



**CX300 ComXpert**  
**Communication Service Monitor**  
VNA Option Guide



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VNA Option Guide

22163053 Rev.001



VIAVI Solutions  
1-844-GO-VIAVI  
[www.viavisolutions.com](http://www.viavisolutions.com)

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产品系列: CX300 - Communications Service Monitor

(Product Family)

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产品主体 (Main Product)						
印刷电路板组件 (PCB Assemblies)	X	O	O	O	O	O
内部配线 (Internal wiring)	X	O	O	O	O	O
显示器 (Display)	O	O	O	O	O	O
电池 (Batteries)	X	O	O	O	O	O
电源 (Power Supply)	X	O	O	O	O	O
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金属外壳零件和紧扣件 (Metal case parts and fixings)	X	O	O	O	O	O
塑料外壳零件 (Plastic case parts)	O	O	O	O	O	O
标签和胶带 (Labels and tapes)	O	O	O	O	O	O
配件 (Accessories)						
外接电缆和适配器 (External cables and adapters)	X	O	O	O	O	O
手册和其它印刷材料 (Handbooks and other printed material)	O	O	O	O	O	O
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# Record of Revisions

RECORD OF REVISIONS

REV.	DATE	ACCEPTANCE
001	September 2022	VIAVI

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# Preface

This preface explains how to use this manual. Topics discussed include the following:

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# About this Manual

## Scope of Manual

This manual describes test and measurement functions associated with the *CX300 ComXpert VNA Option*. Refer to the *CX300 ComXpert Communication Service Monitor Operation Manual* for information about test set operation, system settings, and Analog test and measurement functions.

## Intended Audience

This manual is intended for personnel who are familiar with VNA systems and operation of the *CX300 ComXpert Communication Service Monitor*.

This manual is intended for novice, intermediate, and experienced users who want to use the *CX300 ComXpert VNA Option* effectively and efficiently.

## Related Information

This is the *CX300 ComXpert VNA Option Guide 22163053*. This manual is to be used in conjunction with the following publications:

- *CX300 ComXpert Quick Start Guide, 22130635*, which provides basic operating and safety information
- *CX300 ComXpert P25 Option Guide, 22146777*, which provides information about the test and measurement functions found in the CX300 P25 options
- *CX300 ComXpert DMR Option Guide, 22163052*, which provides information about the test and measurement functions found in the CX300 DMR options
- *CX300 ComXpert Communication Service Monitor Operation Manual, 22130634*, which provides instructions to install, configure, and operate the CX300 ComXpert's standard test and measurement functions
- *CX300 Remote Programming Manual, 22146776*, which defines the Standard-Commands-for-Programmable-Instrument (SCPI) Consortium's SCPI standard and provides instructions for using this manual for various test and measurements
- *CX300 Maintenance Manual, 22130636*, provides basic instructions for assembling the instrument components, setting up the CX300 Test Set, instrument specifications, and instructions for removal, installation and calibration procedures

## Typographical Conventions

This manual uses the following typographical conventions:

**Table 1 Text formatting and other typographical conventions**

Item(s)	Example(s)
References to terms used to identify key areas of the UI such as screens, panes, menus, or toolbars.	Navigate to the <b>Date and Time screen</b> . Open the <b>RF Receiver settings menu</b> . Some controls are also accessed from the <b>Quick Access Toolbar</b> .
Hardware buttons, keys, or switches that you press or flip.	Press the <b>On button</b> . Flip the <b>Power</b> switch to the on position.
Software components such as buttons, menus, tabs, or fields on a PC-based or Web-based user interface	Click <b>Start</b> . Click <b>File &gt; Properties</b> . Type the name of the probe in the <b>Probe Name</b> field.
Directory names, file names, and code and output messages that appear in a command line interface or in some graphical user interfaces (GUIs).	<code>\$NANGT_DATA_DIR/results</code> (directory) – <code>test_products/users/defaultUser.xml</code> (file name) – <code>All results okay.</code> (output message)
Text you must type exactly as shown into a command line interface, text file, or a GUI text field.	– Restart the applications on the server using the following command: <code>\$BASEDIR/startup/npui_init restart</code> Type: <code>a:\set.exe</code> in the dialog box.
References to guides, books, and other publications appear in <i>this typeface</i> .	Refer to <i>Newton's Telecom Dictionary</i> .
Required arguments (text variables in code).	<code>&lt;password&gt;</code>

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## Conventions

### Symbols and Markings

The following conventions are found on the instrument and in product documentation:

**Table 2 Symbols and Markings**

	<b>NOTE</b> This symbol indicates a note that includes important supplemental information or tips related to the main text.
	<b>Attention Symbol</b> This symbol represents a general hazard. It may be associated with either a DANGER, WARNING, CAUTION, or ALERT message. See <a href="#">Table 3</a> for more information.

### Safety Definitions

This manual uses the following terms to indicate conditions or activities which are potential safety hazards:

**Table 3 Safety Definitions**

Term	Definition
<b>CAUTION</b>	Identifies conditions or activities that, if ignored, can result in equipment or property damage, e.g., Fire.
<b>Mise en Garde</b>	Identifiez les conditions ou les activités qui, si ignorées, peuvent entraîner des dommages à l'équipement ou aux biens, p. ex. un incendie.

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# Introduction to the CX300

This chapter provides a general description of the CX300 VNA (Vector Network Analyzer) option. Topics discussed in this chapter include the following:

- CX300 Overview ..... 1-2
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## 1.1 CX300 Overview

The CX300 ComXpert is a compact, bench-top communications test set for use in the Land Mobile Radio or Two-Way Communications Industry. The CX300 is ideal for performing preventative maintenance on two-way radios and their applicable support infrastructure.

Refer to the CX300 product brochure for a succinct overview of the unit, and to the CX300 Operation Manual for additional details.

The CX300 VNA (Vector Network Analyzer) software option provides various features for testing VNA radio systems.

## 1.2 CX300 VNA Option Features and Capabilities

This section highlights key features and capabilities of CX300 VNA software options.

### 1.2.1 VNA

VNA, Software identified as **VNA CX300-SCAA**. Option CX300-SCAA, provides the following test features:

- Selecting measurement mode
- Performing reflection measurements
- Performing DTF (Distance to Fault) measurements - Making a measurement
- Performing reflection - DTF measurements

The following accessory can be purchased for the CX300 ComXpert for the VNA Option:

- Mechanical Y-Cal kit

## 1.3 Verifying VNA Option Installation

The CX300 provides several test and measurement functions which allow the user to evaluate the transmit and receive performance of an analog communications system.

### 1.3.1 Factory Installed Option

When a VNA software option(s) is purchased as a factory installed option, the VNA software is ready to use when the test set is received from the factory.

### 1.3.2 Post Production Option

When a VNA software option is purchased post production, the option software and option license files must be installed on the test set by the end user. See the following steps for selecting and installing Options.

Refer to the CX300 ComXpert Communication Service Monitor Operation Manual for more information on option selection.

CX300 software is a field-upgradeable software which can be updated using StrataSync™ or a USB device.

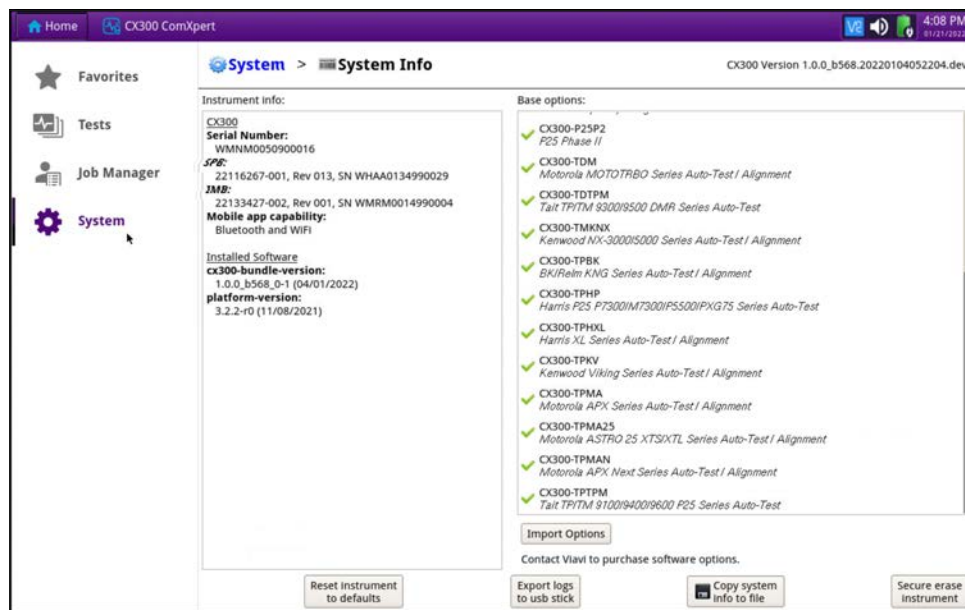


Figure 1-1 Example of System Info Screen

#### To Install CX300 Options:

1. If using a USB device, install the USB device.
2. Navigate to the System Info Screen. See [Figure 1-1](#).

3. Select the **Import Options** button. See [Figure 1-1](#) and [Figure 1-2](#).



**Figure 1-2 Example of Import Options Selected**

4. Select the Option to install, or use the Select All button. See [Figure 1-2](#).
5. Select Open.
6. Select OK. The Option selected is automatically installed to the system.

## 1.4 VNA Test Modes

the CX300 ComXpert has all of the measurement functions necessary to verify cable and antenna systems from Voltage Standing Wave Ratio (VSWR) to power measurements. In addition, the CX300 ComXpert makes distance-to-fault measurements to pinpoint a faulty location accurately.

VNA provides several test modes for the purpose of evaluating the transmit and receive performance of a VNA system. Each test mode contains controls and settings that are required to use the functions in the selected mode. The CX300 contains the following test modes:

- VSWR
- DTF



## 1.4.1 VSWR

To get maximum power into a load it is required that the load impedance match the generator impedance. Any difference in impedance or mismatching would not produce maximum power transfer. An impedance mismatch at the antenna system produces a reflective 'traveling wave', which goes in the opposite direction from the incident wave. As the two traveling waves cross each other in opposite direction, it produces an interference pattern called a "standing wave". VSWR (Voltage Standing Wave Ratio) is the ratio between the power sent forward to the cable and/or antenna and the amount of power that is reflected back to the transmitter.

Some of the consequences of having a high VSWR condition in cellular services include dropped calls, poor reception, and an overall unacceptable performance in the cell (or section of cell) covered by the base station antenna. Therefore, the VSWR of the antenna system including the feed line is one of the most critical factors in the service and maintenance of the RF transmitter systems.

## 1.4.2 DTF

In the DTF (Distance to Fault) measurement mode, you need to set the start and stop distances. The maximum measurable distance is displayed on the left side of the screen depending on the frequency setting. You can set any distance within the maximum measurable distance. Optimum resolution is achieved when the user setting distance is the same as the maximum measurable distance.

## 1.5 Accessing VNA Option

The following procedure describes how to select a test mode of operation.

### To Select Test Mode of Operation

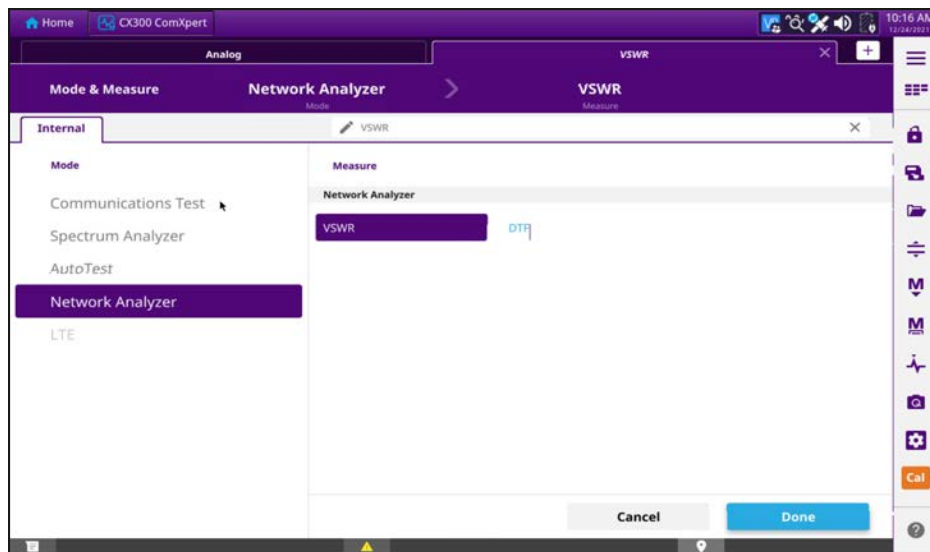


Figure 1-3 Example of Network Analyzer Menu

1. Navigate to the **Test Home Screen**.
2. Select the desired test mode from the **Network Analyzer Pane (VSWR or DTF)**.
3. Perform one of the following to load **VSWR** or **DTF**:
  - Press the **VSWR** or **DTF** button again.
  - Select the **Done Button**.

## 1.6 VNA User Interface Layout

The VNA User Interface (UI) uses the same layout, methods of navigation, and control used in the CX300 Analog Duplex test and measurement mode of operation. Refer to the *CX300 ComXpert Operation Manual* for a detailed description about the UI layout, accessing system and test screens, and configuring controls and settings.

# Using Network Analyzer

This chapter describes the test and measurement functions that are supported in VNA. Topics discussed in this chapter include the following:

- [VSWR Controls and Settings. . . . .](#) 2-2
- [DTF Controls and Settings. . . . .](#) 2-4

## 2.1 VSWR Controls and Settings

VNA controls and settings are configured from the **VNA** settings menu. Some controls are also accessed from the **Quick Access Toolbar** or **Function Toolbar**. The following VNA controls and settings are used to configure the characteristics of the VNA VSWR measurements:

**Table 2-1 VNA VSWR Controls and Settings**

<b>Control/Setting</b>	<b>Description</b>
<b>Frequency</b>	Frequency and span settings define the frequency range used to evaluate signals. If you know the frequency of the signal being evaluated, the center frequency should be set to match the signal's frequency. If you are investigating signals that are within a particular frequency range, it is best to enter a start and stop frequency to define the span.
<b>Amplitude</b>	This setting selects the Reference level and attenuation, You can set the reference and attenuation levels automatically or manually to optimize the display of the traces measured, as desired.
<b>General</b>	Select Data Points, Measurement Mode (Ret. Loss or VSWR).
<b>Trace</b>	You can set the number of measurements to be averaged for a <b>trace</b> presentation. When the averaging reaches to your setting, a new measurement value replaces the measurement value in sequence from the earliest. Trace types: Live, Captured, or Accumulated.

VSWR Menu showing options:

- Frequency
- Amplitude
- General
- Trace

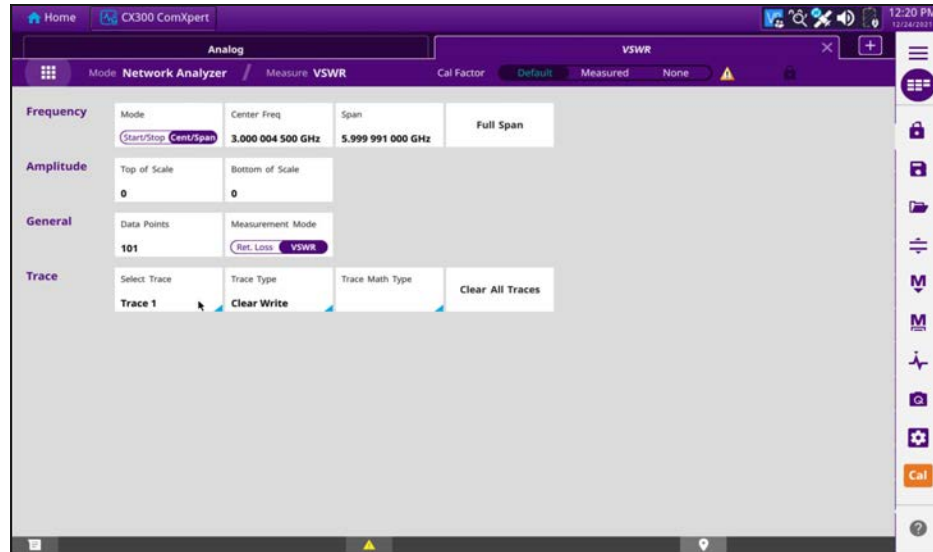


Figure 2-1 Example of VSWR Menu

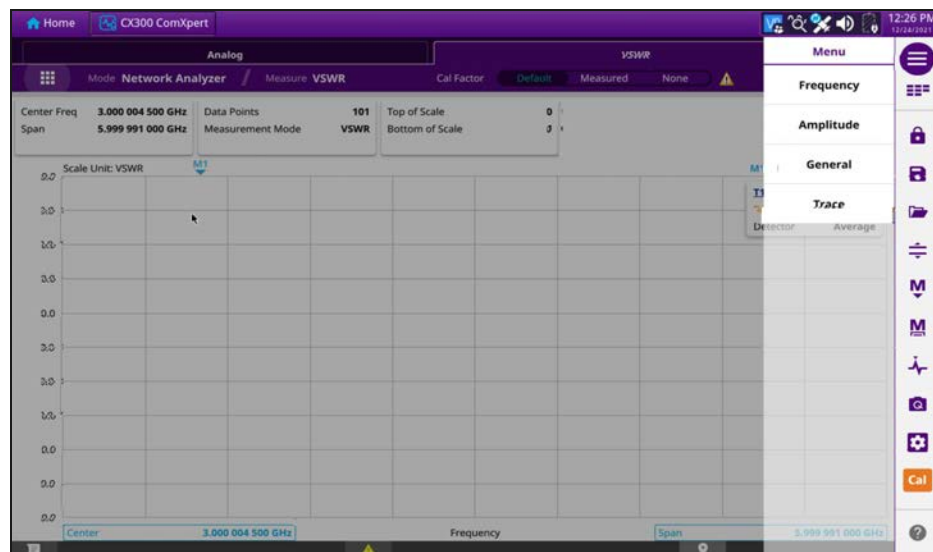


Figure 2-2 Example of VSWR Menu 2

## 2.2 DTF Controls and Settings

VNA controls and settings are configured from the **VNA** settings menu. Some controls are also accessed from the **Quick Access Toolbar** or **Function Toolbar**. The following VNA controls and settings are used to configure the characteristics of the VNA DTF measurements:

**Table 2-2 VNA DTF Controls and Settings**

<b>Control/Setting</b>	<b>Description</b>
<b>Distance</b>	Changes the distance in the DTF measurement. Values can be entered with the numeric keys.
<b>Amplitude</b>	This setting selects the Reference level and attenuation, You can set the reference and attenuation levels automatically or manually to optimize the display of the traces measured, as desired.
<b>Cable Definition</b>	Cable File Type (User or Standard), Cable Name, Velocity, and Loss.
<b>General</b>	Select Data Points, Measurement Mode (Ret. Loss or VSWR), and Unit (Feet or Meters).
<b>Trace</b>	You can set the number of measurements to be averaged for a <b>trace</b> presentation. When the averaging reaches to your setting, a new measurement value replaces the measurement value in sequence from the earliest. Trace types: Live, Captured, or Accumulated.

DTF Menu showing options:

- Distance
- Amplitude
- Cable Definition
- General
- Trace

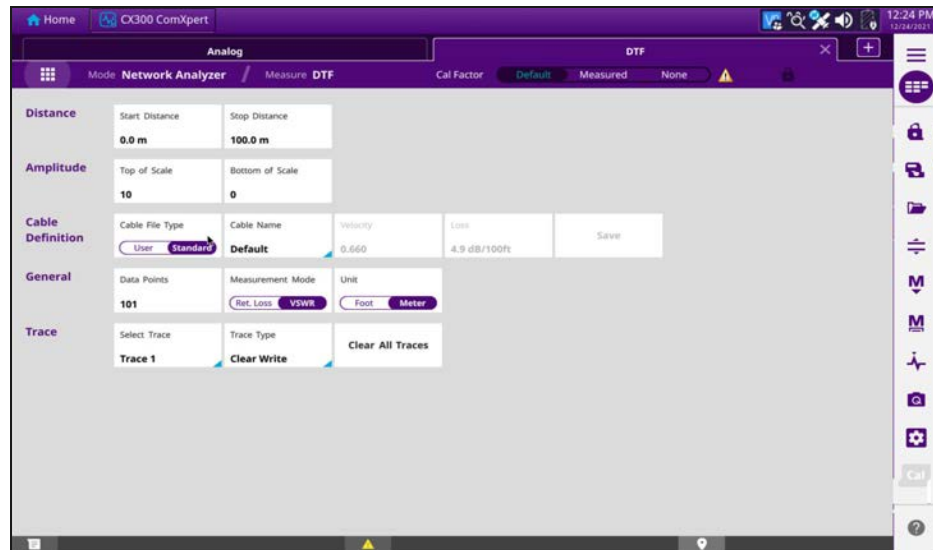


Figure 2-3 Example of DTF Menu

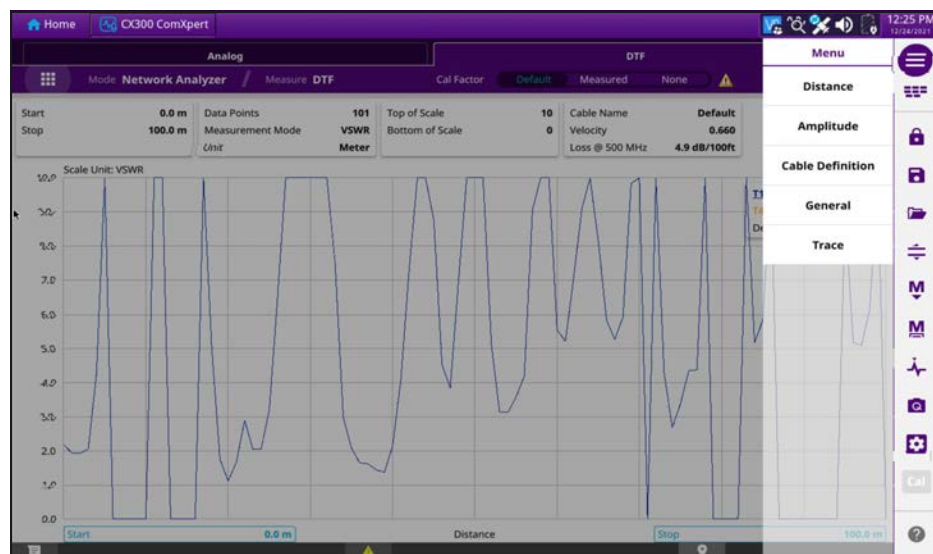


Figure 2-4 Example of DTF Menu 2

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# Performing Measurements

This chapter provides task-based instructions for using the CX300 ComXpert to establish VNA and to perform key VNA tests and measurements. This chapter describes how to use the CX300 in the following test scenarios.

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## 3.1 Selecting measurement mode

### 3.1.1 VNA Transceiver Test Description

The following instructions guide the user through an objective VNA Transmitter Test and a subjective VNA Receiver Test. It is not necessary to control the UUT through the UUT OEM tuner or programming software for this test.

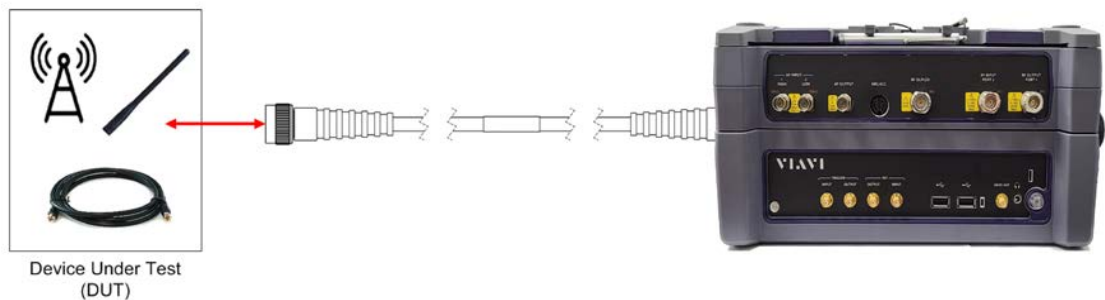
### 3.1.2 Equipment Needed

The following equipment is required to perform the test procedures defined in this section:

- CX300 ComXpert Test Set
- RF Coaxial Cable and adapters
- Mechanical Y-Cal kit

### 3.1.3 Hardware Setup Diagram

Connect the CX300 and DUT/UUT as shown in [Figure 3-1](#) and [Figure 3-2](#), and then proceed to the next section.



**Figure 3-1 Example of Hardware Setup**

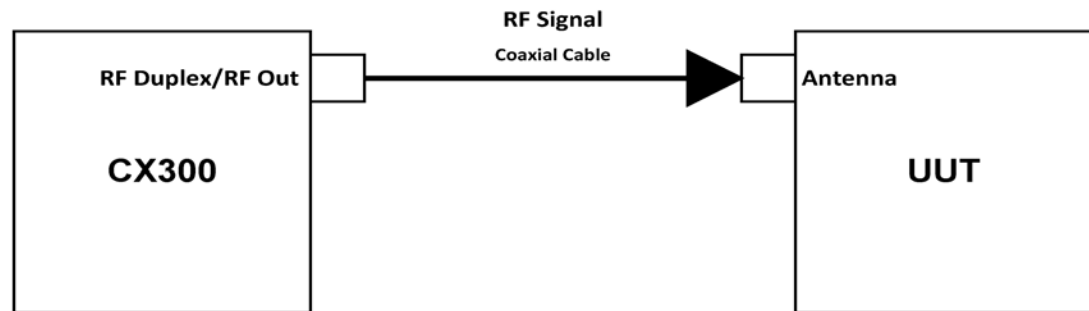


Figure 3-2 Example of Hardware Setup

### 3.1.4 Selecting measurement mode procedures

1. Press the **MODE** hard key.
2. Press the Spectrum Analyzer soft key. The Measure Off mode is selected by default.
3. Press the MEASURE hot key, and then select the measurement mode from the following choices:
  - Frequency
  - Amplitude
  - General
  - Trace

## 3.2 Configuring test parameters

## 3.3 Setting frequency

You can set frequencies manually using the Start Frequency/Stop Frequency or Center Frequency/Span. You can also select from the band list stored in the instrument. It is recommended to set the frequency to a value that covers the normal range of the measurement with enough margins.

## 3.3.1 Setting frequency Procedures

### 3.3.1.1 To set the start and stop frequencies:

1. Go to **Network Analyzer Mode** VSWR/DTF.
2. Press the **Frequency Mode** and select **Start/Stop**.
3. Select inside the **Start Freq** tab.
4. Enter a value by using the numeric keys on the popup. You can also use the arrow keys.
5. Select the unit: GHz, MHz, or kHz.
6. Select inside the **Stop Freq** tab.
7. Enter a value by using the numeric keys on the popup. You can also use the arrow keys.
8. Select the unit: GHz, MHz, or kHz.

See [Figure 3-3](#).

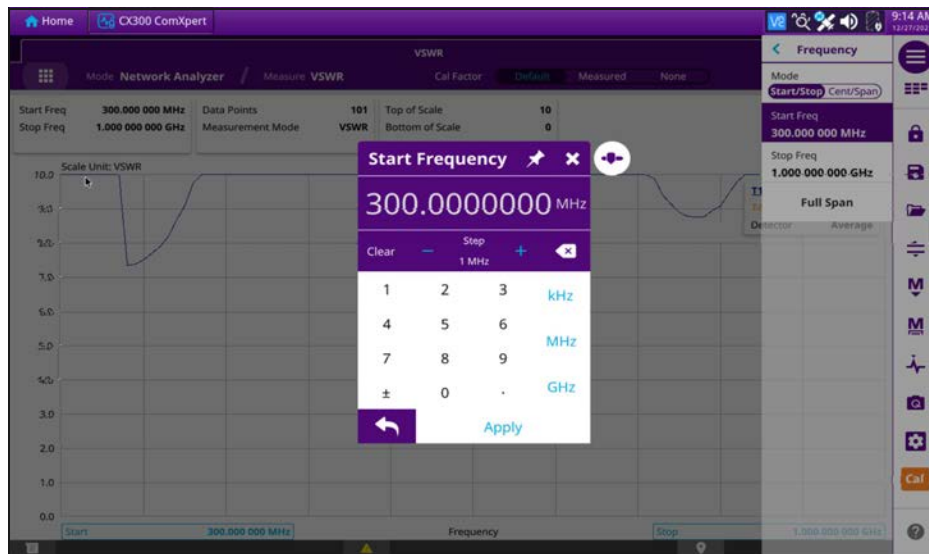


Figure 3-3 Example of Setting Frequency

### 3.3.1.2 To set the center frequency and span:

1. Go to **Network Analyzer Mode** VSWR.
2. Press the **Frequency Mode** and select **Cent/Span**.
3. Select inside the **Center Freq** tab.

4. Enter a value by using the numeric keys. You can also use the arrow keys.
5. Select the unit: GHz, MHz, or kHz.
6. Select inside the **Span** tab.
7. Enter a value by using the numeric keys. You can also use the arrow keys.
8. Select the unit: GHz, MHz, kHz, or Hz.

## 3.4 Performing calibration

To get reliable and accurate measurement results, you must perform a calibration on your instrument after setting frequencies and prior to making a measurement. Perform calibration for Reflection, DTF, and Cable Loss.

A Mechanical Y-Cal kit can be purchased for the unit when ordering the VNA Option. To perform the calibration, you will need to have the following ready:

- Mechanical Y-Cal kit



### NOTE

It is recommended that you perform a calibration right at the Reflection/RF Out port of the instrument without using an extension cable in order to minimize a measurement error. If using an extension cable is inevitable, you need to use a phase stable cable and perform the calibration at the open end of the extension cable.



### CAUTION

Bending or moving the extension cable while making a measurement may cause errors in the measurement.

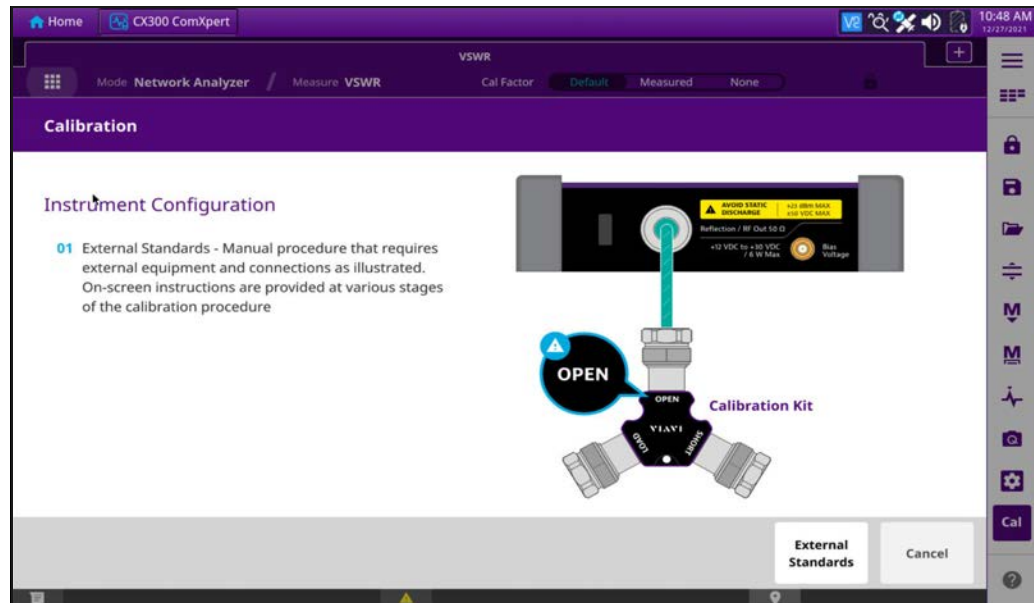


Figure 3-4 Calibration Setup with Calibration Kit (Mechanical Y-Cal kit)

### 3.4.1 Calibration Procedure

1. Go to **Network Analyzer Mode** VSWR.
2. Press the **Cal** soft key on the side toolbar. The on-screen instruction for the calibration appears.



Cal Soft Key

3. Connect the OPEN connector of the CAL Kit directly to the **Reflection/RF Out port** or at the end of the connected extension cable.
4. Press the **Continue** soft key to start calibration.
5. Connect the SHORT connector of the CAL Kit directly to the **Reflection/RF Out port** or at the end of the connected extension cable.
6. Press the **Continue** soft key to continue calibration. The calibration progress bar appears.

7. Connect the LOAD connector of the CAL Kit directly to the **Reflection/RF Out port** or at the end of the connected extension cable.
8. Press the Continue soft key to continue calibration. The calibration progress bar appears. After completion, the calibration status on the screen changes to **ON**.
9. For Calibration Setup Diagram see [Figure 3-4](#).

## 3.5 Setting distance

In the DTF measurement mode, you need to set the start and stop distances. The maximum measurable distance is displayed on the left side of the screen depending on the frequency setting. You can set any distance within the maximum measurable distance. Optimum resolution is achieved when the user setting distance is the same as the maximum measurable distance.

### 3.5.1 Setting distance Procedures

1. Go to **Network Analyzer Mode DTF**.
2. Select **Distance** on the Menu.
3. Select inside the **Start Distance** tab.
4. Enter a value by using the numeric keys. You can also use the arrow keys.
5. Select the **Apply** key.
6. Select inside the **Stop Distance** tab.
7. Enter a value by using the numeric keys. You can also use the arrow keys.
8. Select the **Apply** key.
9. See [Figure 3-5](#).

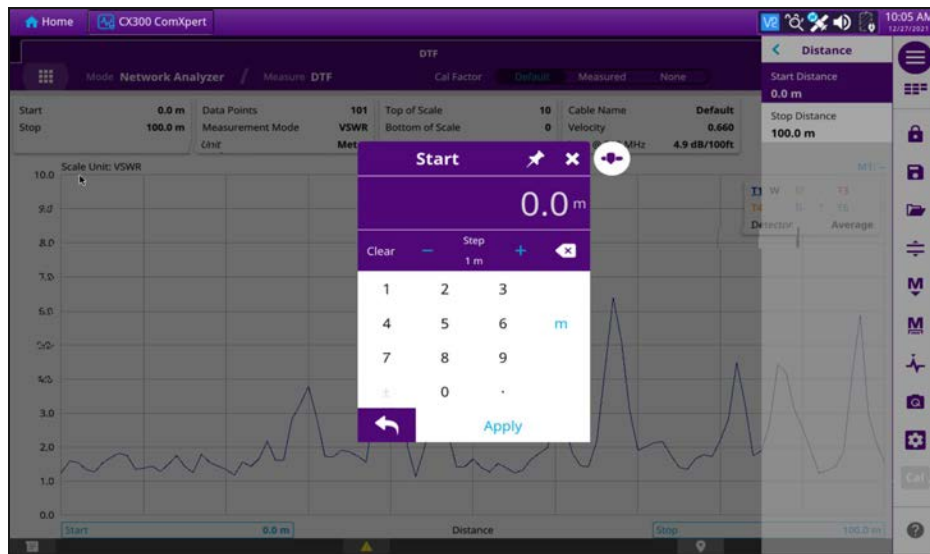


Figure 3-5 Example of Setting Distance

### 3.5.1.1 Adjusting Scale

You can adjust the Y-axis scale to optimize the display of measurement trace(s). Adjusting scale does not affect the calibration state.

### 3.5.1.2 Adjusting Scale Procedures

1. Go to **Network Analyzer Mode DTF**.
2. Select **Amplitude** on the Menu.
3. Select inside the **Top of Scale** tab.
4. Enter a value by using the numeric keys. You can also use the arrow keys.
5. Select the **Apply** key.
6. Select inside the **Bottom of Scale** tab.
7. Enter a value by using the numeric keys. You can also use the arrow keys.
8. Select the **Apply** key.
9. See [Figure 3-6](#).



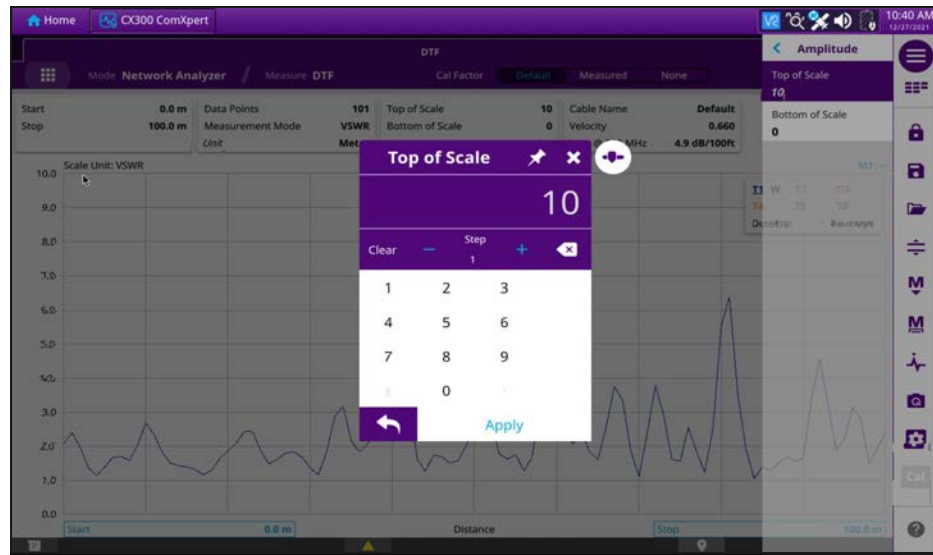


Figure 3-6 Example of Adjusting Scale

## 3.5.2 Connecting a cable

### 3.5.2.1 Connecting a cable for Reflection and DTF measurements

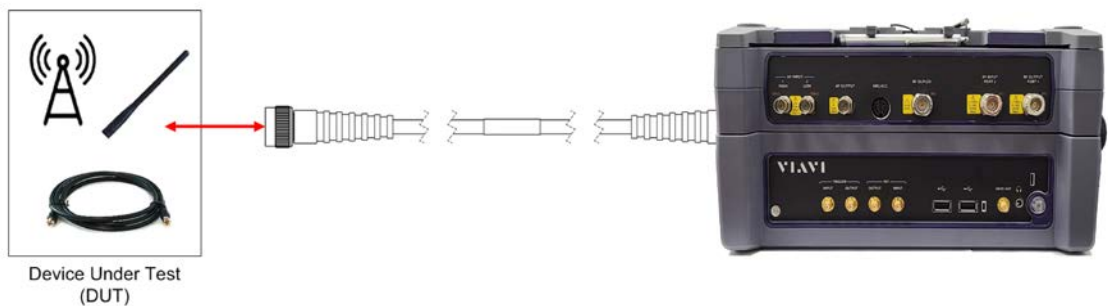


Figure 3-7 Example of Hardware Setup

Connect the CX300 and DUT/UUT as shown in [Figure 3-7](#) and [Figure 3-8](#), and then proceed to the next section.

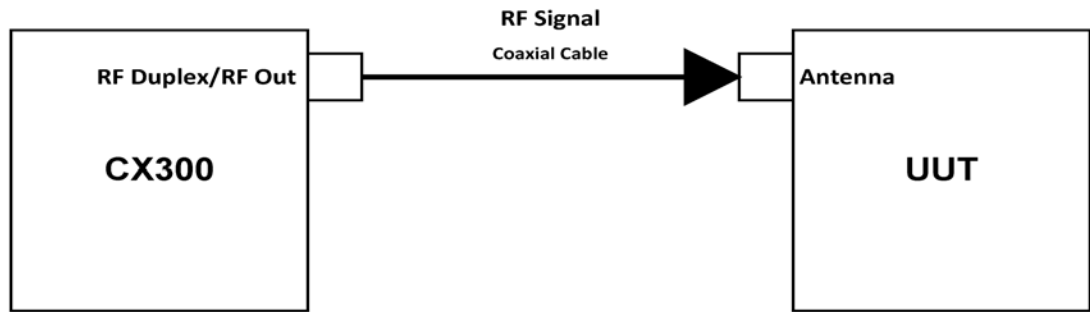


Figure 3-8 Example of Hardware Setup

## 3.6 Performing Reflection measurements

The Reflection measurement can be used to characterize cable and antenna system to ensure transmission line impedance performance and signal reflection characteristics of cell-site across a specific frequency range in voltage standing-wave ration (VSWR) or return loss.

### 3.6.0.1 Equipment Needed

The following equipment is required to perform the test procedures defined in this section:

- CX300 ComXpert Test Set
- RF Coaxial Cable and adapters
- Mechanical Y-Cal kit

### 3.6.1 Making a VSWR measurement

1. Make a proper cable connection as described in [“Connecting a cable for Reflection and DTF measurements”](#).
2. Go to **Network Analyzer Mode** VSWR.
3. Select **General** on the Menu.
4. Select inside the **Data Points** tab to change the resolution of your measurement. Changing the data point does not affect current calibration.
5. Enter a value by using the numeric keys. You can also use the arrow keys.
6. Select the **Apply** key.

See [Figure 3-9](#).



**NOTE**

The larger number you choose, the higher resolution you get and the longer the instrument takes to sweep and display results. Selecting the data point larger than what you need for a measurement will result in unnecessarily long sweep time. It is recommended that you select high resolution data points only for an instance of measuring wide frequency bands or requiring precise measurement data.

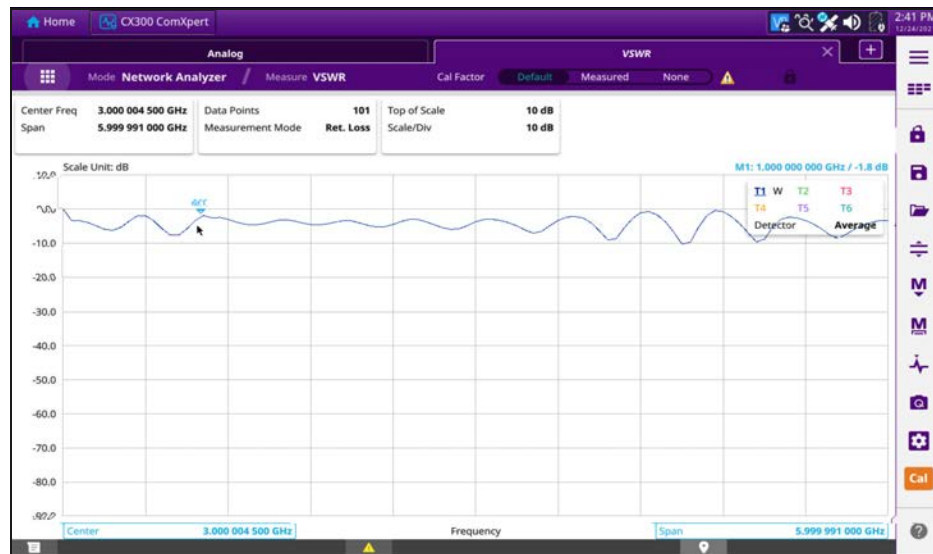


Figure 3-9 Example of Reflection measurement in return loss scale

## 3.7 Performing DTF measurements

The Distance-To-Fault (DTF) measurement can be used to accurately identify fault locations in the cell-site transmission (cable and feed line) system, indicating signal discontinuities in VSWR or return loss over distance in meter or foot. This measurement precisely pinpoints the location of such things as damaged or degraded antennas, connectors, amplifiers, filters, and duplexers.

### 3.7.1 Making a DTF measurement

1. Make a proper cable connection as described in [“Connecting a cable for Reflection and DTF measurements”](#).
2. Go to **Network Analyzer Mode DTF**.
3. Select **General** on the Menu.

4. Select inside the **Data Points** tab to change the resolution of your measurement. Changing the data point does not affect current calibration.
5. Enter a value by using the numeric keys. You can also use the arrow keys.
6. Select the **Apply** key.
7. See [Figure 3-10](#).

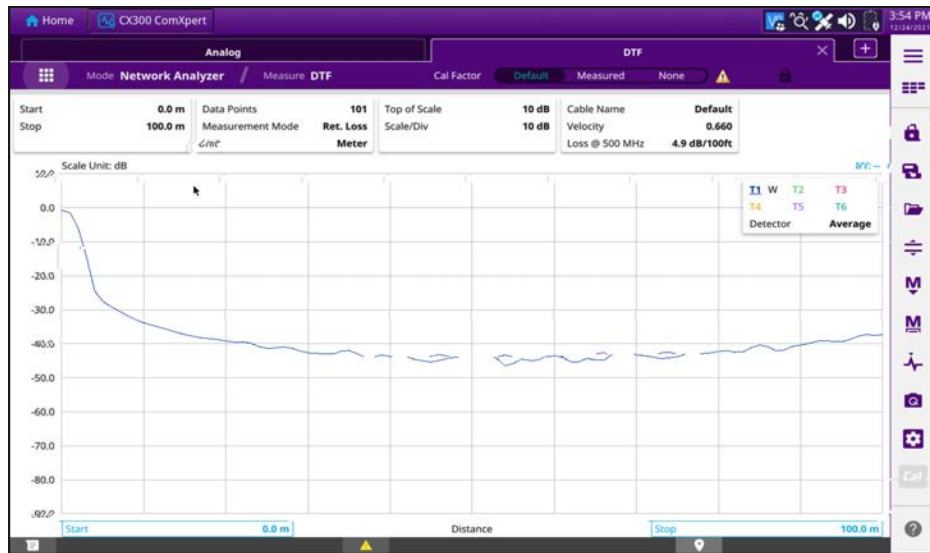


Figure 3-10 Example of DTF measurement



**NOTE**

The larger number you choose, the higher resolution you get and the longer the instrument takes to sweep and display results. Selecting the data point larger than what you need for a measurement will result in unnecessarily long sweep time. It is recommended that you select high resolution data points only for an instance of measuring wide frequency bands or requiring precise measurement data.

## 3.8 Performing cable procedures and cable loss measurements

### 3.8.1 To select a custom cable

1. Go to **Network Analyzer Mode DTF**.
2. Select **Cable Definition** on the Menu.
3. Under **Cable File Type** select **User**.
4. Select inside the **Velocity** tab.
5. Enter a value for **Cable Velocity** by using the numeric keys. You can also use the arrow keys.
6. Select the **Apply** key.
7. Select **Save** on the **Cable Definition** menu.
8. See [Figure 3-11](#).

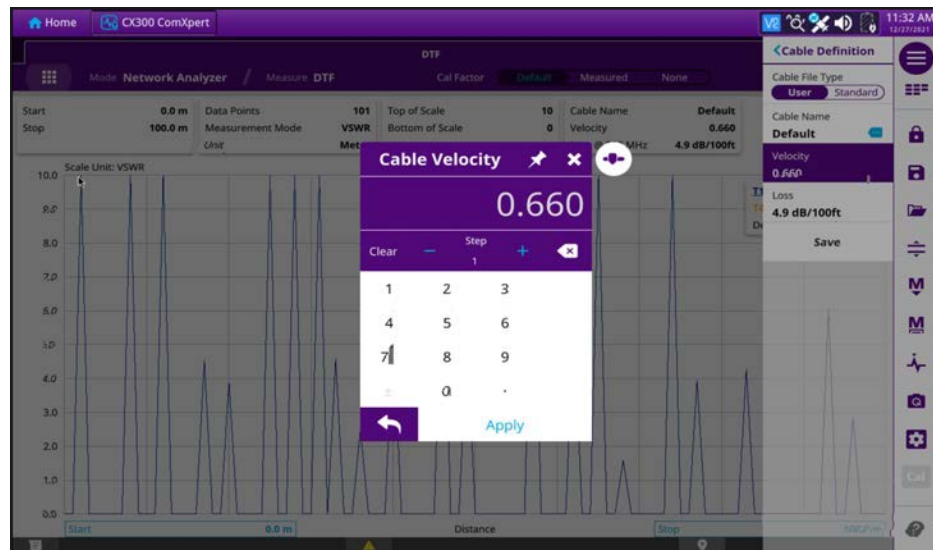


Figure 3-11 Example of Cable Definition/Cable Velocity

### 3.8.2 To select a cable from the Cable List

1. Go to **Network Analyzer Mode DTF**.
2. Select **Cable Definition** on the Menu.
3. Under **Cable File Type** select **Standard**.
4. Select inside the **Cable Name** tab.

5. Select **Cable Name** from the list.
6. Select the **Apply** key.
7. See [Figure 3-12](#).

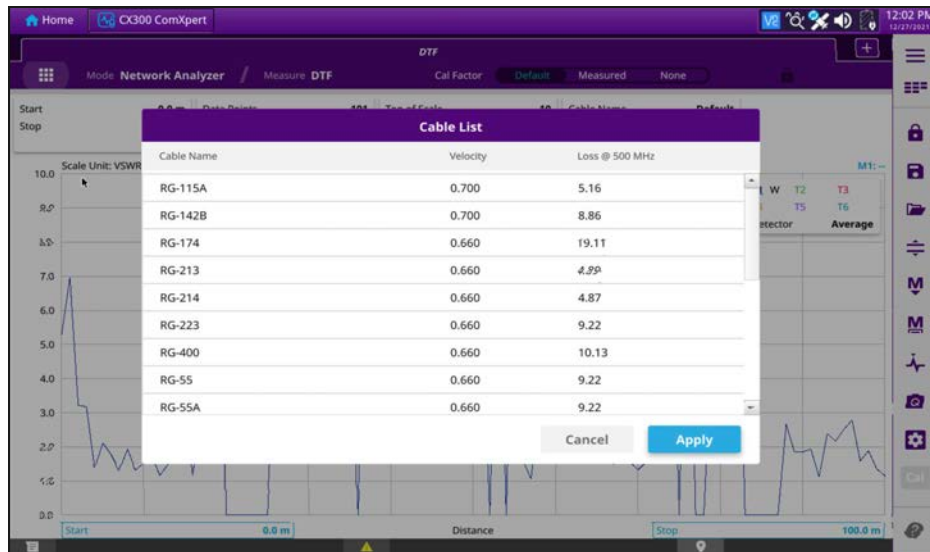


Figure 3-12 Example of Cable List

### 3.8.3 To select the Cable Loss or to define the cable loss

1. Go to **Network Analyzer Mode DTF**.
2. Select **Cable Definition** on the Menu.
3. Under **Cable File Type** select **User**.
4. Select inside the **Loss** tab.
5. Enter a value for **Cable Loss** by using the numeric keys. You can also use the arrow keys.
6. Select the **Apply** key.
7. Select **Save** on the **Cable Definition** menu.
8. See [Figure 3-13](#).



#### NOTE

The velocity affects the calculation of the distance and the cable loss affects the peak level of the discontinuity in a DTF measurement.

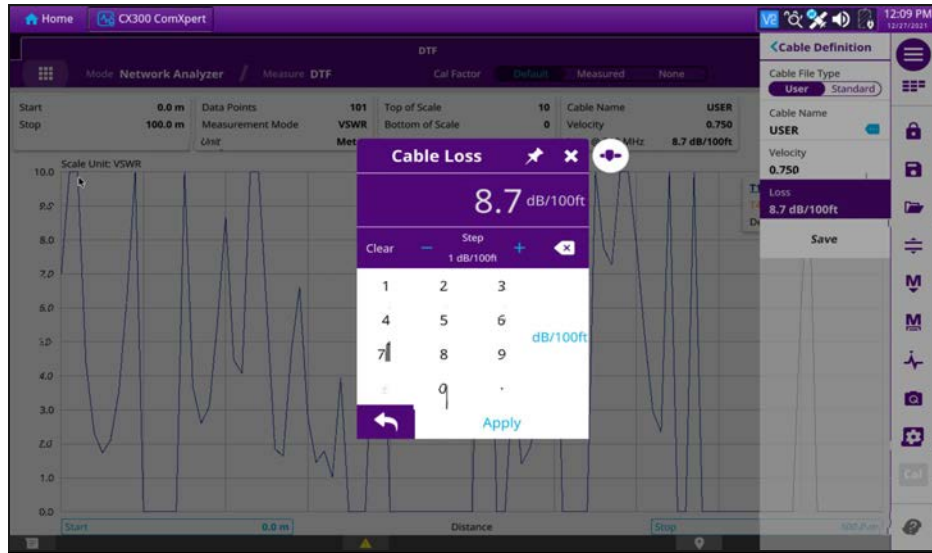


Figure 3-13 Example of Cable Loss

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# Terms and Acronyms

## A - B

**ACC** — accessory

**AES** — Advanced Encryption Standard

**AF** — Audio Frequency

**AGC** — Automatic Gain Control

**Avg** — average

**BER** — Bit Error Rate

## C - D

**C4FM** — A type of modulation called C4FM, which is an acronym for “compatible 4 level frequency modulation.

**dBm** — decibel milliwatts

**DES** — Data Encryption Standard

**DEST ID** — Destination Identifier

**DTF** — Distance to Fault

- F - L**
- FM** — Frequency Modulation
  - GUI** — Graphic User Interface
  - HP** — High Pass in relation to High Pass filter
  - kHz** — kilohertz
  - LP** — Low Pass in relation to Low Pass Filter
- M - N**
- mHz** — millihertz
  - MHz** — megahertz
  - MIC** — microphone
  - Mod** — Modulation
  - NAC** — Network Access Code
- P - S**
- RF** — Radio Frequency
  - SCCB** — Secondary Control Channel Broadcast
  - Sym Dev** — Symbol Deviation
- U - Z**
- TGID** — Talk Group Identifier
  - UI** — User Interface
  - USB** — Universal Serial Bus
  - UUT** — Unit Under Test
  - VNA** — Vector Network Analyzer
  - VSWR** — Voltage Standing Wave Ratio
  - WACN** — Wide Area Communications Network



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**22163053 Rev. 001**  
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**English**

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