arrow. Frequency changes by the delta frequency are specified on the Action tab. The macro ends when a sense signal occurs or when the user clicks Record or presses Enter to record visually detected operation.

Use

This macro manually tests frequency relays.

Notes

- Frequency values can be entered for the range 25 to 2000 Hz for the F6000, F225x, and up to 600 Hz for F2100, F2200, F2500, F2350, F27000; however, the test can run only if there is a harmonic that can cover the specified range.
- The minimum frequency step is 0.001 Hz at the base frequency for the F225x and the F6000, or 0.01 Hz otherwise. The minimum step is multiplied by the harmonic; e.g., 0.002 or 0.02 Hz at second harmonic.

Test Tab

On the CREEPF Test Tab screen (Figure C.14 on page C-30):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark source frequency *ACTION* and enter amplitude and phase values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Results — The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The CREEPF Test Tab Results fields are explained in Table C.14.

Save Results — Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.

Delete Results — Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

Table C.14 CREEPF Test Tab Results Fields

Field	Explanation
Expected F	Expected operate value, in Hz.
+ Hz/– Hz	Plus/minus tolerance in Hz, used for Pass/Fail calculation.
Actual	Recorded test result.
Error	Error in Hz.
Result	Pass/Fail indication.

The CREEPF Test Tab screen is shown in Figure C.14.

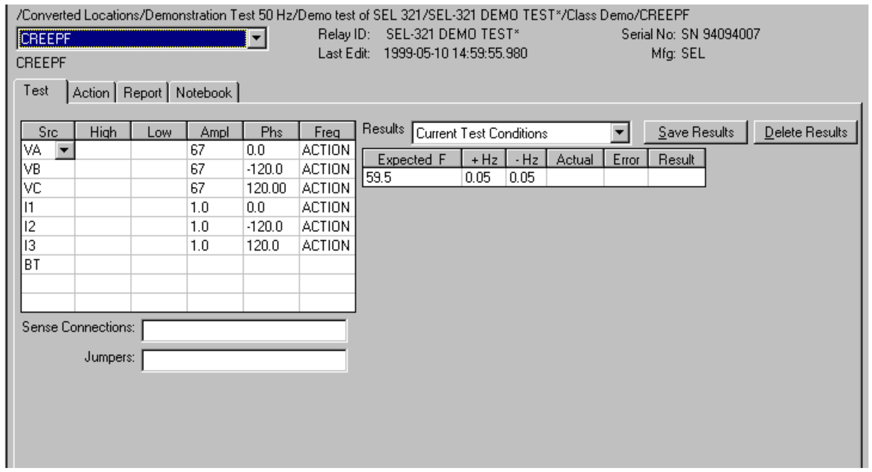


Figure C.14 CREEPF Test Tab Screen

Action Tab

The CREEPF Action Tab Conditions fields are explained in Table C.15.

Table C.15 CREEPF Action Tab Conditions Fields

Field	Explanation
Offset Frequency	The initial frequency for all Action sources, typically line frequency.
Offset Duration	How long to maintain the offset. Be sure it is long enough for the relay to initialize. In CREEPF, it is not important, because the Action does not begin until the user presses an Action key.
Frequency Limit	The frequency at which the ramp stops if Sense is not detected.
Delta Frequency	The +/– increment to be applied.

The CREEPF Action Tab screen is shown in Figure C.15.

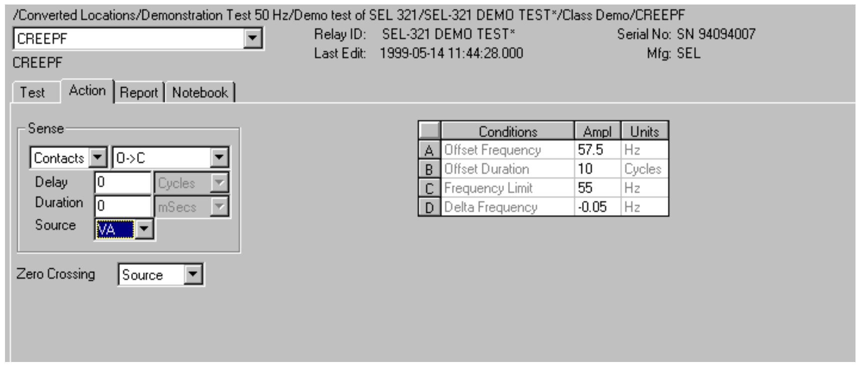


Figure C.15 CREEPF Action Tab Screen

Sense

The CREEPF Sense fields are explained in Table C.16.

Table C.16 CREEPF Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Raise and lower the action value by changing the delta frequency. The test stops as soon as the relay operates, or when Record is pressed and the result is recorded.

Operation Graph

The CREEPF Operation graph is shown in Figure C.16.

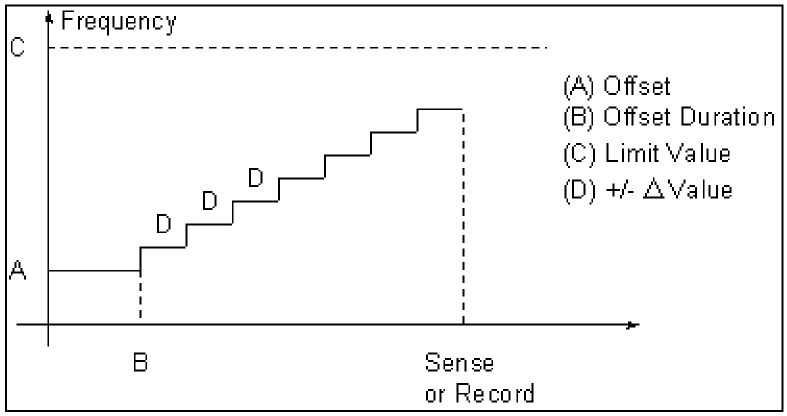


Figure C.16 CREEPF Operation Graph

CREEPI - Manual Current Ramp - I ProTesTPLAN

Description

CREEPI allows the user to step amplitude up or down.

Operation

Test sources are initialized and the Action Offset is applied. The next step requires the user to increment or decrement the current. Click the up or down spinner control on the Test in Progress Window, or use Up Arrow or Down Arrow. Source output changes by the delta current are specified on the Action tab. The macro ends when a sense signal occurs or when the user clicks Record or presses Enter to record visually detected operation.

Use

This macro records visually detected relay operation. For example, use a DC Action source to test an auxiliary relay or a relay target when no contact or voltage sense signal can be provided.

Notes

- Because each keyboard action to change amplitude requires ProTesT to send a command to the Instrument, entering inputs too fast can cause problems.
- If using the F2410 rectified DI source, once a test current has been applied, increments of current exhibit capacitive delay before changing to the new amplitude.

Test Tab

On the CREEPI Test tab (Figure C.17 on page C-35):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The CREEPI Test Tab Results fields are explained in Table C.17.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

Table C.17 CREEPI Test Tab Results Fields

Field	Explanation
Expected I	Expected operate value, in Amps.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The CREEPI Test Tab screen is shown in Figure C.17.

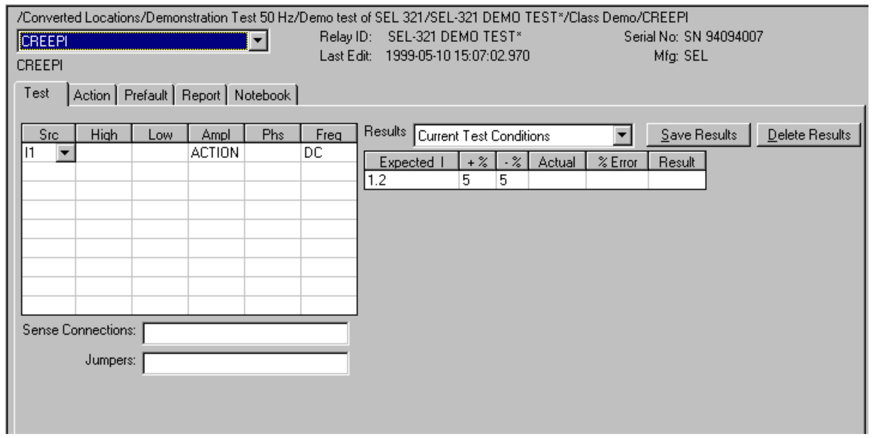


Figure C.17 CREEPI Test Tab Screen

Action Tab

The CREEPI Action Tab Conditions fields are explained in Table C.18.

Table C.18 CREEPI Action Tab Conditions Fields

Field	Explanation
Offset Current	The initial current for all Action sources, typically the normal load current.
Offset Duration	How long to maintain the offset. Be sure it is long enough for the relay to initialize. In CREEPI, it is not important, because the Action does not begin until the user presses an Action key.
Current Limit	The maximum or minimum test current. The larger of Offset or Limit determines the range selected.
Delta Current	The +/– increment to be applied.

The CREEPI Action Tab screen is shown in Figure C.18

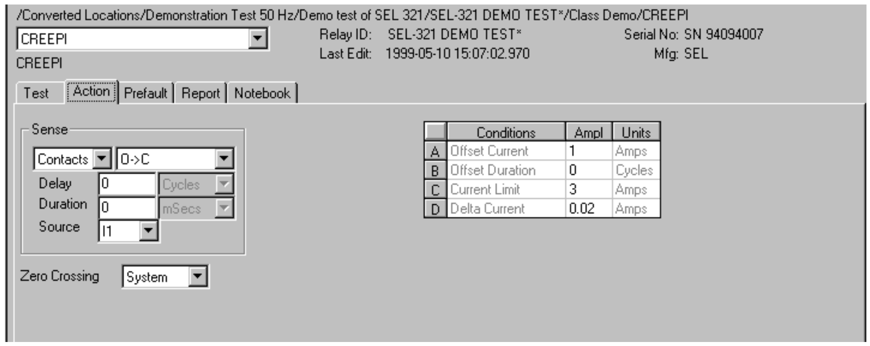


Figure C.18 CREEPI Action Tab Screen

Sense

The CREEPI Sense fields are explained in Table C.19.

Table C.19 CREEPI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

Raise and lower the action value by changing the delta frequency. The test stops as soon as the relay operates, or when Record is pressed and the result is recorded.

Operation Graph

The CREEPI Operation graph is shown in Figure C.19.

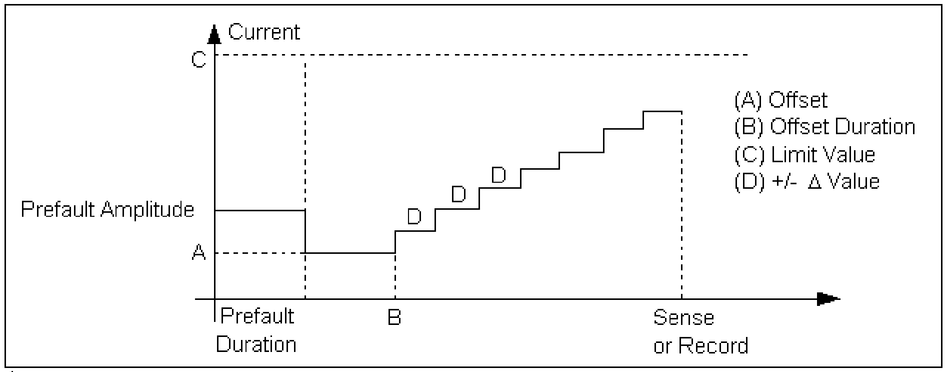


Figure C.19 CREEPI Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The CREEPI Prefault tab fields are explained in Table C.20.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.20 CREEPI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

CREEPV - Manual Voltage Ramp - V ProTesTPLAN

Description

CREEPV allows the user to control the up or down movement of the Action voltage.

Operation

Test sources are initialized and the Action Offset is applied. The next step requires the user to increment or decrement the frequency. Click the up or down spinner control on the Test in Progress Window, or use Up Arrow or Down Arrow. Frequency changes by the delta frequency specified on the Action tab. The macro ends when a sense signal occurs or when the user clicks Record or presses Enter to record visually detected operation.

Use

This macro records visually detected relay operation. For example, use DC Action to test an auxiliary relay or a relay target, when no contact or voltage sense signal can be provided.

Notes

- Since each keyboard action to change amplitude requires ProTesT to send a command to the Instrument, entering inputs too fast can cause problems.
- If using the F2410 rectified DV source, once a test voltage has been applied, increments of voltage exhibit capacitive delay before changing to the new amplitude.

Test Tab

On the CREEPV Test Tab screen (Figure C.20 on page C-40):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The CREEPV Test Tab Results fields are explained in Table C.21.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

Table C.21 CREEPV Test Tab Results Fields

Field	Explanation
Expected V	Expected operate value, in Volts.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The CREEPV Test Tab screen is shown in Figure C.20.

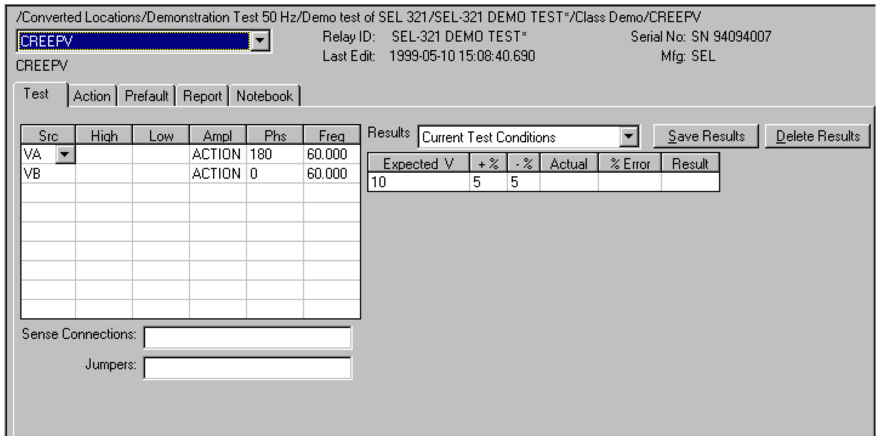


Figure C.20 CREEPV Test Tab Screen

Action Tab

The CREEPV Action Tab Conditions fields are explained in Table C.22.

Table C.22 CREEPV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial voltage for all Action sources, typically the normal load voltage.
Offset Duration	How long to maintain the offset. Be sure it is long enough for the relay to initialize. In CREEPV, it is not important, because the Action does not begin until the user presses an Action key.
Voltage Limit	The minimum or maximum test voltage. The larger of Offset or Limit determines the range selected.
Delta Voltage	The +/– increment to be applied with each press of an Action key.

The CREEPV Action Tab screen is shown in Figure C.21.

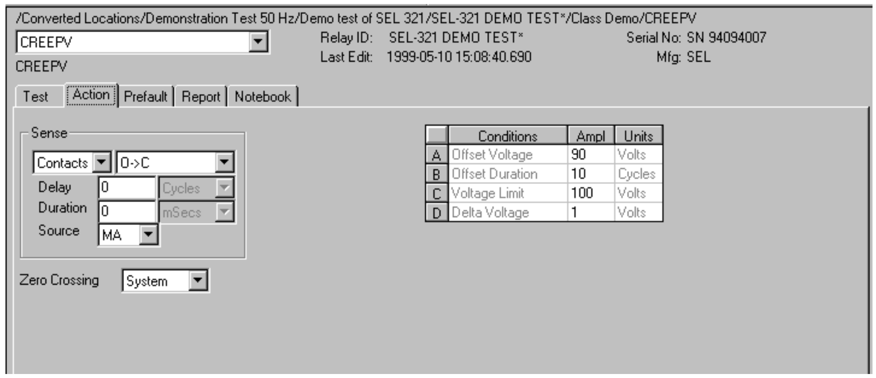


Figure C.21 CREEPV Action Tab Screen

Sense

The CLOSEA Sense fields are explained in Table C.23.

Table C.23 CLOSEA Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

Raise and lower the action value by the delta frequency. The test stops as soon as the relay operates, or when Record is pressed and the result is recorded.

Operation Graph

The CREEPV Operation graph is shown in Figure C.22.

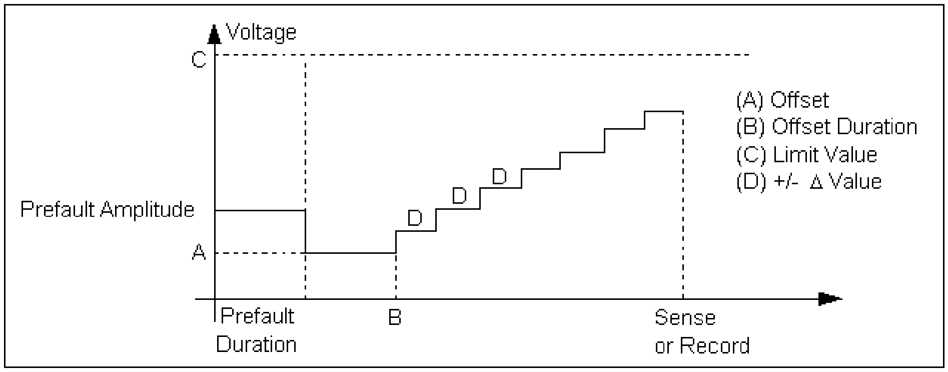


Figure C.22 CREEPV Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins using faulted voltage and increasing current. The CREEPV Prefault Tab fields are explained in Table C.24.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.24 CREEPV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set from the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

DRAMPI - Double Ramp Current - I ProTesTPLAN

Description

The amplitude of one or more current sources is ramped from an offset value toward a limit current. The ramp stops when the relay operates, or when the limit is reached. Current is held steady for the specified number of cycles, then ramps toward a second limit. The second ramp stops when the relay drops out, or when the second limit is reached. Expected values and pass/fail tolerances can be assigned for both pickup and dropout current. The macro can ramp from a high offset toward a low limit, and then ramp back toward a high limit; or, it can ramp from a low offset toward a high limit, and back.

Operation

An offset current is applied, and at the end of the offset duration, a sense check is performed to ensure that the relay has not already operated. The first current ramp stops when the relay operates or when the limit has been reached. The amplitude is then held for the wait time, which can be zero, and another sense check is performed to ensure that the relay has not already dropped out. Then the second ramp proceeds.

Use

This macro tests minimum pickup of current operated relays.

Notes

- Ramp 1 Limit and Ramp 2 Limit are independent of the Offset Current; i.e., the limit current can be higher or lower than the offset current.
- Normal operation assumes that relay pickup and dropout occurs in the range between Ramp 1 Limit and Ramp 2 Limit. If the relay operates between Offset and Ramp 2 Limit during Ramp 1, however, the ramp will reverse direction and never reach the second limit. A No Op will be recorded.

Test Tab

On the DRAMPI Test Tab screen (Figure C.23):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The DRAMPI Test Tab Results fields are explained in Table C.25.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

Table C.25 DRAMPI Test Tab Results Fields

Field	Explanation
Expected I 1	Expected operate Current for Ramp 1.
Expected I 2	Expected operate Current for Ramp 2.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The DRAMPI Test Tab screen is shown in Figure C.23.

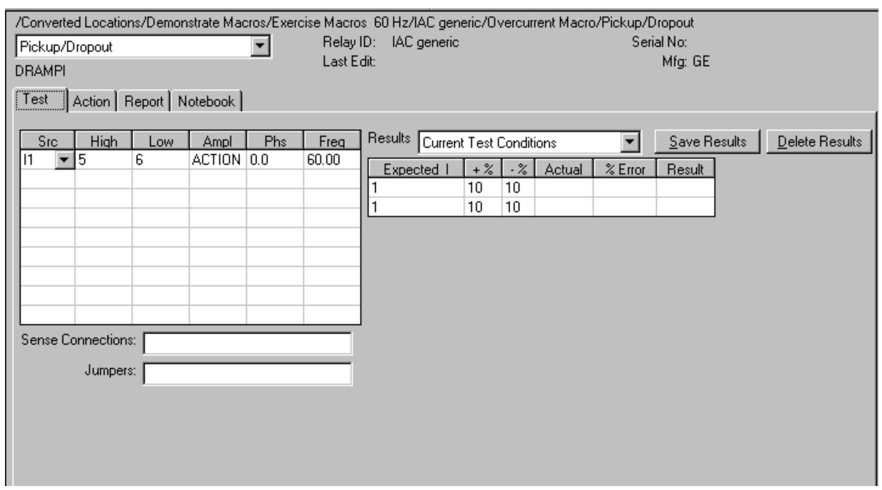


Figure C.23 DRAMPI Test Tab Screen

Action Tab

The DRAMPI Action Tab Conditions fields are explained in Table C.26.

Table C.26 DRAMPI Action Tab Conditions Fields

Field	Explanation
Offset Current	Initial current for all Action sources.
Offset Duration	How long to maintain the offset. Can be 0 cycles.
Delta Current #1	Step size of first ramp. Use a minus sign for a downward ramp.
Delta Time #1	How long each ramp step is held waiting for a sense, given in cycles.
Ramp 1 Limit	Current at which the ramp stops if the relay does not operate. Source range is determined by maximum of Offset, Ramp 1 limit, and Ramp 2 limit.
Wait	How long to wait before beginning Ramp 2. A sense check is performed before Ramp 2 begins.
Delta Current #2	Signed step size of second ramp.
Delta Time #2	Step length of second ramp.
Ramp 2 Limit	Current at which the ramp stops if the relay does not operate.

The DRAMPI Action Tab screen is shown in Figure C.24.

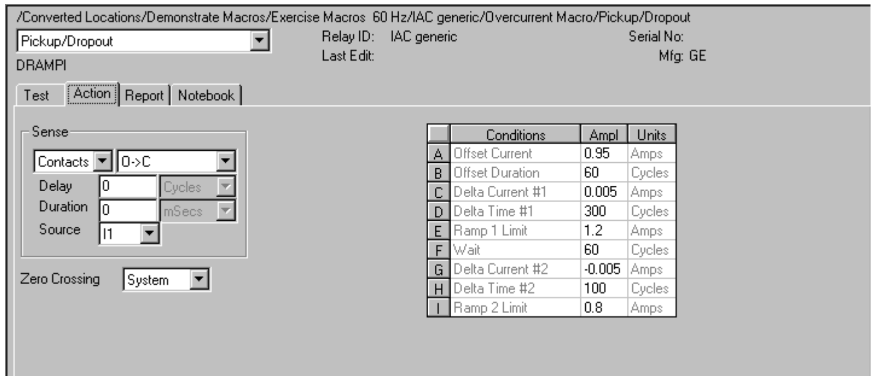


Figure C.24 DRAMPI Action Tab Screen

Sense

The DRAMPI Sense fields are explained in Table C.27.

Table C.27 DRAMPI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

When the relay operates, the pickup current is recorded. After the Wait time, Ramp 2 begins and the dropout current is recorded. If the relay does not operate on either ramp, a No Op is recorded.

Operation Graph

The DRAMPI Operation graph is shown in Figure C.25.

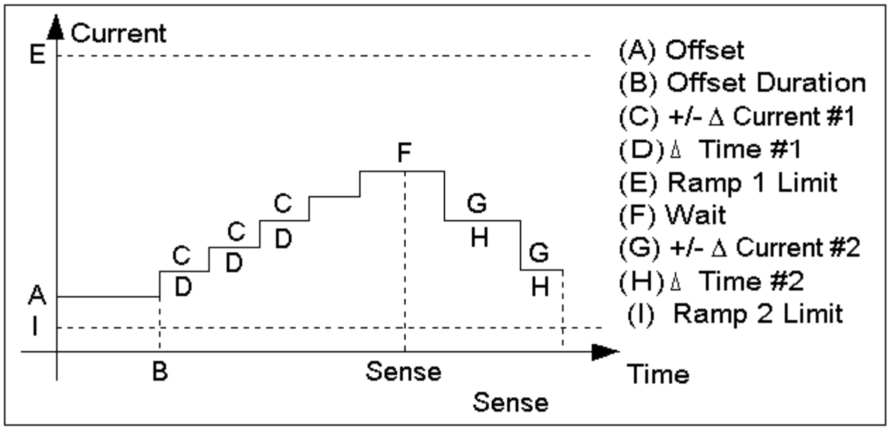


Figure C.25 DRAMPI Operation Graph

DRAMPV - Double Ramp Voltage - V ProTesTPLAN

Description

The amplitude of one or more voltage sources is ramped from an offset value toward a limit voltage. The ramp stops when the relay operates, or when the limit is reached. Voltage is held steady for the specified number of cycles, then ramps toward a second limit. The second ramp stops when the relay drops out, or when the second limit is reached. Expected values and pass/fail tolerances can be given for both pickup and dropout voltage. The macro can ramp from a high offset toward a low limit, and then ramp back toward a high limit; or, it can ramp from a low offset toward a high limit, and back.

Operation

An offset voltage is applied, and at the end of the offset duration, a sense check is performed to ensure that the relay has not already operated. The first voltage ramp stops when the relay operates or the limit has been reached. The amplitude is then held for the wait time, which can be zero, and another sense check is performed, to ensure that the relay has not already dropped out. Then the second ramp proceeds.

Use

This macro tests minimum pickup of voltage operated relays.

Notes

- Ramp 1 Limit and Ramp 2 Limit are independent of the Offset Voltage; i.e., the limit voltage can be higher or lower than the offset voltage.
- Normal operation assumes that relay pickup and dropout occurs in the range between Ramp 1 Limit and Ramp 2 Limit. If the relay operates between Offset and Ramp 2 Limit during Ramp 1, however, the ramp will reverse direction and never reach the second limit. A No Op will be recorded.

Test Tab

On the DRAMPV Test Tab screen (Figure C.26):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The DRAMPV Test Tab Results fields are explained in Table C.28.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.28 DRAMPV Test Tab Results Fields

Field	Explanation
Expected V 1	Expected operate voltage for Ramp 1.
Expected V 2	Expected operate voltage for Ramp 2.
+% / –%	Plus/minus tolerance percentage used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Percent error.
Result	Pass/Fail indication.

The DRAMPV Test Tab screen is shown in Figure C.26

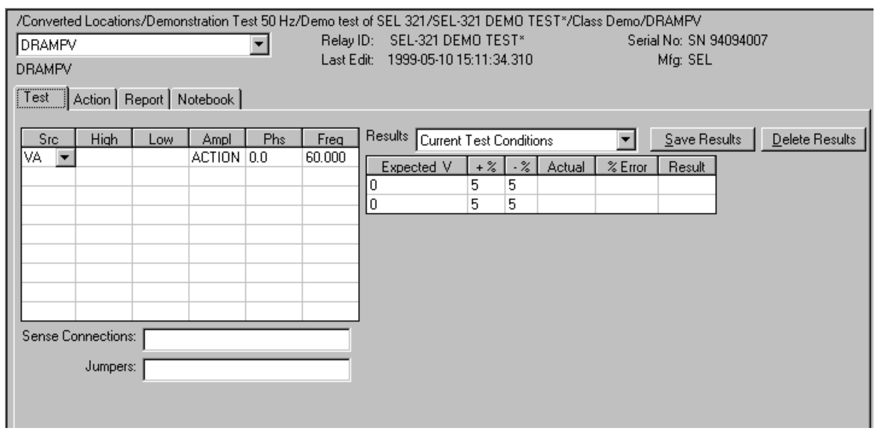


Figure C.26 DRAMPV Test Tab Screen

Action Tab

The DRAMPV Action Tab Conditions fields are explained in Table C.29.

Table C.29 DRAMPV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	Initial voltage for all Action sources.
Offset Duration	How long to maintain the offset. Can be 0 cycles.
Delta Voltage #1	Step size of first ramp. Use a minus sign for a downward ramp.
Delta Time #1	How long each ramp step is held, waiting for a sense, given in cycles.
Ramp 1 Limit	Voltage at which the ramp stops if the relay does not operate. Source range is determined by maximum of Offset, Ramp 1 limit, and Ramp 2 limit.
Wait	How long to wait before beginning Ramp 2. A sense check is performed before Ramp 2 begins.
Delta Voltage #2	Signed step size of second ramp.
Delta Time #2	Step length of second ramp.
Ramp 2 Limit	Voltage at which the ramp stops if the relay does not operate.

The DRAMPV Action Tab screen is shown in Figure C.27

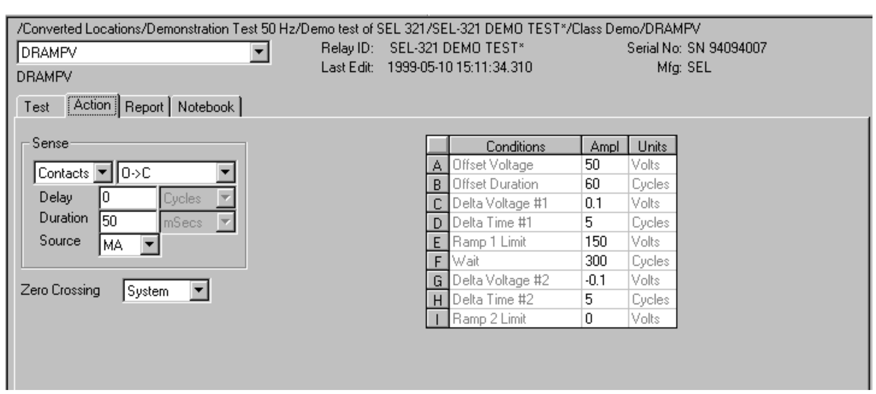


Figure C.27 DRAMPV Action Tab Screen

Sense

The DRAMPV Sense fields are explained in Table C.30.

Table C.30 DRAMPV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Voltage action begins with Ramp 1. When the relay operates the pickup voltage is recorded. After the Wait time, Ramp 2 begins and the dropout voltage is recorded. If the relay does not operate, a No Op is recorded.

Operation Graph

The DRAMPV Operation graph is shown in Figure C.28.

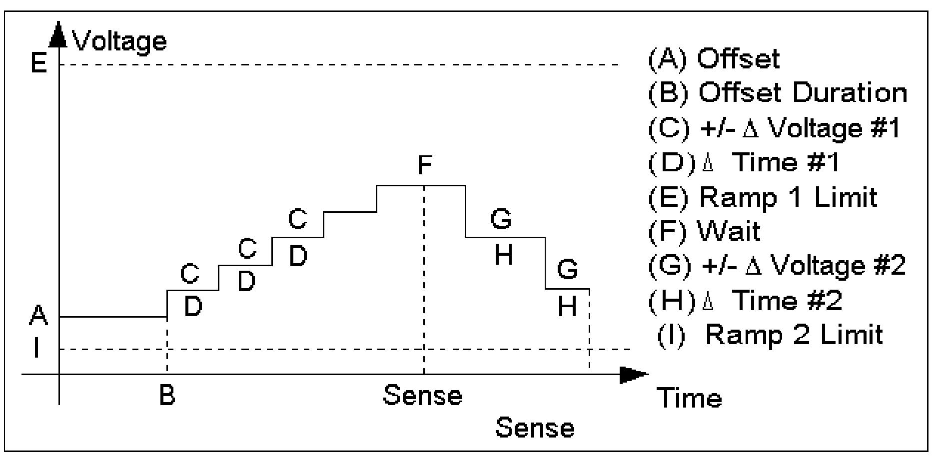


Figure C.28 DRAMPV Operation Graph

EXTERN - Run External Program - All ProTesTPLANS

Description

EXTERN allows for the use of an external program.

Operation

When EXTERN is run, ProTesT executes the specified command line, similar to Start | Run from the Windows task bar. When a macro is run, it launches a user-specified program in the specified drive and path. Command line arguments can be specified. If the external program accepts input from an ASCII file, notebook text can be exported to a file from the Notebook page of the EXTERN Macro, Originator side. Text will be exported to the file named as Input Filename. If the program produces text file output, identified as Output Filename, the text file can be viewed using the Open button on the user side of Notebook.

Use

This macro executes a program to alter settings or to retrieve event data from a microprocessor relay.

Setting changes can be passed via a script recorded in the Notebook and written to a file read by the program called to communicate with the relay.

Notes

- EXTERN runs automatically with AUTORUN.
- The program executed can be a Windows program or a DOS program.

Test Tab

On the EXTERN Test Tab screen (Figure C.29):

Browse	Use this button to open a window to locate a program and optional input or output files.
Open	Use this button to examine the contents of the input file or the output file after the macro has run.

The EXTERN Test Tab Fields are explained in Table C.31.

Table C.31 EXTERN Test Tab Fields

Field	Explanation
Working Directory	Startup path for external program. If program is in the file path, and if changing to the startup directory is not required, this can be left blank. Default Path is the current database path.
Program Name	Command line name to execute program; does not require .EXE, .BAT, or .COM extension.
Arguments	Optional command line arguments. Could also be included with the program name.
File to External Program	File path of optional ASCII input file to the program. Text data will be written to that file from the Originator side of the Notebook.
File from External Program	File path of optional output file from the program. If program writes text output to a file, it will be imported into the User side of the Notebook.
Append Data from External Program	Select the check box if output is to be appended, rather than overwriting previous contents of the output file.

The EXTERN Test Tab screen is shown in Figure C.29

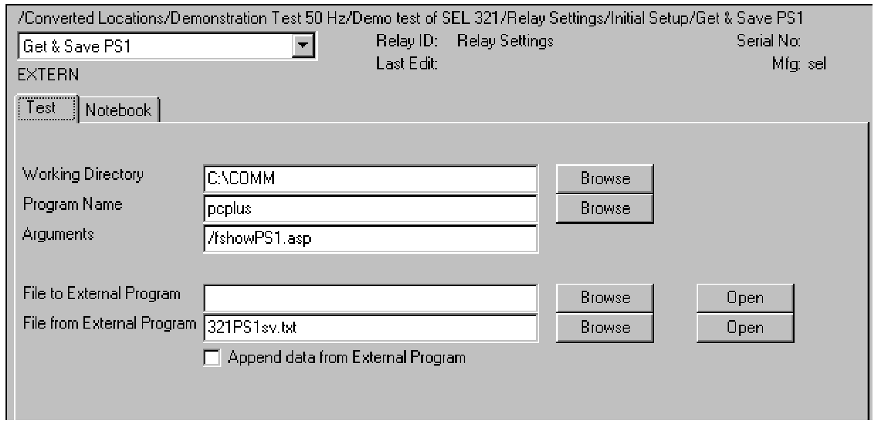


Figure C.29 EXTERN Test Tab Screen

Notebook Tab

Select the Notebook tab and enter text on the Originator side to create a file that can be read by the external program. When EXTERN is Run, the ASCII text is written to the program's Input Filename indicated.

FRDRMP - Frequency Double Ramp - F ProTesTPLAN

Description

The frequency of one or more sources is ramped from an offset value toward a limit frequency. The ramp stops when the relay picks up, or when the limit is reached. The frequency is held steady for a specified number of cycles, then ramps toward a second limit. The second ramp stops when the relay drops out, or when the second limit is reached. Expected values and pass/fail tolerances, in Hertz, can be given for both relay pickup and dropout.

Operation

The frequency of all sources is ramped from offset toward the Ramp 1 limit at the specified Hertz/second rate. Relay pickup stops Ramp 1; otherwise the ramp goes to the first limit. After a wait, Ramp 2 begins.

Sources can be at different harmonics; e.g. one current can be at 60 Hz (or 50 Hz), and another at 120 Hz (or 100 Hz), to test harmonic restraint on a differential relay.

Use

This macro tests frequency and differential relays.

Notes

- F2100, F2200, F2500, F2350 and F2700 instruments cannot ramp frequency at a rate slower than 0.02 Hz/sec. Even though frequency can be specified to 0.01 Hz, a ramp rate of 0.01 Hz/sec cannot be used. Ramp rates above 10 Hz/sec can be specified only to 0.10 Hz/sec.
- F225x and F6000 family instruments can ramp at a rate down to 0.001 Hz/sec.
- One source can have an Action frequency, while all others are at base frequency, as long as the Action is Source 1 of the Master F2000 (Source 1 is the top source on the F2000.) Any source on the F6000 can be Action. Enter ACTION for one source frequency, and indicate the frequency reference for the others: FX (crystal) or FL (line). When the test is run, ProTesT will verify that the Action source is indeed Source 1 of the Master.

- The F6000 does not have FL or FE setting. Map this to the FX setting.
- Source 1 of the Master can, instead, be set to FX base frequency, and all other sources can have ACTION frequency. Any source on the F6000 can be FX.
- F2000 base frequency has a range of 25 to 99.99 Hz. Harmonics allow frequencies up to 600 Hz. Macro frequencies can be specified up to 600 Hz as long as ProTesT can find a harmonic to cover the required range. F2250 Power System Simulators have a frequency range from 10 to 1999 Hz.

Test Tab

On the FRDRMP Test Tab screen (Figure C.30):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source frequency *ACTION* and enter amplitude and phase values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The FRDRMP Test Tab Results fields are explained in Table C.32.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.32 FRDRMP Test Tab Results Fields

Field	Explanation
Expected F	Expected operate frequency for RAMP.
+ Hz/– Hz	Plus/minus tolerance in Hz used for Pass/Fail calculation.
Actual	Recorded test result.
Error Hz	Error in Hertz.
Result	Pass/Fail indication.

The FRDRMP Test Tab screen is shown in Figure C.30.

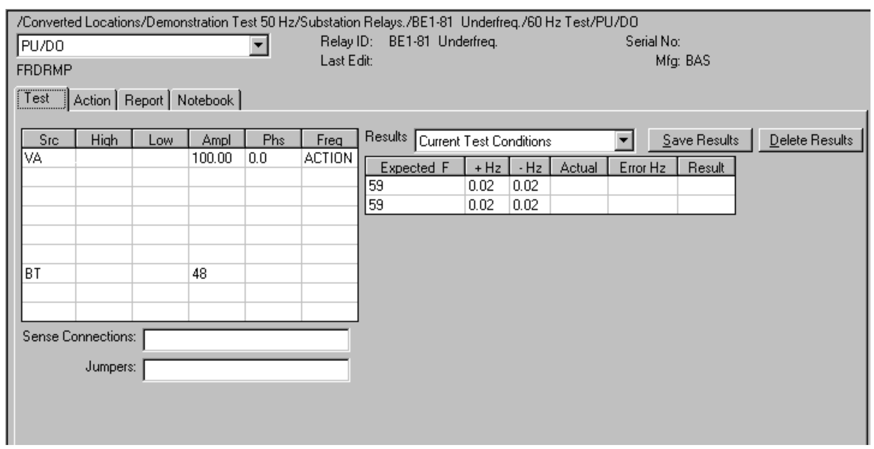


Figure C.30 FRDRMP Test Tab Screen

Action Tab

The FRDRMP Action Tab Conditions fields are explained in Table C.33.

Table C.33 FRDRMP Action Tab Conditions Fields

Field	Explanation
Offset Frequency	Initial frequency for all Action sources.
Offset Duration	How long to maintain the offset. Note that offset duration is measured in Offset Frequency cycles.
Ramp 1 Rate	Rate of frequency change for Ramp 1. Rate is +/– Hz/second; i.e., frequency varies continually with every reference cycle.
Ramp 1 Limit	Frequency at which the Ramp 1 stops; ramp also stops when a sense occurs.
Wait	How many cycles to wait before beginning Ramp 2. Note that Wait is measured in cycles of the frequency in effect at the time.
Ramp 2 Rate	Rate of frequency change for Ramp 2. Rate is +/– Hz/second; i.e., frequency varies continually with every reference cycle. Ramp 2 must be opposite in sign to Ramp 1.
Ramp 2 Limit	Frequency at which the second ramp stops; ramp also stops when a sense occurs. Ramp 2 Limit can be either lower or higher than Ramp 1 Limit or the Offset Frequency.

The FRDRMP Action Tab screen is shown in Figure C.31.

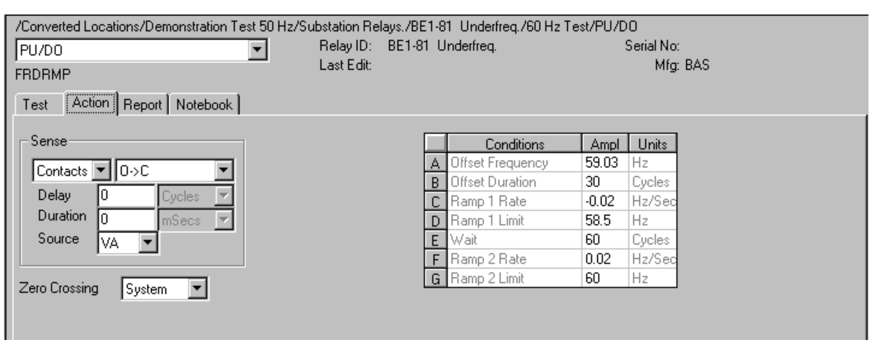


Figure C.31 FRDRMP Action Tab Screen

Sense

The FRDRMP Sense fields are explained in Table C.34.

Table C.34 FRDRMP Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Ramp 1 begins; when the relay operates, and the pickup frequency is recorded. After the Wait time, Ramp 2 begins and the dropout frequency is recorded. If the relay does not operate, a No Op is recorded.

Hints

Use Sense Delay or Sense Duration to ensure solid relay pickup. If a relay is unstable at the pickup point, the down ramp reports a Sense Check; i.e, the relay has already appeared to dropout before Ramp 2 begins.

Operation Graph

The FRDRMP Operation graph is shown in Figure C.32.

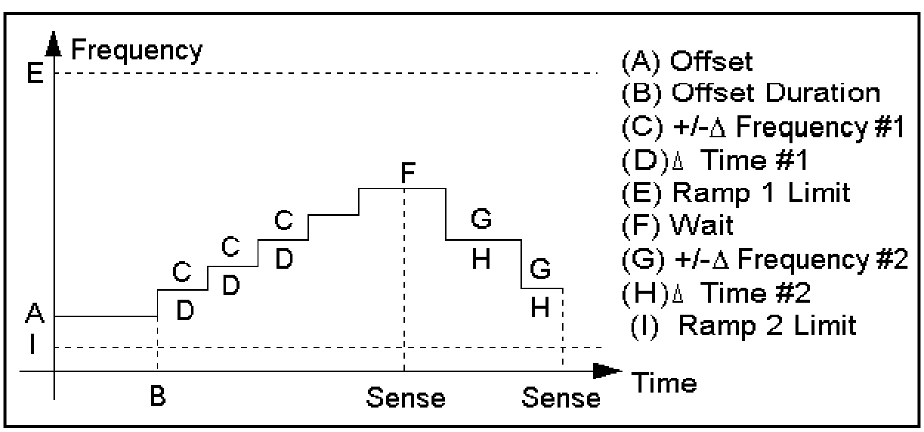


Figure C.32 FRDRMP Operation Graph

FRRMPT - Frequency Ramp, Timer Start - F ProTesTPLAN

Description

The frequency of one or more sources is ramped from an offset value toward a limit frequency. The timer starts when a trigger frequency is reached, to measure relay operate time. Time is displayed in user selected units (mSec/Sec/Cycles).

Operation

The frequency of all sources is ramped at the specified Hertz/second rate, and the timer starts at the specified trigger frequency.

Set Max On Time = 0, and set the Timer Start Frequency to any value between offset and limit. The relay is expected to operate before the Frequency Limit is reached, which terminates the test.

Sources can be at different harmonics; e.g. one current can be at 60 Hz (or 50 Hz), and another at 120 Hz (or 100 Hz), to test harmonic restraint on a differential relay.

Use

This macro tests frequency and differential relays.

Notes

- An optional Maximum On Time can be specified, which holds the sources at the frequency limit for a specified number of seconds. If Max On Time > 0, relay operation must occur while the sources are at the Frequency Limit, otherwise, no sense will be recorded. Recommended Value = 0.
- One source can have an Action frequency, while all others are at base frequency, as long as the Action is Source 1 of the Master F2000. Source 1 is the top source on the F2000. Any source on the F6000 can be Action. Enter ACTION for one source frequency, and indicate the frequency reference for the others: FX (crystal) or FL (line). When the Test is run, ProTesT will verify that the Action source is indeed Source 1 of the Master.
- The F6000 does not have FL or FE setting. Map this to the FX setting.

- Source 1 of the Master can, instead, be set to FX or FL base frequency, and all other sources can have ACTION frequency. Any source on the F6000 can be FX.
- F2250 Power System Simulators can ramp frequency down to 0.001 Hz/sec; however, F2100, F2200, F2500, and F2350 instruments cannot ramp slower than 0.02 Hz/sec.
- Pulse mode sense (e.g., O–>C–>O) cannot be used.
- F2000 base frequency has a range of 25 to 99.99 Hz. Harmonics allow frequencies up to 1999 Hz in F225x, 600 Hz otherwise. Macro frequencies can be specified up to 600 Hz as long as ProTesT can find a harmonic to cover the required range.

Test Tab

On the FRRMPT Test Tab screen (Figure C.33 on page C-66):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source frequency *ACTION* and enter amplitude and phase values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The FRRMPT Test Tab Results fields are explained in Table C.35 on page C-66.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

Table C.35 FRRMPT Test Table Results Fields

Field	Explanation
Expected Time	Expected operate time.
+ %/- %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
Error	Error.
Result	Pass/Fail indication.
Time Units	mSec, and Sec, and Cycles. (Units of expected actual times).

The FRRMPT Test Tab screen is shown in Figure C.33.

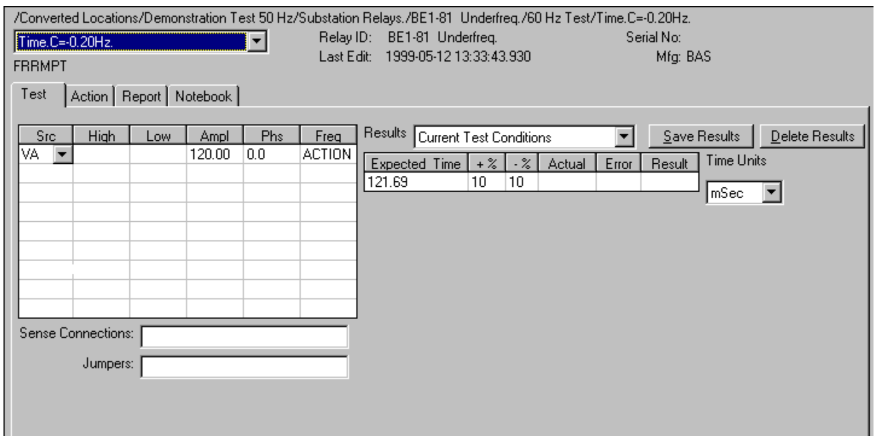


Figure C.33 FRRMPT Test Tab Screen

Action Tab

The FRRMPT Action Tab Conditions fields are explained in Table C.36.

Table C.36 FRRMPT Action Tab Conditions Fields

Offset Frequency	Initial frequency for all Action sources.
Offset Duration	How long to maintain the offset. Note that offset duration is measured in Offset Frequency cycles.
Ramp Rate	Rate of change of frequency. Rate is in Hz/second; i.e., frequency varies continually with every reference cycle.
Frequency Limit	The ramp stops when this frequency is reached.
Timer Start Frequency	When ramping frequency reaches this trigger value, the timer starts. **NOTE: Use the actual operating relay frequency to start this timer.**
Max On Time	Set to 0 unless relay operation is expected to occur after Frequency Limit has been reached.

The FRRMPT Action Tab screen is shown in Figure C.34.

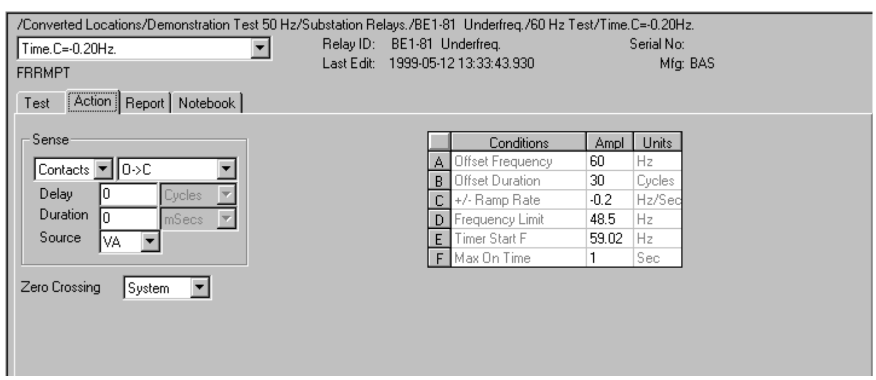


Figure C.34 FRRMPT Action Tab Screen

Sense

The FRRMPT Sense fields are explained in Table C.37.

Table C.37 FRRMPT Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Frequency action then begins. The test stops as soon as the relay operates and the phase is recorded. If the relay does not operate, a No Op is recorded.

Operation Graph

The FRRMPT Operation graph is shown in Figure C.35.

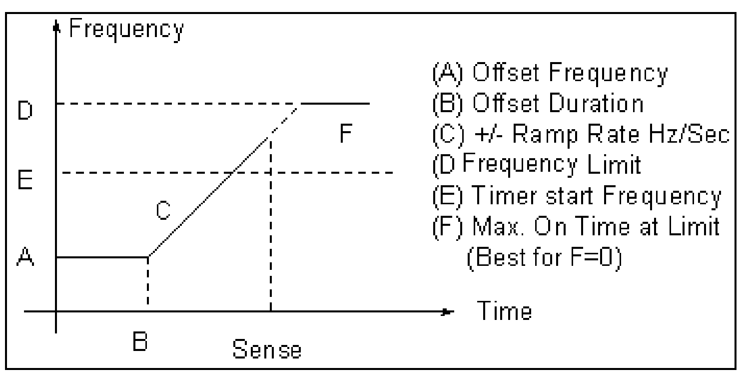


Figure C.35 FRRMPT Operation Graph

GONGOF - Go/No Go Frequency Test - F ProTesTPLAN, V ProTesTPLAN

Description

One or more test sources are set to initial values, and a frequency step change is applied. If the relay operates, when the Expected Value is set to Op, the result is Pass. If the relay does not operate before Maximum On Time expires, the result is Fail.

Operation

GONGOF does an A to B frequency step change. It is also possible for one source to be an Action frequency, while all others are at base frequency, as long as the Action is Source 1 of the Master F2000 or the F6000. Enter ACTION for one source frequency, and indicate the frequency reference for the others: FX (crystal) or FL (line). When the Test is run, ProTesT will verify that the Action source is indeed Source 1 of the Master or F6000.

Use

This macro tests frequency and differential relays.

Notes

- Time intervals for offset and Maximum On Time are measured in cycles at the base frequency in effect at that time; i.e., the two durations may be cycles at different frequencies.
- One source can have an Action frequency, while all others are at base frequency, as long as the Action is Source 1 of the Master F2000 or F6000. Any source on the F6000 can be Action. Enter ACTION for one source frequency, and indicate the frequency reference for the others: FX or FL. When the Test is run, ProTesT will verify that the Action source is indeed Source 1 of the Master.
- The F6000 does not have FL or FE setting. Map this to the FX setting.

- Source 1 of the Master can, instead, be set to crystal (FX) base frequency, and all other sources can have ACTION frequency. Any source on the F6000 can be FX.
- F2000 base frequency has a range of 25 to 99.99 Hz. Harmonics allow frequencies up to 600 Hz. Macro frequencies can be specified up to 600 Hz as long as ProTesT can find a harmonic to cover the required range. F2250 Power System Simulators have a frequency range from 10 to 1999 Hz.

Test Tab

On the GONGOF Test Tab screen (Figure C.36):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source frequency *ACTION* and enter amplitude and phase values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The GONGOF Test Tab Results fields are explained in Table C.38.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.38 GONGOF Test Tab Results Fields

Field	Explanation
Expected Value	Select Op (for operate) or No Op as desired result.
Result	Pass/Fail.

The GONGOF Test Tab screen is shown in Figure C.36.

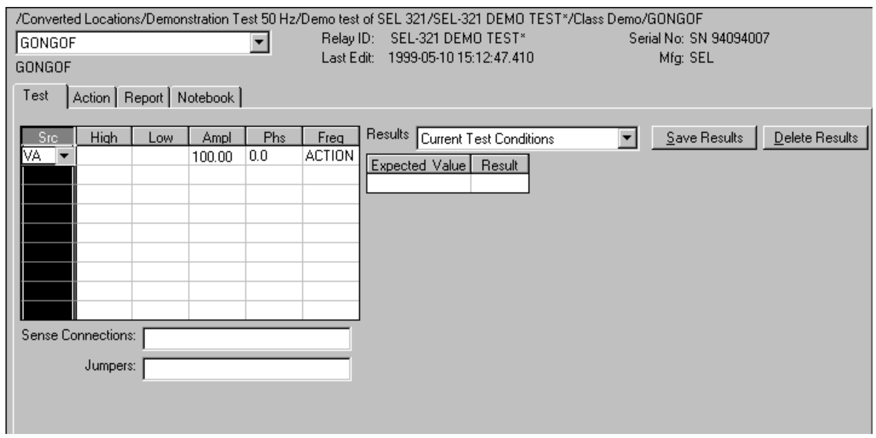


Figure C.36 GONGOF Test Tab Screen

Action Tab

The GONGOF Action Tab Conditions fields are explained in Table C.39.

Table C.39 GONGOF Action Tab Conditions fields

Field	Explanation
Offset Frequency	The initial frequency for all Action sources, typically the normal value.
Offset Duration	How long to maintain the offset, in Offset Frequency cycles. Be sure it is long enough for the relay to initialize.
Test Frequency	The test frequency to apply.
Max On Time	How long to maintain the test frequency, in Test Frequency cycles. Be sure it is long enough for the relay to sense and respond.

The GONGOF Action Tab screen is shown in Figure C.37.

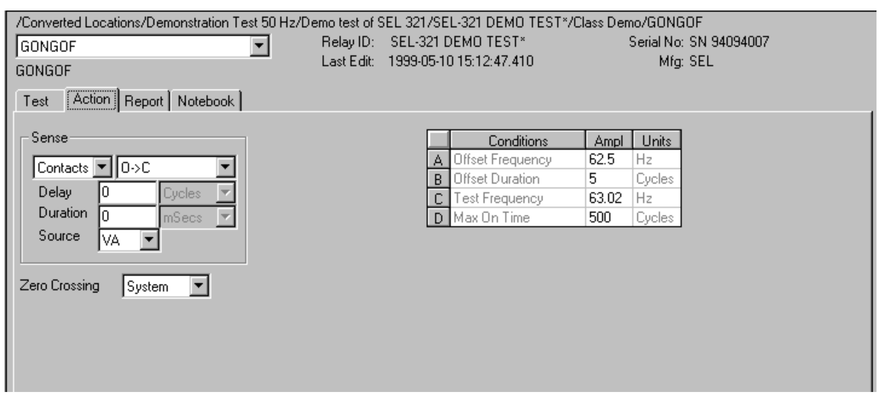


Figure C.37 GONGOF Action Tab Screen

Sense

The GONGOF Sense fields are explained in Table C.40.

Table C.40 GONGOF Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Frequency action then begins. The test stops as soon as the relay operates or maximum on time is reached and the result is recorded as Pass or Fail.

Operation Graph

The GONGOF Operation Graph is shown in Figure C.38.

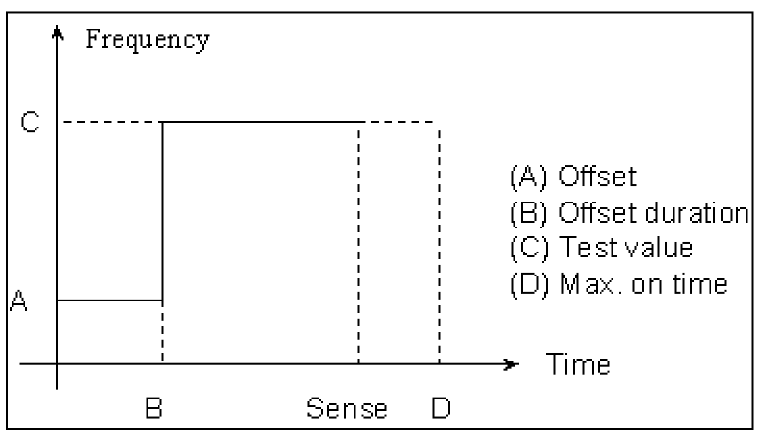


Figure C.38 GONGOF Operation Graph

GONGOI - Go/No-Go Current Test - I ProTesTPLAN, Z ProTesTPLAN

Description

One or more test sources are set to initial values, and a current step change is applied. If the relay operates, when the Expected Value is set to Op, the result is Pass. If the relay does not operate before Maximum On Time expires, the result is Fail.

Operation

GONGOI does an A to B current step change.

Use

This macro performs setpoint testing of overcurrent relays. Use DC Action source to test a relay target, when contact or voltage sense signal can be provided.

Notes

- To use DC Action, set Action current frequency to DC; to use the F2410 rectified DC source, use the source name DI. Phase should be left blank.
- With DC Action on the F2410, use an offset of 0 volts, and a non-zero test current (or vice versa), to ensure a sharp DC current transition, because of capacitive delay.
- With DC Action on the F2410, Pulse Duration should be at least 1.5 seconds (90 cycles at 60 Hz) to allow the F2410 to energize to the test current, when going from 0 to test voltage. When going from an elevated offset voltage to 0, Offset Duration should be greater than 1.5 seconds (90 cycles at 60 Hz). F225x and F6000 DC sources respond immediately.

Test Tab

On the GONGOI Test Tab screen (Figure C.39 on page C-76):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values, except in the case of DC tests.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The GONGOI Test Tab Results fields are explained in Table C.41.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.41 GONGOI Test Tab Results Fields

Field	Explanation
Expected Value	Select Op or No Op as desired result.
Result	Pass/Fail.

The GONGOI Test Tab screen is shown in Figure C.39.

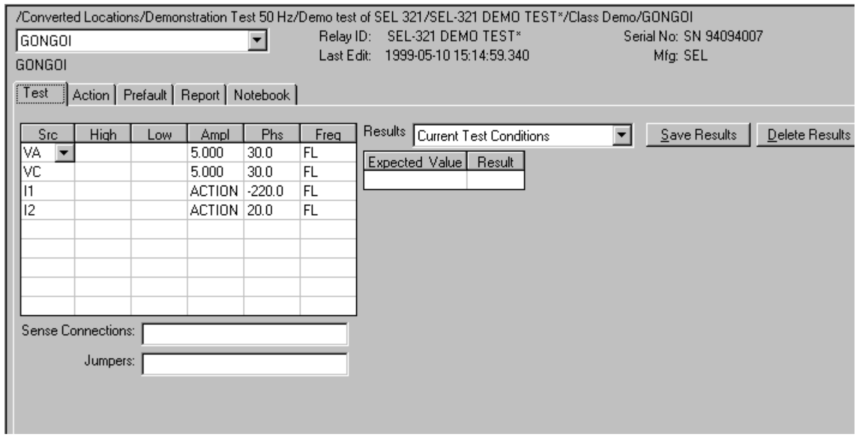


Figure C.39 GONGOI Test Tab Screen

Action Tab

The GONGOI Action Tab Conditions fields are explained in Table C.42.

Table C.42 GONGOI Action Tab Conditions Fields

Field	Explanation
Offset Current	The initial current for all Action sources, typically the normal load current.
Offset Duration	How long to maintain the offset. Be sure it is long enough for the relay to initialize.
Test Current	The test current to apply.
Max On Time	How long to maintain the test current. Be sure it is long enough for the relay to sense and respond.

The GONGOI Action Tab screen is shown in Figure C.40.

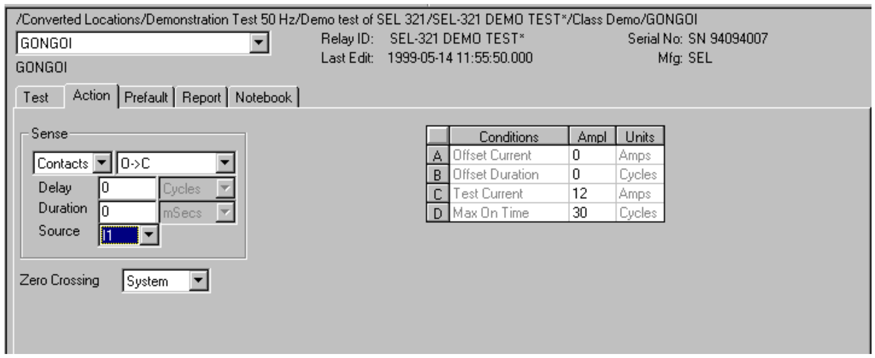


Figure C.40 GONGOI Action Tab Screen

Sense

The GONGOI Sense fields are explained in Table C.43.

Table C.43 GONGOI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Prefault values, move to offset values and then to Action values.

Current action begins. The test stops as soon as the relay operates or the maximum on time is reached, and the result is recorded as either Pass or Fail.

Operation Graph

The GONGOI Operation graph is shown in Figure C.41.

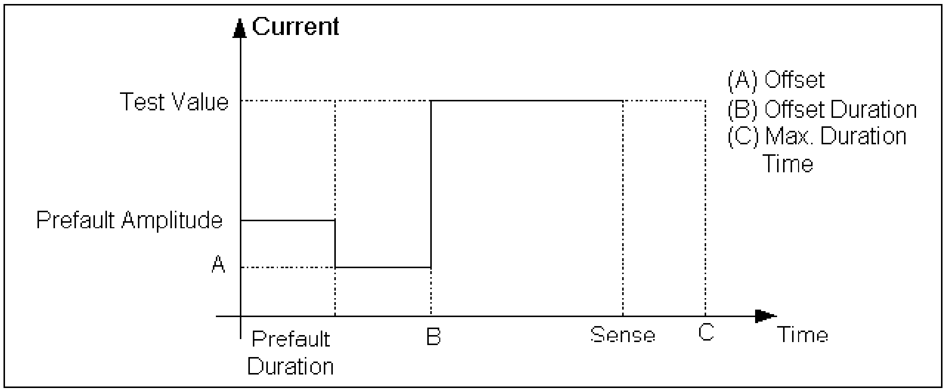


Figure C.41 GONGOI Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

The GONGOI Prefault Tab fields are explained in Table C.44.

Table C.44 GONGOI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

GONGOV - Go/No-Go Voltage Test - V ProTesTPLAN, Z ProTesTPLAN

Description

One or more test sources are set to initial values, and a voltage step change is applied. If the relay operates, when the Expected Value is set to Op, the result is Pass. If the relay does not operate before Maximum On Time expires, the result is Fail.

Operation

GONGOV does an A to B voltage step change.

Use

This macro performs setpoint testing on under/overvoltage relays. Use DC Action source to test an auxiliary relay or a relay target when contact or voltage sense signal can be provided.

Notes

- To use DC Action, set Action current voltage to DC; to use the F2410 rectified DC source, use the source name DV. Phase should be left blank.
- With DC Action on F2410, use an offset of 0 volts, and a non-zero test voltage (or vice versa), to ensure a sharp DC voltage transition.
- With DC Action on F2410, Pulse Duration should be at least 1.5 seconds (90 cycles at 60 Hz) to allow the F2410 to energize to the test voltage, when going from 0 to test voltage. When going from offset voltage to 0, Offset Duration should be greater than 1.5 seconds (90 cycles at 60 Hz).

Test Tab

On the GONGOV Test Tab screen (Figure C.42):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The GONGOV Test Tab Results fields are explained in Table C.45.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.45 GONGOV Test Tab Result Fields

Field	Explanation
Expected Value	Select Op or No Op as desired result.
Result	Pass/Fail.

The GONGOV Test Tab Screen is shown in Figure C.42.

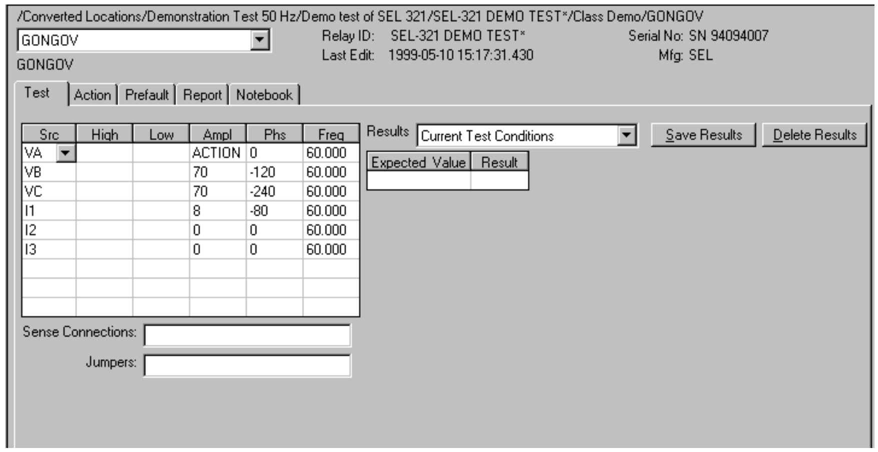


Figure C.42 GONGOV Test Tab Screen

Action Tab

The GONGOV Action Tab Conditions fields are explained in Table C.46.

Table C.46 GONGOV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial voltage for all Action sources, typically the normal voltage.
Offset Duration	How long to maintain the offset. Be sure it is long enough for the relay to initialize.
Test Voltage	The test voltage to apply.
Max On Time	How long to maintain the test voltage. Be sure it is long enough for the relay to sense and respond.

The GONGOV Action Tab Screen is shown in Figure C.43.

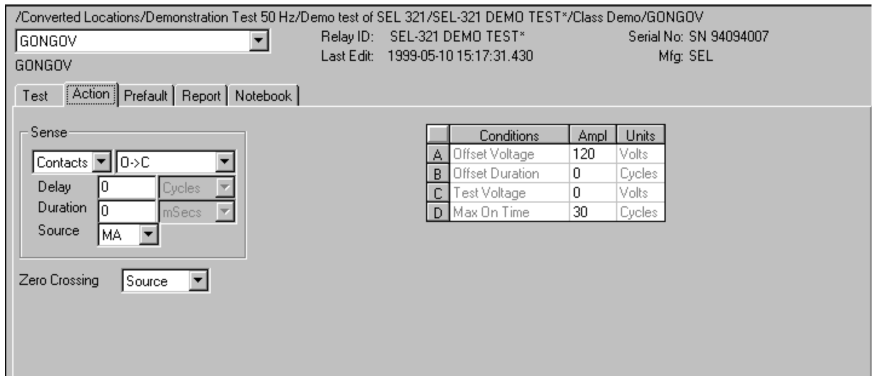


Figure C.43 GONGOV Action Tab Screen

Sense

The GONGOV Sense fields are explained in Table C.47.

Table C.47 GONGOV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

Voltage action begins. The test stops as soon as the relay operates and the result is recorded as Pass or Fail.

Operation Graph

The GONGOV Operation Graph is shown in Figure C.44.

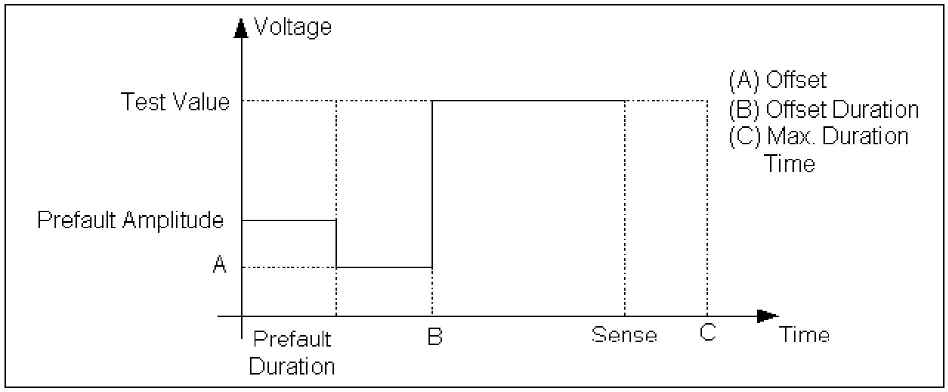


Figure C.44 GONGOV Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

The GONGOV Prefault Tab Fields are explained in Table C.48.

Table C.48 GONGOV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

INDPUI - Inductive Pickup, Current - I ProTesTPLAN

Description

Current is applied to make the relay operate. Current ramps downward until the relay drops out. Current then ramps back up until the relay picks up. Dropout and pickup values are recorded and the average calculated. Expected value and tolerances are applied to the average.

Operation

Current is applied at an initial amplitude to force the relay to operate. As soon as the relay operates, current is immediately lowered to the ramp starting current. The linear ramp moves down, until the relay drops out. The macro then ramps back up, until the relay picks up again. Two separate ramp rates are specified, so that the ramp to dropout can move quickly, followed by a slower ramp back to pickup.

Use

This macro tests minimum pickup and dropout for current relays.

Notes

- The initial amplitude should be high enough to guarantee relay operation. If the amplitude is too high, however, it may cause a high degree of contact bounce as the relay operates. Because the downward ramp begins as soon as the relay operates, the ramp may see unstable sense input and misinterpret the result. To filter contact bounce, use a large amount of sense duration to hold the initial pickup longer. Sense delay may also be helpful.

Test Tab

On the INDPUI Test Tab screen (Figure C.45 on page C-87):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The INDPUI Test Tab Results fields are explained in Table C.49.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.49 INDPUI Test Tab Results Fields

Field	Explanation
Expected I	Expected minimum pickup amplitude.
+ %/– %	Plus/Minus tolerance.
Amplitude 1	Dropout amplitude.
Amplitude 2	Pickup amplitude.
Actual	Average of Amplitude 1 and Amplitude 2; i.e., the minimum pickup.
% Error	Error.
Result	Pass/Fail indication.

The INDPUI Test Tab screen is shown in Figure C.45.

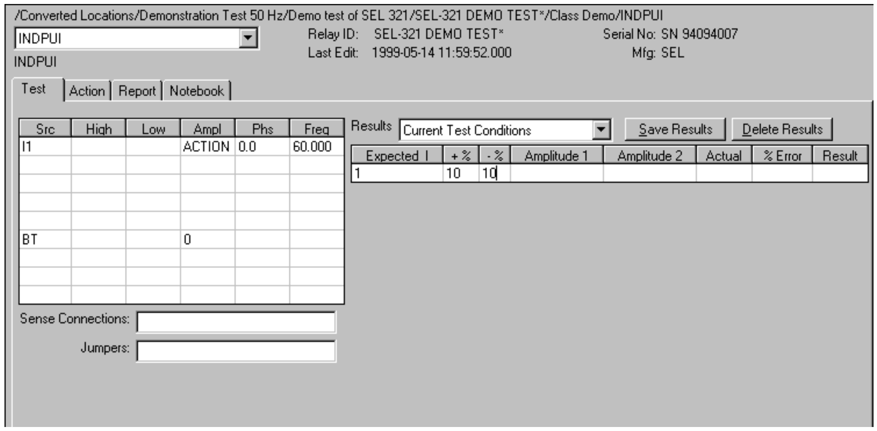


Figure C.45 INDPUI Test Tab Screen

Action Tab

The INDPUI Action Tab Conditions fields are explained in Table C.50.

Table C.50 INDPUI Action Tab Conditions Fields

Field	Explanation
Tap Value	Tap setting used to calculate initial current, usually set on the relay.
Initial Current	Multiple of tap asserted to pick up the relay at the beginning of the test.
Max Time of Initial Current	Maximum time to apply the initial current to guarantee the relay will operate.
Ramp Start Current	Start for the ramp, expressed as % of tap; e.g. 110%.
Delta Current #1	Unsigned step size for Ramp 1, looking for dropout.
Delta Time #1	Delta time for each step of Ramp 1.
Delta Current #2	Unsigned step size for Ramp 2, looking for pickup.
Delta Time #2	Delta time for each step of Ramp 2.

The INDPUI Action Tab screen is shown in Figure C.46.

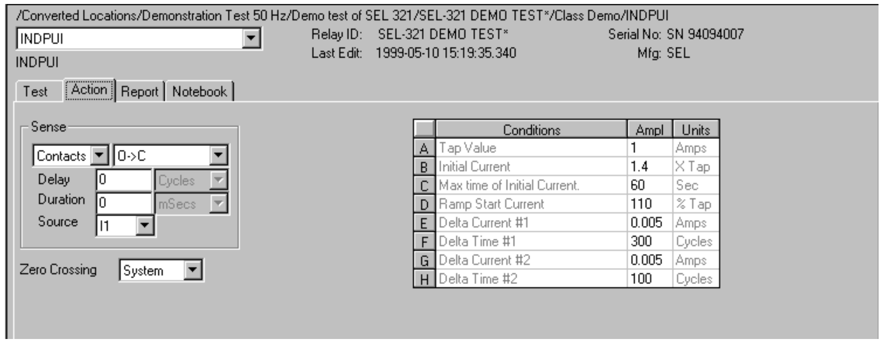


Figure C.46 INDPUI Action Tab Screen

Sense

The INDPUI Sense fields are explained in Table C.51.

Table C.51 INDPUI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Current action then begins. The test looks for the initial relay pickup, a dropout and a pickup. If the relay does not operate initially, an error is noted. Similarly, errors are noted if the relay does not drop out, or if the relay fails to pick up.

Hints

Use enough sense duration to ensure stability of the sense result. If the Test reports equal dropout and pickup values that are the same as the Ramp Start Current, it is likely that Sense Duration is too short. As a result, contact bounce at the initial amplitude is being misinterpreted as pickup, dropout, and pickup, before the ramp has taken a step. Make Sense Duration longer.

Operation Graph

The INDPUI Operation graph is shown in Figure C.47.

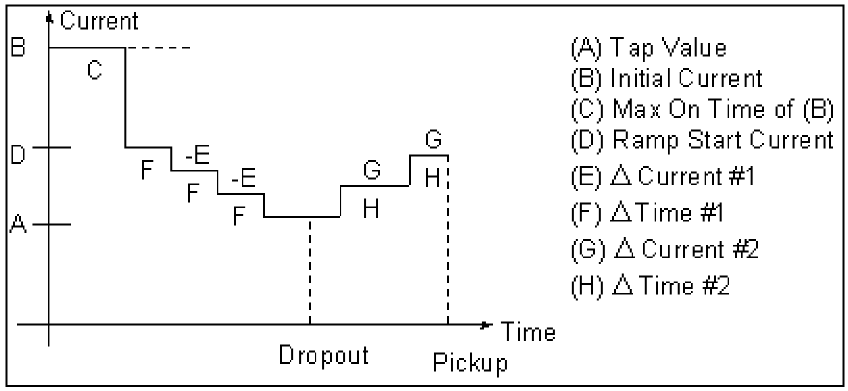


Figure C.47 INDPUI Operation Graph

INDPUV - Inductive Pickup, Voltage - V ProTesTPLAN

Description

Voltage is applied to make the relay operate. Voltage ramps downward until the relay drops out. Voltage then ramps back up until the relay picks up. Dropout and pickup values are recorded, and the average calculated. Expected values and tolerances are applied to the average.

Operation

Voltage is applied at an initial amplitude to force the relay to operate. As soon as the relay operates, voltage is immediately lowered to the ramp starting voltage. The linear ramp moves down, until the relay drops out. The macro then ramps back up, until the relay picks up again. Two separate ramp rates are specified, so that the ramp to dropout can move quickly, followed by a slower ramp back to pickup.

Use

This macro tests minimum pickup and dropout for overvoltage relays.

Notes

- The initial amplitude should be high enough to guarantee relay operation. If the amplitude is too high, however, it may cause a high degree of contact bounce as the relay operates. Because the downward ramp begins as soon as the relay operates, the ramp may see unstable sense input and misinterpret the result. Use a large amount of sense duration to hold the initial pickup longer. Sense delay may also be helpful.

Test Tab

On INDPUV Test Tab screen (Figure C.48):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The INDPUV Test Tab Results fields are explained in Table C.52.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.52 INDPUV Test Tab Results Fields

Field	Explanation
Expected V	Expected minimum pickup amplitude.
+ %/– %	Plus/Minus tolerance.
Amplitude 1	Dropout amplitude.
Amplitude 2	Pickup amplitude.
Actual	Average of Amplitude 1 and Amplitude 2; i.e., the minimum pickup.
% Error	Error.
Result	Pass/Fail indication.

The INDPUV Test Tab screen is shown in Figure C.48.

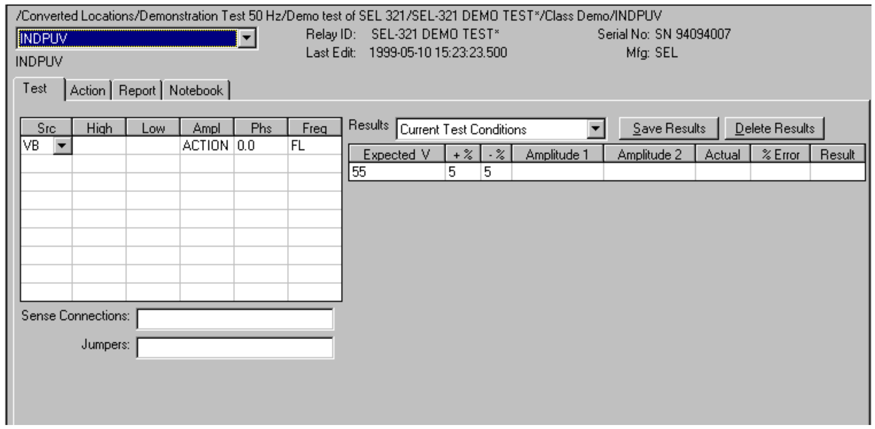


Figure C.48 INDPUV Test Tab Screen

Action Tab

The INDPUV Action Tab Conditions fields are explained in Table C.53.

Table C.53 INDPUV Action Tab Conditions Fields

Field	Explanation
Tap Value	Tap setting used to calculate initial voltage, usually set on the relay.
Initial Voltage	Multiple of tap asserted to pick up the relay at the beginning of the test.
Max Time of Initial Voltage	Maximum time to apply the initial voltage, to guarantee the relay will operate.
Ramp Start Voltage	Start for the ramp, expressed as % of tap; e.g., 110%.
Delta Voltage #1	Unsigned step size for Ramp 1, looking for dropout.
Delta Time #1	Delta time for each step of Ramp 1.
Delta Voltage #2	Unsigned step size for Ramp 2, looking for pickup.
Delta Time #2	Delta time for each step of Ramp 2.

The INDPUV Action Tab screen is shown in Figure C.49.

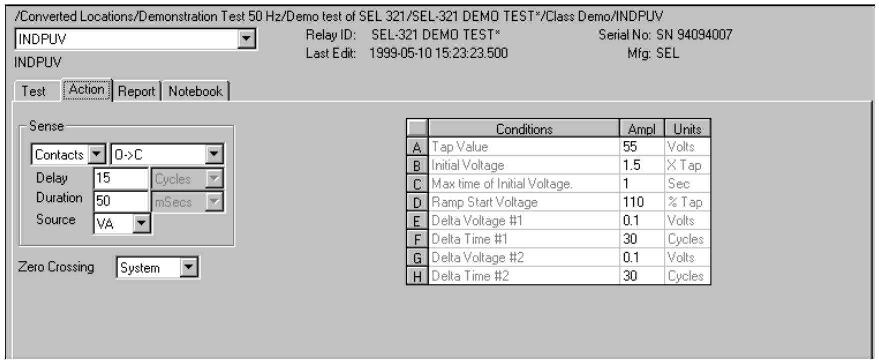


Figure C.49 INDPUV Action Tab Screen

Sense

The INDPUV Sense fields are explained in Table C.54.

Table C.54 INDPUV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Voltage action then begins. The test looks for the initial relay pickup, a dropout and a pickup. If the relay does not operate initially, an error is noted. Similarly, errors are noted if the relay does not drop out, or if the relay fails to pick up.

Hints

Use enough sense duration to ensure stability of the sense result. If the test reports equal dropout and pickup values that are the same as the Ramp Start Voltage, it is likely that Sense Duration is too short. As a result, contact bounce at the initial amplitude is being misinterpreted as pickup, dropout, and pickup, before the ramp has taken a step. Make Sense Duration longer.

Operation Graph

The INDPUV Operation Graph is shown in Figure C.50.

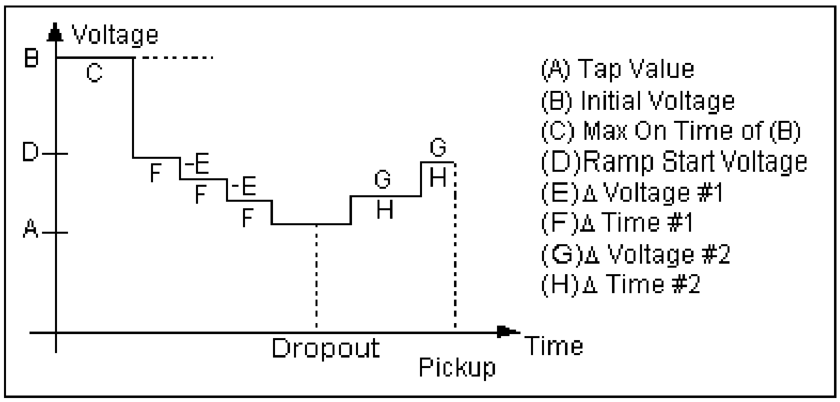


Figure C.50 INDPUV Operation Graph

LRAMPF - Linear Ramp, Frequency - F ProTesTPLAN, V ProTesTPLAN

Description

The frequency of one or more AC sources is ramped from an offset value until the relay operates, or until a limit frequency is reached (recorded as No Op, for No Operation).

Operation

The frequency of all ACTION sources is ramped at the specified Hertz/second rate. Sources can be at different harmonics; e.g. one current can be at 60 Hz (or 50 Hz), and another at 120 Hz (or 100 Hz), to test harmonic restraint on a differential relay.

Use

This macro tests the operating frequency of different relays.

Notes

- scF225x and F6000 instruments can ramp at a rate down to 0.001 Hz/sec; however, F2100, F2200, F2500, F2350 and F2700 instruments cannot ramp frequency slower than 0.02 Hz/sec. Ramp rates ab64ove 10 Hz/sec lose one decimal digit of resolution.
- One source can have an Action frequency, while all others are at base frequency, as long as the Action is Source 1 of the Master F2000. Any source on the F6000 can be Action. Enter ACTION for one source frequency, and indicate the frequency reference for the others: FX (crystal) or FL (line). When the Test is run, ProTesT will verify that the Action source is indeed Source 1 of the Master F2000.
- The F6000 does not have FL or FE setting. Map this to the FX setting.
- Source 1 of the Master F2000 can, instead, be set to FX base frequency, and all other sources can have ACTION frequency. Any source on the F6000 can be FX.
- F2000 base frequency has a range of 25 to 99.99 Hz. Harmonics allow frequencies up to 2000 Hz in F225x and 1000 Hz for the F6000. Macro frequencies can be specified up to 1999 Hz as long as ProTesT can find a harmonic to cover the required range.

Test Tab

On the LRAMPF Test Tab screen (Figure C.51):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source frequency *ACTION* and enter amplitude and phase values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The LRAMPF Test Tab Results Fields are explained in Table C.55.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.55 LRAMPF Test Tab Results Fields

Field	Explanation
Expected F	Expected operate value, in Hertz.
+ Hz/– Hz	Plus/minus tolerance in 0.001 Hz for F225x and F6000 instruments, 0.01 Hz otherwise; used for Pass/Fail calculation.
Actual	Recorded test result.
Error	Error in Hertz.
Result	Pass/Fail indication.

The LRAMPF Test Tab screen is shown in Figure C.51.

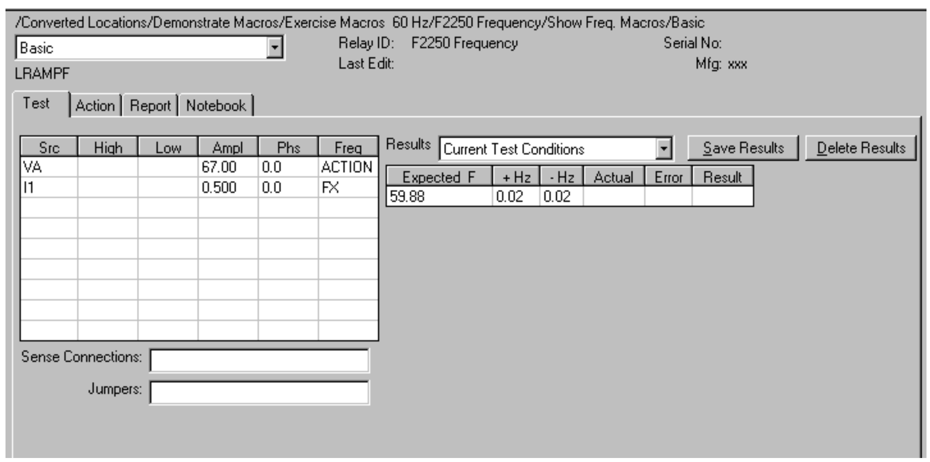


Figure C.51 LRAMPF Test Tab Screen

Action Tab

The LRAMPF Action Tab Conditions fields are explained in Table C.56.

Table C.56 LRAMPF Action Tab Conditions Fields

Field	Explanation
Offset Frequency	Initial frequency for all Action sources.
Offset Duration	How long to maintain the offset. Note that offset duration is measured in Offset Frequency cycles.
Ramp Rate	Rate of change of frequency. Rate is in Hz/second.
Frequency Limit	Frequency at which the ramp stops if the relay does not operate.

The LRAMPF Action Tab screen is shown in Figure C.52.

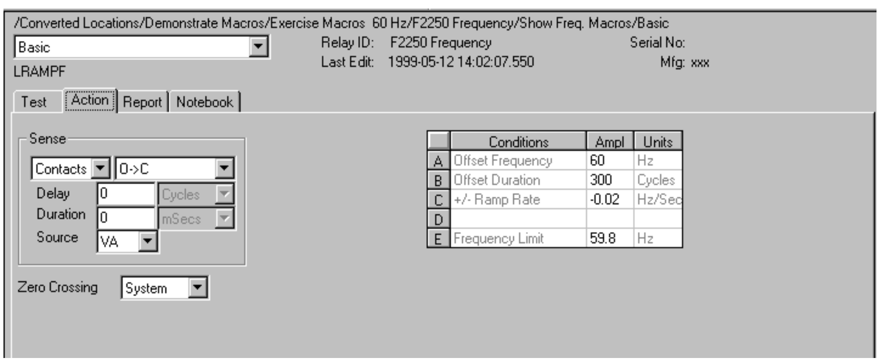


Figure C.52 LRAMPF Action Tab Screen

Sense

The LRAMPF Sense fields are explained in Table C.57.

Table C.57 LRAMPF Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

The test stops as soon as the relay operates and the amplitude is recorded. If the relay does not operate, a No Op is recorded. This is desirable if the relay should not operate.

Operation Graph

The LRAMPF Operation graph is shown in Figure C.53.

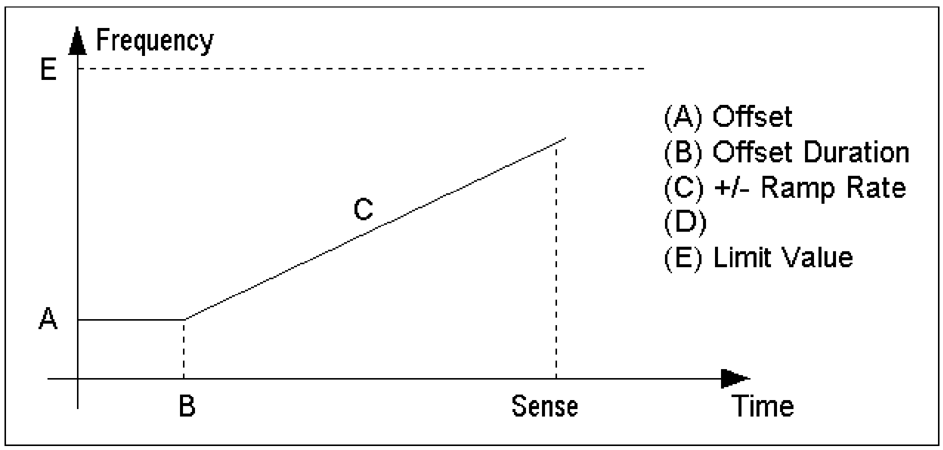


Figure C.53 LRAMPF Operation Graph

LRAMPI - Linear Ramp, Current - I ProTesTPLAN

Description

One or more current sources are ramped from an offset amplitude until the relay operates, or until a limit amplitude is reached (recorded as No Op, for No Operation).

Use this macro to test reach at a specific angle for a distance relay – hence the macros named Reach Linear Ramp Current, RCHLRI. RCHLRI and LRAMPI are identical. If you have both V and Z ProTesTPLANS, use the name you prefer.

Operation

One or more current sources are ramped simultaneously, using the same Action conditions. One or more voltage presets can be applied. Sources can have different phase angles, representing phase offset. Sources can be at different harmonics; e.g. one current can be at 60 Hz (or 50 Hz), and another at 120 Hz (or 100 Hz), to test harmonic restraint on a differential relay.

Use

This macro tests Ohmic reach of current-operated directional distance relays at specific phase angles; Pickup/dropout of overcurrent relays; Minimum pickup and harmonic restraint for differential relays with harmonic inrush restraint.

Notes

- To minimize test time and heating, use an offset as close to the expected operating point as possible.
- Most relays that can be tested with RCHLRI or LRAMPI can be tested faster using RCHBOI or BSRHOI, the binary search macro.

Test Tab

On the LRAMPI Test Tab screen (Figure C.54 on page C-102):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The LRAMPI Test Tab Results fields are explained in Table C.58 on page C-102.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.58 LRAMPI Test Tab Results Fields

Field	Explanation
Expected I	Expected operate value, in Amps.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculations.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The LRAMPI Test Tab screen is shown in Figure C.54.

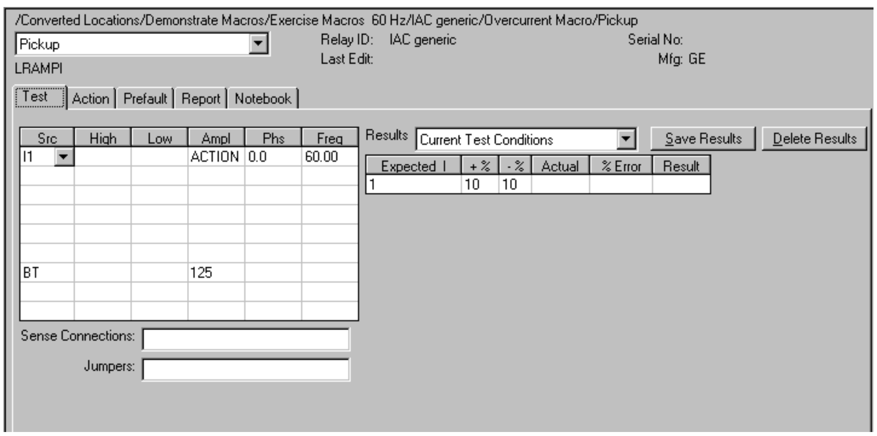


Figure C.54 LRAMPI Test Tab Screen

Action Tab

The LRAMPI Action Tab Conditions fields are explained n Table C.59.

Table C.59 LRAMPI Action Tab Conditions Fields

Field	Explanation
Offset Current	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset. If no offset is wanted, enter 0 cycles.
Delta Current	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each ramp step is held while waiting for a sense.
Current Limit	The amplitude at which the ramp stops if the relay does not operate.

The LRAMPI Action Tab screen is shown in Figure C.55.

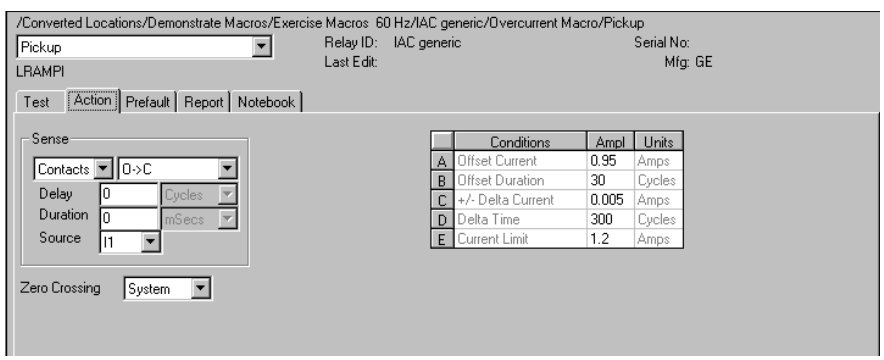


Figure C.55 LRAMPI Action Tab Screen

Sense

The LRAMPI Sense fields are explained in Table C.60.

Table C.60 LRAMPI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the amplitude is recorded. If the relay does not operate, a No Op is recorded. This is desirable if the relay should not operate.

Hints

- Use Offset Current = 0, and non-zero Offset Duration if polarizing voltage must be applied before the Action.
- Test results depend on the ramp rate – too fast causes overshoot, too slow stresses the relay and takes more time. Start with a slow rate, using values that give a stable, acceptable result. Then reduce the delta time until the result is no longer stable. Find the fastest ramp that is acceptable.
- For example, set Delta Current to a range of 10 to 20 percent of the tolerance amplitude. If the Expected Value is 1 Amp with a tolerance of +10%, the tolerance amplitude is 1.0 X 10%, which equals 0.1, resulting in a Delta amplitude of 0.01 to 0.02 Amp (10% to 20% of .01).
- Set Delta Time to be two to five times the nominal relay operating time for best accuracy. Use one to two times for lowest heat and shortest test time.

Operation Graph

The LRAMPI Operation graph is shown in Figure C.56.

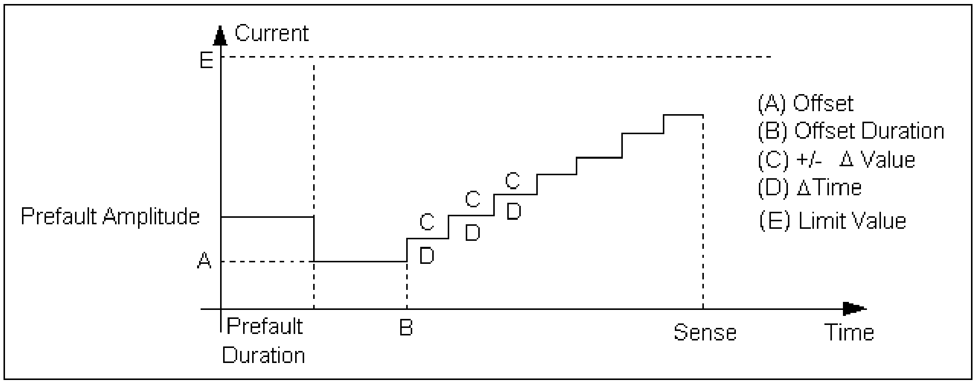


Figure C.56 LRAMPI Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The LRAMPI Prefault Tab fields are explained in Table C.61.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.61 LRAMPV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

LRAMPV - Linear Ramp, Voltage - V ProTesTPLAN

Description

One or more voltage sources are ramped from an offset amplitude until the relay operates, or until a limit amplitude is reached (recorded as No Op, for No Operation).

Use this macro to test reach at a specific angle for a distance relay – hence the macros named Reach Linear Ramp Voltage, RCHLRV. RCHLRV and LRAMPV are identical. If you have both I and Z ProTesTPLANS use the name you prefer.

Operation

One or more voltage sources are ramped simultaneously, using the same Action conditions. One or more voltage presets can be applied. Sources can have different phase angles, representing phasor offset. Sources can be at different harmonics; e.g. one voltage can be at 60 Hz (or 50 Hz), and another at 120 Hz (or 100 Hz).

Use

This macro tests Ohmic reach of voltage-operated directional distance relays at specific phase angles; Pickup/dropout of overvoltage or undervoltage relays.

Notes

- To minimize test time and heating, use an offset as close to the expected operating point as possible.
- Most relays that can be tested with RCHLRV or LRAMPV can be tested faster using RCHBOV or BSRHOV, the binary search macro.
- For maximum source VA, use a source in the high end of a voltage range.

Test Tab

On the LRAMPV Test Tab screen (Figure C.57 on page C-108):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The LRAMPV Test Tab Results fields are explained in Table C.62 on page C-108.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.62 LRAMPV Test Tab Results Fields

Field	Explanation
Expected V	Expected operate value, in volts.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The LRAMPV Test Tab screen is shown in Figure C.57.

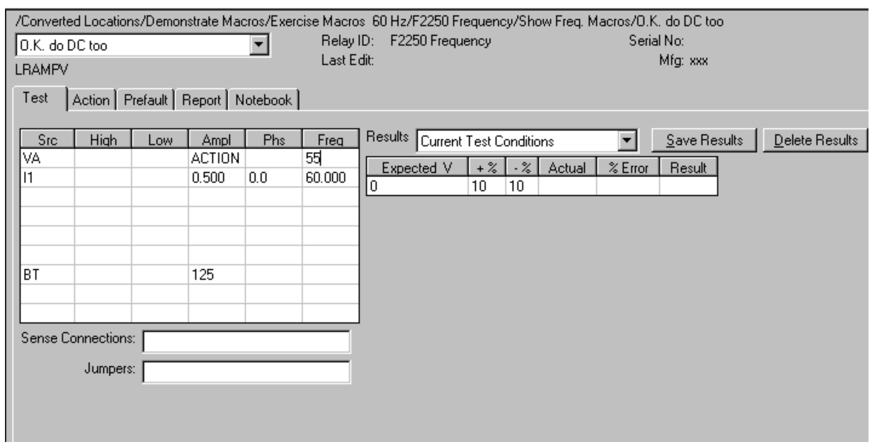


Figure C.57 LRAMPV Test Tab Screen

Action Tab

The LRAMPV Action Tab Conditions fields are explained in Table C.63.

Table C.63 LRAMPV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset. If no offset is wanted, enter 0 Cycles.
Delta Voltage	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each ramp step is held waiting for a sense.
Voltage Limit	The amplitude at which the ramp stops if the relay does not operate. The range is determined by the Offset Voltage or the voltage limit, which ever is larger. Note: Best accuracy is obtained if you use a source in the high end of its range.

The LRAMPV Action Tab screen is shown in Figure C.58.

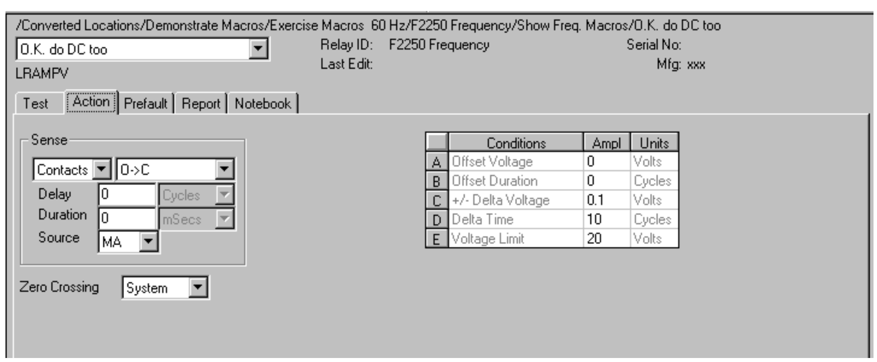


Figure C.58 LRAMPV Action Tab Screen

Sense

The LRAMPV Sense fields are explained in Table C.64.

Table C.64 LRAMPV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the amplitude is recorded. If the relay does not operate, a No Op is recorded. This is desirable if the relay should not operate.

Hints

- Use Offset Voltage, and non-zero Offset Duration if polarizing current must be applied before the Action.
- Test results depend on the ramp rate – too fast causes overshoot, too slow stresses the relay and takes more time. Start with a slow rate, using values that give a stable, acceptable result. Then reduce the delta time until the result is no longer stable. Find the fastest ramp that is acceptable.
- For example, set Delta Voltage to a range of 10 to 20 percent of the tolerance amplitude.
- Set delta time to be two to five times nominal relay operating time for best accuracy. Use one to two times for lowest heat and shortest test time.
- Test results depend on the ramp rate – too fast causes overshoot, too slow stresses the relay and takes more time. Start with a slow rate, using values that give a stable, acceptable result. Then reduce the Delta time until the result is no longer stable. Find the fastest ramp that is acceptable.

Operation Graph

The LRAMPV Operation graph is shown in Figure C.59.

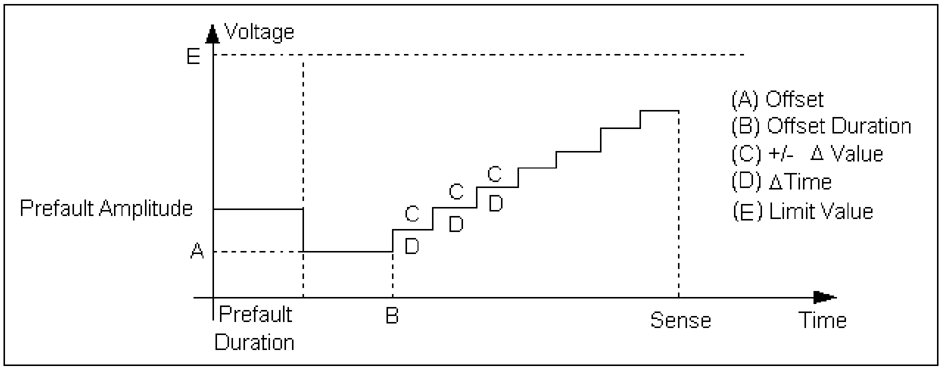


Figure C.59 LRAMPV Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The LRAMPV Prefault Tab fields are explained in Table C.65.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.65 LRAMPV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

MAXTAI - Maximum Torque Angle, Current - Z ProTesTPLAN

Description

The phase of one or more AC currents is rotated from offset in one direction, looking for lead dropout. Phase then returns to the offset and rotates in the other direction, looking for lag dropout. The simple average determines the maximum torque angle.

It is also possible to use MAXTAI for pickup tests.

Operation

The phase of all ACTION sources is rotated at the specified rate. Mark AC source phases ACTION, or A–120 or A+120 for phase offset, and enter values for amplitude and frequency.

Use

This macro tests phase and distance relays.

Test Tab

On the MAXTAI Test Tab screen (Figure C.60 on page C-115):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter source phases *ACTION* or *A-120*, *A+120*, etc. and enter amplitude and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The MAXTAI Test Tab Results fields are explained in Table C.66.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.66 MAXTAI Test Tab Results Fields

Field	Explanation
Expected Angle	Line angle copied from Action tab; i.e., Maximum Torque Angle setting.
Tolerance +/–	+/– degrees tolerance.
Lead Dropout Angle	Recorded operate angle of relay in lead direction.
Lag Dropout Angle	Recorded operate angle of relay in lag direction.
Max Torque Angle	Average of recorded Lead and Lag dropout angles; should be close to Line Angle. Error is measured with respect to the Line Angle.
Error	Error in degrees.
Result	Pass/Fail.

The MAXTAI Test Tab screen is shown in Figure C.60.

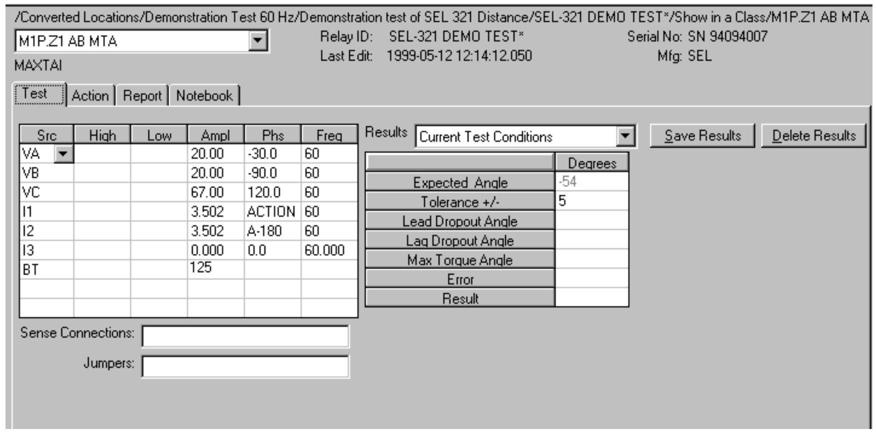


Figure C.60 MAXTAI Test Tab Screen

Action Tab

The MAXTAI Action Tab Conditions fields are explained in Table C.67.

Table C.67 MAXTAI Action Tab Conditions Fields

Field	Explanation
Line Angle	Initial phase for all Action sources, set to presumed angle of maximum torque.
Line Angle Duration	How long to maintain the initial phase. Be sure it is long enough for the relay to pick up.
Delta Angle	Increment of phase rotation, in degrees. Can be positive or negative, which determines whether lead or lag direction is done first.
Delta Time	How long to hold each phase step, during rotation. Measured in cycles.
Angle Limit	How many degrees to go from Line Angle before stopping ramp if the relay does not operate. The same limit is used in each direction.

The MAXTAI Action tab is shown in Figure C.61.

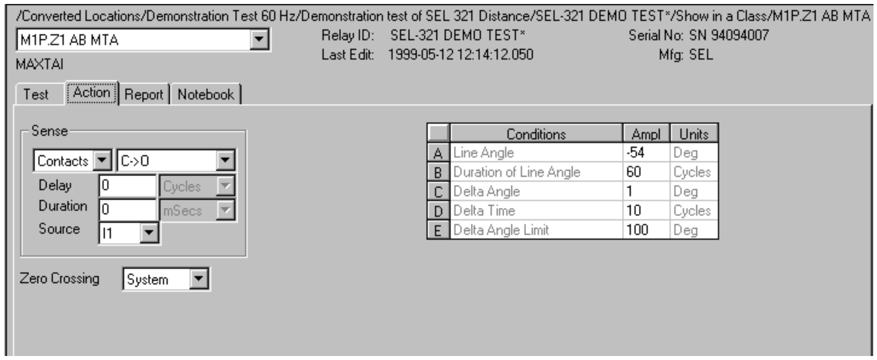


Figure C.61 MAXTAI Action Tab

Sense

The MAXTAI Sense fields are explained in Table C.68.

Table C.68 MAXTAI Sense Fields

Field	**Explanation**
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Phase action then begins. The test stops as soon as the relay operates and the phase is recorded. Phase returns to offset, waits, and begins ramping in the other direction. If the relay does not operate, a No Op is recorded.

Hints

MAXTAI can be used as a pickup test. Set the Line Angle equal to MTA +/– 180 degrees. Phase will ramp into the operate zone of the relay from each direction, lead and lag. The average of the two pickup points will be MTA +/– 180 degrees.

Operation Graph

The MAXTAI Operation graph is shown in Figure C.62.

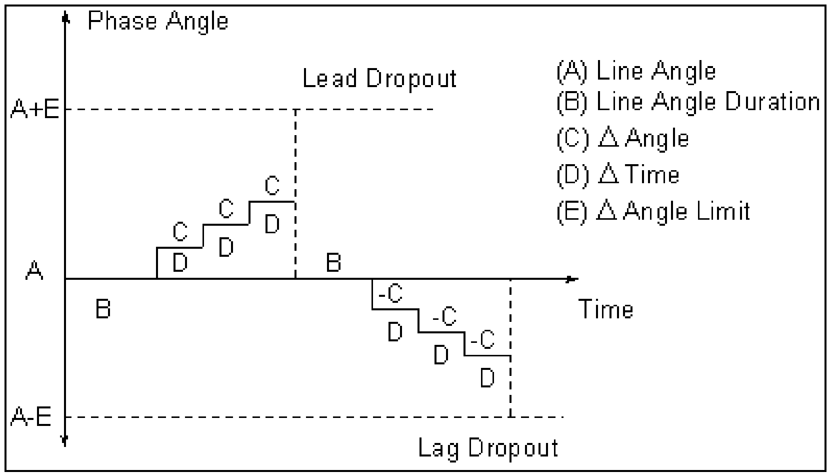


Figure C.62 MAXTAI Operation Graph

MAXTAV - Maximum Torque Angle, Voltage - Z ProTesTPLAN

Description

The phase of one or more AC voltages is rotated from offset in one direction, looking for lead dropout. Phase then returns to the offset and rotates in the other direction, looking for lag dropout. The simple average determines the maximum torque angle.

It is also possible to use MAXTAV for pickup tests.

Operation

The phase of all ACTION sources is ramped at the specified rate. Mark AC source phases ACTION, or A–120 or A+120 for phase offset, and enter values for amplitude and frequency.

Use

This macro tests phase and distance relays.

Test Tab

On the MAXTAV Test Tab screen (Figure C.63 on page C-120):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter source phases *ACTION*, or *A–120* or *A+120*, etc. and enter amplitude and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The MAXTAV Test Tab Results fields are explained in Table C.69.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.69 MAXTAV Test Tab Results Fields

Field	Explanation
Expected Angle	Line angle, copied from Action tab; i.e., Maximum Torque Angle setting.
Tolerance +/–	+/– degrees tolerance.
Lead Dropout Angle	Recorded operate angle of relay in lead direction; i.e., when swinging in counter-clockwise direction.
Lag Dropout Angle	Recorded operate angle of relay in lag direction; i.e., when swinging in clockwise direction.
Max Torque Angle	Average of recorded Lead and Lag dropout angles; should be close to Line Angle. Error is measured with respect to the Line Angle.
Error	Error in degrees.
Result	Pass/Fail.

The MAXTAV Test Tab screen is shown in Figure C.63.

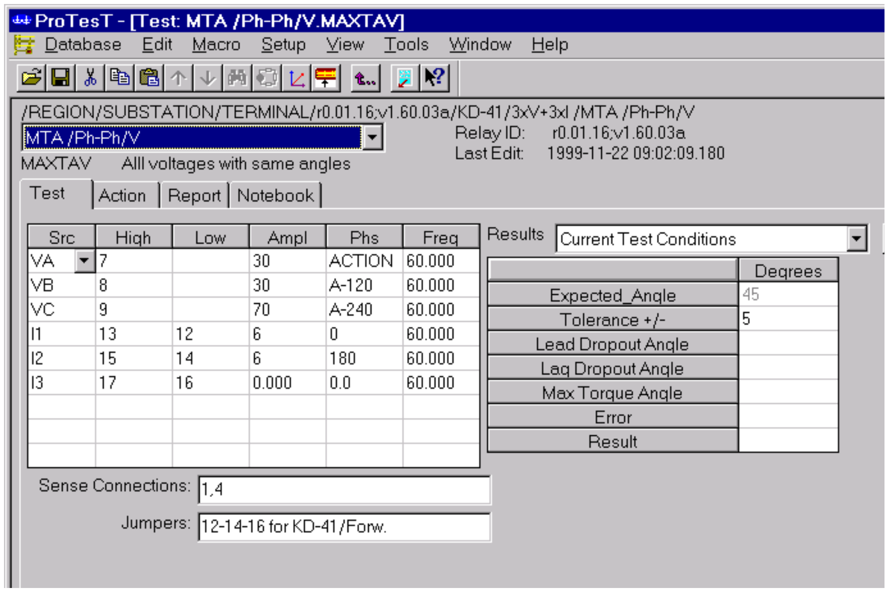


Figure C.63 MAXTAV Test Tab Screen

Action Tab

The MAXTAV Action Tab Conditions fields are explained in Table C.70.

Table C.70 MAXTAV Action Tab Conditions Fields

Field	Explanation
Line Angle	Initial phase for all Action sources, set to presumed angle of maximum torque.
Line Angle Duration	How long to maintain the initial phase. Be sure it is long enough for the relay to pick up.
Delta Angle	The degree increment of phase rotation. Can be positive or negative, which determines whether lead or lag direction is done first.
Delta Time	How long to hold each phase step, during rotation. Measured in cycles.
Angle Limit	How many degrees to go from Line Angle, before stopping ramp, if the relay does not operate. The same limit is used in each direction.

The MAXTAV Action Screen is shown in Figure C.64.

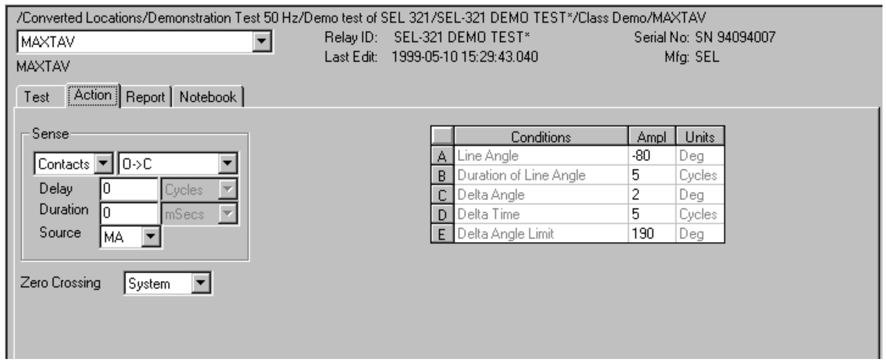


Figure C.64 MAXTAV Action Screen

Sense

The MAXTAV Sense fields are explained in Table C.71.

Table C.71 MAXTAV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Phase action then begins. The test stops as soon as the relay operates and the phase is recorded. Phase returns to offset, waits, and begins ramping in the other direction. If the relay does not operate, a No Op is recorded.

Hints

MAXTAV can be used as a pickup test. Set the Line Angle equal to MTA +/– 180 degrees. Phase will ramp into the operate zone of the relay from each direction, lead, and lag. The average of the two pickup points should be MTA +/– 180 degrees.

Operation Graph

The MAXTAV Operation graph is shown in Figure C.65.

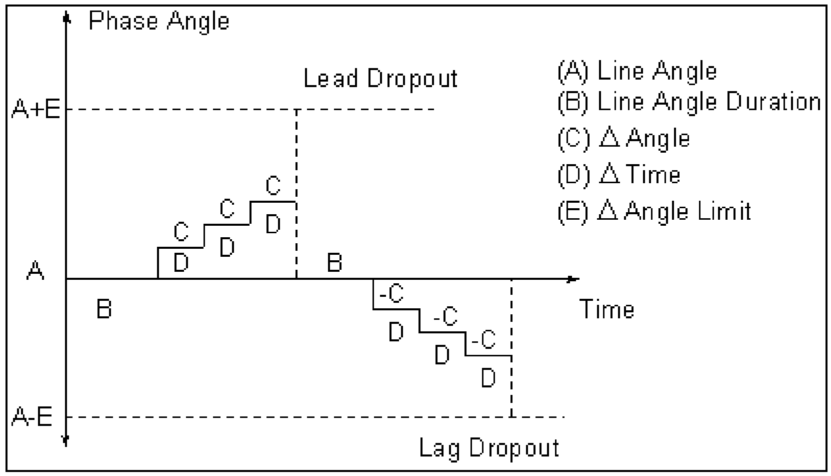


Figure C.65 MAXTAV Operation Graph

NOTEBK - User Instructions and Test Notes - All ProTesTPLANS

Description

The NOTEBK macro opens the Test Plan Notebook to the page for the present test macro. The Notebook provides a two column notepad for Originator test instructions and User comments. Use the **Tab** key to move from one column to the other. The Originator side is password protected, while the user side is not.

Operation

The Notebook is free format, with standard Windows text editing controls, such as:

Home	Moves the cursor to the start of a line.
End	Moves the cursor to the end of a line.
Ctrl+Right Arrow	Moves the cursor one word to the right
Ctrl+Left Arrow	Moves the cursor one word to the left.
Ins key	Toggles between Insert mode and Typeover mode (Insert is the default).

Any ASCII character can be entered. The number of lines per page is limited to 512.

Use

NOTEBK enters or obtains instructions on changing test setup at different points in the Test Plan. It can also be used to record visual inspection notes and a checklist or questionnaire for the User to fill out.

Notes

- Use NOTEBK to pause an Autorun sequence of macro execution; e.g., the Notebook may give instructions on changes to be made in the test setup before proceeding.
- From any NOTEBK it is possible to access all pages in the Test Plan Notebook. There is one page for each macro, and a first page for the Test Plan. Use the spinner arrows or the pull-down list to turn to view other pages in the Notebook. Changing the Notebook view does not change the macro selection.

Instructions and Test Notes

Use Notebook to document relay identification and settings, and to provide online instructions for manual calibration and inspection.

Page one of the six pages of calibration instructions for the NOTEBK Test Tab screen is shown in Figure C.66.

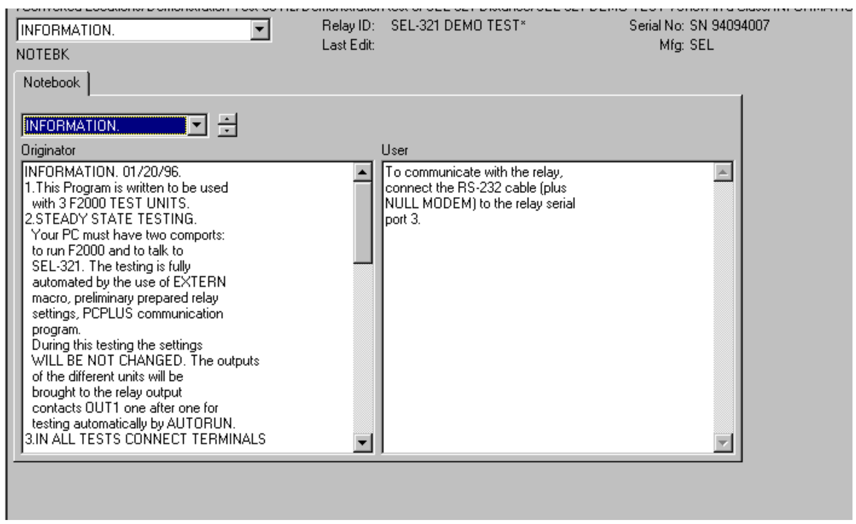


Figure C.66 NOTEBK Test Tab Screen

PHROTI - Phase Rotate, Current - I ProTesTPLAN

Description

The phase of one or more AC currents is rotated from an offset value until the relay operates, or until a limit phase is reached (recorded as No Op, for No Operation).

Operation

The phase of all Action sources is ramped at the specified rate. Mark AC source phases ACTION, or A–120 or A+120 for phase offset, and enter values for amplitude and frequency.

Use

This macro tests phase and power swing relays.

Test Tab

On the PHROTI Test Tab screen (Figure C.67 on page C-127):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark source phases *ACTION*, or *A–120* or *A+120*, etc. and enter amplitude and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.PL

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The PHROTI Test Tab Results fields are explained in Table C.72.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.72 PHROTI Test Tab Results Fields

Field	Explanation
Expected Angle	Expected operate value, in degrees.
+ Deg /– Deg	Plus/minus tolerance in Degrees, used for Pass/Fail calculation.
Actual	Recorded test result.
Error	Error in Degrees.
Result	Pass/Fail indication.

The PHROTI Test Tab screen is shown in Figure C.67.

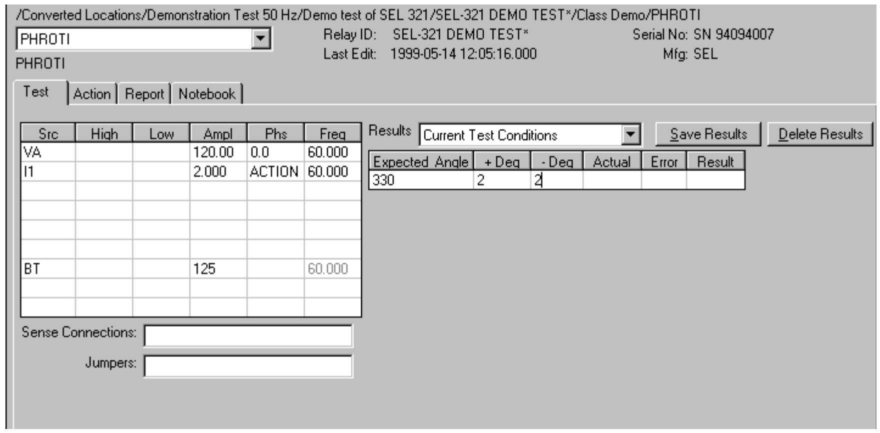


Figure C.67 PHROTI Test Tab Screen

Action Tab

The PHROTI Action Tab Conditions fields are explained in Table C.73.

Table C.73 PHROTI Action Tab Conditions Fields

Field	Explanation
Offset Phase	Initial phase for all Action sources.
Offset Duration	How long to maintain the offset.
+/– Delta Phase	Increment of phase change, in degrees.
Delta Time	How long to hold each phase step, to determine rate of phase rotation. Measured in cycles.
Phase Limit	Phase at which the ramp stops if the relay does not operate.

The PHROTI Action Tab screen is shown in Figure C.68.

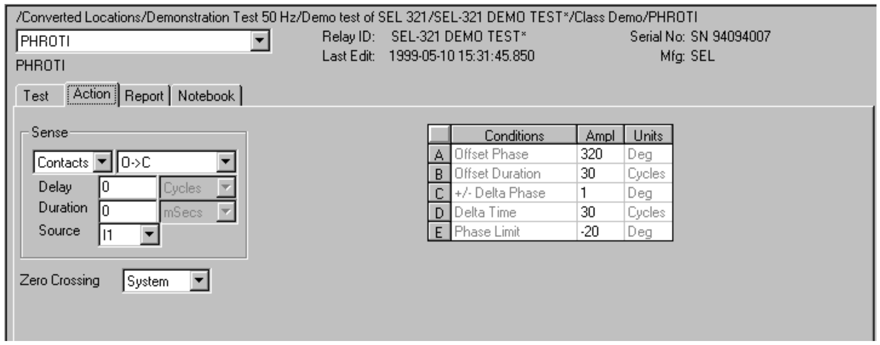


Figure C.68 PHROTI Action Tab Screen

Sense

The PHROTI Sense fields are explained in Table C.74.

Table C.74 PHROTI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Phase action then begins. The test stops as soon as the relay operates and the phase is recorded. If the relay does not operate, a No Op is recorded.

Operation Graph

The PHROTI Operation graph is shown in Figure C.69.

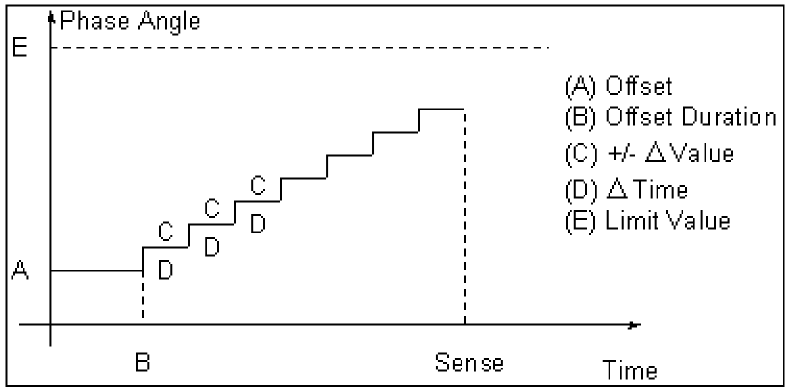


Figure C.69 PHROTI Operation Graph

PHROTV - Phase Rotate, Voltage - V ProTesTPLAN

Description

The phase of one or more voltages is rotated from an offset value until the relay operates, or until a limit phase is reached (recorded as No Op, for No Operation).

Operation

The phase of all Action sources is ramped at the specified rate. Mark voltage phases ACTION, or A–120 or A+120 for phase offset, and enter values for amplitude and frequency.

Use

This macro tests phase and power swing relays.

Test Tab

On the PHROTV Test Tab screen (Figure C.70 on page C-132):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark source phases *ACTION*, or *A–120* or *A+120*, etc. and enter amplitude and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The PHROTV Test Tab Results fields are explained in Table C.75.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.75 PHROTV Test Tab Results Fields

Field	Explanation
Expected Angle	Expected operate value, in degrees.
+ Deg/– Deg	Plus/minus tolerance in Degrees, used for Pass/Fail calculation.
Actual	Recorded test result.
Error	Error in Degrees.
Result	Pass/Fail indication.

The PHROTV Test Tab screen is shown in Figure C.70.

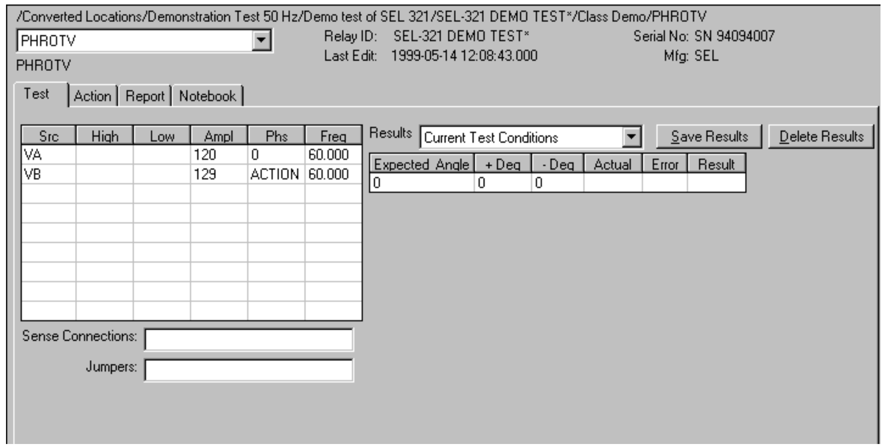


Figure C.70 PHROTV Test Tab Screen

Action Tab

PHROTV Action Tab Conditions fields are explained in Table C.76.

Table C.76 PHROTV Action Tab Conditions Fields

Field	Explanation
Offset Phase	Initial phase for all Action sources.
Offset Duration	How long to maintain the offset.
+/– Delta Phase	Increment of phase change, in degrees.
Delta Time	How long to hold each phase step to determine rate of phase rotation. Measured in cycles.
Phase Limit	Phase at which the ramp stops if the relay does not operate.

The PHROTV Action Tab screen is shown in Figure C.71.

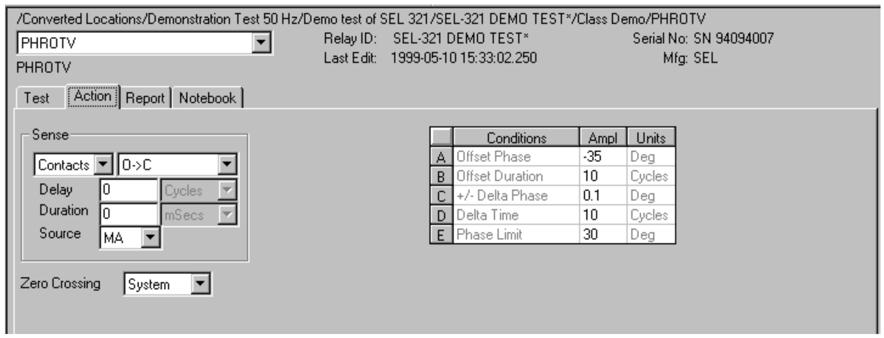


Figure C.71 PHROTV Action Tab Screen

Sense

The PHROTV Sense fields are explained in Table C.77.

Table C.77 PHROTV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Phase action then begins. The test stops as soon as the relay operates and the phase is recorded. If the relay does not operate, a No Op is recorded.

Operation Graph

The PHROTV Operation graph is shown in Figure C.72.

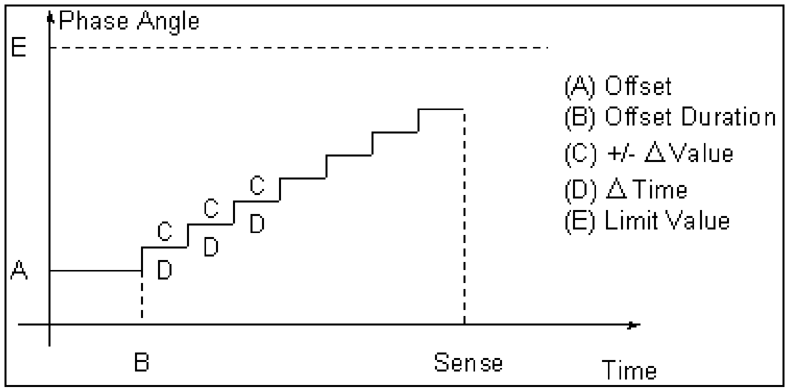


Figure C.72 PHROTV Operation Graph

PHSFTI - PHASE SHIFT, CURRENT - I ProTesTPLAN

Description

One or more test currents are set to initial values, and a phase step change is applied. The expected value is Op or No Op and the result is either Pass or Fail.

Operation

PHSFTI does an A to B phase step change. Phase offset between current sources can be maintained for a phase shift.

Use

This macro tests directional and power swing relays.

Test Tab

On the PHSFTI Test Tab screen (Figure C.73 on page C-136):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark source phases *ACTION*, or *A–120* or *A+120*, etc. and enter amplitude and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The PHSFTI Test Tab Results fields are explained in Table C.78 on page C-136.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.

Delete Results — Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.78 PHSFTI Test Tab Results Fields

Field	Explanation
Result	Pass/Fail.

The PHSFTI Test Tab screen is shown in Figure C.73.

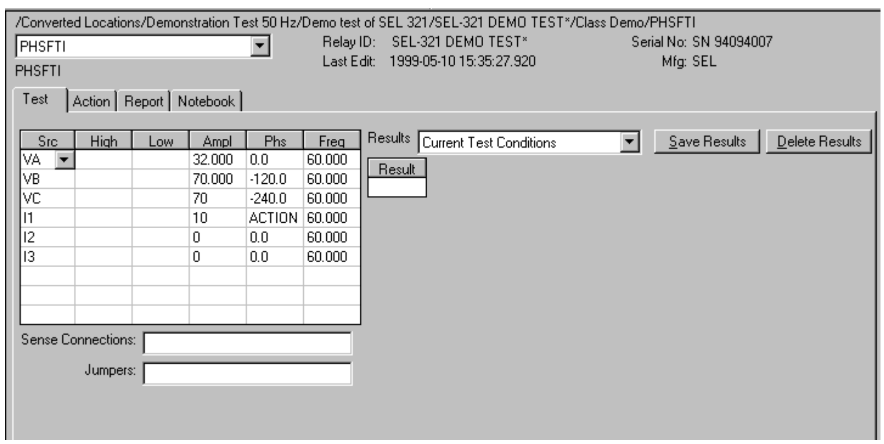


Figure C.73 PHSFTI Test Tab Screen

Action Tab

The PHSFTI Action Tab Conditions fields are explained in Table C.79.

Table C.79 PHSFTI Action Tab Conditions Fields

Field	Explanation
Offset Phase	The initial phase for all Action sources, typically the normal balanced values.
Offset Duration	How long to maintain the offset. Be sure it is long enough for the relay to initialize.
Test Phase	The test phase to apply.
Max On Time	How long to maintain the test phase. Be sure it is long enough for the relay to sense and respond.

The PHSFTI Action Tab screen is shown in Figure C.74.

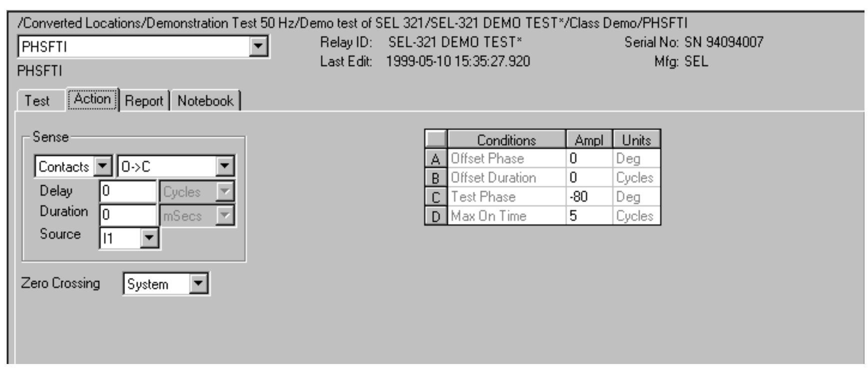


Figure C.74 PHSFTI Action Tab Screen

Sense

The PHSFTI Sense fields are explained in Table C.80.

Table C.80 PHSFTI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

The test stops as soon as the relay operates. The expected result is Op; this can be changed to No Op.

Operation Graph

The PHSFTI Operation graph is shown in Figure C.75.

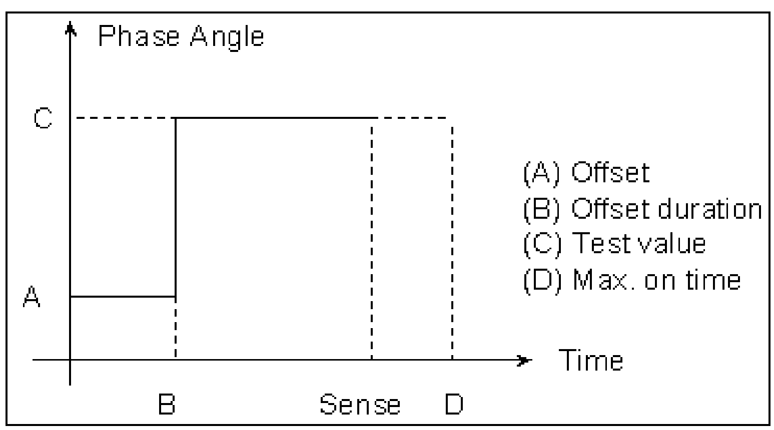


Figure C.75 PHSFTI Operation Graph

PHSFTV - Phase Shift, Voltage - V ProTesTPLAN

Description

One or more test voltages are set to initial values, and a phase step change is applied. The expected value is Op or No Op and the result is either Pass or Fail.

Operation

PHSFTV does an A to B phase step change. Phase offset between voltage sources can be maintained for a phase shift.

Use

This macro tests directional and power swing relays.

Test Tab

On the PHSFTV Test Tab screen (Figure C.76 on page C-140):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark source phases *ACTION*, or *A–120* or *A+120*, etc. and enter amplitude and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The PHSFTV Test Tab Results fields are explained in Table C.81.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

NOTE

Expected and Actual entries are future enhancements.

Table C.81 PHSFTV Test Tab Results Fields

Field	Explanation
Result	Pass/Fail.

The PHSFTV Test Tab screen is shown in Figure C.76.

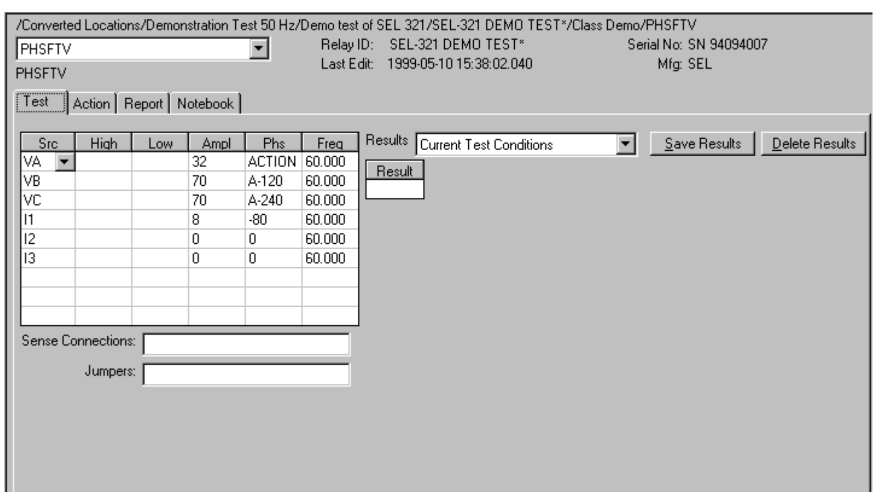


Figure C.76 PHSFTV Test Tab Screen

Action Tab

The PHSFTV Action Tab Conditions fields are explained in Table C.82.

Table C.82 PHSFTV Action Tab Conditions Fields

Offset Phase	The initial phase for all Action sources, typically the normal, balanced values.
Offset Duration	How long to maintain the offset. Be sure it is long enough for the relay to initialize.
Test Phase	The test phase to apply.
Max On Time	How long to maintain the test phase. Be sure it is long enough for the relay to sense and respond.

The PHSFTV Action Tab screen is shown in Figure C.77.

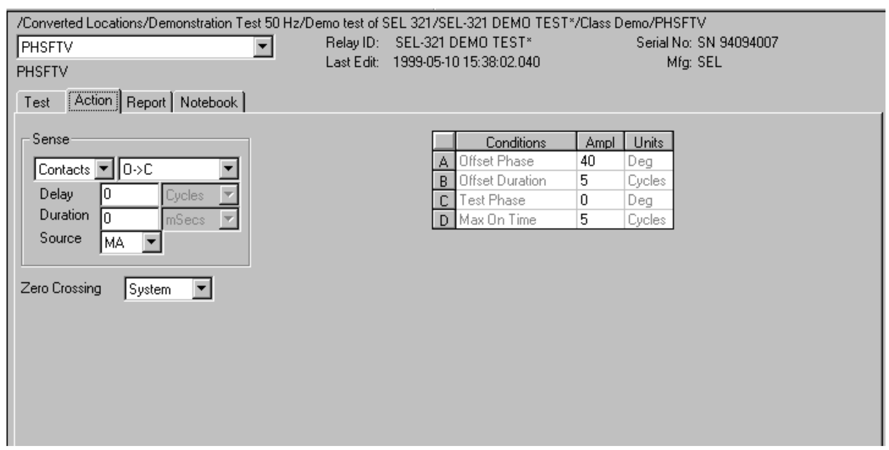


Figure C.77 PHSFTV Action Tab Screen

Sense

The PHSFTV Sense fields are explained in Table C.83.

Table C.83 PHSFTV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Phase action then begins. The test stops as soon as the relay operates. The expected result is Op; this can be changed to No Op.

Operation Graph

The PHSFTV Operation graph is shown in Figure C.78**.**

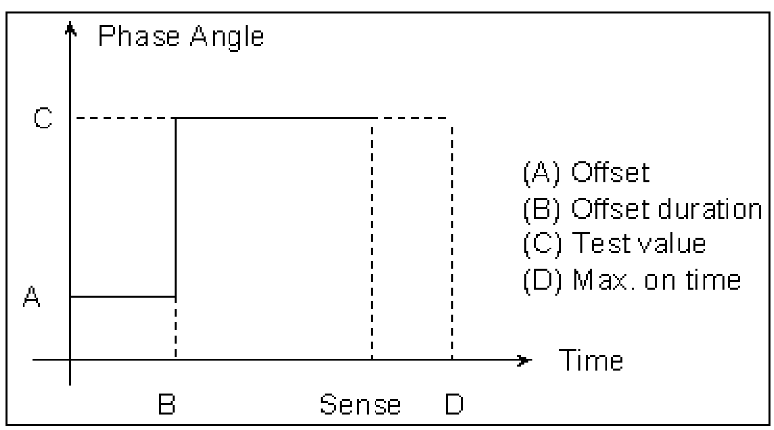


Figure C.78 PHSFTV Operation Graph

PLOTII - I vs. I Differential Current Plot - I ProTesTPLAN

Description

A Preset current is connected to one winding of the relay and an Action current is connected to another relay winding. The initial value of the Action current is set to be in balance with the Preset, and a Binary Search of current is done to find a pickup amplitude. The procedure is repeated for up to 12 values of Preset current. A plot formula is selected according to the type of relay being tested. Depending on the test connections, the plot can display Action vs. Preset current, (Action – Preset) vs. Preset, (Action + Preset) vs. Preset, or relay specific plots of multiples of tap or slope. Two PLOTII macros can be used to plot the upper and lower boundaries between operate and non-operate values of current.

Operation

The Test tab identifies one current as PRESET and one as ACTION. Values of Preset current are entered on the Test tab. Use the Action tab to define Action Conditions for the Binary Search. Action offset is given as a % of Preset, so that each test begins with a different Action offset, one that is balanced with the Preset current. (The Offset % can be greater or smaller than 100%, or equal to 100%, depending on the tap connections.) The Action Limit and sign of the delta current determine whether the search goes up or down.

On the Test tab enter up to 12 Preset amplitudes. The PRESET current is turned on with the ACTION, at values where the sources should be in balance. If other sources are specified, such as voltages, they would also be turned on, although additional sources are not normally required for this test. When an Action point completes, both PRESET and ACTION sources turn off. If a source error occurs, the test result is recorded as SOURCE, and the test continues with the next point. Similarly, a no-operate condition is recorded as No Op. (Source errors are ignored during the search phase of Binary Search, but are detected during the subsequent ramp.)

Use

This macro is used to test Slope of current differential relays.

Notes

- If tap values apply to the relay, enter the values on the Test screen for Preset Tap and Action Tap; the default is 1.0. Tap value is used only for plotting. Test quantities are specified and recorded as current amplitude. The formula can be changed without re-running the test.

Test Tab

On the PLOTII Test Tab Results screen (Figure C.79):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude as *PRESET* and *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The PLOTII Test Tab Results fields are explained in Table C.84.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.84 PLOTII Test Tab Results Fields

Field	Explanation
Preset I	Enter up to 12 values of Preset amplitude in the table. These define the Preset current and the Action offset that will be applied. Zero values are not run.
Expected I	Enter up to 12 values to define the expected pickup current, in amps.
+ %/– %	Enter +% and –% tolerances to determine pass/fail.
Actual	The recorded amplitude is displayed in this column, in Amps.
Error	Test point error.
Result	Pass/Fail result based on current and not formula.

The PLOTII Test Tab screen is shown in Figure C.79.

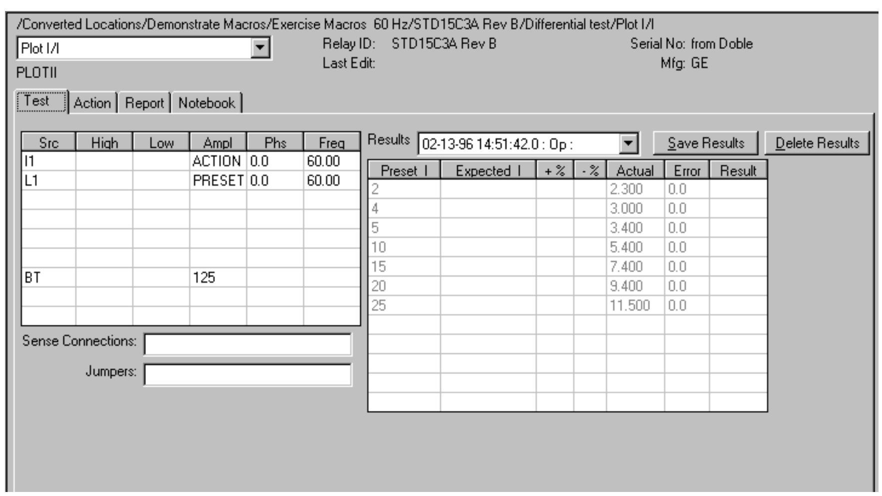


Figure C.79 PLOTII Test Tab Screen

Action Tab

The PLOTII Action Tab Conditions fields are explained in Table C.85.

Table C.85 PLOTII Action Tab Conditions Fields

Field	Explanation
Action Offset	Offset as a percent of Preset for balanced initial condition; value may be greater or less than 100%. Action Tap/Preset Tap * 1000.
Offset Duration	How long to apply the offset, in cycles.
Action Limit	Limit current in amps for test; maximum of Offset and Limit determines source range. Note: Action Offset changes for each test point as a function of Preset.
Pulse Duration	Maximum length of each binary search test pulse; pulse terminates as soon as sense is detected.
Wait	How long to wait between search pulses; wait is at offset current.
Delta Current	Step size of final ramp, after search converges. Use minus sign for downward ramp.
Delta Time	How long each linear ramp step is held, looking for pickup. Set Delta Time to 0 for a pulsed ramp, with return to offset; pulse duration and wait time are the same as for the search.
Reset Time	Time to wait between test values, with ACTION and PRESET currents off.

The PLOTII Action Tab screen is shown in Figure C.80.

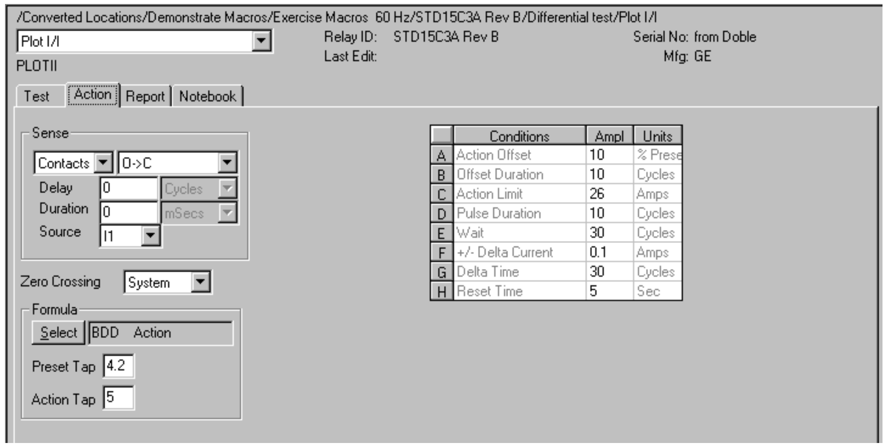


Figure C.80 PLOTII Action Tab Screen

Sense

The PLOTII Sense fields are explained in Table C.86.

Table C.86 PLOTII Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Formula

Select — Click this button to display the Formula pop-up window. Select a formula and click **Apply**. Enter Preset Tap and Action Tap values.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

After a number of search pulses a linear or pulsed ramp begins. Each test point stops when the ramp detects relay operation, normally after three or four steps. If the relay does not operate after the first two search pulses, or after 15 ramp steps, a No Op is recorded.

Operation Graph

The PLOTII Operation graph is shown in Figure C.81.

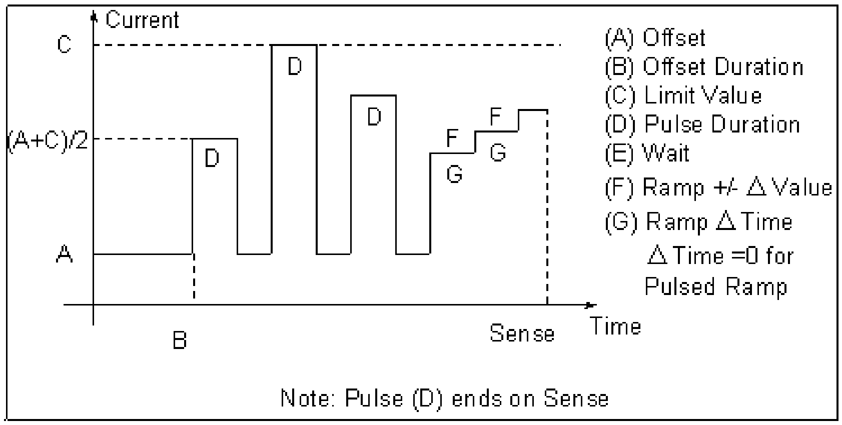


Figure C.81 PLOTII Operation Graph

PLOTVV - V vs. V Differential Voltage Plot - V ProTesTPLAN

Description

A Preset voltage is set to a value, and an Action voltage is searched for a pickup. The initial value of the Action Voltage is set to be in balance with the Preset, and moves up or down with Binary Search to find a pickup amplitude. The procedure is repeated for up to 12 values of Preset voltage. A plot formula is selected according to the type of relay being tested. Depending on the test connections, the plot can display Action vs. Preset current, (Action – Preset) vs. Preset, (Action + Preset) vs. Preset, or relay specific plots of multiples of tap or slope. Two PLOTVV macros can be used to plot the upper and lower boundaries between operate (Op) and non-operate (No Op) values of voltage.

Operation

The Test tab identifies one voltage as PRESET and one as ACTION. Values of Preset voltage are entered on the Test tab. Use the Action tab to define Action Conditions for the Binary Search. Action offset is given as a % of Preset, so that each test begins with a different Action offset, one that is balanced with the Preset voltage. (The Offset% can be greater or smaller than 100%, depending on the tap connections.) The Action Limit and sign of the delta voltage determine whether the search goes up or down.

On the Test tab enter up to 12 Preset amplitudes. The PRESET voltage is turned on with the ACTION, at values where the sources should be in balance. If other sources are specified, such as currents, they would also be turned on, although additional sources are not normally required for this test. When an Action point completes, both PRESET and ACTION sources turn off. If a source error occurs, the test result is recorded as SOURCE, and the test continues with the next point. Similarly, a no-operate condition is recorded as No Op. (Source errors are ignored during the search phase of Binary Search, but are detected during the subsequent ramp.)

Use

This macro tests the slope of voltage differential relays.

Notes

- If tap values apply to the relay, enter values on the Test screen for Preset Tap and Action Tap; the default is 1.0. Tap value is used only for plotting. Test quantities are specified and recorded as current amplitude. The formula can be changed without running the test.

Test Tab

On the PLOTVV Test Tab screen (Figure C.82):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The PLOTVV Test Tab Results fields are explained in Table C.87.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.87 PLOTVV Test Tab Results Fields

Field	Explanation
Preset V	Enter up to 12 values of Preset amplitude in the table. These define the Preset voltage and the Action offset that will be applied. Zero values are not run.
Expected V	Enter up to 12 values to define the expected pickup voltage, in volts.
+ %/– %	Enter + % and – % tolerances to determine Pass/Fail.
Actual	The recorded amplitude is displayed in this column, in volts.
Error	Test point error.
Result	Pass/Fail result based on current and not formula.

The PLOTVV Test Tab screen is shown in Figure C.82.

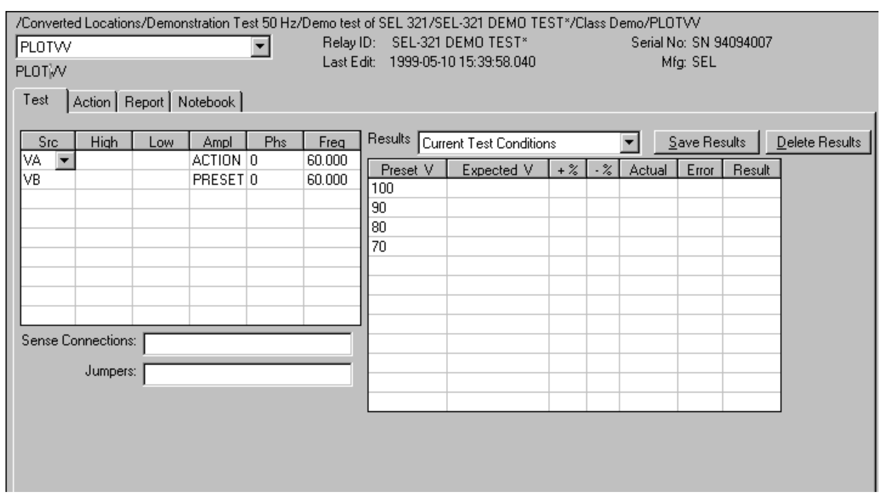


Figure C.82 PLOTVV Test Tab Screen

Action Tab

The PLOTVV Action Tab Conditions fields are explained in Table C.88.

Table C.88 PLOTVV Action Tab Conditions Fields

Field	Explanation
Action Offset	Offset voltage as percent of Preset for balanced initial condition; value may be greater or less than 100%
Offset Duration	How long to apply the offset, in cycles.
Action Limit	Limit voltage in voltage for test; maximum of Offset and Limit determines source range. Note: Offset changes for each test point, as a function of Preset.
Pulse Duration	Maximum length of each binary search test pulse, pulse terminates as soon as sense is detected.
Wait	How long to wait between search pulses, wait is at offset current.
Delta Voltage	Step size of final ramp, after search converges.
Delta Time	How long each linear ramp step is held, looking for pickup. Set Delta Time to 0 for a pulsed ramp, with return to offset; pulse duration and wait time are the same as for the search.
Reset Time	Time to wait between test values, with ACTION and PRESET currents off.

The PLOTVV Action Tab screen is shown in Figure C.83.

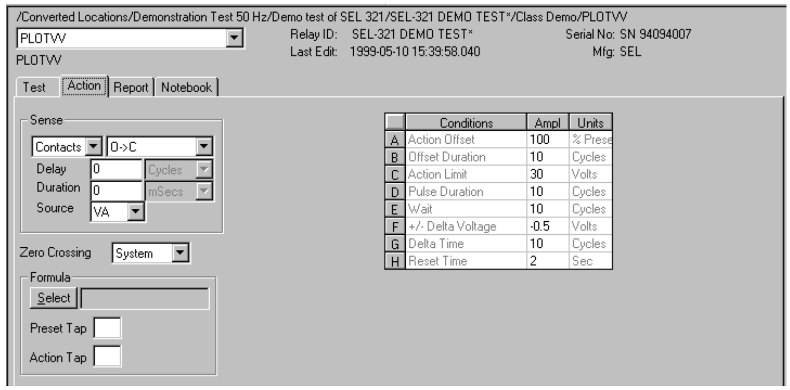


Figure C.83 PLOTVV Action Tab Screen

Sense

The PLOTVV Sense fields are explained in Table C.89.

Table C.89 PLOTVV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Formula

Select — Click this button to display the Formula pop-up window. Select a formula and click **Apply**. Enter Preset Tap and Action Tap values.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

After a number of search pulses a linear or pulsed ramp begins. Each test point stops when the ramp detects relay operation, normally after three or four steps. If the relay does not operate after the first two search pulses, or after 15 ramp steps, a No Op is recorded.

Operation Graph

The PLOTVV Operation graph is shown in Figure C.84.

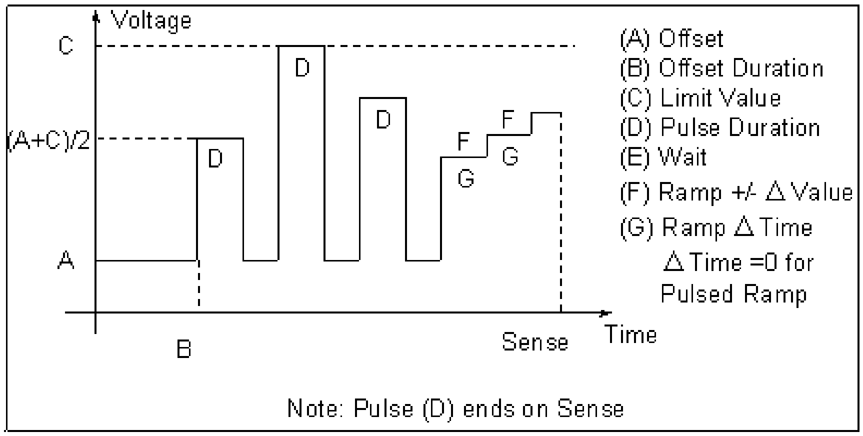


Figure C.84 PLOTVV Operation Graph

POWER - Battery Simulator Power - All ProTesTPLANS

Description

Supply non-stop DC power to the relay being tested, using the F225x and F6000 family internal battery simulator or external F2410 slave Battery Simulator. The selected DC voltage remains applied during all macros used in the Test Plan.

Operation

The battery simulator is turned on by selecting a non-zero amplitude and running the Power macro. The battery simulator remains on until the Power macro is run again with a zero amplitude on the Test Plan.

Test Tab

On the POWER Test Tab screen (Figure C.85 on page C-156):

1. Enter a BT non-zero amplitude and run the macro to turn on DC power.
   Enter a zero amplitude and run the macro to turn the BT source off.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
4. Enter the jumper connections in the Jumpers field.

The POWER Test Tab Results fields are explained in Table C.90.

Table C.90 POWER Test Tab Results Fields

Field	Explanation
Source	Name of the source is always BT. Results do not apply to POWER.
Amplitude	Select DC voltage from a pull-down list that appears when the Ampl field is selected. A value of 0 will turn off the BT source.
On/Off	Specify the state of the DC power supply, either on or off.

The POWER Test Tab screen is shown in Figure C.85.

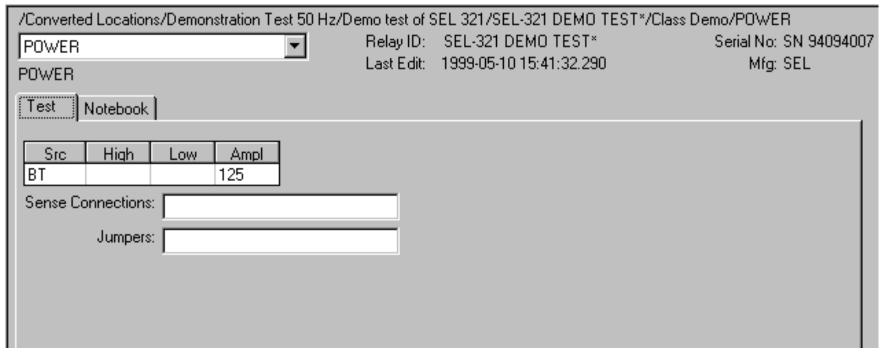


Figure C.85 POWER Test Tab Screen

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

PRAMPI - Pulsed Linear Ramp, Current - I ProTesTPLAN

Description

One or more current sources are ramped, simultaneously, returning to an offset amplitude between pulses. If the limit amplitude is reached with no relay operation, it is recorded as No Op, for No Operation.

For example, use this macro to test reach at a specific angle for a distance relay – hence the Reach Pulse Ramp Curve, RCHPRI macro name. Pulsed ramp reduces heat load on the relay. RCHPRI and PRAMPI are identical. If you have both Z and I ProtestPLANS, use the name you prefer.

Operation

One or more current sources are ramped, simultaneously, in a series of pulses using the same Action conditions. One or more voltage presets can be applied. Sources can have different phase angles, representing phase offset. Sources can be at different harmonics; e.g. one current can be at 60 Hz (or 50 Hz), and another at 120 Hz (or 100 Hz), to test harmonic restraint on a differential relay.

Use

This macro tests Ohmic reach of current-operated directional distance relays at specific phase angles; Pickup/dropout of overcurrent relays; Minimum pickup and harmonic restraint for differential relays with harmonic inrush restraint.

Use Pulsed Ramp instead of Linear Ramp to minimize heat load on relay, or when the relay requires return to offset between test values.

Notes

- Most relays that can be tested with RCHPRI or PRAMPI can be tested faster using RCHBOI or BSRHOI, the binary search macro.

Test Tab

On the PRAMPI Test Tab screen (Figure C.86):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The PRAMPI Test Tab Results fields are explained in Table C.91.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.91 PRAMPI Test Tab Results Fields

Field	Explanation
Expected I	Expected operate value, in Amps.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The PRAMPI Test Tab screen is shown in Figure C.86.

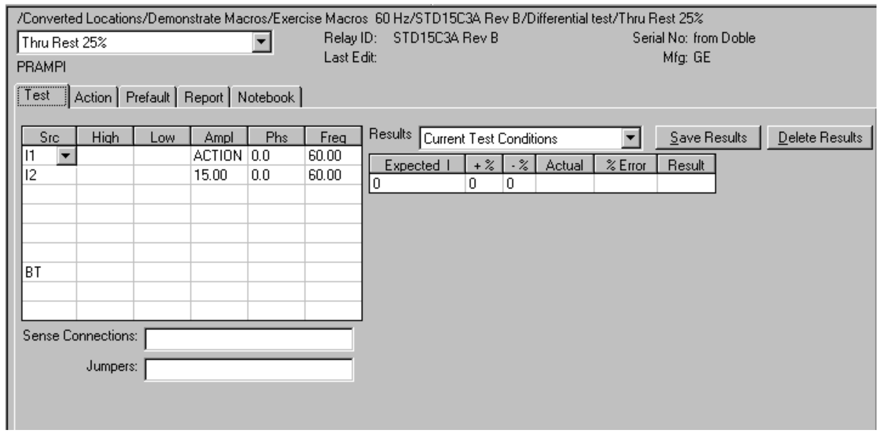


Figure C.86 PRAMPI Test Tab Screen

Action Tab

The PRAMPI Action Tab Conditions fields are explained in Table C.92.

Table C.92 PRAMPI Action Tab Conditions Fields

Field	Explanation
Offset Current	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset. For no offset, enter 0 amps and 0 cycles.
Initial Current	Starting value for the pulsed ramp.
Pulse Duration	How long each pulse is held waiting for a sense.
Wait	How long to wait at offset between pulses.
Delta Current	Step size of pulsed ramp. Use a minus sign for a downward ramp.
Current Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum of the source limit determines the source range.

The PRAMPI Action Tab screen is shown in Figure C.87.

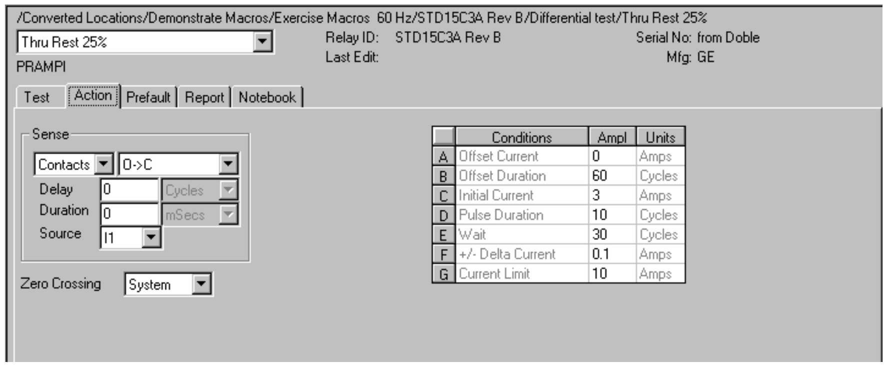


Figure C.87 PRAMPI Action Tab Screen

Sense

The PRAMPI Sense fields are explained in Table C.93.

Table C.93 PRAMPI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the ramp operates and the amplitude is recorded. If the relay does not operate, a No Op is recorded. No Op may be desired, if the relay is not supposed to operate.

Hints

- Use Offset Current = 0, and non-zero Offset Duration Action Delay if polarizing voltage must be applied before the Action.
- Test results depend on the ramp rate – too fast causes overshoot, too slow stresses the relay and takes more time. Start with a slow rate, using values that give a stable, acceptable result. Then reduce the delta time until the result is no longer stable. Find the fastest ramp that is acceptable.
- The Wait time should be long enough to allow the relay to reset or recover from the previous pulse. Make Wait as short as possible to make the test run faster.
- Highest VA output is obtained when a source is used in the high end of its range. Do not select a Current Limit too far beyond expected relay action.

Operation Graph

The PRAMPI Operation graph is shown in Figure C.88.

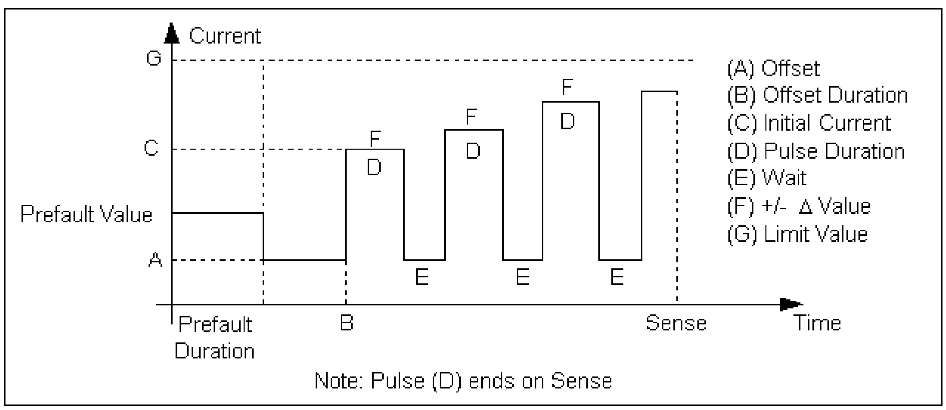


Figure C.88 PRAMPI Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The PRAMPI Prefault Tab fields are explained in Table C.94.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.94 PRAMPI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

PRAMPV - Pulsed Linear Ramp, Voltage - V ProTesTPLAN

Description

One or more voltage sources are ramped, simultaneously, in a series of pulses, returning to an offset amplitude between pulses. If the limit amplitude is reached with no relay operation, it is recorded as No Op, for No Operation.

Use this macro to test reach at a specific angle for a distance relay – hence the Reach Pulse Ramp Voltage, RCHPRV macro name. Pulsed ramp minimizes voltage load on a relay. RCHPRV and PRAMPV are identical. If you have both Z and V ProTesTPLANS, use the name you prefer.

Operation

One or more voltage sources are ramped, simultaneously, in a series of pulses using the same Action conditions. One or more voltage presets can be applied. Sources can have different phase angles, representing phase offset. Sources can be at different harmonics; e.g. one voltage can be at 60 Hz (or 50 Hz), and another at 120 Hz (or 100 Hz).

Use

This macro tests Ohmic reach of voltage-operated directional distance relays at specific phase angles; Pickup/dropout of overvoltage or undervoltage relays.

Use when relay requires a return to offset between test values.

Notes

- Most relays that can be tested with RCHPRV or LRAMPV can be tested faster using RCHBOV or BSRHOV, the binary search macro.

Test Tab

On the PRAMPV Test Tab Results screen (Figure C.89):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Results — The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The PRAMPV Test Tab Results fields are explained in Table C.95.

Save Results — Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.

Delete Results — Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

Table C.95 PRAMPV Test Tab Results Fields

Field	Explanation
Expected V	Expected operate value, in Volts.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication

The PRAMPV Test Tab screen is shown in Figure C.89.

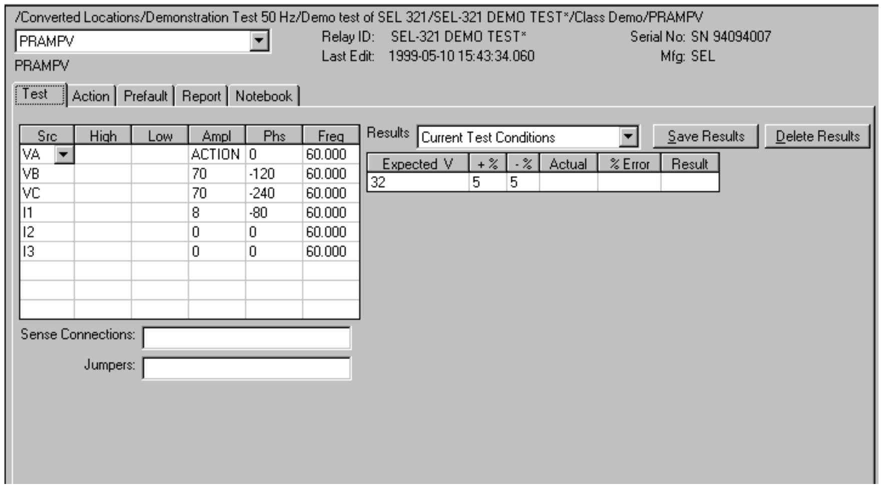


Figure C.89 PRAMPV Test Tab Screen

Action Tab

The PRAMPV Action Tab Conditions fields are explained in Table C.96.

Table C.96 PRAMPV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset. If no offset is wanted, enter 0 volts and 0 cycles.
Initial Voltage	Starting value for the pulsed ramp.
Pulse Duration	How long each pulse is held waiting for a sense.
Wait	How long to wait at offset between pulses.
Delta Voltage	Step size of pulsed ramp. Use a minus sign for a downward ramp.
Voltage Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum of Offset and limit determines the source range.

The PRAMPV Action Tab screen is shown in Figure C.90.

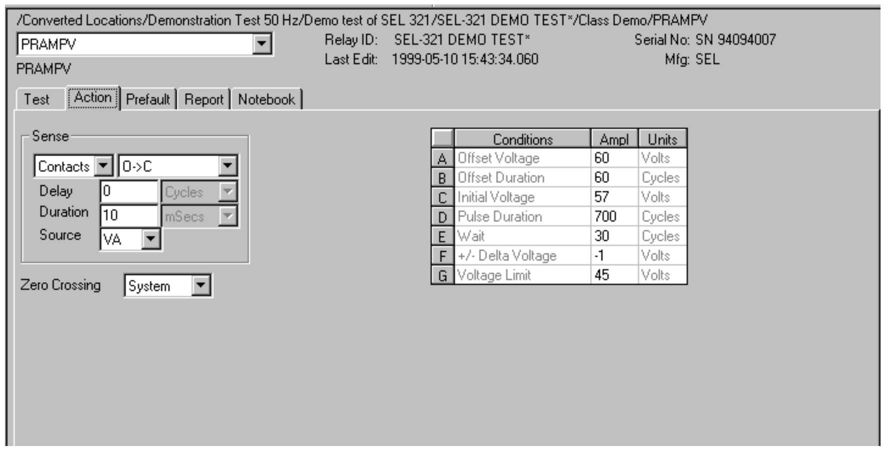


Figure C.90 PRAMPV Action Tab Screen

Sense

The PRAMPV Sense fields are explained in Table C.97.

Table C.97 PRAMPV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the amplitude is recorded. If the relay does not operate a No Op is recorded. No Op may be desired, if the relay is not supposed to operate.

Hints

- Use Offset Voltage, and non-zero Offset Duration Action Delay if polarizing voltage must be applied before the Action.
- Test results depend on the ramp rate – too fast causes overshoot, too slow stresses the relay and takes more time. Start with a slow rate, using values that give a stable, acceptable result. Then reduce the delta time until the result is no longer stable. Find the fastest ramp that is acceptable.
- The Wait time should be long enough to allow the relay to reset or recover from the previous pulse. Make Wait as short as possible to make the test run faster.

Operation Graph

The PRAMPV Operation graph is shown in Figure C.91.

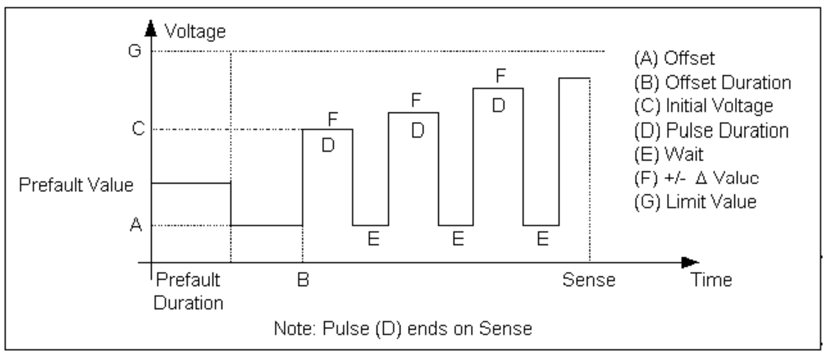


Figure C.91 PRAMPV Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current.

Operation

When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

The PRAMPV Prefault Tab fields are explained in Table C.98.

Table C.98 PRAMPV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

RCHBOI - Reach Binary Search, Current - Z ProTesTPLAN

Description

A fast, high-low pulsed search to bracket relay operate point, followed by either a linear ramp or pulsed ramp for high resolution result. RCHBOI and BSRHOI are identical. If you have both Z and I ProTesTPLANS, use the name you prefer.

The search begins by testing midway between the Action Offset and Limit Current. If the relay does not operate, limit current is applied. If the relay still does not operate, the test is over (recorded as No Op, No Operation). Successive pulses are calculated based on the results of the last pulse; i.e., the next pulse is halfway between the last operate value and the last No Op value. When the difference between pulse amplitudes is less than three times the ramp delta current, the search stops and either a Linear Ramp or a Pulsed Ramp begins.

The ramp backs off twice the delta current, then ramps for a maximum of 15 steps. If the test is properly tuned, three or four steps should be sufficient.

Operation

One or more current sources can be ramped simultaneously, using the same Action conditions. One or more voltage presets can be applied.

Use

Use RCHBOI wherever Linear Ramp or Pulsed Ramp can be used; however, there are cases where it cannot be used successfully such as long reset times in induction disk relays. When properly used, binary search is faster for determining Ohmic reach of current-operated distance relays or measuring pickup/dropout of overcurrent relays.

Notes

- Binary Search requires more tuning than Linear Ramp or Pulsed Ramp. The relay may respond differently to search pulses vs. linear ramp steps. You may hear sensing during the search, but the ramp concludes with No Op, relay operation not detected. Use sense delay to filter relay transient response on the pulses, so that search converges to the correct value.
- If memory action is important to the relay, allow adequate wait time for reset and a long enough pulse time to operate.
- Some relays require the use of pulsed ramp for testing. If so, select the Pulsed Ramp option by setting ramp Delta Time = 0.
- Search can be done either from low offset to high limit, or high offset to low limit. When searching from a high offset, Ramp Delta Voltage must be negative.
- Use Offset Current = 0, and non-zero Offset Duration Action Delay if polarizing voltage must be applied before the Action.
- Use sense delay to ensure that the search converges to a value that can be detected with the ramp. A large amount may be required; e.g., 25 to 50% of the pulse duration. This filters transient response to the leading edge of the pulse. If contact instability is also present, use sense delay as well.

Test Tab

On the RCHBOI Test Tab screen (Figure C.92 on page C-172):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results

The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The RCHBOI Test Tab Results fields are explained in Table C.99.

Save Results

Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.

Delete Results

Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.99 RCHBOI Test Tab Results Fields

Field	Explanation
Expected I	Expected operate value, in Amps.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The RCHBOI Test Tab screen is shown in Figure C.92.

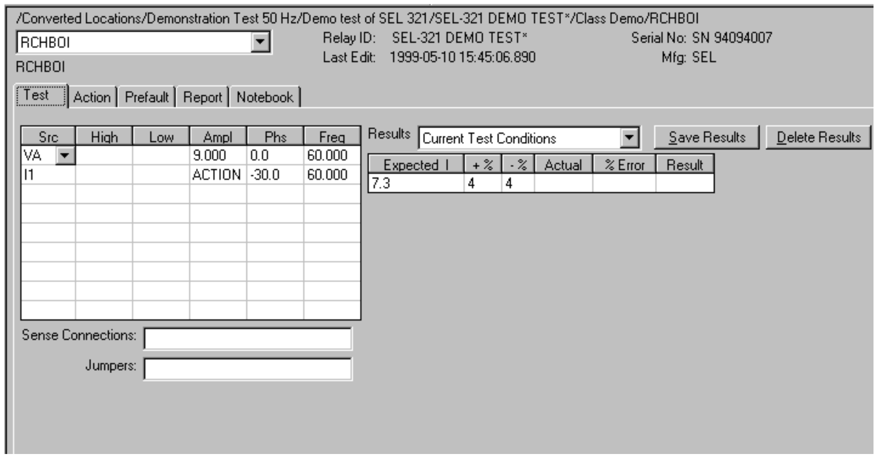


Figure C.92 RCHBOI Test Tab Screen

Action Tab

The RCHBOI Action Tab Conditions fields are explained in Table C.100.

Table C.100 RCHBOI Action Tab Conditions Fields

Field	**Explanation**
Offset Current	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Current Limit	The amplitude that stops the search, if the relay does not operate. The maximum of Offset Current and limit determines the source range.
Pulse Duration	Maximum length of each search pulse; pulse terminates as soon as a sense is detected.
Wait	How long to wait between pulses; wait is at offset current.
Delta Current	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	Duration of each ramp step. A non-zero value selects a linear ramp; setting Delta Time = 0 selects a pulsed ramp, using the same pulse duration and wait as the search.

The RCHBOI Action Tab screen is shown in Figure C.93.

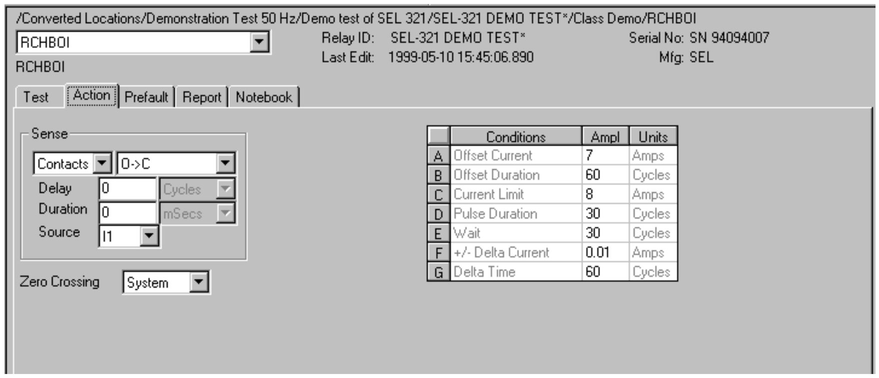


Figure C.93 RCHBOI Action Tab Screen

Operation Graph

The RCHBOI Operation graph is shown in Figure C.94.

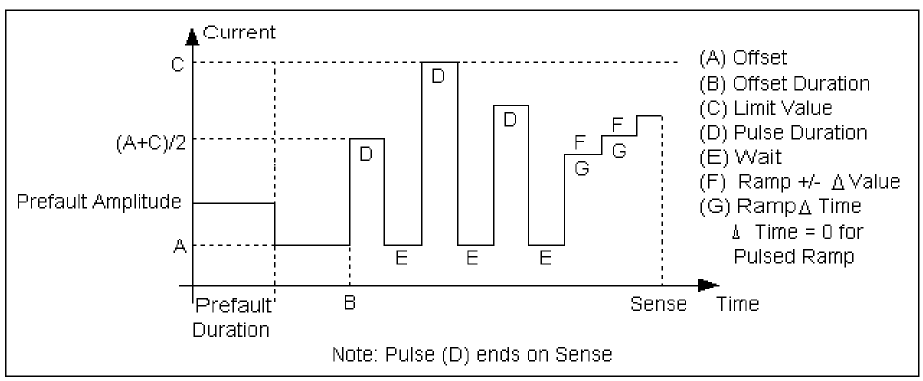


Figure C.94 RCHBOI Operation Graph

Sense

The RCHBOI Sense fields are explained in Table C.101.

Table C.101 RCHBOI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

After a small number of search pulses, the ramp begins. The test stops as soon as the ramp detects relay operation, normally after three or four steps, and the amplitude is recorded. If the relay does not operate after 15 ramp steps are taken, a No Op is recorded. No Op may be desired, if the relay is not supposed to operate.

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current.

The RCHBOI Prefault Tab fields are explained in Table C.102.

Operation

When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.102 RCHBOI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

RCHBOV - Reach Binary Search, Voltage - Z ProTesTPLAN

Description

A fast, high-low pulsed search to bracket relay operate point, followed by linear ramp or pulsed ramp for high resolution result. RCHBOV and BSRHOV are identical. If you have both the V and Z ProTesTPLANS, use the name you prefer.

The search begins by testing midway between the Action Offset and Limit Voltage. If the relay does not operate, limit voltage is applied. If the relay still does not operate, the test is over (recorded as No Op, No Operation). Successive pulses are calculated based on the results of the last pulse; i.e., the next pulse is halfway between the last operate value and the last No Op value. When the difference between pulse amplitudes is less than three times the ramp delta voltage, the search stops and either a Linear Ramp or a Pulsed Ramp begins.

The ramp backs off twice the delta voltage, then ramps for a maximum of 15 steps. If the test is properly tuned, three or four steps should be sufficient.

Operation

This macro is used to ramp one or more current sources simultaneously, using the same Action conditions. One or more voltage presets can be applied.

Use

RCHBOV can be used wherever Linear Ramp or Pulsed Ramp would be used; however, there are cases where it cannot be used successfully. When used properly, Binary Search has faster performance for determining Ohmic reach of voltage-operated distance relays or pickup/dropout of overvoltage or undervoltage relays.

Notes

- Binary Search requires more tuning than Linear Ramp or Pulsed Ramp. The relay may respond differently to search pulses vs. linear ramp steps. You may hear sensing during the search, but the ramp concludes with No Op, relay operation not detected. Use sense delay to filter relay transient response on the pulses, so that search converges to the correct value.
- If memory action is important to the relay, allow adequate wait time for reset and a long enough pulse time to operate.
- Some relays require the use of pulsed ramp for testing. If so, select the Pulsed Ramp option by setting ramp Delta Time = 0.
- Search can be done either from low offset to high limit, or high offset to low limit. When searching from a high offset, Ramp Delta Voltage must be negative.

Test Tab

On the RCHBOV Test Tab screen (Figure C.95 on page C-178):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The RCHBOV Test Tab Results fields are explained in Table C.103.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.103 RCHBOV Test Tab Results Fields

Field	Explanation
Expected V	Expected operate value, in Volts.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The RCHBOV Test Tab screen is shown in Figure C.95.

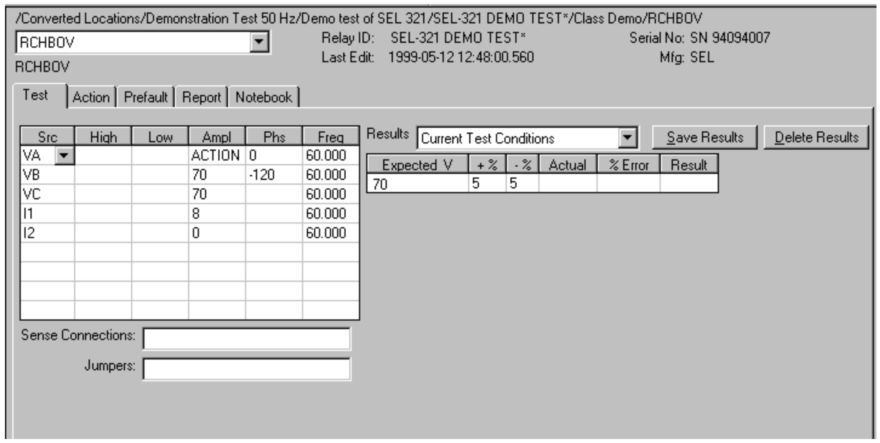


Figure C.95 RCHBOV Test Tab Screen

Action Tab

The RCHBOV Action Tab Conditions fields are explained in Table C.104.

Table C.104 RCHBOV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial amplitude of the Action source. Action offset turns on at the same time as the Preset sources.
Offset Duration	How long to maintain the offset.
Voltage Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum of Offset and limit determines the source range.
Pulse Duration	Maximum length of each search pulse; pulse terminates as soon as a sense is detected.
Wait	How long to wait between pulses; wait is at offset voltage.
Delta Voltage	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each Linear Ramp step is held; set Delta Time = 0 for Pulsed Ramp, using the same pulse duration and wait as the search.

The RCHBOV Action Tab screen is shown in Figure C.96.

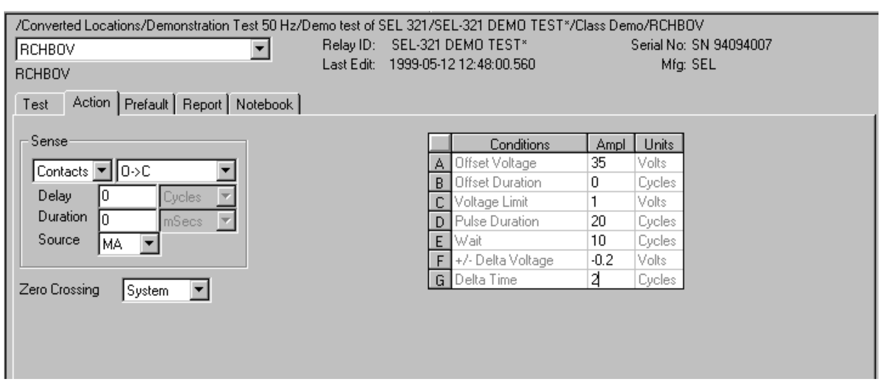


Figure C.96 RCHBOV Action Tab Screen

Sense

The RCHBOV Sense fields are explained in Table C.105.

Table C.105 RCHBOV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

After a small number of search pulses, the ramp begins. The test stops as soon as the ramp detects relay operation, normally after three or four steps, and the amplitude is recorded. If the relay does not operate after 15 ramp steps are taken, a No Op is recorded. No Op may be desired, if the relay is not supposed to operate.

Hints

- Use Offset Voltage = 0, and non-zero Offset Duration Action Delay if polarizing current must be applied before the Action.
- Use sense delay to ensure that the search converges to a value that can be detected with the ramp. A large amount may be required; e.g., 25 to 50% of the pulse duration. This filters transient response to the leading edge of the pulse. If contact instability is also present, use sense duration as well.

Operation Graph

The RCHBOV Operation graph is shown in Figure C.97.

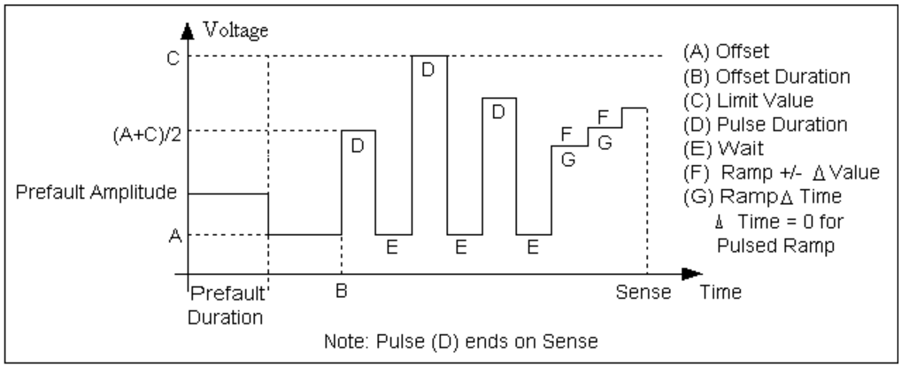


Figure C.97 RCHBOV Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The RCHBOV Prefault Tab fields are explained in Table C.106.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.106 RCHBOV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

RCHLRI - Reach Linear Ramp, Current - Z ProTesTPLAN

Description

One or more current sources are ramped from an offset amplitude until the relay operates, or until a limit amplitude is reached (recorded as No Op, for No Operation).

Use this Macro to test reach at a specific angle for a distance relay – hence the Macro name RCHLRI. RCHLRI and LRAMPI are identical. If you have both V and Z ProTesTPLANS, use the name you prefer.

Operation

One or more current sources are ramped simultaneously, using the same Action conditions. One or more voltage presets can be applied. Sources can have different phase angles, representing phase offset. Sources can be at different harmonics; e.g. one current can be at 60 Hz (or 50 Hz), and another at 120 Hz (or 100 Hz), to test harmonic restraint on a differential relay.

Use

This macro tests Ohmic reach of current-operated directional distance relays at specific phase angles; Pickup/dropout of overcurrent relays; Minimum pickup and harmonic restraint for differential relays with harmonic inrush restraint.

Notes

- To minimize test time and heating, use an offset as close to the expected operating point as possible.
- Most relays that can be tested with RCHLRI or LRAMPI can be tested faster using RCHBOI or BSRHOI, binary search macros.

Test Tab

On the RCHLRI Test Tab screen (Figure C.98):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The RCHLRI Test Tab Results fields are explained in Table C.107.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.107 RCHLRI Test Tab Results Fields

Field	Explanation
Expected I	Expected operate value, in Amps.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The RCHLRI Test Tab screen is shown in Figure C.98.

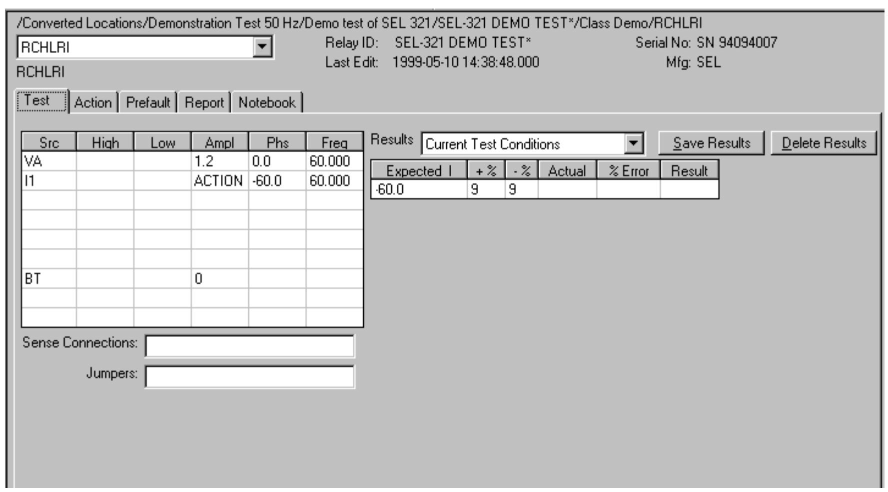


Figure C.98 RCHLRI Test Tab Screen

Action Tab

The RCHLRI Action Tab Conditions fields are explained in Table C.108.

Table C.108 RCHLRI Action Tab Conditions Fields

Field	Explanation
Offset Current	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Delta Current	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each ramp step is held waiting for a sense.
Current Limit	The amplitude at which the ramp stops if the relay does not operate.

The RCHLRI Action Tab screen is shown in Figure C.99.

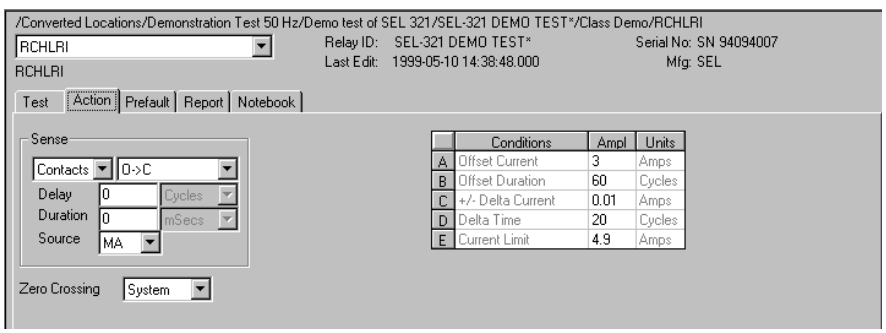


Figure C.99 RCHLRI Action Tab Screen

Sense

The RCHLRI Sense fields are explained in Table C.109.

Table C.109 RCHLRI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

After a small number of search pulses, the ramp begins. The test stops as soon as the relay operates and the amplitude is recorded. If the relay does not operate a No Op is recorded. No Op may be desired, if the relay is not supposed to operate.

Hints

- Use Offset Current = 0, and non-zero Offset Duration if polarizing voltage must be applied before the Action.
- Test results depend on the ramp rate – too fast causes overshoot, too slow stresses the relay and takes more time. Start with a slow rate, using values that give a stable, acceptable result. Then reduce the delta time until the result is no longer stable. Find the fastest ramp that is acceptable.
- For example, set Delta Current equal to 10 to 20 percent of the tolerance amplitude. If the Expected Value is 1 amp with tolerance of +10%, the tolerance amplitude equals 1.0 X 10%, or 0.1; 10% to 20% of that sets delta amplitude equal to .01 to 0.02 Amp.
- Set delta time to be two to five times nominal relay operating time for best accuracy. Use one to two times for lowest heat and shortest test time.

Operation Graph

The RCHLRI Operation graph is shown in Figure C.100.

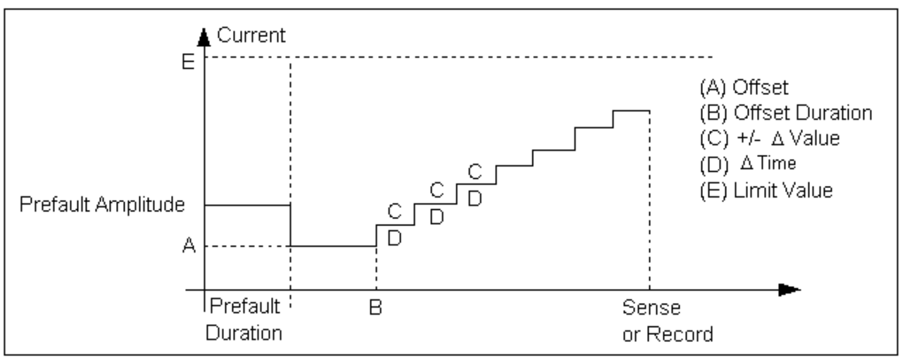


Figure C.100 RCHLRI Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The RCHLRI Prefault Tab fields are explained in Table C.110.

Operation	When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.110 RCHLRI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

RCHLRV - Reach Linear Ramp, Voltage - Z ProTesTPLAN

Description

One or more voltage sources are ramped from an offset amplitude until the relay operates, or until a limit amplitude is reached (recorded as No Op, for No Operation).

Use this macro to test reach at a specific angle for a distance relay – hence the Macro name RCHLRV. RCHLRV and LRAMPV are identical. If you have both I and Z ProTesTPLANS use the name you prefer.

Operation

One or more voltage sources are ramped simultaneously, using the same Action conditions. One or more current presets can be applied. Sources can have different phase angles, representing phase offset. Sources can be at different harmonics; e.g. one voltage can be at 60 Hz (or 50 Hz), and another at 120 Hz (or 100 Hz).

Use

This macro tests Ohmic reach of voltage-operated directional distance relays at specific phase angles; Pickup/dropout of overvoltage or undervoltage relays.

Notes

- To minimize test time and heating, use an offset as close to the expected operating point as possible.
- Most relays that can be tested with RCHLRV or LRAMPV can be tested faster using RCHBOV or BSRHOV, the binary search macro.
- For maximum source VA, use a source in the high end of a voltage range.

Test Tab

On the RCHLRV Test Tab screen (Figure C.101 on page C-192):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The RCHLRV Test Tab Results fields are explained in Table C.111 on page C-192.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.111 RCHLRV Test Tab Results Fields

Field	Explanation
Expected V	Expected operate value, in Volts.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The RCHLRV Test Tab screen is shown in Figure C.101.

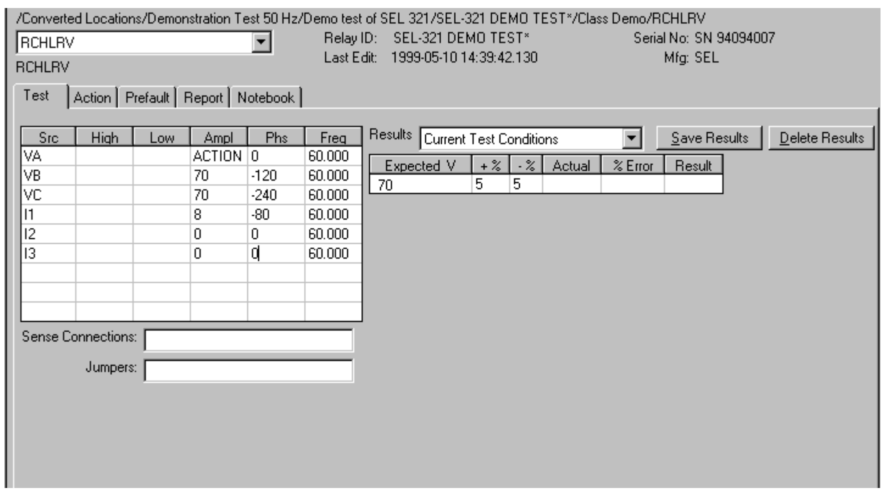


Figure C.101 RCHLRV Test Tab Screen

Action Tab

The RCHLRV Action Tab Conditions fields are explained in Table C.112.

Table C.112 RCHLRV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset. If no offset is wanted, enter 0 volts and 0 cycles.
Delta Voltage	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each ramp step is held waiting for a sense.
Voltage Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum of Offset and limit determines the source range. Note: Best accuracy is obtained if you use a source in the high end of its range.

The RCHLRV Action Tab screen is shown in Figure C.102.

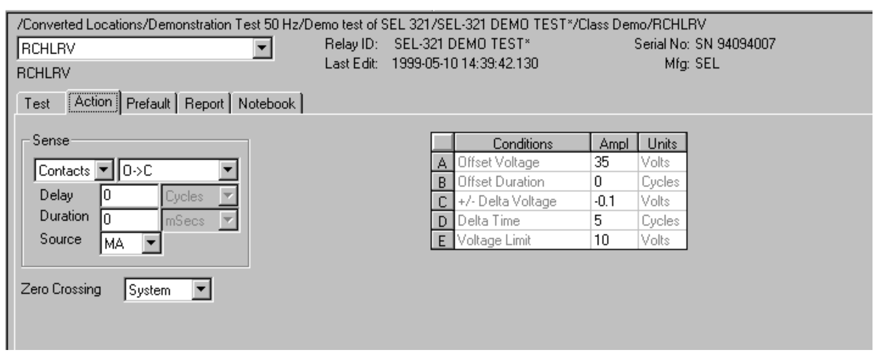


Figure C.102 RCHLRV Action Tab Screen

Sense

The RCHLRV Sense fields are explained in Table C.113.

Table C.113 RCHLRV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the amplitude is recorded. If the relay does not operate a No Op is recorded. No Op may be desired, if the relay is not supposed to operate.

Hints

- Use Offset Voltage, and non-zero Offset Duration, if polarizing current must be applied before the Action.
- Test results depend on the ramp rate – too fast causes overshoot, too slow stresses the relay and takes more time. Start with a slow rate, using values that give a stable, acceptable result. Then reduce the delta time until the result is no longer stable. Find the fastest ramp that is acceptable.

  For example, set Delta Voltage to from 10 to 20 percent of the tolerance amplitude.
- Set delta time to be two to five times nominal relay operating time for best accuracy. Use one to two times for lowest heat and shortest test time.

Operation Graph

The RCHLRV Operation graph is shown in Figure C.103.

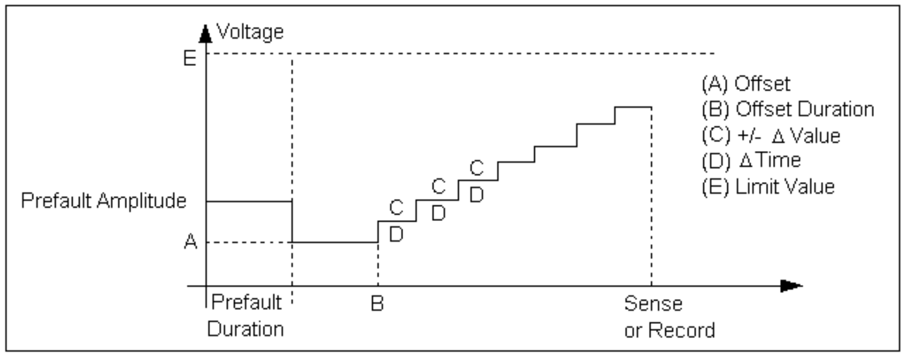


Figure C.103 RCHLRV Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The RCHLRV Prefault Tab fields are explained in Table C.114.

Operation When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.114 RCHLRV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

RCHPRI - Reach Pulsed Linear Ramp, Current - Z ProTesTPLAN

Description

One or more current sources are ramped in a series of pulses, returning to an offset amplitude between pulses. If the limit amplitude is reached with no relay operation, it is recorded as No Op, for No Operation.

Use this macro to test reach at a specific angle for a distance relay – hence the RCHPRI Macro name. Pulsed ramp reduces heat load on an overcurrent relay. RCHPRI and PRAMPI are identical. If you have both Z and I ProtestPLANS, use the name you prefer.

Operation

One or more current sources are ramped simultaneously, using the same Action conditions. One or more voltage presets can be applied. Sources can have different phase angles, representing phase offset. Sources can be at different harmonics; e.g. one current can be at 60 Hz (or 50 Hz), and another at 120 Hz (or 100 Hz), to test harmonic restraint on a differential relay.

Use

This macro tests Ohmic reach of current-operated directional distance relays at specific phase angles; Pickup/dropout of overcurrent relays; Minimum pickup and harmonic restraint for differential relays with harmonic inrush restraint.

Use Pulsed Ramp instead of Linear Ramp to minimize heat load on relay, or when the relay requires return to offset between test values.

Notes

- Most relays that can be tested with RCHPRI or PRAMPI can be tested faster using RCHBOI or BSRHOI, the binary search macro.

Test Tab

On the RCHPRI Test Tab screen (Figure C.104 on page C-198):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The RCHPRI Test Tab Results fields are explained in Table C.115.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.115 RCHPRI Test Tab Results Fields

Field	Explanation
Expected I	Expected operate value, in Amps.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The RCHPRI Test Tab screen is shown in Figure C.104.

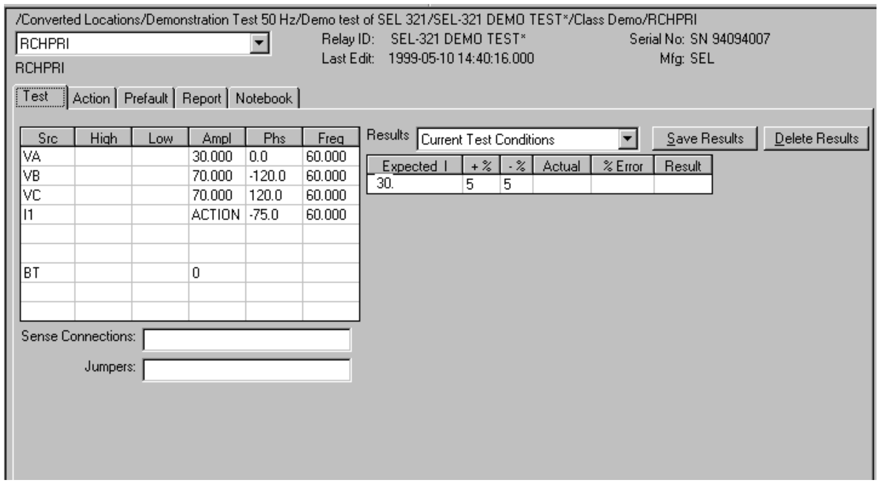


Figure C.104 RCHPRI Test Tab Screen

Action Tab

The RCHPRI Action Tab Conditions fields are explained in Table C.116.

Table C.116 RCHPRI Action Tab Conditions Fields

Field	Explanation
Offset Current	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Initial Current	Starting value for the pulsed ramp.
Pulse Duration	How long each pulse is held waiting for a sense.
Wait	How long to wait at offset between pulses.
Delta Current	Step size of pulsed ramp. Use a minus sign for a downward ramp.
Current Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum Offset and limit determines the source range.

The RCHPRI Action Tab screen is shown in Figure C.105.

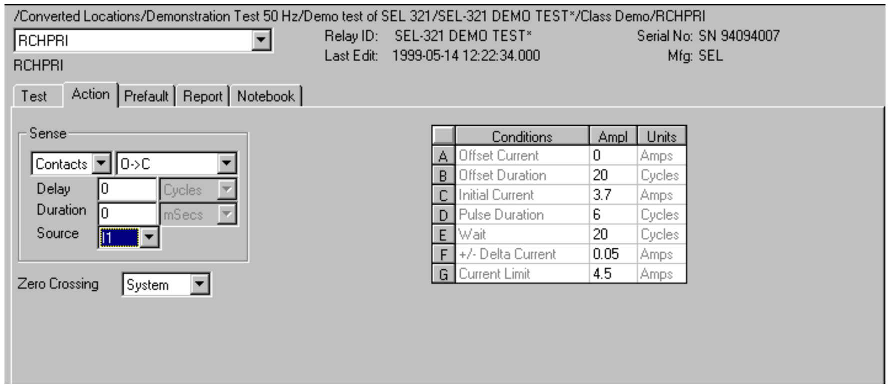


Figure C.105 RCHPRI Action Tab Screen

Sense

The RCHPRI Sense fields are explained in Table C.117.

Table C.117 RCHPRI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the amplitude is recorded. If the relay does not operate a No Op is recorded. No Op may be desired, if the relay is not supposed to operate.

Hints

- Use Offset Current = 0, and non-zero Offset Duration if polarizing voltage must be applied before the Action.
- Test results depend on the ramp rate – too fast causes overshoot, too slow stresses the relay and takes more time. Start with a slow rate, using values that give a stable, acceptable result. Then reduce the delta time until the result is no longer stable. Find the fastest ramp that is acceptable.
- The Wait time should be long enough to allow the relay to reset or recover from the previous pulse. Make Wait as short as possible to make the test run faster.
- Highest VA output is obtained when a source is used in the high end of its range. Do not select a Current Limit too far beyond expected relay action.

Operation Graph

The RCHPRI Operation graph is shown in Figure C.106.

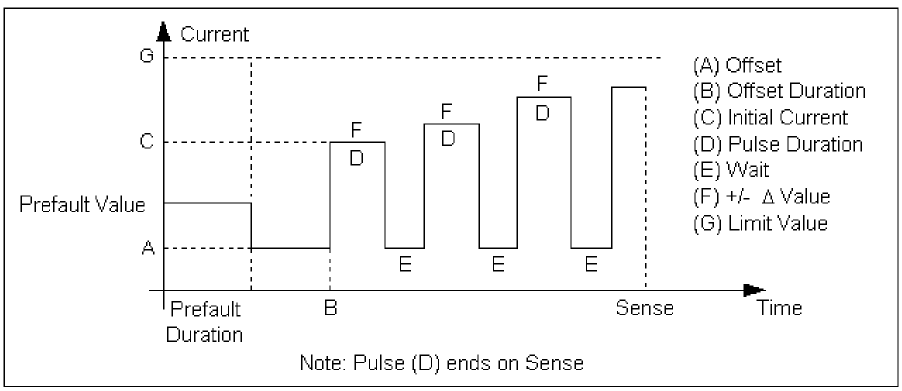


Figure C.106 RCHPRI Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The RCHPRI Prefault Tab fields are explained in Table C.118.

Operation	When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.118 RCHPRI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	Frequency cannot be entered when using the F2000 family of instruments. Frequency is set at the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

RCHPRV - Reach Linear Ramp, Voltage - Z ProTesTPLAN

Description

One or more voltage sources are ramped from an offset amplitude until the relay operates, or until a limit amplitude is reached (recorded as No Op, for No Operation).

Use this macro to test reach at a specific angle for a distance relay – hence the macro name RCHLRV. RCHLRV and LRAMPV are identical. If you have both I and Z ProTesTPLANS use the name you prefer.

Operation

One or more voltage sources are ramped simultaneously, using the same Action conditions. One or more current presets can be applied. Sources can have different phase angles, representing phase offset. Sources can be at different harmonics; e.g. one voltage can be at 60 Hz (or 50 Hz), and another at 120 Hz (or 100 Hz).

Use

This macro tests Ohmic reach of voltage-operated directional distance relays at specific phase angles; Pickup/dropout of overvoltage or undervoltage relays.

Notes

- To minimize test time and heating, use an offset as close to the expected operating point as possible.
- Most relays that can be tested with RCHLRV or LRAMPV can be tested faster using RCHBOV or BSRHOV, binary search macros.
- For maximum source VA, use a source in the high end of a voltage range.

Test Tab

On the RCHPRV Test Tab screen (Figure C.107):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The RCHPRV Test Tab Results fields are explained in Table C.119 on page C-204.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.119 RCHPRV Test Tab Results Fields

Field	**Explanation**
Expected V	Expected operate value, in Volts.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.

The RCHPRV Test Tab screen is shown in Figure C.107.

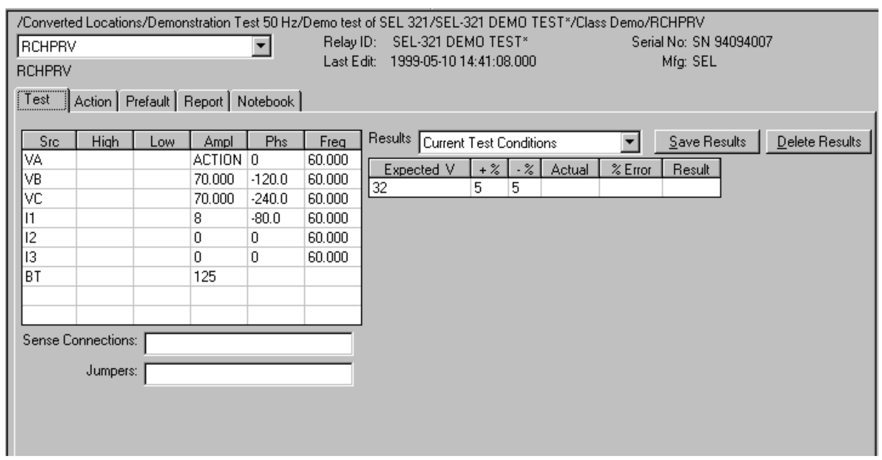


Figure C.107 RCHPRV Test Tab Screen

Action Tab

The RCHPRV Action Tab Conditions fields are explained in Table C.120.

Table C.120 RCHPRV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset. If no offset is wanted, enter 0 volts and cycles.
Initial Voltage	Starting value for the pulsed ramp.
Pulse Duration	How long each pulse is held waiting for a sense.
Wait	How long to wait at offset between pulses.
Delta Voltage	Step size of pulsed ramp. Use a minus sign for a downward ramp.
Voltage Limit	The amplitude at which the ramp stops if the relay does not operate. The Offset and limit determines the source range. The best accuracy is obtained if you use a source in the high end of its range.

The RCHPRV Action Tab screen is shown in Figure C.108.

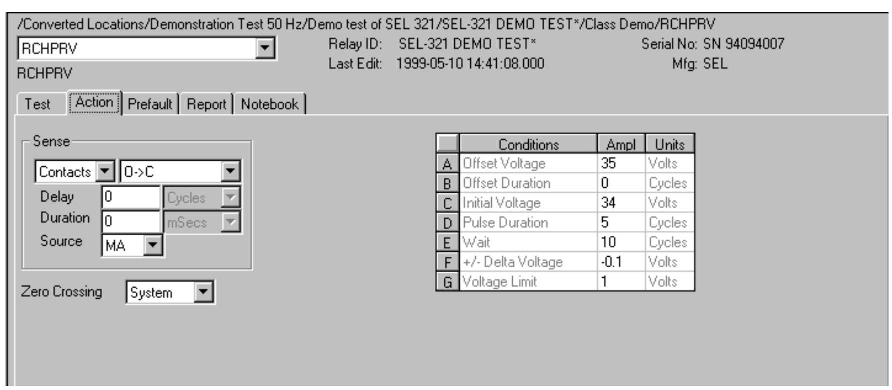


Figure C.108 RCHPRV Action Tab Screen

Sense

The RCHPRV Sense fields are explained in Table C.121.

Table C.121 RCHPRV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the amplitude is recorded. If the relay does not operate a No Op is recorded. No Op may be desired, if the relay is not supposed to operate.

Hints

- Use Offset Voltage, and non-zero Offset Duration, if polarizing current must be applied before the Action.
- Test results depend on the ramp rate – too fast causes overshoot, too slow stresses the relay and takes more time. Start with a slow rate, using values that give a stable, acceptable result. Then reduce the delta time until the result is no longer stable. Find the fastest ramp that is acceptable.

  For example, set Delta Voltage to from 10 to 20 percent of the tolerance amplitude.
- Set delta time to be two to five times nominal relay operating time for best accuracy. Use one to two times for lowest heat and shortest test time.

Operation Graph

The RCHLRV Operation graph is shown in Figure C.109.

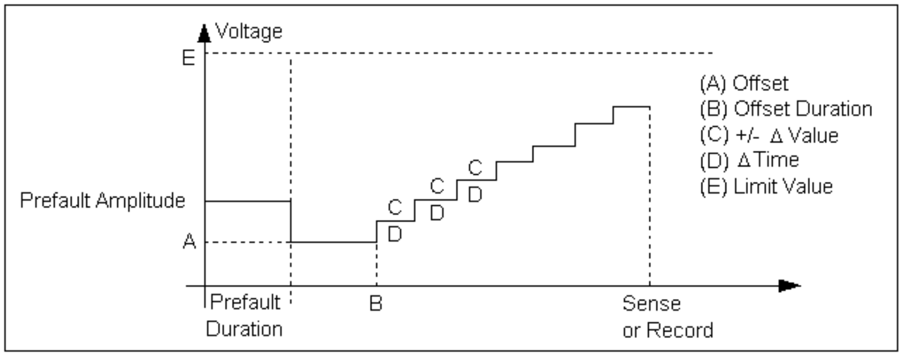


Figure C.109 RCHLRV Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The RCHPRV Prefault Tab fields are explained in Table C.122.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.122 RCHPRV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

SSIMUL - Dynamic State Simulation - All ProTesTPLANS

Description

The SSIMUL macro uses stepped sine wave quantities to simulate an evolving fault, represented by up to 25 states. Up to 12 sources can be used, and independent timer sense events can be recorded, one per F2000 instrument and one per source on the F6000.

Operation

Enter source names, connections, and frequency in the source table. In each state define amplitude and phase for each source, and the state duration in cycles. Synchronized amplitude and phase transitions occur on each state change. The Test View screen shows three states for the sources named in the Source table. Normally, three states represent Prefault, Fault, and Post Fault conditions. As more states are added, the view scrolls to the right, one state at a time. To add a state, add a name in the state name row after the last state.

Use

This macro investigates suspected relay misoperations, or evaluates protection schemes. Use F2250 and F6000 logic output to test reclosers and breaker fail relays.

Notes

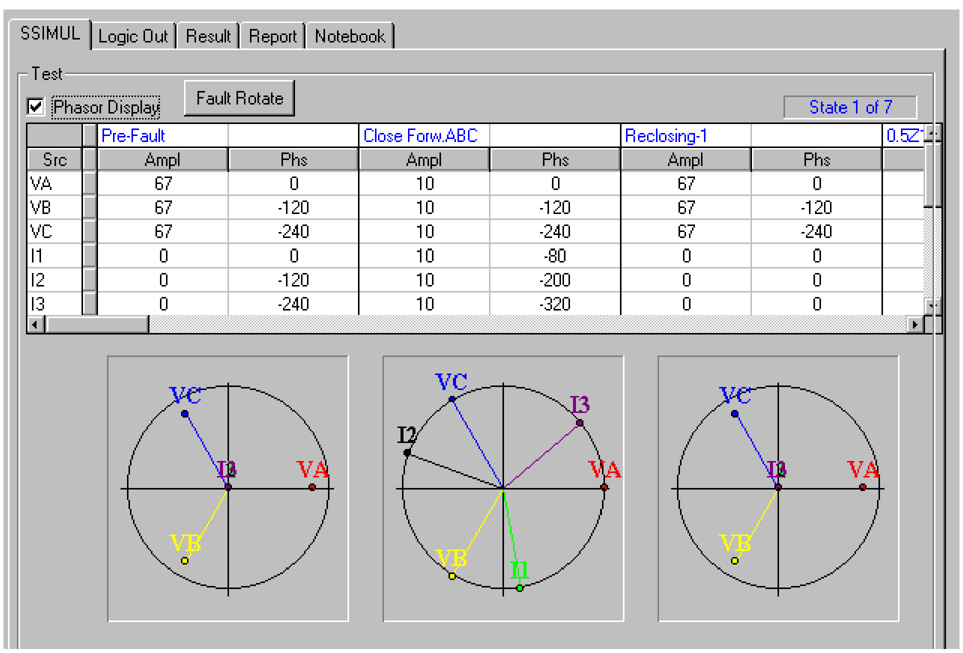
- If different frequencies are to be injected, use an alternate frequency. Set the frequency of one source (which must be Source 1 of the master F2000 or any source of the F6000) to a base frequency different from the frequency reference for all other sources. For example, setting the frequency of Source 1 to FX or FL, and all the other sources to numerical values: 60.00, 60.00 120.00.... FX designates the crystal base frequency and FL designates the line frequency. The frequency for any source must be a harmonic of the base frequency. In this example, the base frequency for Source 1 is FX or FL, and for all other sources it is 60Hz.
- The F6000 does not support FL.
- Use Satellite Synchronization for end-to-end fault simulation testing. Select FS to indicate satellite frequency reference, and click on Duration under the Source table. Select Go At or Preset Until to set the start time when the test is run.

- Use the optional ProTesT Power System Model to calculate fault quantities for different fault scenarios. The Power System Model automatically creates Prefault, Fault, and Post Fault states in SSIMUL for each fault calculation.
- It is possible to approximate point-on-wave inception of a fault. Rather than setting Prefault source phases to 0°, –120°, and 120°, offset all phases by an arbitrary amount; e.g., 90°, –30°, 210°. The fault state occurs on a reference zero crossing, at which all sources are offset by 90°. The fault, therefore, occurs at a different point on the waveform.
- Use the Fault Rotate button on the SSIMUL tab to perform a fault rotation.
- Click the Phasor Display checkbox to change the SSIMUL tab to a phasor configuration tab. This tab allows you to visually configure a phasor test.
- BT cannot be used as a source in the SSIMUL Source Table.

Test View

Sources

The SSIMUL Test View screen is shown in Figure C.110.



Src	Pre-Fault Ampl	Pre-Fault Phs	Close Forw.ABC Ampl	Close Forw.ABC Phs	Reclosing-1 Ampl	Reclosing-1 Phs
VA	67	0	10	0	67	0
VB	67	-120	10	-120	67	-120
VC	67	-240	10	-240	67	-240
I1	0	0	10	-80	0	0
I2	0	-120	10	-200	0	0
I3	0	-240	10	-320	0	0

Figure C.110 SSIMUL Test View Screen

Select **Phasor Display** check box to view the states defined. The SSIMUL Phasor Test View display is shown in Figure C.111.

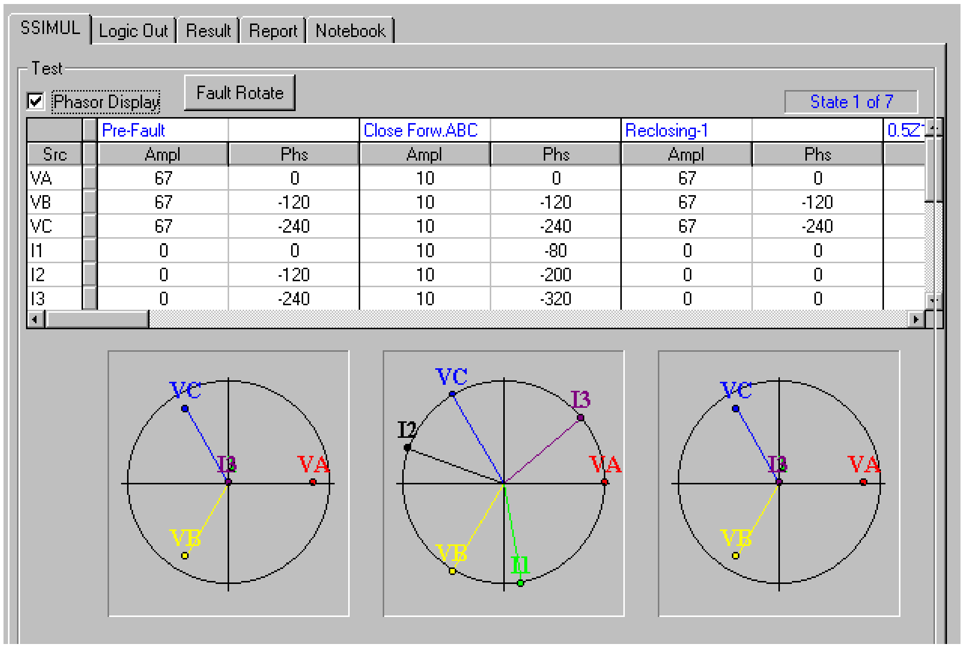


Figure C.111 SSIMUL Phasor Test View Display

States — Displayed three at a time. If less than three are defined, blank states are shown. As more states are added, the State display scrolls horizontally. Use the horizontal scroll bar to move back and forth. To remove unwanted states, highlight the state name and press the **Delete** key.

Enter the Maximum Duration for the state, in cycles. Each state is applied for the number of cycles entered, then all sources change amplitude and phase synchronously to the next state's values.

Satellite Synchronization	For end-to-end, satellite synchronized testing, specify the frequency of all sources as FS or FS*2 (up to FS*20) for harmonics. The Max Duration pull-down box contains options for the first state to start a satellite synchronized test. Select **Go At** or **Preset Until** instead of **Duration** for State 1. Define Go At or Preset Until with a starting time that has been agreed with the test crew at the other end of the line. SSIMUL will display UTC satellite time on the screen, and the time will be continually updated. Satellite status is also displayed to show how many satellites are detected. Satellite synchronized operation requires the satellite interface and a GPS receiver and antenna.
Max Duration	Duration time setting for first state – the default is Duration; i.e., fixed number of cycles before stepping to second state. The pull-down box contains options for satellite-synchronized end-to-end tests Go At Time, and Preset Until.
Go At Time	When test is run, a satellite time window appears with a default Go At time, the UTC time at which test will start. The sources turn on at 0 amplitude, but source values for first state do not appear until the Go At time.
Preset Until	Run test to set up the Instrument, and sources turn on right away at the values of the first state. Transition to the next state does not occur until the selected UTC time.

Logic Out

Click this tab and enter a source name to identify the F225x and F6000 logic output to be used. Source selection is only from sources in the Source column above. Each state has separate columns for logic output 1 (L1) and logic output 2 (L2 - not valid for F6000). To set logic output, click in the state column in the row for the logic source. Click once for low (green led state), twice for high (red led state). Clicking a third time changes to reset.

Result Tab

Click the **Result** tab to arm timers to start in a specified state and to stop on a sense event.

Run	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The SSIMUL Results fields are explained in Table C.123 on page C-214.
Save	Click **Save** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete	Click **Delete** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion. The macro first displays Current Test conditions.

Table C.123 SSIMUL Result Fields

Field	Explanation
Timer Name	Click the pull-down list and select a source name to identify a timer. The list shows only those sources already defined for the macro.
Timer Start	Select the timer start state. This must be done first. The timer starts at the beginning of that state. The pull-down list shows only those states already defined for the macro. This field is used to start timers for edge transitions (O-C-O, On-Off-On) and to enable pulse modes (O-C-O, C-O-C, Off-On-Off, On-Off-On).
Stop Events	Select the stop event for the timer; e.g., ON Æ OFF for voltage, O Æ C for contacts. The timer stops when the event occurs, which may be several states later. If no event occurs before the macro completes, no timer value is displayed, and Result is No Op.
Units	Select time units Msec, Sec, or Cycles.
Expected	Enter the expected time result in the units indicated.
Tolerance Units	Select + or - tolerance units in Msec, %, or Cycles.
+, –	Enter +/– tolerance, in percent.

The SSIMUL Result Tab screen is shown in Figure C.112.

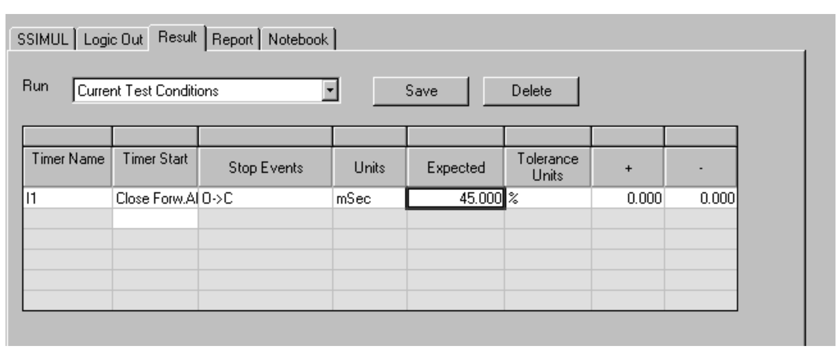


Figure C.112 SSIMUL Result Tab Screen

TFRPLT - Time vs. Frequency Shift Characteristic Plot - F ProTesT-PLAN

Description

One or more test sources are set to initial values, and a frequency shift is applied. Up to 12 different frequency shifts are tested and relay operate time is measured. Expected time and +/– tolerances are optionally specified to determine pass/fail for each test point. A characteristic plot can be displayed and printed.

Operation

A series of frequency shift time tests is performed, stepping frequency from an offset value to a test value, for up to 12 separate tests. All sources turn off between tests, and Offset is applied at the start of each test. A reset time is specified to allow relays with induction disks or other similar devices to reset between tests. If expected operate times and tolerances are entered, pass/fail results are automatically recorded. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro tests frequency relays.

Notes

- Be sure to allow enough reset time to allow the relay to recover fully between tests.
- One source can have an Action frequency, while all others are at base frequency, as long as the Action is Source 1 of the Master F2000 or Source 1 of the F6000. Any source on the F6000 can be Action. Enter ACTION for one source frequency, and indicate the frequency reference for the others: FX (crystal) or FL (line). When the test is run, ProTesT will verify that the Action source is indeed the correct source.
- The F6000 does not have FL or FE setting. Map this to the FX setting.
- Source 1 of the Master F2000 or F6000 can, instead, be set to FX base frequency, and all other sources can have ACTION frequency. Any source on the F6000 can be FX.
- F2000 base frequency has a range of 25 to 99.99 Hz. Harmonics allow frequencies up to 2000 Hz in F225x and 1000 Hz for the F6000. Macro frequencies can be specified up to 1999 Hz as long as ProTesT can find a harmonic to cover the required range.

Test Tab

On the TFRPLT Test Tab screen (Figure C.113 on page C-218):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source frequency amplitude *ACTION* and enter amplitude and phase values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The TFRPLT Test Tab Results Fields are explained in Table C.124.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.124 TFRPLT Test Tab Results Fields

Field	Explanation
Test F	Specify test frequencies, up to 12 tests.
Expected Time	Expected operate time for the relay for the given frequency shift. Refer to the characteristic curves published for the relay.
+ %/– %	Percent tolerance which defines the range of acceptable time results.
Actual	Records the actual operate time, in the selected units (mSec/Sec/Cycles).
% Error	Percent error, absolute value.
Result	Pass/Fail flag.
Time Units	Select from pull-down list: mSec, Sec, or Cycles.

The TFRPLT Test Tab screen is shown in Figure C.113.

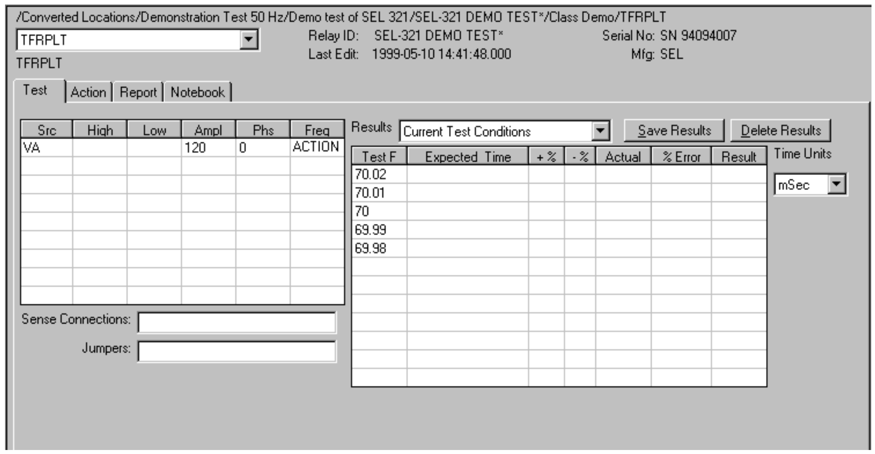


Figure C.113 TFRPLT Test Tab Screen

Action Tab

The TFRPLT Action Tab Conditions fields are explained in Table C.125.

Table C.125 TFRPLT Action Tab Conditions Fields

Field	Explanation
Offset Frequency	Normal frequency; i.e., 50 or 60 Hz.
Offset Time	How long to maintain the offset, in cycles.
Maximum On Time	Maximum number of seconds to sustain frequency shift before recording No Op (no operation).
Reset Time	How long to wait for the relay to reset between test points.
Time Dial	Documentation use only, indicates time action of relay.
Set Point	Documentation use only, indicates frequency trip point of relay.

The TFRPLT Action Tab screen is shown in Figure C.114.

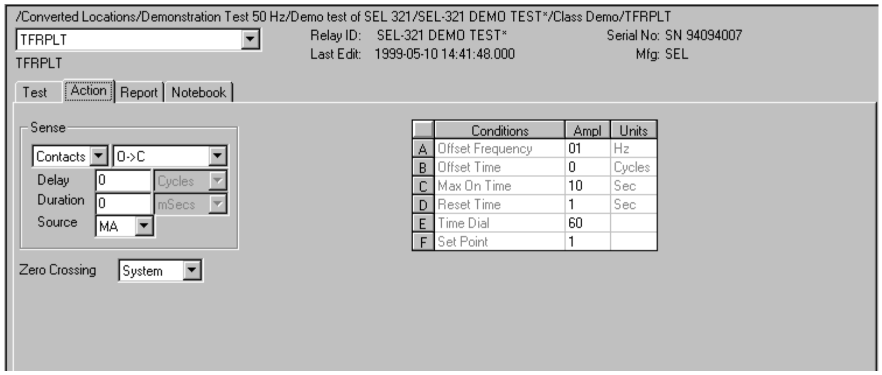


Figure C.114 TFRPLT Action Tab Screen

Sense

The TFRPLT Sense fields are explained in Table C.126.

Table C.126 TFRPLT Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Phase action then begins. The test stops as soon as the relay operates and the phase is recorded. Phase returns to offset, waits for the reset duration before the next test point. If the relay does not operate, a No Op is recorded.

Operation Graph

The TFRPLT Operation graph is shown in Figure C.115.

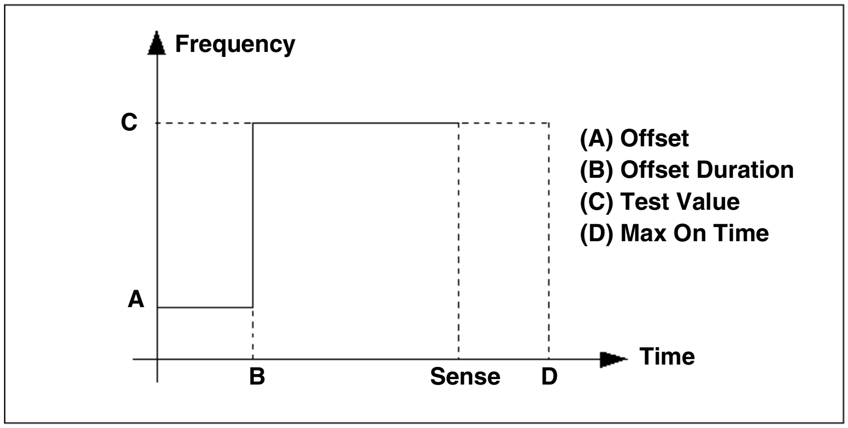


Figure C.115 TFRPLT Operation Graph

TIMEF - Operating Time, Frequency - F ProTesTPLAN

Description

One or more test sources are set to initial values, a frequency step change is applied, and operate time is recorded. An expected operate time can be entered, with +/– tolerances, to determine PASS/FAIL.

Operation

TIMEF does an A to B frequency step change, with timer stop mode enabled.

Use

This macro performs setpoint testing of frequency and power swing relays.

Notes

- One source can have an Action frequency, while all others are at base frequency, as long as the Action is Source 1 of the Master F2000 or Source 1 of the F6000. Any source on the F6000 can be Action. Enter ACTION for one source frequency, and indicate the frequency reference for the others: FX (crystal) or FL (line). When the Test is run, ProTesT will verify that the Action source is indeed Source 1 of the Master F2000 or F6000.
- The F6000 does not have FL or FE setting. Map this to the FX setting.
- Source 1 of the Master F2000 or F6000 can, instead, be set to FX base frequency, and all other sources can have ACTION frequency. Any source on the F6000 can be FX.
- F2000 base frequency has a range of 25 to 99.99 Hz. Harmonics allow frequencies up to 2000 Hz in F225x and 1000 Hz for the F6000. Macro frequencies can be specified up to 1999 Hz as long as ProTesT can find a harmonic to cover the required range.

Test Tab

On the TIMEF Test Tab screen (Figure C.116):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source frequency amplitude *ACTION* and enter amplitude and phase.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The TIMEF Test Tab Results fields are explained in Table C.127.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.127 TIMEF Test Tab Results Fields

Field	Explanation
Expected Time	Expected operate time, in the selected units (mSec/Sec/Cycles)
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.
Time Units	From the pull-down list, select mSec, Sec, or Cycles.

The TIMEF Test Tab screen is shown in Figure C.116.

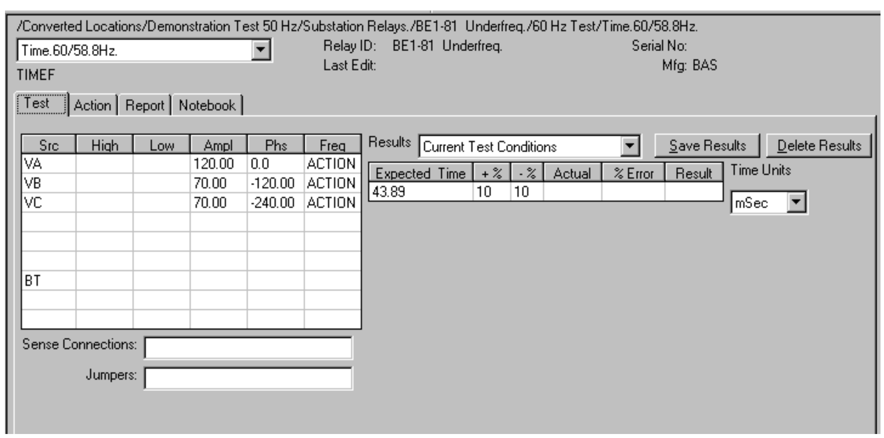


Figure C.116 TIMEF Test Tab Screen

Action Tab

The TIMEF Action Tab Conditions fields are explained in Table C.128.

Table C.128 TIMEF Action Tab Conditions Fields

Field	Explanation
Offset Frequency	The initial frequency for all Action sources; e.g., normal base frequency.
Offset Duration	How long to maintain the offset. Be sure it is long enough for the relay to initialize.
Test Frequency	The test frequency to apply.
Max On Time	How many seconds to maintain the test frequency. Be sure it is long enough for the relay to respond.

The TIMEF Action Tab screen is shown in Figure C.117.

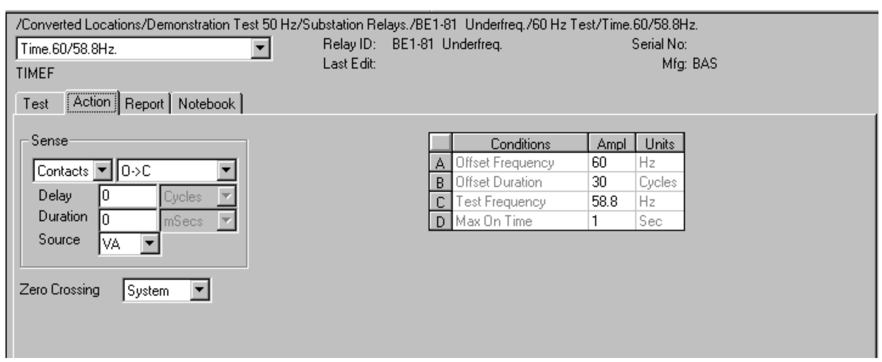


Figure C.117 TIMEF Action Tab Screen

Sense

The TIMEF Sense fields are explained in Table C.129.

Table C.129 TIMEF Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

The frequency is stepped to the test value and the timer is started. The test stops as soon as the relay operates and the time is recorded. If the relay does not operate, a No Op is recorded.

Operation Graph

The TIMEF Operation graph is shown in Figure C.118.

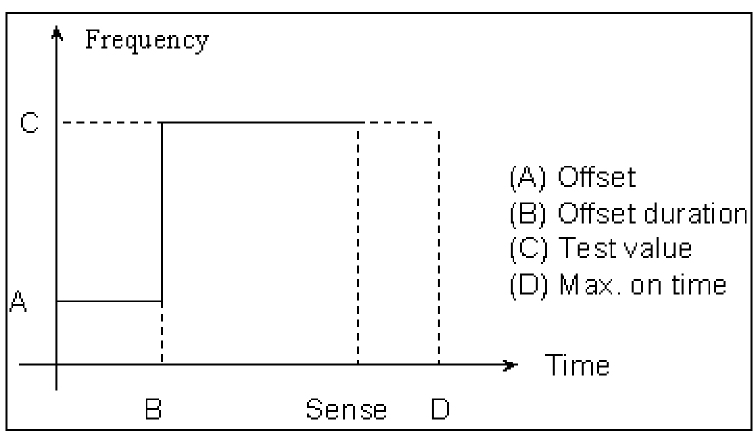


Figure C.118 TIMEF Operation Graph

TIMEI - Operating Time, Current - I ProTesTPLAN - Z ProTesTPLAN

Description

One or more test sources are set to initial values, a current step change is applied, and operate time is recorded. An expected operate time can be entered, with +/– tolerances, to determine PASS/FAIL.

Operation

TIMEI does an A to B current step change, with timer stop mode enabled.

Use

This macro performs setpoint testing of overcurrent relays.

Notes

- Time test with DC Action current can only be done with F225x and F6000 sources. F2410 slave DC source DI cannot do this.
- If using the slave F2410 DC source, and Source 1 of the Master F2000 (top source) is ACTION, while Source 2 is set to DV or DI, be sure to use Source zero crossing. This is true even if DV or DI is not used. If System zero crossing is used, the Timer will not start.

Test Tab

On the TIMEI Test Tab screen (Figure C.119 on page C-228):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source current amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The TIMEI Test Tab Results fields are explained in Table C.130.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

Table C.130 TIMEI Test Tab Results Fields

Field	Explanation
Expected Time	Expected operate time, in the units selected.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication. Op or No Op is given if no tolerances entered.
Time Units	From the drop-down list, select mSec, Sec, or Cycles.

The TIMEI Test Tab screen is shown in Figure C.119**.**

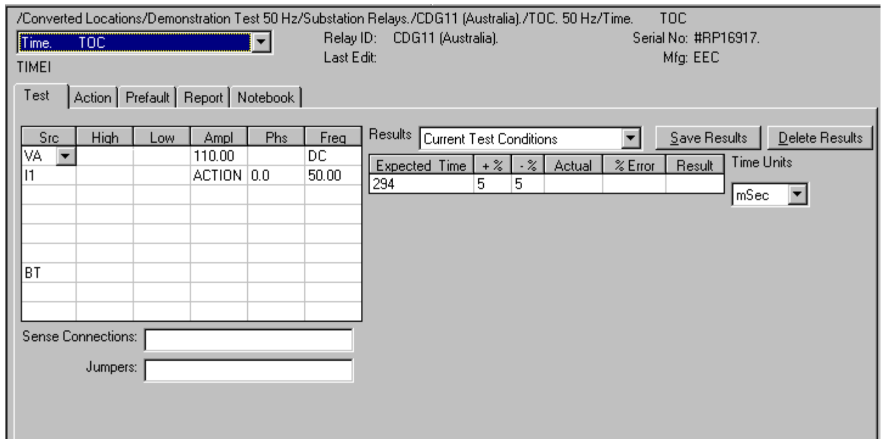


Figure C.119 TIMEI Test Tab Screen

Action Tab

The TIMEI Action Tab fields are explained in Table C.131.

Table C.131 TIMEI Action Tab Fields

Field	Explanation
Offset Current	The initial current for all Action sources; e.g., normal load current.
Offset Duration	How long to maintain the offset. Be sure it is long enough for the relay to initialize.
Test Current	The test current to apply.
Max On Time	How many seconds to maintain the test current. Be sure it is long enough for the relay to respond.

The TIMEI Action Tab screen is shown in Figure C.120.

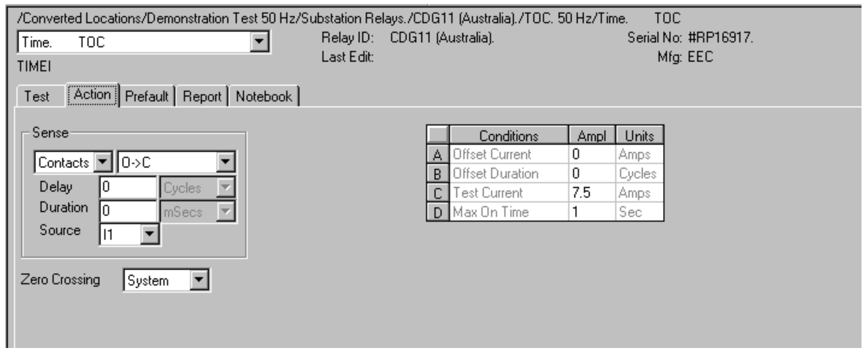


Figure C.120 TIMEI Action Tab Screen

Sense

The TIMEI Sense fields are explained in Table C.132.

Table C.132 TIMEI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The current is stepped to the test value and the timer is started. The test stops as soon as the relay operates and the time is recorded. If the relay does not operate, a No Op is recorded.

Operation Graph

The TIMEI Operation graph is shown in Figure C.121.

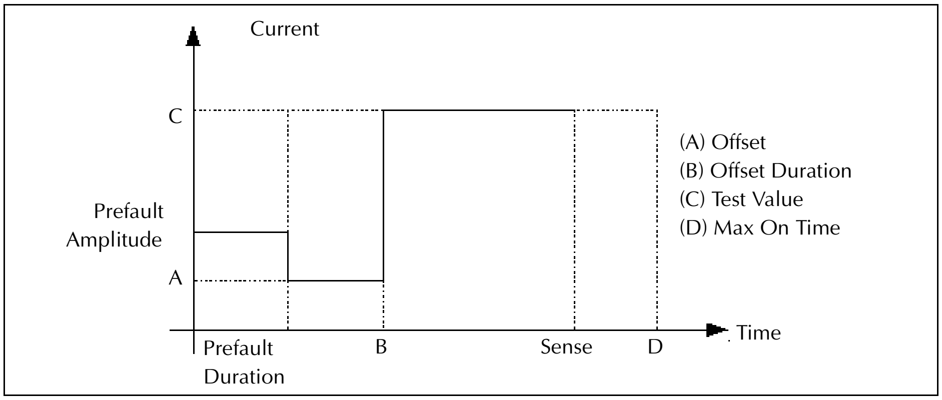


Figure C.121 TIMEI Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The TIMEI Prefault Tab fields are explained in Table C.133.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.133 TIMEI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

TIMEPH - Operating Time, Phase - V ProTesTPLAN

Description

One or more sources, voltage or current, are set to initial values, and have a phase shift applied. Relay operate time is recorded. An expected operate time can be entered with +/– tolerances, to determine Pass/Fail.

Operation

TIMEPH does a step change in phase for sources with ACTION indicated in the phase field. Both current and voltage phases can be changed together. If the expression A+nnn or A–nnn is given for phase, where nnn is a phase offset, the offset is preserved when the phase shift occurs.

Use

This macro tests directional and power swing relays.

Test Tab

On the TIMEPH Test Tab screen (Figure C.122 on page C-233):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source phase *ACTION* and enter amplitude and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The TIMEPH Test Tab Results fields are explained in Table C.134.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

Table C.134 TIMEPH Test Tab Results Fields

Field	Explanation
Expected Time	Expected operate time, in the units selected.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.
Time Units	From the pull-down list, select mSec, Sec, or Cycles.

The TIMEPH Test Tab screen is shown in Figure C.122.

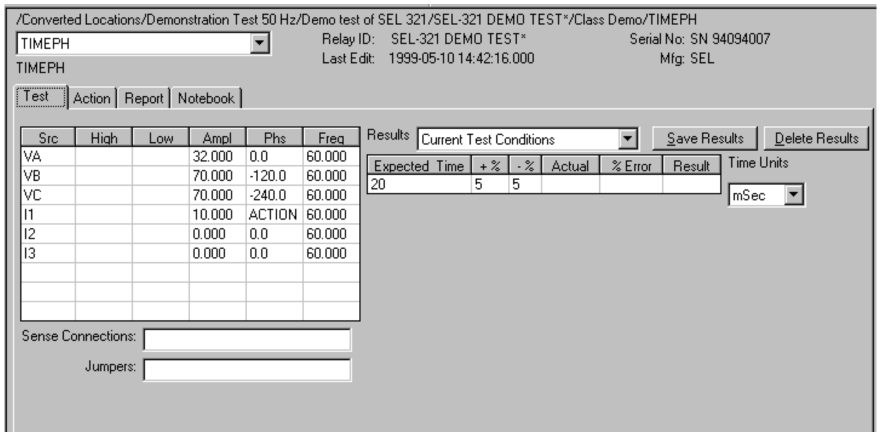


Figure C.122 TIMEPH Test Tab Screen

Action Tab

The TIMEPH Action Tab Conditions fields are explained in Table C.135.

Table C.135 TIMEPH Action Tab Conditions Fields

Field	Explanation
Offset Phase	The initial phase for the source marked ACTION.
Offset Duration	How long to maintain the offset. Be sure it is long enough for the relay to initialize.
Test Phase	The test phase to apply.
Max on Time	How many seconds to apply the test phase before deciding the relay will not operate.

The TIMEPH Action Tab screen is shown in Figure C.123.

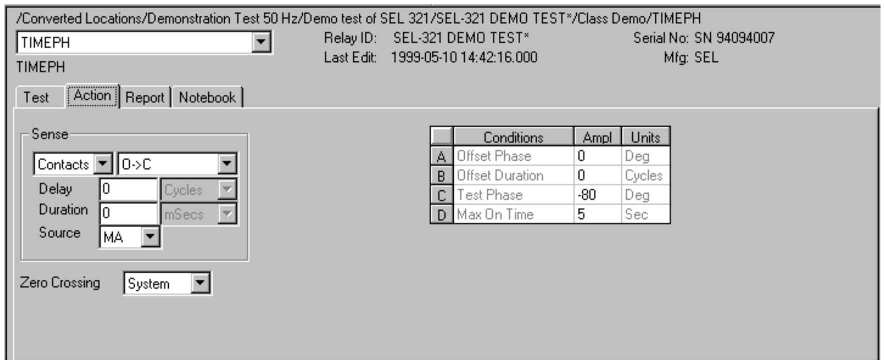


Figure C.123 TIMEPH Action Tab Screen

Sense

The TIMEPH Sense fields are explained in Table C.136.

Table C.136 TIMEPH Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

The phase is shifted to the test value and the timer is started. Phase offset is preserved if multiple Action phases are defined. The test stops as soon as the relay operates and the time is recorded. If the relay does not operate, a No Op is recorded.

Operation Graph

The TIMEPH Operation graph is shown in Figure C.124.

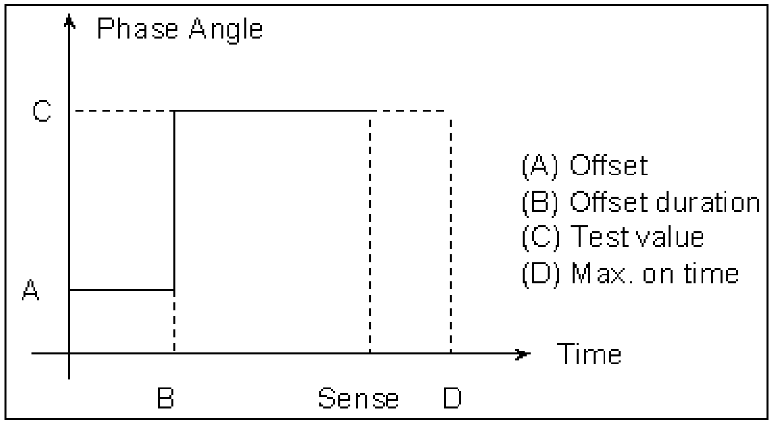


Figure C.124 TIMEPH Operation Graph

TIMEV - Operating Time, Voltage - V ProTesTPLAN - Z ProTesTPLAN

Description

One or more test sources are set to initial values, a voltage step change is applied, and operate time is recorded. An expected operate time can be entered, with +/– tolerances, to determine PASS/FAIL.

Operation

TIMEV does an A to B voltage step change, with timer stop mode enabled.

Use

This macro performs setpoint testing of under/overvoltage relays. Use DC Action to time an auxiliary relay or relay target, when a contact or voltage sense signal can be provided. If using F2410 DV source, ensure that Zero crossing equals SOURCE.

Notes

- If using a slave F2410 DV source, the time test is accurate only for transitions from either 0 volts offset to non-zero test voltage, or from non-zero offset to 0 voltage. The transition occurs either by turning the source ON at the test voltage, or by turning the source OFF, to go to zero voltage. On the transition from 0 volts, timer start is delayed until a signal from the F2410 indicates that 1.5 V is applied at the output contacts.

Test Tab

On the TIMEV Test Tab screen (Figure C.125 on page C-238):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The TIMEV Test Tab Results fields are explained in Table C.137.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.137 TIMEV Test Tab Results Fields

Field	Explanation
Expected Time	Expected operate time, in the units selected.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.
Time Units	Select mSec, sec or cycles from the pull-down list.

The TIMEV Test Tab screen is shown in Figure C.125.

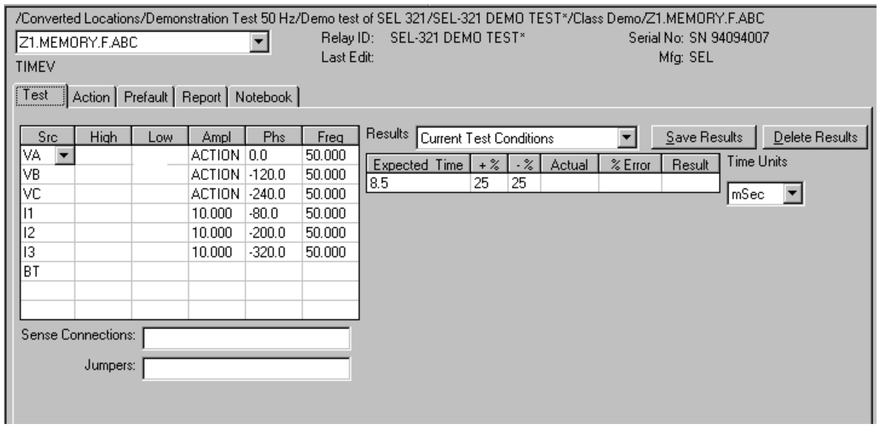


Figure C.125 TIMEV Test Tab Screen

Action Tab

The TIMEV Action Tab Conditions fields are explained in Table C.138.

Table C.138 TIMEV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial voltage for all Action sources; e.g., the normal voltage.
Offset Duration	How long to maintain the offset. Be sure it is long enough for the relay to initialize.
Test Voltage	The test voltage to apply.
Max On Time	How many seconds to maintain the test voltage. Be sure it is long enough for the relay to respond.

The TIMEV Action Tab screen is shown in Figure C.126.

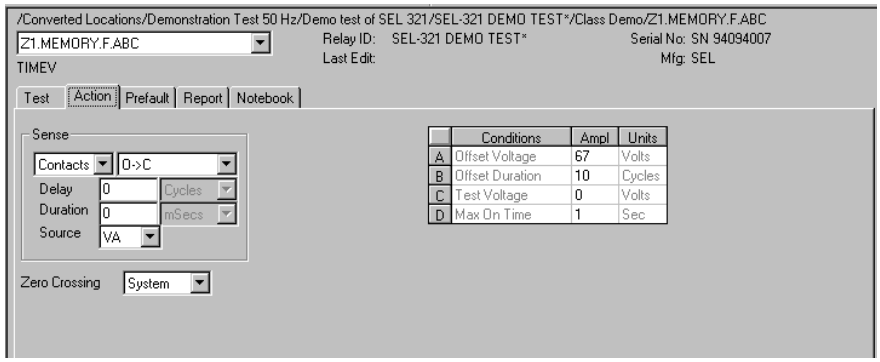


Figure C.126 TIMEV Action Tab Screen

Sense

The TIMEV Sense fields are explained in Table C.139.

Table C.139 TIMEV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The voltage is stepped to the test value and the timer is started. The test stops as soon as the relay operates and the time is recorded. If the relay does not operate, a No Op is recorded.

Operation Graph

The TIMEV Operation graph is shown in Figure C.127.

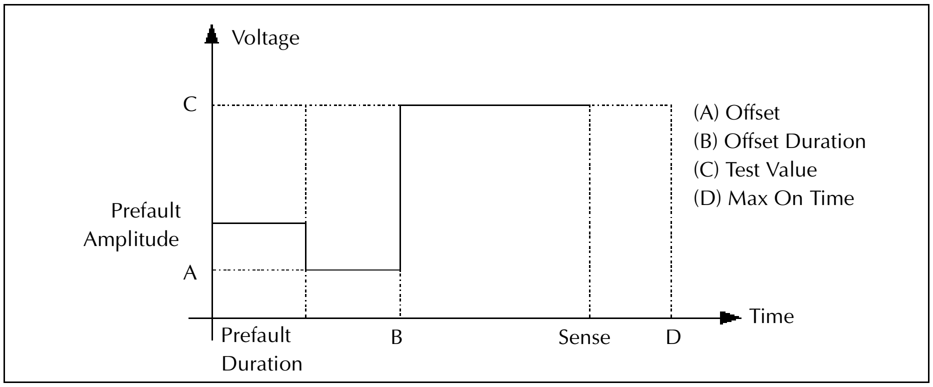


Figure C.127 TIMEV Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The TIMEV Prefault Tab fields are explained in Table C.140.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.140 TIMEV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

TOCPLT - Time Overcurrent Characteristic Plot - I ProTesTPLAN

Description

Test currents are applied at up to 12 different amplitudes and relay operate time is measured. Expected values and +/– tolerances are optionally specified to determine pass/fail for each test point. A characteristic plot can be displayed and printed.

Operation

A series of time tests is performed, stepping current amplitude from an offset to a test current, for up to 12 separate amplitudes. A reset time is specified to allow relays with induction disks or other similar devices to reset between tests. If expected operate times and tolerances are entered, pass/fail results are automatically recorded. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro tests the induction disk, overcurrent relays, and directional overcurrent elements in a distance relay. Run multiple TOCPLT tests at different tap settings and plot a family of characteristic curves.

Notes

- Be sure to allow enough reset time to allow the relay to recover fully between tests.
- If polarizing voltage is needed, use Offset Current and Offset Time on the Action tab (Figure C.129 on page C-244).

Test Tab

On the TOCPLT Test Tab screen (Figure C.128):

1. Select valid source names in the Src column.

2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.

3. Enter the source current amplitude *ACTION* and enter phase and frequency values.

4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.

5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The TOCPLT Test Tab Results fields are explained in Table C.141.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.141 TOCPLT Test Tab Results Fields

Field	Explanation
Test I (or X)	Test Current, in Amps or multiples; depends on the Test Unit selection.
Expected Time	Expected operate time, in the time units selected.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.
Time Units	From the drop-down list, select mSec, Sec, or Cycles.
Test Units	From the drop-down list, select amplitude (Ampl) or XTap.

The TOCPLT Test Tab screen is shown in Figure C.128.

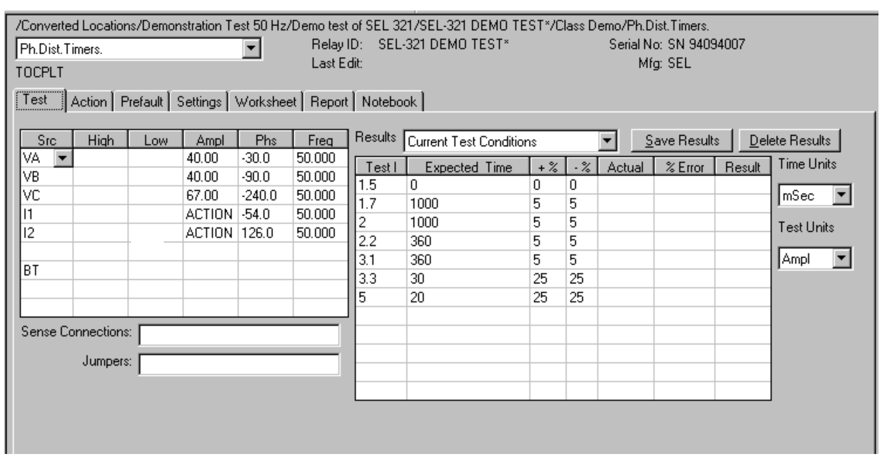


Figure C.128 TOCPLT Test Tab Screen

Action Tab

The TOCPLT Action Tab Conditions fields are shown in Table C.142.

Table C.142 TOCPLT Action Tab Conditions Fields

Field	Explanation
Offset Current	Enter offset amplitude.
Offset Time	Enter offset duration, in cycles.
Max On Time	Maximum number of seconds to apply current before recording No Op (no operation).
Reset Time	Number of seconds to wait between tests to allow the relay to reset.
Time Dial	Documentation use only, indicates time action of relay.
Tap Value	Tap setting of relay, used to compute current amplitude when using multiples of tap. If the Test Unit is XTAP, the Test Current on the Test tab is shown in multiples (X); otherwise as Current (I).

The TOCPLT Action Tab screen is shown in Figure C.129.

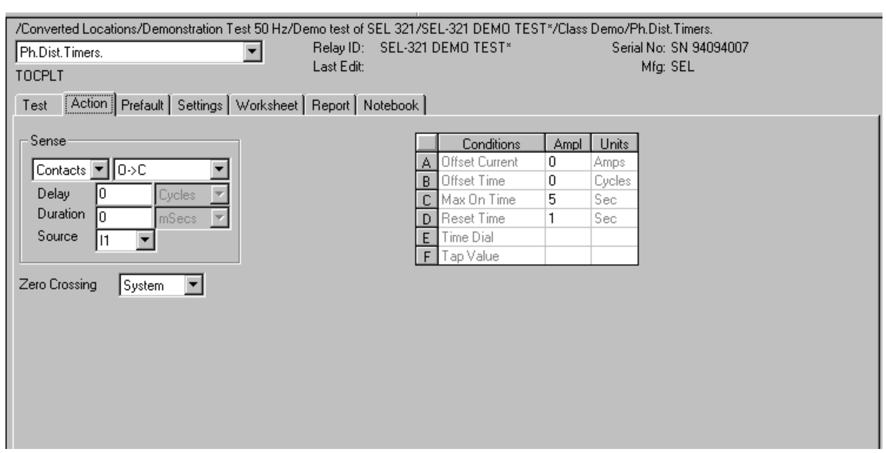


Figure C.129 TOCPLT Action Tab Screen

Sense

The TOCPLT Sense fields are explained in Table C.143.

Table C.143 TOCPLT Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the time is recorded. The Action current turns off before starting the next test and during the reset time. If the relay does not operate a No Op is recorded. No Op may be desired, if the relay is not supposed to operate.

NOTE

The test current is evaluated before running each test point. If needed, the range is increased or decreased to maximize the available power before conducting the test point.

Operation Graph

The TOCPLT Operation graph is shown in Figure C.130.

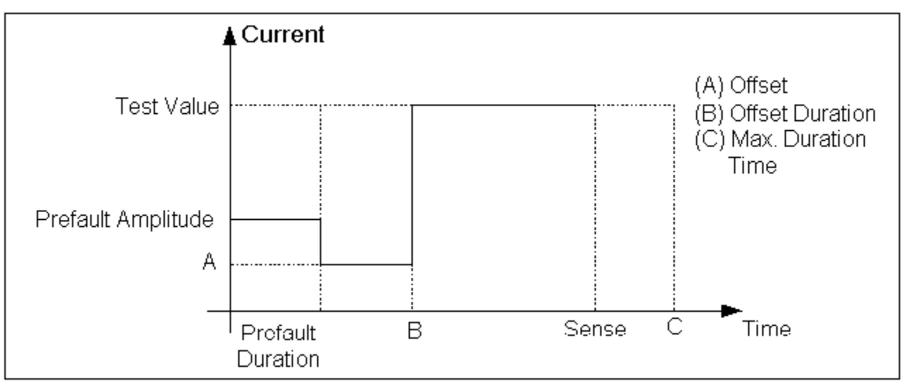


Figure C.130 TOCPLT Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The TOCPLT Prefault Tab fields are explained in Table C.144.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.144 TOCPLT Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

NOTE

The Prefault quantities are applied before each test, up to 12 points.

TOVPLT - Time vs. Voltage Characteristic Plot - V ProTesTPLAN

Description

Test voltages are applied at up to 12 different amplitudes and relay operate time is measured. Expected values and +/– tolerances are optionally specified to determine pass/fail for each test point. A characteristic plot can be displayed and printed.

Operation

A series of time tests is performed, stepping voltage amplitude from an offset to a test voltage, for up to 12 separate amplitudes. A reset time is specified to allow relays with induction disks or other similar devices to reset between tests. If expected operate times and tolerances are entered, pass/fail results are automatically recorded. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro tests over/undervoltage relays. Run multiple TOVPLT tests at different tap settings and plot a family of characteristic curves.

Notes

- Be sure to allow enough reset time to allow the relay to recover fully between tests.

Test Tab

On the TOVPLT Test Tab screen (Figure C.131):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source voltage amplitude *ACTION* and enter phase and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The TOVPLT Test Tab Results fields are explained in Table C.145.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Table C.145 TOVPLT Test Tab Results Fields

Field	Explanation
Test V (or X)	Test Voltage, in volts or multiples; depends on Test Unit selection.
Expected Time	Expected operate time, in the Time units selected.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual	Recorded test result.
% Error	Error.
Result	Pass/Fail indication.
Time Units	From the drop-down list, select mSec, Sec, or Cycles.
Test Units	From the drop-down list, select amplitude (Ampl) or XTap.

The TOVPLT Test Tab screen is shown in Figure C.131.

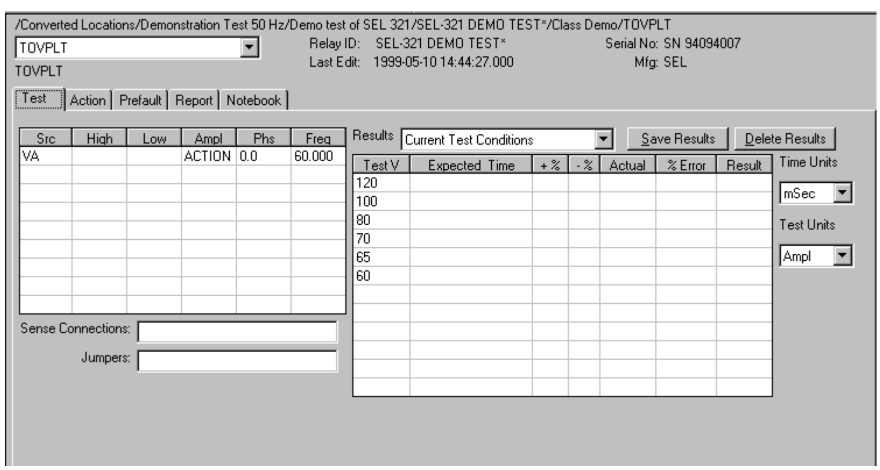


Figure C.131 TOVPLT Test Tab Screen

Action Tab

The TOVPLT Action Tab Conditions fields are explained in Table C.146.

Table C.146 TOVPLT Action Tab Conditions Fields

Field	Explanation
Offset Voltage	Enter offset amplitude.
Offset Duration	Enter offset duration, in cycles.
Maximum On Time	Maximum number of seconds to apply voltage before recording No Op (no operation).
Reset Time	Number of seconds to wait between test pulses to allow the relay to reset.
Time Dial	Documentation use only, indicates time action of relay.
Tap Value	Tap setting of relay, used to compute current amplitude when using multiples of tap. If the Test Unit selection is XTAP, test voltage on test tab is shown as multiples (X); otherwise as Voltage (V).

The TOVPLT Action Tab screen is shown in Figure C.132.

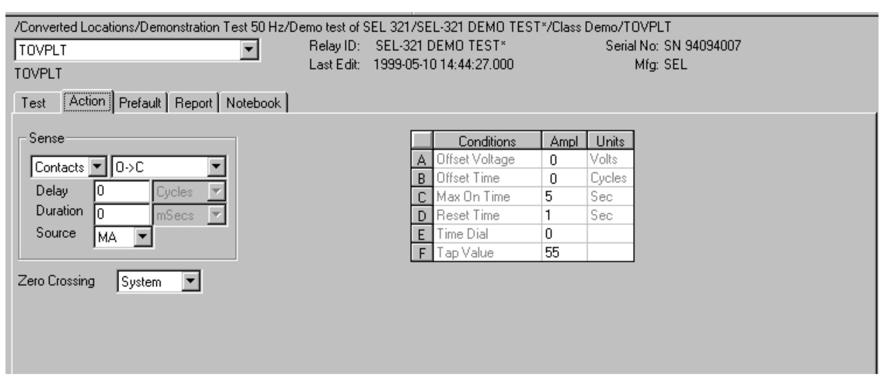


Figure C.132 TOVPLT Action Tab Screen

Sense

The TOVPLT Sense fields are explained in Table C.147.

Table C.147 TOVPLT Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the time is recorded.

NOTE

The test voltage is evaluated before running each test point. If needed, the range is increased or decreased to maximize the available power before conducting the test point.

Operation Graph

The TOVPLT Operation graph is shown in Figure C.133.

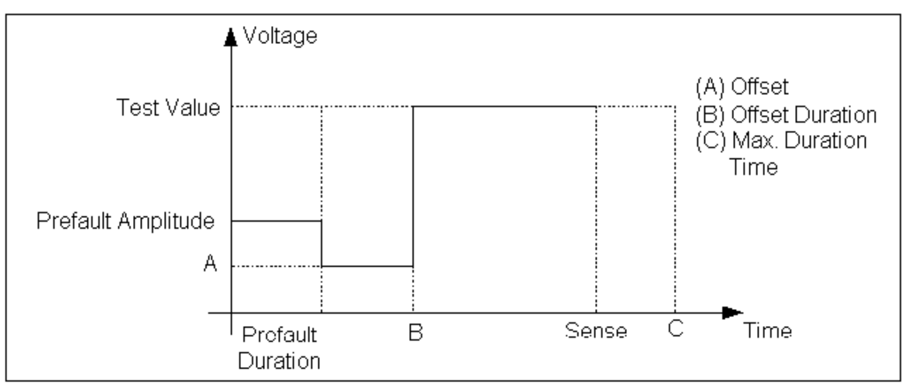


Figure C.133 TOVPLT Operation Graph

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The TOVPLT Prefault Tab fields are explained in Table C.148.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.148 TOVPLT Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

NOTE **The Prefault quantities are applied before each test, up to 12 tests.**

TPHPLT - Time vs. Phase Shift Characteristic Plot - V ProTesTPLAN

Description

One or more test sources are set to initial values, and a phase shift is applied. Up to 12 different phase shifts are tested and relay operate time is measured. Expected time and +/– tolerances are optionally specified to determine pass/fail for each test point. A characteristic plot can be displayed and printed.

Operation

A series of phase shift time tests is performed, stepping phase from an offset value to a test value, for up to 12 separate tests. A reset time is specified to allow the relay to reset between tests. If expected operate times and tolerances are entered, pass/fail results are automatically recorded. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro tests directional and power swing relays.

Notes

- Be sure to provide enough reset time to allow the relay to recover fully between tests.

Test Tab

On the TPHPLT Test Tab screen (Figure C.134):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Enter the source phase *ACTION* and enter amplitude and frequency values.
4. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
5. Enter the jumper connections in the Jumpers field.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The TPHPLT Test Tab Results fields are explained in Table C.149.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

Table C.149 TPHPLT Test Tab Results Fields

Field	Explanation
Test Phase	Specify test phase angles for each test, up to 12 tests.
Expected Time	Expected operate time for the relay for the given phase shift. Refer to the characteristic curves published for the relay.
+ %/– %	Percent tolerance defining the range of acceptable time results.
Actual	Records the actual operate time, in the selected units (mSec/Sec/Cycles).
% Error	Percent error.
Result	Pass/Fail flag.
Time Units	From the drop-down list, select mSec, Sec, or Cycles.

The TPHPLT Test Tab screen is shown in Figure C.134.

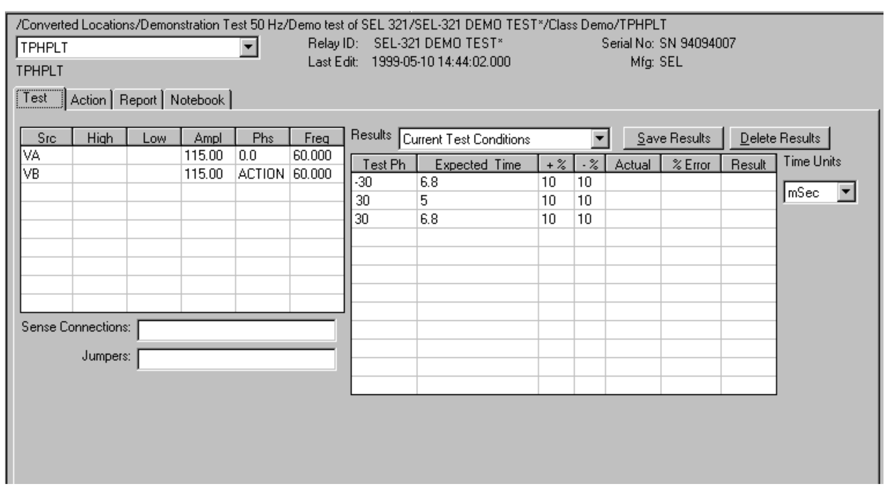


Figure C.134 TPHPLT Test Tab Screen

Action Tab

The TPHPLT Action Tab Conditions fields are explained in Table C.150.

Table C.150 TPHPLT Action Tab Conditions Fields

Field	Explanation
Offset Phase	Enter an offset phase (typically zero for the reference phase).
Offset Duration	Enter an offset duration in cycles.
Max On Time	Maximum number of seconds to sustain phase shift before recording No Op (no operation).
Reset Time	Number of seconds to wait between test pulses, to allow the relay to reset.
Time Dial	Documentation use only, indicates time action of relay.
MTA Value	Documentation use only. Where relevant, indicates maximum torque angle of relay.

The TPHPLT Action Tab screen is shown in Figure C.135.

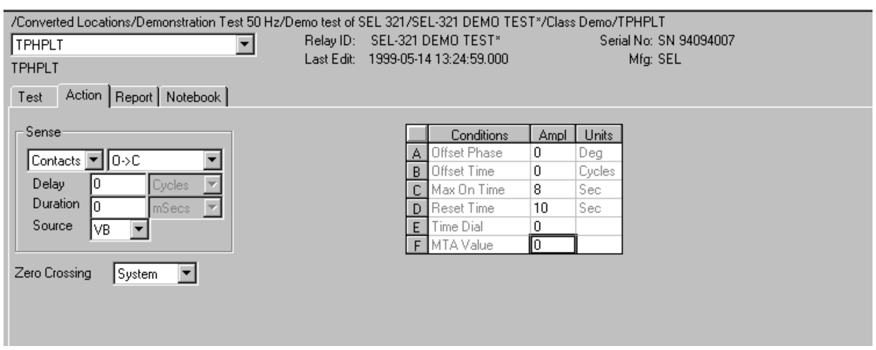


Figure C.135 TPHPLT Action Tab Screen

Sense

The TPHPLT Sense fields are explained in Table C.151.

Table C.151 TPHPLT Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument or input receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize and turn on as follows:

- Non-Action sources turn on at Preset values.
- Action sources turn on at Offset values and move to Action values.

Phase action then begins. The test stops as soon as the relay operates and the time is recorded. Sources turn off and wait before the next test point.

Operation Graph

The TPHPLT Operation graph is shown in Figure C.136**.**

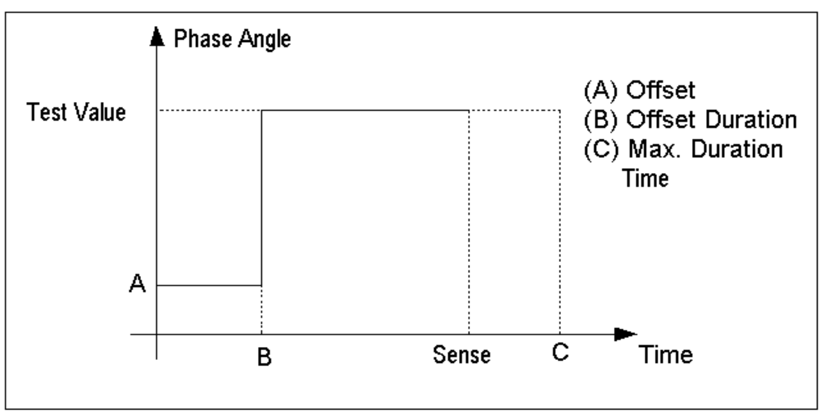


Figure C.136 TPHPLT Operation Graph

TRANS - Transient Waveform Playback - T ProTesTPLAN

Description

Import COMTRADE waveform files, select traces for playback, and save them in the ProTesT database. TRANS allows the user to view and edit transient data files, then play back waveforms through the F6000. Waveform data are imported from data files stored in IEEE COMTRADE format. Such data may represent data channels from DFR recordings or EMTP simulations.

Operation

Create a TRANS Macro in a Test Plan, then open the test and select a Comtrade.cfg file to import. All channels are displayed on a common time scale. Select one or more channels for playback. All other channels can be deleted from the TRANS macro test data; otherwise, deselected channels are merely hidden from view. Use the mouse to select a time frame by drawing a zoom box over selected channels. Run a test and the selected waveform segments are downloaded to the instrument for playback. Timers can be set up on a Results tab similar to timer setup on the SSIMUL macro (page C-209).

Use

This macro evaluates protection schemes, or troubleshoots suspected misoperation. Use to reproduce the effect of DC offset and L/R decay during a fault.

Import Comtrade File

When a TRANS macro is created, the View tab is initially empty. To import a Comtrade file, select Macro | Import from the menu bar. A file browse window is opened. Browse to the drive and folder containing the desired Comtrade files and select the .cfg file. All traces are presented on the View tab. Use the vertical scroll bar to view all the traces.

View Tab

TRANS opens at the View tab (Figure C.137). The figure shows the signal view of waveforms imported already into ProTesT.

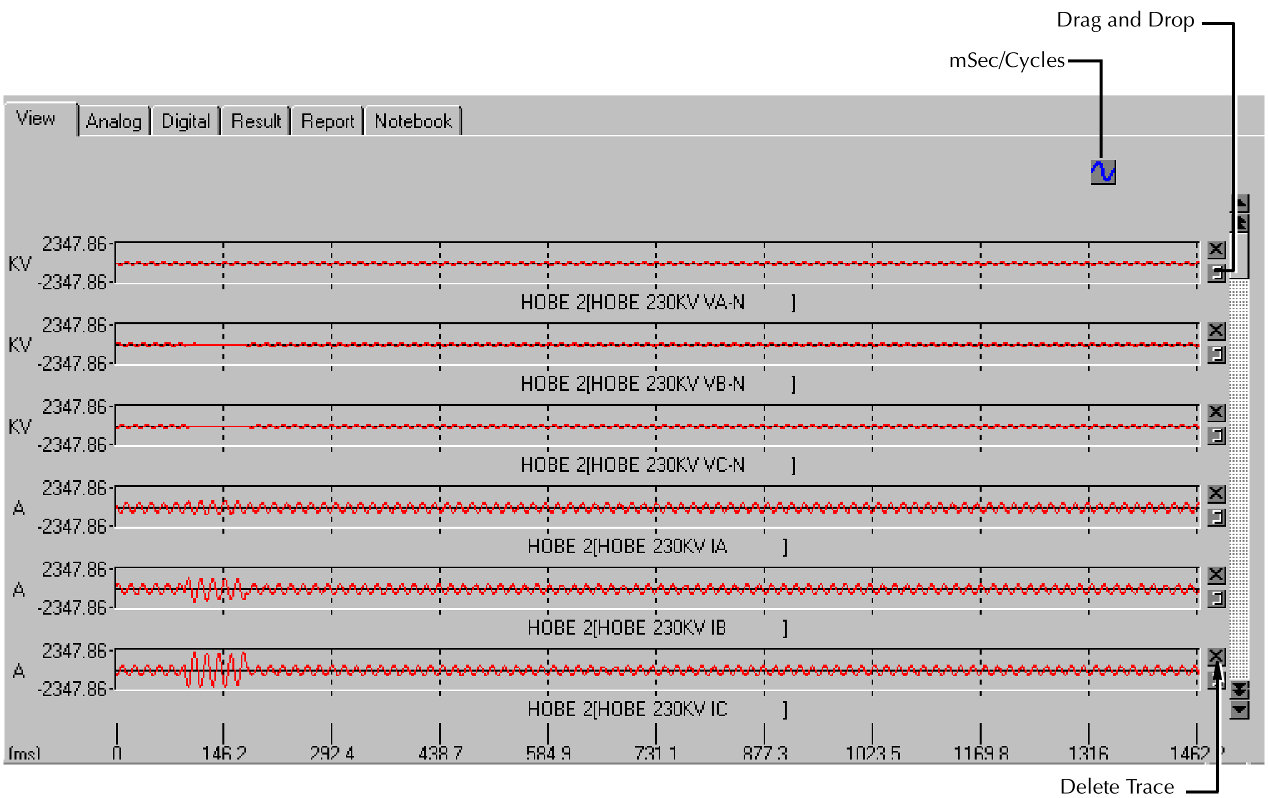


Figure C.137 Test View of TRANS Macro – the View Tab

Control Buttons

mSec/Cycles	Changes the scale shown at the bottom of the tab between cycles and milliseconds.
Delete trace	This is available for each trace. Click **Delete trace** to remove the trace from the view. A prompt asks whether to delete it, or to hide it from view. If deleted, the data is removed from the database.
Drag and Drop	Click **Drag and Drop**, hold down the left mouse button, and drag to another trace. Release the button and, if allowed, the trace being dragged will be copied onto the target, which will now show both traces.

Zoom

To enlarge a trace area of one or more consecutive traces, click the area, drag a zoom box around the area, and release. The traces included in the zoom box are enlarged, covering the time frame included in the box. An Unzoom button appears on the top right (Figure C.138). Click **Unzoom** to restore the trace images to normal size.

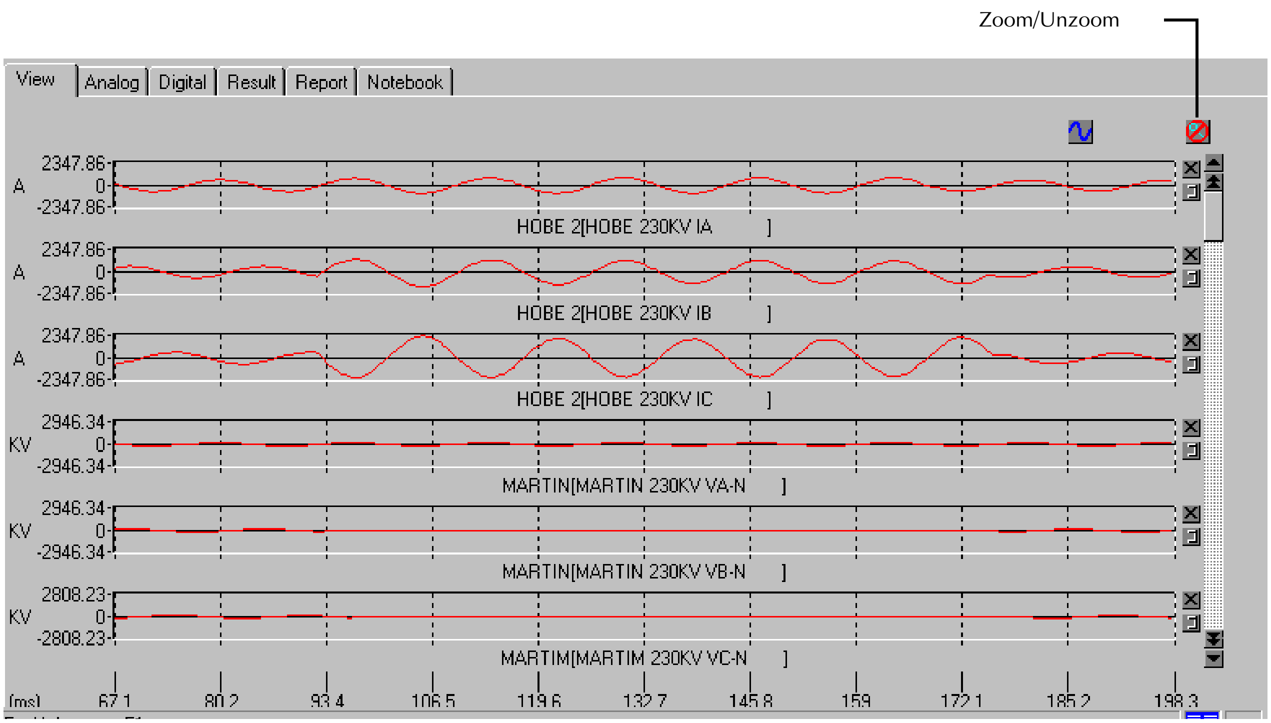


Figure C.138 Zoom Option

Data Readout

Left click anywhere on a graph to place a green start-of-time marker on all traces; right click to place a red time end-of-time marker. A data area to the right of the horizontal scroll bar displays three numbers for each trace: the green value is the waveform amplitude at the green marker, the red value is the amplitude at the red marker, and the yellow value is the difference between them.

NOTE

The three value-readouts may not all be visible until the traces are zoomed.

Viewing Properties

Right click anywhere on the View tab to display a pop-up menu, as long as the start/end time markers are not being shown (Figure C.139).

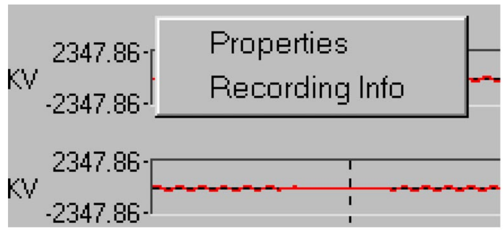


Figure C.139 View Tab Pop-up Menu

Properties (Figure C.140) allow you to customize the waveform display.

Recording Info displays the date and time of the recording, the sample rate, and the number of samples.

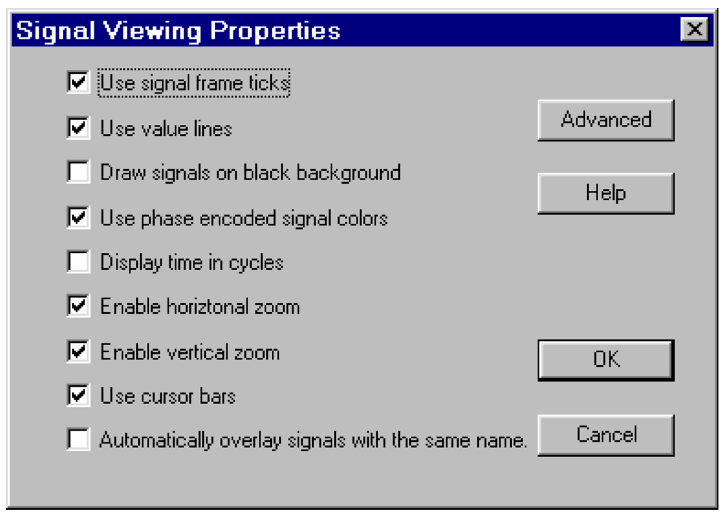
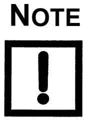


Figure C.140 Signal Viewing Properties

NOTE



Help is not yet implemented.

Click **Advanced** to display a second window (Figure C.141) to set additional properties for the waveform display.

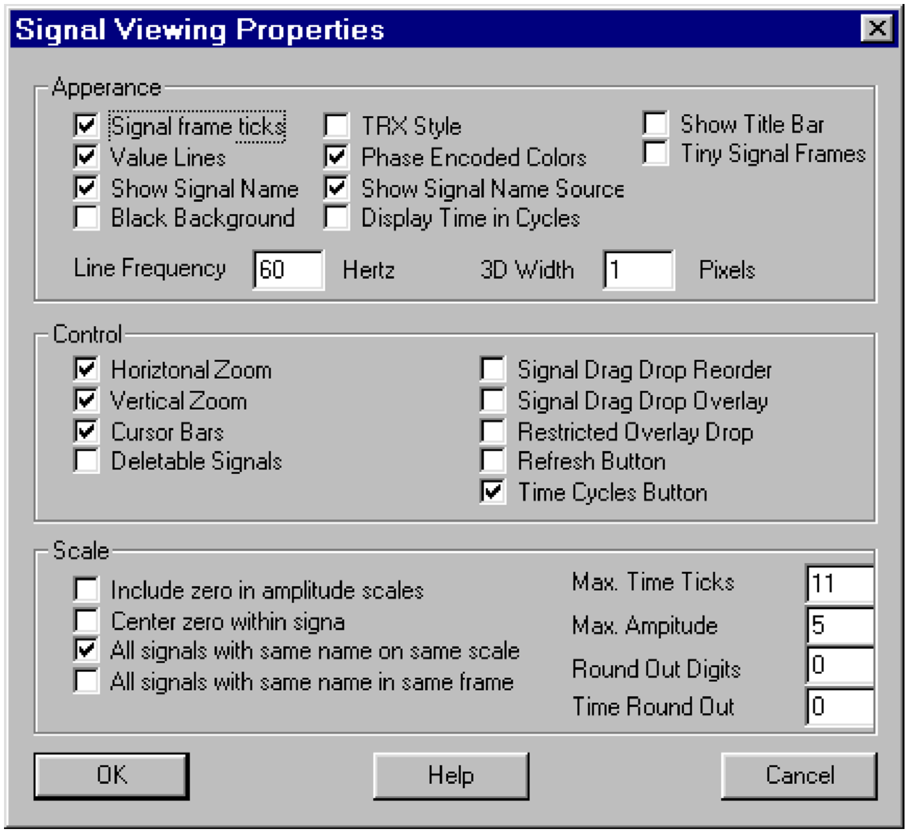


Figure C.141 Signal Viewing Properties - Advanced

Analog Tab

The Analog tab (Figure C.142) lists information about each analog trace.

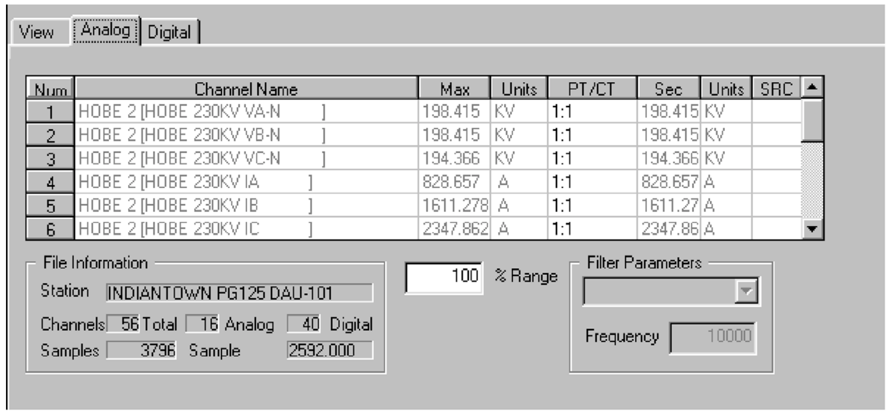


Figure C.142 Analog Tab

SRC	In this column, enter the Doble source that will play that channel trace. All other information is taken from the Comtrade header file.
% Range	Set to 100%. Using a smaller % Range will force TRANS to use a higher range for all sources during playback. Assign a smaller % Range only if playback at 100% Range causes a source to go into thermal overload.

NOTE

The Filter Parameters apply only to F2000, and F2000 transient support is not yet implemented.

Digital Tab

The Digital tab (Figure C.143) lists information about each digital trace.

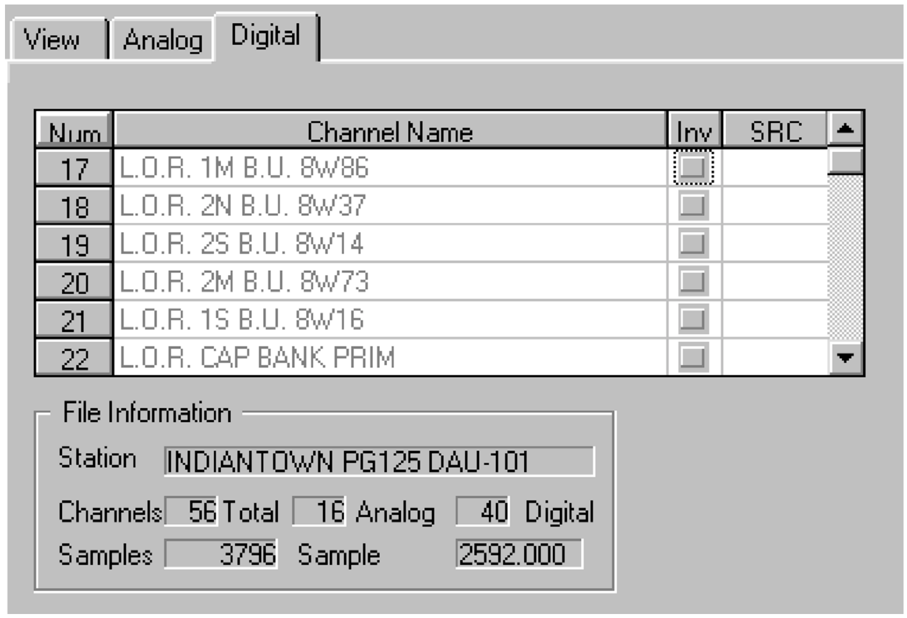


Figure C.143 Digital Tab

Add a Doble source name to the SRC column to identify which logic outputs play the trace. Click **Inv** to invert the output.

ZPLBOI - Z Characteristic Plot - Binary Search Current - Z ProTesTPLAN

Description

A fast, high-low pulsed search to bracket the relay operate point, followed by linear ramp or pulsed ramp for a high resolution result. Impedance value is calculated. Repeated up to 100 times at different impedance angles for fast measurement of impedance characteristic.

The search algorithm begins by testing midway between the Action Offset Current and Current Limit. If the relay does not operate, limit current is applied. If the relay still does not operate, the test is over (recorded as No Op, No Operation). Successive pulses are calculated based on the results of the last pulse; i.e., the next pulse is halfway between the last operate value and the last No Op value. When the difference between pulse amplitudes is less than three times the ramp delta current specified, the search stops and either a Linear Ramp or a Pulsed Ramp begins.

Operation

ZPLBOI does a sequence of Reach Binary Search tests at different impedance phase angles. The user specifies up to four impedance angle arcs, defined by From Angle, To Angle, and Delta. Reach tests are performed at each angle in the arc, including the end points. Multiple arcs make it possible to do a coarse sweep (e.g., every 10×) over a wide range, then test at, perhaps, every 1× near the angle of maximum torque. A third, very coarse, arc could verify no operation in the blind zone of a directional distance relay. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro tests the high resolution steady state characteristic curve for distance relay.

Notes

- Will record up to 100 points for a good curve.
- If fewer points are needed, use ZPXBOI, which allows Pass/Fail evaluation.

Test Tab

On the ZPLBOI Test Tab screen (Figure C.144):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark the Action amplitude(s) and phase(s) *ACTION* or enter the amplitude value.
4. Enter the frequency.
5. Specify phase as *ACTION*, *A–120*, *A+120*, for example, if phase offset is required among multiple Action sources.
6. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
7. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

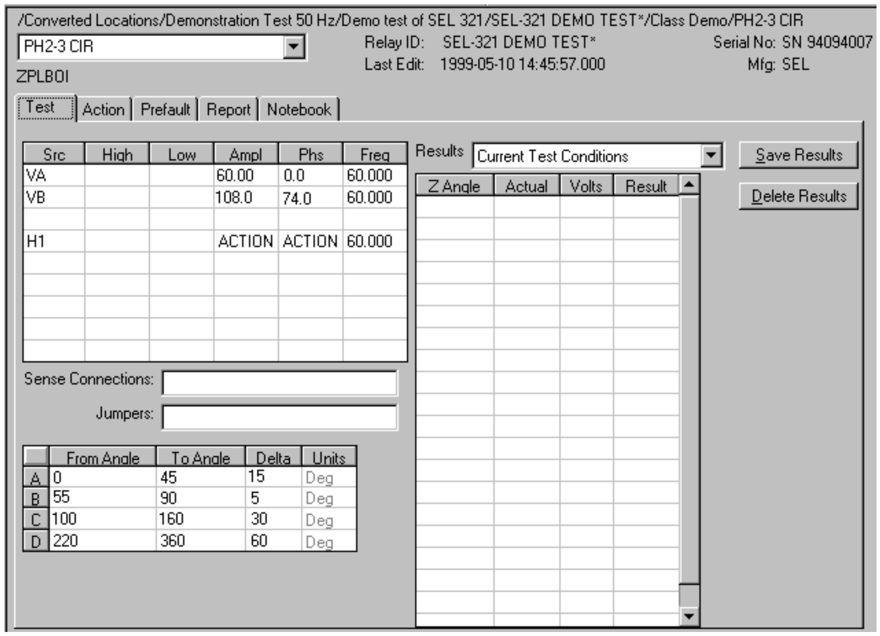


Figure C.144 ZPLBOI Test Tab Screen

Arc Table

For each arc A, B, C, D define up to four impedance Arcs. Specify From Angle, To Angle and Delta for each Arc to cover the angles of interest at a given angular resolution. Select results from the Results pull-down arrow to display prior results.

The arc angles entered are impedance angles. Action source angle is assumed to be lagging, and is calculated by ProTesT based on the Voltage Fault Angle entered on the Action tab.

The ZPLBOI Arcs are defined in Table C.152.

Table C.152 ZPLBOI Arc Definitions

Arc	Definition
From Angle	Starting Impedance Angle of the arc in degrees.
To Angle	End Impedance Angle of the arc in degrees.
Delta	Increment of phase angle in degrees.

Results Table

A scrollable table shows the results of running the macro. ZPLBOI records the impedance angle (Z Angle), calculated impedance, and operate current for up to 100 test points. Impedance is calculated based on the selected Fault Equation (i.e., impedance equation) selected.

There are no expected values, and no Pass/Fail indication. Test result will show only as Run.

Action Tab

The ZPLBOI Action Tab Conditions fields are explained in Table C.153.

Table C.153 ZPLBOI Action Tab Conditions Fields

Field	Explanation
Offset Current	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Current Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum of Offset and limit determines the source range.
Pulse Duration	Maximum length of each search pulse; pulse terminates as soon as a sense is detected.
Wait	How long to wait between pulses; wait is at offset current.
Delta Current	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each Linear Ramp step is held; set to 0 for Pulsed Ramp, using the same pulse duration and wait as the search.

The ZPLBOI Action Tab screen is shown in Figure C.145.

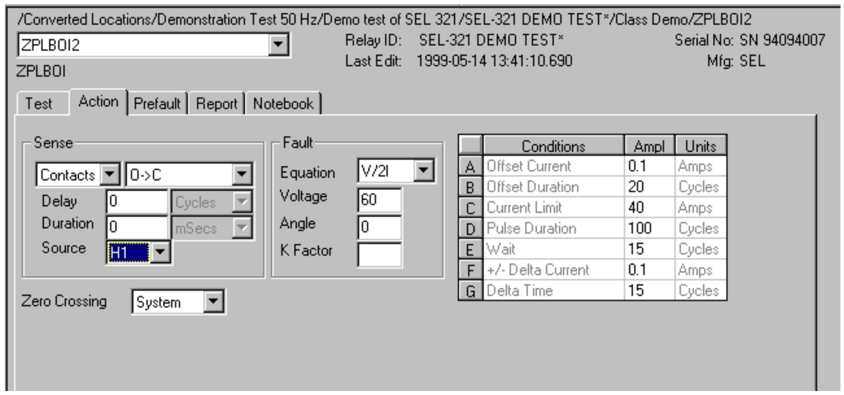


Figure C.145 ZPLBOI Action Tab Screen

Sense

The ZPLBOI Sense fields are explained in Table C.154.

Table C.154 ZPLBOI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the time is recorded. The current Action sources briefly turn off before starting the next test point.

Operation Graph

The ZPLBOI Operation graph is shown in Figure C.146.

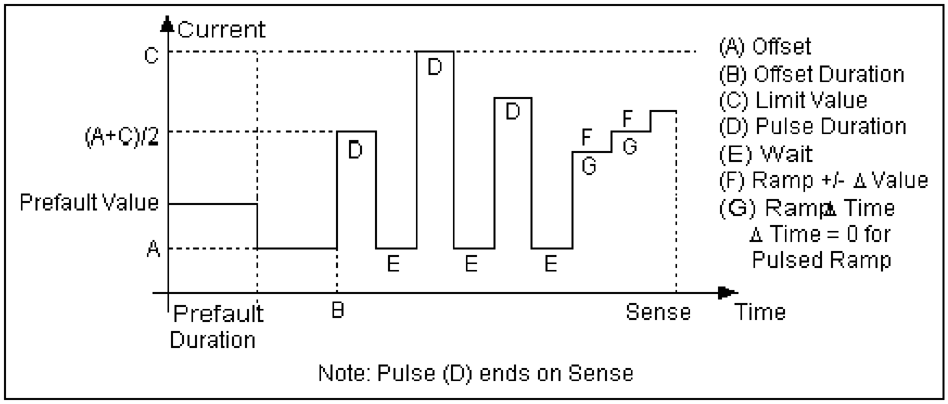


Figure C.146 ZPLBOI Operation Graph

Fault

The ZPLBOI Fault fields are explained in Table C.155.

Table C.155 ZPLBOI Fault Fields

Field	Explanation
Equation	Use the pull-down list to select a steady state fault equation for impedance. Use V/I for single phase fault, V/2I for phase to phase, and V/I√3 for a three phase fault with a delta fault voltage. A formula involving a scalar K (K*V/I) is provided to calculate zero compensated values.
Voltage	Amplitude of fault voltage. On a phase to ground fault, this is the voltage amplitude on the Test tab; however, on a phase to phase fault, this is the vector difference of the two Doble voltages, which are phase to ground quantities.
Angle	Angle of fault voltage entered above. On phase to phase fault, this is angle of the vector difference of the two Doble phase to ground voltages.
K Factor	Scalar value of K for use in an Equation involving K; otherwise it is ignored.

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The ZPLBOI Prefault Tab fields are explained in Table C.156.

Operation	When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.156 ZPLBOI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

ZPLBOV - Z Characteristic Plot - Binary Search Voltage - Z ProTesTPLAN

Description

A fast, high-low pulsed search to bracket the relay operate point, followed by linear ramp or pulsed ramp for a high resolution result. Repeated up to 100 times at different impedance angles for fast measurement of impedance characteristic.

The Search algorithm begins by testing midway between the Action Offset Voltage and Voltage Limit. If the relay does not operate, limit voltage is applied. If the relay still does not operate, the test is over (recorded as No Op, No Operation). Successive pulses are calculated based on the results of the last pulse; i.e., the next pulse is halfway between the last operate value and the last No Op value. When the difference between pulse amplitudes is less than three times the ramp delta voltage specified, the search stops and either a Linear Ramp or a Pulsed Ramp begins.

The ramp backs twice the delta voltage further, then ramps for a maximum of 15 steps. If the test is properly tuned, three or four steps should be sufficient.

Operation

ZPLBOV does a sequence of Reach Binary Search tests at different impedance phase angles. The user specifies up to four impedance angle arcs, defined by From Angle, To Angle, and Delta. Reach tests are performed at each angle in the arc, including the end points. Multiple arcs make it possible to do a coarse sweep (e.g., every 10×) over a wide range, then test at, perhaps, every 1× near the angle of maximum torque. A third, very coarse, arc could verify no operation in the blind zone of a directional distance relay. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro tests the high resolution steady state characteristic curve for distance relay.

Notes

- Will record up to 100 points for a good curve.
- If fewer points are needed, use ZPXBOV, which allows Pass/Fail evaluation.

Test Tab

On the ZPLBOV Test Tab screen (Figure C.147 on page C-274):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark the Action amplitude(s) and phase(s) *ACTION* or enter the amplitude value.
4. Enter the frequency.
5. Specify phase as *ACTION*, *A-120*, *A+120*, for example, if phase offset is required among multiple Action sources.
6. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
7. Enter the jumper connections in the Jumpers field.

Results — The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test.

Save Results — Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.

Delete Results — Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

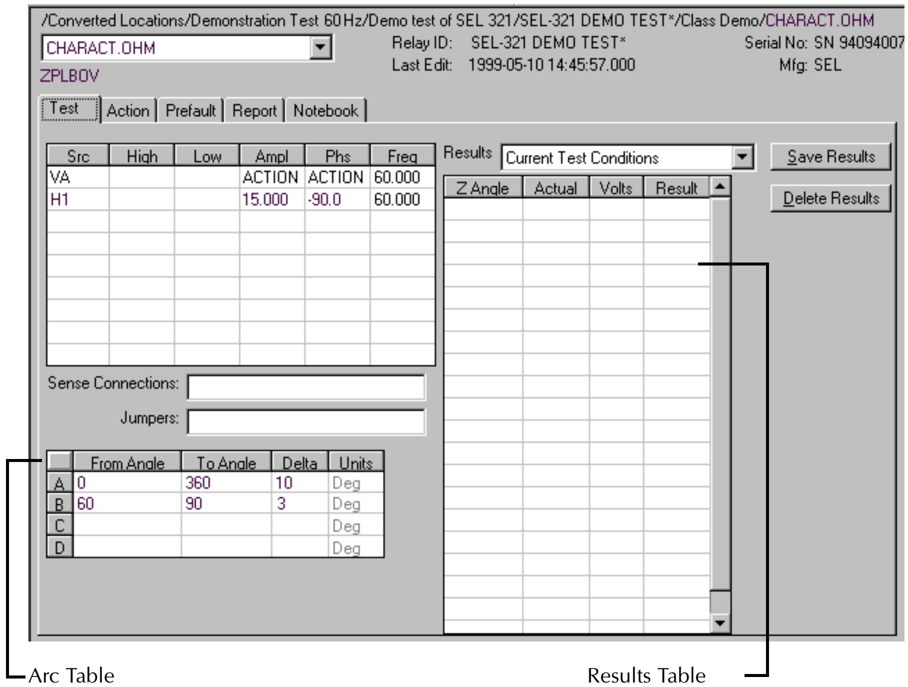


Figure C.147 ZPLBOV Test Tab Screen

Arc Table

Define up to four impedance Arcs. Specify From Angle, To Angle and Delta for each Arc, to cover the angles of interest at a given angular resolution.

The arc angles entered are impedance angles. Action source angle is assumed to be leading, and is calculated by ProTesT, based on the Current Fault Angle entered on the Action tab.

The ZPLBOV Arcs are defined in Table C.157.

Table C.157 ZPLBOV Arc Definitions

Arc	Definition
From Angle	Starting Impedance Angle of the arc in degrees.
To Angle	End Impedance Angle of the arc in degrees.
Delta	Increment of phase angle in degrees.

Results Table

A scrollable table shows the results of running the macro. ZPLBOV records the impedance angle (Z angle), calculated impedance, and operate voltage for up to 100 test points. Impedance is calculated based on the selected Fault Equation (i.e., impedance equation) selected.

There are no expected values, and no Pass/Fail indication. Test result will show only as Run.

Action Tab

The ZPLBOV Action Tab Conditions fields are explained in Table C.158.

Table C.158 ZPLBOV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Voltage Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum Offset and limit determines the source range.
Pulse Duration	Maximum length of each search pulse; pulse terminates as soon as a sense is detected.
Wait	How long to wait between pulses; wait is at offset voltage.
Delta Voltage	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each Linear Ramp step is held; set to 0 for Pulsed Ramp, using the same pulse duration and wait as the search.

The ZPLBOV Action Tab screen is shown in Figure C.148.

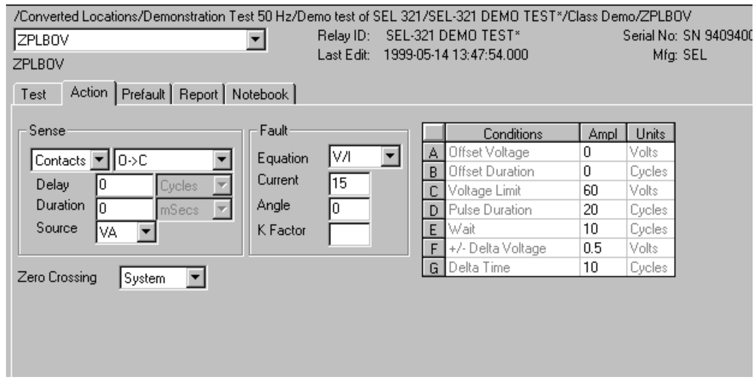


Figure C.148 ZPLBOV Action Tab Screen

Sense

The ZPLBOV Sense fields are explained in Table C.159.

Table C.159 ZPLBOV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the time is recorded. The voltage Action sources briefly turn off before starting the next test point.

Operation Graph

The ZPLBOV Operation graph is shown in Figure C.149.

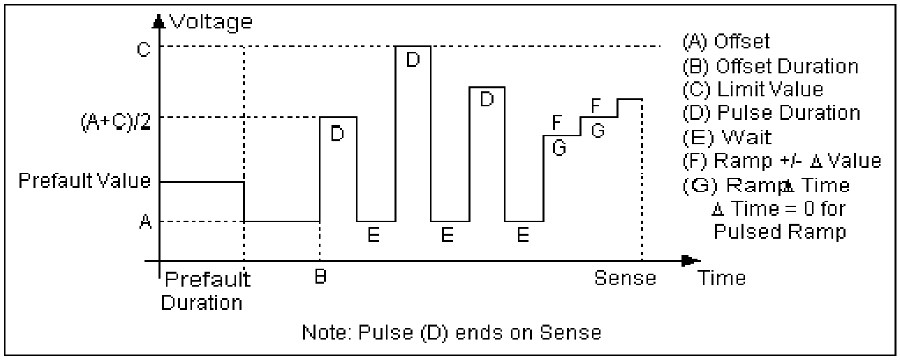


Figure C.149 ZPLBOV Operation Graph

Fault

The ZPLBOV Fault fields are explained in Table C.160.

Table C.160 ZPLBOV Fault Fields

Field	Explanation
Equation	Use the pull-down list to select steady state fault equation for impedance. Use V/I for single phase fault, ÷3 V/2I for phase to phase, and V/I÷3 for a three phase fault with a delta fault voltage. A formula involving a scalar K (K*V/I) is provided to calculate zero compensated values.
Current	Amplitude of fault current. On a phase to ground fault, this is the current amplitude on the Test tab; however, on a phase to phase fault, this is the vector difference of the two Doble currents, which are phase to ground quantities. Must not be zero.
Angle	Angle of fault voltage entered above. On phase to phase fault, this is angle of the vector difference of the two Doble phase to ground currents.
K Factor	Scalar value of K for use in an Equation involving K; otherwise it is ignored.

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

The ZPLBOV Prefault Tab fields are explained in Table C.161.

Table C.161 ZPLBOV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

ZPLLRI - Z Characteristic Plot - Linear Ramp Current - Z ProTesTPLAN

Description

One or more current sources are ramped from an offset amplitude until the relay operates, or until a limit amplitude is reached (recorded as No Op, for No Operation). This can be repeated up to 100 times at different impedance angles.

Operation

ZPLLRI does a sequence of Linear Ramp Reach tests at different impedance angles. The user specifies up to four impedance angle arcs, defined by From Angle, To Angle, and Delta. Reach tests are performed at each angle in the arc, including the end points. Multiple arcs make it possible to do a coarse sweep (e.g., every 10×) over a wide range, then test at, perhaps, every 1× near the angle of maximum torque. A third, very coarse, arc could verify no operation in the blind zone of a directional distance relay. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro tests the high resolution steady state characteristic curve for distance relay.

Notes

- To minimize test time and heating, use an offset as close to the expected operating points as possible or use ZPLBOI instead.
- Will record up to 100 points for a good curve.
- If fewer points are needed, use ZPXBOI, which allows Pass/Fail evaluation.

Test Tab

On the ZPLLRI Test Tab screen (Figure C.150):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark the Action amplitude(s) and phase(s) *ACTION* or enter the amplitude value.
4. Enter the frequency.
5. Specify phase as *ACTION*, *A-120*, *A+120*, for example, if phase offset is required among multiple Action sources.
6. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
7. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

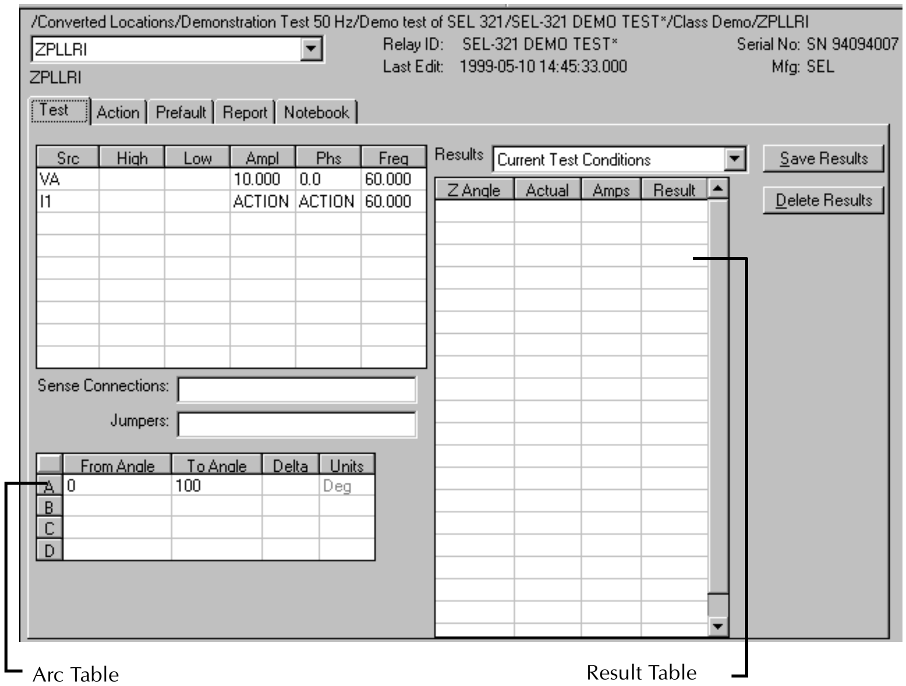


Figure C.150 ZPLLRI Test Tab Screen

Arc Table

Define up to four impedance Arcs. Specify From Angle, To Angle and Delta for each Arc, to cover the angles of interest at a given angular resolution.

The arc angles entered are impedance angles. Action source angle is assumed to be lagging, and is calculated by ProTesT, based on the Voltage Fault Angle entered on the Action tab.

The ZPLLRI Arcs are defined in Table C.162.

Table C.162 ZPLLRI Arc Definitions

Arc	Definition
From Angle	Starting Impedance Angle of the arc in degrees.
To Angle	End Impedance Angle of the arc in degrees.
Delta	Increment of phase angle in degrees.

Results Table

A scrollable table shows the results running of the macro. ZPLLRI records the impedance angle, calculated impedance, and operate current for up to 100 test points. Impedance is calculated based on the selected Fault Equation (i.e., impedance equation) selected.

There are no expected values, and no Pass/Fail indication. Test result will show only as Run.

Action Tab

The ZPLLRI Action Tab Conditions fields are explained in Table C.163.

Table C.163 ZPLLRI Action Tab Conditions Fields

Field	Explanation
Offset Current	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Delta Current	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each Linear Ramp step is held. Use minus for a downward ramp.
Current Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum of the Offset and the limit determines the source range.

The ZPLLRI Action Tab screen is shown in Figure C.151.

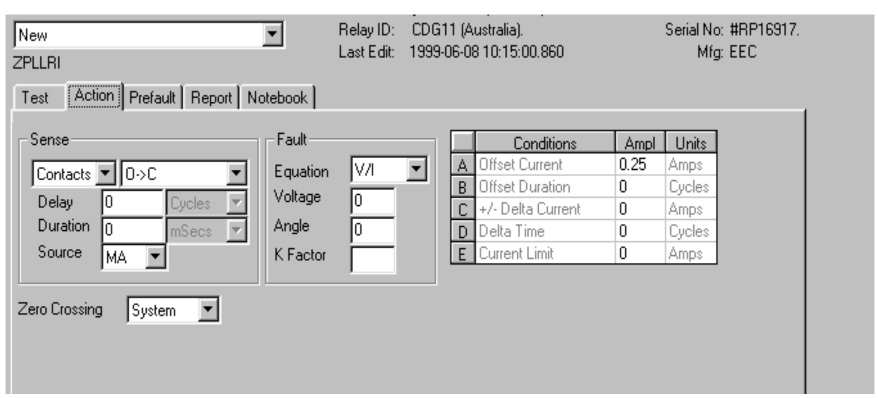


Figure C.151 ZPLLRI Action Tab Screen

Sense

The ZPLLRI Sense fields are explained in Table C.164.

Table C.164 ZPLLRI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the time is recorded. The current Action sources briefly turn off before starting the next test point.

Operation Graph

The ZPLLRI Operation graph is shown in Figure C.152.

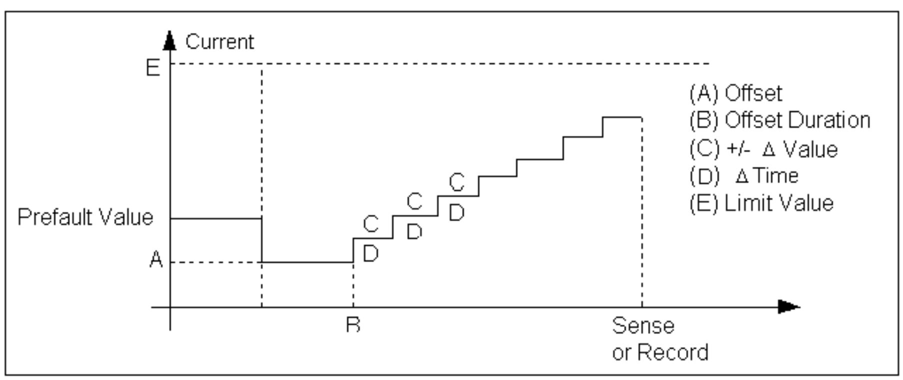


Figure C.152 ZPLLRI Operation Graph

Fault

The ZPLLRI Fault fields are explained in Table C.165.

Table C.165 ZPLLRI Fault Fields

Field	Explanation
Equation	Use the pull-down list to select steady state fault equation for impedance. Use V/I for single phase fault, V/2I for phase to phase, and V/I√3 for a three phase fault with a delta fault voltage. A formula involving a scalar K (K*V/I) is provided to calculate zero compensated values.
Voltage	Amplitude of fault voltage. On a phase to ground fault, this is the voltage amplitude on the Test tab; however, on a phase to phase fault, this is the vector difference of the two Doble voltages, which are phase to ground quantities.
Angle	Angle of fault voltage entered above. On phase to phase fault, this is angle of the vector difference of the two Doble phase to ground voltages.
K Factor	Scalar value of K for use in an Equation involving K; otherwise it is ignored.

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current.

Operation	When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

The ZPLLRI Prefault Tab fields are explained in Table C.166.

Table C.166 ZPLLRI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

ZPLLRV - Z Characteristic Plot - Linear Ramp Voltage - Z ProTesTPLAN

Description

One or more voltage sources are ramped from an offset amplitude until the relay operates, or until a limit amplitude is reached (recorded as No Op, for No Operation). Repeated up to 100 times at different impedance angles.

Operation

ZPLLRV does a sequence of Linear Ramp Reach tests at different impedance angles. The user specifies up to four impedance angle arcs, defined by From Angle, To Angle, and Delta. Reach tests are performed at each angle in the arc, including the end points. Multiple arcs make it possible to do a coarse sweep (e.g., every 10×) over a wide range, then test at, perhaps, every 1× near the angle of maximum torque. A third, very coarse, arc could verify no operation in the blind zone of a directional distance relay. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro tests the high resolution steady state characteristic curve for distance relay.

Notes

- Will record up to 100 points for a good curve.
- If fewer points are needed, use ZPXBOV, which allows Pass/Fail evaluation.

Test Tab

On the ZPLLRV Test Tab screen (Figure C.153):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark the Action amplitude(s) and phase(s) *ACTION* or enter the amplitude value.
4. Enter the frequency.

5. Specify phase as *ACTION*, *A-120*, *A+120*, for example, if phase offset is required among multiple Action sources.
6. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
7. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

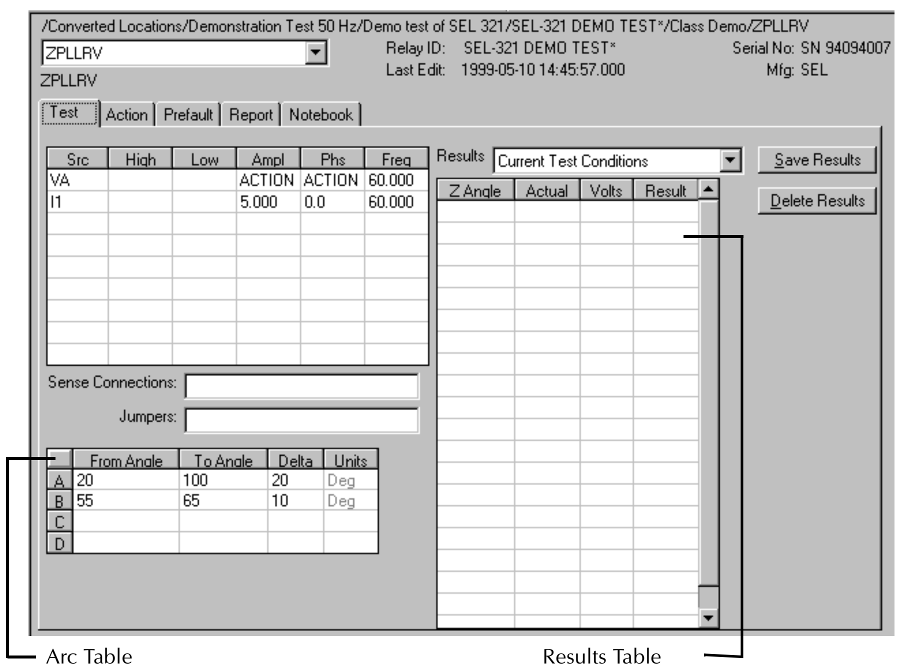


Figure C.153 ZPLLRV Test Tab Screen

Arc Table

Define up to four impedance Arcs. Specify From Angle, To Angle and Delta for each Arc, to cover the angles of interest at a given angular resolution.

The arc angles entered are impedance angles. Action source angle is assumed to be leading, and is calculated by ProTesT, based on the Current Fault Angle entered on the Action tab.

The ZPLLRV Arc are defined in Table C.167.

Table C.167 ZPLLRV Arc Definitions

Arc	Definition
From Angle	Starting Impedance Angle of the arc in degrees.
To Angle	End Impedance Angle of the arc in degrees.
Delta	Increment of phase angle in degrees.

Results Table

A scrollable table shows the results of running the macro. ZPLLRV records the impedance angle, calculated impedance, and operate voltage for up to 100 test points. Impedance is calculated based on the selected Fault Equation (i.e., impedance equation) selected.

There are no expected values, and no Pass/Fail indication. Test result will show only as Run.

Action Tab

The ZPLLRV Action Tab Conditions fields are explained in Table C.168.

Table C.168 ZPLLRV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Delta Voltage	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each Linear Ramp step is held. Use minus for a downward ramp.
Voltage Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum of the Offset and limit determines the source range.

The ZPLLRV Action Tab screen is shown in Figure C.154.

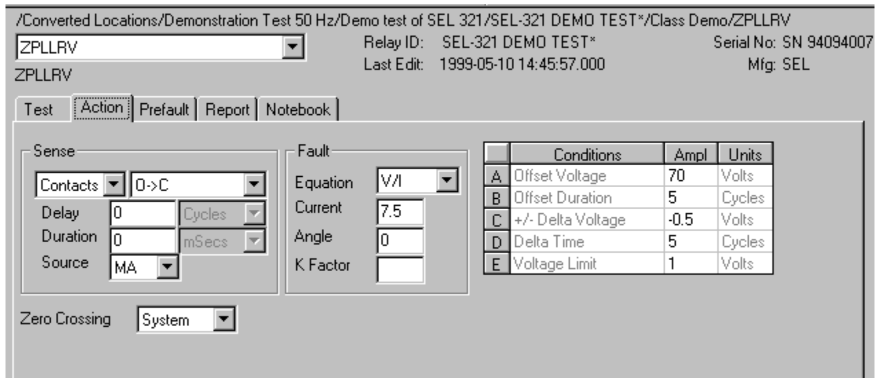


Figure C.154 ZPLLRV Action Tab Screen

Sense

The ZPLLRV Sense fields are explained in Table C.169.

Table C.169 ZPLLRV Sense Fields

Field	**Explanation**
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the time is recorded. The voltage Action sources briefly turn off before starting the next test point.

Operation Graph

The ZPLLRV Operation graph is shown in Figure C.155.

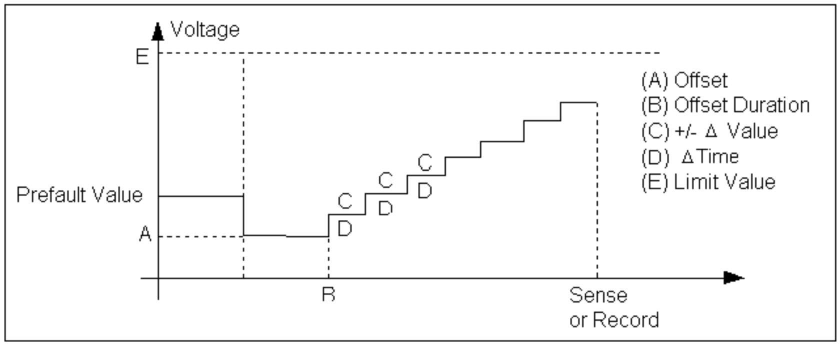


Figure C.155 ZPLLRV Operation Graph

Fault

The ZPLLRV Fault fields are explained in Table C.170.

Table C.170 ZPLLRV Fault Fields

Field	Explanation
Equation	Use the pull-down list to select steady state fault equation for impedance. Use V/I for single phase fault, $\sqrt{3}$ V/2I for phase to phase, and V/I$\sqrt{3}$ for a three phase fault with a delta fault voltage. A formula involving a scalar K (K*V/I) is provided to calculate zero compensated values.
Current	Amplitude of fault current. On a phase to ground fault, this is the current amplitude on the Test tab; however, on a phase to phase fault, this is the vector difference of the two Doble currents, which are phase to ground quantities.
Angle	Angle of fault current entered above. On phase to phase fault, this is angle of the vector difference of the two Doble phase to ground currents.
K Factor	Scalar value of K for use in an Equation involving K; otherwise it is ignored.

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current.

The ZPLLRV Prefault Tab fields are explained in Table C.171.

Operations	When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.171 ZPLLRV Prefault Tab fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

ZPLPRI - Z Characteristic Plot - Pulsed Linear Ramp Current - Z ProTesTPLAN

Description

One or more current sources are ramped in a series of pulses, returning to an offset amplitude between pulses. If the limit amplitude is reached with no relay operation, it is recorded as No Op, for No Operation. Repeated up to 100 times at different impedance angles.

Operation

ZPLPRI does a sequence of Pulsed Linear Ramp Reach tests at different impedance angles. The user specifies up to four impedance angle arcs, defined by From Angle, To Angle, and Delta. Reach tests are performed at each angle in the arc, including the end points. Multiple arcs make it possible to do a coarse sweep (e.g., every 10×) over a wide range, then test at, perhaps, every 1× near the angle of maximum torque. A third, very coarse arc could verify no operation in the blind zone of a directional distance relay. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro tests the high resolution steady state characteristic curve for distance relay. Use Pulsed Ramp instead of Linear Ramp to minimize heat load on relay, or when the relay requires return to offset between test values.

Notes

- Will record up to 100 points for a good curve.
- If fewer points are needed, use ZPXBOI, which allows Pass/Fail evaluation.

Test Tab

On the ZPLPRI Test Tab screen (Figure C.156 on page C-294):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark the Action amplitude(s) and phase(s) *ACTION* or enter the amplitude value.
4. Enter the frequency.
5. Specify phase as *ACTION*, *A-120*, *A+120*, for example, if phase offset is required among multiple Action sources.
6. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
7. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

The ZPLPRI Test Tab screen is shown in Figure C.156.

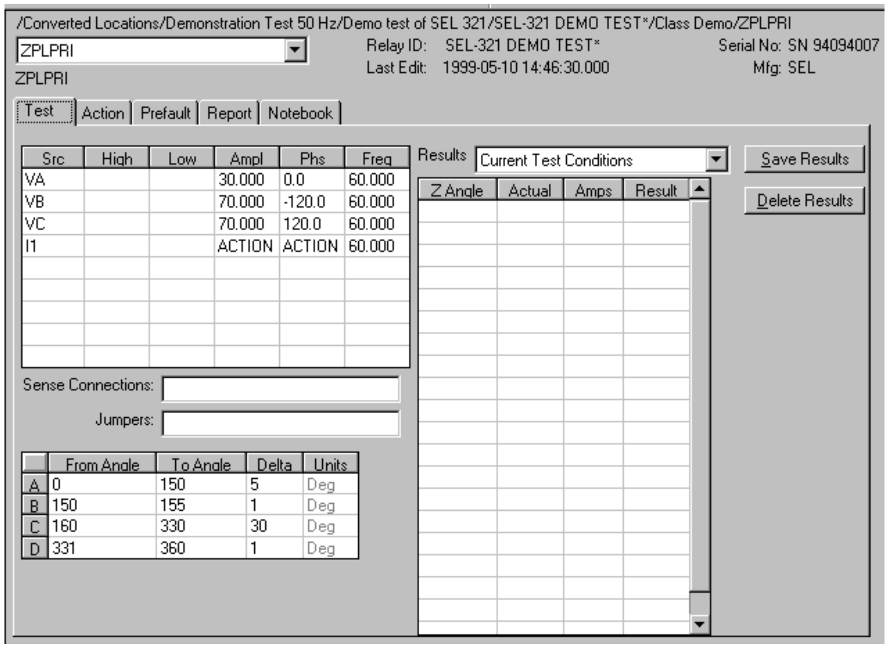


Figure C.156 ZPLPRI Test Tab Screen

Arc Table

Define up to four impedance Arcs. Specify From Angle, To Angle and Delta for each Arc, to cover the angles of interest at a given angular resolution.

The arc angles entered are impedance angles. Action source angle is assumed to be lagging, and is calculated by ProTesT, based on the Voltage Fault Angle entered on the Action tab.

The ZPLPRI Arcs are defined in Table C.172.

Table C.172 ZPLPRI Arc Definitions

Arc	Definition
From Angle	Starting Impedance Angle of the arc in degrees.
To Angle	End Impedance Angle of the arc in degrees.
Delta	Increment of phase angle in degrees.

Results Table

A scrollable table shows the results of running the macro. ZPLPRI records the impedance angle, calculated impedance, and operate current for up to 100 test points. Impedance is calculated based on the selected Fault Equation (i.e., impedance equation) selected.

There are no expected values, and no Pass/Fail indication. Test result will show only as Run.

Action Tab

The ZPLPRI Action Tab Conditions fields are explained in Table C.173.

Table C.173 ZPLPRI Action Tab Conditions Fields

Field	Explanation
Offset Current	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Initial Current	Amplitude of first pulse.
Pulse Duration	Maximum length of each pulse; pulse terminates as soon as a sense is detected.
Wait	How long to wait between pulses; wait is at offset current.
Delta Current	Step size of ramp. Use a minus sign for a downward ramp.
Current Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum of the Offset and limit determines the source range.

The ZPLPRI Action Tab screen is shown in Figure C.157.

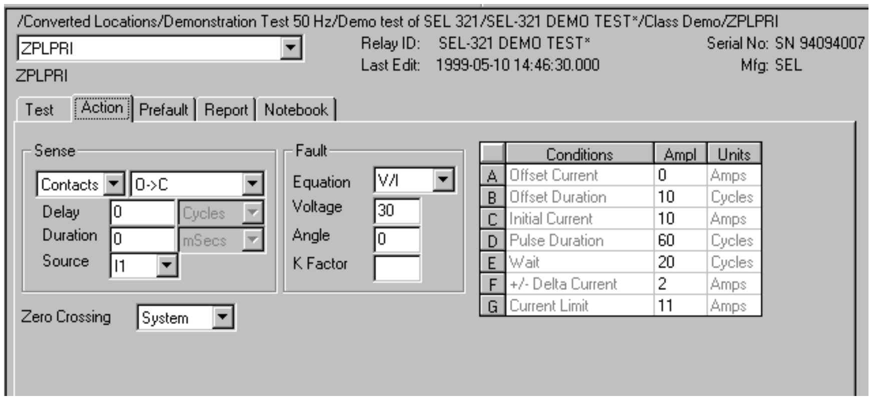


Figure C.157 ZPLPRI Action Tab Screen

Sense

The ZPLPRI Sense fields are explained in Table C.174.

Table C.174 ZPLPRI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the time is recorded. The current Action sources briefly turn off before starting the next test point.

Operation Graph

The ZPLPRI Operation graph is shown in Figure C.158.

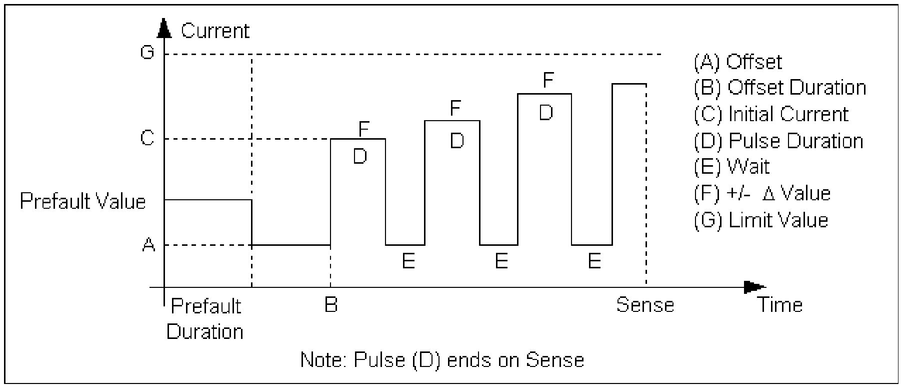


Figure C.158 ZPLPRI Operation Graph

Fault

The ZPLPRI Fault fields are explained in Table C.175.

Table C.175 ZPLPRI Fault Fields

Field	Explanation
Equation	Use the pull-down list to select steady state fault equation for impedance. Use V/I for single phase fault, V/2I for phase to phase, and V/I÷3 for a three phase fault with a delta fault voltage. A formula involving a scalar K (K*V/I) is provided to calculate zero compensated values.
Voltage	Amplitude of fault voltage. On a phase to ground fault, this is the voltage amplitude on the Test tab; however, on a phase to phase fault, this is the vector difference of the two Doble voltages, which are phase to ground quantities.
Angle	Angle of fault voltage entered above. On phase to phase fault, this is angle of the vector difference of the two Doble phase to ground voltages.
K Factor	Scalar value of K for use in an Equation involving K; otherwise it is ignored.

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The ZPLPRI Prefault Tab fields are explained in Table C.176.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.176 ZPLPRI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

ZPLPRV - Z Characteristic Plot - Pulsed Linear Ramp Voltage - Z ProTesTPLAN

Description

One or more voltage sources are ramped in a series of pulses, returning to an offset amplitude between pulses. If the limit amplitude is reached with no relay operation, it is recorded as No Op, for No Operation. Repeated up to 100 times at different impedance angles.

Operation

ZPLPRI does a sequence of Pulsed Linear Ramp Reach tests at different impedance angles. The user specifies up to four impedance angle arcs, defined by From Angle, To Angle, and Delta. Reach tests are performed at each angle in the arc, including the end points. Multiple arcs make it possible to do a coarse sweep (e.g., every 10×) over a wide range, then test at, perhaps, every 1× near the angle of maximum torque. A third, very coarse, arc could verify no operation in the blind zone of a directional distance relay. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro tests the high resolution steady state characteristic curve for distance relay. Use when relay requires return to offset between test values.

Notes

- Will record up to 100 points for a good curve.
- If fewer points are needed, use ZPXBOV, which allows Pass/Fail evaluation.

Test Tab

On the ZPLPRV Test Tab screen (Figure C.159):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark the Action amplitude(s) and phase(s) *ACTION* or enter the amplitude value.
4. Enter the frequency.
5. Specify phase as *ACTION*, *A-120*, *A+120*, for example, if phase offset is required among multiple Action sources.
6. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
7. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

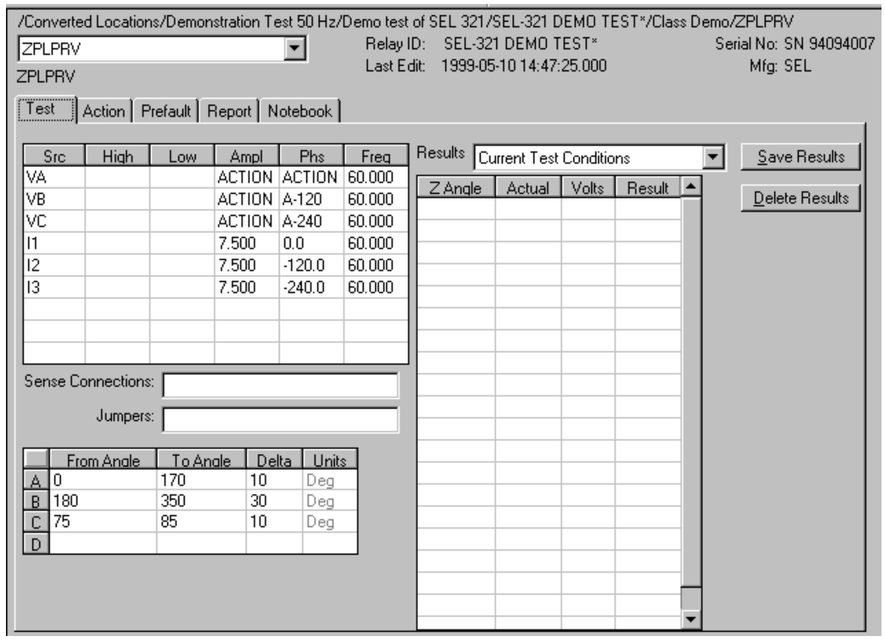


Figure C.159 ZPLPRV Test Tab Screen

Arc Table

Define up to four impedance Arcs. Specify From Angle, To Angle and Delta for each Arc, to cover the angles of interest at a given angular resolution.

The arc angles entered are impedance angles. Action source angle is assumed to be leading, and is calculated by ProTesT, based on the Current Fault Angle entered on the Action tab.

The ZPLPRV Arcs are defined in Table C.177.

Table C.177 ZPLPRV Arcs Definition

Arc	Definition
From Angle	Starting Impedance Angle of the arc in degrees.
To Angle	End Impedance Angle of the arc in degrees.
Delta	Increment of phase angle in degrees.

Results Table

A scrollable table shows the results of running the macro. ZPLPRV records the impedance angle, calculated impedance, and operate voltage for up to 100 test points. Impedance is calculated based on the selected Fault Equation (i.e., impedance equation) selected.

There are no expected values, and no Pass/Fail indication. Test result will show only as Run.

Action Tab

The ZPLPRV Action Tab Conditions fields are explained Table C.178.

Table C.178 ZPLPRV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Initial Voltage	Starting value for the pulsed ramp.
Pulse Duration	How long each pulse is held, waiting for a sense.
Wait	How long to wait at offset between pulses.
Delta Voltage	Step size of pulsed ramp. Use a minus sign for a downward ramp.
Voltage Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum of the Offset and limit determines the source range.

The ZPLPRV Action Tab screen is shown in Figure C.160.

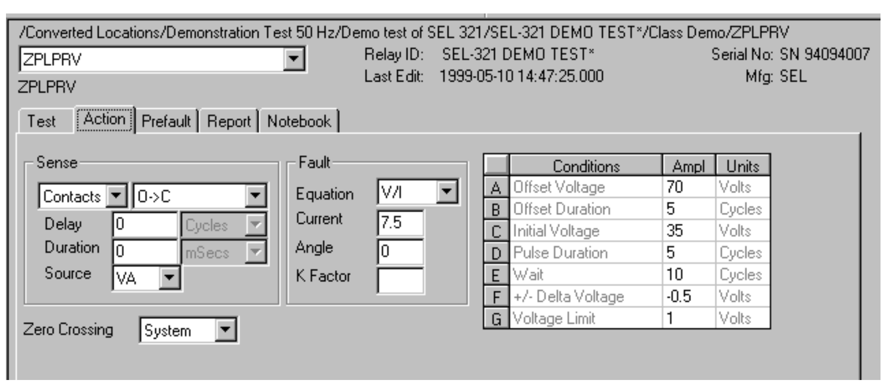


Figure C.160 ZPLPRV Action Tab Screen

Sense

The ZPLPRV Sense fields are explained in Table C.179.

Table C.179 ZPLPRV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the time is recorded. The voltage Action sources briefly turn off before starting the next test point.

Operation Graph

The ZPLPRV Operation graph is shown in Figure C.161.

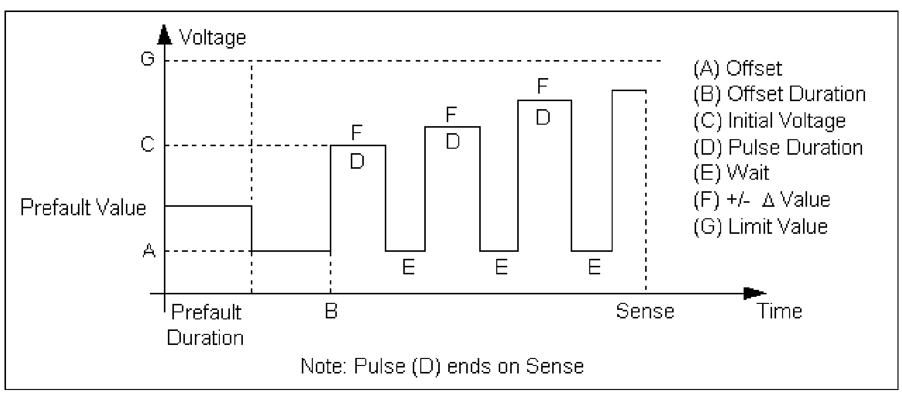


Figure C.161 ZPLPRV Operation Graph

Fault

The ZPLPRV Fault fields are explained in Table C.180.

Table C.180 ZPLPRV Fault Fields

Field	Explanation
Equation	Use the pull-down list to select steady state fault equation for impedance. Use V/I for single phase fault, $\sqrt{3}V/2I$ for phase to phase, and $V/I\sqrt{3}$ for a three phase fault with a delta fault voltage. A formula involving a scalar K (K*V/I) is provided to calculate zero compensated values.
Voltage	Amplitude of fault voltage. On a phase to ground fault, this is the voltage amplitude on the Test tab; however, on a phase to phase fault, this is the vector difference of the two Doble voltages, which are phase to ground quantities.
Angle	Angle of fault voltage entered above. On phase to phase fault, this is angle of the vector difference of the two Doble phase to ground voltages.
K Factor	Scalar value of K for use in an Equation involving K; otherwise it is ignored.

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current. The ZPLPRV Prefault Tab fields are explained in Table C.181.

Operation	When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.181 ZPLPRV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

ZPXBOI - Z Characteristic with Expected Value Binary Search Current - Z ProTesTPLAN

Description

A fast, high-low pulsed search to bracket the relay operate point, followed by linear ramp or pulsed ramp for a high resolution result. Repeated up to 12 times at specified impedance angles to determine an impedance characteristic and Pass/Fail in one test. (Same as ZPLBOI, except that expected values and pass/fail tolerances are offered.)

The Search algorithm begins by testing midway between the Offset Current and Current Limit. If the relay does not operate, limit current is applied. If the relay still does not operate, the test is over (recorded as No Op, No Operation). Successive pulses are calculated based on the results of the last pulse; i.e., the next pulse is halfway between the last operate value and the last No Op value. When the difference between pulse amplitudes is less than three times the ramp delta current, the search stops and either a Linear Ramp or a Pulsed Ramp begins.

The ramp backs off twice the delta current further, then ramps for a maximum of 15 steps. If the test is properly tuned, three or four steps should be sufficient.

Operation

ZPXBOI does up to 12 Reach Binary Search tests at specified impedance angles. Enter selected Z Angles for the test, plus an optional expected impedance and +/– tolerance percentages for each test point. Test results determine both Pass/Fail and the characteristic curve. Test angles can also be entered to verify no operation in the blind zone of a directional distance relay. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro combines the reach test with the impedance curve. Use three or four points for fast relay test, at MTA and on either side.

Test Tab

On the ZPXBOI Test Tab screen (Figure C.162 on page C-308):

1. Select valid source names in the Src column.
2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.
3. Mark the Action amplitude(s) and phase(s) *ACTION* or enter the amplitude value.
4. Enter the frequency.
5. Specify phase as *ACTION*, *A-120*, *A+120*, for example, if phase offset is required among multiple Action sources.
6. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.
7. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The ZPXBOI Test Tab Result fields are explained in Table C.182 on page C-308.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

The ZPXBOI Test Tab screen is shown in Figure C.162.

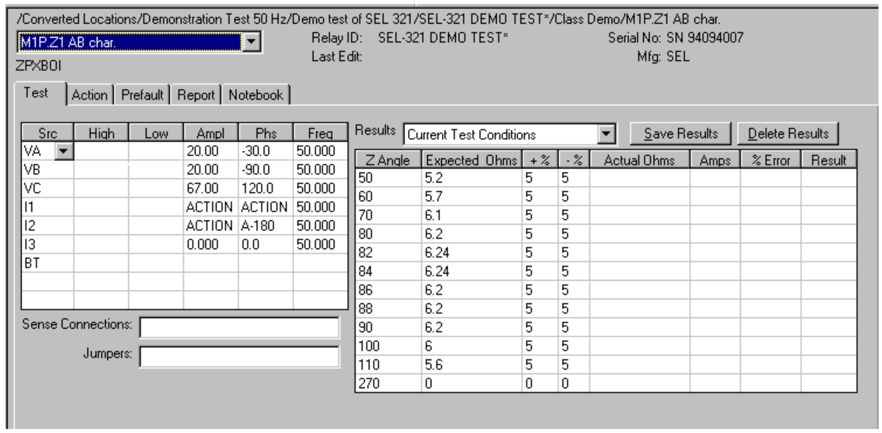


Figure C.162 ZPXBOI Test Tab Screen

The ZPXBOI Test Tab Result fields are explained in Table C.182. The user can enter up to 12 test angles in the table, and expected impedance.

Table C.182 ZPXBOI Test Tab Result Fields

Field	Explanation
Z Angle	Impedance angle for a test point. Action source angle is calculated by ProTesT, based on the Fault Angle entered on Action tab. Source angle is assumed to be lagging. Only non-blank entries are used as test points.
Expected Ohms	Expected steady state impedance at Z angle.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual Ohms	Calculated impedance test result.
Amps	Actual current at pickup.
% Error	Error in expected impedance.
Result	Pass/Fail indication.

Action Tab

The ZPXBOI Action Tab Conditions fields are explained in Table C.183.

Table C.183 ZPXBOI Action Tab Conditions Fields

Field	Explanation
Offset Current	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Current Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum Offset and limit determines the source range.
Pulse Duration	Maximum length of each search pulse; pulse terminates as soon as a sense is detected.
Wait	How long to wait between pulses; wait is at offset current.
Delta Current	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each Linear Ramp step is held; set to 0 for Pulsed Ramp, using the same pulse duration and wait as the search.

The ZPXBOI Action Tab screen is shown in Figure C.163.

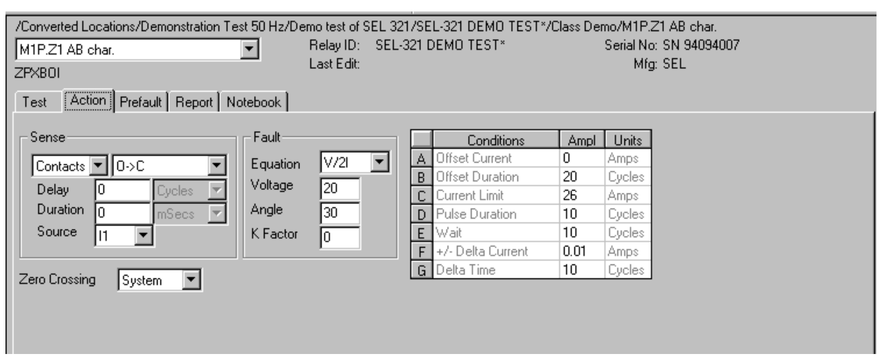


Figure C.163 ZPXBOI Action Tab Screen

Sense

The ZPXBOI Sense fields are explained in Table C.184.

Table C.184 ZPXBOI Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the time is recorded. The current Action sources briefly turn off before starting the next test point.

Operation Graph

The ZPXBOI Operation graph is shown in Figure C.164.

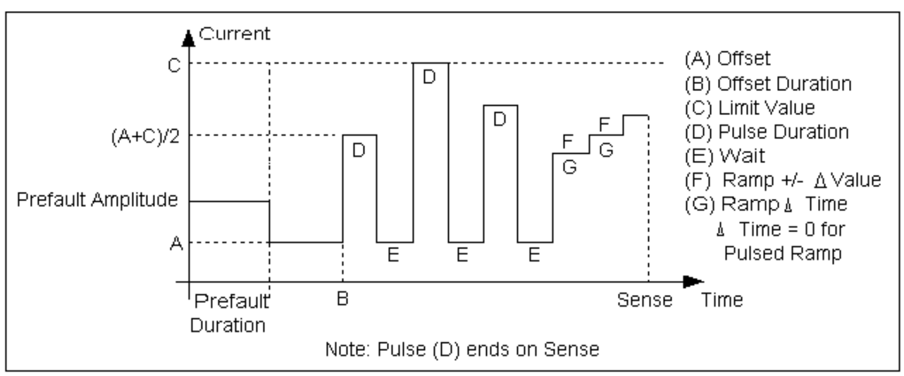


Figure C.164 ZPXBOI Operation Graph

Fault

The ZPXBOI Fault fields are explained in Table C.185.

Table C.185 ZPXBOI Fault Fields

Field	Explanation
Equation	Use the pull-down list to select steady state fault equation for impedance. Use V/I for single phase fault, V/2I for phase to phase, and V/I√3 for a three phase fault with a delta fault voltage. A formula involving a scalar K (K*V/I) is provided to calculate zero compensated values.
Voltage	Amplitude of fault voltage. On a phase to ground fault, this is the voltage amplitude on the Test tab; however, on a phase to phase fault, this is the vector difference of the two Doble voltages, which are phase to ground quantities.
Angle	Angle of fault voltage entered above. On phase to phase fault, this is the angle of the vector difference of the two Doble phase to ground voltages.
K Factor	Scalar value of K for use in an Equation involving K; otherwise it is ignored.

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current.

The ZPXBOI Prefault Tab fields are explained in Table C.186.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

Table C.186 ZPXBOI Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

ZPXBOV - Z Characteristic with Expected Value Binary Search Voltage - Z ProTesTPLAN

Description

A fast, high-low pulsed search to bracket the relay operate point, followed by linear ramp or pulsed ramp for a high resolution result. Repeated up to 12 times at specified impedance angles to determine an impedance characteristic and Pass/Fail in one test. (Same as ZPLBOV, except that expected values and pass/fail tolerances are offered.)

The Search algorithm begins by testing midway between the Offset Voltage and Voltage Limit. If the relay does not operate, voltage limit is applied. If the relay still does not operate, the test is over (recorded as No Op, No Operation). Successive pulses are calculated based on the results of the last pulse; i.e., the next pulse is halfway between the last operate value and the last No Op value. When the difference between pulse amplitudes is less than three times the ramp delta voltage, the search stops and either a Linear Ramp or a Pulsed Ramp begins.

The ramp backs off twice the delta voltage further, then ramps for a maximum of 15 steps. If the test is properly tuned, three or four steps should be sufficient.

Operation

ZPXBOV does up to 12 Reach Binary Search tests at specified impedance angles. Enter selected Z Angles for the test, plus an optional expected impedance and +/– tolerance percentages for each test point. Test results determine both Pass/Fail and the characteristic curve. Test angles can also be entered to verify no operation in the blind zone of a directional distance relay. Select Tools/Graph/Display Graph from the menu bar to display the time characteristic. The plot form can be changed without rerunning the test.

Use

This macro combines the reach test with the impedance curve. Use three or four points for fast relay test, at MTA and on either side.

Notes

- Search can be from either low offset to high voltage limit, or from elevated offset to low limit.

Test Tab

On the ZPXBOV Test Tab screen (Figure C.165):

1. Select valid source names in the Src column.

2. Use the High and Low fields to enter values for the source connections between the instrument and the relay.

3. Mark the Action amplitude(s) and phase(s) *ACTION* or enter the amplitude value.

4. Enter the frequency.

5. Specify phase as *ACTION*, *A-120*, *A+120*, for example, if phase offset is required among multiple Action sources.

6. Enter test relay connections in the Sense Connections field when the test relay is connected as a sense input or to a timer.

7. Enter the jumper connections in the Jumpers field.

Results	The macro initially displays the results for the Current Test conditions. To display prior results, click the pull-down arrow and select a prior test. The ZPXBOV Test Tab Result Fields are explained in Table C.187.
Save Results	Click **Save Results** after running a test and select the new results to save. When exiting the macro, save any macro changes and results if they have not already been saved.
Delete Results	Click **Delete Results** to display a window containing saved test results. Select one or more test results using the mouse. Ctrl+click works as a toggle action to select or unselect items. Click **OK** to complete deletion.

NOTE

If battery simulator voltage is needed, enter BT as a source and select amplitude, or run the POWER macro.

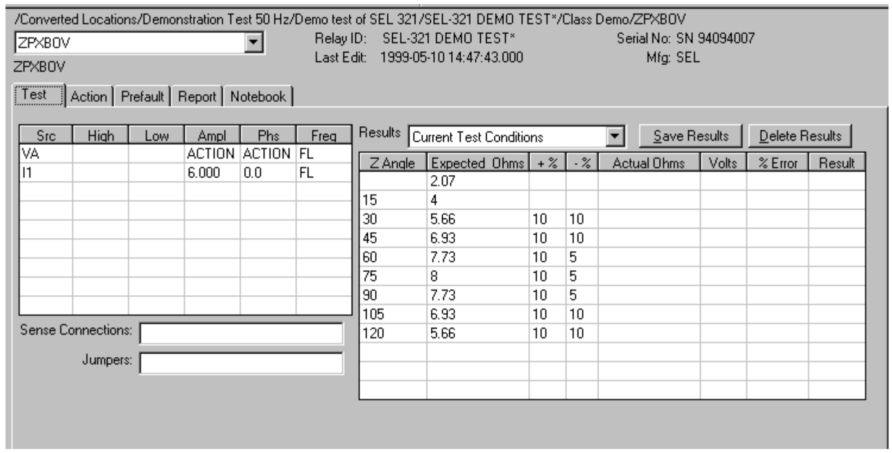


Figure C.165 ZPXBOV Test Tab Screen

Test Tab

The ZPXBOV Test Tab Result fields are explained in Table C.187. Enter up to 12 test angles in the table, and expected impedance.

Table C.187 ZPXBOV Test Tab Result Fields

Field	Explanation
Z Angle	Impedance angle for a test point. Action source angle is calculated by ProTesT, based on the Fault Angle entered on Action tab. Source angle is assumed to be leading. Only non-blank entries are used as test points.
Expected Ohms	Expected steady state impedance at Z angle; optional.
+ %/– %	Plus/minus tolerance percentage, used for Pass/Fail calculation.
Actual Ohms	Calculated impedance test result.
Volts	Actual voltage at pickup.
% Error	Error in expected impedance.
Result	Pass/Fail indication.

Action Tab

The ZPXBOV Action Tab Conditions fields are explained in Table C.188.

Table C.188 ZPXBOV Action Tab Conditions Fields

Field	Explanation
Offset Voltage	The initial amplitude of the Action source.
Offset Duration	How long to maintain the offset.
Voltage Limit	The amplitude at which the ramp stops if the relay does not operate. The maximum Offset and limit determines the source range.
Pulse Duration	Maximum length of each search pulse; pulse terminates as soon as a sense is detected.
Wait	How long to wait between pulses; wait is at offset voltage.
Delta Voltage	Step size of ramp. Use a minus sign for a downward ramp.
Delta Time	How long each Linear Ramp step is held; set to 0 for Pulsed Ramp, using the same pulse duration and wait as the search.

The ZPXBOV Action Tab screen is shown in Figure C.166.

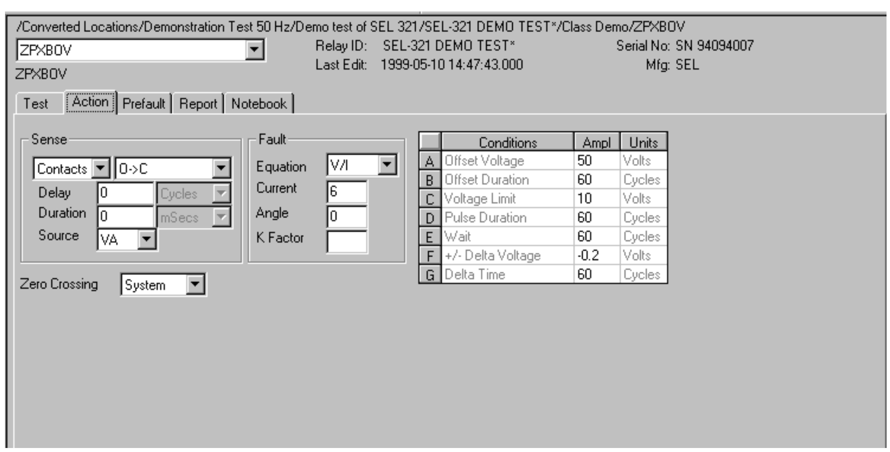


Figure C.166 ZPXBOV Action Tab Screen

Sense

The ZPXBOV Sense fields are explained in Table C.189.

Table C.189 ZPXBOV Sense Fields

Field	Explanation
Pull-down List	Select sense transition: Contacts O–>C, etc., Voltage On–>Off, etc.
Source	Name a source to identify which Instrument, or input, receives the relay sense signal. The source must be an Action. The default is MA for the Master Instrument.

Run

Click **RUN** on the toolbar or press **F12** to run the test. The sources initialize as follows:

- Non-Action sources turn on at Preset values.
- Action values turn on at Prefault values, move to offset values and then to Action values.

The test stops as soon as the relay operates and the time is recorded. The voltage Action sources briefly turn off before starting the next test point.

Operation Graph

The ZPXBOV Operation graph is shown in Figure C.167.

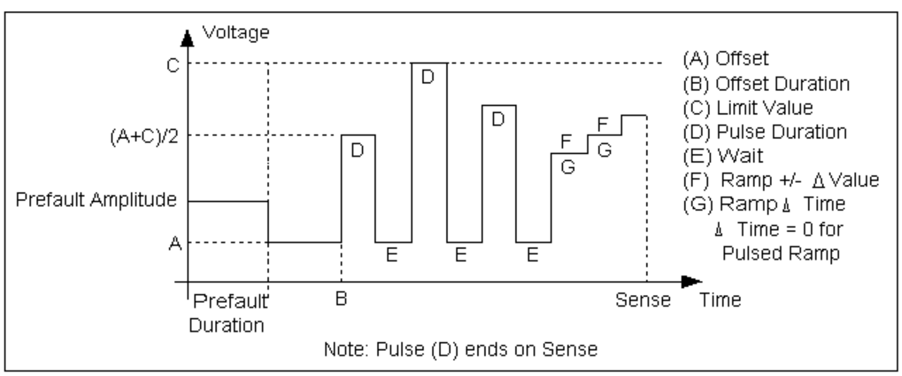


Figure C.167 ZPXBOV Operation Graph

Fault

The ZPXBOV Fault fields are explained in Table C.190.

Table C.190 ZPXBOV Fault Fields

Field	Explanation
Equation	Use the pull-down list to select steady state fault equation for impedance. Use V/I for single phase fault, $\sqrt{3}V/2I$ for phase to phase, and $V/I\sqrt{3}$ for a three phase fault with a delta fault voltage. A formula involving a scalar K (K*V/I) is provided to calculate zero compensated values.
Current	Amplitude of fault current. On a phase to ground fault, this is the amplitude on the Test tab; however, on a phase to phase fault, this is the vector difference of the two Doble currents, which are phase to ground quantities.
Angle	Angle of fault voltage entered above. On phase to phase fault, this is the angle of the vector difference of the two Doble phase to ground voltages.
K Factor	Scalar value of K for use in an Equation involving K; otherwise it is ignored.

Prefault Tab

The Prefault tab is used for steady state macros to assert initial conditions before the values on the Test tab and Action offset are applied. This allows an initial state of normal, balanced voltages and currents to be applied for a duration before the macro action begins with faulted voltage and increasing current.

Operation — When the test is run, the Prefault is applied as indicated. This allows an intelligent relay to see normal conditions before responding to the fault condition generated by running the macro. If the Prefault duration is 0, no Prefault occurs.

The ZPXBOV Prefault Tab fields are explained in Table C.191.

Table C.191 ZPXBOV Prefault Tab Fields

Field	Explanation
Source Name	Source names are set on the Test tab and cannot be modified.
Amplitude	Enter the desired amplitude.
Phase	Enter a phase in the range of –360.0° to 360.0°.
Frequency	The Frequency value is set on the Test tab.
Prefault Duration	Enter a duration for the Prefault condition.

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