HL8200USB Time Domain Reflectometer (TDR) Module

Part No.  HL8200USBM1008

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Warranty

HYPERLABS, Inc. warrants that this Product is free from defects in materials and workmanship. If HYPERLABS receives notice of such defects during the one (1) year warranty period, HYPERLABS will, at its option, repair or replace Products which prove to be defective. Products must be returned, freight prepaid, to a service center designated by HYPERLABS.

HYPERLABS is not obligated to furnish service under this warranty:

A) to repair damage resulting from attempts by personnel other than HYPERLABS representatives to repair or service the Product;

B) to repair damage resulting from improper operation outside of the published environmental specifications, or from connecting the Product to incompatible equipment;

C) if personnel other than HYPERLABS representatives modify the Product.

The above warranty is exclusive and no other warranty, whether written or oral, is expressed or implied. HYPERLABS specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.
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Chapter 1
Specifications

General Information

The HL8200USB TDR Module generates a stimulus pulse (the incident voltage step) on the output connector and takes samples from the incident pulse as well as from the signal reflected from the device under test (DUT). The timing of the samples is determined by the internal time base under the control of the internal EZUSB microcontroller.

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Figure 1. HL8200USB TDR Product Dimensions: 95.2x34.8x127.0mm (3.75x1.37x5.00inches)

Product Specifications

The following specifications apply over an ambient temperature range of -20°C to +85°C after a 10 minute warm-up, for an HL8200USB TDR Module, calibrated at a temperature between +20°C and +30°C.

The required operating voltages are applied to the HL8200USB TDR when it is connected through a USB Port to a controlling computer.
### Table of Electrical Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risetime</td>
<td>max. 200 pS (10% to 90%)</td>
</tr>
<tr>
<td>Amplitude</td>
<td>min. 250 mV, positive going edge</td>
</tr>
<tr>
<td>Aberrations</td>
<td>+7%, -5%, total of 10% P-P within the first 1nS with reference level at 1nS from the step edge; +2%, -2%, total of 3% P-P after the first 1nS with the reference level at 1nS from the step edge</td>
</tr>
<tr>
<td>Pulse Duration</td>
<td>14 microS, repetition at min. 50 microS</td>
</tr>
<tr>
<td>Jitter</td>
<td>max. 10pS RMS</td>
</tr>
<tr>
<td>Edge Delay</td>
<td>Typical. 8m (40nS) from sweep start</td>
</tr>
<tr>
<td>Impedance Connector</td>
<td>50Ω +/- 1%, SMA (Optional BNC)</td>
</tr>
<tr>
<td>Time Base Accuracy</td>
<td>max. 5%</td>
</tr>
<tr>
<td>Power Supply</td>
<td>Powered through the USB port</td>
</tr>
</tbody>
</table>

### Table of Environmental Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions:</td>
<td>127x95x35 mm (5.0x3.75x1.37in)</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
</tr>
<tr>
<td>Non-operating</td>
<td>-20°C to +85°C</td>
</tr>
<tr>
<td>Operating</td>
<td>-20°C to +85°C</td>
</tr>
<tr>
<td>Vibration (nonoperating)</td>
<td>15 minutes, amplitude:0.015in, frequency:10 to 55Hz</td>
</tr>
<tr>
<td>Altitude</td>
<td></td>
</tr>
<tr>
<td>Non-operating</td>
<td>To 50,000 feet</td>
</tr>
<tr>
<td>Operating</td>
<td>To 15,000 feet</td>
</tr>
</tbody>
</table>
Chapter 2
Installation Instructions

This section of the manual provides the basic information required to operate the HL8200USB TDR Module. It also includes installation and first time operation instructions.

Installing the HL8200USB TDR Module

The HL8200USB TDR Module is powered and controlled through a Universal Serial Bus (USB) interface (Figure 2). The head is controlled by a Personal/Laptop Computer (PC).

Figure 2. HL8200USB TDR System Configuration

Chapter 3
Operating Instructions

First time operation requires all the system components shown on Figure 2.

Installation and functionality verification steps are the following:
1. Turn on the PC and run Windows XP operating system.
2. Install the Software supplied on the CD for WINDOWS XP (SP 2 or later) or VISTA following the instruction on the Readme.txt file.
3. Connect the TDR Module through the USB Cable to the USB port on the PC.
4. Run the program HL8200USB.exe and check the start-up screen to look like:

Check that the incident edge is at 8.00m and the amplitude is ~250mV followed by the second edge (Open circuit) at ~9m for the default dielectric constant K=2.23.
5. The default X Axis is “Round Trip [m]”, the default Y Axis is “mV” and vertical Autoscaling is turned “ON”.

![](image_url)
7. “Start [m]” and “End [m]” dials controls the horizontal scale
8. Clicking on the ^ arrow on the dial “Dist [m]” will change the horizontal axis to “TIME [nS]” and it will look like

Check that the incident edge is at 40.00nS
Clicking again on the ^ arrow will change the Distance in feet “Dist [Ft]”. Clicking again takes you back to Dist [m]

9. The Y Axis default is “MVolt” i.e. milliVolt and looks like:
10. Clicking on the ^ arrow of the MVOLT dial changes the vertical scale to “RHO” i.e. Reflection Coefficient and looks like:
Please note that the reflection coefficient at the flat portion of the trace following the incident edge is $\text{RHO}=0$ showing that the internal reference line is 50Ohm.

11. Clicking again the ^ arrow changes the Y Axis to “OHM” i.e. Impedance measurement looking like:
Please note that the flat portion of the trace following the incident edge at ~8m (red cursor) indicates 50 Ohm and is due to the internal impedance reference cable followed by 500 Ohm (the maximum impedance) flat value.

12. Clicking again on the ^ arrow changes the Y axis to “Norm” i.e. Normalized value of 1.0 for the step and looks like:
Please note that the incident step at ~8m starts at zero, has an amplitude of 1.0 and the reflection in open has a value of ~2.0.

13. Saving and retrieving waveforms is done using “SAVE” and “RETRIEVE” by entering the name of the trace in the dialog box and looks like in the following application example before connecting the device (cable) to be measured and looks like this:
The delay is measured between the blue cursor placed on the stored trace and the red cursor placed on the live trace.

14. Another common application is impedance coupon measurements. First use the “ZOOM” feature by placing the Blue Cursor before the incident step and Red Cursor after the end of the coupon and pressing the “ZOOM” will set the Start and End values equal to the horizontal values of the two cursors values. Next place the Blue Cursor on the first flat portion of the trace to measure the internal reference impedance (50 Ohm) and the RED Cursor on the next flat portion of the trace to measure the impedance of the coupon as shown in the following screenshot:
Chapter 4
Block Diagram

The Block Diagram (Figure 3) shows the major circuit blocks of the HL8200USB TDR module. A USB controlled and powered microcontroller (MPU) is taking digital timebase values send it to the sampler and reads back the digitized amplitude values for each sample.

It sets the Period Generator block, a counter/timer to count the cycles of a free-running 12MHz oscillator to set the repetition period of the stimulus to about 90 microsecond. This drives the pulser delay circuit (also a counter timer) which triggers the 20 microsecond duration step generator.
The Delay Control Input of the time base has a counter timer and an interpolator. A 3V amplitude ramp generated by the output channel of a 14 bit D/A converter forms the interpolator portion of the digital time base. The MPU determines the number of integer clock periods of the 12MHz oscillator and combines with the interpolator delay to determine the delay value for each individual samples taken by the Sampler circuit. The Analog Output of the sampler is amplified, converted to digital data by the onboard, 12bit A/D converter and sent back to the PC through the USB port.

The instrument autocalibrates its amplitude and position the incident edge on its own time base every time it is turned on or starts the TDR control program.
Chapter 5
Performance Checks

Introduction

This section of the manual contains the Performance Check and the Adjustment Procedure. When the Performance Check Adjustment is completed, the instrument is checked into the "Performance" information given in Chapter 1. The tolerance and waveforms given in the Adjustment Procedure should be considered only as adjustment guides and not as instrument specifications.

Equipment Required

The following test equipment, or their equivalent, is required for both for the Performance Check of the HL8200 TDR Module and the adjustment procedures. All test equipment must be calibrated. If other equipment is substituted, it must meet or exceed the limits stated in the equipment list.

1) Test oscilloscope Tektronix™ 11800/CSA803-Series.

2) Sampling Head SD26, 20pS rise time.

3) 50 Ω coaxial cable, semi-rigid 500 pS.

4) 50 Ω Termination, SMA.

5) Coaxial Short Circuit, SMA

6) BNC to SMA adapter (if BNC connector Option)
Performance Check Procedure

The Performance Check provides a means of checking the HL8200USB without adjusting any internal controls. Failure to meet any of the requirements given in the procedure indicates a need for internal trigger, internal checks or adjustments, and the unit should be returned to the factory.

Preliminary Procedure

a) Install the HL8200USB TDR Module in a system shown in Figure 2.
b) Install the SD26 Sampling Head in the 11801/CSA803 Sampling Oscilloscope.

c) Trigger the Mainframe with the internal period generator

**1. Check PULSE OUTPUT Period**

a) Change the following controls:

<table>
<thead>
<tr>
<th>11801/CSA803</th>
</tr>
</thead>
<tbody>
<tr>
<td>mV/Div</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweep Range</td>
</tr>
<tr>
<td>Time/Div</td>
</tr>
<tr>
<td>Scan</td>
</tr>
</tbody>
</table>

b) Check that the PULSE OUTPUT duration is meeting specifications.

c) Check that the PULSE OUTPUT amplitude from the baseline level to the pulse top is 250 mV.

**2. Check Time base Accuracy**

a) Connect the calibrated, dual coaxial discontinuity to the output connector of the HL8200USB TDR Module.

b) Adjust Delay and Width such that the first and second discontinuity are positioned approximately at 1/3 and 2/3 of the display graticule.
c) Measure distance between the peaks of the two discontinuities. Verify that the reading is 1000+/− 50pS

### 3. Check Output Pulse Risetime

a) Place the oscilloscope cursors at the 0% and 100% levels of the incident pulse. Use the following procedure to locate the 0% (100% is in parenthesis level for the incident pulse. This procedure is necessary whenever a level is not clearly defined.

1. Find the knee reference point at the start (end) of the step where the rate of change of the slope is maximum (the radius of curvature is least).

2. At a distance of one risetime before (after) the knee reference point in step 1, place the center of a zone which is one risetime in width. The HL8200USB TDR Module risetime is max. 200 pS.

3. Determine the average level of the waveform within the zone and use it for the 0% (100%) reference level.

b) Check that the rise time displayed by the delta cursor from the 10% level to the 90% level is 200 pS or less.

### 4. Check the Aberrations on the Output Pulse

a) Change the Distance and Window control parameters such as the incident step is at approximately 1/3 of the 1.5nS display range.

b) Change Y Axis to Norm.

Place the first cursor at the 50% point and the second cursor at 1nS delay from the first. Move the first cursor on the top of the pulse passing the 100% point.
c) Check that the aberrations indicated by the delta cursors are within +7%, -5%, total of 10% within 1nS of the step edge.

d) Move the first cursor beyond the 1nS reference point.

e) Check that the aberrations indicated by the delta cursors are within +2%, -2%, total of 3% after 1nS from the step edge.

5. Check Time Base Jitter

Switch the X Axis dial from Dist [m] to Time[nS]. The instrument now operates in the Time Domain as opposed to Distance Domain.

The smallest time step is 10.2pS for an Increment = 1

The duration of the acquisition window (like TIME/DIV * 10 on the familiar oscilloscope) is determined by the number of point multiplied by the time step.

The time step (or equivalent time sampling rate) is equal with the smallest time step multiplied by the Increment (I)

This time scale (i.e. acquisition window delay) is calibrated and autocalibrated by the internal microcontroller. Increment = 0 can be used as a cursor since it makes the instrument time step zero, and all the data points are acquired in the same relative time on the stimulus, the pulser (step) generator.

Measuring the jitter is as follows:
a) Find the 40% point and 60% point and measure the slope of the rising edge at the 50% point by dividing the voltage reading by the time reading.

b) Place the sampling point (cursor) by changing the “increment” to zero and choosing the “acquisition window delay” parameter such as to sample the 50% point and record the voltage fluctuations on the acquired waveform.

c) Take the RMS value of the voltage fluctuation and divide by the slope previously measured at a)

d) Check that the jitter is less than 10pS RMS.

6. Check Edge Delay

a) Connect the 50Ω coaxial termination resistor.

b) Place the Cursor to the 50% point of the incident step. Verify that the reading of the cursor is ~8m (40nS) from sweep start for Dielectric K=2.23.

NOTES: