VITREK

V10x Series

Electrical Safety / Hipot Tester

Operating & Maintenance Manual

For Models: V101 to V109

Table of Contents

1 Introduction 1

1.1 About This Manual 1
1.2 Warranty Information 2
1.3 Safety 3
1.3.1 Safety Symbols 3
1.3.2 Warning Summary 3
1.3.3 Power and Grounding 3
1.3.4 Terminals and Wiring 4
1.3.5 User Activated Safety Abort 5
1.3.6 Automatic Safety Abort 5
1.4 Product Information 6
1.5 Models and Accessories 8
1.6 Specifications 9
1.6.1 Dimensions 9
1.6.2 General Specifications 10
1.6.3 AC Voltage Withstand and Leakage Testing (ACW and ACCAP) Specifications 11
1.6.4 DC Voltage Withstand and Leakage Testing (DCW and DCIR) Specifications 13
1.6.5 Pulsed Voltage Withstand Testing (Pulse) Specifications 17
1.6.6 DC Breakdown Voltage Device Testing (BRKDN) Specifications 19
1.6.7 DC Low Resistance Testing (LowΩ) Specifications 19
1.6.8 AC Ground Bond Testing (GB) Specifications 21
1.6.9 Ground Leakage Testing (DCI and ACI) Specifications 23
1.6.10 Switch Unit Integration 24

2 Getting Started 25

2.1 Unpacking and Inspection 25
2.2 Cooling 25
2.3 Mounting Position and Orientation 25
2.4 Installing in a 19” Rack Enclosure 25
2.5 Line Power 25
2.6 Connecting the AC-30 Option to the V10x 26
2.7 Instrument Series Front and Rear Panel Overview 27
2.8 Powering on 29
2.9 Power Off 30
2.10 Glossary 31

3 Theory of Operation 32

3.1 Choose Wisely 33
3.2 Choosing Within the Voltage Withstand and Leakage Testing Group 33
3.3 Choosing Within the Resistance Testing Group 34
3.3.1 Choosing AC, DC, or PULSE Testing 34
3.3.2 Choosing the Limits 35

3.4 AC Voltage Withstand and Leakage Testing (ACW and ACCAP) 38
3.4.1 Actions While Running 38
3.4.2 Connecting to the DUT for AC withstand 38
3.4.3 Checking that the DUT is connected 41
3.4.4 Lead Compensation 41
3.4.5 ACW Examples 41
3.5 DC Voltage Withstand and Leakage Testing (DCW and DCIR) 44
3.5.1 Actions While Running 44
3.5.2 Performing a multi-stage ramp or multiple DC voltage tests 45
3.5.3 Connecting to the DUT for DC withstand 46
3.5.4 Lead Compensation 47
3.5.5 DCW Examples 48
3.6 Pulsed Voltage Withstand Testing (Pulse) 50
3.6.1 Actions While Running 51
3.6.2 Connecting to the DUT for Pulse testing 51
3.6.3 Lead Compensation 52
3.6.4 Pulse Examples 53
3.7 DC Breakdown Voltage Device Testing (BRKDN) 54
3.7.1 Actions While Running 54
3.7.2 Connecting to the DUT for breakdown testing 54
3.7.3 Lead Compensation 55
3.7.4 BRKDN Examples 55
3.8 DC Low Resistance Testing (LowΩ) 56
3.8.1 Actions While Running 56
3.8.2 Connecting to the DUT for LowΩ 56
3.8.3 Lead Compensation (2-Wire) 57
3.8.4 Lead Compensation (4-Wire) 57
3.8.5 LowΩ Examples 57
3.9 AC Ground Bond Testing (GB) 58
3.9.1 Actions While Running 58
3.9.2 Connecting to the DUT 59
3.9.3 Lead Compensation 60
3.9.4 GB Examples 61
3.10 Ground Leakage Testing (DCI and ACI) 62
3.10.1 Actions While Running 63
3.10.2 Connecting to the DUT for ACI or DCI 63
3.10.3 Lead Compensation 63
3.10.4 DCI and ACI Examples 64
3.11 Sequence Timing Control (Pause and Hold) 65
3.12 Switch Matrix 65
3.13 Sequence Start 66

4 Front Panel Operation 67

4.1 Introduction 67
4.2 Quickstart 67
4.3 Security 68

4.4 Menu System 69
4.5 Common Display Elements 70
4.6 Common Behavior....70
4.6.1 Touch Panel Operation 70
4.6.2 OK/Cancel 71
4.6.3 Sequence Editing....71
4.6.4 SI Conformance....71
4.6.5 Test Execution Status....72
4.7 Status Bar 73
4.7.1 Icon Behavior 73
4.7.2 USB Device Errors....75
4.7.3 System Faults and Warnings....75
4.8 Front Panel When Remote Locked....75
4.9 Dial Operation 75
4.10 Editing Numeric Settings 76
4.11 Time Versus Rate Settings....77

5 Testing Menu 78

6 General Test Settings....79

6.1 General Test Settings Menu....79
6.2 Audio Settings 80
6.3 Test Chart....80

7 Create and Edit Test Sequences....81

7.1 Sequence Editing....81
7.2 Sequences with errors....84
7.3 New Sequence....85
7.4 Load Sequence 85
7.5 Copy Sequence....85
7.6 Sequence Settings 86
7.6.1 Save As Sequence Number....86
7.6.2 Execution Options 86
7.6.3 Fast Rerun 87
7.6.4 Report Options....87
7.7 Delete Sequence 89
7.8 Common Arc Configuration....89
7.9 Configuring Discharge 90
7.10 Configuring Time Periods 90
7.11 Insert or Edit a Step....92
7.12 Deleting a Step 92
7.13 Editing Check Limits 93
7.14 Step Validation....93
7.15 Edit ACW step....94
7.15.1 Settings 94
7.15.2 Manual Lead Compensation 96
7.16 Edit ACCAP step....97

7.16.1 Settings 97
7.16.2 Manual Lead Compensation 98
7.17 Edit DCW step 99
7.17.1 Settings 100
7.17.2 Manual Lead Compensation 102
7.18 Edit DCIR step 103
7.18.1 Settings 103
7.18.2 Manual Lead Compensation 106
7.19 Edit GB step 107
7.19.1 Settings 107
7.19.2 Manual Lead Compensation 108
7.20 Edit Low Ω step 109
7.20.1 Settings 109
7.20.2 Manual Lead Compensation 110
7.21 Edit ACI and DCI step 111
7.21.1 Settings 111
7.21.2 Manual Lead Compensation 112
7.22 Edit Pulse step 113
7.22.1 Settings 113
7.22.2 Manual Lead Compensation 114
7.23 Edit BRKDN step 115
7.23.1 Settings 115
7.24 Edit Pause step 117
7.25 Edit Hold step 117
7.26 Edit Switch Control step 118
7.26.1 Switch Step Settings 118

8 Sequence Execution 119

8.1 Selecting a Sequence for Execution 121
8.2 Test Execution Options 122
8.3 Running the Sequence 123
8.4 Sequence Execution Automation 123
8.5 Step Adjustments 124
8.6 Running the Manual Sequence 125
8.7 Running a Multi-Step Sequence 126
8.7.1 Running a Sequence Timing Step 127
8.7.2 Running a Switch Step 128
8.7.3 Selecting Test Measurements While Running 128
8.7.4 Charting Test Measurements While Running 130
8.7.5 End of sequence 131
8.8 Single-Step Execution 132
8.9 Test Time Period Display 132

9 Sequence Results 133

9.1 Summary 134
9.1.1 Export 135

9.2 Review 136
9.3 Series Chart 138
9.3.1 Series Chart Limiting 140
9.3.2 Series Chart Navigation 140
9.3.3 Series Chart Scaling..141
9.3.4 Series Chart Exporting..141
9.4 XY Chart..142
9.4.1 XY Chart Exporting 145
9.5 History 146
9.5.1 History Data Exporting..147
9.6 Charting Options 149

10 System Menu 151

10.1 About...151
10.1.1 Interface Log 152
10.1.2 Calibration 152
10.1.3 System Update..153
10.2 Configuration 155
10.2.1 Start Enables...155
10.2.2 Interfaces 156
10.2.3 Clock...156
10.2.4 Display 157
10.2.5 LAN...159
10.2.6 Security 162
10.2.7 Preferences 163
10.2.8 DIO 164
10.2.9 Automation..167
10.2.10 Switching...169
10.3 Import 175
10.3.1 Factory Reset 175
10.3.2 File Import..176
10.4 Export..177
10.4.1 Exporting Settings..177
10.4.2 Exporting Sequences 178
10.4.3 Exporting the Event Log 178
10.5 Self-Test..179

11 Command and Control Interfaces... 181

11.1 RS232 181
11.1.1 RS232 Connector and Pinout 181
11.2 GPIB..182
11.3 USB...182
11.4 Ethernet 182
11.5 DIO 183
11.5.1 DIO Connector and Pinout 183
11.5.2 DIO Signal Characteristics..184

11.5.3 DIO Signal Timing 187

12 Remote Operation 189

12.1 Computer Control of the V10x 189
12.1.1 LAN (Ethernet) Interface 189
12.1.2 Connecting to the LAN Interface 189
12.1.3 IP Addressing 189
12.1.4 Writing Software to Control the instrument via LAN 190
12.1.5 USB Interface 190
12.1.6 GPIB Interface 191
12.1.7 RS232 Interface 191
12.2 IEEE488.2 Compatibility 191
12.3 SCPI 1999.0 Compatibility 191
12.4 Command Syntax 192
12.4.1 Command Errors 192
12.4.2 Special Characters 192
12.4.3 Fields within a Command 193
12.5 Responses to Commands 195
12.5.1 Response Fields 195
12.6 Command Summaries 196
12.7 Command Details 202
12.7.1 IEEE Mandated Commands 202
12.7.2 IEEE Optional Commands 204
12.7.3 System Remote/Local access commands 205
12.7.4 System Event/Error query commands 205
12.7.5 Command Status 206
12.7.6 Managing Test Sequences 207
12.7.7 Test Sequence Execution and Result Commands 222
12.7.8 Sequence Execution Settings 228
12.7.9 Device Configuration Commands 230
12.8 Device Synchronization 236

13 Periodic Maintenance 237

13.1 Cleaning and Inspection 237
13.1.1 Cable Inspection 237
13.1.2 Fan Filter Cleaning 237
13.1.3 Display Cleaning 238
13.1.4 Terminal Inspection 238
13.1.5 Self-Test 238

14 Performance Verification and Adjustment 239

14.1 Calibration Adjustment 240
14.1.1 Equipment Required 241
14.1.2 Zeros 242
14.1.3 DC Voltage 243
14.1.4 DC Current 243

14.1.5 Low Ω *244*
14.1.6 HSS Current *246*
14.2 Calibration Verification 247
14.2.1 Equipment Required *247*
14.2.2 DC Voltage *248*
14.2.3 DC Current Scaling *250*
14.2.4 DC Current Zero Verification *251*
14.2.5 Low Ω *252*
14.2.6 AC Voltage *253*
14.2.7 AC Current Zero *255*
14.2.8 HSS Current *256*
14.2.9 Ground Bond *257*
14.3 Calibration Point Fault 260
15 WEB Browser Interface 261
16 Troubleshooting 269
16.1 Calibration 269
16.2 Critical Faults 270
16.3 Warnings 270
A. LAN Presence 271
B. Switch Matrix Integration 273
C. Barcode Scanner Integration 275
D. CSV File Format 276
E. Sample Reports 278
F. Security Recovery 282
G. Installing Virtual COM Ports on Windows Variants 283

List of Figures

Figure 1-1 Instrument Dimensions ... 9
Figure 2-1 Front Panel Overview ... 27
Figure 2-2 Rear Panel Overview ... 28
Figure 2-3 Welcome Screen ... 29
Figure 3-1 Leakage Test Circuit Example ... 32
Figure 3-2 AC Voltage Wishstand Test Phases ... 38
Figure 3-3 AC Withstand Isolated Connections ... 39
Figure 3-4 AC Withstand Isolated Connections with Sense ... 40
Figure 3-5 ACCAP Test Connections ... 40
Figure 3-6 DC Voltage Wishstand Test Phases ... 44
Figure 3-7 DC Withstand Isolated Connections ... 46
Figure 3-8 AC Withstand Isolated Connections With Sense ... 47
Figure 3-9 Pulsed Voltage Wishstand Test Phases ... 51
Figure 3-10 Pulse Test Connections ... 52
Figure 3-11 DC Breakdown Voltage Test Phases ... 54
Figure 3-12 DC Breakdown Isolated Connections ... 55
Figure 3-13 Low Ω 2-wire Connections ... 56
Figure 3-14 Low Ω 4-wire Connections ... 57
Figure 3-15 AC Ground Bond Test Phases ... 58
Figure 3-16 Typical GB Test Connection ... 59
Figure 3-17 GB and Withstand Test Connections ... 60
Figure 3-18 ACI and DCI Test Connections ... 63
Figure 4-1 Common Displays for Sequence Execution and Review ... 67
Figure 4-2 Using Stop to Enable Ready ... 68
Figure 4-3 User Log in Screen ... 68
Figure 4-4 Log out Button ... 68
Figure 4-5 V10x Menus ... 69
Figure 4-6 V10x Display Overview ... 70
Figure 4-7 V10x Status Bar ... 73
Figure 4-8 USB Fault Indicators ... 75
Figure 4-9 Example Alert Notification ... 75
Figure 4-10 V10x Numeric Setting Editor ... 76
Figure 4-11 Time Versus Rate Setting ... 77
Figure 5-1 Testing Menu ... 78
Figure 6-1 General Test Settings ... 79
Figure 6-2 Audio Notificaton Settings ... 80
Figure 6-3 Sequence Chart Settings ... 80
Figure 7-1 Editing the Manual Sequence ... 81
Figure 7-2 Editing a Regular Sequence ... 81
Figure 7-3 Selected Step Cursor ... 83
Figure 7-4 Step Label Example ... 83
Figure 7-5 Sequence Error Example ... 84
Figure 7-6 Sequence Execution Invalid ... 84
Figure 7-7 Loading a Sequence for Editing ... 85
Figure 7-8 Sequence Settings ... 86
Figure 7-9 Sequence Number Selection ... 86

Figure 7-10 Report Options 87
Figure 7-11 Sequence Deletion Confirmation Pop-up 89
Figure 7-12 Common Arc Settings Screen 89
Figure 7-13 Step Type Selection 92
Figure 7-14 Step Deletion Confirmation Pop-up 92
Figure 7-15 Editing Step Limits Example #1 93
Figure 7-16 Step Validation Failure Example 93
Figure 7-17 ACW Step Configuration Screens 94
Figure 7-18 ACCAP Step Configuration Screens 97
Figure 7-19 DCW Step Configuration Screens 99
Figure 7-20 DCIR Step Configuration Screens 103
Figure 7-21 GB Step Configuration Screens 107
Figure 7-22 Low Ω Step Configuration Screen 109
Figure 7-23 ACI and DCI Step Configuration Screens 111
Figure 7-24 Pulse Step Configuration Screen 113
Figure 7-25 BRKDN Step Configuration Screens 115
Figure 7-26 Pause Step Configuration Screen 117
Figure 7-27 Hold Step Configuration Screen 117
Figure 7-28 Switch Step Configuration Screen 118
Figure 8-1 Sequence Execution Symbology 119
Figure 8-2 Sequence Loading for Execution 121
Figure 8-3 Loading an Invalid Sequence 121
Figure 8-4 Test Execution Options 122
Figure 8-5 Test Execution Screen 123
Figure 8-6 Barcode Scan Decode Error Examples 124
Figure 8-7 Test Adjustment Using the Dial 124
Figure 8-8 Test Adjustment Using a Keypad 124
Figure 8-9 Results After Running the Manual Sequence 125
Figure 8-10 Multi-Step Sequence Running Example 126
Figure 8-11 Running Sequence Timing Control Steps 127
Figure 8-12 Running Switch Control Steps 128
Figure 8-13 Test Measurement Selection Example 129
Figure 8-14 Test Measurement Charting Examples 130
Figure 8-15 Completion of a Multi-Step Sequence 131
Figure 8-16 Automatic Reports 131
Figure 8-17 Selecting a Single Step For Execution 132
Figure 8-18 Display After Running a Single Step 132
Figure 9-1 Results Menu 133
Figure 9-2 Sequence Results Summary 134
Figure 9-3 Sequence Summary Export Options 135
Figure 9-4 Step Results Review 136
Figure 9-5 Step Results Series Chart Overview 138
Figure 9-6 Step Results Series Chart Examples 139
Figure 9-7 Step Results Showing RMSA Limits 139
Figure 9-8 Step Results Chart Limiting 140
Figure 9-9 DCW Step Series Chart Zoomed 140
Figure 9-10 DCW Step Series Selectively Scaled 141
Figure 9-11 Series Chart Export Options 141

Figure 9-12 Step Results XY Chart Types....142
Figure 9-13 XY Chart Retracing....142
Figure 9-14 Step Results XY Chart Settings....143
Figure 9-15 Step Results XY Chart Trace Colors....143
Figure 9-16 Step Results XY Chart Axis....144
Figure 9-17 Step Results XY Chart Trace Preferences....144
Figure 9-18 XY Chart Export Options....145
Figure 9-19 History Chart....146
Figure 9-20 History Chart Options Screen....147
Figure 9-21 History Export Options....147
Figure 9-22 Chart Trace Preferences....149
Figure 9-23 Series and History Trace Color Option Screens....149
Figure 9-24 Chart Trace Preferences....150
Figure 10-1 System Menu....151
Figure 10-2 About System Screen....151
Figure 10-3 Interface Log Error Example....152
Figure 10-4 System Update Options....153
Figure 10-5 Update Invalid....153
Figure 10-6 System Update Status....154
Figure 10-7 System Configuration Menu Screen....155
Figure 10-8 Start Enables Options Screen....155
Figure 10-9 Interface Options Screen....156
Figure 10-10 Clock Settings Screen....156
Figure 10-11 Display Settings Screen....157
Figure 10-12 Non-Standard Display Themes....158
Figure 10-13 Automatic LAN Configuration Screen....159
Figure 10-14 Manual LAN Configuration Screen....160
Figure 10-15 WiFi Settings Screen....160
Figure 10-16 WiFi Scan Result Screen....161
Figure 10-17 WiFi Join Status Screen....161
Figure 10-18 Security Enable Screen....162
Figure 10-19 User Management Screen....162
Figure 10-20 User Profile Screen....163
Figure 10-21 Preferences Screen....163
Figure 10-22 DIO Settings Screen....165
Figure 10-23 DIO Pin Settings Screens....165
Figure 10-24 DIO Signal Function Screen....166
Figure 10-25 Automation Options Screen....167
Figure 10-26 Automation Scan Pattern Test Screens....168
Figure 10-27 Power On Sequence Settings....168
Figure 10-28 Switching Configuration Default Screen....169
Figure 10-29 Automatic Switch Configuration Probing....170
Figure 10-30 Automatic Switch Configuration Probe Results....170
Figure 10-31 Switching Configuration Ready Screen....171
Figure 10-32 Switching Configuration Ready Screen....172
Figure 10-33 Edit Switch Properties Screen....173
Figure 10-34 Operate Switch Screen....174
Figure 10-35 Import Menu Screen....175

Figure 10-36 Import File List Screen 176
Figure 10-37 Import Settings Example Screen 176
Figure 10-38 Export Menu Screen 177
Figure 10-39 Export running screen examples 178
Figure 10-40 Self-Test Start Screen 179
Figure 10-41 Self-Test Result Screen 180
Figure 11-1 Rear Panel Interfaces 181
Figure 11-2 RS232 Connector Pin Numbering 181
Figure 11-3 DIO Connector Pin Numbering 183
Figure 11-4 DIO Input Start Example 184
Figure 11-5 DIO Input Abort Example 184
Figure 11-6 DIO Input Interlock Example 185
Figure 11-7 DIO Output Testing Example 186
Figure 11-8 DIO Output HV Present Example 186
Figure 12-1 Switches Command Examples 235
Figure 12-2 *OPC? Example 236
Figure 14-1 Calibration Activities 239
Figure 14-2 Preliminary Calibration Steps 240
Figure 14-3 Calibration Adjustment Menu 242
Figure 14-4 Zero Adjustment Start Screens 242
Figure 14-5 DC Voltage Adjustment Start Screen 243
Figure 14-6 DC Voltage Adjustment Screen 243
Figure 14-7 DC Current Adjustment Start Screen 244
Figure 14-8 DC Current Adjustment Screen 244
Figure 14-9 Low Ω Adjustment Start Screen 245
Figure 14-10 Low Ω Adjustment Screen 245
Figure 14-11 1 Ω Adjustment Screen 245
Figure 14-12 HSS Current Adjustment Start Screen 246
Figure 14-13 HSS Current Adjustment Screen 246
Figure 14-14 Calibration Verification Group Menu 248
Figure 14-15 DC Voltage Verification Start Screen 249
Figure 14-16 DC Voltage Verification Screen 250
Figure 14-17 DC Current Scaling Verification Start Screen 250
Figure 14-18 DC Current Scaling Verification Screen 251
Figure 14-19 DC Current Zero Verification Start Screen 251
Figure 14-20 DC Current Zero Verification Screen 251
Figure 14-21 Low Ω 4-wire Verification Start Screen 252
Figure 14-22 Low Ω 4-wire Verification Screen 253
Figure 14-23 AC Voltage Verification Start Screen 253
Figure 14-24 AC Voltage Verification Screen 254
Figure 14-25 AC Current Zero Verification Start Screen 255
Figure 14-26 AC Current Zero Verification Screen 256
Figure 14-27HSS Current Verification Start Screen 256
Figure 14-28 HSS Current Verification Screen 257
Figure 14-29 Ground Bond Verification Start Screen 257
Figure 14-30 Ground Bond Verification Screen 259
Figure 14-31 Calibration Error Example 260

List of Tables

Table 1-1 V10x Models ... 8
Table 1-2 Arc Detection Specifications ... 11
Table 3-1 Step Type Activities ... 33
Table 3-2 Sequence Start Mechanisms ... 66
Table 4-1 Menu Summary ... 69
Table 4-2 Test Execution Status Symbology ... 72
Table 4-3 Status Bar Item Behavior ... 73
Table 7-1 Test Title Formatting ... 81
Table 7-2 Sequence Editor Symbology ... 82
Table 7-3 Sequence Execution Options ... 86
Table 7-4 PDF Report Format Levels ... 88
Table 7-5 Discharge Options ... 90
Table 7-6 Test Step Time Period Limits ... 90
Table 7-7 Time Period Display Examples ... 91
Table 8-1 Manual Sequence Adjustments ... 124
Table 8-2 Time Period Display Examples ... 132
Table 9-1 Status flags not counted as a DUT failure ... 134
Table 9-2 Measurements for Charting ... 149
Table 10-1 Digital Input/Output Functions ... 164
Table 10-2 Exporting Settings ... 177
Table 11-1 RS232 Signals ... 182
Table 11-2 DIO Signals ... 183
Table 11-3 DIO Function Factory Defaults ... 188
Table 12-1 IEEE Mandated commands ... 196
Table 12-2 IEEE Optional commands ... 196
Table 12-3 System Remote Locking commands ... 196
Table 12-4 System Event/Error Query Commands ... 196
Table 12-5 Command Status Commands ... 197
Table 12-6 Commands to manage test sequences ... 198
Table 12-7 Test Sequence Execution and Result Commands ... 199
Table 12-8 Sequence Execution Settings ... 200
Table 12-9 Device Configuration Commands ... 201
Table 12-10 Standard Event Status Register Bit Definitions ... 202
Table 12-11 Step error hints ... 207
Table 12-12 ACez Configuration Fields ... 208
Table 12-13 ACW Configuration Fields ... 209
Table 12-14 DCez Configuration Fields ... 210
Table 12-15 DCW Configuration Fields ... 211
Table 12-16 DCIR Configuration Fields ... 212
Table 12-17 GBez Configuration Fields ... 213
Table 12-18 GB Configuration Fields ... 213
Table 12-19 LowΩ Configuration Fields ... 214
Table 12-20 ACCAP Configuration Fields ... 216
Table 12-21 ACI Configuration Fields ... 217

Table 12-22 DCI Configuration Fields 218
Table 12-23 Pulse Configuration Fields 218
Table 12-24 BRKDN Configuration Fields 219
Table 12-25 Pause Configuration Fields 219
Table 12-26 Hold Configuration Fields 220
Table 12-27 Switch Configuration Fields – legacy 964 format 220
Table 12-28 Switch Configuration Fields – variable format 221
Table 12-29 Manual Step Adjustments 223
Table 12-30 Measurement Item Keywords 224
Table 12-31 Step Status Flags 225
Table 12-32 Step Results 226
Table 12-33 Step Result Availability 227
Table 12-34 Chart Item Keywords 227
Table 12-35 DIO Functions 232
Table 14-1 DC Voltage Verification Levels 249
Table 14-2 DC Current Verification Levels 250
Table 14-3 Low Ω Verification Values 252
Table 14-4 AC Current Zero Verification Parameters 255
Table 14-5 HSS Current Verification Values 257
Table 14-6 Ground Bond Verification Parameters 259

1 Introduction

1.1 About This Manual

This document is formatted to be viewed on a computer using a suitable reader application, instead of printed as a hard copy; however, if it is printed, it should be in color.

Throughout this manual the term V10x is used generically for the series model, such as V105.

It is not necessary to read the entire manual; rather, it is recommended that the user view the table of contents and select those sections applicable to the intended application.

The user may click on any entry in the table of contents to go to the desired section. The table of contents is also available as bookmarks for Adobe Reader or Acrobat; this allows the user to permanently display it alongside the document and navigate it by clicking on each section as needed.

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1.2 Warranty Information

This Vitrek instrument is warranted against defects in material and workmanship for a period of 1 year after the date of purchase (extended up to a total of 3 years with registration and annual calibrations at Vitrek). Vitrek agrees to repair or replace any assembly or component (except batteries) found to be defective, under normal use, during the warranty period. Vitrek's obligation under this warranty is limited solely to repairing any such instrument, which in Vitrek's sole opinion proves to be defective within the scope of the warranty, when returned to the factory or to an authorized service center. Transportation to the factory or service center is to be prepaid by the purchaser. Shipment should not be made without prior authorization by Vitrek.

This warranty does not apply to any products repaired or altered by persons not authorized by Vitrek or not in accordance with instructions provided by Vitrek. If the instrument is defective as a result of misuse, improper repair, improper shipment, or abnormal conditions or operations, repairs will be billed at cost.

Vitrek assumes no responsibility for its products being used in a hazardous or dangerous manner, either alone or in conjunction with other equipment. Special disclaimers apply to this instrument. Vitrek assumes no liability for secondary charges or consequential damages, and, in any event, Vitrek's liability for breach of warranty under any contract or otherwise, shall not exceed the original purchase price of the specific instrument shipped and against which a claim is made.

Any recommendations made by Vitrek or its representatives, for uses of its products are based on tests believed to be reliable, but Vitrek makes no warranties of the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied and no representative or person is authorized to represent or assume for Vitrek any liability in connection with the sale of our products other than set forth herein.

1.3 Safety

1.3.1 Safety Symbols

WARNING — **WARNING** highlights an operating or maintenance procedure, condition or statement that could result in injury to or death of personnel.

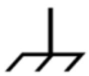
CAUTION — **CAUTION** highlights an operating or maintenance procedure, condition or statement that could result in damage to or destruction of equipment.

NOTE — **NOTE** highlights essential information for operating and maintenance procedures, or conditions.


DANGER – High Voltage


Safety Warning


Protective Earth Terminal


Chassis Ground


Test Ground

1.3.2 Warning Summary

The user should read and be aware of these safety warnings at all times while using the instrument.

WARNING — THE V10X PRODUCES VOLTAGES AND CURRENTS WHICH MAY BE LETHAL, UNSAFE OPERATION MAY RESULT IN SEVERE INJURY OR DEATH.

WARNING — IF THE V10X IS USED IN A MANNER NOT SPECIFIED BY VITREK, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED AND SAFETY MAY BE COMPROMISED.

1.3.3 Power and Grounding

WARNING — THE V10X IS INTENDED TO BE POWERED FROM A POWER CORD HAVING A PROTECTIVE GROUND WIRE WHICH MUST BE INSERTED INTO A POWER OUTLET HAVING A PROTECTIVE GROUND TERMINAL. IF THE V10X IS NOT POWERED FROM A SUITABLE POWER SOURCE THEN THE CHASSIS GROUND TERMINAL LOCATED NEAR THE POWER ENTRY CONNECTOR ON THE REAR PANEL MUST BE PROTECTIVE GROUNDED.

WARNING — TURNING OFF OR OTHERWISE REMOVING POWER TO THE V10X WHILE IT IS GENERATING HIGH VOLTAGES WILL NOT ENABLE THE V10X TO DISCHARGE THE DUT AND MAY DAMAGE THE V10X. THE DUT MAY HAVE DANGEROUS VOLTAGES PRESENT FOR LONG PERIODS OF TIME AFTER THIS OCCURS.

WARNING — DO NOT REMOVE THE POWER CORD FROM THE V10X OR FROM THE SOURCE OF POWER WHILE IT IS OPERATING AT HIGH VOLTAGES. THIS WILL REMOVE THE PROTECTIVE GROUND

FROM THE CHASSIS OF THE V10X AND THE DUT WHICH MAY RESULT IN HAZARDOUS VOLTAGES BEING ACCESSIBLE TO THE USERE.

1.3.4 Terminals and Wiring

WARNING

THE V10X PRODUCES VOLTAGES AND CURRENTS WHICH MAY BE LETHAL, ENSURE NO VOLTAGE OR CURRENT IS PRESENT WHEN CONNECTING TO OR DISCONNECTING FROM THE TERMINALS OR DUT.

The **HIGH VOLTAGE OR HIGH CURRENT PRESENT** warning symbol on the front panel of the V10x is illuminated whenever an unsafe voltage is present on the **HV** terminal, or a high current is present between the **SOURCE** terminals.

WARNING

THE V10X PRODUCES VOLTAGES OF UP TO 10KVRMS ON THE HV TERMINAL(S). THE USER MUST ENSURE THAT CONNECTIONS TO THESE TERMINALS HAVE SUFFICIENT INSULATION FOR THESE VOLTAGES. EVEN WHEN SUFFICIENT INSULATION IS PRESENT, THE USER SHOULD NOT PUT ANY PART OF THEIR BODY IN CLOSE PROXIMITY TO THE CONNECTIONS WHILE HIGH VOLTAGES ARE PRESENT.

The insulation of the wiring to the **HV** terminal of the V10x must be rated for at least the highest voltage expected during the test sequence.

The user should ensure that all personnel remain at a safe distance from the **HV** wiring during testing.

When using high voltages, even if there is sufficient insulation, there may be significant capacitive coupling which can cause an unsafe current to flow to nearby objects and corona can occur even outside of the insulation. This is made worse by sharp corners on objects or the wiring. In severe cases corona can cause interference with the measurements of the V10x and will reduce the capabilities of the wiring insulation over time, eventually resulting in insulation failure.

When using extremely high voltages, especially when using Opt. AC-30, there may be significant mechanical force between the **HV** wiring and nearby objects. Loose wiring can move several inches, and nearby loose objects (e.g., screws or papers) can be attracted to the high voltage wire.

All terminals of the V10x other than the HV terminal are always protected to be within a safe voltage of the V10x chassis ground, so high voltage wire is generally unnecessary for connections to them.

Should the DUT exhibit significant breakdown or arcing while being tested, there may be very high energy HF interference generated. Although this only lasts for a small period of time before the V10x shuts down, in severe cases this can damage nearby equipment, such as computers. The wiring between the V10x terminals and the DUT should be routed as far as possible away from other equipment and from all cabling connected to other equipment.

When charging high capacitance loads to high DC voltages the capacitor may be unsafe if it or the wiring to it exhibits breakdown while being tested. The energy in the breakdown is generated by the capacitor itself, so there can be no limit on this energy imposed by the V10x.

WARNING

SOME V10X MODELS PRODUCE CURRENTS OF UP TO 40ARMS ON THE SOURCE + AND - TERMINALS. THE USER MUST ENSURE THAT CONNECTIONS TO THESE TERMINALS HAVE A SUFFICIENT CURRENT CARRYING RATING.

The current rating of all wiring must be sufficient for at least the highest current expected from that terminal during the test sequence.

Generally, all wiring should be rated for at least 100mA, but the **SOURCE+** and **SOURCE-** terminal wiring for a V102, V104, or V109 performing Ground Bond testing should be rated for the highest set test current (this may be up to 40A).

1.3.5 User Activated Safety Abort

- The user may depress the **STOP** button on the V10x front panel at any time while a test sequence is being run to remove the voltage or current as quickly as possible and abort the test sequence.
- The user can configure for a digital *Interlock* signal to be input to the DIO Interface which will terminate a high voltage or current test step if the interlock is opened. See sections 10.2.8 and 11.5 for information to respectively configure and operate the signal.
- The user can configure for a digital *Abort* signal to be input to the DIO Interface which will abort any type of test step if asserted. See sections 10.2.8 and 11.5 for information to respectively configure and operate the signal.
- There are several interface commands which can be used to abort a running test sequence; see section 12 Remote Operation.

1.3.6 Automatic Safety Abort

- For AC or DC voltage test steps, if the breakdown current level is set to <7mApk and the Hi Safety sequence option is enabled, the V10xx will fail the test if excessive HV terminal current is detected. This effectively reduces the drive capability of the V10x to a safer level of current (nominally 7.5mA peak) during these test steps. See section 7.3.1.
- For AC or DC voltage test steps, the **RETURN** terminal of the V10x provides a protective ground to the DUT. The user may wish to take precautions to ensure its connection to the DUT. If the *Continuity Sense* sequence option is enabled, and the user connects a separate wire between the SENSE+ terminal of the V10x and the portion of the DUT to which the RETURN terminal wire is connected, then if the **RETURN** terminal wire becomes disconnected from the DUT the test step will be immediately aborted and the high voltage removed, preventing a potentially unsafe condition. See section 7.3.1.
- When testing an Isolated DUT then for AC or DC voltage test steps, if the voltage present on the HV terminal is detected as being significantly different from that expected during the execution of a test step, then the test sequence is immediately aborted and any high voltage removed, preventing a potentially unsafe condition.
- Multiple processors in the V10x participate in monitoring the output of the unit and the condition of the load check each other nominally every 5ms, if any mis-operation is detected which lasts more than 10ms then the test sequence is immediately aborted and any high voltage removed, preventing a potentially unsafe condition. This requires no specific configuration by the user.
- The main processor has an advanced hardware “watchdog” managed by cross checking software systems; in the event of a malfunction the system will recover. If this occurs during a test then the test sequence is immediately aborted and any high voltage removed, preventing a potentially unsafe condition. This requires no specific configuration by the user.

1.4 Product Information

The V10x is an advanced Electrical Safety Analyzer with many standard features which make it unique in this field.

- Multiple Capabilities. The V10x is capable of a very wide range of safety tests and is also capable of making specialty measurements on components – all in the same instrument.
- Multiple Safety features. The V10x has many built-in safety features, such as ground current detection, DUT safety ground disconnection detection, and more. The standard digital interface allows the user to use safety interlocks and remote safety indicators with ease.
- No regrets. With all of the features shown here, the V10x is capable of so much more than the typical users' present requirements, the user will not regret choosing the V10x when new more stringent requirements come up in the future.
- Wide range of voltages and currents generated. The V10x has a test voltage range from a few 10's of volts to several 10's of kilovolts (for withstand testing) and a test current range from a few microamps to 10's of amps (for chassis ground bond testing) at DC or over a frequency range from 20 to 500Hz. The V10x is not limited to just a few voltages, currents or frequencies, the user can specify the actual level and frequency they desire. The V10x is not weak either – loads up to 500VA can be accommodated.
- Wide range of voltages and currents measured. The V10x does not just have a wide range of generated voltages and currents – it can measure them too. From microvolts to 10's of kilovolts, and from 100's of picoamps to 100's of milliamps, are all measured by the V10x. Using its' DSP based technology the V10x knows the difference between breakdown currents, leakage currents and arcing currents and gives you all of the results.
- Advanced measurements. When it comes to AC measurements the V10x does not just measure the basics - the V10x measures total, in phase and quadrature components all of the time and makes available more advanced results such as in phase resistance, quadrature reactance, capacitance and dissipation factors.
- Result Analysis. The V10x does not just measure, it analyses the measurements – after a test has been run the minimum, maximum, average, and final measurements are available, a running total of the passes and failures for each test step are also maintained across multiple runs.
- Not just "does not breakdown" but "does breakdown" too. The V10x is not only capable of testing that a DUT does not breakdown, but it is also capable of testing that a surge suppressor type device does breakdown at the correct voltage. Ever worried if that surge suppressor you disconnected while safety testing was correctly reconnected, does it work, is it in specification? Not a problem for the V10x – it can be tested after safety testing.
- The V10x adapts itself to the load automatically. The V10x does not have the load restrictions so often found (and so often hidden in the small print) in other safety analyzers – load capacitances up to a farad during DC withstand testing, highly inductive loads when low resistance testing, and more, are automatically accommodated by the V10x adapting itself to the actual load during each test. Measurements on DUTs like solar panels and computer system line filters are made by the V10x with ease.
- Standalone operation. The V10x can be programmed by the user to perform any number of steps up to the limit of internal storage, about 50,000 on the standard model with typical configuration settings. Each step is automatically performed by the V10x either with or without user intervention as the user desires. The number of sequences is only limited by the size of the internal file system, about 700 with 50k steps, or 3.3M with 10 steps each. The V10x is capable of controlling switch matrix units (also available from Vitrek) – up to 1600 relay channels can be controlled on any number of switches without needing a computer or software. The V10x can export a test report as a PDF file on a flash stick when a test sequence has completed.
- System operation - Wide range of interfaces available. If the user wishes to use the V10x with a computer, then RS232, GPIB or Ethernet interfacing can be chosen as the interfacing medium between them. Giving the user

the flexibility to use the V10x in almost any computing environment. Software (QT Enterprise) is available from Vitrek to provide all the control needed for any system from the simple (just the V10x) to the most complex with the V10x terminals being multiplexed between DUTs and/or points within DUTs by up to 1600 channels in switch matrix units (also available from Vitrek).

- High Speed. The V10x is capable of performing very quickly, up to 100 tests per second can be performed with the test results being made available both during each test and after the entire sequence has been run. The V10x is also capable of chaining similar tests without needing to reduce the applied voltage or current to zero between test steps, this considerably speeds up testing when multiple test levels are required.
- All of the measurements, all of the time. The V10x does not just measure what the user has set limits for, all measurement results for the specific type of test being performed are made available to the user.
- Energy Efficient. The V10x uses direct line switching power supplies to provide a very energy efficient instrument, the V10x only draws significant power from the line when needed to power the load.

1.5 Models and Accessories

Table 1-1 V10x Models

Model	AC Voltage	DC Voltage	Ground Bond	Drive Options	Model
V101	6000V	6000V	*None*	One of: 500VA, AC-2, AC30, DCNEG	V101
V102	6000V	6000V	40A	One of: 500VA, AC-2, AC30, DCNEG	V102
V103	6000V	11000V	*None*	One of: 500VA, AC-2, AC30, DCNEG	V103
V104	6000V	11000V	40A	One of: 500VA, AC-2, AC30, DCNEG	V104
V105	10000V	11000V	*None*	AC30, DCNEG	V105
V106	10000V	11000V	40A	AC30, DCNEG	V106
V107	10000V	15000V	*None*	AC30, DCNEG	V107
V108	10000V	15000V	40A	AC30, DCNEG	V108
V109	N/A	N/A	40A	None	V109

- **500VA** Extends the AC voltage drive capability to 100mArms.
- **AC-2** Changes the AC Voltage capability to 10-2000V and has increased drive capability at all voltage output levels.
- **AC30** Extends the maximum AC Voltage capability to 30KV by means of an external accessory.
- **DCNEG** Changes the polarity of the DC Voltage capability to negative but limits the minimum DC output voltage to 200V.

All models allow the these options and accessories.

- **Pulse Testing** High speed pulsed voltage testing.
- **Rear Terminals** RPO adds rear panel terminals in parallel with the front panel terminals.

  RPOO replaces the front panel terminals with rear panel terminals.
- **GPIB** Addes a GPIB interface.
- **Rack Mounting** Allows for standard 19” rack mounting of the tester.
- **QT Insite** Vitrek’s HIPOT test automation software offering the following features:
  - ✓ A 45 day trial.
  - ✓ The user does not need to write software to use the V10X with a computer.
  - ✓ Easy to use fully graphical interface on a Windows 10 or 11 computer.
  - ✓ Can operate multiple test points when used with Vitrek Switch Matrix units.
  - ✓ Multi-level user log in, enabling the configuration of tests to be locked except for certain users.
  - ✓ Company wide use of test sequences using the local network.
  - ✓ Test sequences can be downloaded into the V10X and run without the computer.
  - ✓ Test results are recorded locally or on the company network.
  - ✓ Prints or exorts (as a PDF file) multi-level test reports.

1.6 Specifications

1.6.1 Dimensions

132mmH x 432mmW x 457mmD (5.2” x 17” x 18”)

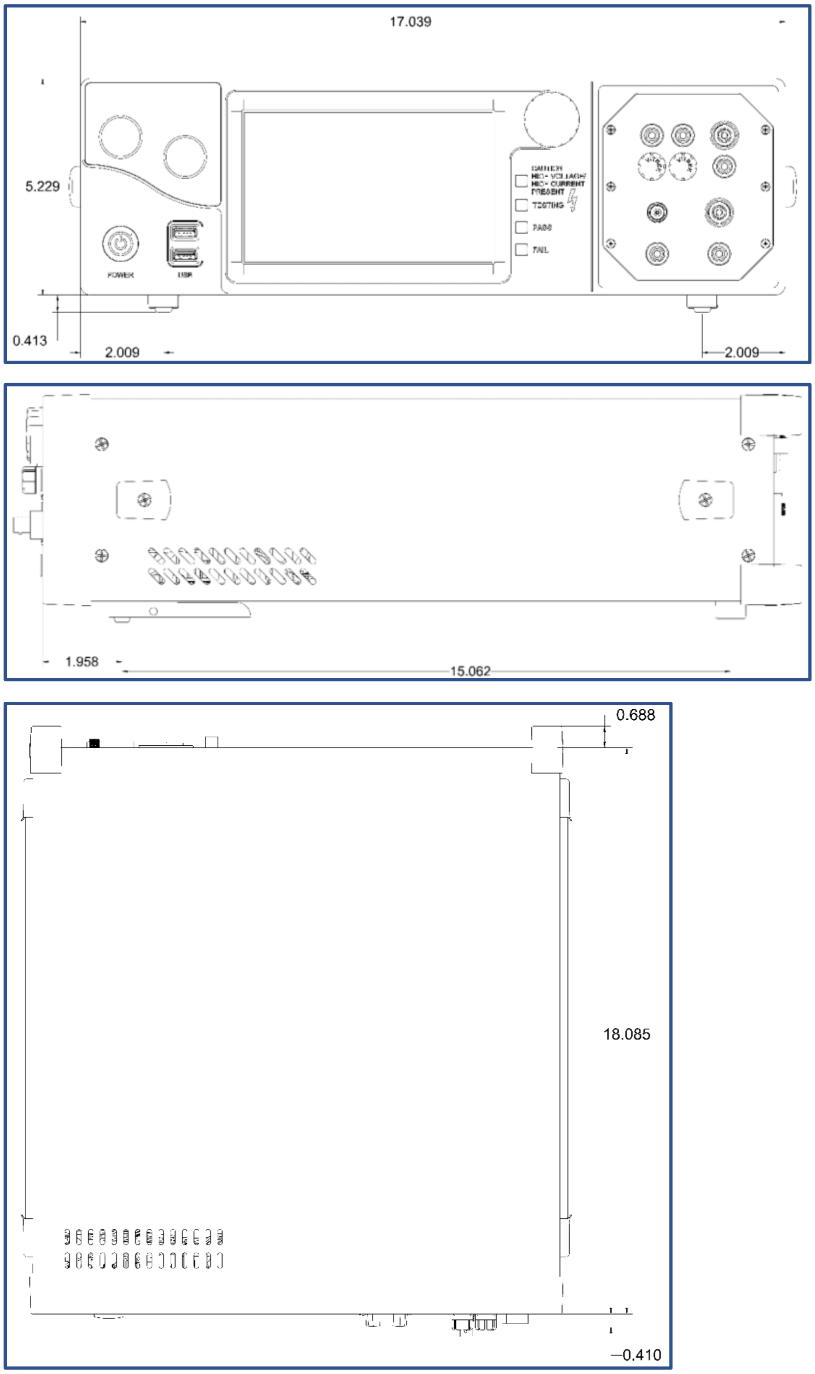


Figure 1-1 Instrument Dimensions

1.6.2 General Specifications

Typical Weight	V101, V103, V107, V109 : 9kg (18lb) net, 12kg (25lb) shipping V106 : 5kg (11lb) net, 8kg (18lb) shipping V101, V103 Opt. 500VA : 13kg (27lb) net, 16kg (35lb) shipping V102, V104, V105: 13kg (27lb) net, 16kg (35lb) shipping V107 Opt AC10 or GB40 : 13kg (27lb) net, 16kg (35lb) shipping Opt. AC-30 : additional 17kg (36lb) net, 21kg (46lb) shipping
Storage Environment	-20 to 75C (non-condensing)
Operating Environment	0 to 50C, <85% RH (non-condensing), Pollution Degree 2
Operating Altitude	0 to 7000ft ASL (10000ft with reduced output drive capability)
Line Power	Installation Category II Standard: 105-265Vrms (45 to 450Hz) or 160-300Vdc, having at least 500VA (750VA for Opt. 500VA) capability Opt. LOLINE: 85 to 130Vrms (45 to 450Hz) Opt. INRUSH : 200-265Vrms (45 to 450Hz) having at least 500VA (750VA for Opt. 500VA) capability
Measurement	Measurement Category I
HV Switching	964i, M10x

THE V10x MUST NOT BE USED IN AN ENVIRONMENT WHERE CONDUCTIVE POLLUTION CAN OCCUR, E.G. IN AN OUTDOOR ENVIRONMENT.

IF FLUIDS OR OTHER CONDUCTIVE MATERIALS ARE ALLOWED TO ENTER THE UNIT ENCLOSURE, EVEN IF NOT POWERED, THEN THE UNIT SHOULD BE IMMEDIATELY TAKEN OUT OF OPERATION AND SERVICED AS SAFETY MAY HAVE BEEN COMPROMISED.

IF THE UNIT IS TRANSPORTED BETWEEN DIFFERING ENVIRONMENTS AND CONDENSATION IS SUSPECTED, THE UNIT SHOULD REMAIN UNPOWERED FOR SUFFICIENT TIME FOR CONDENSATION TO HAVE DISSIPATED.

Specifications are valid at the V10x terminals for 1 year at ambient temperatures within ±5C of calibration temperature (add 5% of accuracy specification per C outside of this). All specifications are relative to the calibration standards used. Add ½ digit to all accuracies for displayed results (results available with enhanced resolution from interfaces).

Arc measurements are performed in the **RETURN** terminal of the V10x. Arc detection is disabled when the DUT is grounded because any arcing is going to ground.

Table 1-2 Arc Detection Specifications

Arc Current	1 to 30mArms (50KHz-5MHz bandwidth) <(± 10% ± 1mA) accuracy at 1MHz
Arc Time	4us, 10us, 15us, 20us, 30us or 40us measurement period

1.6.3 AC Voltage Withstand and Leakage Testing (ACW and ACCAP) Specifications

Loading Capability

The listings below show the maximum loading current and power capabilities of the V10x at ambient temperatures ≤30C. For ambient temperatures above 30C linearly reduce the maximum loading current and power by 1%/C.

For frequencies above 100Hz other than 400Hz, the user should linearly interpolate using the <100Hz and 400Hz capabilities shown in the applicable listing.

Where both a current and power limit is shown, the most stringent limit applies.

V101-V104 and V107, <100Hz : 50mArms (40mArms resistive), reduce by 0.08mA per V above 5525Vrms

V101-V104 and V107, 400Hz : 35mArms, reduce by 0.065mA per V above 5600Vrms

Option AC-2, <100Hz : 200mArms (135mArms resistive), reduce by 0.67mA per V above 1750Vrms

Option AC-2, 400Hz : 140mArms, reduce by 0.4mA per V above 1700Vrms

Option 500VA, <100Hz : 100mArms (50mArms resistive), reduce by 0.14mA per V above 5425Vrms
500VA
Above 65mArms has a limited test time (e.g., 1sec at 100mArms)

Option 500VA, 400Hz : 85mArms (50mArms resistive), reduce by 0.11mA per V above 5375Vrms
Above 65mArms has a limited test time (e.g., 1sec at 100mArms)

V105 and V107 Opt. AC-10, <100Hz : 30mArms (20mArms resistive)

V105 and V107 Opt. AC-10, 400Hz : 22mArms

Option AC-30 : 10mArms (7mArms resistive)
250VA

Surge Current Limiting and Shutdown

Impedance Limiting	V101-V104 and V107 (standard build) : 12KΩ + 0.5H Opt. 500VA : 7KΩ + 0.25H Opt. AC2 : 1.4KΩ + 0.2H V105 and V107 Opt. AC10 : 25KΩ + 1.0H SOURCE set to EXT : 200KΩ
Peak Shutdown Current	V101-V104 and V107 (standard build) : 120mA Opt. 500VA : 145mA Opt. AC2 : 280mA V105 and V107 Opt. AC10 : 60mA SOURCE set to EXT : 21mA

	DUT GROUNDED set to YES : 50mA

Test Voltage and Frequency

Test Voltage Range	V101-V104 and V107 (standard build or Opt. 500VA) : 20 to 6000Vrms, reduce maximum voltage by 0.6V per Hz above 100Hz V105 and V107 Opt. AC-10 : 50 to 10000Vrms, reduce maximum voltage by 1V per Hz above 100Hz Opt. HSS or HSS-2 : 20 to 4000Vrms Opt. AC-2 : 10 to 2000Vrms, reduce maximum voltage by 0.2V per Hz above 100Hz Opt. AC-30 : 120 to 30000Vrms For line voltages below 115V linearly reduce the maximum test voltage by 1%/V unless Opt. LOLINE is fitted (there is no reduction for Opt. LOLINE).
Test Voltage Accuracy	<(± 0.5% ± 1.5V ± (0.01% + 0.2V) per mArms load ± 0.01% per Hz above 100Hz) V105 and V107 Opt. AC10 : Add ±0.1% above 7000Vrms Opt. AC-30 : <(± 1.5% ± 5V ± (0.05% + 1V) per mArms load)
Test Voltage Overshoot	<5% (<0.5s ramp time) <2% (>0.5s ramp time) Settling to <±0.5% of final value in <0.1sec + 2 cycles
Test Voltage Waveform	Sinewave, 1.35 – 1.46 Crest Factor
Test Frequency Range	V101-V104 and V107 : 20 to 500Hz V105 and V107 Opt. AC10 : 40 to 500Hz Opt. AC-30 : 40 to 80Hz
Test Frequency Accuracy	<±0.1%

Current Measurements (DUT isolated)

Measurements are performed in the **RETURN** terminal of the V10x.

Breakdown Current	1uA to 280mApk (DC-50kHz bandwidth) <(± 1% ± 1uA) accuracy <30usec detection time, <3msec response time (typically <500usec)
Leakage Current	0.0nA to 200mArms (RMS, In-phase or Quadrature) Greater of 1 cycle or 10ms measurement period RMS : <(± 0.5% ± 10nA ± 0.15nA per kV*Hz) accuracy InPhs : <(± 0.5% ± 10nA ± 0.01nA per kV*Hz) accuracy Quad : <(± 0.5% ± 10nA ± 0.15nA per kV*Hz) accuracy Add 0.005% per Hz above 100Hz V105 and V107 Opt. AC10 : Add 50nA (RMS, InPhs and Quad) above 7000Vrms <±0.005° per Hz phase relative to test voltage (InPhs, Quad) Add 0.005% per Hz above 100Hz <±0.005° per Hz phase relative to test voltage (InPhs, Quad)
Cable Compensation	<(± 1% of error ± 0.1pF)

Current Measurements (DUT grounded)

Measurements are performed in the **HV** terminal of the V10x.

Breakdown Current	1uA to 50mApk (DC-50kHz bandwidth) <(± 1.5% ± 1uA) accuracy <30usec detection time, <3msec response time (typically <500usec)
Leakage Current	0.0nA to 35mArms (RMS, In-phase, or Quadrature) Greater of 1 cycle or 10ms measurement period RMS or Quad : <(± 1.5% ± 100nA ± 10nA per kV*Hz) accuracy InPhs : <(± 1.5% ± 100nA ± 1nA per kV*Hz) accuracy Add 0.005% per Hz above 100Hz <±0.005° per Hz phase relative to test voltage (InPhs, Quad)
Cable Compensation	<(± 1% of error ± 0.1pF)

<u>Capacitance and Dissipation Factor Measurements (ACCAP)</u>

Capacitance	Add Test Voltage, Frequency, and Quad Leakage Current Accuracies as percentages Examples at 1000V/60Hz with an isolated DUT - 1pF (= 377nA) : 0.65% + 0.1% + 4.73% = ±5.48% 10pF (= 3.77uA) : 0.65% + 0.1% + 0.92% = ±1.67% 100pF (= 37.7uA) : 0.65% + 0.1% + 0.54% = ±1.29% 1nF (= 377uA) : 0.65% + 0.1% + 0.5% = ±1.25% 10nF (= 3.77mA) : 0.65% + 0.1% + 0.5% = ±1.25% 100nF (= 37.7mA) : 0.65% + 0.1% + 0.5% = ±1.25%
Dissipation Factor	For test voltages >100V at 60Hz and capacitive load currents >200uA, the DF accuracy is ±0.005. For accuracy under other circumstances please contact Vitrek.

<u>Test Timing</u>

Ramp	0 to 9999 seconds <(± 1% ± 0.1sec ± 1 cycle) accuracy
Dwell	0.02s to 999 days or user terminated <(± 0.05% ± 20ms ± 1 cycle) accuracy
Fast Discharge	<(20ms + 1 cycle)

1.6.4 DC Voltage Withstand and Leakage Testing (DCW and DCIR) Specifications

<u>Loading Capability</u>

The listings below show the loading capabilities of the V10x at ambient temperatures ≤30C. For ambient temperatures above 30C linearly reduce the maximum loading power and current by 1%/C.

Output powers above 200W have a limited test time (e.g., 4 seconds at 250W).

Capacitive loading is only limited by the maximum ramp time (9999.9sec) and the maximum load current, typically this is a 1F load.

V101, V102, and V106	<50mA, reduce by 0.05mA per V above 6000V
V103, V104, and V105	<9000V : <30mA, reduce by 0.0067mA per V above 6000V

	>9000V : <10mA, reduce by 0.0025mA per V above 9000V
V107	<10mA, reduce by 0.001mA per V above 10000V

Surge Current Limiting and Shutdown

Impedance Limiting	V101, V102 and V106 : 6.5KΩ V103, V104 and V105 : 12.5KΩ V107 : 24 KΩ
Peak Shutdown Current	V101, V102 and V106 : 80mA (50mA if the DUT is Grounded) V103, V104 and V105 : 40mA V107 : 20mA Option HSS-2: 5mA

Test Voltage

Test Voltage Range	V101, V102 and V106 : 20 to 6500V V103, V104 and V105 : 40 to 11000V V107 : 75 to 15000V Opt. HSS or HSS-2 : 20 to 5000V For line voltages below 115V linearly reduce the maximum test voltage by 1%/V unless Opt. LOLINE is fitted (there is no reduction for Opt. LOLINE).
Test Voltage Accuracy	Except V107: <(± 0.25% ± 1.25V ± (0.01% + 0.05V) per mA load) V107: <(± 0.75% ± 2V ± (0.01% + 0.05V) per mA load), add 0.5% above 10000V Opt. HSS-2: <(± 1% ± 2V ± 1V per mA load)
Test Voltage Overshoot	<5% (<0.25s ramp time) <1% Settling to <±0.1% of final value in <0.5sec

Current Measurements (DUT Isolated)

Measurements are performed in the **RETURN** terminal of the V10x.

Breakdown Current	1uA to 280mApk (DC-50kHz bandwidth) <(± 1% ± 1uA) accuracy <30usec detection time <3msec response time (typically <500usec)
Leakage Current	0.0nA to 200mA 7.25msec measurement period (100ms for dwell time >2 sec) <(± 0.25% ± 0.5nA) accuracy Capacitive Loading Effects :

	V101, V102 and V106 : add X * (± 0.2nA ± (2.5nA per KV)) V103, V104 and V105 : add X * (± 0.3nA ± (3.5nA per KV)) V107 : add X * (± 0.5nA ± (5nA per KV)) X = (C/0.01uF) below 0.01uF, or X = √(C/1uF) above 1uF, or otherwise X = 1.0
Cable Compensation	<(± 1% of error)

Resistance Measurements (DUT Isolated)

Measurements are performed in the **HV** and **RETURN** terminals of the V10x.

For applied voltage, breakdown current and arc current accuracies see above.

In the chart below R is the reading in Ohms, C is the capacitive loading. Interpolate between voltages as needed, for accuracies at capacitances above 5uF consult Vitrek. Accuracies are shown as the percentage of the reading.

Test Voltage	C < 0.01uF	C = 0.01uF to 1uF	C = 1uF to 5uF
V101, V102 or V106			
50V	10K-30GΩ : ±0.8%±(R/1GΩ)%	10K-20GΩ : ±0.8%±(R/600MΩ)%	10K-10GΩ : ±0.8%±(R/400MΩ)%
100V	10K-60GΩ : ±0.7%±(R/2GΩ)%	10K-30GΩ : ±0.7%±(R/1GΩ)%	10K-20GΩ : ±0.7%±(R/600MΩ)%
250V	10K-150GΩ : ±0.6%±(R/5GΩ)%	10K-60GΩ : ±0.6%±(R/1.5GΩ)%	10K-30GΩ : ±0.6%±(R/1GΩ)%
500V	10K-300GΩ : ±0.6%±(R/10GΩ)%	10K-80GΩ : ±0.6%±(R/2.5GΩ)%	10K-40GΩ : ±0.6%±(R/1GΩ)%
1000V	20K-600GΩ : ±0.6%±(R/20GΩ)%	20K-100GΩ : ±0.6%±(R/3GΩ)%	20K-50GΩ : ±0.6%±(R/1.5GΩ)%
2500V	50K-1.5TΩ : ±0.6%±(R/50GΩ)%	50K-100GΩ : ±0.6%±(R/3GΩ)%	50K-50GΩ : ±0.6%±(R/1.5GΩ)%
5000V	100K-3TΩ : ±0.6%±(R/100GΩ)%	100K-100GΩ : ±0.6%±(R/3GΩ)%	100K-50GΩ : ±0.6%±(R/1.5GΩ)%
V103, V104 or V105			
50V	10K-30GΩ : ±0.8%±(R/1GΩ)%	10K-15GΩ : ±0.8%±(R/500MΩ)%	10K-10GΩ : ±0.8%±(R/300MΩ)%
100V	10K-60GΩ : ±0.7%±(R/2GΩ)%	10K-25GΩ : ±0.7%±(R/800MΩ)%	10K-15GΩ : ±0.7%±(R/500MΩ)%
250V	10K-150GΩ : ±0.6%±(R/5GΩ)%	10K-40GΩ : ±0.6%±(R/1.3GΩ)%	10K-25GΩ : ±0.6%±(R/750MΩ)%
500V	17K-300GΩ : ±0.6%±(R/10GΩ)%	17K-60GΩ : ±0.6%±(R/1.75GΩ)%	17K-30GΩ : ±0.6%±(R/900MΩ)%
1000V	34K-600GΩ : ±0.6%±(R/20GΩ)%	34K-75GΩ : ±0.6%±(R/2GΩ)%	34K-35GΩ : ±0.6%±(R/1GΩ)%
2500V	84K-1.5TΩ : ±0.6%±(R/50GΩ)%	84K-80GΩ : ±0.6%±(R/2.5GΩ)%	84K-40GΩ : ±0.6%±(R/1GΩ)%
5000V	167K-3TΩ : ±0.6%±(R/100GΩ)%	167K-90GΩ : ±0.6%±(R/2.5GΩ)%	167K-40GΩ : ±0.6%±(R/1GΩ)%
10000V	1.34M-6TΩ : ±0.6%±(R/200GΩ)%	1.34M-90GΩ : ±0.6%±(R/2.5GΩ)%	1.34M-40GΩ : ±0.6%±(R/1GΩ)%
V107			
100V	10K-60GΩ : ±1.2%±(R/2GΩ)%	10K-20GΩ : ±1.2%±(R/500MΩ)%	10K-10GΩ : ±1.2%±(R/300MΩ)%
250V	25K-150GΩ : ±1.1%±(R/5GΩ)%	25K-30GΩ : ±1.1%±(R/1GΩ)%	25K-15GΩ : ±1.1%±(R/500MΩ)%
500V	50K-300GΩ : ±1.1%±(R/10GΩ)%	50K-40GΩ : ±1.1%±(R/1.3GΩ)%	50K-20GΩ : ±1.1%±(R/650MΩ)%
1000V	100K-600GΩ : ±1.1%±(R/20GΩ)%	100K-50GΩ : ±1.1%±(R/1.5GΩ)%	100K-25GΩ : ±1.1%±(R/700MΩ)%
2500V	250K-1.5TΩ : ±1.1%±(R/50GΩ)%	250K-60GΩ : ±1.1%±(R/1.75GΩ)%	250K-25GΩ : ±1.1%±(R/800MΩ)%
5000V	500K-3TΩ : ±1.1%±(R/100GΩ)%	500K-60GΩ : ±1.1%±(R/1.8GΩ)%	500K-25GΩ : ±1.1%±(R/800MΩ)%
10000V	1M-6TΩ : ±1.1%±(R/200GΩ)%	1M-60GΩ : ±1.1%±(R/1.8GΩ)%	1M-25GΩ : ±1.1%±(R/800MΩ)%
15000V	3M-10TΩ : ±1.6%±(R/300GΩ)%	3M-60GΩ : ±1.6%±(R/1.8GΩ)%	3M-25GΩ : ±1.6%±(R/800MΩ)%

Current Measurements (DUT Grounded)

Measurements are performed in the HV terminal of the V10x.

Breakdown Current	1uA to 50mApk (DC-50kHz bandwidth) <(± 1% ± 1uA) accuracy <30usec detection time

	<3msec response time (typically <500usec)
Leakage Current	0.00uA to 50mA 7.25msec measurement period (100ms for dwell time >2 sec) <(± 1% ± 50nA ± (10nA per KV)) accuracy Capacitive Loading Effects : Add X * (± 0.2nA ± (2.5nA per KV)) X = (C/0.01uF) below 0.01uF, or X = √(C/1uF) above 1uF, or otherwise X = 1.0
Cable Compensation	<(± 1% of error)

Resistance Measurements (DUT Grounded)

Measurements are performed between the **HV** terminal of the V10x and ground.

For applied voltage, breakdown current and arc current accuracies see above.

In the chart below R is the reading in Ohms, C is the capacitive loading. Interpolate between voltages as needed, for accuracies at capacitances above 5uF consult Vitrek.

Test Voltage	C < 0.01uF	C = 0.01uF to 1uF	C = 1uF to 5uF
50V	10K-300MΩ : ±1.5%±(R/10MΩ)%	10K-300MΩ : ±1.5%±(R/10MΩ)%	10K-300MΩ : ±1.5%±(R/10MΩ)%
100V	10K-600MΩ : ±1.4%±(R/20MΩ)%	10K-600MΩ : ±1.4%±(R/19MΩ)%	10K-600MΩ : ±1.4%±(R/18MΩ)%
250V	10K-1.5GΩ : ±1.3%±(R/45MΩ)%	10K-1.5GΩ : ±1.3%±(R/45MΩ)%	10K-1.4GΩ : ±1.3%±(R/40MΩ)%
500V	10K-3GΩ : ±1.3%±(R/90MΩ)%	10K-2.75GΩ : ±1.3%±(R/80MΩ)%	10K-2.6GΩ : ±0.6%±(R/80MΩ)%
1000V	20K-5GΩ : ±1.3%±(R/160MΩ)%	20K-5GΩ : ±1.3%±(R/150MΩ)%	20K-4.5GΩ : ±1.3%±(R/130MΩ)%
2500V	50K-11GΩ : ±1.3%±(R/300MΩ)%	50K-9GΩ : ±1.3%±(R/250MΩ)%	50K-8GΩ : ±1.3%±(R/240MΩ)%
4000V	80K-14.5GΩ : ±1.3%±(R/400MΩ)%	80K-12GΩ : ±1.3%±(R/350MΩ)%	80K-9.5GΩ : ±1.3%±(R/280MΩ)%

Test Timing

Ramp	0.01 to 9999 seconds 50kV/sec max slew rate <(± 1% ± 0.1sec) accuracy with typical loads 0.5sec minimum for V107 only
Dwell	0.02s to 999 days or user terminated <(± 0.05% ± 20ms) accuracy (add 100ms for dwell time >2 sec)
Delay	0 to 3600 seconds <(± 0.05% ± 20ms) accuracy

Discharge

Fixed Discharge	Always selected V101,V102,V106 : Nominal loading 7MΩ V103-V105 : Nominal loading 13MΩ V107 : Nominal loading 17MΩ
Controlled Discharge	Auto-selected resistance values in real-time during discharge Selection Criteria : <400W power, <400J energy, <7500V, current <CNFG-TEST-MAX DISCHARGE setting V101,V102,V106 : Nominal loading 9.5KΩ or 40KΩ V103-V104 and V107 : Nominal loading 9.5KΩ or 40KΩ or 240KΩ V105 : Nominal loading 15KΩ or 40KΩ or 240KΩ
Minimum Discharge Time	<(20ms + 10ms per kV) (below 7500V)

1.6.5 Pulsed Voltage Withstand Testing (Pulse) Specifications

Test Voltage and Loading Capability

Test Voltage	V101-V104 (standard build): 50V to 8000V V101-V104 (opt. AC2): 20V to 2750V
Output Impedance	V101-V104 (standard build): 12Kohm + 0.5H nominal output impedance V101-V104 (opt. AC2): 1.4Kohm + 0.2H nominal output impedance
Max Load Current	Limited by the lesser of - a. the test voltage and output impedance b. 145mA (288mA for Opt. AC-2).

Measured Test Voltage Accuracy

Test Voltage Accuracy	<(± 0.5% ± 5V ± (0.2V per mA load))

Load Current Measurements

Measurements are performed in the **RETURN** terminal of the V10x.

Breakdown Current	1uA to 280mApk (DC-50kHz bandwidth) <(± 1% ± 1uA) accuracy <30usec detection time <3msec response time (typically <500usec)

Test Timing

The ramp and dwell times are those specified ± 100us

1.6.6 DC Breakdown Voltage Device Testing (BRKDN) Specifications

Specifications are as for the DC Voltage Withstand Test types except as shown below.

The BRKDN type must not be used with loads having >0.05uF capacitance.

Voltage and Current Accuracy

Breakdown Voltage Accuracy	<(± 0.5% ± 1.5V) (add an additional ±5V if option HSS-2 installed) <30usec detection time <10msec response time
Breakdown Current Accuracy	<(± 1.5% ± 3uA) <30usec detection time <10msec response time

Test Timing

Ramp and Search	<50kV/sec , ± 15% ± 10ms accuracy

1.6.7 DC Low Resistance Testing (LowΩ) Specifications

Test Current Source

Test Current	55mAdc max Opt. LRE-10 : 10mAdc max
Open Circuit Voltage	5V (nominal)
Source Resistance	130Ω (nominal) Opt. LRE-10 : 530 Ω (nominal)

Measurement Accuracy (2-WIRE)

Measurement Period	7.25msec measurement period (100ms for test time >2 sec)
Accuracy	<30KΩ : 0.8% + 0.02Ω 30-100KΩ : 1.5% 100-150KΩ : 5% Opt. LRE-10 : add 0.001Ω Using rear terminals (option RPO only) : add 0.3Ω
Lead Compensation	<(±1% of error ± 0.005Ω)

Measurement Accuracy (4-WIRE)

Measurement Period	7.25msec measurement period (100ms for test time >2 sec)
Accuracy	<30KΩ : 0.8% + 0.002Ω 30-100KΩ : 1.5%

	100-150KΩ : 5% Opt. LRE-10 : add 0.001Ω
Lead Compensation	<(±1% of error ± 0.001Ω)
4-wire Compensation	SOURCE <(±1% total lead impedance, 100Ω max) SENSE <(±0.1% total lead impedance, 100Ω max)

<u>Test Timing</u>

Test Time	0.02s to 999 days or user terminated <(0.1% + 20ms) accuracy (add 100ms for test time >2 sec)
Delay	0.00s to 999 days <(0.1% + 20ms) accuracy (add 100ms for test time >2 sec)

1.6.8 AC Ground Bond Testing (GB) Specifications

Test Current Source

The following apply at the **SOURCE** terminals.

Test Current Range	0.100 to 40.000Arms
Test Current Accuracy	<(±0.5% ± 0.005A ± 0.005% per Hz above 100Hz) accuracy
Test Current Overshoot	<10% (<0.2s ramp time) <5% (<0.5s ramp time) <2% (>0.5s ramp time) Settling to <±0.5% of final value in <0.1sec + 2 cycles
Test Frequency	40Hz to 500Hz <0.1% accuracy
Test Waveform	Sinewave, 1.3 – 1.5 Crest Factor
Compliance	(8Vrms – 0.015V/A) max compliance at test frequencies <75Hz. For line voltages below 115V linearly reduce the maximum compliance by 1%/V unless Opt. LOLINE is fitted (there is no reduction for Opt. LOLINE).
Loading	10ohm max impedance (any phase, within compliance limits) 250W maximum load power

Voltage Measurements

The following apply at the **SENSE** terminals.

Range	0uV to 8.0000Vrms (RMS, In-phase, and quadrature)
Accuracy	<(±0.5% ± 30uV ± 0.5uV*A) accuracy (add 0.005% + 0.05uV*A per Hz above 100Hz) <±0.005° per Hz phase relative to test current
Cable Compensation	<(1% of error)

Impedance Measurements

Accuracy	Add Test Current and Voltage Accuracies as percentages Examples at 50 or 60Hz - 0.1ohm at 1A : 1% + 0.53% = 1.53% 0.1ohm at 10A : 0.55% + 0.5% = 1.05% 0.1ohm at 40A : 0.51% + 0.5% = 1.01% 0.01ohm at 1A : 1% + 0.8% = 1.8% 0.01ohm at 10A : 0.55% + 0.53% = 1.08% 0.01ohm at 40A : 0.51% + 0.51% = 1.02%

	0ohm at 1A : 30.5uohm 0ohm at 10A : 3.5uohm 0ohm at 40A : 1.25uohm

Test Timing

Ramp	0 to 9999 seconds <(± 1% ± 0.1sec ± 1 cycle) accuracy
Dwell	0.02s to 999 days or user terminated <(± 0.05% ± 20ms ± 1 cycle) accuracy
Fast Discharge	<(20ms + 1 cycle)

1.6.9 Ground Leakage Testing (DCI and ACI) Specifications

Voltage Measurements

DC Voltage Range	V101,V102,V106 : 0.0 to +/-8000V V103,V104,V105 : 0.0 to +/-11000V Option HSS or HSS-2 : 0.0 to +/-5000V
AC Voltage Range	V101-V104,V106 : 0.0 to 6000Vrms V105 : 0.0 to 10000Vrms Option HSS or HSS-2 : 0.0 to 4000Vrms
DC Accuracy	<(± 0.25% ± 0.5V)
AC Accuracy	<(± 0.5% ± 0.5V ± 0.01% per Hz above 100Hz)
Input Impedance	Nominally 100MΩ

Return Current Measurements

Current Range	0.0nA to 200mA (DC or ACrms)
DC Current Accuracy	<(± 0.25% ± 0.5nA)
AC Current Accuracy	<(± 0.5% ± 20nA ± 0.005% per Hz above 100Hz)
Input Impedance	<150uA : Nominally 5KΩ >150uA : Nominally 37Ω
Cable Compensation	<(± 1% of error)

Test Timing

Test	0.02s to 999 days or user terminated <(± 0.05% ± 100ms) accuracy
Delay	0 to 3600 seconds <(± 0.05% ± 100ms) accuracy

1.6.10 Switch Unit Integration

<u>Integration</u>

<table>
<tr><th>Model</th><th>Maximum Units</th></tr>
<tr><td>964i</td><td><table><tr><td>Interface</td><td>Limit</td></tr><tr><td>RS232</td><td>1</td></tr><tr><td>VICL</td><td>9</td></tr><tr><td>LAN</td><td></td></tr></table></td></tr>
<tr><td></td><td></td></tr>
<tr><td>M10x</td><td><table><tr><td>Interface</td><td>Limit</td></tr><tr><td>RS232</td><td>1</td></tr><tr><td>VICL</td><td>200</td></tr><tr><td>LAN</td><td>None</td></tr></table></td></tr>
</table>

<u>Timing</u>

Pre-Switch Delay	0 to 3600 seconds (± 20ms)
Post-Switch Delay	0 to 3600 seconds (± 20ms)

2 Getting Started

2.1 Unpacking and Inspection

After the V10x has been shipped or otherwise handled in an unknown manner, the user should visually inspect the V10x for damage before attempting to operate it. Particular attention should be taken to ensure that there are no significant dents or cracks in any outer surfaces and that all terminals are securely mounted to the unit. If any significant dents or cracks, or any loosely mounted terminals, are noted then it is recommended that the V10x be serviced prior to being placed into use, as safety may have been compromised.

2.2 Cooling

The V10x is cooled by means of a rear panel mounted fan and cooling vents in the top cover. Sufficient free air must be allowed behind the rear panel and above the top cover to allow sufficient airflow for cooling purposes. At least 2” of well-ventilated unrestricted space is recommended around the fan intake and above the vents.

The cooling fan has variable speed to save energy while the V10x is not in use or is not heavily loaded. The user may notice that the fan activates shortly after initial application of line power. This is normal; the fan should stop or slow to low speed within 1 minute of application of power. If the fan maintains high speed operation for a long time, then the airflow may be overly restricted, or the fan filter may be blocked, the user should take corrective action.

The cooling fan has a removable filter. This is easily removed for cleaning or replacement without disassembling the V10x, see section 13 - Periodic Maintenance.

The V10x is fully specified for operation in ambient temperatures between 0 and 50C, however best accuracy and full loading capability is obtained if the ambient temperature is maintained below 30C. For best results, the user may wish to operate the V10xx in a conditioned environment.

2.3 Mounting Position and Orientation

The V10x may be installed as either a bench top instrument or installed into a standard 19” rack.

The V10x is primarily intended to be used in a horizontal, or close to horizontal position, oriented with the top cover (with the vent holes) uppermost. There are no known issues with mounting the V10x at any angle or orientation, as long as it is mounted in a secure and stable fashion taking into consideration its weight and weight distribution.

2.4 Installing in a 19” Rack Enclosure

Often when installing the V10x into a rack enclosure it is required to remove the feet from the bottom of the unit. This is easily achieved by simply removing the screws mounting the feet to the bottom of the unit. The user should place the removed feet and mounting hardware into a bag for safe keeping should they be needed at a later date for bench top usage. DO NOT INSERT THE MOUNTING HARDWARE BACK INTO THE BOTTOM OF THE V10x WITHOUT THE FEET INSTALLED, THIS MAY DAMAGE THE UNIT.

Option RM-1 provides the rack mount ears required for mounting in a standard 19” rack enclosure.

When installing the V10x into a rack enclosure it is recommended that the unit be supported through its depth. The use of a tray or angle brackets supporting the bottom edges of the unit is recommended.

2.5 Line Power

WARNING THE V10X IS INTENDED TO BE POWERED FROM A POWER CORD HAVING A PROTECTIVE GROUND WIRE WHICH MUST BE INSERTED INTO A POWER OUTLET HAVING A PROTECTIVE GROUND TERMINAL. IF THE V10X IS NOT POWERED FROM A SUITABLE POWER SOURCE THEN THE CHASSIS GROUND TERMINAL LOCATED NEAR THE POWER ENTRY CONNECTOR ON THE REAR PANEL MUST BE PROTECTIVE GROUNDED.

The user may connect the V10x to any source of line power within the allowable range of voltages and frequencies (see above) without requiring any adjustment to the instrument.

The V10x line power input is fused with a 5mm x 20mm TT3.15A fuse mounted in the rear panel next to the line power entry. If the user needs to replace this fuse it must be replaced with an exact equivalent fuse, noting the time and current ratings. Although the V10x is fused at 3.15Arms, the unit can draw surges of up to 10Apk during normal operation and up to 100Apk during initial application of power. The user should ensure that the power cord is rated for at least 5Arms continuous operation.

2.6 Connecting the AC-30 Option to the V10x

If the V10x has option AC-30 installed, the user must connect the external transformer unit to the V10x in order to be able to use it.

The user may use the V10x without the external transformer unit if the capabilities of option AC-30 are neither programmed nor required.

CAUTION ENSUE THAT ALL CONNECTIONS ARE PROPERLY MADE BETWEEN THE OPTION AC-30 EXTERNAL TRANSFORMER UNIT AND THE V10x **BEFORE** ATTEMPTING TO PERFORM ANY TEST USING OPTION AC-30. EXTREMELY HIGH VOLTAGES CAN BE PRESENT WITHOUT WARNING IF MIS-WIRED.

There are two cables from the option AC-30 external transformer unit which must be correctly connected to the V10x before attempting to perform any test using option AC-30.

- A shielded coaxial cable terminated in a BNC connector. This must be connected to the BNC connector marked **EXT FB** on the front or rear panel of the V10x. Ensure this connector is securely fastened to the selected connector, if this should become disconnected while performing a test, extremely high voltages can exist on the output of the external transformer unit.
- A power line cord type cable terminated in three separate connections –
    - A spade lug. This must be securely connected to the Ground terminal located above the power connector on the rear panel of the V10x.
    - A pair of shrouded banana plugs. These must be connected to the safety banana sockets marked **EXT DRIVE** on the rear panel of the V10x. There is no polarity requirement regarding these connections.

2.7 Instrument Series Front and Rear Panel Overview

This section provides a brief discussion of the front panel, detailed instructions are in the following sections.

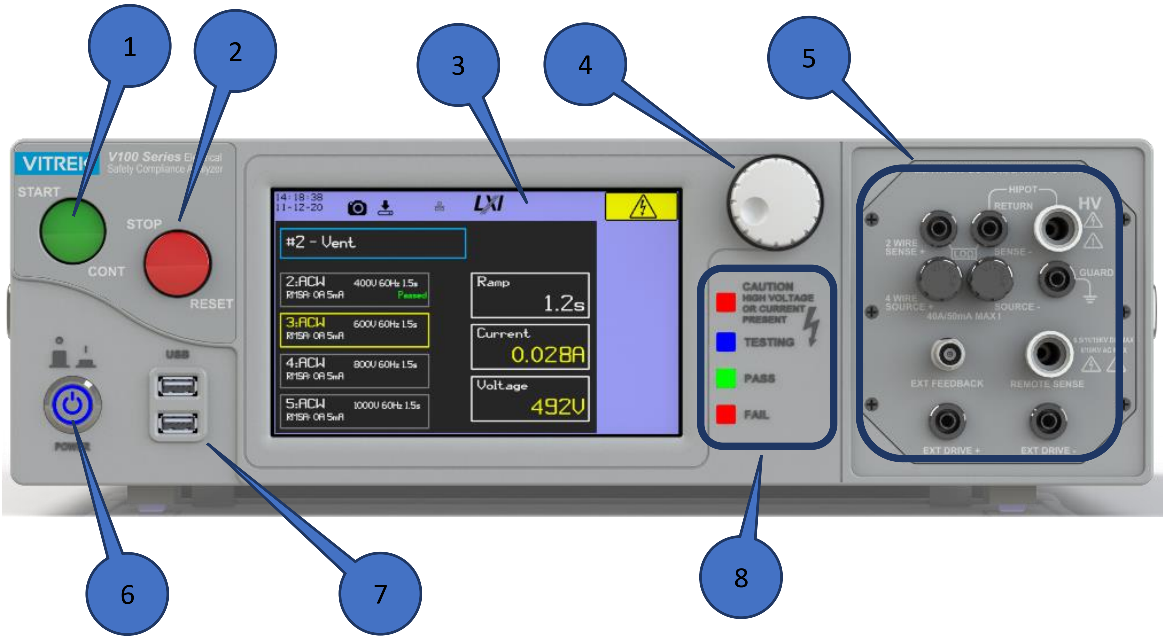


Figure 2-1 Front Panel Overview

1. The Start button allows the user to start performing a previously selected test sequence, or (while running a test sequence) select to continue a test step when it is waiting for the user to do so.
2. The Stop button aborts any test sequence in progress (while running a test sequence).
3. LCD screen and touch panel.
4. Adjustment and navigation dial.
    a. Rotation clockwise corresponds to a rightward shift in a list or the increment of a setting; counter-clockwise corresponds to a leftward shift in a list or the decrement of a setting.
    b. Press the dial to confirm a selection or setting.
5. Front connection terminals.
6. The **Power** switch. This turns on/off the power to the V10x.
7. USB host ports supporting:
    a. Flash drives allowing software update, configuration export/import, and data export.
    b. A barcode scanner.
8. The indicators.
    a. **HIGH VOLTAGE OR HIGH CURRENT PRESENT**. This is illuminated whenever the V10x has a high voltage (>30V) or a high current (>5A) present on its' terminals during a test. Note that user equipment may be sourcing dangerous levels on leads connected to the V10x that won't be detected until a test commences.
    b. **TESTING**. This is illuminated when the V10x is running a test sequence.

c. **PASS**. This is illuminated whenever a test sequence is passing (while running a test sequence) or it has passed all test steps (following completion of the test sequence). It will not light up until at least one step has been completed.

d. **FAIL**. This is illuminated whenever a test sequence is failing (while running a test sequence) or the previously run test sequence has failed any test steps (following completion of the test sequence).

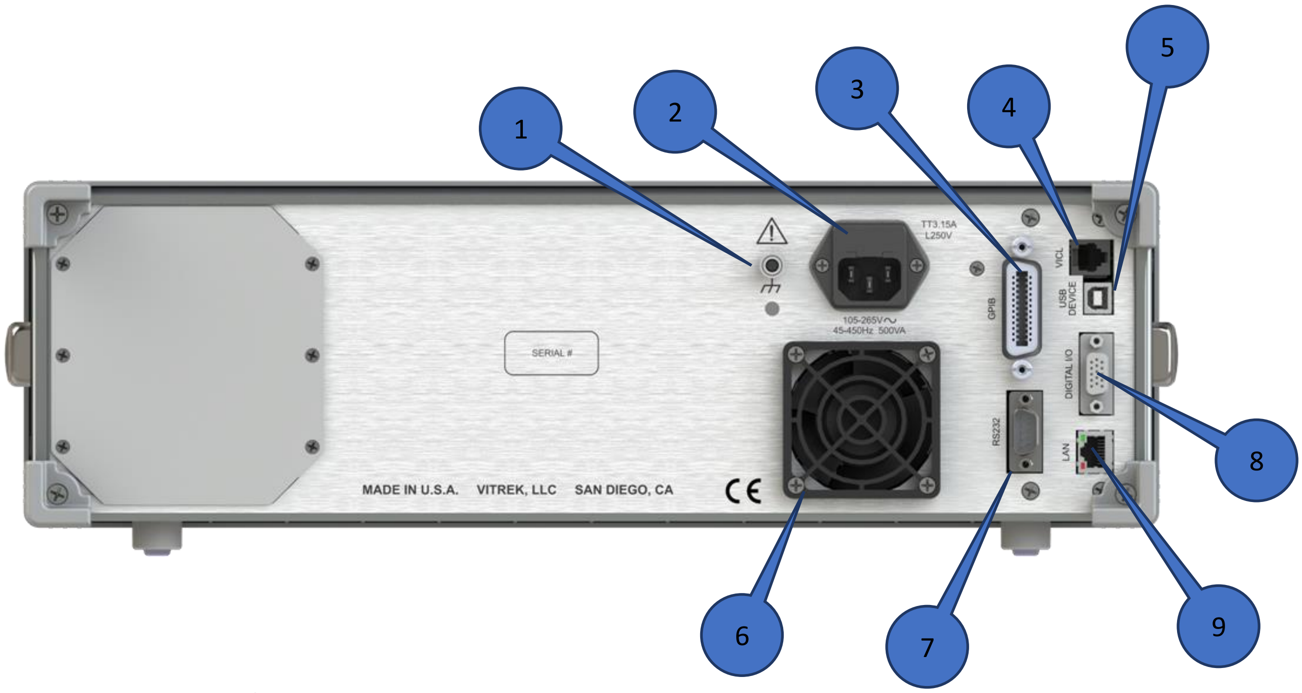


Figure 2-2 Rear Panel Overview

1. Chassis ground.
2. Line power.
3. GPIB interface connector (optional).
4. VICL connector.
5. USB Device connector.
6. Fan.
7. RS232 interface connector (optional).
8. DIO connector (Digital Input/Output).
9. Ethernet LAN connector.

2.8 Powering on

Attach a power cord and push the power button. The display shows color bars the test status indicators will cycle while the system software is loading. When the main software starts the screen will activate showing the welcome screen:

Figure 2-3 Welcome Screen

The upper left area will show Initializing and progressively announce the name of each subsystem as it is initialized:

- Devices...
- Event log...
- History store...
- Results store...
- HIPOT Device...
- Settings DB...
- HTTP server...
- T&M Servers...
- DIO...
- HIPOT Ready...

For the last subsystem there will be a suffix labeling the device being prepared. If a device fails its name will be shown in Red.

2.9 Power Off

WARNING Turning off or otherwise removing power to the V10x while it is generating high voltages will not enable the instrument to discharge the DUT and may damage the tester. The dut may have dangerous voltages present for long periods of time after this occurs.

WARNING Do not remove the power cord from the V10x or from the source of power while it is operating at high voltages. This will remove the protective ground from the chassis of the instrument and the DUT which may result in hazardous voltages being accessible to the user.

2.10 Glossary

AC	The flow of electric current which reaches a maximum in one direction, decreases to zero, then reverses itself and reaches a maximum in the opposite direction. The cycle is repeated continuously, changing polarity and magnitude with time.
ACCAP	AC voltage withstand for breakdown and capacitance testing.
ACI	AC ground leakage test.
ACW	AC voltage withstand for breakdown, arcing, and leakage testing.
Arc	A momentary partial discharge due to the intense concentration of an electric field (high voltage) across a dielectric.
Breakdown	A sudden and uncontrolled flow of current.
BRKDN	DC voltage breakdown test.
DC	The flow of continuous electric current in one direction that can change in magnitude but not polarity.
DCI	DC ground leakage test.
DCIR	DC voltage withstand and leakage test with current or impedance checking.
DCW	DC voltage withstand and leakage test.
Dielectric	An insulator sandwiched between two conductors. In the case of a Hipot test, the DUT's insulation is considered to be a dielectric.
Discharge	The time period after a test step or sequence (depending on user settings) where the unsafe voltage and/or current levels are removed.
Dwell	The time period over which leakage limits are verified.
DUT	**D**evice **U**nder **T**est.
GB	AC ground bond test, a high current test that checks the integrity of a Class I product's safety ground connection.
High-Side Sense	Aka HSS. A V10x feature where instead of measuring current on the return line leakage is measured on the voltage source wire.
HIPOT (strict)	An abbreviation for high potential.
HIPOT (colloquial)	A term given to a class of electrical safety testing instruments used to verify electrical insulation in finished appliances, cables, or other wired assemblies, printed circuit boards, electric motors, and transformers.
Hipot Test	A high voltage test used to stress the insulation of a product and measure the resulting leakage current.
Insulation	A material that is a poor conductor of electricity. Used to isolate electrical circuits from ground and each other.
IR Test	A high voltage test used to record the resistance of a product's insulation.
Leakage Current	Current that leaks through a product's insulation to ground.
LowOHM **LowΩ**	DC low resistance test.
Pulse	Pulsed voltage withstand test.
Ramp	The time period used to increase the test level from zero to the specified setting.
Sequence	An ordered list of test steps. The data is static over time and is configured by the user.
Switch	An external instrument capable of switching the test voltage through a multiplexor, for example a Vitrek 964i or M10x.
Test	The execution of one or all steps in a sequence. The results are dynamic and there are runtime specific configuration items such as a reference label.

3 Theory of Operation

Electrical safety testers — often referred to as hipot testers — are an integral part of electrical and electronic equipment manufacturing. Hipot testers get their name from the high-potential (high voltage) they produce to perform dielectric withstand and insulation resistance tests. In addition to these tests, many hipot testers provide accurate low-resistance measurements and low-resistance/high current outputs to test ground resistance and ground bond integrity.

Electrical safety testing and certification is a requirement for virtually every electronic device and electrical apparatus. The details of what defines a certified product depend upon a daunting number (hundreds) of safety standards and in what region of the world the device will be sold and used. (Safety standards-setting organizations include: EN/IEC (European), UL (US), CSA (Canada), CCC (China) and JEIDA/MITI (Japan).

Manufacturers must submit samples of their products to recognized certification agencies. Nationally Recognized Certification Laboratories (NRTLs) include UL, VDE, FM, ETL and others. The agency certification process confirms compliance with the relevant standard(s). This compliance evaluation investigates two key areas: Construction — mechanical construction, spacing, clearances, etc.; and safety — to assure safe operation (even under high stress conditions.)

The V10x performs a test by running a sequence of 1 or more steps. The use of multiple steps typically involves one of the following cases:

1) Application of a series of test levels on a single DUT
2) In combination with a switch matrix a multiple conductor cable can be tested and verified

The following figure illustrates a basic circuit used for a hipot test.

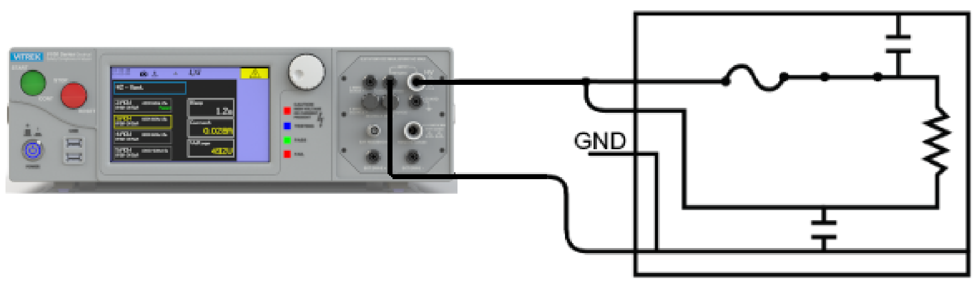


Figure 3-1 Leakage Test Circuit Example

3.1 Choose Wisely

This section describes how to choose and configure the steps within a test sequence.

The table below gives an overall summary of the various types of activities available for each step. After the table are individual sections giving full details for each of these activities. The user only need be conversant with the section for each specific activity which the user intends to perform. The levels shown for each model is those for the standard build, option content may change the available levels and/or frequencies.

Table 3-1 Step Type Activities

Activity Required	Test Step Types	V101	V102	V103	V104	V105	V106	V107	V109
AC Voltage Withstand and Leakage Testing	**ACW** and **ACCAP**	20V-6kV, 20-500Hz	20V-6kV, 20-500Hz	20V-6kV, 20-500Hz	20V-6kV, 20-500Hz	50V-10kV, 40-500Hz	No	20V-6kV, 20-500Hz	No
DC Voltage Withstand and Leakage Testing	**DCW** and **DCIR**	20V-6.5kV	20V-6.5kV	40V-11kV	40V-11kV	40V-11kV	20V-6.5kV	75V-15kV	No
Pulsed Voltage Withstand Testing	**PULSE**	50V-8kV	50V-8kV	50V-8kV	50V-8kV	100V-10kV	No	50V-8kV	No
DC Voltage Breakdown Device Testing	**BRKDN**	20V-6.5kV	20V-6.5kV	40V-11kV	40V-11kV	40V-11kV	20V-6.5kV	75V-15kV	No
DC Low Resistance Testing	**LowΩ**	1mΩ to 150KΩ	1mΩ to 150KΩ	1mΩ to 150KΩ	1mΩ to 150KΩ	1mΩ to 150KΩ	1mΩ to 150KΩ	1mΩ to 150KΩ	1mΩ to 150KΩ
AC Ground Bond Testing	**GB**	No	1uΩ-10Ω @ 0.1-40A	No	1uΩ-10Ω @ 0.1-40A	No	No	Opt. GB40 only	1uΩ-10Ω @ 0.1-40A
Ground Leakage Testing	**ACI** and **DCI**	0.1nA-200mA	0.1nA-200mA	0.1nA-200mA	0.1nA-200mA	0.1nA-200mA	0.1nA-200mA	0.1nA-200mA	0.1nA-200mA
Switch Unit Control	**SWITCH**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Test Sequence Timing Control	**PAUSE** and **HOLD**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

When the user is selecting testing against the requirements of a safety standard, the information given in this section should only be used as a guideline; the user should consult a safety testing professional for information regarding the specific standard and application. The voltage ranges shown above assume the most common option content for each model; see the specifications for each type of test step for the actual ranges.

3.2 Choosing Within the Voltage Withstand and Leakage Testing Group

When Voltage Withstand and Leakage Testing is required, the user must first decide whether to perform this using an AC, DC or pulsed voltage, the frequency to use, the limits to use, and the actual test type(s) to perform.

The V10xx makes no distinction between a DC insulation resistance test and any other type of withstand and leakage test; the user has the choice of performing a DC insulation resistance test at any test voltage within the capability of the instrument.

Many standards require the user to remove any over-voltage suppression devices which would affect voltage withstand testing. To check that such device(s) have been correctly re-installed after this test and to test that they are functioning correctly, see section 3.7.

3.3 Choosing Within the Resistance Testing Group

The user may choose for the V10x to test the resistance of a DUT using one of three activities -

- If the resistance to be tested is more than 100KΩ - use the DC Voltage Withstand capability of the V10x to measure the resistance of the DUT. This can accommodate resistances of below 10KΩ to over 1TΩ using a fixed DC Voltage across the DUT. Typical applications for this include insulation resistance and higher value resistor component testing. See DC Voltage Withstand and Leakage Testing (DCW and DCIR).
- If the resistance is between 1mΩ and 100KΩ and it is allowable to measure using DC at a current of up to 50mA and voltages up to 5V - use the DC Low Resistance capability of the V10x. Typical applications for this include component testing, cable resistance testing, and (if allowed by the safety standard) chassis ground bond testing. See DC Low Resistance Testing (LowΩ).
- If the resistance is between 1uΩ and 10Ω and it is allowable (or required) to measure using AC at a user defined current between 0.1A and 40Arms and a voltage up to 8Vrms (11.5Vpk) - use the AC Ground Bond capability of the V10x (not all models have this capability). Typical applications for this include chassis ground bond testing and cable resistance testing at high currents. The V10x also offers the ability to independently measure the in-phase (resistance) and quadrature (reactance) components of the DUT while maintaining stability with inductive loads for component testing applications. See AC Ground Bond Testing (GB).

3.3.1 Choosing AC, DC, or PULSE Testing

When it is required to test a highly capacitive DUT (typically >0.1uF) the user must use DC testing, as the current flow would be too high if AC or pulse testing were attempted (see the applicable Specifications section for details).

Some standards require that testing be performed using an AC voltage waveform, others require a DC voltage, but others allow either to be used. Also, some DUTs may need to be tested using a DC voltage for other reasons (such as non-linearity). Generally, leakage testing is performed using a DC voltage; however, the V10x is also capable of accurately measuring resistive leakage using an AC voltage.

In some applications the DUT will not withstand the test voltage for an appreciable period of time because of the power dissipation caused by its leakage. In these applications the user should choose to perform pulse testing which can be performed in as little as a few milliseconds with the V10x.

NOTE This is different to 'static discharge' pulse testing.

If AC testing is to be performed it is recommended that the frequency should be the expected line power frequency of the DUT (i.e., 50, 60 or 400Hz) unless this frequency cannot be used because of loading considerations. The frequency is generally not specified by standards.

To summarize, selecting the type of testing is dependent on the requirement; the following guidelines should be used in the order shown -

- If there is a specific requirement for the type of testing – follow the requirement.
- If the load is capacitive >0.1uF – use DC Voltage Withstand Testing.
- If the load has power dissipation requirements which preclude DC or AC testing – use Pulse Voltage Withstand Testing.

- If the load is highly non-linear so cannot withstand AC voltages - use DC Voltage Withstand Testing.
- Otherwise – choose either AC or DC Voltage Withstand Testing.

3.3.2 Choosing the Limits

The V10x monitors three distinct types of DUT current - breakdown, leakage, and arc current. Detailed descriptions of these currents are given later in this section. Because the V10x monitors these currents in separate ways and can enforce different limits on each in the same test, it can be set to differentiate between a DUT which exhibits any of the following –

- Meets all requirements
- Has excessive leakage, but withstands the applied voltage without breaking down
- Breaks down when the voltage is applied
- Exhibits arcing with any of the above

See the detailed description below for setting or disabling arc limits which are optionally enforced throughout the step. If only arc detection is required, the user must still set a breakdown limit.

The breakdown limit is always enforced throughout the step. Leakage limits are only enforced during the dwell period of the step. When performing DC Voltage Withstand Testing this allows the user to set different limits during the ramp (i.e., charging) and dwell periods of the step by using the breakdown and maximum leakage limits respectively.

A minimum leakage limit can be disabled by setting it to zero (or an unlimited resistance).

A summary of the guidelines for setting breakdown and leakage limits is –

- If Pulse Voltage Withstand Testing – set a breakdown limit (no leakage limits are available).
- If the user has both breakdown and maximum leakage limit requirements – set them both according to the requirements.
- If the user has no breakdown limit requirement, only a leakage limit – set the maximum leakage limit according to the requirement and set the breakdown limit significantly higher than this (but low enough to protect the DUT should it breakdown).
- If the user wishes to detect breakdown by using the averaged leakage measurement – set the maximum leakage limit according to the requirement (use the RMS equivalent for the AC types) and set the breakdown limit significantly higher than this (but low enough to protect the DUT should it breakdown).
- Otherwise –
  - For the ACW or DCW types using the Easy option – set the maximum leakage current limit according to the breakdown limit requirement (use the RMS equivalent for the ACW type).
  - For all other types - set the breakdown limit according to the requirement and either disable the leakage limits entirely (only for the ACW type) or set the maximum leakage limit equal to or higher than the breakdown limit.

3.3.2.1 Breakdown Current

A breakdown of a DUT is a sudden, generally heavy, flow of current which does not cease without a reduction in the applied voltage. Many standards bodies (including UL) define breakdown as the sudden uncontrolled flow of current, this is effectively the same definition but is more ambiguous.

Often the user is testing products for compliance with safety standards which specify that the DUT "shall not breakdown" but do not specify a particular current level at which to detect breakdown. It is the industry norm to set a limit at some level above the normal leakage current level drawn by the DUT. Typically, this is a limit of 10mApk (or 7mArms), but this may need to be increased if the DUT has significant leakage or reduced if the DUT has little leakage.

There are four breakdown detectors in the V10x which are active throughout all types of Voltage Withstand tests; these are listed below in order of decreasing speed (the 3rd listed is set by the user breakdown limit, the others are fixed) -

- The V10x AC and DC voltage supplies have a protective trip mechanism which shuts down the voltage if a large peak current flows beyond its capability to supply surge current (for this limit see Surge Current Limiting and Shutdown in the relevant Specifications section for the test type being run). Typically this detected and shuts down the test within 30usec (this is indicated as BREAKDOWN).
- If a step is not set for DUT GROUNDED (option HSS only) and is set for a breakdown limit less than 7mApk, then the V10x continuously monitors the peak current in the **HV** terminal and shuts down the voltage if this exceeds nominally 7.5mApk. Typically, this is detected within 30usec and shuts down the test within 1msec (this is indicated as HV TRIP). This can be disabled in the CNFG-TEST menu.
- The V10x continuously monitors the instantaneous DUT current and shuts down the voltage if this exceeds the user set breakdown peak current limit for that step. Typically, this is detected within 30usec and shuts down the test within 3msec (this is indicated as BREAKDOWN).
- The V10x monitors the RMS current for each cycle (for AC type steps) and the DC current for periods of nominally 5msec (for DC type steps). If this is above the loading capability of the V10x voltage source (for this limit see Loading Capability in the relevant Specifications section for the test type being run) then this shuts down the voltage (this is indicated as OVERCURRENT).

3.3.2.2 Leakage Current

This is not applicable when pulse testing.

The leakage current of a DUT is a steady flow of current caused by leakage in the DUT, generally either intentionally by circuitry or unintentionally by inter-wiring leakage capacitance and resistances. Unlike breakdown current, leakage current is generally fairly linear vs. the applied voltage (i.e., doubling the voltage produces nominally twice the leakage current) but not necessarily so.

For DC there is only a single component of leakage current (the DC leakage current), whereas for AC there are two components –

- In-phase leakage is the component of the leakage current which is in phase with the applied voltage and is caused by the resistance of the DUT.
- Quadrature leakage is the component of the leakage current which is at 90° to the applied voltage and is caused by the reactance of the DUT (typically capacitance).

The total RMS AC current is the scalar formed by combining the in-phase and quadrature vector currents. In-phase and quadrature currents can be of either polarity, which is ignored when comparing against the user set limits.

The V10x measures the RMS AC current (in-phase, quadrature, and total RMS values) for every cycle of the applied voltage, or the mean DC current for every nominally 7.25ms (100ms for dwell times greater than 2 seconds). These values are compared against the user set maximum and minimum limits for leakage current. If enabled and the leakage current is outside the limits during the dwell period of the test, then the DUT is failed. The V10x also offers a special variation of AC Voltage Withstand testing for testing the capacitance (and optionally Dissipation Factor) of a DUT – this uses the in-phase and quadrature measurements to internally compute the more advanced capacitance and DF results required for certain testing applications.

For the ACW and DCW types using the Easy option the V10x uses the user set maximum leakage limit as the breakdown limit. For all other types, the V10x allows the user to independently set both breakdown and leakage limits. In all cases, setting a minimum leakage limit of zero disables the minimum leakage limit.

3.3.2.3 Arc Current and Time

Arcing is similar to breakdown but rapidly "self-extinguishes" without requiring a reduction in the applied voltage (but typically rapidly re-occurs repeatedly). There are many ways in which arcing can occur and a thorough description of arcing is beyond the scope of this document. Generally, arc currents are AC currents in the frequency range of 1 to 2MHz and are fairly high amplitude (often tens of milliamps or more) and have no relationship to either breakdown or leakage currents. Generally arcing can only occur at higher voltages (>300V) and only in a gas or (in rare circumstances) across a surface.

Arcing should not be confused with flashover (which is a breakdown), arcing can be very slight and is often not easily visible, corona is a form of arcing, but the arcs do not extend entirely across the air gap and so is also called partial discharge or partial breakdown.

Some safety standards do not require detection of arcing; however, users often decide to include arc detection because the presence of arcing is often an indication that although the DUT passes breakdown detection at this time it may fail in the future. The V10x allows the user to select either-

a) To not detect arc current.
b) If arc current is detected, the DUT does not fail; only the presence of arcing is reported.
c) If arc current is detected fail the DUT.

If enabled, the V10x continuously measures the AC (RMS) current with band-pass filtering of 50KHz to 5MHz over consecutive 4us periods and compares each measurement with the user set arc current limit. If the limit is exceeded for more than the user set number of consecutive 4us periods, arcing is detected.

If arc detection is required by the user, typically a limit setting of 10mA for 4us is used, a lower current limit increases the sensitivity, increasing the current and/or time decreases the sensitivity. Although a setting as low as 1mA may be made, this setting is particularly sensitive to pickup of RF interface (e.g., local radio stations) so is not recommended.

If arcing occurs and the DUT has significant capacitance, the DUT capacitance may provide most of the energy for the arcing and there may be little, if any, HF current flow from the DUT. In these cases, it may not be possible to detect arcing by current flow. This is generally not the case for DUT capacitances below a few nF, and generally is the case above a few 100nF, but this is very dependent on the DUT and wiring.

3.4 AC Voltage Withstand and Leakage Testing (ACW and ACCAP)

These are used to test that a DUT does not exhibit breakdown or (optionally) arcing in the presence of an applied AC voltage, and optionally to test that the DUT leakage current, impedance or capacitance is within user set limits.

Both are performed in the same manner; the difference between them is in the amount and form of configuration available. The ACW type is intended for comprehensive breakdown, arcing and leakage testing and provides for an easy configuration mode; the ACCAP type for breakdown and capacitance value testing.

3.4.1 Actions While Running

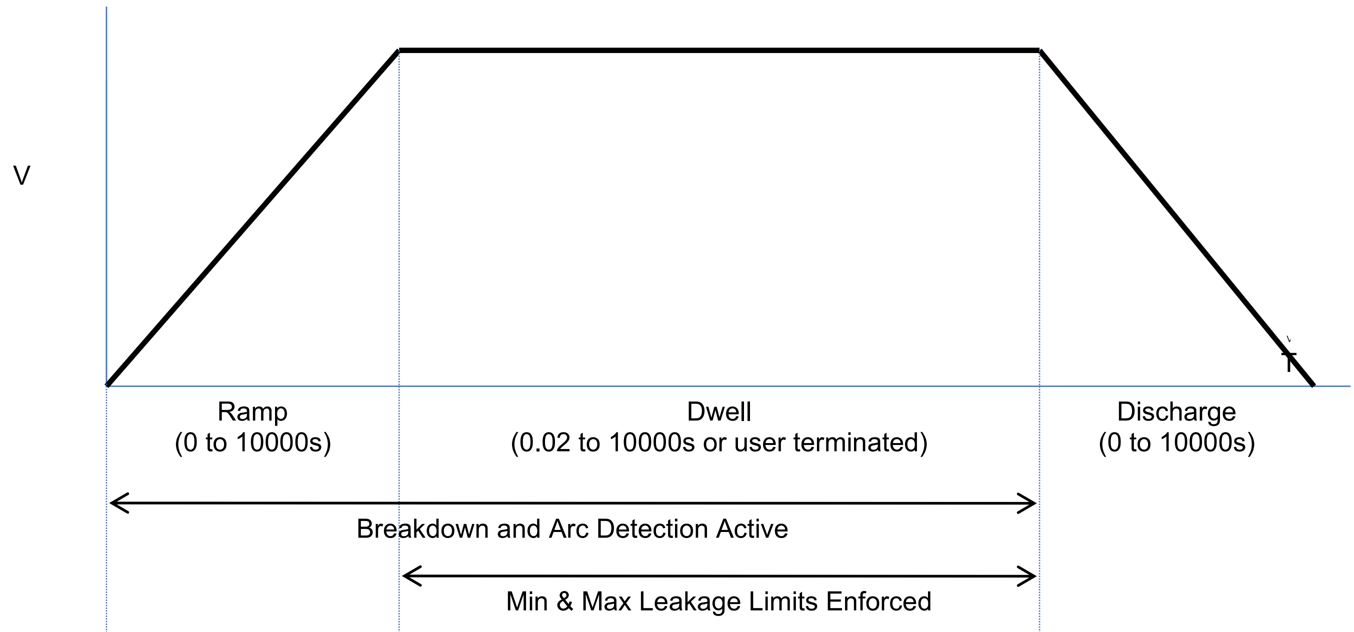


Figure 3-2 AC Voltage Wishstand Test Phases

- On any failure the step is immediately aborted, and optionally the entire test sequence may be aborted.
- For ACW in Easy mode, the discharge period is of zero length, arc detection is not enabled and only RMS leakage limits may be specified.
- If the step is the MANUAL sequence, then the user may manually change the voltage and/or frequency during the dwell period.

For the ACW or ACCAP types, the discharge period can be programmed to be skipped and the next step started at this steps' dwell voltage level if the next step is also ACW or ACCAP.

3.4.2 Connecting to the DUT for AC withstand

See the section 1.3.4 Terminals and Wiring for general wiring and safety recommendations.

The V10x requires that the DUT grounding state match the step configuration

3.4.2.1 Testing a DUT that is isolated

The DUT should be wired between the **HV** and **RETURN** terminals of the V10x; if Opt. AC-30 is being used (Drive setting is set to External) then the DUT should be wired between the output of the external AC-30 unit and the **RETURN** terminal of the V10x.

The V10x provides a safety ground for the DUT during the test via its **RETURN** terminal. The Continuity Sense feature may be used to ensure that the **RETURN** connection is correctly made by connecting the **SENSE+** terminal to a point on the DUT which is connected to the **RETURN** connection. When deciding which point on the DUT to connect to the **HV** terminal and which point to connect to the **RETURN** terminal, the user should consider that only the voltage on the **RETURN** terminal is safe at all times.

For best high impedance load performance there should be low capacitance and leakage between the wires and for low level current measurements there should be little interference pickup in the **RETURN** wire. In extreme circumstances the **RETURN** wire should be the inner wire of a coaxial cable, with the shield connected to the **GUARD** terminal of the V10x. This will significantly reduce the capacitance and leakage between the **HV** and **RETURN** wires. A cable such as RG174 is a suitable choice. If the *Continuity Sense* feature is being used, then the **SENSE+** connection should similarly be a coaxial cable.

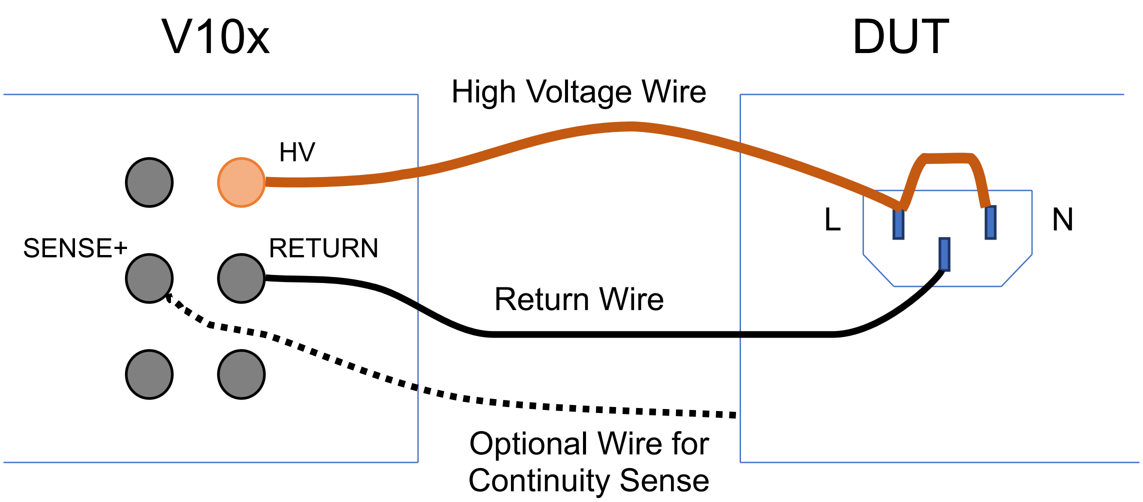


Figure 3-3 AC Withstand Isolated Connections

The example above shows the connections for performing AC voltage withstand testing of Line/Neutral connections to the chassis of a DUT. The optional wire from the DUT chassis to the **SENSE+** terminal of the V10x is used when the user wishes to use the Continuity Sense safety feature.

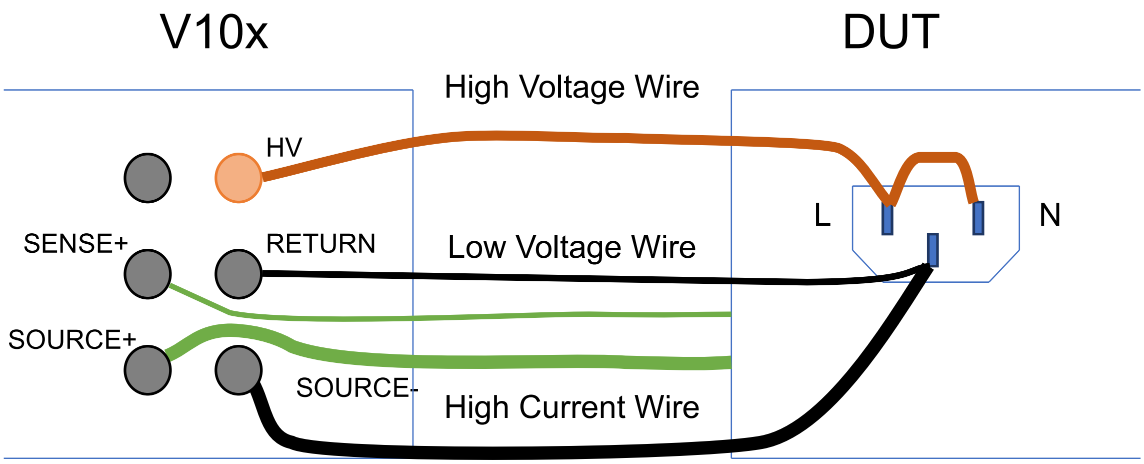


Figure 3-4 AC Withstand Isolated Connections with Sense

The example above shows the connections to a DUT to perform both an AC withstand test on the Line/Neutral line power input, and an AC Ground Bond or DC LowΩ test on the chassis of the DUT in the same sequence. If wired in this manner, then no changes in connections are needed. This will increase the capacitive coupling between the **HV** wire and the other wires, which may need to be compensated for in highly sensitive applications. The Continuity Sense feature may also be used with this wiring configuration.

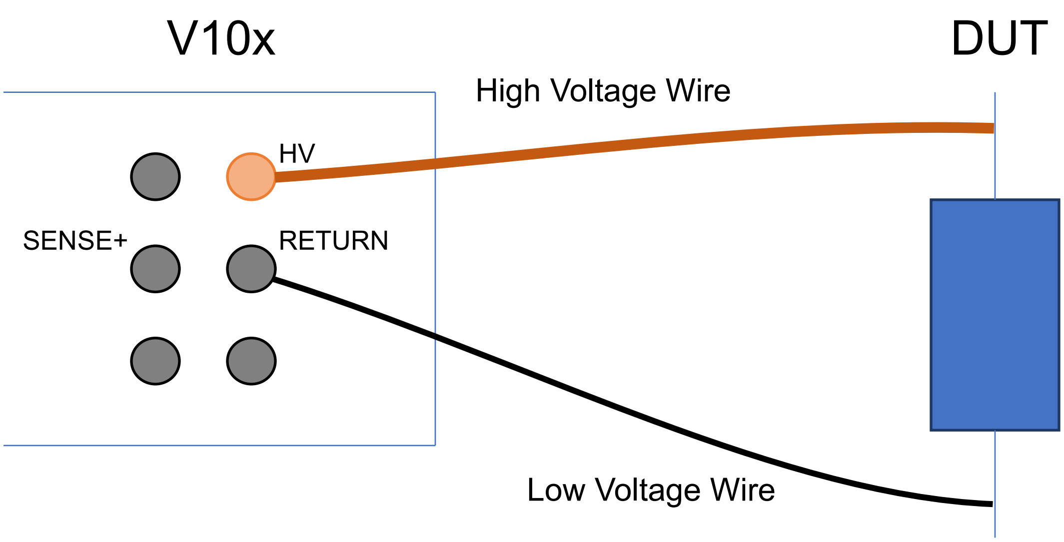


Figure 3-5 ACCAP Test Connections

The example above shows the connections for performing an ACCAP type step to check a capacitor for value and breakdown.

3.4.2.2 Testing a DUT that is grounded

In this case the user only needs to connect the **HV** terminal of the V10x to the point on the DUT which is to be tested. It is expected that the DUT is grounded and that the breakdown and/or leakage is being tested to ground. For safety reasons or if unsure if the DUT is grounded, it may be desirable to also connect the DUT ground to either the **RETURN** or **GUARD** terminals of the V10x, however the user should ensure that the ground of the V10x and that of the DUT are within 5Vrms of each other otherwise excessive ground loop currents may flow, potentially damaging the V10x.

It should be noted that the V10x will measure the leakage current to ground from the **HV** terminal and its wiring in addition to the leakage current in the DUT itself. Particularly when performing AC Withstand testing, the wiring leakage current may be large because of capacitance between the wiring and nearby grounded objects or surfaces.

3.4.3 Checking that the DUT is connected

When testing a DUT using AC Voltage Withstand testing there is the possibility that a disconnected DUT will erroneously pass a test. There is always some amount of capacitance within the load which will always cause an amount of current to flow when properly connected, so the user is recommended to set a minimum RMS or QUAD current setting in one of the two allowed test limit ranges for the ACW type of step. If not configured for a grounded load, the user may also use the Continuity Sense feature to detect a disconnected RETURN path.

3.4.4 Lead Compensation

For many applications lead compensation is not necessary for these types of test steps, as the wiring leakage is generally smaller than the DUT leakage limit and so can be ignored. However, for the more sensitive requirements (e.g., the more stringent levels of medical safety leakage testing) and/or when long lengths of wiring are required, particularly if DUT GROUNDED is set to YES, then lead compensation may be needed.

If the capacitance of loose wiring is to be corrected for and an isolated DUT is being tested, then it is recommended to use shielding of the RETURN wiring rather than lead compensation as the capacitance between loose unshielded wiring is very dependent on the exact routing of the wires.

Performing a lead compensation compensates for the resistive and capacitive leakage currents in the wiring to the V10x in all future runs of this test step. When performing a lead compensation, the normal connections to the V10x should be in place, with the wiring positioned normally, only the DUT itself should not be connected.

⚠ CAUTION High voltages will be present on the wiring while running in lead compensation mode. Ensure that the wiring and the (unused) DUT connections are safely positioned.

When performing lead compensation, the leakage limits are not enforced, otherwise the test step is executed normally.

3.4.5 ACW Examples

Example 1

A DUT is to have its Line/Neutral power connections tested to its chassis for “no breakdown” at 2000Vrms/60Hz using a 1 second ramp and a 30 second dwell. It is known that the DUT leakage is less than 5mArms at this voltage level and frequency (if this is not known, then start by using 5mArms as the limit and adjust it as needed).

This is accomplished in a single step as follows –

Step 1:

ACW in easy mode	Only breakdown detection is needed, so use the easy settings
Voltage: 2000.0V	As required
Frequency: 60.0Hz	As required
Ramp: 1s	As required
Dwell: 30s	As required
Minimum: 0A	As required
Maximum: 5mA	As required
Abort on fail: checked	
Grounding: Isolated	

Example 2

It is required to test a 2-conductor cable which has a specification of >100Mohm resistive leakage and <100pF capacitance at 500Vrms, and a minimum breakdown voltage of 2000Vrms. A decision is made to test for breakdown using a 1 second ramp and a 1 second dwell time since the requirement does not specify it.

Optionally, the Lead Compensation feature could be used to adjust for the DUT wiring capacitance, allowing accurate measurement of the 100pF limit. Otherwise, the measurement will include the capacitance of the wiring between the V10x and the DUT.

All of these tests are accomplished by two ACW test steps in a test sequence –

Firstly, test the lower voltage resistance and capacitance leakage.

Step 1:

ACW	Using standard settings
Voltage: 500.0V	As required
Frequency: 60.0Hz	As required
Ramp: 0.02s	No timing requirement, so set for fast testing
Dwell: 0.10s	No timing requirement, so set for fast testing
Check #1: INPHSO	Test the resistive leakage
Minimum: 100MΩ	As required
Maximum: No limit	As required
Check #2: QUADO	Test the capacitive leakage
Minimum: 26.5MΩ	26.5Mohm = $1/(2\pi FC)$ = the impedance of 100pF at 60Hz
Minimum: No limit	As required
Discharge: None	No need to discharge between this and the next step
Breakdown: 5mApk	Since the DUT is known to have little leakage this could be set lower
Arc Detect:4us 10mA	Optional
Abort on fail: checked	No further test steps if this step fails
Grounding: Isolated	
Sense: Normal	

Secondly, test the high voltage withstand capability.

Step 2:

ACW	Using standard settings for arc detection and no limit checking
Voltage: 2000.0V	As required
Frequency: 60.0Hz	As required
Ramp: 1s	As required
Dwell: 1s	As required
Check #1: None	No leakage testing required
Check #2: None	No leakage testing required
Discharge: Fast	Immediately discharge as this is the last step
Breakdown: 5mApk	Since the DUT is known to have little leakage this could be set lower
Arc Detect:4us 10mA	Optional
Abort on fail: checked	No further test steps if this step fails
Grounding: Isolated	
Sense: Normal	

Example 3

A 0.033uF 1000Vac capacitor is to be tested against its tolerance (0.033uF ± 5%) and DF (<1%) specifications.

A nominal capacitor at 1000V/60Hz will draw 12.4mArms, so this is within the capabilities of all V10x models so the capacitor can be tested at its maximum voltage rating.

This is accomplished in a single step as follows –

Step 1:

ACCAP	
Voltage: 1000.0V	As required
Frequency: 60.0Hz	As required
Ramp: 1s	Slow ramp to better measure breakdown voltage
Dwell: 5s	Optional, could be faster
Capacitance: 31.35nF-34.65nF	As required
Dissipation: 0DF-0.01DF	As required
Discharge: Fast	
Breakdown: 25mApk	Since the DUT is known to have little leakage this could be set lower
Arc Detect: Off	Optional
Abort on fail: checked	
Grounding: Isolated	
Sense: Normal	

3.5 DC Voltage Withstand and Leakage Testing (DCW and DCIR)

These are used to test that a DUT does not exhibit breakdown or (optionally) arcing in the presence of an applied DC voltage and optionally to test that the DUT leakage current or impedance is within user set limits.

All of these are performed in the same manner; the difference between them is in the amount of configuration available. The DCW provides for an easy configuration mode.

3.5.1 Actions While Running

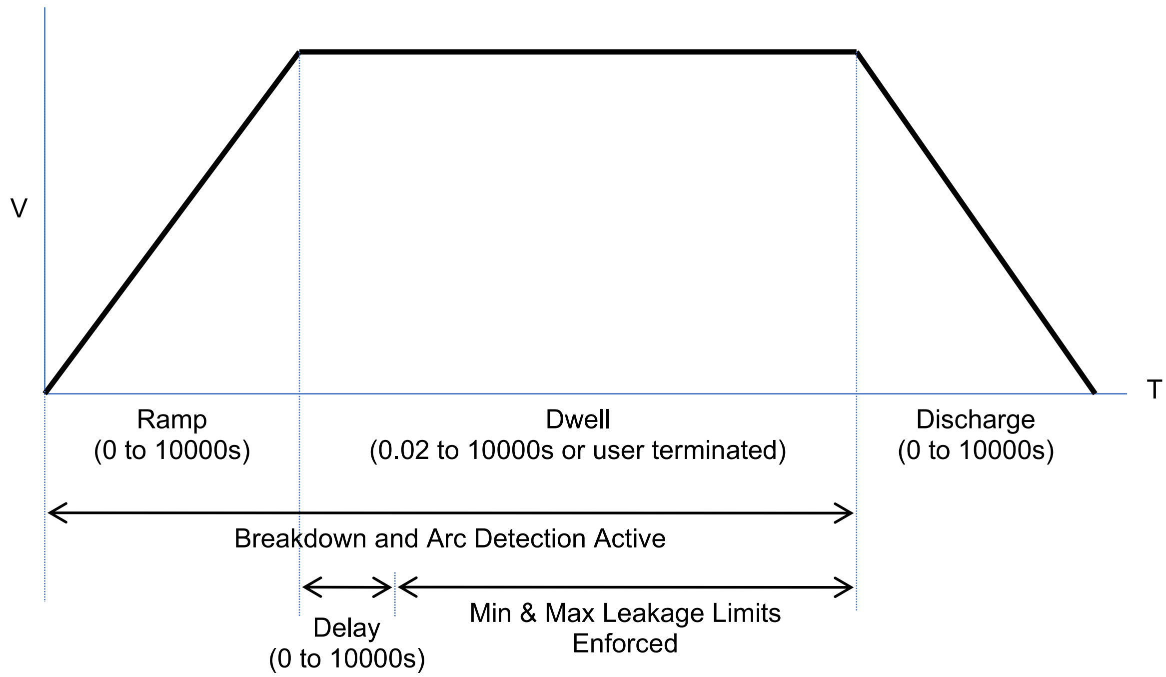


Figure 3-6 DC Voltage Wishstand Test Phases

- For the DCW type, on any failure the step is immediately aborted, and optionally the entire test sequence may be aborted.
- For the DCW and DCIR types, the loading current is analyzed during the last ¾ of the ramp phase and compared to the configured minimum load capacitance for the step (if enabled to do so).
- If the step is the MANUAL sequence, then the user may manually change the voltage during the dwell period if the load capacitance is low.
- For the DCIR type, on any failure other than leakage limit testing the step is immediately aborted. The operation of the leakage limit test is dependent on the “End On” setting.
- For the DCW type using the easy configuration, the delay is of zero length, the discharge period is of zero length and arc detection is not enabled.
- For the DCW in standard mode and DCIR always, the discharge period can be programmed to be skipped and the next step started at this steps’ dwell voltage level if the next step is of the DCW or DCIR type.
- During the discharge period the voltage is reduced to zero in the programmed time or at the programmed rate. If the actual voltage significantly lags the expected voltage during the discharge, then discharge circuitry is automatically engaged to speed up the discharge. The test step will not completely end until the actual voltage is reduced to a safe level. The discharge circuitry is a combination of fixed and controlled loading. Refer to Discharge in section 1.6.4 for details. The controlled loading has energy limitations which may prevent it

engaging until the voltage has been reduced by the fixed loading, and the user may restrict this further by setting a lower maximum discharge current setting in the, see section 6.1 General Test Settings Menu. The **HIGH VOLTAGE OR HIGH CURRENT PRESENT** warning symbol on the front panel of the V10x is illuminated whenever an unsafe voltage is present on the **HV** terminal. If this is the last step in a sequence, then the discharge circuitry remains engaged after the test step has fully terminated. It is not disengaged until the user navigates away from the test execution screen showing the final results.

3.5.2 Performing a multi-stage ramp or multiple DC voltage tests

The V105x allows the user to skip the discharge phase if desired in DCW and DCIR types. If a step has **Discharge** set to *None* and the next step is also a DC Voltage Withstand type and is at a higher voltage than the preceding step, then the discharge phase is skipped automatically. This enables the user to perform a multi-stage ramp with optional dwell phases between each ramp stage.

If each step in such a series has non-zero dwell times then their leakage currents tests are performed normally, however if the dwell time is set to zero in any but the final step then the dwell phase is also skipped in those steps and any dwell leakage current (or resistance) limits defined in such a step will be ignored and the ramp phase of the next step is immediately started after the end of the preceding stage ramp.

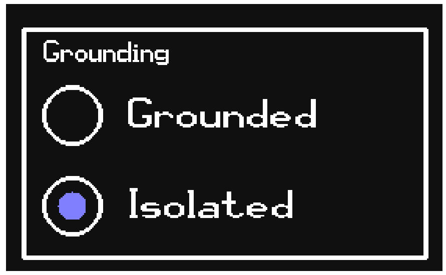
There are several scenarios where this capability assists the user, for example –

- If it is desired to perform leakage measurements at several voltages but it is not desirable to discharge to zero between each voltage. The user can configure several steps, each with **Discharge** set to *None*. In this case there is no discharge phase between each step, only for the final step or if a failure occurs.
- If it is desired to perform leakage current tests at timed intervals, e.g. at 10 minute intervals, then the user may configure many steps, all set for the same voltage and leakage current limits and with DISCHARGE set to NONE. The first step would be configured with the desired ramp settings, all remaining steps are configured with the desired interval between leakage checks as the ramp time. All steps should have a short (but not zero) dwell time configured during which the leakage current will be measured and checked against the limits. Up to 255 such steps can be configured in this manner in a sequence.
- If ramping to a final voltage near the maximum ability of the V10x but the maximum current of the V10x at the final voltage is limiting the ability to charge the load in a timely manner, then the user should consider using a multi-stage ramp by using two (or more) steps. The first step should be configured with a final voltage less than the desired final voltage and with a faster ramp rate and a higher breakdown setting than would have otherwise been possible in a single step because of the lower final voltage. This first step should be configured with DISCHARGE set to NONE and a 0sec dwell period. The second step will be configured as required in all regards, having the slower ramp rate associated with the lower possible breakdown current setting.
- Most materials have a higher dielectric storage effect when the ramp charging current is higher. It may be desirable to perform a faster, higher current ramp to a voltage lower than required in one step, followed by a slower, lower current, ramp to the required final voltage to assist in reducing these effects.

3.5.3 Connecting to the DUT for DC withstand

See the section 1.3.4 Terminals and Wiring for general wiring and safety recommendations.

The V10x requires that the DUT grounding state match the step configuration



3.5.3.1 Testing a DUT that is isolated

The DUT should be wired between the **HV** and **RETURN** terminals of the V10x.

The V10x provides a safety ground for the DUT during the test via its **RETURN** terminal. The Continuity Sense feature may be used to ensure that the **RETURN** connection is correctly made by connecting the **SENSE+** terminal to a point on the DUT which is connected to the **RETURN** connection. When deciding which point on the DUT to connect to the **HV** terminal and which point to connect to the **RETURN** terminal, the user should consider that only the voltage on the **RETURN** terminal is safe at all times.

For best high impedance load performance there should be low leakage between the wires and for low level current measurements there should be little interference pickup in the **RETURN** wire. In extreme circumstances the **RETURN** wire should be the inner wire of a coaxial cable, with the shield connected to the **GUARD** terminal of the V10x. This will significantly reduce the capacitance and leakage between the **HV** and **RETURN** wires. A cable such as RG174 is a suitable choice. If the *Continuity Sense* feature is being used, then the **SENSE+** connection should similarly be a coaxial cable.

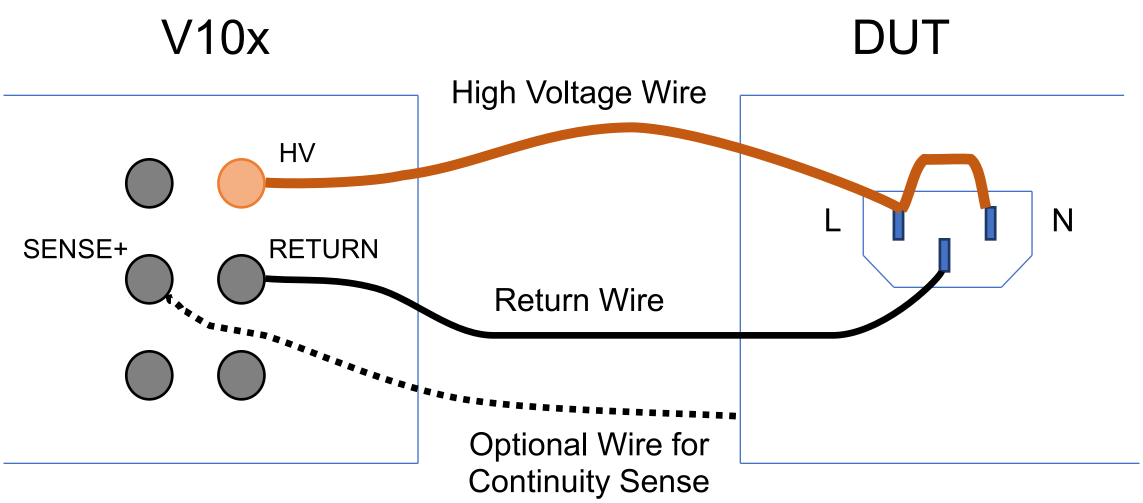


Figure 3-7 DC Withstand Isolated Connections

The example above shows the connections for performing DC voltage withstand testing of Line/Neutral connections to the chassis of a DUT. The optional wire from the DUT chassis to the **SENSE+** terminal of the V10x is used when the user wishes to use the Continuity Sense safety feature.

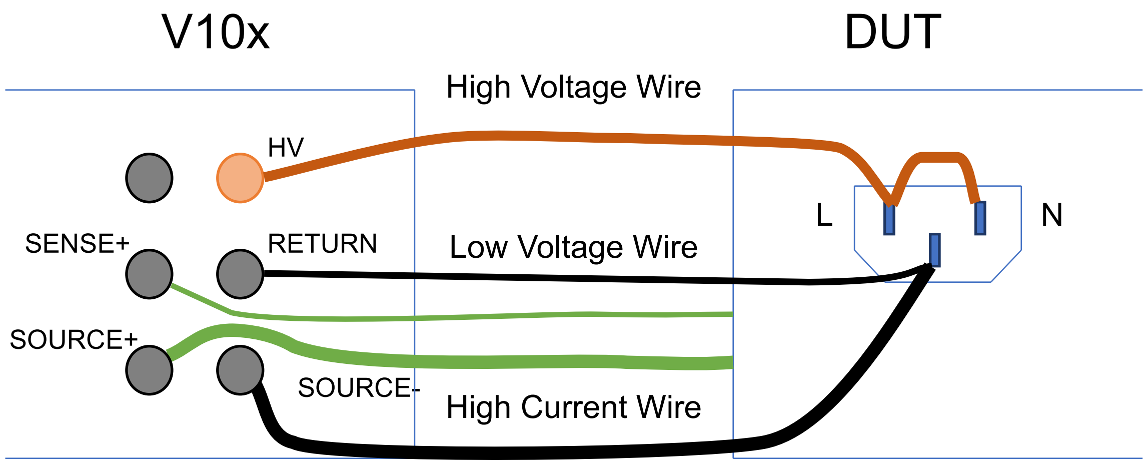


Figure 3-8 AC Withstand Isolated Connections With Sense

The example above shows the connections to a DUT to perform both a DC withstand test on the Line/Neutral line power input, and an AC Ground Bond or DC LowΩ test on the chassis of the DUT in the same sequence. If wired in this manner, then no changes in connections are needed. This will increase the capacitive coupling between the **HV** wire and the other wires, which may need to be compensated for in highly sensitive applications. The Continuity Sense feature may also be used with this wiring configuration.

3.5.3.2 Testing a grounded DUT

In this case the user only need connect the **HV** terminal of the V10x to the point on the DUT which is to be tested. It is expected that the DUT is grounded and that the breakdown and/or leakage is being tested to ground. For safety reasons or if unsure if the DUT is grounded, it may be desirable to also connect the DUT ground to either the **RETURN** or **GUARD** terminals of the V10x however the user should ensure that the ground of the V10x and that of the DUT are within 5Vrms of each other otherwise excessive ground loop currents may flow, potentially damaging the V10x.

3.5.3.3 Checking that the DUT is connected

When testing a DUT during DC Voltage Withstand testing there is the possibility that a disconnected DUT will erroneously pass a test. There is always some amount of capacitance within the load which will always cause an amount of current to flow during ramp when properly connected, so the user is recommended to enable the *Minimum Load* setting discussed in section 7.3.1. If not configured for a grounded load, the user may also use the *Continuity Sense* feature to detect a disconnected **RETURN** path.

Using the *Minimum Load* setting is preferred over setting a minimum leakage current or maximum leakage impedance, particularly when the load has very little leakage and is capacitive, as this method is both more reliable and more sensitive.

3.5.4 Lead Compensation

For many applications lead compensation is not necessary for these types of test steps, as the wiring leakage is generally smaller than the DUT leakage limit and so can be ignored. However, for the more sensitive requirements lead compensation may be needed.

Performing a lead compensation compensates for any leakage currents in the wiring to the V10x in all future runs of this test step. When performing a lead compensation, the normal connections to the V10x should be in place, with the wiring positioned normally, only the DUT itself should not be connected. **CAUTION** High voltages will be present on the wiring while running in lead compensation mode. Ensure that the wiring and the (unused) DUT connections are safely positioned.

When performing a lead compensation, the leakage limits are not enforced, otherwise the test step is executed normally.

3.5.5 DCW Examples

Example 1

A DUT is to have its Line/Neutral power connections tested to its chassis for “no breakdown” at 2000Vdc using a 1 second ramp and a 30 second dwell. It is known that the DUT leakage is less than 5mA at this voltage level (if this is not known, then start by using 5mA as the limit and adjust it as needed).

This is accomplished in a single step as follows –

Step 1:

DCW in easy mode	Only breakdown detection is needed, so use the easy settings
Voltage: 2000.0V	As required
Ramp: 1s	As required
Dwell: 30s	As required
Minimum: 0A	As required
Maximum: 5mA	As required
Abort on fail: checked	
Grounding: Isolated	

Example 2

A solar panel is to be tested for “no breakdown” at 2500Vdc using a 1 second ramp and a 5 second dwell time. The panel is estimated to have between 1 and 4uF of capacitance. The test limit for breakdown has been decided to be 1mA and it has been decided to not test for arcing in the panel because of its capacitance.

This is accomplished in a single step as follows –

Step 1:

DCW in standard mode	Different breakdown and leakage limits, so use standard settings
Voltage: 2500.0V	As required
Ramp: 1s	As required
Dwell: 5s	As required
Delay: 1s	Allow for dielectric storage in the panel
Minimum: 0A	As required
Maximum: 1mA	As required
Arc Detect: Off	As required
Abort on fail: checked	
Breakdown: 20mApk	Must be greater than the charging current
Grounding: Isolated	
Sense: Normal	
Discharge: Fast	

Example 3

The solar panel used in example 2 above is also required to be tested for insulation resistance at 500Vdc, the specification requires the panel to have >100Mohm resistance. A ramp time of 1 second and a dwell time of 5 seconds have been chosen.

The DCIR test is performed first since if the DCIR was performed after the breakdown test then there would be much longer settling time required because the panel is settling from 2500V to 500V, i.e., a 2000V change rather than a 500V change prior to the very sensitive DCIR measurement.

This is accomplished in two steps as follows –

Step 1:

DCIR	
Voltage: 500.0V	As required
Ramp: 1s	As required
Dwell: 5s	As required
Delay: 2s	Allow for dielectric storage in the panel
Check: Ω	
Minimum: 100MΩ	As required
Maximum: No Limit	As required
Termination: Fail	As required
Arc Detect: Off	As required
Abort on fail: checked	Optional, could continue testing if fails
Breakdown: 5mApk	Must be greater than the charging current
Grounding: Grounded	
Sense: Normal	
Discharge: None	No need to discharge before the next step, reduces test time

Step 2:

DCW in standard mode	Different breakdown and leakage limits, so use standard settings
Voltage: 2500.0V	As required
Ramp: 1s	As required
Dwell: 5s	As required
Delay: 1s	Allow for dielectric storage in the panel
Minimum: 0A	As required
Minimum: 1mA	As required
Arc Detect: Off	As required
Abort on fail: checked	
Breakdown: 20mApk	Must be greater than the charging current
Grounding: Grounded	
Sense: Normal	
Discharge: Fast	

<u>Example 4</u>

In example 3 above, it is required to ensure that the panel is connected to the V10x during the tests. Since the panel has very little DC leakage but has significant capacitance, this is easily achieved by adding a low voltage AC test at the start of the sequence. Since the load has a minimum capacitance of 1uF and a maximum of 4uF, the current at 10V/20Hz will be between 1.25 and 5mArms. This requires that Opt.AC-2 option be installed.

This is accomplished in three steps as follows –

Step 1:

ACW in easy mode	Simple RMS min and breakdown, so use the easy settings
Voltage: 10.0V	As required
Frequency: 60.0Hz	As required
Ramp: 20ms	Use a fast time to reduce test time
Dwell: 100ms	Use a fast time to reduce test time
Minimum: 1mA	As required
Maximum: 5mA	As required
Abort on fail: checked	No need for further tests if fails
Grounding: Isolated	

Step 2:

DCIR	
Voltage: 500.0V	As required
Ramp: 1s	As required
Dwell: 5s	As required
Delay: 2s	Allow for dielectric storage in the panel
Check: Ω	
Minimum: 100MΩ	As required
Maximum: No Limit	As required
Termination: Fail	As required
Arc Detect: Off	As required
Abort on fail: checked	Optional, could continue testing if fails
Breakdown: 5mApk	Must be greater than the charging current
Grounding: Grounded	
Sense: Normal	
Discharge: None	No need to discharge before the next step, reduces test time

Step 3:

DCW in standard mode	Different breakdown and leakage limits, so use standard settings
Voltage: 2500.0V	As required
Ramp: 1s	As required
Dwell: 5s	As required
Delay: 1s	Allow for dielectric storage in the panel
Minimum: 0A	As required
Minimum: 1mA	As required
Arc Detect: Off	As required
Abort on fail: checked	
Breakdown: 20mApk	Must be greater than the charging current
Grounding: Grounded	
Sense: Normal	

3.6 Pulsed Voltage Withstand Testing (Pulse)

This type of testing is performed whenever it is required to test that a device can withstand a voltage without breakdown or arcing, but the device will not withstand the voltage for significant periods of time. An example of this is in the testing of the voltage withstand capability of physically small resistors, in this case the resistor may not be able to withstand the power dissipation if the voltage is applied for lengthy periods of time, so normal AC or DC Voltage Withstand testing cannot be performed.

3.6.1 Actions While Running

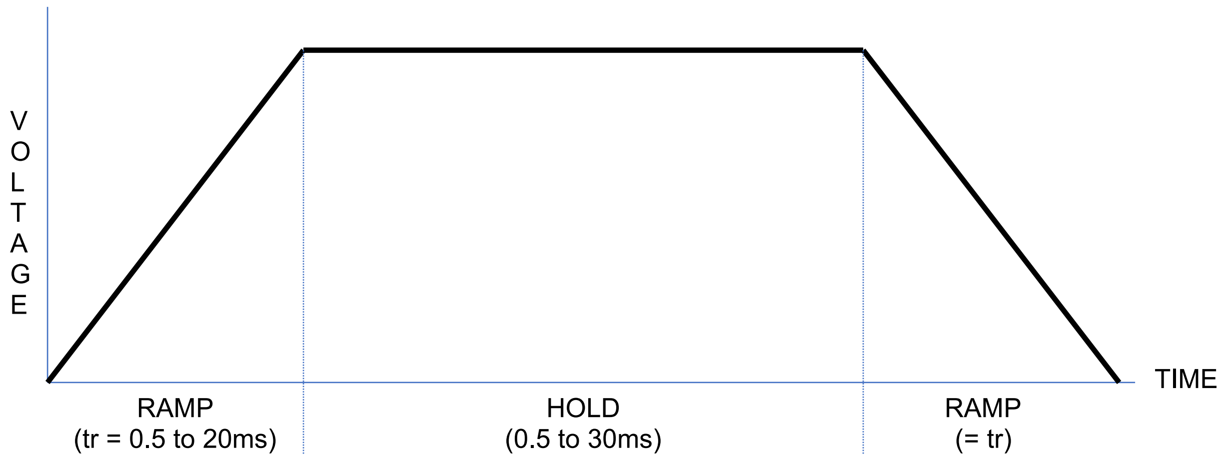


Figure 3-9 Pulsed Voltage Wishstand Test Phases

- Breakdown and (optionally) arc detection is performed throughout the test. On any failure the pulse is immediately aborted.
- A UNIPOLAR+ pulse is shown above, a UNIPOLAR- pulse has the same timing but has the opposite voltage polarity, a BIPOLAR pulse is a pair of opposite polarity pulses (positive first) with no delay between them.
- A delay is enforced following the pulse(s) to allow any stored energy in the V10x or the DUT caused by asymmetry in the waveform to dissipate.
  - After a unipolar pulse of either polarity or after an abnormally terminated bipolar pulse this delay is 500ms.
  - After a normally terminated bipolar pulse, this delay is 40ms.

3.6.2 Connecting to the DUT for Pulse testing

See the section 1.3.4 Terminals and Wiring for general wiring and safety recommendations.

The V10x requires that the DUT (at least that portion which is being measured) is isolated from ground.

The DUT should be wired between the **HV** and **RETURN** terminals of the V10x.

The V10x provides a safety ground termination for the DUT during the test via its **RETURN** terminal. When deciding which point on the DUT to connect to the **HV** terminal and which point to connect to the **RETURN** terminal, the user should consider that only the voltage on the **RETURN** terminal is safe at all times.

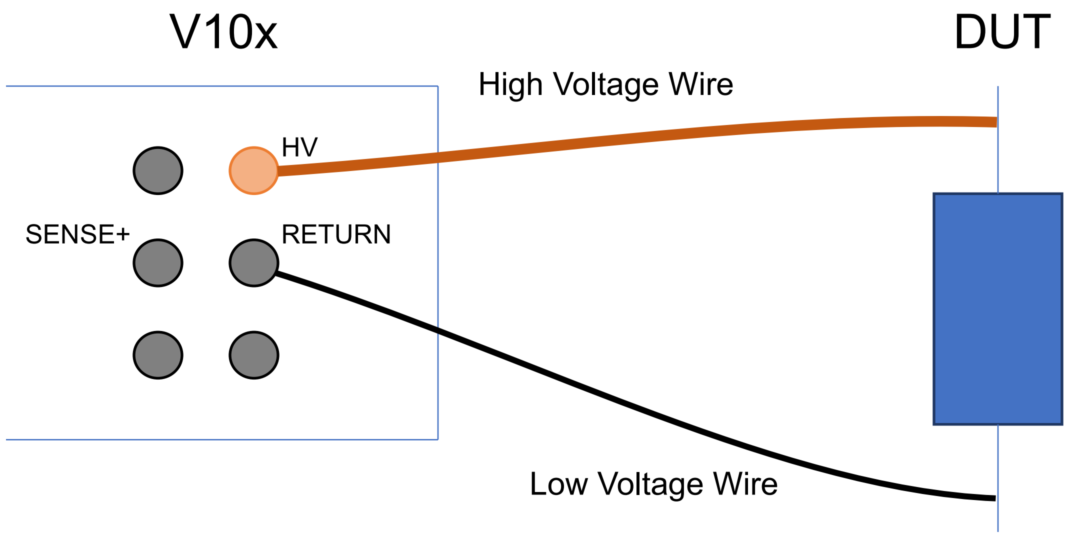


Figure 3-10 Pulse Test Connections

3.6.3 Lead Compensation

This type of test step uses the Lead Compensation feature of the V10x in a different way to all other types as it does not compensate for any cabling effects, but instead compensates for the loading effect on the V10x caused by the load resistance. The output voltage level from the V10x cannot be accurately controlled for this type. The output impedance when running this type is of significance, refer to section 1.6.5**Error! Reference source not found.**.

The V10x reports the actual highest voltage applied across the DUT following the end of this type of test step. Using the reported actual voltage, the user can manually adjust the programmed test voltage level to accommodate loading effects for future runs. Alternatively, the user can run a Lead Compensation with an example DUT connected normally, in which case the V10x will save the measured highest voltage and automatically adjust the output level in subsequent runs. Both of these methods assume that the load resistance does not vary significantly with voltage; if the resistance does vary significantly then the user may need to manually adjust the test voltage accordingly.

3.6.4 Pulse Examples

Example 1

A nominally 10Kohm NTC thermistor is to be tested for breakdown at 400Vpk. The thermistor will only withstand 400V for a maximum of 100msec and will exhibit self-heating very quickly.

This is accomplished in a single step as follows –

Step 1:

PULSE	
Level: 400.0V	As required
Ramp Time: 1ms	Performed as fast as possible, the load has little capacitance
Hold Time: 1.5ms	Performed as fast as possible, the load has little capacitance
Breakdown: 5mApk	Must be greater than the peak load current
Polarity: Unipolar+	As required
Arc Detect:4us 10mA	Optional
Sense: Normal	
Abort on fail: checked	

The actual test voltage may not have achieved the required test voltage with sufficient accuracy. When reviewing the results, the actual test voltage is displayed, as an example this may be 366V. The user may adjust the programmed test voltage from the original 400V setting, to 400*(400/366) = 437V. Then the next time the step is run the applied test voltage into this load will be closer to 400V. Alternatively, the user could run the test sequence using the Lead Compensation feature with a nominal load connected; the V10x will then automatically apply this in future runs of the test.

3.7 DC Breakdown Voltage Device Testing (BRKDN)

This tests that a DUT exhibits breakdown when tested with a user set DC current. The measured breakdown voltage is checked against an allowable range.

The BRKDN type is commonly used for testing high voltage protection devices such as spark gap surge arrestors and MOV style voltage limiters.

3.7.1 Actions While Running

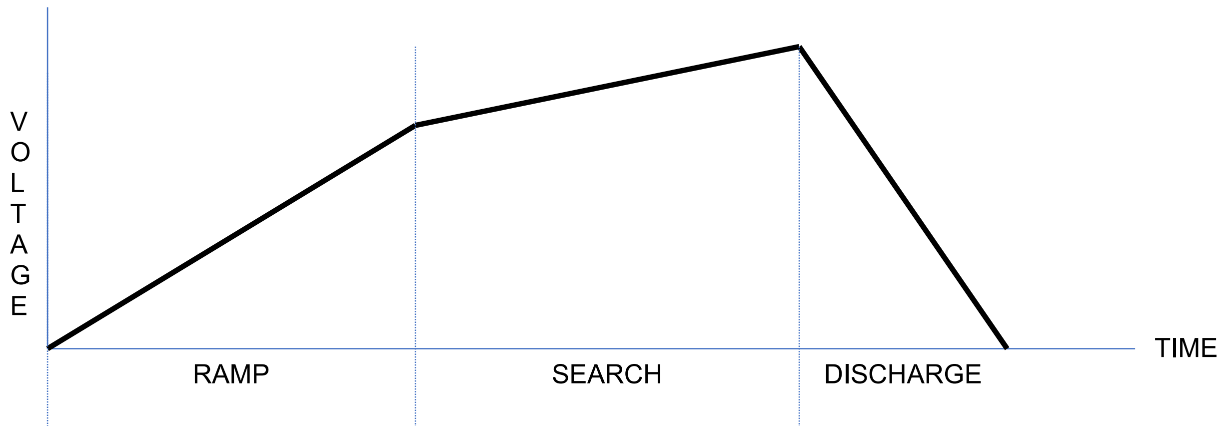


Figure 3-11 DC Breakdown Voltage Test Phases

NOTE – the actual reported test current in breakdown may be slightly higher than expected because of the characteristics of the breakdown of the DUT. If this is excessive then the user should select a slower maximum ramp rate.

3.7.2 Connecting to the DUT for breakdown testing

See the section 1.3.4 Terminals and Wiring for general wiring and safety recommendations.

The V10x requires that the DUT grounding state match the step configuration

3.7.2.1 Testing a DUT that is isolated

The DUT should be wired between the **HV** and **RETURN** terminals of the V10x.

The V10x provides a safety ground termination for the DUT during the test via its **RETURN** terminal. When deciding which point on the DUT to connect to the **HV** terminal and which point to connect to the **RETURN** terminal, the user should consider that only the voltage on the **RETURN** terminal is safe at all times.

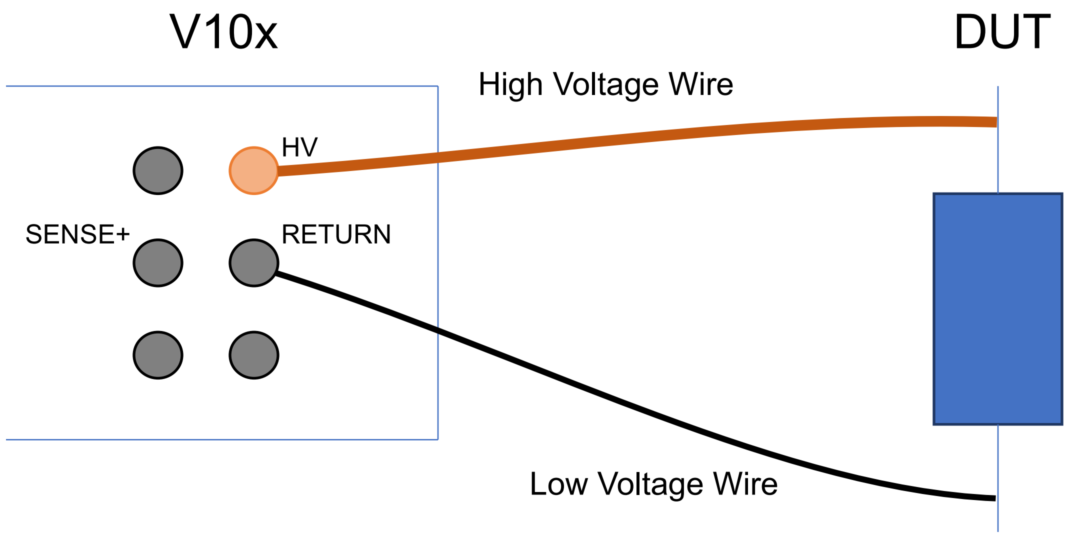


Figure 3-12 DC Breakdown Isolated Connections

3.7.2.2 Testing a grounded DUT

In this case the user only need connect the **HV** terminal of the V10x to the point on the DUT which is to be tested. It is expected that the DUT is grounded, and that the breakdown is being tested to ground. For safety reasons or if unsure if the DUT is grounded, it may be desirable to also connect the DUT ground to either the **RETURN** or **GUARD** terminals of the V10x however the user should ensure that the ground of the V10x and that of the DUT are within 5Vrms of each other otherwise excessive ground loop currents may flow, potentially damaging the V10x.

3.7.3 Lead Compensation

Performing a lead compensation for this type of test step has no affect; the test step is performed normally during lead compensation mode.

3.7.4 BRKDN Examples

<u>Example 1</u>

A MOV is to be tested against its breakdown specifications. The specifications are at a current of 10mA the breakdown voltage shall be between 405 and 495V. The specifications state that a maximum ramp rate of 100000V/sec is to be used. The MOV has <1000pF capacitance.

This is achieved by using a single test step as follows -

Step 1:

BRKDN	
Current: 10mA	As required
Ramp Rate: 200V/s	As recommended (<10*Vmin/sec)
Minimum Breakdown: 405V	As required
Maximum Breakdown: 495V	As required
Arc Detect:4us 10mA	Optional
Abort on fail: checked	
Grounding: Isolated	
Sense: Normal	

The total test time will be less than 350ms. After the sequence is run the actual highest voltage and load current are available for review.

3.8 DC Low Resistance Testing (LowΩ)

This type is primarily for testing resistance values from a few milliohms up to 100KΩ using either 2-wire or 4-wire measurement methods.

3.8.1 Actions While Running

This type of test step is performed using a single measurement phase. The user may program for a delay at the start of the test period before the resistance measurement is checked against the limits. This can be used to allow for capacitance in parallel with the DUT.

When programmed to perform a 4-terminal measurement, the V10x continuously performs a set of checks that the DUT is correctly wired to the V10x throughout the test period.

3.8.2 Connecting to the DUT for LowΩ

See the section 1.3.4 Terminals and Wiring for general wiring and safety recommendations.

The V10x requires that the DUT (at least that portion which is being measured) is floating with respect to ground.

3.8.2.1 2-Wire Measurement Connections

When making 2-terminal measurements the resistance of the wires, the contact resistance to the DUT, and the contact resistance within the V10x front panel terminals are all included in the result, use the following recommendations to reduce these effects –

- Use heavy gage wires.
- Ensure that the connections to the DUT are clean and are solidly made.
- Ensure that the connectors on the wires to the V10x are clean and are not loose. If the connectors are left inserted into the sockets of the V10x front panel for an extended period of time (e.g. a few weeks or more) then they should be occasionally removed, cleaned and re-inserted into the V10x to prevent build-up of corrosion on the connectors.

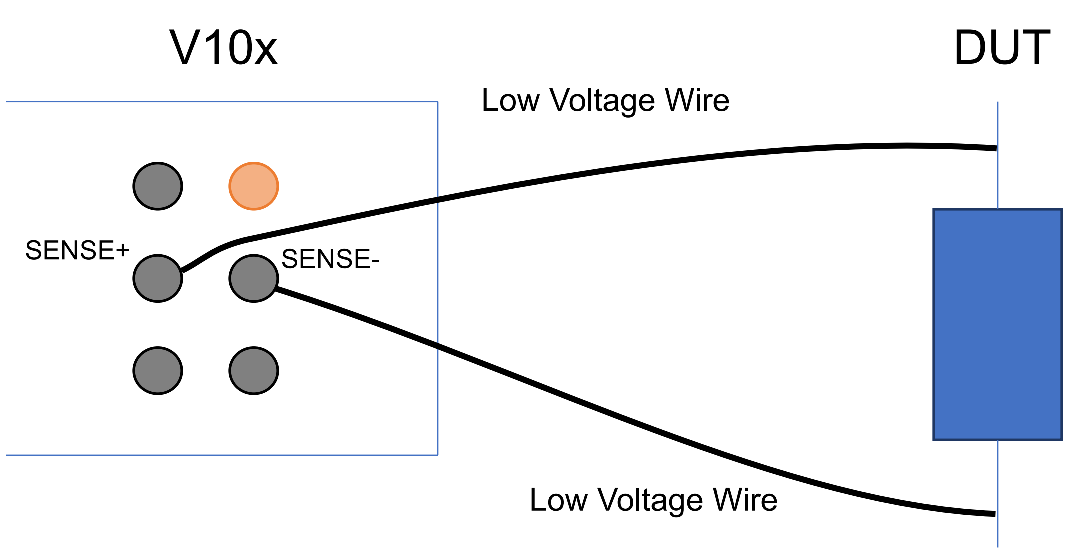


Figure 3-13 Low Ω 2-wire Connections

3.8.2.2 4-Wire Measurement Connections

When making 4-terminal measurements the resistance of the wires, the contact resistance to the DUT, and the contact resistance within the V10x front panel terminals are not included in the result, the only recommendation is that the **SOURCE+** and **SOURCE-** wires be of sufficient gage to withstand the 50mA test current. When wired as shown below, the actual resistance measured is that between the innermost connection points to the DUT (i.e. between the **SENSE+** and **SENSE-** connections).

If any wire has more than nominally 100Ω of resistance then the test is failed with a WIRING FAULT condition.

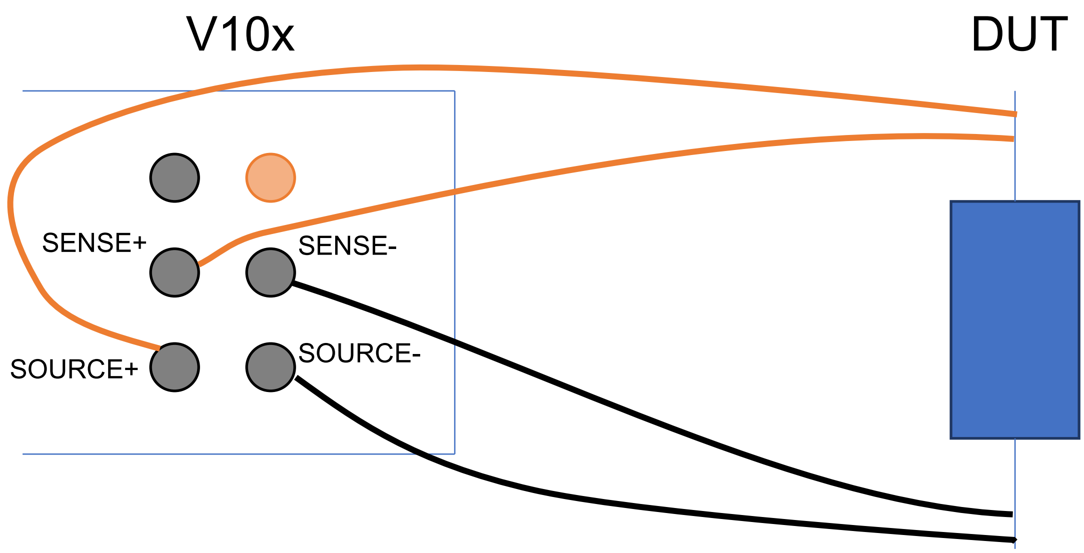


Figure 3-14 Low Ω 4-wire Connections

3.8.3 Lead Compensation (2-Wire)

Performing a lead compensation for this type of test step compensates for lead resistance.

During a lead compensation the **SENSE+** and **SENSE-** wires should be solidly shorted together at the DUT end, the V10x will then measure the lead resistance and automatically subtract it from all future measurements.

3.8.4 Lead Compensation (4-Wire)

Lead Compensation is not usually performed when using a 4-wire measurement since lead resistance is automatically eliminated. If a 4-wire test is configured but the DUT is connected in a 2-wire manner (e.g. separate wires for SOURCE and SENSE, but they are shorted together before the connection to the DUT) then a Lead Compensation may be performed in the same manner as for the 2-wire configuration above.

3.8.5 LowΩ Examples

<u>Example 1</u>

A DUT has a 50Ω input and it is desired to check that the input impedance is within 5% of the nominal 50Ω value.

This is accomplished in a single step as follows –

Step 1:

Low Ω
Test Time: 100ms — Load has very little capacitance so use a fast time
Check Delay: 0s — Load has very little capacitance so no delay needed

Minimum Resistance: 47.50Ω	As required
Maximum Resistance: 52.50Ω	As required
Mode: 2-wire	Lead resistance is well below 2.5ohm, so 2-wire is chosen
Abort on fail: checked	

Example 2

It is required to test that a DUT chassis is bonded to its grounding terminal with no more than 0.1ohm of resistance.

This is accomplished in a single step as follows –

Step 1:

Low Ω	
Test Time: 100ms	Load has very little capacitance so use a fast time
Check Delay: 0s	Load has very little capacitance so no delay needed
Minimum Resistance: 0Ω	As required
Maximum Resistance: 100mΩ	As required
Mode: 4-wire	Lead resistance is significant, so 4-wire is chosen
Abort on fail: checked	

3.9 AC Ground Bond Testing (GB)

This type is primarily for testing resistance values from a few microohms up to 8Ω at a user set AC test current between 0.1 and 40Arms, typically for ground bond testing requirements of safety standards and also for high current connector, cabling, or component testing.

The GB test allows an easy configuration for basic applications; use standard mode for comprehensive testing.

3.9.1 Actions While Running

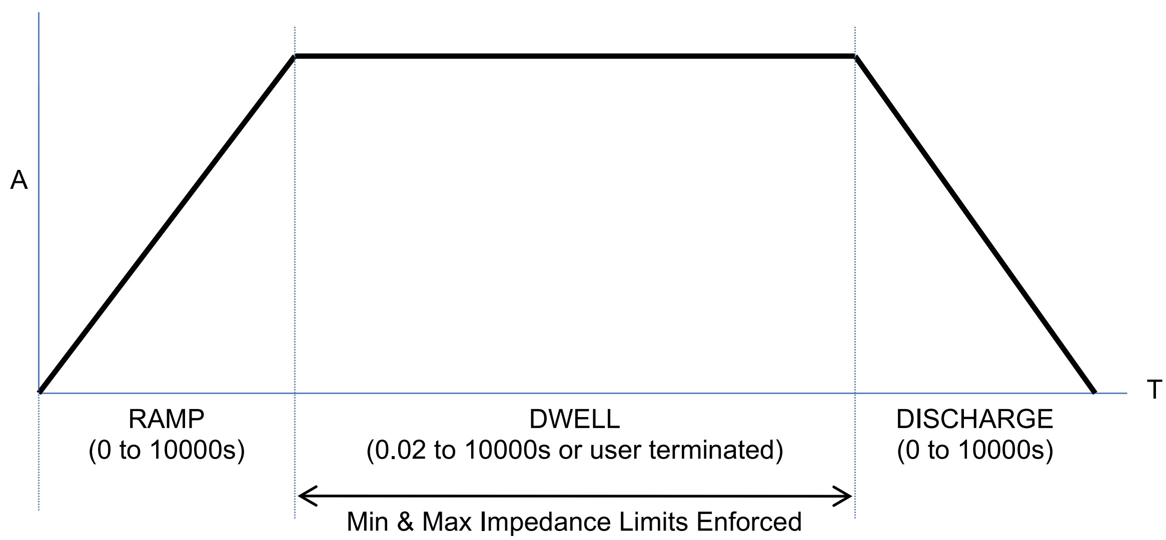


Figure 3-15 AC Ground Bond Test Phases

- Throughout the entire test the actual compliance voltage is measured, and the test current reduced to maintain a constant voltage if above the user set limit – in this situation the execution display will show **C/V Limited**, see Figure 8-1. NOTE – if this limiting occurs during the dwell period but the impedance measurement is within limits then the test is failed with a WIRING FAULT condition.

- On any failure the step is immediately aborted, and optionally the entire test sequence may be aborted.
- In *Easy* mode, the ramp and discharge periods are of zero length.
- For the GB type the discharge period can optionally be skipped if the next step is also a GB type.

3.9.2 Connecting to the DUT

The V10x requires that the DUT (at least that portion which is being measured) is floating with respect to ground.

When making 4-terminal measurements the resistance of the wires, the contact resistance to the DUT, and the contact resistance within the V10x front panel terminals are not included in the result, the only recommendation is that the **SOURCE+** and **SOURCE-** wires be of sufficient gage to withstand the user set test current.

When wired as shown below, the actual resistance measured is that between the innermost connection points to the DUT (i.e., between the **SENSE+** and **SENSE-** connections).

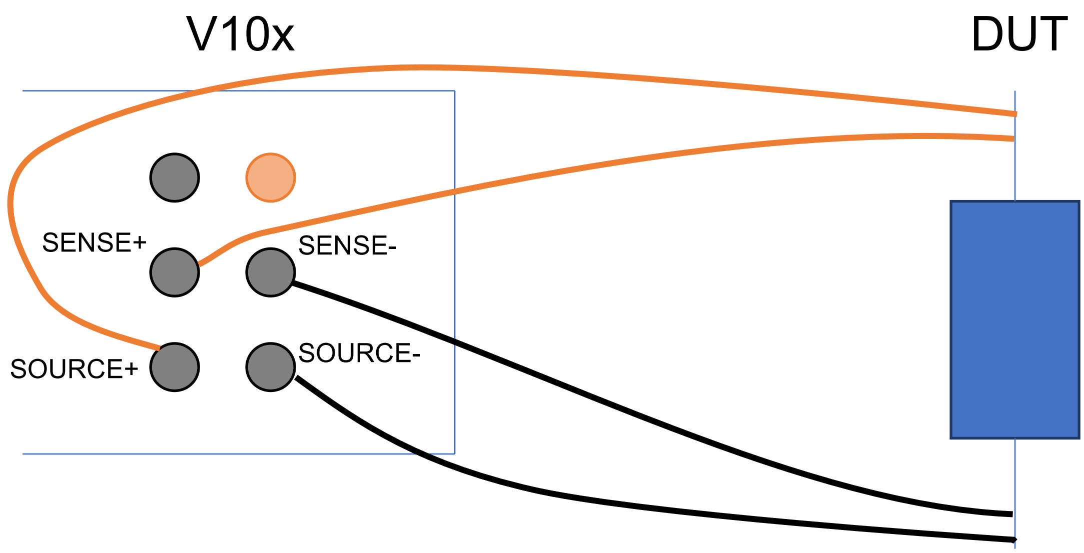


Figure 3-16 Typical GB Test Connection

If there is more than nominally 1.5V peak between the respective SOURCE and SENSE terminals of the V10x then the test is failed with a WIRING FAULT condition – the user must ensure that sufficient wire gage is used for the SOURCE wires (there is very little current flow in the SENSE wires).

If the user needs to make optimum measurements of low impedances, particularly less than a few 10's of mΩ, then the following points should be considered –

- The user should be aware that inductive coupling between the current flow in the **SOURCE** wires and the respective **SENSE** wires will cause errors in the measurement results. If the wires are longer than a few feet and/or are tightly coupled then these errors can be 10's of milliohms at 60Hz and significantly more at 400Hz, particularly when high test currents are being used. This effect is not specific to the V10x, it applies to any high current, low impedance AC measurement.
- When making very low-level measurements or when using long lengths of wiring, the user is recommended to couple (e.g., use a twisted pair) the **SOURCE** wires together and/or couple the **SENSE** wires together for at least the majority of the wire length. Alternatively, if the user maintains at least a ¾" spacing between each wire and all other wires then these effects are also reduced.
- Similarly, there will be some inductive coupling between the DUT and the **SENSE** wires if they are not separated from the DUT sufficiently, to reduce this the **SENSE** wires should not rest on or close to the DUT but should be routed nominally 90° away from the DUT for at least several inches.

- The coupling effects described above will almost always yield a higher-than-expected measurement. If the users' test passes with the measurement within the allowable range of impedances, then, even if these are not accounted for, the DUT is guaranteed to have passed the test – the above effects may only cause a false failure of the test.

Use caution when handling the connections to the DUT after performing a test. If high currents are being used then the power in the contact resistance between the DUT and the SOURCE wires, particularly when using clips, may be high, causing the contacts to become hot – at 40A the power in 1mΩ is 1.6Watts. Similarly, the user should ensure that the connections to the front panel **SOURCE** terminals are fully secure – the user is recommended to use lugs and not plug-in connectors for currents above 10A.

The example below shows the connections to a DUT to perform a DC or AC withstand test on the Line/Neutral line power input, and an AC Ground Bond test on the chassis of the DUT in the same sequence. If wired in this manner, then no changes in connections are needed.

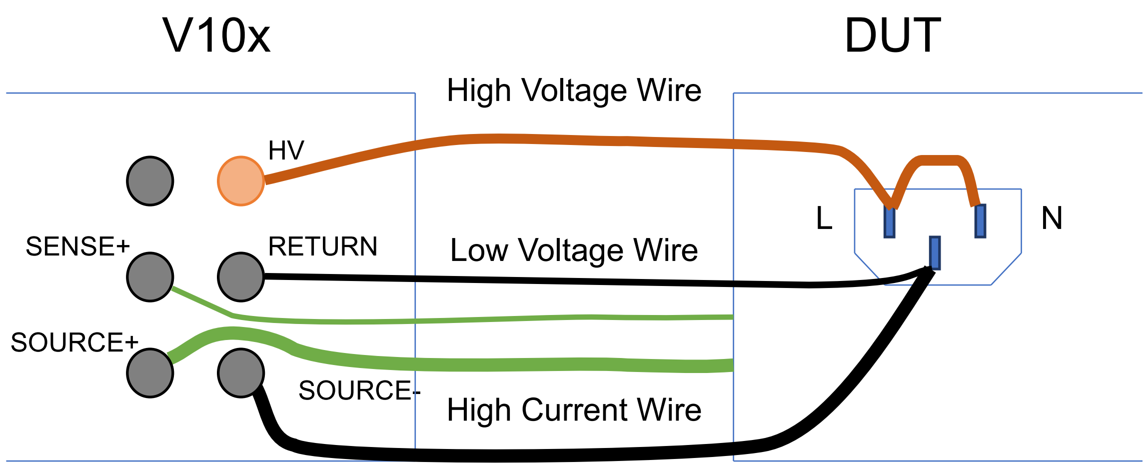


Figure 3-17 GB and Withstand Test Connections

3.9.3 Lead Compensation

Lead Compensation is not usually performed when using a 4-wire measurement since lead resistance is automatically eliminated. If the DUT is connected in a 2-wire manner (e.g., separate wires for SOURCE and SENSE, but they are shorted together before the connection to the DUT) then a Lead Compensation may be performed to offset the resistance of the common wiring in future runs.

Lead Compensation should be used with caution to offset errors caused by inductive coupling between the wiring; the inductive coupling effect is not strictly an offset error as it varies with the DUT resistance and reactance, and the use of Lead Compensation could introduce significant errors.

When performing a lead compensation, the impedance limits are not enforced, otherwise the test step is executed normally.

During a lead compensation the **SOURCE+**, **SENSE+**, **SOURCE-** and **SENSE-** wires should be solidly shorted together at the DUT end, the V10x will then measure the resistance and reactance and will automatically subtract them from all future measurements.

For reference, a near perfect 4-terminal short circuit can be created by connecting the leads to the same short, straight, length of heavy gage conductor in the order **SOURCE+**, **SENSE+**, **SOURCE-,** then **SENSE-**. This creates the situation where there is no current flow in the DUT between the SENSE terminals, so there is no measurable impedance between them. The effective impedance of this connection is well below 1uΩ at line frequencies.

3.9.4 GB Examples

Example 1

It is required to test that a DUT chassis is bonded to its grounding terminal with no more than 2.5V drop at 25Arms when tested for at least 30 seconds.

This is accomplished in a single step as follows –

Step 1:

GB in easy mode	No ramp or discharge, RMS limits, so use the easy settings
Current: 25A	As required
Frequency: 60Hz	As required
Dwell: 30s	As required
Minimum: 0Vrms	As required
Maximum: 2.5Vrms	As required
Abort on fail: checked	

Example 2

It is required to test that a DUT chassis is bonded to its grounding terminal with no more than 0.1Ω impedance at 40Arms when tested for at least 30 seconds. The source of the test current must be maintained below 5Vrms at all times to avoid corrosion breakthrough.

This is accomplished in a single step as follows –

Step 1:

GB in standard mode	Require a voltage limit, so use standard settings
Current: 25A	As required
Frequency: 60Hz	As required
Dwell: 30s	As required
Max. Drive: 5V	As required
Ramp: 0s	Maximum ramp
Discharge: Fast	
Check: RMSO	As required
Minimum: 0Ω	As required
Maximum: 100mΩ	As required
Abort on fail: checked	

Example 3

It is required to test that a line filter inductor is within ±10% of its 1mH nominal inductance and <10mΩ resistance at both 1A @ 60Hz and 10Arms @ 60Hz. At 60Hz the reactance of 1mH is given by 2.π.F.L = 2*3.1416*60.0*0.001 = 0.37699Ω, which is a voltage drop of nominally 3.7699V at 10A so is within the capabilities of the V10x. It has been decided to only test the resistance at the 10A level as that test is the most demanding. It is desired to perform all tests within less than 0.5 second to ensure production throughput.

This is accomplished in three steps as follows –

Step 1:

GB	Use standard settings
Current: 1A	As required, perform the 1A test of inductance first
Frequency: 60Hz	As required
Dwell: 100ms	No timing requirement, so perform a fast test
Max. Drive: 8V	Not needed, so set to the maximum
Ramp: 0s	Maximum ramp
Discharge: None	Do not discharge before the next test, saves test time
Check: QUADO	Test the inductance
Minimum: 339.3mΩ	As required
Maximum: 414.7mΩ	As required
Abort on fail: checked	

Step 2:

GB	Use standard settings
Current: 10A	As required
Frequency: 60Hz	As required
Dwell: 100ms	No timing requirement, so perform a fast test
Max. Drive: 8V	Not needed, so set to the maximum
Ramp: 0s	Maximum ramp
Discharge: None	Do not discharge before the next test, saves test time
Check: QUADO	Test the inductance
Minimum: 339.3mΩ	As required
Maximum: 414.7mΩ	As required
Abort on fail: checked	

Step 3:

GB	Use standard settings
Current: 10A	As required
Frequency: 60Hz	As required
Dwell: 100ms	No timing requirement, so perform a fast test
Max. Drive: 8V	Not needed, so set to the maximum
Ramp: 0s	Maximum ramp
Discharge: Fast	Do not discharge before the next test, saves test time
Check: INPHSO	Test the resistance
Minimum: 0Ω	As required
Maximum: 10mΩ	As required
Abort on fail: checked	

The total test time is nominally 0.3 seconds, which could be reduced to 0.15 second with ease.

3.10 Ground Leakage Testing (DCI and ACI)

These types are intended for testing that a product does not exceed ground leakage requirements, usually of safety standards.

Both types are similar, the difference being that the DCI type tests for DC ground leakage current while the ACI type tests for AC ground leakage current.

3.10.1 Actions While Running

During the test step the V10x measures the ground leakage current and checks that the result is within the user set range. The V10x also measures the voltage on the **HV** terminal relative to ground and makes the result of this measurement available to the user, if not required then this can be ignored.

Optionally, the user can also detect arc currents and fail the DUT if they are found over the user set limit.

The user can set for there to be a delay at the beginning of the test step before the limits are enforced on the ground leakage current measurement.

3.10.2 Connecting to the DUT for ACI or DCI

See the section 1.3.4 Terminals and Wiring for general wiring and safety recommendations.

The V10x measures the current flowing into the **RETURN** terminal to the V10x ground during these tests.

The **RETURN** terminal of the V10x provides a safety ground to the DUT during these types.

NOTE – since the V10x does not control the source of power to the DUT, there is no automatic shutdown if an excessive current flows. The V10x contains a low voltage (<30V) MOV type protection device from the **RETURN** terminal to its chassis ground if excessive current flows, but the user should take additional measures to protect the system from high current flows in the event of a DUT failure.

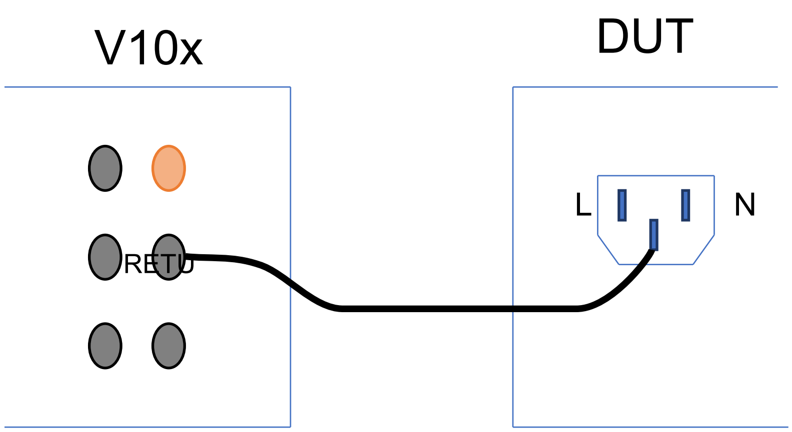


Figure 3-18 ACI and DCI Test Connections

The example above shows a typical DUT ground leakage connection between the DUT and the V10x. The DUT line and neutral connections would normally be connected to a line and neutral line power source. The V10x is used to check that the DUT does not have excessive ground leakage using the ACI type test step.

For this type of testing, it is often also required to test the ground leakage of several exposed portions of the DUT as well as the ground connection of the DUT. In those cases, the same connection to the V10x would be used, but the connection to the DUT would be to each required test point on the DUT.

This type of testing is often used for testing that the patient connections of a medical device meet ground leakage safety standards. In these cases, the DUT would be connected normally, either with or without its power ground connection as required by the standard, and each patient connection would be tested for ground leakage by connecting it to the V10x RETURN terminal.

3.10.3 Lead Compensation

Lead Compensation is not usually performed on these types. If needed, then Lead Compensation can be used to reduce the effects of external leakage current.

When performing lead compensation, the ground leakage current limits are not enforced, otherwise the test step is executed normally.

During lead compensation the **RETURN** wire should not be connected to the DUT.

3.10.4 DCI and ACI Examples

Example 1

It is required to test that a DUT ground leakage from its chassis is less than 5mArms when line powered. The DC leakage current is not required to be tested.

It is assumed that the connection is made prior to the start of the test.

This is accomplished in a single step as follows –

Step 1:

ACI	AC RMS leakage required, so use ACI
Test Time: 100ms	No timing requirement, so perform quickly
Delay Time: 0s	Already connected, so no delay needed
Minimum Leakage: 0Arms	As required
Maximum Leakage: 5mArms	As required
Abort on fail: checked	
Arc detect: Off	Not required

Example 2

The same requirement as in example 1 but both AC and DC leakage currents are to be tested.

This is accomplished in two steps as follows –

Step 1:

ACI	AC RMS leakage required, so use ACI
Test Time: 100ms	No timing requirement, so perform quickly
Delay Time: 0s	Already connected, so no delay needed
Minimum Leakage: 0Arms	As required
Maximum Leakage: 5mArms	As required
Abort on fail: checked	
Arc detect: Off	Not required

Step 2:

DCI	DC leakage required, so use ACI
Test Time: 100ms	No timing requirement, so perform quickly
Delay Time: 0s	Already connected, so no delay needed
Minimum Leakage: 0A	As required
Maximum Leakage: 5mA	As required
Abort on fail: checked	
Arc detect: Off	Not required

Example 3

It is required to test that a medical device patient connection has less than 50uArms ground leakage. The test is to be performed over a 10 second period to ensure that any periodic current is detected.

This is accomplished in a single step as follows –

Step 1:

ACI	AC RMS leakage required, so use ACI
Test Time: 10s	No timing requirement, so perform quickly
Delay Time: 0s	Already connected, so no delay needed
Minimum Leakage: 0Arms	As required
Maximum Leakage: 50uArms	As required
Abort on fail: checked	
Arc detect: Off	Not required

Example 4

It is required to test the leakage current of material sample over a range of voltages. This is to be performed manually, using an external source of voltage. This could be a DC or AC test, for this example DC is used.

The external voltage source is connected to one end of the material sample, with its common terminal grounded, and the V10x **RETURN** terminal is connected to the other end of the material sample.

If the voltage being used is within the measurement capability of the V10x, then the output of the external voltage source could also be connected to the HV terminal of the V10x, in which case the V10x display would also show the actual applied voltage to the material sample.

A single step is used as follows –

Step 1:

DCI	DC leakage required, so use DCI
Test Time: Command	Use manual timing, press the START button when finished
Delay Time: 0s	Already connected, so no delay needed
Minimum Leakage: 0A	As required
Maximum Leakage: 5mA	Set wide limit, the user will manually check the results
Abort on fail: checked	
Arc detect: Off	Not required

3.11 Sequence Timing Control (Pause and Hold)

The **Pause** type is generally used when the user needs to have a fixed delay inserted into a test sequence to allow for wiring or DUT settling between test steps.

The **Hold** type is generally used when operator action is required prior to continuing the test sequence. A timeout is provided which, if it occurs, will abort the entire sequence. The sequence is resumed resumed by one of the following:

- Pressing the **START** button
- Asserting the DIO interface START signal
- Sending the interface CONT command

3.12 Switch Matrix

A low or high voltage switching system is invaluable when testing cables or multiple test points on a DUT. It can speed up the test time by allowing the device to be fully instrumented at the beginning of the process without having to pause and move wiring.

3.13 Sequence Start

The V10x will start executing a sequence based on one of three methods, each can be selectively enabled from the front panel discussed in section 10.2.1. Presuming that the method has been enabled the following table di

Table 3-2 Sequence Start Mechanisms

Method	Execution Conditions
Start Button	The user has loaded a properly configured sequence, the command interface is inactive; and the abort signal is unconfigured or inactive.
Command Interface 'Run'	The command interface is active, and the abort signal is unconfigured or inactive.
DIO Start	A properly configured sequence is already loaded or selected, and the abort signal is unconfigured or inactive.

4 Front Panel Operation

4.1 Introduction

The V10x is a programmable test instrument for electrical compliance testing. The unit uses a menu structure for programming and setting options for test execution. This chapter describes common functions for the various touch screens. All of the illustrations are shown using the default color theme except for the section that discusses the available themes.

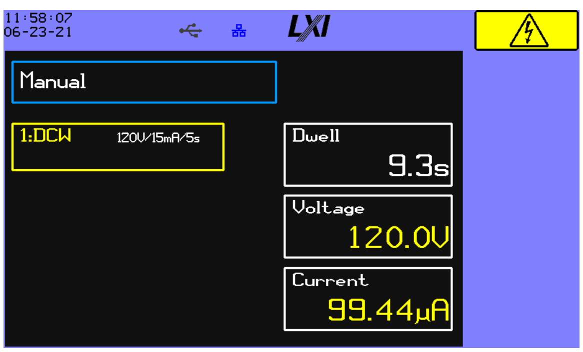
4.2 Quickstart

These are the most commonly used displays involved in the create/run/review sequence workflow.

Ready To Run a Sequence

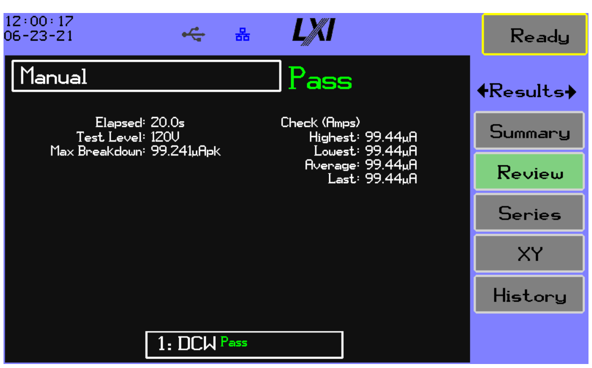
Sequence Step Editor

Running a Sequence



Sequence Results

Step Detailed Results



Step Series Chart

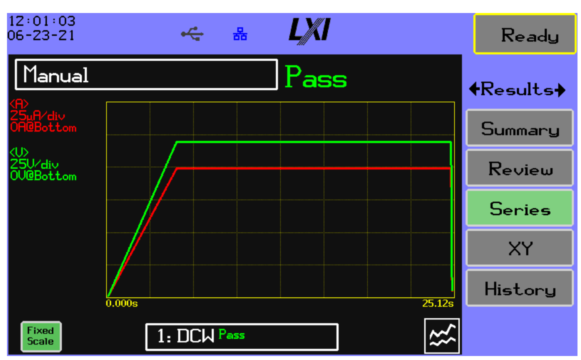


Figure 4-1 Common Displays for Sequence Execution and Review

If the V10x is configured to load the 'last test used' the user is required to make the sequence ready, either by pressing the physical Stop button or the Stop button on the screen illustrated to the right. When the 'blank' configuration is selected the V10x is made ready by loading a valid test.

Figure 4-2 Using Stop to Enable Ready

4.3 Security

The V10x has user level security that when enabled allows the front panel to be secured from unauthorized operation, see section 10.2.6 for full details. This section discusses the user experience with logging in, logging out, and logging back in again.

From the factory the security system is not enabled. In the event the feature has been enabled the first screen displayed requests user credentials in the form of a user name and password:

Figure 4-3 User Log in Screen

When the *Auto-logout* setting is enabled and the system is left idle the user will be automatically logged out when the *Inactivity Time* period has expired; this is the same behavior as if the user touched the Log out button:

Figure 4-4 Log out Button

The Log out button can be used to secure the instrument when the user has completed their work.

To log back in the user only needs to enter their password to resume where they left off. In the event a different user logs in the system will operate as if it was just powered on.

NOTE

The Auto-logout feature is inhibited while a sequence is running.

NOTE

When the command interface runs a sequence when no user is logged in the display activates to show the sequence details then reverts to the log in screen when the sequence ends.

4.4 Menu System

After starting the V10x, the Test Execution screen is displayed as shown in section 8.

The right side of the screen shows a menu bar consisting of a title and a number of buttons. There are three menus each illustrated below:

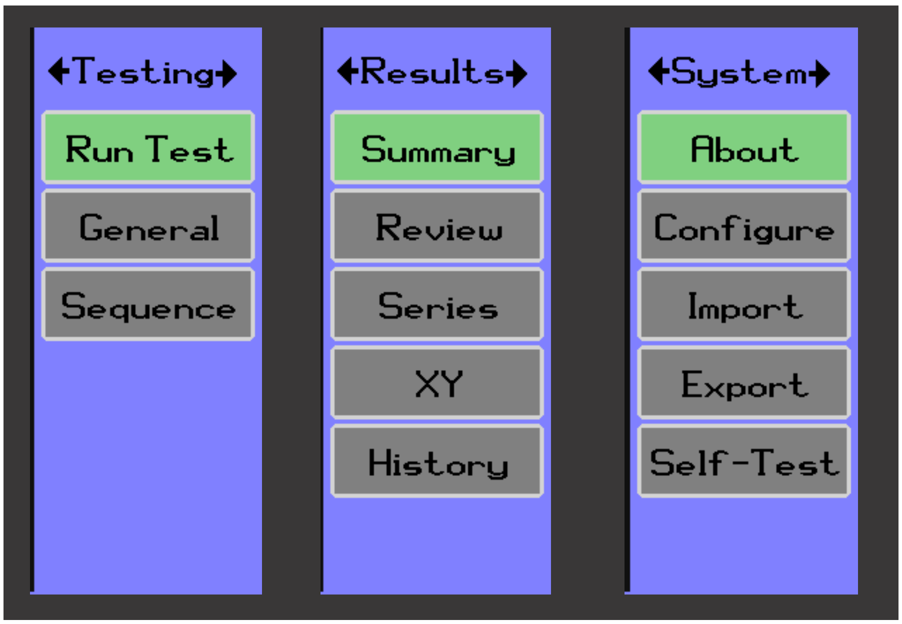


Figure 4-5 V10x Menus

Table 4-1 Menu Summary

Title	Description
Testing	Provides for test sequence configuration and execution.
Results	Presents an array of options for viewing test sequence results.
System	Unit information, system-level settings and user preferences, export/import configuration to external media.

The arrow keys on either side of a menu title scroll the menu choices; as each group is selected, the last used menu option will be shown.

4.5 Common Display Elements

The graphics display area is comprised of four distinct components illustrated below.

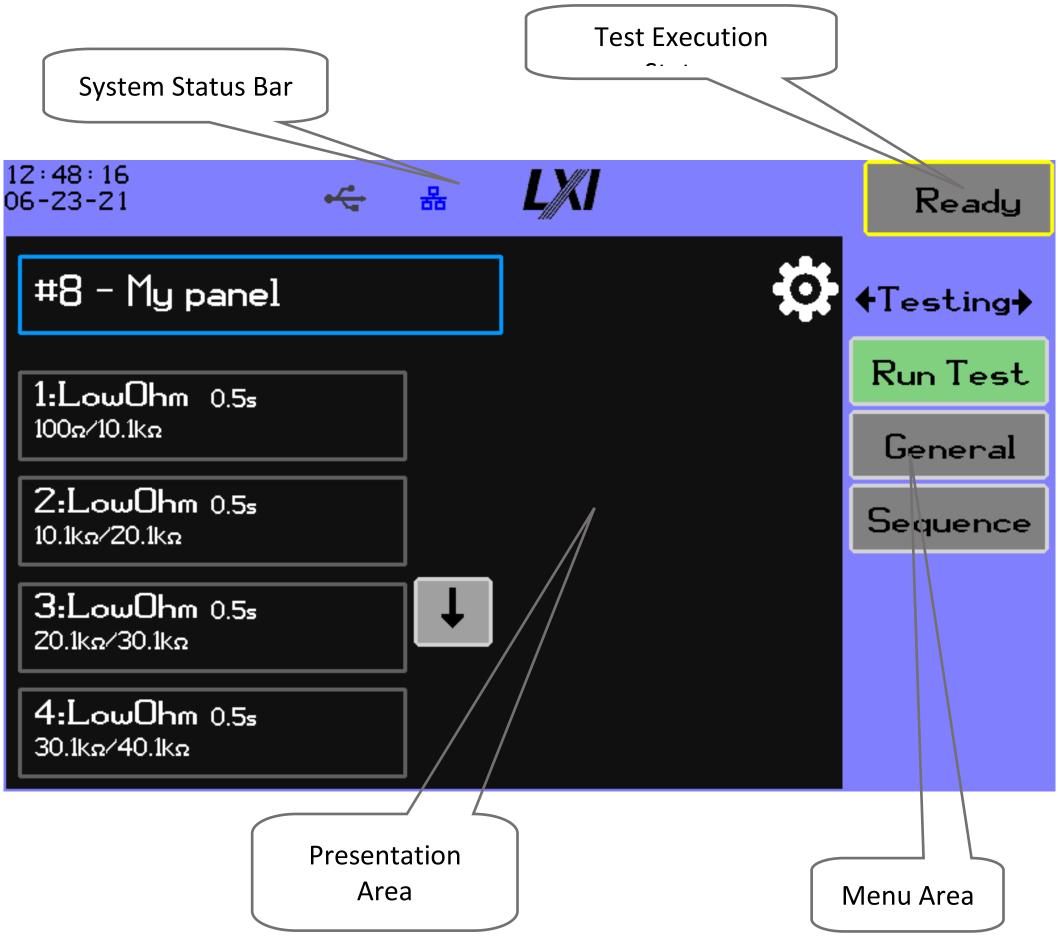


Figure 4-6 V10x Display Overview

4.6 Common Behavior

4.6.1 Touch Panel Operation

If the unit is configured to auto-dim and the display has dimmed any touch to the panel only acts to restore normal brightness and will cause no further action. If the display is automatically dimmed and a flash drive is inserted the display will activate as it was touched.

The V10x LCD panel touchscreen is used for most manual user interaction with the instrument.

- Do not use a pen or pencil, or a sharp object, or a fingernail on the touchscreen, this may damage the screen.
- Do not apply excessive pressure to the touchscreen otherwise it may be damaged.
- The touchscreen interface has been designed to not require the use of a stylus; however, one can be used if desired. If a stylus is used then ensure that it has a smooth surface where it touches the screen and do not apply excessive force, otherwise it may damage the screen.
- It is not recommended to use bulky gloves with the instrument, you may have to resort to a stylus to navigate accurately.
- Typically, the display shows the areas which may be used as buttons or controls with the touchscreen. Most exceptions to this involve the series charts and history where a data cursor is involved.

4.6.2 OK/Cancel

When modifying various settings, the option of OK or Cancel is displayed on the screen. Pressing the **OK** button will save the settings and return to the previous screen. Pressing **Cancel** will not save the settings and return to the previous screen. The settings are saved in non-volatile storage when the user utilizes the **OK** button, not stored when **Cancel** is pressed. Besides the obvious behavior associated with **OK** or **Cancel**, there is an implied **OK** if the user presses a menu button in a setting screen and navigates to another screen. Turning the unit off while changing a setting will cause all changes since the last **OK** to be lost.

4.6.3 Sequence Editing

The System Preferences options – see section 10.2.7 - allow the user to choose if steps and/or sequences require delete confirmation; and if step changes should be auto-saved.

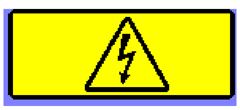
4.6.4 SI Conformance

The unit uses International System of Units (SI) rules when displaying all the settings and most of the measurement results within the Results menu. A specific exception to the display of settings is those shown for changes via the rotary dial; they are shown fixed width using whole units.

4.6.5 Test Execution Status

The icon on the upper right of the display always shows the test sequence execution status. The table below explains the status symbology.

Table 4-2 Test Execution Status Symbology

Display	**Description**
	A valid sequence has not been loaded and made ready.
	A valid sequence is loaded and ready to run.
	Testing cannot commence due to an internal fault.
	A sequence is running, and the V10x does not have a high voltage (>30V) or a high current (>5A) present on its terminals.
	A sequence is running, and the V10x has a high voltage (>30V) or a high current (>5A) present on its terminals.

4.7 Status Bar

4.7.1 Icon Behavior

The status bar is always present at the top of the display. Some of the symbology is always shown and will change color to indicate status; other symbols will only appear under certain circumstances. The following figure illustrates the status bar items. The behavior of each item is listed in Table 4-3 Status Bar Item Behavior.

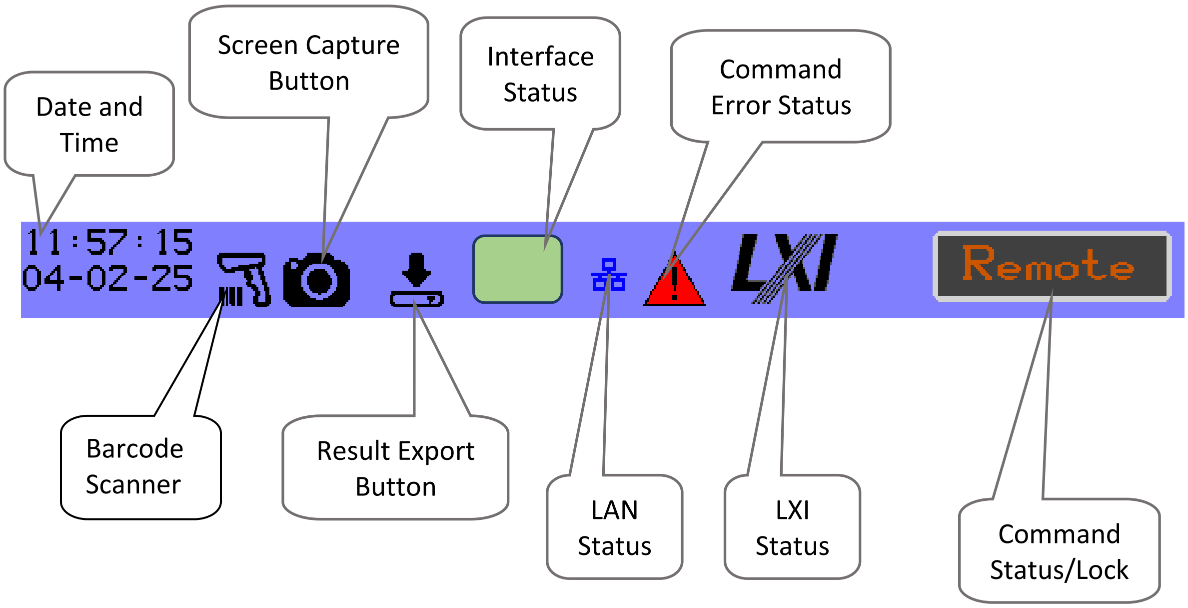
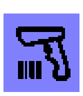
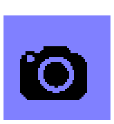
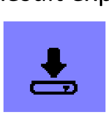
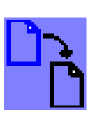


Figure 4-7 V10x Status Bar

Table 4-3 Status Bar Item Behavior

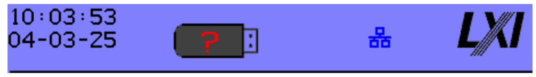
Information	**Behavior**
Date/Time	Always present and updated every second. If the time is shown in Yellow, the clock has not been set since the battery was installed; if the time is shown in Red, the battery clock should be replaced.
Barcode Scanner 	Shown if a compliant barcode scanner is attached to a USB port. Note that the user can insert a compliant keyboard as well but that would not really serve workflow automation. See section 8.4 for details regarding automation. See appendix C for details about the scanner requirements.
Screen capture button 	Only present if a valid USB drive has been inserted. Pressing this button causes the present screen image to be captured to a file on the USB drive. The file takes the form *screenNN.png*, where *NN* is the digits 00 to 99. The unit will try the lowest-numbered digits first, so as to not overwrite a previously saved image; if all combinations are exhausted, it will overwrite *screen99.png.* If the image cannot be saved the camera icon flashes yellow.
Result export button  	Only present if a valid USB drive has been inserted. When pressed while viewing test results, one or more files are exported to the USB drive containing results representing the presently viewed context. Each result section will discuss the file formats. While an export is processing the indicator shows a file copy operation; the indicator also appears when

Information	**Behavior**
	automatic results are being saved.
Interface status	When the command interface is configured to be one of USB, GPIB, or RS232 this area shows the connection status. **USB** Disabled Disconnected Enumerated: attached to a host computer and properly configured (driver installed). Connected: a host computer application has connected to the virtual COM port (VCP). **GPIB** Disconnected Connected **RS232** Disconnected Connected
LAN status	Always present and shows the LAN interface status: No Link No Address: Link integrity achieved but no address has been assigned. Addressed Addressing error indicator, either a static address conflict or a DHCP failure (timeout or invalid address).
Command error status	Only present if a command interface is active and will be shown if an error or event is queued for retrieval by the command interface. See section 10.1 for details on viewing the queue locally.
LXI	Always present and will flash if the LXI **Device Identify** function is activated. If the command interface is disabled, the logo will be grayed out.
Command status/lock	Only present if a command interface is active and is one of the following indicators: • Remote – The connection is active and local control is disabled. • Locked – The connection is active, and local control is disabled and locked. • Local – The connection is active, but local control has been

Information	Behavior
	enabled. See section 4.8 on how the front panel user experience changes when a lock is active. You can touch the Remote button to force local control.

4.7.2 USB Device Errors

If the USB drive has an error or is using an unsupported format, the area taken by the capture and export buttons will instead show a USB drive icon with an error code: **X** for a hardware error, or **?** for unsupported media.



If the user inserts an unsupported device into a USB port the status bar will show a USB fault image.

Figure 4-8 USB Fault Indicators

4.7.3 System Faults and Warnings

There are several alerts that notify the user that instrument operation is or may become compromised:

- Subsystem fault
- High temperature warning

The alert notification takes priority over several of the status line indicators:

Figure 4-9 Example Alert Notification

If the alert caused the DC load to trip the entire screen will show the status condition. See section 16 Troubleshooting to diagnose the fault conditions.

4.8 Front Panel When Remote Locked

The user will not be allowed to make any changes to the instrument’s settings. The user interface can be navigated to view the instrument configuration but items such as checkboxes and radio buttons will be inactive if a change is attempted. In many cases buttons to load or change the test configuration will not be available. In some cases, the entire display will change in response to a change in the remote lock. In other cases where the configuration setting applies to the front panel only access will not be locked.

4.9 Dial Operation

The dial rotates clockwise, counterclockwise, and is pushed to select. The dial is mostly used to navigate charted results and adjust the test levels during dwell. Instructions for using the dial are detailed in sections later in this document.

4.10 Editing Numeric Settings

When configuring the settings for a test step a wide range of units and limits are involved. The units involved are:

Units	Symbol
Time	s
Voltage	V
Frequency	Hz
Current	A
Impedance	Ω
Capacitance	F
Dissipation Factor	DF (aka D)

The screen used to edit a setting provides symbology and buttons that are common to all settings, and buttons that may appear depending on the specific setting and allowed range. The following figure illustrates the typical display:

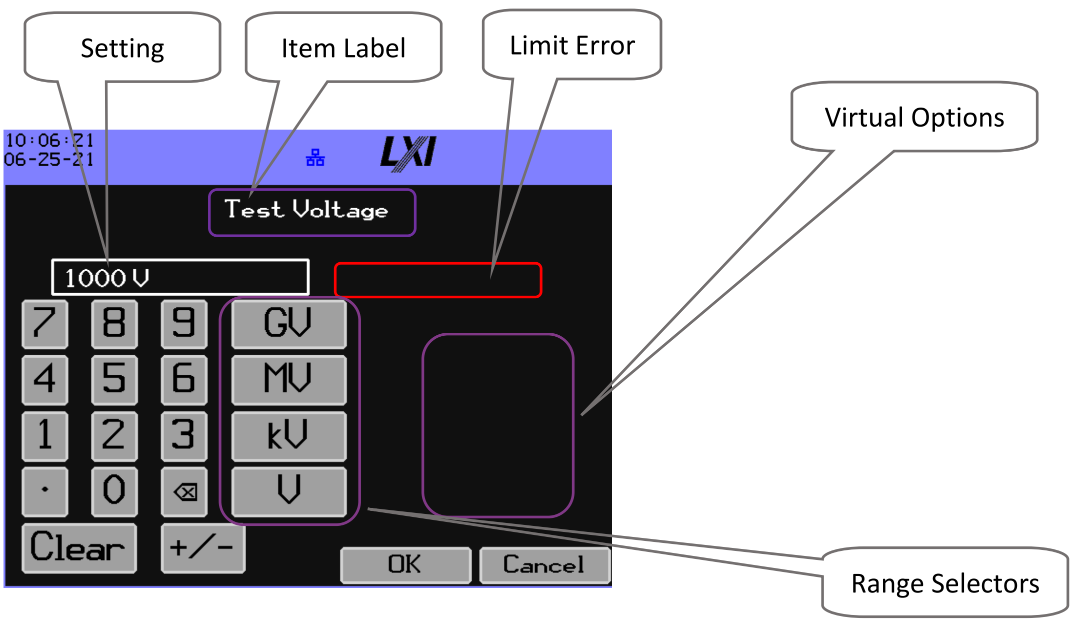


Figure 4-10 V10x Numeric Setting Editor

<u>Setting</u>

This space shows the present setting.

<u>Item Label</u>

This space identifies the setting being modified.

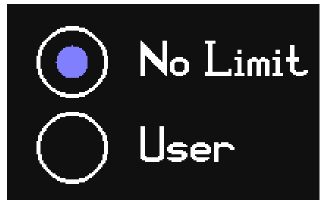
<u>Limit Error</u>

If the present setting exceeds the allowed limits this space will show the limit that is being exceeded.

Virtual Options

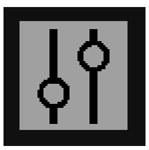
Some time limits such as Dwell are infinite in that the period is terminated by the user. In that case this space provides two buttons for selecting between the manual termination and a user limit:

When setting an impedance maximum limit, the user may choose no maximum:



Range Selectors

The user can quickly shift the range using the handy buttons. In the case of the figure above the user could change from 1000V to 1000kV by touching the **kV** button. Further, depending on the limits of the setting the set of buttons will be appropriately scaled. When the allowed range is very wide this button:


shifts the range.

Clear

This sets the value to zero.

+/-

This toggles the sign on the setting.

4.11 Time Versus Rate Settings

Some settings can alternate between time and a rate; most rates are in terms of Volts/Seconds or Amps/Second. When editing the setting the display has two sets of units units button as illustrated in this example for a withstand discharge period setting:

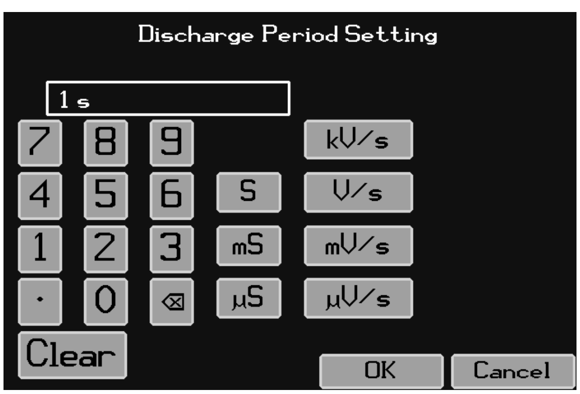


Figure 4-11 Time Versus Rate Setting

When changing units the software will translate the setting by applying the limits corresponding to the setting being configured.

5 Testing Menu

The **Testing** menu encompasses the activities to configure and execute test sequences, the menu options are:

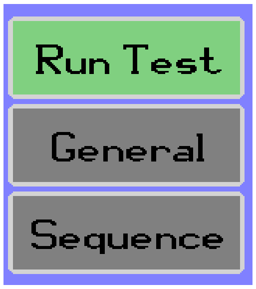


Figure 5-1 Testing Menu

- **Run Test** – Load and executes
- **General** – Configure sequence defaults and test execution limits
- **Sequence** – Create, edit, and delete sequences.

6 General Test Settings

These are settings that apply to all sequences or configure sequence defaults. These settings are accessed from the **Testing** menu by selecting the **General** option:

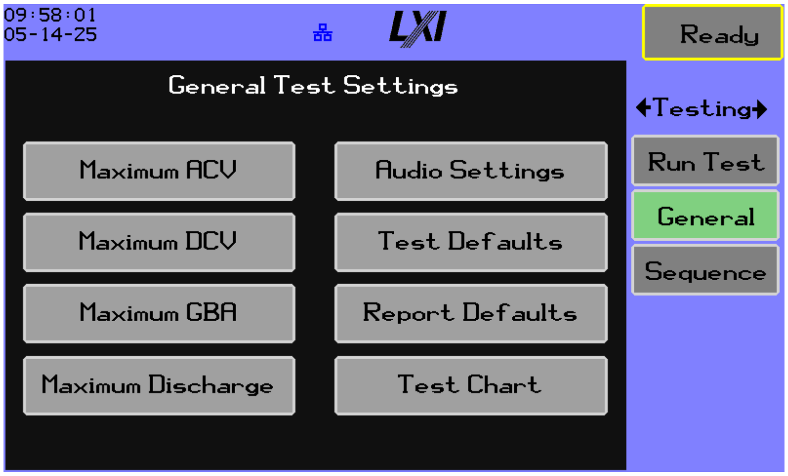


Figure 6-1 General Test Settings

6.1 General Test Settings Menu

Maximum ACV	This allows the user to set a maximum AC Voltage which the V10x will produce. This limits all test steps subsequently defined and will not allow any existing test sequence containing a test step level outside of this limit to run. Note, the factory default setting for this is model specific.
Maximum DCV	This allows the user to set a maximum DC Voltage which the V10x will produce. This limits all test steps subsequently defined and will not allow any existing test sequence containing a test step level outside of this limit to run. Note, the factory default setting for this is model specific.
Maximum GBA	This allows the user to set a maximum AC Current which the V10x will produce. This limits all test steps subsequently defined and will not allow any existing test sequence containing a test step level outside of this limit to run. Note, the factory default setting for this is model specific.
Maximum Discharge	This sets the maximum current which will be used by the V10x when discharging a load at the end of a DCW or DCIR test step. A value between 1mA and 200mA is allowed.
Audio Settings	Configures the tones produced during test execution, see below.
Test Defaults	Configures the default execution settings adopted when a new sequence is created, see section 7.6.
Report Defaults	Configures the default report settings adopted when a new sequence is created, see section 7.6.4 for details.
Test Chart	Allows the user to choose the colors used when displaying a chart while a sequence is running. See section 9.6.

6.2 Audio Settings

The V10x is capable of producing audible notifications when any of the following occurs:

- A sequence starts
- A sequence ends with a pass condition
- A sequence ends with a failure condition

In addition, the volume level for each notification can be set, a setting of zero turns the function off. These settings are configured from the Audio Settings screen:

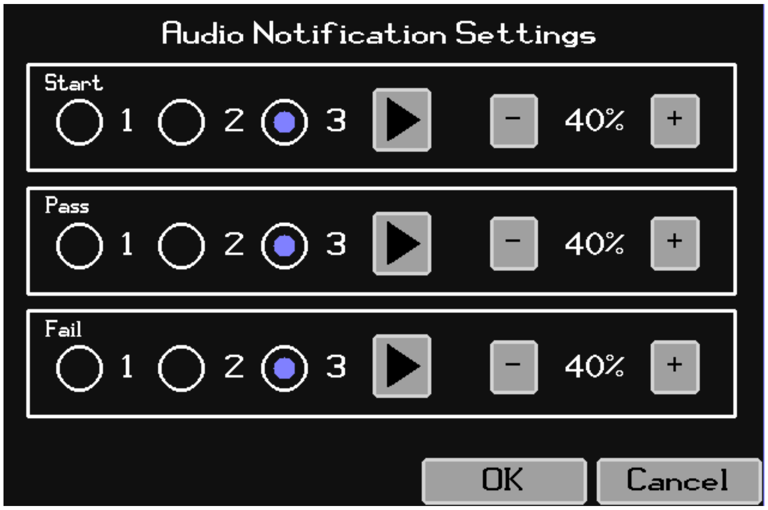


Figure 6-2 Audio Notificaton Settings

For each notification there are three distinct options available. You can use the 'Play Audio' button to preview a notificatoin at the selected volume level.

6.3 Test Chart

This screen configures the trace colors used when the user selects to display the chart. The user can touch either the line-chart icons to select a different color:

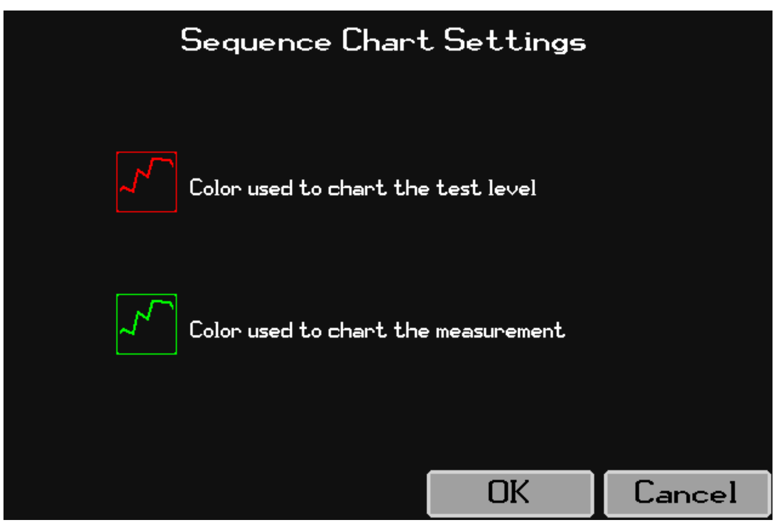


Figure 6-3 Sequence Chart Settings

7 Create and Edit Test Sequences

Although this section is primarily written for the front panel user, when programming the V10x via an interface the user should be conversant with the contents of this section.

Operation of the V10x for testing uses sequences of one or more steps to perform on a DUT (Device Under Test). Each step in a sequence can be configured to be one of several types of activity, including types for timing, waiting for user interaction, and controlling an external switch.

The V10x maintains a special sequence known as the 'manual' sequence that can be modified but not deleted. This sequence is limited to a single step but has the advantage of allowing test level and/or frequency adjustments during a step's dwell period.

The number of sequences and steps is only limited by the model's memory capacity but are effectively large enough to not limit the user. The sequences are numbered but this mostly serves for internal administration of the sequence. The user can define a name for each sequence, the names are not required to be unique. The name can have a maximum of 15 characters.

The primary key identifying a sequence is its number. The manual sequence is always #0. As the user creates sequences they are assigned an identifier. The user can only select the number for DIO selection as described in section 7.6, see section 10.2.8 to configure DIO sequence selection from the front panel, see section 12.7.9.3 to configure via a command interface.

The System Preferences options discussed in section 10.2.7 allow the user to choose if steps and/or sequences require delete confirmation; and if step changes should be auto-saved. These instructions show the user experience when confirmation is on, and auto-save is on.

7.1 Sequence Editing

The sequence editor is accessed from the **Testing** menu by selecting **Sequence**, the display shows the presently loaded sequence:

Figure 7-1 Editing the Manual Sequence

Figure 7-2 Editing a Regular Sequence

The test title has helpful formatting explained in the following table:

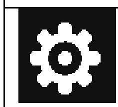
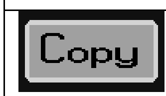
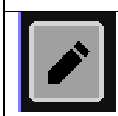
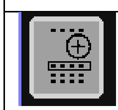
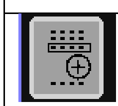
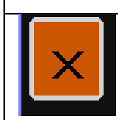
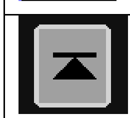
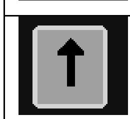
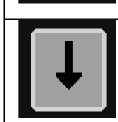
Table 7-1 Test Title Formatting

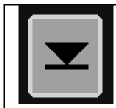
No Test Loaded	This indicates no sequence has been loaded, usually because the **Power On Sequence** is set to *Blank*.
Manual Steps: 1	Indicates the manual sequence is loaded, *Manual* is literal and cannot be changed, only one step is allowed.
#9 - My Test Steps: 13	This indicates a user sequence is loaded, it shows the sequence number, name, and number of steps.
My new Steps: 0	A new sequence is being created; no sequence number has been assigned yet so only the user configuration name is shown.

	This illustrates a sequence created by the command interface that has not been saved.

The following table identifies the symbology involved in editing a sequence. The population of buttons is dynamic in that they appear only when a valid function is available. For example: the 'scroll to first/last' buttons will only appear if more than six steps are present.

Table 7-2 Sequence Editor Symbology

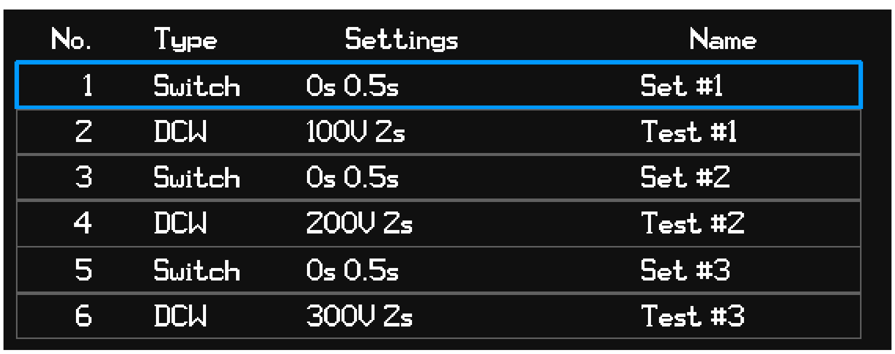
	The title bar shows the sequence number and user label.
	Accesses the sequence options discussed in section 7.6.
	Allows the creation of a new sequence.
	Loads a previously created sequence.
	Copies the existing sequence.
	Edits the presently selected step.
	Inserts a new step above the presently selected step.
	Inserts a new step below the presently selected step.
	Deletes the presently selected step.
	Scrolls the step list to the first step.
	Shift the selected step up by one.
	Switch the selected step with the step directly before it.
	Switch the selected step with the step directly after it.
	Shift the selected step down by one.

	Scrolls the step list to the last step.
	Delete the sequence.
	Clear all steps from the sequence.
	Save the pending changes to the sequence.
	Discard all changes.

The blue rectangle is a cursor for the presently selected step:

Figure 7-3 Selected Step Cursor

The information for each step shown in the list contains the step number, test type, a summary of the step's configuration, and an optional step label. To edit the step label, touch the area on the right side of the summary line. The label is used when browsing the results and the exported reports. For example, one might use labels that identify a DUT section:



No.	Type	Settings	Name
1	Switch	0s 0.5s	Set #1
2	DCW	100V 2s	Test #1
3	Switch	0s 0.5s	Set #2
4	DCW	200V 2s	Test #2
5	Switch	0s 0.5s	Set #3
6	DCW	300V 2s	Test #3

Figure 7-4 Step Label Example

7.2 Sequences with errors

There are times when a previously saved sequence will become invalid – for example if the maximum voltage limit has been changed in the general settings. The steps with errors will be highlighted by showing the step number and type in Orange. In the following example the DCV limit was set to 900V, invalidating the first step:

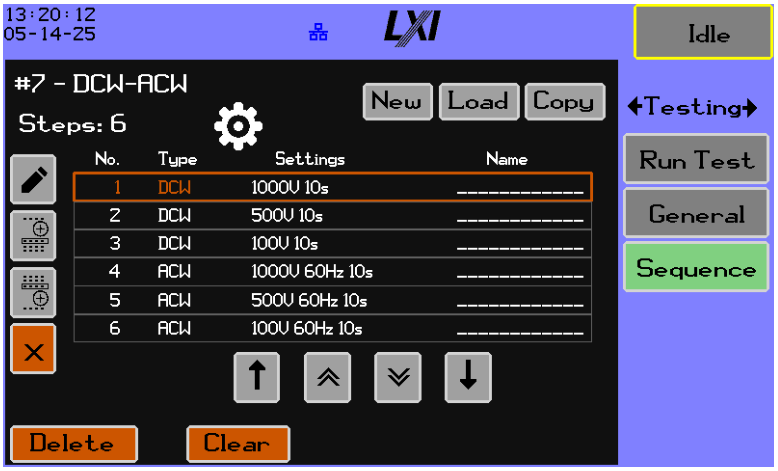


Figure 7-5 Sequence Error Example

If the user navigates to **Run Test** when the sequence has errors, the test title will show Sequence Invalid:

Figure 7-6 Sequence Execution Invalid

7.3 New Sequence

Press the **New** button to create a new sequence. The V10x presents a screen prompting for a Test Name; if you select OK an empty sequence will be created and ready for steps to be inserted. The Execution, Rerun, and Report options will be applied from the defaults discussed in section section 6.1 above.

7.4 Load Sequence

Use the **Load** button to choose among previously created sequences.

NOTE If *Auto-Save Sequence* (see section 10.2.7) is not enabled any changes in the present sequence will be discarded when you load a different sequence.

The V10x will present a list of up to five test labels; each label shows the sequence number, name, and modification date as illustrated below:

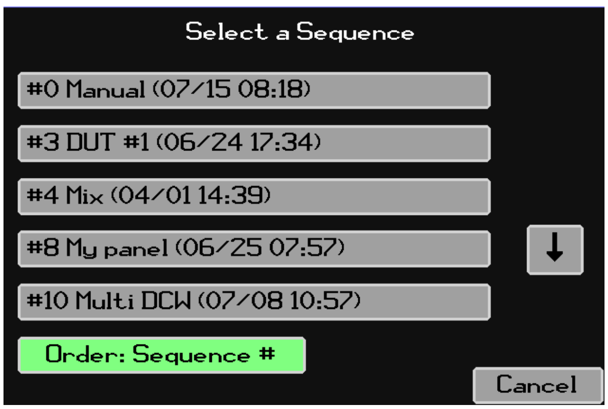


Figure 7-7 Loading a Sequence for Editing

A list of up to five sequences is shown for selection; where there are more than five sequences arrow buttons appear to navigate further, by default sorted by sequence number. Touching a button loads the test for modification.

In addition to sorting by sequence number the list can be sorted by modification time or name. Use the 'Order' button to select the sorting order.

7.5 Copy Sequence

Press the **Copy** button to copy the existing sequence. The V10x presents a screen prompting for a *Test Name*; if you select OK the sequence editor appears showing the copy. The copy is temporary until you **Save** it.

7.6 Sequence Settings

Touching the gear image accesses the sequence settings screen; immediately available are the **Execution** and **Rerun** options, touch the **Report Options** button to change the report options – see section 7.6.4 below. The buttons on the upper left corner are used to change the sequence number and name – not available when working with the Manual sequence.

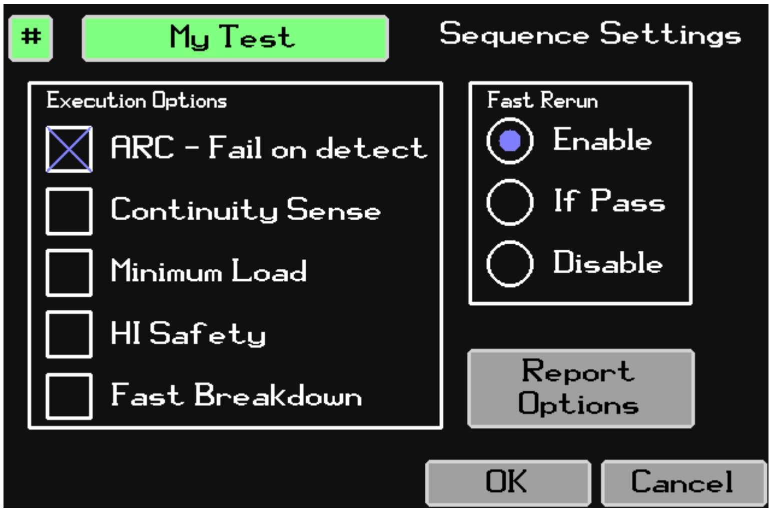
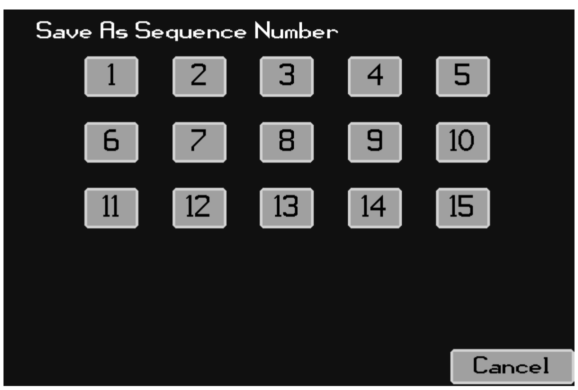


Figure 7-8 Sequence Settings

7.6.1 Save As Sequence Number

The sequence number button **#** is used to select a specific sequence number, this is intended to operate with the DIO facility discussed in section 10.2.8. The user can select a number in the range 1 to 15:



NOTE If you select a number that already exists the sequence will be overwritten.

Figure 7-9 Sequence Number Selection

7.6.2 Execution Options

These settings apply during the execution of all steps in a sequence.

Table 7-3 Sequence Execution Options

ARC - Fail on detect	This allows the user to select whether all test steps configured for arc detection will either fail the test if an arc is detected (FAIL ON DETECT) or not (DETECT ONLY). **NOTE** Arc detection is enabled or disabled by a separate user setting in each individual test step.

Continuity Sense	Enables the *Continuity Sense* feature in certain types of test steps (see the specific test step type sections of this manual for details).
Minimum Load	Controls the ability to detect that there is a minimum load attached during DCW or DCIR type test steps (see the specific test type sections of this manual for details). If enabled in this menu, then each DCW and DCIR test step may be individually configured for minimum loading detection as needed.
HI Safety	Controls the ability of the V10x to detect excessive HV terminal current in high voltage test step types (see the specific test type sections of this manual for details).
Fast Breakdown	Fixes the current measurement range to the maximum leakage limit in order to catch breakdown more quickly.

7.6.3 Fast Rerun

Enable	Allows the user to rerun a test sequence without having to terminate reviewing the results.
If Pass	Allows the user to rerun a test sequence without having to terminate reviewing the results if the sequence has passed.
Disable	Never allows fast rerun.

If fast rerun is not enabled, the user must terminate reviewing results by using the STOP button before they can rerun the test sequence with the START button.

7.6.4 Report Options

When a sequence completes the V10x is capable of automatically saving a sequence report to a flash drive. The following figure illustrates the report option settings:

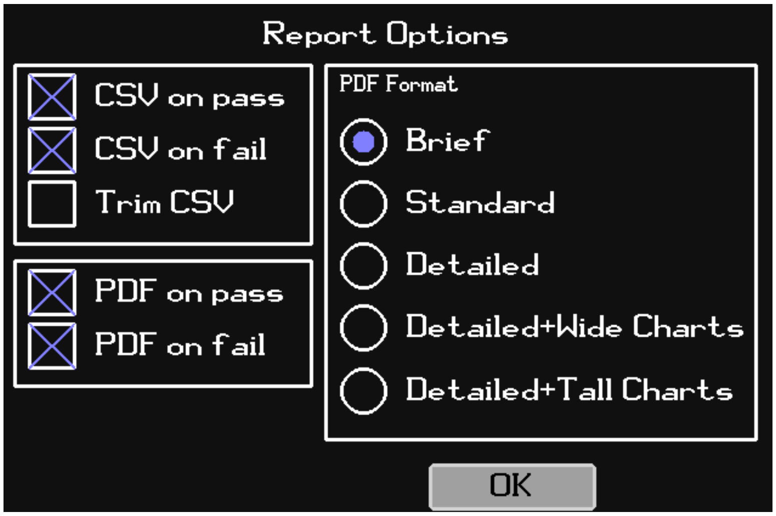


Figure 7-10 Report Options

NOTE A flash drive must be present in one of the USB sockets for the feature to execute. Reports are not generated when the '*Continuously Run Until Failure*' option is selected as discussed in section 8.2; reports are not generated if the user runs a slected step.

The *CSV on* checkboxes allow the file to be generated for pass, fail, or both results.

The *Trim CSV* option causes the report to not output empty columns; this is most useful when there are lots of steps of the same type.

See appendix D for CSV file format details.

The *PDF Format* radio buttons select the level of detail. All report formats have a common page heading that includes the following items:

- Title
- Instrument model, serial number, and firmware version
- The user name (anonymous if user security is not enabled)
- Test date and time
- Sequence pass/fail result
- Sequence number
- Sequence name
- Test label
- Sequence num number
- Sequence result flags

The following table briefly discusses the format option levels:

Table 7-4 PDF Report Format Levels

Level Option	**Description**
Brief	One line per test step showing the step #, type, result, and relevant results; only the first step error is printed.
Standard	Multiple lines per test step, a column showing the main step settings, a column showing execution results; all step errors are printed.
Detailed	Multiple lines per test step, a column showing the main step settings and check limits, a column showing execution results; all step errors are printed.
Detailed+Wide Charts	As *Detailed* above with drive and measurement charts arrayed left to right, the charts are about 2” wide.
Detailed+Tall Charts	As *Detailed* above with drive and measurement charts arrayed top to bottom, the charts are 6” wide.

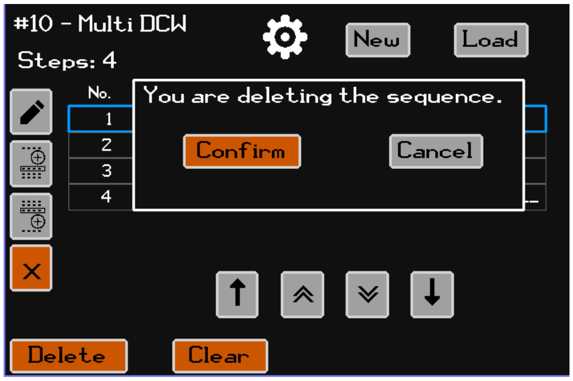
See appendix E for sample reports.

The automatically generated file name is 8 hex digits that encode the test time as a Unix time stamp. For example, presume the test was executed on March 1 in the year 2022 at 16:55:42, the GMT timestamp is 1646153742 decimal, in hex it is 621E500E. The mechanism is intended to retain 8.3 file name formatting.

NOTE Large sequences will require more processing time. A good rule of thumb is every 10 steps take ½ second when producing Brief, Standard, or Detailed; when charts are selected every step takes about ½ second.

7.7 Delete Sequence

If the user touches the **Delete** button the present sequence will be deleted. If the '*Sequence deletion'* **Confirmation** option is checked in the system preferences a dialog will pop up:



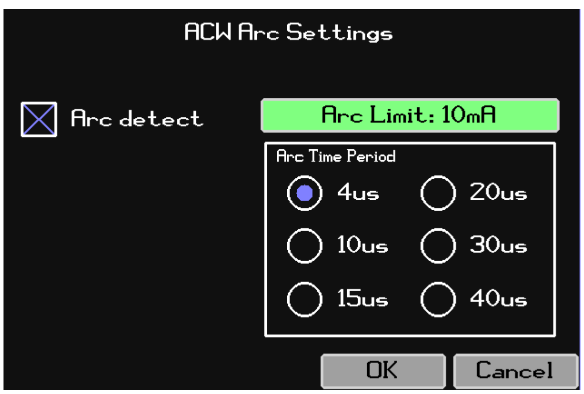
Use the Confirm button to complete deleting the test sequence.

Figure 7-11 Sequence Deletion Confirmation Pop-up

7.8 Common Arc Configuration

Arc detection is only available when the DUT is isolated. See Table 1-2 Arc Detection Specifications for the current limits, the time period must be one of the six options illustrated below.

Most steps that support arc detection use the same display as illustrated for ACW below:



Arc Detect
Enables arc detection for the test step.

Arc Limit
The current limit above which arc is declared present.

Arc Time Period
The period over which arc must be present before arc is declared present.

Figure 7-12 Common Arc Settings Screen

The ACI and DCI steps use settings on the main display, discussed in section 7.21.

7.9 Configuring Discharge

The steps that output high voltage or current have a discharge phase when the dwell period completes. One of four options are available:

Table 7-5 Discharge Options

Option	Description
None	Discharge is skipped if the following step is compatible.
Fast	As fast as possible – a function of the test level and DUT characteristics.
Ramp	Identical to the ramp setting.
Rate	Allows the ramp time period to be programmed either as a time or rate.

In the majority of cases, *Fast* can be used. In the event *None* is selected and the following step is not compatible then a fast discharge is used.

7.10 Configuring Time Periods

Most of the test step types require time period settings for ramp and dwell. The following table lists the maximum periods for the different phases. Where a step is not shown it does not use explicit periods or the time periods are special cases (such as BRKDN).

Table 7-6 Test Step Time Period Limits

Step	Ramp/Discharge period	Delay	Dwell
ACW	9999 seconds	N/A	999 days
ACCAP	9999 seconds	N/A	999 days
DCW	9999 seconds	3600 seconds	999 days
DCIR	9999 seconds	3600 seconds	999 days
GB	9999 seconds	N/A	999 days
LowΩ	N/A	3600 seconds	999 days
ACI	N/A	3600 seconds	999 days
DCI	N/A	3600 seconds	999 days
Pause	N/A	3600 seconds	N/A
Hold	N/A	3600 seconds	N/A

Time periods are always entered in units of seconds. Depending on the display space allocated the period will be shown to the user using a format as illustrated by these dwell examples:

Table 7-7 Time Period Display Examples

Period (seconds)	Display
0.2	200ms
0.5	0.5s
59.5	59.5s
61.2	01m:1.2s
600	10m:0.0s
3600	01h:00m:00s
72000	20h:00m:00s
86400	1d 00:00
259200	3d 00:00
Command	CMD

7.11 Insert or Edit a Step

When a step is selected for editing, or a step insert button is used, the V10x prompts the user to select a step type:

Figure 7-13 Step Type Selection

A type button will be highlighted to indicate the type of the step being edited, or the type of the last edited step.

NOTE

The available step types are dependent on the model and options. The options above illustrate a tester with AC drive, DC drive, GB drive, and Pulse option. The Pause, Hold, and Switch types are not available when working with the manual sequence; the switch type will not be available if the system is not configured for switching, see section 10.2.10 for information on configuration of switches.

After selecting a step type the display changes to present step specific configuration settings are presented. The settings will default to commonly used values unless it is repeated from the last new step, in which case the last set of values will be present.

7.12 Deleting a Step

The Orange X button is used to delete the selected step. If the '*Step deletion*' **Confirmation** option is checked in the system preferences a dialog will pop up:

Figure 7-14 Step Deletion Confirmation Pop-up

The user has the extra step to confirm the action.

7.13 Editing Check Limits

Many of the step types have pairs of check settings in terms of minimum and maximum limits. When editing these settings, the minimum cannot exceed the maximum and conversely the maximum cannot be set below the minimum. When configuring one of these limits you may be warned about a range error that is not a function of the instrument limits but instead is due to straying outside of the working endpoints.

For example, say you are configuring a DCW step's limits in terms of current and the present limits are 10mA to 20mA:

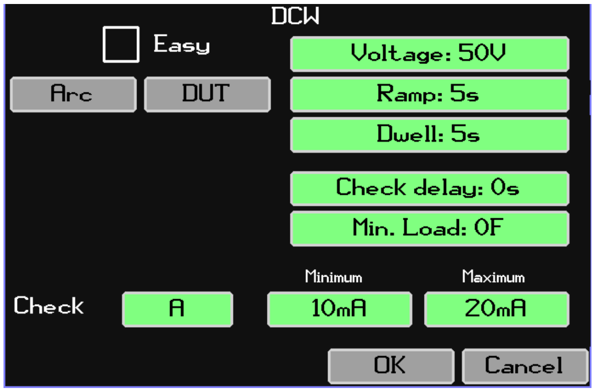


Figure 7-15 Editing Step Limits Example #1

If you require to change the minimum to 25mA and the maximum to 35mA when you attempt to first change the minimum to 25mA you will be warned that it exceeds a maximum of 20mA. Instead change the maximum to 35mA then change the minimum.

7.14 Step Validation

Many of the step settings are interrelated and affect the limits of other settings. When a step is saved it goes through a final validation process that checks the settings in their entirety, if a setting is invalid a dialog is raised indicating the problem. For example: presume a DCW step set at 5.5kV and the grounding setting is enabled. This reduces the maximum drive voltage to 5kV. When the step is saved the excessive level setting fails the validation checks and the resulting dialog looks like:

Figure 7-16 Step Validation Failure Example

7.15 Edit ACW step

This step type supports an 'Easy' configuration mode where some options are not available and are otherwise fixed:

- The breakdown limit is a function of the RMS leakage maximum setting
- Single check for RMS leakage current
- Only normal sense
- No arc detection
- No discharge

The figure below illustrates the visible differences between *Easy* and *Standard* configuration displays. Also note the Drive settings may not be available if the instrument was not ordered with the external drive option.

Easy **Standard (with two checks)**

Figure 7-17 ACW Step Configuration Screens

7.15.1 Settings

The following paragraphs will discuss the configuration in terms of the ***Standard*** configuration since it is a superset of the allowed settings.

Voltage Configures the test output voltage level. The level will be limited according to the following factors:

- Instrument model
- Drive source setting
- Grounding setting
- Maximum ACV limit discussed in section 6.1.

Frequency Configures the test output frequency. The value must stay within the range of possible output frequencies supported by the specific model.

Ramp Allows the ramp time period to be programmed either as a time or rate. The configuration dialog has buttons for **S**econds or **V**olts/**S**econd.

Dwell Sets dwell time period or may be set to be user terminated using the **Command** option in the configuration dialog.

Drive Allows the user to select whether to use the standard internal source at the native terminals or the higher voltage source from an external accessory. When changing from External to Internal the voltage level will be reduced as necessary; when changing to External drive the sense configuration will revert to Normal and the DUT must be isolated.

Check In the standard configuration mode, the user can select zero, one, or two limit checks during dwell. The measurement check options are:

- None
- RMSA
- INPHSA
- QUADA
- RMSO
- INPHSO
- QUADO

RMS. Selects that the leakage check is performed on the RMS current measurement.

INPHS. Selects that the leakage check is performed on the in-phase (i.e., resistive loading) current measurement.

QUAD. Selects that the leakage check is performed on the quadrature (i.e., reactive loading) current measurement.

Minimum Configures the lower limit applied when checking the specified measurement during the dwell period. Depending on the check type the limit is in terms of current or impedance. When checking current a value of zero effectively disables the lower limit.

Maximum Configures the upper limit applied when checking the specified measurement during the dwell period. Depending on the check type the limit is in terms of current or impedance. See AC Voltage Withstand and Leakage Testing (ACW and ACCAP) Specifications Loading Capability for the maximum check limits.

Abort on fail Allows the user to program the V10x to abort the entire sequence if this step fails any of its checks. A safety related failure, a user abort (STOP button), a DIO abort, or command abort always aborts the entire sequence.

Grounding This option is only available when using the Internal source. This configuration allows the user to select either:

- Isolated — The DUT is isolated from ground, the V10x will use the current in the RETURN terminal to measure leakage and detect breakdown.
- Grounded — The DUT is grounded, and the breakdown and/or leakage currents are to be measured to ground. The V10x will use the current in the HV terminal to measure leakage and detect breakdown. The voltage level may be lowered as necessary if it exceeds the HSS limit.

Sense This option is only available when using the Internal source. This setting configures where voltage will be sensed for feedback:

- Normal Volage sense is at the source terminal.
- Remote Voltage is sensed using the remote terminal.

Breakdown Allows breakdown detection to be configured as a maximum instantaneous peak current level. See section 3.3.2.1 Breakdown Current for further details regarding breakdown currents.

- The minimum value which can be set is 1uA.
- The maximum value which can be set is as specified in AC Voltage Withstand and Leakage Testing (ACW and ACCAP) Specifications the Peak Shutdown Current portion of Surge Current Limiting and Shutdown.

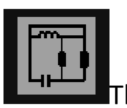
In Easy mode the breakdown detection limit is set to 2 times the maximum RMS leakage current limit with a minimum of 1uApk.

Discharge Configures the discharge phase, see section 0 for options.

Arc Use the checkbox to enable arc detection during this step. Both the time and current level can be independently programmed. See section 3.3.2.3 Arc Current and Time for details. see Table 1-2 Arc Detection Specifications for the current and time limits. Note this only enables arc detection, failing the step if arc is detected must be checked in the sequence options discussed in section 7.6.2.

Note Arc detection is not available if the DUT grounding is set to **Grounded**.

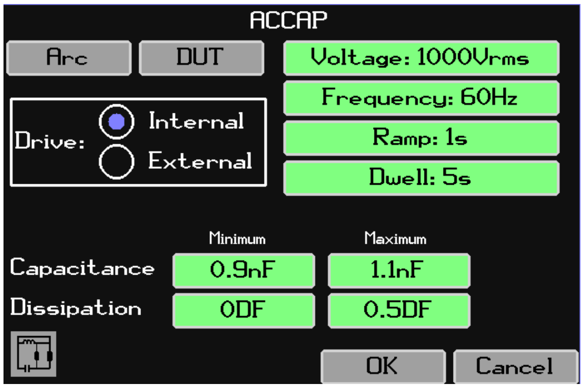
7.15.2 Manual Lead Compensation

The tiny circuit button leads to a form to edit manual lead compensation settings.

The adjustments are in terms of conductance. The values will typically be very small. Note that the settings must be enabled for them to be applied to the measurements.

7.16 Edit ACCAP step

The figure below illustrates the screens unique to editing a ACCAP type step.



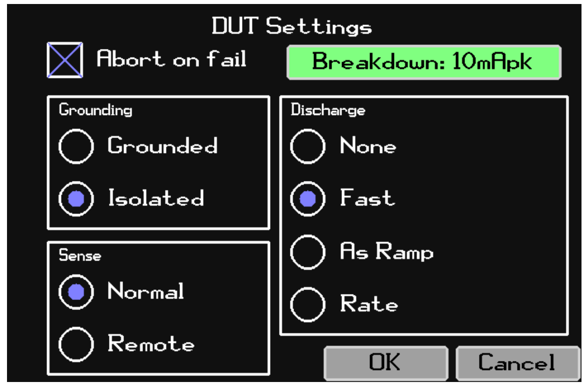


Figure 7-18 ACCAP Step Configuration Screens

7.16.1 Settings

The following paragraphs will discuss the configuration settings for the ACCAP step.

Voltage Configures the test output voltage level. The level will be limited according to the following factors:

- Instrument model
- Drive setting
- Grounding setting
- Maximum ACV limit discussed in section 6.1.

Frequency Configures the test output frequency. The value must stay within the range of possible output frequencies supported by the specific model.

Ramp Allows the ramp time period to be programmed either as a time or rate. The configuration dialog has buttons for **S**econds or **V**olts/**S**econd.

Dwell Sets dwell time period or may be set to be user terminated using the **Command** option in the configuration dialog.

Drive Allows the user to select whether to use the standard internal source at the native terminals or the higher voltage source from an external accessory. When changing from External to Internal the voltage level will be reduced as necessary; when changing to External drive the sense configuration will revert to Normal and the DUT must be isolated.

Capacitance Allows the user to define the range within which the capacitance measurement is considered a PASS during the dwell period.

The highest maximum limit which can be entered is determined by the maximum loading current which the specific V10x model and option content can continuously supply at the configured test voltage and frequency, see AC Voltage Withstand and Leakage Testing (ACW and ACCAP) Specifications Loading Capability.

Dissipation Allows the user to define the range within which the dissipation factor measurement is considered a PASS during the dwell period. The limits are applied without regard to the polarity of the measured dissipation factor.

Setting a DF range of 0.0000->1.0000 will effectively ignore the dissipation factor measurement as all dissipation factors lay within this range by definition.

Abort on fail Allows the user to program the V10x to abort the entire sequence if this step fails any of its checks. A safety related failure, a user abort (STOP button), a DIO abort, or command abort always aborts the entire sequence.

Grounding This option is only available when using the Internal source. This configuratoin allows the user to select either:

- Isolated — The DUT is isolated from ground, the V10x will use the current in the RETURN terminal to measure leakage and detect breakdown.
- Grounded — The DUT is grounded, and the breakdown and/or leakage currents are to be measured to ground. The V10x will use the current in the HV terminal to measure leakage and detect breakdown. The voltage level may be lowered as necessary if it exceeds the HSS limit.

Sense This option is only available when using the Internal source. This setting configures where voltage will be sensed for feedback:

Normal	Volage sense is at the source terminal.
Remote	Voltage is sensed using the remote terminal.

Breakdown Allows breakdown detection to be configured as a maximum instantaneous peak current level. Pressing the LIMIT key while this setting is selected causes it to be set to the maximum value. See section 3.3.2.1 Breakdown Current for further details regarding breakdown currents.

- The minimum value which can be set is 1uA.
- The maximum value which can be set is as specified in AC Voltage Withstand and Leakage Testing (ACW and ACCAP) Specifications the Peak Shutdown Current portion of Surge Current Limiting and Shutdown.

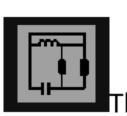
In Easy mode the breakdown detection limit is set to 2 times the maximum RMS leakage current limit with a minimum of 1uApk.

Discharge Configures the discharge phase, see section 0 for options.

Arc Use the checkbox to enable arc detection during this step. Both the time and current level can be independently programmed. See section 3.3.2.3 Arc Current and Time for details. see Table 1-2 Arc Detection Specifications for the current and time limits. Note this only enables arc detection, failing the step if arc is detected must be checked in the sequence options discussed in section 7.6.2.

Note Arc detection is not available if the DUT grounding is set to *Grounded*.

7.16.2 Manual Lead Compensation

The tiny circuit button leads to a form to edit manual lead compensation settings.

The adjustments are in terms of conductance. The values will typically be very small. Note that the settings must be enabled for them to be applied to the measurements.

7.17 Edit DCW step

This step type supports an 'Easy' configuration mode where some options are not available or are otherwise fixed:

- The breakdown limit is a function of the RMS leakage maximum setting
- Single check for leakage current
- Only normal sense
- No arc detect
- No discharge

The figure below illustrates the visible differences between *Easy* and *Standard* configuration displays.

Easy **Standard**

Figure 7-19 DCW Step Configuration Screens

7.17.1 Settings

The following paragraphs will discuss the configuration in terms of the ***Standard*** configuration since it is a superset of the allowed settings.

Voltage Configures the test output voltage level. The level will be limited according to the following factors:

- Instrument model
- Drive setting
- Grounding setting
- Maximum DCV limit discussed in section 6.1.

Ramp Allows the ramp time period to be programmed either as a time or rate. The configuration dialog has buttons for **S**econds or **V**olts/**S**econd.

- For loads having >0.03uF capacitance the test ramp time should be >0.1sec. The ramp time may need to be extended beyond this to ensure the charging current is less than the desired breakdown detection current. For reference, the charging current (in microamps) = C.(dV/dT) where C is the capacitance in uF and (dV/dT) is the ramp rate in Volts per second (e.g., 1000V/sec ramp into a 10uF load is 10000uA =10mA charging current). For optimum results –
  - For loads >0.05uF the ramp time should be >0.5sec.
  - For loads >2uF the ramp time should be >1sec.
  - For loads >20uF the ramp time should be >2sec.
- If a load has significant resistance in series with capacitance, then ensure that the charging current is within the capability of the series resistance to avoid it being damaged. If necessary, reduce the charging current by using a slower ramp rate.

Dwell Sets dwell time period or may be set to be user terminated using the **Command** option in the configuration dialog.

Check delay Allows the user to program a delay within the dwell period before the leakage range check is to be performed.

- The V10x series use a “strong voltage source” method for the DCW and DCIR types. This enables the use of much shorter test times when performing testing into capacitive loads since it is being both charged and tested from a low impedance source, unlike the “classical” approach of using a high source impedance to reduce the effects of voltage source noise but needing very long test times into capacitive loads. For the V10x, there is a short stabilization period required after the end of ramp when making very low leakage current tests (e.g., 10’s of nA) with significant capacitance, typically this is less than 0.5sec for loads up to 1uF extending to 5sec for loads of 10uF and above, which should be accommodated by setting the delay setting accordingly. After this there is no further settling time required for the V10x at any leakage current level. If performing breakdown testing at higher current levels (e.g., 100’s of uA and above) then no delay is typically required.
- Some capacitive loads have a significant dielectric storage affect. Because of this there may be significant leakage current flowing for some time after the dwell period starts. Depending on the materials, dielectric storage effects can last from a fraction of a second to many tens of seconds or even longer.

Min. Load This is only available if the *Minimum Load* option is enabled as discussed in section

7.6.2. This allows the user to specify a minimum capacitance load which should be encountered during ramp. If this loading is not encountered during ramp, then the test is failed with a <MIN LOAD status. This provides an easy to use and very sensitive determination of whether the load is properly connected. Please note the following –

- For settings of below 1nF there must be enough charging current flow during ramp for the set minimum capacitive load to be successfully detected. For a DUT GROUNDED setting of NO (or option HSS or HSS-2 not fitted), then the ramp rate should be >1000V/sec for a 1pF setting reducing to >1V/sec (and lower) for a 1nF (and higher) setting. For a DUT GROUNDED setting of YES, a setting below 1nF is not recommended.
- For settings of over 1nF then the actual load capacitance is estimated during ramp and compared to the Min Load setting (this has no minimum ramp time requirement). This is not an accurate DUT capacitance measurement, the accuracy is typically 10%.
- If there is sufficient resistive load, then this is automatically detected and there will be no <MIN LOAD failure.
- If the expected capacitive load is known, then a setting of half the expected capacitance is recommended.

Check Allows the check limits to be applied to current or impedance; in easy mode it is current and cannot be changed.

Minimum/ Maximum Allows the user to define the range within which the leakage current is considered a PASS during the dwell period. When checking impedance selection, the user may optionally disable the upper limit by selecting the “No Limit” maximum.

- Setting a zero minimum current limit disables the minimum limit and only applies the maximum limit.
- The maximum allowed current limit (or the minimum impedance limit) is the maximum loading current which the specific V10x model and option content can continuously supply at the configured test voltage, see Loading Capability in section 1.6.4.
- Setting a zero minimum and maximum leakage currents for the DCW type disables leakage current testing entirely, only the breakdown and (optionally) the arc current limits are used.
- Setting a very small minimum leakage current (or maximum leakage resistance) limit to attempt to detect a disconnected DUT is not recommended, the *Min. Load* setting should be used instead.
- In easy mode the breakdown detection limit is automatically set to the maximum leakage current limit with a minimum of 1uApk.

Abort on fail Allows the user to program the V10x to abort the entire sequence if this step fails any of its checks. A safety related failure, a user abort (STOP button), a DIO abort, or command abort always aborts the entire sequence.

Grounding This configuration allows the user to select either:

- Isolated — The DUT is isolated from ground, the V10x will use the current in the RETURN terminal to measure leakage and detect breakdown.
- Grounded — The DUT is grounded, and the breakdown and/or leakage currents are to be measured to ground. The V10x will use the current in the HV terminal to measure leakage and detect breakdown. The

voltage level may be lowered as necessary if it exceeds the HSS limit.

Sense This setting configures where voltage will be sensed for feedback:

- Normal — Volage sense is at the source terminal.
- Remote — Voltage is sensed using the remote terminal.

Breakdown Allows breakdown detection to be configured as a maximum instantaneous peak current level. See section 3.3.2.1 Breakdown Current for further details regarding breakdown currents.

- The minimum value which can be set is 1uA.
- The maximum value which can be set is as specified in section 1.6.4.

In Easy mode the breakdown detection limit is set to 2 times the maximum RMS leakage current limit with a minimum of 1uApk.

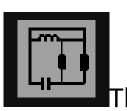
Discharge Configures the discharge phase, see section 0 for options.

- If a load has significant resistance in series with capacitance, then ensure that the discharging current is within the capability of the series resistance to avoid it being damaged. If necessary, reduce the maximum discharging current by reducing the *Maximum Discharge* setting discussed in section 6.1 General Test Settings Menu.

Arc Use the checkbox to enable arc detection during this step. Both the time and current level can be independently programmed. See section 3.3.2.3 Arc Current and Time for details. see Table 1-2 Arc Detection Specifications for the current and time limits. Note this only enables arc detection, failing the step if arc is detected must be checked in the sequence options discussed in section 7.6.2.

Note Arc detection is not available if the DUT grounding is set to **Grounded**.

7.17.2 Manual Lead Compensation

The tiny circuit button leads to a form to edit manual lead compensation settings.

The adjustment is in terms of conductance. The value will typically be very small. Note that the setting must be enabled for it to be applied to the measurements.

7.18 Edit DCIR step

The figure below illustrates the screens unique to editing a DCIR type step.

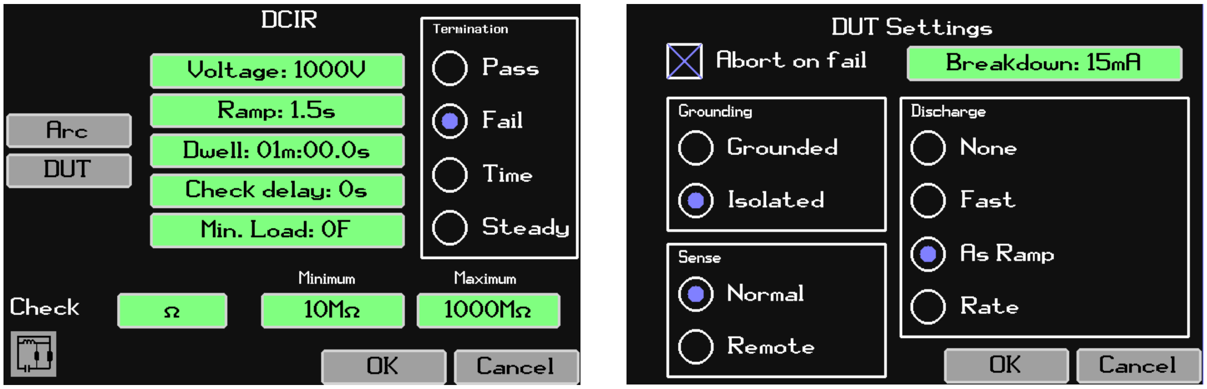


Figure 7-20 DCIR Step Configuration Screens

7.18.1 Settings

The following paragraphs will discuss the configuration settings for the DCIR test.

Voltage Configures the test output voltage level. The level will be limited according to the following factors:

- Instrument model
- Drive setting
- Grounding setting
- Maximum DCV limit discussed in section 6.1.

Ramp Allows the ramp time period to be programmed either as a time or rate. The configuration dialog has buttons for **S**econds or **V**olts/**S**econd.

- For loads having >0.03uF capacitance the test ramp time should be >0.1sec. The ramp time may need to be extended beyond this to ensure the charging current is less than the desired breakdown detection current. For reference, the charging current (in microamps) = C.(dV/dT) where C is the capacitance in uF and (dV/dT) is the ramp rate in Volts per second (e.g., 1000V/sec ramp into a 10uF load is 10000uA =10mA charging current). For optimum results –
  - For loads >0.05uF the ramp time should be >0.5sec.
  - For loads >2uF the ramp time should be >1sec.
  - For loads >20uF the ramp time should be >2sec.
- If a load has significant resistance in series with capacitance, then ensure that the charging current is within the capability of the series resistance to avoid it being damaged. If necessary, reduce the charging current by using a slower ramp rate.

Dwell Sets dwell time period or may be set to be user terminated using the **Command** option in the configuration dialog.

Check delay Allows the user to program a delay within the dwell period before the leakage range check is to be performed.

- The V10x series use a “strong voltage source” method for the DCW and DCIR types. This enables the use of much shorter test times when performing testing into capacitive loads since it is being both charged and tested from a low impedance source, unlike the "classical" approach of using a high source impedance to reduce the effects of voltage source noise but needing very long test times into capacitive loads. For the V10x, there is a short stabilization period required after the end of ramp when making very low leakage current tests (e.g., 10's of nA) with significant capacitance, typically this is less than 0.5sec for loads up to 1uF extending to 5sec for loads of 10uF and above, which should be accommodated by setting the delay setting accordingly. After this there is no further settling time required for the V10x at any leakage current level. If performing breakdown testing at higher current levels (e.g., 100's of uA and above) then no delay is typically required.

- Some capacitive loads have a significant dielectric storage affect. Because of this there may be significant leakage current flowing for some time after the dwell period starts. Depending on the materials, dielectric storage effects can last from a fraction of a second to many tens of seconds or even longer.

Min. Load This is only available if the *Minimum Load* option is enabled as discussed in section 7.6.2. This allows the user to specify a minimum capacitance load which should be encountered during ramp. If this loading is not encountered during ramp, then the test is failed with a <MIN LOAD status. This provides an easy to use and very sensitive determination of whether the load is properly connected. Please note the following –

- For settings of below 1nF there must be enough charging current flow during ramp for the set minimum capacitive load to be successfully detected. For a DUT GROUNDED setting of NO (or option HSS or HSS-2 not fitted), then the ramp rate should be >1000V/sec for a 1pF setting reducing to >1V/sec (and lower) for a 1nF (and higher) setting. For a DUT GROUNDED setting of YES, a setting below 1nF is not recommended.
- For settings of over 1nF then the actual load capacitance is estimated during ramp and compared to the Min Load setting (this has no minimum ramp time requirement). This is not an accurate DUT capacitance measurement, the accuracy is typically 10%.
- If there is sufficient resistive load, then this is automatically detected and there will be no <MIN LOAD failure.
- If the expected capacitive load is known, then a setting of half the expected capacitance is recommended.

Termination Allows the user to select when the dwell period will be ended –

- Pass. The dwell period will be immediately terminated with a PASS status if the leakage measurement is within limits continuously for at least 2% of the dwell period. If the dwell period ends without this being detected, then the pass/fail status for leakage is based upon the final measurement taken at the end of the dwell period.
- Fail. The dwell period will be immediately terminated with a FAIL status if the leakage measurement is outside of limits continuously for at least 2% of the dwell period. If the dwell period ends, then the test step will have a PASS status for leakage. This selection produces comparable results to the DCW type (which terminates dwell immediately on a FAIL condition).
- Time. The dwell period always extends for the entire programmed period. The pass/fail status for leakage is based upon the final measurement taken at the end of the dwell period.
- Steady. The dwell period will be automatically terminated when the leakage is within the allowable limits and the current is steady or decreasing (i.e., steady

or increasing resistance). If the dwell period ends, then the test step will have a FAIL status for leakage.

Check Allows the check limits to be applied to current or impedance.

Minimum/ Maximum Allows the user to define the range within which the leakage current is considered a PASS during the dwell period. When checking impedance selection, the user may optionally disable the upper limit by selecting the "No Limit" maximum.

- Setting a zero minimum current limit disables the minimum limit and only applies the maximum limit.
- The maximum allowed current limit (or the minimum impedance limit) is the maximum loading current which the specific V10x model and option content can continuously supply at the configured test voltage, see Loading Capability in section 1.6.4.
- Setting a zero minimum and maximum leakage currents for the DCW type disables leakage current testing entirely, only the breakdown and (optionally) the arc current limits are used.
- Setting a very small minimum leakage current (or maximum leakage resistance) limit to attempt to detect a disconnected DUT is not recommended, the *Min. Load* setting should be used instead.
- In easy mode the breakdown detection limit is automatically set to the maximum leakage current limit with a minimum of 1uApk.

Abort on fail Allows the user to program the V10x to abort the entire sequence if this step fails any of its checks. A safety related failure, a user abort (STOP button), a DIO abort, or command abort always aborts the entire sequence.

Grounding This configuration allows the user to select either:

- Isolated — The DUT is isolated from ground, the V10x will use the current in the RETURN terminal to measure leakage and detect breakdown.
- Grounded — The DUT is grounded, and the breakdown and/or leakage currents are to be measured to ground. The V10x will use the current in the HV terminal to measure leakage and detect breakdown. The voltage level may be lowered as necessary if it exceeds the HSS limit.

Sense This setting configures where voltage will be sensed for feedback:

- Normal — Volage sense is at the source terminal.
- Remote — Voltage is sensed using the remote terminal.

Breakdown Allows breakdown detection to be configured as a maximum instantaneous peak current level. See section 3.3.2.1 Breakdown Current for further details regarding breakdown currents.

- The minimum value which can be set is 1uA.
- The maximum value which can be set is as specified in the Peak Shutdown Current portion of Surge Current Limiting and Shutdown section in section 1.6.4.

In Easy mode the breakdown detection limit is set to 2 times the maximum RMS leakage current limit with a minimum of 1uApk.

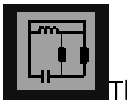
Discharge Configures the discharge phase, see section 0 for options.

- If a load has significant resistance in series with capacitance, then ensure that the discharging current is within the capability of the series resistance to avoid it being damaged. If necessary, reduce the maximum discharging current by reducing the *Maximum Discharge* setting discussed in section 6.1 General Test Settings Menu.

Arc Use the checkbox to enable arc detection during this step. Both the time and current level can be independently programmed. See section 3.3.2.3 Arc Current and Time for details. see Table 1-2 Arc Detection Specifications for the current and time limits. Note this only enables arc detection, failing the step if arc is detected must be checked in the sequence options discussed in in section 7.6.2.

Note Arc detection is not available if the DUT grounding is set to **Grounded**.

7.18.2 Manual Lead Compensation

The tiny circuit button leads to a form to edit manual lead compensation settings.

The adjustment is in terms of conductance. The value will typically be very small. Note that the setting must be enabled for it to be applied to the measurements.

7.19 Edit GB step

This step type supports an 'Easy' configuration mode where some options are not available or are otherwise fixed:

- The maximum drive voltage limit cannot be set
- Is configured to only check RMS voltage limits
- No timed ramp
- Fast discharge

The figure below illustrates the visible differences between *Easy* and *Standard* configuration displays. Also note the Drive settings may not be available if the instrument was not ordered with the external drive option.

Easy **Standard**

Figure 7-21 GB Step Configuration Screens

7.19.1 Settings

The following paragraphs will discuss the configuration in terms of the ***Standard*** configuration since it is a superset of the allowed settings.

Current Configures the test current level.

Frequency Configures the test output frequency. The value must stay within the range of possible output frequencies supported by the specific model.

Dwell Sets dwell time period or may be set to be user terminated using the **Command** option in the configuration dialog.

Max. Drive Allows the open circuit voltage limit to be programmed as a maximum RMS voltage level.

- The open circuit voltage limit is automatically set to 8Vrms in easy mode.

Ramp Allows the ramp time period to be programmed either as a time or rate. The configuration dialog has buttons for **S**econds or **V**olts/**S**econd.

Check Allows the user to select what measurements are checked during the dwell period. The measurement check options are:

- RMSV
- INPHSV
- QUADV
- RMSO

- INPHSO
- QUADO

Check Allows the check limits to be applied to current or impedance; in easy mode it is current and cannot be changed.

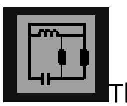
Minimum/ Maximum Allows the user to define ranges within which the selected impedance measurement is considered a PASS during the dwell period. The range can be entered in units of impedance or voltage, the UNIT key toggles the selection. The user may optionally disable the lower limit by entering a zero value for it.

- In-Phase and Quadrature measurements can be of either polarity; the limits are applied to the measurement without regard to polarity.

Abort on fail Allows the user to program the V10x to abort the entire sequence if this step fails any of its checks. A safety related failure, a user abort (STOP button), a DIO abort, or command abort always aborts the entire sequence.

Discharge Configures the discharge phase, see section 0 for options.

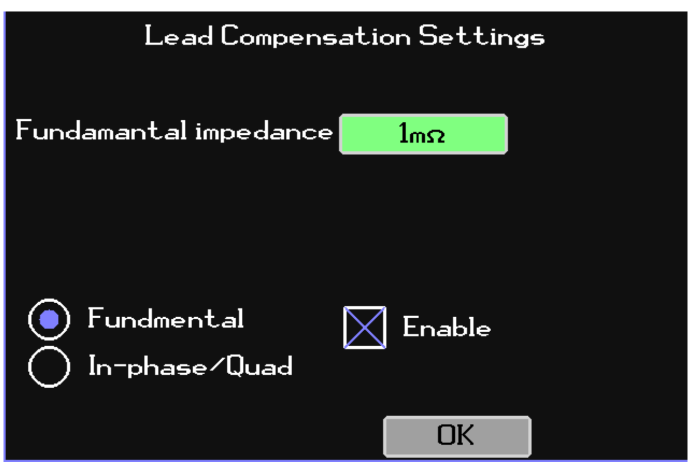
7.19.2 Manual Lead Compensation

The tiny circuit button leads to a form to edit manual lead compensation settings. Compensation can be specified using one of two options:

1) A single setting applied to the fundamental impedance
2) Two settings compensating for in-phase and quadrature impedance

Note that compensatoin must be enabled for the offsets to be applied to the measurements.

Configuring for a fundamental impedance.



Configuring for in-phase and quadrature impedance.

7.20 Edit Low Ω step

The figure below illustrates the configuration screen used to edit a Low Ω test step.

Figure 7-22 Low Ω Step Configuration Screen

7.20.1 Settings

The following paragraphs will discuss the configuration settings for the Low Ω test.

Test Time Sets test time period or may be set to be user terminated using the **Command** option in the configuration dialog.

Check Delay Allows the user to program a delay in the test period before the measurement range check is performed.

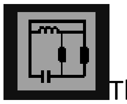
Minimum Resistance The minimum resistance measurement considered a PASS during the test period.

Maximum Resistance The maximum resistance measurement considered a PASS during the test period. The user can select **No Limit** to not check for an upper limit.

Mode Allows the user to program whether the 2-wire or 4-wire measurement technique is to be employed.

Abort on fail Allows the user to program the V10x to abort the entire sequence if this step fails any of its checks. A safety related failure, a user abort (STOP button), a DIO abort, or command abort always aborts the entire sequence.

7.20.2 Manual Lead Compensation


The tiny circuit button leads to a form to edit manual lead compensation settings.

The adjustment is in terms of resistance. The value will typically be very small. Note that the setting must be enabled for it to be applied to the measurements.

7.21 Edit ACI and DCI step

The ACI and DCI step settings are different only in that the leakage limits are in terms of Arms for ACI and Amps for DCI; otherwise, the settings are symmetrical.

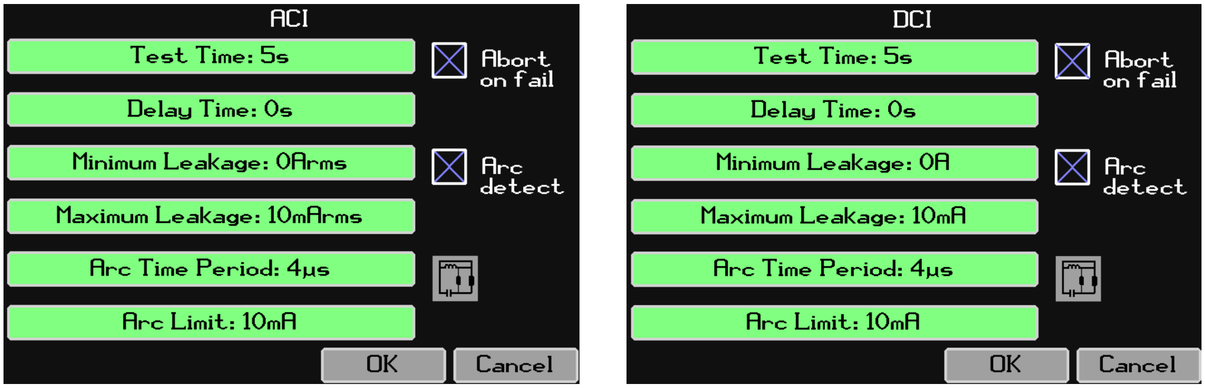


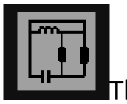
Figure 7-23 ACI and DCI Step Configuration Screens

7.21.1Settings

The following paragraphs will discuss the configuration settings for both ACI and DCI test types.

Test Time	Sets test time period or may be set to be user terminated using the **Command** option in the configuration dialog.
Delay Time	Allows the user to set a delay time before which the limits are not enforced.
Minimum Leakage	The minimum ground leakage current below which the DUT will be failed.
Maximum Leakage	The maximum ground leakage current above which the DUT will be failed.
Abort on fail	Allows the user to program the V10x to abort the entire sequence if this step fails any of its checks. A safety related failure, a user abort (STOP button), a DIO abort, or command abort always aborts the entire sequence.
Arc Detect	Use the checkbox to enable arc detection during this step. Both the time and current level can be independently programmed. See section 3.3.2.3 Arc Current and Time for details. see Table 1-2 Arc Detection Specifications for the current and time limits. Note this only enables arc detection, failing the step if arc is detected must be checked in the sequence options discussed in in section 7.6.2
Arc Time Period	The period over which arc must be present before arc is declared present.
Arc Limit	The current limit above which arc is declared present.

7.21.2 Manual Lead Compensation

The tiny circuit button leads to a form to edit manual lead compensation settings.

The adjustment is in terms of current. The value will typically be very small. Note that the setting must be enabled for the offset to be applied to the measurements.

7.22 Edit Pulse step

The following figure illustrates the screen used to configure a pulse test step.

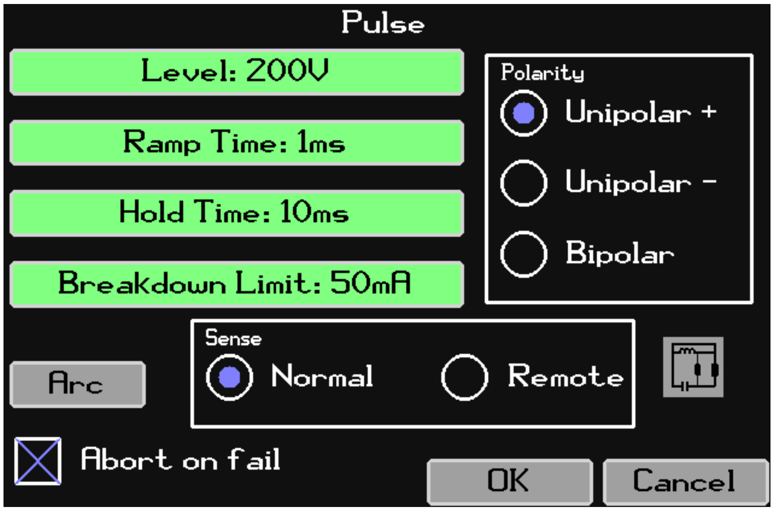


Figure 7-24 Pulse Step Configuration Screen

7.22.1 Settings

The following paragraphs will discuss the configuration settings for the Pulse test step.

Level Allows the test voltage level to be programmed. For a bipolar pulse, both polarities have nominally the same voltage amplitude.

- The amplitude of the pulse is not accurately controlled by the V10x during this type. The actual peak voltage amplitude is displayed for review after a test step has been run, enabling the user to adjust the peak test voltage for a specific DUT. Alternatively, the V10x can do this semi-automatically by using the Lead Compensation feature.

Ramp Time See Figure 3-9 Pulsed Voltage Wishstand Test Phases. The minimum value is 1ms (0.5ms if Opt. AC-2 if installed), and the maximum value is 20ms.

Hold Time See Figure 3-9 Pulsed Voltage Wishstand Test Phases. The minimum value is 1ms (0.5ms if Opt. AC-2 if installed), and the maximum value is 30ms.

Breakdown Limit Allows breakdown detection to be programmed as a maximum peak current level.

NOTE The maximum drive current during testing is limited by the test voltage and the V10x output impedance (see Test Voltage and Loading Capability in section 1.6.5.

Entering a value higher than can be achieved renders this setting inactive.

Polarity Allows the polarity of the pulse to be selected.

- Unipolar+. A single, positive polarity, pulse of voltage is produced.
- Unipolar-. A single, negative polarity, pulse of voltage is produced.
- Bipolar. A pair of opposite polarity pulses of voltage is produced.

Sense Selects where the measurements should be taken.

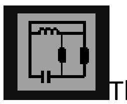
- Normal

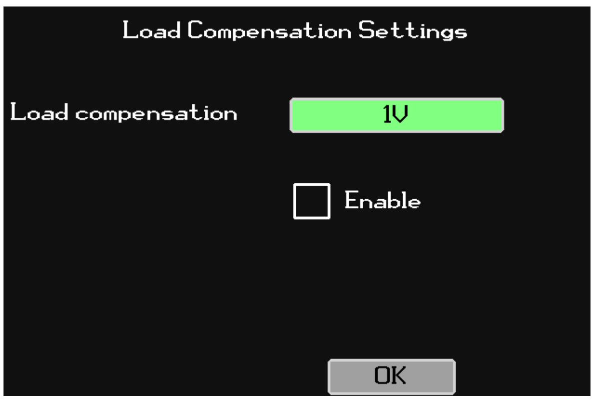
- Remote Sense using the remote terminals.

Arc Use the checkbox to enable arc detection during this step. Both the time and current level can be independently programmed. See section 3.3.2.3 Arc Current and Time for details. see Table 1-2 Arc Detection Specifications for the current and time limits. Note this only enables arc detection, failing the step if arc is detected must be checked in the sequence options discussed in section 7.6.2.

Abort on fail Allows the user to program the V10x to abort the entire sequence if this step fails any of its checks. A safety related failure, a user abort (STOP button), a DIO abort, or command abort always aborts the entire sequence.

7.22.2 Manual Lead Compensation


The tiny circuit button leads to a form to edit manual lead compensation settings.



The adjustment is in terms of a voltage scaling factor. The allowed range is 0.4 to 1.1. Note that the setting must be enabled for it to be applied to the measurements.

7.23 Edit BRKDN step

The figure below illustrates the screens for editing a BRKDN type step.

Figure 7-25 BRKDN Step Configuration Screens

7.23.1 Settings

The following paragraphs will discuss the configuration settings for the BRKDN step.

Current Allows the DC test current to be programmed. The entry is limited to be a minimum value of 1uA.

Ramp Rate Allows the maximum ramp rate to be programmed.

- The accuracy of the breakdown voltage measurement may be limited by the ramp rate at high rates. It is not recommended to set ramp rates of more than 10 times the lowest expected breakdown voltage per second (e.g., if the lowest expected breakdown voltage is 500V then the highest recommended rate setting is 5000V/s).
- If the DUT and cables connected to it have any significant capacitance then a significant portion of the test current may be consumed by the charging current. In this case the DUT will be measured as having a considerably lower breakdown voltage than expected. The user should consider using a lower maximum ramp rate setting in these circumstances.

Minimum Breakdown Sets the minimum breakdown voltage below which the test will fail.

Maximum Breakdown Sets the maximum breakdown voltage above which the test will fail.

Abort on fail Allows the user to program the V10x to abort the entire sequence if this step fails any of its checks. A safety related failure, a user abort (STOP button), a DIO abort, or command abort always aborts the entire sequence.

Grounding This selection allows the user to select either:

- Isolated This selection indicates that the DUT is isolated from ground, the V10x will use the current in the **RETURN** terminal to measure leakage and detect breakdown.
- Grounded This selection indicates that the DUT is grounded, and the breakdown and/or leakage currents are to be measured to ground. The V10x will use the current in the **HV** terminal to measure leakage and detect

breakdown.

Sense This option is only available when using the Internal source.

- Normal
- Remote Sense using the remote terminals.

7.24 Edit Pause step

The **Pause** type step inserts a fixed time delay in the sequence. The figure below illustrates the screen for editing a Pause type step.

Figure 7-26 Pause Step Configuration Screen

Pause time

Specifies the pause time in the test sequence.

7.25 Edit Hold step

A **Hold** type is generally used when operator action is required prior to continuing the test sequence. A timeout is provided which, if it occurs, will abort the entire sequence. The figure below illustrates the screen for editing a Hold type step.

Figure 7-27 Hold Step Configuration Screen

Timeout

Sets the time limit on the action that causes the sequence to continue. If the time limit expires the sequence will fail.

Prompt #1

Line #1 of the text that will be shown on the execution screen when the hold is running - see Figure 8-11.

Prompt #2

Line #2 of the text that will be shown on the execution screen when the hold is running - see Figure 8 11. see Figure 8-11.

7.26 Edit Switch Control step

NOTE If the system settings are not configured to operate a switch this step is not available, see section 10.2.10 to learn about switch unit configuration.

NOTE If you change the switch instrument configuration in that the number of switches has changed or the total number of relays is different any sequences with existing switch steps will be invalidated until the user reviews and saves each switch step.

The figure below illustrates the screen for editing a Switch Control step.

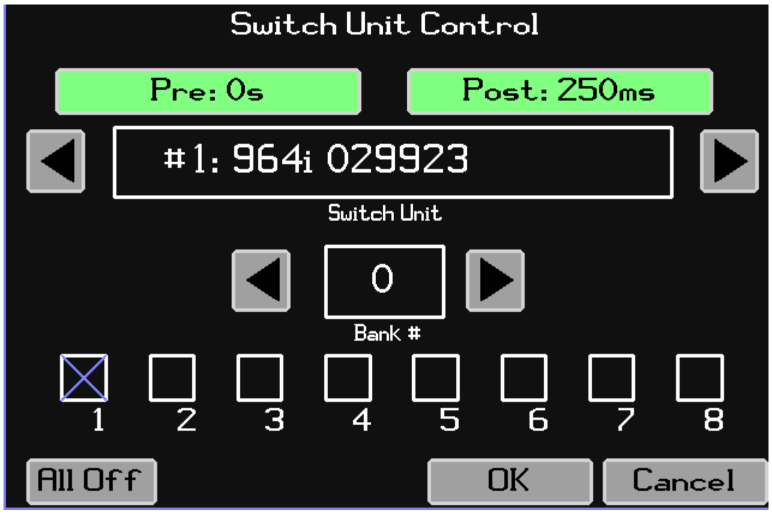
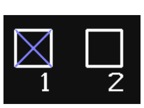


Figure 7-28 Switch Step Configuration Screen

7.26.1 Switch Step Settings

Pre	Specifies a delay time to insert in the sequence before the switch settings will be affected. Generally, this should be set to zero, but may need to be extended if external circumstances require a delay between the preceding step and the connections being changed in this step.
Post	Specifies a delay time to insert in the sequence after the switch settings have been applied. For Vitrek models 964i and M10x and this can be set to zero if there are negligible wiring settling requirements.
Switch Unit	Identifies the switch being configured. The arrow buttons will appear when more than one switch is configured. The rectangle shows the switch number, model, and serial number (if entered or auto-populated).
Bank #	Selects the bank to modify, bank numbers are zero based. Use the arrow buttons to scroll through the banks.
	Relay checkboxes. The numbers identify the relay being controlled. Checking a box configures the selected relay to be closed; when clear the relay will be opened. If the switch is not fitted with the numbered relay '—' will be displayed instead of a number.
All Off	This will reset all relay settings to the open selection.

8 Sequence Execution

The following figure illustrates the screen the used to execute the test sequences. It should also be noted that when the system is configured to execute tests when commanded by an interface this screen will pop up.

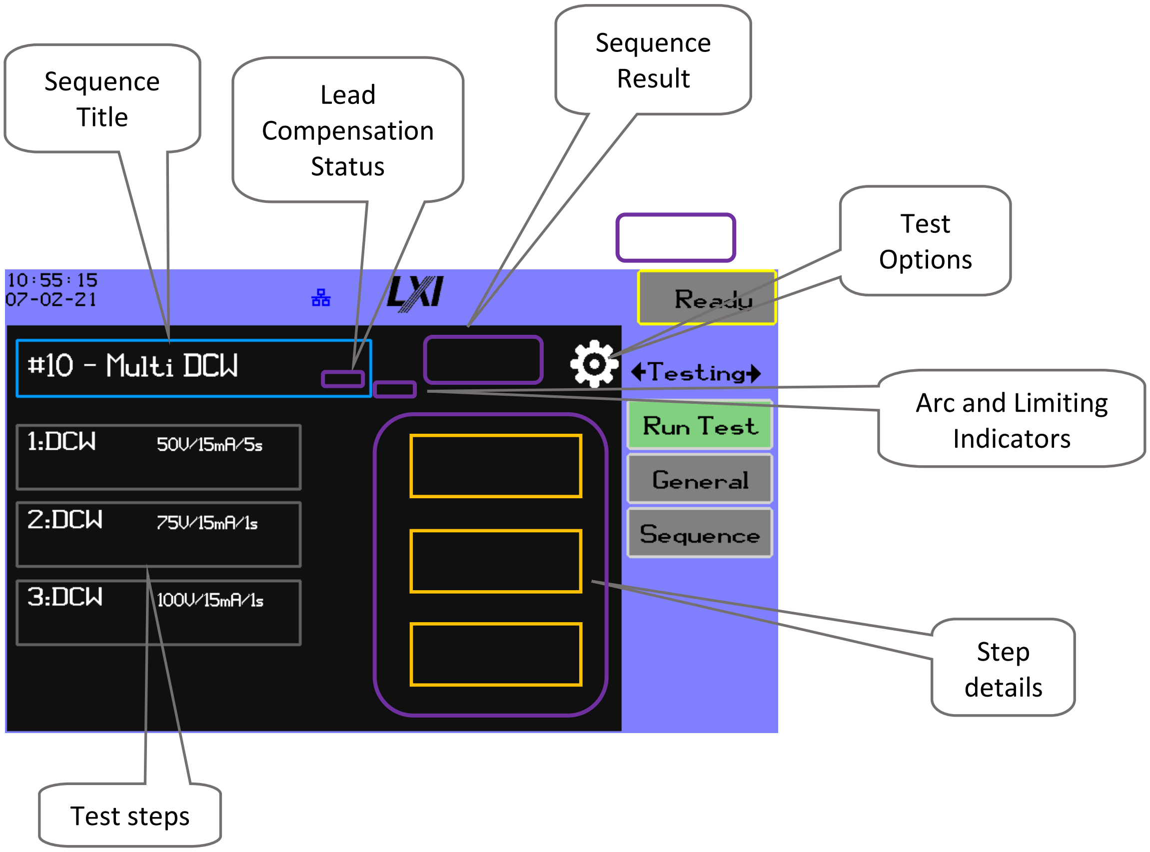


Figure 8-1 Sequence Execution Symbology

Sequence Title

This space shows the sequence number and name of the presently selected test.

NOTE If an attempt was made to execute an invalid sequence **Sequence Invalid** will be shown.

Compensation Status

This will carry a symbol indicating the lead compensation status. It shows three conditions:

1) None of the steps have lead compensation configured.
2) Some steps have lead compensation configured.
3) All steps have lead compensation configured.

Sequence Result

If the sequence has been executed, it will show Pass or Fail.

Test Options

Use this button to modify the test execution options, see section 8.2

Arc and Limiting indicators

During execution, this area will indicate when arc is being detected and when the drive is being limited.

Test Steps

This shows up to four of the sequence's test steps.

Step Details

While the sequence is running this area shows the status of the presently executing step. The contents can be classified into three groups:

1) Step measurements
2) Sequence timing
3) Switch action

When running a test, the user cannot navigate to other areas of the UI except for the adjustments allowed during the dwell period of a manual step – see section 8.5.

8.1 Selecting a Sequence for Execution

By touching the *Sequence Title* area, the user can select among the previously prepared sequences to load.

NOTE If security is enabled the user must have load permissions.

The V10x will present a list of up to five sequence labels; each label shows the sequence number, name, and modification date as illustrated below:

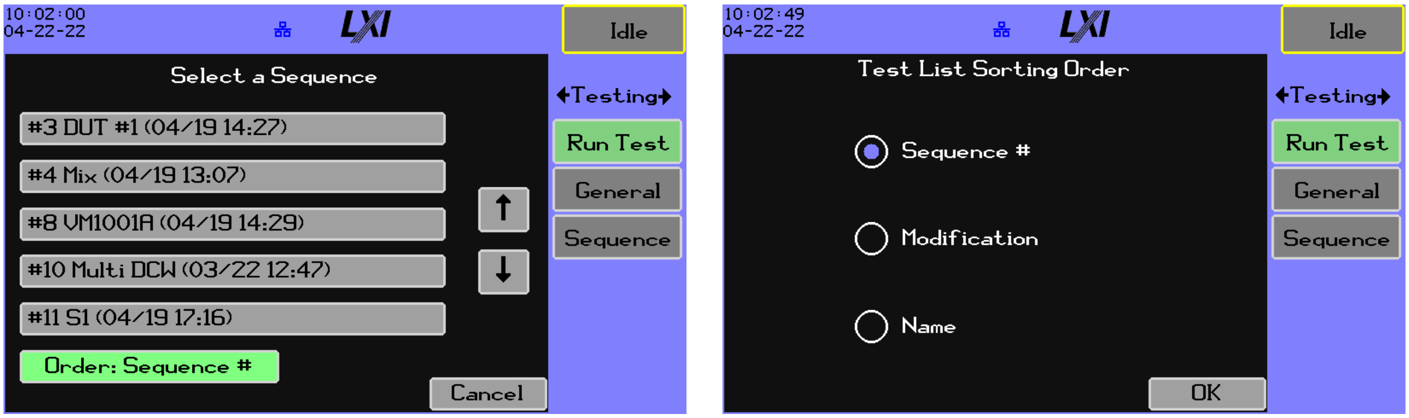


Figure 8-2 Sequence Loading for Execution

The arrow buttons allow for the list to be scrolled, by default sorted by sequence number. Use the 'Order' button to select a different sorting order. The user touches a label to load the test.

In the event the test is invalid a warning message is displayed and it will be blocked from loading for execution:

Figure 8-3 Loading an Invalid Sequence

8.2 Test Execution Options

Use this screen to label the test results and modify how a sequence is executed:

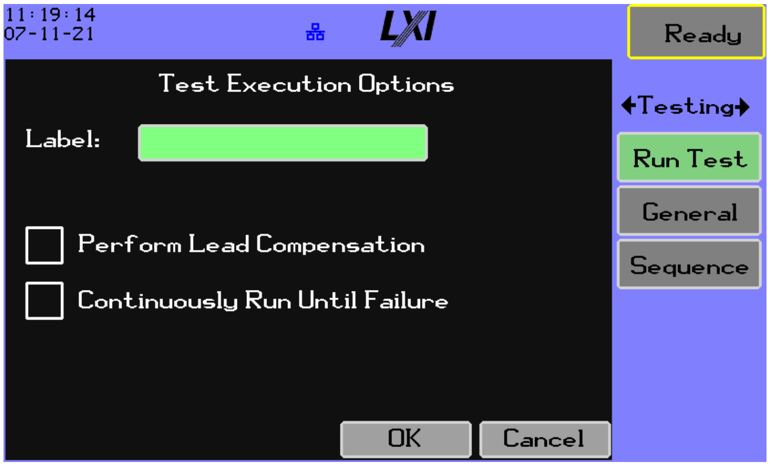


Figure 8-4 Test Execution Options

The *Label* will be referenced in the exported reports. This is the same label that can be filled in when scanning barcodes.

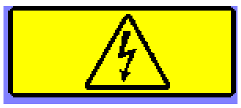
If *Perform Lead Compensation* is checked FIXME. This setting will clear if a different test is loaded or when the user navigates out of the test execution control screen.

Use *Continuously Run Until Failure* to execute the sequence repeatedly until a failure occurs or the sequence is aborted.

8.3 Running the Sequence

Once a valid sequence has been loaded the V10x is ready to execute the test, this is indicated by the execution status indicator showing:

The user can now use the Start button to commence the test. The execution status will change to:

or


as necessary over the course of the test; the front panel Testing indicator will illuminate and the HV warning will light up when unsafe voltages or currents are present on the terminals.

While a test is running the menu disappears and the user cannot navigate away from the execution status display except to adjust a manual step's levels as discussed in section 8.5 below.

If any single test step fails over the course of the sequence the Fail indicator will illuminate. At the end of the sequence the Pass indicator will turn on if all test steps passed.

While the test sequence is running it may be aborted by pressing the Stop button.

8.4 Sequence Execution Automation

The V10x provides mechanisms to automate sequence selection and labeling. See section 10.2.9 for full details on configuration.

By the use of barcode labels on the product the user can scan one symbol to load a model specific test sequence, then scan another to label the test results – nominally the product serial number.

Further the V10x has an advanced scan pattern decoder that can separate the model and serial number from a single scan. Once the configured symbols are scanned and processed the selected sequence will optionally start. Remember test names have a maximum of 15 characters, test labels have a maximum of 20 characters.

The instrument must be in the Testing->Run Test screen and not presently running a test to recognize the scans:

Figure 8-5 Test Execution Screen

In the event the scan cannot be decoded, or the model cannot be matched with a test sequence a dialog will appear for one second showing the error:

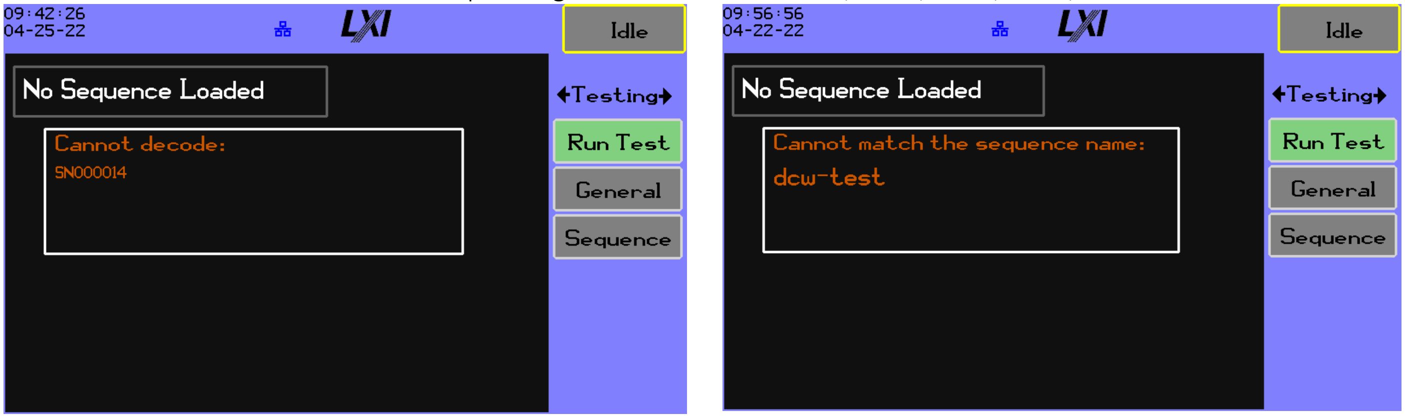


Figure 8-6 Barcode Scan Decode Error Examples

Once the scan has been fully processed the sequence will be loaded and validated. If the sequence has configuration or limit errors the title bar will show Sequence Invalid. If the sequence is valid and the *Start* option (discussed in section 10.2.9.1) is enabled, the sequence is started.

8.5 Step Adjustments

When running the manual sequence some test types allow for adjustments during the dwell time period. The following table lists the test types and what adjustments are allowed:

Table 8-1 Manual Sequence Adjustments

Type	Adjustments
ACW	Test Voltage and Frequency
ACCAP	Test Voltage and Frequency
DCW	Test Voltage
DCIR	Test Voltage
GB	Test Current and Frequency

To perform the adjustment once the step is paused waiting for the user to continue or in timed dwell touch the step information rectangle. For DCW and DCIR the only adjustment is voltage, and the present level will be presented for adjustment via the dial as illustrated by Figure 8-7 below:

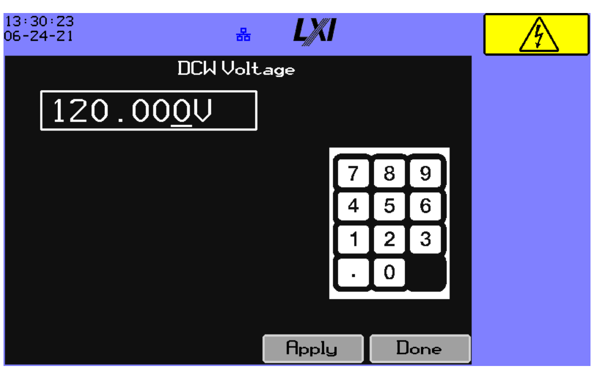


Figure 8-7 Test Adjustment Using the Dial

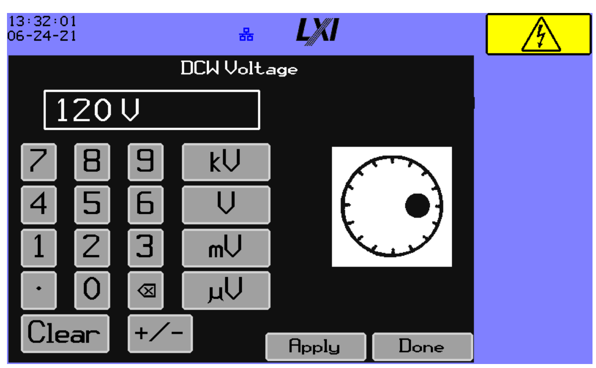
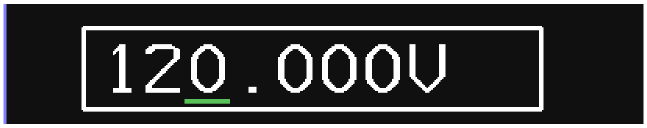


Figure 8-8 Test Adjustment Using a Keypad

To directly enter a setting touch the keypad image, the display will change as illustrated in Figure 8-8; see below instructions on using direct entry.

When the cursor is White rotation of the dial scrolls to between the digits. Pressing the dial selects the digit under the cursor – the cursor color changes to Green:



Rotating the dial clockwise or counterclockwise respectively increases or decreases the setting.

Press the dial to again scroll between the digits.

When you have completed your adjustments, touch **Done**.

When using the keypad, you simply enter the setting and touch **Apply**. To return to using the dial touch the dial image.

When you have completed your adjustments, touch **Done**.

8.6 Running the Manual Sequence

After the ***Manual Sequence*** has completed the final test results will be left in the step details area as illustrated below:

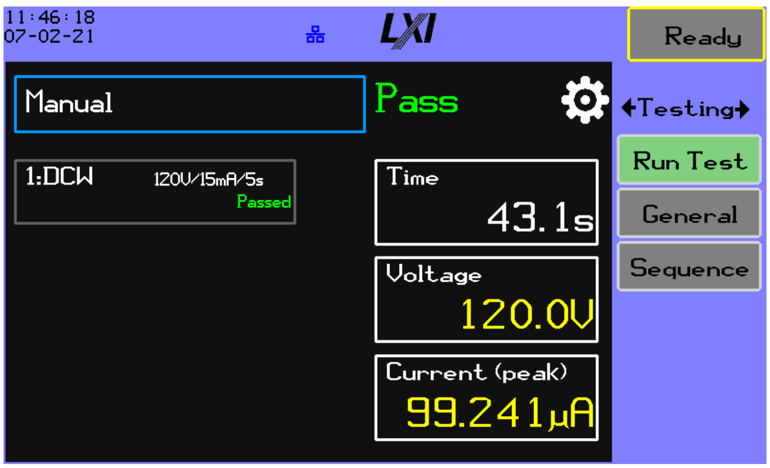


Figure 8-9 Results After Running the Manual Sequence

Note the values are dependent on the step type.

8.7 Running a Multi-Step Sequence

A sequence with two or more steps is a multi-step sequence. During the course of testing the presently running step is highlighted with a gold rectangle and the step details area shows the status of the present step. The following example shows step #4 running:

Figure 8-10 Multi-Step Sequence Running Example

8.7.1 Running a Sequence Timing Step

The figure below illustrates the display when running a timing control step.

Pause

Hold

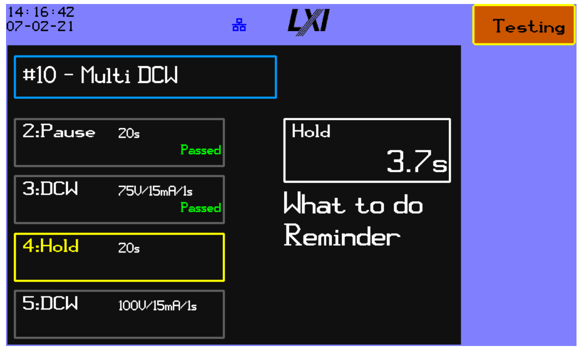


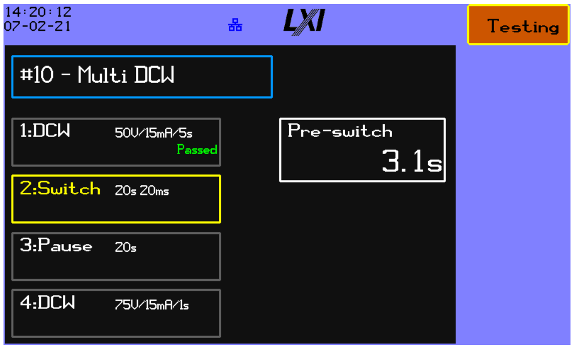
Figure 8-11 Running Sequence Timing Control Steps

Note when running the Hold step the two configured prompts are displayed.

8.7.2 Running a Switch Step

A switch step executes in three phases illustrated below:

Pre-action Delay



Affecting Settings

Post-action Delay

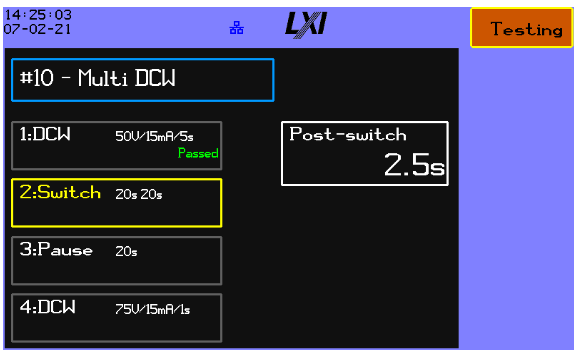


Figure 8-12 Running Switch Control Steps

When the settings are being applied the number indentifies the switch unit being modified.

8.7.3 Selecting Test Measurements While Running

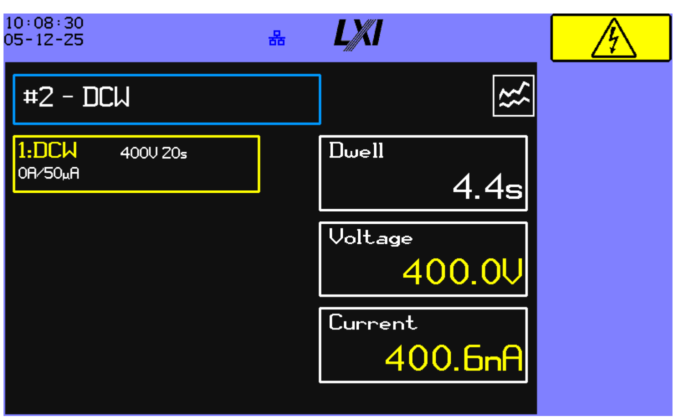
When running a measurement related step (really any step but Pause, Hold, and Switch) the details area contains the test phase execution time, the level, and a test measurement. Many of the steps have more than one measurement, in those cases the user can touch the bottom rectangle to cycle through the various measurements that are available. The following table lists the measurements that can be viewed by test type:

Type	Level	Measurements
ACW	Voltage	▪ RMS current ▪ In-phase current ▪ Quadrature current ▪ RMS impedance ▪ In-phase impedance ▪ Quadrature impedance ▪ Arc current (when Arc detection is enabled)
ACCAP	Voltage	▪ Capacitance ▪ Dissipation factor ▪ Maximum breakdown current ▪ RMS current ▪ In-phase current

		▪ Quadrature current ▪ RMS impedance ▪ In-phase impedance ▪ Quadrature impedance ▪ Arc current (when Arc detection is enabled)
DCW **DCIR**	Voltage	▪ Maximum breakdown current ▪ DC current ▪ DC impedance ▪ Capacitance ▪ Arc current (when Arc detection is enabled)
ACI	Voltage	▪ RMS current ▪ Maximum breakdown current ▪ Arc current (when Arc detection is enabled)
DCI	Voltage	▪ DC current ▪ Maximum breakdown current ▪ Arc current (when Arc detection is enabled)
BRKDN	Voltage	▪ Maximum breakdown current
GB	Current	▪ RMS voltage ▪ In-phase voltage ▪ Quadrature voltage ▪ RMS impedance ▪ In-phase impedance ▪ Quadrature impedance
Low Ω	Ohms	▪ Resistance
Pulse	N/A	Pulse executes too quickly to select among the measurements.

For example, when running a DCW step the display will show the check setting, often leakage current; the user can touch the display to select resistance:

Current Selected



Resistance Selected

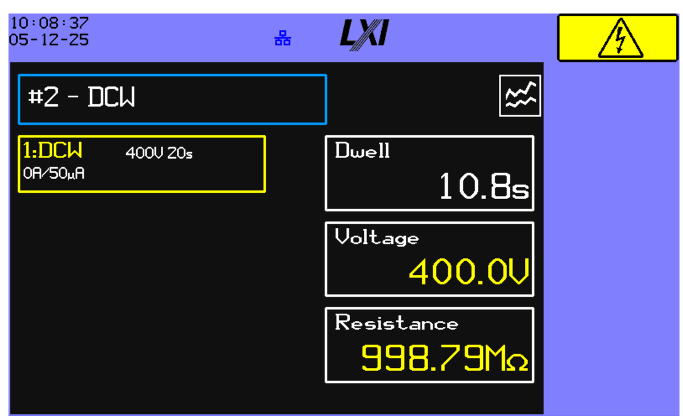
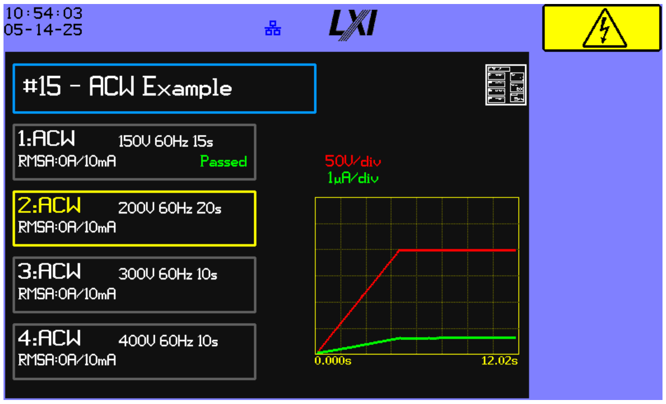


Figure 8-13 Test Measurement Selection Example

8.7.4 Charting Test Measurements While Running

While a step is running a dynamic chart of the test measurements can be displayed. Press the line-chart button above the **Time** display to choose the chart display. The chart's traces will use the colors configured in the general settings, see section 6.3, the vertical limits will be automatically scaled.

Running ACW



Running Low Ohms

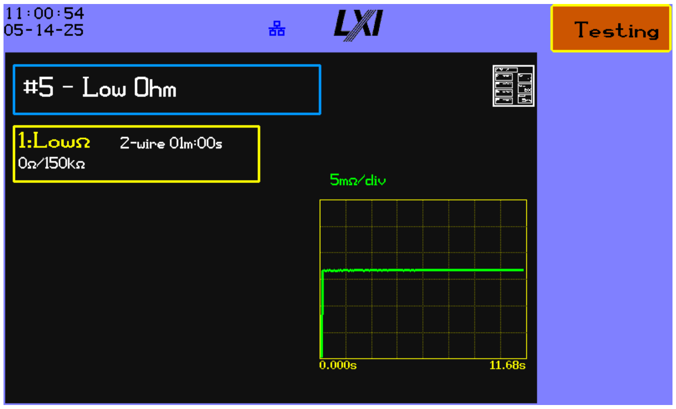


Figure 8-14 Test Measurement Charting Examples

Touch the icon above the chart to display the numeric results. When running a timed or switch step the chart will be blank.

8.7.5 End of sequence

When the sequence completes each step shows its specific result and the combined result is shown next to the title as illustrated below:

Figure 8-15 Completion of a Multi-Step Sequence

If the system is configured to automatically generate reports (see section 7.6.4) and a USB drive is present the selected reports are generated and saved to the USB drive, indicated by the **Generating Reports** banner:

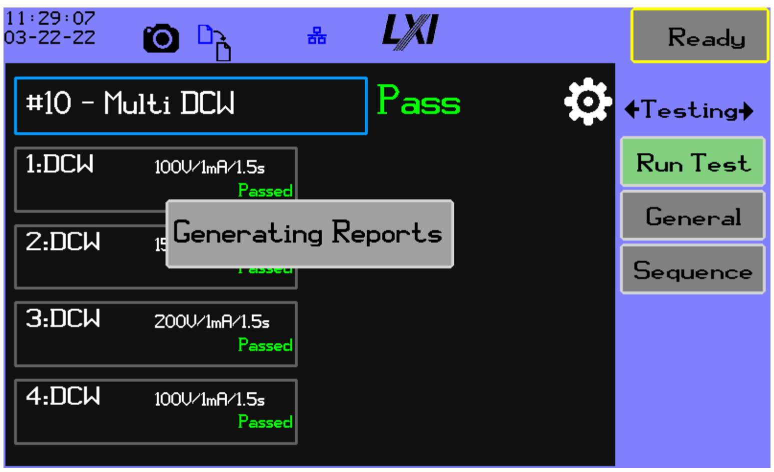
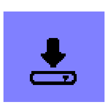


Figure 8-16 Automatic Reports

Further, the export button:



illustrated in section 4.7.1 can be used to manually generate result report, see section 0 for details on running the export process.

8.8 Single-Step Execution

The V10x allows for a single selected step in a multi-step sequence to be executed by touching a selected step as shown below:

Example sequence with 3 steps

Step #2 selected for execution

Figure 8-17 Selecting a Single Step For Execution

Single-step mode is indicated by the blue rectangle highlighting the step instead of the test title and a help graphic on the right. The user can now press the Start button and only the selected step will be executed, when the step competes the results will be displayed:

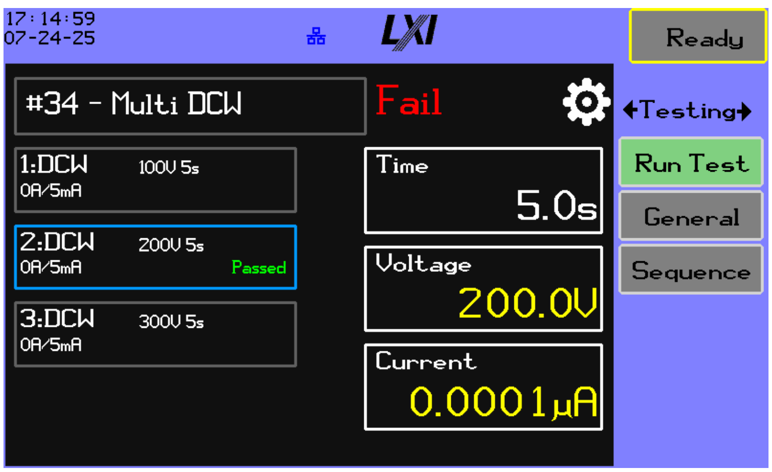


Figure 8-18 Display After Running a Single Step

Observe that while the selected step *Passed* the sequence is still considered *Failed* because not all steps were executed and passed. The sequence pass/fail counters are not modified in this case.

8.9 Test Time Period Display

Table 8-2 Time Period Display Examples

Period (seconds)	Display
0s – 59.9s	SS.Ss
60s – 1 hour	MMm:SSs
1 hour – 24 hours	HH:MM:SS
1 or more days	NNNd HH:MM

The test time period for the present phase will be formatted depending on the interval. The following table lists the intervals and formats.

9 Sequence Results

The results of a sequence are presented by a variety of displays and can be exported as a report in PDF or CSV form to the USB drive.

The results are available from the Results menu illustrated below:

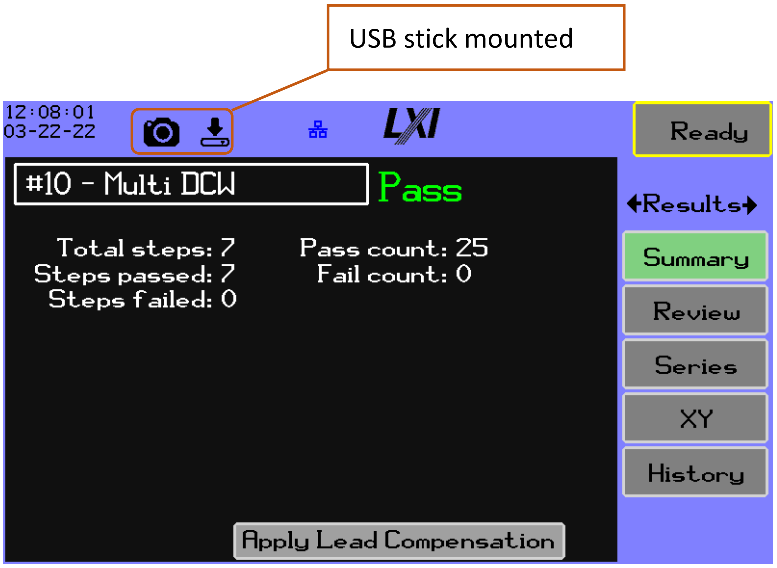
Figure 9-1 Results Menu

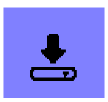
Each view is discussed in the following sections.

NOTE If you change the sequence the results will be invalidated and no longer available.

9.1 Summary

This display summarizes the results and provides an option to update the application of lead compensation:




Use this button to export a sequence report, see the next section.

Total steps

The total number of steps in the sequence, this will be shown in a warning color if not all steps were executed.

Steps passed

The number of steps that passed.

Steps failed

The number of steps that failed.

Pass count

[1,2]The number of times the sequence passed.

Fail count

[1,2,3]The number of times the sequence failed.

Apply Lead Compensation

TBD FIXME compensation.

[1]*Cleared if the sequence is modified.*

[2]Not modified when running a single step in a multistep sequence.

[3]Some *sequence errors aren't counted as DUT failures, see below.*

Figure 9-2 Sequence Results Summary

Table 9-1 Status flags not counted as a DUT failure

- Internal fault
- Overheated
- HOLD step timeout
- User abort
- Forced abort
- Wiring Fault
- Interlock failed
- HV trip
- Switch matrix error
- Minimum loading error
- Continuity failure
- Step type error

9.1.1 Export

When the export button is pressed the user prompted to enter a file name and select the report format; when the PDF format is selected there is also a detail level option:

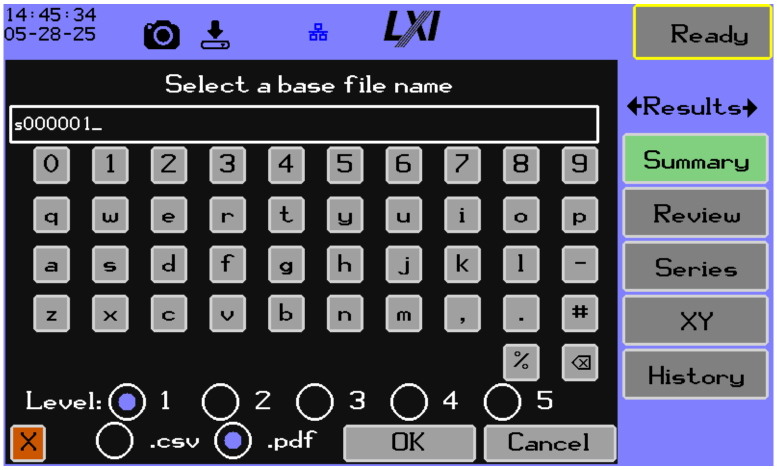


Figure 9-3 Sequence Summary Export Options

The base file name defaults to the sequence run number, starting at one. You can choose a PDF or CSV formatted file; when PDF is selected you can choose one of the five levels of detail, 1-5 correspond to the levels listed in Table 7-4. The exported file will use the base file name with the selected format as an extension. Press **OK** to generate the file; press **Cancel** to skip the function.

See appendix D for CSV file formatting, see appendix E for formatted report samples.

9.2 Review

The Review option shows the final measurements for each step as illustrated:

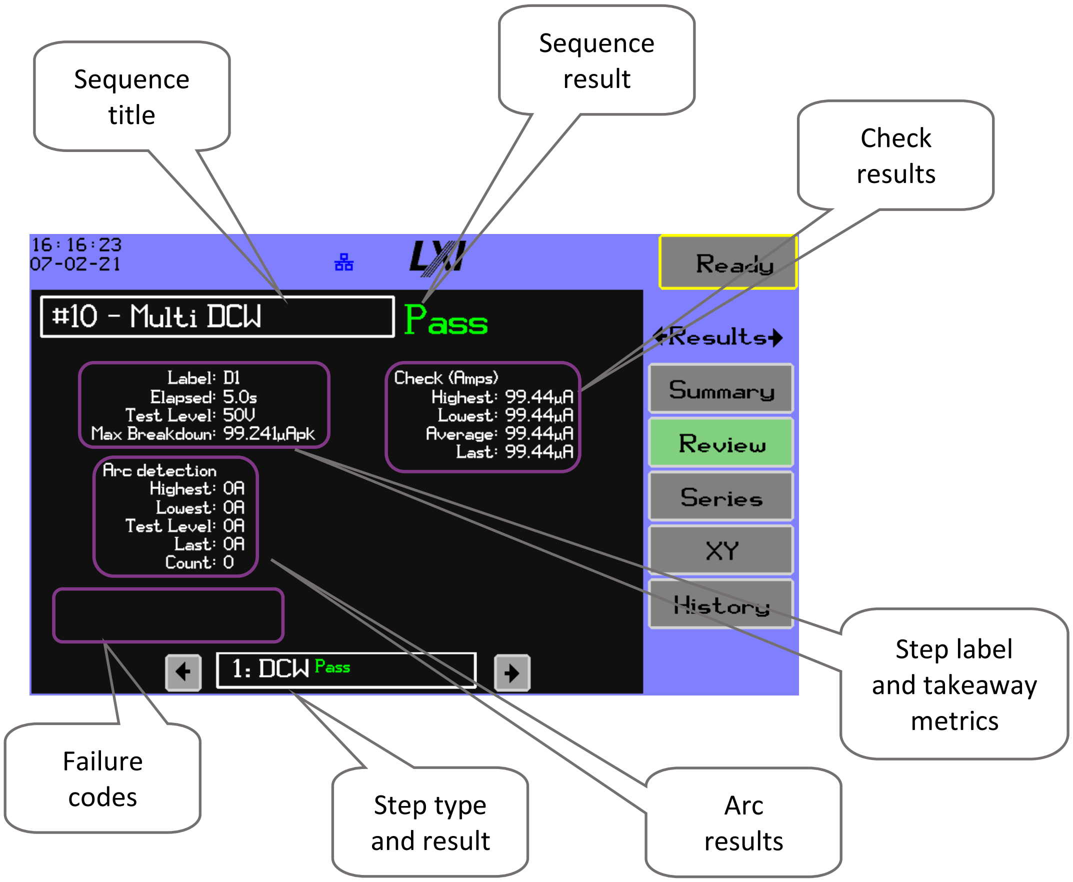


Figure 9-4 Step Results Review

<u>Sequence title</u>

This space shows the number and name of the sequence.

<u>Sequence result</u>

Pass or Fail.

<u>Check results</u>

This space shows the measurements keyed to the step's check definition.

<u>Failure codes</u>

If the event that the step failed this space will list a brief description of the failures. The text shown is an abbreviation of the error codes listed in table Table 12-31. The list will contain one or more of the following:

- Internal fault
- Unstable load
- Breakdown > setting
- HOLD Step timeout
- User abort
- Continuity failure
- Wiring fault
- Arc detected
- 1st check < minimum

- 1st check > maximum
- 2nd check < minimum
- 2nd check > maximum
- Interlock failed
- HV TRIP
- Switch matrix failure
- Breakdown > surge
- Overheated
- Step type error
- Minimum loading error
- Breakdown > sustained
- Unsteady current
- Forced abort
- Discharge timeout

<u>Step type and result</u>

This shows the step type and Pass or Fail.

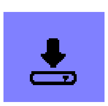
<u>Arc results</u>

If the step had arc detection enabled and arc was detected the results are shown here.

<u>Step label and takeaway metrics</u>

This space shows the step label if one was assigned, and step type metrics considered most relevant to the user.

The arrow buttons on either side of the ***Step Type and Result*** are used to scroll forwards or backwards through the sequence, the scrolling wraps at the beginning and end. The dial can also be used to scroll back and forth among the steps.

 When a USB stick has been mounted use this button to export a sequence report as discussed in section 0.

9.3 Series Chart

The Series display is a chart of measurements taken over the execution period of the step where the Y axis is the measured data, and the X axis is time.

NOTE The maximum charted time period for a series is 30 seconds.FIXME time

The series chart contains the following elements:

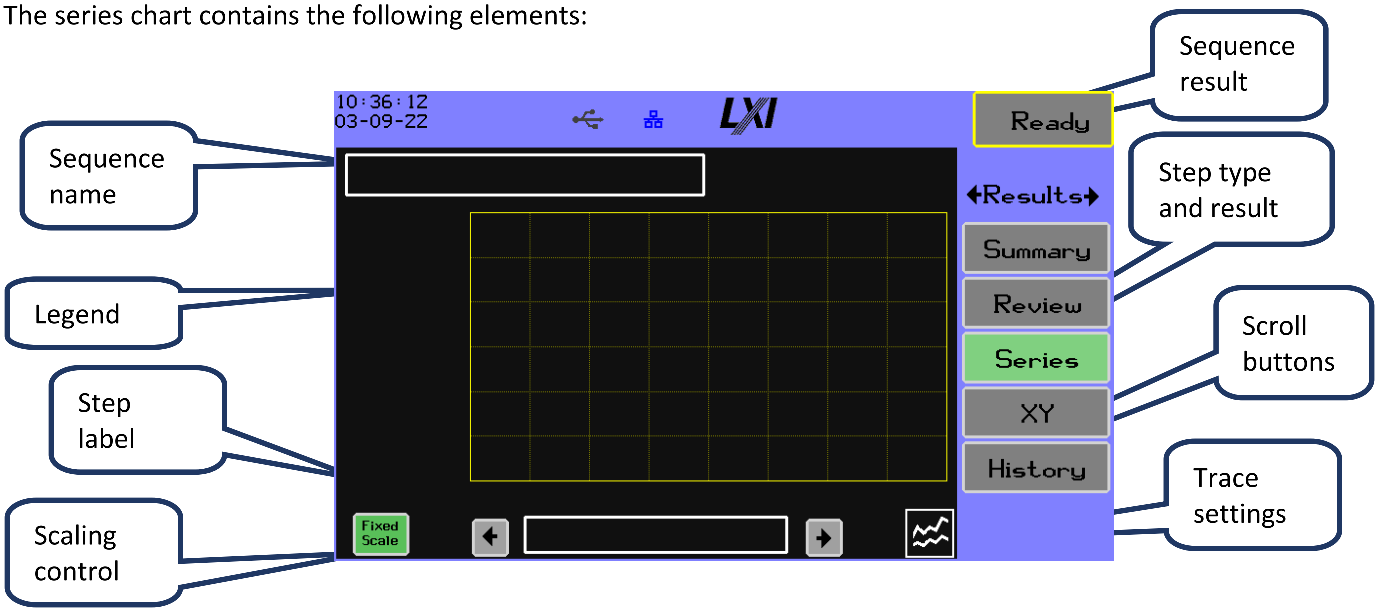


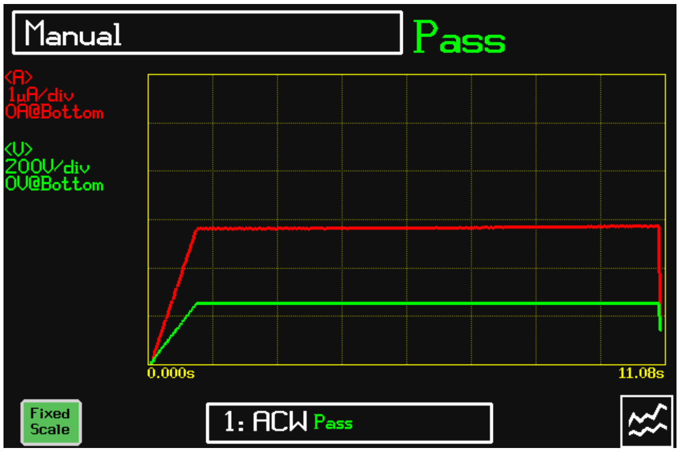
Figure 9-5 Step Results Series Chart Overview

Sequence Name	Identifies the sequence name.
Legend	Lists up to four charted items and the present scaling factors. [1]
Step label	The optional step label.
Scaling control	Toggles between fixed and automatic scaling.
Sequence result	The overall sequence result as Pass or Fail.
Step type and result	The step type and step specific result.
Scroll buttons	When the sequence has two or more steps the arrow buttons scroll the step.
Trace settings	A menu button to select the traces, colors, and manual scaling.

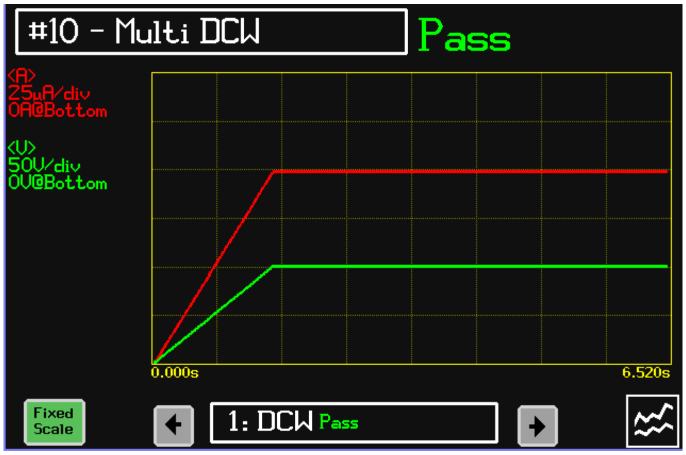
[1] Only the first four selected measurements are shown even though the chart may contain many other traces.

When a USB stick has been mounted use this button to export the raw data set in a CSV formatted file.

The following figure illustrates two example charts, respectively for AC then DC withstand steps:



A 1 second ramp, 10 seconds of dwell, fast discharge. The data shows the ramp, dwell, and discharge periods.



There is a compatible follow-on step, so the chart only exhibits the ramp and dwell periods as there is no discharge.

Figure 9-6 Step Results Series Chart Examples

The following figure illustrates the same manual ACW step above showing the RMSA limits:

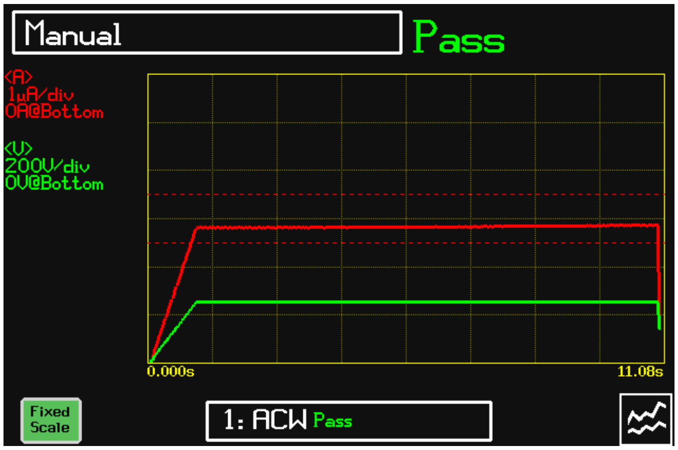


Figure 9-7 Step Results Showing RMSA Limits

9.3.1 Series Chart Limiting

When using fixed scaling the charted data may exceed the scale limits. In that case limited trace is shown with a dotted line at the top of the chart as illustrated:

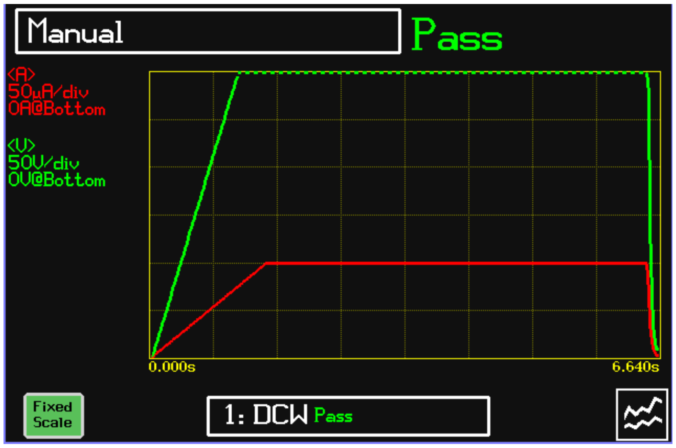


Figure 9-8 Step Results Chart Limiting

9.3.2 Series Chart Navigation

The series chart provides for a cursor that shows a relative time stamp for the sample; further the series can be zoomed. The cursor is activated by touching the chart where you want it to appear, or press the dial select and the cursor appears in the middle. While the cursor is up pressing the dial select button toggles between time-scroll and zoom; the following figure illustrates a zoom over the end of the ramp:

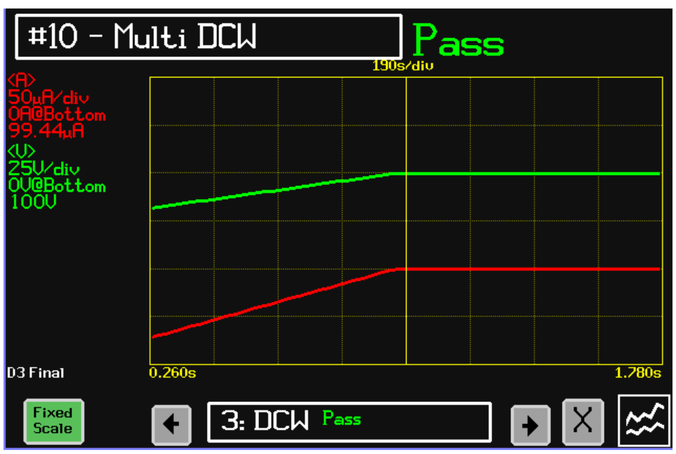


Figure 9-9 DCW Step Series Chart Zoomed

The X button is used to remove the cursor and restore the chart to the full time span. Observe the 'D3 Final' text is the user's step label, refer to Figure 7-4 to learn about labeling your steps.

The button launches a process to configure the trace settings for the present step – see section 9.6.

NOTE The chart settings are specific to each step type, so your choices for DCW are completely different than say GB.

9.3.3 Series Chart Scaling

There are three scaling options:

1. Fixed
2. Auto-all
3. Auto per-trace

Touching the scaling control button toggles between *Fixed* and *Auto* scale modes. When automatically scaled, the per-division values depend on the limits of the data being plotted. While in fixed mode, the trace legend can be touched to cause scaling for the associated trace to be automatically computed; in that case, the legend is shown with an asterisk. The following figure illustrates fixed scaling for current, and auto-scaling for voltage:

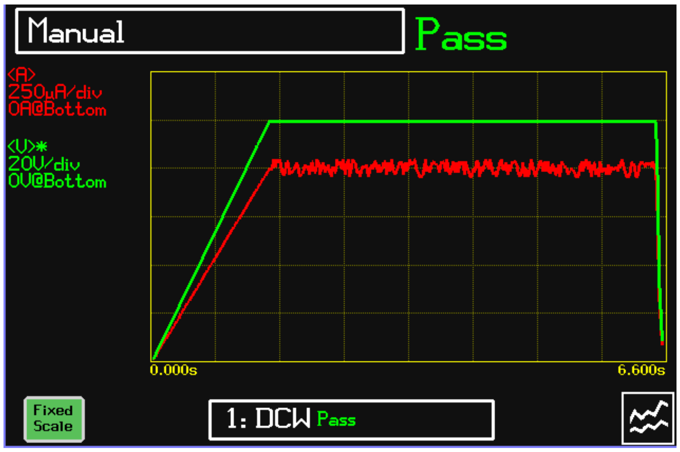


Figure 9-10 DCW Step Series Selectively Scaled

NOTE If you change a fixed scale setting the scaling mode will revert to fixed.

9.3.4 Series Chart Exporting

The raw data illustrated by the chart can be exported when the export button is touched, a dialog is launched to select the file name and export options:

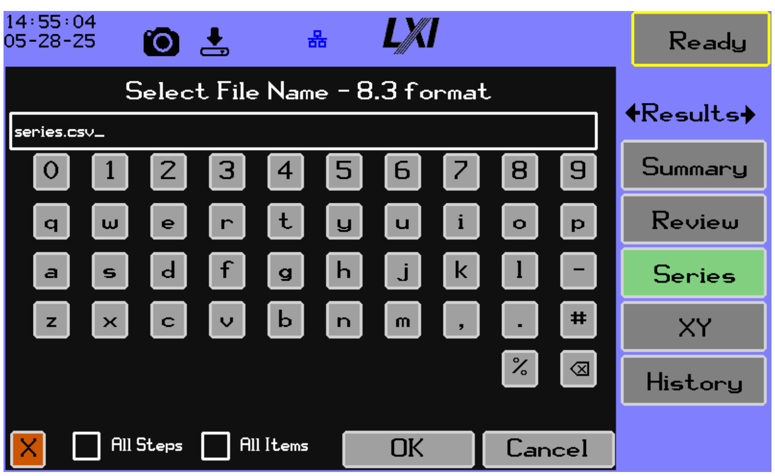


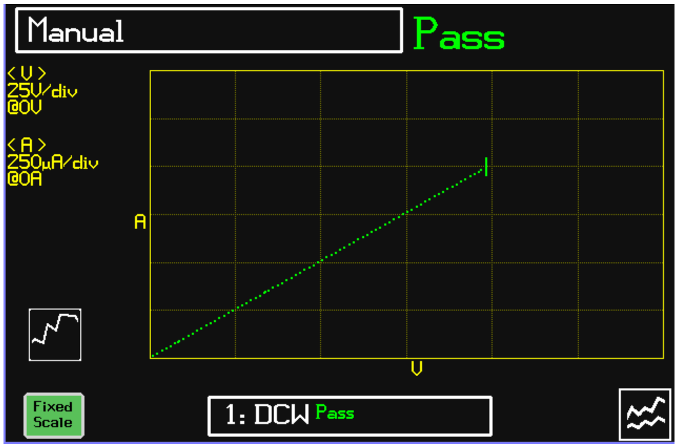
Figure 9-11 Series Chart Export Options

By default, only the present step's data will be exported and will only include the selected charted items. The two checkboxes respectively allow the user to include all steps or all measured items for each step. The first column of the resulting file carries the measurement time stamp relative to the start of the step; the remaing columns contain the selected measurements.

9.4 XY Chart

The XY display provides a visual representation of the relationship between two measurements; the chart is a scatter plot with optional connecting lines. One measurement is selected for the X axis, another measurement is selected for the Y axis; for example, voltage versus current for a DC withstand test, shown here without and with connecting line segments:

Drawn as dots.



Drawn with connecting lines.

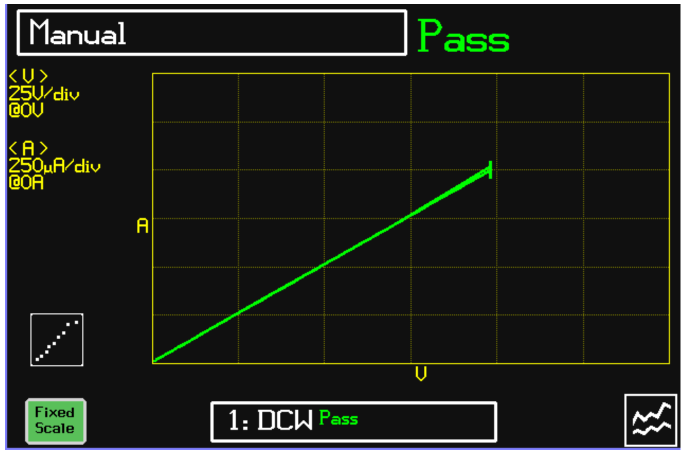
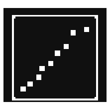
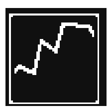


Figure 9-12 Step Results XY Chart Types

The chart type can be toggled by using the button above scaling control:

 Selects the pure scatter form.

 Selects the connecting lines.

The chart settings are specific to each step type, so your choices for DCW are completely different than say GB.

NOTE

The scatter chart can sometimes present counterintuitive information when plotting current versus voltage because the current levels will discharge at a lower rate than during the voltage ramp:

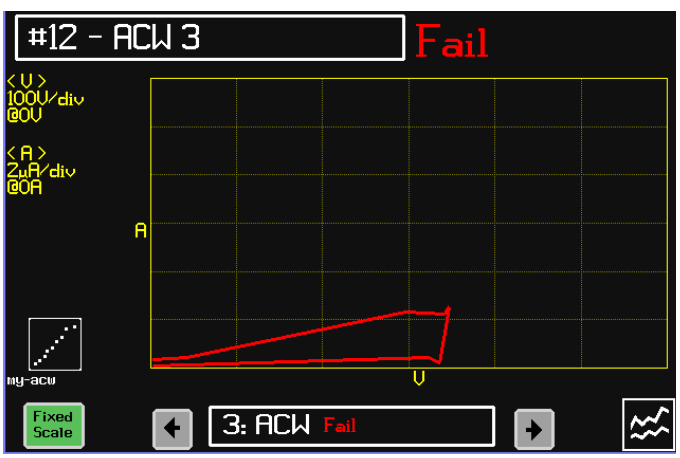
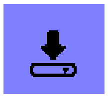


Figure 9-13 XY Chart Retracing

 When a USB stick has been mounted use this button to export a CSV file of the raw data set.

This XY chart has all the elements shown in Figure 9-5 and offers the same scaling controls.

As in the series charts the XY chart options are specific to each step type; for example, the DCW chart can be configured to show current versus voltage, ACCAP might be set to chart voltage versus capacitance.

To configure the XY chart, touch the  button; the V10x presents buttons to configure axis choices and trace color:

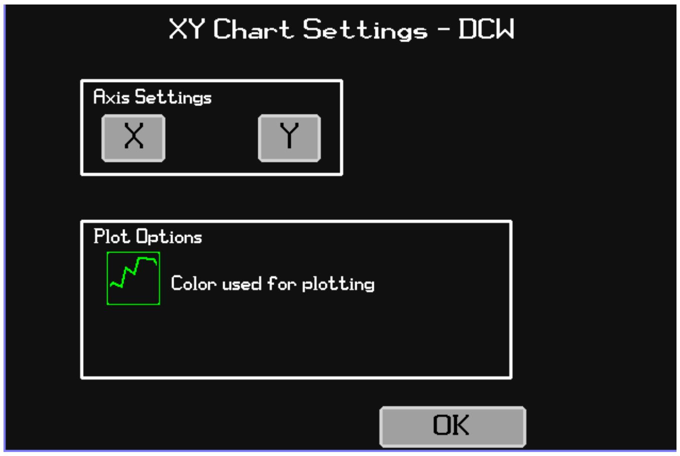


Figure 9-14 Step Results XY Chart Settings

Use the  button to select the trace color, there are eight options:

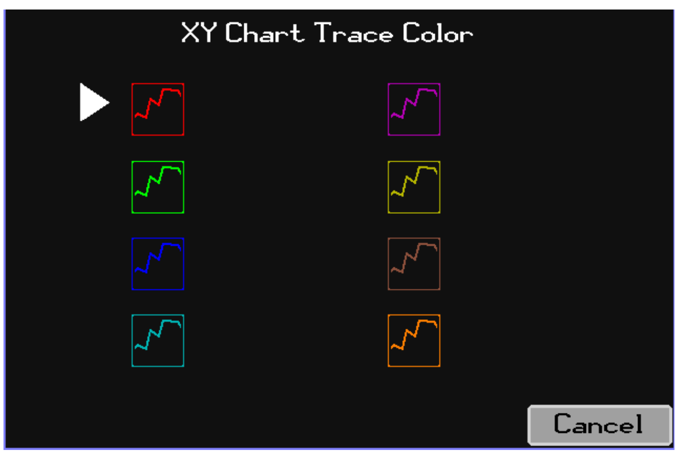


Figure 9-15 Step Results XY Chart Trace Colors

Configuring an axis is nearly identical except for the X or Y direction so we will only show X, as illustrated:

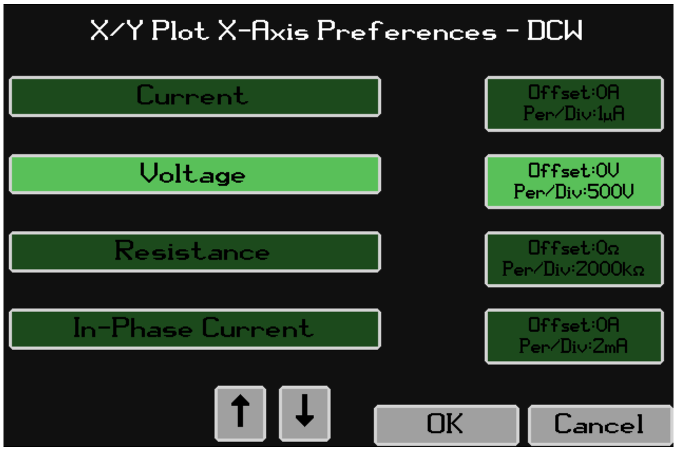


Figure 9-16 Step Results XY Chart Axis

Only one metric can be selected for the axis, use the arrow keys to scroll through the list of measurements, touch the label to assign it to the axis. The button on the right allows the positioning, offset, and per-division values to be adjusted:

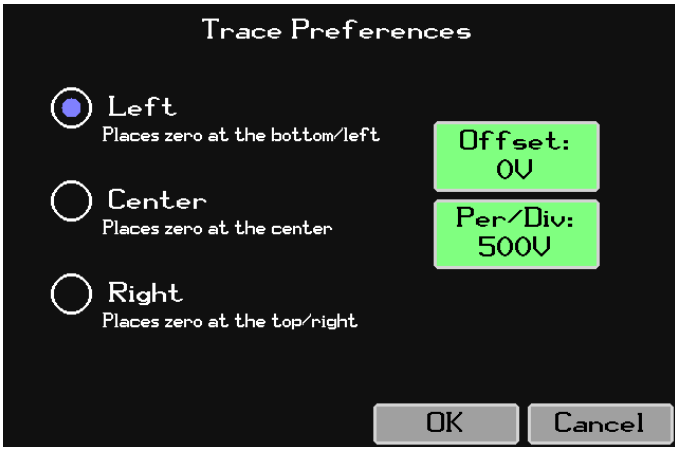


Figure 9-17 Step Results XY Chart Trace Preferences

9.4.1 XY Chart Exporting

The raw data illustrated by the chart can be exported when the export button is touched, a dialog is launched to select the file name:

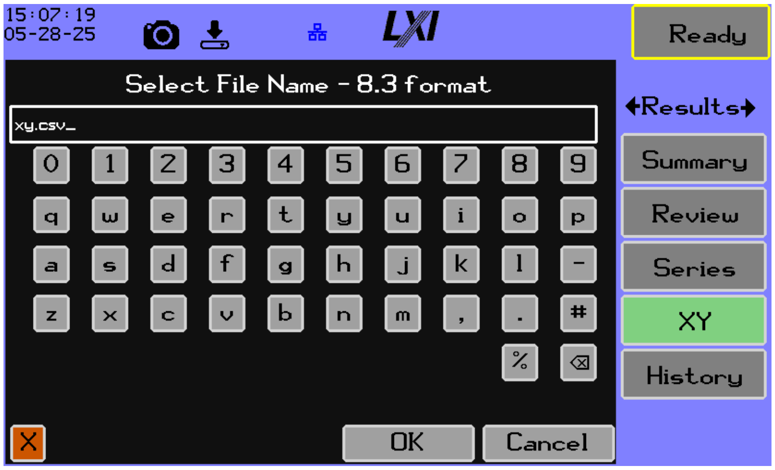


Figure 9-18 XY Chart Export Options

The file will have three columns:

1) Measurement time stamp relative to the start of the step
2) X axis value
3) Y axis value

9.5 History

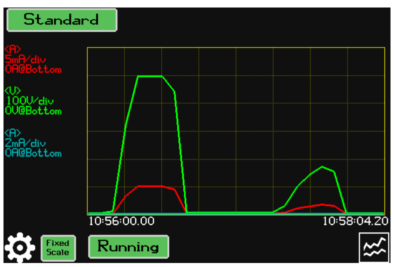
The V10x maintains history records of the instrument's measurements versus time (see Table 9-2 for a list). This facility is useful to look back in time at results of multiple tests. When the V10x powers on the history store will commence recording data into the **Standard** record, this record can be stopped and started by the user. The **Sequence** record covers the last test sequence cycle.

The recorded data elements consist of average, minimum, and maximum samples from the 10ms measurement intervals. There is no time limit on the record store; over time adjacent samples are coalesced by preserving the extents and averaging the averages.

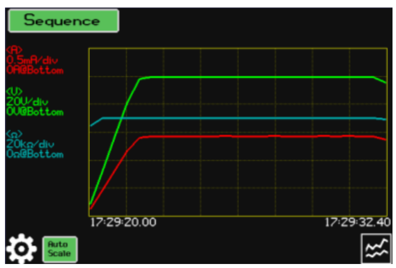
The chart provides options to configure the display format, what measurements to display, and value scaling. Note that regardless of what measurements are selected to display all items continue to be recorded. The display always plots the averages; the max/min are optional.

The following figure illustrates the Standard store encompassing two different sequences verses those sequences individually.

Standard



Sequence – Single DCW



Sequence – Multiple DCW

Figure 9-19 History Chart

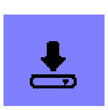
The button on the upper left toggles between history data records: **Standard** contains continuously sampled data that can be stopped and started with the *Running* toggle button; the **Sequence** set carries measurements taken the last time a test was executed.

Touch the displayed chart or manipulate the dial to bring up a cursor for scrolling over the data; press the dial repeatedly to toggle between scroll and zoom. When the cursor is enabled, press the **X** button to remove the cursor. Press the dial or the screen to bring the cursor back.

The scale button chooses if all traces will be scaled using **Fixed** using static settings or **Auto**matic per trace. When using Fixed mode, the item's legend can be touched to automatically scale the data.

Scaling is either fixed to the user configuration, auto-scaled to every capture, or manually toggled on a per-trace basis.

The plotted data will be displayed using a **Fixed** scale, continuously **Auto** scaled, or manually scaled if the user touches the legend for charted item.

 When a USB stick has been mounted use this button to export the raw data set in a CSV formatted file.

The settings ⚙ (gear) icon in the lower left corner brings up a dialog to configure the chart, as shown:

Figure 9-20 History Chart Options Screen

The radio buttons allow the user to select how the time is formatted; the **Show Extents** checkbox enables display of maximum/minimum extents in one of two forms:

- Fill – draws vertical lines up and down from the average sample point.
- Trace – draws the maximum and minimum as distinct horizontal lines.

The **Traces** button in the lower right corner of the History chart opens a dialog for selecting the measurements to display and configuring the scaling, as shown in the next section.

9.5.1 History Data Exporting

The raw data illustrated by the chart can be exported when the export button is touched, a dialog is launched to select the file name:

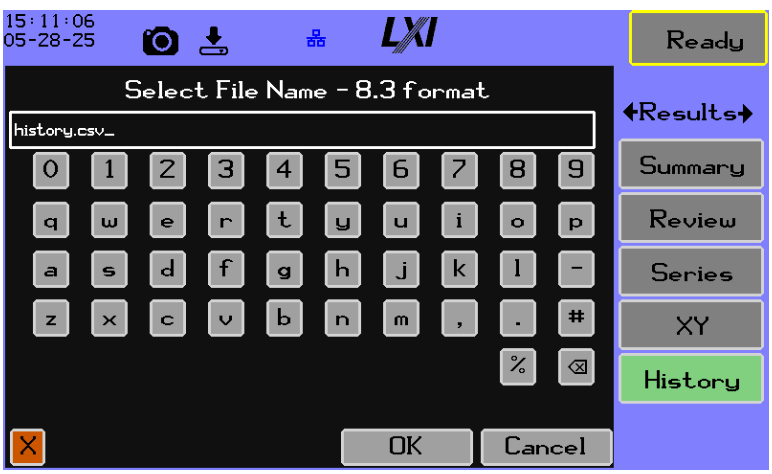


Figure 9-21 History Export Options

The first two columns carry:

1) The history data timestamp matcing the history chart option setting
2) The data timestamp in milliseconds.

For each selected item there are three columns:

1) Average over the time interval
2) Minimum over the time interval

3) Maximum over the time interval

9.6 Charting Options

The Series and History charts use the same mechanism to select the measurements to display, illustrated below:

Figure 9-22 Chart Trace Preferences

The series trace settings are unique to each step type so the settings for DCW are completely different than say GB. The history chart is unified across all step types. In addition a series chart can show test limits for measurements that were being checked during step execution.

The buttons on the left toggle a trace on and off, the button in the middle chooses the trace color, the buttons on the right allow the positioning, offset, and per-division values to be adjusted. The following table lists the available measurements:

Table 9-2 Measurements for Charting

Label	Description	Label	Description
Current	DC or RMS current (in Amps)	*Quadrature Voltage*	Quadrature voltage (in Volts)
Voltage	DC or RMS voltage (in Volts)	*In-Phase Impedance*	In-phase impedance (in Ohms)
Resistance	DC or RMS impedance (in Ohms)	*Quadrature Impedance*	Quadrature impedance (in Ohms)
In-Phase Current	In-phase current (in Amps)	*Capacitance*	Capacitance (in F)
Quadrature Current	Quadrature current (in Amps)	*Dissipation*	Dissipation factor (in DF)
In-Phase Voltage	In-phase voltage (in Volts)		

Each trace can be shown in one of eight colors as illustrated below, in the case of History two shades are used to discriminate the averages from min max.

Series **History**

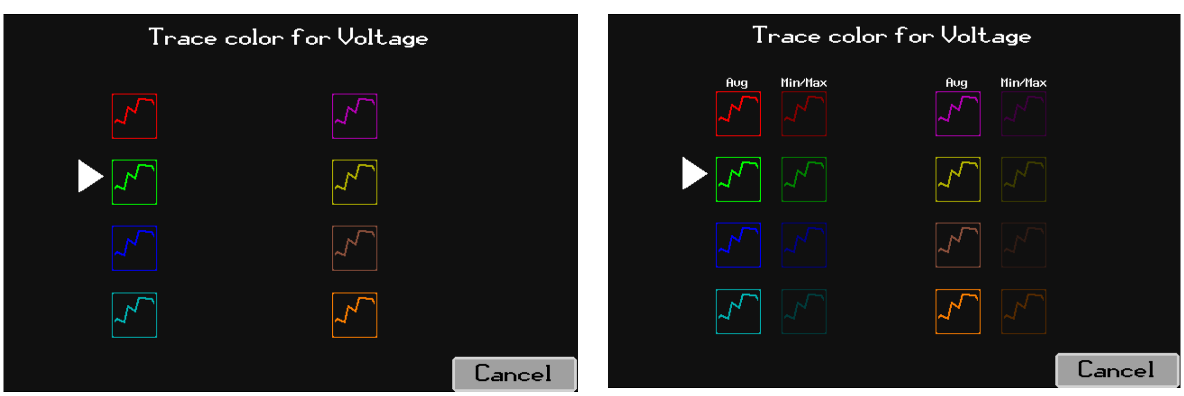


Figure 9-23 Series and History Trace Color Option Screens

When a measurement is enabled the right-hand buttons provide for configuring a trace's properties position and scale as illustrated:

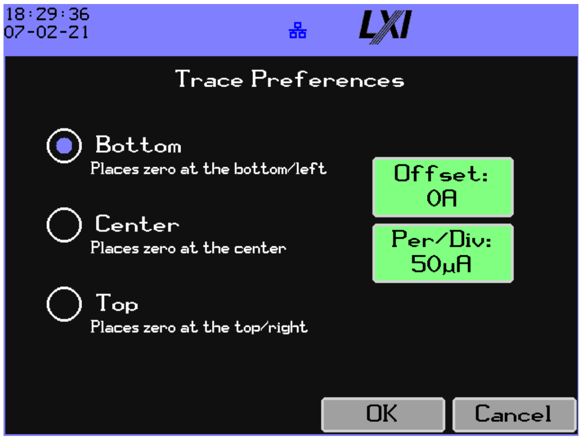


Figure 9-24 Chart Trace Preferences

10 System Menu

The system conceptually surrounds the instrument. It provides the facilities to configure the user experience, command interfaces, Self-Test, and transfer of settings to/from a USB drive. The menu appears as follows:

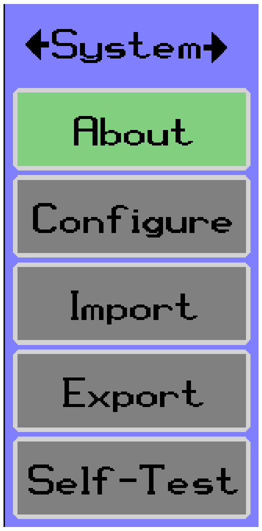


Figure 10-1 System Menu

10.1 About

The About button provides a display listing vital system informaton and storage metrics as as illustrated below:

Identity	Shows the manufacturer, model, and serial number.
Firmware	The version of the main application, main boot loader, and display system.
MAC	This is the address of the interface in use. If the V10x does not have the WiFi option, it is always the Ethernet LAN MAC address; if the system is configured to use Wi-Fi then it would be the wireless MAC address.
HIPOT	HIPOT testing subsystem type, coprocessor firmware versions, and calibration status.
Build	Build configuration options.
RTC	Shows the clock status if the battery is low or the clock has not been set.
SD	Size and usage of internal storage media.
IP	IP address.
USB	Size and usage of the USB drive, if present.

Figure 10-2 About System Screen

10.1.1 Interface Log

The **Interface Log** button displays the contents of the remote interface's error/event queue. This is useful information for the system's engineer when developing an integrated test environment. The following figure illustrates typical errors:

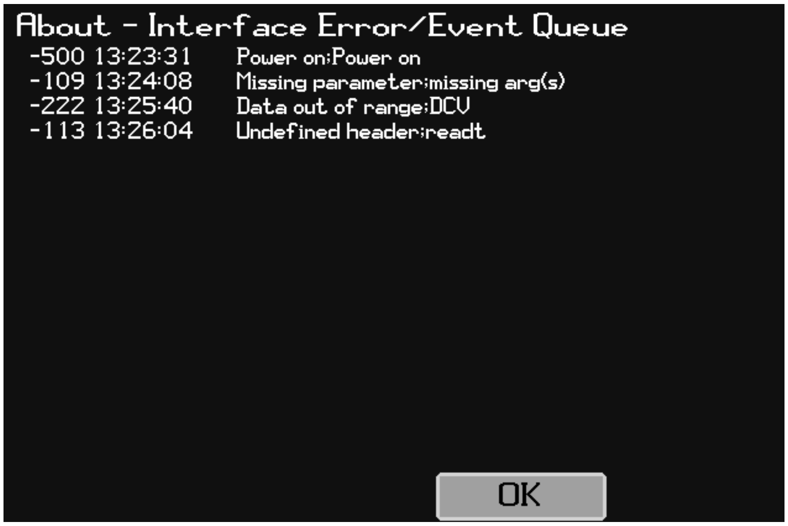


Figure 10-3 Interface Log Error Example

Up to 20 of the most recent errors are displayed. The full error list can be queried, see section 12.7.4.

There are three columns:

1) The SCPI error code from SCPI 1999.0, see pages 21-15 through 21-27.
2) The time the error occurred.
3) A description of the error.

The four errors above are then:

-500 A power on event.

-109 A command was issued that was mising one or more arguments.

-222 A DC voltage parameter was out of range

-113 A unrecognized command was entered, in this case the 'ready' commands was mistyped.

10.1.2 Calibration

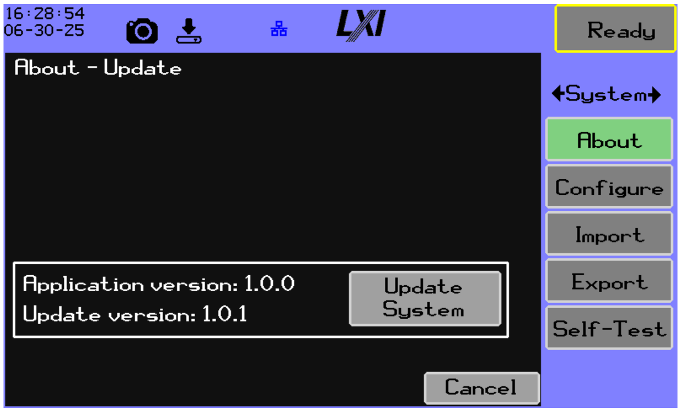
When this button is pressed, the user is prompted to enter a PIN, the default value is 3247. Refer to section 14 for complete details on performing calibration activities.

10.1.3 System Update

The **Update** button is presented if a USB drive containing an update is present. Most often the update includes all operating files, on rare occasions it is only necessary to update the core firmware.

When the button is pressed you are preseneted with an update option as illustrated:

Updating the entire system



Updating the main firmware

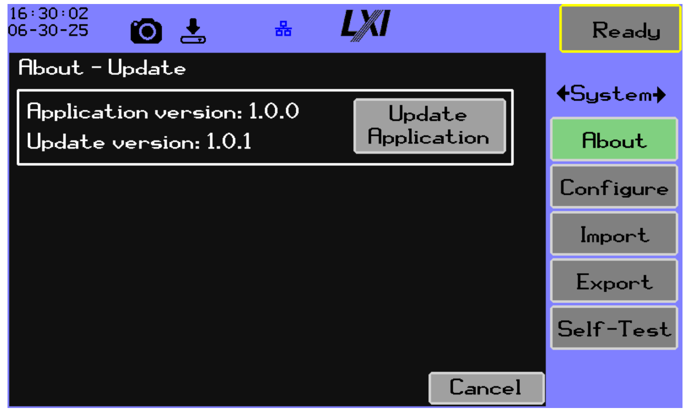


Figure 10-4 System Update Options

When you choose to peform the update the files undergo validation to ensure they are compatible with the V10X. In the event the files are corrupted or are invalid you will see this message:

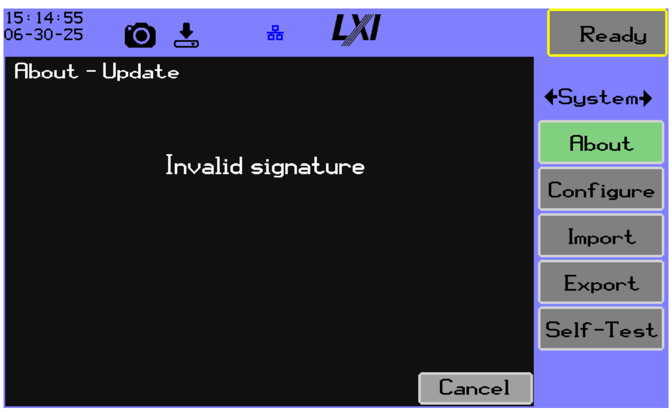


Figure 10-5 Update Invalid

While the update is running one or more status messges will be displayed. When all files have been udated you can choose to restart the instrument or restart later:

Updating the entire system

Updating the main firmware

Figure 10-6 System Update Status

When you choose to rebboot you will be promted to remove the USB drive.

10.2 Configuration

The Configuration menu button provides a menu of the various areas that can be configured:

Figure 10-7 System Configuration Menu Screen

NOTE If the user does not have ‘Settings’ permission the menu will only show **Clock** and **Display**.

10.2.1 Start Enables

These settings configure what actions can start a sequence.

Figure 10-8 Start Enables Options Screen

Button	The Start button on the front panel can start a sequence.
Interface	The command interface if configured properly can start a sequence. This also includes the web remote screen functions, see section 15.
DIO	DIO if configured properly can start a sequence.

10.2.2 Interfaces

Use this to configure which interface is enabled for remote command operation, as illustrated:

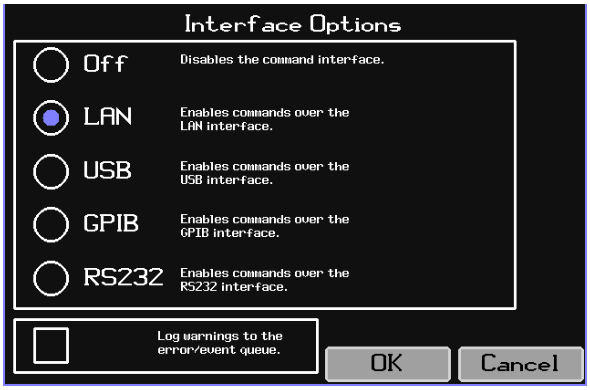


Figure 10-9 Interface Options Screen

Off	Disables the remote command facility.
LAN	Enables command processing via the Ethernet interface.
USB	Enables command processing via the USB VCP interface.
GPIB	Enables command processing via the GPIB interface, the address setting will become visible when this is selected.
RS232	Enables command processing via the RS232 interface, the baud rate setting will become visible when this is selected.

The "Log warnings…" checkbox causes the remote interface command processor to log warnings in addition to errors in the error/event queue.

NOTE If you change the interface to RS232 and a Vitrek switch is connected the V10x will enter remote command mode. Either remove the cable or force local control as discussed in section 4.7.1.

After changing the interface from **Off** to any other setting the V10x may take up to 1 second to accept a connection.

10.2.3 Clock

This menu option provides for setting the clock and calendar, choosing how the date and time are formatted on the screen, and how date and time will be formatted in report files.

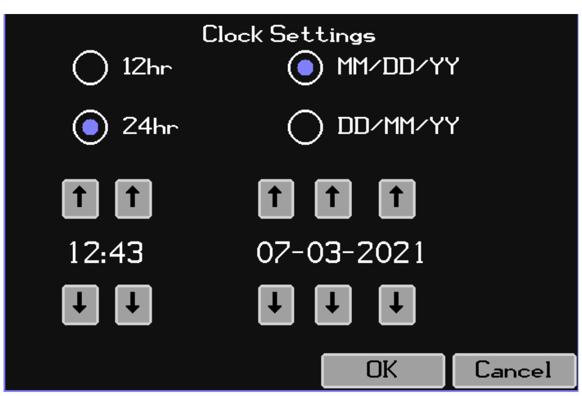


Figure 10-10 Clock Settings Screen

10.2.4 Display

The display menu selection provides control of display behavior and selection of a color theme.

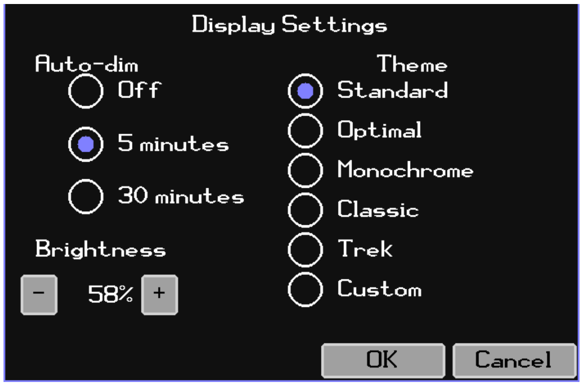


Figure 10-11 Display Settings Screen

The Auto-dim feature allows selection of dimming times of five or thirty minutes after screen inactivity, increasing the life of the backlight. The Brightness setting controls the brightness of the display and may be range-limited to a specific display model. The themes are choices for the UI colors illustrated below.

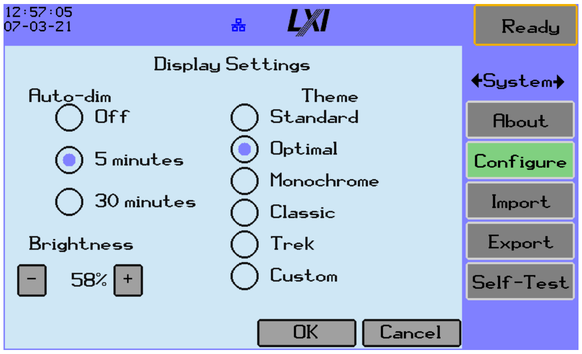
10.2.4.1 Themes

The V10x has five built in themes and an option for a user theme. Visit the Vitrek web site to create your own theme. The built-in themes are described in the following table:

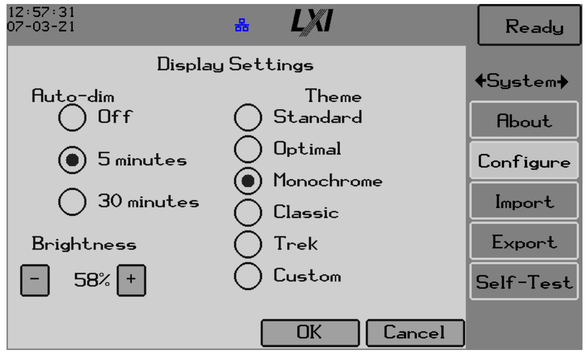
Theme	**Description**
Standard	A color set conforming to the Vitrek standard color set. The Standard theme is used throughout this manual.
Optimal	A brighter display helpful in well lighted workspaces such as many engineering labs.
Monochrome	Mostly shades of gray suitable for color blind individuals.
Classic	A color set similar to the colors seen when instruments first started using color displays.
Trek	A darker set of colors useful in dimmer workspaces.

The following figure illustrates the non-Standard color themes.

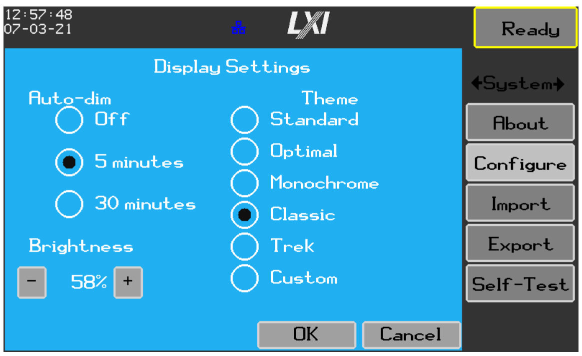
Optimal



Monochrome



Classic



Trek

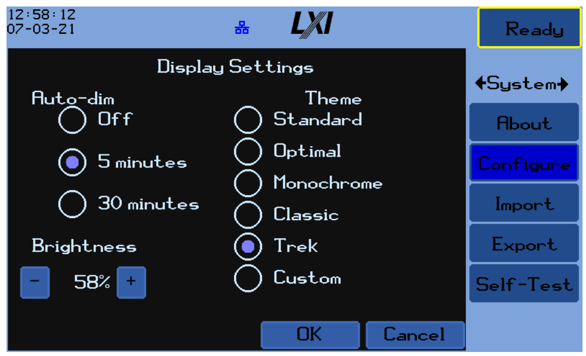


Figure 10-12 Non-Standard Display Themes

10.2.5 LAN

The V10x has a built-in Ethernet LAN interface and allows an optional WiFi interface. When the WiFi interface is present the main configuration screen offers buttons to select Wired or WiFi. Only the selected interface is active at one time. The following figures illustrate the configuration options when the WiFi interface is installed.

10.2.5.1 Automatic Settings

The V10x can be configured to automatically obtain a network address by selecting *Automatic*, or the user can manually configure the unit for network operation by selecting *Manual*. *Automatic* is illustrated as follows:

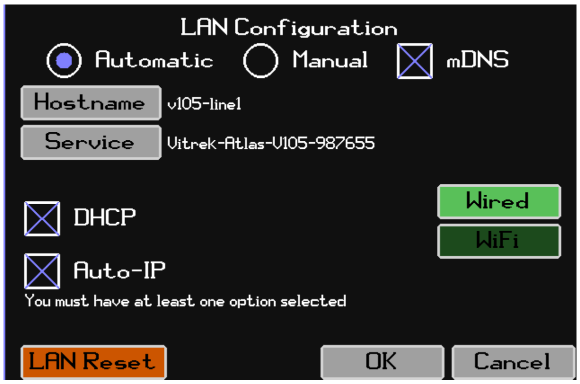


Figure 10-13 Automatic LAN Configuration Screen

NOTE When the LAN is set to Automatic, the user can utilize one or both of DHCP and Auto-IP, but at least one must be selected.

The following options apply to either *Automatic* or *Manual* configuration.

- The **mDNS** option enables multicast DNS (mDNS) operation. The unit will announce service capabilities and respond to mDNS name and service queries. See appendix A for details on useful mDNS features helpful in the lab or production environment.
- The **Hostname** and Service buttons respectfully allow the network hostname and service name to be configured. See appendix A for details on how the names are applied. If you type a blank hostname or service name, the factory default will be applied as necessary. The character set available for the names is restricted to those allowed for internet naming.

The **LAN Reset** button can be used to reset the network interface settings to the factory defaults excepting the host and service names. The web username and password will also be restored to the factory defaults. When pressed, the button will change to an "Are you sure?" prompt, as shown below:

When the "Are you sure?" button is pressed, the settings are reset, and a banner is displayed for two seconds as the LAN interface is reconfigured: **LAN Resetting**.

If you select *Manual* as the configuration method it is required to enter proper values for the IP address, subnet mask, and gateway address for the interface to operate properly.

NOTE Only IPv4 addresses are supported at this time.

10.2.5.2 Manual LAN Configuration Settings

The Manual configuration screen is shown below:

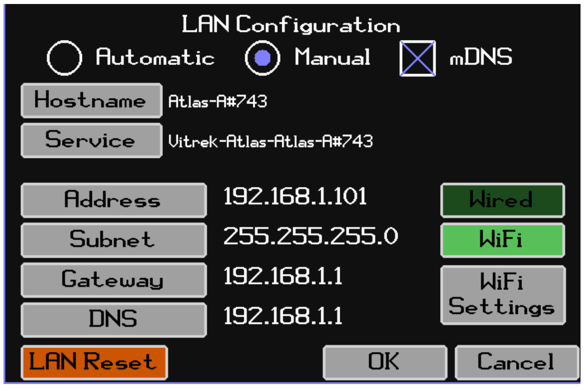


Figure 10-14 Manual LAN Configuration Screen

If the manual configuration has not been previously set it will default to values that filled in by the last successful DHCP registration.

10.2.5.3 LAN Interface Selection

If the V10x has the *Wi-Fi* option installed the user can choose between Wired and Wireless communication using the buttons as illustrated:

10.2.5.4 Wi-Fi Settings

To access the wireless LAN the V10x must be configured with the SSID and password for the access point. Touching the WiFi Settings button brings up a display showing the present SSID, security mode, and a blanked-out password:

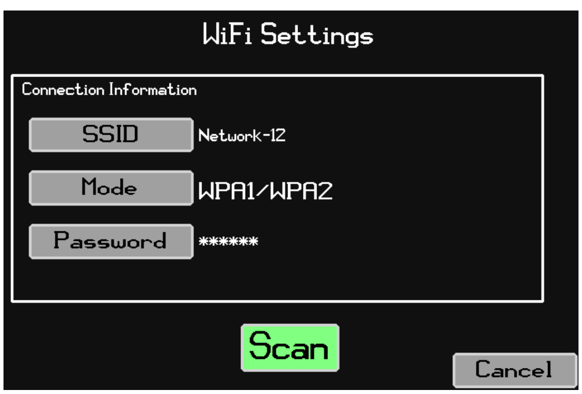


Figure 10-15 WiFi Settings Screen

You can manually enter the SSID, mode, and password; once the password is entered V10x will connect to the wireless network.

The connection process can be automated using the **Scan** button, the V10x will show a busy indicator while performing active probes:

When the probe completes the scan results are displayed, for example:

Signal level shown with bars | Signal level in dBm

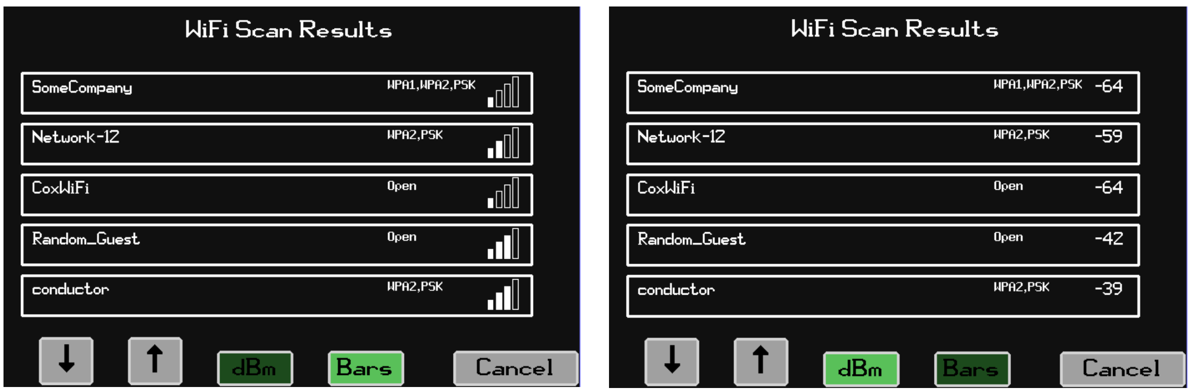


Figure 10-16 WiFi Scan Result Screen

You can use the dBm button to show RSSI in terms of dBm. Use the arrow buttons to navigate the list, touch a label to select the access point for connection; you will be prompted to enter the password.

After the password has been entered the V10x will attempt to join the network and show the process result:

Join Running | Join Completion

Figure 10-17 WiFi Join Status Screen

Touch **Continue** to proceed.

10.2.6 Security

The Security facilities allow for per-user access settings. From the factory this feature is not enabled, when the Security menu is selected, and the check box enabled the first level settings are as shown:

Figure 10-18 Security Enable Screen

The Inactivity Time can be set to 5 to 120 minutes. If this time period expires without the user having touched the display the user will be automatically logged out.

When the feature is first activated a default set of credentials is created:

User	atlas
Password	2914
Permissions	All

You are free to delete this user if it is not needed.

Use the Manage Users button to add, edit, and delete user profiles:

Figure 10-19 User Management Screen

A list of the present users is shown with arrow buttons to scroll, after each name is a list showing what permissions the user has:

Run Cannot be turned off, all users can run a test sequence.

Load The user can load test sequences.

Sequence The user can create, edit, and delete test sequences.

Settings The user can modify the system configuration settings.

Users The user can modify the user access list.

So, using the example display user fred can load and run any sequence, user phil can only run a previously loaded sequence, tjw and u5 can access all areas, and the hipot user is maintained for accessing the system.

Use the + button to add a new user, use the trash can icon to delete the user, touch the user name to modify the user's permissions and password. Attempting to delete a single remaining user will be ignored.

NOTE You should maintain a user with permissions to access the system settings and user profiles. In the event you lock yourself out contact Vitrek customer support.

Adding or modifying a user would look like:

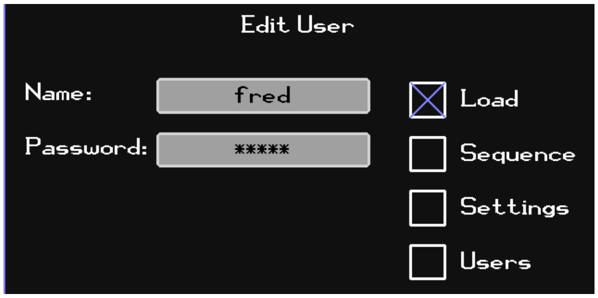


Figure 10-20 User Profile Screen

Passwords are set in terms of a numeric PIN of up to six digits, there is no mechanism to see a previously created password, you can only enter a new password.

NOTE If the Security function is disabled the user list information persists and will be available when enabled in the future.

10.2.7 Preferences

The preference options affect the user experience in how sequences are edited and the sound played when the user interacts with the touch panel and dial, the display looks like:

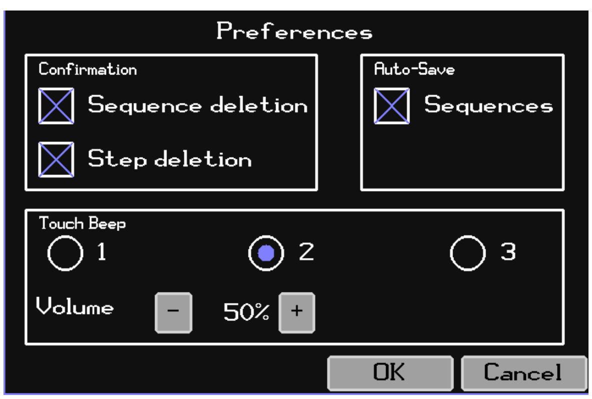


Figure 10-21 Preferences Screen

Use the **Confirmation** options to require a confirmation action whenever a step or entire sequence is directed to be deleted. The *Auto-Save Sequences* option results in sequence changes being automatically saved when the user navigates away from the sequence editor.

NOTE The user can still use the Save button when they desire.

10.2.8 DIO

This section provides on instructions on configuring the **Digital Input/Output** (**DIO**) interface. See section 11.5 for details on the physical connector, signal characteristics, and factory defaults.

NOTE The DIO signals are fully symmetric in that any individual pin can be configured for input or output with high or low polarity.

There are 12 signals that can be assigned to any one of the functions listed in the following table.

Table 10-1 Digital Input/Output Functions

Input Functions	Start	Starts a test sequence upon a transition from inactive to active. This may also be used to continue a test sequence when it is waiting for user interaction (e.g., in a HOLD step or if programmed for a user terminated test step). If the *Sequence* input signals are not used to select a sequence then a sequence must have been already manually selected. If the V10x is waiting for the front panel *Start* button to be pressed while running a test sequence (i.e., waiting for user interaction) then an inactive to active transition of the *Start* signal will continue the sequence. **NOTE** The **Start** function can be explicitely disabled in the system configuration, see section 10.2.1.
	Abort	Aborts a test sequence when active. This signal has priority over the *Start* signal; disabling it while *Abort* is active.
	Interlock	Aborts a test sequence (high voltage or current steps only) when inactive.
	Sequence1	These signals are only used at the instant of the *Start* signals' transition which starts a sequence; they are ignored at all other times. Sequence #0 through #15 are selected and run according to the state of these signals. See section 7.6 regarding selection of a sequence number from the front panel; see section 12.7.1.12 to number a sequence created over the command interface.
	Sequence2	
	Sequence4	
	Sequence8	
Output Functions	HV Present	Active whenever an unsafe voltage or current is present on the V10x terminals.
	Testing	Active while running a sequence.
	Pass	Active after the end of a sequence if passed.
	Fail	Active after the end of a sequence if failed.
	Dwell	Active during the dwell period of a measurement type of test.
	Arc	Active when Arc has been detected in the present step.

There is an additional option setting 'None' that is effectively an input that is ignored.

The top level DIO configuration screen looks like:

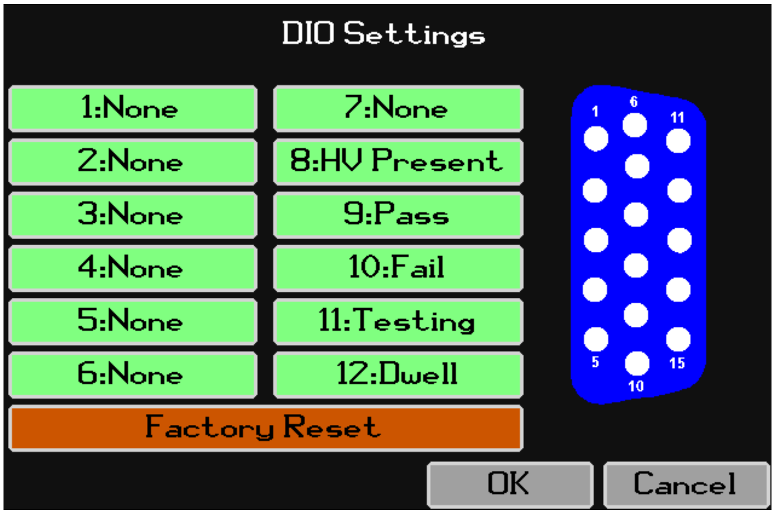


Figure 10-22 DIO Settings Screen

The display shows the present functions assigned to each pin and an image of the DB15 for reference.

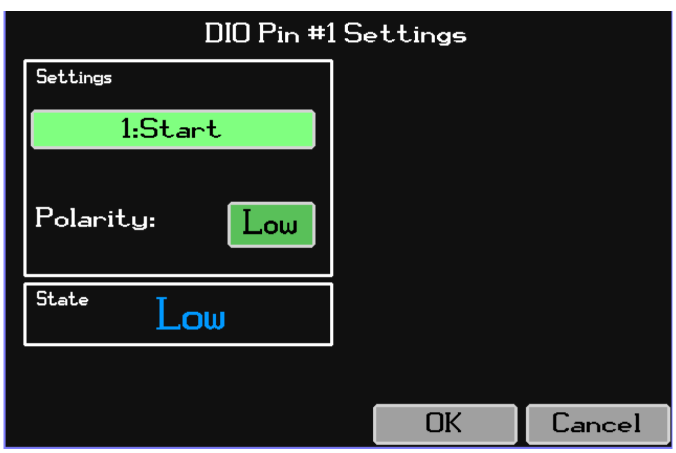
NOTE While the DIO system is being configured the normal evaluation and processing of the inputs is inhibited and none of the outputs will reflect the actual test state of the instrument.

CAUTION When the user exits this screen with OK the DIO changes are applied and the V10x may immediately act on input state changes.

Any changes made to the DIO settings will only be applied if the **OK** button on the top-level **DIO Settings** screen is used; navigating away using a menu key will cause all changes to be abandoned.

A signal is selected for configuration by touching its button to bring up a display of the polarity setting and the present level:

Input Function



Output Function

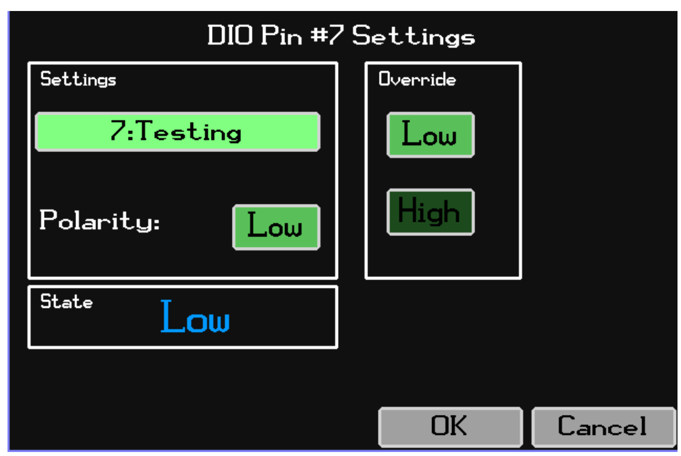


Figure 10-23 DIO Pin Settings Screens

The display on the left applies when the signal is assigned to an input function, the display on the right applies when the signal is assigned to an output function.

The *Polarity* button toggles the polarity setting; for an input function it configures the level that triggers the action, for an output function it sets the level asserted when the state is true. The *State* indicator shows the present level. Output signals can be manually set for testing. The system integrator can use these features to verify that an input to the V10x has the expected polarity; or to verify an output setting.

To configure the signal's function, touch the button identifying the present setting present setting label button:

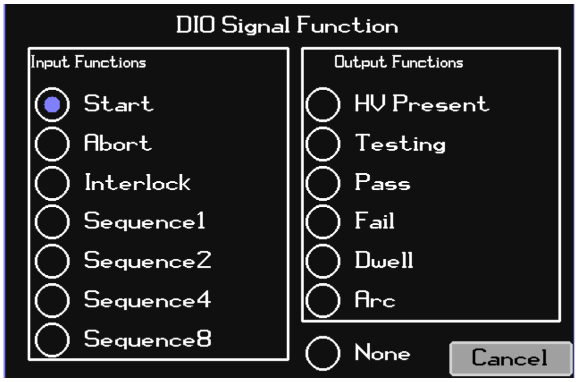


Figure 10-24 DIO Signal Function Screen

Input functions can only be assigned to a single pin; in the event the user assigns a function twice the previously configured pin will be revered to *None*. When a function is changed the present polarity setting is preserved.

The **Factory Reset** button sets all pins to the factory default functions.

10.2.9 Automation

These settings configure what sequence is loaded when the instrument powers up and integration of a barcode scanner.

10.2.9.1 Scan Settings

While executing test sequences the V10x can accept a sequence name and/or a test label from a barcode scanner plugged into a front panel USB port. This allows for a more streamlined factory test process with less error. Typically, the user would use a sequence name matching a model and a test label set to a serial number. All symbols must be terminated by a ***linefeed*** or ***carriage return*** character, but not both.

The system allows for two scanning methodologies:

1) One or two direct barcode symbols explicitly carrying the sequence name and label selected with the *Direct* option setting.
2) A single barcode symbol with fixed formatting carrying both pieces of information selected with the *Pattern* option setting.

The configuration settings for the two modes are illustrated below:

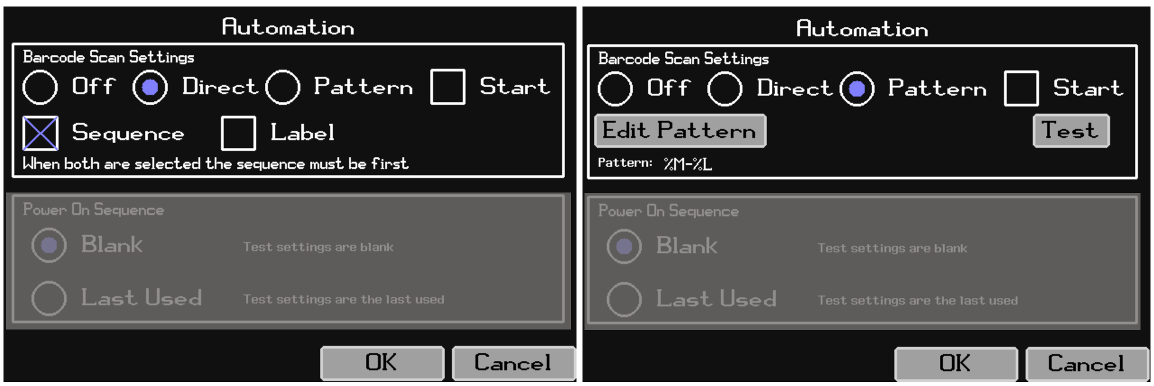


Figure 10-25 Automation Options Screen

In either mode thee *Start* option allows the sequence to start once the symbols have been processed.

When the *Direct* mode is selected the user can have one or two barcode symbols. If the *Sequence* option is checked a scan symbol can carry a sequence name that will be automatically loaded. If the *Label* option is checked a scan symbol will label the test results on the next execution cycle. If both of these options are checked the sequence symbol must be scanned first; each symbol must have a line terminator.

Use the *Pattern* mode to scan a single barcode symbol containing both the model and label strings. The user enters a text string specifying a template that is matched against a scan symbol to extract the sequence and/or label. The pattern length is limited to 40 characters. For details on constructing the scan pattern see appendix C. After entering the pattern, you can test it. The initial display and scan result for '%M-%L' would look like:

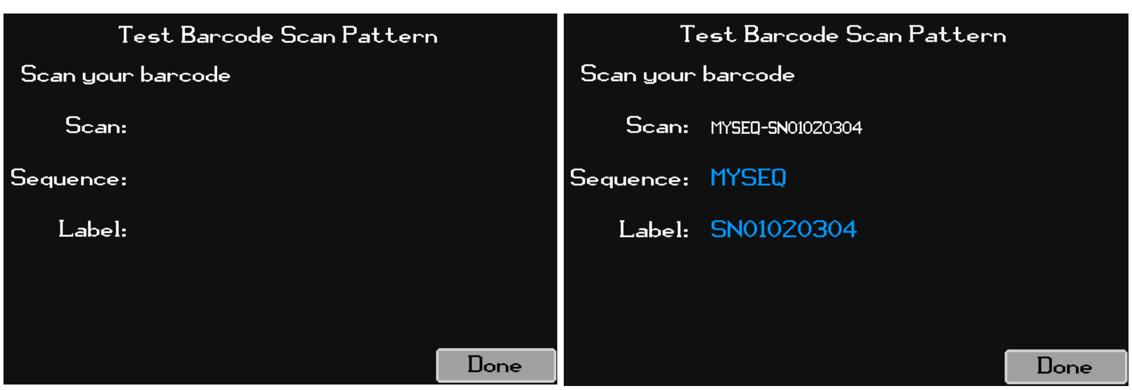


Figure 10-26 Automation Scan Pattern Test Screens

The user scans the production symbols to verify the pattern. In the event the pattern cannot be decoded the **Sequence** and/or **Label** results will show error messages. The maximum length of the model and label are respectively 15 and 20 characters.

10.2.9.2 Power On Sequence

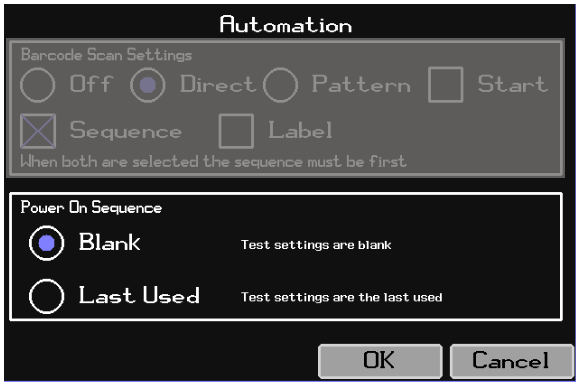


Figure 10-27 Power On Sequence Settings

The *Blank* setting is intended to have the user always having to load a valid sequence to make the V10x ready for testing. In contrast *Last Used* option causes the V10x to load the last sequence present when the instrument was last powered off; the V10x is made ready by the user having to press the Stop button as shown in Figure 4-2.

10.2.10 Switching

This menu option configures the high voltage switching facility. By default, switching is disabled, when first enabled the VICL interface is selected.

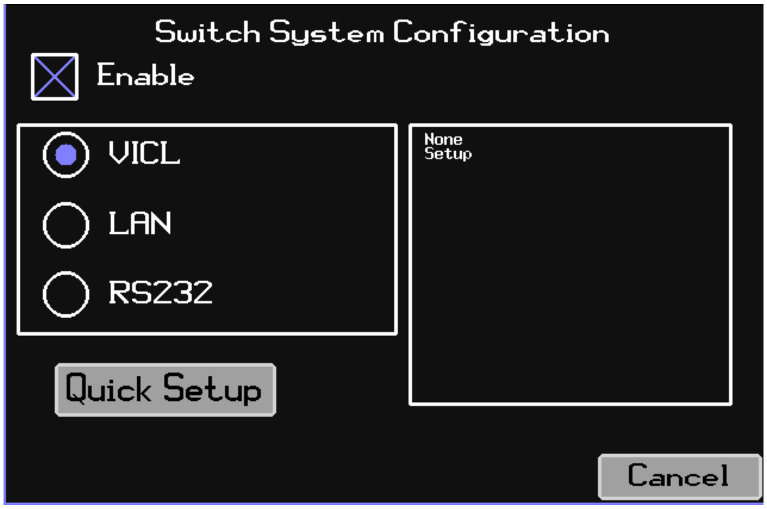


Figure 10-28 Switching Configuration Default Screen

When the Enable option is selected the user can choose the interface and configure the switches automatically or manually. Touch the rectangle with 'None Setup' to manually add one or more switches.

10.2.10.1 Switching Quick Setup

The options available for quick setup vary depending on the selected interface:

Option	**Interface**
Auto	All
1 964i	VICL, RS232
2 964i	VICL
3 964i	VICL
4 964i	VICL

It is recommended to use the Auto feature in all cases as it provides details on the switches helpful when integrating high voltages switches. The M10x series do not allow a quick option because they have a variety of relay options and should be automatically configured, or with manual addition discussed later. The 964i series should be running firmware version 1.07 or greater.

10.2.10.2 Automatic Switch Setup

NOTE It is highly recommended that automatic setup be used to configure the switch units as this verifies the connections and accuratly determines the number of relays.

The V10x will probe the configured interface and collect information on the attached switches. Note that when using the VICL interface the probe will end when a sequential address does not reply; meaning that if you have three switches configured with addresses 1,2,4 address #4 it will not be detected because #3 is not present.

While the probe is running the V10x displays:

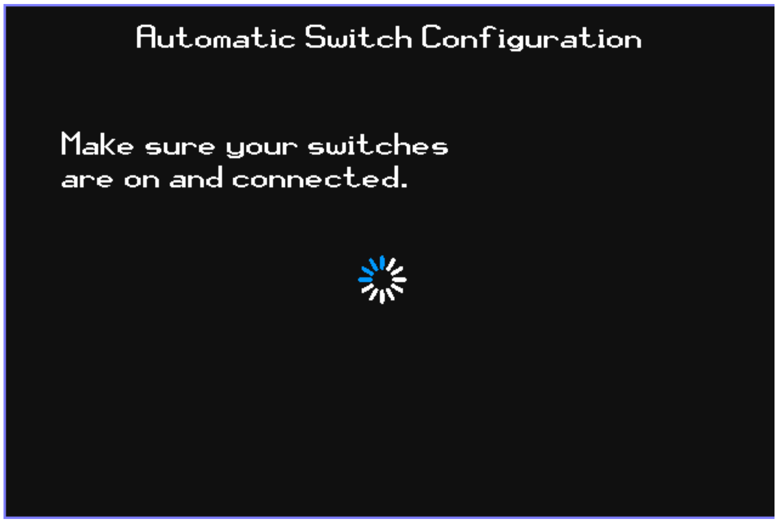


Figure 10-29 Automatic Switch Configuration Probing

Once the probe completes it will display None found or a list of the discovered switches. For example, if you have three 964i models connected via VICL:

Figure 10-30 Automatic Switch Configuration Probe Results

You can use the Redo button to repeat the probe in case one or more switches was not powered on or connected. The list shows the logical unit number, model, serial number if available, and the number of relays. Touch the information button to manually operate the switch, discussed in section 10.2.10.3.2.

Use the OK button to select the list.

You now are shown the switches available for operation:

Figure 10-31 Switching Configuration Ready Screen

Touch OK to complete the configuration or touch the list of switches to manage the units discussed below.

10.2.10.3 Manage Switch Units

On this screen you are shown the list of configured switches with buttons to add, configure, or operate a switch:

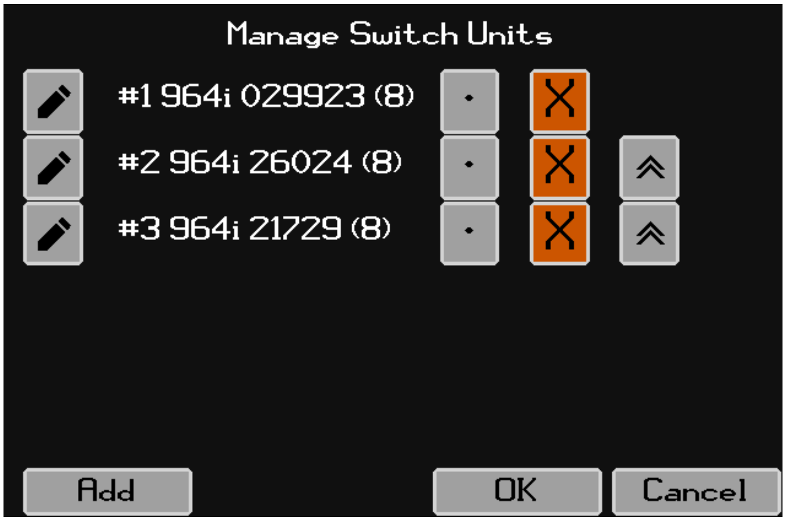
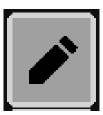


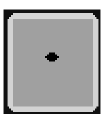
Figure 10-32 Switching Configuration Ready Screen

NOTE: The order shown on this list is the same order used when configuring and executing a switch control step, use the shift buttons to rearrange as necessary.

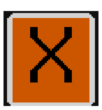
This display can



Configure the switch's settings.



Operate a switch's relays.



Delete a switch from the list. The system will prompt to confirm th eactin.

Shift the switch up one position in the list.

Manually add a switch unit.

10.2.10.3.1 Configure Switch Unit

You can fully configure a switch unit with this screen, such as when manually adding a switch.

964i Properties

M10x Properties

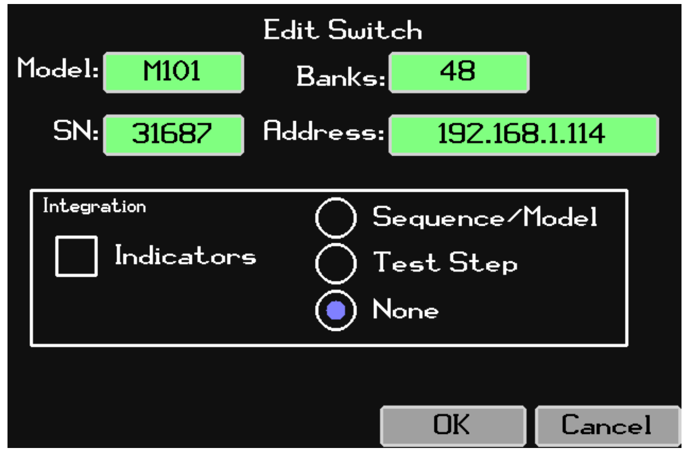


Figure 10-33 Edit Switch Properties Screen

The four items in the top portion can be touched to edit the respective settings.

The integration options are available for the M10x series switches.

The *Indicators* option enables the front panel lights to be operated during the test sequence.

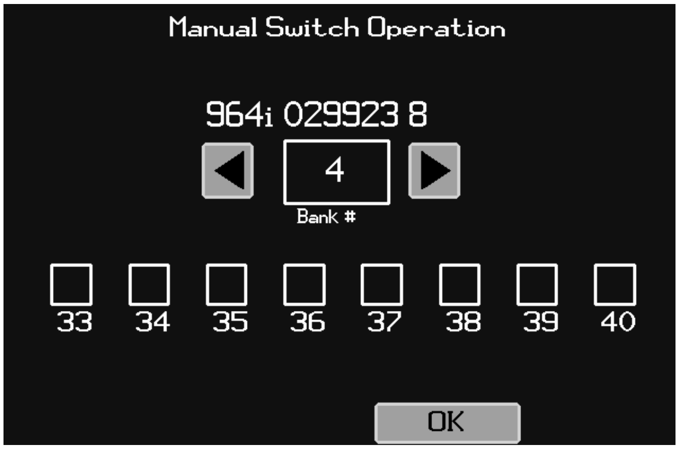
The radio buttons select:

Sequence/Model	The switch's activity display will be configured to show the sequence and model.
Test Step	The switch's activity display will be configured to show the present step information.
None	The switch display will not be operated.

10.2.10.3.2 Operate Switch Unit

This screen is helpful to manually operate a switch during the integration process. The remote indicator on the unit will illuminate and the display will reflect relay changes.

Full Bank



Partial Bank

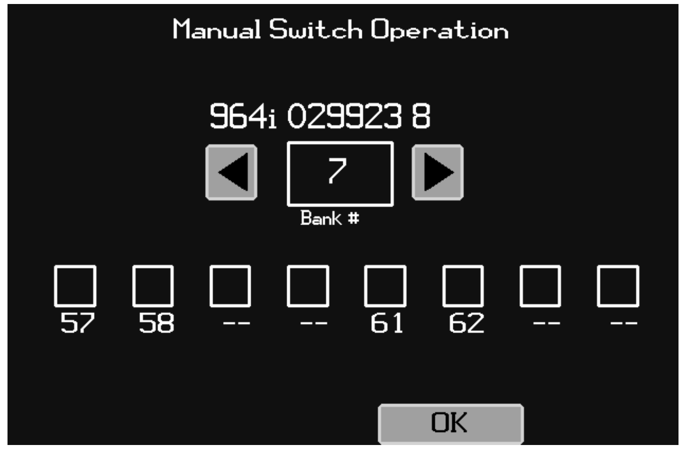


Figure 10-34 Operate Switch Screen

You can scroll the banks and use the checkboxes to control individual relays. The '—' indicates a relay that is not fitted. When you exit the screen, all relays will be opened.

10.3 Import

Configuration settings and sequences can be imported from previously exported files – see section 10.4 below. When the **Import** option is selected the user has the option of performing a **Factory Reset** or performing a **File Import** as illustrated:

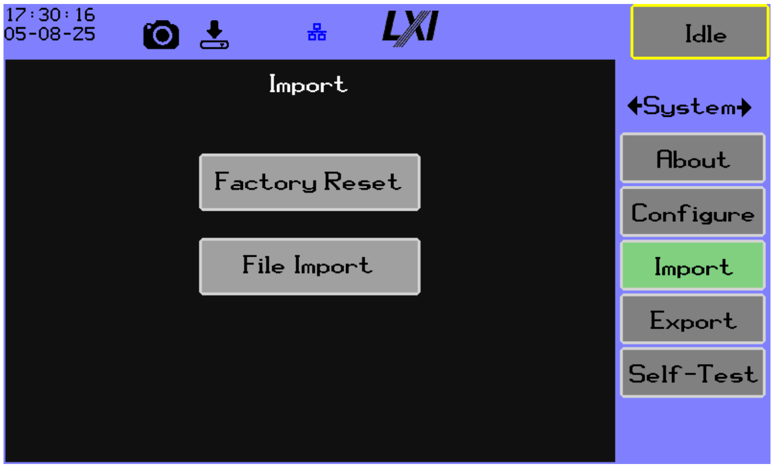


Figure 10-35 Import Menu Screen

10.3.1 Factory Reset

Use this to restore most settings to the factory state. The user will be prompted to confirm the action.

NOTE ‘Most settings’ means that sequences will not be deleted.

When the reset completes the V10x will reboot.

10.3.2 File Import

A USB drive must be present for this process to continue. The V10x will present a list of files available, both configuration settings and sequences, sorted by name. When there are multiple .xfg or .seq files to the right of the list are wildcard option buttons:

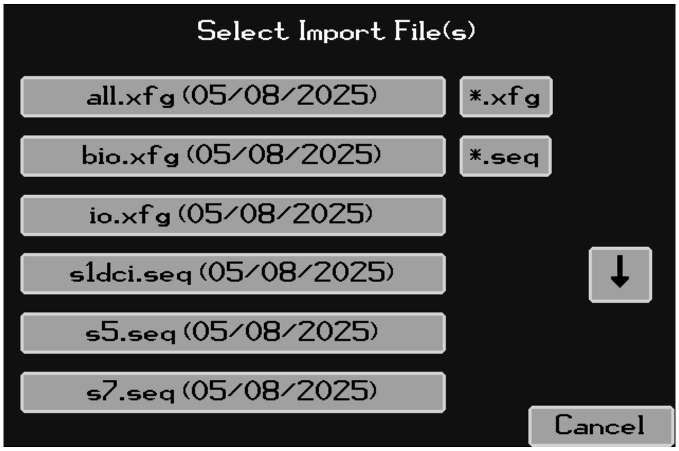


Figure 10-36 Import File List Screen

When a file is being exported the filename is shown, when the import completes a list of the settings that were modified are shown below as illustrated in this example when importing a file containing all the system settings:

Figure 10-37 Import Settings Example Screen

If the file is corrupted a warning message will be displayed. When importing multple files the process will halt when an error occurs.

10.4 Export

The Export process allows the user to save V10x settings and event information onto a USB drive. The settings can be archived or transfered to another V10x. The event log is useful when diagnosing anomously test perfomance.

A USB drive must be present; if not the user is prompted to insert a drive. When a drive is present a menu is presented as illustrated:

Figure 10-38 Export Menu Screen

The top six options allow the wide array of settings to be exported to a USB drive; in the case of **Sequences** the user selects one or all sequences to save.

10.4.1 Exporting Settings

The following table summarizes the settings exported by section.

Table 10-2 Exporting Settings

Button	Settings Included
System	System level settings such as display brightness, user-beep volume, switch interface, security flags, users, switch settings.
LAN	Network settings such as the manual/automatic selection, static address settings, hostname.
General	General HIPOT test settings.
I/O	DIO Settings.
Charting	Chart settings such as trace selections, scaling factors, and trace colors.
All Settings	All of the above.

For each section the user is prompted to enter a file name, the destination file is formed by appending '.xfg' to the entered name. Note the file name is restricted to 1-8 characters. If the file already exists on the USB drive the user is prompted to confirm the export. The selected settings will be saved to the named file and can be archived or imported to another V10x.

10.4.2 Exporting Sequences

You can choose to export all or a single sequence. Sequence information is stored in two files respectively using the extensions '.seq' and '.dat' appended to the sequence number.

When exporting 'All' sequences the files are copied directly and any identically named files on the USB drive will be overwritten.

When you choose to select a single sequence you are prompted for a filename, if a file with the extension '.seq' exists the user is prompted to confirm overwriting the file.

While either export selection is running the system displays a busy

Exporting All Sequences

Exporting Selectes Sequences

Figure 10-39 Export running screen examples

When the export process completes the user is presented with a result message, either **Complete** or **Error**. When an error occurs most likely this is due to a bad USB drive.

10.4.3 Exporting the Event Log

A file named atlas.txt will be saved onto the flash drive. This file might be requested by Vitrek customer support personnel.

10.5 Self-Test

Prior to performing a self-test, the V10x must have been continuously powered and turned on for at least 5 minutes.

The user may press the Stop button at any time during the self-test procedure to abort it. The HIGH VOLTAGE OR HIGH CURRENT PRESENT warning symbol is illuminated whenever high voltages are present on the V10x terminals during this procedure.

WARNING The self-test process drives high voltage to the front and/or rear terminals that could result in injury to or death of personnel.

When **Self-Test** is selected, the user is prompted to remove all connections:

Figure 10-40 Self-Test Start Screen

NOTE Even leaving test leads with no external connection attached to the V10x terminals can impair the self-test.

Once the user has verified that all connections to the V10x have been removed the Start button is pressed.

The V10x executes a series of internal procedures, showing **OK** in green when a phase passes, **Failed** in red if the phase fails, or **N/A** if the test does not apply to the model type. Typically, a failure indicates that an internal adjustment diverged too far to allow proper operation of the instrument.

When the process completes an **Exit** button is presented as illustrated:

Figure 10-41 Self-Test Result Screen

Depending on build options the test list may differ from the illustration above.

Press Exit to continue.

11 Command and Control Interfaces

The V10x can be integrated with command-and-control systems to operate in an automated test environment. The interfaces can be classified into three groups:

1) RS232, GPIB, USB, and LAN interfaces allow for command language processing.
2) DIO provides control and status via digital signaling.
3) VICL provides a connection to one or more Vitrek switch matrix units.

NOTE The GPIB and RS232 interfaces are optional and may not exist on your instrument.

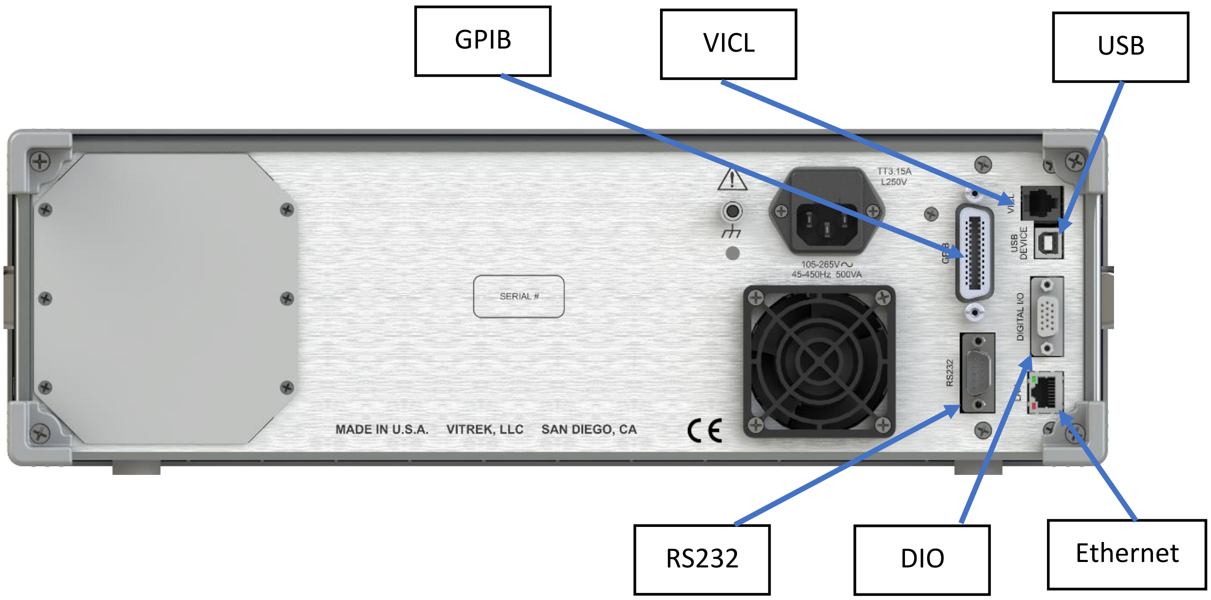


Figure 11-1 Rear Panel Interfaces

11.1 RS232

The RS232 port can be used as either a command interface or for controlling a switch matrix unit. For command use see section 10.2.2, to controlling a switch matrix see section 10.2.10.

11.1.1 RS232 Connector and Pinout

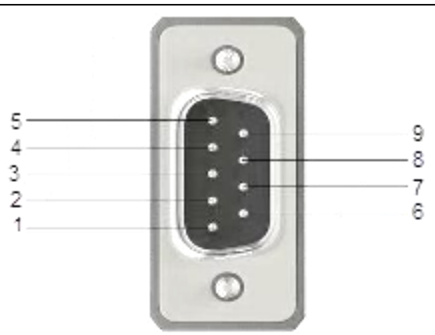
	The RS232 port is available at the rear panel of the V10x on the 9-pin connector identified as “RS232” as shown in the illustration to the left. The connector is a standard 9-pin male D-sub type; any suitable female mating connector may be used. The diagram to the left shows the pin locations within the connector as viewed from the rear panel of the V10x.

Figure 11-2 RS232 Connector Pin Numbering

The following table contains a description of the signal on each pin in the connector.

Table 11-1 RS232 Signals

Pin	Signal	Signal Name	DTE Signal direction
1	N/C	---	---
2	RXD	Receive Data	In
3	TXD	Transmit Data	Out
4	DTR	Data Terminal Ready	Out
5	GND	Ground	
6	DSR	Data Set Ready	In
7	RTS	Request to Send	Out
8	CTS	Clear to Send	In
9	N/C	---	---

Using a RS232 cable supplied by Vitrek, connect the RS232 port on the V10xx rear panel to the RS232 (Serial) port of a computer. The user may supply their own cable, in which case it should be a 9-wire female-female null modem cable capable of full handshake 115200baud operation.

11.2 GPIB

Use a standard GPIB cable to connect the V10x to the controller. It is recommended to use a high quality, shielded GPIB cable. Cables may be purchased from Vitrek.

11.3 USB

The instrument uses a standard USB type-B connector. A USB Type A to USB Type B cables may be purchased from Vitrek.

11.4 Ethernet

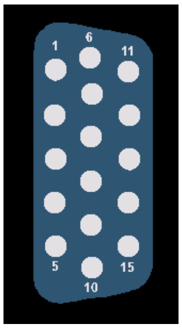
Capable of 10baseT or 100baseTX operation, MDI/MDIX auto-selected.

11.5 DIO

Using the V10x Digital Input & Output (DIO) interface the user may perform any combination of the following –

- Control the V10x using a PLC type device, starting, stopping, selecting a sequence, and determining the pass/fail status.
- Control the V10x using external start and/or stop switches.
- Abort a test sequence when a safety interlock is opened.
- Allow the V10x to illuminate external safety indicators.

11.5.1 DIO Connector and Pinout



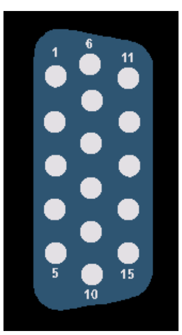
The DIO signals are available at the rear panel of the V10x on the 15-pin connector identified as “DIGITAL I/O” as shown in Figure 11-1 above. The connector is a standard three-row 15-pin female D-sub type; any suitable male mating connector may be used.

The diagram to the left shows the pin locations on the connector as viewed from the rear panel of the V10x.

Figure 11-3 DIO Connector Pin Numbering

The following table contains a description of the signal on each pin in the connector. Each input and output signal can be configured as the active level being low or high, or each input may be disabled.

Table 11-2 DIO Signals

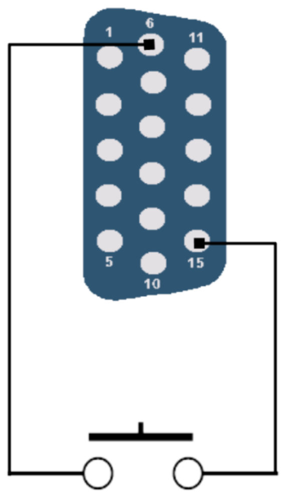
<table>
<tr><td rowspan="15">
</td><td>Pin 1</td><td>I/O #1</td><td rowspan="12">Soft configured Input/Output function, see section 10.2.8.</td></tr>
<tr><td>Pin 2</td><td>I/O #2</td></tr>
<tr><td>Pin 3</td><td>I/O #3</td></tr>
<tr><td>Pin 4</td><td>I/O #4</td></tr>
<tr><td>Pin 5</td><td>I/O #5</td></tr>
<tr><td>Pin 6</td><td>I/O #6</td></tr>
<tr><td>Pin 7</td><td>I/O #7</td></tr>
<tr><td>Pin 8</td><td>I/O #8</td></tr>
<tr><td>Pin 9</td><td>I/O #9</td></tr>
<tr><td>Pin 10</td><td>I/O #10</td></tr>
<tr><td>Pin 11</td><td>I/O #11</td></tr>
<tr><td>Pin 12</td><td>I/O #12</td></tr>
<tr><td>Pin 13</td><td>Common</td><td rowspan="2">Common Reference signal for all digital inputs and outputs (Digital Ground, internally connected to the V10x chassis ground).</td></tr>
<tr><td>Pin 14</td><td>Common</td></tr>
<tr><td>Pin 15</td><td>+12VDC</td><td>Internal +12VDC power source, internally fused 100mA (self-resetting)</td></tr>
</table>

11.5.2 DIO Signal Characteristics

Each DIO signal is capable of operating as an input function or output function.

11.5.2.1 DIO Input

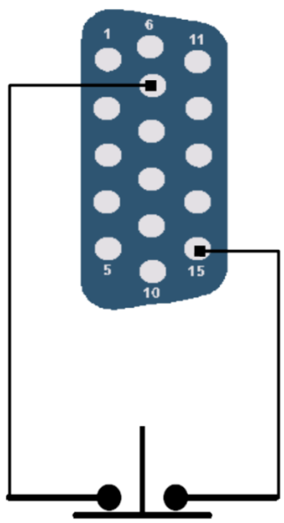
An input function is activated by connecting a signal pin to the +12V pin, say with a push button. The current is limited to 6mA. For example, presume that signal #6 is desired to be used for the start function and is activated with a push button:



In this example the polarity setting would be ***High***.
Configuration:

Figure 11-4 DIO Input Start Example

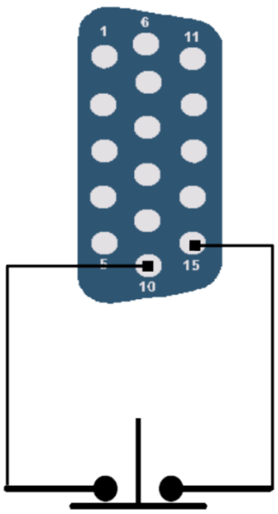
As another example let's use a normally closed push button for the abort function on signal #7:



In this example the polarity setting would be ***Low***. Configuration:

Figure 11-5 DIO Input Abort Example

And a final example illustrates the interlock function using a **Vitrek SE Series Safety Enclosure** which provides a closed switch when the cover is secure. Interlock activates the signal goes false, let's use signal #10:



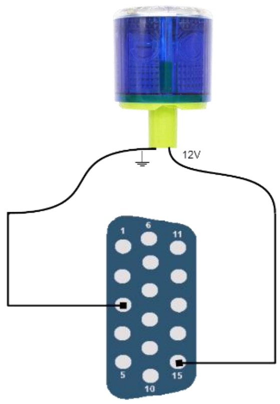
In this example the polarity setting would be ***High***. Configuration:

Figure 11-6 DIO Input Interlock Example

11.5.2.2 DIO Output

As an output it sources 12V and must have a load that must not exceed 200mA on a single output, and the total current used on all active outputs cannot exceed 300mA. When it is desired to sense a voltage change it is recommended that the load be a relay with a coil voltage of 12V and a maximum operating current of 25mA, source voltage through the contacts suitable for your relay and application. Most often the outputs are used to activate indicator lights, in which case you should follow the current limits stated above.

For example, presume that signal #3 is desired to be used to indicate when testing is active by directly powering a warning light that uses 12V DC at 100mA:



In this example the polarity setting would be ***High***. Configuration:

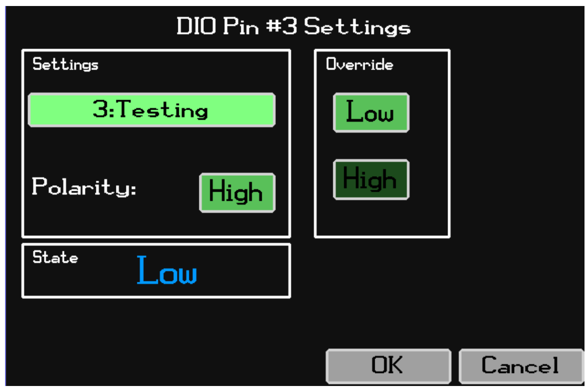
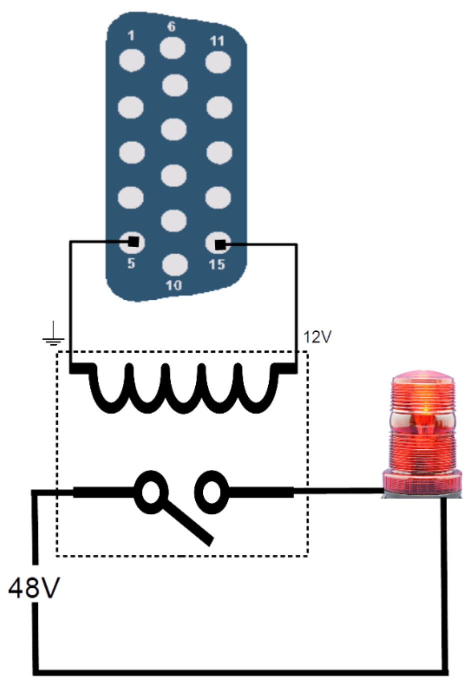


Figure 11-7 DIO Output Testing Example

As a second example presume that signal #5 is desired to be used indicate when high voltage or current is present by illuminating a warning light that uses 48V DC; the user chooses a 12V relay that has an operating current of 20mA and the contacts are rated for 48V DC:



In this example the polarity setting would be ***High***. Configuration:

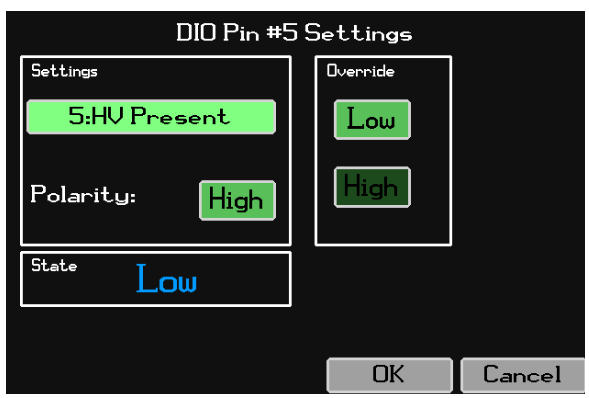


Figure 11-8 DIO Output HV Present Example

11.5.3 DIO Signal Timing

In this section there are several references to signals needing to be active or inactive for minimum periods of time. The time shown is the minimum guaranteed time for the action described to occur, times less than shown may also function correctly but they are not guaranteed to be reliable.

11.5.3.1 Start function

The following timing constraints on the DIO signals must be observed when starting a test sequence using the **Start** function –

- At least 5ms must have passed since the last sequence completed.
- If the **Abort** function is enabled, the signal must be inactive for >5ms before the inactive to active transition of the **Start** signal.
- The **Start** signal must have been inactive for >5ms before attempting to start.
- The **Start** signal must be active for >5ms, there is no maximum time.
- If enabled, the assigned **SequenceN** function signals must all be stable in the required state for >5ms before and after the inactive to active transition of the **Start** signal.

The test sequence is started within <(5ms + 2ms per test step in the sequence commanded by the **SequenceN** input signals if enabled) after recognition of the inactive to active transition of the **Start** signal. At that time the **Pass**, **Fail** and **Testing** output signals are set by the V10x to the following states with <±100us skew between them-

- **Pass** and **fail** – both made inactive if the sequence is valid and started correctly, otherwise PASS is made inactive and FAIL is made active.
- **Testing** – made active if the sequence is valid and started correctly, otherwise remains inactive.

11.5.3.2 Terminating with the Abort or Interlock functions

If enabled and the **Abort** signal is active for >5ms then any running test sequence is aborted.

If enabled and the Interlock signal is inactive for >5ms then a test sequence is aborted if it is presently running an ACW, ACCAP, ACI, BRKDN, DCW, DCIR, DCI, GB, or PULSE type step. It has no effect on any other type of step or if a test sequence is not being run.

11.5.3.3 Pass and Fail functions at the end of a test sequence

Within <5ms after a test has completed the **Pass** and **Fail** signals are set by the V10x to the following states with <±100us skew between them, one is made active and the other remains inactive depending on the status of the sequence.

11.5.3.4 Testing function at the end of a test sequence

Within <5ms after a test has completed the **Testing** signal is made inactive.

11.5.3.5 HV Present and Dwell functions

These are asynchronous signals which indicate their respective conditions. They do not have any relevant timing specifications.

11.5.3.6 DIO function defaults

The following table lists the factory default settings for the DIO signal functions.

Table 11-3 DIO Function Factory Defaults

Pin #	Function	Direction	Polarity
Pin 1	Start	Input	Disabled•
Pin 2	Abort	Input	Disabled•
Pin 3	Interlock	Input	Disabled•
Pin 4	Sequence1	Input	Disabled•
Pin 5	Sequence2	Input	Disabled•
Pin 6	Sequence4	Input	Disabled•
Pin 7	Sequence8	Input	Disabled•
Pin 8	HV Present	Output	High
Pin 9	Pass	Output	High
Pin 10	Fail	Output	High
Pin 11	Testing	Output	High
Pin 12	Dwell	Output	High
•The user chooses the polarity when the function is activated.			

12 Remote Operation

12.1 Computer Control of the V10x

There are a great many software languages, compilers, and development platforms. It is beyond the scope of this document to attempt to provide you with complete assistance regarding writing software to control the V10x, so it is described in general form. Examples, where given, use the Microsoft Visual Studio Express 2012 development platform and the VB.NET language or Python 3.8. The examples are portions of code and in practice you may wish to provide handlers for recovering from timeout errors.

The protocol used for communications is entirely ASCII based, using the commonly used command and data fields approach, and is the same protocol for all interfaces.

NOTE Use of the V10x via an interface is not dependent on the instrument front panel state. It is only required that an interface must have been enabled, see section 10.2.2.

12.1.1 LAN (Ethernet) Interface

Speed	10baseT or 100baseTX, auto-selected
Duplex	Half or full-duplex, auto-selected
MDI/MDIX	Auto-selected
Protocols	ICMPv4, ARP, UDP/IPv4, TCP/IPv4, DHCPv4, mDNS, IGMPv3 (reducing to v1 or v2 automatically as needed)
TCP Port	10733
Max. MTU	1500 (maximum Ethernet payload)
Remote Connections	Only one remote connection is allowed at any given time
Connector	RJ45
Cable required	CAT5 or CAT5e UTP or STP
Cable Length	<100m (per standard)

12.1.2 Connecting to the LAN Interface

The LAN connector located on the rear panel of the V10x must be connected to your network or connected to a computer either directly or through a switch (a hub is not recommended). Standard CAT5e UTP cable is sufficient for the majority of applications and the V10x has auto MDI/MDIX, so the use of a crossover cable is not necessary.

12.1.3 IP Addressing

The LAN interface of the instrument uses IP communications, an IP address must be assigned in some manner to the V10x. There are three methods of doing this as described below:

1. Using a manually entered IP address, gateway, DNS server, and subnet mask.
2. Using an IP address, gateway, DNS server, and subnet mask obtained from a DHCP server (all four must be provided by the server).
3. Using an IP address obtained by the Auto-IP method (RFC3927). The IP address will be in the range from 169.254.1.0 to 169.254.254.255.

Whichever method is used, you should note the IP address of the instrument and use that address to communicate via the LAN interface. If you use a fixed manually entered IP then this will not change unless the manual configuration is changed, however using DHCP it may occasionally change (depending on the specific DHCP server, it may issue the same IP address each time or it may not) and using Auto-IP it will never be the same IP address each time that the V10x is linked. The actual IP address of the instrument can be viewed by navigating to System->About.

NOTE If using Auto-IP then the traffic to and from the instrument should not be able to pass through a router, so the instrument must be local to the computer.

NOTE If using DHCP or Auto-IP, then it may take some time to obtain a valid IP address after attachment to the network. This typically takes a few seconds but can occasionally take considerably longer.

NOTE The unit does not support generating VLAN traffic, and although it can receive VLAN formatted traffic it ignores the VLAN information. If used on a network which uses VLAN then it should be located on a portion of that network which does not have the VLAN content. Check with your IT department regarding this if necessary.

12.1.4 Writing Software to Control the instrument via LAN

All network communication with the instrument uses TCP/IP port 10733. The instrument only allows one active socket at any given time, so you should close the TCP/IP socket when finished using it. To avoid unnecessary lockouts, the instrument will allow a replacement socket if the previously active socket is still open but has not been active for >1 minute, in which case it will close the expired socket (this only occurs if a new socket is attempted, otherwise the instrument will keep a socket open even if it is not active).

TCP/IP has CRC error checking, packet loss detection, and automatic retransmission of lost or corrupted data. This means that the user need not perform error checking using commands such as *SYSTem:ERRor:ALL?* when using the LAN interface except for testing your software, as each command is guaranteed to reach the instrument without error.

12.1.5 USB Interface

Connector	USB Type B
Compatibility	Compatible with Windows, Mac, and Linux
Speed	Full
Device	Communications Device
Driver	See appendix G for older versions of Windows

12.1.5.1 Connecting to the USB Interface

The USB connector located on the rear panel of the instrument must be connected to the computer or a hub using a standard USB AB type cable. The use of a quality cable is particularly recommended if interference is likely, as lower quality cables have poor shielding (if any) and have a high RF impedance in the ground connection. It is recommended that the controlling PC and instrument have solid earth grounds.

The instrument uses drivers built into the most common operating systems and does not use a vendor supplied driver. When the instrument is first connected to a computer (sometimes to each specific USB port of a computer) the operating system of the computer must load its native VCP device driver, this may take a short while. During that time, the instrument cannot be communicated with via the USB. The instrument appears as a standard Virtual COM port. It is shown in the Windows Device Manager as a Virtual COM Port.

NOTE For Windows 10/11, Mac OS, and Linux, no install is required. For pre-Windows 10 Operating Systems, INF files are required for installation of the USB drivers for communicating with the instrument. See appendix G for detailed instructions.

12.1.5.2 Writing Software to Control the Instrument via USB

Since the interface enumerates as a serial port see section 12.1.7.2.

12.1.6 GPIB Interface

Connector	GPIB
Compatibility	Only compatible with National Instruments GPIB controllers

12.1.6.1 Connecting to the GPIB Interface

Using a standard GPIB cable connect the GPIB port on the V10x rear panel to the GPIB port of a computer. It is recommended to use a high quality, shielded GPIB cable. Cables may be purchased from Vitrek.

12.1.6.2 Writing Software to Control the Instrument via GPIB

The instrument has been tested with National Instrument's NI4882 API and Visa API.

12.1.7 RS232 Interface

Connector USB Type B connector
Compatibility Compatible with Windows XP and later operating systems
USB Speed Full-speed
USB Device Enumerates as a Virtual COM Port
Driver None is required for Windows 10 and 11, see appendix G for other versions of Windows.

Connector	9 pin D-sub
Compatibility	TIA/EIA-232-F
Speed	9600 to 115200

12.1.7.1 Connecting to the RS232 Interface

Use a cable supplied by Vitrek or a 9-wire NULL modem cable with a female connector for the V10x side, and a suitable connector for the host system (PC, Mac, or PLC). . It is recommended that the controlling system and instrument have solid earth grounds.

12.1.7.2 Writing Software to Control the Instrument via RS232

Use your chosen platform's OS to open the serial port, configure the baud rate to match the instrument setting (see section 10.2.2), configure 8 bits, configure no parity, enable DTR/DSR and RTS/CTS.

12.2 IEEE488.2 Compatibility

The instrument is largely compatible with mandatory portions of the IEEE488.2 standard.

12.3 SCPI 1999.0 Compatibility

The instrument is largely compatible with SCPI version 1999.0 and uses a command tree.

12.4 Command Syntax

All commands to the instrument use the standard 7-bit ASCII character set using 8-bit encoding (the 8th bit is zero) independent of the actual interface being used. A command is a stream of characters, the instrument storing received characters until a command terminator character is received and then action is taken on the commands. Further characters may be received while the instrument is taking the actions needed for a preceding command, but no action will be taken on them until all pending command decode activity is completed.

Each command is a KEYWORD field defining the command possibly followed by further fields which refine the action of the command. The available command keywords and the fields required for each are described in tables later in this section.

More than one command can be present in a single command set, in which case each command is separated from the previous by a command separator character. If an error is found in any command within a command set, then that command and any remaining commands which follow it in the command set will not be actioned.

Since the interface is based on streaming ASCII characters the use of separator and terminator characters is required to ensure that the extents of each field can be established. To improve the readability of commands you may also wish to employ whitespace characters to spread fields apart.

12.4.1 Command Errors

If in the processing of a command an error is encountered no response is transmitted and further command processing is halted. After every command, the error/event queue should be queried to determine if an error occurred.

12.4.2 Special Characters

Certain ASCII characters serve a special purpose as described below.

12.4.2.1 Command Terminator Characters

The end of a command set is determined by the presence of a command terminator which may be the line feed, carriage return, form feed, or NUL (0 value) ASCII characters.

Everything between successive command terminators is a command set. A command set is limited to a maximum of 2000 characters in total. There is no action taken or error generated if a command terminator is immediately followed by another command terminator.

12.4.2.2 Command Separator Character

If more than one command is in a command set, then each successive command is separated from the previous by a command separator which is the semi-colon ASCII character (;).

Everything between successive command separators or command terminators is a command. There is no action taken or error generated if a command separator is immediately followed by another command separator or a command terminator.

12.4.2.3 Field Separator Character

Many commands require one or more fields which refine the action of the command; each field is separated from the previous by a field separator which is the comma ASCII character (,).

Everything between successive field separators, command separators or command terminators is a field.

12.4.2.4 Whitespace Characters

Most fields and sub-fields can have one or more whitespace characters at the beginning and/or end. The space, tab and underscore ASCII characters are considered as whitespace characters.

12.4.3 Fields within a Command

Command fields are one of the types described below. In certain cases, a single field may be formed by multiple sub-fields, in which case each successive sub-field (each having one of the field types described below) is separated from the previous by a preceding sub-field separator character.

12.4.3.1 KEYWORD Command Field Syntax

A KEYWORD field is a combination of printable ASCII characters which match the corresponding allowable keywords as described later. A KEYWORD field is not case-sensitive (e.g., the letters V and v are equivalent) and may be preceded and/or followed by one or more whitespace characters but may not contain any whitespace characters within it.

Examples of valid KEYWORD fields are –

```
*CLS
*cls
*Cls
add
ADD
SYSTem:ERRor:ALL
```

12.4.3.2 STRING Command Field Syntax

A STRING field is any combination of any printable ASCII characters in the range ‘a’ through ‘z’. A STRING field is literal, containing the exact definition of the required string.

Note that STRING fields are only terminated by a command terminator or separator character and may contain what would normally be any other separator character (if printable).

Examples of valid STRING fields are –

- AMPS
- inphsv
- sequence

12.4.3.3 NR1 Command Field Syntax

A NR1 field is any combination of ASCII numeric (0 through 9) characters which form an integer value. A NR1 command field must not include a polarity character. A NR1 field may be preceded and/or followed by one or more whitespace characters but may not contain any whitespace characters within it.

All NR1 fields must be in the range 0 to 4294967295 and will cause a syntax error if outside of this range and in most commands this range is further limited and will cause a data range error if that range is exceeded.

Examples of valid NR1 fields are –

- 10
- 153465782

12.4.3.4 NR3 Command Field Syntax

A NR3 field is any combination of ASCII characters which form a floating point value. A NR3 field may be preceded and/or followed by one or more whitespace characters but may not contain any whitespace characters within it.

All NR3 fields are decoded and used within the V10x with approximately 1 in 107 resolution and unless otherwise started may be in the range 0 to 10+99 and may contain a number of characters which is only limited by the maximum length of a command set.

Examples of valid NR3 fields are –

- 10
- 10.0
- +10.0
- 1e1
- -10.0
- +1.2345678E+6
- +1.2345678e+6
- +1.2345678e-6
- +1.2345678e6
- 153465782.34

12.4.3.5 Boolean Command Field Syntax

Many commands accept a setting that enables or disables; turns on or off; or activates/deactivates a function or feature. The keyword takes one of the following forms:

Keyword	Effect
0 (zero)	Disabled/Off
Off	Disabled/Off
N	Disabled/Off
Non-zero	Enabled/On
On	Enabled/On
Y	Enabled/On

12.4.3.6 List Field Syntax

A command parameter expressed as a list takes the form of a group of comma separated elements surrounded by parenthesis. For example:

(1,2,3)
(1,2)
(99,111,13,56)

12.4.3.7 Time interval set to command/hold

Several test steps include a dwell time interval or can be held until a command is sent to terminate the step. When specifying this parameter, the value is either in the form of an NR3 representing the period in seconds, the keyword Command indicating dwell will persist until ended, or blank indicating dwell will persist until ended.

12.4.3.8 Invalid results

When requested numeric data is not available a value of 9.91E37 is reported. See SCPI version 1999.0 volume 1 section 7.2.1.5 for further information.

12.5 Responses to Commands

Some commands cause the instrument to respond with a requested data response or set of data responses. The response is formed by a set of fields, similar to those for commands described above.

NOTE All command keywords which end with the ? character cause a response; all command keywords which do not end with the ? character do not cause a response.

All responses from the instrument use the standard 7-bit ASCII character set using 8-bit encoding (the 8th bit is zero) independent of the actual interface being used.

You may request more than one response in a set of commands, in which case each response (or set of responses) is separated from the previous by a semicolon separator and the responses are included in the same order as they were requested. A complete response is always terminated by a carriage return followed by a line feed ASCII character and may contain up to 1 million characters in total.

It is expected that after a command is given to the unit to produce a response that the originator will not issue further commands requesting a response until that prior response has been fully received. If the unit receives a command which requests a response, but the prior response has not been fully transmitted then this raises a Tx Overrun error.

12.5.1 Response Fields

As defined for each such command a response is one or more fields, each of which is of the following types.

12.5.1.1 STRING Response Field Syntax

A STRING response is a set of ASCII characters forming the response. Only printable ASCII characters are used, and the length of a STRING response is variable, the terminating comma (if more response fields follow it) or the terminating carriage return and line feed characters should be used to determine the end of a STRING field.

12.5.1.2 NR1 Response Field Syntax

An NR1 response is a set of ASCII numeric characters defining an integer value. The length of a NR1 response is variable, the terminating comma (if more response fields follow it) or the terminating carriage return and line feed characters should be used to determine the end of an NR1 field. An NR1 response never includes a polarity symbol as all such responses are positive.

12.5.1.3 NR3 Response Field Syntax

A NR3 response is a set of ASCII characters defining a floating point numeric value. The length of an NR3 response is fixed at 11 characters. However, it is recommended that the terminating comma (if more response fields follow it) or the terminating carriage return and line feed characters be used to determine the end of a NR3 field.

A NR3 response always has the following parts in the order shown –

- A polarity character, defining the polarity of the numeric
- 6-digit characters with an embedded decimal point character, defining the mantissa portion of the numeric
- The letter E character (upper case)
- A polarity character, defining the polarity of the exponent
- A single digit character defining the exponent (which is always a multiple of 3)

There is a special case of an NR3 response which is used to indicate that the data is not available. Normally a zero value uses a +0.00000E-9 response; a response of +0.00000E+0 indicates that the value is unavailable.

12.6 Command Summaries

In the following tables unless otherwise noted the commands are symmetric in that they can have both command and query forms.

Table 12-1 IEEE Mandated commands

Command Keyword	Parameter	Description	Section
*CLS	-	Clear status command.	12.7.1.1
*ESR?	-	Standard Event Status Register query.	12.7.1.2
*STB?	-	Read Status Byte Query	12.7.1.3
*SRE	*setting*	Service Request Enable	12.7.1.4
*ESE	*setting*	Event Status Enable	12.7.1.5
*RST	-	Reset the V10x to a known state.	12.7.1.6
*IDN?	-	Query the unique device identification string.	12.7.1.7
*OPC	-	Operation complete command.	12.7.1.8
*OPC?	-	Operation complete query.	12.7.1.9
*WAI	-	Wait-to-continue command.	12.7.1.10
*RCL	*n*	Restore test settings from store n.	12.7.1.11
*SAV	*n*	Save test settings into store n.	12.7.1.12
*SDS	-	Save the default operational test settings.	12.7.1.13
*TST	-	Executes a self-test query	12.7.1.14

Table 12-2 IEEE Optional commands

Command Keyword	Parameter	Description	Section
*OPT[1]	-	Responds with a set of <STRING> fields indicating each installed option.	12.7.2.1

[1]Query only.

Table 12-3 System Remote Locking commands

Command Keyword	Parameter	Description	Section
SYSTem:LOCK:REQuest?[1]	-	Requests to lock out the local user.	12.7.3.1
SYSTem:LOCK:RELease[2]	-	Enters the LOCAL state (front panel configuration changes enabled).	12.7.3.2
SYSTem:LOCK:OWNer?[1]	-	Reports the present state of the lock.	12.7.3.3
LOCAL[2]	-	Alias for SYSTem:LOCK:RELease.	12.7.3.2
LOCKOUT[2]	-	Requests to lock out the local user.	12.7.3.4

[1]Query only.

[2]Command only.

Table 12-4 System Event/Error Query Commands

Command Keyword	Parameter	Description	Section
STATus:PRESet	-	Enables errors and disables all other events	12.7.4.1
SYSTem:ERRor:ALL?	-	See SCPI 1999.0	12.7.4.2
SYSTem:ERRor:CODE:ALL?	-	See SCPI 1999.0	12.7.4.3

Command Keyword	Parameter	Description	Section
STATus:PRESet	-	Enables errors and disables all other events	12.7.4.1
SYSTem:ERRor[:NEXT]?	-	See SCPI 1999.0	12.7.4.4
SYSTem:ERRor:CODE[:NEXT]?	-	See SCPI 1999.0	12.7.4.5
SYSTem:ERRor:COUNt?	-	See SCPI 1999.0	12.7.4.6
SYSTem:ERRor:ENABle	codes	See SCPI 1999.0	12.7.4.7
SYSTem:ERRor:ENABle:ADD	-	See SCPI 1999.0	12.7.4.8
SYSTem:ERRor:ENABle:DELete	-	See SCPI 1999.0	12.7.4.9
SYSTem:ERRor:ENABle[:LIST]	-	See SCPI 1999.0	12.7.4.10
SYSTem:VERSion	-	See SCPI 1999.0	12.7.4.11

Table 12-5 Command Status Commands

Command Keyword	Parameter	Description	Section
*ERR[1]	-	Responds with a <NR1> field value of the ERR register then clears the ERR register.	12.7.5.1

[1]Query only.

Table 12-6 Commands to manage test sequences

Command Keyword	Parameter	Description	Section
ADD[2]	*Type,Settings*	Add a test step to the working sequence.	12.7.6.1
		ACez	Table 12-12
		ACW	Table 12-13
		DCez	Table 12-14
		DCW	Table 12-15
		DCIR	Table 12-16
		GBez	Table 12-17
		GB	Table 12-18
		LowΩ	Table 12-19
		ACCAP	Table 12-20
		ACI	Table 12-21
		DCI	Table 12-22
		Pulse	Table 12-23
		BRKDN	Table 12-24
		Pause	Table 12-25
		Hold	Table 12-26
		Switch	Table 12-27
SET[2]	See above	Modify an existing step.	12.7.6.2
CLRLEADS[2]	-	Clears the lead compensation data from the active test sequence.	12.7.6.3
LEADS?[1]	-	Responds with a <BOOL> indicating if the active test sequence contains lead compensation data.	12.7.6.4
NAME	Name	Sets or queries the active test sequence name.	12.7.6.5
NOSEQ[2]	-	Clears the active test sequence and creates a new blank sequence.	12.7.6.6
RCL	*n*	Alias for ***RCL**.	12.7.1.11
SAVE	*n*	Alias for ***SAV**.	12.7.1.12

[1]Query only.

[2]Command only.

Table 12-7 Test Sequence Execution and Result Commands

Command Keyword	Parameter	Description	Section
READY	-	Makes the active test sequence ready to be run by the START button or queries the ready state.	12.7.7.1
RUN	*cc*	Runs the active test sequence or queries the running state.	12.7.7.2
ABORT[2]	-	Aborts a running test sequence.	12.7.7.3
CONT[2]	-	Continues a running test sequence.	12.7.7.4
REMSTART[2]	*Boolean*	Configure the remote start function.	12.7.7.5
LOCSTART [1]	-	Query the remote start setting.	12.7.7.6
SEQ [1]	-	Responds with a <NR1> which is the active test sequence # (-1 if none, 100 if defined by the interface, otherwise 0 through 99).	12.7.7.7
STEP [1]	-	Responds with a <NR1> indicating the step # presently being actioned in a running test sequence (0 if none, otherwise 1 through 999999)	12.7.7.8
AMPS[2]	*Current*	Sets the current test level of a running MANUAL test sequence.	12.7.7.9
FREQ[2]	*Hertz*	Sets the test frequency of a running MANUAL test sequence.	12.7.7.9
VOLTS[2]	*Voltage*	Sets the voltage test level of a running MANUAL test sequence.	12.7.7.9
MEASRSLT [1]	*FREQ* *AMPS* *INPHSA* *QUADA* *VOLTS* *INPHSV* *QUADV* *OHMS* *INPHSO* *QUADO* *ARC* *ARCC* *BRKDN* *CAP* *DF*	Responds with a <NR3> measurement result during execution of a test step.	12.7.7.10
RSLT [1]	-	Responds with a <NR1> indicating the overall test sequence fail status and reason. This is the logical OR of all individual step status flags.	0
STAT [1]	-	Responds with a <STRING> indicating the pass/fail state of each test step. This can also be used while running a test sequence. The response contains one character for each defined test step- P passed F failed - Not performed ? In process	12.7.7.12
STEPRSLT [1]	*step index*	Responds with a set of fields giving the complete set of results for the specified test step.	12.7.7.13
CHART[1]	*step index, items*	Responds with chart data items for the specified step.	12.7.7.14
ARCRSLT[1]	*step index*	Responds with the accumulated arc count for the specified test step.	12.7.7.15

[1]Query only.
[2]Command only.

Table 12-8 Sequence Execution Settings

Command Keyword	Parameter	Description	Section
BEEP	*f,v*	Configure or query a test execution related beep volume setting.	12.7.8.1
TONE	*f,v,t*	Configure or query a test execution related beep tone setting.	12.7.8.2
CONTSENSE	*Boolean*	Configure or query the global *Continuity Sense* setting.	12.7.8.3
FAILARC	*Boolean*	Configure or query the global *ARC fail on detect* setting.	12.7.8.3
HVSAFETY	*Boolean*	Configure or query the global *HI Safety* detection setting.	12.7.8.3
HISAFETY	*Boolean*	Alias for HVSAFETY.	12.7.8.3
FASTBRKDN	*Boolean*	Configure or query the global *Fast Breakdown* detection setting for DCW and ACW tests.	12.7.8.3
MINLOAD	*Boolean*	Configure or query the global *Minimum Load* detection setting during the ramp period of DCW and DCIR steps.	12.7.8.3
MAXDISCHARGE	*Current*	Configures the maximum allowed discharge current during DCW and DCIR type steps to the parameter value in amps, values between 1mA and 200mA are valid.	12.7.8.4
VLIMIT	*AC,volts* *DC,volts*	Configures the maximum AC or DC voltage allowed for withstand test steps.	12.7.8.5
ALIMIT	*Amps*	Configures the maximum current allowed for ground bond test steps.	12.7.8.6
FASTRERUN	*NR1*	Configures how a test sequence may be rerun from the front panel. 0 – enable 1 – enable if pass 2 – disable	12.7.8.7
SEQuence:CONTsense	*Boolean*	Configure or query the sequence specific *Continuity Sense* setting.	12.7.8.3
SEQuence:FAILarc	*Boolean*	Configure or query the sequence specific *ARC fail on detect* setting.	12.7.8.3
SEQuence:HVSAFety	*Boolean*	Configure or query the sequence specific *HI Safety* detection setting.	12.7.8.3
SEQuence:HISAFety	*Boolean*	Alias for SEQuence:HVSAFETY.	12.7.8.3
SEQuence:FASTbrkdown	*Boolean*	Configure or query the sequence specific *Fast Breakdown* detection setting for DCW and ACW tests.	12.7.8.3
SEQuence:MINLoad	*Boolean*	Configure or query the sequence specific *Minimum Load* detection setting during the ramp period of DCW and DCIR steps.	12.7.8.3

Table 12-9 Device Configuration Commands

Command Keyword	Parameter	Description	Section
BEEP	*KEY,v* *Literal KEY*	Configure or query the user interface beep volume and tone setting.	12.7.9.1
TONE	*KEY,t* *Literal KEY*	Configure or query the user interface beep tone setting.	12.7.9.2
DIO	*Signal,Level*	Configure or query the settings of the specified DIO signal.	12.7.9.3
DIO:RESet[2]	-	Reset the DIO configuration to the factory defaults.	12.7.9.4
DIO:FUNCtion	*Function,Pin,Level*	Configure or query a DIO function.	12.7.9.5
DIO:LEVel? [1]	*Function*	Queries the level on a DIO function pin.	12.7.9.6
SYSTem:DATE	*y,m,d*	Configure or query the system date.	12.7.9.7
SYSTem:TIME	*h,m,s*	Configure or query the system time.	12.7.9.8
DATE	-	Alias for SYSTem:DATE.	12.7.9.7
TIME	-	Alias for SYSTem:TIME.	12.7.9.8
TIME12	*Boolean*	Configure or query the 12/24hr configuration setting.	12.7.9.9
SYSTem:IDENtify	*Boolean*	Control the system identify indicator.	12.7.9.10
DHCP	*Boolean*	Configure or query the Ethernet DHCP setting	12.7.9.11
IP	*Dotted decimal*	Configure or query the Ethernet LAN IP address.	12.7.9.12
SUBNET	*Dotted decimal*	Configure or query the Ethernet IP subnet mask.	12.7.9.13
GATEWAY	*Dotted decimal*	Configure or query the Ethernet LAN gateway IP address.	12.7.9.14
DNS	*Dotted decimal*	Configure or query the Ethernet LAN DNS server address.	12.7.9.15
GPIB	*address*	Configure or query the GPIB address setting.	12.7.9.16
RS232	*baud*	Configure or query the RS232 baud rate setting.	12.7.9.17
SWITCHES	*ss*	Configure or query the switch matrix unit control setting.	12.7.9.18
SERNUM [1]	-	Query the instrument serial number.	12.7.9.19

[1]Query only.

[2]Command only.

12.7 Command Details

12.7.1 IEEE Mandated Commands

12.7.1.1 *CLS

Clear status command. The error/event queue will be cleared, pending operation complete operations will be canceled, and clears the following registers:

- STB
- SRE
- ESR
- ERR

12.7.1.2 *ESR?

Standard **Event Status Register** query. The contents of the **Event Status Register** will be output as a decimal value. See IEEE 488.2 11.5.1.1 for complete details. The following table summarizes the contents.

Table 12-10 Standard Event Status Register Bit Definitions

Bit	Description
7	This bit indicates that an off-to-on transition has occurred in the device's power supply.
6	User request; not used by the V10x.
5	Command error.
4	Execution error.
3	Device-Specific error; set when an error occurs that cannot be placed in the error event queue.
2	Query error; not used by the V10x.
1	Request control; not used by the V10x.
0	Operation complete; it indicates that the device has completed all selected pending operations.

12.7.1.3 *STB?

Standard **Read Status Byte** query. The contents of the **Status Byte Register** will be output as a decimal value. The SBR is logically ANDed with the value of the SRE register; if the result is non-zero then the GPIB SRQ line is asserted. The STB register is read by the GPIB interface when a serial poll bus command is performed. The **SBR** can be read using any of the interface options. The **SBR** is an 8-bit registers (i.e., has values from 0 to 255). Each bit is defined as follows –

- Bit 0, decimal value 1, binary value 00000001 – set if a high voltage is currently present on the HV terminal. The value of this status bit is "dynamic" – i.e., its value can change without user interaction.
- Bit 1, decimal value 2, binary value 00000010 – set when a test step dwell period is completed; cleared when read, when a test sequence is started, when a different test sequence is selected, or when reset.
- Bit 2, decimal value 4, binary value 00000100 – set when at least one entry is present in the error/event queue.
- Bit 3, decimal value 8, binary value 00001000 – set when a test sequence is completed; cleared when read, when a test sequence is started, when a different test sequence is selected, or when reset.

- Bit 4, decimal value 16, binary value 00010000 – set when a test failure has been detected; cleared when read, when a test sequence is started, when a different test sequence is selected, or when reset.
- Bit 5, decimal value 32, binary value 00100000 – set when an ARC current over limit has been detected; cleared when read, when a test sequence is started, when a different test sequence is selected, or when reset.
- Bit 6, decimal value 64, binary value 01000000 – as defined by IEEE488.1, set if the V10x is asserting the SRQ line, otherwise it is cleared.
- Bit 7, decimal value 128, binary value 10000000 – set when a test sequence is currently being performed. The value of this status bit is "dynamic" – i.e., its value can change without user interaction.

12.7.1.4 *SRE

See IEEE 488.2 11.3.2.4 for details.

12.7.1.5 *ESE

See IEEE 488.2 11.5.1.3 for details.

12.7.1.6 *RST

Reset the V10x to a known state. The following actions are taken:

- If a sequence is running it will be aborted.
- The test sequence is cleared.
- A pending OPC command or query is canceled.

12.7.1.7 *IDN?

Query the unique device identification string. The response is four string values separated by commas:

Manufacturer,Model,Serial-Number,Firmware-Version

The firmware-version is composed of multiple elements separated by forward slashes; the first item is the main version, followed by sub system versions.

The firmware version as reported is intended to express the components associated with HIPOT testing.

12.7.1.8 *OPC

The command form executes an operation complete request, the V10x will set the OPC bit in the Standard Event Status Register when all pending selected device operations have been finished. The only pending operation is sequence execution. The command form is not especially useful because the ESR will have to be polled, the query form discussed below is much more useful.

12.7.1.9 *OPC?

The query form places an ASCII character "1" into the device's Output Queue when all pending selected device operations have been finished. The only pending operation is sequence execution, see section 12.8 for an example.

12.7.1.10 *WAI

Wait-to-continue command. The V10x will not execute any further commands or queries until all pending operations have completed. The only pending operation is sequence execution, refer to section 12.8 for a usage example.

12.7.1.11 *RCL

Recall a test sequence from profile store N, N being a number in the range 0 to 99. The 0 (zero) value refers to the manual sequence. If the parameter is out of range or the selected sequence has not been previously saved a **Data out of range** error is placed in the error/event queue and the V10x will be set to **Idle**. The sequence will be validated and if it passes the V10x will be put into the **Ready** state; in the case there is an error the V10x will become **Idle**.

12.7.1.12 *SAV

Save the present sequence into store N, N being a number in the range 0 to 99. The 0 (zero) value refers to the manual sequence. If the sequence being saved has more than one step it cannot be saved to the manual slot. The selected sequence will be loaded the next time the V10x is power cycled if the *Last Used* option is checked in the power-on options.

12.7.1.13 *SDS

Save the present test settings for use as the power-on configuration.

12.7.1.14 *TST

Executes the self-test query. FIXME.

If the self-test completes successfully the response is ***TST complete**; if an element fails a test the response will identify the failure and provide details that may help correct the issue.

12.7.2 IEEE Optional Commands

12.7.2.1 *OPT

Reports the factory option set. The string is a set of comma separated tokens listed below.

Option Symbol	Description
AC2	The AC2 option has been installed.
AC6	The instrument is equipped with the AC6 AC drive component.
AC6-500VA	Extends the AC6 voltage drive capability to 100mArms.
AC10	The instrument is equipped with the AC10 AC drive component.
AC30	The instrument has the external drive option fitted.
DC6	The instrument is equipped with the DC6 DC drive component.
DC11	The instrument is equipped with the DC11 DC drive component.
DC15	The instrument is equipped with the DC15 DC drive component.
DCNEG	The DC output has reversed polarity.
GB	The instrument is able to perform ground bond testing.
Pulse	The instrument is equipped to perform pulsed voltage testing.
HSS1	The instrument has the standard high side testing component.
HSS2	The instrument has the enhanced high side testing component.
GPIB	The instrument has the **G**eneral **P**urpose **I**nterface **B**us option.

For example: **AC6,DC6,GB,HSS1,GPIB**. See section 1.5 for information on all options.

12.7.3 System Remote/Local access commands

12.7.3.1 SYSTem:LOCK:REQuest?

This event shall only be implemented as a query. It will attain the lock on this device and returns 1. The lock persists until the connection is closed or the RELease command is executed.

12.7.3.2 SYSTem:LOCK:RELease

Releases the user lock.

12.7.3.3 SYSTem:LOCK:OWNer?

Reports the present state of the lock. The response is one of two strings:

- **REMote**
- **LOCal**

12.7.3.4 LOCKOUT

This command will attain the lock on this device. The lock persists until the connection is closed or the RELease command is executed.

12.7.4 System Event/Error query commands

12.7.4.1 STATus:PRESet

See SCPI 1999.0.

12.7.4.2 SYSTem:ERRor:ALL?

See SCPI 1999.0.

12.7.4.3 SYSTem:ERRor:CODE:ALL?

See SCPI 1999.0.

12.7.4.4 SYSTem:ERRor[:NEXT]?

See SCPI 1999.0.

12.7.4.5 SYSTem:ERRor:CODE[:NEXT]?

See SCPI 1999.0.

12.7.4.6 SYSTem:ERRor:COUNt?

See SCPI 1999.0.

12.7.4.7 SYSTem:ERRor:ENABle

See SCPI 1999.0.

12.7.4.8 SYSTem:ERRor:ENABle:ADD

See SCPI 1999.0.

12.7.4.9 SYSTem:ERRor:ENABle:DELete

See SCPI 1999.0.

12.7.4.10 SYSTem:ERRor:ENABle[:LIST]

See SCPI 1999.0.

12.7.4.11 SYSTem:VERSion

See SCPI 1999.0.

12.7.5 Command Status

12.7.5.1 *ERR

This is a numeric value register. The value is cleared to zero when read by the user. The value is set according to the success or failure of the last decoded command on this interface. The possible values of this register are defined as follows –

0. The command was decoded without error.
1. The command could not be decoded at this time.
2. Unused.
3. Unused.
4. The command created a test step which is not compatible with this specific instruments' capability.
5. The command contained a numeric value field which was outside of the allowable range.
6. The command contained a field which did not have the correct syntax.
7. The command did not contain an expected field.
8. The command contained additional fields beyond those expected.
9. The command keyword was not recognized.
10. The V10x had an internal memory error while executing the command.
11. The previous response had not yet been transmitted when this query command was executed.
12. The set of commands was too long, over 1023 characters.

12.7.6 Managing Test Sequences

Commands in this section are used to create, modify, save, and load test sequences.

12.7.6.1 ADD

This command adds a step to the active sequence. Regardless of success or failure after parsing the parameters the V10x will be placed into an idle state until a valid sequence is configured and the **Ready** command issued. The command parameters are parsed and verified against the instrument settings. If the verification fails an error is placed in the placed in the error/event queue. The following table lists the error cases.

Table 12-11 Step error hints

Type	Error Description	Error Information	Hints
Command error	Data out of range	ACV	An AC voltage level or limit is invalid.
Command error	Data out of range	DCV	An DC voltage level or limit is invalid.
Command error	Data out of range	AMPS	A current level or limit is invalid.
Command error	Data out of range	Breakdown	The breakdown limit is invalid.
Command error	Data out of range	Frequency	A frequency setting is invalid.
Command error	Data out of range	Time	A time period is invalid.
Command error	Data out of range	Loading	The DC minimum loading setting is invalid.
Command error	Data out of range	Check	A check limit is out of range.
Command error	Data out of range	Arc	The arc limit settings are invalid.
Execution error	Settings conflict	Testing	Steps cannot be modified while a sequence is active.
Execution error	Settings conflict	Mismatch	Two settings are in conflict, such as grounding and arc.
Execution error	Settings conflict	No switch	A switch control step was submitted but switches are not configured at the system level.

Table 12-12 ACez Configuration Fields

Field #	Field Format	Value
1	<STRING>	ACEZ
2	<NR3>	Test Voltage (in Vrms)
3	<NR3>	Test Frequency (in Hz)
4	<NR3>	Ramp Time (in seconds)
5	<NR3>	Dwell time (in seconds)
	<EMPTY>	Step is to be user terminated
6	<NR3>	Minimum Leakage Limit (in Arms)
7	<NR3>	Maximum Leakage Limit (in Arms)
8	<STRING>	ABORT - Abort on failure CONT - Continue on failure
9	<EMPTY> <MISSING>	Option AC-30 is not used, may only be <MISSING> if field 10 is also <MISSING>
	<STRING>	INT : Option AC-30 is not used EXT : Option AC-30 is to be used (valid if option AC-30 is fitted)
10	<EMPTY> <MISSING>	Load is not grounded
	<STRING>	GND : Load is grounded (valid if option HSS is fitted) ISO : Load is not grounded

Example –

ADD,ACEZ,1000.0,60.0,1.5,60.0,0.0,0.005,ABORT

Configures the following (in order) –

An ACez type test step
1000V test voltage
60Hz test frequency
1.5 second ramp time
60 second dwell time
No minimum leakage current limit
5mArms maximum leakage current limit (i.e., 7.07mApk breakdown limit)
Abort test sequence if fails
HV Terminal used (AC-30 not used or not installed) since both fields 9 and 10 are missing
DUT is isolated since both fields 9 and 10 are missing

Table 12-13 ACW Configuration Fields

Field #	Field Format	Value
1	<STRING>	ACW
2	<NR3>	Test Voltage (in Vrms)
3	<NR3>	Test Frequency (in Hz)
4	<NR3>	Breakdown Limit (in Apk)
5	<NR3>	Ramp Time (in seconds)
6	<NR3>	Dwell time (in seconds)
	<EMPTY>	Step is to be user terminated
7	<STRING>	NONE - No 1st checked leakage RMSA - 1st checked value is RMS leakage current INPHSA - 1st checked value is In-Phase leakage current QUADA - 1st checked value is Quadrature leakage current RMSO - 1st checked value is RMS leakage impedance INPHSO - 1st checked value is In-Phase leakage impedance QUADO - 1st checked value is Quadrature leakage impedance
8	<NR3>	1st Minimum Leakage Limit (in A or Ω)
	<EMPTY>	Only valid if no 1st checked leakage
9	<NR3>	1st Maximum Leakage Limit (in A or Ω)
	<EMPTY>	No 1st maximum limit (only valid for impedance or no 1st checked leakage)
10	<STRING>	NONE - No 2nd checked leakage RMSA - 2nd checked value is RMS leakage current INPHSA - 2nd checked value is In-Phase leakage current QUADA - 2nd checked value is Quadrature leakage current RMSO - 2nd checked value is RMS leakage impedance INPHSO - 2nd checked value is In-Phase leakage impedance QUADO - 2nd checked value is Quadrature leakage impedance
11	<NR3>	2nd Minimum Leakage Limit (in A or Ω)
	<EMPTY>	Only valid if no 2nd checked leakage
12	<NR3>	2nd Maximum Leakage Limit (in A or Ω)
	<EMPTY>	No 2nd maximum limit (only valid for impedance or no 2nd checked leakage)
13	<NR1>	Time period for arc detection (4, 10, 15, 20, 30 or 40)
	<EMPTY>	Arc detection disabled
14	<NR1>	Arc detection limit (in mA)
	<EMPTY>	Only valid if arc detection disabled in field 13
15	<STRING>	NONE - No discharge if next step compatible FAST - Fast discharge RAMP - Discharge same as ramp
16	<STRING>	ABORT - Abort on failure CONT - Continue on failure
17	<EMPTY> <MISSING>	Option AC-30 is not used, may only be <MISSING> if field 18 is also <MISSING>
	<STRING>	INT : Option AC-30 is not used EXT : Option AC-30 is to be used (valid if option AC-30 is fitted)
18	<EMPTY> <MISSING>	Load is not grounded, may only be <MISSING> if field 19 is also <MISSING>
	<STRING>	GND : Load is grounded (valid if option HSS is fitted) ISO : Load is not grounded
19	<NR3>	Lead compensation in terms of in phase conductance
20	<NR3>	Lead compensation in terms of quadrature conductance

Example –

ADD,ACW,1000.0,60.0,0.01,1.5,60.0,RMSA,0.0,0.005,NONE,,,,,FAST,ABORT

Configures the following (in order) –

An ACW type test step
1000V test voltage
60Hz test frequency
10mApk breakdown limit
1.5 second ramp time
60 second dwell time
1st checked value is rms leakage current
No minimum 1st leakage current limit
5mArms maximum 1st leakage current limit
No 2nd checked limit (so following two fields are <EMPTY>)
No arc detection (so following field is also <EMPTY>)
Fast discharge
Abort test sequence if fails
HV Terminal used (AC-30 not used or not installed) since both fields 17 and 18 are missing
DUT is isolated since both fields 17 and 18 are missing

Table 12-14 DCez Configuration Fields

Field #	Field Format	Value
1	<STRING>	DCEZ
2	<NR3>	Test Voltage (in V)
3	<NR3>	Ramp Time (in seconds)
4	<NR3>	Dwell time (in seconds)
	<EMPTY>	Step is to be user terminated
5	<NR3>	Minimum Leakage Limit (in A)
6	<NR3>	Maximum Leakage Limit (in A)
7	<STRING>	ABORT - Abort on failure CONT - Continue on failure
8	<EMPTY> <MISSING>	Load is not grounded
	<STRING>	GND : Load is grounded (only valid if option HSS or HSS-2 is fitted) ISO : Load is not grounded

Example –

ADD,DCEZ,1000.0,1.5,60.0,0.0,0.005,ABORT

Configures the following (in order) –

A DCez type test step
1000V test voltage
1.5 second ramp time
60 second dwell time

No minimum leakage current limit

5mA maximum leakage current limit

Abort test sequence if fails

DUT is isolated since field 8 is missing

Table 12-15 DCW Configuration Fields

Field #	Field Format	Description
1	<STRING>	DCW
2	<NR3>	Test Voltage (in V)
3	<NR3>	Breakdown Limit (in A)
4	<NR3>	Ramp Time (in seconds)
5	<NR3>	Dwell time (in seconds)
	<EMPTY>	Step is to be user terminated
6	<NR3>	Pre-check delay (in seconds)
7	<STRING>	AMPS - Leakage limits are in Amps OHMS - Leakage limits are in Ω
8	<NR3>	Minimum Leakage Limit (in A or Ω)
9	<NR3>	Maximum Leakage Limit (in A or Ω)
	<EMPTY>	No maximum limit (only valid for impedance)
10	<NR1>	Time period for arc detection (4, 10, 15, 20, 30 or 40)
	<EMPTY>	Arc detection disabled
11	<NR1>	Arc detection limit (in mA)
	<EMPTY>	Only valid if arc detection disabled in field 10
12	<STRING>	NONE - No discharge if next step compatible FAST - Fast discharge RAMP - Discharge same as ramp
13	<STRING>	ABORT - Abort on failure CONT - Continue on failure
14	<NR3>	Min Load (in Farads), may be <MISSING> if field 15 is also <MISSING>
15	<EMPTY> <MISSING>	Load is not grounded, may be <MISSING> if field 16 is also <MISSING>
	<STRING>	GND : Load is grounded (only valid if option HSS or HSS-2 is fitted) ISO : Load is not grounded
16	<NR3>	Lead compensation in terms of conductance

Example –

ADD,DCW,1000.0,0.015,1.5,60.0,0.0,AMPS,0.0,25e-6,4,10,FAST,ABORT

Configures the following (in order) –

A DCW type test step

1000V test voltage

15mA breakdown limit

1.5 second ramp time

60 second dwell time

0 second delay

Define leakage limits in Amps

No minimum leakage current limit

25uA maximum leakage current limit

4us arc detection time
10mA arc detection limit
Fast discharge
Abort test sequence if fails
Minimum load during ramp is set to 0 since both fields 14 and 15 are missing
DUT is isolated since both fields 14 and 15 are missing

Table 12-16 DCIR Configuration Fields

Field #	Field Format	Value
1	<STRING>	DCIR
2	<NR3>	Test Voltage (in V)
3	<NR3>	Breakdown Limit (in A)
4	<NR3>	Ramp Time (in seconds)
5	<NR3>	Dwell time (in seconds)
	<EMPTY>	Step is to be user terminated
6	<NR3>	Pre-check delay (in seconds)
7	<STRING>	PASS - Test is ended as soon as passes FAIL - Test is ended as soon as fails TIME - Test always extends for the full time STDY – Test is ended if the load is within limits and is steady or improving
8	<STRING>	AMPS - Leakage limits are in Amps OHMS - Leakage limits are in Ω
9	<NR3>	Minimum Leakage Limit (in A or Ω)
10	<NR3>	Maximum Leakage Limit (in A or Ω)
	<EMPTY>	No maximum limit (only valid for impedance)
11	<NR1>	Time period for arc detection (4, 10, 15, 20, 30 or 40)
	<EMPTY>	Arc detection disabled
12	<NR1>	Arc detection limit (in mA)
	<EMPTY>	Only valid if arc detection disabled in field 11
13	<STRING>	NONE - No discharge if next step compatible FAST - Fast discharge RAMP - Discharge same as ramp
14	<STRING>	ABORT - Abort on failure CONT - Continue on failure
15	<NR3>	Min Load (in Farads), may be <MISSING> if field 16 is also <MISSING>
16	<EMPTY> <MISSING>	Load is not grounded, may be <MISSING> if field 17 is also <MISSING>
	<STRING>	GND : Load is grounded (valid if option HSS or HSS-2 is fitted) ISO : Load is not grounded
17	<NR3>	Lead compensation in terms of conductance

Example –

ADD,DCIR,1000.0,0.015,1.5,60.0,0.0,FAIL,AMPS,0.0,25e-6,4,10,FAST,ABORT

Configures the following (in order) –

A DCW type test step
1000V test voltage

15mA breakdown limit

1.5 second ramp time

60 second dwell time

0 second delay

Test is terminated as soon as a failure is detected

Define leakage limits in Amps

No minimum leakage current limit

25uA maximum leakage current limit

4us arc detection time

10mA arc detection limit

Fast discharge

Abort test sequence if fails

Minimum load during ramp is set to 0 since both fields 15 and 16 are missing

DUT is isolated since both fields 15 and 16 are missing

Table 12-17 GBez Configuration Fields

Field #	Field Format	Value
1	<STRING>	GBEZ
2	<NR3>	Test Current (in Arms)
3	<NR3>	Test Frequency (in Hz)
4	<NR3>	Dwell time (in seconds)
	<EMPTY>	Step is to be user terminated
5	<NR3>	Minimum Voltage Drop Limit (in Vrms)
6	<NR3>	Maximum Voltage Drop Limit (in Vrms)
7	<STRING>	ABORT - Abort on failure CONT - Continue on failure

Example –

ADD,GBEZ,25.0,60.0,60.0,0.0,0.1,ABORT

Configures the following (in order) –

A GBez type test step

25A test current

60Hz test frequency

60 second dwell time

No minimum voltage drop

0.1V maximum voltage drop

Abort test sequence if fails

Table 12-18 GB Configuration Fields

Field #	Field Format	Value
1	<STRING>	GB
2	<NR3>	Test Current (in Arms)

3	<NR3>	Test Frequency (in Hz)
4	<NR3>	Maximum open circuit drive (in Vrms)
5	<NR3>	Ramp Time (in seconds)
6	<NR3>	Dwell time (in seconds)
	<EMPTY>	Step is to be user terminated
7	<STRING>	RMSV - Checked value is RMS voltage drop INPHSV - Checked value is In-phase voltage drop QUADV - Checked value is quadrature voltage drop RMSO - Checked value is RMS impedance INPHSO - Checked value is in-phase impedance QUADO - Checked value is quadrature impedance
8	<NR3>	Minimum Limit (in V or Ω)
9	<NR3>	Maximum Limit (in V or Ω)
10	<STRING>	NONE - No discharge if next step compatible FAST - Fast discharge RAMP - Discharge same as ramp
11	<STRING>	ABORT - Abort on failure CONT - Continue on failure
12	<MISSING> <NR3>	IF field 13 is missing Lead compensation is fundamental impedance; when field 13 is present this is compensation in terms of in phase impedance
13	<MISSING> <NR3>	Lead compensation in terms of quadrature resistance

Example –

ADD,GB,25.0,60.0,5.0,0.0,60.0,RMSO,0.0,0.1,FAST,ABORT

Configures the following (in order) –

A GB type test step
25A test current
60Hz test frequency
5V max open circuit voltage
0 second ramp time
60 second dwell time
Check RMS impedance
No minimum impedance
0.1Ω maximum impedance
Fast discharge
Abort test sequence if the step fails

Table 12-19 LowΩ Configuration Fields

Field #	Field Format	Value
1	<STRING>	LOWOHM
2	<BOOL>	1 or Y - Test using 2-wire mode 0 or N - Test using 4-wire mode
3	<NR3>	Test time (in seconds)
	<EMPTY>	Step is to be user terminated
4	<NR3>	Check delay (in seconds)

<table>
<tr><td>5</td><td><NR3></td><td>Minimum Resistance Limit (in Ω)</td></tr>
<tr><td>6</td><td><NR3></td><td>Maximum Resistance Limit (in Ω)</td></tr>
<tr><td>7</td><td><STRING></td><td>ABORT - Abort on failure
CONT - Continue on failure</td></tr>
<tr><td rowspan="2">8</td><td><MISSING></td><td rowspan="2">Lead compensation in terms of resistance</td></tr>
<tr><td><NR3></td></tr>
</table>

Example –

ADD,LOWOHM,0,5.0,0.0,1.25,1.75,ABORT

Configures the following (in order) –

A LowΩ type test step
Use 4-wire mode
5 second test time
0 second delay
1.25Ω minimum resistance
1.75Ω maximum resistance
Abort test sequence if the step fails

Table 12-20 ACCAP Configuration Fields

Field #	Field Format	Value
1	<STRING>	ACCAP
2	<NR3>	Test Voltage (in Vrms)
3	<NR3>	Test Frequency (in Hz)
4	<NR3>	Breakdown Limit (in Apk)
5	<NR3>	Ramp Time (in seconds)
6	<NR3>	Dwell time (in seconds)
	<EMPTY>	Step is to be user terminated
7	<NR3>	Minimum Capacitance Limit (in F)
8	<NR3>	Maximum Capacitance Limit (in F)
9	<NR3>	Minimum DF Limit (no units)
10	<NR3>	Maximum DF Limit (no units)
11	<NR1>	Time period for arc detection (4, 10, 15, 20, 30 or 40)
	<EMPTY>	Arc detection disabled
12	<NR1>	Arc detection limit (in mA)
	<EMPTY>	Only valid if arc detection disabled in field 11
13	<STRING>	NONE - No discharge if next step compatible FAST - Fast discharge RAMP - Discharge same as ramp
14	<STRING>	ABORT - Abort on failure CONT - Continue on failure
15	<EMPTY> <MISSING>	Option AC-30 is not used, may only be <MISSING> if field 16 is also <MISSING>
	<STRING>	INT : Option AC-30 is not used EXT : Option AC-30 is to be used (only valid if option AC-30 is fitted)
16	<EMPTY> <MISSING>	Load is not grounded, may only be <MISSING> if field 17 is also <MISSING>
	<STRING>	GND : Load is grounded (only valid if option HSS is fitted) ISO : Load is not grounded
17	<NR3>	Lead compensation in terms of in phase conductance
18	<NR3>	Lead compensation in terms of quadrature conductance

Example –

ADD,ACCAP,1000.0,60.0,0.01,1.5,60.0,0.9e-9,1.1e-9,0.0,1.0,,,FAST,ABORT

Configures the following (in order) –

An ACCAP type test step
1000V test voltage
60Hz test frequency
10mApk breakdown limit
1.5 second ramp time
60 second dwell time
0.9nF minimum capacitance
1.1nF maximum capacitance
No minimum dissipation factor
No maximum dissipation factor (1.0 disables the maximum)
No arc detection (so following field is also <EMPTY>)

Fast discharge

Abort test sequence if fails

HV Terminal used (AC-30 not used or not installed) since both fields 15 and 16 are missing

DUT is isolated since both fields 15 and 16 are missing

Table 12-21 ACI Configuration Fields

Field #	Field Format	Value
1	<STRING>	ACI
2	<NR3>	Test time (in seconds)
	<EMPTY>	Step is to be user terminated
3	<NR3>	Delay time (in seconds)
4	<NR3>	Minimum Leakage Current Limit (in Arms)
5	<NR3>	Maximum Leakage Current Limit (in Arms)
6	<NR1>	Time period for arc detection (4, 10, 15, 20, 30 or 40)
	<EMPTY>	Arc detection disabled
7	<NR1>	Arc detection limit (in mA)
	<EMPTY>	Only valid if arc detection disabled in field 6
8	<STRING>	ABORT - Abort on failure CONT - Continue on failure
9	<MISSING>	Lead compensation in terms of current
	<NR3>	

Example –

ADD,ACI,5.0,0.0,0.0,50e-6,,,ABORT

Configures the following (in order) –

An ACI type test step

5 second test time

0 second delay time

No minimum leakage current

50uA maximum leakage current

No arc detection (so following field is also <EMPTY>)

Abort test sequence if the step fails

Table 12-22 DCI Configuration Fields

Field #	Field Format	Value
1	<STRING>	DCI
2	<NR3>	Test time (in seconds)
	<EMPTY>	Step is to be user terminated
3	<NR3>	Delay time (in seconds)
4	<NR3>	Minimum Leakage Current Limit (in A)
5	<NR3>	Maximum Leakage Current Limit (in A)
6	<NR1>	Time period for arc detection (4, 10, 15, 20, 30 or 40)
	<EMPTY>	Arc detection disabled
7	<NR1>	Arc detection limit (in mA)
	<EMPTY>	Only valid if arc detection disabled in field 6
8	<STRING>	ABORT - Abort on failure CONT - Continue on failure
9	<MISSING>	Lead compensation in terms of current
	<NR3>	

Example –

ADD,DCI,5.0,0.0,0.0,50e-6,,,ABORT

Configures the following (in order) –

A DCI type test step
5 second test time
0 second delay time
No minimum leakage current
50uA maximum leakage current
No arc detection (so following field is also <EMPTY>)
Abort test sequence if the sequence fails

Table 12-23 Pulse Configuration Fields

Field #	Field Format	Value
1	<STRING>	PULSE
2	<NR3>	Level (in V)
3	<STRING>	POSITIVE - Unipolar +ve NEGATIVE – Unipolar –ve BIPOLAR - Bipolar
4	<NR3>	Ramp time (tr) (in seconds)
5	<NR3>	Hold Time (th) (in seconds)
6	<NR3>	Breakdown Current Limit (in A)
7	<NR1>	Time period for arc detection (4, 10, 15, 20, 30 or 40)
	<EMPTY>	Arc detection disabled
8	<NR1>	Arc detection limit (in mA)
	<EMPTY>	Only valid if arc detection disabled in field 7
9	<STRING>	ABORT - Abort on failure CONT - Continue on failure
10	<MISSING>	Load compensation scale factor, must be in the range 0.4 to 1.1 inclusive
	<NR3>	

Example –

ADD,PULSE,250.0,POSITIVE,1e-3,10e-3,0.05,4,10,ABORT

Configures the following (in order) –

A PULSE type test step
A single positive pulse
1ms ramp time
10ms hold time
50mA maximum current
4us arc detection
10mA arc detection limit
Abort test sequence if the sequence fails

Table 12-24 BRKDN Configuration Fields

Field #	Field Format	Value
1	<STRING>	BRKDN
2	<NR3>	Test Current Level (in A)
3	<NR3>	Initial Ramp Rate (in V/sec)
4	<NR3>	Minimum Breakdown Voltage (in V)
5	<NR3>	Maximum Breakdown Voltage (in V)
6	<STRING>	ABORT - Abort on failure CONT - Continue on failure
7	<EMPTY>	Load is not grounded
	<MISSING>	
	<STRING>	GND : Load is grounded (only valid if option HSS or HSS-2 is fitted) ISO : Load is not grounded

Example –

ADD,BRKDN,0.001,1000.0,500.0,600.0,ABORT

Configures the following (in order) –

A BRKDN type test step
1mA test current level
1000V/sec initial ramp rate
500V minimum breakdown voltage
600V minimum breakdown voltage
Abort test sequence if fails
Load is not grounded (field 7 is missing)

Table 12-25 Pause Configuration Fields

Field #	Field Format	Value
1	<STRING>	PAUSE
2	<NR3>	Pause time (in seconds)

Example –

ADD,PAUSE,5.0

Configures the following (in order) –

A PAUSE type test step
5 second pause time

Table 12-26 Hold Configuration Fields

<table>
<tr><th>Field #</th><th>Field Format</th><th>Value</th></tr>
<tr><td>1</td><td><STRING></td><td>HOLD</td></tr>
<tr><td>2</td><td><NR3></td><td>Timeout (in seconds)</td></tr>
<tr><td>3</td><td><STRING></td><td>Text for the top prompt line[1]</td></tr>
<tr><td>4</td><td><STRING></td><td>Text for the bottom prompt line [1]</td></tr>
<tr><td rowspan="3">5</td><td><EMPTY></td><td rowspan="2">Local START button is enabled</td></tr>
<tr><td><MISSING></td></tr>
<tr><td><BOOL></td><td>1 or Y – Disables the local START button
0 or N – Enables the local START button</td></tr>
</table>

[1] Must be quoted if the text contains spaces, a single quote is not allowed in the prompt text, can be blank.

Example –

ADD,HOLD,30.0,'Information','More Information'

Configures the following (in order) –

A HOLD type test step
60 second timeout
The top prompt will display **Information**
The bottom prompt will display **More Information**
The local start button is enabled

Table 12-27 Switch Configuration Fields – legacy 964 format

Field #	Field Format	Value
1	<STRING>	SWITCH
2	<NR3>	Pre-switch delay (in seconds)
3	<NR3>	Post-switch delay (in seconds)
4-11	<NR1>	964 #1 Switch bank data banks 7-0 respectively
12-19	<NR1>	964 #2 Switch bank data banks 7-0 respectively (only if configured for >1x964)
20-27	<NR1>	964 #3 Switch bank data banks 7-0 respectively (only if configured for >2x964)
28-35	<NR1>	964 #4 Switch bank data banks 7-0 respectively (only if configured for 4x964)

Example –

ADD,SWITCH,0.0,0.25,0x04,0x00,0x00,0x00,0x01,0x00,0x00,0x00

Configures the following (in order) –

A SWITCH type test step
0 second pre-switch delay
0.25 second post-switch delay
Bank #7 set to hexadecimal 04 (closes relay #59)
Bank #6 set to hexadecimal 00
Bank #5 set to hexadecimal 00
Bank #4 set to hexadecimal 00
Bank #3 set to hexadecimal 01 (closes relay #24)
Bank #2 set to hexadecimal 00
Bank #1 set to hexadecimal 00
Bank #0 set to hexadecimal 00

Table 12-28 Switch Configuration Fields – variable format

Field #	Field Format	Value
1	<STRING>	SWITCH
2	<NR3>	Pre-switch delay (in seconds)
3	<NR3>	Post-switch delay (in seconds)
4	<list>	Switch #1 relays to close
5	<list>	Switch #2 relays to close
[…]	<list>	Further switch settings.
N	<list>	Switch N relays to close.

Any relays not explicitly set will be open.

Example –

ADD,SWITCH,0.0,0.25,(1,2,3),(9,10),()

Configures the following (in order) –

A SWITCH type test step
0 second pre-switch delay
0.25 second post-switch delay
Switch #1 relays 1 through 3 closed, all other relays opened
Switch #2 relays 9 and 10, all other relays opened
Switch #3 all relays opened

12.7.6.2 SET

This command operates nearly identical to 'Add' discussed above except a step index parameter is inserted in front of the step type. If the step number is valid then the step contents are modified according to the command contents. In the case the step number is not valid a **Command Error** will be placed in the error/event queue.

Example –

SET,1,GB,25.0,60.0,5.0,0.0,60.0,RMSO,0.0,0.1,FAST,ABORT

12.7.6.3 CLRLEADS

This command clears the lead compensation offsets for all the steps in the active sequence. A save operation must be executed to save the changes for the next time the sequence is loaded.

12.7.6.4 LEADS?

Query the lead compensation status. The response is 0 (zero) if there are no steps or at least one step does not have valid lead compensation data; the response is 1 (one) if all steps have valid lead compensation data.

12.7.6.5 NAME

The query form of the command produces a response identifying the active sequence name.

The command form requires a single parameter to name the active sequence.

In the case where the name parameter is longer than 15 characters an **Execution Error** will be placed in the error/event queue and the name will not be changed.

12.7.6.6 NOSEQ

Clears the active test sequence. Any present changes to the active test sequence are discarded and all steps are cleared. In its place is a new sequence with no steps with a name of 'Unnamed'. The V10x will be placed into an idle state until a valid sequence is configured and the **Ready** command issued.

12.7.7 Test Sequence Execution and Result Commands

Commands in this section are used to start, modify, stop, and query running commands sequences.

12.7.7.1 READY

Makes the active test sequence ready to be run by the START button or interface command. If the present sequence is not valid an **Execution Error** will be placed in the error/event queue and the V10x remains idle. Remember that if the sequence has been modified by *add* or *set* commands the changes will be hidden until the **Ready** command is issued. The query form of the command returns 0 (zero) if the interface sequence is not ready to be run from the START button; the response is 1 (one) if the sequence has been made ready.

12.7.7.2 RUN

In the command form runs the active test sequence. It accepts one optional parameter keyword 'leads' that if present runs the sequence in a manner to form lead compensation coefficients.

The system must be configured to allow Interface commands to issue START, otherwise a **Settings Conflict** will be placed in the error/event queue and the sequence will not be started.

If the present sequence is not valid an **Execution Error** will be placed in the error/event queue and the V10x remains idle.

If the Abort DIO signal is configured and active an **Execution Error** will be placed in the error/event queue.

If a sequence is already running an **Execution Error** will be placed in the error/event queue.

If the active sequence does not have at least one test step an **Execution Error** will be placed in the error/event queue.

The query form response is 0 (zero) if a sequence is not running or 1 (one) if a sequence is running.

12.7.7.3 ABORT

This command aborts a running test sequence.

12.7.7.4 CONT

This command continues a running test sequence.

If a sequence is not paused state an **Execution Error** will be placed in the error/event queue.

12.7.7.5 REMSTART

This command configures the behavior of the instrument's *Start* button while the command interface is active. Normally when the command interface is active the *Start* button is ignored and cannot start a sequence. This command allows *Start* button activation to be made available by the *LOCSTART* command discussed below.

If this command is sent while a sequence is running an **Execution Error** will be placed in the error/event queue.

12.7.7.6 LOCSTART

This command queries if the start button or DIO start have been activated since the last time the command was received. The response is a 1 if either signal occurred, otherwise a 0 (zero).

12.7.7.7 SEQ

This command queries the active sequence number. The response is 100 if the sequence was freshy created by the interface; the response is 0 (zero) to 99 if the sequence has been stored. Note that sequence 0 (zero) is the manual sequence.

12.7.7.8 STEP

This command queries the presently running step #. It responds with a 0 (zero) if a sequence is not presently running, otherwise 1 through 999999.

12.7.7.9 Adjust

When running the manual sequence, the V10x allows for adjustment of the test levels during the dwell period. The following table lists the possible adjustment commands associated with the step types that allow this feature.

Table 12-29 Manual Step Adjustments

Type	Amps	Freq	Volts
ACW		X	X
ACCAP		X	X
DCW			X
DCIR			X
GB	X	X	

If the present step is not in the dwell period or does not allow adjustment of the specified setting an **Execution Error** will be placed in the error/event queue and no adjustment is made.

If the setting parameter is not formatted properly or exceeds operational limits a **Command Error** will be placed in the error/event queue and no adjustment is made.

12.7.7.10 MEASRSLT

This query command reports a measurement during execution of a step. The keyword parameter must be one of those listed in the following table.

Table 12-30 Measurement Item Keywords

Keyword	Description
FREQ	frequency (in Hz)
AMPS	DC or RMS current (in Amps)
INPHSA	In-phase current (in Amps)
QUADA	Quadrature current (in Amps)
VOLTS	DC or RMS voltage (in Volts)
INPHSV	In-phase voltage (in Volts)
QUADV	Quadrature voltage (in Volts)
OHMS	DC or RMS impedance (in Ω)
INPHSO	In-phase impedance (in Ω)
QUADO	Quadrature impedance (in Ω)
ARC	Arc current (in Amps)
ARCC	Arc counter in counts
BRKDN	Breakdown current (in Amps)
CAP	Capacitance (in F)
DF	Dissipation factor (in D or DF)

If the query parameter is not recognized a **Command Error** will be placed in the error/event queue and there is no response.

If a sequence is not running the response will be 9.91E37. If the presently executing step does not provide the requested measurement the response will be 9.91E37.

12.7.7.11 RSLT

This query command responds with a <NR1> indicating the overall test sequence status flags. This is the logical OR of all individual step status flags. This can also be used while running a test sequence.

If the active sequence has not been executed an **Execution Error** will be placed in the error/event queue and there is no response.

The value is formed by the addition (or logical OR) of the values shown in the table below. Note that a value of zero indicates that no failure occurred.

Table 12-31 Step Status Flags

Bit #	Value	Description
0	1	V10x Internal Fault
1	2	Unstable load
2	4	Breakdown detected (> setting)
3	8	HOLD Step timeout exceeded
4	16	User abort
5	32	Continuity Sense failure detected
6	64	Wiring fault detected
7	128	Arc detected
8	256	1^{st} check <minimum setting
9	512	1^{st} check >maximum setting
10	1024	2^{nd} check <minimum setting
11	2048	2^{nd} check >maximum setting
12	4096	INTERLOCK failure
13	8192	HV TRIP activated
14	16384	Switch Matrix error – a unit did not communicate or an attempt was made to activate a relay that does not exist.
15	32768	Breakdown detected (> surge drive ability limit for test type)
16	65536	V10x Overheated
17	131072	Step type incompatible with the model and option content
18	262144	Minimum Loading was not encountered during ramp in a DCW or DCIR type step
19	524288	Breakdown detected (> sustained drive ability limit for test type)
20	1048576	A steady or decreasing current was not detected during dwell but the load was otherwise within the limits in a DCIR type step configured to terminate in this manner
21	2097152	User forced abort
22	4194304	Discharge timeout

12.7.7.12 STAT

This query command responds with a <STRING> indicating the pass/fail state of each test step. This can also be used while running a test sequence. The response contains one character for each defined test step-

P passed

F failed

- Not performed

? In process

In the case where the sequence has not been run a single '-' character is the response.

12.7.7.13 STEPRSLT

Responds with a set of fields giving the complete set of results for the specified test step. One parameter is required that specifies the step number to report where the first step is 1 (one).

If the active sequence has not been executed or is presently running an **Execution Error** will be placed in the error/event queue and there is no response.

If the step number is not in the allowed range an **Execution Error** will be placed in the error/event queue and there is no response.

The response is a comma separated list of values listed below.

Table 12-32 Step Results

Field #	Field Format	Value
1	<NR1>	0 – Not executed 1 – Terminated during Ramp 2 – Terminated during Dwell (during delay) 3 – Terminated during Dwell (after delay) Others – Terminated
2	<NR3>	Elapsed time of last executed period (in seconds)
3	<NR1>	Status of this step, see Table 12-31.
4	<NR3> or <EMPTY>	Final test level (in Volts or Amps)
5	<NR3> or <EMPTY>	Final test frequency (in Hz)
6	<NR3> or <EMPTY>	Highest breakdown current (in Amps, peak)
7	<NR3> or <EMPTY>	Highest voltage (in Volts)
8	<NR3> or <EMPTY>	Highest 1st check result
9	<NR3> or <EMPTY>	Lowest 1st check result
10	<NR3> or <EMPTY>	Average 1st check result
11	<NR3> or <EMPTY>	Last 1st check result
12	<NR3> or <EMPTY>	Highest 2nd check result
13	<NR3> or <EMPTY>	Lowest 2nd check result
14	<NR3> or <EMPTY>	Average 2nd check result
15	<NR3> or <EMPTY>	Last 2nd check result
16	<NR3> or <EMPTY>	Highest arc current (in Amps)
17	<NR3> or <EMPTY>	Lowest arc current (in Amps)
18	<NR3> or <EMPTY>	Average arc current (in Amps)
19	<NR3> or <EMPTY>	Last arc current (in Amps)

Not all of the above fields are valid for each step type; fields which are not used for a step type are empty.

The table below shows the valid fields for each step type. The *Check Result* fields are empty if no check was defined or performed; otherwise, they have the same units as used for the check limits (i.e., Volts, Amps, Ohms, Farads etc.).

Table 12-33 Step Result Availability

Field #	ACW	DCW, DCIR	GB	LowΩ	ACCAP	ACI	DCI	BRKDN	Pulse	Pause, Hold, Switch
1	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid
2	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid
3	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid
4	Valid (in V)	Valid (in V)	Valid (in A)	Empty	Valid (in V)	Valid (in V)	Valid (in V)	Valid	Empty	Empty
5	Valid	Empty	Valid	Empty	Valid	Valid	Empty	Empty	Empty	Empty
6	Valid	Valid	Empty	Empty	Valid	Empty	Empty	Valid	Valid	Empty
7	Empty	Empty	Empty	Empty	Empty	Empty	Empty	Valid	Valid	Empty
8	Valid or Empty	Valid	Valid	Valid	Valid	Valid	Valid	Empty	Empty	Empty
9	Valid or Empty	Valid	Valid	Valid	Valid	Valid	Valid	Empty	Empty	Empty
10	Valid or Empty	Valid	Valid	Valid	Valid	Valid	Valid	Empty	Empty	Empty
11	Valid or Empty	Valid	Valid	Valid	Valid	Valid	Valid	Empty	Empty	Empty
12	Valid or Empty	Empty	Empty	Empty	Valid	Empty	Empty	Empty	Empty	Empty
13	Valid or Empty	Empty	Empty	Empty	Valid	Empty	Empty	Empty	Empty	Empty
14	Valid or Empty	Empty	Empty	Empty	Valid	Empty	Empty	Empty	Empty	Empty
15	Valid or Empty	Empty	Empty	Empty	Valid	Empty	Empty	Empty	Empty	Empty
16	Valid or Empty	Valid or Empty	Empty	Empty	Valid or Empty	Valid or Empty	Valid or Empty	Empty	Valid or Empty	Empty
17	Valid or Empty	Valid or Empty	Empty	Empty	Valid or Empty	Valid or Empty	Valid or Empty	Empty	Valid or Empty	Empty
18	Valid or Empty	Valid or Empty	Empty	Empty	Valid or Empty	Valid or Empty	Valid or Empty	Empty	Valid or Empty	Empty
19	Valid or Empty	Valid or Empty	Empty	Empty	Valid or Empty	Valid or Empty	Valid or Empty	Empty	Valid or Empty	Empty

12.7.7.14 CHART

Responds with the chart data for the specified test step. At least 2-N parameters are required that specify the step number to report where the first step is 1 (one) and the chart items to report as listed:

Table 12-34 Chart Item Keywords

Keyword	Description
AMPS	DC or RMS current (in Amps)
INPHSA	In-phase current (in Amps)
QUADA	quadrature current (in Amps)
VOLTS	DC or RMS voltage (in Volts)
INPHSV	In-phase voltage (in Volts)
QUADV	quadrature voltage (in Volts)
OHMS	DC or RMS impedance (in Ω)
INPHSO	In-phase impedance (in Ω)
QUADO	quadrature impedance (in Ω)
CAP	capacitance (in F)
DF	dissipation factor (unitless)

If the active sequence has not been executed or is presently running an **Execution Error** will be placed in the error/event queue and there is no response.

If the step number is not in the allowed range an **Execution Error** will be placed in the error/event queue and there is no response.

If an item query parameter is not recognized a **Command Error** will be placed in the error/event queue and there is no response.

If the step type does not support charting (for example pause) or chart data was not collected the response is the single word 'None'.

Where data is available the response is a comma separated list of the requested items preceded by a relative time stamp; each row is delimited by a semi-colon.

12.7.7.15 ARCRSLT

Responds with the number of arc events for the specified test step. One parameter is required that specifies the step number to report where the first step is 1 (one).

If the active sequence has not been executed or is presently running an **Execution Error** will be placed in the error/event queue and there is no response.

If the step number is not in the allowed range an **Execution Error** will be placed in the error/event queue and there is no response.

The response is an NR1 identifying the number of arc events detected while the step was in dwell.

12.7.8 Sequence Execution Settings

Commands in this section affect how the V10x executes a sequence.

12.7.8.1 BEEP

This command configures or queries the volume associated by one of the three audible beep tones produced by the V10x when executing a test sequence, a minimum of one keyword is required:

- Start
- Pass
- Fail

The command form requires a second parameter to configure the volume setting in the range 0 to 4:

0 – off
1 – soft volume
2 – medium volume
3 – louder volume
4 – loudest

The query form of the command responds with the volume setting in the range 0 (zero) to 4.

12.7.8.2 TONE

This command configures or queries the volume and tone associated by one of the three audible signals produced by the V10x when executing a test sequence, a minimum of one keyword is required:

- Start
- Pass

- Fail

The command form requires two additional parameters to configure the volume setting in the range 0 to 100, and a selection code for one of three sounds in the range 1 to 3.

The query form of the command responds with the volume setting and sound code.

12.7.8.3 Test Execution Flags

There are several test execution flags that affect various aspects of a sequence when it is running. The settings have general defaults that are adopted when a sequence is created via the NOSEQ command (see section 12.7.6.6). The flags are referenced using the following keywords:

- CONTSENSE
- FAILARC
- HVSAFETY
- FASTBRKDN
- MINLOAD

When using the keyword as a command query command the sequence specific setting forms the response; using the keyword as a configuration command sets both the general and sequence specific settings.

When using the hierarchical ***SEQuence*** command only the sequence specific settings are accessed.

12.7.8.4 MAXDISCHARGE

Configures the maximum allowed discharge current during DCW and DCIR type steps to the parameter value in amps, values between 1mA and 200mA are valid.

12.7.8.5 VLIMIT

Configures the maximum AC or DC voltage allowed when configuring and running withstand test steps. The first parameter must be a keyword selecting **AC** or **DC**. In the query form the response is the maximum voltage setting. In command form a second parameter specifies a limit up to the instrument’s capability. The limit change may invalidate existing sequences, the V10x will be placed into an idle state until a valid sequence is configured and the **Ready** command issued.

12.7.8.6 ALIMIT

Configures the maximum current allowed when configuring and running ground bond test steps. In the query form the response is the maximum current setting. In command a single parameter specifies a limit up to the instrument’s capability. The limit change may invalidate existing sequences, the V10x will be placed into an idle state until a valid sequence is configured and the **Ready** command issued.

12.7.8.7 FASTRERUN

Configures how a test sequence may be rerun from the front panel. The query form of the command responds with the setting expressed as an NR1. The command form configures the setting to one of the following values:

0 – enable fast rerun
1 – enable fast rerun if pass
2 – disable fast rerun

12.7.9 Device Configuration Commands

Commands in this section configure the V10x at the system level.

12.7.9.1 BEEP

This command configures or queries the volume level of the sound produced by the V10x when the user operates the touch panel or uses the selector dial, a minimum of one keyword is required – 'key'.

The command form requires a second parameter to configure the volume setting in the range 0 to 4:

0 – off
1 – soft volume
2 – medium volume
3 – louder volume
4 – loudest

The query form of the command responds with the volume setting in the range 0 (zero) to 4.

12.7.9.2 TONE

This command configures or queries the volume and tone produced by the V10x when the user operates the touch panel or uses the selector dial, a minimum of one keyword is required – 'key'.

The command form requires two additional parameters to configure the volume setting in the range 0 to 100, and a selection code for one of three sounds in the range 1 to 3.

The query form of the command responds with the volume setting and sound code.

12.7.9.3 DIO

NOTE Issuing a DIO input configuration command disables handling of all physical input signals for sixty seconds to provide time for all configuration commands to be processed. When the time limit expires the signals can be processed in a coherent manner. The time limit will be shorter if the command connection closes earlier.

CAUTION When the program message completes the DIO changes are applied and the V10x may immediately act on input state changes.

The base DIO command is used to enable or disable a DIO signal; it is enabled by configuring a high or low polarity setting. The command requires a minimum of one parameter keyword selecting the DIO signal to modify as listed:

Signal
Start
Sequence
Abort
Interlock
HV
Pass
Fail
Testing
Dwell

This command uses the factory default pin assignments listed in Table 11-3.

In the command form a second parameter is required to configure the polarity or disable the signal:

OFF – disable the signal
HI – enable the signal with active high polarity
LO – enable the signal with active low polarity

The query form of the command responds with the present signal setting.

NOTE The signal parameter keyword 'Sequence' affects the physical Sequence[8,4,2,1].

12.7.9.4 DIO:RESet

Use this command to reset the DIO configuration to the factory defaults. This is most useful when the hierarchical commands have been used and it is desired to revert to the simple commands.

12.7.9.5 DIO:FUNCtion

NOTE Issuing a DIO function command to configure an input will disable handling of all physical input signals for sixty seconds to provide time for all configuration commands to be processed. When the time limit expires the signals can be processed in a coherent manner. The time limit will be shorter if the command connection closes earlier.

CAUTION When the program message completes the DIO changes are applied and the V10x may immediately act on input state changes.

This command requires a minimum of one parameter specifying the pin number in the range 1-12. If the pin number is invalid a **Data out of range** error is placed in the error/event queue and the command is rejected.

In the command form two additional parameters are required:

- Function
- Polarity

The following table lists the function names:

Table 12-35 DIO Functions

Function
Start
Sequence1
Sequence2
Sequence4
Sequence8
Abort
Interlock
HV
Pass
Fail
Testing
Dwell
Arc
None

The polarity setting must be one of:

HI – enable the signal with active high polarity
LO – enable the signal with active low polarity

If the function name or level parameters are not valid an **Illegal parameter value** error is placed in the error/event queue and the command is rejected.

An input function cannot be assigned to more than one pin; in the event a duplicate is attempted a **Settings conflict** error is placed in the error/event queue.

The query form of the command responds with the present pin settings.

12.7.9.6 DIO:LEVel?

Queries the level on a DIO pin for both inputs and outputs. The command requires a parameter keyword specifying the DIO function as listed in Table 12-35. If the function has not been assigned to a pin, there is no response and a **Settings conflict** error is placed in the error/event queue. The normal response is Hi or Lo.

12.7.9.7 SYSTem:DATE

The command form sets the system date, and it requires three NR1 values to respectively set the internal calendar date. The following table lists the acceptable range for each component:

Value	Minimum	Maximum
Year	2000	2099
Month	1	12
Day	1	Month specific

The query form responds with the calendar date in the form **yyyy,mm,dd**.

12.7.9.8 SYSTem:TIMe

The command form sets the system time, and it requires three NR1 values to respectively set the internal clock. The following table lists the acceptable range for each component:

Value	Minimum	Maximum
Hour	0	23
Minute	0	59
Second	0	60

This command complies with SCPI 199.0 in that if the seconds value is rounded to 60 it shall be set to 0 and the minute value incremented. Any other carries shall be rippled. The query form responds with the calendar date in the form **hh,mm,ss**.

12.7.9.9 TIME12

Configure or query the setting that selects if time is display in 12 or 24 hour representations.

12.7.9.10 SYSTem:IDENtify

The command form sets the state of the system identify indicator, the parameter is a Boolean setting that if true turns the indicator on and if false turns the indicator off. The query form responds with the present state of the indicator.

12.7.9.11 DHCP

This command configures the option to enable or disable the rising current time filter. The keyword is a Boolean setting.

NOTE Note that changing this setting while using the Ethernet LAN interface will probably cause the connection to be lost.

12.7.9.12 IP

Configure or query the Ethernet LAN IP address. The command form requires a single string parameter in dotted decimal notation. In the case where the string parameter is longer than 15 characters a **Too much data** error will be placed in the error/event queue and the address will not be changed.

NOTE Note that changing this setting while using the Ethernet LAN interface will probably cause the connection to be lost.

The query form response is the present IP address whether manual or automatic.

12.7.9.13 SUBNET

Configure or query the Ethernet LAN subnet address. The command form requires a single string parameter in dotted decimal notation. In the case where the string parameter is longer than 15 characters a **Too much data** error will be placed in the error/event queue and the address will not be changed.

The query form response is the present subnet address whether manual or automatic.

12.7.9.14 GATEWAY

Configure or query the Ethernet LAN gateway address. The command form requires a single string parameter in dotted decimal notation. In the case where the string parameter is longer than 15 characters a **Too much data** error will be placed in the error/event queue and the address will not be changed.

The query form response is the present gateway address whether manual or automatic.

12.7.9.15 DNS

Configure or query the Ethernet LAN DNS server address. The command form requires a single string parameter in dotted decimal notation. In the case where the string parameter is longer than 15 characters a **Too much data** error will be placed in the error/event queue and the address will not be changed.

The query form response is the present DNS server address whether manual or automatic.

12.7.9.16 GPIB

Configure or query the GPIB address setting.

In the case where the V10x is not provisioned with the GPIB interface a **Settings Conflict** error will be placed in the error/event queue and the address will not be changed.

The command form requires a single NR1 parameter in the range 2 to 29.

The query form response is the present GPIB address setting.

12.7.9.17 RS232

Configure or query the RS232 port baud rate setting.

In the case where the V10x is not provisioned with the RS232 interface a **Settings Conflict** error will be placed in the error/event queue and the baud rate will not be changed.

The command form requires a single NR1 parameter in the range 9600 to 921600.

The query form response is the present baud rate setting.

12.7.9.18 SWITCHES

Configure or query the switch matrix unit control settings.

The command form requires at least one parameter that is one of the listed keywords:

- NONE – no external switch matrix units
- 964SER – a single 964i using RS232
- 964VICL1 – a single 964i using VICL
- 964VICL2 – two 964i using VICL
- 964VICL3 – three 964i using VICL
- 964VICL4 – four 964i using VICL
- VICL – selects the VICL interface, requires additional parameters
- RS232 – selects the RS232 interface, requires additional parameters

- LAN – selects the LAN interface, requires additional parameters

In the case where the V10x is not provisioned with the RS232 interface and the '964SER' or 'RS232' keywords are used a **Settings Conflict** error will be placed in the error/event queue and the baud rate will not be changed.

For the latter three settings further parameters are required taking the form of quadruplets identifying the model, serial number, number of relays, and connection settings. The RS232 form is limited to one set, VICL allows 252, LAN allows as many as your local network can support. Note that the serial number can be blank.

```
switches,vicl,964i,032182,32,1,M101,871023,80,2,M101,871753,80,3,M101,871165,80,4,M101,871165,80,5
switches,rs232,M103,943123,120,115200
switches,lan,M101,871023,80,192.168.1.23,M101,871753,80,192.168.1.19,M101,871165,80,192.168.1.31
```

Figure 12-1 Switches Command Examples

See appendix B for information on integrating Vitrek switches. Note that in the serial number can be blank.

The query form response is the present switch matrix settings.

12.7.9.19 SERNUM

This is a query only command. The response is the V10x serial number.

12.8 Device Synchronization

The *OPC commands allow synchronization with test sequence completion without having to poll the V10x. The 'Operation Complete' condition becomes true when a test sequence completes.

In simple terms after issuing the 'Run' command discussed in section 12.7.7.2 one of *OPC or *OPC? are issued. In the former case when the sequence completes the OPC bit is set in the Event Status Register; in the latter case the command stream blocks until the sequence completes at which time a '1' is sent as a response.

If the *OPC command or query is executed without a past command available for context, for example immediately after *RST, the condition is immediately met: the OPC bit in the ESR is immediately set or execution of *OPC? will immediately respond with 1.

The following figure illustrates commands to use *OPC? for synchronization:

```
noseq
add,dcw,50.0,0.015,5,5.0,0.0,AMPS,0.0,0.05,,,none,abort
add,dcw,75.0,0.015,5,5.0,0.0,AMPS,0.0,0.05,,,none,abort
add,dcw,100.0,0.015,5,5.0,0.0,AMPS,0.0,0.05,,,fast,abort
name,Run-Me
ready
run
*opc?
stat?
rslt?
steprslt?,1
steprslt?,2
steprslt?,3
```

Figure 12-2 *OPC? Example

If you elect to poll for test completion, make sure your code waits for testing to start before waiting for testing to stop. The test may not start due to an error.

13 Periodic Maintenance

The V10x series requires minimal periodic maintenance.

NOTE The V10x contains no internal user servicable parts and requires no internal periodic maintenance. The covers of the V10x should onlyu be removed by Vitrek or its authorzied service centers – removal of the covers may affect warranty and calibration certification.

The following procedures are recommended to be performed at monthly intervals. These require no special tools or equipment and take the average user about ten minutes to perform.

13.1 Cleaning and Inspection

13.1.1 Cable Inspection

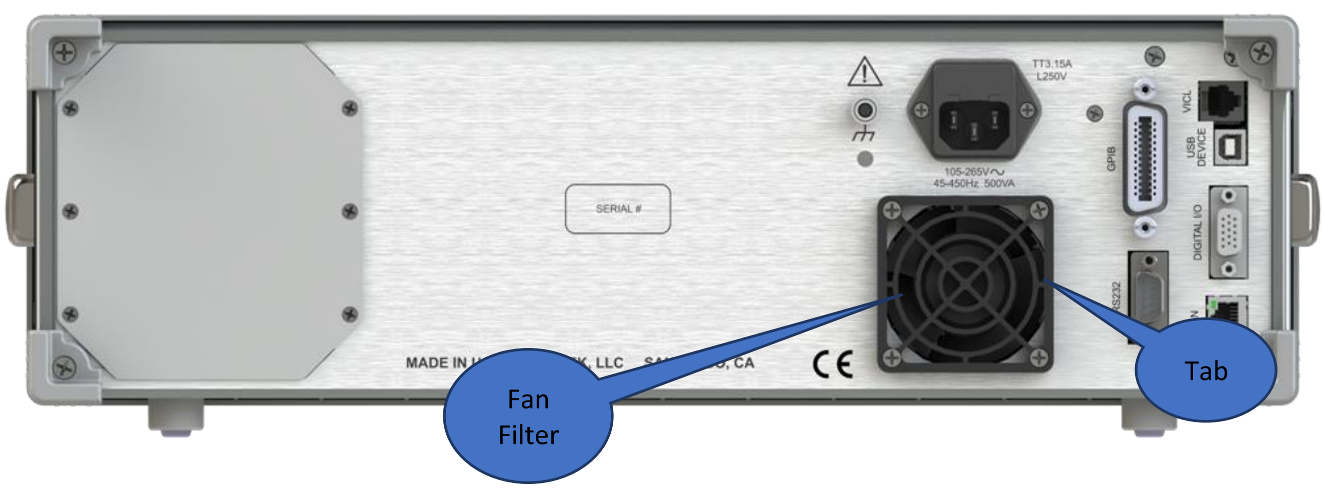
Carefully inspect the power cord, any high voltage cabling and (if Opt. AC-30 is fitted) all cables to the external AC-30 transformer, for breaks, abrasions, or cracks in the outer insulation. Replace any cable found to be damaged.

If a high voltage cable has become excessively dirty then the user should clean it by wiping it with a wetted cloth, with a cleaning agent if needed. If a high voltage cable is wetted ensure it is fully dried before returning it to use.

13.1.2 Fan Filter Cleaning

With power completely removed from the V10x, visually inspect the cleanliness of the fan filter. The fan filter is located on the rear panel of the V10x, near the power entry socket.

CAUTION Do not remove the four screws surrounding the filter. Do not operate the V10x without a fan filter installed.



To remove the filter, pull on one of the tabs on the filter cover to remove the cover and then remove the filter itself. Carefully brush off or blow out any dirt which may have accumulated on the filter. Replacement filters can be purchased from Vitrek if needed. If the filter is damaged, e.g., is torn, then it must be replaced. When replacing the filter into the cover, take care to ensure the filter is installed flat and does not impair operation of the fan.

13.1.3 Display Cleaning

When cleaning the LCD display, take care to avoid scratching the surface of the panel. Ensure no surfaces are damp when reconnecting power to the instrument.

13.1.4 Terminal Inspection

Visually inspect the terminals and the area immediately around them in the front and/or rear panels and clean them if required.

CAUTION If the internal surfaces of terminals are wetted during cleaning, then ensure that they are fully dried before operating the V10x at high voltages, otherwise safety may be compromised.

Carefully visually inspect the high voltage terminal shrouds for mechanical damage. If there is any cracking in the shroud, then safety may be compromised, and the terminal should be replaced. Replacement of high voltage terminals should only be carried out at Vitrek or one of its certified repair establishments.

13.1.5 Self-Test

It is recommended to run the Self-Test function periodically; it is highly recommended when changing the environment where the instrument is operated. See section 10.5. for information on executing the self-test process.

14 Performance Verification and Adjustment

The V10x has been designed to give many years of service without needing calibration. However, particularly for devices used to test for product safety, it is important to periodically ensure that the device is properly working within its specifications.

There are three strategies recommended for periodic performance verification/adjustment of the V10x. Which one is selected by the user depends on the user's specific requirements regarding quality level and the availability of equipment.

- Periodic Adjustment Calibration Only. This is the simplest of the strategies, while it gives the typical user a reasonable degree of certainty that the V10x is performing to its specifications, it does not cross-check that the calibration technique was performed correctly and does not account for some (rare) possible malfunctions in the V10x.
- Periodic Adjustment followed by Verification. With this strategy the user ensures that the V10x was within specification as received by performing the adjustment calibration and checking that the adjustments are within the product specification, then checking that the calibration was correctly performed and checking for the rare possible V10x malfunctions by means of the post-adjustment verification. This completely ensures that the outgoing V10x meets its specifications but leaves the possibility of an error made during the adjustment calibration leading to the incorrect indication that the incoming V10x did not meet specifications.
- Periodic Verification – Adjustment – Verification. This is the most complete strategy but is also the costliest in time. The time cost can be reduced by performing the initial verification and then only performing the Adjustment – Verification components if the initial verification indicates that it is necessary (as an example, only perform if beyond some percentage of specification in the initial verification).

To access the calibration facility, navigate to System->About and touch the **Calibration** button. You will be prompted to enter the calibration password. The default factory password is 3247. Upon successful entry of the password the instrument displays calibration date information and menu options as illustrated:

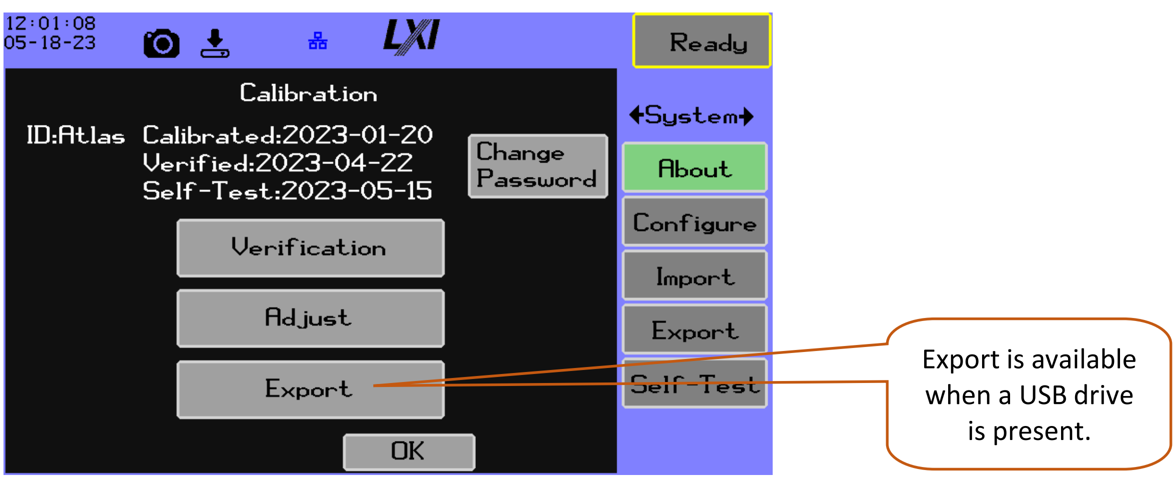


Figure 14-1 Calibration Activities

The three dates are respectively the date of the last adjustment, the last date at least one performance metric was verified, and the last date a full self-test was run. The user can change the calibration lock password or save the present calibration data if a flash stick is present. From this view the user can choose **Verification** or **Adjust** discussed in the following sections. For both choices the user will be prompted remove all connections and press the **Start** button.

CAUTION Failure to remove all connections before pressing the **Start** button could result in damage to the instrument or attached equipment.

Once **Start** is pressed the V10x performs a few internal tests to ensure basic functionality of the product before proceeding to the selected procedure:

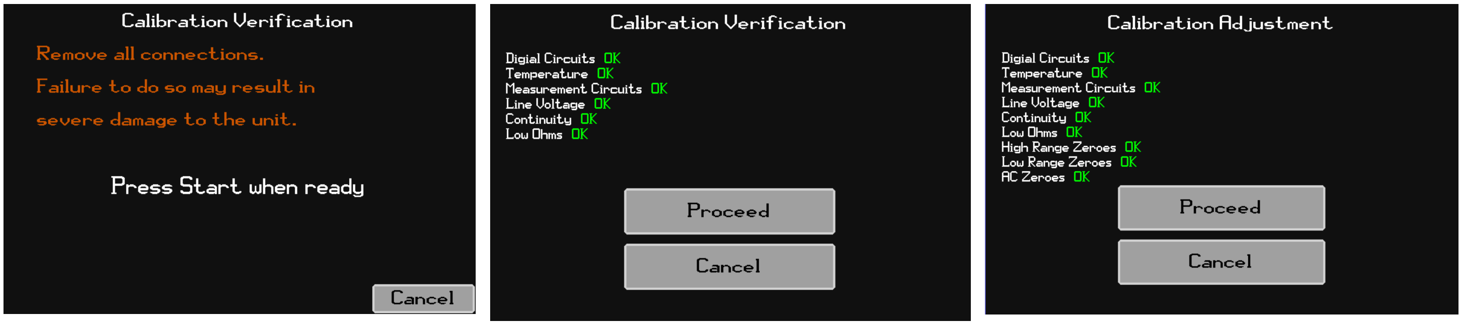


Figure 14-2 Preliminary Calibration Steps

CAUTION During the adjustment preparation phase the output terminals will be active with high voltage that could result in injury to or death of personnel.

Touch **Proceed** to continue to Verification or Adjustment.

14.1 Calibration Adjustment

The V10x employs internal software calibration adjustments, there are no physical adjustments required. These adjustments are needed to correct for manufacturing tolerances in the components used in the V10x, it is important to note that there is no calibration of design defects allowed for, giving the end user a high degree of certainty that the V10x maintains its specifications. Typically, adjustment should be rarely needed; however, the user may wish to perform it at periodic intervals to ensure optimal performance.

NOTE

- The V10x should be fully powered and turned on for at least 10 minutes (1 hour is recommended) prior to being calibrated. Initially there should be no connections to any of the V10x terminals and it is recommended to not have any connections to the interface ports during the procedure.
- In many cases the same accuracy determining circuitry is used in several different modes of operation. As an example, there is no difference between the DC and AC voltage modes of operation in the accuracy determining circuitry of the V10x. Because of this the entire product can be calibrated with complete certainty by only a few fairly simple calibrations.
- The combination of the adjustment calibration and the internal self-test ensures the performance of the V10x in all but the most unusual of circumstances. Even if a formal calibration verification procedure is not performed, the user can have a very high degree of certainty that the V10x is performing to its capabilities.
- The adjustment calibration procedure has been designed to use widely available equipment, such as the multi-function calibrators available from Fluke. No voltages over 1000V are needed during this procedure. This document describes the equipment needed and provides details regarding the use of the V10x during this procedure; it does not describe how to use that equipment.
- The user can press the **Stop** button to abort the procedure. This discards any changes which have been made during the procedure. DO NOT REMOVE POWER FROM THE V10x DURING THE ADJUSTMENT CALIBRATION

PROCEDURE. If a failure occurs during the procedure, the V10x will automatically halt the procedure and discard any changes made.

- The front panel High Voltage warning light is illuminated whenever there are high voltages or currents present on the V10x terminals. When illuminated the user should not touch the connections to the V10x.

14.1.1 Equipment Required

1. (All models) A shorting plug suitable for use between the **SENSE+** and **SENSE-** terminals. This must have a resistance of less than 5mΩ at a nominal 30mAdc current for a 4:1 accuracy ratio (the V10x specification is 20mΩ).
2. (All models) A true 4-wire short circuit having a 4-terminal resistance of less than 0.5mΩ at a nominal 30mAdc current for a 4:1 accuracy ratio (the V10x specification is 2mΩ) and (V102/V104/V109 only) an impedance of less than 1.625uΩ at 5Arms/60Hz current for a 4:1 accuracy ratio (the V102/V104/V109 specification is 6.5uΩ).
3. (All models except the V109) A source of 100Vdc, 500Vdc and 1000Vdc capable of driving a 100MΩ load with an accuracy of better than ±0.075% for a 4:1 accuracy ratio (the V10x specification is ±0.3%).
4. (All models) A source of 100uA, 1mA, 10mA and 50mAdc capable of driving at least 1.5V compliance with an accuracy of better than ±0.0625% for a 4:1 accuracy ratio (the V10x specification is ±0.25%).
5. (All models) A 10KΩ resistance with an accuracy of better than ±0.2% at a nominal 0.5mAdc current (the V10x specification is ±0.8%). Preferably this resistor should be a 4-terminal device.
6. (V109 only) A 10Ω resistance with an accuracy of better than ±0.2% at a nominal 30mAdc current (the V10x specification is ±0.8%). This resistor should be a 4-terminal device.
7. (V102/V104/V109 only) A nominally 1Ω 4-wire impedance with an accuracy of better than ±0.375% at 1Arms/60Hz current for a 4:1 accuracy ratio (the specification is ±1.5%). The actual value must be known to within the accuracy limits and must be in the range 0.9 to 1.1Ω.
8. A nominal 1MΩ ± 20% resistor capable of withstanding 1000V and a milli-ammeter with an accuracy of better than ±0.25% at 1mAdc for a 4:1 accuracy ratio (the V10x specification is ±1%).

The adjustment procedure is executed from the Calibration Adjustment menu:

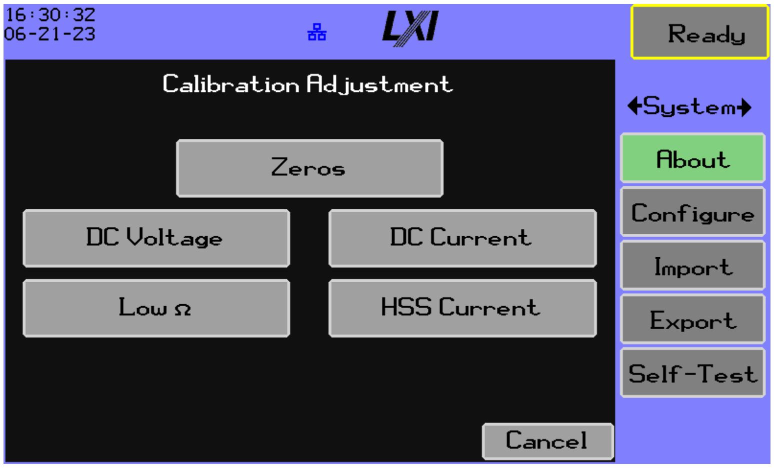


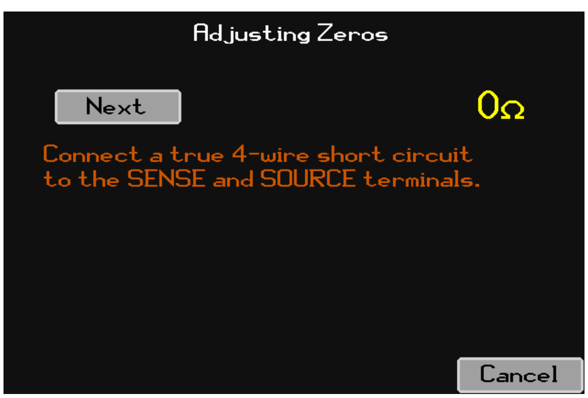
Figure 14-3 Calibration Adjustment Menu

It is recommended that the user perform the calibration process in the order discussed in the following sections.

14.1.2 Zeros

This step zeroes out internal voltage measurements. The user is required to apply items #1 and #2 from the equipment list.

Connect a short between the SENSE+ and SENSE- terminals. This is equipment #1 listed above. NOTE – this short circuit must have less than 5uV of thermally induced voltage, the user may need to wait for some time after making connections. Ensure that the short circuit is properly inserted into the terminals and then press **Start** to commence the 2-wire zeroing process.



Connect a true 4-wire short circuit to the SENSE and SOURCE terminals. This is equipment #2 listed above. NOTE – this short circuit must have less than 5uV of thermally induced voltage, the user may need to wait for some time after making connections. Ensure that the short circuit is properly inserted into the terminals and then press **Start** to perform the 4-wire zeroing process.

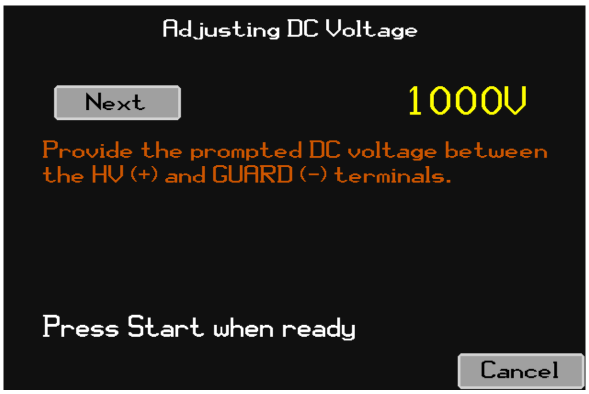
Figure 14-4 Zero Adjustment Start Screens

The zeroing procedures will exit automatically when completed. The user should remove the 4-wire short.

The V10x now automatically performs a 4-wire resistance zero adjustment. When the V10x has completed its 4-wire zero adjustments, the user is prompted to remove the 4-wire short circuit. When it has been removed press START to continue the procedure.

14.1.3 DC Voltage

The stage requires the user to provide a source of high voltage (equipment #3 listed above) between the **HV** (+) and **GUARD** (-) terminals as prompted by the V10x. Apply the connections to the V10x terminals ensuring the connections are to the correct terminals and with the correct polarity, and then set the source to provide the voltage. DO NOT TOUCH TERMINALS OR CONNECTORS WHILE VOLTAGE IS APPLIED. When the voltage is correctly applied press **START** to continue the procedure.

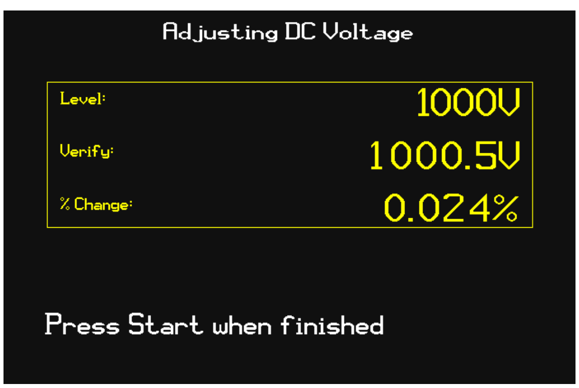


The required voltage level is shown. Once the source is properly connected press the **Start** button to commence the voltage adjustment.

Figure 14-5 DC Voltage Adjustment Start Screen

CAUTION During this group the voltage source and instrument wiring will be active with high voltage that could result in injury to or death of personnel.

While the adjustment point is running the V10x displays the specified level, the adjusted measurement, and a percentage difference between this calibration and the last calibration of the V10x:



When the user is satisfied that the adjustment has been completed press the **Start** button to accept the adjustment and continue; pressing the **Stop** button abandons the sequence.

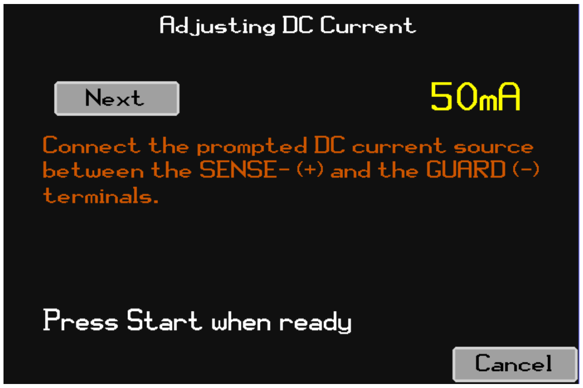
Figure 14-6 DC Voltage Adjustment Screen

The V10x specification at 1000V is ±0.3%. The V10x display will show an error if the adjustment is out of range for calibration, not if the change is beyond the specification. The V10x specification for the remaining levels is ±0.35%.

The DC voltage adjustment step is repeated as necessary for the required adjustment levels.

14.1.4 DC Current

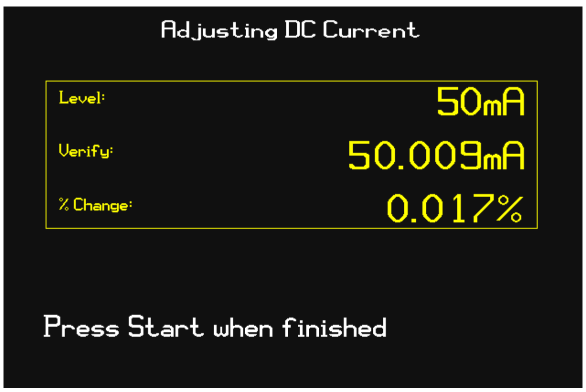
The stage requires the user to provide a source of current (equipment #4 listed above) between the **SENSE-** (+) and **GUARD** (-) terminals of the V10x. Apply the connections to the V10x terminals ensuring the connections are to the correct terminals and with the correct polarity, and then set the source to provide the current.



The required current level is shown. Once the source is properly connected press the **Start** button to commence the current adjustment.

Figure 14-7 DC Current Adjustment Start Screen

While the adjustment point is running the V10x displays the specified level, the adjusted measurement, and a percentage difference between this calibration and the last calibration of the V10x:



When the user is satisfied that the adjustment has been completed press the **Start** button to accept the adjustment and continue; pressing the **Stop** button abandons the sequence.

Figure 14-8 DC Current Adjustment Screen

The V10x specification at 50mA is ±0.25%. The V10x display will show an error if the adjustment is out of range for calibration, not if the change is beyond the specification.

The DC current adjustment step is repeated as necessary for the required adjustment levels.

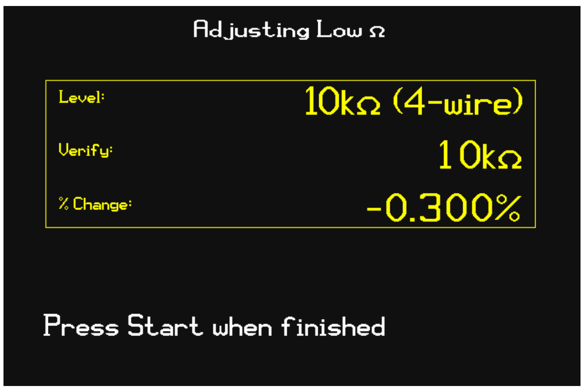
14.1.5 Low Ω

This category calibrates low resistance measurements. The user is prompted to provide accurate reference resistance standards using the 4-wire connection method – the internal current source is from the **SOURCE** terminals, and the voltage measurement uses the **SENSE** terminals, ensure that the resistor is connected with the + terminals and – terminals correctly paired for a 4-wire measurement. When the specified resistance is correctly applied press **START** to continue the procedure.

The required resistance level is shown. Once the reference is properly connected press the **Start** button to commence the resistance adjustment.

Figure 14-9 Low Ω Adjustment Start Screen

While the adjustment point is running the V10x displays the specified level, the adjusted measurement, and a percentage difference between this calibration and the last calibration of the V10x:



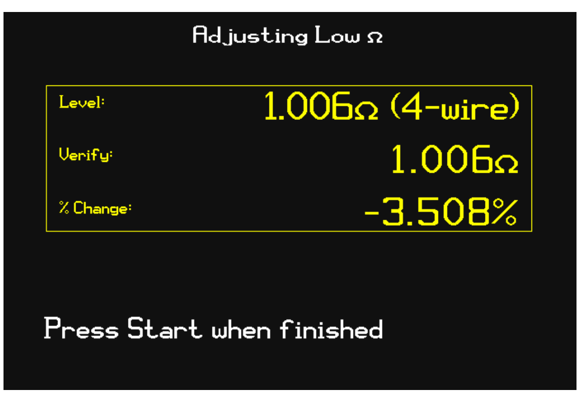
When the user is satisfied that the adjustment has been completed press the **Start** button to accept the adjustment and continue; pressing the **Stop** button abandons the sequence.

Figure 14-10 Low Ω Adjustment Screen

The V10x specification at 10kΩ ±0.8%. The V10x display will show an error if the adjustment is out of range for calibration, not if the change is beyond the specification.

Depending on the model one or more reference resistances will be requested.

A final 1Ω is requested, (equipment #7 listed above). When the user presses the **Start** button the V10x prompts for the calibrated value of the 1Ω reference. When the user completes entering the calibration value the test proceeds before using the reference value as illustrated, in this case the reference resistance is 1.006Ω:

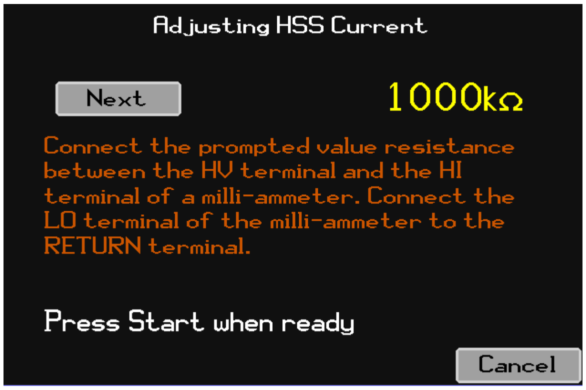


When the user is satisfied that the adjustment has been completed press the **Start** button to accept the adjustment and continue; pressing the **Stop** button abandons the sequence.

Figure 14-11 1 Ω Adjustment Screen

14.1.6 HSS Current

This phase adjusts the HSS current measurement. The user is prompted to attach a 1Mohm resistor and a milli-ammeter (equipment #8 listed above). The resistor should be connected between the HV terminal of the V10x and the HI terminal of the milli-ammeter, the LO terminal of the milli-ammeter should be connected to the RETURN terminal of the V10x.

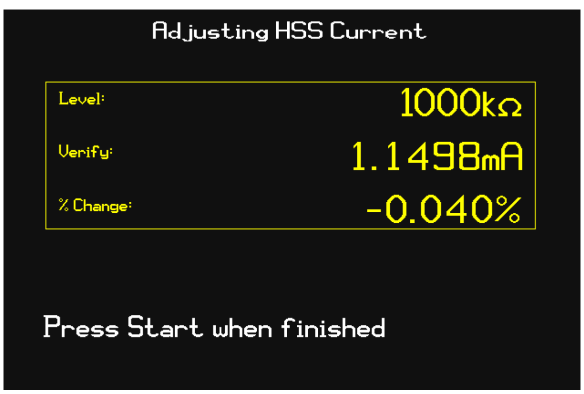


When the equipment is correctly connected press **Start** to commence the adjustment procedure.

Figure 14-12 HSS Current Adjustment Start Screen

CAUTION During this stage the output terminals will be active with high voltage that could result in injury to or death of personnel.

While the adjustment point is running the V10x displays the specified resistance, the adjusted measurement (nominally 1mA), and a percentage difference between this calibration and the last calibration of the V10x:



Use the dial to adjust the V10x reading to be within the allowable tolerance of the milli-ammeter reading (the V10x specification is ±0.01mA). When the user is satisfied that the adjustment has been completed press the **Start** button to accept the adjustment and complete all adjustments; pressing the **Stop** button abandons the sequence.

Figure 14-13 HSS Current Adjustment Screen

14.2 Calibration Verification

The V10x has built-in verification tools which may be followed by the user. In some circumstances the user may wish to not use these tools but instead construct one or more test sequences according to their needs and use external equipment to monitor the voltages and/or current during the execution of the sequence. Or the user may wish to supplement the built-in verification with one or more specific test cases. The use of user test sequences for verification is beyond the scope of this document.

NOTE

- For several steps the equipment needed to perform performance verification is highly specialized and may not be available to many users. Making very high voltage measurements with high precision requires special skills and equipment, particularly when performing high AC voltage testing. If there are any doubts regarding the correct methods to use, consult the manufacturer of the test equipment being used.
- The V10x should be fully powered and turned on for at least 10 minutes (1 hour is recommended) prior to being calibrated. Initially there should be no connections to any of the terminals and it is recommended to not have any connections to the interface ports during the procedure.
- In the various steps shown in this procedure, if a step is specific to certain models, then it is denoted as such.
- The user can press **Stop** to abort a verification step.
- The front panel High Voltage warning light is illuminated whenever there are high voltages or currents present on the V10x terminals. When illuminated the user should not touch the connections to the V10x.
- Several of the verification steps are performed at very high voltages, the user must ensure that the wiring used has sufficient insulation for the voltages.
- Any optional customer requested factory voltage and current generation limitations are applied during verification and so will also affect the procedure.
- Since the V10x is internally grounded, the measurement equipment, current sources and test loads used during verification must not be grounded.

14.2.1 Equipment Required

1. (All except the V109). A measurement device capable of measuring DC voltages of 100V to 1000V, 6000V, 10000V, and 14000V (actual voltages depend on the model being verified), having an input impedance of 10MΩ or greater, and an accuracy which yields the desired error ratio to the V10x series accuracy (see the DC Voltage Verification portion for the accuracies). At voltages at or below 1000V there is a great range of products available which easily achieve very high ratios (e.g., a bench-top 6 ½ digit DMM has a typical DC voltage accuracy of ±0.005%, producing more than a 50:1 error ratio). At voltages above 1000V, however, there are a very limited number of products available.
2. A source of DC currents in the range 1uA to 50mAdc capable of driving at least 1.5V compliance with an accuracy which yields the desired error ratio to the V10x series accuracy (see the DC Current Scaling Verification portion for the accuracies). This is achievable with most multi-function calibration products (e.g., Fluke).
3. (All except the V109). A measurement device capable of measuring AC RMS voltages of 100V to 1900V, 6000V, and 10000V (depending on the model being verified), with a frequency range of at least 60 to 400Hz, having an input impedance of 10MΩ or greater, and an accuracy which yields the desired error ratio to the V10x series accuracy (see the AC Voltage Verification portion for the accuracies). At all but the 100V level there is a very limited number of products available.
4. A set of DC resistance standards of values 100KΩ, 10KΩ, 100Ω and 1Ω, capable of being connected using a 4-wire configuration, and accuracies which yield the desired error ratio to the V10x series accuracy (see the Low

Ohms Resistance Verification portion for the accuracies). This is achievable with most multi-function calibration products (e.g., Fluke) or Resistance Decade Boxes (e.g., ESI).

5. A shorting plug suitable for use between the **SENSE+** and **SENSE-** terminals. This must have a resistance of less than 5mΩ at a nominal 30mAdc current for a 4:1 accuracy ratio (the V10x series specification is 20milliohms).
6. A true 4-wire short circuit having a 4-terminal resistance of less than 0.5mΩ at a nominal 30mAdc current for a 4:1 accuracy ratio (the V10x series specification is 2mΩ) and (V102/4/6/8/9 only) an impedance of less than 1.625uΩ at 5Arms/60Hz current for a 4:1 accuracy ratio (the V102/4/6/8/9 specification is 6.5uOhm).
7. (V102/4/6/8/9 only). A set of AC resistance standards of values 1Ω, 100mΩ and 50mΩ, calibrated for use at 60Hz, capable of being connected using a 4-wire configuration, and accuracies which yield the desired error ratio to the V10x series accuracy at the currents used in the V10x (see the Ground Bond Verification portion for the accuracies and current levels). These may have to be custom built.
8. Nominal 100KΩ, 1MΩ and 10MΩ ± 20% resistors capable of withstanding 1000V and a milli-ammeter with an accuracy of better than ±0.25% at 100uA, 1mA and 10mAdc for a 4:1 accuracy ratio (the V10x specification is ±1%).

The verification points are organized into groups, each group has a model specific set of values to verify; the user can select any group and scroll through the values as necessary to their requirements. The groups are presented with this menu display:

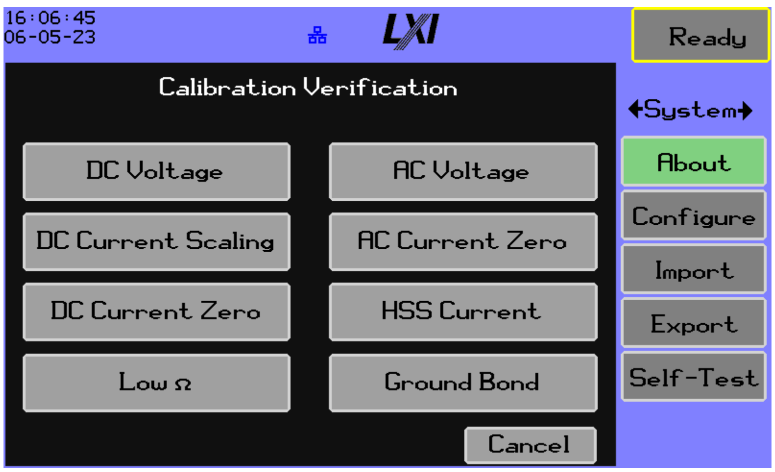
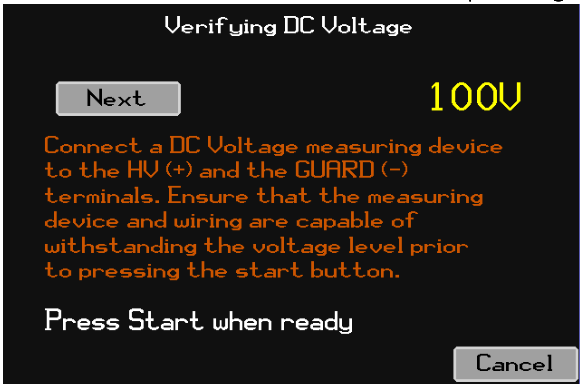


Figure 14-14 Calibration Verification Group Menu

In general, the **Start** button is used to initiate the verification process, then to confirm the point and continue. The **Stop** button will abandon the group. The groups can be run in any order.

14.2.2 DC Voltage

This group validates the instrument's accuracy outputting high voltage DC. When selected the user is prompted with the first recommended level and a reminder on making connections to the measurement device:



The test level that will be verified is shown, the **Next** button will index through the test levels wrapping from last to first.

Figure 14-15 DC Voltage Verification Start Screen

The user should connect a DC Voltage measuring device (equipment #1 in the equipment list above) to the **HV** (+) and the **GUARD** (-) terminals of the V10x. While prompting to press **Start** there are no unsafe voltages present so the user may safely make connections and configure the measurement device as needed. In some circumstances a different measuring device may be used depending on the voltage being measured.

CAUTION During this group the output terminals will be active with high voltage that could result in injury to or death of personnel.

CAUTION Ensure that the measuring device and wiring is capable of withstanding the voltage level prior to pressing the start switch at each step.

The table below shows a complete listing of the voltages that may be requested for verification and the V10x specification at each level.

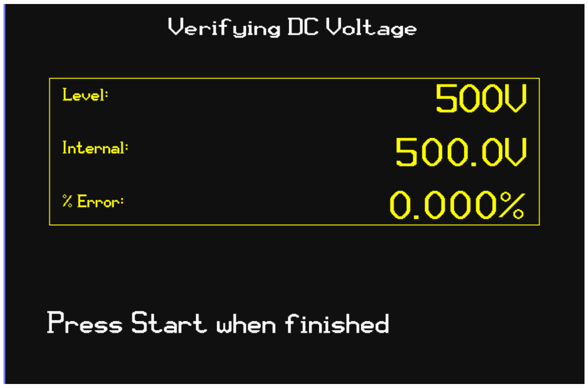
Table 14-1 DC Voltage Verification Levels

Voltage Level	V10x Models	V10x Accuracy
100V	All except V109	V107i: ±2.75% (2.75V) Others: ±0.75% (0.75V)
500V	All except V109	V107: ±1.15% (5.75V) Others: ±0.35% (1.75V)
1000V	All except V109	V107: ±0.95% (9.5V) Others: ±0.3% (3V)
1900V	All except V109	V107: ±0.855% (16.25V) Others: ±0.276% (5.25V)
6000V	All except V109	V107: ±0.783% (47V) Others: ±0.258% (15.5V)
10000V	V103, V104, V105 and V107 only	V107 : ±0.77% (77V) Others: ±0.255% (25.5V)
14000V	V107 only	±0.764% (107V)

When prompted for each step the user should either –

- Press **Start** to perform the verification (the output voltage will be present after pressing this switch).
- Press **Stop** to abort the group.

While the verification point is running the V10x displays the output level, the internal measurement, and a percentage error:

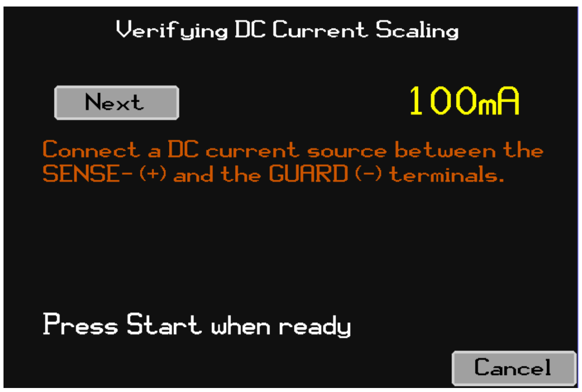


During each step, the user should measure the actual voltage and record it, checking against the v10x specification. The **Internal** display is shown for enhanced verification. When the user is satisfied that the step has been completed, the user should press **Start** to continue or **Stop** to abort the sequence.

Figure 14-16 DC Voltage Verification Screen

14.2.3 DC Current Scaling

The DC Current group validates the instrument's accuracy measuring current. When selected the user is prompted with the first recommended level and a reminder on making connections to the measurement device:



The test level that will be verified is shown, the **Next** button will index through the test levels wrapping from last to first.

Figure 14-17 DC Current Scaling Verification Start Screen

The user should connect a DC current source (equipment #2 in the list above) between the **SENSE**- (+) and the **GUARD** (-) terminals of the V10x.

The table below shows the listing of the currents prompted for verification and the V10x specification at each level.

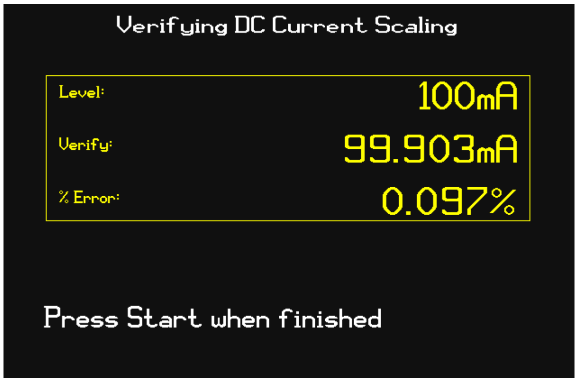
Table 14-2 DC Current Verification Levels

Current Level	V10x Accuracy
100mA	±0.25% (0.25mA)
10mA	±0.25% (0.025mA)
1mA	±0.25% (2.5uA)
100uA	±0.25% (0.25uA)

When prompted for each step the user should either –

- Press **Start** to perform the verification (the user should ensure that the requested current is present prior to pressing this switch).
- Press **Stop** to abort the group.

While the verification point is running the V10x displays the output level, the internal measurement, and a percentage error:



During each step, the user should note the displayed current and record it, checking against the V10x specification. When the user is satisfied that the step has been completed, the user should press **Start** to continue or **Stop** to abort the sequence.

Figure 14-18 DC Current Scaling Verification Screen

14.2.4 DC Current Zero Verification

This group validates the instrument's ability to zero out component drift, temperature, and humidity when measuring DC current. When selected the user is prompted to remove all connections and is shown the first point will generate no output:

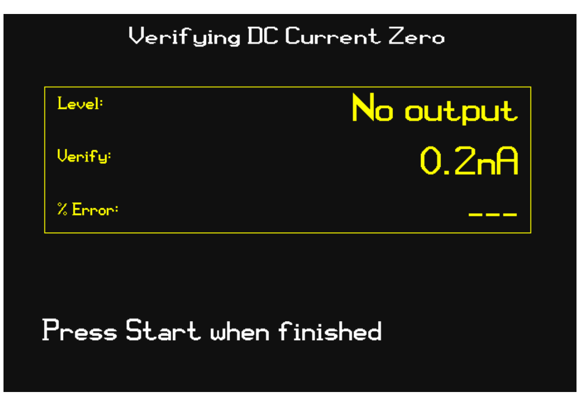
No connections to any terminals should be present during these steps. The product prompts for the DC current zero to be verified at a zero-output voltage level and at a 5000V output level.

Figure 14-19 DC Current Zero Verification Start Screen

CAUTION During this group the output terminals will be active with high voltage that could result in injury to or death of personnel.

After making sure the instrument's terminals have no connections the user should either –

- Press **Start** to perform the verification.
- Press **Stop** to abort the group.



During each step, the user should note the displayed current and record it, checking against the V10x specification of ±0.5nA. When the user is satisfied that the step has been completed, the user should press **Start** to continue or **Stop** to abort the group.

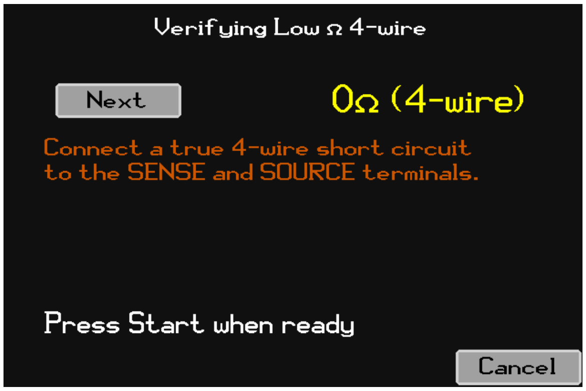
Figure 14-20 DC Current Zero Verification Screen

14.2.5 Low Ω

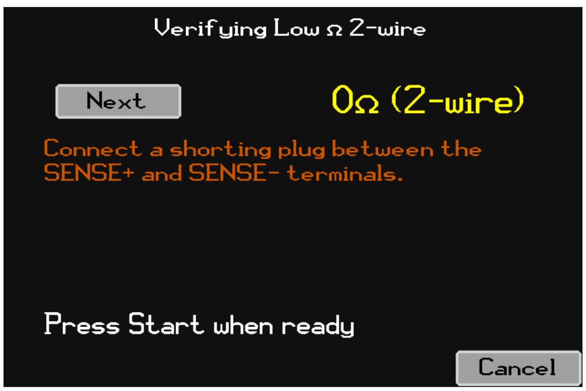
This group validates the instrument's capabilities to measure resistance. There are two subgroups for verifying low resolution resistance verification:

- Low Ω 4-wire
- Low Ω 2-wire

When verifying 4-wire resistance measurements the user is prompted with the first recommended level and a reminder on making connections to the resistance standard(s):



For the first point connect a true 4-wire short circuit to the SENSE and SOURCE terminals. For the remaining points connect the prompted value resistance standard to the SENSE and SOURCE terminals using the 4-wire connection method.



There is only one verification point. Connect a shorting plug between the SENSE+ and SENSE- terminals.

Figure 14-21 Low Ω 4-wire Verification Start Screen

The table below shows the listing of the resistances requested for verification and the V10x specification at each resistance value.

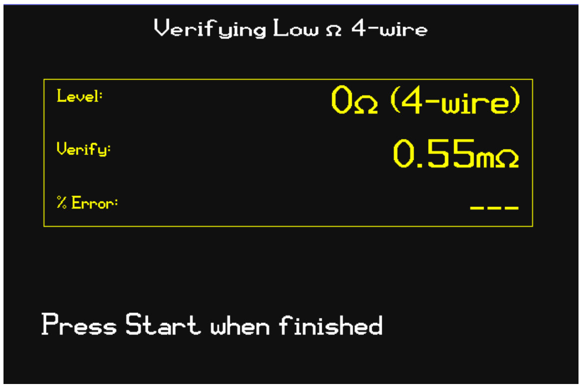
Table 14-3 Low Ω Verification Values

Resistance	V10xx Accuracy
100KΩ	±1.5% (1.5KΩ)
10KΩ	±0.8% (0.08KΩ)
100Ω	±0.8% (0.8Ω)
1Ω	±1% (10mΩ)
Zero Ω (4-wire)	±2mΩ
Zero Ω (2-wire)	±20mΩ

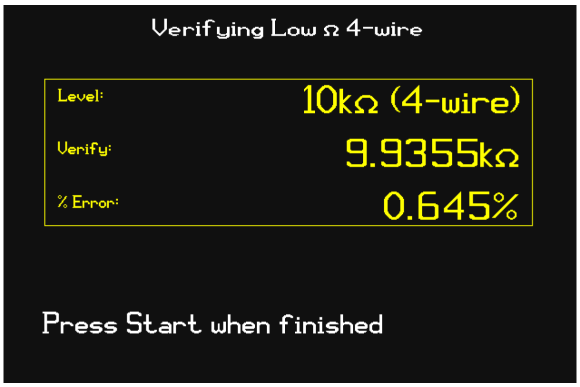
When prompted for each step the user should either –

- Press the **Start** switch to perform the verification.
- Press the **Stop** switch to abort the group.

When prompted for each step the standard resistance should be applied before pressing **Start**.



For the zero ohm point connect a true 4-wire short circuit to the SENSE and SOURCE terminals.

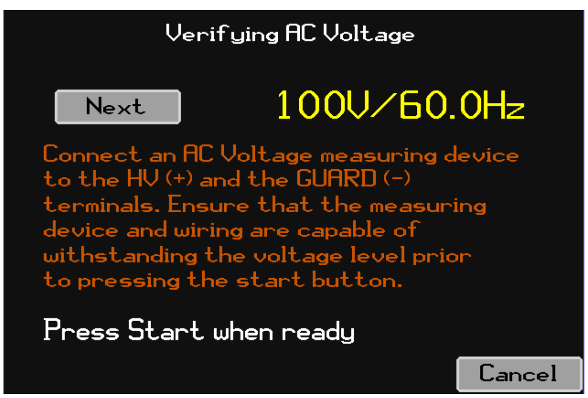


Connect the standard reference using the 4-wire connections.

Figure 14-22 Low Ω 4-wire Verification Screen

14.2.6 AC Voltage

This group validates the instrument's accuracy outputting high voltage AC. When selected the user is prompted with the first recommended level and a reminder on making connections to the measurement device:



During each step, the user should measure the actual voltage and record it, checking against the v10x specification. When the user is satisfied that the step has been completed, the user should press Start to continue or Stop to abort the sequence. The Internal display is shown for advanced user.

Figure 14-23 AC Voltage Verification Start Screen

CAUTION During this group the output terminals will be active with high voltage that could result in injury to or death of personnel.

The user should connect an AC Voltage measuring device (equipment #3 in the list above) to the **HV** (+) terminal and the **GUARD** (-) terminal of the v10x. While the v10x prompts whether to verify the voltage there is no unsafe voltages present so the user may safely make connections and configure the measurement device as needed. In some circumstances a different measuring device may be used depending on the voltage being measured.

CAUTION Ensure that the measuring device and wiring is capable of withstanding the voltage level prior to pressing the start switch at each step.

The table below shows a complete listing of the voltages and frequencies that may be requested for verification and the V10x specification at each level point:

Voltage Level/Frequency	V10x Models	V10x Accuracy
10000V/60Hz	V105 only	±0.515% (51.5V)
6000V/60Hz	All except V106, V109 and if option AC2 is not fitted	±0.525% (31.5V)
1900V/60Hz	All except V106, V109	±0.579% (11V)
1000V/60Hz	All except V106, V109	±0.65% (6.5V)
1000V/400Hz	All except V106, V109	±3.65% (36.5V)
300V/60Hz	All except V106, V109	±1% (3V)
100V/60Hz	All except V106, V109	±2% (2V)

When prompted for each step the user should either –

- Press **Start** to perform the verification (the output voltage will be present after pressing this switch).
- Press **Stop** to abort the group.

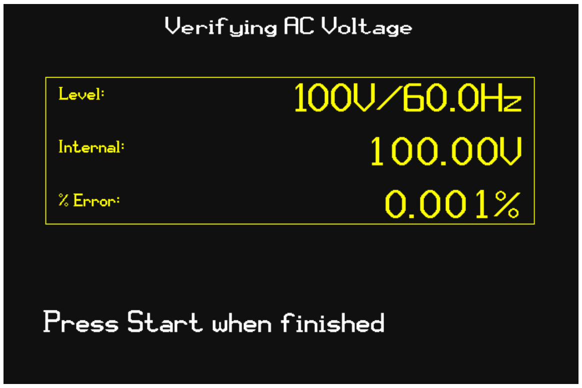


Figure 14-24 AC Voltage Verification Screen

During each step, the user should measure the actual voltage and record it, checking against the V10x specification. When the user is satisfied that the step has been completed, the user should press **Start** to continue or **Stop** to abort the sequence. The **Internal** display is shown for enhanced verification.

14.2.7 AC Current Zero

This group validates the instrument's ability to zero out component drift, temperature, and humidity when measuring AC current. When selected the user is prompted with the first recommended level and a reminder on making connections to the measurement device:

No connections to any terminals should be present during these steps. The test condition that will be verified is shown, the **Next** button will index through the test levels wrapping from last to first.

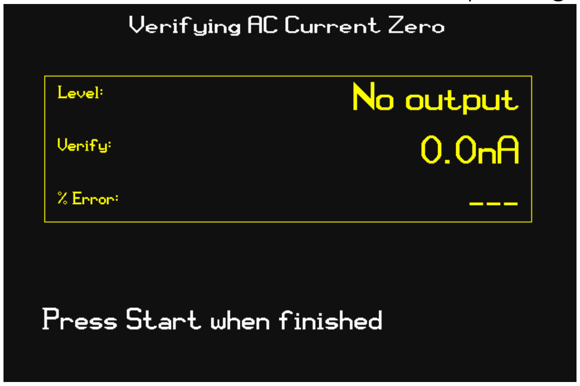
Figure 14-25 AC Current Zero Verification Start Screen

CAUTION During this group the output terminals will be active with high voltage that could result in injury to or death of personnel.

The following table lists the parameters for each verification step.

Table 14-4 AC Current Zero Verification Parameters

Voltage Level/Frequency/Parameter	V10x Models	V10x Accuracy
Zero/Zero/RMS	All except V106, V109	10nA
2000V/60Hz/RMS	All except V106, V109	28nA
2000V/60Hz/InPhase	All except V106, V109	±11.2nA
5000V/60Hz/RMS	All except V106, V109 and if option AC2 is not fitted	55nA
9000V/60Hz/RMS	V105 only	141nA



During each step, the user should note the displayed current and record it, checking against the V10x specification shown in the table above.

When the user is satisfied that the step has been completed, press **Start** to continue or **Stop** to abort the group.

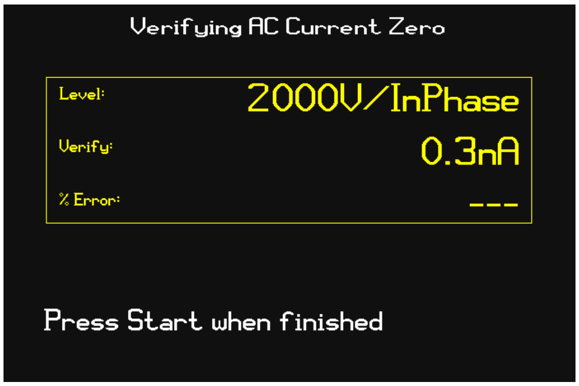
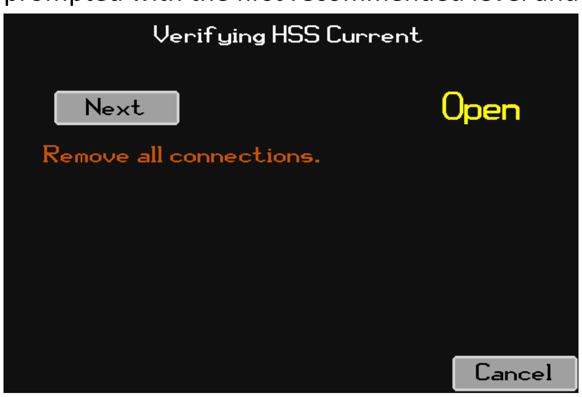


Figure 14-26 AC Current Zero Verification Screen

14.2.8 HSS Current

The HSS Current group validates the instrument's current measurement into a grounded DUT. When selected the user is prompted with the first recommended level and a reminder on making connections to the measurement device:



The test level that will be verified is shown, the **Next** button will index through the test levels wrapping from last to first.

Figure 14-27HSS Current Verification Start Screen

CAUTION During this group the output terminals will be active with high voltage that could result in injury to or death of personnel.

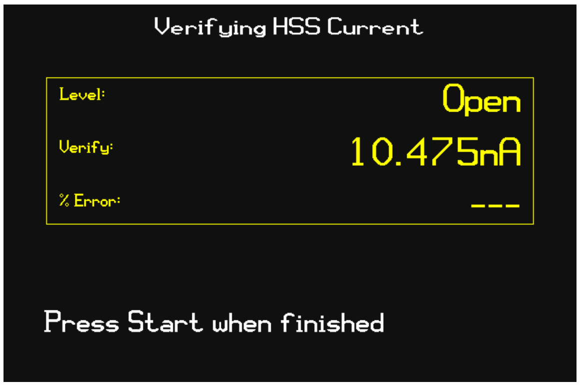
The first step in this series requires no external equipment, all V10x terminals should be disconnected. For the remaining steps in this series the user should connect the prompted value resistance (equipment #8 in the equipment list above) between the **HV** terminal of the V10x and the HI terminal of the milli-ammeter. The LO terminal of the milli-ammeter should be connected to the RETURN terminal of the V10x. The milli-ammeter is used to determine the actual load current, the V10x displays the value which it is measuring.

The table below shows the listing of the resistances requested for verification, the measurement current levels, and the V10x specification at each current level.

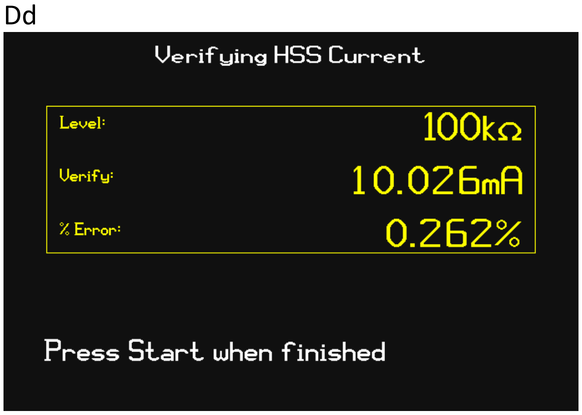
Table 14-5 HSS Current Verification Values

Resistance/Current	V10x Accuracy
Open/0uA	±0.05uA
100KΩ/10mA	±1% (0.1mA)
1MΩ/1mA	±1.005% (0.01005mA)
10MΩ/100uA	±1.05% (1.05uA)

- Press **Start** to perform the verification.
- Press **Stop** to abort the group.



Dd



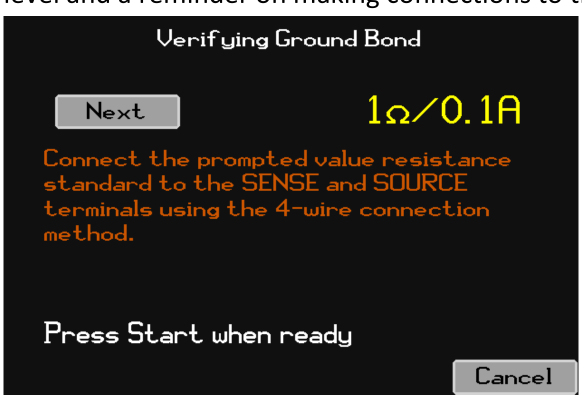
Except for the open connection, the user should note the displayed measurement on the V10x display and record the difference between this measurement and the milli-ammeter reading, checking against the V10x specification shown in the table above.

When the user is satisfied that the step has been completed, the user should press **Start** to continue or **Stop** to abort the group.

Figure 14-28 HSS Current Verification Screen

14.2.9 Ground Bond

This group validates the instrument's capabilities to perform the ground bond function. Note this operation is available only if the V10x is provisioned for ground bond testing. When selected the user is prompted with the first recommended level and a reminder on making connections to the measurement device:



The test level that will be verified is shown, the **Next** button will index through the test levels wrapping from last to first.

Figure 14-29 Ground Bond Verification Start Screen

The user should connect the prompted value resistance standard (equipment #7 in the equipment list above) to the **SENSE** and **SOURCE** terminals of the V10x using a 4-wire connection method. For all 4-wire connections the V10x internal current source is from the **SOURCE** terminals, and the voltage sense uses the **SENSE** terminals, ensure that the resistor is connected with the + terminals and – terminals correctly paired for a 4-wire measurement. The user should also ensure that the cabling to the **SOURCE** terminals of the V10x is capable of handling the measurement current shown. To reduce cross-coupling between the SOURCE and SENSE wiring, the user is recommended to use one twisted pair for the SOURCE connections and a separate twisted pair for the SENSE connections.

CAUTION During this group the output terminals will be active with dangerous voltage and current levels that could result in injury to or death of personnel.

CAUTION Ensure that the reference resistances and wiring are capable of withstanding the voltage and current levels prior to pressing the start switch at each step.

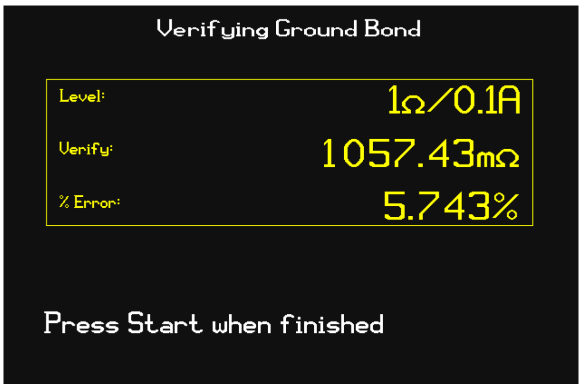
The table below shows the listing of the resistances requested for verification, the measurement current levels, and the V10x specification at each resistance value and current level.

Table 14-6 Ground Bond Verification Parameters

Resistance/Current	V10x Accuracy
1Ω/0.1A	±6.03% (0.0603Ω)
1Ω/1A	±1.5% (0.015Ω)
100mΩ/1A	±1.53% (1.53mΩ)
100mΩ/10A	±1.05% (1.05mΩ)
50mΩ/25A	±1.02% (0.51mΩ)

When prompted for each step the user should either –

- Press **Start** to perform the verification (the output current will be present after pressing this switch).
- Press **Stop** to abort the group.



During each step, the user should note the displayed resistance measurement on the V10x display and record it, checking against the V10x specification shown in the table above.

When the user is satisfied that the step has been completed, press **Start** to continue or **Stop** to abort the group.

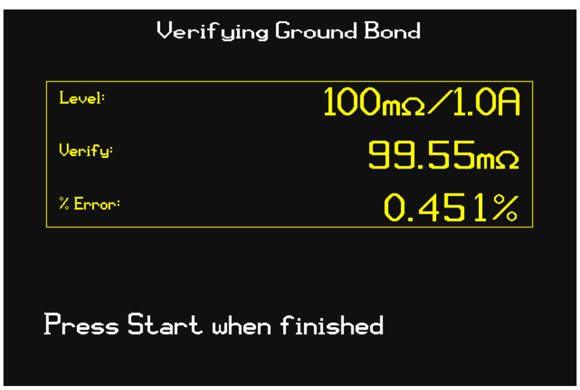


Figure 14-30 Ground Bond Verification Screen

14.3 Calibration Point Fault

Some of the calibration points might fail. When that occurs an error code is shown below the status rectangle:

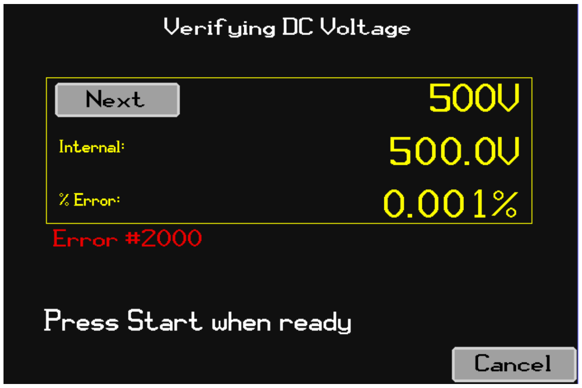


Figure 14-31 Calibration Error Example

The error code is hexadecimal, see Table 12-31 to identify the error condition.

15 WEB Browser Interface

The instrument series operates a web server providing powerful tools for configuration, status, and control:

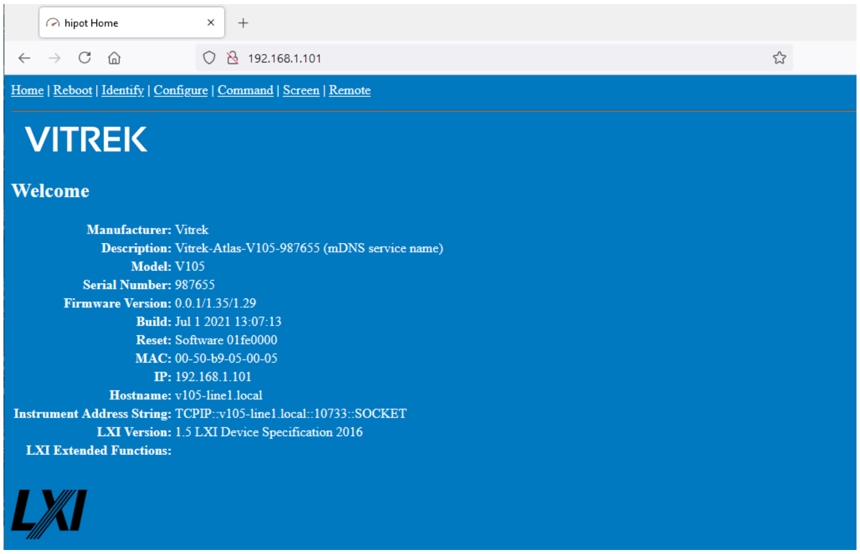
- Realtime clock setting
- LAN configuration settings
- Setting the username and password
- Instrument command
- Remote presence

The applications that can configure and control the unit are password protected. The username and password can be changed (see the configuration section below). The username and password will, however, be reset to the factory defaults if the front panel is used to execute the LAN Reset function.

The factory default username is ***hipot***, the factory default password is ***elephant***.

To access the web interface, you must know the unit's mDNS name or IP address. To use the IP address, navigate to the System->About screen:

Type that IP address into your browser's location bar:



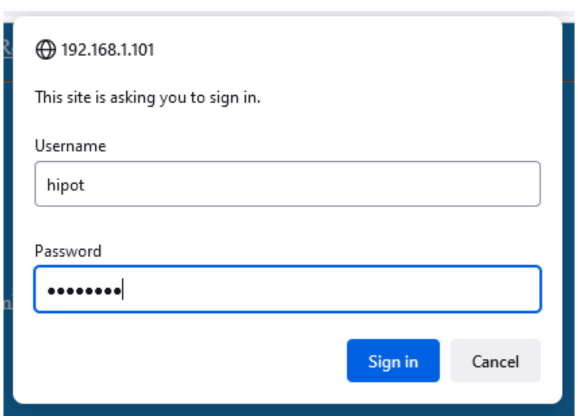
The V10x presents the Home page – aka the Welcome page. You will see a menu bar at the top and basic device information.

Most of the menu bar links require the user to authenticate by entering a username and password. Many browsers will prompt to remember the credentials, it is the user's choice as to whether or not to save the credentials.

For example: presume you click on the **Configure** link, you will be prompted to enter a username and password.

NOTE How the user name and password are requested is dependent on the browser and browser version, the following example is from Firefox version 89.0.2.

This illustration uses the factory defaults:



You will enter the credentials and click on OK.

NOTE If you use Cancel too many times the browser may stop trying to load the page and you will have to force a reload using control-F5.

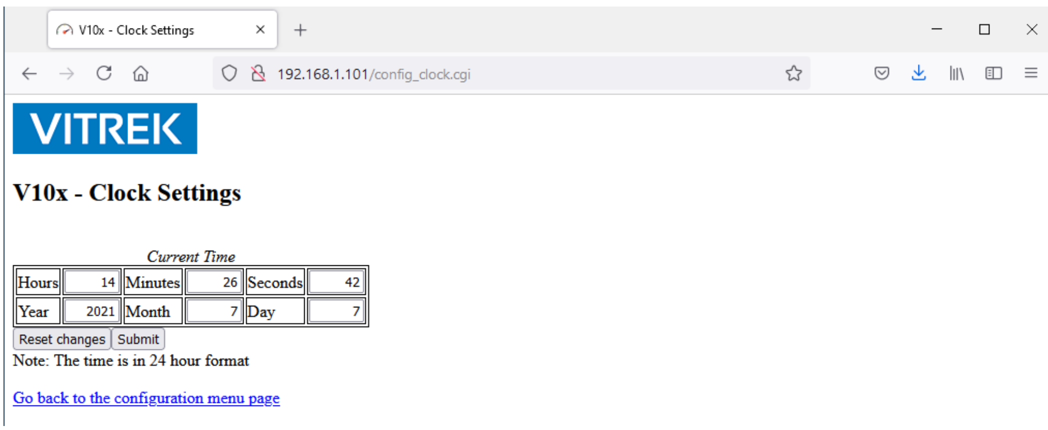
Most browsers will automatically send the credentials in the background. If more than five minutes passes between challenges you will have to type the credentials.

Reboot

Use this command to cause the V10x to restart as if the power was cycled.

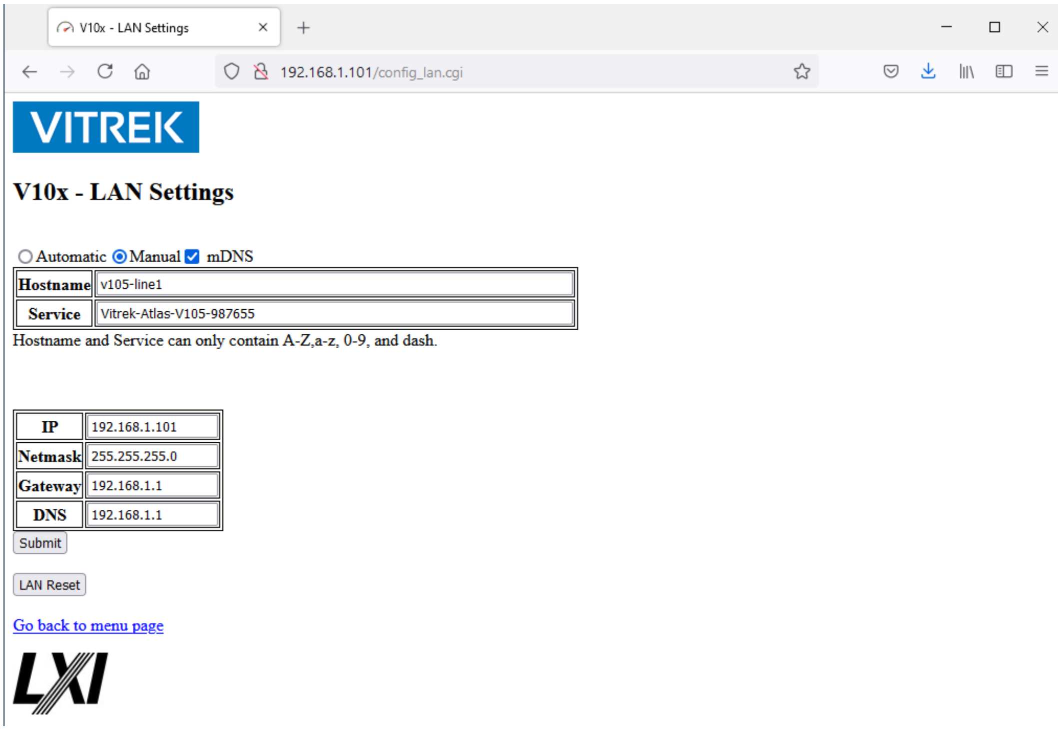
Configuration Menu

Clock



Use this page to set the instrument's real time clock.

LAN Settings



The LAN interface can be configured to use an automatic or manual configuration. You must have at least one of DHCP or Auto-IP enabled. Check the **Manual** radio button to configure manually.

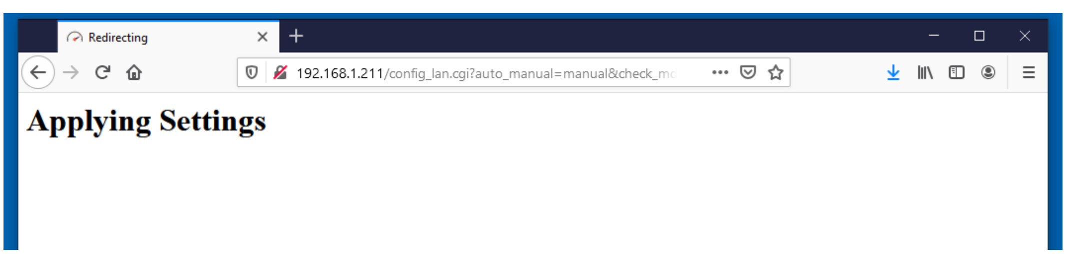
Press the **Submit** button to save the LAN configuration.

NOTE Your changes may affect the IP address you are presently using to access the unit.

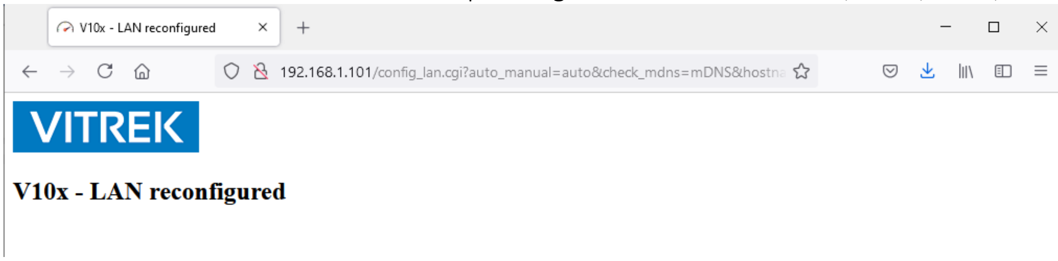
If you typed a blank hostname or service name the factory default will be applied as necessary. The character set available for the names is restricted to those allowed for internet naming.

The **LAN Reset** button can be used to reset the network interface settings to the factory defaults excepting the host and service names. The web username and password will also be restored to the factory defaults.

When the **Submit** or **LAN Reset** buttons are pressed the settings are saved and the interface is configured, the web page will change to:

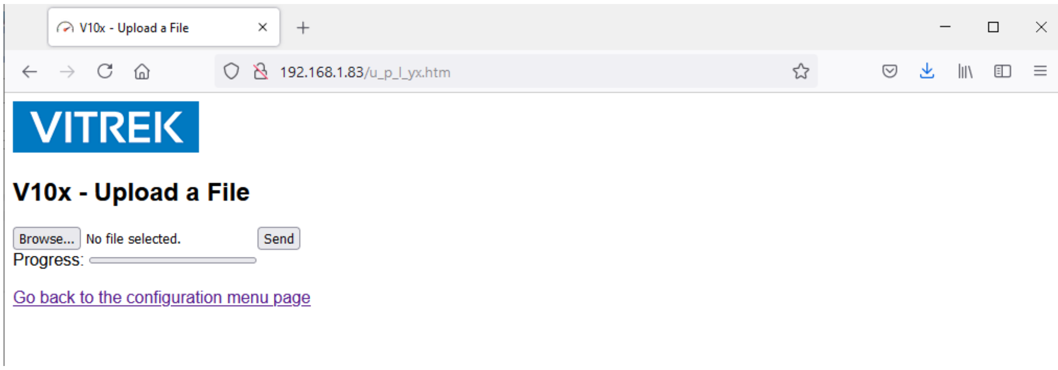


If the address is static the page will redirect to the main configuration page after a few seconds. If the address is changed from manual to dynamic the page will show:



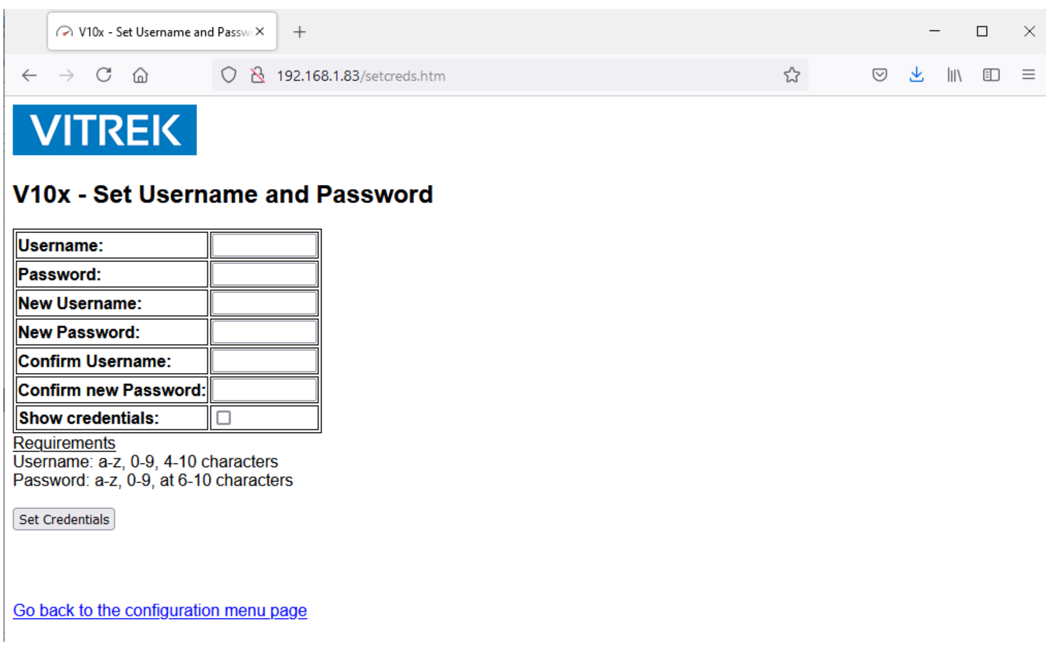
You will have to determine the new address from the unit's display and enter it into the location bar.

Upload



You can use this facility to install firmware updates or custom configuration files. You click on **Browse** to active the native browser's file navigation mechanism to select the file, then click on **Send** to upload the file.

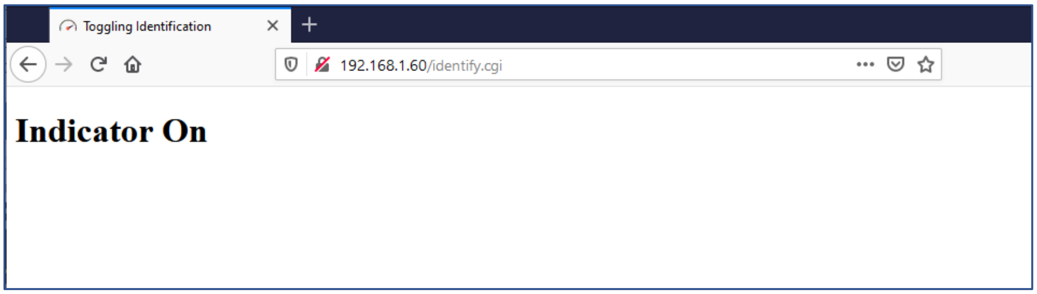
Set Password



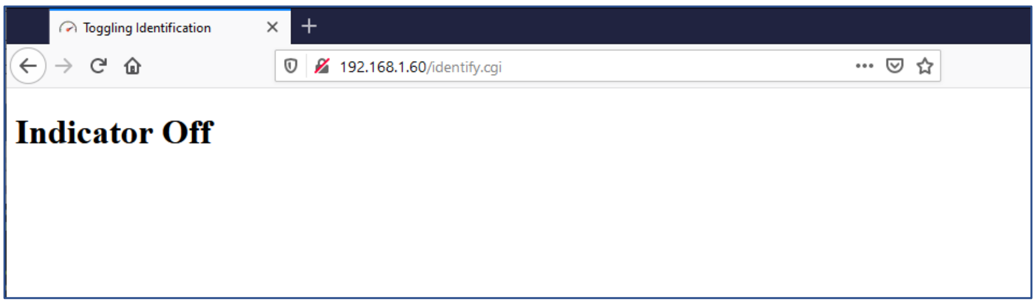
You can use this tool to change the access credentials. You will have to type the present username and password, the new username and new password twice, then click on **Set Credentials** to update the information in the V10x.

Identify

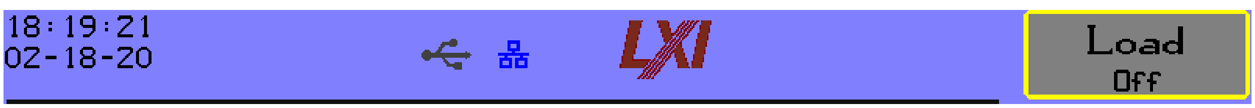
This link toggles the identity indicator visible on the front panel status bar. The browser will briefly display a status message showing if the indicator is now on or off:



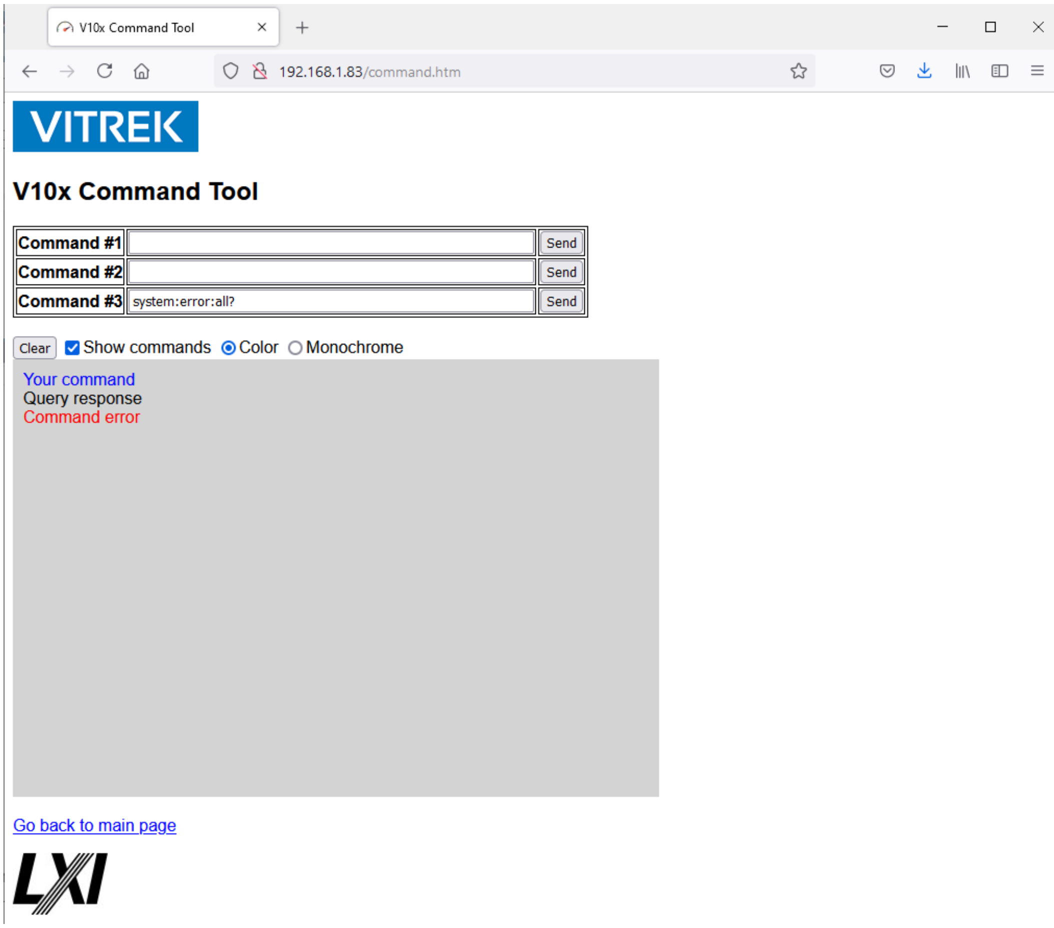
OR



On the V10x the LXI logo found on the status bar will flash between its normal and a reddish color:



Command



This applet allows interface commands to be issued to the unit, any command response is show below. When the page loads it shows the color coding that will help discriminate commands and responses. The user can use the radio buttons to select Color or Monochrome text in the history area. When Monochrome is selected the formatting looks like:

Your command
Query response
Command error

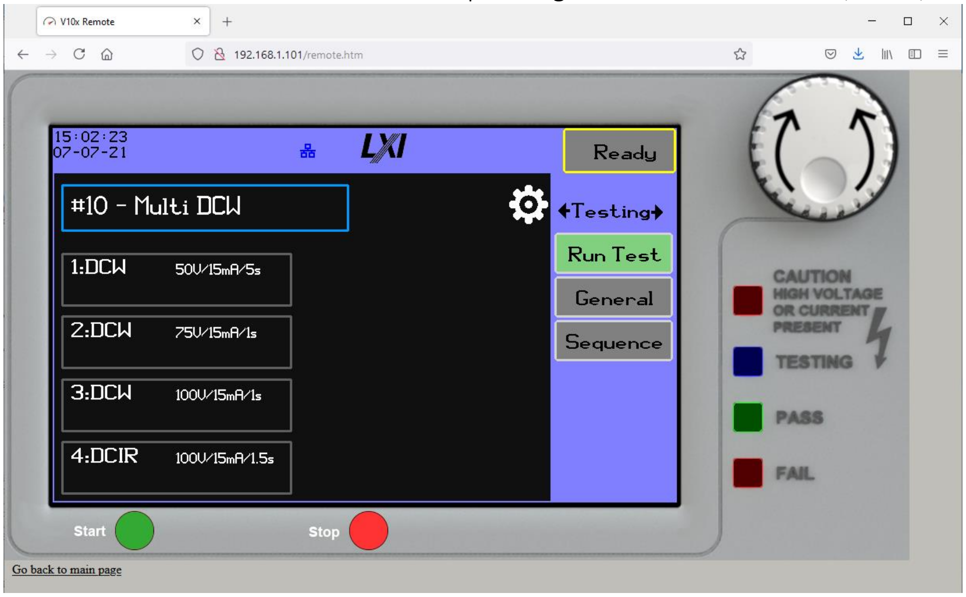
The "system:error:all?" command is placed into command #3 as a convenience.

The user should be familiar with the command set. When commands are issued the unit will apply a command lock on the front panel interface that will end in 60 seconds if no other commands are issued. As long as commands are being issued the lock timer is pushed out 60 seconds.

Screen

This link shows a screen capture of the present contents of the front panel display. It is an 800x480 png image. You can use your browser functions to save the image if you wish.

Remote



This applet allows full control over the unit as if the user is interacting with the front panel. The screen image is updated once per second, more often if the user is clicking on the virtual screen or manipulating the dial.

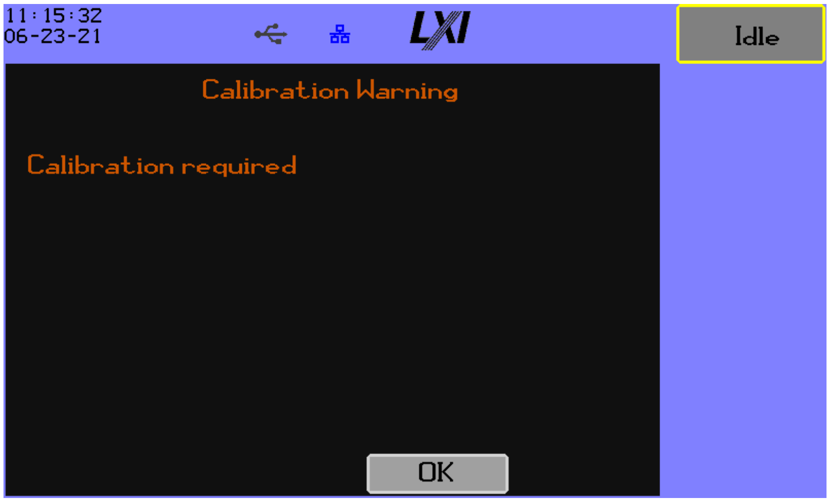
A mouse clock on the screen image acts like a touch to the front panel. Click on the center of the dial to issue a button press, click on the left side of the dial to rotate clockwise, click on the right side of the dial to rotate counterclockwise.

Click on the Green Start button image to emulate a press of the physical Start button, click on the Red Stop button image to emulate the physical Stop button. The start button must be enabled in the system configuration, see section 10.2.1.

16 Troubleshooting

16.1 Calibration

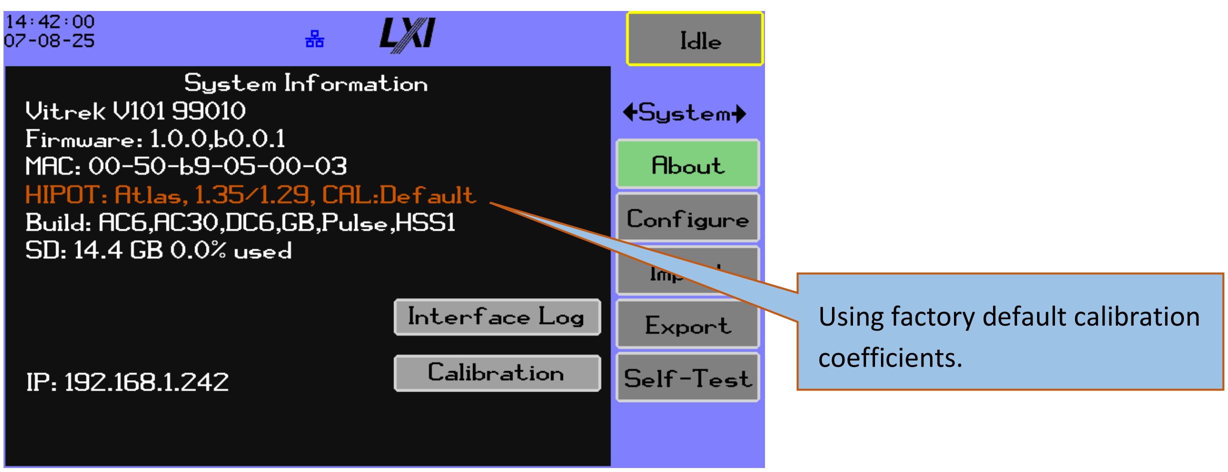
If for any reason the calibration data has been corrupted, when the instrument is powered on it will show a Calibration Warning screen:



There are four calibration warning states:

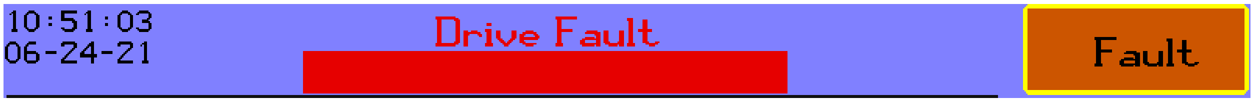
- Calibration unavailable
- Calibration uninitialized
- Calibration needs Self-Test
- Calibration required (illustrated above)

External adjustment calibration is required. See section 14 for complete details. The calibration status of the instrument can be viewed on the System->About screen, the information is highlighted below:



16.2 Critical Faults

A critical fault may occur if the loading circuitry is damaged by overheating, high voltages, component failure, or otherwise. The fault is illustrated below:



16.3 Warnings

A critical fault may occur if the loading circuitry is damaged by overheating, high voltages, component failure, or otherwise. The fault is illustrated below:

A. LAN Presence

The instrument series complies with LXI (LAN eXtensions for Instrumentation) Version 1.5 LXI Device Specification 2016. In addition, it has the extended functionality supporting the VXI-11 Discovery and Identification Extended Function. In combination with mDNS service discovery the IP address of the instrument can be easily ascertained without having to browse the local display.

Addressing

Depending on the settings discussed in section 4.3 the LAN interface's configuration is dynamic, automatic, or manual.

When the LAN status indicator is blue then the V10x is properly configured.

Naming

NOTE The instrument's factory name takes the form *MODEL-SN* where *MODEL* is the instrument's model and *SN* is the serial number, for example V102-020304. The factory service name is in the form Vitrek-MODEL-SN, for example: Vitrek-V102-020304.

After the interface has an address, the instrument will attempt to determine its name on the network. If the manual configuration has a DNS address or the addressing is dynamic the V10x will use reverse DNS, then forward DNS to validate the hostname; if the DNS server provided a hostname that matches the IP address then the unit advertises that name on the welcome page.

NOTE The V10x will still respond to mDNS lookups if the feature is enabled. It is recommended that mDNS remain enabled – it has been observed that some Windows configurations will not actually use DNS to lookup a name, instead relying on NBNS then mDNS. Contact your IT administrator to resolve these issues.

If the DNS query is not satisfied the V10x will present the mDNS local name on the welcome page if the configured name did not conflict with another device on the network or the conflict could be resolved – see below.

In the event DNS lookup failed or mDNS was not enabled or could not be resolved the V10x will show the IP address on the welcome screen.

mDNS Conflict Resolution

Conflicts with mDNS names and services are resolved during the probing phase. If the conflicts cannot be resolved the V10x will not enable mDNS. The conflicts are resolved by appending a suffix in the form "-N" where the N is a number in the range 2 through 9.

To illustrate how the resolution occurs here is an example.

Presume a lab with two V10x instruments deployed for testing, and you want the name and service to relate to the work at hand. You intend to name the first as "lab-V101-ps" and the second "lab-V101-panel" but name them both "lab-V101-ps". You power up the first then the second, the second detects the naming conflict and adopts "lab-V101-ps-2" and until reconfigured will use that name. Service naming works in the same way.

Services and Protocols

The V10x utilizes and supports the following protocols.

- The DHCP Protocol (only if configured to use DHCP).

- The ARP protocol (only to ensure the uniqueness of its own IP address, and as necessary to confirm the presence of the computer which has a TCP/IP socket established to the V10x, the V10x does not arbitrarily generate ARP requests).
- The ICMP reception of a 'ping' and the transmission of its response (it cannot generate a 'ping').
- mDNS if enabled in the LAN configuration. It will respond to type A queries containing its name with the .local suffix; it will respond with its service name to PTR queries for _lxi._tcp.local or _http._tcp.local.
- The instrument will respond to VXI-11 Discovery requests with the command TCP/IP port number – 10733.
- The instrument has a web server on TCP/IP port 80 and provides pages for status, command, and configuration.
- Transfer of ASCII data from the V10x to a computer using the TCP/IP protocol to which it has a TCP/IP socket established only when and as directed by that computer (only a single socket is allowed by the instrument). Data transmitted from the V10x can only be configuration information, measurement results, and measurement status information. These are all non-broadcast datagrams, so in a well-designed network these datagrams will not be transmitted beyond the connection between the computer and the V10x.

The instrument does not support:

- Communications with a computer with which it does not have a TCP/IP socket established (which can only be established by the computer, not by the V10x).
- Reception of any broadcast requests other than DHCP (only if enabled), ARP, mDNS (only if enabled), and VXI-11 discovery; all other received broadcasts are silently ignored.
- Transmission of any broadcast packets other than DHCP (only if enabled), mDNS (only if enabled), and ARP (only as required to ensure the uniqueness of its own IP address).
- Network management protocols such as SNMP, SSDP, LLDP, SDP, CDP etc., or routing protocols such as RIP etc.
- Any 'file system', NETBIOS, or similar protocols.
- POP, SMTP, IMAP, or similar protocols which might establish a connection to another computer.

B. Switch Matrix Integration

The V10x series can be integrated with Vitrek high voltage switches using a variety of physical interfaces as listed in the following table:

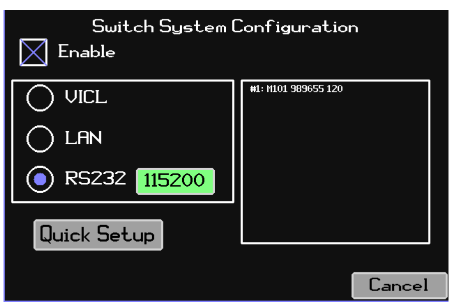
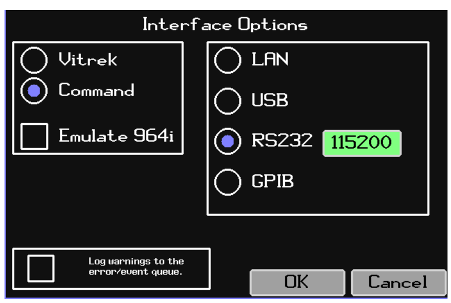
Interface	**Maximum Number of Switch Units**
RS232•	1 model 964i or M10x
VICL	4 model 964i 252 model M10x
LAN	Model M10x only limited by the network address space

•Your V10x must have the RS232 interface option.

The following illustrations are intended to be a quick reference for configuring the instruments, refer to the respective manuals for complete details.

RS232

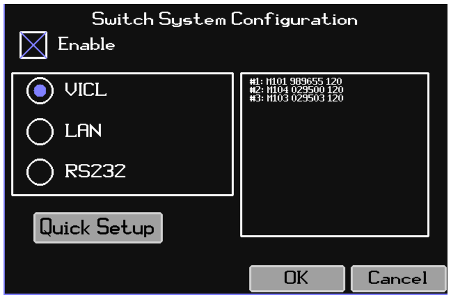
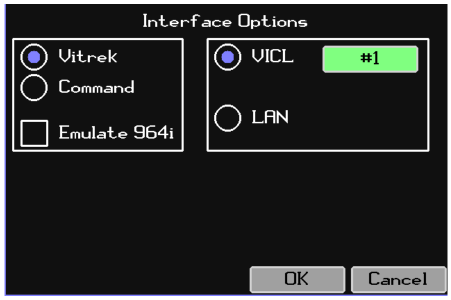
Using a RS232 cable supplied by Vitrek, connect the RS232 port on the V10x rear panel to the RS232 port of the Vitrek 948i or M10x. The user may supply their own cable, in which case it should be a 9-wire female-female null modem cable capable of full handshake 115200baud operation.

<table>
<tr><td>V10x</td><td>M10x</td><td>964i</td></tr>
<tr><td>
</td><td>
</td><td>CONFIGURE INTERFACE
RS232 115200baud</td></tr>
</table>

VICL

Using a VICL cable supplied by Vitrek, connect the VICL – OUT port on the V10x to a Vitrek 964i or M10x VICL – IN port. If using more than one switch, then connect each additional VICL – IN port to the preceding VICL – OUT port. The switches do not need to be wired together in any specific order when using the VICL interface.

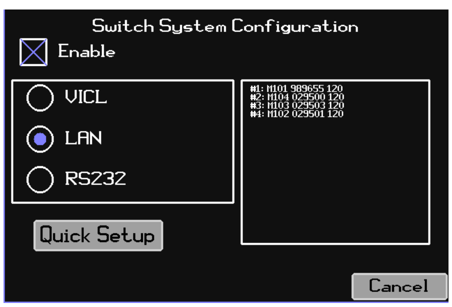
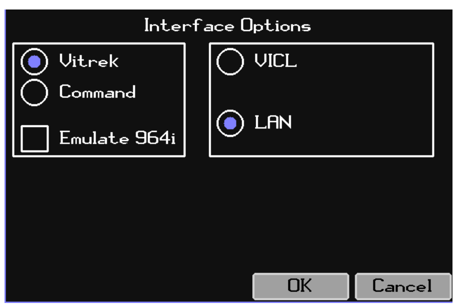
NOTE Remember to assign the VICL addresses in sequence.

V10x	M10x	964i
		**CONFIGURE INTERFACE** **VICL Addr 1**

LAN

Connect the Ethernet ports on all the instruments to a properly configured Ethernet switch or router. Make sure all instruments are indicating positive LAN status as discussed in Table 4-3.

NOTE The switches should have static addresses so the settings only have to be done once. See section 10.2.5.2 for details.

V10x	M10x	964i
		Not supported

C. Barcode Scanner Integration

The V10x allows use of a barcode scanner that complies with the USB HID class specification version 1.11. Only devices with a single interface are supported.

The barcode scan pattern is a string that contains a minimum of the two required type codes and a delimiter. There must be termination character that is either carriage return or linefeed. The symbol can have the termination character, or the barcode scanner must be configured to add the termination character. Multiple terminators will cause symbol scanning to malfunction.

The two type codes are expressed as:

%M Represents the sequence name and is usually associated with a model.

%L Represents the test label and is usually associated with a serial number.

A question mark in the symbol matches any character, matching characters in the symbol string are skipped when forming the results.

A quite simple scan pattern would be '%M-%L' that would allow scanning of these examples:

Symbol String	Sequence Name (model)	Test Label (serial number)
VM100A-SN0102AB	VM100A	SN0102AB
MyModel-MySerial	MyModel	MySerial
X2000-987665	X2000	987665

Note that case is ignored in the scanning process. The literal dash separates the components.

A somewhat more complicated scan pattern would be 'SEQ%S,MMDD%L;19'; observe that the comma terminates the sequence name and must not be a valid character for the sequence name, the semi-colon terminates the label in the same way. Example symbols and the extracted strings:

Symbol String	Sequence Name (model)	Test Label (serial number)
SEQVM100A,MMDDSN0102AB;19	VM100A	SN0102AB
SEQMyModel,MMDDMySerial;19	MyModel	MySerial
SEQX2000,MMDD987665;19	X2000	987665

Now presume the MMDD above is actually a production date code that is numeric, such as 'SEQVM100A,0722SN0102AB;19'. The proper pattern then would be 'SEQ%M,????%L;19'.

The following example shows how the wildcard '?' marks character positions, and the label is first then followed by the model: ''??????????%L#??????%M????'; there is still literal marker required.

Symbol String	Sequence Name (model)	Test Label (serial number)
ABCDEFGHI-SN0102AB#123456VM100A99AA	VM100A	SN0102AB
ABCDEFGHI-MySerial#123456MyModel99AA	MyModel	MySerial
ABCDEFGHI-SN0102AB#123456X200099AA	X2000	987665

D. CSV File Format

This description presumes the 'Trim CSV' option was off.

Row 1 – Instrument Identification:

A. Literal 'Model:'
B. Instrument model
C. Literal 'Serial Number:'
D. Instrument serial number
E. Literal 'Firmware:'
F. Instrument firmware revision code

Row 2 – Sequence Information:

A. Literal 'User:'
B. User name (Anonymous if user security is not enabled)
C. Literal 'Performed:'
D. Sequence execution date and time
E. Literal 'Sequence:'
F. Sequence number
G. Literal 'Name:'
H. Sequence name
I. Literal 'Label:'
J. The sequence label, defaults to the run number
K. Literal 'Run:'
L. The run number
M. Literal 'Result:'
N. **Pass** or **Fail**
O. Literal 'Flags:'
P. The sequence result flags, a logical or of the values listed in Table 12-31

Row 3 – Step detail headings

A. Step #
B. Type
C. Result
D. Period
E. Flags
F. Final test level
G. Final test frequency
H. Highest breakdown
I. Highest voltage
J. Highest 1st check
K. Lowest 1st check
L. Average 1st check
M. Last 1st check
N. Highest 2nd check
O. Lowest 2nd check
P. Average 2nd check

Q. Last 2nd check
R. Highest arc current
S. Lowest arc current
T. Average arc current
U. Last arc current

Row 4-N:

Step details organized to match the headings.

E. Sample Reports

Visit https://vitrek.com/V10X-series-hipot-testers/ to download the full PDF examples.

The following samples are not intended to representative of production testing; they show formatting allowing the user to select options that best fit their needs. I mix of all supported test steps was used:

1) Switch
2) ACW
3) ACCAP
4) Pause
5) ACI
6) DCW
7) DCIR
8) DCI
9) Hold
10) BRKDN
11) Hold
12) Low Ohms
13) GB

All report formats use a common heading that looks like:

Vitrek 10x Test Report (Brief)	**Sequence:9**	Page 1
Model:V101 Serial Number:099008 Firmware:1.0.0	**Name:My Test**	
Operator:Anonymous	**Label:#12**	
Test time:05-28-25 15:58:32	**Run:12**	
Passed all tests	**Flags:0x000000**	

Brief

The brief report has a column heading on each page followed by a single line of information for each step:

Step #	Type	Result	Flags	Information
1	Switch for 327ms	Passed	0x000000	
2	ACW 110.0V/60Hz for 5s	Passed	0x000000	RMSA Average:1.1836uArms QUADO Average:211.57MΩ qua
3	ACCAP 220.0V/60Hz for 5s	Passed	0x000000	Cap. Average:0.0nF Dis. Average:0.9215DF
4	Pause for 5.079s	Passed	0x000000	
5	ACI for 5.04s	Passed	0x000000	Arms Average:0.0739uArms
6	DCW 155.0V for 5.02s	Passed	0x000000	Amps Average:1.5503uA
7	DCIR 125.0V for 5.02s	Passed	0x000000	Ohms Average:99.971MΩ
8	DCI for 5.02s	Passed	0x000000	Amps Average:0.0010uA
9	Hold for 5.576s	Passed	0x000000	
10	BRKDN for 13.04s	Passed	0x000000	Max voltage:325.03V Max current:7.7224uApk
11	Hold for 5.765s	Passed	0x000000	
12	Low Ohms for 10.02s	Passed	0x000000	Ohms Average:1.0043Ω
13	GB 1.0A/60Hz for 5s	Passed	0x000000	RMSV Average:1Vrms

In the event a step fails the informaton line will show the error details.

Standard

ACW and ACCAP are special cases as they support two limit checks.

Step # 2	ACW 110.0V/60Hz for 5s	Passed Final level:110.011V Final frequency:60Hz Highest breakdown:1.699455uApk RMSA Last:1.1848uArms Max:1.1915uArms Min:1.1811uArms Avg:1.1836uArms QUADO Last:211.25MΩ qua Max:212.22MΩ qua Min:210.89MΩ qua Avg:211.57MΩ qua
Step # 3	ACCAP 220.0V/60Hz for 5s	Passed Final level:220.0109V Final frequency:60Hz Highest breakdown:3.517169uApk Cap. Last:0.0nF Max:0.0nF Min:0.0nF Avg:0.0nF Dis. Last:0.9215DF Max:0.9217DF Min:0.9214DF Avg:0.9215DF

Detailed

All step settings and results are included.

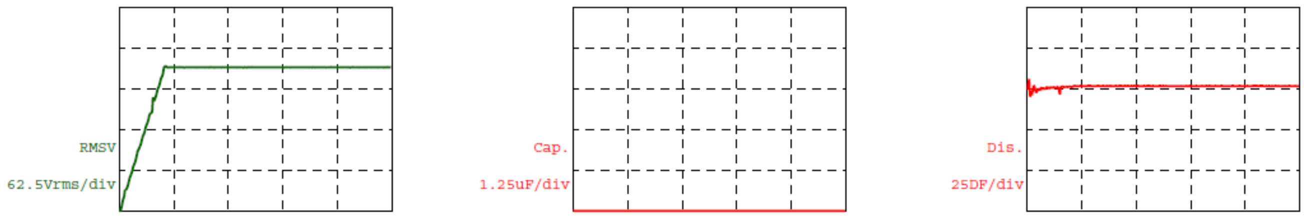
Step # 2	ACW 110.0V/60Hz for 5s Ramp:1s Fast discharge RMSA 0Arms to 10mArms QUADO 10MΩ qua to 2000MΩ qua	Passed Final level:110.011V Final frequency:60Hz Highest breakdown:1.699455uApk RMSA Last:1.1848uArms Max:1.1915uArms Min:1.1811uArms Avg:1.1836uArms QUADO Last:211.25MΩ qua Max:212.22MΩ qua Min:210.89MΩ qua Avg:211.57MΩ qua
Step # 3	ACCAP 220.0V/60Hz for 5s Ramp:1s Fast discharge Cap. 0F to 1.1nF Dis. 0DF to 0.95DF	Passed Final level:220.0109V Final frequency:60Hz Highest breakdown:3.517169uApk Cap. Last:0.0nF Max:0.0nF Min:0.0nF Avg:0.0nF Dis. Last:0.9215DF Max:0.9217DF Min:0.9214DF Avg:0.9215DF

Detailed+Wide Charts

This option carries the same text as the Detailed report above plus up to three charts on a single row; ACCAP will always show 3, DCW 2, GB 2, Low Ohms 1.

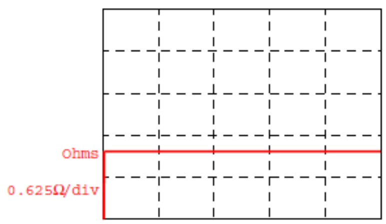
Step # 3 ACCAP 220.0V/60Hz for 5s
Ramp:1s Fast discharge
Cap. 0F to 1.1nF
Dis. 0DF to 0.95DF

Passed
Final level:220.0109V
Final frequency:60Hz
Highest breakdown:3.517169uApk
Cap. Last:0.0nF Max:0.0nF Min:0.0nF Avg:0.0nF
Dis. Last:0.9215DF Max:0.9217DF Min:0.9214DF Avg:0.9215DF



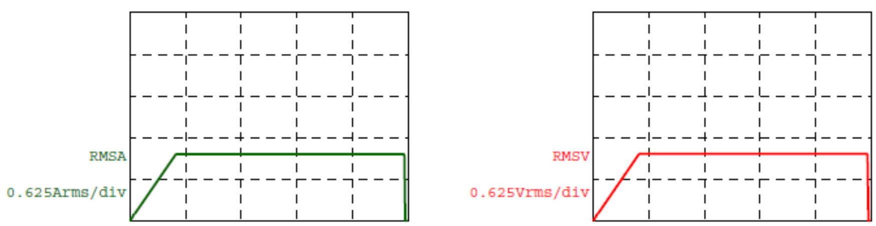
Step # 12 Low Ohms for 10.02s
Check Delay: 0s 4-wire
0Ω to 1.75Ω

Passed
Ohms Last:1.0043Ω Max:1.0043Ω Min:1.0042Ω Avg:1.0043Ω



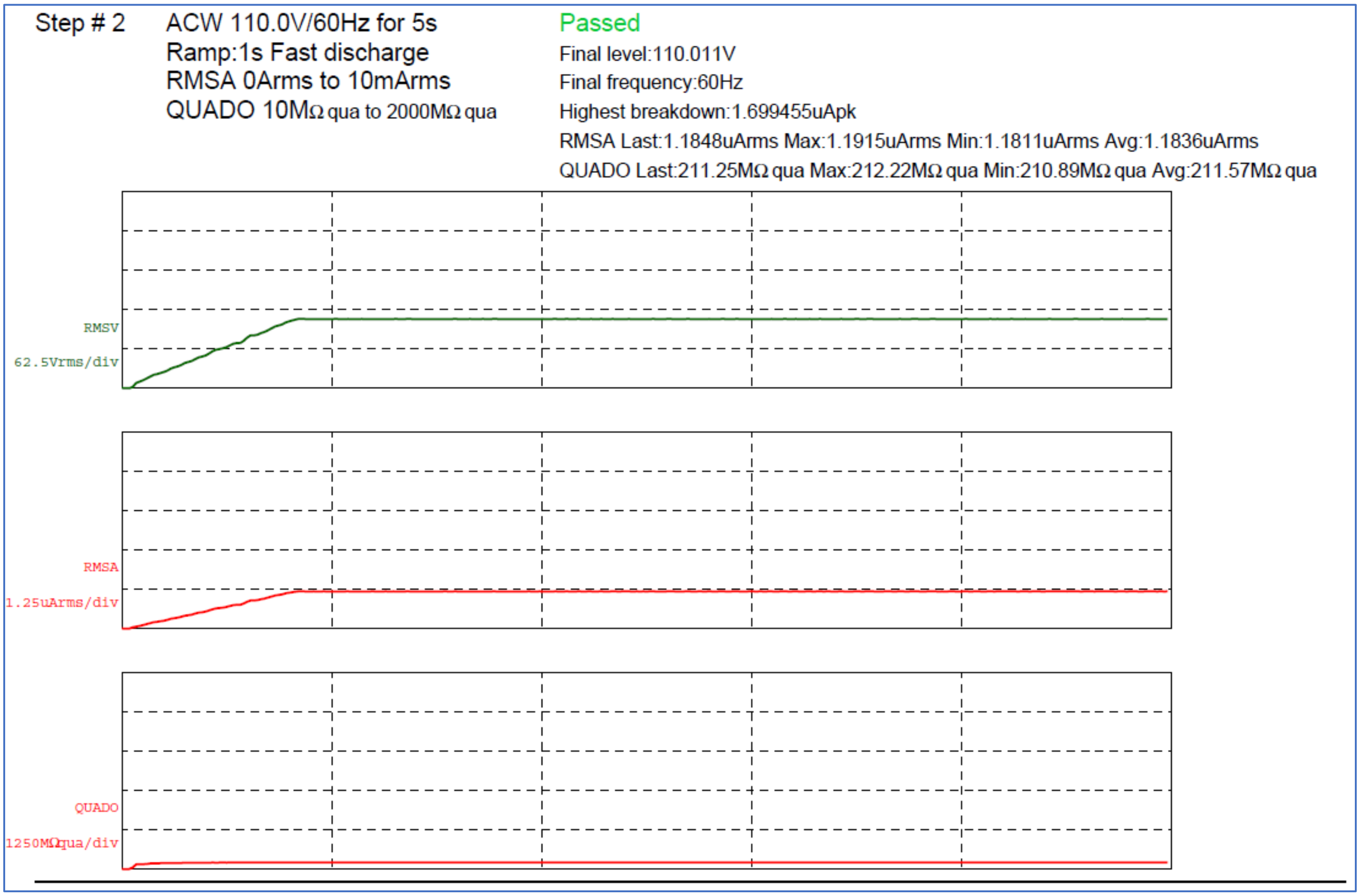
Step # 13 GB 1.0A/60Hz for 5s
Ramp:1s Fast discharge
RMSV 0Vrms to 1.1Vrms

Passed
Final level:1A
Final frequency:60Hz
RMSV Last:1Vrms Max:1Vrms Min:1Vrms Avg:1Vrms



Detailed+Tall Charts

This option carries the same text as the Detailed report above plus up to three charts stacked vertically.



F. Security Recovery

In the event the instrument was configured with access security enabled and the configured credentials have been forgotten there is a recovery process that requires a call to Vitrek customer support.

Presume that you are faced with the log in screen discussed in section 4.3 and your credentials are not working, or the credentials you have available do not provide the necessary access level.

After entering the user name enter a password of *3456789* and touch **Log in**.

The display shows the serial number and a challenge code:

Call Vitrek at the phone number shown and ask for V10x security recovery support. Tell them the serial number and challenge code, they will reply with a recovery code which you enter and touch **OK**.

You will be granted access to the instrument with all permissions available. Immediately navigate to System->Configure->Security and enter proper credentials or otherwise modify the security settings as necessary.

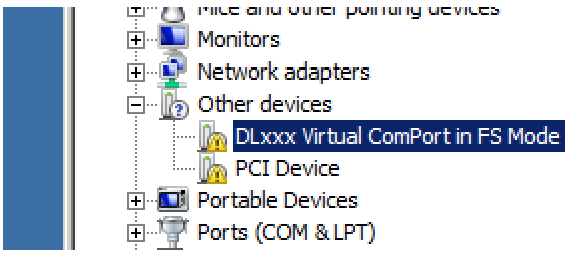
If you are not granted access you did not enter the code properly, repeat the process.

G. Installing Virtual COM Ports on Windows Variants

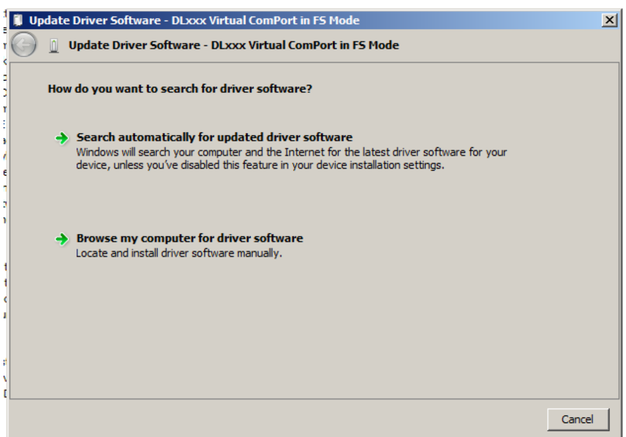
The necessary Windows inf files are provided on the CD shipped with the instrument. If necessary, you can visit https://vitrek.com/V10x-series-hipot-testers/ to download the necessary files.

Windows 7

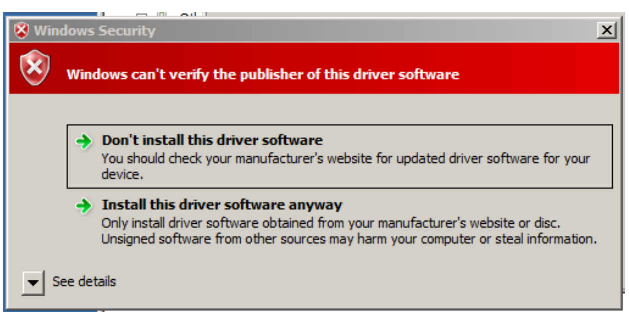
When the USB cable is connected between the instrument and PC, the PC may show a pop-up indicating that driver software is being installed. Let it complete the process and state the driver was not installed or cancel it. Open Windows Device Manager and look for the **FIXME Virtual ComPort**:



Right click on the ComPort and select Update Driver. On the dialog that opens select Browse my computer for driver software:



Browse to **\vcp\win7** on the CD (or where you downloaded and extracted the driver files) and click on Next. A warning dialog appears:

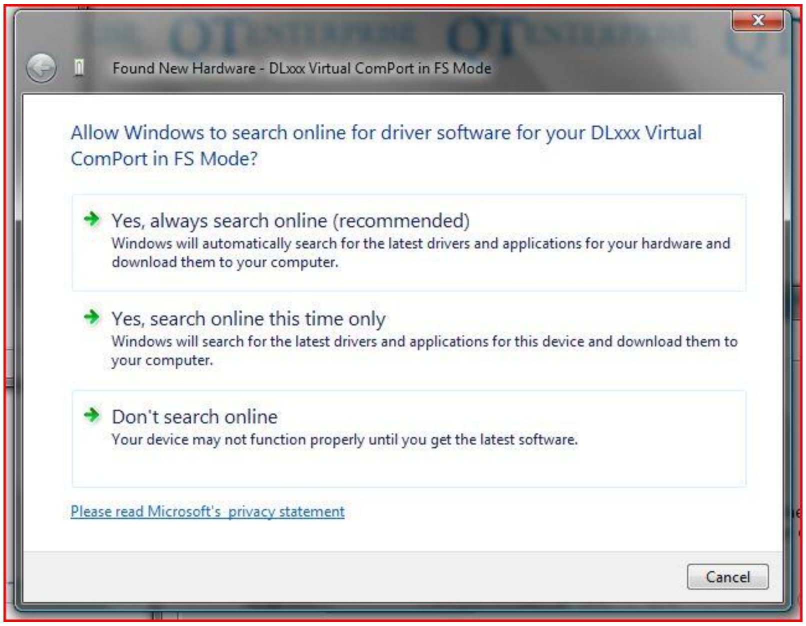


Select **Install this driver software anyway**, you are done.

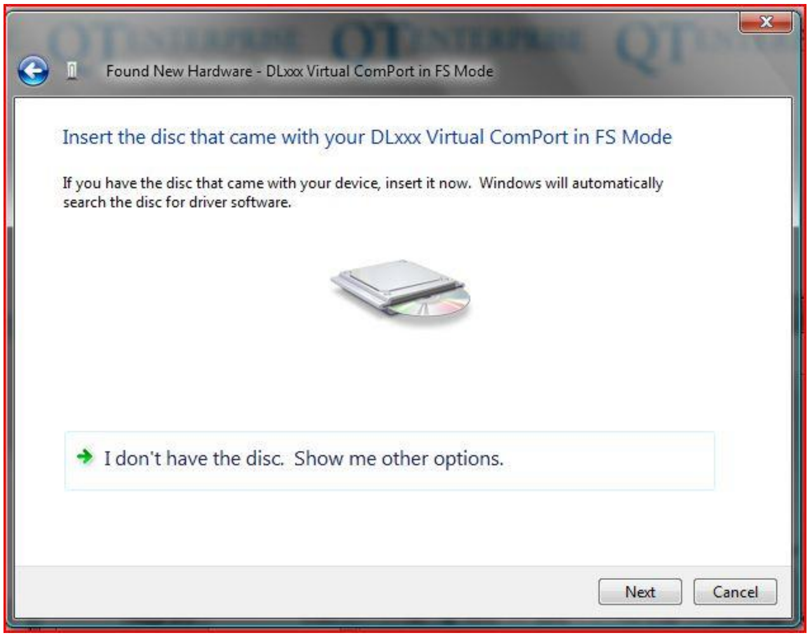
Windows Vista

Upon connection of the USB cable a dialog will appear:

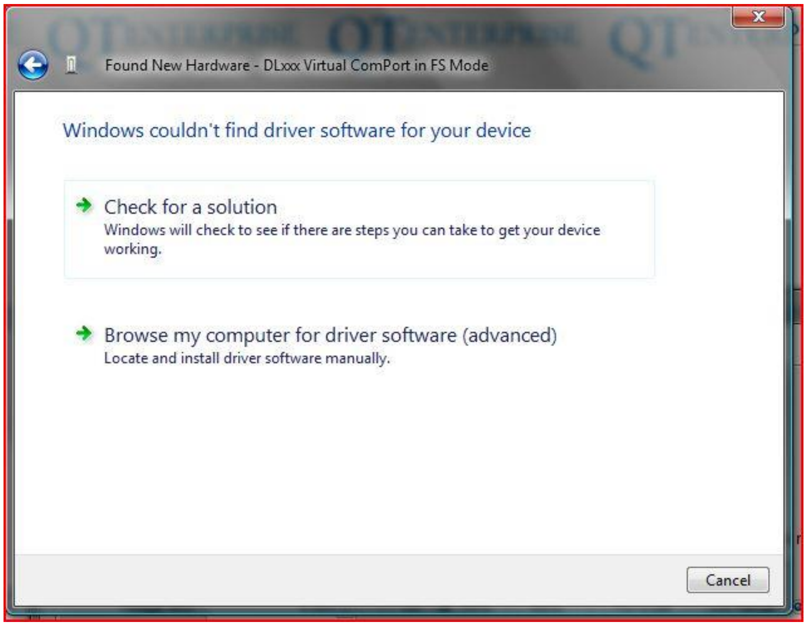
Select **Locate and install driver software**. On the next dialog select **Don't search online**:



Then select **Show me other options**:



Then **Browse my computer for driver software**:



Browse to **\vcp\win7** on the CD (or where you downloaded and extracted the driver files), click on **Open**. A warning dialog is displayed:

Click on Install this driver software anyway. You are done. Find the port using Open Windows Device Manager and look for the **FIXME Virtual ComPort**.

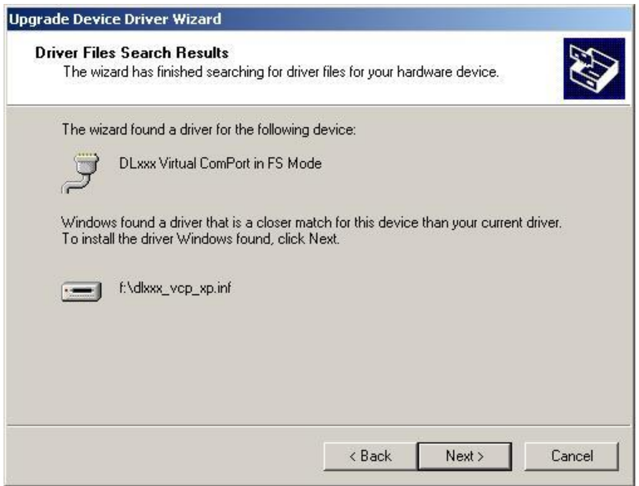
Windows 2000 and XP

Upon connection of the USB cable the driver wizard dialog will appear:

Click on **Next**:

Check **Search for a suitable driver for my device**, click on **Next**

Check **Specify a location**, click on **Next**. Browse to **\vcp\xp** on the CD (or where you downloaded and extracted the driver files) and select V10x_vcp_xp.inf, click on **Open**, windows shows:

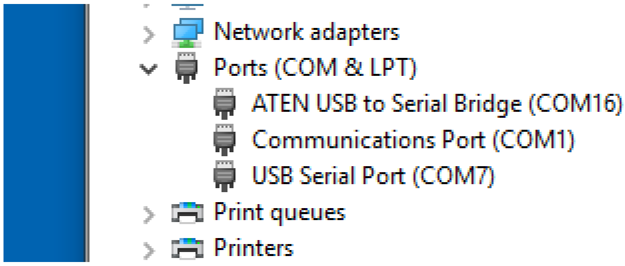


Click on **Next**, a warning dialog will appear:

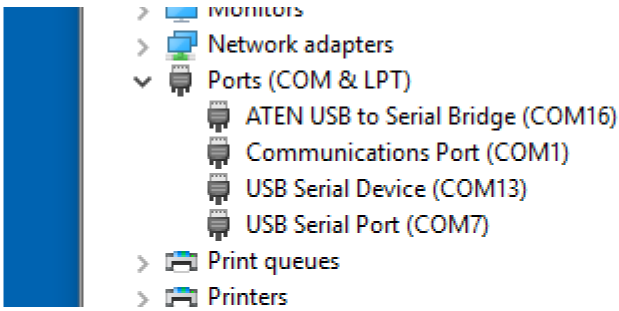
Click on Yes. Installation will complete. Find the port using Open Windows Device Manager and look for the **FIXME Virtual ComPort**.

Windows 10

On Windows 10 the COM port will not carry an obvious name to identify the interface to the V10x. If you run Windows Device Manager, you may already have multiple COM ports:



To isolate which port is the V10x look at the Ports list without the instrument attached, then plug in the USB cable and look again:



It will be observed that COM13 is the V10x.