NATIONAL INSTRUMENTS™
TestStand™

User Manual

NATIONAL INSTRUMENTS™

March 2001 Edition
Part Number 322016B-01

Worldwide Technical Support and Product Information

`ni.com`

National Instruments Corporate Headquarters

11500 North Mopac Expressway Austin, Texas 78759-3504 USA Tel: 512 794 0100

Worldwide Offices

Australia 03 9879 5166, Austria 0662 45 79 90 0, Belgium 02 757 00 20, Brazil 011 284 5011, Canada (Calgary) 403 274 9391, Canada (Ottawa) 613 233 5949, Canada (Québec) 514 694 8521, Canada (Toronto) 905 785 0085, China (Shanghai) 021 6555 7838, China (ShenZhen) 0755 3904939, Denmark 45 76 26 00, Finland 09 725 725 11, France 01 48 14 24 24, Germany 089 741 31 30, Greece 30 1 42 96 427, Hong Kong 2645 3186, India 91805275406, Israel 03 6120092, Italy 02 413091, Japan 03 5472 2970, Korea 02 596 7456, Mexico 5 280 7625, Netherlands 0348 433466, New Zealand 09 914 0488, Norway 32 27 73 00, Poland 0 22 528 94 06, Portugal 351 1 726 9011, Singapore 2265886, Spain 91 640 0085, Sweden 08 587 895 00, Switzerland 056 200 51 51, Taiwan 02 2528 7227, United Kingdom 01635 523545

For further support information, see the *Technical Support Resources* appendix. To comment on the documentation, send e-mail to `techpubs@ni.com`

Important Information

Conventions

The following conventions are used in this manual:

[ ]	Square brackets enclose optional items—for example, [`response`].
»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.
✎	This icon denotes a note, which alerts you to important information.
bold	Bold text denotes items that you must select or click on in the software, such as menu items and dialog box options. Bold text also denotes parameter names.
italic	Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.
`monospace`	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames and extensions, and code excerpts.
`monospace italic`	Italic text in this font denotes text that is a placeholder for a word or value that you must supply.

Contents

Chapter 1
TestStand Architecture Overview

General Test Executive Concepts 1-1
TestStand Capabilities and Concepts 1-2
Major Software Components of TestStand 1-4
- TestStand Sequence Editor 1-5
- TestStand Run-Time Operator Interfaces 1-5
- TestStand Test Executive Engine 1-6
- Module Adapters 1-6

TestStand Building Blocks 1-7
- Variables and Properties 1-7
  - Expressions 1-8
  - Categories of Properties 1-9
- Steps 1-11
  - Built-In Step Properties 1-11
  - Step Types 1-12
- Sequences 1-15
  - Sequence Parameters 1-15
  - Sequence Local Variables 1-15
  - Lifetime of Local Variables, Parameters, and Custom Step Properties 1-16
  - Step Groups 1-16
  - Built-in Sequence Properties 1-17
- Sequence Files 1-17
  - Storage of Types in Files 1-17
- Process Models 1-17
  - Station Model 1-18
  - Main Sequence and Client Sequence File 1-18
  - Model Callbacks 1-19
  - Entry Points 1-19
- Automatic Result Collection 1-23
- Callback Sequences 1-23
  - Engine Callbacks 1-24
  - Front-End Callbacks 1-24
- Sequence Executions 1-25
  - Normal and Interactive Executions 1-25
  - Terminating and Aborting Executions 1-26

Chapter 2 Sequence Editor Concepts

Sequence Editor Screen 2-1
Windows 2-2
Views 2-2
Tabs 2-3
Lists and Trees 2-3
Context Menus 2-4
Copy, Cut, and Paste 2-4
Drag and Drop 2-5
Menu Bar 2-5
Toolbars 2-5
Status Bar 2-5
Sequence Editor Windows 2-6
Sequence File Window 2-6
Execution Window 2-6
Type Palette Window 2-7
Station Globals Window 2-8
Workspace Window 2-9
Users Window 2-14
Basic Tasks in TestStand 2-14
Creating a Sequence 2-14
Controlling Sequence Flow 2-18
Preconditions 2-19
Post Action 2-20
Goto Built-In Step Type 2-20
Run-Time Errors 2-21
Running a Sequence 2-21
Debugging a Sequence 2-22
Generating Test Reports 2-23
Using an Operator Interface 2-25

Chapter 3 Configuring and Customizing TestStand

Configuring TestStand 3-1
Sequence Editor Startup Options 3-1
Configure Menu 3-2
Customizing TestStand 3-3
TestStand Directory Structure 3-3
NI and User Subdirectories 3-4
The Components Directory 3-4

Creating String Resource Files 3-6
Resource String File Format 3-7
Using Data Types 3-8
Creating Step Types 3-8
Using the Tools Menu 3-9
Customizing the Engine and Front-End Callbacks 3-10
Modifying the Process Model 3-10
Using Process Model Callbacks 3-11
Creating Code Templates 3-11
Modifying Run-Time Operator Interfaces 3-12
Adding Users and Managing User Privileges 3-12

Chapter 4
Sequence Editor Menu Bar

Menus 4-1
File Menu 4-1
Login 4-2
Logout 4-2
New 4-2
Open 4-2
Close 4-2
New Workspace 4-2
Open Workspace 4-2
Save 4-3
Save As 4-3
Save All 4-3
Unload All Modules 4-3
Most Recently Opened Files 4-3
Exit 4-3
Edit Menu 4-4
Cut and Copy 4-4
Paste 4-4
Delete 4-4
Select All 4-5
Diff Sequence File With 4-5
Sequence Properties 4-5
Sequence File Properties 4-6
Sequence File Callbacks 4-6
View Menu 4-7
Station Globals 4-8
Type Palette 4-8
User Manager 4-8
Workspace 4-8

Paths 4-8
Find Type 4-12
Browse Sequence Context 4-13
Toolbars 4-14
Status Bar 4-14
Launch Report Viewer 4-14
Execute Menu 4-15
Execution Entry Point List 4-15
Run Active Sequence 4-15
Restart 4-15
Run Selected Steps 4-16
Run Selected Steps Using 4-16
Loop on Selected Steps 4-16
Loop on Selected Steps Using 4-17
Break On First Step 4-17
Tracing Enabled 4-18
Debug Menu 4-18
Resume 4-18
Step Over 4-18
Step Into 4-19
Step Out 4-19
Break 4-19
Terminate 4-19
Abort (no cleanup) 4-19
Break All 4-19
Terminate All 4-20
Abort All (no cleanup) 4-20
Resume All 4-20
Configure Menu 4-20
Sequence Editor Options 4-20
Station Options 4-21
Search Directories 4-34
External Viewers 4-35
Adapters 4-35
Report Options 4-35
Model Options 4-36
Source Control Menu 4-36
Tools Menu 4-37
Sequence File Documentation 4-37
Sequence File Converters 4-39
Update Sequence Files 4-39
Import/Export Properties 4-40
Update Automation Identifiers 4-40
Assemble Test VIs for Run-time Distribution 4-40

Run Engine Installation Wizard 4-40
Run Database Viewer 4-41
Customize 4-41
Window Menu 4-44
Cascade 4-44
Tile 4-44
Close All Windows 4-44
Close Completed Execution Displays 4-44
<List of Open Windows> 4-44

Chapter 5
Sequence Files

Sequence File Window Views 5-1
All Sequences View 5-2
Sequence View Context Menu 5-3
Open Sequence 5-3
Insert Sequence 5-3
Rename 5-3
Browse Sequence Context 5-3
View Contents 5-3
Sequence Properties 5-3
Sequence File Properties 5-6
Sequence File Callbacks 5-10
Individual Sequence View 5-11
Main, Setup, and Cleanup Tabs 5-11
Step Group List View and Tree View 5-12
Step Group List View Columns 5-13
Step Group Context Menu 5-15
Parameters Tab 5-31
Lifetime of Local Variables, Parameters, and Custom Step Properties 5-31
Parameters Tab Context Menu 5-32
Locals Tab 5-34
Lifetime of Local Variables, Parameters, and Custom Step Properties 5-35
Locals Tab Context Menu 5-35
Preconditions Dialog Box 5-38
Sequence File Globals View 5-41
Lifetime and Scope of Sequence File Global Variables 5-41
Sequence File Globals View Context Menu 5-42
Insert Global 5-43
View Contents 5-43
Go Up One Level 5-44

Browse Sequence Context 5-44
Rename 5-44
Properties 5-44
Sequence File Types View 5-45
Comparing and Merging Sequence Files 5-45

Chapter 6 Sequence Execution

Sequence Editor and Run-Time Operator Interfaces 6-1
What is an Execution? 6-1
Starting an Execution 6-2
Execution Entry Points 6-2
Executing a Sequence Directly 6-2
Interactively Executing Steps 6-3
Sequence Editor Execution Window 6-3
Steps Tab 6-4
Tracing 6-5
Debugging 6-5
Steps Tab Columns 6-5
Steps Tab Context Menu 6-6
Context Tab 6-7
Context Tab Context Menu 6-8
Report Tab 6-9
Call Stack Pane 6-11
Watch Expression Pane 6-12
Edit Expression 6-13
Add Watch 6-13
Modify Value 6-13
Refresh 6-14
Status Bar 6-14
Result Collection 6-15
Custom Result Properties 6-17
Standard Result Properties 6-18
Subsequence Results 6-19
Loop Results 6-21
Engine Callbacks 6-22
Step Execution 6-25
Step Status 6-27
Failures 6-28
Run-Time Errors 6-29

Chapter 7 Station Global Variables

Station Globals Window 7-1
    View Ring Control for Station Globals 7-2
Context Menu for the Globals View 7-2
        Insert Global 7-2
        View Contents 7-3
        Go Up One Level 7-3
        Browse Sequence Context 7-3
        Rename 7-3
        Global Variable Properties 7-3
        Reload Station Globals 7-3
Persistence 7-4
Special TestStand Station Globals 7-5

Chapter 8 Sequence Context and Expressions

Sequence Context 8-1
    Sequence Context Subproperties 8-3
        StationGlobals 8-3
        RunState 8-4
        RunState.SequenceFile and Other SequenceFile Objects 8-8
        RunState.Sequence and Other Sequence Objects 8-9
        RunState.Step and Other Step Objects 8-10
        RunState.InitialSelection 8-10
    Using the Sequence Context 8-12
Expressions 8-13

Chapter 9 Types

Creation, Modification, and Storage of Types 9-1
    Where You Create and Modify Types 9-1
    Storage of Types in Files and Memory 9-2
Using Data Types 9-4
    Specifying Array Sizes 9-6
        Dynamic Array Sizing 9-7
        Empty Arrays 9-8
    Display of Data Types 9-8
    Modifying Data Types and Values 9-10
        Single Values 9-10
        Arrays 9-12

Numeric Value Formats 9-12
Containers 9-15
Using the Standard Named Data Types 9-15
Path 9-16
Error and Common Results 9-16
Creating and Modifying Data Types 9-17
Custom Data Types Tab Tree and List Views 9-17
Value Field 9-19
Creating a New Custom Data Type 9-21
Adding Fields to Data Types 9-22
Properties Dialog Box for Custom Data Types 9-22
General Tab 9-23
Bounds Tab 9-24
Version Tab 9-25
Struct Passing Tab 9-25
Properties Dialog Box for Data Type Fields 9-26
Property Flags 9-27
Using Step Types 9-30
Creating and Modifying Custom Step Types 9-32
Custom Step Type Properties 9-33
Lifetime of Local Variables, Parameters, and Custom Step Properties 9-34
Built-In Step Type Properties 9-34
General Tab 9-36
Menu Tab 9-38
Substeps Tab 9-40
Disable Properties Tab 9-43
Code Templates Tab 9-44
Version Tab 9-51
Struct Passing Tab 9-51
Apply Changes to All Loaded Steps 9-51
View Changes 9-51
View Contents 9-51
Other Step Type Editing Features 9-52
Combining Step Types 9-52
Step Type Menu Editor 9-53
Type Palette Window 9-54

Chapter 10
Built-In Step Types

Overview 10-1
Custom Properties That Are Common to All Built-In Step Types 10-1
Step Status, Error Occurred Flag, and Run-Time Errors 10-3

Customizing Built-In Step Types 10-3
Step Types That You Can Use with Any Module Adapter 10-4
Action 10-4
Pass/Fail Test 10-5
Numeric Limit Test 10-7
Multiple Numeric Limit Test 10-11
String Value Test 10-15
Step Types That Work With a Specific Module Adapter 10-18
Sequence Call 10-18
Step Types That Do Not Use Module Adapters 10-20
Statement 10-20
Message Popup 10-21
Call Executable 10-26
Property Loader 10-28
Importing/Exporting Properties 10-28
Goto 10-29
Label 10-29

Chapter 11
Synchronization Step Types

Synchronization Objects 11-1
Common Attributes of Synchronization Objects 11-2
Synchronization Step Types 11-4
Lock 11-5
Create Operation 11-6
Lock Operation 11-7
Early Unlock Operation 11-9
Get Status Operation 11-10
Step Properties 11-11
Semaphore 11-12
Create Operation 11-12
Acquire Operation 11-14
Release Operation 11-15
Get Status Operation 11-16
Step Properties 11-17
Rendezvous 11-19
Create Operation 11-19
Rendezvous Operation 11-20
Get Status Operation 11-21
Step Properties 11-22
Queue 11-23
Create Operation 11-23
Enqueue Operation 11-25

Dequeue Operation 11-27
Flush Operation 11-30
Get Status Operation 11-31
Step Properties 11-33
Notification 11-35
Create Operation 11-35
Set Operation 11-37
Clear Operation 11-39
Pulse Operation 11-40
Wait Operation 11-41
Get Status Operation 11-45
Step Properties 11-46
Wait 11-48
Wait for Time Interval Operation 11-48
Wait for Time Multiple Operation 11-49
Wait for Thread Operation 11-50
Wait for Execution Operation 11-51
Retrieving the Results from Executions and Threads 11-52
Step Properties 11-52
Thread Priority 11-53
Set Thread Priority Operation 11-54
Get Thread Priority Operation 11-55
Step Properties 11-56
Batch Synchronization 11-56
Synchronized Sections 11-56
Requirements for Using Enter and Exit Operations 11-58
Enter Synchronized Section Operation 11-59
Exit Synchronized Section Operation 11-60
Step Properties 11-61
Batch Specification 11-62
Create Operation 11-62
Add Thread Operation 11-63
Remove Thread Operation 11-65
Get Status Operation 11-66
Step Properties 11-67

Chapter 12
User Management

User Manager Window 12-1
Users View 12-2
User List Tab 12-3
User List Context Menu 12-3

Profiles Tab 12-5
Profiles Tab Context Menu 12-6
Types View 12-7
User Standard Data Types 12-8
Adding New Properties and Privileges to the User Data Type 12-10
Verifying User Privileges 12-11
Accessing Privilege Settings for the Current User 12-11
Accessing Privilege Settings for Any User 12-12

Chapter 13 Module Adapters

Overview 13-1
Configuring Adapters 13-3
Source Code Templates 13-4
DLL Flexible Prototype Adapter 13-5
Configuring the DLL Adapter 13-5
Specifying a DLL Adapter Module 13-5
Module Tab 13-6
Editing the Function Call 13-11
Source Code Tab 13-12
Debugging DLLs 13-14
Debugging LabVIEW DLLs You Call with the Flexible DLL Adapter 13-15
Using MFC in a DLL 13-15
Loading Subordinate DLLs 13-16
LabVIEW Standard Prototype Adapter 13-16
LabVIEW Standard Prototype Adapter Module Structure 13-16
Test Data Cluster 13-17
Error Out Cluster 13-19
Input Buffer 13-20
Invocation Information 13-20
Sequence Context 13-21
Configuring the LabVIEW Standard Prototype Adapter 13-22
Specifying a LabVIEW Standard Prototype Adapter Module 13-24
Debugging a LabVIEW Standard Prototype Adapter Module 13-25
C/CVI Standard Prototype Adapter 13-27
C/CVI Standard Adapter Module Prototypes 13-27
Example C/CVI Standard Prototype Code Module 13-31
Specifying a C/CVI Standard Prototype Adapter Module 13-32
Configuring the C/CVI Standard Prototype Adapter 13-35
Executing Code Modules In-Process 13-36

Executing Code Modules in an External Instance of LabWindows/CVI ... 13-38
Loading Subordinate DLLs ... 13-39
Sequence Adapter ... 13-40
Specifying a Sequence Adapter Module ... 13-41
Multithreading and Remote Execution Settings ... 13-44
Setting up TestStand as a Server for Remote Execution ... 13-49
ActiveX Automation Adapter ... 13-51
Specifying an ActiveX Automation Adapter Module ... 13-51
Running and Debugging ActiveX Automation Servers ... 13-55
Configuring the ActiveX Automation Adapter ... 13-56
Using ActiveX Servers with TestStand ... 13-58
Registering a Server ... 13-58
Compatibility Issues with Visual Basic ... 13-58
HTBasic Adapter ... 13-60
Configuring the HTBasic Adapter ... 13-61
Specifying an HTBasic Adapter Module ... 13-62
Debugging an HTBasic Adapter Module ... 13-63
Passing Data To and Returning Data From a Subroutine ... 13-64

Chapter 14
Process Models

TestStand Process Models ... 14-1
Features Common to all TestStand Process Models ... 14-2
Sequential Model ... 14-2
Parallel and Batch Models ... 14-3
Parallel Model ... 14-4
Batch Model ... 14-6
Selecting the Default Process Model ... 14-9
Directory Structure for Process Model Files ... 14-9
Special Editing Capabilities for Process Model Sequence Files ... 14-10
Sequence Properties Model Tab ... 14-11
Normal Sequences ... 14-12
Callback Sequences ... 14-12
Entry Point Sequences ... 14-13

Chapter 15
Managing Reports

Implementation of the Test Report Capability ... 15-1
Using Test Reports ... 15-2
Failure Chain in Reports ... 15-5
Batch Reports ... 15-6

Report Options Dialog Box 15-6
Contents Tab 15-7
Report File Pathname Tab 15-10
Property Flags that Affect Reports 15-13

Chapter 16
Run-Time Operator Interfaces

Overview 16-1
TestStand Run-Time Operator Interfaces 16-2
LabWindows/CVI Run-Time Operator Interface 16-2
LabVIEW Run-Time Operator Interface 16-4
Building a Standalone Executable 16-4
Visual Basic Run-Time Operator Interface 16-5
Delphi Run-Time Operator Interface 16-7
Distributing a Run-Time Operator Interface 16-8

Chapter 17
Distributing TestStand

Creating a Run-Time TestStand Engine Installation 17-1
Using a Custom TestStand Engine Installation 17-5
Distributing your Operator Interface 17-7
Installing the Customized Engine 17-7
LabVIEW 17-7
LabWindows/CVI 17-7
Visual Basic 17-8
Delphi 17-9
Distributing Sequences and Code Modules 17-9
Distributing Sequence Files 17-9
Distributing DLL Code Modules 17-9
Distributing DLLs Called By LabVIEW VIs 17-10
Distributing Object and Static Library Code Modules 17-10
Distributing LabVIEW Test VIs 17-11
Packaging VIs and SubVIs for a Sequence File 17-12
Distributing VIs by Saving Them without Full Hierarchy 17-13
Distributing VIs by Saving Them with Full Hierarchy 17-14
Distributing ActiveX Automation Code Modules 17-14
Customizing and Distributing a LabVIEW Run-Time Server 17-15
Rebuilding the TestStand LabVIEW Run-Time Server 17-16
Distributing the TestStand LabVIEW Run-Time Server 17-16

Chapter 18 Databases

Database Concepts ... 18-1
- Databases and Tables ... 18-1
- Database Sessions ... 18-2
- Microsoft ADO, OLE DB, and ODBC Database Technologies ... 18-3
- Data Links ... 18-5
- Database Logging Implementation ... 18-6

Using Database Logging ... 18-7
- Database Options Dialog Box ... 18-8
  - Logging Options Tab ... 18-9
  - Data Link Tab ... 18-10
  - Schemas Tab ... 18-12
  - Statements Tab ... 18-14
  - Columns/Parameters Tab ... 18-17
- Logging Property in the Sequence Context ... 18-20

TestStand Database Result Tables ... 18-22
- Default TestStand Table Schema ... 18-22
- Creating the Default Result Tables ... 18-29
- Adding Support for Other Database Management Systems ... 18-30

Database Viewer ... 18-31
- Menus ... 18-33
  - File Menu ... 18-33
  - Options Menu ... 18-34
  - SQL Menu ... 18-34
  - Windows Menu ... 18-34

Using Data Links ... 18-34
- Data Link Properties Dialog Box ... 18-35
  - Provider Tab ... 18-35
  - Connection Tab ... 18-37
  - Advanced Tab ... 18-38
  - All Tab ... 18-39

Using the ODBC Administrator ... 18-39
- Third-Party ODBC Database Drivers ... 18-42
- Example Data Link and Result Table Setup for Microsoft Access ... 18-42
  - Database Options—Specifying a Data Link and Schema ... 18-43
  - Database Viewer—Creating Result Tables ... 18-43

Built-In Database Step Types ... 18-44
- Using the Select Data Link Dialog Box ... 18-45
- Open Database ... 18-48
  - Data Link Tab ... 18-49
  - Custom Properties ... 18-50

Close Database 18-50
Custom Properties 18-51
Open SQL Statement 18-52
SQL Statement Tab 18-52
Advanced Tab 18-54
Custom Properties 18-57
Close SQL Statement 18-58
Custom Properties 18-59
Data Operation 18-59
Record/Operation Tab 18-60
Column Values Tab 18-62
Custom Properties 18-64
Property Loader 18-65
Loading From File 18-66
Properties Tab 18-67
Source Tab 18-68
Loading From Database 18-69
Properties Tab 18-71
Filtering Tab 18-74
Custom Properties 18-75
Importing/Exporting Properties 18-78
Source/Destination Tab 18-78
Importing/Exporting Using Files or Clipboard 18-79
Properties Tab 18-82
Additional Columns Tab 18-83
Structured Query Language (SQL) 18-85
SQL Commands 18-86
SQL Objects 18-87
SQL Clauses 18-88
SQL Operators 18-89
SQL Functions 18-91
Format Strings 18-93
Date/Time Format Strings 18-93
Numeric Format Strings 18-96

Appendix A
Technical Support Resources

Glossary

Index

Figures

Figure 1-1. TestStand System Architecture 1-4
Figure 1-2. Expression Browser Dialog Box 1-9
Figure 1-3. Flowchart of Test UUTs Sequence in the Default Process Model 1-20
Figure 1-4. Test UUTs Entry Point Sequence in the Default TestStand Process Model 1-21
Figure 1-5. List of All Sequences in TestStand Process Model 1-22

Figure 2-1. Example Sequence Editor Screen 2-2
Figure 2-2. Example Sequence File Window 2-6
Figure 2-3. Example Execution Window 2-7
Figure 2-4. Type Palette Window 2-8
Figure 2-5. Example Station Globals Window 2-8
Figure 2-6. Workspace Window 2-10
Figure 2-7. Users Window 2-14
Figure 2-8. Main Step Group in an Example Sequence 2-15
Figure 2-9. Insert Step Submenu 2-15
Figure 2-10. Step Properties Dialog Box 2-17
Figure 2-11. Preconditions Dialog Box 2-19
Figure 2-12. HTML Report for an Example Sequence 2-24

Figure 4-1. File Menu 4-1
Figure 4-2. Edit Menu 4-4
Figure 4-3. Sequence Properties Dialog Box 4-5
Figure 4-4. Sequence File Properties Dialog Box 4-6
Figure 4-5. Sequence File Callbacks Dialog Box 4-7
Figure 4-6. View Menu 4-7
Figure 4-7. Edit Paths in Files Dialog Box 4-9
Figure 4-8. Edit Paths Dialog Box 4-10
Figure 4-9. Find Type Dialog Box 4-12
Figure 4-10. Browse Variables and Properties in Sequence Context Dialog Box 4-13
Figure 4-11. Execute Menu 4-15
Figure 4-12. Loop on Selected Steps Dialog Box—Loop Count Tab 4-16
Figure 4-13. Loop on Selected Steps Dialog Box—Stop Expression Tab 4-17
Figure 4-14. Debug Menu 4-18
Figure 4-15. Configure Menu 4-20
Figure 4-16. Execution Options 4-22
Figure 4-17. Time Limits Options 4-25
Figure 4-18. Preferences Options 4-27
Figure 4-19. Model Options 4-29
Figure 4-20. User Manager Options 4-30
Figure 4-21. Localization Options 4-31
Figure 4-22. Source Control Options 4-32

Figure 4-23. Search Directories Dialog Box 4-34
Figure 4-24. Source Control Menu 4-36
Figure 4-25. Tools Menu 4-37
Figure 4-26. Customize Tool Menu Dialog Box 4-41
Figure 4-27. Export Tools Menu Dialog Box 4-43
Figure 4-28. Window Menu 4-44

Figure 5-1. View Ring Control for Sequence Files 5-2
Figure 5-2. All Sequences View in the Sequence File Window 5-2
Figure 5-3. Sequence Properties Dialog Box 5-4
Figure 5-4. General Tab in the Sequence File Properties Dialog Box 5-6
Figure 5-5. Advanced Tab in the Sequence File Properties Dialog Box 5-8
Figure 5-6. Synchronization Tab in the Step Properties Dialog Box 5-9
Figure 5-7. Callbacks Dialog Box 5-10
Figure 5-8. Individual Sequence View for an Example Sequence 5-11
Figure 5-9. Step Group Tree View (Left) and List View (Right) 5-12
Figure 5-10. Step Group List View Columns for Steps 5-13
Figure 5-11. Step Group List View Columns for Step Properties 5-14
Figure 5-12. Insert Step Menu with LabVIEW Standard Prototype Adapter Selected 5-15
Figure 5-13. General Tab in the Step Properties Dialog Box 5-20
Figure 5-14. Run Options Tab in the Step Properties Dialog Box 5-21
Figure 5-15. Post Actions Tab in the Step Properties Dialog Box 5-25
Figure 5-16. Loop Options Tab in the Step Properties Dialog Box 5-27
Figure 5-17. Synchronization Tab in the Step Properties Dialog Box 5-29
Figure 5-18. Expressions Tab in the Step Properties Dialog Box 5-30
Figure 5-19. Parameters Tab 5-31
Figure 5-20. Insert Parameter Submenu 5-32
Figure 5-21. Locals Tab 5-35
Figure 5-22. Insert Local Submenu 5-36
Figure 5-23. Preconditions Dialog Box for a Sequence 5-38
Figure 5-24. Sequence File Globals View for an Example Sequence 5-41
Figure 5-25. Insert Global Submenu 5-43
Figure 5-26. Step Types Tab in Sequence File Types View 5-45
Figure 5-27. Differ Window 5-46

Figure 6-1. Steps Tab in the Sequence Editor Execution Window 6-4
Figure 6-2. Context Tab in an Execution Window 6-8
Figure 6-3. HTML Report for an Example Sequence 6-10
Figure 6-4. Call Stack Pane while Suspended in a Subsequence 6-11
Figure 6-5. Steps Tab Displaying a Sequence Invocation in the Middle of the Call Stack 6-12
Figure 6-6. Watch Expression Pane 6-13
Figure 6-7. Execution Window Status Bar 6-14

Figure 6-8. A Result in a ResultList Array 6-16
Figure 6-9. Run-Time Error Dialog Box 6-30

Figure 7-1. Station Globals Window 7-1
Figure 7-2. Insert Global Submenu 7-2

Figure 8-1. Variables/Properties Tab of the Expression Browser 8-14
Figure 8-2. Operators/Functions Tab of the Expression Browser 8-15

Figure 9-1. Type Conflict In File Dialog Box 9-3
Figure 9-2. Insert Local Submenu 9-5
Figure 9-3. Initial State of Array Bounds Dialog Box 9-6
Figure 9-4. Array Bounds Dialog Box with Settings for a Three-Dimensional Array 9-7
Figure 9-5. Array Bounds Dialog Box with an Initially Empty Array 9-8
Figure 9-6. Local Variables with Various Data Types 9-9
Figure 9-7. Properties Dialog Box for a Number Local Variable 9-11
Figure 9-8. Contents of Array Local Variable in List View 9-12
Figure 9-9. Numeric Format Dialog Box 9-13
Figure 9-10. Standard Data Types Tab of the Type Palette Window 9-16
Figure 9-11. Custom Data Types Tab with Root Node Selected 9-18
Figure 9-12. Custom Data Types Tab Showing the Contents of a Container 9-19
Figure 9-13. Custom Data Types Tab Showing the Value Field for a Number 9-20
Figure 9-14. Modify Numeric Value Dialog Box 9-20
Figure 9-15. Insert Custom Data Type Submenu 9-21
Figure 9-16. Insert Fields Submenu 9-22
Figure 9-17. Properties Dialog Box for a Numeric Data Type 9-23
Figure 9-18. Edit Flags Dialog Box 9-27
Figure 9-19. Edit Data Type Flags Dialog Box 9-29
Figure 9-20. Insert Step Submenu 9-30
Figure 9-21. Step Types Tab of the Type Palette Window 9-32
Figure 9-22. Custom Properties of a Step Type 9-33
Figure 9-23. Step Type Properties Dialog Box—General Tab 9-36
Figure 9-24. Step Type Properties Dialog Box—Menu Tab 9-39
Figure 9-25. Step Type Properties Dialog Box—Substeps Tab 9-41
Figure 9-26. Step Type Properties Dialog Box—Disable Properties Tab 9-43
Figure 9-27. Step Type Properties Dialog Box—Code Templates Tab 9-47
Figure 9-28. Create Code Templates Dialog Box 9-48
Figure 9-29. Edit Code Template Dialog Box 9-49
Figure 9-30. Combine with Step Type Operation 9-52
Figure 9-31. Step Type Menu Editor Dialog Box 9-53
Figure 9-32. Type Palette Window—Palette Ring 9-55
Figure 9-33. Configure Type Palettes Dialog Box 9-55

Figure 10-1. Properties That All Steps Contain 10-2
Figure 10-2. Edit Pass/Fail Source Dialog Box 10-6
Figure 10-3. Pass/Fail Test Step Properties 10-6
Figure 10-4. Limits Tab in Edit Numeric Limit Test Dialog Box 10-7
Figure 10-5. Data Source Tab in the Edit Numeric Limit Test Dialog Box 10-9
Figure 10-6. Numeric Limit Test Step Properties 10-10
Figure 10-7. Edit Multiple Numeric Limit Test Dialog Box 10-12
Figure 10-8. Multiple Numeric Limit Test Properties 10-13
Figure 10-9. Multiple Numeric Limit TestData Source Tab with Array Data Source 10-14
Figure 10-10. Multiple Numeric Limit TestData Source Tab with Multiple Data Sources 10-15
Figure 10-11. Limits Tab in the Edit String Value Test Dialog Box 10-16
Figure 10-12. Data Source Tab in Edit String Value Test Dialog Box 10-17
Figure 10-13. String Value Test Step Properties 10-17
Figure 10-14. Specify Module Dialog Box for Sequence Call Step 10-19
Figure 10-15. Edit Statement Step Dialog Box 10-21
Figure 10-16. Configure Message Box Step Dialog Box—Text and Buttons Tab 10-22
Figure 10-17. Configure Message Box Step Dialog Box—Options Tab 10-23
Figure 10-18. Message Popup Step Properties 10-24
Figure 10-19. Configure Call Executable Dialog Box 10-26
Figure 10-20. Call Executable Step Properties 10-27
Figure 10-21. Edit Goto Step Dialog Box 10-29
Figure 10-22. Label Step Properties 10-30

Figure 11-1. Create Operation for Lock Step Configuration Dialog Box 11-6
Figure 11-2. Lock Operation for Lock Step Configuration Dialog Box 11-7
Figure 11-3. Get Early Unlock Operation for Lock Step Configuration Dialog Box 11-9
Figure 11-4. Get Status Operation for Lock Step Configuration Dialog Box 11-10
Figure 11-5. Lock Step Properties 11-11
Figure 11-6. Create Operation for Semaphore Step Configuration Dialog Box 11-13
Figure 11-7. Acquire Operation for Semaphore Step Configuration Dialog Box 11-14
Figure 11-8. Release Operation for Semaphore Step Configuration Dialog Box 11-15
Figure 11-9. Get Status Operation for Semaphore Step Configuration Dialog Box 11-16
Figure 11-10. Semaphore Step Properties 11-17
Figure 11-11. Create Operation for Rendezvous Step Configuration Dialog Box 11-19
Figure 11-12. Rendezvous Operation for Rendezvous Step Configuration Dialog Box 11-20
Figure 11-13. Get Status Operation for Rendezvous Step Configuration Dialog Box 11-21
Figure 11-14. Rendezvous Step Properties 11-22
Figure 11-15. Create Operation for Queue Step Configuration Dialog Box 11-24

Figure 11-16. Enqueue Operation for Queue Step Configuration Dialog Box 11-25
Figure 11-17. Dequeue Operation for Queue Step Configuration Dialog Box 11-27
Figure 11-18. Flush Operation for Queue Step Configuration Dialog Box 11-30
Figure 11-19. Get Status Operation for Queue Step Configuration Dialog Box......... 11-31
Figure 11-20. Queue Step Properties.. 11-33
Figure 11-21. Create Operation for Notification Step Configuration Dialog Box 11-36
Figure 11-22. Set Operation for Notification Step Configuration Dialog Box 11-37
Figure 11-23. Clear Operation for Notification Step Configuration Dialog Box........ 11-39
Figure 11-24. Pulse Operation for Notification Step Configuration Dialog Box........ 11-40
Figure 11-25. Wait Operation for Notification Step Configuration Dialog Box......... 11-42
Figure 11-26. Get Status Operation for Notification Step Configuration Dialog Box 11-45
Figure 11-27. Notification Step Properties 11-46
Figure 11-28. Wait for Time Interval Operation for Wait Step Configuration Dialog Box.. 11-48
Figure 11-29. Wait for Time Multiple Operation for Wait Step Configuration Dialog Box.. 11-49
Figure 11-30. Wait for Thread Operation for Wait Step Configuration Dialog Box 11-50
Figure 11-31. Wait for Execution Operation for Wait Step Configuration Dialog Box 11-51
Figure 11-32. Wait Step Properties 11-52
Figure 11-33. Set Thread Priority Operation for Thread Priority Configuration Dialog Box.. 11-54
Figure 11-34. Get Thread Priority Operation for Thread Priority Configuration Dialog Box.. 11-55
Figure 11-35. Thread Priority Step Properties.. 11-56
Figure 11-36. Enter Operation for Batch Synchronization Step Configuration Dialog Box.. 11-59
Figure 11-37. Exit Operation for Batch Synchronization Step Configuration Dialog Box.. 11-60
Figure 11-38. Batch Synchronization Step Properties.. 11-61
Figure 11-39. Create Operation for Batch Specification Step Configuration Dialog Box.. 11-62
Figure 11-40. Add Thread Operation for Batch Specification Step Configuration Dialog Box.. 11-64
Figure 11-41. Remove Thread Operation for Batch Specification Step Configuration Dialog Box.. 11-65
Figure 11-42. Get Status Operation for Batch Specification Step Configuration Dialog Box.. 11-66
Figure 11-43. Batch Specification Step Properties... 11-67

Figure 12-1. Users View in the User Manager Window 12-2
Figure 12-2. User List Tab for Users View 12-3

Figure 12-3. Insert New User Dialog Box 12-4
Figure 12-4. Edit User Dialog Box 12-5
Figure 12-5. Profile Tab in the Users View 12-6
Figure 12-6. Types View in the User Manager Window 12-7
Figure 12-7. User Standard Data Type 12-8

Figure 13-1. Adapter Configuration Dialog Box 13-3
Figure 13-2. Choose Code Template Dialog Box 13-4
Figure 13-3. Specify Module Dialog Box for DLL Flexible Prototype Adapter—Module Tab 13-6
Figure 13-4. Specify Module Dialog Box for DLL Flexible Prototype Adapter—Source Code Tab 13-12
Figure 13-5. Test Data Cluster 13-17
Figure 13-6. Standard Error Out Cluster 13-19
Figure 13-7. Invocation Information Cluster 13-20
Figure 13-8. Sequence Context Control 13-21
Figure 13-9. LabVIEW Adapter Configuration Dialog Box 13-22
Figure 13-10. Specify Module Dialog Box for LabVIEW Standard Prototype Adapter 13-24
Figure 13-11. Stepping into a LabVIEW VI 13-26
Figure 13-12. Specify Module Dialog Box for C/CVI Standard Prototype Adapter—Module Tab 13-32
Figure 13-13. Specify Module Dialog Box for C/CVI Standard Prototype Adapter—Source Code Tab 13-34
Figure 13-14. C/CVI Standard Adapter Configuration Dialog Box 13-36
Figure 13-15. Auto-Load Library Configuration Dialog Box 13-37
Figure 13-16. Example Sequence Parameters 13-40
Figure 13-17. Specify Module Dialog Box for the Sequence Adapter—Edit Sequence Call Tab 13-41
Figure 13-18. Thread Settings Dialog Box 13-44
Figure 13-19. Execution Settings Dialog Box 13-45
Figure 13-20. Remote Execution Settings Dialog Box 13-47
Figure 13-21. Specify Module Dialog Box for ActiveX Automation Adapter 13-51
Figure 13-22. Edit <parameter> Value Dialog Box 13-54
Figure 13-23. Automation Adapter Configuration Dialog Box 13-56
Figure 13-24. HTBasic Adapter Configuration Dialog Box 13-61
Figure 13-25. Specify Module Dialog Box for HTBasic Adapter 13-62

Figure 14-1. The Model Options Dialog Box 14-3
Figure 14-2. Parallel Model Test UUTs Dialog Box 14-5
Figure 14-3. Batch UUT Identification Dialog Box 14-7
Figure 14-4. Batch Results Dialog Box 14-8
Figure 14-5. Process Model Settings on the Advanced Tab of the Sequence File Dialog Box 14-11

Figure 14-6. Type Ring Control in the Sequence Properties Model Tab 14-12
Figure 14-7. Model Tab for an Execution Entry Point Sequence............................. 14-14

Figure 15-1. HTML Test Report on the Report Tab 15-3
Figure 15-2. ASCII-Text Test Report on the Report Tab.. 15-4
Figure 15-3. Failure Chain in HTML Report 15-5
Figure 15-4. Example Batch Report 15-6
Figure 15-5. Report Options Dialog Box—Contents Tab 15-7
Figure 15-6. Report Options Dialog Box—Report File Pathname Tab 15-10

Figure 17-1. Opening Dialog Box for the TestStand Engine Installation Wizard..... 17-2
Figure 17-2. Installation Wizard: Default Components to Include 17-3
Figure 17-3. Customize Files to Include in Installation Dialog Box 17-3
Figure 17-4. Select Files to Include Dialog Box 17-4
Figure 17-5. Select MDAC Installer Dialog Box 17-5

Figure 18-1. Microsoft Windows Database Technologies 18-4
Figure 18-2. Database Options Dialog Box—Logging Options Tab 18-9
Figure 18-3. Database Options Dialog Box—Data Link Tab 18-11
Figure 18-4. Database Options Dialog Box—Schemas Tab 18-13
Figure 18-5. Database Options Dialog Box—Statements Tab 18-14
Figure 18-6. Database Options Dialog Box—Columns/Parameters Tab 18-18
Figure 18-7. Subproperties of the Logging Property 18-21
Figure 18-8. Database Viewer Main Window 18-32
Figure 18-9. Data Link Properties Dialog Box—Provider Tab 18-35
Figure 18-10. Data Link Properties Dialog Box—Connection Tab 18-37
Figure 18-11. Data Link Properties Dialog Box—Advanced Tab 18-38
Figure 18-12. Data Link Properties Dialog Box—All Tab 18-39
Figure 18-13. ODBC Data Source Administrator Dialog Box—User DSN Tab 18-40
Figure 18-14. ODBC Microsoft Access 97 Setup Dialog Box.................................. 18-41
Figure 18-15. ODBC Data Source Administrator Dialog Box—Drivers Tab............ 18-42
Figure 18-16. Build SQL Select Statement Dialog Box 18-46
Figure 18-17. Select Data Link Dialog Box 18-46
Figure 18-18. Edit Data Link Dialog Box 18-47
Figure 18-19. Edit Open Database dialog box—Data Link Tab 18-49
Figure 18-20. Edit Close Database Dialog Box.. 18-51
Figure 18-21. Edit Open SQL Statement dialog box—SQL Statement Tab 18-52
Figure 18-22. Build SQL Select Statement Dialog Box 18-53
Figure 18-23. Edit Open SQL Statement Dialog Box—Advanced Tab..................... 18-55
Figure 18-24. Edit Close SQL Statement Dialog Box 18-58
Figure 18-25. Data Operation Dialog Box—Record/Operation Tab.......................... 18-60
Figure 18-26. Data Operation Dialog Box—Column Values Tab 18-62
Figure 18-27. Edit Property Loader Dialog Box—Properties Tab............................. 18-67
Figure 18-28. Edit Property Loader Dialog Box—Source Tab 18-68

Figure 18-29. Property Loader Dialog Box—Properties Tab....................................18-71
Figure 18-30. Create Columns Dialog Box..18-73
Figure 18-31. Property Loader Dialog Box—Column Values Tab 18-74
Figure 18-32. Import/Export Properties Dialog Box—Source/Destination Tab for File..18-79
Figure 18-33. Import/Export Properties Dialog Box—Source/Destination Tab for Databases 18-81
Figure 18-34. Import/Export Properties Dialog Box—Properties Tab.......................18-82
Figure 18-35. Import/Export Properties Dialog Box—Additional Columns Tab........18-84

Tables

Table 1-1. Callback Types 1-23

Table 2-1. Mouse and Keyboard Actions for Navigating List and Tree Views 2-3
Table 2-2. Standard Values for the Status Property after Execution Completes....2-18

Table 3-1. Sequence Editor Startup Options 3-1
Table 3-2. TestStand Subdirectories...3-3
Table 3-3. TestStand Component Subdirectories 3-5
Table 3-4. Resource String File Escape Codes..3-8

Table 6-1. Custom Properties in the Step Results for Steps That Use the Built-In Step Types 6-17
Table 6-2. Standard Step Result Properties 6-18
Table 6-3. Property Names for Subsequence Results...6-19
Table 6-4. Engine Callbacks...6-22
Table 6-5. Order of Actions That a Step Performs..6-25
Table 6-6. Standard Values for the Status Property...6-27

Table 7-1. Status of Station Globals in Various Contexts 7-4

Table 8-1. First-Level Properties of a Sequence Context......................................8-2
Table 8-2. StationGlobals TS Subproperty in the Sequence Context.....................8-3
Table 8-3. RunState Subproperty in the Sequence Context..................................8-4
Table 8-4. Subproperties of the SequenceFile Objects in the Sequence Context...8-8
Table 8-5. Subproperties of the Sequence Objects in the Sequence Context 8-9
Table 8-6. InitialSelection Subproperty in the Sequence Context..........................8-11
Table 8-7. Expression Operators 8-16
Table 8-8. Function Expression Operators 8-17
Table 8-9. Levels of Precedence in Expressions 8-21

Table 9-1. Graphical Interfaces Where you Access Data Types and Step Types 9-1
Table 9-2. Creating Data Type Instances from Context Menus 9-4
Table 9-3. Adapter Dialog Box Names 9-31
Table 9-4. Creation of Types 9-57

Table 10-1. Numeric Limit Test Comparison Types 10-7

Table 11-1. Dequeue Behaviors for Data You Enqueue by Value 11-28
Table 11-2. Dequeue Behaviors for Data You Enqueue by Reference 11-29
Table 11-3. Wait Behaviors for Data Set or Pulsed by Value 11-43
Table 11-4. Wait Behaviors for Data Set or Pulsed by Reference 11-44

Table 12-1. Description of Subproperties in User Data Type 12-8

Table 13-1. Specific Names of the Specify Module Dialog Boxes 13-2
Table 13-2. TestStand Numeric Data Types 13-8
Table 13-3. TestStand String Data Types 13-9
Table 13-4. Adapter Interpretation of Ambiguous Declarations 13-13
Table 13-5. Options for Stepping Out of LabWindows/CVI DLL Functions 13-15
Table 13-6. Test Data Cluster Elements 13-18
Table 13-7. Old Test Data Cluster Elements from LabVIEW Test Executive 13-19
Table 13-8. Error Out Cluster Elements 13-20
Table 13-9. Error Out Cluster Elements 13-21
Table 13-10. tTestData Structure Member Fields 13-27
Table 13-11. tTestError Structure Member Fields 13-29
Table 13-12. Step Properties Updated by C/CVI Standard Prototype Adapter 13-30
Table 13-13. Path Resolution of Sequence Pathnames for Remotely Executed Steps 13-48
Table 13-14. Variant Data Types Supported by the ActiveX Automation Adapter 13-55
Table 13-15. HTBasic routines for Accessing TestStand Properties 13-64

Table 14-1. TestStand Process Models 14-1

Table 16-1. Files in the LabWindows/CVI Run-Time Operator Interface Project File 16-2
Table 16-2. Top-Level Files in the LabVIEW Run-Time Operator Interface 16-4
Table 16-3. Top-Level Files in the Visual Basic Run-Time Operator Interface 16-5
Table 16-4. Top-Level Files in the Delphi Run-Time Operator Interface 16-7

Table 17-1. Custom TestStand Engine Installer Actions 17-6

Table 18-1. Example Database Table 18-2
Table 18-2. UUT_RESULT Table Schema 18-23
Table 18-3. STEP_RESULT Table Schema 18-23
Table 18-4. STEP_CALLEXE Table Schema 18-25
Table 18-5. STEP_MSGPOPUP Table Schema 18-25
Table 18-6. STEP_PASSFAIL Table Schema 18-25
Table 18-7. STEP_STRINGVALUE Table Schema 18-26
Table 18-8. STEP_PROPERTYLOADER Table Schema 18-26
Table 18-9. STEP_SEQCALL Table Schema 18-27
Table 18-10. MEAS_NUMERICLIMIT Table Schema 18-27
Table 18-11. MEAS_SINGLEPOINT Table Schema 18-28
Table 18-12. MEAS_WAVE Table Schema 18-28
Table 18-13. MEAS_WAVEPAIR Table Schema 18-29
Table 18-14. Example Data for Property Loader Step 18-70
Table 18-15. SQL Commands 18-86
Table 18-16. SQL Objects 18-87
Table 18-17. SQL Clauses 18-88
Table 18-18. SQL Operators 18-89
Table 18-19. SQL Functions 18-91
Table 18-20. Example Format Strings 18-93
Table 18-21. Symbols for Date/Time Format Strings 18-93
Table 18-22. Symbols for Numeric Format Strings 18-96

1 TestStand Architecture Overview

This chapter describes the TestStand architecture and provides an overview of important TestStand concepts and components. This chapter also introduces many terms and features that later chapters discuss in more detail. It is a good idea to become familiar with the contents of this chapter before proceeding to other chapters in the manual.

Getting Started with TestStand contains brief descriptions of TestStand components and the installation instructions for TestStand. It is a good idea to read *Getting Started with TestStand* before you read this manual. For a brief description of the TestStand sequence editor and how you perform basic tasks in it, refer to Chapter 2, *Sequence Editor Concepts*.

General Test Executive Concepts

A test executive is a program in which you can organize and execute sequences of reusable test modules. The test modules often have a standard interface. Ideally, a test executive permits you to create the modules in a variety of programming environments.

This document uses a number of concepts that are applicable to test executives in general and some that are unique to the TestStand Test Executive. The following concepts are applicable to test executives in general.

- *Code module*—A program module, such as a Windows dynamic link library (`.dll`) or LabVIEW VI (`.vi`), containing one or more functions that perform a specific test or other action.
- *Test module*—A code module that performs a test.
- *Step*—An individual element of a test sequence. A step may call step modules or perform other operations.
- *Step module*—The code module that a step calls.

- *Sequence*—A series of steps you specify for execution in a particular order. Whether and when a step is executed can depend on the results of previous steps.
- *Subsequence*—A sequence that another sequence calls. You specify a subsequence call as a step in the calling sequence.
- *Sequence file*—A file that contains the definition of one or more sequences.
- *Sequence editor*—A program that provides a graphical user interface for creating, editing, and debugging sequences.
- *Run-time operator interface*—A program that provides a graphical user interface for executing sequences on a production station. A sequence editor and run-time operator interface can be separate application programs or different aspects of the same program.
- *Test executive engine*—A module or set of modules that provide an application programming interface (API) for creating, editing, executing, and debugging sequences. A sequence editor or run-time operator interface uses the services of a test executive engine.
- *Application Development Environment (ADE)*—A programming environment such as LabVIEW, LabWindows/CVI, or Microsoft Visual C/C++, in which you can create test modules and run-time operator interfaces.
- *Unit Under Test (UUT)*—The device or component that you are testing.

TestStand Capabilities and Concepts

TestStand is a flexible, powerful test executive framework that has the following major features:

- Out-of-the-box configuration and components that give you a ready-to-run, full-featured test executive.
- Numerous methods for you to modify the out-of-the-box configuration and components or to add new components. These extensibility mechanisms enable you to create the test executive that meets your particular requirements without modifying the TestStand test execution engine. You can upgrade to newer versions of TestStand without losing your customizations.
- Sophisticated sequencing, execution, and debugging capabilities and a powerful sequence editor that is separate from the run-time operator interfaces.

- Four separate run-time operator interfaces with source code for LabVIEW, LabWindows/CVI, Visual Basic, and Delphi.
- Independence from particular ADEs. You can create test modules in a wide variety of ADEs and call preexisting modules or executables. You can create your own run-time operator interface in any programming language that can control ActiveX automation servers.
- Conversion of sequence files from the LabVIEW Test Executive Toolkit Version 2.0 or the LabWindows/CVI Test Executive Toolkit Version 2.0 to TestStand.
- Comprehensive ActiveX API for building multithreaded test executives and other sequencing applications.

To provide these features, TestStand expands on the traditional test executive concepts and introduces many new ones. The new concepts include *step types*, *step properties*, *sequence variables*, *sequence parameters*, *module adapters*, and *process models*.

The remainder of this chapter consists of two major sections that introduce the new concepts as well as the enhancements to the traditional concepts. The first section discusses the major software components of TestStand. The second section discusses the features and building blocks in TestStand that you use to create test sequences and entire test systems.

Major Software Components of TestStand

This section provides an overview of the major software components of TestStand.

Figure 1-1 shows the high-level relationships between elements of the TestStand system architecture.

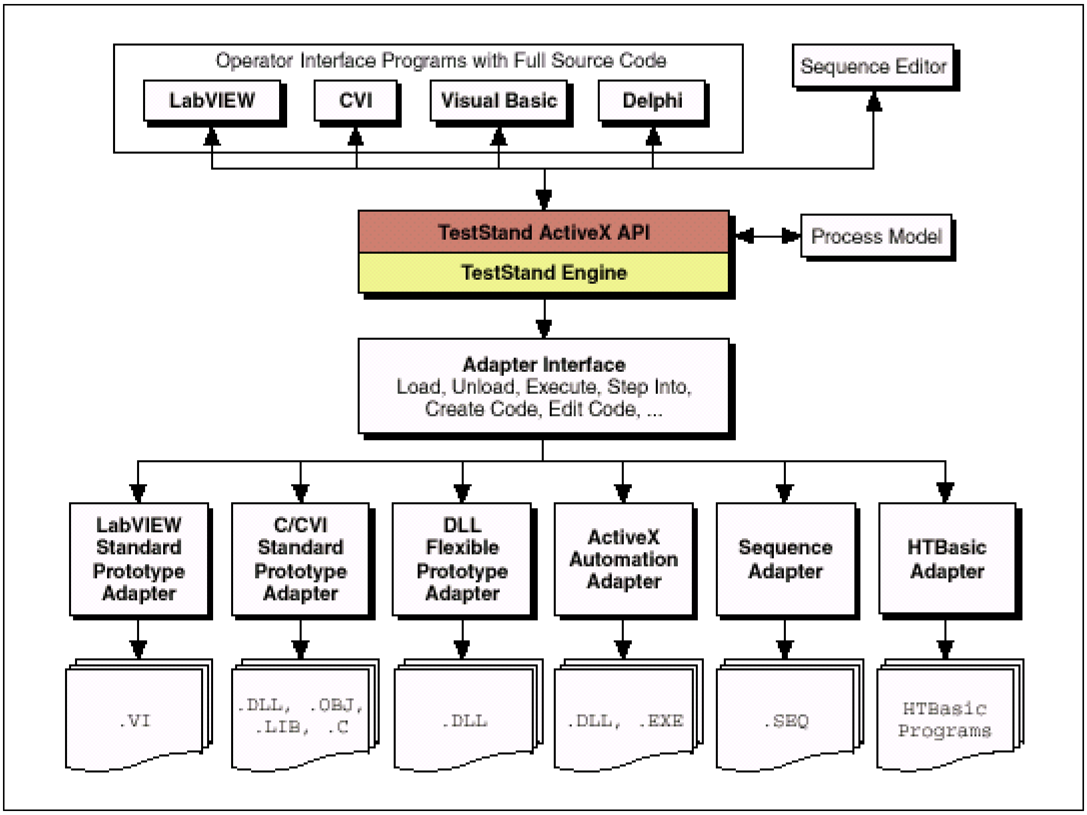

Operator Interface Programs with Full Source Code
LabVIEW
CVI
Visual Basic
Delphi
Sequence Editor
TestStand ActiveX API
TestStand Engine
Process Model
Adapter Interface
Load, Unload, Execute, Step Into, Create Code, Edit Code, ...
LabVIEW Standard Prototype Adapter
C/CVI Standard Prototype Adapter
DLL Flexible Prototype Adapter
ActiveX Automation Adapter
Sequence Adapter
HTBasic Adapter
.VI
.DLL, .OBJ, .LIB, .C
.DLL
.DLL, .EXE
.SEQ
HTBasic Programs

Figure 1-1. TestStand System Architecture

As shown in Figure 1-1, the TestStand engine plays a pivotal role in the TestStand architecture. The TestStand engine can run sequences. Sequences contain steps that can call external code modules. By using module adapters that have a standard adapter interface, the TestStand engine can load and execute different types of code modules. TestStand sequences can call subsequences through the same adapter interface. TestStand uses a special type of sequence called a process model to direct the high-level sequence flow. The TestStand engine exports an ActiveX

Automation API that the TestStand sequence editor and run-time operator interfaces use.

TestStand Sequence Editor

The TestStand sequence editor is an application program in which you create, modify, and debug sequences. The sequence editor gives you easy access to all the powerful TestStand features, such as step types and process models. The sequence editor has the debugging tools you are familiar with in ADEs such as LabVIEW, LabWindows/CVI, and Microsoft Visual C/C++. These debugging tools include breakpoints, single-stepping, stepping into or over function calls, tracing, a variable display, and a watch window.

In the TestStand sequence editor, you can start multiple concurrent executions. You can execute multiple instances of the same sequence, and you can execute different sequences at the same time. Each execution instance has its own Execution window. In trace mode, the Execution window displays the steps in the currently executing sequence. When execution is suspended, the Execution window displays the next step to execute and provides single-stepping options.

TestStand Run-Time Operator Interfaces

Your TestStand software includes four run-time operator interfaces in source and executable form. Each run-time operator interface is a separate application program. The operator interfaces differ primarily based on the programming language and ADE in which each is developed. TestStand comes with run-time operator interfaces developed in LabVIEW, LabWindows/CVI, Visual Basic, and Delphi.

Although you can use the TestStand sequence editor on a production station, the TestStand run-time operator interfaces are simpler and fully customizable. Like the sequence editor, the run-time operator interfaces allow you to start multiple concurrent executions, set breakpoints, and single-step. Unlike the sequence editor, however, the run-time operator interfaces do not allow you to modify sequences, and they do not display sequence variables, sequence parameters, step properties, and so on.

If you want to customize one of the run-time operator interfaces, modify the source code for the program. If you want to write your own run-time operator interface, use the source code of one of the run-time operator interfaces as a starting point. Refer to Chapter 16, *Run-Time Operator Interfaces*, for more information on the run-time operator interfaces that come with TestStand.

TestStand Test Executive Engine

The TestStand test executive engine is a set of DLLs that export an ActiveX Automation *Application Programming Interface* (*API*) you can use to create, edit, execute, and debug sequences. The TestStand sequence editor and run-time operator interfaces use the engine API. You can call the engine API from any programming environment that supports access to ActiveX Automation Servers. Thus, you can call the engine API from test modules, including test modules you write in LabVIEW and LabWindows/CVI.

The **Help** menu of the sequence editor contains a link to the online help. For more information on the engine API, refer to the *TestStand Programmer Help*.

Module Adapters

Most steps in a TestStand sequence invoke code in another sequence or in a code module. When invoking code in a code module, TestStand must know the type of code module, how to call it, and how to pass parameters to it. The different types of code modules include LabVIEW VIs, objects in ActiveX Automation Servers, C functions in DLLs, and C functions in source, object, or library modules that you create in LabWindows/CVI or other compilers. Also, TestStand must know the list of parameters that the code module requires.

TestStand uses *module adapters* to obtain this knowledge. TestStand currently provides the following module adapters for the following purposes:

- **DLL Flexible Prototype Adapter**—Calls C functions in a DLL with a variety of parameter types.
- **LabVIEW Standard Prototype Adapter**—Calls any LabVIEW VI that has the TestStand standard G parameter list.
- **C/CVI Standard Prototype Adapter**—Calls any C function that has the TestStand standard C parameter list. The function can be in an object file, library file, or DLL. It also can be in a source file that is in the project you are currently using in the LabWindows/CVI ADE.
- **ActiveX Automation Adapter**—Calls methods and accesses the properties of an ActiveX object.
- **Sequence Adapter**—Calls subsequences with parameters.
- **HTBasic Adapter**—Calls HTBasic subroutines.

The module adapters contain other important information in addition to the calling convention and parameter lists. If the module adapter is specific to an ADE, the adapter knows how to open the ADE, how to create source code for a new code module in the ADE, and how to display the source for an existing code module in the ADE. The ActiveX Automation Adapter and the DLL Flexible Prototype Adapter can query the type library for server information or the DLL for the parameter list information and display it to the sequence developer.

TestStand Building Blocks

This section provides an overview of the TestStand features and building blocks you use to create test sequences and entire test systems.

Variables and Properties

TestStand gives you various places in which you can store data values. These places are called *variables* and *properties*.

Variables are properties you can freely create in certain contexts. You can have variables that are *global* to a sequence file or *local* to a particular sequence. You also can have *station global* variables. The values of station global variables are persistent across different executions and even across different invocations of the sequence editor or run-time operator interfaces. The TestStand engine maintains the value of station global variables in a file on the run-time computer.

Each step in a sequence can have properties. For example, a step might have an integer error code property. The type of a step determines the set of properties it has. Refer to the *Step Types* section later in this chapter for more information on types of steps.

You can use TestStand variables to share data among tests that you write in different programming languages even if they do not have compatible data representations. You can pass values you store in variables and properties to code modules. You also can use the TestStand API to access variable and property values directly from code modules.

When executing sequences, TestStand maintains a *SequenceContext* that contains references to all global variables and all local variables and step properties in active sequences. The contents of the sequence context changes depending on the currently executing sequence and step. If you pass a sequence context object reference to the code module, you can use the TestStand API to access the variables and properties in the sequence context.

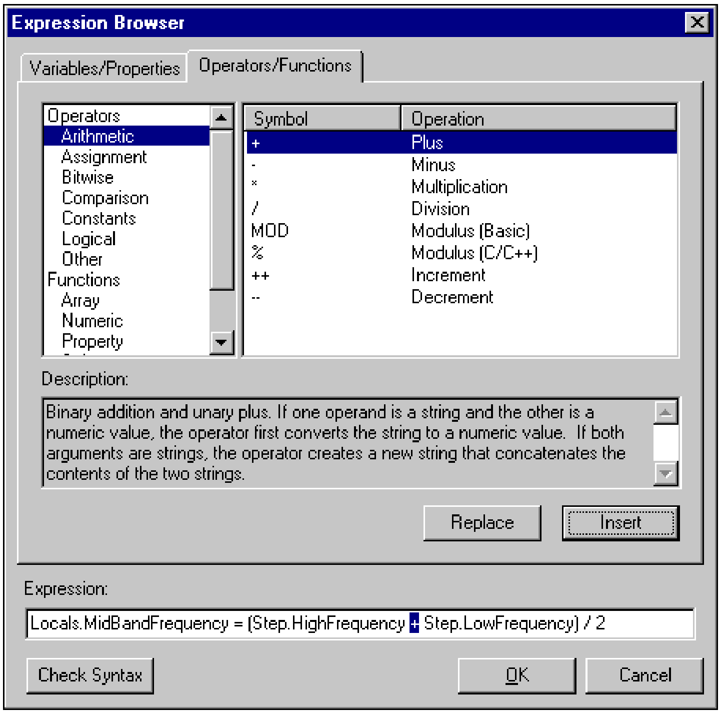
Expressions

In TestStand, you can use the values of variables and properties in numerous ways, such as passing a variable to a code module or using a property value to determine whether to execute a step. Sometimes you want to use an expression, which is a formula that calculates a new value from the values of multiple variable or properties. You can use an expression wherever you can use a simple variable or property value. In expressions, you can access all variables and properties in the sequence context that is active when TestStand evaluates the expression. The following is an example of an expression:

```
Locals.MidBandFrequency = (Step.HighFrequency +
    Step.LowFrequency) / 2
```

TestStand supports all applicable expression operators and syntax that you use in C, C++, Java, and Visual Basic. If you are not familiar with expressions in these standard languages, TestStand also provides an expression browser dialog box you access by clicking the **Browse** button that appears next to controls that accept expressions. With the expression browser, you can interactively build an expression by selecting from lists of available variables, properties, and expression operators. The expression browser also lists a number of functions you can use in expressions. The expression browser has help text for each expression operator and function.

Figure 1-2 shows the Expression Browser dialog box.



Symbol	Operation
+	Plus
-	Minus
*	Multiplication
/	Division
MOD	Modulus (Basic)
%	Modulus (C/C++)
++	Increment
--	Decrement

Binary addition and unary plus. If one operand is a string and the other is a numeric value, the operator first converts the string to a numeric value. If both arguments are strings, the operator creates a new string that concatenates the contents of the two strings.

```
Locals.MidBandFrequency = (Step.HighFrequency + Step.LowFrequency) / 2
```

Figure 1-2. Expression Browser Dialog Box

Categories of Properties

A property is a storage space for information. A property can store a single value or an array of values of the same data type. Each property has a name. One type of property, the container property, does not have a value. A container property can contain any number of subproperties.

A value is a number, a string, a Boolean, or an ActiveX reference. TestStand stores numbers as 64-bit, floating-point values in the IEEE 754 format. TestStand stores an ActiveX reference as an `IDispatch` pointer or an `IUnknown` pointer. Values are not containers and thus cannot contain subproperties. Arrays of values can have multiple dimensions.

The following are the major categories of properties according to the kinds of values they contain.

- A *single-valued property* contains a single value. Because TestStand has four types of values, TestStand has four types of single-valued properties: number properties, string properties, Boolean properties, and ActiveX reference properties.
- An *array property* contains an array of values. TestStand has number array properties, string array properties, Boolean array properties, and ActiveX reference array properties.
- A *property-array property* contains a value that is an array of subproperties of a single type.
- A *container property* contains no values. Usually, container properties contain multiple subproperties. Container properties are analogous to structures in C/C++ and to clusters in LabVIEW.

Standard and Custom Named Data Types

When you create a variable or property, you specify its data type. In some cases, you use a simple data type such as a number or a Boolean. In other cases, you want to define your own data type by adding subproperties to a container to create an arbitrarily complex data structure. You can do so by creating a *named data type*. When you create a named data type, you can reuse it for multiple variables or properties. Although each variable or property you create with a named data type has the same data structure, the values they contain can differ.

TestStand defines certain *standard named data types*. You can add subproperties to the standard data types, but you cannot delete any of their built-in subproperties. The standard named data types include `Path`, `Error`, and `CommonResults`.

You can define your own *custom named data types*. You must choose a unique name for each of your custom data types. You can add or delete subproperties in each custom data type without restriction. For example, you might create a `Transmitter` data type that contains subproperties such as `NumChannels` and `PowerLevel`.

When you create a variable or property, you can select from among the simple property types and the named data types.

Built-In and Custom Properties

TestStand defines a number of properties that are always present for objects such as steps and sequences. An example is the *run mode* property for steps. TestStand normally hides these properties in the sequence editor, although it lets you modify some of them through dialog boxes. Such properties are called *built-in properties*.

You can define new properties in addition to the built-in properties. Examples are high- and low-limit properties in a step or local variables in a sequence. Such properties are called *custom properties*.

Steps

A sequence consists of a series of steps. In TestStand, a step can perform many actions, such as initializing an instrument, performing a complex test, or making a decision that affects the flow of execution in a sequence. Steps can perform these actions through several types of mechanisms. A step can jump to another step, execute an expression, call a subsequence, or call an external code module.

In TestStand, steps can have custom properties. For steps that call code modules, custom step properties are useful for storing parameters to pass to the code module for the step. They also serve as a place for the code module to store its results. You can use the TestStand API to access the values of custom step properties from code modules.

Not all steps call code modules. Some steps perform standard actions you configure using a dialog box. In this case, custom step properties are useful for storing the configuration settings you specify.

Built-In Step Properties

TestStand steps have a number of built-in properties you can specify using the various options on the Step Properties dialog box. The following list explains the capabilities of each built-in step property.

- *Preconditions*—Set this property to specify the conditions that must be true for TestStand to execute the step during the normal flow of execution in a sequence.
- *Load/Unload Options*—Set this property to control when TestStand loads and unloads the code modules or subsequences that each step invokes.
- *Run Mode*—Set this property to specify whether TestStand skips a step or forces the step to pass or fail without executing the step module.

- *Record Results*—Set this property to specify whether TestStand stores the results of the step in a list. Refer to the *Automatic Result Collection* section in this chapter for more information.
- *Step Failure Causes Sequence Failure*—Set this property to specify whether TestStand sets the status of the sequence to `Failed` when the status of the step is `Failed`.
- *Ignore Run-Time Errors*—Set this property to specify whether Test Stand continues execution normally after the step even though a run-time error occurs in the step.
- *Post Actions*—Set this property to execute callbacks or jump to other steps after executing the step, depending on the pass/fail status of the step or any custom condition.
- *Loop*—Set this property to cause a single step to execute multiple times before executing the next step. You can specify the conditions under which to terminate the loop. You also can specify whether to collect results for each loop iteration, for the loop as a whole, or for both.
- *Pre Expressions*—Set this property to specify an expression to evaluate before executing the step module.
- *Synchronization*—Set this property to specify whether a step should block another instance of the step from executing at the same time in a different thread.
- *Post Expression*s—Set this property to specify an expression to evaluate after executing the step module.
- *Status Expression*—Set this property to specify an expression that determines the value of the `status` property of the step.

For more information on using these properties, refer to the *Step Properties Dialog Box* section of Chapter 5, *Sequence Files*.

Step Types

Just as each variable or property has a data type, each step has a *step type*.

A step type can contain any number of custom properties. Each step of that type has the custom step properties in addition to the built-in step properties. All steps of the same type have the same properties, but the values of the properties can differ.

The step type specifies the initial values of all the step properties. When you create the step in the sequence editor, TestStand sets the initial values of the step properties from the values that the step type specifies.

To modify the values of the built-in step properties you use the Step Properties dialog box. Usually, you can modify the values of custom step properties using a dialog box specific to the step type. If the step type does not have a dialog box for the custom properties, you view the custom properties by selecting **View Contents** from the context menu for the step. Although step modules usually do not modify the values of the built-in step properties at run time, they often modify and interrogate the values of the custom step properties.

A step type also can use any number of *substeps* to define standard behavior for each step of that type. Substeps are actions that the TestStand engine performs for a step in addition to calling the step module. Because a step type defines its substeps, each step of that type shares the same set of substeps. The different categories of substeps are as follows:

- Edit substep
- Pre Step substep
- Post Step substep
- Custom substep

The sequence developer invokes the Edit substep by selecting a menu item in the context menu for the step or by clicking a button in the Step Properties dialog box for the step. The step type specifies the name of the menu item and the caption of the button. The Edit substep displays a dialog box in which the sequence developer edits the values of custom step properties. For example, an Edit substep might display a dialog box in which the sequence developer specifies the high and low limits for a test. The Edit substep might then store the high and low limit values as step properties.

The engine calls the Pre Step substep before calling the step module. You can specify an adapter and a module to invoke in the Pre Step substep. For example, a Pre Step substep might call a code module that retrieves measurement configuration parameters and stores those parameters in step properties for use by the step module.

The engine calls the Post Step substep after calling the step module. You can specify an adapter and a module to invoke in the Post Step substep. A Post Step substep might call a code module that compares the values the step module stored in step properties against limit values that the Edit substep stored in other step properties.

Currently, TestStand does not call Custom substeps. Operator interface programs, test code, and other modules can use the TestStand API to invoke Custom substeps that you define.

TestStand includes a number of predefined step types. Some of the more generally applicable step types are as follows:

- Action
- Numeric Limit Test
- String Value Test
- Pass/Fail Test
- Label
- Goto
- Statement
- Property Loader
- Message Popup
- Call Executable
- Sequence Call

For a description of each of these step types, refer to Chapter 10, *Built-In Step Types*. Although you can create a test application using only the predefined step types, you also can create your own step types. By creating your own step types, you can define standard, reusable classes of steps that apply specifically to your own application. For example, you might define a Switch Matrix Configuration step or a Transmitter Adjacent Channel Power Test step.

The sequence developer creates a new step by selecting the **Insert Step** item in the context menu that appears when you right click a sequence window. The **Insert Step** item opens a hierarchical submenu that contains the step types available on the computer. When you create a new step type, you specify its name and position within the submenu.

Source Code Templates

When you create a step type, you also can define *source code templates* for that step type. When the sequence developer creates a new step of that type, the developer can use a source code template to generate source code for the step module. For a particular step type, you can specify different source code templates for the different module adapters.

Sequences

In TestStand, a sequence consists of the following:

- Parameters
- Local variables
- A main group of steps
- A group of setup steps
- A group of cleanup steps
- Built-in sequence properties

Sequence Parameters

Each sequence has its own list of parameters. You use parameters to pass data to a sequence when you call that sequence as a subsequence. This use of parameters is analogous to passing arguments to a function call or wiring data to terminals when you call a SubVI in LabVIEW. You can also specify a default value for each parameter. When the sequence developer inserts a step that calls one sequence from another, the developer can specify the values to pass for the parameters of the subsequence.

You can specify the number of parameters and the data type of each parameter. If the developer does not specify the value of a parameter, TestStand passes the default value. You can access parameters from code modules of steps in the sequence by using the TestStand API.

You also can pass parameters by value or by reference to any step in the sequence that calls one of the following items:

- A subsequence
- A DLL, using the DLL Flexible Prototype Adapter
- A method or property on an object, using the ActiveX Automation Adapter

Sequence Local Variables

You can create an unlimited number of local variables in a sequence. You can use local variables to store data relevant to the execution of the sequence. You can access local variables from code modules of steps in the sequence using the TestStand API. You also can pass local variables by value or by reference to any step in the sequence that calls one of the following items:

- A subsequence
- A DLL, using the DLL Flexible Prototype Adapter
- A method or property on an object, using the ActiveX Automation Adapter

Lifetime of Local Variables, Parameters, and Custom Step Properties

Multiple instances of a sequence can run at the same time. This situation can occur when you call a sequence recursively or when a sequence runs in multiple concurrent threads. Each instance of the sequence has its own copy of the sequence parameters, local variables, and custom properties of each step. When a sequence completes, TestStand discards the values of the parameters, local variables, and custom properties.

Step Groups

A sequence contains the following groups of steps: Setup, Main, and Cleanup. When TestStand executes a sequence, the steps in the Setup group execute first. The steps in the Main group execute next. The steps in the Cleanup group execute last. Usually, the Setup group contains steps that initialize instruments, fixtures, or a Unit Under Test (UUT). The Main group usually contains the bulk of the steps in a sequence, including the steps that test the UUT. The Cleanup group contains steps that power down or restore the initial state of instruments, fixtures, and the UUT.

If you use separate step groups, you ensure that the steps in the Cleanup group execute regardless of whether the sequence completes successfully or a run-time error occurs in the sequence. If a Setup or Main step causes a run-time error to occur, the flow of execution jumps to the Cleanup step group. The Cleanup steps always run even if some of the Setup steps do not run. If a Cleanup step causes a run-time error, execution continues at the next Cleanup step.

If a run-time error occurs in a sequence, TestStand reports the run-time error to the calling sequence. Execution in the calling sequence jumps to the Cleanup group in the calling sequence. This process continues up to the top-level sequence. Thus, when a run-time error occurs, TestStand terminates execution after running all the Cleanup steps of all the sequences in the sequence call hierarchy.

Built-in Sequence Properties

Sequences have a few built-in properties that you can specify using the Sequence Properties dialog box. For example, you can specify that the flow of execution jumps to the Cleanup step group whenever a step sets the status of the sequence to `Failed`.

Sequence Files

Sequence files can contain one or more sequences. Sequence files also can contain global variables that all sequences in the sequence file can access.

Sequences files have a few built-in properties that you can specify using the Sequence File Properties dialog box. For example, you can specify Load and Unload Options that override the Load and Unload Options of all the steps in all the sequences in the file.

Storage of Types in Files

Each sequence file contains the definitions of all data types and step types that the variables, properties, parameters, and steps in the sequence file use. This is true for all TestStand files that use types.

In memory, TestStand allows only one definition for each type. If you load a file that contains a type definition and a type definition of the same name already exists in memory, TestStand verifies that the two type definitions are identical. If they are not identical, TestStand informs you of the conflict. You can select one of the definitions to replace the other, or you can rename one of them so that they can coexist.

Process Models

Testing a UUT requires more operations than executing a set of tests. Usually, the test executive must perform a series of operations before and after it executes the sequence that performs the tests. Common operations include identifying the UUT, notifying the operator of pass/fail status, generating a test report, and logging results. These operations define the testing *process*. The set of such operations and their flow of execution is called a *process model*. Some traditional test executives implement their process models internally and do not allow you to modify them. Other test executives do not define a process model at all. TestStand comes with a default process model that you can modify or replace.

Having a process model is essential so that you can write different test sequences without repeating standard testing operations in each sequence.

Ability to modify the process model is essential because the testing process can vary based on your production line, your production site, or the systems and practices of your company.

TestStand provides a mechanism for defining a process model. A process model is a sequence file. You can edit a process model in the same way that you edit your other sequences. TestStand comes with a fully functional default process model. You can write your own process model, or you can copy the default process model and then modify it.

Note Always make modifications to a copy of the default process model. If you modify the default process model, your edits may be overwritten when you install subsequent TestStand releases.

Station Model

You can select a process model file to use for all sequence files. This process model file is called the *station model* file. The TestStand installation program establishes `SequentialModel.seq` as the station model file. You can use the Station Options dialog box to select a different station model. You also can use the Station Options dialog box to allow individual sequence files to specify their own process model file.

Main Sequence and Client Sequence File

In TestStand, the sequence that initiates the tests on a UUT is called the *main sequence*. You must name each main sequence `MainSequence`. When you create a new sequence file, TestStand automatically inserts a `MainSequence` sequence in the file. The process model invokes the main sequence as part of the overall testing process. The process model defines what is constant about your testing process, whereas main sequences define the steps that are unique to the different types of tests you run.

When you begin an execution, you usually do so from a main sequence in one of your sequence files. TestStand determines which process model file to use with the main sequence. TestStand uses the station model file unless the sequence file specifies a different process model file and you set the Station Options to allow sequence files to override your station model setting.

After TestStand identifies the process model to use with a main sequence, the file that contains the main sequence becomes a *client sequence file* of the process model.

Model Callbacks

By default, each main sequence you execute uses the process model that you select for the entire test station. TestStand has a mechanism called a *model callback* that allows the sequence developer to customize the behavior of a process model for each main sequence that uses it. By defining one or more model callbacks in a process model, you specify the set of process model operations that the sequence developer can customize.

You define a model callback by adding a sequence to the process model file, marking it as a callback, and calling it from the process model. The sequence developer can override the callback in the model sequence file by using the Sequence File Callbacks dialog box to create a sequence of the same name in the client sequence file.

For example, the default TestStand process model defines a `TestReport` callback that generates the test report for each UUT. Normally, the `TestReport` callback in the default process model file is sufficient because it handles many types of test results. The sequence developer can, however, override the default `TestReport` callback by defining a different `TestReport` callback in a particular client sequence file.

Process models use callbacks to invoke the main sequence in the client sequence file. Each client sequence file must define a sequence named `MainSequence`. The process model contains a `MainSequence` callback that is merely a placeholder. The `MainSequence` in the client sequence file overrides the `MainSequence` placeholder in the model file.

To alter the behavior of the process model for all sequences, you can modify a copy of the process model or replace it entirely. To redefine the set of customizable operations, you can define new callbacks in, or delete existing callbacks from, the process model file.

Entry Points

A process model defines a set of *entry points*. Each entry point is a sequence in the process model file. You mark a sequence in the model file as an entry point in the Sequence Properties dialog box.

By defining multiple entry points in a process model, you give the test station operator different ways to invoke a main sequence. For example, the default TestStand process model provides two entry points: `Test UUTs` and `Single Pass`. The `Test UUTs` entry point initiates a loop that repeatedly identifies and tests UUTs. The `Single Pass` entry point tests a single UUT without identifying it. Such entry points are called *execution entry points*.

Execution entry points appear in the **Execute** menu of the sequence editor or operator interface when the active window contains a non-model sequence file that has a `MainSequence` callback.

Figure 1-3 contains a flowchart of the major operations of the `Test UUTs` entry point sequence in the default process model. Notice that the sequence implements many of its operations as callbacks. The box on the left shows the flow of control. The box on the right shows the action that each callback in the default model performs if you do not override it.

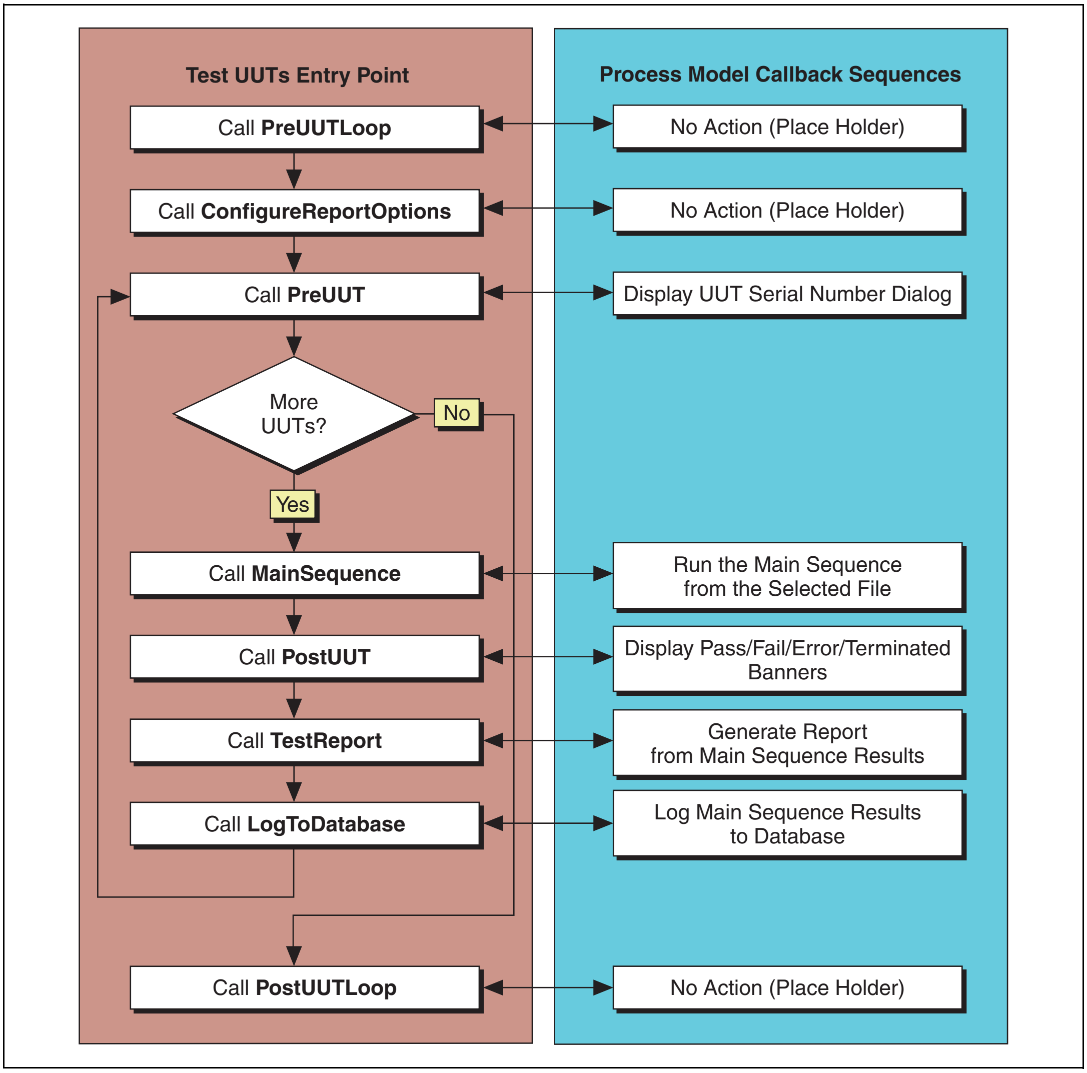
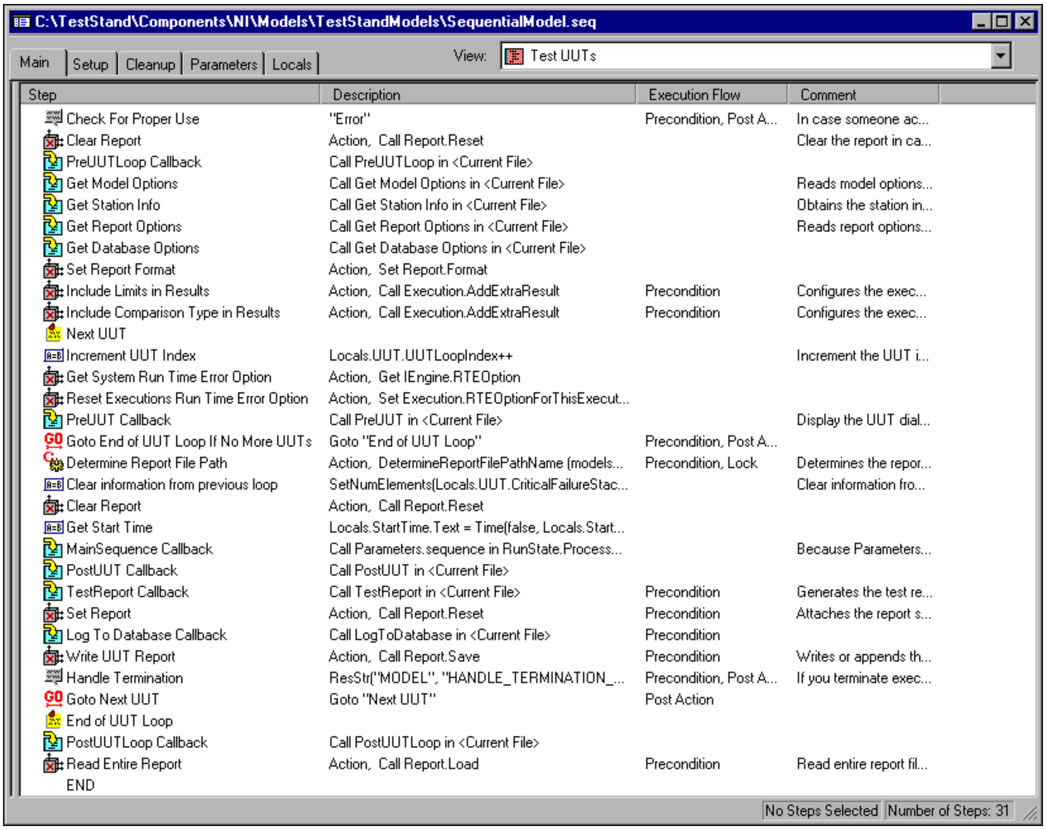

Test UUTs Entry Point
Call PreUUTLoop
Call ConfigureReportOptions
Call PreUUT
More UUTs?
No
Yes
Call MainSequence
Call PostUUT
Call TestReport
Call LogToDatabase
Call PostUUTLoop
Process Model Callback Sequences
No Action (Place Holder)
No Action (Place Holder)
Display UUT Serial Number Dialog
Run the Main Sequence from the Selected File
Display Pass/Fail/Error/Terminated Banners
Generate Report from Main Sequence Results
Log Main Sequence Results to Database
No Action (Place Holder)

Figure 1-3. Flowchart of Test UUTs Sequence in the Default Process Model

Like any other sequence, the sequence for a process model entry point can contain calls to DLLs, calls to subsequences, Goto steps, and so on.

Figure 1-4 shows the entire set of steps for the `Test UUTs` entry point in the default process model.



C:\TestStand\Components\NI\Models\TestStandModels\SequentialModel.seq

Main | Setup | Cleanup | Parameters | Locals — View: Test UUTs

Step	Description	Execution Flow	Comment
Check For Proper Use	"Error"	Precondition, Post A...	In case someone ac...
Clear Report	Action, Call Report.Reset		Clear the report in ca...
PreUUTLoop Callback	Call PreUUTLoop in <Current File>		
Get Model Options	Call Get Model Options in <Current File>		Reads model options...
Get Station Info	Call Get Station Info in <Current File>		Obtains the station in...
Get Report Options	Call Get Report Options in <Current File>		Reads report options...
Get Database Options	Call Get Database Options in <Current File>		
Set Report Format	Action, Set Report.Format		
Include Limits in Results	Action, Call Execution.AddExtraResult	Precondition	Configures the exec...
Include Comparison Type in Results	Action, Call Execution.AddExtraResult	Precondition	Configures the exec...
Next UUT			
Increment UUT Index	Locals.UUT.UUTLoopIndex++		Increment the UUT i...
Get System Run Time Error Option	Action, Get IEngine.RTEOption		
Reset Executions Run Time Error Option	Action, Set Execution.RTEOptionForThisExecut...		
PreUUT Callback	Call PreUUT in <Current File>		Display the UUT dial...
Goto End of UUT Loop If No More UUTs	Goto "End of UUT Loop"	Precondition, Post A...	
Determine Report File Path	Action, DetermineReportFilePathName (models...	Precondition, Lock	Determines the repor...
Clear information from previous loop	SetNumElements(Locals.UUT.CriticalFailureStac...		Clear information fro...
Clear Report	Action, Call Report.Reset		
Get Start Time	Locals.StartTime.Text = Time(false, Locals.Start...		
MainSequence Callback	Call Parameters.sequence in RunState.Process...		Because Parameters...
PostUUT Callback	Call PostUUT in <Current File>		
TestReport Callback	Call TestReport in <Current File>	Precondition	Generates the test re...
Set Report	Action, Call Report.Reset	Precondition	Attaches the report s...
Log To Database Callback	Call LogToDatabase in <Current File>	Precondition	
Write UUT Report	Action, Call Report.Save	Precondition	Writes or appends th...
Handle Termination	ResStr("MODEL", "HANDLE_TERMINATION_...	Precondition, Post A...	If you terminate exec...
Goto Next UUT	Goto "Next UUT"	Post Action	
End of UUT Loop			
PostUUTLoop Callback	Call PostUUTLoop in <Current File>		
Read Entire Report	Action, Call Report.Load	Precondition	Read entire report fil...
END			

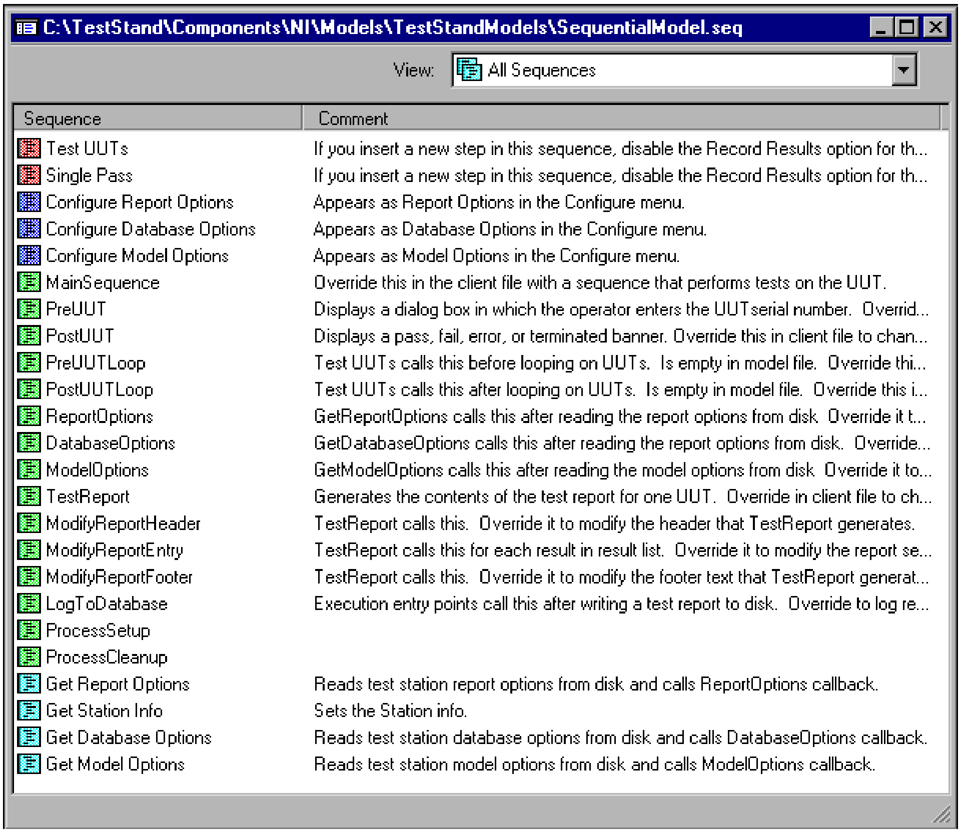
No Steps Selected | Number of Steps: 31

Figure 1-4. Test UUTs Entry Point Sequence in the Default TestStand Process Model

To execute a sequence without a process model, select the **Run *Sequence Name*** item in the **Execute** menu, where ***Sequence Name*** is the name of the sequence you are currently viewing. This option is useful for debugging. It executes the sequence directly, skipping the process model operations such as UUT identification and test report generation. You can execute any sequence this way, not only main sequences.

A process model can define other types of entry points, such as *configuration entry points*. An example is the `Config Report Options` entry point, which appears as **Report Options** in the **Configure** menu of the sequence editor or run-time operator interface. Refer to Chapter 14, *Process Models*, for more information on process model entry points.

Figure 1-5 shows a list of all the sequences in the default TestStand process model. The first five sequences are entry points. The last four sequences are utility subsequences that the execution entry points call. The other sequences are callbacks that you can override in a client sequence file.


C:\TestStand\Components\NI\Models\TestStandModels\SequentialModel.seq
View: All Sequences

Sequence	Comment
Test UUTs	If you insert a new step in this sequence, disable the Record Results option for th...
Single Pass	If you insert a new step in this sequence, disable the Record Results option for th...
Configure Report Options	Appears as Report Options in the Configure menu.
Configure Database Options	Appears as Database Options in the Configure menu.
Configure Model Options	Appears as Model Options in the Configure menu.
MainSequence	Override this in the client file with a sequence that performs tests on the UUT.
PreUUT	Displays a dialog box in which the operator enters the UUT serial number. Overrid...
PostUUT	Displays a pass, fail, error, or terminated banner. Override this in client file to chan...
PreUUTLoop	Test UUTs calls this before looping on UUTs. Is empty in model file. Override thi...
PostUUTLoop	Test UUTs calls this after looping on UUTs. Is empty in model file. Override this i...
ReportOptions	GetReportOptions calls this after reading the report options from disk. Override it t...
DatabaseOptions	GetDatabaseOptions calls this after reading the report options from disk. Override...
ModelOptions	GetModelOptions calls this after reading the model options from disk. Override it to...
TestReport	Generates the contents of the test report for one UUT. Override in client file to ch...
ModifyReportHeader	TestReport calls this. Override it to modify the header that TestReport generates.
ModifyReportEntry	TestReport calls this for each result in result list. Override it to modify the report se...
ModifyReportFooter	TestReport calls this. Override it to modify the footer text that TestReport generat...
LogToDatabase	Execution entry points call this after writing a test report to disk. Override to log re...
ProcessSetup	
ProcessCleanup	
Get Report Options	Reads test station report options from disk and calls ReportOptions callback.
Get Station Info	Sets the Station info.
Get Database Options	Reads test station database options from disk and calls DatabaseOptions callback.
Get Model Options	Reads test station model options from disk and calls ModelOptions callback.

Figure 1-5. List of All Sequences in TestStand Process Model

Automatic Result Collection

TestStand can automatically collect the results of each step. You can enable or disable result collection for a step, a sequence, or for the entire test station.

Each sequence has a local array that stores the results of each step. The contents in the results for each step can vary depending on the step type. When TestStand stores the results for a step into the array, it adds information such as the name of the step and its position in the sequence. For a step that calls a sequence, TestStand also adds the result array from the subsequence.

Refer to the *Result Collection* section in Chapter 6, *Sequence Execution*, for more information on how TestStand collects results.

Callback Sequences

Callbacks are sequences that TestStand calls under specific circumstances. You can create new callback sequences or you can replace existing callbacks to customize the operation of the test station. To add a callback sequence to a sequence file, use the Sequence File Callbacks dialog box.

TestStand defines three categories of callbacks. The categories are based on the entity that invokes the callback and the location in which you define the callback. Table 1-1 shows the different types of callbacks.

Table 1-1. Callback Types

Callback Type	Where You Define the Callback	Who Calls the Callback
Model Callbacks	Process model file, the client sequence file, or `StationCallbacks.seq`	Sequences in the process model file
Engine Callbacks	`StationCallbacks.seq` for engine station callbacks, the process model file for engine process model callbacks, or a regular sequence file for engine sequence file callbacks	Engine
Front-End Callbacks	`FrontEndCallbacks.seq`	Operator interface program

The *Process Models* section earlier in this chapter discusses model callbacks in detail.

Engine Callbacks

The TestStand engine defines a set of callbacks that it invokes at specific points during execution. These callbacks are called *engine callbacks*. TestStand defines the name of each engine callback.

Engine callbacks are a way for you to configure TestStand to call certain sequences before and after the execution of individual steps, before and after interactive executions, after loading a sequence file, and before unloading a sequence file. Because the TestStand engine controls the execution of steps and the loading and unloading of sequence files, TestStand defines the set of engine callbacks and their names.

The engine callbacks exist in three general groups, based on the file in which the callback sequence appears. You can define engine callbacks in sequence files, in process model files, and in the `StationCallbacks.seq` file.

Note TestStand installs a `StationCallbacks.seq` file in the `<TestStand>\Components\NI\Callbacks\Station` directory. You can add your own station engine callbacks in the `StationCallbacks.seq` file in the `<TestStand>\Components\User\Callbacks\Station` directory.

Front-End Callbacks

Front-end callbacks are sequences in the `FrontEndCallbacks.seq` file that operator interface programs call. Front-end callbacks allow multiple operator interfaces to share the same implementation for a specific operation. The version of `FrontEndCallback.seq` that TestStand installs contains one front-end callback sequence, `LoginLogout`. The sequence editor and all operator interfaces that come with TestStand call `LoginLogout`.

When you implement operations as front-end callbacks, you write them as sequences. Thus you can modify a front-end callback without modifying the source code for the operator interfaces or rebuilding the executables for them. For example, to change how the various operator interfaces perform the login procedure, you only have to modify the `LoginLogout` sequence in `FrontEndCallbacks.seq`.

You can create new front-end callbacks by adding a sequence to `FrontEndCallbacks.seq` file. You can then invoke this sequence from each of the operator interface programs that you use. You invoke the sequence using functions in the TestStand API. You cannot edit the source for the TestStand sequence editor. Thus, you cannot make the sequence editor call new front-end callbacks that you create.

Note TestStand installs predefined front-end callbacks in the `FrontEndCallbacks.seq` file in the `<TestStand>\Components\NI\Callbacks\FrontEnd` directory. You can add your own front-end callbacks or override a predefined callback in the `FrontEndCallbacks.seq` file in the `<TestStand>\Components\User\Callbacks\FrontEnd` directory.

Sequence Executions

When you run a sequence, TestStand creates an *execution object*. The execution object contains all the information that TestStand needs to run your sequence and the subsequences it calls. While an execution is active, you can start another execution by running the same sequence again or by running a different one. TestStand does not limit the number of executions that you can run concurrently. An execution object initially starts with a single execution thread. You can use the sequence call multithreading options to create additional threads within an execution or to launch new executions. An execution groups related threads. If you set a breakpoint in an execution, all threads in the execution suspend. If you terminate an execution, all threads in the execution terminate.

Usually, the TestStand sequence editor creates a new window for each execution. This window is called an *Execution window*. In the Execution window, you can view steps as they execute, the values of variables and properties, and the test report. Usually, run-time operator interface programs also have a view or window for each execution.

Normal and Interactive Executions

You start an execution in the sequence editor by selecting the **Run *Sequence Name*** item or one of the process model entry points from the **Execute** menu. This is called a *normal execution*.

You run steps in *interactive mode* by selecting one or more steps and choosing the **Run Selected Steps** or **Loop Selected Steps** items in the *context menu*. In interactive mode, only the selected steps in the sequence execute, regardless of any branching logic that the sequence contains. The selected steps run in the order in which they appear in the sequence.

You can run steps in interactive mode from two different contexts:

- You can run steps interactively from a Sequence File window. When you do so, you create a new execution. This is called a *root interactive* *execution*. You can set station options to control whether the Setup and Cleanup step groups of the sequence run as part of a root interactive execution.

- You also can run steps interactively from an existing Execution window for a normal execution that is suspended at a breakpoint. You can run steps only in the sequence and step group in which execution is suspended. When you do this, the selected steps run within the context of the normal execution. This is called a *nested interactive execution*. The steps that you run interactively can access the variable values of the normal execution and add to its results. These results are included in the test report if you used the process model for the original execution. When the selected steps complete, the execution returns to the step at which it was suspended when you chose **Run Selected Steps** or **Loop Selected Steps**.

You can configure whether TestStand evaluates preconditions when executing interactively by selecting **Configure»Station Options** and setting the **Evaluate Preconditions in Interactive Mode** option on the Execution tab.

Terminating and Aborting Executions

The menus in the sequence editor and run-time operator interfaces have commands that allow you to stop execution before the execution has completed normally. The TestStand engine API has corresponding methods that allow you to stop execution from a code module. You can stop one execution or all executions. You can issue the stop request at any time, but it does not take effect in each execution until the currently executing code module returns control.

You can stop executions in two ways. When you *terminate* an execution, all the Cleanup step groups in the sequences on the call stack run before execution ends. Also, the process model can continue to run. Depending on the process model, it might continue testing with the next UUT or generate a test report.

When you *abort* an execution, the Cleanup step groups do *not* run, and process model cannot continue. In general, it is better to terminate execution so that the Cleanup step groups can return your system to a known state. You abort an execution when you want the execution to stop completely as soon as possible. Usually, you abort an execution only when you are debugging and you are sure that is safe to not run the cleanup steps for a sequence.

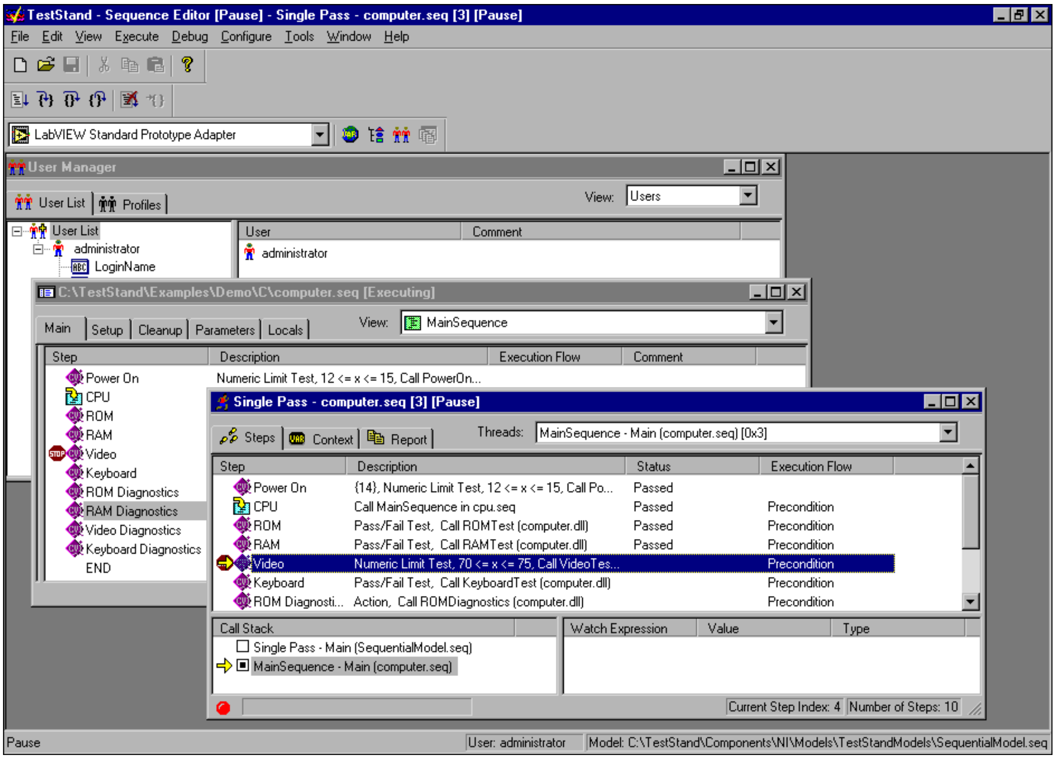
2 Sequence Editor Concepts

This chapter describes the various parts of the main window for the TestStand sequence editor. It also describes how you perform basic tasks in the sequence editor.

Sequence Editor Screen

The sequence editor main window contains standard window features common to Windows applications, such as windows, menus, toolbars, and a status bar.

Figure 2-1 shows an example of the sequence editor main window.


TestStand - Sequence Editor [Pause] - Single Pass - computer.seq [3] [Pause]
File Edit View Execute Debug Configure Tools Window Help
LabVIEW Standard Prototype Adapter
User Manager
User List
Profiles
View: Users
C:\TestStand\Examples\Demo\C\computer.seq [Executing]
Main Setup Cleanup Parameters Locals
View: MainSequence
Single Pass - computer.seq [3] [Pause]
Steps Context Report
Threads: MainSequence - Main (computer.seq) [0x3]

User List
- administrator
  - LoginName

User	Comment
administrator	

Step	Description	Execution Flow	Comment
Power On	Numeric Limit Test, 12 <= x <= 15, Call PowerOn...		
CPU			
ROM			
RAM			
Video			
Keyboard			
ROM Diagnostics			
RAM Diagnostics			
Video Diagnostics			
Keyboard Diagnostics			
END			

Step	Description	Status	Execution Flow
Power On	{14}, Numeric Limit Test, 12 <= x <= 15, Call Po...	Passed	
CPU	Call MainSequence in cpu.seq	Passed	Precondition
ROM	Pass/Fail Test, Call ROMTest (computer.dll)	Passed	Precondition
RAM	Pass/Fail Test, Call RAMTest (computer.dll)	Passed	Precondition
Video	Numeric Limit Test, 70 <= x <= 75, Call VideoTes...		Precondition
Keyboard	Pass/Fail Test, Call KeyboardTest (computer.dll)		Precondition
ROM Diagnosti...	Action, Call ROMDiagnostics (computer.dll)		Precondition

Call Stack
Single Pass - Main (SequentialModel.seq)
MainSequence - Main (computer.seq)

Watch Expression	Value	Type

Current Step Index: 4 Number of Steps: 10

Pause User: administrator Model: C:\TestStand\Components\NI\Models\TestStandModels\SequentialModel.seq

Figure 2-1. Example Sequence Editor Screen

Windows

The sequence editor uses child windows to display sequence files, sequence executions, station globals, data types, step types, users, user privileges, and projects in the workspace. This manual refers to these child windows simply as *windows*.

Views

Each TestStand window can contain different views to display various elements of sequence files, sequence executions, types, or globals. For example, a sequence file contains multiple sequences. The pull-down ring control in the upper right corner of the Sequence File window sets the current view for the Sequence File window. The Sequence File window views include a list of all sequences, a list of steps in a particular sequence, a list of the sequence file global variables, and a list of types that the sequence file uses.

Tabs

Some TestStand windows display a series of tabs in which you can access detailed information unique to the view. For example, when you view a sequence in a sequence file, the following tabs are available:

- **Main**—Displays the steps in the main sequence.
- **Setup**—Displays steps that execute before the Main step group runs.
- **Cleanup**—Displays steps that execute after the Main step group runs.
- **Parameters**—Lists the values that the sequence receives when another sequence calls it.
- **Locals**—Displays variables accessible by any of the steps in the sequence.

Lists and Trees

The sequence editor uses lists and trees to show the relationship and hierarchical nature of the data that appears in each view. For example, a list view for the Sequence File window displays all the sequences in a sequence file. When you select a sequence in that list and press <Ctrl-Enter>, the view changes to a list of all steps in the selected sequence. You also can display the steps of a sequence in a tree view where the steps are the nodes and the step properties are the branches of the tree.

Table 2-1 describes the standard behavior for keyboard and mouse actions that you perform on objects in list views and tree views.

Table 2-1. Mouse and Keyboard Actions for Navigating List and Tree Views

Mouse Action	Keyboard Action	Type of View	Behavior
Double-click	Press <Enter>	List view	Displays the Properties dialog box for the object.
<Ctrl>-Double-click	Press <Ctrl-Enter>	List view	Expands the object to show its contents.
Double-click a closed node	Press <Enter> or <+>	Tree view	Expands the tree view node.
Double-click an opened node	Press <Enter> or <->	Tree view	Collapses the tree view node.

Table 2-1. Mouse and Keyboard Actions for Navigating List and Tree Views (Continued)

Mouse Action	Keyboard Action	Type of View	Behavior
Click to select node	Use arrows to select node	Tree view	Show contents of tree node in list view
<Alt>-Double-click	Press <Alt-Enter>	List or tree view	Displays the Properties dialog box for the object.
(None)	<Backspace>	List or tree view	Go up one level in tree view and show contents of that level in list view

Each item in a list view can have multiple columns. For example, a step in a list view has a Step column, a Description column, an Execution Flow column, and a Comment column. You can expand a column to the width of its largest entry by double-clicking the vertical separator at the right edge of the column heading.

Context Menus

To open a context menu in a window, click the right mouse button. The list of menu items in a context menu varies depending on the view, the mouse position, and whether any items are selected. Most of the context menu items do not appear in the main window menu bar, so you can access them only from the context menus. For example, you can insert a step into a sequence only by using the **Insert Step** context menu item.

Certain menu items appear in several different context menus. Whenever you right click an object to display its context menu, you see commands that are relevant to that object. For example, the **Properties** item displays the Properties dialog box for the object. The **View Contents** item displays the contents of the object in the list view.

When you right click the list view background and select the **Go Up 1 Level** menu item, the focus moves up one level in the tree view and the contents of that level appear in the list view.

Copy, Cut, and Paste

While you are viewing sequences, steps, types, workspace items, or variables in a list or tree format, you can cut, copy, and paste items between different views and windows.

Drag and Drop

While you are viewing sequences, steps, types, workspace items, or variables in a list or tree format, you can drag and drop items between different views and windows. You can use this technique to move steps up or down in a sequence.

Menu Bar

The sequence editor uses a common menu bar. Some menu items might dim depending on the state of the sequence editor session and which window is active. Refer to Chapter 4, *Sequence Editor Menu Bar*, for information on the sequence editor main menu bar and menu items.

Toolbars

Toolbars and their icons give you quick access to commonly used menu items. To find out what a toolbar button does, position the mouse cursor over the button. A help description appears on the status bar of the main window.

The sequence editor maintains three toolbars: the Standard, Debug, and Environment toolbars. To configure which toolbars are visible, select **View»Toolbar** or right click the toolbar area.

Status Bar

The status bar at the bottom of the sequence editor window displays the current state of the editor or displays help information. The left portion of the status bar displays help messages. When you select menu items or toolbar icons, a short description appears for the selected item. Otherwise, the status bar displays the current execution state, such as `Edit` or `Running`.

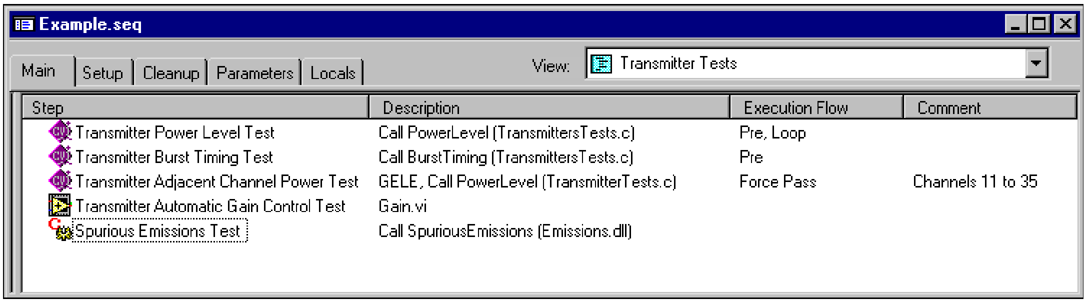
The right portion of the status bar displays the current user and the process model for the active sequence window. You can open the process model sequence file in a new window by double-clicking on the model pathname in the status bar.

Sequence Editor Windows

This section describes all the windows in the sequence editor.

Sequence File Window

In the sequence editor, you use a Sequence File window to view and edit a sequence file. Figure 2-2 shows an example Sequence File window. You use the View ring control at the top right of the Sequence File window to view an individual sequence, a list of all sequences in the file, the global variables in the file, or the types you use in the file. In an individual sequence view, you use the tabs to view the Main, Setup, or Cleanup step groups, the sequence parameters, or the sequence local variables.



Step	Description	Execution Flow	Comment
Transmitter Power Level Test	Call PowerLevel (TransmittersTests.c)	Pre, Loop	
Transmitter Burst Timing Test	Call BurstTiming (TransmittersTests.c)	Pre	
Transmitter Adjacent Channel Power Test	GELE, Call PowerLevel (TransmitterTests.c)	Force Pass	Channels 11 to 35
Transmitter Automatic Gain Control Test	Gain.vi		
Spurious Emissions Test	Call SpuriousEmissions (Emissions.dll)		

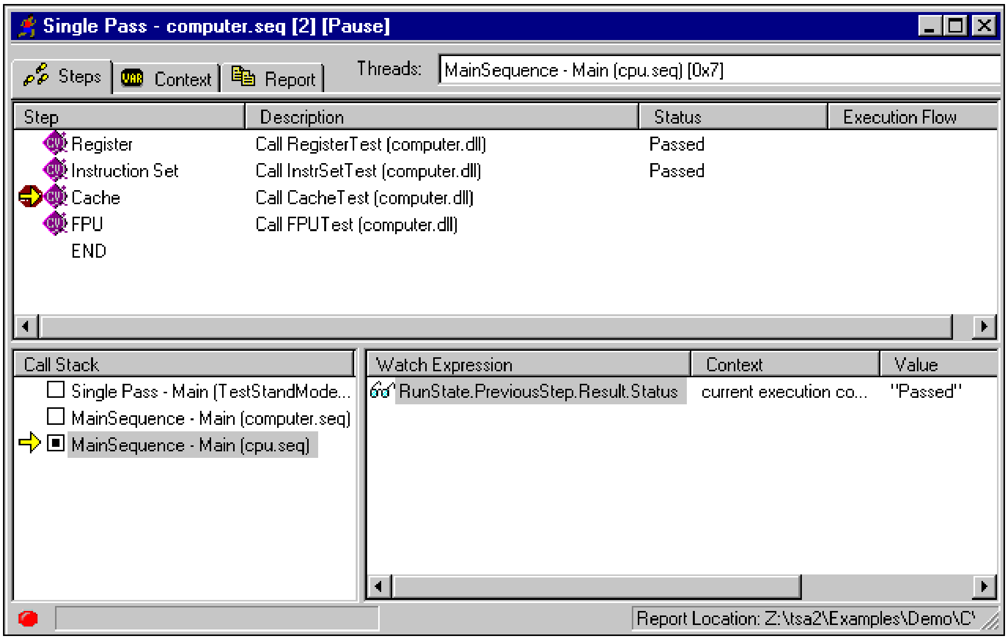
Figure 2-2. Example Sequence File Window

Refer to Chapter 5, *Sequence Files*, to learn more about editing a sequence file using the Sequence File window.

Execution Window

The sequence editor displays each execution in a separate window, called the Execution window. The Execution window is divided into several areas. The top half of the window contains tabs that display the Steps view, the Context view, and the Report view. The bottom half of the window is divided into the Call Stack view and the Watch Expression view. A status bar appears at the bottom edge of the window.

Figure 2-3 shows an example of a sequence editor Execution window.


Single Pass - computer.seq [2] [Pause]
Steps
Context
Report
Threads:
Report Location: Z:\tsa2\Examples\Demo\C\

MainSequence - Main (cpu.seq) [0x7]

Step	Description	Status	Execution Flow
Register	Call RegisterTest (computer.dll)	Passed	
Instruction Set	Call InstrSetTest (computer.dll)	Passed	
Cache	Call CacheTest (computer.dll)		
FPU	Call FPUTest (computer.dll)		
END			

Call Stack
Single Pass - Main (TestStandMode...
MainSequence - Main (computer.seq)
MainSequence - Main (cpu.seq)

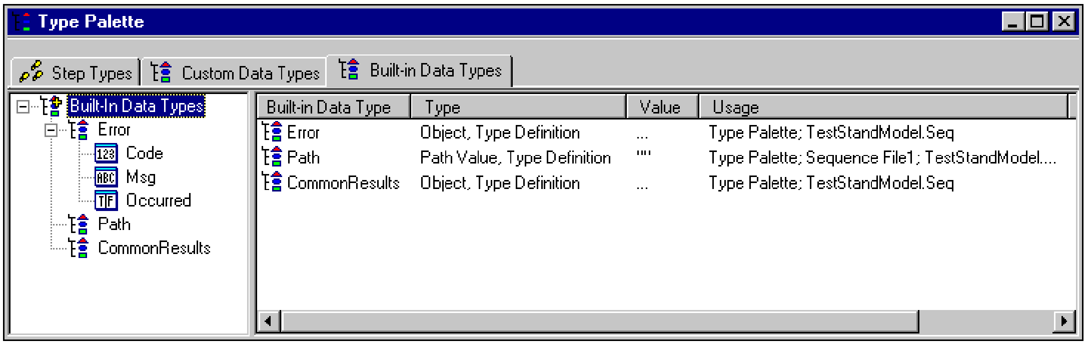
Watch Expression	Context	Value
RunState.PreviousStep.Result.Status	current execution co...	"Passed"

Figure 2-3. Example Execution Window

Refer to Chapter 6, *Sequence Execution*, to learn more about using the Execution window to start and debug an execution.

Type Palette Window

You use the Type Palette window to store the data types and step types that you want to be available to you in the sequence editor at all times. The Type Palette window contains tabs for step types, custom data types, and standard data types, as shown in Figure 2-4.



Built-in Data Type	Type	Value	Usage
Error	Object, Type Definition	...	Type Palette; TestStandModel.Seq
Path	Path Value, Type Definition	""	Type Palette; Sequence File1; TestStandModel....
CommonResults	Object, Type Definition	...	Type Palette; TestStandModel.Seq

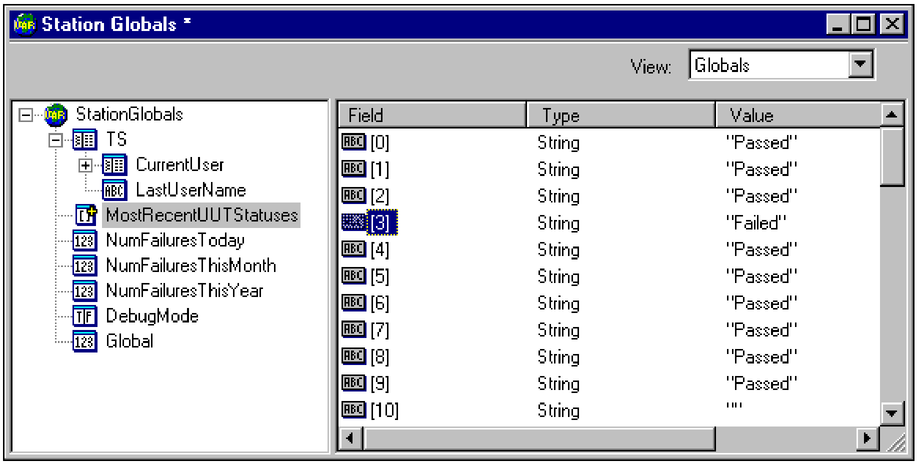
Figure 2-4. Type Palette Window

Refer to Chapter 9, *Types*, to learn more about using data types and step types.

Station Globals Window

The Station Globals window displays the variables that TestStand maintains from one TestStand session to the next. Usually, you use station global variables to maintain statistics or to represent the configuration of your test station.

Figure 2-5 shows an example Station Globals window.



View: Globals

Field	Type	Value
[0]	String	"Passed"
[1]	String	"Passed"
[2]	String	"Passed"
[3]	String	"Failed"
[4]	String	"Passed"
[5]	String	"Passed"
[6]	String	"Passed"
[7]	String	"Passed"
[8]	String	"Passed"
[9]	String	"Passed"
[10]	String	""

Figure 2-5. Example Station Globals Window

Refer to Chapter 7, *Station Global Variables*, to learn more about using station globals. Refer to Chapter 9, *Types*, to learn more about using data types.

Workspace Window

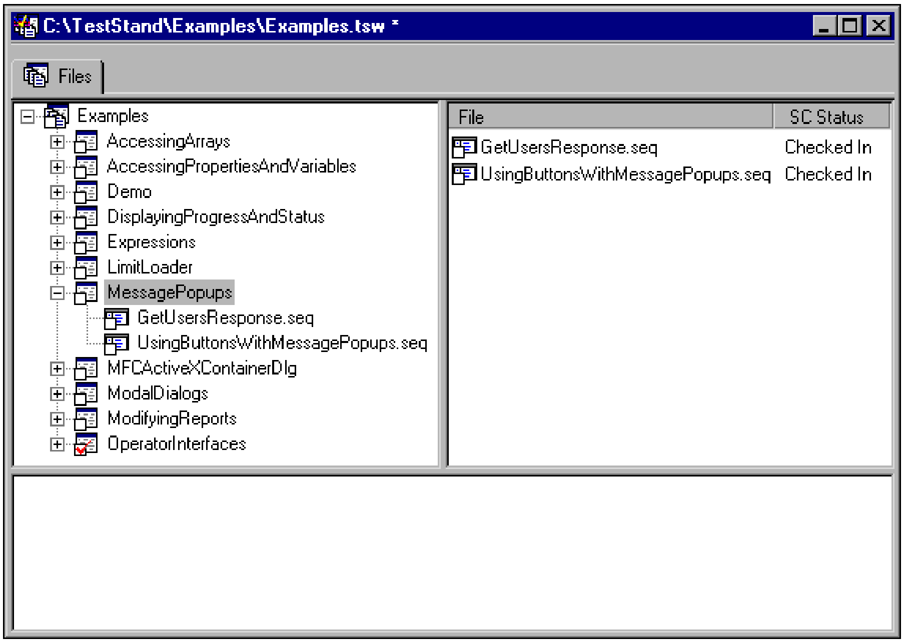
The Workspace window displays the contents of a TestStand workspace (`.tsw`) file. A workspace file displays a list of any number of TestStand project (`.tsp`) files. In TestStand, a project file can contain any type of file or folder but a workspace file can contain only projects.

Use TestStand projects to organize related files. You can insert any number of files into a project. You also can insert folders to contain files or other folders. Workspace files and project files do not contain the contents of other files. Instead, they retain references to the files they organize.

The following icons appear in the Workspace window.

- Project file.
- Workspace file.
- Sequence file.
- Any file, other than a sequence file, within a project.
- File is a code module or folder contains code modules.
- File not found on disk.
- File is currently checked into the source code control system.
- File is currently checked out of the source code control system.

The Workspace window tree view enables you to browse all the files in the workspace. The list view displays the contents of the item that you select in the tree view. The message window in the bottom portion of the Workspace window displays messages from the source control system you use. In Figure 2-6, the tree view shows the sequence files in the MessagePopups project.



File	SC Status
GetUsersResponse.seq	Checked In
UsingButtonsWithMessagePopups.seq	Checked In

Figure 2-6. Workspace Window

You can open only one workspace file at a time. If you have a workspace open and you try to open or create another, TestStand prompts you to save the workspace file before you can open or create another file.

To open any file from within the Workspace window, double-click on the file. For example, if you double click on a sequence file in the Workspace, TestStand will open the file in the Sequence Editor.

To organize your files, use the commands in the Edit menu to cut, copy, paste, and delete any file in the workspace. You also can drag and drop files and projects within the workspace environment.

You can display a context menu by right-clicking in the Workspace window. The items in the context menu vary depending on the location that you click on in the window. The context menu can contain the following items:

- **Open**—Opens the selected file. If you choose this command from the context menu of a sequence file, TestStand opens the file in the Sequence Editor.
- **Add Existing Project to Workspace**—Adds an existing project to the workspace.

- **Insert New Project into Workspace**—Creates a new project on disk and adds the project to the workspace.
- **Insert Code Modules**— Adds code module files to the workspace. Under each sequence file, TestStand creates a folder called Code Modules that contains the code modules the sequence file calls. The folder also includes any code module source files that the sequence file references.
- **New Folder**—Adds a new folder to the selected project or file.
- **Insert New Folder From Disk**—Adds a folder from disk to the selected project or file. After you select the folder, a dialog box asks you if you want to add the files within the folder. Select Yes to insert the folder you select and all of its contents such that the content of the new folder in the Workspace matches the directory structure of the folder on disk. Select No to insert the folder and its subfolders without adding the files that the folders contain. When you select to add files, code module files appear in code module folders beneath the sequence files that reference them.
- **Add Files**—Adds the files you choose from a dialog box to the selected workspace item.
- **Add to Source Control**—Adds the selected project or file to source control.
- **Get Latest Version**—Copies the latest version of the selected project or file from source control to your local machine. Click the Advanced Options button to display a dialog box that varies based on your source code control provider.
- **Check Out**—Checks the selected files out of source control and places a writable copy of the files on your local machine. Click the Advanced Options button to display a dialog box that varies based on your source code control provider.

Note Before you make changes to a file, check the file out of source control. If, for a file checked into source control, you make the local copy of the file writable and then make changes, TestStand asks you if you want to reload the file when you try to check the file out. If you reload the file, the version checked into source control overwrites the version on your local machine and you lose the changes you have made to the local file.

- **Check In**—Checks the selected file into source control.
  - **Keep Checked Out**—Checks the latest file changes into source control while keeping the file checked out to your local machine so you can continue to edit it.
- **Undo Check Out**—Checks the selected file back into source control and discards any changes you have made to the file. Click the Advanced Options button to display a dialog box that varies based on your source code control provider.
- **Show History**—Shows the source code control history of the selected file. The history gives you information about previous versions of the file.
- **Show Differences**—Shows the differences between the two files you select to compare. For example, you might compare your local copy of a file with the same file checked into source control. If you select to compare sequence files and you have either Microsoft Visual SourceSafe or MKS Source Integrity as your default provider, the TestStand Differ shows the differences between the two sequence files. If you have a provider other than Visual SourceSafe or MKS Source Integrity, the diff utility for your provider presents the differences between the two files in a new window. In this case, the source code control provider diff window only allows you to diff the sequence files as text files. Unless the files have only minor differences, it is not practical to diff sequence files as text files. To diff the files as sequence files, complete the following steps:
  1. To preserve your changes, make a copy of your local file.
  2. Undo checkout of your local file and recheck the file out to obtain the latest changes from source control.
  3. Load the local file and the copy that contains your changes into the sequence editor.
  4. Use the sequence editor diff window to merge the changes from the copy into the local file you have checked out.
- **View Contents**—Selects in the tree view the selected project, folder, or file that you select in the list view. The list view then displays the contents of the selected item.
- **Properties**—Shows the properties of the selected file. This command brings up a dialog box that can contain the following tabs:
  - **General**—Displays the path name of the file, the date the file was last modified, and the source code control status of the file.

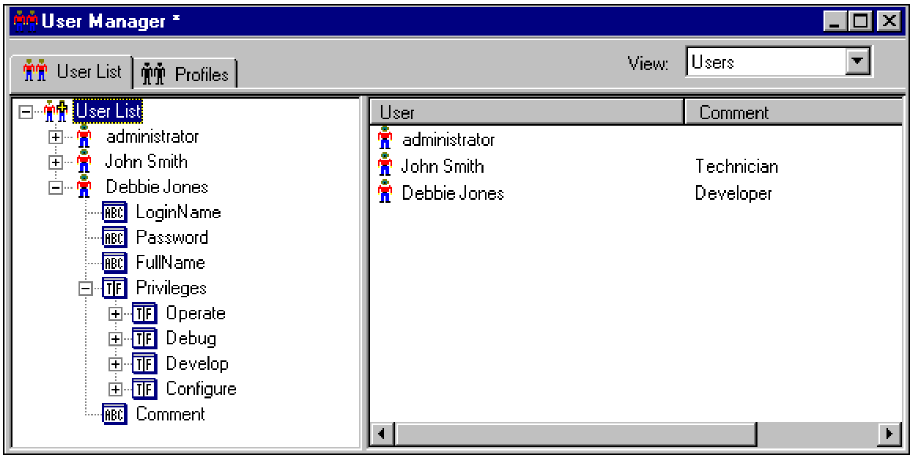
  - **Source Control**—This tab appears for workspace and project items only. Use this tab to change the source control project and launch the source control system. Click the Advanced Options button to display a dialog box that varies based on your source code control provider. For a workspace item, this tab also enables you to change and connect to a source control provider and to change the source control user name.
- **Rename**—Allows you to change the name the Workspace window displays for the selected project or folder.
- **Clear Messages**—Clears the messages in the Message window.
- **Hide Messages Window**—Hides the Message window.
- **Remove from Source Control**—Removes the selected project or file from source control. You can only access this option from the Source Control menu in the sequence editor.

Note Some source code control providers delete the local machine copy of the files you remove from source control using this command.

- **Refresh All**—Refreshes the source code control status of all files in the workspace and verifies that the files exist on disk.
- **Provider Options**—Allows you to view and set options for your source code control system.
- **Run**—Launches your source code control provider. You can access this option by selecting Source **Control»Run** or by right-clicking in the workspace and selecting Properties from the context menu.
- **Load/Unload**—Loads or unloads workspace files. You can only access this option from the Workspace Browser in an operator interface.
- **Show SCC Messages**—Displays messages from the source control system. You can only access this option from the Workspace Browser in an operator interface.

Users Window

You use the Users window to view and change the user list, user privileges, and the profiles for adding new users, as shown in Figure 2-6.



User	Comment
administrator	
John Smith	Technician
Debbie Jones	Developer

Figure 2-7. Users Window

Refer to the *User Manager Window* section in Chapter 12, *User Management*, to learn more about adding users and changing user privileges.

Basic Tasks in TestStand

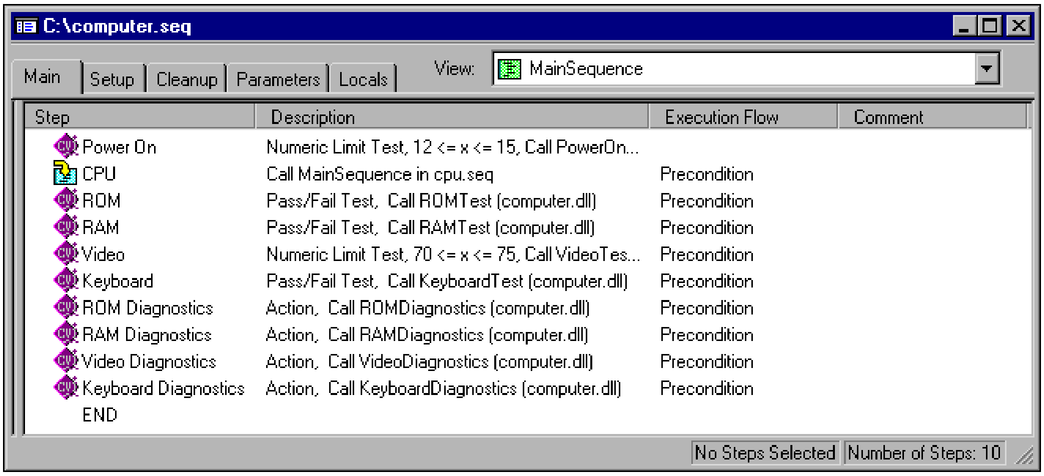
This section describes how to perform some basic tasks in TestStand.

Creating a Sequence

In the sequence editor, you use a Sequence File window to view and edit a sequence file. You can open an existing sequence file by selecting **File»Open**, or you can create a new Sequence File window by selecting **File»New**.

You use the View ring control at the top right of the Sequence File window to view an individual sequence, a list of all sequences in the file, the global variables in the file, or the types that you use in the file. In an individual sequence view, you use the tabs to view the Main, Setup, or Cleanup step groups, the sequence parameters, or the sequence local variables.

Figure 2-8 shows the Main step group of an example sequence in the Sequence File window.



C:\computer.seq

Main | Setup | Cleanup | Parameters | Locals

View: MainSequence

Step	Description	Execution Flow	Comment
Power On	Numeric Limit Test, 12 <= x <= 15, Call PowerOn...		
CPU	Call MainSequence in cpu.seq	Precondition	
ROM	Pass/Fail Test, Call ROMTest (computer.dll)	Precondition	
RAM	Pass/Fail Test, Call RAMTest (computer.dll)	Precondition	
Video	Numeric Limit Test, 70 <= x <= 75, Call VideoTes...	Precondition	
Keyboard	Pass/Fail Test, Call KeyboardTest (computer.dll)	Precondition	
ROM Diagnostics	Action, Call ROMDiagnostics (computer.dll)	Precondition	
RAM Diagnostics	Action, Call RAMDiagnostics (computer.dll)	Precondition	
Video Diagnostics	Action, Call VideoDiagnostics (computer.dll)	Precondition	
Keyboard Diagnostics	Action, Call KeyboardDiagnostics (computer.dll)	Precondition	
END			

No Steps Selected | Number of Steps: 10

Figure 2-8. Main Step Group in an Example Sequence

To insert steps in the Main, Setup, and Cleanup tabs of an individual sequence view, right click and use the context menu that appears. The **Insert Step** item in the context menu displays a submenu of all the step types, including the step types that come with TestStand and any custom step types that you create. Each step in a sequence has a step type. The step type defines the custom step properties and standard behavior for each step of that type.

Figure 2-9 shows the submenu for the **Insert Step** item.

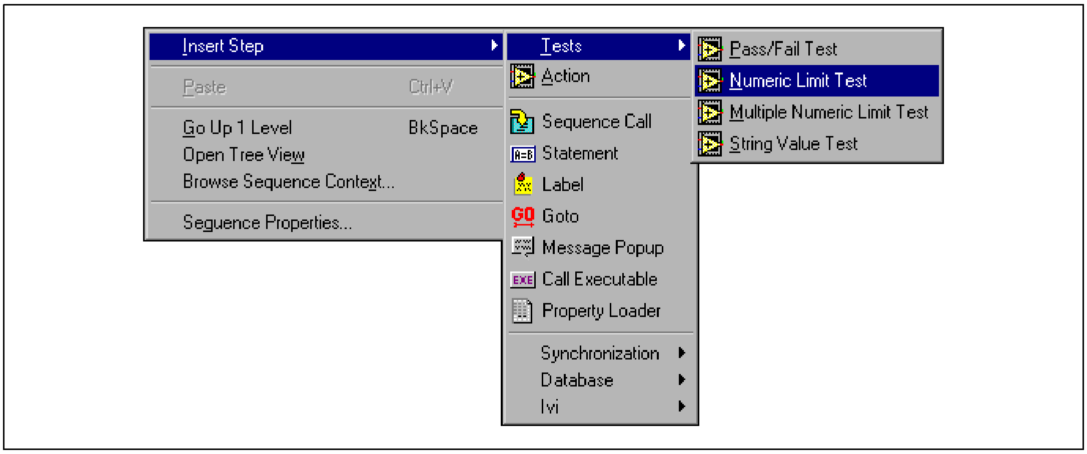


Figure 2-9. Insert Step Submenu

An icon appears to the left of each step type in the submenu. When you select a step type, TestStand displays the same icon next to the name of the new step in the list view. Many step types, such as the Pass/Fail Test and Action step types, can work with any module adapter. For these step types, the icon that appears in the submenu is the same as the icon for the module adapter that you select in the ring control on the tool bar. In Figure 2-9, the LabVIEW Standard Prototype Adapter is the current adapter, and its icon appears next to several step types, including Pass/Fail Test and Action. If you select one of these step types, TestStand uses the LabVIEW Standard Prototype Adapter for the new step.

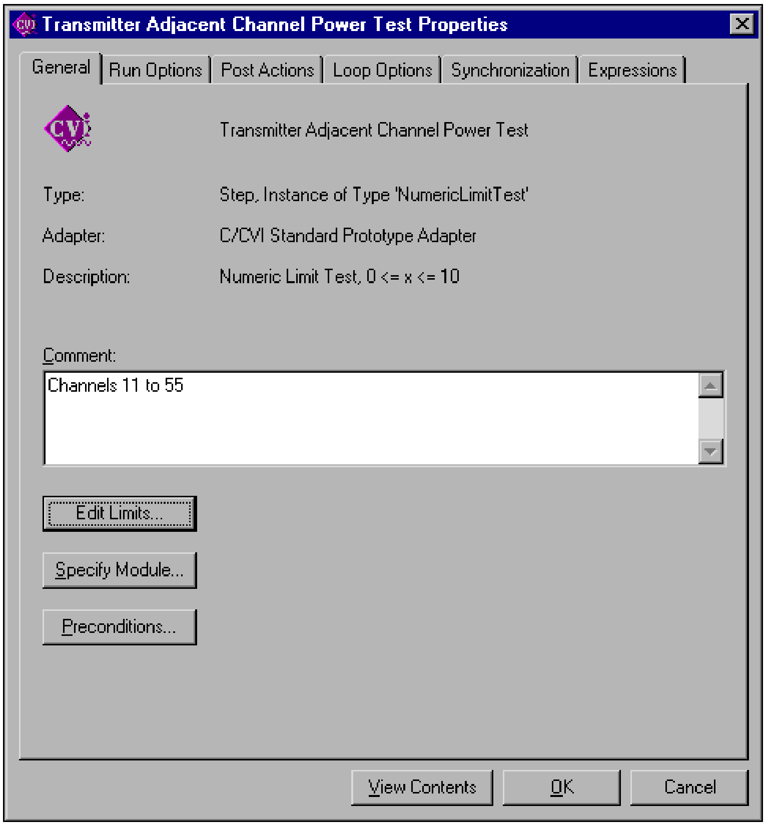
Some step types require a particular module adapter and always use the icon for that adapter. For example, the Sequence Call step type always uses the Sequence Adapter icon. Other step types, such as Statement and Goto, do not use module adapters and have their own icons.

When you select an entry in the submenu, TestStand creates a step using the step type and module adapter that the submenu entry indicates. After you insert the step, you use the **Specify Module** item in the context menu for the step to specify the code module or sequence, if any, that the step calls. The **Specify Module** command displays a dialog box that is different for each adapter. Some adapters require you to specify the values to pass as arguments when executing the code module. Refer to Chapter 13, *Module Adapters*, for information on the Specify Module dialog box for each adapter.

For each step type, other items can appear in the context menu above **Specify Module**. For example, the **Edit Limits** item appears in the context menu for Numeric Limit Test steps, and the **Edit Destination** item appears in the context menu for Goto steps. You use these menu items to modify step properties that are specific to the step type. Refer to Chapter 10, *Built-In Step Types*, for information on the menu item for each step type.

To modify step properties that are common to all step types, use the **Properties** command in the context menu, double-click the step, or press <Enter> when the step is selected.

Figure 2-10 shows the Step Properties dialog box.



Transmitter Adjacent Channel Power Test

Type: Step, Instance of Type 'NumericLimitTest'

Adapter: C/CVI Standard Prototype Adapter

Description: Numeric Limit Test, 0 <= x <= 10

Comment:

Channels 11 to 55

Figure 2-10. Step Properties Dialog Box

The Step Properties dialog box contains the following tabs:

- **General**—Contains buttons to display the Specify Module dialog box, the step-type-specific dialog box and the Preconditions dialog box.
- **Run Options**—Specifies various options for loading and running the step code module.
- **Post Actions**—Specifies what action to take when the step finishes executing.
- **Loop Options**—Specifies whether TestStand loops on the step. TestStand can loop a fixed number of times or loop until a specified number of iterations pass or fail. You also can customize the loop conditions.

- **Synchronization**—Specifies when TestStand should postpone execution of this step or other steps to synchronize the execution of multiple steps. You also can use the synchronization step types to perform more advanced types of synchronization. Refer to Chapter 11**,** *Synchronization Step Types***,** for more information on the synchronization step types.
- **Expressions**—Specifies expressions that TestStand executes before and after the step executes.

Refer to Chapter 5, *Sequence Files*, for more information on sequence files and adding steps to sequences.

Controlling Sequence Flow

TestStand has several features you can use to control the flow of execution in a sequence. These include the post actions for a step, the preconditions for a step, and the Goto step type. You can combine these features in various ways. For example, you can use the preconditions on a Goto step to specify when to loop back to an earlier statement.

Every step in TestStand has a status property. The status property is a string that indicates the result of the step execution. Although TestStand imposes no restrictions on the values to which the step or its code module can set the status property upon completion, TestStand recognizes the values that appear in Table 2-2.

Table 2-2. Standard Values for the Status Property after Execution Completes

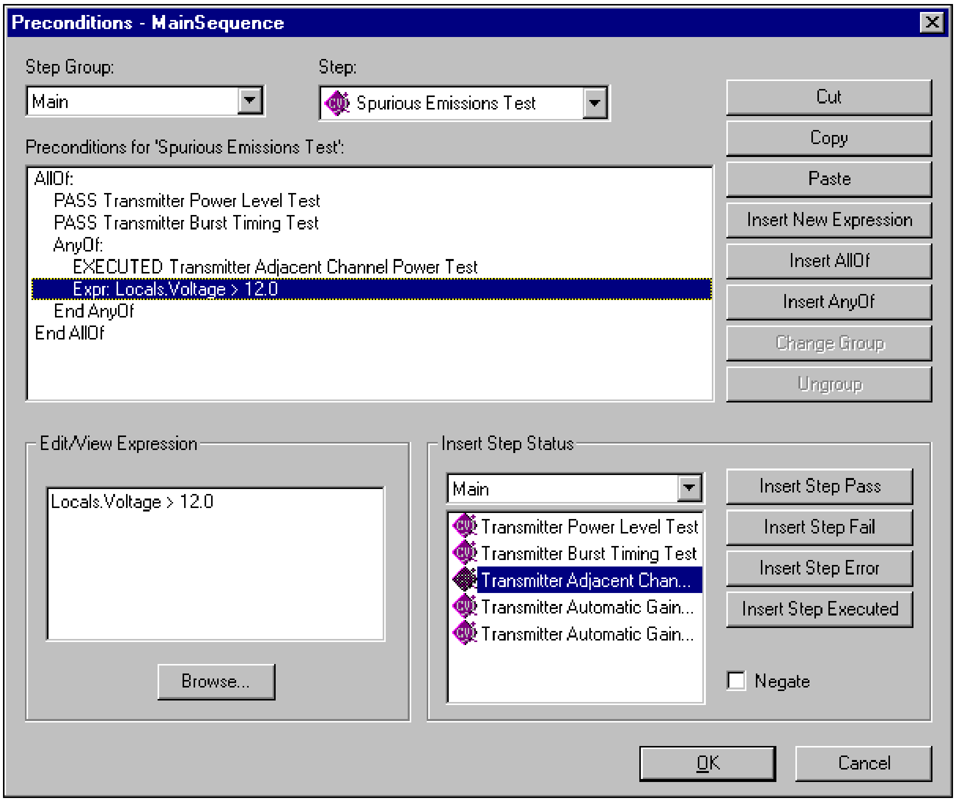
Value	Meaning
`Passed`	Indicates that the step performed a test that passed.
`Failed`	Indicates that the step performed a test that failed.
`Error`	Indicates that a run-time error occurred.
`Done`	Indicates that the step completed without setting its status.
`Terminated`	Indicates that the step called a subsequence that terminated.
`Skipped`	Indicates that the step did not execute.

The preconditions and post actions you define can use the step status to control the flow of execution.

Preconditions

The preconditions for a step specify the conditions that must be true for TestStand to execute the step during the normal flow of execution in a sequence. You access the Preconditions dialog box by clicking the **Preconditions** button on the Sequence Properties dialog box or by clicking the **Preconditions** button on the Step Properties dialog box.

Figure 2-11 shows the Preconditions dialog box.



Preconditions for 'Spurious Emissions Test':

```
AllOf:
    PASS Transmitter Power Level Test
    PASS Transmitter Burst Timing Test
    AnyOf:
        EXECUTED Transmitter Adjacent Channel Power Test
        Expr: Locals.Voltage > 12.0
    End AnyOf
End AllOf
```

```
Locals.Voltage > 12.0
```

Figure 2-11. Preconditions Dialog Box

You can use a simple step status comparison as a condition. For example, you might want to execute a step only when the Power On test passes. The Preconditions dialog box has special controls to make this easy. You also can specify an arbitrary expression that TestStand evaluates at run time. For example, you might want to execute the Keyboard test only when the `Locals.KeyboardInstalled` variable is `True`. You also can create complex preconditions by grouping conditions with the `All Of` and the

`Any Of` operators. The `All Of` operator evaluates to `True` when all conditions in its group are `True`. The `Any Of` operator evaluates to `True` when at least one condition in its group is `True`. `All Of` is analogous to logical `AND` while `Any Of` is analogous to logical `OR`.

Refer to the section *Preconditions Dialog Box* in Chapter 5, *Sequence Files*, for more information on how to use preconditions.

Post Action

You use the Post Actions tab in the Step Properties dialog box to specify an action that occurs after the step executes. You can make the action conditional on the Pass/Fail status of the step or on any custom condition. Your choices of actions include:

- **Goto next step**—Execution continues normally with the next step. This is the default value.
- **Goto destination**—Execution branches to the destination you select. You can branch to any step in the current step group, to the end of the current step group, or to the Cleanup step group. If the post action for a step specifies that execution branches to the Cleanup step group and the current step is in the Cleanup step group, execution proceeds normally with the next step in the Cleanup group.
- **Terminate execution**—Execution terminates. Refer to the *Terminating and Aborting Executions* section in Chapter 1, *TestStand Architecture Overview*, for more information on execution termination.
- **Call sequence**—TestStand calls a sequence before continuing to the next step. You can select any sequence in the sequence file. TestStand does not pass any arguments to the sequence. If the sequence has parameters, TestStand uses the default values of the parameters.
- **Break**—TestStand suspends execution before continuing to the next step.

Refer to the *Step Properties Dialog Box* section in Chapter 5, *Sequence Files*, for more information on the Post Action tab of the Step Properties dialog box.

Goto Built-In Step Type

You use Goto steps to set the next step that the TestStand engine executes. You usually use a Label step as the target of a Goto step. This lets you rearrange or delete steps in a sequence without having to change the target names in Goto steps. You specify the Goto step target by selecting the **Edit**

Destination item from the step context menu or the **Edit Destination** button on the Step Properties dialog box.

Refer to the *Goto* section in Chapter 10, *Built-In Step Types*, for more information on how to use the Goto step type.

Run-Time Errors

When a run-time error occurs in a step, execution in the sequence jumps to the Cleanup step group. After the Cleanup step group completes executing, TestStand reports the run-time error to the sequence call step in the calling sequence. This process continues up through the top-level sequence. Thus, when a run-time error occurs, TestStand terminates execution after running all the Cleanup steps of the sequences that are active at the time of the run-time error.

Running a Sequence

You can initiate an execution by launching a sequence through a model entry point, by launching a sequence directly, or by executing a group of steps interactively.

A list of entry points appears in the **Execute** menu of the sequence editor and operator interfaces. Each entry point in the menu represents a separate entry point sequence in the process model that applies to the active sequence file. When you select an entry point from the **Execute** menu, you actually run an entry point sequence in a process model file. The entry point sequence, in turn, invokes the main sequence in the active sequence file. The default TestStand process model provides two execution entry points: `Test UUTs` and `Single Pass`. The `Test UUTs` entry point initiates a loop that repeatedly identifies and tests UUTs. The `Single Pass` entry point tests a single UUT without identifying it.

To execute a sequence without using a process model, select the **Run *Sequence Name*** item in the **Execute** menu, where ***Sequence Name*** is the name of the sequence you are currently viewing. This command executes the sequence directly, skipping the process model operations such as UUT identification and test report generation. You can execute any sequence this way, not only main sequences. Usually, you execute a sequence in this way to perform unit testing or debugging.

You can execute selected steps in a sequence interactively by choosing **Run Selected Steps** or **Loop Selected Steps** from the context menu in the sequence editor or by clicking the **Run Tests** or **Loop Tests** buttons in the run-time operator interfaces. When you run steps interactively, TestStand does not evaluate step preconditions. If you execute steps in a Sequence File window, you initiate the interactive execution as an independent, top-level execution. If you execute steps in an Execution window when the execution is suspended, you initiate a nested interactive execution.

When you start a new execution, the sequence editor creates a new Execution window. Run-time operator interface programs update a view or create a new window for each new execution.

Refer to Chapter 14, *Process Models*, for more information on process models. Refer to Chapter 6, *Sequence Execution*, for more information on starting executions.

Debugging a Sequence

TestStand has several features you can use to debug a sequence. These include tracing, breakpoints, single-stepping, the sequence context browser, and watch expressions.

If tracing is enabled, the sequence editor and operator interfaces display the progress of an execution by highlighting the currently executing step in a step view. Usually, you disable tracing if you want to avoid using computer time to display the progress of your execution. You use the **Tracing Enabled** item in the **Execute** menu to enable or disable tracing. You set tracing options on the Execution tab in the Station Options dialog box. Refer to the *Configure Menu* and *Execute Menu* sections in Chapter 4, *Sequence Editor Menu Bar*, for more information on the tracing options.

The sequence editor and operator interfaces allow you to set breakpoints, to step into or step over steps, to step out of sequences, and to set the next step to execute. You also can terminate execution, abort execution, and run or loop on selected steps while at a breakpoint. In the sequence editor, these commands appear in the **Debug** menu. Refer to the *Debug Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information on debugging commands.

When using the sequence editor, you can display the variables and properties during an execution by selecting the Context view of the Execution window. The Context view displays the sequence context for the sequence invocation that is currently selected in the call stack. The sequence context contains all the variables and properties that the steps in the selected sequence invocation can access. You use the Context view to examine and modify the values of these variables and properties.

You can drag individual variables or properties from the Context view to the *Watch Expression* view so that you can view changes in specific values while you single-step or trace through the sequence.

Refer to Chapter 8, *Sequence Context and Expressions*, for more information on sequence contexts. Refer to Chapter 6, *Sequence Execution*, for more information on running and debugging an execution.

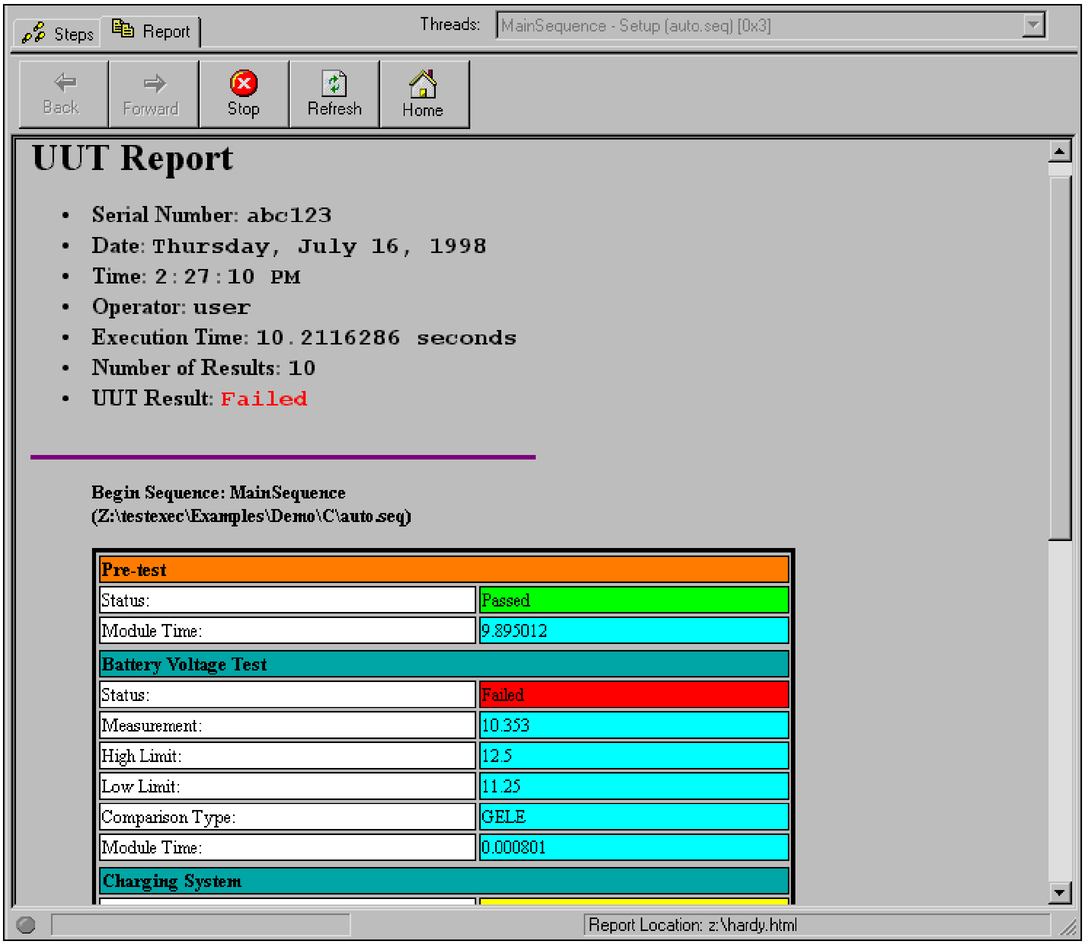
Generating Test Reports

TestStand automatically collects the results of an execution. As each step executes, TestStand appends the results from the step to a tree of results for an entire execution. When an execution completes, the default process model can generate a report from the information stored in the result tree. By default, an execution generates a report only when you start the execution through a model entry point such as `Test UUTs` or `Single Pass`.

To set options that control report generation, select the **Report Options** item in the **Configure** menu. You can select either *HTML* or *ASCII* text formats. You can specify the report file name and whether TestStand generates the file name from the sequence file name, the time and date, or the UUT serial number. You can specify a result-filtering expression. For example, you can choose to include results only for steps that fail during an execution. You can specify whether TestStand appends results to the file if a file already exists. You also can specify whether the report includes measurement values, test limits, and execution times.

The Report view of the sequence editor Execution window displays the report for the current execution. Usually, the Report view is empty until execution completes. You also can use an external application to view reports by selecting **View»Launch External Viewer**. You can use **Configure»External Viewers** to specify the external application that TestStand launches to display a particular report format.

Figure 2-12 shows an HTML report for an example sequence.



UUT Report

- Serial Number: abc123
- Date: Thursday, July 16, 1998
- Time: 2:27:10 PM
- Operator: user
- Execution Time: 10.2116286 seconds
- Number of Results: 10
- UUT Result: Failed

Begin Sequence: MainSequence
(Z:\testexec\Examples\Demo\C\auto.seq)

Pre-test	
Status:	Passed
Module Time:	9.895012
Battery Voltage Test	
Status:	Failed
Measurement:	10.353
High Limit:	12.5
Low Limit:	11.25
Comparison Type:	GELE
Module Time:	0.000801
Charging System	

Report Location: z:\hardy.html

Figure 2-12. HTML Report for an Example Sequence

Refer to the *Result Collection* section in Chapter 6, *Sequence Execution*, for more information on how TestStand collects results. Refer to Chapter 15, *Managing Reports*, for more information on available report options and customizing the report output.

Using an Operator Interface

Although you can use the TestStand sequence editor on a production station, the TestStand run-time operator interfaces are simpler. Also, they come with full source code so that you can customize them. Like the sequence editor, the run-time operator interfaces allow you to start multiple, concurrent executions, set breakpoints, and single-step. Refer to Chapter 16, *Run-Time Operator Interfaces*, in this document for more information on the operator interfaces included with TestStand.

3 Configuring and Customizing TestStand

This chapter describes how to configure and customize a TestStand station.

Configuring TestStand

This section outlines the configuration options in TestStand.

Sequence Editor Startup Options

You can append certain options to the sequence editor command line, separating various parameters by spaces. The valid startup options for the sequence editor appear in Table 3-1.

Table 3-1. Sequence Editor Startup Options

Option	Purpose
filename1 {*filename2*}…	The sequence editor automatically loads the sequence files at startup. Example: `SeqEdit "c:\MySeqs\seq1.seq" "c:\MySeqs\seq2.seq"`

The sequence editor, LabWindows/CVI operator interface, Visual Basic operator interface, and Delphi operator interface support command-line options to open and run sequences.

You can open sequence files from the command line as shown below:

```
testexec.exe c:\sequencefiles\asequencefiletoopen.seq
   c:\sequencefiles\anothersequencefiletoopen.seq
```

The following are examples that show how to run a particular sequence in a sequence file and how to run an execution entry point, such as TestUUTs:

```
testexec.exe -run MainSequence
   c:\sequenceFiles\Asequencefiletorun.seq
```

```
testexec.exe -runEntryPoint "Test UUTs"
   c:\sequenceFiles\Asequencefiletorun.seq
```

Notice that quotes are necessary since there is a space in the argument `"Test UUTs"`.

The LabVIEW operator interface does not support command-line options.

Configure Menu

The **Configure** menu in the sequence editor and in the operator interfaces contains commands that control the operation of the TestStand station. This section gives a brief overview of the items in the **Configure** menu. Refer to the *Configure Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information on each menu item.

You can use the **Station Options** command to set preferences for your TestStand station. The settings affect all sequence editor and operator interface sessions that you run on your computer. The command displays a dialog box with the following tabs.

- **Execution**—Contains options for breakpoints, tracing, and interactive execution.
- **Time Limits**—Specifies time limits for executions. If you specify a time limit, you choose an action to take when a time limit expires.
- **Preferences**—Specifies general options for the TestStand station, such as the name of the test station.
- **Model**—Specifies the process model file for the station as a whole and whether each individual sequence may specify its own process model file.
- **User Manager**—Specifies whether TestStand enforces user privileges. It also specifies the location of the user manager configuration file.
- **Localization**—Specifies the language in which to display text and other region specific settings.
- **Remote Execution**—Specifies whether remote test stations may run sequences on this test station.
- **Source Control**—Specifies general options that apply to source control operations in TestStand.

The **Search Directories** command lets you customize the search paths for finding files. The dialog box displays a list of paths. The paths that appear first in the list take precedence over the paths that appear later. When you first run TestStand, the list contains a default set of directory paths.

The **External Viewers** command displays a dialog box in which you can specify the external viewer to use for each report format.

The **Adapters** command displays a dialog box in which you can configure a specific module adapter or specify the active module adapter. Refer to the *Configuring Adapters* section in Chapter 13, *Module Adapters*, for more information.

The **Report Options** command displays a dialog box in which you can customize the generation of report files. Refer to Chapter 14, *Process Models*, for more information on available report options.

The **Database Options** command displays a dialog box in which you customize the logging of test result data. Refer to Chapter 18, *Databases*, for more information on available database logging options.

The **Model Options** command displays a dialog box in which you specify process model specific options such as the number of test sockets in the system. Currently, this command is not available when you use the sequential model.

Customizing TestStand

This section outlines methods that you can use to customize a TestStand station.

TestStand Directory Structure

The TestStand installation program installs the TestStand engine, the sequence editor, the module adapters, and additional components on your system. Table 3-2 shows the names and contents of each subdirectory of the TestStand installation.

Table 3-2. TestStand Subdirectories

Directory Name	Contents
`AdapterSupport`	Support files for certain Adapters.
`Api`	Header files and additional utility functions for using the TestStand API in Visual C++, LabWindows/CVI, and other programming environments.
`Bin`	TestStand sequence editor executable, engine DLLs, and support files.
`Cfg`	Configuration files for TestStand engine and sequence editor options.

Table 3-2. TestStand Subdirectories (Continued)

Directory Name	Contents
`CodeTemplates`	Source code templates for step types. This directory contains an `NI` and a `User` subdirectory.
`Components`	Components that come with TestStand and components that you develop. These components include callback files, converters, icons, language files, process model files, step type support files, and utility files. This directory contains an `NI` and a `User` subdirectory.
`Doc`	Documentation files.
`Examples`	Example sequences and tests.
`OperatorInterfaces`	LabVIEW, LabWindows/CVI, Visual Basic, and Delphi operator interfaces with source code. This directory contains an `NI` and a `User` subdirectory.
`Setup`	TestStand Installer/Uninstaller.
`Tutorial`	Sequences and code modules that you use in the tutorial sessions in the *Getting Started with TestStand* manual.

NI and User Subdirectories

Three of the TestStand directories contain source files that you might want to modify or replace. They are the `OperatorInterfaces`, `CodeTemplates`, and `Components` directories. Each directory contains an `NI` and a `User` subdirectory.

TestStand installs its files into the `NI` subdirectory. If you modify these files directly, the installers for newer versions of TestStand might overwrite your customizations. Consequently, it is best to keep the files you create or modify separate from the files that TestStand installs.

For this purpose, the TestStand installer creates a `User` subdirectory tree for you. Not only do you use the `User` subdirectory to protect your customized components, you use it as the staging area for the components that you include in your own run-time distribution of TestStand.

The Components Directory

TestStand installs the sequences, executables, project files, and source files for TestStand components in the `<TestStand>\Components\NI` directory. Most of the subdirectories in the `<TestStand>\Components\NI` directory have the name of a type of TestStand component. For example, the `<TestStand>\Components\NI\StepTypes` subdirectory contains support files for the TestStand built-in step types.

In general, if you want to create a new component or customize a TestStand component, copy the component files from the `NI` subdirectory to the `User` subdirectory before customizing. This ensures that the installers for newer versions of TestStand do not overwrite your customizations. If you copy the component files as the basis for creating a new component, ensure that you rename the files so that your customizations do not conflict with the default TestStand components.

The TestStand engine searches for sequences and code modules using the TestStand search directory path. The default search precedence places the `<TestStand>\Components\User` directory tree before the `<TestStand>\Components\NI` directory tree. This ensures that TestStand loads the sequences and code modules that you customize instead of loading the default TestStand versions of the files. To modify the precedence of the TestStand search directory paths, use **Configure»Search Directories** menu of the sequence editor menu bar.

When you distribute a run-time version of the TestStand engine, you can bundle your components in the `User` directory with the TestStand run-time distribution. Refer to Chapter 17, *Distributing TestStand*, for more information on how to distribute the TestStand engine and your custom components.

Table 3-3 lists each subdirectory in the `NI` and `User` directory trees in `<TestStand>\Components`.

Table 3-3. TestStand Component Subdirectories

Directory Name	Contents
`Callbacks`	The `Callbacks` directory contains the sequence files in which TestStand stores station engine callbacks and front-end callbacks. TestStand installs the station engine and front-end callback files into the `<TestStand>\Components\NI\Callbacks` directory tree. Refer to *Customizing the Engine and Front-End Callbacks* section in this chapter for more information on customizing the station and front-end callbacks.
`Icons`	The `Icons` directory contains icon files for module adapters and step types. TestStand installs the icon files for module adapters and built-in step types into the `<TestStand>\Components\NI\Icons` directory. Refer to the *Creating Step Types* section in this chapter for more information on creating your own icons for your custom step types.

Table 3-3. TestStand Component Subdirectories (Continued)

Directory Name	Contents
`Language`	The `Language` directory contains string resource files. It has one subdirectory per language, for example, `English`. Refer to the *Creating String Resource Files* section in this chapter for more information on creating resource string files in the `Language` directory tree.
`Models`	The `Models` directory contains the default process model sequence files and supporting code modules. Refer to the *Modifying the Process Model* section in this chapter for more information on customizing the process model.
`RuntimeServers`	The `RuntimeServers` directory contains a LabVIEW run-time application for executing LabVIEW code modules. Refer to the *Customizing and Distributing a LabVIEW Run-Time Server* section in Chapter 17, *Distributing TestStand*, for more information on using LabVIEW run-time servers.
`StepTypes`	The `StepTypes` directory contains support files for step types. TestStand installs the support files for the built-in step types into the `<TestStand>\Components\NI\StepTypes` directory tree. Refer to the *Creating Step Types* section in this chapter for more information on customizing your own step types.
`Tools`	The `Tools` directory contains sequences and supporting files for the **Tools** menu commands. Refer to the *Using the Tools Menu* section in this chapter for more information on customizing the **Tools** menu.

Creating String Resource Files

TestStand uses the `GetResourceString` function to obtain the string messages that it displays on windows and dialog boxes in the sequence editor and operator interfaces. `GetResourceString` works with string resource files that are in a `.ini` style format. `GetResourceString` takes a string category and a tag name as arguments. `GetResourceString` searches for the string resource in all string resource files that are in a predefined set of directories.

The directory search order is as follows:

1. `<TestStand>\Components\User\Language\<`*`current language`*`>`
2. `<TestStand>\Components\User\Language`
3. `<TestStand>\Components\NI\Language\<`*`current language`*`>`

4. `<TestStand>\Components\NI\Language\English`
5. `<TestStand>\Components\NI\Language`

To change the current language setting, select **Configure»Station Options**.

TestStand installs the default resource string files in the `<TestStand>\Components\NI\Language` directory tree. If you want to customize a resource string file for a different language, you must copy an existing language file from the `NI` directory tree, place it in the `User` directory tree in a language subdirectory, and modify it. If you want to create a resource string file that applies to all languages, place the resource file in the base `<TestStand>\Components\User\Language` directory.

If you want to create your own resource string file for your custom components, ensure that the category names inside the resource file are unique so that they do not conflict with any names that TestStand uses.

Note The TestStand engine loads resource files when you start the TestStand application. If you make changes to the resource files, you need to restart the TestStand application for the changes to take effect.

Resource String File Format

Each string resource file must have the `.ini` file extension. The format of a string resource file is as follows:

```
[category1]
tag1 = "string value 1"
tag2 = "string value 2"

[category2]
tag1 = "string value 1"
tag2 = "string value 2"
```

Note When you create new entries in a string resource file, begin your category name with a unique ID such as a company prefix. Using a unique ID will prevent name collision. For example, `NI_SUBSTEPS` uses NI as a unique ID.

When you specify custom resource strings, you create the category and tag names. The number of categories and tags is unlimited.

A string can be of unlimited size. If a string has more than 512 characters, you must break it into multiple lines. Each line has a tag suffix of `line`*`NNNN`*, where *`NNNN`* is the line number with zero padding. The following is an example of a multiple-line string:

```
[category1]
tag1 line0001 = "This is the first line of a very long"
tag1 line0002 = "paragraph. This is the second line"
```

You can use escape codes to insert unprintable characters. Table 3-4 lists the escape codes you can use.

Table 3-4. Resource String File Escape Codes

Escape Code	Description
`\n`	Linefeed character.
`\r`	Carriage return character.
`\t`	Tab character.
`\x`*`nn`*	Hexadecimal value. For example, `\x1B` represents the ASCII ESC character, which has a decimal value of 27.
`\\`	Backslash character.

The following string shows how to use `\n`, the embedded linefeed character:

```
tag1 = "This is line one.\nThis is line two"
```

Using Data Types

You can use data types to define station globals, sequence file globals, sequence locals, or properties of steps and step types. You can create and modify your own data types in TestStand. You also can modify the TestStand standard named data types by adding subproperties to them. Refer to the *Creating and Modifying Data Types* and *Using the Standard Named Data Types* sections in Chapter 9, *Types*, for more information.

Creating Step Types

If you want to change or enhance a TestStand built-in step type, do not edit the built-in step type or any of its supporting source code modules. Instead, copy and rename the built-in step type in the sequence editor. Also, copy its supporting modules from the `<TestStand>\Components\NI\StepTypes` directory tree to `<TestStand>\Components\User\StepTypes` directory. Make the changes to the copies. This practice ensures that a newer installation of TestStand does not overwrite your customizations. Refer to the *Using Step Types* section in Chapter 9, *Types*, for more information on step types and how you use them.

When you create a new step type, you can designate a specific icon to associate with that step type. The TestStand engine loads all available icons when you start the engine, so you must restart the sequence editor before you can associate a new icon with a step type. The `<TestStand>\Components\NI\Icons` directory contains icon files for the TestStand engine, the module adapters, and the built-in step types. If you want to override the `<TestStand>\Components\NI` icons or load icons for your `<TestStand>\Components\User\Icons` directory and restart the engine. The TestStand engine loads all icons from the `<TestStand>\Components\User\Icons` and `<TestStand>\Components\NI\Icons` directories. If an icon of the same name exists in both directories, the TestStand engine uses the one from the `<TestStand>\Components\User\Icons` directory. The TestStand engine does not search for icon files in any other directories.

Note When you create new step types, begin your type with a unique ID such as a company prefix. Using a unique ID will prevent name collision. For example, `NI_PropertyLoader` uses NI as a unique ID.

Using the Tools Menu

The `<TestStand>\Components\NI\Tools` directory contains sequences and supporting files for the default TestStand **Tools** menu commands. The tools include a documentation generator, converters for LabVIEW and LabWindows/CVI Test Executive toolkit sequences, and a database viewer application.

If you want to create your own **Tools** menu commands, place any supporting code modules in the `<TestStand>\Components\User\Tools` directory tree. If you want to change or enhance a TestStand **Tools** menu command, do not edit the supporting source code modules. Instead, copy the files to `<TestStand>\Components\User\Tools` directory tree, and make the changes to this copy. This practice ensures that a newer installation of TestStand does not overwrite your customizations.

Refer to the *Tools Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information on how to add your own commands to the **Tools** menu.

Refer to Chapter 17, *Distributing TestStand*, for more information on distributing a custom **Tools** menu with the run-time version of TestStand.

Customizing the Engine and Front-End Callbacks

The `<TestStand>\Components\NI\Callbacks` directory tree contains sequences and supporting files for the default TestStand front-end and station engine callbacks. TestStand installs the station engine callbacks in the `Station` subdirectory and the front-end callbacks in the `FrontEnd` subdirectory.

You can replace these callbacks individually. To do so, you must create a callback file in the `<TestStand>\Components\User\Callbacks` directory tree that has same name and relative location as the `NI` directory copy. For example, the `FrontEndCallbacks.seq` in the `<TestStand>\NI\Callbacks\FrontEnd` directory contains the default `LoginLogout` callback. To override `LoginLogout`, create a `LoginLogout` sequence in a new version of `FrontEndCallbacks.seq` in the `<TestStand>\User\Callbacks\FrontEnd` directory. TestStand then loads the `LoginLogout` sequence from the `User` directory instead of from the `NI` directory.

Refer to the *Callback Sequences* section in Chapter 1, *TestStand Architecture Overview*, for an overview of the different categories of callbacks. Refer to the *Engine Callbacks* section in Chapter 6, *Sequence Execution*, for more information on engine callbacks.

Note You must not define a `SequenceFileUnload` callback in the `FrontEndCallback.seq` or `StationCallbacks.seq` sequence files. If you make this error, TestStand hangs when you shut down the TestStand engine.

Modifying the Process Model

TestStand installs the process model sequence files, `SequentialModel.seq`, `ParallelModel.seq`, and `BatchModel.seq`, and their supporting files into the `<TestStand>\Components\NI\Models\TestStandModels` directory.

If you want to change or enhance the process model files, copy the entire contents of the `<TestStand>\Components\NI\Models\TestStandModels` directory to `<TestStand>\Components\User\Models` and make the changes to the copies. This practice ensures that a newer installation of TestStand does not overwrite your customizations.

For example, if you want to change the HTML report output for all sequences, copy the `reportgen_html.seq` from the `NI` directory tree to the `User` directory tree and make changes to the copy.

Refer to Chapter 14, *Process Models*, for more information on the default process model.

Refer to Chapter 15, *Managing Reports*, for more information on customizing the reports that TestStand generates.

Using Process Model Callbacks

Model callbacks allow you to customize the behavior of a process model for each main sequence that uses it. By defining one or more model callbacks in a process model, you specify which process model operations the sequence developer can customize. You can override the callback in the model sequence file by using the Sequence File Callbacks dialog box to create a sequence of the same name in the client sequence file.

Refer to the *Process Models* section in Chapter 1, *TestStand Architecture Overview*, for an overview of process models and model callbacks. Refer to Chapter 14, *Process Models*, for more information on the default process model and its callbacks.

Creating Code Templates

When you create step types, you can associate one or more code templates with the step type. Each code template has a name. TestStand installs its code templates in the `<TestStand>\CodeTemplates\NI` directory tree, where each subdirectory name is the name of a code template. Each code template has different source code files for each module adapter. TestStand stores the source files for the different module adapters in the template subdirectory. TestStand also maintains a `.ini` file in each template subdirectory. The `.ini` file contains a description string that TestStand uses for the code template. TestStand installs a default template in the `Default_Template` subdirectory.

Refer to the *Code Templates Tab* section in Chapter 9, *Types*, for more information on using and creating your own code templates.

Modifying Run-Time Operator Interfaces

TestStand installs the executable, project, and source files for each run-time operator interface in the `<TestStand>\OperatorInterfaces\NI` directory tree. If you want to customize one of the run-time operator interfaces, copy the operator interface project and source files from the `NI` subdirectory to the `<TestStand>\OperatorInterfaces\User` subdirectory before customizing. This practice ensures that a newer installation of TestStand does not overwrite your customizations.

Refer to Chapter 16, *Run-Time Operator Interfaces*, for more information on the operator interfaces that come with TestStand.

Adding Users and Managing User Privileges

To add users to the TestStand user list, select **Configure»User Manager**. Refer to Chapter 12, *User Management*, for more information on adding new users, changing user privileges, and adding new user privileges.

4 Sequence Editor Menu Bar

This chapter describes the menu items in the sequence editor menu bar.

Menus

The sequence editor menu bar contains commands that apply to the entire test station. This section contains descriptions of the menu items in the sequence editor menu bar. For some commands, the description summarizes the features of the command and refers you to additional information later in this document.

File Menu

This section describes the **File** menu shown in Figure 4-1.

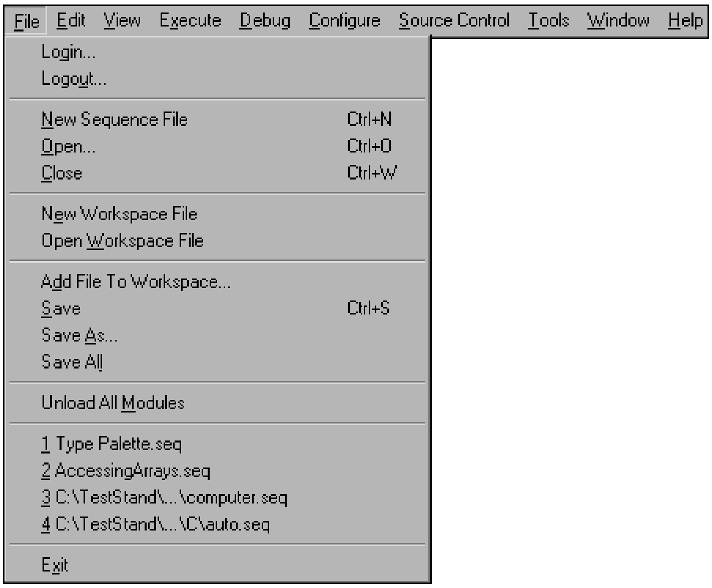


Figure 4-1. File Menu

Login

The **Login** command, which automatically executes when you open the sequence editor, prompts you for a login name and password. If you click the **Cancel** button, TestStand gives you no privileges. Use the **Login** command to log in as a different user. Each user can have different privilege settings, so logging in as a different user can change your privileges. Refer to Chapter 12, *User Management*, for more information.

Logout

The **Logout** command logs out the current user and displays the Login prompt.

New

Use the **New** command to create a new Sequence File window.

Open

Use the **Open** command to open an existing sequence file. When you select **Open**, a dialog box appears prompting you to choose a file to load into a new window.

Close

Use the **Close** command to close an existing window. When you select **Close**, a dialog box might appear, prompting you to save any changes before closing the window.

New Workspace

Use the **New Workspace** command to create a new workspace. Only one workspace can be open at a time. If a workspace is already open, TestStand closes it before creating a new workspace.

Open Workspace

Use the **Open Workspace** command to load an existing workspace file. Only one workspace can be open at a time. If a workspace is already open, TestStand closes it before opening a new workspace.

Save

Use the **Save** command to write the contents of the active Sequence File window to disk.

Save As

Use the **Save As** command to write the contents of the active Sequence File window to disk using a new name that you enter. The title bar on the Sequence File window displays the new name.

To save a sequence file in TestStand 1.0.*x* format, select **File»Save As** from the sequence editor and select TestStand 1.0.*x* Sequence File from the Save as Type control.

Note If your TestStand sequence file contains step types that are not present in previous versions of TestStand or if it uses TestStand features that previous versions of TestStand do not support, the sequence file you save in 1.0.*x* format will not function correctly. TestStand does not warn you if the file you save cannot load or run in a previous version of TestStand.

Save All

The **Save All** command saves all open files to disk, which includes sequence files, globals, type palette, users, and configuration information.

Unload All Modules

The **Unload All Modules** command removes from memory all step code modules, all code modules that substeps call, and all sequence files that are not currently in a window. You can use this command only if no executions are active. This command is useful when you want to rebuild a DLL after an execution, but the DLL is still loaded in TestStand. The ADE that you use to build the DLL cannot write out the new contents of the DLL until TestStand unloads it.

Most Recently Opened Files

For your reference, a list of the most recently opened files appears in the **File** menu.

Exit

Use the **Exit** command to close the current sequence editor session. If you have modified any open files since the last save, or if any windows contain unnamed files, the sequence editor prompts you to save them.

Edit Menu

You use the items in the **Edit** menu for editing sequences and steps. Figure 4-2 shows the **Edit** menu.

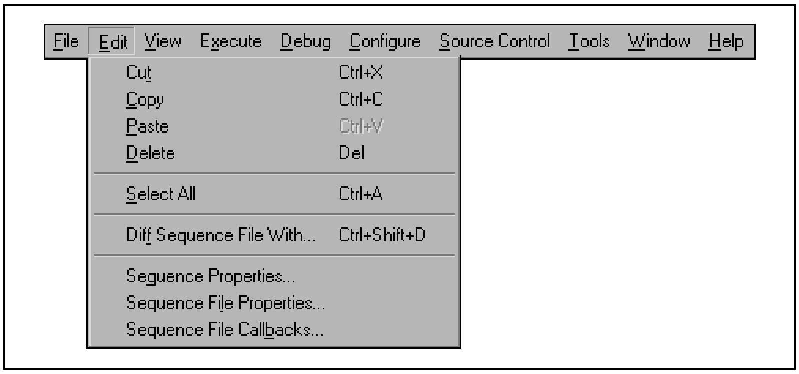


Figure 4-2. Edit Menu

Cut and Copy

The **Cut** and **Copy** commands place text or an object in the clipboard. The **Cut** command removes the selected text or object and places it in the clipboard. The **Copy** command copies the selected text or object and places it in the clipboard, leaving the original in place.

The text or object that you cut or copy does not remain in the clipboard. Every time you cut or copy text or an object, you replace the previous contents of the clipboard.

Paste

The **Paste** command inserts text or an object from the clipboard. You can paste text or an object from the clipboard as many times as you like. The text or object that you paste remains in the clipboard until you use **Cut** or **Copy** again.

Delete

The **Delete** command deletes selected text or object without replacing the contents of the clipboard. Because **Delete** does not place the selected text or object in the clipboard, you cannot use the **Paste** command to restore it.

Select All

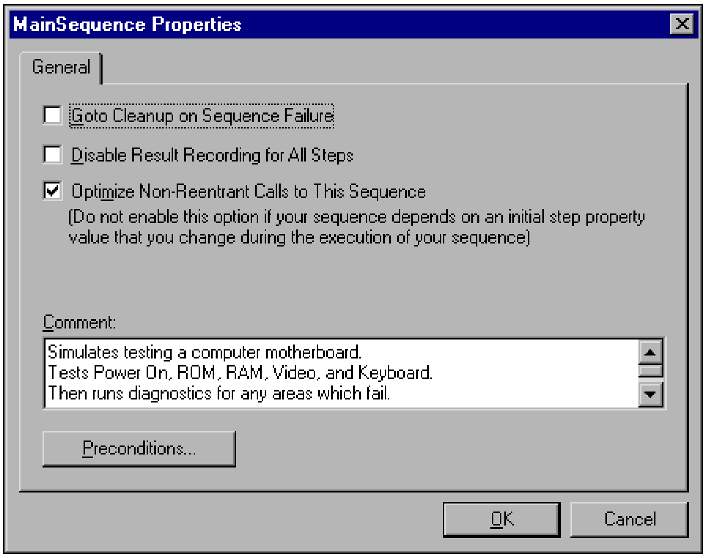
The **Select All** command highlights all the objects in the active window.

Diff Sequence File With

The Diff Sequence File With command enables you to select a sequence file to compare with the selected sequence file. A Differences window displays the differences between the two files. As you view the differences, you can transfer individual changes between the files. You cannot compare differences for a new sequence file until you save the file on disk.

Sequence Properties

The **Sequence Properties** command displays the properties for a selected sequence in the active Sequence File window, as shown in Figure 4-3. Refer to the *Sequence View Context Menu* section in Chapter 5, *Sequence Files*, for more information.


MainSequence Properties

General

[ ] Goto Cleanup on Sequence Failure

[ ] Disable Result Recording for All Steps

[✓] Optimize Non-Reentrant Calls to This Sequence
(Do not enable this option if your sequence depends on an initial step property value that you change during the execution of your sequence)

Comment:

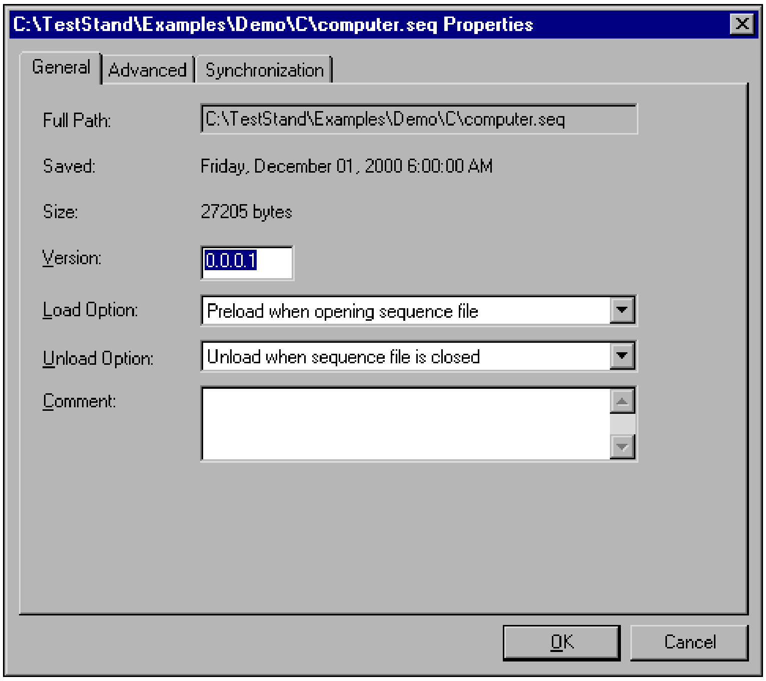
Simulates testing a computer motherboard.
Tests Power On, ROM, RAM, Video, and Keyboard.
Then runs diagnostics for any areas which fail.

Figure 4-3. Sequence Properties Dialog Box

Sequence File Properties

The **Sequence File Properties** command displays the pathname, disk size, and disk date of the active sequence file. You also can use it to edit various properties of a sequence file, including the load and unload options, a comment, and the sequence file type. If the sequence file type is normal, you also can specify a process model file for the sequence file.

Figure 4-4 shows the Sequence File Properties dialog box.



Full Path: C:\TestStand\Examples\Demo\C\computer.seq
Saved: Friday, December 01, 2000 6:00:00 AM
Size: 27205 bytes
Version: 0.0.0.1
Load Option: Preload when opening sequence file
Unload Option: Unload when sequence file is closed
Comment:

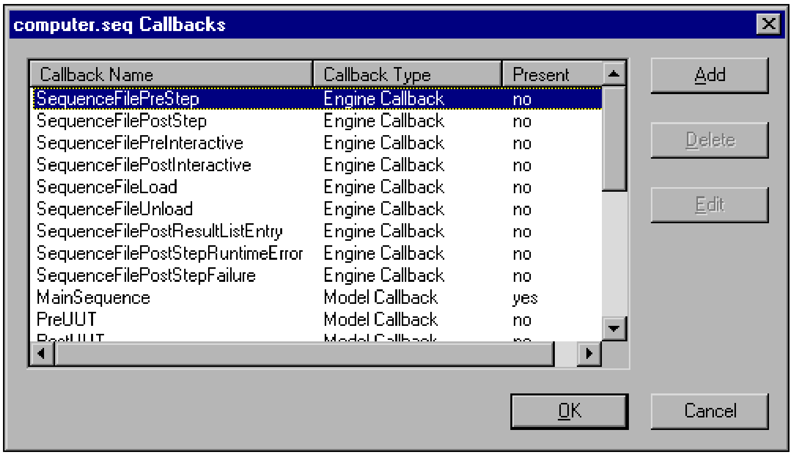
Figure 4-4. Sequence File Properties Dialog Box

Refer to the *Sequence View Context Menu* section in Chapter 5, *Sequence Files*, for more information on sequence file properties.

Sequence File Callbacks

The **Sequence File Callbacks** command displays a dialog box of all callbacks that you can override in the sequence file. This includes the Engine Callbacks that TestStand defines, and the Model Callbacks that the process model for the sequence file defines.

Figure 4-5 shows the Sequence File Callbacks dialog box.



Callback Name	Callback Type	Present
SequenceFilePreStep	Engine Callback	no
SequenceFilePostStep	Engine Callback	no
SequenceFilePreInteractive	Engine Callback	no
SequenceFilePostInteractive	Engine Callback	no
SequenceFileLoad	Engine Callback	no
SequenceFileUnload	Engine Callback	no
SequenceFilePostResultListEntry	Engine Callback	no
SequenceFilePostStepRuntimeError	Engine Callback	no
SequenceFilePostStepFailure	Engine Callback	no
MainSequence	Model Callback	yes
PreUUT	Model Callback	no

Figure 4-5. Sequence File Callbacks Dialog Box

Refer to the *Sequence View Context Menu* section in Chapter 5, *Sequence Files*, for more information on using the Sequence File Callbacks dialog box.

View Menu

This section explains how to use the commands in the **View** menu. Figure 4-6 shows the **View** menu.

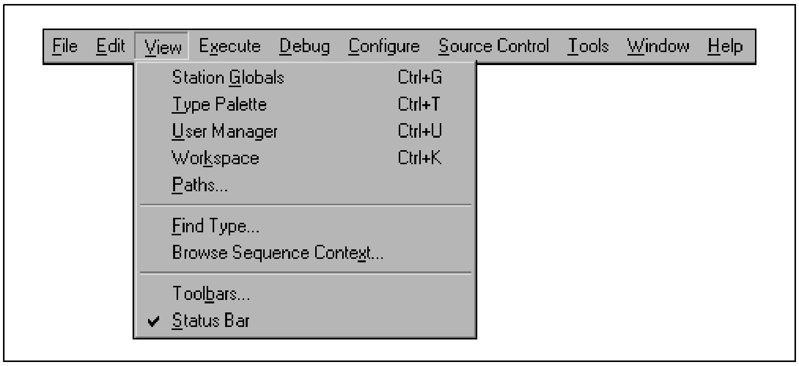


Figure 4-6. View Menu

Station Globals

The **Station Globals** command displays a window containing the station global variables and the types they use, including built-in and custom data types. For a detailed discussion of station globals, refer to Chapter 7, *Station Global Variables*.

Type Palette

The **Type Palette** command displays a list of commonly used step types, built-in data types, and custom data types. For a detailed discussion of the types and the type palette, refer to Chapter 9, *Types*.

User Manager

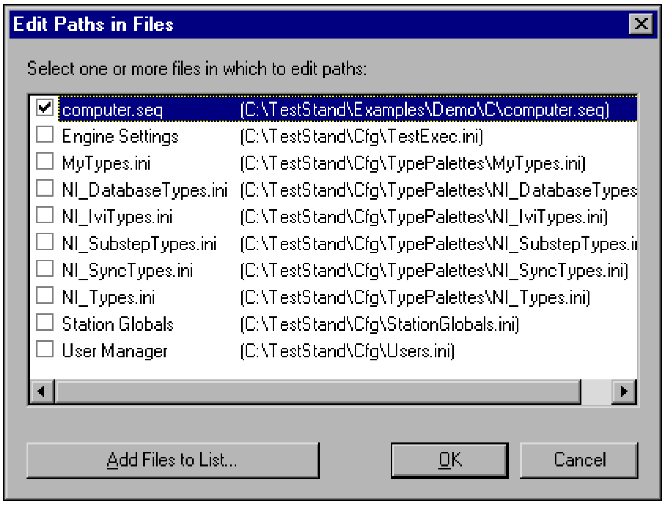
The **User Manager** command displays a window for managing TestStand users and their privileges. From this window you can add new users, update user privileges, and change the types of privileges that users can have. For a detailed discussion of user management, refer to Chapter 12, *User Management*.

Workspace

The Workspace command displays a window for managing projects. You can organize files into projects so that you are able to quickly open related files. You also can use the Workspace window to check files and projects in or out of various source code control systems. TestStand disables the Workspace menu item when no workspace is loaded. For more information on the workspace, refer to the *Workspace Window* section of Chapter 2, *Sequence Editor Concepts*.

Paths

The **Paths** command lets you modify the directory portion of pathnames in sequence files and station configuration files. This can be useful after you copy a sequence file or configuration file from one computer to another. Figure 4-7 shows the Edit Paths in Files dialog box.


Edit Paths in Files

Select one or more files in which to edit paths:

☑	computer.seq	(C:\TestStand\Examples\Demo\C\computer.seq)
☐	Engine Settings	(C:\TestStand\Cfg\TestExec.ini)
☐	MyTypes.ini	(C:\TestStand\Cfg\TypePalettes\MyTypes.ini)
☐	NI_DatabaseTypes.ini	(C:\TestStand\Cfg\TypePalettes\NI_DatabaseTypes
☐	NI_IviTypes.ini	(C:\TestStand\Cfg\TypePalettes\NI_IviTypes.ini)
☐	NI_SubstepTypes.ini	(C:\TestStand\Cfg\TypePalettes\NI_SubstepTypes.i
☐	NI_SyncTypes.ini	(C:\TestStand\Cfg\TypePalettes\NI_SyncTypes.ini)
☐	NI_Types.ini	(C:\TestStand\Cfg\TypePalettes\NI_Types.ini)
☐	Station Globals	(C:\TestStand\Cfg\StationGlobals.ini)
☐	User Manager	(C:\TestStand\Cfg\Users.ini)

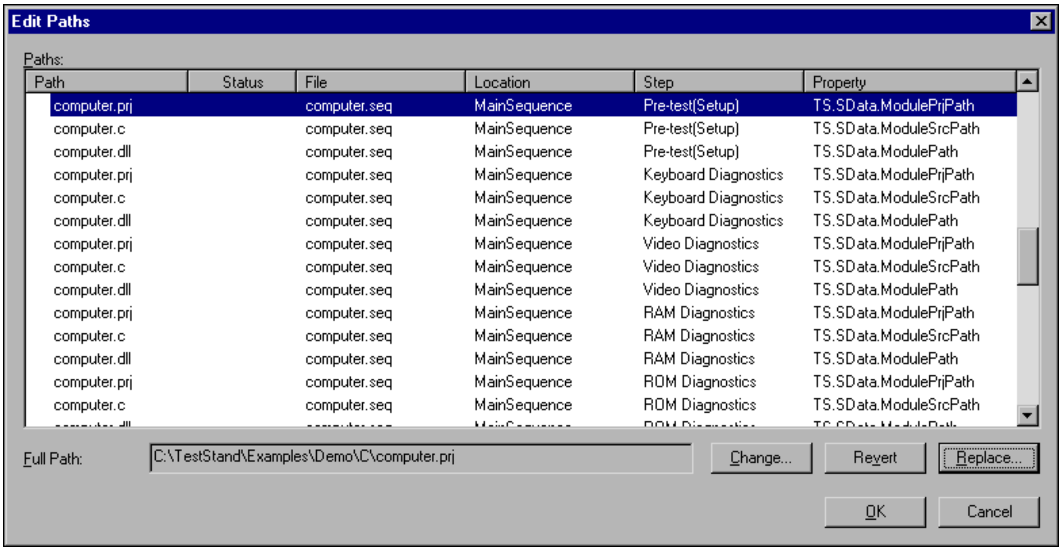
Figure 4-7. Edit Paths in Files Dialog Box

The list box contains the station configuration files and sequence files currently in memory. For each of the sequence files in memory, the list box shows the simple filename and the complete pathname. For each of the station configuration files, the list box shows a symbolic tag and a pathname. The following are the symbolic tags and purposes of the station configuration files:

- `Engine Settings` is the file in which TestStand stores the station options.
- `Station Globals` is the file in which TestStand stores that names and values of the station global variables.
- `User Manager` is the file in which TestStand stores the information regarding the user manager.

To edit the paths in one of the files in the list box, double-click the file. To edit paths in multiple files in the list box, select the files and click the **OK** button. To edit the paths in a sequence file that is not in the list box, use the **Add Files to List** button.

When you select one or more files to edit, the Edit Paths dialog box appears. Figure 4-8 shows the Edit Paths dialog box.



Path	Status	File	Location	Step	Property
computer.prj		computer.seq	MainSequence	Pre-test(Setup)	TS.SData.ModulePrjPath
computer.c		computer.seq	MainSequence	Pre-test(Setup)	TS.SData.ModuleSrcPath
computer.dll		computer.seq	MainSequence	Pre-test(Setup)	TS.SData.ModulePath
computer.prj		computer.seq	MainSequence	Keyboard Diagnostics	TS.SData.ModulePrjPath
computer.c		computer.seq	MainSequence	Keyboard Diagnostics	TS.SData.ModuleSrcPath
computer.dll		computer.seq	MainSequence	Keyboard Diagnostics	TS.SData.ModulePath
computer.prj		computer.seq	MainSequence	Video Diagnostics	TS.SData.ModulePrjPath
computer.c		computer.seq	MainSequence	Video Diagnostics	TS.SData.ModuleSrcPath
computer.dll		computer.seq	MainSequence	Video Diagnostics	TS.SData.ModulePath
computer.prj		computer.seq	MainSequence	RAM Diagnostics	TS.SData.ModulePrjPath
computer.c		computer.seq	MainSequence	RAM Diagnostics	TS.SData.ModuleSrcPath
computer.dll		computer.seq	MainSequence	RAM Diagnostics	TS.SData.ModulePath
computer.prj		computer.seq	MainSequence	ROM Diagnostics	TS.SData.ModulePrjPath
computer.c		computer.seq	MainSequence	ROM Diagnostics	TS.SData.ModuleSrcPath

Full Path: C:\TestStand\Examples\Demo\C\computer.prj

Figure 4-8. Edit Paths Dialog Box

Each entry in the list box of the Edit Paths dialog box represents a property that has the `Path` data type. The list box contains many columns of information for each entry. The Path column displays the current value of the property. The current value can be a simple pathname, a relative pathname, or an absolute pathname. The Status column displays `Empty` when the current value of the property is an empty pathname. The Status column displays `Not found` when TestStand cannot find the pathname on disk. The File column displays the name of the file that contains the property. The Sequence column displays the name of the sequence, if any, that contains the property. The location column specifies that particular part of the sequence that contains the property, for example, a step type or one of the step groups. The Step column displays the name of the step or substep, if any, that contains the property. The Property column displays the name of the property.

The Full Path indicator in the bottom left corner of the dialog box shows the absolute pathname to which TestStand can resolve the current value of the selected path. TestStand searches for the file through the search paths you enter using the Search Directories dialog box. If TestStand cannot find the file, the Full Path indicator shows `Not found`.

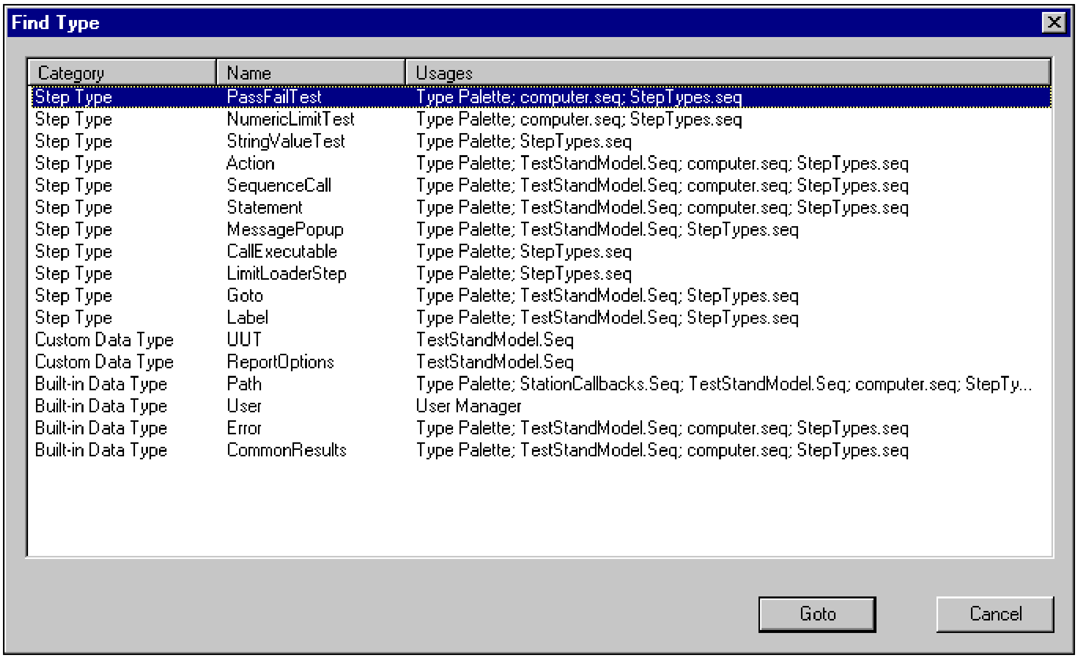
Use the **Change** button to browse on disk for the file to which you want the path value to refer. If you find such a file, a dialog box prompts you to set the path value to the absolute pathname or to save the directory path in the list of search paths.

Use the **Revert** button to set the selected path to the value it had when you opened the dialog box.

Use the **Replace** button to change a substring in one or more of the path values. This is particularly useful for path values that are absolute pathnames. For example, if several pathnames begin with `c:\myfiles`, but the files are now in `d:\testfiles`, you can use the **Replace** button to change all instances of `c:\myfiles` in the list to `d:\testfiles`.

Find Type

The **Find Type** command displays a dialog box that contains a list of all types currently in memory. TestStand generates the list of types from all sequences currently in memory, the types that the user manager uses, the types that station global variables use, and types in the Type Palette window. To jump to the window that contains a type, double-click on the type or select the type and then click the **Goto** button. Figure 4-9 shows the Find Type dialog box.

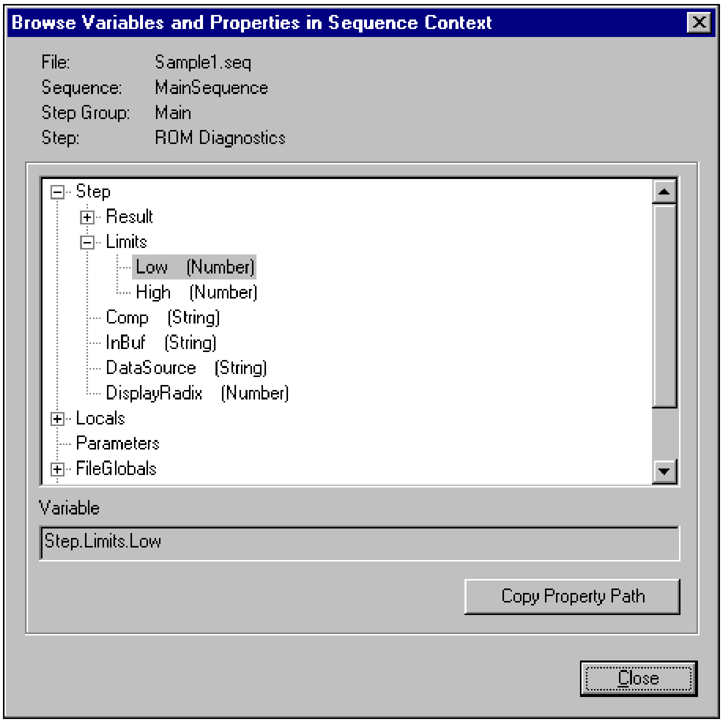


Category	Name	Usages
Step Type	PassFailTest	Type Palette; computer.seq; StepTypes.seq
Step Type	NumericLimitTest	Type Palette; computer.seq; StepTypes.seq
Step Type	StringValueTest	Type Palette; StepTypes.seq
Step Type	Action	Type Palette; TestStandModel.Seq; computer.seq; StepTypes.seq
Step Type	SequenceCall	Type Palette; TestStandModel.Seq; computer.seq; StepTypes.seq
Step Type	Statement	Type Palette; TestStandModel.Seq; computer.seq; StepTypes.seq
Step Type	MessagePopup	Type Palette; TestStandModel.Seq; StepTypes.seq
Step Type	CallExecutable	Type Palette; StepTypes.seq
Step Type	LimitLoaderStep	Type Palette; StepTypes.seq
Step Type	Goto	Type Palette; TestStandModel.Seq; StepTypes.seq
Step Type	Label	Type Palette; TestStandModel.Seq; StepTypes.seq
Custom Data Type	UUT	TestStandModel.Seq
Custom Data Type	ReportOptions	TestStandModel.Seq
Built-in Data Type	Path	Type Palette; StationCallbacks.Seq; TestStandModel.Seq; computer.seq; StepTy...
Built-in Data Type	User	User Manager
Built-in Data Type	Error	Type Palette; TestStandModel.Seq; computer.seq; StepTypes.seq
Built-in Data Type	CommonResults	Type Palette; TestStandModel.Seq; computer.seq; StepTypes.seq

Figure 4-9. Find Type Dialog Box

Browse Sequence Context

The **Browse Sequence Context** command displays a tree view of variable and property names, as shown in Figure 4-10. A *sequence context* is the TestStand API object that contains the variables and properties that you can access at a particular point during execution.



File: Sample1.seq
Sequence: MainSequence
Step Group: Main
Step: ROM Diagnostics

```
Step
    Result
    Limits
        Low   (Number)
        High   (Number)
    Comp   (String)
    InBuf   (String)
    DataSource   (String)
    DisplayRadix   (Number)
Locals
Parameters
FileGlobals
```

Variable: Step.Limits.Low

Figure 4-10. Browse Variables and Properties in Sequence Context Dialog Box

The tree view shows variables and properties that you can access in expressions or in step modules. The set of variable and property names that appears in the tree view depends on the active window and the currently selected item.

For example, the `Step` base property name appears when you use **Browse Sequence Context** on a step in the active sequence window. A text message above the tree view describes the active window and selected item.

The variables and properties that you can access at run time differ depending on the state of execution.

In expressions you access the value of a variable or property by entering a *path* from the sequence context to the particular variable or property. For example, you can set the status of a step using the following expression:

```
Step.Result.Status = "Passed"
```

In step modules, you access the value of a variable or property by using `PropertyObject` methods in the TestStand API on the sequence context. As with expressions, you must specify a path from the sequence context to the particular property or variable.

You can use the dialog box for the **Browse Sequence Context** command to help you to build a string literal that specifies the path to a station variable, sequence file variable, sequence local variable, sequence parameter, or step property. Selecting **Copy Variable Name** copies the string literal to the system clipboard, which you can then paste into an expression or into the code for a step module.

Toolbars

The **Toolbars** command displays a list of available toolbars. Visible toolbars have checkmarks beside them in the toolbar list.

Status Bar

Use the **Status Bar** command to specify whether the status bar is visible at the bottom of the main window. When the status bar is visible, a checkmark appears beside this command in the menu.

Launch Report Viewer

Use the **Launch Report Viewer** command to display the report for the current Execution window in the external viewer associated with the report format. This option is available only when an Execution window is active and the execution is complete.

Execute Menu

This section explains how to use the commands in the **Execute** menu shown in Figure 4-11.

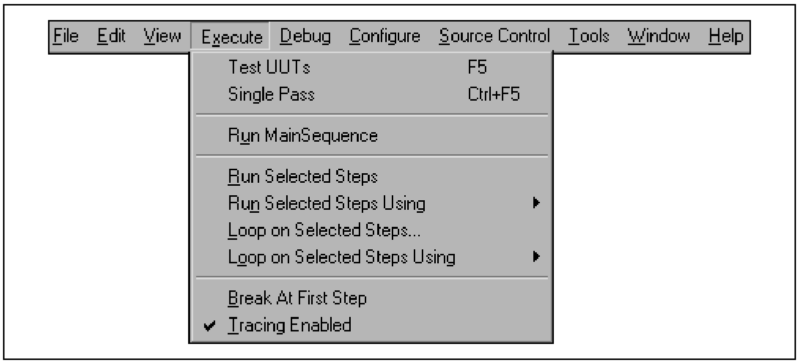


Figure 4-11. Execute Menu

Execution Entry Point List

Model execution entry points appear at the top of the **Execute** menu. For example, the default TestStand process model provides two entry points: `Test UUTs` and `Single Pass`. When you select a model entry point you invoke an execution using the active sequence. Refer to the *Starting an Execution* section in Chapter 6, *Sequence Execution*, for more information on using execution entry points to start an execution.

Run Active Sequence

Use the **Run Active Sequence** command to initiate an execution of the active sequence without using a process model.

Restart

Use the **Restart** command to rerun a completed execution. This option is available only when an Execution window is active and the execution is complete.

Run Selected Steps

To execute selected steps in a sequence interactively, choose **Run Selected Steps**. If you execute steps in a Sequence File window, you initiate the interactive execution as an independent, top-level execution. If you execute steps in an Execution window for a sequence execution that is suspended, you initiate the interactive execution as an extension of the suspended execution.

Refer to the *Interactively Executing Steps* section in Chapter 6, *Sequence Execution*, for more information on running steps interactively.

Run Selected Steps Using

To interactively execute selected steps using the process model entry point you select, choose **Run Selected Steps Using**. When you execute the steps with an entry point such as Single Pass, the process model can generate a report and log the results to a database. The **Run Selected Steps Using** command is available only in a sequence file window.

Loop on Selected Steps

To execute and loop on selected steps in a sequence interactively, choose **Loop on Selected Steps**. Figure 4-12 shows the Loop Count tab in the Loop on Selected Steps dialog box.

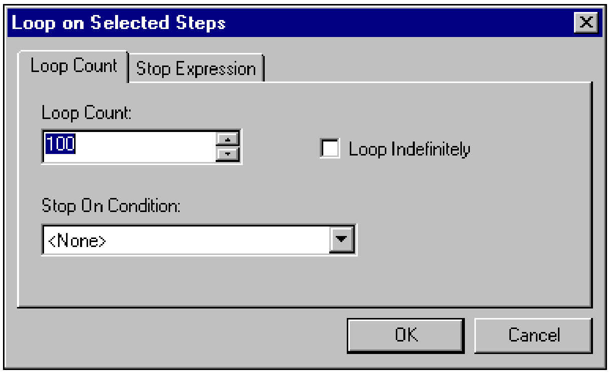
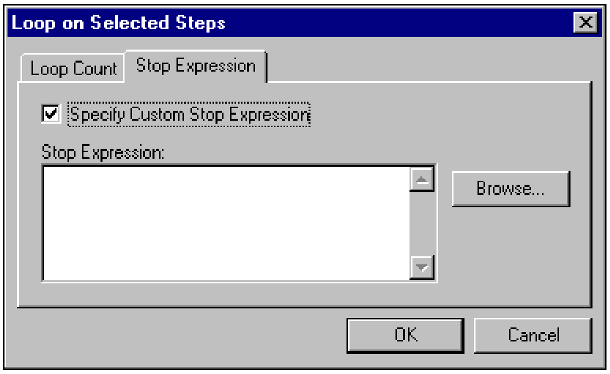


Figure 4-12. Loop on Selected Steps Dialog Box—Loop Count Tab

The Loop Count control specifies the maximum number of times that TestStand executes the selected steps. If you enable the Loop Indefinitely checkbox, the Loop Count control dims. You also can specify that TestStand stop the interactive execution when any step status is error, pass, or fail. If you want TestStand to evaluate a custom expression after each step executes to determine whether TestStand continues the interactive execution, you can use the Stop Expression tab to specify the expression. The stop expression must evaluate to a Boolean value. TestStand stops looping if the stop expression evaluates to True.

Figure 4-13 shows the Stop Expression tab. When you enable the Specify Custom Stop Expression checkbox, the Stop On Condition control dims on the Loop Count tab.



[✓] Specify Custom Stop Expression

Stop Expression:

Figure 4-13. Loop on Selected Steps Dialog Box—Stop Expression Tab

If you execute steps in a Sequence File window, you initiate the interactive execution as an independent, top-level execution. If you execute steps in an Execution window for a sequence execution that is suspended, you initiate the interactive execution as an extension of the suspended execution.

Refer to the *Interactively Executing Steps* section in Chapter 6, *Sequence Execution*, for more information on running steps in a loop interactively.

Loop on Selected Steps Using

Use **Loop on Selected Steps Using** to interactively loop on the selected steps using the process model entry point you select. When you loop on steps with an entry point such as Single Pass, the process model can generate a report and log the results to a database. The **Loop on Selected Steps Using** command is available only in a sequence file window.

Break On First Step

Use **Break On First Step** to suspend execution on the first step that you execute whenever you initiate execution in the active sequence. When enabled, this command has a checkmark beside it in the menu.

Tracing Enabled

Use **Tracing Enabled** to highlight each step as it becomes the active step during execution. When you disable this feature, updates to the sequence execution display occur only when execution is suspended. When enabled, this command has a checkmark beside it in the menu.

Debug Menu

This section explains how to use the commands in the **Debug** menu shown in Figure 4-14.

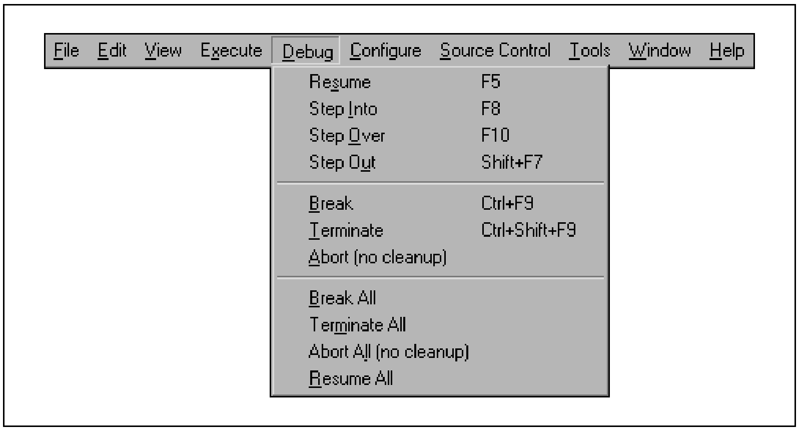


Figure 4-14. Debug Menu

Resume

Use the **Resume** command to continue execution when your sequence execution is in a breakpoint state.

Step Over

Use the **Step Over** command to execute the step that the execution pointer points to when your sequence execution is in a breakpoint state. If the step is a call to another sequence, **Step Over** executes the entire sequence and then enters a breakpoint state on the step following the sequence step. If the engine encounters a breakpoint within the sequence step, **Step Over** pauses at the breakpoint.

Step Into

The **Step Into** command is similar to the **Step Over** command except that **Step Into** enters and suspends within the function, VI, or sequence that the step calls. If the step calls a code module that TestStand cannot suspend within, TestStand suspends the execution at the following step.

Step Out

The **Step Out** command resumes execution through the end of the current sequence and breakpoints on the next step in the calling sequence.

Break

The **Break** command suspends the active execution after completing the execution of the current step.

Terminate

The **Terminate** command terminates a running or suspended execution. A running execution terminates only after completing the currently executing step. When you terminate an execution, TestStand runs the Cleanup step groups for all active sequences on the call stack.

Note If any of your step modules wait for user input or do not return quickly for any other reason, the step module can use the `Execution` class in the TestStand API to monitor for termination or abort requests.

Abort (no cleanup)

The **Abort** command aborts a running or suspended execution. A running execution aborts only after completing the currently executing step. When an execution aborts, TestStand does not run any Cleanup step groups.

Note If any of your step modules wait for user input or do not return quickly for any other reason, the step module can use the `Execution` class in the TestStand API to monitor for termination or abort requests.

Break All

The **Break All** command is similar to the **Break** command except that **Break All** suspends all running executions.

Terminate All

The **Terminate All** command is similar to the **Terminate** command except that **Terminate All** terminates all running executions.

Abort All (no cleanup)

The **Abort All** command is similar to the **Abort** command except that **Abort All** aborts all running executions.

Resume All

The **Resume All** command is similar to the **Resume** command except that **Resume All** continues all suspended executions.

Configure Menu

This section describes how to use the commands in the **Configure** menu shown in Figure 4-15.

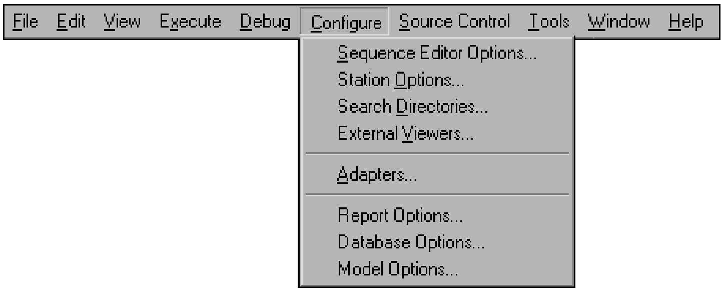


Figure 4-15. Configure Menu

Sequence Editor Options

Use the **Sequence Editor Options** command to set preferences for the sequence editor. The command displays a dialog box with the following options:

- **Display Warning on Run Mode Changes in Execution Window**—Displays a warning dialog box when you modify the run mode for a step in an Execution window. When you modify the run mode in a Sequence File window, the modification applies to all subsequent executions, and TestStand writes the new run mode to disk when you save the sequence file. When you modify the run mode in an Execution window, the modification affects only that execution and TestStand does not save the modification to disk.

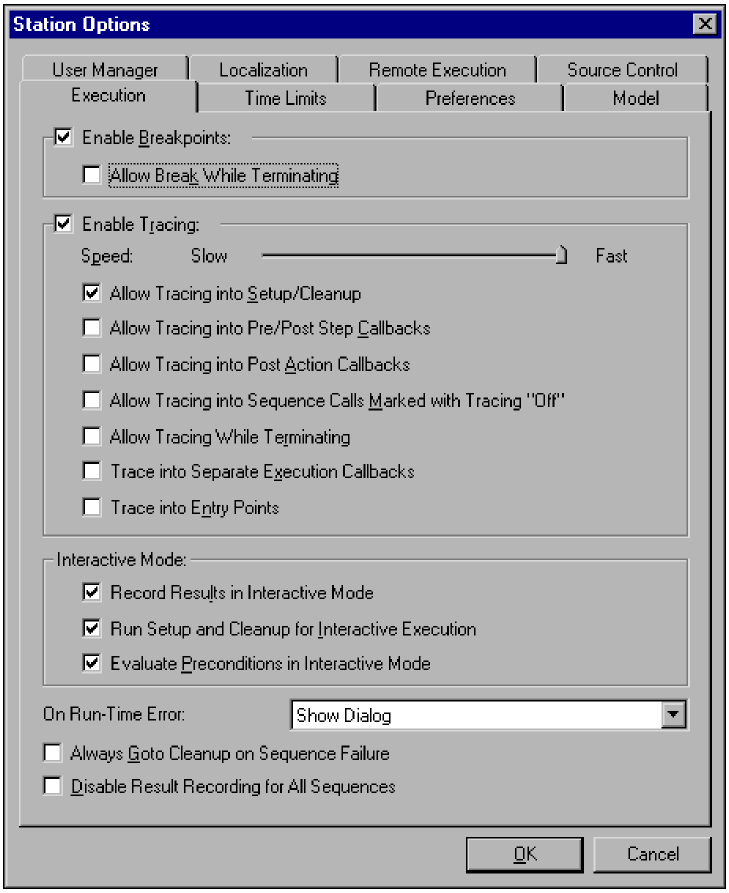
- **Close Completed Execution Displays on Execution Start**—Closes all completed Execution windows automatically when you start a new execution.
- **Allow Editing NI Installed Types**—Allows you to modify the step and data types that come with TestStand. This includes built-in step types, standard data types, and some custom data types. If you attempt to edit an National Instruments installed type, TestStand displays a dialog box stating that you must enable this option before you can edit the type.
- **Disable 'View User Manager' Command**—Disables the User Manager menu and toolbar items.
- **Allow Editing of Read Only Files**—Enables you to make changes in the sequence editor to files that are marked as read only on disk. You cannot save changes back to the read only file.
- **Show List View Tip Strips**—Disables the tooltip that displays the entire contents of a field. A tip strip is useful for viewing a field that is longer than the column that displays it.
- **Save Before Running**—Configures the sequence editor to never save modified files, to always save modified files, or to prompt you to save modified files before running.
- **Backup Sequence Files When Resaving in Older or Newer Format**—Configures the sequence editor to never backup, always backup, or to prompt you to backup sequence files you resave with an older or newer format.

Station Options

Use the **Station Options** command to set preferences for your TestStand station. The settings affect all sequence editor and operator interface sessions that you run on your computer. The command displays a dialog box with the following tabs: Execution, Time Limits, Preferences, Model, User Manager, Localization, Remote Execution, and Workspace.

Execution

The Execution tab has options for breakpoints, tracing, and interactive execution. Figure 4-16 shows the Execution tab.



☑ Enable Breakpoints:

☐ Allow Break While Terminating

☑ Enable Tracing:

Speed: Slow — Fast

☑ Allow Tracing into Setup/Cleanup

☐ Allow Tracing into Pre/Post Step Callbacks

☐ Allow Tracing into Post Action Callbacks

☐ Allow Tracing into Sequence Calls Marked with Tracing "Off"

☐ Allow Tracing While Terminating

☐ Trace into Separate Execution Callbacks

☐ Trace into Entry Points

Interactive Mode:

☑ Record Results in Interactive Mode

☑ Run Setup and Cleanup for Interactive Execution

☑ Evaluate Preconditions in Interactive Mode

On Run-Time Error: Show Dialog

☐ Always Goto Cleanup on Sequence Failure

☐ Disable Result Recording for All Sequences

Figure 4-16. Execution Options

The following options are available on the Execution tab.

- **Enable Breakpoints**—Enables all breakpoints. When you enable breakpoints, the following additional options are available.
  - **Allow Break While Terminating**—Honors breakpoints when terminating an execution.
- **Enable Tracing**—Enables tracing. When tracing is in effect, the sequence editor or operator interface program displays each step as it executes. This is useful for debugging but adds significant

performance overhead to the execution of your test programs. When you enable tracing, the following additional options are available.

- **Speed**—Specifies whether TestStand inserts a delay between trace events sent to the sequence editor or any operator interface. This delay only applies when tracing is enabled. You can use this to slow down the tracing so that you can observe each step as it executes.
- **Allow Tracing Into Setup/Cleanup**—Enables tracing of steps in the Setup and Cleanup step groups of each sequence.
- **Allow Tracing Into Pre/Post Step Callbacks**—Enables tracing of steps in any of the Pre Step and Post Step Engine Callbacks.
- **Allow Tracing Into Post Action Callbacks**—Enables tracing of steps in Post Action callbacks.
- **Allow Tracing Into Sequence Calls Marked With Tracing "Off"**—Enables tracing into all subsequences when tracing is enabled for the calling sequence.

  In the Run Options tab of the Step Properties dialog box, you can choose a setting that disables tracing when the step calls a subsequence. If you enable the Allow Tracing Into Sequence Calls Marked With Tracing "Off" option in the Station options dialog box, TestStand ignores that Step Property setting and does not alter the tracing state when it calls the subsequence.
- **Allow Tracing While Terminating**—Enables tracing of steps that run while execution is terminating. Examples of steps that can run when execution is terminating are steps in Cleanup step groups that run when you terminate execution in the middle of a sequence.
- **Trace Into Separate Execution Callbacks**—Enables tracing in callbacks that run as executions separate from the top-level sequence execution. Examples include front-end callbacks and callbacks that you execute from the **Tools** menu.
- **Trace Into Entry Points**—Enables tracing of steps in process model point sequences, such as the `Test UUTs` and `Single Pass` entry points.

• **Interactive Mode**—Use this section to set options that apply when you run steps interactively.

- **Record Results in Interactive Mode**—Records the results of steps that you run interactively. If you run steps interactively from an Execution window when suspended in a normal execution, TestStand appends the results to the result list for the active sequence invocation. Thus, the results appear in the test report for the normal execution.

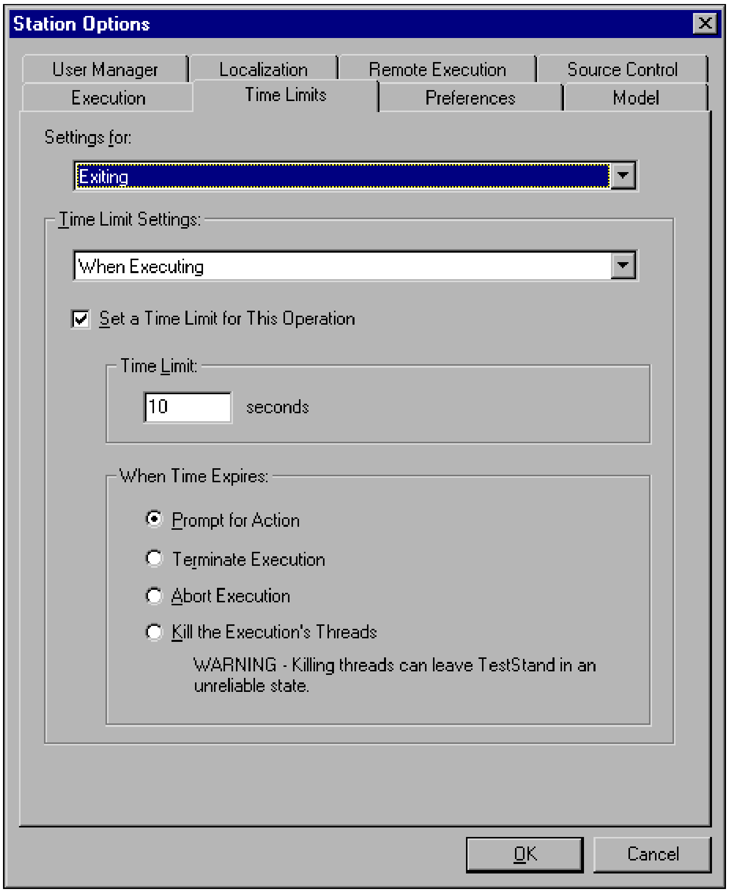
If you run steps interactively from a Sequence File window, TestStand accumulates the results in a result list for the interactive execution. If the interactive execution uses a process model that generates a report, the interactive step results appear in the report. You also can access an interactive execution result list from an Engine post-interactive callback.

  - **Run Setup and Cleanup for Interactive Execution**—Specifies whether to run the Setup and Cleanup step groups for the sequence that contains the selected steps. This option applies only when you run the steps from a Sequence File window.

- **On Run-Time Error**—Use this option to specify the action TestStand takes when a run-time error occurs. The On Run-Time Error ring control contains the following options:
  - **Show Dialog**—Displays a dialog box when a run-time error occurs. The dialog box lists the step, the cause of the error, and prompts you with options for handling the error. Options for handling the error include ignoring the error and continuing execution, retrying the step, jumping to the Cleanup step group, and aborting immediately. You also can choose to break at the current step and to suppress the run-time error dialog box during the remainder of the current execution. Refer to the *Run-Time Errors* section in Chapter 6, *Sequence Execution*, for more information.
  - **Run Cleanup**—Execution jumps to the Cleanup step group. If the error propagates normally to the calling sequence, the calling sequence also jumps to the cleanup step group. Thus, the cleanup steps run for all active sequences and the execution terminates.
  - **Ignore**—Clears the error occurred flag for the step and execution proceeds at the next step in the sequence.
  - **Abort**—Immediately halts execution without running cleanup steps.
- **Always Goto Cleanup On Sequence Failure**—Causes execution to jump to the Cleanup step group when a step sets the sequence status to Failure. This option takes precedence over Goto Destination post action settings.
- **Disable Result Recording for All Sequences**—When you disable result recording with this option, the process model does not generate a result report for sequence executions.

Time Limits

The Time Limits tab allows you to specify time limits for executions. If you specify a time limit, you choose an action to take when a time limit expires. Figure 4-17 shows the Time Limits tab.



Settings for: Exiting

Time Limit Settings: When Executing

[✓] Set a Time Limit for This Operation

Time Limit: 10 seconds

When Time Expires:

[● Prompt for Action]

Terminate Execution

Abort Execution

Kill the Execution's Threads

WARNING - Killing threads can leave TestStand in an unreliable state.

Figure 4-17. Time Limits Options

The tab maintains different time limits for normal execution and for executions that run while the engine is exiting. To switch between the different time limits, use the Settings ring control.

The Time Limit Settings selection ring contains the following types of time limits.

- **When Executing**—Applies to an execution from start to completion.
- **When Terminating**—Applies to executions from a termination request to completion.
- **When Aborting**—Applies to executions from an abort request to completion.

To enable the time limit, place a checkmark in the Set a Time Limit for this Operation checkbox.

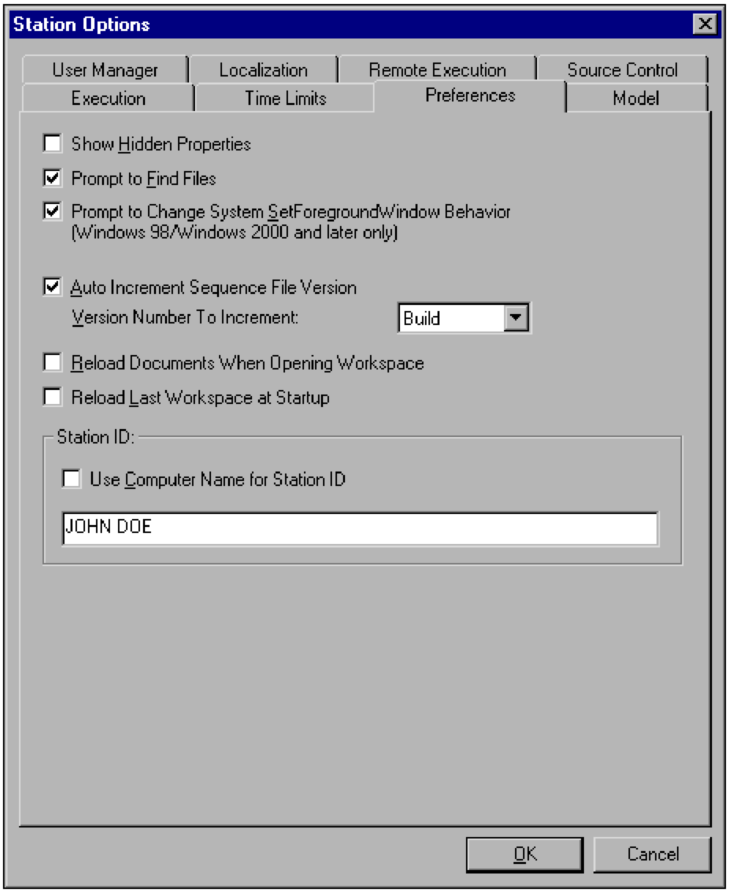
TestStand can take one of the following actions when the time limit expires:

- **Prompt for Action**—Displays a dialog box with the option to terminate, abort, or kill the execution.
- **Terminate Execution**—Initiates a termination of a running execution.
- **Abort Execution**—Initiates an abort of a running or terminating execution.
- **Kill the Execution's Threads**—Ends the thread for a running, terminating, or aborting execution.

When you terminate a running execution, TestStand executes all the Cleanup step groups in sequences on the call stack before execution stops. A terminating sequence can time out when a step in one of the Cleanup step groups hangs or takes a long time to complete. When you abort a running or terminating execution, TestStand returns up the call stack without running any Cleanup step groups. An abort operation also can time out when the last executed step hangs or takes a long time to complete. When you *kill* a running, terminating, or aborting execution, TestStand terminates the thread running the execution without any cleanup of system resources. This can leave TestStand in an unreliable state.

Preferences

The Preferences tab specifies general options for TestStand. Figure 4-18 shows the Preferences tab.



- [ ] Show Hidden Properties
- [✓] Prompt to Find Files
- [✓] Prompt to Change System SetForegroundWindow Behavior (Windows 98/Windows 2000 and later only)
- [✓] Auto Increment Sequence File Version

Version Number To Increment: Build

- [ ] Reload Documents When Opening Workspace
- [ ] Reload Last Workspace at Startup

Station ID:

- [ ] Use Computer Name for Station ID

JOHN DOE

Figure 4-18. Preferences Options

The following options are available on the Preferences tab.

- **Show Hidden Properties**—Displays hidden properties. Most hidden properties are built-in step properties that TestStand uses.
- **Prompt to Find Files**—Displays a file dialog box when TestStand cannot find necessary files in the current directory search path.

- **Prompt to Change System SetForegroundWindow Behavior**—On versions of Windows subsequent to Windows 95 and NT 4.0, the operating system allows you to restrict when one application can bring another application to the front. TestStand removes the restriction so that it can activate windows in other development environments. This option causes TestStand to prompt you before removing the restriction. When you disable this option, TestStand does not prompt you, and TestStand does not change your system settings.

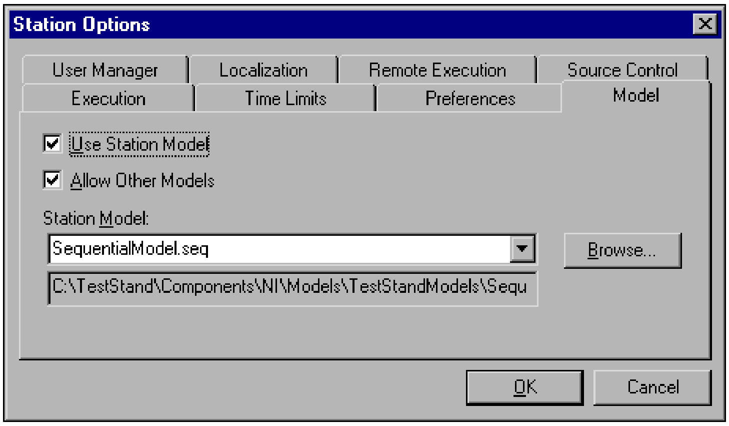
  Notice that this is a system restriction. Changes to this restriction affect the behavior of any application that attempts to bring its window to the front when another application window is active.

  National Instruments recommends that you enable this checkbox and allow TestStand to change your system settings when you execute test modules in external processes.

  The system configuration setting is a `DWORD` value stored in the registry. The value is `HKEY_CURRENT_USER\Control Panel\Desktop\ForegroundLockTimeout`. This value is the amount of time in milliseconds that a foreground application must be idle (not receiving user input) before the operating system allows a background application to bring its window to the front. The typical value for this setting is `0x7D0` (2,000 m s). TestStand sets the value to zero.
- **Auto Increment Sequence File Version**—Automatically increments the specified portion of the sequence file version number when you save a sequence file. A version number consists of four numbers separated by periods. The numbers are named from left to right in the following order: Major, Minor, Revision, and Build.
- **Reload Documents When Opening Workspace**—Loads the documents you had open when you last closed the workspace file. If this option is enabled when you load the workspace, the Sequence Editor reloads the documents.
- **Reload Last Workspace at Startup**—Loads the workspace that was open when the Sequence Editor last closed. If this option is enabled when you launch TestStand, the Sequence Editor opens the workspace.
- **Station ID**—Specifies whether TestStand identifies the test station with the name of the computer or with a name you provide.

Model

The Model tab specifies the model options for the station and for sequences. Figure 4-19 shows the Model tab.



☑ Use Station Model

☑ Allow Other Models

Station Model:

SequentialModel.seq

C:\TestStand\Components\NI\Models\TestStandModels\Sequ

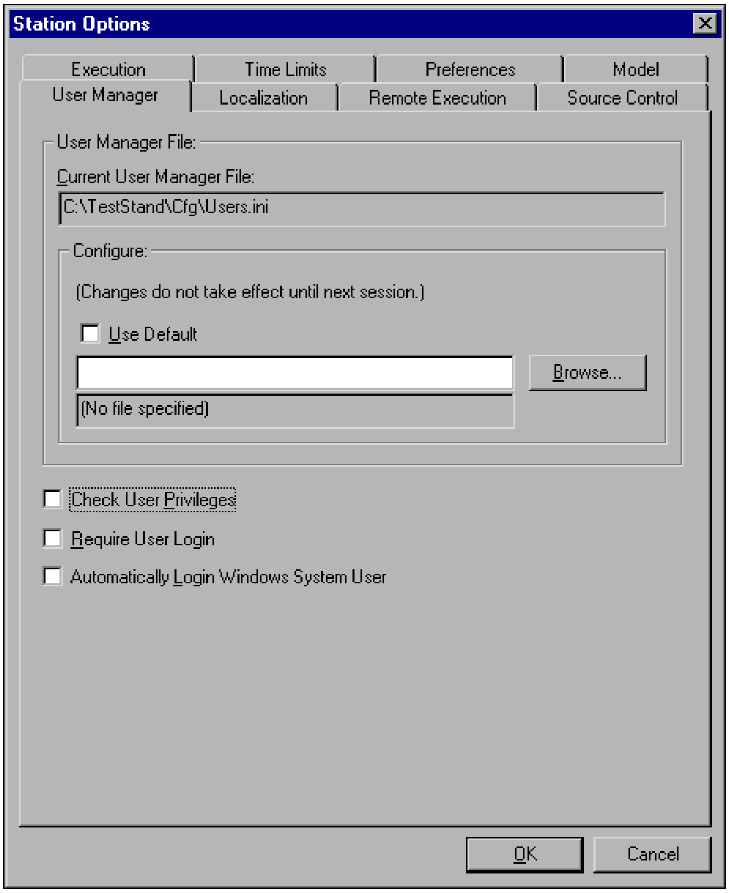
Figure 4-19. Model Options

The following options are available on the Model tab.

- **Use Station Model**—Enables the Station Model control, which specifies the pathname of the station model sequence file. When you disable this option, no station model is in effect, and individual sequence files have no process model unless they specify one explicitly. Usually, sequence files do not specify process model files explicitly.
- **Allow Other Models**—Allows sequence files to specify a process model file other than the current station model file. When you disable this option, you can only load sequence files that do not specify a process model file and sequences that specify the current station model file as their process model file.
- **Station Model**—Specifies the pathname of the station model sequence file.

User Manager

The User Manager tab specifies whether TestStand enforces user privileges. It also specifies the location of the user manager configuration file. Figure 4-20 shows the User Manager tab.



User Manager File:

Current User Manager File: C:\TestStand\Cfg\Users.ini

Configure:

(Changes do not take effect until next session.)

☐ Use Default

(No file specified)

☐ Check User Privileges

☐ Require User Login

☐ Automatically Login Windows System User

Figure 4-20. User Manager Options

The following options are available on the User Manager tab.

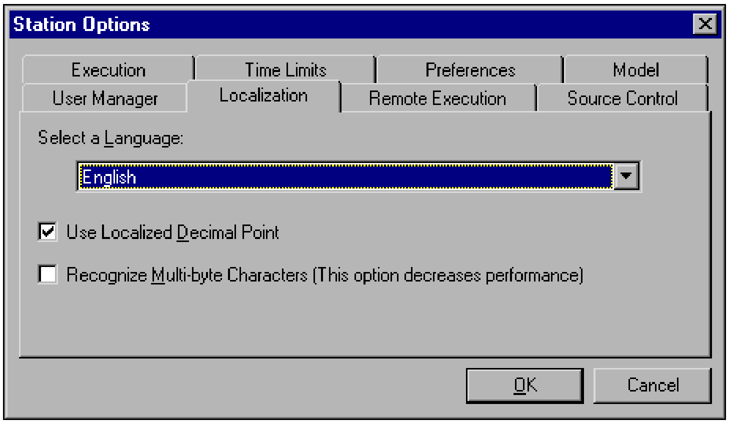
- **Current User Manager File**—Displays the user manager file that is currently in memory. The default file is `<TestStand>\Cfg\Users.ini`.
- **Configure**—Allows you to specify the location of the user manager file.

A change to this option does not take effect until the next time you start the sequence editor.

- **Check User Privileges**—Prevents users from accessing features for which they do not have privileges. When you disable this option, any user can access any feature without regard to privileges. You must have sufficient privileges to change this option or any other option that affects privilege checking.
- **Require User Login**—If you disable user privilege checking, this option disables all privileged operations when a user is not logged in. When a user logs in, all privileged operations are available.
- **Automatically Login Windows System User**—TestStand attempts to log in the current Windows user name in the TestStand user list. If the user name is found in the TestStand user list, TestStand automatically logs in the user at the appropriate level without prompting for a password. If the user name is not found, TestStand prompts the user to log in. In order for this option to work, you must create a user entry in the TestStand User Manager and enter the Windows login name for the user as their TestStand login name.

Localization

The Localization tab specifies the station language and other regional settings. Figure 4-21 shows the Localization tab.



Select a Language: English

[✓] Use Localized Decimal Point

[ ] Recognize Multi-byte Characters (This option decreases performance)

Figure 4-21. Localization Options

The Localization tab contains the following controls:

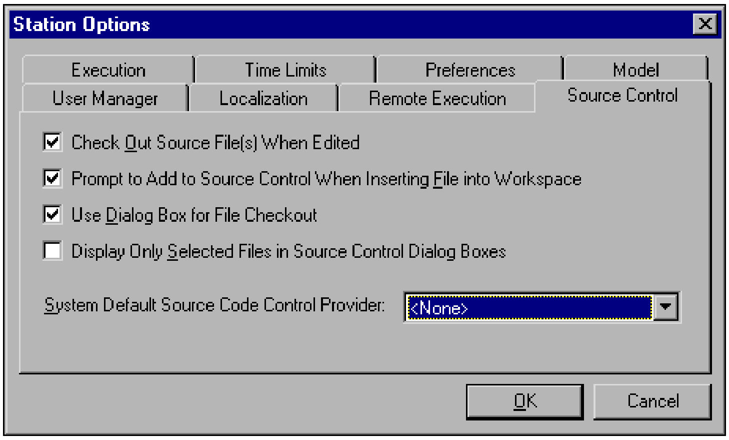
- **Select a Language**—Specifies the language that TestStand uses to display text. The language setting determines the set of string resource files that TestStand uses. Refer to the *Creating String Resource Files* section of Chapter 3, *Configuring and Customizing TestStand*, for more information on string resource files.
- **Use Localized Decimal Point**—Specifies that TestStand uses the decimal point character you set in the Windows Regional Options control panel. If you do not set this option, TestStand uses the period character as the decimal point symbol.
- **Recognize Multi-byte Characters**—Specifies that TestStand recognizes extended character code sequences when it compares and processes strings. Set this option if you use strings with extended character code such as the codes for Japanese or Chinese characters. This option decreases the speed at which TestStand compares and processes strings.

Remote Execution

The Remote Execution tab specifies whether a remote machine can run a sequence on this station.

Source Control

The Source Control tab specifies options that affect various source control operations. The options on the Source Control tab are available only if a workspace file is open. Figure 4-22 shows the Source Control tab.



- [✓] Check Out Source File(s) When Edited
- [✓] Prompt to Add to Source Control When Inserting File into Workspace
- [✓] Use Dialog Box for File Checkout
- [ ] Display Only Selected Files in Source Control Dialog Boxes

System Default Source Code Control Provider: <None>

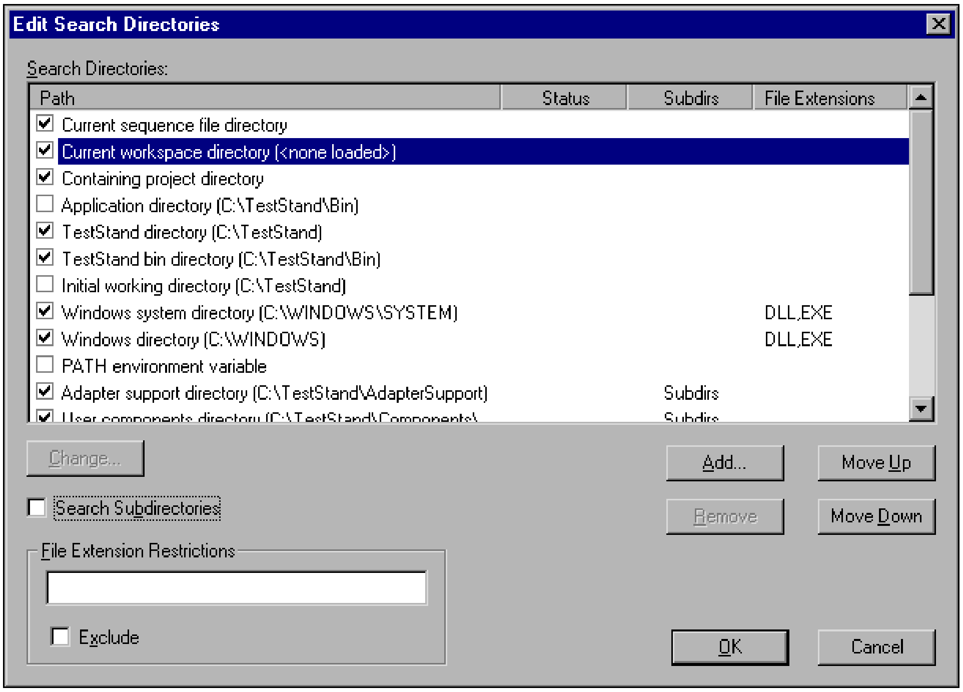
Figure 4-22. Source Control Options

The following options are available on the Source Control tab:

- **Check Out Source Files When Edited**—Specifies whether a dialog box prompts you to check out a file when you edit a sequence file that is in the current workspace and is checked into source control.
- **Prompt to Add to Source Control When Inserting File into Workspace**—Prompts you to add a file to the source control system when you insert the file into the workspace.
- **Use Dialog Box for File Checkout**—Displays a dialog box that lists the files you are checking out when you check out files using the Workspace window.
- **Display only Selected Files in Source Control Dialog Boxes**—Displays only selected workspace files in source code control dialog boxes. If this options is not set, the source code control dialog boxes include all files under the selected item in the workspace.
- **System Default Source Code Control Provider**—Allows you to change your default source code control provider.

Search Directories

The **Search Directories** command lets you customize the search paths for finding files. Figure 4-23 shows the Edit Search Directories dialog box.



Search Directories:

	Path	Status	Subdirs	File Extensions
✓	Current sequence file directory			
✓	Current workspace directory (<none loaded>)			
✓	Containing project directory			
☐	Application directory (C:\TestStand\Bin)			
✓	TestStand directory (C:\TestStand)			
✓	TestStand bin directory (C:\TestStand\Bin)			
☐	Initial working directory (C:\TestStand)			
✓	Windows system directory (C:\WINDOWS\SYSTEM)			DLL,EXE
✓	Windows directory (C:\WINDOWS)			DLL,EXE
☐	PATH environment variable			
✓	Adapter support directory (C:\TestStand\AdapterSupport)		Subdirs	
✓	User components directory (C:\TestStand\Components\		Subdirs	

☐ Search Subdirectories

File Extension Restrictions

☐ Exclude

Figure 4-23. Search Directories Dialog Box

The dialog box displays a list of paths, the higher paths taking precedence over the lower paths. The list contains a default set of paths. A checkbox appears to the left of each path in the list. When you place a checkmark next to a path, TestStand includes the path in the overall search path. To reorder paths in the list, select a path and click the **Move Up** or **Move Down** buttons. Click the **Add** button to add a custom directory search path.

You can use the File Extension Restrictions control to search only for files with specific filename extensions. For example, to search for only DLLs and executable files, enter the following string:

```
DLL, EXE
```

To search for all files except for files with specific extensions, enable the Exclude option. A tilde (~) appears at the beginning of File Extensions column for the row that you have selected.

The Search Subdirectories option specifies whether to include all subdirectories within the selected path in the overall search path.

Note If you add a large directory tree to the search paths and specify the search subdirectories option, TestStand must search the entire tree each time it locates a file. You can improve performance by using the File Extension Restrictions control to limit the types of files for which TestStand searches a directory tree. For example, if a directory tree contains VI files only, specify VI in the File Extension Restriction control to prevent TestStand from searching the directory tree for files of other types such as `.seq` and `.dll`.

Note For best performance, move the following search paths to the end of the search path list: the search paths you add that refer to large directory trees, the search paths you add that refer to directories on network drives, and the search paths you add that contain files which you use infrequently.

External Viewers

The **External Viewers** command displays a dialog box in which you can specify the external viewer to use for a particular report format. You specify both the external viewer, such as Microsoft Notepad and Microsoft Internet Explorer, and the report format, such as text, `.txt`, and HTML, `.html`, files.

Use the **Add** button to add an entry to the viewer list. Use the **Delete** button to remove an entry. If you do not specify an external viewer for a format, the file opens in the application that Windows associates with the file extension of the report file.

Adapters

The **Adapters** command displays a dialog box in which you can select the active module adapter for inserting steps, or configure a specific module adapter. Refer to the *Configuring Adapters* section in Chapter 13, *Module Adapters*, for more information.

Report Options

The **Report Options** command displays a dialog box in which you can customize the generation of report files. The command calls an entry point in the default TestStand process model file. The options you set apply to all sequences you run on the station. Refer to Chapter 15, *Managing Reports*, for more information on available report options.

Model Options

The Model Options command displays a dialog box in which you can customize the behavior of the current process model. This option is dimmed if the current process model is `SequentialModel.seq`, the default TestStand process model. Refer to the *Parallel and Batch Models* section in Chapter 14, *Process Models*, for a description of the Model Options dialog box.

Source Control Menu

TestStand integrates with any source code control system that supports the Microsoft SCC interface. You can check files and projects in and out of your source code control system from a TestStand workspace. You select your default source code control provider when you install your SCC program. You can change the default provider by selecting **Configure»Station Options** and going to the Source Control tab.

Note National Instruments has tested TestStand with the following source code control providers: Microsoft Visual SourceSafe, Perforce, MKS Source Integrity, and Rational ClearCase.

You can access source control commands in the sequence editor through the context menu for any file or project in the workspace or through the Source Control menu in the Sequence Editor. The Source Control menu is shown in Figure 4-24. The Source Control menu items are available only if a workspace file is open and the active window is a file window.

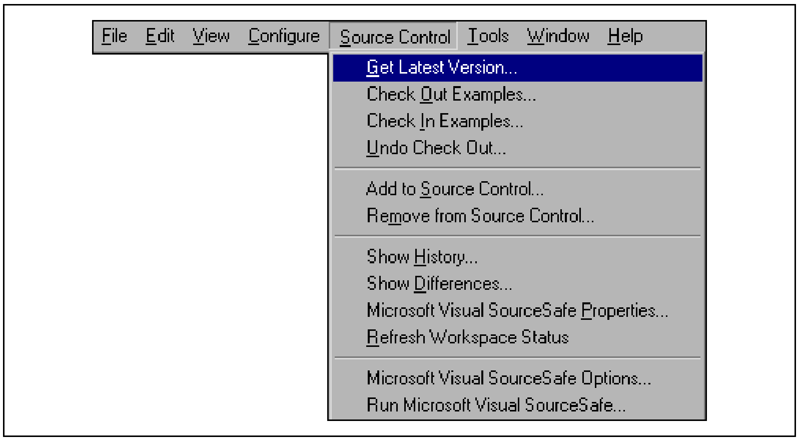


Figure 4-24. Source Control Menu

For a description of each command in the Source Control menu, refer to the *Workspace Window* section of Chapter 2, *Sequence Editor Concepts*.

Tools Menu

This section explains how to use the commands in the **Tools** menu shown in Figure 4-25.

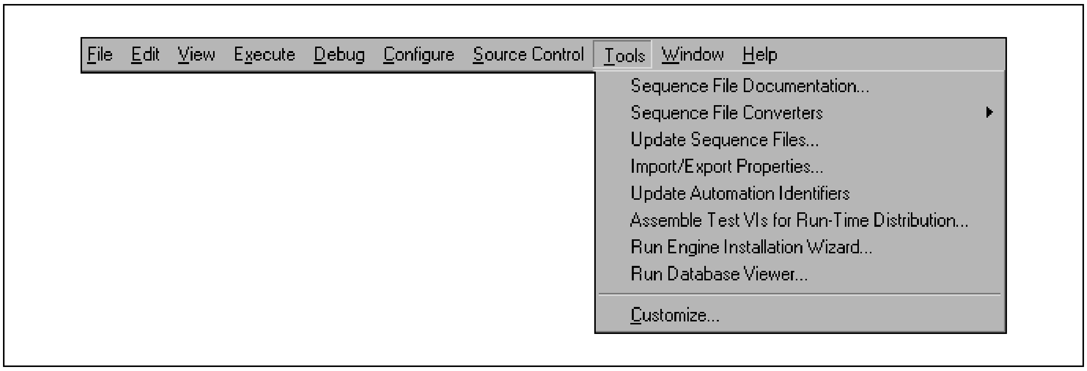
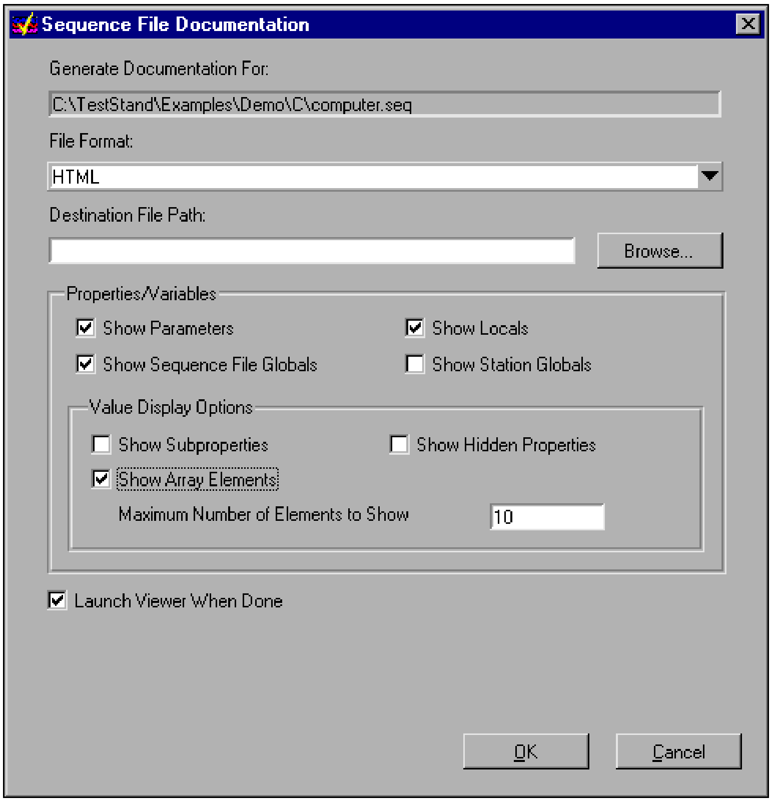

File
Edit
View
Execute
Debug
Configure
Source Control
Tools
Window
Help
Sequence File Documentation...
Sequence File Converters
Update Sequence Files...
Import/Export Properties...
Update Automation Identifiers
Assemble Test VIs for Run-Time Distribution...
Run Engine Installation Wizard...
Run Database Viewer...
Customize...

Figure 4-25. Tools Menu

Sequence File Documentation

Use the **Sequence File Documentation** submenu to generate ASCII text or HTML documentation for a sequence file. When you select **Tools»Sequence File Documentation**, TestStand displays the following dialog box in which you specify which items to include in the documentation.



Generate Documentation For: C:\TestStand\Examples\Demo\C\computer.seq

File Format: HTML

Destination File Path:

Properties/Variables

☑ Show Parameters ☑ Show Locals

☑ Show Sequence File Globals ☐ Show Station Globals

Value Display Options

☐ Show Subproperties ☐ Show Hidden Properties

☑ Show Array Elements

Maximum Number of Elements to Show 10

☑ Launch Viewer When Done

The Sequence File Documentation dialog box contains the following controls:

- **File Format**—Specifies the file format of the documentation file. The options are HTML and Text.
- **Destination File Path**—Specifies the name and location of the documentation file to create.
- **Show Parameters**—Specifies whether sequence parameters appear in the documentation file.
- **Show Locals**—Specifies whether sequence local variables appear in the documentation file.
- **Show Sequence File Globals**—Specifies whether sequence file global variables appear in the documentation file.
- **Show Station Globals**—Specifies whether the current station global variables appear in the documentation file.

- **Show Subproperties**—Specifies whether the subproperties of structured variables appear in the documentation file.
- **Show Hidden Properties**—Specifies whether variables or properties that are marked as hidden appear in the documentation file.
- **Show Array Elements**—Specifies whether the elements of array variables appear in the documentation file.
- **Maximum Number of Elements to Show**—Specifies the maximum number of array elements from an array variable to include in the documentation file.
- **Launch Viewer When Done**—Specifies that the documentation tool opens the documentation file in a viewer application.

Sequence File Converters

Use the **Sequence File Converters** submenu to convert a sequence file from the LabWindows/CVI or the LabVIEW Test Executives into a TestStand sequence file. Refer to the *Converting From the LabVIEW Test Executive to TestStand* and *Converting From the LabWindows/CVI Test Executive to TestStand* online help documents for more information on converting sequences. You can access these documents by going to the `<TestStand>\Doc` directory or by selecting the appropriate document from **Start»Programs»National Instruments»TestStand»Online Help**.

Update Sequence Files

Use the **Update Sequence Files** command to load and resave all the sequence files in a folder and its subfolders. When you open a sequence file, TestStand automatically updates the file to the most recent file format and updates it to use the latest version of the types it contains. However, this conversion can increase the time it takes to load a file. You can use the **Update Sequence Files** command to ensure that a group of files are updated such that they load as quickly as possible.

In addition, if you change the definition of a data type or step type and you do not increment the type version, TestStand prompts you to resolve the type difference when you later load a sequence file that contains a different definition of the type. You can use the **Update Sequence Files** command to update a group of files to use the changes you make to a type so that TestStand does not prompt you when you load the updated files.

Import/Export Properties

The **Import/Export Properties** command imports variables and step property values from an external file, database, or the system clipboard into a sequence, or exports variables and step property values from a sequence to an external file, database, or the system clipboard. A common use of this command is to import or export the limit properties values for the steps in a sequence. Refer to the *Importing/Exporting Properties* section in Chapter 10, *Built-In Step Types*, for more information on importing and exporting properties.

Update Automation Identifiers

The following discussion applies only when you configure the ActiveX Automation Adapter to use early binding. When you update the interface for an ActiveX Automation server and the object and member identifiers for the server have changed, you must re-specify any step that uses the server. You use the **Update Automation Identifiers** command to update the identifiers in the active sequence file based on the name of the object or member.

For steps that create an object, the command updates the object identifiers, `CLSID` and `IID`. For steps that call a method or property, the command updates the member identifier, `MEMBERID`. Refer to the *ActiveX Automation Adapter* section of Chapter 13, *Module Adapters*, for more information on configuring the adapter to use early or late binding and information on developing ActiveX servers while you are developing sequences.

Assemble Test VIs for Run-time Distribution

Use the **Assemble Test VIs for Run-time Distribution** command to save the entire test VI hierarchy for a specific sequence file. For all steps in a sequence file that use the LabVIEW Standard Prototype Adapter, the command saves the test VIs to a single directory and saves all sub VIs, run-time menu files, and external subroutines to a separate VI library. For more information, refer to the *Packaging VIs and SubVIs for a Sequence File* section of Chapter 17, *Distributing TestStand*.

Run Engine Installation Wizard

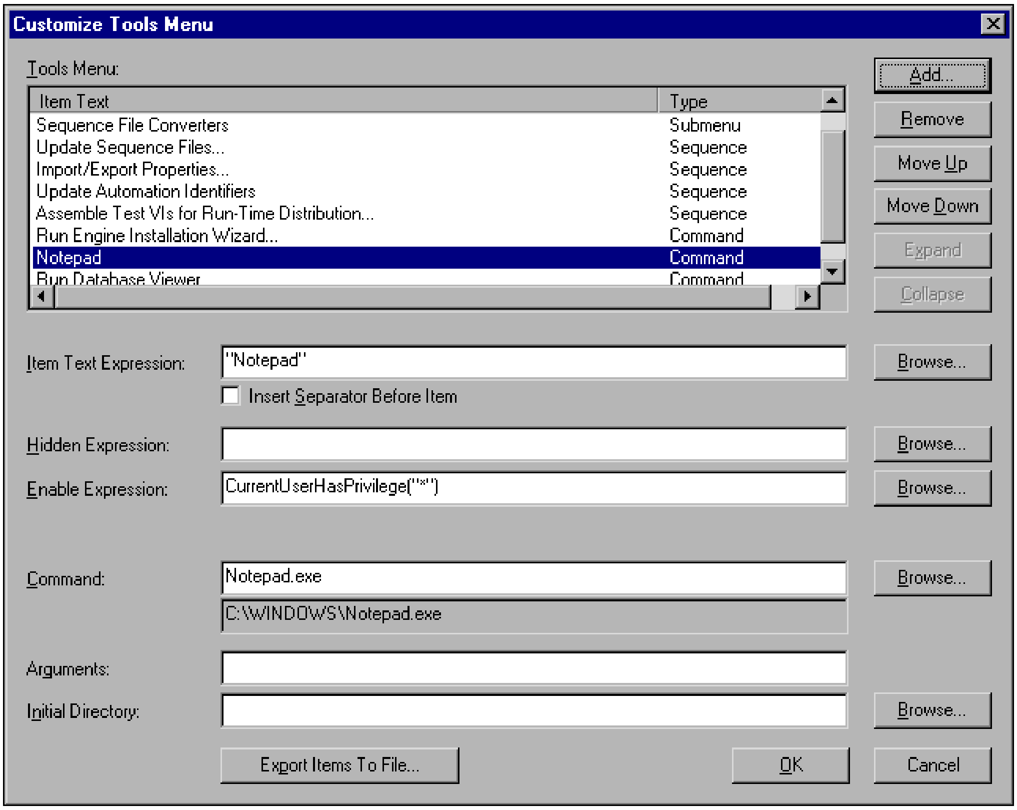
Use the **Run Engine Installation Wizard** command to create a custom TestStand engine installation. Refer to the *Creating a Run-Time TestStand Engine Installation* section in Chapter 17, *Distributing TestStand*, for more information on using the installation wizard.

Run Database Viewer

Use the **Run Database Viewer** command to launch a utility application that allows you to create and discard database tables and columns. You also can use the database viewer to view and edit the values that a database stores. For more information on the database viewer, refer to the *Database Viewer* section of Chapter 18, *Databases*.

Customize

Use the **Customize** command to create your own entries in the **Tools** menu. Figure 4-26 shows the Customize Tools Menu dialog box.



Item Text	Type
Sequence File Converters	Submenu
Update Sequence Files...	Sequence
Import/Export Properties...	Sequence
Update Automation Identifiers	Sequence
Assemble Test VIs for Run-Time Distribution...	Sequence
Run Engine Installation Wizard...	Command
Notepad	Command
Run Database Viewer	Command

Item Text Expression: "Notepad"

[ ] Insert Separator Before Item

Hidden Expression:

Enable Expression: CurrentUserHasPrivilege("*")

Command: Notepad.exe

C:\WINDOWS\Notepad.exe

Arguments:

Initial Directory:

Figure 4-26. Customize Tool Menu Dialog Box

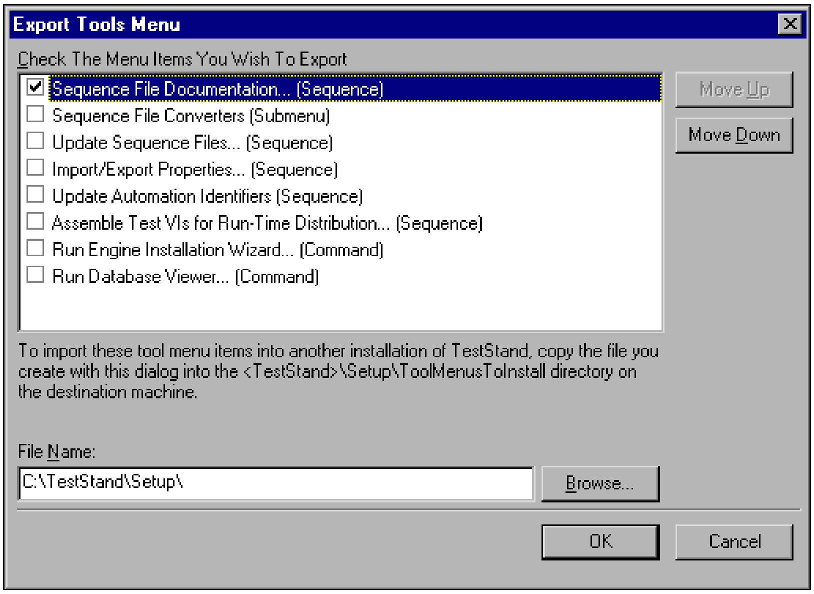
The Customize Tool Menu dialog box contains the following controls:

- **Add**—Inserts a new menu item above the selected item in the Tools Menu list. You can add the following types of menu items:
  - **Submenu**—Contains additional menu items.
  - **Command**—Invokes a Windows executable.
  - **Sequence**—Initiates an execution on a sequence in a sequence file.
  - **Sequence File**—Creates a submenu that lists all sequences in a sequence file as menu items.
- **Remove**—Deletes the menu item from the **Tools** menu.
- **Move Up** and **Move Down**—Changes the order of items within the menu or submenus.
- **Expand**—Allows you to view the menu items in a submenu.
- **Collapse—**Allows you to step out of an item in a submenu.
- **Item Text Expression**—Specifies the expression that evaluates to the literal text to display for the menu item.
- **Insert Separator Before Item**—Specifies that a menu separator precedes the tool menu item.
- **Hidden Expression**—Allows you to specify an expression that determines when a menu item is hidden. If the field is empty, TestStand treats the expression as `False`.

Note TestStand evaluates the Hidden Expression in the `ConstructToolMenus` method of the `Engine` class. The sequence editor constructs the **Tools** menu by calling this method each time you click that menu in the Sequence Editor, but an operator interface might construct the **Tools** menu only once during initialization.

- **Enable Expression**—Appears for Command and Sequence item types. This option lets you specify an expression that determines when the menu item is enabled. The expression must return `True` to enable the menu item and `False` to dim the menu item.
- **Edits Selected File**—Appears for Sequence and Sequence File item types. Set this option for tool menu items you add that edit the selected sequence file. This option advises the sequence editor to prompt the user to check out the selected file from source control if it is not already checked out.
- **Command**—Specifies the executable path. This option appears only for the **Command** menu type.

- **Arguments**—Specifies the command-line arguments. This option appears only for the **Command** menu type.
- **Initial Directory**—Specifies the initial working directory for the executable. This option appears only for the **Command** menu type.
- **Sequence File and Sequence**—Specify the target for the Sequence File and Sequence menu item types.
- **Export Items To File**—Displays a dialog box that contains a list of tool menu items. You use the dialog box to select which tool menu items to export to a tool menu file. Tool menu files enable you to distribute tool menu items to other TestStand installations. You install tool menu files in `<TestStand>\Setup\ToolMenusToInstall`. When TestStand starts, it appends the items stored in all tool menu files in this directory to the tools menu. After appending the new tool items, TestStand deletes the tool menu files. The Export Tools Menu dialog box is shown in Figure 4-27.


Export Tools Menu

Check The Menu Items You Wish To Export

- ☑ Sequence File Documentation... (Sequence)
- ☐ Sequence File Converters (Submenu)
- ☐ Update Sequence Files... (Sequence)
- ☐ Import/Export Properties... (Sequence)
- ☐ Update Automation Identifiers (Sequence)
- ☐ Assemble Test VIs for Run-Time Distribution... (Sequence)
- ☐ Run Engine Installation Wizard... (Command)
- ☐ Run Database Viewer... (Command)

To import these tool menu items into another installation of TestStand, copy the file you create with this dialog into the <TestStand>\Setup\ToolMenusToInstall directory on the destination machine.

File Name: C:\TestStand\Setup\

Figure 4-27. Export Tools Menu Dialog Box

The Export Tools Menu dialog box contains the following controls:

- **Menu Items**—List of menu items available for export. This list is populated by the Tools menu list on the Customize Tools Menu dialog box.

- **Move Up** and **Move Down**—Changes the order of items within the menu or submenus.
- **File Name**—Specifies the path to which the file will be saved.

Window Menu

This section explains how to use the commands in the **Window** menu shown in Figure 4-28.

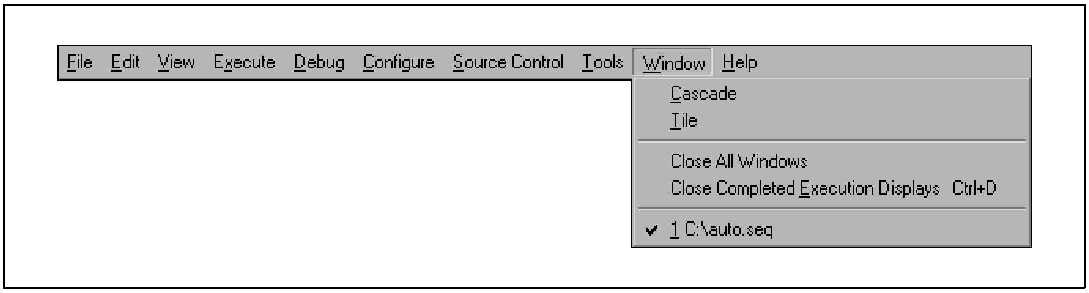


Figure 4-28. Window Menu

Cascade

Use the **Cascade** command to arrange all open windows so that each title bar is visible.

Tile

Use the **Tile** command to arrange all open windows in smaller sizes to fit next to each other.

Close All Windows

Use the **Close All Windows** command to close all open windows in the sequence editor.

Close Completed Execution Displays

Use the **Close Completed Execution Displays** command to close all execution displays that are no longer executing.

<List of Open Windows>

A list of all open windows appears at the bottom of the **Window** menu.

5 Sequence Files

This chapter describes TestStand sequence files. Each sequence file contains one or more sequences. Sequences, in turn, contain steps that conduct tests, set up instruments, or perform other actions necessary to test a UUT. In addition to sequences, sequence files can contain global variables. You can access sequence file global variables from every sequence in the file. Sequence files also contain the definitions for the data types and step types that the sequences in the file use.

You use the sequence editor to create and edit sequence files. You can execute sequences from the sequence editor or from any other TestStand operator interface program.

Several types of sequence files exist. Most sequence files you work with are *normal sequence files*. Normal sequence files contain sequences that test UUTs. *Model sequence files* contain process model sequences. *Station Callback sequence files* contain the station callback sequences. *Front-End Callback sequence files* contain Front-End callback sequences. Usually, your computer has only one Station Callback sequence file and one Front-End Callback sequence file.

In the sequence editor, you use a Sequence File window to view and edit a sequence file. To open an existing sequence file into a Sequence File window, select **File»Open**. To create a new Sequence File window, select **File»New**.

Sequence File Window Views

You use the View ring control at the top right of the Sequence File window to select the aspect of the file to display. You can use the View ring control to view an individual sequence, a list of all sequences in the file, the global variables in the file, or the types that you use in the file.

Figure 5-1 shows the contents of the View ring control for an example sequence file.

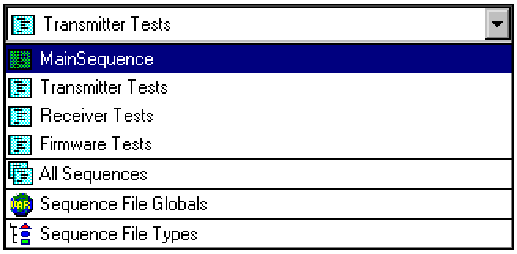


Figure 5-1. View Ring Control for Sequence Files

All Sequences View

Sequence files can contain multiple sequences. To access a list of the sequences in a file, select All Sequences from the View ring control. You can use this view to create new sequences and to cut, copy, and paste sequences. You also can drag and drop sequences from this view to the All Sequences view in another Sequence File window.

Figure 5-2 shows the All Sequences view for an example file and also shows the ring control where you select this view.

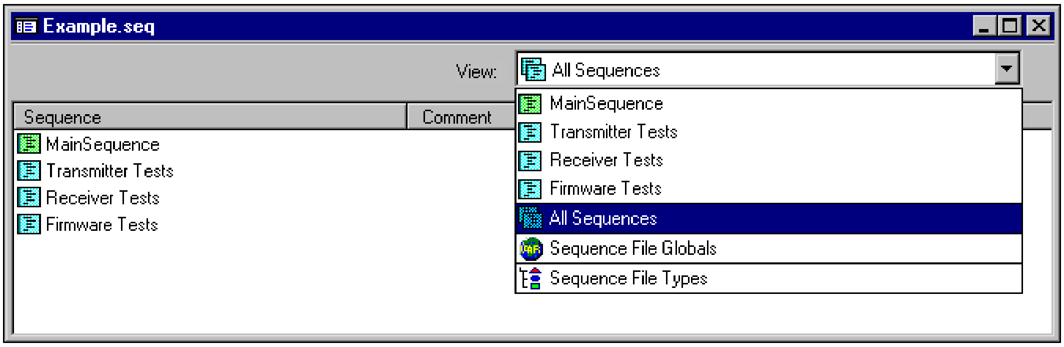


Figure 5-2. All Sequences View in the Sequence File Window

Sequence View Context Menu

To access a context menu, right click the view. The items in the context menu vary depending on the whether you right click a sequence or the background area of the view. This section describes the items that the context menu can contain.

Open Sequence

The **Open Sequence** command changes the sequence file view to display the contents of the selected sequence.

Insert Sequence

The **Insert Sequence** command adds a new sequence to the sequence file.

Rename

The **Rename** command allows you to edit the name of the selected sequence.

Browse Sequence Context

The **Browse Sequence Context** command displays a tree view that contains the names of variables, properties, and sequence parameters you can access from expressions and step modules when the sequence is running. This command also appears in the **View** menu of the sequence editor menu bar. Refer to the *View Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information.

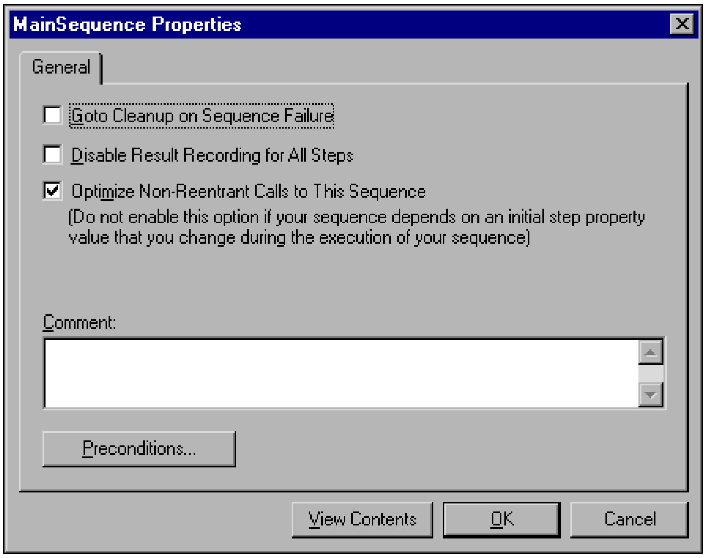
View Contents

The **View Contents** command changes the sequence file view to display the contents of the selected sequence.

Sequence Properties

The **Properties** command displays the Sequence Properties dialog box for the selected sequence. You use the Sequence Properties dialog box to view and edit the built-in properties of the selected sequence. Usually, the dialog box has a single tab, the General tab. If the current sequence file is a process model file, the dialog box has a second tab, the Model tab.

Figure 5-3 shows the Sequence Properties dialog box.



- [ ] Goto Cleanup on Sequence Failure
- [ ] Disable Result Recording for All Steps
- [x] Optimize Non-Reentrant Calls to This Sequence

(Do not enable this option if your sequence depends on an initial step property value that you change during the execution of your sequence)

Comment:

Figure 5-3. Sequence Properties Dialog Box

The General tab contains the following controls:

- **Goto Cleanup on Sequence Failure**—Causes the execution to branch immediately to the Cleanup step group. TestStand maintains an internal status value for each executing sequence. When you set the status property of a step to `Failed` and the Step Failure Causes Sequence Failure option is set for the step, TestStand sets the internal sequence status value to `Failed`. The Goto Cleanup on Sequence Failure option controls the flow of execution when TestStand sets the internal sequence status value to `Failed`. Disable this option if you want execution to continue normally at the next step. This option takes precedence over Goto Destination post action settings.
- **Disable Results for All Steps**—Prevents TestStand from adding results for the steps in the sequence to the results list. Refer to the *Result Collection* section in Chapter 6, *Sequence Execution*, for more information on the results list.

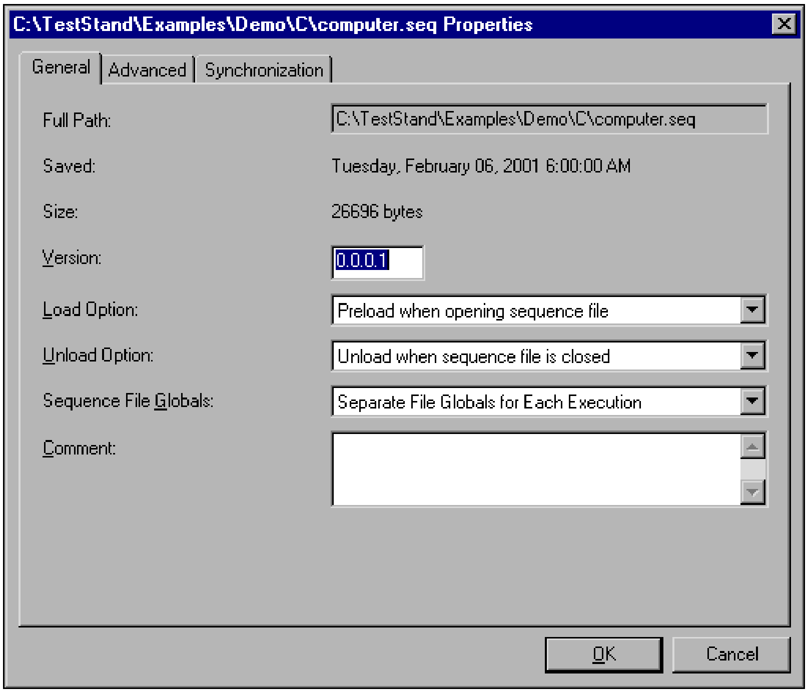
- **Optimize Non-Reentrant Calls to this Sequence**—Decreases the time it takes TestStand to call the sequence after the first call to the sequence in an execution. If you disable this option, TestStand initializes a new copy of each custom step property in a sequence each time it calls the sequence. TestStand performs this initialization so that the sequence always begins executing with the initial property values that the steps in the sequence specify. This initialization is necessary only if a sequence relies on the initial value of a custom step property and then modifies its value. Few sequences rely on this information.

  When you enable this option, TestStand initializes the values of custom step properties in the sequence the first time it calls the sequence in an execution. TestStand saves the values of the custom step properties after the sequence completes and reuses the values when it calls the sequence again. If the same sequence is called at the same time in different threads or recursively within the same thread, TestStand creates unique copies of the custom step properties.
- **Comment**—Places a comment for the sequence in the All Sequences view. The sequence comment also appears in the documentation that TestStand generates for the sequence file.
- **Preconditions**—Displays the Preconditions dialog box in which you specify the conditions that must be true for each step in the sequence to run. When you access this dialog box from the Step Properties dialog box, it applies only to a particular step. When you access the dialog box from the Sequence Properties dialog box, you can view and edit the preconditions for each step in the sequence. Refer to the *Preconditions Dialog Box* section in this chapter for more information.

If the sequence file is a process model file, the Sequence Properties dialog box also has a Model tab. Refer to Chapter 14, *Process Models*, for more information on sequence properties that are unique to process model files.

Sequence File Properties

Select **Edit»Sequence File Properties** to display the Sequence File Properties dialog box for the sequence file. Figure 5-4 shows the General tab in the Sequence File Properties dialog box.



C:\TestStand\Examples\Demo\C\computer.seq Properties

General | Advanced | Synchronization

Full Path: C:\TestStand\Examples\Demo\C\computer.seq

Saved: Tuesday, February 06, 2001 6:00:00 AM

Size: 26696 bytes

Version: 0.0.0.1

Load Option: Preload when opening sequence file

Unload Option: Unload when sequence file is closed

Sequence File Globals: Separate File Globals for Each Execution

Comment:

OK | Cancel

Figure 5-4. General Tab in the Sequence File Properties Dialog Box

The General tab contains the following controls:

- **Full Path**—Displays the location of the sequence file on disk.
- **Saved**—Displays the time at which you last saved the sequence file.
- **Size**—Displays the size of the sequence file on your disk drive.
- **Version**—Displays the sequence file version number. A version number consists of four integer numbers that you separate with periods. The numbers from left to right denote the Major, Minor, Revision, and Build version. You can manually specify the version number or you can select **Configure»Station Options** and set the **Auto Increment Sequence File Version** option on the Preferences tab. This control specifies that the Sequence Editor increments the version number each time you save the sequence file.

- **Load Option**—Specifies one of the following load option settings for every step in the sequence file.
  - Preload when opening sequence file
  - Preload when execution begins
  - Load dynamically
  - Use step load option

    The Use Step Load Option setting tells TestStand to load each code module according to the load option for the particular step that calls the code module. Refer to the *Step Properties Dialog Box* section in this chapter for more information on the other load option values.
- **Unload Option**—Specifies one of the following unload option settings for every step in the sequence file.
  - Unload when precondition fails
  - Unload after step executes
  - Unload after sequence executes
  - Unload when sequence file is closed
  - Use step unload option

    The Use Step Unload Option setting tells TestStand to unload each code module according to the unload option for the particular step that calls the code module. For more information on the other unload option values, refer to the *Step Properties Dialog Box* section in this chapter.

Note If you enable the sequence property Optimize Non-Reentrant Calls to This Sequence, TestStand does not unload the code modules for the sequence until after the execution ends, regardless of the unload options for the sequence file or the steps in the sequence.

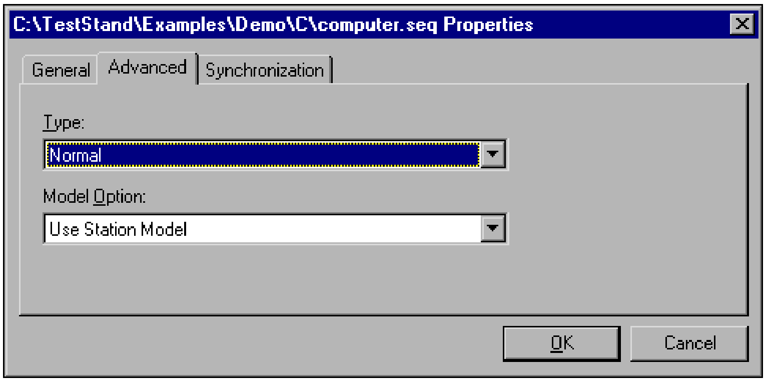
- **Sequence File Globals**—Specifies whether multiple executions share the sequence file global variable values. You can select one of the following settings:
  - **Separate File Globals for Each Execution**—Specifies that each execution that runs the file creates a separate run-time copy of the global variables and initializes them to their default values. This command is the default setting.
  - **All Executions Share the Same File Globals**—Specifies that the first execution that runs the sequence file creates a run-time copy of the global variables and initializes them to their default values.

You might use this setting to share variables between multiple executions you start with the Batch or Parallel process model.

Refer to the *Lifetime and Scope of Sequence File Global Variables* section in this chapter for more information on sequence file globals.

- **Comment**—Places a comment that appears in the documentation that TestStand generates for the sequence file.

Figure 5-5 shows the Advanced tab in the Sequence File Properties dialog box.



Type: Normal

Model Option: Use Station Model

Figure 5-5. Advanced Tab in the Sequence File Properties Dialog Box

The Advanced tab contains the following controls:

- **Type**—Specifies one of the following type settings for the sequence file.
  - Normal
  - Model
  - Front-End Callbacks
  - Station Callbacks
  - Reserved

  If you use the sequence file as a process model, set the type to Model. If you do not use the file as a process model, leave the type set to Normal.
- **Model Option**—Selects one of the following settings for the process model file to use for the sequence file.
  - **Use Station Model**—Causes TestStand to use the process model file that the Station Model option in the Station Options dialog box specifies. This is the default setting for this option.

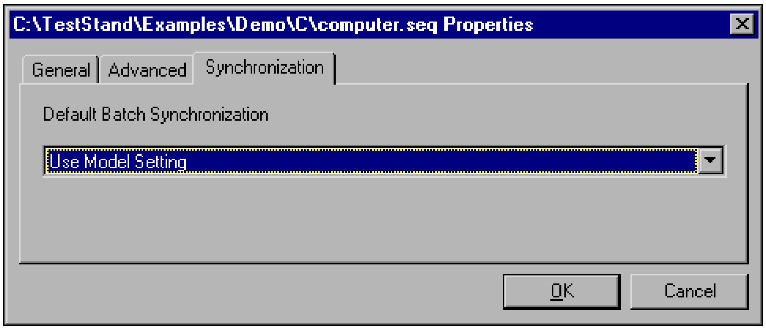
- **No Model**—Specifies that the sequence file does not use a process model.
- **Require Specific Model**—Specifies a particular process model file. If you select this value, the tab displays additional controls that you can use to specify the location of a process model file.

Note The Require Specific Model setting is valid only when you set the Allow Other Models setting under **Configure»Station Options»Model**.

Refer to the *Process Models* section in Chapter 1, *TestStand Architecture Overview*, and to Chapter 14, *Process Models*, for more information on process models.

Figure 5-6 shows the Synchronization tab in the Sequence File Properties dialog box

.



Default Batch Synchronization: Use Model Setting

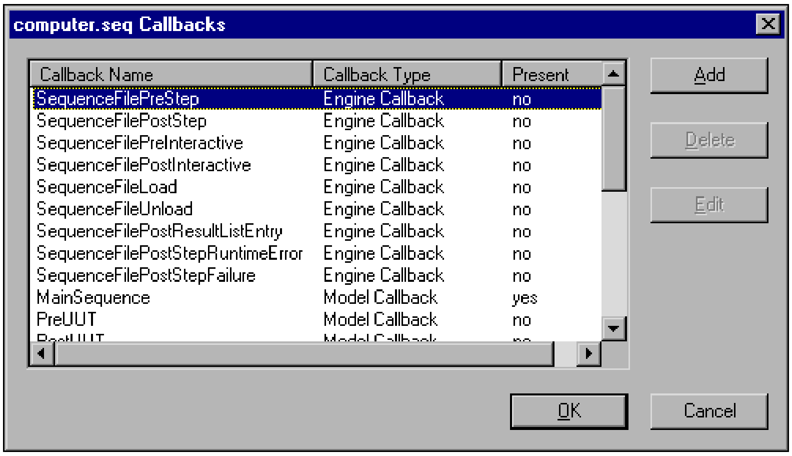
Figure 5-6. Synchronization Tab in the Step Properties Dialog Box

The Synchronization tab contains the following control:

- **Default Batch Synchronization**—Specifies a default batch synchronization setting for the sequence file. The default batch synchronization setting applies to each step in the sequence file that specifies a batch synchronization option of Use Sequence File Setting. Refer to the *Batch Synchronization* section of Chapter 11, *Synchronization Step Types*, for a description of batch synchronization settings.

Sequence File Callbacks

Select **Edit»Sequence File Callbacks** to display the Callbacks dialog box for the sequence file. Figure 5-7 shows the Callbacks dialog box.



Callback Name	Callback Type	Present
SequenceFilePreStep	Engine Callback	no
SequenceFilePostStep	Engine Callback	no
SequenceFilePreInteractive	Engine Callback	no
SequenceFilePostInteractive	Engine Callback	no
SequenceFileLoad	Engine Callback	no
SequenceFileUnload	Engine Callback	no
SequenceFilePostResultListEntry	Engine Callback	no
SequenceFilePostStepRuntimeError	Engine Callback	no
SequenceFilePostStepFailure	Engine Callback	no
MainSequence	Model Callback	yes
PreUUT	Model Callback	no

Figure 5-7. Callbacks Dialog Box

The Callbacks dialog box lists every callback that you can override in the sequence file. The columns in the list display the name of the callback, indicate whether the callback is an Engine or Model callback, and indicate whether the sequence file overrides the callback. The **Add** button overrides the selected callback by inserting a sequence with the same name into the sequence file. The **Delete** button deletes the sequence that overrides the selected callback. The **Edit** button dismisses the dialog box and displays the sequence that overrides the selected callback. Refer to the *Process Models* section in Chapter 1, *TestStand Architecture Overview*, for more information on model callbacks. Refer to the *Engine Callbacks* section in Chapter 6, *Sequence Execution*, for more information on engine callbacks.

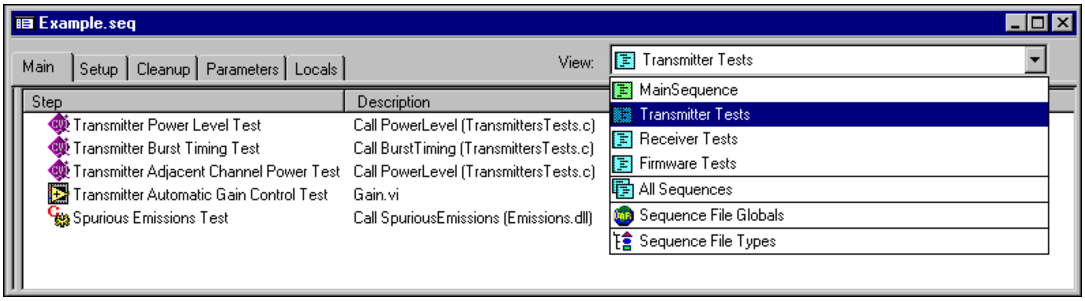
The following restrictions apply to the `SequenceFileLoad` and `SequenceFileUnload` callbacks.

- TestStand can hang when it executes a `SequenceFileLoad` callback that calls into another sequence file containing a `SequenceFileLoad` callback which calls back into the original sequence file. This can occur with any number of levels of sequence files as long as the dependencies among the `SequenceFileLoad` callbacks exist between sequence files.

- TestStand can enter an infinite loop when it executes a `SequenceFileUnload` callback that calls into another sequence file containing a `SequenceFileUnload` callback which calls back into the original sequence file. To break the infinite loop, you select the **Debug»Terminate All Executions** command.
- You must not define a `SequenceFileUnload` callback in the `FrontEndCallback.seq` or `StationCallbacks.seq` sequence files. If you make this error, TestStand hangs when you shut down the TestStand engine.

Individual Sequence View

Each sequence can contain steps, parameters, and local variables. To view the contents of a specific sequence, select it from the View ring control. Figure 5-8 shows the contents of an example sequence and also shows the ring control where you select views.



Step	Description
Transmitter Power Level Test	Call PowerLevel (TransmitterTests.c)
Transmitter Burst Timing Test	Call BurstTiming (TransmitterTests.c)
Transmitter Adjacent Channel Power Test	Call PowerLevel (TransmitterTests.c)
Transmitter Automatic Gain Control Test	Gain.vi
Spurious Emissions Test	Call SpuriousEmissions (Emissions.dll)

Figure 5-8. Individual Sequence View for an Example Sequence

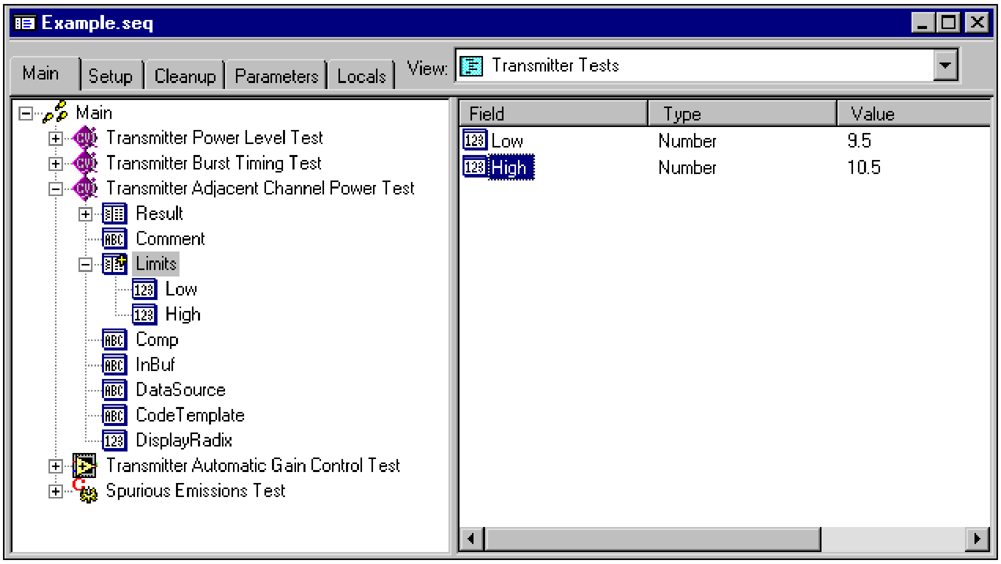
The Sequence view has five tabs: Main, Setup, Cleanup, Parameters, and Locals. You select a tab to choose which part of the sequence to view.

Main, Setup, and Cleanup Tabs

The Main, Setup, and Cleanup tabs each show one of the step groups in the sequence. In the Setup step group, insert steps that initialize or configure your instruments, fixtures, and UUT. In the Main step group, insert steps that test your UUT. In the Cleanup step group, insert steps that power down or de-initialize your instruments, fixtures, and UUT. Refer to Chapter 6, *Sequence Execution*, for more information on how TestStand uses the different step groups.

Step Group List View and Tree View

Each step group tab normally displays a list of the steps in the group. This list is called the step group *list view*. You can drag the step group *divider bar* away from the left edge of the window to reveal a tree-structured view that allows you to browse the custom properties for each step. This tree-structured view is called the step group *tree view*. The list view always displays the contents of the item that you select in the tree view. Usually, you only use the tree view when you design and debug a new step type. In Figure 5-9, the tree view shows the custom properties of a Numeric Limit Test step.



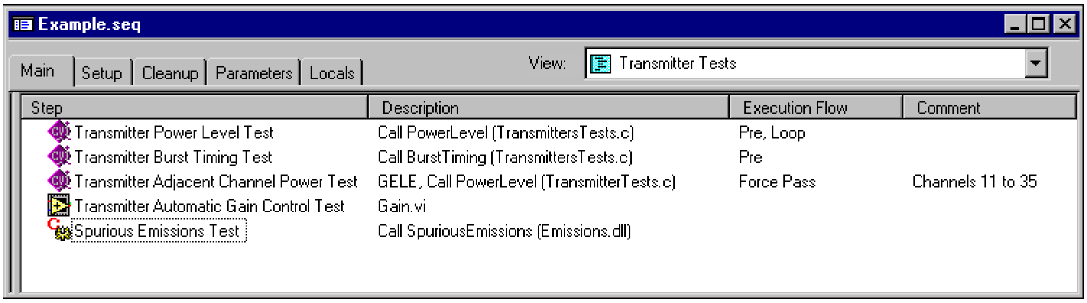
```
Main
  Transmitter Power Level Test
  Transmitter Burst Timing Test
  Transmitter Adjacent Channel Power Test
    Result
    Comment
    Limits
      Low
      High
    Comp
    InBuf
    DataSource
    CodeTemplate
    DisplayRadix
  Transmitter Automatic Gain Control Test
  Spurious Emissions Test
```

Field	Type	Value
Low	Number	9.5
High	Number	10.5

Figure 5-9. Step Group Tree View (Left) and List View (Right)

Step Group List View Columns

The columns in the list view for a step group vary according to whether the list view is displaying steps or step properties. Figure 5-10 shows the list view displaying steps.



Example.seq

Main | Setup | Cleanup | Parameters | Locals

View: Transmitter Tests

Step	Description	Execution Flow	Comment
Transmitter Power Level Test	Call PowerLevel (TransmittersTests.c)	Pre, Loop	
Transmitter Burst Timing Test	Call BurstTiming (TransmittersTests.c)	Pre	
Transmitter Adjacent Channel Power Test	GELE, Call PowerLevel (TransmitterTests.c)	Force Pass	Channels 11 to 35
Transmitter Automatic Gain Control Test	Gain.vi		
Spurious Emissions Test	Call SpuriousEmissions (Emissions.dll)		

Figure 5-10. Step Group List View Columns for Steps

When the list view displays steps, it contains the following columns:

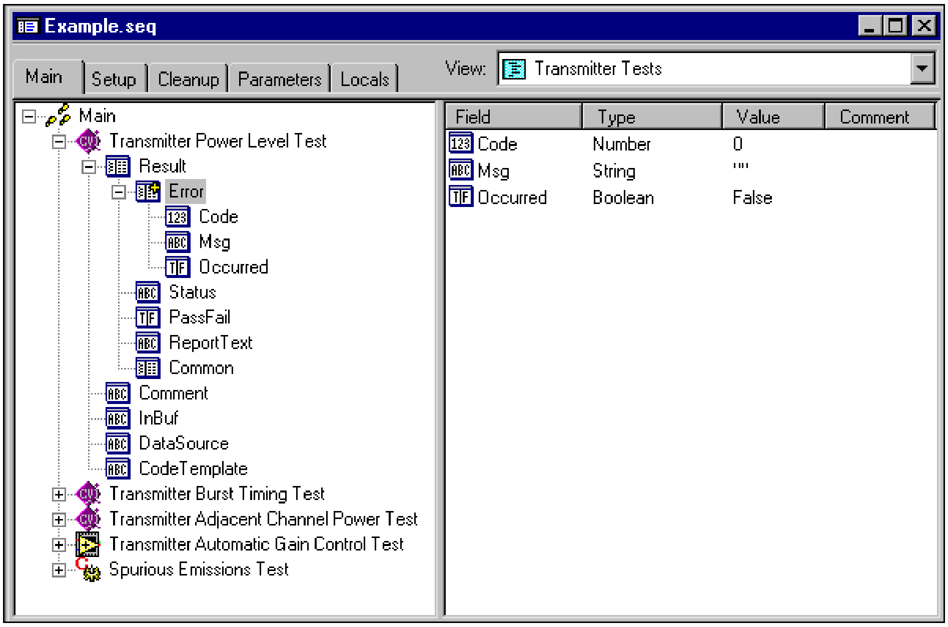
- **Step**—Displays the name of the step and its icon. You can click to the left of the step icon to toggle the breakpoint for the step.
- **Description**—Displays a description of the step that varies according to the type of step and the adapter with which it was created.
- **Execution Flow**—Indicates whether the properties of the step are set to control the flow of execution in the sequence. The following values can appear in this column:
  - **Precondition**—Indicates that the step has a precondition.
  - **Post Action**—Indicates that the step has a post action.
  - **Loop**—Indicates that step has been configured to loop.
  - **Skip**—Indicates that the run mode of the step has been set to `SKIP`.
  - **Force Pass**—Indicates that the run mode of the step has been set to `PASS`.
  - **Force Fail**—Indicates that the run mode of the step has been set to `FAIL`.
  - **Lock**—Indicates that the step acquires a lock that prevents the step from executing concurrently with other steps that acquire the same lock.
  - **Batch**—Indicates that the step specifies an explicit batch synchronization setting that synchronizes the execution of the step

on the set of system test sockets when the step runs in a batch execution.

  – **New Thread/New Execution**—Indicates that the step is a sequence call that launches a subsequence in a new thread or a new execution.

- **Comment**—Displays the comment for the step that you specify in the Step Properties dialog box.

Figure 5-11 shows the list view displaying step properties.



Field	Type	Value	Comment
Code	Number	0	
Msg	String	""	
Occurred	Boolean	False	

Figure 5-11. Step Group List View Columns for Step Properties

When the list view displays step properties, it contains the following columns:

- **Field**—Displays the names and icons for the subproperties of the step property that is currently selected in the tree view. If the property selected in the tree view contains a value or array of values, the value names and icons also appear in this column.
- **Type**—Displays the data type of each subproperty or value.
- **Value**—Displays the current value for each subproperty or value element.
- **Comment**—Displays the comment for each subproperty.

Note To expand a column to the width of its largest entry you can double-click the vertical separator at the right edge of the column heading.

Step Group Context Menu

To access a context menu, right click the tree view or list view. The items in the context menu vary depending on the whether you right click the following sites:

- A step
- A step property
- The background area of the tree view
- The background of the list view

This section describes the items that the context menu can contain.

Insert Step

The **Insert Step** menu item has a submenu from which you select the type of step you want to insert into the sequence. Figure 5-12 shows the **Insert Step** submenu.

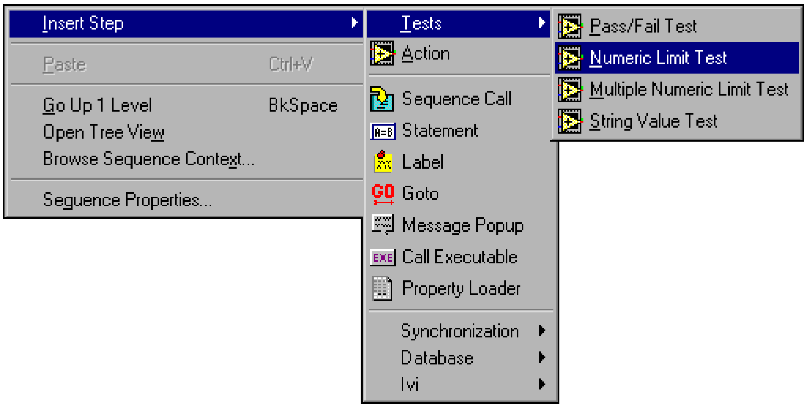


Figure 5-12. Insert Step Menu with LabVIEW Standard Prototype Adapter Selected

Many of the steps types in the **Insert Step** submenu allow you to call code modules. Of these step types, some can work with all module adapters, and others require a specific module adapter. Each adapter allows you to call a category of code modules, such as LabVIEW VIs, LabWindows/CVI source or object modules, or DLLs. Some adapters also know how to control the application development environments in which you build these types of code modules.

Before you insert a step that can call a code module using any adapter, you must select the appropriate module adapter for the type of code module you want the step to call. You use the pull-down ring control in the sequence editor tool bar to select a module adapter. The pull-down ring control shows an icon for each adapter. When a step type in the **Insert Step** submenu can work with any adapter, the icon for the module adapter that is currently selected in the toolbar appears beside that step type. When you insert a step, the adapter icon also appears beside the step name. After you create a step with a particular module adapter, you cannot change its module adapter assignment.

When a step type in the **Insert Step** submenu works with only one specific module adapter, the icon for that module adapter appears beside that step type. After you insert a step using one of these step types, the adapter icon also appears beside the step name.

When you insert a step that does not call a code module, such as a Goto or Label step, the currently selected adapter has no effect. These step types have unique icons. These icons appear next to these step types in the **Insert Step** submenu and next to the steps that you create using these step types.

Edit

The full name of the **Edit** menu item varies according to the type of the selected step. For example, the menu item name is **Edit Message Settings** for a Message Popup step, **Edit Limits** for a Numeric List Test step, and **Edit Destination** for a Goto step. For each step, the menu item invokes a dialog box in which you edit the settings that are unique to the type of the step. Some step types, such as the Label step and the Action step, do not have step-type-specific settings. For these step types, this menu item is disabled. A step type may provide more than one **Edit** menu item so that you can use separate dialog boxes to edit unrelated step functionality.

Specify Module

The **Specify Module** command displays a Specify Module dialog box for the selected step. The dialog box that appears depends on the module adapter for the step. You use the Specify Module dialog box to specify the code module that the step calls. You also can specify options that TestStand uses when it calls the step. Refer to Chapter 13, *Module Adapters*, for more information on the Specify Module dialog box for each adapter.

Edit Code

The **Edit Code** command displays the source code for the code module that the step calls. TestStand uses the module adapter for the step to determine the appropriate application in which to display the source code.

Toggle Breakpoint

The **Toggle Breakpoint** command sets or clears the breakpoint state for the selected steps.

Run Mode

The **Run Mode** menu item displays a submenu from which you can set the following run mode values for the selected steps.

- **Force Pass**—TestStand does not execute the step. Instead, TestStand sets the status of the step to `Passed` automatically.
- **Force Fail**—TestStand does not execute the step. Instead, TestStand sets the status of the step to `Failed` automatically.
- **Skip**—TestStand does not execute the step. Instead, TestStand sets the status of the step to `Skipped` automatically.
- **Normal**—This value tells TestStand to execute the step normally. This is the default value.

Run Selected Steps

The **Run Selected Steps** command runs the selected steps in interactive mode. Refer to the *Interactively Executing Steps* section in Chapter 6, *Sequence Execution*, for more information on running steps in interactive mode.

Run Selected Steps Using

To interactively execute selected steps using the process model entry point you select, choose **Run Selected Steps Using**. When you execute the steps with an entry point such as Single Pass, the process model can generate a report and log the results to a database. The **Run Selected Steps Using** command is available only in a sequence file window.

Loop Selected Steps

The **Loop Selected Steps** command loops on the selected steps in interactive mode. Before running the steps, this command displays a dialog box that you use to specify how many times to loop. Refer to the *Loop on Selected Steps* section in Chapter 4, *Sequence Editor Menu Bar*, for more information on this command. Refer to the *Interactively Executing Steps* section in Chapter 6, *Sequence Execution*, for more information on running steps in interactive mode.

Loop on Selected Steps Using

Use **Loop on Selected Steps Using** to interactively loop on the selected steps using the process model entry point you select. When you loop on steps with an entry point such as Single Pass, the process model can generate a report and log the results to a database. The **Loop on Selected Steps Using** command is available only in a sequence file window.

Open Tree View

The **Open Tree View** command moves the step group divider bar away from the left edge of the window so that the tree view is visible. You can use the tree view to browse the custom properties contained in each step.

Close Tree View

The **Close Tree View** command moves the step group divider bar flush against the left edge of the window to hide the tree view. The command also causes the list view to display the steps in the step group.

View Contents

The **View Contents** command displays the tree view node that corresponds to the currently selected item in the list view. The list view then displays the contents of the item. If the tree view is currently closed, it opens to display the selected node. You use this command to view the subproperties of steps and properties.

Go Up One Level

The **Go Up One Level** command selects the next higher level node in the tree view. The list view displays the contents of the newly selected node. If you invoke this command when the highest level node is selected in the tree view, the Sequence File window displays the All Sequences view.

Browse Sequence Context

The **Browse Sequence Context** command displays a tree view that contains the names of variables, sequence parameters, and step properties you can access from expressions and step modules when the selected step is running. This command also appears in the **View** menu of the sequence editor menu bar. Refer to the *View Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information.

Sequence Properties

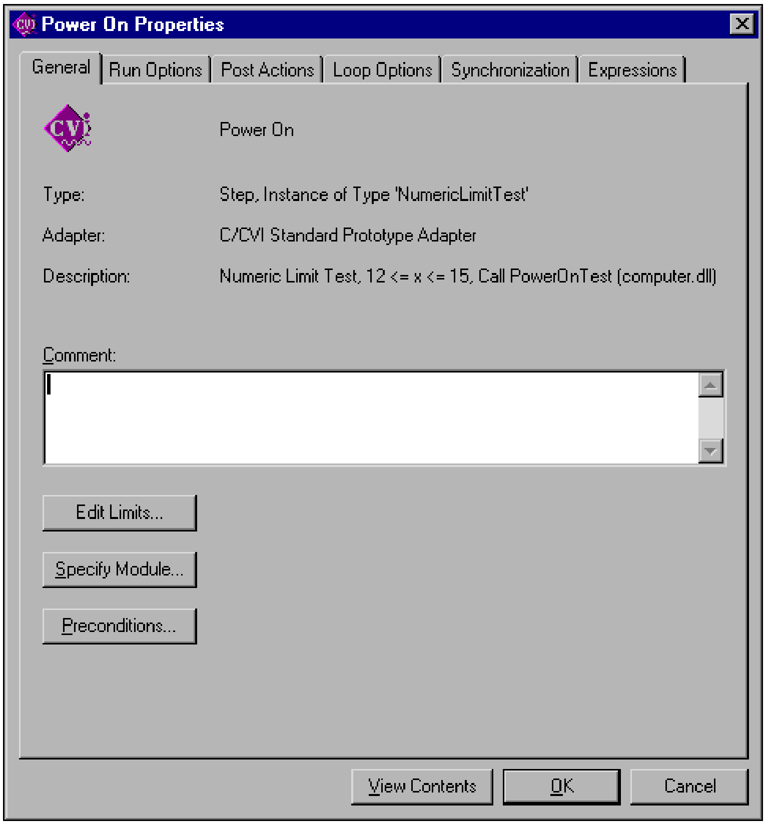
The **Sequence Properties** command displays the Sequence Properties dialog box. Refer to the *Sequence View Context Menu* section earlier in this chapter for more information on the Sequence Properties dialog box.

Step Properties Dialog Box

The **Properties** command displays the Properties dialog box for the selected step or property. If the selected item is a property, you can use the Properties dialog box to edit the value of the property. If the selected item is a step, the Step Properties dialog box appears with General, Run Options, Post Actions, Loop Options, Synchronization, and Expressions tabs in which you can set characteristics of the step.

General Tab

Figure 5-13 shows the General tab in the Step Properties dialog box.



Power On

Type: Step, Instance of Type 'NumericLimitTest'

Adapter: C/CVI Standard Prototype Adapter

Description: Numeric Limit Test, 12 <= x <= 15, Call PowerOnTest (computer.dll)

Comment:

Figure 5-13. General Tab in the Step Properties Dialog Box

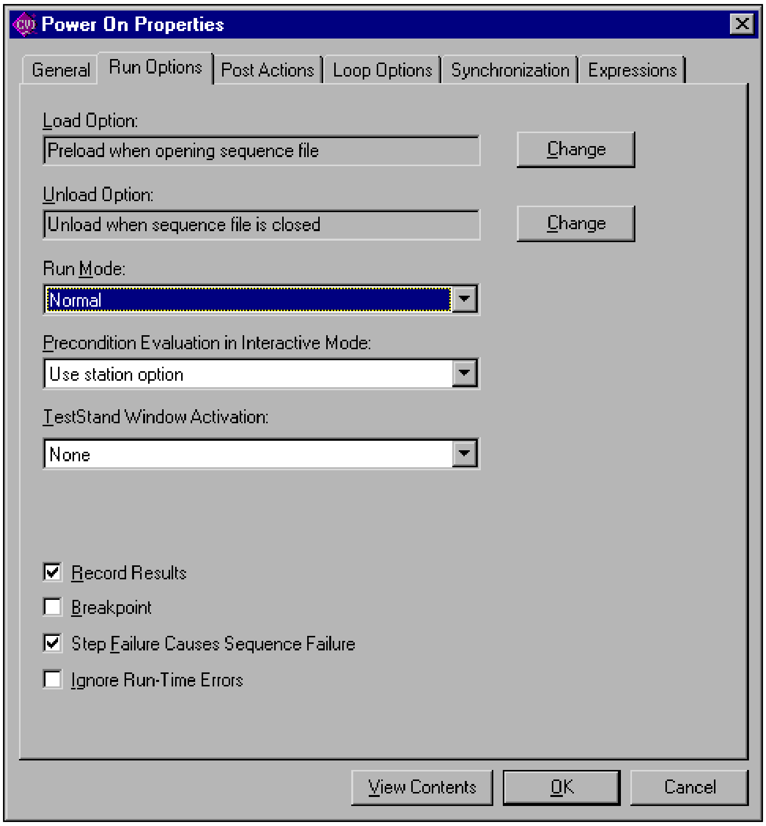
The General tab contains the following controls:

- **Comment**—Places a comment for the step in the Step Group list view. The step comment also appears in the documentation that TestStand generates for the sequence file.
- **Edit**—Displays a dialog box you use to edit the settings that are unique to the type of the step. The button caption varies according to the type of the step. For example, Figure 5-12 shows an **Edit Limits** button. For more information, refer to the discussion of the **Edit** context menu item earlier in this chapter.

- **Specify Module**—Displays the Specify Module dialog box for the selected step. The dialog box that appears depends on the module adapter for the step. You use the Specify Module dialog box to specify the code module that the step calls. You also can specify options that TestStand uses when it calls the step. Refer to Chapter 13, *Module Adapters*, for more information on the Specify Module dialog box for each adapter.
- **Preconditions**—Displays the Preconditions dialog box, where you specify the conditions that must be true for the step to execute. Refer to the *Preconditions Dialog Box* section in this chapter for more information.

Run Options Tab

Figure 5-14 shows the Run Options tab in the Step Properties dialog box.


Power On Properties

Load Option: Preload when opening sequence file

Unload Option: Unload when sequence file is closed

Run Mode: Normal

Precondition Evaluation in Interactive Mode: Use station option

TestStand Window Activation: None

[✓] Record Results
[ ] Breakpoint
[✓] Step Failure Causes Sequence Failure
[ ] Ignore Run-Time Errors

Figure 5-14. Run Options Tab in the Step Properties Dialog Box

The Run Options tab contains the following controls:

- **Load Option**—Specifies one of the following load option settings for the step.
  - **Preload when opening sequence file**—Loads the step module when TestStand loads into memory the sequence that contains the step.
  - **Preload when execution begins**—Loads the step module when any sequence in the sequence file that contains the step begins executing. This value is the default setting.
  - **Load dynamically**—Does not load the step module until the step is ready to call it.
- **Unload Option**—Specifies one of the following Unload Option settings for the step.
  - **Unload when precondition fails**—Unloads the step module when the precondition for the step evaluates to `False`.
  - **Unload after step executes**—Unloads the step module after the step finishes executing.
  - **Unload after sequence executes**—Unloads the step module after the sequence that contains it finishes executing.
  - **Unload when sequence file is closed**—Unloads the step module when TestStand unloads the sequence file that contains the step from memory. This value is the default setting.

Note If you enable the general sequence property Optimize Non-Reentrant Calls to This Sequence, TestStand does not unload the code modules for the sequence until after the execution ends, regardless of the unload options for the sequence file or the steps in the sequence.

- **Run Mode**—Sets the following run-mode values for the step.
  - Force Pass
  - Force Fail
  - Skip
  - Normal

- **Precondition Evaluation in Interactive Mode**—Determines whether TestStand evaluates the step precondition when you run the step interactively. The control contains the following options:
  - Use Station Options
  - Evaluate Precondition
  - Do Not Evaluate Precondition
- **TestStand Window Activation**—Determines whether the TestStand application activates its window when the step completes. The control contains the following options:
  - No Activation
  - Activate When Step Completes
  - If Initially Active, Reactivate When Step Completes
- **Record Results**—Determines whether the contents of the `Result` property for the step are added to the result list for the sequence. Refer to the *Result Collection* section in Chapter 6, *Sequence Execution*, for more information on result collection.
- **Breakpoint**—Causes TestStand to break at this step before executing it. You also can set the breakpoint state for a step by selecting the **Toggle Breakpoint** item in the context menu or by clicking to the left of the step icon in the sequence editor.
- **Step Failure Causes Sequence Failure**—TestStand maintains an internal status value for each executing sequence. When TestStand sets the status property of a step to `Failed`, and you have enabled the Step Failure Causes Sequence Failure option for the step, TestStand sets the internal sequence status value to `Failed`. If the internal status of the sequence is `Failed` when the sequence returns, TestStand sets the status of the calling step to `Failed`. This affects steps that use the Sequence Call step type or the Action step type when the adapter is the Sequence adapter. Steps that use the Pass/Fail Test, Numeric Limit Test, and String Value Test step types with the Sequence adapter overwrite the step status.
- **Ignore Run-time Errors**—Prevents the step from reporting a run-time error to the sequence. When a step causes a run-time error, the step stops executing, and TestStand sets the status of the step to `Error`. If you disable this option, TestStand also sets the internal status of the sequence to `Error`, and execution branches to the Cleanup step group for the sequence. If you enable this option, TestStand does not set the internal status of the sequence to `Error`. Instead, TestStand resets the

`Error.Occurred` property of the step to `False` and execution continues normally with the next step. The value of the `Result.Status` property remains set to `Error` for the step.

If the step is a sequence call, the Run Options tab displays two addition controls:

- **Sequence Call Trace Setting**—Controls tracing for calls to a subsequence. You can choose one of the following options.
  - **Use current trace setting**—Maintains the current tracing state when it calls the subsequence. This is the default value. Usually, only process model files use other values for this option.
  - **Enable tracing in sequence**—Enables tracing for calls to the subsequence, and it restores the original tracing state when the subsequence returns.
  - **Disable tracing in sequence**—Disables tracing for calls to the subsequence, and restores the original tracing state when the subsequence returns. However, if you enable the Allow Tracing into Sequence Calls Marked with Tracing Off option in the Station Options dialog box, TestStand ignores this setting and does not alter the tracing state when it calls the subsequence.
  - **Use Initial Execution Setting**—Enables the tracing state unless the execution was created with tracing disabled. Typically, a process model uses this setting to control the tracing state when the model calls the main sequence in the client file.
- **Ignore Termination** —Controls what happens when a subsequence that you call from this step causes execution to terminate. If you enable this option, TestStand terminates the subsequence, sets the status of the calling step to `Terminated`, but allows the calling sequence to proceed normally from the next step. Usually, only process model files use this option. This option has no effect when execution aborts. Refer to the *Terminating and Aborting Executions* section in Chapter 1, *TestStand Architecture Overview*, for more information on execution termination.

Post Actions Tab

The Post Actions tab in the Step Properties dialog box specifies an action that occurs after a step executes. You can make the action conditional on the Pass/Fail status of the step or on any custom condition.

Figure 5-15 shows the Post Actions tab in the Step Properties dialog box.

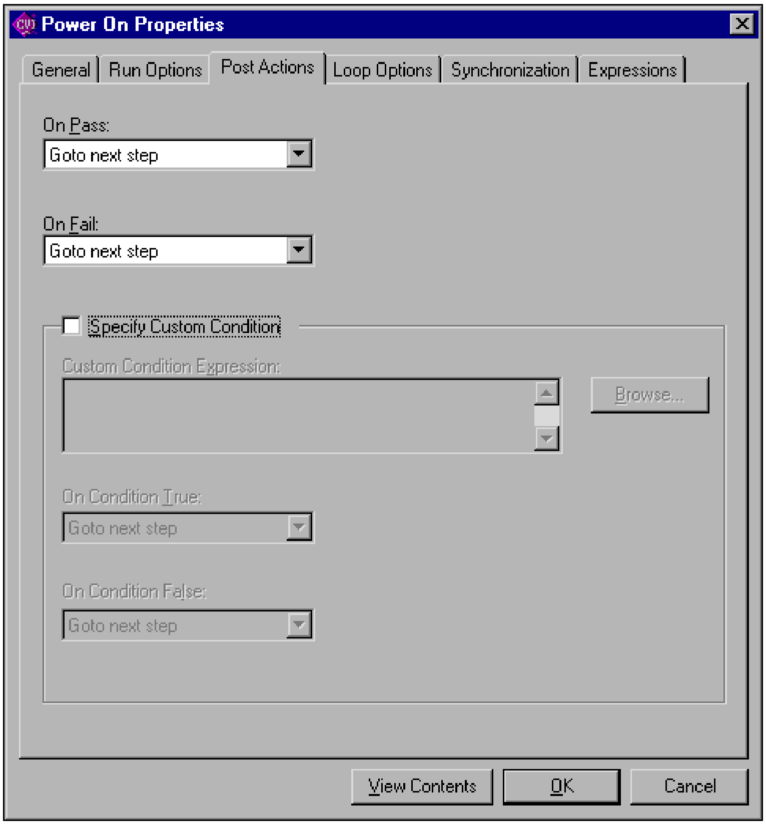


Figure 5-15. Post Actions Tab in the Step Properties Dialog Box

The Post Actions tab contains the following controls:

- **On Pass**—Specifies an action that occurs when the step completes and its status is `Passed`.
- **On Fail**—Specifies an action that occurs when the step completes and its status is `Failed`.
- **Destination**—Specifies the destination step for the On Pass, On Fail, On Condition True, and On Condition False controls.

Note For steps that do not have a Passed or Failed status, you can use a custom condition. For example, the TestStand engine sets the status of an Action step type to Done, rather than Passed or Failed. You can select the Specify Custom Condition checkbox and enter a custom condition expression that evaluates to True or False. Then select the appropriate Post Actions in the On Condition True and On Condition False ring controls. If you want to unconditionally perform a post action, you can enter `True`, in the Custom Condition Expression control.

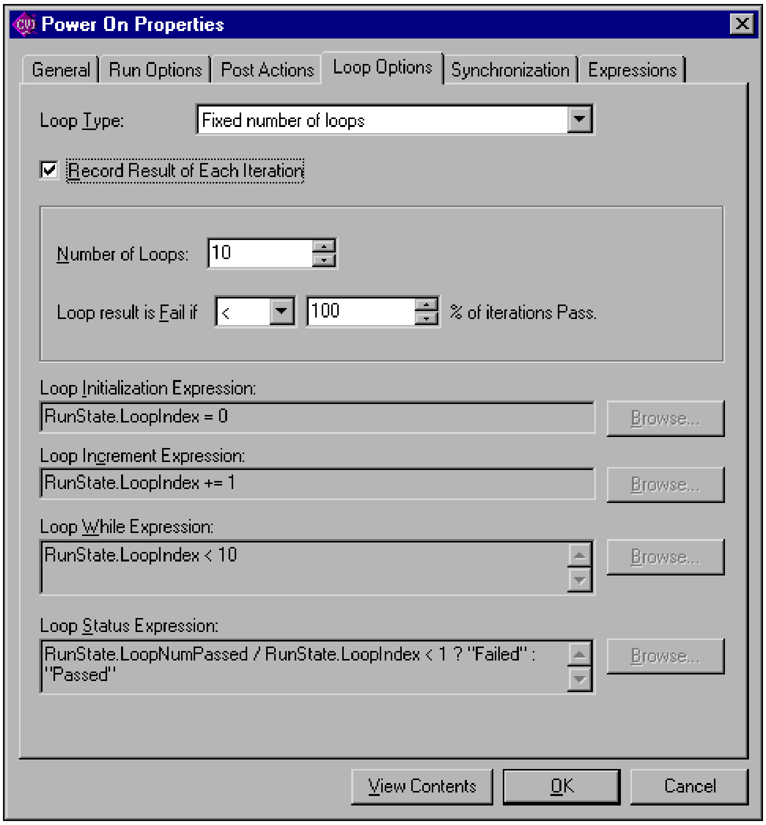
- **Specify Custom Condition**—Specifies that a custom condition controls the post action for the step.
- **Custom Condition Expression**—Specifies the Boolean expression that controls the post action for the step.
- **On Condition True**—Specifies the action that occurs when the step completes and the custom condition expression evaluates to `True`.
- **On Condition False**—Specifies the action that occurs when the step completes and the custom condition expression evaluates to `False`.

The following post actions appear in the ring controls for the On Pass, On Fail, On Condition True, and On Condition False controls:

- **Goto next step**—Execution continues normally with the next step. This is the default value.
- **Goto destination**—Execution branches to the destination you select. You can branch to any step in the current step group, to the end of the current step group, or to the Cleanup step group. If the post action for a step specifies that execution branches to the Cleanup step group and the current step is in the Cleanup step group, execution proceeds normally with the next step in the Cleanup group.
- **Terminate execution**—Execution terminates. Refer to the *Terminating and Aborting Executions* section in Chapter 1, *TestStand Architecture Overview*, for more information on execution termination.
- **Call sequence**—TestStand calls a sequence before continuing to the next step. You can select any sequence in the sequence file. TestStand does not pass any arguments to the sequence. If the sequence has parameters, TestStand uses their default values.
- **Break**—TestStand breakpoints before continuing to the next step.

Loop Options Tab

The Loop Options tab in the Step Properties dialog box configures an individual step to run repeatedly in a loop when it executes. To loop on several steps at once, place the steps in a new sequence, create a Sequence Call step that calls the sequence, and loop on the Sequence Call step. Figure 5-16 shows the Loop Options tab in the Step Properties dialog box.


Power On Properties

General | Run Options | Post Actions | Loop Options | Synchronization | Expressions

Loop Type: Fixed number of loops

[✓] Record Result of Each Iteration

Number of Loops: 10

Loop result is Fail if < 100 % of iterations Pass.

Loop Initialization Expression: RunState.LoopIndex = 0

Loop Increment Expression: RunState.LoopIndex += 1

Loop While Expression: RunState.LoopIndex < 10

Loop Status Expression: RunState.LoopNumPassed / RunState.LoopIndex < 1 ? "Failed" : "Passed"

Figure 5-16. Loop Options Tab in the Step Properties Dialog Box

The Loop Options tab displays the following options:

- **Loop Type**—Specifies the type of looping for the step:
  - **None**—TestStand does not loop on the step. This is the default value.
  - **Fixed number of loops**—TestStand loops on the step a specific number of times and determines the final pass or fail status of the step based on the percentage of loop iterations in which the step status is `Passed`.
  - **Pass/Fail count**—TestStand loops on the step until the step passes or fails a specific number of times or until a maximum number of loop iterations complete. TestStand determines the final status of the step based on whether the specific number of passes or failures occur or based on the number of loop iterations reaches the maximum.

- **Custom**—Customizes the looping behavior for the step. You specify a Loop Initialization expression, a Loop Increment expression, a Loop While expression, and a final Loop Status expression. The following example code illustrates the order in which TestStand uses the loop expressions.

```
Loop_Initialization_Expression;
while (Loop_While_Expression == True)
    {
    Execute_Step;
    Loop_Increment_Expression;
    }
Loop_Status_Expression;
```

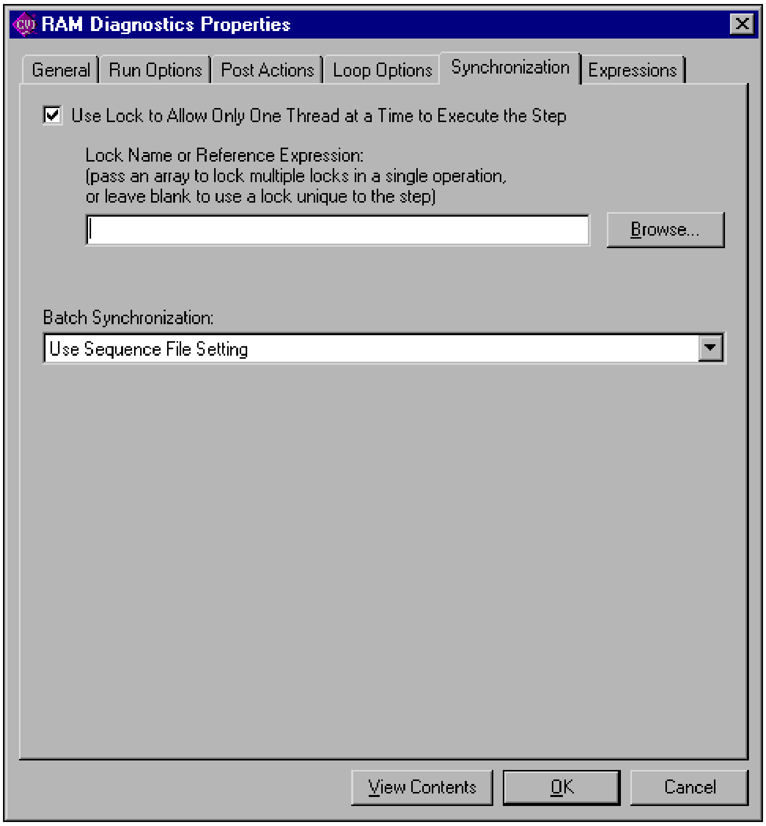
- **Record Result of Each Iteration**—Adds the step result to the sequence results list after each loop iteration. TestStand also adds the final result that it computes for the step loop as a whole if you have enabled the Record Results property for the step. Refer to the *Result Collection* section in Chapter 6, *Sequence Execution*, for more information on result collection.

Note You do not have to use the Loop Options tab to cause execution to iterate for a step or for series of steps. Instead, you can use a Goto step to create a loop inside your sequence. You can use the preconditions for the Goto step in combination with any number of variables to control the loop.

Synchronization Tab

The Synchronization tab in the Step Properties dialog box specifies a synchronization action that TestStand performs around the execution of the step. You can specify that a lock protects the execution of the step or that the step synchronizes with other steps in a batch execution.

Figure 5-17 shows the Synchronization tab in the Step Properties dialog box.



[✓] Use Lock to Allow Only One Thread at a Time to Execute the Step

Lock Name or Reference Expression:
(pass an array to lock multiple locks in a single operation, or leave blank to use a lock unique to the step)

Batch Synchronization: Use Sequence File Setting

Figure 5-17. Synchronization Tab in the Step Properties Dialog Box

The Synchronization tab contains the following controls:

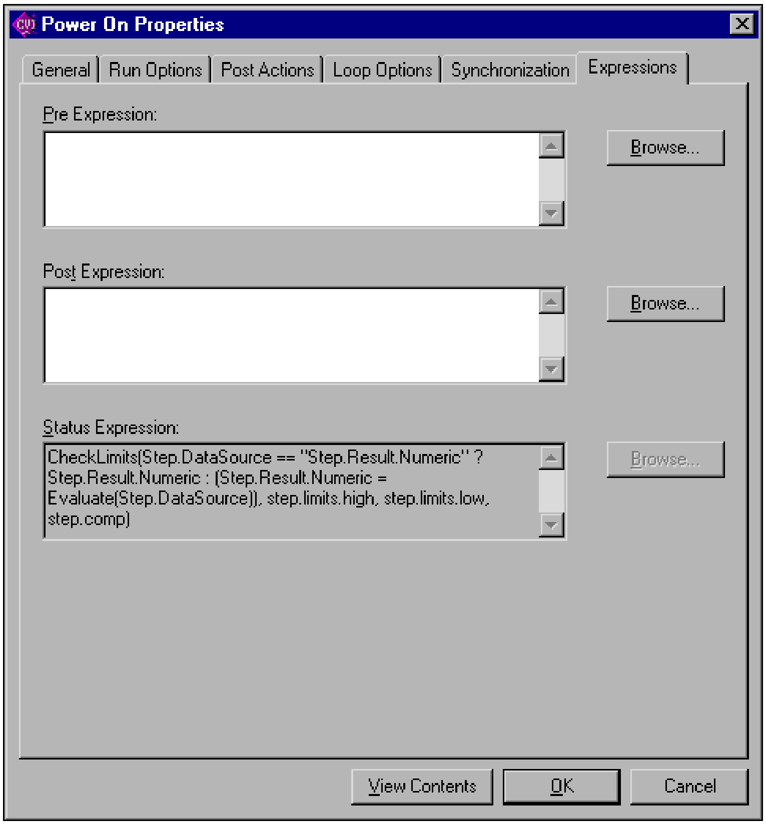
- **Use Lock to Allow Only One Thread to Execute the Step**—Specifies that the step acquires a lock before it executes and releases the lock after it completes.
- **Lock Name or Reference Expression**—Specifies which lock the step acquires and releases. Enter a string expression to specify the name of an existing lock. You also can enter an expression that evaluates to an ActiveX reference to an existing lock object. Leave the control empty to specify that TestStand uses a lock that is unique to the step.
- **Batch Synchronization**—Specifies the batch synchronization operation that the step enters before it executes and exits after it completes. Refer to the *Batch Synchronization* section of Chapter 11,

Synchronization Step Types, for more information on batch synchronization operations.

Expressions Tab

You use the Expressions tab to specify optional expressions that TestStand evaluates before or after it calls the step module.

Figure 5-18 shows the Expressions tab in the Step Properties dialog box.



```
CheckLimits(Step.DataSource == "Step.Result.Numeric" ?
Step.Result.Numeric : (Step.Result.Numeric =
Evaluate(Step.DataSource)), step.limits.high, step.limits.low,
step.comp)
```

Figure 5-18. Expressions Tab in the Step Properties Dialog Box

The Expressions tab contains the following controls:

- **Pre Expression**—Specifies an expression that TestStand evaluates before it calls the step module. Usually, you use this expression to set the value of a custom step property from the values of other variables and properties.

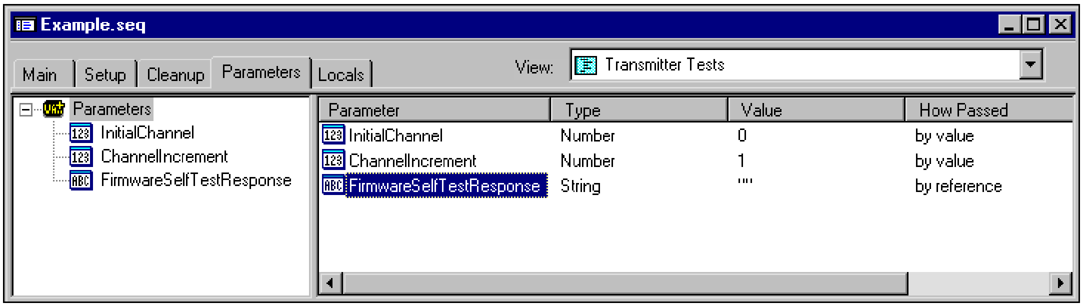
- **Post Expression**—Specifies an expression that TestStand evaluates after it calls the step module. Usually, you use this expression to set the value of one of the subproperties in the `Result` property of the step based on the values of other variables and properties.
- **Status Expression**—Sets the status property for the step. Because the status is a string property, this expression must evaluate to a string.

If you leave an expression field empty, TestStand does not evaluate it.

Note Certain types of steps such as Numeric Limit Tests, String Value Tests, Pass/Fail Tests, and Statement steps reserve one or more of these expressions to perform operations specific to the type of step. In these cases, you cannot use the expressions that the step type reserves. The expressions appear dimmed in the tab.

Parameters Tab

Sequences can have steps that call other sequences. A sequence can have parameters so that you can pass values to it and receive values from it. You define the parameters for a sequence on the Parameters tab. Figure 5-19 shows the Parameters tab for an example sequence.



Parameter	Type	Value	How Passed
InitialChannel	Number	0	by value
ChannelIncrement	Number	1	by value
FirmwareSelfTestResponse	String	""	by reference

Figure 5-19. Parameters Tab

Lifetime of Local Variables, Parameters, and Custom Step Properties

Multiple instances of a sequence can run at the same time. This situation can occur when you call a sequence recursively or when a sequence runs in multiple concurrent threads. Each instance of the sequence has its own copy of the sequence parameters, local variables, and custom properties of each step. When a sequence completes, TestStand discards the values of the parameters, local variables, and custom properties.

Parameters Tab Context Menu

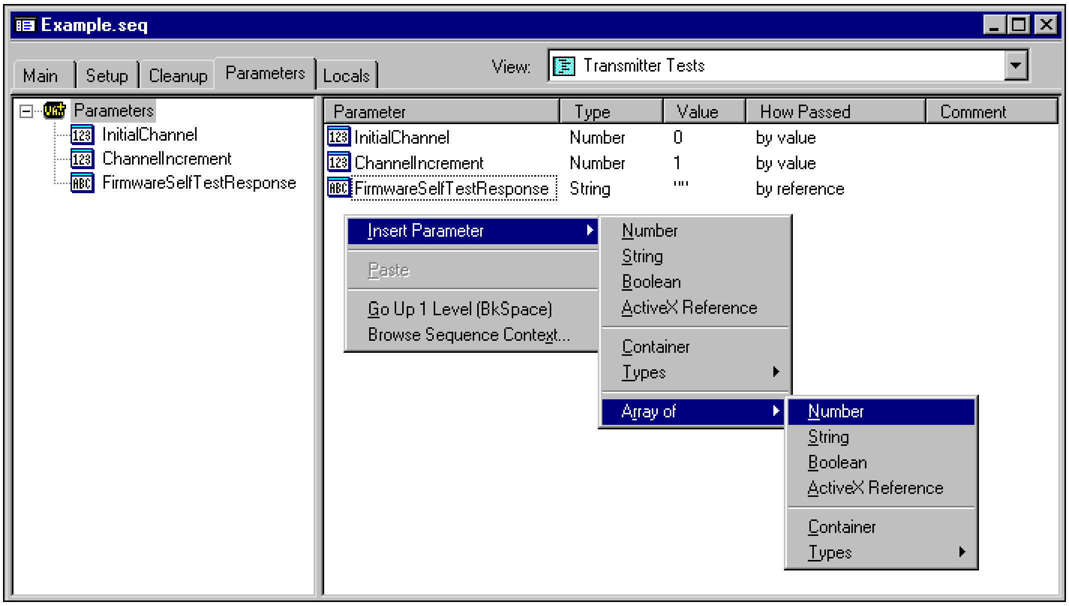
To access a context menu, right click the tree view or list view on the Parameters tab. The items in the context menu vary depending on whether you right click the following sites:

- A parameter
- A parameter subproperty
- The background area of the tree view
- The background of the list view

This section describes the items that the context menu can contain.

Insert Parameter

The **Insert Parameter** menu item has a submenu from which you select the data type for the parameter you want to insert. Figure 5-20 shows the **Insert Parameter** submenu in a sequence.



Parameter	Type	Value	How Passed	Comment
InitialChannel	Number	0	by value	
ChannelIncrement	Number	1	by value	
FirmwareSelfTestResponse	String	""	by reference	

Figure 5-20. Insert Parameter Submenu

If you want to insert a parameter with a custom data type, you must create a named data type. You can create a named data type in the Sequence File Types view of the Sequence File window or in the Types Palette window. Refer to Chapter 9, *Types*, for more information on types and type editing.

After you create the named data type, it appears in the **Types** submenu of the **Insert Parameter** submenu.

View Contents

The **View Contents** command selects the tree view node that corresponds to the currently selected item in the list view. The list view then displays the contents of the item. If the tree view is currently closed, it opens to display the selected node. You use this command to view the subproperties of sequence parameters.

Go Up One Level

The **Go Up One Level** command selects the next higher level node in the tree view. The list view displays the contents of the newly selected node. If you invoke this command when the highest-level node is selected in the tree view, the Sequence File window displays the All Sequences view.

Browse Sequence Context

The **Browse Sequence Context** command displays a tree view that contains the names of variables and sequence parameters you can access from expressions and step modules when the sequence is running. This command also appears in the **View** menu of the sequence editor menu bar. Refer to the *View Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information.

Rename

The **Rename** command allows you to edit the name of the selected parameter or subproperty.

Pass By Reference

The **Pass By Reference** command tells TestStand that the parameter is a reference to the argument that the calling sequence passes to the parameter. Passing a parameter by reference allows the subsequence to change the actual value of the argument in the calling sequence.

If you disable the **Pass By Reference** command for a parameter, TestStand copies the argument value that the calling sequence passes as the parameter. This prevents the subsequence from changing the value of the argument in the calling sequence. On the other hand, copying a large object or array that you pass as a parameter can degrade performance.

You enable the **Pass By Reference** command if you want to return a value from a subsequence to the calling sequence. You also can enable the option to reduce the time it takes to pass a large object or array to a subsequence. You disable the option if you want to guarantee that any changes that a subsequence makes to a parameter does not affect the argument in the calling sequence.

Note Do not pass a parameter by reference to a subsequence you call in a separate thread unless you are certain that you want the new thread to see changes that you make to the variable in the calling sequence after the sequence call returns.

Check Type

The **Check Type** option tells TestStand to verify that the data type of the argument you pass as a parameter is compatible with the data type of the parameter. For example, TestStand reports a run-time error if you set this option for a String parameter and then pass a numeric value instead.

Although type checking is usually a fast operation, you can turn this option off if you want to avoid any possible overhead. You also can turn this option off if you want to pass arguments with different types in the same parameter field for calls. To pass arguments in this way, you specify `Container` as the data type for the parameter and you disable the **Check Type** option. You can use the `PropertyExists` expression function to determine whether the argument that a calling sequence passes to your container parameter contains a particular subproperty.

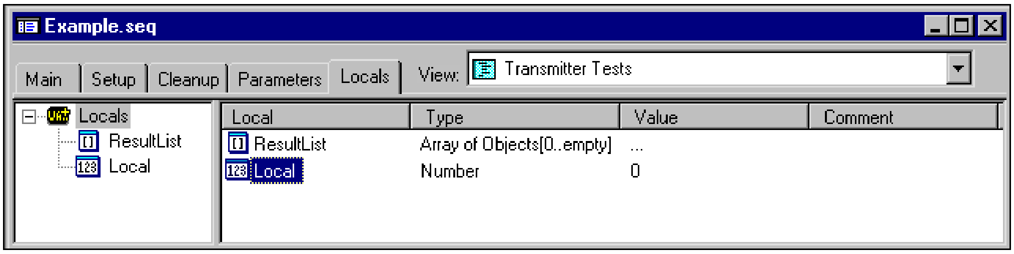
Parameter Properties

The **Properties** command displays a dialog box that you can use to change the default value of a parameter or of one of its subproperties. TestStand uses the default values for all the parameters to a sequence when you run the sequence directly. When you call the sequence from a step in another sequence and the step passes fewer arguments than the sequence has, TestStand uses the default values for the remaining sequence parameters.

Locals Tab

Sequences can have any number of local variables. You can use local variables to hold values that you set or get in step modules. You also can use local variables for maintaining counts, for holding intermediate values, or for any other purpose. Refer to the *Using Data Types* section in Chapter 9, *Types*, for more information on using local variables.

Figure 5-21 shows the Locals tab for an example sequence.



Local	Type	Value	Comment
ResultList	Array of Objects[0..empty]	...	
Local	Number	0	

Figure 5-21. Locals Tab

Lifetime of Local Variables, Parameters, and Custom Step Properties

Multiple instances of a sequence can run at the same time. This situation can occur when you call a sequence recursively or when a sequence runs in multiple concurrent threads. Each instance of the sequence has its own copy of the sequence parameters, local variables, and custom properties of each step. When a sequence completes, TestStand discards the values of the parameters, local variables, and custom properties.

Locals Tab Context Menu

To access a context menu, right click the tree view or list view on the Locals tab. The items in the context menu vary depending on whether you right click the following sites:

- A local variable
- A local variable subproperty
- The background area of the tree view
- The background of the list view

This section describes the items that the context menu can contain.

Insert Local

The **Insert Local** menu item has a submenu from which you select the data type for the local variable you want to insert. Figure 5-22 shows the **Insert Local** submenu in a sequence view.

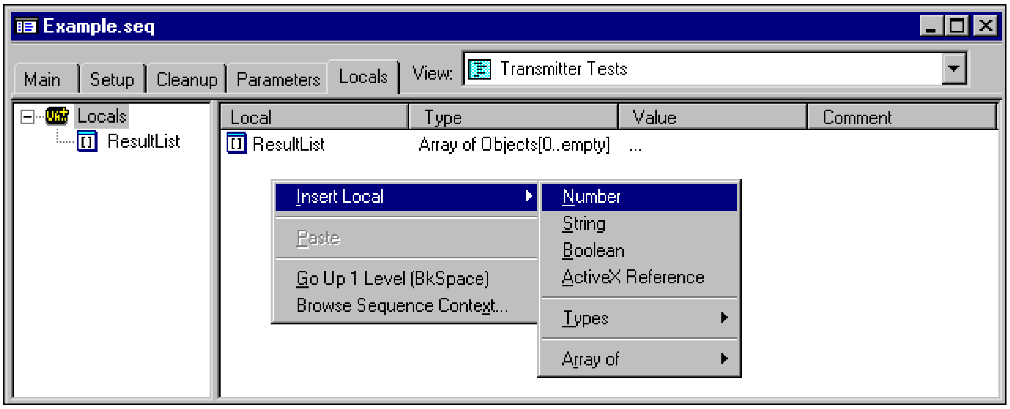


Figure 5-22. Insert Local Submenu

If you want to insert a local variable with a custom data type, you must create a named data type. You can create a named data type in the Sequence File Types view of the Sequence File window or in the Types Palette window. Refer to Chapter 9, *Types*, for more information on types and type editing. After you create the named data type, it appears in the **Types** submenu of the **Insert Local** submenu.

If you create an array, an Array Bounds dialog box appears. Refer to the *Specifying Array Sizes* section in Chapter 9, *Types*, for more information on the Array Bounds dialog box.

Notice that sequences always start with one local variable, `ResultList`. If you delete this local variable, TestStand cannot collect results for the sequence. Refer to the *Result Collection* section in Chapter 6, *Sequence Execution*, for more information on the results list.

View Contents

The **View Contents** command selects the tree view node that corresponds to the currently selected item in the list view. The list view then displays the contents of the item. If the tree view is currently closed, it opens to display the selected node. You use this command to view the subproperties of local variables.

Go Up One Level

The **Go Up One Level** command selects the next higher level node in the tree view. The list view displays the contents of the newly selected node. If you invoke this command when the highest level node is selected in the tree view, the Sequence File window displays the All Sequences view.

Browse Sequence Context

The **Browse Sequence Context** command displays a tree view that contains the names of global variables, local variables, and sequence parameters you can access from expressions and step modules when the selected step is running. This command also appears in the **View** menu of the sequence editor menu bar. Refer to the *View Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information.

Rename

The **Rename** command allows you to edit the name of the selected local variable or subproperty.

Propagate to Subsequence

Set the **Propagate to Subsequence** option to specify that a local variable appears at run time as a local variable in subsequences that the sequence calls. The variable continues to propagate as the call chain extends. Typically, you configure local variables to propagate in order to automatically pass a set of values to all subsequences that a sequence calls.

Allow Propagation from Caller

Set the **Allow Propagation from Caller** option to specify which variable takes precedence when a subsequence defines a variable with the same name as a variable that a calling sequence propagates. If **Allow Propagation from Caller** is not set, TestStand preserves the local variable in the subsequence. If **Allow Propagation from Caller** is set, TestStand replaces the variable in the subsequence with the variable that the caller propagates.

When a propagated variable replaces an existing sequence variable, TestStand generates an error if the types of the variables do not match.

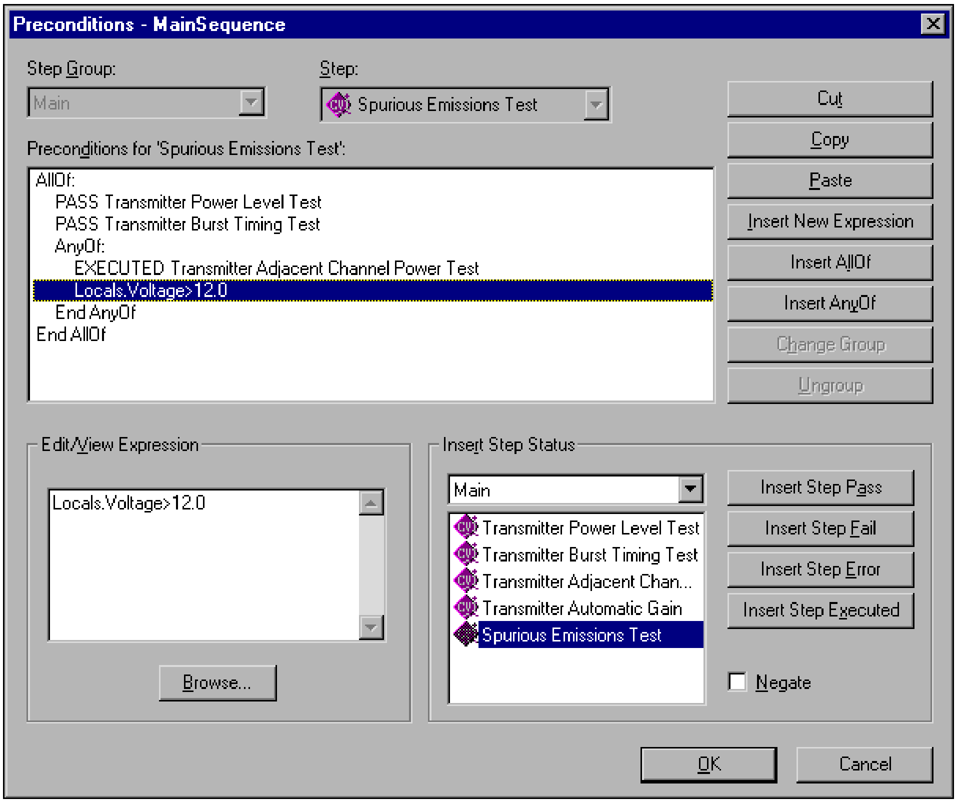
Properties

The **Properties** command displays a dialog box you can use to change the default value for the selected local variable or subproperty. TestStand sets the values of the local variables to their default values when the sequence begins executing. If the local variable or subproperty is an array, you use the Bounds tab in the dialog box to change the array bounds.

Preconditions Dialog Box

TestStand has several features that you can use to control the flow of execution in a sequence. These include the post actions for a step, the preconditions for a step, and the Goto step type. You can combine these features in various ways. For example, you can use the preconditions on a Goto step to specify when to loop back to an earlier statement. This section discusses the Preconditions dialog box.

To access the Preconditions dialog box, click the **Preconditions** button on the Sequence Properties dialog box or click the **Preconditions** button on the Step Properties dialog box. Figure 5-23 shows the Preconditions dialog box for a sequence.



Preconditions for 'Spurious Emissions Test':

```
AllOf:
    PASS Transmitter Power Level Test
    PASS Transmitter Burst Timing Test
    AnyOf:
        EXECUTED Transmitter Adjacent Channel Power Test
        Locals.Voltage>12.0
    End AnyOf
End AllOf
```

Edit/View Expression: Locals.Voltage>12.0

Insert Step Status: Main

- Transmitter Power Level Test
- Transmitter Burst Timing Test
- Transmitter Adjacent Chan...
- Transmitter Automatic Gain
- Spurious Emissions Test

Figure 5-23. Preconditions Dialog Box for a Sequence

The Step Group and Step controls indicate the step to which the preconditions apply. When you invoke the dialog box from the Sequence Properties dialog box, you can use these controls to select any step group and step in the sequence. When you invoke the dialog box from the Step Properties dialog box, you cannot operate these controls.

The Preconditions list box shows the preconditions of the step. The label above the list box includes the name of the step. The following items can appear in the Preconditions list box:

- **Step status condition expression**—Step status conditions refer to the status of other steps in the sequence. In the list box, step status conditions begin with `PASS`, `NOT PASS`, `FAIL`, `NOT FAIL`, `ERROR`, `NOT ERROR`, `EXECUTED`, or `NOT EXECUTED`, followed by the name of the step.
- **Arbitrary expression**—You can enter an item that contains an arbitrary expression.
- **AllOf block**—Brackets multiple expressions and evaluates to `True` only if all the expressions in the block evaluate to `True`. Each `AllOf` block consists of a line containing `AllOf` and another line containing `End AllOf`.
- **AnyOf block**—Brackets multiple expression and evaluates to `True` if one or more expressions in the block evaluate to `True`. Each `AnyOf` block consists of a line containing `AnyOf` and another line containing `End AnyOf`.

You can nest one or more blocks within another block. A block treats a nested block as just another expression.

The following buttons appear in the Preconditions dialog box:

- **Cut** or **Copy**—Cuts or copies the entire block that you select on an `AllOf` or `AnyOf` line in the list box. The **Cut** and **Copy** buttons dim when you select an `End AllOf` or `End AnyOf` line.
- **Insert New Expression**—Inserts an empty arbitrary expression below the current line in the Preconditions list box.
- **Insert AllOf**—Inserts an empty `AllOf` block below the current line in the Preconditions list box.
- **Insert AnyOf**—Inserts an empty `AnyOf` block below the current line in the Preconditions list box.

To nest a block within an existing block, select the `AllOf` or `AnyOf` line of the existing block and click the **Insert AnyOf** or **Insert AllOf** button.

To add a block at the same level as an existing block, select the `End AllOf` or `End AnyOf` line of the existing block and click the **Insert AnyOf** or **Insert AllOf** button.

When you select an `AllOf` line, you can use the **Change to AnyOf** button to change the block to an `AnyOf` block. When you select an `AnyOf`, you can click the **Change to AllOf** button to change the block to an `AllOf` block.

When you select the `AllOf` line or `AnyOf` line of a block that contains only one expression or that is nested within another block, you can use the **Ungroup** button to remove the block but keep its contents.

You use the Edit/View Expression text box to view or modify an expression line in the Preconditions list box. You can enter or modify the expression manually in the text box. You also can use the **Browse** button to display an expression browser dialog box in which you can interactively build an expression from lists of available variables, properties, and expression operators. Refer to Chapter 8, *Sequence Context and Expressions*, for more information on expressions.

You use the Insert Step Status section of the dialog box to design a step status expression. You use the ring control and list box to choose a step group and step in the sequence. You can use the Negate checkbox to negate the meaning of an expression. The following describes the command buttons in this section:

- **Insert Step Pass**—Inserts an expression that is `True` if the status for the most recent execution of the selected step is `Passed`.
- **Insert Step Fail**—Inserts an expression that is `True` if the status for the most recent execution of the selected step is `Failed`.
- **Insert Step Error**—Inserts an expression that is `True` if the status of the most recent execution of the selected step is `Error`, which indicates that a run-time error occurred in the step.
- **Insert Step Executed**—Inserts an expression that is `True` if the status for the most recent execution of the selected step is anything other than an empty string.

If, for example, you select the ROM step, enable the Negate checkbox, and click the **Insert Step Pass** button, TestStand inserts a line containing `NOT PASS ROM` in the list box.

Sequence File Globals View

Each sequence file can contain any number of global variables. Figure 5-24 shows the contents of the Sequence File Globals view for an example sequence, and also shows the ring control where you select this view.

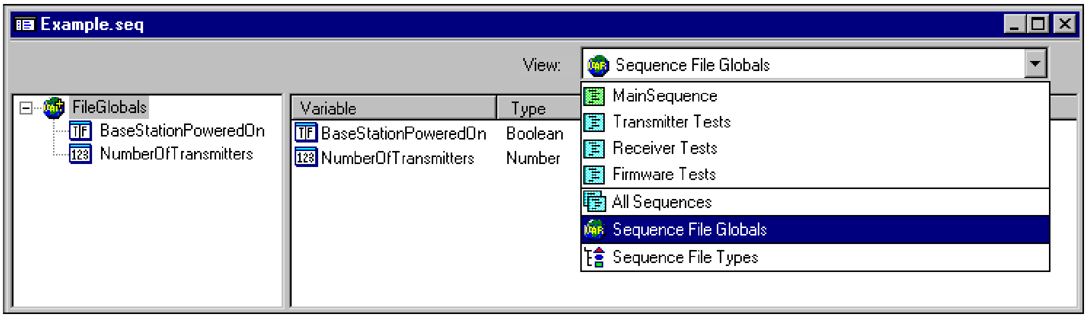


Figure 5-24. Sequence File Globals View for an Example Sequence

Lifetime and Scope of Sequence File Global Variables

The **Sequence File Globals** control on the Sequence File properties dialog box specifies the lifetime of the sequence file global variables. The default setting, **Separate File Globals for Each Expression,** specifies that each execution that runs the file creates a separate run-time copy of the global variables and initializes them to their default values.

You also can specify a Sequence File Globals setting of **All Executions Share the Same File Globals**. This setting specifies that the first execution that runs the sequence file creates a run-time copy of the global variables and initializes them to their default values. Any other execution that runs the file concurrently uses the same global variables. When the last execution that uses the file globals completes, TestStand discards the file globals.

For either setting, if a sequence file unloads from memory and an execution later reloads the file, the execution creates a new run-time copy of the file globals and initializes them to their default values.

Any sequence in the file can access the global variables for the file. A subsequence can access the global variables in the sequence file that contains the calling sequence. It also can access the global variables in the process model file and in the client sequence file explicitly, in one of the following ways:

- In an expression
- In a call to the TestStand API

The sequence context contains references to the calling sequence, the main sequence in the client sequence file, and the process model entry point sequence. Refer to Chapter 8, *Sequence Context and Expressions*, for more information.

Sequence File Globals View Context Menu

To access a context menu, right click the tree view or list view in the Globals view. The items in the context menu vary depending on the whether you right click the following sites;

- A global variable
- A global variable subproperty
- The background of the tree view
- The background of the list view

This section describes the items that the context menu can contain.

Insert Global

The **Insert Global** menu item has a submenu from which you select the data type for the sequence file global variable you want to insert. Figure 5-25 shows the **Insert Global** submenu.

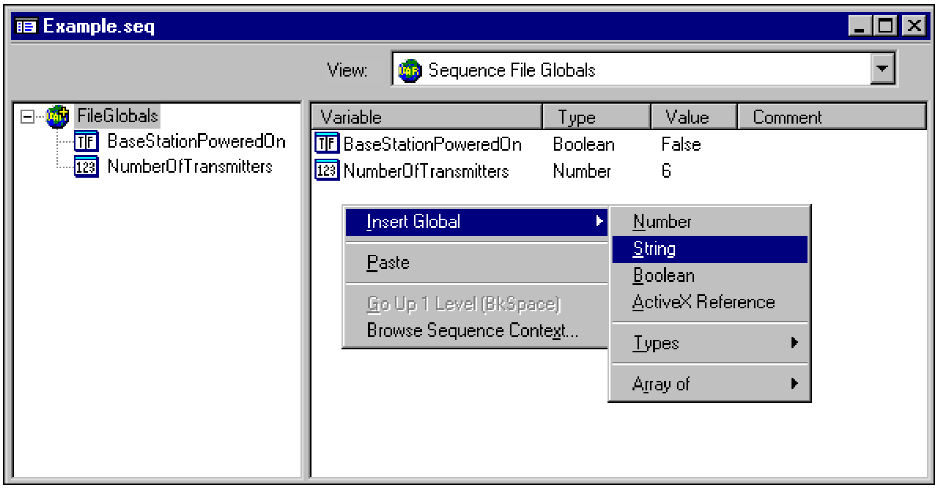


Figure 5-25. Insert Global Submenu

If you want to insert a global variable with a custom data type, you must create a named data type. You can create a named data type in the Sequence File Types view of the Sequence File window or in the Type Palette window. Refer to Chapter 9, *Types*, for more information on types and type editing. After you create the named data type, it appears in the **Types** submenu of the **Insert Global** submenu.

If you create an array, an Array Bounds dialog box appears. Refer to the *Specifying Array Sizes* section in Chapter 9, *Types*, for more information on the Array Bounds dialog box.

View Contents

The **View Contents** command selects the tree view node that corresponds to the currently selected item in the list view. The list view then displays the contents of the item. If the tree view is currently closed, it opens to display the selected node. You use this command to view the subproperties of sequence file global variables.

Go Up One Level

The **Go Up One Level** command selects the next higher level node in the tree view. The list view displays the contents of the newly selected node.

Browse Sequence Context

The **Browse Sequence Context** command displays a tree view that contains the names of the station global variables and sequence file global variables that you can access from expressions and step modules when sequences in the file are running. This command also appears in the **View** menu of the sequence editor menu bar. Refer to the *View Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information.

Rename

The **Rename** command allows you to edit the name of the selected global variable or subproperty.

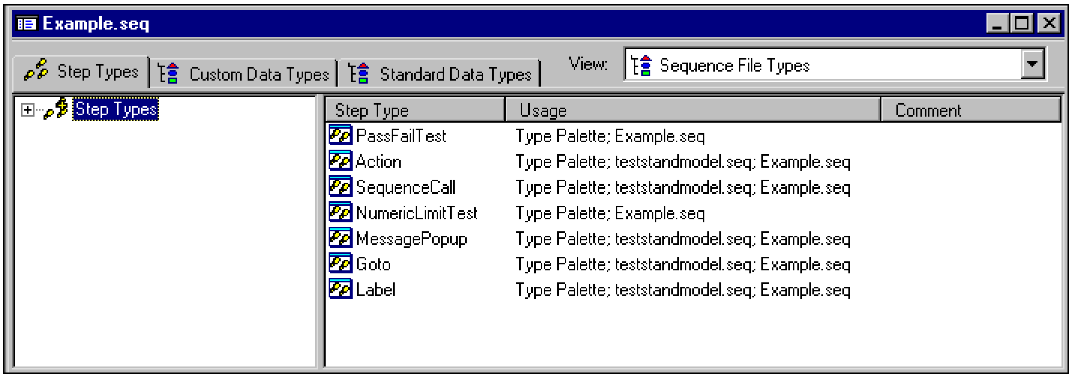
Properties

The **Properties** command displays a dialog box that you can use to change the default value for the selected global variable or subproperty. TestStand sets the values of the global variables to their default values when the sequence begins executing. If the globals variable or subproperty is an array, you use the Bounds tab in the dialog box to change the array bounds.

Sequence File Types View

Sequence files contain the type definitions for every step, property, and variable that the file contains. You can view the types that a sequence file contains by selecting Sequence File Types from the sequence file View ring control.

Figure 5-26 shows the Sequence File Type view for an example sequence file.



Step Type	Usage	Comment
PassFailTest	Type Palette; Example.seq	
Action	Type Palette; teststandmodel.seq; Example.seq	
SequenceCall	Type Palette; teststandmodel.seq; Example.seq	
NumericLimitTest	Type Palette; Example.seq	
MessagePopup	Type Palette; teststandmodel.seq; Example.seq	
Goto	Type Palette; teststandmodel.seq; Example.seq	
Label	Type Palette; teststandmodel.seq; Example.seq	

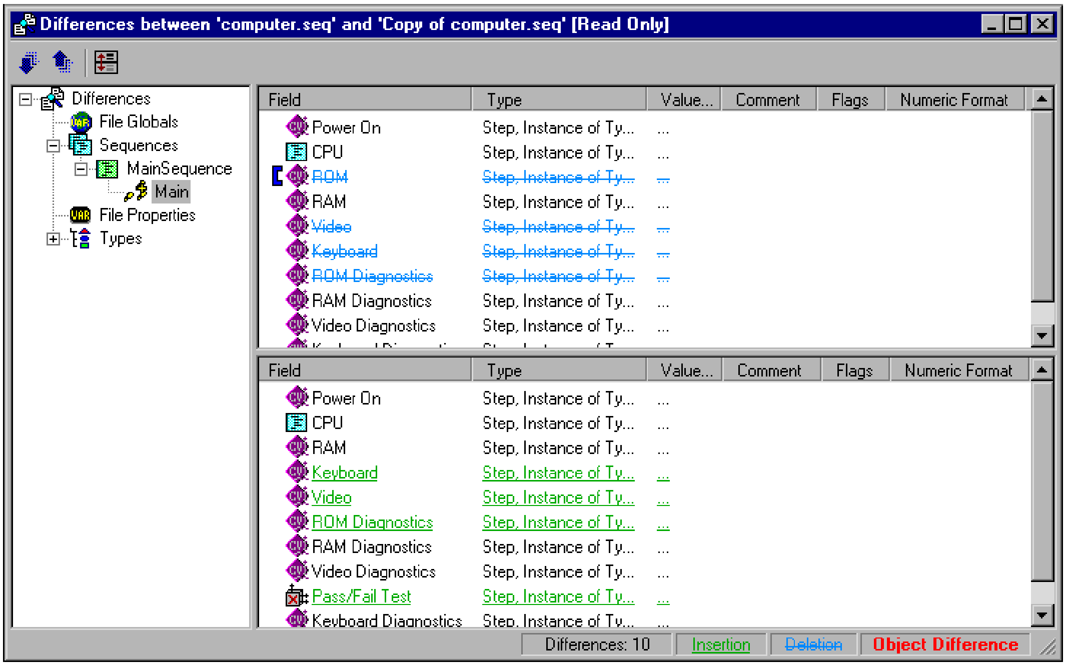
Figure 5-26. Step Types Tab in Sequence File Types View

Refer to Chapter 9, *Types*, for more information on the types and type editing.

Comparing and Merging Sequence Files

The TestStand Differ is a graphical tool in the Sequence Editor that enables you to compare and merge differences between two sequence files. The TestStand Differ compares the sequence files and presents the differences in a new window.

To diff two sequence files, first activate the sequence file window for the file that you want TestStand to designate as the original file. Next, select **Edit»Diff Sequence File With**. From the Select Sequence File dialog box, choose the file for TestStand to compare to the original sequence file. When displaying differences, TestStand considers this second file to be a modified version of the original file. Figure 5-27 shows the Differ window that TestStand opens to display the differences between the original file and the modified file.



Differences between 'computer.seq' and 'Copy of computer.seq' [Read Only]

- Differences
  - File Globals
  - Sequences
    - MainSequence
      - Main
  - File Properties
  - Types

Field	Type	Value...	Comment	Flags	Numeric Format
Power On	Step, Instance of Ty...	...			
CPU	Step, Instance of Ty...	...			
~~ROM~~	~~Step, Instance of Ty...~~	~~...~~			
RAM	Step, Instance of Ty...	...			
~~Video~~	~~Step, Instance of Ty...~~	~~...~~			
~~Keyboard~~	~~Step, Instance of Ty...~~	~~...~~			
~~ROM Diagnostics~~	~~Step, Instance of Ty...~~	~~...~~			
RAM Diagnostics	Step, Instance of Ty...	...			
Video Diagnostics	Step, Instance of Ty...	...			

Field	Type	Value...	Comment	Flags	Numeric Format
Power On	Step, Instance of Ty...	...			
CPU	Step, Instance of Ty...	...			
RAM	Step, Instance of Ty...	...			
Keyboard	Step, Instance of Ty...	...			
Video	Step, Instance of Ty...	...			
ROM Diagnostics	Step, Instance of Ty...	...			
RAM Diagnostics	Step, Instance of Ty...	...			
Video Diagnostics	Step, Instance of Ty...	...			
Pass/Fail Test	Step, Instance of Ty...	...			
Keyboard Diagnostics	Step, Instance of Ty...	...			

Differences: 10 | Insertion | ~~Deletion~~ | **Object Difference**

Figure 5-27. Differ Window

The tree view at the left side of the Differ window shows a hierarchical view of the items that differ between the two files. The two list view panes show the contents of the differing item you select in the tree view. The top list view pane shows the contents of the selected item in the original file. The bottom list view pane shows the contents of the selected item in the modified file.

Any insertions you make appear in green underlined text. Deletions appear in blue strikethrough text. Differences between the original and modified files appear in red. Move through the differences using the up and down arrows or by using the options on the **Edit»Diff** menu.

You can display a context menu by right-clicking in the Differ window. The items in the context menu vary depending on where you click in the window. The context menu can contain the following items:

- **Copy Item to File**—Copies the selected item to the other file in the Differ window. You can choose this option only when the selected item does not exist in the other file.
- **Replace Selected Items in File**—Replaces the corresponding items in the other file with the items you select. You can choose this option when the selected items exist in both files but are different.
- **Apply Changes to Other File**—Applies all changes within the selected item to the other file. You can choose this option only when you select a list view item that contains items with changes.
- **Apply Changes from <filename>**—Applies the changes in the selected tree view item from one file to the other.
- **Show Details of Differences**—Displays a dialog box that shows the item name, type of difference, and description of the currently selected item.
- **Rediff Sequence Files**—Recompares the two files. You might want to use this option if you change a file in the differ such that an item in the tree view no longer contains differences. Rediffing the files removes items from the tree view that no longer contain differences.
- **Find Previous Difference**—Selects the tree view item for the previous difference between the two files.
- **Find Next Difference**—Selects the tree view item for the next difference between the two files.
- **Properties**—Displays the Properties dialog box for the selected item. For more information on the Properties dialog box, refer to the Properties command in the *Workspace Window* section in Chapter 2, *Sequence Editor Concepts*.

6

Sequence Execution

This chapter describes the execution of sequences in TestStand. It also describes the Execution window in the TestStand sequence editor.

Sequence Editor and Run-Time Operator Interfaces

TestStand comes with a fully functional sequence editor and run-time operator interfaces. Like the sequence editor, the *run-time operator interfaces* allow you start multiple concurrent executions, set breakpoints, and perform single-step debugging. However, the run-time operator interfaces do not display sequence variables, sequence parameters, and step properties, or allow you to use watch expressions.

What is an Execution?

An *execution* is an object that TestStand creates to contain all the information that TestStand uses to run your sequence and the subsequences it calls. When an execution is active, you can start other executions by running the same sequence again or by running different sequences. TestStand does not limit the number of executions you can run concurrently. An execution starts with a single thread but it may launch additional threads. When you suspend, terminate, or abort an execution, you stop all threads in that execution but you do not affect threads in other executions.

Whenever TestStand begins executing a sequence, it makes a *run-time copy* of the sequence local variables and the custom properties of the sequence steps. If the sequence calls itself recursively, TestStand creates a separate run-time copy of the local variables and custom step properties for each activation instance of the sequence. Modifications to the values of local variables and custom step properties apply only to the run-time copy and do not affect the sequence file in memory or on disk.

For each active execution, TestStand maintains an *execution pointer*, that points to the current step, a call stack, and a run-time copy of the local variables and custom properties for all sequences and steps on the call stack.

The Execution tab in the Station Options dialog box provides a number of execution options that control tracing, breakpoints, and result collection. Refer to the *Station Options* section in Chapter 4, *Sequence Editor Menu Bar*, for more information on the station execution options.

Starting an Execution

You can initiate an execution by launching a sequence through a model entry point, by launching a sequence directly, or by executing a group of steps interactively.

Execution Entry Points

You can start execution through an entry point only if a sequence file that contains a sequence with the name `MainSequence` occupies the active window. A list of entry points appears in the **Execute** menu of the sequence editor.

Each entry point in the menu represents a separate entry point sequence in the process model which applies to the active sequence file. When you select an entry point from the **Execute** menu, you are actually running an entry point sequence in a process model file. The entry point sequence, in turn, invokes the main sequence one or more times.

Execution entry points in a process model give the test station operator different ways to invoke a main sequence. Entry points handle common operations such as UUT identification and test report generation. For example, the default TestStand process model provides two execution entry points: `Test UUTs` and `Single Pass`. The `Test UUTs` entry point initiates a loop that repeatedly identifies and tests UUTs. The `Single Pass` entry point tests a single UUT without identifying it.

Refer to the *Process Models* section in Chapter 1, *TestStand Architecture Overview*, and to Chapter 14, *Process Models*, for more information on process models.

Executing a Sequence Directly

To execute a sequence without using a process model, select the **Run *Sequence Name*** item in the **Execute** menu, where ***Sequence Name*** is the name of the sequence you are currently viewing. This command executes the sequence directly, skipping the process model operations such as UUT identification and test report generation. You can execute any sequence this way, not only main sequences. Usually, you execute a sequence in this way to perform unit testing or debugging.

Interactively Executing Steps

You can execute selected steps in a sequence interactively by choosing **Run Selected Steps** or **Loop Selected Steps** from the context menu in the sequence editor or by clicking the **Run Tests** or **Loop Tests** buttons in the run-time operator interfaces.

In interactive mode, only the selected steps in the sequence execute, regardless of any branching logic that the sequence contains. The selected steps run in the order in which they appear in the sequence. However, TestStand does honor the Run Mode property—force fail, force pass, or skip—for a selected step.

If you execute steps in a Sequence File window, you initiate the interactive execution as an independent top-level execution, or *root interactive execution*. When you do so, you create a new execution. You can set station options to control whether the Setup and Cleanup step groups of the sequence run as part of the root interactive execution. Root interactive executions do not invoke the process model.

If you execute steps in an Execution window when the execution is suspended, you initiate the interactive execution as a *nested interactive execution*, which is an extension of the suspended execution. In a nested interactive execution, the selected steps run within the context of the normal execution.

You can configure whether TestStand evaluates preconditions when executing interactively by going to **Configure»Station Options** and selecting the **Evaluate Preconditions in Interactive Mode** option on the Execution tab.

Sequence Editor Execution Window

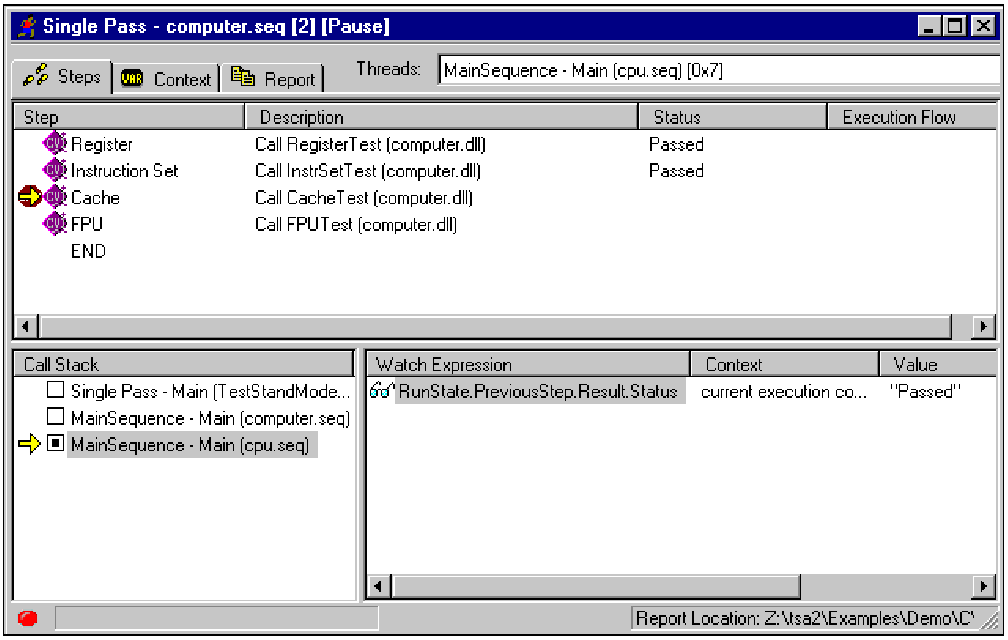
Operator interfaces usually provide a separate Execution window or view for each execution that you start. For instance, the sequence editor displays each execution in a separate window.

The Execution window is divided into several areas. The top half of the window contains the Steps tab, Context tab, and Report tab. The bottom half of the window is divided into the Call Stack pane and the Watch Expression pane. A status bar appears at the bottom edge of the window.

The Threads ring control lists all the threads running in the execution. TestStand imposes no limit on the number of simultaneous executions or on the number of threads running in an execution. Each entry in the ring control contains the name of the active sequence in the call stack for the thread. When you select a different thread from the ring control, the contents of the various tabs and panes in the Execution window change to display the state of the new thread.

Steps Tab

The Steps tab displays a list of the steps in the step group that is currently executing. Figure 6-1 shows the Steps tab in the Execution window.



Threads: MainSequence - Main (cpu.seq) [0x7]

Step	Description	Status	Execution Flow
Register	Call RegisterTest (computer.dll)	Passed	
Instruction Set	Call InstrSetTest (computer.dll)	Passed	
Cache	Call CacheTest (computer.dll)		
FPU	Call FPUTest (computer.dll)		
END			

Call Stack
Single Pass - Main (TestStandMode...
MainSequence - Main (computer.seq)
MainSequence - Main (cpu.seq)

Watch Expression	Context	Value
RunState.PreviousStep.Result.Status	current execution co...	"Passed"

Report Location: Z:\tsa2\Examples\Demo\C'

Figure 6-1. Steps Tab in the Sequence Editor Execution Window

When execution is suspended at a breakpoint, you can view the steps of any of the sequences that are active on the call stack. Use the Call Stack pane to select the active sequence to display on the Steps tab.

Tracing

If tracing is enabled, the sequence editor displays the progress of an execution by placing a yellow arrow icon to the left of the icon for the currently executing step on the Steps tab. The arrow icon is called the execution pointer. When execution suspends at a breakpoint, the Steps tab displays the execution pointer next to the step that will run when execution resumes. After each step completes, the Execution window updates the contents of the Steps tab, the position of the execution pointer, and the values of any watch expressions in the Watch panel.

If tracing is disabled, the Execution window does not update until execution suspends at a breakpoint. The Step tab might display no steps at all, or it might contain the steps and execution pointer that it displayed at the most recent breakpoint.

Usually, you disable tracing if you want to avoid using computer time to display the progress of your execution. You use the **Tracing Enabled** item in the **Execute** menu to enable or disable tracing. You also can control tracing from the Execution tab in the Station Options dialog box.

Debugging

The sequence editor and operator interfaces allow you to set breakpoints, to step over or step into steps, to step out of sequences, and to set the next step to execute. You also can terminate execution, abort execution, toggle tracing, and run or loop on selected steps. In the sequence editor, these commands are in the **Execute** menu and the **Debug** menu. Refer to the *Execute Menu* and *Debug Menu* sections, in Chapter 4, *Sequence Editor Menu Bar*, for more information on debugging commands.

Steps Tab Columns

As shown in Figure 6-1, the Steps tab contains the following columns:

- **Step**—Displays the name and icon of the step. Click in the space to the left of the step icon to toggle the breakpoint for the step.
- **Description**—Displays a description of the step that varies according to the type of step and the module adapter that it uses.
- **Status**—Displays the value of the status property for the step. If the step has not yet executed, its status is an empty string. After the step executes, its status reflects the result of its execution. Possible status values can vary based on the type of step. Typical values include `Passed`, `Failed`, `Done`, and `Error`. Refer to the *Step Status* section in this chapter for more information on step status values.

- **Execution Flow**—Indicates the properties that the step uses to control the flow of execution in the sequence. The values that can appear in this column and their meanings are as follows:
  - **Precondition**—Indicates that the step has a precondition.
  - **Post Action**—Indicates that the step has a post action.
  - **Loop**—Indicates that step is configured to loop.
  - **Skip**—Indicates that the run mode of the step is Skip.
  - **Force Pass**—Indicates that the run mode of the step is Force Pass.
  - **Force Fail**—Indicates that the run mode of the step is Force Fail.
  - **New Thread**—Indicates that the step calls a subsequence that runs in a new thread.
  - **New Execution**—Indicates that the step launches a subsequence in a new execution.
  - **Lock**—Indicates that the step acquires a lock before executing and releases the lock after it completes.
  - **Batch**—Indicates that the step enters a batch synchronization section before executing and exits the section after it completes.

Steps Tab Context Menu

When execution is suspended at a breakpoint, you can access a context menu for the Steps tab by right-clicking the name or icon of a step. The context menu can contain the following items.

Toggle Breakpoint

The **Toggle Breakpoint** command sets or clears the breakpoint state for the selected steps.

Run Mode

The **Run Mode** menu item displays a submenu from which you can set the run mode for the selected steps. The following run mode values are possible.

- **Force Pass**—TestStand does not execute the step. Instead, TestStand sets the status of the step to `Passed`.
- **Force Fail**—TestStand does not execute the step. Instead, TestStand sets the status of the step to `Failed`.

- **Skip**—TestStand does not execute the step. Instead, TestStand sets the status of the step to `Skipped`.
- **Normal**—TestStand executes the step normally. This is the default value.

Set Next Step

The **Set Next Step** command tells TestStand to start from the selected step when you resume execution.

Run Selected Steps

The **Run Selected Steps** command runs the selected steps in interactive mode.

Loop Selected Steps

The **Loop Selected Steps** command loops on the selected steps in interactive mode. Before running the steps, this command displays a dialog box in which you specify the number of times to loop, and a stop condition that TestStand evaluates after it executes each step.

Show Step in Context Tab

The **Show Step in Context Tab** command moves from the Steps tab to the Context tab and selects the step that you were viewing on the Steps tab. Usually, you use this command to view the values of the custom properties of a step after it executes.

Properties

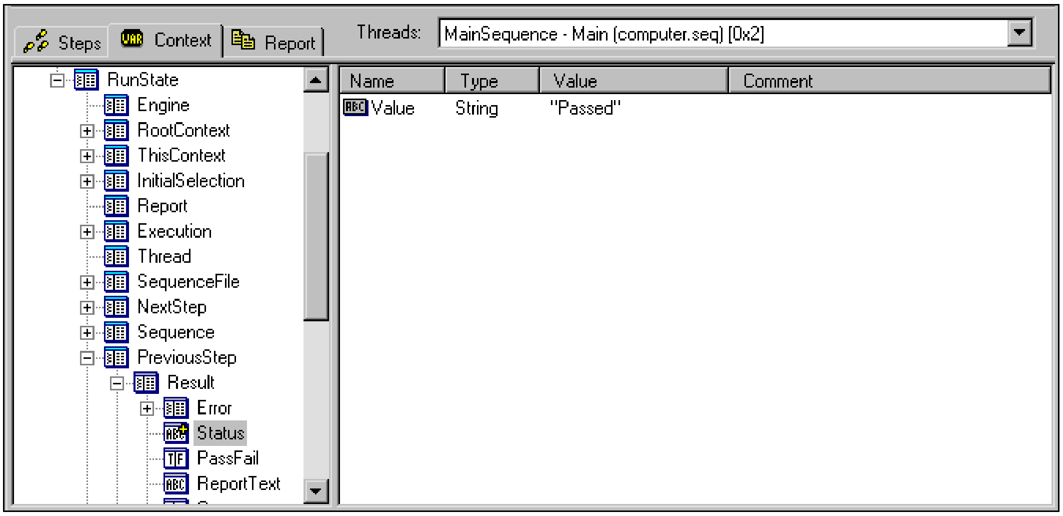
The **Properties** command displays the Step Properties dialog box for the selected step. Usually, most controls in the dialog box are disabled, because you cannot edit most step properties during an execution.

Context Tab

The Context tab displays the sequence context for the sequence invocation that is currently selected in the Call Stack pane. The sequence context contains all the variables and properties that the steps in the selected sequence invocation can access.

You use the Context tab to examine and modify the values of these variables and properties. You can drag individual variables or properties from the Context tab to the Watch Expression pane so that you can view changes in their values while you single-step or trace through the sequence. When execution completes, the Context tab disappears. Refer to Chapter 8, *Sequence Context and Expressions*, for more information on sequence contexts.

Figure 6-2 shows the Context tab for an example sequence in which execution is suspended.



Name	Type	Value	Comment
Value	String	"Passed"	

Figure 6-2. Context Tab in an Execution Window

The sequence context view contains entries for each step in the sequence. To locate a particular step on the Context tab, select the **Show Step in Context Tab** item from the context menu for a step on the Steps tab.

Context Tab Context Menu

When execution is suspended, you can access a context menu for the Context tab by right clicking a variable or property. The context menu can contain the following items.

View Contents

The **View Contents** command selects the tree view node that corresponds to the currently selected item in the list view. If the tree view is currently closed, it opens to display the selected node. You use this command to view the subproperties of variables and properties.

Refresh

When an execution suspends, other executions that are not suspended can change the values of station global variables that appear on the Context tab for the suspended execution. You can use the **Refresh** command to update the Context tab so that it displays the current values of the station global variables.

Object Properties

The **Properties** command displays a dialog box that you use to change the current value of the selected variable or property.

Report Tab

The Report tab displays the report for the current execution. When you use the default process model, the Report tab is empty until execution completes.

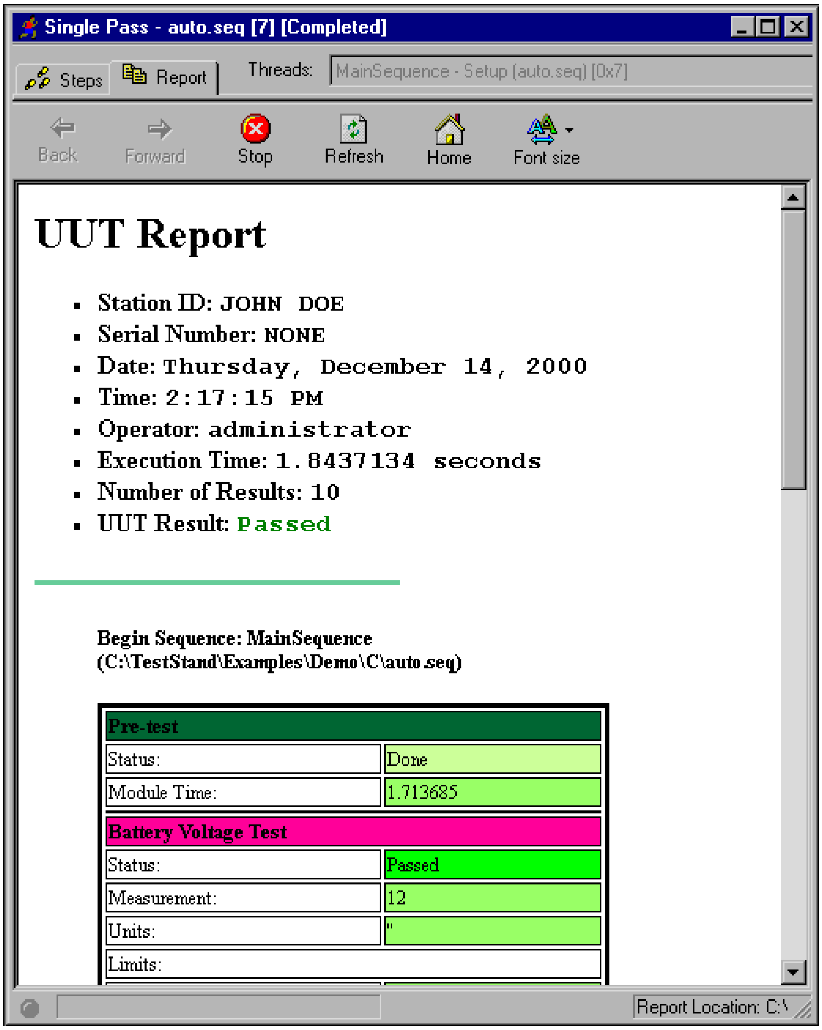
By default, an execution generates a report only when you start the execution through a model entry point such as `Test UUTs` or `Single Pass`. To set options that control report generation, select **Configure»Report Options**. The default process model can generate reports in either HTML or ASCII text formats.

The Report tab in the sequence editor can display reports in HTML or ASCII text format. You also can use an external application to view reports in these or other formats by selecting **View»Launch Report Viewer** when an Execution window is active. You use **Configure»External Viewers** to specify the external application that TestStand launches to display a particular report format.

The sequence editor uses the Internet Explorer component to display HTML reports. If your sequence generates a very large number of results, this component can take a substantial amount of time to load and display the report. If the report does not appear in an acceptable amount of time after the process model generates it, you can use **Configure»Report Options** to specify a filter expression that reduces the number of results in the report. Another way to display a large report quickly is to change the report format to ASCII text.

When you select the Report tab, TestStand hides the Call Stack and Watch Expression panes so that it can use the entire Execution window to display the report. Refer to Chapter 14, *Process Models*, for more information on report generation.

Figure 6-3 shows an HTML report for an example sequence.


Single Pass - auto.seq [7] [Completed]
Steps
Report
Threads:
MainSequence - Setup (auto.seq) [0x7]
Back
Forward
Stop
Refresh
Home
Font size
Report Location: C:\

UUT Report

- Station ID: JOHN DOE
- Serial Number: NONE
- Date: Thursday, December 14, 2000
- Time: 2:17:15 PM
- Operator: administrator
- Execution Time: 1.8437134 seconds
- Number of Results: 10
- UUT Result: Passed

Begin Sequence: MainSequence
(C:\TestStand\Examples\Demo\C\auto.seq)

Pre-test	
Status:	Done
Module Time:	1.713685

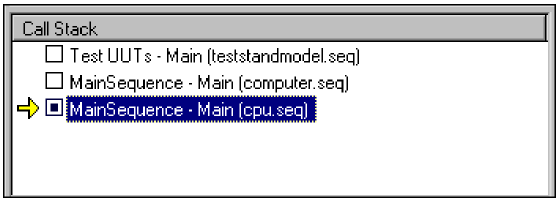
Battery Voltage Test	
Status:	Passed
Measurement:	12
Units:	''
Limits:	

Figure 6-3. HTML Report for an Example Sequence

Call Stack Pane

Usually, when a step invokes a subsequence, the sequence that contains the calling step waits for the subsequence to return. The subsequence invocation is nested in the invocation of the calling sequence. The sequence that is currently executing is the *most nested sequence*. The chain of active sequences that are waiting for nested subsequences to complete is called the call stack. The last item in the call stack is the most nested sequence invocation.

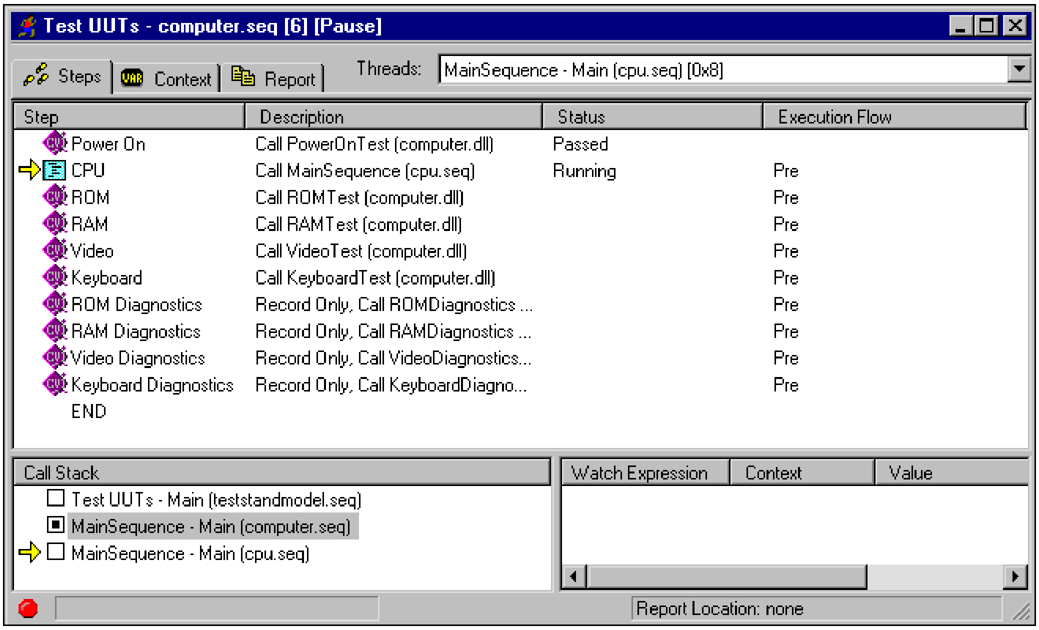
The Call Stack pane displays the call stack for the execution thread that is currently selected in the Thread ring control. A yellow pointer icon appears to the left of the most nested sequence invocation. The call stack in Figure 6-4 shows that the `Test UUTs` model entry is calling the main sequence in `Computer.seq`, which in turn is calling the main sequence in the `CPU.seq`.



Call Stack
☐ Test UUTs - Main (teststandmodel.seq)
☐ MainSequence - Main (computer.seq)
▣ MainSequence - Main (cpu.seq)

Figure 6-4. Call Stack Pane while Suspended in a Subsequence

When execution suspends, you can select a sequence invocation in the call stack by clicking its radio button. The Steps tab displays the steps for the sequence invocation. The Watch Expression pane evaluates its watch expressions using the sequence context for the selected sequence invocation. In Figure 6-5, the main sequence from `Computer.seq` is selected in the Call Stack pane.



MainSequence - Main (cpu.seq) [0x8]

Step	Description	Status	Execution Flow
Power On	Call PowerOnTest (computer.dll)	Passed	
CPU	Call MainSequence (cpu.seq)	Running	Pre
ROM	Call ROMTest (computer.dll)		Pre
RAM	Call RAMTest (computer.dll)		Pre
Video	Call VideoTest (computer.dll)		Pre
Keyboard	Call KeyboardTest (computer.dll)		Pre
ROM Diagnostics	Record Only, Call ROMDiagnostics ...		Pre
RAM Diagnostics	Record Only, Call RAMDiagnostics ...		Pre
Video Diagnostics	Record Only, Call VideoDiagnostics...		Pre
Keyboard Diagnostics	Record Only, Call KeyboardDiagno...		Pre
END			

Call Stack
Test UUTs - Main (teststandmodel.seq)
MainSequence - Main (computer.seq)
MainSequence - Main (cpu.seq)

Watch Expression	Context	Value

Report Location: none

Figure 6-5. Steps Tab Displaying a Sequence Invocation in the Middle of the Call Stack

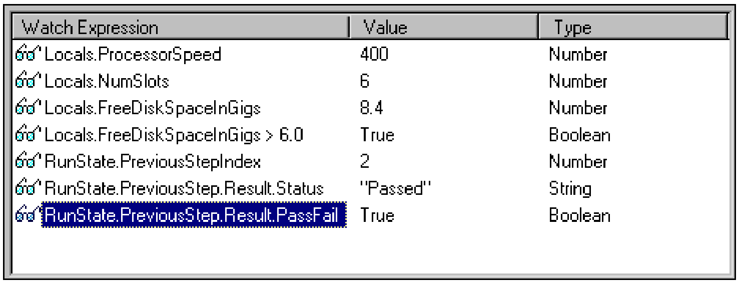
When the steps view displays the steps for a call stack item that is not the most nested item, a green pointer icon appears next to the sequence call step that is waiting to complete.

Watch Expression Pane

The Watch Expression pane displays the values of watch expressions that you enter. TestStand updates the values in the Watch Expression pane when execution suspends at a breakpoint. If tracing is enabled, TestStand also updates the values after executing each step.

Usually, you enter watch expressions to monitor the values of variables and properties as you trace or single-step through a sequence. You can drag individual variables or properties from the Context tab to the Watch Expression pane.

Figure 6-6 shows several example watch expressions in the Watch Expression pane.



Watch Expression	Value	Type
Locals.ProcessorSpeed	400	Number
Locals.NumSlots	6	Number
Locals.FreeDiskSpaceInGigs	8.4	Number
Locals.FreeDiskSpaceInGigs > 6.0	True	Boolean
RunState.PreviousStepIndex	2	Number
RunState.PreviousStep.Result.Status	"Passed"	String
RunState.PreviousStep.Result.PassFail	True	Boolean

Figure 6-6. Watch Expression Pane

When execution is suspended, you can access a context menu by right clicking in the Watch Expression pane. The items in the context menu vary depending on the whether you right click the following sites:

- A watch expression
- A watch expression icon
- The background of the pane

This section describes the items that the context menu can contain.

Edit Expression

The **Edit Expression** command displays an expression browser dialog box in which you can edit the selected watch expression.

Add Watch

The **Add Watch** command inserts an empty watch expression into the pane and then displays an expression browser dialog box in which you can edit the new expression.

Modify Value

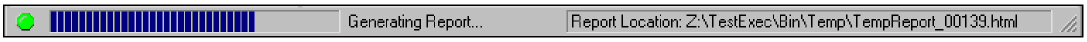
The **Modify Value** command displays a dialog box in which you can edit the value of the selected watch expression. TestStand dims the **Modify Value** command if the selected expression does not evaluate to a single variable or property value. For example, you can modify the value of `Locals.X` but not the value of `Locals.X + 5`.

Refresh

When an execution suspends at a breakpoint, other executions that are not suspended can change the values of station global variables that a watch expression refers to. Use the **Refresh** command to update the Watch Expression pane so that it displays the current values for watch expressions that contain station global variables.

Status Bar

Figure 6-7 shows the status bar for an Execution window in the sequence editor.



Generating Report...

Report Location: Z:\TestExec\Bin\Temp\TempReport_00139.html

Figure 6-7. Execution Window Status Bar

The status bar contains the following four elements arranged from left to right.

- **Execution Status LED**—The LED is green while the execution runs, red when the execution suspends, and dark gray when the execution completes.
- **Progress Indicator Bar**—Through the TestStand API, a step module can request that an operator interface program display an indication of the step's progress toward completion. Usually, a step module developer uses this feature if the step takes longer than a few seconds to complete. The Execution window displays the degree of progress in the Progress Indicator bar. The default process model also uses the Progress Indicator bar to display progress while it generates the test report.
- **Status Message**—Through the TestStand API, step modules can request that an operator interface program display a short message. The Execution window displays these messages to the right of the Progress Indicator bar.

Note The `<TestStand>\Examples` directory contains sample test modules that demonstrate how to control the Progress Indication Bar and Status Message indicator.

- **Report Location**—Each execution has its own test report. The Execution window displays the location of the test report for the execution in the rightmost box on the status bar. Usually, the process model fills in the Report Location with the pathname of the file to which the model writes the report.

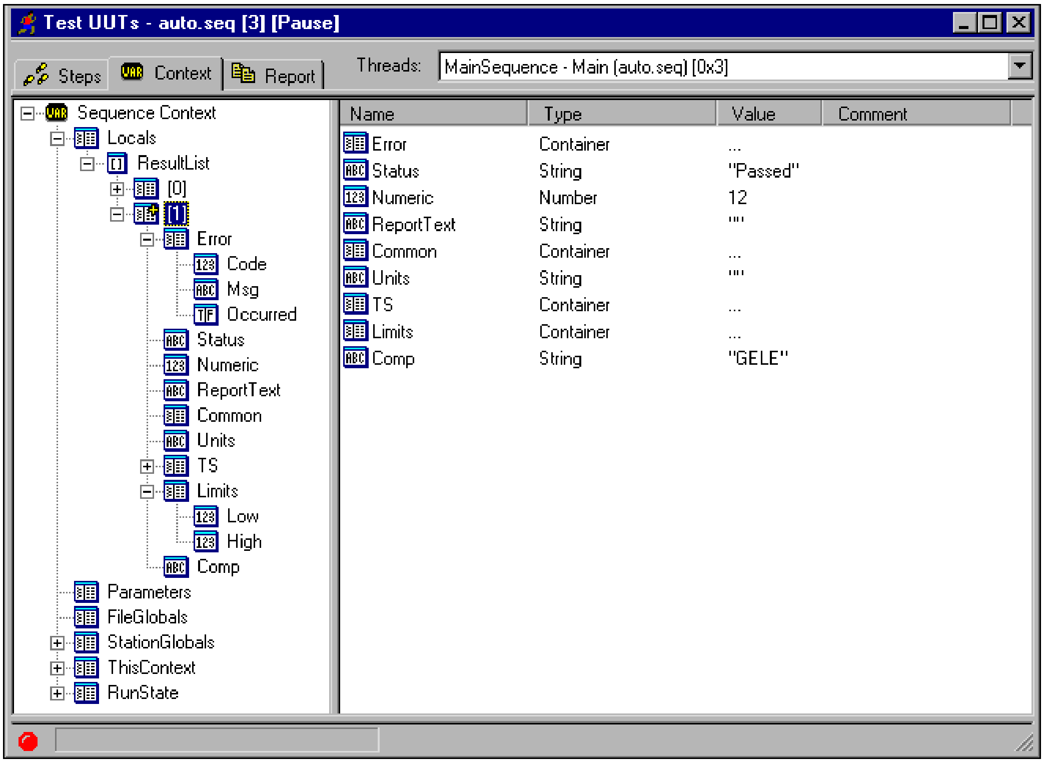
Result Collection

TestStand can automatically collect the results of each step. You can configure this feature for each step on the Run Options tab of the Step Properties dialog box. You can disable result collection for an entire sequence in the Sequence Properties dialog box. You can completely disable result collection on your computer in the Station Options dialog box.

Each sequence has a `ResultList` local variable that is initially an empty array of container properties. TestStand appends a new container property to the end of the `ResultList` array before a step executes. This container property is called the *step result*. After the step executes, TestStand automatically copies the contents of the `Result` subproperty for the step into the step result.

Each step type can define different contents for its `Result` subproperty. TestStand can append step results that contain `Result` properties from different step types to the same `ResultList` array. When TestStand copies the `Result` property for a step to its step result, it also adds information such as the name of the step and its position in the sequence. For a step that calls a subsequence, TestStand also adds the `ResultList` array variable from the subsequence.

Figure 6-8 shows the result of a Numeric Limit Test step in expanded form on the Context tab of the Execution window.


Test UUTs - auto.seq [3] [Pause]
Steps
Context
Report
Threads:
MainSequence - Main (auto.seq) [0x3]

```
Sequence Context
  Locals
    ResultList
      [0]
      [1]
        Error
          Code
          Msg
          Occurred
        Status
        Numeric
        ReportText
        Common
        Units
        TS
        Limits
          Low
          High
        Comp
  Parameters
  FileGlobals
  StationGlobals
  ThisContext
  RunState
```

Name	Type	Value	Comment
Error	Container	...	
Status	String	"Passed"	
Numeric	Number	12	
ReportText	String	""	
Common	Container	...	
Units	String	""	
TS	Container	...	
Limits	Container	...	
Comp	String	"GELE"	

Figure 6-8. A Result in a ResultList Array

Through the TestStand API, a code module can request that TestStand insert additional step properties in the step results for all steps automatically. A code module also can use the API to insert additional step result information for a particular step.

Custom Result Properties

Because each step type can have a different set of subproperties under its `Result` property, the step result varies according to the step type. Table 6-1 lists the custom properties that the step result can contain for steps that use one of the built-in step types.

Table 6-1. Custom Properties in the Step Results for Steps That Use the Built-In Step Types

Custom Step Property	Step Types that Use the Property
`Error.Code`	All
`Error.Msg`	All
`Error.Occurred`	All
`Status`	All
`Common`	All
`Numeric`	`NumericLimitTest`
`PassFail`	`PassFailTest`
`String`	`StringValueTest`
`ButtonHit`	`MessagePopup`
`Response`	`MessagePopup`
`ExitCode`	`CallExecutable`
`NumPropertiesRead`	`NI_VariableAndPropertyLoader`
`NumPropertiesApplied`	`NI_VariableAndPropertyLoader`
`ReportText`	All
`Limits.Low`	`NumericLimitTest`
`Limits.High`	`NumericLimitTest`
`Comp`	`NumericLimitTest`, `StringValueTest`
`Measurement`	`NI_MultipleNumericLimitTest`

Note Table 6-1 does not include the result properties for IVI step types, Synchronization step types, or Database step types. For the result properties for the IVI step types, refer to `<TestStand>\Doc\IVIStepTypes.pdf`. Refer to Chapter 11, *Synchronization Step Types*, and Chapter 18, *Databases*, for descriptions of the synchronization and database result properties.

For the NumericLimitTest and the StringValueTest, the `Limits.Low`, `Limits.High`, and `Comp` properties are not subproperties of the `Result` property. Thus, TestStand does not automatically include these properties in the step result. Depending on options you set, the default process model uses the TestStand API to include the `Limits.Low`, `Limits.High`, and `Comp` properties in the step results for NumericLimitTest and StringValueTest steps that contain these properties.

The `Common` result subproperty uses the `CommonResults` custom data type. The `Common` property is a subproperty of the `Result` property for every built-in step type. Consequently, you can add a subproperty to the result of every step type by adding a subproperty to the definition of the `CommonResults` type.

Be aware that if you modify `CommonResults` without incrementing the type version number, you might see a type conflict when you open other sequence files. These conflicts will include the `FrontendCallback.seq` when you are logging in or out.

Standard Result Properties

In addition to copying custom step properties, TestStand also adds a set of standard properties to each step result. TestStand adds standard result properties to the step result as subproperties of the `TS` property. Table 6-2 lists the standard result properties.

Table 6-2. Standard Step Result Properties

Standard Result Property	Description
`TS.StartTime`	Time at which the step began executing, specifically, the number of seconds since the TestStand engine initialized.
`TS.TotalTime`	Number of seconds the step took to execute. This time includes the time for all step options including preconditions, expressions, post actions, module loading, and module execution.
`TS.ModuleTime`	Number of seconds that the step module took to execute.
`TS.Index`	Zero-based position of the step in the step group.

Table 6-2. Standard Step Result Properties (Continued)

Standard Result Property	Description
`TS.StepName`	Name of the step.
`TS.StepGroup`	Step group that contains the step. The value is `Main`, `Setup`, or `Cleanup`.
`TS.Id`	A number that TestStand assigns to the step result. The number is unique with respect to all other step results in the current TestStand session.
`TS.InteractiveExeNum`	A number that TestStand assigns to an interactive execution. The number is unique with respect to all other interactive executions in the current TestStand session. TestStand adds this property only if you run the step interactively.
`TS.StepType`	Name of the step type.
`TS.Server`	This property contains the name of the server machine on which the step runs the subsequence it calls. This result property exists only for sequence call steps that run subsequences on a remote machine.
`TS.StepCausedSequenceFailure`	This property exists only if the step fails. The value is `True` if the step failure causes the sequence to fail. The value is `False` if the step failure does not cause the sequence to fail or if the sequence has already failed.

Subsequence Results

If a step calls a subsequence or generates a call to a callback sequence, TestStand creates a special step result subproperty to store the result of the subsequence. Table 6-3 lists the name of the subproperty for each type of subsequence call.

Table 6-3. Property Names for Subsequence Results

Result Subproperty Name	Type of Subsequence Call
`TS.SequenceCall`	Sequence Call
`TS.PostAction`	Post Action Callback
`TS.SequenceFilePreStep`	SequenceFilePreStep Callback
`TS.SequenceFilePostStep`	SequenceFilePostStep Callback
`TS.ProcessModelPreStep`	ProcessModelPreStep Callback

Table 6-3. Property Names for Subsequence Results (Continued)

Result Subproperty Name	Type of Subsequence Call
`TS.ProcessModelPostStep`	ProcessModelPostStep Callback
`TS.StationPreStep`	StationPreStep Callback
`TS.StationPostStep`	StationPostStep Callback
`TS.SequenceFilePreInteractive`	SequenceFilePreInteractive Callback
`TS.SequenceFilePostInteractive`	SequenceFilePostInteractive Callback
`TS.ProcessModelPreInteractive`	ProcessModelPreInteractive Callback
`TS.ProcessModelPostInteractive`	ProcessModelPostInteractive Callback
`TS.StationPreInteractive`	StationPreInteractive Callback
`TS.StationPostInteractive`	StationPostInteractive Callback
`TS.SequenceFilePostResultListEntry`	SequenceFilePostResultListEntry Callback
`TS.ProcessModelPostResultListEntry`	ProcessModelPostResultListEntry Callback
`TS.StationPostResultListEntry`	StationPostResultListEntry Callback
`TS.SequenceFilePostStepRuntimeError`	SequenceFilePostStepRuntimeError Callback
`TS.ProcessModelPostStepRuntimeError`	ProcessModelPostStepRuntimeError Callback
`TS.StationPostStepRuntimeError`	StationPostStepRuntimeError Callback
`TS.SequenceFilePostStepFailure`	SequenceFilePostFailure Callback
`TS.ProcessModelPostStepFailure`	ProcessModelPostFailure Callback
`TS.StationPostStepFailure`	StationFilePostFailure Callback

TestStand adds the following properties to the subproperty for each subsequence.

- `SequenceFile`—Absolute path of the sequence file that contains the subsequence.
- `Sequence`—Name of the subsequence that the step called.
- `Status`—Status of the subsequence that the step called.
- `ResultList`—Value of `Locals.ResultList` for the subsequence that the step called. This property contains the results for the steps in the subsequence.

As an example, TestStand adds the following properties to the result of any step that calls another sequence:

```
TS.SequenceCall.SequenceFile
TS.SequenceCall.Sequence
TS.SequenceCall.Status
TS.SequenceCall.ResultList
```

Loop Results

When you configure a step to loop, you can use the Record Result of Each Iteration option on the Loop tab of the Step Properties dialog box to specify that TestStand store a separate result for each loop iteration in the result list. In the result list, the results for the loop iterations come immediately after the result for the step as a whole.

TestStand adds a `TS.LoopIndex` numeric property to each loop iteration result to record the value of the loop index for that iteration. TestStand also adds the following special loop result properties to the main result for the step.

- `TS.EndingLoopIndex`—Value of the loop index when looping completes.
- `TS.NumLoops`—Number of times the step loops.
- `TS.NumPassed`—Number of loops for which the step status is `Passed` or `Done`.
- `TS.NumFailed`—Number of loops for which the step status is `Failed`.

When you run a sequence using the `TestUUTs` or `SinglePass` execution entry points, the default process model generates the test report by traversing the results for the main sequence in the client sequence file and all of the subsequences it calls. Refer to the *Process Models* section in Chapter 1, *TestStand Architecture Overview*, and to Chapter 14, *Process Models*, for more information on process models.

Engine Callbacks

TestStand specifies a set of callback sequences that it invokes at specific points during execution. These callbacks are called engine callbacks. TestStand defines the name of each engine callback.

Engine callbacks are a way for you to tell TestStand to call certain sequences before and after the execution of individual steps, before and after interactive executions, after loading a sequence file, and before unloading a sequence file. Because the TestStand engine controls the execution of steps and the loading and unloading of sequence files, TestStand defines the set of engine callbacks and their names.

The engine callbacks are in three general groups, based on the file in which the callback sequence appears. You can define engine callback sequences in normal sequence files, in process model files, and in the `StationCallbacks.seq` file.

TestStand invokes engine callbacks in a normal sequence file only when executing steps in the sequence file or loading or unloading the sequence file. TestStand invokes engine callbacks in process model files when executing steps in the model file, steps in sequences that the model calls, and steps in any nested calls to subsequences. TestStand invokes the engine callbacks in `StationCallbacks.seq` whenever TestStand executes steps on the test station. Table 6-4 shows the different engine callbacks.

Table 6-4. Engine Callbacks

Engine Callback	Where You Define the Callback	When the Engine Calls the Callback
`SequenceFilePreStep`	Any sequence file	Before the engine executes each step in the sequence file
`SequenceFilePostStep`	Any sequence file	After the engine executes each step in the sequence file
`SequenceFilePreInteractive`	Any sequence file	Before the engine begins an interactive execution of steps in the sequence file
`SequenceFilePostInteractive`	Any sequence file	After the engine completes an interactive execution of steps in the sequence file

Table 6-4. Engine Callbacks (Continued)

Engine Callback	Where You Define the Callback	When the Engine Calls the Callback
`SequenceFileLoad`	Any sequence file	When the engine loads the sequence file into memory
`SequenceFileUnload`	Any sequence file	When the engine unloads the sequence file from memory
`SequenceFilePostResultList Entry`	Any sequence file	After the engine fills out the step result for a step in the sequence file
`SequenceFilePostStepRuntime Error`	Any sequence file	After a step in the sequence file generates a run-time error
`SequenceFilePostStepFailure`	Any sequence file	After a step in the sequence fails
`ProcessModelPreStep`	Process model file	Before the engine executes each step in any sequence that the process model calls, and each step in any resulting subsequence calls
`ProcessModelPostStep`	Process model file	After the engine executes each step in any sequence that the process model calls, and each step in any resulting subsequence calls
`ProcessModelPreInteractive`	Process model file	Before the engine begins interactive execution of steps in a client sequence file
`ProcessModelPostInteractive`	Process model file	After the engine begins interactive execution of steps in a client sequence file

Table 6-4. Engine Callbacks (Continued)

Engine Callback	Where You Define the Callback	When the Engine Calls the Callback
`ProcessModelPostResultListEntry`	Process model file	After the engine fills out the step result for a step in any sequence that the process model calls or in any resulting subsequence calls.
`ProcessModelPostStepRuntimeError`	Process model file	After a step generates a run-time error when the step is in a sequence that the process model calls or in any result subsequence
`ProcessModelPostStepFailure`	Process model file	After a step fails when the step is in a sequence that the process model calls or in any result subsequence
`StationPreStep`	`StationCallbacks.seq`	Before the engine executes each step in any sequence file
`StationPostStep`	`StationCallbacks.seq`	After the engine executes each step in any sequence file
`StationPreInteractive`	`StationCallbacks.seq`	Before the engine begins any interactive execution
`StationPostInteractive`	`StationCallbacks.seq`	After the engine completes any interactive execution
`StationPostResultListEntry`	`StationCallbacks.seq`	After the engine fills out the step result for a step in any sequence file
`StationPostStepRuntimeError`	`StationCallbacks.seq`	After any step generates a run time error
`StationPostStepFailure`	`StationCallbacks.seq`	After any step fails

Note TestStand installs predefined station engine callbacks in the `StationCallbacks.seq` file in the `<TestStand>\Components\NI\Callbacks\Station` directory. Add your own station engine callbacks in the `StationCallbacks.seq` file in the `<TestStand>\Components\User\Callbacks\Station` directory.

The following are examples of how you might use engine callbacks:

- Use the `SequenceFileLoad` callback to ensure that the configuration for external devices that the subsequence file uses occurs only once during execution. Usually, you initialize the devices that a sequence requires by creating steps in the Setup group for the sequence. However, if you call the sequence repeatedly, you can move the Setup steps into a `SequenceFileLoad` callback for the subsequence file so that they run only when the sequence file loads.
- Use the `StationPreStep` and `StationPostStep` callbacks to accumulate statistics on all steps that execute on the test station. You can inspect the name and types of steps to accumulate data on specific steps.

Note If you define a `SequenceFilePreStep`, `SequenceFilePostStep`, `SequenceFilePreInteractive`, or `SequenceFilePostInteractive` callback in a model file, the callback applies only to the steps in the model file.

Note You must not define a `SequenceFileUnload` callback in the `StationCallbacks.seq` sequence file. If you make this error, TestStand hangs when you shut down the TestStand engine.

Step Execution

Depending on options you set, a step performs a number of actions as it executes. Table 6-5 lists the more significant actions that a step can take, in the order that the step performs them.

Table 6-5. Order of Actions That a Step Performs

Action Number	Description	Remarks
1	Enter batch synchronization section	If option is set
2	Acquire step lock	If option is set
3	Allocate step result	—
4	Evaluate precondition	—

Table 6-5. Order of Actions That a Step Performs (Continued)

Action Number	Description	Remarks
5	Check run mode	—
6	Load module if not already loaded	—
7	Evaluate Loop Initialization expression	Only if looping
8	Evaluate Loop While expression, skip to action 22 if `False`	Only if looping
9	Allocate loop iteration result	Only if looping
10	Call Pre Step engine callbacks	—
11	Evaluate Pre expression	—
12	Call Pre Step substeps for step type	—
13	Call module	—
14	Call Post Step substeps for step type	TestStand calls Post Step substeps even if the user code module generates a run-time error. This enables Post Step substeps to perform error handling, if appropriate.
15	Evaluate Post expression	—
16	Evaluate Status expression	—
17	Call Post Step engine callbacks	—
18	Call Post Step failure engine callbacks	Only if loop iteration fails
19	Fill out loop iteration result	Only if looping
20	Call PostResultListEntry engine callbacks	Only if looping
21	Evaluate Loop Increment expression, return to action 8	Only if looping
22	Evaluate Loop Status expression	Only if looping

Table 6-5. Order of Actions That a Step Performs (Continued)

Action Number	Description	Remarks
23	Unload module if required	—
24	Update sequence failed state	
25	Call Post Step failure engine callbacks	Only if step fails
26	Execute post action	—
27	Fill out step result	—
28	Call PostResultListEntry engine callbacks	Only if failed
29	Release step lock	If option is set
30	Exit batch synchronization section	If option is set

Usually, a step performs only a subset of these actions, depending on the configuration of the step and the test station. When TestStand detects a run-time error, it usually proceeds to action 27. If a run-time error occurs in a loop iteration, TestStand performs action 19 before it performs action 27.

Step Status

Every step in TestStand has a `Result.Status` property. The status property is a string that indicates the result of the step execution. Although TestStand imposes no restrictions on the values to which the step or its code module can set the status property, TestStand and the built-in step types use and recognize the values that appear in Table 6-6.

Table 6-6. Standard Values for the Status Property

String Value	Meaning	Source of the Status Value
`Passed`	Indicates that the step performed a test that passed	Step or code module
`Failed`	Indicates that the step performed a test that failed.	Step or code module
`Error`	Indicates that a run-time error occurred.	TestStand
`Done`	Indicates that the step completed without setting its status.	TestStand

Table 6-6. Standard Values for the Status Property (Continued)

String Value	Meaning	Source of the Status Value
`Terminated`	Indicates that the step called a subsequence in which execution terminated. Occurs only for sequence call steps for which you enable the Ignore Termination option.	TestStand
`Skipped`	Indicates that the step did not execute because the run mode for the step is Skip.	TestStand
`Running`	Indicates that the step is currently running.	TestStand
`Looping`	Indicates that the step is currently running in loop mode.	TestStand

Failures

TestStand considers a step to have failed if the step executes and the step status is `Failed`. If you enable the Step Failure Causes Sequence Failure option on the Run Options tab of the Step Properties dialog box, TestStand sets the sequence status to `Failed` when the step fails. When the sequence returns as `Failed`, the Sequence Call step also fails. In this way, a step failure in a subsequence can propagate up through the chain of sequence call steps.

Note For most step types, the Step Failure Causes Sequence Failure option is enabled by default.

You can also control how execution proceeds after a step failure causes a sequence to fail. To configure a sequence to jump to the Cleanup step group upon failure, enable the Goto Cleanup on Sequence Failure option in the Sequence Properties dialog box. By default, this option is disabled.

Run-Time Errors

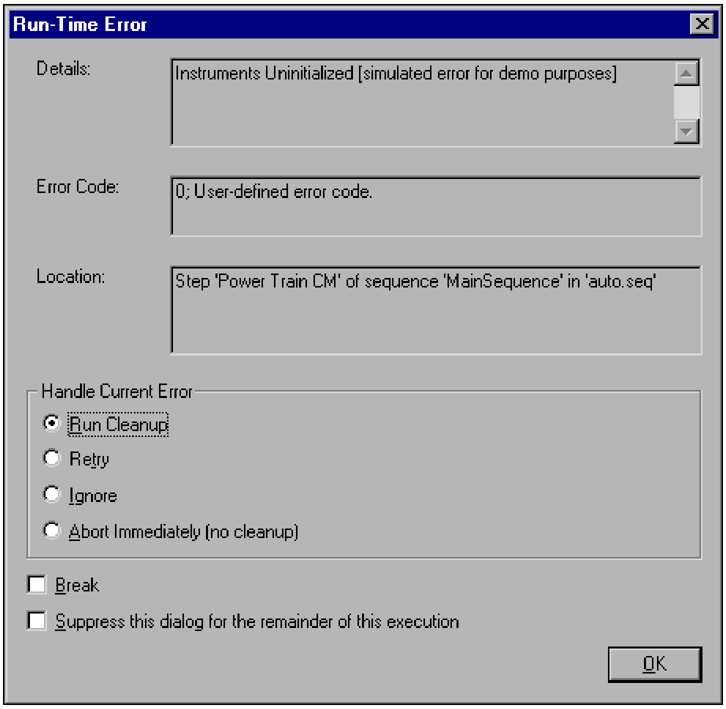
TestStand generates a run-time error if it encounters a condition that prevents a sequence from executing. If, for example, a precondition refers to the status of a step that does not exist, TestStand generates a run-time error when it attempts to evaluate the precondition. TestStand also generates a run-time error when a code module causes an access violation or any other exception. A step or its code module can explicitly generate a run-time error by setting the value of the `Step.Result.Error.Occurred` property to `True`. Usually, the step or code module also sets the values of the `Step.Result.Error.Msg` and `Step.Result.Error.Code` properties to indicate the source of the error.

TestStand does not use run-time errors to indicate UUT test failures. Instead, a run-time error indicates that a problem exists with the testing process itself and that testing cannot continue. Usually, a code module reports a run-time error if it detects an error in a hardware or software resource that it utilizes to perform a test.

When a step causes a run-time error, the step stops executing, and TestStand sets the status of the step to `Error`. TestStand also sets the internal status of the sequence to `Error`, and execution branches to the Cleanup step group for the sequence. If the sequence is executing as a subsequence, TestStand sets the `Result.Error.Occurred` property of the calling step to `True`. TestStand also sets the `Result.Error.Code` and `Result.Error.Msg` properties of the calling step to the values of these properties in the subsequence step that generated the run-time error. In this way, the run-time error in a subsequence becomes a run-time error in the step that invokes it. The result is that TestStand executes the Cleanup steps in all active sequences and then terminates execution.

However, if you enable the Ignore Run-Time Errors step option for a step that causes a run-time error, TestStand does not set the internal status of the sequence that contains the step to `Error`. Instead, TestStand resets the `Error.Occurred` property of the step to `False` and execution continues normally with the next step in the sequence. The `Result.Status` property in the step that caused the run-time error retains `Error` as its value.

TestStand allows you to decide interactively how to handle a run-time error. If a step causes a run-time error and you select **Show Dialog** in the On Run-Time Error control on the Execution tab of the Station Options dialog box, TestStand displays the Run-Time Error dialog box, shown in Figure 6-9.



Details: Instruments Uninitialized [simulated error for demo purposes]

Error Code: 0; User-defined error code.

Location: Step 'Power Train CM' of sequence 'MainSequence' in 'auto.seq'

Handle Current Error: [✓ Run Cleanup] Retry Ignore Abort Immediately (no cleanup)

Figure 6-9. Run-Time Error Dialog Box

The Run-Time Error dialog box gives you four possible ways to handle the run-time error.

- **Run Cleanup**—Execution proceeds to the Cleanup step group for the sequence. Run Cleanup is the default action when you have disabled the Show Dialog On Run-Time Error option.
- **Retry**—TestStand runs the step again.
- **Ignore**—TestStand does not set the internal status of the sequence to `Error`. Instead, TestStand resets the `Error.Occurred` property of the step to `False` and execution continues normally with the next step in the sequence. The `Result.Status` property of the step remains set to `Error`.
- **Abort Immediately**—TestStand stops execution immediately, without running any cleanup steps.

The dialog box also provides two further options:

- **Break**—When you choose the **Run Cleanup** or **Ignore** actions and enable the Break option, TestStand suspends execution at the step that caused the run-time error. This option dims if you choose **Abort Immediately**.
- **Suppress this dialog for the remainder of this execution**—This option prevents the Run-Time Error dialog box from appearing for any run-time errors that occur later in the execution.

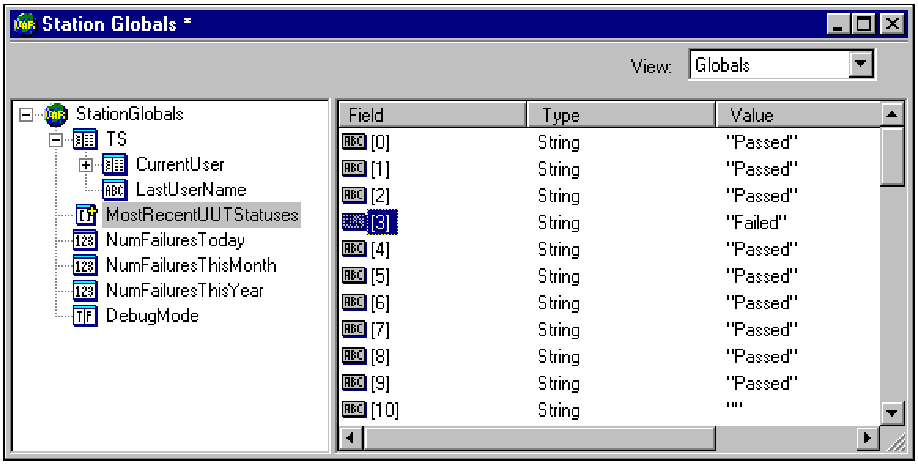
7 Station Global Variables

This chapter describes station global variables and the Station Globals window.

In TestStand, you can define variables with various scopes. You can define variables that are local to a sequence, global to a sequence file, and global to the test station. You can access station global variables from any step, expression, or code module. Unlike other variables, TestStand saves the values of global variables from one session to the next. Usually, you use station global variables to maintain statistics or to represent the configuration of your test station.

Station Globals Window

You view and edit global variables in the Station Globals window of the sequence editor. Use the **Station Globals** menu item in the sequence editor **View** menu to access the Station Globals window. Figure 7-1 shows example variables in the Station Globals window.



- StationGlobals
  - TS
    - CurrentUser
    - LastUserName
  - MostRecentUUTStatuses
  - NumFailuresToday
  - NumFailuresThisMonth
  - NumFailuresThisYear
  - DebugMode

Field	Type	Value
[0]	String	"Passed"
[1]	String	"Passed"
[2]	String	"Passed"
[3]	String	"Failed"
[4]	String	"Passed"
[5]	String	"Passed"
[6]	String	"Passed"
[7]	String	"Passed"
[8]	String	"Passed"
[9]	String	"Passed"
[10]	String	""

Figure 7-1. Station Globals Window

View Ring Control for Station Globals

Use the View ring control at the top right corner of the window to select which aspect of the station globals to display in the window. You have the following choices:

- **Globals**—Displays the station global variables and their values.
- **Global Types**—Displays the named data types that the station global variables use. The view is empty if no station globals use named data types. Refer to Chapter 9, *Types*, for more information on types and type editing.

Context Menu for the Globals View

To access a context menu, right click a global variable, subproperty, or on the background area of the view. The context menu can contain the following items.

Insert Global

The **Insert Global** menu item has a submenu from which you select the data type for the global variable you want to insert. Figure 7-2 shows the **Insert Global** submenu.

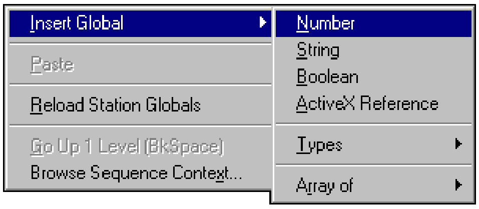


Figure 7-2. Insert Global Submenu

If you want to insert a global variable with a custom data type, you must create a named data type first. You can create a named data type in the Global Types view of the Station Globals window, in the Sequence File Types view of a Sequence File window, or in the Type Palette window. Refer to Chapter 9, *Types*, for more information on types and type editing. After you create the named data type, it appears in the **Types** submenu of the **Insert Globals** submenu.

View Contents

The **View Contents** command selects the tree view node that corresponds to the currently selected item in the list view. The list view then displays the contents of the item. If the tree view is currently closed, it opens to display the selected node. You use this command to view the subproperties of global variables.

Go Up One Level

The **Go Up One Level** command selects the next higher level node in the tree view. The list view displays the contents of the newly selected node.

Browse Sequence Context

The **Browse Sequence Context** command displays a tree view that contains the names of global variables their subproperties you can access from any expression or step module. This command also appears in the **View** menu of the sequence editor menu bar. Refer to the *View Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information.

Rename

The **Rename** command allows you to edit the name of the selected global variable or subproperty.

Global Variable Properties

The **Properties** command displays a dialog box that you can use to change the value of a global variable or one of its subproperties.

Reload Station Globals

The **Reload Station Globals** command discards the current station globals and reloads the station globals from disk. Usually, you use this command to discard edits that you make to the station globals. If you do not reload the station globals, your edits are saved when you exit the sequence editor. You can select this command only when no executions are running.

Persistence

The values of station globals persist from one TestStand session to the next. TestStand stores the station globals in the `StationGlobals.ini` file in the `<TestStand>\Cfg` directory. TestStand loads the station globals from `StationGlobals.ini` when the engine initializes, and it saves the station global variables to `StationGlobals.ini` when the engine shuts down. Usually, the engine initializes when you start the sequence editor or an operator interface program and the shuts down when you exit the sequence editor or operator interface. When the engine saves the station globals, it saves their most recent values, and it also saves any additions or deletions that you made to the list of station globals during the session.

To save the station globals manually in the sequence editor, select **File»Save** when the Station Globals window is the active window. You also can save the station globals to disk in a code module by using the `CommitGlobalsToDisk` method in the Engine class of the TestStand API. When TestStand saves the station globals, TestStand changes the disk date of `StationGlobals.ini` only if the station globals in memory differ from the station globals in the file.

Table 7-1 summarizes the status of station globals in various contexts.

Table 7-1. Status of Station Globals in Various Contexts

Context	Status of Station Globals	Remarks
Multiple concurrent executions in the same TestStand session.	All executions share the same station globals.	Station global values are stored in `StationGlobals.ini`.
Multiple, concurrent instances of the TestStand engine.	Each instance maintains a separate copy of the station globals.	When you start each new instance of the sequence editor or operator interface, the engine loads a copy of the station globals from `StationGlobals.ini`.

Table 7-1. Status of Station Globals in Various Contexts (Continued)

Context	Status of Station Globals	Remarks
Changes to the station globals by you or your sequences.	The engine saves the current state of the station globals to `StationGlobals.ini` when the sequence editor or operator interface exits.	If you make changes to the station globals in two concurrent sequence editor or operator interface instances, the instance that exits last might overwrite the changes that the other instance saved in `StationGlobals.ini`. If, when an instance exits, the engine detects that another instance modified the file after the current instance loaded it, then the engine displays a prompt giving you the choice to overwrite the `StationGlobals.ini` or to discard your changes.

Special TestStand Station Globals

TestStand provides a special-purpose station global variable named `TS`. TestStand uses the `TS` variable to contain special values that it adds as subproperties. TestStand adds the following special variables:

- `TS.LastUserName`—A string property that holds the login name of the last user to log in.
- `TS.CurrentUser`—A property of type `User` that contains information on the user that is currently logged in. Refer to the *Verifying User Privileges* section in Chapter 12, *User Management*, for information on verifying user privileges. TestStand does not save the `TS.CurrentUser` property in `StationGlobals.ini`.

8 Sequence Context and Expressions

This chapter describes the properties in the TestStand sequence context and how to use expressions in TestStand.

Sequence Context

Before executing the steps in a sequence, TestStand creates a run-time copy of the sequence. This allows TestStand to maintain separate local variable and step property values for each sequence invocation. For each sequence invocation, TestStand also maintains a *sequence context* that contains references to all global variables and to all local variables and step properties in the active sequence. The contents of a sequence context can vary depending on the currently executing step.

You implicitly use a sequence context to access variables and step properties in expressions. You explicitly use a sequence context when you call the TestStand API to access variables and properties from a step module. Refer to the *Expressions* section in this chapter for information on expressions. For more information on the TestStand API, refer to the *TestStand Programmer Help*.

Note To refer to a subproperty, you use a period to separate the name of the property from the name of the subproperty. For example, you refer to the `CurrentUser` subproperty in the `TS` subproperty of the `StationGlobals` property as `StationGlobals.TS.CurrentUser`.

Tables 8-1 through 8-6 list the properties in a sequence context and describe their contents. Table 8-1 lists the first-level properties. The subsequent tables list subproperties of these properties.

Table 8-1. First-Level Properties of a Sequence Context

Sequence Context Subproperty	Description
`Step`	Contains the properties of the currently executing step in the current sequence invocation. The `Step` property exists only while a step executes. The property does not exist when the execution is between steps, for example, at a breakpoint.
`Locals`	Contains the sequence local variables for the current sequence invocation.
`Parameters`	Contains the sequence parameters for the current sequence invocation.
`FileGlobals`	Contains the sequence file global variables for the current execution.
`StationGlobals`	Contains the station global variables for the engine invocation. TestStand maintains a single copy of the station globals in memory. Refer to Table 8-2 for the default contents of the `StationGlobals` property.
`ThisContext`	Holds a reference to the current sequence context. You usually use this property to pass the entire sequence context as an argument to a subsequence or a step module.
`RunState`	Contains properties that describe the state of execution in the sequence invocation. Refer to Table 8-3 for the contents of the `RunState` property.

Some of the properties in the sequence context refer to objects that exist before, and persist after, the current execution. Any modifications you make to these objects affect all executions in the current TestStand session. If you save the modifications to disk, they affect future TestStand sessions. These properties include the following:

- `Station.Globals`
- `RunState.InitialSelection`
- `RunState.SequenceFile`
- `RunState.ProcessModelClient`

Sequence Context Subproperties

This section discusses sequence context subproperties.

StationGlobals

The `StationGlobals` property object contains the station global variables for the engine invocation. Each TestStand session maintains a single copy of the station global variables in memory. Any modifications you make to a station global property affect all executions in the current TestStand session and future TestStand sessions. Refer to Chapter 7, *Station Global Variables*, for more information on station global variables.

TestStand creates a `TS` subproperty in the StationGlobals property to hold the standard station global variables that TestStand defines. Table 8-2 shows the contents of the `TS` subproperty.

Table 8-2. StationGlobals TS Subproperty in the Sequence Context

Sequence Context Subproperty	Description
`TS`	Contains the TestStand-specific station globals.
`LastUserName`	Login name of the user that logged in most recently.
`CurrentUser`	`User` object for the user that is currently logged in. The property does not exist if no user has logged in. Refer to Chapter 12, *User Management*, for more information on the `User` standard data type.

RunState

The `RunState` property object contains properties that describe the state of execution in the sequence invocation. Table 8-3 shows the subproperties of the `RunState` property object.

Table 8-3. RunState Subproperty in the Sequence Context

Sequence Context Subproperty	Description
`Engine`	Engine object in which the sequence invocation executes. Refer to the *TestStand Programmer Help* for more information on the methods and properties of this object.
`Root`	Sequence context for the root sequence invocation. If you initiate an execution using a process model entry point, the property is the sequence context for the process model entry point. For example, if you use an entry point from the default TestStand process model, the `Root` property is the sequence context of the `Test UUTs` or the `Single Pass` sequence. If you initiate an execution on a sequence without using a process model entry point, the `Root` property object is the sequence context for the sequence you run.
`Main`	Sequence context for the least nested sequence that is not in a process model. If you initiate an execution using the TestStand default model entry point, the `Main` property is the sequence context of `MainSequence`. If you initiate an execution on a sequence without using a process model entry point, the `Main` property object is the sequence context for whichever sequence you run.
`ThisContext`	Reference to the current sequence context. You usually use this property to pass the entire sequence context as an argument to another sequence or a step module.
`Caller`	Sequence context for the sequence that called the current sequence. This property does not exist in the root sequence context.

Table 8-3. RunState Subproperty in the Sequence Context (Continued)

Sequence Context Subproperty	Description
`InitialSelection`	Contains references to the non-execution versions of the steps, sequences, sequence file, and execution that are selected or active when you start an execution. You usually use this property in custom **Tools** menu commands to operate on the selected objects in a sequence file. Refer to Table 8-6 for the contents of the `InitialSelection` property. **Note:** Whenever you make changes to subproperty values in a Step, Sequence, or SequenceFile object that the `InitialSelection` property contains, you modify the non-execution version of the object. TestStand saves the modifications when you save the selected sequence file. Whenever you modify the selected file or the objects it contains from a code module, you must increment the `SelectedFile.ChangeCount` subproperty of `InitialSelection`.
`Report`	Report object for the execution. Refer to the *TestStand Programmer Help* for more information on the methods and properties of Report objects.
`Execution`	Execution object in which the sequence invocation runs. Refer to the *TestStand Programmer Help* for more information on the methods and properties of Execution objects.
`Thread`	Thread object in which the sequence invocation executes. Refer to the *TestStand Programmer Help* for more information on the methods and properties of Thread objects.
`SequenceFile`	The SequenceFile object for the sequence invocation. Refer to the *TestStand Programmer Help* for more information on the methods and properties of SequenceFile objects. Refer to Table 8-4 for the contents of the `SequenceFile` property. **Note:** TestStand saves any changes you make to property values of a SequenceFile object when you save the sequence file.

Table 8-3. RunState Subproperty in the Sequence Context (Continued)

Sequence Context Subproperty	Description
`Sequence`	Run-time copy of the Sequence object for the sequence invocation. The Sequence object contains the parameters, local variables, and steps for the sequence. Any changes you make to property values in this object modify only the execution version of the object. Refer to Table 8-5 for the contents of the `Sequence` property.
`PreviousStep`	Run-time copy of the Step object for the previously executed step in the sequence invocation. The property exists only after the first step in a step group executes. Any changes to property values in this object modify only the execution version of the object.
`Step`	Run-time copy of the Step object for the step that is currently executing. This property does not exist when the execution pauses between steps, for example, at a breakpoint. Any changes to property values in this object modify only the execution version of the object.
`NextStep`	Run-time copy of the Step object for the step that follows the currently executing step in the sequence. This property does not exist during and after the execution of the last step in a sequence step group. Any changes to property values in this object modify only the execution version of the object.
`SequenceError`	Container that holds the error code, message, and occurred flag to report to the step that calls the sequence.
`ErrorReported`	Boolean that indicates whether TestStand sent a `BREAK ON RTE` message to the operator interface for the error that `SequenceError` stores. Typically, an operator interface displays a run-time error handler dialog box when it receives a `BREAK ON RTE` event. When a sequence with an error returns, TestStand transfers the value of `ErrorReported` to the context of the calling sequence. This prevents the calling sequence from generating a duplicate `BREAK ON RTE` event for the error that the subsequence returns.
`IsProcessModel`	Boolean that indicates whether the sequence invocation is a sequence in the process model.

Table 8-3. RunState Subproperty in the Sequence Context (Continued)

Sequence Context Subproperty	Description
`Tracing`	Boolean that indicates whether tracing is active for the sequence invocation.
`SequenceFailed`	Boolean that indicates whether the current status of the sequence invocation is `Failed`.
`StepGroup`	String that contains the name of the step group that the sequence invocation is executing. Can be `Main`, `Setup`, or `Cleanup`.
`CallStackDepth`	Zero-based index of the currently executing sequence on the call stack. If, for example, the call stack contains three sequence invocations, `CallStackDepth` is 2. The sequence call stack includes calls to process model sequences, including calls to entry points.
`PreviousStepIndex`	Zero-based index of the previously executed step in the step group. TestStand sets the property value to `-1` before executing the first step in a sequence step group.
`StepIndex`	Zero-based index of the currently executing step in the step group. TestStand sets the value to `-1` when the execution is between steps, such as at a breakpoint.
`NextStepIndex`	Zero-based index of the step that follows the currently executing step in the step group. TestStand sets the value to `-1` when executing the last step in a sequence step group. By modifying the value of this property, you can specify the step that TestStand executes next. **Note:** Changes that you make to this property do not affect the value of the `RunState.NextStep` property object immediately.
`LoopIndex`	The loop index for the active step in the sequence invocation. By default, steps that you configure to loop use this property to store the loop index. The value of the loop index depends on the looping construct you choose to use for the step.
`LoopNumPassed`	Number of iterations that a looping step completes with a status of `Passed` or `Done`.
`LoopNumFailed`	Number of iterations that a looping step completes with a status of `Failed`.

Table 8-3. RunState Subproperty in the Sequence Context (Continued)

Sequence Context Subproperty	Description
`ProcessModelClient`	The SequenceFile object for the client sequence of the process model. This property exists only for executions that you initiate through a process model entry point. **Note:** TestStand saves any changes you make to property values in the sequence file object when you save the sequence file.
`IsEditor`	Boolean that indicates whether the current GUI is a sequence editor.

RunState.SequenceFile and Other SequenceFile Objects

Several sequence context subproperties are SequenceFile objects. The subproperties are the following:

- `RunState.SequenceFile`
- `RunState.ProcessModelClient`
- `RunState.InitialSelection.SelectedFile`

Table 8-4 shows the subproperties of the SequenceFile objects. TestStand saves any changes that you make to property values in a SequenceFile object when you save the sequence file. Refer to the *TestStand Programmer Help* for more information on the methods and properties of SequenceFile objects.

Table 8-4. Subproperties of the SequenceFile Objects in the Sequence Context

Sequence Context Subproperty	Description
`ChangeCount`	The number of changes you have made to the sequence file object. You must increment this property whenever you modify other `SequenceFile` object properties from a code module. The increment indicates to the sequence editor that you have changed the sequence file.
`LastSavedChangeCount`	The value of the `ChangeCount` property when the sequence editor last saved the sequence file.
`Data`	Contains the sequences and file globals in the sequence file.

Table 8-4. Subproperties of the SequenceFile Objects in the Sequence Context (Continued)

Sequence Context Subproperty	Description
Seq	Subproperty of `Data`. Contains an array of all Sequence objects in the sequence file.
FileGlobalDefaults	Subproperty of `Data`. Contains the default values for the global variables in the sequence file.
Path	The absolute pathname of the sequence file.

RunState.Sequence and Other Sequence Objects

Each SequenceFile object in the sequence context contains an array of Sequence objects in its `Data.Seq` subproperty. The `RunState.Sequence` subproperty of the sequence context is the Sequence object for the current sequence invocation. `RunState.Sequence` is a run-time copy of the `RunState.SequenceFile.Data.Seq` array element for the sequence that is currently executing.

Table 8-5 shows the subproperties of the Sequence objects. Refer to the *TestStand Programmer Help* for more information on the methods and properties of Sequence objects.

Table 8-5. Subproperties of the Sequence Objects in the Sequence Context

Sequence Context Subproperty	Description
Locals	Contains the local variables of the sequence. In `RunState.Sequence`, the local variables contain the current values in the sequence invocation. In nonexecution instances of Sequence objects, the local variables contain their default values.
ResultList	In `RunState.Sequence`, the `ResultList` local variable contains an array of step results for the sequence invocation. `ResultList` is empty in nonexecution instances of Sequence objects.
Main	Contains an array of all Step objects in the Main step group.
Setup	Contains an array of all Step objects in the Setup step group.

Table 8-5. Subproperties of the Sequence Objects in the Sequence Context (Continued)

Sequence Context Subproperty	Description
`Cleanup`	Contains an array of all Step objects in the Cleanup step group.
`Parameters`	Contains the parameters of the sequence. In `RunState.Sequence`, the parameters contain the values that the calling sequence passes. In nonexecution instances of Sequence objects, the parameters contain their default values.

RunState.Step and Other Step Objects

Each Sequence object in the sequence context contains an array of Step objects for each step group. The `RunState.Step` subproperty of the sequence context is a Step object in the `RunState.Sequence` Sequence object. It represents the step that is currently executing.

All Step objects include custom properties including a `Result` subproperty, which contains the `Error`, `Status`, and `Common` subproperties. Refer to Chapter 10, *Built-In Step Types*, for more information on the step properties for each of the built-in step types. Refer to the *TestStand Programmer Help* for more information on the methods and properties of Step objects.

The properties of the Step objects in `RunState.Sequence` contain the values for the current sequence invocation. The properties of the Step objects in the other Sequence objects in the sequence context contain their default values.

RunState.InitialSelection

The `RunState.InitialSelection` subproperty specifies the set of steps and sequences, the file, or the execution that is selected or active when you start a new execution. You usually use this property in sequences that custom **Tools** menu commands or process model entry points call. Table 8-6 lists the subproperties of the `InitialSelection`.

Table 8-6. InitialSelection Subproperty in the Sequence Context

Sequence Context Subproperty	Description
`SelectedSteps`	Contains an array of step objects that were selected when the execution started. The array is empty for non-root sequence contexts.
`SelectedSequences`	Contains an array of sequence objects that were selected when the execution started. The array is empty for non-root sequence contexts.
`SelectedFile`	Specifies the sequence file object for the active sequence file when the execution started. This property exists only in the root sequence context when a sequence file is initially active.
`SelectedPropertyObjectFile`	Specifies the `PropertyObjectFile` object for the active file when the execution started. When the initially active file is a sequence file, this property is identical to `SelectedFile`. This property only exists in the root sequence context when a file window is initially active.
`SelectedStepGroupByIndex`	Contains the index of the step group that was selected when the execution started. The index values are as follows: 0—Setup Step Group 1—Main Step Group 2—Cleanup Step Group This property only exists in the root sequence context.
`Execution`	When you select an existing execution display window and start a new execution, this property specifies the execution object for the existing execution that the window displays. This property exists only in the root sequence context when an execution window is initially active.

Whenever you make changes to subproperty values in a Step, Sequence, or SequenceFile object that the `RunState.InitialSelection` property contains, you modify the nonexecution version of the object. TestStand saves the modifications when you save the selected sequence file. Whenever you modify the selected file or the objects it contains from a code module, you must increment the `ChangeCount` property of the `SelectedFile` subproperty.

Using the Sequence Context

In expressions, you access the value of a variable or property by specifying a path from the sequence context to the particular variable or property. For example, you can set the status of a step using the following expression:

```
Step.Result.Status = "Passed"
```

Refer to the *Expressions* section in this chapter for more information on using expressions.

During an execution, you can view and modify the values of the properties in the sequence context from the Context tab of the Execution window. The Context tab displays the sequence context for the sequence invocation that is currently selected in the Call Stack pane. You also can monitor individual variables or properties from the Watch Expression pane. Refer to the *Sequence Editor Execution Window* section in Chapter 6, *Sequence Execution*, for more information on using the Context tab and Watch Expression pane of the Execution window.

You can pass a reference to sequence context object to a step module. In step modules, you access the value of a variable or property by using `PropertyObject` methods in the TestStand API on the sequence context. As with expressions, you must specify a path from the sequence context to the particular property or variable. Refer to Chapter 13, *Module Adapters*, for more information on how to pass the sequence context to a code module for each adapter. Refer to the *TestStand Programmer Help* for more information on accessing the properties in the sequence context from code modules.

Use **View»Browse Sequence Context** of the sequence editor menu bar to access a tree view containing the names of variables, properties, and sequence parameters that you can access from expressions and step modules. Refer to the *View Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information.

Expressions

In TestStand, you can use an expression to calculate a new value from the values of multiple variables or properties. In general, you can use an expression anywhere you can use a simple variable or property value. The Statement step type evaluates an expression as a step in a sequence. For most steps, you can specify a Pre Expression, a Post Expression, and a Status Expression on the Expressions tab of the Step Properties dialog box. TestStand executes the pre expression before executing the step module, and it executes that post expression and status expression after executing the step module.

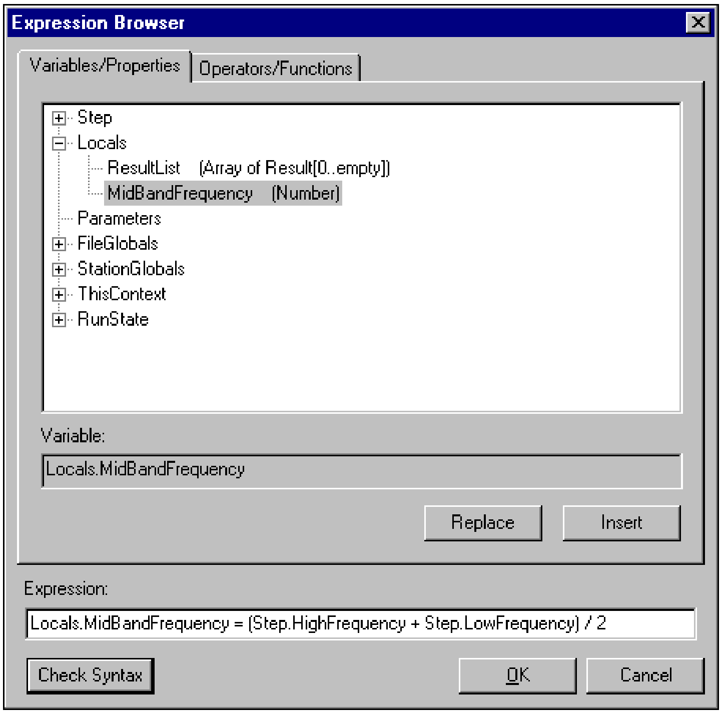
In expressions, you can access all variables and properties in the sequence context that is active when TestStand evaluates the expression. The following is an example of an expression:

```
Locals.MidBandFrequency = (Step.HighFrequency +
    Step.LowFrequency) / 2
```

TestStand supports all relevant expression operators and syntax that you use in C, C++, Java, and Visual Basic. If you are not familiar with expressions in these standard languages, TestStand also provides an Expression Browser dialog box that you access by clicking the **Browse** button that appears beside the controls that accept expressions.

When you use the Expression Browser dialog box to edit an expression in a sequence file, you can create variables and parameters without exiting the dialog box. Right-click on the `Locals`, `Parameters`, `FileGlobals`, or the `StationGlobals` item to display a context menu that you can use to insert a variable or parameter. Right-click on a variable or parameter to rename, delete, or configure its properties.

Figure 8-1 shows the Expression Browser dialog box.



Step
Locals
ResultList (Array of Result[0..empty])
MidBandFrequency (Number)
Parameters
FileGlobals
StationGlobals
ThisContext
RunState

Variable:

Locals.MidBandFrequency

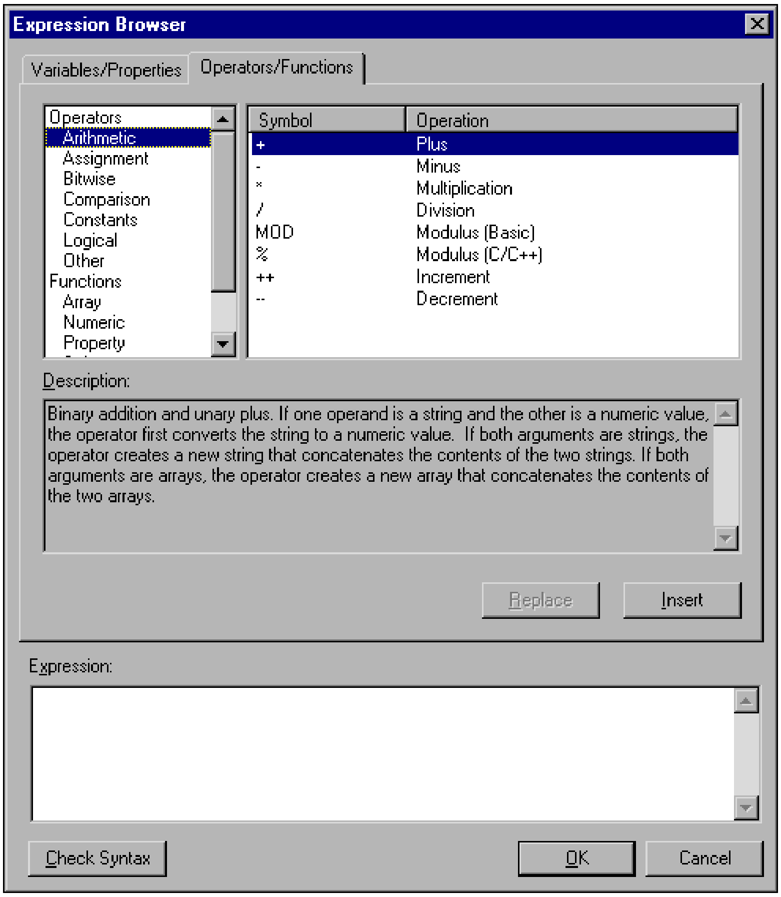
Expression:

Locals.MidBandFrequency = (Step.HighFrequency + Step.LowFrequency) / 2

Figure 8-1. Variables/Properties Tab of the Expression Browser

The Expression Browser dialog box allows you to interactively build an expression by selecting from lists of available variables, properties, operators, and functions. You select variables and properties from the Variables/Properties tab. You select operators and functions from the Operators/Functions tab. The Operators/Functions tab contains a Description text box that shows help text for the currently selected operator or function. Using the **Insert** and **Replace** buttons, you can copy a variable, property, or operator to the cursor location in the Expression control. Using the **Check Syntax** button, you can verify the syntax of the expression in the Expression control.

Figure 8-2 shows the Operators/Functions tab of the Expression Browser dialog box.



Symbol	Operation
+	Plus
-	Minus
*	Multiplication
/	Division
MOD	Modulus (Basic)
%	Modulus (C/C++)
++	Increment
--	Decrement

Binary addition and unary plus. If one operand is a string and the other is a numeric value, the operator first converts the string to a numeric value. If both arguments are strings, the operator creates a new string that concatenates the contents of the two strings. If both arguments are arrays, the operator creates a new array that concatenates the contents of the two arrays.

Figure 8-2. Operators/Functions Tab of the Expression Browser

Table 8-7 lists the operators and constant formats you can use in expressions.

Table 8-7. Expression Operators

Operator Class	Operators in Symbol Form
Arithmetic	The arithmetic symbols include the following items: `+`, `-`, `*`, `/`, `MOD`, `%`, `++`, and `--`.
Assignment	The assignment symbols include the following items: `=`, `+=`, `-=`, `*=`, `/=`, `%=`, `^=`, `&=`, and `|=`.
Comparison	The comparison symbols include the following items: `==`, `!=`, `<>`, `>`, `>=`, `<`, and `<=`.
Logical	The logical symbols include the following items: `&&`, `||`, and `!`.
Bitwise	The bitwise symbols include the following items: `AND`, `OR`, `NOT`, `XOR`, `&`, `|`, `~`, `^` , `>>`, and `<<`.
Constants	The formats for the different types of constants include the following items: `1.23e-4` Floating Point `1234` Integer `0x1234efa9` Hexadecimal Integer `0b11011011` Binary Integer `True` Boolean `False` Boolean `"1234wxyz"` String Nothing Empty ActiveX Reference `NAN` Not a number `IND` Indeterminate number `INF` Infinite number

Table 8-7. Expression Operators (Continued)

Operator Class	Operators in Symbol Form
Other	Some additional operators include the following items: `()` Parenthesis—Alter evaluation order `.` Dot—Property field separator `[]` Brackets—Array subscript `,` Comma—Expression separator `?:` Conditional—Given a Boolean value, chooses one of two other expressions to evaluate. Usage: *`booleanValue ? expr1 : expr2`*. {} Array Constant // Single line comment (C++) ’ Single line comment (Basic) /* */ Comment (C/C++)

The operand for an array subscript must evaluate to a numeric value, unless the array contains step or sequence elements. For arrays of step or sequence elements, the subscript can evaluate to a string value that contains the name of a step or sequence element in the array. For example, `RunState.Sequence.Main["MyGoto"]`.

Table 8-8 lists the functions you can call from an expression. Optional function parameters appear within angle brackets. For descriptions of each individual parameter, refer to the online help in the Expression Browser dialog box.

Table 8-8. Function Expression Operators

Function	Description
Array	
`GetArrayBounds(array, lower, upper)`	Retrieves the upper and lower bounds of an array.
`GetNumElements(array)`	Returns the number of elements in an array.
`InsertElements(array, index, numElements)`	Inserts new elements into a one-dimensional array.
`RemoveElements(array, index, numElements)`	Removes elements from a one-dimensional array.

Table 8-8. Function Expression Operators (Continued)

Function	Description
`SetArrayBounds(array, lower, upper)`	Changes the bounds of an array.
`SetNumElements(array, numElements)`	Sets the number of elements in a one-dimensional array.
Numeric	
`Abs(number)`	Returns the absolute value of a number.
`Max(number, number, ...)`	Returns the highest number.
`Min(number, number, ...)`	Returns the lowest number.
`Random(low, high)`	Returns a random number between `low` and `high`.
`Round(number, <option>)`	Rounds a number to an integer.
`Val(string, <isValid>)`	Converts a string to number.
Property	
`CommentOf(object)`	Returns the comment for an object.
`NameOf(object)`	Returns the name of an object.
`PropertyExists("propertyName")`	Returns `True` if the property exists, `False` otherwise.
`TypeOf(object, <typeDisplayName>)`	Returns the type of an object.
String	
`DelocalizeExpression(expressionString, <decimalPointOption>)`	Converts a localized expression string to a standard form for evaluation.
`Find(string, stringToSearchFor, <indexToSearchFrom>, <ignoreCase>, <searchInReverse>)`	Searches a string for a substring.
`Left(string, numChars)`	Retrieves a substring from the left side of a string.
`Len(string)`	Returns the number of characters in a string.
`LocalizedDecimalPoint()`	Returns the value of the localized decimal point.

Table 8-8. Function Expression Operators (Continued)

Function	Description
`LocalizeExpression`	Converts an expression string to conform to the localization settings for the computer.
`Mid(string, startIndex,<numChars>)`	Retrieves a substring from the middle of a string.
`Replace(string, startIndex, numCharsToReplace, replacementString)`	Replaces the given number of characters at the specified index with a replacement string.
`ResStr (category, tag, <defaultString>, <found>)`	Retrieves a string from the string resource files. An alternative name for this function is `GetResourceString`.
`Right(string, numChars)`	Retrieves a substring from the right side of a string.
`SearchAndReplace (string, searchString, replacementString, <startIndex>, <ignoreCase>, <maxReplacements>, <searchInReverse>, <numReplacements>)`	Finds and replaces one or more substrings with a replacement string.
`Str(value)`	Converts a number or Boolean to a string.
`StrComp("StringA", "StringB", <compareOption>, <maxChars>)`	Compares two strings.
Time	
`Date(<longFormat>, <year>, <month>, <monthDay>, <weekDay>, <timeStampInSeconds>, <baseTimeIsInitTime>)`	Retrieves the current date.
`Seconds(<returnSecondsSinceStartup>)`	Returns the number of seconds since you launched the application or the number of seconds since January 1, 1970.
`Time(<24Hr>, <h>, <m>, <s>, <ms>, <timeStampInSeconds>, <baseTimeIsInitTime>)`	Retrieves the current time.

Table 8-8. Function Expression Operators (Continued)

Function	Description
Other	
`AllOf(boolean, ...)`	Returns the logical `And` for any number of parameters.
`AnyOf(boolean, ...)`	Returns the logical `Or` for any number of parameters.
`CheckLimits (value, high, low, comparisonType, <DoNotCopyToResults>)`	Returns `Passed` if the value is within the limits. Returns `Failed` otherwise.
`CurrentUserHasPrivilege(string)`	Returns `True` if the current user has the privilege you specify. You can specify a property path or a simple property name. For example, if there is a privilege called "`Develop.SequenceFiles.Save`", the following privileges are equivalent: `Develop.SaveSequenceFiles` `SaveSequenceFiles`
`Evaluate(string)`	Returns the value of an expression that you specify in a string.
`FindFile(file, <useCurSeqFileDir>, <PathToFile>, <promptFlag>, <searchFlag>, <canceled>)`	Attempts to locate the file you specify in the search directories.

Table 8-9 summarizes the levels of precedence in expressions.

Table 8-9. Levels of Precedence in Expressions

Expression Type	Operator	Example
primary	Literal Identifier (expression) {element1, element2, ...}	3.14 or Locals.String (Seconds() / 1000) {1.0, 2.5, 5.0}
postfix	property[index] function	Locals.Array[25] Len(Locals.String)
unary	++, --, +, -, ~, !, NOT	++Locals.Number or -3.14
multiplicative	*, /, %, MOD	10 * Locals.Number
additive	+, -	5 - Locals.Number
shift	<<, >>	Locals.Number >> 2
relational	<, >, <=, >=	Locals.Number <= 0.1
equality	==, <>, !=	Locals.Number == 2.0
bitwise AND	&, AND	Locals.Number & 0xFFFF
bitwise exclusive OR	^, XOR	Locals.Number ^ 0xFFFF
bitwise inclusive OR	|, OR	Locals.Number | 0x0008
logical AND	&&	Locals.Bool && Step.Result.PassFail
logical OR	||	Locals.Bool || Step.Result.PassFail
conditional	? :	Step.Result.PassFail ? 5.0 : 6.0
assignment	=, +=, -=, *=, /=, %=, &=, ^=, |=, <<=, >>=	locals.number += 2.0

comma	,	Locals.Number1 = 5.0,
		Locals.Number2 = 6.0

9

Types

This chapter discusses how you create, modify, and use step types, custom named data types, and standard named data types in TestStand. This chapter also describes the Type Palette window.

For an overview of the categories of types, refer to the *Step Types* and *Standard and Custom Named Data Types* sections in Chapter 1, *TestStand Architecture Overview*.

Creation, Modification, and Storage of Types

This section describes the windows and views in which you can create, modify or examine data types and step types. This section also describes how TestStand stores the definitions for data types and step types.

Where You Create and Modify Types

Table 9-1 describes each graphical interface where you can access data types and step types: the windows, the views, the contents of a display, and the corresponding files. Each display presents the types that correspond to the file that you have open.

Table 9-1. Graphical Interfaces Where you Access Data Types and Step Types

Window	View within the Window	Contents of the Display	Corresponding Files
Sequence File window	Sequence File Types view	Tabs for the step types, custom data types, and standard data types that the variables and steps in the sequence file use.	When you save the contents of the Sequence File window, TestStand writes the definitions of the types to the sequence file. Refer to Chapter 5, *Sequence Files*, for more information on the Sequence File window.
Station Globals window	Global Types view	Tabs for the custom data types and standard data types that the station global variables use.	When you save the contents of the Station Globals window, TestStand writes the definitions of the types to the `StationGlobals.ini` file in the `<TestStand>\Cfg` directory. Refer to Chapter 7, *Station Global Variables*, for more information on the Station Globals window.

Table 9-1. Graphical Interfaces Where you Access Data Types and Step Types (Continued)

Window	View within the Window	Contents of the Display	Corresponding Files
User Manager window	Types view	Tabs for the custom data types and standard data types that the User objects use.	All Users and User Profiles use the User standard data type. To customize the User standard data type, add subproperties to it on the Standard Data Types tab. If any of these subproperties use custom data types, the custom data types appear on the Custom Data Types tab. When you save the contents of the User Manager window, TestStand writes the definitions to the `Users.ini` file in the `<TestStand>\Cfg` directory. Refer to Chapter 12, *User Management*, for more information on the User Manager window.
Type Palette window	One view for each type palette file.	Tabs for the step types, custom data types, and standard data types that you want to have available in the sequence editor at all times.	By dragging a type into a type palette file in the Type Palette window, you ensure that the type is always available even when it is not in the Types views of the User Manager window, the Station Globals window, or any of the open Sequence File windows. When you save the Types Palette window, TestStand saves all type palette files. Typically, type palette files reside in the `<TestStand>\Cfg\TypePalettes` directory. Refer to the *Type Palette Window* section in this chapter for more information.

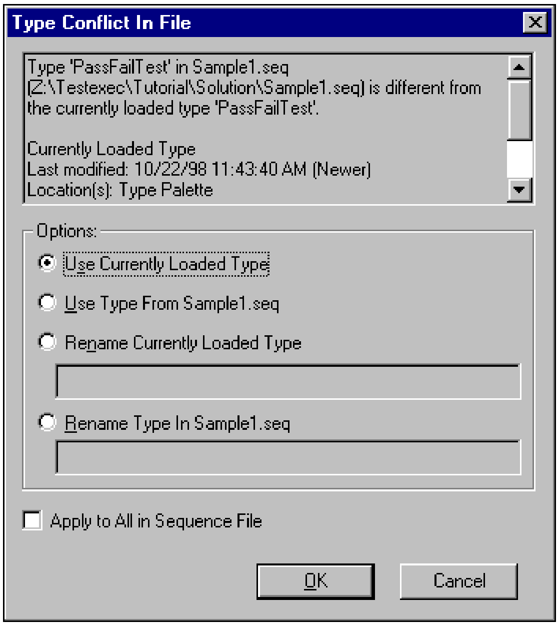
Storage of Types in Files and Memory

For each type that a TestStand file uses, TestStand stores the definition of the type in the file. You also can specify that a file always saves the definition for a type, even if it does not currently use the type. Because many files can use the same type, many files can contain definitions for the same type. All your sequence files, for example, might contain the definitions for the Pass/Fail Test step type and the `CommonResults` standard data type.

In memory, TestStand allows only one definition for each type. Although the type can appear in multiple views, only one underlying definition of the type exists in memory. If you modify the type in one view, it updates in all views. The **Find Type** command in the sequence editor **View** menu displays a dialog box that contains a list of all types that are currently in memory. The list identifies the set of files that use each type. For more information, refer to the *View Menu* section in Chapter 4, *Sequence Editor Menu Bar*.

If you load a file that contains a type definition and another type definition of the same name already exists in memory, TestStand verifies that the two type definitions are identical. If they are not identical, TestStand informs you of the conflict through the Type Conflict In File dialog box.

Figure 9-1 shows the Type Conflict In File dialog box.



Type 'PassFailTest' in Sample1.seq (Z:\Testexec\Tutorial\Solution\Sample1.seq) is different from the currently loaded type 'PassFailTest'.

Currently Loaded Type
Last modified: 10/22/98 11:43:40 AM (Newer)
Location(s): Type Palette

Options:
- [✓ Use Currently Loaded Type]
- Use Type From Sample1.seq
- Rename Currently Loaded Type
- Rename Type In Sample1.seq

☐ Apply to All in Sequence File

Figure 9-1. Type Conflict In File Dialog Box

You can select one of the definitions to replace the other, or you can rename one of them so that they can coexist in memory. If you enable the Apply to All in Sequence File checkbox, TestStand applies the selected option to all conflicts in the sequence file.

Using Data Types

You use data types when you insert variables, parameters, or step properties. Each view in which you can insert a variable, parameter or property has a context menu with an **Insert** item. You can use the context menu items in the views that are listed in the following table.

Table 9-2. Creating Data Type Instances from Context Menus

Name of Context Menu Item	Location of Context Menu	Item Inserted
Insert Global	Sequence File Globals view of the Sequence File window	Sequence file global variable
Insert Parameter	Parameters tab of individual sequence file views in the Sequence File window	Sequence parameter
Insert Local	Locals tab of individual sequence file views in the Sequence File window	Sequence local variable
Insert Global	Globals view of the Station Globals window	Station global variable
Insert User	Users view of the User Manager window	New object with the User data type
Insert Field	Type Palette window and the Types views in the Sequence File, Station Globals, or User Manager windows	New element in an existing data type

Except for the **Insert User** item, all the context menu items in Table 9-2 give you a submenu from which you can choose a data type. The submenu includes the following categories of types:

- One of the simple data types that TestStand defines, including the Number, Boolean, String, and ActiveX reference data types.
- A named data type. This submenu includes all the custom named data types that are currently in the Type Palette window or in the Types view of the window you are currently editing. The submenu also includes standard named data types that come with TestStand, such as `Error`, `Path`, and `CommonResults`. Refer to the *Using the Standard Named Data Types* section in this chapter for more information.
- An array of elements that all have the same data type.

In the submenu for **Insert Parameter**, you also can select the Container type. You cannot add fields to parameters you create with the Container type. Creating a parameter with the Container type is useful only if you want to pass an object of any type to the sequence. If so, you must also turn off type checking for the parameter. If you want to create a parameter with a complex data type, you must first create the data type in the Sequence File Types view or the Type Palette window. Then select the data type from the **Types** submenu in the **Insert Parameter** submenu.

Figure 9-2 shows the **Insert Local** submenu. The submenu includes three custom data types as examples: `Fixture`, `Subassembly`, and `YieldStatistics`.

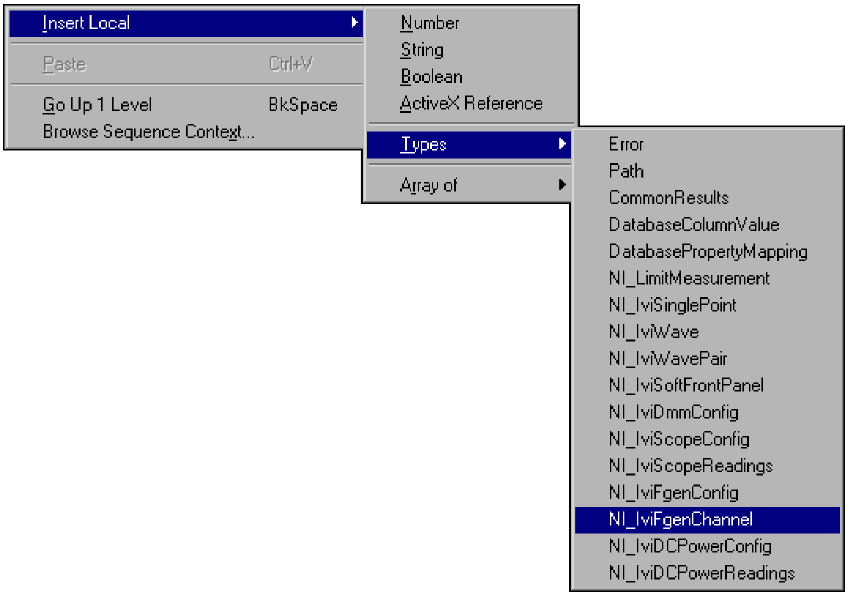
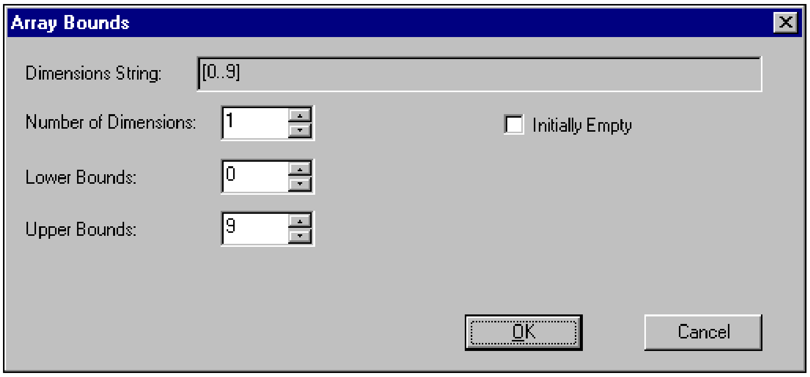


Figure 9-2. Insert Local Submenu

If the submenu does not contain the data type you require, you must create the data type in the Type Palette window or one of the type views. If the data type already exists in another window, drag or copy the data type from the other window to the window you are editing or to the Type Palette window.

Specifying Array Sizes

When you choose an item from the **Array of** submenu in an **Insert** submenu, the Array Bounds dialog box appears. Figure 9-3 shows the initial state of the Array Bounds dialog box.



Dimensions String: [0..9]
Number of Dimensions: 1
Initially Empty
Lower Bounds: 0
Upper Bounds: 9

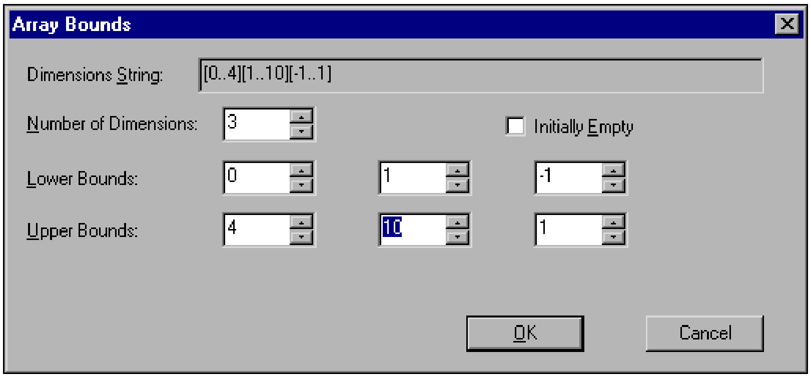
Figure 9-3. Initial State of Array Bounds Dialog Box

The Dimensions String indicator shows a string that describes the array dimensions. You use the Number of Dimensions numeric control to set the number of dimensions in the array. The maximum number of dimensions is 16. The number of controls that appear next to the Lower Bounds and Upper Bounds labels depends on the setting of the Num Dimensions control.

You use the Lower Bounds and Upper Bounds controls to set the minimum and maximum index for each dimension. For example, you can make one dimension zero-based and another dimension one-based. The Upper Bounds setting must be greater than or equal to the Lower Bounds setting for the same dimension. You can calculate the number of elements in each dimension according to the following formula:

```
Upper Bounds - Lower Bounds + 1
```

Figure 9-4 shows the Array Bounds dialog box with settings for a three-dimensional array.



Dimensions String: [0..4][1..10][-1..1]
Number of Dimensions: 3
Lower Bounds: 0 1 -1
Upper Bounds: 4 10 1

Figure 9-4. Array Bounds Dialog Box with Settings for a Three-Dimensional Array

The first and outermost dimension has five elements, with `0` as the minimum index and `4` as the maximum index. The second dimension has ten elements, with `1` as the minimum index and `10` as the maximum index. The third and innermost dimension has three elements, with `-1` as the minimum index and `1` as the maximum index.

After you create a variable, parameter, or property as an array, you can modify the array bounds by selecting the **Properties** item in the context menu for the variable, parameter, or property in the list view. Select the Bounds tab that now appears in the Properties dialog box to modify the array bounds.

Dynamic Array Sizing

In TestStand, you can resize an array during execution.

In an expression, you can use the `GetNumElements` and `SetNumElements` functions to obtain and modify the upper and lower bounds for a one-dimensional array. For multi-dimensional arrays or to change the number of dimensions in the array, you must use the `GetArrayBounds` and `SetArrayBounds` expression functions. You can find the documentation for these functions on the Operators tab of the Expression Browser dialog box. Refer to Chapter 8, *Sequence Context and Expressions*, for more information on expressions.

In a code module, you use the `GetDimensions` and `SetDimensions` methods of the PropertyObject class to obtain or set the upper and lower bounds of an array or to change the number of dimensions. Refer to the *TestStand Programmer Help* for more information.

Empty Arrays

If you want the array to have no elements when you start execution, enable the Initial Empty checkbox. When you enable the Initial Empty checkbox, the Upper Bounds control for each dimension dims. Defining an array as initially empty is useful if you do not know the maximum array size the sequence requires during execution or if you want to save memory during the periods of execution when the sequence does not use the array.

Figure 9-5 shows the Array Bounds dialog box with settings for a three-dimensional array that is initially empty.

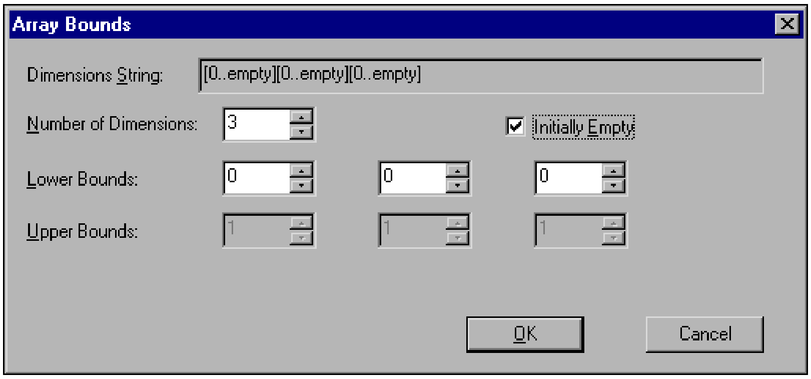
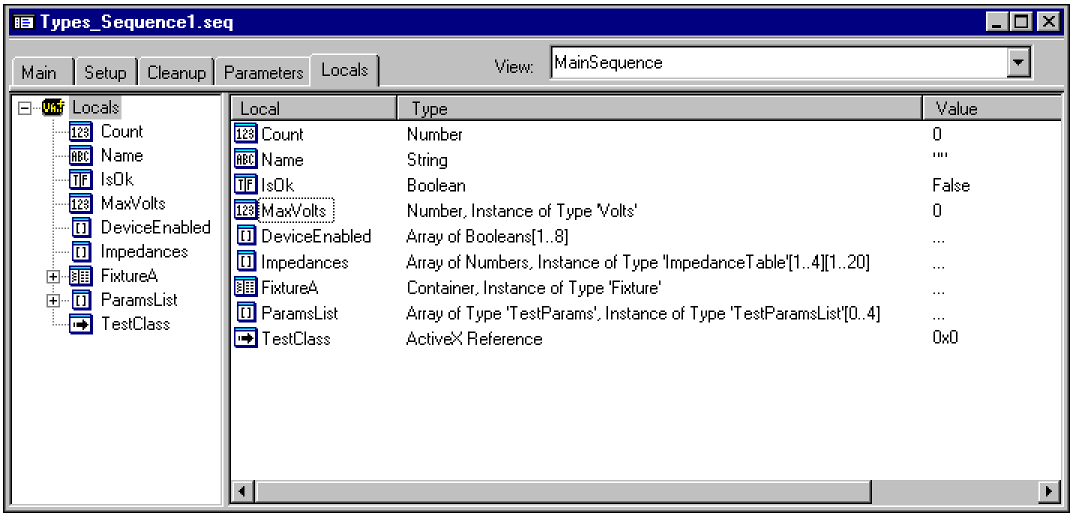


Figure 9-5. Array Bounds Dialog Box with an Initially Empty Array

Display of Data Types

The data type of each variable or property you create appears in the Type column next to the variable or property name. If the data type is an array, the words `Array of` appear in the Type column, followed by the data type of the array elements and the range of each dimension. If the data type is a named data type, the underlying type appears in the Type column, followed by the words `Instance of Type` and the data type name.

Figure 9-6 shows the variables with different data types on the Locals tab of a sequence file view.



Local	Type	Value
Count	Number	0
Name	String	""
IsOk	Boolean	False
MaxVolts	Number, Instance of Type 'Volts'	0
DeviceEnabled	Array of Booleans[1..8]	...
Impedances	Array of Numbers, Instance of Type 'ImpedanceTable'[1..4][1..20]	...
FixtureA	Container, Instance of Type 'Fixture'	...
ParamsList	Array of Type 'TestParams', Instance of Type 'TestParamsList'[0..4]	...
TestClass	ActiveX Reference	0x0

Figure 9-6. Local Variables with Various Data Types

The following describes the data type of each local variable in Figure 9-6:

- `Count` has the Number data type, which is one of the simple data types that TestStand predefines.
- `Name` has the String data type, which is one of the simple data types that TestStand predefines.
- `IsOk` has the Boolean data type, which is one of the simple data types that TestStand predefines.
- `MaxVolts` has the `Volts` data type, which is a custom data type. In this example, the `Volts` data type is an alias for the Number data type.
- `DeviceEnabled` is a one-dimensional array of Booleans, with indexes from 1 to 8.
- `Impedances` has the `ImpedanceTable` data type, which represents a two dimensional array of numbers.
- `FixtureA` has the `Fixture` data type, which represents a container that contains multiple fields with different data types.

- `ParamsList` has the `TestParamList` data type, which represents a one-dimensional array of elements with the `TestParams` data type. The `TestParams` data type represents a container that contains multiple fields with different data types.
- `TestClass` has the ActiveX reference data type, which is one of the simple data types that TestStand predefines.

Modifying Data Types and Values

Except for the resizing of arrays, you cannot change the internal structure of a variable, parameter, or property after you create it. You cannot change its data type setting, nor can you deviate from the data type. You can, however, change the contents of the data type itself. Changing the contents of a data type affects all variables, parameters, and properties that use the data type. Refer to the *Creating and Modifying Data Types* section in this chapter for more information.

You can modify the value of a variable, parameter, or property in the list view in which you create it. For variables and properties, this value is the initial value when you start execution or call the sequence. For parameters, this value is the default value if you do not pass an argument value explicitly. If the data type is a single-valued data type, such as Number or Boolean, the value appears in the Value column of the list view. In Figure 9-6, the values of the first four local variables appear in the Value column.

Single Values

You modify the value of a single-valued data type by selecting the **Properties** item in the context menu for the variable, parameter, or property in the list view. The Properties dialog box appears. Figure 9-7 shows the Properties dialog box for the `Max Volts` local variable from Figure 9-6.

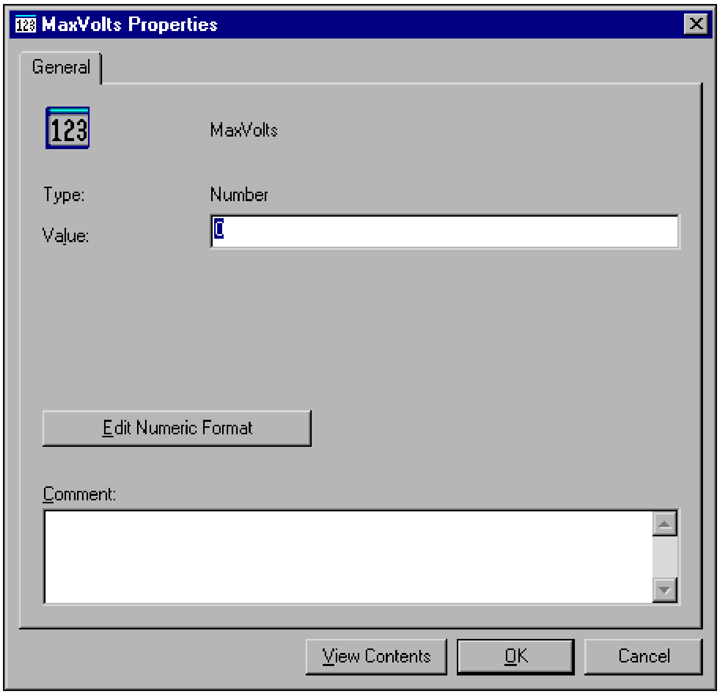


Figure 9-7. Properties Dialog Box for a Number Local Variable

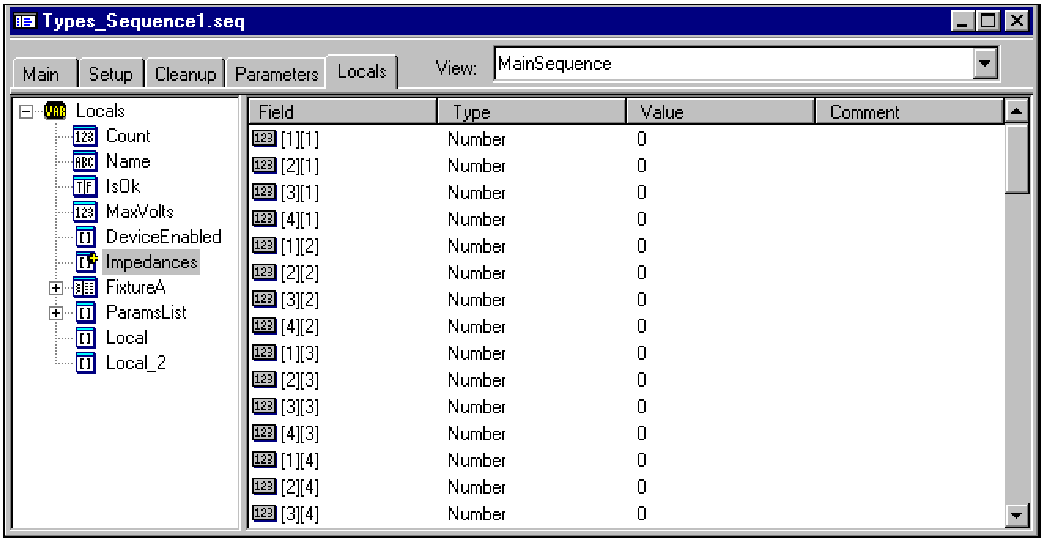
ActiveX References

If the variable, parameter, or property is an ActiveX reference, you can use the Properties dialog box to release the reference. You can set the reference value only from within an expression, a step code module using the TestStand API, or by calling the TestStand API directly, through the ActiveX Automation Adapter. TestStand stores the ActiveX reference as an `IDispatch` pointer or `IUnknown` pointer. The value you assign to the ActiveX reference must be a valid ActiveX pointer. Whenever you assign a non-zero value to an ActiveX reference, TestStand adds a reference to the object for as long as the variable, parameter, or property contains that value. To release the reference to the object, assign the variable, parameter, or property a new value or the constant `Nothing`. In addition, TestStand automatically releases the reference to the object when the variable, parameter, or property loses its scope. For example, if a sequence local variable contains a reference to an object, TestStand releases the reference when the call to the sequence completes.

Note Do not release an ActiveX variable by assigning it a value of zero. Instead, assign the variable a value of `Nothing`.

Arrays

If the variable, parameter, or property is an array that contains values, you access the elements of the array in the list view by selecting **View Contents** from the context menu. Figure 9-8 shows the contents of the `Impedances` array local variable from Figure 9-6.



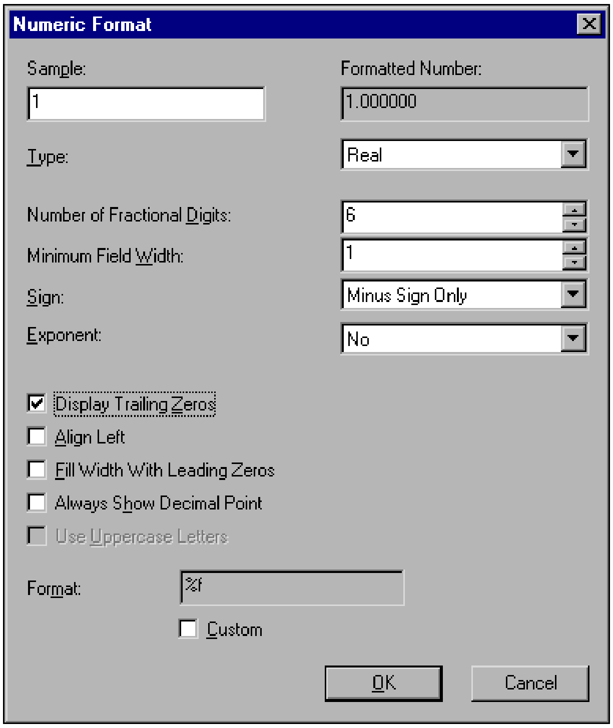
Field	Type	Value	Comment
[1][1]	Number	0	
[2][1]	Number	0	
[3][1]	Number	0	
[4][1]	Number	0	
[1][2]	Number	0	
[2][2]	Number	0	
[3][2]	Number	0	
[4][2]	Number	0	
[1][3]	Number	0	
[2][3]	Number	0	
[3][3]	Number	0	
[4][3]	Number	0	
[1][4]	Number	0	
[2][4]	Number	0	
[3][4]	Number	0	

Figure 9-8. Contents of Array Local Variable in List View

The array indexes appear in the Field column of the list view. You can use the **Properties** item in the context menu for each array element to modify the initial value.

Numeric Value Formats

You can use the Numeric Format dialog box to specify the format that TestStand uses to display the value of a numeric variable or property. To display the Numeric Format dialog box, click the **Edit Numeric Format** button on the Properties dialog box for a numeric or numeric array variable or property. Figure 9-9 shows the Numeric Format dialog box.


Numeric Format

Sample: 1

Formatted Number: 1.000000

Type: Real

Number of Fractional Digits: 6

Minimum Field Width: 1

Sign: Minus Sign Only

Exponent: No

[✓] Display Trailing Zeros

[ ] Align Left

[ ] Fill Width With Leading Zeros

[ ] Always Show Decimal Point

[ ] Use Uppercase Letters

Format: %f

[ ] Custom

Figure 9-9. Numeric Format Dialog Box

The Numeric Format dialog box can contain the following controls:

- **Sample**—A sample number to which the dialog box applies the current format settings. You can enter different numbers to test the effects of the format settings.
- **Formatted Number**—Displays the effect of the format settings on the sample number.
- **Type**—Specifies the numeric format type. You can choose one of the following options from the ring control: Real, Integer, Unsigned Integer, Hexadecimal, Octal, or Binary.
- **Number of Fractional Digits**—Specifies the number of digits to display after the decimal point. This control appears only when you set the **Type** to Real and do not set the **Show Exponent** option to Automatic. If the value to format contains more fractional digits than this control specifies, the fractional portion of the formatted number rounds to the specified number of fractional digits. If the value to format contains fewer fractional digits than this control specifies, the

Display Trailing Zeros control determines whether to append zeros to reach the specified number of fractional digits.

- **Maximum Number of Significant Digits**—Specifies the maximum number of significant digits to display. This control appears only when you set the **Type** to Real and set the **Show Exponent** option to Automatic.
- **Minimum Number of Digits**—Specifies the minimum number of digits to display. This control appears only when you do not set the **Type** to Real. If the value to format contains fewer digits than the minimum, this option prefixes the formatted number with leading zeros.
- **Minimum Field Width**—Specifies the minimum number of characters in the formatted number. If the number does not contain the minimum number of characters, TestStand appends spaces before or after the number, according to the setting of the **Align Left** control.
- **Sign**—Specifies when a sign prefixes the formatted number. You can choose one of the following options from the ring control: Minus Sign Only, Plus or Minus Sign, or Space or Minus Sign.
- **Show Exponent**—Specifies whether the number appears in scientific notation. You can choose one of the following options from the ring control:
  - **Yes**—Use scientific notation.
  - **No**—Do not use scientific notation.
  - **Automatic**—Use the most compact form of notation for the current value.
- **Display Trailing Zeros**—Appends zeros to the fractional portion of the formatted number if the value to format contains fewer fractional digits than the number that the **Number of Fractional Digits** control specifies. This control applies when the **Type** is Real and the formatted number does not contain an exponent.
- **Align Left**—Specifies that the formatted number aligns against the left edge of its field.
- **Fill Width With Leading Zeros**—Specifies that empty space before the number fills with zeros instead of spaces. This control applies only when you set the **Align Left** option and set the **Type** to Real.
- **Show Decimal Point**—Specifies that the formatted number includes a decimal point even when it does not have a fractional portion. This control applies only when you set the **Type** to Real and the formatted number does not contain an exponent.

- **Show Radix Prefix**—Specifies whether a radix prefix precedes binary, octal, or hex numbers.
- **Use Uppercase Letters**—Specifies that radix prefixes, exponent characters, and hexadecimal digits appear in uppercase.
- **Format**—Displays the underlying format code that the dialog box settings specify.
- **Custom**—Enables editing of the underlying format code.
- **Check Format**—Checks the validity of an underlying format code you enter in the **Format** control.

Containers

If the variable, parameter, or property is a container that contains one or more fields, you select **View Contents** from the context menu to display the fields in the list view. For fields that have values in the Value column, you use the **Properties** item in the context menu to examine or modify the value. For a field that is an array or container, you select **View Contents** again to view its elements or fields.

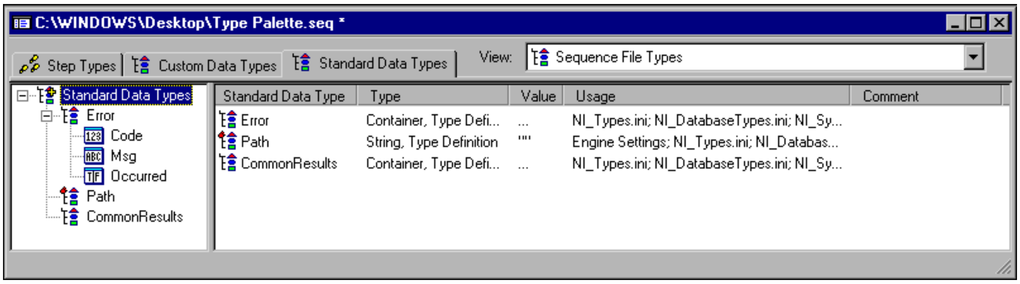
Note If you want to modify an NI-installed type, you must first enable the Allow Editing NI Installed Types option on the Preferences tab of the Station Options dialog box.

Using the Standard Named Data Types

TestStand defines standard named data types, such as `Path`, `Error`, and `CommonResults`. You can add subproperties to the standard data types, but you cannot delete any of their built-in subproperties.

The Standard Data Types tab in the Type Palette window shows the standard data types in the selected type palette file. The Standard Data Types tab in the Station Globals or Sequence File window shows only the standard data types that the variables, parameters, or properties in the window use.

Figure 9-10 shows the Standard Data Types tab of the Type Palette window.



C:\WINDOWS\Desktop\Type Palette.seq *

Step Types | Custom Data Types | Standard Data Types

View: Sequence File Types

- Standard Data Types
  - Error
    - Code
    - Msg
    - Occurred
  - Path
  - CommonResults

Standard Data Type	Type	Value	Usage	Comment
Error	Container, Type Defi...	...	NI_Types.ini; NI_DatabaseTypes.ini; NI_Sy...	
Path	String, Type Definition	""	Engine Settings; NI_Types.ini; NI_Databas...	
CommonResults	Container, Type Defi...	...	NI_Types.ini; NI_DatabaseTypes.ini; NI_Sy...	

Figure 9-10. Standard Data Types Tab of the Type Palette Window

The *Path* section and the *Error and Common Results* section of this document describe some of the more generally applicable standard data types.

Path

You use the `Path` standard data type to store a pathname. The `Path` data type stores the pathname as a string.

The variables, parameters, and properties you define using the `Path` data type appear in the Edit Paths dialog box that the **Paths** command in the **View** menu displays. You can use the Edit Paths dialog box to view the pathnames in sequence files and station configuration files and to modify the directory portion of pathnames you select. This dialog box can be useful after you copy a sequence file or configuration file from one computer to another. The Edit Paths dialog box shows all variables, parameters, and properties that have the `Path` data type. Refer to the *View Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information.

Error and Common Results

TestStand inserts a `Results` property in every step you create, regardless of whether you use a built-in step type or a custom step type. The `Results` property has at least three subproperties: `Error`, `Status`, and `CommonResults`.

The `Error` subproperty uses the `Error` standard data type. Steps in TestStand use the `Error` subproperty to indicate run-time errors. The `Error` standard data type is a container that contains three subproperties. When a run-time error occurs in a step, the step sets the `Occurred` subproperty to `True`, the `Code` subproperty to a value that indicates that source of the error, and the `Msg` subproperty to a string that describes the error. You can add more subproperties to the `Error` standard data type. In this way, your steps can record extra run-time error information in a standard way.

The `CommonResults` standard data type is an object that is initially empty. By adding subproperties to it, you can add extra result information to all steps in a standard way.

If you choose to add more subproperties to `Error` or `CommonResults`, newer versions of TestStand retain them for you.

Creating and Modifying Data Types

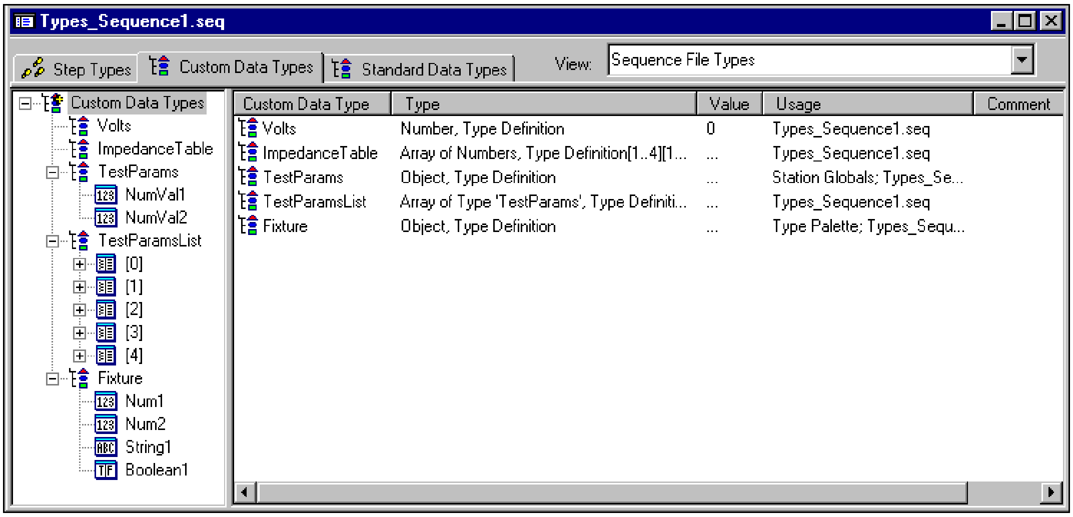
You create and modify data types in the Sequence File Types view of a Sequence File window, the Global Types view of the Station Globals window, and the Type Palette window. You use the Custom Data Types tab to create and modify custom data types. You use the Standard Data Types tab to add subproperties to the standard data types. The two tabs are very similar.

Note This section discusses creating and modifying custom data types on the Custom Data Types tab. The same information applies to the Standard Data Types tab.

Custom Data Types Tab Tree and List Views

The Custom Data Types tab contains a tree view and a list view. When you select the root node of the tree view, the custom data types appear in the list view.

Figure 9-11 shows the Custom Data Types tab for an example sequence file, with the root node selected.



Custom Data Type	Type	Value	Usage	Comment
Volts	Number, Type Definition	0	Types_Sequence1.seq	
ImpedanceTable	Array of Numbers, Type Definition[1..4][1...	...	Types_Sequence1.seq	
TestParams	Object, Type Definition	...	Station Globals; Types_Se...	
TestParamsList	Array of Type 'TestParams', Type Definiti...	...	Types_Sequence1.seq	
Fixture	Object, Type Definition	...	Type Palette; Types_Sequ...	

Figure 9-11. Custom Data Types Tab with Root Node Selected

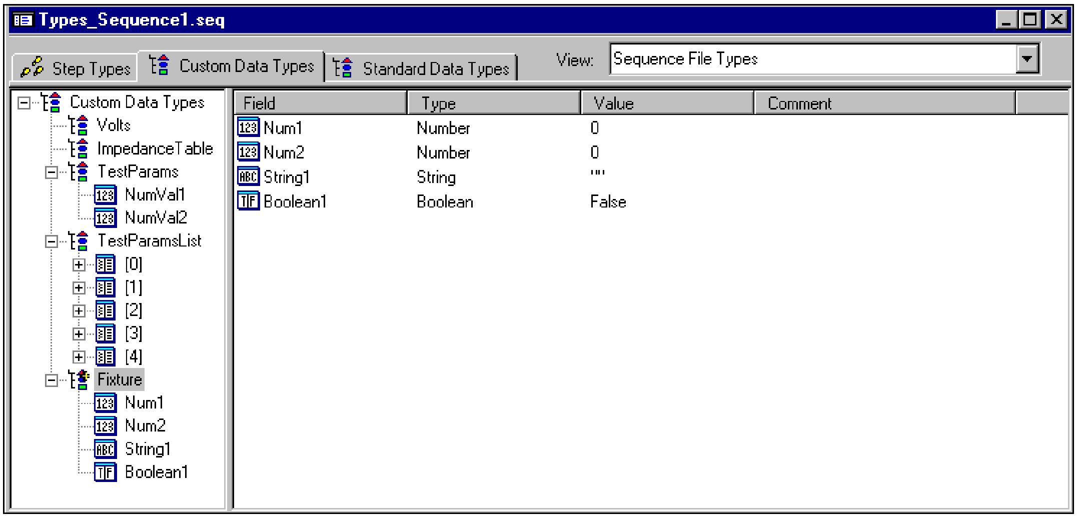
The Custom Data Type column of the list view shows the name of each custom data type. The Type column shows the underlying data type. For information on the contents of the Type column, refer to the *Display of Data Types* section earlier in this chapter. If the underlying data type is a single-value type, such as Number or Boolean, the Value column shows the initial or default value that TestStand applies to all variables, parameters, and properties you create using the custom data type. The Usage column shows the files that use the data type. The Comment column shows a descriptive comment that you can create for the data type.

You can open the nodes in the tree view to show all the subproperties of each custom data type that is a container or an array of containers. You can click the plus sign (+) that appears on the left of the tree view to expand a node. When the node is open, a minus (–) sign appears to the left of the node. You can click the minus sign to collapse the node.

In Figure 9-11, the tree view is partially open and shows the fields of the `TestParams` and `Fixture` containers and the elements of the `TestPararmsList` array. Notice that a plus sign appears to the left of each element of the `TestParamsList` array because each element is a `TestParams` container. When you view the contents of an array, the list view displays all the array elements.

To update the list view to display the contents of the node, select the node in the tree view. From the list view, you display the contents of an item by selecting **View Contents** item from the context menu for the item. To display the contents of the next highest level, press <Backspace> in either the tree view or the list view, or select the **Go Up 1 Level** item from the context menu in the list view background.

Figure 9-12 shows the Custom Data Types tab with the list view showing the contents of the `Fixture` container data type.

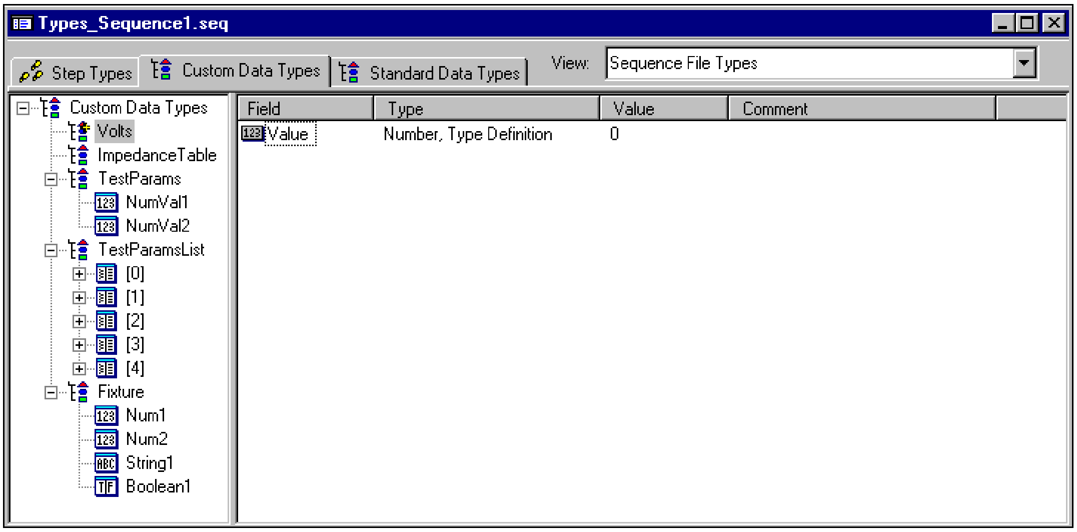


Field	Type	Value	Comment
Num1	Number	0	
Num2	Number	0	
String1	String	""	
Boolean1	Boolean	False	

Figure 9-12. Custom Data Types Tab Showing the Contents of a Container

Value Field

The list view displays a value in the Value column for any item that has a single-valued type or single-valued underlying type. When you select the **View Contents** command on such an item, its Value field appears in the list view. Figure 9-13 shows the Custom Data Types tab with the list view showing the Value field for the `Volts` custom data type, which uses Number as its underlying data type.

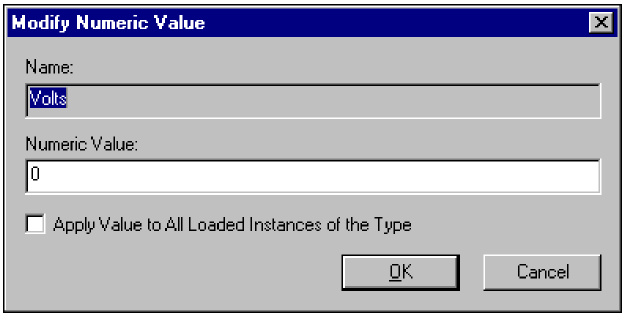


Field	Type	Value	Comment
Value	Number, Type Definition	0	

Figure 9-13. Custom Data Types Tab Showing the Value Field for a Number

If you double-click or press <Enter> on the Value field in the list view or select the **Modify Value** item from the context menu for the Value field, the Modify Value dialog box appears.

Figure 9-14 shows the Modify Numeric Value dialog box for the `Volts` data type.



Name: Volts

Numeric Value: 0

Figure 9-14. Modify Numeric Value Dialog Box

The value you enter in the dialog box is the initial or default value that all variables, parameters, or properties you create with the data type use. If any other variables, parameters, or properties already have the data type, you can change their initial or default values by enabling the Apply Value to All Loaded Instances of the Type checkbox.

Creating a New Custom Data Type

To create a new custom data type, select the root node in the tree view so that the existing custom data types appear in the list view. Right click the background of the list view, and select the **Insert Custom Data Type** item from the context menu. Figure 9-15 shows the **Insert Custom Data Type** submenu that appears.

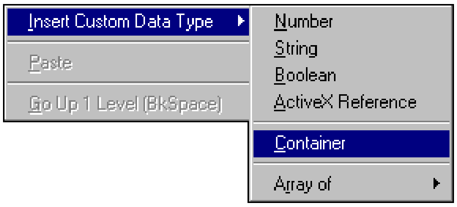


Figure 9-15. Insert Custom Data Type Submenu

The submenu gives you a set of data types from which to choose an underlying type. You can select an array of any type, a container, or any of the simple data types that TestStand defines.

If you select an array type from the submenu, the Array Bounds dialog box appears. You use the dialog box to specify the array bounds that TestStand applies initially to each variable, parameter, or property that you create with the data type. After you create the variable, parameter, or property, you can change its array bounds on the Bounds tab of the Properties dialog box. Select the **Properties** item in the context menu for the variable, parameter, or property. Refer to the *Specifying Array Sizes* section earlier in this chapter for more information on setting the size of an array.

If you select the Container type from the submenu, TestStand creates the data type without any fields.

Note When you create new data types, begin your types with a unique ID such as a company prefix. Using a unique ID helps to prevent name collisions. For example, `NI_InstrumentConfigurationOptions` uses NI as a unique ID.

Adding Fields to Data Types

You can add any number of fields to a data type or data type subproperty that you create as a container. To add fields to a container property in a new or existing data type, right click the icon for the data type or a data type subproperty in the list view, and select the **View Contents** item from the context menu. For a new data type, the list view becomes empty. For an existing data type, the list view displays the fields currently in the data type. Right click the background of the list view, and select **Insert Field** item from the context menu. Figure 9-16 shows the **Insert Field** submenu that appears.

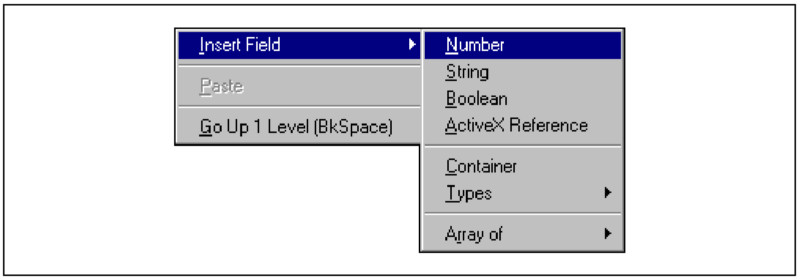


Figure 9-16. Insert Fields Submenu

The submenu gives you a set of data types to choose from. You can select any of the simple data types that TestStand defines, an array of any type, a container, or a custom or standard named data type.

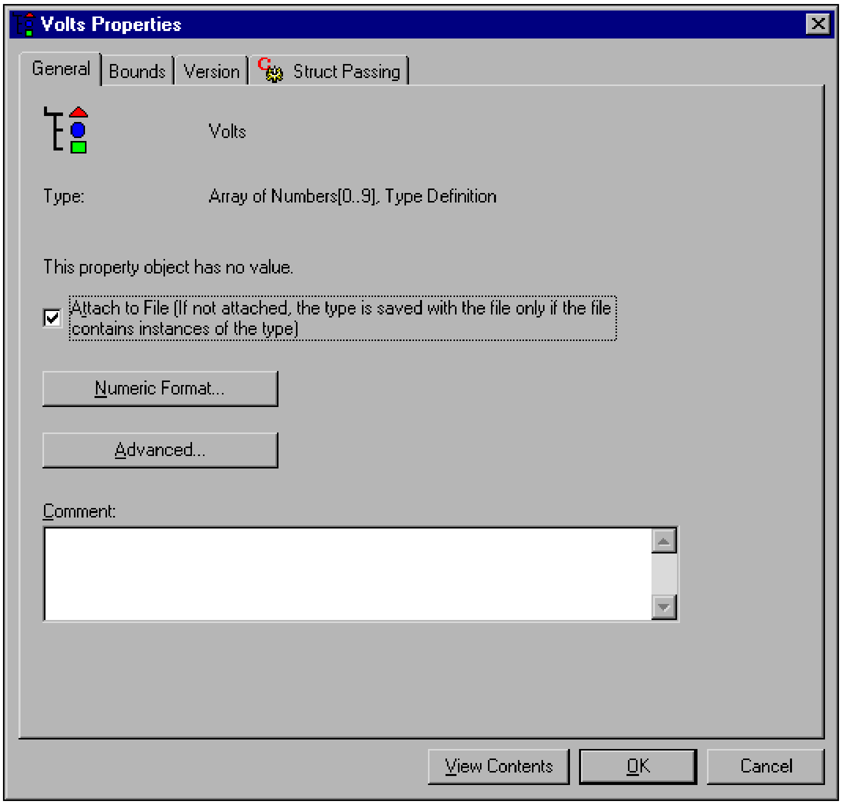
To cut, copy, paste, or rename fields, use the context menu that appears when you right click the icon for the field in the list view.

Note If you want to modify a NI installed data type, you must first enable the **Allow Editing NI Installed Types** option on the Sequence Editor Options dialog box.

Properties Dialog Box for Custom Data Types

To examine and modify the properties of an existing custom data type, access the Properties dialog box for the type. Right click the icon for the data type in the list view, and select the **Properties** item from the context menu. The contents of the Properties dialog box vary depending on the underlying data type.

Figure 9-17 shows the Properties dialog box for the `Volts` data type.



Volts

Type: Array of Numbers[0..9], Type Definition

This property object has no value.

[✓] Attach to File (If not attached, the type is saved with the file only if the file contains instances of the type)

Comment:

Figure 9-17. Properties Dialog Box for a Numeric Data Type

The data type Properties dialog box can contain the following tabs: General, Bounds, Version, or Struct Passing.

General Tab

The General tab can contain the following controls:

- **Value**—Specifies the default value that TestStand assigns to all variables, parameters, and properties you create with the data type. For variables and properties, this value is the initial value when you start execution or call the sequence. For parameters, this value is the default value if you do not pass an argument value explicitly. You can change the value in each individual variable, parameter, or property after you create it. To assign the value you specify to all existing instances of the data type, enable the **Apply Value to All Loaded Instances of the Type** option. The Value control appears for single-valued data types.

- **Attach to File**—Specifies that TestStand saves the data type in the file regardless of whether any variables, parameters, or properties in the file currently refer to it. This setting is useful when you design a data type and save the file before you create the variable, parameter, or property that uses the data type. When you create a new data type on the Custom Data Types tab or you copy an existing data type from another window onto the tab, TestStand automatically enables the **Attach to File** option for you.

  If you the disable the **Attach to File** checkbox, TestStand does not save the data type unless a variable, parameter, or property in the file refers to it. This setting is useful when, instead of creating or copying the data type explicitly, you copy a variable, parameter, or property that refers to the type from another window and the current file does not already contain the type. In this case, TestStand automatically disables the **Attach to File** option for you. If you later delete the variable, parameter, or property, TestStand also deletes the data type for you.
- **Numeric Format**—Displays the Numeric Format dialog box. For more information, refer to the *Numeric Value Formats* section in this chapter.
- **Advanced**—Displays the Edit Flags dialog box that contains the property flags that you can modify in TestStand. Refer to the *Property Flags* section in this chapter for more information.
- **Comment**—Specifies the default comment that TestStand assigns to all variables, parameters, and properties you create with the data type.

Bounds Tab

The Bounds tab appears for array data types only. Refer to the *Specifying Array Sizes* section earlier in this chapter for more information on setting the size of an array. If you have already created variables, parameters, or properties with the data type, you can change their array bounds by enabling the **Apply Bounds to All Loaded Instances of the Type** checkbox.

Version Tab

The Version tab contains controls that you can use to specify the version of a type and how TestStand resolves differences between type definitions in separate files.

- **Version**—Use this control to edit the type version number. When you edit a type, you can increment the version number so that TestStand does not prompt users to resolve the conflict between the revised type and older versions of the type that might exist in other files. When TestStand loads a file that contains a different version of a type than a currently loaded type, TestStand resolves the conflict by automatically using the type with the highest version number. Note that you cannot edit the version of NI step types.
- **Modified**—Indicates that you have edited the type since you last set its version number. Because the type no longer corresponds to the version number you assigned, TestStand always prompts the user to resolve a conflict between the type and a differing definition of the type in another file. Uncheck this control to inform TestStand that the version number is correct for the current state of the type.
- **Always Prompt User to Resolve the Conflict**—Specifies that TestStand ignores version numbers and always prompts the user to resolve conflicts between type definitions that differ.
- **Use the Definition that has the Highest Version Number**—This control specifies that TestStand automatically uses the type with the highest version number when it encounters type definitions that differ.

Struct Passing Tab

You can use the DLL adapter to pass a TestStand variable or property to a structure parameter in a code module function. The data type of the variable or property you pass must contain the all the fields that the structure parameter expects.

There are several ways to format data types fields in the in-memory representation of a structure parameter. Use the Struct Passing tab to specify how TestStand formats in memory an instance of a data type that you pass as a structure. The Struct Passing tab can contain the following controls.

- **Allow Objects of This Type to be Passed as Structs**—Enables you to pass instances of the data type to structure parameters.
- **Packing**—Select the packing options according to the development environment and compiler settings that you use to create the DLLs you call.

Visual C++ and Symantec C++ have a default of 8-byte packing. LabVIEW, Borland C++ and Watcom C++ have a default of 1-byte packing. For LabWindows/CVI, the default packing can be either 8-byte or 1-byte, depending upon its compatibility mode. For example, in Visual C++ compatibility mode, LabWindows/CVI has a default of 8-byte packing. You configure the Packing option for all data types that specify Default Adapter Packing in the DLL Flexible Prototype Adapter Configuration dialog box.

- **Property**—Use this ring to select a subproperty of the data type in order to specify its in-memory format. You also can configure the in-memory format for a data type subproperty in the properties dialog box for the subproperty.
- **Exclude When Passing Structure**—Specifies that TestStand does not include the selected subproperty in the in-memory representation of the data type.
- **Type**—Displays the data type of the selected subproperty.
- **Store Array As**—Appears for array subproperties only. This control contains the following options:
  - **Embedded Array**—The array resides within the in-memory representation of the data type.
  - **Pointer To Array**—A pointer to the array resides within the in-memory representation of the data type.
- **Store Struct As**—Appears for container subproperties only. This control contains the following options:
  - **Embedded Struct**—The structure representation of the container property resides within the in-memory representation of the data type.
  - **Pointer To Struct**—A pointer to the structure representation of the container property resides within the in-memory representation of the data type.
- **<Type Ring>**—Specifies how to format the subproperty in memory. The choices vary according to the subproperty type and are the same as the data passing options you specify for parameters in the DLL Flexible Prototype Adapter Specify Module dialog box.

Properties Dialog Box for Data Type Fields

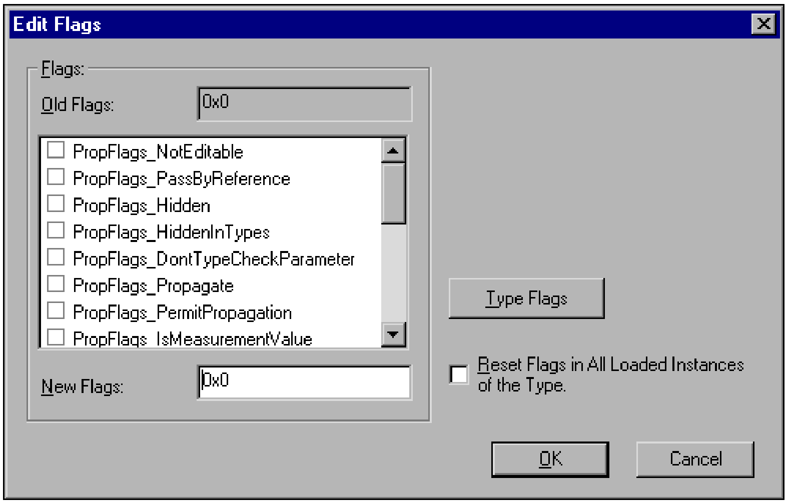
To examine and modify the properties for a field of a custom data type, access the Properties dialog box for the field. To access the fields, select the **View Contents** item from the context menu. Select the **Properties** item from the context menu for one of the fields. The Properties dialog box for a data type field is the same as the Properties dialog box for a custom data type, except for the following differences:

- The Properties dialog box for a data type field does not contain the **Attach to File** checkbox.
- The Properties dialog box for a data type field does not contain a Version tab.
- The Structure tab on the Properties dialog box for a data type field allows you to configure the in-memory format of the selected property only.

A Properties dialog box does not exist for the Value field of a data type. Instead, you can access the Modify Value dialog box. Refer to the *Value Field* section earlier in this chapter for more information on the Modify Value dialog box.

Property Flags

TestStand includes a set of property flags that you can modify. You can access the Edit Flags dialog box by clicking on the Advanced button in the Properties dialog box of a property object. Typically, you only need to configure property flags when you develop a relatively sophisticated custom step type. Figure 9-18 shows the Edit Flags dialog box.



Old Flags: 0x0

- [ ] PropFlags_NotEditable
- [ ] PropFlags_PassByReference
- [ ] PropFlags_Hidden
- [ ] PropFlags_HiddenInTypes
- [ ] PropFlags_DontTypeCheckParameter
- [ ] PropFlags_Propagate
- [ ] PropFlags_PermitPropagation
- [ ] PropFlags_IsMeasurementValue

New Flags: 0x0

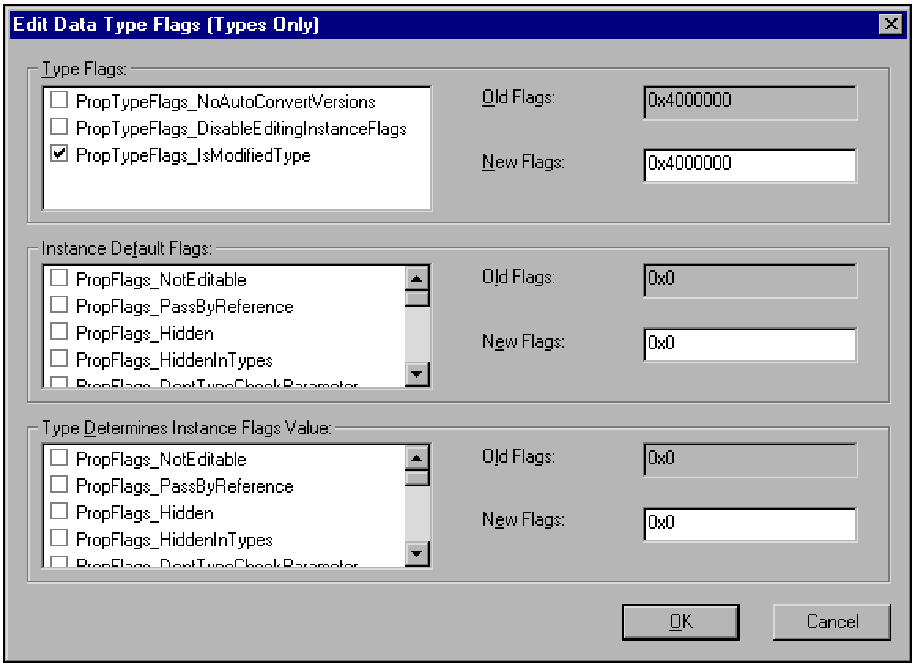
Figure 9-18. Edit Flags Dialog Box

The Edit Flags dialog box allows you to change the values of the property flags for a property object. The list of flags corresponds to the available property flag constants in the TestStand API. Checking an item in the listbox activates the corresponding flag in the object.

The **Reset Flags in All Loaded Instances of the Type** checkbox is only visible if you are editing the properties of a type definition. If you select this option and click on the **OK** button, all flags in all instances of the type will be set back to the default values that the type specifies. This option does not affect type instances that have been saved to disk and are not currently loaded.

The Property Flags represent the state of the object. You can change the state of the object by checking or unchecking its Flags in the listbox. For example, if you check an object's `PropFlags_NotEditable` flag, the object's property page becomes read-only and the object's value (if it is a string, number, etc.) cannot be changed. Each flag is a single bit in a 32-bit integer value; when you check or uncheck a flag, the New Flags control shows you what the combined hexadecimal value of all flags is after your changes. This is the same value that is returned by the API PropertyObject.GetFlags method. The Old Flags control shows the initial value of the object's flags when the dialog was first opened. You can edit the New Flags control value directly by entering a decimal or hexadecimal value. If you edit the New Flags control directly, each flag list item reflects your changes.

The **Type Flags** button is only visible from the Edit Flags dialog box when you are editing the properties of a type definition. Click on the Type Flags button to display the Edit Data Type Flags dialog box, as shown in Figure 9-19.


Edit Data Type Flags (Types Only)

Type Flags:
- ☐ PropTypeFlags_NoAutoConvertVersions
- ☐ PropTypeFlags_DisableEditingInstanceFlags
- ☑ PropTypeFlags_IsModifiedType

Old Flags: 0x4000000
New Flags: 0x4000000

Instance Default Flags:
- ☐ PropFlags_NotEditable
- ☐ PropFlags_PassByReference
- ☐ PropFlags_Hidden
- ☐ PropFlags_HiddenInTypes

Old Flags: 0x0
New Flags: 0x0

Type Determines Instance Flags Value:
- ☐ PropFlags_NotEditable
- ☐ PropFlags_PassByReference
- ☐ PropFlags_Hidden
- ☐ PropFlags_HiddenInTypes

Old Flags: 0x0
New Flags: 0x0

Figure 9-19. Edit Data Type Flags Dialog Box

The Edit Data Type Flags dialog box contains the following listboxes:

- **Type Flags**—Flags which are valid only for a property object that is a type definition. Type Flags do not exist in instances of the type.
- **Instance Default Flags**—When TestStand creates a new instance of the type, the values in this list box determine the initial flag values in the instance.
- **Type Determines Instance Flags Value**—When you set a flag in this list box, the value of the flag that the Instance Default Flags control specifies always determines the value of the flag that appears in instances of the type. In this case, type instances cannot change the value of the flag.

For a description of each of the property flag constants in the TestStand API, refer to the *Property Flags Constants* and the *PropertyObjTypeFlags Constants* topics in the *TestStand Programmer Help*.

Using Step Types

You use step types when you insert steps in the Main, Setup, and Cleanup tabs of an individual sequence view in the Sequence File window. The **Insert Step** item in the context menu displays a submenu that shows all the step types that appear in the Type Palette window or in the current sequence file. This includes step types that come with TestStand and custom step types that you create.

Figure 9-20 shows the submenu for the **Insert Step** item. The submenu includes one custom step type, `Custom Transmitter Test`.

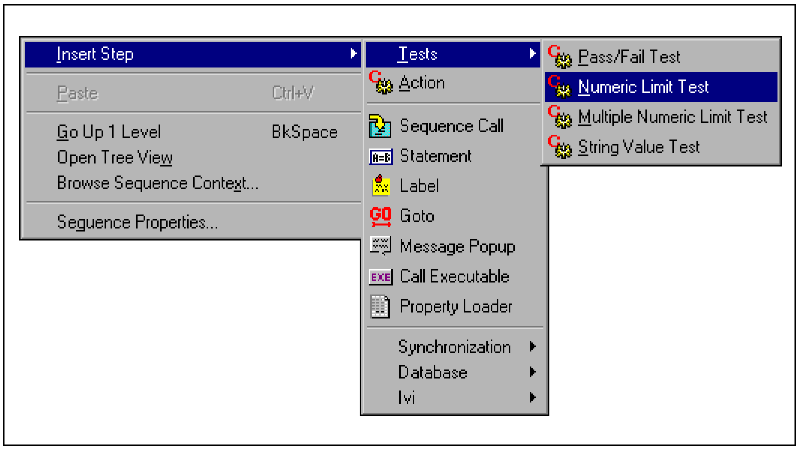


Figure 9-20. Insert Step Submenu

An icon appears to the left of each step type in the submenu. When you select a step type, TestStand displays the same icon next to the name of the new step in the list view. Many step types, such as the Pass/Fail Test and Action step types, can work with any module adapter. For these step types, the icon that appears in the submenu is the same as the icon for the module adapter that you select in the ring control on the tool bar. In Figure 9-20, the LabVIEW Standard Prototype Adapter is the current adapter, and its icon appears next to several step types, including Pass/Fail Test and Action. If you select one of these step types, TestStand uses the LabVIEW Standard Prototype Adapter for the new step.

Some step types require a particular module adapter and always use the icon for that adapter. For example, the Sequence Call step type always uses the Sequence Adapter icon. Other step types, such as Statement and Goto, do not use module adapters and have their own icons.

When you select an entry in the submenu, TestStand creates a step using the step type and module adapter that the submenu entry indicates. After you insert the step, use the context menu for the step to access the **Specify Module** item, and then specify the code module or sequence, if any, that the step calls. The **Specify Module** command displays a dialog box that is different for each adapter. The generic name for the dialog box is the Specify Module dialog box. Refer to Chapter 13, *Module Adapters*, for information on the Specify Module dialog box for each adapter. Table 9-3 shows the dialog boxes for each adapter.

Table 9-3. Adapter Dialog Box Names

Module Adapter	Name of Specify Module Dialog Box in Context
DLL Flexible Prototype Adapter	Edit DLL Call dialog box
LabVIEW Standard Prototype Adapter	Edit LabVIEW VI Call dialog box
C/CVI Standard Prototype Adapter	Edit C/CVI Module Call dialog box
Sequence Adapter	Edit Sequence Call dialog box
ActiveX Automation Adapter	Edit Automation Call dialog box
HTBasic Adapter	Edit HTBasic Subroutine Call

For each step type, other items can appear in the context menu above **Specify Module**. For example, the **Edit Limits** item appears in the context menu for Numeric Limit Test steps, and the **Edit Pass/Fail Source** item appears in the context menu for Pass/Fail Test steps. The menu item displays a dialog box in which you modify step properties that are specific to the step type. This dialog box is called a *step-type-specific* dialog box. Refer to Chapter 10, *Built-In Step Types*, for information on the menu item for each of the built-in step types.

To modify step properties that are common to all step types, use the **Properties** command in the context menu, double-click the step, or press <Enter> with the step selected. The Step Properties dialog box contains command buttons to open the Specify Module dialog box and the step-type-specific dialog boxes. Refer to Chapter 5, *Sequence Files*, for more information on the Step Properties dialog box.

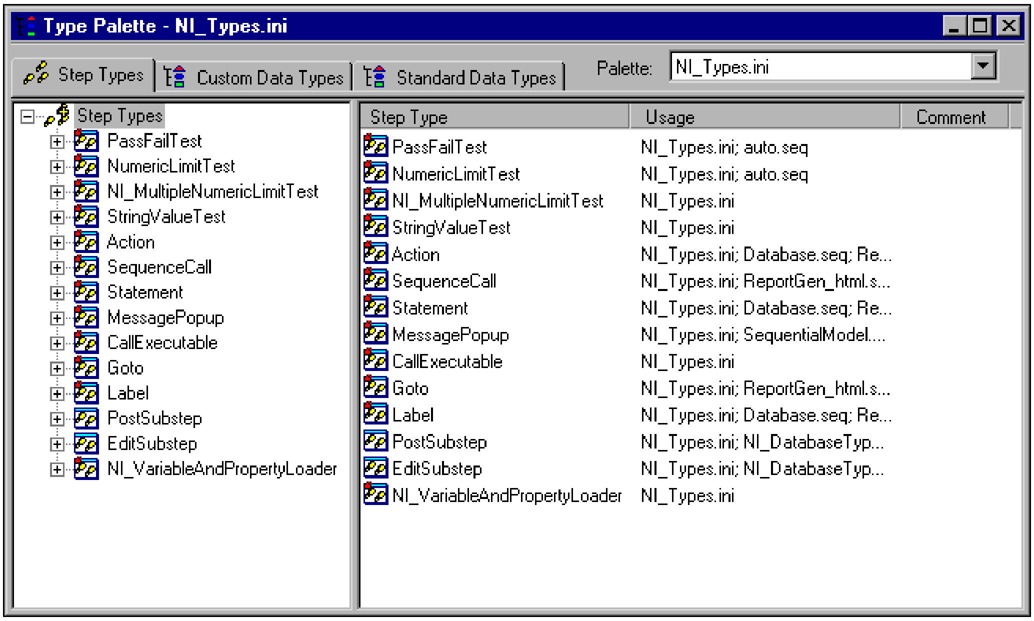
Creating and Modifying Custom Step Types

If you want to change or enhance a TestStand built-in step type, do not edit the built-in step type or any of its supporting source code modules. Instead, copy and rename a built-in step type and its supporting modules, and make the changes to the new files. This practice ensures that a newer installation of TestStand does not overwrite your customizations. It also makes it easier for you to distribute your customizations to other users.

Note When you create new step types, begin your types with a unique ID such as a company prefix. Using a unique ID will prevent name collision. For example, `NI_PropertyLoader` uses NI as a unique ID.

The Step Types tab in the Type Palette window shows all the step types in the selected type palette file. The Step Types tab in the Sequence File Types view of the Sequence File window shows only the step types that the steps in the sequence file use.

Figure 9-21 shows the Step Types tab of the Type Palette window.



Step Type	Usage	Comment
PassFailTest	NI_Types.ini; auto.seq	
NumericLimitTest	NI_Types.ini; auto.seq	
NI_MultipleNumericLimitTest	NI_Types.ini	
StringValueTest	NI_Types.ini	
Action	NI_Types.ini; Database.seq; Re...	
SequenceCall	NI_Types.ini; ReportGen_html.s...	
Statement	NI_Types.ini; Database.seq; Re...	
MessagePopup	NI_Types.ini; SequentialModel....	
CallExecutable	NI_Types.ini	
Goto	NI_Types.ini; ReportGen_html.s...	
Label	NI_Types.ini; Database.seq; Re...	
PostSubstep	NI_Types.ini; NI_DatabaseTyp...	
EditSubstep	NI_Types.ini; NI_DatabaseTyp...	
NI_VariableAndPropertyLoader	NI_Types.ini	

Figure 9-21. Step Types Tab of the Type Palette Window

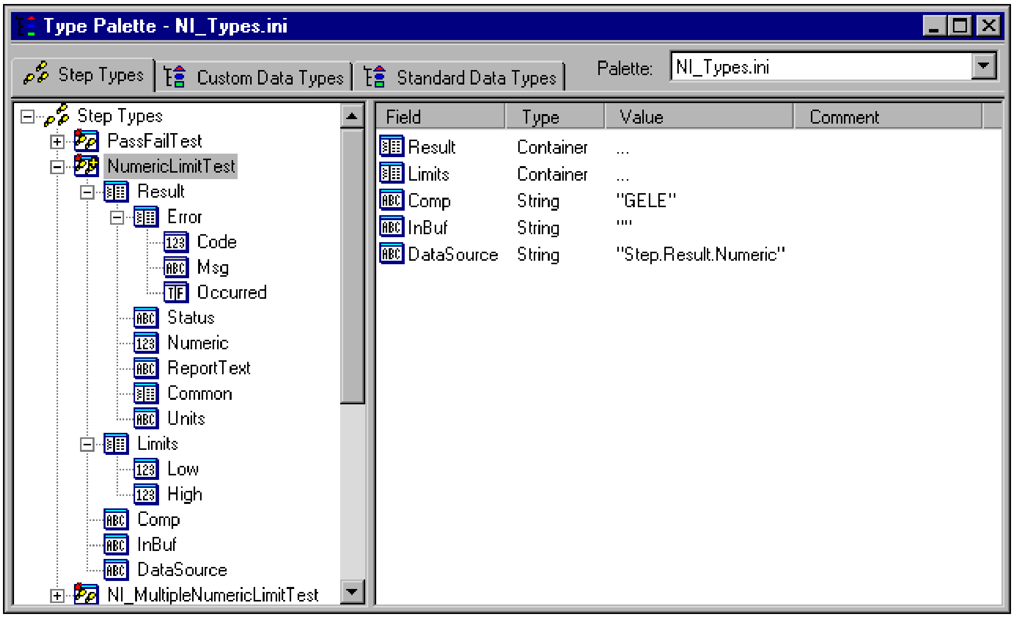
To insert a new step type, right click the background of the list view and select **Insert Step Type** item from the context menu. To copy an existing step type, select the **Copy** and **Paste** items from the context menu of the step type.

Custom Step Type Properties

You can define any number of custom properties in a step type. Each step you create with the step type has the custom properties you define.

You can open the nodes in the tree view of the Step Types tab to display all step types and their custom properties. To display the custom properties of a step type in the list view, select the node for the step type in the tree view. To display the subproperties of a custom property in the list view, select the node for the custom property in the tree view. From the list view, you display the contents of a step type or property by selecting the **View Contents** item from the context menu for the step type or property. To display the contents of the next highest level, press <Backspace> in either the tree view or the list view, or select the **Go Up 1 Level** item from the context menu in the list view background.

Figure 9-22 shows the custom properties for the Numeric Limits step.



Field	Type	Value	Comment
Result	Container	...	
Limits	Container	...	
Comp	String	"GELE"	
InBuf	String	""	
DataSource	String	"Step.Result.Numeric"	

Figure 9-22. Custom Properties of a Step Type

You add custom properties to a step type in the same way you add fields to a data type. Refer to the *Adding Fields to Data Types* section earlier in this chapter for more information.

Lifetime of Local Variables, Parameters, and Custom Step Properties

Multiple instances of a sequence can run at the same time. This situation can occur when you call a sequence recursively or when a sequence runs in multiple concurrent executions. Each instance of the sequence has its own copy of the sequence parameters, local variables, and custom properties of each step. When a sequence completes, TestStand discards the values of the parameters, local variables, and custom properties.

Built-In Step Type Properties

TestStand defines many properties that are common to all step types. These are called the built-in step type properties. Some *built-in step type properties* exist only in the step type itself. These are called *class step type properties*. TestStand uses the class properties to define how the step type works for all step instances. Step instances do not contain their own copies of the class properties.

Other built-in step type properties exist in each step instance. These are called *instance step type properties*. Each step you create with the step type has its own copy of the instance properties. TestStand uses the value you specify for an instance property in the step type as the initial value of the property in each new step you create.

Normally, after you create a step, you can change the values of its instance properties. However, when you create a custom step type, you can prevent users from changing the values of specific instance properties in the steps they create. For example, you might use the Edit substep of a step type to set the Status Expression for the step. In that case, you do not want the user to explicitly change the Status Expression value. TestStand uses this capability in some of the built-in step types, such as Numeric Limit Test and String Value Test.

To examine and modify the values of the built-in properties, select the **Properties** item from the context menu for a step type in the list view. The Step Type Properties dialog box contains the following tabs:

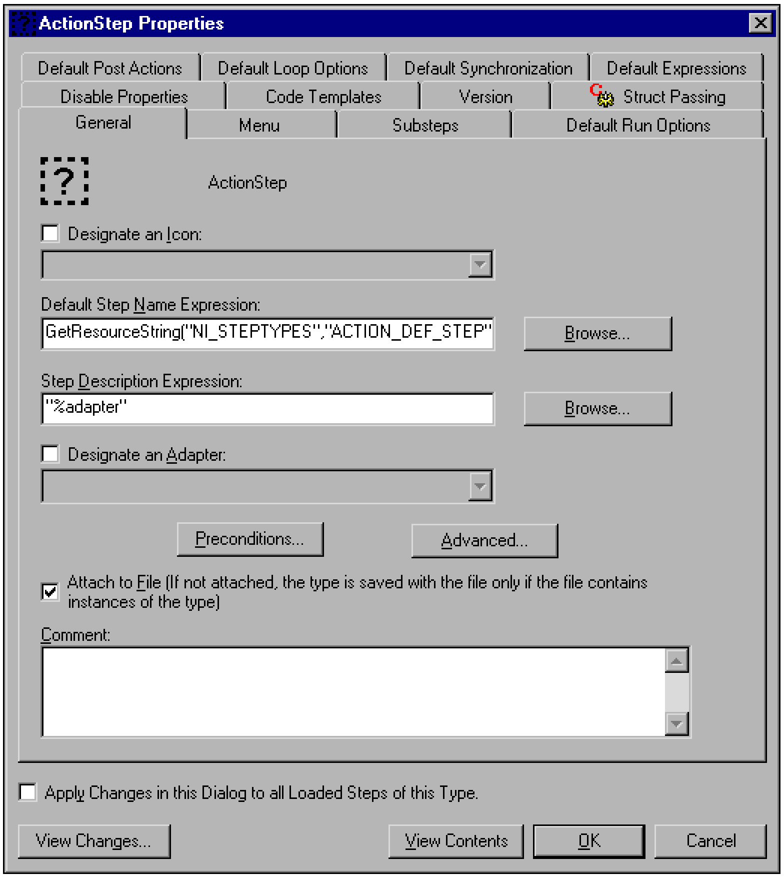
- General
- Menu
- Substeps
- Default Run Options
- Default Post Actions
- Default Loop Options
- Default Expressions
- Default Synchronization
- Disable Properties
- Code Templates
- Version
- Struct Passing

The Default Run Options, Default Post Actions, Default Loop Options, Default Expressions, and Default Synchronization tabs display instance properties. These tabs have the same appearance and behavior as the Run Options, Post Actions, Loop Options, Expressions, and Synchronization tabs of the Step Properties dialog box for a step instance. Refer to the *Step Group Context Menu* section of Chapter 5, *Sequence Files*, for more information on the Step Properties dialog box.

Most of the properties in the other tabs are class properties. This section discusses each of these tabs in detail.

General Tab

You use the General tab to specify a name, description, and comment for the step type. You also can specify an icon and a module adapter. Figure 9-23 shows the General tab of the Step Type Properties dialog box for the Action step type.



ActionStep

☐ Designate an Icon:

Default Step Name Expression: GetResourceString("NI_STEPTYPES","ACTION_DEF_STEP"

Step Description Expression: "%adapter"

☐ Designate an Adapter:

☑ Attach to File (If not attached, the type is saved with the file only if the file contains instances of the type)

Comment:

☐ Apply Changes in this Dialog to all Loaded Steps of this Type.

Figure 9-23. Step Type Properties Dialog Box—General Tab

The General tab of the Step Type properties dialog box contains the following controls:

- **Designate an Icon**—Specifies an icon for the step type. If you enable the checkbox, you can select from a list of icons that are in the `<TestStand>\Components\NI\Icons` and `<TestStand>\Components\User\Icons` directories. TestStand displays the icon next to the step names for all steps that use the step type. If you disable the checkbox, TestStand displays the icon of the module adapter for each step. If you can use any module adapter with the step type, it is best to disable the checkbox.

- **Default Step Name Expression**—Specifies a string expression that TestStand evaluates when you create a new step with the step type. TestStand uses the value of the expression as the name of the new step. If a step with the same name already exists in the sequence, TestStand appends `_Copy`*`n`* to the name to make it unique. If you want to store the name in a string resource file, you can use the `ResStr` expression function to retrieve the name from the file. Storing the name in a string resource file is useful when you want to display the name in different languages. Refer to the *Creating String Resource Files* section in Chapter 3, *Configuring and Customizing TestStand*, for more information.
- **Step Description Expression**—Specifies a string expression that TestStand evaluates whenever it displays the Description field for a step. TestStand uses the value of the expression as the contents of the Description field for the step. If you include the `%ModuleDescription` macro in a string that you surround with double quotes, TestStand replaces the `%ModuleDescription` macro with text that the module adapter provides that describes the code module that the step uses.
- **Designate an Adapter**—Specifies a single module adapter for the step type. If you enable the checkbox, all steps you create with the step type use the module adapter that you designate, regardless of the module adapter that you select in the sequence editor toolbar.

  You can choose from a list of all the TestStand module adapters. If the step type does not require a module adapter, select `<None>` from the module adapter list. When you designate a module adapter, a **Specify Module** button appears. Click the **Specify Module** button if you want to specify the module adapter call for all steps that you create with the step type.

  If you want to prevent the sequence developer from modifying the call, enable the Specify Module checkbox on the Disable Properties tab. Refer to Chapter 13, *Module Adapters*, for information on the Specify Module dialog box for each module adapter.
- **Advanced**—Displays the Edit Flags dialog box that contains the flags that you can modify in TestStand. Refer to the *Property Flags* section of this chapter for more information.

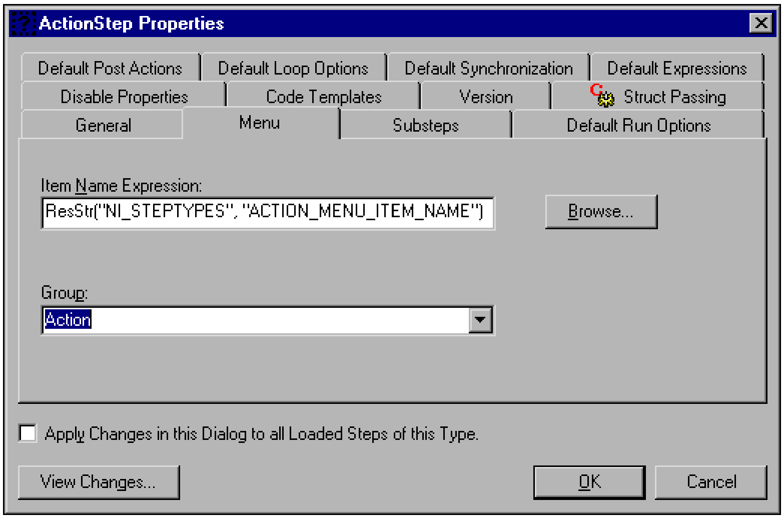
- **Attach to File**—Causes TestStand to save the step type in the file regardless of whether the file contains any steps that use the step type. When you create a new step type or copy an existing step type from another window, TestStand automatically enables the Attach to File option for you.

  Disable the Attach to File checkbox if you want TestStand to save the step type only when the file contains a step that uses it. When you copy a step that uses the step type into the sequence file and the sequence file does not already contain the step type, TestStand automatically disables the Attach to File option for you. If you later delete the step, TestStand also deletes the step type for you.
- **Comment**—Specifies text that appears in the Comment field for the step type in the list view. TestStand copies the comment into each step you create with the step type. You can change the comment for each step after you create that step.

Menu Tab

You use the Menu tab to specify the menu item name that appears for the step type in the **Insert Step** submenu. The **Insert Step** submenu appears in the context menu of individual sequence views in the Sequence File window. Use the Step Type Menu Editor to configure the organization of the **Insert Step** submenu. Refer to the *Step Type Menu Editor* section in this chapter for a description of the menu editor.

Figure 9-24 shows the Menu tab of the Step Type Properties dialog box for the Action step type.



Item Name Expression:
ResStr("NI_STEPTYPES", "ACTION_MENU_ITEM_NAME")

Group:
Action

☐ Apply Changes in this Dialog to all Loaded Steps of this Type.

Figure 9-24. Step Type Properties Dialog Box—Menu Tab

The Menu tab of the Step Type properties dialog box contains the following controls:

- **Item Name Expression**—Specifies an expression for the step type name that appears in the **Insert Step** submenu. Note that if you specify a literal string in this expression control, you must enclose it in double quotation marks. If you want to use a name from a string resource file, you can use the `ResStr` expression function to retrieve the name from the file. Refer to the *Creating String Resource Files* section in Chapter 3, *Configuring and Customizing TestStand*, for more information.
- **Group**—Indicates the Step Type menu group to which the step type belongs. Use the Step Type Menu Editor to specify the groups to which step types belong.

Substeps Tab

You use the Substeps tab to specify substeps for the step type. You use substeps to define standard actions, other than calling the step module, that TestStand performs for all instances of the step type. You implement a substep through a call to a code module. The code modules you call from substeps are called *substep modules*. The substeps for a step type define the editing and run-time behavior for all step instances of that type. For each step that uses the step type, TestStand calls the same substep modules with the same arguments. A sequence developer does not add or remove substeps or otherwise alter the step type when configuring a particular step instance. Although you can specify any number of substeps for a step type, the list of substeps is not a sequence and substeps do not have preconditions, post actions, or other execution options. The order in which pre and post substeps execute is the only execution option you specify. You can specify four categories of substeps for a step type.

TestStand calls the *Pre Step substeps* before calling the step module. You might implement a Pre Step substep to retrieve and store measurement configuration parameters into custom step properties that the step module can access.

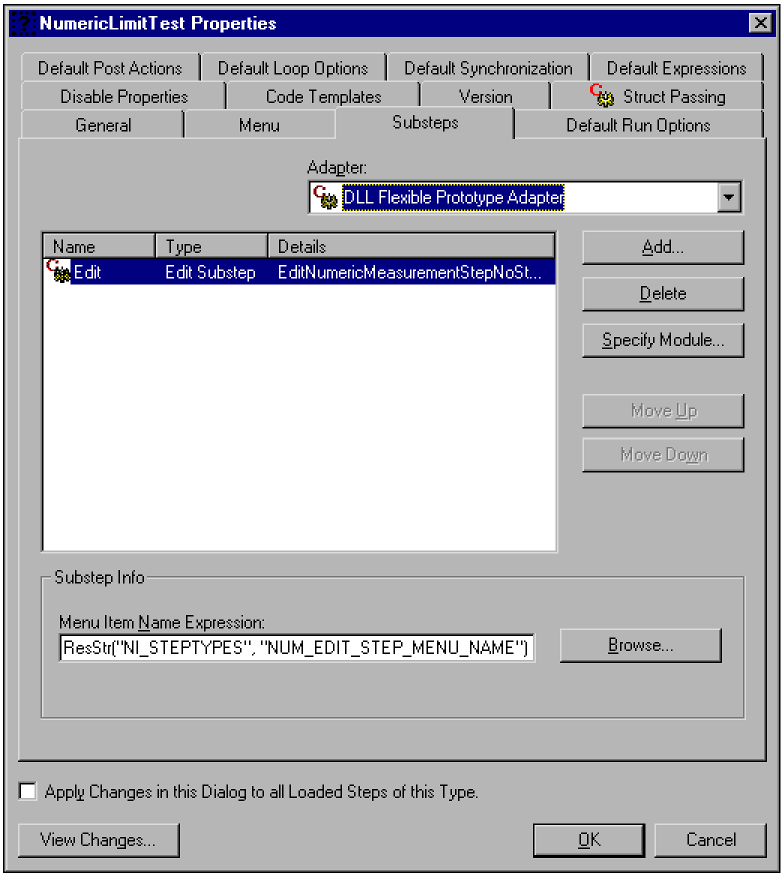
TestStand calls the *Post Step substeps* after calling the step module. You might implement a Post Step substep to compare the values that the step module stores in custom step properties against limit values that the Edit substep stores in other custom step properties.

The sequence developer can invoke the *Edit substeps* by selecting the menu items that appear above the **Specify Module** item in the context menu for the step. Usually, an Edit substep displays a dialog box in which the sequence developer edits the values of custom step properties. For example, an Edit substep might display a dialog box in which the sequence developer specifies the high and low limits for a test. The Edit substep might then store the high- and low-limit values as step properties.

Dialog boxes displayed by the specified Edit substep code module must be modal. For all dialog boxes except Microsoft Foundation Classes (MFC) dialog boxes, use the Engine.NotifyStartOfModalDialog and Engine.NotifyEndOfModalDialog methods of the TestStand API. Refer to the modal examples in `<TestStand>\Examples\ModalDialogs`.

TestStand does not call Custom substeps. You can use the TestStand API to invoke a Custom substep from a test module, operator interface, or other code module.

Figure 9-25 shows the Substeps tab of the Step Type Properties dialog box for the Numeric Limit Test step type.



Adapter: DLL Flexible Prototype Adapter

Name	Type	Details
Edit	Edit Substep	EditNumericMeasurementStepNoSt...

Substep Info

Menu Item Name Expression: ResStr("NI_STEPTYPES", "NUM_EDIT_STEP_MENU_NAME")

☐ Apply Changes in this Dialog to all Loaded Steps of this Type.

Figure 9-25. Step Type Properties Dialog Box—Substeps Tab

The Substeps tab can contain the following controls:

- **Adapter**—Specifies the adapter for the next substep you insert into the substep list.
- **<Substep List>**—Displays the substeps for the step type. Substeps of the same category always appear contiguously in the list. Use the **Move Up** and **Move Down** buttons to reorder substeps within a category. The order of the substeps in the list defines the order in which Pre and Post substeps execute and the order in which the menu items

for Edit substeps appear in the context menu of individual sequence views in the Sequence File window.

- **Add**—Displays a menu from which you select the category of substep to insert into the substep list. You can select from the following categories of substeps: Pre Substep, Post Substep, Edit Substep, and Custom Substep.
- **Delete**—Deletes the selected substep from the substep list.
- **Specify Module**—Displays the Specify Module dialog box for the selected substep in the substep list. Refer to Chapter 13, *Module Adapters*, for more information on the Specify Module dialog box for each module adapter.
- **Move Up**—Moves the selected substep up within the group of substeps of the same category in the substep list.
- **Move Down**—Moves the selected substep down within the group of substeps of the same category in the substep list.
- **Menu Item Name Expression**—Specifies the name of the menu item that invokes the Edit substep in the context menu of individual sequence views in the Sequence File window. This control appears only when you select an Edit substep in the substep list. Note that if you specify a literal string in this expression control, you must enclose it in double quotation marks. If you want to use a name from a string resource file, you can use the `ResStr` expression function to retrieve the name from the file. Refer to the *Creating String Resource Files* section in Chapter 3, *Configuring and Customizing TestStand*, for more information.

Source code is available for many of the substep modules that the built-in step types use. You can find the source code project files in the `<TestStand>\Components\NI\StepTypes` subdirectory. If you want to use existing step type source code as a starting point for your own step type, copy the files into the `<TestStand>\Components\User\StepTypes` subdirectory and use unique filenames to rename the copies.

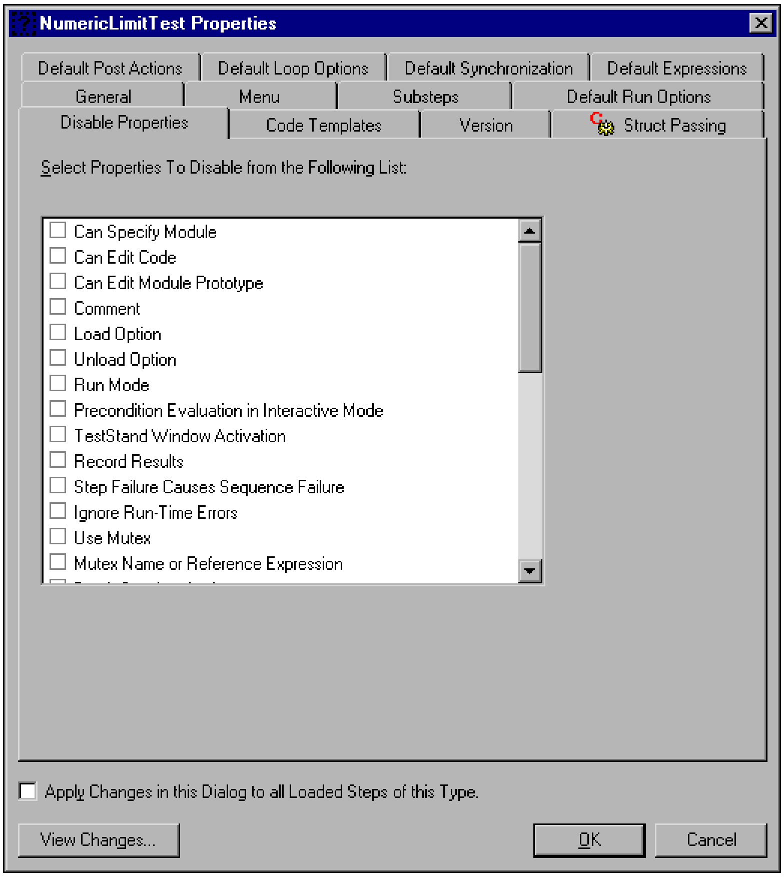
Note When TestStand calls a substep, it does not pass data through the standard structures and clusters you use with the LabVIEW and C/CVI Standard Prototype Adapters. An exception is that when a substep returns a run-time error, TestStand sets the step error properties according to contents of the output error cluster or structure. For all input cluster/structure values and for all non-error cluster/structure output values, you must use the sequence context parameter and the TestStand API to access the corresponding step properties from your substep. For adapters that do not require a standard prototype, TestStand calls substep code modules the same way it calls other code modules.

Disable Properties Tab

You can use the Disable Properties tab to prevent the sequence developer from modifying the settings of built-in instance properties in individual steps. In this way, you make the settings you specify in the Step Type Properties dialog box permanent for all step instances.

The tab contains a list of checkboxes. Each checkbox represents one built-in instance property or a group of built-in instance properties. When you enable a checkbox, you prevent the sequence developer from modifying the value of the corresponding property or group of properties.

Figure 9-26 shows the Disable Properties tab of the Step Type Properties dialog box for the Numeric Limit Test step type.



Select Properties To Disable from the Following List:

- ☐ Can Specify Module
- ☐ Can Edit Code
- ☐ Can Edit Module Prototype
- ☐ Comment
- ☐ Load Option
- ☐ Unload Option
- ☐ Run Mode
- ☐ Precondition Evaluation in Interactive Mode
- ☐ TestStand Window Activation
- ☐ Record Results
- ☐ Step Failure Causes Sequence Failure
- ☐ Ignore Run-Time Errors
- ☐ Use Mutex
- ☐ Mutex Name or Reference Expression

☐ Apply Changes in this Dialog to all Loaded Steps of this Type.

Figure 9-26. Step Type Properties Dialog Box—Disable Properties Tab

Most of the checkboxes on the Disable Properties tab apply to a specific control in the Step Properties dialog box. The following bulleted items describe two exceptions, the Specify Module checkbox and the Preconditions checkbox.

- **Specify Module**—If you enable this checkbox, the sequence developer cannot access the Specify Module dialog box on any steps that use the step type. You can enable the Specify Module checkbox for step types that always make the same module adapter call. Refer to the *General Tab* section earlier in this chapter for information on how to specify a module adapter call for a step type. For example, the checkbox is enabled for the Statement step type because Statement steps do not call code modules.

  If you uncheck the Specify Module checkbox but check the Edit Module Prototype checkbox, a sequence developer can view the Specify Module dialog box but cannot modify any of the parameter information in that dialog box.
- **Precondition**—If you check this checkbox, a sequence developer cannot edit preconditions for steps that use the step type.

Code Templates Tab

You use the Code Template tab to associate one or more code templates with the step type. A code template is a set of source files that contain skeleton code. The skeleton code serves as a starting point for the development of code modules for steps that use the step type. TestStand uses the code template when a sequence developer clicks the **Create Code** button on the Source Code tab in the Specify Module dialog box for a step.

TestStand comes with a default code template that you can use for any step type. You can customize code templates for individual step types. For the Numeric Limit Test step type, for instance, you might want to include example code for accessing the high- and low-limit properties in a step.

Templates Files for Different Adapters

Because different module adapters require different types of code modules, a code template normally consists of one or more source files for each module adapter. For the default code template, for example, TestStand comes with one `.c` file for the DLL Flexible Prototype Adapter, one `.c` file for the C/CVI Standard Prototype Adapter, and eight `.vi` files for the LabVIEW Standard Prototype Adapter. The multiple `.vi` files correspond to the different combinations of parameter options that the sequence developer can choose in the Edit LabVIEW VI Call dialog box.

TestStand uses the code template name as the name of a subdirectory in the `<TestStand>\CodeTemplates\NI` or `<TestStand>\CodeTemplates\User` directory. TestStand stores the source files for the different module adapters in the subdirectory. TestStand also stores a `.ini` file in each subdirectory. The `.ini` file contains a description string that TestStand displays for the code template. The subdirectory name for the default code template is `Default_Template`.

Code templates for the C/CVI Standard Prototype Adapter always specify two parameters: a pointer to `tTestData` structure and a pointer to a `tTestError` structure. When TestStand uses a C/CVI template module to create skeleton code, it validates the function prototype in the template module against this requirement. TestStand reports an error if the prototype is incorrect.

Code templates for the LabVIEW Standard Prototype Adapter always specify `Test Data` and `error out` clusters as parameters. The eight different `.vi` files for each LabVIEW Standard Prototype Adapter code template specify various combinations of the Input buffer, Invocation Information, and Sequence Context parameters. When TestStand uses a LabVIEW template VI to create skeleton code, it chooses the correct `.vi` file to use based on the current settings in the Optional Parameters section of the Edit LabVIEW VI Call dialog box.

Code templates for the DLL Flexible Prototype Adapter can have any number of parameters that are compatible with the data types you can specify on the Module tab of the Edit DLL Call dialog box.

When TestStand uses a code template for a DLL to create skeleton code, it compares the parameter list in the source file to the parameter information on the Module tab. If these sets of information do not match, TestStand prompts the sequence developer to select which prototype to use for the skeleton code. If the sequence developer chooses to use the prototype from the template source file, the developer also can request that TestStand update the Module tab to match the source file. However, the template source file does not contain sufficient information for TestStand to update the Value controls for the parameters on the Module tab.

You can specify entries for TestStand to place in the Value controls, as described in the *Using the Code Templates Tab* section in this chapter. TestStand stores this information in the `.ini` file in the template subdirectory.

Creating and Customizing Template Files

You use the Code Templates tab to create a new code template. TestStand prompts you to specify a subdirectory name and an existing code template as a starting point. TestStand copies the files for the existing template into the new subdirectory in the `<TestStand>\CodeTemplates\User` directory and changes the names. You must then modify the template files to customize them. If you do not intend to use a particular adapter module, you can delete the template files for those adapter modules.

You can customize the template files to include example code that helps the test developer learn how to access the important custom properties of the step. The method you use to customize the source files for a code template can vary based on the module adapter. For example, to show how to obtain the high- and low-limit properties in a LabVIEW or CVI template for a Numeric Limit Test step, you might include example calls to the `GetValNumber` method of the Property Class in the TestStand API. Although you can use the `GetValNumber` method in the template for the DLL Flexible Prototype Adapter too, you might customize the prototype for the code module by specifying the high and low limits as value parameters.

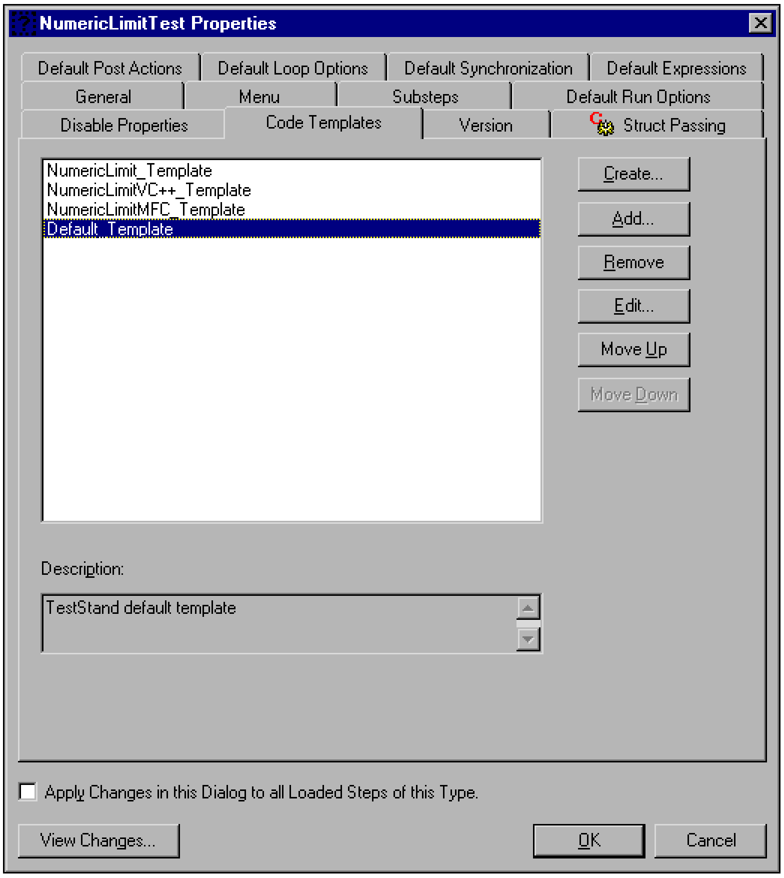
As another example, you might want to show how to return a measurement value from a code module. In a LabVIEW template, you might show how to refer to the `Numeric Measurement` element of the `Test Data` cluster. In a CVI code module, you might show how to refer to the `measurement` field in the `tTestData` structure. For the DLL Flexible Prototype Adapter, you might customize the prototype in the template by specifying the measurement as a reference parameter.

Multiple Templates Per Step Type

You can specify more than one code template for a step type. For example, you might want to have code templates that contain example code for conducting the same type of tests with different types of instruments or data acquisition boards. When a step type has multiple code templates and the sequence developer clicks the **Create Code** button in the Specify Module dialog box, TestStand prompts the sequence developer to choose from a list of templates.

Using the Code Templates Tab

Figure 9-27 shows the Code Templates tab of the Step Type Properties dialog box for the Numeric Limit Test step type.



NumericLimit_Template
NumericLimitVC++_Template
NumericLimitMFC_Template
Default_Template

Description:

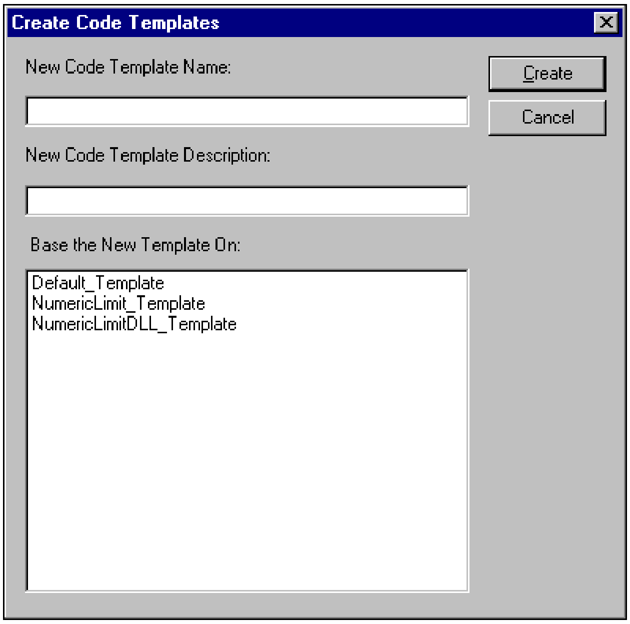
TestStand default template

Figure 9-27. Step Type Properties Dialog Box—Code Templates Tab

The list box shows the code templates that are currently associated with the step type. The Description indicator displays the description string for the currently selected code template. The following command buttons appear to the right of the list box.

- **Create**—Creates a new code template. When you click the **Create** button, the Create Code Templates dialog box appears.

Figure 9-28 shows the Create Code Templates dialog box.



Default_Template
NumericLimit_Template
NumericLimitDLL_Template

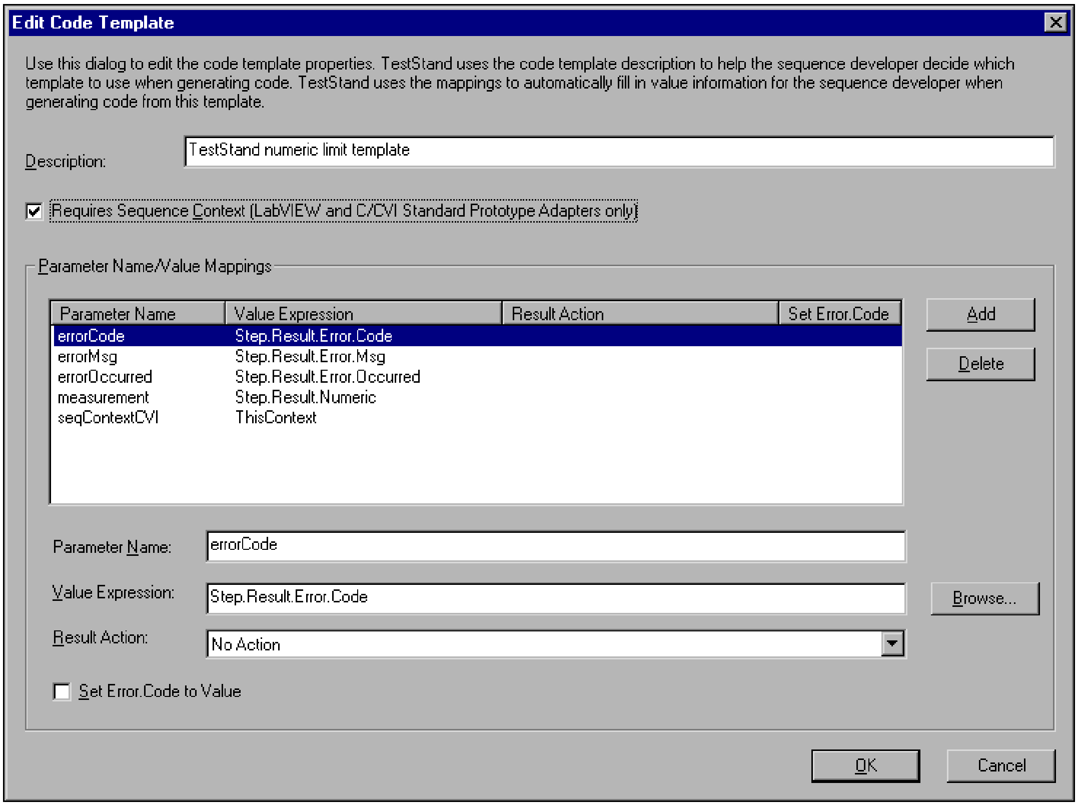
Figure 9-28. Create Code Templates Dialog Box

Enter the subdirectory name for the code template in the New Code Template Name control. Enter a brief description for the code template in the New Code Template Description control. Use the Base the New Template On list box to choose an existing code template for TestStand to copy.

- **Add**—Associates an existing code template with the step type. When you click the **Add** button, a dialog box appears in which you can select from a list of code templates. TestStand generates the list from the set of subdirectories in the `<TestStand>\CodeTemplates\NI` and `<TestStand>\CodeTemplates\User` directories. If you specify a code template that is not in the list, the code template subdirectory must be in the TestStand search directory paths. To customize the TestStand search directory paths, use the **Search Directories** command in the **Configure** menu of the sequence editor menu bar.
- **Remove**—Use this button to disassociate the currently selected code template from the step type.
- **Edit**—Use this button to modify properties of the currently selected code template. When you click the **Edit** button, the Edit Code Template dialog box appears.

- **Move Up** and **Move Down**—Changes the order of the items in the code template list. The order of the code templates in the list box is the order that TestStand uses to display the code templates in the Choose Code Template dialog box.

Figure 9-29 shows the Edit Code Template dialog box.



Use this dialog to edit the code template properties. TestStand uses the code template description to help the sequence developer decide which template to use when generating code. TestStand uses the mappings to automatically fill in value information for the sequence developer when generating code from this template.

Description: TestStand numeric limit template

[✓] Requires Sequence Context (LabVIEW and C/CVI Standard Prototype Adapters only)

Parameter Name/Value Mappings

Parameter Name	Value Expression	Result Action	Set Error.Code
errorCode	Step.Result.Error.Code		
errorMsg	Step.Result.Error.Msg		
errorOccurred	Step.Result.Error.Occurred		
measurement	Step.Result.Numeric		
seqContextCVI	ThisContext		

Parameter Name: errorCode

Value Expression: Step.Result.Error.Code

Result Action: No Action

[ ] Set Error.Code to Value

Figure 9-29. Edit Code Template Dialog Box

The Edit Code Template dialog box contains the following controls:

- **Description**—Sets the description string.
- **Require Sequence Context**—Specifies whether the code template requires that the sequence context be passed. If you check this control, TestStand completes the following step, depending on the environment the code template was created in.
  - When the sequence developer clicks the Create Code button on the Source Code tab of the Edit C/CVI Module Call dialog box,

TestStand enables the Pass Sequence Context checkbox on the Module tab.

- When the sequence developer clicks the Create VI on the Source on the Edit LabVIEW VI Call dialog box, TestStand enables the Sequence Context ActiveX Pointer checkbox.

- **Parameter Name/Value Mappings**—Specifies default parameter values to use on the Module tab of the Edit DLL Call dialog box for the DLL Flexible Prototype Adapter. TestStand applies the default parameter values when the sequence developer clicks the **Create Code** button on the Source Code tab in the Edit DLL Call dialog box.

  In a template code module for the DLL Flexible Prototype Adapter, you can access step properties and sequence variables through the TestStand API or as parameters to the code module. If you access them as parameters, the sequence developer must specify the parameter values on the Module tab of the Edit DLL Call dialog box. The values that the sequence developer must specify are usually the same for most step instances. For this reason, it can be worthwhile to specify default parameter values that TestStand inserts on the Module tab automatically when the sequence developer clicks the **Create Code** button. The Create Code button appears on the Source Code tab that is located after the Module tab.

  The following controls are available in the Parameter Name/Value Mappings section of the Edit Code Template dialog box:

  - **Add**—Inserts an empty entry at the end of the list box.
  - **Delete**—Deletes the currently selected entry in the list box.
  - **Parameter Name**—Sets the name of a parameter exactly as it will appear in the parameter list in the template code module. To specify the return value, use `%ReturnValue`.
  - **Value Expression**—Sets the expression that you want TestStand to insert into the Value control for the parameter on the Module tab of the Specify Module dialog box for the DLL Flexible Prototype Adapter, which is called the Edit DLL Call dialog box.
  - **Result Action**—Selects the value that you want to appear in the Result Action ring control of the Module tab. The sequence developer can use the ring control on the Module tab to cause TestStand to set the `Error.Occurred` step property to `True` automatically when the return value or parameter value after the call is greater than zero, less than zero, equal to zero, or not equal to zero.

- **Set Error.Code to Value**—Specifies the state, enabled or disabled, of the other Set Error.Code to Value checkbox which exists on the Module tab of the Edit DLL Call dialog box. This checkbox appears on the Module tab where you enter return values and reference parameters. Sequence developers can use this checkbox to cause TestStand to assign the return value or the output value to the `Error.Code` step property automatically.

Version Tab

The Version tab for a Step Type Properties dialog box is identical to the Version tab you use on the Properties dialog box for a custom data type. Refer to the *Version Tab* subsection of the *Properties Dialog Box for Custom Data Types* section in this chapter for a description of the Version tab.

Struct Passing Tab

The Struct Passing tab for a Step Type Properties dialog box is identical to the Struct Passing tab you use on the Properties dialog box for a custom data type. Refer to the *Struct Passing Tab* subsection of the *Properties Dialog Box for Custom Data Types* section in this chapter for a description of the Struct Passing tab.

Apply Changes to All Loaded Steps

The changes you make to step properties in the Step Type Properties dialog box affect the default property values for new step instances you create from a step type. However, you can use the **Apply Changes in this Dialog to all Loaded Steps of this Type** control to specify that the changes you make also apply to all instances of the step type that are currently in memory.

View Changes

Use the **View Changes** button to display a list of the properties you have changed since you opened the Step Properties dialog box.

View Contents

The **View Contents** command selects the tree view node for the step. You use this command to view the custom properties of the step type.

Other Step Type Editing Features

Combining Step Types

Use the **Combine With Step Type** item in the step type context menu to combine the functionality of two step types into a single new step type. Typically, you use this feature when you find that your sequences commonly use steps of two different step types together to perform an operation that would be more convenient to perform with a single step. For example, you might combine a step type that reads a measurement from a specialized instrument with the numeric limit test step type in order to read a measurement and check limits on it in a single step.

Combine With Step Type creates a new step type that has all of the custom properties and substeps that both step types define. If both step types define a property with the same name or if the value of an inherent step property conflicts, **Combine With Step Type** uses the property or value for the step from which you initiate the combining operation. **Combine With Step Type** is a step type editing tool. You must verify that the source step types do not use the same properties in conflicting ways and that the order of the substeps in the combined step type is correct for the behavior you intend.

Figure 9-30 shows the **Combine With Step Type** item in the step type context menu.

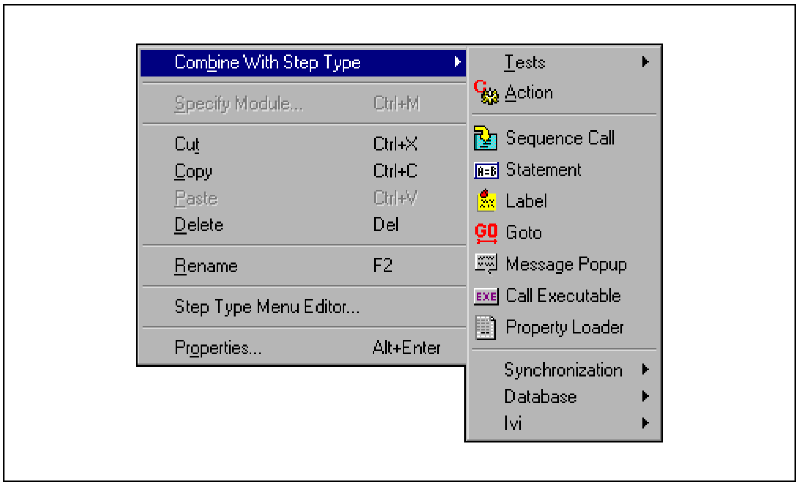
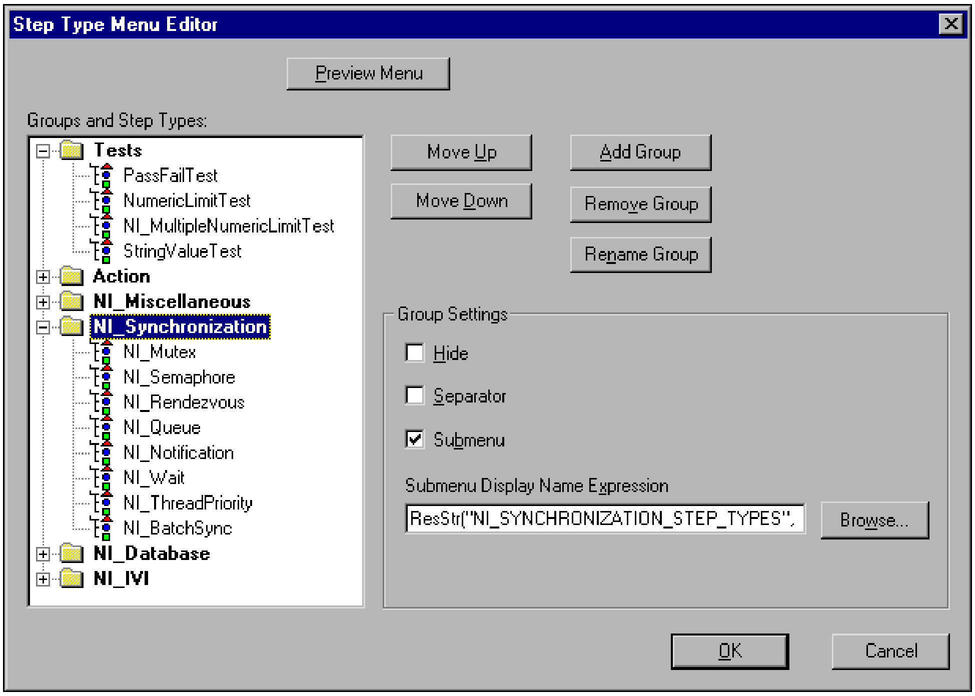


Figure 9-30. Combine with Step Type Operation

Step Type Menu Editor

TestStand allows you to use any combination of different type palette files. Step type developers can use the step type menu editor to ensure that the Insert Step submenu properly organizes the step types that their type palette files contain. To display the step type menu editor, select the Step Type Menu Editor item from the context menu in the Step Types tab. Figure 9-31 shows the step type menu editor.



Hide: ☐
Separator: ☐
Submenu: ☑
Submenu Display Name Expression: ResStr("NI_SYNCHRONIZATION_STEP_TYPES",

Figure 9-31. Step Type Menu Editor Dialog Box

The Step Type Menu Editor dialog box contains the following controls:

- **Groups and Step Types**—Contains all of the step types that appear in the menu. Steps types reside in groups, and groups appear as folders in the tree control. Groups do not appear as items in the menu. Instead, step types that reside in the same group appear together in the menu. However, you can designate that a group appears as a submenu. In this case, the contents of the group appear in a submenu within the menu. You can drag and drop Step types and groups within the tree control to change the order of appearance of the step types in the menu. When you drag an item over a group, the group highlights to indicate that you can insert the item into the group. A line between two items indicates that the item you drag can drop between the items that the line separates.

- **Preview Menu**—Displays a menu that previews the appearance of the Insert Step submenu.
- **Move Up/Move Down**—Changes the relative order of groups or step types at a particular level in the tree. Use drag and drop to change the level of an item in the tree.
- **Add Group**—Adds a new group to the bottom of the list of groups. Use drag and drop to move the group within the tree control.
- **Remove Group**—Removes the selected group. You can remove a group only if it is empty.
- **Rename Group**—Renames the selected group in the tree control. Typically, the group name does not appear in the menu. When you move a type palette file to a new system, TestStand use the group name to determine when to group step types from the new file in the same group as existing step types. Step types that specify the same group name appear together even if the step types reside in different files.
- **Group Settings/Step Type Settings**—Changes the appearance of groups or step types in the menu. Different controls appear depending on whether you select a group or a step type in the tree.
  - **Hide**—Removes the selected group or step type from the menu.
  - **Separator**—Places menu separators around the selected group.
  - **Submenu**—Causes all step types and subgroups in the selected group to appear inside a submenu.
- **Submenu Display Name Expression**—Specifies an expression that determines the name of the submenu item if the group appears as a submenu. If the expression is empty or evaluates to an empty string, the submenu name defaults to the name of the group.
- **Browse**—Click this button to browse for properties and functions to build the Submenu Display Name Expression.

Type Palette Window

You use the Type Palette window to view and edit Type Palette files. You use the Type Palette files to store the data types and step types that you want to be available in the sequence editor at all times. When you create a new type in the Sequence File Types view of a Sequence File window, the type does not appear in the **Insert Local**, **Insert Global**, **Insert Parameter**, **Insert Field**, and **Insert Step** submenus in other Sequence File windows.

To use the type in other sequence files, you can manually copy or drag the new type from one Sequence File window to another. A better approach is to copy or drag the new type to the Type Palette window or to recreate it there. Each type in a Type Palette file appears in the appropriate **Insert** submenus in all windows.

Use the Palette ring in the Type Palette window to select the type palette file that the Type Palette window displays. Figure 9-32 shows the palette ring in the Type Palette window.

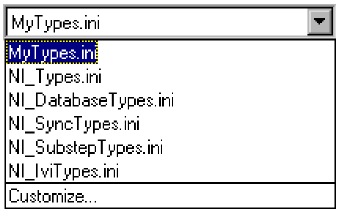


Figure 9-32. Type Palette Window—Palette Ring

When you save the contents of the Types Palette window, TestStand writes contents of all modified type palette files. Typically, type palette files reside in the `<TestStand>\Cfg\TypePalettes` directory.

Use the Customize item in the palette ring to display the Configure Type Palettes dialog box, as shown in Figure 9-33.

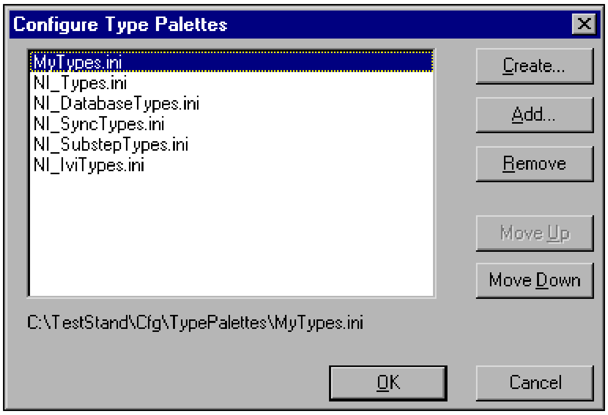


Figure 9-33. Configure Type Palettes Dialog Box

The Configure Type Palettes dialog box contains the following controls:

- **<Type Palette List>**—Displays the type palette files that TestStand loads in the order that TestStand loads them
- **Create**—Creates a new type palette file.
- **Add**—Adds an existing type palette file to the list.
- **Remove**—Removes the selected file from the list.
- **Move Up/Move Down**—Change the order of the type palette files in the list.

You can distribute step types and data types you create to other machines by installing your type palette file to the `<TestStand>\Cfg\TypePalettes\` directory. You must prefix the file names of the type palettes you install with `Install_`. At startup, TestStand searches the `TypePalettes` directory for type palette files with the `Install_` prefix. When TestStand finds a palette file to install whose base file name is not the same as any existing palette, TestStand removes the `Install_` prefix and adds the palette to the palette list. When TestStand finds a palette file to install whose base file name is the same as an existing palette, TestStand merges the types from the install file into the existing palette file and then deletes the install file.

The Type Palette window contains tabs that display the step types, custom data types, and standard data types in the selected type palette file. Typically, you create new types in the `MyTypes.ini` type palette file or in a new type palette file that you create.

Note You can manually copy a type from the Sequence File Types view to a Type palette.

Remember the following tasks when you create new step types in the Type palette:

1. Specify the menu item name for a step type on the Menu tab of the step properties dialog box.
2. Specify the default name for new steps you create from your type and the description expression for these steps in the General tab of the step properties dialog box.
3. Specify the menu item name (and button name) that invoke the editing dialog box you (optionally) define for your step type in the Edit Step section of the Substeps tab on the step properties dialog box.

The Type Palette window contains tabs for step types, custom data types, and standard data types. After you install TestStand, the Step Types tab displays all the built-in step types, the Custom Data Types tab is empty, and the Standard Data Types tab contains several standard data types.

Table 9-4. Creation of Types

Creation Site	Where TestStand Stores the Type	Purpose
Type palette	Type palette	Makes the type available to any Sequence File in the TestStand development environment
Sequence File Types view	Sequence file	Makes the type available in the sequence file, even when you move the file to another computer

Note You can manually copy a type from the Sequence File Types view to a Type palette.

10 Built-In Step Types

This chapter describes the core set of built-in step types that TestStand provides. First, the chapter discusses properties and features that all the built-in step types share. Next, the chapter describes the functionality of each of the core step types. The chapter groups the step type descriptions into the following categories:

- Step types that you can use with any module adapter. Step types such as the Numeric Limit Test and the String Value Test call any code module you specify. They also might perform additional actions such as comparing a value the code module returns with limits you specify.
- Step types that always use a specific module adapter to call code modules. The Sequence Call is the only step type in this category.
- Step types that perform a specific action and do not require you to write a code module. Step types such as the MessagePopup and the Statement perform an action that you configure in an editing dialog box that is specific to the step type.

Note TestStand also includes sets of application-specific step types. For example, TestStand provides sets of step types that make it easier control IVI instruments, to synchronize multiple threads, and to access databases. For more information on these step types, refer to the following sources: `<TestStand>\Doc\IVIStepTypes.pdf`, Chapter 11, *Synchronization Step Types*, and Chapter 18, *Databases*.

Overview

This section describes general features of built-in step types.

Custom Properties That Are Common to All Built-In Step Types

Each step type defines its own set of custom properties. All steps that use the same step type have the same set of custom properties.

All built-in step types contain certain custom properties. Figure 10-1 shows the custom step properties that all built-in step types have.

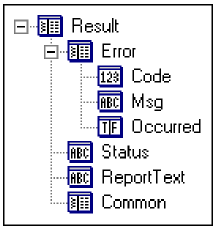


Figure 10-1. Properties That All Steps Contain

The common custom step properties are the following:

- `Step.Result.Error.Occurred` is a Boolean flag that indicates whether a run-time error occurred in the step. TestStand documentation refers to this property as the *error occurred flag*.
- `Step.Result.Error.Code` is a code that describes the error that occurred.
- `Step.Result.Error.Msg` is a message string that describes the error that occurred.
- `Step.Result.Status` specifies the status of the last execution of the step, such as `Done`, `Passed`, `Failed`, `Skipped`, or `Error`. TestStand documentation refers to this property as the *step status*.
- `Step.Result.Common` is a placeholder container that you can customize. To customize the container you modify the `CommonResults` standard data type. Refer to the *Using Data Types* section in Chapter 9, *Types*, for more information on standard TestStand data types.
- `Step.Result.ReportText` contains a message string that TestStand includes in the report. You can set the value of the message string directly in the code module. In the C/CVI and LabVIEW module adapters, code modules can set this property by modifying the corresponding member of the test data structure or cluster. Refer to Chapter 13, *Module Adapters*, for more information on the property assignments that the module adapters automatically perform to and from step properties.

Step Status, Error Occurred Flag, and Run-Time Errors

The error occurred flag can become `True` in the following situations:

- A run-time error condition occurs, and the code module sets the value to `True`.
- An exception occurs in the code module or at any other time during step execution.

When a step finishes execution and the error occurred flag is `True`, the Test Stand engine responds as follows:

- Makes no evaluation of post and status expressions for a step. Instead, TestStand sets the step status to `Error`.
- Evaluates the Ignore Run-time Errors step property.
  - If `False`, TestStand reports the run-time error to the sequence.
  - If `True`, TestStand continues execution normally after the step.

Before TestStand executes a step, it sets the step status to `Running` or `Looping`. When a step finishes execution and the error occurred flag is `False`, the TestStand engine responds as follows: when the step status is still `Looping` or `Running`, TestStand changes the step status to `Done`.

The step status becomes `Passed` or `Failed` only when a code module, a module adapter, or a step type explicitly sets the step status to `Passed` or `Failed`.

Refer to Chapter 13, *Module Adapters*, for more information on the assignments that module adapters make to and from step properties.

Customizing Built-In Step Types

If you want to change or enhance a TestStand built-in step type, do not edit the built-in step type or any of its supporting source code modules. Instead, copy and rename the built-in step type and any supporting modules, and make the changes to these copies. This practice ensures that a newer installation of TestStand does not overwrite your customizations.

Source code is available for the code modules that the built-in step types use as substeps. You find the source code project files in the `<TestStand>\Components\NI\StepTypes` subdirectory. If you use these source files as a starting point for step types you create, make your own copies of these files in the `<TestStand>\Components\User\StepTypes` subdirectory and rename them.

Step Types That You Can Use with Any Module Adapter

TestStand comes with four built-in step types that you can use with any module adapter: Action, Pass/Fail Test, Numeric Limit Test, and String Value Test. When you insert a step in a sequence, TestStand binds the step to the adapter that you select in the ring control on the sequence editor toolbar. The icon for the adapter appears as the icon for the step. The icons for the different adapters are as follows:

DLL Flexible Prototype Adapter

C/CVI Standard Prototype Adapter

LabVIEW Standard Prototype Adapter

Sequence Adapter

ActiveX Automation Adapter

HTBasic Adapter

<None>

If you choose <None> for adapter, the step does not call a code module.

To specify the code module that the step calls, you select the **Specify Module** item from the step context menu or the **Specify Module** button on the Step Properties dialog box. Each step has a Specify Module dialog box that corresponds to its module adapter. Refer to Chapter 13, *Module Adapters*, for more information on the Specify Module dialog box for each module adapter.

Action

You usually use Action steps to call code modules that do not perform tests but, instead, perform actions necessary for testing, such as initializing an instrument. By default, Action steps do not pass or fail. The step type does not modify the step status. Thus, the status for an Action step is `Done` or `Error` unless your code module specifically sets another status for the step or the step calls a subsequence that fails. When an action uses the Sequence Adapter to call a subsequence and the subsequence fails, the sequence adapter sets the status of the step to `Failed`.

The Action step type does not define any additional step properties other than the custom properties that all steps contain.

Pass/Fail Test

You usually use a Pass/Fail Test step to call a code module that makes its own pass/fail determination.

After the code module executes, the Pass/Fail Test step type evaluates the `Step.Result.PassFail` property. If `Step.Result.PassFail` is `True`, the step type sets the step status to `Passed`. Otherwise, it sets the step status to `Failed`.

The following are the different ways that a code module can set the value of `Step.Result.PassFail`:

- Use the TestStand API to set the value of `Step.Result.PassFail` directly in a code module.
- Pass `Step.Result.PassFail` as a reference parameter to a subsequence or code module if you use the Sequence Adapter, the DLL Flexible Prototype Adapter, or the ActiveX Automation Adapter.
- The C/CVI and LabVIEW module adapters update the value of `Step.Result.PassFail` automatically after calling the code module. The C/CVI module adapter updates the value of `Step.Result.PassFail` based on the value of the `result` field of the `tTestData` parameter that it passes to the C function. The LabVIEW module adapter updates the value of `Step.Result.PassFail` based on the value of `Pass/Fail Flag` in the `TestData` cluster that it passes to the VI. Refer to Chapter 13, *Module Adapters*, for more information on the assignments that module adapters make to and from step properties.

By default, the step type uses the value of the `Step.Result.PassFail` Boolean property to determine whether the step passes or fails. To customize the Boolean expression that determines whether the step passes, select the **Edit Pass/Fail Source** item in the context menu for the step or the **Edit Pass/Fail Source** button on the Step Properties dialog box. Figure 10-2 shows the Edit Pass/Fail Source dialog box.

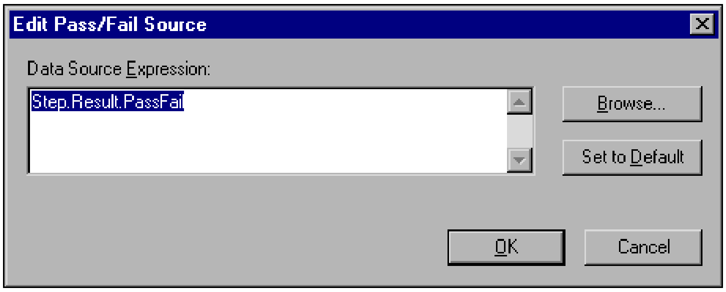


Figure 10-2. Edit Pass/Fail Source Dialog Box

Figure 10-3 shows the step properties for the Pass/Fail Test step type.

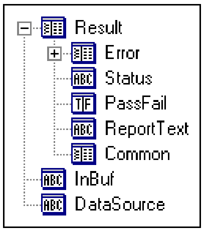


Figure 10-3. Pass/Fail Test Step Properties

The Pass/Fail Test step type defines the following step properties and the common custom properties.

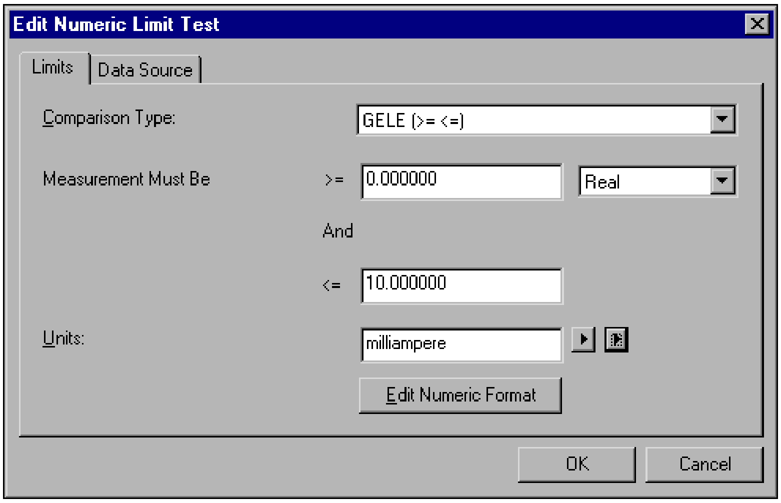
- `Step.Result.PassFail` specifies the Boolean pass/fail flag. Pass is `True`, Fail is `False`. Usually, you set this value in the step module or with a custom pass/fail source expression.
- `Step.InBuf` specifies an arbitrary string that the C/CVI and LabVIEW module adapters pass to the test in the `tTestData` structure or `TestData` cluster automatically. This property exists to maintain compatibility with previous test executives. Usually, code modules you develop for TestStand receive data as input parameters or access data as properties using the TestStand API.
- `Step.DataSource` specifies the Boolean expression that the step uses to set the value of `Step.Result.PassFail`. The default value of the expression is `"Step.Result.PassFail"`, which has the effect of using the value that the code module sets. You can customize this expression if you do not want to set the value of `Step.Result.PassFail` in the code module. For example, you can set the data source expression to refer to multiple variables and properties, such as, `RunState.PreviousStep.Result.Numeric * Locals.Attenuation > 12`.

Numeric Limit Test

You usually use a Numeric Limit Test step to call a code module that returns a single measurement value. After the code module executes, the Numeric Limit Test step type compares the measurement value to predefined limits. If the measurement value is within the bounds of the limits, the step type sets the step status to `Passed`. Otherwise, it sets the step status to `Failed`.

To customize the type of comparison and limits that TestStand uses to set the step status, select the **Edit Limits** item from the step context menu or click the **Edit Limits** button on the Step Properties dialog box.

Figure 10-4 shows the Limits tab on the Edit Numeric Limit Test dialog box.



Comparison Type: GELE (>= <=)

Measurement Must Be >= 0.000000 Real

And

<= 10.000000

Units: milliampere

Figure 10-4. Limits Tab in Edit Numeric Limit Test Dialog Box

The Comparison Type ring control on the Limits tab specifies the type of comparison the step type performs, if any, to determine the step status. Table 10-1 lists the available comparison types.

Table 10-1. Numeric Limit Test Comparison Types

Type	Description
`EQ`	Numeric Measurement = Low Limit
`NE`	Numeric Measurement != Low Limit

Table 10-1. Numeric Limit Test Comparison Types (Continued)

Type	Description
`GT`	Numeric Measurement > Low Limit
`LT`	Numeric Measurement < Low Limit
`GE`	Numeric Measurement >= Low Limit
`LE`	Numeric Measurement <= Low Limit
`GTLT`	Numeric Measurement > Low Limit and < High Limit
`GELE`	Numeric Measurement >= Low Limit and <= High Limit
`GELT`	Numeric Measurement >= Low Limit and < High Limit
`GTLE`	Numeric Measurement > Low Limit and <= High Limit
`No Comparison`	TestStand makes no Pass/Fail determination, and sets the status to Passed automatically.

Depending on the setting of the Comparison Type ring control, the dialog box displays additional controls in which you enter high and low limits. You can choose to display the limit values in real, integer, unsigned integer, hexadecimal, octal, or binary formats. Click the Edit Numeric Format button to display a dialog box in which you can further customize the format with which to display the limit values. The format you specify also controls the format of the limit and the measurement values in the report. Refer to the *Numeric Value Formats* section in Chapter 9, *Types*, for a description of the numeric format dialog box.

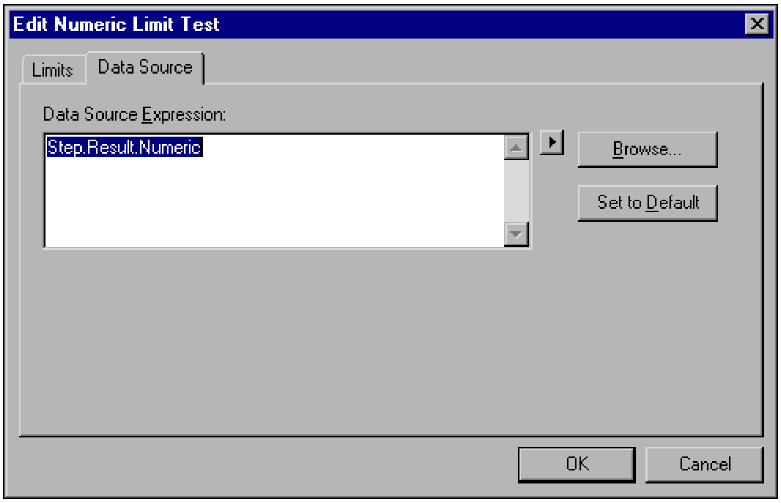
Use the Units control to specify a label that describes the measurement units for the limits and the value for which the step checks limits. The units you specify appear in both the report and the result database. The units and units prefix are for display and documentation purposes and do not scale the measured value or affect the limit comparison. Use the drop-down rings adjacent to the units control to select standard units and prefixes. Select the Short Name item in each ring to toggle between the long and short names for a unit or prefix.

Note The `<TestStand>\Components\NI\Language\<Language>\Units.ini` file defines the units and prefixes available in the drop-down rings. To redefine the units that the rings provide, edit a copy of this file that you create in `<TestStand>\Components\User\Language\<Language>\Units.ini`.

A Numeric Limit Test step uses the `Step.Result.Numeric` property to store the measurement value. A code module can set the value of `Step.Result.Numeric` in the following ways:

- Use the TestStand API to set the value of `Step.Result.Numeric` directly in a code module.
- Pass `Step.Result.Numeric` as a reference parameter to a module you call with the Sequence Adapter, the DLL Flexible Prototype Adapter, or the ActiveX Automation Adapter.
- The C/CVI and LabVIEW module adapters update the value of `Step.Result.Numeric` automatically after calling the code module. The C/CVI module adapter updates the value of `Step.Result.Numeric` based on the value of the `measurement` field of the `tTestData` parameter that it passes to the C function. The LabVIEW module adapter updates the value of `Step.Result.Numeric` based on the value of `Numeric Measurement` in the `TestData` cluster that it passes to the VI. Refer to Chapter 13, *Module Adapters*, for more information on the assignments that the module adapters automatically makes to and from step properties.

By default, the step type uses the value of the `Step.Result.Numeric` property as the numeric measurement to compare the limits against. To customize the numeric expression that specifies the measurement data source, you access the Data Source tab of the Edit Numeric Limit Test dialog box shown in Figure 10-5.



Data Source Expression: Step.Result.Numeric

Figure 10-5. Data Source Tab in the Edit Numeric Limit Test Dialog Box

You can use the drop-down ring to the right of the Data Source Expression control to quickly select measurement values in local variables or properties of previous steps.

Figure 10-6 shows the step properties for the Numeric Limit Test step type.

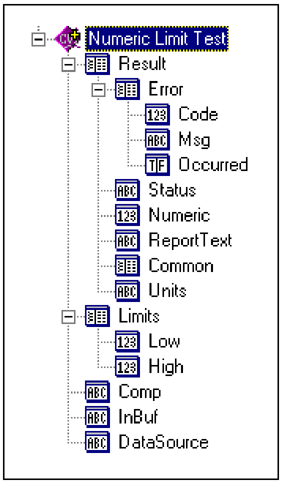


Figure 10-6. Numeric Limit Test Step Properties

The Numeric Limit Test step type defines the following step properties in addition to the common custom properties.

- `Step.Result.Numeric` specifies the numeric measurement value. Usually, you set this value in the step module.
- `Step.Limits.High` and `Step.Limits.Low` specify the limits for the comparison expression.
- `Step.Comp` specifies the type of comparison, for example, `EQ`.
- `Step.Result.Units` specifies a label that indicates the unit of measurement.
- `Step.InBuf` specifies an arbitrary string that the C/CVI and LabVIEW module adapters pass to the test in the `tTestData` structure or `TestData` cluster automatically. This property exists to maintain compatibility with previous test executives. Usually, code modules that you develop for TestStand receive data as input parameters or access data as properties using the TestStand API.

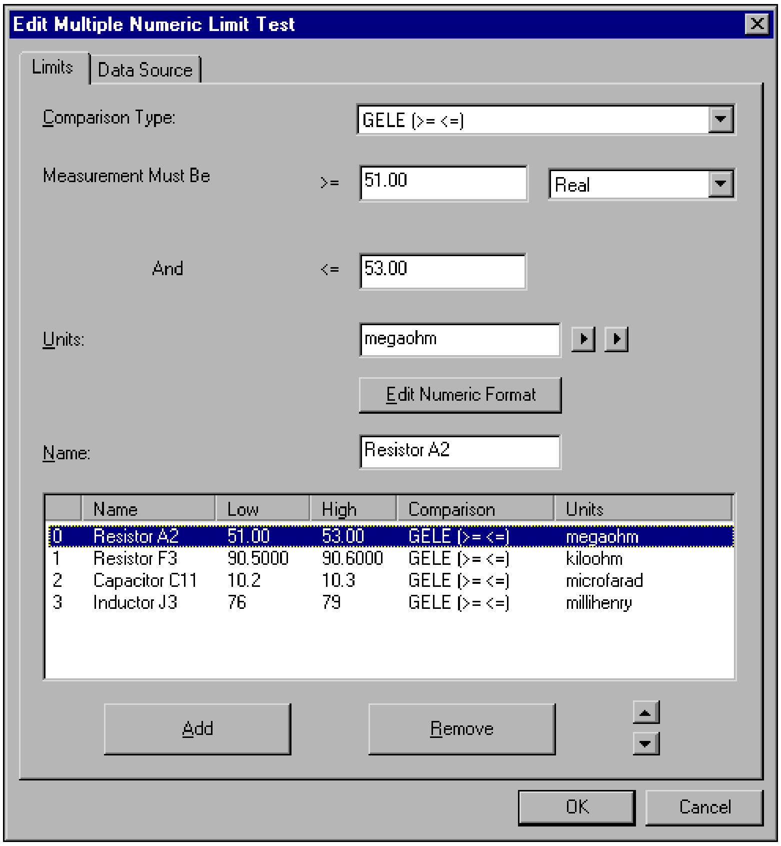
- `Step.DataSource` specifies a numeric expression that the step type uses to set the value of `Step.Result.Numeric`. The default value of the expression is `"Step.Result.Numeric"`, which has the effect of using the value that the code module sets. You can customize this expression if you do not want to set the value of `Step.Result.Numeric` in the code module.

You can use a Numeric Limit Test without a code module. This practice is useful when you want to limit-check a value that you already have acquired. To set up this limit-check, select `<None>` as the module adapter before you insert the step in the sequence, and configure `Step.DataSource` to specify the value that you already have acquired.

Multiple Numeric Limit Test

Use the Multiple Numeric Limit Test to limit check a set of related measurements. Although you can use several Numeric Limit Test steps to limit test a set of related measurements, it can be easier to use the Multiple Numeric Limit Test step type to check limits for multiple measurements in a single step.

The Multiple Numeric Limit Test allows you to test limits for any number of measurements. Each measurement can have independent limits, units, display format, data source, and comparison type. You configure each measurement the same way you configure an individual numeric limit test step. A multiple numeric limit test step passes if all of its measurements pass. Figure 10-7 shows the editing dialog box for a multiple numeric limit test.



Comparison Type: GELE (>= <=)

Measurement Must Be >= 51.00 Real

And <= 53.00

Units: megaohm

Name: Resistor A2

	Name	Low	High	Comparison	Units
0	Resistor A2	51.00	53.00	GELE (>= <=)	megaohm
1	Resistor F3	90.5000	90.6000	GELE (>= <=)	kiloohm
2	Capacitor C11	10.2	10.3	GELE (>= <=)	microfarad
3	Inductor J3	76	79	GELE (>= <=)	millihenry

Figure 10-7. Edit Multiple Numeric Limit Test Dialog Box

Figure 10-8 shows the multiple numeric limit test properties.

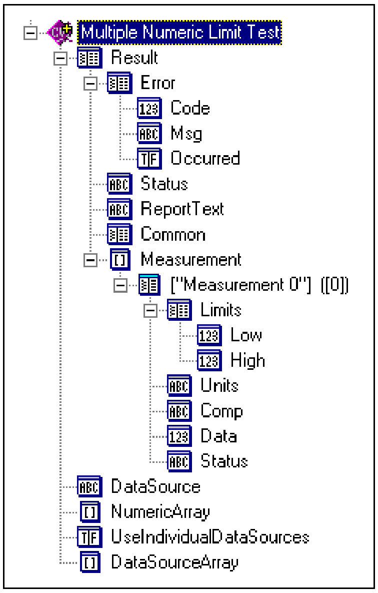


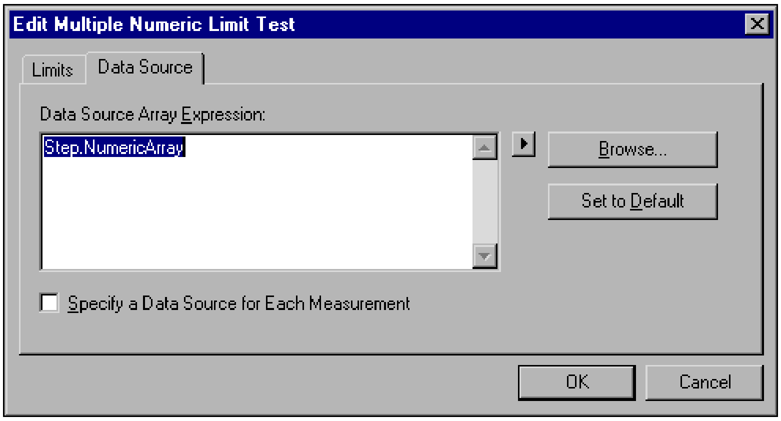
Figure 10-8. Multiple Numeric Limit Test Properties

The Multiple Numeric Limit Test step type defines the following step properties in addition to the common custom properties.

- `Step.Result.Measurement` is an array that stores the measurements you configure for the step. Each element of the measurement array is an instance of the NI_LimitMeasurement data type. The NI_LimitMeasurement type defines the following fields:
  - `Limits.High` and `Limits.Low` specify the limits to which the step compares the measurement value.
  - `Units` specifies a label that describes the measurement units for the limits and the measurement value.
  - `Comp` specifies the type of comparison, for example, EQ.
  - `Data` stores the numeric measurement value. The step obtains this value from the corresponding element in `Step.NumericArray` or from the data source you specify.
  - `Status` stores the result of the comparison of the measurement value with the limits. The result is either `Passed` or `Failed`.
- `Step.DataSource` specifies an expression that identifies the numeric array that provides the data values for all measurements, when you do not use a separate data source for each measurement.

- `Step.NumericArray` provides a numeric array that is the default data source that `Step.DataSource` specifies.
- `Step.UseIndividualDataSources` specifies whether the step stores separate data source expressions for each measurement in the `Step.DataSourceArray`. If this property is `False`, the step obtains the data values for each measurement from the numeric array that the `Step.DataSource` property specifies.
- `Step.DataSourceArray` specifies a data source for each measurement element in the measurement array

Use the Data Source tab on the Edit Multiple Numeric Limit Test dialog box to specify the data source for each measurement you configure. By default, the data source is the numeric array property Step.NumericArray. The code module the step calls can return multiple measurement values in one operation by setting the value of the Step.NumericArray property. You also can specify an alternate numeric array from which the step obtains the measurement values. Figure 10-9 shows the Data Source tab.

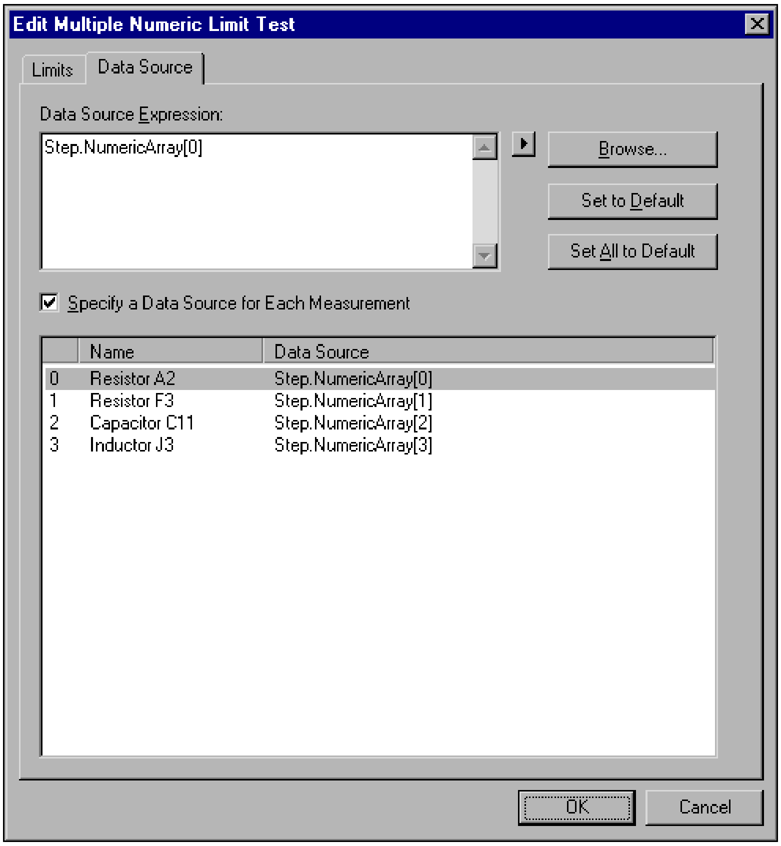


Data Source Array Expression: Step.NumericArray

☐ Specify a Data Source for Each Measurement

Figure 10-9. Multiple Numeric Limit TestData Source Tab with Array Data Source

If you select the **Specify a Data Source for Each Measurement** option, the Data Source tab shows the list of measurements. Use the Data Source Expression control to specify the data source for the selected measurement. For each measurement, you typically specify values or combinations of values that you already store in variable or property values. In this case, you do not call a code module because you are checking the limits of existing measurement values.



Step.NumericArray[0]

[✓] Specify a Data Source for Each Measurement

	Name	Data Source
0	Resistor A2	Step.NumericArray[0]
1	Resistor F3	Step.NumericArray[1]
2	Capacitor C11	Step.NumericArray[2]
3	Inductor J3	Step.NumericArray[3]

Figure 10-10. Multiple Numeric Limit TestData Source Tab with Multiple Data Sources

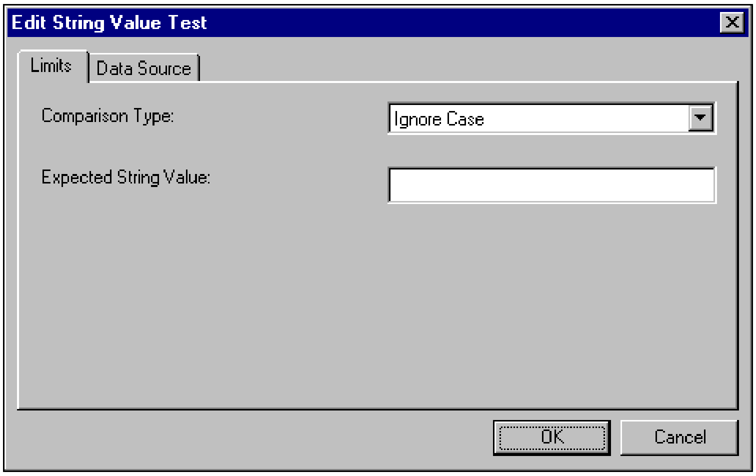
You can use the dropdown ring to the right of the Data Source Expression control to quickly select measurement values in local variables or properties of previous steps.

String Value Test

You usually use a String Value Test step to call a code module that returns a string value. After the code module executes, the String Value Test step type compares the string that the step obtains to the string that the step expects to receive. If the string that the step obtains matches the string that it expects, the step type sets the step status to `Passed`. Otherwise, it sets the step status to `Failed`.

You can specify the type of comparison that TestStand uses to set the step status. You also can specify the string that the step expects to receive. To do so, select the **Edit Expected String** item in the context menu for the step or the **Edit Expected String** button in the Step Properties dialog box.

Figure 10-11 shows the Limits tab on the Edit String Value Test dialog box.



Comparison Type: Ignore Case

Expected String Value:

Figure 10-11. Limits Tab in the Edit String Value Test Dialog Box

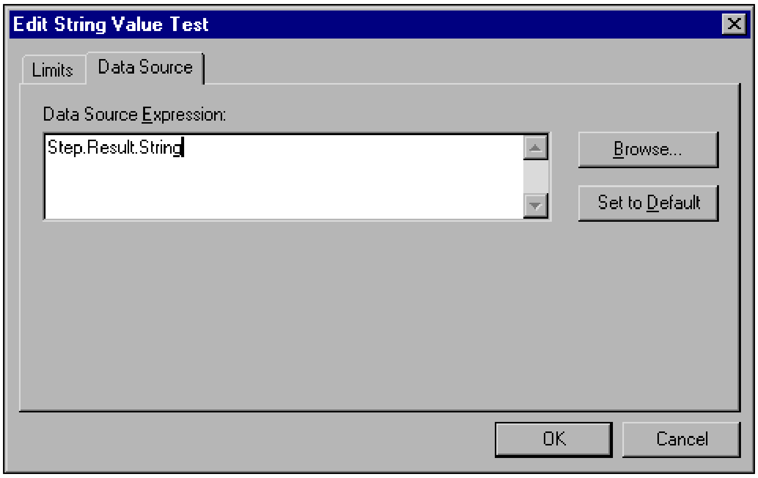
On the Limits tab, you can specify the expected string and whether the string comparison is case-sensitive.

A String Value Test step always uses the `Step.Result.String` property to store the string value. A code module can directly set the value of `Step.Result.String` in the following ways:

- Use the TestStand API to set the value of `Step.Result.String` directly in a code module.
- Pass `Step.Result.String` as a reference parameter to a module you call with the Sequence Adapter, the DLL Flexible Prototype Adapter, or the ActiveX Automation Adapter.
- The C/CVI and LabVIEW module adapters update the value of `Step.Result.String` automatically, after calling the code module. The C/CVI module adapter updates the value of `Step.Result.String`, based on the value of the `stringMeasurement` field of the `tTestData` parameter that it passes to the C function. The LabVIEW module adapter updates the value of `Step.Result.String`, based on the value of `String Measurement` in the `TestData` cluster that it passes to the VI.

Refer to Chapter 13, *Module Adapters*, for more information on the assignments that the module adapters automatically make to and from step properties.

By default, the step type uses the value of the `Step.Result.String` property as the string value to compare the limits against. To customize the string expression that specifies the value to compare, you access the Data Source tab of the Edit String Value Test dialog box shown in Figure 10-12.



Data Source Expression: Step.Result.String

Figure 10-12. Data Source Tab in Edit String Value Test Dialog Box

The Data Source tab specifies a data source expression that TestStand evaluates to obtain the string it compares against the expected string.

Figure 10-13 shows the step properties for the String Value Test step type.

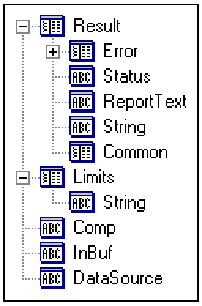


Figure 10-13. String Value Test Step Properties

The String Value Test step type defines the following step properties in addition to the common custom properties.

- `Step.Result.String` specifies the string value. Usually, you set this value in the step module.
- `Step.Limits.String` specifies the expected string for the string comparison.
- `Step.Comp` specifies the type of comparison, such as `Ignore Case`.
- `Step.InBuf` specifies an arbitrary string that the C/CVI and LabVIEW module adapters automatically pass to the test in the `tTestData` structure or `TestData` cluster. This property exists to maintain compatibility with previous test executives. Usually, code modules that you develop for TestStand receive data as input parameters or use the TestStand ActiveX API to access data as properties.
- `Step.DataSource` specifies a string expression that the step type uses to set the value of `Step.Result.String`. The default value of the expression is `Step.Result.String`, which has the effect of using the value that the code module sets. You can customize this expression if you do not want to set the value of `Step.Result.String` in the code module.

You can use a String Value Test step without a code module. This is useful to test a string that you already have acquired. To set up this test, select `<None>` as the module adapter before you insert the step in the sequence, and configure `Step.DataSource` to specify the string you already have acquired.

Step Types That Work With a Specific Module Adapter

This section describes step types that work with a specific module adapter.

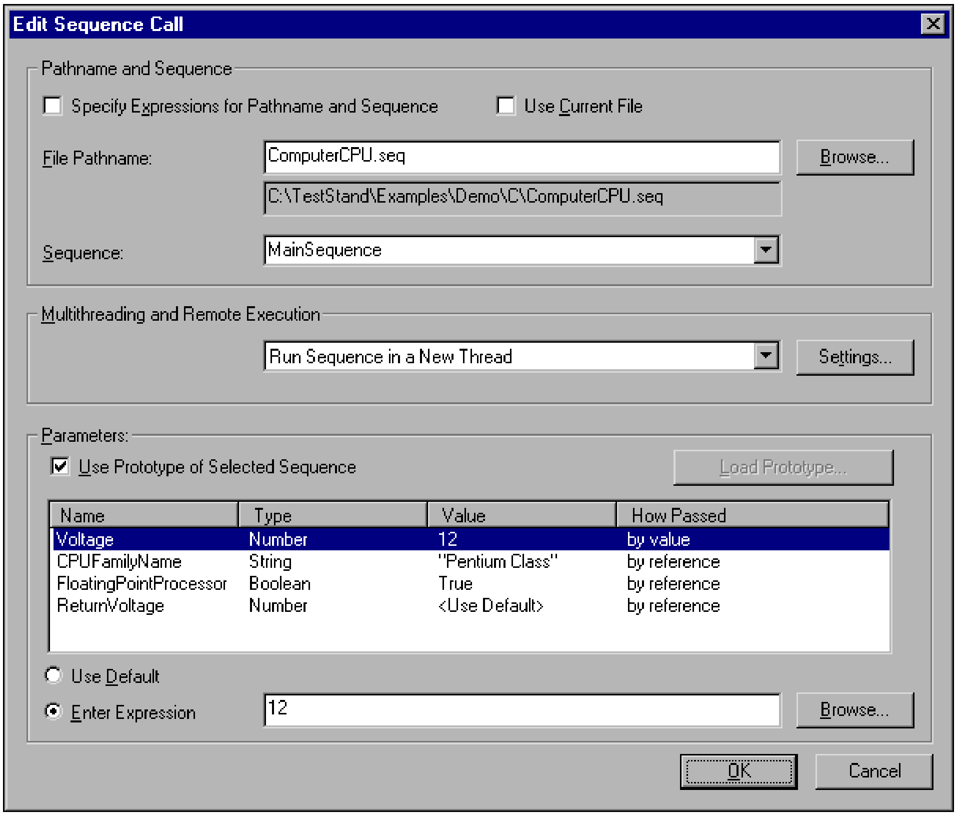
Sequence Call

You use a Sequence Call step to call another sequence in the current sequence file or in another sequence file. A Sequence Call step always uses the Sequence Adapter.

You can use the Sequence Adapter with other step types such as Pass/Fail Test or Numeric Limit Test. Using a Sequence Call step is the same as using an Action step with the Sequence Adapter, except that the step type sets the step status to `Passed` rather than `Done` when the subsequence succeeds. If the sequence fails, the sequence adapter sets the sequence call step status to

`Failed`. A sequence fails when the status for a step in the sequence is `Failed` and you have enabled the Step Failure Causes Sequence Failure option for the step.

To specify the subsequence that the Sequence Call step executes, select the **Specify Module** item in the context menu for the step or click the **Specify Module** button on the Step Properties dialog box. Figure 10-14 shows the Specify Module dialog box for a Sequence Call step.



Specify Expressions for Pathname and Sequence: [ ]
Use Current File: [ ]
File Pathname: ComputerCPU.seq
C:\TestStand\Examples\Demo\C\ComputerCPU.seq
Sequence: MainSequence
Run Sequence in a New Thread
Use Prototype of Selected Sequence: [✓]

Name	Type	Value	How Passed
Voltage	Number	12	by value
CPUFamilyName	String	"Pentium Class"	by reference
FloatingPointProcessor	Boolean	True	by reference
ReturnVoltage	Number	<Use Default>	by reference

Use Default [✓ Enter Expression]: 12

Figure 10-14. Specify Module Dialog Box for Sequence Call Step

To specify the sequence and the sequence file, you can use literal strings or expressions that TestStand evaluates at run time.

In the Parameters section of the dialog box, you can specify the values or expressions to pass for each parameter in the sequence call. For each parameter, you can choose to use the default value for the parameter rather than specifying an explicit value.

Refer to the *Sequence Adapter* section in Chapter 13, *Module Adapters*, for more information on using the Specify Module dialog box for the Sequence Adapter.

After the sequence call executes, the Sequence Adapter can set the step status. If the subsequence fails, the adapter sets the step status to `Failed`. If a run-time error occurs in the subsequence, the adapter sets the step status to `Error`. If the subsequence succeeds, the adapter does not set the step status. Instead, the Sequence Call step sets the step status to `Passed`.

The Sequence Call step type does not define any additional step properties other than the custom properties that are common to all steps.

Step Types That Do Not Use Module Adapters

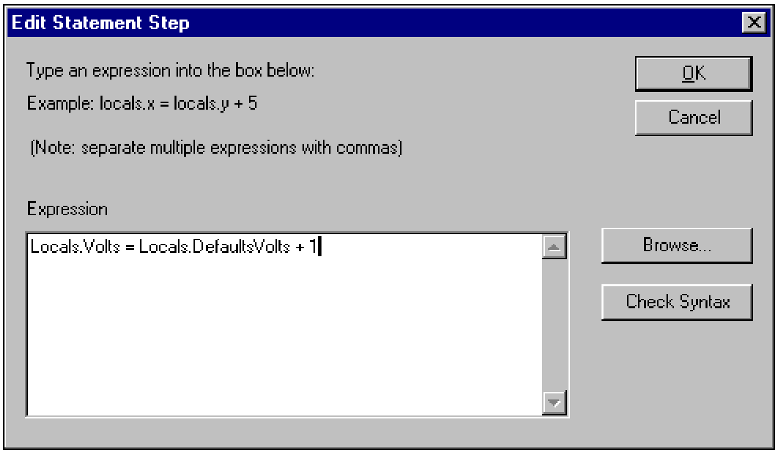
This section describes step types that do not use module adapters. When you create an instance of one of these step types, you only use a dialog box to configure the step. You do not write a code module.

Statement

You use Statement steps to execute expressions. For example, you can use a Statement step to increment the value of a local variable in a sequence.

To specify the expression for a Statement step, you either select the **Edit Expression** item in the context menu for the step or you click the **Edit Expression** button in the Step Properties dialog box.

Figure 10-15 shows the Edit Statement Step dialog box.



Type an expression into the box below:

Example: locals.x = locals.y + 5

(Note: separate multiple expressions with commas)

Expression

```
Locals.Volts = Locals.DefaultsVolts + 1
```

Figure 10-15. Edit Statement Step Dialog Box

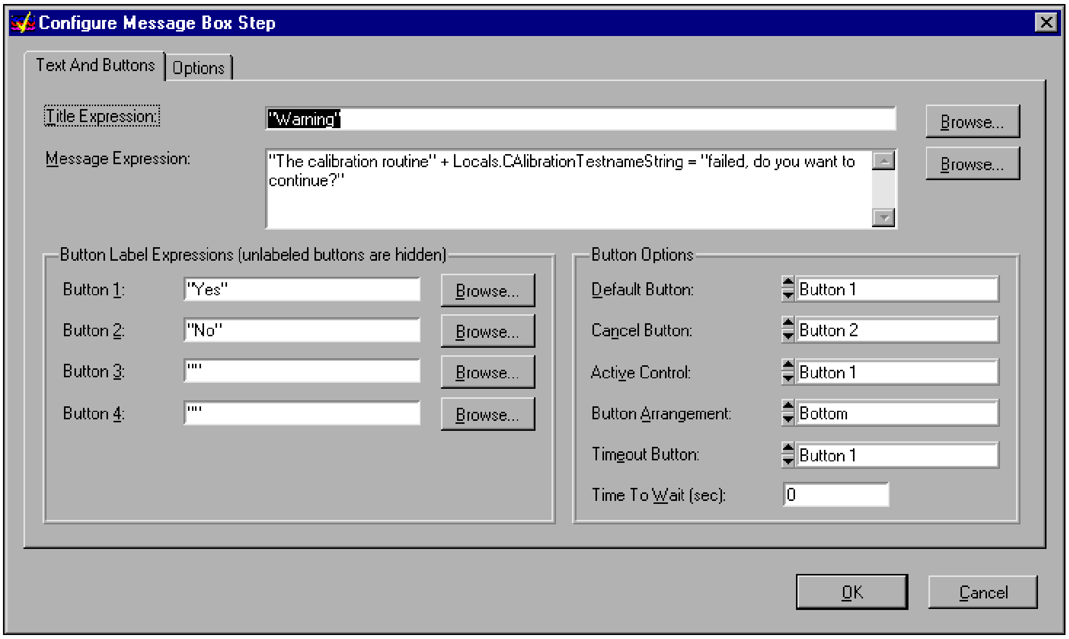
By default, Statement steps do not pass or fail. If the step cannot evaluate the expression or if the expression sets `Step.Result.Error.Occurred` to `True`, TestStand sets the step status to `Error`. Otherwise, it sets the step status to `Done`.

The Statement step type does not define any additional step properties other than the custom properties that are common to all steps.

Message Popup

You use Message Popup steps to display messages to the operator and to receive response strings from the operator. For example, you can use a Message Popup step to warn the operator when a calibration routine fails.

To specify the expression for the Message Popup step, select the **Edit Message Settings** item in the step context menu for the step or click the **Edit Message Settings** button in the Step Properties dialog box. Figure 10-16 shows the Text and Buttons tab on the Configure Message Box Step dialog box.


Configure Message Box Step
Text And Buttons
Options
Browse...
Button Label Expressions (unlabeled buttons are hidden)
Button Options
OK
Cancel

Title Expression: "Warning"

Message Expression: "The calibration routine" + Locals.CAlibrationTestnameString = "failed, do you want to continue?"

Button 1:	"Yes"
Button 2:	"No"
Button 3:	""
Button 4:	""

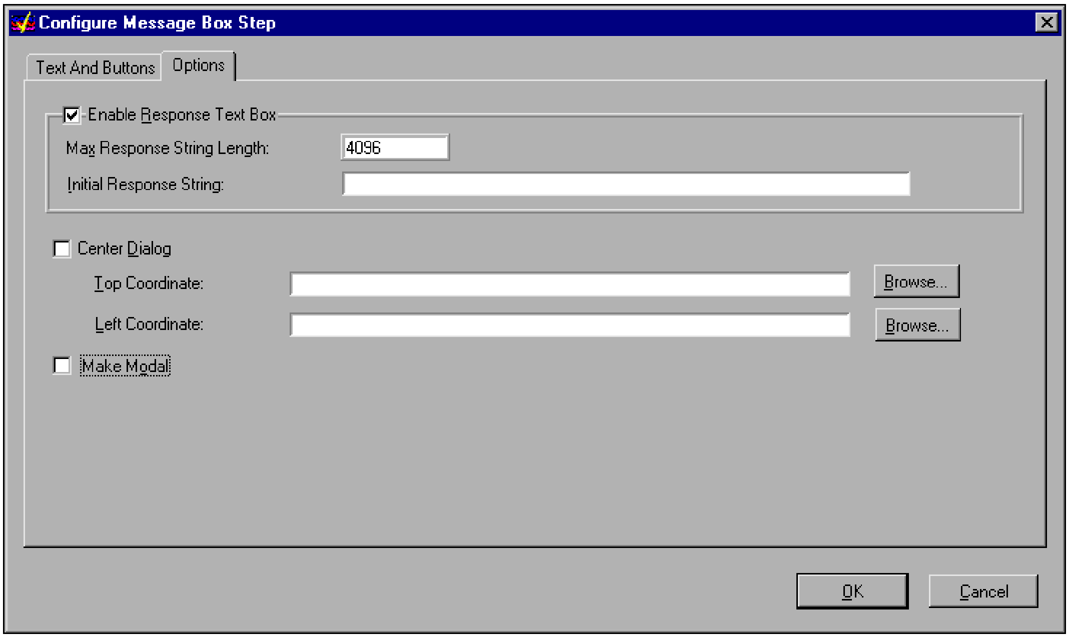
Default Button:	Button 1
Cancel Button:	Button 2
Active Control:	Button 1
Button Arrangement:	Bottom
Timeout Button:	Button 1
Time To Wait (sec):	0

Figure 10-16. Configure Message Box Step Dialog Box—Text and Buttons Tab

The **Title Expression** and **Message Expression** controls specify the text that the step displays in the pop-up message box. In these two controls, you can specify literal strings or string expressions that TestStand evaluates at run time. You also can customize expressions for each button label and customize the arrangement of the buttons. If you do not specify a label for a button, the button does not appear in the pop-up message box. The **Default Button** ring control selects which button, if any, has <Enter> as its shortcut key. The **Cancel Button** ring control selects which button, if any, has <Esc> as its shortcut key. The **Active Control** ring control selects one of the four buttons or the input string as the initially active control.

The **Timeout Button** selection ring specifies which message box button activates automatically after a timeout period expires. Use the **Time To Wait** control to specify the timeout period in seconds. An example use for the timeout option is to create a message popup step that displays a notification message that automatically dismisses itself after a short delay, in case an operator is not present to acknowledge the message.

Figure 10-17 shows the Options tab on the Configure Message Box Step dialog box.


Configure Message Box Step

Text And Buttons | Options

[✓] Enable Response Text Box

Max Response String Length: 4096

Initial Response String:

[ ] Center Dialog

Top Coordinate:

Left Coordinate:

[ ] Make Modal

Figure 10-17. Configure Message Box Step Dialog Box—Options Tab

The Options tab contains the following controls:

- **Enable Response Text Box**—Specifies whether a string control appears to prompt the operator for a response.
- **Max Response String Length**—Specifies the maximum number of characters allowed for the string that the user can input. If you do not want to specify a maximum response string length, enter `-1` in this control.
- **Initial Response String**—Specifies the initial string that appears in the dialog box.
- **Center Dialog**—Specifies that the dialog box appears centered in relation to the screen.
- **Top** and **Left Coordinate**—Specifies a constant dialog box position or a position that varies according to the values of variables or properties you use in expressions.

- **Make Modal**—Specifies that a message popup appears modal with respect to the application. A modal dialog box is a dialog box that you must dismiss before you can operate other application windows.

After the operator closes the pop-up message box, the step sets the `Step.Result.ButtonHit` step property to the one-based index of the button that the operator selects. The step copies the response string to `Step.Result.Response`.

By default, Message Popup steps do not pass or fail. After a step executes, TestStand sets the step status to `Done` or `Error`.

Figure 10-18 shows the step properties for the Message Popup step type.

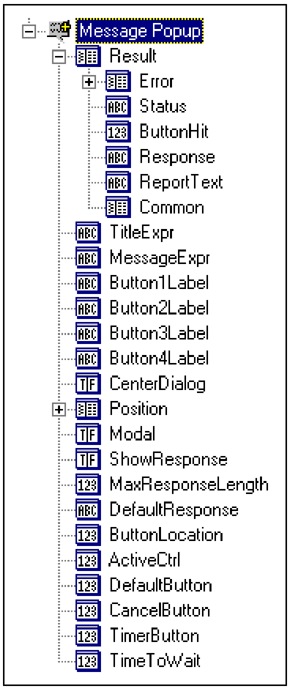

```
Message Popup
  Result
    Error
    Status
    ButtonHit
    Response
    ReportText
    Common
  TitleExpr
  MessageExpr
  Button1Label
  Button2Label
  Button3Label
  Button4Label
  CenterDialog
  Position
  Modal
  ShowResponse
  MaxResponseLength
  DefaultResponse
  ButtonLocation
  ActiveCtrl
  DefaultButton
  CancelButton
  TimerButton
  TimeToWait
```

Figure 10-18. Message Popup Step Properties

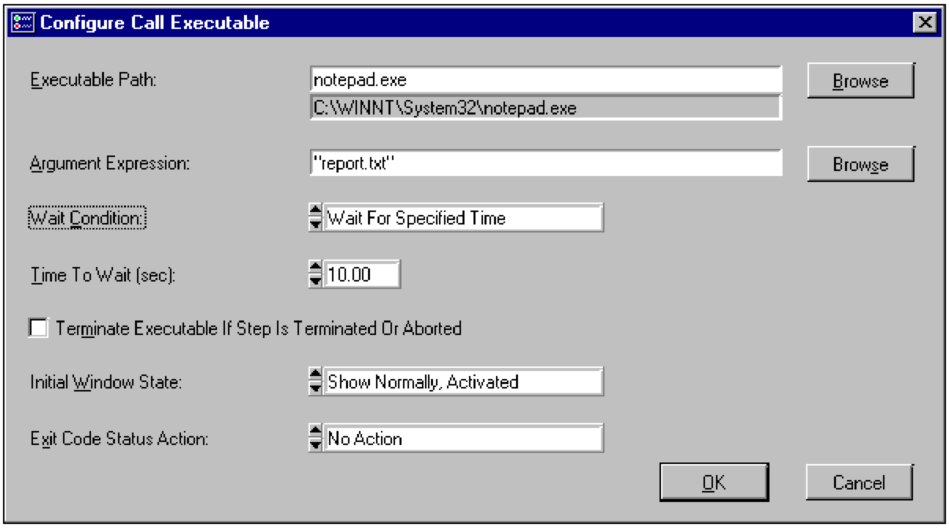
The Message Popup step type defines the following step properties in addition to the common custom properties.

- `Step.Result.ButtonHit` contains the one-based index of the button that the operator selects.
- `Step.Result.Response` contains the response text that the operator enters.
- `Step.TitleExpr` contains the expression for the string that appears as the title of the pop-up message box.
- `Step.MessageExpr` contains the expression for the string that appears as the text message in the pop-up message box.
- `Step.Button1Label`, `Button2Label`, `Button3Label`, and `Button4Label` specify the expression for the label text for each button.
- `CenterDialog` specifies that the message popup appears in the center of the screen.
- `Position.Top` and `Position.Left` specify the location of the message popup when `CenterDialog` is `False`.
- `Modal` specifies whether the message popup is a modal dialog box.
- `Step.ShowResponse` enables the response text box control in the pop-up message box.
- `Step.MaxResponseLength` specifies the maximum number of characters that the operator can enter in the response text box control.
- `Step.DefaultResponse` contains the initial text string that the step displays in the response text box control.
- `Step.ButtonLocation` specifies whether to display the buttons on the bottom or side of the pop-up message box.
- `Step.ActiveCtrl` identifies one of the four buttons or the input string as the active control.
- `Step.DefaultButton` specifies which button, if any, has <Enter> as its shortcut key.
- `Step.CancelButton` specifies which button, if any, has <Esc> as its shortcut key.
- `Step.TimerButton` specifies the index of the button that activates automatically after a timeout elapses. A value of zero indicates that no timeout occurs.
- `Step.TimeToWait` specifies the number of seconds before the button that `Step.TimerButton` specifies activates.

Call Executable

You use Call Executable steps to launch an application or run a system command. For example, you can use a Call Executable step to call a system command to copy files to a network drive.

To specify the executable path, arguments, and options for the Call Executable step, select the **Configure Call Executable** item in the context menu for the step or click the **Configure Call Executable** button on the Step Properties dialog box. Figure 10-19 shows the Configure Call Executable dialog box.


Configure Call Executable

Executable Path: notepad.exe
C:\WINNT\System32\notepad.exe

Argument Expression: "report.txt"

Wait Condition: Wait For Specified Time

Time To Wait (sec): 10.00

☐ Terminate Executable If Step Is Terminated Or Aborted

Initial Window State: Show Normally, Activated

Exit Code Status Action: No Action

Figure 10-19. Configure Call Executable Dialog Box

The Configure Call Executable dialog box contains the following controls:

- **Executable Path**—Specifies an absolute or relative pathname for the executable.
- **Argument Expression**—Specifies an argument to pass to the executable. You can specify the argument as a literal string or as an expression that TestStand evaluates at run time.
- **Wait Condition**—Specifies whether the step waits for the executable to exit. The possible values are `No Wait`, `Wait for Exit`, and `Wait for Specified Time`. If you choose `Wait for Specified Time` and the executable process does not exit before the time limit you specify expires, the step type sets the `Step.Result.Error.Occurred` to indicate a run-time error.

- **Time to Wait**—Specifies the time you want the step to wait for the executable to exit before it indicates a run-time error.
- **Terminate Executable If Step Is Terminated Or Aborted**—Causes the executable process to stop running when the operator terminates or aborts the execution in TestStand. This option applies only when the wait condition is `Wait For Exit` or `Wait For Specified Time`.
- **Initial Window State**—Specifies whether the step launches the executable as a hidden, normal, minimized, or maximized application, and whether the application is active initially.
- **Exit Code Status Action**—Causes the step type to set the step status in response to the exit code that the executable returns. You can choose to set the step status to `Failed` if the exit code is less than zero, greater than zero, equal to zero, or not equal to zero.

The final status of a Call Executable step depends on whether the step waits for the executable to exit. If the step does not wait for the executable to exit, the step type always sets the step status to `Done`. If a timeout occurs while the step is waiting for the executable to exit, the step type sets the status to `Error`. If the step waits for the executable to exit and a timeout does not occur, the step type sets the step status to `Done`, `Passed`, or `Failed`, depending on the status action you specify in the Exit Code Status Action ring control. If you set the Exit Code Status Action control to the No Action option, the step type always sets the step status to `Done`. Otherwise, you can choose to set the step status to `Passed` or `Failed` based on whether the exit code is equal to zero, not equal to zero, greater than zero, or less than zero.

Figure 10-20 shows the step properties for the Call Executable step type.

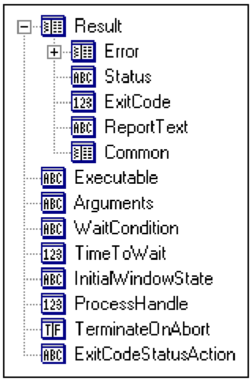


Figure 10-20. Call Executable Step Properties

The Call Executable step type defines the following step properties and the common custom properties.

- `Step.Result.ExitCode` contains the exit code that the executable returns.
- `Step.Executable` specifies the pathname of the executable to launch.
- `Step.Arguments` specifies the expression for the argument string that the step passes to the executable.
- `Step.WaitCondition` specifies whether the step waits for the executable to exit before completing.
- `Step.TimeToWait` specifies the number of seconds to wait for the executable to exit.
- `Step.ProcessHandle` contains the Windows process handle for the executable.
- `Step.InitialWindowState` specifies whether the executable is initially active, not active, hidden, normal, minimized, or maximized.
- `Step.TerminateOnAbort` specifies whether to terminate the executable process when the execution terminates or aborts.
- `Step.ExitCodeStatusAction` specifies whether to set the step status using the exit code that the executable returns.

Property Loader

Use the Property Loader step type to dynamically load the values for properties and variables from a text file, a Microsoft Excel file, or a database at run time. Refer to the *Property Loader* section in Chapter 18, *Databases*, for more information on the Property Loader step type.

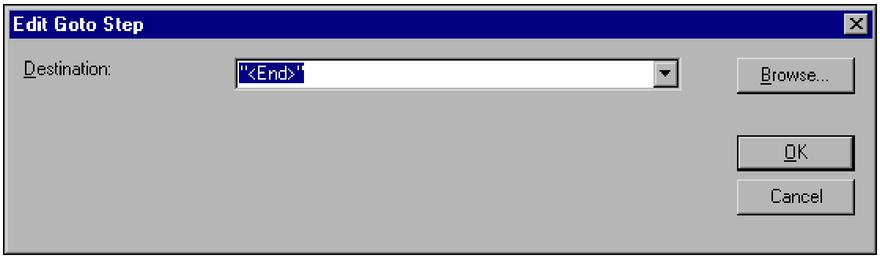
Importing/Exporting Properties

When you edit a sequence file, you can select **Tools»Import/Export Properties** to import values from a database, file, or clipboard into step properties or variables or to export values from step properties or variables to a database, file, or clipboard. For more information on importing and exporting properties, refer to the *Importing/Exporting Properties* section of Chapter 18, *Databases*.

Goto

You use Goto steps to set the next step that the TestStand engine executes. You usually use a Label Step as the target of a Goto step. Use of a Label Step allows you to rearrange or delete other steps in a sequence without having to change the specification of targets in Goto steps.

To specify the Goto step target, select the **Edit Destination** item from the step context menu or click the **Edit Destination** button on the Step Properties dialog box. Figure 10-21 shows the Edit Goto Step dialog box.



Destination: "<End>"

Figure 10-21. Edit Goto Step Dialog Box

The Destination control contains a list of all steps in the step group. The Destination control lists two additional targets: <Cleanup> allows you to jump to the Cleanup step group, and <End> allows you to jump directly to the end of the current step group.

By default, Goto steps do not pass or fail. After a Goto step executes, TestStand sets the step status to `Done` or `Error`.

The Goto step type does not define any additional step properties other than the custom properties that are common to all steps.

Label

You usually use a Label Step as the target for a Goto step. Use of Label Steps allows you to rearrange or delete other steps in a sequence without having to change the specification of targets in Goto steps.

Label steps do not pass or fail. After a Label step executes, the TestStand engine sets the step status to `Done` or `Error`.

You can edit a Label step to specify a description that appears next to the Label step name in the Sequence Editor. Figure 10-22 shows the step properties for the Label step type.

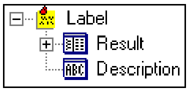


Figure 10-22. Label Step Properties

The Label step type defines the following step property in addition to the common custom properties.

- `Description` specifies a string that appears next to the step name in the sequence editor.

11 Synchronization Step Types

This section describes step types that you use to synchronize, pass data between, and perform other operations in multiple threads of an execution or multiple running executions in the same process. You configure these steps using dialog boxes. You do not write code modules for these steps.

Synchronization Objects

Most synchronization step types create and control a particular type of synchronization object. The following is a list of the types of synchronization objects.

- **Lock**—Use a lock to guarantee exclusive access to a resource. For example, if several execution threads write to a device that does not have a thread-safe driver, you can use a lock to make sure that only one thread accesses the device at a time.
- **Semaphore**—Use a semaphore to limit access to a resource to a specific number of threads. A semaphore is similar to a lock, except that it restricts access to the number of threads that you specify rather than to just one thread. For example, you can use a semaphore to restrict access to a communications channel to a limited number of threads so that each thread has sufficient bandwidth. Typically, you limit access to a shared resource to only one thread at a time. Therefore, a typical application uses Locks rather than Semaphores.
- **Rendezvous**—Use a rendezvous to make a specific number of threads wait for each other before they proceed past a location you specify. For example, if different threads configure different aspects of a testing environment, you can use a rendezvous to ensure that the none of the threads proceeds beyond the configuration process until all threads have completed their configuration tasks.
- **Queue**—Use a queue to pass data from a thread that produces it to a thread that processes it. For example, a thread that performs tests asynchronously with respect to the main sequence might use a queue to receive commands from the main sequence.
- **Notification**—Use a notification to notify one or more threads when a particular event or condition occurs. For example, if you display a

dialog box in a separate thread, you can use a notification to signal another thread when the user dismisses the dialog box.

- **Batch**—Use a batch to define and synchronize a group of threads. This is useful when you want to test a group of similar UUTs simultaneously. You test each UUT in a separate thread, and you use the Batch Specification step to include the UUT threads in one batch. You use the Batch Synchronization step to control the interaction of the UUT threads as they execute the test steps. More specifically, you place Batch Synchronization steps around one or more test steps to create a synchronized section. You can configure a synchronized section so that only one UUT enters the section at a time, no UUTs enter the section until all are ready, and no UUTs proceed beyond the section until all are done. This useful when, for a particular test, you have only one test resource which you must apply to each UUT in turn. You can also configure a synchronized section to guarantee that only one thread executes the steps in the section. This is useful for an action that applies to the entire batch, such as raising the temperature in an environmental chamber. Having a separate thread for each UUT allows you to exploit parallelism while enforcing serialization when necessary. It also allows you to use preconditions and other branching options so that each UUT has its own flow of execution.

  Typically, you do not have to create a batch. The TestStand Batch process model does this for you. The model uses Batch Specification steps to group TestSocket execution threads together so that you can use Batch Synchronization steps to synchronize them in your sequence file. If you want to create a synchronized section around a single step, you can do so using the Synchronization tab of the Step Properties dialog box rather than by using explicit Batch Synchronization steps. For more information on the Batch process model, refer to the *Batch Model* section in Chapter 14, *Process Models*. For more information on batch synchronization, refer to the *Batch Synchronization* section in this chapter.

Common Attributes of Synchronization Objects

All synchronization objects share the following attributes that you specify in the step type configuration dialog box.

- **Name**—When you create a synchronization object, you can specify a unique name with a string literal or an expression that evaluates to a string. If an object with the same name and type already exists, you create a reference to the existing object. Otherwise you create a reference to a new synchronization object. By creating a reference to an existing object, you can access the same synchronization object from multiple threads or executions.

If you specify an empty string as the name for a synchronization object, TestStand creates an unnamed synchronization object that you can access only through an ActiveX reference variable. To associate an unnamed synchronization object with an ActiveX reference variable, you must select Using ActiveX Reference as the object lifetime.

Note To access a synchronization object across threads without creating a reference in each thread, store a reference to the synchronization object in an ActiveX reference variable and access the object from multiple threads using the variable.

By default, a synchronization object is accessible only from the operating system process in which you create it. However, you can make a synchronization object accessible from other processes, such as multiple instances of an operator interface, by using an asterisk (*) as the first character in the name. In addition, you can create a synchronization object on a specific machine by beginning the name with the machine name, such as “`\\machinename\syncobjectname`”. You can then use this name to access the synchronization object from any machine on your network. To access synchronization objects on other machines, you must configure DCOM for the `TSAutoMgr.exe` server located in the `<TestStand>\bin` directory. For instructions on configuring DCOM, see the *Setting up TestStand as a Server for Remote Execution* section in Chapter 13, *Module Adapters*, which contains instructions for setting up TestStand as a server for remote execution. Follow the instructions given for the `REngine.exe` server but apply them to the `TSAutoMgr.exe` server.

Note When you specify an object on a remote machine using a string constant in a dialog box expression control, be sure to escape the backslashes and surround the name in quotes. For example, use `"\\\\machinename\\syncobjname"` instead of `\\machinename\syncobjname`.

All named TestStand synchronization objects share the same name space. Thus, you cannot have a lock and a queue or other synchronization objects with the same name. Synchronization object names are case-insensitive.

- **Lifetime**—You specify a lifetime for each reference you create to a synchronization object. The object exists for at least as long the reference exists. The object can, however, exist longer if another reference to it has a different lifetime.

The reference lifetime choices are Same as Execution, Same as Thread, Same as Sequence, or Using ActiveX Reference. If you refer to your object only by name, then you typically set its reference lifetime to Same as Execution, Same as Thread, or Same as Sequence. This guarantees that the object lives as long as the execution, thread, or sequence in which you create the reference. If you want to explicitly control the lifetime of the object reference or if you wish to refer to the object using an ActiveX reference variable, choose the Using ActiveX Reference option. You can use the ActiveX reference to the object in place of its name when performing operations on the object.

You can also use the reference from other threads without performing a Create operation in each thread. An ActiveX reference releases its object when you set the variable equal to Nothing, when you reuse the variable to store a different reference, or when the variable goes out of scope. When the last ActiveX reference to a synchronization object releases, TestStand disposes of the object.

Some synchronization objects have an operation, such as Lock or Acquire, for which you also can specify a lifetime. In this case, the lifetime determines the duration of the operation.

- **Timeout**—Most of the synchronization objects can perform one or more operations that timeout if they do not complete within the number of seconds you specify. You can specify that TestStand treats a timeout as an error condition or you can explicitly check for the occurrence of a timeout by checking the value of the `Step.Result.TimeoutOccurred` property.

Synchronization Step Types

Each type of synchronization object has a step type to create and control the object. The batch synchronization object has two step types, Batch Specification and Batch Synchronization. For all other synchronization objects, the name of the step type is the same as the name of the synchronization object type it controls. The following additional synchronization step types exist:

- **Wait**—Use the Wait step to wait for an execution or thread to complete or for a time interval to elapse.
- **Thread Priority**—Use the Thread Priority step to adjust the operating system priority of a TestStand thread.

To use any synchronization step type, insert a step of that type and select **Configure** from the context menu to display the Configuration dialog box. In the configuration dialog box, select an operation for the step to perform. You can then specify settings for the operation you select. Some operations store output values to variables you specify. If the control for an output value is labeled as an optional output, you can leave the control empty.

The following sections describe the functionality, the configuration dialog box, and the custom properties of each synchronization step type.

Lock

Use lock steps to ensure that only one thread can access a particular resource or data item at a time. For example, if you examine and update the value of a global variable from multiple threads or executions, you can use a lock to ensure that only one thread examines and updates the variable at a time. If multiple threads are waiting to lock a lock, they do so in first in first out (FIFO) order as the lock becomes available.

A thread can lock the same lock an unlimited number of times without unlocking it. To release the lock, the thread must balance each lock operation with an unlock operation.

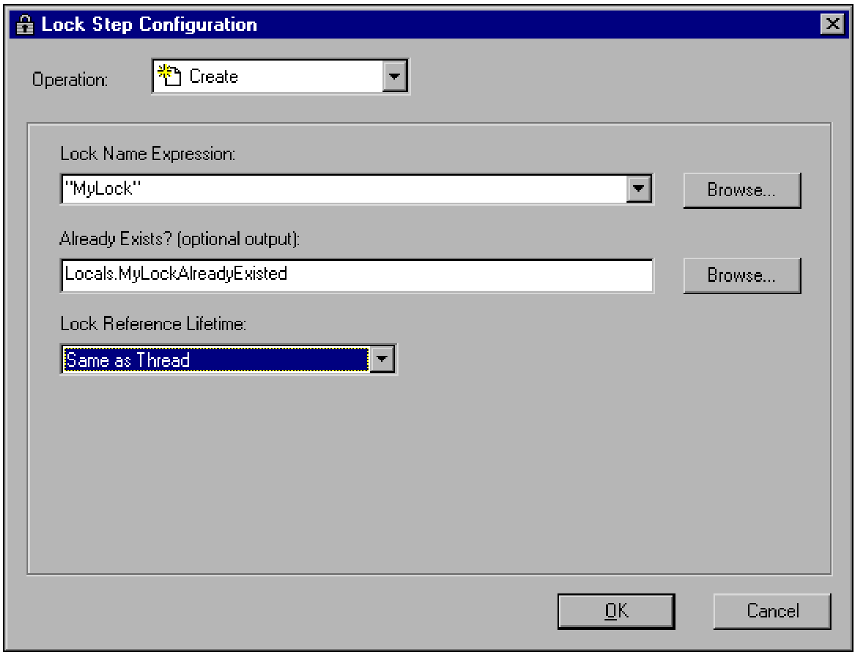
Locks in TestStand have deadlock detection. If all threads using a set of locks reside on the same machine and all of the locks in that set reside on that machine as well, TestStand detects and reports a run-time error if deadlock occurs as a result of those locks and threads. To avoid deadlock, either always lock a set of locks in the same order in every thread, or lock all of the locks a thread requires in one Lock operation by specifying an array of lock names or references. See the *Lock Operation* section of this chapter for more information on locking more than one lock at a time.

Note You can create a lock around a single step using the Synchronization tab of the Step Properties dialog box rather than by using explicit Lock steps.

Note TestStand variables and properties are thread safe.

Create Operation

To use a lock, you first create a reference to a new or existing lock object. To create a lock reference, insert a Lock step and select **Configure Lock** from the context menu for the step.



Operation: Create

Lock Name Expression: "MyLock"

Already Exists? (optional output): Locals.MyLockAlreadyExisted

Lock Reference Lifetime: Same as Thread

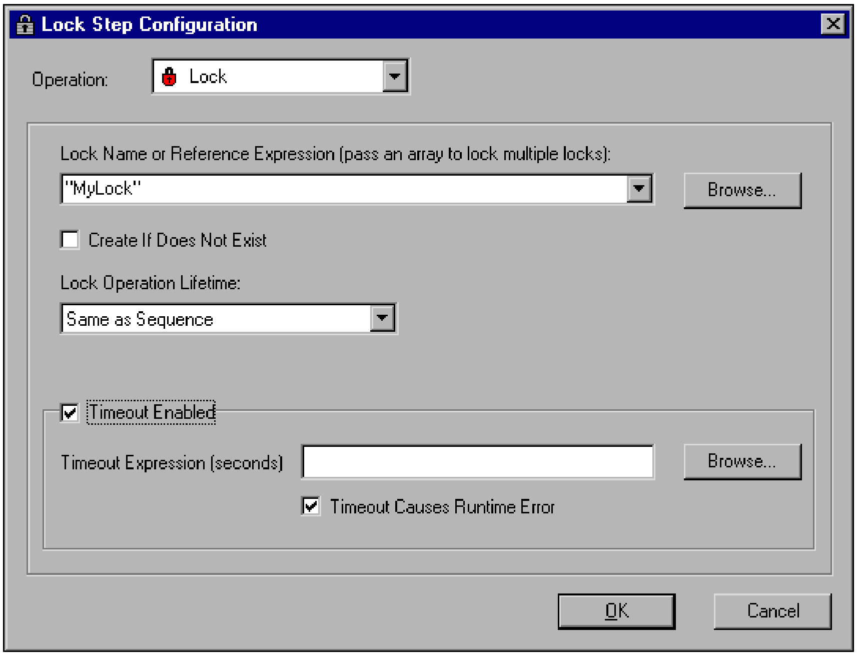
Figure 11-1. Create Operation for Lock Step Configuration Dialog Box

The Create operation contains the following controls:

- **Lock Name Expression**—Use this control to specify a name for the synchronization object using a string literal or an expression that evaluates to a string. Refer to the *Common Attributes of Synchronization Objects* section of this document for more information on synchronization object names.
- **Already Exists**—Use this control to specify a location to store a Boolean value that indicates whether the synchronization object already exists.
- **Lock Reference Lifetime**—Use this control to specify a lifetime for the reference to the synchronization object.

Lock Operation

To use a lock to guarantee that only one thread executes certain steps at a time, insert a Lock step before the steps you want to protect and configure it to perform a Lock operation.



Operation: Lock

Lock Name or Reference Expression (pass an array to lock multiple locks): "MyLock"

☐ Create If Does Not Exist

Lock Operation Lifetime: Same as Sequence

☑ Timeout Enabled

Timeout Expression (seconds)

☑ Timeout Causes Runtime Error

Figure 11-2. Lock Operation for Lock Step Configuration Dialog Box

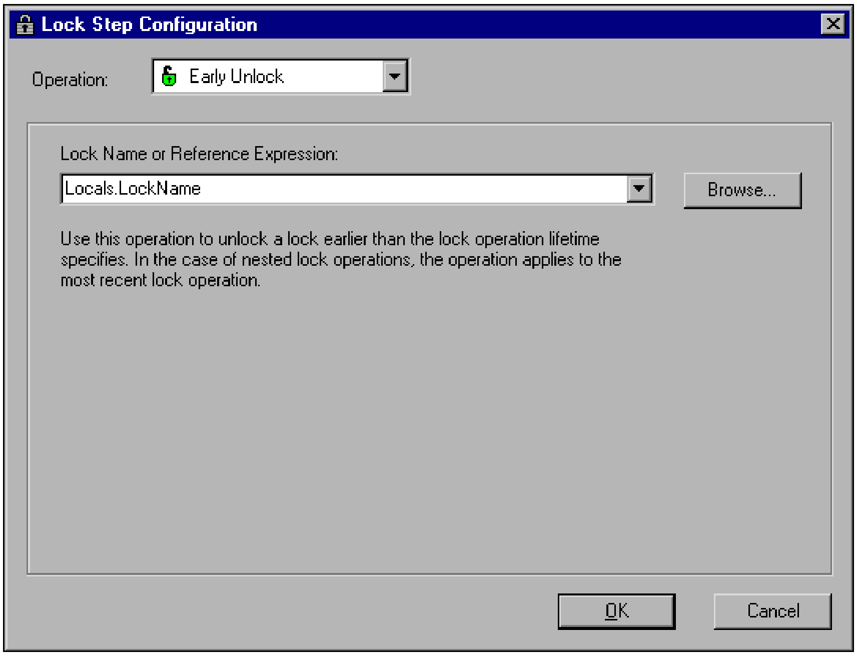
The Lock operation contains the following controls:

- **Lock Name or Reference Expression**—Use this control to specify the lock on which to perform the operation. You can specify the lock by name or by the ActiveX reference you receive when you create the lock with the Using ActiveX Reference lifetime option. You can specify multiple locks using either a string array containing the names of the locks or an ActiveX reference array containing ActiveX references to the locks. When you specify multiple locks, the Lock operation attempts to lock all of the locks. If the operation cannot lock all of the locks, it unlocks the ones it has so far and tries again after a random delay. This continues until the operation either succeeds in locking all of the locks or the timeout you specify occurs. When you lock all of the locks a thread requires in a single Lock operation, you avoid the possibility of deadlock; however, when you lock more than one lock at a time, you lose the guarantee of first in first out (FIFO) ordering of which thread gets to lock a particular lock first.

- **Create If Does Not Exist**—Use this control to specify that the operation automatically creates the lock(s) whose name(s) you specify. Locks you create with this option have a reference lifetime of Same as Execution.
- **Lock Operation Lifetime**—Use this control to specify how long you want the thread to lock the lock. Refer to the *Common Attributes of Synchronization Objects* section of this document for more information on lifetime settings. Once the lifetime of the last lock operation for the owning thread ends, the lock again becomes available for a thread to lock.
- **Timeout Enabled, Timeout Expression, Timeout Causes Run-Time Error**—Use these controls to specify the timeout behavior when waiting to acquire the Lock. If a timeout occurs, the property `Step.Result.TimeoutOccurred` is set to `True`.

Early Unlock Operation

If you want to release the lock before the lock operation lifetime expires, insert a Lock step to perform the Early Unlock operation as shown below.



Locals.LockName

Use this operation to unlock a lock earlier than the lock operation lifetime specifies. In the case of nested lock operations, the operation applies to the most recent lock operation.

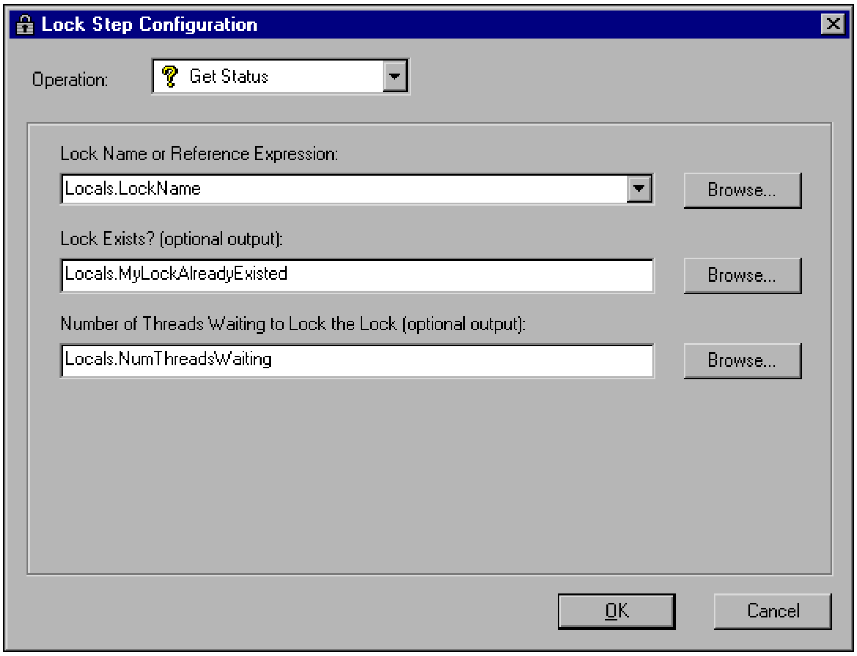
Figure 11-3. Get Early Unlock Operation for Lock Step Configuration Dialog Box

The Early Unlock operation contains the following controls:

- **Lock Name or Reference Expression**—Use this control to specify the lock on which to perform the operation. You can specify the lock by name or by the ActiveX reference you receive when you create the lock with the Using ActiveX Reference lifetime option.

Get Status Operation

Use the Get Status operation to find out information about an existing lock or to determine if a particular lock exists as shown below.



Operation: Get Status

Lock Name or Reference Expression: Locals.LockName

Lock Exists? (optional output): Locals.MyLockAlreadyExisted

Number of Threads Waiting to Lock the Lock (optional output): Locals.NumThreadsWaiting

Figure 11-4. Get Status Operation for Lock Step Configuration Dialog Box

The Get Status operation contains the following controls:

- **Lock Name or Reference Expression**—Use this control to specify the lock on which to perform the operation. You can specify the lock by name or by the ActiveX reference you receive when you create the lock with the Using ActiveX Reference lifetime option.
- **Lock Exists?**—Use this control to specify a location to store a Boolean value that indicates whether the lock exists.
- **Number of Threads Waiting to Lock the Lock**—Use this control to specify a location to store the number of threads waiting to lock the lock.

Step Properties

Figure 11-5 shows the step properties for the Lock step type.

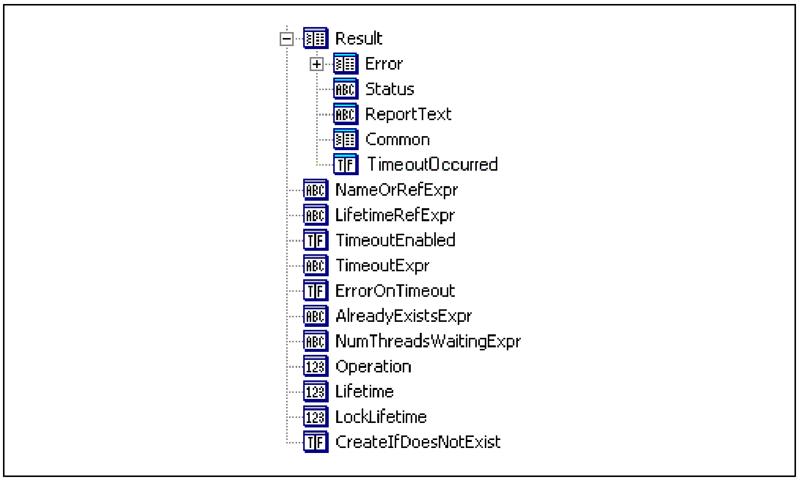


Figure 11-5. Lock Step Properties

The Lock step type defines the following step properties in addition to the common custom properties.

- `Step.Result.TimeoutOccurred` is set to `True` if the Lock operation times out. This property exists only if the step is configured for the Lock operation.
- `Step.NameOrRefExpr` contains the Lock Name Expression for the Create operation and the Lock Name or Reference Expression for all other lock operations. In the case of the Lock operation, this expression can optionally specify an array of names or references.
- `Step.LifetimeRefExpr` contains the ActiveX Reference Expression for the lock reference lifetime or lock operation lifetime when you set either lifetime to Use ActiveX Reference.
- `Step.TimeoutEnabled` contains the Timeout Enabled setting for the Lock operation.
- `Step.TimeoutExpr` contains the Timeout Expression, in seconds, for the Lock operation.
- `Step.ErrorOnTimeout` contains the Timeout Causes Run-Time Error setting for the Lock operation.
- `Step.AlreadyExistsExpr` contains the Already Exists expression for the Create operation or the Lock Exists expression for the Get Status operation.

- `Step.NumThreadsWaitingExpr` contains the Number of Threads Waiting to Lock the Lock expression for the Get Status operation.
- `Step.Operation` contains a value that specifies the operation the step is configured to perform. The valid values are 0 = Create, 1 = Lock, 2 = Early Unlock, 3 = Get Status.
- `Step.Lifetime` contains a value that specifies the lifetime setting to use for the Create operation. The valid values are 0 = Same as Sequence, 1 = Same as Thread, 2 = Use ActiveX Reference, 3 = Same as Execution.
- `Step.LockLifetime` contains a value that specifies the lifetime setting to use for the Lock operation. The valid values are 0 = Same as Sequence, 1 = Same as Thread, 2 = Use ActiveX Reference.
- `Step.CreateIfDoesNotExist` contains the Create If Does Not Exist setting for the Lock operation.

Semaphore

Use Semaphore steps to limit concurrent access to a resource to a specific number of threads. A semaphore stores a numeric count and allows threads to increment (release) or decrement (acquire) the count as long as the count stays equal to or greater than zero. If a decrement would cause the count to go below zero, the thread attempting to decrement the count blocks until the count increases. When multiple threads are waiting to decrement a semaphore, the semaphore unblocks the threads in first in first out (FIFO) order whenever another thread increments the semaphore count.

A semaphore with an initial count of one behaves like a lock, with one exception. Like a lock, a one-count semaphore restricts access to a single thread at a time. Unlike a lock, a thread cannot acquire a one-count semaphore multiple times without first releasing it after each acquire. When a thread attempts to acquire the semaphore a second time without releasing it, the count is zero and the thread blocks. Refer to the *Lock* section of this chapter for more information on lock objects.

Create Operation

To use a semaphore, you first create a reference to a new or existing semaphore object. To create a semaphore reference, insert a Semaphore step and select **Configure Semaphore** from the context menu for the step.

Figure 11-6 shows the Semaphore Step Configuration dialog box with the Create operation selected.

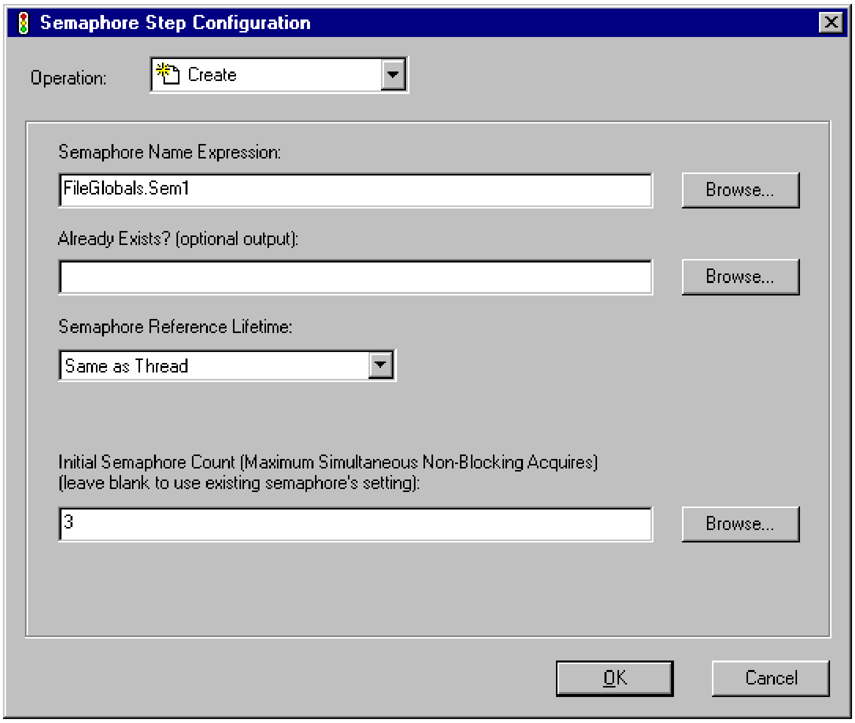

Semaphore Step Configuration
Operation:
Create
Semaphore Name Expression:
FileGlobals.Sem1
Browse...
Already Exists? (optional output):
Browse...
Semaphore Reference Lifetime:
Same as Thread
Initial Semaphore Count (Maximum Simultaneous Non-Blocking Acquires)
(leave blank to use existing semaphore's setting):
3
Browse...
OK
Cancel

Figure 11-6. Create Operation for Semaphore Step Configuration Dialog Box

The Create operation contains the following controls:

- **Semaphore Name Expression**—Use this control to specify a unique name for the synchronization object using a string literal or an expression that evaluates to a string. Refer to the *Common Attributes of Synchronization Objects* section of this document for more information on synchronization object names.
- **Already Exists**—Use this control to specify a location to store a Boolean value that indicates whether the synchronization object already exists.
- **Semaphore Reference Lifetime**—Use this control to specify a lifetime for the reference to the synchronization object.
- **Initial Semaphore Count**—Use this control to specify the initial value for the count. This value must be greater than or equal to 0. If you know that the semaphore already exists, you can leave this setting

blank. If the semaphore already exists and you specify an initial count that differs from the existing initial count, the step reports an error at run time.

Acquire Operation

Before you access a resource that a semaphore protects you must perform an Acquire (decrement) operation on the semaphore, as shown below.

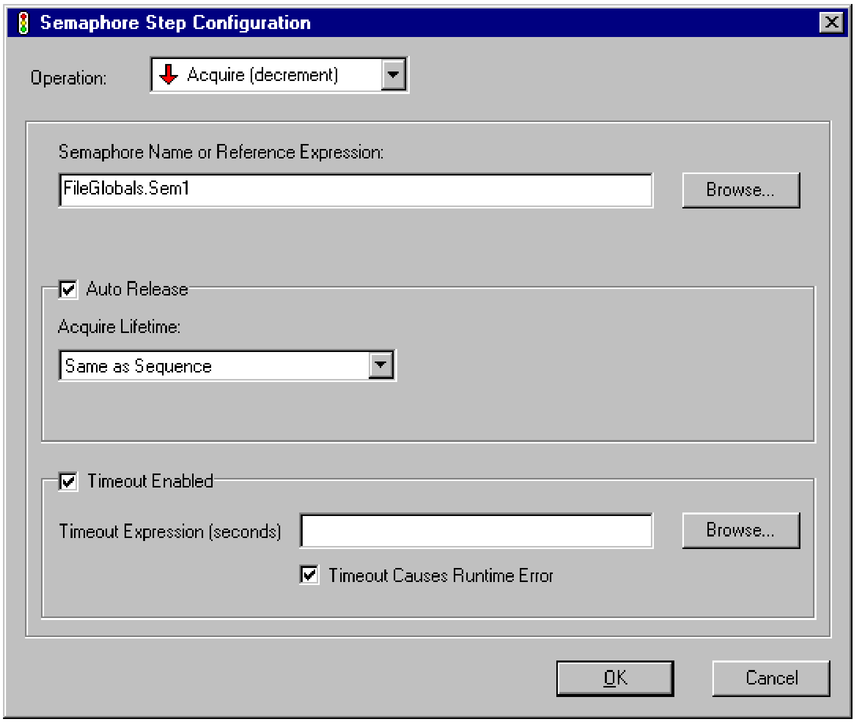


Figure 11-7. Acquire Operation for Semaphore Step Configuration Dialog Box

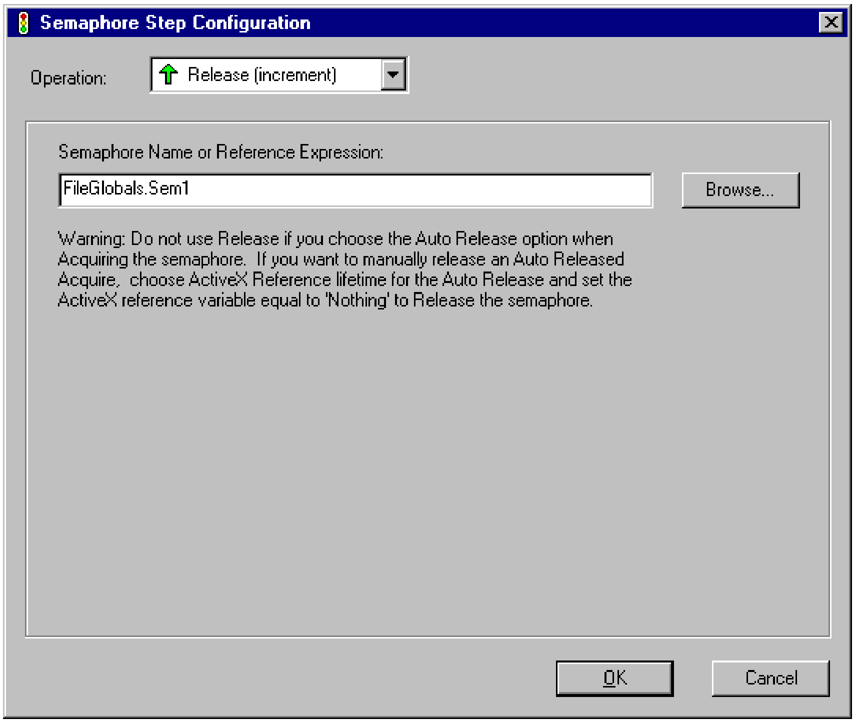
The Acquire operation contains the following controls:

- **Semaphore Name or Reference Expression**—Use this control to specify the semaphore on which to perform the operation. You can specify the semaphore by name or by the ActiveX reference you receive when you create the semaphore with the Using ActiveX Reference lifetime option.
- **Auto Release**—Use this control to specify whether to release (increment) the semaphore automatically when the lifetime you specify expires.

- **Acquire Lifetime**—Use this control to specify how long the thread holds the semaphore after it acquires the semaphore. The thread releases the semaphore automatically when the lifetime of the acquire ends. Refer to the *Synchronization Objects* section of this chapter for more information on lifetime settings.
- **Timeout Enabled, Timeout Expression, Timeout Causes Run-Time Error**—Use these controls to specify the timeout behavior when waiting to acquire the semaphore. If a timeout occurs, the property `Step.Result.TimeoutOccurred` is set to `True`.

Release Operation

Use the release operation when you want direct control over the count or if you use semaphores in a way that requires unmatched increments and decrements. If you enable Auto Release in the Acquire operation, do not explicitly release the semaphore using the Release operation.


Semaphore Step Configuration
Operation:
Release (increment)
Semaphore Name or Reference Expression:
Browse...
OK
Cancel

FileGlobals.Sem1

Warning: Do not use Release if you choose the Auto Release option when Acquiring the semaphore. If you want to manually release an Auto Released Acquire, choose ActiveX Reference lifetime for the Auto Release and set the ActiveX reference variable equal to 'Nothing' to Release the semaphore.

Figure 11-8. Release Operation for Semaphore Step Configuration Dialog Box

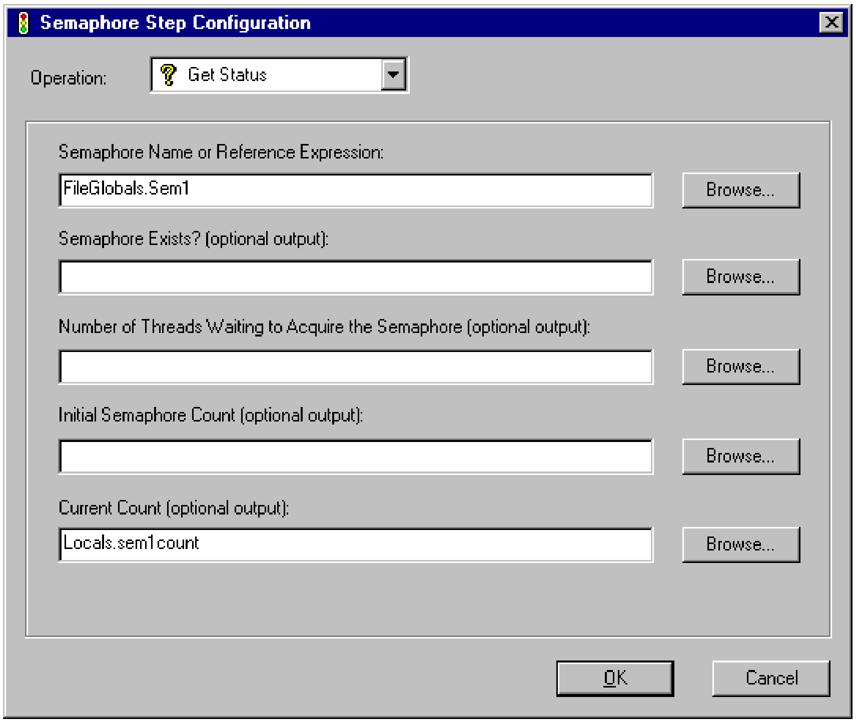
The Release operation contains the following controls:

- **Semaphore Name or Reference Expression**—Use this control to specify the semaphore on which to perform the operation. You can specify the semaphore by name or by the ActiveX reference you receive when you create the semaphore with the Using ActiveX Reference lifetime option.

The release operation immediately increments the count for the semaphore. If you perform the Acquire operation with the Auto Release option enabled, do not use the Release operation. Typically, you use the Release operation only on semaphores that require unmatched increments and decrements. For example, if you create a semaphore with an initial count of zero, all threads block when they perform an acquire. You can then perform release operations to release the threads when you are ready.

Get Status Operation

You can use the Get Status operation to obtain information about the current state of the semaphore as shown below.



Semaphore Step Configuration

Operation: Get Status

Semaphore Name or Reference Expression: FileGlobals.Sem1

Semaphore Exists? (optional output):

Number of Threads Waiting to Acquire the Semaphore (optional output):

Initial Semaphore Count (optional output):

Current Count (optional output): Locals.sem1count

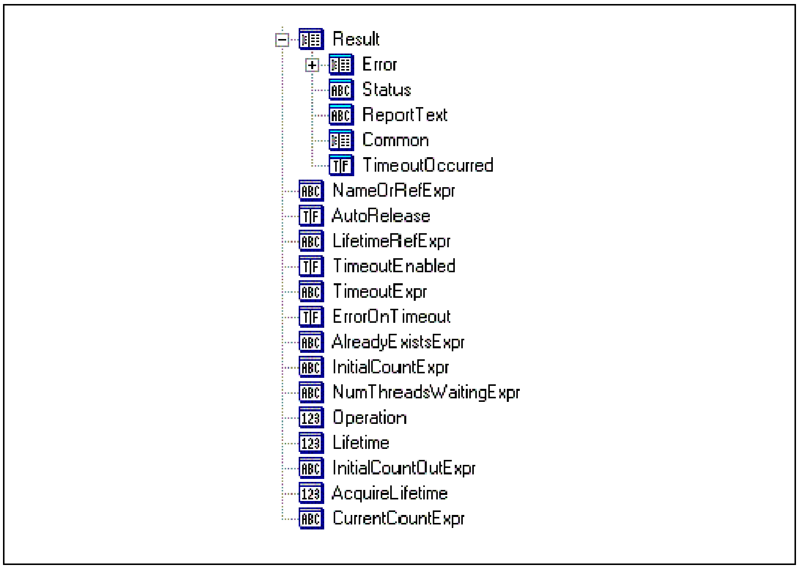
Figure 11-9. Get Status Operation for Semaphore Step Configuration Dialog Box

The Get Status operation contains the following controls:

- **Semaphore Name or Reference Expression**—Use this control to specify the semaphore on which to perform the operation. You can specify the semaphore by name or by the ActiveX reference you receive when you create the semaphore with the Using ActiveX Reference lifetime option.
- **Semaphore Exists?**—Use this control to specify a location to store a Boolean value that indicates whether the semaphore exists.
- **Number of Threads Waiting to Acquire the Semaphore**—Use this control to specify a location to store the number of threads waiting to acquire the semaphore.
- **Initial Semaphore Count**—Use this control to specify a location to store the initial semaphore count.
- **Current Count**—Use this control to specify a location to store the current value of the semaphore count.

Step Properties

Figure 11-10 shows the step properties for the Semaphore step type.



```
Result
    Error
    Status
    ReportText
    Common
    TimeoutOccurred
NameOrRefExpr
AutoRelease
LifetimeRefExpr
TimeoutEnabled
TimeoutExpr
ErrorOnTimeout
AlreadyExistsExpr
InitialCountExpr
NumThreadsWaitingExpr
Operation
Lifetime
InitialCountOutExpr
AcquireLifetime
CurrentCountExpr
```

Figure 11-10. Semaphore Step Properties

The Semaphore step type defines the following step properties in addition to the common custom properties.

- `Step.Result.TimeoutOccurred` is set to `True` if the Acquire operation times out. This property exists only if the step is configured for the Acquire operation.
- `Step.NameOrRefExpr` contains the Semaphore Name Expression for the Create operation and the Semaphore Name or Reference Expression for all of the other operations.
- `Step.AutoRelease` contains a Boolean value that specifies whether the Acquire operation automatically performs a Release when the Acquire lifetime expires.
- `Step.LifetimeRefExpr` contains the ActiveX Reference Expression for the semaphore lifetime or acquire lifetime when you set either lifetime to Use ActiveX Reference.
- `Step.TimeoutEnabled` contains the Timeout Enabled setting for the Acquire operation.
- `Step.TimeoutExpr` contains the Timeout Expression, in seconds, for the Acquire operation.
- `Step.ErrorOnTimeout` contains the Timeout Causes Run-Time Error setting for the Acquire operation.
- `Step.AlreadyExistsExpr` contains the Already Exists expression for the Create operation or the Semaphore Exists expression for the Get Status operation.
- `Step.InitialCountExpr` contains the numeric expression that the Create operation uses for the initial count of the semaphore.
- `Step.NumThreadsWaitingExpr` contains the Number of Threads Waiting to Acquire the Semaphore expression for the Get Status operation.
- `Step.Operation` contains a value that specifies the operation the step performs. The valid values are 0 = Create, 1 = Acquire, 2 = Release, 3 = Get Status.
- `Step.Lifetime` contains a value that specifies the lifetime setting for the Create operation. The valid values are 0 = Same as Sequence, 1 = Same as Thread, 2 = Use ActiveX Reference, 3 = Same as Execution.
- `Step.InitialCountOutExpr` contains the Initial Semaphore Count expression for the Get Status operation.
- `Step.AcquireLifetime` contains a value that specifies the lifetime setting for the Acquire operation. The valid values are 0 = Same as

Sequence, 1 = Same as Thread, 2 = Use ActiveX Reference. The Acquire operation uses this setting only when `Step.AutoRelease` is set to `True`.

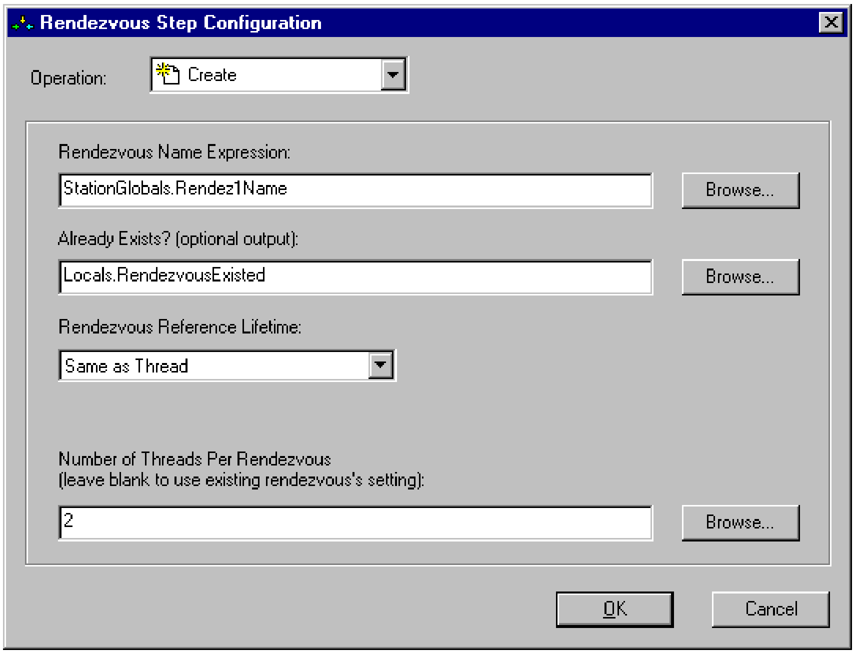
- `Step.CurrentCountExpr` contains the Current Count expression for the Get Status operation.

Rendezvous

Use a rendezvous to make threads wait for each other before they proceed past a location you specify. As each thread performs the rendezvous operation, it blocks. When the number of blocked threads reaches the total you specify when you create the rendezvous, the rendezvous unblocks all its waiting threads and they resume execution.

Create Operation

The rendezvous Create operation is shown below.



Operation: Create

Rendezvous Name Expression: StationGlobals.Rendez1Name

Already Exists? (optional output): Locals.RendezvousExisted

Rendezvous Reference Lifetime: Same as Thread

Number of Threads Per Rendezvous (leave blank to use existing rendezvous's setting): 2

Figure 11-11. Create Operation for Rendezvous Step Configuration Dialog Box

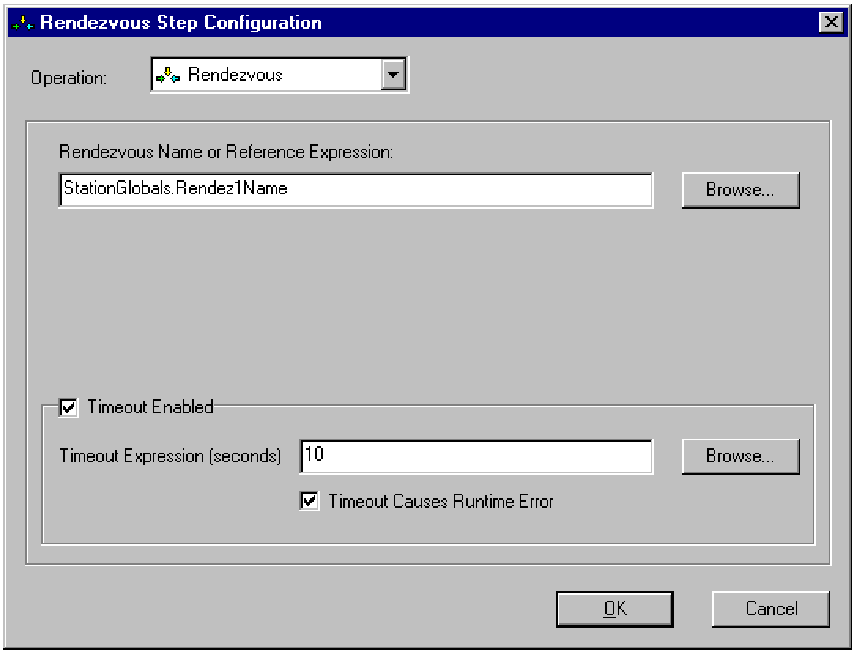
The Create operation contains the following controls:

- **Rendezvous Name Expression**—Use this control to specify a unique name for the synchronization object using a string literal or an expression that evaluates to a string. Refer to the *Common Attributes of Synchronization Objects* section of this document for more information on synchronization object names.

- **Already Exists**—Use this control to specify a location to store a Boolean value that indicates whether the synchronization object already exists.
- **Rendezvous Reference Lifetime**—Use this control to specify a lifetime for the reference to the synchronization object.
- **Number of Threads Per Rendezvous**—Use this control to specify the number of threads that must rendezvous before the step permits the threads to continue execution past the rendezvous point. This value must be greater than zero. If you know that the rendezvous already exists, you can leave this setting blank. If you specify a value different than the setting in the existing rendezvous, the step reports an error at run time.

Rendezvous Operation

The primary operation on a rendezvous step is the Rendezvous operation as shown below.



Operation: Rendezvous

Rendezvous Name or Reference Expression: StationGlobals.Rendez1Name

☑ Timeout Enabled

Timeout Expression (seconds) 10

☑ Timeout Causes Runtime Error

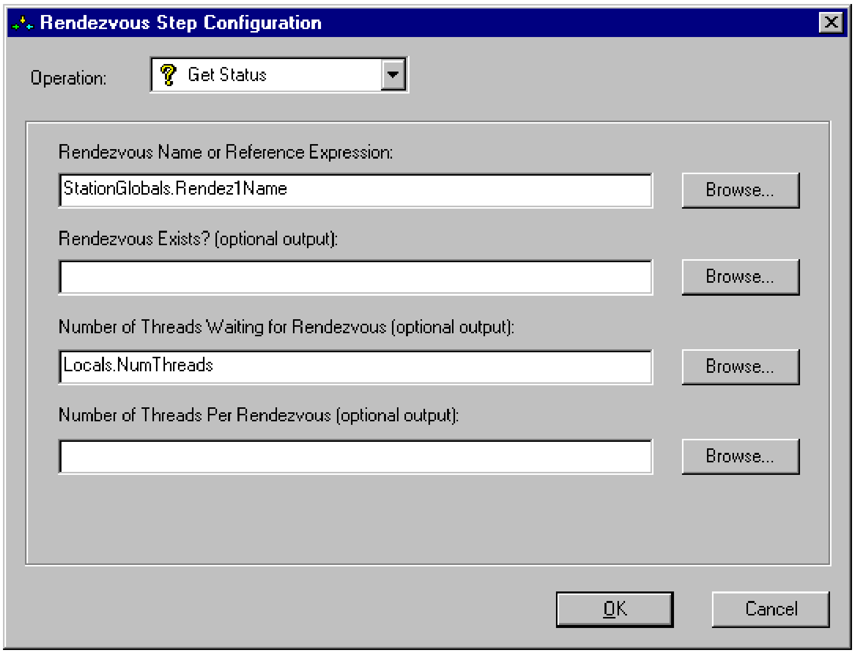
Figure 11-12. Rendezvous Operation for Rendezvous Step Configuration Dialog Box

The Rendezvous operation contains the following controls:

- **Rendezvous Name or Reference Expression**—Use this control to specify the rendezvous on which to perform the operation. You can specify the rendezvous by name or by the ActiveX reference you receive when you create the rendezvous with the Using ActiveX Reference lifetime option.
- **Timeout Enabled, Timeout Expression, Timeout Causes Run-Time Error**—Use these controls to specify a timeout and timeout behavior when waiting to rendezvous with other threads. If a timeout occurs, the property `Step.Result.TimeoutOccurred` is set to `True`.

Get Status Operation

You can use the Get Status operation to get information about a rendezvous' current state as shown below.



Operation: Get Status

Rendezvous Name or Reference Expression: StationGlobals.Rendez1Name

Rendezvous Exists? (optional output):

Number of Threads Waiting for Rendezvous (optional output): Locals.NumThreads

Number of Threads Per Rendezvous (optional output):

Figure 11-13. Get Status Operation for Rendezvous Step Configuration Dialog Box

The Get Status operation contains the following controls:

- **Rendezvous Name or Reference Expression**—Use this control to specify the rendezvous on which to perform the operation. You can specify the rendezvous by name or by the ActiveX reference you receive when you create the rendezvous with the Using ActiveX Reference lifetime option.

- **Rendezvous Exists?**—Use this control to specify a location to store a Boolean value that indicates whether the rendezvous exists.
- **Number of Threads Waiting for Rendezvous**—Use this control to specify a location to store the number of threads waiting on the rendezvous operation.
- **Number of Threads Per Rendezvous**—Use this control to specify a location to store the number of threads that must rendezvous before the step permits the threads to continue execution past the rendezvous point.

Step Properties

Figure 11-14 shows the step properties for the Rendezvous step type.

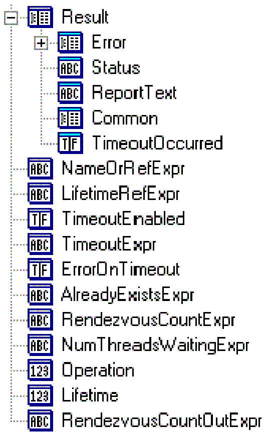


Figure 11-14. Rendezvous Step Properties

The Rendezvous step type defines the following step properties in addition to the common custom properties.

- `Step.Result.TimeoutOccurred` is set to `True` if the rendezvous operation times out. This property exists only if the step is configured for the rendezvous operation.
- `Step.NameOrRefExpr` contains the Rendezvous Name Expression for the Create operation and the Rendezvous Name or Reference Expression for other rendezvous operations.

- `Step.LifetimeRefExpr` contains the ActiveX Reference Expression for the rendezvous lifetime when you set the lifetime to Use ActiveX Reference.
- `Step.TimeoutEnabled` contains the Timeout Enabled setting for the rendezvous operation.
- `Step.TimeoutExpr` contains the Timeout Expression, in seconds, for the rendezvous operation.
- `Step.ErrorOnTimeout` contains the Timeout Causes Run-Time Error setting for the rendezvous operation.
- `Step.AlreadyExistsExpr` contains the Already Exists expression for the Create operation or the Rendezvous Exists expression for the Get Status operation.
- `Step.RendezvousCountExpr` contains the Number of Threads Per Rendezvous expression for the Create operation.
- `Step.NumThreadsWaitingExpr` contains the Number of Threads Waiting for Rendezvous expression for the Get Status operation.
- `Step.Operation` contains a value that specifies the operation the step performs. The valid values are 0 = Create, 1 = Rendezvous, 2 = Get Status.
- `Step.Lifetime` contains a value that specifies the lifetime for the Create operation. The valid values are 0 = Same as Sequence, 1 = Same as Thread, 2 = Use ActiveX Reference, 3 = Same as Execution.
- `Step.RendezvousCountOutExpr` contains the Number of Threads Per Rendezvous expression for the Get Status operation.

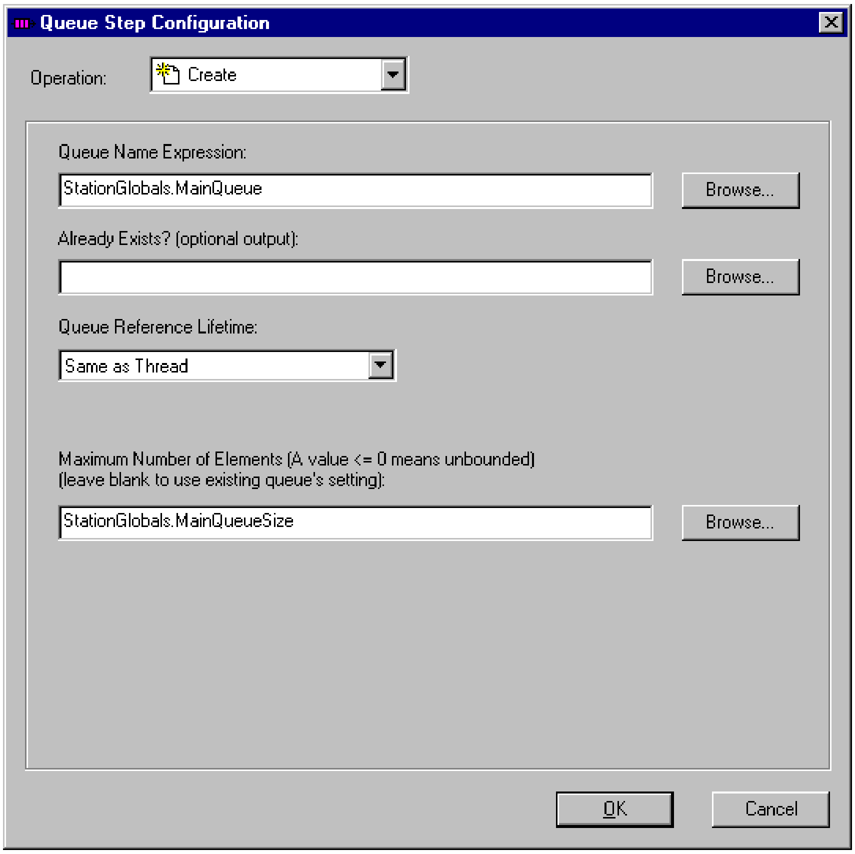
Queue

Use queue steps to synchronize the production and consumption of data among your threads. A queue has two primary operations, enqueue and dequeue. Enqueue places a data item on the queue and dequeue removes an item from the queue. Normally, the enqueue operation blocks when the queue is full and the dequeue operation blocks when the queue is empty. If multiple threads block on the same queue operation, the threads unblock in first in first out (FIFO) order.

Create Operation

To create a reference to a new or existing queue object, insert a Queue step and select **Configure Queue** from the context menu for the step.

Figure 11-15 shows the Queue Step Configuration dialog box with the Create operation selected.



Operation: Create

Queue Name Expression: StationGlobals.MainQueue

Already Exists? (optional output):

Queue Reference Lifetime: Same as Thread

Maximum Number of Elements (A value <= 0 means unbounded) (leave blank to use existing queue's setting): StationGlobals.MainQueueSize

Figure 11-15. Create Operation for Queue Step Configuration Dialog Box

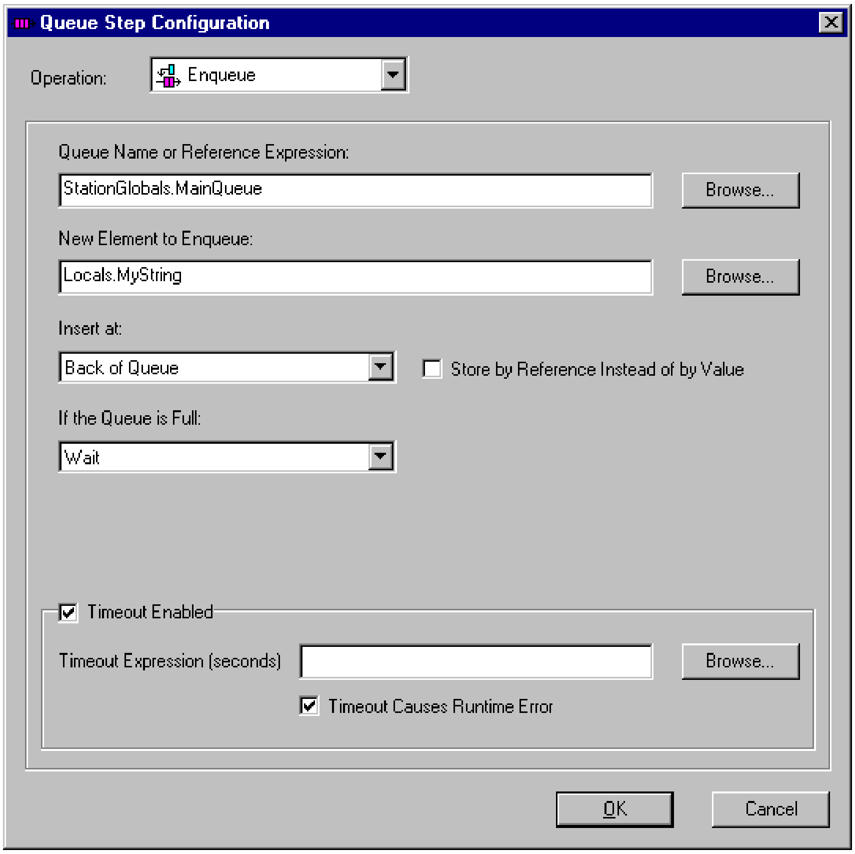
The Create operation contains the following controls:

- **Queue Name Expression**—Use this control to specify a unique name for the synchronization object using a string literal or an expression that evaluates to a string. Refer to the *Common Attributes of Synchronization Objects* section of this document for more information on synchronization object names.
- **Already Exists**—Use this control to specify a location to store a Boolean value that indicates whether the synchronization object already exists.
- **Queue Reference Lifetime**—Use this control to specify a lifetime for the reference to the synchronization object.

- **Maximum Number of Elements**—Use this control to specify the maximum number of items that the queue can store. A value less than or equal to zero specifies that the queue does not have a maximum number of elements. If you know that the queue already exists, you can leave this setting blank. If you specify value different than the maximum number of elements for the existing queue, the step reports an error at run time.

Enqueue Operation

Use the Enqueue operation, as shown below, to add new elements to the queue.


Queue Step Configuration

Operation: Enqueue

Queue Name or Reference Expression: StationGlobals.MainQueue

New Element to Enqueue: Locals.MyString

Insert at: Back of Queue

☐ Store by Reference Instead of by Value

If the Queue is Full: Wait

☑ Timeout Enabled

Timeout Expression (seconds):

☑ Timeout Causes Runtime Error

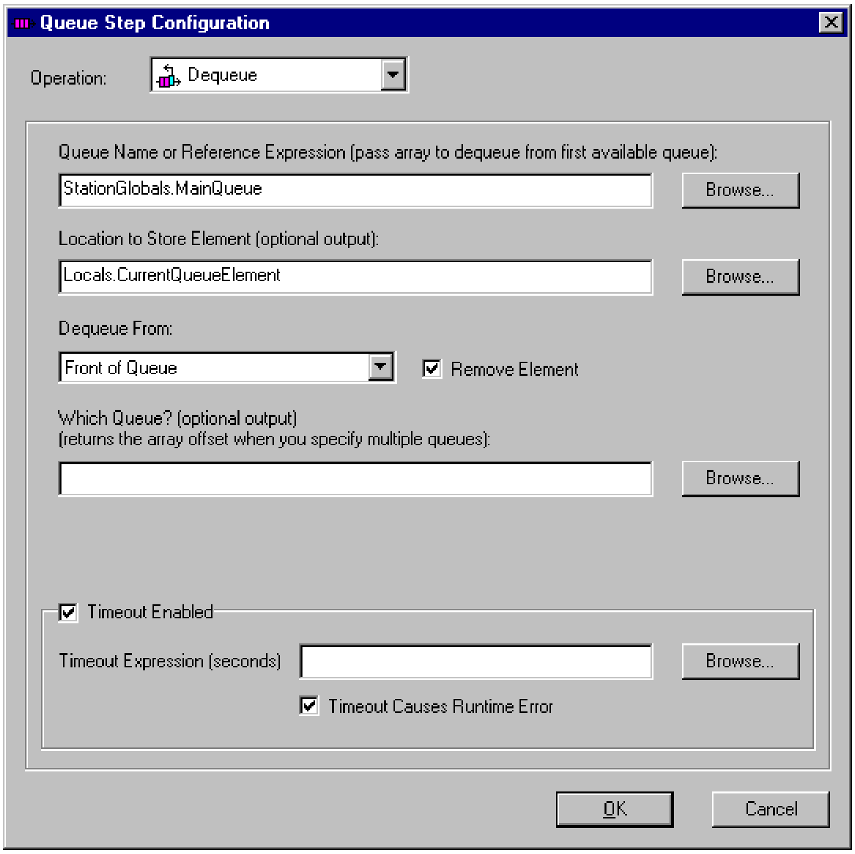
Figure 11-16. Enqueue Operation for Queue Step Configuration Dialog Box

The Enqueue operation contains the following controls:

- **Queue Name or Reference Expression**—Use this control to specify the queue on which to perform the operation. You can specify the queue by name or by the ActiveX reference you receive when you create the queue with the Using ActiveX Reference lifetime option.
- **New Element to Enqueue**—Use this control to specify the data to insert into the queue. The data can be any type, including a number, string, Boolean, ActiveX reference, structured type (container), or arrays of these types. When you dequeue the element you must specify a location with the appropriate type. By default, the queue stores a copy of the data you enqueue. However, if you enable the Store by Reference Instead of by Value option, the enqueue operation stores an ActiveX reference to the data value instead. When you dequeue this reference into an ActiveX reference variable, you can access the data using the TestStand API PropertyObject interface and the ActiveX Automation Adapter.
- **Insert At**—Use this control to specify where to store the new queue element. The choices are Back of Queue and Front of Queue.
- **Store by Reference Instead of by Value**—Use this control to specify how to store the data you specify in the New Element to Enqueue control. Enable the option if you want to store an ActiveX reference to the data. Disable the option if you want to store a copy of the data.
- **If the Queue is Full**—Use this control to specify what to do if the queue is full. The choices are Wait, Discard Front Element, Discard Back Element, and Do Not Enqueue. If you chose the Wait option, the thread blocks until the queue is no longer full. All other options return immediately.
- **Timeout Enabled, Timeout Expression, Timeout Causes Run-Time Error**—Use these controls to specify a timeout and timeout behavior for when the queue is full. The timeout only applies if you specify the Wait option for the If the Queue is Full setting. If a timeout occurs, the property `Step.Result.TimeoutOccurred` is set to `True`.

Dequeue Operation

Use the Dequeue operation, as shown below, to remove an element and/or store the data from an element.


Queue Step Configuration

Operation: Dequeue

Queue Name or Reference Expression (pass array to dequeue from first available queue): StationGlobals.MainQueue

Location to Store Element (optional output): Locals.CurrentQueueElement

Dequeue From: Front of Queue

[✓] Remove Element

Which Queue? (optional output)
(returns the array offset when you specify multiple queues):

[✓] Timeout Enabled

Timeout Expression (seconds)

[✓] Timeout Causes Runtime Error

Figure 11-17. Dequeue Operation for Queue Step Configuration Dialog Box

The Dequeue operation contains the following controls:

- **Queue Name or Reference Expression**—Use this control to specify the queue on which to perform the operation. You can specify the queue by name or by the ActiveX reference you receive when you create the queue with the Using ActiveX Reference lifetime option. You can specify multiple queues using either a string array containing the names of the queues, or an ActiveX reference array containing ActiveX references to the queues. When you specify multiple queues, the Dequeue operation dequeues an element from the first queue you specify that has an element available. You can ascertain which queue the operation dequeues from by using the Which Queue control to specify a location to store the array offset of the queue.

- **Location to Store Element**—Use this control to specify the location in which to store the queue element. You may leave this control blank if you do not want to store the data. The type of the location must be compatible with the data that the element stores. Table 11-1 and Table 11-2 illustrate the outcomes depending on the type of the data in the queue and the data type of the storage location. In these tables, Simple Type refers to a number, string, Boolean, or array of any type, and Structured Type refers to an instance of a user-defined type where the root property is a container.

Table 11-1. Dequeue Behaviors for Data You Enqueue by Value

Dequeue Type—Destination	Enqueue Type (By Value)—Source		
	Simple Type	**Structured Type**	**ActiveX Reference**
Simple Type	If types match, dequeue copies the data to the location you specify. If types do not match, dequeue reports a type mismatch error.	Type mismatch error.	Type mismatch error.
Structured Type	Type mismatch error.	Replaces the property you specify as the dequeue location with a copy of the structured value that the queue stores.	Type mismatch error.
ActiveX Reference	Type mismatch error.	Stores an ActiveX reference to the structured value that the queue stores.	Copies the ActiveX reference the queue stores to the location you specify.

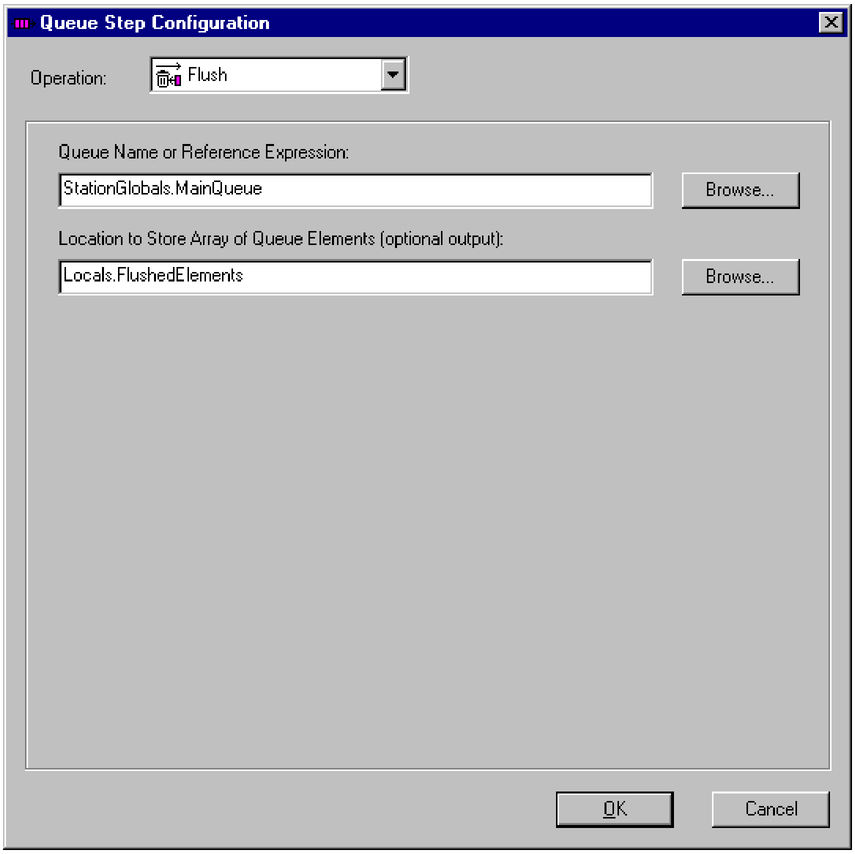
Table 11-2. Dequeue Behaviors for Data You Enqueue by Reference

Dequeue Type—Destination	Enqueue Type (By Reference)—Source		
	Simple Type	**Structured Type**	**ActiveX Reference**
Simple Type	If types match, dequeue copies the data to the location you specify. If types do not match, dequeue reports a type mismatch error.	Type mismatch error.	Type mismatch error.
Structured Type	Type mismatch error.	Makes a copy of the structured value that the queue stores by reference, and replaces the property you specify as the dequeue location with that copy.	Type mismatch error.
ActiveX Reference	Stores an ActiveX reference to the simple type as it is stored in the queue.	Stores an ActiveX reference to the structured value that the queue stores.	Stores an ActiveX reference to the ActiveX reference that the queue stores.

- **Dequeue From**—Use this control to specify where in the queue to dequeue from. The options are Front of Queue and Back of Queue.
- **Remove Element**—Use this control to specify whether the operation removes the element from the queue. If you do not enable this option, the operation retrieves the value of the element without removing it from the queue.
- **Which Queue**—Use this control to specify a location to store the array offset of the queue on which the dequeue operation occurs. Typically, you do not use this control unless you are dequeuing from multiple queues. See the description for the Queue Name or Reference Expression control for this operation for more information on dequeuing with multiple queues.
- **Timeout Enabled, Timeout Expression, Timeout Causes Run-Time Error**—Use these controls to specify a timeout and timeout behavior when waiting to dequeue an element. If a timeout occurs, the property `Step.Result.TimeoutOccurred` is set to `True`.

Flush Operation

Use the Flush operation, as shown below, to empty the queue and optionally retrieve all its elements.



Operation: Flush

Queue Name or Reference Expression: StationGlobals.MainQueue

Location to Store Array of Queue Elements (optional output): Locals.FlushedElements

Figure 11-18. Flush Operation for Queue Step Configuration Dialog Box

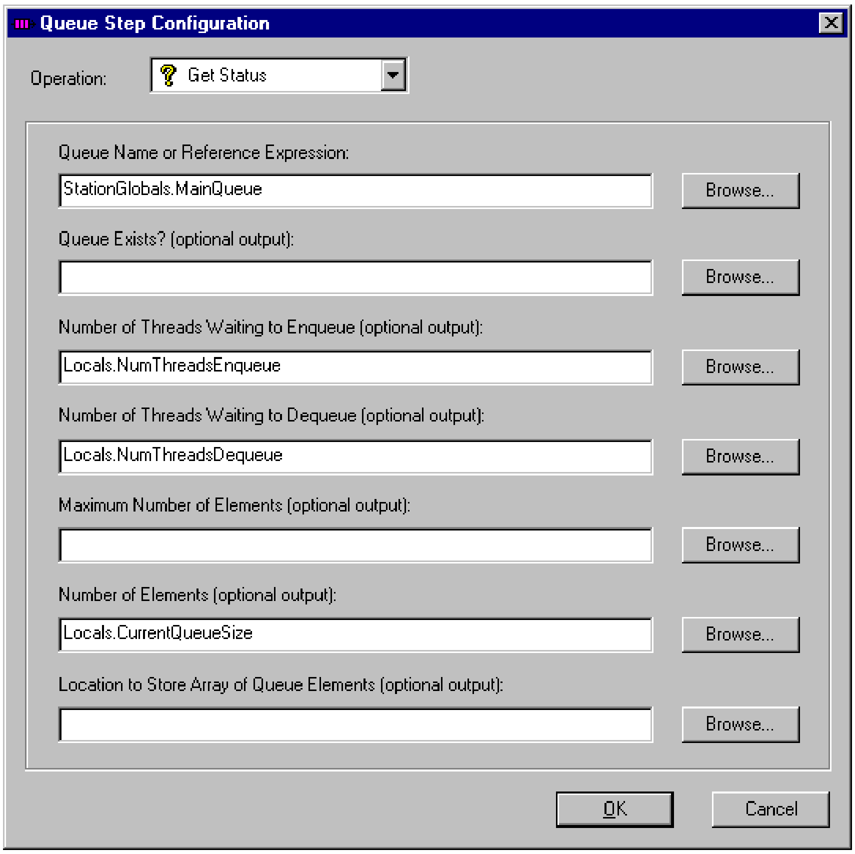
The Flush operation contains the following controls:

- **Queue Name or Reference Expression**—Use this control to specify the queue on which to perform the operation. You can specify the queue by name or by the ActiveX reference you receive when you create the queue with the Using ActiveX Reference lifetime option.
- **Location to Store Array of Queue Elements**—Use this control to specify an array property in which to store the elements of the queue. This output is optional. All queue elements must be of the same data

type as the array you specify and no queue element can be an array. The step reports a run-time error if you specify a value in this control and the queue items do not meet these conditions.

Get Status Operation

Use the Get Status operation, as shown below, to obtain information about the current state of a queue.



Operation: Get Status

Queue Name or Reference Expression: StationGlobals.MainQueue

Queue Exists? (optional output):

Number of Threads Waiting to Enqueue (optional output): Locals.NumThreadsEnqueue

Number of Threads Waiting to Dequeue (optional output): Locals.NumThreadsDequeue

Maximum Number of Elements (optional output):

Number of Elements (optional output): Locals.CurrentQueueSize

Location to Store Array of Queue Elements (optional output):

Figure 11-19. Get Status Operation for Queue Step Configuration Dialog Box

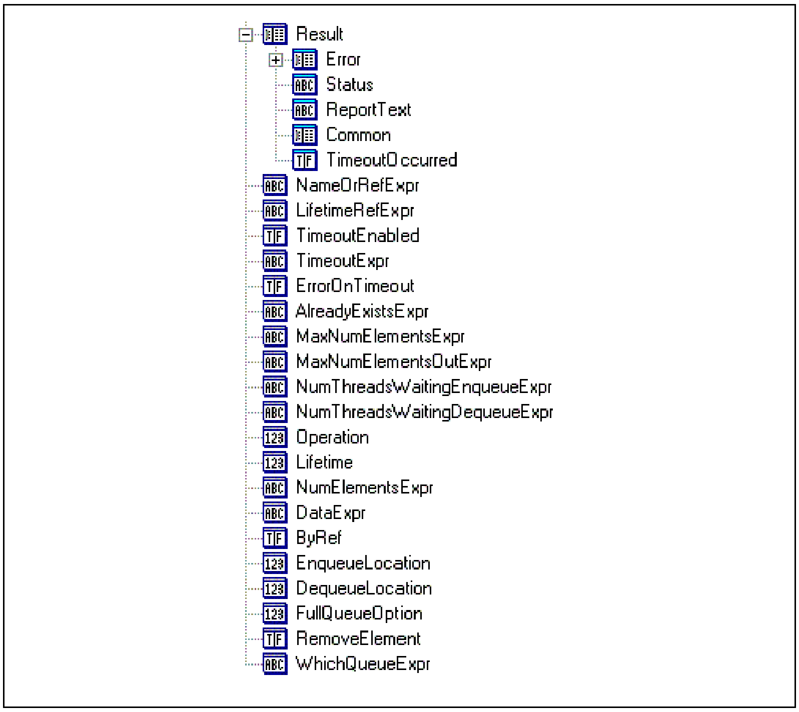
The Get Status operation contains the following controls:

- **Queue Name or Reference Expression**—Use this control to specify the queue on which to perform the operation. You can specify the queue by name or by the ActiveX reference you receive when you create the queue with the Using ActiveX Reference lifetime option.

- **Queue Exists**—Use this control to specify a location to store a Boolean value that indicates whether the synchronization object exists.
- **Number of Threads Waiting to Enqueue**—Use this control to specify a location to store the number of threads waiting to enqueue data.
- **Number of Threads Waiting to Dequeue**—Use this control to specify a location to store the number of threads waiting to dequeue data.
- **Maximum Number of Elements**—Use this control to specify a location to store the maximum number of elements of the queue.
- **Number of Elements**—Use this control to specify a location to store the number of elements in the queue.
- **Location to Store Array of Queue Elements**—Use this control to specify an array property in which to store the elements of the queue. This feature is optional. If you specify an array property in this control, all queue elements must be of the same data type as the array you specify, and no queue element can be an array. The step reports a run-time error if you specify a value in this control and the queue items do not meet these conditions.

Step Properties

Figure 11-20 shows the step properties for the Queue step type.



```
Result
    Error
    Status
    ReportText
    Common
    TimeoutOccurred
NameOrRefExpr
LifetimeRefExpr
TimeoutEnabled
TimeoutExpr
ErrorOnTimeout
AlreadyExistsExpr
MaxNumElementsExpr
MaxNumElementsOutExpr
NumThreadsWaitingEnqueueExpr
NumThreadsWaitingDequeueExpr
Operation
Lifetime
NumElementsExpr
DataExpr
ByRef
EnqueueLocation
DequeueLocation
FullQueueOption
RemoveElement
WhichQueueExpr
```

Figure 11-20. Queue Step Properties

The Queue step type defines the following step properties in addition to the common custom properties.

- `Step.Result.TimeoutOccurred` is set to `True` if an Enqueue or Dequeue operation times out. This property exists only if the step is configured for the Enqueue or Dequeue operation.
- `Step.NameOrRefExpr` contains the Queue Name Expression for the Create operation and the Queue Name or Reference Expression for all other operations. In the case of the Dequeue operation, this expression can specify an array of names or references.
- `Step.LifetimeRefExpr` contains the ActiveX Reference Expression for the queue lifetime when you set the lifetime to Use ActiveX Reference.

- `Step.TimeoutEnabled` contains the Timeout Enabled setting for the Enqueue or Dequeue operation.
- `Step.TimeoutExpr` contains the Timeout Expression, in seconds, for the Enqueue or Dequeue operation.
- `Step.ErrorOnTimeout` contains the Timeout Causes Run-Time Error setting for the Enqueue or Dequeue operation.
- `Step.AlreadyExistsExpr` contains the Already Exists expression for the Create operation or the Queue Exists expression for the Get Status operation.
- `Step.MaxNumElementsExpr` contains the expression that specifies the maximum number of elements of the queue for the Create operation.
- `Step.MaxNumElementsOutExpr` contains the expression that specifies where to store the maximum number of elements of the queue for the Get Status operation.
- `Step.NumThreadsWaitingEnqueueExpr` contains the expression that specifies where to store the number of threads that are waiting to enqueue for the Get Status operation.
- `Step.NumThreadsWaitingDequeueExpr` contains the expression that specifies where to store the number of threads that are waiting to dequeue for the Get Status operation.
- `Step.Operation` contains a value that specifies the operation the step performs. The valid values are 0 = Create, 1 = Enqueue, 2 = Dequeue, 3 = Flush, 4 = Get Status.
- `Step.Lifetime` contains a value that specifies the lifetime setting for the Create operation. The valid values are 0 = Same as Sequence, 1 = Same as Thread, 2 = Use ActiveX Reference, 3 = Same as Execution.
- `Step.NumElementsExpr` contains the expression that specifies where to store the current number of elements in the queue for the Get Status operation.
- `Step.DataExpr` contains the New Element to Enqueue expression when you configure the step for the Enqueue operation, the Location to Store Element expression when you configure the step for the Dequeue operation, and the Location to Store Array of Queue Elements expression when you configure the step for the Flush or Get Status operation.

- `Step.ByRef` contains the Boolean value that specifies whether the step stores a queue element by ActiveX reference instead of by value for the Enqueue operation.
- `Step.EnqueueLocation` contains a value that specifies the location to store the queue element for the Enqueue operation. The valid values are 0 = Front of Queue, 1 = Back of Queue
- `Step.DequeueLocation` contains a value that specifies the location to remove the queue element from for the Dequeue operation. The valid values are 0 = Front of Queue, 1 = Back of Queue
- `Step.FullQueueOption` contains a value that specifies the options for the If the Queue is Full setting of the Enqueue operation. The valid values are 0 = Wait, 1 = Discard Front Element, 2 = Discard Back Element, 3 = Do Not Enqueue.
- `Step.RemoveElement` contains a Boolean value that specifies whether the step removes the element from the queue when it performs the Dequeue operation.
- `Step.WhichQueueExpr` contains the expression that specifies where to store the array offset of the queue on which the Dequeue operation occurs.

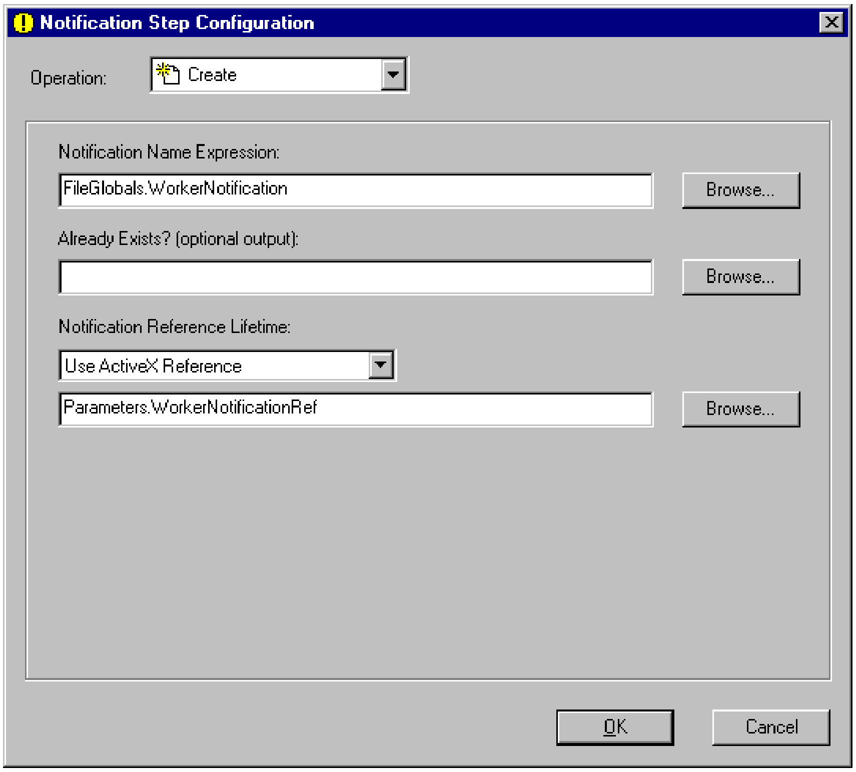
Notification

Use Notification steps to notify one or more threads when a particular event or condition has been met. You also can pass data to the threads you notify.

Create Operation

To create a reference to a new or existing notification object, insert a Notification step and select **Configure Notification** from the context menu for the step.

Figure 11-21 shows the Notification Step Configuration dialog box with the Create operation selected.



Operation: Create

Notification Name Expression: FileGlobals.WorkerNotification

Already Exists? (optional output):

Notification Reference Lifetime: Use ActiveX Reference

Parameters.WorkerNotificationRef

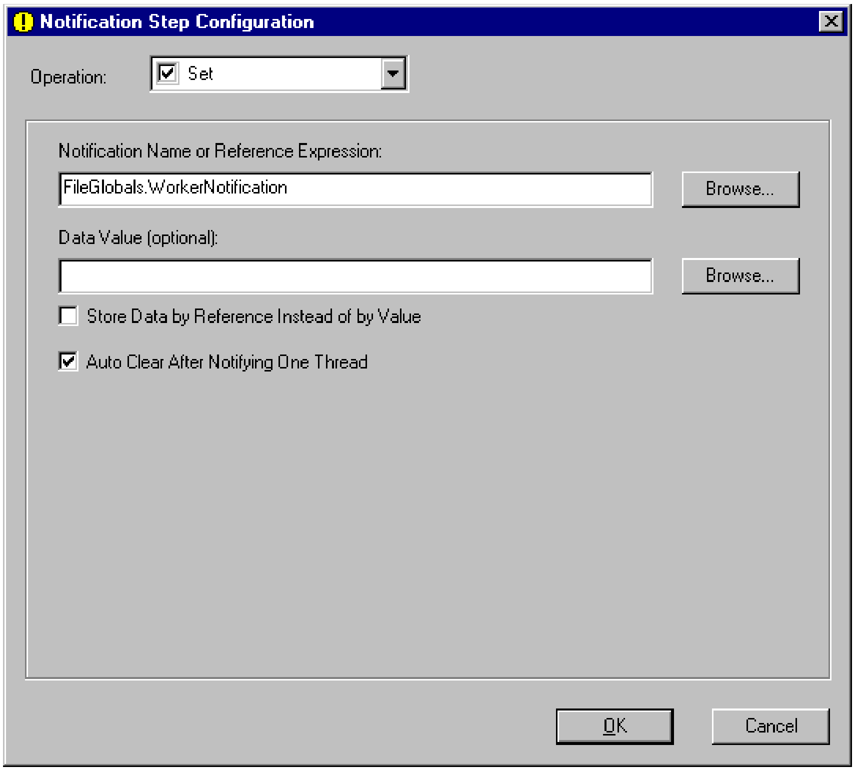
Figure 11-21. Create Operation for Notification Step Configuration Dialog Box

The Create operation contains the following controls:

- **Notification Name Expression**—Use this control to specify a unique name for the synchronization object using a string literal or an expression that evaluates to a string. Refer to the *Common Attributes of Synchronization Objects* section of this document for more information on synchronization object names.
- **Already Exists**—Use this control to specify a location to store a Boolean value that indicates whether the synchronization object already exists.
- **Notification Reference Lifetime**—Use this control to specify the lifetime of the reference to the synchronization object.

Set Operation

Use the Set operation to notify one or more threads that an event has occurred or a condition has been met. When the notification is in a Set state, Wait operations on the notification succeed immediately. The Set operation is shown below.



Operation: [✓] Set

Notification Name or Reference Expression: FileGlobals.WorkerNotification

Data Value (optional):

[ ] Store Data by Reference Instead of by Value

[✓] Auto Clear After Notifying One Thread

Figure 11-22. Set Operation for Notification Step Configuration Dialog Box

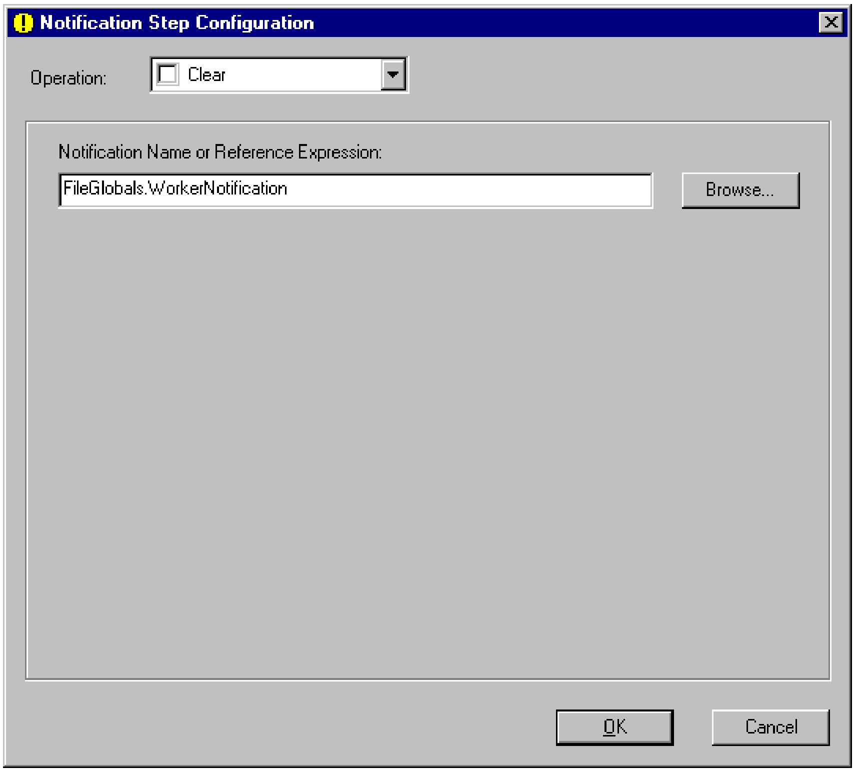
The Set operation contains the following controls:

- **Notification Name or Reference Expression**—Use this control to specify the notification on which to perform the operation. You can specify the notification by name or by the ActiveX reference you receive when you create the notification with the Using ActiveX Reference lifetime option.

- **Data Value**—Use this control to specify an optional data element to store with the set state of the notification. Threads that wait on the notification can then optionally retrieve this data. The data can be any type, including a number, string, Boolean, ActiveX reference, structured type (container), or arrays of these types. When you later wait on the notification, you must store the element into a location with the appropriate type. By default, the notification stores a copy of the value. However, if you enable the Store Data by Reference Instead of by Value option, the operation stores an ActiveX reference to the value instead. If you later store this reference into an ActiveX reference variable in the Wait operation, you can access the data using the TestStand API PropertyObject interface and the ActiveX Automation Adapter.
- **Store Data by Reference Instead of by Value**—Use this control to specify how to store the data you specify in the Data Value control. Enable the option if you want to store an ActiveX reference to the property. Disable the option if you want to store a copy of the data.
- **Auto Clear After Notifying One Thread**—Use this control to specify whether to clear the state of the notification after one thread receives the notification. Once you clear the state of a notification, subsequent Wait operations block until you perform another Set operation.

Clear Operation

Use the Clear operation, as shown below, to clear the state of a notification so that subsequent Wait operations block until the next Set operation.



Operation: Clear

Notification Name or Reference Expression: FileGlobals.WorkerNotification

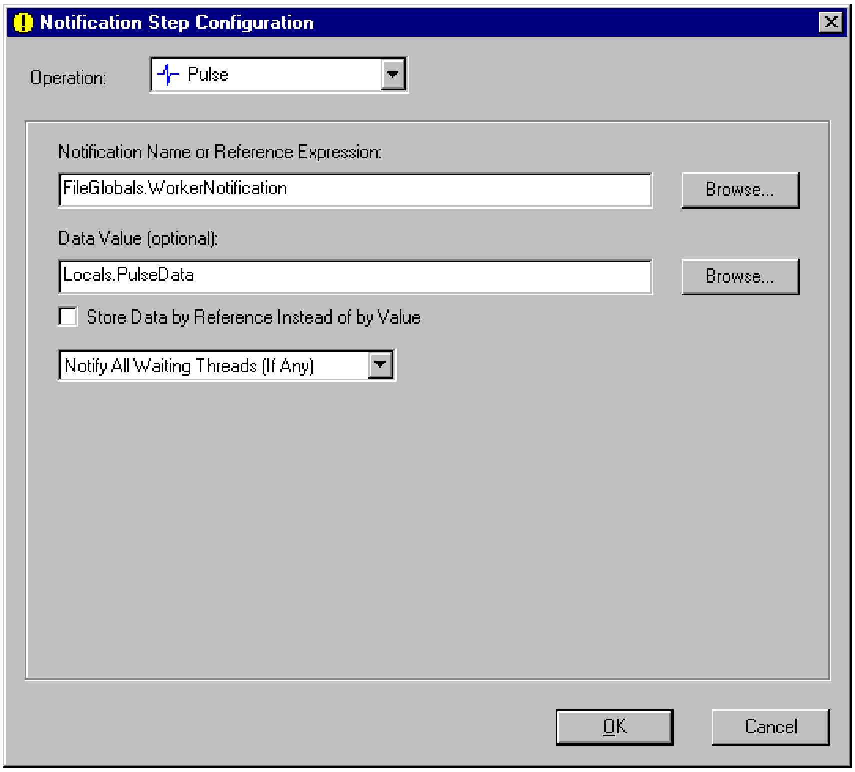
Figure 11-23. Clear Operation for Notification Step Configuration Dialog Box

The Clear operation contains the following controls:

- **Notification Name or Reference Expression**—Use this control to specify the notification on which to perform the operation. You can specify the notification by name or by the ActiveX reference you receive when you create the notification with the Using ActiveX Reference lifetime option.

Pulse Operation

Use the Pulse operation to notify one or all currently waiting threads. This operation differs from the Set operation in that it notifies only threads that are already waiting when the Pulse operation occurs. Threads that wait on the notification after a Pulse operation occurs block until you Set or Pulse the notification again. A Pulse operation places the notification in a Cleared state, even if the notification was in a Set state before the Pulse operation. The Pulse operation is shown below.


Notification Step Configuration

Operation: Pulse

Notification Name or Reference Expression: FileGlobals.WorkerNotification

Data Value (optional): Locals.PulseData

Store Data by Reference Instead of by Value: unchecked

Notify All Waiting Threads (If Any)

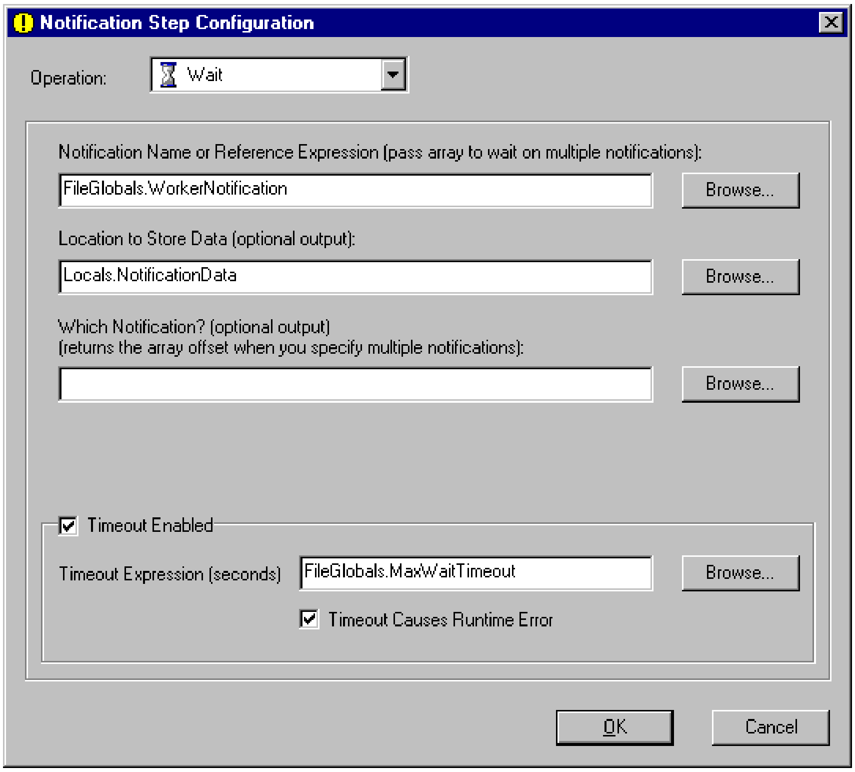
Figure 11-24. Pulse Operation for Notification Step Configuration Dialog Box

4. **Notification Name or Reference Expression**—Use this control to specify the notification on which to perform the operation. You can specify the notification by name or by the ActiveX reference you receive when you create the notification with the Using ActiveX Reference lifetime option.

- **Data Value**—Use this control to specify an optional data element to send with the pulse notification. The data can be of any type (number, string, Boolean, ActiveX reference, structured type (container), or arrays of these types). When you later wait on the notification, you must store the element into a location of an appropriate type. By default, the notification stores a copy of the data value you specify. However, if you enable the Store Data by Reference Instead of by Value option, the operation stores an ActiveX reference to the value instead. If you later store this reference into an ActiveX reference variable in the Wait operation, you can access the data using the TestStand API PropertyObject interface and the ActiveX Automation Adapter.
- **Store Data by Reference Instead of by Value**—Use this control to specify how to store the data you specify in the Data Value control. Enable the option to store an ActiveX reference to the property. Leave the option disabled to store a copy of the data.
- **Notify All/First Waiting Thread/s (If Any)**—Use this control to specify whether to notify all currently waiting threads or just the first waiting thread.

Wait Operation

Use the Wait operation to wait until you Set or Pulse the notification. If the notification is already in a Set state, the Wait operation completes immediately. The Wait operation is shown below.



Operation: Wait

Notification Name or Reference Expression (pass array to wait on multiple notifications): FileGlobals.WorkerNotification

Location to Store Data (optional output): Locals.NotificationData

Which Notification? (optional output)
(returns the array offset when you specify multiple notifications):

☑ Timeout Enabled

Timeout Expression (seconds) FileGlobals.MaxWaitTimeout

☑ Timeout Causes Runtime Error

Figure 11-25. Wait Operation for Notification Step Configuration Dialog Box

The Wait operation contains the following controls:

- **Notification Name or Reference Expression (can pass array)**—Use this control to specify the notification on which to perform the operation. You can specify the notification by name or by the ActiveX reference you receive when you create the notification with the Using ActiveX Reference lifetime option. The Wait operation allows you to specify multiple notifications using either a string array containing the names of the notifications or an ActiveX reference array containing ActiveX references to the notifications. When you specify multiple notifications, the Wait operation waits until you Set or Pulse any of the notifications in the array. If you Set or Pulse more than one of the notifications, the Wait operation responds to the notification that appears first in the array. To ascertain which notification the Wait operation responds to, use the Which Notification control to specify a location to store the array offset of the notification.

- **Location to Store Data**—Use this control to specify a location to store the notification data. You may leave this control blank if you do not want to store the data. The type of the location must be compatible with the data that the notification sends. Table 11-3 and Table 11-4 illustrate the wait outcome depending on the type of the data and the data type of the storage location. In these tables, Simple Type refers to a number, string, Boolean, or array of any type, and Structured Type refers to an instance of a user-defined type where the root property is a container.

Table 11-3. Wait Behaviors for Data Set or Pulsed by Value

Storage Type—Destination	Set or Pulse Data Type (By Value)—Source		
	Simple Type	**Structured Type**	**ActiveX Reference**
Simple Type	If the types match, the step copies the data to the location you specify. If the types do not match, the step reports a type mismatch error.	Type mismatch error.	Type mismatch error.
Structured Type	Type mismatch error.	Replaces the property you specify as the storage location with a copy of the structured value that the notification stores.	Type mismatch error.
ActiveX Reference	Type mismatch error.	Stores an ActiveX reference to the structured value that the notification stores.	Copies the ActiveX reference the notification stores to the location you specify.

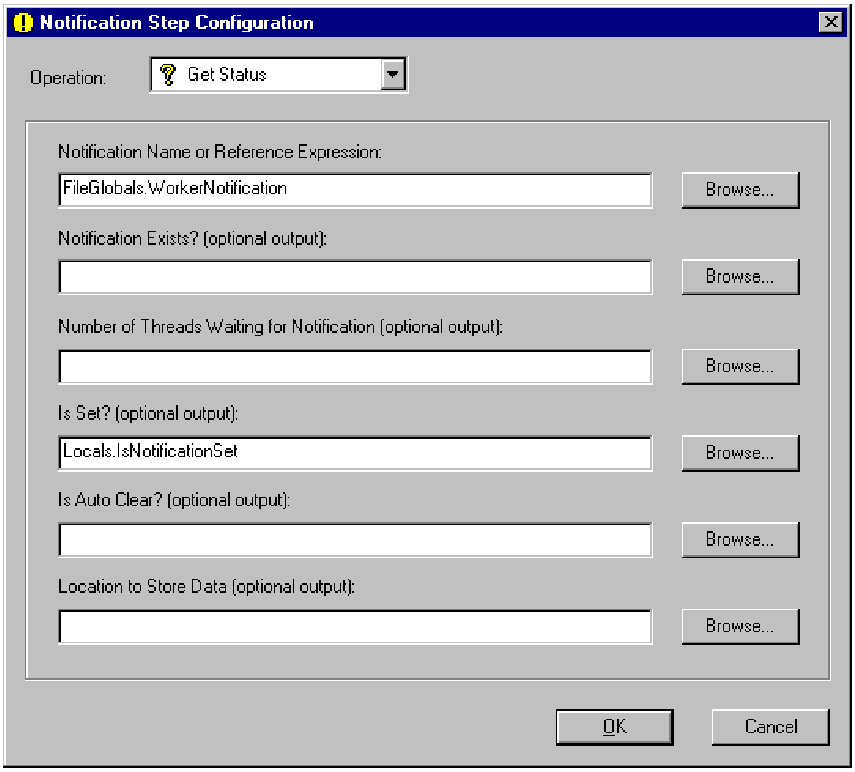
Table 11-4. Wait Behaviors for Data Set or Pulsed by Reference

Storage Type—Destination	Set or Pulse Data Type (By Reference)—Source		
	Simple Type	**Structured Type**	**ActiveX Reference**
Simple Type	If the types match, the step copies the data to the location you specify. If the types do not match, the step reports a type mismatch error.	Type mismatch error.	Type mismatch error.
Structured Type	Type mismatch error.	Makes a copy of the structured value the notification stores by reference and replaces the property you specify as the storage location with the copy.	Type mismatch error.
ActiveX Reference	Stores an ActiveX reference to the simple type that the notification stores.	Stores an ActiveX reference to the structured value that the notification stores.	Stores an ActiveX reference to the ActiveX reference that the notification stores.

- **Which Notification**—Use this control to specify a location to store the array offset of the notification to which the operation responds. Typically, you do not use this control unless you wait on multiple notifications. Refer to description for the Notification Name or Reference Expression control for this operation for more information on waiting for multiple notifications.
- **Timeout Enabled, Timeout Expression, Timeout Causes Run-Time Error**—Use these controls to specify a timeout and timeout behavior when waiting for a notification. If a timeout occurs, the property `Step.Result.TimeoutOccurred` is set to `True`.

Get Status Operation

Use the Get Status operation, as shown below, to get information about the state of the notification object.



Operation: Get Status

Notification Name or Reference Expression: FileGlobals.WorkerNotification

Notification Exists? (optional output):

Number of Threads Waiting for Notification (optional output):

Is Set? (optional output): Locals.IsNotificationSet

Is Auto Clear? (optional output):

Location to Store Data (optional output):

Figure 11-26. Get Status Operation for Notification Step Configuration Dialog Box

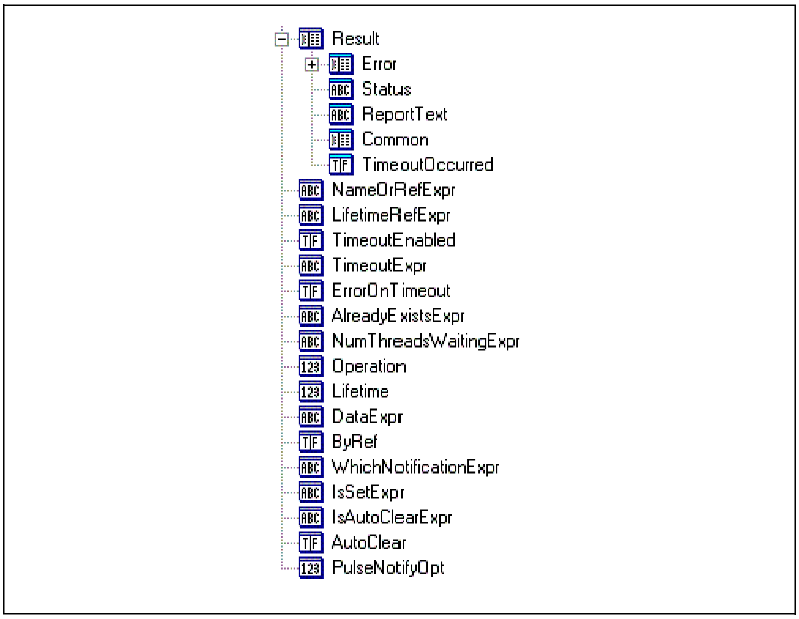
The Get Status operation contains the following controls:

- **Notification Name or Reference Expression**—Use this control to specify the synchronization object on which to perform the operation. You can specify the notification by name or by the ActiveX reference you receive when you create the notification with the Using ActiveX Reference lifetime option.
- **Notification Exists**—Use this control to specify a location to store a Boolean value that indicates whether the synchronization object exists.
- **Number of Threads Waiting for Notification**—Use this control to specify a location to store a numeric value that corresponds to the number of threads waiting on the notification.

- **Is Set**—Use this control to specify a location to store a Boolean value that indicates whether the notification is in a Set state.
- **Is Auto Clear**—Use this control to specify a location to store a Boolean value that indicates whether the notification clears itself after one thread receives the notification. The value of this setting is only meaningful if the notification is in a Set state.
- **Location to Store Data**—Use this control to specify a location to store the notification data, if any. You may leave this control blank if you do not want to store the data. The type of the location must be compatible with the data that the notification sends. Refer to the description of the Location to Store Data control for the Wait operation for more information about data type compatibility.

Step Properties

Figure 11-27 shows the step properties for the Notification step type.



```
Result
    Error
    Status
    ReportText
    Common
    TimeoutOccurred
NameOrRefExpr
LifetimeRefExpr
TimeoutEnabled
TimeoutExpr
ErrorOnTimeout
AlreadyExistsExpr
NumThreadsWaitingExpr
Operation
Lifetime
DataExpr
ByRef
WhichNotificationExpr
IsSetExpr
IsAutoClearExpr
AutoClear
PulseNotifyOpt
```

Figure 11-27. Notification Step Properties

The Notification step type defines the following step properties in addition to the common custom properties.

- `Step.Result.TimeoutOccurred` is set to `True` if a Wait operation times out. This property exists only if the step is configured for the Wait operation.

- `Step.NameOrRefExpr` contains the Notification Name Expression for the Create operation and the Notification Name or Reference Expression for all other operations. In the case of the Wait operation, this expression can optionally specify an array of names or references.
- `Step.LifetimeRefExpr` contains the ActiveX reference expression for the notification lifetime when you set the lifetime to Use ActiveX Reference.
- `Step.TimeoutEnabled` contains the Timeout Enabled setting for the Wait operation.
- `Step.TimeoutExpr` contains the Timeout Expression, in seconds, for the Wait operation.
- `Step.ErrorOnTimeout` contains the Timeout Causes Run-Time Error setting for the Wait operation.
- `Step.AlreadyExistsExpr` contains the Already Exists expression for the Create operation or the Notification Exists expression for the Get Status operation.
- `Step.NumThreadsWaitingExpr` contains the expression that specifies where to store the number of threads that are waiting on the notification for the Get Status operation.
- `Step.Operation` contains a value that specifies the operation the step is set to perform. The valid values are 0 = Create, 1 = Set, 2 = Clear, 3 = Pulse, 4 = Wait, 5 = Get Status.
- `Step.Lifetime` contains a value that specifies the lifetime setting for the Create operation. The valid values are 0 = Same as Sequence, 1 = Same as Thread, 2 = Use ActiveX Reference, 3 = Same as Execution.
- `Step.DataExpr` contains the Data Value expression for the Set or Pulse operation, or the Location to Store Data expression for the Wait or Get Status operation.
- `Step.ByRef` contains the Boolean value that specifies whether to store the data by ActiveX reference instead of by value for a Set or Pulse operation.
- `Step.WhichNotificationExpr` contains the expression that specifies where to store the array offset of the notification to which the Wait operation responds.
- `Step.IsSetExpr` contains the expression that specifies where to store the Boolean value that indicates whether the notification is in a Set state. The Get Status operation uses this expression.

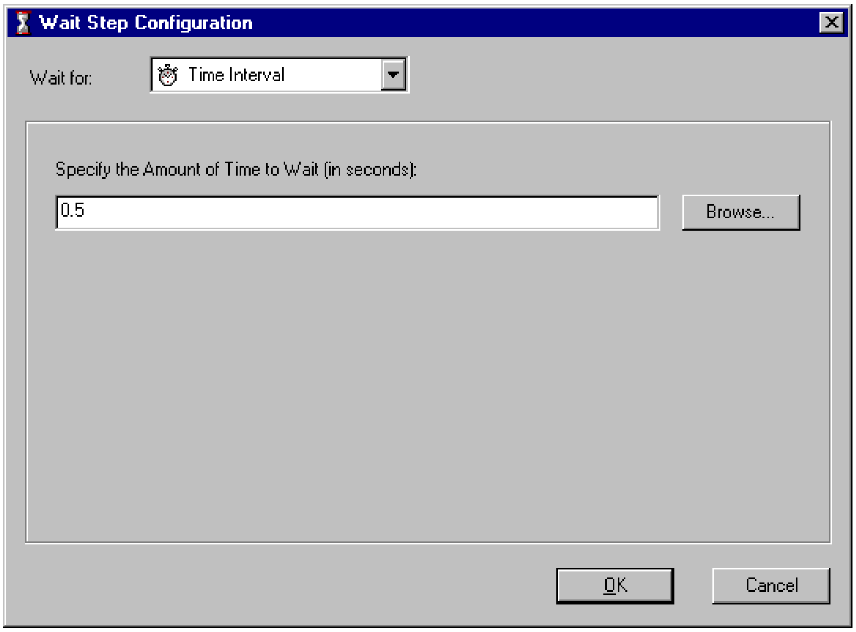
- `Step.IsAutoClearExpr` contains the expression that specifies where to store the Boolean value that indicates whether the notification is configured to auto clear. The Get Status operation uses this expression.
- `Step.AutoClear` contains the Auto Clear setting for the Set operation.
- `Step.PulseNotifyOpt` contains the setting for the Pulse operation that indicates the threads to which a pulse notification is sent. The valid values are 0 = Notify First Waiting Thread, 1 = Notify All Waiting Threads.

Wait

Use Wait steps to wait for an execution or thread to complete or for a time interval to elapse.

Wait for Time Interval Operation

The Wait for Time Interval operation causes a thread to wait for a duration you specify. The thread sleeps while it waits and so relinquishes its processing time to other threads.



Wait Step Configuration

Wait for: Time Interval

Specify the Amount of Time to Wait (in seconds): 0.5

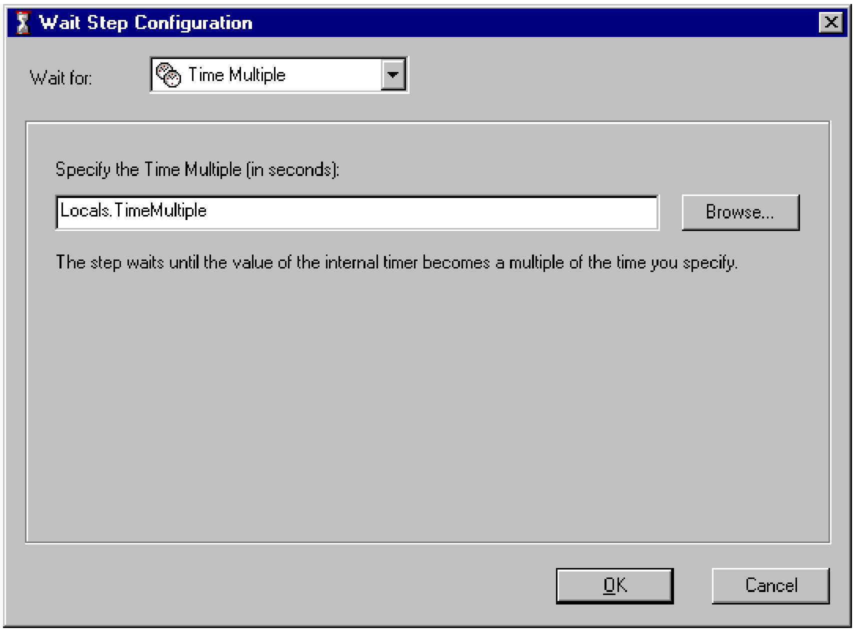
Figure 11-28. Wait for Time Interval Operation for Wait Step Configuration Dialog Box

The Wait for Time Interval operation contains the following control:

- **Specify the Amount of Time to Wait**—Use this control to specify a numeric expression that indicates the amount of time for the thread to wait in seconds.

Wait for Time Multiple Operation

Use the Wait for Time Multiple operation of the Wait step type to cause a thread to wait until the value of the internal timer becomes a multiple of the time you specify.



Locals.TimeMultiple

The step waits until the value of the internal timer becomes a multiple of the time you specify.

Figure 11-29. Wait for Time Multiple Operation for Wait Step Configuration Dialog Box

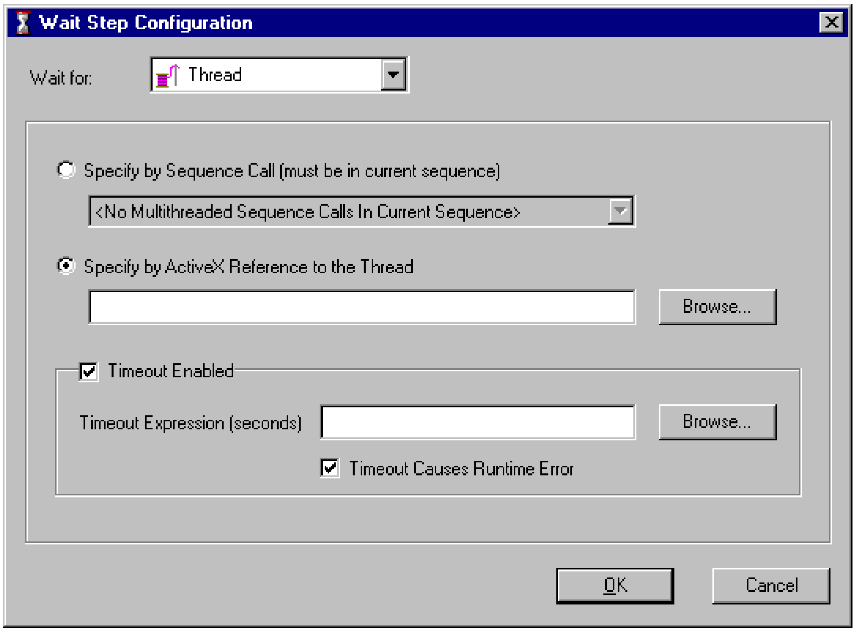
The Wait for Time Multiple operation contains the following control:

- **Specify the Time Multiple**—Use this control to specify a numeric expression that indicates the time multiple to use to decide how long to wait.

A common use of the Wait for Time Multiple operation is to force a loop to cycle at a specific rate.

Wait for Thread Operation

Use the Wait for Thread operation to wait for a TestStand thread to finish executing.



Specify by Sequence Call (must be in current sequence)

<No Multithreaded Sequence Calls In Current Sequence>

[✓ Specify by ActiveX Reference to the Thread]

[✓] Timeout Enabled

Timeout Expression (seconds)

[✓] Timeout Causes Runtime Error

Figure 11-30. Wait for Thread Operation for Wait Step Configuration Dialog Box

The Wait for Thread operation contains the following controls:

- **Specify by Sequence Call**—Use this control to specify the thread to wait for by selecting a sequence call within the same sequence as the wait step. You can only specify sequence calls that run in a new thread.
- **Specify by ActiveX Reference to Thread**—Use this control to specify the thread to wait for by using an ActiveX reference to the thread. When you specify the thread with a reference variable, you can refer to threads that other sequences and executions create.
- **Timeout Enabled, Timeout Expression, Timeout, Causes Run-Time Error**—Use these controls to specify a timeout and timeout behavior when waiting for the thread to finish executing. If a timeout occurs, the property `Step.Result.TimeoutOccurred` is set to `True`.

Wait for Execution Operation

Use the Wait for Execution operation to wait for the completion of a TestStand execution.

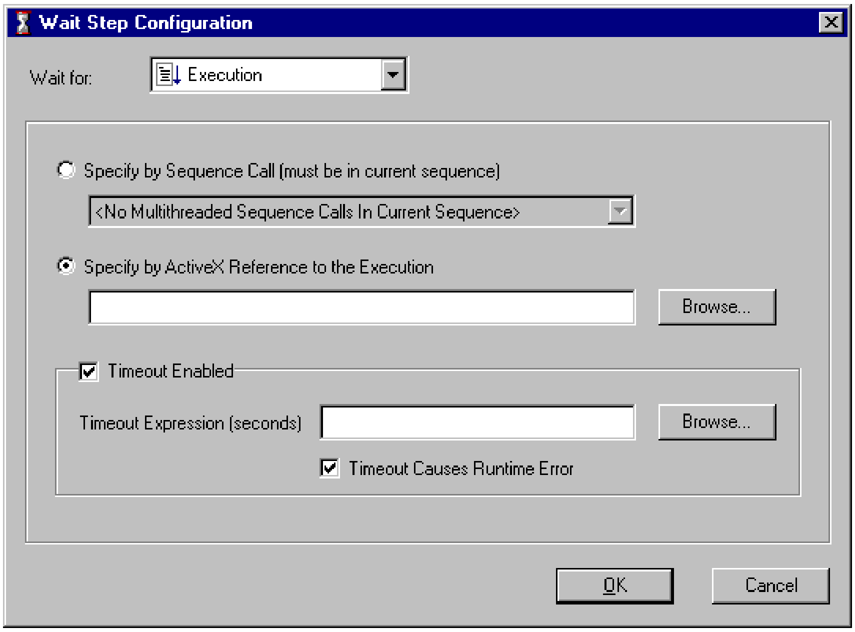

Wait Step Configuration
Wait for:
Execution
Specify by Sequence Call (must be in current sequence)
<No Multithreaded Sequence Calls In Current Sequence>
Specify by ActiveX Reference to the Execution
Browse...
Timeout Enabled
Timeout Expression (seconds)
Browse...
Timeout Causes Runtime Error
OK
Cancel

Figure 11-31. Wait for Execution Operation for Wait Step Configuration Dialog Box

The Wait for Execution operation contains the following controls:

- **Specify by Sequence Call**—Use this control to specify the execution to wait for by selecting a sequence call within the same sequence as the wait step. You can only specify sequence calls that run in a new execution.
- **Specify an ActiveX Reference to the Execution**—Use this control to specify an ActiveX reference to the TestStand execution on which to wait.
- **Timeout Enabled, Timeout Expression, Timeout Causes Run-Time Error**—Use these controls to specify a timeout and timeout behavior when waiting for an execution. If a timeout occurs, the property `Step.Result.TimeoutOccurred` is set to `True`.

Retrieving the Results from Executions and Threads

When the thread or execution completes, the Wait step copies the result status and error information for the thread or execution to its own status and error properties. Thus, if a Wait step waits on a sequence that fails, the status of the wait step is `Failed`.

The result list entry for a Wait step contains a `TS.AsyncSequenceCall.ResultList` property which is the result list for the thread or execution. You can also access the same result list in the `TS.SequenceCall.ResultList` property in the result for the sequence call step that launches the thread or execution.

Step Properties

Figure 11-32 shows the step properties for the Wait step type.

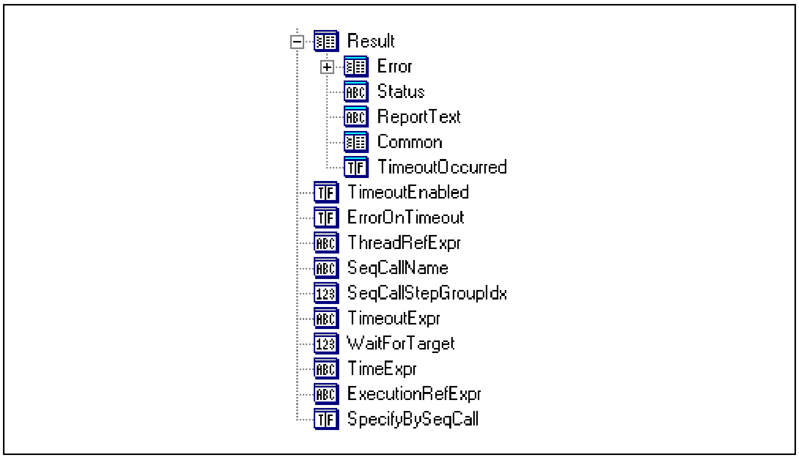


Figure 11-32. Wait Step Properties

The Wait step type defines the following step properties in addition to the common custom properties.

- `Step.Result.TimeoutOccurred` is set to `True` if the Wait for Thread or Wait for Execution operation times out. This property exists only if the step is configured for one of these operations.
- `Step.TimeoutEnabled` contains the timeout enabled setting for the Wait for Thread or the Wait for Execution operation.
- `Step.ErrorOnTimeout` contains the Timeout Causes Run-Time Error setting for the Wait for Thread or the Wait for Execution operation.

- `Step.ThreadRefExpr` contains the thread reference expression for the Wait for Thread operation when the `Step.SpecifyBySeqCall` property is set to `False`.
- `Step.SeqCallName` contains the name of the sequence call step that creates the thread or execution the step waits for when the `Step.SpecifyBySeqCall` property is set to `True`.
- `Step.SeqCallStepGroupIdx` contains the step group of the sequence call step that creates the thread or execution that the step waits for when the `Step.SpecifyBySeqCall` property is set to `True`. The valid values are 0 = Setup, 1 = Main, 2 = Cleanup.
- `Step.TimeoutExpr` contains the timeout expression, in seconds, for the Wait for Thread or the Wait for Execution operation.
- `Step.WaitForTarget` contains a value that specifies the type of wait operation the step performs. The valid values are 0 = Time Interval, 1 = Time Multiple, 2 = Thread, 3 = Execution.
- `Step.TimeExpr` contains the time expression for the Time Interval or Time Multiple operation of the step.
- `Step.ExecutionRefExpr` contains the expression that evaluates to a reference to the execution on which the Wait for Execution operation waits.
- `Step.SpecifyBySeqCall` contains the Specify By Sequence Call setting for the Wait for Thread or the Wait for Execution operation.

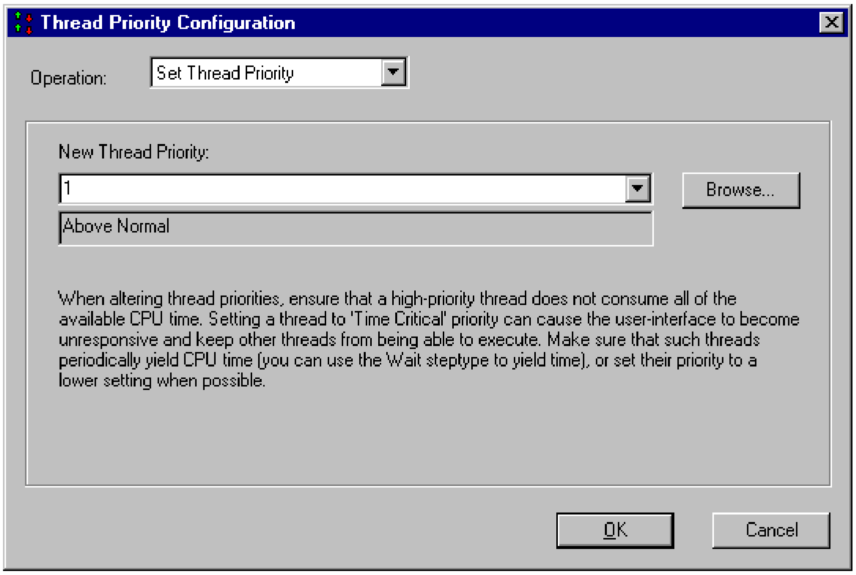
Thread Priority

Use the Thread Priority step to boost or lower the priority of a thread so that it receives more or less CPU time than other threads.

When you use this step you must take care to not starve important threads of CPU time by boosting the priority of another thread too high. When you alter a thread priority, it is good practice to save the previous priority value and restore it once your thread no longer requires the altered priority value. Be aware that setting a thread to Time Critical priority can cause the user interface for your application to become unresponsive.

Set Thread Priority Operation

Use the Set Thread Priority operation to raise or lower the priority of the current thread, as shown below.



Operation: Set Thread Priority

New Thread Priority: 1

Above Normal

When altering thread priorities, ensure that a high-priority thread does not consume all of the available CPU time. Setting a thread to 'Time Critical' priority can cause the user-interface to become unresponsive and keep other threads from being able to execute. Make sure that such threads periodically yield CPU time (you can use the Wait steptype to yield time), or set their priority to a lower setting when possible.

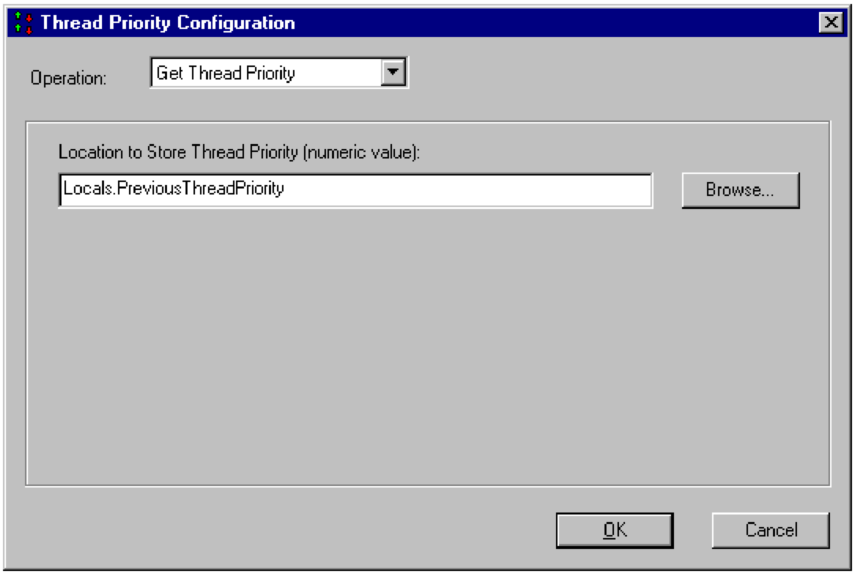
Figure 11-33. Set Thread Priority Operation for Thread Priority Configuration Dialog Box

The Set Thread Priority operation contains the following controls:

- **New Thread Priority**—Use this control to specify a numeric value expression that indicates the new priority for the thread. If you specify the priority as a numeric constant, the name that corresponds to that priority is shown in the indicator control below this control. Use the drop-down list for this control to specify a priority constant for one of the valid priority settings. The valid values are –15 = Idle, –2 = Low, –1 = Below Normal, 0 = Normal, 1 = Above Normal, 2 = High, and 15 = Time Critical.

Get Thread Priority Operation

Use the Get Thread Priority operation, as shown below, to get the current priority setting for the current thread.


Thread Priority Configuration

Operation: Get Thread Priority

Location to Store Thread Priority (numeric value): Locals.PreviousThreadPriority

Figure 11-34. Get Thread Priority Operation for Thread Priority Configuration Dialog Box

The Get Thread Priority operation contains the following controls:

- **Location to Store Thread Priority**—Use this control to specify a location to store a numeric value that is the priority setting for the current thread. When you set the thread priority for a sequence, it is a good idea to save the previous priority in the Setup step group and restore the priority in the Cleanup step group.

Step Properties

Figure 11-35 shows the step properties for the Thread Priority step type.

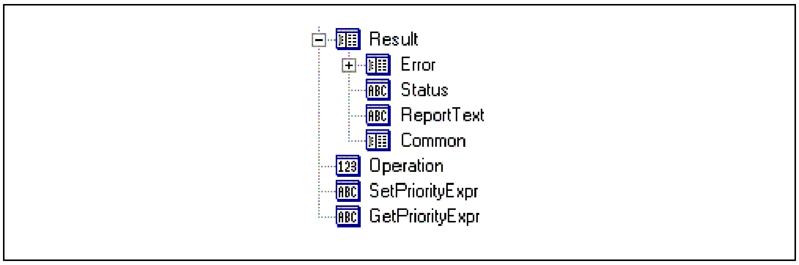


Figure 11-35. Thread Priority Step Properties

The Thread Priority step type defines the following step properties in addition to the common custom properties.

- `Step.Operation` contains a value that specifies the operation the step is set to perform. The valid values are 0 = Set Thread Priority, 1 = Get Thread Priority.
- `Step.SetPriorityExpr` specifies the thread priority expression for the Set Thread Priority operation.
- `Step.GetPriorityExpr` specifies the location to store the thread priority for the Get Thread Priority operation.

Batch Synchronization

Use Batch Synchronization steps to define sections of a sequence in which to synchronize multiple threads that belong to one batch. Typically, you use these steps in a sequence that you execute using the Batch process model.

Synchronized Sections

You use Batch Synchronization steps to define synchronized sections by placing a step at the beginning and end of a section of steps in a sequence and specifying an Enter operation for the beginning step and an Exit operation for the ending step. You must place the Enter and Exit steps in the same sequence, but you do not have to place them in the same step group. The three types of synchronized sections are serial section, parallel section, and one-thread-only section. All synchronized sections have the following properties in common:

- Each thread in a batch that enters a synchronized section blocks at the Enter step until all other threads in the batch arrive at their respective instances of the Enter step.
- Each thread in a batch that reaches the end of the synchronized section blocks at the Exit step until all other threads in the batch arrive at their respective instances of the Exit step.

Serial Sections

You use a serial section to ensure that each thread in the batch executes the steps in the section sequentially and in the order that you specify when you create the batch. When all threads in a batch arrive at their respective instances of an Enter step for a serial section, TestStand releases one thread at a time in ascending order according to the Order Numbers you assign to the threads when you add them to the batch using the Batch Specification step. As each thread reaches the Exit step for the section, the next thread in the batch proceeds from the Enter step. After all the threads in the batch arrive at the Exit step, they exit the section together. Refer to the *Batch Specification* section in this chapter for more information on Order Numbers.

Parallel Sections

When all threads in a batch arrive at their respective instances of an Enter step for a parallel section, TestStand releases all the threads at once. Each thread that arrives at the Exit step for the section blocks until all threads in the batch reach that step.

One-Thread-Only Sections

You use a one-thread-only section to specify that only one thread in the batch executes the steps in the section. Typically, you use this section type to perform an operation that applies to the batch as a whole such as raising the temperature in a test chamber. When all threads in a batch arrive at their respective instances of an Enter step for a one-thread-only section, TestStand releases only the thread with the lowest Order Number. When that thread arrives at the Exit step for the section, all remaining threads in the batch jump from the Enter step to the Exit step, skipping the steps within the section. The threads in the batch then exit the section together.

Mismatched Sections

Sections become mismatched when all threads in a batch are blocked at an Enter or an Exit operation, but they are not all blocked at the same Enter or Exit operation. This can occur when a sequence has a conditional flow of execution due to preconditions, post actions, or other flow control operations.

When TestStand detects mismatched sections, it handles them as follows:

- The thread that is at the Enter or Exit step that appears earliest in the hierarchy of sequences and subsequences proceeds as if all threads in the batch are at the same step.
- If multiple Enter and Exit operations are equally early in the hierarchy of sequences and subsequences, Enter operations proceed first.

Nested Sections

Nesting of sections can occur either within the same sequence or as a result of calling a subsequence inside of a synchronized section when the subsequence also contains a synchronized section. When you nest one section inside another, TestStand honors the inner section if the type of the outer section is Serial or Parallel. For example, if you nest one serial section in another serial section, each thread that enters the outer section proceeds only until the Enter step of the inner section and then waits for the other threads to reach the same step.

TestStand ignores the inner section if the type of the outer section is One-Thread-Only.

Note You can create a synchronized section around a single step using the Synchronization tab of the Step Properties dialog box rather than by using explicit Batch Synchronization steps.

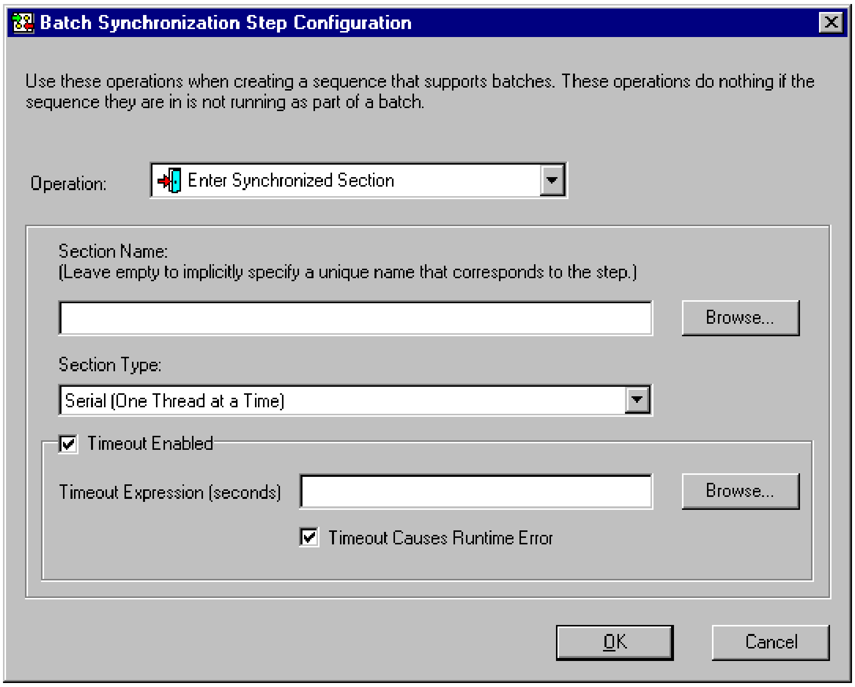
Requirements for Using Enter and Exit Operations

TestStand generates a run-time error if your Enter and Exit operations do not adhere to the following requirements:

- Each Exit operation must match the most nested Enter operation.
- A thread cannot reenter a section it is already within.
- You must exit a section in the same sequence that you enter it.

Enter Synchronized Section Operation

Use the Enter Synchronized Section operation to mark the beginning of a synchronized section and to define the type of synchronization for that section.


Batch Synchronization Step Configuration

Use these operations when creating a sequence that supports batches. These operations do nothing if the sequence they are in is not running as part of a batch.

Operation: Enter Synchronized Section

Section Name:
(Leave empty to implicitly specify a unique name that corresponds to the step.)

Section Type: Serial (One Thread at a Time)

[✓] Timeout Enabled

Timeout Expression (seconds)

[✓] Timeout Causes Runtime Error

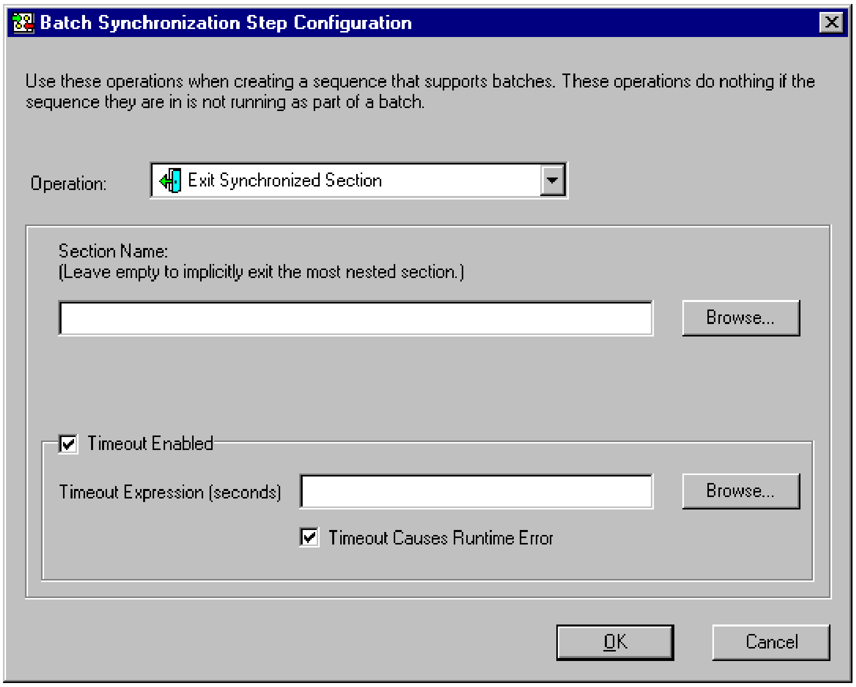
Figure 11-36. Enter Operation for Batch Synchronization Step Configuration Dialog Box

The Enter operation contains the following controls:

- **Section Name**—Use this control to specify a name for the synchronized section or leave this control blank if you want TestStand to generate a unique name for you based on the step name.
- **Section Type**—Use this control to specify the type of synchronized section.
- **Timeout Enabled, Timeout Expression, Timeout Causes Run-Time Error**—Use these controls to specify a timeout and timeout behavior for when a thread must wait at the Enter step. If a timeout occurs, the property `Step.Result.TimeoutOccurred` is set to `True`.

Exit Synchronized Section Operation

Use the Exit Synchronized Section operation to mark the end of a synchronized section.



Use these operations when creating a sequence that supports batches. These operations do nothing if the sequence they are in is not running as part of a batch.

Operation: Exit Synchronized Section

Section Name:
(Leave empty to implicitly exit the most nested section.)

☑ Timeout Enabled

Timeout Expression (seconds)

☑ Timeout Causes Runtime Error

Figure 11-37. Exit Operation for Batch Synchronization Step Configuration Dialog Box

The Exit operation contains the following controls:

- **Section Name**—Use this control to specify the name of the synchronized section to exit, or leave this control blank to refer the most nested section.
- **Timeout Enabled, Timeout Expression, Timeout Causes Run-Time Error**—Use these controls to specify a timeout and timeout behavior for when a thread must wait at the Exit step. If a timeout occurs, the property `Step.Result.TimeoutOccurred` is set to `True`.

Step Properties

Figure 11-38 shows the step properties for the Batch Synchronization step type.

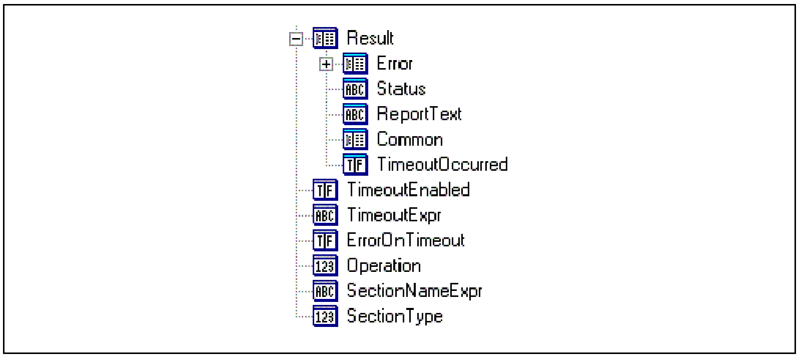


Figure 11-38. Batch Synchronization Step Properties

The Batch Synchronization step type defines the following step properties in addition to the common custom properties.

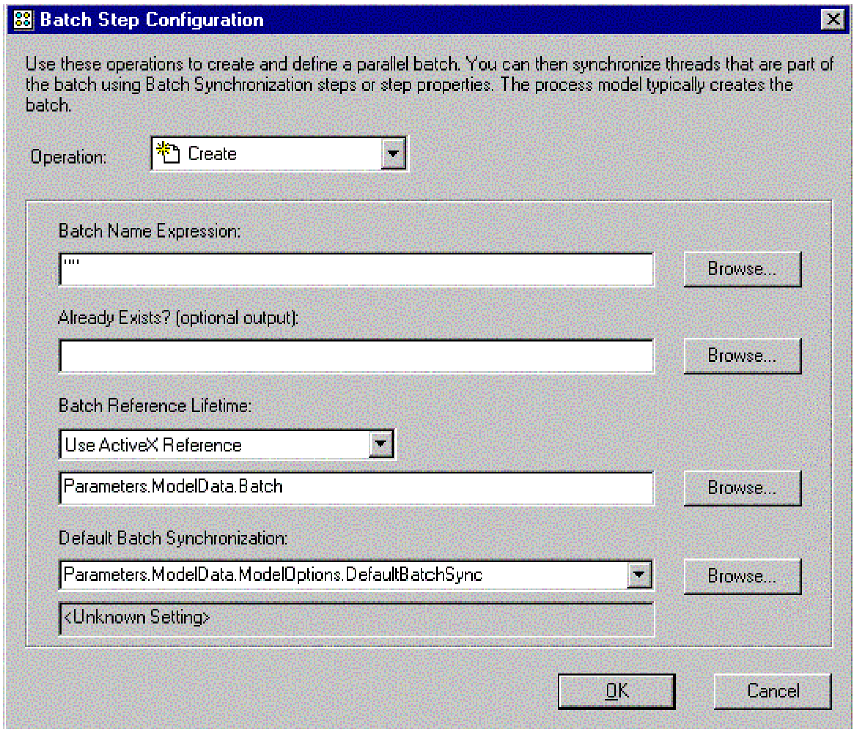
- `Step.Result.TimeoutOccurred` is set to `True` if an Enter or Exit operation times out.
- `Step.TimeoutEnabled` contains the timeout enabled setting for the Enter or Exit operation.
- `Step.TimeoutExpr` contains the timeout expression, in seconds, for the Enter or Exit operation.
- `Step.ErrorOnTimeout` contains the Timeout Causes Run-Time Error setting for the Enter or Exit operation.
- `Step.Operation` contains a value that specifies the operation the step performs. The valid values are 0 = Enter Synchronized Section, 1 = Exit Synchronized Section.
- `Step.SectionNameExpr` contains the expression that specifies the name of the section for the Enter or Exit operation.
- `Step.SectionType` contains a value that specifies the type of section the Enter operation defines. The valid values are 1 = Serial, 2 = Parallel, 3 = One Thread Only.

Batch Specification

When you write a process model, you can use Batch Specification steps to define a group of threads where each thread in the group runs an instance of the client sequence. You define a group so that you can perform batch synchronization operations on the threads in the group. The TestStand Batch process model uses Batch Specification steps to create a batch that contains a thread for each test socket. For more information on the Batch process model refer to the *Batch Model* section of Chapter 14, *Process Models*. For more information on batch synchronization, see the section on the *Batch Synchronization* step type in this chapter.

Create Operation

To create a reference to a new or existing batch object, insert a Batch Specification step and select **Configure Batch Specification** from the context menu for the step.



Use these operations to create and define a parallel batch. You can then synchronize threads that are part of the batch using Batch Synchronization steps or step properties. The process model typically creates the batch.

Operation: Create

Batch Name Expression: ""

Already Exists? (optional output):

Batch Reference Lifetime: Use ActiveX Reference

Parameters.ModelData.Batch

Default Batch Synchronization: Parameters.ModelData.ModelOptions.DefaultBatchSync

<Unknown Setting>

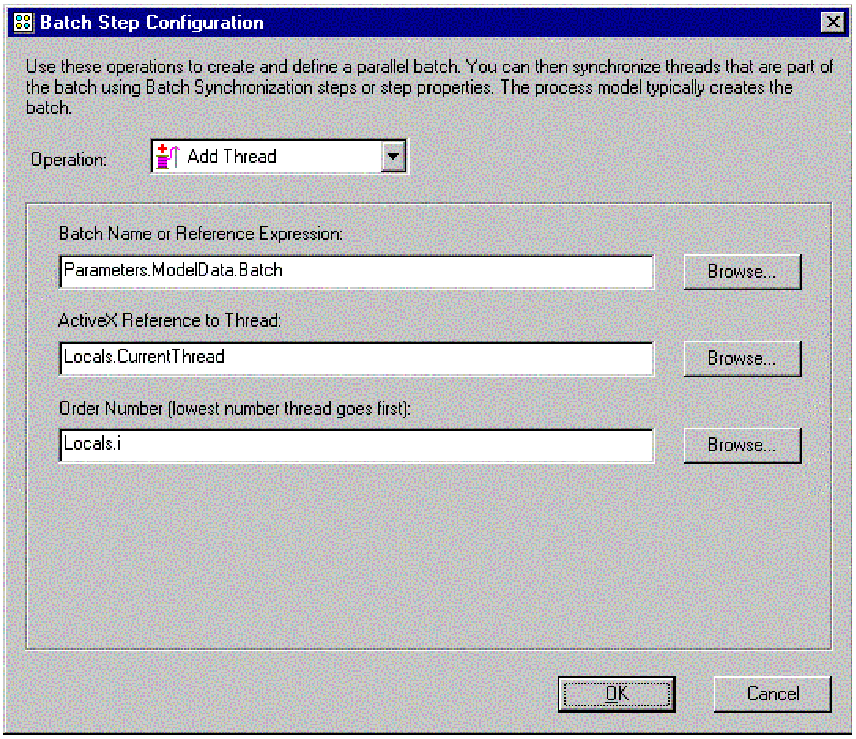
Figure 11-39. Create Operation for Batch Specification Step Configuration Dialog Box

The Create operation contains the following controls:

- **Batch Name Expression**—Use this control to specify a unique name for the synchronization object using a string literal or an expression that evaluates to a string. Refer to the *Common Attributes of Synchronization Objects* section of this document for more information on synchronization object names.
- **Already Exists**—Use this control to specify a location to store a Boolean value that indicates whether the synchronization object already exists.
- **Batch Reference Lifetime**—Use this control to specify the lifetime of the reference to the synchronization object.
- **Default Batch Synchronization**—Use this control to specify the default method of batch synchronization to use with the batch object. This setting affects the per step batch synchronization setting when the Batch Synchronization setting on the Synchronization tab of a step's Step Properties dialog box is set to Use Model Setting or Use Sequence File Setting and the sequence file's Batch Synchronization setting is set to Use Model Setting. Per step batch synchronization treats each step as if it is within its own synchronized section of the type you specify.

Add Thread Operation

Use the Add Thread operation to add a TestStand thread to your group of batch threads as shown below.


Batch Step Configuration

Use these operations to create and define a parallel batch. You can then synchronize threads that are part of the batch using Batch Synchronization steps or step properties. The process model typically creates the batch.

Operation: Add Thread

Batch Name or Reference Expression: Parameters.ModelData.Batch

ActiveX Reference to Thread: Locals.CurrentThread

Order Number (lowest number thread goes first): Locals.i

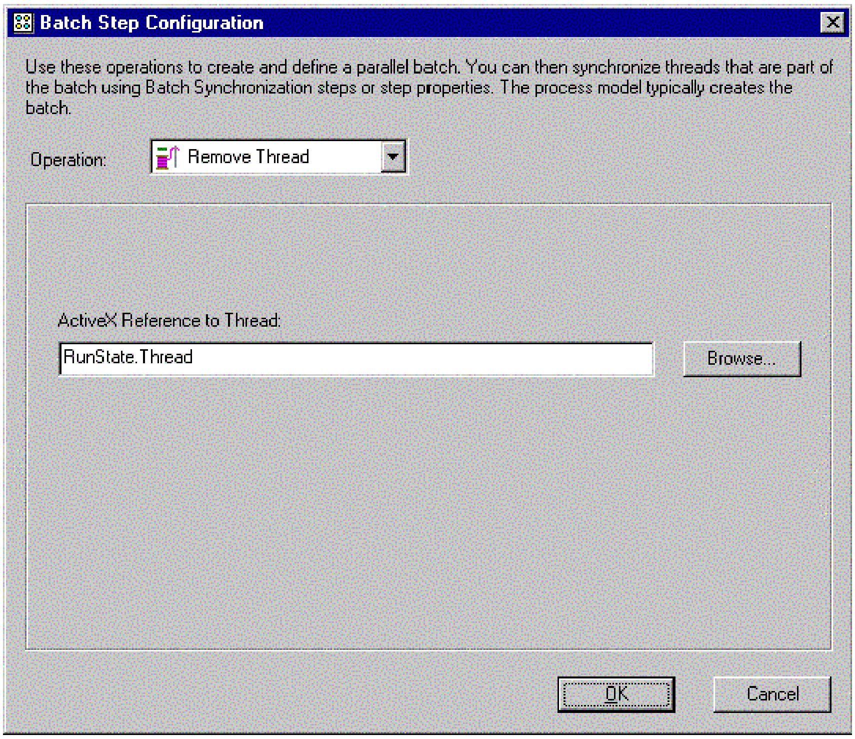
Figure 11-40. Add Thread Operation for Batch Specification Step Configuration Dialog Box

The Add Thread operation contains the following controls:

- **Batch Name or Reference Expression**—Use this control to specify the batch on which to perform the operation. You can specify the batch by name or by the ActiveX reference you receive when you create the batch with the Using ActiveX Reference lifetime option.
- **ActiveX Reference to Thread**—Use this control to specify a thread object to add to the batch. A thread can belong to only one batch at a time. Adding a thread to a batch removes the thread from its previous batch, if any. Additionally, when a thread terminates, it removes itself from the batch.
- **Order Number**—Use this control to specify the order in which threads enter synchronized sections. Threads with a lower order number enter a synchronized section before threads with a higher order number.

Remove Thread Operation

Use the Remove Thread operation to remove a TestStand thread from a group of batch threads as shown below.


Batch Step Configuration

Use these operations to create and define a parallel batch. You can then synchronize threads that are part of the batch using Batch Synchronization steps or step properties. The process model typically creates the batch.

Operation: Remove Thread

ActiveX Reference to Thread: RunState.Thread

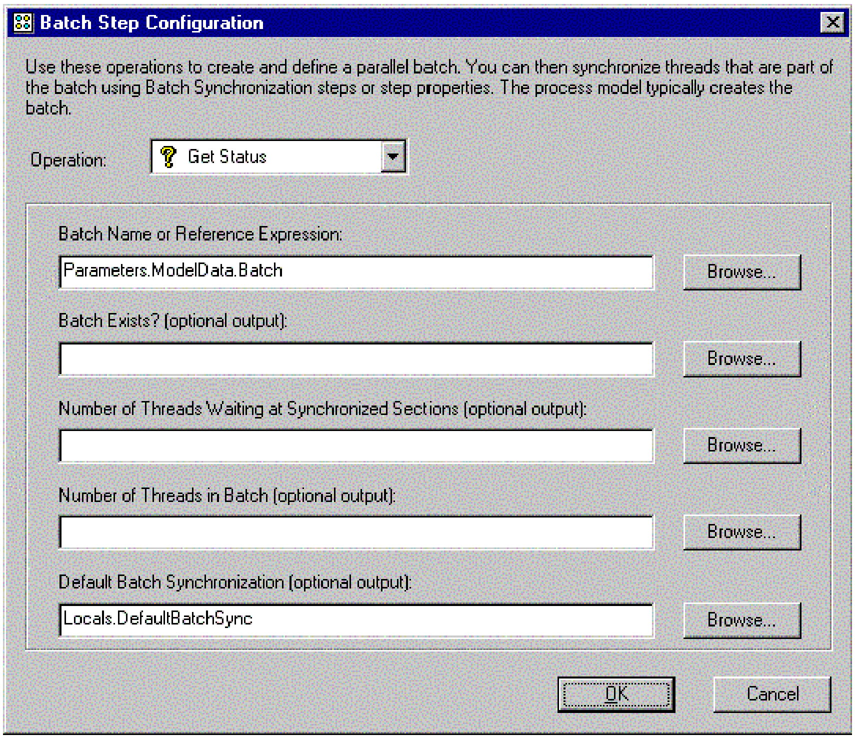
Figure 11-41. Remove Thread Operation for Batch Specification Step Configuration Dialog Box

The Remove Thread operation contains the following controls:

- **ActiveX Reference to Thread**—Use this control to specify the thread you wish to remove from its batch.

Get Status Operation

You can use the Get Status operation to obtain information about the current state of the batch as shown below.



Use these operations to create and define a parallel batch. You can then synchronize threads that are part of the batch using Batch Synchronization steps or step properties. The process model typically creates the batch.

Operation: Get Status

Batch Name or Reference Expression: Parameters.ModelData.Batch

Batch Exists? (optional output):

Number of Threads Waiting at Synchronized Sections (optional output):

Number of Threads in Batch (optional output):

Default Batch Synchronization (optional output): Locals.DefaultBatchSync

Figure 11-42. Get Status Operation for Batch Specification Step Configuration Dialog Box

The Get Status operation contains the following controls:

- **Batch Name or Reference Expression**—Use this control to specify the batch on which to perform the operation. You can specify the batch by name or by the ActiveX reference you receive when you create the batch with the Using ActiveX Reference lifetime option.
- **Batch Exists?**—Use this control to specify a location to store a Boolean value that indicates whether the batch already exists.
- **Number of Threads Waiting at Synchronized Sections**—Use this control to specify a location to store a numeric value that indicates the number of threads waiting to enter or exit synchronized sections.

- **Number of Threads in Batch**—Use this control to specify a location to store the numeric value that is the number of threads that are currently part of the batch.
- **Default Batch Synchronization**—Use this control to specify a location to store a numeric value that specifies the default method of batch synchronization that the batch uses.

Step Properties

Figure 11-43 shows the step properties for the Batch Specification step type.

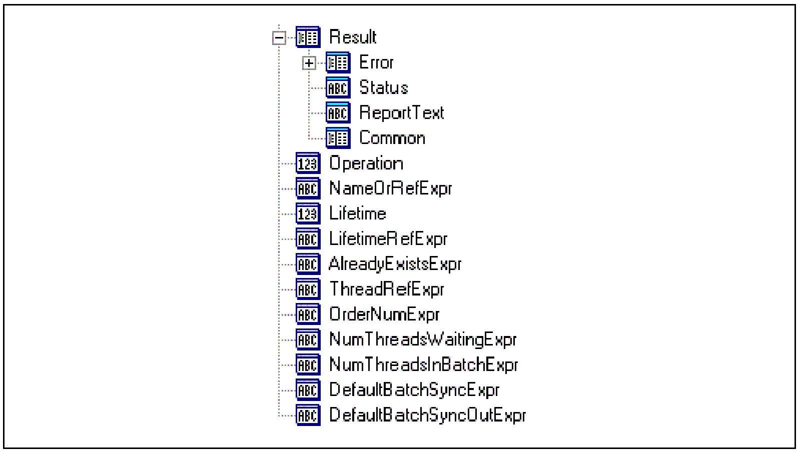


Figure 11-43. Batch Specification Step Properties

The Batch Specification step type defines the following step properties in addition to the common custom properties.

- `Step.Operation` contains a value that specifies the operation the step performs. The valid values are 0 = Create, 1 = Add Thread, 2 = Remove Thread, 3 = Get Status.
- `Step.NameOrRefExpr` contains the Name expression for the Create operation and the Name or Reference expression for other batch operations.
- `Step.Lifetime` contains a value that specifies the lifetime for the Create operation. The valid values are 0 = Same as Sequence, 1 = Same as Thread, 2 = Use ActiveX Reference, 3 = Same as Execution.

- `Step.LifetimeRefExpr` contains the ActiveX reference expression for the batch lifetime when you set the lifetime to Use ActiveX Reference.
- `Step.AlreadyExistsExpr` contains the Already Exists expression for the Create operation or the Batch Exists expression for the Get Status operation.
- `Step.ThreadRefExpr` contains the ActiveX Reference to Thread expression for the Add Thread and Remove Thread operations.
- `Step.OrderNumExpr` contains the Order Number expression for the Add Thread operation.
- `Step.NumThreadsWaitingExpr` contains the Number of Threads Waiting at Synchronized Sections expression for the Get Status operation.
- `Step.NumThreadsInBatchExpr` contains the Number of Threads in Batch expression for the Get Status operation.
- `Step.DefaultBatchSyncExpr` contains the Default Batch Synchronization expression for the Create operation.
- `Step.DefaultBatchSyncOutExpr` contains the Default Batch Synchronization expression for the Get Status operation.

12 User Management

This chapter describes TestStand user management, the User Manager window, and how to add users and set user privileges.

The TestStand engine maintains a list of users, their login names and passwords, and their privileges. This capability of the TestStand engine is called the *user manager*. TestStand limits the sequence editor and operator interfaces functionality depending on the privilege settings that the user manager stores for the user who is currently logged in.

When you launch the sequence editor or any of the operator interfaces that come with TestStand, they display the Login dialog box by calling the `LoginLogout` front-end callback sequence. The `LoginLogout` sequence calls the `DisplayLoginDialog` method of the `Engine` class, which displays the actual dialog box.

The User Manager tab of the Station Options dialog box specifies whether TestStand enforces user privileges and specifies the location of the user manager configuration file. Refer to the *Configure Menu* section in Chapter 4, *Sequence Editor Menu Bar*, for more information on these options.

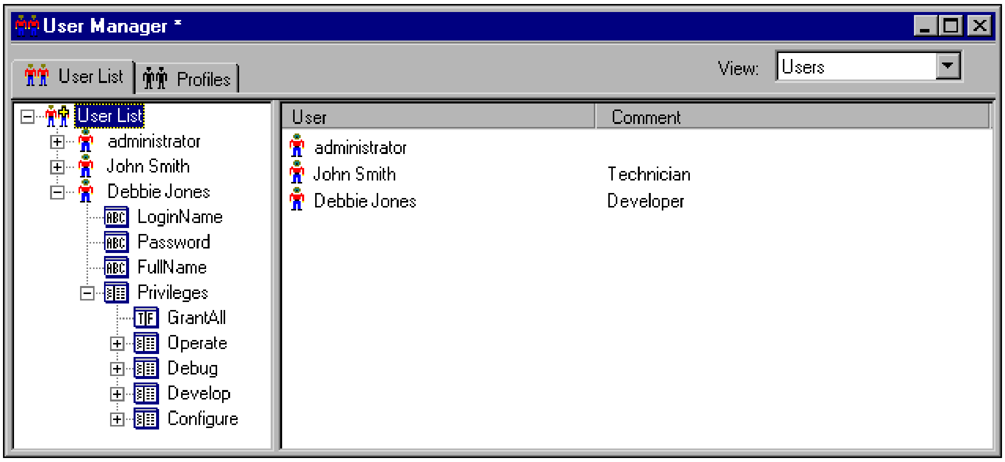
Note The TestStand User Manager is designed to help you implement policies and procedures concerning the use of your test station. It is not a security system and it does not inhibit or control the operating system or third-party applications. You must use the system-level security features that are available with your operating system to secure your test station computer against unauthorized use.

User Manager Window

In the TestStand sequence editor, you use the User Manager window to view and edit the user list and the privileges of each user. To open the User Manager window, select **View»User Manager**. In the User Manager window, use the View ring control at the top right to access the list of users or to access the list of types that TestStand uses to store user privileges.

Users View

To access the list of users, select Users from the View ring control. You can use this view to add new users or to modify the privileges and other properties of existing users. Figure 12-1 shows the Users view in the User Manager window.



User	Comment
administrator	
John Smith	Technician
Debbie Jones	Developer

Figure 12-1. Users View in the User Manager Window

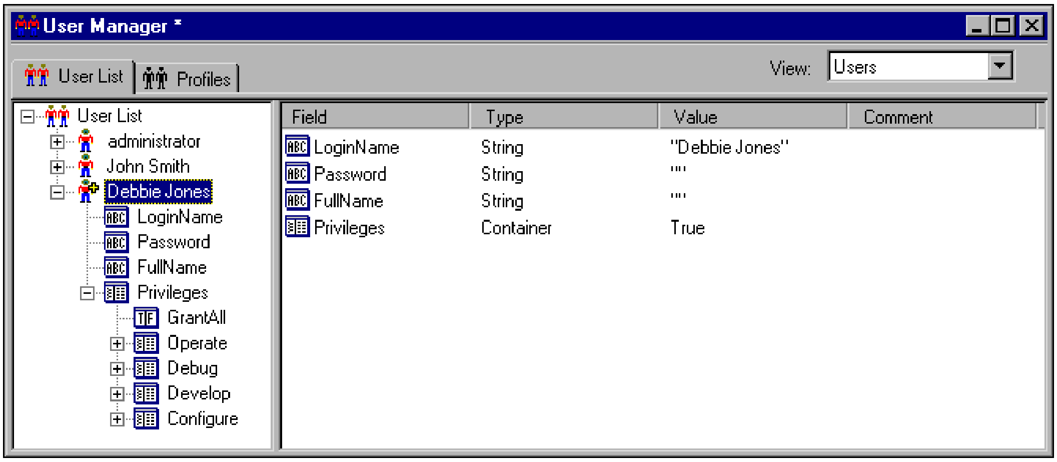
The Users view has two tabs: User List and Profiles. The User List tab contains a list of current users. Each entry contains properties that define the login name, the login password, and the TestStand privileges. TestStand stores these properties in User containers, which have the `User` standard data type.

The Profiles tab contains a list of profiles that you can apply when you create new users. A profile defines a set of values for the properties in the `User` data type. When you create a new user, you can initialize the values for a new user from a profile. If you make changes to the values in a profile, your changes do not affect the privileges for users who are already in the user list. TestStand defines four default profiles: *operator*, *technician*, *developer*, and *administrator*.

User List Tab

The User List tab contains two panes. The tree view in the left pane allows you to browse the custom properties for each user. The list view in the right pane displays the contents of the node you select in the tree view.

The columns in the list view vary according to whether the list view displays users or user properties. When the list view displays users, the columns appear as in Figure 12-1. When the list view displays user properties, the columns appear as in Figure 12-2.



Field	Type	Value	Comment
LoginName	String	"Debbie Jones"	
Password	String	""	
FullName	String	""	
Privileges	Container	True	

Figure 12-2. User List Tab for Users View

User List Context Menu

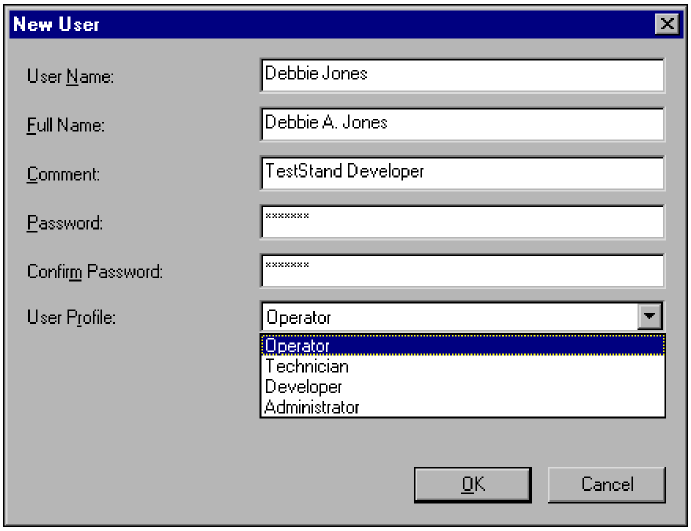
A context menu appears when you right click the tree view or list view. The items in the context menu vary depending on the whether you right click the following sites:

- A user
- A user property
- The background of the tree view
- The background of the list view

The User List tab context menu contains the common editing and navigation commands, and the following additional commands.

Insert User

You use the **Insert User** command to add a new user to the user list. Figure 12-3 shows the New User dialog box that the command displays.



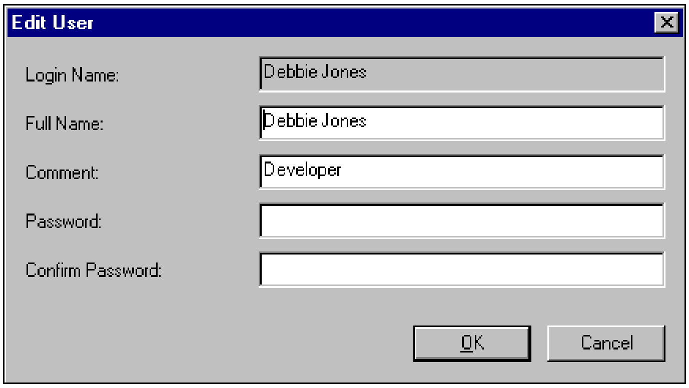
User Name: Debbie Jones
Full Name: Debbie A. Jones
Comment: TestStand Developer
Password: *******
Confirm Password: *******
User Profile: Operator
Operator
Technician
Developer
Administrator

Figure 12-3. Insert New User Dialog Box

The Login Name and the Password controls specify a case-sensitive login name and password. You can use the Full Name and Comment controls to add additional information about the user. The User Profile ring control selects a profile, which defines an initial set of privilege settings to give the new user.

Properties

You can use the **Properties** command to edit an existing user or a user property. Figure 12-4 shows the Edit User dialog box that the command displays when you invoke it on a user.



Login Name: Debbie Jones
Full Name: Debbie Jones
Comment: Developer
Password:
Confirm Password:

Figure 12-4. Edit User Dialog Box

Edit User Type

The **Edit User Type** command switches from the Users view to the Types view in the User Manager window and displays the `User` standard data type.

Profiles Tab

The Profiles tab contains two panes. The tree view in the left pane allows you to browse the custom property values for each profile. The list view in the right pane displays the contents of the item you select in the tree view. The columns in the list view vary according to whether the list view displays profiles or profile properties.

Figure 12-5 shows the Profiles tab in the Users view.

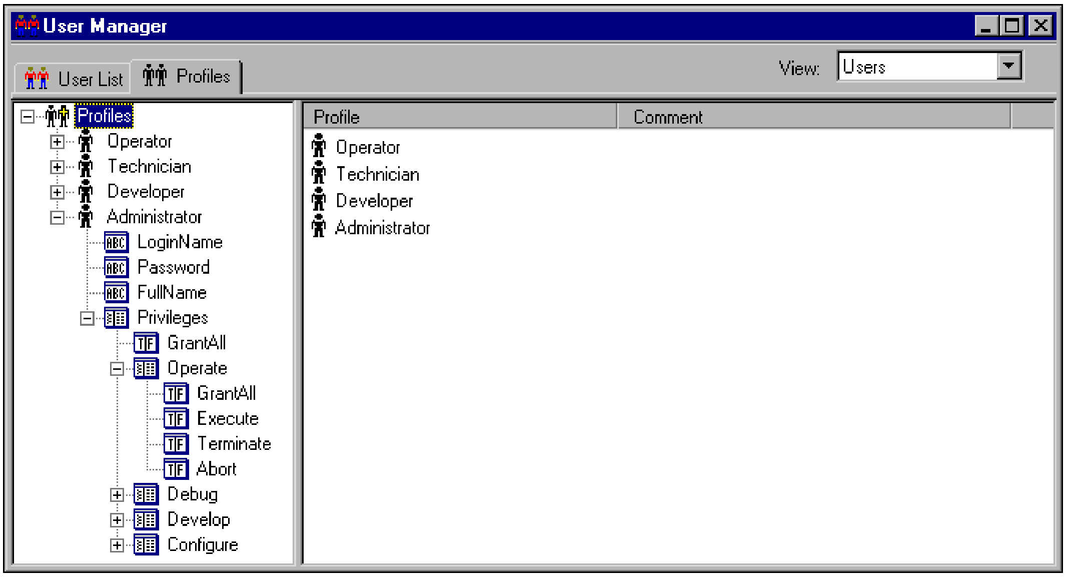


Figure 12-5. Profile Tab in the Users View

The tree view in Figure 12-5 shows the set of privilege values that each of the profiles define. The User standard data type defines the set of privilege properties. The privileges are grouped in categories such as Operate and Debug. Each profile defines values for each of the privilege settings. Each user also has these privilege properties. When you create a new user, TestStand copies the privilege setting values from the profile you choose and applies them to the new user.

Each group of privileges has a Boolean `GrantAll` subproperty. When the `GrantAll` property is set to `True`, it overrides the values of each privilege in the group and any subgroups. If the Boolean is set to `False`, the privilege settings are honored.

Profiles Tab Context Menu

To access a context menu, you right click the tree view or list view. The items in the context menu vary depending on whether you right click the following sites:

- A user
- A user property

- The background of the tree view
- The background of the list view

The Profiles tab context menu contains the common editing and navigation commands, and the following additional commands.

Insert Profile

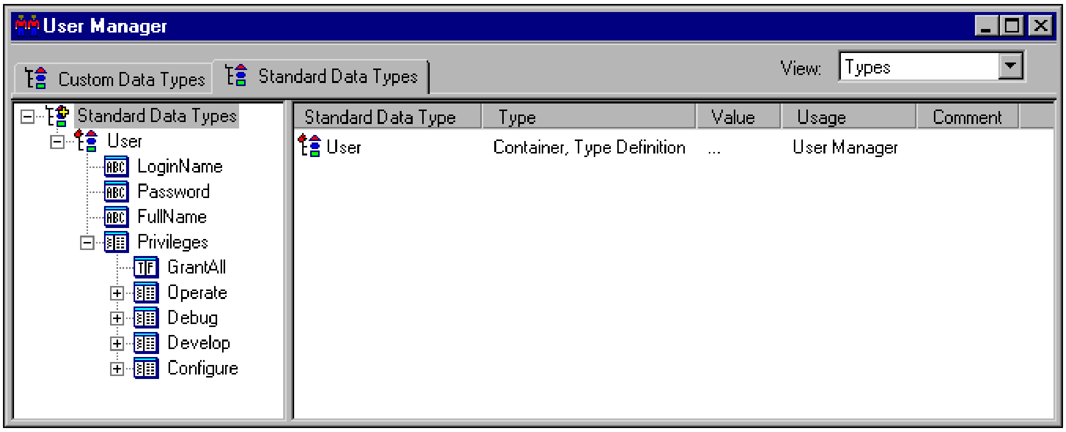
You use the **Insert Profile** command to add a new profile to the profile list.

Edit User Type

The **Edit User Type** command switches from the Types view to the Users view in the User Manager window and displays the `User` standard data type.

Types View

To access a list of the types that the User Manager uses, select **Types** from the View ring control. You can use this view to add new properties to the `User` data type, or to create your own custom data types to add to the `User` data type. Figure 12-6 shows the Types view for the User Manager Window. The Types view has two tabs, Standard Data Types and Custom Data Types.



Standard Data Type	Type	Value	Usage	Comment
User	Container, Type Definition	...	User Manager	

Figure 12-6. Types View in the User Manager Window

User Standard Data Types

The Standard Data Types tab contains the standard data types that the User Manager uses. TestStand stores the properties for each user in a User container, which has the `User` standard data type.

Figure 12-7 shows the tree view of the `User` standard data type.

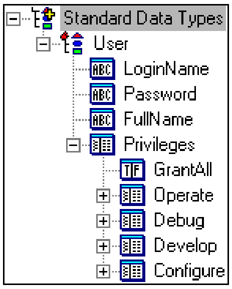


Figure 12-7. User Standard Data Type

Table 12-1 lists the properties in the `User` data type. Subproperties appear in the table indented under the properties they belong to. For example, you reference the `Execute` subproperty as `User.Privileges.Operate.Execute`.

Table 12-1. Description of Subproperties in User Data Type

Subproperty	Description
`LoginName`	User login name.
`Password`	Encrypted user login password.
`FullName`	Descriptive user name.
`Privileges.GrantAll`	User has all TestStand privileges. When `True`, TestStand ignores all specific privilege settings in the `Operate` privilege group.
`Operate.GrantAll`	User can perform all `Operate` privileges. When `True`, TestStand ignores all specific privilege settings in the `Operate` privilege group.
`Execute`	User can initiate an execution.
`Terminate`	User can terminate an execution.

Table 12-1. Description of Subproperties in User Data Type (Continued)

Subproperty	Description
`Abort`	User can abort an execution.
`Debug.GrantAll`	User can perform all `Debug` privileges. When `True`, TestStand ignores all privilege settings in the `Debug` privilege group.
`ControlExecFlow`	User can control the flow of execution by setting breakpoints, single-stepping, and using the **Set Next Step** and **Run Mode** commands.
`SinglePass`	User can use the Single Pass execution entry point.
`RunAnySequence`	User can run an individual sequence without using execution entry points.
`RunSelectedTests`	User can run selected tests from a sequence using the **Run Selected Steps** command.
`LoopSelectedTests`	User can run selected tests from a sequence in a loop using the **Loop on Selected Steps** command.
`EditStationGlobals`	User can create and modify globals in the Station Globals Window.
`Develop.GrantAll`	User can perform all `Develop` privileges. When `True`, TestStand ignores all privilege settings in the `Develop` privilege group.
`EditSequenceFiles`	User can edit sequence files, sequences, and steps.
`SaveSequenceFiles`	User can save sequence files.
`EditWorkspace`	User can edit workspaces and projects.
`UseSourceControl`	User can perform source code control operations.
`Configure.GrantAll`	User can perform all `Configure` privileges. When `True`, TestStand ignores all privilege settings in the `Configure` privilege group.
`EditTypes`	User can create and modify standard data types, custom data types, and step types.

Table 12-1. Description of Subproperties in User Data Type (Continued)

Subproperty	Description
`ConfigEngine`	User can configure the engine as follows: • Customize the **Tools** menu. • Modify engine files in the Edit Paths dialog box. • Modify settings on the Search Directories dialog box. • Modify settings on all tabs of the Station Options dialog box, except the User Manager tab.
`ConfigAdapter`	User can configure adapters in the Adapter Configuration dialog box.
`ConfigApp`	User can modify the settings on the Preferences tab of the Sequence Editor Options dialog box.
`ConfigReport`	User can modify the settings in the Report Options dialog box.
`ConfigDatabase`	User can modify the settings in the Database Options dialog box.
`ConfigModel`	User can modify the settings in the Model Options dialog box.
`EditUsers`	User can add and modify users in the User Manager Window and the options on the User Manager tab of the Station Options dialog box.
`EditProcessModelFiles`	User can edit process model files.

Adding New Properties and Privileges to the User Data Type

You can add new subproperties to the `User` data type. For example, you might want to add an ID string property for each user, or you might want to add a `ConfigHardware` Boolean property in the `User.Privilege.Configure` group to specify whether a user has the privilege to configure special hardware on the station.

You also can use the Custom Data Types tab to define your own data types, which you can then add to the `User` standard data type. Refer to the *Using Data Types* section in Chapter 9, *Types*, for more information on data types and editing data types.

Verifying User Privileges

This section discusses how to verify that a user has a specific privilege.

Accessing Privilege Settings for the Current User

If you want to verify in an expression that the current user has a specific privilege, call the `CurrentUserHasPrivilege` expression function. If you want to verify the privilege in a code module, call the `CurrentUserHasPrivilege` method of the Engine class in the TestStand API.

When you call the `CurrentUserHasPrivilege` expression function or method, you must specify the property name of the privilege as a string argument. The current user has a privilege if the property is `True` or if the `GrantAll` property in any enclosing privilege group is `True`. For example, a user has the privilege to terminate an execution if the `User.Privileges.Configure.Terminate` property is `True,` if the `User.Privileges.Configure.GrantAll` property is `True`, or if the `User.Privileges.GrantAll` property is `True`. The `CurrentUserHasPrivilege` function returns `True` if the current user has the privilege or you have disabled privilege checking.

You can pass any subset of the property name tree structure to the `CurrentUserHasPrivilege` function. For example, you can use either of the following two expressions to determine whether the current user has the privilege to terminate an execution:

- `CurrentUserHasPrivilege("Terminate")`
- `CurrentUserHasPrivilege("Configure.Terminate")`

You can pass `"*"` as the string argument to `CurrentUserHasPrivilege` to determine whether a user is currently logged in. Refer to Chapter 8, *Sequence Context and Expressions*, for more information on using expressions.

The `CurrentUserHasPrivilege` method behaves identically to the expression function, except that it takes additional parameters. Refer to the *TestStand Programmer Help* for more information.

Accessing Privilege Settings for Any User

The TestStand API has methods that allow you to access the privileges of any user. You use the `GetUser` method of the `Engine` class to return a `User` object. You can then use the `HasPrivilege` method in the `User` class to inspect the value of a specific privilege. The `HasPrivilege` method behaves identically to the `CurrentUserHasPrivilege` expression function. Refer to the *TestStand Programmer Help* for more information.

13

Module Adapters

This chapter describes the module adapters that come with TestStand.

Overview

The TestStand engine uses a module adapter to invoke the code in a step module. Each module adapter supports one or more specific types of code modules. The different types of code modules include TestStand sequences, LabVIEW VIs, HTBasic subroutines, ActiveX Automation Objects, C functions in DLLs, and C functions in source files, object files, or library modules that you create in LabWindows/CVI or other compilers. A module adapter knows how to load and call a code module, how to pass parameters to a code module, and how to return values and status from a code module.

When you edit a step that uses a module adapter, TestStand relies on the adapter to display a dialog box in which you specify the code module for the step and also specify any parameters to pass when you invoke the code module. This dialog box is called the Specify Module dialog box. The actual title of the dialog box is different for the different adapters. Table 13-1 lists the names of the various dialog boxes that appear when you either click the **Specify Module** button in the Step Properties dialog box or when you right-click on a step and select the **Specify Module** menu item.

TestStand stores the name and location of the code module, the parameter list, and any additional options as properties of the step. TestStand hides most of these adapter-specific step properties.

If the module adapter is specific to an application development environment (ADE), the adapter knows how to open the ADE, how to create source code for a new code module in the ADE, and how to display the source for an existing code module in the ADE. Some adapters support stepping into the source code in the ADE while you execute the step from the TestStand sequence editor.

Table 13-1. Specific Names of the Specify Module Dialog Boxes

Module Adapter	Specify Module Dialog Box That Appears	Description
ActiveX Automation Adapter	Edit Automation Call dialog box	Allows you to call methods and access the properties of an ActiveX object.
C/CVI Standard Prototype Adapter	Edit C/CVI Module Call dialog box	Allows you to call any C function that has the TestStand standard C parameter list. The function can be in an object file, library file, or DLL. It also can be in a source file when you are using the LabWindows/CVI development environment and the source file is part of a LabWindows/CVI project.
DLL Flexible Prototype Adapter	Edit DLL Call dialog box	Allows you to call C functions in a DLL with a variety of parameter types.
LabVIEW Standard Prototype Adapter	Edit LabVIEW VI Call dialog box	Allows you to call any LabVIEW VI that has the TestStand standard G parameter list.
TestStand Sequence Adapter	Edit Sequence Call dialog box	Allows you to call subsequences with parameters.
HTBasic Adapter	Edit HTBasic Subroutine Call	Allows you to call HTBasic subroutines with no parameters. TestStand and HTBasic exchange data using the TestStand API. TestStand supports HTBasic version 7.2 or later.

Configuring Adapters

You can configure some of the module adapters. To configure these module adapters, select **Configure»Adapters** from the TestStand main menu. Figure 13-1 shows the Adapter Configuration dialog box that the **Adapters** command displays.

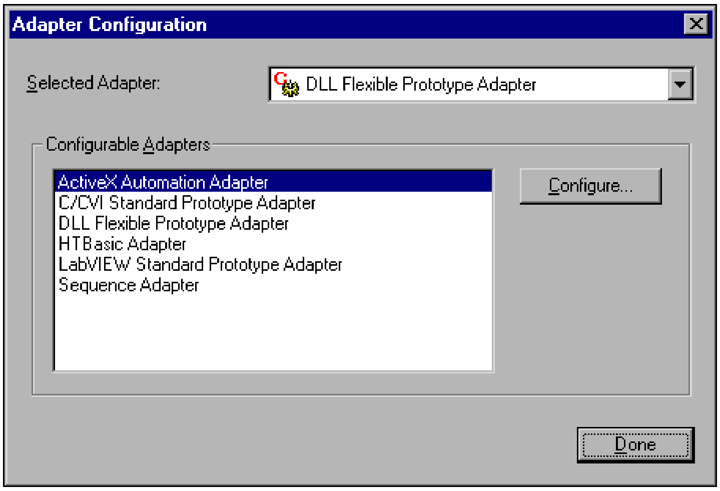

Adapter Configuration
Selected Adapter:
DLL Flexible Prototype Adapter
Configurable Adapters
ActiveX Automation Adapter
C/CVI Standard Prototype Adapter
DLL Flexible Prototype Adapter
HTBasic Adapter
LabVIEW Standard Prototype Adapter
Sequence Adapter
Configure...
Done

Figure 13-1. Adapter Configuration Dialog Box

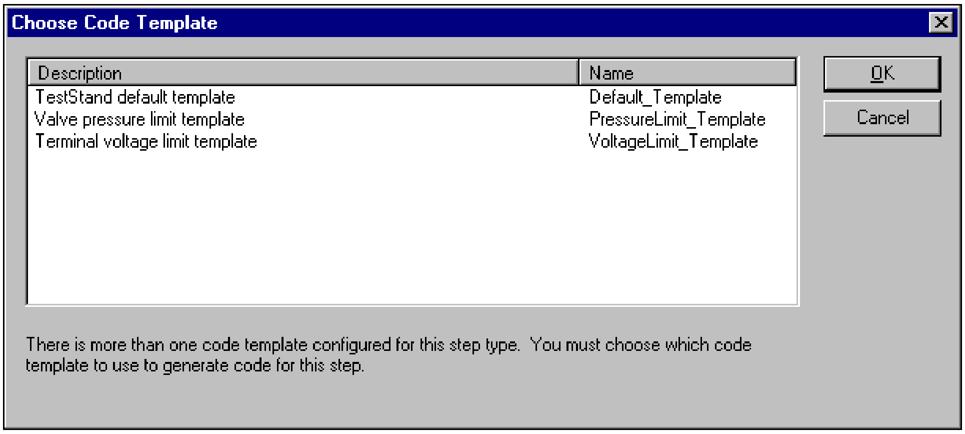
The Selected Adapter ring control specifies the module adapter that a new step you create uses. The selected adapter applies only to step types that can use any module adapter, such as the Action, Numeric Limit Test, Multiple Numeric Limit Test, String Value Test, and Pass/Fail Test step types. Refer to the discussion on the **Insert Step** command in the *Step Group Context Menu* section of Chapter 5, *Sequence Files*, for more information on how TestStand uses the selected adapter when you insert a step.

To configure an adapter, select an adapter from the Configurable Adapters list and click the **Configure** button. The **Configure** button displays an adapter-specific dialog box for configuring the adapter. Refer to the adapter-specific sections in this chapter for information on the specific configuration options for each adapter.

Source Code Templates

With some module adapters, you can use a source code template to generate the source code shell for a step module. The template files are different for each step type and each module adapter. A step type can define multiple source code templates, each for a particular adapter/step type combination. Currently, you can use source code templates with only the LabVIEW, the DLL Flexible Prototype, the C/CVI Standard Prototype Adapters, and the HTBasic Adapters.

For each module adapter that supports source code templates, the Specify Module dialog box displays a command button for creating source code for the step that is based on a template. If more than one template is available for the adapter/step type combination that you use to create the step, the adapter prompts you to select from a list of the templates as shown in Figure 13-2. If only one template is available, the adapter uses that template without prompting you.



Description	Name
TestStand default template	Default_Template
Valve pressure limit template	PressureLimit_Template
Terminal voltage limit template	VoltageLimit_Template

There is more than one code template configured for this step type. You must choose which code template to use to generate code for this step.

Figure 13-2. Choose Code Template Dialog Box

TestStand comes with default templates for each of the built-in step types. You can create additional templates for built-in step types. When you create a new step type, you can create one or more source code templates for it. Refer to the *Using Step Types* section in Chapter 9, *Types*, for more information on creating source templates for step types.

DLL Flexible Prototype Adapter

The DLL Flexible Prototype Adapter allows you to call C functions in a DLL with a variety of parameter types. You can create the DLL code module with LabWindows/CVI, Visual C++, or any other ADE that creates a C-language DLL.

Configuring the DLL Adapter

The DLL Adapter Configuration dialog box contains the following controls:

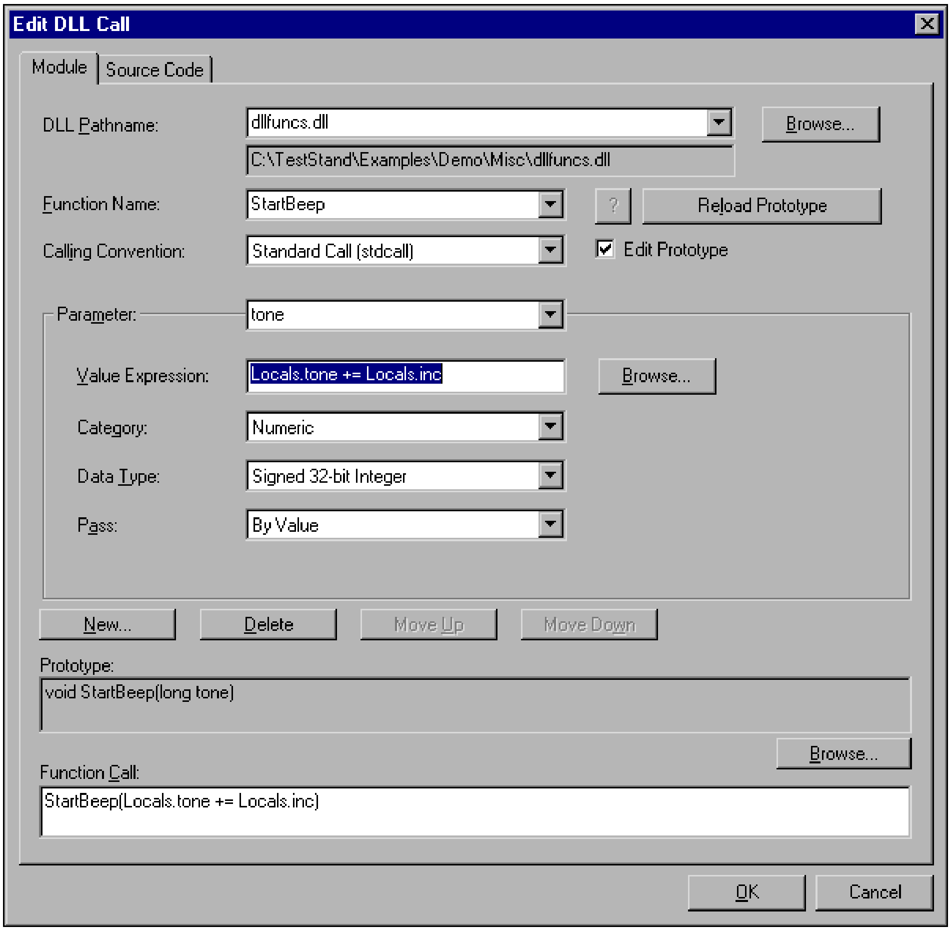
- **Show Function Parameters in Function Description**—Specifies that the description for a step displays the function and its parameters. When you disable the option, the description displays the function and the DLL name.
- **Default Struct Packing**—Specifies how the DLL Adapter packs structure parameters it passes. Set the packing options to match the default for structure packing in your DLL development environment.

Specifying a DLL Adapter Module

The Specify Module dialog box for the DLL Flexible Prototype Adapter is called the Edit DLL Call dialog box. The Edit DLL Call dialog box contains a Module tab and a Source Code tab. The Module tab specifies the code module that the adapter executes for the step and specifies parameter information for the module. The Source Code tab contains additional information that TestStand requires when you want to create and edit a code module in another application program.

Module Tab

Figure 13-3 shows the Module tab of the Edit DLL Call dialog box.



DLL Pathname: dllfuncs.dll
C:\TestStand\Examples\Demo\Misc\dllfuncs.dll
Function Name: StartBeep
Calling Convention: Standard Call (stdcall)
Edit Prototype [✓]
Parameter: tone
Value Expression: Locals.tone += Locals.inc
Category: Numeric
Data Type: Signed 32-bit Integer
Pass: By Value
Prototype:
void StartBeep(long tone)
Function Call:
StartBeep(Locals.tone += Locals.inc)

Figure 13-3. Specify Module Dialog Box for DLL Flexible Prototype Adapter—Module Tab

The Module tab can contain the following controls:

- **DLL Pathname**—Specifies the DLL file that contains the function that the step calls. You can specify an absolute or relative pathname for the DLL file. Relative pathnames are relative to the TestStand search directory paths.

You can customize the TestStand search directory paths with the **Search Directories** command in the **Configure** menu of the sequence editor menu bar.

- **Function**—Selects the function in the DLL that the step calls. If the DLL file contains a type library, the adapter automatically populates the function ring control with all the function names in the type library. Otherwise, the adapter reads the DLL file and finds the names of all functions that the DLL exports. If a DLL type library contains links to a help file for a function, you can click the **?** button to access the help.
- **Calling Convention**—Specifies the calling convention of the function.
- **Edit Prototype**—Enables editing of the function prototype. The adapter clears this control when it reads a function prototype from the DLL type library. Checkmark the control to enable manual editing of the function prototype.
- **Parameter**—Specifies the data type of the return value of each parameter.

  For each parameter you also specify the value or expression to pass. If a DLL file contains a type library, the adapter queries the type library for the parameter list information and displays it in the parameter section automatically when you select a new function in the Function ring control. At any time, you can request the adapter to query the type library for the currently selected function by clicking the **Reload Prototype** button. If the DLL does not have type library information, you must enter parameter information manually.

  The Parameter ring control lists a symbolic name for each parameter and a special entry for the return value. When you select a parameter in the ring control, the type of controls in the Parameter section change. To insert or remove parameters, click the **New** or **Delete** buttons. To rearrange the parameter order, select the parameter you want to move and select the **Move Up** or **Move Down** button.
- **Category**—Specifies a group of data types to list in the DataType control. The categories include Numeric, String, Array, Object, and Struct. The Data Type control specifies the data type of the function parameter.

Numeric Parameters

Table 13-2 shows the Numeric category data types.

Table 13-2. TestStand Numeric Data Types

Numeric Data Type Setting	Equivalent C Data Type
Signed 8-big Integer	`char`
Unsigned 8-bit Integer	`unsigned char`
Signed 16-bit Integer	`short`
Unsigned 16-bit Integer	`unsigned short`
Signed 32-bit Integer	`long`
Unsigned 32-bit Integer	`unsigned long`
32-bit Real Number	`float`
64-bit Real Number	`double`

Pass by Value or by Reference

When you select the Numeric category for a parameter, the adapter displays the Pass control. This control specifies whether TestStand passes the value of the argument you specify in the Value control, or passes a pointer to the argument.

If you choose to pass a pointer, the argument you specify in the Value control must be the name of a station global variable, sequence file global variable, sequence parameter, sequence local variable, or step property. When you select the Numeric category for the return value, you can leave the Value control empty or specify the name of a station global variable, sequence file global variable, sequence parameter, sequence local variable, or step property.

Note You can pass `NULL` to a pointer parameter of type Number, String, Array, or Structure by passing an empty ActiveX reference or the constant `Nothing`. Do not pass the constant `0`.

Result Actions

The adapter displays the Result Action ring control and the Set Error.Code to Value checkbox for return values and parameters you pass by pointer. Depending on the settings of these controls, TestStand can set the `Error.Occurred` and `Error.Code` properties of the step automatically based on the value in the numeric argument when the function returns.

You use the Result Action control to configure TestStand to set the `Error.Occurred` property to `True` when the return value or parameter value after the call is greater than zero, less than zero, equal to zero, or not equal to zero. You use the Set Error.Code to Value checkbox to request TestStand to assign the output value of the argument to the `Error.Code` property.

Enumeration Parameters

When you select a numeric parameter that accepts an enumerated type from a DLL that has a type library, the Value Expression control becomes a combo box from which you can select elements of the enumeration. You also can enter an enumeration symbol or its corresponding numeric value directly into the Value Expression control or the Function Call control.

String Parameters

In general, when you use string parameters, use one of the buffer types if you want the DLL function to be able to change the contents of the argument in TestStand. Use the C String or Unicode String type if the DLL function does not modify the argument.

Table 13-3 shows the String category data types.

Table 13-3. TestStand String Data Types

String Data Type Setting	Equivalent C Data Type
C String	`const char *`
C String Buffer	`char[]`
Unicode String	`const wchar_t *` or `const unsigned short *`
Unicode String Buffer	`wchar_t[]` or `unsigned short[]`

You can pass a string literal, a TestStand string property, or an expression that evaluates to a string as the value of a string parameter.

If you specify one of the string buffer types, the adapter copies the contents of the string argument and a trailing zero element into a temporary buffer before calling the DLL function. You specify the minimum size of the temporary buffer in the Number of Elements control. If the string value is longer than the buffer size you specify, the adapter resizes the temporary buffer so that it is large enough to hold contents of the string argument and the trailing zero element. After the DLL function returns, TestStand copies the value that the function writes into the temporary buffer back to the string argument.

If you specify the C String or Unicode String type, the adapter passes the address of the actual string directly to the function without copying it to a buffer. The code module must not change the contents of the string.

Array Parameters

The Array category contains the same data types as the numeric category. You can specify an array that contains elements that have any numeric type. TestStand reformats the contents of the numeric array argument into a temporary array that contains elements that have the data type you select.

You use the **Number of Elements** control to specify the number of elements in the temporary array. If the array argument has fewer elements than the temporary array, the adapter fills the remaining elements in the temporary array with zeroes. If the array argument has more elements than the temporary array, TestStand fills the temporary array with the maximum number of elements that can fit.

If you want the number of elements in the temporary array to always match the number of elements in the array argument, specify a negative value in the Number of Elements control. This specification is equivalent to the following expression:

`GetNumElements (`*`arrayArgument`*`)`

If you specify a zero value in the Number of Elements control, TestStand passes the address of a temporary array with no elements to the DLL function.

When the DLL function returns, TestStand fills the contents of the array argument with the contents of the temporary array. If the array argument has fewer elements than the temporary array, TestStand stores only the number of elements from the temporary array that fit into the array argument. If the array argument has more elements than the temporary array, TestStand stores all the elements of the temporary array in the array argument and makes no changes to the remaining elements of the array argument.

Object Parameters

The Object category includes the ActiveX Automation `IDispatch` Pointer, ActiveX Automation `IUnknown` Pointer, and LabWindows/CVI ActiveX Automation Handle data types. You can use these types to pass a reference to a built-in or custom TestStand object to the DLL function. You also can use these types to pass the value of an ActiveX reference property to the DLL function.

If you specify an ActiveX reference property as the value of an object parameter, TestStand passes the value of the property. Otherwise, TestStand passes a reference to the property object you specify. The DLL function can use the property object reference in conjunction with the TestStand API to get and set the values of properties in the object, to add properties to the object, and so on. Refer to the *TestStand API Overview* in the *TestStand Programmer Help* for more information on using object references in code modules.

Structure Parameters

You can pass variables and properties that you create with named data types to function parameters that accept structures. When you create or edit a data type, you specify whether the type can be a structure argument and how the type represents itself in memory when you pass it to a structure parameter.

Editing the Function Call

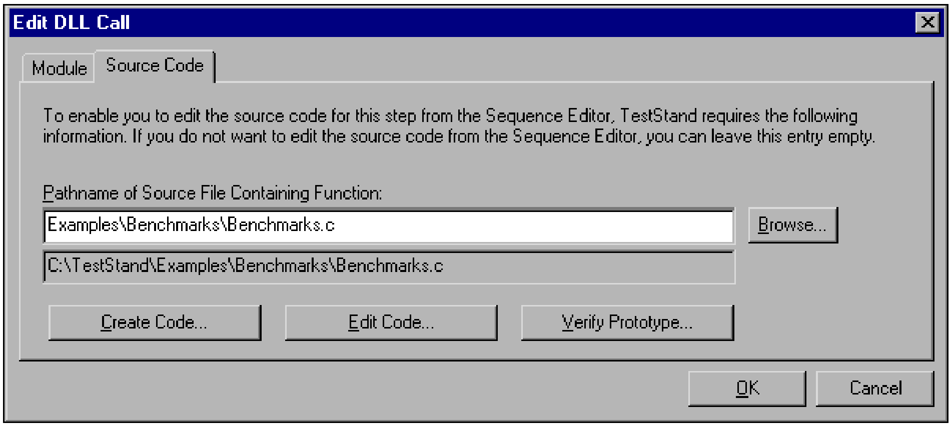
You can use the various controls in the Module tab to edit the function name and its argument values. Alternatively, you can use the Function Call control to directly edit the function name and all of the function arguments at once. In the Function Call control, edit the call just as you would in a source code editor. You can use Cut and Paste to edit multiple arguments or the entire function call. If you enter a different number of arguments than the function prototype specifies, TestStand displays a prompt that gives you the option to alter the prototype to match the number of arguments you specify.

When you make a change in the Function Call control, the Browse, Revert, and the Accept or Goto Error buttons appear. All other controls dim. Use the Browse control to insert variables, properties, or expression operators into the Function Call control. Use Goto Error button to highlight a syntax error in the Function Call control. Use the Accept button to apply the changes you make in the Function Call control. Use the Revert button the discard the changes you make in the Function Call control.

Note The DLL Flexible Prototype Adapter allows you to call functions with variable argument lists.

Source Code Tab

Figure 13-4 shows the Source Code tab of the Edit DLL Call dialog box.



To enable you to edit the source code for this step from the Sequence Editor, TestStand requires the following information. If you do not want to edit the source code from the Sequence Editor, you can leave this entry empty.

Pathname of Source File Containing Function: Examples\Benchmarks\Benchmarks.c

C:\TestStand\Examples\Benchmarks\Benchmarks.c

Figure 13-4. Specify Module Dialog Box for DLL Flexible Prototype Adapter—Source Code Tab

You can use the Source Code tab to generate the source code for the DLL function, to edit the source code, and to resolve differences between the parameter list in the source code and the parameter information on the Module tab. TestStand can call the step code module even if you do not use the Source code tab.

Enter the pathname of the source file in the Pathname of Source File Containing Function control. If you want to create a new source file, you must enter an absolute pathname. If you are using an existing source file, you can enter an absolute or relative pathname. Relative pathnames are relative to the TestStand search directory paths.

To create the source code shell for the function, click the **Create Code** button. If the file does not already exist, the adapter creates it. If the file already exists, the adapter appends the function to the end of the file. If the function already exists in the file, a dialog box gives you the opportunity to replace the current function or to add the new function shell above the current function.

If template source code exists for the step type that you use for the step, the adapter inserts the parameter information from the template source code into the new function shell. It also uses the template parameter list to complete the parameter information on the Module tab. If the step type does not have a code template, TestStand uses the default template for the adapter. When the Module tab already contains parameter information that differs from the parameter list in the template, the adapter displays a dialog box in which you can resolve the conflict.

After the adapter creates the code, it launches the application that is currently registered on your system for the type of the file, such as LabWindows/CVI for `.c` files, and displays the file in the application.

If you already have the source code for the function and you want to edit it, click the **Edit Code** button.

When you click the **Create Code** button and the parameter list of the function in the source code does not match the parameter information on the Module tab, the adapter displays a dialog box in which you can resolve the conflict. You also can click the **Verify Prototype** button to check for any conflicts between the source code and the parameter information on the Module tab.

When the adapter parses the parameter list in the source code, it has to interpret the parameter declarations. The return value and each parameter must have one of the numeric, array, or object types discussed earlier in this chapter. Some C parameter declarations can be ambiguous, as described in Table 13-4. For example, `char *` and `char []` can each represent either a null-terminated string or a fixed-size character array.

Table 13-4 indicates how the adapter interprets ambiguous declarations.

Table 13-4. Adapter Interpretation of Ambiguous Declarations

C Data Type in Parameter Declaration in Source Code	Parameter Information on Module Tab
`char *`	Type: C String
`char []`	Type: C String Buffer Number of Elements: `-1`

Table 13-4. Adapter Interpretation of Ambiguous Declarations (Continued)

C Data Type in Parameter Declaration in Source Code	Parameter Information on Module Tab
`char` [*nnn*], where *nnn* is a numeric literal	Type: C String Buffer Number of Elements: *nnn*
`wchar_t *`	Type: Unicode String
`wchar_t []`	Type: Unicode String Buffer Number of Elements: `-1`
`wchar_t [`*nnn*`]`, where *nnn* is a numeric literal	Type: Unicode String Buffer Number of Elements: *nnn*
`int *`	Type: Signed 32-bit integer Pass: Pointer to value
`int []`	Type: Array Data Type: Signed 32-bit integer. Number of Elements: `-1`
`int [`*nnn*`]`, where *nnn* is a numeric literal	Type: Array Data Type: Signed 32-bit integer Number of Elements: *nnn*

The adapter handles the other numeric types in the same way it handles the signed 32-bit integers.

Debugging DLLs

To debug a DLL, create the DLL with debugging enabled in LabWindows/CVI or in another ADE. To debug DLLs, you must launch the sequence editor or run-time operator interface from LabWindows/CVI or the other ADE. In LabWindows/CVI, you use the **Select External Process** command in the **Run** menu of the Project window to identify the executable for the sequence editor or run-time operator interface. You then use the **Run** command to start the executable.

If you select the **Step Into** command in TestStand while execution is currently suspended on a step that calls into a LabWindows/CVI DLL that you are debugging, LabWindows/CVI breaks at the first statement in the DLL function.

Table 13-5 describes your options for stepping out of a LabWindows/CVI DLL function that you are debugging.

Table 13-5. Options for Stepping Out of LabWindows/CVI DLL Functions

LabWindows/CVI Command for Stepping Out	Result in TestStand
Finish Function	Execution of the function. When you use this command on the last function in the call stack, TestStand suspends execution on the next step in the sequence.
Step Into or Step Over	When you use this command on the last executable statement of the function, TestStand suspends execution on the next step in the sequence.
Continue	TestStand does not suspend execution when the function call returns.

Refer to the LabWindows/CVI product manuals for more information on debugging DLLs in an external process.

Debugging LabVIEW DLLs You Call with the Flexible DLL Adapter

You must use a LabVIEW operator interface to debug a VI that you build into a DLL with LabVIEW 6*i* or later. First, open the operator interface in the LabVIEW development environment. Before executing the operator interface, open the VI that represents the DLL function to debug and place a break point in the diagram of this VI. Next, use the LabVIEW operator interface to load and execute the sequence file that calls the LabVIEW DLL. When the sequence step calls the DLL function, LabVIEW stops at the breakpoint you set in the VI.

Using MFC in a DLL

Microsoft Foundation Class Library (MFC) places several requirements on DLLs that use the DLL version of the MFC run-time library. If you call functions in a DLL that use the DLL version of the MFC run-time library, verify that the DLL meets these requirements. Also, if the DLL uses resources such as dialog boxes, verify that the `AFX_MANAGE_STATE` macro appears at the beginning of the function body of each function that you call. Refer to your MFC documentation for more information.

Loading Subordinate DLLs

TestStand directly loads and runs the DLLs that you specify in the Specify Module dialog box for the DLL Flexible Prototype Adapter. Most likely, your code modules call subsidiary DLLs, such as instrument drivers. You must ensure that the operating system can find and load the subsidiary DLLs. The operating system searches for the DLLs using the following search directory precedence.

1. The directory in which the application resides
2. The current working directory
3. Under Windows 98/95, the `Windows\System` directory. Under Windows NT and Windows 2000, the Windows\System32 and `Windows\System` directories
4. The Windows directory
5. The directories listed in the PATH environment variable

LabVIEW Standard Prototype Adapter

The LabVIEW Standard Prototype Adapter allows you to call any LabVIEW VI that has the specific structure that the adapter requires. The LabVIEW Standard Prototype Adapter uses a LabVIEW ActiveX server to run VI code modules. The server can be the LabVIEW development environment or a LabVIEW-built application that has enabled the LabVIEW ActiveX server.

LabVIEW Standard Prototype Adapter Module Structure

Code modules for the LabVIEW Standard Prototype Adapter are VIs that contain a specific set of controls and indicators that you assign to a connector pane terminal. The controls and indicators must have names and data types that match the LabVIEW Standard Prototype Adapter parameter list. TestStand does not require a particular connector pane pattern or that the controls and indicators be assigned to specific terminals. TestStand only requires that you assign the controls and indicators to a terminal in the connector pane of the VI.

You usually create new VIs from the Specify Module dialog box for a step that uses the LabVIEW Standard Prototype Adapter. In this case, TestStand creates the required controls and automatically assigns them to connector pane terminals for you.

Before calling a VI, the adapter assigns values from TestStand to the controls that you wire to the connector pane. After calling the VI, the adapter copies values from the indicators to properties of the TestStand step. The adapter copies each value into its corresponding property when the following conditions are true:

- The property exists.
- The VI does not change the value of the property directly, through the TestStand API.

A VI must contain a `Test Data` cluster control and an `error out` cluster control that is wired to the connector pane. A VI also can contain optional controls, which include `Input Buffer`, `Invocation Info`, and `Sequence Context`. The following sections discuss each of the required and optional VI controls.

Test Data Cluster

The LabVIEW Standard Prototype Adapter must use the `Test Data` cluster to return result data from the VI to TestStand. TestStand can use the data to make a PASS/FAIL determination.

Figure 13-5 shows the Test Data cluster.

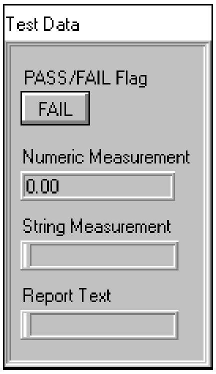


Figure 13-5. Test Data Cluster

Table 13-6 lists the elements of the `Test Data` cluster, their types, and descriptions of how the adapter uses them.

Table 13-6. Test Data Cluster Elements

Name	Type	Description
`PASS/FAIL Flag`	TF	The test VI sets this element to indicate whether the test passed. Valid values are `True (PASS)` or `False (FAIL)`. The adapter copies its value into the `Step.Result.PassFail` property if the property exists.
`Numeric Measurement`	DBL	Numeric measurement that the test VI returns. The adapter copies this value into the `Step.Result.Numeric` property if the property exists.
`String Measurement`	abc	String value that the test function returns. The adapter copies the string into the `Step.Result.String` property if the property exists.
`Report Text`	abc	Output message to display in the report. The adapter copies the message value into the `Step.Result.ReportText` property if the property exists.

The LabVIEW Standard Prototype Adapter also supports an older version of the `Test Data` cluster from the LabVIEW Test Executive product. The `Test Data` cluster in the LabVIEW Test Executive does not contain a `Report Text` element. Instead, the cluster contains two string elements, `User Output` and `Comment`.

Table 13-7 lists these elements of the older `Test Data` cluster, their types, and description of how the adapter uses them.

Table 13-7. Old Test Data Cluster Elements from LabVIEW Test Executive

Name	Type	Description
`Comment`	abc	Output message to display in the report. The adapter copies the message value into the `Step.Result.ReportText` property if the property exists.
`User Output`	abc	String value that the test function returns. The adapter dynamically creates the step property `Step.Result.UserOutput`, and copies the string value to the step property.

Error Out Cluster

TestStand must use the contents of the `error out` cluster to determine whether a run-time error has occurred and to take appropriate action, if necessary. When you create a VI, use the standard LabVIEW `error out` cluster, shown in Figure 13-6.

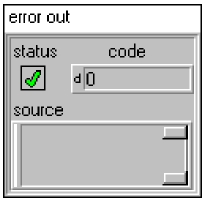


Figure 13-6. Standard Error Out Cluster

Table 13-8 lists the elements of the `error out` cluster, their types, and descriptions of how the adapter uses them.

Table 13-8. Error Out Cluster Elements

Name	Type	Description
`status`	TF	The test VI must set this to `True` if an error occurs. The adapter copies the output value into the `Step.Result.Error.Occurred` property if the property exists.
`code`	I32	The test VI can set this element to a non-zero value if an error occurs.
`source`	abc	The test VI can set this element to a descriptive string if an error occurs.

Input Buffer

You use the `Input buffer` string control to pass input data directly to the VI. The LabVIEW Standard Prototype Adapter automatically copies the contents of the `Step.InBuf` property to the `Input buffer` control if the property exists.

Invocation Information

You use the `Invocation Information` cluster control to pass additional information to the VI. Figure 13-7 shows the `Invocation Information` control.

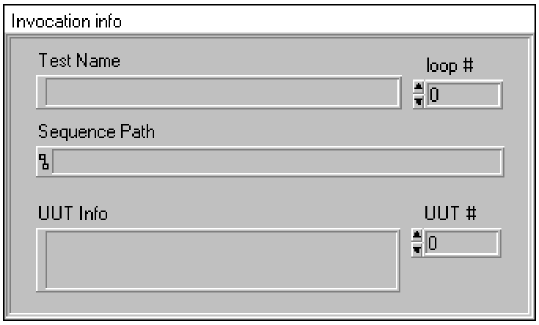


Figure 13-7. Invocation Information Cluster

Table 13-9 lists the elements of the `Invocation Information` cluster, their types, and descriptions of how the adapter assigns a value to each cluster element.

Table 13-9. Error Out Cluster Elements

Name	Type	Description
`Test Name`	abc	Contains the name of the step that invokes the VI.
`loop #`	I32	Contains the loop count if the step that invokes the VI is looping on the step.
`Sequence Path`	⊶	Contains the name and absolute path of the sequence file that is running the VI.
`UUT Info`	abc	Contains the value of the `RunState.Root.Locals.UUT.SerialNumber` property if the property exists.
`UUT #`	I32	Contains the value of the `RunState.Root.Locals.UUT.UUTLoopIndex` property if the property exists.

Sequence Context

You use the `Sequence Context` control to obtain a reference to the TestStand sequence context object. You can use the sequence context to access all the objects, variables, and properties in the execution. Figure 13-8 shows the `Sequence Context` control. Refer to the *TestStand Programmer Help* for more information on using the sequence context from a VI.

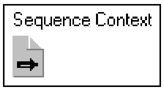
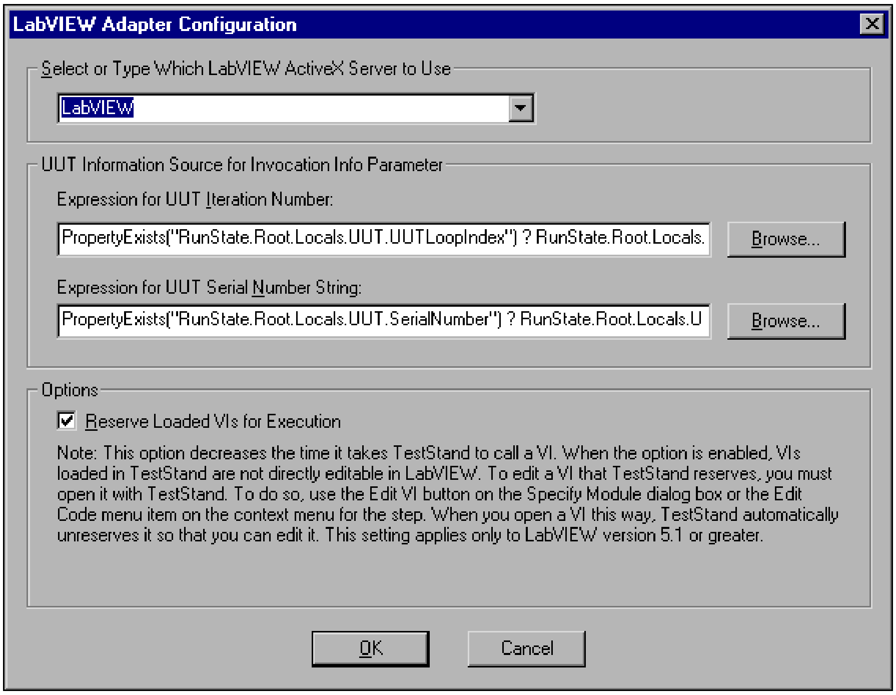


Figure 13-8. Sequence Context Control

Configuring the LabVIEW Standard Prototype Adapter

To run VIs, the LabVIEW Standard Prototype Adapter uses a LabVIEW ActiveX server. The server can be the LabVIEW development environment or a LabVIEW-built application that includes the LabVIEW ActiveX server. You specify which server the adapter uses in the Select Which LabVIEW ActiveX Server to Use ring control. Figure 13-9 shows the LabVIEW Adapter Configuration dialog box.


LabVIEW Adapter Configuration

Select or Type Which LabVIEW ActiveX Server to Use: LabVIEW

UUT Information Source for Invocation Info Parameter

Expression for UUT Iteration Number: PropertyExists("RunState.Root.Locals.UUT.UUTLoopIndex") ? RunState.Root.Locals.

Expression for UUT Serial Number String: PropertyExists("RunState.Root.Locals.UUT.SerialNumber") ? RunState.Root.Locals.U

Options

☑ Reserve Loaded VIs for Execution

Note: This option decreases the time it takes TestStand to call a VI. When the option is enabled, VIs loaded in TestStand are not directly editable in LabVIEW. To edit a VI that TestStand reserves, you must open it with TestStand. To do so, use the Edit VI button on the Specify Module dialog box or the Edit Code menu item on the context menu for the step. When you open a VI this way, TestStand automatically unreserves it so that you can edit it. This setting applies only to LabVIEW version 5.1 or greater.

Figure 13-9. LabVIEW Adapter Configuration Dialog Box

You can type in the ProgID of the server to connect to or select one of the following choices from the ring:

- **LabVIEW**—The version of the LabVIEW development environment you most recently launched. To use LabVIEW to debug test VIs, you must select this option so that the VIs run in the LabVIEW development environment.
- **TestStandLVGUIRTS**—The LabVIEW operator interface application. If you use the LabVIEW operator interface, this is the most efficient choice because it does not launch a separate server application.

- **TestStandLVRTS**—TestStand installs a prebuilt executable with source files for a LabVIEW run-time server in the `<TestStand>\Components\NI\RuntimeServers\LabVIEW` directory tree. TestStand registers this ActiveX server under the `TestStandLVRTS` ProgID. This server enables you to run VIs on machines that do not install a LabVIEW development environment or other LabVIEW server application. Refer to the *Customizing and Distributing a LabVIEW Run-Time Server* section in Chapter 17, *Distributing TestStand*, for more information on LabVIEW run-time servers.
- **BridgeVIEW**—The version of the BridgeVIEW development environment you most recently launched. To use BridgeVIEW to debug test VIs, you must select this option so that the VIs run in the BridgeVIEW development environment.

The UUT Information Source section contains the following controls:

- **Expression for UUT Iteration Number**—Specifies the expression that the adapter evaluates at run time to generate a value to pass to the `UUT #` element of the `Invocation Information` cluster.
- **Expression for UUT Serial Number String**—Specifies the expression that the adapter evaluates at run time to generate a value to pass to the `UUT Info` element of the `Invocation Information` cluster.

The Options section contains the following control:

- **Reserve Loaded VIs for Execution**—Specifies that LabVIEW reserves each VI to run when TestStand loads the VI. When a VI is reserved for execution, references that it creates during execution remain valid until the VI is unreserved. VIs that LabVIEW reserves take less time to call but you cannot edit them in LabVIEW unless you click the **Edit VI** button on the Specify Module dialog box or the **Edit Code** menu item from the context menu for the calling step.

  TestStand unreserves a VI under the following circumstances:

  – When you select **File»Unload All Modules** from the sequence editor menu

  – When the VI is unloaded based on sequence file or step unload options

  – When you open a VI for editing from within TestStand.

  The **Reserve Loaded VIs for Execution** option eliminates the need to use permanent reference VIs for sharing LabVIEW references between step modules.

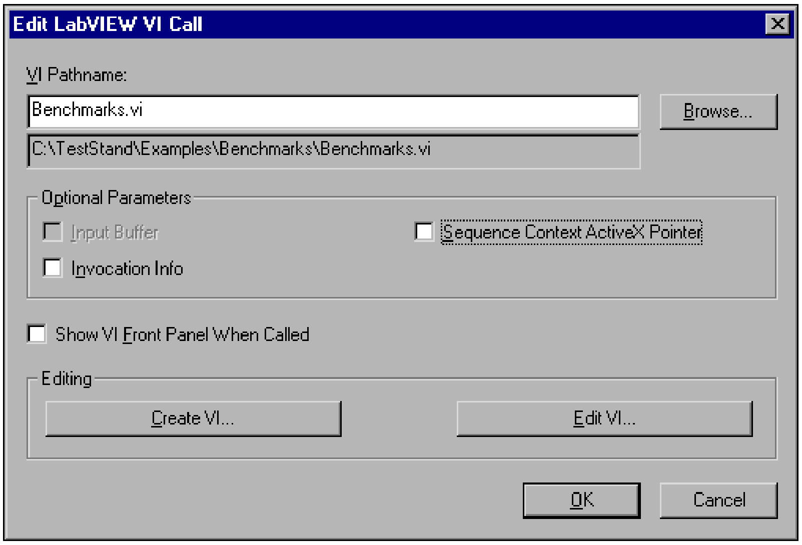
You can create a reference in a VI called by one step in a sequence and then use the reference in another VI. For example, you can create a file refnum from Open File and use the reference in Read File or Write File. You must explicitly destroy the LabVIEW reference when you are done with it; for example, Close File.

A LabVIEW reference exists only as long as the VI that creates it. If you set the Unload Option for a step that calls a VI to Unload After a Step Executes or Unload When Precondition Fails, the LabVIEW references the step creates may be destroyed on completion of the step.

If you do not reserve VIs for execution, you can use the permanent reference VIs to maintain LabVIEW references between steps. Refer to the `<TestStand>\Examples\AccessingPropertiesAnd Variables\UsingLabVIEW` example for more information.

Specifying a LabVIEW Standard Prototype Adapter Module

The Specify Module dialog box for the LabVIEW Standard Prototype Adapter is called the Edit LabVIEW VI Call dialog box. Figure 13-10 shows the Edit LabVIEW VI Call dialog box.


Edit LabVIEW VI Call

VI Pathname: Benchmarks.vi

C:\TestStand\Examples\Benchmarks\Benchmarks.vi

Optional Parameters

☐ Input Buffer ☐ Sequence Context ActiveX Pointer

☐ Invocation Info

☐ Show VI Front Panel When Called

Figure 13-10. Specify Module Dialog Box for LabVIEW Standard Prototype Adapter

The VI Module Pathname control specifies the path and name of the VI that the step calls. You can specify an absolute or relative pathname for the file. Relative pathnames are relative to the TestStand search directory paths. To customize the TestStand search directory paths, use the **Configure»Search Directories** command in the sequence editor menu bar.

The Optional Parameters section contains a checkbox for each of the optional parameters that you can wire to the connector pane of the VI. The checkbox controls are Input Buffer, Invocation Info, and Sequence Context ActiveX Pointer. The Input Buffer control dims if the `Step.InBuf` property does not exist for the step you are editing. For example, the Input Buffer control dims for an Action step.

Normally, when the adapter executes a step that calls a LabVIEW VI, the adapter does not activate the front panel of the VI. If you want the adapter to activate the front panel of the VI, enable the Show VI Front Panel When Called control. The adapter returns the state of the front panel to its original visibility state after the VI finishes executing.

To create a code shell for the VI, click the **Create VI** button. If the VI file that you specify does not already exist, the adapter creates it. If the file already exists, the adapter prompts you to overwrite the existing file. If a VI code template file exists for the step type you are using for the step, the adapter uses the template to create the new VI.

If the VI already exists and you want to edit it, click the **Edit Code** button.

Debugging a LabVIEW Standard Prototype Adapter Module

To debug a VI while executing the VI from TestStand, you must configure the adapter to use the LabVIEW development environment as the LabVIEW server. Here are the two ways you can suspend the execution of a VI in LabVIEW.

- Before executing the VI, load the VI into LabVIEW and place it in a pause state by clicking the **Pause** icon button.
- Select the **Step Into** command in TestStand when execution suspends on a step that calls into a LabVIEW VI.

When LabVIEW suspends a VI, LabVIEW displays the front panel for the VI as shown in Figure 13-11.

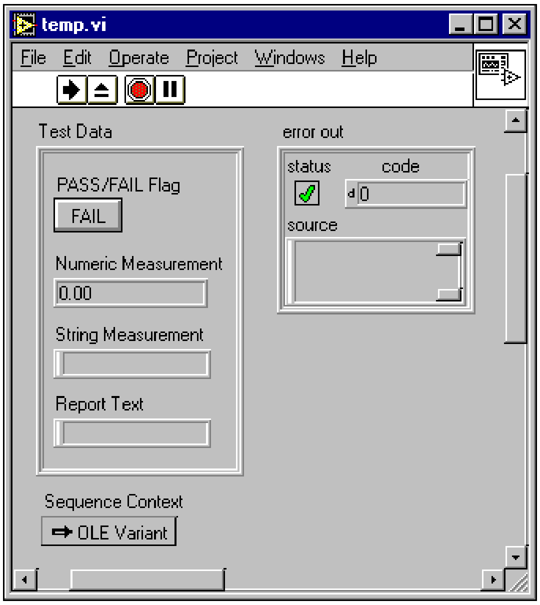


Figure 13-11. Stepping into a LabVIEW VI

A suspended front panel has four icon buttons:

- Run
- Return to Caller
- Abort Execution
- Pause

From a suspended front panel, you can run the VI multiple times before returning to the calling TestStand step. To debug the VI, open the VI diagram and use the standard LabVIEW debug tools. After you finish debugging the VI, you must click the **Return to Caller** icon button to return to the calling step and suspend the execution on the next step. If you click the **Abort Execution** icon button, the adapter returns a run-time error to the calling step. When you abort the VI execution, the adapter sets the step property `Step.Result.Error.Occurred` to `True`. It also sets the `Step.Result.Error.Code` and `Step.Result.Error.Msg` properties equal to the error that the LabVIEW server returns.

C/CVI Standard Prototype Adapter

The C/CVI Standard Prototype Adapter allows you to call any C function that has the TestStand standard C parameter list. The function can exist in an object file, library file, or DLL. The function can also exist in a source file that is located in the project that you are currently using in the LabWindows/CVI development environment.

C/CVI Standard Adapter Module Prototypes

The C/CVI Standard Prototype Adapter supports two prototypes, a standard and an extended prototype. TestStand provides the extended prototype for backward compatibility with the LabWindows/CVI Test Executive Version 2.0 and earlier. The extended prototype has an additional string parameter. National Instruments recommends that you use the standard prototype unless you have a reason not to do so.

The standard prototype is as follows:

```
void TX_TEST StandardFunc(tTestData *data,
tTestError *error)
```

The extended prototype is as follows:

```
int TX_TEST ExtendedFunc(char *params, tTestData *data,
tTestError *error)
```

These prototypes contain two structure parameters, which the adapter uses to pass values into and out of the code module. Table 13-10 lists the fields in the `tTestData` structure.

Table 13-10. tTestData Structure Member Fields

Field Name	Data Type	In/ Out	Description
`result`	`int`	Out	Set by test function to indicate whether the test passed. Valid values are `PASS` or `FAIL`. The adapter copies its value into the `Step.Result.PassFail` property if the property exists.
`measurement`	`double`	Out	Numeric measurement that the test function returns. The adapter copies this value into the `Step.Result.Numeric` property if the property exists.

Table 13-10. tTestData Structure Member Fields (Continued)

Field Name	Data Type	In/ Out	Description
`inBuffer`	`char *`	In	For passing a string parameter to a test function. The adapter copies the `Step.InBuf` property value into this field if the property exists.
`outBuffer`	`char *`	Out	Output message to display in the report. The adapter copies the message value into the `Step.Result.ReportText` property if the property exists.
`modPath`	`char * const`	In	Directory path of module that contains the test function. The adapter sets this value before executing the code module.
`modFile`	`char * const`	In	Filename of module that contains the test function. The adapter sets this value before executing the code module.
`hook`	`void *`	In	Reserved (no longer used).
`hookSize`	`int`	In	Reserved (no longer used).
`mallocFuncPtr`	`tMallocPtr const`	In	Contains a function pointer to `malloc`, which a code module must use to allocate memory for any buffer that it assigns to the `inBuffer`, `outBuffer`, and `errorMessage` fields.
`freeFuncPtr`	`tFreePtr`	In	Contains a function pointer to `free`, which a code module must use to free any buffers that the `inBuffer`, `outBuffer`, and `errorMessage` fields point to.
`seqContextDisp`	`struct IDispatch *`	In	Dispatch pointer to the sequence context. NULL if you choose not to pass the sequence context.
`seqContextCVI`	`CAObjHandle`	In	LabWindows/CVI ActiveX Automation handle for the sequence context. `0` if you choose not to pass the sequence context.

Table 13-10. tTestData Structure Member Fields (Continued)

Field Name	Data Type	In/ Out	Description
`stringMeasurement`	`char *`	Out	String value that the test function returns. The adapter copies the string into the `Step.Result.String` property if the property exists.

`replaceStringFuncPtr`	`tReplaceStringPtr const`	In	Contains a function pointer to `ReplaceString`, which a code module can use to reassign a value to the `inBuffer`, `outBuffer`, and `errorMessage` fields. The `ReplaceString` prototype is as follows:
			`int ReplaceString(`
			`char **destString,`
			`char *srcString)`
			The function return value is non-zero if successful.

`structVersion`	`int`	In	Structure version number. A test module can use this value to detect new versions of the structure.

Note Use the sequence context to access all the objects, variables, and properties in the execution. Refer to the *TestStand Programmer Help* for more information on using the sequence context from a C/CVI code module.

Table 13-11 lists the fields in the `tTestError` structure.

Table 13-11. tTestError Structure Member Fields

Field Name	Data Type	In/ Out	Description
`errorFlag`	`Boolean (int)`	Out	The test function must set this value to `True` if an error occurs. The adapter copies the output value into the `Step.Result.Error.Occurred` property if the property exists.
`errorLocation`	`tErrLoc (int)`	Out	Reserved (no longer used).

Table 13-11. tTestError Structure Member Fields (Continued)

Field Name	Data Type	In/ Out	Description
`errorCode`	`int`	Out	The test function can set this value to a non-zero value if an error occurs.
`errorMessage`	`char *`	Out	The test function can set this field to a descriptive string if an error occurs.

Before calling a code module, the adapter assigns values from TestStand to input fields of the `tTestData` structure.

After calling the code module, the adapter copies the values of the output fields of the structures to properties of the step. The adapter copies a value into a property when the following conditions are true:

- The property exists.
- The code module does not change the value of the property directly, through the TestStand API.

In some cases, the adapter translates the value of a structure field to a different value in the corresponding property.

Table 13-12 lists all the properties that the Adapter updates and the value translation, if any, that it makes.

Table 13-12. Step Properties Updated by C/CVI Standard Prototype Adapter

Structure Member	Valid Values that Tests Can Return	Step.Result Property	Step Property Value
`result`	`PASS` or `FAIL`	`PassFail`	`True/False`
`outBuffer`	*`string value`*	`ReportText`	*`string value`*
`measurement`	*`floating-point value`*	`Numeric`	*`numeric value`*
`stringMeasurement`	*`string value`*	`String`	*`string value`*
`errorFlag`	`True` or `False`	`Error.Occurred`	`True/False`
`errorCode`	*`integer value`*	`Error.Code`	*`numeric value`*
`errorMessage`	*`string value`*	`Error.Msg`	*`string value`*

Example C/CVI Standard Prototype Code Module

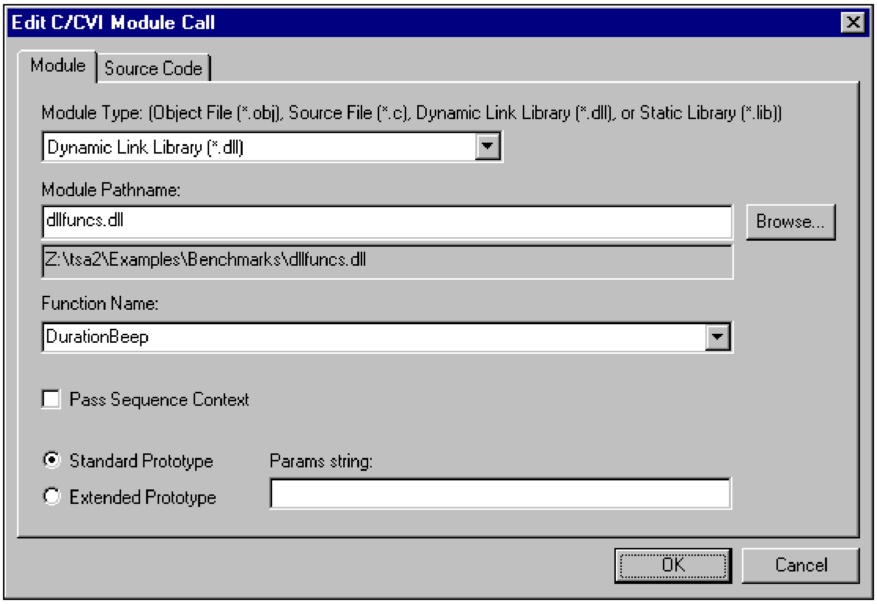
When you create a code module for the C/CVI Standard Prototype Adapter, you must add the `<TestStand>\Bin\stdtst.h` header file to your source file. The `stdtst.h` file includes the type definitions for the `tTestData` and `tTestError` structures. The following is an example code module that uses the C/CVI standard prototype.

```
// Simple test example
#include "stdtst.h"

void TX_TEST __declspec(dllexport) FunctionName (tTestData *testData,
tTestError *testError)
{
    int error = 0;

    // REPLACE THE FOLLOWING WITH YOUR SPECIFIC TEST CODE
    // double measurement = 5.0;
    // char *lastUserName = NULL;

    // testData->measurement = measurement;

    // The following code shows how to access the step properties via
    // the TestStand API
    // if ((error = TS_PropertyGetValString(testData->seqContextCVI, NULL,
    //    "StationGlobals.TS.LastUserName", 0, lastUserName)) < 0)
    //    goto Error;

Error:
    // FREE RESOURCES
    // CA_FreeMemory(lastUserName);

    // If an error occurred, set the error flag to cause a run-time error
    // in TestStand.
    if (error < 0)
        {
        testError->errorFlag = TRUE;

        // OPTIONALLY SET THE ERROR CODE AND STRING
        // testError->errorCode = error;
        // testData->replaceStringFuncPtr(&testError->errorMessage,
        //      "A run-time error occurred.");
    }
}
```

Specifying a C/CVI Standard Prototype Adapter Module

The Specify Module dialog box for the C/CVI Standard Prototype Adapter is called the Edit C/CVI Module Call dialog box. To access this dialog box, click the **Specify Module** button on the General tab of a Step Properties dialog box. The Edit C/CVI Module Call dialog box contains a Module tab and a Source Code tab. The Module tab specifies the code module that the adapter executes for the step, and the Source Code tab contains additional information that TestStand requires when you want to create and edit a code module in LabWindows/CVI.

Figure 13-12 shows the Module tab on the Edit C/CVI Module Call dialog box.


Edit C/CVI Module Call

Module | Source Code

Module Type: (Object File (*.obj), Source File (*.c), Dynamic Link Library (*.dll), or Static Library (*.lib))
Dynamic Link Library (*.dll)

Module Pathname:
dllfuncs.dll
Z:\tsa2\Examples\Benchmarks\dllfuncs.dll

Function Name:
DurationBeep

☐ Pass Sequence Context

● Standard Prototype
○ Extended Prototype

Params string:

Figure 13-12. Specify Module Dialog Box for C/CVI Standard Prototype Adapter—Module Tab

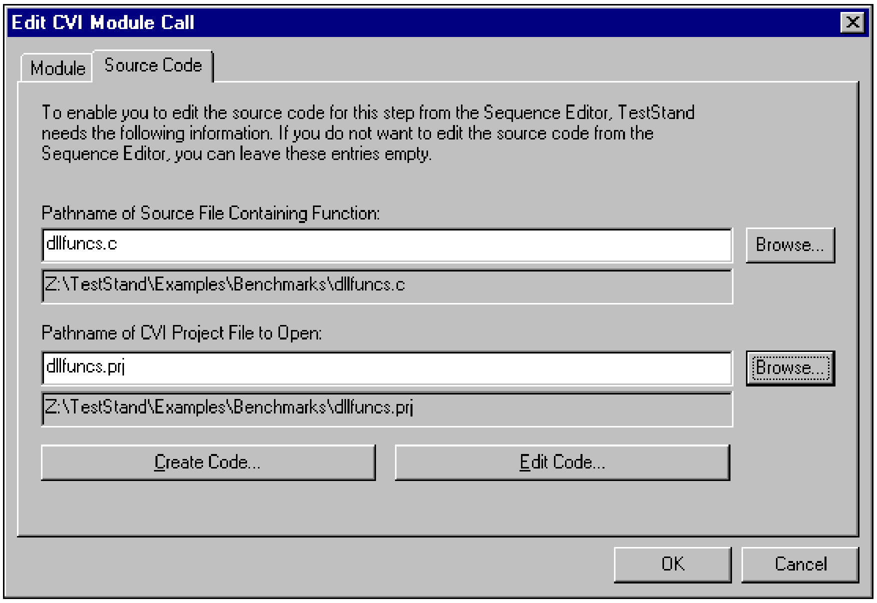
- **Module Type**—Selects the type of code module the step calls. The adapter supports calling functions in C source files, object files, dynamic link library files, and static library files.
- **Module Pathname**—Specifies the pathname of the code module file that contains the function that the step calls. You can specify an absolute or relative pathname for the module file. Relative pathnames

are relative to the TestStand search directory paths. To customize the TestStand search directory paths, use the **Search Directories** command in the **Configure** menu of the sequence editor menu bar.

- **Function Name**—Selects the function in the code module that the step calls. The adapter attempts to read the code module file and find the names of all functions. If the **Module Type** is not a .c file, the adapter populates the **Function Name** ring control with the names of all the functions the module contains.
- **Standard Prototype** and **Extended Prototype**—Selects the function prototype for the function. Use the Params String control to specify the value of the extra parameter for the extended prototype.
- **Pass Sequence Context**—Specifies whether the adapter passes a sequence context to the code module. The adapter passes the sequence context in the following two forms in the `tTestData` structure:
  - As an CVI ActiveX Automation handle in the `seqContextCVI` field
  - As an ActiveX Automation dispatch pointer in the `seqContextDisp` field

  Enable the checkbox if you want to call the TestStand API in the code module or if the code module must pass the sequence context to another function.

Figure 13-13 shows the Source Code tab for the Edit C/CVI Module Call dialog box.


Edit CVI Module Call

To enable you to edit the source code for this step from the Sequence Editor, TestStand needs the following information. If you do not want to edit the source code from the Sequence Editor, you can leave these entries empty.

Pathname of Source File Containing Function: dllfuncs.c

Z:\TestStand\Examples\Benchmarks\dllfuncs.c

Pathname of CVI Project File to Open: dllfuncs.prj

Z:\TestStand\Examples\Benchmarks\dllfuncs.prj

Figure 13-13. Specify Module Dialog Box for C/CVI Standard Prototype Adapter—Source Code Tab

You can use the Source Code tab to generate or edit the source code for the function. You do not have to use the Source code tab in order for TestStand to be able to call the step code module.

Enter the pathname of the source file in the Pathname of Source File Containing Function control. If you want to create a new source file, you must enter an absolute pathname. If you are using an existing source file, you can enter an absolute or relative pathname. Relative pathnames are relative to the TestStand search directories.

If the code module is a DLL or static library, you must enter the name of the LabWindows/CVI project that you use to create the DLL or static library file. If the code module is an object module, you can specify a project if you want to.

To create the source code shell for the function, click the **Create Code** button. If the source file you specify does not already exist, the adapter creates it. If the file already exists, the adapter appends the function to the end of the file. If a source code template file exists for the step type that you are using for the step, the adapter uses the template to create the shell of the new function. If the project file you specify does not already exist, the adapter creates it and adds the source file to it.

If you already have the source code for the function, and you want to edit it, click the **Edit Code** button.

When you use the **Create Code** button or the **Edit Code** button, the adapter launches a copy of LabWindows/CVI and opens the source file. If you specify a project file in the Source Code tab, the adapter also opens the project in LabWindows/CVI. When you use the **Create Code** button and the function already exists in the file, a dialog box appears giving you the choice of replacing the current function or adding the new function shell above the current function.

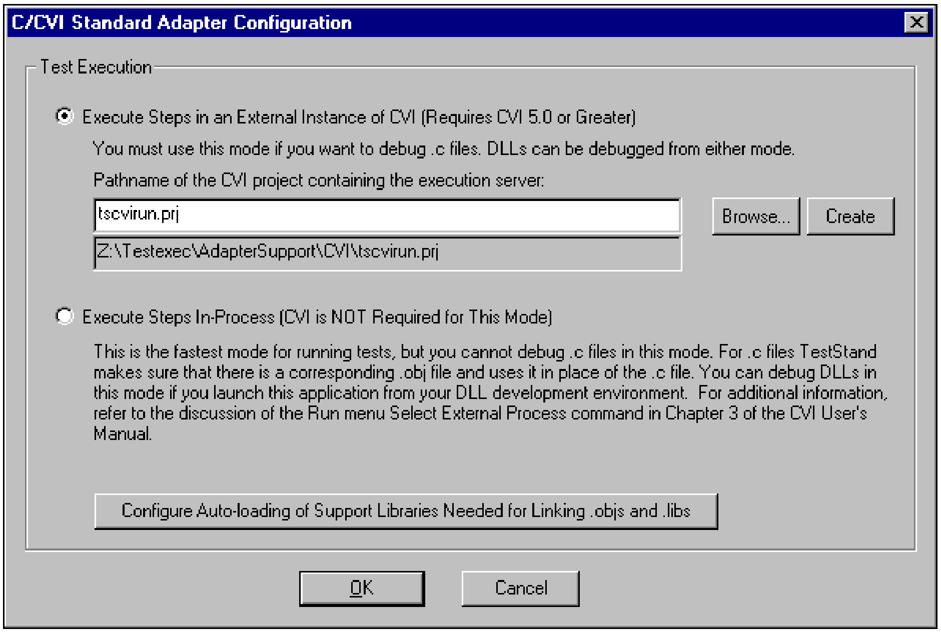
Note You cannot use the **Create Code** button when you select the Extended Prototype.

Configuring the C/CVI Standard Prototype Adapter

You can specify the test execution mode—*in-process* or *out-of-process*—for the C/CVI Standard Prototype Adapter. When the adapter runs tests in-process, it executes them in the same process as the sequence editor or operator interface you are running. When the adapter runs tests out-of-process, it executes them in an external instance of the LabWindows/CVI development environment. To specify this option, use the **Adapters** command in the **Configure** menu.

The adapter can launch two different copies of LabWindows/CVI. The adapter uses one copy to execute test modules. By default, the adapter opens `<TestStand>\AdapterSupport\CVI\tscvirun.prj` in this copy of LabWindows/CVI. You can use the adapter configuration dialog box to change which project the adapter uses to run test modules. The adapter uses the other copy of LabWindows/CVI to let you edit the projects that you use to create DLLs, static libraries, and object files.

Figure 13-14 shows the configuration dialog box for the C/CVI Standard Prototype Adapter.


C/CVI Standard Adapter Configuration

Test Execution

(●) Execute Steps in an External Instance of CVI (Requires CVI 5.0 or Greater)

You must use this mode if you want to debug .c files. DLLs can be debugged from either mode.

Pathname of the CVI project containing the execution server:

tscvirun.prj

Z:\Testexec\AdapterSupport\CVI\tscvirun.prj

( ) Execute Steps In-Process (CVI is NOT Required for This Mode)

This is the fastest mode for running tests, but you cannot debug .c files in this mode. For .c files TestStand makes sure that there is a corresponding .obj file and uses it in place of the .c file. You can debug DLLs in this mode if you launch this application from your DLL development environment. For additional information, refer to the discussion of the Run menu Select External Process command in Chapter 3 of the CVI User's Manual.

Browse...
Create
Configure Auto-loading of Support Libraries Needed for Linking .objs and .libs
OK
Cancel

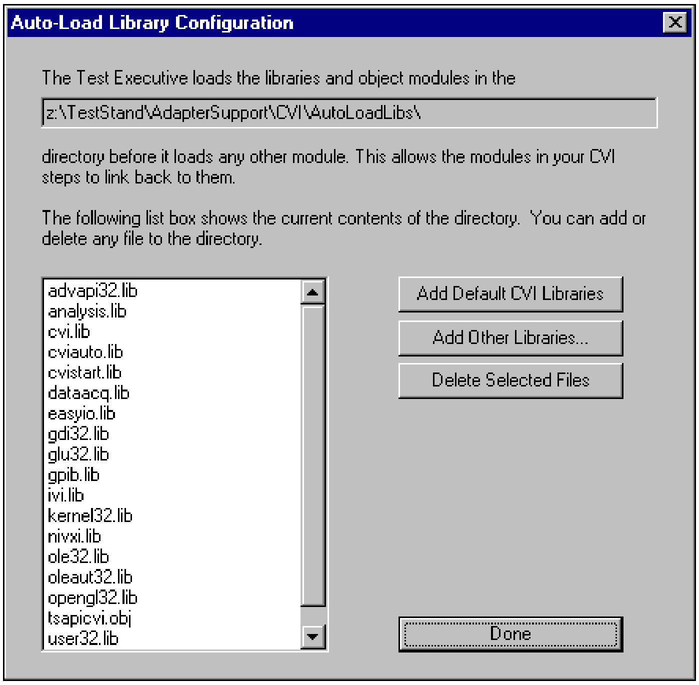
Figure 13-14. C/CVI Standard Adapter Configuration Dialog Box

Executing Code Modules In-Process

When executing code modules in the same process as the sequence editor or operator interface, the adapter loads and runs code modules directly, without using the LabWindows/CVI development environment.

Object and Library Code Modules

When the adapter loads an object or static library file, the LabWindows/CVI Run-time Engine resolves all external references in the file. When running tests in-process, the adapter must load the support libraries that the object file or static library file depends on before it loads the file. To configure a list of support libraries for the adapter to load, manually copy the support libraries to the `<TestStand>\Adapter Support\CVI\AutoLoadLibs` directory, or click the **Configure Auto-loading of Support Libraries Needed for Linking .objs and .libs** button on the C/CVI Standard Adapter Configuration dialog box. When you click the **Configure Auto-Loading** button, the Auto-Load Library Configuration dialog box appears as shown in Figure 13-15.


Auto-Load Library Configuration

The Test Executive loads the libraries and object modules in the

z:\TestStand\AdapterSupport\CVI\AutoLoadLibs\

directory before it loads any other module. This allows the modules in your CVI steps to link back to them.

The following list box shows the current contents of the directory. You can add or delete any file to the directory.

advapi32.lib
analysis.lib
cvi.lib
cviauto.lib
cvistart.lib
dataacq.lib
easyio.lib
gdi32.lib
glu32.lib
gpib.lib
ivi.lib
kernel32.lib
nivxi.lib
ole32.lib
oleaut32.lib
opengl32.lib
tsapicvi.obj
user32.lib

Figure 13-15. Auto-Load Library Configuration Dialog Box

The **Add Default CVI Libraries** button searches for an installation of the LabWindows/CVI development environment and copies the LabWindows/CVI static library files to the auto-load library directory.

You can click the **Browse** button to search for files to copy to the auto-load library directory.

The **Delete Selected Files** button removes the selected files from the auto-load library directory.

Source Code Modules

When it executes tests in-process, the module adapter cannot directly execute code modules that exist in C source files. Instead, the adapter attempts to find an object file that has the same name. If the adapter finds the object file, the adapter executes the code in the object file. If the adapter cannot find the object file, the adapter prompts you to create the object file in an external version of LabWindows/CVI. If you decline to create the object module, the adapter reports a run-time error.

Debugging a DLL Code Module

When you want to be able to debug code modules that are in-process, the code modules must exist in DLLs that you enable for debugging in LabWindows/CVI or in another ADE. To enable debugging, you must launch the sequence editor or run-time operator interface from LabWindows/CVI or the other ADE. In LabWindows/CVI, use the **Select External Process** command in the **Run** menu of the Project window to identify the executable you want to launch. Use the **Run** command to launch the executable.

If you select the **Step Into** command in TestStand while execution is currently suspended on a step that calls into a LabWindows/CVI DLL that you are debugging, LabWindows/CVI breaks at the first statement in the DLL function.

Refer to Table 13-5 to learn about your options for stepping out of a LabWindows/CVI DLL function that you are debugging.

Refer to the LabWindows/CVI product manuals for more information on debugging DLLs in an external process.

Executing Code Modules in an External Instance of LabWindows/CVI

To execute tests in an external instance of LabWindows/CVI, the adapter launches a copy of LabWindows/CVI and loads an execution server project in LabWindows/CVI. You can specify the execution server project to load in the C/CVI Standard Adapter Configuration dialog box. The default project is `<TestStand>\AdapterSupport\CVI\tscvirun.prj`.

When a TestStand step calls a function in an object, static library, or DLL file, the execution server project automatically loads the file and executes the function in the external instance of LabWindows/CVI.

If you want a TestStand step to call a function in a C source file, you must include the C source file in the execution server project before you run the project. Also, you must include in the project all support libraries other than LabWindows/CVI libraries.

Debugging C Source and DLL Code Modules

When the adapter executes tests in an external instance of LabWindows/CVI, you can debug C source and DLL code modules. To debug DLL code modules, you must enable the DLL Debugging options when you create the DLL in LabWindows/CVI. LabWindows/CVI honors all breakpoints you set in the source files for the DLL project.

Note When you execute tests in an external instance of LabWindows/CVI, you do not need to launch the sequence editor or operator interface application from LabWindows/CVI to debug DLL modules you call with the C/CVI Standard Prototype Adapter.

If you select the **Step Into** command in TestStand when execution is currently suspended on a step that calls into the DLL, LabWindows/CVI breaks at the first statement in the DLL function.

Refer to Table 13-5 to learn about your options for stepping out of a LabWindows/CVI DLL function that you are debugging.

Loading Subordinate DLLs

TestStand directly loads and runs the DLLs that you specify in the Specify Module dialog box for the DLL Flexible Prototype Adapter. Most likely, your code modules will call subsidiary DLLs, i.e. instrument drivers. You must ensure that the operating system can find and load the subsidiary DLLs. The operating system searches for the DLLs using the following search directory precedence:

1. The directory in which the application resides
2. The current working directory
3. Under Windows 98/95, the `Windows\System` directory. Under Windows NT and Windows 2000, the `Windows\System32` and `Windows\System` directories
4. The Windows directory
5. The directories listed in the PATH environment variable

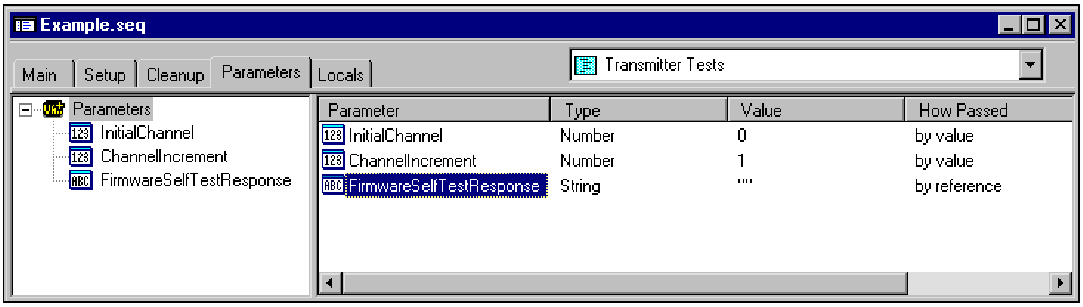
Sequence Adapter

The Sequence Adapter allows you to pass parameters when you make a call to a subsequence. You can call a subsequence in the current sequence file or in another sequence file, and you can make recursive sequence calls. For subsequence parameters, you can specify a literal value, pass a variable or property by reference or by value, or use the default value that the subsequence defines for the parameter.

Usually, you use the Sequence Call built-in step type to call sequences, but you can use the Sequence Adapter from any step type that can use module adapters, such as Pass/Fail Test or Numeric Limit Test. Using a Sequence Call step is the same as using an Action step with the Sequence Adapter except that the Sequence Call step sets the step status to `Passed` instead of `Done` if a failure or an error does not occur.

After the sequence call step executes, the Sequence Adapter may set the step status. If the sequence that the step calls fails, the adapter sets the step status to `Failed`. If no runtime error occurs, the adapter does not set the step status. Depending on the type of step, the resulting status is `Done` or `Passed`. If a run-time error occurs in the sequence, the adapter sets the step status to `Error` and sets the `Result.Error.Occurred` property to `True`. The adapter also sets the `Result.Error.Code` and `Result.Error.Msg` properties to the values of the same properties in subsequence step that generated the run-time error.

You can define the parameters for a sequence on the Parameters tab of the Sequence File window shown in Figure 13-16.



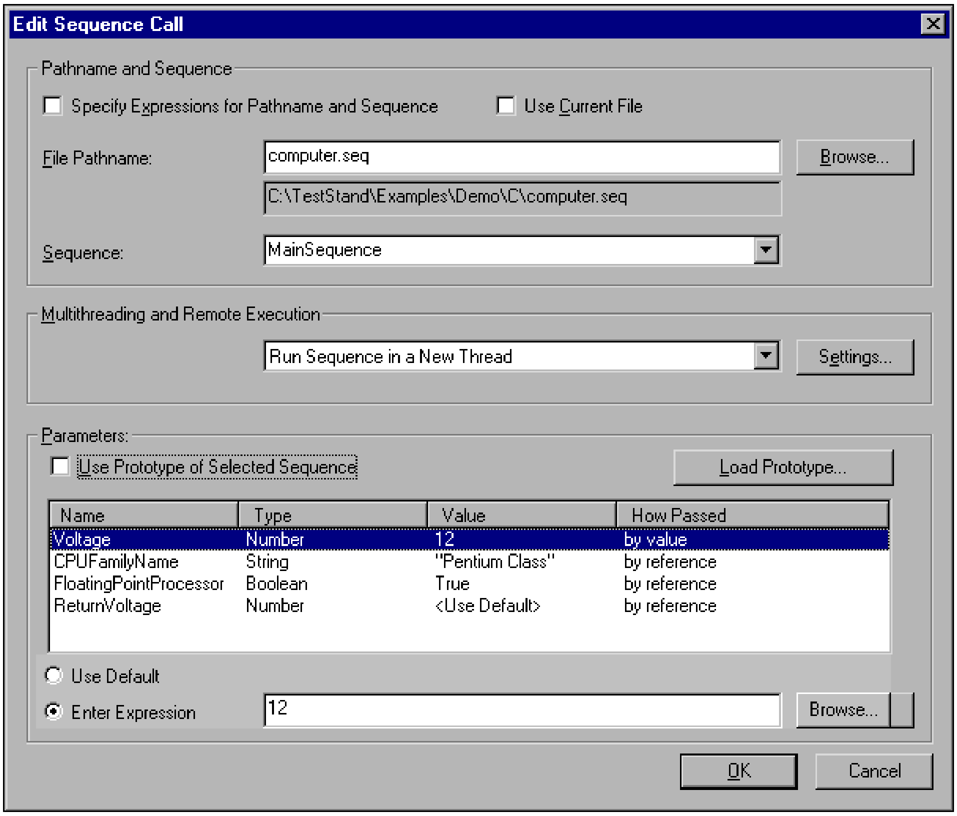
Parameter	Type	Value	How Passed
InitialChannel	Number	0	by value
ChannelIncrement	Number	1	by value
FirmwareSelfTestResponse	String	""	by reference

Figure 13-16. Example Sequence Parameters

The Parameters tab defines each parameter name, its TestStand data type, its default value, and whether you pass the argument by value or by reference. For more information on sequence file parameters, refer to the *Parameters Tab* section in Chapter 5, *Sequence Files*.

Specifying a Sequence Adapter Module

The Specify Module dialog box for the Sequence Adapter is called the Edit Sequence Call dialog box. This section describes the controls on the Edit Sequence Call dialog box, as shown in Figure 13-17.



Edit Sequence Call

Pathname and Sequence

☐ Specify Expressions for Pathname and Sequence ☐ Use Current File

File Pathname: computer.seq

C:\TestStand\Examples\Demo\C\computer.seq

Sequence: MainSequence

Multithreading and Remote Execution

Run Sequence in a New Thread

Parameters:

☐ Use Prototype of Selected Sequence

Name	Type	Value	How Passed
Voltage	Number	12	by value
CPUFamilyName	String	"Pentium Class"	by reference
FloatingPointProcessor	Boolean	True	by reference
ReturnVoltage	Number	<Use Default>	by reference

○ Use Default

● Enter Expression 12

Figure 13-17. Specify Module Dialog Box for the Sequence Adapter—Edit Sequence Call Tab

The Specify Module Dialog Box for the Sequence Adapter contains the following controls:

- **Specify Expressions for Pathname and Sequence**—Selects whether you specify the sequence name and the sequence file pathname through literal strings or through expressions that TestStand evaluates at run time. When you use literal strings, you enter the actual pathname of the sequence file in the File Pathname control. When you enable this option, you cannot use the Use Prototype of Selected Sequence option.

- **Use Current File**—Enable this checkbox if you want to call a sequence in the sequence file that you are currently editing. The File Pathname or File Path Expression control dims when you enable the Use Current File checkbox.
- **File Pathname**—Specifies the pathname of the sequence file.
- **Sequence**—Contains the names of the sequences in the sequence file you specify. When you use expressions, the File Path Expression and Sequence Expression controls appear in place of the File Pathname and Sequence controls. You use these controls to specify the expressions for the sequence file pathname and the sequence name.
- **Multithreading and Remote Execution**—Allows you to specify that the sequence you call runs in a separate thread, in a separate execution, or on a remote computer. The ring control contains the following items:
  - **None**—Specifies that the sequence you call runs in the current thread.
  - **Run Sequence in a New Thread**—Specifies that the sequence you call runs in a new a thread within the current execution. Threads in the same execution share the same report and the same result tree. In addition, all threads in an execution suspend or terminate when the execution suspends or terminates.
  - **Run Sequence in a New Execution**—Specifies that the sequence you call runs in a new execution. Separate executions have separate reports and result trees. Suspending or terminating an execution does not affect other executions. Separate executions also can run under different process models.
  - **Run Sequence on Remote Computer**—Specifies that the sequence you call runs on the remote computer you specify. To execute the sequence remotely, the sequence adapter connects to an instance of the TestStand Engine on the remote machine.

Note When you specify that a sequence runs in a new thread or a new execution, the status of the sequence call is `Done` or `Error` and does not depend on the status of the sequence you call. Although the status of the sequence call is `Done` or `Error`, when the asynchronous sequence completes, it updates the status of the result for the sequence call in the result list. To determine the status of an asynchronous subsequence from a step in the calling sequence, use a Wait step to wait for the asynchronous sequence to complete. The status of the Wait step is the status of the asynchronous sequence.

- **Settings**—Displays a dialog box in which you configure multithreading and remote execution settings. The dialog box varies according to the selection you make in the ring control. For a description of the available settings, refer to the *Multithreading and Remote Execution Settings* section in this chapter.
- **Parameters**—Contains the following items:
  - **Use Prototype of Selected Sequence**—When enabled, updates the contents of the parameter list box whenever you select a different sequence from the Sequence ring control. When you enable Specify Expressions for Pathname and Sequence, you cannot use this option.
  - **Load Prototype**—Loads a prototype from a sequence that has the same parameter list definition as the sequences that the step might call. You use this button when Specify Expressions for Pathname and Sequence is enabled.
  - **List Box**—Displays the parameters that the step passes to the sequence. For each parameter, the list box shows the name of the parameter, its TestStand data type, the value the step passes to the sequence, and whether the step passes the argument by value or by reference.

    The contents of the list box must be consistent with the parameter definitions in the sequence that the step calls. You must extract the parameter definitions from the sequence or from another sequence that has the same parameter list.
  - **Use Default**—When enabled, the step passes the default value that the sequence defines for the parameter.
  - **Enter Expression**—Specifies the value that the step passes for a parameter. You can specify an expression that TestStand evaluates at run time. The parameter definition in the sequence determines whether the step passes the argument by value or by reference.

Although the parameter list that the step uses must be *consistent* with the parameter list that the sequence defines, the step can specify fewer parameters than the sequence specifies. The data types for the parameters in the step must be compatible with the corresponding parameters in the sequence. The adapter uses the default values for the parameters that the step does not pass explicitly.

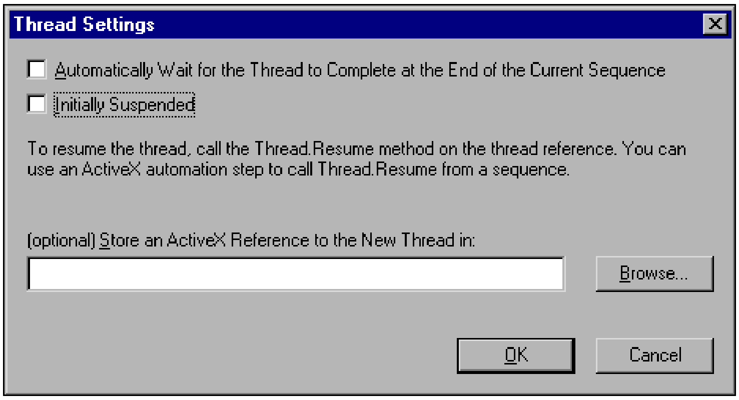
Note When you call a sequence on a remote host, you can pass single-valued properties or arrays of number, Boolean, and string properties. You can pass these properties by value or by reference. You also can pass container properties or ActiveX reference properties to a remote sequence if the receiving parameter type is an ActiveX reference property.

Multithreading and Remote Execution Settings

Click the Settings button on the Specify Module dialog box to display a dialog box in which you specify multithreading and remote execution options. The Multithreading and Remote Execution ring control determines which dialog box the Settings button displays.

Thread Settings

If you specify that the sequence you call runs in a new thread, the Settings button displays the Thread Settings dialog box, shown in Figure 13-18.



Thread Settings

- [ ] Automatically Wait for the Thread to Complete at the End of the Current Sequence
- [ ] Initially Suspended

To resume the thread, call the Thread.Resume method on the thread reference. You can use an ActiveX automation step to call Thread.Resume from a sequence.

(optional) Store an ActiveX Reference to the New Thread in:

Figure 13-18. Thread Settings Dialog Box

The Thread Settings dialog box contains the following controls.

- **Automatically Wait for the Thread to Complete at the End of the Current Sequence**—Specifies that the calling sequence waits for the thread it launches to complete before the calling sequence returns.
- **Initially Suspended**—Specifies that TestStand creates the new thread in a suspended state. You can call the Thread.Resume method in the TestStand API to start the thread.
- **Store an ActiveX Reference to the New Thread in**—Stores a reference to the new Thread object in the ActiveX reference variable you specify. You can use this reference in subsequent calls to the TestStand API. You also can use this reference in a Wait step to wait for the thread to complete. This control is optional.

Execution Settings

If you specify that the sequence you call runs in a new execution, clicking the Settings button displays the Execution Settings dialog box, shown in Figure 13-19.

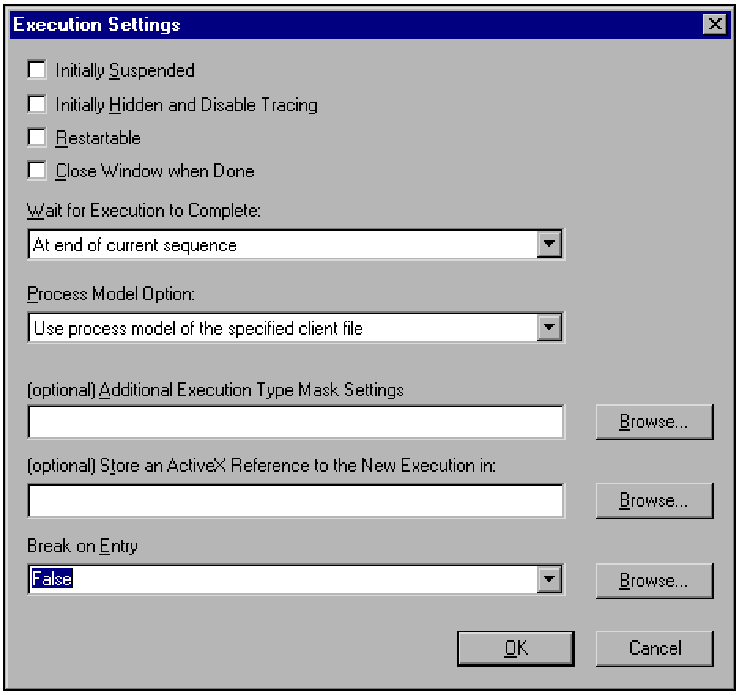

Execution Settings
☐ Initially Suspended
☐ Initially Hidden and Disable Tracing
☐ Restartable
☐ Close Window when Done
Wait for Execution to Complete:
At end of current sequence
Process Model Option:
Use process model of the specified client file
(optional) Additional Execution Type Mask Settings
Browse...
(optional) Store an ActiveX Reference to the New Execution in:
Browse...
Break on Entry
False
Browse...
OK
Cancel

Figure 13-19. Execution Settings Dialog Box

The Execution Settings dialog box contains the following controls.

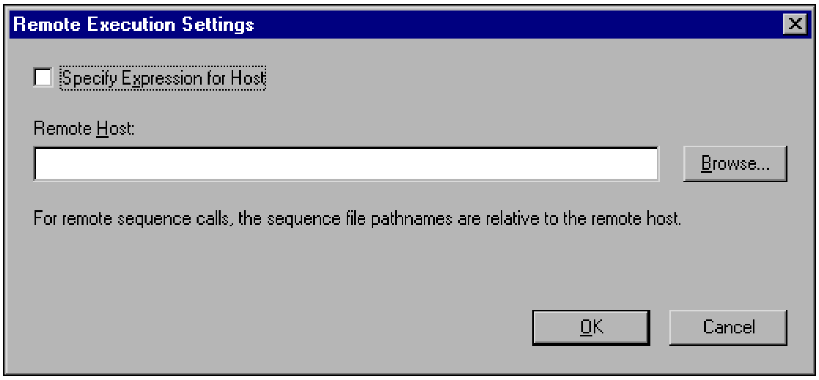
- **Initially Suspended**—Specifies that TestStand creates the new execution in a suspended state. You can call the Execution.Resume method in the TestStand API to start the execution.
- **Initially Hidden and Disable Tracing**—Specifies that the window for the new execution is initially hidden and that tracing is initially turned off.
- **Restartable**—Specifies whether the execution can be restarted after it completes.
- **Close Window when Done**—Specifies that the window for the execution closes when the execution completes.

- **Wait for Execution to Complete**—Specifies whether to wait for the execution to complete. You can select from the following options in the ring control.
  - **Do not wait**—The calling sequence does not wait for the execution to complete.
  - **Before executing next step**—The calling sequence waits for the execution to complete before it executes another step.
  - **At end of current sequence**—The calling sequence waits for the execution to complete before the calling sequence returns.
- **Process Model Option**—Specifies which process model the new execution uses. You can select from the following options in the ring control:
  - **Do not use a process model**—The new execution does not run under a process model.
  - **Use process model of specified client file**—The execution runs under the model that the sequence file you call specifies as its model. If the file you call does not specify a model, the execution runs under the default station model. When you select this option, the Edit Sequence Call dialog box allows you to designate which entry point to call in the process model. Typically, the process model entry point then calls the `MainSequence` in the client sequence file you specify.
  - **Use a specific process model**—When you select this option, the controls on the Edit Sequence Call dialog box change to allow you to specify the process model under which the new execution runs. You also specify which entry point to call in the process model. Typically, the process model entry point then calls the `MainSequence` in the client sequence file you specify
- **Additional Execution Type Mask Settings**—Provides the option of passing a numeric value that specifies execution mask settings for the new execution. Refer to the *ExecutionTypeMask* documentation in the *TestStand Programmer Help* for a list of available type mask settings. The settings you specify in this control are combined with any execution mask settings that other options on the dialog box require.
- **Store an ActiveX Reference to the new Execution in**—Stores a reference to the new Execution object in the ActiveX reference variable you specify. You can use this reference in subsequent calls to the TestStand API. You also can use this reference in a Wait step to wait for the execution to complete. This control is optional.

- **Break on Entry**—Suspends execution before executing the first step, when set to `True`.

Remote Execution Settings

If you specify that the sequence you call runs on a remote computer, clicking the Settings button displays the Remote Execution Settings dialog box, shown in Figure 13-20.



For remote sequence calls, the sequence file pathnames are relative to the remote host.

Figure 13-20. Remote Execution Settings Dialog Box

The Remote Execution Settings dialog box contains the following controls.

- **Specify expression for host**—Selects whether you specify the remote host name through literal strings or through expressions that TestStand evaluates at run time. When you disable the option, you can use the **Browse** button to select a remote host name on the network. When you enable the option, you can use the **Browse** button to build an expression.
- **Remote Host**—Contains the name of the remote host.

When you specify a sequence file pathname on the Edit Sequence Call tab and you enable the step for remote execution, TestStand locates the sequence file according to the type of path, as described in Table 13-13.

Table 13-13. Path Resolution of Sequence Pathnames for Remotely Executed Steps

Type of Path	Where Found When You Edit	Where Found When You Execute	Example
Relative	In the TestStand search paths that you configure on the client (local) machine.	In the TestStand search paths that you configure on the server (remote) machine.	`Transmit.seq`
Absolute	On the client (local) machine.	On the server (remote) machine.	`C:\Projects\Transmit.seq`
Network	On the machine specified in the network path.	On the machine specified in the network path.	`\\Remote\Transmit.seq`

When you edit a step in a sequence file on a client and you specify an absolute or relative path for the sequence file the step calls, TestStand resolves the path for the sequence file on the client system. When you run the step on the client, TestStand resolves the path for the sequence file on the server system.

You have three ways to manage your remote sequence files for remote execution.

- Add a common pathname to the search paths for the client and the server so that each resolves to the same relative pathname.
- Duplicate the files on your client and server system so that the client edits an identical file to the file that the server runs.
- Use absolute paths that specify a mapped network drive or full network path so that the file that the client edits and the file the server runs are the same sequence file.

When you execute a remote sequence, you cannot single-step or set breakpoints in the remote sequence. If you enable tracing, TestStand updates the status bar with tracing information for the remote sequence.

When a remote sequence executes on a server, the sequence context and call stack includes only the sequences that run on the remote system. If you want to access properties from the client sequence context, you must pass the property objects or their values as parameters to the remote sequence. You can use the TestStand API to access properties within a property object.

Setting up TestStand as a Server for Remote Execution

If you want TestStand to invoke a sequence on a remote TestStand server host, you must properly configure the server on the remote system. You must enable the TestStand server to accept remote execution requests, you must register the server with the operating system, and you must configure the Windows system security to allow users to access and launch the server remotely.

To allow the remote server to accept remote execution requests from a client machine, you enable the Enable Remote Execution option on the Remote Execution tab of the Station Options dialog box.

A TestStand server is active while the TestStand application `<TestStand>\bin\rengine.exe` runs on a remote system. Each TestStand client communicates with a dedicated version of the remote engine application. In Windows 2000/NT, the remote server launches automatically each time a TestStand client uses the server. In Windows *Me*/9*x*, you must launch the remote server manually, and only one client can use the server at a time. You can automatically launch the server by placing a shortcut to the application in the startup folder on the server system.

Note To exit REngine in Windows *Me*/9*x*, select <Ctrl-Alt-Del> to display the Close Programs dialog box. Select REngine and click on the End Task button.

TestStand automatically registers the server during installation. If you want to manually register or unregister the server, you can invoke the executable with the `/RegServer` and `/UnregServer` command-line arguments respectively.

Before a client can communicate with a server, you must configure the security permissions for the server on the Windows system of the server.

For Windows 2000/NT, you must complete the following steps to configure the security permissions for the server.

1. Login using a userid that has administrator privileges.
2. Run `dcomcnfg` from the command line, which displays the Distributed COM Configuration Properties application window.
3. On the Default Properties tab, verify that the Enable Distributed COM on this computer option is enabled.

4. On the Applications tab, select TestStand Remote Engine and then click the **Properties** button. On the Identity tab of the TestStand Remote Engine Properties dialog box, verify that the Interactive User option is selected.
5. You must give permission to the appropriate users so that they can access the remote server. You should give access permissions to everyone and give launch permission to appropriate users. Only users who have launch permission are able to access the server. You can set these permissions in one of the following ways:
   – Specify the default security on the Default Security tab of the Distributed COM Configuration Properties application window.
   – Give individual users access to the server. On the Applications tab, select TestStand Remote Engine and then click the **Properties** button. Use the Security tab of the TestStand Remote Engine Properties dialog box to configure the permissions for a specific server.

For Windows *Me*/9*x*, you must complete the following steps to configure the security permissions for the server.

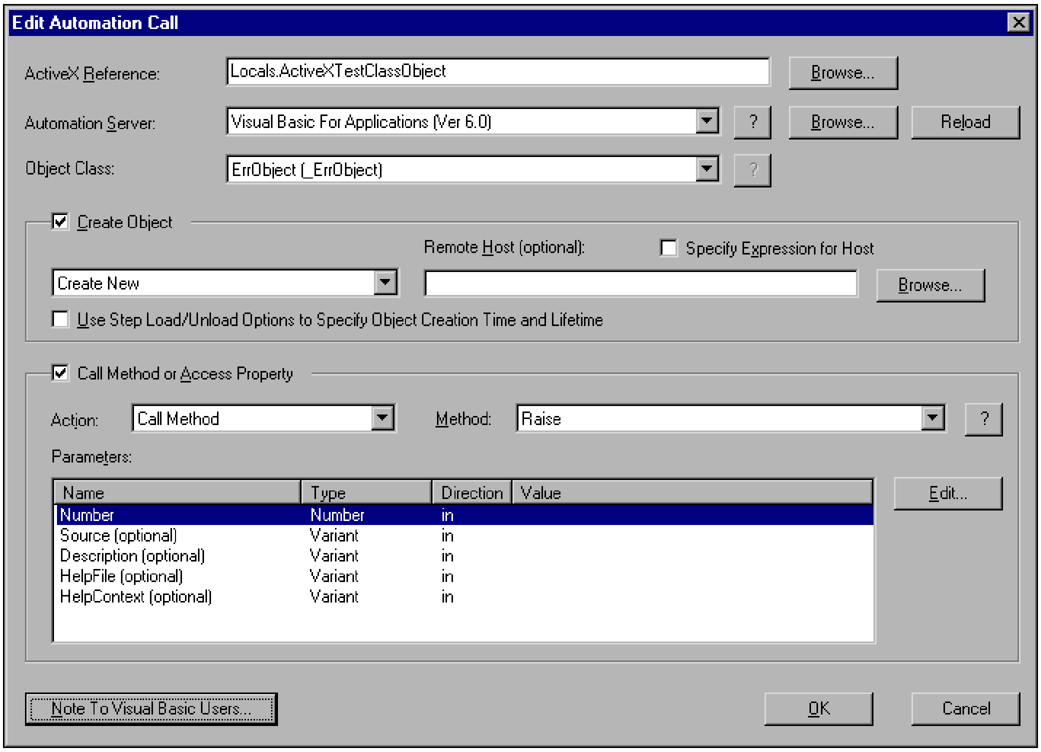
1. Go to the Access Control tab of the Network Properties dialog box in the Windows Control Panel, and enable User-level access control.
2. Run `dcomcnfg` from the command line, which displays the Distributed COM Configuration Properties dialog box.
3. On the Default Properties tab, verify that the Enable Distributed COM on this Computer option is enabled.
4. On the Default Security tab, verify that the Enable Remote Connection option is enabled.
5. You must give permission to the appropriate users so that they can access the remote server. You can set these permissions in one of the following ways:
   – You can specify the default security on the Default Security tab of the Distributed COM Configuration Properties dialog box.
   – You can give individual users access to the server. To give access, you select the server name, TestStand Remote Engine, on the Applications tab and then click the **Properties** button. On the Security tab of the TestStand Remote Engine Properties dialog box, you can add users to a list for access to the server.

ActiveX Automation Adapter

The ActiveX Automation Adapter allows you to create ActiveX Automation class objects and to call methods and access properties of ActiveX automation objects. When you create an object, you can assign the object reference to a variable or property for later use in other ActiveX Automation Adapter steps. When you call methods and access properties, you can specify an expression for each input and output parameter.

Specifying an ActiveX Automation Adapter Module

The Specify Module dialog box for the ActiveX Automation Adapter is called the Edit Automation Call dialog box shown in Figure 13-21.



ActiveX Reference: Locals.ActiveXTestClassObject

Automation Server: Visual Basic For Applications (Ver 6.0)

Object Class: ErrObject (_ErrObject)

Create New

Use Step Load/Unload Options to Specify Object Creation Time and Lifetime

Action: Call Method

Method: Raise

Parameters:

Name	Type	Direction	Value
Number	Number	in	
Source (optional)	Variant	in	
Description (optional)	Variant	in	
HelpFile (optional)	Variant	in	
HelpContext (optional)	Variant	in	

Figure 13-21. Specify Module Dialog Box for ActiveX Automation Adapter

The Edit Automation Call dialog box contains the following controls.

- **ActiveX Reference**—Specifies a variable or property of type ActiveX Reference. When a step creates an object, the adapter assigns the object reference to the variable or property, if specified. Otherwise, the adapter automatically releases the object reference after executing the step. If the step does not create an object, but instead calls a method or accesses a property, the ActiveX Reference control must contain the value of a valid ActiveX reference that refers to the object on which to call the method or access the property. You can use the **Browse** button to access the Expression Browser dialog box.

- **Automation Server**—Specifies the name of the server that the step uses. The adapter populates the ring control with the list of the ActiveX automation servers that are registered with Windows. To select a server from the list, click the ring control, or use the **Browse** button to load a type library file from disk for a specific server. TestStand registers the type library with Windows. If you want the adapter to refresh the list of registered servers and their type library information, click the **Reload** button. You also refresh server type library information when you select **File»Unload All Modules**.
- **Object Class**—Specifies the name of the server class that the step uses when it creates or invokes an object of that class. When you select a server, the adapter populates the Object Class control with a list of objects defined for that server. The ring control separates the list of objects into two groups that are separated by a line. The upper group includes all top-level objects that the adapter can create. The lower group includes all other objects that the server creates as a result of an invocation of a method or get property call. If a server type library contains help strings or links to a help file for a class, click the **?** button to access the help.
- **Create Object**—Specifies whether the step creates a new instance of the object class when the adapter executes the step. When the step creates an object and you specify a property name in the ActiveX Reference control, the adapter assigns the value of the object handle to the property. Otherwise, the adapter automatically releases the object reference after it executes the step.

Note In the ActiveX Reference control, if you specify an existing ActiveX object such as `Runstate.Engine` or `Runstate.Sequence`, you should not select Create Object. You should select Create Object only when you want to create a new instance of an object.

When you create an object you can select one of the following options:

- **Create New**—Creates a new object and obtains a reference to the object. If the server application is already running, this option might or might not launch another copy of the application. The server application decides when to launch multiple copies of itself.

    - **Attach to Active**—Obtains a reference to an active Application object.
    - **Create From File**—Loads an existing object from a file, and obtain a reference to the object. If the server application is already running, this option might or might not launch another copy of the application. The server application decides when to launch multiple copies of itself. When you make this selection, the dialog box displays a file selection control and a **Browse** button. You can use these controls to specify the path of the file.
    - **Remote Host (optional)**—Specifies the remote system to create the object on. This control dims when you select **Attach to Active**. Refer to the *Setting up TestStand as a Server for Remote Execution* section of this chapter as a guide for configuring a remote server. Substitute references to the TestStand Remote Engine with your own ActiveX Automation Server.
    - **Specify Expression for Host**—Specifies that the Remote Host control contains an expression that the adapter evaluates at run time to determine the name of the remote host.
    - **Use Step Load/Unload Options to Specify Object Creation Time and Lifetime**—Controls the lifetime of an object the step creates. If you do not set this option, the step creates the object when the step begins and the step releases its internal reference to the object when the step completes. If you set this option, the step creates the object when the step loads according to its Load option and holds an internal reference to the object until the step unloads according to its Unload Option.

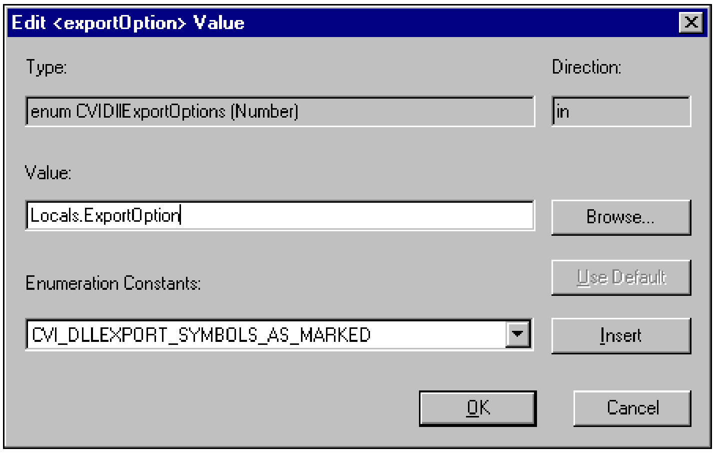
- **Call Method or Access Property**—Specifies the class method that the step invokes or specifies the class property that the step accesses. The Type control lists the types of access that the server defines for the selected object class. The options include Call Method, Set Property, and Get Property. For example, if an object class does not have any methods, the control does not list the Call Method option.

  After you select the type of access, the adapter populates the Member control with the method or property names that the class defines for the access type. If a server type library contains help strings or links to a help file for a method or property, select the **?** button to access the help.

- **Parameters**—Contains the input and output parameters for the selected method or property. If the selected access type is Get Property, the control usually contains a single output parameter. If the access type is Set Property, the control usually contains a single input parameter. When you call a method, the control can contain any number of input and output parameters. The Adapter automatically populates the Value field for parameters that have default values.

  To specify an expression for each parameter, you can double-click the parameter or you can select the parameter and click the **Edit** button. When you make this selection, TestStand displays the Edit <parameter> Value dialog box.

Figure 13-22 shows the Edit <parameter> Value dialog box.


Edit <exportOption> Value

Type: enum CVIDllExportOptions (Number)

Direction: in

Value: Locals.ExportOption

Enumeration Constants: CVI_DLLEXPORT_SYMBOLS_AS_MARKED

Figure 13-22. Edit <parameter> Value Dialog Box

In the Edit <parameter> Value dialog box, the Type and Direction controls indicate the ActiveX data type for the parameter and whether the parameter is input, output, or both. In the Value control you specify the parameter argument. For input parameters, you must specify a value for the parameter argument. If an input parameter has a default value, you can click the **Use Default** button to instruct the adapter to use the default value that the server specifies. For optional parameters, you can leave the Value control empty or you can specify the name of a variable, parameter, or property. If the type library defines enumeration constants for input parameters, you can select a constant from the Enumeration Constants control and click the **Insert** button to copy the constant name to the expression in the Value control. The server indicates which input parameters are optional. TestStand marks all method output parameters as optional.

The ActiveX Automation Adapter supports the Variant data types shown in Table 13-14.

Table 13-14. Variant Data Types Supported by the ActiveX Automation Adapter

Variant Type	Variant Description
`VT_EMPTY`	nothing
`VT_NULL`	SQL-style Null
`VT_I2`	2-byte signed int
`VT_I4`	4-byte signed int
`VT_R4`	4-byte real
`VT_R8`	8-byte real
`VT_CY`	currency
`VT_DATE`	date
`VT_BSTR`	OLE Automation string
`VT_DISPATCH`	`IDispatch FAR*`
`VT_ERROR`	`SCODE`
`VT_BOOL`	True = `-1`, False = `0`
`VT_VARIANT`	`VARIANT FAR*`
`VT_UNKNOWN`	`IUnknown FAR*`
`VT_UI1`	`unsigned char`
`VT_ARRAY`	`SAFEARRAY*`

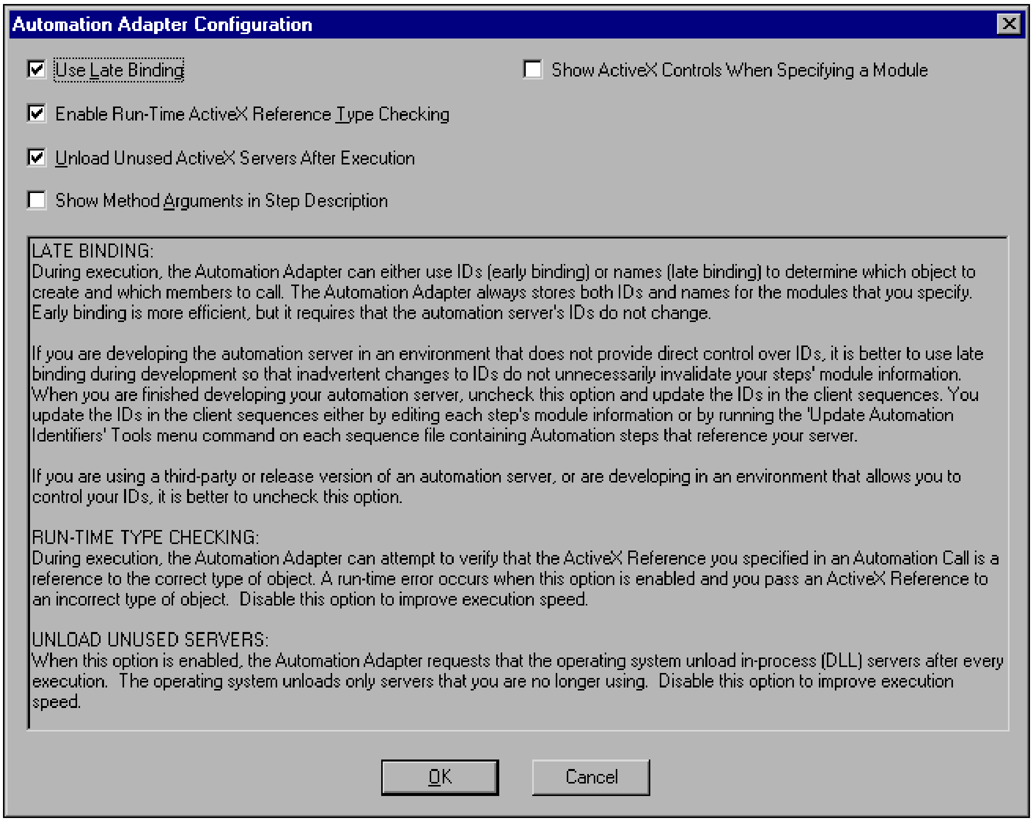
The TestStand ActiveX Automation Adapter does not support the handling of events that an ActiveX automation server generates.

Running and Debugging ActiveX Automation Servers

TestStand does not Step Into your automation server. To debug an out-of-process executable server, you must launch the automation server in the ADE that created the server and then you must independently launch the sequence editor or run-time operator interface. If you want to debug an in-process DLL server, you usually launch the sequence editor or run-time operator interface from the ADE. When you work in Visual Basic, place breakpoints in your automation server source code and select **Run»Start with Full Compile**. In TestStand, run the sequence that calls into your automation server and the execution will automatically break at the breakpoint that you set in Visual Basic. Refer to your ADE documentation for more information on debugging ActiveX Automation servers.

Configuring the ActiveX Automation Adapter

When you select to configure the ActiveX Automation Adapter in the Adapter Configuration dialog box, TestStand displays the Automation Adapter Configuration dialog box, shown in Figure 13-23.



- [✓] Use Late Binding
- [ ] Show ActiveX Controls When Specifying a Module
- [✓] Enable Run-Time ActiveX Reference Type Checking
- [✓] Unload Unused ActiveX Servers After Execution
- [ ] Show Method Arguments in Step Description

LATE BINDING:
During execution, the Automation Adapter can either use IDs (early binding) or names (late binding) to determine which object to create and which members to call. The Automation Adapter always stores both IDs and names for the modules that you specify. Early binding is more efficient, but it requires that the automation server's IDs do not change.

If you are developing the automation server in an environment that does not provide direct control over IDs, it is better to use late binding during development so that inadvertent changes to IDs do not unnecessarily invalidate your steps' module information. When you are finished developing your automation server, uncheck this option and update the IDs in the client sequences. You update the IDs in the client sequences either by editing each step's module information or by running the 'Update Automation Identifiers' Tools menu command on each sequence file containing Automation steps that reference your server.

If you are using a third-party or release version of an automation server, or are developing in an environment that allows you to control your IDs, it is better to uncheck this option.

RUN-TIME TYPE CHECKING:
During execution, the Automation Adapter can attempt to verify that the ActiveX Reference you specified in an Automation Call is a reference to the correct type of object. A run-time error occurs when this option is enabled and you pass an ActiveX Reference to an incorrect type of object. Disable this option to improve execution speed.

UNLOAD UNUSED SERVERS:
When this option is enabled, the Automation Adapter requests that the operating system unload in-process (DLL) servers after every execution. The operating system unloads only servers that you are no longer using. Disable this option to improve execution speed.

Figure 13-23. Automation Adapter Configuration Dialog Box

The ActiveX Automation Adapter Configuration dialog box contains the following controls:

- **Use Late Binding**—Specifies whether the adapter uses late binding or early binding. When you specify the module for an Automation step, TestStand stores the IDs and names of the object and member that the step calls. During execution, the Automation Adapter must invoke the ActiveX Automation server and specify which object to create and which member to call. You can use one of the following methods to specify to the server what operations to perform on what object.
  - **Early Binding**—Configures the module adapter to use IDs.
  - **Late Binding**—Configures the module adapter to use names.

    Early binding is more efficient but requires that the IDs for objects and methods exposed by automation servers do not change. If you are developing an automation server in an ADE that does not provide direct control over IDs, National Instruments recommends that you use late binding during development so that inadvertent changes to IDs do not invalidate the module information for the step. When you finish developing your automation server, uncheck this option and update IDs in the client sequences. To update the IDs in the client sequences, either edit the module information for each step that references your server or run the **Tools»Update Automation Identifiers** command on each sequence file that contains Automation steps that reference your server.

    If you are using only a third-party or release version of an automation server, or if you are developing a server in an ADE that allows you to control your server's IDs, National Instruments recommends that you disable the Use Late Binding option.

    When you configure the adapter to use late binding, the Automation Adapter uses the stored names to determine the proper IDs to use at run time. The Automation Adapter looks in the most recent version of the type information for the server. Servers also can specify type information in different languages (locales). If the Automation Adapter cannot find a version of the type information that uses the system default language ID, it attempts to find type information that uses the English or Neutral language IDs, in that order.
- **Enable Run-Time ActiveX Reference Type Checking**—Specifies that the adapter verifies that the ActiveX Reference you specify in an Automation Call is a reference to the correct type of object. This option instructs the adapter to generate a run-time error when you pass an

ActiveX Reference to an incorrect type of object. Disable this option to improve execution speed.

- **Unload Unused ActiveX Serves After Execution**—Specifies that the Automation Adapter requests the operating system to unload in-process (DLL) servers after every execution. The operating system unloads only servers that you are no longer using. Disable this option to improve execution speed.
- **Show Method Arguments in Step Description**—Specifies that the description for steps that use the Automation Adapter includes the arguments that steps pass to the methods they call.
- **Show ActiveX Controls When Specifying a Module**—Specifies that the Automation Adapter Specify Module dialog box includes ActiveX controls in the list of available servers.

Using ActiveX Servers with TestStand

This section discusses using ActiveX servers with TestStand.

Registering a Server

To register an ActiveX Automation server DLL, call the Windows executable `regsvr32.exe`, using the DLL pathname as the command-line argument. To unregister the DLL server, call `regsvr32.exe` using `/u` and the DLL pathname as the command-line argument.

You usually can register an ActiveX Automation server executable by running the server executable with the `/RegServer` command-line argument. To unregister an executable server, call the executable with the `/UnregServer` command-line argument.

Visual Basic does not automatically register a server when you build the server DLL or executable. You must manually register the server as outlined previously in this section. Visual Basic does temporarily register a server when you run the server project inside the Visual Basic ADE. When you complete the debugging session, Visual Basic unregisters the server.

Compatibility Issues with Visual Basic

If you are developing an automation server in an ADE that does not give you direct control over IDs, you must ensure that the adapter can find the server identifiers or the names defined in a TestStand step. When you rebuild an ActiveX Automation server in Visual Basic, you can select one of three compatibility options. Depending on the level of compatibility and the changes you make to a project, Visual Basic compiles an appropriate new server, which can contain new identifiers. To specify the level of compatibility, select the Project Properties command from the Project menu in Visual Basic. On the Project Properties dialog box, use the radio buttons in the Version Compatibility section of the Components tab to select the level of compatibility. Visual Basic has the following compatibility options.

- **No compatibility**—Specifies that when you rebuild a server with this option, the new server maintains no compatibility with a previously compiled server. Visual Basic generates new unique identifiers for the server, and this action prevents any previously compiled client application that uses early binding from working properly with the server.

  When you use this option to rebuild a server, Visual Basic changes the IDs that it uses to uniquely identify the type information of the server. TestStand therefore cannot properly update an Automation Adapter step regardless of whether you configure the adapter for early or late binding. National Instruments does not recommend use of this setting with your TestStand projects.
- **Project compatibility**—Causes Visual Basic to maintain the ID assignments that it uses to uniquely identify the type information for the server. You usually use this option when you have multiple projects under development within Visual Basic. The setting is not meant to assure compatibility with client applications that were not compiled in Visual Basic and that use early binding. You can use the Project compatibility option only after you build the server DLL or executable a first time.

  When you use this option to rebuild a server, TestStand can then use the type information to determine the IDs associated with the names stored in the step. It is recommended that you configure the Automation Adapter to use late binding when you create a server and select this option.
- **Binary compatibility**—Causes Visual Basic to maintain the ID assignments that it uses to identify objects and methods. When you use this option Visual Basic attempts to maintain compatibility with compiled client applications that use early binding. If you remove a member from the server, Visual Basic can no longer maintain binary compatibility. You can use the Binary compatibility option only after you build the server DLL or executable a first time.

  When you use this option to rebuild a server, TestStand can then use the IDs stored in the step without accessing the type information at run time. It is recommended that you configure the Automation Adapter to use early binding when you create a server and select this option.

National Instruments makes the following recommendations regarding use of the Visual Basic ActiveX Automation server in conjunction with development of sequences within TestStand. These approaches ensure that the ActiveX Automation adapter can properly find and invoke the server after you recompile the server.

- Use the following approach while you develop and debug sequences:
  - Use the Project Compatibility option to rebuild your server in Visual Basic.
  - Configure the ActiveX Automation Adapter to use late binding.
- Use the following approach when the interface for the server is completely developed and debugged:
  - Use the Binary Compatibility option to rebuild your server in Visual Basic.
  - Use the **Tools»Update Automation Identifiers** command to assign the new server identifiers to the steps.
  - After you properly assign the new server identifiers to the steps, you can enable the ActiveX Automation Adapter to use early binding.

For more information on creating and debugging Visual Basic ActiveX automation servers, refer to your Visual Basic documentation and to the following Internet document:

Ivo Salmre, “Building, Versioning, and Maintaining Visual Basic Components,” *Microsoft Developer Network*, Microsoft Corporation, February 1998.

HTBasic Adapter

The HTBasic Adapter allows you to call HTBasic subroutines. You do not pass parameters directly to a subroutine. Instead, the subroutine exchanges data by calling get or set subroutines contained in an HTBasic CSUB. These subroutines use the TestStand API to get data from and set data in TestStand. For more information about using these subroutines, refer to the *Passing Data To and Returning Data From a Subroutine* section in this chapter.

Configuring the HTBasic Adapter

Figure 12-21 displays the HTBasic Adapter Configuration dialog box.

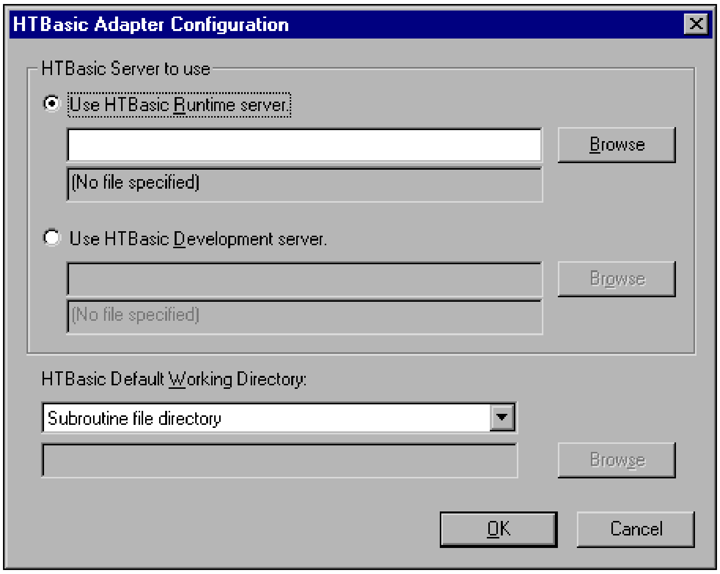

HTBasic Adapter Configuration
HTBasic Server to use
Use HTBasic Runtime server.
Browse
(No file specified)
Use HTBasic Development server.
Browse
(No file specified)
HTBasic Default Working Directory:
Subroutine file directory
Browse
OK
Cancel

Figure 13-24. HTBasic Adapter Configuration Dialog Box

The HTBasic Adapter runs subroutines by communicating with a special program running in an HTBasic application. An HTBasic application that runs this program is called the HTBasic server. This server can be the HTBasic development environment or the HTBasic run-time version. You specify which server the adapter uses by selecting the appropriate control in the HTBasic Server to use group of controls.

You can configure the paths to each executable. From the **Use HTBasic Development server** ring control, specify the location of the development version of the HTBasic server. From the **Use HTBasic Runtime server** ring control, specify the location of the run-time version of the HTBasic server.

Use the **HTBasic Default Working Directory** ring control to specify where the HTBasic adapter sets the working directory prior to invoking a subroutine. This setting applies only to HTBasic steps that set the step Working Directory option to Use adapter default. The ring control has four choices: Do not change working directory, HTBasic server directory, Subroutine file directory, and Use specified directory. The default value is

Subroutine file directory. You can enable the browse button and edit box only when you select **Use specified directory**.

Specifying an HTBasic Adapter Module

The Specify Module dialog box for the HTBasic Adapter is called the Edit HTBasic Subroutine Call dialog box. The dialog box contains controls to specify the subroutine file path, subroutine name, and other options.

Figure 12-22**.** displays the Edit HTBasic Subroutine Call dialog box.

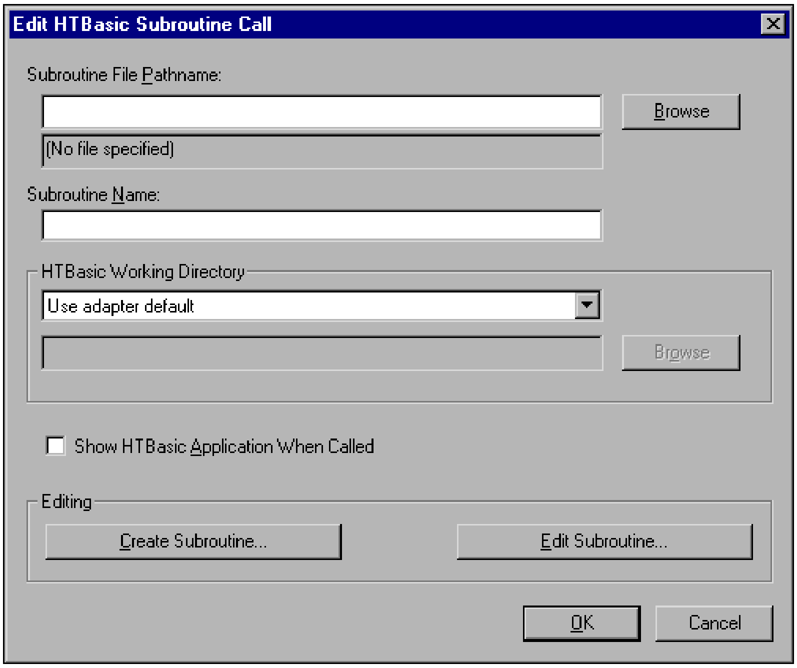


Figure 13-25. Specify Module Dialog Box for HTBasic Adapter

The Subroutine File Pathname control specifies the HTBasic program file that contains the subroutine the step calls. You can specify an absolute or relative path name for the HTBasic program file. Relative path names are relative to the TestStand search directory paths. You can customize the TestStand search directory paths by selecting **Configure»Search Directories** from the menu bar in the sequence editor.

To load and call a subroutine, you must write the subroutine file to disk using the Store command instead of the Save command. HTBasic is only able to programmatically load and run subroutines that have been stored.

The Subroutine Name control specifies the name of the subroutine the step calls.

The HTBasic Working Directory group of controls allows you to specify the options for the adapter to set the working directory of the HTBasic server prior to invoking the subroutine. You should set this option if your test code assumes a particular working directory path.

The ring control has five choices: Use adapter default, Do not change working directory, HTBasic server directory, Subroutine file directory, and Use specified directory. The default value is Use adapter default. You enable the browse button and edit box only when you select Use specified directory.

When the adapter executes a step that calls an HTBasic subroutine, the adapter does not activate the HTBasic application. If you want the adapter to activate the HTBasic application, enable the Show HTBasic Application When Called control.

To create a code shell for a subroutine, click the **Create Subroutine** button. If the HTBasic file that you specify does not already exist, the adapter creates it. If the file already exists, the adapter prompts you to replace the file. If the HTBasic code template file exists for the step type you selected for this step, the adapter uses the template to create the new subroutine.

If you want to edit a subroutine that already exists, click the **Edit Subroutine** button.

Debugging an HTBasic Adapter Module

To debug an HTBasic subroutine while executing the subroutine from TestStand, you must configure the adapter to use the HTBasic development environment as the HTBasic server.

If you select the **Step Into** command in TestStand when execution is currently suspended on a step that calls an HTBasic subroutine, HTBasic displays the HTBasic server window and pauses at the call of the subroutine. When suspended, you can single step through the subroutine using `Alt-F1`. When you have completed debugging a particular subroutine, you must click the HTBasic **Continue** button to resume execution and return control back to TestStand. After you step out of the subroutine, TestStand suspends execution on the next step in the sequence.

For more information about debugging HTBasic programs, refer to your HTBasic documentation.

Passing Data To and Returning Data From a Subroutine

TestStand provides a library of CSUB routines that use the TestStand API to access to TestStand variables and properties from an HTBasic subroutine. Table 13-15 lists the HTBasic routines for accessing TestStand properties.

Table 13-15. HTBasic routines for Accessing TestStand Properties

Function Name	TestStand Type	HTBasic Type
`Getvalnumber`	Number	REAL
`Setvalnumber`	Number	REAL
`Getvalstring`	String	STRING
`Setvalstring`	String	STRING
`Getvalboolean`	Boolean	INTEGER
`Setvalboolean`	Boolean	INTEGER
`Getvalnumarray`	Array of Number	Array of REAL
`Setvalnumarray`	Array of Number	Array of REAL
`Getvalstrarray`	Array of String	Array of STRING
`Setvalstrarray`	Array of String	Array of STRING

For more information about these subroutines, refer to the *Using the API in Different Programming Languages* section of the *TestStand Programmer Help*.

14 Process Models

This chapter discusses the purpose and usage of the process models that come with TestStand. It also describes the directory structure that TestStand uses for process model files and the special capabilities that the TestStand sequence editor has for editing process model sequence files.

You can better understand the information in this chapter if you have already read the *Process Models* section in Chapter 1, *TestStand Architecture Overview*, which discusses the purpose of process models, model callbacks, and entry points, and the relationship between a process model and a client sequence file. This chapter does not repeat that information.

TestStand Process Models

Table 14-1 lists the TestStand process models and their respective sequence files. You can use the process models to control the testing process on your test station.

Table 14-1. TestStand Process Models

Process Model	Process Model Sequence File
Sequential Model	`<TestStand>\Components\NI\Models\TestStandModels\SequentialModel.seq`
Batch Model	`<TestStand>\Components\NI\Models\TestStandModels\BatchModel.seq`
Parallel Model	`<TestStand>\Components\NI\Models\TestStandModels\ParallelModel.seq`

The Sequential Model is the default TestStand process model. The Batch and Parallel models have features to help you implement test stations that test multiple UUTs at the same time.

You can create your own process models or you can modify a copy of a model TestStand provides.

Features Common to all TestStand Process Models

All process models that TestStand provides identify UUTs, generate test reports, log results to databases, and display UUT status information. These process models also allow client sequence files to customize various model operations by overriding model-defined callback sequences.

Process models provide execution and configuration entry points that you use to configure model settings and to run client files under the model. Model entry points typically appear in an application under the Execute and Configure menus.

The models that TestStand provides have the following execution entry points:

- **Single Pass**—Tests one UUT or a single batch of UUTs without identifying them.
- **Test UUTs**—Tests and identifies multiple UUTs or UUT batches in a loop.

The models that TestStand provides have the following configuration entry points:

- **Report Options**—Displays a dialog box in which you configure the location and contents of report files.
- **Database Options**—Displays a dialog box in which you configure the logging of results to database tables.
- **Model Options**—Displays a dialog box in which you configure the number of test sockets and other options related to process models. The Sequential Model disables this entry point.

Note When you select the Test UUTs entry to start an execution that continuously tests UUTs, the execution does not use configuration changes you make to the Report, Database, or Model options after the execution starts.

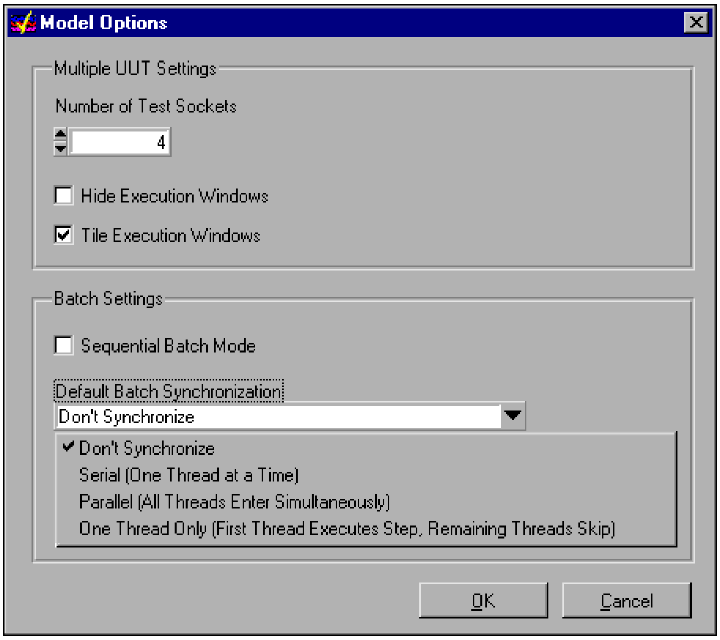
Sequential Model

You typically use the Sequential model to test one UUT at a time. Although you can manually or programmatically run multiple simultaneous executions under the Sequential model, the Batch and Parallel models offer more features to facilitate parallel testing. Because the Sequential Model is the simplest process model, it is the easiest to modify.

Parallel and Batch Models

The Parallel and Batch models make it easier to simultaneously test groups of similar UUTs. You use the Parallel and Batch models to run the same test sequence on multiple UUTs at the same time.

For both the Parallel and Batch models, you specify the number of test sockets in your system in the Model Options dialog box. To display the Model Options dialog box, shown in Figure 14-1, select **Configure»Model Options**.


Model Options

Multiple UUT Settings

Number of Test Sockets: 4

☐ Hide Execution Windows

☑ Tile Execution Windows

Batch Settings

☐ Sequential Batch Mode

Default Batch Synchronization: Don't Synchronize

✔ Don't Synchronize
Serial (One Thread at a Time)
Parallel (All Threads Enter Simultaneously)
One Thread Only (First Thread Executes Step, Remaining Threads Skip)

Figure 14-1. The Model Options Dialog Box

The Model Options dialog box can contain the following controls.

- **Number of Test Sockets**—Specifies the number of UUTs that the system can test simultaneously. The Parallel and Batch process models launch a separate test sequence execution for each test socket.

  When running under a model, a sequence can inspect the value of `RunState.TestSockets.MyIndex` to determine the zero-based index of the test socket on which it is running. The value of `RunState.TestSockets.Count` indicates the number of test sockets in the system.

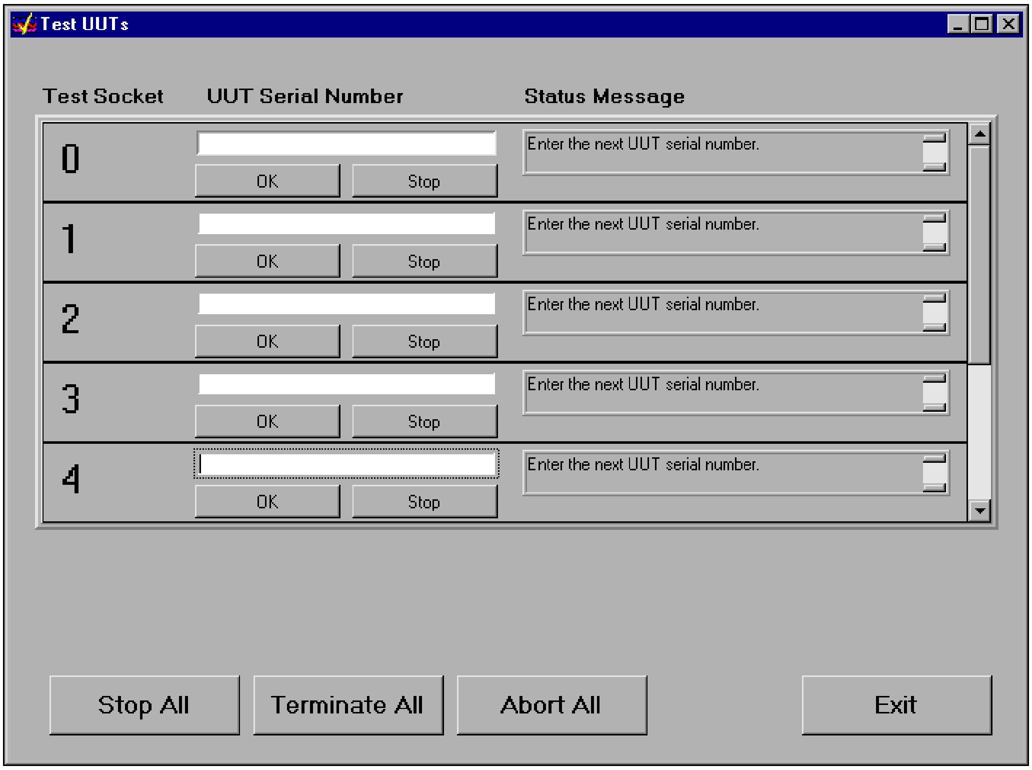
- **Hide Execution Windows**—Specifies that the operator interface application does not display windows for individual test socket executions.
- **Tile Execution Windows**—Specifies that the operator interface application arranges test socket execution windows so they do not overlap.
- **Sequential Batch Mode**—Specifies that the model runs test socket executions one at a time in ascending test socket order. This option is only applicable to the Batch model.
- **Default Batch Synchronization**—Specifies the Batch Synchronization for sequence files that do not change their Batch Synchronization setting from the default value of Use Model Setting. This option is only applicable to the Batch model. Because the default batch synchronization setting for a step is Use Sequence File Setting and the default batch synchronization setting for a sequence file is Use Model Setting, setting the Default Batch Synchronization setting in the model effectively changes the batch synchronization setting for all steps that do not specify a non-default setting. Refer to the *Batch Synchronization* section of Chapter 11, *Synchronization Step Types*, for more information about the batch synchronization settings.
- **Bring UUT Dialog to Front When Status Changes**—Specifies that the UUT dialog box activates whenever a UUT completes testing or when a test socket execution terminates.

Parallel Model

Use the Parallel model to control multiple independent test sockets. The parallel model allows you to start and stop testing on any socket at any time. For example, you might have five test sockets for testing radios. The parallel model allows you to load a new radio into an open socket while the other sockets are busy testing other radios.

When you select the Single Pass entry point, the Parallel model launches a single pass execution for each test socket without prompting for UUT serial numbers.

When you select the Test UUTs entry point, the Parallel model displays the Test UUTs dialog box, shown in Figure 14-2.



Enter the next UUT serial number.
Enter the next UUT serial number.
Enter the next UUT serial number.
Enter the next UUT serial number.
Enter the next UUT serial number.

Figure 14-2. Parallel Model Test UUTs Dialog Box

The Test UUTs dialog box enables you to view the status and control testing on each test socket in your system. The Test UUTs dialog box can contain the following controls:

- **Test Socket**—Displays the test socket index.
- **UUT Serial Number**—Enters a serial number that identifies the UUT in the test socket.
- **OK**—Starts an execution on the test socket. The execution tests UUTs in a loop until you stop, terminate, or abort.
- **Stop**—Stops testing on the test socket. If the test socket is currently testing a UUT, the test socket stops execution after the current UUT completes.

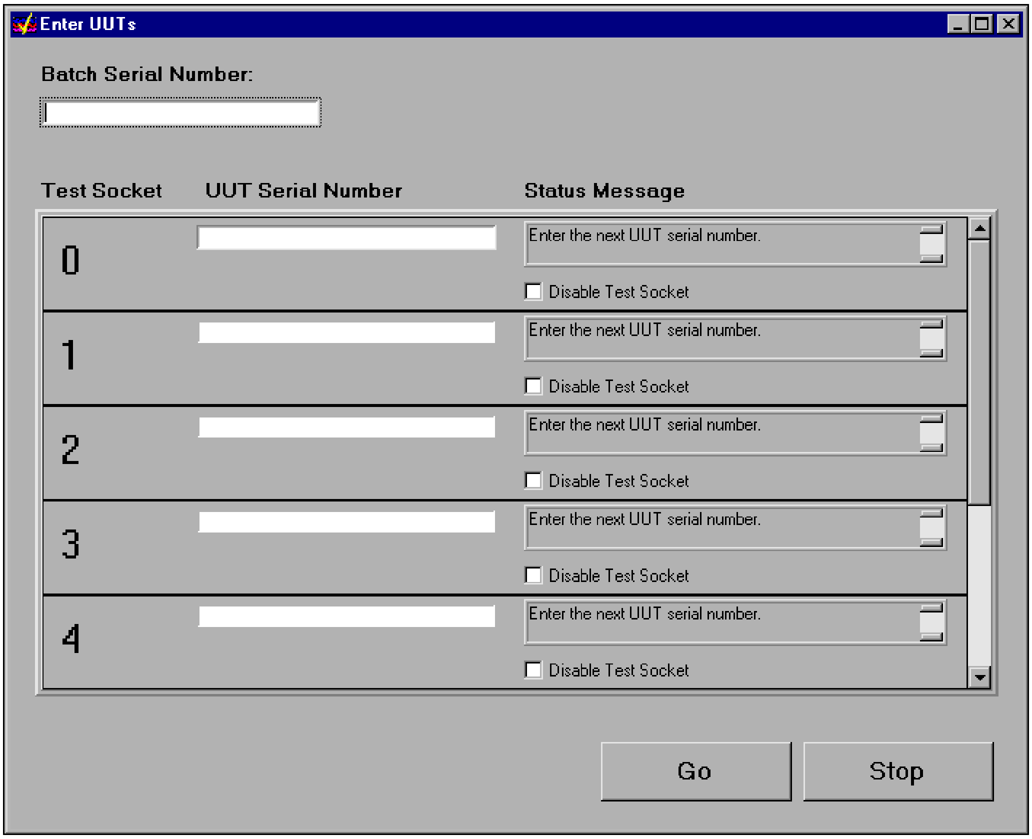
- **Next UUT**—Acknowledges the completion of the current UUT. After you press the Next UUT button, you can enter a new UUT serial number and press OK to start testing the next UUT.
- **View Report**—Displays the report for the UUT in the test socket. You can select whether to view only the report for the current UUT or to view the entire file that you configure UUT reports for the test socket to append to.
- **Terminate**—Terminates the execution for the test socket.
- **Abort—**Aborts the test execution for the test socket. The test sequence does not run its cleanup steps.
- **Restart**—Resumes testing on a test socket you stop, terminate, or abort. After you press the Restart button, you can enter a new UUT serial number and press OK to start testing a new UUT.
- **Stop All**—Stops testing on all test sockets. Test sockets that are currently testing UUTs do not stop until their current UUT completes.
- **Terminate All**—Terminates the test executions for all test sockets.
- **Abort All**—Aborts the test executions for all test sockets. The test sequences do not run their cleanup steps.
- **Exit**—Exits the Test UUTs dialog box. The dialog disables its controls and does not exit until all test sockets complete testing their current UUTs.

Batch Model

Use the Batch model to control a set of test sockets that test multiple UUTs as a group. For example, you might have a set of circuit boards attached to a common carrier. The Batch model ensures that you start and finish testing all boards at the same time. The Batch model also provides batch synchronization features. For example, you can specify that, because a particular step applies to the batch as a whole, the step runs only once per batch instead of once for each UUT. The batch model also enables you to specify that certain steps or groups of steps cannot run on more than one UUT at a time or that certain steps must run on all UUTs at the same time. The batch model can generate batch reports that summarize the test results for the UUTs in the batch.

When you select the Single Pass entry point, the Batch model launches a single pass execution for each test socket without prompting for UUT serial numbers.

When you select the Test UUTs entry point, the Batch model displays the Batch UUT Identification dialog box, shown in Figure 14-3.



Enter the next UUT serial number.

Enter the next UUT serial number.

Enter the next UUT serial number.

Enter the next UUT serial number.

Enter the next UUT serial number.

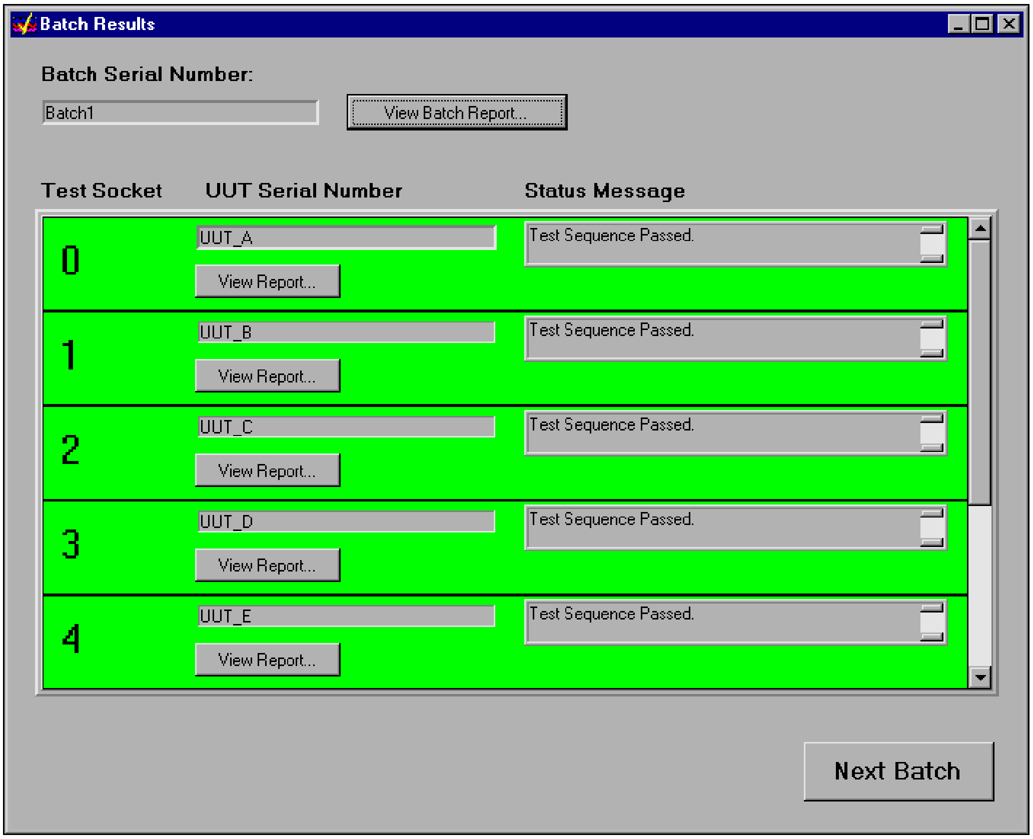
Figure 14-3. Batch UUT Identification Dialog Box

The Batch UUT Identification dialog box enables you to specify the UUTs and test sockets on which to initiate a batch test. The Batch UUT Identification dialog box can contain the following controls:

- **Batch Serial Number**—Identifies the serial number of the batch of UUTs to test. Leave the control empty if there is no applicable serial number.
- **Test Socket**—Displays the test socket index.
- **UUT Serial Number**—Identifies the serial number of the UUT to test in the test socket.

- **Status Message**—Displays the state of the test socket or displays a prompt.
- **Disable Test Socket**—Disables the test socket.
- **Go**—Starts testing for the current batch of UUTs. The batch model runs an instance of the client sequence file in a separate execution for each test socket.
- **Stop**—Exits the dialog box without starting another batch test.

When a UUT batch completes, the Batch model displays the Batch Results dialog box.



Batch Serial Number: Batch1

Test Socket	UUT Serial Number	Status Message
0	UUT_A	Test Sequence Passed.
1	UUT_B	Test Sequence Passed.
2	UUT_C	Test Sequence Passed.
3	UUT_D	Test Sequence Passed.
4	UUT_E	Test Sequence Passed.

Figure 14-4. Batch Results Dialog Box

The Batch Results dialog box enables you to view the status and reports for each test socket and UUT when a batch test completes. The Batch Results dialog box can contain the following controls:

- **Batch Serial Number**—Displays a serial number that identifies the batch of UUTs.
- **View Batch Report**—Display the report for the batch. You can select whether to view the report for the current batch only or to view the entire file that you configure batch reports to append to.
- **Test Socket**—Displays the test socket index.
- **UUT Serial Number**—Displays a serial number that identifies the UUT in the test socket.
- **View Report**—Display the report for the UUT in the test socket. You can select whether to view the report for the current UUT only or to view the entire file that you configure UUT reports for the test socket to append to.
- **Status Message**—Displays the final status of the UUT.
- **Next Batch**—Returns to the Batch UUT Identification dialog box.

Selecting the Default Process Model

To change your default process model, select **Configure»Station Options** and click the Model tab. Select a model from the from the Station Model ring control or click the Browse button and select a process model sequence file. You also can use the Sequence File Properties dialog box to specify that a sequence file always uses a particular process model.

Directory Structure for Process Model Files

The TestStand installer places process model files in the `<TestStand>\Components\NI\Models\TestStandModels` directory.

The default process model consists of a process model sequence file and several supporting sequence files and code modules. The name of the default process model sequence file is `SequentialModel.seq`. TestStand also includes two other process models whose sequence files are `ParallelModel.seq` and `BatchModel.seq`.

For information on the implementation of the process models that TestStand installs, refer to `<TestStand>\Components\NI\Models\TestStandModels\TestStandProcessModels.pdf`.

If you want to modify a TestStand process model, copy the `TestStandModels` directory to a new subdirectory under the `<TestStand>\Components\User\Models` directory. In the new directory, rename the process model sequence files and any code module files. Update the process model sequence file you are customizing to call the modules with the new file names you select. By placing your modifications under `<TestStand>\Components\User`, you ensure that a newer installation of TestStand does not overwrite your customizations. The list of search paths in TestStand includes the subdirectories in `<TestStand>\Components\User`. Not only do you use the `<TestStand>\Components\User` directory to protect your customized components, you also use it as the staging area for the components that you include in your own run-time distribution of TestStand.

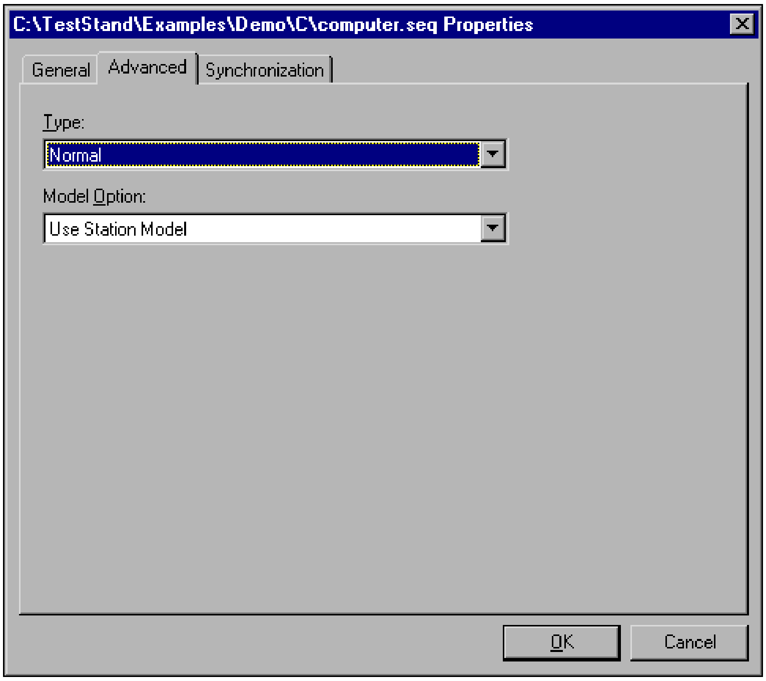
When you create a custom process model, you must establish your custom process model sequence file as the process model for the station. You make this assignment in the Model tab of the Station Options dialog box.

Special Editing Capabilities for Process Model Sequence Files

The TestStand sequence editor has specific features for creating or modifying process model sequence files.

If you want TestStand to treat a sequence file as a process model, you must mark it as a process model file. To do so, select **Edit»Sequence File Properties**. In the Sequence File Properties dialog box, select the Advanced tab. On the Advanced tab, select the **Model** entry in the Type ring control.

Figure 14-5 shows the settings on the Advanced tab of the Sequence File Properties dialog box.



Type: Normal

Model Option: Use Station Model

Figure 14-5. Process Model Settings on the Advanced Tab of the Sequence File Dialog Box

Although you edit a process model sequence file in a regular Sequence File window, the file has special contents. In particular, some of the sequences in the files are model entry points, and some are model callbacks. TestStand maintains special properties for the entry point and callback sequences. You can specify the values of these properties when you edit the sequences in a process model file. When you access the Sequence Properties dialog box for any sequence in a model file, the dialog box contains a Model tab.

Sequence Properties Model Tab

To access the Sequence Properties dialog box, select the **Sequence Properties** item from the context menu in a step list of an individual sequence view, or select the **Properties** item from the context menu for a sequence in the All Sequences view. If the sequence file is a process model file, the dialog box contains a Model tab. The first control on the Model tab is the Type ring control.

Figure 14-6 shows the pull-down menu for the Type ring control.

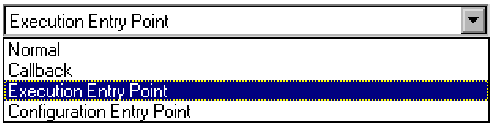


Figure 14-6. Type Ring Control in the Sequence Properties Model Tab

The Type ring control lists the different types of sequences that a process model file can contain. The following sections describe these different types of sequences.

Normal Sequences

A *normal* sequence is any sequence *other* than a callback or entry point. In a process model file, you use normal sequences as utility subsequences that the entry points or callbacks call. When you select the **Normal** entry in the Types ring control, nothing else appears on the Model tab.

Callback Sequences

Model callbacks are sequences that entry point sequences call and that the client sequence file can override. By marking sequences in a process model file as callbacks, you specify the set of process model operations that a sequence developer can customize. When editing the client file, the sequence developer can override the callback by selecting **Edit»Sequence File Callbacks**. Refer to the *Sequence View Context Menu* section in Chapter 5, *Sequence Files*, for more information on using the Sequence File Callbacks dialog box.

Some model callbacks have full implementations. For example, the `TestReport` callback in the default process model is sufficient to handle most types of test results. Other model callbacks are merely placeholders that you override with sequences in the client file. For example, the `MainSequence` callback in the model file is a placeholder for the `MainSequence` callback in the client file.

When you select the Callback entry in the Type ring control, the Copy Steps and Locals when Creating an Overriding Sequence checkbox appears. This checkbox determines TestStand behavior when you click the **Add** button in the Sequence File Callbacks dialog box to create an overriding sequence in the client file. If you enable the checkbox, TestStand copies all the steps and local variables in the callback sequence in the model file to the callback sequence that you create in the client file. TestStand always copies the sequence parameters regardless of the checkbox setting.

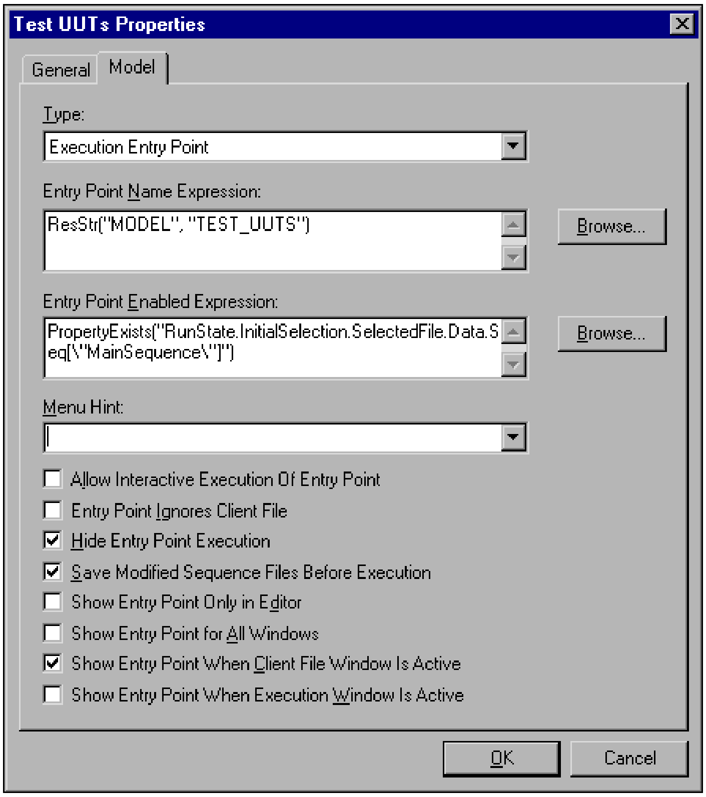
Entry Point Sequences

Entry point sequences are sequences that you can invoke from the menus in the TestStand sequence editor or from an operator interface program. You can specify two different types of entry points:

- *execution entry point*—Runs test programs. Execution entry points typically call the `MainSequence` callback in the client file. The default process model contains two execution entry points: `Test UUTs` and `Single Pass`. By default, execution entry points appear in the **Execute** menu. Execution entry points appear in the menu only when the active window contains a sequence file that has a `MainSequence` callback.
- *configuration entry point*—Configures a feature of the process model. Configuration entry points usually save the configuration information in a `.ini` file in the `<TestStand>\Cfg` directory. By default, configuration entry points appear in the **Configure** menu. For example, the default process model contains the configuration entry point, `Config Report Options`. The `Configure Report Options` entry point appears as **Report Options** in the **Configure** menu.

When you select Execution Entry Point or Configuration Entry Point from the Type ring control, a number of controls appear on the Model tab. The contents of the Model tab are the same for all types of entry points.

Figure 14-7 shows the contents of the Model tab for the `Test UUTs` execution entry point.



Type:
Execution Entry Point

Entry Point Name Expression:
ResStr("MODEL", "TEST_UUTS")

Entry Point Enabled Expression:
PropertyExists("RunState.InitialSelection.SelectedFile.Data.Seq[\"MainSequence\"]")

Menu Hint:

- [ ] Allow Interactive Execution Of Entry Point
- [ ] Entry Point Ignores Client File
- [x] Hide Entry Point Execution
- [x] Save Modified Sequence Files Before Execution
- [ ] Show Entry Point Only in Editor
- [ ] Show Entry Point for All Windows
- [x] Show Entry Point When Client File Window Is Active
- [ ] Show Entry Point When Execution Window Is Active

Figure 14-7. Model Tab for an Execution Entry Point Sequence

The Model tab for an Execution Entry Point Sequence contains the following controls:

- **Entry Point Name Expression**—Specifies a string expression for the menu item name of the entry point. If you specify a literal string for the menu item name, you must enclose it in double quotation marks. If you want to store the name in a string resource file, you can use the `ResStr` expression function to retrieve the name from the file. Refer to the *Expressions* section in Chapter 8, *Sequence Context and Expressions*, for more information.
- **Entry Point Enabled Expression**—Specifies a Boolean expression that TestStand evaluates to determine whether to enable the menu item for the entry point. If the expression evaluates to `False`, TestStand

dims the entry point in the menu. If the expression is empty, the entry point is enabled in the menu.

- **Menu Hint**—Specifies a menu for the entry point. If you leave the Menu Hint control empty, TestStand uses the default menu for the entry point type. Click the arrow at the right edge of the control to pull down a menu that contains the following entries: **File**, **Edit**, **View**, **Execute**, **Debug**, **Configure**, **Window**, and **Help**.

  You can enter one or more names directly in the control. If you specify multiple names, you must separate them with commas. TestStand uses the first menu name in the list that it can find in the operator interface. This option is useful if you use multiple operator interfaces that have different menu names. If TestStand cannot find any menus in the operator interface with the names that you list in the control, it uses the default menu for the entry point type.
- **Allow Interactive Execution of Entry Point**—Specifies whether you can invoke the entry point for steps you run interactively.
- **Entry Point Ignores Client File**—Prevents the sequence from using the client file. This option prevents TestStand from preloading the client sequence file when you run the entry point even if the client sequence file is set to preload when execution begins. For example, the `Configure Report Options` entry point uses this option so that the **Configure»Report Options** command is available for you to use even when TestStand is unable to preload the modules in the active sequence file.

  When you run the entry point, TestStand uses the callback implementations in the model file regardless of whether the client file overrides them.
- **Hide Entry Point Execution**—Prevents TestStand from displaying an Execution window for the execution of the entry point. If you enable this option, you do not see a window for the execution unless a run-time error or breakpoint occurs.
- **Save Modified Sequence Files Before Execution**—Causes TestStand to save the contents of windows to disk when you invoke the entry point. If this option is enabled when you run the entry point, TestStand checks all windows that have pathnames. If one or more windows have changes that you have not yet saved, TestStand prompts you to save your changes. If you click **Yes**, TestStand saves the files.
- **Show Entry Point Only in Editor**—Causes the entry point to appear only in the TestStand sequence editor and not in the run-time operator interfaces.

- **Show Entry Point for All Windows**—Causes the entry point to appear in the menu regardless of the type of window, if any, that is currently active. For example, the `Configure Report Options` entry point configures the report options for the model and has no client-specific effects. Thus, you might want to access it from any window or even when no window is active. When you enable this option, TestStand dims the remaining two checkboxes.
- **Show Entry Point When Client File Window is Active**—Causes the entry point to appear in the menu when a Sequence File window is the active window. For example, the execution entry points appear in the **Execute** menu only when a sequence file is active.
- **Show Entry Point When Execution Window is Active**—Causes the entry point to appear in the menu when an Execution window is the active window.

15

Managing Reports

This chapter describes how to manage and use test reports in TestStand.

Implementation of the Test Report Capability

Most of the test report capabilities that this chapter describes are not native to the TestStand engine or sequence editor. Instead, the default process model that comes with TestStand implements the test report capabilities. This approach allows you to customize all aspects of test reports. Refer to `<TestStand>\Components\NI\Models\TestStandProcessModels.pdf` for more information.

If you do not modify or replace the test report implementation in the process model, you can still customize the contents of test reports using the Report Options dialog box that the default process model provides. Refer to the *Report Options Dialog Box* section in this chapter for more information.

The default process model relies on the automatic result collection capability of the TestStand engine to accumulate the raw data for the test report for each UUT. The TestStand engine can automatically collect the result of each step into a result list for an entire sequence. The result list for a sequence contains the result of each step that runs and the result list of each subsequence call it makes. The default process model calls the main sequence in the client sequence file to test a UUT. Thus, the result list that the TestStand engine accumulates for the main sequence contains the raw data for the test report for the UUT. Refer to the *Result Collection* section in Chapter 6, *Sequence Execution*, for information on automatic result collection.

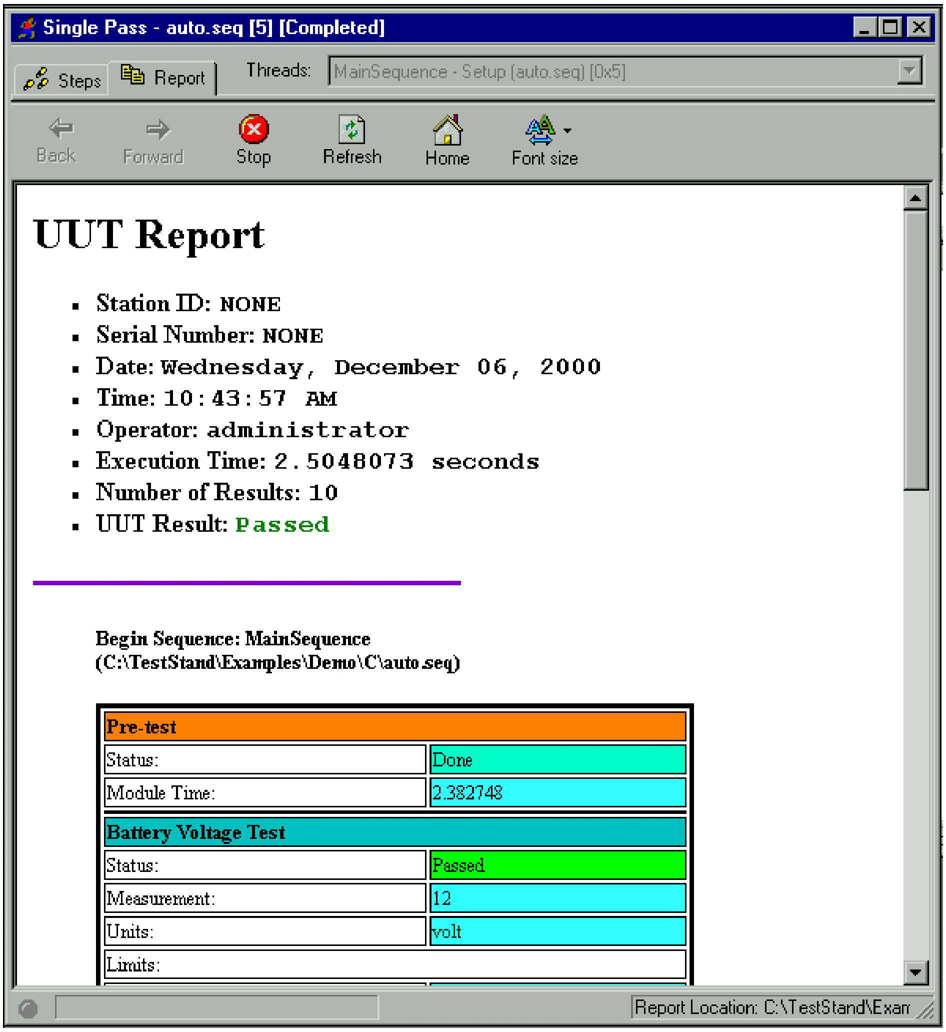
Using Test Reports

The `Test UUTs` and `Single Pass` entry points in the TestStand process models generate UUT test reports. The `Test UUTs` entry point generates a test report and writes it to disk after each pass through the UUT loop. The **Configure»Report Options** menu item displays the Report Options dialog box, where you can set options that determine the contents and format of the test report and the names and locations of test report files.

In the TestStand sequence editor, the Report tab of the Execution window displays the report for the current execution. Usually, the Report tab is empty until execution completes. The default process model can generate reports in either HTML or ASCII text formats.

The Report tab can display reports in HTML, XML, or ASCII text. You also can use an external application to view reports in these or other formats by selecting **View»Launch Report Viewer** when an Execution window is active. Use the menu item **Configure»External Viewers** to specify the external application that TestStand launches to display a particular report format.

Figure 15-1 shows a test report in HTML text format, as it appears on the Report tab of an Execution window.


Single Pass - auto.seq [5] [Completed]
Steps
Report
Threads:
MainSequence - Setup (auto.seq) [0x5]
Back
Forward
Stop
Refresh
Home
Font size

UUT Report

- Station ID: NONE
- Serial Number: NONE
- Date: Wednesday, December 06, 2000
- Time: 10:43:57 AM
- Operator: administrator
- Execution Time: 2.5048073 seconds
- Number of Results: 10
- UUT Result: Passed

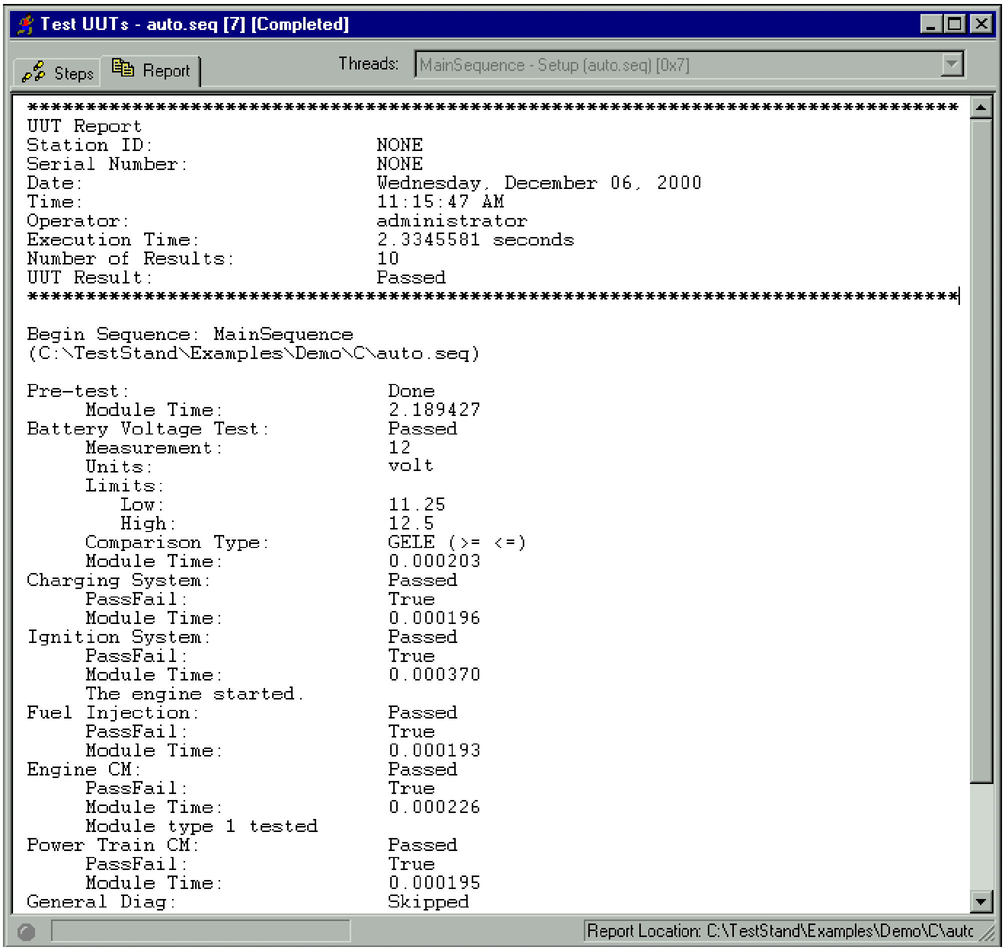
Begin Sequence: MainSequence
(C:\TestStand\Examples\Demo\C\auto.seq)

Pre-test	
Status:	Done
Module Time:	2.382748
Battery Voltage Test	
Status:	Passed
Measurement:	12
Units:	volt
Limits:	

Report Location: C:\TestStand\Exam

Figure 15-1. HTML Test Report on the Report Tab

Figure 15-2 shows a test report in ASCII format as it appears on the Report tab of an Execution window.


Test UUTs - auto.seq [7] [Completed]
Steps
Report
Threads:
MainSequence - Setup (auto.seq) [0x7]

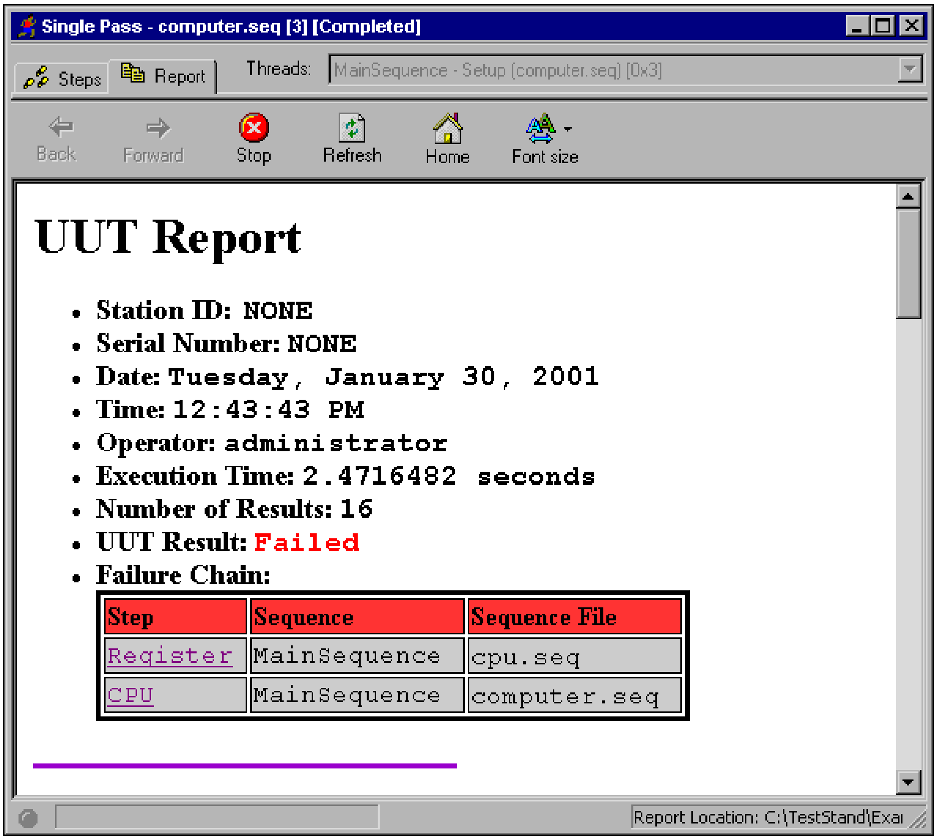
```
********************************************************************************
UUT Report
Station ID:                   NONE
Serial Number:                NONE
Date:                         Wednesday, December 06, 2000
Time:                         11:15:47 AM
Operator:                     administrator
Execution Time:               2.3345581 seconds
Number of Results:            10
UUT Result:                   Passed
********************************************************************************

Begin Sequence: MainSequence
(C:\TestStand\Examples\Demo\C\auto.seq)

Pre-test:                      Done
     Module Time:              2.189427
Battery Voltage Test:          Passed
     Measurement:              12
     Units:                    volt
     Limits:
        Low:                   11.25
        High:                  12.5
     Comparison Type:          GELE (>= <=)
     Module Time:              0.000203
Charging System:               Passed
     PassFail:                 True
     Module Time:              0.000196
Ignition System:               Passed
     PassFail:                 True
     Module Time:              0.000370
     The engine started.
Fuel Injection:                Passed
     PassFail:                 True
     Module Time:              0.000193
Engine CM:                     Passed
     PassFail:                 True
     Module Time:              0.000226
     Module type 1 tested
Power Train CM:                Passed
     PassFail:                 True
     Module Time:              0.000195
General Diag:                  Skipped
```

Report Location: C:\TestStand\Examples\Demo\C\autc

Figure 15-2. ASCII-Text Test Report on the Report Tab

Failure Chain in Reports

For UUTs that fail, HTML and Text reports include a failure chain section in the report header. The first item in the failure chain table shows the step whose failure causes the UUT to fail. The remaining items show the sequence call steps through which the execution reaches the failing step. In HTML reports, each step name in the failure chain is a hyperlink to the section of the report that displays the result for the step. Figure 15-3 shows a failure chain in which the failure of the Register step in `CPU.seq` causes the UUT to fail when the CPU step in `computer.seq` calls `CPU.seq`.


Single Pass - computer.seq [3] [Completed]
Steps
Report
Threads:
MainSequence - Setup (computer.seq) [0x3]
Back
Forward
Stop
Refresh
Home
Font size
Report Location: C:\TestStand\Exa

UUT Report

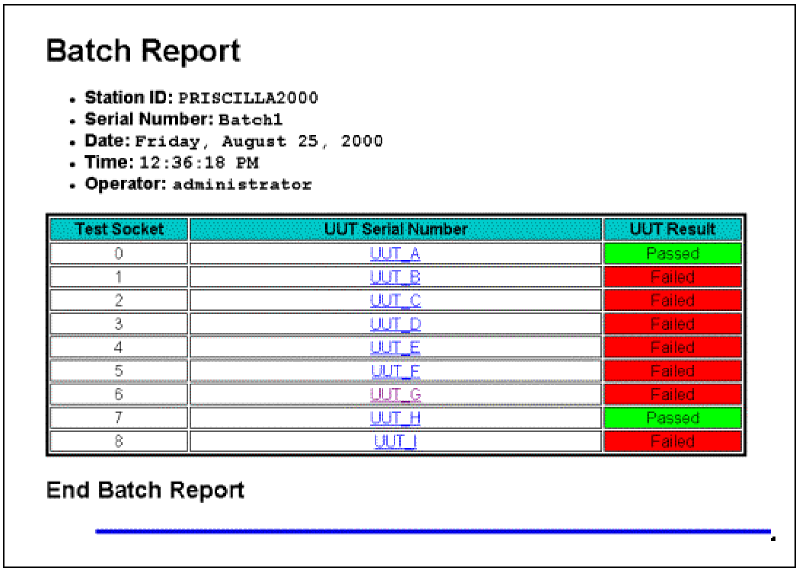
- Station ID: NONE
- Serial Number: NONE
- Date: Tuesday, January 30, 2001
- Time: 12:43:43 PM
- Operator: administrator
- Execution Time: 2.4716482 seconds
- Number of Results: 16
- UUT Result: Failed
- Failure Chain:

Step	Sequence	Sequence File
Register	MainSequence	cpu.seq
CPU	MainSequence	computer.seq

Figure 15-3. Failure Chain in HTML Report

Batch Reports

When you use the Batch process model, the model generates a batch report in addition to a report for each UUT. The batch report summarizes the results for all the UUTs in the batch. When the report format is HTML, the batch report provides hyperlinks to each UUT report. Figure 15-4 shows an example batch report.



Batch Report

- **Station ID:** `PRISCILLA2000`
- **Serial Number:** `Batch1`
- **Date:** `Friday, August 25, 2000`
- **Time:** `12:36:18 PM`
- **Operator:** `administrator`

Test Socket	UUT Serial Number	UUT Result
0	UUT_A	Passed
1	UUT_B	Failed
2	UUT_C	Failed
3	UUT_D	Failed
4	UUT_E	Failed
5	UUT_F	Failed
6	UUT_G	Failed
7	UUT_H	Passed
8	UUT_I	Failed

End Batch Report

Figure 15-4. Example Batch Report

You can use the Report File Pathname tab on the Report Options dialog box to specify that all batch and UUT reports reside in the same file, that all reports reside in separate files, or you can select one of several intermediate configurations. The Report File Pathname tab on the Report Options dialog box provides a graphical indicator to illustrate how the options you select affect the names and contents of the report files. Refer to the *Report File Pathname Tab* section for more information on the indicators.

Report Options Dialog Box

To access the Report Options dialog box, select **Configure»Report Options**.

You can customize the generation of report files in the Report Options dialog box. When you use the **Test UUTs** and **Single Pass** items in the

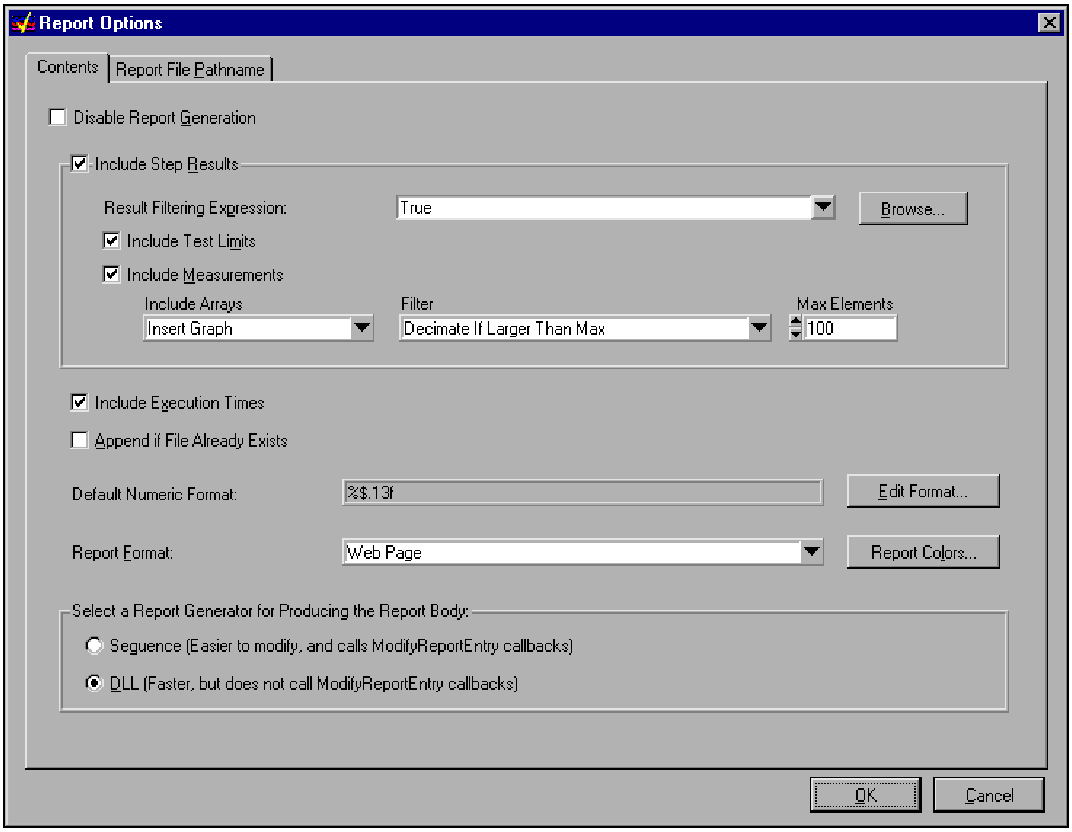
Execute menu, the settings in the Report Options dialog box apply to all sequences that you run on a station.

When you select the **Report Options** command, TestStand calls the `Config Report Options` entry point in the default process model. Thus, while the dialog box is active in the sequence editor, the Running tag appears on the left side of the status bar of the sequence editor window.

The Report Options dialog box contains two tabs: the Contents tab and the Report File Pathname tab.

Contents Tab

Figure 15-5 shows the Contents tab of the Report Options dialog box.



Report Options

Contents | Report File Pathname

☐ Disable Report Generation

☑ Include Step Results

Result Filtering Expression: True

☑ Include Test Limits

☑ Include Measurements

Include Arrays: Insert Graph

Filter: Decimate If Larger Than Max

Max Elements: 100

☑ Include Execution Times

☐ Append if File Already Exists

Default Numeric Format: %$.13f

Report Format: Web Page

Select a Report Generator for Producing the Report Body:

○ Sequence (Easier to modify, and calls ModifyReportEntry callbacks)

● DLL (Faster, but does not call ModifyReportEntry callbacks)

Figure 15-5. Report Options Dialog Box—Contents Tab

The following controls appear on the Contents tab of the Report Options dialog box:

- **Disable Report Generation**—Prevents generation of a test report.
- **Include Step Results**—Displays the results of each step. Disable this checkbox if you want to include only a header for each UUT. The header indicates whether the UUT passed or failed.
- **Result Filtering Expression**—Applies a filtering expression to determine what steps appear in the report. Specifically, this control contains an expression that the report generator evaluates for each step result. The report generator includes the step in the report when the expression evaluates to `True`.

  You can use any subproperty in the expression but you must you use `Result` in place of `Step.Result`. For example, if you want to include only failing steps in the report, set the expression to `Result.Status == "Failed"`. Use the ring control to select predefined expressions for all steps, only failing steps, or only passing steps.
- **Include Test Limits**—Adds to the report all result properties that indicate that they contain test limits.
- **Include Measurements**—Adds to the report all result properties that indicate that they contain measurements. When you include measurements, you can configure the following controls:
  - **Include Arrays**—Specifies whether the report displays measurement values that are numeric arrays. You can select from the following options:
    - **Do Not Include Arrays**—Numeric array values do not appear in the report.
    - **Insert Table**—Numeric array values appear in tables.
    - **Insert Graph**—Numeric array values appear in graphs. This option is available for HTML reports only.
  - **Filter**—Specifies options for limiting the amount of data the array measurements add to the report. You can select from the following options:
    - **Include All**—All numeric array elements appear in the report.
    - **Include Up To Max**—The report truncates numeric arrays to the maximum size in the Max Elements control.

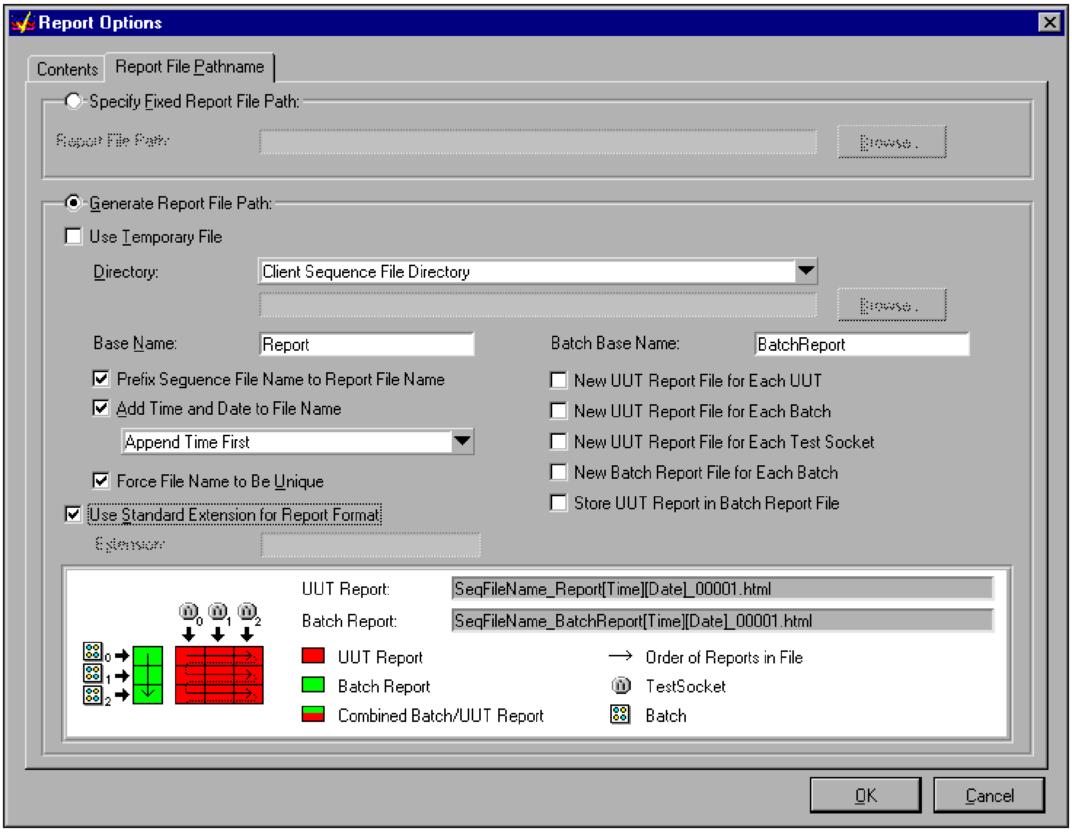
        - **Exclude If Larger Than Max**—The report does not display array measurements that contain more than the number of elements in the Max Elements control.
        - **Decimate If Larger Than Max**—The report samples and displays the specified maximum number of elements from arrays that contain more than the number of elements in the Max Elements control.
    - **Max Elements**—Specifies the maximum array size that applies to options you select in the Filter control.
- **Include Execution Times**—Adds to the report the time each step module takes to execute. This information includes the time that the subsequence, LabVIEW VI, or C function requires to execute. It does not include the time that the TestStand engine requires to evaluate preconditions, load the step module, and so on.
- **Append if File Already Exists**—Appends the report to the target file, if the target file already exists. If you disable this option, the report overwrites the target file. If you create a separate report for each UUT and you disable this option, the report for each UUT overwrites the target file, if it already exists.
- **Default Numeric Format**—Determines how the report formats numeric values for which you did not specify a numeric format.
- **Report Format**—Specifies the output format of the report file. Use this ring control to select either a Web Page format (`.html`) or an ASCII Text format (`.txt`).
- **Report Colors**—Specifies the colors of the report. This option is only available when you select the Web Page format.
- **Select a Report Generator for Producing the Report Body**—Contains radio buttons that make TestStand use a sequence or use a DLL to produce the body of the report. The report body is the section of the report between the header and footer that contains individual results for each sequence and step that TestStand called. In the default TestStand process model, the `TestReport` callback determines whether TestStand builds the report body with a sequence call or with a DLL call.

  If you select the sequence report generation option, `TestReport` calls the `AddReportBody` sequence in either `ReportGen_txt.seq` or `ReportGen_html.seq` to build the report body. The sequence report generator uses a series of sequences with steps that recursively process the result list for the execution.

If you select the DLL report generation option, `TestReport` calls a function in the `modelsupport.dll` to build the report body. The DLL report generator is a single call into a C-language DLL that processes the entire result list for the execution before returning. You can access the project and source code for the LabWindows/CVI-built DLL. If you select the DLL option, TestStand generates reports faster, but TestStand does not call `ModifyReportEntry` callbacks.

Report File Pathname Tab

Figure 15-6 shows the Report File Pathname tab of the Report Options dialog box.



Report Options

Contents | Report File Pathname

Specify Fixed Report File Path:
Report File Path: Browse...

[✓ Generate Report File Path:]
[ ] Use Temporary File
Directory: Client Sequence File Directory
Browse...
Base Name: Report
Batch Base Name: BatchReport
[✓] Prefix Sequence File Name to Report File Name
[✓] Add Time and Date to File Name
Append Time First
[✓] Force File Name to Be Unique
[✓] Use Standard Extension for Report Format
Extension:
[ ] New UUT Report File for Each UUT
[ ] New UUT Report File for Each Batch
[ ] New UUT Report File for Each Test Socket
[ ] New Batch Report File for Each Batch
[ ] Store UUT Report in Batch Report File

UUT Report: SeqFileName_Report[Time][Date]_00001.html
Batch Report: SeqFileName_BatchReport[Time][Date]_00001.html

🟥 UUT Report
🟩 Batch Report
🟩🟥 Combined Batch/UUT Report
→ Order of Reports in File
TestSocket
Batch

OK | Cancel

Figure 15-6. Report Options Dialog Box—Report File Pathname Tab

You can specify a fixed pathname to use for all report files, or you can specify options that the report generator uses to generate report file pathnames. The Report File Pathname tab of the Report Options dialog box contains a Generate Report File Path section. This section provides a graphical indicator to illustrate how the options you select affect the names and contents of the report files.

The controls that appear on the Report File Pathname tab vary according to the process model you use. The tab can contain the following controls:

- **Specify Fixed Report File Path**—When you select the Specify Fixed Report File Path radio button, you enable the Report File Path control in which you can specify a pathname that applies to all report files. You must specify an absolute pathname. Each report file that the report generator creates overwrites the previous report file, unless you enable the Append if File Already Exists option on the Contents tab.
- **Use Temporary File**—Enables the control in which you set the pathname for a temporary report file. The report generator deletes the file when you close the Execution window. Enable this option when you do not want to save your test report after you close the Execution window.
- **Directory**—Specifies the directory in which the report generator writes the report file. In the ring control, you can choose one of the following options.
  - **Client Sequence File Directory**—The directory that contains the client sequence file. For example, if you choose the **Test UUTs** item from the Execute menu when the `d:\Tests\MySeqs\Seq2.seq` sequence file is active, the report generator writes the report file in the `d:\Tests\MySeqs` directory.
  - **<TestStand Directory>\reports\**—The `reports` subdirectory in the TestStand directory.
  - **Specific Directory**—A directory that you specify in the string control that appears under the ring control. You must enter an absolute path in the string control.
- **Base Name**—Specifies the base name for the report filename. Depending on your settings for other options, the report generator might add text to the base name. Do not include a file extension in this control.

- **Batch Base Name**—Specifies the base name for the batch report file name. Depending on your settings for other options, the report generator might add text to the batch base name. Do not include a file extension in this control. This control is available only when you use the Batch process model.
- **Prefix Sequence File Name to Report File Name**—Adds the base name of the client sequence file to the beginning of the name you specify in the Base Name control. For example, if the client file name is `auto.seq` and you enter `report` in the Base Name control, TestStand names an HTML version of the report `auto_report.html`.
- **Add Time and Date to File Name**—Appends a string containing the current time and date in localized format to the base name of the report file. For example, `auto_report.html` might become `auto_report[12 47 54 PM][6 24 99].html`. You can select Append Time First, Append Date First, Time Only, or Date Only from the ring control to specify how the time and date append to the file name.
- **Force File Name to be Unique**—Appends a unique numeric value to the report file name if the file already exists. For example, `auto_report.html` might become `auto_report_00002.html`.
- **Use Standard Extension for Report Format**—TestStand applies the file format extension that corresponds to the report format you specify on the Contents tab of this dialog box. Otherwise, you can enter a file format extension, such as `doc` in the Extension control. Notice that you do not include the dot character in your entry.
- **Append UUT Serial Number to Report File Name**—Appends the UUT serial number to the report file name. For example, `auto_report.html` might become `auto_report[ABC12345].html`. This option causes the report generator to create a separate file for each UUT.
- **Append Batch Serial Number to UUT Report File Name**—Appends the batch serial number to the UUT report file name. This option prevents the report generator from storing in the same file UUT reports from different batches. This control is available only when you use the Batch process model.
- **Append Test Socket Index to UUT Report File Name**—Appends the test socket index number to the UUT report file name. This option prevents the report generator from storing in the same file UUT reports from different test sockets. This control is available only when you use the Batch or Parallel process model.

- **Append Batch Serial Number to Batch Report File Name**—Appends the batch serial number to the batch report file name. This option prevents the report generator from storing in the same file batch reports from different batches. This control is available only when you use the Batch process model.
- **Store UUT Report in Batch Report File**—Stores UUT reports in the same file as the batch report. This control is available only when you use the Batch process model.

Property Flags that Affect Reports

TestStand provides several flags that affect reporting that you can set on variables and properties. These flags are `IncludeInReport`, `IsMeasurement`, and `IsLimit`. The report generator uses these flags to identify result properties to automatically display in the report. Refer to the *Property Flags* section of Chapter 9, *Types*, for a description of property flags.

TestStand step types set the `IncludeInReport` flag on a subset of their result properties to specify that these properties automatically appear in the report. TestStand step types also set the `IsMeasurement` and `IsLimit` flags on properties that hold output values or limit values. The report generator uses these flags to selectively exclude limits or output values according to the option you select in the Report Options dialog box. If an array or container property sets a reporting flag, the report generator also considers the flag to be set for all array elements or subproperties within the containing object.

When you set the `IncludeInReport`, `IsMeasurement`, and `IsLimit` flags on result properties in custom step types you create, you cause the report generator to format the properties into the report. Depending on your report formatting requirements, you might use these flags to achieve the report output you want without changing the report generator.

16 Run-Time Operator Interfaces

This chapter describes how to create or customize an operator interface application. It also describes the various operator interface applications that come with TestStand. For more information on the architecture and design of an operator interface, refer to the *Writing an Application* topic in the *TestStand Programmer Help*.

Overview

TestStand includes four full run-time operator interfaces in both source and executable form, so they are fully customizable. Each run-time operator interface is a separate application program that uses the TestStand API. The operator interfaces differ primarily based on the language and ADE in which each is developed. TestStand includes run-time operator interfaces developed in LabVIEW, LabWindows/CVI, Visual Basic, and Delphi. Like the sequence editor, the run-time operator interfaces allow you to start multiple concurrent executions, set breakpoints, and single-step. Unlike the sequence editor, however, the run-time operator interfaces do not allow you to modify sequences, and they do not display sequence variables, sequence parameters, step properties, and so on.

If you are not an experienced programmer, you might find the source code for each run-time operator interface somewhat complex. Before you start attempting to customize the source code for a run-time operator interface, you should first familiarize yourself with the TestStand API, as follows:

1. Thoroughly read the *TestStand API Overview* section in the *TestStand Programmer Help*. This section contains an overview of the TestStand ActiveX Server functionality and discusses how to call the API from different programming languages. Also familiarize yourself with the available methods and properties of each object class in the API.
2. Read the topic *Writing an Application* in the *TestStand Programmer Help* document. The topic describes the architecture and design of an operator interface.
3. Review the example projects and source code located in the `<TestStand>\Examples\OperatorInterfaces` directory. These

examples illustrate the basic programming requirements for creating a simple operator interface application that uses the TestStand API.

The first decision you must make is whether you should customize one of the run-time operator interfaces that TestStand includes, or create your own application from the ground up. For example, you might want a simple operator interface application on your production floor that does not allow you to debug an execution or display the details of an execution that the TestStand engine is running. Attempting to customize and remove functionality from a fully functional run-time operator interface application might be too time consuming. Instead, you can customize one of the examples in the `<TestStand>\Examples\OperatorInterfaces` directory or create your own application from the ground up.

TestStand Run-Time Operator Interfaces

TestStand installs the executable, project, and source files for each fully functional run-time operator interface in the `<TestStand>\OperatorInterfaces\NI` directory tree. If you want to customize one of these run-time operator interfaces, copy the operator interface project and source files from the `NI` subdirectory to the `<TestStand>\OperatorInterfaces\User` subdirectory before customizing them. This practice ensures that a newer installation of TestStand does not overwrite your customizations. In addition, National Instruments recommends that you track the changes you make to the operator interface source so that you can integrate your changes with any enhancements from future versions of the TestStand run-time operator interfaces.

LabWindows/CVI Run-Time Operator Interface

TestStand installs the executable, project, and source files for the LabWindows/CVI run-time operator interface in the `<TestStand>\OperatorInterfaces\NI\CVI` directory. Table 16-1 lists the files included in the `testexec.prj` project file and describes the purpose of each file.

Table 16-1. Files in the LabWindows/CVI Run-Time Operator Interface Project File

File	Description
`cfgfile.c`	Contains code to save and restore settings, and the most-recently-used-files list to a file in the same directory as the executable or project.
`cvibmp.c`	Contains code to translate icon bitmaps from the Windows bitmap format into the LabWindows/CVI bitmap format.

Table 16-1. Files in the LabWindows/CVI Run-Time Operator Interface Project File (Continued)

File	Description
`data.c`	Contains global settings and data that other source modules access. Contains lists of data about loaded sequence files, executions, icons, and adapters. It also contains an API to access the lists of data.
`engine.c`	Contains all the code that accesses the TestStand ActiveX automation server. Also creates and destroys the records of data for sequence files, executions, sequences, steps, and so on.
`exedisp.c`	Contains all the code for updating execution displays. Each execution display has its own data record for its panel. Many of the functions in this module access that data record to update settings, data, and display information.
`filelist.c`	Contains code to maintain, save, and restore the most-recently-used-file list at the bottom of the **File** menu.
`main.c`	Contains the `main` procedure for the program, and consequently calls the initialization and cleanup routines for the application. It also contains the highest-level code for processing the command-line arguments.
`maingui.c`	Contains all the graphical user interface code that is not specific to the execution display or sequence display. This includes code to handle the single window (tab-dialog) setting of the application as well as initialization and cleanup of the different display components such as the **Tools** menu. Also, this file contains all user interface callbacks that are common to both sequence displays and execution displays. For example, menu item callbacks that are common to both sequence and execution displays are located in this file.
`seqdisp.c`	Contains code for updating the sequence display, where you can launch executions and load and display sequences. The application uses only one sequence display at a time.
`teerror.c`, `teerror.h`	Contains code to report and display error messages. The header file provides several useful error-checking macros.
`rnstchng.c`	Contains run-state change callbacks used to control the flow of UIMessages from the TestStand engine when suspended at a breakpoint in the source code for the Operator Interface. Also contains code to clean up properly when terminating the operator interface prematurely from within LabWindows/CVI. Use this file for compatibility with LabWindows/CVI versions earlier than 5.5.
`tsapicvi.fp`	The TestStand API wrapper functions.

Refer to the file `TestStand\OperatorInterfaces\NI\CVI\readme.doc` for any additional information on the LabWindows/CVI run-time operator interface project.

LabVIEW Run-Time Operator Interface

TestStand installs the executable and source files for the LabVIEW operator interface in the `<TestStand>\OperatorInterfaces\NI\LV` directory. Table 16-2 shows the three top-level VIs in the LabVIEW Run-Time Operator Interface.

Table 16-2. Top-Level Files in the LabVIEW Run-Time Operator Interface

File	Description
`TestStand - Runtime Operator Interface.vi`	This VI launches the operator interface by creating a reference to the TestStand ActiveX automation server and dynamically loads and calls `TestStand - Sequence Display.vi`.
`TestStand - Sequence Display.vi`	This VI displays the Sequence Display window of the operator interface. Whenever a new execution starts, the hierarchy of the Sequence Display creates a new instance of `TestStand - Execution Display.vi`.
`TestStand - Execution Display.vi`	This VI is the master VI for the Execution Display window of the operator interface. For every new execution started, with the exception of executions started during the shutdown procedure, the `TestStand - Sequence Display.vi` hierarchy makes a temporary copy of this VI and runs it. Depending on whether the execution starts hidden or not, this VI also opens its own panel.

Refer to the file, `<TestStand>\OperatorInterfaces\NI\LV\readme.doc`, for any additional information on the LabVIEW run-time operator interface VIs.

Building a Standalone Executable

To make an executable version of the LabVIEW run-time operator interface, load the following script file into the LabVIEW Application Builder tool and build the application:
`<TestStand>\OperatorInterfaces\NI\LV\testexec.bld`

Note The default build script enables the ActiveX server for the resulting application with the ProgID prefix `TestStandLVGUI`. You can configure TestStand to use this application as the LabVIEW server that runs test VIs. Refer to the *Configuring the LabVIEW Standard Prototype Adapter* section in Chapter 13, *Module Adapters*, for more information.

To run the operator interface that you have built, you launch `testexec.exe`.

Visual Basic Run-Time Operator Interface

TestStand installs the executable, project, and source files for the Visual Basic operator interface in the `<TestStand>\OperatorInterfaces\NI\VB` directory. Table 16-3 shows the primary files in the Visual Basic run-time operator interface.

Table 16-3. Top-Level Files in the Visual Basic Run-Time Operator Interface

Files	Description
Forms	
`AdapterCfg.frm`	An implementation of an adapter configuration dialog box that calls the internal adapter configuration dialog box of the adapter that the user selects.
`DoNothing.frm`	A dialog box that immediately unloads itself. Use this dialog box to make Visual Basic remove any menus that are displayed when the menus must be dynamically updated because of a change in the execution state of a sequence that TestStand is running.
`ExeDisplay.frm`	The code that implements the execution displays. This file contains all the callbacks and source code that relate to maintaining and updating an execution display.
`OkBox.frm`	A simple text message dialog box that contains a scrollable text control. Use this dialog box to report error messages.
`SeqDisplay.frm`	The code that creates the sequence display window. This file contains all the callbacks and source code that relate to maintaining and updating the sequence display, as well as code to start executions.
`Splash.frm`	The About dialog box.
`TermAbortCancel.frm`	A dialog box that gives the user the choice of terminating, aborting, or canceling an execution. This dialog box appears when a user attempts to close an execution display of an execution that has not finished running.

Table 16-3. Top-Level Files in the Visual Basic Run-Time Operator Interface (Continued)

Files	Description
Modules	
`Data.bas`	Contains global settings and data that other source modules access. This module is also responsible for initialization and cleanup of the `LoadedSeqFileList.bas` module and the `ExeList.bas` module.
`ErrorHandler.bas`	Contains code for displaying the current error information contained in the Visual Basic `global Err` object.
`ExeList.bas`	Contains code for maintaining a list of execution displays and their corresponding executions. Also, provides methods and properties to perform different operations and get information on the execution displays and their corresponding executions.
`LoadedSeqFileList.bas`	Maintains the list of the sequence files that are loaded for the sequence display. `SeqDisplay.frm` calls functions in this module to load and unload sequence files and get information about the list.
`MiscGUI.bas`	Contains utility functions that both `SeqDisplay.frm` and `ExeDisplay.frm` use. Also, contains code to start the login/logout callback and to maintain the **Tools** menu items and entry point menu items for the displays.
Class Modules	
`EntryPointMenu.cls`	Contains code for maintaining and updating the menus that exist for the entry points of a model sequence file. The Visual Basic run-time operator interface creates instances of this class for every menu that can contain entry points.
`RunLoopEntryPointMenu.cls`	Contains code for maintaining and updating the menus for starting interactive executions with the entry points of a model sequence file.
`WaitCursor.cls`	Contains code for displaying a wait cursor for the life of an object that is created as an instance of this class. When the object terminates, the cursor returns to its previous state.
`SeqFileData.cls`	Contains code for a data structure that the operator interface uses to store information about sequence files, such as the file date when the file was last loaded.

Refer to the file, `<TestStand>\OperatorInterfaces\NI\VB\readme.doc`, for more information on the Visual Basic run-time operator interface project.

Delphi Run-Time Operator Interface

TestStand installs the executable, project, and source files for the Delphi operator interface in the `<TestStand>\OperatorInterfaces\NI\Delphi` directory. Table 16-4 shows the files in the Delphi run-time operator interface.

Table 16-4. Top-Level Files in the Delphi Run-Time Operator Interface

Files	Description
Forms	
`AdapterCfg.dfm` `AdapterCfg.pas`	An implementation of an adapter configuration dialog box that calls the internal adapter configuration dialog box of the adapter that the user selects.
`ExeDisplay.dfm` `ExeDisplay.pas`	The code that implements the execution displays. This file contains all the callbacks and source code that relate to maintaining and updating an execution display.
`OkBox.dfm` `OkBox.pas`	A simple text message dialog box that contains a scrollable text control. Use this dialog box to report error messages.
`SeqDisplay.dfm` `SeqDisplay.pas`	The code that creates the sequence display window. This file contains all the callbacks and source code that relate to maintaining and updating the sequence display, as well as code to start executions.
`SplashScreen.dfm` `SplashScreen.pas`	The About dialog box.
`TermAbortCancel.dfm` `TermAbortCancel.pas`	A dialog box that gives the user the choice of terminating, aborting, or canceling an execution. This dialog box appears when a user attempts to close an execution display of an execution that has not finished running.
Other Source Files	
`Data.pas`	Contains global settings and data that other source modules access. This module is also responsible for initialization and cleanup of the `LoadedSeqFileList.pas` module and the `ExeList.pas` module.

Table 16-4. Top-Level Files in the Delphi Run-Time Operator Interface (Continued)

Files	Description
`ErrorHandler.pas`	Contains code for displaying the current error information.
`ExeList.pas`	Contains code for maintaining a list of execution displays and their corresponding executions. This module also provides methods and properties to perform different operations on and to get information from the execution displays and their corresponding executions.
`LoadedSeqFileList.pas`	Maintains the list of the sequence files that are loaded for the sequence display. `SeqDisplay.pas` calls functions in this module to load and unload sequence files and get information about the list.
`MiscGUI.pas`	Contains utility functions that both `SeqDisplay.pas` and `ExeDisplay.pas` use. Also, contains code to start the login/logout callback and to maintain the **Tools** menu items and entry point menu items for the displays.
`EntryPointMenu.pas`	Contains code for maintaining and updating the menus that exist for the entry points of a model sequence file. The Delphi run-time operator interface creates instances of this class for every menu that can contain entry points.
`WaitCursor.pas`	Contains code for displaying a wait cursor for the life of an object that is created as an instance of this class. When the object terminates, the cursor returns to its previous state.
`SeqFileInfo.pas`	Contains code for a data structure that the operator interface uses to store information about sequence files, such as the file date when the file was last loaded.

Refer to the file, `<TestStand>\OperatorInterfaces\NI\Delphi\readme.doc` for more information on the Delphi run-time operator interface.

Distributing a Run-Time Operator Interface

Refer to Chapter 17, *Distributing TestStand*, for more information on distributing the TestStand engine with your customized run-time operator interface application.

17 Distributing TestStand

This chapter describes how to create an installer for a customized TestStand engine, how to distribute the TestStand engine with a run-time operator interface, and how to distribute each type of code module that TestStand supports. This chapter also describes how to customize and distribute a LabVIEW run-time server.

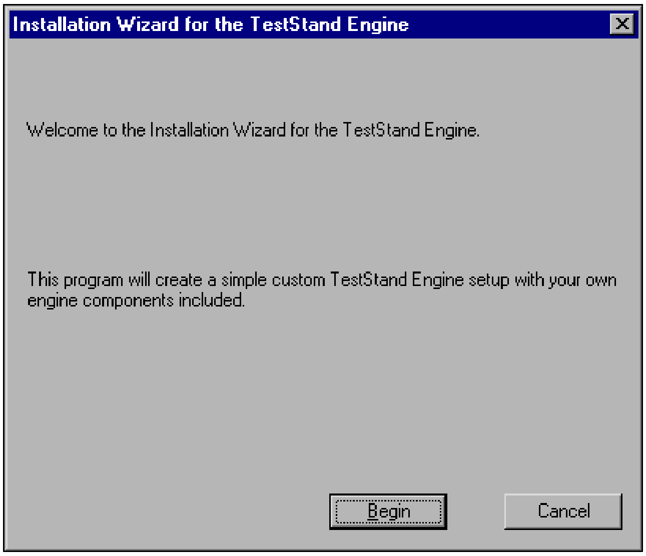
Creating a Run-Time TestStand Engine Installation

TestStand provides a wizard that you can use to create a custom installer to distribute the TestStand engine and components. When you distribute your operator interface application, you can either install the TestStand engine separately or customize the operator interface installer to call the installer for your TestStand engine.

Note The Installation Wizard is not intended to be used to distribute test sequences and code modules. For more information on distributing sequence files and code modules, refer to the *Distributing Sequences and Code Modules* section in this chapter.

Complete the following steps to create a custom TestStand engine installation.

1. Launch the wizard by selecting **Installation Wizard for the TestStand Engine** from the TestStand program group or by selecting **Tools»Run Engine Installation Wizard** from the sequence editor. Figure 17-1 shows the dialog box for the wizard.



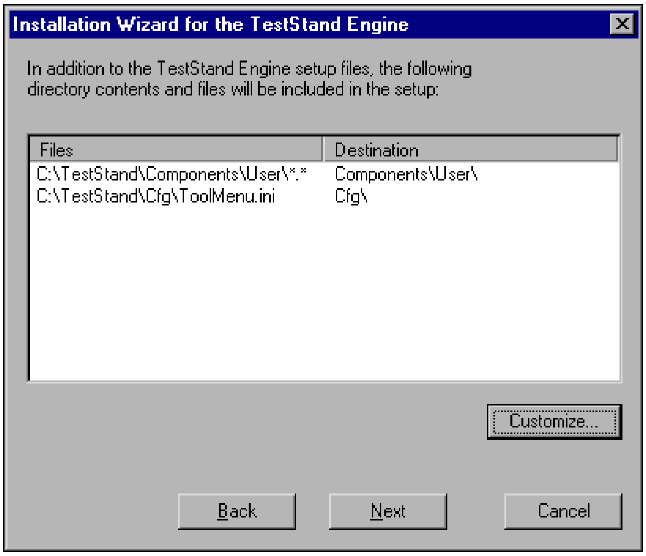
Welcome to the Installation Wizard for the TestStand Engine.

This program will create a simple custom TestStand Engine setup with your own engine components included.

Figure 17-1. Opening Dialog Box for the TestStand Engine Installation Wizard

2. Click the **Begin** button.

   The wizard displays the dialog box shown in Figure 17-2. This dialog box lists the additional files the wizard includes in the installation for the TestStand engine. By default, the wizard includes the `<TestStand>\Components\User` directory in the custom installer, which ensures that the installer contains any custom engine components you create. In addition, the wizard adds the `ToolMenu.ini` file from your TestStand station. Refer to Chapter 3, *Configuring and Customizing TestStand*, for more information on the TestStand components that you can customize.

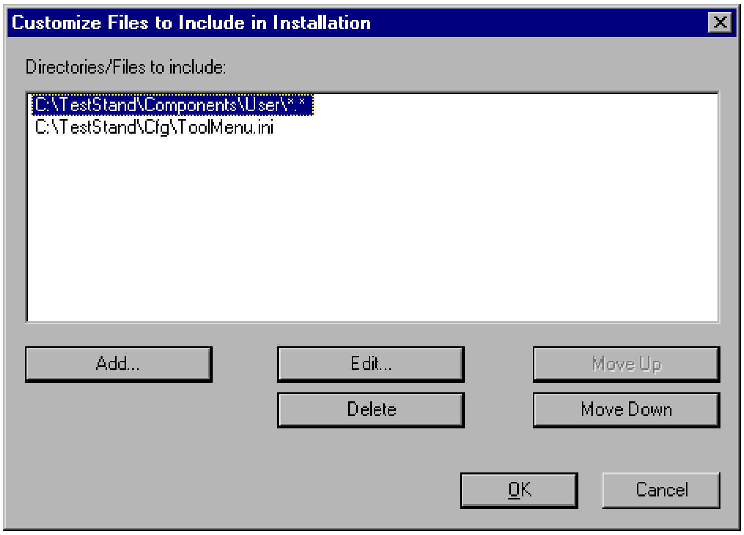


In addition to the TestStand Engine setup files, the following directory contents and files will be included in the setup:

Files	Destination
C:\TestStand\Components\User\*.*	Components\User\
C:\TestStand\Cfg\ToolMenu.ini	Cfg\

Figure 17-2. Installation Wizard: Default Components to Include

3. Click the **Customize** button to select which additional files the wizard includes in the installation. When you make this selection, the wizard displays the Customize Files to Include in Installation dialog box shown in Figure 17-3.



Directories/Files to include:

C:\TestStand\Components\User\*.*
C:\TestStand\Cfg\ToolMenu.ini

Figure 17-3. Customize Files to Include in Installation Dialog Box

4. Click the **Add** button to insert new entries in the file list. Click the **Edit** and **Delete** buttons to edit and delete existing entries. When you insert or edit an entry, the wizard displays the Select Files to Include dialog box, shown in Figure 17-4.

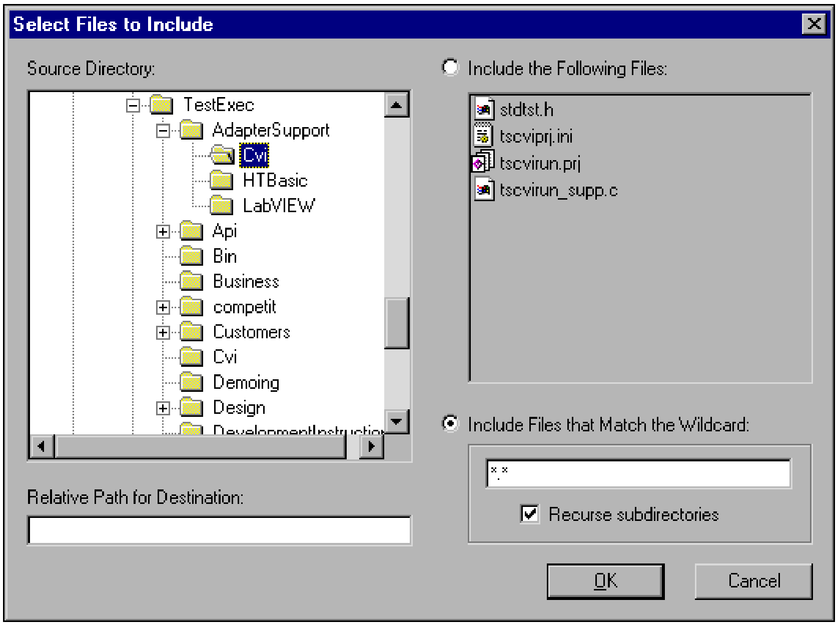
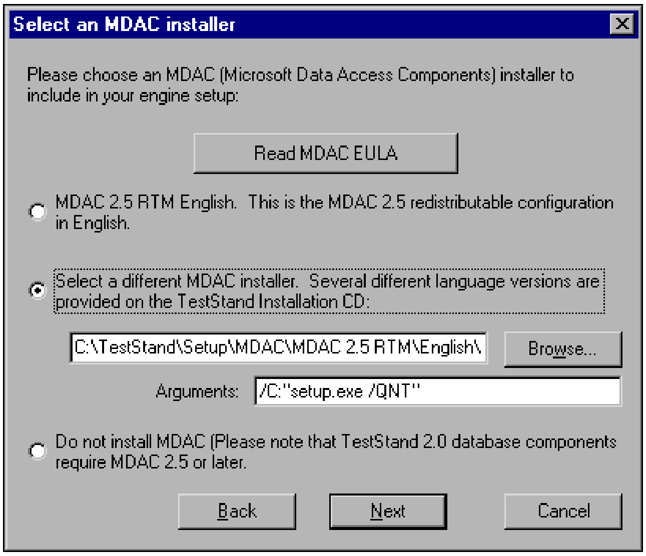


Figure 17-4. Select Files to Include Dialog Box

5. Include individual files or include all files that match a filename containing wildcard characters. When you specify files using wildcard characters, you can recurse subdirectories, and the resulting installation maintains the directory structure when distributing these files to a target system. You use the Relative Path for Destination control to specify the destination subdirectory of the distributed TestStand engine where the installation installs the specified files.
6. When you are finished customizing the files to include in the installation, click **Next** to continue. The wizard displays the MDAC (Microsoft Data Access Components) dialog box shown in Figure 17-5. You should read the MDAC EULA (End User License Agreement) before including MDAC in your installation. The default version of MDAC is 2.5 RTM English, which is the typical redistribution installation. You can browse for a different version to include or, if you will not be using any TestStand database components, you can choose not to include MDAC.



Please choose an MDAC (Microsoft Data Access Components) installer to include in your engine setup:

- MDAC 2.5 RTM English. This is the MDAC 2.5 redistributable configuration in English.
- [✓ Select a different MDAC installer. Several different language versions are provided on the TestStand Installation CD:]
  - C:\TestStand\Setup\MDAC\MDAC 2.5 RTM\English\
  - Arguments: /C:"setup.exe /QNT"
- Do not install MDAC (Please note that TestStand 2.0 database components require MDAC 2.5 or later.

Figure 17-5. Select MDAC Installer Dialog Box

7. After you select an MDAC option from the dialog box, click the **Next** button. The wizard prompts you to identify the directory that will contain the installation files. Upon completing the build process, the wizard creates the following installation files:
   - `TSEngine.cab`—Compressed file that contains the TestStand engine files.
   - `SetupTSEngine.exe`—Setup executable that uncompresses, installs, and registers the TestStand engine.

Using a Custom TestStand Engine Installation

To invoke the custom TestStand engine installation, run the setup executable file separately or call it from another installation. The setup executable supports the following command-line options:

`-x`	Delete the `TSEngine.cab` file after installing the TestStand engine. Instruct the operating system to delete the `SetupTSEngine.exe` file after rebooting the target computer.
`-noprompt`	Do not prompt during installation.
`<path>`	Install at specified location; default is `c:\TestStand`.

Table 17-1 lists the actions the installer takes depending on whether the TestStand engine is already installed on a target system and depending on which command-line options you pass to the setup executable.

Table 17-1. Custom TestStand Engine Installer Actions

Engine Already Installed?	`-noprompt` **Specified?**	`<path>` **Specified?**	**Installer Actions**
No or different version	No	No	Prompt to specify install directory. Installer uses `c:\TestStand` as default. If a different version of the engine is already present, the installer displays a warning to the user and provides the option of canceling the install.
No or different version	No	Yes	Prompt to specify install directory. Installer uses command-line specified path as default. If a different version of the engine is already present, the installer displays a warning to the user and provides the option of canceling the install.
No or different version	Yes	No	No prompt for installation directory. Installer uses `c:\TestStand` as the install directory.
No or different version	Yes	Yes	No prompt for installation directory. Installer uses command-line specified path as default.
Yes, same version	No	Yes/No	Prompt to confirm installation. Installer uses previously installed location.
Yes, same version	Yes	Yes/No	No prompt. Installer uses previously installed location.

Refer to the *Distributing your Operator Interface* section in this chapter for recommendations on how to bundle a custom engine installation with a distribution of your operator interface application.

Distributing your Operator Interface

Installing the Customized Engine

The following sections explain how to bundle a custom TestStand engine installation with your distribution kit for LabVIEW, LabWindows/CVI, Visual Basic, and Delphi.

LabVIEW

You can use the Application Builder in the LabVIEW Professional Development System to create an installation for your operator interface. To bundle a custom TestStand engine installation in your LabVIEW installer, complete the following steps:

1. Add the `SetupTSEngine.exe` and `TSEngine.cab` as support files to your source files. You can install the files in the installation directory of your application.
2. In the Advanced section on the installer tab, select the `SetupTSEngine.exe` file in the Run Executable After Installation section. Specify the `-x` command-line option to delete the engine installation files after the executable runs.

LabWindows/CVI

You can use the Create Distribution Kit feature in the LabWindows/CVI development environment to create an installation for your operator interface. To bundle a custom TestStand engine installation in your LabWindows/CVI distribution kit, complete the following steps:

1. Add the `SetupTSEngine.exe` and `TSEngine.cab` files to your distribution kit. You can install the file in the base installation directory of your application.
2. On the Advanced Distribution Kit Options dialog box, select the `SetupTSEngine.exe` file in the Executable to Run After Setup section. Specify the `-x` command-line option to delete the engine installation files after the executable runs.
3. If you want to alter the default message at the end of the installation of your application to indicate that the TestStand engine installs next, you can use a custom template file as the installation script. TestStand includes two custom script files, `<TestStand>\Operator Interfaces\CVI\TestStandCVITemplate.inf` and `<TestStand>\OperatorInterface\CVI\TestStandCVI55`

template.inf. These files are based on the LabWindows/CVI template files you find in <CVI>\Bin\template.inf in LabWindows/CVI 5.0.1 and LabWindows/CVI 5.5 respectively. The custom scripts contain an altered ExitSuccess procedure.

Refer to the LabWindows/CVI documentation for more information on using the Advanced Distribution Kit dialog box of the Create Distribution Kit feature in LabWindows/CVI.

Visual Basic

You can use the Application Setup Wizard feature in Visual Basic to create an installation for your operator interface. To bundle a custom TestStand engine installation in your Visual Basic 6.0 application installation, complete the following steps:

1. Update the VisualBasic\SetupKit\Setup1\Setup1.vpb project to automatically launch SetupTSEngine.exe after successfully installing your operator interface application. To set up this behavior, insert code into the Form_Load subroutine in the Setup1.frm module. You might want to review existing code in the Setup1.vpb project that calls the AXDIST.EXE and WINT351.EXE installers dynamically when you include the files in the application installation.

   You cannot use the FsyncShell function to launch the TestStand engine installer. The FsyncShell function prevents the TestStand engine installer from running properly. If you want to wait for the TestStand installer to complete its installation before completing the application installation, you can use the ShellAndWait function in the ShellAndWait module that TestStand includes in the <TestStand>\OperatorInterfaces\VB directory.

   If you want to automatically delete the engine installation files after the executable runs, you can specify the -x command-line option when you call the TestStand engine installer.
2. Add the SetupTSEngine.exe and TSEngine.cab files to your installation. Install the file in the installation directory of your application.

Refer to the Visual Basic documentation for more information on using the Application Setup Wizard feature in Visual Basic.

Delphi

To bundle a custom TestStand engine installation in your Delphi application installation, use a third party installation package such as InstallShield or Wise.

Distributing Sequences and Code Modules

This section explains how to distribute sequence files, DLL code modules, object code modules, static library code modules, LabVIEW test VIs, and ActiveX automation code modules.

Distributing Sequence Files

For each step in a sequence that calls a code module, TestStand stores the module name and path as properties of the step. The path can be an absolute path or a path that is relative to a directory in the TestStand search directories. When you distribute a sequence file, you also must distribute the appropriate step modules and their support files onto the target system. Also, you must ensure that sequence files can locate their step module files using the TestStand search paths list.

If you distribute a sequence file that contains absolute paths, TestStand will not find its code modules unless the target system contains a similar directory structure. National Instruments recommends that you use relative paths whenever possible. You can configure the directory paths on your target system so that TestStand finds the code modules of your sequence files. Select **Configure»Search Directories** to specify the directory paths that TestStand searches.

Distributing DLL Code Modules

A DLL file might require that other support DLL files be installed on a system so that TestStand can properly load the DLL into memory. You must ensure that you install the appropriate support DLL files on a target system before running the DLL tests within TestStand.

Distributing DLLs Called By LabVIEW VIs

Before distributing a VI that calls a DLL, you must determine whether you want to distribute the DLL to your target machines or whether you expect the DLL to exist in the DLL search path on your target machines.

In LabVIEW, you use the Call Library Function (CLF) to call a DLL. In the CLF function, you can reference the DLL by base name (for example, `foo.dll`) or you can reference the DLL by absolute path (for example, `c:\MyDirectory\foo.dll`).

If you do not want to distribute the DLL, reference the DLL by base name in the CLF. The Assemble Test VIs tool does not assemble DLLs that you reference by base name.

If you want to distribute the DLL, reference the DLL by absolute path in the CLF. The Assemble Test VIs tool saves the DLL to the support files subdirectory it creates and adjusts the DLL path in the CLF to account for the new relative locations of the VI and the DLL it calls.

Distributing Object and Static Library Code Modules

When the C/CVI Standard Prototype Adapter loads an object or static library file, the LabWindows/CVI Run-time Engine attempts to resolve all external references in the file. When you distribute object or static library code modules, you must distribute the appropriate support files to the target system.

When running object or static library code module tests in-process, the adapter must load the support libraries that the code module depends on before it loads the code module file. The adapter automatically loads all support libraries from the `<TestStand>\AdapterSupport\CVI\AutoLoadLibs` directory. You must ensure that you copy the appropriate support files to the parallel directory on a target system. One option is for you to include the contents of the `AutoLoadLibs` directory on your development system in the distribution of the custom TestStand engine.

If you want a TestStand step to call a code module out-of-process in an external instance of LabWindows/CVI, you must include all support libraries other than LabWindows/CVI libraries in the project on the target system.

Refer to the *Configuring the C/CVI Standard Prototype Adapter* section in Chapter 13, *Module Adapters*, for more information on using different types of code modules with the C/CVI Standard Prototype Adapter.

Distributing LabVIEW Test VIs

The LabVIEW Standard Prototype Adapter loads and runs VIs using a LabVIEW ActiveX server. The LabVIEW server can be the LabVIEW development environment or any LabVIEW-built run-time application enabled as a LabVIEW ActiveX server. When you distribute a TestStand test VI, you must ensure that the LabVIEW server can locate all of the VIs subVIs.

Note Before distributing your test system components to your target machines, National Instruments recommends that you test the components together on your development system. In testing, ensure that your sequences reference your assembled test VIs instead of your development VIs.

The method you use to guarantee that the LabVIEW server can locate subVIs depends on how you want to distribute your source VIs. When you develop your test VI in LabVIEW, you usually save the VI without its hierarchy. For each subVI reference in a VI, LabVIEW saves the location of the subVI within the VI. When TestStand requests a LabVIEW server to load a VI, the server attempts to locate all subVIs in the VI hierarchy. If the LabVIEW server cannot find the subVI in the expected location that is stored within the VI, the LabVIEW server searches the VI search path list as defined in the preferences for the server.

A LabVIEW server reads its search path list from an `.ini` file with the same base name as the server application. For example, the LabVIEW development environment executable `LabVIEW.exe` uses `LabVIEW.ini`. By default, the search path preferences for a LabVIEW server are as follows:

1. The directory that contains the top-level VI that the server is opening.
2. The list of directories containing found subVIs that the LabVIEW server dynamically builds each time the server loads a VI.
3. The `vi.lib` subdirectory in the Library directory for the LabVIEW server.
4. The `user.lib` subdirectory in the Library directory for the LabVIEW server.
5. The `instr.lib` subdirectory in the Library directory for the LabVIEW server.

Refer to the *Search Paths* topic in the *LabVIEW Online Reference* for more information on the VI Search Path preference.

The rest of this section describes three options for distributing your VIs. You might want to use one of these options or a combination of these options.

Packaging VIs and SubVIs for a Sequence File

TestStand includes a utility in the **Tools** menu that can save the entire test VI hierarchy for the sequence files you select. For all steps in sequence files that use the LabVIEW Standard Prototype Adapter, the utility saves the test VIs to a single directory and all subVIs, run-time menu files, and external subroutines to a separate VI library.

If a sequence calls subsequences in other sequence files, the subsequence files are automatically selected for packaging, except when the subsequence is specified with a dynamically determined expression.

For a VI that a sequence references with a relative path, the utility recreates the folder(s) of the relative path within the target directory you specify. In this case, the utility places the VI in the most nested folder so that the relative path from the target directory to the VI is the same as the relative path the sequence file specifies. To run this utility, select the **Tools»Assemble Test VIs for Run-Time Distribution** command. The command displays a dialog box in which you select the sequence files whose VIs you are packaging. You should select all sequence files that use LabVIEW VIs. You can choose to remove the diagrams from the VIs you package.

When you create a run-time distribution kit you must install the VIs and support VI library that the utility creates on your target system. Also, you must ensure that sequence files that call the VI tests can locate the files using the TestStand search paths list on your target system. You can alter the search path list by selecting **Configure»Search Directories**.

If your tests call any subVIs dynamically, the packaging utility does not save the subVIs in the support VI library. You must distribute these dynamically-called VIs separately.

Note The VI packager only collects VIs. It does not recompile old versions of LabVIEW VIs. You should perform a mass compile in LabVIEW before you package your VIs. Correct any errors in the mass compile before running the packager.

Distributing VIs by Saving Them without Full Hierarchy

If you want to maintain your test VIs on a target system as independent files, and you do not want to resave your VIs with their full hierarchy, you must distribute all required subVIs and support files to the target system. Support files include external subroutines, run-time menus, and DLLs. This requirement includes distributing VIs and VI libraries from the LabVIEW library subdirectories, that is, `vi.lib`, `user.lib`, and `instr.lib`, and any other files from additional directories in your search path preferences. In addition, if you want to maintain multiple LabVIEW servers on your target system, you must ensure that each LabVIEW server can find any required subVIs.

For example, if your development system contained a directory structure of sequences and VIs, you could distribute your VIs as follows:

1. Duplicate the entire directory structure of sequences and VIs on your target system. If you do not install the files in the same absolute path, you must ensure that the sequences and VIs do not contain absolute paths. For example, a sequence step should call VIs using a relative path, and VIs should call DLLs using only their base name.
2. Copy the required subVIs and VI libraries from the library subdirectories of the LabVIEW development system to the appropriate library subdirectories of each LabVIEW server. If the target system already contains a copy of the LabVIEW development environment, you need to copy only additional files that the target system does not have. If the target system contains only a LabVIEW run-time server, you can copy all of the library subdirectories from the development system to the target system. If the target system contains multiple LabVIEW servers, you can maintain a single LabVIEW server library directory by customizing the preferences for each server to reference to this single library.

If you upgrade the version of LabVIEW on your systems, you must rebuild all LabVIEW run-time servers with the new version of LabVIEW, mass compile your test VIs and subVIs, and update your library subdirectories where appropriate.

Distributing VIs by Saving Them with Full Hierarchy

LabVIEW allows you to save your VIs with their full hierarchy into a VI library. This includes saving all subVIs, controls, and external subroutines, including the ones in `vi.lib`. You can remove the diagrams from all of the VIs.

Using this LabVIEW feature, you can resave your test VIs with their full hierarchy to a new, separate directory image that you can distribute to a target system. National Instruments does not recommend this method if your sequence refers to test VIs that are not in VI libraries since you would need to add the library names to each pathname reference. If your sequence does refer to test VIs within VI libraries, you must use the same library names when you save VIs with full hierarchy so that the pathname for the VI module in the sequence is correct.

To save the full hierarchy for a VI, select **File»Save with Options»Custom Save** from within the LabVIEW development environment and select the following options:

- To new location - single prompt
- Save entire hierarchy
- Include `vi.lib` files (This selection is necessary only if the target LabVIEW server is not the LabVIEW development environment.)
- Include external subroutines
- Include run-time menus
- Remove diagrams (This selection is optional.)

To streamline the saving process, you can create a new VI and place all test VIs on its diagram as subVIs. Then save this VI and its VI hierarchy. With this process, you do not have to save VIs individually for every VI used with a sequence. Instead, you perform the saving procedure only once.

If your tests call any subVIs dynamically, you must distribute these dynamically-called VIs separately.

Distributing ActiveX Automation Code Modules

When the ActiveX Automation Adapter attempts to load an ActiveX Automation server, the server must be registered with the operating system. When distributing your ActiveX Automation server code modules, you must ensure that you properly install and register them on a target system before using the server from within TestStand.

Customizing and Distributing a LabVIEW Run-Time Server

The LabVIEW Standard Prototype Adapter runs VIs using a LabVIEW ActiveX server. The server can be the LabVIEW development environment or a LabVIEW-built run-time application enabled as a LabVIEW ActiveX server through the LabVIEW Application Builder. TestStand requires that you install a LabVIEW run-time server if your sequences call LabVIEW VIs.

If you choose to distribute the application version of the LabVIEW run-time operator interface, it can serve as the LabVIEW ActiveX server that TestStand uses to run your test VIs. The operator interface that ships with TestStand has the default ActiveX server name, `TestStandGUIRTS`.

If you are not distributing a LabVIEW operator interface or installing the LabVIEW development environment on your target machine(s), TestStand can use another LabVIEW run-time server to execute your VIs. The TestStand installation includes a prebuilt LabVIEW run-time server with source in the `<TestStand>\Components\NI\RuntimeServers\LabVIEW` directory. The executable name is `TestStandLVRTS.exe` and the ActiveX server name is `TestStandLVRTS`. If you want to customize the server, copy all source files from the `NI` subdirectory to the `<TestStand>\Components\User\RuntimeServers\LabVIEW` subdirectory before you customize the files. This practice ensures that a newer installation of TestStand does not overwrite your customizations.

Refer to the *Configuring the LabVIEW Standard Prototype Adapter* section in Chapter 13, *Module Adapters*, for more information on configuring which LabVIEW server TestStand uses.

Note When distributing a LabVIEW run-time server, you must ensure that the server can locate all subVIs. Refer to the *Distributing LabVIEW Test VIs* section for information on how LabVIEW servers reference subVIs.

Rebuilding the TestStand LabVIEW Run-Time Server

National Instruments uses a specific version of LabVIEW to build the LabVIEW run-time server that comes with TestStand. To learn which LabVIEW version corresponds to your LabVIEW run-time server, refer to the `readme.txt` file that is located in the same directory as the executable. Whenever you save your VIs with a newer version of LabVIEW, you must rebuild any LabVIEW run-time servers that TestStand uses to execute the newer VIs. To rebuild or customize the TestStand LabVIEW run-time server, complete the following steps:

1. Create a copy of the run-time source files in your `User` directory structure. Except for `TestStandLVRTS.exe` and `TestStandLVRTS.tlb`, copy all source files from the following subdirectory:

   `<TestStand>\Components\NI\RuntimeServers\LabVIEW`

   Then paste those source files into the following subdirectory:

   `<TestStand>\Components\User\RuntimeServers\LabVIEW`
2. In the LabVIEW Application Builder tool, load the version of the script file, `TestStandLVRTS.bld`, that is now located in your `User` directory structure, and build the application.

Distributing the TestStand LabVIEW Run-Time Server

The TestStand Engine Installation wizard automatically includes the default NI LabVIEW run-time server with any engine installation. If you include the `<TestStand>\Components\User` directory in the custom engine installation, the wizard also includes any customized version of the LabVIEW run-time server in the custom engine installation. The resulting engine installation automatically registers the LabVIEW run-time server that is located in the `NI` directory first and then it registers the LabVIEW run-time server that is located in the `User` directory. If the version in `User` uses the same ProgID, `TestStandLVRTS`, its registration replaces the previously registered server in `NI`.

Note Before distributing your test system components to your target machines, National Instruments recommends that you test the components together on your development system. In testing, ensure that you configure the LabVIEW adapter to use the LabVIEW ActiveX server that your target machines use.

To manually distribute the LabVIEW run-time server, you must include the following files:

- `TestStandLVRTS.exe`
- `TestStandLVRTS.tlb`
- `data\LVWUtil32.dll`

To manually register and unregister the ActiveX server in a LabVIEW run-time application, launch the executable with the `/RegServer` or `/Unregserver` command-line argument. With this method, the executable registers or unregisters itself and terminates. You also can register the server by launching the executable.

You may choose to distribute additional files with the LabVIEW run-time server that are required to run your code modules. If your application uses serial port functionality, you must include the `serpdrv` files from the LabVIEW development system in the same directory as the executable file. If your application uses a GPIB or data acquisition board, you must install the hardware drivers that come with the board.

If your application uses data acquisition functionality with NI-DAQ 6.6 or earlier, you must copy `daqdrv` files to the same directory as the executable file. If your application uses NI-DAQ 6.7 or later, you must copy `lvdaq.dll` to the same directory as the executable file.

If you choose to distribute your test VIs to a target system as independent files, and you do not want to resave your VI libraries with their full hierarchy, you must also distribute any files required by the test VIs, that is, files from the `vi.lib`, `user.lib`, and `instr.lib` directories. Refer to the *Distributing VIs by Saving Them without Full Hierarchy* section in this chapter for more information.

Refer to the *LabVIEW Application Builder Release Notes* documentation for more information on creating a LabVIEW application that includes the LabVIEW ActiveX server.

18 Databases

This chapter describes the database features of TestStand. These features include logging results from an execution to a database. This chapter also outlines six built-in step types for accessing databases directly from your test sequences.

This chapter assumes that you have a basic understanding of database concepts and SQL and that you know how to use your Database Management System (DBMS) client software.

Database Concepts

This section summarizes key database concepts that you must know when using databases with TestStand. It also summarizes key Windows features that TestStand uses to communicate with database management systems.

Databases and Tables

A database is an organized collection of data. You can store data in and retrieve data from a database. Although the underlying details vary on how a database stores its internal data, most modern Database Management Systems (DBMS), also known as database servers, store data in table form.

Tables contain *records*, also known as *rows*. Each row consists of *fields*, also known as *columns*. Every table in a database must have a unique name, and every column within a table must have a unique name. Each column in a table has a data type. The available data types vary depending on the DBMS.

You can use database tables to store many different types of data. Table 18-1 shows an example table. The table contains columns for the Unit Under Test (UUT) number, a step name, a step result, and a measurement. The order of the data in the table is not important. Ordering, grouping, and other manipulations of the data occur when you retrieve the data from the table.

Table 18-1. Example Database Table

UUT_NUM	STEP_NAME	RESULT	MEAS
20860B456	TEST1	PASS	0.5
20860B456	TEST2	PASS	(NULL)
20860B123	TEST1	FAIL	0.1
20860B789	TEST1	PASS	0.3
20860B789	TEST2	PASS	(NULL)

A row can contain an empty column value, which means that the specific cell contains a `NULL` value, also referred to as a *SQL Null* value.

You use a SQL SELECT command, also known as a *query*, to retrieve records from a database. The result of a query often is called a *record set* or *SQL statement data*. The data you receive does not necessarily reflect the entire contents of any particular table in the database. For instance, you might retrieve only selected columns and rows from one table, or you might retrieve data that is a combination of the contents of multiple tables. The query defines the contents and order of the data. You can refer to each column you retrieve by the name of the column or by a one-based number that refers to the order of the column in the query.

Database Sessions

Database operations occur within a database session. A simple session consists of the following steps:

1. Connect to the database.
2. Open database tables.
3. Fetch data from and store data to the open database tables.
4. Close the database tables.
5. Disconnect from the database.

TestStand has a built-in step type for each of the five steps in a simple database session. The step types include Open Database, Open SQL Statement, Data Operation, Close SQL Statement, and Close Database. Refer to the *Built-In Database Step Types* section later in this chapter for more information on these step types. Refer to *Structured Query Language (SQL)* section later in this chapter for a complete list of SQL commands.

Microsoft ADO, OLE DB, and ODBC Database Technologies

To access data within a database, you typically use some type of database client technology, preferably one that provides a uniform interface to different database systems. Microsoft has integrated several database interface technologies into the Windows operating system. TestStand uses *ActiveX Data Objects* (ADO) as its database client technology. Microsoft built ADO on top of the *Object-linking and Embedding Database* (OLE DB). Applications that use ADO, such as TestStand, use the OLE DB interfaces indirectly. The OLE DB layer interfaces to databases directly through a specific OLE DB provider for the DBMS or through a generic *Open Database Connectivity* (ODBC) provider, which interfaces to a specific ODBC driver for the DBMS. Figure 18-1 shows the high-level relationships between TestStand and components of the Windows database technologies.

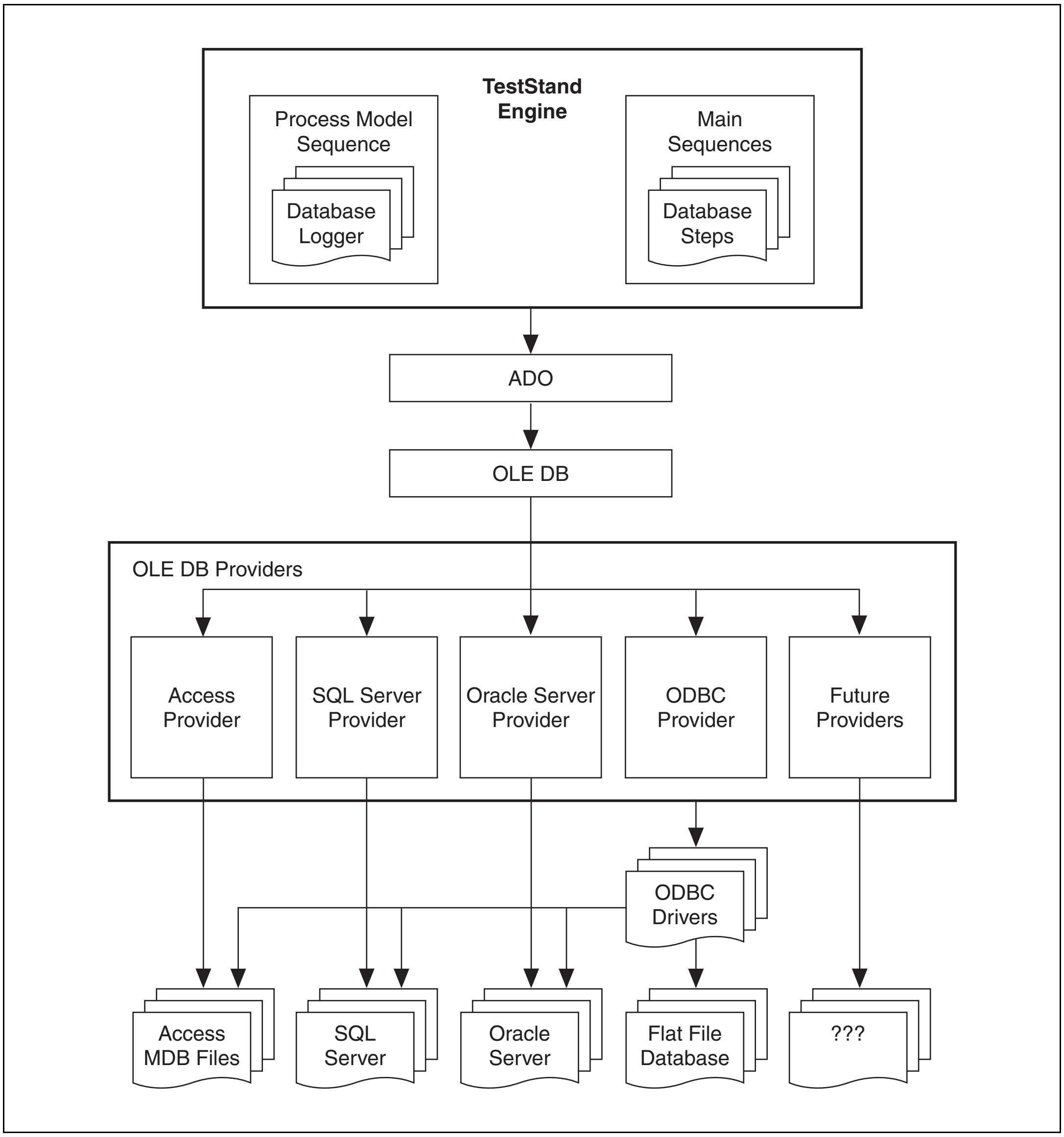


Figure 18-1. Microsoft Windows Database Technologies

Refer to the Microsoft Web site at `http://www.microsoft.com/data/` for more information on database technologies for Windows operating systems.

Data Links

Before you can access data from a database within TestStand, you must provide specific connection information. This connection information is called a *data link*. In a data link, you can specify various kinds of information, such as the server on which the data resides, the database or file that contains the data, the user ID, and the permissions to request when connecting to the data source.

For example, to connect to a Microsoft SQL Server database, you can specify the OLE DB provider for SQL Server, a server name, a database name, and a user ID and password. To connect to a Microsoft Access database, you can specify the OLE DB provider for ODBC and an ODBC data source name. The ODBC data source name specifies which ODBC driver to use, the database file (`.mdb`), and an optional user ID and password. You can define ODBC data source names in the ODBC Administrator in the Windows Control Panel.

A *connection string* is a string version of the connection information required to open a session to a database. TestStand allows you to build a connection string using a data link dialog box. The data link dialog box and the information that the connection string specifies vary depending on the OLE DB provider.

For example, a connection string for a Microsoft SQL Server database might contain the following:

```
Provider=SQLOLEDB.1;Integrated Security=SSPI;Persist
Security Info=True;
User ID=guest;Initial Catalog=pubs;Data
Source=SERVERCOMPUTER
```

You can store the contents of a connection string in a file with a `.udl` extension. This file is referred to as a Microsoft Data Link (`.udl`) file. You can create a data link file by right-clicking in Windows Explorer and selecting **New»Text Document**. Rename the file extension to `.udl`. Right-click on the file and select **Open** to display the Data Link Properties dialog box. Refer to the *Using Data Links* section later in this chapter for more information on specifying data links.

Database Logging Implementation

The database logging capability in TestStand is not native to the TestStand engine or sequence editor. The default process model that comes with TestStand contains sequences that implement the logging features. You can customize any portion of the database logging sequences. Refer to the *Special Editing Capabilities for Process Model Sequence Files* section in Chapter 14, *Process Models*, for more information on customizing the default process model.

The default process model relies on the automatic result collection capability of the TestStand engine to accumulate the raw data to log to a database for each UUT. The TestStand engine can collect the results of each step into a result list for an entire sequence automatically. The result list for a sequence contains the result of each step it runs and the result list of each subsequence call it makes. The default process model calls the main sequence in the client sequence file to test a UUT. Thus, the result list that the TestStand engine accumulates for the main sequence contains the raw data to log to a database for the UUT. Refer to the *Result Collection* section in Chapter 6, *Sequence Execution*, for more information on automatic result collection.

The Test UUTs and Single Pass entry points in the TestStand process models log the raw results to a database. The Test UUTs entry point logs results after each pass through the UUT loop.

The **Configure»Database Options** menu item displays the Database Options dialog box where you can set the following options:

- Specify the data link to which TestStand logs results.
- Specify the database schema that TestStand uses. A schema contains the SQL statements, table definitions, and TestStand expressions to instruct TestStand how to log results to a database. TestStand includes a set of predefined schemas, at least one for each supported DBMS. You can create new schemas that log results to tables you define.
- Specify various filtering options to limit the amount of data that TestStand logs.

For more information on the Database Options dialog box, refer to the *Database Options Dialog Box* section later in this chapter.

You can also customize or replace any portion of the database logging sequences. Refer to the *Special Editing Capabilities for Process Model Sequence Files* section in Chapter 14, *Process Models*, for more information on customizing the default process model.

Using Database Logging

Before you use the default process model to log results to a database, you must do the following:

1. Decide to which DBMS you want TestStand to log the results. By default, TestStand supports Microsoft Access, Microsoft SQL Server, and Oracle. If you decide to use another DBMS, refer to the *Adding Support for Other Database Management Systems* section later in this chapter.
2. Make sure you have installed the appropriate client DBMS software that is required to communicate with the DBMS. You must decide whether to use an ODBC driver or a specific OLE DB provider for your DBMS. Microsoft Access and Microsoft SQL Server require you to install only an ODBC driver or OLE DB provider. TestStand installs the Microsoft MDAC components, which include providers for Microsoft Access and SQL Server. Most Oracle ODBC drivers and OLE DB providers require that you install Oracle Client also. Refer to the `<TestStand>\Doc\readme.txt` for more information on suggested providers, versions of ODBC drivers, and client DBMS software.
3. Create the default database tables in a database in your DBMS. TestStand comes with SQL script files for creating and deleting the default database tables that the default schemas require. These script files are located in the `<TestStand>\Components\NI\Model\TestStandModel\Database` directory. For example, the `Access Create Generic Recordset Result Tables.sql` file contains SQL commands to create the default tables for Access. The `Access Drop Result Tables.sql` file contains SQL commands to delete the default tables.

   TestStand installs an example Microsoft Access database, `TestStand Results.mdb`, in the `<TestStand>\Components\NI\Model\TestStandModel\Databases` directory.

   For more information on creating the default database tables using a SQL script file, refer to the *Database Viewer* section later in this chapter. Refer to the *TestStand Database Result Tables* section later in this chapter for more information on the default table schema that the process model uses.

4. Use the Database Options dialog box to enable database logging and to define a data link and schema for the default process model to use. Refer to the next section, *Database Options Dialog Box*, for more information on the Database Options dialog box, and refer to the *Using Data Links* section later in this chapter for more information on defining data links.

Database Options Dialog Box

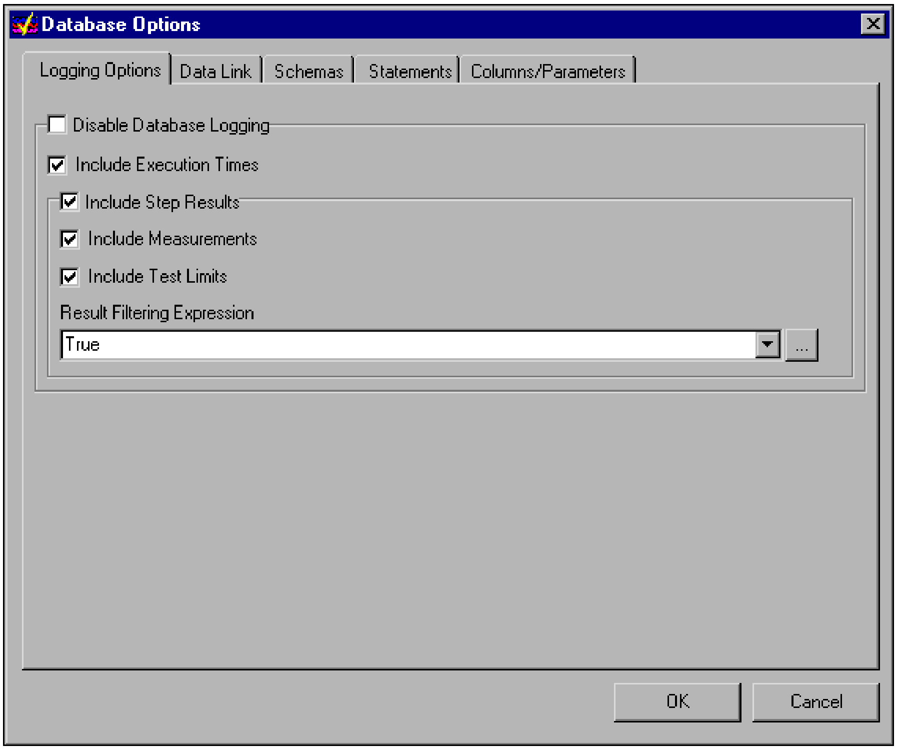
You access the Database Options dialog box by selecting **Configure»Database Options**. In the Database Options dialog box, you can customize the logging of results to a database. The settings you choose in the Database Options dialog box apply to all executions that use the `Test UUTs` and `Single Pass` entry points.

When you select **Configure»Database Options**, TestStand executes the `Config Database Options` entry point in the default process model. Thus, while the dialog box is active in the sequence editor, the `Running` message appears on the left side of the status bar.

The Database Options dialog box contains the following tabs: Logging Options, Data Link, Schemas, Statements, and Columns/Parameters.

Logging Options Tab

Figure 18-2 shows the Logging Options tab of the Database Options dialog box.



☐ Disable Database Logging

☑ Include Execution Times

☑ Include Step Results

☑ Include Measurements

☑ Include Test Limits

Result Filtering Expression: True

Figure 18-2. Database Options Dialog Box—Logging Options Tab

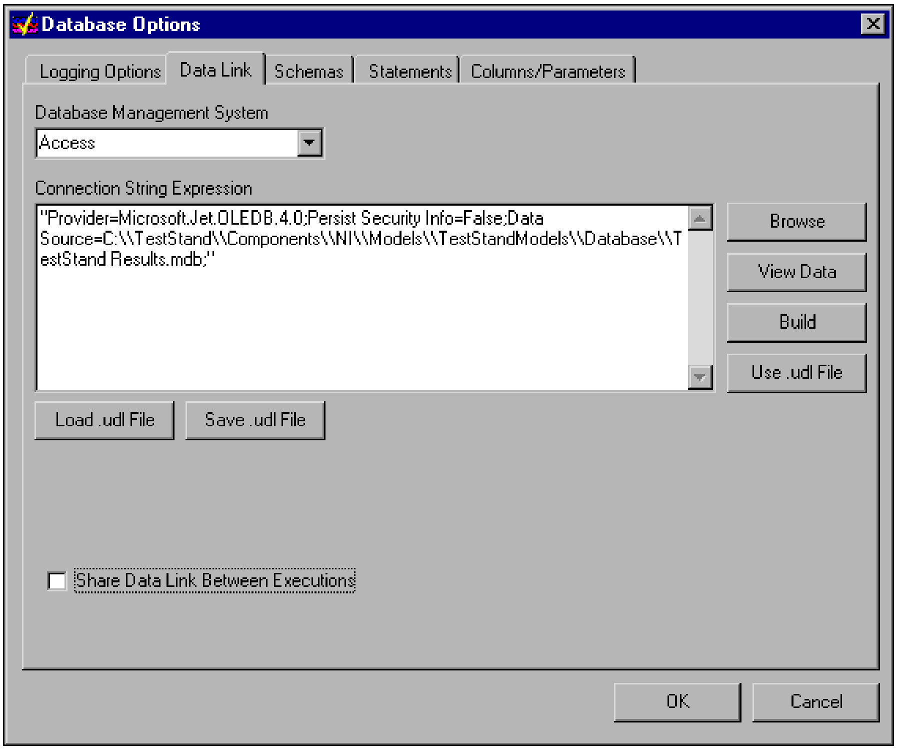
The Logging Options tab contains the following controls:

- **Disable Database Logging**—Enable this option if you do not want TestStand to log data to a database.
- **Include Execution Times**—Enable this option if you want to log the time that each step module takes to execute. This is the time that the subsequence, LabVIEW VI, or C function takes to execute.
- **Include Step Results**—Enable this option if you want to log the results of each step. Disable this option if you want to include only information on each UUT that you test. Refer to the *TestStand Database Result Tables* section later in this chapter for more information on what UUT information TestStand logs to the database.

- **Include Measurements**—Enable this option if you want to log the measurement values that steps acquire. The default schemas recognizes specific step properties as containing values to log. These include properties such as `Result.Numeric`, `Result.String`, and `Result.Measurement`. For the Numeric Limit Test built-in step type, `Result.Numeric` contains the numeric measurement the step acquires. For the String Value Test built-in step type, `Result.String` contains the measurement value the step returns in string form. For the Multiple Numeric Limit step type, `Result.Measurement[].Data` contains the numeric measurements the step acquires.
- **Include Test Limits**—Enable this option if you want to log values that step types use as test limits. The default schemas recognize specific step properties as containing test limits. These properties include `Limit.Low`, `Limit.High`, `Limit.String`, and `Comp`. The Numeric Limit Test compares the measurement value it acquires against `Limit.Low`, `Limit.High`, or both, and uses `Comp` to select the type of comparison to make. The String Value Test compares the string it acquires against `Limit.String` and uses `Comp` to indicate whether to ignore the case in the comparison.
- **Result Filtering Expression**—Specifies which step results appear in the database. You do so by specifying an expression that the database logger evaluates for each step result. The database logger includes the step in the database if the expression evaluates to `True`. You can use any subproperty in the `Result` property of the step, but you must use `Logging.StepResult` in place of `Step.Result`. For example, if you want to include only failing steps in the database, set the expression to `Logging.StepResult.Status == "Failed"`. You can use the menu ring to the right of the control to select predefined expressions for all steps, only failing steps, or only passing steps. You can open the Expression Browser to build the expression by selecting the **Browse** button.

Data Link Tab

The Data Link tab specifies the data link information that the process model requires to connect to a database and to log data. Figure 18-3 shows the Data Link tab of the Database Options dialog box.



"Provider=Microsoft.Jet.OLEDB.4.0;Persist Security Info=False;Data Source=C:\\TestStand\\Components\\NI\\Models\\TestStandModels\\Database\\TestStand Results.mdb;"

Figure 18-3. Database Options Dialog Box—Data Link Tab

The Data Link tab contains the following controls:

- **Database Management System**—Specifies the name of the DBMS to which you want to log data. Because of the different requirements of each DBMS, TestStand might log data to each DBMS differently. TestStand supports Oracle, Microsoft Access, and Microsoft SQL Server by default. You can use the menu ring to the right of the control to select one of these names. Refer to the *Adding Support for Other Database Management Systems* section later in this chapter for more information. Currently, the default TestStand schemas do not reference the value specified by this control.
- **Connection String Expression**—Specifies the connection string expression that TestStand uses to open a data source to log results to. The Connection String control requires a string expression, that the TestStand process model evaluates at run time. The expression can be a literal value or a string you build using variables or properties. If the value is a string literal, you must encapsulate the string value with quotes (`""`).

You can update the contents of the Connection String control in any of the following ways:

- **Browse**—Edits a connection string expression in an Expression Browser dialog box.
- **View**—Launches the Database Viewer application and opens the connection string within the viewer. Refer to the *Database Viewer* section in this chapter for more information on using the Database Viewer application.
- **Build**—Allows you to construct the connection string using the Data Link Properties dialog box. Refer to the *Data Link Properties Dialog Box* section later in this chapter for more information.
- **Use .udl File**—Allows you to select a Microsoft Data Link (`.udl`) filename as the connection string. The text in the data link file specifies the connection string. When you select a Microsoft Data Link file, TestStand updates the Connection String control with the name of the file, as in the following example:

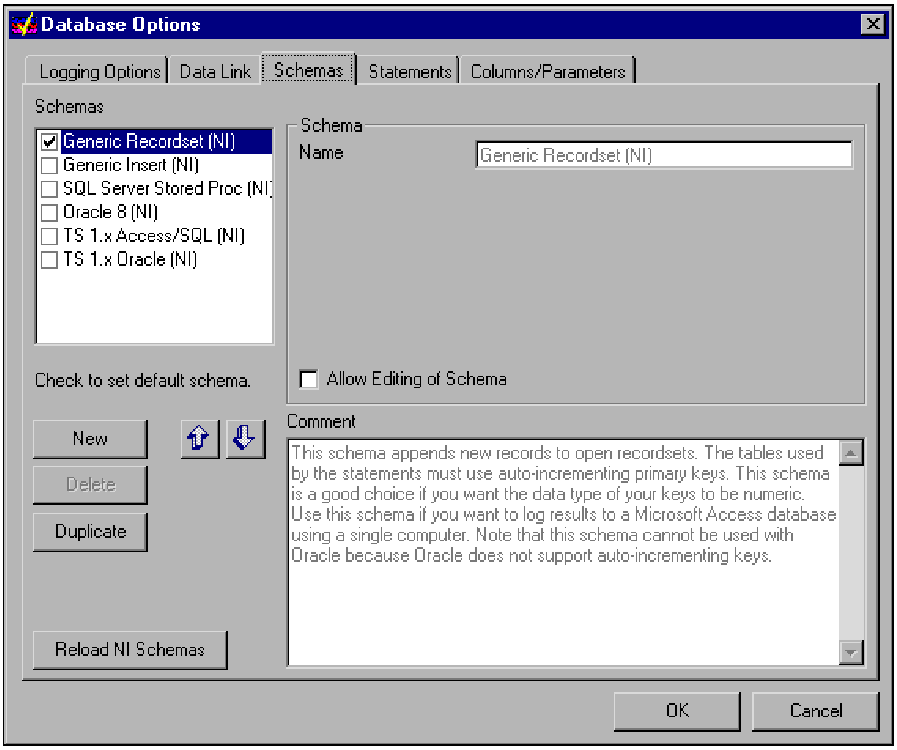
  "FILE NAME=C:\\Program Files\\Common Files\\System\\
  OLE DB\\Data Links\\Access.udl"

• **Load .udl File**—Allows you to select a Microsoft Data Link (`.udl`) filename and import the connection string from the file to the control.

• **Save .udl File**—Allows you to specify a Microsoft Data Link (`.udl`) filename and export the connection string from the control to the file.

Schemas Tab

The Schemas tab specifies the database schemas available and the default schema that the TestStand process model uses. A schema defines how TestStand logs results to a database. A schema consists of a list of statements and each statement consists of a list of columns. Figure 18-4 shows the Schemas tab of the Database Options dialog box.



Schemas

- [✓] Generic Recordset (NI)
- [ ] Generic Insert (NI)
- [ ] SQL Server Stored Proc (NI)
- [ ] Oracle 8 (NI)
- [ ] TS 1.x Access/SQL (NI)
- [ ] TS 1.x Oracle (NI)

Check to set default schema.

Schema

Name: Generic Recordset (NI)

[ ] Allow Editing of Schema

Comment

This schema appends new records to open recordsets. The tables used by the statements must use auto-incrementing primary keys. This schema is a good choice if you want the data type of your keys to be numeric. Use this schema if you want to log results to a Microsoft Access database using a single computer. Note that this schema cannot be used with Oracle because Oracle does not support auto-incrementing keys.

Figure 18-4. Database Options Dialog Box—Schemas Tab

The Schemas tab contains the following controls:

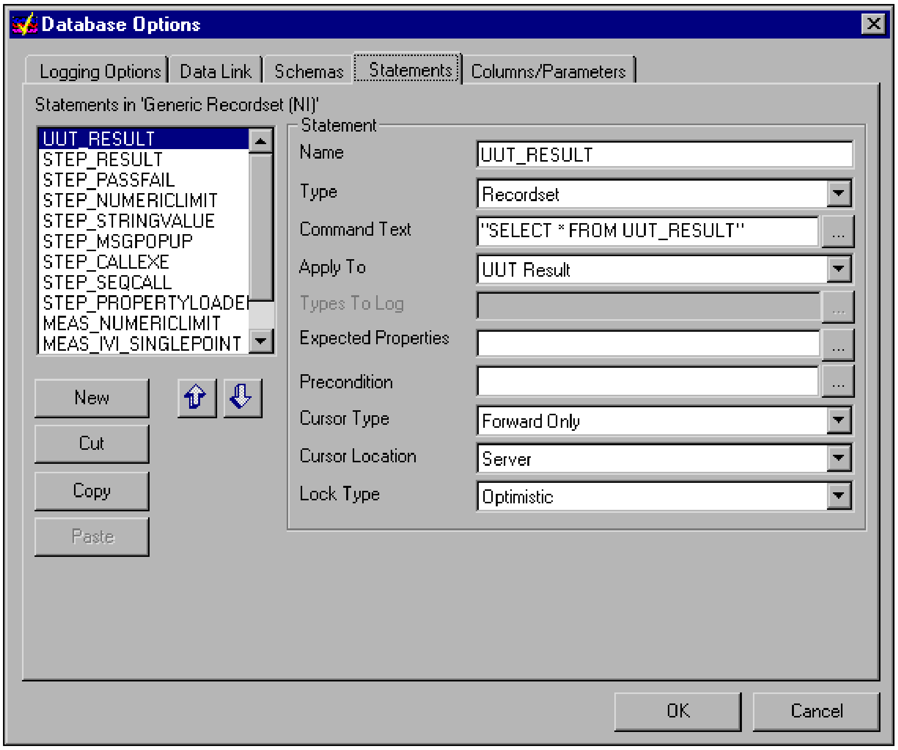
- **Schemas**—Contains a list of schemas. When you select a schema, the Schema section displays the settings for the selected item. You can specify the default schema that the TestStand process model uses by enabling the checkbox for the selected schema.

  You can use the **Duplicate** and **Delete** buttons to copy and delete items from the list. You can use the up and down arrow buttons to control the order of the items in the list.
- **Reload NI Schemas**—Reloads all the default NI schemas that TestStand installs.
- **Name**—Specifies the name of the schema.
- **Allow Editing of Schema**—Enables controls that edit the schema.

Note To ensure that the installers for newer versions of TestStand do not overwrite your schema customizations, use the **Duplicate** button to copy an NI schema. Make your changes to the new copy of the schema and enable the checkbox next to the new schema to make it the default.

Statements Tab

The Statements tab defines the data that TestStand logs. Statements define the type of results the schema operates on and the conditions that must be true before TestStand logs the results. Statements also define the database action to perform. In addition, statements specify what database columns or parameters to log and the TestStand expressions to evaluate to determine the column or parameter values. Figure shows the Statements tab of the Database Options dialog box.



Statements in 'Generic Recordset (NI)'

UUT_RESULT
STEP_RESULT
STEP_PASSFAIL
STEP_NUMERICLIMIT
STEP_STRINGVALUE
STEP_MSGPOPUP
STEP_CALLEXE
STEP_SEQCALL
STEP_PROPERTYLOADEI
MEAS_NUMERICLIMIT
MEAS_IVI_SINGLEPOINT

Statement

Name	UUT_RESULT
Type	Recordset
Command Text	"SELECT * FROM UUT_RESULT"
Apply To	UUT Result
Types To Log	
Expected Properties	
Precondition	
Cursor Type	Forward Only
Cursor Location	Server
Lock Type	Optimistic

Figure 18-5. Database Options Dialog Box—Statements Tab

The Statements tab contains the following controls:

- **Statements**—Contains a list of statements for the schema specified on the Schemas tab. When you select a statement, the Statement section displays the settings for the selected item.

You can use the **New**, **Cut**, **Copy** and **Paste** buttons to edit the contents of the list control. You can use the up and down arrow buttons to control the order of the items in the list.

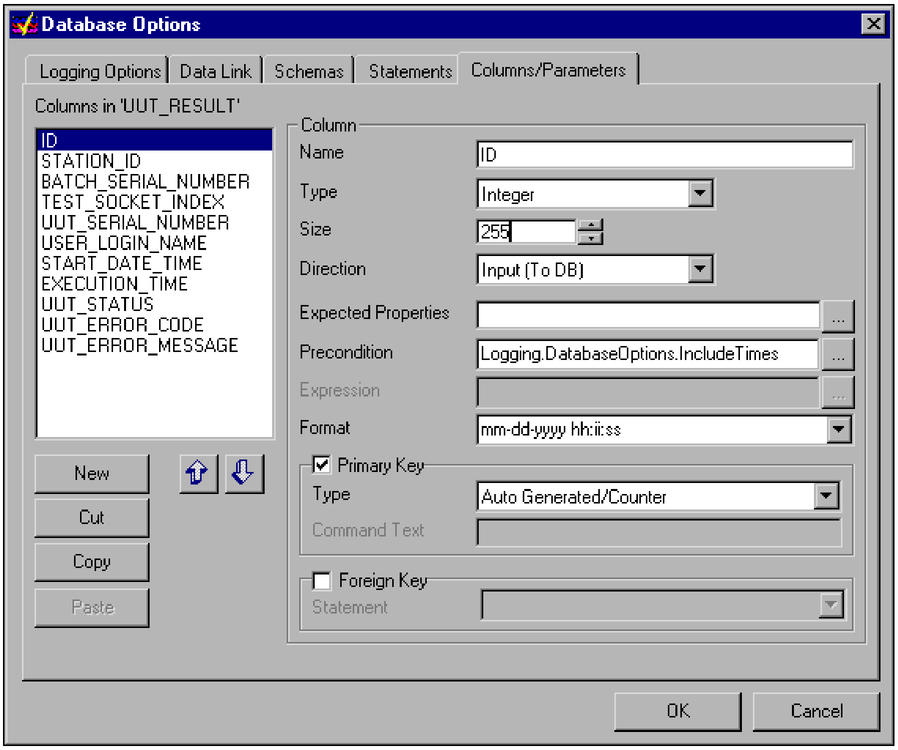
- **Name**—Edits the name of the statement. Typically, the statement name has the same name as the database table to which it logs data.
- **Type**—Specifies the type of statement. You can select one of the following options:
  - **Recordset**—Specifies that the statement returns a recordset. For the columns defined on the Columns tab, TestStand inserts a new record into the recordset. You would typically use an SQL `SELECT` command that returns a recordset with this option.
  - **Command**—Specifies that TestStand executes a command for each result that applies to the statement. For each column defined on the Columns tab, TestStand creates a parameter. This type of statement is called a parameterized statement. For input parameters, TestStand assigns the column value to the parameter before executing the statement. For output parameters, TestStand retrieves the parameter value after executing the statement. You would typically usa an SQL `INSERT` command that contains the question mark "?" keyword to specify the parameters.
  - **Stored Procedure—**Specifies that TestStand executes a stored procedure for each result that applies to the statement. For each column defined on the Columns tab, TestStand creates a parameter. For input parameters, TestStand assigns the column value to the parameter before executing the statement. For output parameters, TestStand retrieves the parameter value after executing the statement. Stored procedures also can return a value in addition to output parameters.
- **Command Text**—Specifies the text of a command that the statement issues against the data link. This is typically an SQL `SELECT` or SQL `INSERT` statement, but it can be any type of command statement that the database provider recognizes, including stored procedure calls.
- **Apply To**—Specifies the class of results on which the statement operates. You can choose one of the following options from the ring control:
  - **UUT Result**—TestStand applies the statement once per UUT.
  - **Step Result**—TestStand applies the statement to each step result.
  - **Step Result Subproperty**—TestStand applies the statement to each subproperty of a step result.

- **Types to Log**—Specifies the data types of results for which the statement applies. For step results, the type must be the name of a TestStand step type. For step result subproperties, the type must be the name of a TestStand data type. This option does not apply to a UUT Result. Leave the control empty to instruct TestStand to not require any type matching.
- **Expected Properties**—Specifies the properties that must exist before TestStand applies the statement to a particular result. Leave the control empty to instruct TestStand not to require any expected properties.
- **Precondition**—Specifies an expression that must evaluate to True before TestStand applies the statement to a particular result. Leave the control empty to instruct TestStand to not apply a precondition.
- **Cursor Type**—Specifies the type of server or client cursor for the statement. You can choose one of the following options from the ring control:
  - **Unspecified**—Do not specify a cursor type.
  - **Dynamic**—Additions, changes, and deletions by other users are visible, and all types of movement through the set of records are allowed.
  - **Static**—Additions, changes, and deletions by other users are not visible.
  - **Forward Only**—Identical to a static cursor except that you can only scroll forward through records. This option improves performance when you want to make a single pass through a set of records.
  - **Keyset**—Similar to dynamic cursor, except that you cannot see records that other users add. Records that other users delete are inaccessible from your set of records. Data changes by other users within records are visible.
- **Cursor Location**—Specifies where the data source maintains cursors for a connection. You can choose one of the following options from the ring control:
  - **Server**—Uses cursors the data provider supplies. These cursors are sometimes very flexible and allow for additional sensitivity to reflect changes that other users make to the actual data.
  - **Client**—Uses client-side cursors that a local cursor library supplies. Local cursor engines often allow many features that driver supplied cursors do not.

- **Lock Type**—Specifies when the data source locks a record. You can choose one of the following options from the ring control.
  - **Unspecified**—Do not specify a lock type.
  - **Read Only**—You cannot alter the data in a record.
  - **Pessimistic**—The provider does what is necessary to ensure successful editing of the records, usually by locking records at the data source immediately upon editing.
  - **Optimistic**—The provider locks records only when you send the data back to the database.
  - **Batch Optimistic**—Required for batch updates.

Columns/Parameters Tab

The Columns/Parameters tab specifies the columns or parameters that TestStand logs for each result for which the statement applies. For recordset statements, TestStand expects the recordset to return the specified column names, and the order of the columns in the list control is arbitrary. For command statements, TestStand creates a parameter for each item in the list. Depending on whether the parameter is an input or an output operation, TestStand will set or get the value, respectively. The name of the parameter is arbitrary, but the parameter list order must match the required parameters for the statement. Figure 18-6 shows the Column/Parameters tab of the Database Options dialog box.



Database Options

Logging Options | Data Link | Schemas | Statements | Columns/Parameters

Columns in 'UUT_RESULT'

ID
STATION_ID
BATCH_SERIAL_NUMBER
TEST_SOCKET_INDEX
UUT_SERIAL_NUMBER
USER_LOGIN_NAME
START_DATE_TIME
EXECUTION_TIME
UUT_STATUS
UUT_ERROR_CODE
UUT_ERROR_MESSAGE

Column
Name: ID
Type: Integer
Size: 255
Direction: Input (To DB)
Expected Properties:
Precondition: Logging.DatabaseOptions.IncludeTimes
Expression:
Format: mm-dd-yyyy hh:ii:ss
[✓] Primary Key
Type: Auto Generated/Counter
Command Text:
[ ] Foreign Key
Statement:

Figure 18-6. Database Options Dialog Box—Columns/Parameters Tab

The Columns/Parameters tab contains the following controls:

- **Columns/Parameters**—Contains a list of columns or parameters for the statement specified on the Statements tab. When you select a column or parameter, the Column/Parameter section displays the settings for the selected item. For parameterized statements, the order of the parameters in the list must correspond to the required parameters for the statement.

  You can use the **New**, **Cut**, **Copy**, and **Paste** buttons to edit the elements of the list control. You can use the up and down arrow buttons to control the order of the items in the list.

- **Name**—Edits the name of the column or parameter. For recordset statements, the name must match a column in the returned recordset. For parameterized statements, the name is arbitrary.

- **Type**—Specifies the data type of the column or parameter value. You can choose one of the following options from the ring control: Small Integer, Integer, Float, Double Precision, String, Boolean, Binary, or Date/Time, GUID.
- **Size**—Specifies the maximum number of bytes that TestStand writes to or reads from a column or parameter. If the column does not have a size limitation, you can specify 0 to instruct TestStand to write or read the entire value.
- **Direction**—Specifies whether the column or parameter is an input or output value. You can select one of the following options:
  - **Input**—Indicates that TestStand writes the column value or parameter to the database.
  - **Output**—Indicates that TestStand retrieves the column value or parameter from the database.
  - **Input/Output**—Indicates that TestStand writes and retrieves the column value or parameter.
  - **Return Value**—Indicates that TestStand retrieves the parameter value as a return value from the database.
- **Expected Properties**—Specifies the properties that must exist before TestStand assigns or retrieves a value for the column or parameter. Leave the control empty to instruct TestStand to not require any expected properties.
- **Precondition**—Specifies an expression that must evaluate to True before TestStand assigns or retrieves a value for the column or parameter. Leave the control empty to instruct TestStand to not apply a precondition.
- **Expression**—Specifies an expression that the column or parameter evaluates to obtain the input value to log or the variable property location to store the output value retrieved.
- **Format**—Specifies how to convert a string value when assigning a string to a column. You usually use this control when writing to a column of type Date/Time or Currency. Refer to the *Format Strings* section in this chapter for more information.

- **Primary Key**—Enable this control to specify that the database column is a primary key. The values in a primary key column must be unique.
  - **Type**—Specifies how TestStand obtains a unique primary key value to assign to a new record. You can choose one of the following options from the ring control:
    - **Auto Generated/Counter**—TestStand requests the value that the database assigns to the new record.
    - **Store GUID Value**—TestStand generates a unique string value. The database column type must be GUID or String and must be at least 36 bytes for string.
    - **Get Value from Statement**—TestStand obtains the value from the statement you specify.
  - **Command Text**—Specifies the text of a command that the statement issues against the data link to obtain the primary key value. You use this control only when you select Get Value from Statement in the type ring. The statement must return the value in a recordset that contains a single column with one record.
- **Foreign Key**—Enable this control to specify that the database column is a foreign key. A foreign key is a column that references a primary key in a table.
  - **Statement**—Select the statement that contains the primary key column in which the foreign key references. TestStand automatically assigns the primary key value to the column or parameter.

Logging Property in the Sequence Context

When the database logger starts, it creates a temporary property name `Logging` in the sequence context in which the database logger evaluates expressions. The `Logging` property contains subproperties that provide information about database settings, process model data structures, and the results that the logger processes. As logging processes the result list, the logger updates subproperties of `Logging` to refer to the UUT result, step result, and the step result subproperty the logger is processing. You can reference the Logging subproperties in the precondition and value expressions that you specify for statements and column values. Figure 18-7 shows the subproperties for the `Logging` property.

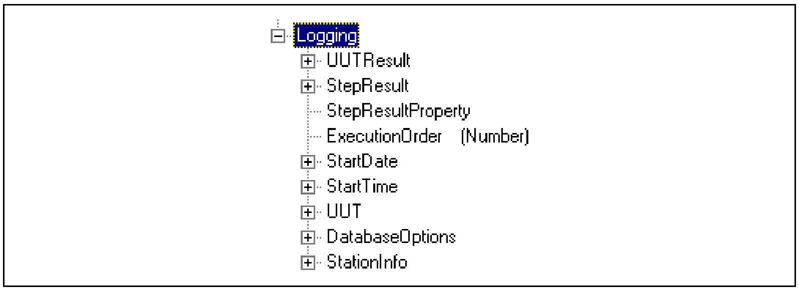


Figure 18-7. Subproperties of the Logging Property

The following describes each subproperty of the Logging property.

- `UUTResult`—Contains the UUT result that the logger is processing. If the logger is processing a step or a subproperty, this property holds the UUT result that contains the step result or subproperty.
- `StepResult`—Contains the step result that the logger is processing. If the logger is processing a subproperty, this property holds the step result that contains the subproperty. If the logger is processing a UUT result, this property contains the result of the sequence call in the process model that calls the MainSequence in the client file.
- `StepResultProperty`—Contains the subproperty of the step result that the logger is processing. If the logger is not processing a subproperty, this property does not exist.
- `ExecutionOrder`—Contains a numeric value that the logger increments after it processes each step result.
- `StartDate`—Specifies the date on which the UUT test began. This property is an instance of the DateDetails custom data type.
- `StartTime`—Specifies the time at which the UUT test began. This property is an instance of the TimeDetails custom data type.
- `UUT`—Specifies the serial number, test socket index, and other information about the unit under test. This property is an instance of the UUT custom data type.
- `DatabaseOptions`—Contains the process model database settings you configure in the Database Options dialog box. This property is an instance of the DatabaseOptions custom data type.
- `StationInfo`—Specifies the station ID and the login name. This property is an instance of the StationInfo custom data type.

The TestStand process model files define the structure of the DatabaseOptions, DateDetails, TimeDetails, UUT, and StationInfo custom data types that the logging properties use.

TestStand Database Result Tables

This section describes the default table schemas that TestStand uses. This section also outlines how to modify existing schemas or create new schemas.

Default TestStand Table Schema

The default TestStand database schema require the following tables in your database:

- UUT_RESULT
- STEP_RESULT
- STEP_SEQCALL
- STEP_PASSFAIL
- STEP_CALLEXE
- STEP_MSGPOPUP
- STEP_PROPERTYLOADER
- STEP_STRINGVALUE
- MEAS_NUMERICLIMIT
- MEAS_IVI_WAVE
- MEAS_IVI_WAVEPAIR
- MEAS_IVI_SINGLEPOINT

The UUT_RESULT table contains information on each UUT that TestStand tests. The STEP_RESULT table contains information on each step that TestStand executes while testing each UUT. The other table names with the prefix “STEP” contain information for each specific step type. The table names with the prefix “MEAS” contain information on sub results that TestStand logs for a step type.

Each table contains a primary key column ID. The data type of the column is Number, String, or GUID, depending on the selected schema. Each table might contain foreign key columns. The data types of the columns must match the primary key that the data types reference.

Table 18-2 lists the name, data type, and description of each column in the UUT_RESULT table.

Table 18-2. UUT_RESULT Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table. For Access and SQL Server, the default process model assumes that this column increments automatically. For Oracle, the default process model uses an Oracle SQL sequence to generate a unique number.
`STATION_ID`	String	Station ID, usually the computer name.
`BATCH_SERIAL_NUMBER`	String	Serial number of the Batch. Only applies to executions that use the batch process model.
`TEST_SOCKET_INDEX`	Number	Test socket for the UUT. Only applies to executions that use the parallel or batch process models.
`UUT_SERIAL_NUMBER`	String	Serial number of the UUT.
`USER_LOGIN_NAME`	String	Login name of the user who tested the UUT.
`START_DATE_TIME`	Date-time	Time and date at which the UUT test began executing.
`EXECUTION_TIME`	Number	Number of seconds the UUT test took to execute.
`UUT_STATUS`	String	Status of the UUT test.
`UUT_ERROR_CODE`	Number	Error code, if the UUT test status is `Error`.
`UUT_ERROR_MESSAGE`	String	Error message, if the UUT test status is `Error`.

Table 18-3 lists the name, data type, and description of each column in the STEP_RESULT table.

Table 18-3. STEP_RESULT Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table. For Access and SQL Server, the default process model assumes that this column increments automatically. For Oracle, the default process model uses an Oracle SQL sequence to generate a unique number.
`UUT_RESULT`	Foreign Key	UUT ID from the UUT_RESULT table that associates the step result with a UUT.

Table 18-3. STEP_RESULT Table Schema (Continued)

Column Name	Data Type	Description
`STEP_PARENT`	Foreign Key	ID of the parent sequence call step result, if the step is a step in a subsequence.
`STEP_NAME`	String	Name of the step.
`STEP_TYPE`	String	Name of the step type.
`STATUS`	String	Status of the step.
`REPORT_TEXT`	String	Report text of the step.
`ERROR_CODE`	Number	Error code, if the step status is `Error`.
`ERROR_MESSAGE`	String	Error message, if the step status is `Error`.
`MODULE_TIME`	Number	Number of seconds the step module took to execute.
`TOTAL_TIME`	Number	Number of seconds the step took to execute, including module execution and all step options, such as preconditions, expressions, post-actions, and module loading.
`NUM_LOOPS`	Number	Number of loops the step executed, if any.
`NUM_PASSED`	Number	Number of loops the step returned a status of `Passed`, if any.
`NUM_FAILED`	Number	Number of loops the step returned a status of `Failed`, if any.
`ENDING_LOOP_INDEX`	Number	The loop index after executing the ending loop.
`LOOP_INDEX`	Number	The value of the loop index for an iteration of the step.
`INTERACTIVE_EXENUM`	Number	Number that TestStand assigns to an interactive execution. The number is unique with respect to all other interactive executions in the current TestStand session. TestStand adds this property only if you run the step interactively.
`STEP_GROUP`	String	Step group that contains the step. The value is `"Main"`, `"Setup"`, or `"Cleanup"`.
`STEP_INDEX`	Number	Zero-based position of the step in the step group.
`ORDER_NUMBER`	Number	The order in which the step executed within the execution.

Table 18-4 lists the name, data type, and description of each column in the STEP_CALLEXE table. The default TestStand schemas log subproperties of the Call Executable step into this table.

Table 18-4. STEP_CALLEXE Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table.
`STEP_RESULT`	Foreign Key	Step ID from the STEP_RESULT table that associates the result with a step.
`EXIT_CODE`	Number	The exit code of the executable.

Table 18-5 lists the name, data type, and description of each column in the STEP_MSGPOPUP table. The default TestStand schemas log subproperties of the Message Popup step into this table.

Table 18-5. STEP_MSGPOPUP Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table.
`STEP_RESULT`	Foreign Key	Step ID from the STEP_RESULT table that associates the result with a step.
`BUTTON_PRESSED`	Number	The button that was pressed.
`RESPONSE`	String	The response, if one exists.

Table 18-6 lists the name, data type, and description of each column in the STEP_PASSFAIL table. The default TestStand schema logs subproperties of the Pass/Fail Test step into this table.

Table 18-6. STEP_PASSFAIL Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table.
`STEP_RESULT`	Foreign Key	Step ID from the STEP_RESULT table that associates the result with a step.
`PASS_FAIL`	Boolean	If the step is a Pass/Fail step, whether the step passed or failed.

Table 18-7 lists the name, data type, and description of each column in the STEP_STRINGVALUE table. The default TestStand schema logs subproperties of the String Value Test step into this table.

Table 18-7. STEP_STRINGVALUE Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table.
`STEP_RESULT`	Foreign Key	Step ID from the STEP_RESULT table that associates the result with a step.
`STRING_VALUE`	String	The value of the string that the module returned.
`STRING_LIMIT`	String	The string against which TestStand compares the string that the module returns.

Table 18-8 lists the name, data type, and description of each column in the STEP_PROPERTYLOADER table. The default TestStand schema logs subproperties of the Property Loader step into this table.

Table 18-8. STEP_PROPERTYLOADER Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table.
`STEP_RESULT`	Foreign Key	Step ID from the STEP_RESULT table that associates the result with a step.
`NUM_PROP_READ`	Number	The number of property or variable values read from the file or database.
`NUM_PROP_APPLIED`	Number	The number of property or variable values applied from the file or database to the sequence file.

Table 18-9 lists the name, data type, and description of each column in the STEP_SEQCALL table. The default TestStand schema logs subproperties of the Sequence Call step into this table.

Table 18-9. STEP_SEQCALL Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table.
`STEP_RESULT`	Foreign Key	Step ID from the STEP_RESULT table that associates the result with a step.
`SEQUENCE_NAME`	String	The name of the sequence that was called.
`SEQUENCE_FILE_PATH`	String	The path to the sequence file.

Table 18-10 lists the name, data type, and description of each column in the MEAS_NUMERICLIMIT table. The default TestStand schema logs the measurements of the Numeric Limit Test step and the Multiple Numeric Limit Test step into this table.

Table 18-10. MEAS_NUMERICLIMIT Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table.
`STEP_RESULT`	Foreign Key	Step ID from the STEP_RESULT table that associates the result with a step.
`NAME`	String	The name of the measurement.
`COMP_OPERATOR`	String	The comparison operator for the step.
`HIGH_LIMIT`	Number	The high limit for the step comparison.
`LOW_LIMIT`	Number	The low limit for the step comparison.
`UNITS`	String	A label that describes the units for the measurement.
`DATA`	Number	The value of the numeric measurement that the module returned.
`STATUS`	String	The status of the numeric limit comparison.

Table 18-11 lists the name, data type, and description of each column in the MEAS_SINGLEPOINT table. The default TestStand schema logs the measurements of the IVI steps into this table.

Table 18-11. MEAS_SINGLEPOINT Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table.
`STEP_RESULT`	Foreign Key	Step ID from the STEP_RESULT table that associates the result with a step.
`TYPE`	Number	The type of measurement.
`CHANNEL`	String	The channel name for the measurement.
`DATA`	Number	The value of the numeric measurement that the module returned.

Table 18-12 lists the name, data type, and description of each column in the MEAS_WAVE table. The default TestStand schema logs the measurements of the IVI steps into this table.

Table 18-12. MEAS_WAVE Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table.
`STEP_RESULT`	Foreign Key	Step ID from the STEP_RESULT table that associates the result with a step.
`TYPE`	Number	The type of measurement.
`CHANNEL`	String	The channel for the step comparison.
`INITIALX`	Number	The offset to the first point in the waveform.
`DELTAX`	Number	The offset between the points in the waveform.
`DATA`	Binary	The waveform for the numeric measurement that the module returned.

Table 18-13 lists the name, data type, and description of each column in the MEAS_WAVEPAIR table. The default TestStand schema logs the measurements of the IVI steps into this table.

Table 18-13. MEAS_WAVEPAIR Table Schema

Column Name	Data Type	Description
`ID`	Primary Key	Unique value that identifies each entry in the table.
`STEP_RESULT`	Foreign Key	Step ID from the STEP_RESULT table that associates the result with a step.
`TYPE`	Number	The type of measurement.
`CHANNEL`	String	The channel name for the measurement.
`INITIALX`	Number	The offset to the first point in the waveforms.
`DELTAX`	Number	The offset between the points in the waveforms.
`DATA0`	Binary	The first waveform for the numeric measurement that the module returned.
`DATA1`	Binary	The second waveform for the numeric measurement that the module returned.

The default TestStand database schemas assume that result tables conform to the above table definitions. If you want to modify the table schema, you must alter the tables in your database and create a new schema using the Database Options dialog box. Refer to the *Database Options Dialog Box* section for more information on using the Database Options dialog box.

Creating the Default Result Tables

The TestStand logging feature requires that you create the database tables in a database for your DBMS. TestStand includes the Database Viewer application for viewing data in a database table, editing table information, and executing SQL commands. You can use Database Viewer to create the default result tables that the schema requires. To use the Database Viewer application, you must have previously set up the DBMS server and any required DBMS client software.

TestStand comes with SQL script files for creating and deleting database tables that the default schemas require. TestStand installs these script files in the `<TestStand>\Components\NI\Model\TestStandModel\Database` directory. For example, the `Access Generic Recordset Create Result Tables.sql` file contains SQL commands to create the default tables for Access. The `Access Drop Result Tables.sql` file contains SQL commands to delete the default tables.

For more information on creating the default database tables using a SQL script file, refer to the *Database Viewer* section later in this chapter. Refer to the *TestStand Database Result Tables* section earlier in this chapter for more information on the default schemas. Refer to the *Using Data Links* section later in this chapter for more information on configuring your system to access your DBMS.

Adding Support for Other Database Management Systems

By default, TestStand supports Oracle, Microsoft SQL Server, and Microsoft Access. TestStand supports these DBMS in the following ways:

- TestStand includes schemas for each DBMS, and each schema conforms to the default database tables. You can review the default schemas in the Database Options dialog box.
- You can create result tables for the default table schema for each DBMS by using the SQL script files located in the `<TestStand>\Components\NI\Model\TestStandModel\Database` directory.

If you want to add support for another DBMS, you must create a new schema in the Database Options dialog box. You can use the **Duplicate** button on the Schemas tab to copy an existing schema and then customize its statements and column and parameter settings to work with the new DBMS.

You also can create new script files for your new DBMS by completing the following steps:

1. Create new script files in the `<TestStand>\Components\User\Model\TestStandModel\Database` directory. It is a good idea to include the name of the DBMS in the filename.
2. Enter the SQL commands for creating and deleting your DBMS tables to the new script files. Refer to any of the SQL database syntax files that TestStand provides for an example.

   For example, the SQL database syntax file for Oracle result tables might contain the following commands:

```
CREATE TABLE UUT_RESULT
(
   ID                   NUMBER       PRIMARY KEY,
   UUT_SERIAL_NUMBER    CHAR (255),
   USER_LOGIN_NAME      CHAR (255),
    START_DATE_TIME      DATE,
    EXECUTION_TIME       NUMBER,
    UUT_STATUS           CHAR (255),
    UUT_ERROR_CODE       NUMBER,
    UUT_ERROR_MESSAGE    CHAR (255)
)
/
CREATE SEQUENCE SEQ_UUT_RESULT START WITH 1
/
CREATE FUNCTION UUT_RESULT_NEXT_ID RETURN NUMBER IS
    X NUMBER;
BEGIN
    SELECT SEQ_UUT_RESULT.NextVal INTO X FROM DUAL;
    RETURN X;
END;
/
```

Notice that TestStand uses three separate commands, each separated by the '/' character, to create the UUT RESULT table in Oracle.

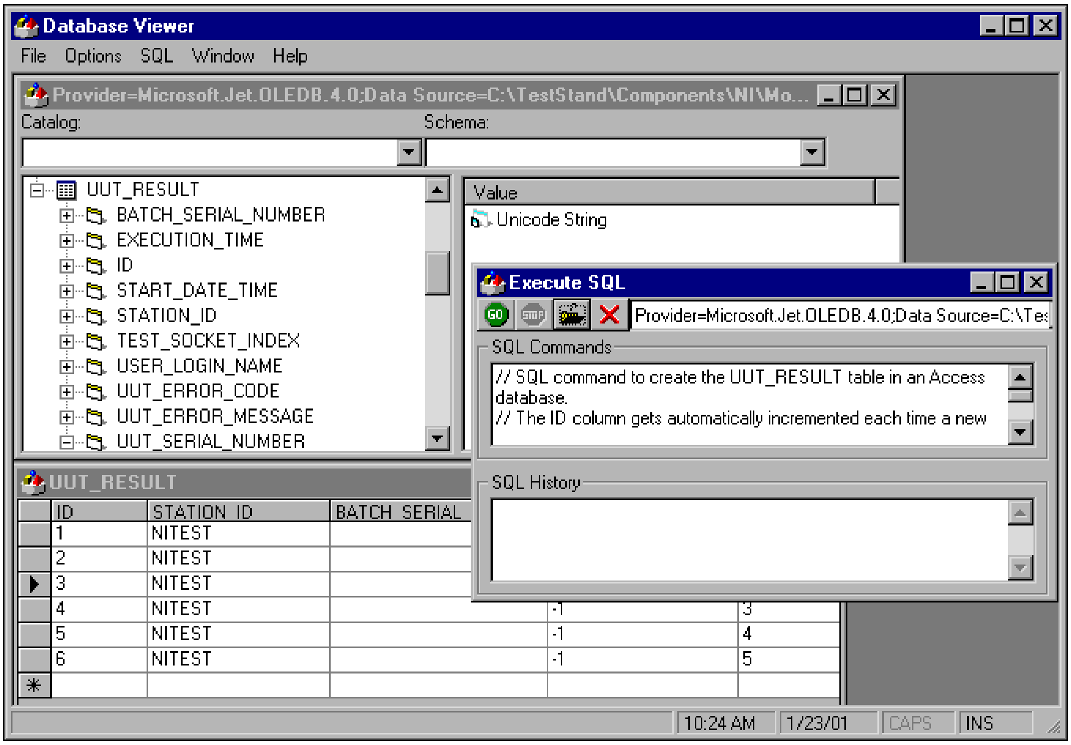
You use a similar syntax for deleting tables. For example, the SQL script file for Oracle might contain the following commands for deleting result tables:

```
DROP TABLE STEP_RESULT
/
DROP SEQUENCE SEQ_STEP_RESULT
/
DROP FUNCTION STEP_RESULT_NEXT_ID
/
```

Database Viewer

TestStand includes the Database Viewer application for viewing data in a database, editing table information, and executing SQL commands. The Database Viewer application, `DatabaseView.exe`, is located in the following directory: `<TestStand>\Components\NI\Tools\DatabaseView`.

Figure 18-8 shows the Database Viewer main window.



Database Viewer

File Options SQL Window Help

Provider=Microsoft.Jet.OLEDB.4.0;Data Source=C:\TestStand\Components\NI\Mo...

Catalog: Schema:

- UUT_RESULT
  - BATCH_SERIAL_NUMBER
  - EXECUTION_TIME
  - ID
  - START_DATE_TIME
  - STATION_ID
  - TEST_SOCKET_INDEX
  - USER_LOGIN_NAME
  - UUT_ERROR_CODE
  - UUT_ERROR_MESSAGE
  - UUT_SERIAL_NUMBER

Value
Unicode String

Execute SQL

Provider=Microsoft.Jet.OLEDB.4.0;Data Source=C:\Tes

SQL Commands

```
// SQL command to create the UUT_RESULT table in an Access
database.
// The ID column gets automatically incremented each time a new
```

SQL History

UUT_RESULT

ID	STATION_ID	BATCH_SERIAL		
1	NITEST			
2	NITEST			
3	NITEST			
4	NITEST		-1	3
5	NITEST		-1	4
6	NITEST		-1	5

10:24 AM 1/23/01 CAPS INS

Figure 18-8. Database Viewer Main Window

The Database Viewer displays the following three types of windows:

- **Data Link Window**—Contains a tree view of the tables that are defined for the data link. The list view displays the contents of the currently selected node in the tree view. The Catalog control lists the available catalogs defined by the DBMS. The Schema control lists the available schemas defined by the DBMS.

  You can display a context menu by right-clicking on the window. The items in the context menu vary depending on whether you right-click on a node in the tree view, on an entry in the list view, or on the background area. The context menu can contain the following items:

  – **View Data**—Opens in the Database Viewer a new Data View window with the contents of the table. You can access this command on a table node in the tree view of the Data Link window.

  – **Add Table**—Creates a new table in the DBMS.

  - **Drop Table**—Deletes a table from the DBMS.
  - **Add Column**—Adds a new column to a table.
  - **Drop Column**—Deletes a column from a table.
- **Execute SQL Window**—Contains a SQL Commands control and a SQL History control. You can enter SQL commands in the SQL Commands control and execute its contents by selecting the Go icon button. You can load SQL script files by clicking on the Open File icon button. Use the Clear icon button to delete the contents from the SQL Commands control.
- **Data View Window**—Contains a grid display of the data returned from a SQL command. Database Viewer automatically opens a new Data View window when you use the View Data context menu command on a table node in the tree view of the Data Link window or when you issue a SQL command that returns a recordset.

The status bar at the bottom of the main window displays the status for executing commands.

Menus

The Database Viewer menu bar contains commands that apply to all windows and commands that apply to specific windows. This section contains descriptions of the menu items in the menu bar.

File Menu

The **File** menu contains the following commands:

- **Open**—Opens a database file such as a Microsoft Access database file (`.mdb`) or opens a data link by selecting a Microsoft Data Link (`.udl`) filename.
- **New Data Link**—Opens a data link by constructing a connection string using the Data Link Properties dialog box. Refer to the *Data Link Properties Dialog Box* section later in this chapter for more information.
- **New Execute SQL Window**—Opens an Execute SQL window. This command is available only after you open a data link.
- **Close**—Closes an open window.
- **Exit**—Closes the current viewer session. The application closes all open windows automatically.

Just below the **Exit** command on the **File** menu, TestStand provides a list of the most recently used data link files.

Options Menu

The **Options** menu can contain the following items.

- **Edit Data**—Allows you to edit the contents of a table. This control applies to the Data View window.
- **Viewer Options**—Displays the Viewer Options dialog box which allows you to customize the behavior of the application.
- **Database Options**—Displays the Database Options dialog box.

SQL Menu

The **SQL** menu is available only when an Execute SQL window is active. The **SQL** menu has the following commands:

- **Execute**—Executes SQL commands in the SQL Commands control in the active Execute SQL window.
- **Stop**—Stops the execution of SQL commands.
- **Load From File**—Imports the contents of a text file into the SQL Commands control in the active Execute SQL window.
- **Clear**—Deletes the contents from the SQL Commands control in the active Execute SQL window.

Windows Menu

The **Windows** menu has the following commands:

- **Refresh**—Updates the contents of a Data Link View window or a Data View window.
- **Cascade**—Arranges all open windows so that each title bar is visible.
- **Tile**—Arranges all open windows in smaller sizes to fit next to each other.
- **Arrange Icons**—Arranges all minimized windows at the bottom of the main window.

Using Data Links

TestStand requires you to define a data link when you specify the database where TestStand logs results, or when you use the database step types. TestStand uses the Windows Data Link Properties dialog box to build a data link connection string.

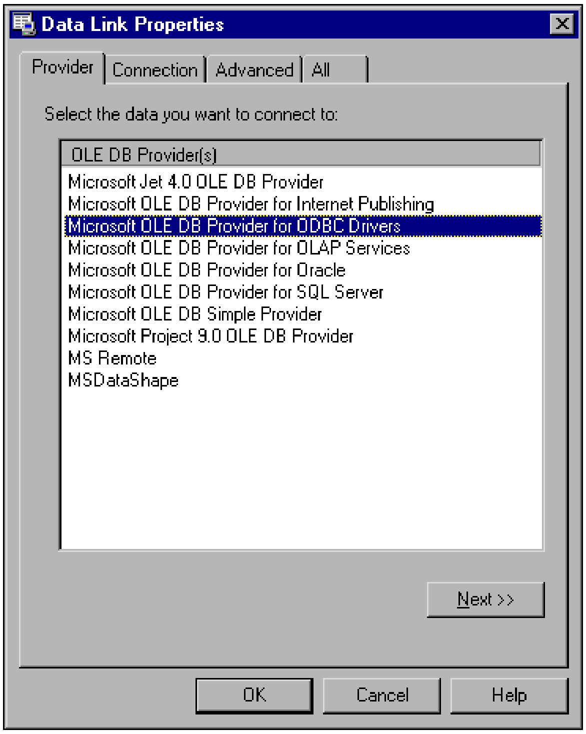
The following sections describe the Data Link Properties dialog box and the Windows ODBC Administrator.

Data Link Properties Dialog Box

You can display the Data Link Properties dialog box when you create or edit a connection string for a data link. You use the Data Link Properties dialog box to specify initialization properties for your OLE DB provider. This section describes the four tabs of the Data Link Properties dialog box.

Provider Tab

Use the Provider tab to select the appropriate OLE DB provider for the type of data you want to access. Figure 18-9 shows the Provider tab for the Data Link Properties dialog box.



Select the data you want to connect to:

OLE DB Provider(s)
Microsoft Jet 4.0 OLE DB Provider
Microsoft OLE DB Provider for Internet Publishing
Microsoft OLE DB Provider for ODBC Drivers
Microsoft OLE DB Provider for OLAP Services
Microsoft OLE DB Provider for Oracle
Microsoft OLE DB Provider for SQL Server
Microsoft OLE DB Simple Provider
Microsoft Project 9.0 OLE DB Provider
MS Remote
MSDataShape

Figure 18-9. Data Link Properties Dialog Box—Provider Tab

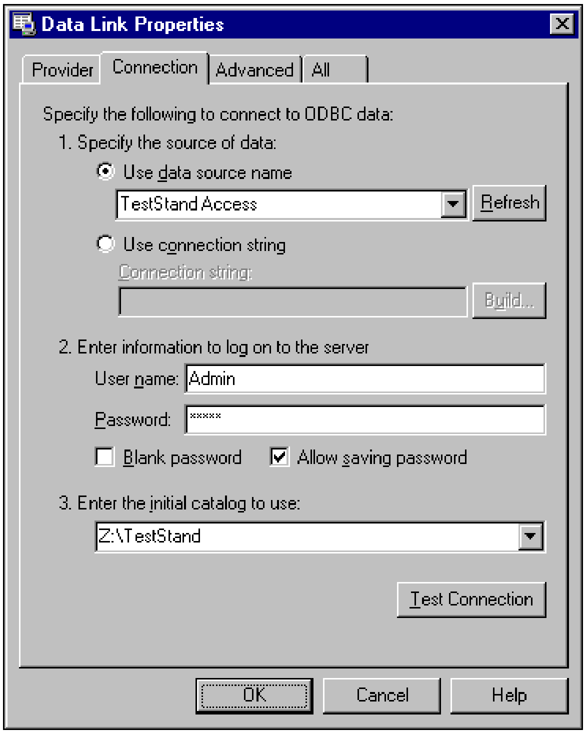
Typically, a provider communicates with a specific DBMS such as Oracle or SQL Server. The Microsoft OLE DB Provider for ODBC Drivers allows you to use any ODBC driver. Some providers have limited functionality. Refer to the `<TestStand>\Doc\readme.txt` for information on suggested providers, versions of ODBC drivers, and client DBMS software. The following recommendations are a summary of the contents in the `readme.txt` file:

- To communicate with Access, use the Microsoft Jet 4.0 OLE DB Provider.
- To communicate with SQL Server, use the Microsoft OLE DB Provider for SQL Server.
- To communicate with Oracle, use the Microsoft OLE DB Provider from Oracle.

You can use the **Help** button to display the online help for this tab.

Connection Tab

Use the Connection tab to specify how to connect to your data using the selected OLE DB provider. The contents of the Connection tab vary for each OLE DB provider. Figure 18-10 shows the contents of the Connection tab of the Data Link Properties dialog box when you select the Microsoft OLE DB Provider for ODBC drivers.


Data Link Properties

Provider | Connection | Advanced | All

Specify the following to connect to ODBC data:

1. Specify the source of data:
   - (●) Use data source name: TestStand Access
   - ( ) Use connection string
     Connection string:
2. Enter information to log on to the server
   User name: Admin
   Password: *****
   [ ] Blank password [✓] Allow saving password
3. Enter the initial catalog to use:
   Z:\TestStand

Figure 18-10. Data Link Properties Dialog Box—Connection Tab

You can use the **Help** button to display the online help for this tab.

Note If the connection requires a password, you must save the password in the connection string by checking the Allow Saving Password control.

Note If you want to use the Microsoft OLE DB Provider for ODBC drivers to connect to an ODBC data source, you must first configure a data source name within the ODBC Administrator. Refer to the *Using the ODBC Administrator* section later in this chapter for more information on defining ODBC data source names.

Advanced Tab

Use the Advanced tab to view and set other initialization properties for your data. Figure 18-11 shows the Advanced tab of the Data Link Properties dialog box. For more information on advanced initialization properties, refer to the documentation that you receive with the OLE DB provider.

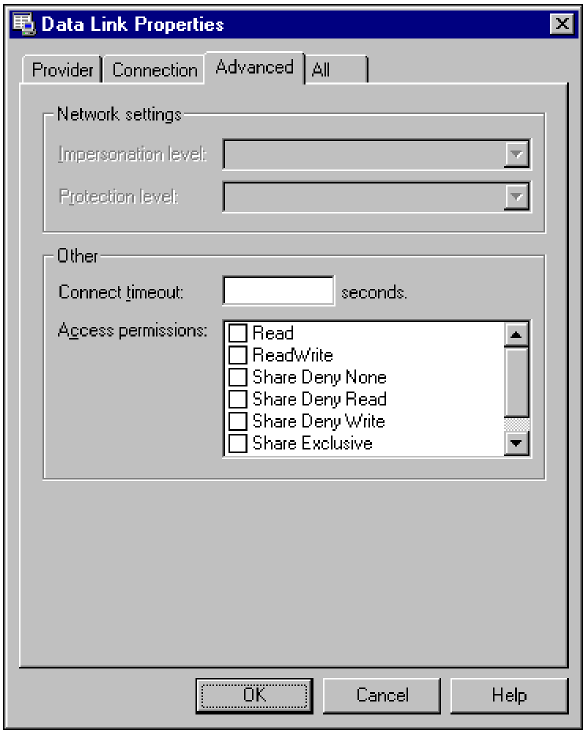
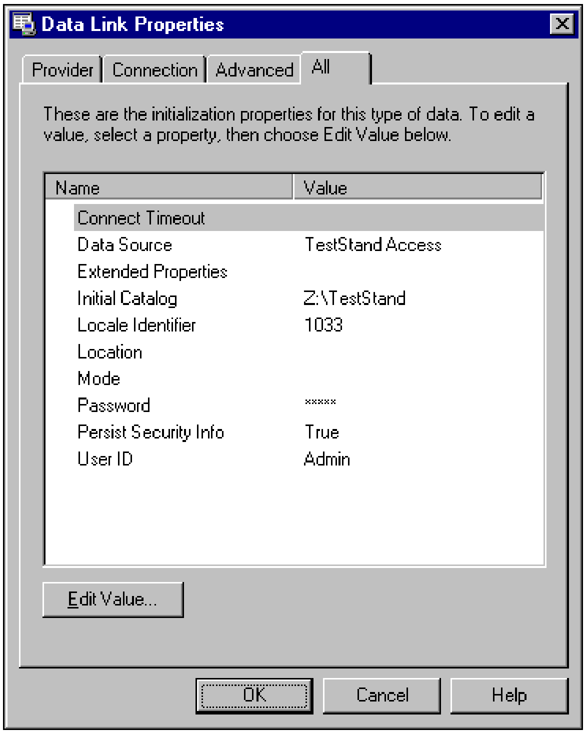


Figure 18-11. Data Link Properties Dialog Box—Advanced Tab

You can use the **Help** button to display the online help for this tab.

All Tab

Use the All tab to view and edit all the initialization properties that are available for the selected OLE DB provider. The available properties vary depending on the OLE DB provider that you select. Figure 18-12 shows the All tab of the Data Link Properties dialog box.



These are the initialization properties for this type of data. To edit a value, select a property, then choose Edit Value below.

Name	Value
Connect Timeout	
Data Source	TestStand Access
Extended Properties	
Initial Catalog	Z:\TestStand
Locale Identifier	1033
Location	
Mode	
Password	*****
Persist Security Info	True
User ID	Admin

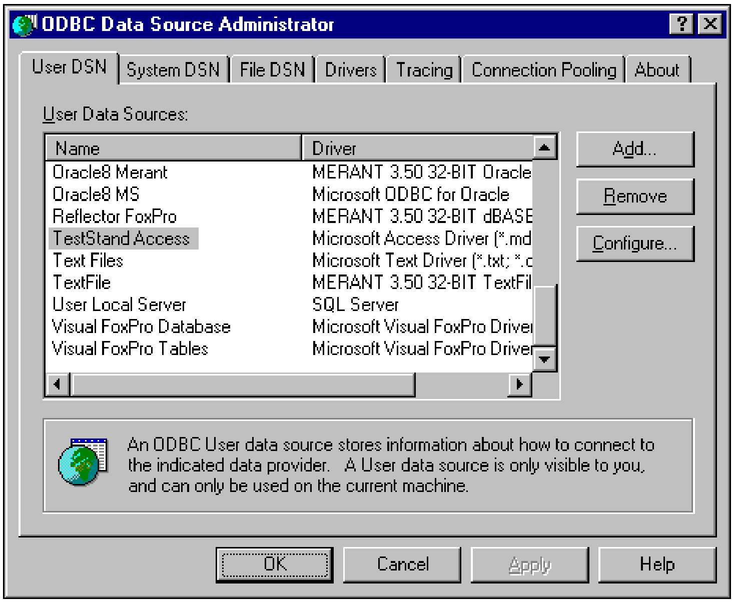
Figure 18-12. Data Link Properties Dialog Box—All Tab

You can use the **Help** button to display the online help for this tab.

Using the ODBC Administrator

To access databases through the ODBC standard, you must have an ODBC driver for each database system you use. Each ODBC driver must register itself with the operating system when you install it. You also must define and name *data sources* in the ODBC Administrator in the Windows Control Panel. When you do so, you typically specify information such as a server, a database, and additional database-specific options. You can define one or more data sources for each ODBC driver.

You can display the ODBC Administrator by going to your Windows Start menu and selecting **Start»Settings»Control Panel** and double clicking on the ODBC icon in your Windows Control Panel. Figure 18-13 shows the ODBC Data Source Administrator dialog box.



Name	Driver
Oracle8 Merant	MERANT 3.50 32-BIT Oracle
Oracle8 MS	Microsoft ODBC for Oracle
Reflector FoxPro	MERANT 3.50 32-BIT dBASE
TestStand Access	Microsoft Access Driver (*.md
Text Files	Microsoft Text Driver (*.txt; *.c
TextFile	MERANT 3.50 32-BIT TextFil
User Local Server	SQL Server
Visual FoxPro Database	Microsoft Visual FoxPro Driver
Visual FoxPro Tables	Microsoft Visual FoxPro Driver

An ODBC User data source stores information about how to connect to the indicated data provider. A User data source is only visible to you, and can only be used on the current machine.

Figure 18-13. ODBC Data Source Administrator Dialog Box—User DSN Tab

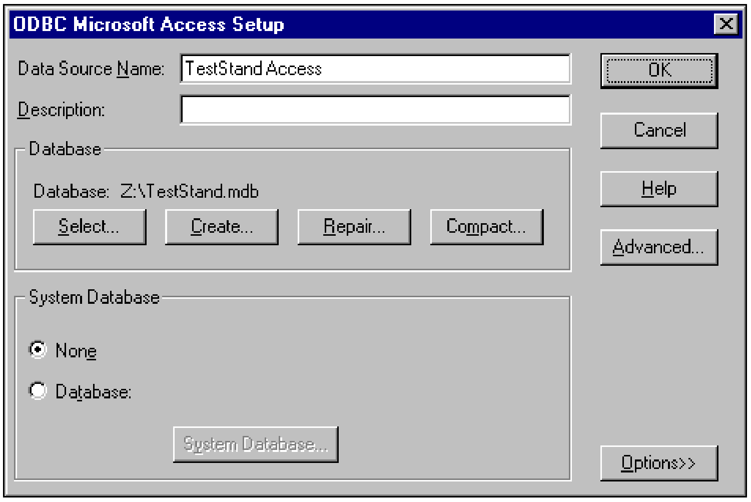
The ODBC Data Source Administrator dialog box lists all the registered ODBC data sources. The dialog box has three tabs for defining data sources.

- User DSN—Allows you to define data sources that are visible only to you.
- System DSN—Allows you to define data sources for all users.
- File DSN—Allows you to set the ODBC Administrator to store the data source definitions in a directory that you specify.

For the User DSN and System DSN tabs, the ODBC Administrator stores the data source definitions in the Windows System Registry. You can use the **Add** or **Configure** buttons on these tabs to display a driver-specific dialog box in which you can configure a new or an existing data source. The system then saves the configuration for the data source in the Registry or as a file.

You can use the **Help** button to display the online help for any tab in the ODBC Data Source Administrator Dialog Box.

Figure 18-14 shows an example driver-specific dialog box for Microsoft Access 97.


ODBC Microsoft Access Setup

Data Source Name: TestStand Access

Description:

Database

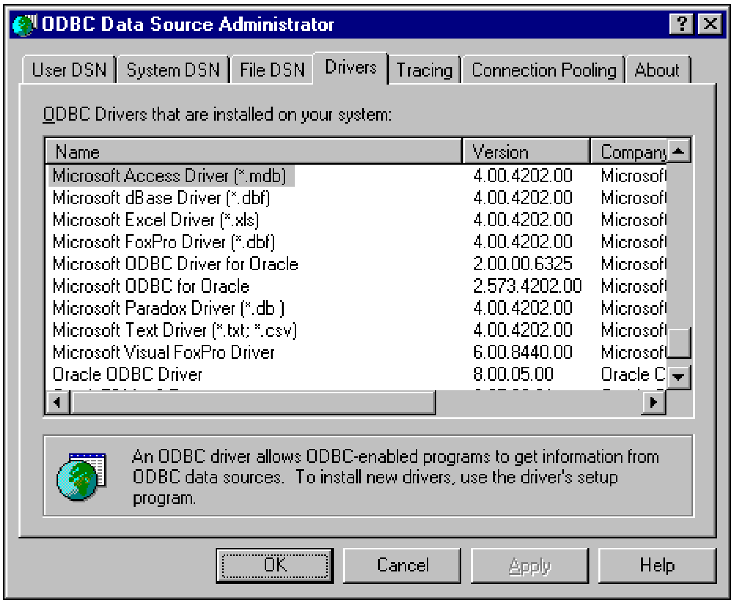
Database: Z:\TestStand.mdb

System Database

(● None) Database:

Figure 18-14. ODBC Microsoft Access 97 Setup Dialog Box

You can view the available drivers for your system on the Drivers tab of the ODBC Data Source Administrator dialog box. Figure 18-15 shows the Microsoft Access Driver highlighted on the Drivers tab.



ODBC Drivers that are installed on your system:

Name	Version	Company
Microsoft Access Driver (*.mdb)	4.00.4202.00	Microsoft
Microsoft dBase Driver (*.dbf)	4.00.4202.00	Microsoft
Microsoft Excel Driver (*.xls)	4.00.4202.00	Microsoft
Microsoft FoxPro Driver (*.dbf)	4.00.4202.00	Microsoft
Microsoft ODBC Driver for Oracle	2.00.00.6325	Microsoft
Microsoft ODBC for Oracle	2.573.4202.00	Microsoft
Microsoft Paradox Driver (*.db)	4.00.4202.00	Microsoft
Microsoft Text Driver (*.txt; *.csv)	4.00.4202.00	Microsoft
Microsoft Visual FoxPro Driver	6.00.8440.00	Microsoft
Oracle ODBC Driver	8.00.05.00	Oracle C

An ODBC driver allows ODBC-enabled programs to get information from ODBC data sources. To install new drivers, use the driver's setup program.

Figure 18-15. ODBC Data Source Administrator Dialog Box—Drivers Tab

Third-Party ODBC Database Drivers

Because the database features of TestStand comply with the ODBC standard, you can use any ODBC-compliant database drivers. TestStand does not install any ODBC database drivers. DBMS vendors and third-party developers offer their own drivers. Refer to your vendor documentation for information on registering your specific database drivers with the ODBC Administrator.

Note The TestStand CD-ROM contains the LabVIEW SQL Toolkit and the LabWindows/CVI SQL Toolkit. If you install either toolkit, the toolkit may install third-party ODBC drivers. You cannot redistribute the database driver files the SQL Toolkit includes without purchasing a run-time license. Contact National Instruments for more information on redistributing database driver files.

Example Data Link and Result Table Setup for Microsoft Access

This section outlines an example of how to set up a TestStand data link to a Microsoft Access database file (`.mdb`) to log results using the default process model. The example uses the Microsoft Jet OLE DB provider.

Database Options—Specifying a Data Link and Schema

To configure the database logging options complete the following steps:

1. Launch the sequence editor and log in as Administrator.
2. Select **Configure»Database Options** to display the Database Options dialog box. The Logging Options tab is active.
3. Enable database logging by removing the checkmark next to the Disable Database Logging option.
4. Click on the **Data Link** tab of the Database Options dialog box and select **Access** from the ring control for the Database Management System option.
5. Click on the **Build** button. The Data Link Properties dialog box appears.
6. Select the **Microsoft Jet 4.0 OLE DB Provider** item on the Provider tab of the Data Link Properties dialog box.
7. Click on the **Next** button. The Connection tab becomes active.
8. On the Connection tab, click on the **Browse** button to the right of the Select or Enter a Database Name control to display the Select Access Database dialog box.
9. Using the Select Access Database dialog box, find your Microsoft database file (`.mdb`) and click on **Open** to select the file.
10. On the Data Link Properties dialog box, click on the **Test Connection** button to verify that you properly entered the required information.
11. Click on **OK** to close the Data Link Properties dialog box.
12. Notice that the Connection Sting control on the Database Options dialog box now contains a literal string expression version of the data link connection string.

Database Viewer—Creating Result Tables

To create the default result tables in your database, complete the following steps:

1. If you are continuing from the steps in the immediately preceding section, skip to step 2. Otherwise, complete the following:
    a. Launch the sequence editor and log in as Administrator.
    b. Select **Configure»Database Options** to display the Database Options dialog box. The Logging Options tab is active.
    c. Click on the Data Link tab of the Database Options dialog box.

2. Select **View** to open the data link in the Database Viewer application. This step requires that the Connection String control contains a valid expression.
3. Select **File»New Execute SQL Window** to open an Execute SQL window.
4. Select **SQL»Load From File** command and select the `Access Create Generic Recordset Result Tables.sql` file in the `<TestStand>\Components\NI\Models\TestStandModel\Database` directory. Notice that the SQL Command control contains a set of SQL commands for creating the default result tables.
5. Select **SQL»Execute** command to create the default result tables. Review the results of the SQL commands in the SQL History control. Make sure the tables are created successfully.
6. Click on the Data Link window and select the **Window»Refresh** command to view the tables.

After completing the preceding steps, any execution you launch with the TestUUTs or Single Pass entry point automatically logs its results to the database.

Built-In Database Step Types

TestStand includes six built-in steps that you can use to communicate with a database. The step type names and the descriptive names include the following:

- `NI_OpenDatabase`—Open Database
- `NI_CloseDatabase`—Close Database
- `NI_OpenSQLStatement`—Open SQL Statement
- `NI_CloseSQLStatement`—Close SQL Statement
- `NI_DataOperation`—Data Operation
- `NI_PropertyLoader`—Property Loader

A simple sequence of database steps might include the following steps:

1. Connect to the database using the Open Database step.
2. Issue a SQL query on tables in the database using the Open SQL Statement step.
3. Create new records, then get and update existing records using Data Operation steps.

4. Close the SQL query using the Close SQL Statement step.
5. Close the database connection using the Close Database step.

Use the Property Loader step type to import property and variable values from a file or database during an execution.

The following sections describe how to interactively access your database to configure a database step type and describes each database step type, including the step type edit dialog boxes and the custom step properties.

Using the Select Data Link Dialog Box

When you edit a database step, the Edit dialog box might have to access the database so it can display a list of available tables in the database or a list of columns in a table. To assist you, TestStand allows you to define a set of data links that you can reuse whenever you edit a database step. A data link typically includes a name of a server, a name of a database, a user ID, and a password. Whenever you edit a database step, you can select a predefined data link to speed up your development.

For example, when you edit an Open SQL Statement step, you typically must build a SQL statement. If you select a predefined data link, the Build SQL Select Statement dialog box can automatically populate the Table and Column controls with a list of valid names, as shown in Figure 18-16.

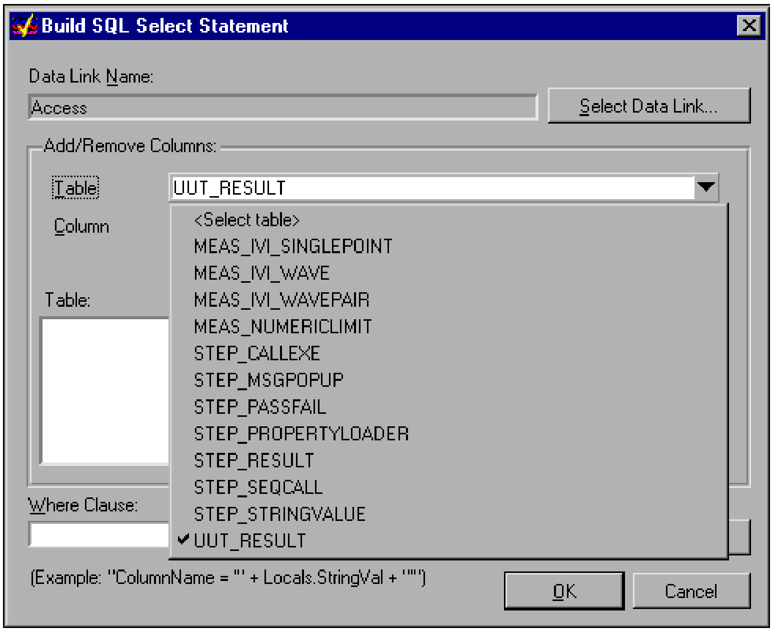


Figure 18-16. Build SQL Select Statement Dialog Box

You can define a new data link by selecting the **Select Data Link** button on the edit dialog boxes for the database step types. Figure 18-17 shows the Select Data Link dialog box.

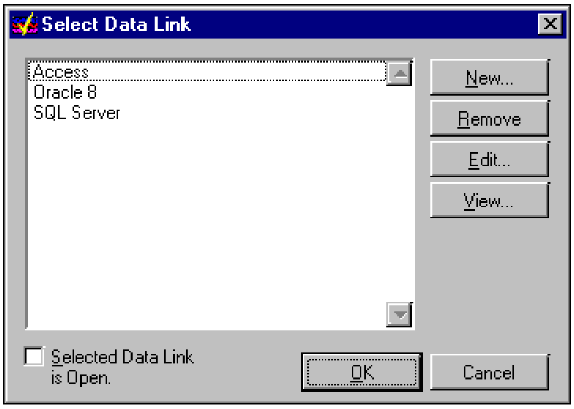
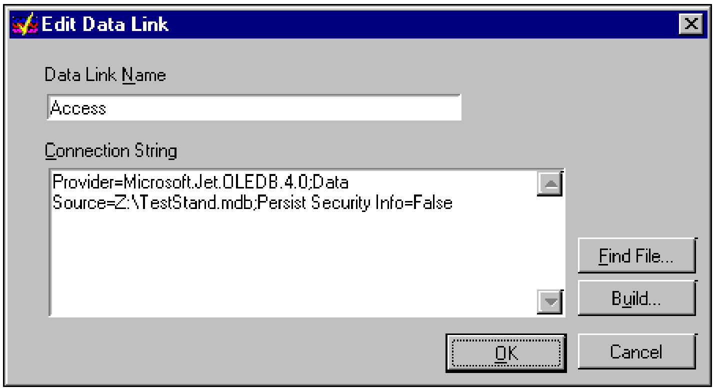


Figure 18-17. Select Data Link Dialog Box

The Select Data Link dialog box lists the currently defined data links. When you select a data link, TestStand attempts to open a connection to the data source. If TestStand successfully opens the data link, TestStand leaves the connection open for later use. The Select Data Link dialog box has the following options:

- **Selected Data Link is Open—**Indicates whether a connection is open for the currently selected data link. You can manually close an open connection by unchecking the control while the data link is selected.
- **New** or **Edit—**You can create new data links or edit existing data links by using the **New** or **Edit** buttons, respectively. The **New** and **Edit** buttons display the Edit Data Link dialog box, as shown in Figure 18-18.



Data Link Name: Access

Connection String:
Provider=Microsoft.Jet.OLEDB.4.0;Data Source=Z:\TestStand.mdb;Persist Security Info=False

Figure 18-18. Edit Data Link Dialog Box

The Edit Data Link dialog box contains the following controls:

- **Data Link Name**—Specifies a name for the data link. TestStand displays this name in the list control on the Select Data Link dialog box.
- **Connection String**—Specifies the connection information for the data link. The string specifies the data source and options to use when opening the data source. The contents of the string can include the name of the server where the data resides, the database or file that contains the data, and the user ID and permissions to use when connecting to the data source.

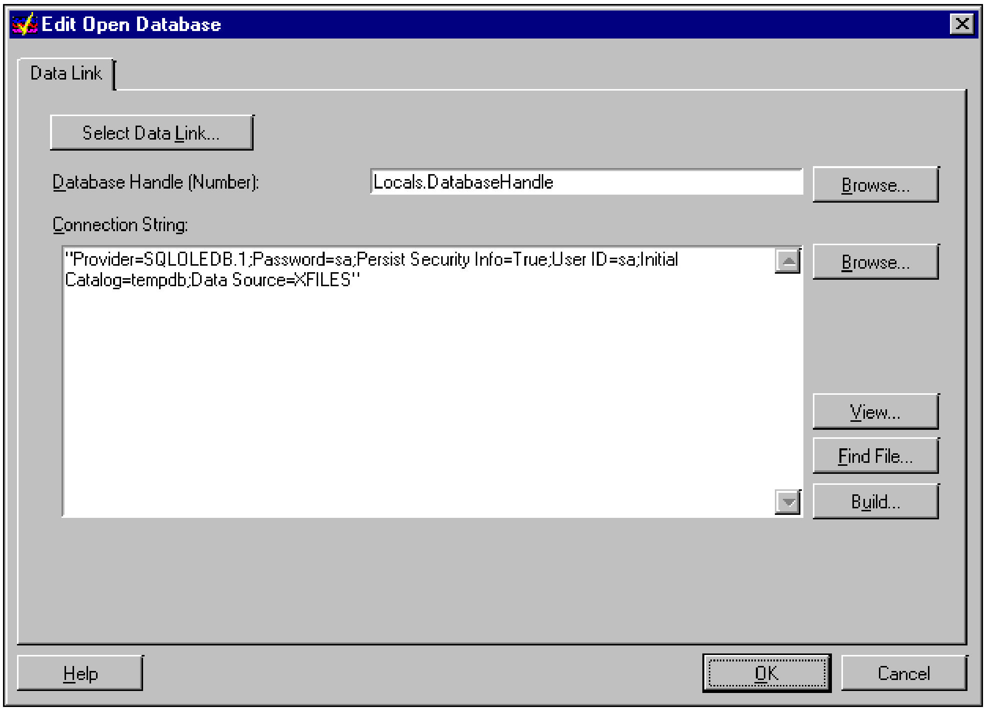
  - **Find File**—Allows you to select a Microsoft Data Link file (`.udl`). A data link file specifies the connection string. When you select a Microsoft Data Link file, TestStand updates the Connection String control with the pathname of the file.
  - **Build**—Allows you to construct a connection string using the Data Link Properties dialog box.
- **Remove**—Removes existing data links from the list. Select a name from the list and click on the **Remove** button.
- **View**—Launches the Database Viewer application and opens the connection string within the viewer. Refer to the *Database Viewer* section earlier in this chapter for more information on using the Database Viewer application.

Open Database

Use the Open Database step type to open a database for use in TestStand. An Open Database step returns a database handle that you can use to open SQL statements.

Data Link Tab

The Data Link tab specifies the information TestStand requires to connect to a database. Figure 18-19 shows the Data Link tab of the Edit Open Database dialog box.



Database Handle (Number): Locals.DatabaseHandle

Connection String:

```
"Provider=SQLOLEDB.1;Password=sa;Persist Security Info=True;User ID=sa;Initial
Catalog=tempdb;Data Source=XFILES"
```

Figure 18-19. Edit Open Database dialog box—Data Link Tab

The Data Link tab contains the following controls:

- **Select Data Link**—Selects a predefined data link from a list. When you select a data link, TestStand updates the Connection String control on the Data Link tab with its value. Refer to the *Using Data Links* section earlier in this chapter for more information on predefining data links.
- **Database Handle**—Specifies the name of a variable or property of type Number that the value of the database is assigned to. You can use the **Browse** button to display the Expression Browser dialog box.
- **Connection String**—Specifies the connection string TestStand uses to open the data source. The Connection String control requires a string expression that TestStand evaluates at run time. The expression can be

a literal value or a string you build using variables or properties. If the value is a string literal, you must encapsulate the string value with quotes (`""`).

You can update the contents of the Connection String control as follows:

– **Browse**—Allows you to edit a connection string expression in an Expression Browser dialog box.

– **View**—Launches the Database Viewer application and opens the connection string within the viewer. Refer to the *Database Viewer* section earlier in this chapter for more information on using the Database Viewer application.

– **Find File**—Selects a Microsoft Data Link (`.udl`) filename as the connection string. When you select a Microsoft Data Link file, TestStand updates the Connection String control with the name of the file, as in the following:

  "FILE NAME=C:\\Program Files\\Common Files\\ System\\OLE DB\\Data Links\\Access.udl"

– **Build**—Constructs a connection string using the Data Link Properties dialog box. Refer to the *Data Link Properties Dialog Box* section later in this chapter for more information.

You can use the **Help** button to display the online help for this tab.

Custom Properties

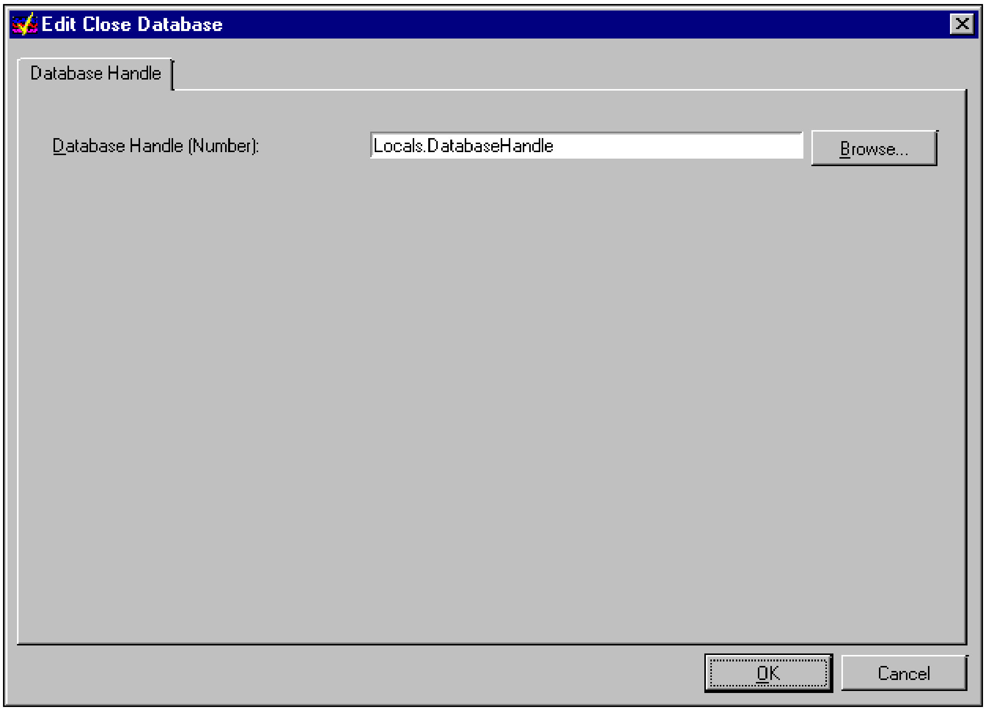
The Open Database step type defines the following step properties in addition to the common custom properties:

- `Step.ConnectionString` specifies a string expression that contains the name of the data link to open.
- `Step.DatabaseHandle` specifies the numeric variable or property that the value of the opened database handle is assigned to.

Close Database

Use the Close Database step to close the database handle that you obtain from an Open Database step. It is a good idea to place Close Database steps in Cleanup step groups.

Figure 18-20 shows the Edit Close Database dialog box.



Database Handle (Number): Locals.DatabaseHandle

Figure 18-20. Edit Close Database Dialog Box

The Edit Close Database dialog box contains a single control, **Database Handle**. This control specifies the name of the variable or property that contains the database handle that is to be closed. The variable or property is of the Number data type. After closing the database handle, the step assigns a value of zero to the variable or property.

Custom Properties

The Close Database step type defines the following step property in addition to the common custom properties:

- `Step.DatabaseHandle` specifies the name of the variable or property that contains the open database handle that is to be closed. The variable or property is of the Number data type.

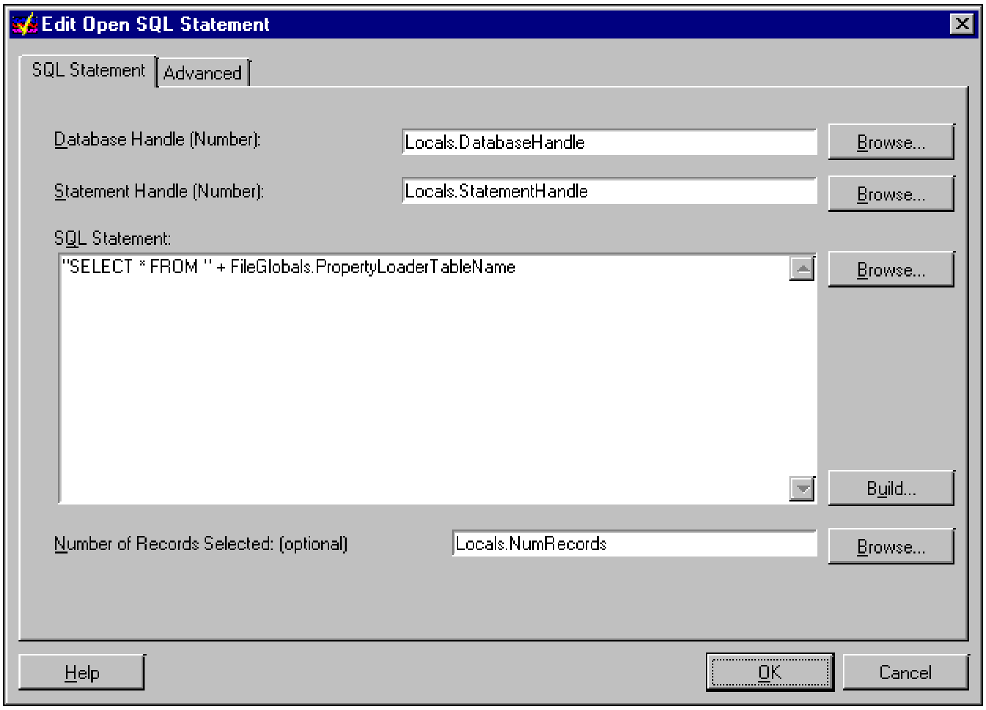
Note TestStand does not automatically close open database handles. You must call a Close Database step for your open handles. If you abort an execution, you must exit the application process that loaded the TestStand engine to guarantee that TestStand frees all database handles. Selecting Unload All Modules does not close the handles.

Open SQL Statement

After you open a database, you typically select a set of data in the database to work with. You use the Open SQL Statement step type to select this data. After you open a SQL statement, you can perform multiple operations on that data set using Data Operation steps. An Open SQL Statement step returns a statement handle that you can use in Data Operation steps.

SQL Statement Tab

Figure 18-21 shows the SQL Statement tab of the Edit Open SQL Statement dialog box.



Database Handle (Number): Locals.DatabaseHandle

Statement Handle (Number): Locals.StatementHandle

SQL Statement:

```
"SELECT * FROM " + FileGlobals.PropertyLoaderTableName
```

Number of Records Selected: (optional) Locals.NumRecords

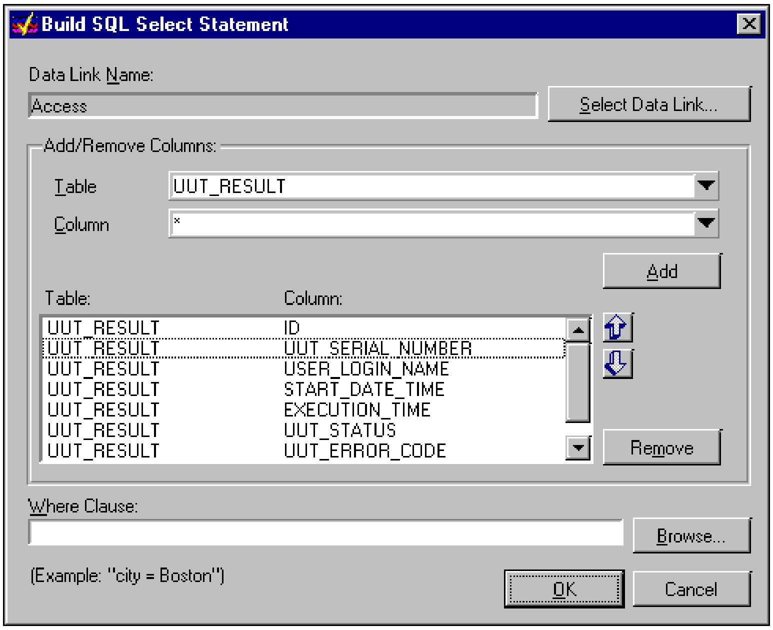
Figure 18-21. Edit Open SQL Statement dialog box—SQL Statement Tab

The SQL Statement tab contains the following controls:

- **Database Handle (Number)**—Specifies the name of the variable or property that contains the database handle you obtain from an Open

Database statement. The variable or property is of the Number data type.

- **Statement Handle (Number)**—Specifies a variable or property to which the step assigns the value of the SQL statement handle.The variable or property is of the Number data type. If you leave the control blank, the step automatically releases the SQL statement handle after executing the step.
- **SQL Statement**—Specifies the SQL statement that the step opens. You can specify the SQL statement as a literal string or as an expression that TestStand evaluates at run time. You can use the **Build** button to construct the SQL statement. Refer to the *Structured Query Language (SQL)* section later in this chapter for more information. You cannot use the **Build** button to edit an existing SQL statement expression.
- **Number of Records Selected**—Specifies a variable or property to which the step assigns the number of records that the SQL statement returns. The variable or property is of the Number data type.
- **Build**—Opens the Build SQL Select Statement dialog box where you can construct a SQL select statement. Figure 18-22 shows the Build SQL Select Statement dialog box.



Data Link Name: Access

Add/Remove Columns:

Table: UUT_RESULT

Column: *

Table:	Column:
UUT_RESULT	ID
UUT_RESULT	UUT_SERIAL_NUMBER
UUT_RESULT	USER_LOGIN_NAME
UUT_RESULT	START_DATE_TIME
UUT_RESULT	EXECUTION_TIME
UUT_RESULT	UUT_STATUS
UUT_RESULT	UUT_ERROR_CODE

Where Clause:

(Example: "city = Boston")

Figure 18-22. Build SQL Select Statement Dialog Box

The Build SQL Select Statement dialog box contains the following controls:

- **Data Link Name**—Indicates the name of the data link to use to populate the Table and Column ring controls. You must use the **Select Data Link** button to select a predefined data link from a list. When you select a data link, TestStand automatically updates the Table and Column ring controls in the Add/Remove Columns section. Refer to the *Using Data Links* section earlier in this chapter for more information on predefining data links.
- **Add/Remove Columns**—Select the tables and columns to include in the SQL `SELECT` statement. TestStand populates the Table ring control with the tables that the selected data link defines. When you select a table in the Table ring control, TestStand populates the Column ring control with a list of all columns in the table. If you want to select all columns in the SQL statement, choose the `*` item in the Column control.

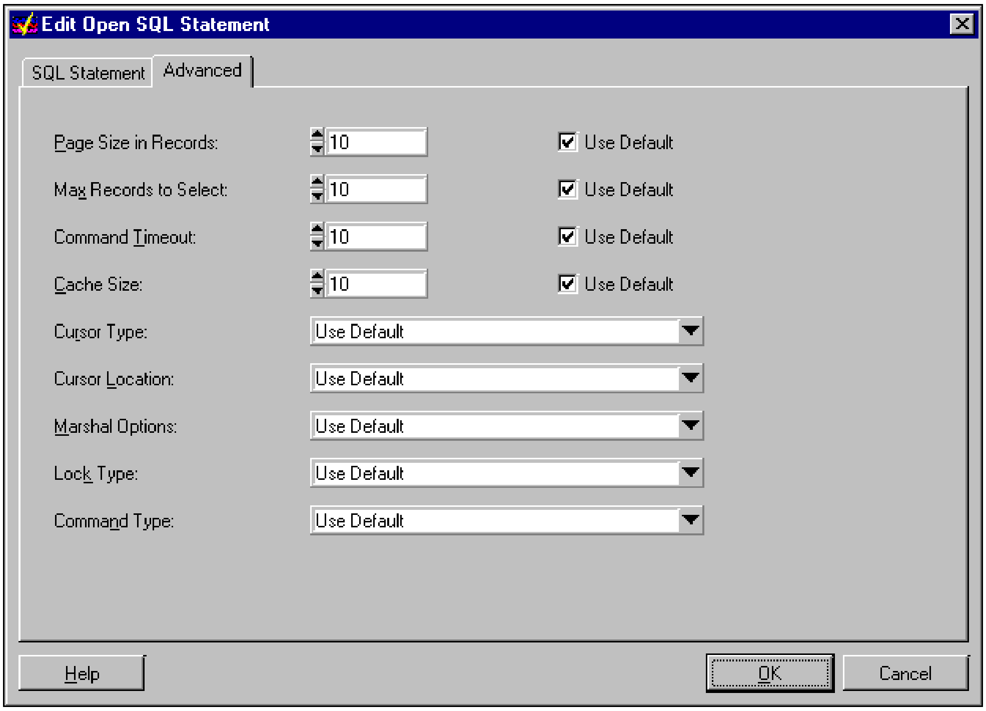
  You can use the **Add** button to insert the selected table and column into the Table and Column list control. You can remove an item from the list control by selecting the item you want to delete and clicking on the **Remove** button. You can reorder the items in the list control by selecting an item and clicking on the up or down arrow buttons.
- **Where Clause**—Specifies a SQL `WHERE` clause to include in the SQL `SELECT` statement. You can specify a literal string or an expression that TestStand evaluates at run-time. Refer to the *Structured Query Language (SQL)* section later in this chapter for an overview of SQL commands.

You can use the **Browse** button for each control to display an Expression Browser dialog box. You can use the **Help** button to display the online help for this tab.

Advanced Tab

The Advanced tab of the Edit Open SQL Statement dialog box specifies optional attributes that TestStand can set when opening a SQL statement. In most cases, the database defines default values for each attribute. When you select the Use Default option, the step does not set the attribute. Some databases do not support all the attributes in the dialog box.

Figure 18-23 shows the Advanced tab of the Edit Open SQL Statement dialog box.



Page Size in Records: 10 [✓] Use Default
Max Records to Select: 10 [✓] Use Default
Command Timeout: 10 [✓] Use Default
Cache Size: 10 [✓] Use Default
Cursor Type: Use Default
Cursor Location: Use Default
Marshal Options: Use Default
Lock Type: Use Default
Command Type: Use Default

Figure 18-23. Edit Open SQL Statement Dialog Box—Advanced Tab

The Advanced tab contains the following controls:

- **Page Size in Records**—Specifies the number of records in a page.
- **Max Records to Select**—Specifies the maximum number of records the connection returns from the data source.
- **Command Timeout**—Specifies the number of seconds TestStand waits for a command to execute.
- **Cache Size**—Specifies the number of records the connection maintains in a memory buffer and how many records the connection retrieves at one time.
- **Cursor Type**—Specifies the type of cursor for the SQL statement. In the ring control, you can choose one of the following options:
  - **Dynamic**—Additions, changes, and deletions by other users are visible, and all types of movement through the set of records are allowed.

  - **Static**—Additions, changes, or deletions by other users are not visible.
  - **Forward Only**—Identical to a static cursor except that you can only scroll forward through records. This improves performance when you want to make a single pass through a set of records.
  - **Keyset**—Similar to a dynamic cursor except that you cannot see records that other users add. Records that other users delete are inaccessible from your set of records. Data changes by other users within records are visible.
- **Cursor Location**—Specifies where the data source maintains cursors for a connection. In the ring control, you can choose one of the following options:
  - **Server**—Uses cursors the data provider supplies. These cursors are sometimes very flexible and allow for additional sensitivity to reflect changes that other users make to the actual data.
  - **Client**—Uses client-side cursors that a local cursor library supplies. Local cursor engines often allow many features that driver-supplied cursors might not.
- **Marshal Options**—Specifies how modified data is written back to the server. In the ring control, you can choose one of the following options:
  - **Write All Records**—All records are written back to the server.
  - **Write Modified Records Only**—Only modified data is written back to the server.
- **Lock Type**—Specifies when the data source locks a record. In the ring control, you can choose one of the following options:
  - **Read Only**—You cannot alter the data in a record.
  - **Pessimistic**—The provider does what is necessary to ensure successful editing of the records, usually by locking records at the data source immediately upon editing.
  - **Optimistic**—The provider locks records only when you put the data back to the database.
  - **Batch Optimistic**—This type is required for batch updates.
- **Command Type**—Specifies how Microsoft ADO interprets the SQL statement. In the ring control, you can choose one of the following options:
  - **Unknown**—ADO attempts to determine the command type.
  - **Text**—SQL statement or, for some providers, a command string in the provider's command language.

- **Table**—Used for a table name.
- **Stored Procedure**—Specifies a call to a stored procedure.

You can use the **Help** button to display the online help for this tab.

Custom Properties

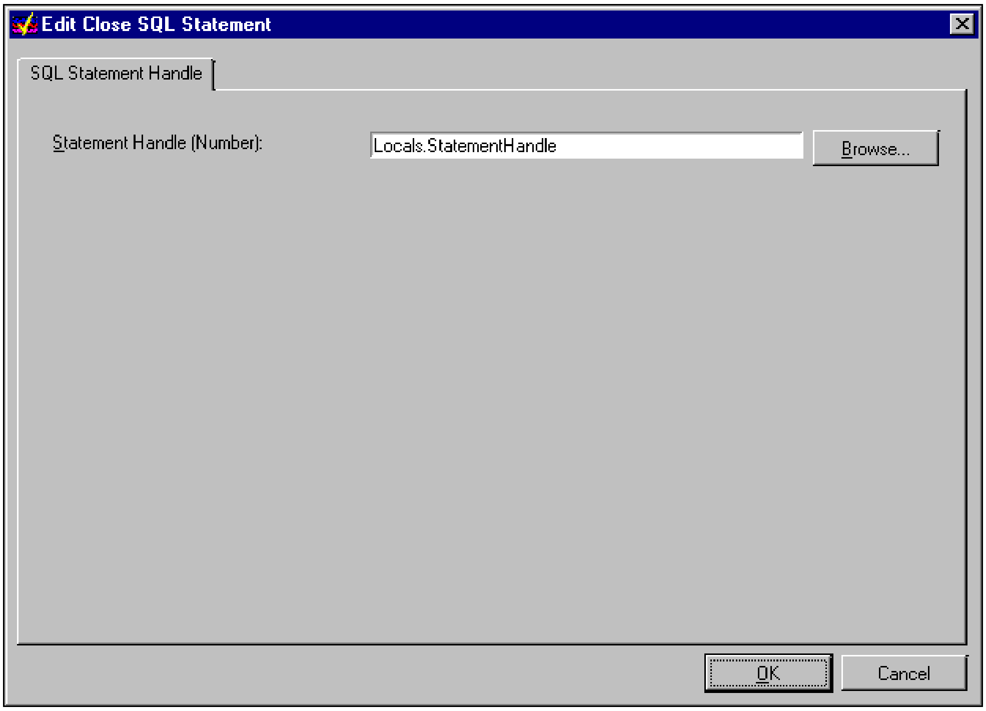
The Open SQL Statement step type defines the following step properties in addition to the common custom properties:

- `Step.PageSize` specifies the number of records in a page for the SQL statement.
- `Step.CommandTimeout` specifies the amount of time in seconds TestStand waits when attempting to issue a command to the open database connection.
- `Step.CacheSize` specifies the cache size for the SQL statement.
- `Step.MaxRecordsToSelect` specifies the maximum number of records the SQL statement can return.
- `Step.CursorType` specifies the cursor type that the SQL statement uses.
- `Step.CursorLocation` specifies where the data source maintains cursors for a connection.
- `Step.MarshalOptions` specifies the marshal options for the updated records in the SQL statement.
- `Step.LockType` specifies the lock type for the records the SQL statement selects.
- `Step.CommandType` specifies the command type of the SQL statement.
- `Step.DatabaseHandle` specifies the name of the variable or property that contains the database handle with which you open the SQL statement.
- `Step.StatementHandle` specifies the numeric variable or property that the value of the SQL statement handle is assigned to.
- `Step.SQLStatement` specifies a string expression that contains a SQL command.
- `Step.NumberOfRecordsSelected` specifies the numeric variable or property to which the step assigns the number of records the SQL statement returns.

Close SQL Statement

Use the Close SQL Statement step to close a SQL statement handle that you obtain from an Open SQL Statement step. It is a good idea to place Close SQL Statement steps in Cleanup step groups.

Figure 18-24 shows the Edit Close SQL Statement dialog box.



Statement Handle (Number): Locals.StatementHandle

Figure 18-24. Edit Close SQL Statement Dialog Box

The Edit Close SQL Statement dialog box contains a single control, Statement Handle (Number). This control specifies the name of the variable or property of type Number that contains which statement handle that is to be closed. After closing the statement handle, the step assigns a value of zero to the variable or property.

Custom Properties

The Close SQL Statement step type defines the following step property in addition to the common custom properties:

- `Step.StatementHandle` specifies the name of the variable or property of type Number that contains the SQL statement handle that is to be closed.

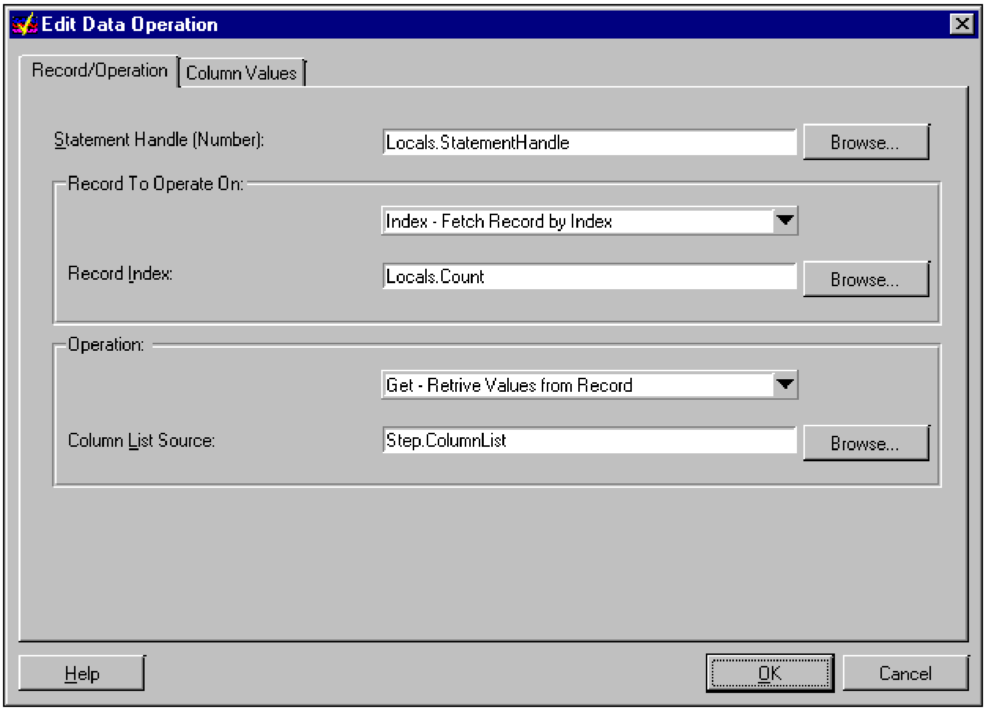
Note TestStand does not automatically close open SQL statement handles. You must call a Close SQL Statement for your open handles. If you abort an execution, you must exit the application process that loaded the TestStand engine to guarantee that TestStand frees all database handles. Selecting Unload All Modules does not close the handles.

Data Operation

You use the Data Operation step type to perform operations on a SQL statement that you open with an Open SQL Statement step. With the Data Operation step, you can fetch new records, retrieve values from a record, modify existing records, create new records, and delete records.

Record/Operation Tab

Figure 18-25 shows the Record/Operation tab of the Edit Data Operation dialog box.



Statement Handle (Number): Locals.StatementHandle

Record To Operate On: Index - Fetch Record by Index

Record Index: Locals.Count

Operation: Get - Retrive Values from Record

Column List Source: Step.ColumnList

Figure 18-25. Data Operation Dialog Box—Record/Operation Tab

The Record/Operation tab contains the following controls:

- **Statement Handle (Number)**—Specifies the name of the variable or property of type Number that contains the SQL statement handle on which to operate.
- **Record to Operate On**—Specifies whether the step operates on the current record, fetches a new record, or creates a new record. The ring control contains the following options:
  - **New**—Create a new record and operate on this new record.
  - **Current**—Operate on a record you previously fetched or created.
  - **Next**—Fetch the next record for the SQL statement.

  - **Previous**— Fetch the previous record for the SQL statement.
  - **Index**—Fetch the record with the index you specify in the **Record Index** control.
- **Record Index**— Contains a literal numeric value or a numeric expression that TestStand evaluates at run time.

Note If the first operation you execute on a SQL statement is a Fetch Next, the operation returns the first record, not the second.

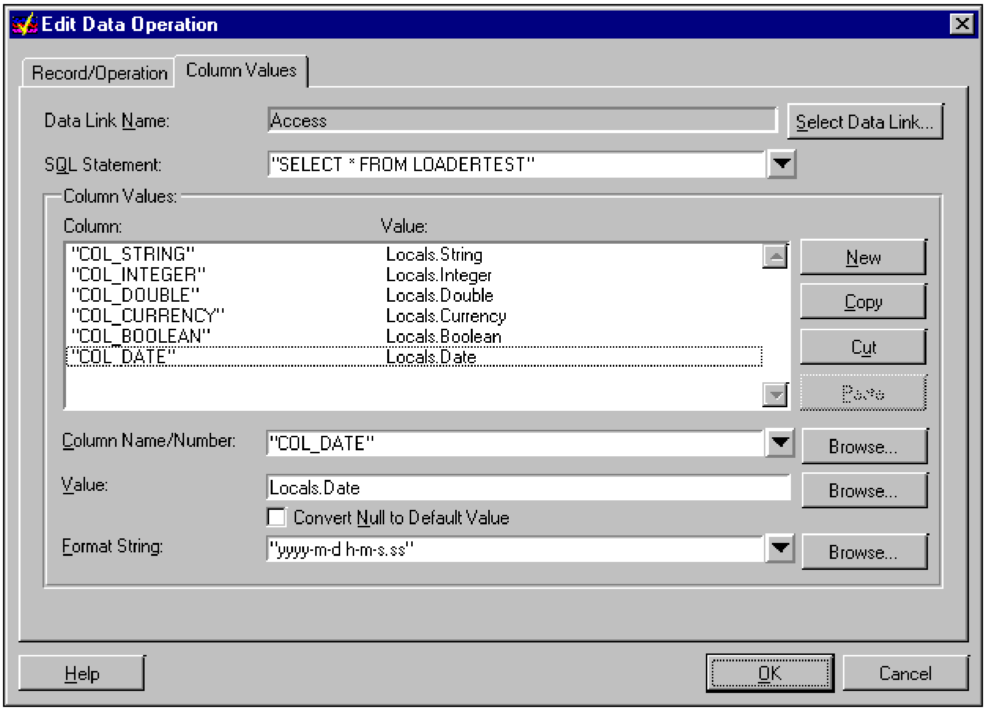
- **Operation**—Specifies the operation the step performs on the selected record. The ring control contains the following options:
  - **Fetch**—No operation is performed on this record.
  - **Set**—Sets the values of the selected record. The **Column List Source** control contains the name of a variable or property that lists the assignments the step performs. You specify the assignments in the Column Values tab. Refer to the *Column Values Tab* section later in this chapter for more information. You must issue a Put operation to update the selected record with any pending change to its values.
  - **Get**—Gets the values from the selected record. The **Column List Source** control contains the name of a variable or property that lists the assignments the step performs. You specify the assignments in the Column Values tab. Refer to the *Column Values Tab* discussion later in this section for more information.
  - **Put**—Updates the selected record with any pending changes to its values.
  - **Delete**—Deletes the selected record from the database.
  - **Set and Put**—Equivalent to a Set followed by a Put.
- **Column List Source**—Specifies the name of the variable or property in which to store the list of mappings between SQL columns and TestStand variables or properties. The Column List Source variable or property must be an array of type `DatabaseColumnValue`.

You can use the **Browse** button to display an Expression Browser dialog box for a control that contains a TestStand expression. You can use the **Help** button to display the online help for this tab.

Column Values Tab

The Column Values tab of the Edit Data Operations dialog box applies only to Get, Set, and Set and Put operations that you perform in a Data Operation step. You can use the Column Values tab to specify the mapping between SQL columns and TestStand variables and properties. For a Get operation, a mapping between a column and variable or property instructs TestStand to assign the column value to the variable or property. For a Set operation, a mapping between a column and a variable or property instructs TestStand to assign the value of the variable or property to the column. The Column List Source control on the Record/Operation tab specifies a variable or property that stores this mapping.

Figure 18-26 shows the Column Values tab of the Edit Data Operation dialog box.



Data Link Name: Access

SQL Statement: "SELECT * FROM LOADERTEST"

Column Values:

Column:	Value:
"COL_STRING"	Locals.String
"COL_INTEGER"	Locals.Integer
"COL_DOUBLE"	Locals.Double
"COL_CURRENCY"	Locals.Currency
"COL_BOOLEAN"	Locals.Boolean
"COL_DATE"	Locals.Date

Column Name/Number: "COL_DATE"

Value: Locals.Date

☐ Convert Null to Default Value

Format String: "yyyy-m-d h-m-s.ss"

Figure 18-26. Data Operation Dialog Box—Column Values Tab

The Column Values tab contains the following controls:

- **Data Link Name**—Contains the name of a data link to open and query. The dialog box uses the data link to populate the ring control that contains column names. You can use the **Select Data Link** button to select a predefined data link from a list. Refer to the *Using Data Links* section earlier in this chapter for more information on predefining data links.
- **SQL Statement**—Specifies the SQL Statement the dialog box uses to populate the ring control that contains column names. The SQL Statement ring control contains a list of the Open SQL Statement steps in the current sequence file. TestStand can populate the **Column Name (Number)** ring control only if the selected SQL statement step uses a string literal or a valid expression.
- **Column Values**—Specifies the mappings of column names to variables or properties. The list control displays the mappings. The **Column Name/Number**, **Values**, and **Format String** controls specify the settings for the currently selected mapping. You can use the **New**, **Cut**, **Copy**, and **Paste** buttons to create a new item in the list, remove items from the list, and rearrange the items in the list. You can use the **Browse** button to display an Expression Browser dialog box.
- **Column Name/Number**, **Values** and **Format String** controls must contain valid expressions that TestStand evaluates at run time. To refer to a column by its order in the SQL statement, enter a one-based number without surrounding quotes in the **Column Name/Number** field.

  When the Data Operation step performs a Get operation, the **Value** control must contain the name of a variable or property. When the Data Operation step performs a Put operation, the **Value** control can contain a literal value or an expression that TestStand evaluates at run time.

  The **Format String** control specifies how to convert a string value when assigning a string expression to a column or when assigning the value of a column to a string variable or property. Typically, you use this control when getting or setting data from a column that is of the date-time or currency type. Refer to the *Format Strings* section later in this chapter for a list of format strings.

You can use the **Help** button to display the online help for this tab.

Custom Properties

The Data Operation step type defines the following step properties in addition to the common custom properties:

- `Step.StatementHandle` specifies a string expression that contains the name of the SQL statement to operate on.
- `Step.RecordToOperateOn` specifies the record to operate on. Valid values include:

  0 - New

  1 - Current

  2 - Next

  3 - Previous

  4 - Index
- `Step.RecordIndex` specifies the index of the record to operate on when `Step.RecordToOperateOn` is set to fetch a specific index.
- `Step.Operation` specifies the operation to perform on the record. Valid values include:

  0 - Fetch only

  1 - Set

  2 - Get

  3 - Put

  4 - Delete

  5 - Set and Put
- `Step.SQLStatement` specifies the SQL statement that the Edit Data Operation dialog box uses to populate the ring controls that contain column names.
- `Step.ColumnListSource` specifies the name of the variable or property that stores the column-to-variable or column-to-property mappings. The variable or property must be an array of type `DatabaseColumnValue`. By default, the value is `Step.ColumnList`.
- `Step.ColumnList` specifies the column-to-variable or column-to-property mapping to perform on a Get or Set operation. The property must be an array of type `DatabaseColumnValue`.

The `DatabaseColumnValue` custom data type contains the following subproperties:

- `ColumnName` specifies the name of the column from which to get a value or to which to assign a value.
- `ColumnNumber` specifies the number of the column in the SQL statement.
- `Data` specifies the variable or property to which TestStand assigns the column value or the expression that TestStand evaluates and assigns to the column.
- `FormatString` specifies an optional format string for dates, times, and currencies. Use the empty string (`""`) if you want to use the default format. Refer to the *Format Strings* section later in this chapter for a description of valid format strings.
- `WriteNull` specifies whether to write `NULL` to the column instead of the value in the Data expression property.
- `Status` indicates the error code returned for the Get or Set operation.

Note You cannot encapsulate your data operations within a transaction. Transactions are not available in the current version of TestStand database step types.

Property Loader

Use the Property Loader step type to dynamically load the values for properties and variables from a text file, a Microsoft Excel file, or a DBMS database at run time. For example, you can develop a common sequence that can test two different models of a cellular phone, where each model requires unique limit values for each step. If you use step properties to hold the limit values, you can include a Property Loader step in the sequence to load the correct limit values into the step properties.

You usually place a Property Loader step in the Setup step group of a sequence. In this way, the Property Loader step initializes the property and variable values before the steps in the Main step group execute.

Loading From File

The source of file-based values can be a tab-delimited text file (`.txt`), a comma-delimited text file (`.csv`), or an Excel file (`.xls`). The data is in a table format. The following is an example of a tab-delimited limits file with one data block specified by starting and ending markers.

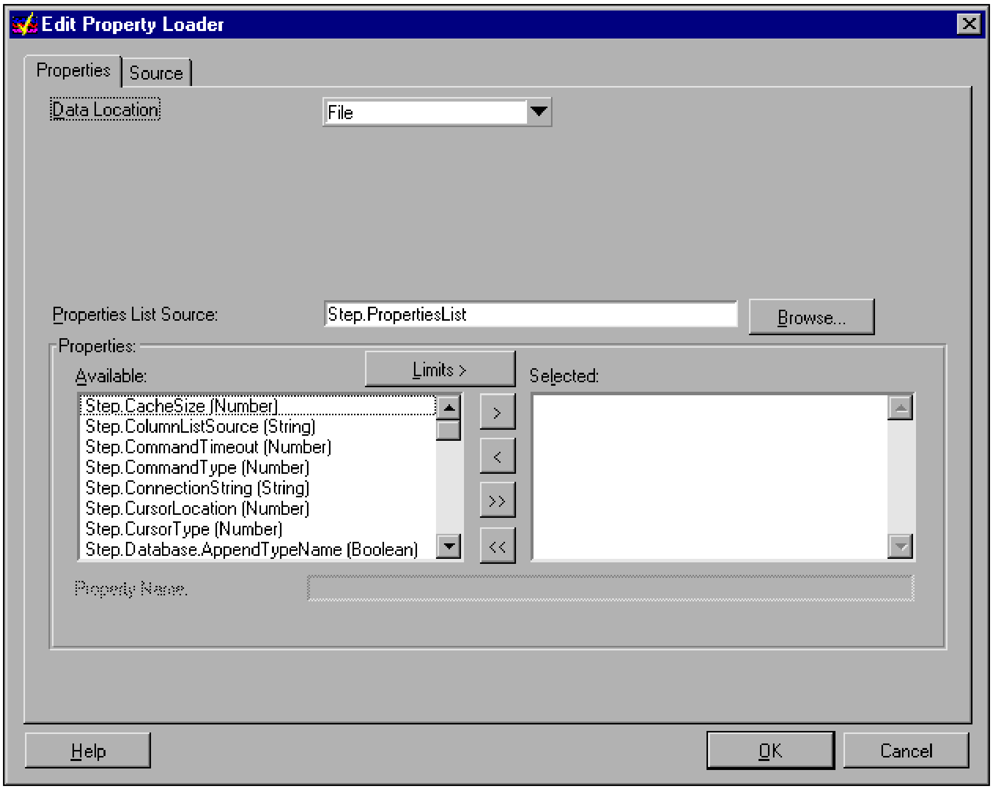
```
Start Marker

<Step Name>         Limits.Low    Limits.High    Limits.String
Voltage at Pin A    9.0           11.0
Voltage at Pin B    8.5           9.5
Self Test Output                                 "SYSTEM OK"

<Locals>                          Variable Value
Count                             100


<FileGlobals>                     Variable Value
Count                             99


<StationGlobals>                Variable Value
Power_On                        False

End Marker
```

For the step name section the row names are step names and the column headings are the names of step properties. Not all columns apply to each row. Each row has values only for the columns that define properties that are actually in the step for the row. For variable sections each row specifies the name of the property and its corresponding value. Starting and ending data markers designate the bounds of the table. A data file can contain more than one block of data.

You can use the Importing/Exporting Properties command in the Tools menu to export property and variable data in the appropriate table format. Refer to the *Importing/Exporting Properties* section later in this chapter.

Properties Tab

Figure 18-27 shows the Properties tab of the Edit Property Loader dialog box, when you select File in the Data Location control.



Data Location: File

Properties List Source: Step.PropertiesList

Properties:

Available:

Step.CacheSize (Number)
Step.ColumnListSource (String)
Step.CommandTimeout (Number)
Step.CommandType (Number)
Step.ConnectionString (String)
Step.CursorLocation (Number)
Step.CursorType (Number)
Step.Database.AppendTypeName (Boolean)

Selected:

Figure 18-27. Edit Property Loader Dialog Box—Properties Tab

The Properties tab contains the following additional controls:

- **Properties List Source**—Specifies the name of the variable or property in which to store the property mappings the step performs. The variable or property must be an array of type `DatabasePropertyMapping`.
- **Properties**—Specifies the mapping of column names to variables or properties that the step loads. The section contains two lists of variables and properties. The first list contains the properties and variables that are available but not selected. The second list contains the properties and variables you select.

You can move a single property from one list to the other by clicking on the single arrow buttons. The double arrow buttons move all properties from one list to the other. The **Limits** button moves all limit properties to the Selected list.

- **Property Name**—Displays the currently selected property in the Selected list control. For array element properties, you must edit the property name to specify the array index.

You can use the **Help** button to display the online help for this tab.

Source Tab

Figure 18-28 shows the Source tab of the Edit Property Loader dialog box, when you select File in the Data Location control.

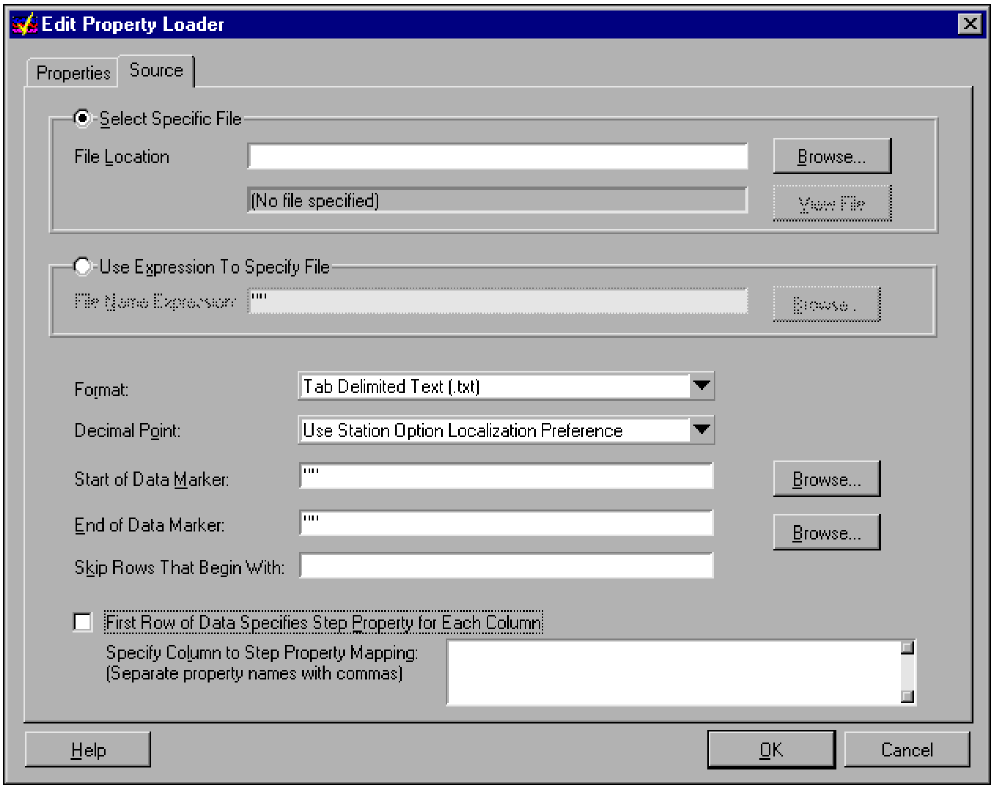

Edit Property Loader
Properties
Source
Select Specific File
File Location
Browse...
(No file specified)
View File
Use Expression To Specify File
File Name Expression
""
Browse...
Format:
Tab Delimited Text (.txt)
Decimal Point:
Use Station Option Localization Preference
Start of Data Marker:
""
Browse...
End of Data Marker:
""
Browse...
Skip Rows That Begin With:
First Row of Data Specifies Step Property for Each Column
Specify Column to Step Property Mapping:
(Separate property names with commas)
Help
OK
Cancel

Figure 18-28. Edit Property Loader Dialog Box—Source Tab

On the Source tab, select a specific file, or specify a string expression that TestStand evaluates at run time for the file pathname. You must also select a file format. Valid formats are tab-delimited text (`.txt`), comma-delimited text (`.csv`), and Excel file (`.xls`).

The Start of Data Marker control specifies the string that designates the beginning of a block of data. The End of Data Marker control specifies the string that designates the end of a block of data. You can specify literal strings for the beginning and ending markers, or you can specify string expressions that TestStand evaluates at run time. The marker strings must appear in the first column of the file. If you specify an empty expression ("") for the starting and ending markers, the step type assumes that the file contains a single block of data.

A Property Loader step ignores all rows that begin with the string you specify in the Skip Rows that Begin With control. This feature is useful when the limits file includes comment lines.

Disable the First Row of Data Specifies Step Property for Each Column option if you do not want to include the step property names for each column as the first row of each data block in the limits file. If you disable this option, you must use the Specify Column to Step Property Mapping text box to specify the list of property names. Separate the property names with commas, as in the following example:

```
Limits.Low, Limits.High, Limits.String
```

You can use the **Help** button to display the online help for this tab.

Loading From Database

The source of database values is a recordset returned from an Open SQL Statement step. The SQL statement recordset is in a table format where each row pertains to a particular sequence step or to a variable scope, as shown in Table 4. The column headings are the names of properties in the steps or variable scopes. Not all columns apply to each row. Each row has values only for the columns that define properties or variables that are actually in the step or variable scope for the row.

Table 18-14. Example Data for Property Loader Step

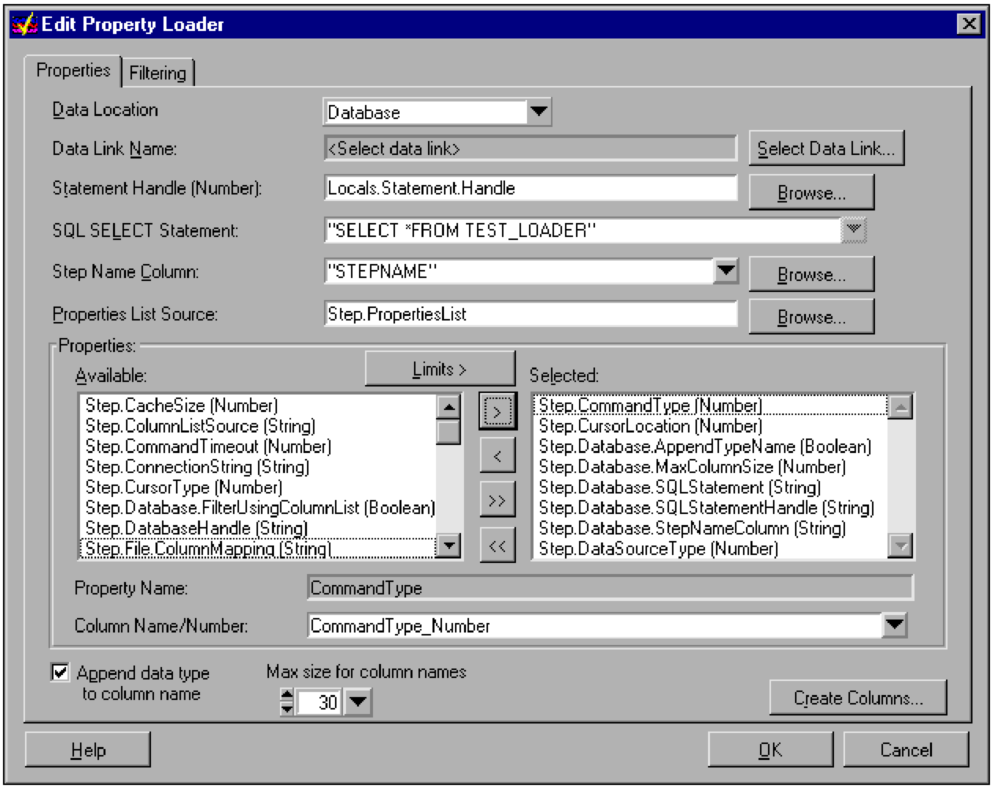
STEPNAME	LIMITS_ HIGH	LIMITS_ LOW	LIMITS_ STRING	POWER_ON	COUNT	SEQUENCE NAME
Voltage at Pin A	9	11	—	—	—	Phone Test.seq
Voltage at Pin B	8.5	9.5	—	—	—	Phone Test.seq
Self Test Output	—	—	"SYS OK"	—	—	Phone Test.seq
<Locals>	—	—	—	—	100	Phone Test.seq
<File Globals>	—	—	—	—	99	Phone Test.seq
<Station Globals>	—	—	—	False	—	Phone Test.seq
Frequency at Pin A	100,000	10,000	—	—	—	Frequency Test.seq
Frequency at Pin B	90,000	9,000	—	—	—	Frequency Test.seq
Self Test Output	—	—	"OK"	—	—	Frequency Test.seq

For database sources, the Property Loader step can filter the data that the SQL statement returns so that you load values only from rows that contain specific column values. This is equivalent to the start and end markers when importing values from a file. For example, in Table 18-14 you can load the rows only for rows where the SEQUENCE NAME field contains the value, `Phone Test.seq`.

You can use the Importing/Exporting Properties command in the Tools menu to export property and variable data to your database table. Refer to the *Importing/Exporting Properties* section in this chapter.

Properties Tab

Figure 18-29 shows the Properties tab of the Edit Property Loader dialog box, when you select Database in the Data Location control.


Edit Property Loader

Properties | Filtering

Data Location: Database

Data Link Name: <Select data link>

Statement Handle (Number): Locals.Statement.Handle

SQL SELECT Statement: "SELECT *FROM TEST_LOADER"

Step Name Column: "STEPNAME"

Properties List Source: Step.PropertiesList

Properties:

Available:
- Step.CacheSize (Number)
- Step.ColumnListSource (String)
- Step.CommandTimeout (Number)
- Step.ConnectionString (String)
- Step.CursorType (Number)
- Step.Database.FilterUsingColumnList (Boolean)
- Step.DatabaseHandle (String)
- Step.File.ColumnMapping (String)

Selected:
- Step.CommandType (Number)
- Step.CursorLocation (Number)
- Step.Database.AppendTypeName (Boolean)
- Step.Database.MaxColumnSize (Number)
- Step.Database.SQLStatement (String)
- Step.Database.SQLStatementHandle (String)
- Step.Database.StepNameColumn (String)
- Step.DataSourceType (Number)

Property Name: CommandType

Column Name/Number: CommandType_Number

[✓] Append data type to column name

Max size for column names: 30

Figure 18-29. Property Loader Dialog Box—Properties Tab

The Properties tab contains the following controls:

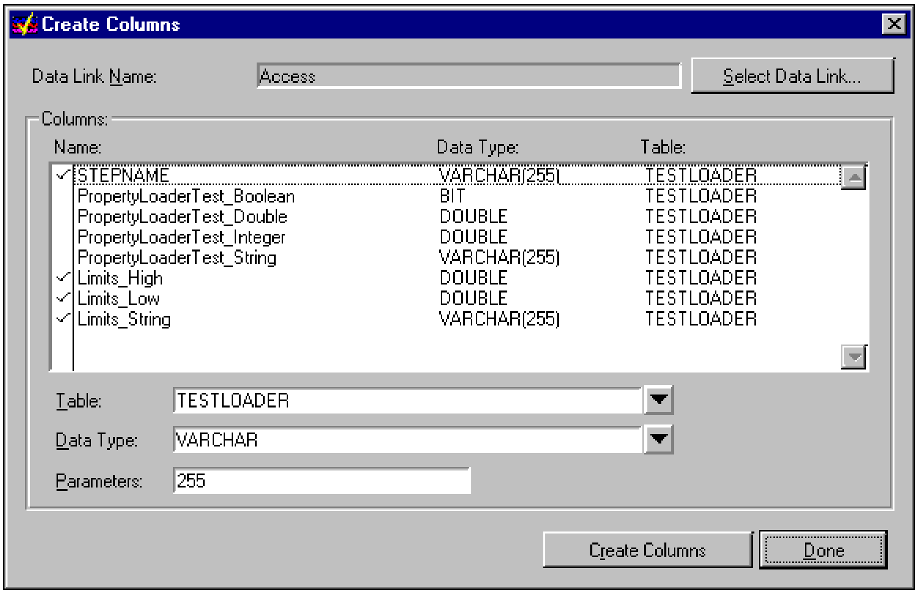
- **Data Link Name**—Contains the name of the data link that the dialog box uses to populate the Step Name Column ring control and to create columns. You can use the **Select Data Link** button to select a predefined data link from a list. Refer to the *Using Data Links* section earlier in this chapter for more information on predefining data links.
- **Statement Handle (Number)**—Specifies the name of the variable or property that contains the SQL statement handle the step uses to import values at run time. The variable or property is of the Number data type.

- **SQL SELECT Statement**—Specifies the SQL statement the dialog box uses at edit time to create columns and populate ring controls that contain column names. The SQL SELECT Statement ring control contains a list of the Open SQL Statement steps in the current sequence file. TestStand can populate the ring controls only if the selected SQL statement step uses a string literal or an expression that is valid at edit time.
- **Step Name Column**—Specifies the name of the SQL statement column that contains the names of the sequence steps and variable scopes that define the rows of data.
- **Properties List Source**—Specifies the name of the variable or property in which to store the property mappings the step performs. The variable or property must be an array of type `DatabasePropertyMapping`.
- **Properties**—Specifies the mapping of column names to variables or properties that the step loads. The section contains two lists of variables and properties. The first list contains the properties and variables that are available but not selected. The second list contains the properties and variables you select.

  You can move a single property from one list to the other by clicking on the single arrow buttons. The double arrow buttons move all properties from one list to the other. The **Limits** button moves all limit properties to the Selected list.
- **Property Name**—Displays the currently selected property in the Selected list control.
- **Column Name/Number**—Specifies the name or index of the column from which the step loads the property.
- **Append data type to column name**—Specifies whether TestStand automatically appends the name of the data type of a property to the column name for a property when you select a property from the Available list.
- **Max size for column names**—Specifies the maximum number of characters for a column name. Many databases limit the size of a column name. Use the ring control to select the limit for any DBMS TestStand supports by default.
- **Create Columns**—Displays the Create Columns dialog box. TestStand automatically populates the dialog box with the list of column names that you have selected but that the SQL statement does not return. You typically use the Create Columns dialog box, shown in Figure 18-30, to add new columns to a database table for any newly selected properties.

You can use the **Browse** button to display an Expression Browser dialog box for a control that contains a TestStand expression.

Figure 18-30 shows the Create Columns dialog box.



Data Link Name: Access

Name:	Data Type:	Table:
✓ STEPNAME	VARCHAR(255)	TESTLOADER
PropertyLoaderTest_Boolean	BIT	TESTLOADER
PropertyLoaderTest_Double	DOUBLE	TESTLOADER
PropertyLoaderTest_Integer	DOUBLE	TESTLOADER
PropertyLoaderTest_String	VARCHAR(255)	TESTLOADER
✓ Limits_High	DOUBLE	TESTLOADER
✓ Limits_Low	DOUBLE	TESTLOADER
✓ Limits_String	VARCHAR(255)	TESTLOADER

Table: TESTLOADER
Data Type: VARCHAR
Parameters: 255

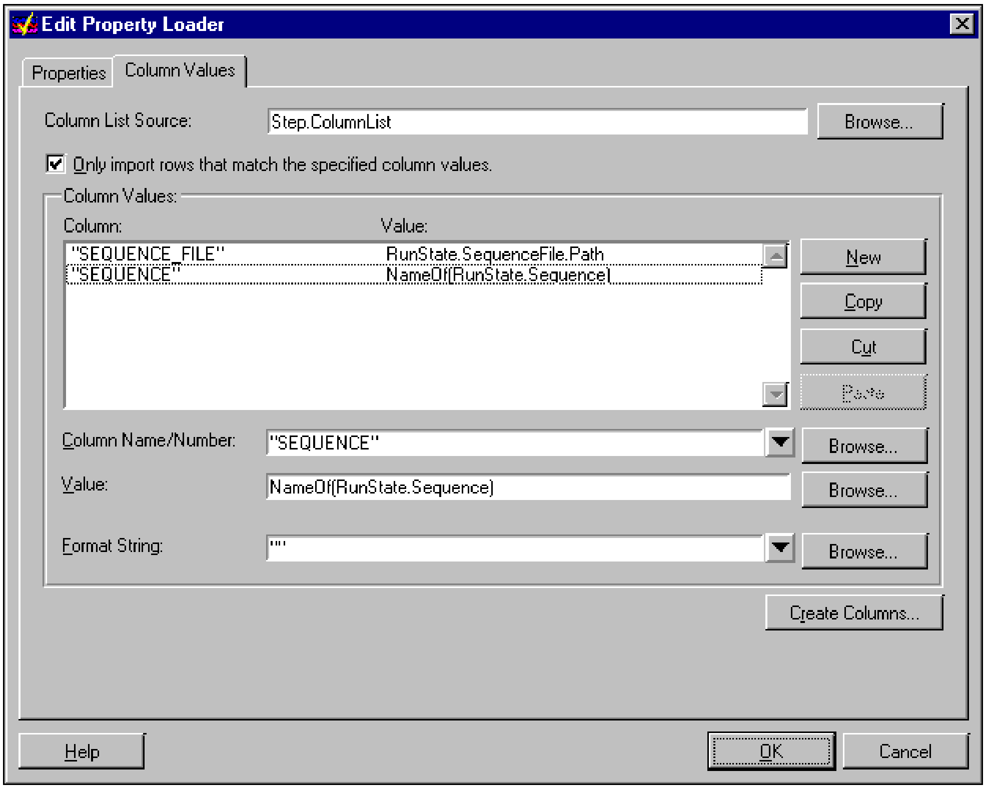
Figure 18-30. Create Columns Dialog Box

The Create Columns dialog box contains the following controls:

- **Data Link Name**—Contains the name of the data link to create columns with. You can use the **Select Data Link** button to select a predefined data link from a list. Refer to the *Using Data Links* section earlier in this chapter for more information on predefining data links.
- **Columns**—Contains the column names that you selected in the Edit Property Loader dialog box but that are not in the specified SQL statement.
- **Table**—Specifies the table in which to create the checked columns.
- **Data Type**—Specifies the column data type.
- **Parameters**—Specifies any parameter information for the data type. For example, you can specify a size limit for a character data type by entering a number in the **Parameters** control.
- **Create Columns**—Creates columns for the checked items in the **Columns** list control.

Filtering Tab

The Filtering tab of the Edit Property Loader dialog box allows you to filter the data the SQL statement returns so that you load values only from rows that contain specific column values. Figure 18-31 shows the Filtering tab of the Property Loader dialog box, when you select Database in the Data Location control.



Column List Source: Step.ColumnList

☑ Only import rows that match the specified column values.

Column Values:

Column:	Value:
"SEQUENCE_FILE"	RunState.SequenceFile.Path
"SEQUENCE"	NameOf(RunState.Sequence)

Column Name/Number: "SEQUENCE"

Value: NameOf(RunState.Sequence)

Format String: ""

Figure 18-31. Property Loader Dialog Box—Column Values Tab

The Filtering tab contains the following controls:

- **Column List Source**—Specifies the name of the variable or property in which to store the list of column value comparisons. The variable or property must be an array of type `DatabaseColumnValue`.
- **Only import rows that match the specified column values**—Specifies whether the step loads only the rows that match the specific column values. When you uncheck this control, the **Column Values** section is dimmed.

- **Column Values**—Specifies the columns values that each row must match. The **Column Name/Number**, **Values**, and **Format String** controls specify the settings for the currently selected mapping. You can use the **New**, **Cut**, **Copy**, and **Paste** buttons to create a new item in the list, remove items from the list, and rearrange the items in the list.
- **Column Name/Number**, **Values** and **Format String** controls must contain valid expressions that TestStand evaluates at run time. To refer to a column by its order in the SQL statement, enter a one-based number without surrounding quotes in the **Column Name/Number** field.

  The **Format String** control specifies how to convert a string value when comparing a column value to a string expression. Typically, you use this control when comparing data from a column that is of the date-time or currency type. Refer to the *Format Strings* section later in this chapter for a list of format strings.
- **Create Columns**—Displays the Create Columns dialog box. TestStand automatically populates the dialog box with the list of any column names that you specify and that the SQL statement does not return. You typically use the Create Columns dialog box to add new columns to a database table. Refer to the *Properties Tab* discussion earlier in this section for more information about using the Create Columns dialog box.

You can use the **Browse** button to display an Expression Browser dialog box for a control that contains a TestStand expression.

You can use the **Help** button to display the online help for this tab.

Custom Properties

The Property Loader step type defines the following step properties in addition to the common custom properties:

- `Step.Result.NumPropertiesRead` indicates the total number of values that the step loaded from the file or database.
- `Step.Result.NumPropertiesApplied` indicates the total number of values the step assigned to properties or variables. If this number is less than `Step.Result.NumPropertiesRead`, the step was unable to update properties or variables.
- `Step.ColumnListSource` specifies the name of the variable or property that stores the list of column comparisons you use to filter the rows in a database recordset. The variable or property must be an array of type `DatabaseColumnValue`. By default, the value is `Step.ColumnList`.

- `Step.ColumnList` specifies the column comparisons TestStand makes on a recordset before loading its values into properties. This property must be an array of type `DatabaseColumnValue`.

  The `DatabaseColumnValue` custom data type contains the following subproperties:

  – `ColumnName` specifies the name of the column on which to perform the comparison.

  – `ColumnNumber` indicates the number of the column in the recordset.

  – `Data` specifies the expression that TestStand evaluates at run time to compare against the column value.

  – `FormatString` specifies an optional format string for dates, times, and currencies. Use an empty string (`""`) if you want to use the default format. Refer to the *Format Strings* section later in this chapter for a description of valid format strings.

  – `WriteNull` is not used.

  – `Status` is not used.

- `Step.PropertiesListSource` specifies the name of the variable or property that stores the list of variables and properties into which to load data. The variable or property must be an array of type `DatabasePropertyMapping`. By default, the value is `Step.PropertiesList`.

- `Step.PropertiesList` specifies the list of variables and properties in which to load data. The list must be an array of type `DatabasePropertyMapping`. Each element of the array defines a mapping between the source data and a TestStand variable or property.

  The `DatabasePropertyMapping` custom data type contains the following subproperties:

  – `PropertyName` specifies the name of the property or variable to assign a value to.

  – `PropertyType` specifies the scope of the property or variable, such as step, local, file global, or station global.
  Valid values include:

    0 - Step

    1 - Local

    2 - File Global

    3 - Station Global

  - `DataType` specifies the TestStand type of the property. Valid values include:

    1 - Boolean

    2 - Number

    3 - String
  - `ColumnName` specifies the name of the column from which to get the value.
- `Step.Database.SQLStatementHandle` specifies the name of the variable or property that contains the SQL statement handle the step uses at run time to load values.
- `Step.Database.SQLStatement` specifies the SQL statement the Edit Property Loader dialog box uses to populate ring controls that contain column names.
- `Step.Database.StepNameColumn` specifies the name of the column in the recordset that contains the names of the steps and variable scopes that define the rows of data.
- `Step.Database.AppendTypeName` specifies whether TestStand appends the data type name of the property to the column name when selecting a property from the available list.
- `Step.Database.MaxColumnSize` specifies the maximum number of characters for a column name.
- `Step.Database.FilterUsingColumnList` specifies whether the step loads only the rows that match the specific column value.
- `Step.File.Path` specifies a literal pathname for the data file.
- `Step.File.DecimalPoint` specifies the type of decimal point the file uses.
- `Step.File.UseExpr` specifies whether to use Step.File.Path or Step.File.FileExpr for the pathname of the data file.
- `Step.File.FileExpr` specifies a pathname expression that TestStand evaluates at run time.
- `Step.File.Format` specifies the type of delimiters in the file and the file type. The possible values are Tab, Comma, or Excel.
- `Step.File.Start.MarkerExpr` specifies the expression for the starting marker.
- `Step.File.EndMarkerExpr` specifies the expression for the ending marker.
- `Step.File.Skip` specifies the string that, when it appears at the beginning of a row, causes the step type to ignore the row.

- `Step.File.MapColumnsUsingFirstRow` specifies whether the first row of each data block in the data file contains the names of the step properties into which the step loads the property values.
- `Step.File.ColumnMapping` specifies the names of the properties into which the step loads the values if Step.File.MapColumnsUsingFirstRowisFalse.

Importing/Exporting Properties

When you edit a sequence file, you can select **Tools»Import/Export Properties** to import values from a database, file, or clipboard into step properties or variables or to export values from step properties or variables to a database, file, or clipboard. The Import/Export Properties command displays the Import/Exports Properties dialog box. The dialog box contains three tabs when you have set the Data Location ring control to Database: Source/Destination, Properties, and Additional Columns.

In addition to the three tabs, the Import/Export Properties dialog box contains the following controls:

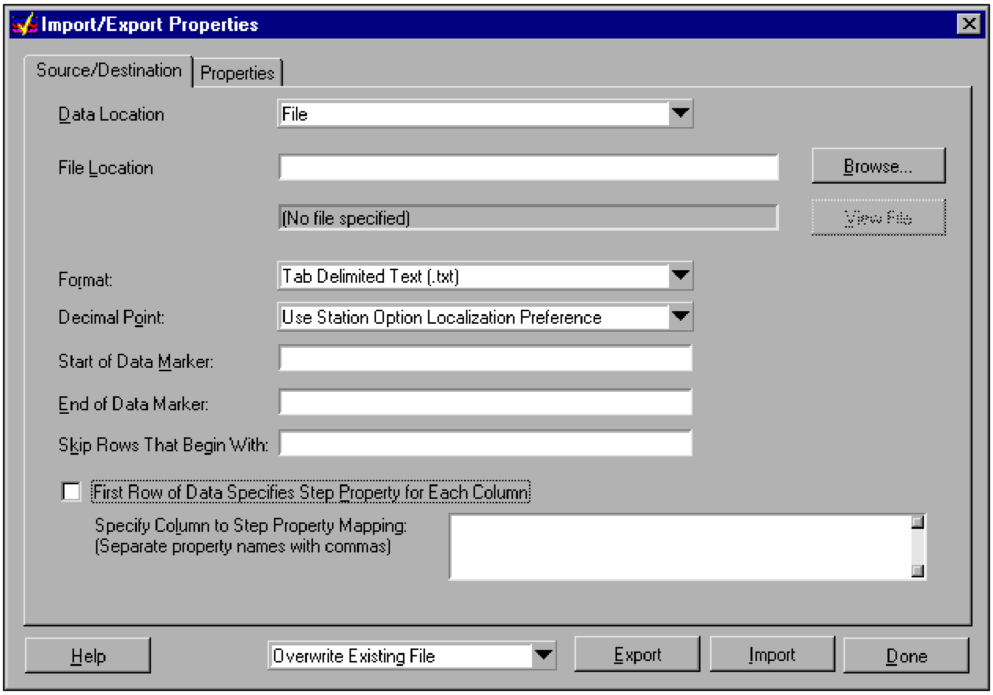
- **Export**—Exports the properties and variables you specify on the Properties tab and Additional Columns tab. The ring control to the left of the **Export** button specifies whether to create new rows in the database or file, or to overwrite any previously written rows for the step or variable group. For databases, if the Additional Columns tab specifies column values that match an existing record, only the records that match these specified values are overwritten.
- **Import**—Imports the properties and variables you specify on the Properties tab and Additional Columns tab.
- **Done**—Closes the Import/Export Properties dialog box.

Source/Destination Tab

The Source/Destination tab specifies from where TestStand imports data or to where TestStand exports data. The Data Location control allows you to specify that TestStand imports/exports data to the clipboard, a file, or a database.

Importing/Exporting Using Files or Clipboard

When you select file or clipboard as the location, the Import/Export Properties dialog box appears as shown in Figure 18-32.



Data Location: File
File Location:
(No file specified)
Format: Tab Delimited Text (.txt)
Decimal Point: Use Station Option Localization Preference
Start of Data Marker:
End of Data Marker:
Skip Rows That Begin With:
☐ First Row of Data Specifies Step Property for Each Column
Specify Column to Step Property Mapping: (Separate property names with commas)
Overwrite Existing File

Figure 18-32. Import/Export Properties Dialog Box—Source/Destination Tab for File

The source of the file-based values can be a tab delimited text file (`.txt`), a comma delimited text file (`.csv`), or an Excel file (`.xls`). The data is in a table format, as shown below:

```
Start Marker
<Step Name>         Limits.Low    Limits.High   Limits.String
Voltage at Pin A    9.0           11.0
Voltage at Pin B    8.5           9.5
Self Test Output                                 "SYSTEM OK"


<Locals>                          Variable Value
Count                             100


<FileGlobals>                       Variable Value
Count                               99
```

```
<StationGlobals>                    Variable Value
Power On                            False
End Marker
```

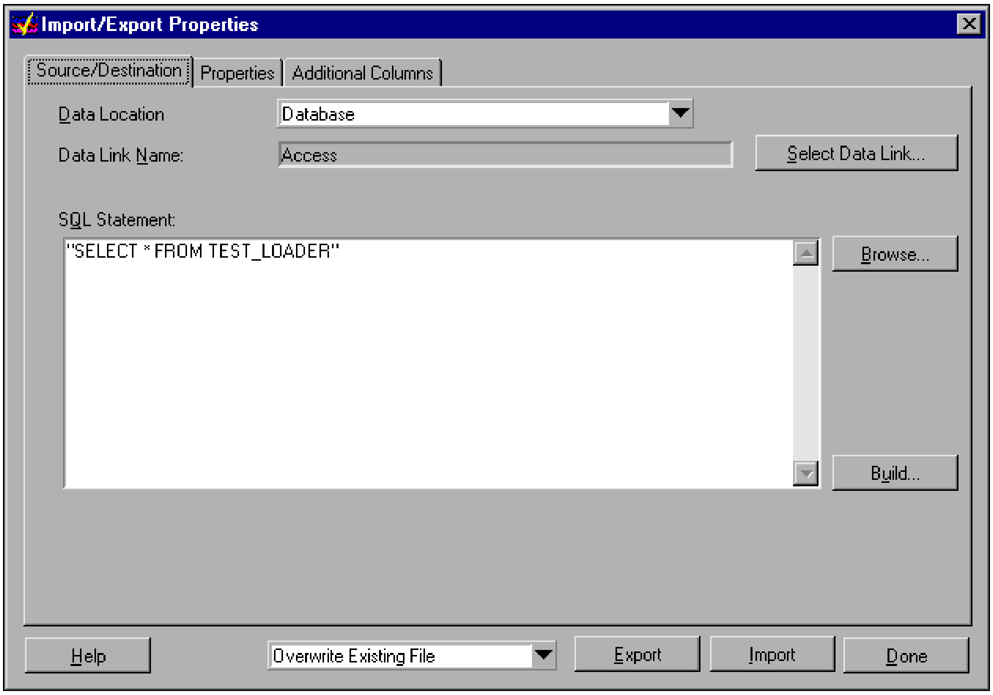
For the step name section, the row names are step names and the column headings are the names of step properties. Not all columns apply to each row. Each row has values only for the columns that define properties that are actually in the step for the row. For variable sections, each row specifies the name of the property and its corresponding value. Starting and ending data markers designate the bounds of the table. A data file can contain more than one block of data. The following is an example of a tab delimited limits file with one data block specified by starting and ending markers.

The Source/Destination tab for file or clipboard locations contain the following controls:

- **File Location**—Specifies the file location. This control is dimmed when you select clipboard as the location.
- **Format**—Specifies the file or clipboard data format. The file format can be tab delimited text (`.txt`), comma delimited text (`.csv`), or Excel file (`.xls`). The clipboard format can be tab delimited text (`.txt`) or comma delimited text (`.csv`).
- **Decimal Point**—Specifies the decimal point setting TestStand uses to import and export properties.
- **Start of Data Marker**—Specifies a string that designates the beginning of a block of limit data. The marker string must appear at the beginning of a row.
- **End of Data Marker**—Specifies the string that designates the end of a block of limit data. The marker string must appear at the beginning of a row.
- **Skip Rows That Begin With**—Causes the import/export command to ignore all rows that begin with the string that you specify in the Skip Rows that Begin With control. This feature is useful when the file includes comment lines.
- **First Row of Data Specifies Step Property for Each Column**—Defines the step property names for each column as the first row of each data block in the file. If you disable this option, you must use the Specify Column to Step Property Mapping text box to specify the list of property names. Separate the property names with commas, as in the following example:

  ```
  Limits.Low,Limits.High,Limits.String
  ```

When you select databases as the location, the Import/Export Properties dialog box appears with an Additional Columns tab. The Source/Destination tab is shown in Figure 18-33.



Data Location: Database
Data Link Name: Access
SQL Statement: "SELECT * FROM TEST_LOADER"
Overwrite Existing File

Figure 18-33. Import/Export Properties Dialog Box—Source/Destination Tab for Databases

The Source/Destination tab for database location contains the following controls:

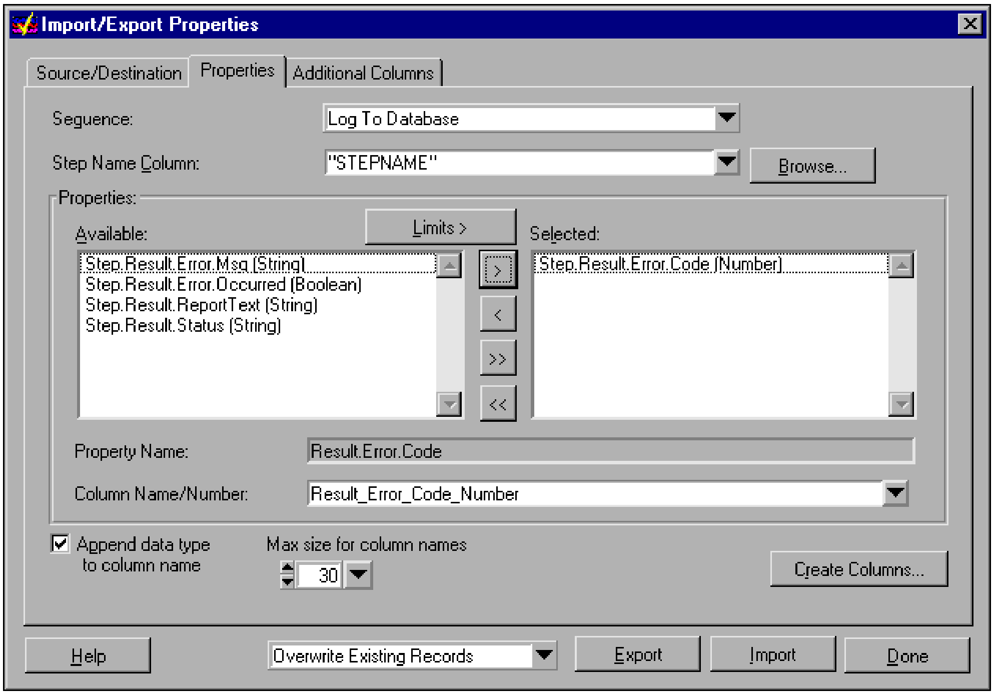
- **Data Link Name**—Contains the name of the data link the dialog box uses to import and to export. You can use the **Select Data Link** button to select a predefined data link from a list. Refer to the *Using Data Links* section earlier in this chapter for more information on predefining data links.
- **SQL Statement**—Specifies the SQL statement the dialog box uses to import and export property and variable values. The SQL statement must return a recordset that includes the column names that you specify.
- **Build**—Allows you to construct the SQL statement. Refer to the *SQL Statement Tab* section earlier in this chapter for more information on

the Build SQL Select Statement. You cannot use the **Build** button to edit an existing SQL statement expression.

You can use the **Browse** button to display the Expression Browser dialog box. You can use the **Help** button to display the online help for this tab.

Properties Tab

Figure 18-34 shows the Properties tab of the Import/Export Properties dialog box.



Import/Export Properties

Source/Destination | Properties | Additional Columns

Sequence: Log To Database

Step Name Column: "STEPNAME"

Properties:

Available:
Step.Result.Error.Msg (String)
Step.Result.Error.Occurred (Boolean)
Step.Result.ReportText (String)
Step.Result.Status (String)

Selected:
Step.Result.Error.Code (Number)

Property Name: Result.Error.Code

Column Name/Number: Result_Error_Code_Number

☑ Append data type to column name

Max size for column names: 30

Overwrite Existing Records

Figure 18-34. Import/Export Properties Dialog Box—Properties Tab

The Properties tab contains the following controls:

- **Sequence**—Selects the sequence to which to import values or from which to export values.
- **Step Name Column**—Specifies the name of the column in the SQL statement that contains the names of the sequence steps and variable scopes that define the rows of data. This control applies only to importing and exporting using a database. You can use the **Browse** button to display the Expression Browser dialog box.

- **Properties**—Specifies the names of variables and properties to import or export and the column names to use for them. The section contains a list of available variable and properties and a list of variables and properties that you select.

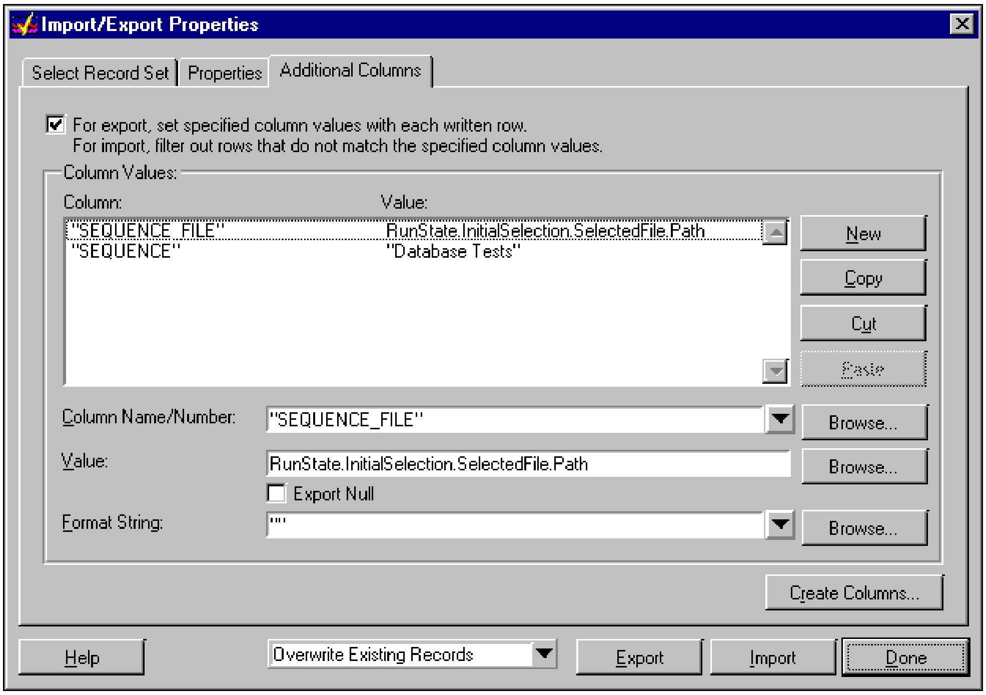
  You can move a single property from one list to the other by clicking on the single arrow buttons. The double arrow buttons move all properties from one list to the other.
- **Property Name**—Displays the currently selected property in the Selected list control. For array element properties, you must edit the property name to specify the array index.
- **Column Name**—Specifies the name of the column where the step imports or exports the property. This control applies only to importing and exporting using a database.
- **Append data type to column name**—Specifies whether TestStand automatically appends the name of the data type of a property to the column name for a property when you select a property from the available list. This control applies only to importing and exporting using a database.
- **Max size for column names**—Specifies the maximum number of characters for a column name. Many databases limit the size of a column name. Use the ring control to select the limits for the DBMS TestStand supports by default. This control applies only to importing and exporting using a database.
- **Create Columns**—Displays the Create Columns dialog box. TestStand automatically populates the dialog box with the list of any column names you specify and that the SQL statement does not return. You typically use the Create Columns dialog box to add new columns to a database table. Refer to *Properties Tab* discussion earlier in this section for more information on using the Create Columns dialog box. This control applies only to importing and exporting using a database.

You can use the **Help** button to display the online help for this tab.

Additional Columns Tab

When you export to a database, the Additional Columns tab defines the set of column values that TestStand writes to the database for each record. When you import from a database, the tab defines the column values that a record must match before TestStand loads values from the record.

Figure 18-35 shows the Additional Columns tab of the Import/Export Properties dialog box.



☑ For export, set specified column values with each written row.
For import, filter out rows that do not match the specified column values.

Column Values:

Column:	Value:
"SEQUENCE_FILE"	RunState.InitialSelection.SelectedFile.Path
"SEQUENCE"	"Database Tests"

Column Name/Number: "SEQUENCE_FILE"

Value: RunState.InitialSelection.SelectedFile.Path

☐ Export Null

Format String: ""

Overwrite Existing Records

Figure 18-35. Import/Export Properties Dialog Box—Additional Columns Tab

The checkbox at the top of the tab enables the controls on the Additional Columns tab. The Additional Columns tab contains the following controls:

- **Column Values**—Specifies the mappings of column names to variables or properties. The list control displays the mappings. The **Column Name/Number**, **Values**, and **Format String** controls specify the settings for the currently selected mapping. You can use the **New**, **Cut**, **Copy**, and **Paste** buttons to create a new item in the list, remove items from the list, and rearrange the items in the list.
- **Column Name/Number**, **Values**, and **Format String** controls must contain valid expressions that TestStand evaluates at run time.

  When you export values, the **Value** control can contain a literal value or an expression that TestStand evaluates at run time. When importing values, the **Value** control must contain the name of a variable or property.

The **Format String** control specifies how to convert a string value when comparing a column value to a string expression. Typically, you use this control when comparing data from a column that is of the date/time or currency type. Refer to the *Format Strings* section later in this chapter for a list of format strings.

- **Create Columns**—Displays the Create Columns dialog box. TestStand automatically populates the dialog box with the list of any column names you specify and that the SQL statement does not return. You typically use the Create Columns dialog box to add new columns to a database table. Refer to *Properties Tab* discussion earlier in this section for more information on using the Create Columns dialog box.

You can use the **Browse** button to display an Expression Browser dialog box for a control that contains a TestStand expression. You can use the **Help** button to display the online help for this tab.

Structured Query Language (SQL)

The Structured Query Language (SQL) is a widely supported standard for database access. You can use SQL commands to manipulate the rows and columns in database tables. The following list describes some of the most useful SQL commands:

- `CREATE TABLE`—Creates a new table, specifying the name and data type for each column.
- `SELECT`—Retrieves all rows in a table that match specific conditions.
- `INSERT`—Adds a new record to the table. You can then assign values for the columns.
- `UPDATE`—Changes values in specific columns for all rows that match specific conditions.
- `DELETE`—Deletes all rows that match specific conditions.

The rest of this section lists and explains the SQL commands, objects, clauses, operators, and functions.

SQL Commands

Table 18-15 lists the SQL commands you can use with the Open SQL Statement step.

Table 18-15. SQL Commands

SQL Command	Syntax	Description	Example
`CREATE TABLE`	`CREATE TABLE` *`table name (column def, column def,...)`*	Creates a new database table.	`CREATE TABLE` *`testres (uut_num`* `char(10) NOT NULL,` *`meas1`* `NUMBER (10,2)` *`meas2`* `NUMBER (10,2))`
`DELETE`	`DELETE [from]` *`table name`* `[WHERE` *`clause`*`]`	Removes rows from a database table. The `WHERE` clause selects specific rows to delete.	`DELETE` *`testres`* `WHERE` *`meas1`* `< 0.0`
`DROP TABLE`	`DROP [TABLE]` *`table_name`*	Removes a database table.	`DROP TABLE` *`testres`*
`INSERT`	`INSERT [into]` *`table_name`* `[`*`options`*`] [(`*`col_name, col_name`*`,...)] VALUES (`*`expr, expr`*`...)`	Creates a new record and places data values into its columns. The `VALUES` clause specifies the values.	`INSERT` *`testres`* `(`*`uut_num`*`,` *`meas1`*`,` *`meas2`*`) VALUES (2860C890, 0.4, 0.6)`

Table 18-15. SQL Commands (Continued)

SQL Command	Syntax	Description	Example
`SELECT`	`SELECT [DISTINCT] {* | `*`col_expr`*`, `*`col_expr`*`...} FROM {`*`from clause`*`} [WHERE `*`clause`*`] [GROUP BY {`*`group clause`*`}}] [HAVING {`*`having clause`*`}] [UNION [ALL] (SELECT...)] [ORDER BY {`*`order_clause`*`,...}] [FOR UPDATE OF {`*`col_expr`*`,...}]`	Query that specifies columns from tables.	`SELECT `*`uut_num`*`, `*`meas1`*` FROM `*`testres`*` WHERE meas1 < 0 ORDER BY `*`uut_num`*` DESC`
`UPDATE`	`UPDATE table_name [`*`options`*`] SET `*`col_name`*` = `*`expr`*`,... [WHERE `*`clause`*`]`	Sets columns in existing rows to new values.	`UPDATE `*`testres`*` SET `*`meas2`*` = (meas1 + 0.1) WHERE `*`meas1`*` < 0`

SQL Objects

Table 18-16 lists SQL objects, which are the building blocks for SQL statements.

Table 18-16. SQL Objects

Object	Description	Examples

`table_name`	Describes the target table name of the operation. For file-based databases, can include full path.	*`Testres`*
		`c:\db\`*`testres`*`.dbf`

`col_name`	Refers to a column in a table. Some databases restrict the length of column names.	*`uut_num`* *`meas1`*

`col_expr`	Specifies a single column name or a complex combination of column names, operators, and functions.	`uut_num`
		`meas1`` + `*`meas2`*
		`LOWER(`*`uut_num`*`)`

`sort_expr`	Any column expression.	—
`data_type`	Specifies the data type of a column.	`CHAR (30) NUMBER (10.5)`

Table 18-16. SQL Objects (Continued)

Object	Description	Examples
`constraint`	Constrains the contents of a column.	`NOT NULL`
`column_defn`	Describes a column to create in a new table. Consists of *`col_name`*, *`data_type`*, and (optional) *`constraint`*.	*`uut_num`* `CHAR(10) NOT NULL` *`meas1`* `NUMBER (10.5)`
`char_expr`	Any expression that yields a character data type.	`'PASSED'` `STR(42.6, 10, 2)`
`date_expr`	Any expression that yields a date data type.	`DATE()`
`num_expr`	Any expression that yields a number data type.	*`meas1`* `+` *`meas2`*
`logical_expr`	Any expression that yields a logical data type.	—
`expr`	Any expression.	—

SQL Clauses

Table 18-17 lists the types of clauses you can use in SQL statements.

Table 18-17. SQL Clauses

Name/Syntax	Applicable Commands	Description	Examples
`FROM` *`table_name`* `[`*`options`*`] [`*`table alias`*`]`	`SELECT` `DELETE`	Specifies table name. Can be a full pathname for file-based databases.	`SELECT * FROM` *`testres`*
`WHERE` *`expr1 comparison_oper expr2`* `[`*`logical_oper expr3 comparison_oper expr4`*`]...`	`SELECT` `DELETE` `UPDATE`	Specifies conditions that apply to each row in the table to determine an active set of rows.	`SELECT * FROM` *`testres`* `WHERE` *`meas1`* `< 0.0 and` *`meas2`* `> 1.0`
`GROUP BY` *`col_expr`* `{`*`col_expr,...`*`}`	`SELECT`	Combines records that have identical values in multiple columns and orders rows by groups.	`SELECT * FROM` *`testres`* `GROUP BY` *`meas1`*

Table 18-17. SQL Clauses (Continued)

Name/Syntax	Applicable Commands	Description	Examples
`HAVING` *`expr1 comparison_oper expr2`*	`SELECT` used with `GROUP BY`	Specifies which grouped records are displayed.	`SELECT * FROM` *`testres`* `GROUP BY` *`uut_num`* `HAVING` *`meas1`* `< 0`
`ORDER BY {`*`sort_expr`* `[DESC | ASC]}...`	`SELECT`	Specifies row order in the active set of rows.	`SELECT * FROM` *`testres`* `ORDER BY` *`uut_num`* `DESC`
`FOR UPDATE OF` *`col_name`* `[`*`col_name`*`...]`	`SELECT`	Locks columns in selected rows for updates or deletion.	`SELECT * FROM` *`testres`* `FOR UPDATE OF` *`meas1, meas2`*

SQL Operators

Table 18-18 lists the operators you can use in SQL statements.

Table 18-18. SQL Operators

Operator Class and Operators	Description	Examples
Constants		
	Numeric constant	`1234, 1234.5678`
`'' ""`	Character constant	'PASSED', “CVI”
`{}`	Date-time constant	{2/8/60},{16:59:59}
`.T. .F.`	Logical constant	.T., .F.
Numeric		
`()`	Operator precedence	(*`meas1`* + *`meas2`*) * (*`meas3`* - *`meas4`*)
`+ -`	Sign	- *`meas1`*
`* /`	Multiply/divide	*`meas1`* * *`meas2`*, *`meas1`* / *`meas2`*
`+ -`	Add/subtract	*`meas1`* + *`meas2`*, *`meas1`* - *`meas2`*
`** ^`	Exponentiation	*`meas1`* ** *power*, *`meas1`* `^ 2`
Character		
`+`	Concatenate (keep trailing blanks)	*'keep ' + 'space' (result: 'keep space')*
`-`	Concatenate (drop trailing blanks)	*'drop ' - 'space' (result: 'dropspace')*

Table 18-18. SQL Operators (Continued)

Operator Class and Operators	Description	Examples
Comparison		
`=`	Equal	`WHERE` *`meas1`* `=` *`meas2`*
`<>`	Not equal	`WHERE` *`meas1`* `<>` *`meas2`*
`>=`	Greater than or equal	`WHERE` *`meas1`* `>=` *`meas2`*
`<=`	Less than or equal	`WHERE` *`meas1`* `<=` *`meas2`*
`IN`	Contained in the set()	`WHERE` *`uut_num`* `IN ('2860A123','2860A1234')`
`[NOT] IN`		`WHERE result NOT IN ('FAILED', 'RETEST')`
`ANY, ALL`	Compare with list of rows	`WHERE` *`uut_num`* `= ANY (SELECT...)`
`BETWEEN`	Within value range	`WHERE` *`meas1`* `BETWEEN 0.0 AND 1.0`
`EXISTS`	Existence of at least one row	`WHERE EXISTS (SELECT...)`
`[NOT] LIKE`	Character pattern match	`WHERE` *`uut_num`* `LIKE 'TEK%'`
`[NOT] NULL`	Empty	`WHERE` *`uut_num`* `NOT NULL`
Date		
`+ -`	Add/subtract	*`testdate`* `+ 5 {`*`result: new date`*`}` *`testdate`* `- {2/8/60}` `(`*`result:number of days`*`)`
Logical		
`()`	Precedence	`WHERE (`*`res1`* `AND` *`res2`*`) OR (`*`res3`* `AND` *`res4`*`)`
`NOT`	Negation	`WHERE NOT (`*`uut_num`* `IN (SELECT...))`
`AND`	And	`WHERE` *`meas1`* `< 0.0 AND` *`meas2`* `> 1.0`
`OR`	Or	`WHERE` *`meas1`* `< 0.0 OR` *`meas2`* `< 1.0`
Set		
`UNION`	Set of all rows from all individual distinct queries	`SELECT ... UNION SELECT...`
Other		
`*`	All columns	`SELECT * FROM` *`testres`*
`COUNT(*)`	Count of all rows	`SELECT COUNT(*) FROM` *`testres`*
`DISTINCT`	Only non-duplicate rows	`SELECT DISTINCT FROM...`

SQL Functions

Table 18-19 lists the functions you can use in SQL statements.

Table 18-19. SQL Functions

Function	Description
`ROUND(num_expr1, num_expr2)`	`num_expr1` rounded to `num_expr2` decimal places.
`CHR(num_expr)`	Character having ASCII value `num_expr`.
`LOWER(char_expr)`	Change all characters in `char_expr` to lower case.
`LTRIM(char_expr)`	Strip leading spaces from `char_expr`.
`LEFT(char_expr)`	Leftmost character of `char_expr`.
`RIGHT(char_expr)`	Rightmost character of `char_expr`.
`SPACE(num_expr)`	Construct a string with `num_expr` blanks.
`IFF(logical_expr, True_Value, False_Value)`	Return `True_Value` if `logical_expr` is true, otherwise return `False_Value`.
`STR(num_expr, width [prec])`	Converts `num_expr` to string of `width` characters with optional `prec` fractional digits.
`STRVAL(expr)`	Converts any `expr` to a character string.
`TIME()`	Returns time of day as a character string.
`LEN(char_expr)`	Number of characters in `char_expr`.
`AVG(column_name)` `(must be numeric column)`	Average of all non-NULL values in `column_name`.
`COUNT(*)`	Number of rows in table.
`MAX(col_expr)`	Maximum value of `col_expr`.
`MIN(col-expr)`	Minimum value of `col_expr`.
`MAX(num_expr1, num_expr2)`	Maximum of `num_expr1` and `num_expr2`.
`MIN(num_expr1, num_expr2)`	Minimum of `num_expr1` and `num_expr2`.
`SUM(col_expr)`	Sum of values in `col_expr`.

Table 18-19. SQL Functions (Continued)

Function	Description
DTOC(date_expr, fmt_value[, separator_char])	Convert *date_expr* to character string using *fmt* and optional *separator_char*. *fmt_values* are: 0: MM/DD/YY 1: DD/YY/MM 2: YY/MM/DD 10: MM/DD/YYYY 11: DD/MM/YYYY 12: YYYY/MM/DD
USERNAME()	Returns name of current user (not supported by all databases).
MOD(num_expr1, num_expr2)	Remainder of *num_expr1* divided by *num_expr2*.
MONTH(date_expr)	Returns month from *date_expr* as a number.
DAY(date_expr)	Returns day from *date_expr* as a number.
YEAR(date_expr)	Returns year from *date_expr* as a number.
POWER(num_expr1, num_expr2)	Returns *num_expr1* raised to *num_expr2* power.
INT(num_expr)	Returns integer part of *num_expr*.

NUMVAL(char_expr)
VAL(char_expr)
	Converts *char_expr* to a number. If *char_expr* is not a valid number, returns zero.

DATE()
TODAY()
	Returns today's date.

DATEVAL(char_expr)	Converts *char_expr* to a date.
CTOD(char_expr, fmt)	Converts *char_expr* to date format using *fmt* template.

Format Strings

Format strings consist of symbols that describe how a value should be formatted. Table 18-20 shows some example format strings. The symbols used in these examples are described later in this section.

Table 18-20. Example Format Strings

Format String	Value	Formatted Value
`mm/dd/yy`	Mar 14, 1995	03/14/95
`dd.mm.yy`	Mar 14, 1995	14.03.95
`'Stephen Hawkins, born' Mmmm d, yyyy`	Mar 14, 1995	Stephen Hawkins, born March 14, 1995
`hh:mm:ss`	3:47:42 PM	15:47:42
`hh:mm:ss AM/PM`	3:47:42 PM	03:47:42 PM
`$#,##0.00`	210.6	$210.60
`$#,##0.00;($#,##0.00)`	210.6 –156.20348	$210.60 ($156.20)
`GN`	153 1.875	153 1,875
`0[S/1000]`	12567 199	12 0

Date/Time Format Strings

Date/time format strings control which parts of the date or time are converted or retrieved, the order of the parts, and how the months and days are abbreviated. Table 18-21 lists the symbols you can use in date/time format strings.

Table 18-21. Symbols for Date/Time Format Strings

Symbol	Description	Example Output
m	Month as number without leading zero.	12, 5
mm	Month as number with leading zero, if applicable.	12, 05
mmm	Month as three-letter abbreviation, lowercase.	mar

Table 18-21. Symbols for Date/Time Format Strings (Continued)

Symbol	Description	Example Output
`Mmm`	Month as three-letter abbreviation, initial cap.	Mar
`MMM`	Month as three-letter abbreviation, uppercase.	MAR
`mmmm`	Month as full name, lowercase.	march
`Mmmm`	Month as full name, initial cap.	March
`MMMM`	Month as full name, uppercase.	MARCH
`d`	Day of the month as number without leading zero.	25, 5
`dd`	Day of the month as number with leading zero, if applicable.	25, 05
`ddd`	Day of the month as three-letter abbreviation, lowercase.	tue
`Ddd`	Day of the month as three-letter abbreviation, initial cap.	Tue
`DDD`	Day of the month as three-letter abbreviation, uppercase.	TUE
`dddd`	Day of the month as full name, lowercase.	tuesday
`Dddd`	Day of the month as full name, initial cap.	Tuesday
`DDDD`	Day of the month as full name, uppercase.	TUESDAY
`yy`	Last two digits of year.	60
`yyyy`	Four-digit year.	1960
`h`	Hour of the day, without leading zero (use am/pm symbol for 12-hour style).	12, 5
`hh`	Hour of the day, with leading zero (use am/pm symbol for 12-hour style).	12, 05
`i` (or `m`)	Minute of the hour, without leading zero.	57, 5
`ii` (or `mm`)	Minute of the hour, with leading zero.	57, 05
`s`	Second of the minute, without leading zero.	57, 5
`ss`	Second of the minute, with leading zero.	57, 05
`ss.ssssss`	Second of the minute with fractional seconds (up to six ‘s’ symbols after the decimal point).	57.123456
am/pm	“am” or “pm” string, lowercase (forces 12-hour clock).	am

Table 18-21. Symbols for Date/Time Format Strings (Continued)

Symbol	Description	Example Output
AM/PM	“AM” or “PM” string, uppercase (forces 12-hour clock).	AM
a/p	“a” or “p” string (forces 12-hour clock).	a
A/P	“A” or “P” string, uppercase (forces 12-hour clock).	A
/ - . : , <space>	Output the character.	—
\<character>	Output the character following the ‘\’ character.	\U\T\C is UTC
"<string>" '<string>'	Output the string.	“UTC” is UTC
`GD`	General format for dates is The Short Date Format in the International section of the Windows Control Panel. **Note:** Do not combine other format symbols with `GD` except `[US]`.	—
`GDT`	General format for dates with times. The Time Format in the Regional Settings section of the Windows Control Panel is appended to the Short Date Style. This is the default if no format string is given. **Note:** Do not combine other format symbols with `GDT` except `[US]`.	—
`GL`	General long format for dates. The Long Date Style in the Regional Settings section of the Windows Control Panel. **Note:** Do not combine other format symbols with `GL` except `[US]`.	—
`GLT`	General long format for dates with times. The Time Style in the Regional Settings section of the Windows Control Panel is appended to the Long Date Format. **Note:** Do not combine other format symbols with `GLT` except `[US]`.	—

Table 18-21. Symbols for Date/Time Format Strings (Continued)

Symbol	Description	Example Output
`GT`	General format for time. The Time Style in the Regional Settings section of the Windows Control Panel. **Note:** Do not combine other format symbols with `GT`.	—
`[US]`	Combine with `GD`, `GDT`, `GL`, `GLT`, or `GT` to override the Regional Settings section of the Windows Control Panel and use the United States defaults instead.	—

Numeric Format Strings

You can use numeric format strings to format numbers in a variety of ways. Numeric formats can have one or two sections separated by a semicolon. For formats with one section, use the same format for positive and negative numbers. For formats with two sections, use the second section as the format for negative numbers. Table 18-22 lists the symbols you can use in numeric format strings.

Table 18-22. Symbols for Numeric Format Strings

Symbol	Description
`$`	Outputs the currency string from the Regional Settings section of the Windows Control Panel.
`.`	Outputs the decimal point character from the Regional Settings section of the Windows Control Panel.
`,`	Outputs the thousands separator character from the Regional Settings section of the Windows Control Panel.
`#`	Outputs a digit. If there is no digit in the position, outputs nothing.
`0`	Outputs a digit. If there is no digit in the position, outputs a zero.
`?`	Outputs a digit. If there is no digit in the position, outputs a space.
`%`	Outputs the value as a percent. The value is multiplied by 100, and the '%' character is output.
`e-`	Outputs in scientific notation, shows exponent sign only if negative.
`e+`	Outputs in scientific notation, always shows exponent sign.
`E+ E-`	Outputs uppercase analogs of `e+` and `e-`.

Table 18-22. Symbols for Numeric Format Strings (Continued)

Symbol	Description
`- + (),` <space>	Outputs the character.
\<character>	Outputs the character following the '\' character.
"<string>" '<string>'	Outputs the string.
`GN`	General format for numbers. This is the default if no format string is given. **Note:** You can combine `GN` only with symbols that are enclosed in brackets, such as `[US]`.
`GF`	General fixed format for numbers from the Regional Settings section of the Windows Control Panel. **Note:** You can combine `GF` only with symbols that are enclosed in brackets, such as `[US]`.
`GC`	General currency format for numbers from the Regional Settings section of the Windows Control Panel. **Note:** You can combine `GC` only with symbols that are enclosed in brackets, such as `[US]`.
`[S/`*`n`*`]`	Scales (divides) the number by a power of 10 before output. *n* must be a power of 10.
`[S*`*`n`*`]`	Scales (multiplies) the number by a power of 10 before output. *n* must be a power of 10.
`[US]`	Ignores the information in the Regional Settings section of the Windows Control Panel. Substitutes the United States defaults instead.

A Technical Support Resources

Web Support

National Instruments Web support is your first stop for help in solving installation, configuration, and application problems and questions. Online problem-solving and diagnostic resources include frequently asked questions, knowledge bases, product-specific troubleshooting wizards, manuals, drivers, software updates, and more. Web support is available through the Technical Support section of `ni.com`

NI Developer Zone

The NI Developer Zone at `ni.com/zone` is the essential resource for building measurement and automation systems. At the NI Developer Zone, you can easily access the latest example programs, system configurators, tutorials, technical news, as well as a community of developers ready to share their own techniques.

Customer Education

National Instruments provides a number of alternatives to satisfy your training needs, from self-paced tutorials, videos, and interactive CDs to instructor-led hands-on courses at locations around the world. Visit the Customer Education section of `ni.com` for online course schedules, syllabi, training centers, and class registration.

System Integration

If you have time constraints, limited in-house technical resources, or other dilemmas, you may prefer to employ consulting or system integration services. You can rely on the expertise available through our worldwide network of Alliance Program members. To find out more about our Alliance system integration solutions, visit the System Integration section of `ni.com`

Worldwide Support

National Instruments has offices located around the world to help address your support needs. You can access our branch office Web sites from the Worldwide Offices section of `ni.com`. Branch office Web sites provide up-to-date contact information, support phone numbers, e-mail addresses, and current events.

If you have searched the technical support resources on our Web site and still cannot find the answers you need, contact your local office or National Instruments corporate. Phone numbers for our worldwide offices are listed at the front of this manual.

Glossary

Prefix	Meaning	Value
m-	milli-	10^{-3}
k-	kilo-	10^{3}
M-	mega-	10^{6}

A

abort	To stop an execution without running any of the Cleanup step groups in the sequences on the call stack run. When you abort an execution, no report generation occurs.
active window	The window that user input affects at a given moment. The title of an active window is highlighted.
ActiveX (Microsoft ActiveX)	Set of Microsoft technologies for reusable software components. Formerly called *OLE*.
ActiveX control	A reusable software component that adds functionality to any compatible ActiveX control container.
ActiveX Automation Adapter	*See* Adapter.
ActiveX reference property	A container of information that maintains a reference to an ActiveX object. TestStand maintains the value of the property as an `IDispatch` or `IUnknown` pointer.
ActiveX server	Any executable code that makes itself available to other applications according to the ActiveX standard. ActiveX implies a client/server relationship in which the client requests objects from the server and asks the server to perform actions on the objects.

Adapter	A service of the TestStand engine that steps use to invoke code in another sequence or in a code module. The adapter knows the type of the code module, how to call it, and how to pass parameters to it. The following Adapters are available: DLL Flexible Prototype Adapter, LabVIEW Standard Prototype Adapter, C/CVI Standard Prototype Adapter, and ActiveX Automation Adapter. The general name for all the specific adapters is *module adapter*.
administrator	A user profile that usually contains all privileges for a test station.
Application Development Environment (ADE)	A programming environment such as LabVIEW, LabWindows/CVI, or Microsoft Visual C, in which you can create test modules and run-time execution operator interfaces.
Application Programming Interface (API)	A set of classes, methods, and properties that you use to control a specific service, such as the TestStand engine.
array property	A property that contains an array of single-valued properties of the same type.
ASCII	American Standard Code for Information Interchange.

B

binding	*See* early binding and late binding.
block diagram	Pictorial description or representation of a program or algorithm. In LabVIEW, the block diagram that consists of executable icons called nodes and wires that carry data between the nodes, is the source code for the VI. The block diagram resides in the Diagram window of the VI.
breakpoint	An interruption in the execution of a program.
built-in property	A property that all steps or sequences contain. An example is the step run mode property. TestStand normally does not display these properties in the sequence editor, although it lets you modify some of them through dialog boxes.
built-in step type property	A property that is common to all steps of the same type. A built-in step type property is either a class step type property or an instance step type property.

button	A dialog box item that, when selected, executes a command associated with the dialog box.

C

C/CVI Standard Prototype Adapter	*See* Adapter.
checkbox	An input control in a dialog box that allows you to toggle between two possible options.
class	Defines a list of methods and properties that you can use with respect to the objects that you create as instances of that class. A class is like a data type definition except that it applies to objects rather than variables.
class step type property	A built-in step property that exists only in the step type itself. TestStand uses these properties to define how the step type works for all step instances. Step instances do not contain their own copies of class properties.
client sequence file	A sequence file that contains the main sequence that a process model invokes to test a UUT. Each client sequence file contains a sequence called `MainSequence`. The process model defines what is constant about your testing process, whereas the client sequence file defines the steps that are unique to the different types of tests you run.
clipboard	A temporary storage area the operating system uses to hold data that you cut, copy, or delete from a work area.
cluster	A set of ordered, unindexed data elements in LabVIEW of any data type including numeric, Boolean, string, array, or cluster. The elements must be all controls or all indicators.
code module	A program module, such as a Windows Dynamic Link Library (`.dll`) or LabVIEW VI (`.vi`), that contains one or more functions that perform a specific test or other action. The module adapters in TestStand call many types of code modules.
code template	A source file that contains skeleton code. The skeleton code serves as a starting point for the development of code modules for steps that use a particular step type.

configuration entry point	A sequence in the process model file that configures a feature of the process model. Configuration entry points usually save configuration information in a `.ini` file in the `TestStand\cfg` directory. By default, configuration entry points appear in the **Configure** menu. For example, the default process model contains the configuration entry point `Config Report Options`. The `Config Report Options` entry point appears as **Report Options** in the **Configure** menu.
connector	Part of a LabVIEW VI or function node that contains its input and output terminals, through which data passes to and from the node.
container property	A property that contains no values, and typically contains multiple subproperties. Container properties are analogous to structures in C/C++ and to clusters in LabVIEW.
context menu	Menus that appears when you right-click an object. The menu items that appear pertain to that object specifically.
control	An input and output device in a panel or window in which you enter data or make a setting.
control flow	The sequential order of instructions that determines execution order.
custom named data type	A data type that you define and name. For example, you might create a `Transmitter` data type that contains subproperties such as number of channels, `NumChannels`, and power level, `PowerLevel`.
custom property	A property that you define in a step type. Each step you create with the step type has its own copy of the custom property. TestStand uses the value that you specify for the custom property in the step type as the initial value of the property in each new step you create. Normally, after you create a step, you can change the value of the property in the step.

D

developer	A user profile that usually contains all privileges associated with operating, debugging, and developing sequences and sequence files, but excludes configuration of user privileges, report options, and database options.
dialog box	A user interface in which you specify additional information for the completion of a command.

DLL	dynamic link library
DLL Flexible Prototype Adapter	*See* Adapter.

E

early binding	Setting that causes the ActiveX Automation Adapter to use IDs to specify to automation servers what operations to perform on objects. *See* late binding.
Edit substep	A substep that the engine calls when a developer or user edits the step. You invoke the substep with the menu item that appears in the context menu above **Specify Module**. The Edit substep displays a dialog box in which the sequence developer edits the values of custom step properties. For example, the Edit Limits item appears in the context menu for Numeric Limit test steps, and the Edit Pass/Fail Source item appears in the context menu for Pass/Fail test steps.
engine	A module or set of modules that provide an API for creating, editing, executing, and debugging sequences. A sequence editor or run-time execution operator interface uses the services of a test executive engine.
engine callback	A sequence that TestStand invokes at specific points during execution. You use engine callbacks to tell TestStand to call certain sequences before and after the execution of individual steps, before and after interactive executions, after loading a sequence file, and before unloading a sequence file.
entry point	A sequence in the process model file that TestStand displays as a menu item, such as `Test UUTs`, `Single Pass`, and `Report Options`.
error occurred flag	A Boolean flag, `Step.Result.Error.Occurred`, that indicates whether a run-time error occurred in a step.
execution	An object that contains all the information TestStand needs to run a sequence, its steps, and any subsequences it calls. Typically, the TestStand sequence editor creates a new window for each execution.

execution entry point	A sequence in a process model that runs tests against a UUT. Execution entry points call the `MainSequence` callback in the client sequence file. The default process model contains two execution entry points: `Test UUTs` and `Single Pass`. By default, execution entry points appear in the **Execute** menu. Execution entry points appear in the menu only when the active window contains a sequence file that has a `MainSequence` callback.
Execution window	A window in the sequence editor or operator interface that displays the steps that an execution runs. When execution is suspended, the execution window displays the next step to execute and provides single-stepping options. In the sequence editor you also can view variables and properties for any active sequence context in the call stack.
expression	A formula that calculates a new value from the values of multiple variable or properties. In expressions, you can access all variables and properties in the sequence context that is active when TestStand evaluates the expression. The following is an example of an expression: `Locals.MidBandFrequency = (Step.HighFrequency + Step.LowFrequency) / 2`

F

front-end callback	A common sequence that the sequence editor and run-time operator interfaces call. Front-end callbacks allow multiple applications to share the same implementation for a specific operation. TestStand installs the sequence file `FrontEndCallback.seq`, which contains the front-end callback sequence, `LoginLogout`.
front-end callback sequence file	A sequence file that contains front-end callbacks. TestStand installs the sequence file `FrontEndCallback.seq`, which contains the front-end callback sequence, `LoginLogout`.
front panel	The interactive user interface of a LabVIEW VI. Modeled from the front panel of physical instruments, it is composed of switches, slides, meters, graphs, charts, gauges, LEDs, and other controls and indicators.

G

global variable	TestStand defines two types of globals: sequence file globals and station globals. Sequence file globals are accessible by any sequence or step in the sequence file. Station globals are accessible by any sequence file loaded on the station. The values of station global variables are persistent across different executions and even across different invocations of TestStand.
GUI	*See* run-time operator interface.

H

hex	hexadecimal
highlight	The way in which input focus appears on a TestStand screen.To move the input focus onto an item.

I

`IDispatch` pointer	A pointer to an interface that exposes objects, methods, and properties to Automation programming tools and other applications.
in-process	When executable code runs in the same process space as the client, in other words, an ActiveX server in a dynamic-link library (DLL).
instance step type property	A built-in step property that exists in each step instance. Each step that you create with the step type has its own copy of the property. TestStand uses the value you specify for an instance property in the step type as the initial value of the property in each new step that you create. Normally, after you create a step, you can change the values of its instance properties.
interactive mode	When you run steps by selecting one or more steps in a sequence and choosing the **Run Selected Steps** or **Loop Selected Steps** items in the context menu or menu bar. The selected steps in the sequence execute, regardless of any branching logic that the sequence contains. The selected steps run in the order in which they appear in the sequence.
`IUnknown` pointer	An interface, provided by all ActiveX objects, that enables you to control the lifetime and obtain other interfaces of an object.

K

kill	To stop a running, terminating, or aborting execution by terminating the thread of the execution without any cleanup of memory. This action can leave TestStand in an unreliable state.

L

LabVIEW	Laboratory Virtual Instrument Engineering Workbench. A program development application based on the programming language G and used commonly for test and measurement purposes.
LabVIEW Standard Prototype Adapter	*See* Adapter.
late binding	Setting that causes the ActiveX Automation Adapter to use names to specify to a server what operations to perform on objects. *See* early binding.
list box	A control that displays a list of possible choices.
local variable	A property of a sequence that holds a value or additional subproperties. Only a step within the sequence can directly access the property value.

M

main sequence	The sequence that initiates the tests on a UUT. The process model invokes the main sequence as part of the overall testing process. The process model defines what is constant about your testing process, whereas main sequences define the steps that are unique to the different types of tests you run.
MB	Megabytes of memory.
menu bar	Horizontal bar that contains names of main menus.
method	Performs an operation or function on an object.
MFC	Microsoft Foundation Class Library
model callback	A mechanism that allows a sequence file to customize the default behavior of a sequence in the process model.

model sequence file	A special type of sequence file that contains process model sequences. The sequences within the model sequence file direct the high-level sequence flow of an execution when you test a UUT.
module adapter	A component that the TestStand engine uses to invoke code in another sequence or in a code module from another ADE, such as LabVIEW. When the adapter invokes code in a code module, the adapter knows how to call the code module and how to pass parameters to it.

N

named data type	A type of variable or property that you give a unique name. The data type usually contains multiple subproperties thus creating an arbitrarily complex data structure. All variables or properties that use the data type have the same data structure, but the values they contain can differ.
nested interactive execution	When you run steps interactively from an execution window for a normal execution that is suspended at a breakpoint. You can run steps only in the sequence and step group in which execution is suspended. The selected steps run within the context of the normal execution.
normal execution	When you start an execution in the sequence editor by selecting the **Run *Sequence Name*** item or one of the process model entry points from the **Execute** menu, where ***Sequence Name*** is the name of the sequence that you are running.
normal sequence file	Any sequence file containing sequences that test UUTs.
numeric property	A 64-bit floating-point value in the IEEE 754 format.

O

object	A service that an ActiveX server makes available to clients.
operator	A user profile that usually contains all privileges associated with operating a test station, but excludes debugging of sequence executions, editing of sequence files, and configuration of user privileges, station options, report options, and database options.
operator interface	*See* run-time operator interface.
out-of-process	When executable code does not run in the same process space as the client, such as an ActiveX server in an executable.

P

pop-up menus	*See* context menu.
post actions	Actions that TestStand takes depending on the pass/fail status of the step or a custom condition that the engine evaluates after executing a step. Post actions allow you to execute callbacks or jump to other steps after executing the step.
Post Step substep	A substep that the engine invokes after calling a step module. A Post Step substep might call a code module that compares the values the step module stored in step properties against limit values that the Edit substep stored in other step properties.
Pre Step substep	A substep that the engine invokes before calling the step module. For example, a Pre Step substep might call a code module that retrieves measurement configuration parameters and stores them into step properties for use by the step module.
preconditions	A set of conditions for a step that must be true for TestStand to execute the step during the normal flow of execution in a sequence.
process model	A series of operations before and after a test executive executes the sequence that performs the tests. Common operations include identifying the UUT, notifying the operator of pass/fail status, generating a test report, and logging results.
property	A container of information, which stores and maintains a setting or attribute of an object. A property can contain a single value, an array of values of the same type, or no value at all. A property also can contain any number of subproperties. Each property has a name.
property-array property	A property containing a value that is an array of subproperties of a single type. In addition to the array of subproperties, property-array properties can contain any number of subproperties of other types.

R

reference count	Information that each ActiveX object uses to keep track of the number of things that reference it. This allows the object to determine when to free the resources it uses.
reference property	*See* ActiveX reference property.

resource string	Text strings stored in an external file so that you can alter the strings without directly altering the application.
root interactive execution	When you run selected steps from a Sequence File window in an independent execution. Root interactive executions do not invoke process models.
RTF	rich text format
run mode	The mode in which you execute a step, such as normal, skip, force pass, or force fail.
run-time error	An error condition that forces an execution to terminate. When the error occurs while running a sequence, TestStand jumps to the Cleanup step group, and the error propagates to any calling sequence up through to the top-level sequence.
run-time operator interface	A program that provides a graphical user interface (GUI) for executing sequences on a production station. Sometimes the sequence editor and run-time operator interfaces are different aspects of the same program.
RunState	Contains properties that describe the state of execution in the sequence invocation. Refer to Table 8-3, *RunState Subproperty in the Sequence Context*, for the contents of the RunState property.

S

s	seconds
sequence	A series of steps that you specify for execution in a particular order. Whether and when a step is executed can depend on the results of previous steps.
SequenceContext	A TestStand object that contains references to all global variables and all local variables and step properties in active sequences. The contents of the sequence context changes depending on the currently executing sequence and step.
sequence editor	A program that provides a graphical user interface for creating, editing, and debugging sequences.
sequence file	A file that contains the definition of one or more sequences.

single-valued property	A property that contains a single value. TestStand has four types of these properties: Number properties, String properties, Boolean properties, and ActiveX reference properties.
source code template	A set of source files that contain skeleton code, which serves as a starting point for the development of code modules for steps. TestStand uses the source code template when a sequence developer clicks the **Create Code** button on the Source Code tab in the Specify Module dialog box for a step.
SQL Null	An empty column in a row in a database table.
standard named data type	A data type that TestStand defines and names. You can add subproperties to the standard data types, but you cannot delete any of their built-in subproperties. The standard named data types are `Path`, `Error`, and `CommonResults`.
station	A complete TestStand test implementation that operators, developers, and administrators use to perform tests.
station callback sequence file	A sequence file that contains the station callback sequences. Station callbacks run before and after the engine executes each step in any normal or interactive execution.
station globals	Variables that are persistent across different executions and even across different invocations of the sequence editor or run-time operator interfaces. The TestStand engine maintains the value of station global variables in a file on the run-time computer.
station model	A process model that you select to use for all sequence files for a station. The TestStand installation program establishes `SequentialModel.seq` as the default station model file. You use the Station Options dialog box to select a different station model.
step	Any action, such calling a test module to perform a specific test, that you can include within a sequence of other actions.
step group	A set of steps in a sequence. A sequence contains the following groups of steps: Setup, Main, and Cleanup. When TestStand executes a sequence, the steps in the Setup group execute first, the steps in the Main group execute next, and the steps in the Cleanup group execute last.
step module	The code module that a step calls.
step property	A property of a step.

step result	A container property that contains a copy of the subproperties from the `Result` property of a step and additional execution information such as the name of the step and its position in the sequence. TestStand automatically creates a step result as each step executes and places the step result into a result list that TestStand uses to generate its reports.
step status	A string value that indicates the status of a step in an execution. Every step in TestStand has a `Result.Status` property. Although TestStand imposes no restrictions on the values to which the step or its code module can set the status property, TestStand and the built-in step types use and recognize a predefined set of values.
step type	A component that defines a set of custom step properties and standard behavior for each step of that type. All steps of the same type have the same properties, but the values of the properties can differ. Step types define their standard behaviors using substeps.
step-type-specific dialog box	A dialog box that step types display when you invoke their Edit substep. The dialog box lets you modify step properties that are specific to the step type. You invoke the dialog box with the menu item that appears in the context menu above **Specify Module**. For example, the **Edit Limits** item appears in the context menu for Numeric Limit test steps, and the **Edit Pass/Fail Source** item appears in the context menu for Pass/Fail test steps.
subsequence	A sequence that another sequence calls. You specify a subsequence call as a step in the calling sequence.
substep	Actions that a step type performs for a step other than calling the step module. You define a substep by selecting an adapter and specifying a module call. TestStand defines three different types of substeps: Edit substep, Pre Step substep, and Post Step substep.
substep module	The code module that a Edit, Pre Step, or Post Step substep calls.

T

technician	A user profile that usually contains all privileges associated with operating, and debugging sequences and sequences files, but excludes editing of sequence files and configuration of user privileges, station options, report options, and database options.

template	*See* code template.
terminal	Object or region on a LabVIEW VI node through which data passes.
terminate	To stop an execution by halting the normal execution flow and running all the Cleanup step groups in the sequences on the call stack.
test executive engine	*See* engine.
test module	A code module that performs a test.
ThisContext	Holds a reference to the current sequence context. You usually use this property to pass the entire sequence context as an argument to a subsequence or a step module. See also *SequenceContext*.

U

Unit Under Test (UUT)	The device or component that you are testing.
user manager	The component of the TestStand engine that maintains a list of users, their login names and passwords, and their privileges. You can access the user manager from the User Manager window in the sequence editor.

V

variables	Properties that you can freely create in certain contexts. You can have variables that are global to a sequence file or local to a particular sequence. You also can have station global variables.
variables window	A window that shows the values of all the currently active variables or properties.
variant	Data type that can hold any defined type of data.
VI	Virtual instrument.
VI library	Special file of type `.LLB` that contains a collection of related VIs for a specific use.

W

watch window	A window that shows the values of user-selectable variables and expressions that are currently active.
window	A working area that supports specific tasks related to developing and executing programs.
wire	Tool used in LabVIEW to define data paths between source and sink terminals.

Index

A

Abort control, Parallel Model Test UUTs dialog box, 14-6
Abort (no cleanup) command, Debug menu, 4-19
Abort All control, Parallel Model Test UUTs dialog box, 14-6
Abort All (no cleanup) command, Debug menu, 4-20
Abort Immediately option, Run-Time Error dialog box, 6-30
aborting execution, 1-26
Acquire operation, Semaphore step
  Acquire Lifetime control, 11-15
  Auto Release control, 11-14
  illustration, 11-14
  Semaphore Name or Reference Expression control, 11-14
  Timeout Causes Run-Time Error control, 11-15
  Timeout Enabled control, 11-15
  Timeout Expression control, 11-15
Action steps, 10-4
ActiveX Automation Adapter, 13-51 to 13-60
  configuring, 13-56 to 13-58
    Automation Adapter Configuration dialog box (figure), 13-56
    Enable Run-time ActiveX Reference Type Checking, 13-57 to 13-58
    Show ActiveX Controls When Specifying a Module, 13-58
    Show Method Arguments in Step Description, 13-58
    Unload Unused ActiveX Servers After Execution, 13-58
    Use Late Binding control, 13-57
  running and debugging servers, 13-55 to 13-56
  specifying in Edit Automation Call dialog box, 13-51 to 13-55
    ActiveX Reference control, 13-51 to 13-52
    Automation Server control, 13-52
    Call Method or Access Property section, 13-53
    Create Object control, 13-52 to 13-53
    Object Class control, 13-52
    Parameters control, 13-54
  using with TestStand, 13-58 to 13-60
    compatibility issues with Visual Basic, 13-58 to 13-60
    registering servers, 13-58
  variant data types supported (table), 13-55
ActiveX Automation code modules, distributing, 17-14
ActiveX Data Objects (ADO), 18-3
ActiveX Reference to Thread control
  Add Thread operation, 11-64
  Remove Thread operation, 11-65
ActiveX references, modifying, 9-11
Adapter Configuration dialog box, 13-3
adapters. *See* module adapters.
Adapters command, Configure menu, 3-3, 4-35
Add control, Customize Tool Menu dialog box, 4-42
Add/Remove Columns control, Build SQL Select Statement dialog box, 18-54
Add Thread operation, Batch Specification step, 11-63 to 11-64
  ActiveX Reference to Thread control, 11-64
  Batch Name or Reference Expression control, 11-64
  illustration, 11-63 to 11-64
  Order Number control, 11-64
Add Watch command, Watch Expression pane, 6-13

Additional Columns tab, Import/Export Properties dialog box, 18-83 to 18-85
  Column Name/Number control, 18-84
  Column Values control, 18-84
  Create Columns control, 18-85
  Format String control, 18-84 to 18-85
  illustration, 18-84
  Value control, 18-84
ADO (ActiveX Data Objects), 18-3
Advanced tab
  Data Link Properties dialog box, 18-38
  Sequence File Properties dialog box, 5-8 to 5-9, 14-11
Advanced tab, Edit Open SQL Statement dialog box, 18-54 to 18-57
  Cache Size control, 18-55
  Command Timeout control, 18-55
  Command Type control, 18-56 to 18-57
  Cursor Location control, 18-56
  Cursor Type control, 18-55 to 18-56
  illustration, 18-55
  Lock Type control, 18-56
  Marshal Options control, 18-56
  Max Records to Select control, 18-55
  Page Size in Records control, 18-55
Align Left control, Numeric Format dialog box, 9-14
All Sequences view context menu, 5-3 to 5-5
  Browse Sequence Context command, 5-3
  Insert Sequence command, 5-3
  Open Sequence command, 5-3
  Rename command, 5-3
  Sequence File Callbacks command, 5-10 to 5-11
  Sequence File Properties command, 5-6 to 5-9
  Sequence Properties command, 5-3 to 5-5
  View Contents command, 5-3
All tab, Data Link Properties dialog box, 18-39
AllOf block, Preconditions dialog box, 5-39
Already Exists control, Create operation
  Batch Specification step, 11-63
  Lock step, 11-6
  Notification step, 11-36
  Queue step, 11-24
  Rendezvous step, 11-20
  Semaphore step, 11-13
AnyOf block, Preconditions dialog box, 5-39
Append data type to column name control
  Properties tab, Import/Export Properties dialog box, 18-83
  Properties tab, Property Loader dialog box, 18-72
Application Development Environment (ADE), 1-2
Arbitrary expression, Preconditions dialog box, 5-39
architecture of TestStand. *See* TestStand architecture overview.
Argument Expression control, Configure Call Executable dialog box, 10-26
Arguments control, Customize Tool Menu dialog box, 4-43
arithmetic operators (table), 8-16
Array Bounds dialog box
  array sizing, 9-6 to 9-7
  empty arrays, 9-8
array function operators (table), 8-17 to 8-18
Array of submenu, 9-6
Array parameters, specifying for DLL Flexible Prototype Adapter, 13-10 to 13-11
arrays
  array property, 1-10
  dynamic array sizing, 9-7 to 9-8
  empty arrays, 9-8
  modifying values, 9-12
  specifying array sizes, 9-6 to 9-7
Assemble Test VIs for Run-time Distribution command, Tools menu, 4-40
assignment operators (table), 8-16

Attach to File control, General tab
custom data type Properties dialog box, 9-24
Step Type Properties dialog box, 9-38
attributes of synchronization objects, 11-2 to 11-4
lifetime, 11-3 to 11-4
name, 11-2 to 11-3
timeout, 11-4
Auto Clear After Notifying One Thread, Set operation, Notification step, 11-38
Auto Increment Sequence File Version option, Preferences tab, 4-28
Auto Release control, Acquire operation, Semaphore step, 11-14
Auto-Load Library Configuration dialog box, 13-37
automatic result collection. *See* result collection.
Automatically Login Windows System User option, User Manager tab, 4-31

B

Backup Sequence Files When Resaving in Older or Newer Format option, Sequence Editor Options dialog box, 4-21
Batch Exists? control, Get Status operation, 11-66
Batch model, 14-6 to 14-9
Batch Results dialog box, 14-8 to 14-9
Batch UUT Identification dialog box, 14-7 to 14-8
overview, 14-6
Batch Name Expression control, Create operation, 11-63
Batch Name or Reference Expression control
Add Thread operation, 11-64
Get Status operation, 11-66
Batch Reference Lifetime control, Create operation, 11-63
Batch Results dialog box, 14-8 to 14-9
Batch Serial Number control, 14-9
illustration, 14-8
Next Batch control, 14-9
Status Message control, 14-9
Test Socket control, 14-9
UUT Serial Number control, 14-9
View Batch Report control, 14-9
View Report control, 14-9
Batch Serial Number control
Batch Results dialog box, 14-9
Batch UUT Identification dialog box, 14-7
Batch Specification step, 11-62 to 11-68
Add Thread operation, 11-63 to 11-64
ActiveX Reference to Thread control, 11-64
Batch Name or Reference Expression control, 11-64
illustration, 11-63 to 11-64
Order Number control, 11-64
Create operation, 11-62 to 11-63
Already Exists control, 11-63
Batch Name Expression control, 11-63
Batch Reference Lifetime control, 11-63
Default Batch Synchronization control, 11-63
illustration, 11-62
Get Status operation, 11-66 to 11-67
Batch Exists? control, 11-66
Batch Name or Reference Expression control, 11-66
Default Batch Synchronization control, 11-67
illustration, 11-66
Number of Threads in Batch control, 11-67

Number of Threads Waiting at Synchronized Sections control, 11-66
Remove Thread operation
ActiveX Reference to Thread control, 11-65
illustration, 11-65
step properties, 11-67 to 11-68
batch synchronization object, 11-1 to 11-2
Batch Synchronization step, 11-56 to 11-61
Enter Synchronized Section operation, 11-59
illustration, 11-59
Section Name control, 11-59
Section Type control, 11-59
Timeout Causes Run-Time Error control, 11-51
Timeout Enabled control, 11-44
Timeout Expression control, 11-44
Exit Synchronized Section operation, 11-60
Exit operation requirements, 11-58
illustration, 11-60
Section Name control, 11-60
Timeout Causes Run-Time Error control, 11-60
Timeout Enabled control, 11-60
Timeout Expression control, 11-60
requirements for using Enter and Exit operations, 11-58
step properties, 11-61
synchronized sections, 11-56 to 11-58
mismatched sections, 11-58
nested sections, 11-58
one-thread-only section, 11-57
parallel sections, 11-57
serial sections, 11-57
Batch UUT Identification dialog box, 14-7 to 14-8
Batch Serial Number control, 14-7
Disable Test Socket control, 14-8
Go control, 14-8
illustration, 14-7
Status Message control, 14-8
Stop control, 14-8
Test Socket control, 14-7
UUT Serial Number control, 14-7
bitwise operators (table), 8-16
Bounds tab, custom data types Properties dialog box, 9-24
Break command, Debug menu, 4-19
Break All command, Debug menu, 4-19
Break on First Step command, Execute menu, 4-17
Break option
Post Actions tab, 5-26
Run-Time Error dialog box, 6-31
Breakpoint option, Run Options tab, 5-23
breakpoints
enabling/disabling, 4-22
toggling, 5-17
Browse Sequence Context command
All Sequences view context menu, 5-3
Globals View context menu, 7-3
Locals tab context menu, 5-37
Parameters tab context menu, 5-33
Sequence File Globals view context menu, 5-44
Step Group context menu, 5-19
View menu, 4-13 to 4-14
Build control
Source/Destination tab, Import/Export Properties dialog box, 18-81
SQL statement tab, Edit Open SQL Statement dialog box, 18-53 to 18-54
Build SQL Select Statement dialog box
Add/Remove Columns control, 18-54
Data Link Name control, 18-54
illustration, 18-53
Where Clause control, 18-54

built-in database step types, 18-44 to 18-78
  Close Database, 18-50 to 18-52
  Close Database step type
    custom properties, 18-51 to 18-52
    Edit Close Database dialog box, 18-51
  Close SQL Statement, 18-58 to 18-59
  Close SQL Statement step type
    custom properties, 18-59
    Edit Close SQL Statement dialog box, 18-58
  Data Operation, 18-59 to 18-65
  Data Operation step type
    Column Values tab, Edit Data Operation dialog box, 18-62 to 18-63
    custom properties, 18-64 to 18-65
    Record/Operation tab, Edit Data Operation dialog box, 18-60 to 18-61
  Open Database, 18-48 to 18-50
    custom properties, 18-50
    Data Link tab, 18-49 to 18-50
  Open SQL Statement, 18-52 to 18-57
  Open SQL statement step type
    Advanced tab, Edit Open SQL Statement dialog box, 18-54 to 18-57
    custom properties, 18-57
    SQL statement tab, Edit Open SQL Statement dialog box, 18-52 to 18-54
  overview, 18-44 to 18-45
  Property Loader, 18-65 to 18-78
  Property Loader dialog box
    Filtering tab, 18-74 to 18-75
    Properties tab, 18-71 to 18-73
  using Select Data Link dialog box, 18-45 to 18-48
built-in step properties
  definition, 1-11
  sequence properties, 1-17
  step type properties, 9-34 to 9-35
  types and capabilities of step properties, 1-11 to 1-12
built-in step types, 10-1 to 10-30. *See also* Step Type Properties dialog box; step types.
  any module adapter, 10-4 to 10-18
    Action steps, 10-4
    Numeric Limit Test, 10-7 to 10-11
    Pass/Fail Test, 10-5 to 10-6
    String Value Test, 10-15 to 10-18
  common custom properties, 10-1 to 10-2
  customizing, 10-3
  error occurred flag, 10-3
  module adapter not used, 10-20 to 10-30
    Call Executable, 10-26 to 10-28
    Goto, 10-29
    Label, 10-29 to 10-30
    Message Popup, 10-21 to 10-25
    Property Loader, 10-28
    Statement, 10-20 to 10-21
  run-time errors, 10-3
  specific module adapters, 10-18 to 10-20
    Sequence Call, 10-18 to 10-20
  step status, 10-3

C

Call Executable steps, 10-26 to 10-28
  Configure Call Executable dialog box, 10-26 to 10-27
  properties (figure), 10-27
  step properties defined, 10-28
Call sequence option, Post Actions tab, 5-26
Call Stack pane, Execution window, 6-11 to 6-12

callback sequences, 1-23 to 1-25
  callback types (table), 1-23
  displaying
    in Callbacks dialog box, 5-10 to 5-11
    with Sequence File Callbacks command, 4-6 to 4-7
  engine callbacks, 1-24
  front-end callbacks
    customizing, 3-10
    overview, 1-24 to 1-25
  model callbacks
    customizing, 3-10 to 3-11
    defining, 1-19
    overview, 1-19
    purpose and use, 14-12
  restrictions on SequenceFileLoad and SequenceFileUnload callbacks, 5-10 to 5-11
  Sequence Properties Model tab, 14-12 to 14-13
Callbacks dialog box, 5-10 to 5-11
Calling Convention control, Module tab, Edit DLL Call dialog box, 13-7
Cascade command, Window menu, 4-44
Category control, Module tab, Edit DLL Call dialog box, 13-7
C/CVI Standard Prototype Adapter, 13-27 to 13-39
  Configuration dialog box (figure), 13-36
  configuring, 13-35 to 13-39
  example code module, 13-31
  executing code modules in external instance, 13-38 to 13-39
    debugging C source and DLL code modules, 13-39
  executing code modules in-process, 13-36 to 13-38
    debugging DLL code module, 13-38
    object and library code modules, 13-36 to 13-37
    source code modules, 13-37
  loading subordinate DLLs, 13-39
  prototypes, 13-27 to 13-30
    step properties updated (table), 13-30
    tTestData structure member fields (table), 13-27 to 13-29
    tTestError structure member fields (table), 13-29 to 13-30
  specifying in Edit C/CVI Module Call dialog box, 13-32 to 13-35
    Module tab, 13-32 to 13-33
    Source Code tab, 13-34 to 13-35
Check Out Source Files When Edited option, Source Control tab, 4-33
Check Type option, Parameters tab context menu, 5-34
Check User Privileges option, User Manager tab, 4-31
Choose Code Template dialog box, 13-4
class step type properties, 9-34
clauses, SQL, 18-88 to 18-89
Cleanup tab, step groups, 5-11
Clear operation, Notification step
  illustration, 11-39
  Notification Name or Reference Expression control, 11-39
client sequence file, 1-18
Close command, File menu, 4-2
Close Completed Execution Displays command, Window menu, 4-44
Close Completed Execution Displays on Execution option, Sequence Editor Options dialog box, 4-21
Close Database step type, 18-50 to 18-52
  custom properties, 18-51 to 18-52
  Edit Close Database dialog box, 18-51
Close SQL Statement step type, 18-58 to 18-59
  custom properties, 18-59
  Edit Close SQL Statement dialog box, 18-58

Close Tree View command, Step Group context menu, 5-18
code modules
  definition, 1-1
  executing in external instance, 13-38 to 13-39
    debugging C source and DLL code modules, 13-39
  executing in-process, 13-36 to 13-38
    debugging DLL code module, 13-38
    object and library code modules, 13-36 to 13-37
    source code modules, 13-37
code templates
  creating, 3-11, 9-46
  customizing, 9-46
  multiple templates per step type, 9-46
  source code templates
    for module adapters, 13-4
    for step types, 1-14
  template files for different adapters, 9-44 to 9-45
Code Templates tab, Step Type Properties dialog box, 9-44 to 9-51
  Add button, 9-48
  Create button, 9-47 to 9-48
  Create Code Templates dialog box, 9-48
  Edit button, 9-48
  Edit Code Template dialog box, 9-49 to 9-51
  illustration, 9-47
  Move Down button, 9-49
  Move Up button, 9-49
  overview, 9-44
  Remove button, 9-48
Collapse control, Customize Tool Menu dialog box, 4-42
Column List Source control
  Filtering tab, Property Loader dialog box, 18-74
  Record/Operation tab, Edit Data Operation dialog box, 18-61
Column Name control, Properties tab, Import/Export Properties dialog box, 18-83
Column Name/Number control
  Additional Columns tab, Import/Export Properties dialog box, 18-84
  Column Values tab, Edit Data Operation dialog box, 18-63
  Filtering tab, Property Loader dialog box, 18-75
  Properties tab, Property Loader dialog box, 18-72
Column Values control
  Additional Columns tab, Import/Export Properties dialog box, 18-84
  Column Values tab, Edit Data Operation dialog box, 18-63
  Filtering tab, Property Loader dialog box, 18-75
Column Values tab, Edit Data Operation dialog box, 18-62 to 18-63
  Column Name/Number control, 18-63
  Column Values control, 18-63
  Data Link Name control, 18-63
  Format String control, 18-63
  illustration, 18-62
  SQL Statement control, 18-63
  Values control, 18-63
columns, in databases, 18-1
Columns control, Create Columns dialog box, 18-73
combining step types, 9-52
Command control, Customize Tool Menu dialog box, 4-42
Command Text control, Statements tab, 18-15
Command Timeout control, Advanced tab, Edit Open SQL Statement dialog box, 18-55
Command Type control, Advanced tab, Edit Open SQL Statement dialog box, 18-56 to 18-57

Comment control
  General tab
    custom data type Properties dialog box, 9-24
    Step Properties dialog box, 5-20
    Step Type Properties dialog box, 9-38
  Sequence File Properties dialog box, 5-8
  Sequence Properties dialog box, 5-5
CommonResults standard data type, 9-16 to 9-17
comparing and merging sequence files, 5-45 to 5-47
comparison operators (table), 8-16
Components directory, 3-4 to 3-6
  customizing, 3-4 to 3-6
  subdirectories (table), 3-5 to 3-6
configuration. *See also* customizing TestStand.
  ActiveX Automation Adapter, 13-56 to 13-58
  C/CVI Standard Prototype Adapter, 13-35 to 13-39
  DLL Flexible Prototype Adapter, 13-5
  HTBasic Adapter, 13-61 to 13-62
  LabVIEW Standard Prototype Adapter, 13-22 to 13-24
  module adapters, 13-3
  TestStand, 3-1 to 3-3
    Configure menu, 3-2 to 3-3
    sequence editor startup options, 3-1 to 3-2
configuration entry points, 14-13
Configure Call Executable dialog box, 10-26 to 10-27
  Argument Expression control, 10-26
  Executable Path control, 10-26
  Exit Code Status Action control, 10-27
  Initial Window State control, 10-27
  Terminate Executable If Step Is Terminated Or Aborted control, 10-27
  Time to Wait control, 10-27
  Wait Condition control, 10-26
Configure menu, 3-2 to 3-3, 4-20 to 4-36
  Adapters command, 3-3, 4-35
  Database Options command, 3-3, 18-6, 18-8
  External Viewers command, 3-3, 4-35
  Model Options command, 3-3, 4-36
  Report Options command, 3-3, 4-35
  Search Directories command, 3-2, 4-34 to 4-35
  Sequence Editor Options command, 4-20 to 4-21
  Station Options command, 3-2, 4-21 to 4-33
Configure Message Box Step dialog box
  Options tab, 10-23 to 10-24
  Text and Buttons tab, 10-22
Configure Type Palettes dialog box, 9-55 to 9-56
connection string, in data links, 18-5
Connection String control
  Data Link tab, Open Database step type, 18-49 to 18-50
  Edit Data Link dialog box, 18-47 to 18-48
Connection String Expression control, Data Link tab, 18-11 to 18-12
Connection tab, Data Link Properties dialog box, 18-37
constants operators (table), 8-16
containers
  container properties, 1-10
  modifying values, 9-15
context menus
  All Sequences view context menu, 5-3 to 5-5
  Context tab context menu, 6-8 to 6-9
  creating data type instances (table), 9-4 to 9-5
  Differ window, 5-47
  Globals View context menu, 7-2 to 7-3

Locals tab context menu, 5-35 to 5-38
Parameters tab context menu, 5-32 to 5-34
Profiles tab context menu, 12-6 to 12-7
purpose and use, 2-4
Sequence File Globals view context menu, 5-42 to 5-44
Step Group context menu, 5-15 to 5-31
Steps tab context menu, 6-6 to 6-7
User List context menu, 12-3 to 12-5
Workspace window, 2-10 to 2-13
Context tab, Execution window, 6-7 to 6-9
Context tab context menu, 6-8 to 6-9
Properties command, 6-9
Refresh command, 6-9
View Contents command, 6-8
controlling sequences flow. *See* sequence flow, controlling.
conventions used in manual, *iv*
copy, cut, and paste capabilities, sequence editor screen, 2-4
Copy button, Preconditions dialog box, 5-39
Copy command, Edit menu, 4-4
Copy Item to File option, Differ window, 5-47
Create Code Templates dialog box, 9-48
Create Columns control
Additional Columns tab, Import/Export Properties dialog box, 18-85
Create Columns dialog box, 18-73
Filtering tab, Property Loader dialog box, 18-75
Properties tab, Import/Export Properties dialog box, 18-83
Properties tab, Property Loader dialog box, 18-72 to 18-73
Create Columns dialog box
Columns control, 18-73
Create Columns control, 18-73
Data Link Name control, 18-73
Data Type control, 18-73
illustration, 18-73
Parameters control, 18-73
Table control, 18-73
Create operation
Batch Specification step, 11-62 to 11-63
Already Exists control, 11-63
Batch Name Expression control, 11-63
Batch Reference Lifetime control, 11-63
Default Batch Synchronization control, 11-63
illustration, 11-62
Lock step
Already Exists control, 11-6
illustration, 11-6
Lock Name Expression control, 11-6
Notification step, 11-35 to 11-36
Already Exists control, 11-36
illustration, 11-36
Notification Name Expression control, 11-36
Notification Reference Lifetime control, 11-36
Queue step, 11-23 to 11-25
Already Exists control, 11-24
illustration, 11-24
Maximum Number of Elements control, 11-24
Queue Name Expression control, 11-24
Queue Reference Lifetime control, 11-24
Rendezvous step, 11-19 to 11-20
Already Exists control, 11-20
illustration, 11-19
Rendezvous Name Expression control, 11-19 to 11-20
Semaphore step, 11-12 to 11-14
Already Exists control, 11-13
illustration, 11-13

Initial Semaphore Count control, 11-13
Semaphore Name Expression control, 11-13
Semaphore Reference Lifetime control, 11-13
CREATE TABLE command, SQL, 18-86
Current Count control, Get Status operation, Semaphore step, 11-17
Current User Manager File option, User Manager tab, 4-30
Cursor Location control, Edit Open SQL Statement dialog box, 18-56
Cursor Type control, Edit Open SQL Statement dialog box, 18-55 to 18-56
Custom Condition Expression control, Post Actions tab, 5-26
Custom control, Numeric Format dialog box, 9-15
custom data types Properties dialog box, 9-22 to 9-26
Bounds tab, 9-24
General tab, 9-23 to 9-24
Advanced control, 9-24
Attach to File control, 9-24
Comment control, 9-24
illustration, 9-23
Numeric Format control, 9-24
Value control, 9-23 to 9-24
illustration, 9-23
Struct Passing tab, 9-25 to 9-26
Allow Objects of This Type to be Passed as Structs control, 9-25
Exclude When Passing Structure control, 9-26
Packing control, 9-25 to 9-26
Property control, 9-26
Store Array As control, 9-26
Store Struct As control, 9-26
Type control, 9-26
<Type Ring> control, 9-26
Version tab, 9-25
Always Prompt User to Resolve the Conflict control, 9-25
Modified control, 9-25
Use the Definition that has the Highest Version Number control, 9-25
Version control, 9-25
Custom Data Types tab tree and list views, 9-17 to 9-20
creating and modifying custom data types, 9-17 to 9-20
list view, 9-18 to 9-19
tree view, 9-18
Value field, 9-19 to 9-20
custom named data types, 1-10
custom properties. *See also* step properties.
built-in step types, 10-1 to 10-2
Close Database step type, 18-51 to 18-52
Close SQL Statement step type, 18-59
custom step type properties, 9-33 to 9-34
Data Operation step type, 18-64 to 18-65
definition, 1-11
lifetime of custom step properties, 1-16, 5-31
Open Database step type, 18-50
Open SQL statement step type, 18-57
Property Loader step type, 18-75 to 18-78
custom step types. *See* step types.
customer education, A-1
Customize command, Tools menu, 4-41
Customize Tool Menu dialog box, 4-41 to 4-44
Add control, 4-42
Arguments control, 4-43
Collapse control, 4-42
Command control, 4-42
Edits Selected File control, 4-42
Enable Expression control, 4-42
Expand control, 4-42
Export Items To File control, 4-43

Hidden Expression control, 4-42
illustration, 4-41
Initial Directory control, 4-43
Insert Separator Before Item control, 4-42
Item Text Expression control, 4-42
Move Up and Move Down controls, 4-42
Remove control, 4-42
Sequence File and Sequence control, 4-43
customizing TestStand, 3-3 to 3-12
code templates, 3-11
creating string resource files, 3-6 to 3-8
data types, 3-8
directory structure, 3-3 to 3-6
engine and front-end callbacks, 3-10
process model, 3-10 to 3-11
process model callbacks, 3-11
run-time operator interfaces, 3-12
step types, 3-8 to 3-9
Tools menu, 3-9, 4-41 to 4-44
users and user privileges, 3-12
cut and paste capabilities, sequence editor screen, 2-4
Cut button, Preconditions dialog box, 5-39
Cut command, Edit menu, 4-4

D

Data Link Name control
Build SQL Select Statement dialog box, 18-54
Column Values tab, Edit Data Operation dialog box, 18-63
Create Columns dialog box, 18-73
Edit Data Link dialog box, 18-47
Properties tab, Property Loader dialog box, 18-71
Source/Destination tab, Import/Export Properties dialog box, 18-81
Data Link Properties dialog box, 18-35 to 18-39
Advanced tab, 18-38
All tab, 18-39
Connection tab, 18-37
Provider tab, 18-35 to 18-36
Data Link tab, Database Options dialog box, 18-10 to 18-12
Connection String Expression control, 18-11 to 18-12
Database Management System control, 18-11
illustration, 18-11
Load .udl File control, 18-12
Save .udl File control, 18-12
Data Link tab, Edit Open Database dialog box, 18-49 to 18-50
Connection String control, 18-49 to 18-50
Database Handle control, 18-49
illustration, 18-49
Select Data Link control, 18-49
Data Link window, Database Viewer, 18-32 to 18-33
data links. *See also* Data Link Properties dialog box; Select Data Link dialog box.
defining, 18-34
example data link setup for Microsoft Access, 18-42 to 18-43
purpose and use, 18-5
Data Operation step type, 18-59 to 18-65
Column Values tab, Edit Data Operation dialog box, 18-62 to 18-63
Column Name/Number control, 18-63
Column Values control, 18-63
Data Link Name control, 18-63
Format String control, 18-63
illustration, 18-62
SQL Statement control, 18-63
Values control, 18-63
custom properties, 18-64 to 18-65
Record/Operation tab, Edit Data Operation dialog box, 18-60 to 18-61
Column List Source control, 18-61

illustration, 18-60
Operation control, 18-61
Record Index control, 18-61
Record to Operate On control, 18-60 to 18-61
Statement Handle (Number) control, 18-60
Data Source tab
Edit Numeric Limit Test dialog box, 10-9 to 10-10
Edit String Value Test dialog box, 10-17
Multiple Numeric Limit Test, 10-14 to 10-15
Data Type control, Create Columns dialog box, 18-73
data types, 9-3 to 9-29. *See also* types.
arrays
dynamic array sizing, 9-7 to 9-8
empty arrays, 9-8
specifying array sizes, 9-6 to 9-7
context menu items for using, 9-4 to 9-5
Insert Field, 9-4
Insert Global, 9-4
Insert Local, 9-4
Insert Local submenu, 9-5
Insert Parameter, 9-4 to 9-5
Insert User, 9-4
submenus, 9-5
creating and modifying, 9-17 to 9-29
adding fields, 9-22
displaying and changing Value field, 9-19 to 9-20
graphical interfaces for accessing types (table), 9-1 to 9-2
Insert Custom Data Type submenu, 9-21
Insert Fields submenu, 9-22
new custom data type, 9-21
property flags, 9-27 to 9-29
using Custom Data Types tab tree and list views, 9-17 to 9-20
using Properties dialog boxes, 9-22 to 9-27
custom named data types, 1-10
customizing, 3-8
displaying, 4-12, 9-8 to 9-10
modifying types and values, 9-10 to 9-15
ActiveX references, 9-11 to 9-12
arrays, 9-12
containers, 9-15
numeric formats, 9-12 to 9-15
single values, 9-10 to 9-11
Numeric category data types (table), 13-8
Properties dialog box
custom data types, 9-22 to 9-27
data type fields, 9-26 to 9-27
standard named data types, 9-15 to 9-17
CommonResults, 9-17
Error, 9-16 to 9-17
Path, 9-16
purpose and use, 1-10
String category data types (table), 13-9
User data type
adding new properties and privileges, 12-10
Standard Data Types tab, 12-8 to 12-10
subproperties (table), 12-8 to 12-10
variant data types supported by ActiveX Automation Adapter (table), 13-55
Data Value control
Pulse operation, 11-41
Set operation, Notification step, 11-38
Data View window, Database Viewer, 18-33
database client technology. *See* Microsoft databases; ODBC administrator.
database concepts, 18-1 to 18-6
data links, 18-5
database logging implementation, 18-6
database sessions, 18-2 to 18-3
database table example (figure), 18-2

definition of databases and tables, 18-1 to 18-2
fields and columns, 18-1
Microsoft ADO, OLE DB, and ODBC technologies, 18-3 to 18-4
records and rows, 18-1
Database Handle control
Data Link tab
Edit Open Database dialog box, 18-49
Open Database step type, 18-49
Edit Close Database dialog box, 18-51
SQL statement tab, Edit Open SQL Statement dialog box, 18-52 to 18-53
database logging. *See also* Database Options dialog box.
implementation in TestStand, 18-6
Logging property in sequence context, 18-20 to 18-21
preparation for using, 18-7 to 18-8
specifying data link for Microsoft Access, 18-43
Database Management System control, Data Link tab, 18-11
Database Options command, Configure menu, 3-3, 18-6, 18-8
Database Options configuration entry point, 14-2
Database Options dialog box, 18-8 to 18-20
Columns/Parameters tab, 18-17 to 18-20
Columns/Parameters control, 18-18
Direction control, 18-19
Expected Properties control, 18-19
Expression control, 18-19
Foreign Key control, 18-20
Format control, 18-19
illustration, 18-18
Name control, 18-18
Precondition control, 18-19
Primary Key control, 18-20
Size control, 18-19
Type control, 18-19
Data Link tab, 18-10 to 18-12
Connection String Expression control, 18-11 to 18-12
Database Management System control, 18-11
illustration, 18-11
Load .udl File control, 18-12
Save .udl File control, 18-12
Logging Options tab, 18-9 to 18-10
Disable Database Logging control, 18-9
illustration, 18-9
Include Execution Times control, 18-9
Include Measurements control, 18-10
Include Step Results control, 18-9
Include Test Limits control, 18-10
Result Filtering Expression control, 18-10
Schemas tab, 18-12 to 18-14
Allow Editing of Schema control, 18-13
illustration, 18-13
Reload NI Schemas control, 18-13
Schemas control, 18-13
Statements tab, 18-14 to 18-17
Apply To control, 18-15
Command Text control, 18-15
Cursor Location control, 18-16
Cursor Type control, 18-16
Expected Properties control, 18-16
illustration, 18-14
Lock Type control, 18-17
Name control, 18-15
Precondition control, 18-16
Statements control, 18-14 to 18-15
Type control, 18-15
Types to Log control, 18-16

database result tables, 18-22 to 18-31
  adding support for other database management systems, 18-30 to 18-31
  creating default result tables, 18-29 to 18-30
  creating for Microsoft Access, 18-42 to 18-44
  default TestStand table schema, 18-22 to 18-29
    MEAS_NUMERICLIMIT table schema, 18-27
    MEAS_SINGLEPOINT table schema, 18-28
    MEAS_WAVE table schema, 18-28
    MEAS_WAVEPAIR table schema, 18-29
    STEP_CALLEXE table schema, 18-25
    STEP_MSGPOPUP table schema, 18-25
    STEP_PASSFAIL table schema, 18-25
    STEP_PROPERTYLOADER table schema, 18-26
    STEP_RESULT table schema, 18-23 to 18-24
    STEP_SEQCALL table schema, 18-27
    STEP_STRINGVALUE table schema, 18-26
    UUT_RESULT table schema, 18-23
database step types. *See* built-in database step types.
Database Viewer, 18-31 to 18-34
  creating result tables for Microsoft Access, 18-43 to 18-44
  Data Link window, 18-32 to 18-33
  Data View window, 18-33
  Execute SQL window, 18-33
  File menu, 18-33
  main window (figure), 18-32
  Options menu, 18-34
  SQL menu, 18-34
  Windows menu, 18-34
date/time format strings (table), 18-93 to 18-96
Debug menu, 4-18 to 4-20
  Abort (no cleanup) command, 4-19
  Abort All (no cleanup) command, 4-20
  Break command, 4-19
  Break All command, 4-19
  Resume command, 4-18
  Resume All command, 4-20
  Step Into command, 4-19
  Step Out command, 4-19
  Step Over command, 4-18
  Terminate command, 4-19
  Terminate All command, 4-20
debugging
  ActiveX Automation servers, 13-55 to 13-56
  C source and DLL code modules, 13-39
  DLL code module, 13-38
  DLLs, 13-14 to 13-15
    LabVIEW DLLs called with Flexible DLL Adapter, 13-15
    options for stepping out of LabWindows/CVI DLL functions (table), 13-15
  HTBasic Adapter, 13-63
  LabVIEW Standard Prototype Adapter, 13-25 to 13-26
  sequences execution, 2-22 to 2-23
  Steps tab, 6-5
decimal point, localized, 4-32
decimal point controls
  Decimal Point control, Import/Export Properties dialog box, 18-80
  Show Decimal Point control, Numeric Format dialog box, 9-14
  Use Localized Decimal Point option Localization tab, 4-32

Default Batch Synchronization control
- Create Operation, Batch Specification step, 11-63
- Get Status operation, Batch Specification step, 11-67
- Model Options dialog box, 14-4
- Sequence File Properties dialog box, 5-9
- Synchronization tab, 5-9

default result tables. *See* database result tables.

Default Step Name Expression control, Step Type Properties dialog box, 9-37

Delete command, Edit menu, 4-4

DELETE command, SQL, 18-86

Delphi
- distributing, 17-9
- run-time operator interface, 16-7 to 16-8

Dequeue operation, Queue step, 11-27 to 11-29
- dequeue behaviors for data enqueued by value (table), 11-28 to 11-29
- Dequeue From control, 11-29
- illustration, 11-27
- Location to Store Element control, 11-28 to 11-29
- Queue Name of Reference Expression control, 11-27 to 11-28
- Remove Element control, 11-29
- Timeout Causes Run-Time Error control, 11-29
- Timeout Enabled control, 11-29
- Timeout Expression control, 11-29
- Which Queue control, 11-29

Designate an Adapter control, Step Type Properties dialog box, 9-37

Designate an Icon control, Step Type Properties dialog box, 9-36 to 9-37

Destination control, Post Actions tab, 5-25

Destination File Path control, Sequence File Documentation submenu, 4-38

Diff Sequence File With command, Edit menu, 4-5

Differ window, 5-45 to 5-47
- context menu items, 5-47
  - Apply Changes from <filename>, 5-47
  - Apply Changes to Other File, 5-47
  - Copy Item to File, 5-47
  - Find Next Difference, 5-47
  - Find Previous Difference, 5-47
  - Properties, 5-47
  - Rediff Sequence Files, 5-47
  - Replace Selected Items in File, 5-47
  - Show Details of Differences, 5-47
- illustration, 5-46
- purpose and use, 5-45 to 5-46

directory search paths, setting, 4-34 to 4-35

directory structure
- process models, 14-9 to 14-10
- TestStand, 3-3 to 3-6
  - Components directory, 3-4 to 3-6
  - NI and User subdirectories, 3-4
  - subdirectories (table), 3-3 to 3-4

Disable Database Logging control, Logging Options tab, 18-9

Disable Properties tab, Step Type Properties dialog box, 9-43 to 9-44
- illustration, 9-43
- Precondition checkbox, 9-44
- Specify Module checkbox, 9-44

Disable Result Recording for All Sequence option, Execution tab, 4-24

Disable Results for All Steps option, Sequence Properties dialog box, 5-4

Disable Test Socket control, Batch UUT Identification dialog box, 14-8

Disable the First Row of Data that Specifies Step Property for Each Column control, Source tab, Edit Property Loader dialog box, 18-69

Disable "View User Manager" Command option, Sequence Editor Options dialog box, 4-21

Display only Selected Files in Source Control Dialog Boxes option, Source Control tab, 4-33
Display Warning on Run Mode Changes in Execution Window option, Sequence Editor Options dialog box, 4-20 to 4-21
distributing TestStand, 17-1 to 17-17
  ActiveX Automation code modules, 17-14
  creating installer for run-time engine, 17-1 to 17-5
  custom engine installation, 17-5 to 17-6
    installer actions (table), 17-6
    invoking, 17-5
  DLL code modules, 17-9
  DLLs called by LabVIEW VIs, 17-10
  installing customized engine, 17-7 to 17-9
    Delphi, 17-9
    LabVIEW, 17-7
    LabWindows/CVI, 17-7 to 17-8
    Visual Basic, 17-8
  LabVIEW run-time server, 17-15 to 17-17
    distributing, 17-16 to 17-17
    rebuilding, 17-16
  LabVIEW test VIs, 17-11 to 17-12
    packaging VIs and subVIs for sequence file, 17-12
    requirements, 17-11 to 17-12
    saving VIs with full hierarchy, 17-14
    saving VIs without full hierarchy, 17-13
  object and static library code modules, 17-10
  sequence files, 17-9
DLL code modules, distributing, 17-9
DLL Flexible Prototype Adapter, 13-5 to 13-16
  configuring
    Default Struct Packing control, 13-5
    Show Function Parameters in Function Description command, 13-5
  debugging DLLs, 13-14 to 13-15
    LabVIEW DLLs called with Flexible DLL Adapter, 13-15
    options for stepping out of LabWindows/CVI DLL functions (table), 13-15
  loading subordinate DLLs, 13-16
  Module tab of Edit DLL Call dialog box, 13-6 to 13-11
    Array parameters, 13-10 to 13-11
    Calling Convention control, 13-7
    Category control, 13-7
    DLL Pathname field, 13-6 to 13-7
    Enumeration parameters, 13-9
    Function control, 13-7
    illustration, 13-6
    Numeric parameters, 13-8
    Object parameters, 13-11
    Parameter ring control, 13-7
    pass by value or by reference, 13-8
    Result Actions, 13-9
    String parameters, 13-9 to 13-10
    Structure parameters, 13-11
  Source Code tab of Edit DLL Call dialog box, 13-12 to 13-14
    adapter interpretation of ambiguous declarations (table), 13-13
    Create Code button, 13-12
    Edit Code button, 13-13
    Pathname of Source file Containing Function control, 13-12
    Verify Prototype button, 13-13
  specifying DLL adapter module, 13-5 to 13-14
    editing the function call, 13-11 to 13-12
    Module tab of Edit DLL Call dialog box, 13-6 to 13-11

Source Code tab of Edit DLL Call dialog box, 13-12 to 13-14
using MFC run-time library, 13-15 to 13-16
DLL Pathname field, Module tab, Edit DLL Call dialog box, 13-6 to 13-7
DLLs called by LabVIEW VIs, distributing, 17-10
drag and drop capabilities, sequence editor screen, 2-5
Drivers Tab, ODBC Data Source Administrator dialog box, 18-42
DROP TABLE command, SQL, 18-86
dynamic array sizing, 9-7 to 9-8

E

Early Unlock operation, Lock step
- illustration, 11-9
- Lock Name or Reference Expression control, 11-9

Edit button
- Code Templates tab, Step Type Properties dialog box, 9-48
- General tab, Step Properties dialog box, 5-20

Edit command, Step Group context menu, 5-16
Edit Automation Call dialog box, 13-51 to 13-55
- ActiveX Reference control, 13-51 to 13-52
- Automation Server control, 13-52
- Call Method or Access Property section, 13-53
- Create Object control, 13-52 to 13-53
- illustration, 13-51
- Object Class control, 13-52
- Parameters control, 13-54

Edit button, Select Data Link dialog box, 18-47
Edit C/CVI Module Call dialog box, 13-32 to 13-35
- Module tab, 13-32 to 13-33
  - Extended Prototype, 13-33
  - Function Name, 13-33
  - illustration, 13-32
  - Module Pathname, 13-32 to 13-33
  - Module Type, 13-32
  - Pass Sequence Context, 13-33
  - Standard Prototype, 13-33
- Source Code tab, 13-34 to 13-35
  - Create Code button, 13-34 to 13-35
  - Edit Code button, 13-35
  - illustration, 13-34
  - Pathname of Source File Containing Function control, 13-34 to 13-35

Edit Close Database dialog box, 18-51
Edit Close SQL Statement dialog box, 18-58
Edit Code command, Step Group context menu, 5-17
Edit Code Template dialog box, 9-49 to 9-51
- Description control, 9-49
- illustration, 9-49
- Parameter Name/Value Mappings section, 9-50 to 9-51
- Require Sequence Context control, 9-49 to 9-50

Edit Data Link dialog box, 18-47 to 18-48
- Connection String control, 18-47 to 18-48
- Data Link Name control, 18-47
- Remove control, 18-48
- View control, 18-48

Edit Data Operation dialog box
- Column Values tab, 18-62 to 18-63
  - Column Name/Number control, 18-63
  - Column Values control, 18-63
  - Data Link Name control, 18-63
  - Format String control, 18-63
  - illustration, 18-62

SQL Statement control, 18-63
Values control, 18-63
Record/Operation tab, 18-60 to 18-61
Column List Source control, 18-61
illustration, 18-60
Operation control, 18-61
Record Index control, 18-61
Record to Operate On control, 18-60 to 18-61
Statement Handle (Number) control, 18-60
Edit Data Type Flags dialog box
illustration, 9-29
Instant Default Flags listbox, 9-29
Type Determines Instance Flags Value listbox, 9-29
Type Flags listbox, 9-29
Edit DLL Call dialog box
Module tab, 13-6 to 13-11
Array parameters, 13-10 to 13-11
Calling Convention control, 13-7
Category control, 13-7
DLL Pathname field, 13-6 to 13-7
Enumeration parameters, 13-9
Function control, 13-7
illustration, 13-6
Numeric parameters, 13-8
Object parameters, 13-11
Parameter ring control, 13-7
pass by value or reference, 13-8
Result Actions, 13-9
String parameters, 13-9 to 13-10
Structure parameters, 13-11
Source Code tab, 13-12 to 13-14
adapter interpretation of ambiguous declarations (table), 13-13
Create Code button, 13-12
Edit Code button, 13-13
Pathname of Source file Containing Function control, 13-12
Verify Prototype button, 13-13
Edit Expression command, Watch Expression pane, 6-13
Edit Flags dialog box, 9-27 to 9-29
Edit Data Type Flags dialog box, 9-29
illustration, 9-27
Reset Flags in All Loaded Instances of Type checkbox, 9-28
Type Flags button, 9-28
Edit LabVIEW VI Call dialog box, 13-24 to 13-25
Create VI button, 13-25
Edit Code button, 13-25
illustration, 13-24
Optional Parameters section, 13-25
VI Module Pathname control, 13-25
Edit menu, 4-4 to 4-7
Copy command, 4-4
Cut command, 4-4
Delete command, 4-4
Diff Sequence File With command, 4-5
Paste command, 4-4
Select All command, 4-5
Sequence File Callbacks command, 4-6 to 4-7
Sequence File Properties command, 4-6
Sequence Properties command, 4-5
Edit Multiple Numeric Limit Test dialog box, 10-12
Edit Numeric Limit Test dialog box
Data Source tab, 10-9 to 10-10
Limits tab, 10-7
Edit Open Database dialog box, 18-49 to 18-50
Connection String control, 18-49 to 18-50
Database Handle control, 18-49
illustration, 18-49
Select Data Link control, 18-49
Edit Open SQL Statement dialog box
Advanced tab, 18-54 to 18-57
Cache Size control, 18-55
Command Timeout control, 18-55

Command Type control, 18-56 to 18-57
Cursor Location control, 18-56
Cursor Type control, 18-55 to 18-56
illustration, 18-55
Lock Type control, 18-56
Marshal Options control, 18-56
Max Records to Select control, 18-55
Page Size in Records control, 18-55
SQL statement tab, 18-52 to 18-54
Build control, 18-53 to 18-54
Database Handle (Number) control, 18-52 to 18-53
illustration, 18-53
Number of Records Selected control, 18-53
SQL Statement control, 18-53
Statement Handle (Number) control, 18-53
Edit <parameter> Value dialog box, 13-54
Edit Pass/Fail Source dialog box, 10-6
Edit Paths dialog box, 4-10
Edit Paths in Files dialog box, 4-9
Edit Property Loader dialog box
Properties tab, 18-67 to 18-68
illustration, 18-67
Properties control, 18-67 to 18-68
Properties List Source control, 18-67
Property Name control, 18-68
Source tab, 18-68 to 18-69
Disable the First Row of Data that Specifies Step Property for Each Column control, 18-69
illustration, 18-68
Skip Rows that Begin With control, 18-69
Specify Column to Step Property Mapping text box, 18-69
Start of Data Marker control, 18-69
Edit Sequence Call dialog box, Sequence Adapter
Edit Sequence Call tab, 13-41 to 13-44
Execution Settings dialog box, 13-45 to 13-47
Remote Execution Settings dialog box, 13-47 to 13-48
Thread Settings dialog box, 13-44
Edit Sequence Call tab, Sequence Adapter, 13-41 to 13-44
File Pathname control, 13-42
illustration, 13-41
Multithreading and Remote Execution control, 13-42
Parameters section, 13-43
Sequence control, 13-42
Settings control, 13-43
Specify Expressions for Pathname and Sequence, 13-41 to 13-42
Use Current File control, 13-42
Edit Statement Step dialog box, 10-21
Edit String Value Test dialog box
Data Source tab, 10-17
Limits tab, 10-16
Edit substep
overview, 1-13
Substeps tab, 9-40
Edit User dialog box, 12-5
Edit User Type command
Profiles tab context menu, 12-7
User List context menu, 12-5
Edits Selected File control, Customize Tool Menu dialog box, 4-42
empty arrays, 9-8
Enable Breakpoints option, Execution tab, 4-22
Enable Expression control, Customize Tool Menu dialog box, 4-42
Enable Tracing option, Execution tab, 4-22 to 4-23

End of Data Marker control, Source/Destination tab, 18-80
engine callbacks, 6-22 to 6-25
  available engine callbacks (table), 6-22 to 6-24
  customizing, 3-10
  definition, 6-22
  examples of using, 6-25
  overview, 1-24
Enqueue operation, Queue step, 11-25 to 11-26
  If the Queue is Full control, 11-26
  illustration, 11-25
  Insert At control, 11-26
  New Element to Enqueue control, 11-26
  Queue Name or Reference Expression control, 11-26
  Store by Reference Instead of by Value control, 11-26
  Timeout Causes Run-Time Error control, 11-26
  Timeout Enabled control, 11-26
  Timeout Expression control, 11-26
Enter Synchronized Section operation, Batch Synchronization step
  Enter operation requirements, 11-58
  illustration, 11-59
  Section Name control, 11-59
  Section Type control, 11-59
  Timeout Causes Run-Time Error control, 11-51
  Timeout Enabled control, 11-59
  Timeout Expression control, 11-59
entry points, 1-19 to 1-22
  configuration entry points, 14-13
  defining multiple entry points, 1-19
  definition, 1-19
  entry point sequences
    configuration entry point, 14-13
    execution entry point, 14-13
  Execution Entry Point Sequence Model tab, 14-14 to 14-16
    Allow Interactive Execution of Entry Point control, 14-15
    Entry Point Enabled Expression control, 14-14 to 14-15
    Entry Point Ignores Client File control, 14-15
    Entry Point Name Expression control, 14-14
    Hide Entry Point Execution control, 14-15
    illustration, 14-14
    Menu Hint control, 14-15
    Save Modified Sequence Files Before Execution control, 14-15
    Show Entry Point for All Windows control, 14-16
    Show Entry Point Only in Editor control, 14-15
    Show Entry Point When Client File Window is Active control, 14-16
    Show Entry Point When Execution Window is Active control, 14-16
  execution entry points
    definition, 1-19 to 1-20
    process models, 14-13
    purpose and use, 6-2
  flowchart of TestUUTs sequence in default process model (figure), 1-20
  list of all sequences (figure), 1-22
  set of steps for TestUUTs entry point (figure), 1-21
Enumeration parameters, specifying for DLL Flexible Prototype Adapter, 13-9
error occurred flag, built-in step types, 10-3
Error Out cluster, LabVIEW Standard Prototype Adapter, 13-19 to 13-20
  element types and descriptions (table), 13-20
  illustration, 13-19

Error standard data type, 9-16 to 9-17
escape codes for unprintable characters (table), 3-8
Executable Path control, Configure Call Executable dialog box, 10-26
Execute menu, 4-15 to 4-18
- Break on First Step command, 4-17
- Execution Entry Point List command, 4-15
- Loop on Selected Steps command, 4-16 to 4-17
- Loop on Selected Steps Using command, 4-17
- Restart command, 4-15
- Run Active Sequence command, 4-15
- Run Selected Steps command, 4-16
- Tracing Enabled command, 4-18

Execute SQL window, Database Viewer, 18-33
execution. *See also* Execution window.
- definition, 6-1
- direct execution without process model, 6-2 to 6-3
- engine callbacks, 6-22 to 6-25
- failures, 6-28
- interactive execution, 1-25 to 1-26, 6-3
- normal execution, 1-25 to 1-26
- overview, 1-24, 6-1 to 6-2
- Preconditions dialog box, 5-38 to 5-40
- run-time errors, 6-29 to 6-31
- starting, 6-2 to 6-3
- step execution (table), 6-25 to 6-27
- step status property, 6-27 to 6-28
- terminating and aborting executions, 1-26
- Wait for Execution operation, 11-51

Execution Entry Point List command, 4-15
Execution Entry Point Sequence, Model tab, 14-14 to 14-16
- Allow Interactive Execution of Entry Point control, 14-15
- Entry Point Enabled Expression control, 14-14 to 14-15
- Entry Point Ignores Client File control, 14-15
- Entry Point Name Expression control, 14-14
- Hide Entry Point Execution control, 14-15
- illustration, 14-14
- Menu Hint control, 14-15
- Save Modified Sequence Files Before Execution control, 14-15
- Show Entry Point for All Windows control, 14-16
- Show Entry Point Only in Editor control, 14-15
- Show Entry Point When Client File Window is Active control, 14-16
- Show Entry Point When Execution Window is Active control, 14-16

execution entry points
- definition, 1-19 to 1-20
- process models, 14-13
- purpose and use, 6-2

execution pointer, 6-1
Execution Settings dialog box, Sequence adapter
- Additional Execution type Mask Settings control, 13-46
- Break on Entry control, 13-47
- Close Window when Done control, 13-45
- illustration, 13-45
- Initially Hidden and Disable Tracing control, 13-45
- Initially Suspended control, 13-45
- Process Model Option, 13-46
- Store an ActiveX Reference to the new Execution in control, 13-46
- Wait for Execution to Complete control, 13-44

Execution tab, Station Options dialog box, 4-22 to 4-24
- Always Goto Cleanup On Sequence Failure option, 4-24

Disable Result Recording for All Sequence option, 4-24
Enable Breakpoints option, 4-22
Enable Tracing option, 4-22 to 4-23
illustration, 4-22
Interactive Mode option, 4-23 to 4-24
On Run-Time Error, 4-23 to 4-24

Execution window, 6-3 to 6-14
areas in, 6-3 to 6-4
Call Stack pane, 6-11 to 6-12
Context tab, 6-7 to 6-9
context menu, 6-8 to 6-9
illustration, 6-8
definition, 1-25
example (figure), 2-7
overview, 2-6
Report tab, 6-9 to 6-10
result collection, 6-15 to 6-21
custom result properties, 6-17 to 6-18
loop results, 6-21
ResultList array (figure), 6-16
standard result properties, 6-18 to 6-19
subsequence results, 6-19 to 6-21
status bar, 6-14
Steps tab, 6-4 to 6-7
columns, 6-5 to 6-6
context menu, 6-6 to 6-7
debugging, 6-5
illustration, 6-4
tracing, 6-5
Threads ring control, 6-4
Watch Expression pane, 6-12 to 6-14
Add Watch command, 6-13
Edit Expression command, 6-13
illustration, 6-13
Modify Value command, 6-13
Refresh command, 6-14

Exit Code Status Action control, Configure Call Executable dialog box, 10-27

Exit command, File menu, 4-3

Exit Synchronized Section operation
Exit operation requirements, 11-58
illustration, 11-60
Section Name control, 11-60
Timeout Causes Run-Time Error control, 11-60
Timeout Enabled control, 11-60
Timeout Expression control, 11-60

Expand control, Customize Tool Menu dialog box, 4-42

Export control, Import/Export Properties dialog box, 18-78

Export Items To File control, Customize Tool Menu dialog box, 4-43

Export Tools Menu dialog box, 4-43 to 4-44
File Name control, 4-44
Menu Items control, 4-43
Move Up and Move Down controls, 4-44

exporting properties. *See* Import/Export Properties command, Tools menu; Import/Export Properties dialog box.

Expression Browser dialog box, 8-14 to 8-15
illustration, 1-9, 8-14
Operators/Functions tab, 8-15
purpose and use, 8-14

expressions, 8-13 to 8-21
expression operators (table), 8-16 to 8-17
function operators (table), 8-18 to 8-20
levels of precedence (table), 8-21
purpose and use, 8-13
using values of variables and properties, 1-8 to 1-9

Expressions tab, Step Properties dialog box, 5-30 to 5-31
Post Expression control, 5-31
Pre Expression control, 5-30
Status Expression control, 5-31

External Viewers command, Configure menu, 3-3, 4-35

F

failure chain in reports, 15-5
failure of steps, 6-28
fields, in databases, 18-1
File Format control, Sequence File Documentation submenu, 4-38
File Location control, Source/Destination tab, 18-80
File menu, 4-1 to 4-3
- Close command, 4-2
- Exit command, 4-3
- Login command, 4-2
- Logout command, 4-2
- most recently opened files list, 4-3
- New command, 4-2
- New Workspace command, 4-2
- Open command, 4-2
- Open Workspace command, 4-2
- Save command, 4-3
- Save All command, 4-3
- Save As command, 4-3
- Unload All Modules command, 4-3

File menu, Database Viewer, 18-33
File Name control, Export Tools Menu dialog box, 4-44
Filtering tab, Property Loader dialog box, 18-74 to 18-75
- Column List Source control, 18-74
- Column Name/Number control, 18-75
- Column Values control, 18-75
- Create Columns control, 18-75
- Format String control, 18-75
- illustration, 18-74
- Only import rows that match the specified column values control, 18-74
- Values control, 18-75

Find Next Difference option, Differ window, 5-47
Find Previous Difference option, Differ window, 5-47
Find Type command, View menu, 4-12
Flush operation, Queue step, 11-30 to 11-31
- illustration, 11-30
- Location to Store Array of Queue Elements control, 11-30
- Queue Name or Reference Expression control, 11-30

Foreign Key control, Columns/Parameters tab, 18-20
Format controls
- Check Format control, Numeric Format dialog box, 9-15
- Columns/Parameters tab, 18-19
- Numeric Format dialog box, 9-15
- Source/Destination tab, 18-80

Format String control
- Additional Columns tab, Import/Export Properties dialog box, 18-84 to 18-85
- Column Values tab, Edit Data Operation dialog box, 18-63
- Filtering tab, Property Loader dialog box, 18-75

format strings, 18-93 to 18-97
- date/time (table), 18-93 to 18-96
- example (table), 18-93
- numeric format (table), 18-96 to 18-97

Formatted Number control, Numeric Format dialog box, 9-13
front-end callbacks
- customizing, 3-10
- overview, 1-24 to 1-25

function call, editing in Module tab, 13-11 to 13-12
Function control, Module tab, Edit DLL Call dialog box, 13-7
function operators for expressions (table), 8-18 to 8-20
functions, SQL, 18-91 to 18-92

G

General tab
- custom data types Properties dialog boxes, 9-23 to 9-24
  - Advanced control, 9-24
  - Attach to File control, 9-24
  - Comment control, 9-24
  - illustration, 9-23
  - Numeric Format control, 9-24
  - Value control, 9-23 to 9-24
- Sequence File Properties dialog box, 5-6 to 5-8
  - Comment control, 5-8
  - Full Path control, 5-6
  - illustration, 5-6
  - Load Option, 5-7
  - Saved control, 5-6
  - Sequence File Globals control, 5-7 to 5-8
  - Size control, 5-6
  - Unload Option, 5-7
  - Version control, 5-7
- Step Properties dialog box, 5-20 to 5-21
  - Comment control, 5-20
  - Edit button, 5-20
  - illustration, 5-20
  - Preconditions button, 5-21
  - Specify Module button, 5-21
- Step Type Properties dialog box, 9-36 to 9-38
  - Attach to File control, 9-38
  - Comment control, 9-38
  - Default Step Name Expression control, 9-37
  - Designate an Adapter control, 9-37
  - Designate an Icon control, 9-36 to 9-37
  - illustration, 9-36
  - Step Description Expression control, 9-37

Get Status operation
- Batch Specification step, 11-66 to 11-67
  - Batch Exists? control, 11-66
  - Batch Name or Reference Expression control, 11-66
  - Default Batch Synchronization control, 11-67
  - illustration, 11-66
  - Number of Threads in Batch control, 11-67
  - Number of Threads Waiting at Synchronized Sections control, 11-66
- Lock step
  - illustration, 11-10
  - Lock Exists? operation, 11-10
  - Lock Name or Reference Expression control, 11-10
  - Number of Threads Waiting to Lock the Lock control, 11-10
- Notification step, 11-45 to 11-46
  - illustration, 11-45
  - Is Auto Clear control, 11-46
  - Is Set control, 11-46
  - Location to Store Data control, 11-46
  - Notification Exists control, 11-45
  - Notification Name or Reference Expression control, 11-45
  - Number of Threads Waiting for Notification control, 11-45
- Queue step, 11-31 to 11-32
  - illustration, 11-31
  - Location to Store Array of Queue Elements control, 11-32
  - Maximum Number of Elements control, 11-32
  - Number of Elements control, 11-32
  - Number of Threads Waiting to Dequeue control, 11-32
  - Number of Threads Waiting to Enqueue control, 11-32

Queue Exists control, 11-32
Queue Name or Reference Expression control, 11-31
Rendezvous step, 11-21 to 11-22
illustration, 11-21
Number of Threads Per Rendezvous control, 11-22
Number of Threads Waiting for Rendezvous control, 11-22
Rendezvous Exists? control, 11-22
Rendezvous Name or Reference Expression control, 11-21 to 11-22
Semaphore step, 11-16 to 11-17
Current Count control, 11-17
illustration, 11-16
Initial Semaphore Count control, 11-17
Number of Threads Waiting to Acquire the Semaphore control, 11-17
Semaphore Exists? control, 11-17
Semaphore Name or Reference Expression control, 11-17
Get Thread Priority operation, 11-55
global variables
definition, 1-7
lifetime and scope of sequence file global variables, 5-41 to 5-42
station global variables
persistence, 7-4 to 7-5
special station globals, 7-5
Globals View context menu, 7-2 to 7-3
Browse Sequence Context command, 7-3
Go Up One Level command, 7-3
Insert Global submenu, 7-2
Properties command, 7-3
Reload Station Globals command, 7-3
Rename command, 7-3
View Contents command, 7-3
Go Up One Level command
Globals View context menu, 7-3
Locals tab context menu, 5-37
Parameters tab context menu, 5-33
Sequence File Globals view context menu, 5-44
Step Group context menu, 5-18
Goto built-in step type, 2-20 to 2-21
Goto Cleanup On Sequence Failure option, Sequence Properties dialog box, 5-4
Goto destination option, Post Actions tab, 5-26
Goto next step option, Post Actions tab, 5-26
Goto steps, 10-29
Group control, Menu tab, 9-29

H

Hidden Expression control, Customize Tool Menu dialog box, 4-42
Hide Entry Point Execution option, Execution Entry Point Sequence Model tab, 14-15
Hide Execution Windows control, Model Options dialog box, 14-4
HTBasic Adapter, 13-60 to 13-64
configuration, 13-61 to 13-62
debugging, 13-63
HTBasic routines for accessing TestStand properties (table), 13-64
passing data to and returning data from subroutine, 13-64
specifying in Edit HTBasic Subroutine Call dialog box, 13-62 to 13-63
HTBasic Subroutine Call dialog box, 13-62 to 13-63
Create Subroutine button, 13-63
Edit Subroutine button, 13-63
Subroutine File Pathname control, 13-62
Subroutine Name control, 13-63

I

Ignore option, Run-Time Error dialog box, 6-30
Ignore Run-time Errors option
  effect on execution, 6-29
  Run Options tab, Step Properties dialog box, 5-23 to 5-24
Ignore Termination option, Run Options tab, 5-24
Import control, Import/Export Properties dialog box, 18-78
Import/Export Properties command, Tools menu, 4-40, 10-28
Import/Export Properties dialog box, 18-78 to 18-85
  Additional Columns tab, 18-83 to 18-85
    Column Name/Number control, 18-84
    Column Values control, 18-84
    Create Columns control, 18-85
    Format String control, 18-84 to 18-85
    illustration, 18-84
    Value control, 18-84
  Done control, 18-78
  Export control, 18-78
  Import control, 18-78
  Properties tab, 18-82 to 18-83
    Append data type to column name control, 18-83
    Column Name control, 18-83
    Create Columns control, 18-83
    illustration, 18-82
    Max size for column name control, 18-83
    Properties control, 18-83
    Property Name control, 18-83
    Sequence control, 18-82
    Step Name Column control, 18-82
  Source/Destination tab, 18-78 to 18-82
    Build control, 18-81
    Data Link Name control, 18-81
    database location, 18-81 to 18-82
    Decimal Point control, 18-80
    End of Data Marker control, 18-80
    File Location control, 18-80
    file or clipboard location, 18-79 to 18-80
    First Row of Data Specifies Step Property for Each Column control, 18-80
    Format control, 18-80
    Skip Rows That Begin With control, 18-80
    SQL Statement control, 18-81
    Start of Data Marker control, 18-80
Initial Directory control, Customize Tool Menu dialog box, 4-43
Initial Semaphore Count control
  Create operation, 11-13
  Get Status operation, 11-17
Initial Window State control, Configure Call Executable dialog box, 10-27
Input buffer string control, LabVIEW Standard Prototype Adapter, 13-20
Insert AllOf button, Preconditions dialog box, 5-39 to 5-40
Insert AnyOf button, Preconditions dialog box, 5-39 to 5-40
Insert At control, Enqueue operation, 11-26
INSERT command, SQL, 18-86
Insert Custom Data Type submenu, 9-21
Insert Field command, 9-4
Insert Fields submenu, 9-22
Insert Global submenu
  Globals View context menu, 7-2
  Sequence File Globals view context menu, 5-43
  using data types, 9-4

Insert Local command
- Locals tab context menu, 5-36
- using data types, 9-4

Insert Local submenu
- Array of submenu, 9-6
- using data types, 9-5

Insert New Expression button, Preconditions dialog box, 5-39

Insert New User dialog box, 12-4

Insert Parameter submenu
- Parameters tab context menu, 5-32 to 5-33
- using data types, 9-4 to 9-5

Insert Profile command, Profiles tab context menu, 12-7

Insert Sequence command, All Sequences view context menu, 5-3

Insert Step Status section, Preconditions dialog box, 5-40

Insert Step submenu
- creating sequences, 2-15
- displaying and selecting step types, 9-30
- Step Group context menu, 5-15 to 5-16

Insert User command
- User List context menu, 12-4
- using data types, 9-4

Installation Wizard for TestStand Engine, 17-1 to 17-5
- Customize Files to Include in Installation dialog box, 17-3
- Default Components to Include (figure), 17-3
- Opening dialog box, 17-2
- procedure for running, 17-1 to 17-5
- Select Files to Include dialog box, 17-4
- Select MDAC Installer dialog box, 17-5

instance step type properties, 9-34

interactive execution, 1-25 to 1-26, 6-3

Interactive Mode option, Execution tab, 4-23 to 4-24

Invocation Information cluster control, LabVIEW Standard Prototype Adapter, 13-20 to 13-21

Item Name Expression control, Menu tab, 9-39

K

keyboard actions for navigating lists and tree views (table), 2-3 to 2-4

L

Label step, 10-29 to 10-30

LabVIEW run-time operator interface, 16-4 to 16-5
- building standalone executable, 16-4 to 16-5
- distributing, 17-7
- top-level files (table), 16-4

LabVIEW run-time server
- distributing, 17-15 to 17-17
- rebuilding, 17-16

LabVIEW Standard Prototype Adapter, 13-16 to 13-26
- configuring, 13-22 to 13-24
  - BridgeVIEW option, 13-23
  - Expression for UUT Iteration Number option, 13-23
  - Expression for UUT Serial Number String option, 13-23
  - LabVIEW option, 13-22
  - Reserve Loaded VIs for Execution option, 13-23
  - TestStandLVGUIRTS option, 13-22
  - TestStandLVRTS option, 13-23
- debugging, 13-25 to 13-26
- specifying in Edit LabVIEW VI Call dialog box, 13-24 to 13-25

structure, 13-16 to 13-21
Error Out cluster, 13-19 to 13-20
Input buffer string control, 13-20
Invocation Information cluster control, 13-20 to 13-21
Sequence Context control, 13-21
Test Data cluster, 13-17 to 13-19
LabVIEW test VIs, distributing, 17-11 to 17-12
packaging VIs and subVIs for sequence file, 17-12
saving VIs with full hierarchy, 17-14
saving VIs without full hierarchy, 17-13
LabVIEW VIs that call DLLs, distributing, 17-10
LabWindows/CVI prototype adapter. *See* C/CVI Standard Prototype Adapter.
LabWindows/CVI run-time operator interface
distributing, 17-7 to 17-8
files in project file (table), 16-2 to 16-4
language, selecting, 4-32
Launch Report Viewer command, View menu, 4-14
lifetime attribute, synchronization objects, 11-3 to 11-4
Limit Loader step type, 10-28
Limits tab
Edit Numeric Limit Test dialog box, 10-7
Edit String Value Test dialog box, 10-16
list views. *See* Custom Data Types tab tree and list views.
Load Option
Run Options tab, Step Properties dialog box, 5-22
Sequence File Properties dialog box, 5-7
local variables
definition, 1-7
lifetime of local variables, 1-16
sequence local variables, 1-15 to 1-16
Localization tab, Station Options dialog box, 4-31 to 4-32
illustration, 4-31
Recognize Multi-byte Characters option, 4-32
Select a Language option, 4-32
Use Localized Decimal Point option, 4-32
Locals tab
illustration, 5-35
overview, 5-34
Locals tab context menu, 5-35 to 5-38
Allow Propagation from Caller option, 5-37
Browse Sequence Context command, 5-37
Go Up One level command, 5-37
Insert Local command, 5-36
Propagate to Subsequence option, 5-37
Properties command, 5-37 to 5-38
Rename command, 5-37
View Contents command, 5-36
Location to Store Array of Queue Elements control
Flush operation, 11-30
Get Status operation, 11-32
Location to Store Data control
Get Status operation, Notification step, 11-46
Wait operation, Notification step, 11-43
Location to Store Element control, Dequeue operation, 11-28 to 11-29
Location to Store Thread Priority control, Get Thread Priority operation, 11-55
Lock Exists? control, Get Status operation, 11-10
Lock Name Expression control, Lock step Create operation, 11-6
Lock Name or Reference Expression control
Early Unlock operation, 11-9
Get Status operation, 11-10
Lock operation, 11-6 to 11-7

Lock Operation Lifetime control, Lock operation, 11-8
Lock Reference Lifetime Expression control, Lock step Create operation, 11-6
Lock step, 11-5 to 11-12
  Create operation
    Already Exists control, 11-6
    illustration, 11-6
    Lock Name Expression control, 11-6
    Lock Reference Lifetime Expression control, 11-6
  Early Unlock operation
    illustration, 11-9
    Lock Name or Reference Expression control, 11-9
  Get Status operation
    illustration, 11-10
    Lock Exists? operation, 11-10
    Lock Name or Reference Expression control, 11-10
    Number of Threads Waiting to Lock the Lock control, 11-10
  Lock operation, 11-7 to 11-8
    Create If Does Not Exist control, 11-7
    illustration, 11-7
    Lock Name or Reference Expression control, 11-6 to 11-7
    Lock Operation Lifetime control, 11-7
    Timeout Causes Run-Time Error control, 11-7
    Timeout Enabled control, 11-7
    Timeout Expression control, 11-7
  step properties, 11-11 to 11-12
lock synchronization object, 11-1
Lock Type control
  Advanced tab, Edit Open SQL Statement dialog box, 18-56
  Statements tab, 18-17
Logging Options tab, Database Options dialog box, 18-9 to 18-10
  Disable Database Logging control, 18-9
  illustration, 18-9
  Include Execution Times control, 18-9
  Include Measurements control, 18-10
  Include Step Results control, 18-9
  Include Test Limits control, 18-10
  Result Filtering Expression control, 18-10
Logging property in sequence context. *See also* database logging.
  overview, 18-20
  subproperties, 18-21
logical operators (table), 8-16
Login command, File menu, 4-2
Logout command, File menu, 4-2
Loop on Selected Steps command, Execute menu, 4-16 to 4-17
Loop on Selected Steps dialog box
  Loop Count tab, 4-16
  Stop Expression tab, 4-17
Loop on Selected Steps Using command
  Execute menu, 4-17
  Step Group context menu, 5-18
Loop Options tab, Step Properties dialog box, 5-26 to 5-28
  illustration, 5-27
  Loop Type control, 5-27 to 5-28
  Record Result of Each Iteration option, 5-28
Loop Selected Steps command
  Step Group context menu, 5-18
  Steps tab context menu, 6-7
Loop Type control, Loop Options tab, 5-27 to 5-28

M

main sequence, 1-18
Main tab, step groups, 5-11
Marshal Options control, Edit Open SQL Statement dialog box, 18-56
MEAS_NUMERICLIMIT table schema, 18-27
MEAS_SINGLEPOINT table schema, 18-28
MEAS_WAVE table schema, 18-28
MEAS_WAVEPAIR table schema, 18-29
menu bar, sequence editor. *See* sequence editor menu bar.
Menu Item Name Expression control, Substeps tab, 9-42
Menu Items control, Export Tools Menu dialog box, 4-43
Menu tab, Step Type Properties dialog box, 9-38 to 9-39
  Group control, 9-39
  illustration, 9-38 to 9-39
  Item Name Expression control, 9-39
merging and comparing sequence files, 5-45 to 5-47
Message Popup steps, 10-21 to 10-25
  Configure Message Box Step dialog box
    Options tab, 10-23 to 10-24
    Text and Buttons tab, 10-22
  properties (figure), 10-24
  step properties defined, 10-25
MFC (Microsoft Foundation Class) run-time library, using with DLLs, 13-15 to 13-16
Microsoft Access databases
  adding support for, 18-30
  example data link and result table setup for Microsoft Access, 18-42 to 18-44
Microsoft databases. *See also* ODBC administrator.
  ActiveX Data Objects (ADO), 18-3
  database technologies (figure), 18-4
  Object-linking and Embedding Database (OLE DB), 18-3
Microsoft SQL Server, adding support for, 18-30
Microsoft Visual Basic
  compatibility issues, 13-58 to 13-60
  run-time operator interface
    distributing, 17-8
    top-level files (table), 16-5 to 16-6
mismatched sections, Batch Synchronization step, 11-58
model callbacks
  customizing, 3-10 to 3-11
  defining, 1-19
  overview, 1-19
  purpose and use, 14-12
Model Option, Sequence File Properties dialog box, 5-8 to 5-9
Model Options command, Configure menu, 3-3, 4-36
Model Options configuration entry point, 14-2
Model Options dialog box
  Bring UUT Dialog to Front When Status Changes control, 14-4
  Default Batch Synchronization control, 14-4
  Hide Execution Windows control, 14-4
  illustration, 14-3
  Number of Test Sockets control, 14-3
  Sequential Batch Mode control, 14-4
  Tile Execution Windows control, 14-4
Model tab
  Execution Entry Point Sequence, 14-14 to 14-16
    Allow Interactive Execution of Entry Point control, 14-15
    Entry Point Enabled Expression control, 14-14 to 14-15
    Entry Point Ignores Client File control, 14-15
    Entry Point Name Expression control, 14-14

Hide Entry Point Execution control, 14-15
illustration, 14-14
Menu Hint control, 14-15
Save Modified Sequence Files Before Execution control, 14-15
Show Entry Point for All Windows control, 14-16
Show Entry Point Only in Editor control, 14-15
Show Entry Point When Client File Window is Active control, 14-16
Show Entry Point When Execution Window is Active control, 14-16
Sequence Properties dialog box, 14-11 to 14-16
callback sequences, 14-12 to 14-13
entry point sequences, 14-13 to 14-16
normal sequences, 14-12
Station Options dialog box
Allow Other Models option, 4-29
illustration, 4-29
Station Model field, 4-29
Use Station Model option, 4-29
Modify Numeric Value dialog box, 9-20
Modify Value command, Watch Expression pane, 6-13
module adapters, 13-1 to 13-64
ActiveX Automation Adapter, 13-51 to 13-60
available module adapters, 1-6
C/CVI Standard Prototype Adapter, 13-27 to 13-39
configuring, 13-3
DLL Flexible Prototype Adapter, 13-5 to 13-16
HTBasic Adapter, 13-60 to 13-64
LabVIEW Standard Prototype Adapter, 13-16 to 13-26
overview, 1-6 to 1-7, 13-1 to 13-2
Sequence Adapter, 13-40 to 13-50
source code templates, 13-4
Specify Module dialog boxes (table), 13-2
step type requirements, 9-30 to 9-31
Module tab
Edit C/CVI Module Call dialog box, 13-32 to 13-33
Extended Prototype, 13-33
Function Name, 13-33
illustration, 13-32
Module Pathname, 13-32 to 13-33
Module Type, 13-32
Pass Sequence Context, 13-33
Standard Prototype, 13-33
Edit DLL Call dialog box, 13-6 to 13-11
Array parameters, 13-10 to 13-11
Calling Convention control, 13-7
Category control, 13-7
DLL Pathname field, 13-6 to 13-7
Enumeration parameters, 13-9
Function control, 13-7
illustration, 13-6
Numeric parameters, 13-8
Object parameters, 13-11
Parameter ring control, 13-7
pass by value or reference, 13-8
Result Actions, 13-9
String parameters, 13-9 to 13-10
Structure parameters, 13-11
mouse and keyboard actions for navigating lists and tree views (table), 2-3 to 2-4
multi-byte characters, recognizing, 4-32
Multiple Numeric Limit Test, 10-11 to 10-15
Data Source tab, 10-14 to 10-15
Edit Multiple Numeric Limit Test dialog box, 10-12
properties (figure), 10-13
step properties defined, 10-13 to 10-14

N

name attribute, synchronization objects, 11-2 to 11-3
Name control
  Columns/Parameters tab, 18-18
  Statements tab, 18-15
named data types, 1-10
nested interactive execution, 1-26, 6-3
nested sections, Batch Synchronization step, 11-58
New button, Select Data Link dialog box, 18-47
New command, File menu, 4-2
New Element to Enqueue control, Enqueue operation, 11-26
New Thread Priority control, Set Thread Priority operation, 11-54
New Workspace command, File menu, 4-2
NI Developer Zone, A-1
NI subdirectory, 3-4
normal sequences, Sequence Properties Model tab, 14-12
Notification Exists control, Get Status operation, 11-45
Notification Name Expression control, Create operation, 11-36
Notification Name or Reference Expression control
  Clear operation, 11-39
  Get Status operation, 11-45
  Pulse operation, 11-40
  Set operation, 11-37
  Wait operation, 11-42
Notification Reference Lifetime control, Create operation, 11-36
Notification step, 11-35 to 11-48
  Clear operation
    illustration, 11-39
    Notification Name or Reference Expression control, 11-39
  Create operation, 11-35 to 11-36
    Already Exists control, 11-36
    illustration, 11-36
    Notification Name Expression control, 11-36
    Notification Reference Lifetime control, 11-36
  Get Status operation, 11-45 to 11-46
    illustration, 11-45
    Is Auto Clear control, 11-46
    Is Set control, 11-46
    Location to Store Data control, 11-46
    Notification Exists control, 11-45
    Notification Name or Reference Expression control, 11-45
    Number of Threads Waiting for Notification control, 11-45
  Pulse operation, 11-40 to 11-41
    Data Value control, 11-41
    illustration, 11-40
    Notification Name or Reference Expression control, 11-40
    Notify All/First Waiting Thread/s (If Any), 11-41
    Store Data by Reference Instead of by Value control, 11-41
  Set operation, 11-37 to 11-38
    Auto Clear After Notifying One Thread control, 11-38
    Data Value control, 11-38
    illustration, 11-37
    Notification Name or Reference Expression control, 11-37
    Store Data by Reference Instead of by Value control, 11-38
  step properties, 11-46 to 11-48
  Wait operation, 11-41 to 11-44
    illustration, 11-42
    Location to Store Data control, 11-43 to 11-44

Notification Name or Reference Expression control, 11-42
Timeout Causes Run-Time Error control, 11-44
Timeout Enabled control, 11-44
Timeout Expression control, 11-44
Which Notification control, 11-44
notification synchronization object, 11-1 to 11-2
Notify All/First Waiting Thread/s (If Any) control, Pulse operation, Notification step, 11-41
Number of Elements control, Get Status operation, Queue step, 11-32
Number of Fractional Digits control, Numeric Format dialog box, 9-13 to 9-14
Number of Test Sockets control, Model Options dialog box, 14-3
Number of Threads in Batch control, Get Status operation, 11-67
Number of Threads Per Rendezvous control
Create operation, 11-20
Get Status operation, 11-22
Number of Threads Waiting
at Synchronized Sections control, Get Status operation, 11-66
for Notification control, Get Status operation, 11-45
for Rendezvous control, Get Status operation, 11-22
to Acquire the Semaphore control, Get Status operation, 11-16
to Dequeue control, Get Status operation, 11-32
to Enqueue control, Get Status operation, 11-32
to Lock the Lock control, Get Status operation, 11-10
Numeric category data types (table), 13-8
Numeric Format button, General tab, custom data type Properties dialog box, 9-24
Numeric Format dialog box, 9-12 to 9-15
Align Left control, 9-14
Check Format control, 9-15
Custom control, 9-15
Display Trailing Zeros control, 9-14
Format control, 9-15
Formatted Number control, 9-13
Full Width With Leading Zeros control, 9-14
illustration, 9-13
Maximum Number of Significant Digits control, 9-14
Minimum Field Width control, 9-14
Minimum Number of Digits control, 9-14
Number of Fractional Digits control, 9-13 to 9-14
Sample control, 9-13
Show Decimal Point control, 9-14
Show Exponent control, 9-14
Show Radix Prefix control, 9-15
Sign control, 9-14
Type control, 9-13
Use Uppercase Letters control, 9-15
numeric format strings (table), 18-96 to 18-97
numeric function operators (table), 8-18
Numeric Limit Test step, 10-7 to 10-11
Comparison Type ring control, 10-8
comparison types (table), 10-7 to 10-8
Edit Numeric Limit Test dialog box
Data Source tab, 10-9 to 10-10
Limits tab, 10-7
Multiple Numeric Limit Test, 10-11 to 10-15
Data Source tab, 10-14 to 10-15
Edit Multiple Numeric Limit Test dialog box, 10-12
properties (figure), 10-13
step properties defined, 10-13 to 10-14
properties (figure), 10-10

setting value of Step.Result.Numeric, 10-9
step properties defined, 10-10 to 10-11
Units control, 10-8
Numeric parameters, specifying for DLL Flexible Prototype Adapter, 13-8

O

object and static library code modules, distributing, 17-10
Object parameters, specifying for DLL Flexible Prototype Adapter, 13-11
Object-linking and Embedding Database (OLE DB), 18-3
objects, SQL, 18-87 to 18-88
ODBC administrator, 18-39 to 18-44
accessing and using databases, 18-39 to 18-40
example data link and result table setup for Microsoft Access, 18-42 to 18-44
creating result tables, 18-43 to 18-44
specifying data link and schema, 18-43
ODBC Data Source Administrator dialog box
Drivers Tab, 18-42
User DSN tab, 18-40
ODBC Microsoft Access 97 Setup dialog box (figure), 18-41
third party ODBC database drivers, 18-42
OLE DB (Object-linking and Embedding Database), 18-3
On Condition False control, Post Actions tab, 5-26
On Condition True control, Post Actions tab, 5-26
On Fail control, Post Actions tab, 5-25
On Pass control, Post Actions tab, 5-25
On Run-Time Error, Execution tab, 4-23 to 4-24
one-thread-only section, Batch Synchronization step, 11-57
Open command, File menu, 4-2
Open Database Connectivity administrator. *See* ODBC administrator.
Open Database step type, 18-48 to 18-50
custom properties, 18-50
Data Link tab, Edit Open Database dialog box, 18-49 to 18-50
Open Sequence command, All Sequences view context menu, 5-3
Open SQL statement step type, 18-52 to 18-57
Advanced tab, Edit Open SQL Statement dialog box, 18-54 to 18-57
Cache Size control, 18-55
Command Timeout control, 18-55
Command Type control, 18-56 to 18-57
Cursor Location control, 18-56
Cursor Type control, 18-55 to 18-56
illustration, 18-55
Lock Type control, 18-56
Marshal Options control, 18-56
Max Records to Select control, 18-55
Page Size in Records control, 18-55
custom properties, 18-57
SQL statement tab, Edit Open SQL Statement dialog box, 18-52 to 18-54
Build control, 18-53 to 18-54
Database Handle (Number) control, 18-52 to 18-53
illustration, 18-53
Number of Records Selected control, 18-53
SQL Statement control, 18-53
Statement Handle (Number) control, 18-53
Open Tree View command, Step Group context menu, 5-18
Open Workspace command, File menu, 4-2

Operation control, Record/Operation tab, Edit Data Operation dialog box, 18-61
operator interfaces. *See* run-time operator interfaces.
operators
    expression operators (table), 8-16 to 8-17
    SQL operators (table), 18-89 to 18-90
Operators/Functions tab, Expression Browser dialog box, 8-15
Optimize Non-Reentrant Calls to this Sequence option, Sequence Properties dialog box, 5-5
Options menu, Database Viewer, 18-34
Options tab, Configure Message Box Step dialog box, 10-23 to 10-24
Oracle databases, adding support for, 18-30
Order Number control, Add Thread operation, 11-64

P

Packing control, Struct Passing tab, 9-25 to 9-26
Page Size in Records control, Edit Open SQL Statement dialog box, 18-55
Palette ring, Type Palette window, 9-55
Parallel and Batch models, 14-3 to 14-9
    Batch model, 14-6 to 14-9
    Model Options dialog box, 14-3 to 14-4
        Bring UUT Dialog to Front When Status Changes control, 14-4
        Default Batch Synchronization control, 14-4
        Hide Execution Windows control, 14-4
        illustration, 14-3
        Number of Test Sockets control, 14-3
        Sequential Batch Mode control, 14-4
        Tile Execution Windows control, 14-4
    Parallel model, 14-4 to 14-6
Parallel Model Test UUTs dialog box
    Abort All control, 14-6
    Abort control, 14-6
    Exit control, 14-6
    illustration, 14-5
    Next UUT control, 14-6
    OK control, 14-5
    Restart control, 14-6
    Stop All control, 14-6
    Stop control, 14-5
    Terminate All control, 14-6
    Terminate control, 14-6
    Test Socket control, 14-5
    UUT Serial Number control, 14-5
    View Report control, 14-6
parallel sections, Batch Synchronization step, 11-57
Parameter ring control, Module tab, 13-7
parameters, lifetime of, 5-31
Parameters control, Create Columns dialog box, 18-73
Parameters tab, 5-31 to 5-34
Parameters tab context menu, 5-32 to 5-34
    Browse Sequence Context command, 5-33
    Check Type option, 5-34
    Go Up One Level command, 5-33
    Insert Parameter submenu, 5-32 to 5-33
    Pass By Reference command, 5-33 to 5-34
    Properties command, 5-34
    Rename command, 5-33
    View Contents command, 5-33
Pass By Reference command, Parameters tab context menu, 5-33 to 5-34
pass by value or by reference, DLL Flexible Prototype Adapter, 13-8
Pass/Fail Test step, 10-5 to 10-6
    Edit Pass/Fail Source dialog box, 10-6
    properties (figure), 10-6

setting value of Step.Result.PassFail, 10-5 to 10-6
step properties defined, 10-6
paste capabilities, sequence editor screen, 2-4 to 2-5
Paste command, Edit menu, 4-4
Path standard data type, 9-16
Paths command, View menu, 4-8 to 4-11
Post Actions tab, Step Properties dialog box, 5-24 to 5-26
Break option, 5-26
Call sequence option, 5-26
Custom Condition Expression control, 5-26
Destination control, 5-25
Goto destination option, 5-26
Goto next step option, 5-26
illustration, 5-25
On Condition False control, 5-26
On Condition True control, 5-26
On Fail control, 5-25
On Pass control, 5-25
overview, 2-20
Specify Custom Condition control, 5-26
Terminate execution option, 5-26
Post Expression control, Expressions tab, 5-31
Post Step substep
definition, 1-13
Substeps tab, 9-40
Pre Expression control, Expressions tab, 5-30
Pre Step substep
definition, 1-13
Substeps tab, 9-40
Precondition control
Columns/Parameters tab, 18-19
Statements tab, 18-16
Precondition Evaluation in Interactive Mode control, Run Options tab, 5-23
Precondition option, Disable Properties tab, 9-44
Preconditions button
General tab, Step Properties dialog box, 5-21
Sequence Properties dialog box, 5-5, 5-38
Step Properties dialog box, 5-38
Preconditions dialog box, 5-38 to 5-40
controlling sequence flow, 2-19 to 2-20
Copy button, 5-39
Cut button, 5-39
illustration, 2-19, 5-38
Insert AllOf button, 5-39
Insert AnyOf button, 5-39 to 5-40
Insert New Expression button, 5-39
Insert Step Status section
Insert Step Error, 5-40
Insert Step Executed, 5-40
Insert Step Fail, 5-40
Insert Step Pass, 5-40
list box items
AllOf block, 5-39
AnyOf block, 5-39
Arbitrary expression, 5-39
Step status condition expression, 5-39
purpose and use, 2-19 to 2-20
Preferences tab, Station Options dialog box, 4-27 to 4-28
Auto Increment Sequence File Version option, 4-28
illustration, 4-27
Prompt to Change System SetForegroundWindow Behavior option, 4-28
Prompt to Find Files option, 4-27
Reload Documents When Opening workspace option, 4-28
Reload Last Workspace at Startup option, 4-28
Show Hidden Properties option, 4-27
Station ID option, 4-28

Primary Key control, Columns/Parameters tab, 18-20
privileges for users, verifying, 12-11 to 12-12
  any user, 12-12
  current user, 12-11
process models, 1-17 to 1-22, 14-1 to 14-16. *See also* model callbacks.
  client sequence file, 1-18
  configuration entry points, 14-2
  customizing, 3-10 to 3-11
  definition, 1-17
  directory structure, 14-9 to 14-10
  entry points, 1-19 to 1-22
    flowchart of Test UUTs sequence in default process model (figure), 1-20
    list of all sequences (figure), 1-22
    set of steps for Test UUTs entry point (figure), 1-21
  execution entry points, 14-2
  features common to all TestStand process models, 14-2
  main sequence, 1-18
  overview, 1-17 to 1-18
  Parallel and Batch models, 14-3 to 14-9
    Batch model, 14-6 to 14-9
    Model Options dialog box, 14-3 to 14-4
    Parallel model, 14-4 to 14-6
  selecting default process model, 14-9
  sequential model, 14-2
  special editing capabilities for sequence files, 14-10 to 14-16
    callback sequences, 14-12 to 14-13
    entry point sequences, 14-13 to 14-16
    normal sequences, 14-12
    Sequence Properties Model tab, 14-11 to 14-16
  station model, 1-18
  TestStand process models (table), 14-1
Profiles tab
  User Manager Users view, 12-5 to 12-7
    illustration, 12-6
    Profiles tab context menu, 12-6 to 12-7
  Users view, 12-5 to 12-7
Profiles tab context menu, 12-6 to 12-7
  Edit User Type command, 12-7
  Insert Profile command, 12-7
Prompt to Add to Source Control When Inserting File into Workspace option, Source Control tab, 4-33
Prompt to Change System SetForegroundWindow Behavior option, Preferences tab, 4-28
Prompt to Find Files option, Preferences tab, 4-27
Propagate to Subsequence option, Locals tab context menu, 5-37
properties. *See also* custom properties; step properties; variables.
  array property, 1-10
  built-in properties
    definition, 1-11
    sequence properties, 1-17
    step properties, 1-11 to 1-12
    step type properties, 9-34 to 9-35
  categories, 1-9 to 1-11
  class step type properties, 9-34
  container property, 1-10
  definition, 1-7
  displaying with Browse Sequence Context command, 4-13 to 4-14
  importing/exporting. *See* Import/Export Properties dialog box.
  instance step type properties, 9-34
  property-array property, 1-10
  single-valued property, 1-10
  standard and custom named data types, 1-10
  using in expressions, 1-8 to 1-9

Properties command
  Context tab context menu, 6-9
  Globals View context menu, 7-3
  Locals tab context menu, 5-37 to 5-38
  Parameters tab context menu, 5-34
  Sequence File Globals view context menu, 5-44
  Step Group context menu, 2-16, 5-19
  Steps tab context menu, 6-7
Properties control, Properties tab
  Edit Property Loader dialog box, 18-67 to 18-68
  Import/Export Properties dialog box, 18-83
  Property Loader dialog box, 18-72
properties dialog boxes
  custom data types, 9-22 to 9-27
    Bounds tab, 9-24
    General tab, 9-23 to 9-24
    illustration, 9-23
    Struct Passing tab, 9-25 to 9-26
    Version tab, 9-25
  data type fields, 9-26 to 9-27
  Differ window, 5-47
  Sequence File Properties dialog box, 5-6 to 5-9
  Sequence Properties dialog box, 5-4 to 5-5
  Step Properties dialog box, 2-17 to 2-18, 5-19 to 5-31
  Step Type Properties dialog box, 9-35 to 9-51
Properties List Source control, Properties tab
  Edit Property Loader dialog box, 18-67
  Property Loader dialog box, 18-72
Properties tab
  Edit Property Loader dialog box, 18-67 to 18-68
  Import/Export Properties dialog box, 18-82 to 18-83
    Append data type to column name control, 18-83
    Column Name control, 18-83
    Create Columns control, 18-83
    illustration, 18-82
    Max size for column name control, 18-83
    Properties control, 18-83
    Property Name control, 18-83
    Sequence control, 18-82
    Step Name Column control, 18-82
  Property Loader dialog box, 18-71 to 18-73
    Append data type to column name control, 18-72
    Column Name/Number control, 18-72
    Create Columns control, 18-72 to 18-73
    Data Link Name control, 18-71
    illustration, 18-71
    Max size for column name control, 18-72
    Properties control, 18-72
    Properties List Source control, 18-72
    Property Name control, 18-72
    SQL Select Statement control, 18-72
    Statement Handle (Number) control, 18-71
    Step Name Column control, 18-72
Properties tab, Edit Property Loader dialog box
  illustration, 18-67
  Properties control, 18-67 to 18-68
  Properties List Source control, 18-67
  Property Name control, 18-68
property flags, 9-27 to 9-29. *See also* Edit Flags dialog box.
  Edit Data Type Flags dialog box, 9-29
  Edit Flags dialog box, 9-27 to 9-28
  reports affected by flags, 15-13

Reset Flags in All Loaded Instances of the Type checkbox, 9-28
Type flags button, 9-28
property function operators (table), 8-18
Property Loader dialog box
Filtering tab, 18-74 to 18-75
Column List Source control, 18-74
Column Name/Number control, 18-75
Column Values control, 18-75
Create Columns control, 18-75
Format String control, 18-75
illustration, 18-74
Only import rows that match the specified column values control, 18-74
Values control, 18-75
Properties tab, 18-71 to 18-73
Append data type to column name control, 18-72
Column Name/Number control, 18-72
Create Columns control, 18-72 to 18-73
Data Link Name control, 18-71
illustration, 18-71
Max size for column name control, 18-72
Properties control, 18-72
Properties List Source control, 18-72
Property Name control, 18-72
SQL Select Statement control, 18-72
Statement Handle (Number) control, 18-71
Step Name Column control, 18-72
Property Loader step type, 18-65 to 18-78
custom properties, 18-75 to 18-78
Filtering tab, Property Loader dialog box, 18-74 to 18-75
Column List Source control, 18-74
Column Name/Number control, 18-75
Column Values control, 18-75
Create Columns control, 18-75
Format String control, 18-75
illustration, 18-74
Only import rows that match the specified column values control, 18-74
Values control, 18-75
loading from database, 18-69 to 18-70
loading from file, 18-66
Properties tab, Edit Property Loader dialog box, 18-67 to 18-68
illustration, 18-67
Properties control, 18-67 to 18-68
Properties List Source control, 18-67
Property Name control, 18-68
Properties tab, Property Loader dialog box, 18-71 to 18-73
Append data type to column name control, 18-72
Column Name/Number control, 18-72
Create Columns control, 18-72 to 18-73
Data Link Name control, 18-71
illustration, 18-71
Max size for column name control, 18-72
Properties control, 18-72
Properties List Source control, 18-72
Property Name control, 18-72
SQL Select Statement control, 18-72
Statement Handle (Number) control, 18-71
Step Name Column control, 18-72

Source tab, Edit Property Loader dialog box, 18-68 to 18-69
Disable the First Row of Data that Specifies Step Property for Each Column control, 18-69
illustration, 18-68
Skip Rows that Begin With control, 18-69
Specify Column to Step Property Mapping text box, 18-69
Start of Data Marker control, 18-69
Property Name control, Properties tab
Edit Property Loader dialog box, 18-68
Import/Export Properties dialog box, 18-83
Property Loader dialog box, 18-72
Property ring, Struct Passing tab, 9-26
property-array property, definition, 1-10
prototype adapters. *See* C/CVI Standard Prototype Adapter.
Provider tab, Data Link Properties dialog box, 18-35 to 18-36
Pulse operation, Notification step, 11-40 to 11-41
Data Value control, 11-41
illustration, 11-40
Notification Name or Reference Expression control, 11-40
Notify All/First Waiting Thread/s (If Any), 11-41
Store Data by Reference Instead of by Value control, 11-41

Q

Queue Exists control, Get Status operation, 11-32
Queue Name Expression control, Create operation, 11-24
Queue Name or Reference Expression control
Dequeue operation, 11-27 to 11-28
Enqueue operation, 11-26
Flush operation, 11-30
Get Status operation, 11-31
Queue Reference Lifetime control, Create operation, 11-24
Queue step, 11-23 to 11-34
Create operation, 11-23 to 11-25
Already Exists control, 11-24
illustration, 11-24
Maximum Number of Elements control, 11-24
Queue Name Expression control, 11-24
Queue Reference Lifetime control, 11-24
Dequeue operation, 11-27 to 11-29
dequeue behaviors for data enqueued by value (table), 11-28 to 11-29
Dequeue From control, 11-29
illustration, 11-27
Location to Store Element control, 11-28 to 11-29
Queue Name of Reference Expression control, 11-27 to 11-28
Remove Element control, 11-29
Timeout Causes Run-Time Error control, 11-29
Timeout Enabled control, 11-29
Timeout Expression control, 11-29
Which Queue control, 11-29
Enqueue operation, 11-25 to 11-26
If the Queue is Full control, 11-26
illustration, 11-25
Insert At control, 11-26
New Element to Enqueue control, 11-26
Queue Name or Reference Expression control, 11-26
Store by Reference Instead of by Value control, 11-26
Timeout Causes Run-Time Error control, 11-26

Timeout Enabled control, 11-26
Timeout Expression control, 11-26
Flush operation, 11-30 to 11-31
illustration, 11-30
Location to Store Array of Queue Elements control, 11-30 to 11-31
Queue Name or Reference Expression control, 11-30
Get Status operation, 11-31 to 11-32
illustration, 11-31
Location to Store Array of Queue Elements control, 11-32
Maximum Number of Elements control, 11-32
Number of Elements control, 11-32
Number of Threads Waiting to Dequeue control, 11-32
Number of Threads Waiting to Enqueue control, 11-32
Queue Exists control, 11-32
Queue Name or Reference Expression control, 11-31
step properties, 11-33 to 11-35
queue synchronization object, 11-1

R

Recognize Multi-byte Characters option, Localization tab, 4-32
Record Index control, Record/Operation tab, 18-61
Record Result of Each Iteration option, Loop Options tab, 5-28
Record Results option, Run Options tab, 5-23
Record to Operate On control, Record/Operation tab, 18-60 to 18-61
Record/Operation tab, Edit Data Operation dialog box, 18-60 to 18-61
Column List Source control, 18-61
illustration, 18-60
Operation control, 18-61
Record Index control, 18-61
Record to Operate On control, 18-60 to 18-61
Statement Handle (Number) control, 18-60
records, in databases, 18-1
Rediff Sequence Files option, Differ window, 5-47
Refresh command
Context tab context menu, 6-9
Watch Expression pane, Execution window, 6-14
Release operation, Semaphore step, 11-15 to 11-16
illustration, 11-15
Semaphore Name or Reference Expression control, 11-16
Reload Documents When Opening workspace option, Preferences tab, 4-28
Reload Last Workspace at Startup option, Preferences tab, 4-28
Reload Station Globals command, Globals View context menu, 7-3
Remote Execution Settings dialog box, Sequence Adapter, 13-47 to 13-48
illustration, 13-47
path resolution of sequence pathnames for remotely executed steps (table), 13-48
Remote Host control, 13-47
Specify expression for host option, 13-47
Remote Execution tab, Station Options dialog box, 4-32
Remove control, Customize Tool Menu dialog box, 4-42
Remove Element control, Dequeue operation, 11-29
Remove Thread operation, Batch Specification step, 11-65
ActiveX Reference to Thread control, 11-65
illustration, 11-65

Rename command
- All Sequences view context menu, 5-3
- Globals View context menu, 7-3
- Locals tab context menu, 5-37
- Parameters tab context menu, 5-33
- Sequence File Globals view context menu, 5-44

Rendezvous Exists?, Get Status operation, 11-22
Rendezvous Name Expression control, Create operation, 11-19 to 11-20
Rendezvous Name or Reference Expression
- Get Status operation, 11-21 to 11-22
- Rendezvous operation, 11-21

Rendezvous Reference Lifetime operation, Create operation, 11-20
Rendezvous step, 11-19 to 11-23
- Create operation, 11-19 to 11-20
  - Already Exists control, 11-20
  - illustration, 11-19
  - Rendezvous Name Expression control, 11-19 to 11-20
- Get Status operation, 11-21 to 11-22
  - illustration, 11-21
  - Number of Threads Per Rendezvous control, 11-22
  - Number of Threads Waiting for Rendezvous control, 11-22
  - Rendezvous Exists? control, 11-22
  - Rendezvous Name or Reference Expression control, 11-21 to 11-22
- Rendezvous operation, 11-20 to 11-21
- step properties, 11-22 to 11-23

rendezvous synchronization object, 11-1
Replace Selected Items in File option, Differ window, 5-47
Report Options command, Configure menu, 3-3, 4-35
Report Options configuration entry point, 14-2
Report Options dialog box, 15-6 to 15-10
- Contents tab, 15-7 to 15-10
  - Append if File Already Exists option, 15-9
  - Default Numeric Format option, 15-9
  - Disable Report Generation option, 15-8
  - illustration, 15-7
  - Include Execution Times option, 15-9
  - Include Measurements option, 15-8
  - Include Step Results option, 15-8
  - Include Test Limits option, 15-8
  - Report Colors option, 15-9
  - Report Format option, 15-9
  - Result Filtering Expression option, 15-8
  - Select a Report Generator for Producing the Report Body option, 15-9
- overview, 15-6 to 15-7
- Report File Pathname tab, 15-10 to 15-13
  - Add Time and Date to File Name control, 15-12
  - Append Batch Serial Number to Batch Report File control, 15-13
  - Append Batch Serial Number to UUT Report File control, 15-12
  - Append Test Socket Index to UUT Report File Name control, 15-12
  - Append UUT Serial Number to Report File Name control, 15-12
  - Base Name control, 15-11
  - Batch Base Name control, 15-12
  - Directory controls, 15-11
  - Force File Name to be Unique option, 15-12
  - illustration, 15-10
  - Prefix Sequence File Name to Report File Name option, 15-12
  - Specify Fixed Report File Path button, 15-11

Store UUT Report in Batch Report File control, 15-13
Use Standard Extension for Report Format control, 15-12
Use Temporary File option, 15-11
Report tab, Execution window, 6-9 to 6-10
reports
ASCII format test report (figure), 15-4
batch reports, 15-6
failure chain, 15-5
generating test reports, 2-23 to 2-25
HTML test report (figure), 2-24, 15-3
implementation of test report capability, 15-1
Launch Report Viewer command, 4-14
property flags affecting reports, 15-13
using test reports, 15-2
Require User Login option, User Manager tab, 4-31
resource string files. *See* string resource files.
Restart command, Execute menu, 4-15
Restart control, Parallel Model Test UUTs dialog box, 14-6
Result Actions, DLL Flexible Prototype Adapter, 13-9
result collection
automatic result collection, overview, 1-23
Execution window, 6-15 to 6-21
custom result properties, 6-17 to 6-18
loop results, 6-21
ResultList array (figure), 6-16
standard result properties, 6-18 to 6-19
subsequence results, 6-19 to 6-21
Result Filtering Expression control, Logging Options tab, 18-10
results tables. *See* database result tables.
Resume command, Debug menu, 4-18
Resume All command, Debug menu, 4-20
Retry option, Run-Time Error dialog box, 6-30
root interactive execution, 1-25 to 1-26, 6-3
rows, in databases, 18-1
Run Active Sequence command, Execute menu, 4-15
Run Cleanup option, Run-Time Error dialog box, 6-30
Run Database Viewer command, Tools menu, 4-41
Run Engine Installation Wizard command, Tools menu, 4-40
Run Mode, Run Options tab, 5-22
Run Mode submenu
Step Group context menu, 5-17
Force Fail, 5-17
Force Pass, 5-17
Normal, 5-17
Skip, 5-17
Steps tab context menu, 6-6 to 6-7
Run Options tab, Step Properties dialog box, 5-21 to 5-24
Breakpoint option, 5-23
Ignore Run-time Errors option, 5-23 to 5-24
Ignore Termination option, 5-24
illustration, 5-21
Load Option, 5-22
Precondition Evaluation in Interactive Mode control, 5-23
Record Results option, 5-23
Run Mode, 5-22
Sequence Call Trace Setting option, 5-24
Step Failure Causes Sequence Failure option, 5-23
TestStand Window Activation control, 5-23
Unload Option, 5-22
Run Selected Steps command
Execute menu, 4-16
Step Group context menu, 5-17
Steps tab context menu, 6-7

Run Selected Steps Using command, Step Group context menu, 5-17
running sequences, 2-21 to 2-22
RunState subproperty, 8-4 to 8-8
RunState.InitialSelection subproperty, 8-10 to 8-12
RunState.Sequence subproperty and other Sequence objects, 8-9 to 8-10
RunState.SequenceFile subproperty and other SequenceFile objects, 8-8 to 8-9
RunState.Step subproperty and other Step objects, 8-10
run-time copy, created during execution, 6-1
Run-Time Error dialog box, 6-30 to 6-31
  Abort Immediately option, 6-30
  Break option, 6-31
  Ignore option, 6-30
  illustration, 6-30
  Retry option, 6-30
  Run Cleanup option, 6-30
  Suppress this dialog for the remainder of this execution option, 6-31
run-time errors, 6-29 to 6-31
  built-in step type, 10-3
  description, 6-29
  handling interactively, 6-29
  Ignore Run-Time Errors option enabled, 6-29
  overview, 2-21
run-time operator interfaces, 16-1 to 16-8
  advantages, 2-25
  compared with sequence editor, 6-1
  considerations for customizing, 16-1 to 16-2
  customizing, 3-12
  definition, 1-2
  Delphi interface, 16-7 to 16-8
  distributing. *See* distributing TestStand.
  LabVIEW interface, 16-4 to 16-5
  LabWindows/CVI interface, 16-2 to 16-4
  overview, 1-5
  Visual Basic interface, 16-5 to 16-7

S

Save command, File menu, 4-3
Save All command, File menu, 4-3
Save As command, File menu, 4-3
Save Before Running options, Sequence Editor Options dialog box, 4-21
Search Directories command, Configure menu, 3-2, 4-34 to 4-35
Section Name control
  Enter Synchronized Section operation, 11-59
  Exit Synchronized Section operation, 11-60
Section Type control, Enter Synchronized Section operation, 11-59
Select a Language option, Localization tab, 4-32
Select All command, Edit menu, 4-5
SELECT command, SQL, 18-87
Select Data Link control, Data Link tab, 18-49
Select Data Link dialog box, 18-45 to 18-48
  Edit Data Link dialog box, 18-47 to 18-48
  Edit option, 18-47
  illustration, 18-46
  New option, 18-47
  overview, 18-45
  Selected Data Link is Open option, 18-47
Semaphore Exists? control, Get Status operation, 11-17
Semaphore Name Expression control
  Acquire operation, 11-14
  Create operation, 11-13
Semaphore Name or Reference Expression control
  Get Status operation, 11-17
  Release operation, 11-16

Semaphore Reference Lifetime control, Create operation, 11-13
Semaphore step, 11-12 to 11-19
- Acquire operation, 11-14 to 11-15
  - Acquire Lifetime control, 11-15
  - Auto Release control, 11-14
  - illustration, 11-14
  - Semaphore Name or Reference Expression control, 11-14
  - Timeout Causes Run-Time Error control, 11-15
  - Timeout Enabled control, 11-15
  - Timeout Expression control, 11-15
- Create operation, 11-12 to 11-14
  - Already Exists control, 11-13
  - illustration, 11-13
  - Initial Semaphore Count control, 11-13
  - Semaphore Name Expression control, 11-13
  - Semaphore Reference Lifetime control, 11-13
- Get Status operation, 11-16 to 11-17
  - Current Count control, 11-17
  - illustration, 11-16
  - Initial Semaphore Count control, 11-17
  - Number of Threads Waiting to Acquire the Semaphore control, 11-17
  - Semaphore Exists? control, 11-17
  - Semaphore Name or Reference Expression control, 11-17
- Release operation, 11-15 to 11-16
  - illustration, 11-15
  - Semaphore Name or Reference Expression control, 11-16
- step properties, 11-17 to 11-19

semaphore synchronization object, 11-1

Sequence Adapter, 13-40 to 13-50
- Edit Sequence Call tab, Specify Module dialog box, 13-41 to 13-44
  - File Pathname control, 13-42
  - illustration, 13-41
  - Multithreading and Remote Execution control, 13-42
  - Parameters section, 13-43
  - Sequence control, 13-42
  - Settings control, 13-43
  - Specify Expressions for Pathname and Sequence, 13-41 to 13-42
  - Use Current File control, 13-42
- example parameters (figure), 13-40
- Execution Settings dialog box
  - Additional Execution type Mask Settings control, 13-46
  - Break on Entry control, 13-47
  - Close Window when Done control, 13-45
  - Initially Hidden and Disable Tracing control, 13-45
  - Initially Suspended control, 13-45
  - Process Model Option, 13-46
  - Store an ActiveX Reference to the new Execution in control, 13-46
  - Wait for Execution to Complete control, 13-44
- path resolution of sequence pathnames (table), 13-48
- Remote Execution dialog box, 13-47 to 13-48
  - illustration, 13-47
  - path resolution of sequence pathnames for remotely executed steps (table), 13-48
  - Remote Host control, 13-47
  - Specify expression for host option, 13-47
- setting up TestStand as server for remote execution, 13-49 to 13-50

specifying in Edit Sequence Call dialog box, 13-41 to 13-48
Edit Sequence Call tab, 13-41 to 13-44
Execution Settings dialog box, 13-45 to 13-47
Remote Execution Settings dialog box, 13-47 to 13-48
Thread Settings dialog box, 13-44
Thread Settings dialog box, 13-44
Automatically Wait for the Thread to Complete at the End of the Current Sequence control, 13-44
illustration, 13-44
Initially Suspended control, 13-44
Store an ActiveX Reference to the New Thread in control, 13-44
Sequence Call step, 10-18 to 10-20
Sequence Call Trace Setting option, Run Options tab, 5-24
sequence context, 8-1 to 8-12
definition, 1-7
first-level properties (table), 8-2
overview, 8-1
properties referring to objects that exist before and after current execution, 8-2
purpose and use, 8-12
subproperties, 8-3 to 8-12
RunState, 8-4 to 8-8
RunState.InitialSelection, 8-10 to 8-12
RunState.Sequence and other Sequence objects, 8-9 to 8-10
RunState.SequenceFile and other SequenceFile objects, 8-8 to 8-9
RunState.Step and other Step objects, 8-10
StationGlobals, 8-3
Sequence Context control, LabVIEW Standard Prototype Adapter, 13-21
Sequence control, Properties tab, Import/Export Properties dialog box, 18-82
sequence editor
compared with run-time operator interfaces, 6-1
configuring startup options, 3-1 to 3-2
context menus, 2-4
controlling sequence flow, 2-18 to 2-21
copy, cut, and paste capabilities, 2-4 to 2-5
creating sequences, 2-14 to 2-18
definition, 1-2
drag and drop capabilities, 2-5
Execution window. *See* Execution window.
lists and trees, 2-3 to 2-4
menu bar. *See* sequence editor menu bar.
mouse and keyboard actions for navigating lists and tree views (table), 2-3 to 2-4
overview, 1-5
screens, 2-1 to 2-5
Sequence File window, 2-6
Station Globals window, 2-8 to 2-9
status bar, 2-5
tabs, 2-3
toolbars, 2-5
Type Palette window, 2-7 to 2-8
Users window, 2-14
views, 2-2 to 2-3
windows, 2-2 to 2-5
Workspace window, 2-9 to 2-13
sequence editor Execution window. *See* Execution window.
sequence editor menu bar, 4-1 to 4-44
Configure menu, 3-2 to 3-3, 4-20 to 4-36
Debug menu, 4-18 to 4-20
Edit menu, 4-4 to 4-7
Execute menu, 4-15 to 4-18
File menu, 4-1 to 4-3
overview, 2-5
Source Control Menu, 4-36 to 4-37
Tools menu, 4-37 to 4-44

View menu, 4-7 to 4-14
Window menu, 4-44
Sequence Editor Options command, Configure menu, 4-20 to 4-21
Sequence Editor Options dialog box
Allow Editing NI Installed Types, 4-21
Allow Editing of Read Only Files option, 4-21
Backup Sequence Files When Resaving in Older or Newer Format option, 4-21
Close Completed Execution Displays on Execution, 4-21
Disable “View User Manager” Command option, 4-21
Display Warning on Run Mode Changes in Execution Window option, 4-20 to 4-21
Save Before Running options, 4-21
Show List View Tip Strips option, 4-21
sequence execution. *See* execution.
Sequence File and Sequence control, Customize Tool Menu dialog box, 4-43
Sequence File Callbacks command
All Sequences view context menu, 5-10 to 5-11
Edit menu, 4-6 to 4-7
Sequence File Converters submenu, Tools menu, 4-39
Sequence File Documentation submenu, Tools menu, 4-37 to 4-39
Destination File Path control, 4-38
File Format control, 4-38
illustration, 4-38
Launch Viewer When Done control, 4-39
Maximum Number of Elements to Show control, 4-39
Show Array Elements control, 4-39
Show Hidden Properties control, 4-39
Show Locals control, 4-38
Show Parameters control, 4-38
Show Sequence File Globals control, 4-38
Show Station Globals control, 4-38
Show Subproperties control, 4-39
Sequence File Globals control, Sequence File Properties dialog box, 5-7 to 5-8
Sequence File Globals view, 5-41 to 5-44
context menu, 5-42 to 5-44
illustration, 5-41
lifetime and scope of sequence file global variables, 5-41 to 5-42
Sequence File Globals view context menu, 5-42 to 5-44
Browse Sequence Context command, 5-44
Go Up One level command, 5-44
Insert Global submenu, 5-43
Properties command, 5-44
Rename command, 5-44
View Contents command, 5-43
Sequence File Properties command
All Sequences view context menu, 5-6 to 5-9
Edit menu, 4-6
Sequence File Properties dialog box
Advanced tab, 5-8 to 5-9
illustration, 5-8, 14-11
Model Option, 5-8 to 5-9
No Model control, 5-9
Require Specific Model control, 5-9
Type control, 5-8
General tab, 5-6 to 5-8
Comment control, 5-8
Full Path control, 5-6
illustration, 5-6
Load Option, 5-7
Saved control, 5-6
Sequence File Globals control, 5-7 to 5-8
Size control, 5-6
Unload Option, 5-7
Version control, 5-7

Synchronization tab
Default Batch Synchronization control, 5-9
illustration, 5-9
sequence file views, 5-1 to 5-45
All Sequences view, 5-2 to 5-9
All Sequences view context menu, 5-3 to 5-5
Browse Sequence Context command, 5-3
Insert Sequence command, 5-3
Open Sequence command, 5-3
Rename command, 5-3
Sequence File Callbacks command, 5-10 to 5-11
Sequence File Properties command, 5-6 to 5-9
Sequence Properties command, 5-3 to 5-5
View Contents command, 5-3
Individual Sequence view, 5-11 to 5-38
Locals tab, 5-34 to 5-38
Locals tab context menu, 5-35 to 5-38
Main, Setup, and Cleanup tabs, 5-11 to 5-31
Parameters tab, 5-31 to 5-34
Parameters tab context menu, 5-32 to 5-34
Step Group context menu, 5-15 to 5-31
step group list view and tree view, 5-12
step group list view columns, 5-13 to 5-15
Sequence File Globals view, 5-41 to 5-44
context menu, 5-42 to 5-44
lifetime and scope of sequence file global variables, 5-41 to 5-42
Sequence File Types view, 5-45
Sequence File Types view (table), 9-1
Sequence File window views, 5-1 to 5-2
Sequence File window
accessing types (table), 9-1
All Sequences view, 5-2 to 5-9
creating new sequence file, 2-14 to 2-18
example (figure), 2-6
Individual Sequence view, 5-11 to 5-38
purpose and use, 2-6
Sequence File Globals view, 5-41 to 5-44
Sequence File Types view, 5-45
using View ring, 5-1 to 5-2
View ring contents (figure), 5-2
sequence files
client sequence file, 1-18
comparing and merging, 5-45 to 5-47
definition, 1-2
distributing, 17-9
overview, 1-17
special editing capabilities for sequence files, 14-10 to 14-16
storage of types in files, 1-17
types of files, 5-1
sequence flow, controlling, 2-18 to 2-21
Post Actions tab, 2-20
preconditions, 2-19 to 2-20, 5-38 to 5-40
status property values after execution completion (table), 2-18
sequence local variables, 1-15 to 1-16
sequence parameters, 1-15. *See also* Parameters tab context menu.
Sequence Properties command
All Sequences view context menu, 5-3 to 5-5
Edit menu, 4-5
Step Group context menu, 5-19
Sequence Properties dialog box, 5-4 to 5-5
Comment control, 5-5
Disable Results for All Steps option, 5-4
Goto Cleanup on Sequence Failure control, 5-4

illustration, 5-4
Optimize Non-Reentrant Calls to this Sequence option, 5-5
Preconditions button, 5-5
Sequence Properties Model tab, 14-11 to 14-16
callback sequences, 14-12 to 14-13
entry point sequences, 14-13 to 14-16
normal sequences, 14-12
sequence views. *See* sequence file views.
SequenceContext, 1-7
SequenceFileLoad callbacks, restrictions on, 5-10 to 5-11
SequenceFileUnload callbacks, restrictions on, 5-10 to 5-11
sequences, 1-15 to 1-17
built-in sequence properties, 1-17
callback sequences, 1-23 to 1-25
components, 1-15
creating, 2-14 to 2-18
debugging, 2-22 to 2-23
definition, 1-2
lifetime of local variables, parameters, and custom step properties, 1-16
running, 2-21 to 2-22
sequence parameters, 1-15
step groups, 1-16
Sequential Batch Mode control, Model Options dialog box, 14-4
Sequential model
default TestStand process model, 14-1
typical use, 14-2
serial sections, Batch Synchronization step, 11-57
Set Next Step command, Steps tab context menu, 6-7
Set operation, Notification step, 11-37 to 11-38
Auto Clear After Notifying One Thread control, 11-38
Data Value control, 11-38
illustration, 11-37
Notification Name or Reference Expression control, 11-37
Store Data by Reference Instead of by Value control, 11-38
Set Thread Priority operation, 11-54
Setup tab, step groups, 5-11
Show Array Elements control, Sequence File Documentation submenu, 4-39
Show Decimal Point control, Numeric Format dialog box, 9-14
Show Details of Differences option, Differ window, 5-47
Show Exponent control, Numeric Format dialog box, 9-14
Show Hidden Properties control, Sequence File Documentation submenu, 4-39
Show Hidden Properties option, Preferences tab, 4-27
Show List View Tip Strips option, Sequence Editor Options dialog box, 4-21
Show Locals control, Sequence File Documentation submenu, 4-38
Show Parameters control, Sequence File Documentation submenu, 4-38
Show Radix Prefix control, Numeric Format dialog box, 9-15
Show Sequence File Globals control, Sequence File Documentation submenu, 4-38
Show Station Globals control, Sequence File Documentation submenu, 4-38
Show Step in Context Tab command, Steps tab context menu, 6-7
Show Subproperties control, Sequence File Documentation submenu, 4-39
Sign control, Numeric Format dialog box, 9-14
Single Pass execution entry point, 14-2
single-valued property, 1-10
Skip Rows That Begin With control, Source tab, 18-69, 18-80

software components of TestStand, 1-4 to 1-7
  module adapters, 1-6 to 1-7
  relationship between elements (figure), 1-4
  run-time operator interfaces, 1-5
  sequence editor, 1-5
  test executive engine, 1-6
Source Code tab
  Edit C/CVI Module Call dialog box, 13-34 to 13-35
    Create Code button, 13-34 to 13-35
    Edit Code button, 13-35
    illustration, 13-34
    Pathname of Source File Containing Function control, 13-34
  Edit DLL Call dialog box, 13-12 to 13-14
    adapter interpretation of ambiguous declarations (table), 13-13
    Create Code button, 13-12
    Edit Code button, 13-13
    Pathname of Source file Containing Function control, 13-12
    Verify Prototype button, 13-13
source code templates
  module adapters, 13-4
  step types, 1-14
Source Control Menu, 4-36 to 4-37
Source Control tab, Station Options dialog box, 4-32 to 4-33
  Check Out Source Files When Edited option, 4-33
  Display only Selected Files in Source Control Dialog Boxes option, 4-33
  illustration, 4-32
  Prompt to Add to Source Control When Inserting File into Workspace option, 4-33
  System Default Source Code Control Provider option, 4-33
  Use Dialog Box for File Checkout option, 4-33
Source tab, Edit Property Loader dialog box, 18-68 to 18-69
  Disable the First Row of Data that Specifies Step Property for Each Column control, 18-69
  illustration, 18-68
  Skip Rows that Begin With control, 18-69
  Specify Column to Step Property Mapping text box, 18-69
  Start of Data Marker control, 18-69
Source/Destination tab, Import/Export Properties dialog box, 18-78 to 18-82
  Build control, 18-81
  Data Link Name control, 18-81
  database location, 18-81 to 18-82
  Decimal Point control, 18-80
  End of Data Marker control, 18-80
  File Location control, 18-80
  file or clipboard location, 18-79 to 18-80
  First Row of Data Specifies Step Property for Each Column control, 18-80
  Format control, 18-80
  Skip Rows That Begin With control, 18-80
  SQL Statement control, 18-81
  Start of Data Marker control, 18-80
special station global variables, 7-5
Specify an ActiveX Reference to the Execution control, Wait for Execution operation, 11-51
Specify by ActiveX Reference to Thread control, Wait for Thread operation, 11-50
Specify by Sequence Call control
  Wait for Execution operation, 11-51
  Wait for Thread operation, 11-50
Specify Column to Step Property Mapping text box, Source tab, Edit Property Loader dialog box, 18-69
Specify Custom Condition control, Post Actions tab, 5-26
Specify Module button, General tab, Step Properties dialog box, 5-21

Specify Module command
  dialog boxes for adapters (table), 9-31, 13-2
  specifying code module or sequence, 2-16
  Step Group context menu, 5-16
Specify Module dialog box, Sequence Call step, 10-19
Specify Module option, Disable Properties tab, 9-44
Specify the Amount of Time to Wait control, Wait for Time Interval operation, 11-49
Specify the Time Multiple control, Wait for Time Multiple operation, 11-49
SQL menu, Database Viewer, 18-34
SQL Select Statement control, Property Loader dialog box, 18-72
SQL Statement control
  Source/Destination tab, Import/Export Properties dialog box, 18-81
  SQL statement tab, Edit Open SQL Statement dialog box, 18-53
SQL statement tab, Edit Open SQL Statement dialog box, 18-52 to 18-54
  Build control, 18-53 to 18-54
  Database Handle (Number) control, 18-52 to 18-53
  illustration, 18-53
  Number of Records Selected control, 18-53
  SQL Statement control, 18-53
  Statement Handle (Number) control, 18-53
SQL (Structured Query Language), 18-55 to 18-92
  Build SQL Select Statement dialog box, 18-53 to 18-54
  clauses (table), 18-88 to 18-89
  commands (table), 18-86 to 18-87
  Execute SQL window, Database Viewer, 18-33
  functions (table), 18-91 to 18-92
  most commonly used commands, 18-85
  objects (table), 18-87 to 18-88
  Open SQL statement step type, 18-52 to 18-57
    custom properties, 18-57
    Edit Open SQL Statement dialog box
      Advanced tab, 18-54 to 18-57
      SQL statement tab, 18-52 to 18-54
  operators (table), 18-89 to 18-90
  record sets or SQL statement data, 18-2
  SELECT command (queries), 18-2
  SQL menu, Database Viewer, 18-34
Standard Data Types tab, User Manager Types view, 12-8 to 12-10
  adding new properties and privileges, 12-10
  subproperties in User data type (table), 12-8 to 12-10
  tree view of User standard data type (figure), 12-8
standard named data types, 9-15 to 9-17
  CommonResults, 9-17
  Error, 9-16 to 9-17
  Path, 9-16
  purpose and use, 1-10
Start of Data Marker control
  Source tab, Edit Property Loader dialog box, 18-69
  Source/Destination tab, Import/Export Properties dialog box, 18-80
Statement Handle control
  Edit Close SQL Statement dialog box, 18-58
  Edit Open SQL Statement dialog box, 18-53
Statement Handle (Number) control
  Properties tab, Property Loader dialog box, 18-71
  Record/Operation tab, Edit Data Operation dialog box, 18-60
Statement steps, 10-20 to 10-21

Statements tab, Database Options dialog box, 18-14 to 18-17
- Apply To control, 18-15
- Command Text control, 18-15
- Cursor Location control, 18-16
- Cursor Type control, 18-16
- Expected Properties control, 18-16
- illustration, 18-14
- Lock Type control, 18-17
- Name control, 18-15
- Precondition control, 18-16
- Statements control, 18-14 to 18-15
- Type control, 18-15
- Types to Log control, 18-16

station global variables
- persistence, 7-4 to 7-5
- special station globals, 7-5

Station Globals command, View menu, 4-8

Station Globals Types view (table), 9-1

Station Globals window, 7-1 to 7-2
- accessing types (table), 9-1
- Globals View context menu, 7-2 to 7-3
- illustration, 7-1
- overview, 2-8 to 2-9
- View ring control, 7-2

Station ID option, Preferences tab, 4-28

station model, 1-18

Station Options command, Configure menu, 4-21

Station Options dialog box, 4-21 to 4-33
- Execution tab, 4-22 to 4-24
  - Always Goto Cleanup On Sequence Failure option, 4-24
  - Disable Result Recording for All Sequence option, 4-24
  - Enable Breakpoints option, 4-22
  - Enable Tracing option, 4-22 to 4-23
  - illustration, 4-22
  - Interactive Mode option, 4-23 to 4-24
  - On Run-Time Error, 4-23 to 4-24
- Localization tab, 4-31 to 4-32
  - illustration, 4-31
  - Recognize Multi-byte Characters option, 4-32
  - Select a Language option, 4-32
  - Use Localized Decimal Point option, 4-32
- Model tab
  - Allow Other Models option, 4-29
  - illustration, 4-29
  - Station Model field, 4-29
  - Use Station Model option, 4-29
- overview, 3-2
- Preferences tab, 4-27 to 4-28
  - Auto Increment Sequence File Version option, 4-28
  - illustration, 4-27
  - Prompt to Change System SetForegroundWindow Behavior option, 4-28
  - Prompt to Find Files option, 4-27
  - Reload Documents When Opening Workspace option, 4-28
  - Reload Last Workspace at Startup option, 4-28
  - Show Hidden Properties option, 4-27
  - Station ID option, 4-28
- Remote Execution tab, 4-32
- Source Control tab, 4-32 to 4-33
  - Check Out Source Files When Edited option, 4-33
  - Display only Selected Files in Source Control Dialog Boxes option, 4-33
  - illustration, 4-32
  - Prompt to Add to Source Control When Inserting File into Workspace option, 4-33
  - System Default Source Code Control Provider option, 4-33
  - Use Dialog Box for File Checkout option, 4-33

Time Limits tab, 4-25 to 4-26
illustration, 4-25
Set a Time Limit for this Operation checkbox, 4-26
Time Limits Setting ring, 4-26
User Manager tab, 4-30 to 4-31
Automatically Login Windows System User option, 4-31
Check User Privileges option, 4-31
Configure option, 4-30
Current User Manager File option, 4-30
illustration, 4-30
Require User Login option, 4-31
StationGlobals subproperty, 8-3
status bar
Execution window, 6-14
sequence editor screen, 2-5
Status Bar command, View menu, 4-14
Status Expression control, Expressions tab, 5-31
Status Message control
Batch Results dialog box, 14-9
Batch UUT Identification dialog box, 14-8
status property of steps, 6-27 to 6-28
Step Description Expression control, Step Type Properties dialog box, 9-37
step execution (table), 6-25 to 6-27
Step Failure Causes Sequence Failure option, Run Options tab, 5-23
Step Group context menu, 5-15 to 5-31
Browse Sequence Context command, 5-19
Close Tree View command, 5-18
Edit command, 5-16
Edit Code command, 5-17
Go Up One Level command, 5-18
Insert Step submenu, 5-15 to 5-16
Loop on Selected Steps Using command, 5-18
Loop Selected Steps command, 5-18
Open Tree View command, 5-18
Properties command, 5-19
Run Mode submenu, 5-17
Run Selected Steps command, 5-17
Run Selected Steps Using command, 5-17
Sequence Properties command, 5-19
Specify Module command, 5-16
Step Properties dialog box, 5-19 to 5-31
Toggle breakpoint command, 5-17
View Contents command, 5-18
step groups
list view and tree view, 5-12
list view columns, 5-13 to 5-15
Main, Setup, and Cleanup tabs, 5-11 to 5-31
overview, 1-16
Step Into command, Debug menu, 4-19
step module, 1-1
Step Name Column control
Properties tab, Import/Export Properties dialog box, 18-82
Properties tab, Property Loader dialog box, 18-72
Step Out command, Debug menu, 4-19
Step Over command, Debug menu, 4-18
step properties. *See also* Step Properties dialog box; Step Type Properties dialog box.
Batch Specification step, 11-67 to 11-68
Batch Synchronization step, 11-61
built-in step properties, 1-11 to 1-12
Call Executable steps, 10-28
Close Database step type, 18-51 to 18-52
Close SQL Statement step type, 18-59
Data Operation step type, 18-64 to 18-65
lifetime of custom step properties, 5-31
lifetime of local variables, parameters, and custom step properties, 1-16
Lock step, 11-11 to 11-12
Message Popup steps, 10-25

Multiple Numeric Limit Test, 10-13 to 10-14
Notification step, 11-46 to 11-48
Numeric Limit Test step, 10-10 to 10-11
Open Database step type, 18-49 to 18-50
Open SQL statement step type, 18-57
Pass/Fail Test step, 10-6
Property Loader step type, 18-75 to 18-78
Queue step, 11-33 to 11-35
Rendezvous step, 11-22 to 11-23
Semaphore step, 11-17 to 11-19
String Value Test step, 10-18
Thread Priority step, 11-56
Wait step, 11-52 to 11-53

Step Properties dialog box, 5-19 to 5-31
- Expressions tab, 5-30 to 5-31
  - Post Expression control, 5-31
  - Pre Expression control, 5-30
  - Status Expression control, 5-31
- General tab, 5-20 to 5-21
  - Comment control, 5-20
  - Edit button, 5-20
  - illustration, 5-20
  - Preconditions button, 5-21
  - Specify Module button, 5-21
- illustration, 2-17
- Loop Options tab, 5-26 to 5-28
  - illustration, 5-27
  - Loop Type control, 5-27 to 5-28
  - Record Result of Each Iteration option, 5-28
- overview, 2-17 to 2-18
- Post Actions tab, 5-24 to 5-26
  - Break option, 5-26
  - Call sequence option, 5-26
  - Custom Condition Expression control, 5-26
  - Destination control, 5-25
  - Goto destination option, 5-26
  - Goto next step option, 5-26
  - illustration, 5-25
  - On Condition False control, 5-26
  - On Condition True control, 5-26
  - On Fail control, 5-25
  - On Pass control, 5-25
  - Specify Custom Condition control, 5-26
  - Terminate execution option, 5-26
- Run Options tab, 5-21 to 5-24
  - Breakpoint option, 5-23
  - Ignore Run-time Errors option, 5-23 to 5-24
  - Ignore Termination option, 5-24
  - illustration, 5-21
  - Load Option, 5-22
  - Precondition Evaluation in Interactive Mode control, 5-23
  - Record Results option, 5-23
  - Run Mode, 5-22
  - Sequence Call Trace Setting option, 5-24
  - Step Failure Causes Sequence Failure option, 5-23
  - TestStand Window Activation control, 5-23
  - Unload Option, 5-22
- Synchronization tab, 5-28 to 5-29
  - Batch Synchronization control, 5-29
  - illustration, 5-29
  - Lock Name or Reference Expression control, 5-29
  - Use Lock to Allow Only One Thread to Execute the Step control, 5-29

step status
- built-in step types, 10-3
- failures, 6-28
- standard values for status property (table), 6-27 to 6-28

Step status condition expression, Preconditions dialog box, 5-39

Step Type Menu Editor dialog box, 9-53 to 9-54
  Add Group control, 9-54
  Browse control, 9-54
  Group Settings/Step Type Settings control, 9-54
  Groups and Step Types control, 9-53 to 9-54
  illustration, 9-53
  Move Up/Move Down control, 9-54
  Preview Menu control, 9-54
  Remove Group control, 9-54
  Rename Group control, 9-54
  Submenu Display Name Expression control, 9-54
Step Type Properties dialog box, 9-35 to 9-51
  Code Templates tab, 9-44 to 9-51
    Add button, 9-48
    Create button, 9-47 to 9-48
    Create Code Templates dialog box, 9-48
    creating and customizing template files, 9-46
    Edit button, 9-48
    Edit Code Template dialog box, 9-49 to 9-51
    illustration, 9-47
    Move Down button, 9-49
    Move Up button, 9-49
    multiple templates per step type, 9-46
    overview, 9-44
    Remove button, 9-48
    template files for different adapters, 9-44 to 9-45
  Default Expressions, 9-35
  Default Loop Options, 9-35
  Default Post Options, 9-35
  Default Run Options, 9-35
  Default Synchronization, 9-35
  Disable Properties tab, 9-43 to 9-44
    illustration, 9-43
    Precondition checkbox, 9-44
    Specify Module checkbox, 9-44
  General tab, 9-36 to 9-38
    Attach to File control, 9-38
    Comment control, 9-38
    Default Step Name Expression control, 9-37
    Designate an Adapter control, 9-37
    Designate an Icon control, 9-36 to 9-37
    illustration, 9-36
    Step Description Expression control, 9-37
  Menu tab, 9-38 to 9-39
    Group control, 9-39
    illustration, 9-39
    Item Name Expression control, 9-39
  overview, 9-35
  Strict Passing tab, 9-51
  Substeps tab, 9-40 to 9-42
    Adapter control, 9-41
    Add control, 9-42
    Delete button, 9-42
    Edit substep, 9-40
    illustration, 9-41
    Menu Item Name Expression control, 9-42
    Move Down control, 9-42
    Move Up control, 9-42
    Post Step substep, 9-40
    Pre Step substep, 9-40
    Specify Module button, 9-42
    <Substep List> control, 9-41 to 9-42
  Version tab, 9-51
  View Changes button, 9-51
step types, 1-12 to 1-14, 9-30 to 9-54. *See also* built-in database step types; built-in step types; synchronization step types; types.
  combining, 9-52

creating and modifying custom step types, 9-32 to 9-51
apply changes to all loaded steps, 9-51
built-in step type properties, 9-34 to 9-51
copying and renaming built-in step types, 9-32
custom step type properties, 9-33 to 9-34
displaying custom properties with View Contents button, 9-41
overview, 3-8 to 3-9
viewing changes to properties, 9-51
definition, 1-12
displaying with Find Type command, 4-12
Insert Step submenu, 9-30
overview, 1-12 to 1-13
predefined step types, 1-14
source code templates, 1-14
substeps, 1-13
using, 9-30 to 9-31
STEP_CALLEXE table schema, 18-25
STEP_MSGPOPUP table schema, 18-25
STEP_PASSFAIL table schema, 18-25
STEP_PROPERTYLOADER table schema, 18-26
STEP_RESULT table schema, 18-23 to 18-24
steps
built-in step properties, 1-11 to 1-12
definition, 1-1
lifetime of custom step properties, 5-31
overview, 1-11
properties, 1-7
Steps tab, Execution window, 6-4 to 6-7
columns, 6-5 to 6-6
debugging, 6-5
illustration, 6-4
tracing, 6-5
Steps tab context menu, 6-6 to 6-7
Loop Selected Steps command, 6-7
Properties command, 6-7
Run Mode submenu, 6-6 to 6-7
Run Selected Steps command, 6-7
Set Next Step command, 6-7
Show Step in Context Tab command, 6-7
Toggle Breakpoint command, 6-6
STEP_SEQCALL table schema, 18-27
STEP_STRINGVALUE table schema, 18-26
Stop All control, Parallel Model Test UUTs dialog box, 14-6
Store Array As control, Struct Passing tab, 9-26
Store by Reference Instead of by Value control, Enqueue operation, 11-26
Store Data by Reference Instead of by Value control
Pulse operation, Notification step, 11-41
Set operation, Notification step, 11-38
Store Struct As control, Struct Passing tab, 9-26
Strict Passing tab, Step Type Properties dialog box, 9-51
String category data types (table), 13-9
string function operators (table), 8-18 to 8-19
String parameters, specifying for DLL Flexible Prototype Adapter, 13-9 to 13-10
string resource files, 3-6 to 3-8
default resource string files, 3-7
escape codes (table), 3-8
format, 3-7 to 3-8
search order for directories, 3-6 to 3-7
String Value Test step, 10-15 to 10-18
Edit String Value Test dialog box
Data Source tab, 10-17
Limits tab, 10-16
properties (figure), 10-17
setting value of Step.Result.String, 10-16 to 10-17
step properties defined, 10-18

Struct Passing tab, custom data types
  Properties dialog boxes
    Allow Objects of This Type to be Passed as Structs control, 9-25
    Exclude When Passing Structure control, 9-26
    Packing control, 9-25 to 9-26
    Property control, 9-26
    Store Array As control, 9-26
    Store Struct As control, 9-26
    Type control, 9-26
    <Type Ring> control, 9-26
Structure parameters, specifying for DLL Flexible Prototype Adapter, 13-11
subdirectories for TestStand (table), 3-3 to 3-4
subproperties of sequence context, 8-3 to 8-12
    RunState, 8-4 to 8-8
    RunState.InitialSelection, 8-10 to 8-12
    RunState.Sequence and other Sequence objects, 8-9 to 8-10
    RunState.SequenceFile and other SequenceFile objects, 8-8 to 8-9
    RunState.Step and other Step objects, 8-10
    StationGlobals, 8-3
subsequence, 1-2
substep modules, 9-40
substeps, 1-13
Substeps tab, Step Type Properties dialog box, 9-40 to 9-42
    Adapter control, 9-41
    Add control, 9-42
    Delete button, 9-42
    Edit substep, 9-40
    illustration, 9-41
    Menu Item Name Expression control, 9-42
    Move Down control, 9-42
    Move Up control, 9-42
    Post Step substep, 9-40
    Pre Step substep, 9-40
    Specify Module button, 9-42
    <Substep List> control, 9-41 to 9-42
synchronization objects, 11-1 to 11-4
    batch, 11-1 to 11-2
    common attributes, 11-2 to 11-4
        lifetime, 11-3 to 11-4
        name, 11-2 to 11-3
        timeout, 11-4
    lock, 11-1
    notification, 11-1 to 11-2
    queue, 11-1
    rendezvous, 11-1
    semaphore, 11-1
synchronization step types, 11-4 to 11-68
    Batch Specification, 11-62 to 11-68
        Add Thread operation, 11-63 to 11-64
        Create operation, 11-62 to 11-63
        Get Status operation, 11-66 to 11-67
        Remove Thread operation, 11-65
        step properties, 11-67 to 11-68
    Batch Synchronization, 11-56 to 11-61
        Enter Synchronized Section operation, 11-59
        Exit Synchronized Section operation, 11-60
        requirements for using Enter and Exit operations, 11-58
        step properties, 11-61
        synchronized sections, 11-56 to 11-58
    Lock, 11-5 to 11-12
        Create operation, 11-6
        Early Unlock operation, 11-9
        Get Status operation, 11-10
        Lock operation, 11-7 to 11-8
        step properties, 11-11 to 11-12
    Notification, 11-35 to 11-48
        Clear operation, 11-39
        Create operation, 11-35 to 11-36
        Get Status operation, 11-45 to 11-46

Pulse operation, 11-40 to 11-41
Set operation, 11-37 to 11-38
step properties, 11-46 to 11-48
Wait operation, 11-41 to 11-44
overview, 11-4 to 11-5
Queue, 11-23 to 11-34
Create operation, 11-23 to 11-25
Dequeue operation, 11-27 to 11-29
Enqueue operation, 11-25 to 11-26
Flush operation, 11-30 to 11-31
Get Status operation, 11-31 to 11-32
step properties, 11-33 to 11-35
Rendezvous, 11-19 to 11-23
Create operation, 11-19 to 11-20
Get Status operation, 11-21 to 11-22
Rendezvous operation, 11-20 to 11-21
step properties, 11-22 to 11-23
Semaphore, 11-12 to 11-19
Acquire operation, 11-14 to 11-15
Create operation, 11-12 to 11-14
Get Status operation, 11-16 to 11-17
Release operation, 11-15 to 11-16
step properties, 11-17 to 11-19
Thread Priority, 11-53 to 11-56
Get Thread Priority operation, 11-55
Set Thread Priority operation, 11-54
step properties, 11-56
Wait, 11-48 to 11-53
retrieving results from executions and threads, 11-52
step properties, 11-52 to 11-53
Wait for Execution operation, 11-51
Wait for Thread operation, 11-50
Wait for Time Interval operation, 11-48 to 11-49
Wait for Time Multiple operation, 11-49

Synchronization tab
Sequence File Properties dialog box, 5-9
Default Batch Synchronization control, 5-9
illustration, 5-9
Step Properties dialog box, 5-28 to 5-29
Batch Synchronization control, 5-29
illustration, 5-29
Lock Name or Reference Expression control, 5-29
Use Lock to Allow Only One Thread to Execute the Step control, 5-29
System Default Source Code Control Provider option, Source Control tab, 4-33
system integration, by National Instruments, A-1

T

Table control, Create Columns dialog box, 18-73
table schema. *See* database result tables.
tables (databases), 18-1 to 18-2
technical support resources, A-1 to A-2
templates. *See* code templates; Code Templates tab, Step Type Properties dialog box.
Terminate command, Debug menu, 4-19
Terminate All command, Debug menu, 4-20
Terminate All control, Parallel Model Test UUTs dialog box, 14-6
Terminate control, Parallel Model Test UUTs dialog box, 14-6
Terminate Executable If Step Is Terminated Or Aborted control, Configure Call Executable dialog box, 10-27
Terminate execution option, Post Actions tab, 5-26
terminating executions, 1-26

Test Data cluster, LabVIEW Standard Prototype Adapter, 13-17 to 13-19
  element types and descriptions (table), 13-18
  illustration, 13-17
  older elements (table), 13-19
test executive engine, 1-2, 1-6
test module, 1-1
test reports. *See* reports.
Test Socket control
  Batch Results dialog box, 14-9
  Batch UUT Identification dialog box, 14-7
  Parallel Model Test UUTs dialog box, 14-5
Test UUTs execution entry point, 14-2
TestStand
  configuring, 3-1 to 3-3
  customizing, 3-3 to 3-12
  directory structure, 3-3 to 3-6
TestStand architecture overview, 1-1 to 1-26
  building blocks, 1-7 to 1-26
    automatic result collection, 1-23
    callback sequences, 1-23 to 1-25
    process models, 1-17 to 1-22
    sequence executions, 1-25 to 1-26
    sequence files, 1-17
    sequences, 1-15 to 1-17
    steps, 1-11 to 1-14
    variables and properties, 1-7 to 1-14
  capabilities and concepts, 1-2 to 1-3
  general concepts, 1-1 to 1-2
  software components, 1-4 to 1-7
    module adapters, 1-6 to 1-7
    relationship between elements (figure), 1-4
    run-time operator interfaces, 1-5
    sequence editor, 1-5
    test executive engine, 1-6
TestStand database result tables. *See* database result tables.
TestStand process models. *See* process models.
TestStand Window Activation control, Run Options tab, 5-23
Text and Buttons tab, Configure Message Box Step dialog box, 10-22
Thread Priority step, 11-53 to 11-56
  Get Thread Priority operation, 11-55
  Set Thread Priority operation, 11-54
  step properties, 11-56
Thread Settings dialog box, Sequence Adapter, 13-44
  Automatically Wait for the Thread to Complete at the End of the Current Sequence control, 13-44
  illustration, 13-44
  Initially Suspended control, 13-44
  Store an ActiveX Reference to the New Thread in control, 13-44
Threads ring control, Execution window, 6-4
Tile command, Window menu, 4-44
Tile Execution Windows control, Model Options dialog box, 14-4
time function operators (table), 8-19
Time Limits tab, Station Options dialog box, 4-25 to 4-26
  illustration, 4-25
  Set a Time Limit for this Operation checkbox, 4-26
  Time Limits Settings ring, 4-26
Time to Wait control, Configure Call Executable dialog box, 10-27
timeout attribute, synchronization objects, 11-4
Timeout Causes Run-Time Error control
  Acquire operation, Semaphore step, 11-15
  Dequeue operation, 11-29
  Enqueue operation, 11-26
  Enter Synchronized Section operation, 11-59

Exit Synchronized Section operation, 11-60
Lock operation, 11-8
Rendezvous operation, 11-21
Wait for Execution operation, 11-51
Wait for Thread operation, 11-50
Wait operation, 11-44
Timeout Enabled control
Acquire operation, Semaphore step, 11-15
Dequeue operation, 11-29
Enqueue operation, 11-26
Enter Synchronized Section operation, 11-59
Exit Synchronized Section operation, 11-60
Lock operation, 11-8
Rendezvous operation, 11-21
Wait for Execution operation, 11-51
Wait for Thread operation, 11-50
Wait operation, 11-44
Timeout Expression control
Acquire operation, Semaphore step, 11-15
Dequeue operation, 11-29
Enqueue operation, 11-26
Enter Synchronized Section operation, 11-59
Exit Synchronized Section operation, 11-60
Lock operation, 11-8
Rendezvous operation, 11-21
Wait for Execution operation, 11-51
Wait for Thread operation, 11-50
Wait operation, 11-44
Toggle Breakpoint command
Step Group context menu, 5-17
Steps tab context menu, 6-6
toolbars, sequence editor screen, 2-5
Toolbars command, View menu, 4-14
Tools menu, 4-37 to 4-44
Assemble Test VIs for Run-time Distribution command, 4-40
Customize command, 4-41 to 4-44
customizing, 3-9
Import/Export Properties command, 4-40
Run Database Viewer command, 4-41
Run Engine Installation Wizard command, 4-40
Sequence File Converters submenu, 4-39
Sequence File Documentation submenu, 4-37 to 4-39
Update Automation Identifiers command, 4-40
Update Sequence Files command, 4-39
tracing, enabling/disabling, 4-22 to 4-23
tracing, Steps tab, 6-5
Tracing Enabled command, Execute menu, 4-18
tree views. *See* Custom Data Types tab tree and list views.
TS.CurrentUser station global variable, 7-5
TS.LastUserName station global variable, 7-5
Type Conflict in File dialog box, 9-3
Type control
Columns/Parameters tab, 18-19
Numeric Format dialog box, 9-13
Sequence File Properties dialog box, 5-8
Statements tab, Database Options dialog box, 18-15
Type Palette command, View menu, 4-8
Type Palette window, 9-54 to 9-57
accessing types (table), 9-2
Configure Type Palettes dialog box, 9-55 to 9-56
creating new step types, 9-56 to 9-57
distributing step types, 9-56
illustration, 2-8
overview, 2-7, 9-54 to 9-55
Palette ring, 9-55
Step Types tab (figure), 9-32

<Type Ring> control, Struct Passing tab, 9-26
types. *See also* data types; step types.
  creating and modifying, 9-1 to 9-2
  storage in files and memory, 9-2 to 9-3
  windows and views that display types (table)
    Sequence File window, 9-1
    Station Globals window, 9-1
    Type Palette window, 9-2
    User Manager window, 9-1 to 9-2
Types view. *See* User Manager Types view.

U

unit under test (UUT), 1-2
Unload All Modules command, File menu, 4-3
Unload Option
  Run Options tab, Step Properties dialog box, 5-22
  Sequence File Properties dialog box, 5-7
unprintable characters, escape codes for (table), 3-8
Update Automation Identifiers command, Tools menu, 4-40
UPDATE command, SQL, 18-87
Update Sequence Files command, Tools menu, 4-39
Use Dialog Box for File Checkout option, Source Control tab, 4-33
Use Localized Decimal Point option, Localization tab, 4-32
Use Uppercase Letters control, Numeric Format dialog box, 9-15
User DSN tab, ODBC Data Source Administrator dialog box, 18-40
User List context menu, 12-3 to 12-5
  Edit User Type command, 12-5
  Insert User command, 12-4
User List tab, User Manager Users view
  illustration, 12-3
  overview, 12-3
  User List context menu, 12-3 to 12-5
User Manager command, View menu, 4-8
User Manager tab, Station Options dialog box, 4-30 to 4-31
  Automatically Login Windows System User option, 4-31
  Check User Privileges option, 4-31
  Configure option, 4-30
  Current User Manager File option, 4-30
  illustration, 4-30
  Require User Login option, 4-31
User Manager Types view, 12-7 to 12-10
  adding new properties and privileges, 12-10
  illustration, 12-7
  Standard Data Types tab, 12-8 to 12-10
User Manager Users view, 12-2 to 12-7
  illustration, 12-2
  Profiles tab, 12-5 to 12-7
    illustration, 12-6
    Profiles tab context menu, 12-6 to 12-7
  User List tab, 12-3 to 12-5
    Edit User dialog box, 12-5
    illustration, 12-3
    Insert New User dialog box, 12-4
    User List context menu, 12-3 to 12-5
User Manager window, 12-1 to 12-12
  accessing types (table), 9-2
  overview, 12-1
  sequence editor Users window, 2-14
  verifying user privileges, 12-11 to 12-12
    any user, 12-12
    current user, 12-11
User subdirectory, 3-4
User's View. *See* User Manager Users view.
UUT Serial Number control
  Batch Results dialog box, 14-9
  Batch UUT Identification dialog box, 14-7

Parallel Model Test UUTs dialog box, 14-5

UUT_RESULT table schema, 18-23

V

Value control

Additional Columns tab, Import/Export Properties dialog box, 18-84

General tab, custom data types Properties dialog box, 9-23 to 9-24

Value field

custom data types, 9-19 to 9-20

Modify Numeric Value dialog box, 9-20

Values control, Filtering tab, Property Loader dialog box, 18-75

variables. *See also* properties.

definition, 1-7

displaying with Browse Sequence Context command, 4-13 to 4-14

global

definition, 1-7

lifetime and scope of sequence file global variables, 5-41 to 5-42

local

definition, 1-7

lifetime of local variables, 1-16

sequence local variables, 1-15 to 1-16

sequence context of, 1-7 to 1-8

standard and custom named data types, 1-10

station global variables

persistence, 7-4 to 7-5

special station globals, 7-5

using in expressions, 1-8 to 1-9

verifying user privileges, 12-11 to 12-12

any user, 12-12

current user, 12-11

Version control, Sequence File Properties dialog box, 5-6

Version tab

custom data types Properties dialog boxes

Always Prompt User to Resolve the Conflict control, 9-25

Modified control, 9-25

Use the Definition that has the Highest Version Number control, 9-25

Version control, 9-25

Step Type Properties dialog box, 9-51

View Batch Report control, Batch Results dialog box, 14-9

View Changes button, 9-51

View Contents command

All Sequences view context menu, 5-3

Context tab context menu, 6-8

displaying custom properties of step types, 9-51

Globals View context menu, 7-3

Locals tab context menu, 5-36

Parameters tab context menu, 5-33

Sequence File Globals view context menu, 5-43

Step Group context menu, 5-18

View menu, 4-7 to 4-14

Browse Sequence Context command, 4-13 to 4-14

Find Type command, 4-12

Launch Report Viewer command, 4-14

Paths command, 4-8 to 4-11

Station Globals command, 4-8

Status Bar command, 4-14

Toolbars command, 4-14

Type Palette command, 4-8

User Manager command, 4-8

Workspace command, 4-8

View Report control

Batch Results dialog box, 14-9

Parallel Model Test UUTs dialog box, 14-6

views. *See also* sequence file views.
    sequence editor screen, 2-2 to 2-3
Visual Basic. *See* Microsoft Visual Basic.

W

Wait Condition control, Configure Call Executable dialog box, 10-26
Wait operation, Notification step, 11-41 to 11-44
    illustration, 11-42
    Location to Store Data control, 11-43 to 11-44
    Notification Name or Reference Expression control, 11-42
    Timeout Causes Run-Time Error control, 11-44
    Timeout Enabled control, 11-44
    Timeout Expression control, 11-44
    Which Notification control, 11-44
Wait step, 11-48 to 11-53
    retrieving results from executions and threads, 11-52
    step properties, 11-52 to 11-53
    Wait for Execution operation
        illustration, 11-51
        Specify an ActiveX Reference to the Execution control, 11-51
        Specify by Sequence Call control, 11-51
        Timeout Causes Run-Time Error control, 11-51
        Timeout Enabled control, 11-44
        Timeout Expression control, 11-44
    Wait for Thread operation
        illustration, 11-50
        Specify by ActiveX Reference to Thread control, 11-50
        Specify by Sequence Call control, 11-50
        Timeout Causes Run-Time Error control, 11-44
        Timeout Enabled control, 11-44
        Timeout Expression control, 11-44
    Wait for Time Interval operation, 11-48 to 11-49
        illustration, 11-48
        Specify the Amount of Time to Wait control, 11-49
    Wait for Time Multiple operation
        illustration, 11-49
        Specify the Time Multiple control, 11-49
Watch Expression pane, Execution window, 6-12 to 6-14
    Add Watch command, 6-13
    Edit Expression command, 6-13
    illustration, 6-13
    Modify Value command, 6-13
    Refresh command, 6-14
Web support from National Instruments, A-1
Where Clause control, Build SQL Select Statement dialog box, 18-54
Which Notification control, Wait operation, 11-44
Which Queue control, Dequeue operation, 11-29
Window menu
    Cascade command, 4-44
    Close Completed Execution Displays command, 4-44
    open windows list, 4-44
    Tile command, 4-44
Windows menu, Database Viewer, 18-34
Workspace command, View menu, 4-8
Workspace window, 2-9 to 2-13
    context menu options, 2-10 to 2-13
        Add Existing Project to Workspace, 2-10
        Add Files, 2-11
        Add to Source Control, 2-11
        Check In, 2-12
        Check Out, 2-11

Clear Messages, 2-13
Get Latest Version, 2-11
Hide Messages Window, 2-13
Insert Code Modules, 2-11
Insert New Folder From Disk, 2-11
Insert New Project into Workspace, 2-11
Load/Unload, 2-13
New Folder, 2-11
Open, 2-10
Properties, 2-12 to 2-13
Provider Options, 2-13
Refresh All, 2-13
Remove from Source Control, 2-13
Rename, 2-13
Run, 2-13
Show Difference, 2-12
Show History, 2-12
Show SCC Messages, 2-13
Undo Check Out, 2-12
View Contents, 2-12
icons, 2-9
illustration, 2-10
overview, 2-9
Worldwide technical support, A-2

Z

zeros
Display Trailing Zeros control, Numeric Format dialog box, 9-14
Full Width With Leading Zeros control, Numeric Format dialog box, 9-14