Keysight X-Series Signal Analyzers

This manual provides documentation for the following models:

UXA Signal Analyzer N9040B
PXA Signal Analyzer N9030B
MXA Signal Analyzer N9020B
EXA Signal Analyzer N9010B
CXA Signal Analyzer N9000B
MXE EMI Receiver N9038B
PXE EMI Receiver N9048B

KEYSIGHT TECHNOLOGIES

N6141EM1E
EMI Measurement Application
Measurement Guide

Notices

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Contents

1 About the EMI Measurement Application

This book provides information on using the N6141EM1E EMI application in your N9038B MXE and N9048B PXE EMI Receiver or your X-Series Signal Analyzer.

The MXE/PXE EMI Receivers allow you to fully test devices in compliance with CISPR 16-1-1:2019 and MIL-STD-461G. The X-Series signal analyzers allow you to make the same measurements in a precompliance environment.

The N6141EM1E EMI measurement application enables you to perform conducted and radiated emissions tests to both commercial and MIL-STD requirements. It provides better sensitivity, accuracy, and reduces test margins, across the MXE/PXE EMI Receiver or X-Series signal analyzers, so you can make more precise measurements. The wide range of features enables you to use the scan table to set up frequency ranges, gains, bandwidths and dwell time. You can scan a frequency range and display the results in log or linear format, search for signals, measure the peak, quasi-peak, and average values of the signals and place the results in a table. Use the Signal List feature to mark and delete unwanted signals, leaving only those of interest.

This measurement application enables you to:

- Identify out-of-limit device emissions
  - See device emissions typically hidden in the noise floor
  - Differentiate between ambient signals and device emissions
  - View signals over time to identify intermittent responses
- Maximize signals and compare against regulatory requirements
  - Use built-in commercial and MIL-STD compliant bandwidths, detectors and band presets
  - Continuously monitor signals with bar meters to detect maximum amplitude
  - Compare measured emissions to regulatory limits

The following topics are in this section:

The Role of Precompliance in the Product Development Cycle

To ensure successful electromagnetic interference (EMI) compliance testing, precompliance testing has been added to the development cycle. In precompliance testing, the electromagnetic compatibility (EMC) performance is evaluated from design through production units.

It is important to have a strategy that will help you test for potential EMI problems throughout the product development cycle. It is also important to have equipment and processes in place that will allow you to observe how close you are to compliance at any given time in the development cycle. This reduces the time and cost associated with final compliance testing.

Compliance Measurements

Electrical or electronic equipment that use the public power grid or has the potential for electromagnetic emissions must pass EMC (electromagnetic compatibility) requirements. These requirements fall into four broad types of testing:

- **Conducted emissions** testing focuses on signals present on the AC mains that are generated by the equipment under test (EUT). The frequency range of these measurements is typically 9 kHz to 30 MHz. However, MIL-STD measurement may have a wider frequency range.
- **Radiated emissions** testing searches for signals being emitted from the EUT through space. The typical frequency range for these measurements is 30 MHz to 1 GHz or 6 GHz, although FCC regulations require testing up to 40 GHz.
- **Radiated immunity** is the ability of a device or product to withstand radiated electromagnetic fields.
- **Conducted immunity** is the ability of a device or product to withstand electrical disturbances on power or data lines.

User Interface Layout

The default startup mode in the N9038B MXE and N9048B PXE EMI Receiver is the EMI Measurement application (N6141EM1E) mode. The default mode for the X-Series signal analyzers, is the Spectrum Analyzer mode. There are several measurements in the EMI Measurement mode accessible via the Mode/Meas key.

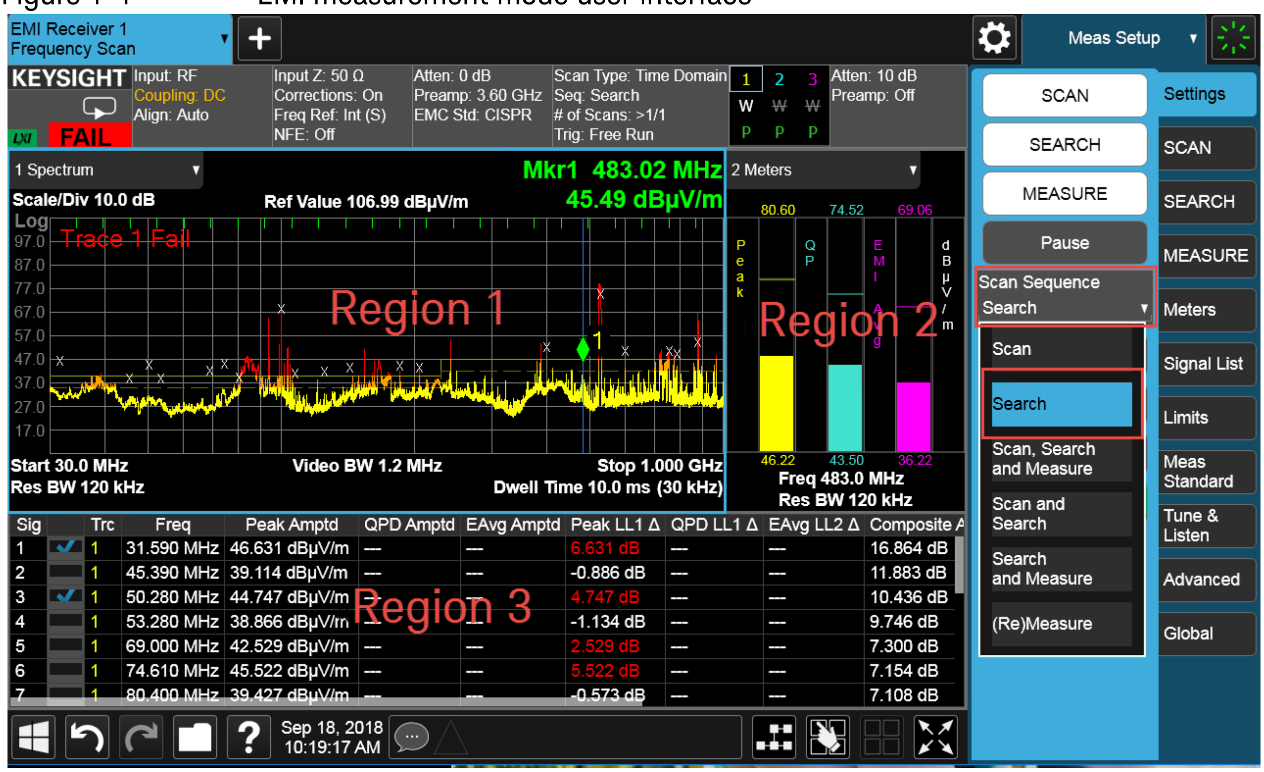
You can access this application by way of the front panel or a remote interface.

The EMI measurement application provides the following measurements:

- Frequency Scan
- Strip Chart
- APD (Amplitude Probability Distribution)
- Disturbance Analyzer (Click)
- Monitor Spectrum
- Real time Scan (N9048B PXE EMI Receiver only)

The user interface for a frequency scan measurement has three display regions showing information regarding different setting menus.

Figure 1-1 EMI measurement mode user interface



- **Region 1**: Spectrum and setting information of the scan table, trace/detector, and input/output
- **Region 2**: Meter graphs, metrics, and related setting information
- **Region 3**: Signal list with suspect signals populated by searching

Navigating the Menu System

It is important to understand the N6141EM1E's menu structure. The Meters menu is for making a single frequency measurement with up to three detectors updated simultaneously. The frequency of meters represents the current frequency of EMI Measurement mode.

The Scan and Measure menus apply to Scan Sequence. A Scan Sequence is very important for understanding the philosophy of N6141EM1E operation because it aligns with the CISPR test flow. The N6141EM1E is designed with clearly independent settings for Scan (Region 1), Meters (Region 2), and (Re) Measure (Region 3). The current values for Region 1 and Region 2 settings are presented in each region. Figure 1-2 shows the EMI test flow recommended by CISPR 16-2-3. Scan only, Search only, and Re Measure are the settings of the Scan Sequence on the N6141EM1E corresponding to prescan, data reduction, and final measurement of the EMI test flow. Table 1-1 lists the menu path of the sets of settings for Meters, Scan, and (Re)Measure respectively.

Figure 1-2 CISPR-recommended EMI test flow

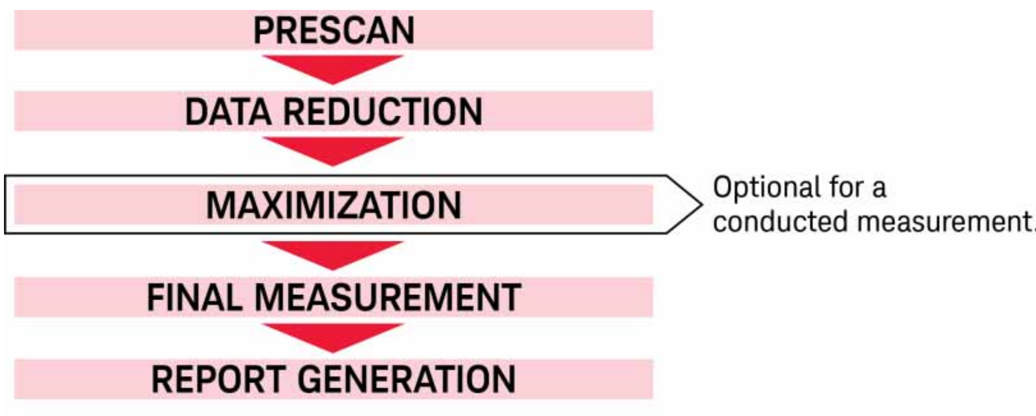


Table 1-1 Key path for settings of Meters, Scan, and (Re)Measure

Settings	Meters	Scan	(Re)Measure
Frequency	FREQ > Frequency (Meters)	MEAS SETUP > Settings tab > Scan Table > Start Freq / Stop Freq[a]	
Detector	MEAS SETUP > Detectors	MEAS SETUP > Detectors	MEAS SETUP > Detectors
RBW	BW >Res BW (Meters)	MEAS SETUP > Settings tab > Scan Table >RBW The resolution bandwidth for each range can be adjusted.	
Attenuation	AMPTD > Attenuation tab > Atten (Meters)	MEAS SETUP> Settings tab > Scan Table > Atten The attenuation for each range can be adjusted.	

Table 1-1 Key path for settings of Meters, Scan, and (Re)Measure

Settings	Meters	Scan	(Re)Measure
Preamp	AMPTD > Signal Path tab > Internal Preamp (Meters)	MEAS SETUP > Settings tab > Scan Table Int. Preamp, or AMPTD > Signal Path tab > Internal Preamp (Scan) to set for the Current Scan Range	
Auto range, auto preamp	MEAS SETUP > Meters tab > Meters Config > Autorange/Auto Preamp	MEAS SETUP > Settings tab > Scan Table > Int Preamp	MEAS SETUP > MEASURE tab > Measure Config > Autorange/Auto Preamp
Dwell time	MEAS SETUP > Meters tab > Meters Config > Dwell Time	MEAS SETUP > Settings tab > Scan Table > Dwell Time	MEAS SETUP > MEASURE tab > Measure Config > Dwell Time
Limit lines	MEAS SETUP > Meters tab > Meters Config > Limit In Limit column, limit lines can be modified and turned on or off.	MEAS SETUP > Limits tab > Limits Table	MEAS SETUP > MEASURE tab > Measure Config > Limit In the Limit for Δ column, the limit associated with each detector can be changed.
RF input (1/2) (MXE/PXE only)	Input/Output > Input tab > RF Input port		
RF coupling (AC/DC) (MXE/PXE only)	Input/Output > Input tab > RF Coupling		
Preselector on/off (MXE/PXE only)	Input/Output > Input tab > RF Preselector		
Corrections	Input/Output > Corrections tab		

a. The Start Freq and Stop Freq in the FREQ menu is for setting the displayed spectrum span on the screen, not for scanning. By default, they are coupled to the Start Freq and Stop Freq in the Scan Table (MEAS SETUP, Settings tab, Scan Table) if Auto is selected.

2 Conducted Emissions Measurement Example

Conducted emissions testing focuses on emissions that are conducted along a power line that are generated by the equipment under test (EUT). The transducer that is typically used to couple the emissions of the power line to the EMI receiver is a line impedance stabilization network (LISN).

The regulatory limits specify the maximum EUT emission energy, usually in dBμV, detected by the LISN. The test range for these measurements is typically 150 kHz to 30 MHz, though some limits may start as low as 9 kHz, depending on the regulation.

This procedure follows the EMI test flow recommended by CISPR.

The following topics are in this section:

Prescan

For some EMI standards, limit lines are given for quasi-peak and EMI average detectors, which requires an extremely long measurement time. Usually, a prescan with the peak detector (faster than quasi-peak or EMI average) is used to collect suspect signals. A prescan is run with the LISN set to both the Neutral and Line positions. (Some LISNs offer four-phase testing.) Then, final measurements are made with quasi-peak and EMI average detectors.

This example will show you how to

– setup a scan table
– load limit lines and amplitude corrections
– set two traces to scan against a limit line simultaneously

Step 1: Access the EMI measurement application and setup the prescan

This section demonstrates how to set up and perform conducted emission tests in the 150 kHz to 30 MHz range.

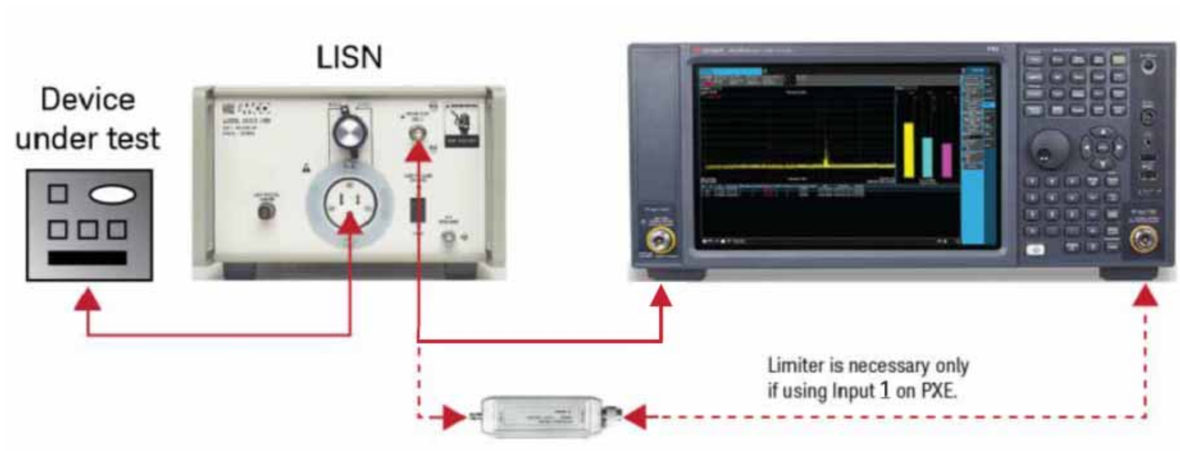
TIP **You can set up two or more ranges with different settings for a single scan. Select the check boxes to select the appropriate ranges and the receiver will scan them sequentially. The maximum scan points is 4,000,001 and the maximum scan time is 4,000 seconds.**

All limit lines, corrections, traces, signal lists, and scan tables can be saved in csv format. This format allows you to easily edit or create files on your PC.

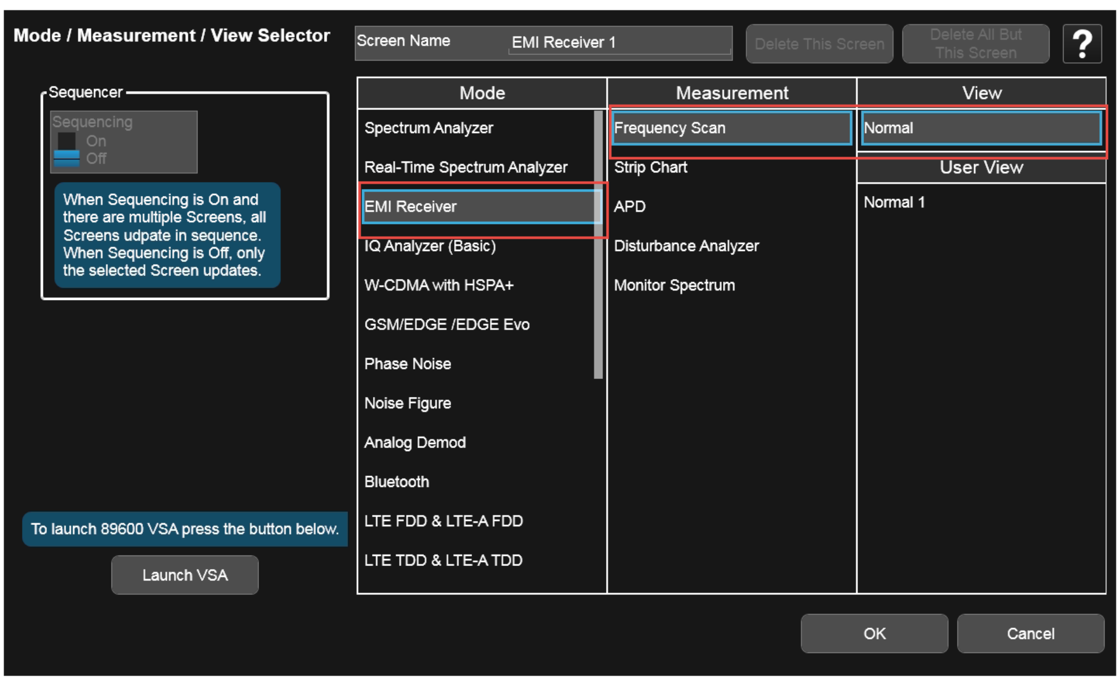
CAUTION **Before connecting a signal to the receiver or signal analyzer, make sure the instrument can safely accept the signal level provided. The signal level limits are marked next to the RF Input connectors on the front panel.**

Step	Action	Notes
1. Test setup	Connect the EUT, Limiter, and LISN, to the EMI receiver as shown below. Set the LISN to Neutral (N) L2.	

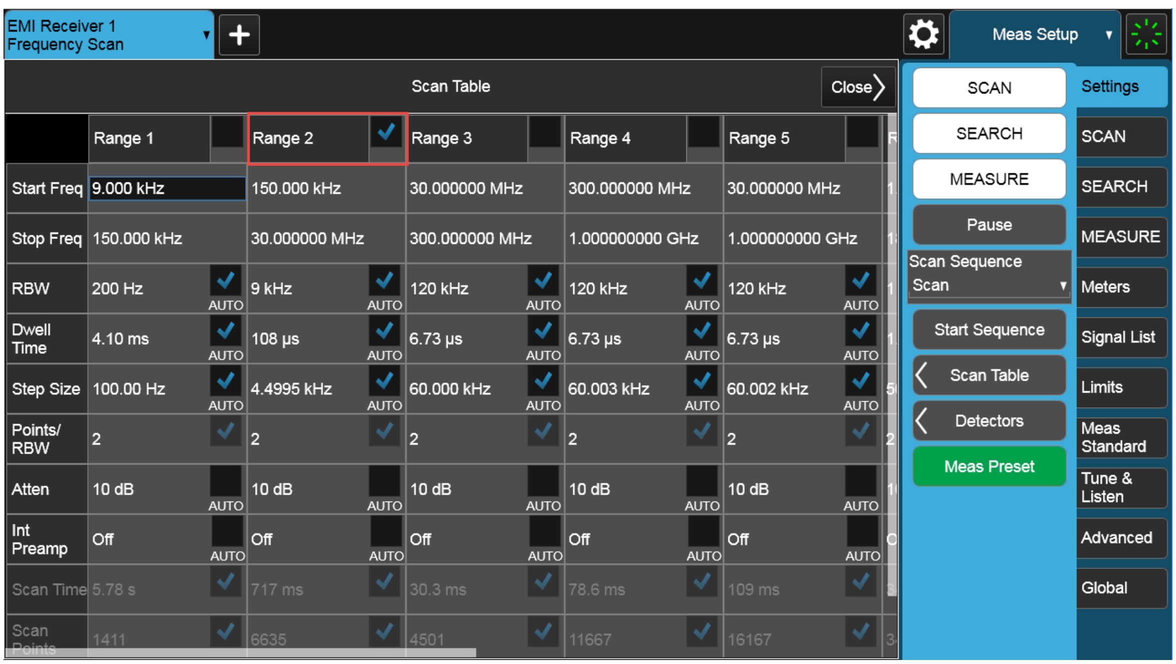
Step	Action	Notes



2. Make sure you are in EMI Receiver mode	Select **MODE/MEAS**, **EMI Receiver** Mode, **Frequency Scan** Measurement, and **Normal** View.	EMI Receiver is the default startup mode for the MXE/PXE. The X-Series analyzer's default startup mode is Spectrum Analyzer. Alternately, if you are using a remote desktop connection, select the Screen tab (at the top of the Spectrum display) to open the Mode selector window.



Step	Action	Notes
3. Preset the EMI Receiver mode	Select **Mode Preset**.	Alternately, if you are running the application from a remote desktop connection, select Mode Preset. 
4. Set the EMC standard to CISPR	Select **MEAS SETUP, Meas Standard** tab and set EMC Standard to **CISPR**.	For MIL Std measurements, change range preset to MIL.
5. Open the Scan Table and select the desired range	Select the **Settings** tab, **Scan Table**, then select **Range 2** to turn on. Ensure all other ranges are off.	The Scan Table allows you to configure up to 10 different scan ranges. Each scan range has settings for critical measurement parameters, such as frequency, attenuation, and preamp settings. You can choose to use the default parameter settings in each range or set each one individually to meet you measurement needs.

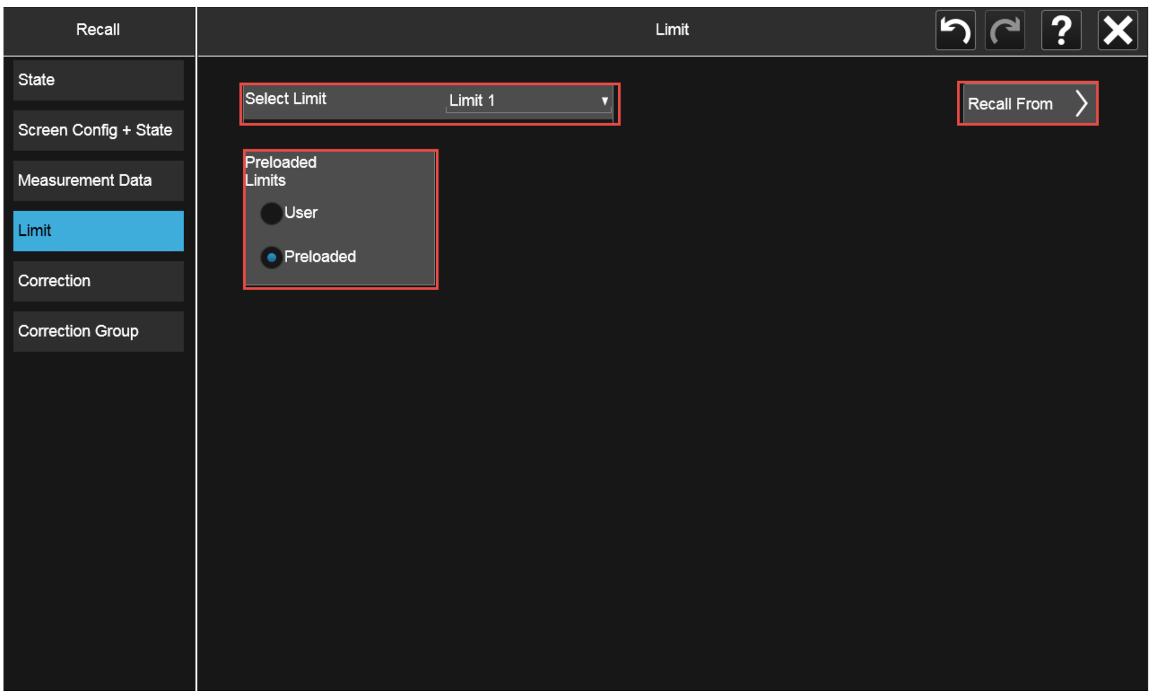


Step 2: Load limit lines

The EMI measurement application has many built-in limit line files for commercial and military standards. They are organized in different folders such as EN, FCC, GB and VCCI.

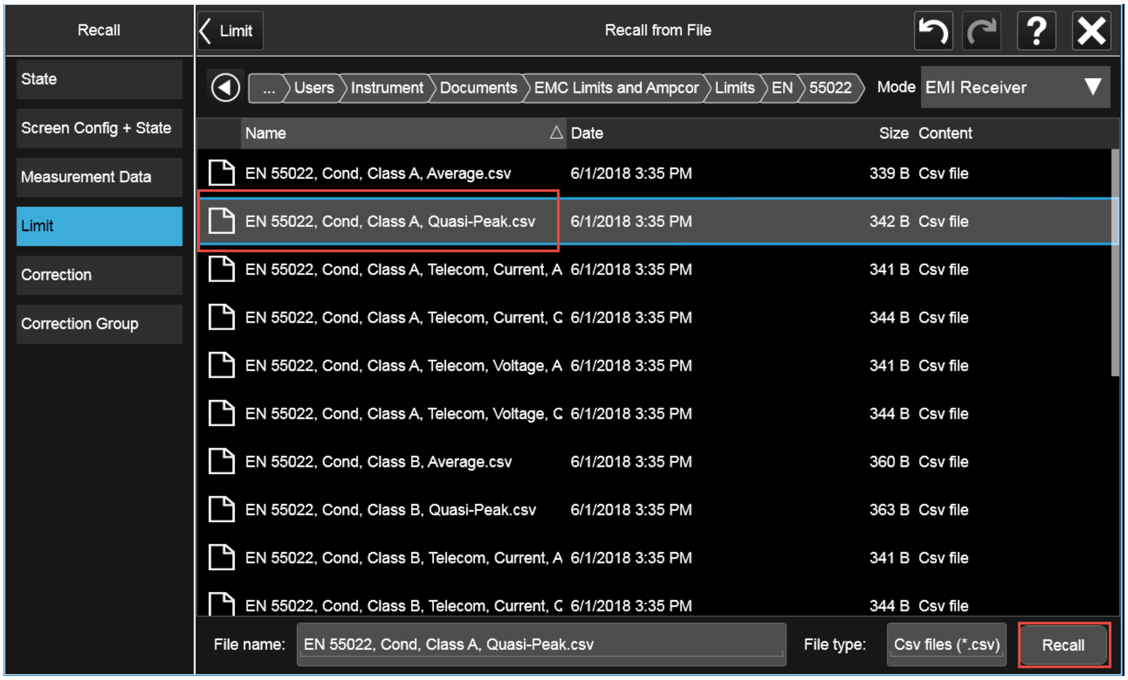
In this section we will load a built-in limit line file.

Step	Action	Notes
6. Load the built-in limit line file	Select **Recall**, **Limit** tab, set Select Limit to **Limit 1**, set Preloaded Limits to **Preloaded**, then **Recall From**.	Alternately, if you are running the application from your desktop, select the folder icon in the Control Bar (bottom of the window).

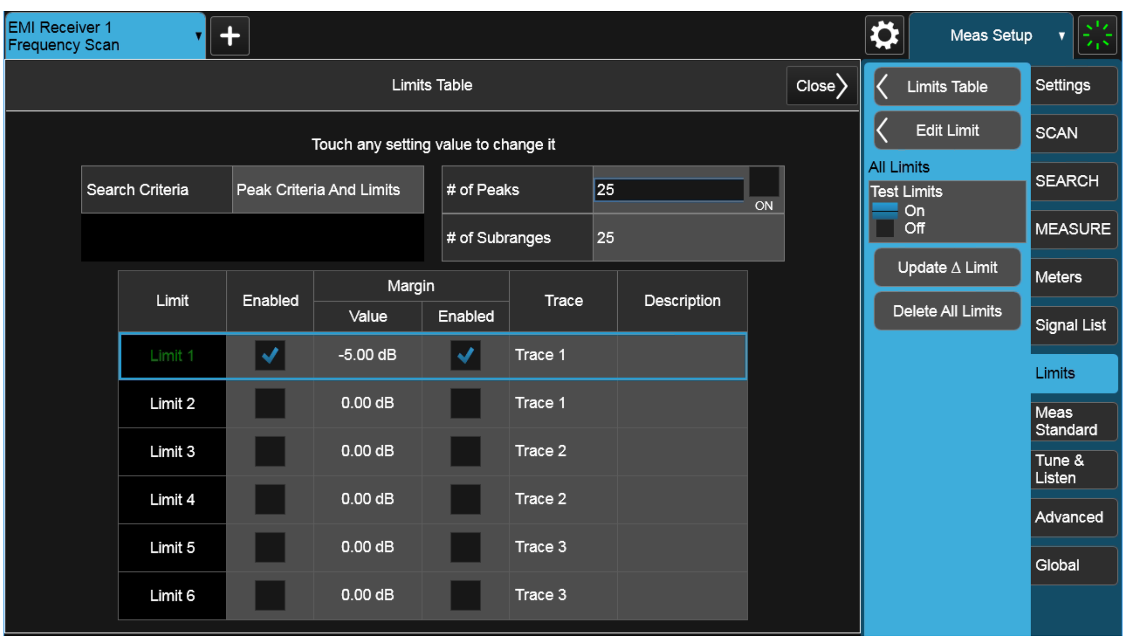


7. Recall the limit	Select **EN** folder, **55022** folder, then `EN55022, Cond, Class A, Quasi-Peak,` then **Recall**.	For MIL Std measurements, load the built-in limit file, "MIL CE101-2 Cond, Power Leads, AC+DC,28V".

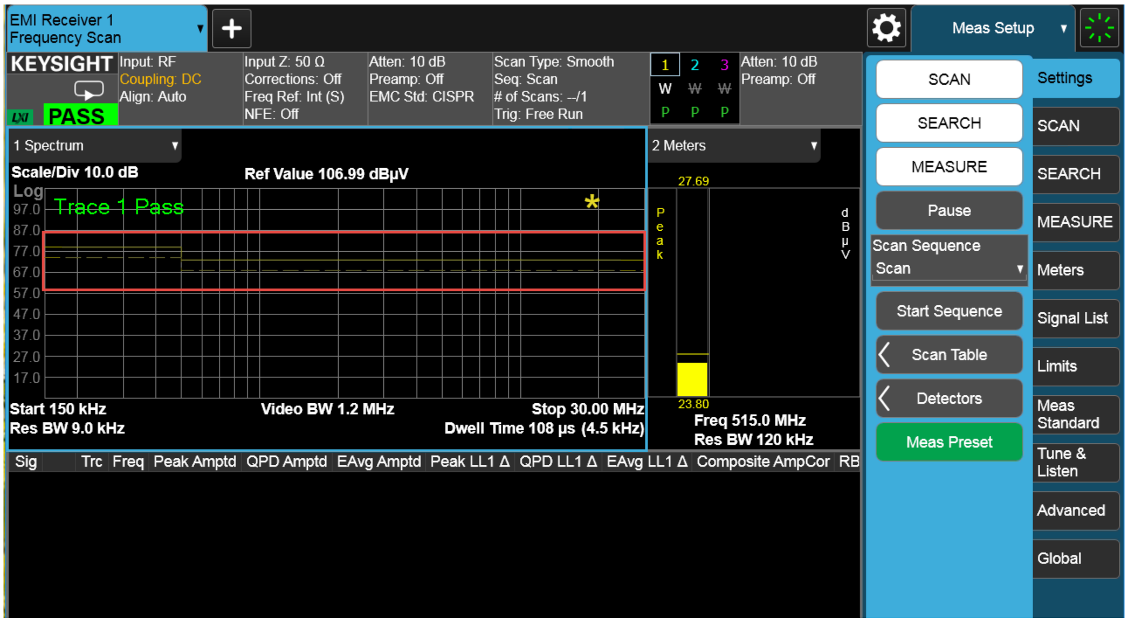
Step	Action	Notes



Step	Action	Notes
8. Assign Limit 1 to Trace 1	Select MEAS SETUP, **Limits**, **Limits Table**, select Limit 1 to Trace1, then select **Enabled**.	Limit lines are assigned to a specific trace.
9. Add a 5 dB margin to Limit Line 1	Select the Value entry for Limit 1 and set the Margin to **–5 dB**, select **Enabled**, then **Close** the Limit Table.	



Step	Action	Notes
10. Make sure that both the limit and the margin are on	See the figure below.	

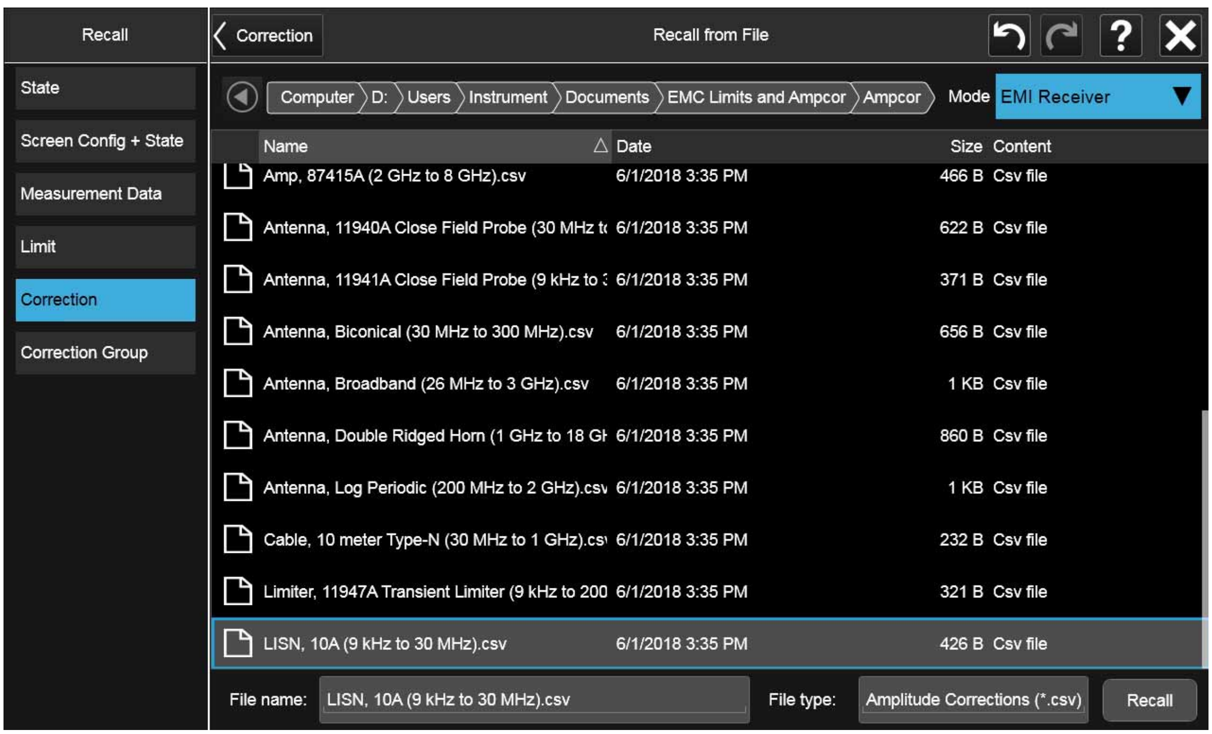


Step 3: Load corrections

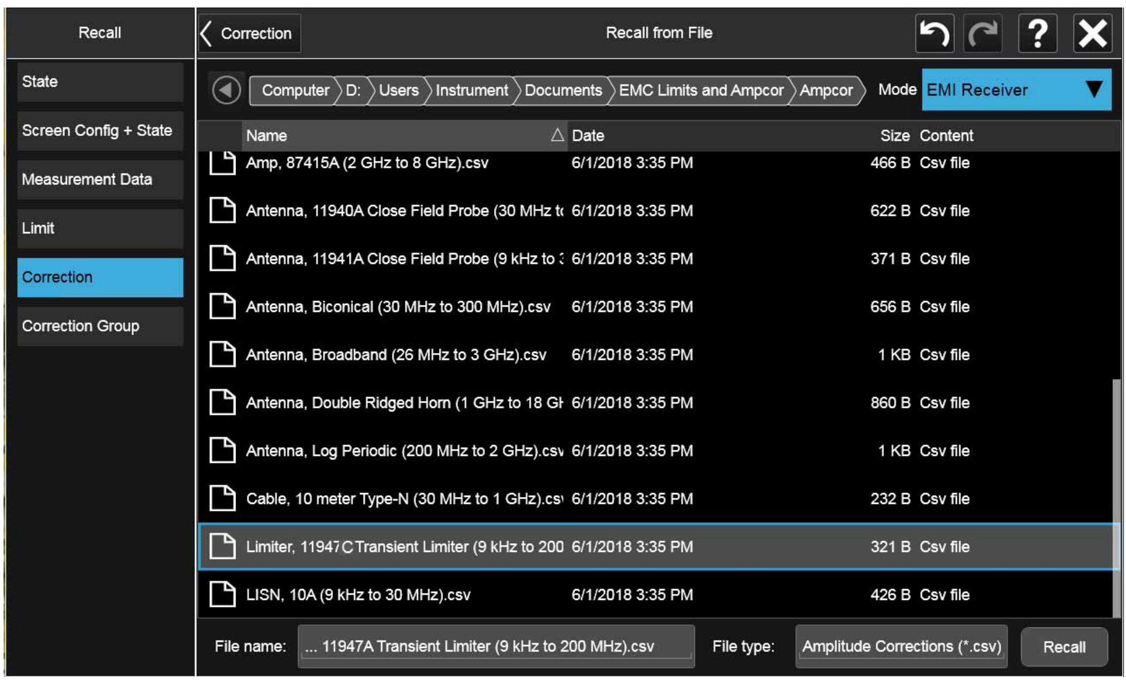
The EMI Measurement application has built-in typical correction files for many accessories on the market, such as amplifiers, Line Impedance Stabilization Networks (LISNs), transient limiters and antennas. You can create your own correction files for devices not preloaded in the application or modify the existing ones.

In this section we will load a built-in correction file.

Step	Action	Notes
1. Load a built-in LISN correction file	Select **Recall**, **Correction** tab. Set Select Correction to **Correction 1**, Preloaded Correction to **Preloaded**, then **Recall From**. Select `LISN, 10A (9 kHz to 30 MHz).csv`, **Recall**.	



Step	Action	Notes
2. (For X-Series Signal Analyzers or when using Input 1 on the MXE/PXE) Load a built-in transient limiter correction file	Select **Recall**, **Correction** tab. Set Select Correction to **Correction 2**, Preloaded Correction to **Preloaded**, then **Recall From**. Select `Limiter, 11947C Transient Limiter (9 kHz to 200 MHz.csv`, then **Recall**.	**NOTE** A transient limiter is used to prevent damage to the sensitive RF input circuitry of signal analyzers from power line transients encountered when using a LISN. The MXE/PXE, have a built-in limiter so that an external limiter is not needed when using Input 2.



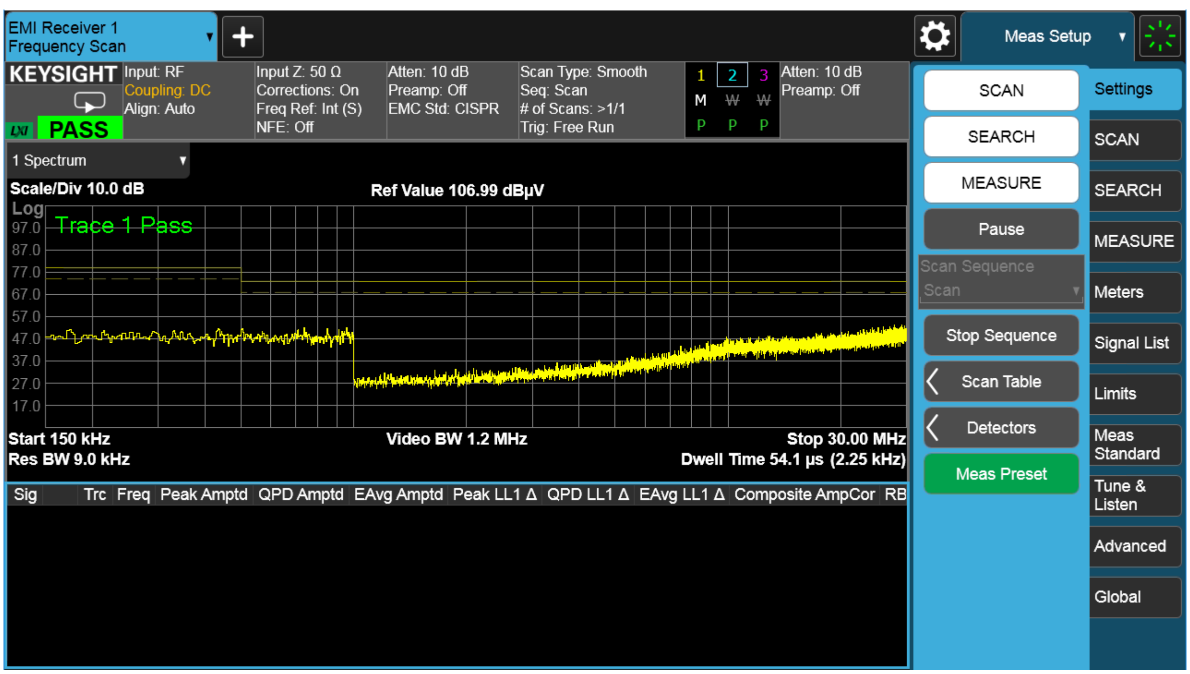
3. Verify that Corrections 1 and 2 are turned on	Select **Input/Output**, **Corrections** tab, **Correction 2**, Correction **On**. Select Correction **Correction2**, Correction **On**.	

Step	Action	Notes

Step 4: Take a scan of the ambient environment with the EUT off

At this point the EUT is setup with all of the correct parameters, including bandwidth, frequency range, LISN compensation, transient limiter compensation (if using an X-Series signal analyzer), and limit line. However, before starting conducted measurements, consider the effect of the ambient environment on the results. The power cable between the LISN, (limiter, if applicable) and EUT can act as an antenna, which can cause false EUT responses on the display. To test this, turn off the EUT and check the display to ensure that the noise floor is at least 6 dB below the limit line.

Step	Action	Notes
1. Set the scan sequence for a Scan only	Select **MEAS SETUP**, the **Settings** tab and set **Scan Sequence** to **Scan**.	The default value.
2. Turn the EUT off and start the scan	Select **Start Sequence**.	



Step	Action	Notes
3. Stop the Scan	Ensure the noise floor is at least 6 dB below the limit line. Select **Stop Sequence**.	If ambient signals are within 6 dB of the limit line, try shortening the cables between the devices. Some additional shielding may also be required. Do not use ferrite beads on the power cord because common mode signals from the EUT may be suppressed causing a lower value measurement.

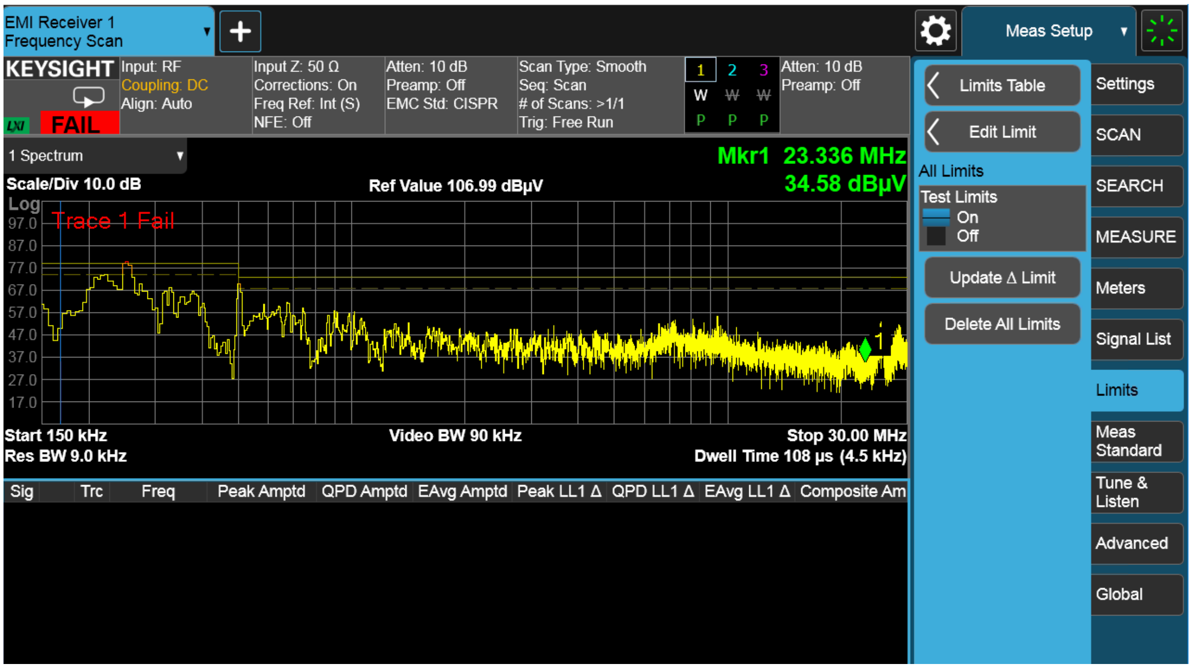
Step 5: Run a prescan with the LISN in the neutral position

TIP The analyzer's digital IF architecture guards against IF overload, even if signals are above the reference level. This reduces operator error by eliminating an overload caused by incorrect reference level settings.

Step	Action	Notes
1. Turn on all three meters	Select **MEAS SETUP, Meters** tab, **Meters Config**. Set Meter 2 to Quasi Peak and Meter 3 to EMI Average. (These are the default values.) Turn **On** all three meters, then **Close** the table.	It is not necessary to turn on three detectors for scanning, searching, and measuring, but it is helpful to see three meters for tuning signals later in the process. Note: For MIL-Std measurements, do not turn on Meters 2 and 3.
2. Set the line switch on the LISN to neutral	On the LISN, set the line to **(N) L2**.	

3. Start the scan	Select the **Settings** tab, then **Start Sequence**.	Alternately, you can go to SWEEP, Start Scan, or press the front panel Restart key.

Step	Action	Notes



4. Observe the trace data	Select **Stop Sequence**.	

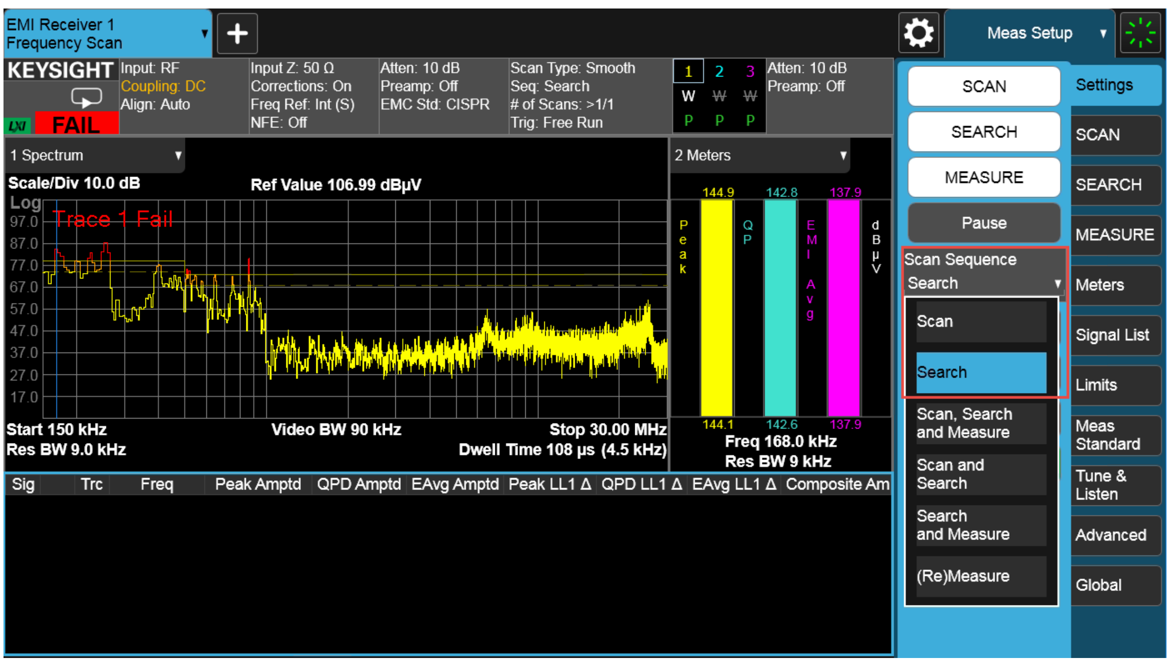
Data Reduction

Suspect frequencies that are close to or greater than the specified limits warrant further review and final measurement. Sometimes the suspect signals are searched in subranges based on a certain standard requirement. You might also want to add or delete signals from the suspect list manually. This process is called data reduction.

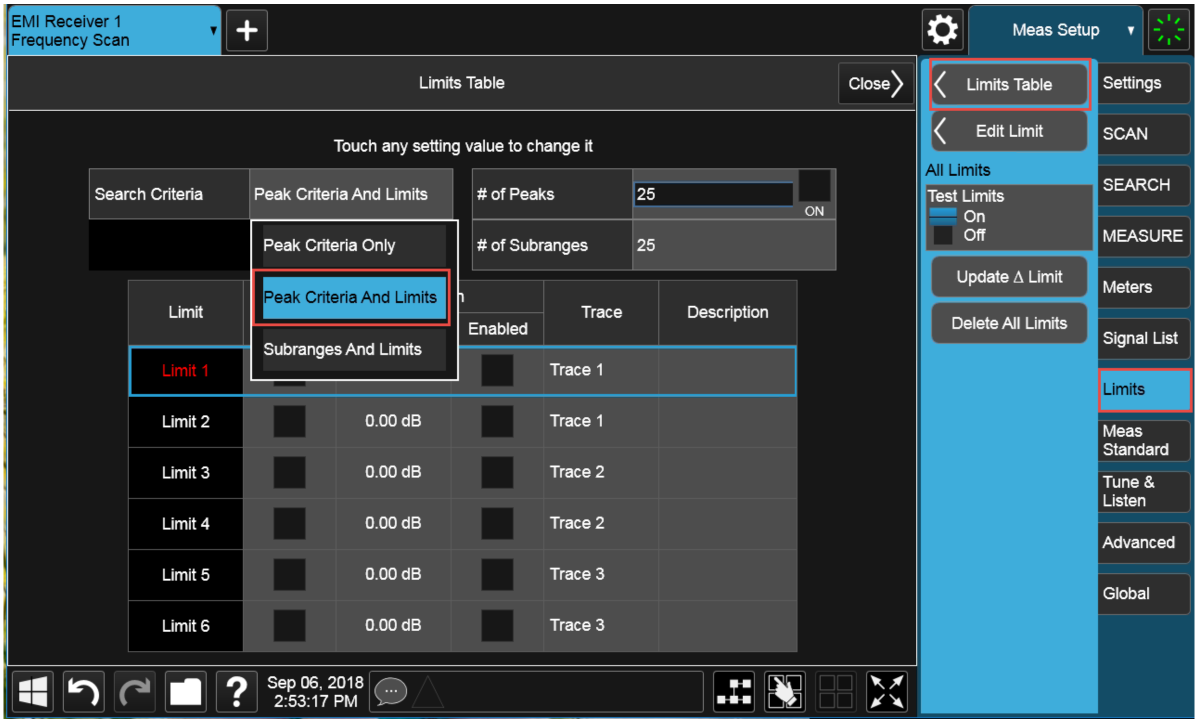
Step 1: Search for signals above a limit line

In this section, we will set the Scan Sequence to Search only. The Search Criteria will be set to Peak Criteria and Limits for collection of signals over the limit.

Step	Action	Notes
1. Set the scan sequence to search only	Select **MEAS SETUP**, the **Settings** tab, and set **Scan Sequence** to **Search**.	

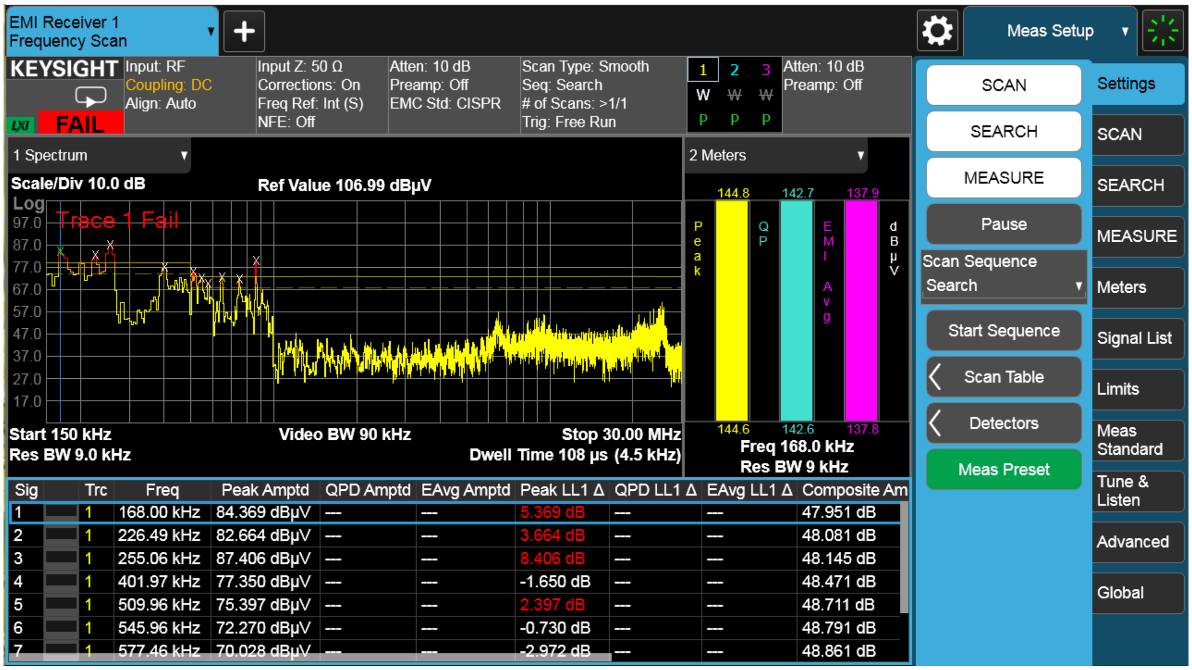


2. Set the search criteria to peak criteria and limits	Select the **Limits** tab, **Limits Table**, then **Search Criteria** to **Peak Criteria and Limits**. Set the **# of Peaks** to **10**, then **Close** the Limits Table.	When Peak Criteria and Limits is selected, the search finds the peaks that meet the Excursion and Threshold (set in the Limits tab) and also considers limits and margin if they are turned on. Setting the number of peaks to 10 will add only the top 10 signals over the limit line margin to the signal list.



Step	Action	Notes
3. Start the search	Select the **Settings** tab, **Start Sequence**.	**Tip:** To Clear existing signals in the Signal List table, select the Signal List tab then Delete All. Otherwise, new signals will be appended to the signal list without clearing older ones.
4. Stop the search	Once the signals have been added to the list, select **Stop Sequence**. If there are no signals in the signal list, then no further measuring needs to be done and the product passes the conducted emissions limit. If there are signals above or close to the limit, continue with the process below.	

Step	Action	Notes

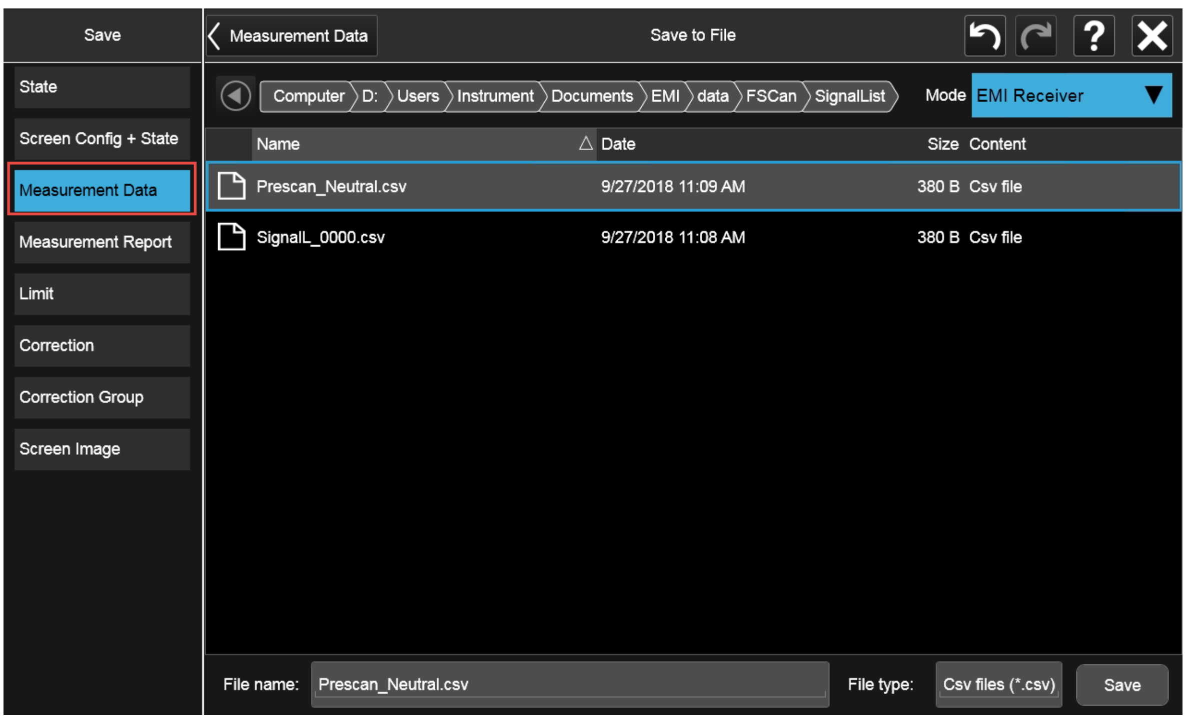


Step 2: Save the measurement data with LISN in the neutral position

Save Measurement Data lets you specify a data type (for example, trace data) for saving and exporting purposes. Measurement Data files are .csv files that can be exported into Excel or other spreadsheets.

The main application of a Measurement Data file is for importing data to a PC for further analysis, but in this case, we will be using this feature to save and later recall a Prescan/Data Reduction signal list back into the instrument for performing the final measurement.

Step	Action	Notes
1. Save the Measurement Data	Select **Save**, **Measurement Data**. Set Save From Trace to **Trace 1**, Data Type to **Signal List**, then select **Save As**. Enter a file name (for example, `Prescan_Neutral)`, then **Save**.	This list will be recalled later for running the final measurement.



Step 3: Run prescan and data reduction with LISN in the line position

Since the measurement parameters have been set up, it is easy to run the prescan and data reduction with the LISN in the line position.

Step	Action	Notes
1. Run the prescan with the LISN set to line	Set the line switch on the LISN to **L1(L)** From the EMI Measurement application: – Select **MEAS SETUP,** the **Signal List** tab, **Delete All** – Select the **Settings** tab, set **Scan Sequence** to **Scan** – Select **Start Sequence** – Once the prescan has run, select **Stop Sequence**	
2. Run Data Reduction	Set **Scan Sequence** to **Search**. Select **Start Sequence**.	
3. Stop the Search	Once the signals have been added to the list, select **Stop Sequence**. If there are no signals in the signal list, then no further measuring needs to be done and the product passes the conducted emissions limit. If there are signals above or close to the limit, continue with the process below.	
4. Save Measurement Data	Once the signals have been added to the list, select **Save**, **Measurement Data.** Set **Save From Trace** to **Trace 1**, **Data Type** to **Signal List**, **Save As**. Enter a file name (for example, `Prescan_L1`), then **Save**.	This list will be recalled for making the final measurement.

Final Measurement

The final measurement process contains the tasks of remeasuring signals for increased frequency accuracy and performing an automatic measure process to identify the highest signal amplitudes using peak, quasi-peak, EMI average detectors.

Step 1: Making a final measurement

For this example we will remeasure all signals in both the neutral and line signal lists using different limits for Detector 1 and 2. Auto range and auto preamp will be turned on for this measurement.

TIP The EMI Measurement application can be set up to conduct a scan, search, and final measurement automatically by selecting MEAS SETUP, Scan Sequence, Scan, Search, Measure.

Step	Action	Notes
1. Recall the neutral measurement data	Select **Recall**, **Measurement Data**. Set **Recall To Trace** to **Trace 1**, **Data Type** to **Signal List**, then **Recall From**. Select the `Prescan_Neutral file`, **Recall**.	
2. Set the scan sequence to Re(Measure)	Select **MEAS SETUP**, **Settings** tab, set **Scan Sequence** to **(Re)Measure**.	
3. Set the LISN to Neutral	Select (**N)L2**.	
4. Select the signals for Re(Measure)	Select the **MEASURE** tab, and select **(Re)Measure Type**. **Current Signal** will make a final measurement on the signal selected in the signal list. **All Signals** will make a final measurement on all signals in the signal list.	
5. Start the search	Select the **Settings** tab, **Start Sequence**.	

Step	Action	Notes
6. Repeat the final measurement procedure for Prescan_L1	Select **Stop Sequence**. Recall the Prescan L1 file and Start Sequence to measure the signals in the `Prescan_L1` file. Set the LISN to **L1(L)**.	

Report Generation

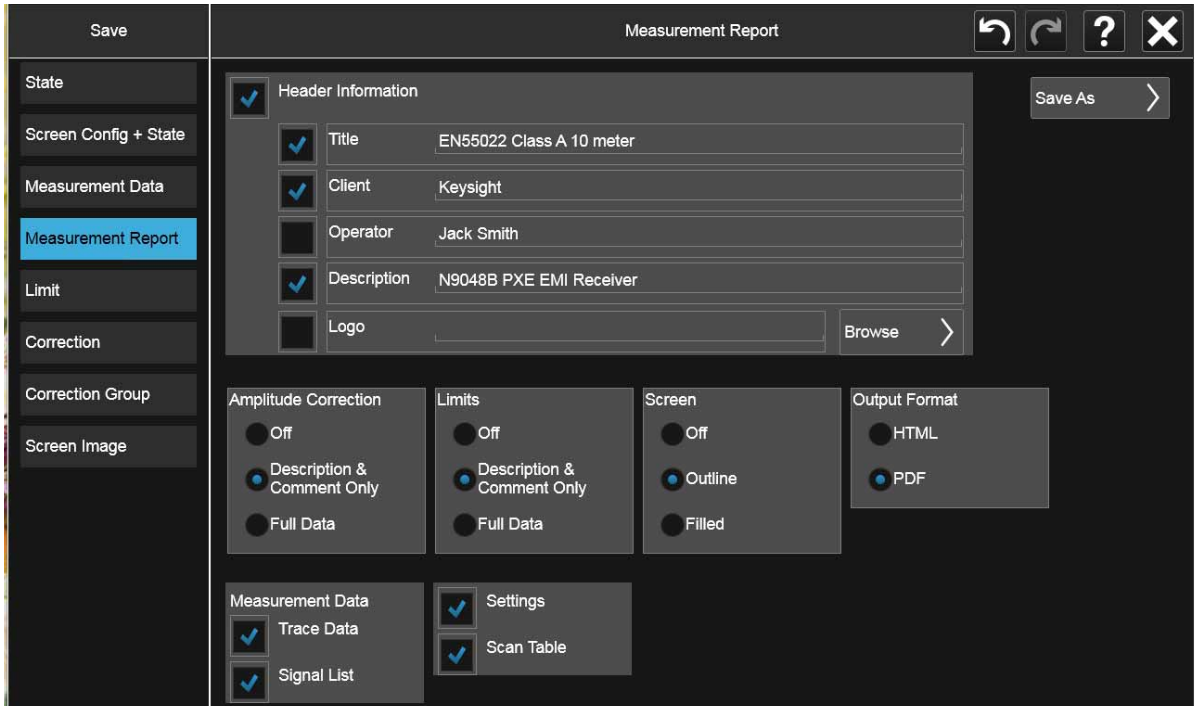
The EMI Measurement application supports two formats, HTML and PDF. You can customize content to include amplitude corrections, limits, scan tables, trace data, signal lists, and screen captures.

Step 1: Configure and generate a report

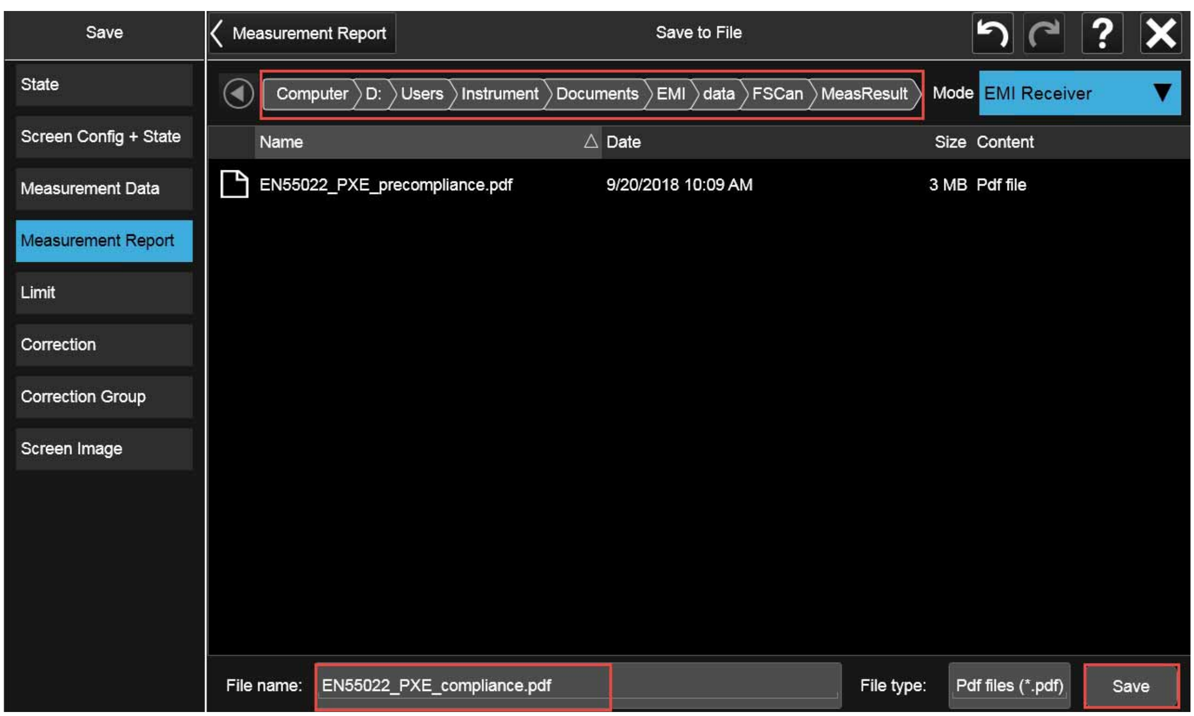
In this example we will generate a report with customized content and header information.

Step	Action	Notes
1. Open the Measurement Report form	Select **Save**, **Measurement Report**.	
2. Fill in the header information	Click on the Title entry line and use the soft keypad to type a name for this report, then select the check box to the left of the entry to include this in the report. Do the same for the other Header fields as needed.	
3. Select the data you want to include in the report, and the output format	Select the data you want to include in the report (such as, Amplitude Correction, Limits, Trace Data and so on. Then select the Output format, either HTML or PDF.	

Step	Action	Notes



Step	Action	Notes
4. Save the report	Select **Save As**, enter a file name, then **Save**.	Note the location of the Measurement Report as shown below.



3 Radiated Emissions Measurement Example

Radiated emissions measurements are not as straightforward as conducted emissions measurements. There is the added complexity of the ambient environment, which could interfere with measuring the emissions from the equipment under test (EUT).

This procedure follows the EMI test flow recommended by CISPR and uses a whip antenna to simulate radiated emissions.

Prescan

For some EMI standards, limit lines are given for quasi-peak and EMI average detectors, which requires an extremely long measurement time. Usually, a prescan with the peak detector (faster than quasi-peak or EMI average) is used to collect suspect signals. Then, final measurements are made with quasi-peak and EMI average detectors. For a commercial radiated compliance measurement, when conducting a prescan, it is important to investigate the full frequency spectrum with the equipment under test (EUT) rotated 360° as well as the antenna height scanned between 1 and 4 meters and adjusted between vertical and horizontal orientations.

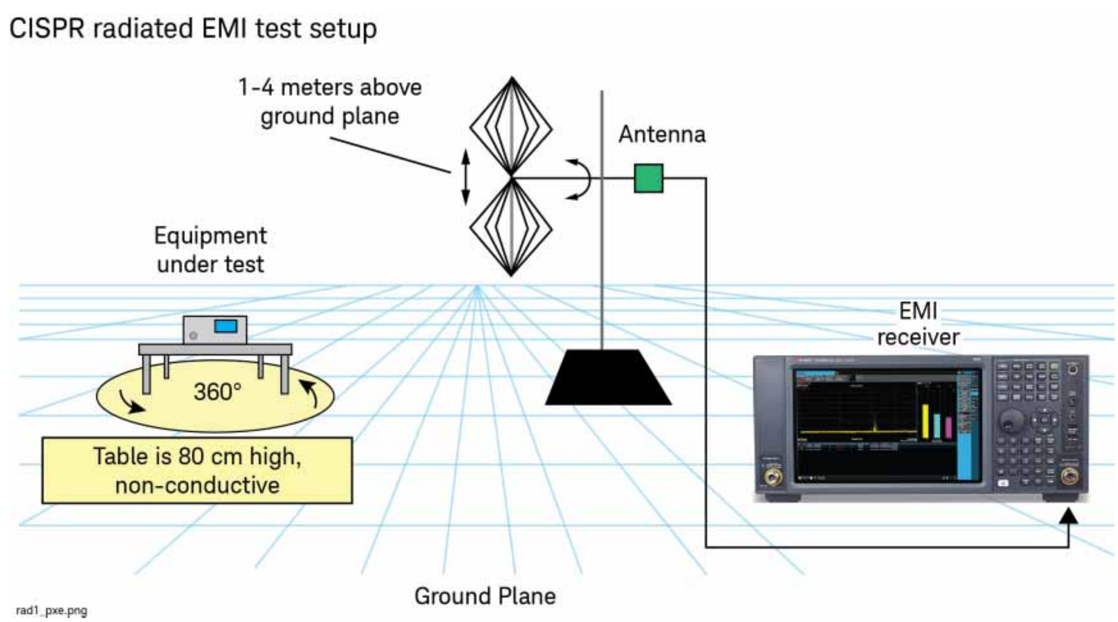
This example will show you how to:

- load limit lines and amplitude corrections
- setup a scan table with both discrete and time domain scan types for comparison
- set two traces to scan against the two limit lines simultaneously

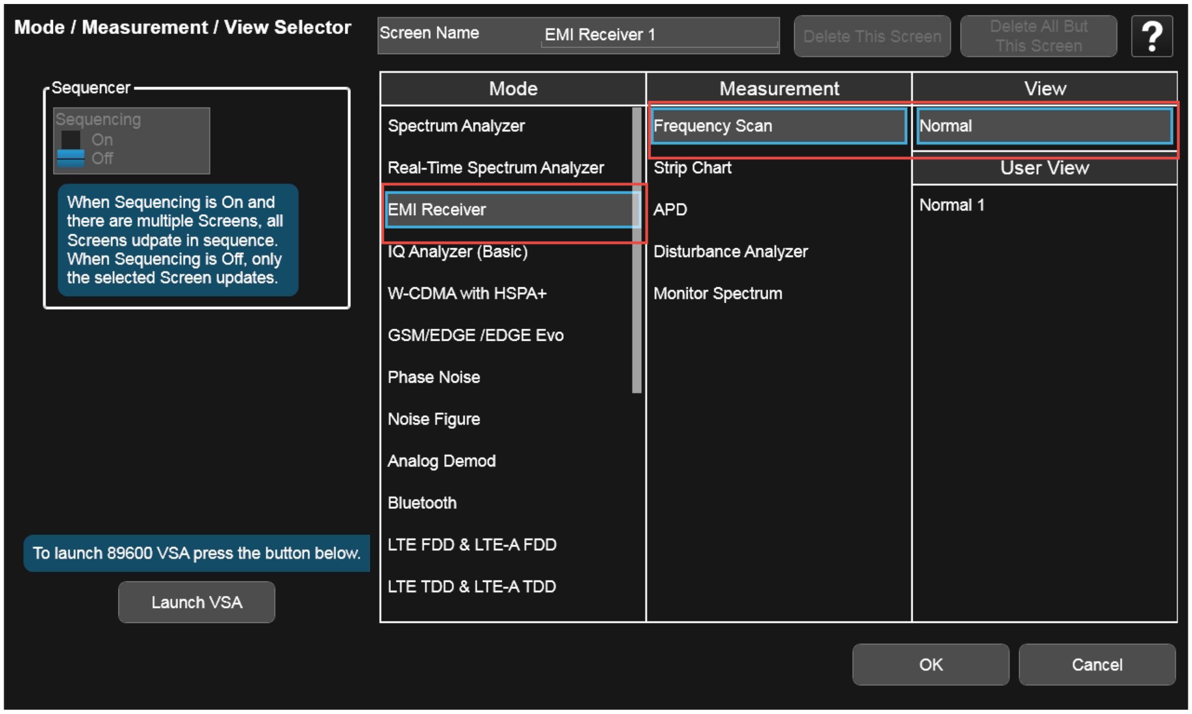
Step 1: Access the EMI measurement application and setup the prescan

CAUTION **Before connecting a signal to the receiver or signal analyzer, make sure the instrument can safely accept the signal level provided. The signal level limits are marked next to the RF Input connectors on the front panel.**

Step	Action	Notes
1. Test setup	Arrange the antenna, EUT, and receiver as shown below.	Separate the antenna and device under test (EUT) as specified by the regulatory agency requirements. If space is limited, the antenna can be moved closer to the EUT and you can edit the limits to reflect the new position. For example, if the antenna is moved from 10 meters to 3 meters, the amplitude must be adjusted by 10.45 dB. It is important that the antenna is not placed in the near field of the radiating device.

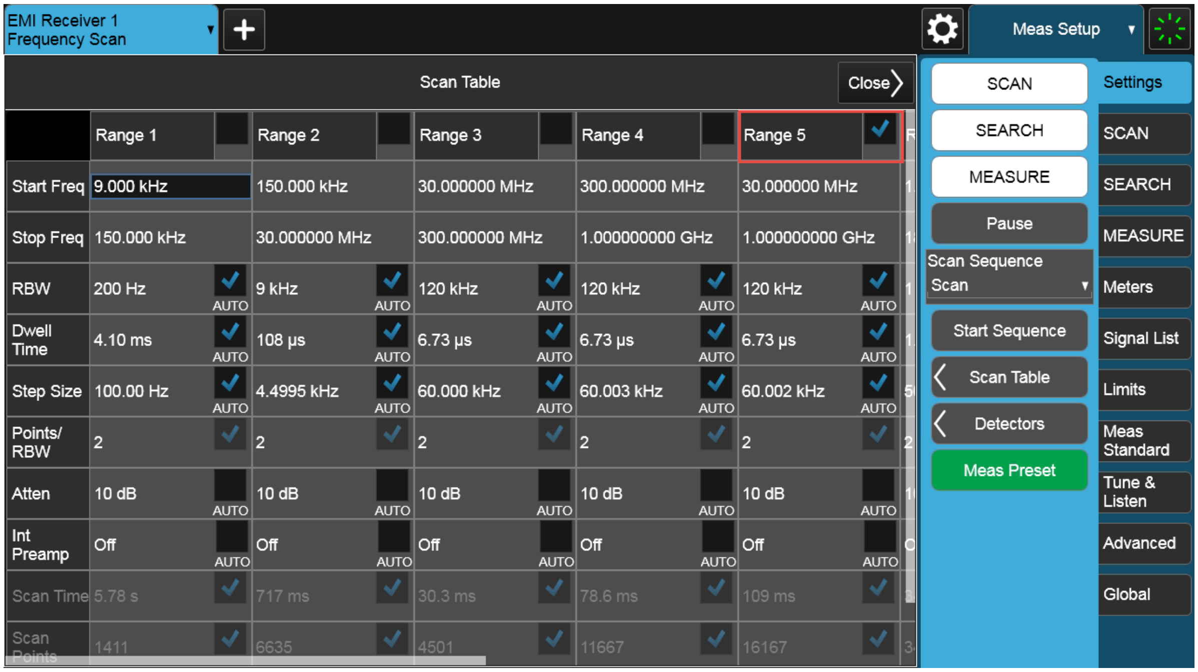


Step	Action	Notes
2. Make sure you are in EMI Receiver mode	Select **MODE/MEAS**, **EMI Receiver** Mode, **Frequency Scan** Measurement, and **Normal** View.	EMI Receiver is the default startup mode for the MXE/PXE. The X-Series analyzer's default startup mode is Spectrum Analyzer. Alternately, if you are using a remote desktop connection, select the Screen tab (at the top of the Spectrum display) to open the Mode selector window.



Step	Action	Notes
3. Preset the EMI Receiver mode	Select **Mode Preset**.	Alternately, if you are running the application from a remote desktop connection, select Mode Preset 
4. Set the EMC standard to CISPR	Select **MEAS SETUP, Meas Standard** tab. Set **EMC Standard** to **CISPR**.	For MIL Std measurements, change to MIL
5. Open the Scan Table and select the desired range	Select the **Settings** tab, **Scan Table**, then select **Range 5** to turn on. Ensure all other ranges are off.	

Step	Action	Notes



Step 2: Load and edit limit lines

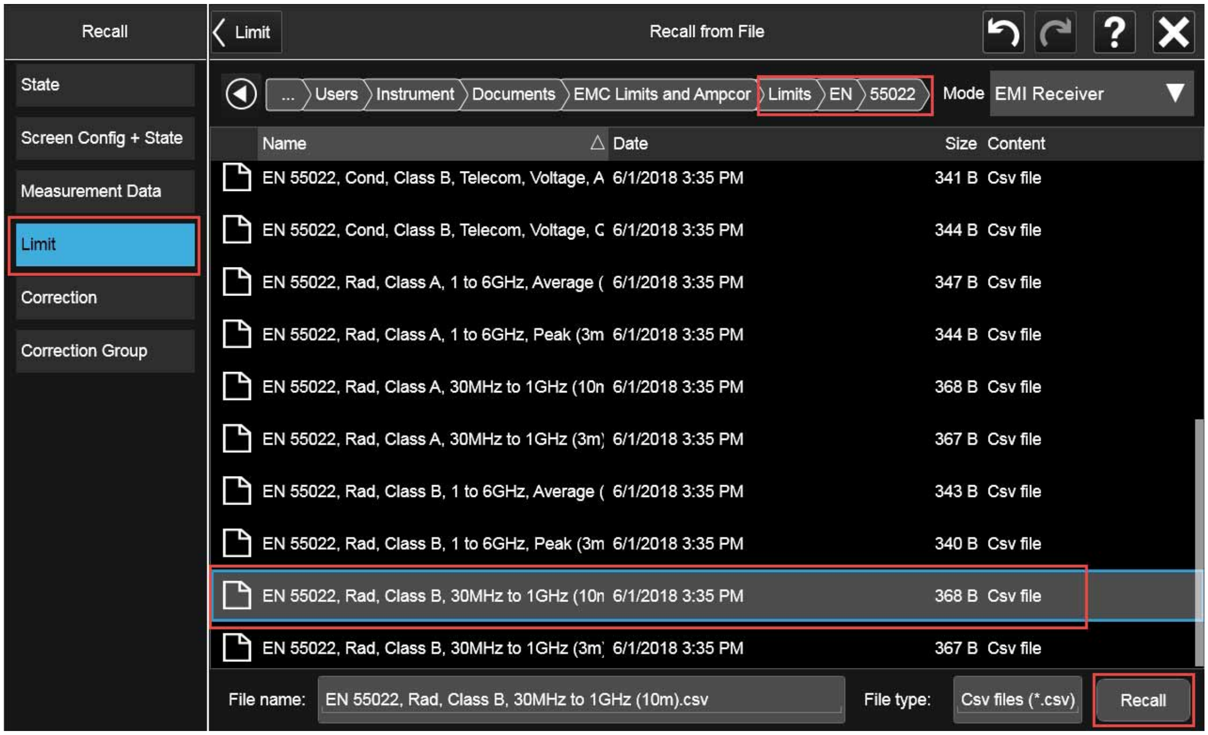
The EMI Measurement application has many built-in limit line files for commercial and military standards. They are organized in different folders such as EN, FCC, GB and VCCI.

This section demonstrates how to load the built-in limit line file, "EN55022, Rad, Class A, 30 MHz to 1 GHz (10m)" and use the limit line editor to view the limit line values. We will then add a 5 dB margin to the limit line. Using a margin on a limit line allows you to account for the system uncertainties in the measurements.

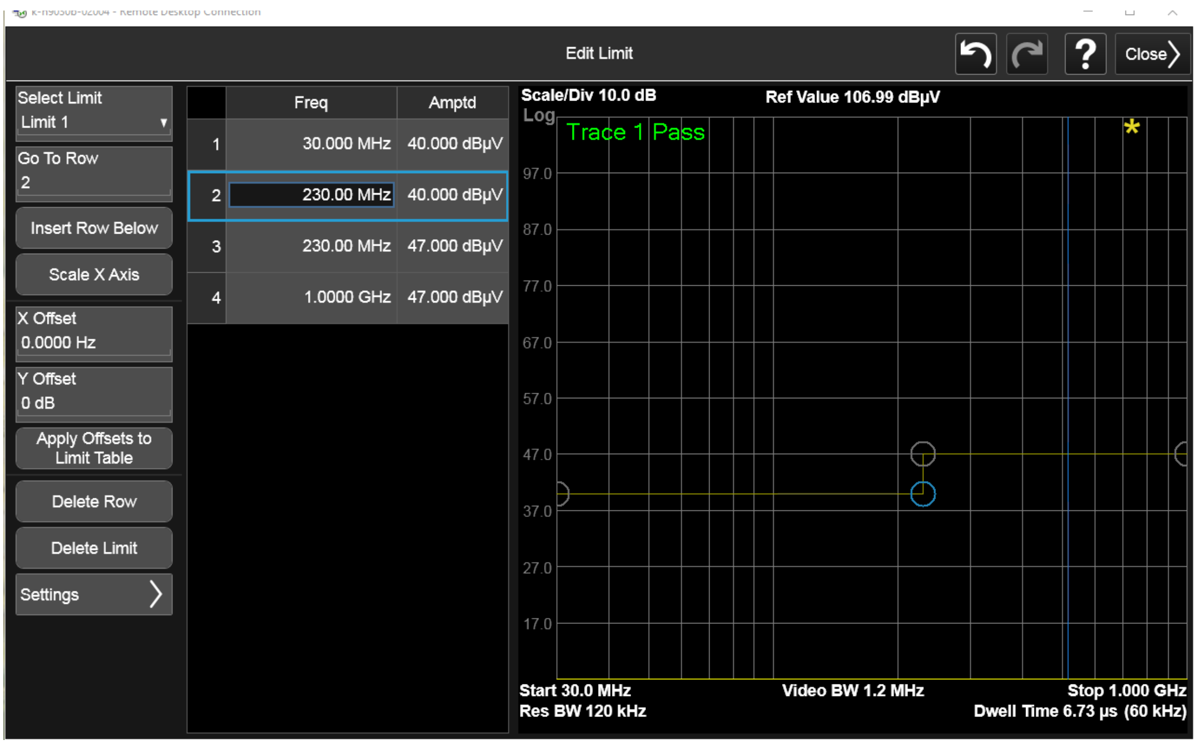
TIP All limit lines, corrections, traces, signal lists, and scan tables can be saved in .csv format. This format allows you to easily edit or create files on your PC.

CAUTION Before connecting a signal to the receiver or signal analyzer, make sure the instrument can safely accept the signal level provided. The signal level limits are marked next to the RF Input connectors on the front panel.

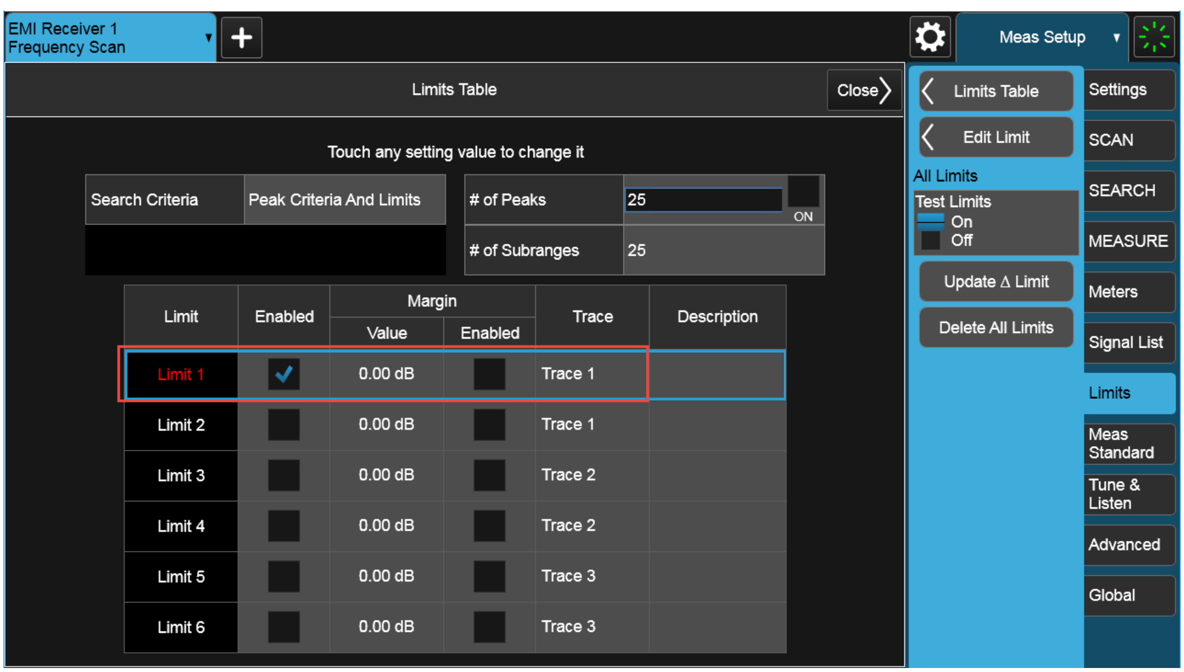
Step	Action	Notes
1. Load the built-in limit line file	Select **Recall**, **Limit** tab, set **Select Limit** to **Limit 1**, set **Preloaded Limits** to **Preloaded**, then select **Recall From**. Select **EN** folder, **55022** folder, then `EN55022, Rad, Class B, 30 MHz to 1 GHz (10m)`, **Recall**.	For MIL Std measurements, load the built-in limit file, "MIL RE102-1 Rad, Surface Ship, Below Deck.csv." Alternately, if you are running the application from your desktop, select the folder icon in the Control Bar (bottom of the window).

Step	Action	Notes
		
2. Edit the limit line	Select **MEAS SETUP**, **Limits** tab, **Edit Limit**. Select **Close** when finished.	You can now add or delete a point or modify the frequency and amplitude of the current point.

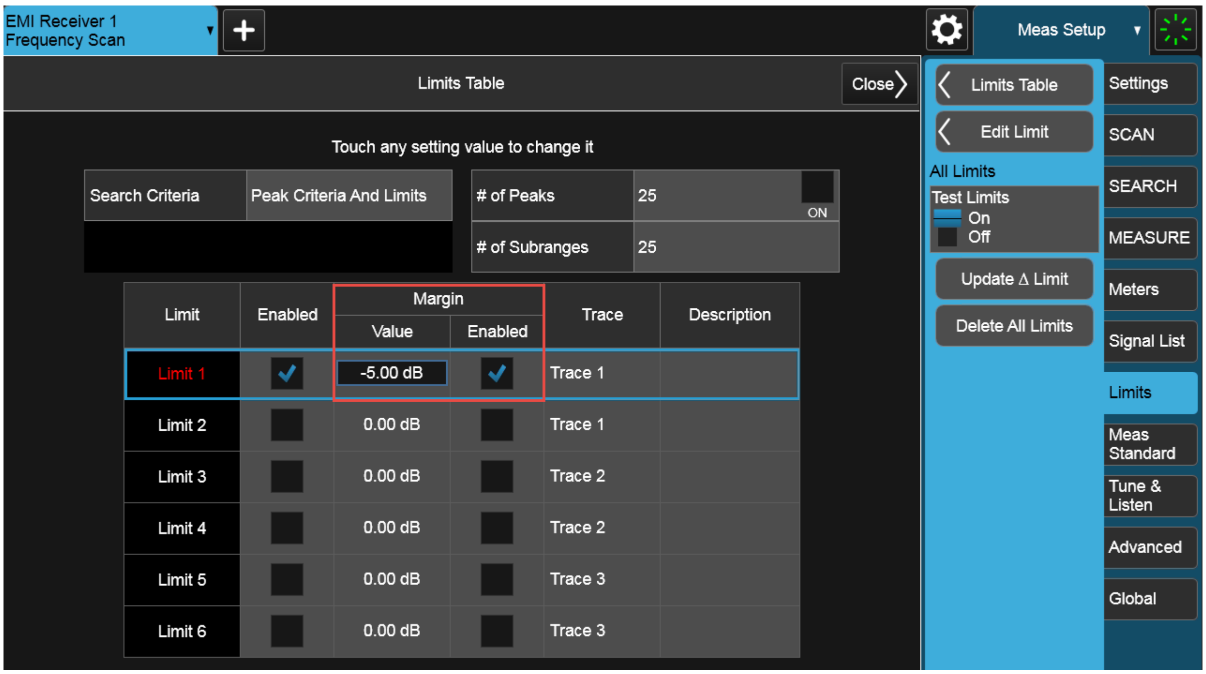
Step	Action	Notes



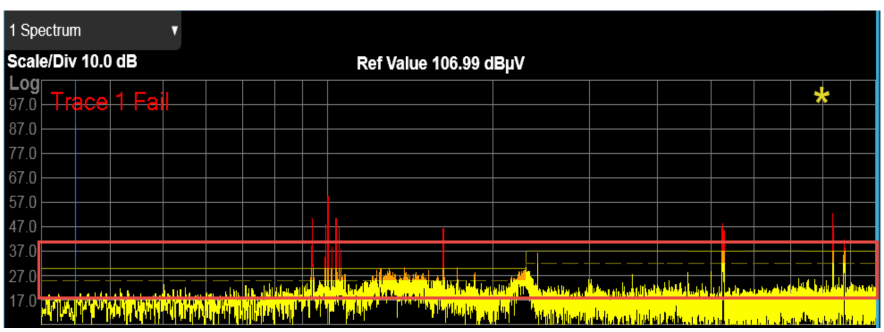
Step	Action	Notes
3. Assign Limit 1 to Trace 1	Select the **Limits Table**, select **Limit 1** to **Trace1**, **Enabled**.	Limit lines are assigned to a specific trace.



Step	Action	Notes
4. Add a 5 dB margin to Limit Line 1	Set the **Margin** to **–5 dB**, select **Enabled**, then **Close** the Limit Table.	



Step	Action	Notes
5. Check that both the limit and the margin are on		

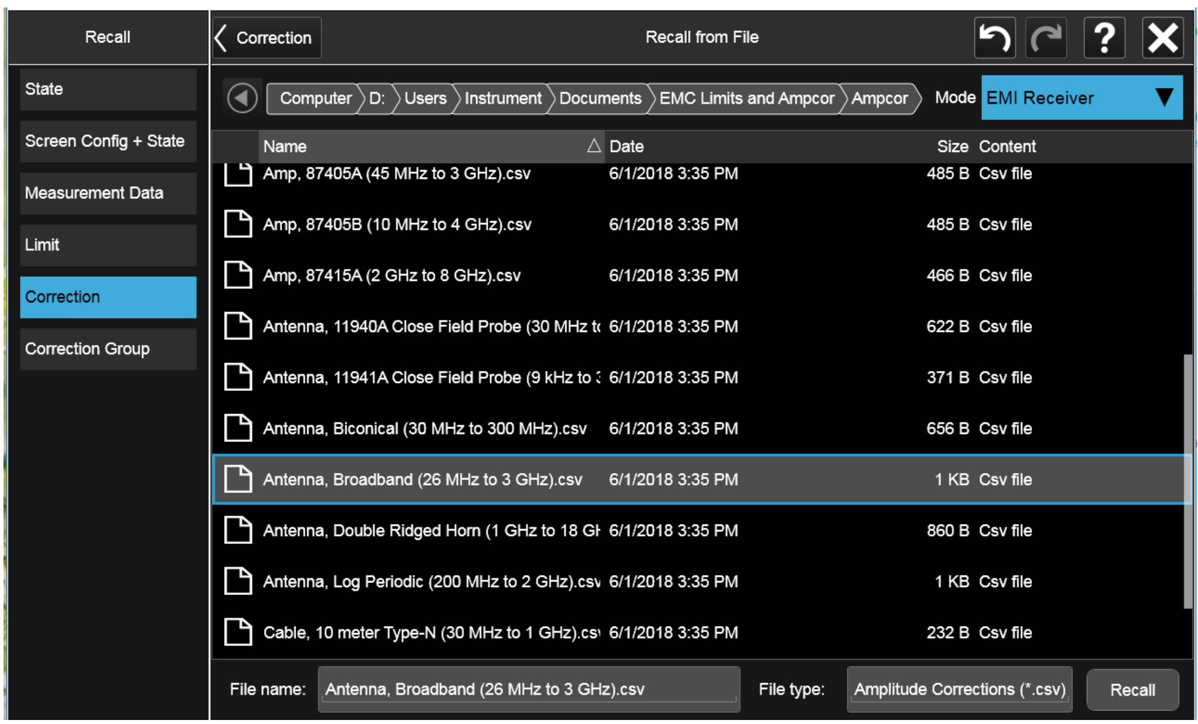


Step 3: Load and edit corrections

The EMI measurement application has built-in typical correction files for many accessories on the market, such as amplifiers, Line Impedance Stabilization Networks (LISNs), and antennas. You can create your own correction files for devices not preloaded in the application or edit the existing files.

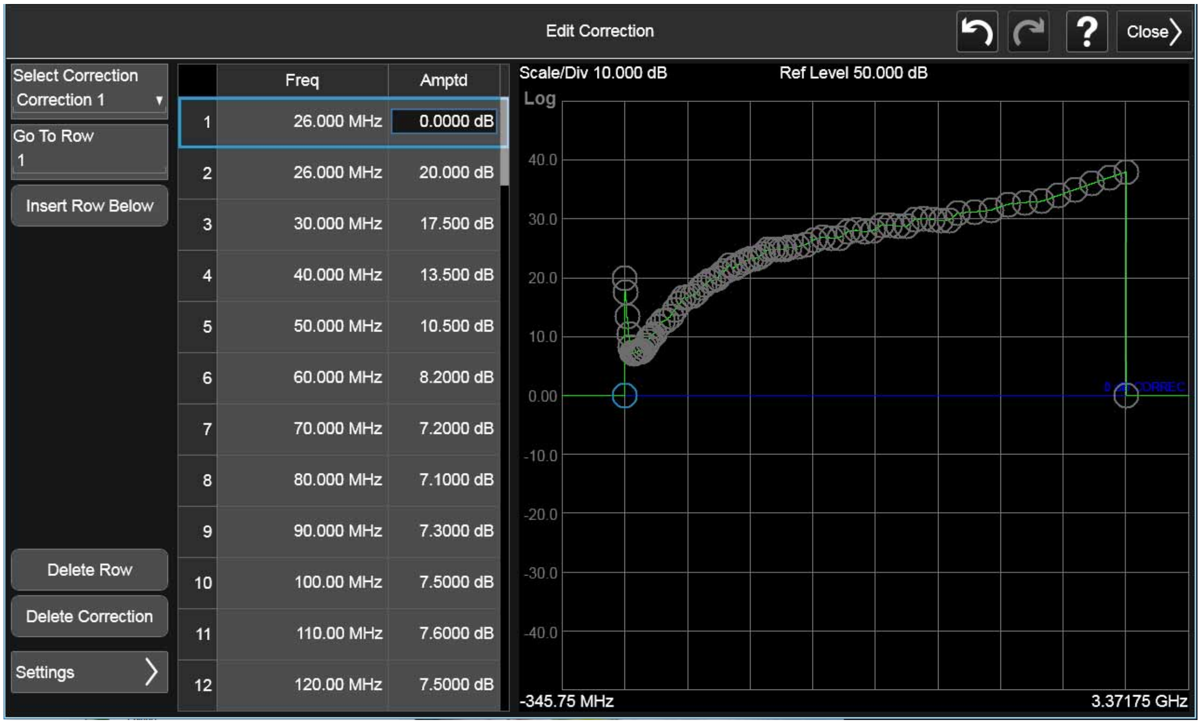
In this section we will load a built-in correction file and then edit the correction.

Step	Action	Notes
1. Load a built-in Antenna correction file	Select **Recall**, **Correction** tab. Set **Select Correction** to **Correction 1**, **Preloaded Correction** to **Preloaded**, then select **Recall From**. Select `Antenna, Broadband (26 MHz to 3 GHz).csv`, then **Recall**.	

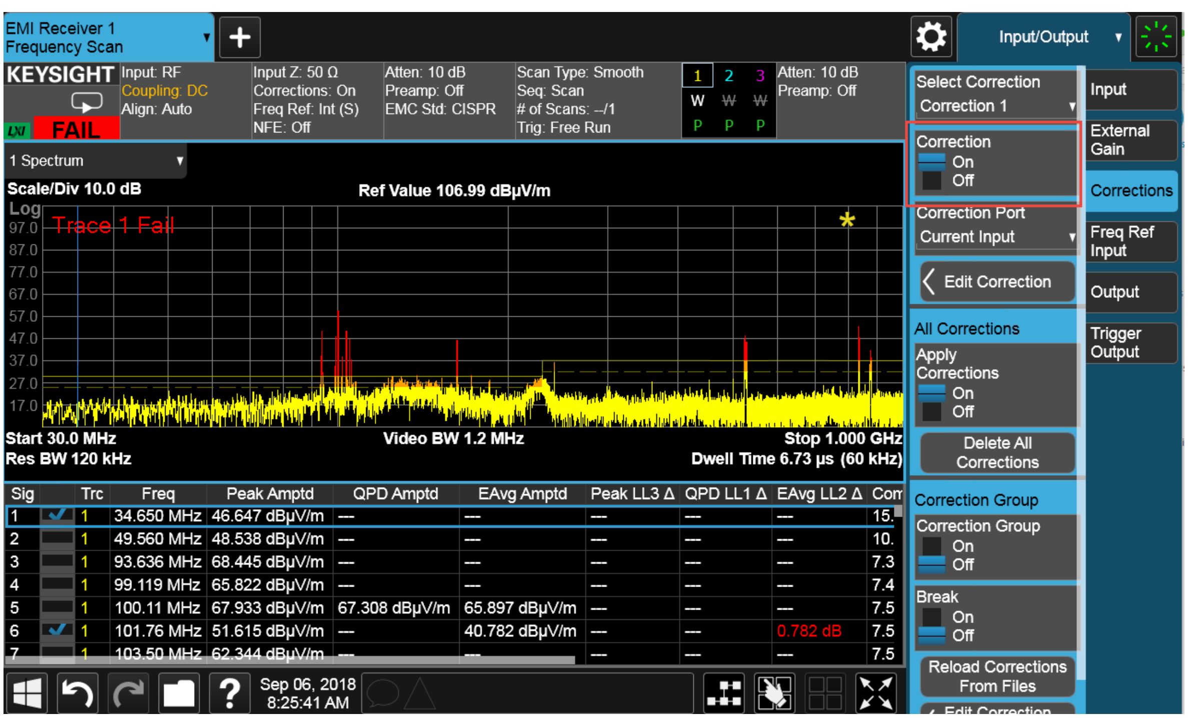


2. Edit the correction	Select **Input/Output**, **Corrections** tab, **Select Correction**, **Correction 1**, then **Edit Correction**. **Close** when finished.	You can add or delete a point or modify the frequency and amplitude of the current point.

Step	Action	Notes



3. Verify that Corrections 1 is turned on	**Select Correction**, **Correction1**, toggle **Correction** to **On**.	Corrections will automatically turn on once you have entered the editor.



Step 4: Modify the Scan Table settings

The Scan Table allows you to configure up to 10 different scan ranges. Each scan range has settings for critical measurement parameters, such as frequency, attenuation, and preamp settings. You can choose to use the default parameter settings in each range or set each one individually to meet your measurement needs.

In this section we will set Range 5 to CISPR C/D 30 MHz - 1 GHz and then make setting changes to dwell time, attenuation, and preamp. The dwell time selected results in a recommended minimum CISPR scan time.

TIP **You can set up two or more ranges with different settings for a single scan. Select the check boxes to select the appropriate ranges and the receiver will scan them sequentially. The maximum scan points is 4,000,001 and the maximum scan time is 4,000 seconds.**

Step	Action	Notes
1. Open the Scan Table	Select **Settings** tab, **Scan Table** go to **Range 5**.	Clear any other range that is selected.
2. Set the dwell time, attenuation, and preamplifier	In the Scan Table, set **Dwell Time** to **62 µs**. Set **Attenuation** to **0 dB**. Set I**nternal Preamp** to **Low Band**. **Close** the Scan table.	**NOTE** For MIL-Std measurements, leave the default dwell time setting as 6.73 µS. To access the Int Preamp settings, select "Off". You will then be given the option of selecting Off, Low Band, or Full Range.

Step	Action	Notes

Step 5: Use a multiple trace scan to view max hold and current signal values

The recommended commercial prescanning methodology requires that suspect emissions be collected while the device is rotated on a turntable and antenna heights are scanned. This ensures the identification of all signals that might exceed the limit. You can use the multi-trace capability of the receiver to simplify this collection and provide insight into which instrument orientation contributes to the highest signal levels.

In this section, we will set Trace 1 to Max Hold to capture a summary of the emissions from the measured turntable azimuths and antenna heights. In addition, we will set Trace 2 to Clear/Write to capture the emissions profile of the current EUT position. The signals in Trace 1 will be tested against Limit Line 1 and written to the suspect list.

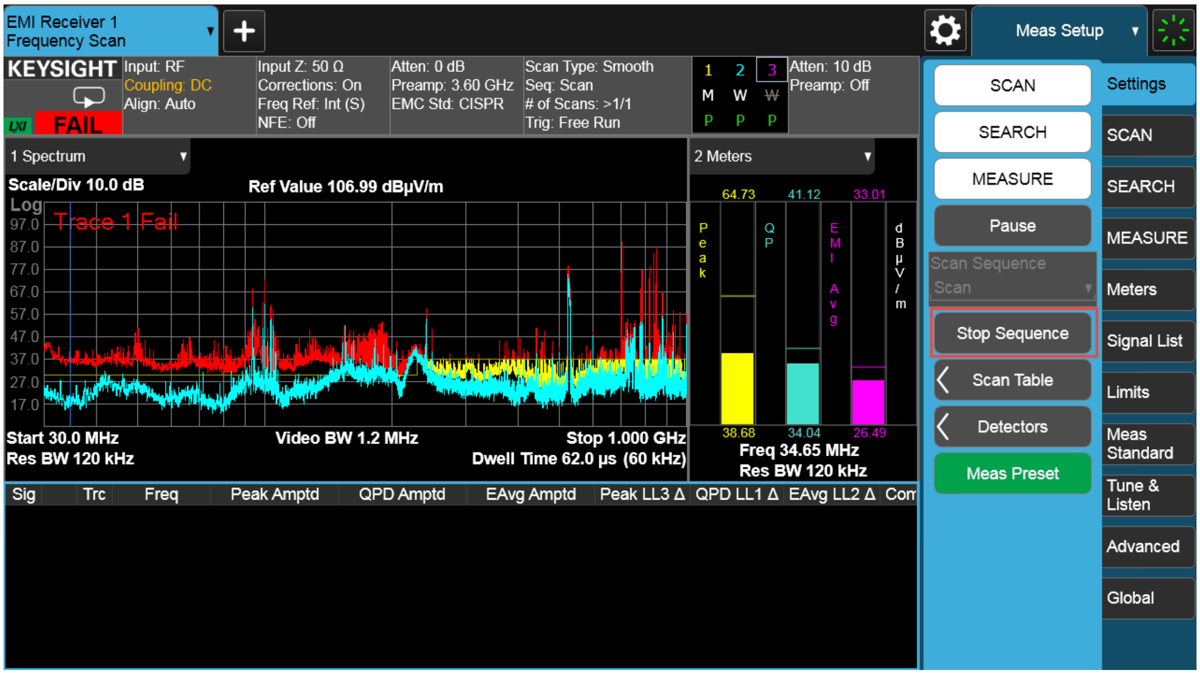
TIP The X-Series signal analyzer's digital IF architecture guards against IF overload, even if signals are above the reference level. This reduces operator error by eliminating an overload caused by incorrect reference level settings.

Step	Action	Notes
1. Turn on all three meters	Select **MEAS SETUP,** the **Meters** tab, **Meters Config**. Set **Meter 2** to **Quasi Peak** and **Meter 3** to **EMI Average**. (These are the default values.) Turn **On** all three meters, then **Close** the table.	It is not necessary to turn on three detectors for scanning, searching, and measuring, but it is helpful to see three meters for tuning signals later in the process. **NOTE** For MIL-Std measurements, do not turn on Meters 2 and 3.

Step	Action	Notes
2. Set the scan sequence for a Scan only	Select the **Settings** tab, set **Scan Sequence** to **Scan**.	The default setting.
3. Set the scan type to stepped	Select the **SCAN** tab, set **Scan Type** to: ***MXE*: Smooth (Swept)**, ***PXE*: Discrete (Stepped)**	

Step	Action	Notes
4. Set the frequency scan to continuous	Select **Sweep**, **Frequency Scan** to **Continuous**.	The default value.
5. Set trace 1 to max hold and the detector to peak	Select **Trace**, set **Select Trace** to **Trace 1**, set **Trace Type** to **Max Hold**, and **View/Blank** to **Active**. Select the **Detector** tab and select **Peak**.	Trace 1 is the yellow trace.
6. Set trace 2 to clear write and the detector to peak	Select the **Trace Control** tab, set **Select Trace** to **Trace 2**, **Trace Type** to **Clear/Write**, and set **View/Blank** to **Active**. Select the **Detector** tab and select **Peak**.	Trace 2 is the blue trace.
7. Start the scan	Select **MEAS SETUP**, **Settings** tab, then **Start Sequence**.	Alternately, you can go to SWEEP, Start Scan, or press the Restart key.

Step	Action	Notes



8. Observe the two traces updating, then stop the scan	Select **Stop Sequence**.	

Step 6: Reduce the prescan time by using a time domain scan or Accelerated TDS (N9048B PXE EMI Receiver only)

NOTE Smooth Scan is currently only available in the X-Series signal analyzers.

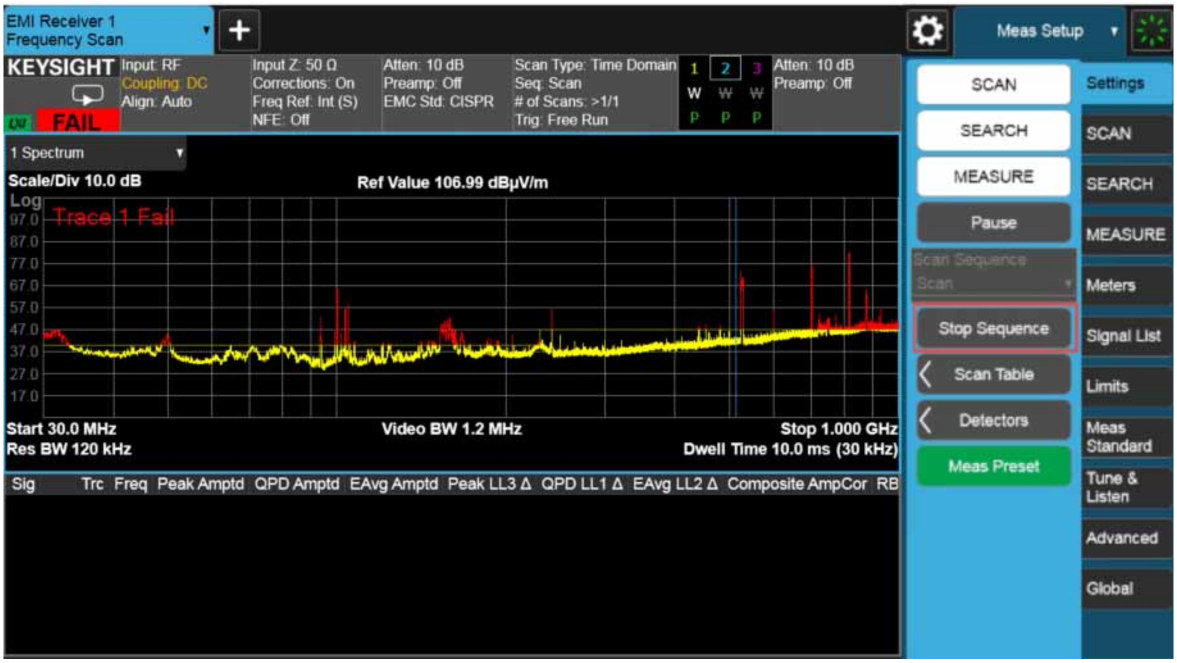
The EMI measurement application supports three scan types: Discrete (Stepped), Smooth (Swept), and Time Domain. Discrete scan is the traditional stepped frequency scan. Smooth scan is a swept frequency scan. It is faster than a discrete scan because it does not require retuning the local oscillator (LO) for each frequency point. Time domain scan, while based on stepping the LO, is the fastest scan type. Time domain scan uses overlapped FFT technology to collect data in acquisition bandwidths that contain multiple resolution bandwidths.

In this section, we will demonstrate the advantage that time domain scanning offers for reducing prescan times when using longer dwell times. Commercial test methodology requires that engineers set the measurement dwell time to the inverse of the slowest emission pulse repetition frequency from the EUT. In this example we will use a 10 ms dwell time.

TIP The EMI Measurement application allows you to set reference levels, limit lines, traces, meters, corrections and more during scanning. For example, if you did not set the reference level or limit line appropriately, you can do so without stopping the scan. The changes will take effect immediately during the scan.

Step	Action	Notes
1. Turn off trace 2 and set trace 1 to clear write	Select **Trace**, set **Select Trace** to **Trace 2**, and **View/Blank** to **Blank**. Set **Select Trace** to **Trace 1,** set **Trace Type** to **Clear Write**.	
2. Set the dwell time to 10 ms	Select **MEAS SETUP**, **Scan Table**, **Range 5**, **Dwell time** to **10 ms**. **Close** the table.	
3. Change the scan type to time domain	Select the **SCAN** tab, set **Scan Type** to **Time Domain**. Select the **Settings** tab, then **Start Sequence**.	The scan speed of a Time Domain scan is much faster than that of the Smooth (Swept) or Discrete (Stepped).

Step	Action	Notes
4. Start the scan	Select **Start Sequence**.	Observe the time required to cover the frequency span.



Step	Action	Notes
5. Stop the scan	Select **Stop Sequence**	

Alternately, if you are using a PXE EMI Receiver, you can use the Accelerated TDS feature to reduce prescan time.

NOTE Accelerated TDS requires Option WT1/WT2 on the N9048B PXE EMI Receiver.

Step	Action	Notes
6. Turn on Accelerated TDS	Select the **SCAN** tab, turn **Accelerated TDS (30 MHz - 3.2 GHz**) to **On**.	
7. Start the scan	Select the **Settings** tab, **Start Sequence**.	Observe the time taken to complete the scan. You will find the time taken is greatly reduced with Accelerated TDS turned on.
8. Stop the scan	Select **Stop Sequence**	

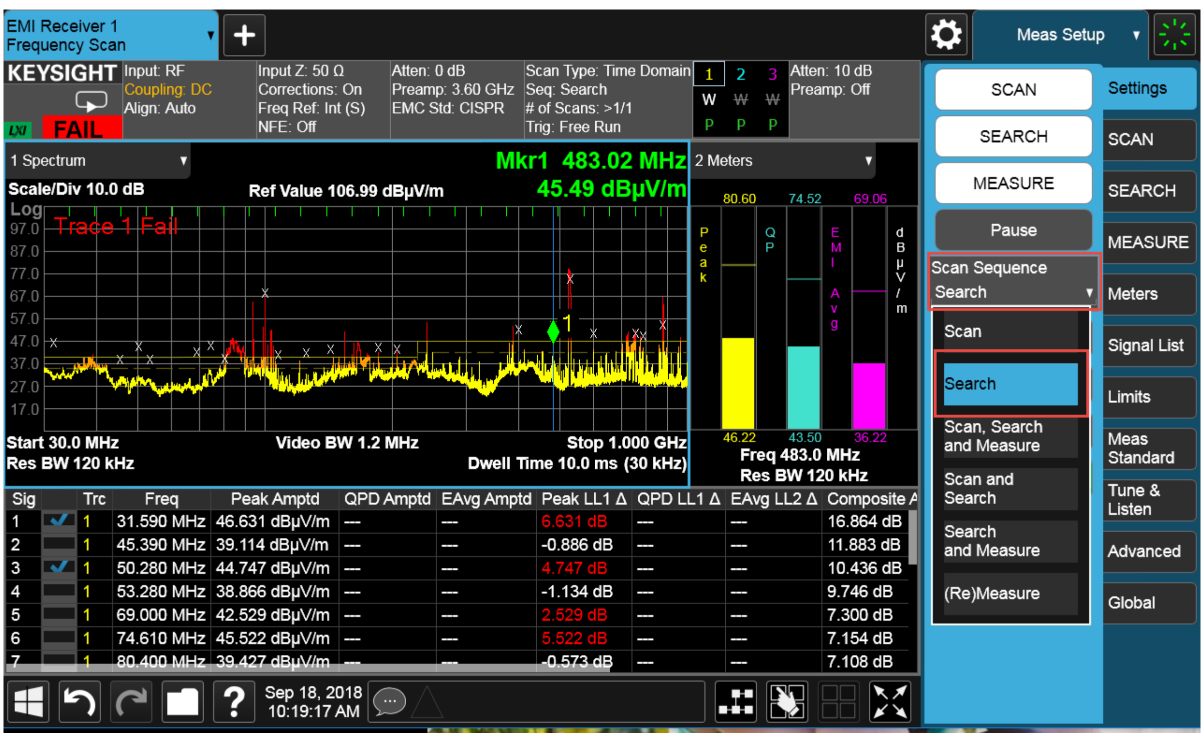
Data Reduction

Suspect frequencies that are close to or greater than the specified limits warrant further review and final measurement. Sometimes the suspect signals are searched in subranges based on a certain standard requirement. You might also want to add or delete signals from the suspect list manually. This process is called data reduction.

Step 1: Search for signals above a limit line

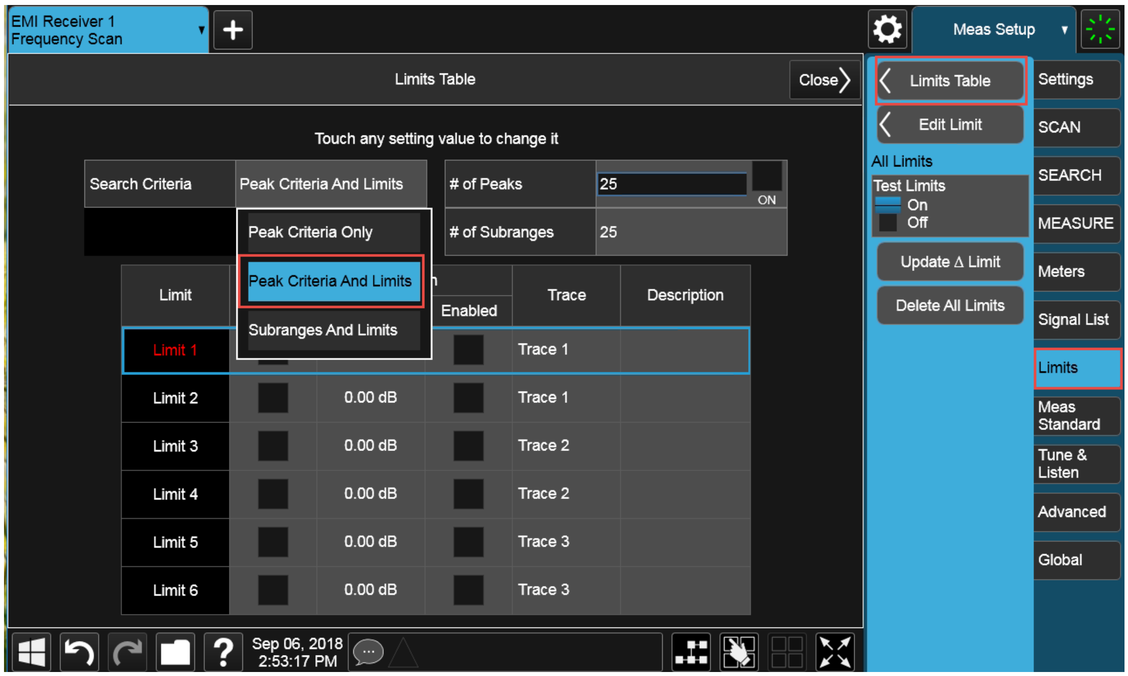
In this section, we will set the Scan Sequence to Search only. The Search Criteria will be set to Peak Criteria and Limits for collection of signals over the limit. To simplify the process, Trace 2 and Limit 2 will be turned off.

Step	Action	Notes
1. Stop the scan	Select **MEAS SETUP**, **Settings** tab, then **Stop Sequence**.	If not done at the end of the last section.
2. Set the scan sequence to search only	Set **Scan Sequence** to **Search**.	

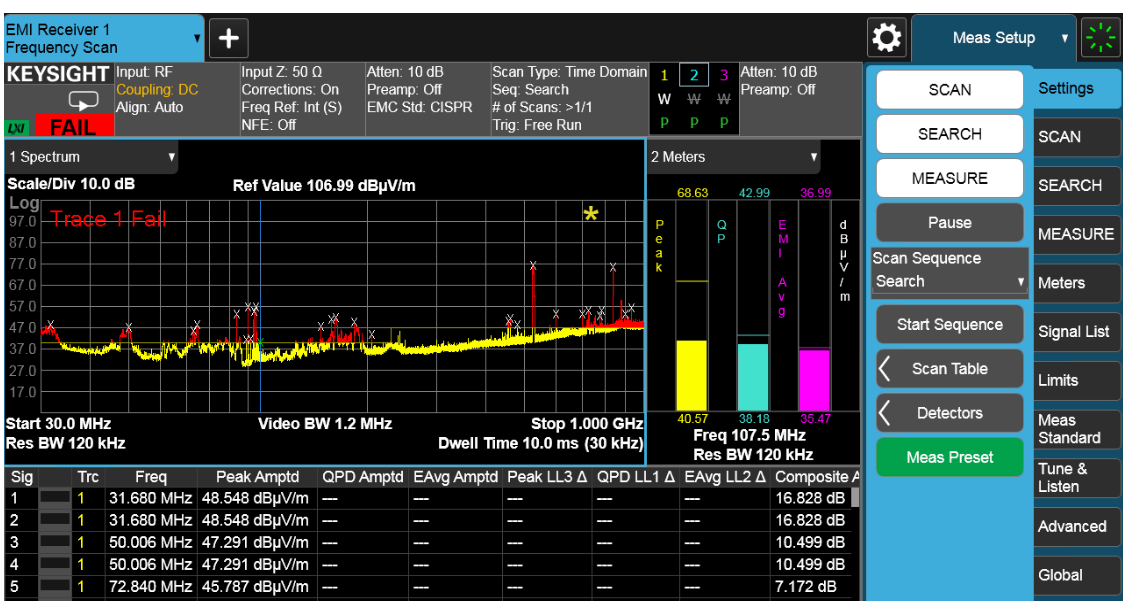


3. Set the search criteria to peak criteria and limits	Select the **Limits** tab, **Limits Table**, **Search Criteria** to **Peak Criteria and Limits**, then **Close** the Limits Table.	When Peak Criteria and Limits is selected, the search finds the peaks that meet the Excursion and Threshold (set in the Limits tab) and also considers limits and margin if they are turned on.

Step	Action	Notes



Step	Action	Notes
4. Start the search	Select the **Settings** tab then, **Start Sequence**.	**TIP** To Clear existing signals in the Signal List table, select the Signal List tab then Delete All. Otherwise, new signals will be appended to the signal list without clearing older ones.

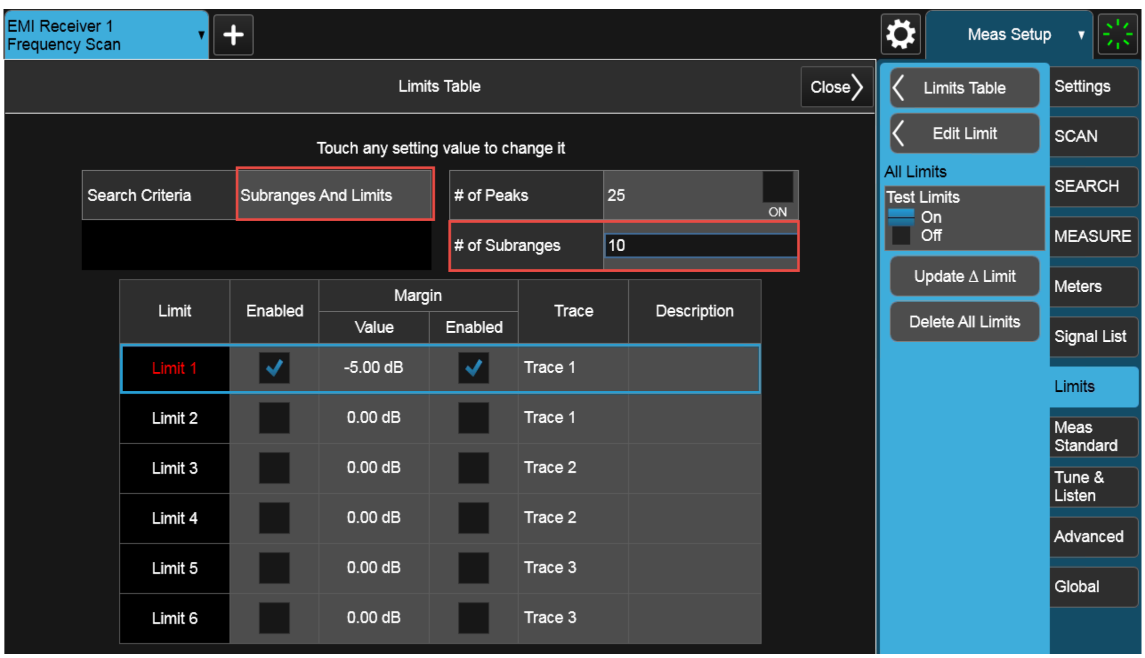


Step	Action	Notes
5. Stop the search	Once the signals have been added to the list, select **Stop Sequence**. If there are no signals in the signal list, then no further measuring needs to be done and the product passes the conducted emissions limit. If there are signals above or close to the limit, continue with the process below.	

Step 2: Searching in subranges

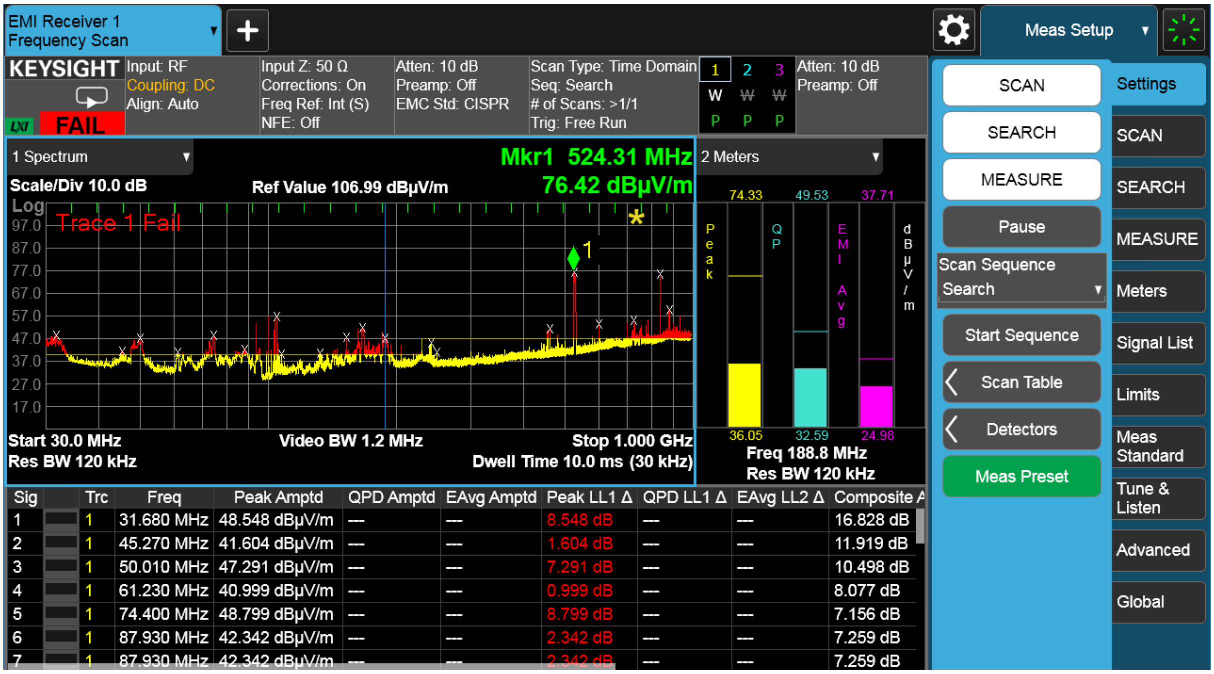
In this section, we will set the search criteria to Subranges and Limits. When Subranges and Limits is selected, the entire start and stop frequency span is divided into equal width of subranges. The number of subranges depends on the value set for # of Subranges. Performing a search finds the peaks for each subrange, and the peaks that exceed the limits and margin (if they are turned on) will be added into the signal list.

Step	Action	Notes
1. Set the search criteria to subranges and limits	Select the **Limits** tab, **Limits Table**, Search Criteria to **Subranges and Limits**. Set the # of Subranges to **10**, then **Close** the Limits table.	When Peak Criteria and Limits is selected, the search finds the peaks that meet the Excursion and Threshold (set in the Marker menu) and also considers limits and margin if they are turned on.



Step	Action	Notes
2. Clear the list and start a new search	Select the **Signal List** tab, **Delete All**. Select the **Settings** tab, then **Start Sequence**.	**TIP** Alternately, you can go to Sweep, Start Sequence. From this menu you can use Clear List and Start to clear a signal list before starting a new search. Otherwise, new signals will be appended to the signal list without clearing older ones.

Step	Action	Notes



Step 3: Deleting and adding signals

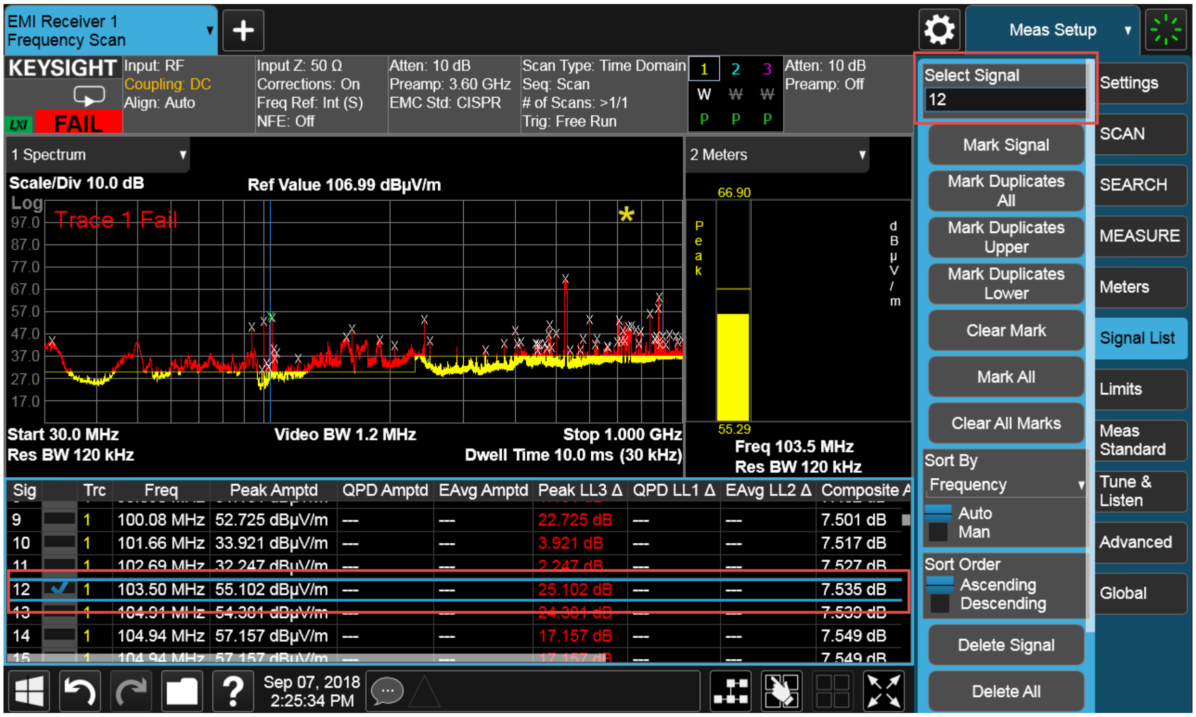
The EMI measurement application allows you to edit a signal list by marking and deleting signals or adding a signal at the current marker frequency. The application offers flexible features to adjust the frequencies of signals in the signal list as shown in Table 3-1. EMC engineers spend a lot of time optimizing the signal list during the data reduction and radiation maximization process.

In this demonstration, we will use Mark Signals and Delete Marked functions to delete signals from signal list. We will also use the Mkr->List function to add additional signals to the signal list.

Table 3-1 Key path for adjusting the frequencies in a suspect list

Category	Description	Key path
Move to Frequency	Move meters to marker frequency	Marker, Marker-> tab, Move Meters to Marker Freq
	Move marker to meters frequency	Marker, Marker-> tab, Move Maker to Meters Freq
	Move meters to the frequency of the closest signal	MEAS SETUP, Meters tab, Snap to Meters (Select Closest Signal)
Add to List	Add marker frequency to list	Peak Search, Marker-> tab, Mkr->List
Couple frequencies	Add meters frequency to list.	MEAS SETUP, Meters tab, Meters->List (Append)
	Replace current signal frequency with meters frequency.	MEAS SETUP, Meters tab, Meters->Signal (Replace)
Couple Meters	Couple meters frequency to current signal. The blue line form meters frequency follows the current signal when navigating signals	MEAS SETUP, Meters tab, Couple Meters to Signal List
	Couple meters frequency to current marker. The blue line for meters frequency follows the current marker movement.	MEAS SETUP, Meters tab, Couple Meters to Marker

Step	Action	Notes
1. Select a signal from the signal list and mark it	Select **MEAS SETUP**, **Signal List** tab, **Select Signal**, **Mark Signal**. Use the knob, up/down arrow keys, mouse, or your finger touch to highlight the signal. The highlighted signal is shown in the Select Signal box.	You can also mark signals in the signal list by selecting the check box in the Sig column.



Step	Action	Notes
2. Delete the marked signal	Select **Delete Signal**.	Or, you can use Delete All to delete all signals.
3. Add a peak into the signal list using Mkr->List	Select **Peak Search**, **Marker->**, **Mkr->List**.	The frequency of the current marker will be added to the list. This signal may be a duplicate of an already existing signal, but any signal can be added.

Maximization

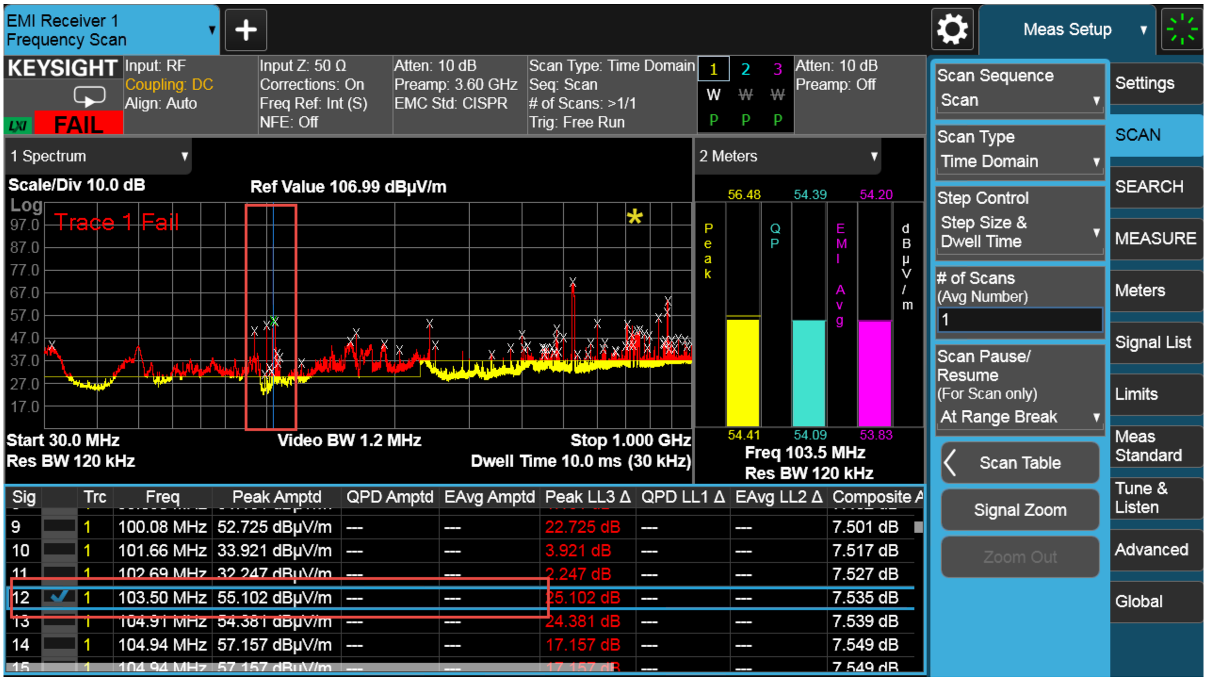
Before final measurement, it is important to maximize each signal. This step allows you to find out the maximum amplitude of each suspect signal through frequency adjustment, antenna height scan, azimuth rotation, and polarization change. Several features in the EMI receiver mode, such as signal zoom, marker zoom, global center frequency, monitor spectrum, and strip chart, can be used for this purpose.

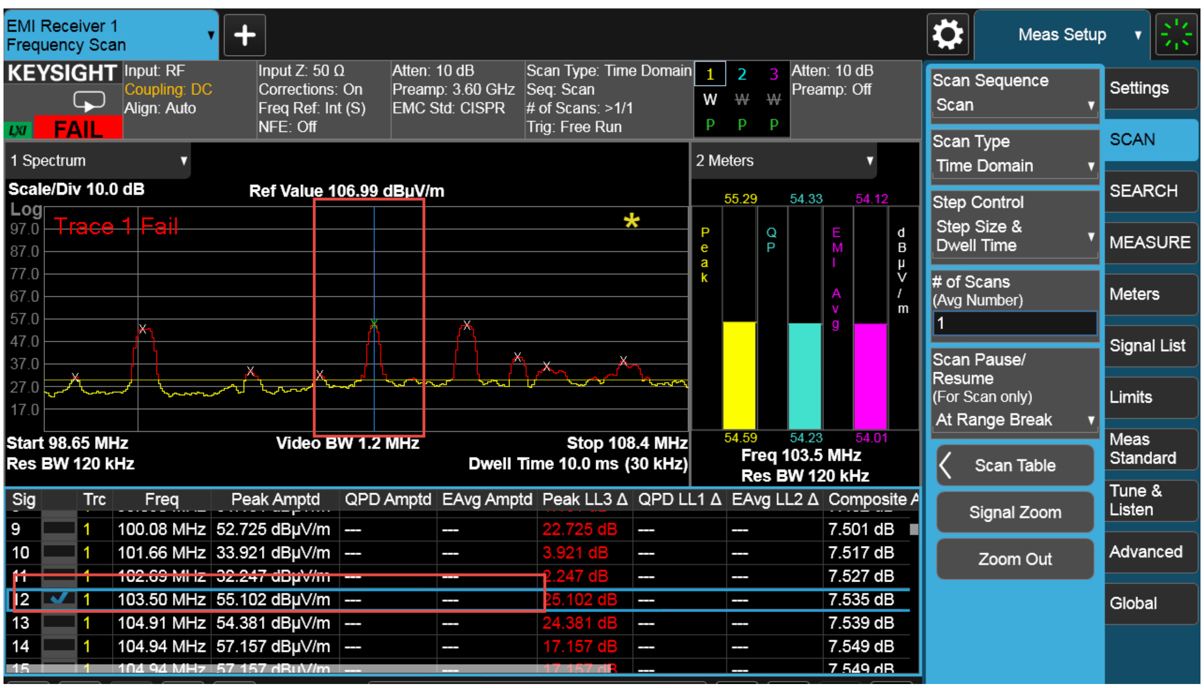
Step1: Tune signals by zooming in

In this demonstration, we view signal details by zooming in with the Signal Zoom function. The cross marker may not be well centered on the signal, so we can adjust the signal frequency with Meters and the Meters->Signal (Replace) function.

Step	Action	Notes
1. Select a signal from the signal list	Select **MEAS SETUP**, **Signal List** tab. Use the knob, arrow keys, scroll bar, mouse pointer, or finger to select a signal, or use **Select Signal** and enter in the **Sig #**. Select **Mark Signal**.	
2. Zoom in on the signal	Select the **SCAN** tab, **Signal Zoom**. Select Signal Zoom as many times as needed to reduce the frequency uncertainty of the signal.	Each time you select Signal Zoom, it centers the selected signal and increases the magnification factor by 10. Meters are coupled to the current signal frequency, so the blue meter's frequency line follows the signal.

Step	Action	Notes





Step	Action	Notes
3. Adjust the frequency of the current signal and replace the older one	Select **FREQ**, **Frequency (Meters)**, use the knob to adjust the meter frequency (blue line on the spectrum display) to the center of the signal. Select **MEAS Setup**, the **Meters** tab, **Meters->Signal (Replace)** to replace the current signal with the meters frequency.	
4. Zoom out to full span view	Select the **Scan** tab, then **Zoom Out** until the spectrum is back to full span view.	

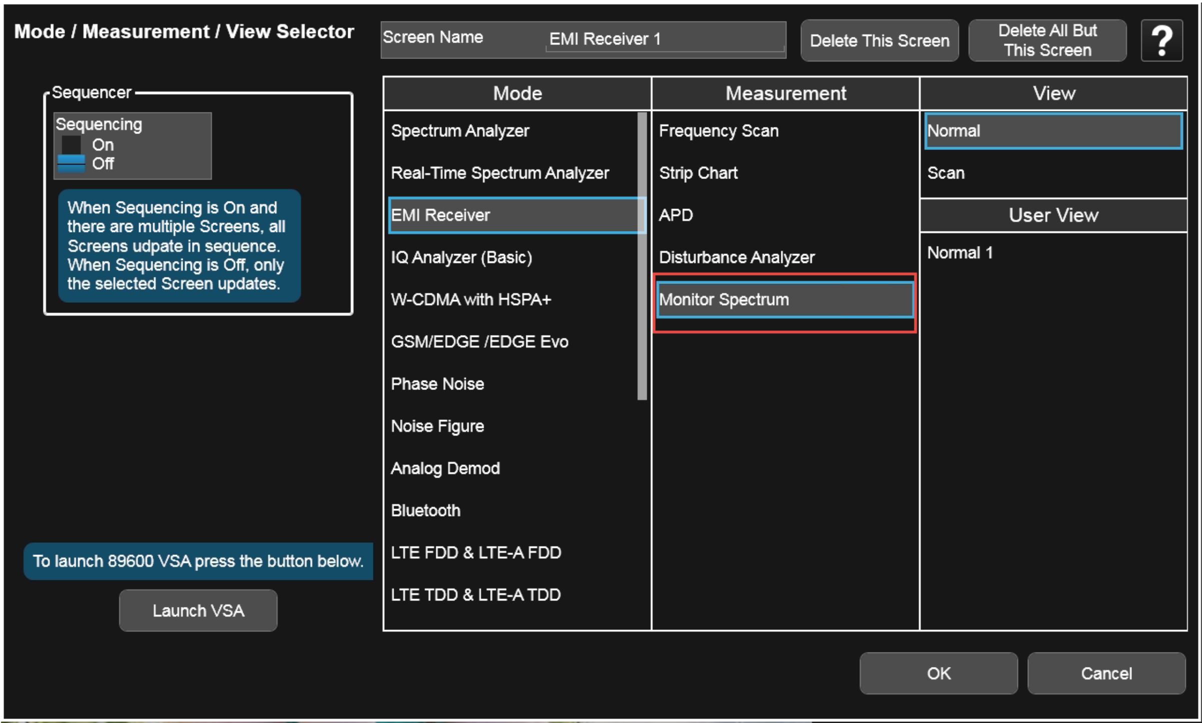
Step 2: Tune signals in Monitor Spectrum measurement

Monitor Spectrum is a measurement in EMI Receiver mode that updates the spectrum and the meters simultaneously. In this measurement, the center frequency of the spectrum display is tuned to the meter frequency. The spectrum display is created from an FFT of the signal in the receiver IF bandwidth. Monitor Spectrum simplifies identification of the signal's maximum amplitude and allows you to update the suspect signal list with the adjustments.

In this section, we will pick an FM signal (around 100 MHz) from the signal list and use Monitor Spectrum to adjust the meters frequency. Then, turn on Trace 2 with Max Hold to track the envelope of the frequency shift for the FM signal: Marker->CF and CF->Signal (Replace) are used to adjust the meters frequency and replace the current signal.

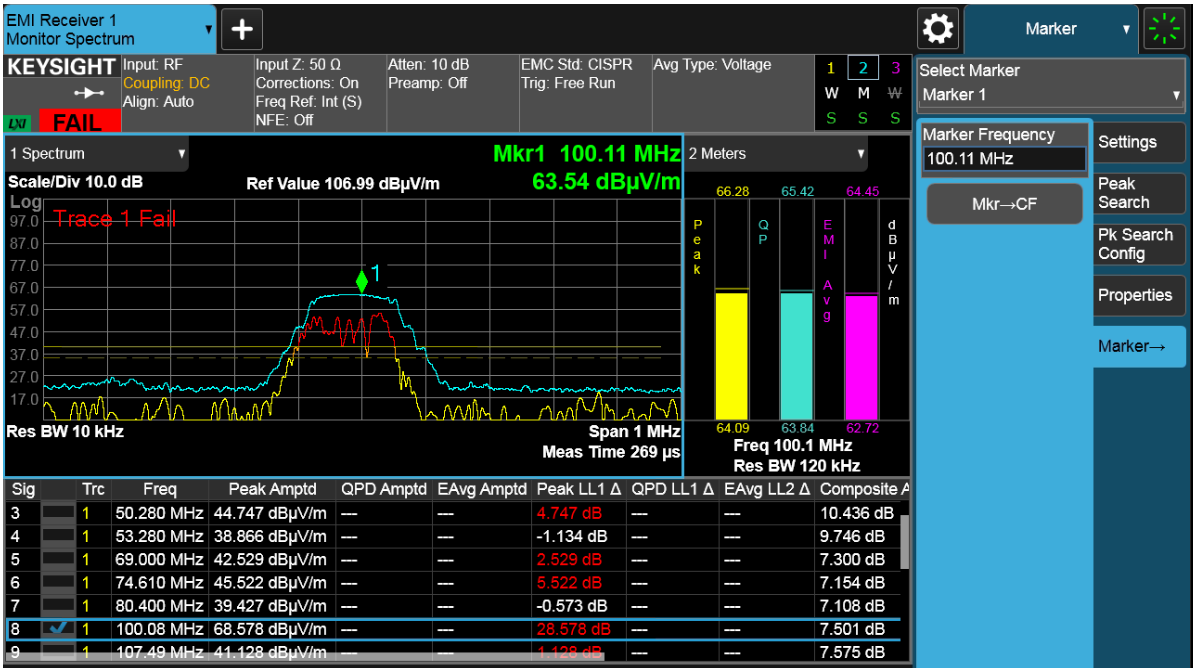
TIP The Monitor Spectrum measurement shares the same signal list with the Frequency Scan measurement, This allows you to update the signal list directly from the Monitor Spectrum measurement.

Step	Action	Notes
1. Select a signal from the signal list	Select **MEAS SETUP**, **Signal List** tab. Use the knob, arrow keys, scroll bar, mouse pointer, or finger to highlight a signal. Select **Mark Signal**.	Meter frequency is coupled to the current signal by default. (MEAS SETUP, Meters tab, Couple Meters to Signal List. An FM signal with drifting frequency was select for this example.
2. Switch to a monitor spectrum measurement	Select **MODE/MEAS**, **Monitor Spectrum** Measurement.	Alternately, if you are using a remote desktop connection, select the Screen tab (at the top of the window) to open the Mode/Measurement/View window.

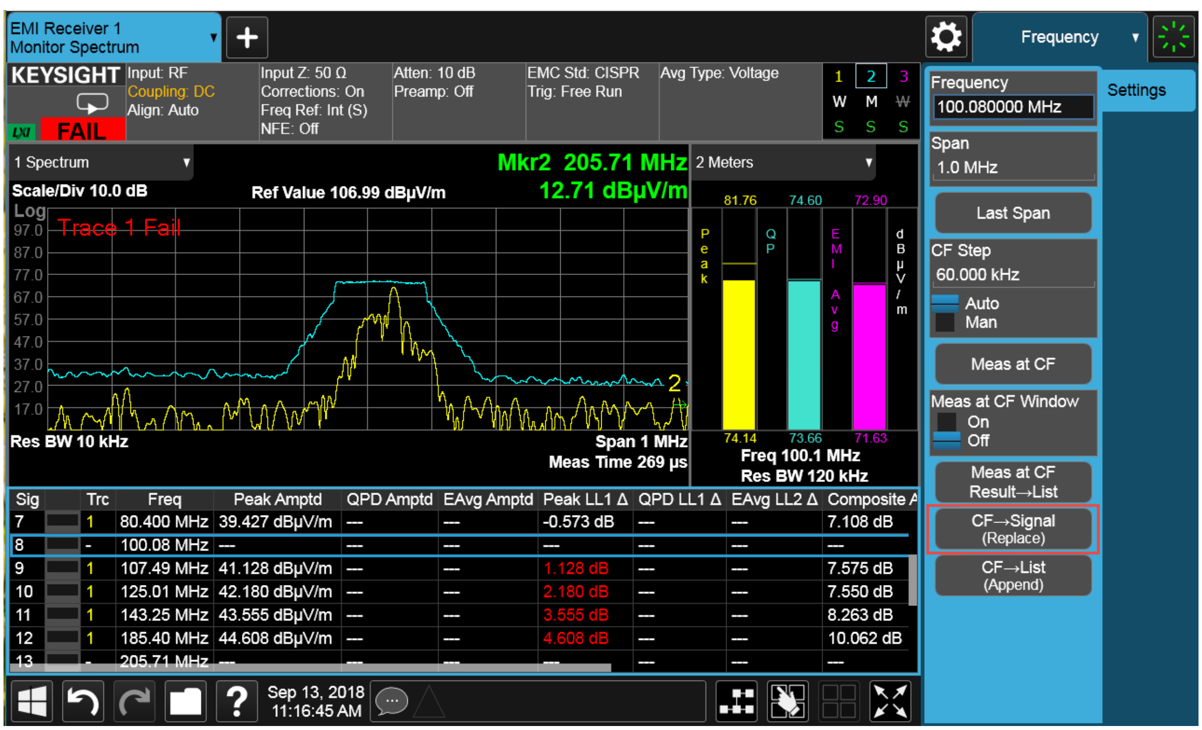


Step	Action	Notes
3. Turn on trace 2 and set to max hold	Select **Trace**. In the **Select Trace** field, select **Trace 2**. In the **Trace Control** tab, set **Trace Type** to **Max Hold**, and **View/Blank** to **Active**.	
4. Put a marker on trace 2	Select **Marker**, the **Properties** tab, set **Select Marker** to **Marker 2**. Set **Marker Trace** to **Trace 2**.	
5. Use peak search and move the marker to the center frequency	Select the **Peak Search** tab, **Peak Search**. Select the **Marker->** tab, **Mkr-> CF**.	

Step	Action	Notes



Step	Action	Notes
6. Replace the current signal with the frequency of the marker	Select **FREQ**, **CF-> Signal (Replace)**.	



Step	Action	Notes
7. Switch back to a frequency scan measurement	Select **MODE/MEAS**, **Frequency Scan** Measurement.	Alternately, if you are using a remote desktop connection, select the Screen tab (at the top of the window) to open the Mode/Measurement/View window

Final Measurement

The final measurement process contains the tasks of remeasuring signals for increased frequency accuracy, performing an automatic measure process to identify the highest signal amplitudes using peak, quasi-peak, EMI average detectors.

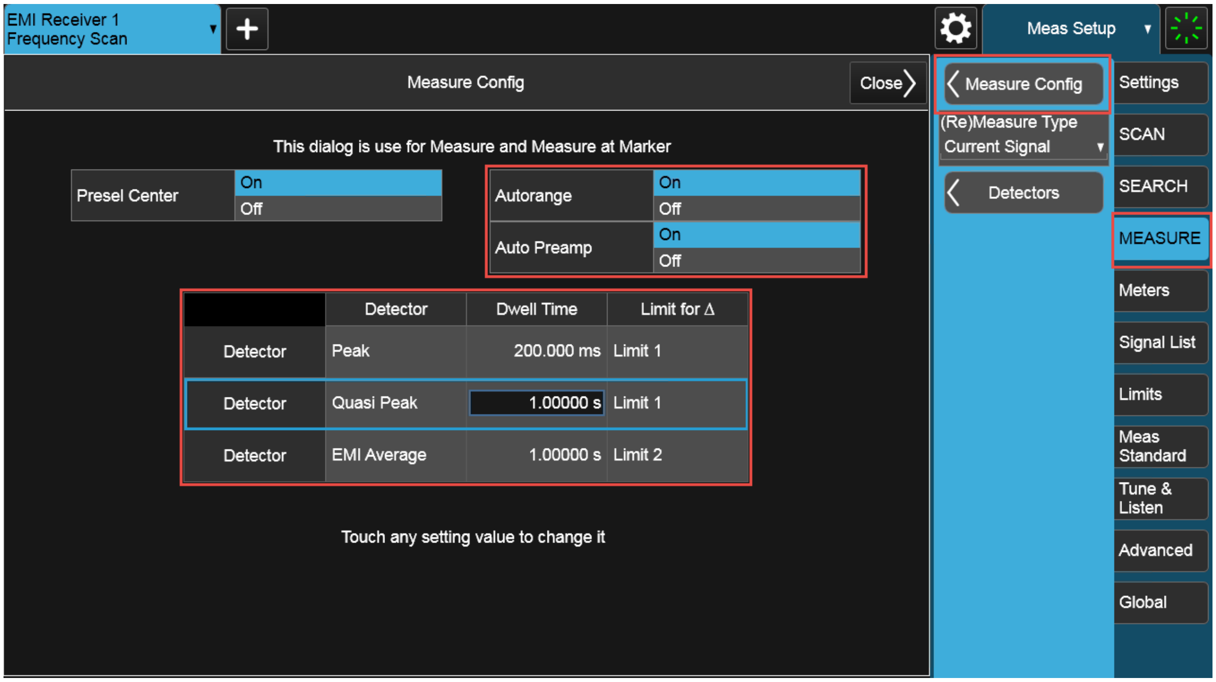
Step1: Making a final measurement

For this example we will remeasure all of the signals in the signal list using different limits for Detector 1 and 2 and also turn on auto range and auto preamp for the measurement.

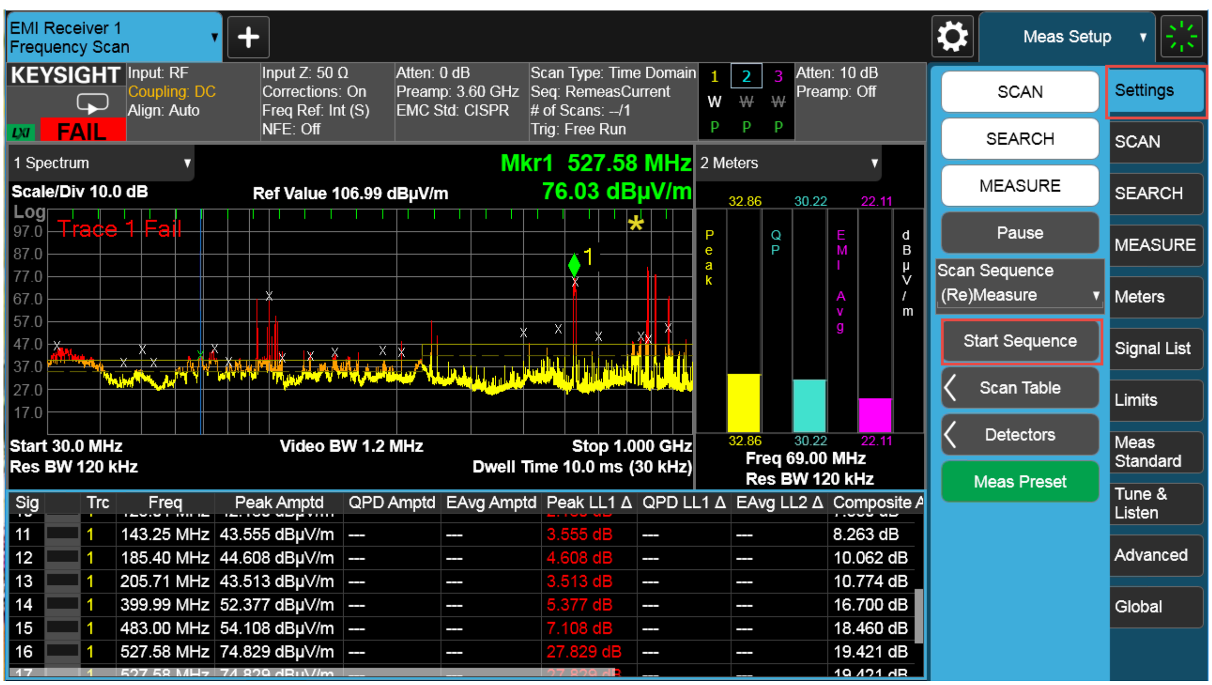
TIP **The EMI measurement application can be set up to conduct a scan, search, and final measurement automatically by selecting MEAS SETUP, Scan Sequence, Scan, Search, Measure.**

Step	Action	Notes
1. Set the scan sequence to Re(Measure)	Select **MEAS Setup**, the **Settings** tab, set **Scan Sequence** to **(Re)Measure**.	
2. Select the signals for Re(Measure)	Select the **MEASURE** tab, and select (**Re)Measure Type** to: **Current Signal** will make a final measurement on the signal selected in the signal list. **All Signals** will make a final measurement on all signals in the signal list.	
3. Select the detectors, dwell time, and limits for final measurement	Select **Measure Config**. In the Detector column, verify that both Quasi Peak and EMI Average detectors are set to **1.0 s**, the default value. In the Limit for Δ column, verify that Quasi Peak detector is set to **Limit 1** and EMI Average detector is set to **Limit 2,** the default values.	For MIL-Std measurements, turn off Detectors 2 and 3 and keep Detector 1 on. If the message, "changing limit or detector will discard the delta values" appears, select Enter to confirm.
4. Set auto range and preamp for final measurement	Select Autorange **On** and Auto Preamp **On**. **Close** the Measure Config window.	

Step	Action	Notes



Step	Action	Notes
5. Start the final measurement	In **Meas Setup**, select the **Settings** tab, then **Start Sequence**.	Alternately, you can select Start Sequence from the Sweep menu or press the Restart key.



Step	Action	Notes
6. Stop the search	Select **Stop Sequence**.	

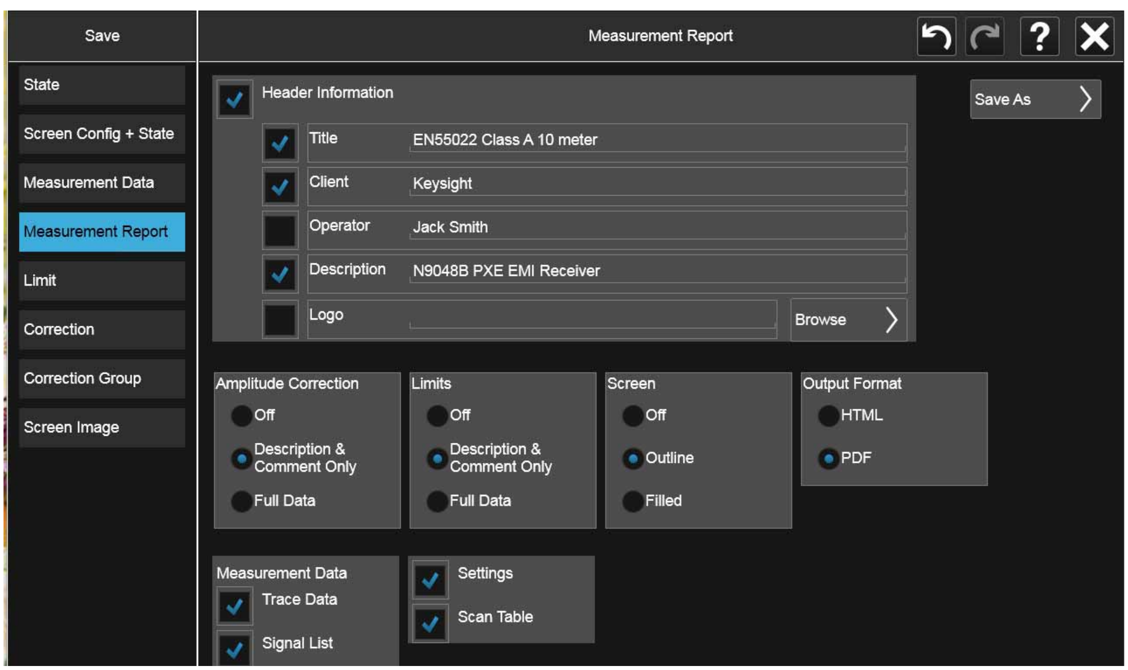
Report Generation

The EMI measurement application supports two formats, HTML and PDF. You can customize content to include amplitude corrections, limits, scan tables, trace data, signal lists, and screen captures.

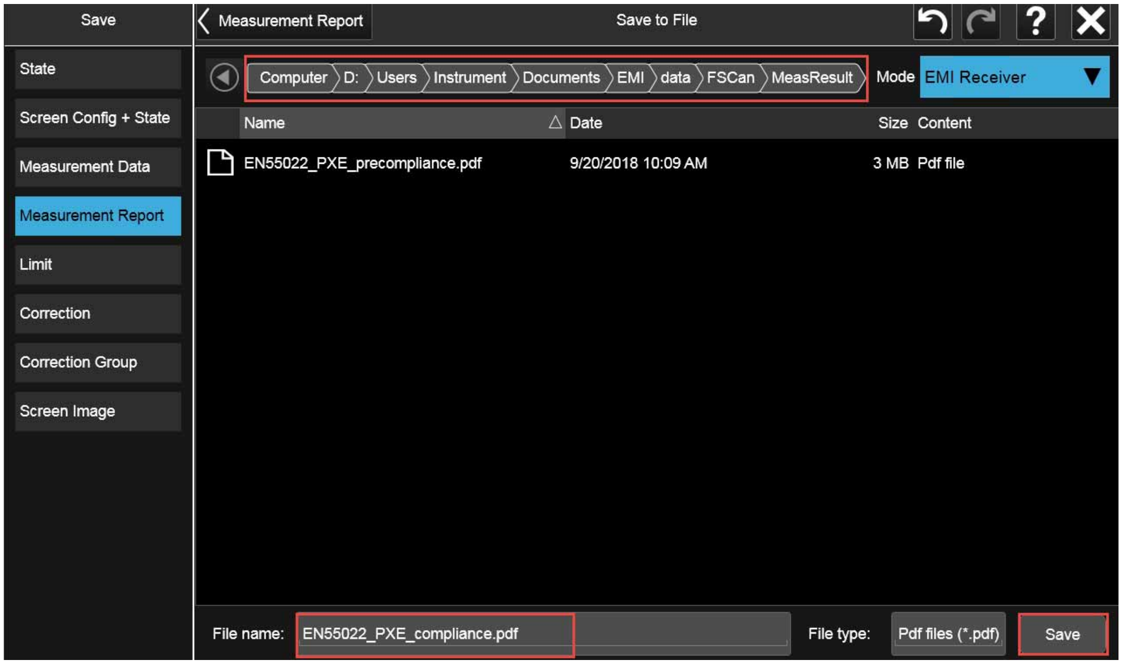
Step: 1 Configure and generate a report

We will generate a report in PDF format with customized content and header information.

Step	Action	Notes
1. Open the Measurement Report form	Select **Save**, **Measurement Report**.	
2. Fill in the header information	Click/touch the Title entry line and use the soft keypad to type a name for this report, then select the check box to the left of the entry to include this in the report. Do the same for the other Header fields as needed.	
3. Select the data you want to include in the report, and the output format	Select the data you want to include in the report (such as, Amplitude Correction, Limits, Trace Data and so on). Then select the Output format, either HTML or PDF.	



Step	Action	Notes
4. Save the report	Select **Save As**, enter a file name, then **Save**.	Note the location of the Measurement Report as shown below.



4 Disturbance Analyzer Measurements

The following topics are in this section:

Overview

A broad range of commercially-available electronic devices exhibit intermittent operation that generates impulsive (or discontinuous) radiated and conducted disturbances. Common examples of these devices are washing machines, refrigerators, thermostats, motor-operated apparati, and automatic dispensing machines. The level of effective interference created by the discontinuous nature of these disturbances is significantly different (and typically less) than the effective interference created by a continuous disturbance.

To address this situation, CISPR (Comite International Special des Perturbations Radioelectriques) developed different sets of conducted emissions limits for these classes of devices. There is one set of limits for continuous disturbances and a different set of limits for discontinuous disturbances, commonly called "clicks". The definitions of a click, the measurement conditions and methodologies, and the limits associated with different classes of equipment are all presented in the CISPR 14-1 International Standard document.

Because the effective level of interference caused by a discontinuous disturbance can be less than the effective level of interference caused by a continuous disturbance, CISPR limits for click amplitudes are relaxed from limits for continuous disturbances. The amount of relaxation depends upon the rate of the measured clicks over time. The lower the click rate, the greater the relaxation.

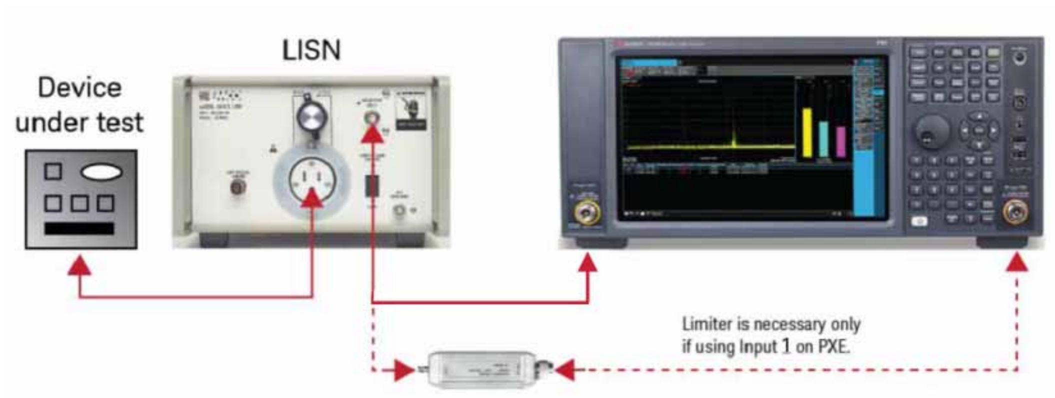
The following sections describe the operation of the Disturbance Analyzer measurement included in the N6141EM1E EMI Measurement application. It is important to note that compliant discontinuous disturbance measurements require an EMI receiver that is CISPR-compliant.

Making a Measurement

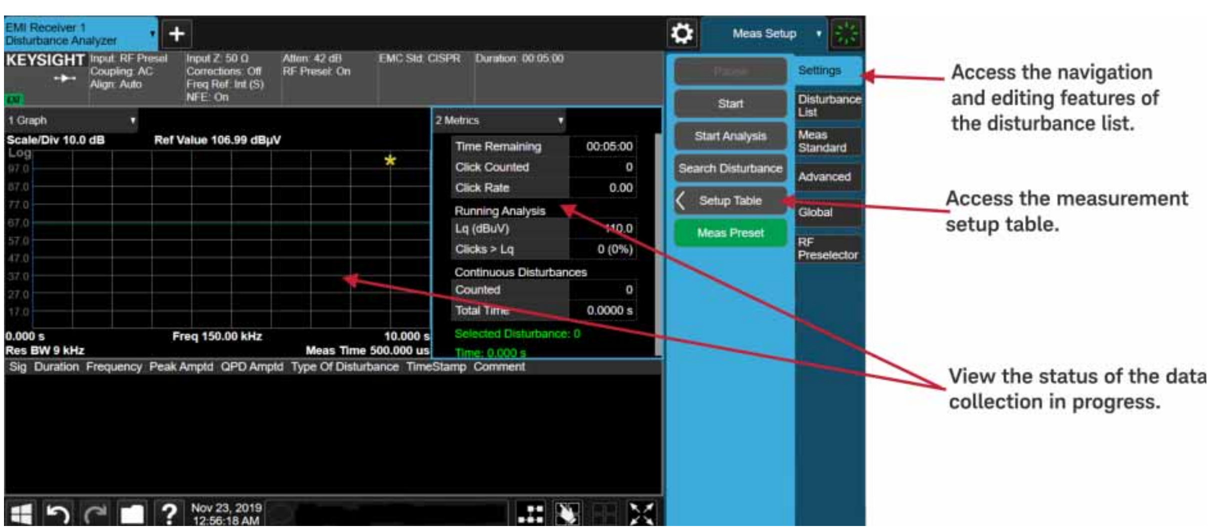
CAUTION Before connecting a signal to the MXE/PXE receiver or X-Series signal analyzer, make sure the instrument can safely accept the signal level provided. The signal level limits are marked next to the RF Input connectors on the front panel.

Setting up a one-channel Click measurement

Step	Action	Notes
1. Test setup	Connect the EUT, Limiter, and LISN, to the EMI receiver as shown below.	

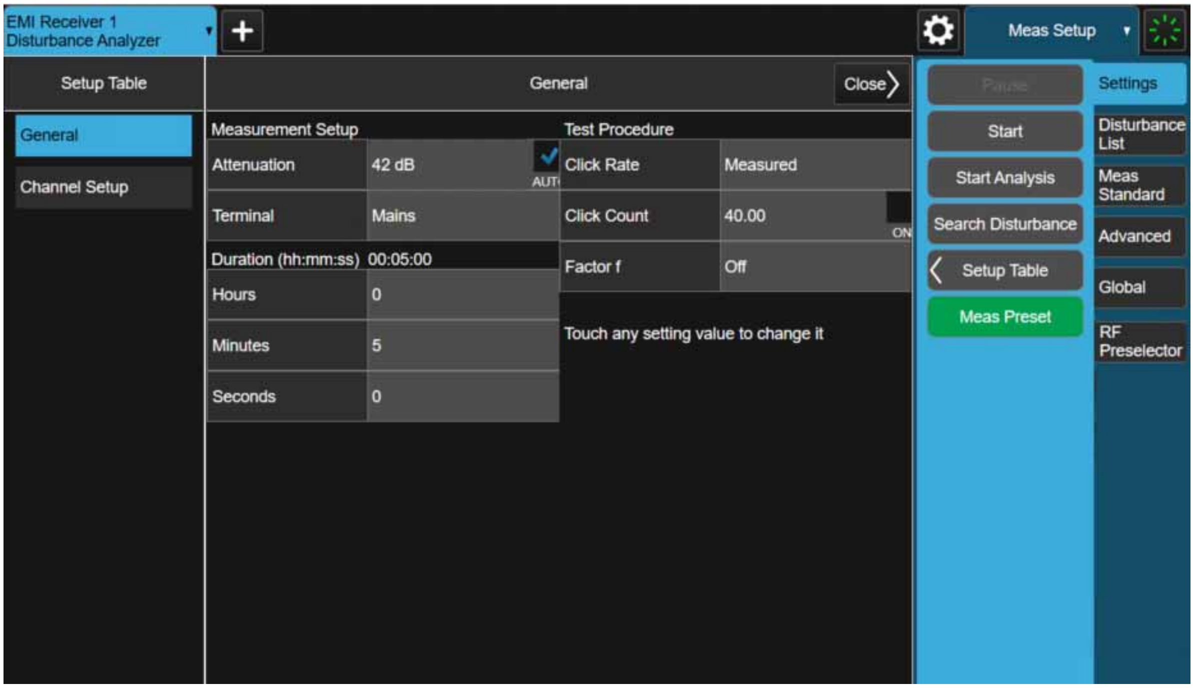


Step	Action	Notes
2. Select the Disturbance Analyzer measurement	Select **MODE/MEAS**, **EMI Receiver** Mode, **Disturbance Analyzer** Measurement, **Normal** View, then **OK**.	Alternately, if you are using a remote desktop connection, select the Screen tab (at the top of the Spectrum display) to open the Mode selector window.



NOTE The RF Preselector tab is only available in the N9038B MXE and N9048B PXE EMI Receiver.

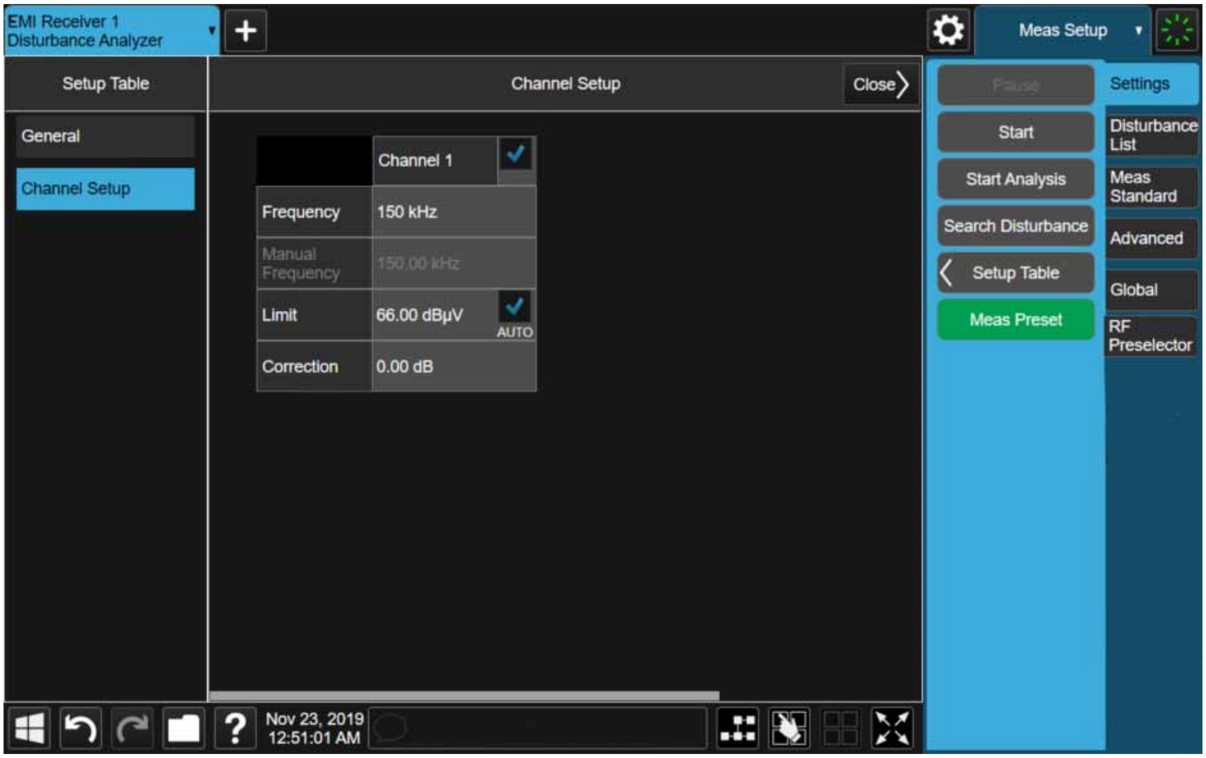
Step	Action	Notes
3. Access the Setup Table to configure a Click measurement	Select **MEAS SETUP**, the **Settings** tab, **Setup Table**.	This table enables you to configure the measurement with all parameters needed to measure Clicks to the appropriate limit.



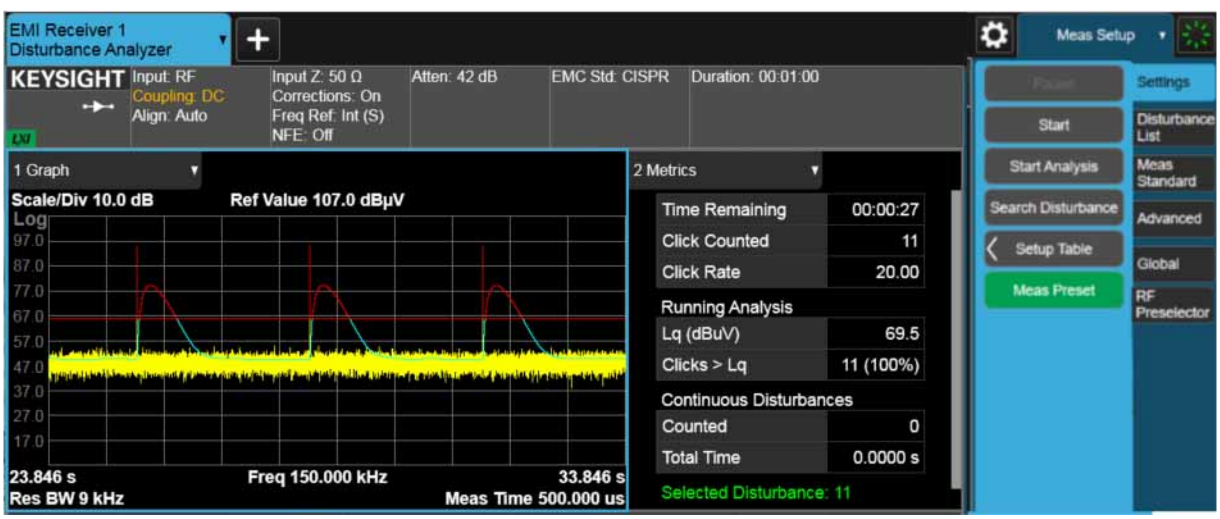
NOTE The EMI measurement application allows you to either make measurements using autocoupled settings or manual settings. When using autocoupled settings, the limits and input attenuation settings used during the measurement are determined by your measurement frequency and terminal selection. These autocoupled settings provide the appropriate limit values as given in CISPR 14.

Step	Action	Notes
4. Set up the measurement parameters in the General tab	Under **Measurement Setup**, select: Attenuation: **Auto** Terminal: **Mains**	
5. Setup the test procedure in the General tab	Under **Test Procedure**, select: Click Rate: **Measured** Click Count: **Off** Factor f: **Off**	
6. Setup the test duration in the General tab	Select **1** minute.	
7. Set up Channel parameters	Select the **Channel Setup** tab, select: Frequency: **150 kHz** Limit: **Auto** Correction: **0.00 dB**	

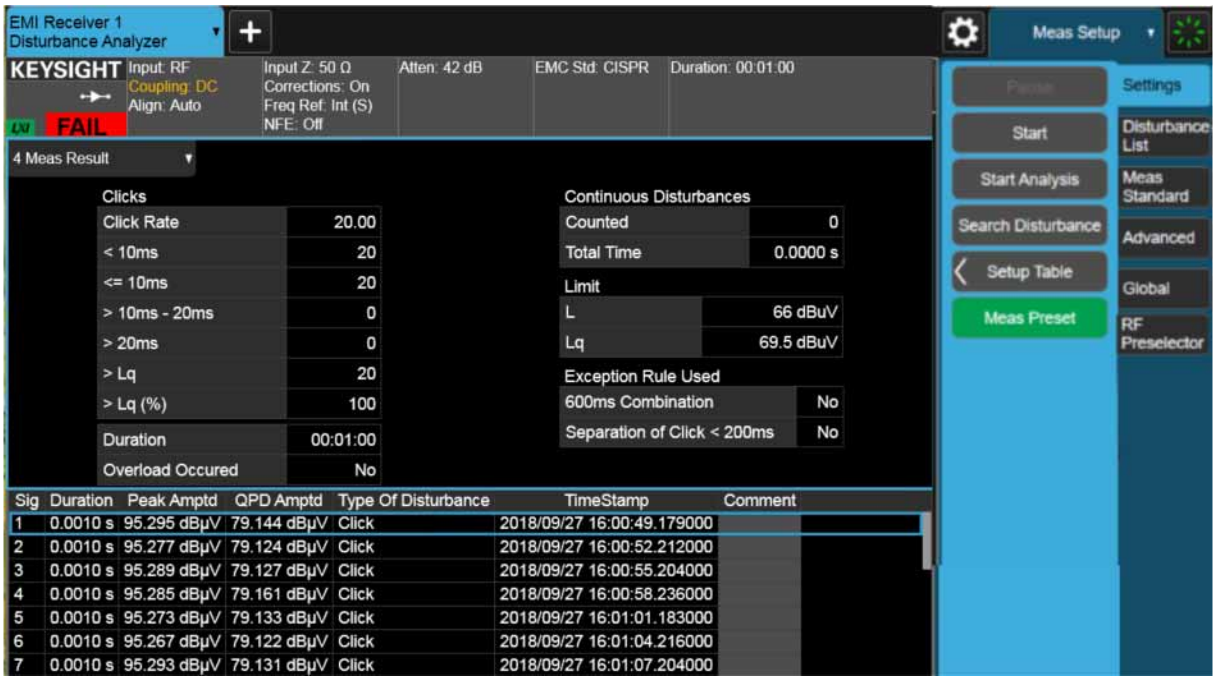
Step	Action	Notes



8. Start the measurement	Close the Setup Table and select **Start**.	If there is information in the disturbance list, you will be asked if it is okay to delete before starting a new measurement.



Step	Action	Notes
9. Review the final results	Results are automatically presented after data collection has finished (either test duration or click count).	After the data collection has finished, the Disturbance Measurement will automatically analyze the data, apply all appropriate exceptions (as defined in CISPR14) and display the results.



Step	Action	Notes
10. Save the results	Select **Save**, **Trace + State**.	You can save to either a register or a file.

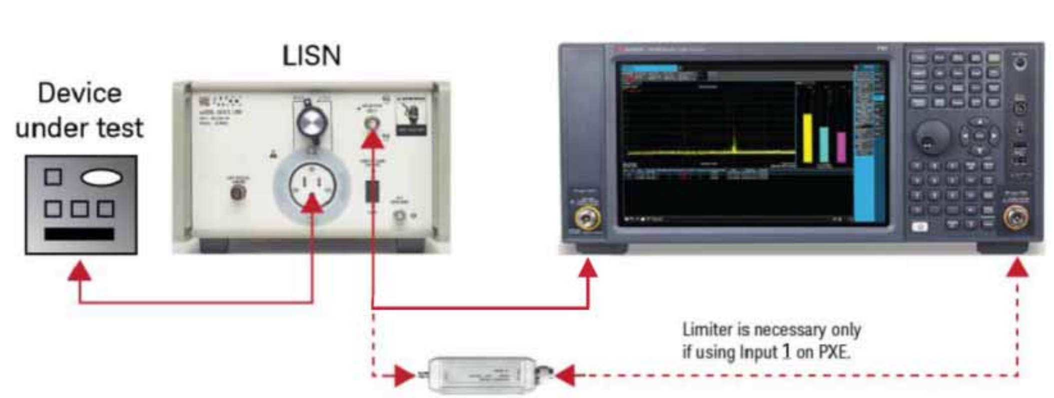
Setting up a multi-channel Click measurement

NOTE This measurement is specific to the N9048B PXE EMI receiver and requires Option N90484CKB and Option N9048B-WF1.

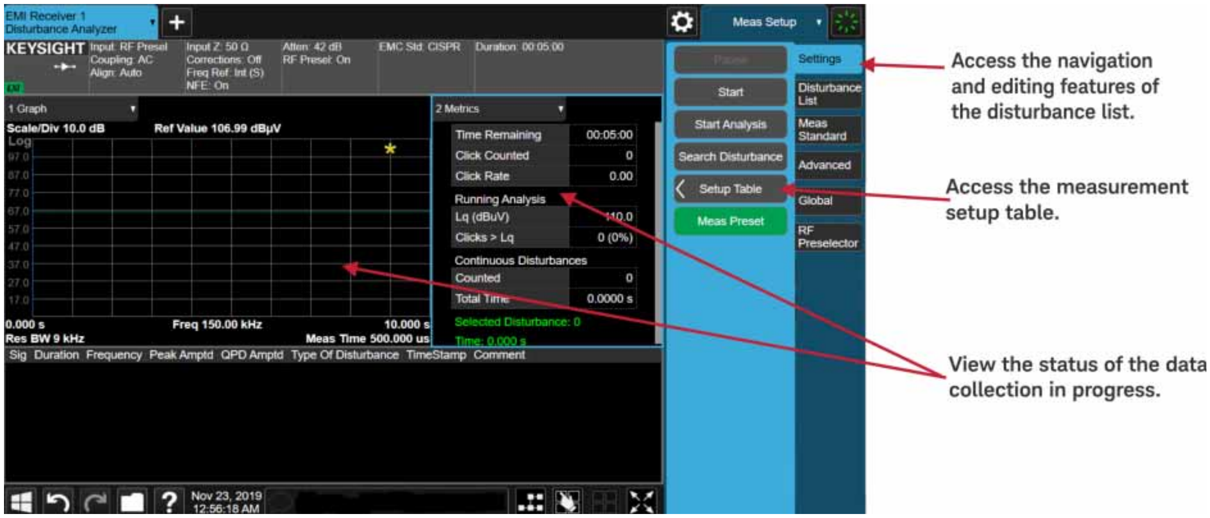
The EMI measurement application allows you to select the default CISPR defined frequencies or you can also enter up to five non-standard measurement frequencies.

The EMI measurement application allows you to select the default CISPR 14 requires that discontinuous disturbance measurements be made at four frequencies: 150 kHz, 500 kHz, 1.4 MHz and 30 MHz. The EMI measurement application allows you to select these default frequencies or to enter up to five non-standard measurement frequency.

Step	Action	Notes
1. Test setup	Connect the EUT, Limiter, and LISN, to the EMI receiver as shown below.	

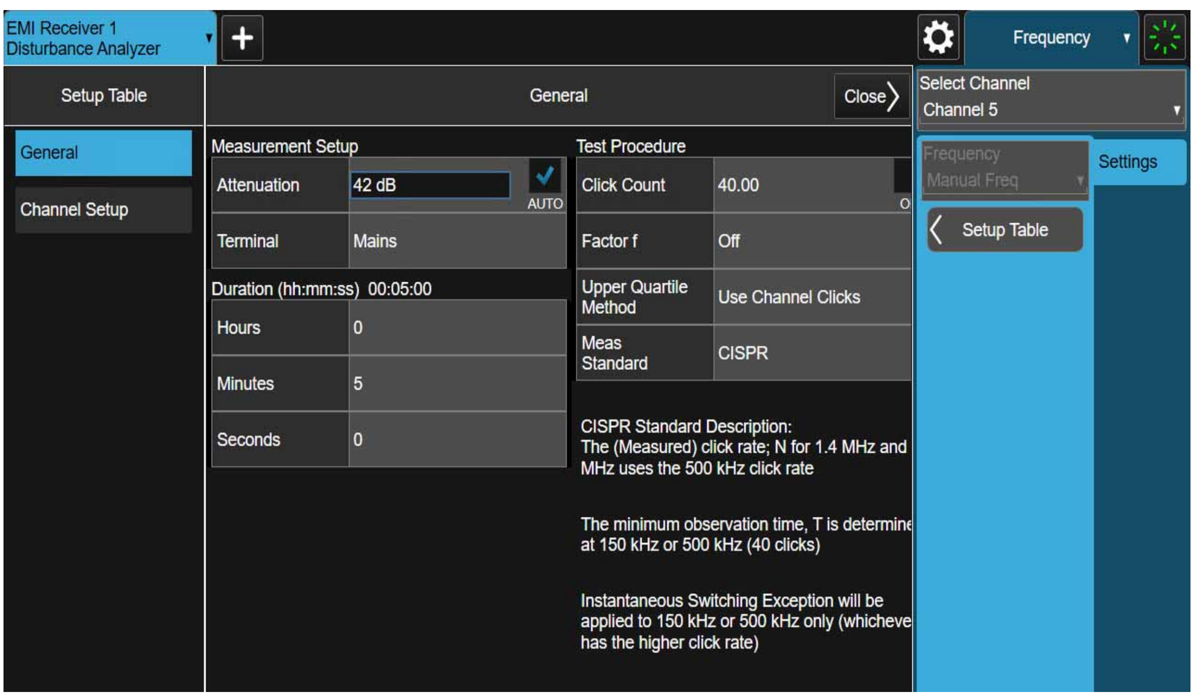


2. Select the Disturbance Analyzer measurement	Select **MODE/MEAS**, **EMI Receiver** Mode, **Disturbance Analyzer** Measurement, **Normal** View, then **OK**.	Alternately, if you are using a remote desktop connection, select the Screen tab (at the top of the Spectrum display) to open the Mode selector window.



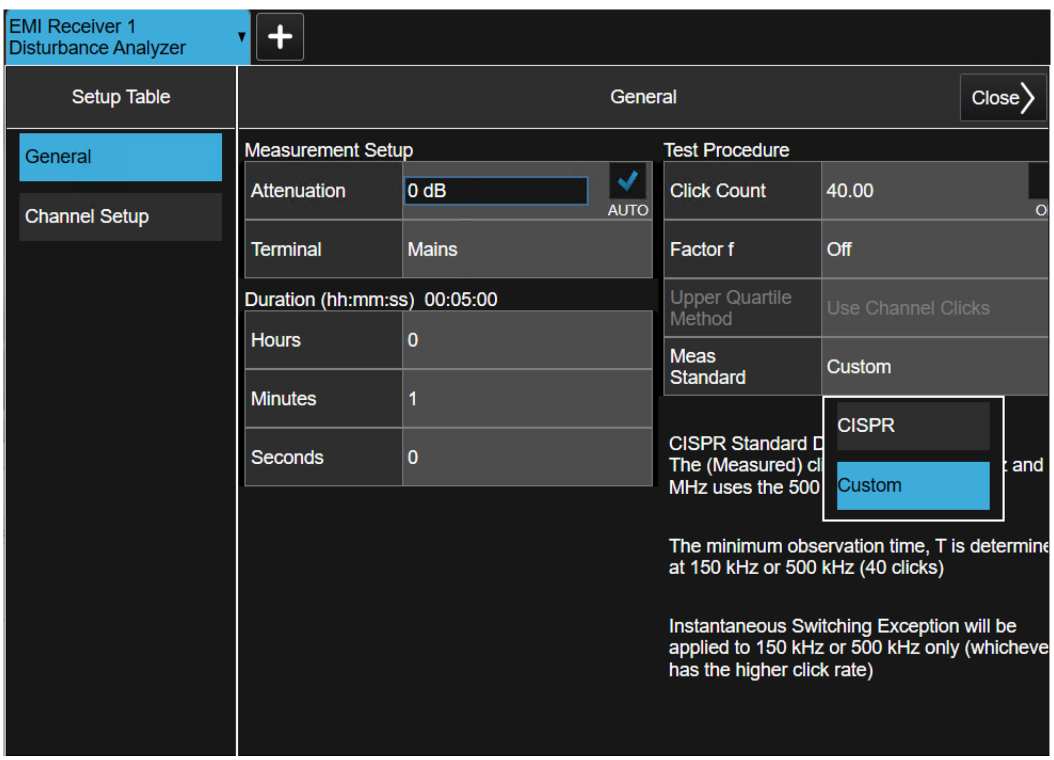
NOTE	The RF Preselector tab is only available in the N9038B MXE and N9048B PXE EMI Receiver.

Step	Action	Notes
3. Access the Setup Table to configure a Click measurement	Select **MEAS SETUP**, the **Settings** tab, **Setup Table**.	This table enables you to configure the measurement with all parameters needed to measure Clicks to the appropriate limit.



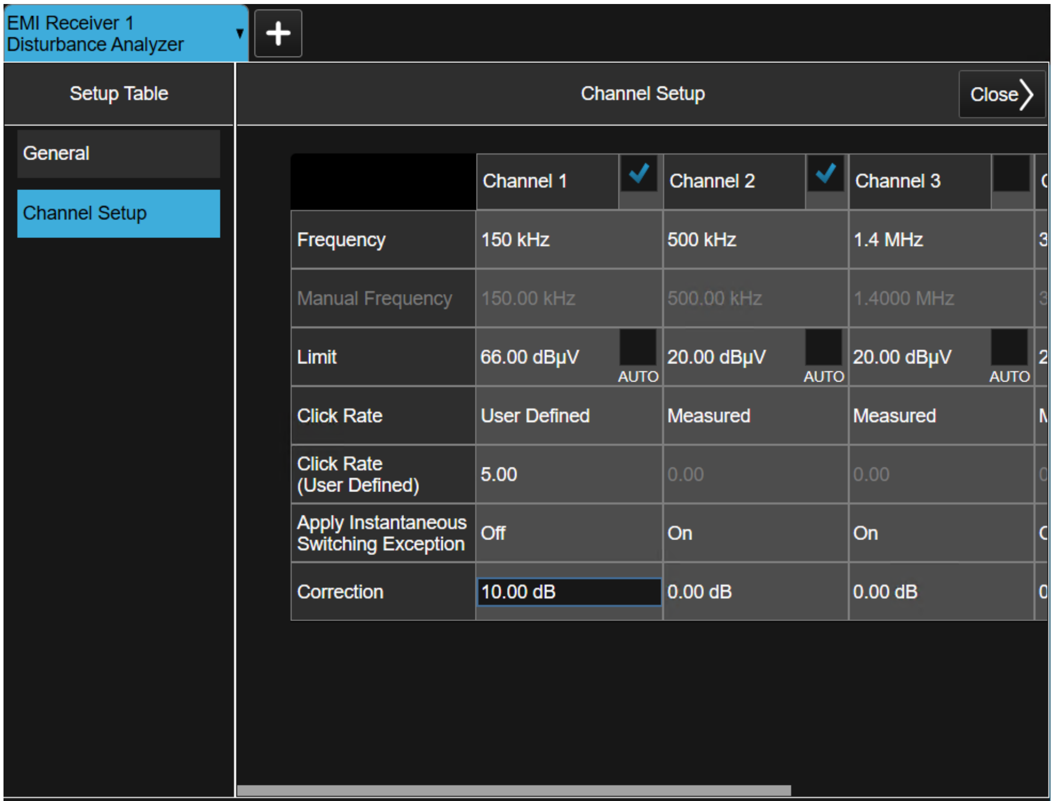
NOTE	The EMI measurement application allows you to either make measurements using autocoupled settings or manual settings. When using autocoupled settings, the limits and input attenuation settings used during the measurement are determined by your measurement frequency and terminal selection. These autocoupled settings provide the appropriate limit values as given in CISPR 14.

Step	Action	Notes
4. Set up the measurement parameters in the General tab	Under **Measurement Setup**, select: Attenuation: **Auto** Terminal: **Mains**	
5. Setup the test procedure in the General tab	Under **Test Procedure**, select: Click Rate: **Measured** Click Count: **Off** Factor f: **Off** Duration: **1** minute	
6. Select the Meas Standard to be used for the measurement	Select either **CISPR** or **Custom**.	Selecting CISPR, automatically sets the CISPR defined settings in the Channel Setup tab. Selecting Custom, allows you to specify all settings for up to 5 channels using the Channel Setup tab.

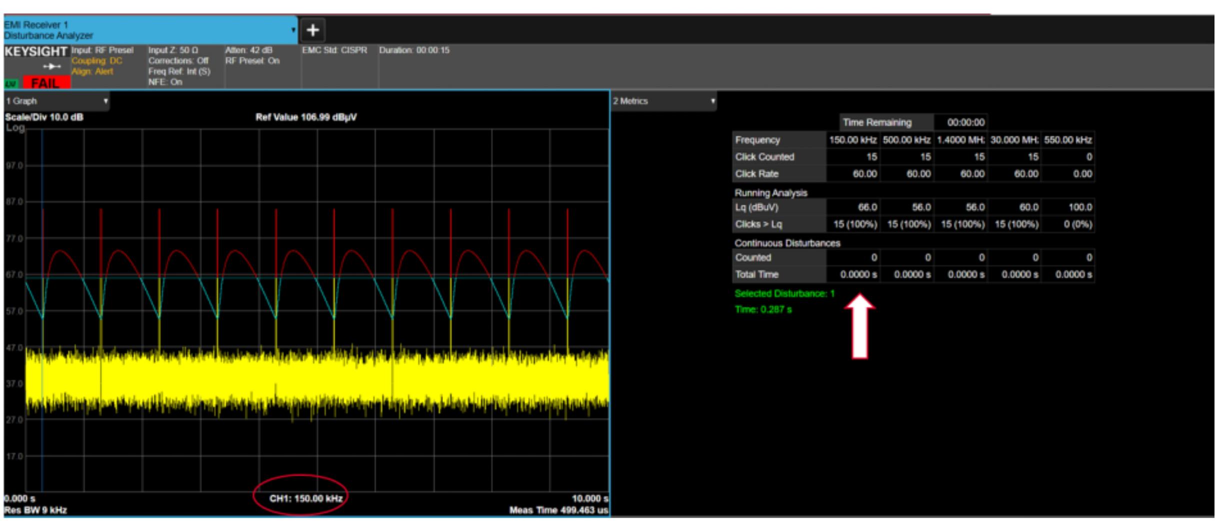


7. Setup Custom Settings (optional)	Select the **Channel Setup** tab modify settings for each channel as desired.	For example, you can specific channels, setup a fifth channel, specify the frequency of each channel, define the Click Rate, and so on.

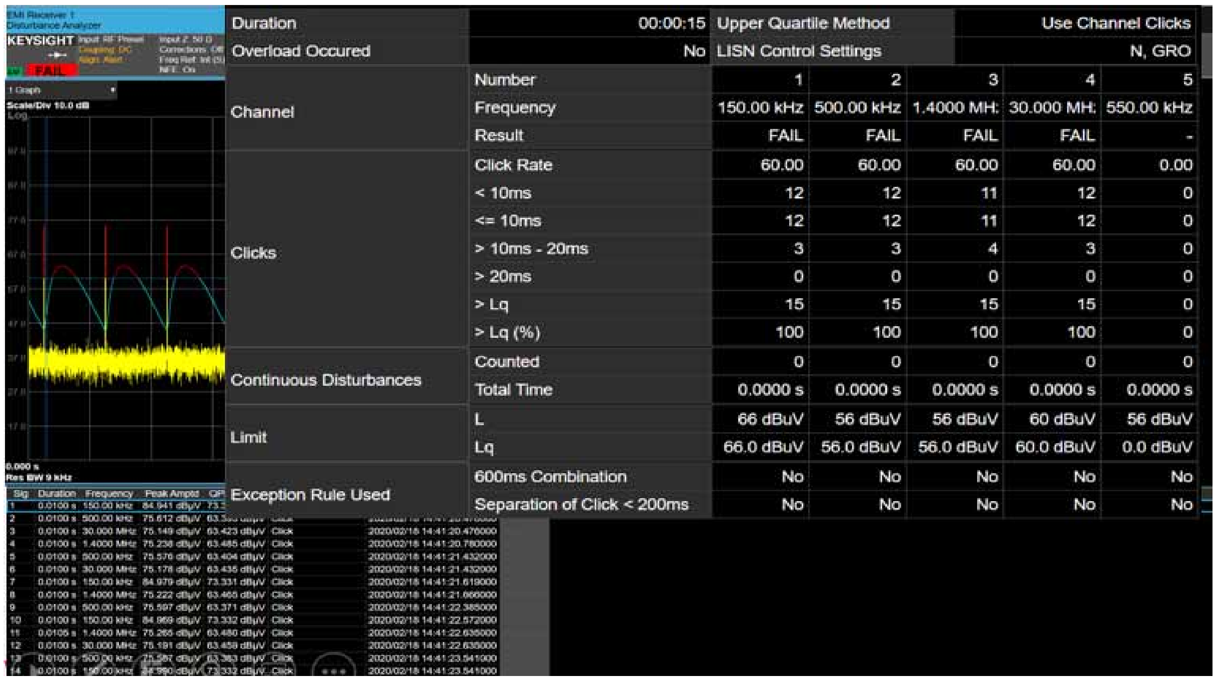
Step	Action	Notes



Step	Action	Notes
8. Start the measurement	Select **MODE/MEAS**, **EMI Receiver** Mode, **Disturbance Analyzer** Measurement, and **Results** View.	



Step	Action	Notes
9. Review the final results	Results are automatically presented after data collection has finished (either test duration or click count).	After the data collection has finished, the Disturbance Measurement will automatically analyze the data, apply all appropriate exceptions (as defined in CISPR14) and display the results.



10. Save the results	Select **Save**, **Trace + State**.	You can save to either a register or a file.

Setup Table Parameters

General Tab

Meas Setup

Attenuation

The attenuation is set so that, in the worst case, an input signal with a quasi-peak value equal to the maximum relaxed discontinuous disturbance limit will not overload the receiver. If you know in advance that your input signals will be lower, you can use a lower value of input attenuation.

Terminal

CISPR 14 defines limits based on the terminals at which the measurements are made. Table 1 in CISPR 14 defines the limits for continuous disturbance over frequency for both mains and load terminals and for motors of varying power levels. The limits for discontinuous disturbances (clicks) are based on these limits.

Test Procedure

Click Rate

The click rate (N) is the key metric used to determine the click limit Lq. The click rate is determined by counting the number of clicks per minute. The determination of N is based on whether you are using continuous operation or switching cycles to collect clicks. For devices that operate continuously:

N = n1/T,

where n1 = number of clicks during the operation time
T = observation time.

For certain appliances requiring switching operations as defined in CISPR 14-1, Annex A, N is calculated as:

N= (n2 * f)/T,

where n2 = number of switching operations during the operation time
f = factor given in CISPR 14 Annex A.

CISPR 14-1 requires that the click rate N be determined at:

- 150 kHz for measurements in the frequency range of 148.5 kHz - 500 kHz
- 500 kHz for measurements in the frequency range of 500 kHz - 30 MHz.

In this application you have two choices of click rate to be used to determine the click limit:

– MEASURED - the click rate measured from the particular signal under test, using the formulas listed above, or

– USER - a manually-entered click rate

Click Count

Uses a fixed number of clicks to terminate the click data collection cycle. The measurement will use both the number entered and the set measurement duration as terminators for data collection.

Factor f

For certain types of products that must be cycled to emit discontinuous disturbances (rather than run continuously), CISPR 14-1 requires users to operate the product over enough cycles to produce 40 clicks.

Factor f is used to calculate the click rate for these types of devices. See CISPR 14-1, Annex A Table A.2 for the factor to use for your specific EUT.

Channel Setup tab

Frequency

CISPR 14 requires that discontinuous disturbance measurements be made at four frequencies: 150 kHz, 500 kHz, 1.4 MHz and 30 MHz. The EMI measurement application allows you to select these default frequencies or to enter a non-standard measurement frequency.

Limit

The limit used for the data analysis is a function of the nature and rate of the measured discontinuous disturbances and the level of the continuous disturbances. CISPR 14-1 defines the limit for a continuous disturbance (L) as a function of frequency and measurement location (mains or terminal). This document also defines a limit that can be used for discontinuous disturbances (Lq). Lq is relaxed from L according to the number of clicks measured per minute, known as the click rate N:

44 dB for $N < 0.2$

$20 \log (30/N)$ dB for $0.2 <= N < 30$

No relaxation for $N >= 30$

Selecting Auto Limit configures the receiver to autocouple the default continuous disturbance limit values to the frequency and terminal selection. This will be the starting point of the Lq calculation once N has been calculated during and after the data collection. Turning off Auto, allows you to enter a specific limit value as a starting point from which to calculate a discontinuous disturbance limit based on the characteristics of the measured signal.

Correction

Offsets the amplitude of all measured values by the value you enter.

NOTE

This information is given as an example. CISPR 14-1 is the reference document for disturbance measurement requirements. Refer to CISPR 14-1 to identify the test requirements for your specific EUT.

5 APD (Amplitude Probability Distribution) Measurements

The following topics are in this section:

Overview

CISPR (Comite International Special des Perturbations Radioelectriques) introduced the Amplitude Probability Distribution measurement (APD) in Amendment 1:2005 to CISPR 16-1-1:2003 as a new weighting method to accurately determine the electromagnetic disturbance emitted by electrical appliances or equipment, which degrade the performance of digital communication systems, especially the impact of impulsive disturbances on the system.

The APD of disturbance is defined as the complimentary cumulative distribution function of the absolute amplitude of the signal you are measuring. Alternately, it can be estimated from the measured data by finding the ratio of the time the signal amplitude exceeds a certain level (x0) and the total signal analysis time.

The APD measurement results can be used to evaluate its interference potential on digital communication systems according to CISPR 16-3, sub-clause 4.7. The experimental results show the correlation between APD and performance of digital communication systems (for example, BER and throughput results). Therefore an APD measurement may be applicable to the compliance test of some products or product families, such as microwave ovens.

The APD measurement is passed when:

– the Disturbance Level (E meas) at the specified Probability is within the limit and,

– the Probability of time (ρ meas) at the specified Disturbance Level is within the limit.

The following sections describe the operation of the APD measurement included in the EMI receiver measurement application. The APD measurement results show the power statistical data both in graphical format and in a signal list on the screen.

It is important to note that compliant measurements require to be run on an EMI receiver that is CISPR-compliant, like the Keysight N9038B MXE and N9048B PXE EMI receivers.

TIP **Traditional limit lines are a function of frequency and amplitude. APD limits differ from traditional limit lines because APD is dependent on frequency, amplitude, and probability.**

Making a Measurement

CAUTION

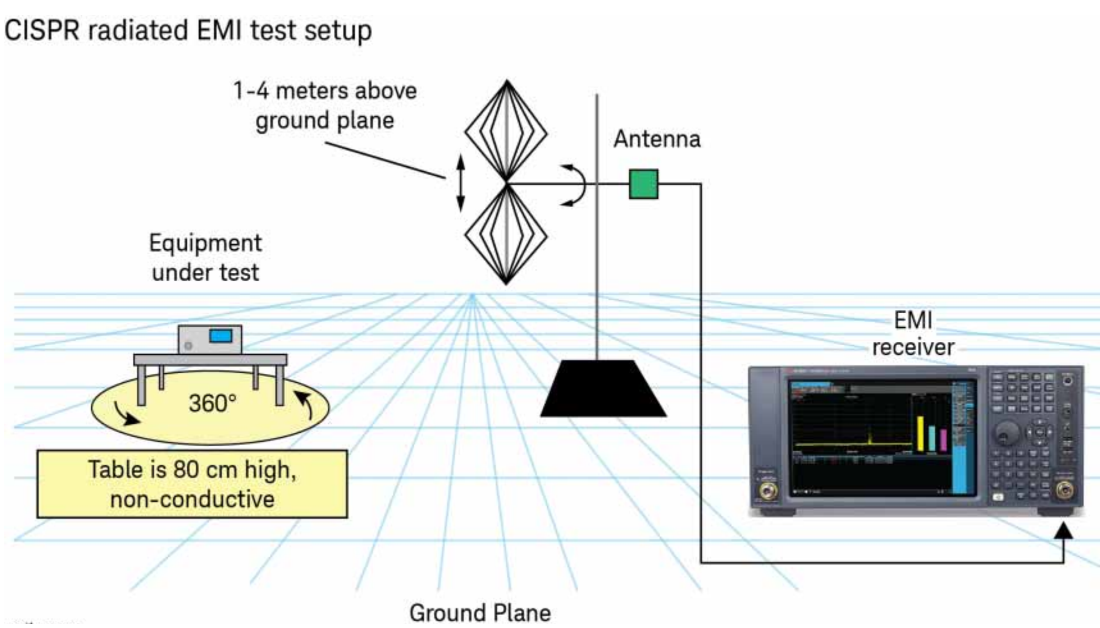
Before connecting a signal to the MXE/PXE receiver or X-Series signal analyzer, make sure the instrument can safely accept the signal level provided. The signal level limits are marked next to the RF Input connectors on the front panel.

See the AMPTD Y Scale menu for details on setting internal attenuation to prevent overloading the receiver.

NOTE

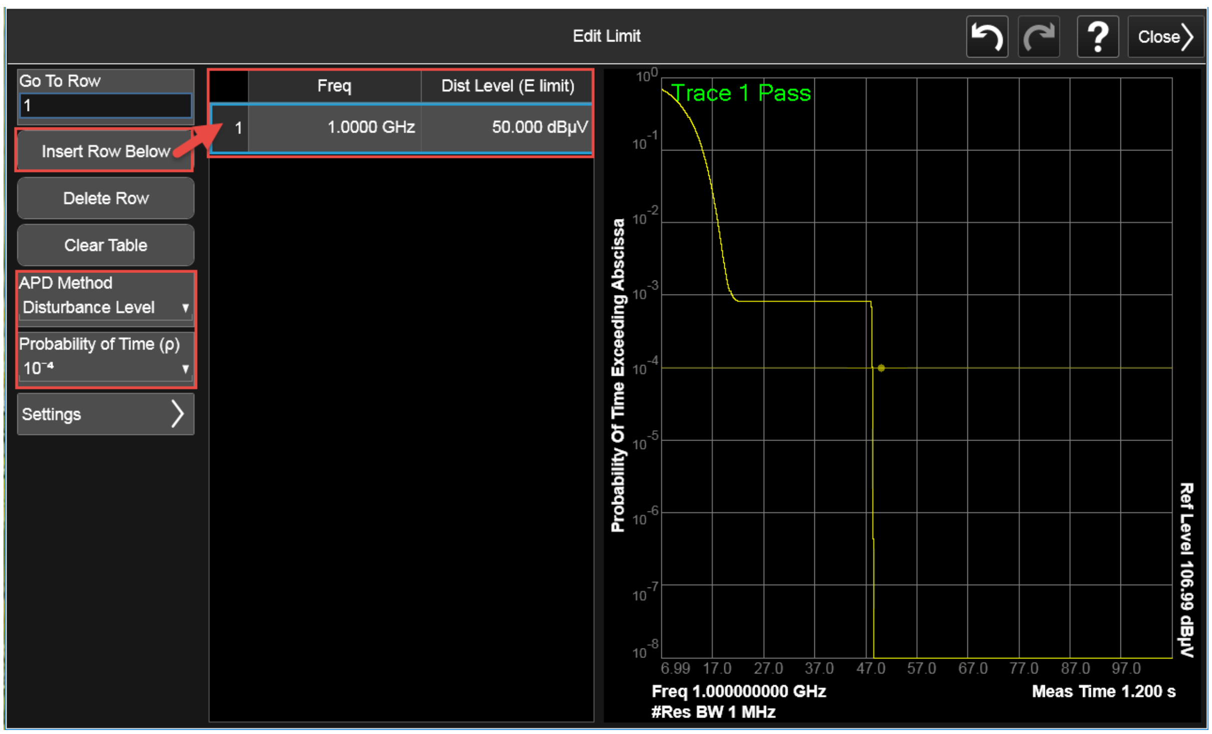
This measurement requires Option DP2 or Option B40 on the X-Series analyzers.

Step	Action	Notes
1. Test setup	Arrange the antenna, EUT and receiver as shown below.	



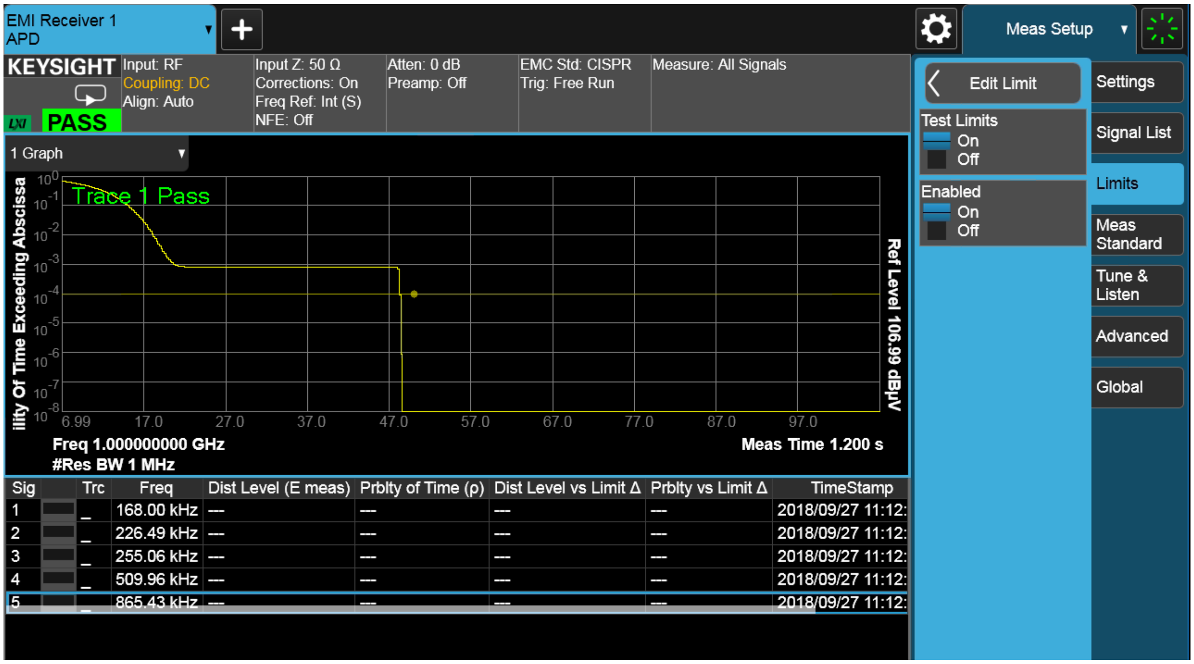
Step	Action	Notes
2. Select the APD measurement	Select **MODE/MEAS**, **EMI Receiver** Mode, **APD** Measurement, **Normal** View.	
3. Set the frequency	Select **FREQ**, set **Frequency** to **1 GHz**.	
4. Set the measurement time	Select **MEAS SETUP,** set **Meas Time** to **1.2 s**.	
5. Set the resolution bandwidth	Select **BW**, **Res BW 1 MHz**.	

Step	Action	Notes
6. Select the APD method to Disturbance Level and define a limit line	Select **MEAS SETUP**, the **Limits** tab, **Edit Limit**. – Set **APD Method** to **Disturbance Level**. – Set **Probability of Time (ρ)** to **10^{-4}**. – Select **Insert Row Below** and set **Freq** to **1.0 GHz.** . – Set **Dist Level (E limit)** to **50 dBμV** – Select **Close**.	You need to define the limit before making the limit test. Once you define the limit data, the PASS/FAIL box (in upper left corner) will be shown.



7. Turn on the limit line	Set Test Limits **On**.	
8. Measure signals	Select the **Settings** tab, set Measure to **All Signals** or **Marked Signals**.	Watch the APD measurement as it progresses.

Step	Action	Notes



6 Strip Chart Measurement

The following topics are in this section:

Overview

The Strip Chart measurement can be used to monitor and record a signal amplitude over time. The three detectors can be monitored at the same time for up to 2 hours of signal capture.

This measurement can also be synchronized with the rotation of the turntable to record emission patterns, allowing you to identify and record the orientation of maximum signal emission.

This example will use the Strip Chart measurement to capture a time variant signal and use markers to analyze the time difference of two pulses. The pulses were generated by an N5182B MXG X-Series signal generator with the following settings:

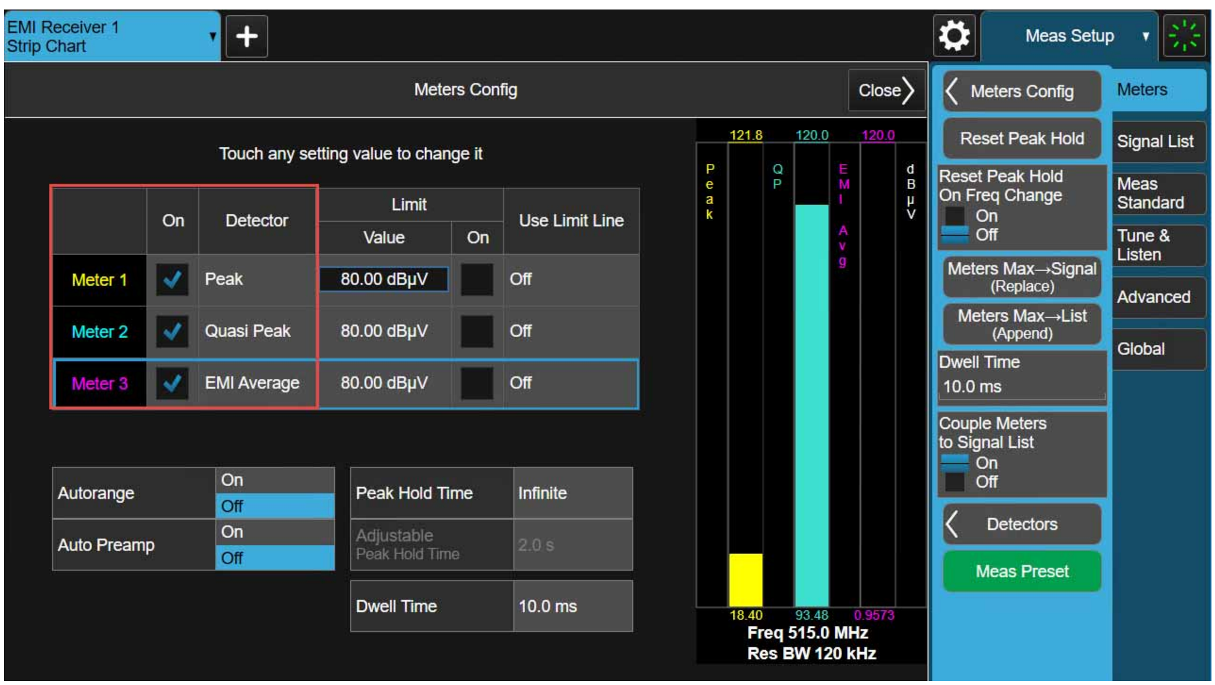
- Frequency: 515 MHz
- Amplitude: –10 dBm
- Pulse source: free run
- Pulse period: 4 seconds
- Pulse width 200 ms
- Pulse, RF output, and Modulation turned on

While the signal used for this example may not simulate an interference signal, it will allow you to see the basic functionality of the Strip Chart measurement and how it may be useful for determining greater detail about an interference signal that you may be investigating.

Making a Measurement

CAUTION Before connecting a signal to the MXE/PXE receiver or X-Series signal analyzer, make sure the instrument can safely accept the signal level provided. The signal level limits are marked next to the RF Input connectors on the front panel.

Step	Action	Notes
1. Preset the EMI Receiver mode	Select **Mode Preset**.	Alternately, if you are running the application from a remote desktop connection, select Mode Preset. 
2. Select the Strip Chart measurement	Select **MODE/MEAS**, **EMI Receiver** Mode, **Strip Chart** Measurement, **Normal** View, **OK**.	
3. Turn on Meters	Select **MEAS SETUP**, **Meters Config**, and select all three meters to turn on.	



Step	Action	Notes
4. Select single sweep	Select **Sweep**, **Sweep/Control**, **Single**.	
5. Select the duration time	Select the **X-Scale** tab, **Strip Chart Duration**, set to **30 s**.	
6. Restart the sweep	Select the **Sweep/Control** tab, **Start**.	You can also just press the Restart key.

Step	Action	Notes
7. Zoom in, if needed, by adjusting the x and y scales and reference value of time until you can see the appropriate pulses	Select the **X-Scale** tab, **Ref Value** and set as applicable. Select **AMPTD**, **Ref Value** and **Scale/Div** and set as applicable.	
8. Place a marker on the highest peak	Select **Peak Search**.	
9. Place a delta marker on the next highest peak	Select the **Settings** tab, set **Marker Mode** to **Delta**. Select the **Peak Search** tab, **Next Peak**	The time and amplitude difference between the markers can be read at the top of the Markers display.

7 Real Time Scan Measurements

The following topics are in this section:

Overview

The Real Time Scan measurement provides real-time results of the spectrum at the receiver input by limiting the measurement to a single FFT acquisition. It sets the LO to a fixed frequency, captures data and performs Fast Fourier Transforms (FFT) simultaneously. This provides gap free spectrum data.

The measurement is only available on the N9048B PXE with Wideband Digital IF (WF1) and Wideband Time Domain Scan (WT1/ WT2) options installed and licensed.

The Real-time Scan application enables the following:

- detection of small signals close to the noise level
- displays the frequency domain, time domain, and spectrogram with three EMC detectors simultaneously
- meets dwell measurement requirements using the Time Domain Scan capabilities

This example will use a time variant signal connected to the RF Input, which is generated by an N5182B MXG X-Series signal generator with the following settings:

- Sweep: Frequency
- Sweep Type: Step
- Sweep Repeat: Continuous
- Frequency Start: 490 MHz
- Frequency Stop: 530 MHz
- Amplitude: –20 dBm
- Pulse Source: Free Run
- Pulse Period: 1 s
- Pulse Width: 1 ms
- Pulse, RF Output, and Modulation: On

This example explains the versatile functionality of the measurement when working with time slices in different views and markers.

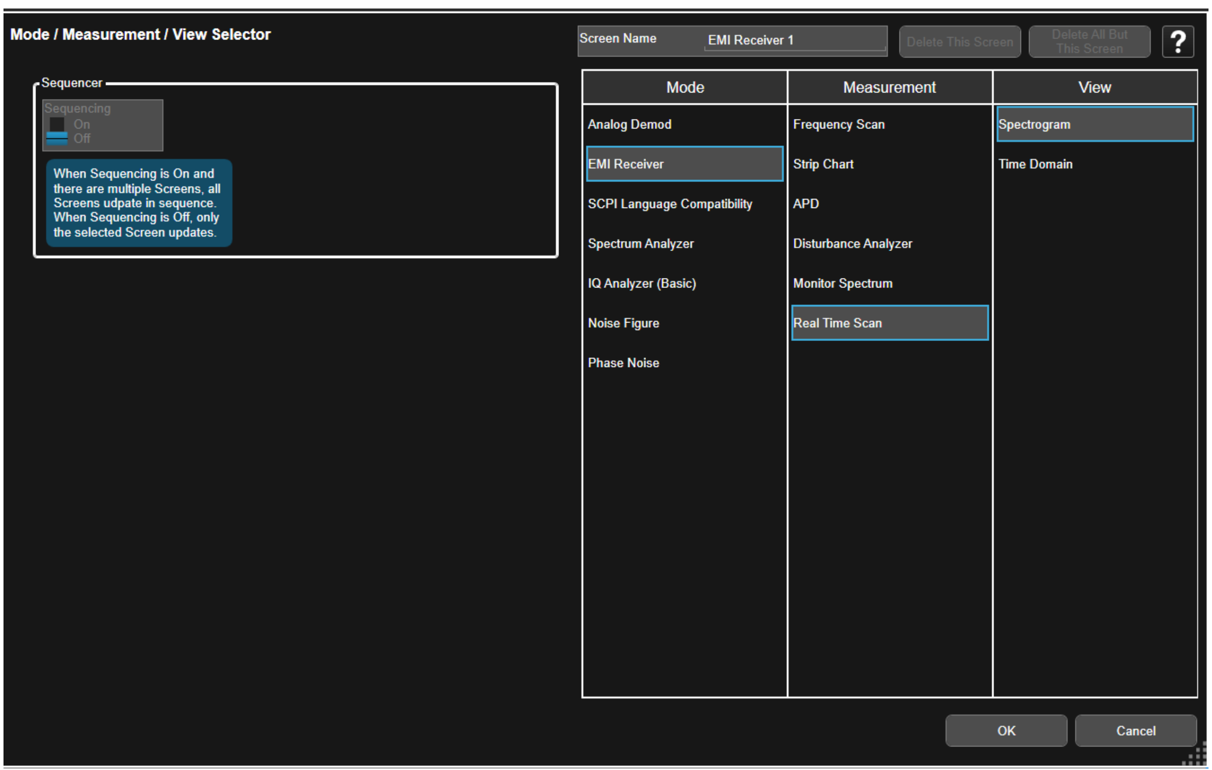
While the signal used for this example may not simulate an interference signal, it will allow you to see the basic functionality of the Real Time Scan Measurement and how it may be useful for determining greater detail about an interfering signal that you may be investigating.

Making a Measurement

CAUTION Before connecting a signal to the PXE receiver, make sure the instrument can safely accept the signal level provided. The signal level limits are marked next to the RF Input connectors on the front panel.

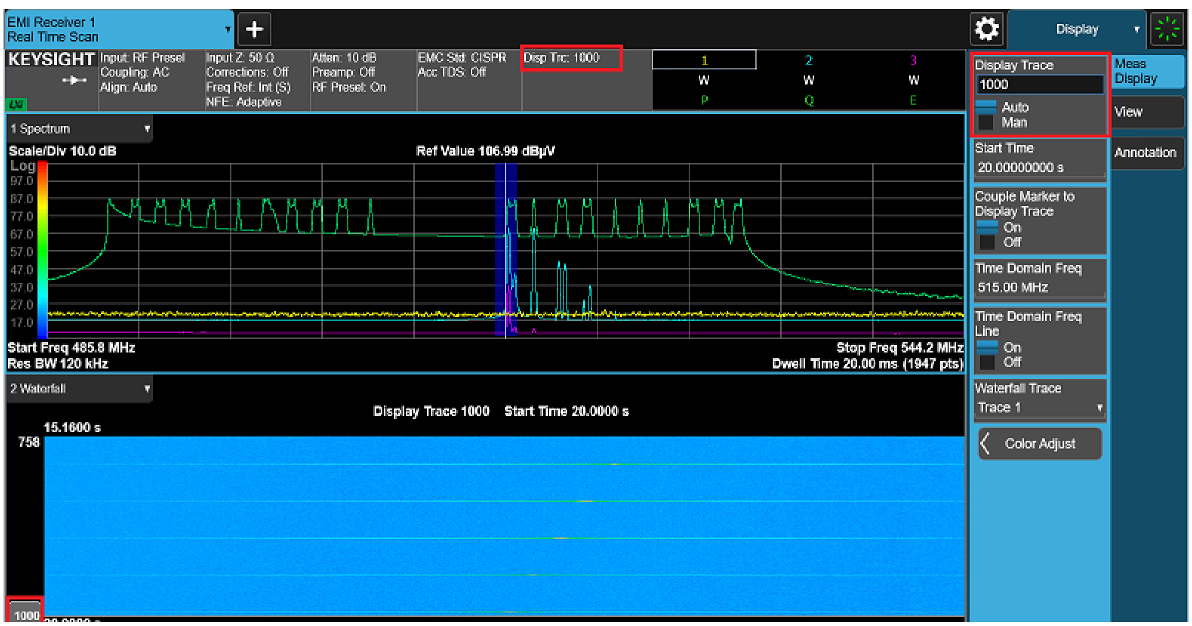
NOTE This measurement requires Option WF1 on the N9048B PXE EMI Receiver.

Step	Action	Notes
1. Preset the EMI Receiver mode	Select **Mode Preset**.	Alternately, if you are running the application from a remote desktop connection, select Mode Preset. 
2. Select the Real-time Scan measurement	Select **MODE/MEAS**, **EMI Receiver** Mode, **Real-time Scan** Measurement, **Spectrogram** View, **OK**.	



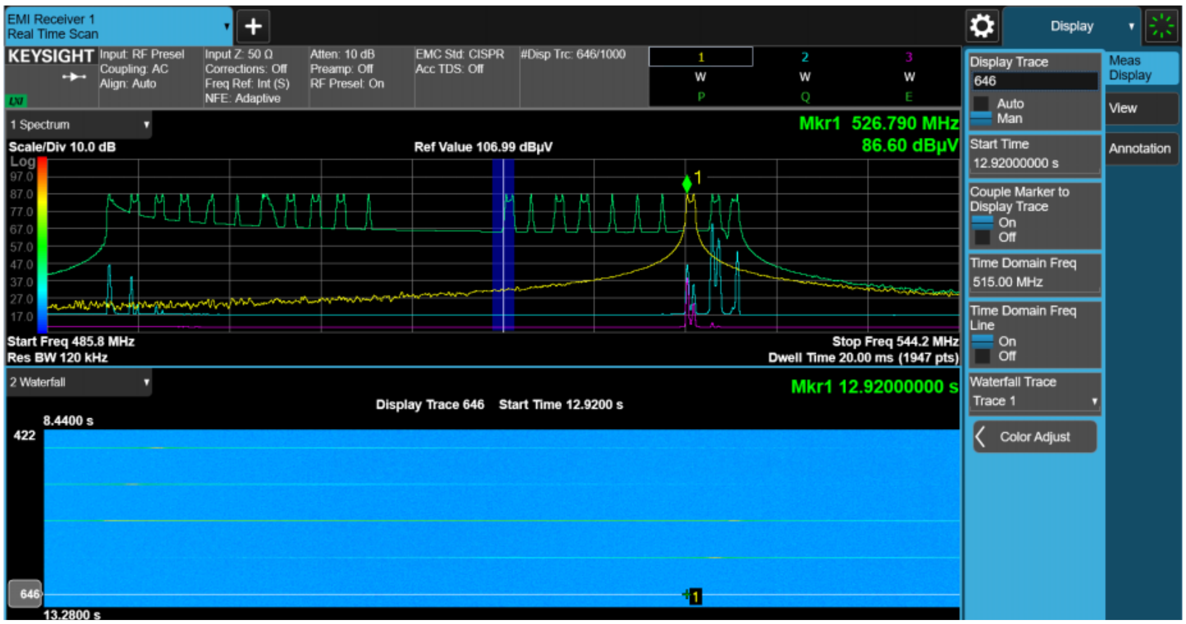
Step	Action	Notes
3. Select single sweep	Select **Sweep**, **Sweep/Control**, **Single**.	The Sweep/Control is default to continuous.

Step	Action	Notes
4. Set the measurement count	Select **MEAS SETUP**, **Settings** tab, set **Hold Number** to **1000**.	In continuous sweep, the measurement keeps the last 12,000 time slices based on first in first out method.
5. Turn on Max Hold trace	Select **Trace, Trace/Control** tab, turn **Max Hold Display** On.	Max Hold trace is available for all 3 traces. Max Hold operation runs in the background by default if a trace is turned on. Therefore, you can turn it on anytime during the measurement and the max hold trace data is readily available without restarting the scan.
6. Start the Scan	Select **Sweep**, **Restart**.	The scan stops when the count reaches the set hold value. Trace 1 - 3 show the latest time slice. This is the result you can view in the Monitor Spectrum measurement, but each time slice is recorded. Max Hold Trace 1 is shown in green.



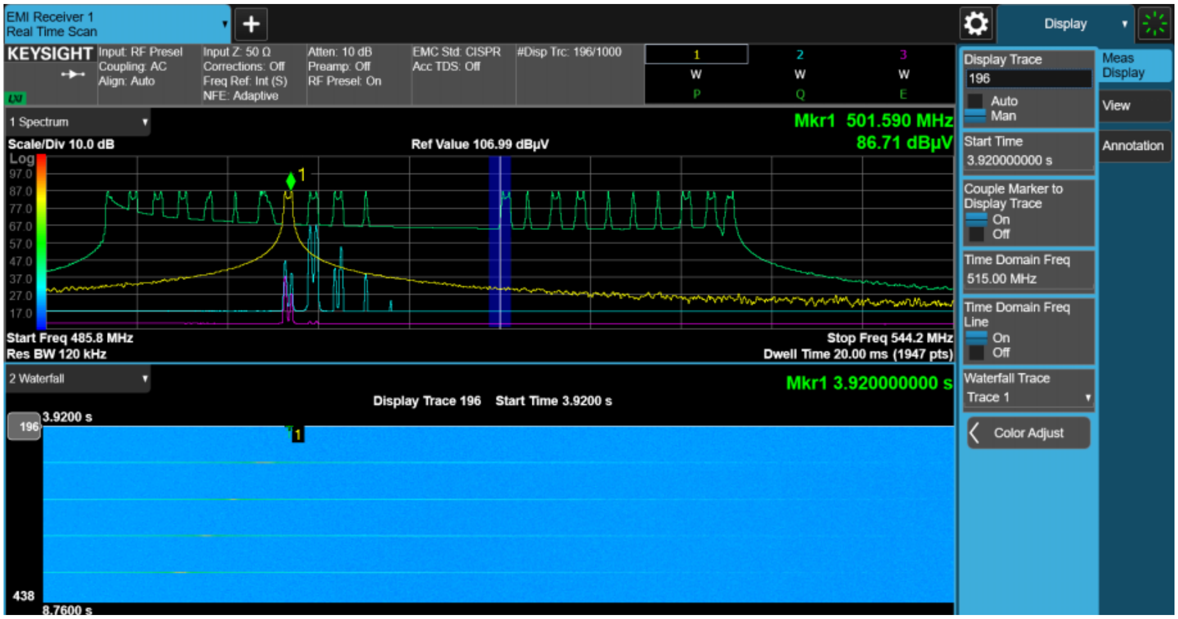
Step	Action	Notes
7. Review time slices	Select **Display**, the **Meas Display** tab, change the **Display Trace** value to one between **1-1000**. Alternately, move the vertical blue bar at the left edge of the Waterfall view.	Display Trace mode changes to Manual when the value is changed manually. To view the latest trace, toggle it to Auto. Trace 1 - 3 show the trace data corresponding to time slice number since the scan was started.

Step	Action	Notes
8. Peak Search on the selected time slice	Select **Marker**, the **Peak Search** tab, **Next Peak**.	This places the marker on the highest peak of the selected trace in the Spectrum. Marker annotations is shown as a “+” sign in the Waterfall view.

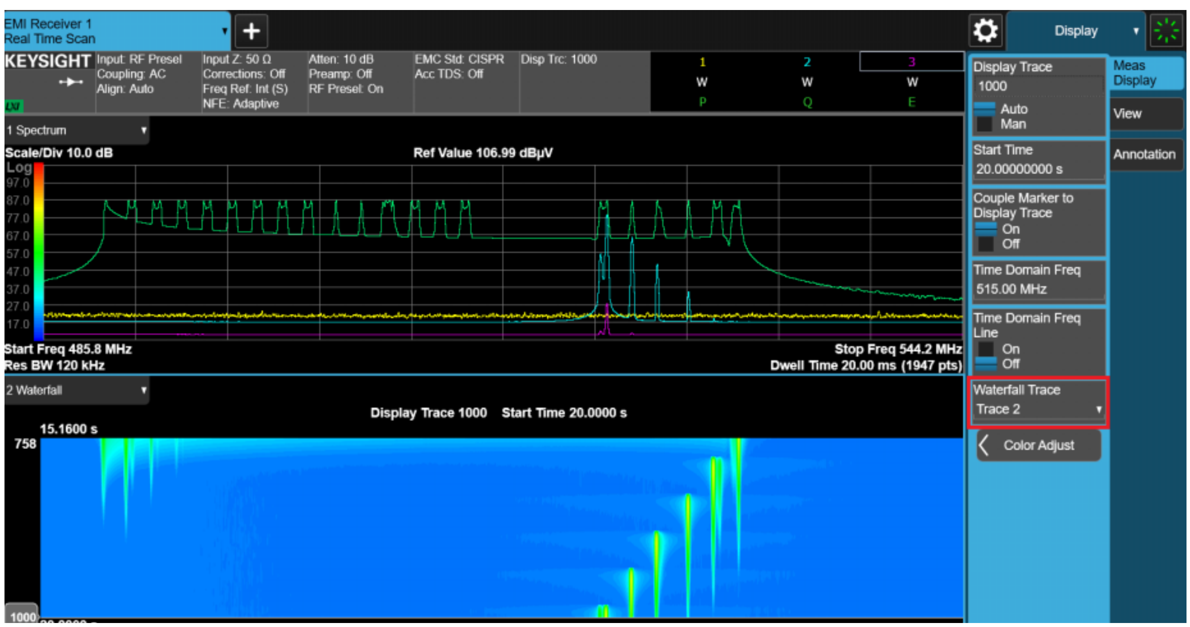


Step	Action	Notes
9. Peak Search on all available time slices	Select **Marker**, the **Peak Search** tab, **Peak Search All Traces**.	This places a marker on a different time slice than the time slice currently shown, you will find the marker diamond disappears from screen.
	Select the **Marker ->** tab, **Move Display Trace -> Marker**	This action auto-couples the display trace to the time slice of the current marker. Move Marker –> Display Trace does the opposite coupling.

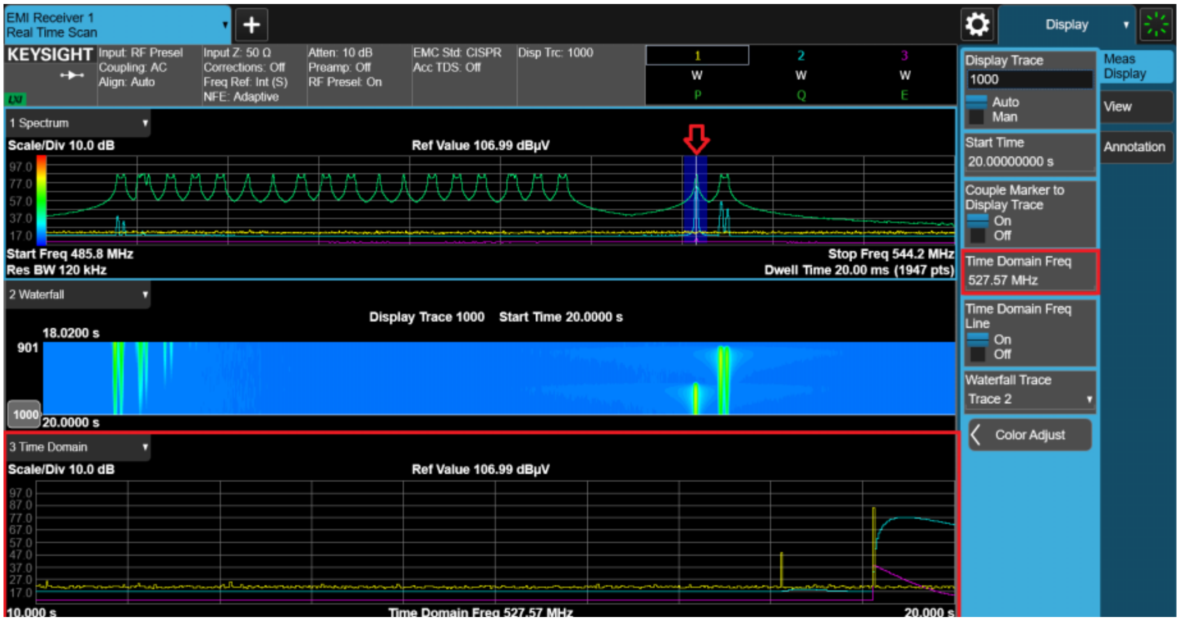
Step	Action	Notes



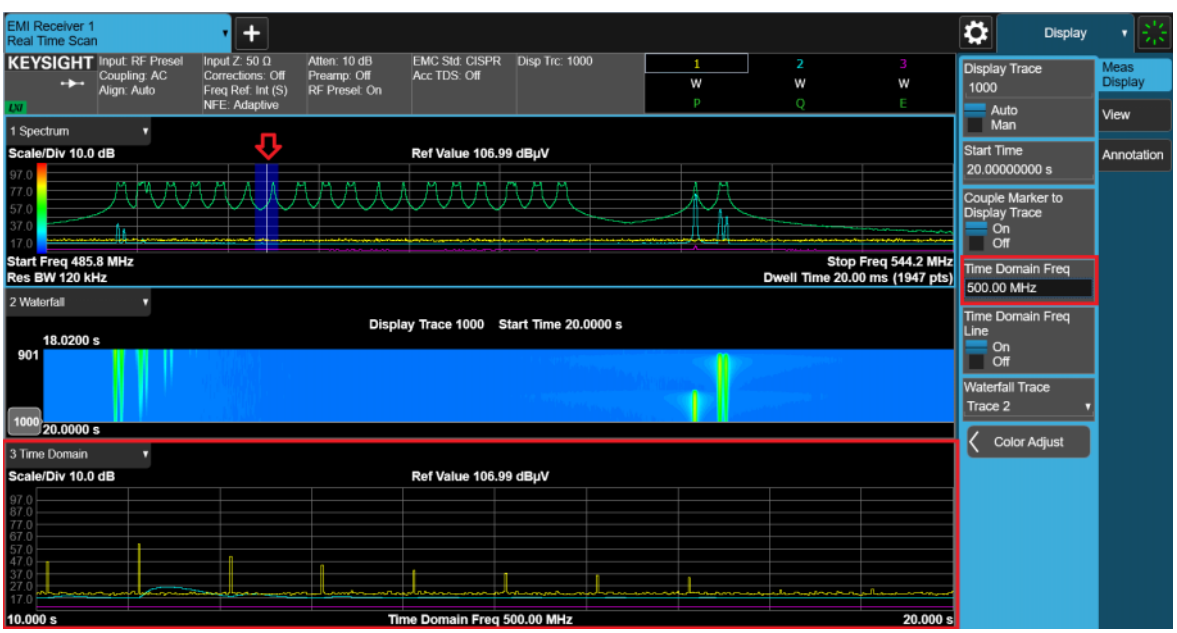
Step	Action	Notes
10. Select Waterfall Trace	Select **Display**, the **Meas Display** tab, set **Waterfall Trace** to **Trace 2**.	Waterfall shoes Trace 1 by default.Waterfall shows a blank screen if an off trace is selected.



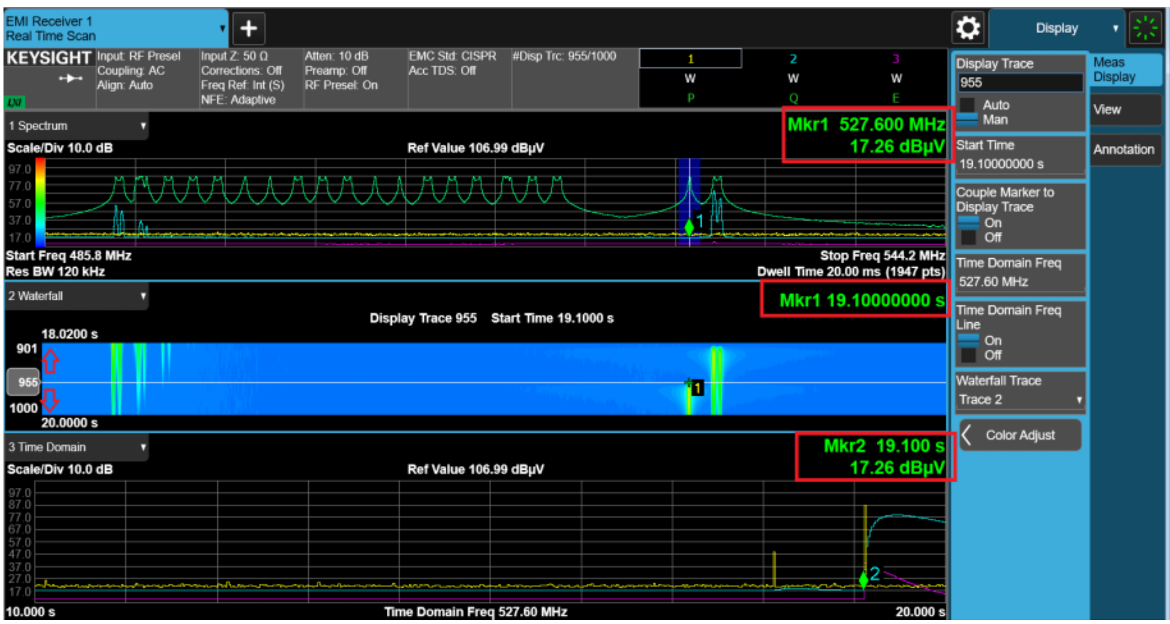
Step	Action	Notes
11. Turn on Time Domain view to see the time variant behavior	Select the  icon, add the **Time Domain** view to the bottom of the Window.	The Time Domain window displays the signal amplitude over time. The trace is aggregated from all the time slices, where one frequency bin is extracted from each time slice and they are stitched to form a trace.



Step	Action	Notes
12. Change the frequency of the Time Domain view	Select **Display**, the **Meas Display** tab, set the **Time Domain Freq** to **500 MHz**.	Alternately, drag the vertical blue bar on the Spectrum view horizontally. As you move, the Time Domain trace is updated accordingly. The Time Domain Frequency sets the frequency on which the Time Domain trace is built. This is essentially the result you can view in the Strip Chart measurement.



Step	Action	Notes
13. Turn on markers on all views	Select the **Spectrum** view, select **Marker**, turn on **Marker 1**, set **Marker Trace** to **Trace 2**. Perform a **Peak Search**. Select the **Time Domain** view, select **Marker**, turn on **Marker 2**, set **Marker Trace** to **Time Domain 2**.	Marker is default to Trace 1 if the Spectrum window is in focus when the marker is turned on, and Time Domain 1 if the Time Domain window is in focus when the marker is turned on. If you move the display trace slider on the Waterfall view vertically, you will see all marker readings change accordingly. If you change the Time Domain Frequency, you will find the marker values are not matched anymore. You can auto-couple the value by performing a Move Time Domain Freq –> Marker.



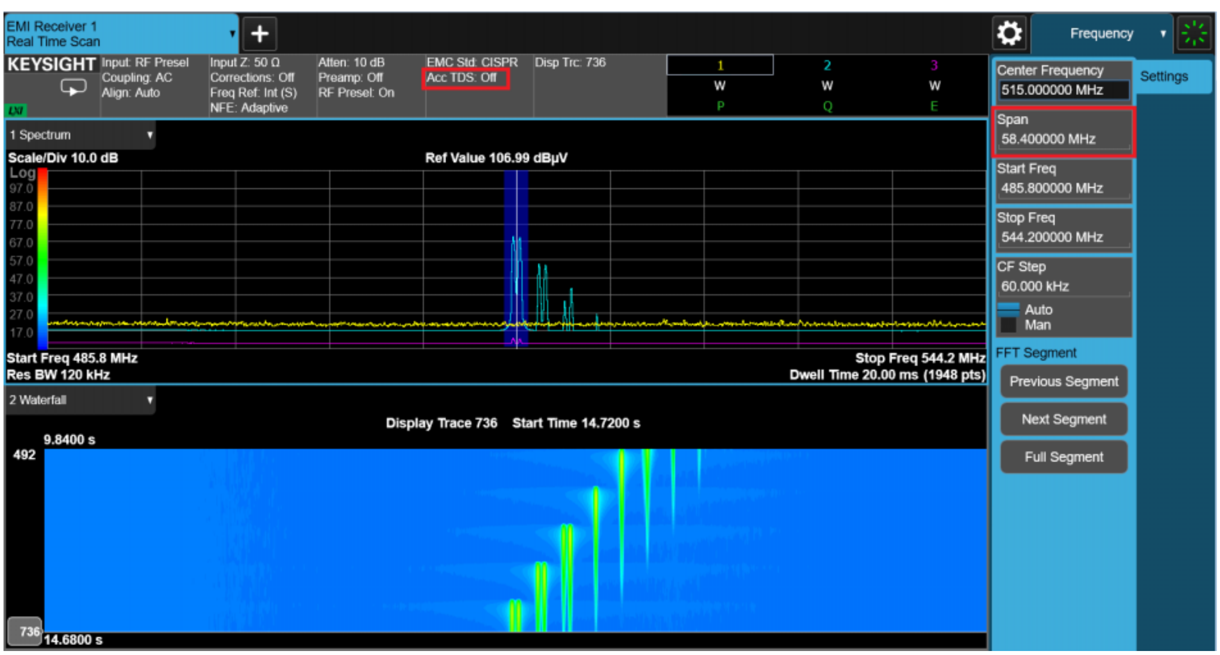
Increasing the Frequency Span with Accelerated TDS

The Accelerate TDS feature enables you to increase the data capture bandwidth in the Real Time Scan measurement. Compared to non-Accelerated TDS, you can analyze a data spectrum up to 350 MHz in a single segment.

This section demonstrates how to set up Accelerated TDS to increase the frequency span when measuring in the radiated range.

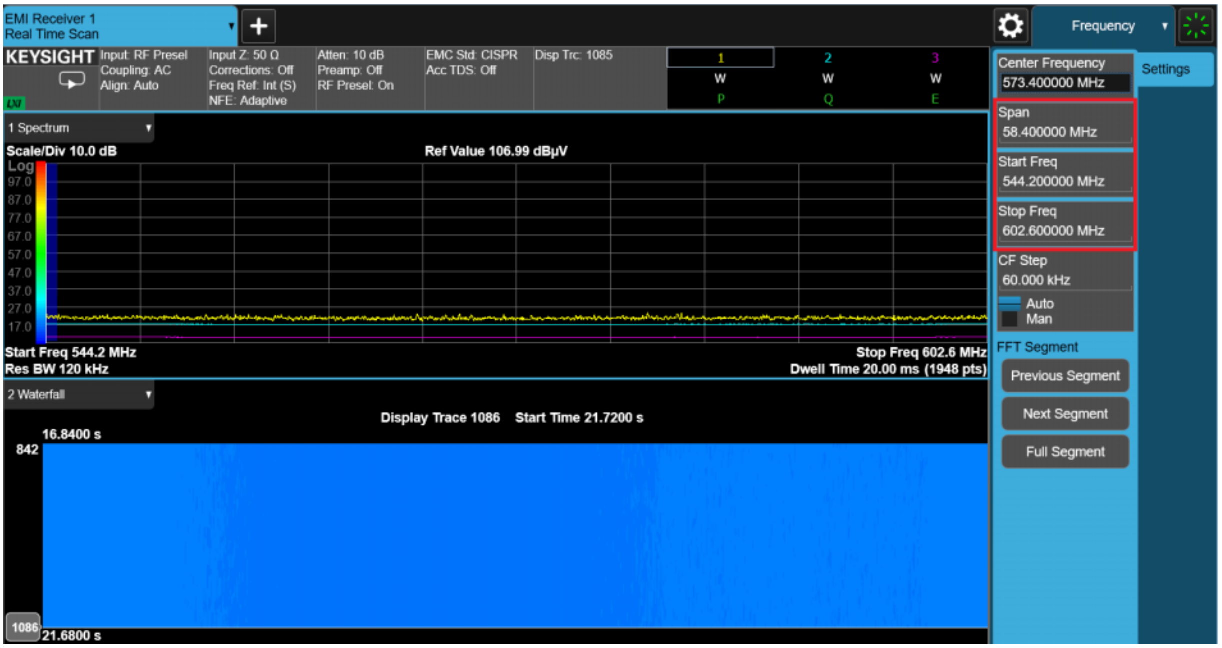
NOTE This measurement requires Option WT1/WT2 on the N9048B EMI Receiver.

Step	Action	Notes
1. Preset the EMI Receiver mode	Select **Mode Preset**.	Alternately, if you are running the application from a remote desktop connection, select Mode Preset.
2. Select the Real-time Scan measurement	Select **MODE/MEAS**, **EMI Receiver** Mode, **Real-time Scan** Measurement, **Spectrogram** View, **OK**.	
3. Select Full Segment	Select **FREQ**, **Full Segment**.	With the default standard RBW of 120 kHz, the span is limited to 58.4 MHz.

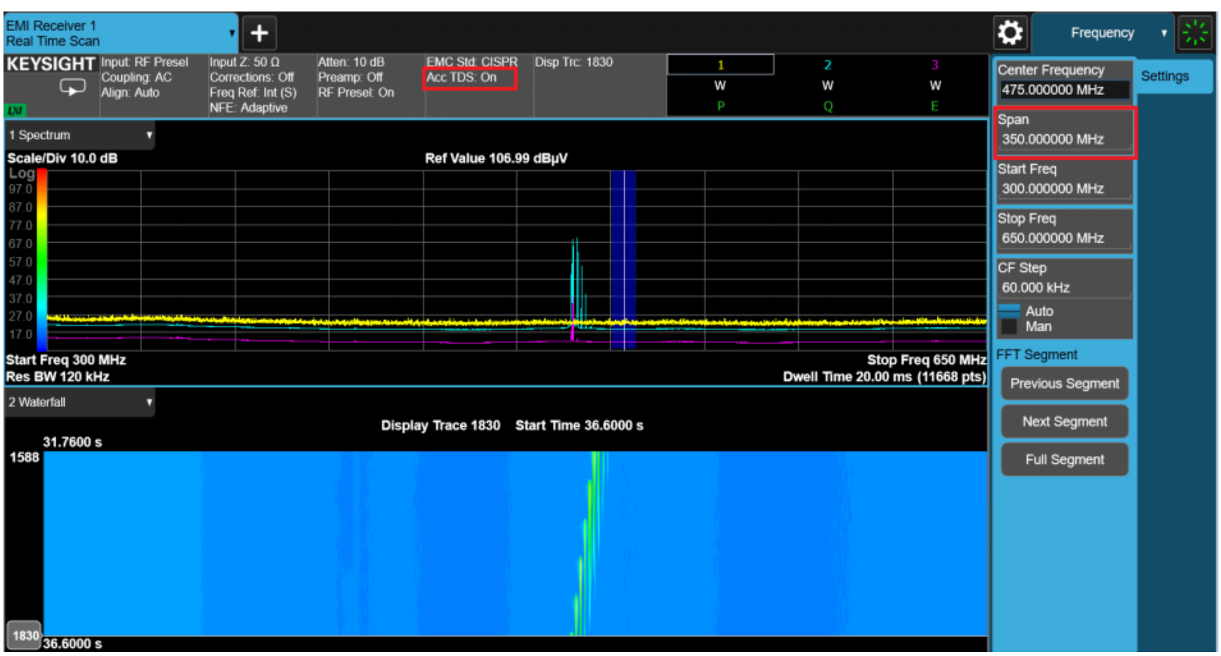


Step	Action	Notes
4. Select Next Segment	Select **FREQ**, **Next Segment**.	The frequency range moved to the next segment.

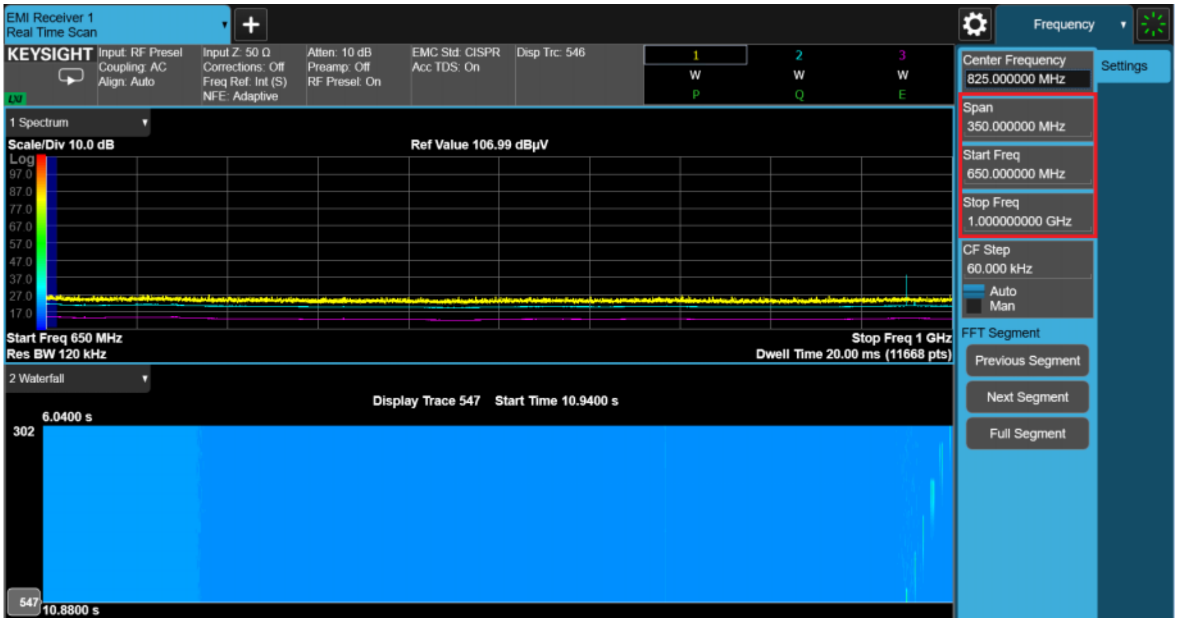
Step	Action	Notes



Step	Action	Notes
5. Turn on Accelerated TDS	Select **MEAS SETUP**, turn **Accelerated TDS (30 MHz - 3.2 GHz)** to On.	
6. Select Full Segment	Select **FREQ**, **Full Segment**.	With the default standard RBW of 120 kHz, the maximum span is increased to 350 MHz.



Step	Action	Notes
7. Select Next Segment	Select **FREQ**, **Next Segment**.	The frequency range moved to the next segment.



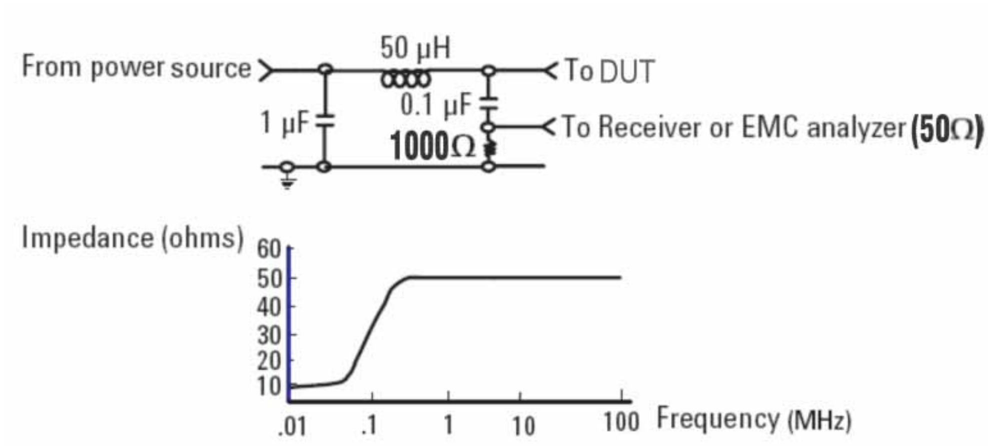
A: Line Impedance Stabilization Networks (LISN)

A line impedance stabilization network serves three purposes:

1. The LISN isolates the power mains from the device under test. the power supplied to the EUT must be as clean a possible. Any noise on the line will be coupled to the EMI receiver and interpreted as noise generated by the EUT
2. The LISN isolates any noise generated by the EUT from being coupled to the power mains. Excess noise on the power mains can cause interference with the proper operation of other devices on the line.
3. The signals generated by the EUT are coupled to the EMI receiver using a high-pass filter, which is part of the LISN. Signals that are in the pass band of the high-pass filter see a 50Ω load, which is the input to the EMI receiver.

LISN Operation

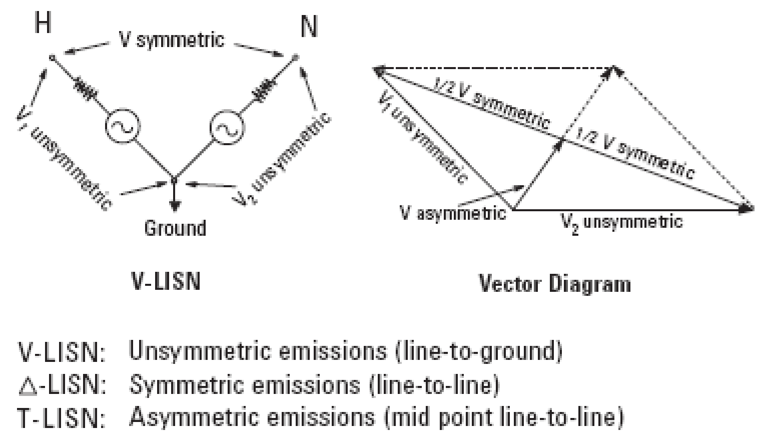
The following graphic shows a typical LISN circuit diagram for one side of the line relative to earth ground. The chart represents the impedance of the EUT port versus frequency.



The 1 µF inductor in combination with the 50 µH inductor is the filter that isolates the mains from the EUT. The 50 µH inductor isolates the noise generated by the EUT from the mains. The 0.1 µF inductor couples the noise generated by the EUT to the EMI receiver. At frequencies above 150 kHz, the EUT signals are presented with a 50Ω impedance.

Types of LISNs

The most common type of LISN is the V-LISN. It measures the unsymmetrical voltage between line and ground. This is done for both the hot and the neutral lines or for a three phase circuit in a "Y" configuration, between each line and ground. There are other specialized types of LISNs. A delta LISN measures the line-to-line or symmetric emissions voltage. The T-LISN, sometimes used for telecommunications equipment, measures the asymmetric voltage, which is the potential difference between the midpoint potential between two lines and ground.



Transient Limiter Operation

The purpose of the limiter is to protect the input of the signal analyzer from large transients when connected to a LISN. Switching EUT power on or off can cause large spikes generated in the LISN.

NOTE The N9038B and N9048B PXE RF Input 2 has a built in transient limiter and does not require the use of an external limiter.

The Cokeva 11947C transient limiter incorporates a limiter, high-pass filter, and an attenuator. It can withstand 10 kW for 10 µsec and has a frequency range of 9 kHz to 200 MHz. The high-pass filter reduces the line frequencies coupled to the spectrum analyzer.

B: Antenna Factors

Field Strength Units

Radiated EMI emissions measurements measure the electric field. The field strength is calibrated in dBμV/m. Field strength in dBμV/m is derived from the following:

Pt = total power radiated from an isotropic radiator

PD = the power density at a distance r from the isotropic radiator (far field)

PD = Pt /4πr2

R = 120 mΩ

PD = E2/R

E2/R = Pt /4πr2

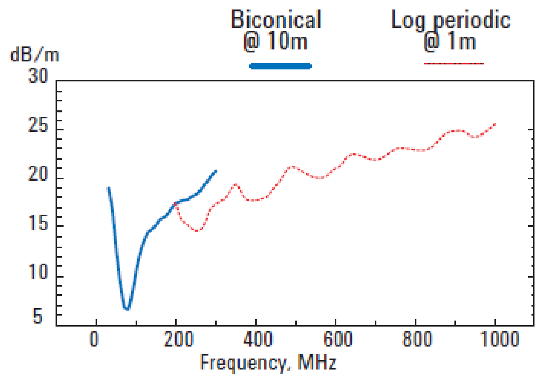
E = (Pt x 30)1/2 /r (V/m)

Far field[1] is considered to be >λ/2π

1. Far Field is the minimum distance from a radiator where the field becomes a planar wave.

Antenna factors

The definition of antenna factors is the ratio of the electric field in volts per meter present at the plane of the antenna versus the voltage out of the antenna connector.



Linear units: AF = Antenna factor (1/m)
E = Electric field strength (V/m)
V = Voltage output from antenna (V)

$$AF = \frac{Ein}{V\ out}$$

Log units: AF(dB/m) = E(dBμV/m) - V(dBμV)
E(dBμV/m) = V(dBμV) + AF(dB/m)

NOTE

Antenna factors are not the same as antenna gain.

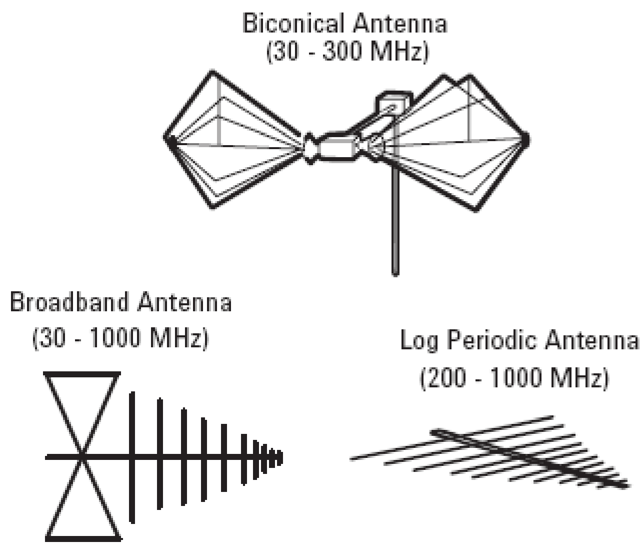
The antenna factor is the ratio of the electric field strength to the voltage V (units: V or μV) induced across the terminals of an antenna. The voltage measured at the output terminals of an antenna is not the actual field intensity because of the actual antenna gain, aperture characteristics, and loading effects

Antenna gain combines the antenna's directivity and electrical efficiency. In a receiving antenna, the gain describes how well the antenna converts radio waves arriving from a specified direction into electrical power. A plot of the gain is the radiation pattern.

Types of antennas used for commercial radiated measurements

There are three types of antennas used for commercial radiated emissions measurements:

- Biconical antenna: 30 MHz to 300 MHz
- Log periodic antenna: 200 MHz to 1 GHz (the biconical and log periodic overlap frequency)
- Broadband antenna: 30 MHz to 1 GHz (larger format than the biconical or log periodic antennas)



C: Basic Electrical Relationships

The decibel is used extensively in electromagnetic measurements. It is the log of the ratio of two amplitudes. The amplitudes are in power, voltage, amps, electric field units, and magnetic field units.

decibel = dB = 10 log (P2/P1)

Data is sometimes expressed in volts or field strength units. In this case, replace

P with V2/R.

If the impedances are equal, the equation becomes:

dB = 20 log (V2/V1)

A unit of measure used in EMI measurements is dBμV. The relationship of dBμV and dBm is as follows:

dBμV = 107 + PdBm

This is true for an impedance of 50Ω.

Wave length (l) is determined using the following relationship:

λ = 3x108/f (Hz) or λ = 300/f (MHz)

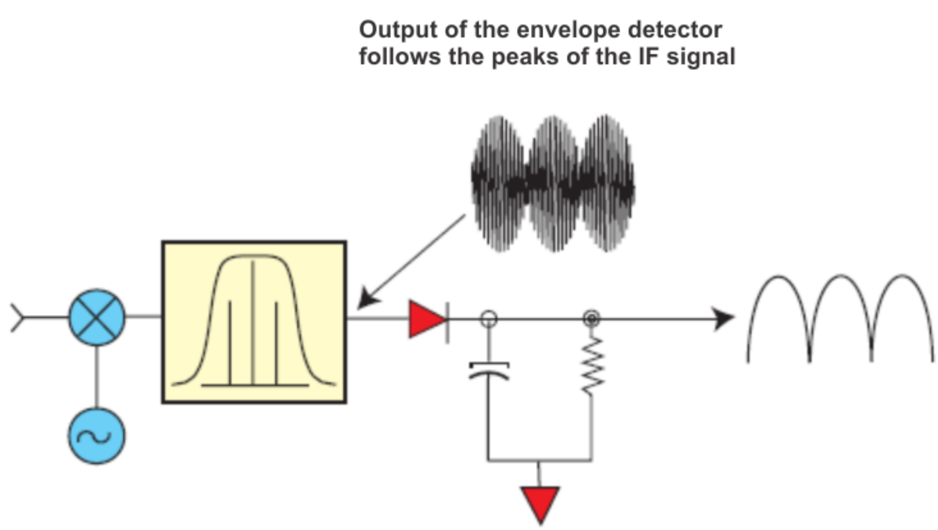
D: Detectors Used in EMI Measurements

Peak Detector

Initial EMI measurements are made using a peak detector. This mode is much faster than quasi-peak, or average modes of detection. Signals are normally displayed on spectrum analyzers or EMC analyzers in peak mode. Since signals measured in peak detection mode always have amplitude values equal to or higher than quasi-peak or average detection modes, it is a very easy process to take a sweep and compare the results to a limit line. If all signals fall below the limit, then the product passes and no further testing is needed.

Peak detector operation

The EMI receiver has an envelope or peak detector in the IF chain that has a time constant, such that the voltage at the detector output follows the peak value of the IF signal at all times. In other words, the detector can follow the fastest possible changes in the envelope of the IF signal, but not the instantaneous value of the IF sine wave.



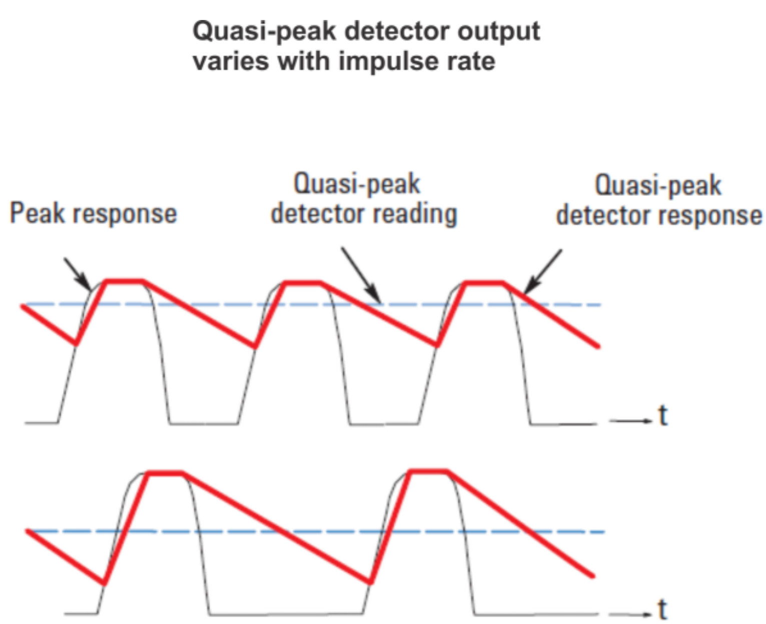
Quasi-Peak Detector

Most radiated and conducted limits are based on quasi-peak detection mode. Quasi-peak detectors weigh signals according to their repetition rate, which is a way of measuring their annoyance factor. As the repetition rate increases, the quasi-peak detector does not have time to discharge as much, resulting in a higher voltage output. (See the following graphic.) For continuous wave (CW) signals, the peak and the quasi-peak are the same.

Quasi-peak detectors always give a reading less than or equal to peak detectors, but quasi-peak measurements are much slower by two or three orders of magnitude compared to a peak detector.

Quasi-peak detector operation

The quasi-peak detector has a charge rate much faster than the discharge rate. The higher the repetition rate of the signal, the higher the output of the quasi-peak detector. The quasi-peak detector also responds to different amplitude signals in a linear fashion. High-amplitude, low-repetition-rate signals could produce the same output as low-amplitude, high-repetition-rate signals.



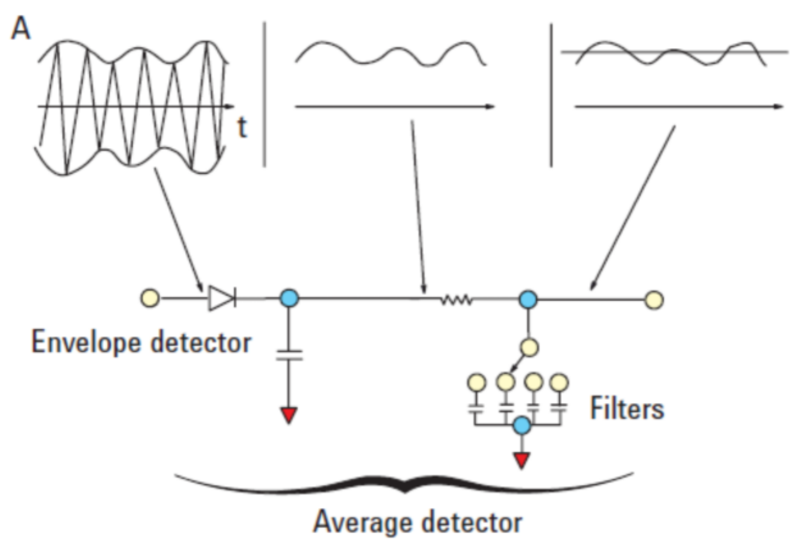
Average Detector

The average detector is required for some conducted emissions tests in conjunction with using the quasi-peak detector. Also, radiated emissions measurements above 1 GHz are performed using average detection. The average detector output is always less than or equal to peak detection.

Average detector operation

Average detection is similar in many respects to peak detection. The following graphic shows a signal that has just passed through the IF and is about to be detected. The output of the envelope detector is the modulation envelope. Peak detection occurs when the post detection bandwidth is wider than the resolution bandwidth. For average detection to take place, the peak detected signal must pass through a filter whose bandwidth is much less than the resolution bandwidth. The filter averages the higher frequency components, such as noise at the output of the envelope detector.

Average detection



RMS Average Detector

RMS (root-mean-square) average weighting receivers employ a weighting detector that is a combination of a RMS and an average detector. It is defined to evaluate the effect that impulsive disturbance is interfering on modern digital radio communication services. The RMS average detector output is always less than peak detection. Its measurement is slower compared to peak detection.

RMS Average detector operation

RMS average detector is a combination of a RMS detector and an average detector.

The RMS detector is used for pulse repetition frequency (PRF) above the corner frequency (f_c). Its output is independent of the signal peak-average ratio.

The average detector is used for PRF below f_c.

Thus the pulse response curve is divided in two regions with the following characteristics:

10 dB/decade when PRF < f_c

20 dB/decade when PRF > f_c

Glossary of Acronyms and Definitions

Ambient level

1. The values of radiated and conducted signal and noise existing at a specified test location and time when the test sample is not activated.

2. Those levels of radiated and conducted signal and noise existing at a specified test location and time when the test sample is inoperative. Atmospherics, interference from other sources, and circuit noise, or other interference generated within the measuring set compose the ambient level.

Amplitude modulation

1. In a signal transmission system, the process, or the result of the process, where the amplitude of one electrical quantity is varied in accordance with some selected characteristic of a second quantity, which need not be electrical in nature.

2. The process by which the amplitude of a carrier wave is varied following a specified law.

Anechoic chamber

A shielded room which is lined with radio absorbing material to reduce reflections from all internal surfaces. Fully lined anechoic chambers have such material on all internal surfaces, wall, ceiling and floor. Its also called a "fully anechoic chamber." A semianechoic chamber is a shielded room which has absorbing material on all surfaces except the floor.

Antenna (aerial)

1. A means for radiating or receiving radio waves. A transducer which either emits radio frequency power into space from a signal source or intercepts an arriving electromagnetic field, converting it into an electrical signal.

2. A transducer which either emits radio frequency power into space from a signal source or intercepts an arriving electromagnetic field, converting it into an electrical signal.

Antenna factor

The factor which, when properly applied to the voltage at the input terminals of the measuring instrument, yields the electric field strength in volts per meter and a magnetic field strength in amperes per meter.

Antenna induced voltage

The voltage which is measured or calculated to exist across the open circuited antenna terminals.

Antenna terminal conducted interference

Any undesired voltage or current generated within a receiver, transmitter, or their associated equipment appearing at the antenna terminals.

Auxiliary equipment

Equipment not under test that is nevertheless indispensable for setting up all the functions and assessing the correct performance of the EUT during its exposure to the disturbance.

Balun

A balun is an antenna balancing device, which facilitates use of coaxial feeds with symmetrical antennas such as a dipole.

Broadband emissions

Broadband is an interference amplitude when several spectral lines within the RFI receivers specified bandwidth.

Broadband interference (measurements)

A disturbance that has a spectral energy distribution sufficiently broad, so that the response of the measuring receiver in use does not vary significantly when tuned over a specified number of receiver bandwidths.

Conducted interference

Interference resulting from conducted radio noise or unwanted signals entering a transducer (receiver) by direct coupling.

Cross-coupling

The coupling of a signal from one channel, circuit, or conductor to another, where it becomes an undesired signal.

Decoupling network

An electrical circuit for preventing test signals which are applied to the EUT from affecting other devices, equipment, or systems that are not under test. IEC 801-6 states that the coupling and decoupling network systems can be integrated in one box or they can be separate networks.

Dipole

1. An antenna consisting of a straight conductor usually not more than a half-wavelength long, divided at its electrical center for connection to a transmission line.

2. Any one of a class of antennas producing a radiation pattern approximating that of an elementary electric dipole.

Electromagnetic compatibility (EMC)

1. The capability of electronic equipment of systems to be operated within defined margins of safety in the intended operating environment at designed levels of efficiency without degradation due to interference.

2. EMC is the ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable disturbances into that environment or into other equipment.

Electromagnetic interference

The impairment of a wanted electromagnetic signal by an electromagnetic disturbance

Electromagnetic wave

The radiant energy produced by the oscillation of an electric charge characterized by oscillation of the electric and magnetic fields.

Emission

Electromagnetic energy propagated from a source by radiation or conduction.

Far Field

The region where the power flux density from an antenna approximately obeys the inverse square law of the distance. For a dipole this corresponds to distances greater than l/2 where l is the wave length of the radiation.

Ground plane

1. A conducting surface or plate used as a common reference point for circuit returns and electric or signal potentials.

2. A metal sheet or plate used as a common reference point for circuit returns and electrical or signal potentials.

Immunity

1. The property of a receiver or any other equipment or system enabling it to reject a radio disturbance.

2. The ability of electronic equipment to withstand radiated electromagnetic fields without producing undesirable responses.

Intermodulation

Mixing of two or more signals in a nonlinear element, producing signals at frequencies equal to the sums and differences of integral multiples of the original signals.

Isotropic

Isotropic means having properties of equal values in all directions.

Monopole antenna

An antenna consisting of a straight conductor, usually not more than one-quarter wave length long, mounted perpendicularly over a ground plane. For receiving antennas the output signal to the receiver is taken, between the lower end of the monopole and the ground plane. One side of the antenna feedline is attached to the lower end of the monopole, and the other side is attached to the ground plane, often called “Earth”. This contrasts with a dipole antenna which consists of two identical rod conductors, with the signal from the transmitter applied between the two halves of the antenna.

Narrowband emissions

That which has its principal spectral energy lying within the bandpass of the measuring receiver in use.

Open area

A site for radiated electromagnetic interference measurements which is open flat terrain at a distance far enough away from buildings, electric lines, fences, trees, underground cables, and pipe lines so that effects due to such are negligible. This site should have a sufficiently low level of ambient interference to permit testing to the required limits.

Polarization

Describes the orientation of the field vector of a radiated field.

Radiated interference

Radio interference resulting from radiated noise of unwanted signals. Compare radio frequency interference below.

Radiation

The emission of energy in the form of electromagnetic waves.

Radio frequency interference

RFI is the high frequency interference with radio reception. This occurs when undesired electromagnetic oscillations find entrance to the high frequency input of a receiver or antenna system.

RFI sources

Sources are equipment and systems as well as their components which can cause RFI.

Shielded enclosure

A screened or solid metal housing designed expressly for the purpose of isolating the internal from the external electromagnetic environment. The purpose is to prevent outside ambient electromagnetic fields from causing performance degradation and to prevent emissions from causing interference to outside activities.

Stripline

Parallel plate transmission line to generate an electromagnetic field for testing purposes.

Susceptibility

Susceptibility is the characteristic of electronic equipment that permits undesirable responses when subjected to electromagnetic energy.

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