Keysight N9038A MXE EMI Receiver

Self-Guided Demonstration

Demo Guide

This document demonstrates electromagnetic interference (EMI) compliance measurements using the MXE EMI receiver.

KEYSIGHT TECHNOLOGIES

Table of Contents

Introduction

This demonstration guide will familiarize you with the N9038A MXE EMI receiver when making EMC compliance measurements. The MXE allows you to fully test devices up to 44 GHz in compliance with CISPR 16-1-1:2010 and MIL-STD-461. This guide follows the EMI test flow recommended by CISPR and uses an N9038A MXE EMI receiver with firmware version A.13.58, a whip antenna, and an N5181/2B MXG X-Series signal generator.

User interface layout

The default startup mode in the MXE is EMI receiver mode. There are several measurements in EMI receiver mode accessible via the [Meas] key, such as frequency scan, Strip Chart, monitor spectrum, and APD. The user interface for frequency scan measurement has three display regions showing information regarding different setting menus (Figure 1).

Region 1#: Spectrum and setting information of 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

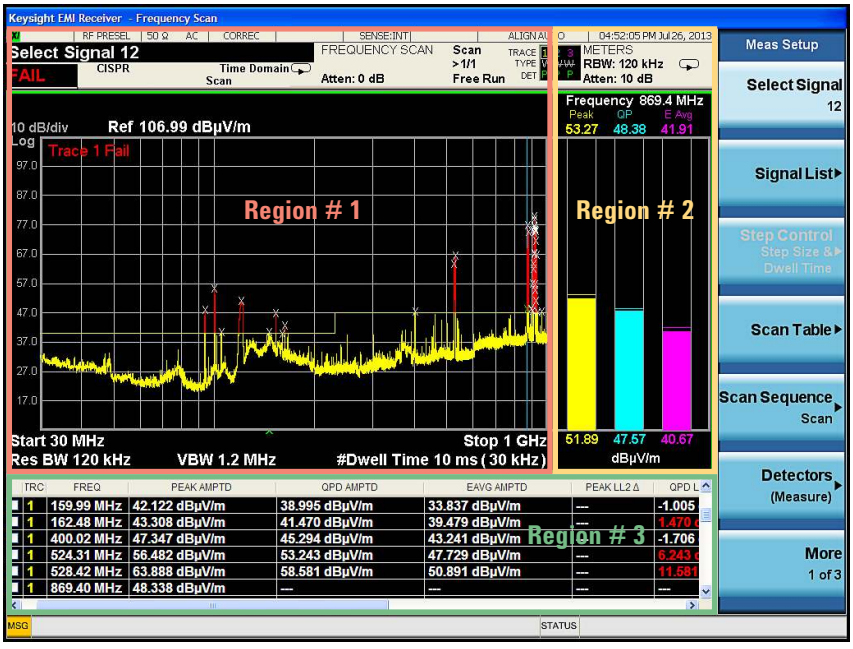

Figure 1. N9038A MXE EMI receiver user interface

Navigating the menu system

Before starting the demonstration, it is important to understand the MXE'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 receiver mode.

The scan and (re) measure menus apply to scan sequence. Scan sequence is very important for understanding the philosophy of MXE operation because it aligns with the CISPR test flow. The MXE is designed with clearly independent settings for meters (Region 1), scan (Region 2), and (re) measure. The current values for the Region 1 and Region 2 settings are presented in each region. Figure 2 shows the EMI test flow recommended by CISPR 16-2-3. Scan only, search only, and (re) measure are the settings of scan sequence on the MXE corresponding to pre-scan, data reduction, and final measurement of the EMI test flow. Table 1 lists the menu path of the sets of settings for meters, scan, and (re) measure respectively.

All keystrokes surrounded by [ ] indicate front panel hard keys and keystrokes surrounded by { } indicate soft keys on the side of display.

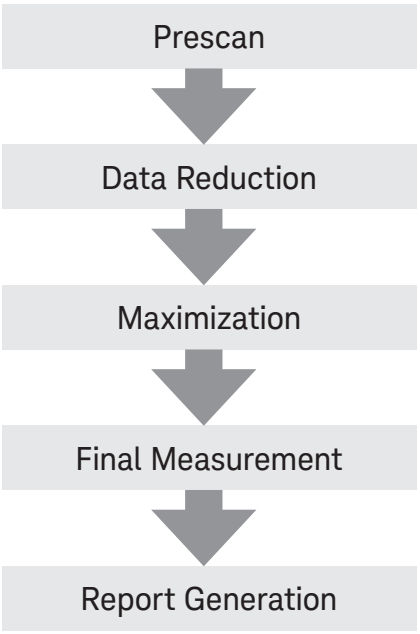

Figure 2. CISPR-recommended EMI test flow

Table 1. Keystrokes for settings of meters, scan, and (re) measure

Settings	Meters	Scan	(Re) measure
Frequency	[Frequency], {Frequency (Meters)}	[Meas Setup], {Scan Table}, {Start Freq}/{Stop Freq} *	—
Detector	[Mode setup], {Meter control}, {Meters}, {Detector (Meters)}	[Trace/Detector], {More 1 of 2}, {Detector (Trace)}	[Meas Setup], {Detectors (Measure)}
RBW	[BW], {RBW (Meters)}	[Meas Setup], {Scan Table}, {Res BW}	
Attenuation	[AMPTD], {Atten (Meters)}	[Meas Setup], {Scan Table}, {More 1 of 3}, {Attenuation}	
Preamp	[AMPTD], {More 1 of 2}, {Int Preamp (Meters)}	[Meas Setup], {Scan Table}, {More 1 of 3}, {Internal Preamp}	
Auto range, auto preamp	[Mode setup], {Meter Control}, {Autorange}	[Meas Setup], {Scan Table}, {More 1 of 3}, {More 2 of 3}, {Autorange}/{Auto Preamp}	[Meas Setup], {More 1 of 2}, {Autorange (Measure)}
Dwell time	[Mode setup], {Meter Control}, {Dwell Time (per point)}	[Meas Setup], {Scan Table}, {More 1 of 3}, {Dwell Time}	[Meas Setup], {Detectors (Measure)}, {Dwell Time}
Limit lines	[Mode setup], {Meter Control}, {Meters}, {Limit}	[Meas setup], {More 1 of 2}, {Limits}	[Meas Setup], {Detectors (Measure)}, {Limit for Δ}
RF input (1/2)	[Input/output], {RF Input}, {RF Input Port}	[Meas Setup], {Scan Table}, {More 1 of 3}, {More 2 of 3}, {RF Input}	—
RF coupling (AC/DC)	[Input/output], {RF Input}, {RF Coupling}		
Preselector on/off	[Input/output], {RF Input}, {RF Preselector}		
Corrections	[Input/output], {More 1 of 2}, {Corrections}		

*Note: The {Start Freq} and {Stop Freq} under [Frequency] is for setting displayed span on the screen, not for scanning. In default, they are coupled to the {Start Freq} and {Stop Freq} under scan table if Auto is selected.

Demonstration Preparation

This demonstration guide includes the following sections:

- Making measurements
- Diagnostic testing tools
- Single frequency measurement
- Other features

The Making Measurements section is organized according to the test flow recommended by CISPR as shown in Figure 2. The demonstrations are designed to be replicated sequentially.

For most of the demonstrations, test signals were received by a whip antenna, such as FM radio and cellular signals. The MXG was only used to generate a pulse signal for the APD demo. All keystrokes surrounded by [ ] indicate front panel hard keys and keystrokes surrounded by { } indicate soft keys on the side of display.

All of these demonstrations use commercial EMI settings. If you wish to use MIL-STD-461 settings for these demonstrations, make the corresponding setting changes indicated in each demonstration.

Equipment	Requirements
N9038A MXE EMI receiver	Firmware A.13.58 or above
N5181/ 2B MXG X-Series signal generator	Pulse signal
A whip antenna	Any whip antenna working at up to 3 GHz

Making Measurements

Step 1: 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 for final measurement with quasi-peak and EMI average detectors. For a commercial compliance measurement, when conducting a prescan, it is important to investigate the full frequency spectrum with the device under test (DUT) rotated 360° as well as the antenna height scanned between 1 and 4 m and adjusted between vertical and horizontal orientations.

For Demonstrations 1-5, we will load limit lines and amplitude corrections, set up a scan table with both smooth and time domain scan types for comparison, and set two traces to scan against the two limit lines simultaneously.

Did you know?

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

Demo 1: Load and edit limit lines

In this demonstration, we will load the built-in limit line file, "EN 55022, Rad, Class A, 30 MHz to 1 GHz(10m).csv," and use the limit line editor to view the limit line values. The MXE has many built-in limit line files for commercial and military standards organized in different folders, such as EN, FCC, GB, and VCCI.

We will also add a 5 dB margin to the limit line. Using a margin on a limit line allows users to account for the system uncertainties in their measurements.

Step 1–Demo 1	**Keystrokes**
Make sure you are in EMI receiver mode	[Mode], {EMI Receiver} EMI receiver is the default startup mode
Preset EMI receiver mode	[Mode Preset]
Set EMC standard to CISPR	[Mode Setup], {EMC Standard}, {CISPR} *Note: For MIL-STD measurements, set EMC standard to MIL-STD: [Mode Setup], {EMC Standard}, {MIL}*
Load the built-in limit line file, "EN 55022, Rad, Class A, 30 MHz to 1 GHz(10m).csv" See Figure 3	[Recall], {Data}, {Limit}, {Limit}, {Select Limit}, {Limit 1}, {Preloaded Limits} [Return], {Open}, {File/Folder} [↓] to move the focus to "EN" folder, [Enter], [↓] to move the focus to"55022" folder, [Enter], [↓], [→] to move the focus to the file "EN 55022, Rad, Class A, 30 MHz to 1 GHz(10m).csv," [Enter] *Note: For MIL_STD measurements, load the built-in limit line file, "MIL RE102-1 Rad, Surface Ship, Below Deck.csv": [Recall], {Data}, {Limit}, {Limit}, {Select Limit}, {Limit 1}, {Preloaded Limits}, [Return], {Open}, [Tab] several times to move focus on the folders, [↓] to move the focus to "MIL-461" folder, [Enter], [↓], [→] to move the focus to the file "MIL RE102-1 Rad, Surface Ship, Below Deck.csv," [Enter]* An easier way to select folders and files is using a USB mouse connected to the MXE
Edit the limit line with limit line editor See Figure 4	[Meas Setup], {More 1 of 3}, {Limits}, {Select Limit}, {Limit 1}, {Edit} Now you have entered the limit line editor and can add/delete a point or modify the frequency and amplitude of the current point
Assign Limit 1 to Trace 1 Limit lines are assigned to a specific trace	[Meas Setup], {More 1 of 3}, {Limits}, {Properties}, {Test Trace}, {Trace 1}
Turn on Limit Line 1 Turn on and add 5 dB margin See Figure 5	[Meas Setup], {More 1 of 3}, {Limits}, {Limit On}, {Margin On}, [-], [5], {dB} Check to make sure that the limit is on—it will turn on automatically once you've entered the editor

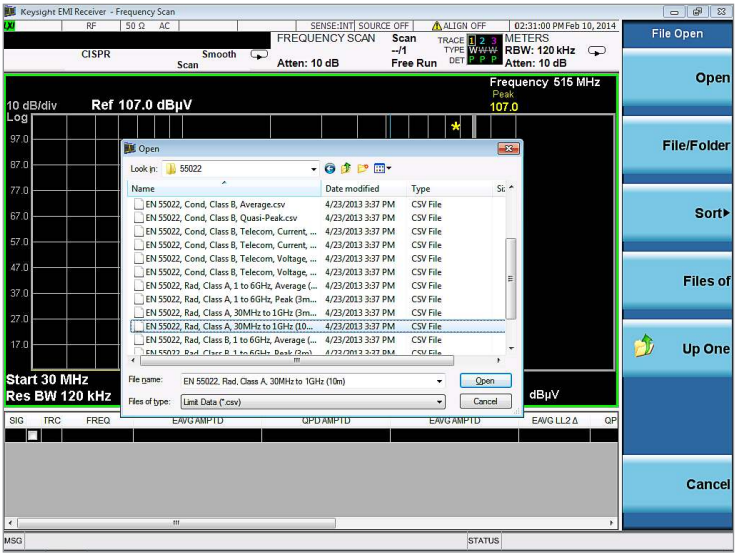

Figure 3. Recall limit lines

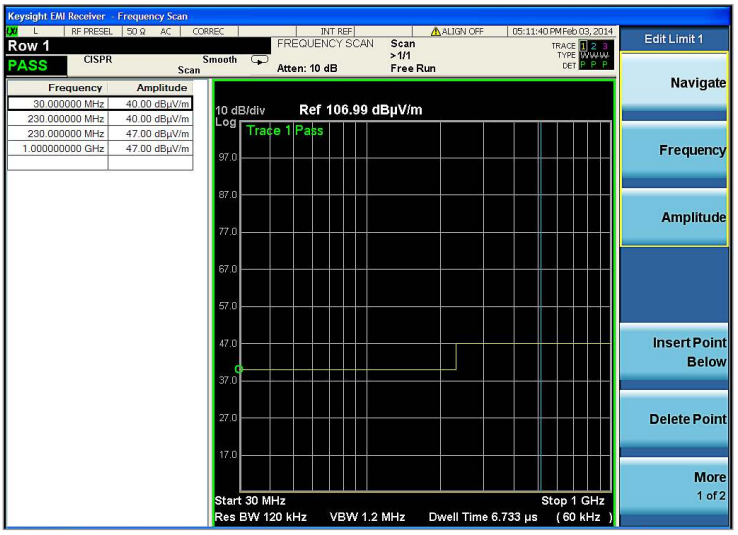

Figure 4. Limit line editor

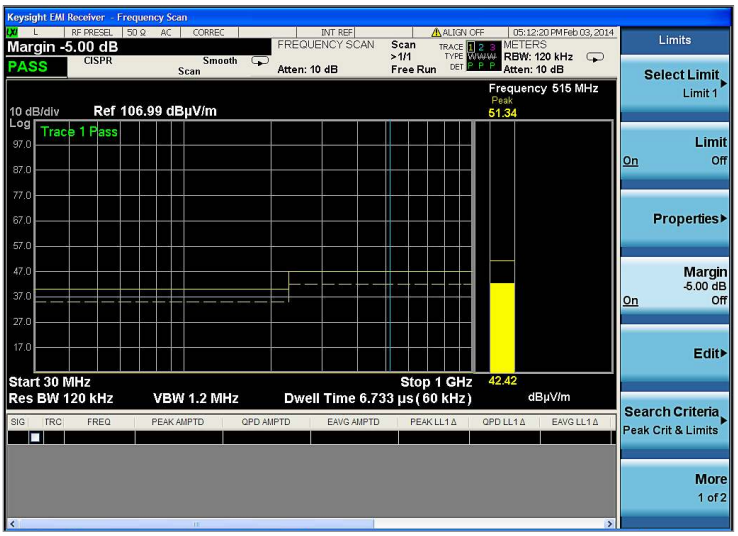

Figure 5. Limit plus margin

Demo 2: Load and edit corrections

In this demonstration, we will load the built-in correction file “Antenna, Broadband (26 MHz to 3 GHz).csv.” The MXE has built-in correction files for many accessories on the market, such as amplifiers, LISNs, and antennas. You can create your own correction files for devices not preloaded on the MXE.

Step 1–Demo 2 Instructions for MXE	Keystrokes
Load the built-in correction file “Antenna, Broadband (26 MHz to 3 GHz).csv” See Figure 6	[Recall], {Data}, {Amplitude Correction}, {Amplitude Correction}, {Select Correction}, {Correction 1}, {Preloaded Corrections} [Return], {Open}, {File/Folder} [↓], [→] to move the focus to file “Antenna, Broadband (26 MHz to 3 GHz).csv,” [Enter]
Edit the correction with correction editor See Figure 7	[Input/Output], {More 1 of 2}, {Corrections}, {Select Correction}, {Correction 1}, {Edit} Now that you have entered correction editor, you can add/delete a point or modify the frequency and amplitude of the current point (Figure 7)
Turn on Correction 1	[Input/Output], {More 1 of 2}, {Corrections}, {Correction On} Check to make sure that the correction is on—it will turn on automatically once you’ve ever entered the editor

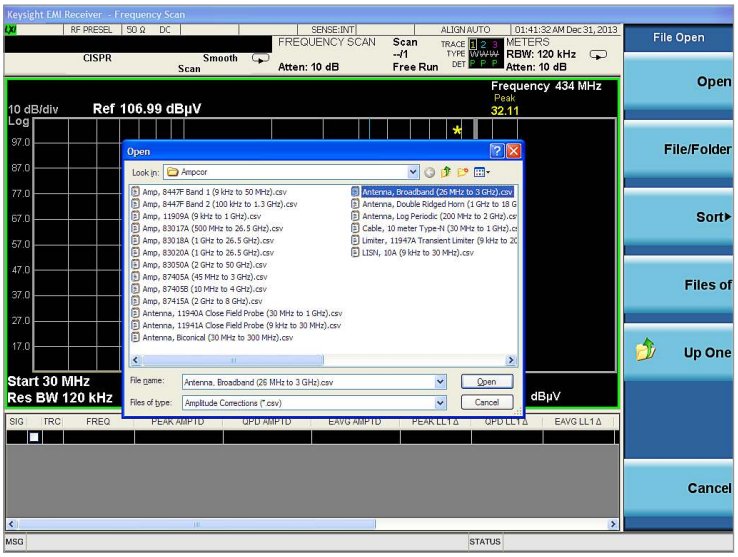

Figure 6. Load corrections

Figure 7. Correction editor

Demo 3: Set up scan table

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

In this demonstration, we are going to set Range 5 to CISPR C/D 30 MHz – 1 GHz by pushing one button in the {Range Preset} menu, and then make some setting changes to dwell time, attenuation, and preamp. The dwell time selected results in a recommended minimum CISPR scan time.

Did you know?

You can set up two or more ranges with different settings for a single scan. Check the boxes to select the appropriate ranges and the MXE will scan them sequentially. Just be sure to keep track of the total scan points (500,001) and maximum scan time (4,000 seconds).

Step 1–Demo 3 Instructions for MXE	Keystrokes
Access the Scan Table See Figure 8	[Meas Setup], {Scan Table} The scan table is also accessible by USB mouse connected to the MXE by clicking on the {Scan Table} key mentioned above
Select Range 5 and confirm it is on	Check if Range 5 is checked and that other ranges are off (not checked); if other ranges are selected, go to: {Select Range 5}, {Range On}, and uncheck all other ranges
Range preset to CISPR Band C/D 30 MHz – 1 GHz	[Meas Setup], {Scan Table}, {More 1 of 3}, {More 2 of 3}, {Range Preset}, {CISPR C/D 30 MHz-1 GHz} *Note: For MIL-STD measurements, change range preset to MIL-STD 1 GHz 30 MHz – 1 GHz: [Meas Setup], {Scan Table}, {More 1 of 3}, {More 2 of 3}, {Range Preset}, {More 1 of 2}, {MIL-STD 1 GHz 30 MHz-1 GHz}*
Set dwell time to 62 microseconds	[Meas Setup], {Scan Table}, {More 1 of 3}, {Dwell Time}, [6], [2], {us} *Note: For MIL-STD measurements, leave the default dwell time setting as 15 ms, which is set by range preset*
Set attenuation to 0 dB	[Meas Setup], {Scan Table}, {More 1 of 3}, {Attenuation}, [0], {dB}
Turn on preamplifier	[Meas Setup], {Scan Table}, {More 1 of 3}, {Internal Preamp}, {Low Band [3.60 GHz]}

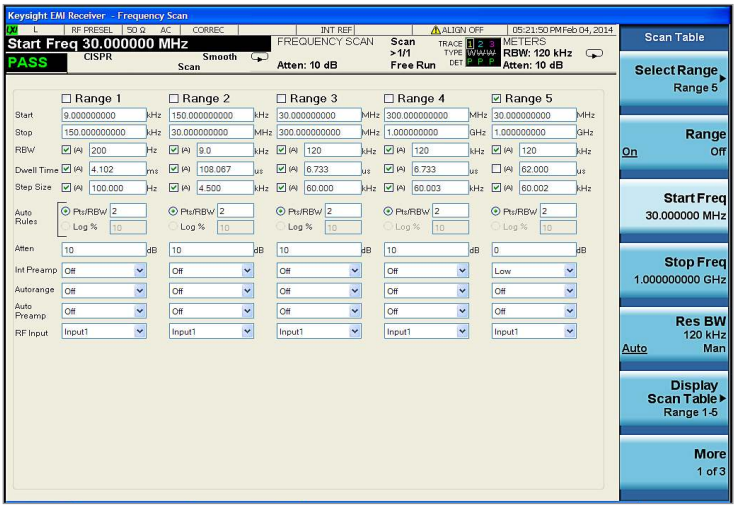

Figure 8. Scan table

Demo 4: 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 that identification of all signals that might exceed the limit. You can use the multi-trace capability of the MXE to simplify this collection and provide insight into which instrument orientation contribute the highest signal levels.

In this demo, we will use Trace 1 in the max hold trace to capture a summary of the emissions from the measured turntable azimuths and antenna heights. In addition, we will use Trace 2 in the clear/write trace to capture the emissions profile of the current DUT position. The signals in Trace 1 will be tested against Limit Line 1 and written to the suspect list.

Did you know?

The MXE's digital IF architecture guards against IF overload, even if signals are above the reference level. This architecture allows you to reduce operator error by eliminating overload caused by incorrect reference level settings.

Step 1– Demo 4 Instructions for MXE	Keystrokes
Turn on all three meters It's not necessary to turn on three detectors for scanning, searching, and measuring, but it's helpful to see three meters for turning signals later in the process *Note: For MIL-STD measurements, do not turn on Meters 2 and 3*	[Mode setup], {Meters Control}, {Meters}, {Select Meter}, {Meter 2}, {Meter On}, {Detector (Meters)}, {Quasi Peak} [Mode Setup], {Meters Control}, {Meters}, {Select Meter}, {Meter 3}, {Meter On}, {Detector (Meters)}, {EMI Average}
Set scan sequence to scan only	[Meas Setup], {Scan Sequence}, {Scan Only}. This is the default setting
Set frequency scan in continuous mode	[Sweep/Control], {Frequency Scan Cont}. This is the default setting
Set Trace 1 to max hold trace type and set the detector to peak. Trace 1 is the yellow trace	[Trace/Detector], {Select Trace}, {Trace 1}, {Max Hold} {More 1 of 2}, {Detector (Trace)}, {Peak}
Set Trace 2 to clear write trace type and the detector to peak. Trace 2 is the blue trace	[Trace/Detector], {Select Trace}, {Trace 2}, {Clear Write}, {More 1 of 2}, {Detector (Trace)}, {Peak}
Set scan type to smooth	[Meas Setup], {More 1 of 3}, {Scan Type}, {Smooth}. This is the default setting
Start a scan with smooth scan type	[Sweep/Control], {Start} or {Clear List And Start}, or just press [Restart] The {Clear List And Start} will clear the signal list table before a new scan
Observe the two traces updating, then stop the scan. See Figure 9	[Sweep/Control], {Stop}

Figure 9. Swept traces in both clear write and max hold trace types; whip antenna length was changed during the sweep to simulate antenna height scan, resulting in the difference between the traces

Demo 5: Reduce prescan time with time domain scan

The MXE supports three scan types: {Smooth}, {Discrete}, and {Time Domain}. Discrete scan is the traditional stepped frequency scan. Smooth scan is a swept frequency scan. It is faster than discrete scan because it doesn't require retuning the LO for each frequency point. Time domain scan, while based on stepping 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 demonstration, we are going to demonstrate the advantage 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 DUT. In this example we will use a 10 millisecond dwell time.

Did you know?

The MXE allows you to set reference levels, limit lines, traces, meters, corrections, and more during scanning. If you didn't set the reference level or limit line appropriately, you can do so without stopping the scan and the changes will take effect immediately during scanning.

Step 1–Demo 5 Instructions for MXE	Keystrokes
Turn off Trace 2	[Trace/Detector], {Select Trace}, {Trace 2}, {View/Blank}, {Blank}
Set the dwell time to 10 ms	[Meas Setup], {Scan Table}, {More 1 of 3}, {Dwell Time}, [1], [0], {ms}
Start the sweep and observe the time required to cover the frequency span	[Sweep/Control], {Start} or {Clear List And Start}, or just press [Restart]
Stop the scan	[Sweep/Control], {Stop}
Change the scan type to time domain scan	[Meas Setup], {More 1 of 3}, {Scan Type}, {Time Domain}
Start a new scan with time domain scan type	[Restart] The scan speed of time domain scan type is many times faster than that of smooth or discrete scan type

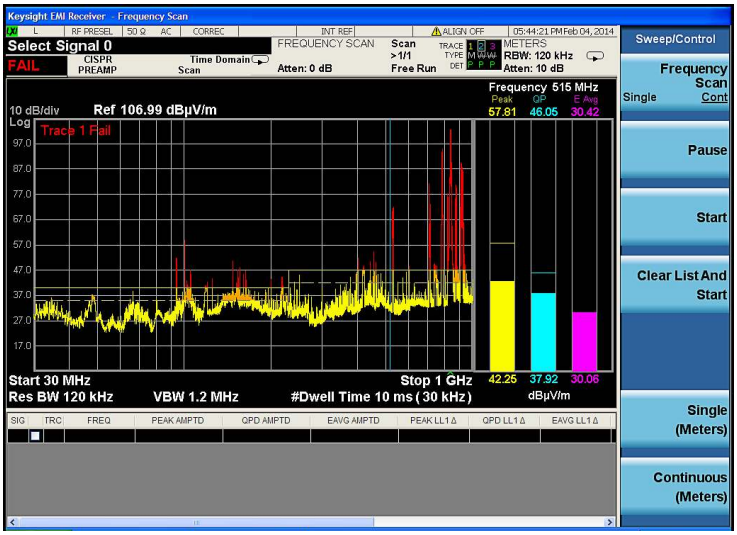

Figure 10. Swept trace collected using time domain scan

Step 2: Data reduction

Suspect frequencies that are close to or greater than 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.

Demo 1: Search signals above limit line

In this demonstration, we will set {Scan Sequence} to {Search Only} and {Search Criteria} to {Peak Criteria and Limits} for collecting signals over limit. To simplify the following demonstration, we will turn off Trace 2 and Limit 2 set in the last demonstration.

Did you know?

The MXE can search just the top number of peaks by setting [Meas Setup], {More 1 of 3}, {Limits}, {Search criteria}, {# of Peaks}.

Step 2– Demo 1 Instructions for MXE	Keystrokes
Stop the scan	[Sweep/Control], {Stop}
Set scan sequence to search only	[Meas Setup], {Scan Sequence}, {Search Only}
Set search criteria to peak criteria and limits	[Meas Setup], {More 1 of 3}, {Limits}, {Search Criteria}, {Peak Criteria and Limits} This is the default setting
Start a search	[Sweep/Control], {Start} or [Restart] {Clear List And Start} will clear the signal list before a new search, otherwise, new signals will be appended to the signal list without clearing older ones

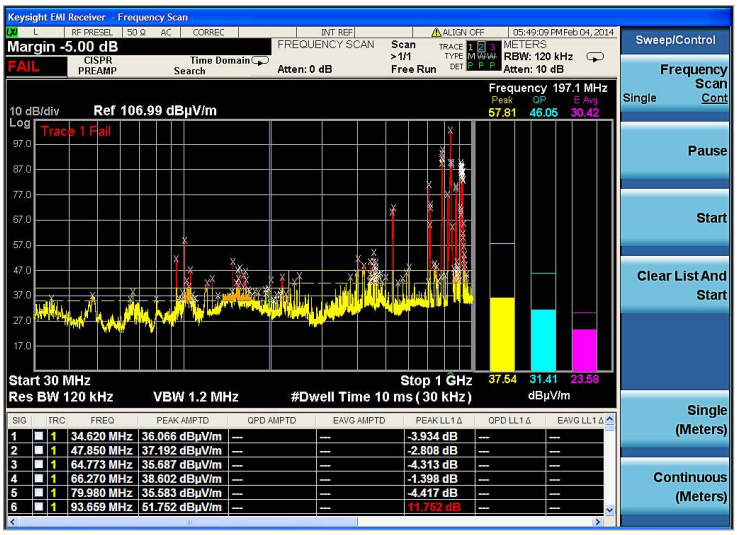

Figure 11. Suspect list collected using the search command

Demo 2: Search in sub-ranges

In this demonstration, we will set {Search Criteria} to {Subranges and Limits}, which divides the frequency band into a specified number of subranges and selects one peak in each subrange if there are any signals over the limit line.

See the search results in subranges in Figure 12.

Step 2–Demo 2 Instructions for MXE	Keystrokes
Set search criteria to {Subranges and Limits} and set the number of subranges to 10	[Meas Setup], {More 1 of 3}, {Limits}, {Search criteria}, {Subranges and Limits}, {# of Subranges}, [1], [0], [Enter]
Clear list and start a new search	[Sweep/Control], {Clear List And Start}

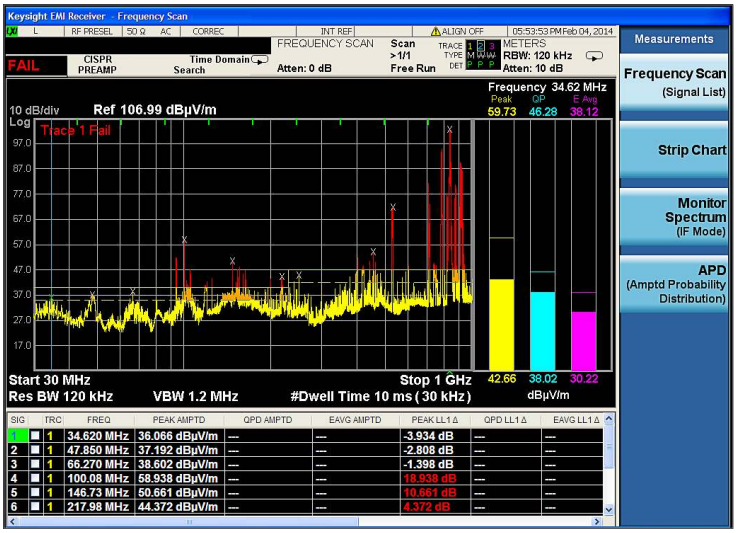

Figure 12. Search in subranges

Demo 3: Delete or add signals

The MXE allows you to edit a signal list by marking and deleting signals or adding a signal at the current marker frequency. The MXE offers flexible features to adjust the frequencies of signals in the signal list as shown in Table 2. 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.

Step 2–Demo 3 Instructions for MXE	**Keystrokes**
Select a signal from signal list and mark it	[Meas Setup], {Signal List}, {Mark Signals}, {Select Signal}, using knob or [↓] [↑] to select a signal, mark by pushing {Mark Signal} You can mark more signals in the same way
Delete the marked signal	[Return], {Delete Signals} {Delete Marked} to delete all marked signals Or {Delete Signal} to delete the current signal
Add a peak into signal list using {Mkr →List}	[Peak Search] [Marker →], {Mkr →List}, the frequency of current marker will be added to signal list

Table 2. Summary of keystrokes for adjusting the frequencies of the suspect signals

Category	**Descriptions**	**Key strokes**
Move to frequency	Move meters to marker frequency	[Marker →], {Move Meters to Marker Freq}
	Move marker to meters frequency	[Marker →], {Move Marker to Meters Freq}
	Move meters to the frequency of the closest signal	[Marker →], {Snap to Meters}
Add to list	Add marker frequency to list	[Marker →], {Mkr →List}
Couple frequencies	Add meters frequency to list	[Marker →], {Meters →List (Append)}
	Replace current signal frequency with meters frequency	[Marker →], {Meters →Signal (Replace)}
Couple frequencies	Couple meters frequency to current signal; the blue line for meters frequency follows the current signal when navigating signals	[Mode Setup], {Meters Control}, {Couple Meters to Signal List}
	Couple meters frequency to current marker; the blue line for meters frequency follows current marker movement	[Mode Setup], {Meters Control}, {Couple Meters to Marker}

Step 3: 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 on the MXE, such as signal zoom, marker zoom, global center frequency, monitor spectrum, and Strip Chart, can be used for this purpose.

Demo 1: Tune signals by zooming in

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

Step 3–Demo 1 Instructions for MXE	Keystrokes
Select a signal from signal list and zoom in *Note that meters are coupled to the current signal frequency, so the blue meters frequency line follows the signal*	[Meas Setup], {Signal List}, {Select Signal}, using knob or [↓] [↑] to select a signal Press {Signal Zoom} times until the signal is close-up
Adjust the frequency of the current signal and replace the older one	[FREQ], {Frequency (Meters)}, using knob to adjust the meter frequency (blue line) to the center of the signal [Marker →], {Meters →List (Replace)} to replace the current signal with meters frequency
Zoom out to full span view	[Meas Setup], {Signal List} Press {Zoom Out} times until the spectrum is back to full span view

Figure 13. Zoomed-in spectrum

Demo 2: Tune signals in spectrum analyzer mode

In this demonstration, we will switch to spectrum analyzer mode to tune a signal with the flexible span/RBW, max hold, and PowerSuite features. A very useful function for this use case is {Global Center Frequency}, which couples the meters frequency in EMI receiver mode and the center frequency in spectrum analyzer mode. This simplifies switching between these two modes by taking the frequency of the suspect signal to spectrum analyzer mode and bringing the adjusted frequency back to EMI receiver mode to write back to signal list.

Step 3–Demo 2 Instructions for MXE	Keystrokes
Select a signal from the list	[Meas Setup], {Signal List}, {Select Signal}, using knob or [↓] [↑] to select a signal
Couple meters frequency in EMI receiver mode to center frequency in spectrum analyzer mode by turning on global center frequency	[Mode Setup], {Global Settings}, {Global Center Frequency On}
Switch to spectrum analyzer mode	[Mode], {Spectrum Analyzer}
Change span and RBW for a better view of the signal	[SPAN], using [↓] [↑] or knob to adjust span [BW], {Res BW}, using [↓] [↑] or knob to adjust RBW
Adjust the center frequency appropriately to centralize the signal	[FREQ], using knob to adjust the meter frequency to the center of the zoomed in signal [Trace/Detector], {Max Hold} and [Peak Search], [Marker →], {Mkr →CF} may be used for centering up the frequency or amplitude varying signals
Switch back to EMI receiver mode *Note that the meters frequency has been changed to the same as the new center frequency in spectrum analyzer mode*	[Mode], {EMI Receiver}
Replace the current signal with the new meters frequency	[Marker →], {Meters →Signal (Replace)}

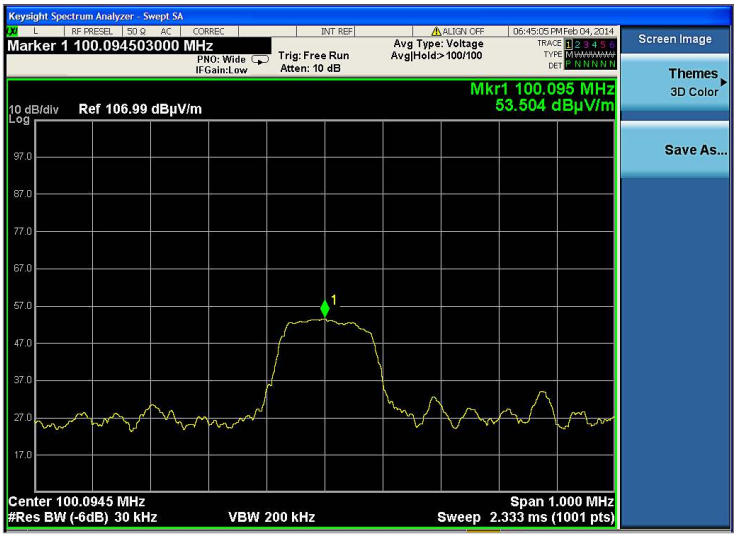

Figure 14. Tune signals in spectrum analyzer mode

Demo 3: 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 maximum amplitude and allows you to conveniently update the suspect signal list with the adjustments.

In this demonstration, we will pick an FM signal (around 100 MHz) from the signal list and use monitor spectrum to adjust the meters frequency. 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.

Did you know?

Monitor spectrum shares the same signal list with frequency scan measurement, so you can conveniently update the signal list directly from the monitor spectrum measurement.

Step 3–Demo 3 Instructions for MXE	Keystrokes
Select a signal from signal list An FM signal with drifting frequency was selected for this demonstration	[Meas Setup], {Signal List}, {Select Signal}, using knob or [↓] [↑] to select a signal. *Note that meter frequency is coupled to current signal in default; set this by [Mode setup], {Meter Control}, {Couple Meters to Signal List On}*
Switch to monitor spectrum measurement	[Meas], {Monitor Spectrum}
Turn on Trace 2 and max hold Max hold will trace out the frequency excursion of the signal	[Trace/Detector], {Select Trace}, {Trace 2}, {Max Hold}
Put a marker on Trace 2	[Marker], {Properties}, {Marker Trace}, {Trace 2}
Peak search and marker →CF	[Peak Search], {Mkr →CF}
Replace the current signal with the frequency of the marker	[FREQ], {CF →Signal (Replace)}
Switch back to frequency scan measurement	[Meas], {Frequency Scan (Signal List)}

Figure 15. Use monitor spectrum to adjust signals

Step 4: Final measurement

Demo 1: Make a final measurement

In this demonstration, we will conduct final measurements with peak, quasi-peak, and EMI average detectors for all of the signals in the list. We will set different limits for Detector 1 and 2, as well as turn auto range and auto preamp on for the measurement.

Did you know?

The MXE automatically conducts the scan, search, and final measurement sequentially with [Meas Setup], {Scan Sequence}, {Scan, Search, and Measure}.

Step 4–Demo 1 Instructions for MXE	Keystrokes
Set scan sequence to (Re)measure	[Meas Setup], {Scan Sequence}, {(Re)measure}, {(Re)measure}, {Current Signal} {Current Signal} will make a final measurement on the signal you have currently selected from the list {All Signals} will make final measurements for all signals in the list
Set detectors, dwell time, and limits for final measurement *Note: For MIL-STD measurements, turn off Detectors 2 and 3 and keep Detector 1 as default*	[Meas Setup], {Detectors (Measure)}, {Select Detector}, {Detector 2}, {Dwell Time}, [1], {s}, {Detector}, {Quasi Peak}, {Limit for Δ}, {Limit 1} [Meas Setup], {Detectors (Measure)}, {Select Detector}, {Detector 3}, {Dwell Time}, [1], {s}, {Detector EMI Average}, {Limit for Δ}, {Limit 2} If the message box, “changing limit or detector will discard the delta values” appears, press [Enter] to confirm
Set limits for final measurement	Use Limit 1 as in Demo 4
Set auto range and auto preamp for final measurement	[Meas Setup], {More 1 of 3}, {Autorange}, {Autorange On}, {Auto Preamp On}
Start final measurement See final measurement window in Figure 16	[Sweep/Control], {Start} or [Restart]

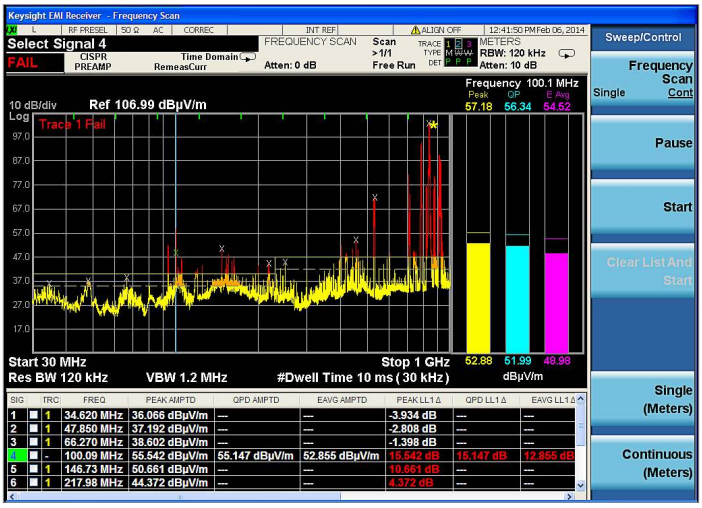

Figure 16. Final measurement

Step 5: Report generation

The MXE supports two report formats, HTML and PDF. You can customize content to include amplitude corrections, limits, scan tables, trace data, signal lists, and screen shots.

Demo 1: Configure and generate a report

In this demonstration, we will generate a report in PDF format with customized content and header information.

Step 5–Demo 1 Instructions for MXE	Keystrokes
Set report file format to PDF Configure report contents See the interface of report configuration in Figure 17	[Save], {Data}, {Meas Result}, {Meas Result}, {Output Format}, {PDF}, {Trace}, {Edit Header}, here users can edit the title, client, operator, and descriptions [Return], [Return], {Screen}, {3D Color}
Save report	[Save], {Data}, make sure {Meas Result} is highlighted {Save as}, change directory, and file name as needed and press [Enter] Use [Tab] to move the focus

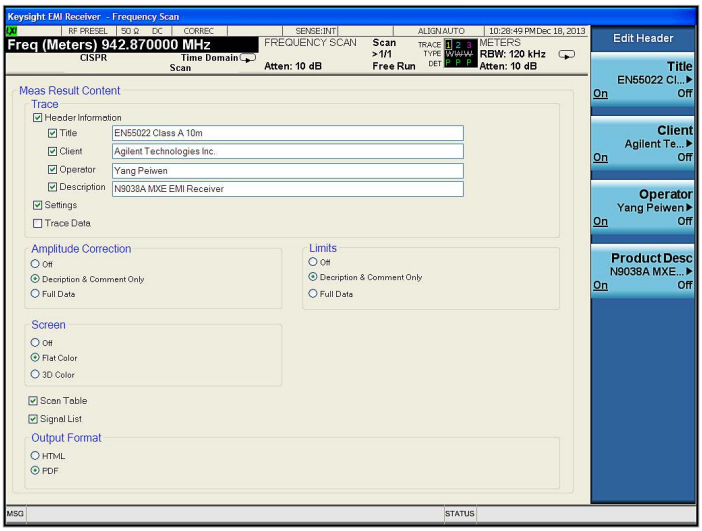

Figure 17. Report configuration

Single Frequency Measurement

To measure discrete frequencies, you can use the meters and measure at marker functions instead of scanning the whole range.

Meters

Meters can display up to three detectors simultaneously with current update values on the bottom and peak hold values on the top. In the frequency scan measurement, a blue vertical line represents the current frequency position of meters, which is also the current frequency shared by other measurements in EMI receiver mode, such as Strip Chart and monitor spectrum. The frequency of the meters can be at any position, even outside the span displayed on the screen in the frequency scan measurement. This differs from the monitor spectrum measurement, where the meters measure the center frequency of the spectrum display.

In this demonstration, we will turn on three detectors and set parameters for meters to measure the amplitude at the current EMI receiver frequency.

Did you know?

The meters graph in Strip Chart and monitor spectrum can be enlarged by pressing [View/Display], {Expand Meters On}. An example of expanded meters in monitor spectrum measurement is shown in Figure 18.

Meters Demo Instructions for MXE	Keystrokes
Switch to EMI receiver mode	[Mode], {EMI Receiver}
Set meters frequency	[FREQ], {Frequency (Meters)}, tune to any frequency of interest
Turn on Meter 2 and Meter 3, and set detectors and limits for them *Note: For MIL-STD measurements, do not turn on Meters 2 and 3 and keep Detector 1 as defaulti*	[Mode setup], {Meters Control}, {Meters}, {Select Meter}, {Meter 2}, {Meter On}, {Detector (Meters)}, {Quasi Peak}, {Limit On}, [3], [7], {dBuV} [Mode setup], {Meters Control}, {Meters}, {Select Meter}, {Meter 3}, {Meter On}, {Detector (Meters)}, {EMI Average}, {Limit On}, [2], [7], {dBuV}
Set dwell time for meters *Note: For MIL-STD measurements, set dwell time to 15 ms*	[Mode setup], {Meters Control}, {Dwell Time}, [1], {s}
Set RBW for meters	[BW], {RBW (Meters) Auto} Auto RBW will couple RBW setting to the EMC standard and meters frequency
Turn on auto range and auto preamp for meters	[Mode setup], {Meters Control}, {Autorange}, {Autorange On}, {Auto Preamp On}
Reset peak hold *Note that the peak hold is not reset when changing meter frequency; {Reset Peak Hold} can be used for peak hold reset if needed*	[Mode setup], {Meters Control}, {Reset Peak Hold}
Read values of meters	

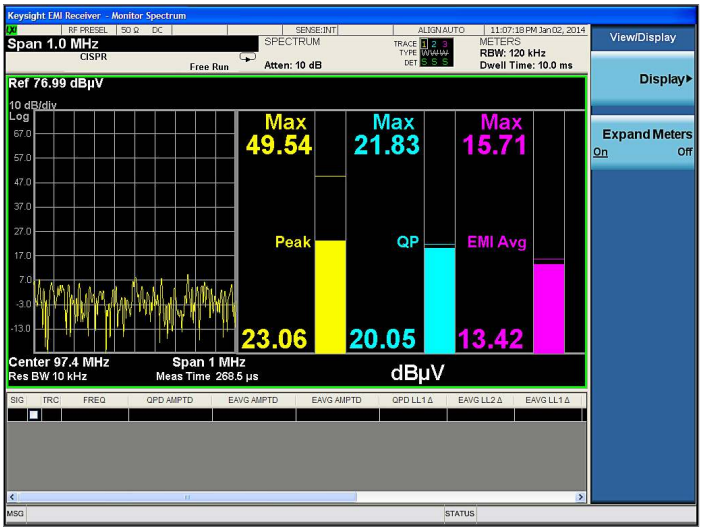

Figure 18. Expanded meters

Measure at marker

Different from meters, measure at marker captures the frequency of the current marker (only within the range displayed of the frequency scan measurement). Measure at marker shares all of the same settings as the (re) measure function for scan sequence. Refer to Table 1 for the summary of settings for (re) measure.

In this demonstration, we will use measure at marker to measure a signal at the frequency of a marker.

Measure at Marker Demo Instructions for MXE	**Keystrokes**
Turn on a marker and tune to the frequency of interest	[Marker], tune marker to any frequency of interest using knob or [↓] ↑]
Set detectors for measure at marker The detectors for measure at marker are coupled to those for (re) measure *Note: For MIL-STD measurements, Turn off Detector 2 and Detector 3 and keep Detector 1 as peak detector in default*	[Marker Function], {Detectors (Measure)}, {Select Detector}, {Detector 2}, {Dwell Time}, [1], {s}, {Detector}, {Quasi Peak}, {Limit for Δ}, {Limit 1} [Marker Function], {Detectors (Measure)}, {Select Detector}, {Detector 3}, {Dwell Time}, [1], {s}, {Detector}, {EMI Average}, {Limit for Δ}, {Limit 2} If the message, “changing limit or detector will discard the delta values” appears, press [Enter] to confirm
Measure at marker See Figure 19	[Marker Function], {Measure at Marker}

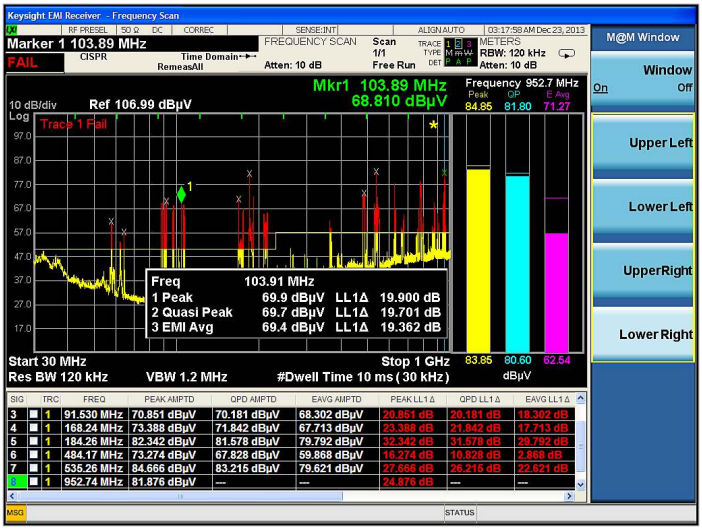

Figure 19. Measure at marker

Diagnostic Tools

In addition to world-class EMI compliance measurement features, the MXE offers a full range of diagnostic tools that can speed up the time-to-repair, including spectrum analysis, Strip Chart, spectrogram, trace zoom, and monitor spectrum. We will show you how to use these tools for diagnostic testing in this section.

Spectrum analysis is one of the most powerful diagnostic tools used widely by EMC engineers. The MXE allows you to move seamlessly between spectrum analyzer and EMI receiver modes as shown in Step 3, Demo 2 in the “Making Measurements” section.

Strip Chart

Strip Chart 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.

Strip Chart can also be synchronized with the rotation of the turn table to record emission patterns, allowing you to identify and record the orientation of maximum signal emission.

In this demonstration, we will use Strip Chart to capture a time variant signal and use markers to analyze the time difference of two pulses.

Strip Chart Demo Instructions for MXE	Keystrokes
Make sure you are in EMI receiver mode	[Mode], {EMI Receiver}
Select a signal from the list An FM signal with changing frequency or a time-varying GSM signal are recommended for this demonstration	[Meas Setup], {Signal List}, {Select Signal}, using knob or [↓] [↑] to select a signal
Switch to Strip Chart measurement	[Meas], {Strip Chart}
Stop the data capture after 30 seconds of data	[Sweep/Control], {Stop}
Zoom in by adjusting the scale and reference value of time until you can see the appropriate pulses	[Span/X Scale], {Ref Value}, use [↓] [↑] to adjust the reference point on the right side of the display [Span/X Scale], {Scale/Div}, use [↓] [↑] to adjust the scale of X axis of the display
Put a marker on the highest peak	[Peak Search]
Put a delta marker on the next highest peak	[Marker], { Delta}, [Peak Search], {Next Peak}
Now read the time and amplitude difference between them on the top of the marker display	

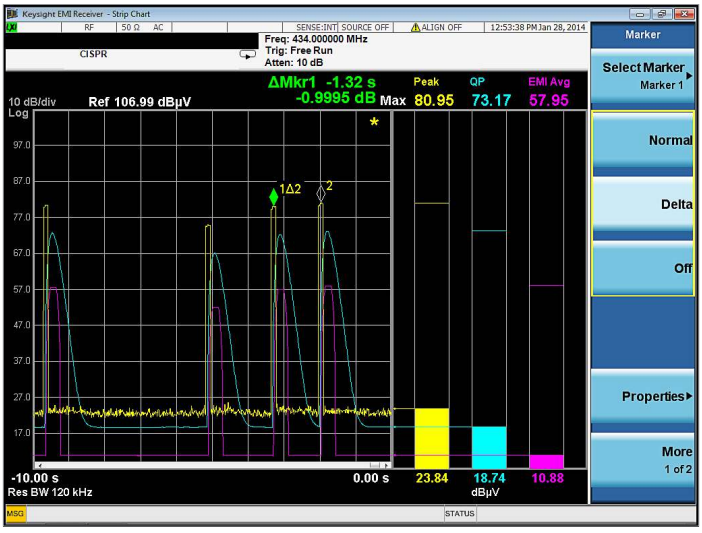

Figure 20. Use Strip Chart to monitor a signal over time

Spectrogram

Spectrogram is a tool for tracking signal characteristics in both frequency and time domain. It's a powerful tool to analyze time variant and frequency hopping signals.

In this demonstration, we will use spectrogram to analyze intermittent pulsed signals. We will demonstrate how to automatically adjust spectrogram colors as well as play back the spectrums with {Display Trace} and measure the amplitude, frequency, and time of signals on current display trace.

Spectrogram Demo Instructions for MXE	Keystrokes
Switch to frequency scan measurement	[Meas], {Frequency Scan}
Select a signal from the list, preferably an intermittent pulse signal	[Meas Setup], {Signal List}, {Select Signal}, using knob or [↓] [↑] to select a signal
Couple center frequency in spectrum analyzer mode to meter frequency in EMI receiver mode by global center frequency	[Mode Setup], {Global Settings}, {Global Center Frequency On}
Switch to spectrum analyzer mode	[Mode], {Spectrum Analyzer}
Turn on spectrogram	[View/Display], {Spectrogram}
Set span to the appropriate value to observe the signals of interest The update speed of spectrogram is proportional to span	[Span/X Scale], use [↓] [↑] to adjust span value
Adjust spectrogram color for better signal contrast	[View/Display], {Color Adjust}, {Auto Adjust Hue Positions}, this will adjust colors automatically according to the levels of currently captured signals Some other settings also affect spectrogram color: {Ref Hue}, {Ref Hue Position}, and {Bottom Hue Position} under [View/Display] and as well as {Ref Level} under {AMPTD/Y Scale}
Pause the spectrogram	[Single]
Put a marker on a signal on the current trace and move to the signal of interest	[Marker], use [↓] [↑] or knob to move marker on a signal of interest on current spectrum trace
Move the display trace line to play back past spectrum	[View/Display], {Display Trace}, use knob or [↓] [↑] to move the white display trace line to display a past spectrum
Put Marker 2 as the delta of Marker 1 on a signal on current trace	[Marker], {Select Marker}, {Marker 2}, {Delta}, {Properties}, {Relative to}, {Marker 1}
Move Marker 2 to another signal on current spectrum trace to compare with the signal on Marker 1 position	[Marker], use [↓] [↑] or knob to move marker on a signal of interest on current trace
Read the delta value of amplitude, frequency and time of these two signals with Marker1 and Marker 2	

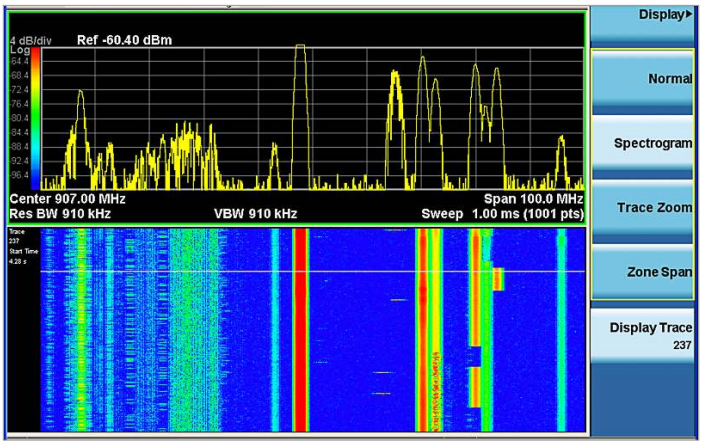

Figure 21. Spectrogram

Trace zoom

Trace zoom in spectrum analyzer mode allows you to view close-up and full-span spectrum simultaneously in two separate windows. This is useful for looking into the details of high-density signals by zooming into a sub-band of a wide span.

In this demonstration, we will use the trace zoom function look more closely at a signal and peak search in the zoom span only.

Did you know?

Zone span is different from trace zoom. Zone span can set different RBW, VBW, and sweep times for signals with only one active window. Trace zoom makes two windows active simultaneously and requires that both windows use the same bandwidths and sweep times.

Trace Zoom Demo Instructions for MXE	Keystrokes
Turn on trace zoom	[View/Display], {Trace Zoom}
Move zoom block around the signals of interest	[FREQ], {Zoom Center}, use knob or [↓] [↑] to move zoom block to the signals of interest
Change zoom span to focus on the signals of interest only	[Span], {Zoom Span}, use knob or [↓] [↑] to change zoom span
Put a marker on the signal of interest	[Peak Search], use knob or [↓] [↑] to move marker to a signal of interest Observe the signals in both windows

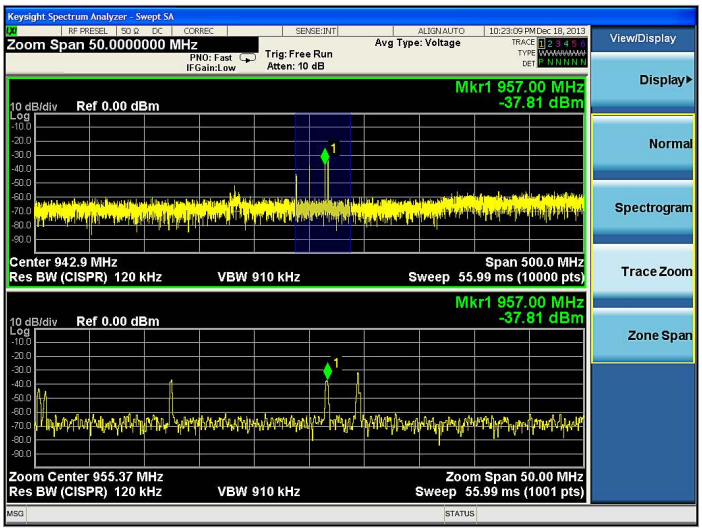

Figure 22. Trace zoom

Other Features

APD

Amplitude probability distribution (APD) measures the probability of an emission exceeding a specified level. It is being considered by CISPR as an alternative option for the EMI average detector for measuring microwave ovens.

There are two types of APD limits allowed by CISPR. The first specifies an emission value for a given probability. The second specifies a probability for a given emissions amplitude. The MXE supports both of these types of limits.

In this demonstration, we will use the APD measurement to measure the probability of a pulse exceeding a specified level. We will start by configuring the signal generator to output a pulse train, set APD measure time and Res BW, create and turn on a limit line, and use APD to measure the pulse.

Did you know?

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.

APD Demo Instructions for MXG	**Keystrokes**
Preset signal generator MXG	[Preset]
Set frequency 1 GHz and amplitude 50 dBuV	[FREQ], [1], {GHz} [AMPLD], [5], [0], {dBuV}
Set pulse period 1 s, pulse width 1 ms Set pulse on	[PULSE], {Pulse Period}, [1], {s} [PULSE], {Pulse Width}, [1], {ms} [PULSE], {Pulse On}
Set RF on and modulation on	[RF on/off] [Mod on/off] The green lights on indicates RF and modulation on
APD Demo Instructions for MXE	**Keystrokes**
Make sure you are in EMI receiver mode	[Mode], {EMI Receiver}
Switch to APD measurement	[Meas], {APD}
Set frequency	[FREQ], {Frequency}, [1], {GHz}
Set measurement time	[Meas Setup], {Meas Time}, [1], [.], [2], {s}
Set RBW	[BW], {Res BW}, [1], {MHz}
Select APD method to {Disturbance Level} and define a limit line	[Meas Setup], {More 1 of 2}, {Limits}, {Edit}, {APD Method}, {Disturbance Level}, {Probability of Time}, {10-2} [Meas Setup], {More 1 of 2}, {Limits}, {Edit}, {Frequency}, [1], {GHz}, {Dist Level (E limit)}, [5], [0], {dBuV}
Turn limit line on	[Meas Setup], {More 1 of 2}, {Limits}, {Limit On}
APD Demo Instructions for MXG	**Keystrokes**
Toggle modulation on and off See Figure 23	Toggle [Mod on/off], and [Mod on/off] Watch the APD measurement as you slowly toggle the pulse modulation on and off–you should see the trace pass with Mod on and the trace fail with Mod off

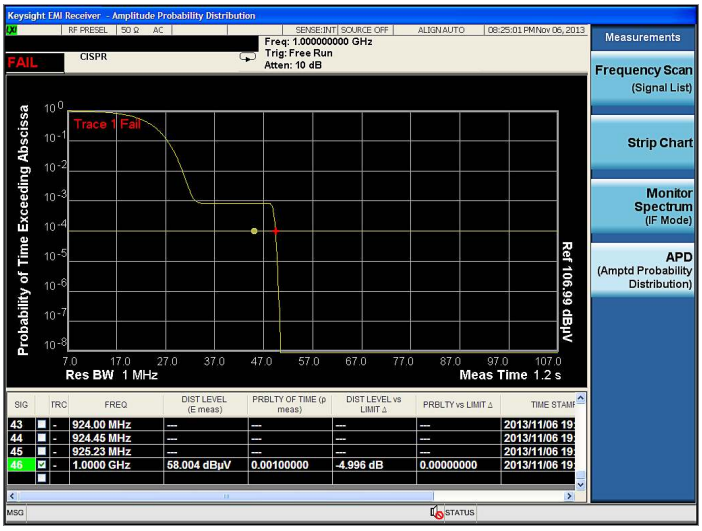

Figure 23. APD

Disturbance analyzer

One type of commercial conducted emissions measurement is called a discontinuous disturbance, also known as click, measurement. Discontinuous disturbance parameters, measurement methodologies, and limits for various product types are provided in CISPR 14-1. Examples of the types of products covered in this standard are home appliances, power tools, toys, and vending machines.

The MXE includes a discontinuous disturbance measurement feature designed to automate the process of collecting and analyzing emissions from products covered by CISPR 14. In order to demonstrate this feature, an RF source capable of generating a pulsed RF signal below 30 MHz (50 ms pulse width, 2 second pulse period and 90 dBuV amplitude) is used to simulate a conducted emissions discontinuous disturbance signal.

Disturbance Demo Instructions for MXG	Keystrokes
Preset signal generator MXG	[Preset]
Set frequency 1.4 MHz and amplitude 90 dBuV	[FREQ], [1], [.], [4], {MHz} [AMPLD], [9], [0], {dBuV}
Set pulse period 2 s, pulse width 50 ms Set pulse on	[PULSE], {Pulse Period}, [2], {s} [PULSE], {Pulse Width}, [5], [0], {ms} [PULSE], {Pulse On}
Set RF on and modulation on Connect the signal generator with to Input 2 on the MXE	[RF on/off] [Mod on/off] The green lights on indicates RF and modulation on

Disturbance Demo Instructions for MXE	Keystrokes
Ensure that the MXE is in receiver mode	[Mode], {EMI Receiver}
Preset the instrument	[Mode Preset]
Switch to disturbance analyzer measurement	[Meas], {Disturbance Analyzer}
Setup a 1 minute measurement at 1.4 MHz Select Input 2 and switch to DC coupling	[Meas Setup], {Setup Table}, {Frequency}, {1.4 MHz}, [Return], {Terminal}, {Mains}, {Limit Auto}, {Attenuation Auto}, {Click Rate Measured}, {More 1 of 2}, {Duration}, {Minutes}, [1], {Enter}, {Return}, {Click Correction 0dB}, {Click Count Off}, {Factor f Off}. [Input/Output], {RF Input}, {RF Input Port}, {RF Input 2}, {RF Coupling DC}
Begin the disturbance measurement The 1 minute measurement will begin automatically When the measurement is complete, data collection will finish and the click analysis screen will be displayed (as shown in Figure 24)	[Sweep/Control], {Start}, or [Restart] If there is information in the disturbance list, the MXE will automatically ask you to delete it before starting a new measurement, press [ENTER]
View the pulse train and select Disturbance 1	[Meas Setup], {Select Disturbance}, use knob or [↓] [↑] to select disturbance 1
Adjust viewing parameters to view disturbances in more detail by changing the scale/div setting to 50 ms	[Span], [Scale/Div], [5], [0], {ms}
Select disturbance to view	[Meas Setup], {Select Disturbance}, rotate knob and observe display as the disturbance list entries are selected
Save results	[Save], {Trace (+ state)}, {Register 1}

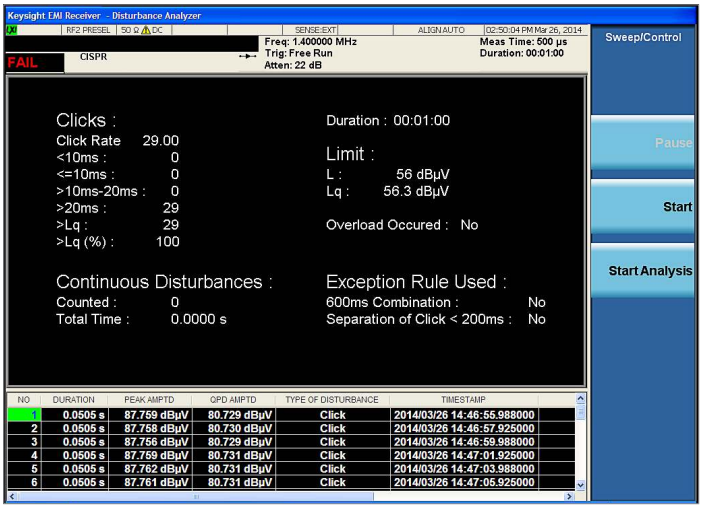

Figure 24. Click analysis screen

Appendix

Frequently asked questions

Following are answers to common questions when making compliance measurements with the MXE.

Table 3. Troubleshooting the MXE

Question	Answer
Should I use DC coupling for CISPR band A/B?	It's recommended to use DC coupling on the MXE for frequencies below 10 MHz, otherwise the noise floor will be high and risk failing the test for CISPR band A (9 kHz to 150 kHz) and B (150 kHz to 30 MHz). To switch RF coupling from AC to DC, push [Input/Output], {RF Input}, {RF Coupling DC}.
What do I do if an external pulse limiter is not available for a conducted emission test?	Input 2 of the MXE is designed with a transient limiter to protect the receiver from large output pulses generated by LISNs. Input 2 is recommended for conducted measurements.
Why is the noise floor of RF Input 2 higher than Input 1?	This difference is due to the extra attenuation loss of the built-in pulse limiter on the path of RF Input 2.
What do I do when the message, "Align 20 Hz to 3.6 GHz required," appears?	The message, "Align 20 Hz to 3.6 GHz required,"is a warning message to remind you to align the preselector. Auto alignment doesn't cover preselector alignment, so manual alignment is required. Perform the alignment by pushing [System], {Alignment}, {Align Now}, {RF Preselector Only (20 Hz – 3.6 GHz)}.
What do I do if I want to scan over 4,000 seconds?	On the MXE, the default scan type {Smooth} limits the maximum scan time to 4,000 seconds. The combination setting of dwell time and step size, or scan time and scan points are subject to this limitation. If you want to scan over this limitation, the scan type should be set to {Discrete (Stepped)} or {Time Domain}.
What settings are reset by [Mode Preset]?	[Mode Preset] aborts the currently running measurement and resets most, but not all settings in the current mode. Select {Restore Input/Output Defaults} and {Restore Mode Defaults} to reset the remaining settings. The following settings are not reset by [Mode Preset]: – All the other settings under [Input/Output] except for {RF Preselector}, and {RF Calibrator}; – {Mode IDN Response}, {Noise Reduction}, and {Global Settings} under [Mode Setup] – {Detector}, and {Limit for Δ} under [Meas Setup]

File structures and locations

The MXE can save measurement results and instrument configurations. Table 4 lists the kinds of files supported on the MXE, including settings, screenshots, and measurement results.

There are two locations to store both limit lines and amplitude correction data, named "Preloaded" and "User." Keysight Technologies, Inc. uses the preloaded folder to store factory-configured limit and correction files. The contents of these files can be overwritten when the instrument software is updated. The user folder is designed specifically for customer use. Information in the user folders is not over-written during software updates.

The default folder selection for recalling limit lines and amplitude correction data can be selected using the following paths:

[Recall], {Data}, {Limit}, {Limit}, {Preloaded Limits} or {Limit (User)}

[Recall], {Data}, {Amplitude Correction}, {Amplitude Correction}, {Preloaded Corrections} or {Correction (User)}

Table 4. File types and directory path

File Category	File Type	Directory Path
State file	.state	\\My Documents\EMI\state State can also be saved into registers by pushing [Save], {State}, {Register 1},... {Register 16}
Screen image	.png	\\My Documents\EMI\screen
Amplitude corrections (Preloaded) If {Preloaded Corrections} is selected	.csv	\\My Documents\EMC Limits and Ampcor\Ampcor
Amplitude corrections (User) If {Correction (User)} is selected	.csv	\\My Documents\amplitudeCorrections
Limit lines (Preloaded) If {Preloaded Limits} is selected	.csv	\\My Documents\EMC Limits and Ampcor\Limits
Limit lines (User) If {Limit (User)} is selected	.csv	\\My Documents\EMI\data\FSCan\Limits
Trace data	.csv	\\My Documents\EMI\data\FSCan\Traces
Signal list	.csv	\\My Documents\EMI\data\FSCan\SignalList
Scan table	.csv	\\My Documents\EMI\data\FSCan\ScanTable
Measurement results (report)	.html, .pdf	\\My Documents\EMI\data\FSCan\MeasResult

Web Resources

Product page: **www.keysight.com/find/MXE**
X-Series signal analyzers: **www.keysight.com/find/X-Series**
X-Series measurement applications: **www.keysight.com/find/X-Series_Apps**

myKeysight

myKeysight

www.keysight.com/find/mykeysight
A personalized view into the information most relevant to you.

www.lxistandard.org
LAN eXtensions for Instruments puts the power of Ethernet and the Web inside your test systems. Keysight is a founding member of the LXI consortium.

Three-Year Warranty
www.keysight.com/find/ThreeYearWarranty
Keysight's commitment to superior product quality and lower total cost of ownership. The only test and measurement company with three-year warranty standard on all instruments, worldwide.

Keysight Assurance Plans
www.keysight.com/find/AssurancePlans
Up to five years of protection and no budgetary surprises to ensure your instruments are operating to specification so you can rely on accurate measurements.

www.keysight.com/quality
Keysight Technologies, Inc.
DEKRA Certified ISO 9001:2008
Quality Management System

Keysight Channel Partners
www.keysight.com/find/channelpartners
Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

www.keysight.com/find/MXE

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at:
www.keysight.com/find/contactus

Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	0800 000154
Sweden	0200 882255
Switzerland	0800 805353 Opt. 1 (DE) Opt. 2 (FR) Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:
www.keysight.com/find/contactus
(BP-07-10-14)

KEYSIGHT TECHNOLOGIES

Published in USA, August 1, 2014
5990-7423EN
www.keysight.com