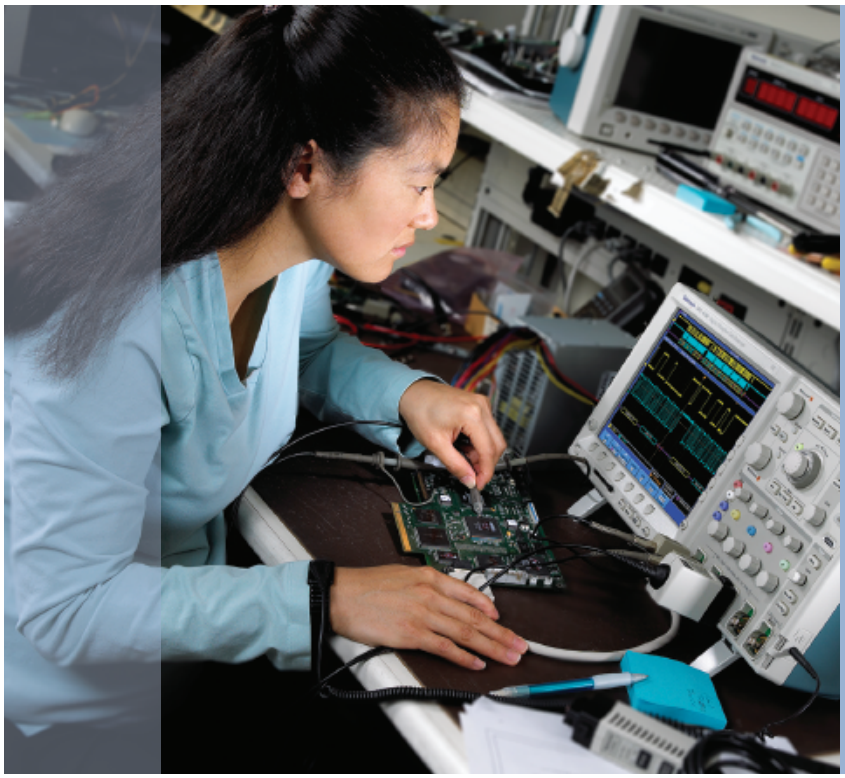
Application Note



Automated Limit Testing

Limit Testing with Tektronix DPO4000 and MSO4000 Series Oscilloscopes and National Instruments LabVIEW SignalExpress™ TE for Windows

Introduction

Automated limit testing allows engineers and technicians to set up a pass/fail measurement on an electronic signal that automates the process of determining whether an acquired signal meets, or is within, a given set of criteria.

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Background

A limit test typically consists of comparing a waveform to upper and lower boundaries which the measured waveform must not cross. These boundaries are typically defined by the user to specify a tolerance band around a waveform. If any part of the waveform falls outside the limit, the software returns a failure message and the location of the failure on the waveform.

LabVIEW SignalExpress TE Configuration

National Instruments LabVIEW SignalExpress TE (Tektronix Edition) requires no programming. There are many built-in steps available for immediate use in LabVIEW SignalExpress TE. For example, by inserting a signal acquisition step, the user can readily configure the appropriate oscilloscope and necessary input channel, vertical settings, horizontal settings, and triggering without writing a single line of code. A user can also quickly browse the settings for each instrument by leaving the **Step Setup** panel open and selecting different steps.

Solving the Problem Quickly

An engineer is working on new high speed embedded design. At this point, she is concerned that there may be a metastability in the system. One digital device's output signal has the expected voltage amplitude, but she has noticed glitches on the output of the device. She suspects the glitches are being caused by setup and hold violations. The engineer concludes an automated limit test would be the quickest way to validate her speculation.

The engineer begins by connecting the output of the device under test to CH1 of the Tektronix DPO4104 (1GHz, 5GS/s) oscilloscope. Next she sets up the oscilloscope with only two button pushes: **Default Setup** and **Autoset**, the waveform is ready for capture in LabVIEW SignalExpress TE. See Figure 1.

With only a basic understanding of LabVIEW SignalExpress TE, the engineer begins the steps to configure an automated limit test. Connecting a USB cable from the scope to the computer brings up the LabVIEW SignalExpress TE open dialog box. See Figure 2. Clicking the **OK** button launches the LabVIEW SignalExpress TE program.

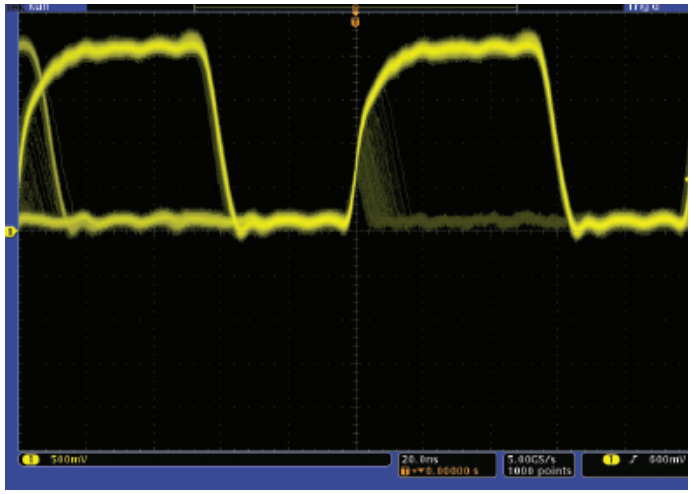

Figure 1. Glitches seen, above, on the output waveform of the device under test.

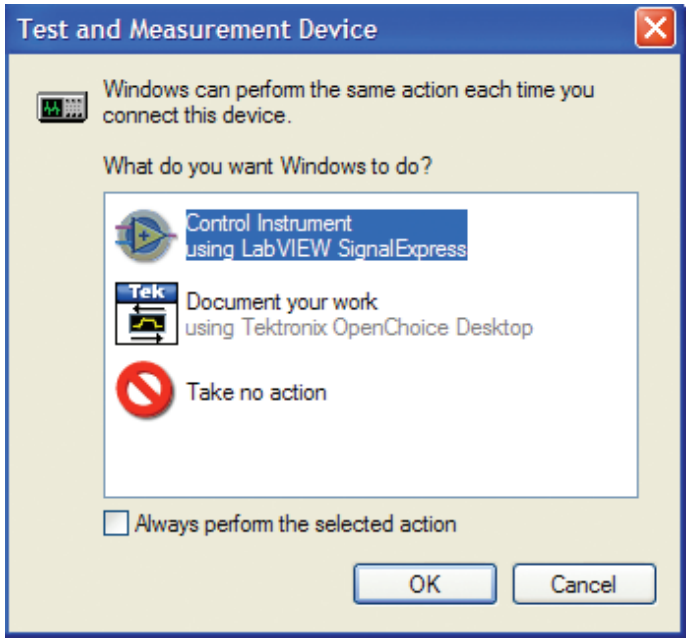

Figure 2. The LabVIEW SignalExpress TE dialog box automatically appears after connecting the oscilloscope to the computer via a USB cable, prompting the user to launch LabVIEW SignalExpress TE.

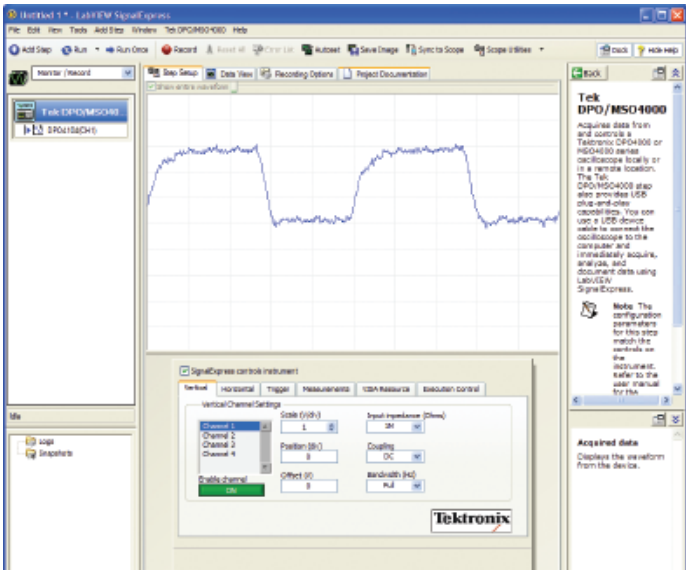

Figure 3. Tektronix DPO/MSO4000 Step Setup view with the Vertical tab selected.

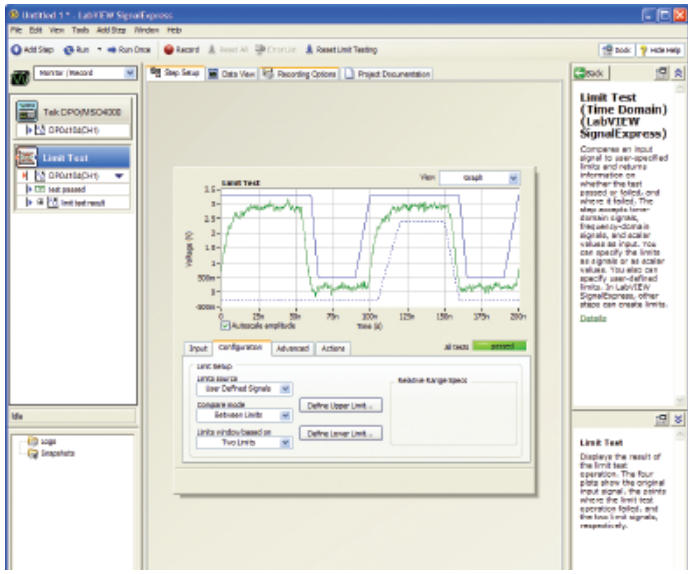

Figure 4. The Add Step button easily adds a Limit Test step.

When the LabVIEW SignalExpress TE program opens, the Tektronix DPO/MSO4000 step inserts itself automatically. The engineer selects **Run Once** and the waveform appears on the display. See Figure 3.

Next the engineer returns to the data view by selecting the **Data View** tab near the top of the screen.

Now the engineer clicks and drags the **DPO4000 (CH1)** output to the Data View's empty graph to view the **CH1 data**. She then clicks the **Add Step** button and selects **Analysis** > **Test and Compare** > **Limit Test**. See Figure 4. On the **Configuration** tab, she selects the following settings: **User Defined Signals**, **Between Limits**, and **Two Limits**, and then graphically defines the upper and lower test limits.

The last step the engineer needs to complete is automating the limit test. This is accomplished by adding the **Execution Control** > **Conditional Repeat** step, then simply dragging the **Limit Test** step into the **Conditional Repeat** step. The setup menu for **Input Configuration** is displayed. The sequence of steps, in this case, is setup such that the test ends if a FALSE Boolean signal condition is met; otherwise, the loop is to repeat. See Figure 5.

Finally, the **Load/Save Signals** > **Save to ASCII/LVM** step is added to save the violations to an ASCII file.

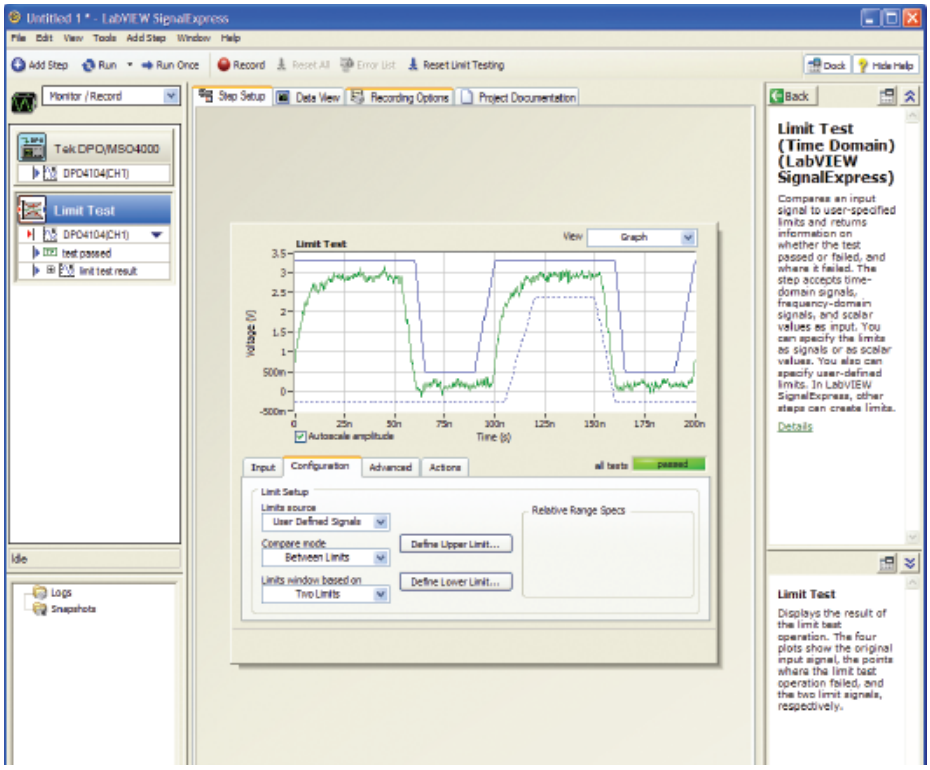

Figure 5. The Limit Test step, in the Project View (left pane), is dragged and dropped into the Conditional Repeat step. The input Configuration menu, seen in the center pane, is used to repeat a sequence of steps inside the loop until one or more conditions are met. The variable can be a Boolean or scalar result.

Running the Limit Test

The limit waveforms specify the pass/fail conditions. These are the initial values our engineer estimates to define an acceptable margin. She verifies her assumption by clicking the project **Run** button to run the test.

The limit test application acquires waveforms and compares them to the boundary limits. If the signal crosses an upper or lower limit a violation occurs and shown on-screen in red, at the offending location. See Figure 6.

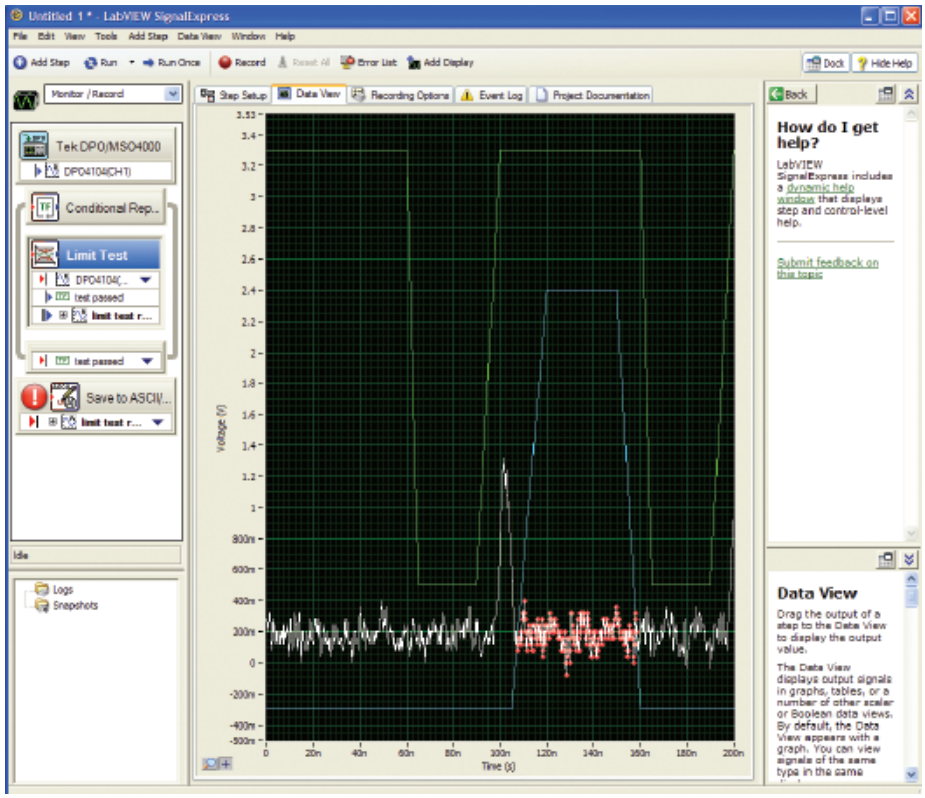

Figure 6. Running the Automated Limit Test reveals violations seen in the Data View as red dots at the boundary crossings.

Clicking on the **Save to ASCII** step displays the signal information, in the project pane. See Figure 7.

Enabling channels 2 and 3, in the LabVIEW SignalExpress TE Tektronix DPO/MSO4000 Step **Vertical** pane, and dragging both channels into a new **Data View** pane, the engineer is able to see the system clock (ch2) and data (ch3), in relation to the output waveform (ch1). She reviews the results and concludes her speculation was correct: insufficient setup time between the system clock and data edge is causing the glitches at the output of the device under test. See Figure 8.

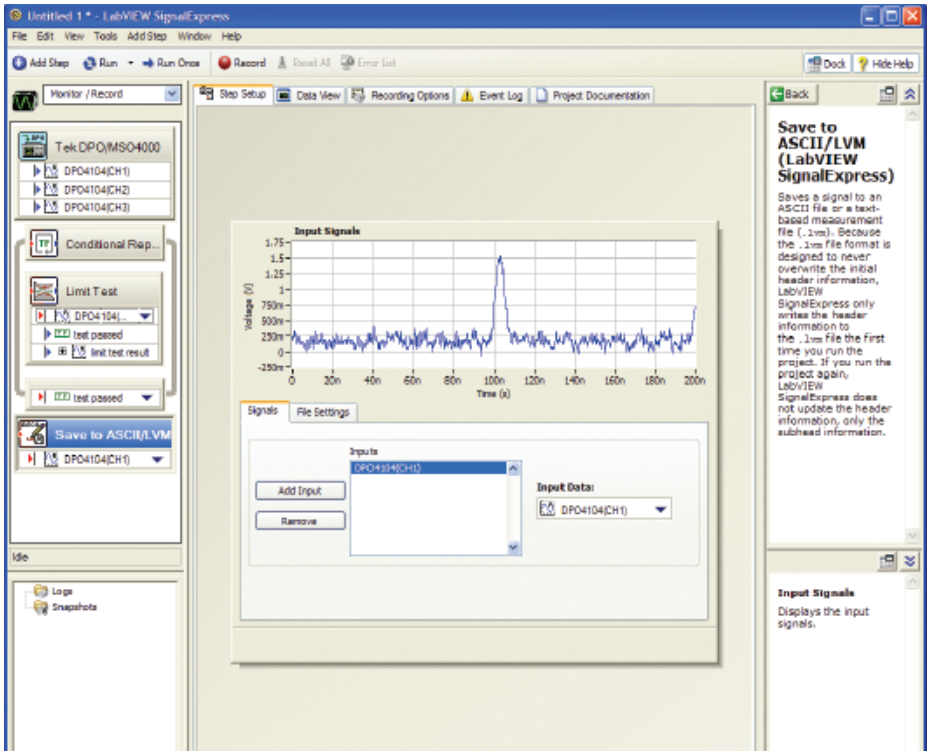

Figure 7. Save to ASCII view, above, shows the limit test signal data. Because the choice "Overwrite once, then append to file" is selected every time the limit test is run, the signal data is appended to the existing text file, archiving the results for all test runs.

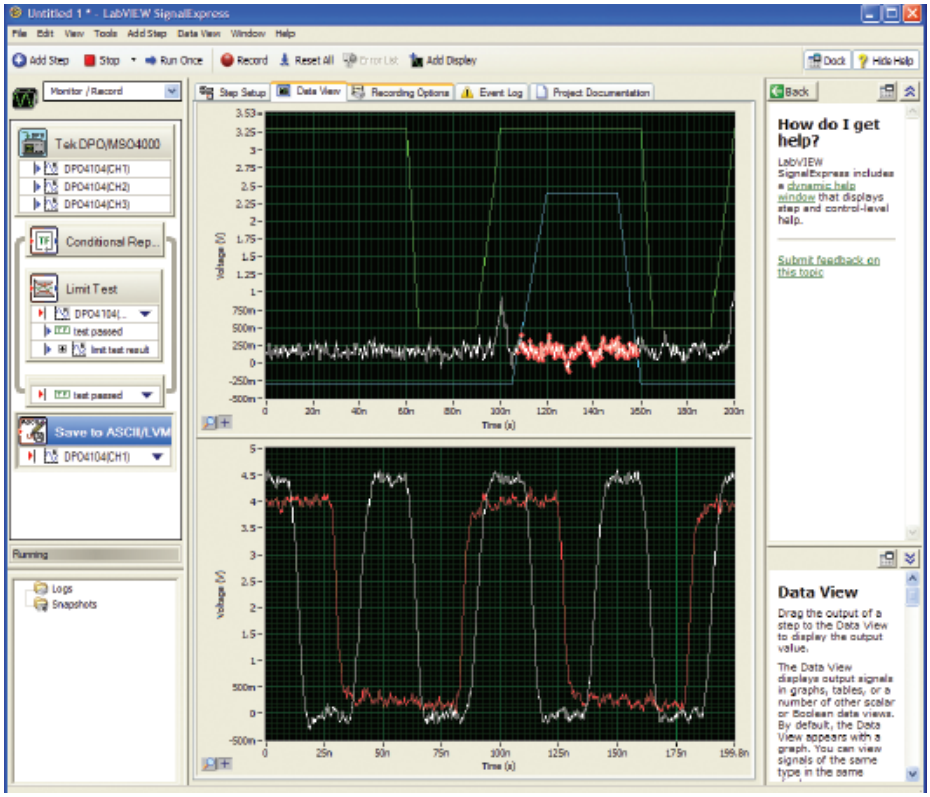

Figure 8. Insufficient setup time between clock (ch2) and data (ch3), bottom pane above, is causing glitches on the on the output waveform (ch1) of the device under test, top pane above.

Conclusion

Until now, electronic design and test engineers, and technicians spent hours acquiring and analyzing electronic measurements manually. The advancing complexity of today's electronic devices requires more tests to verify and validate a design without introducing additional time in the product development cycle.

The Tektronix DPO4000 and MSO4000 Series oscilloscopes with the LabVIEW SignalExpress TE software package deliver a simple, interactive solution for limit testing various AC/DC electronic signal conditions. Engineers can use this powerful combination to save valuable time by automating measurements, and performing analysis, verification, characterization, and validation.

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