

# HYPERLABS ZTDR™

## User Manual and Technical Guide

Applies to Model Numbers

HL11xx Series

© 2015 – HYPERLABS INC.

Revision 2.0.1 | [www.hyperlabsinc.com](http://www.hyperlabsinc.com)

## Introduction

These consolidated reference materials apply to the ZTDR™ software included with all HL11xx TDR instruments from HYPERLABS. The same software package is compatible with all instruments in this series.

ZTDR™ is compatible with Microsoft Windows® XP, Vista, 7, and 8. For deployment in other applications, a free DLL is available on the HYPERLABS website.

For further technical support, please visit our website: [www.hyperlabsinc.com/support.aspx](http://www.hyperlabsinc.com/support.aspx)

## Table of Contents

Section 1: Changelog .....	3
Version 2.0 .....	3
Version 1.1 .....	3
Section 2: Instrument Operation .....	3
Section 3: Static Sensitivity and Protection .....	3
Section 4: Driver and Software Installation.....	4
Section 5: Running the ZTDR™ Software.....	4
Section 6: Overview of ZTDR™ Software and Display Controls.....	5
Section 7: Waveform Display .....	5
Section 8: Cursor Readings .....	6
Section 9: Display Options.....	6
Section 10: Horizontal Axis Controls .....	7
Section 10.1: Horizontal Units .....	7
Section 10.2: Window Start and End.....	7
Section 10.3: Dielectric Constant (K) and Velocity of Propagation (V/C).....	7
Section 10.4: Cursor-based Zoom.....	7
Section 11: Vertical Axis Controls .....	8
Section 11.1: Vertical Units .....	8
Section 11.2: Vertical Limits and Scaling.....	8
Section 12: Waveform Acquisition and Averaging.....	9
Section 13: Program Log and Status Indicator.....	9
Section 14: Data Logging and Storage .....	10
Section 14.1: Printing .....	10
Section 14.2: CSV Logging .....	10
Section 14.3: Saving to PNG.....	10
Section 14.4: Storing and Retrieving Waveforms .....	10

Section 15: Horizontal Reference (Zero) Point.....	11
Section 15.1: Set the Horizontal Reference.....	11
Section 15.2: Resetting Horizontal Reference .....	11
Section 16: Instrument Calibration .....	12
Section 16.1: Vertical and Timescale Calibration.....	12
Section 16.2: NIST Certification .....	12
Section 17: Save and Load Settings .....	13
Section 17.1: Automatic Settings Save and Recall .....	13
Section 17.2: Saving and Loading Settings on Demand .....	13
Section 18: Additional Resources .....	14

## Section 1: Changelog

Below is a list of major software improvements and features added in various releases of ZTDR™. To ensure that you are always using the most recent version of ZTDR™, please bookmark our website:

<http://www.hyperlabsinc.com/ZTDR.aspx>

### Version 2.0

- Software multithreading has been introduced, providing a more responsive user interface and seamless data acquisition routines.
- Due to multithreading, there is no longer a performance detriment to frequent auto-calibration. For this reason, we have removed the option to disable automatic amplitude calibration.
- A green status indicator LED has been added to indicate an in-progress data acquisition or recalibration. More information about this feature can be found in *Section 13* below.
- The **Data** menu has been removed, and all data logging options have now been moved to the **File** menu.

### Version 1.1

- We have added the ability to set a horizontal zero reference. This is available from the **Calibration** menu.
- Program settings can now be saved and loaded on demand. Acquisition environment settings are also saved and loaded automatically at program startup and shutdown.

## Section 2: Instrument Operation

All HYPERLABS instruments are controlled via USB. The ZTDR™ software and drivers are compatible with all versions of Windows XP, Windows Vista, Windows 7, and Windows 8. At this time, we have no plans to port the ZTDR™ user interface to OS X, Linux, or other operating systems.

HYPERLABS also provides a free DLL for ZTDR™ which can be used with other applications and operating systems. For additional information about the DLL, please visit our website.

The instrument should always be plugged into the PC prior to running the ZTDR™ software. A green LED on the back panel of the instrument will indicate that it is plugged into a working USB port.

## Section 3: Static Sensitivity and Protection

Instruments in the HL11xx series are compliant with Class 2 of ESDS Component Sensitivity Classification (ESD STM5.1-1998). Additional static protection is not required to use these instruments in most applications.

## Section 4: Driver and Software Installation

HYPERLABS instruments utilize third-party drivers from FTDI. On internet-connected computers, the latest signed drivers will be automatically downloaded and installed as soon the instrument is plugged in to a working USB port.

If the computer is not connected to the internet or not configured for automatic driver installation, the FTDI drivers must be manually installed. Please visit the following page to download the latest version of the FTDI drivers:  
<http://www.ftdichip.com/Drivers/D2XX.htm>

If the program states it cannot find “FTD2xx.dll”, download the driver package at the address above, extract the .ZIP file, and copy the FTD2xx.dll file into the installation directory listed below.

Once the FTDI driver is installed, the ZTDR™ software can be installed by running “setup.exe” in the included install package. If the package is in compressed (.zip) format, all files must be extracted prior to installation.

By default, the software will install to the following directory: “C:\HYPERLABS\ZTDR\”

During installation, the user may elect to install to a different directory. No other user options are available during the installation process.

## Section 5: Running the ZTDR™ Software

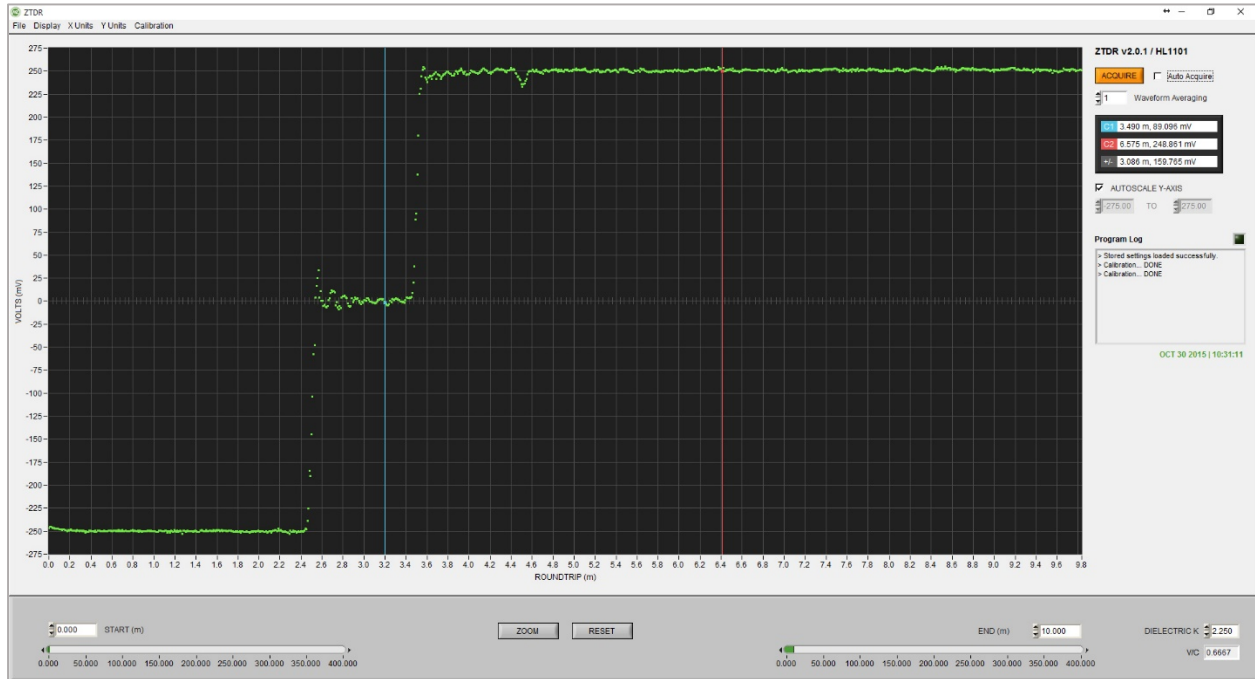
The instrument is initialized and calibrated at startup, a process that takes a few seconds. The software will not be responsive to user input during that time. When this process is complete, the operator will see the user interface shown on the following page. A message in the right-side panel will say “Calibration... DONE!”

**NOTE:** For optimal results, the instrument should be plugged in for a 5 minute “warm up” period prior to use. After warmup, the operator should recalibrate the instrument (see *Section 15* below).

If any error messages are shown, please make sure that the instrument is plugged in and the drivers installed (see *Sections 2-4* above) before contacting HYPERLABS for additional support.

## Section 6: Overview of ZTDR™ Software and Display Controls

When the ZTDR™ software is running, the user will see a screen similar to *Figure 1* below.



*Figure 1: ZTDR™ software after initialization and calibration*

This User Manual is organized according to ZTDR™ control functionality. Please see the Table of Contents for a list of the controls covered in the sections below.

## Section 7: Waveform Display

ZTDR™ displays waveforms in the time domain, i.e. as a function of time or distance.

The horizontal axis shows **ROUNDTRIP** time or distance. Units can be changed using the **X Units** menu (see *Section 10.1* below). The acquisition window **START** and **END** points and the **DIELECTRIC K** can also be changed on demand (see *Sections 10.2-10.3* below).

The operator can adjust the vertical display using the **Y Units** menu (see *Section 10.1* below) and the scaling controls found in the right panel (see *Section 11.2* below).

The operator can also position the cursors on the waveform using drag-and-drop (see *Section 8* below). No other actions can be performed directly on the Waveform Display.

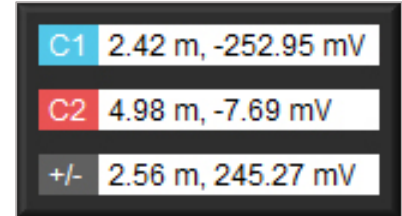
For further help reading the actual waveform output, please review the Application Guides on our website, or contact HYPERLABS for assistance.

## Section 8: Cursor Readings

ZTDR™ has two cursors which can be used to take spot measurements on the Waveform Display. **C1** is blue, and **C2** is red. These cursors can be positioned by dragging and dropping them on the waveform.

Cursor readings are found in the right-hand panel of the ZTDR™ software, as shown in *Figure 2* at right. The grey **+/-** box displays the horizontal and vertical difference between the two cursors in the selected units.

**NOTE:** The cursors always snap to the closest point on the waveform, so the cursors will jump slightly as each waveform is acquired. For the most accurate cursor readings, HYPERLABS recommends switching to manual acquisition before positioning the cursors or logging the results.



*Figure 2: Example cursor readings in m, mV*

## Section 9: Display Options

In the **Display** menu found at the top of the ZTDR™ interface, the operator can control the look of the Waveform Display. These options are aesthetic, and do not impact the way in which the waveform is acquired.

There are three options for displaying the plot itself. In the default **Dots** mode, each acquired data point is displayed individually. In **Thin Line** and **Thick Line** modes, the data points are connected with vectors. This option affects only the active waveform. For ease of reading, recalled waveforms (see *Section 14* below) are always displayed as a thin magenta line.

The color scheme is also adjustable. A **Dark Background** shows bright waveform on a dark grid, similar to most test and measurement instruments. The **Light Background** is useful for saving toner when printing the data.

## Section 10: Horizontal Axis Controls

Horizontal Controls impact the way in which the waveform is displayed by the ZTDR™ software. Combined with the Vertical Axis Controls (see *Section 11* below), these allow the operator to customize the test environment.

### Section 10.1: Horizontal Units

The horizontal axis is displayed in **DISTANCE (m)**, **DISTANCE (ft)**, or **TIME (ns)**. The unit of measure can be changed using the **X Units** menu bar. When a unit is chosen, a new waveform will be acquired and displayed in the selected horizontal units.

Any horizontal unit can be used to locate faults, measure impedance, or otherwise analyze the device under test. Accurate distance readings are dependent on having set the proper Dielectric Constant (see *Section 10.3* below).

### Section 10.2: Window Start and End

The **START** and **END** points of the waveform acquisition window can be set by either entering a numerical value or adjusting the appropriate slider. These controls use the active horizontal unit (see *Section 10.1* above).

A minimum window width is required for data acquisition. If **END** is set too close to **START** (within 1 m, 3 ft, or 5 ns), the software will automatically adjust **END** to satisfy the minimum width.

**NOTE:** The waveform consists of 1024 equidistant data points, and ZTDR™ automatically sizes the acquisition window as closely as possible to the desired width. Rounding may result in a slightly smaller acquisition window.

### Section 10.3: Dielectric Constant (K) and Velocity of Propagation (V/C)

Because electrical signals propagate at different speeds through different materials, ZTDR™ gives the operator the ability to customize the **DIELECTRIC K**. Below this control, the **V/C** box shows the velocity of propagation as a ratio of the speed of light. **V/C** is derived from **DIELECTRIC K**, and cannot be changed manually.

Some common materials and their K and V/C values are listed here.

Material	K	V/C
Coaxial cable with polyethylene insulation	2.25	0.6667
Coaxial cable with Teflon insulation	2.06	0.6967
Aluminum Oxide (Alumina)	9.8	0.3194

Figure 3: Table of Dielectric Constants for Common Materials

### Section 10.4: Cursor-based Zoom

The cursors can also be used to zoom in on any portion of the waveform. To do this, place Cursor 1 on the left edge of the area to be magnified, and Cursor 2 to the right. Then click the **ZOOM** button found below the waveform. To reset the horizontal scale to their default values, simply click the **RESET ZOOM** button.



## Section 11: Vertical Axis Controls

The vertical axis controls of the ZTDR™ software are similar to the horizontal controls (see *Section 10* above).

### Section 11.1: Vertical Units

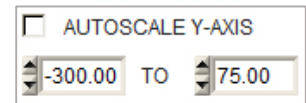
The **Y Units** menu changes the units displayed on the vertical axis of the Waveform Display Area. Options include: **Volts (mV)**, **Normalized**, **Impedance (Ohm)**, and **Reflection Coefficient (Rho)**.

Different vertical units provide different types of information about the device under test. The fundamental shape of the waveform does not differ between **mV**, **Norm**, and **Rho**. In **Ohm**, the shape is somewhat distorted due to the fundamental way in which impedance is calculated.

For recommendations on which units to use in specific test environments, please reference *Figure 5* on the next page or contact HYPERLABS. Proper values for the upper and lower limits depend on the selected vertical unit, and can also be found in *Figure 5*.

### Section 11.2: Vertical Limits and Scaling

The Waveform Display can be set to **AUTOSCALE Y-AXIS**, or to manual scaling. The user can toggle the mode using the controls in the right-side panel, show in *Figure 4* in greater detail.



*Figure 4: Y axis scaling controls*

If the software is set to manual scaling, the user can adjust the limits of the vertical axis using the controls shown in *Figure 4* at right. In **AUTOSCALE** mode, the limits controls are dimmed.

*Figure 5* below shows the default limits of each unit type when in manual scaling mode.

UNITS	Lower Limit	Upper Limit	Description
Voltage (mV)	-250	250	Default setting, measures the reflected voltage of the 250 mV incident pulse
Normalized Voltage	0	2.0	Reflected voltage represented as a fractional value, where 0 indicates the initial value, 1.0 indicates the normalized incident step (250 mV), and 2.0 indicates an open (full reflection)
Impedance (Ω)	0	500	Impedance, in Ohms (Ω), of the device under test
Reflection Coefficient (Rho)	-1.0	1.0	Coefficient used to calculate impedance, where 0.0 represents 50 Ω; Impedance (Z) = 50 * (1 + Rho) / (1 - Rho)

*Figure 5: Recommended Vertical Scale for Each Unit Type*

## Section 12: Waveform Acquisition and Averaging

The operator can control the frequency of waveform acquisition and toggle between automatic and manual acquisition. This is done using the controls found in the right-hand panel, and shown at right in *Figure 6*.



*Figure 6: Waveform Acquisition Control*

By default, ZTDR™ operates in **AUTO** acquisition mode. In this mode, waveforms are acquired and displayed on the Waveform Display at regular intervals.

Alternatively, the software can be set to manual mode. In this mode, the software acquires and displays a single waveform whenever the operator clicks the orange **ACQUIRE** button.

Multiple waveforms can be taken using the **AVERAGING** control, found above the message box in the right-hand panel, and shown in *Figure 7* at right.



*Figure 7: Waveform Averaging Control*

On each acquisition, the software acquires the desired number of waveforms, cycles through them, and displays the average as a single waveform. The default value is 1, which indicates that a single waveform is acquired.

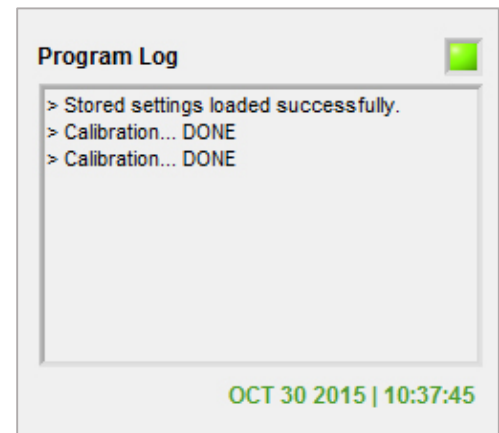
**NOTE:** As of ZTDR™ Version 2.0, software multithreading eliminates the need to turn off automatic acquisition while using waveform averaging.

## Section 13: Program Log and Status Indicator

ZTDR™ displays messages and status updates to the user in the **Program Log** found in the right-hand panel of the instrument, shown in *Figure 8* at right.

In Version 2.0, a green status indicator LED has also been added above the **Program Log**. While this is lit up, a calibration or data acquisition is in progress.

The software also displays a timestamp for each waveform acquisition. This is displayed immediately below the message pane, in green text.



*Figure 8: Sample Program Log, timestamp, and active status indicator LED*

## Section 14: Data Logging and Storage

ZTDR™ has a variety of logging features to simplify the storage of data obtained during testing. As of Version 2.0, these controls are now found in the **File** menu in the main program menu bar.

### Section 14.1: Printing

When the user selects the **Print** menu option, ZTDR™ formats the waveform acquisition for printing. To save ink, the color scheme is automatically switched to **Light Background**, and switched back once printing is complete.

### Section 14.2: CSV Logging

The **Save CSV** menu item in ZTDR™ saves the waveform data to a comma-separated values (.csv) file. This raw data can be used for data storage or post-processing in other software.

The structure of the CSV file is simple. The first column contains the horizontal values, and the second contains the vertical values. The header row shows the horizontal (m, ft, or ns) and vertical units (mV, norm, Ohm, Rho) used to acquire the waveform.

For simplicity of post-processing, the CSV file does not include a timestamp or serial number. We recommend that the user store this data in the filename for later reference.

### Section 14.3: Saving to PNG

Using **Save PNG** feature, the operator can save the waveform and ZTDR™ window to a PNG image file. The user can select the directory to save the file, but no other options are available.

### Section 14.4: Storing and Retrieving Waveforms

In ZTDR™, waveforms can be stored and retrieved later as an on-screen reference for subsequent tests.

The **Store Waveform** menu item captures the waveform on the screen and saves it to a waveform file (.ztdr). The **Recall Waveform** option is used to load old waveforms into the Waveform Display as a magenta plot. The **Clear Waveform** menu option removes the stored waveform from the screen.

**NOTE:** When a waveform is loaded, the horizontal and vertical scale and unit controls are set to the parameters used for the original measurement, and cannot be changed.

## Section 15: Horizontal Reference (Zero) Point

The horizontal reference (zero) can now be changed in ZTDR™. Options to set and reset the horizontal offset can be found in the **Calibration** menu located in the main program menu bar.

### Section 15.1: Set the Horizontal Reference

The horizontal reference point feature sets the 0.0 time or distance to the point on the waveform where the step goes to open. The system **must be in open** (i.e. unterminated, no short circuit) in order for this feature to work.

The reference point can be set to either the output port of the TDR instrument, or to the end of a reference cable being used in the test setup. As long as the step to open can be seen in the current acquisition window, this feature will work.

Clicking the **Set Zero** menu option opens a prompt reminds the user to put the test system in open. Clicking the **Yes** button performs the function, while clicking **No** cancels it.

When the Horizontal Reference feature is active, the **START** and **END** window boxes will appear as a shade of light yellow, and the 0.0 point will be positioned somewhere in the middle of the waveform. This is shown in *Figure 9* below.

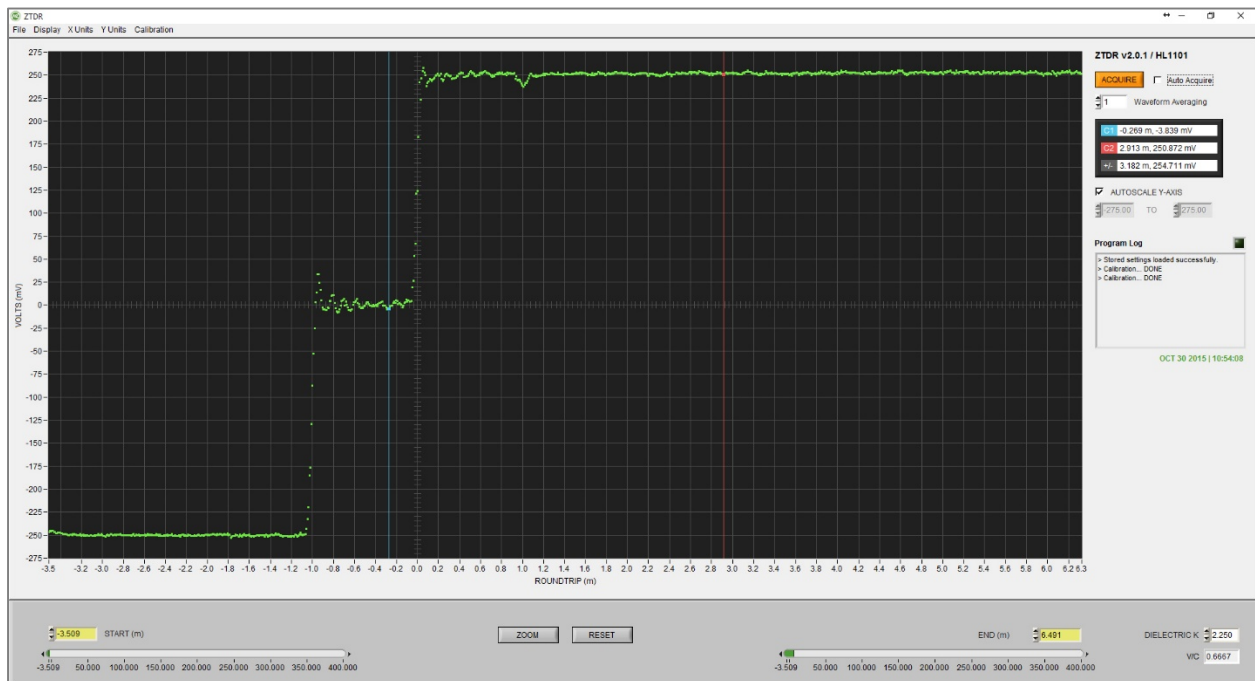


Figure 2: Waveform with Horizontal Reference set to outside panel of instrument

### Section 15.2: Resetting Horizontal Reference

To remove the horizontal offset, click the **Reset Zero** menu option found in the **Calibration** menu. This resets the axis to the very beginning of the waveform.

## Section 16: Instrument Calibration

All HYPERLABS TDRs have an internal calibration feature, and the instrument automatically calibrates at software startup. Calibration can also be performed during data collection. To use these features, use the **Calibration** menu located in the main program menu bar.

### Section 16.1: Vertical and Timescale Calibration

There are two types of calibration built into ZTDR™, regular amplitude **Recalibration** and extended **Timebase Calibration**. Either can be performed using the **Calibration** menu at the top of the user interface. The status of every calibration attempt is shown in the Message Log box.

**NOTE:** The “Vert Cal” option from previous ZTDR™ versions is now simply called “**Recalibration**”. The functionality of this feature has not changed.

When an amplitude **Recalibration** is performed, the instrument is quickly calibrated to within 1% of a of high-quality 50  $\Omega$  semi-rigid coaxial cable found within the instrument housing.

ZTDR™ automatically performs an amplitude calibration every 30 seconds. As of Version 2.0, it is no longer possible to disable automatic recalibration.

The **Timebase Cal** feature recalibrates the entire instrument, including both the timebase and the amplitude. This “extended” calibration is performed at instrument startup. It can also be performed on demand, but it is generally not necessary once the instrument is warmed up..

**NOTE:** For optimal accuracy, HYPERLABS recommends letting the instrument warm up for approximately 5 minutes before use. Warmup can be performed simply by plugging the instrument into a USB port. ZTDR™ does not need to be running during warm up. Once the warmup is complete, click **Timebase Cal** to recalibrate.

### Section 16.2: NIST Certification

Each instrument, including the internal reference cable, is calibrated by HYPERLABS using NIST-traceable equipment at the time of initial shipment.

If regular NIST re-certification is required, the instrument can be sent to HYPERLABS periodically for calibration and certification. At the time of service, HYPERLABS will verify the unit using NIST-traceable instruments and provide a certificate of calibration. Please see our website for current pricing and RMA procedures.

## Section 17: Save and Load Settings

ZTDR™ is capable of saving test environment variables for use in subsequent test sessions. The stored variables are: **dielectric constant K**, **vertical units**, **vertical minimum/maximum**, **horizontal units**, **window start**, **window end**, **horizontal offset**, **auto scaling**, and **auto acquisition**.

These settings can be saved and loaded on demand. When starting ZTDR™, the program also auto-loads the test settings in use in the most recent test session.

### Section 17.1: Automatic Settings Save and Recall

The first time ZTDR™ is run, the default test environment settings are used. When the user exits the program, the active settings are stored in the “**user.ini**” file found in the main program directory. The next time the program runs, it automatically loads these settings.

If the startup settings become corrupt, delete “**user.ini**” and a new one will be created the next time ZTDR™ runs.

### Section 17.2: Saving and Loading Settings on Demand

To save the environmental settings for later use in ZTDR™, select the **Save Settings** option from the **File** menu. Settings are stored in an **.ini** file of the user's choosing. The default save location is the **settings** folder found in the main program directory.

Use the **Load Settings** option in the **File** menu to retrieve stored settings. This action immediately overrides all active settings.

### Section 17.3: Restoring Default Settings

If the user wants to revert to default ZTDR™ settings (measurement units, window, etc.), this can be accomplished using the **Reset Defaults** option in the **File** menu.

Sometimes, a settings file will become corrupt and unusable. If this happens, ZTDR™ will alert the user and revert to default settings automatically.

## Section 18: Additional Resources

This manual for HYPERLABS ZTDR™ is primarily intended to cover instrument setup and familiarize the user with the major features of the hardware and software. The applications for TDRs are too many and varied to cover fully in this User Manual.

Accordingly, we have made a wide variety of Application Guides and other reference materials on our website. A full listing of Application Guides can be found at: <http://www.hyperlabsinc.com/application-guides.aspx>

If help for your application isn't provided in our Application Guides, HYPERLABS is always happy to provide unlimited technical support to our customers. For up-to-date telephone or email support options, please see our webpage: <http://www.hyperlabsinc.com/contact-us.aspx>

## Section 19: Copyright Information

The information contained in this User Manual is © 2015 by HYPERLABS INC. This manual may be freely distributed as-is, but any translations, edits, or revisions are prohibited unless expressly approved by HYPERLABS.

The ZTDR™ software title and screenshots, and all instrument model numbers (e.g. HL11xx) listed in this User Manual are also © 2015 by HYPERLABS, Inc.

The “HL Circle” and HYPERLABS logo found at the top of each page of this User Manual are © 2012-2014 by HYPERLABS INC.

Windows® is a registered trademark of the Microsoft Corp., which is not affiliated with HYPERLABS INC.