# 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 PXE EMI Receiver N9048B



Distributed by:

N6141EM0E EMI Measurement Application Measurement Guide

## Notices

© Keysight Technologies, Inc. 2020

No part of this manual may be reproduced in any form or by any means (including electronic storage and retrieval or translation into a foreign language) without prior agreement and written consent from Keysight Technologies, Inc. as governed by United States and international copyright laws.

#### Manual Part Number

N9048-90009

#### Edition

Edition 1, January 2020

Supersedes: July 2019

#### Published by: Keysight Technologies 1400 Fountaingrove Parkway Santa Rosa, CA 95403

#### Warranty

THE MATERIAL CONTAINED IN THIS DOCUMENT IS PROVIDED "AS IS," AND IS SUBJECT TO BEING CHANGED, WITHOUT NOTICE, IN FUTURE EDITIONS. FURTHER, TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, KEYSIGHT DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED WITH REGARD TO THIS MANUAL AND ANY INFORMATION CONTAINED HEREIN, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. KEYSIGHT SHALL NOT BE LIABLE FOR ERRORS OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH THE FURNISHING, USE, OR PERFORMANCE OF THIS DOCUMENT OR ANY INFORMATION CONTAINED HEREIN. SHOULD KEYSIGHT AND THE USER HAVE A SEPARATE WRITTEN AGREEMENT WITH WARRANTY TERMS COVERING THE MATERIAL IN THIS DOCUMENT THAT CONFLICT WITH THESE TERMS, THE WARRANTY TERMS IN THE SEPARATE

#### AGREEMENT WILL CONTROL.

#### Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

#### **U.S. Government Rights**

The Software is "commercial computer software," as defined by Federal Acquisition Regulation ("FAR") 2.101. Pursuant to FAR 12.212 and 27.405-3 and Department of Defense FAR Supplement ("DFARS") 227.7202, the U.S. government acquires commercial computer software under the same terms by which the software is customarily provided to the public. Accordingly, Keysight provides the Software to U.S. government customers under its standard commercial license, which is embodied in its End User License Agreement (EULA), a copy of which can be found at

http://www.keysight.com/find/sweula The license set forth in the EULA represents the exclusive authority by which the U.S. government may use, modify, distribute, or disclose the Software. The EULA and the license set forth therein. does not require or permit, among other things, that Keysight: (1) Furnish technical information related to commercial computer software or commercial computer software documentation that is not customarily provided to the public; or (2) Relinquish to, or otherwise provide, the government rights in excess of these rights customarily provided to the public to use, modify, reproduce, release, perform, display, or disclose commercial computer software or commercial computer software documentation. No additional government requirements beyond those set forth in the EULA shall apply, except to the

extent that those terms, rights, or licenses are explicitly required from all providers of commercial computer software pursuant to the FAR and the DFARS and are set forth specifically in writing elsewhere in the EULA. Keysight shall be under no obligation to update, revise or otherwise modify the Software. With respect to any technical data as defined by FAR 2.101, pursuant to FAR 12.211 and 27.404.2 and DFARS 227.7102. the U.S. government acquires no greater than Limited Rights as defined in FAR 27.401 or DFAR 227.7103-5 (c), as applicable in any technical data.

## Safety Notices

#### CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

#### WARNING

A **WARNING** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

## Where to Find the Latest Information

Documentation is updated periodically. For the latest information about these products, including instrument software upgrades, application information, and product information, browse to one of the following URLs, according to the name of your product:

http://www.keysight.com/find/uxa

http://www.keysight.com/find/pxa

http://www.keysight.com/find/mxa

http://www.keysight.com/find/exa

http://www.keysight.com/find/cxa

http://www.keysight.com/find/pxe

To receive the latest updates by email, subscribe to Keysight Email Updates at the following URL:

http://www.keysight.com/find/MyKeysight

Information on preventing instrument damage can be found at:

www.keysight.com/find/PreventingInstrumentdamage

#### Is your product software up-to-date?

Periodically, Keysight releases software updates to fix known defects and incorporate product enhancements. To search for software updates for your product, go to the Keysight Technical Support website at:

#### http://www.keysight.com/find/techsupport

#### 1 About the EMI Measurement Application

The Role of Precompliance in the Product Development Cycle11Compliance Measurements11User Interface Layout12Navigating the Menu System13

#### 2 Conducted Emissions Measurement Example

Prescan 16 Step 1: Access the EMI measurement application and setup the prescan 16 Step 2: Load limit lines 18 Step 3: Load corrections 21 Step 4: Take a scan of the ambient environment with the EUT off 24 Step 5: Run a prescan with the LISN in the neutral position 25 Data Reduction 27 Step 1: Search for signals above a limit line 27 Step 2: Save the measurement data with LISN in the neutral position 29 Step 3: Run prescan and data reduction with LISN in the line position 30 Final Measurement 32 32 Step 1: Making a final measurement Report Generation 34 Step 1: Configure and generate a report 34

#### 3 Radiated Emissions Measurement Example

Prescan	38	
Step 1: Ac	cess the EMI measurement application and setup the prescan	39
Step 2: Loa	ad and edit limit lines 41	
Step 3: Loa	ad and edit corrections 44	
Step 4: Mc	odify the Scan Table settings 47	
Step 5: Us	e a multiple trace scan to view max hold and current signal	

values 48 Step 6: Reduce the prescan time by using a time domain scan or Accelerated TDS (N9048B PXE EMI Receiver only) 51 54 Data Reduction Step 1: Search for signals above a limit line 54 Step 2: Searching in subranges 56 Step 3: Deleting and adding signals 57 Maximization 60 Step1: Tune signals by zooming in 60 Step 2: Tune signals in Monitor Spectrum measurement 62 Final Measurement 66 Step1: Making a final measurement 66 **Report Generation** 68 Step: 1 Configure and generate a report 68

#### 4 Disturbance Analyzer Measurements

Overview	72		
Making a Me	easurement	. 73	
Setting up	a Click me	asurement	73
Setup Table	Parameters	s 77	
General Ta	b 77		
Channel Se	etup tab	78	

#### 5 APD (Amplitude Probability Distribution) Measurements

Overview	82	
Making a M	easurement	83

#### 6 Strip Chart Measurement

Overview 88

Making a Measurement 89

#### 7 Real Time Scan Measurements

Overview 92

Making a Measurement93Increasing the Frequency Span with Accelerated TDS99

## Appendix A Line Impedance Stabilization Networks (LISN)

LISN Operation	104	
Types of LISNs	105	
Transient Limite	r Operation	105

### Appendix B Antenna Factors

Field Strength Units	107	
Antenna factors	108	
Types of antennas us	ed for commercial radiated measurements	109

#### Appendix C Basic Electrical Relationships

## Appendix D Detectors Used in EMI Measurements

Peak Detector 113
Peak detector operation 113
Quasi-Peak Detector 114
Quasi-peak detector operation 114
Average Detector 115
Average detector operation 115
RMS Average Detector 116
RMS Average detector operation 116

## Glossary of Acronyms and Definitions 117

Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

## 1 About the EMI Measurement Application

This book provides information on using the N6141EM0E EMI application in your PXE EMI Receiver or your X-Series Signal Analyzer.

The PXE EMI Receiver allows 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 N6141EM0E 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 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" on page 11

"Compliance Measurements" on page 11

"User Interface Layout" on page 12

"Navigating the Menu System" on page 13

## 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 N9048B PXE is EMI Measurement application (N6141EM0E) mode. For the X-Series signal analyzers, the default mode is 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 N6141EM0E'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 N6141EM0E operation because it aligns with the CISPR test flow. The N6141EM0E 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 N6141EM0E 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.



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 <sup>a</sup>	
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.	

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 $\Delta$ column, the limit associated with each detector can be changed.
RF input (1/2) (PXE only)	Input/Output > Input tab > RF Input port		
RF coupling (AC/DC) (PXE only)	Input/Output > Input tab > RF Coupling		
Preselector on/off (PXE only)	Input/Output > Input tab > RF Preselector		
Corrections	Input/Output > Corrections tab		

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

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.

Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

## 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 dB $\mu$ V, 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" on page 16

"Data Reduction" on page 27

"Final Measurement" on page 32

"Report Generation" on page 34



Conducted Emissions Measurement Example Prescan

#### 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.	

## Conducted Emissions Measurement Example Prescan

Step	Action	Notes
Device under test	LISN	Limiter is necessary only if using Input 1 on PXE.

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 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.

Sequencer-	Mode	Measurement	View
Sequencing On	Spectrum Analyzer	Frequency Scan	Normal
<b>—</b> оп	Real-Time Spectrum Analyzer	Strip Chart	User View
When Sequencing is On and there are multiple Screens, all	EMI Receiver	APD	Normal 1
Screens udpate in sequence. When Sequencing is Off, only	IQ Analyzer (Basic)	Disturbance Analyzer	
the selected Screen updates.	W-CDMA with HSPA+	Monitor Spectrum	
	GSM/EDGE /EDGE Evo		
	Phase Noise		
	Noise Figure	92 1	
	Analog Demod		
	Bluetooth		
To launch 89600 VSA press the button below.	LTE FDD & LTE-A FDD		
Launch VSA	LTE TDD & LTE-A TDD		
		in and the second se	

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 <b>MEAS SETUP, Meas</b> <b>Standard</b> tab and set EMC Standard to <b>CISPR</b> .	For MIL Std measurements, change range preset to MIL.
5. Open the Scan Table and select the desired range	<ul> <li>Select the Settings tab, Scan Table, then select Range 2 to turn on.</li> <li>Ensure all other ranges are off.</li> </ul>	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.

EMI Receiv Frequency	ver 1 Scan	• +								- 2	₽	Meas Set	ib 🔺 😽
					Scan Table					Close		SCAN	Settings
	Range 1		Range 2	~	Range 3		Range 4		Range 5			SEARCH	SCAN
Start Freq	9.000 kHz		150.000 kHz		30.000000 MH	lz	300.000000 M	(Hz	30.000000 N	IHz 1		MEASURE	SEARCH
Stop Freq	150.000 kHz		30.000000 MH:	z	300.000000 M	Hz	1.000000000	GHz	1.00000000	GHz 1		Pause	MEASURE
RBW	200 Hz		9 kHz		120 kHz		120 kHz		120 kHz		Scan s Scan	Sequence	Meters
Dwell Time	4.10 ms		108 µs		6.73 µs		6.73 µs		6.73 µs		Sta	art Sequence	Signal List
Step Size	100.00 Hz		4.4995 kHz		60.000 kHz		60.003 kHz		60.002 kHz	мло анто 5	< - :	Scan Table	Limits
Points/ RBW	2	Auro	2	No Te	2		2		2	2	<	Detectors	Meas Standard
Atten	10 dB	4100	10 dB	4100	10 dB	4100	10 dB	41000	10 dB	4/170		leas Preset	Tune & Listen
Int Preamp	Off	AUTO	Off	AUTO	off	AUTO	off	AUTO	Off	AUTO			Advanced
Scan Time		1		1		1							Global
Scan	1411	1	6635	1	4501	1		~		3			

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.

Conducted Emissions Measurement Example Prescan

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

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



# Conducted Emissions Measurement Example Prescan

Step		Action	Notes	
	Recall	Limit	Recall from File	<b>nc ? X</b>
	State	Users Instrument Documents EM	IC Limits and Ampcor $ angle$ Limits $ angle$ EN $ angle$ 55022	Mode EMI Receiver
	Screen Config + State	Name	∆ Date	Size Content
	Measurement Data	EN 55022, Cond, Class A, Average.csv	6/1/2018 3:35 PM	339 B Csv file
	Limit	EN 55022, Cond, Class A, Quasi-Peak.csv	6/1/2018 3:35 PM	342 B Csv file
	Correction	EN 55022, Cond, Class A, Telecom, Current, /	A 6/1/2018 3:35 PM	341 B Csv file
	Correction Group	EN 55022, Cond, Class A, Telecom, Current,	C 6/1/2018 3:35 PM	344 B Csv file
		EN 55022, Cond, Class A, Telecom, Voltage, /	A 6/1/2018 3:35 PM	341 B Csv file
		EN 55022, Cond, Class A, Telecom, Voltage,	C 6/1/2018 3:35 PM	344 B Csv file
		EN 55022, Cond, Class B, Average.csv	6/1/2018 3:35 PM	360 B Csv file
		EN 55022, Cond, Class B, Quasi-Peak.csv	6/1/2018 3:35 PM	363 B Csv file
		EN 55022, Cond, Class B, Telecom, Current, A	A 6/1/2018 3:35 PM	341 B Csv file
		EN 55022, Cond, Class B, Telecom, Current,	C 6/1/2018 3:35 PM	344 B Csv file
		File name: EN 55022, Cond, Class A, Quasi-Pea	ak.csv File type	Csv files (*.csv) Recall
<b>8.</b> A	ssign Limit 1 to	Trace 1 Select MEAS SETUP, Li	imits, Limits Limit lines	are assigned to a specific

 Assign Limit 1 to Trace 1 Select MEAS SETUP, Limits, Limits Table, select Limit 1 to Trace1, then select Enabled.

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.

			Limi	ts Table			Close	Limits	Table	Settings
		ा	ouch any settir	ng value to ct	nange it			🕻 🛛 Edit L	limit	SCAN
Se	arch Criteria	Peak Criteri	a And Limits	# of Pea	ks	25	CN	All Limits Test Limits		SEARCH
				# of Sub	ranges	25		Off		MEASUR
	Limit	Enabled	Marg	jin	Trace	Description		Update .	∆ Limit	Meters
		Lindbled	Value	Enabled	Have	Description		Delete A	ll Limits	Signal Li
	Limit 1	-	-5.00 dB	-	Trace 1	T T				Limits
	Limit 2		0.00 dB		Trace 1					Meas
	Limit 3		0.00 dB		Trace 2					Standard Tune &
	Limit 4		0.00 dB		Trace 2					Listen
	Limit 5		0.00 dB		Trace 3					Advance
	Limit C		0.00 48		Trace 2					Global

trace.



#### 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	Select Recall, Correction tab.	
correction file	Set Select Correction to <b>Correction 1</b> , Preloaded Correction to <b>Preloaded</b> , then <b>Recall From</b> .	
	Select LISN, 10A (9 kHz to 30 MHz).csv, <b>Recall</b> .	

#### Conducted Emissions Measurement Example Prescan

Step	Action	Notes	;
Recall	Correction	Recall from File	5 C ? X
State	Computer D. Users Instru	ment $ig angle$ Documents $ig angle$ EMC Limits and Ampcor $ig angle$	Ampcor Mode EMI Receiver
Screen Config + State	Name	△ Date	Size Content
Measurement Data	Amp, 87415A (2 GHz to 8 GHz).cs	sv 6/1/2018 3:35 PM	466 B Csv file
Limit	Antenna, 11940A Close Field Prob	be (30 MHz tr 6/1/2018 3:35 PM	622 B Csv file
Correction	Antenna, 11941A Close Field Prot	be (9 kHz to \$ 6/1/2018 3:35 PM	371 B Csv file
Correction Group	Antenna, Biconical (30 MHz to 300	0 MHz).csv 6/1/2018 3:35 PM	656 B Csv file
	Antenna, Broadband (26 MHz to 3	3 GHz).csv 6/1/2018 3:35 PM	1 KB Csv file
	Antenna, Double Ridged Horn (1 4	GHz to 18 Gł 6/1/2018 3:35 PM	860 B Csv file
	Antenna, Log Periodic (200 MHz t	to 2 GHz).csv 6/1/2018 3:35 PM	1 KB Csv file
	Cable, 10 meter Type-N (30 MHz 1	to 1 GHz).cs <sup>1</sup> 6/1/2018 3:35 PM	232 B Csv file
	Limiter, 11947A Transient Limiter (	(9 kHz to 200 6/1/2018 3:35 PM	321 B Csv file
	LISN, 10A (9 kHz to 30 MHz).csv	6/1/2018 3:35 PM	426 B Csv file
	File name: LISN, 10A (9 kHz to 30 M	IHz).csv File type:	Amplitude Corrections (*.csv) Recall

2. (For X-Series Signal Analyzers or when using Input 1 on the 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 N9048B PXE, has a built-in limiter so that an external limiter is not needed when using Input 2.

## Conducted Emissions Measurement Example Prescan

Step	Action	Ν	otes
Recall		Recall from File	า C ? X
State	Computer D: Users Ins	strument〉Documents〉EMC Limits and Ampcor	Ampcor Mode EMI Receiver
Screen Config + State	Name	🛆 Date	Size Content
Measurement Data	Amp, 87415A (2 GHz to 8 GHz	z).csv 6/1/2018 3:35 PM	466 B Csv file
Limit	Antenna, 11940A Close Field F	Probe (30 MHz tr 6/1/2018 3:35 PM	622 B Csv file
Correction	Antenna, 11941A Close Field F	Probe (9 kHz to 🗧 6/1/2018 3:35 PM	371 B Csv file
Correction Group	Antenna, Biconical (30 MHz to	300 MHz).csv 6/1/2018 3:35 PM	656 B Csv file
Conceasi Croup	Antenna, Broadband (26 MHz	to 3 GHz).csv 6/1/2018 3:35 PM	1 KB Csv file
	Antenna, Double Ridged Hom	(1 GHz to 18 GF 6/1/2018 3:35 PM	860 B Csv file
	Antenna, Log Periodic (200 Mł	Hz to 2 GHz).csv 6/1/2018 3:35 PM	1 KB Csv file
	Cable, 10 meter Type-N (30 M	Hz to 1 GHz).cs <sup>,</sup> 6/1/2018 3:35 PM	232 B Csv file
	Limiter, 11947C Transient Limit	ter (9 kHz to 200 6/1/2018 3:35 PM	321 B Csv file
	LISN, 10A (9 kHz to 30 MHz).c	sv 6/1/2018 3:35 PM	426 B Csv file
	File name: 11947A Transient L	imiter (9 kHz to 200 MHz).csv File type:	Amplitude Corrections (*.csv) Recall

**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 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 for a Scan or	sequence Ily	Select <b>MEAS SETUP</b> , the <b>Settings</b> tab and set <b>Scan Sequence</b> to <b>Scan</b> .	The default value.

2. Turn the EUT off and start Select Start Sequence. the scan



because common mode signals from the EUT may be suppressed causing a lower

value measurement.

Conducted Emissions Measurement Example Prescan

#### 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.	It is not necessary to turn on three detectors for scanning, searching, and	
	Set Meter 2 to Quasi Peak and Meter 3 to EMI Average. (These are the default values.)	measuring, but it is helpful to see three meters for tuning signals later in the process.	
	Turn <b>On</b> all three meters, then <b>Close</b> the table.	Note: For MIL-Std measurements, do not turn on Meters 2 and 3.	
2. Set the line switch on the	On the LISN, set the line to <b>(N) L2</b>		

LISN to neutral



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.

# Conducted Emissions Measurement Example Prescan



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.







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	
EMI Receiver 1 Frequency Scan	+		35	Meas Setup
	Limits Table		Close	Limits Table Settings
	Touch any setting value to o	change it		C Edit Limit SCAN
Search Criteria	Peak Criteria And Limits # of Pea	# of Peaks 25 # of Subranges 25		Test Limits SEARCH
	Peak Criteria Only # of Sul			Off MEASURE
Limit	Peak Criteria And Limits	Trace Description		Delete All Limits
Limit 1	Subranges And Limits	Trace 1		Signal List
Limit 2	0.00 dB	Trace 1		Meas
Limit 3	0.00 dB	Trace 2		Standard Tune &
Limit 4	0.00 dB	Trace 2		Advanced
Limit 5	0.00 dB	Trace 3		Global
Limit 6	0.00 dB	Trace 3	- 2	
	Sep 06, 2018			
<b>3.</b> Start the search	Select the <b>Sett</b> <b>Sequence</b> .	ings tab, Start	<b>Tip:</b> To Clear Signal List t tab then De signals will l list without	ar existing signals in the able, select the Signal List lete All. Otherwise, new be appended to the signal clearing older ones.
4. Stop the search	Once the signals the list, select <b>S</b>	s have been added to top Sequence.		
	If there are no si then no further r done and the pro conducted emiss If there are signa	gnals in the signal list, neasuring needs to be oduct passes the sions limit.		
	limit, continue w	with the process below.		



#### 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	Select Save, Measurement Data.	This list will be recalled later for running		
Data	Set Save From Trace to <b>Trace 1</b> , Data Type to <b>Signal List</b> , then select <b>Save As</b> .	the final measurement.		
	Enter a file name (for example, Prescan_Neutral ), then <b>Save</b> .			

Step	Action	Not	tes
Save	Keasurement Data	Save to File	า๙? X
State	Computer D: Users	⟩Instrument	ignalList Mode EMI Receiver
Screen Config + State	Name	∆ Date	Size Content
Measurement Data	Prescan_Neutral.csv	9/27/2018 11:09 AM	380 B Csv file
Measurement Report	SignalL_0000.csv	9/27/2018 11:08 AM	380 B Csv file
Limit			
Correction			
Correction Group			
Screen Image			
	File name: Prescan_Neutral.c	sv	File type: Csv files (*.csv) Save

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	Set the line switch on the LISN to <b>L1(L)</b>	
LISN set to line	From the EMI Measurement application:	
	<ul> <li>Select MEAS SETUP, the Signal List tab, Delete All</li> </ul>	
	<ul> <li>Select the Settings tab, set</li> <li>Scan Sequence to Scan</li> </ul>	
	<ul> <li>Select Start Sequence</li> </ul>	
	<ul> <li>Once the prescan has run, select <b>Stop Sequence</b></li> </ul>	
2. Run Data Reduction	Set Scan Sequence to Search.	
	Select Start Sequence.	

Step	Action	Notes
3. Stop the Search	Once the signals have been added to the list, select <b>Stop Sequence</b> .	
	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 <b>Save</b> , <b>Measurement Data.</b>	This list will be recalled for making the final measurement.
	Set Save From Trace to Trace 1, Data Type to Signal List, Save As.	
	Enter a file name (for example, Prescan_L1), then <b>Save</b> .	

Conducted Emissions Measurement Example 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 <b>Recall, Measurement</b> <b>Data</b> .	
	Set <b>Recall To Trace</b> to <b>Trace 1</b> , <b>Data Type</b> to <b>Signal List</b> , then <b>Recall From</b> .	
	Select the Prescan_Neutral file, <b>Recall</b> .	
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 ( <b>N)L2</b> .	
4. Select the signals for Re(Measure)	Select the <b>MEASURE</b> tab, and select (Re)Measure Type.	
	<b>Current Signal</b> will make a final measurement on the signal selected in the signal list.	
	<b>All Signals</b> will make a final measurement on all signals in the signal list.	
5. Start the search	Select the <b>Settings</b> tab, <b>Start</b> <b>Sequence</b> .	

Conducted Emissions Measurement Example Final Measurement

Ste	ep	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 <b>L1(L)</b> .	

Conducted Emissions Measurement Example Report Generation

## **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 <b>Save</b> , <b>Measurement</b> 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.	

#### Conducted Emissions Measurement Example Report Generation

Step	Actic	n	N	otes				
Save			Measurement Report		า	3	?	×
State	Header Information				ĺ	Save A	٨s	
Screen Config + State	Title	EN55022 Class A 10 me	ter			La la		
Measurement Data	Client	Keysight						
Measurement Report	Operator	Jack Smith						
Limit	Description	N9048B PXE EMI Recei	ver					
Correction	Logo	k		Browse >				
Correction Group	Amplitude Correction	Limits	Screen	Output Format				
Screen Image	Off Description & Comment Only Full Data Measurement Data	Orf     Description &     Comment Only     Full Data     Settings	Off Outline Filled	HTML     PDF				
	Signal List	Scan Table						

4. Save the report

Select **Save As**, enter a file name, then **Save**.

Note the location of the Measurement Report as shown below.



Conducted Emissions Measurement Example Report Generation
Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

### 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" on page 38
- "Data Reduction" on page 54
- "Maximization" on page 60
- "Final Measurement" on page 66
- "Report Generation" on page 68



#### 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.

CISPR radiated EMI test setup



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 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.

Mode / Measurement / View Selector Screen Name EMI Receiver 1	Delete This Screen				
Sequencer Mode Measurement View					
Sequencing Spectrum Analyzer Frequency Scan Normal					
Real-Time Spectrum Analyzer Strip Chart User View					
When Sequencing is On and EMI Receiver APD Normal 1					
Screens udpate in sequence. When Sequencing is Off, only					
the selected Screen updates. W-CDMA with HSPA+ Monitor Spectrum					
GSM/EDGE /EDGE Evo					
Phase Noise					
Noise Figure					
Analog Demod					
Bluetooth					
To Jaunch 89600 VSA press the button below.					
LTE TDD & LTE-A TDD					
OK Cancel					
<b>3.</b> Preset the EMI Receiver Select Mode Preset. Alternately, if you are running the					
mode application from a remote desktop					
connection, select Mode Preset	쓵				
4. Set the EMC standard to Select MEAS SETUP Meas For MIL Std measurements chance	e to				
CISPR Standard tab. MIL	0 10				
Set EMC Standard to CISPR.					
5. Open the Scan Table and Select the Settings tab, Scan					
select the desired range Table, then select Range 5 to turn					
on.					
Ensure all other ranges are off.					

Step			1	Actio	on				Note	s			
EMI Receiv Frequency	ver 1 Scan	<b>·</b> +	•]		Scan Table				ſ	Close	<b>*</b>	Meas Setu	Settings
	Range 1		Range 2		Range 3		Range 4		Range 5		E	SEARCH	SCAN
Start Freq	9.000 kHz		150.000 kHz		30.000000 MHz		300.000000 MH	Ηz	30.000000 MH	iz 1		IEASURE	SEARCH
Stop Freq	150.000 kHz		30.000000 MHz		300.000000 MH	z	1.000000000 G	Hz	1.000000000	GHz 1		Pause	MEASURE
RBW	200 Hz	AUTO	9 kHz	AUTO	120 kH <del>z</del>	AUTO	120 kHz	AUTO	120 kH <del>z</del>	AUTO	Scan a	sequence V	Meters
Dwell Time	4.10 ms	AUTO	108 µs	AUTO	6.73 µs	AUTO	6.73 µs	AUTO	6.73 µs	AUTO	Sta	irt Sequence	Signal List
Step Size	100.00 Hz	AUTO	4.4995 kHz	AUTO	60.000 kHz	AUTO	60.003 kHz	AUTO	60.002 kHz		< :	Scan Table	Limits
Points/ RBW	2	1	2	1	2	~	2	1	2	2	<	Detectors	Meas Standard
Atten	10 dB	AUTO	10 dB	AUTO	10 dB	AUTO	10 dB	AUTO	10 dB	AUTO	N	leas Preset	Tune & Listen
Int Preamp	Off	АЦТО	Off	AUTO	off	АЦЛС	Off	AUTO	off	АЛТО			Advanced
Scan Time		1		1		1		1					Global
Scan Boints	1411	4	6635	4	4501	1	11667	1	16167	✓ 3			

#### 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				
<ol> <li>Load the built-in limit line file</li> </ol>	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	Alternately, if you are running the				
	Select ${\ensuremath{\text{EN}}}$ folder, ${\ensuremath{\text{55022}}}$ folder, then	application from your desktop, select the folder icon in the Control Bar				
	EN55022, Rad, Class B, 30 MHz to 1 GHz (10m), <b>Recall</b> .	(bottom of the window).				

Recall	Limit		Recall from Fi	le	l	<u>ר</u> (	? 🗙
State	Users	angleInstrument $ angle$ Documents $ angle$ E	EMC Limits and Ampcor	Limits EN 55022	Mode	EMI Receiver	▼
Screen Config + State	Name		∆ Date		Size (	Content	
Measurement Data	EN 55022, Co	ond, Class B, Telecom, Voltage	e, A 6/1/2018 3:35 PM		341 B (	Csv file	
Limit	EN 55022, Co	ond, Class B, Telecom, Voltage	e, C 6/1/2018 3:35 PM		344 B (	Csv file	
Correction	EN 55022, Ra	ad, Class A, 1 to 6GHz, Averag	ge ( 6/1/2018 3:35 PM		347 B (	Csv file	
Correction Group	EN 55022, Ra	ad, Class A, 1 to 6GHz, Peak (	(3m 6/1/2018 3:35 PM		344 B (	Csv file	
	EN 55022, Re	ad, Class A, 30MHz to 1GHz (	10n 6/1/2018 3:35 PM		368 B (	Csv file	
	EN 55022, Re	ad, Class A, 30MHz to 1GHz (	3m; 6/1/2018 3:35 PM		367 B (	Csv file	
	EN 55022, Ra	d, Class B, 1 to 6GHz, Avera	ge ( 6/1/2018 3:35 PM		343 B (	Csv file	
	EN 55022, Ra	ad, Class B, 1 to 6GHz, Peak (	(3m 6/1/2018 3:35 PM	ş	340 B (	Csv file	
	🕒 EN 55022, Re	nd, Class B, 30MHz to 1GHz (	10n 6/1/2018 3:35 PM		368 B (	Csv file	
	EN 55022, Ra	ad, Class B, 30MHz to 1GHz (	3m 6/1/2018 3:35 PM		367 B (	Csv file	
	File name: EN 5	5022, Rad, Class B, 30MHz to	o 1GHz (10m).csv	File type:	Csv	files (*.csv)	Recall
2. Edit the limit	line	Select MEAS SET	<b>UP</b> , <b>Limits</b> tab,	You can now a	add oi	r delete a po	int or

Edit Limit une Select MEAS SETUP, Lim 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	Ac	tion			Notes						
За к-полово-плим – иктоте лезиор соплесной			Ed	lit Limit			5	C	?	Clos	o se∕
Select Limit	Freq	Amptd	Scale/Di	iv 10.0 dB	Ref Value 106	.99 dBµV		50			
Limit 1 1 Go To Row	30.000 MHz	40.000 dBµ∨	Log	race 1 Pass						*	
2 2	230.00 MHz	40.000 dBµV	97.0								
Insert Row Below 3	230.00 MHz	47.000 dBµV	87.0								
Scale X Axis	1.0000 GHz	47.000 dBµV	77 0								
X Offset 0.0000 Hz			67.0								
Y Offset 0 dB			57.0								
Apply Offsets to Limit Table			47.0			-0					-0
Delete Row			37.0			0					
Delete Limit			27.0								
Settings			47.0								
			17.0								
			Start 30. Res BW	0 MHz 120 kHz	Video BW 1	.2 MHz	Dw	ell Time	Stop 6.73 μ	1.000 s (60	GHz kHz)

**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.

EMI Receiver 1 Frequency Sca	n •	+							₽	Meas Setu	• · [器
			Limit	is Table				Close	<	Limits Table	Settings
		î	rouch any settin	g value to ch	nange it				<	Edit Limit	SCAN
Sea	Search Criteria Peak Criteria And Limits		a And Limits	# of Peal	ks	25		ON	All Li Test	mits Limits	SEARCH
			# of Sub	ibranges 25				On Off	MEASURE		
	Limit	Enchlad	Marg	in	Troop		Description		_	Jpdate ∆ Limit	Meters
	Limit	Enabled	Value	Enabled	Trace			6		elete All Limits	Signal List
	Limit 1	<b>×</b>	0.00 dB		Trace 1						Limits
	Limit 2		0.00 dB		Trace 1						Meas Standard
	Limit 3		0.00 dB		Trace 2						Tune &
	Limit 4		0.00 dB		Trace 2						Advanced
	Limit 5		0.00 dB		Trace 3						Global
	Limit 6		0.00 dB		Trace 3						

Step	Action	Notes
<b>4.</b> Add a 5 dB margin to Limit Line 1	Set the <b>Margin</b> to <b>-5 dB</b> , select <b>Enabled</b> , then <b>Close</b> the Limit Table.	

**Enabled**, then **Close** the Limit Table.

EMI Receive Frequency	er 1 Scan	+							\$	Meas Setu	p v 🔛
	Limits Table Close								<	Limits Table	Settings
		ĩ	Fouch any settin	g value to ch	nange it				<	Edit Limit	SCAN
	Search Criteria	Peak Criteria And Limits		# of Pea	ks	25			All Limits Test Limits		SEARCH
				# of Sub	ranges	25				On Off	MEASURE
	Linsit	Enabled	Marg	in	Traco	Description			L.	Jpdate ∆ Limit	Meters
	Limit	Enabled	Value	Enabled	Trace		Jeschpuon	1		elete All Limits	Signal List
	Limit 1	<b>X</b>	-5.00 dB	<b>_</b>	Trace 1						Limits
	Limit 2		0.00 dB		Trace 1						Meas
	Limit 3		0.00 dB		Trace 2						Tune &
	Limit 4		0.00 dB		Trace 2						Listen
	Limit 5		0.00 dB		Trace 3						Clobal
	Limit 6		0.00 dB		Trace 3						Ciobal

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	Select Recall, Correction tab.	
correction file	Set Select Correction to Correction 1, Preloaded Correction to Preloaded, then select Recall From.	
	Select Antenna, Broadband (26 MHz to 3 GHz).csv, then <b>Recall</b> .	

Recall		Recall from File	ר ? X
State	Computer D: Users Instrument Doce	uments $ angle$ EMC Limits and Ampcor $ angle$	Ampcor Mode EMI Receiver V
Screen Config + State	Name	∆ Date	Size Content
Measurement Data	Amp, 87405A (45 MHz to 3 GHz).csv	6/1/2018 3:35 PM	485 B Csv file
Limit	Amp, 87405B (10 MHz to 4 GHz).csv	6/1/2018 3:35 PM	485 B Csv file
Correction	Amp, 87415A (2 GHz to 8 GHz).csv	6/1/2018 3:35 PM	466 B Csv file
Correction Group	Antenna, 11940A Close Field Probe (30 MHz	tr 6/1/2018 3:35 PM	622 B Csv file
C. Strategic Strategic	Antenna, 11941A Close Field Probe (9 kHz to	\$ 6/1/2018 3:35 PM	371 B Csv file
	Antenna, Biconical (30 MHz to 300 MHz).csv	6/1/2018 3:35 PM	656 B Csv file
	Antenna, Broadband (26 MHz to 3 GHz).csv	6/1/2018 3:35 PM	1 KB Csv file
	Antenna, Double Ridged Horn (1 GHz to 18 G	6/1/2018 3:35 PM	860 B Csv file
	Antenna, Log Periodic (200 MHz to 2 GHz).cs	w 6/1/2018 3:35 PM	1 KB Csv file
	Cable, 10 meter Type-N (30 MHz to 1 GHz).ca	s <sup>1</sup> 6/1/2018 3:35 PM	232 B Csv file
	File name: Antenna, Broadband (26 MHz to 3 G	Hz).csv File type:	Amplitude Corrections (*.csv) Recall
2. Edit the correct	tion Select Innut/Outnu	t You ca	n add or delete a point or modify
	Corrections tab. Se	elect the fre	equency and amplitude of the
	Correction, Correc	ction 1, then currer	t point.

N6141EM0E EMI Measurement Application Measurement Guide

Edit Correction. Close when finished.

Step		Acti	on		Notes			
				Edit Correction		ょ) (	⊲ ?	Close
Select Correction		Freq	Amptd	Scale/Div 10.000 dB	Ref Level 50.000 dB			
Go To Row	1	26.000 MHz	0.0000 dB	209				
1	2	26.000 MHz	20.000 dB	40.D			-099	Ð
Insert Row Below	3	30.000 MHz	17.500 dB	30.0		DEBE	Bor	
	4	40.000 MHz	13.500 dB	20.0				
	5	50.000 MHz	10.500 dB	10.0				
	6	60.000 MHz	8.2000 dB	0.00				0
	7	70.000 MHz	7.2000 dB	10.0				
	8	80.000 MHz	7.1000 dB	-10.0				
	9	90.000 MHz	7.3000 dB					
Delete Row	10	100.00 MHz	7.5000 dB	-30.0				
Delete Correction	11	110.00 MHz	7.6000 dB	-40.0			_	
Settings	12	120.00 MHz	7.5000 dB	-345.75 MHz			3.	37175 GHz

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

Step			A	ctio	n				Note	S			
EMI Receiv Frequency	rer 1 Scan	• +	•								\$	Meas Setu	P 🔹 🔛
					Scan Table					Close	Range	5 7	Settings
	Range 1		Range 2		Range 3		Range 4		Range 5		Range I	ange→SA Preset To	SCAN
Start Freq	9.000 kHz		150.000 kHz		30.000000 MHz	2	300.00000 M	Hz	30.000000 M	Hz 1	9 k	CISPR A Hz-150 kHz	SEARCH
Stop Freq	150.000 kHz		30.000000 MHz		300.000000 MH	łz	1.000000000	GHz	1.000000000	GHz 1	( 150	CISPR B kHz-30 MHz	MEASURE
RBW	200 Hz		9 kHz		120 kHz		120 kHz		120 kHz		30 N	CISPR C 1Hz-300 MHz	Meters
Dwell Time	4.10 ms		108 µs		6.73 µs		6.73 µs		62.0 µs	ALITO I	C 30	ISPR C/D MHz-1 GHz	Signal List
Step Size	100.00 Hz		4.4995 kHz		60.000 kHz		60.003 kHz		60.002 kHz		300	CISPR D MHz-1 GHz	Limits
Points/ RBW	2		2	Marto	2	Auto	2		2	2		SHZ-18 GHZ	Meas Standard
Atten	10 dB	AUTO	10 dB	AUTO	10 dB	AUTO	10 dB	AUTO	0 dB	AUTO	MIL	Hz - 1kHz	Tune & Listen
Int Preamp	Off	AUTO	Off	AUTO	Off	AUTC	off	AUTO	Low Band	AUTO	1 K MIL 10 k	Hz – 10 kHz Std 150 kHz Hz – 150 kHz	Advanced
Scan Time					30.3 ms						MIL 1501	Std 30 MHz kHz – 30 MHz	Global
Scan Points	1411	1	6635	~	4501	4	11667	~	16167	3	MIL 30 I	. Std 1 GHz MHz – 1 GHz	
4		?	Sep 06, 2018 9:52:23 AM	Q,	A						MIL	Std >1 GHz	

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.

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

Step	Action Notes											
1. Turn on all three meters	Select <b>MEAS SETUP,</b> the <b>N</b> tab, <b>Meters Config</b> .	Select MEAS SETUP, the Meters tab, Meters Config.					It is not necessary to turn on three detectors for scanning, searching, and					
	Set <b>Meter 2</b> to <b>Quasi Peal</b> <b>Meter 3</b> to <b>EMI Average</b> . are the default values.)	et <b>Meter 2</b> to <b>Quasi Peak</b> and <b>Aeter 3</b> to <b>EMI Average</b> . (These re the default values.) measuring, bu meters for tun process.				it it is helpful to see three hing signals later in the						
	Turn <b>On</b> all three meters, then <b>Close</b> the table.			NOT			For MIL-Std measuremer not turn on N and 3.	nts, do Meters 2				
	Meters Config			c		K	Meters Config	Settings				
Touch any setting	value to change it	80. P	50 7 O	4.52 6	59.06 A	C	Reset Peak Hold	SCAN				
- W - W		e	P	M	в	Res	et Peak Hold	and analysis				

Touch any cotting value to shongs it						80	60	74.52 69			_	Reset Peak Hold	SCAN
		iouch any se	and value to chain	yen		P	QP				d B	Reset Peak Hold	SEARC
	On	Detector	Limit		Use Limit Line	a k					¥	On	
			Value	On							/ m	Off	MEASU
Meter 1	1	Peak	80.00 dBµV/m		off							Meters→Signal (Replace)	Motore
Meter 2		Quasi Peak	80.00 dBuV/m		Off							Meters→List (Append)	Meters
			00.00 JD ///		0.4							Meters Max→Signal	Signal L
Meter 3	×	Emi Average	ео.оо авµv/m									Meters Max→List	Limits
		Processo -										(Append) Snap to Meters	Meas Standa
utorange		On	Peak Hold Ti	me	Infinite							(Select Closest Signal)	Tune &
		Off	1									Dwell Time	Listen
Auto Pream	Р	Of	Adjustable Peak Hold Tim		2.0 s							10.0 ms	Advanc
		On										Couple Meters	Auvente
			Dwell Time		10.0 ms	44	.57 Freq 4	40.70 483.0	MH	33 33 Z		to Signal List On Off	Global
							Res E	SW 12	20 KI	12		Couple Meters	

- 2. Set the scan sequence for a Scan only
   Select the Settings tab, set Scan
   The default setting.

   Sequence to Scan.
   Sequence to Scan.
- 3. Set the scan type to stepped
   Select the SCAN tab, set Scan

   Type to :
   MXE: Smooth (Swept),

   PXE: Discrete (Stepped)

Ste	ep	Action	Notes	
EF	MI Receiver 1			Meas Setup 🔻 🔆
	· · · · · · · · · · · · · · · · · · ·	Meters Config	Close	Scan Sequence Search
	Touch any set	ting value to change it	80,60 74.52 69.06 P Q E d	Scan Type SCAN Smooth (Swept) v
	On Detector	Limit Use Limit Line	e P M B a μ k V	Discrete (Stepped)
	Meter 1 Peak	Value On 80.00 dBuV/m Off		Smooth (Swept)
	Meter 2 Quasi Peak	80.00 dBµ√/m Off		Time Domain
	Meter 3 V EMI Average	80.00 dBµ∨/mOff		Scan Pause/ Resume
				(For Scan only) At Range Break v Meas
	Autorange On	Peak Hold Time Infinite		Scan Table Standard Tune &
	Auto Preamp On Off	Adjustable Peak Hold Time 2.0 s		Signal Zoom Listen Advanced
		Dwell Time 10.0 ms	43.70 41.04 33.45	Global
			Freq 483.0 MHz Res BW 120 kHz	
4.	Set the frequency scan to continuous	Select <b>Sweep</b> , <b>Frequenc</b> to <b>Continuous</b> .	<b>Scan</b> The default va	alue.
5.	Set trace 1 to max hold and the detector to peak	Select <b>Trace</b> , set <b>Select 1</b> <b>Trace 1</b> , set <b>Trace Type</b> <b>Hold</b> , and <b>View/Blank</b> to	Trace to Trace 1 is the to Max	yellow trace.
		Select the <b>Detector</b> tab an <b>Peak</b> .	d select	
6.	Set trace 2 to clear write and the detector to peak	Select the Trace Control Select Trace to Trace 2 Type to Clear/Write, and View/Blank to Active.	tab, set Trace 2 is the c, <b>Trace</b> d set	blue trace.
		Select the <b>Detector</b> tab an <b>Peak</b> .	d select	
7.	Start the scan	Select <b>MEAS SETUP</b> , <b>Se</b> tab, then <b>Start Sequence</b>	ttingsAlternately, yoe.Scan, or press	ou can go to SWEEP, Start s the Restart key.



8. Observe the two traces supdating, 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 <b>Trace</b> , set <b>Select Trace</b> to <b>Trace 2</b> , and <b>View/Blank</b> to <b>Blank</b> .	
	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.	
	<b>Close</b> the table.	
<b>3.</b> Change the scan type to time domain	Select the <b>SCAN</b> tab, set <b>Scan</b> <b>Type</b> to <b>Time Domain</b> .	The scan speed of a Time Domain scan is much faster than that of the Smooth
	Select the <b>Settings</b> tab, then <b>Start Sequence</b> .	(Swept) or Discrete (Stepped).
4. Start the scan	Select Start Sequence.	Observe the time required to cover the



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.									
<b>NOTE</b> Accelerated TDS requires Option WT1/WT2 on the N9048B PXE EMI Receiver.									
6. Turn on Accelerated TDS	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 <b>Settings</b> tab, <b>Start</b> <b>Sequence</b> .	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								

Radiated Emissions Measurement Example Data Reduction

### 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 <b>MEAS SETUP</b> , <b>Settings</b> tab, then <b>Stop Sequence</b> .	If not done at the end of the last section.

2. Set the scan sequence to Set Scan Sequence to Search. search only



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. Radiated Emissions Measurement Example Data Reduction

Step		Action			Notes		
EMI Receiv Frequency	ver 1 Scan	F				Meas Setup	• <u>***</u>
		Limits	Table		Close	Limits Table	Settings
		Touch any setting	value to change it			Edit Limit	SCAN
	Search Criteria	Peak Criteria And Limits	# of Peaks	25	ON	All Limits Test Limits	SEARCH
		Peak Criteria Only	# of Subranges	25		Off	MEASURE
	Limit	Peak Criteria And Limits	Enabled	Description		Update $\Delta$ Limit Delete All Limits	Meters Signal List
	Limit 1	Subranges And Limits	Trace 1				Limits
	Limit 2	0.00 dB	Trace 1				Meas
	Limit 3	0.00 dB	Trace 2				Tune &
	Limit 4	0.00 dB	Trace 2				Advanced
	Limit 5	0.00 dB	Trace 3				Global
	Limit 6	0.00 dB	Trace 3		- <u>-</u>		
	) (* 🗖 ?	Sep 06, 2018					
4. Start	the search	Select th Seque	e <b>Settings</b> ta nce.	b then, <b>Start</b>	TIP	To Clear ex signals in the List table, s Signal List Delete All. new signals appended the list without older ones.	isting he Signal select the tab then Otherwise, s will be so the signal clearing
EMI Receive Frequency S	er 1 Scan +					Meas Setup	v 🔆
KEYSIG	HT Input RF Coupling: DC Align: Auto	Input Z 50 Ω Atten 10 dE Corrections: On Preamp: Off Freq Ref: Int (S) EMC Std: C	Scan Type: Time Seq: Search ISPR # of Scans: >1/1	a Domain 1 2 3 A W W W F	Atten: 10 dB Preamp: Off	SCAN	Settings
1 Spectrum		NFE: Off	Trig: Free Run	P P P P	*	SEARCH	SCAN
Scale/Div 1		Ref Value 106.99 dBµV/m		68.63 4	2.99 35.99	MEASURE	SEARCH



Step	Action	Notes
5. Stop the search	Once the signals have been added to the list, select <b>Stop Sequence</b> .	
	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		
<ol> <li>Set the search criteria to subranges and limits</li> </ol>	Select the <b>Limits</b> tab, <b>Limits Table</b> , Search Criteria to <b>Subranges and</b> <b>Limits</b> .	When Peak Criteria and Limits is selected, the search finds the peaks that meet the Excursion and Threshold (set in		
	Set the # of Subranges to <b>10</b> , then <b>Close</b> the Limits table.	limits and margin if they are turned on.		

EMI Receiver Frequency Sca	in T	+						\$	Meas Setu	ip v 💥
			Limi	ts Table			Close	C Limits	a Table	Settings
7		C Edit	Limit	SCAN						
Se	arch Criteria	n Criteria Subranges And Limits		# of Pea	ks	25		All Limits Test Limits		SEARCH
				# of Sub	ranges	10		On Off		MEASURE
	Limit	Enabled	Margin Trace Descripti		Description		Update	e∆Limit	Meters	
	Cinit	Lilabled	Value	Enabled	Hace	Description		Delete	All Limits	Signal List
	Limit 1	~	-5.00 dB	<b>~</b>	Trace 1					Limits
	Limit 2		0.00 dB		Trace 1					Meas
	Limit 3		0.00 dB		Trace 2					Standard Tune &
	Limit 4		0.00 dB		Trace 2					Listen
	Limit 5		0.00 dB		Trace 3					Advanced
										Global
	Limit 6		0.00 dB	ł	Trace 3					

Step	Action	Notes
2. Clear the list and start a new search	Select the <b>Signal List</b> tab, <b>Delete All</b> .	TIP Alternately, you can go to Sweep, Start
	Select the <b>Settings</b> tab, then <b>Start Sequence</b> .	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 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.

Radiated Emissions Measurement Example Data Reduction

#### Table 3-1Key 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
<ol> <li>Select a signal from the signal list and mark it</li> </ol>	Select MEAS SETUP, Signal List tab, Select Signal, Mark Signal.	You can also mark signals in the signal list by selecting the check box in the Sig
	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.	column.

## Radiated Emissions Measurement Example Data Reduction

Step	Action	Notes	
EMI Receiver 1 Frequency Scan KEYSIGHT Input: RF Coupling DC Aign. Auto Scale/Div 10.0 dB Ref Val Comparison Ref Val Comparison Ref Val Comparison Ref Val Comparison Ref Val Comparison C	2:50 Ω Atten: 10 dB Scan Type: Time Domain Preamp: 3:60 GHz Seq: Scan EMC Std: CISPR # of Scans: >1/1 Trig: Free Run Iue 106.99 dBμV/m	1       2       3       Aften: 10 dB         W       W       W       Preamp: Off         p       p       p       p         66 90       V       V         R       V       V         k       V       V	Meas Setup V VVV Select Signal 12 Settings SCAN Mark Signal SCAN Mark Duplicates Upper Mark Duplicates Lower Clear Mark Mark All
17.0       Start 30.0 MHz       Vid         Sig Trc Freq Peak Amp         9       1       100.08 MHz       52.725 dBµ         10       1       101.66 MHz       33.921 dBµ         11       101.66 MHz       22.47 dBµ         12       1       103.50 MHz       55.102 dBµ         13       1       104.91 MHz       55.102 dBµ         14       1       104.94 MHz       57.157 dBµ         15       1       104.94 MHz       57.157 dBµ         15       1       04.94 MHz       57.157 dBµ         15       1       04.94 MHz       57.157 dBµ	Ico BW 1.2 MHz       Stop 1.000 GHz         Dwell Time 10.0 ms (30 kHz)         old       QPD Amptd         EAvg Amptd       Peak LL3 Δ         QPD Amptd       EAvg Amptd         Peak LL3 Δ       QPD L         V/m       -         -       2.2.726 dB         V/m       -         -       2.247 dB         V/m       -         -       2.4301 dB         V/m       -         V/m       -         2.4.301 dB       -         V/m       -         0.7, 2018       -         0.7, 2018       -	56 29 Freq 103.5 MHz Res BW 120 kHz L1 △ EAvg LL2 △ Composite A 7.501 dB 7.517 dB 7.535 dB 7.539 dB 7.549 dB 7.549 dB 7.549 dB	Clear All Marks Sort By Frequency Auto Man Sort Order Ascending Delete Signal Delete All
<b>2.</b> Delete the marked sign	al Select <b>Delete Signal</b> .	Or, you can signals.	use Delete All to delete all
3. Add a peak into the signal list using Mkr->L	Select Peak Search, Marke ist Mkr->List.	r->, The frequent be added to duplicate of but any sign	cy of the current marker will the list. This signal may be a an already existing signal, al can be added.

Radiated Emissions Measurement Example Maximization

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

### Radiated Emissions Measurement Example Maximization





Step	Action	Action Notes	
3. Adjust the frequencies the current sign replace the old	uency of Select FREQ, nal and (Meters), use er one meter frequency spectrum displa signal.	Frequency e the knob to adjust the cy (blue line on the ay) to the center of the	
	Select <b>MEAS</b> tab, <b>Meters</b> - to replace the c meters frequence	Setup, the Meters > Signal (Replace) current signal with the ncy.	
4. Zoom out to ful view	ll span Select the Sca Out until the s span view.	<b>an</b> tab, then <b>Zoom</b> spectrum is back to full	

#### 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.

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 <b>MEAS SETUP</b> , <b>Signal List</b> tab.	Meter frequency is coupled to the current signal by default. (MEAS SETUP,
	Use the knob, arrow keys, scroll bar, mouse pointer, or finger to highlight a signal.	Meters tab, Couple Meters to Signal List.
		An FM signal with drifting frequency was
	Select Mark Signal.	select for this example.

TIP



Mode / Measurement / View Selector	Screen Name EMI Receive	er 1 Delete T	his Screen Delete All But This Screen ?
(Sequencer	Mode	Measurement	View
Sequencing On	Spectrum Analyzer	Frequency Scan	Normal
Off	Real-Time Spectrum Analyzer	Strip Chart	Scan
When Sequencing is On and there are multiple Screens, all	EMI Receiver	APD	User View
Screens udpate in sequence. When Sequencing is Off, only	IQ Analyzer (Basic)	Disturbance Analyzer	Normal 1
the selected Screen updates.	W-CDMA with HSPA+	Monitor Spectrum	
	GSM/EDGE /EDGE Evo		
	Phase Noise		
	Noise Figure		
	Analog Demod		
	Bluetooth		
To Jaunch 89600 VSA press the button below	LTE FDD & LTE-A FDD		
Launch VSA	LTE TDD & LTE-A TDD		
		(	OK Cancel
3. Turn on trace 2 and set to max hold	Select <b>Trace</b> . In the <b>Sele</b> field, select <b>Trace 2</b> . In the <b>Control</b> tab, set <b>Trace</b>	e <b>t Trace</b> le <b>Trace</b> <b>Type</b> to	
	Max Hold, and View/E Active.	Blank to	
4. Put a marker on trace 2	Select Marker, the Prop set Select Marker to M	perties tab, larker 2.	
	Set Marker Trace to Tra	ace 2	

5.	Use peak search and move the marker to the center frequency	Select the <b>Peak Search</b> tab, <b>Peak</b> Search.	
	center frequency	Select the <b>Marker-&gt;</b> tab, <b>Mkr-&gt;</b> CF.	

-

\_

### Radiated Emissions Measurement Example Maximization



6. Replace the current signal with the frequency of the marker

Select FREQ, CF-> Signal (Replace).



Radiated Emissions Measurement Example Maximization

Step	Action	Notes
7. Switch back to a frequency scan measurement	Select <b>MODE/MEAS</b> , <b>Frequency</b> <b>Scan</b> 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

Radiated Emissions Measurement Example Final Measurement

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

#### Radiated Emissions Measurement Example Final Measurement



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.



6. Stop the search

Select Stop Sequence.

Radiated Emissions Measurement Example Report Generation

### **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.

Ste	əp	Action	Notes
1.	Open the Measurement Report form	Select <b>Save</b> , <b>Measurement</b> 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 <b>Save As</b> , enter a file name, then <b>Save</b> .	Note the location of the Measurement Report as shown below.

Save	Keasurement Report	Save to File	じて	? >
State	Computer D: Users	angleInstrument $ angle$ Documents $ angle$ EMI $ angle$ data $ angle$ FSC	Can MeasResult Mode EMI Receiver	
Screen Config + State	Name	∆ Date	Size Content	
Measurement Data	EN55022_PXE_precompli	liance.pdf 9/20/2018 10:09 AM	3 MB Pdf file	
Measurement Report				
Limit				
Correction				
Correction Group				
Screen Image				
	File name: EN55022_PXE_c	compliance.pdf	File type: Pdf files (*.pdf)	Save

Radiated Emissions Measurement Example Report Generation Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

### 4 Disturbance Analyzer Measurements

The following topics are in this section:

"Overview" on page 72

"Making a Measurement" on page 73

"Setup Table Parameters" on page 77



Disturbance Analyzer Measurements Overview

### 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 N6141EM0E EMI Measurement application. It is important to note that compliant discontinuous disturbance measurements require an EMI receiver that is CISPR-compliant.
# Making a Measurement



Before connecting a signal to the 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 Click measurement

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 N9048B PXE EMI Receiver.

Step	Action	Notes			
<b>3.</b> Access the Setup Table to configure a Click measurement	Select <b>MEAS SETUP</b> , the <b>Settings</b> tab, <b>Setup Table</b> .	This table enables you to configure the measurement with all parameters needed to measure Clicks to the appropriate limit.			
EMI Receiver 1		Meas Setup 🔻 👯			

Di	sturbance Analyzer			•••	Meas Setu	ip Y 🖓			
	Setup Table		Gen	General Close				Pause	Settings
	General	Measurement Setup		Test Procedure			Start		Disturbance List
	Channel Setup	Attenuation	42 dB	Click Rate	Measured		Sta	art Analysis	Meas
1		Terminal	Mains	Click Count	40.00	ON	Searc	ch Disturbance	Advanced
		Duration (hh:mm:ss)	00:05:00	Factor f	Off		< s	etup Table	
		Hours	0		na Anna an Anna a		M	leas Preset	Global
		Minutes	5	Touch any setting val	lue to change it				RF Preselector
		Seconds	0						
									$\sim N_{\rm eff}$
	NOTE	ne EMI measurer	nent application allo	ws you to either	make meas	suremen limite ar	ts usin	ig autocoup	oled
	US	sed during the m	settings. when using autocoupled settings, the limits and input attenuation settings assurement are determined by your measurement frequency and terminal selection.						
	Th	nese autocoupled	d settings provide th	e appropriate lir	mit values a	s given iı	n CÍSP	PR 14.	
4.	Set up the me	asurement	Under <b>Measurement Setup</b> ,						
	parameters in	the	select:						
	General tab		Attenuation: Auto						
5.	Setup the test	procedure	Under <b>Test Procedure</b> , select::						
	in the General	ιασ	Click Rate: Measured						
			Click Count: Off Factor f: Off						
~	O atom the test	dunation in							
6.	<b>6.</b> Setup the test duration in the General tab		Select <b>1</b> minute.						
7.	7. Set up Channel parameters		Select the <b>Chann</b>	el Setup tab,					
			select:						
			Frequency: ISU KI	HZ					
			Correction: <b>0.00 dB</b>						

Disturbance Analyzer Measurements Making a Measurement

Step	Actio	n	Notes		
EMI Receiver 1 Disturbance Analyzer	F			Meas Setup	• • 😹
Setup Table		Channel Setup	Close	Pause	Settings
General				Start	Disturbance List
Channel Setup	Chanr	nel 1		Start Analysis	Meas Standard
	Frequency 150 kł	łz		Search Disturbance	Advanced
	Frequency 150.00	) kHz		Setup Table	Global
	Limit 66.00	dΒμV Αυτο		Meas Preset	RF Preselector
	Correction 0.00 d	B			Treaction
					8
	Nov 23, 2019 12:51:01 AM				-

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.

EMI Receiver 1 Disturbance Analy	/zer	÷					Meas Set	up • 👯
KEYSIGHT	put RF oupling: DC	Input Z: 50 Ω Corrections: On	Atten: 42 dB	EMC Std.	CISPR Duration: 00:01:0	00	Pause	Settings
	lign: Auto	Freq Ref. Int (S) NFE: Off					Start	Disturbance
1 Graph	•		297		2 Metrics	•	Start Analysis	Meas Standard
Scale/Div 10.0 dl	B R	ef Value 107.0 dBµV	/		Time Remaining	00:00:27	Search Disturbance	Advanced
97.0					Click Counted	11	Setup Table	1
87.0					Click Rate	20.00		Global
67.0					Running Analysis		Meas Preset	RF Preselector
57.0					Lq (dBuV)	69.5		
47.0 you have been	Transmitter and the state of the state of the	and and the bar of the problem of the bar of	- a section of the section	Protection and the	Clicks > Lq	11 (100%)		
37.0					Continuous Disturb	ances		
27.0					Counted	0		
11.0					Total Time	0.0000 s		
23.846 s Res BW 9 kHz		Freq 150.000 kHz	Meas Time	33.846 s 500.000 us	Selected Disturban	ce: 11		

St	ер	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.

KEYS	SIGH	T Input: RF	Input	Ζ: 50 Ω	Atten: 42 dB	EMC Std. CISPR	Duration: 00.0	1:00			
	•+	Alian: Auto	Corre Frea	ctions: On Ref: Int (S)						Pause.	Settings
04	FAIL		NFE:	Off						Start	Disturbance
4 Meas	Resul	L 🔻									NAME OF
	4	Clicks				Continuous [	Disturbances			tart Analysis	Standard
	j.	Click Rate		20.00		Counted		0	Sea	rch Disturbance	
		< 10ms		20		Total Time		0.0000 s	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)		Advanced
		<= 10ms		20		Limit				Setup Table	Global
		> 10ms - 20ms		0		L		66 dBu∨		leas Preset	OC
		> 20ms		0		Lq		69.5 dBu∨			Preselector
		> Lq		20		Exception Ru	le Used				
		> Lq (%)		100		600ms Comt	bination	No			
	0	Duration		00:01:00		Separation o	f Click < 200m	ns No			
		Overload Occure	d	No							
Sig D	uratio	n Peak Amptd	QPD Am	ptd Type C	)f Disturbance	TimeStamp	Com	nent			
1 0.	.0010	s 95.295 dBµV	79.144 de	BuV Click		2018/09/27 16:00:49.	179000				
2 0.	.0010	s 95.277 dBµ∨	79.124 di	BµV Click		2018/09/27 16:00:52.	212000				
3 0.	.0010	s 95.289 dBµV	79.127 de	BuV Click		2018/09/27 16:00:55.	204000		- T		
4 0.	.0010	s 95.285 dBµV	79.161 di	BµV Click		2018/09/27 16:00:58.	236000				
5 0.	.0010	s 95.273 dBµV	79.133 de	BµV Click		2018/09/27 16:01:01.	183000				
6 0.	.0010	s 95.267 dBµV	79.122 di	BuV Click		2018/09/27 16:01:04.	216000				
7 0.	.0010	s 95.293 dBµV	79.131 di	BuV Click		2018/09/27 16:01:07.	204000				

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. Disturbance Analyzer Measurements Setup Table Parameters

## 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.

Disturbance Analyzer Measurements Setup Table Parameters Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

# 5 APD (Amplitude Probability Distribution) Measurements

The following topics are in this section:

"Overview" on page 82

"Making a Measurement" on page 83



APD (Amplitude Probability Distribution) Measurements Overview

## 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 ( $\rho$  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 N9048B PXE EMI receiver.

**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.

APD (Amplitude Probability Distribution) Measurements Making a Measurement

# Making a Measurement

CAUTION	Before connecting a signal to the PXE receins instrument can safely accept the signal leve the RF Input connectors on the front panel.	ver or X-Series signal analyzer, make sure the el provided. The signal level limits are marked next to				
	See the AMPTD Y Scale menu for d prevent overloading the receiver.	etails on setting internal attenuation to				
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 as shown below.	receiver				

#### CISPR radiated EMI test setup



Ste	ep	Action	Notes
6.	Select the APD method to Disturbance Level and define a limit line	<ul> <li>Select MEAS SETUP, the Limits tab, Edit Limit.</li> <li>Set APD Method to Disturbance Level.</li> </ul>	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.
		<ul> <li>Set Probability of Time (ρ)</li> <li>to 10<sup>-4</sup>.</li> </ul>	
		<ul> <li>Select Insert Row Below and set Freq to 1.0 GHz.</li> </ul>	
		<ul> <li>Set Dist Level (E limit) to</li> <li>50 dBμV</li> </ul>	
		– Select <b>Close</b> .	



8.	Measure signals	Select the <b>Settings</b> tab, set Measure	Watch the APD measurement as it
		to All Signals or Marked	progresses.
		Signals	

#### APD (Amplitude Probability Distribution) Measurements Making a Measurement

I

Step		A	ction		No	otes		
EMI Receiver 1 APD	+		Y2		a		Meas Setu	p • •
	it RF ipling: DC n: Auto	Input Z: 50 Ω Corrections: On Freq Ref: Int (S)	Atten: 0 dB Preamp: Off	EMC Std. CISPR Trig: Free Run	Measure: All Signals		C Edit Limit	Settings
1 Graph	-	NFE: Off					On Off	Signal List
	Pass						Enabled	Limits
<b>Absc</b>						R	On Off	Meas Standard
10 <sup>-0</sup>						f Level		Tune & Listen
10 <sup>-5</sup>						106.99		Advanced
μ δ 10 <sup>-7</sup>						dBµV		Global
≝ <sup>10</sup> 6.99 17 Freq 1.00000 #Res BW 1 M	7.0 27.0 00000 GHz MHz	37.0	47.0 57.0	67.0 77	0 87.0 97. Meas Tin	0 ne 1.200 s		
Sig Trc F	req Dist Le	evel (E meas) Pr	blty of Time (ρ)	Dist Level vs Limit ∆	Prbity vs Limit Δ	TimeStamp		
2 226	49 kHz				2018	3/09/27 11:12		
3 255.	06 kHz				2018	8/09/27 11:12:		
4 _ 509.	96 kHz				2018	8/09/27 11:12:		
5 865.	43 kHz				2018	3/09/27 11:12:		

APD (Amplitude Probability Distribution) Measurements Making a Measurement Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

# 6 Strip Chart Measurement

The following topics are in this section: **"Overview" on page 88** 

"Making a Measurement" on page 89



Strip Chart Measurement Overview

## 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.

Strip Chart Measurement Making a Measurement

## Making a Measurement

## CAUTION

Before connecting a signal to the 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 <b>MODE/MEAS</b> , <b>EMI</b> <b>Receiver</b> Mode, <b>Strip Chart</b> Measurement, <b>Normal</b> View, <b>OK</b> .		
3.	Turn on Meters	Select <b>MEAS SETUP</b> , <b>Meters</b> <b>Config</b> , and select all three meters to turn on.		

Chart								Meas Set	up Y
			Mete	rs Cor	fig		Close	Keters Config	Meters
		Touch any se	tting value to chan	ige it		121.8 120.0	120.0	Reset Peak Hold	Signal Li
			Limit			P Q P a	e d M B	Reset Peak Hold On Freq Change	Meas Standard
	On	Detector	Value	On	Use Limit Line	ĸ	A.	On Off	Tune &
Meter 1	1	Peak	80.00 dBµV		Off			Meters Max→Signal (Replace)	Advance
Meter 2	1	Quasi Peak	80.00 dBµV		Off			Meters Max-List (Append)	Havano
Meter 3		EMI Average	80.00 dBuV		Off			Dwell Time	Global
								Couple Meters	
		10000						to Signal List	
Autorange		Off	Peak Hold Ti	me	Infinite			Off	
Auto Preamp	<b>,</b>	On	Adjustable Peak Hold Tim		2.0 s			C Detectors	
								Meas Preset	
			Dwell Time		10.0 ms	18.40 93.48 Freq 515.0 M	0.9573 AHz		
						Res BW 120	kHz		

 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.

Strip Chart Measurement Making a Measurement

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



Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

# 7 Real Time Scan Measurements

The following topics are in this section:

"Overview" on page 92

"Making a Measurement" on page 93

"Increasing the Frequency Span with Accelerated TDS" on page 99



Real Time Scan Measurements Overview

## 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. Real Time Scan Measurements Making a Measurement

# 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.

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

Ste	əp	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	Select MODE/MEAS, EMI	

2. Select the Real-time Scan measurement

NOTE

Select MODE/MEAS, EMI Receiver Mode, Real-time Scan Measurement, Spectrogram View,

OK.

lode / Measurement / View Selector	Screen Name EMI Receiv	er 1 Dolata Tit	Screen Deinte All Dot. This Screen ?
Sequencer	Mode	Measurement	View
Sequencing On OH	Analog Demod	Frequency Scan	Spectrogram
When Sequencing is On and	EMI Receiver	Strip Chart	Time Domain
there are multiple Screens, all Screens udpate in sequence. When Sequencing is Off. only	SCPI Language Compatibility	APD	
the selected Screen updates.	Spectrum Analyzer	Disturbance Analyzer	
	IQ Analyzer (Basic)	Monitor Spectrum	-
	Noise Figure	Real Time Scan	
	Phase Noise		
			OK Cancel

**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 <b>MEAS SETUP</b> , <b>Settings</b> tab, set <b>Hold Number</b> to <b>1000</b> .	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 <b>Trace, Trace/Control</b> tab, turn <b>Max Hold Display</b> 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 <b>Sweep</b> , <b>Restart</b> .	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.



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.





9. Peak Search on all available time slices

Select Marker, the Peak Search tab, Peak Search All Traces.

Select the Marker -> tab, Move Display Trace -> Marker This places a marker on a different time slice than the time slice currently shown, you will find the marker diamond disappears from screen.

This action auto-couples the display trace to the time slice of the current marker. Move Marker -> Display Trace does the opposite coupling.

#### Real Time Scan Measurements Making a Measurement



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.



11. Turn on Time Domain view to see the time variant behavior

Select the **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.

#### Real Time Scan Measurements Making a Measurement

Step	Act	ion			Notes			
EMI Receiver 1 Real Time Scan KEYSIGHT Input: RF Presel Coupling: AC Align: Auto	Input Z: 50 Q Atten: 10 dB Corrections. Off Froq Ref. Int (S) RFE Adaptive	EMC Std: CISPR Dis Acc TDS: Off	p Trc. 1000	1 W p	2 W	3 W E	Display Display Trace 1000	Meas Display
1 Spoctnum • Scate/Div 10.0 dB 97 0 77 0 57 0 37 0	murm	Ref Value 106.99 dBj	μv M				Man Start Time 20.00000000 s Couple Marker to Display Trace On	Annotation
Start Freq 485.8 MHz Res BW 120 KHz 2 Waterfall • 18.0200 s 901	Disp	ay Trace 1000 Start 1	Time 20.0000 s	•	Stop I well Time 20.00	Freq 544.2 MHz ) ms (1947 pts)	Time Domain Freq 527.57 MHz Time Domain Freq Line On Off	
1000 20.0000 s 3 Time Demain ▼ Scate/Div 10.0 dB 97.0		Ref Value 106.99 dB	μV				Trace 2 v	
770 770 570 470 370 270 170 10.000 s	n	ne Domain Fred 527.5	7 MHz		L	20.000 s		

**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.

EMI Receiver 1 Real Time Scar	1	• +							\$	Display	- ※
KEYSIGHT	Input: RF Presel Coupling: AC Align: Auto	Input Z. 50 Ω Corrections: Off Freq Ref. Int (S)	Atten: 10 dB Preamp: Off RF Preset: On	EMC Std: CISPR Acc TDS: Off	Disp Trc. 1000	1 W	2 W	3 W	Display 1000	Trace	Meas Display
UN 1 Sportnum		NFE: Adaptive	and the fill of the second			P	Q	E	Aut Ma	lo n	View
Scale/Div 10.0	dB	4		Ref Value 106.99	9 dBµV				Start Tir	ne	Annotation
97.0	MMM	Y M A A A	MMA	MMM	AMM	4 19			20.0000	00000 s	
57.0		VVVV	4400	$\nabla \nabla \nabla \nabla \nabla$				-	Couple Display On	Marker to Trace	
17.0 Start Fred 485	8 MH7		and the second sec	1			Sto	Freg 544.2 MHz	III Off		
Res BW 120 ki	łz						Dwell Time 20.	00 ms (1947 pts)	Time Do 500.00	omain Freq MHz	
2 Waterfall			Displ	ay Trace 1000 S	tart Time 20.0000	5			Time Do Line	omain Freq	1
901						1			On		
						1			Waterfa Trace 2	ll Trace	
20.0000	3								< co	lor Adjust	
3 Time Domain Scale/Div 10.0	dB.			Ref Value 106 9	9 dBuV						
97.0											
97.0 77.0											
57.0	1	1									
37.0			l.	James	la marine des						
10.000 s	STREET, STREET		Π	me Domain Freq 5	500.00 MHz			20.000 s			

Step	Action	Notes
<b>13.</b> Turn on markers on all views	Select the <b>Spectrum</b> view, select <b>Marker</b> , turn on <b>Marker 1</b> , set <b>Marker Trace</b> to <b>Trace 2</b> . Perform a <b>Peak Search</b> .	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.
	Select the Time Domain view, select Marker, turn on Marker 2, set Marker Trace to Time Domain 2	If you move the display trace slider on the Waterfall view vertically, you will see all marker readings change accordingly.
	۷.	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 N9018B 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.	
3. Select Full Segment	Select FREQ, Full Segment.	With the default standard RBW of 120 kHz, the span is limited to 58.4 MHz.



4. Select Next Segment

Select FREQ, Next Segment.

The frequency range moved to the next segment.

#### Real Time Scan Measurements Increasing the Frequency Span with Accelerated TDS

Step		Action			Notes			
EMI Receiver 1 Real Time Scan KEYSIGHT Input RF Prosel	h Input Ζ: 50 Ω Atte	ten: 10 dB EMC Std: CISPR	Disp Trc: 1085	1	2	3	Freq	uency <b>v 🔣</b>
Coupling: AC Align: Auto	Corrections Off Pre Freq Ref. Int (S) RF NFE: Adaptive	eamp: Off Acc TDS: Off Preset On		W P	<b>W</b> Q	W E	573.400000 MH Span	z Settings
1 Spectrum + Scale/Div 10.0 dB		Ref Value 106.9	) dBµV				58.400000 MHz Start Freq 544.200000 MH	z
87.0 77.0 67.0 57.0							Stop Freq 602.600000 MH CF Step	z
47 0 37.0 27.0 17.0	وه المداني و المالي المراجع المديني المراجع المراجع المراجع الم		han an a	Al 40. 4		ار داد رو را در ار می اور را در ار می 	60.000 kHz Auto Man	
Start Freq 544.2 MHz Res BW 120 kHz					Stop F Dwell Time 20.00	Freq 602.6 MHz ) ms (1948 pts)	FFT Segment Previous Segn	nent
2 vvaternali •		Display Trace 1086 S	tart Time 21.7200 s				Next Segme	nt
842							Full Segmer	11
1086 21.6800 s								

- 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.

al Time Scal	n	• +							₿	Frequency	1
Eysight T	Input: RF Presel Coupling: AC Align: Auto	Input Z 50 Q Corrections: Off Freq Ref: Int (S) NFE: Adaptive	Atten: 10 dB Preamp: Off RF Preset: On	EMC Std. CISPR Acc TDS: On	Disp Trc: 1830	1 W P	2 W Q	3 W E	Center Fr 475.0000	equency 000 MHz	Settings
Spectrum									Span 350.000	000 MHz	
ale/Div 10.0	dB			Ref Value 105.9	9 dBµV				Start Free 300.0000	R DOO MHz	
									Stop Fred 650.000	l DOO MHz	
0									CF Step 60.000 k	Hz	
0						te dinangkan kana ana ang sinaka		han a lan a 104 m <sup>1</sup> e lan an a	Auto Man		
							St	op Freq 650 MHz	FFT Segn	nent	
art Freq 300 s BW 120 k	MHz Hz						well Time 20.0	0 ms (11668 pts)			
art Freq 300 es BW 120 ki Waterfall	MHz Hz						well Time 20.0	0 ms (11668 pts)	Previou	is Segment	
art Freq 300 Is BW 120 ki Waterfall 31.7600	MHz Hz s		Disp	lay Trace 1830 S	tart Time 36.6000 s		well Time 20.0	0 ms (11668 pts)	Previou Next	is Segment Segment	

#### Real Time Scan Measurements Increasing the Frequency Span with Accelerated TDS

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

MI Receiver 1 leal Time Scan Ö • + Frequency Input Z: 50 Q Corrections: Off Freq Ref: Int (S) NFE: Adaptive KEYSIGHT Input RF Pr Coupling: Au Align: Auto Atten: 10 dB Preamp: Off RF Preset: On EMC Std: CISPR Disp Trc: 546 Acc TDS: On Center Frequency 825.000000 MHz Settings W Span 350.000000 MHz 1 Spectrum Scale/Div 10.0 dB Ref Value 106.99 dBµV Start Freq 650.000000 MHz Stop Freq 1.000000000 GHz CF Step 60.000 kHz Auto Man Start Freq 650 MHz Res BW 120 kHz Stop Freq 1 GHz Dwell Time 20.00 ms (11668 pts) FT Segment Previous Segment 2 Waterfall Display Trace 547 Start Time 10.9400 s Next Segment 6.0400 s Full Segment 302 547 10.8800 s

Real Time Scan Measurements Increasing the Frequency Span with Accelerated TDS Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

# 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  $50\Omega$  load, which is the input to the EMI receiver.



Line Impedance Stabilization Networks (LISN) LISN Operation

## 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  $\mu$ F inductor in combination with the 50  $\mu$ H inductor is the filter that isolates the mains from the EUT. The 50  $\mu$ H inductor isolates the noise generated by the EUT from the mains. The 0.1  $\mu$ F inductor couples the noise generated by the EUT to the EMI receiver. At frequencies above 150 kHz, the EUT signals are presented with a 50 $\Omega$  impedance.

Line Impedance Stabilization Networks (LISN) Types of LISNs

## 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.



V-LISN: Unsymmetric emissions (line-to-ground) △-LISN: Symmetric emissions (line-to-line) T-LISN: Asymmetric emissions (mid point line-to-line)

### 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 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  $\mu$ sec and has a frequency range of 9 kHz to 200 MHz. The high-pass filter reduces the line frequencies coupled to the spectrum analyzer.

Line Impedance Stabilization Networks (LISN) Types of LISNs Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

# B: Antenna Factors

## Field Strength Units

Radiated EMI emissions measurements measure the electric field. The field strength is calibrated in dB $\mu$ V/m. Field strength in dB $\mu$ V/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  $/4\pi r^2$ R = 120 m $\Omega$ PD = E2/R E2/R = Pt  $/4\pi r^2$ 

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

Far field<sup>1</sup> is considered to be  $>\lambda/2\pi$ 

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



Antenna Factors Field Strength Units

### 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.



### 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  $\mu$ V) 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.
Antenna Factors Field Strength Units

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)



Broadband Antenna (30 - 1000 MHz)

Log Periodic Antenna (200 - 1000 MHz)

Antenna Factors Field Strength Units Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

# 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:

 $dB\mu V = 107 + PdBm$ 

This is true for an impedance of  $50\Omega$ .

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

 $\lambda = 3x108/f$  (Hz) or  $\lambda = 300/f$  (MHz)



Basic Electrical Relationships

Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

# 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.





Detectors Used in EMI Measurements Quasi-Peak Detector

# 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.



# Quasi-peak detector output varies with impulse rate

Detectors Used in EMI Measurements Average Detector

## 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



Detectors Used in EMI Measurements RMS Average Detector

## 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  $f_{\rm c}$ .

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

10 dB/decade when PRF <  $f_{\rm c}$ 

20 dB/decade when PRF >  $f_{\rm C}$ 

Keysight X-Series Signal Analyzer EMI Measurement Application/N6141EM0E

Measurement Guide

# 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.



Distributed by:

This information is subject to change without notice. © Keysight Technologies 2020 Edition 1, January 2020 N9048-90009 www.keysight.com

dataTec