**Introduction**

In wireless communication systems, cables, connectors, and antennas and other components cause problems. The Agilent CSA spectrum analyzer with the optional stimulus/response measurement suite can help you quickly find these problems. Within the stimulus/response suite you can use the return loss and the distance-to-fault (DTF) measurements with built-in signal source and bridge to help you determine the severity of the problems in your communication system.

The built-in signal source sends signals through your system and looking for reflections back to help pin point fault locations. The bridge separates the input signal and the reflected signal so they can be measured and compared. It redirects the returning signal internally back to the RF input for analysis. When your system has minor problems, your return loss could be 30 dB or higher while a system with severe faults will show a return loss close to 0 dB.

The DTF measurement will allow you to determine how far away from the Agilent CSA signal source input a fault is located, up to 300 m away. This paper will step you through making a DTF measurement with the Agilent CSA. Figure 1 shows a screen capture of a DTF measurement.

![Figure 1. DTF screen capture](image)

- **Largest fault 6.76 m away from input**
- **Return loss**
- **Measurement result table**
- **Calibration menu**
- **Start/Stop distance of your cable**
Figure 3 shows the hard key front panel of the Agilent CSA. Hard keys will be noted in **bold text** while soft keys will be noted in *italics* in this document.
Demonstration

To start using the DTF measurement, push the following keys:

**Mode**: Stimulus/response: Distance-to-fault

There are two hard keys that you will use the most when using the DTF measurement. They are the **Freq Channel** and **Mode Preset** keys, which are circled in red in Figure 3. **Mode Preset** will reset the instrument and start you in two-port insertion loss. To return to the DTF measurement window press **Meas** and select Distance-to-fault.

**Freq channel menu**

In DTF you will be concerned with the Start and Stop distance of your cable. Push the **Freq Range** button once to select Auto as in Figure 5 if you do not know the frequency range that you want to use.

Next enter your Start/Stop distance of the cable you wish to measure. The maximum distance is 304.8 m with Auto frequency range selected. If your start distance is 0 m you will always show a fault at 0 m. This is caused by the reflection from the connection at the RF output. This DC component is sometimes referred to as the “dead zone.”

To calibrate the instrument, you will press the **Calibrate** button and walk through the step-by-step instructions shown next.

Before you start the calibration process, you may want to select the type of cable you are testing as this will help make your calibration more accurate. Under **Meas Setup** you will find **Cable Type**, where there is a long list of radio guide (RG) and base transceiver station (BTS) cable types. If you are not using an RG or BTS cable you can select “custom.” A sample of the BTS cables in the menu is shown in Figure 4.

**Calibration – the first step**

After selecting your **Start/Stop** distance and **Cable type** select the **Calibrate** key under the **Freq Channel** button.

Calibrating the Agilent CSA will ensure your measurements are accurate and will save you time in making duplicate measurements to check your results. The easy-to-use, step-by-step guide minimizes the need for training and helps technicians master the instruments and get their work done efficiently.
Step-by-Step Menu

The step-by-step menu is as follows:

Specify frequency range
You should have already specified the Start/Stop distance under the Freq Channel menu or selected Auto after entering your Start/Stop distance.

Once confirmed select Continue.

Connect the open
You may connect the open directly to the RF output or use a Type-N cable connected to an open.

Once confirmed select Continue.

Do not change or remove the connection
Make sure you do not remove the connection until the next screen appears. The larger the distance you select the longer each step of the calibration will take. In addition, the more averages you have set the longer this will take. To turn Averaging off: Meas Setup: Avg Mode: Off.

Connect the short
You may connect the open directly to the RF output or use a Type-N cable connected to the short.

Once confirmed select Continue.

Connect the load
You may connect the open directly to the RF output or use a Type-N cable connected to the load.

Once confirmed select Continue.

Now that you have calibrated your instrument, the calibrated frequency range will appear in the upper left hand corner of the screen.

Figures 6a–6d. Step-by-step menu
Making a Distance-to-Fault Measurement

After calibrating your instrument, connect the cable you want to test to the RF output on the Agilent CSA. You will notice that the top four faults over the distance that you selected are shown in severity order with yellow markers. These are fault indicators and can be turned on/off under the View/Display menu. Even when these are turned off, you will see the return loss, distance of the fault from the RF output, and voltage standing wave ratio (VSWR) of those top four faults as shown in Figure 7. VSWR measures the impedance mismatch between the transmission line and a load; the higher the VSWR, the greater the mismatch.

Again, if your start distance is 0 m you will see a fault at 0 m that corresponds to your connection at the RF output. This is shown as fault two in Figure 1.

In order to determine the severity of the any other faults on screen you can also use markers to see the distance and return loss of up-to-four other faults at one time as shown in Figure 7. Press Marker to use up-to-four markers and their associated delta marker.

How to Pick the Best Cable Matches and Connections

It is important that your connections are solid so that you have little loss between cables. When choosing between different connectors and matching cables the Agilent CSA will help you make the best connection possible.

Figure 8 shows the DTF measurement with two 6-feet RG-214 Type-N cables connected with a Type-N female-to-female connector. You can see the fault at 6-feet is 32.3 dB. The higher the return loss, the better the connection/cable match.
Figure 9 shows the DTF measurement with the same two cables as shown above with a less than perfect connection. The return loss at 6-feet, fault #2, is now 20 dB. This measurement can be used to pick the best cable matches as well. If you have determined a good cable and connector you will be able to find the best matching cable using this same technique of comparing the return loss at a known connection. You can compare these different cables/matches by using the following technique of comparing two traces.

Comparing Two Traces
Faults in cables and connections can occur due to weather, erosion over time, construction damage, and many other reasons. The Agilent CSA allows you to save and name traces so that you can recall them at a later date. It is a good idea to make a DTF measurement and save that trace on new or newly repaired systems so that you can compare them later when doing maintenance check ups.

When saving a trace you can either name it yourself or the Agilent CSA will name it automatically. To name your trace, make sure you select Ask under the following menu: **Save**: Name: Filename: Ask.

To save your measurement press **Save**: Type: Trace: Device: Internal (or USB): Save Now. See menu in Figure 10a.

When recalling a saved file you can choose whether to view it as trace 1 or trace 2. The fault indicators and table will only show on trace 1; however, you can use markers on either trace 1 or trace 2.

To Recall a saved trace push the following: **Recall**: Type: Trace: Device: Internal (or USB): Destination: Trace 1 or 2: Recall Now. On your Agilent CSA, trace 1 will be in yellow and trace 2 will be in blue as in Figure 11.
To see the change in severity from the saved trace to the new trace press **Marker** and push **Marker Trace** to select trace 2. Select the Normal marker and then use the knob to scroll to the fault you want to evaluate. In Figure 11 you can see the marker readout for the old #3 fault is 29.8 dB while the current reading in the Fault Indicator Table for fault #3 is 21.4 dB. This difference of 8.4 dB may indicate a connection that has degraded, and may be loose, dirty or broken.

**Conclusion**

Your communication system needs to be reliable, so you need to be sure your cables and connections are clean, tight, and in good condition. The Agilent CSA spectrum analyzer with built-in bridge and signal source makes it easy to measure distance-to-fault and return loss, so you know the condition of the cables when you install them and during routine maintenance, and you can quickly find the problem when a repair is needed. Test results can be stored and recalled so you can monitor your system and identify potential problems before they become big problems. The Agilent CSA has outstanding RF performance in an easy-to-use, portable package so you can be confident in the measurements. And, the built in step-by-step calibration and test set-up graphics minimize the learning curve on a new instrument.
Remove all doubt

Our repair and calibration services will get your equipment back to you, performing like new, when promised. You will get full value out of your Agilent equipment throughout its lifetime. Your equipment will be serviced by Agilent-trained technicians using the latest factory calibration procedures, automated repair diagnostics and genuine parts. You will always have the utmost confidence in your measurements.

Agilent offers a wide range of additional expert test and measurement services for your equipment, including initial start-up assistance onsite education and training, as well as design, system integration, and project management.

For more information on repair and calibration services, go to:

www.agilent.com/find/removealldoubt