ASTRONICS
TEST SYSTEMS

R8200 VNA Overview

R8200 Communications System Analyzer
Vector Network Analyzer (VNA)

R8200 VNA Overview

The purpose of this document is to inform and demonstrate the most important features and functions of the R8200 Vector Network Analyzer (VNA) in operational testing applications.

The R8200 incorporates a single-port Vector Network Analyzer (VNA) with a frequency range up to 6 GHz. Maximum measurement accuracy is achieved with the included Open/Short/Load calibration kit. This VNA enables near-instantaneous measurements of cable/antenna Return Loss (RL) and Voltage Standing Wave Ratio (VSWR). The Distance-To-Fault (DTF) function is a Frequency Domain Reflectometer (FDR). It sweeps and profiles discontinuities in the transmission line to accurately pinpoint the faulty components and significantly reduce the time to locate and repair. Verifying your communications infrastructure performance and rapidly locating impairments has never been easier.

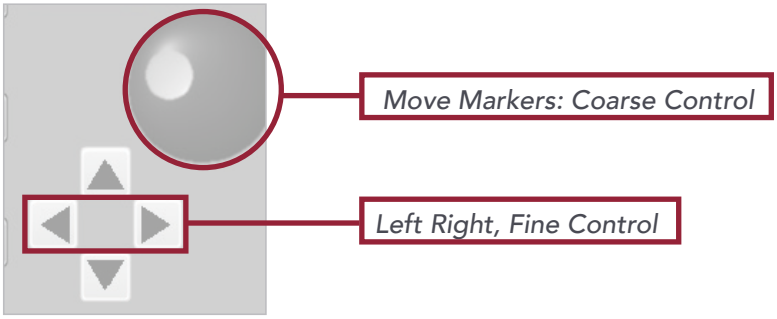
Features and Functions

- Near Real Time Measurements
- 101 to 10K Trace points
- Six markers for each trace with Absolute or Delta modes
- Start/Stop or Center/Span frequency entry
- Library of Calibration Kits and Cable Types
- Measurements
  - » Simultaneous VSWR/Return Loss
  - » Cable Loss
  - » RF passive components, Filters, Duplexers etc, Test & Align
  - » Distance to Fault (Return Loss)
- Trace Processing
  - » Smoothing
  - » Averaging
  - » IF BW
  - » Scaling

Basic User Interface Navigation

Trace Markers

There are 6 trace markers for each trace that are moved and set by:



Starting the VNA Application

- Press blue **"Instruments"** button & select **"Single-Port VNA"**
- Defaults to Return Loss/VSWR Mode
- Once started, it runs in the background and remembers your settings even if you ESC the VNA instrument

What is VNA?

Overview

A Vector Network Analyzer (VNA) is much like a multimeter that measures resistance. But where a multimeter measures a resistor at DC (0 Hz), a VNA measures resistance of an RF circuit at its operating frequency, measuring both the resistance and the phase of the circuit.

1-port: forward reflected power only

Sends a signal to the DUT and measures the reflected signal from the DUT

Compare VNA and Tracking Generator

VNA – Measures both magnitude and phase with built-in directional coupler

Tracking Generator – Measure transmitted signal through DUT unless used with an external coupler (return loss bridge)

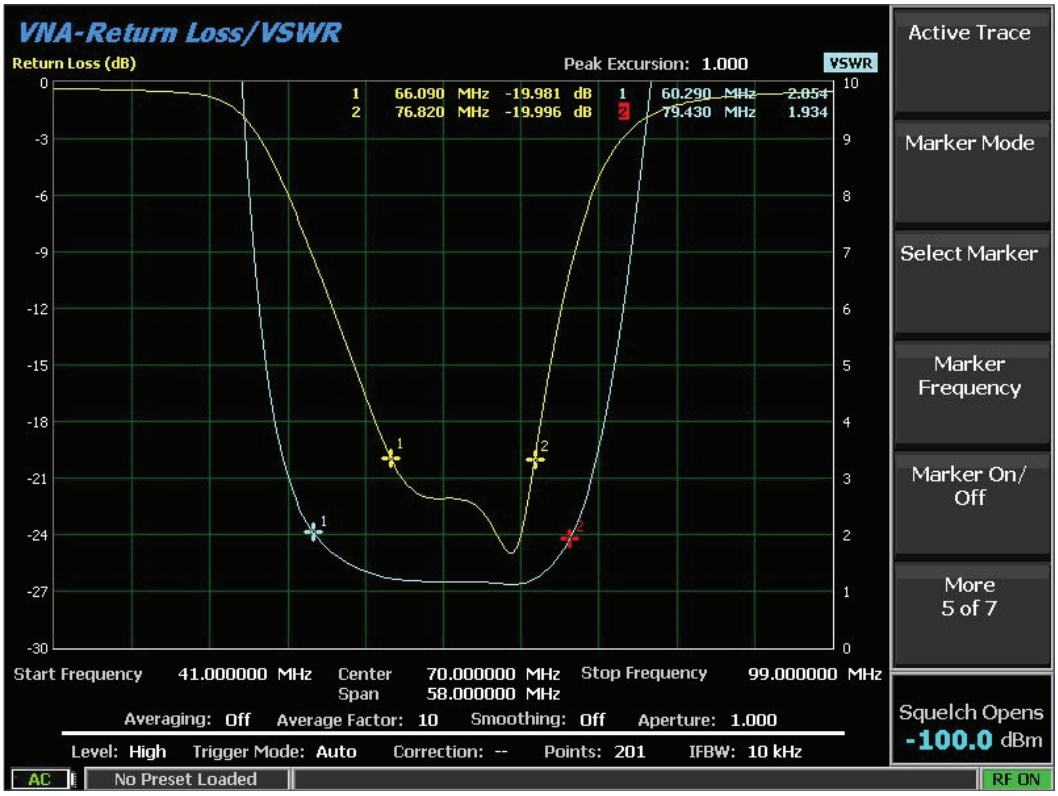
Specifications

Best-in-Class performance

- Frequency Range: 1 MHz - 6 GHz
- Frequency Resolution: 20 Hz
- Frequency Accuracy:
  - » Aging: ±0.1 ppm / year
  - » Temp.: ±0.01 ppm
- Measurement Bandwidths: 10 Hz to 100 kHz (1-3-10 sequence)
- Temperature Stability: 0,015 dB/°C
- Output Power: - 3 dBm (High), -30 dBm (Low)
- Accuracy of reflection measurement:
  - » -15 dB to 0 dB, ±0.4 dB / ± 3 deg
  - » -25 dB to -15 dB, ±1.0 dB / ± 6 deg
  - » -35 dB to -25 dB, ± 3dB / ± 20 deg
- Trace Noise Magnitude (IFBW 1 kHz): 0.005 dB rms
- Measurement Speed: 100 µs/data point
- Measurement Points: 101 to 10001

Three “Displays” or modes of operation (more to come)

- Return Loss/VSWR Mode
- Distance to Fault (Return Loss)
- Calibration



Return Loss/VSWR Mode

What does it show?

The Return Loss and VSWR application allows a user to view the quality of matching of a transmission system versus frequency. Both Return Loss and VSWR are conveniently displayed on a single screen to allow a user to quickly assess system performance in the domain of choice. Multiple markers may be placed and measured against a reference marker to determine relative match performance across frequency.

What is it used for?

- Testing and tuning antennas

- Testing and tuning passive RF components such as filters (notch, bandpass, lowpass, highpass) , diplexers, duplexers, combiners, etc.
- Measuring cable loss

Calibration

- See Calibration Mode for Details
- Correction On/Off: turn on and off the calibration correction
- Compensate for System and Test Cable Characteristics

Frequency

- Start / Stop Frequency Entry
- Center Frequency / Span Entry

Balancing measurement accuracy and measurement speed

- Output Level
  - » High – Increase Dynamic Range, Reduce Noise
  - » Low – Reduce Cross-Talk and Interference
- # of Points
  - » More points increase resolution but increase sweep time
- IFBW
  - » Impacts Calibration. Set Before Calibration
  - » Smaller BW increases resolution and lowers noise floor
  - » Smaller BW increases sweep time
- Averaging
  - » Averaging: Each point is averaged over time
  - » Lowers Noise Floor
  - » Less responsive to rapid changes
- Smoothing
  - » Averages each point with surrounding points
  - » Provides smoother traces
  - » Can provide misleading information if overdone

Trace scaling

- Auto Scaling
- Manual Scaling
  - » Ref Level: value at the top of the scale
  - » Vertical Scale: range of values per division

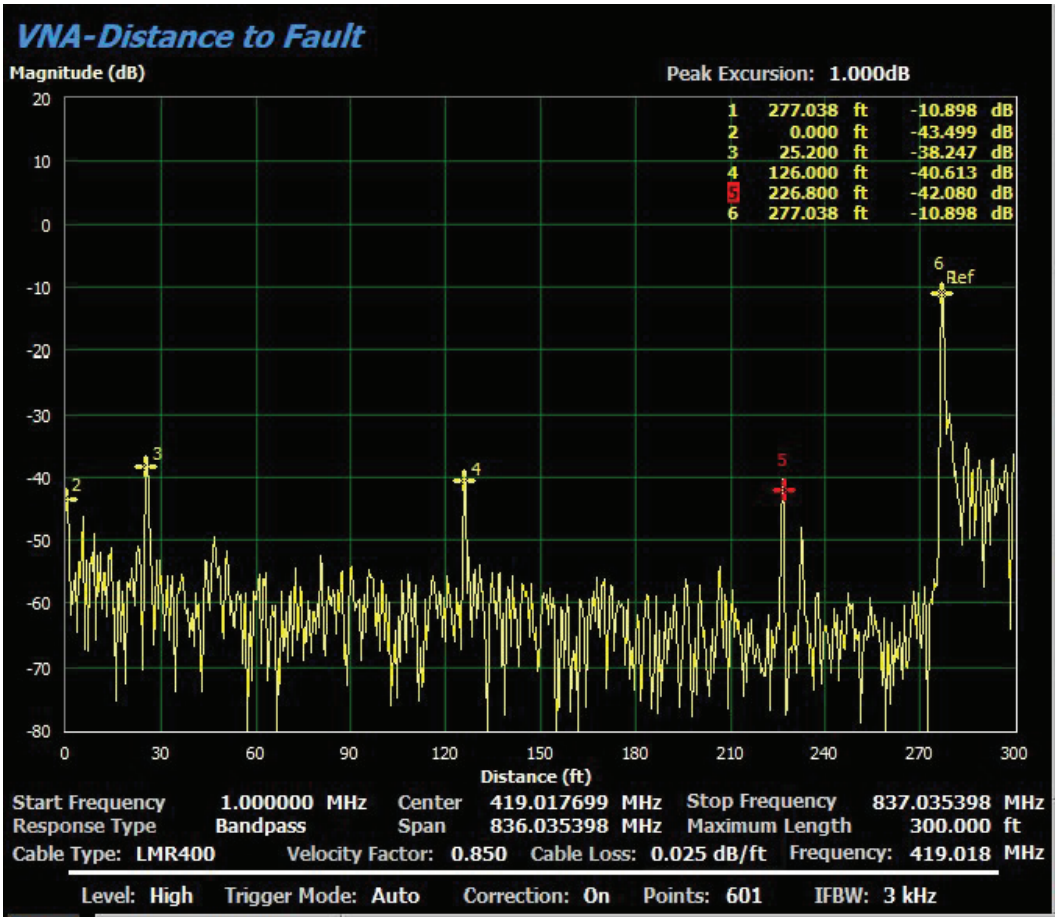
Trace Triggering

- Freeze: stops the sweep
- Single: sweeps once, then stops
- Auto: Sweeps continuously

Markers

- Active Trace: Selects the working trace
  - » Return Loss: Yellow trace measured on left vertical axis
  - » VSWR: Cyan trace measured on right vertical axis
- Mode: Off, Absolute or Delta
  - » Off: No markers displayed on this trace
  - » Absolute: Marker value is actual measured value
  - » Delta: Marker value is relative to Reference Marker
  - » Each of the two traces has its own mode
- Turning markers on and off
  - » Select Marker: 1 through 6 for each trace
  - » Marker On/Off: turn selected marker off to remove
- Placing markers
  - » Numerically
    - Marker Frequency: enter frequency to set marker position
  - » Visually
    - Scroll Wheel (Coarse Tuning)
    - Left/Right Arrow Keys (Fine Tuning)
  - » Automatically
    - Max/Min: place marker on highest or lowest data point
    - Peak/Valley
      - › **Peak Excursion: defines how much the trace must fall or rise on both sides of a local min/max to be identified as a peak/valley.**
      - › **Left / Right: step directly from one peak/valley to the next.**

Distance To Fault (DTF) Mode



What does it show?

The Distance To Fault application allows the R8200 to sweep the response of a system versus frequency, and via transform domain analysis, determine locations of mismatches along a transmission line. The necessary transmission line parameters such as velocity factor and frequency dependent loss values can be entered manually or recalled from a library of standard cable types.

The user can zoom into segments of the transmission line of interest. Also, sweep settings may be adjusted to coincide with a frequency range of interest. Multiple markers may be placed on the trace to accurately identify location of anomalies and their magnitudes.

What is it used for?

- Measure distance to fault in RF transmission infrastructure
- Identify type of fault
- Pinpoint failed RF component
- Provide guidance to tower crew on areas to focus their inspection efforts

Calibration

- See Calibration Mode for Details
- Correction On/Off: turn on and off the calibration correction
- Compensate for System and Test Cable Characteristics

Time = Distance

- Frequency Domain data is transformed into Time Domain Data
- Time data is displayed as distance
- Distance units: Meters or Feet
- Cable type
  - » Velocity Factor: percentage of speed of light that signals travel in the cable.
  - » Cable Loss: amount of signal lost in 1 meter or foot of cable.
    - Allows DTF to compensate for cable loss when displaying Return Loss values along the length of the cable.
  - » Cable design and materials impact both of these cable properties
  - » Cable manufacturers provide this data on the product datasheet
- Max Distance
  - » User provided approximation of cable length to set the range and scale of the distance trace.
  - » Minimum value allowed is based on a number of settings such as center frequency.
- Start/stop distance: user can “zoom into” a segment of cable.
  - » Very helpful when sweeping a cable that is significantly shorter than the minimum cable length limitation at certain settings.

Response Type: Three ways to transform Frequency Domain to Time Domain

- Bandpass:
  - » Center Frequency: user adjustable value not available in lowpass types
- Lowpass: Simulates the results given by a Time Domain Reflectometer. The shaper of the lowpass response indicates the nature of the discontinuity (inductive, capacitive, or resistive)
  - » Impulse
  - » Step: Integral of impulse response which relates to the impedance of the transmission line.

Balancing measurement accuracy and measurement speed

- Output Level
- # of Points
- IFBW – impacts calibration

Trace scaling

- Auto Scaling
- Manual Scaling
  - » Ref Level: value at the top of the scale
  - » Vertical Scale: range of values per division

Trace Triggering

- Freeze: stops the sweep
- Single: sweeps once, then stops
- Auto: Sweeps continuously

Markers

- Mode: Off, Absolute or Delta
  - » Off: No markers displayed on this trace
  - » Absolute: Marker value is actual measured value
  - » Delta: Marker value is relative to Reference Marker
- Turning markers on and off
  - » Select Marker: 1 through 6
  - » Marker On/Off: turn selected marker off to remove
- Placing markers
  - » Numerically
    - Marker Distance: enter distance to set marker position
  - » Visually
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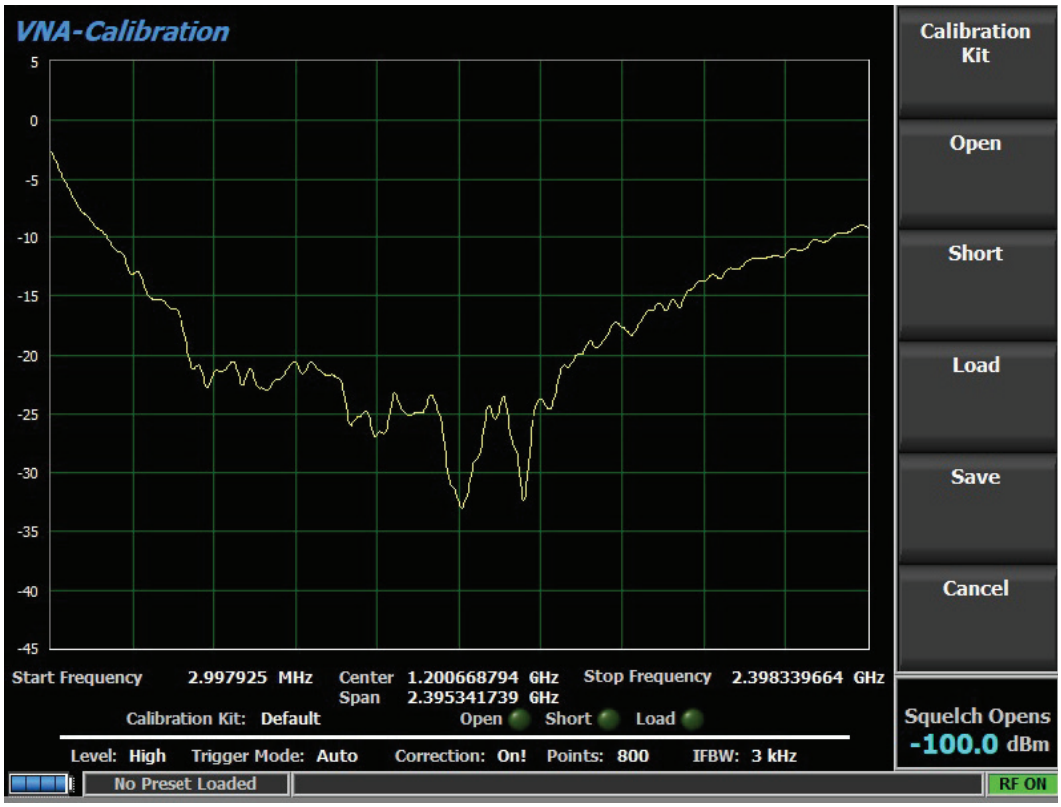
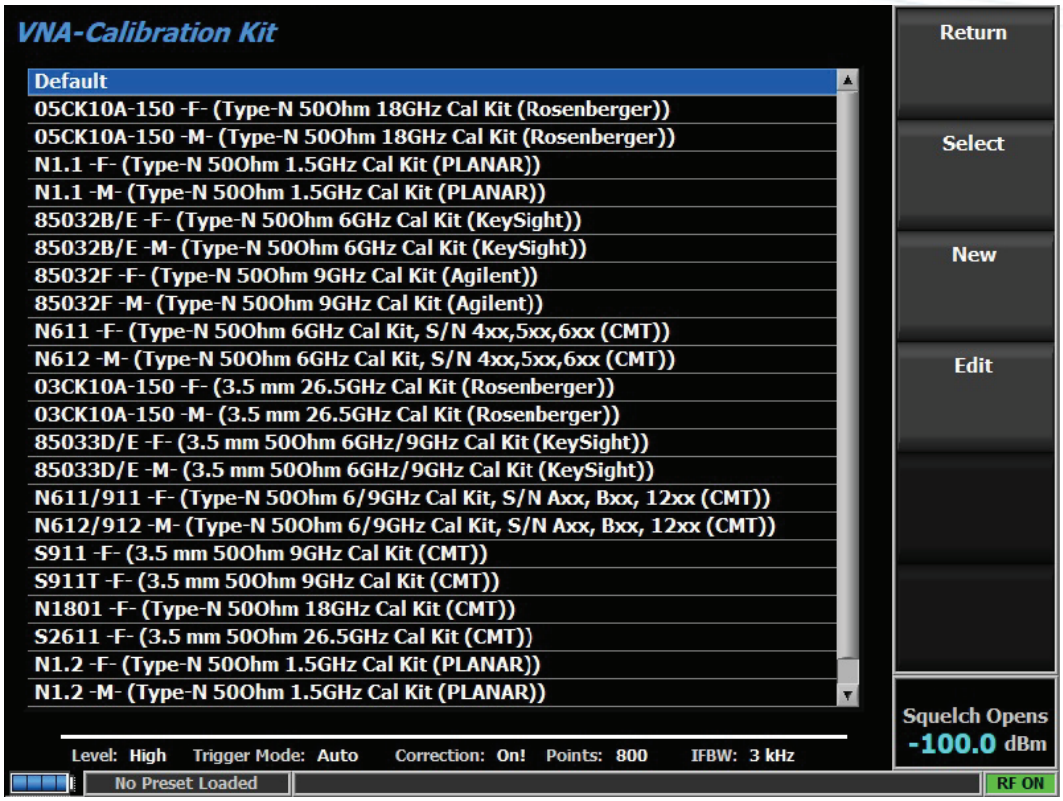
Calibration Mode



What does it do?

- Not the same as periodic factory calibration
- Correction or user-calibration
  - » Compensate for test cables, fixtures, temperature changes
- Performed when any hardware is changed in the test setup or certain parameters are changed in the software
- Compensate for calibration kit
  - » Cal Kit Library
    It is impossible to make a perfect short circuit, as there will always be some inductance in the short. It is impossible to make a perfect open circuit, as there will always be some fringing capacitance. The R8200 has data stored about the common devices in a calibration kit. Additional, user defined calibration kits can be loaded into the instrument from the manufacturer's datasheet.



How does it work?

- Connect the calibration standards and press the appropriate button
  - » Open
  - » Short
  - » Load
- Save / Cancel: Returns to the previously active Mode.

APPENDIX: VNA Application Menu Tree

- Return Loss/VSWR
  - » Select Display: Return Loss/VSWR / Distance To Fault / Calibration
  - » Output Level: High. Low
  - » Trigger Mode: Freeze / Single / Auto
  - » Correction: Off, On
  - » Start Frequency: 1 MHz to 5,999.996 MHz
  - » Stop Frequency: 1 MHz to 6,000 MHz
  - » Center Frequency: 1.002 MHz to 5,999.998 MHz
  - » Span: 0.004 MHz to 5,999 MHz
  - » # of Points: 101 to 10,001
  - » IFBW: 10 Hz, 30 Hz, 100 Hz, 300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz, 100 kHz
  - » Averaging: Off, On
  - » Averaging Factor: 1 to 999
  - » Smoothing: Off, On
  - » Smoothing Aperture: 0.01 % to 20 %
  - » Return Loss Ref Value: 1000 dB to -1000 dB
  - » Return Loss Scale: 0.001 dB/div to 200 dB/div
  - » Return Loss Auto Scale
  - » VSWR Ref Value: 1 to 10,001
  - » VSWR Scale: 0.001 to 1000
  - » VSWR Auto Scale
  - » Active Trace: Return Loss, VSWR
    - Return Loss
    - VSWR
  - » Marker Mode (for Active Trace)
    - Off
    - Absolute / Delta
      - › **Select Marker: 1 / 2 / 3 / 4 / 5 / 6**
      - › **Marker Frequency: 1 MHz to 6,000 MHz**
      - › **Marker On/Off**
      - › **Max Peak**
      - › **Peak Excursion: 0.001 dB to 1,000 dB**
      - › **Peak Left**
      - › **Peak Right**
      - › **Min Valley**
      - › **Valley Left**

- **Valley Right**

- Distance To Fault
  - Select Display: Return Loss/VSWR / Distance To Fault / Calibration
  - Response Type
    - Bandpass
    - Lowpass Impulse
    - Lowpass Step
  - Maximum Length: min (calculated based on settings) to 1,000 m (3,280.84 ft)
  - Start Distance: -1,000 m to 999.95 m (-3,280.8399 ft to 3,280.6759 ft)
  - Stop Distance: -999.95 m to 1,000 m (-3,280.6759 ft to 3,280.8399 ft)
  - Output Level: High, Low
  - Trigger Mode: Freeze / Single / Auto
  - Correction: Off, On
  - Center Frequency (Only in Response Type: Bandpass): 1.1 MHz to 5,999.9 MHz
  - # of points: 101 to 10,001
  - IFBW: 10 Hz, 30 Hz, 100 Hz, 300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz, 100 kHz
  - Distance Units: m, ft
  - Ref Value: -1,000 dB to 1,000 dB
  - Scale: 0.001 dB/Div to 200 dB/Div
  - Auto Scale
  - Cable List
    - Return
    - Select
    - Page Up
    - Page Down
    - New / Edit
      - **Cable Description: 16 Characters (0-9, A-Z, /, ", -)**
      - **Velocity Factor: 0.001 to 1**
      - **Cable Loss 1: 0 dB/m to 1,000 dB/m**
      - **Frequency 1: 1 MHz to 6,000 MHz**
      - **Cable Loss 2: 0 dB/m to 1,000 dB/m**
      - **Frequency 2: 1 MHz to 6,000 MHz**
      - **Cable Loss 3: 0 dB/m to 1,000 dB/m**
      - **Frequency 3: 1 MHz to 6,000 MHz**
      - **Save Cancel**
    - Delete

- Velocity Factor: 0.001 to 1
- Cable Loss: 0 dB/m to 1,000 dB/m
- Marker Mode
  - Off
  - Absolute / Delta
    - **Select Marker: 1 / 2 / 3 / 4 / 5 / 6**
    - **Marker Distance: 0 to Max Length value**
    - **Marker On/Off**
    - **Max Peak**
    - **Peak Excursion: 0.001 dB to 1,000 dB**
    - **Peak Left**
    - **Peak Right**
    - **Min Valley**
    - **Valley Left**
    - **Valley Right**

- Calibration
  - Calibration Kit
    - Return
    - Select
    - New / Edit
      - **Name: 16 Characters (0-9, A-Z, /, ", -)**
      - **Description: 50 Characters (0-9, A-Z, /, ", -)**
      - **Edit Field**
      - **Save**
      - **Cancel**
    - Delete
  - Open
  - Short
  - Load
  - Save
  - Cancel