

## 1009: Creating an S<sub>11</sub> Trace

### Introduction

An S<sub>11</sub> is a measurement of return loss by frequency. On the CT100B, the S<sub>11</sub> is shown as line on a graph with frequency on the X axis and reflection coefficient on the Y axis.

In this app note, we will create an S<sub>11</sub> trace for a small WI-FI antenna. The antenna has a resonant frequency of 2.4 GHz, which will appear as a deep notch in the S<sub>11</sub> trace.

These steps may not be optimal for electrically long devices such as cables, however they will work for any electrically short device, that is, any device much shorter than the launch cable.

### Equipment needed

Torque wrench (8 lb. in.)

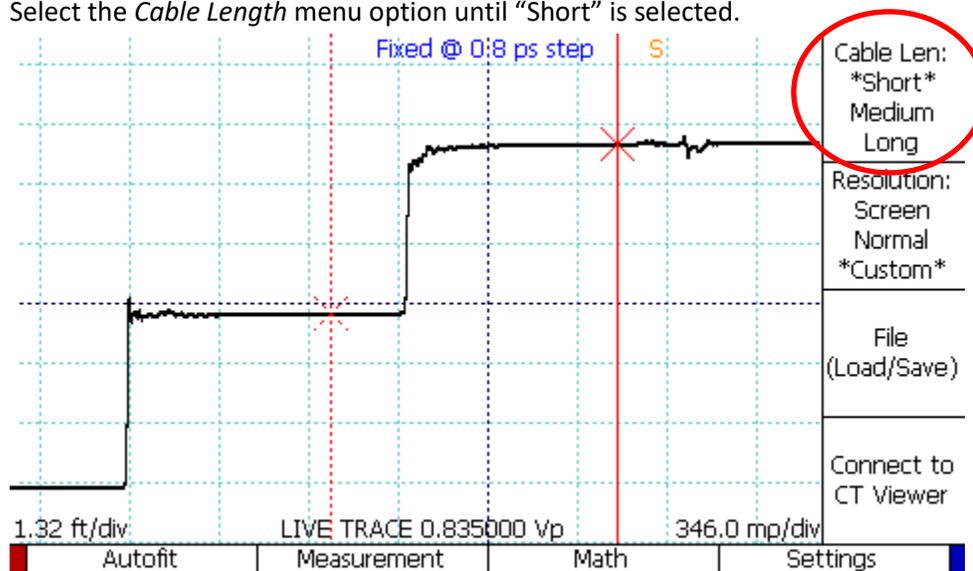
Phase stable launch cable

S<sub>11</sub> Calibration Standards

WI-FI antennae

### Step 1 Set Cable Length to Short

- Press the BLUE button to show the Main menu.
- Select the *Cable Length* menu option until “Short” is selected.

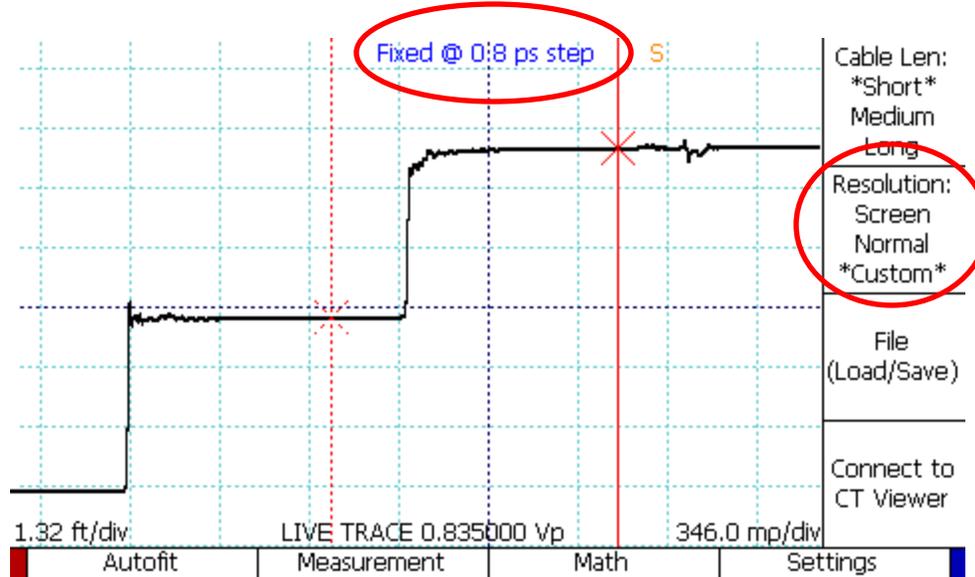


Calibrating for an S<sub>11</sub> takes time. Setting cable length to Short will speed up the calibration.

### Step 2 Set Resolution to 0.8 ps per step

From the main menu, select the *Resolution* menu option until “Custom” is selected.

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- Press the M-FUNC button until the blue text at the top of the screen reads “Fixed”.
- Turn the M-FUNCTION knob until the fixed resolution is set to 0.8 ps step.

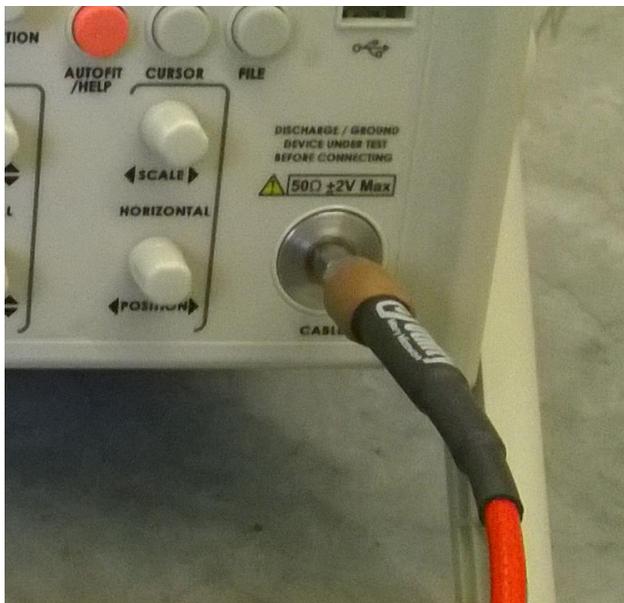
### Step 3 Set Smooth to 1024

- Press the M-FUNC button until the blue text at the top of the screen reads “Smooth”.
- Turn the M-FUNCTION knob until the smooth value is at 1024.

Increasing smooth reduces noise, which increases the maximum frequency of the  $S_{11}$  trace.

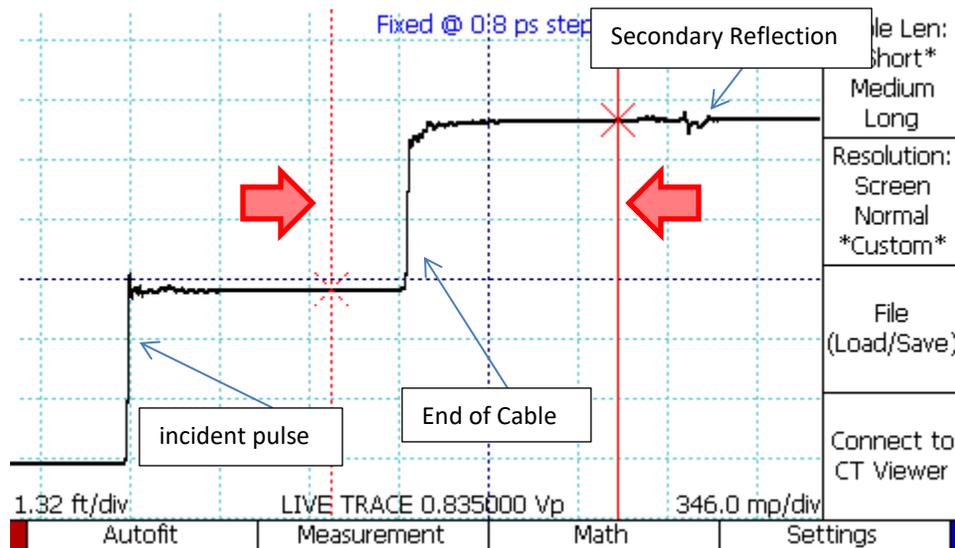
### Step 4 Attach phase stable launch cable

- Connect the phase stable launch cable to the test port on the CT100B.
- Tighten the connection using the torque wrench.



## Step 5 Position Cursors

- Press the AUTOFIT/HELP button, then select *Autofit* from the menu. The CT100B will automatically find the end of the launch cable. This will appear as a sharp rising edge.
- Use the horizontal position knob to put a cursor in the flat area somewhat before the start of the rising edge.
- Use the horizontal scale knob to zoom out until a secondary reflection can be seen.
- Press the cursor button to switch to the other cursor.
- Use the horizontal position knob to position the second cursor about 2/3 of the way from the top of the rising edge to the secondary reflection. See the image below for an example of good cursor positioning for an S11.



Positioning the cursors sets up the calculation region of the S11. By positioning the cursors as above, the S11 region will include the full signals from the calibration standards and the antenna. The region will not include unwanted signals such as the incident pulse and the secondary reflections.

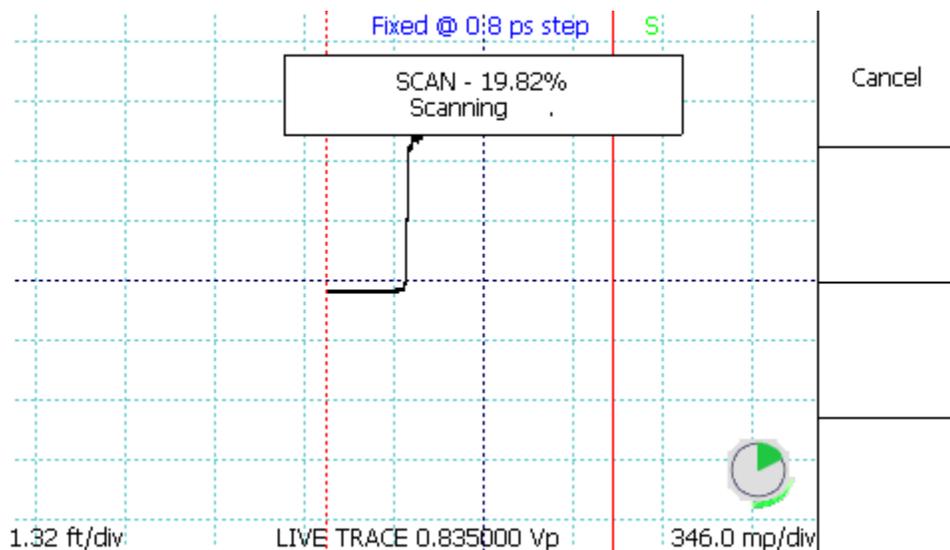
## Step 6 Create an S11 Calibration

The S11 Calibration Standards include precision short, open and load connectors. Follow these instructions to create a set of calibration traces using these connectors.

- From the main menu, select Math, then SParam & Normalize Tools to open the SParam menu.
- Choose S11 Calibration. An introduction to S11 Calibration appears. Press Start to continue. The Open calibration window appears.
- Attach the open connector from the calibration standard to the end of the launch cable. Tighten with the torque wrench. See image of a calibration standard attached to the end of a cable below.



- Press the Scan Open menu option. The CT100B will now save a scan. See below for an image of a scan in progress. This may take a few minutes. When it is finished the Short calibration window will appear.



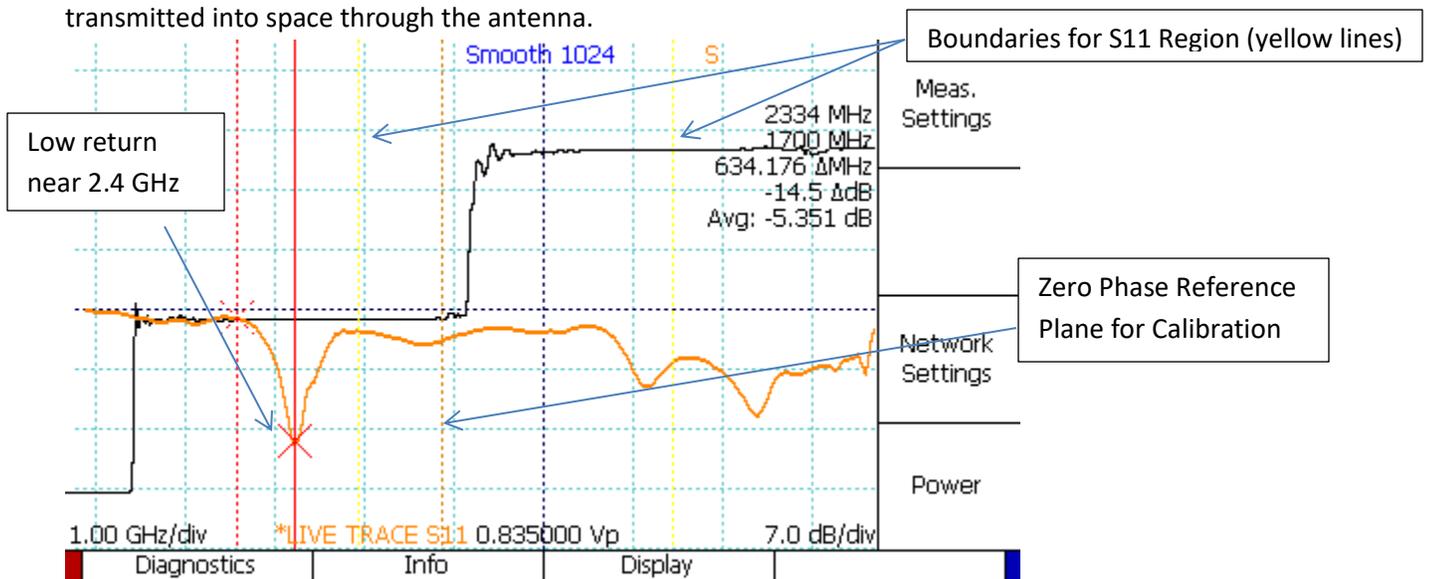
- Remove the open connector, attach the short from the calibration set, tighten it with a torque wrench, then press Scan Short. Repeat the same steps for the Load connector.
- When the Load scan is completed, the Measurement Trace screen appears. Select Use Live Trace. An S11 trace will appear.

### Step 7 Attach WI-FI Antenna

- Attach WI-FI Antenna to the end of the launch cable.



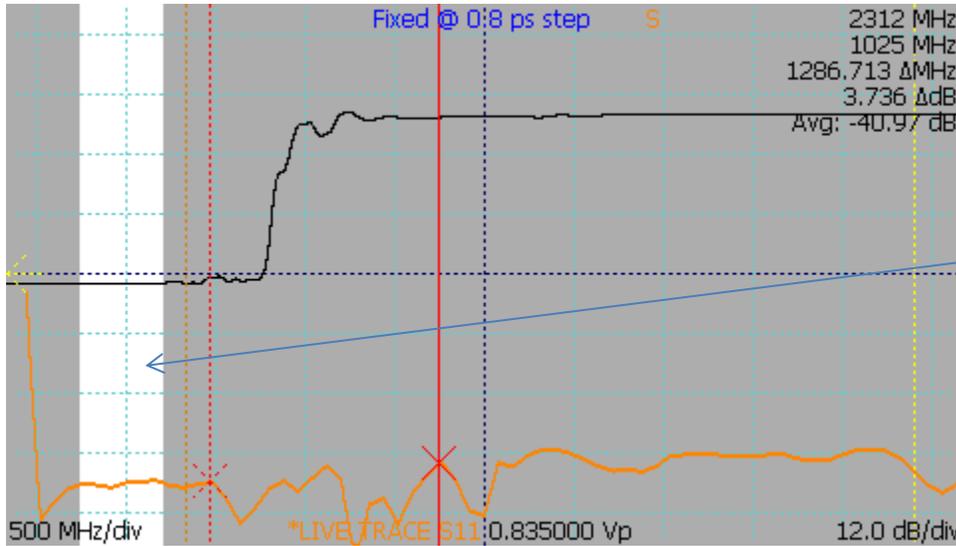
The S11 Trace will update with the values for the antenna. The trace is relatively high, but with a deep valley centered near 2.4 GHz. The meaning of this trace is that at every frequency, the antenna reflects most of the energy back towards the CT100B, except near 2.4 GHz. At this frequency, the energy is transmitted into space through the antenna.



### Step 8 (optional) Use Between Two Cursors.

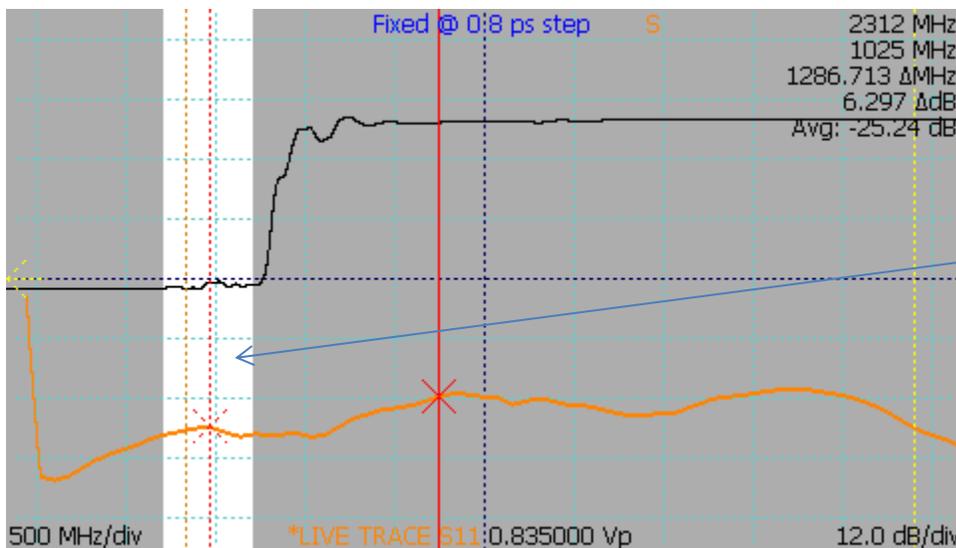
- Select the S11 Options menu item. Then select Between Cursor menu item until it says "Between Cursor On".
- Press the SELECT button until the live trace is selected.

- Manipulate the cursors with the cursor button and horizontal position. Changing the cursors changes the S11.
- Move the cursors to bracket the flat space before the antenna. Notice that the S11 drops to a very low value.



Between cursors bracketing flat area before the antenna.

- Move the cursors to bracket the connector of the antenna. Notice that the S11 shows significantly more reflection coefficient.



Between cursors bracketing the connector on the antenna.