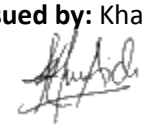
Test Report # 317246 B

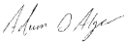
Equipment Under Test:	Power Wave Communication Kit
Test Date(s):	
Prepared for:	The Lincoln Electric Company Attn: Samir Farah 22801 St. Claire Ave Cleveland, OH 44117

Report Issued by: Khairul Aidi Zainal, Laboratory Manager

Signature: 

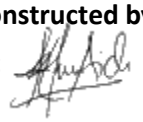
Date: 10/6/17

Report Reviewed by: Adam Alger, Quality Systems Engineer

Signature: 

Date: 10/02/2017

Report Constructed by: Khairul Aidi Zainal, Laboratory Manager

Signature: 

Date: 9/12/17

CONTENTS

Laird Technologies Test Services in Review

The Laird Technologies, Inc. laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope
A2LA Certificate Number: 1255.01
Scope of accreditation includes all test methods listed herein, unless otherwise noted.

Federal Communications Commission (FCC) – USA

Accredited recognition of two 3 meter Semi-Anechoic Chambers

Accredited Test Firm Registration Number: 953492

Innovation, Science and Economic Development Canada

ISED Site listing of two 3 meter Semi-Anechoic Chambers based on RSS-GEN – Issue 4
File Number: IC 3088A-2
File Number: IC 3088A-3

1 TEST REPORT SUMMARY

During 8/1/2017 to 8/13/2017the Equipment Under Test (EUT), **Power Wave Communication kit**, as provided by **The Lincoln Electric Company** was tested to the following requirements:

Requirements	Description	Method	Compliant
FCC: 15.247 (a) (1),(b) (1) ISED:RSS 247 5.1.b	Output Power	ANSI C63.10	Yes
FCC: 15.247 (a) (1) ISED:RSS 247 5.1.a	Bandwidth	ANSI C63.10	Yes
FCC: 15.247 (a) (1) ISED:RSS 247 5.1.b	Channel Separation	ANSI C63.10	Yes
FCC: 15.247 (a) (1)(iii) ISED:RSS 247 5.1.d	Channel Occupancy	ANSI C63.10	Yes
FCC: 15.247 (d) ISED: RSS-GEN 8.10	Transmitter Spurious	ANSI C63.10	Yes
FCC: 15.247 (d) IC: RSS-GEN 8.10	Spurious Radiated Emissions in Restricted Bands	ANSI C63.10	Yes
FCC: 2.1055 (d) IC: RSS-GEN 6.11	Frequency Stability	ANSI C63.10	Yes
FCC: 15.207 IC: RSS-GEN 8.8	AC Power Line Conducted Emissions	ANSI C63.10	Yes

Notice:

The results relate only to the item tested and described in this report. Any modifications made to the equipment under test after the specified test date(s) may invalidate the data herein.

If the resulting measurement margin is seen to be within the uncertainty value, as listed in this report, the possibility exists that this unit may not meet the required limit specification if subsequently tested.

2 CLIENT INFORMATION

Company Name	The Lincoln Electric Company
Contact Person	Samir Farah
Address	22801 St, Clair Avenue, Cleveland, OH. 44117

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	Power Wave Communication Kit
Model Number	G8814
Serial Number	100002017212001, 100002017132023 (radiated) 100002017212002, 100002017123015 (Conducted)
FCC / IC ID	2AJY8-LEWB0000111/22017-LEWB0000111

2.2 Product Description

A connectivity gateway that will be used in conjunction with a welder. The gateway implements Bluetooth and WLAN technologies

2.3 Modifications Incorporated for Compliance

Client understands the modifications. Bluetooth radio power setting set at level 14 instead of maximum (15).

2.4 Deviations and Exclusions from Test Specifications

None at test time

2.5 Additional Information

The EUT could be programmed for specific test modes in two ways:

1. EUT was programmed into the appropriate test modes using a proprietary test tool, ArcLink Suite. The test tool was installed on a laptop and connection to the EUT was via an Ethernet cable. The revision of the test tool used during testing was 7.0.0.3395
2. Programming through a series of button pushes on the front of the EUT.

3 REFERENCES

Publication	Edition	Date
CFR 47 Part 15	-	2017
ANSI C63.10	-	2013
RSS-247	2	2017
RSS GEN	4	2014

4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k = 2.

References	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

Measurement Type	Configuration	Uncertainty ±
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

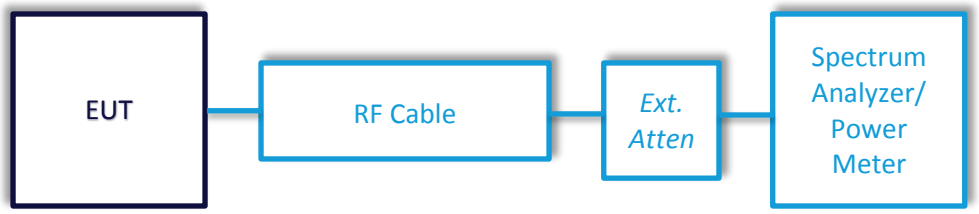
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	$1x10^{-7}$	$0.55x10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 Antenna Port Conducted Emissions

Description of Measurement	The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter. The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.
Example Calculations	Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm) Margin (dB) = Limit (dBm) – Corrected Reading (dBm)

Block Diagram



Instrumentation

Laird
Smart Technology. Delivered.

Date : 31-Jul-2017 Test : Conducted measurements Job # : C-2771

PE: Aidi Customer : Lincoln Electric Quote #: 317246

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	11/21/2016	11/21/2017	Active Calibration
2	AA 960160	UTiFLEX Cable	Micro-Coax	UFC142A-0-0720-2002	218652-001	6/29/2016	8/3/2017	Active Verification

5.1.1 Antenna Port Conducted Emissions – 20dB Bandwidth

Operator	Zach Wilson
QA	Aidi Zainal
Test Date	8/17/2017
Location	Radio Bench
Temp. / R.H.	70 / 82
Requirement	15.247 (a) (1)
Method	ANSI C63.10

Test Parameters

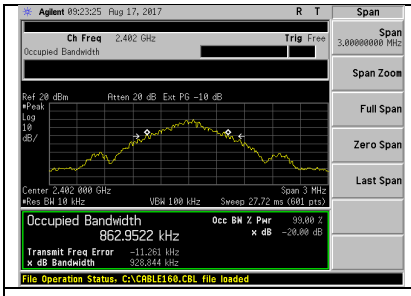
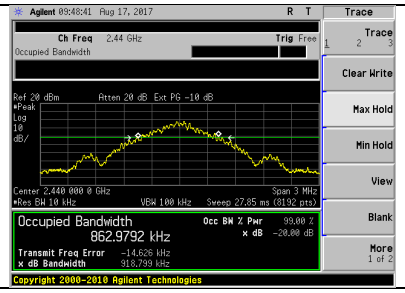
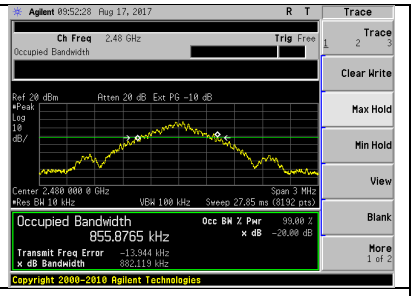
Frequency	2402, 2440, 2480 MHz
Modulation	GFSK, EDR2, EDR3
RBW	GFSK=10 kHz, EDR2/3=15 kHz
VBW	GFSK=100 kHz, EDR2/3=150 kHz
Span	3 MHz
EUT Power	36 VDC via Power Supply @ 120VAC/60Hz

Table

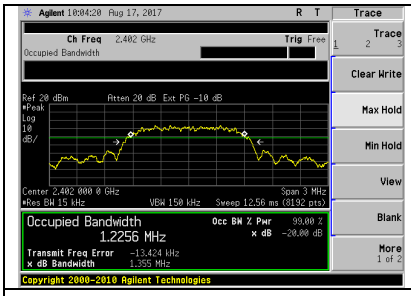
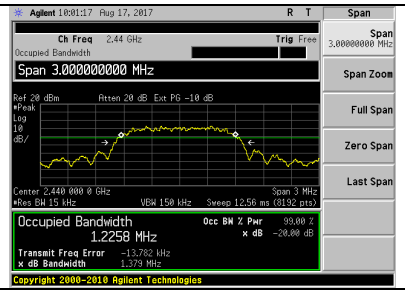
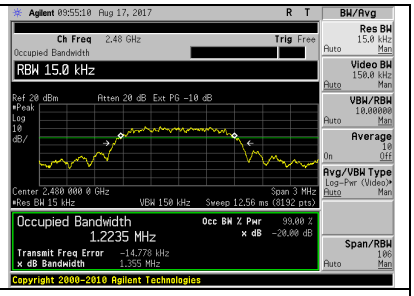
	20 dB Bandwidth (kHz)		
Data Rate	**2402 MHz**	**2440 MHz**	**2480 MHz**
1 Mbps	928.84	918.71	882.12
2 Mbps	1355.00	1379.00	1355.00
3 Mbps	1351.00	1350.00	1351.00

Plots

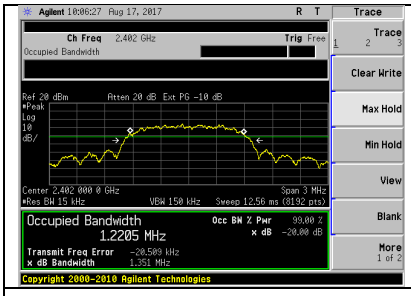
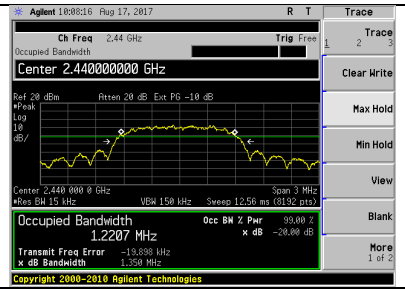
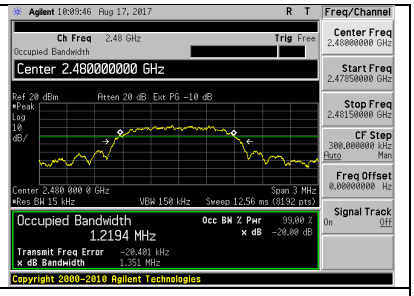
GFSK

		
Low Channel	Middle Channel	High Channel

EDR2

		
Low Channel	Middle Channel	High Channel

EDR3

		
Low Channel	Middle Channel	High Channel

5.1.2 Antenna Port Conducted Emissions – Conducted output power

Operator	Zach Wilson
QA	Aidi Zainal
Test Date	8/17/2017
Location	Radio Bench
Temp. / R.H.	70 / 82
Requirement	FCC 15.247 a.1, b.1
Method	ANSI C63.10 7.8.5

Limits:

Maximum Conducted Output Power (dBm)	Maximum Conducted Output Power (watts)
21	0.125

Test Parameters

Frequency	2402, 2440, 2480 MHz
RBW	2 MHz
VBW	6 MHz
Span	5 MHz
Modulations	GFSK, EDR2, EDR3
EUT Power	36 VDC from Power Supply @ 120VAC/60Hz

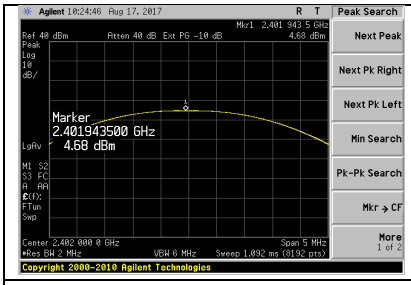
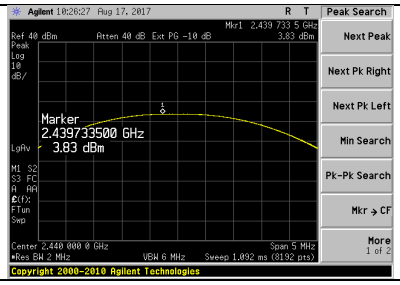
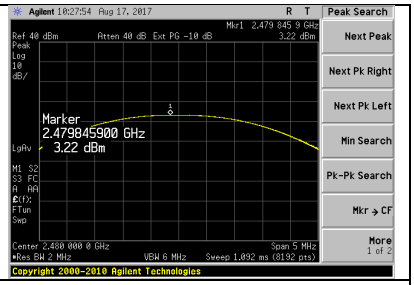
Data

	Pout (dBm)		
Data Rate	2402 MHz	2440 MHz	2480 MHz
1 Mbps	4.68	3.83	3.22
2 Mbps	4.80	4.11	3.53
3 Mbps	5.36	4.74	4.11

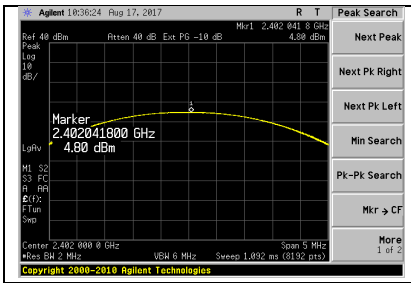
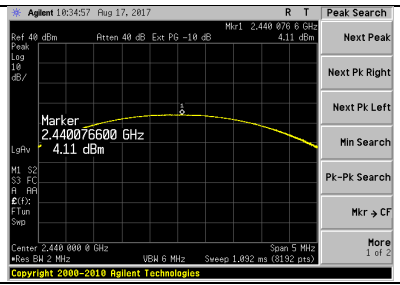
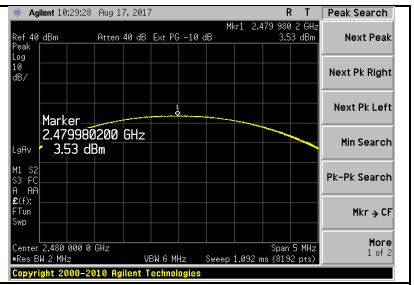
Worst case margin = 21.0 dBm-5.4 = 15.6dB

Plots

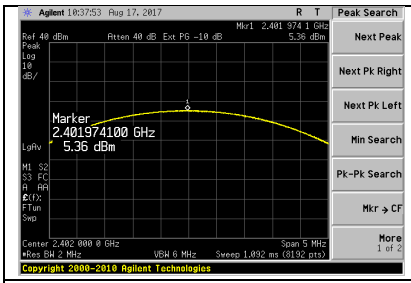
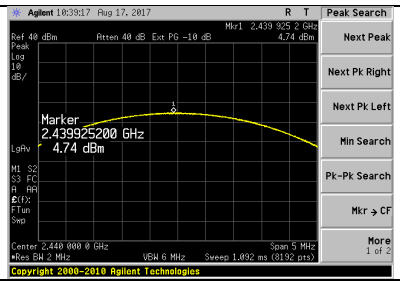
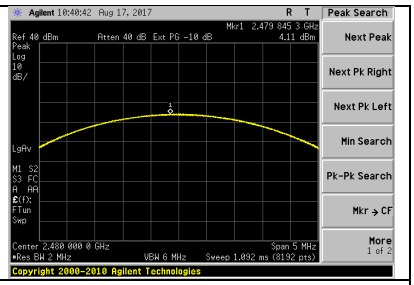
GFSK

		
Low Channel	Middle Channel	High Channel

EDR2

		
Low Channel	Middle Channel	High Channel

EDR3

		
Low Channel	Middle Channel	High Channel

5.1.3 Antenna Port Conducted Emissions – Channel Occupancy

Operator	Aidi
QA	Coty H.
Test Date	8/16/2017
Location	Conducted measurement area
Temp. / R.H.	72F / 76%
Requirement	15.247 (a) (1) (iii)
Method	C63.10 2013 section 7.8

Limits:

400ms in (number of channels X 400ms)
400ms in 31.6 seconds observation window

Test Parameters

Frequency	2402, 2440 and 2480 MHz
VBW	Single Occupancy = 300 kHz, Hops in 5s = 910 kHz
RBW	Single Occupancy = 30 kHz, Hops in 5s = 91 kHz
Span	Zero Span
EUT Power	36 VDC via Teseq Variable Supply
Note	Occupancy time in 31.2 seconds is determined by counting how many transmissions occur in 5 seconds and extrapolating out to 31.6 second:
Example calculation	Single occupancy, ms = 0.844 Number of hops in 5 s = 19 hops Occupancy in 31.6 s = (0.844ms) X 19 X (31.6s/5s) = 101.3ms

Data

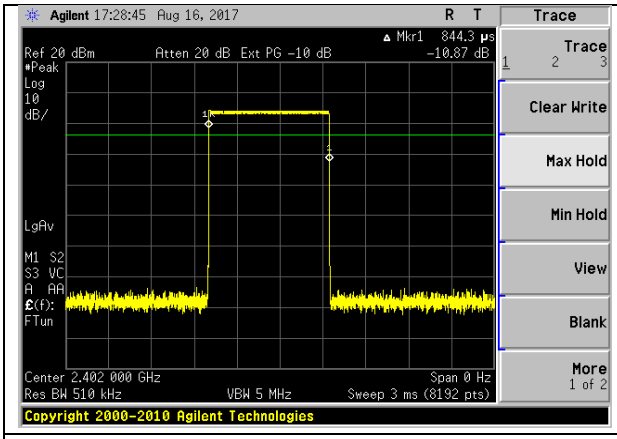
Basic Rate (1MBPS)						
Frequency (MHz)	Single hop Occupancy (ms)	# of hops in 5s	# of hops in 31.6 S	Occupancy in 31.6 s (ms)	Limit (ms)	Margin (ms)
2402.0	0.844	19.0	120.1	101.3	400.0	298.7
2440.0	0.844	19.0	120.1	101.3	400.0	298.7
2480.0	0.844	19.0	120.1	101.3	400.0	298.7

EDR2 (2MBPS)						
Frequency (MHz)	Single hop Occupancy (ms)	# of hops in 5s	# of hops in 31.6 S	Occupancy in 31.6 s (ms)	Limit (ms)	Margin (ms)
2402	0.845	22.0	139.0	117.5	400.0	282.5
2440	0.845	22.0	139.0	117.5	400.0	282.5
2480	0.845	22.0	139.0	117.5	400.0	282.5

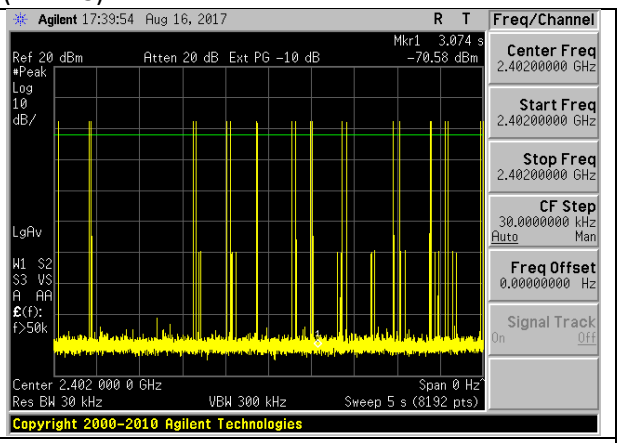
EDR3 (3MBPS)						
Frequency (MHz)	Single hop Occupancy (ms)	# of hops in 5s	# of hops in 31.6 S	Occupancy in 31.6 s (ms)	Limit (ms)	Margin (ms)
2402	0.845	22.0	139.0	117.5	400	282.5
2440	0.845	22.0	139.0	117.5	400	282.5
2480	0.845	22.0	139.0	117.5	400	282.5

Plots

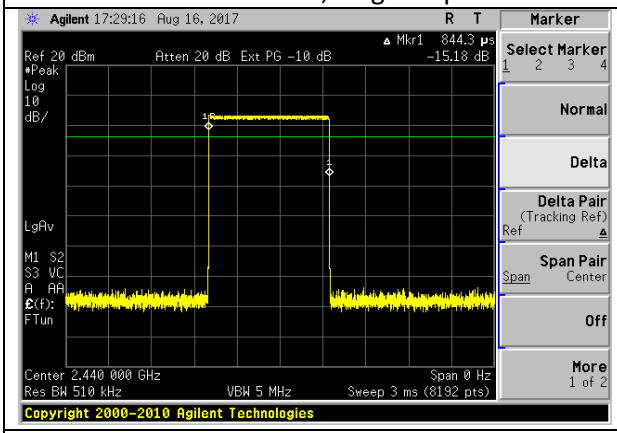
Basic rate (1MBPS)



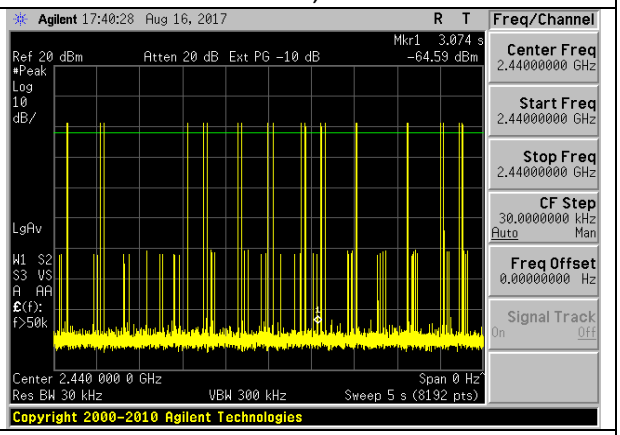
Low channel, Single hop



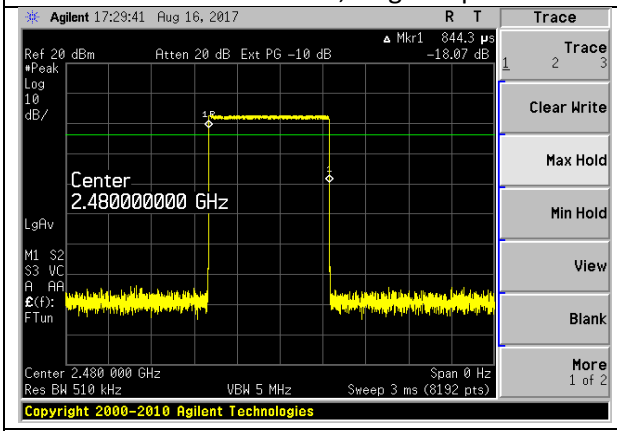
Low channel, 5 seconds



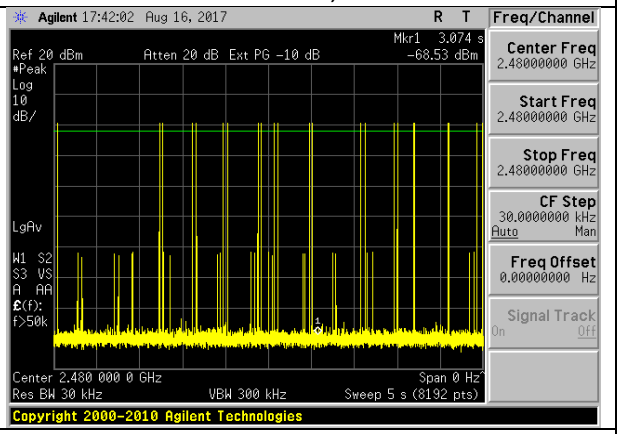
Middle channel, Single hop



Middle channel, 5 seconds

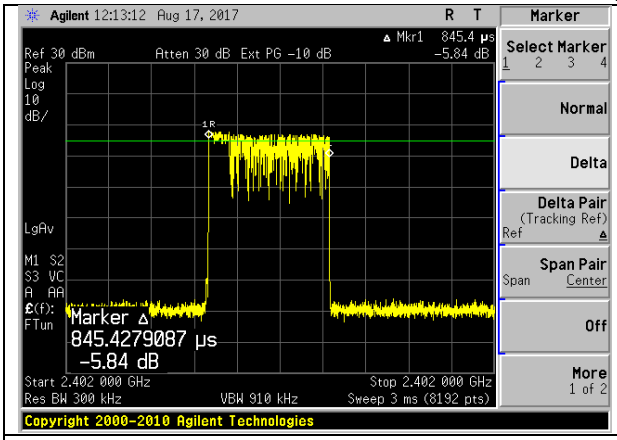


High channel, Single hop

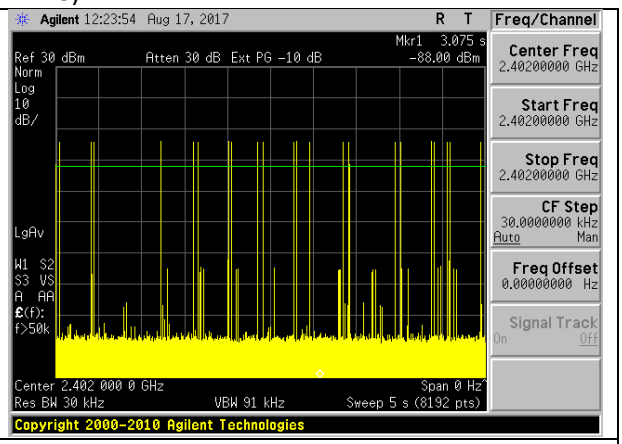


High channel, 5 seconds

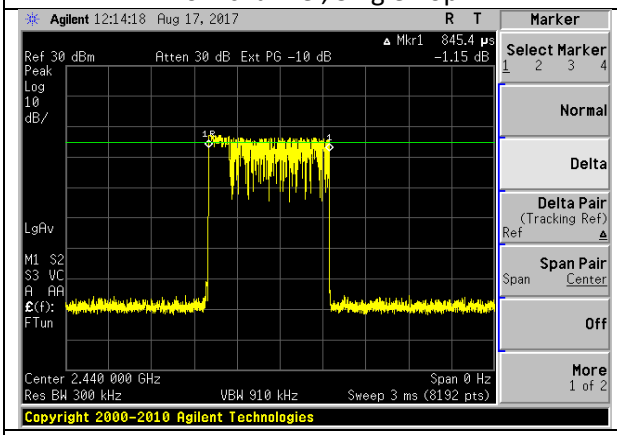
EDR2 (2MBPS)



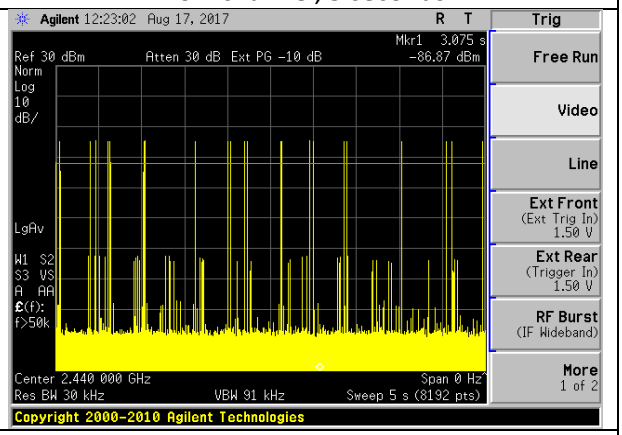
Low channel, Single hop



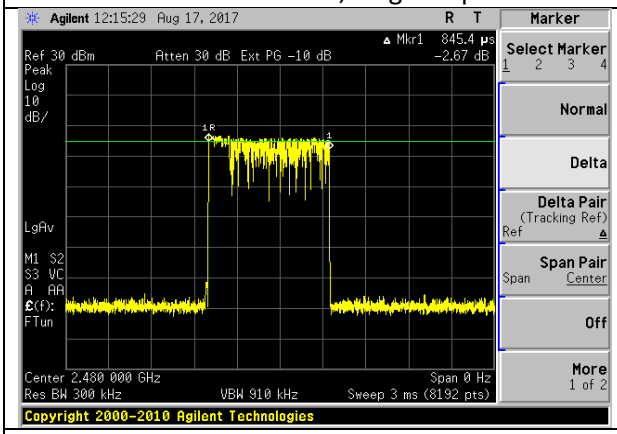
Low channel, 5 seconds



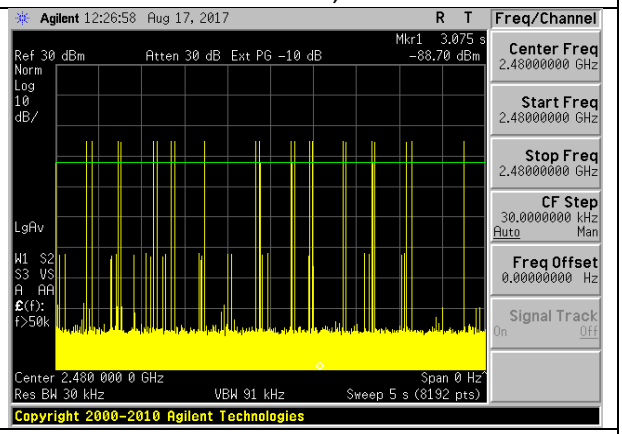
Middle channel, Single hop



Middle channel, 5 seconds

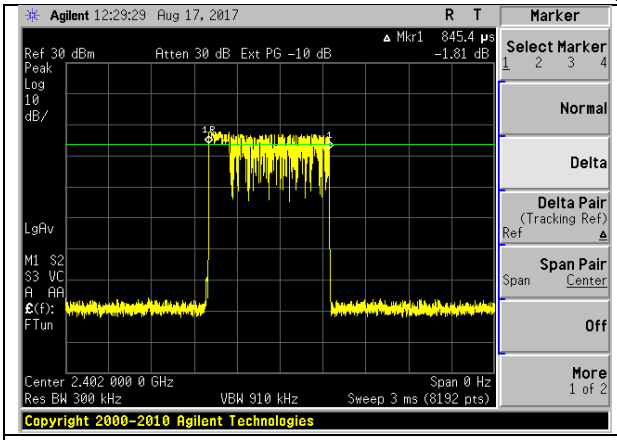


High channel, Single hop

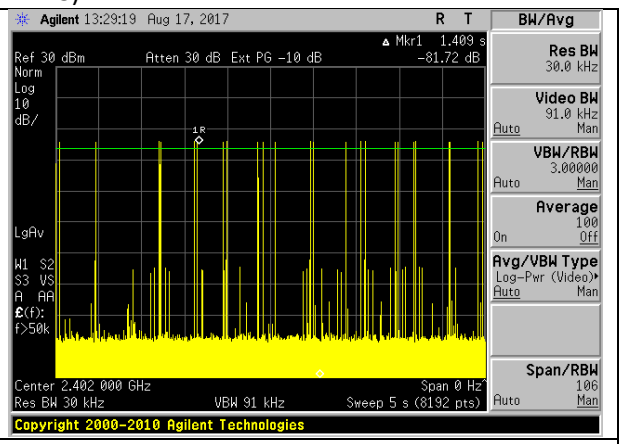


High channel, 5 seconds

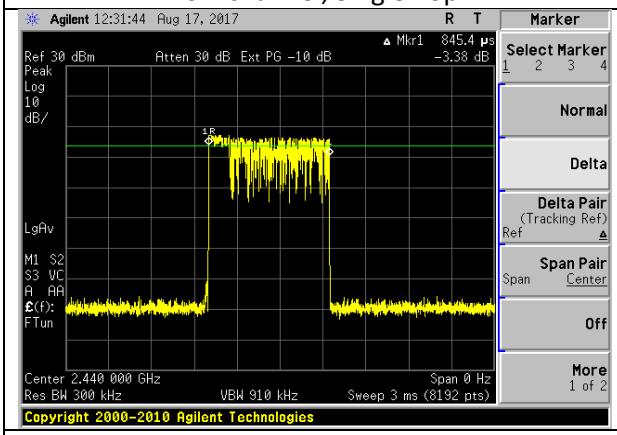
EDR3 (3MBPS)



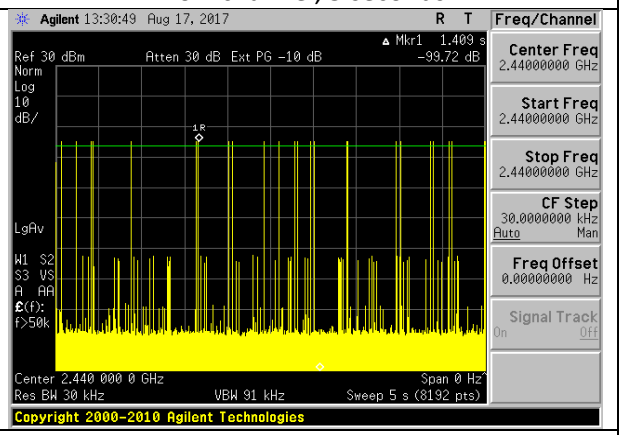
Low channel, Single hop



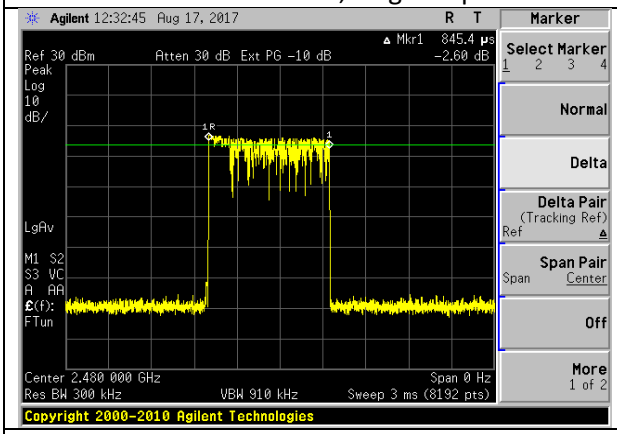
Low channel, 5 seconds



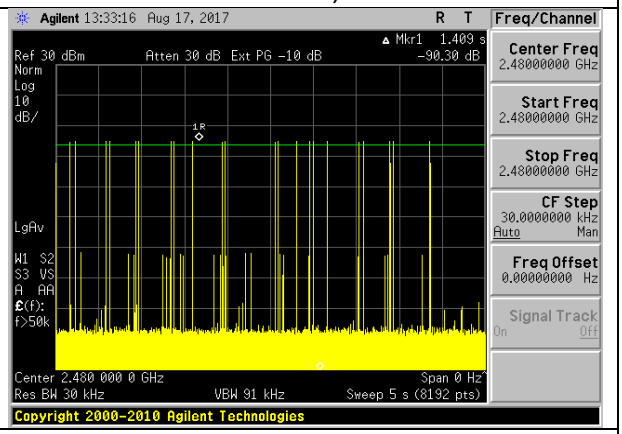
Middle channel, Single hop



Middle channel, 5 seconds



High channel, Single hop



High channel, 5 seconds

5.1.4 Antenna Port Conducted Emissions – Channel separation and number of channels

Operator	Zach Wilson
QA	Aidi Zainal
Test Date	8/17/2017
Location	Radio Bench
Temp. / R.H.	70 / 82
Requirement	FCC 15.247 a.1
Method	ANSI C63.10

Limits:

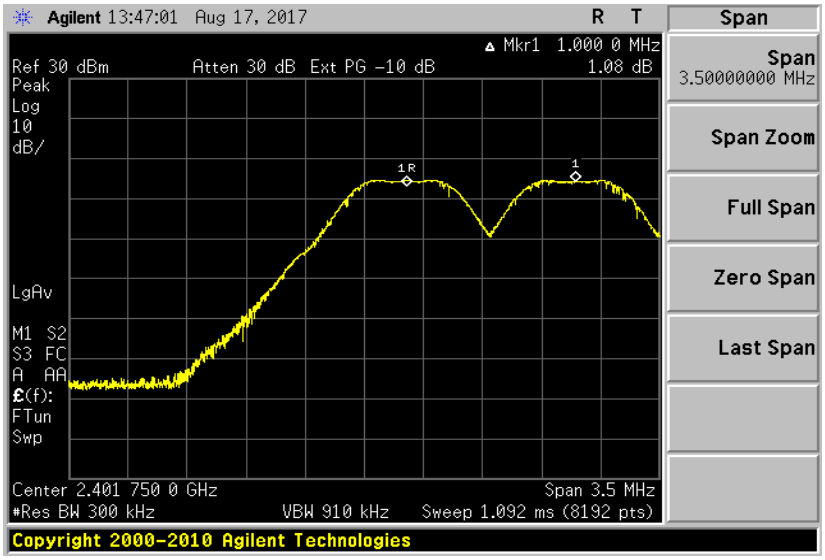
Channel separation: 25kHz, 20dB bandwidth or 2/3 of 20dB Bandwidth

Number of channels ≥ 15

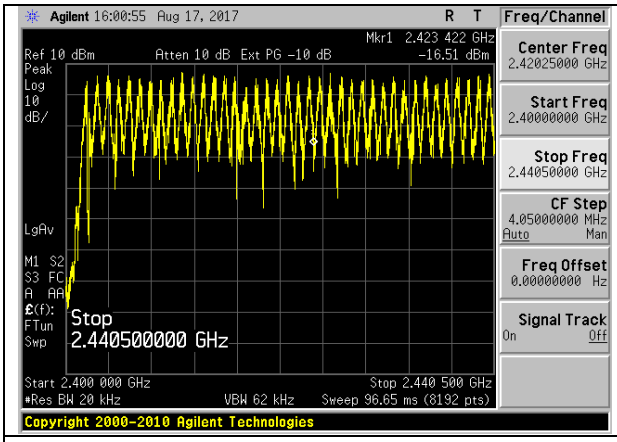
Test Parameters

Frequency	2402, 2440, 2480 MHz
Modulation	GFSK
VBW	910 kHz
RBW	300 kHz
Span	3.5 MHz

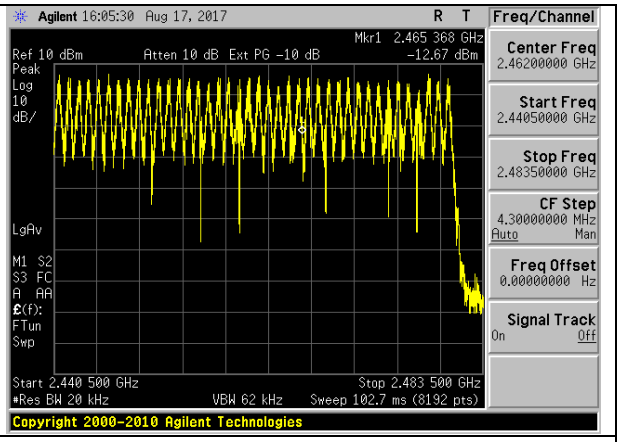
Data



Channel separation = 1MHz



2400 to 2440.5 MHz, 39 channels



2440.5 to 2483.5 MHz, 40 channels

Number of channels = 39 +40 = **79 channels.**

5.1.5 Antenna Port Conducted Emissions – Tx Conducted Spurious

Operator	Zach Wilson
QA	Aidi Zainal
Test Date	8/17/2017
Location	Conducted measurement area
Temp. / R.H.	72F / 76%
Requirement	15.247 (d)
Method	ANSI C63.10

Limits:

Spurious Emissions Limit (dBc from Reference Point)
20

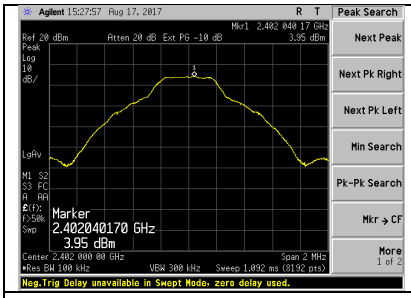
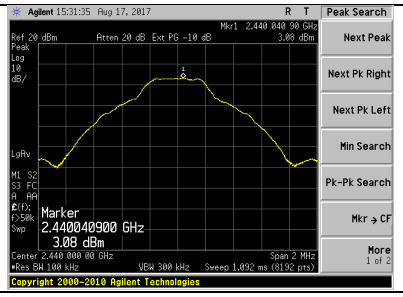
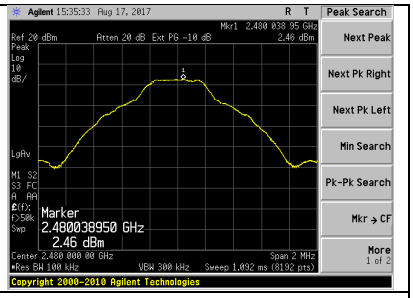
Test Parameters

Frequency	2402, 2440, 2480 MHz
Settings	Peak detector with Max hold
Settings	RBW=100kHz
Settings	VBW = 300kHz
EUT Spec	Spurious emissions < 20dBc
EUT Power	36 VDC via Teseq Variable Supply

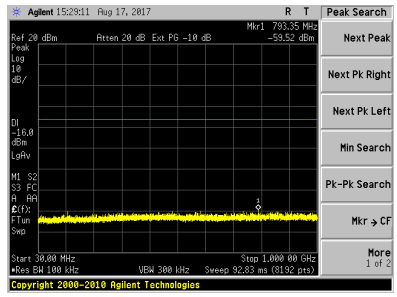
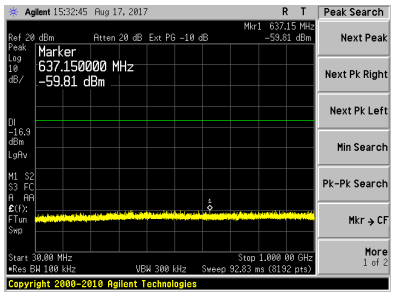
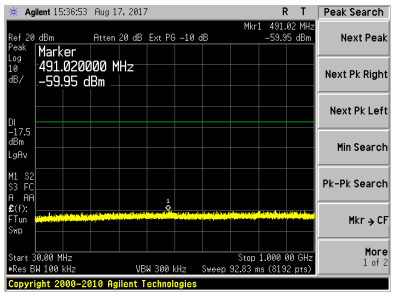
All emissions within the range of investigation were found to be greater than 20dB below the limit.

Plots

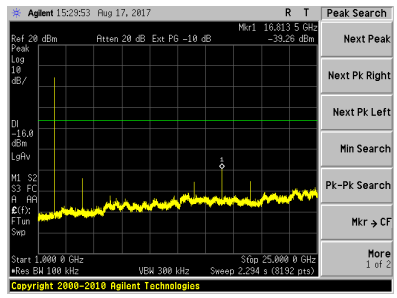
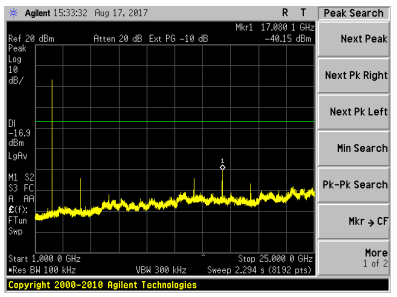
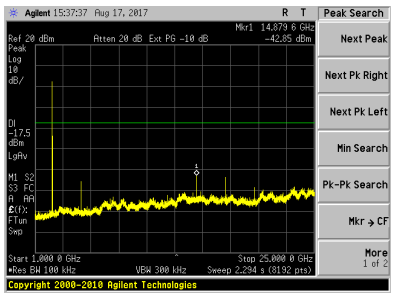
BR (1MBPS):

		
Low Channel	Middle Channel	High Channel

Reference level

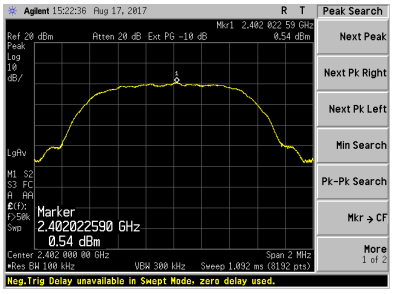
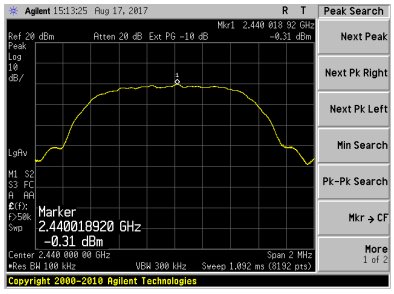
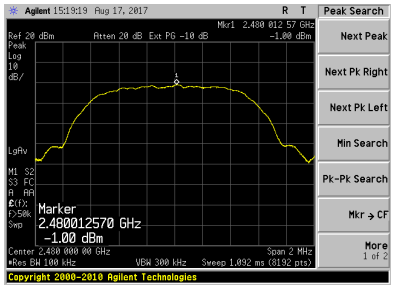
		
Low Channel	Middle Channel	High Channel

30MHz to 1000MHz

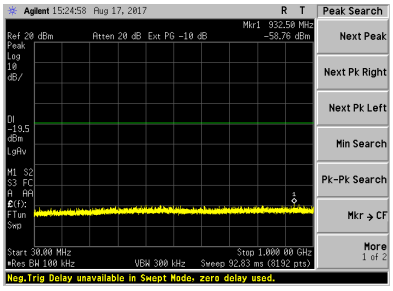
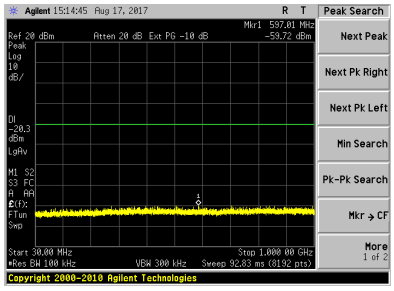
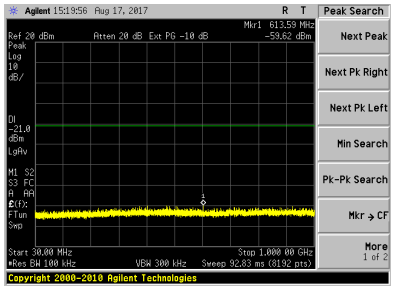
		
Low Channel	Middle Channel	High Channel

1000MHz to 25000MHz

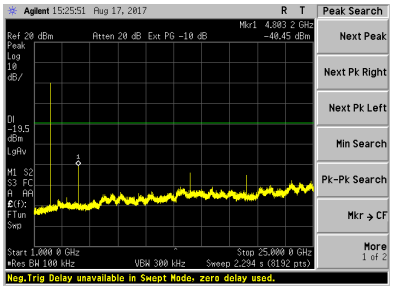
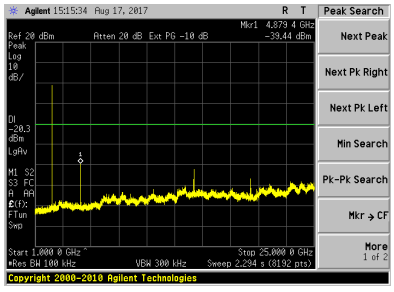
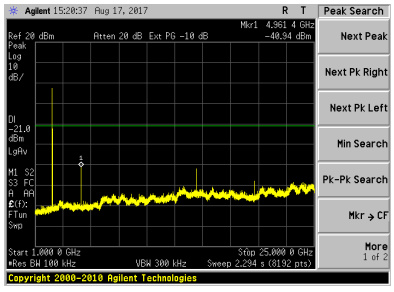
EDR2 (2MBPS):

		
Low Channel	Middle Channel	High Channel

Reference level

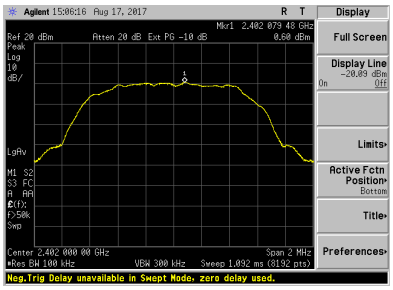
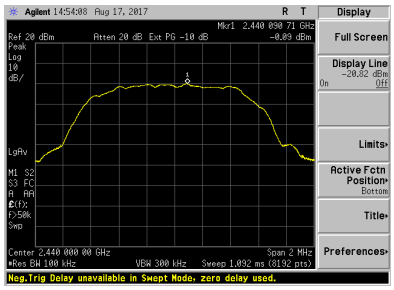
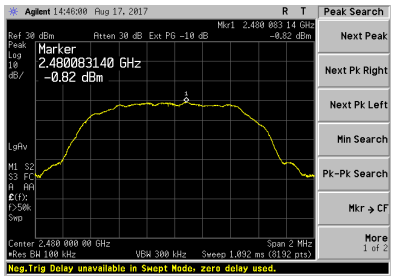
		
Low Channel	Middle Channel	High Channel

30MHz to 1000MHz

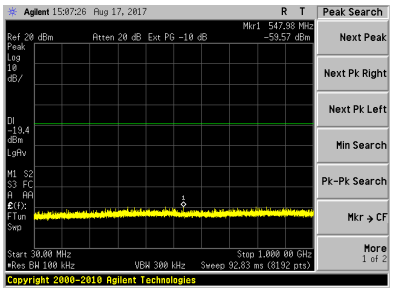
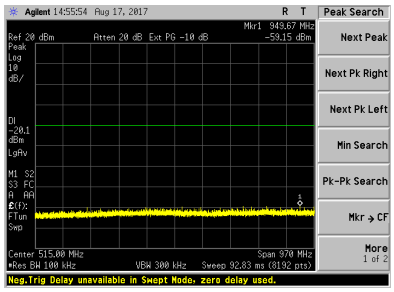
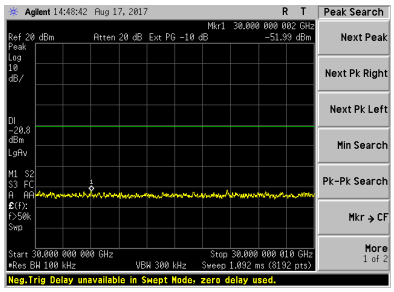
		
Low Channel	Middle Channel	High Channel

1000MHz to 25000MHz

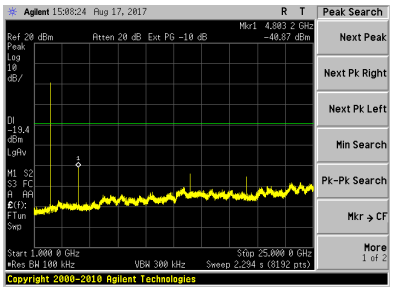
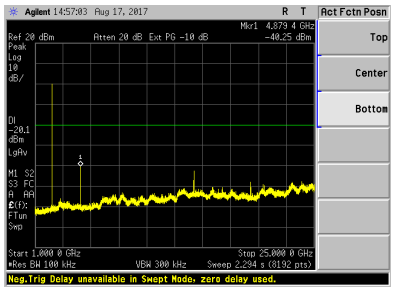
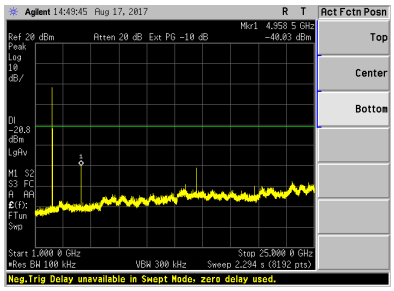
EDR3 (3MBPS):

		
Low Channel	Middle Channel	High Channel

Reference level

		
Low Channel	Middle Channel	High Channel

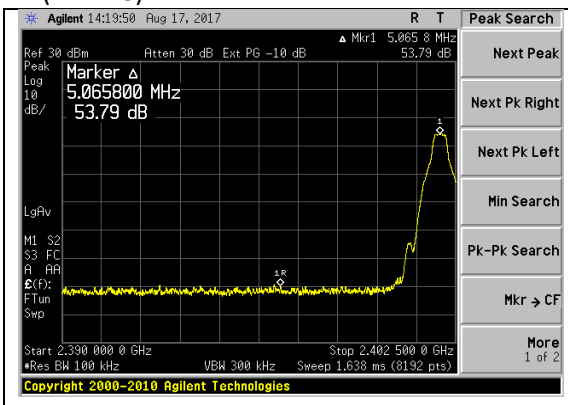
30MHz to 1000MHz

		
Low Channel	Middle Channel	High Channel

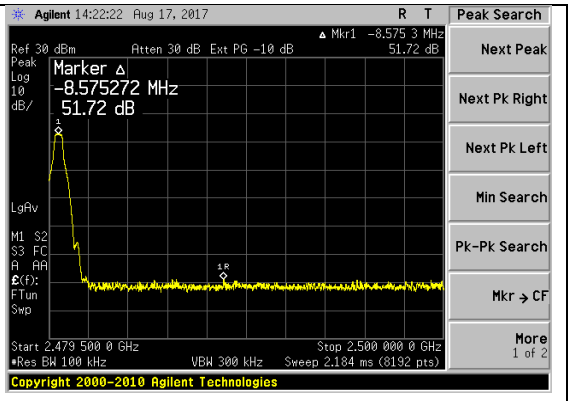
1000MHz to 25000MHz

Band-edges:

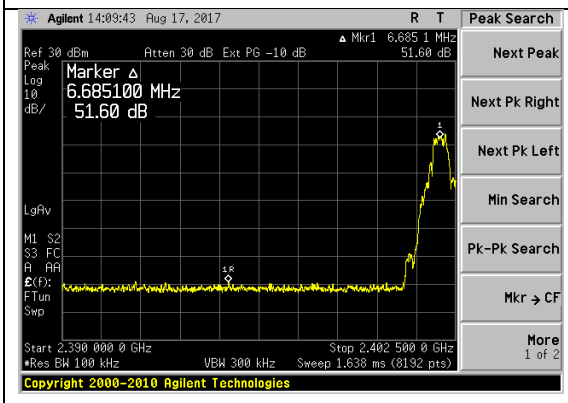
A. BR (1MBPS)



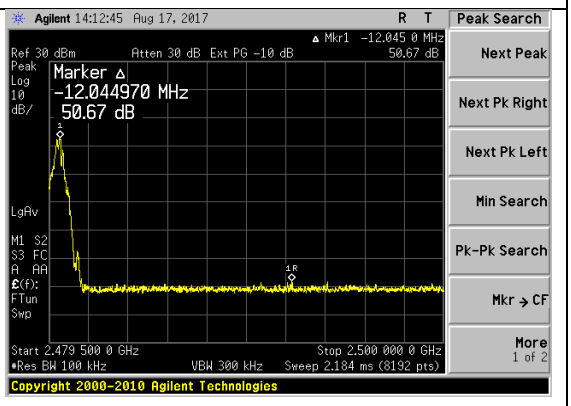
Lower Band Edge



Upper Band Edge

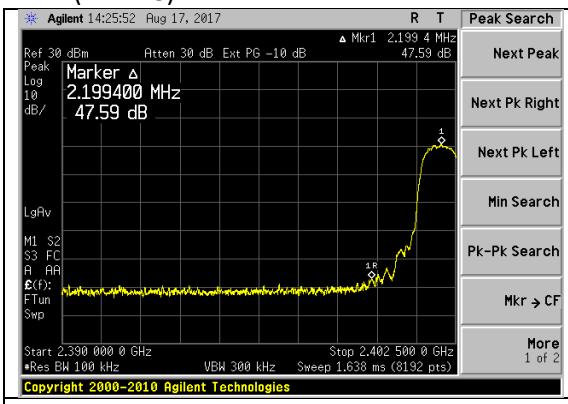


Lower Band Edge while hopping

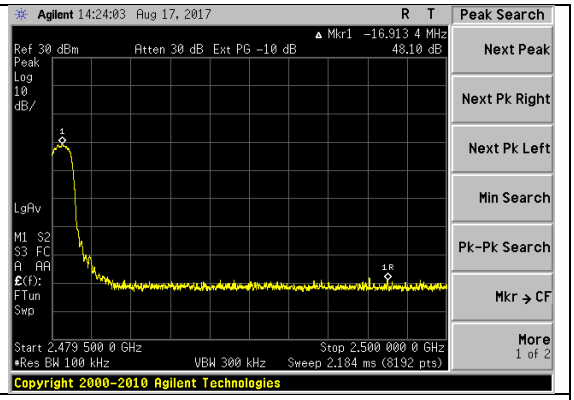


Upper Band Edge while hopping

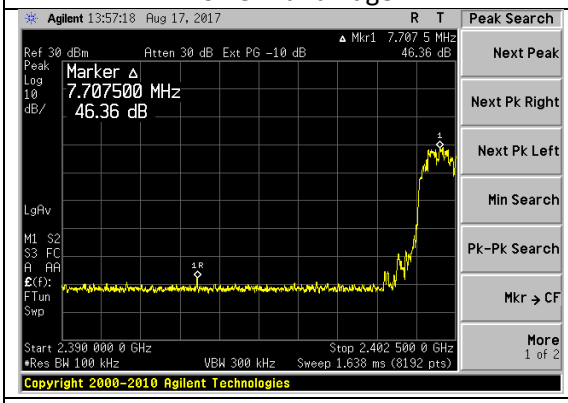
B. EDR2 (2MBPS)



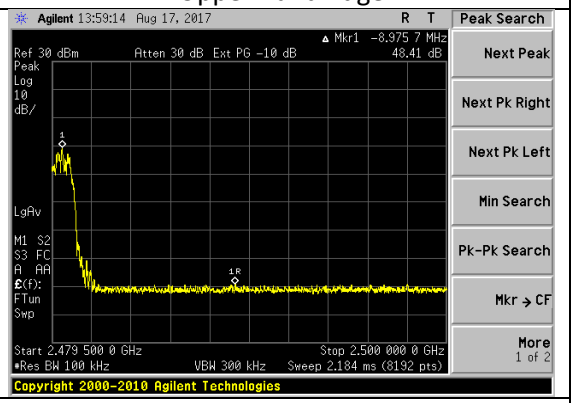
Lower Band Edge



Upper Band Edge

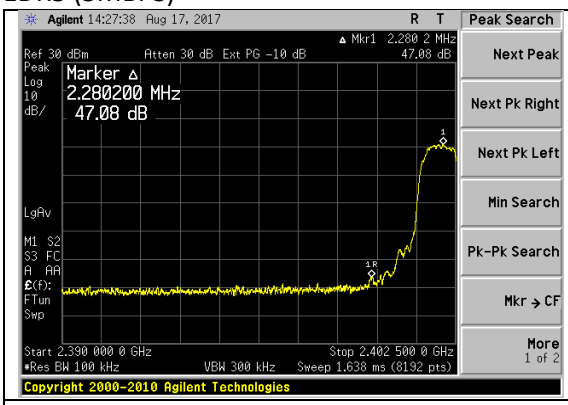


Lower Band Edge while hopping

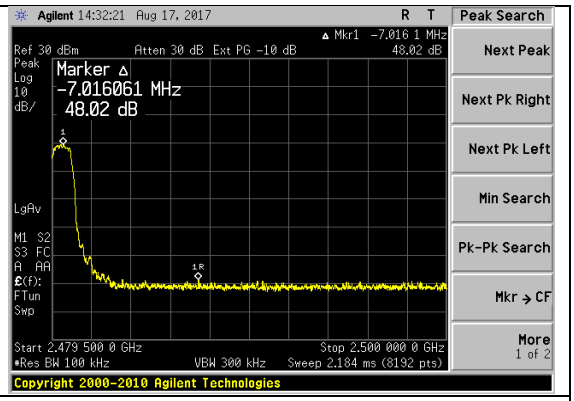


Upper Band Edge while hopping

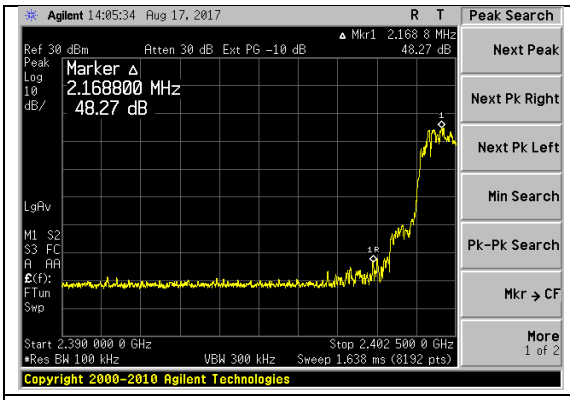
C. EDR3 (3MBPS)



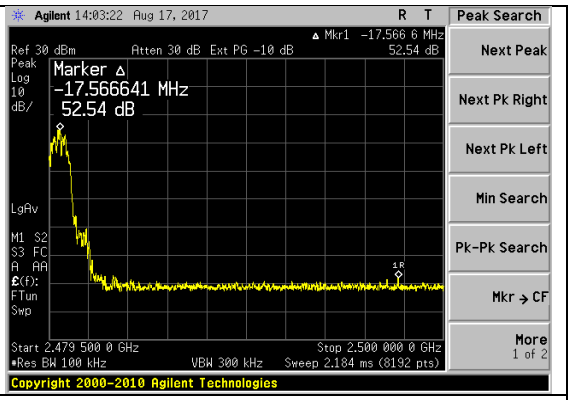
Lower Band Edge



Upper Band Edge



Lower Band Edge while hopping



Upper Band Edge while hopping

5.1.6 Antenna Port Conducted Emissions – Frequency Stability

Operator	Zach Wilson
QA	Aidi Zainal
Test Date	8/17/2017
Location	Radio Bench
Temp. / R.H.	70 / 82
Requirement	FCC 2.1055
Method	ANSI C63.10

Test Parameters

Frequency	2402, 2440, 2480 MHz
EUT Power	36 VDC, 30.6VDC and 41.4VDC

Data

	Supply Voltage				
	30.6 VDC	36.0 VDC	41.4VDC	Freq Deviation	Limit
Low channel (Hz)	2401986946	2401987876	2401987306	930	240200
Middle channel (Hz)	2439987441	2439987297	2439986878	563	244000
High channel (Hz)	2479986935	2479986633	2479987276	643	248000

5.1.7 Antenna Port Conducted Emissions – Equal Channel Usage

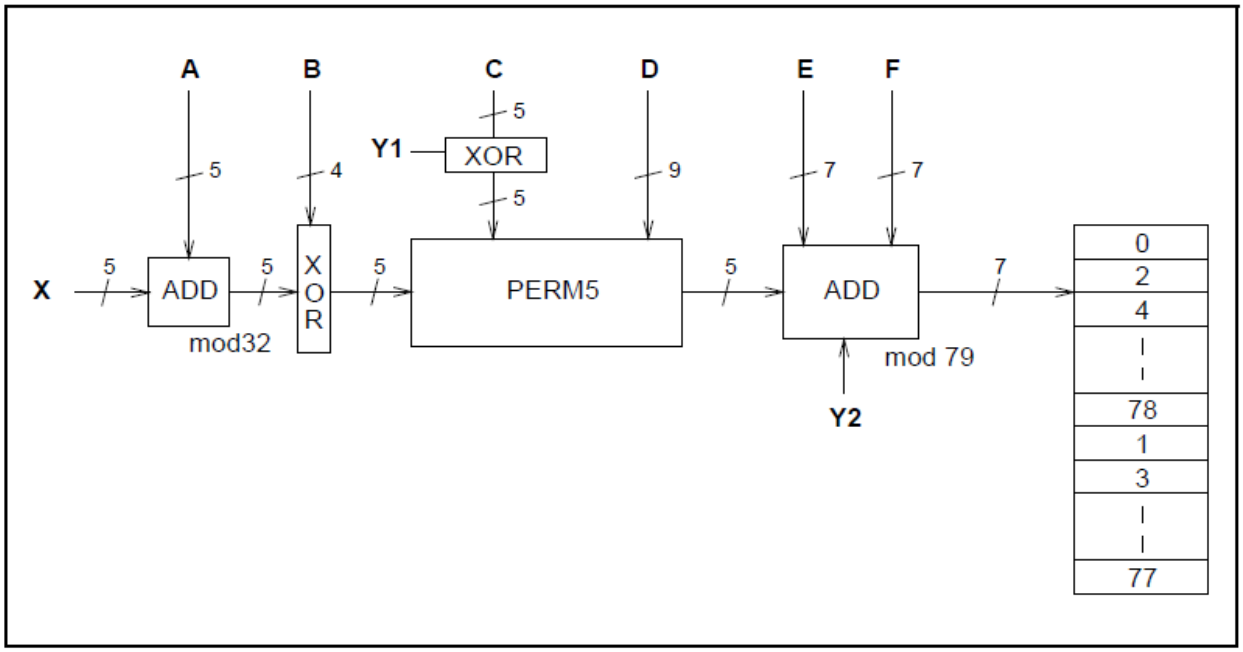
Operator	Aidi Zainal
QA	N/A
Test Date	N/A
Location	N/A
Temp. / R.H.	N/A
Requirement	N/A
Method	Declaration by manufacturer

The transceiver implemented in the EUT is a Bluetooth core specification V2.1 + EDR hence satisfies this requirement.

5.1.8 Antenna Port Conducted Emissions – Pseudorandom Hopping Sequence

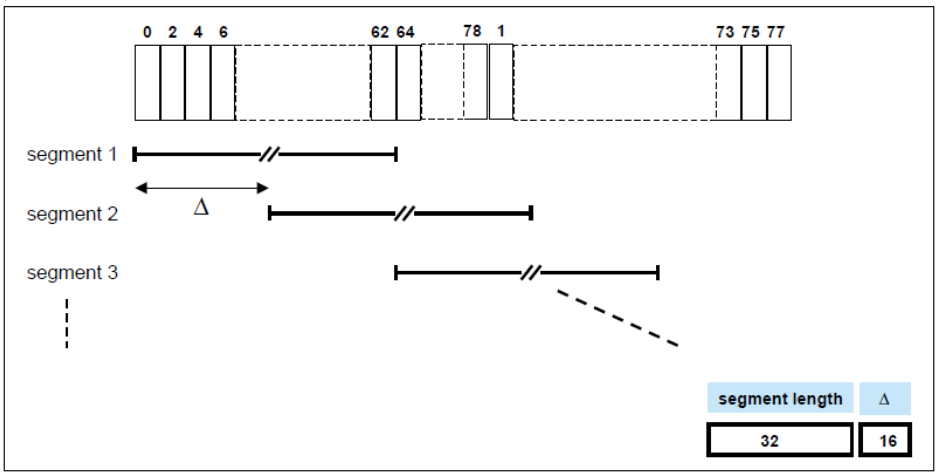
Operator	Aidi Zainal
QA	N/A
Test Date	N/A
Location	N/A
Temp. / R.H.	N/A
Requirement	N/A
Method	Declaration referencing Bluetooth Core specifications

Bluetooth devices use a hopping kernel to generate a hopping map. The figure below represents the basic hop selection kernel for the hop system. The output of the adder addresses a bank of 79 registers. The registers are loaded with the synthesizer code words corresponding to the hop frequencies 0 to 78. Note that the upper half of the bank contains the even hop frequencies, whereas the lower half of the bank contains the odd hop frequencies.



The X input determines the phase in the 32-hop segment, whereas Y1 and Y2 selects between master-to-slave and slave-to-master. The inputs A to D determine the ordering within the segment, the inputs E

and F determine the mapping onto the hop frequencies. The kernel addresses a register containing the RF channel indices. This list is ordered so that first all even RF channel indices are listed and then all odd hop frequencies. In this way, a 32-hop segment spans about 64 MHz and visits these hops in a pseudo-random order. Next, a different 32-hop segment is chosen, etc. When the basic channel hopping sequence is selected, the output constitutes a pseudo-random sequence that slides through the 79 hops. The principle is depicted below:



5.1.9 Antenna Port Conducted Emissions – Receiver synchronization and input bandwidth

Operator	Aidi Zainal
QA	N/A
Test Date	N/A
Location	N/A
Temp. / R.H.	N/A
Requirement	N/A
Method	Declaration referencing Bluetooth Core specifications

During the pairing process, the Master sets the data rate with the slave device. This will then determine the bandwidth of the receiver input. If a request is made for a change in data rate after pairing, the receiver bandwidth changes accordingly. This is set in the Bluetooth protocol.

During typical operation a physical radio channel is shared by a group of devices that are synchronized to a common clock and frequency hopping pattern. One device provides the synchronization reference and is known as the master. All other devices synchronized to a master's clock and frequency hopping pattern are known as slaves. A group of devices synchronized in this fashion form a piconet. This is the fundamental form of communication in the Bluetooth BR/EDR wireless technology.

Devices in a piconet use a specific frequency hopping pattern, which is algorithmically determined by certain fields in the Bluetooth address and clock of the master. The basic hopping pattern is a pseudo-random ordering of the 79 frequencies, separated by 1 MHz, in the ISM band. The hopping pattern can be adapted to exclude a portion of the frequencies that are used by interfering devices.

Each packet starts with an access code. If a packet header follows, the access code is 72 bits long, otherwise the access code is 68 bits long. This access code is used for synchronization, DC offset compensation and identification. The access code identifies all packets exchanged on the channel of the piconet: all packets sent in the same piconet are preceded by the same channel access code. In the receiver of the Bluetooth unit, a sliding correlator correlates against the access code and triggers when a threshold is exceeded. This trigger signal is used to determine the receive timing.

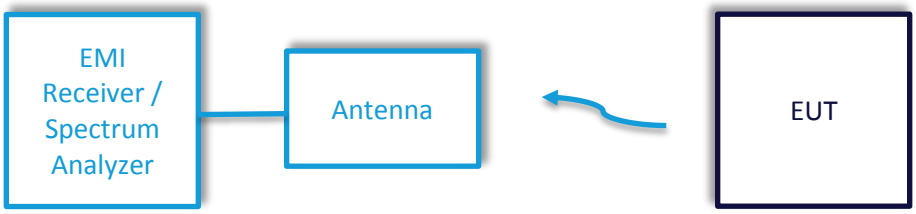
Slaves maintain an estimate of the master's native clock by adding a timing offset to the slave's native clock. This offset shall be updated each time a packet is received from the master. By comparing the

exact RX timing of the received packet with the estimated RX timing, slaves shall correct the offset for any timing misalignments. Since only the channel access code is required to synchronize the slave, slave RX timing can be corrected with any packet sent in the master-to-slave transmission slot.

5.2 Radiated Emissions

Description of Measurement	The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna. The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values. The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.
Example Calculations	Measurement (dBµV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBµV/m) Margin (dB) = Limit (dBµV/m) - Corrected Reading (dBµV/m) Example at 4000 MHz: Reading = 40 dBµV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBµV/m Average Limit = 20 log (500) = 54 dBµV/m Margin = 54 dBµV/m - 50.8 dBµV/m = 3.2 dB

Block Diagram



Instrumentation

Laird
Smart Technology. Delivered.

Date : 31-Jul-2017 Test : Radiated Emissions Job # : C-2771

PE: Aidi Customer : Lincoln Electric Quote #: 317246

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2017	5/12/2018	Active Calibration
2	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	10/13/2016	10/13/2017	Active Calibration
3	EE 960159	Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	462101702	4/12/2017	4/12/2018	Active Calibration
4	AA 960154	High Pass Filter 2.4 GHz	KWM	HPF-L-14186	7272-02	7/25/2016	8/24/2017	Active Calibration
5	EE 960087	Spectrum Analyzer	Agilent	N9010A	MY53400296	12/22/2016	12/22/2017	Active Calibration
6	AA 960176	Cable - low loss 6m	A.H. Systems, Inc.	SAC-26G-6	395	5/15/2017	5/15/2018	Active Verification
7	AA 960174	Small Horn Antenna	ETS Lindgren	3116C-PA	00206880	5/1/2017	5/1/2018	Active Calibration

5.2.1 Radiated Emissions

Operator	Zach Wilson, Aidi Zainal
QA	Aidi Zainal, Coty Hammerer
Test Date	8/1/17 to 8/10/17
Location	5m Chamber
Temp. / R.H.	75 °F / 55%
Requirement	15.247 (d)
Method	ANSI C63.10 Sections 6.3, 6.5, 6.6

Limits:

	30-88 MHz	88-216 MHz	216 – 960 MHz	960+ MHz
Field Strength (µV/m)	100	150	200	500
Field Strength (dBµV/m)	40.0	43.5	46.0	54.0

Test Parameters

Frequency	30MHz to 25000MHz
Distance	3 meters
RBW	1 MHz
VBW	Avg 30 Hz, Peak 50 MHz

Notes	EUT tested in orientation declared by customer as normal operation
Example Calculation	Limit (dBµV) = 20* Log[Limit (µV)] 40 = 20* log (100) Raw Data + Antenna Factor + Cable Factor = Reported Data 19.77 dBµV + 12.50 dB/m + 0.93 dB = 38.80 dBµV/m

Table

Table

A. Emissions in the 30MHz to 1000MHz range

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
33.4	1.00	194	42.5	49.5	7.0	Vertical	TT
45.9	1.00	119.5	38.3	49.5	11.2	Vertical	TT
120.0	1.00	175.5	40.53	54.0	13.5	Vertical	TT
180.0	1.00	149.5	40.21	54.0	13.8	Vertical	TT
540.0	1.00	0	46.2	57.0	10.8	Horizontal	TT
600.0	1.00	133	47.3	57.0	9.7	Vertical	TT

Note:

1. All Emissions seen in this range was determined to be NOT a function of the radio. The emissions seen originates from the digital portion of the product which is classified as a class A industrial product.
2. TT = Table top

B. Band-edge emissions

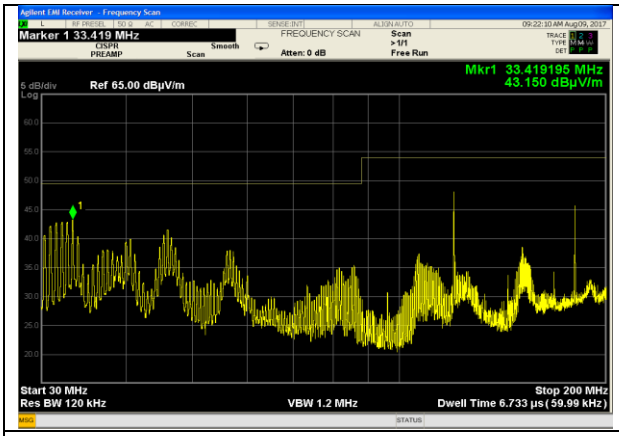
Data rate	Frequency (MHz)	Peak (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dB)	Frequency (MHz)	Average (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)	
1MBPS	2485.7	61.3	74.0	12.7	2485.3	47.8	54.0	6.2	UBE
2MBPS	2483.8	62.5	74.0	11.5	2483.5	48.2	54.0	5.9	
3MBPS	2492.4	61.6	74.0	12.5	2483.5	48.2	54.0	5.8	
1MBPS	2347.3	59.3	74.0	14.7	2370.4	44.9	54.0	9.1	LBE
2MBPS	2369.2	58.9	74.0	15.1	2389.6	45.0	54.0	9.0	
3MBPS	2366.3	59.5	74.0	14.5	2389.6	45.0	54.0	9.0	

C. Emissions in the 1000MHz to 25000MHz range

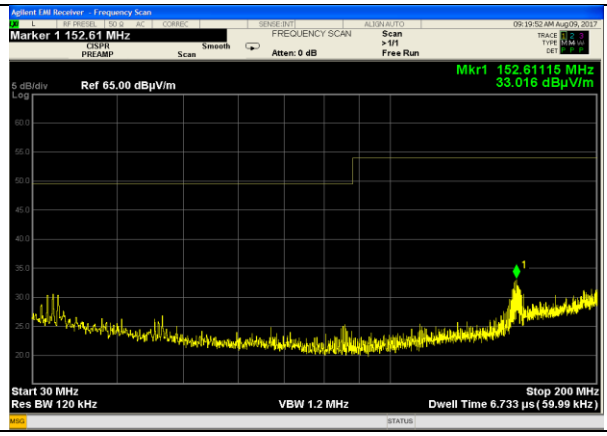
Frequency (GHz)	Peak (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dB)	Average (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)	Azimuth (degrees)	Height (cm)	Polarity
4.804	53.5	74.0	20.5	50.5	54.0	3.5	194.5	100.0	Vertical
4.798	55.6	74.0	18.4	53.1	54.0	0.9	229.3	200.9	Horizontal
4.960	55.1	74.0	18.9	52.8	54.0	1.2	231.3	261.6	Vertical
1.080	56.4	74.0	17.6	47.2	54.0	6.8	157.0	199.0	Horizontal
14.878	56.8	74.0	17.2	47.0	54.0	7.0	233.8	113.7	Horizontal
17.356	60.9	74.0	13.1	50.2	54.0	3.8	234.8	105.3	Vertical
17.080	60.7	74.0	13.3	50.6	54.0	3.4	236.5	103.6	Vertical
17.080	61.1	74.0	12.9	51.6	54.0	2.4	233.5	279.2	Horizontal
19.216	55.2	74.0	18.8	38.8	54.0	15.2	58.8	185.3	Horizontal
19.520	55.1	74.0	18.9	38.8	54.0	15.2	235.8	149.6	Horizontal
19.840	56.0	74.0	18.0	39.5	54.0	14.5	231.3	211.9	Horizontal
19.216	56.5	74.0	17.5	38.6	54.0	15.4	32.3	150.0	Vertical
19.520	54.6	74.0	19.4	38.7	54.0	15.3	198.3	150.0	Vertical
19.840	55.0	74.0	19.0	38.4	54.0	15.6	200.8	153.9	Vertical
16.814	62.4	74.0	11.6	52.6	54.0	1.4	232.5	285.3	Horizontal
4.804	53.5	74.0	20.5	50.5	54.0	3.5	194.5	100.0	Vertical
16.815	62.2	74.0	11.8	52.7	54.0	1.3	232.8	100.0	Vertical

Plots

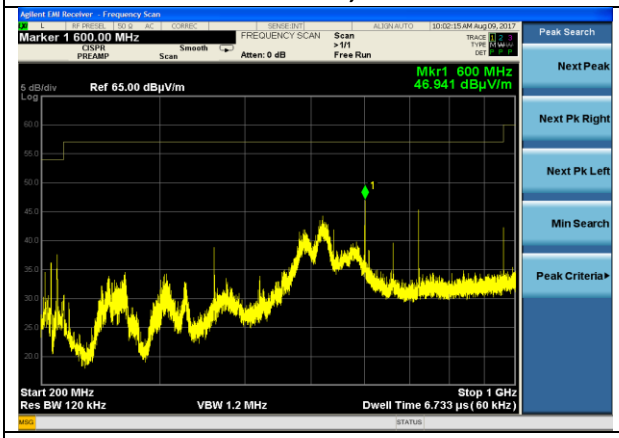
30MHz to 1000 MHz



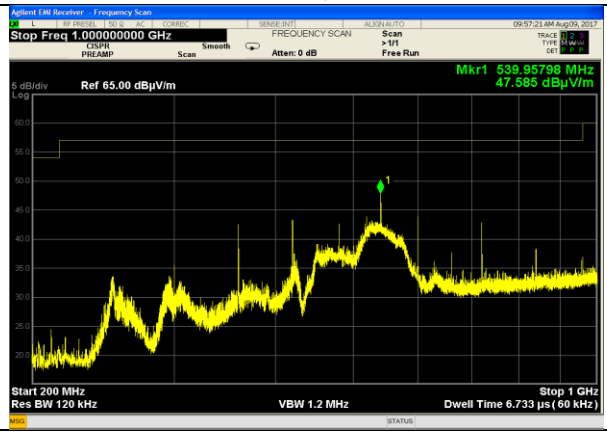
30 to 200 MHz, Vertical



30 to 200 MHz, Horizontal

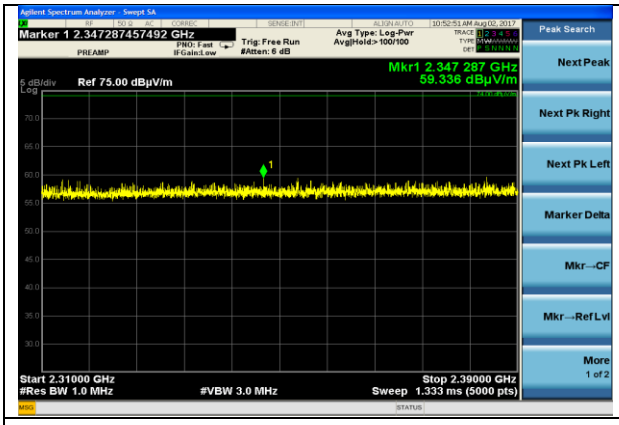


200 to 1000 MHz, Vertical

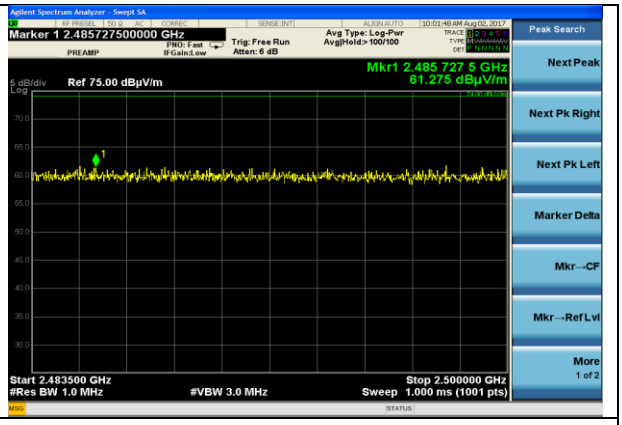


200 to 1000 MHz, Horizontal

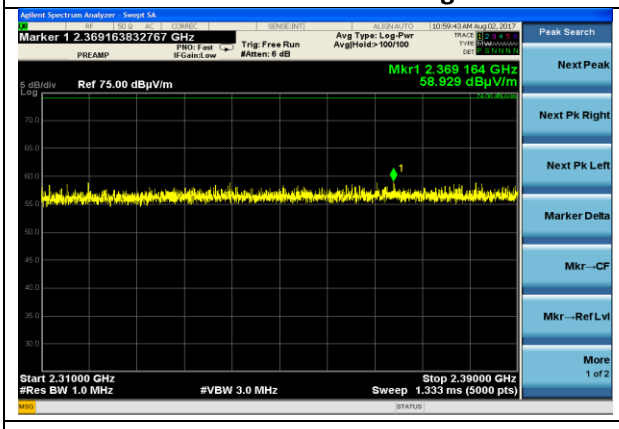
2310 to 2390 MHz, 2483.5 to 2500 MHz
PEAK



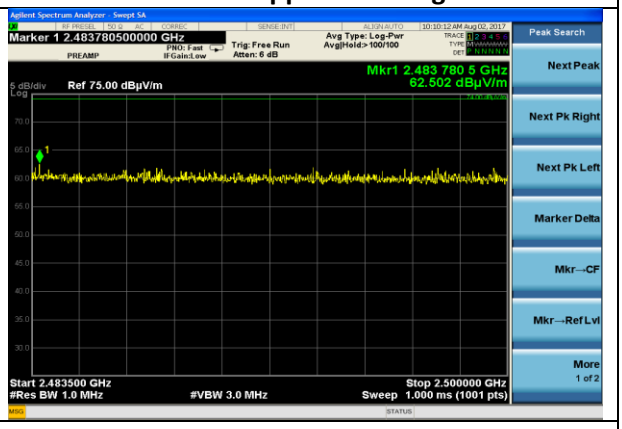
1 MBPS Lower Band Edge



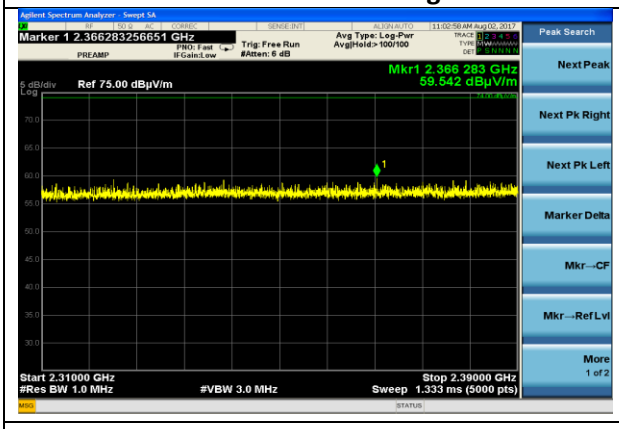
1 MBPS Upper Band Edge



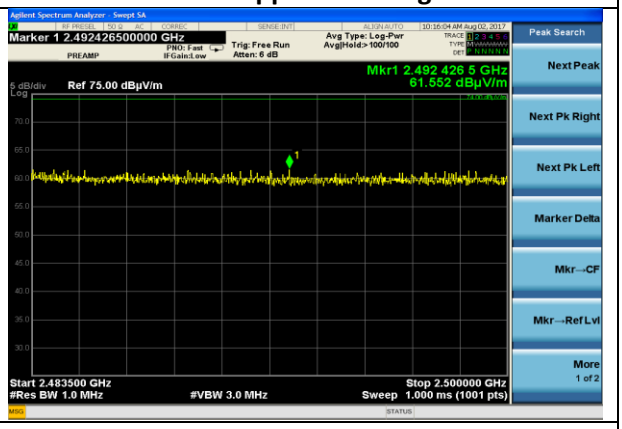
EDR2 Lower Band Edge



EDR2 Upper Band Edge

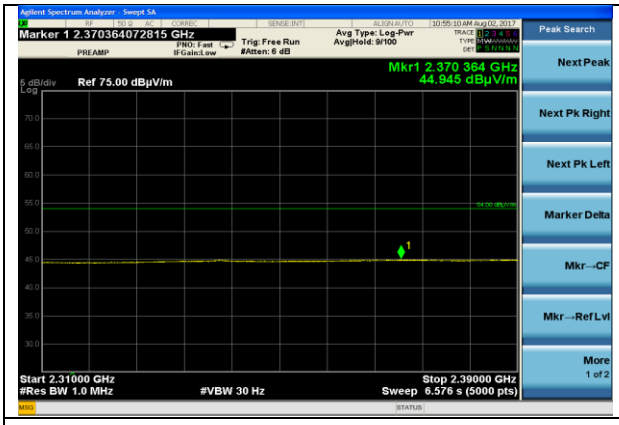


EDR3 Lower Band Edge

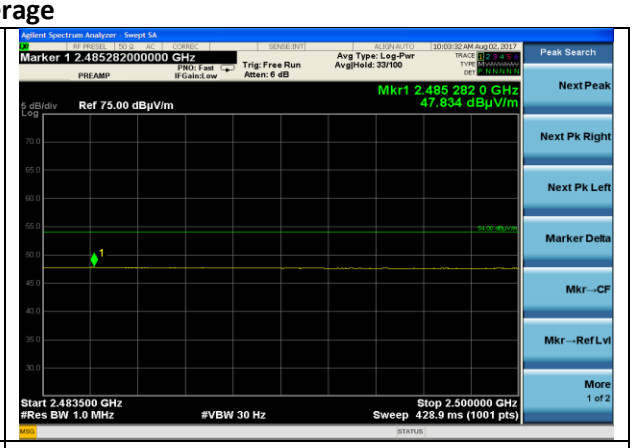


EDR3 Upper Band Edge

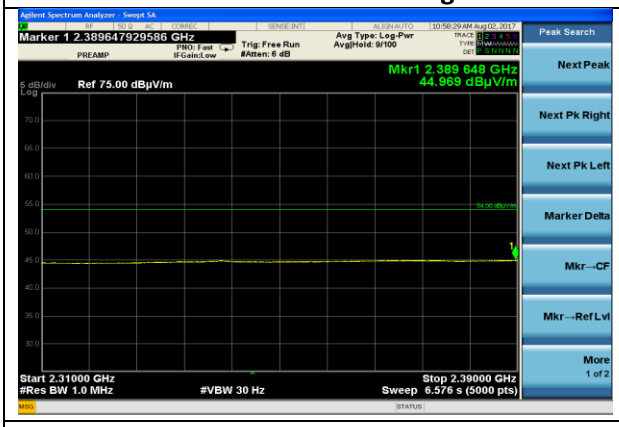
Average



1 MBPS Lower Band Edge

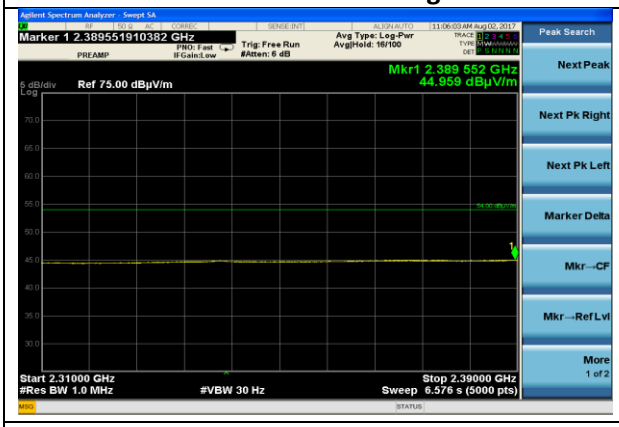


1 MBPS Upper Band Edge



EDR2 Lower Band Edge

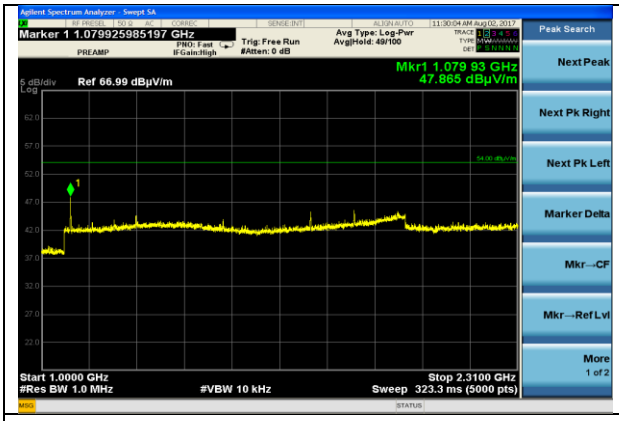
EDR2 Upper Band Edge



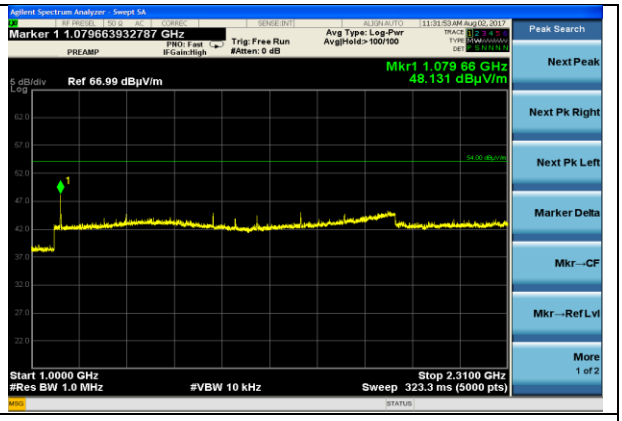
EDR3 Lower Band Edge

EDR3 Upper Band Edge

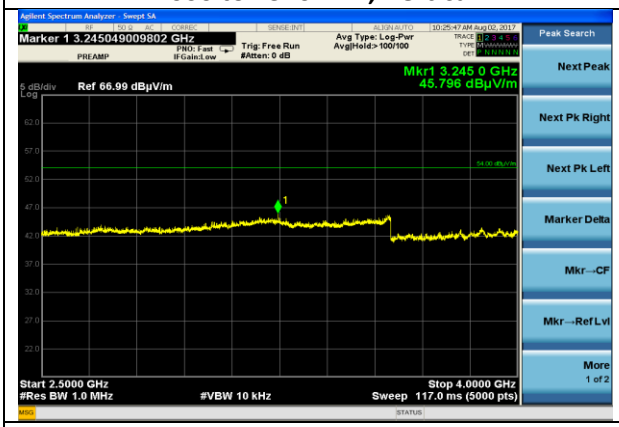
1000 to 4000 MHz



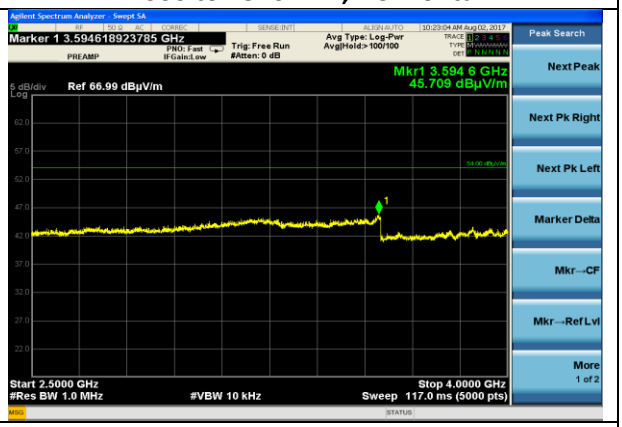
1000 to 2310MHz, Vertical



1000 to 2310MHz, Horizontal



2500 to 4000MHz, Vertical



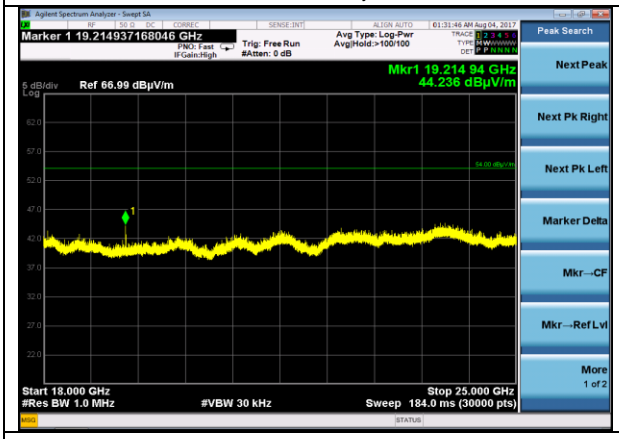
2500 to 4000MHz, Horizontal

Plots are taken with reduced video bandwidth in the interest of dynamic range

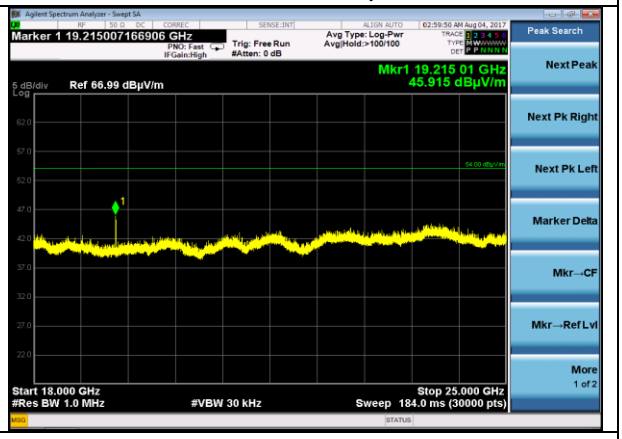
4000 to 25000MHz

4000 to 18000 MHz, Horizontal

4000 to 18000 MHz, Vertical



18000 to 25000 MHz, Horizontal



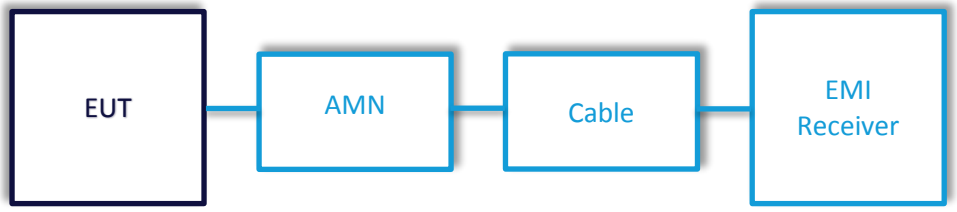
18000 to 25000 MHz, Vertical

Plots are taken with reduced video bandwidth in the interest of dynamic range

5.3 AC Mains Conducted Emissions

	A line impedance stabilization network (LISN) or artificial mains network (AMN) allows the emissions of the power supply conductors to be measured while isolating the EUT from the supply mains.
Description of Measurement	The AMN, cable, and other necessary measurement system correction factors are loaded onto the EMI receiver when the measurements are performed. The data is gathered and reported as the corrected values. Maximum emissions are determined with a peak max hold trace then measurements at a selection of the highest points are made with quasi-peak and average detectors. Results are recorded and compared to limit for each line. (e.g. line and neutral)
Example Calculations	Measurement (dBµV) + Cable factor (dB) + Other (dB) = Corrected Reading (dBµV) Margin (dB) = Limit (dBµV) - Corrected Reading (dBµV)

Block Diagram



5.3.1 AC Mains Conducted Emissions

Operator	Aidi Zainal
QA	Adam Alger
Test Date	8/16/2017
Location	Conducted Area
Temp. / R.H.	70F / 77%
Requirement	FCC: 15.207 IC: RSS-GEN 8.8
Method	ANSI C63.10 Section 6.2

Limits:

Frequency of Emission (MHz)	Quasi-Peak Limit (dBuV)	Average Limit (dBuV)
0.15 - 0.50	66 to 56	56 to 46
0.5 – 5	56	46
5-30	60	50

Test Parameters

Frequency	150 kHz - 30 MHz
Settings	RBW 9 kHz
Settings	VBW 90 kHz
EUT Power	36VDC, supplied by generic AC to DC (which is powered via 120VAC)

Instrumentation

Laird
Smart Technology. Delivered.

Date : 31-Jul-2017 Test : AC Mains emissions Job # : C-2771

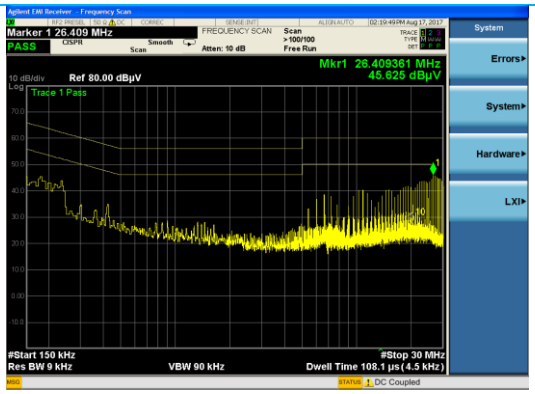
PE: Aidi Customer : Lincoln Electric Quote #: 317246

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960089	LISN	COM-POWER	LI-215A	191943	3/13/2017	3/13/2018	Active Calibration
2	EE 960088	EMI Receiver	Agilent	N9038A	MY51210138	3/2/2017	3/2/2018	Active Calibration

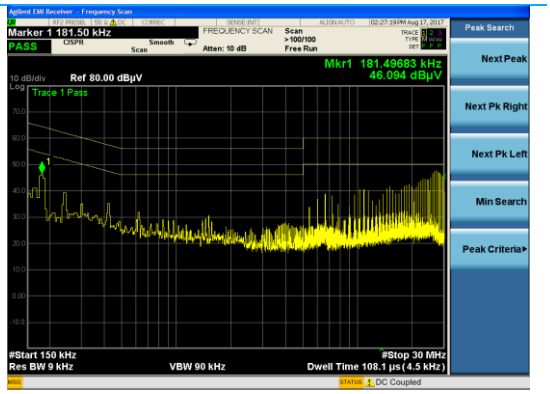
Table

		Quasi-Peak			Average		
Frequency (MHz)	Line	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)
0.187	1	41.1	64.2	23.1	32.7	54.2	21.5
10.806	1	39.7	60.0	20.3	38.7	50.0	11.3
22.208	1	42.8	60.0	17.2	41.6	50.0	8.4
27.611	1	44.6	60.0	15.4	42.8	50.0	7.2
0.180	2	44.9	64.5	19.6	34.1	54.5	20.4
10.203	2	39.7	60.0	20.3	38.6	50.0	11.4
27.013	2	46.9	60.0	13.1	45.5	50.0	4.5

Plots



Line 1



Line 2

6 REVISION HISTORY

Version	Date	Notes	Person
V0	9/14/17	Draft	Aidi Zainal
V1	10/6/17	Final	Aidi Zainal

END OF REPORT