Impinj Inc.

TEST REPORT FOR

Speedway Revolution
IPJ-REV-R220

Tested to The Following Standards:

FCC Part 15 Subpart C Section(s)

15.207 & 15.247
(FHSS 902-928 MHz)

Report No.: 101403-2

Date of issue: August 16, 2018

This test report bears the accreditation symbol indicating that the testing performed herein meets the test and reporting requirements of ISO/IEC 17025 under the applicable scope of testing for CKC Laboratories, Inc.

We strive to create long-term, trust based relationships by providing sound, adaptive, customer first testing services. We embrace each of our customers' unique EMC challenges, not as an interruption to set processes, but rather as the reason we are in business.

Test Certificate # 803.05

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

Impinj Inc.
400 Fairview Ave. N
Suite 1200
Seattle, WA 98109

Representative: Greg Robinson
Customer Reference Number: 701820

REPORT PREPARED BY:

Terri Rayle
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 101403

DATE OF EQUIPMENT RECEIPT: August 11, 2018
DATE(S) OF TESTING: August 11, 2018

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the equipment provided by the client, tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.

Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Test Facility Information

Our laboratories are configured to effectively test a wide variety of product types. CKC utilizes first class test equipment, anechoic chambers, data acquisition and information services to create accurate, repeatable and affordable test results.

TEST LOCATION(S):
CKC Laboratories, Inc.
22116 23rd Drive S.E., Suite A
Canyon Park, Bothell, WA 98021

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.11

Site Registration & Accreditation Information

Location	NIST CB #	TAIWAN	CANADA	FCC	JAPAN
Canyon Park Bothell, WA	US0081	SL2-IN-E-1145R	3082C-1	US1022	A-0148

SUMMARY OF RESULTS

Standard / Specification: FCC Part 15 Subpart C - 15.247 (FHSS 902-928MHz)

Test Procedure	Description	Modifications	Results
15.247(a)(1)(i)	Occupied Bandwidth	NA	NP
15.247(a)(1)	Carrier Separation	NA	NP
15.247(a)(1)(i)	Number of Hopping Channels	NA	NP
15.247(a)(1)(i)	Average Time of Occupancy	NA	NP
15.247(b)(2)	Output Power	NA	NP
15.247(d)	RF Conducted Emissions & Band Edge	NA	NP
15.247(d)	Radiated Emissions & Band Edge	NA	Pass
15.207	AC Conducted Emissions	NA	NP

NA = Not Applicable
NP = CKC Laboratories was not contracted to perform test.

ISO/IEC 17025 Decision Rule
The declaration of pass or fail herein is based upon assessment to the specification(s) listed above, including where applicable, assessment of measurement uncertainties. For performance related tests, equipment was monitored for specified criteria identified in that section of testing.

Modifications During Testing

This list is a summary of the modifications made to the equipment during testing.

Summary of Conditions
No modifications were made during testing.

Modifications listed above must be incorporated into all production units.

Conditions During Testing

This list is a summary of the conditions noted to the equipment during testing.

Summary of Conditions
None

EQUIPMENT UNDER TEST (EUT)

During testing, numerous configurations may have been utilized. The configurations listed below support compliance to the standard(s) listed in the Summary of Results section.

Configuration 1

Equipment Tested:

Device	Manufacturer	Model #	S/N
Speedway Revolution	Impinj Inc.	IPJ-REV-R220	37016201091
AC Adaptor	CUI, Inc.	SDI50-24-U	NA
Circular Polarized UHF Antenna	Times-7	SlimLine - A5010	0008640

Support Equipment:

Device	Manufacturer	Model #	S/N
Laptop	Dell	Latitude E7240	NA
8-Port Gigabit Desktop Switch with 8-Port PoE	TP-Link	TL-SG1008PE	2159470000322
AC Adaptor	Dell	LA65NM130	NA

Configuration 2

Equipment Tested:

Device	Manufacturer	Model #	S/N
Speedway Revolution	Impinj Inc.	IPJ-REV-R220	37016201091
AC Adaptor	CUI, Inc.	SDI50-24-U	NA
Circular Polarized UHF Antenna	Times-7	SlimLine - A5020	NA

Support Equipment:

Device	Manufacturer	Model #	S/N
Laptop	Dell	Latitude E7240	NA
8-Port Gigabit Desktop Switch with 8-Port PoE	TP-Link	TL-SG1008PE	2159470000322
AC Adaptor	Dell	LA65NM130	NA

General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Stand-Alone Equipment
Type of Wideband System:	UHF RFID
Operating Frequency Range:	902-928MHz
Number of Hopping Channels:	50
Modulation Type(s):	ASK
Maximum Duty Cycle:	100%
Number of TX Chains:	1
Antenna Type(s) and Gain:	Circular Polarized UHF Antenna Slimline A5010, 8.5dBiC Circular Polarized UHF Antenna Slimline A5020, 5.5dBiC
Beamforming Type:	NA
Antenna Connection Type:	External Connector
Nominal Input Voltage:	24Vdc
Firmware / Software used for Test:	Impinj Item Test V1.4.1.0

FCC Part 15 Subpart C

15.247(d) Radiated Emissions & Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 22116 23rd DR SE • Bothell WA, 98021 • (425) 402-1717		
Customer:	**Impinj Inc.**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**101403**	Date:	8/11/2018
Test Type:	**Maximized Emissions**	Time:	11:52:25
Tested By:	Steven Pittsford	Sequence#:	1
Software:	EMITest 5.03.11		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Frequency Range: 9kHz-10GHz (No emissions observed below 30MHz)
Frequency tested: 902.75, 914.75, 927.25
Firmware power setting; 30dBm
EUT Firmware: Impinj Item Test V1.4.1.0.
Protocol /MCS/Modulation: Continuously modulated

Antenna type: Circular Polarized UHF Antenna
Antenna Gain: 8.5dBiC
Antenna in X, Y & Z axis investigated

Duty Cycle: 100%

Test Method: ANSI 63.10 (2013)
Bothell Lab C
Temperature (ºC): 22-25
Relative Humidity (%): 37-42

Setup: The EUT is set on a foam test table.
The antenna is connected to antenna port 1 via a 1.25-meter RG058 cable
A shielded Cat5e is run from the EUT to a gigabit switch located outside the chamber
The switch is then attached to the support laptop


Impinj Inc. WO#: 101403 Sequence#: 1 Date: 8/11/2018
15.247(d) / 15.209 Radiated Spurious Emissions Test Distance: 3 Meters Vert
140
120
100
80
60
40
20
dBµV/m
9k
100k
1M
10M
100M
1G
10G
Frequency [k=kHz M=MHz G=GHz]
Readings
QP Readings
Ambient
1 - 15.247(d) / 15.209 Radiated Spurious Emissions
Peak Readings
Average Readings
Software Version: 5.03.11

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN03540	Preamp	83017A	5/2/2017	5/2/2019
T2	AN01467	Horn Antenna-ANSI C63.5 Calibration	3115	7/21/2017	7/21/2019
T3	ANP06515	Cable	Heliax	6/29/2018	6/29/2020
T4	ANP06540	Cable	Heliax	10/30/2017	10/30/2019
T5	ANP06934	Cable	32026-29801-29801-18	3/13/2018	3/13/2020
T6	AN02872	Spectrum Analyzer	E4440A	11/3/2017	11/3/2019
T7	AN03170	High Pass Filter	HM1155-11SS	11/27/2017	11/27/2019
T8	AN03628	Biconilog Antenna	3142E	6/7/2017	6/7/2019
T9	ANP06123	Attenuator	18N-6	5/5/2017	5/5/2019
T10	ANP05305	Cable	ETSI-50T	10/24/2017	10/24/2019
T11	ANP05360	Cable	RG214	1/31/2018	1/31/2020
	AN00052	Loop Antenna	6502	5/7/2018	5/7/2020

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5 T9	T2 T6 T10	T3 T7 T11	T4 T8	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	2708.247M	52.9	-33.8	+28.7	+2.6	+0.5	+0.0	51.9	54.0	-2.1	Horiz
	Ave		+0.4	+0.0	+0.6	+0.0	360		Low		165
			+0.0	+0.0	+0.0						
^	2708.272M	57.0	-33.8	+28.7	+2.6	+0.5	+0.0	56.0	54.0	+2.0	Horiz
			+0.4	+0.0	+0.6	+0.0	204		Low		165
			+0.0	+0.0	+0.0						
3	2744.250M	50.0	-33.8	+28.8	+2.6	+0.5	+0.0	49.1	54.0	-4.9	Horiz
	Ave		+0.4	+0.0	+0.6	+0.0	360		Mid		161
			+0.0	+0.0	+0.0						
^	2744.250M	54.4	-33.8	+28.8	+2.6	+0.5	+0.0	53.5	54.0	-0.5	Horiz
			+0.4	+0.0	+0.6	+0.0	360		Mid		165
			+0.0	+0.0	+0.0						
5	6403.692M	38.6	-33.6	+35.4	+5.4	+0.6	+0.0	47.7	54.0	-6.3	Vert
			+0.8	+0.0	+0.5	+0.0	157		Mid		152
			+0.0	+0.0	+0.0						
6	36.150M	14.1	+0.0	+0.0	+0.0	+0.1	+0.0	33.2	40.0	-6.8	Vert
			+0.0	+0.0	+0.0	+12.5	81				99
			+5.9	+0.3	+0.3						
7	6319.417M	38.0	-33.5	+35.3	+5.2	+0.6	+0.0	46.8	54.0	-7.2	Vert
			+0.7	+0.0	+0.5	+0.0	342		Low		154
			+0.0	+0.0	+0.0						
8	6490.750M	36.9	-33.6	+35.5	+5.6	+0.6	+0.0	46.5	54.0	-7.5	Horiz
			+0.9	+0.0	+0.6	+0.0	360		High		151
			+0.0	+0.0	+0.0						
9	5416.457M	38.5	-33.1	+33.9	+4.5	+0.6	+0.0	46.2	54.0	-7.8	Horiz
			+0.8	+0.0	+1.0	+0.0	180		Low		180
			+0.0	+0.0	+0.0						

10	2781.750M	46.0	-33.8	+28.9	+2.6	+0.5	+0.0	45.2	54.0	-8.8	Horiz
	Ave		+0.4	+0.0	+0.6	+0.0	360		High		162
			+0.0	+0.0	+0.0						
^	2781.750M	51.3	-33.8	+28.9	+2.6	+0.5	+0.0	50.5	54.0	-3.5	Horiz
			+0.4	+0.0	+0.6	+0.0	360		High		162
			+0.0	+0.0	+0.0						
12	489.700M	10.1	+0.0	+0.0	+0.0	+0.3	+0.0	37.0	46.0	-9.0	Vert
	QP		+0.0	+0.0	+0.0	+18.3	360				99
			+5.9	+1.1	+1.3						
^	489.700M	13.0	+0.0	+0.0	+0.0	+0.3	+0.0	39.9	46.0	-6.1	Vert
			+0.0	+0.0	+0.0	+18.3	187				99
			+5.9	+1.1	+1.3						
14	1854.500M	48.8	-34.5	+26.8	+2.3	+0.4	+0.0	44.8	54.0	-9.2	Horiz
			+0.3	+0.0	+0.7	+0.0			High		175
			+0.0	+0.0	+0.0						
15	3709.000M	41.5	-33.4	+30.9	+3.8	+0.4	+0.0	44.7	54.0	-9.3	Vert
			+0.6	+0.0	+0.9	+0.0	147		High		162
			+0.0	+0.0	+0.0						
16	1829.520M	48.8	-34.5	+26.6	+2.3	+0.4	+0.0	44.6	54.0	-9.4	Horiz
			+0.3	+0.0	+0.7	+0.0	360		Mid		156
			+0.0	+0.0	+0.0						
17	4636.280M	39.4	-33.2	+32.1	+4.0	+0.5	+0.0	44.5	54.0	-9.5	Horiz
			+0.9	+0.0	+0.8	+0.0	197		High		155
			+0.0	+0.0	+0.0						
18	1805.522M	48.7	-34.5	+26.4	+2.2	+0.5	+0.0	44.3	54.0	-9.7	Horiz
			+0.3	+0.0	+0.7	+0.0	38		Low		154
			+0.0	+0.0	+0.0						
19	3659.095M	41.2	-33.4	+30.8	+3.7	+0.4	+0.0	44.2	54.0	-9.8	Horiz
			+0.6	+0.0	+0.9	+0.0			Mid		152
			+0.0	+0.0	+0.0						
20	3610.702M	40.7	-33.5	+30.7	+3.6	+0.4	+0.0	43.3	54.0	-10.7	Vert
			+0.6	+0.0	+0.8	+0.0			Low		152
			+0.0	+0.0	+0.0						
21	4575.035M	37.6	-33.1	+32.0	+4.0	+0.5	+0.0	42.7	54.0	-11.3	Vert
			+0.9	+0.0	+0.8	+0.0	360		Mid		146
			+0.0	+0.0	+0.0						
22	4513.962M	36.8	-33.1	+31.9	+3.9	+0.5	+0.0	41.7	54.0	-12.3	Vert
			+0.9	+0.0	+0.8	+0.0	360		Low		152
			+0.0	+0.0	+0.0						
23	7317.950M	31.4	-34.1	+36.5	+5.4	+0.9	+0.0	41.1	54.0	-12.9	Vert
	Ave		+0.5	+0.0	+0.5	+0.0	184		Mid		146
			+0.0	+0.0	+0.0						
^	7317.950M	41.4	-34.1	+36.5	+5.4	+0.9	+0.0	51.1	54.0	-2.9	Vert
			+0.5	+0.0	+0.5	+0.0	183		Mid		146
			+0.0	+0.0	+0.0						
25	96.900M	14.9	+0.0	+0.0	+0.0	+0.1	+0.0	29.6	43.5	-13.9	Vert
			+0.0	+0.0	+0.0	+7.7	59				99
			+5.9	+0.5	+0.5						
26	5488.500M	30.7	-33.1	+34.2	+4.5	+0.7	+0.0	38.8	54.0	-15.2	Vert
	Ave		+0.9	+0.0	+0.9	+0.0	180		Mid		185
			+0.0	+0.0	+0.0						

^	5488.500M	40.6	-33.1	+34.2	+4.5	+0.7	+0.0	48.7	54.0	-5.3	Vert
			+0.9	+0.0	+0.9	+0.0	180		Mid		185
			+0.0	+0.0	+0.0						
28	9147.163M	26.2	-33.9	+37.2	+6.2	+0.8	+0.0	38.0	54.0	-16.0	Vert
	Ave		+0.9	+0.0	+0.6	+0.0	95		Mid		137
			+0.0	+0.0	+0.0						
^	9147.163M	40.1	-33.9	+37.2	+6.2	+0.8	+0.0	51.9	54.0	-2.1	Vert
			+0.9	+0.0	+0.6	+0.0	238		Mid		134
			+0.0	+0.0	+0.0						
30	9272.665M	25.5	-33.8	+37.3	+6.2	+0.9	+0.0	37.5	54.0	-16.5	Vert
	Ave		+0.8	+0.0	+0.6	+0.0	78		High		154
			+0.0	+0.0	+0.0						
^	9272.665M	40.5	-33.8	+37.3	+6.2	+0.9	+0.0	52.5	54.0	-1.5	Vert
			+0.8	+0.0	+0.6	+0.0	289		High		154
			+0.0	+0.0	+0.0						
32	8345.415M	26.1	-34.6	+37.0	+5.8	+0.8	+0.0	36.3	54.0	-17.7	Vert
	Ave		+0.7	+0.0	+0.5	+0.0	135		High		154
			+0.0	+0.0	+0.0						
^	8345.415M	40.4	-34.6	+37.0	+5.8	+0.8	+0.0	50.6	54.0	-3.4	Vert
			+0.7	+0.0	+0.5	+0.0	129		High		154
			+0.0	+0.0	+0.0						
34	7418.165M	26.2	-34.4	+36.8	+5.5	+1.1	+0.0	36.2	54.0	-17.8	Horiz
	Ave		+0.5	+0.0	+0.5	+0.0	360		High		151
			+0.0	+0.0	+0.0						
^	7418.165M	37.5	-34.4	+36.8	+5.5	+1.1	+0.0	47.5	54.0	-6.5	Horiz
			+0.5	+0.0	+0.5	+0.0	360		High		151
			+0.0	+0.0	+0.0						
36	7221.997M	26.2	-33.9	+36.2	+5.3	+0.8	+0.0	35.7	54.0	-18.3	Vert
	Ave		+0.5	+0.0	+0.6	+0.0	155		Low		160
			+0.0	+0.0	+0.0						
^	7221.997M	37.0	-33.9	+36.2	+5.3	+0.8	+0.0	46.5	54.0	-7.5	Vert
			+0.5	+0.0	+0.6	+0.0	155		Low		160
			+0.0	+0.0	+0.0						
38	8124.747M	25.7	-34.7	+36.8	+5.7	+0.7	+0.0	35.6	54.0	-18.4	Horiz
	Ave		+0.8	+0.0	+0.6	+0.0			Low		150
			+0.0	+0.0	+0.0						
^	8124.747M	38.7	-34.7	+36.8	+5.7	+0.7	+0.0	48.6	54.0	-5.4	Horiz
			+0.8	+0.0	+0.6	+0.0	85		Low		150
			+0.0	+0.0	+0.0						
40	8232.292M	25.8	-34.8	+36.9	+5.7	+0.7	+0.0	35.6	54.0	-18.4	Vert
	Ave		+0.8	+0.0	+0.5	+0.0	182		Mid		139
			+0.0	+0.0	+0.0						
^	8232.292M	40.4	-34.8	+36.9	+5.7	+0.7	+0.0	50.2	54.0	-3.8	Vert
			+0.8	+0.0	+0.5	+0.0	238		Mid		134
			+0.0	+0.0	+0.0						

42	9027.497M	23.9	-34.0	+37.1	+6.2	+0.6	+0.0	35.4	54.0	-18.6	Vert
	Ave		+1.0	+0.0	+0.6	+0.0			Low		150
			+0.0	+0.0	+0.0						
^	9027.427M	38.0	-34.0	+37.1	+6.2	+0.6	+0.0	49.5	54.0	-4.5	Vert
			+1.0	+0.0	+0.6	+0.0			Low		150
			+0.0	+0.0	+0.0						
44	5563.500M	25.2	-33.2	+34.3	+4.5	+0.7	+0.0	33.1	54.0	-20.9	Vert
	Ave		+0.9	+0.0	+0.7	+0.0			High		159
			+0.0	+0.0	+0.0						
^	5563.500M	39.8	-33.2	+34.3	+4.5	+0.7	+0.0	47.7	54.0	-6.3	Vert
			+0.9	+0.0	+0.7	+0.0			High		159
			+0.0	+0.0	+0.0						

Test Location:	CKC Laboratories, Inc. • 22116 23rd DR SE • Bothell WA, 98021 • (425) 402-1717		
Customer:	**Impinj Inc.**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**101403**	Date:	8/11/2018
Test Type:	**Maximized Emissions**	Time:	09:08:43
Tested By:	Steven Pittsford	Sequence#:	2
Software:	EMITest 5.03.11		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 2			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 2			

Test Conditions / Notes:

Frequency Range: 9kHz-10GHz (No emissions observed below 30MHz)
Frequency tested: 902.75, 914.75, 927.25
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Duty Cycle: 100%

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Bothell Lab C
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Relative Humidity (%): 37-42

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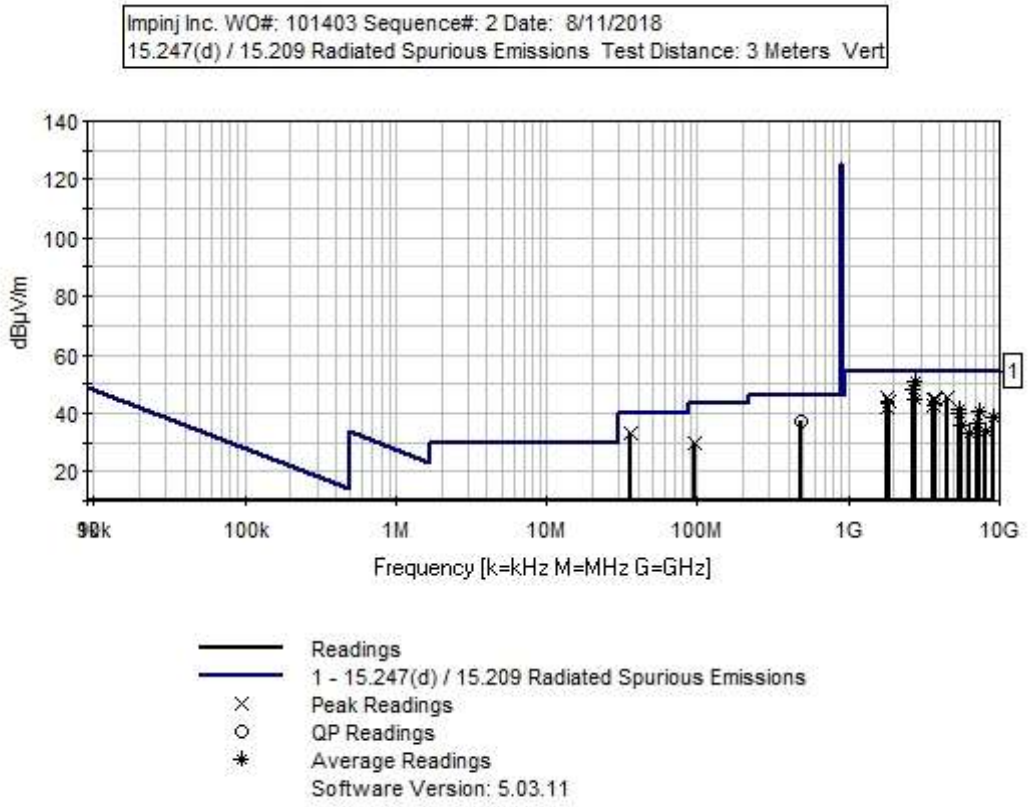
A shielded Cat5e is run from the EUT to a gigabit switch located outside the chamber
The switch is then attached to the support laptop.


Impinj Inc. WO#: 101403 Sequence#: 2 Date: 8/11/2018
15.247(d) / 15.209 Radiated Spurious Emissions Test Distance: 3 Meters Vert
140
120
100
80
60
40
20
dBµV/m
1
100k
1M
10M
100M
1G
10G
Frequency [k=kHz M=MHz G=GHz]
Readings
1 - 15.247(d) / 15.209 Radiated Spurious Emissions
Peak Readings
QP Readings
Average Readings
Software Version: 5.03.11

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN03540	Preamp	83017A	5/2/2017	5/2/2019
T2	AN01467	Horn Antenna-ANSI C63.5 Calibration	3115	7/21/2017	7/21/2019
T3	ANP06515	Cable	Heliax	6/29/2018	6/29/2020
T4	ANP06540	Cable	Heliax	10/30/2017	10/30/2019
T5	ANP06934	Cable	32026-29801-29801-18	3/13/2018	3/13/2020
T6	AN02872	Spectrum Analyzer	E4440A	11/3/2017	11/3/2019
T7	AN03170	High Pass Filter	HM1155-11SS	11/27/2017	11/27/2019
	AN00052	Loop Antenna	6502	5/7/2018	5/7/2020
T8	AN03628	Biconilog Antenna	3142E	6/7/2017	6/7/2019
T9	ANP06123	Attenuator	18N-6	5/5/2017	5/5/2019
T10	ANP05360	Cable	RG214	1/31/2018	1/31/2020
T11	ANP05305	Cable	ETSI-50T	10/24/2017	10/24/2019

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5 T9	T2 T6 T10	T3 T7 T11	T4 T8	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	2744.375M	51.9	-33.8	+28.8	+2.6	+0.5	+0.0	51.0	54.0	-3.0	Vert
	Ave		+0.4	+0.0	+0.6	+0.0	316		Mid		158
			+0.0	+0.0	+0.0						
^	2744.375M	56.7	-33.8	+28.8	+2.6	+0.5	+0.0	55.8	54.0	+1.8	Vert
			+0.4	+0.0	+0.6	+0.0	204		Mid		158
			+0.0	+0.0	+0.0						
3	2708.247M	49.1	-33.8	+28.7	+2.6	+0.5	+0.0	48.1	54.0	-5.9	Vert
	Ave		+0.4	+0.0	+0.6	+0.0	7		Low		158
			+0.0	+0.0	+0.0						
^	2708.247M	56.4	-33.8	+28.7	+2.6	+0.5	+0.0	55.4	54.0	+1.4	Vert
			+0.4	+0.0	+0.6	+0.0	67		Low		158
			+0.0	+0.0	+0.0						
5	36.150M	14.1	+0.0	+0.0	+0.0	+0.1	+0.0	33.2	40.0	-6.8	Vert
			+0.0	+0.0	+0.0	+12.5	81				99
			+5.9	+0.3	+0.3						
6	1805.540M	50.0	-34.5	+26.4	+2.2	+0.5	+0.0	45.6	54.0	-8.4	Horiz
			+0.3	+0.0	+0.7	+0.0	232		Low		154
			+0.0	+0.0	+0.0						
7	4513.512M	40.4	-33.1	+31.9	+3.9	+0.5	+0.0	45.3	54.0	-8.7	Vert
			+0.9	+0.0	+0.8	+0.0	74		Low		147
			+0.0	+0.0	+0.0						
8	3709.000M	41.8	-33.4	+30.9	+3.8	+0.4	+0.0	45.0	54.0	-9.0	Vert
			+0.6	+0.0	+0.9	+0.0	181		High		151
			+0.0	+0.0	+0.0						

9	489.700M	10.1	+0.0	+0.0	+0.0	+0.3	+0.0	37.0	46.0	-9.0	Vert
	QP		+0.0	+0.0	+0.0	+18.3	360				99
			+5.9	+1.3	+1.1						
^	489.700M	13.0	+0.0	+0.0	+0.0	+0.3	+0.0	39.9	46.0	-6.1	Vert
			+0.0	+0.0	+0.0	+18.3	187				99
			+5.9	+1.3	+1.1						
11	2781.740M	45.7	-33.8	+28.9	+2.6	+0.5	+0.0	44.9	54.0	-9.1	Vert
	Ave		+0.4	+0.0	+0.6	+0.0	195		High		158
			+0.0	+0.0	+0.0						
^	2781.740M	50.7	-33.8	+28.9	+2.6	+0.5	+0.0	49.9	54.0	-4.1	Vert
			+0.4	+0.0	+0.6	+0.0	196		High		158
			+0.0	+0.0	+0.0						
13	3659.000M	41.5	-33.4	+30.8	+3.7	+0.4	+0.0	44.5	54.0	-9.5	Vert
			+0.6	+0.0	+0.9	+0.0	217		Mid		147
			+0.0	+0.0	+0.0						
14	1854.465M	47.8	-34.5	+26.8	+2.3	+0.4	+0.0	43.8	54.0	-10.2	Vert
			+0.3	+0.0	+0.7	+0.0	360		High		153
			+0.0	+0.0	+0.0						
15	3611.000M	40.4	-33.5	+30.7	+3.6	+0.4	+0.0	43.0	54.0	-11.0	Vert
			+0.6	+0.0	+0.8	+0.0	322		Low		147
			+0.0	+0.0	+0.0						
16	1829.500M	46.2	-34.5	+26.6	+2.3	+0.4	+0.0	42.0	54.0	-12.0	Vert
			+0.3	+0.0	+0.7	+0.0	348		Mid		159
			+0.0	+0.0	+0.0						
17	5416.500M	33.4	-33.1	+33.9	+4.5	+0.6	+0.0	41.1	54.0	-12.9	Horiz
	Ave		+0.8	+0.0	+1.0	+0.0	167		Low		163
			+0.0	+0.0	+0.0						
^	5416.500M	40.9	-33.1	+33.9	+4.5	+0.6	+0.0	48.6	54.0	-5.4	Horiz
			+0.8	+0.0	+1.0	+0.0	167		Low		163
			+0.0	+0.0	+0.0						
19	7418.000M	30.9	-34.4	+36.8	+5.5	+1.1	+0.0	40.9	54.0	-13.1	Vert
	Ave		+0.5	+0.0	+0.5	+0.0	179		High		158
			+0.0	+0.0	+0.0						
^	7418.000M	39.9	-34.4	+36.8	+5.5	+1.1	+0.0	49.9	54.0	-4.1	Vert
			+0.5	+0.0	+0.5	+0.0	170		High		158
			+0.0	+0.0	+0.0						
21	7318.000M	31.0	-34.1	+36.5	+5.4	+0.9	+0.0	40.7	54.0	-13.3	Vert
	Ave		+0.5	+0.0	+0.5	+0.0	195		Mid		163
			+0.0	+0.0	+0.0						
^	7318.000M	39.5	-34.1	+36.5	+5.4	+0.9	+0.0	49.2	54.0	-4.8	Vert
			+0.5	+0.0	+0.5	+0.0	192		Mid		163
			+0.0	+0.0	+0.0						
23	5488.500M	32.0	-33.1	+34.2	+4.5	+0.7	+0.0	40.1	54.0	-13.9	Vert
	Ave		+0.9	+0.0	+0.9	+0.0	204		Mid		152
			+0.0	+0.0	+0.0						
^	5488.445M	39.6	-33.1	+34.2	+4.5	+0.7	+0.0	47.7	54.0	-6.3	Vert
			+0.9	+0.0	+0.9	+0.0	171		Mid		152
			+0.0	+0.0	+0.0						
25	96.900M	14.9	+0.0	+0.0	+0.0	+0.1	+0.0	29.6	43.5	-13.9	Vert
			+0.0	+0.0	+0.0	+7.7	59				99
			+5.9	+0.5	+0.5						

26	9027.500M	27.2	-34.0	+37.1	+6.2	+0.6	+0.0	38.7	54.0	-15.3	Vert
	Ave		+1.0	+0.0	+0.6	+0.0	185		Low		153
			+0.0	+0.0	+0.0						
^	9027.500M	39.2	-34.0	+37.1	+6.2	+0.6	+0.0	50.7	54.0	-3.3	Vert
			+1.0	+0.0	+0.6	+0.0	206		Low		153
			+0.0	+0.0	+0.0						
28	7222.000M	27.3	-33.9	+36.2	+5.3	+0.8	+0.0	36.8	54.0	-17.2	Vert
	Ave		+0.5	+0.0	+0.6	+0.0	360		Low		153
			+0.0	+0.0	+0.0						
^	7222.000M	39.9	-33.9	+36.2	+5.3	+0.8	+0.0	49.4	54.0	-4.6	Vert
			+0.5	+0.0	+0.6	+0.0	360		Low		153
			+0.0	+0.0	+0.0						
30	5563.500M	27.7	-33.2	+34.3	+4.5	+0.7	+0.0	35.6	54.0	-18.4	Vert
	Ave		+0.9	+0.0	+0.7	+0.0			High		158
			+0.0	+0.0	+0.0						
^	5563.500M	38.0	-33.2	+34.3	+4.5	+0.7	+0.0	45.9	54.0	-8.1	Vert
			+0.9	+0.0	+0.7	+0.0	194		High		158
			+0.0	+0.0	+0.0						
32	8124.750M	23.7	-34.7	+36.8	+5.7	+0.7	+0.0	33.6	54.0	-20.4	Horiz
	Ave		+0.8	+0.0	+0.6	+0.0	181		Low		153
			+0.0	+0.0	+0.0						
^	8124.750M	37.4	-34.7	+36.8	+5.7	+0.7	+0.0	47.3	54.0	-6.7	Horiz
			+0.8	+0.0	+0.6	+0.0	159		Low		153
			+0.0	+0.0	+0.0						
34	6319.250M	24.4	-33.5	+35.3	+5.2	+0.6	+0.0	33.2	54.0	-20.8	Vert
	Ave		+0.7	+0.0	+0.5	+0.0	360		Low		153
			+0.0	+0.0	+0.0						
^	6319.250M	39.9	-33.5	+35.3	+5.2	+0.6	+0.0	48.7	54.0	-5.3	Vert
			+0.7	+0.0	+0.5	+0.0	360		Low		153
			+0.0	+0.0	+0.0						

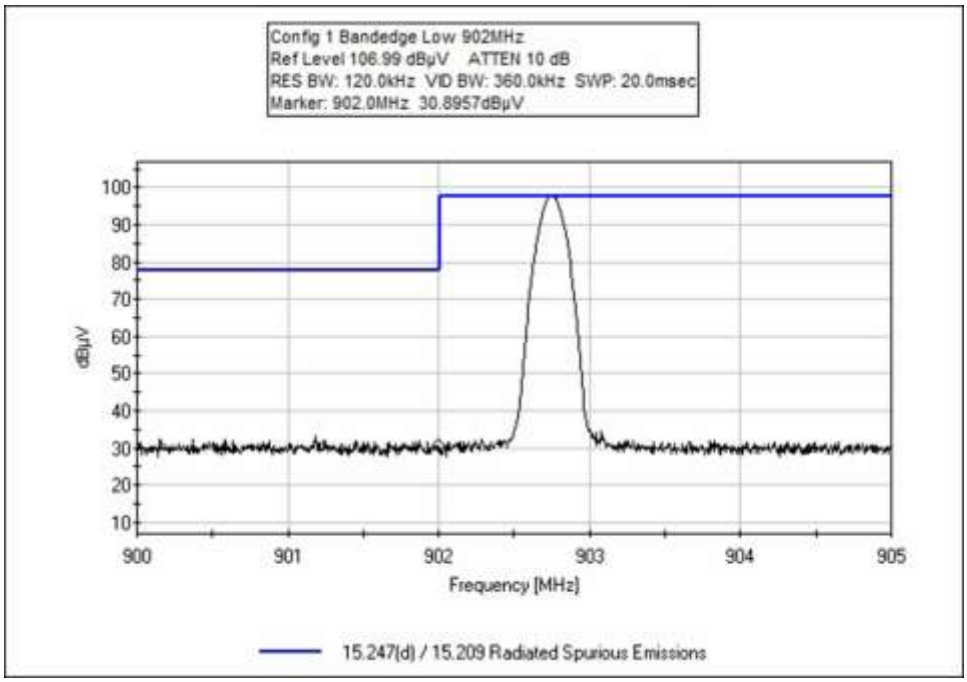
Band Edge

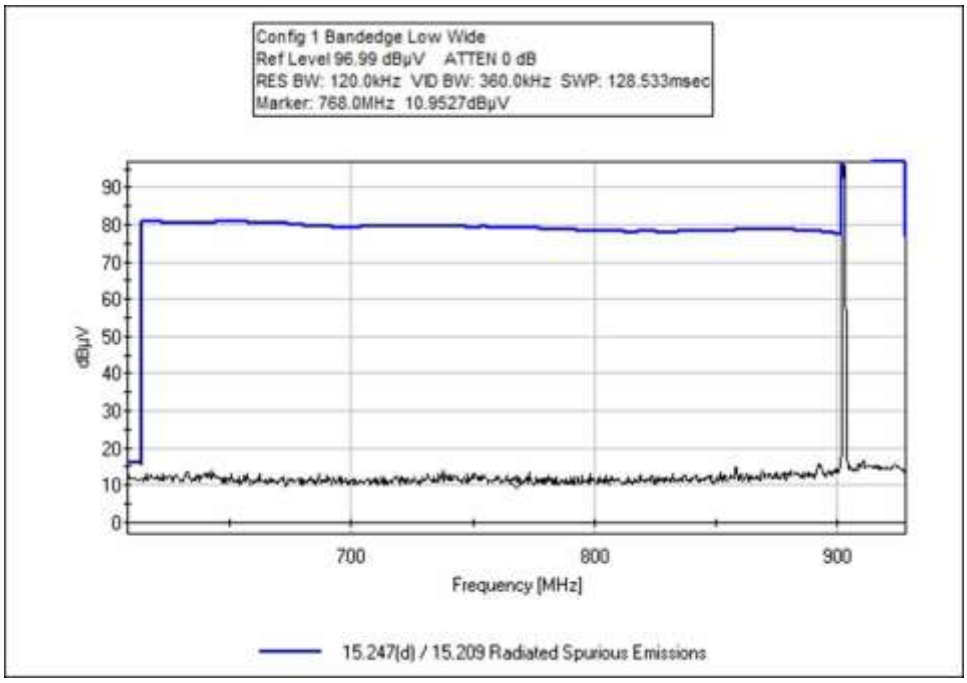
Band Edge Summary – Configuration 1					
Frequency (MHz)	**Modulation**	**Ant. Type**	**Field Strength (dBuV/m @3m)**	**Limit (dBuV/m @3m)**	**Results**
614	ASK	Circular Polarized UHF Antenna Slimline A5010, 8.5dBiC	38.2	<54	Pass
902	ASK	Circular Polarized UHF Antenna Slimline A5010, 8.5dBiC	64.4	<111.2	Pass
928	ASK	Circular Polarized UHF Antenna Slimline A5010, 8.5dBiC	54.6	< 111.2	Pass
960	ASK	Circular Polarized UHF Antenna Slimline A5010, 8.5dBiC	48.8	<54	Pass

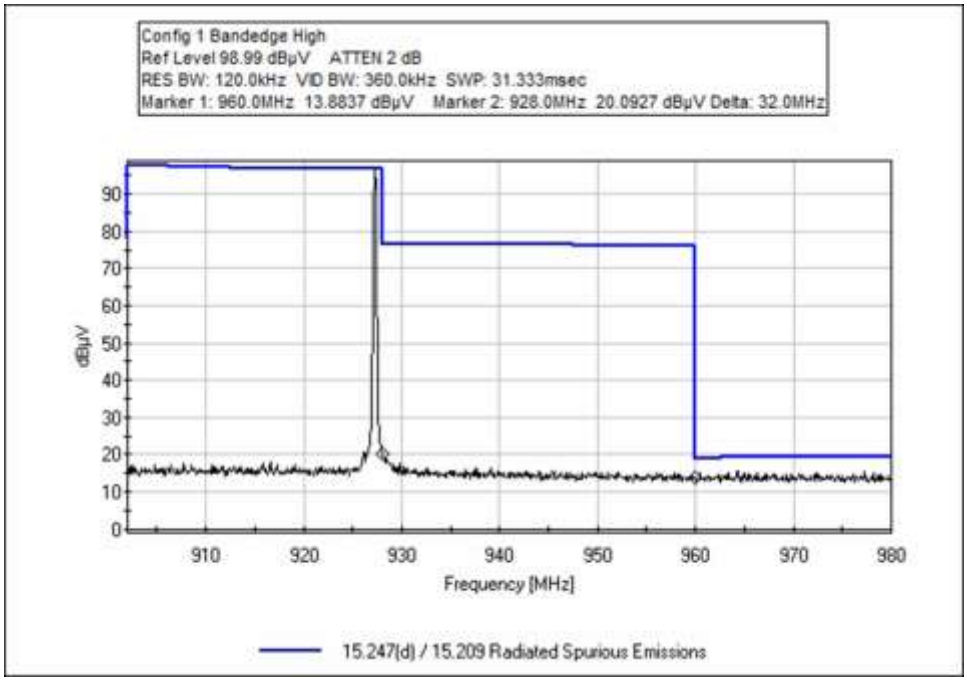
Band Edge Summary – Configuration 2					
Frequency (MHz)	**Modulation**	**Ant. Type**	**Field Strength (dBuV/m @3m)**	**Limit (dBuV/m @3m)**	**Results**
614	ASK	Circular Polarized UHF Antenna Slimline A5020, 5.5dBiC	38.2	<54	Pass
902	ASK	Circular Polarized UHF Antenna Slimline A5020, 5.5dBiC	50.7	<108.2	Pass
928	ASK	Circular Polarized UHF Antenna Slimline A5020, 5.5dBiC	51.5	< 108.2	Pass
960	ASK	Circular Polarized UHF Antenna Slimline A5020, 5.5dBiC	46.1	<54	Pass

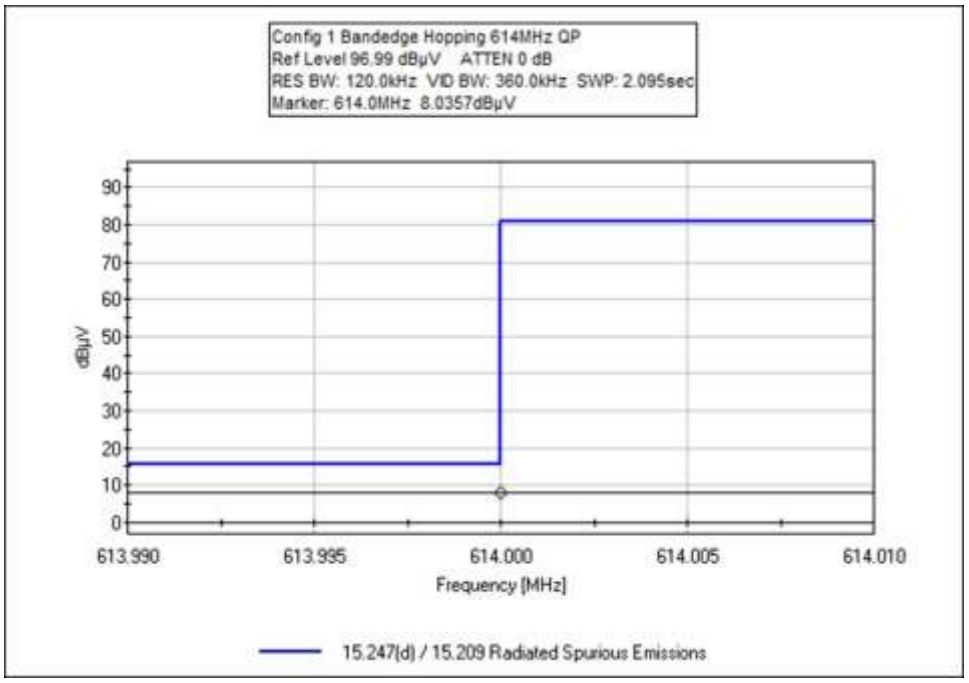
Band Edge Plots

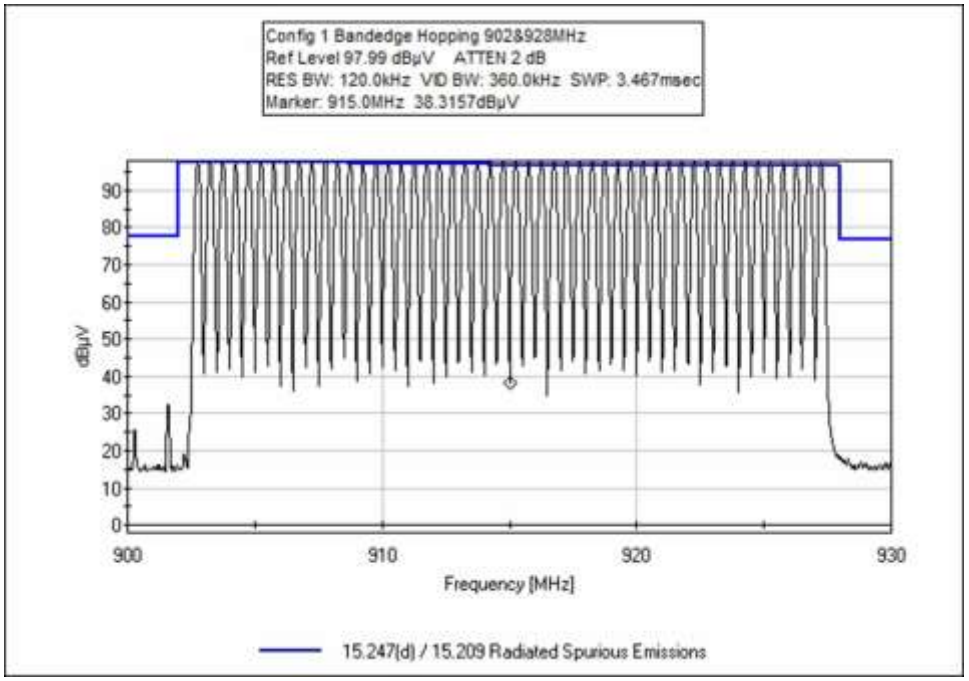
Plots show raw data with the limit line being corrected for all transducers

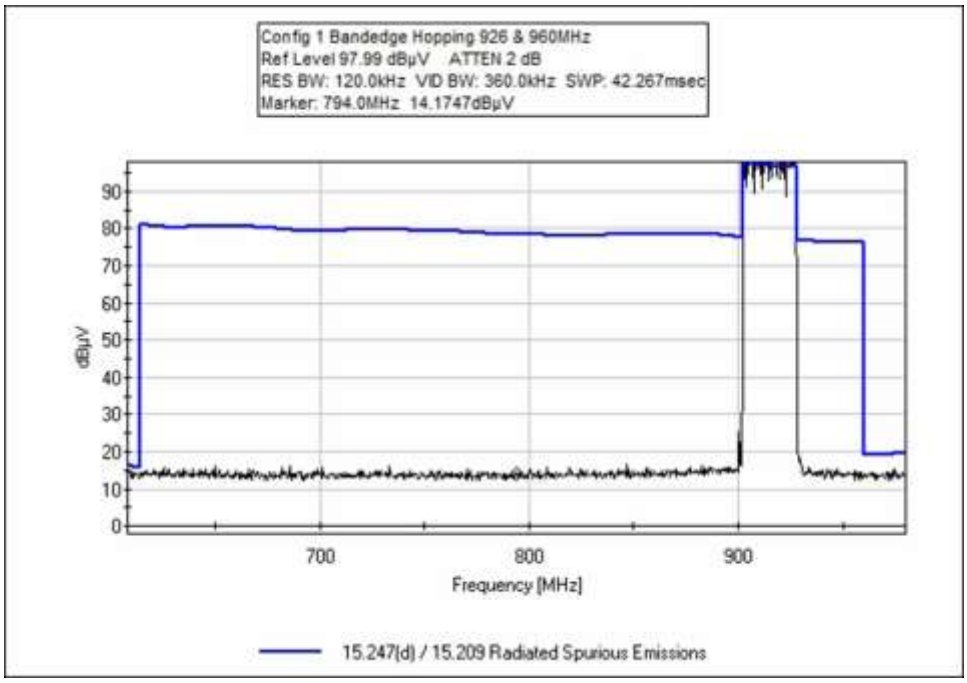


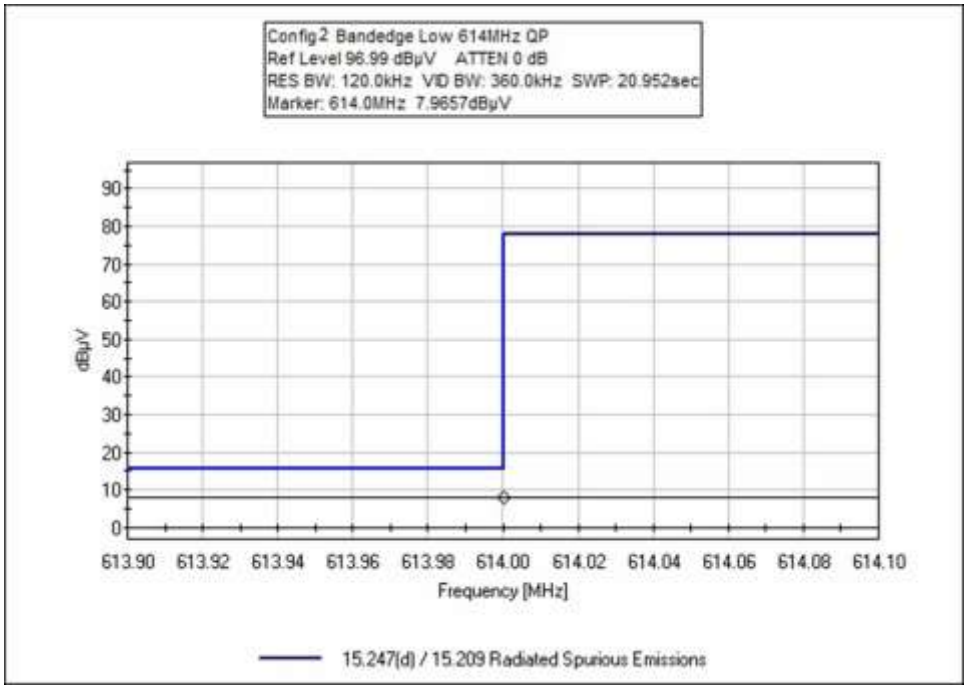

Config 1 Bandedge Low Wide
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 128.533msec
Marker: 768.0MHz 10.9527dBµV
dBµV
90
80
70
60
50
40
30
20
10
0
700
800
900
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions

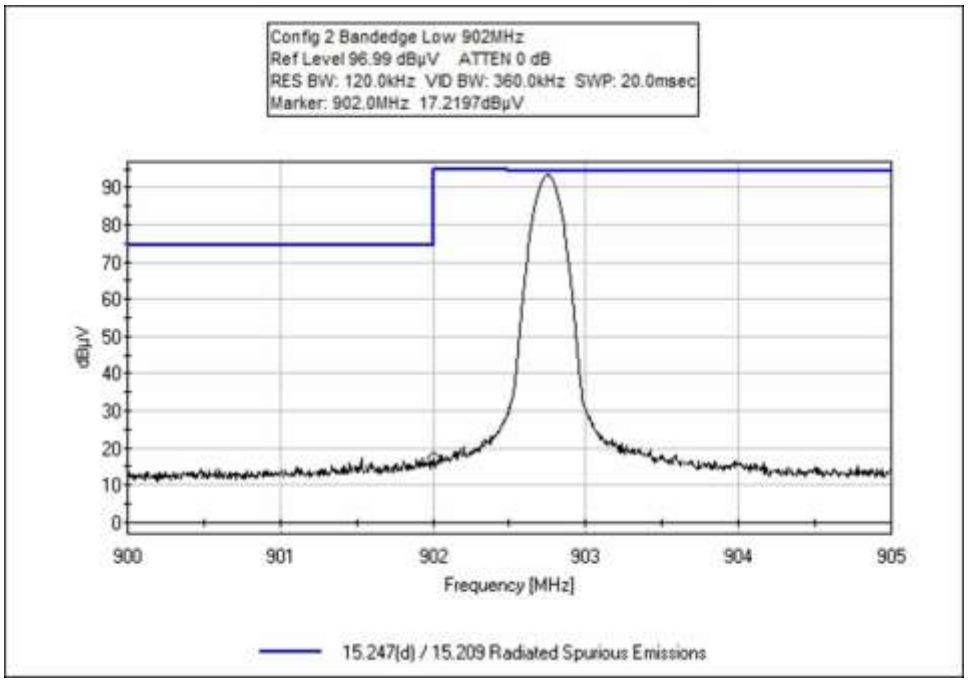

Config 1 Bandedge High
Ref Level 98.99 dBµV ATTEN 2 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 31.333msec
Marker 1: 960.0MHz 13.8837 dBµV Marker 2: 928.0MHz 20.0927 dBµV Delta: 32.0MHz
dBµV
90
80
70
60
50
40
30
20
10
0
910
920
930
940
950
960
970
980
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions

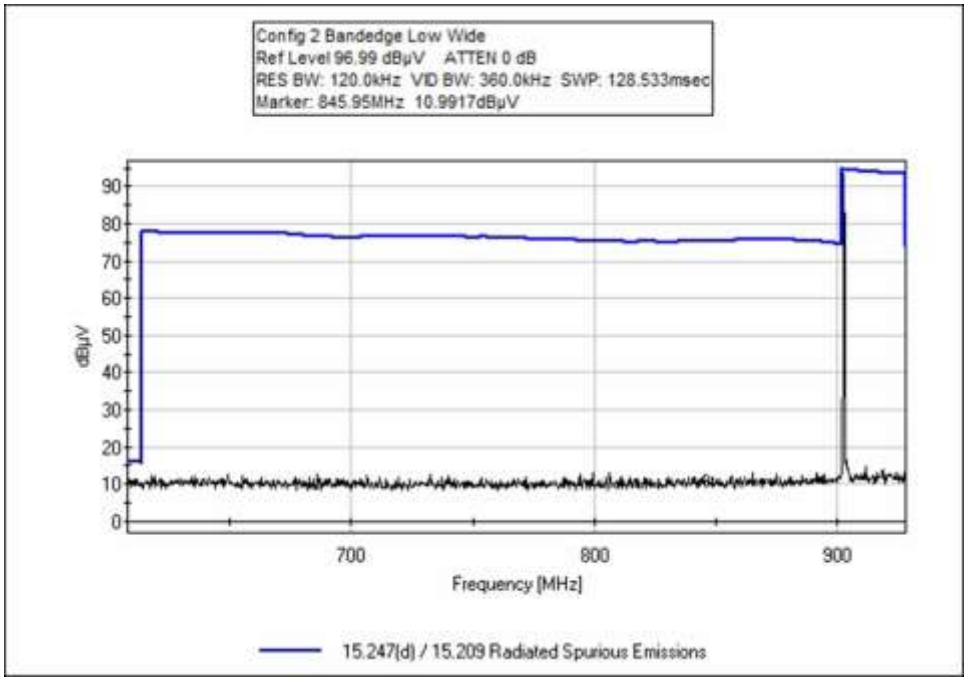

Config 1 Bandedge Hopping 614MHz QP
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 2.095sec
Marker: 614.0MHz 8.0357dBµV
dBµV
90
80
70
60
50
40
30
20
10
0
613.990
613.995
614.000
614.005
614.010
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions

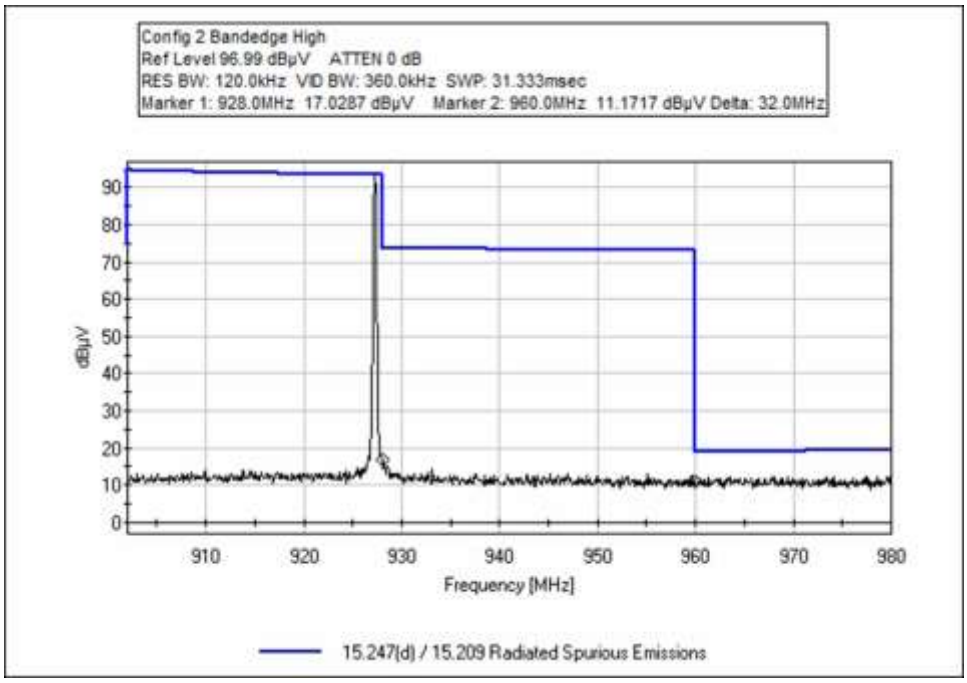

Config 1 Bandedge Hopping 902&928MHz
Ref Level 97.99 dBµV ATTEN 2 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 3.467msec
Marker: 915.0MHz 38.3157dBµV
dBµV
90
80
70
60
50
40
30
20
10
0
900
910
920
930
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions

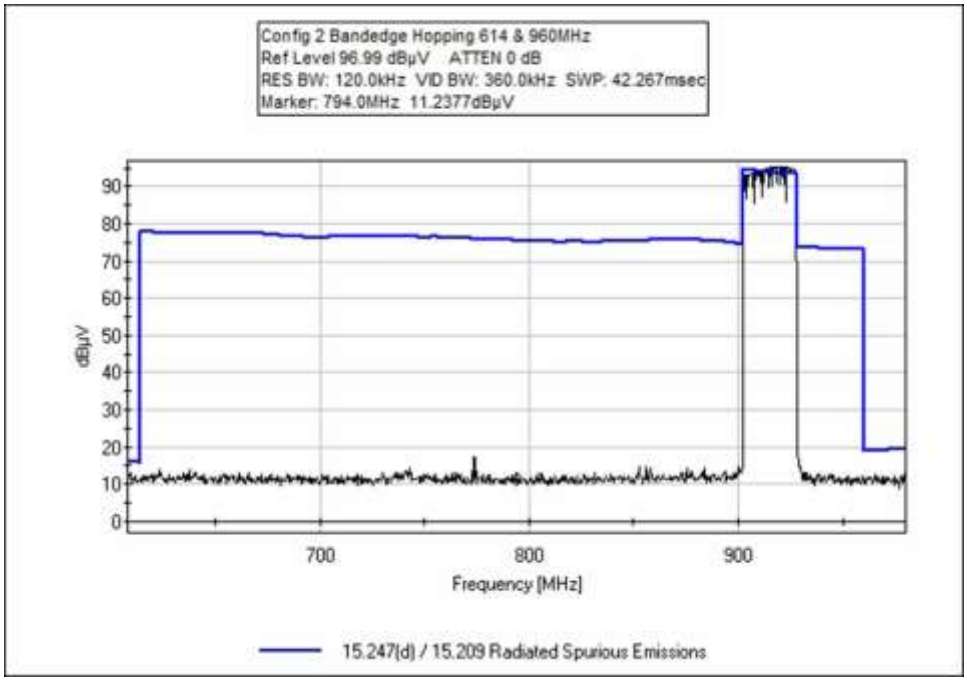

Config 1 Bandedge Hopping 926 & 960MHz
Ref Level 97.99 dBµV ATTEN 2 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 42.267msec
Marker: 794.0MHz 14.1747dBµV
dBµV
90
80
70
60
50
40
30
20
10
0
700
800
900
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions

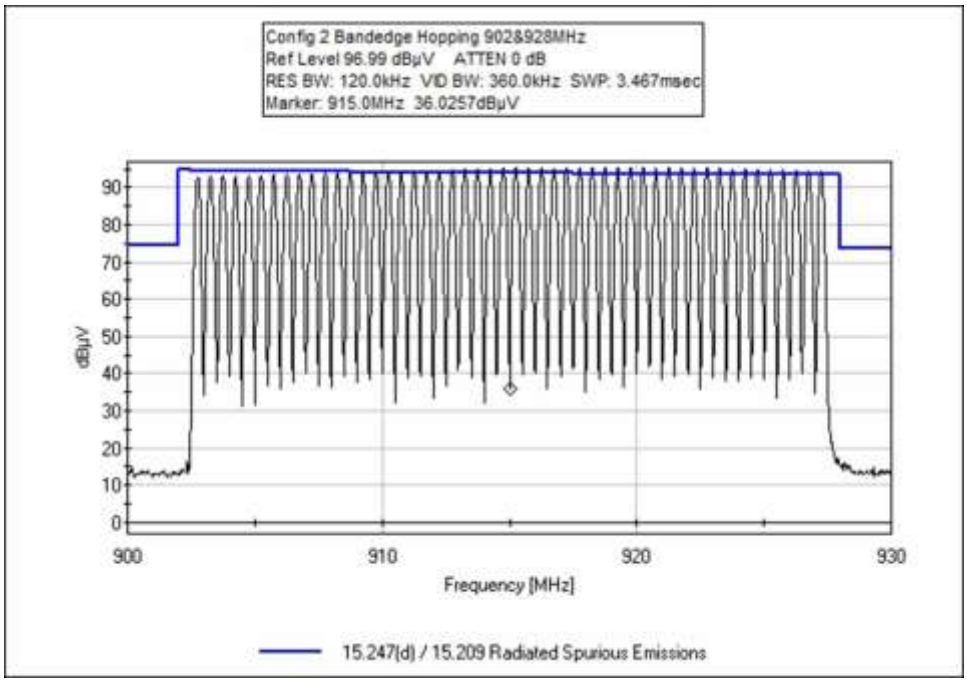

Config 2 Bandedge Low 614MHz QP
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 20.952sec
Marker: 614.0MHz 7.9657dBµV
dBµV
90
80
70
60
50
40
30
20
10
0
613.90
613.92
613.94
613.96
613.98
614.00
614.02
614.04
614.06
614.08
614.10
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


Config 2 Bandedge Low 902MHz
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 20.0msec
Marker: 902.0MHz 17.2197dBµV
dBµV
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


Config 2 Bandedge Low Wide
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 128.533msec
Marker: 845.95MHz 10.9917dBµV
dBµV
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


Config 2 Bandedge High
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 31.333msec
Marker 1: 928.0MHz 17.0287 dBµV Marker 2: 960.0MHz 11.1717 dBµV Delta: 32.0MHz
dBµV
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


Config 2 Bandedge Hopping 614 & 960MHz
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 42.267msec
Marker: 794.0MHz 11.2377dBµV
dBµV
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


Config 2 Bandedge Hopping 902&928MHz
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 3.467msec
Marker: 915.0MHz 36.0257dBµV
dBµV
90
80
70
60
50
40
30
20
10
0
900
910
920
930
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 22116 23rd DR SE • Bothell WA, 98021 • (425) 402-1717		
Customer:	**Impinj Inc.**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**101403**	Date:	8/11/2018
Test Type:	**Maximized Emissions**	Time:	10:43:49
Tested By:	Steven Pittsford	Sequence#:	3
Software:	EMITest 5.03.11		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Frequency Range: 600-1000MHz
Frequency tested: 902.75, 927.25 & Hopping
Firmware power setting; 30dBm
EUT Firmware: Impinj ItemTest V1.4.1.0.
Protocol /MCS/Modulation: Continuously modulated

Antenna type: Circular Polarized UHF Antenna
Antenna Gain: 8.5dBiC
antenna in X, Y & Z axis investigated

Duty Cycle: 100%

Test Method: ANSI 63.10 (2013)
Bothell Lab C3
Temperature (ºC): 22-25
Relative Humidity (%): 37-42

Setup: The EUT is set on a foam test table.
The antenna is connected to antenna port 1 via a 1.25-meter RG058 cable
A shielded Cat5e is run from the EUT to a gigabit switch located outside the chamber
The switch is then attached to the support laptop.

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	ANP06540	Cable	Heliax	10/30/2017	10/30/2019
T2	AN02872	Spectrum Analyzer	E4440A	11/3/2017	11/3/2019
T3	AN03628	Biconilog Antenna	3142E	6/7/2017	6/7/2019
T4	ANP06123	Attenuator	18N-6	5/5/2017	5/5/2019
T5	ANP05305	Cable	ETSI-50T	10/24/2017	10/24/2019
T6	ANP05360	Cable	RG214	1/31/2018	1/31/2020

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5	T2 T6	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	960.000M	13.9	+0.4 +1.6	+0.0 +2.1	+24.9	+5.9	+0.0 1	48.8	54.0	-5.2	Vert 114
2	614.000M QP	8.0	+0.3 +1.3	+0.0 +1.5	+21.2	+5.9	+0.0 1	38.2	46.0	-7.8	Vert 99
^	614.000M	13.3	+0.3 +1.3	+0.0 +1.5	+21.2	+5.9	+0.0 1	43.5	46.0	-2.5	Vert 99
4	902.000M	30.9	+0.3 +1.5	+0.0 +2.0	+23.8	+5.9	+0.0 1	64.4	111.2	-46.8	Vert 114
5	928.000M	20.1	+0.4 +1.6	+0.0 +2.0	+24.6	+5.9	+0.0 1	54.6	111.2	-56.6	Vert 114

Test Location:	CKC Laboratories, Inc. • 22116 23rd DR SE • Bothell WA, 98021 • (425) 402-1717		
Customer:	**Impinj Inc.**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**101403**	Date:	8/11/2018
Test Type:	**Maximized Emissions**	Time:	11:12:41
Tested By:	Steven Pittsford	Sequence#:	4
Software:	EMITest 5.03.11		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 2			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 2			

Test Conditions / Notes:

Frequency Range: 600-1000MHz
Frequency tested: 902.75, 927.25 & Hopping
Firmware power setting; 30dBm
EUT Firmware: Impinj ItemTest V1.4.1.0.
Protocol /MCS/Modulation: Continuously modulated

Antenna type: Circular Polarized UHF Antenna
Antenna Gain: 5.5dBiC
antenna in X, Y & Z axis investigated

Duty Cycle: 100%

Test Method: ANSI 63.10 (2013)
Bothell Lab C3
Temperature (ºC): 22-25
Relative Humidity (%): 37-42

Setup: The EUT is set on a foam test table.
The antenna is connected to antenna port 1 via a 1.25-meter RG058 cable
A shielded Cat5e is run from the EUT to a gigabit switch located outside the chamber
The switch is then attached to the support laptop.

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	ANP06540	Cable	Heliax	10/30/2017	10/30/2019
	AN02872	Spectrum Analyzer	E4440A	11/3/2017	11/3/2019
T2	AN03628	Biconilog Antenna	3142E	6/7/2017	6/7/2019
T3	ANP06123	Attenuator	18N-6	5/5/2017	5/5/2019
T4	ANP05305	Cable	ETSI-50T	10/24/2017	10/24/2019
T5	ANP05360	Cable	RG214	1/31/2018	1/31/2020

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5	T2	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	614.000M	8.0	+0.3 +1.5	+21.2	+5.9	+1.3	+0.0	38.2	46.0	-7.8	Vert 120
QP											
^	614.000M	11.6	+0.3 +1.5	+21.2	+5.9	+1.3	+0.0	41.8	46.0	-4.2	Vert 120
3	960.000M	11.2	+0.4 +2.1	+24.9	+5.9	+1.6	+0.0	46.1	54.0	-7.9	Vert 120
4	928.000M	17.0	+0.4 +2.0	+24.6	+5.9	+1.6	+0.0	51.5	108.2	-56.7	Vert 120
5	902.000M	17.2	+0.3 +2.0	+23.8	+5.9	+1.5	+0.0	50.7	108.2	-57.5	Vert 120

Test Setup Photos

Configuration 1, Below 1GHz

Configuration 1, Above 1GHz Cone placement

Configuration 2, Below 1GHz

Configuration 2, Above 1 GHz Cone placement

SUPPLEMENTAL INFORMATION

Measurement Uncertainty

Uncertainty Value	Parameter
4.73 dB	Radiated Emissions
3.34 dB	Mains Conducted Emissions
3.30 dB	Disturbance Power

Uncertainties reported are worst case for all CKC Laboratories' sites and represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2. Compliance is deemed to occur provided measurements are below the specified limits.

Emissions Test Details

TESTING PARAMETERS

Unless otherwise indicated, the following configuration parameters are used for equipment setup: The cables were routed consistent with the typical application by varying the configuration of the test sample. Interface cables were connected to the available ports of the test unit. The effect of varying the position of the cables was investigated to find the configuration that produced maximum emissions. Cables were of the type and length specified in the individual requirements. The length of cable that produced maximum emissions was selected.

The equipment under test (EUT) was set up in a manner that represented its normal use, as shown in the setup photographs. Any special conditions required for the EUT to operate normally are identified in the comments that accompany the emissions tables.

The emissions data was taken with a spectrum analyzer or receiver. Incorporating the applicable correction factors for distance, antenna, cable loss and amplifier gain, the data was reduced as shown in the table below. The corrected data was then compared to the applicable emission limits. Preliminary and final measurements were taken in order to ensure that all emissions from the EUT were found and maximized.

CORRECTION FACTORS

The basic spectrum analyzer reading was converted using correction factors as shown in the highest emissions readings in the tables. For radiated emissions in dBµV/m, the spectrum analyzer reading in dBµV was corrected by using the following formula. This reading was then compared to the applicable specification limit. Individual measurements were compared with the displayed limit value in the margin column. The margin was calculated based on subtracting the limit value from the corrected measurement value; a positive margin represents a measurement exceeding the limit, while a negative margin represents a measurement less than the limit.

SAMPLE CALCULATIONS		
	Meter reading	(dBµV)
+	Antenna Factor	(dB/m)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	(dBµV/m)

TEST INSTRUMENTATION AND ANALYZER SETTINGS

The test instrumentation and equipment listed were used to collect the emissions data. A spectrum analyzer or receiver was used for all measurements. Unless otherwise specified, the following table shows the measuring equipment bandwidth settings that were used in designated frequency bands. For testing emissions, an appropriate reference level and a vertical scale size of 10 dB per division were used.

MEASURING EQUIPMENT BANDWIDTH SETTINGS PER FREQUENCY RANGE			
TEST	BEGINNING FREQUENCY	ENDING FREQUENCY	BANDWIDTH SETTING
CONDUCTED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	9 kHz	150 kHz	200 Hz
RADIATED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	30 MHz	1000 MHz	120 kHz
RADIATED EMISSIONS	1000 MHz	>1 GHz	1 MHz

SPECTRUM ANALYZER/RECEIVER DETECTOR FUNCTIONS

The notes that accompany the measurements contained in the emissions tables indicate the type of detector function used to obtain the given readings. Unless otherwise noted, all readings were made in the "positive peak" detector mode. Whenever a "quasi-peak" or "average" reading was recorded, the measurement was annotated with a "QP" or an "Ave" on the appropriate rows of the data sheets. In cases where quasi-peak or average limits were employed and data exists for multiple measurement types for the same frequency then the peak measurement was retained in the report for reference, however the numbering for the affected row was removed and an arrow or caret ("^") was placed in the far left-hand column indicating that the row above takes precedence for comparison to the limit. The following paragraphs describe in more detail the detector functions and when they were used to obtain the emissions data.

Peak

In this mode, the spectrum analyzer or receiver recorded all emissions at their peak value as the frequency band selected was scanned. By combining this function with another feature called "peak hold," the measurement device had the ability to measure intermittent or low duty cycle transient emission peak levels. In this mode the measuring device made a slow scan across the frequency band selected and measured the peak emission value found at each frequency across the band.

Quasi-Peak

Quasi-peak measurements were taken using the quasi-peak detector when the true peak values exceeded or were within 2 dB of a quasi-peak specification limit. Additional QP measurements may have been taken at the discretion of the operator.

Average

Average measurements were taken using the average detector when the true peak values exceeded or were within 2 dB of an average specification limit. Additional average measurements may have been taken at the discretion of the operator. If the specification or test procedure requires trace averaging, then the averaging was performed using 100 samples or as required by the specification. All other average measurements are performed using video bandwidth averaging. To make these measurements, the test engineer reduces the video bandwidth on the measuring device until the modulation of the signal is filtered out. At this point, the measuring device is set into the linear mode and the scan time is reduced.