



Using Area-based Templates for Pass/Fail Waveform Testing

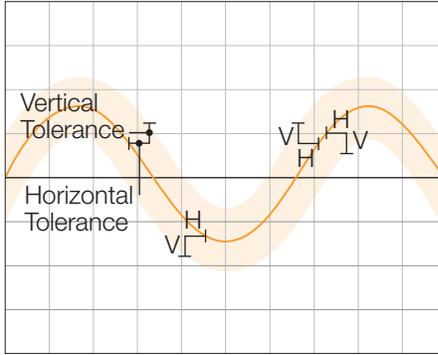
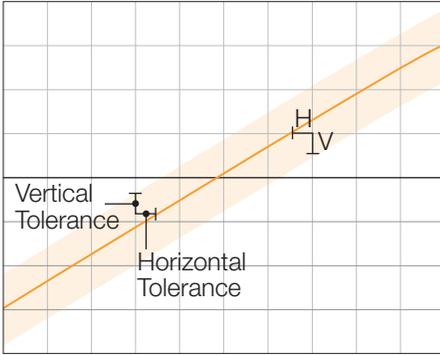
Enhanced Limit Testing with Tektronix TBS1000B Series Oscilloscopes

Application Note

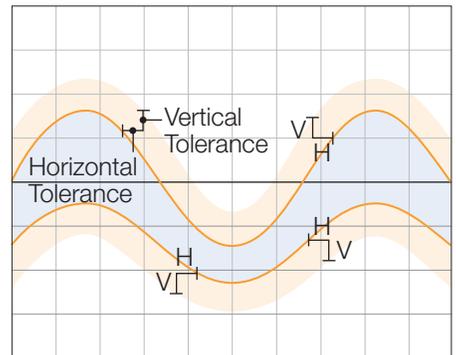
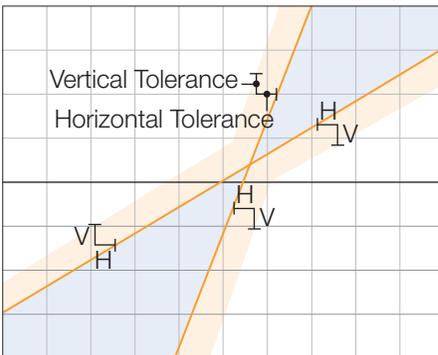
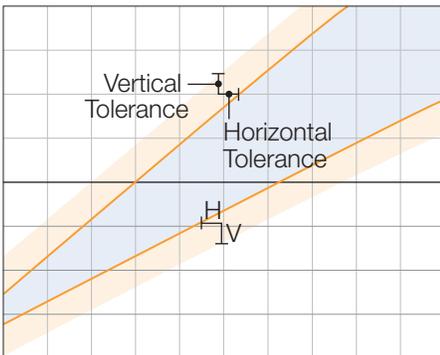
Introduction

Limit testing is a simple tool that enables engineers and technicians to quickly identify signal anomalies and act upon them. Limit testing indicates that a test measurement occurred outside the limits of a predefined template. It also shows when the infraction occurred and can trigger specific predefined actions. This feature is particularly useful in automated production and debugging environments.

This application note reviews how you can use the limit test feature to support your product evaluation and production testing. It discusses the key differences between standard single-waveform “+/-” band templates and the enhanced dual waveform area-based templates supported by TBS1000B Series digital storage oscilloscopes.



Figures 1a. and 1b. Conventional limit testing.



Figures 2a. 2b. and 2c. Area-based limit testing.

Background

A limit test function directs the oscilloscope to monitor a source waveform against a predefined template. It outputs a pass or fail result by automatically evaluating whether or not the source waveform falls within the boundaries of the template. If any part of the source waveform exceeds the template boundaries, a limit test violation is noted.

Standard limit testing uses a “+/-” band type of template that is created from a single reference waveform, generally a “golden” waveform. The user specifies horizontal and vertical tolerances to create a band around the “golden” waveform, defining the limit test template envelope (Figures 1a and 1b). When an acquired waveform is compared with the template, each acquired sample point value is compared to the vertical and horizontal min/max values of the template. Any source

waveform data point that falls outside the corresponding template envelope is a violation.

In standard limit testing, the tolerance band is the same height and width for the whole record, since it uses one single reference line and the same vertical and horizontal tolerance throughout the record. The advantage of the new area-based limit testing is that the tolerance band can be almost any shape, since it is based on two reference lines, although the vertical and horizontal tolerance is still applied across the whole record (Figures 2a, 2b and 2c).

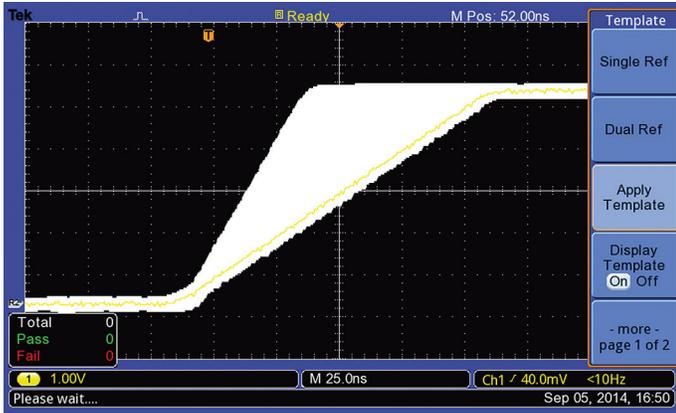


Figure 3. Area-based template to evaluate the rise time of a signal.

Area-based Templates

Area-based templates represent an improvement over the standard “+/-” band type of templates by offering more flexibility in template creation. Users are able to create more complex tolerance bands to address a wider variety of applications. Figure 3 shows an example in which an area-based template is being used to test rise-time.

The TBS1000B Series of oscilloscopes supports the creation of standard line-based templates based on a single waveform as well as enhanced templates using two reference waveforms. In Dual Ref mode, a user can define a limit testing tolerance band as the area between the two reference waveforms with specific horizontal and vertical tolerances — in other words, an area-based template.

Solving Problems Quickly

Let’s say you are working with a Keithley Series 2280S-32-6 Programmable DC Power Supply. This instrument has a programmable voltage slew rate when in constant voltage mode.

Imagine that your goal is to build an automatic test to ensure that the product’s output fall times are within an acceptable range for a number of slew rate settings.

In this case, the specification indicates that the discharge time should fall within 10 milliseconds to 50 milliseconds. During the discharge time the voltage should smoothly decrease from 90% of V_{out} to 10% of V_{out} . ($V_{out} = 5V$).

An automatic limit test would be a great solution, but the standard single reference template would not be adequate in this case. As the capacitor discharge time can be anywhere within 10 milliseconds to 50 milliseconds, the tolerances will change the farther the waveform gets from the trigger. A limit test is needed that can accommodate this more complex condition.

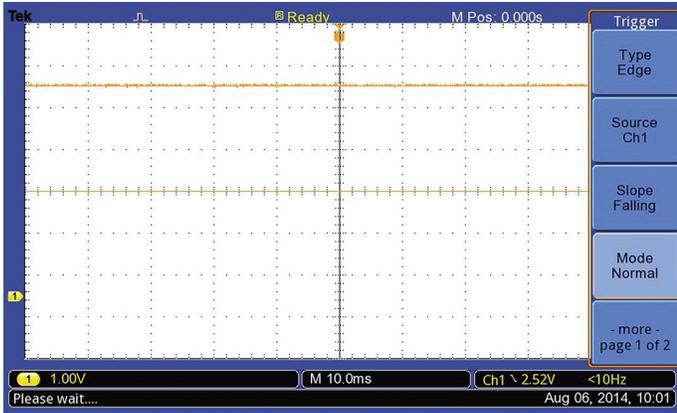


Figure 4. Trigger set-up.

Using the TBS1000B's enhanced limit testing allows you to take advantage of its dual reference waveform template option.

Begin by connecting a TP0101 passive probe from CH1 of the power supply to CH1 of the TBS1102B oscilloscope. Then follow these steps:

1. Build the first boundary. Press Output on the power supply to turn the output on. Set the output voltage to 5V, and the Slew Fall rate to 65V/s (this value can be adjusted to meet the 50ms fall time).

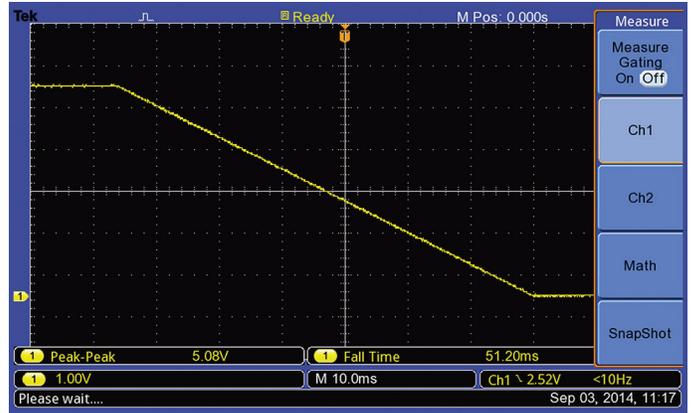


Figure 5. 50ms falling edge becomes the first boundary.

2. On the oscilloscope, push Default Setup and Autoset to trigger a stable waveform on the display. Push Trigger Menu. Choose the following settings: "Edge" as the trigger type, "CH1" as the trigger source, "Falling" for slope, and "Normal" for mode. Rotate the "Vertical Position" knob to move the waveform above the center of the grid and set the "Vertical Scale" knob to 1V/div. Move the trigger level to the center grid line (see Figure 4).
3. Press Output on the power supply to turn the output off. The scope will trigger at the falling edge of the power supply signal. On the oscilloscope, press Measure to confirm the waveform characteristics. In the measurement sub-menu of CH1, select "Fall Time" and "Peak-Peak". Note the fall time is about 50ms (see Figure 5).

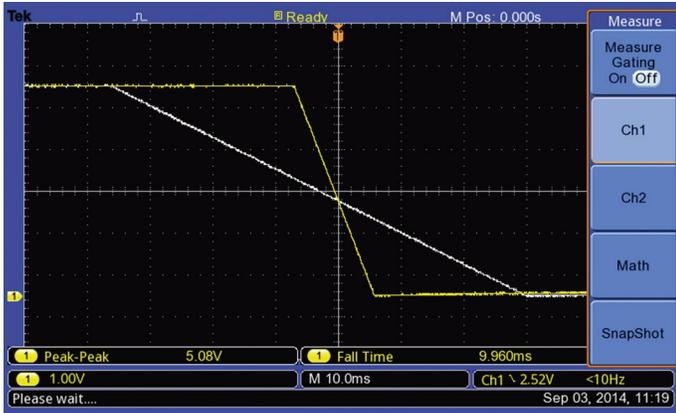


Figure 6. 10ms falling edge becomes the second boundary.

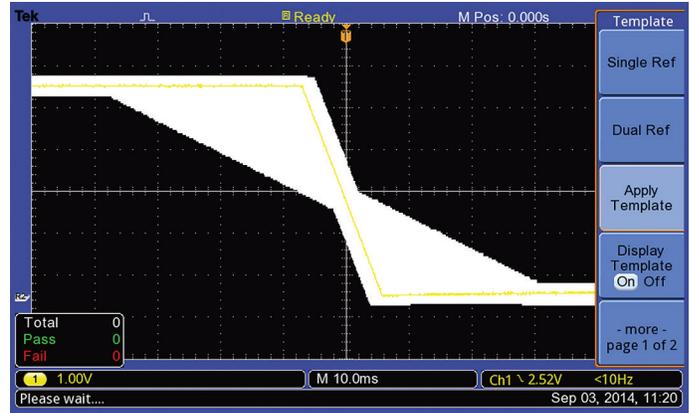


Figure 7. Apply the template.

4. On the oscilloscope, press Function and select “Limit Test”. In the side-bezel menu, select “CH1” as the source. In the “Template Setup” sub-menu, press Dual Ref so that the template is based on two waveforms. Then select “Save First Source” to set the current waveform as the first reference line.
5. Now you need to define the second boundary of the tolerance area. Press Output on the power supply to turn the output on. Change the Slew Fall rate to 310V/s (this value can be adjusted to meet the 10ms fall time).
6. Press Output on the power supply to close it. The scope is triggered at another falling edge. Note that the “Fall Time” is now 10ms (see Figure 6).
7. On the oscilloscope, press Function, and select “Limit Test”. In the bezel menu, select “CH1” as the source. In the “Template Setup” sub-menu, press Dual Ref and select “Save Second Source” to set the 10ms falling edge as the second boundary.
8. Now you can add vertical and horizontal tolerance to the area defined by the two boundary lines. On the oscilloscope, press Back. Press “More”, then select “V limit”. Rotate the “Multipurpose” knob to set the vertical tolerance to 200mdiv; select “H limit” and then rotate the “Multipurpose” knob to set the horizontal tolerance to 200mdiv. Select “More” and then press Apply Template to build the template based on the two reference lines and the specified vertical and horizontal tolerances (see Figure 7).
9. Now the template is ready on the oscilloscope as Reference Waveform A (Ref A). You can save both the setup file and the Ref A waveform to a USB drive (by pressing Save/Recall, selecting “Save setup” in the “Action” sub-menu, and pressing Save) and share them with the manufacturing team.
10. The manufacturing engineer can now load the setup file and the reference waveform on other TBS1000B oscilloscopes for use during production.

Conclusion

Limit testing is widely used in production environments to verify and validate products. Engineers use it to save valuable time by creating automated tests which can analyze, verify, characterize and validate a product's operation. Standard limit testing uses only a single waveform to create a test template with specific horizontal and vertical tolerances – a method that is inadequate for applications that have more complex conditions, such as those that change over time. The Tektronix TBS1000B Series oscilloscopes support a dual reference waveform feature which enables engineers to create enhanced area-based templates that support a wider variety of applications.

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