

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



Test Certificate # 803.05

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.

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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

DATE OF EQUIPMENT RECEIPT:**DATE(S) OF TESTING:****REPORT PREPARED BY:**

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

Project Number: 101403

August 11, 2018

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.

A handwritten signature in black ink, reading "Steve Behm", is positioned above a horizontal line.

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

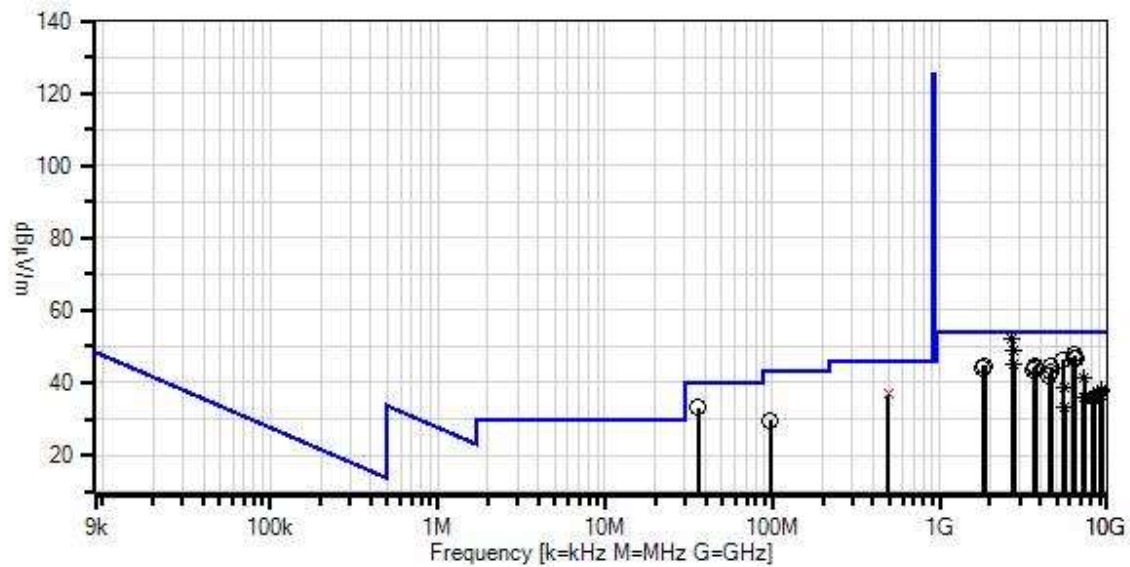
Antenna type: Circular Polarized UHF Antenna
 Antenna Gain: 8.5dBiC
 Antenna in X, Y & Z axis investigated

Duty Cycle: 100%

Test Method: ANSI 63.10 (2013)
 Bothell Lab C
 Temperature (°C): 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. W/O#: 101403 Sequence#: 1 Date: 8/11/2018
15.247(d) / 15.209 Radiated Spurious Emissions Test Distance: 3 Meters Vert



— 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	Helix	6/29/2018	6/29/2020
T4	ANP06540	Cable	Helix	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 Ave	52.9	-33.8 +0.4 +0.0	+28.7 +0.0 +0.0	+2.6 +0.6 +0.0	+0.5 +0.0 +0.0	+0.0 360	51.9	54.0 Low	-2.1	Horiz 165
^	2708.272M	57.0	-33.8 +0.4 +0.0	+28.7 +0.0 +0.0	+2.6 +0.6 +0.0	+0.5 +0.0 +0.0	+0.0 204	56.0	54.0 Low	+2.0	Horiz 165
3	2744.250M Ave	50.0	-33.8 +0.4 +0.0	+28.8 +0.0 +0.0	+2.6 +0.6 +0.0	+0.5 +0.0 +0.0	+0.0 360	49.1	54.0 Mid	-4.9	Horiz 161
^	2744.250M	54.4	-33.8 +0.4 +0.0	+28.8 +0.0 +0.0	+2.6 +0.6 +0.0	+0.5 +0.0 +0.0	+0.0 360	53.5	54.0 Mid	-0.5	Horiz 165
5	6403.692M	38.6	-33.6 +0.8 +0.0	+35.4 +0.0 +0.0	+5.4 +0.5 +0.0	+0.6 +0.0 +0.0	+0.0 157	47.7	54.0 Mid	-6.3	Vert 152
6	36.150M	14.1	+0.0 +0.0 +5.9	+0.0 +0.0 +0.3	+0.0 +0.0 +0.3	+0.1 +12.5 +0.0	+0.0 81	33.2	40.0	-6.8	Vert 99
7	6319.417M	38.0	-33.5 +0.7 +0.0	+35.3 +0.0 +0.0	+5.2 +0.5 +0.0	+0.6 +0.0 +0.0	+0.0 342	46.8	54.0 Low	-7.2	Vert 154
8	6490.750M	36.9	-33.6 +0.9 +0.0	+35.5 +0.0 +0.0	+5.6 +0.6 +0.0	+0.6 +0.0 +0.0	+0.0 360	46.5	54.0 High	-7.5	Horiz 151
9	5416.457M	38.5	-33.1 +0.8 +0.0	+33.9 +0.0 +0.0	+4.5 +1.0 +0.0	+0.6 +0.0 +0.0	+0.0 180	46.2	54.0 Low	-7.8	Horiz 180

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

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

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			

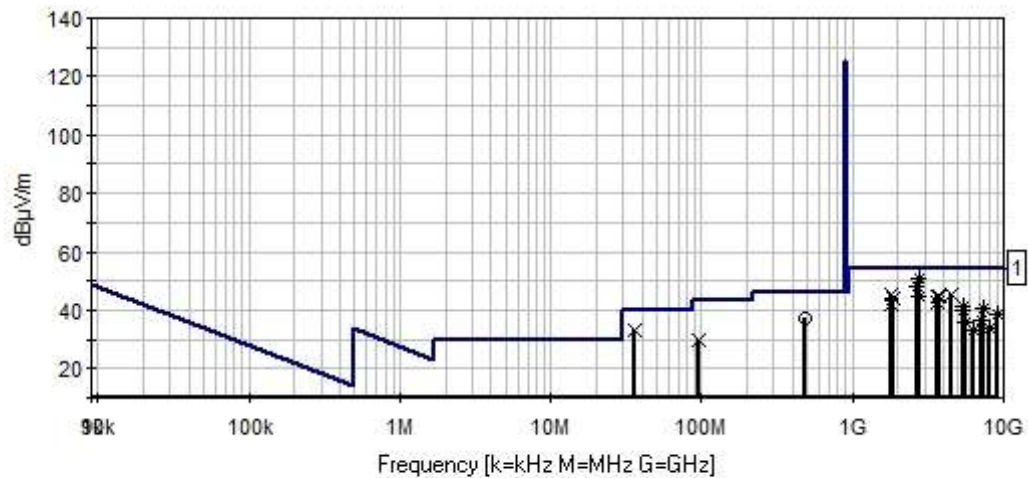
Support Equipment:

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 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: 5.5dBiC Antenna in X, Y & Z axis investigated Duty Cycle: 100% Test Method: ANSI 63.10 (2013) Bothell Lab C Temperature (°C): 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.
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Impinj Inc. WO#: 101403 Sequence#: 2 Date: 8/11/2018
15.247(d) / 15.209 Radiated Spurious Emissions Test Distance: 3 Meters Vert



— 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	Heliac	6/29/2018	6/29/2020
T4	ANP06540	Cable	Heliac	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 Ave	51.9	-33.8 +0.4 +0.0	+28.8 +0.0 +0.0	+2.6 +0.6 +0.0	+0.5 +0.0	+0.0 316	51.0	54.0 Mid	-3.0	Vert 158
^	2744.375M	56.7	-33.8 +0.4 +0.0	+28.8 +0.0 +0.0	+2.6 +0.6 +0.0	+0.5 +0.0	+0.0 204	55.8	54.0 Mid	+1.8	Vert 158
3	2708.247M Ave	49.1	-33.8 +0.4 +0.0	+28.7 +0.0 +0.0	+2.6 +0.6 +0.0	+0.5 +0.0	+0.0 7	48.1	54.0 Low	-5.9	Vert 158
^	2708.247M	56.4	-33.8 +0.4 +0.0	+28.7 +0.0 +0.0	+2.6 +0.6 +0.0	+0.5 +0.0	+0.0 67	55.4	54.0 Low	+1.4	Vert 158
5	36.150M	14.1	+0.0 +0.0 +5.9	+0.0 +0.0 +0.3	+0.0 +0.0 +0.3	+0.1 +12.5	+0.0 81	33.2	40.0	-6.8	Vert 99
6	1805.540M	50.0	-34.5 +0.3 +0.0	+26.4 +0.0 +0.0	+2.2 +0.7 +0.0	+0.5 +0.0	+0.0 232	45.6	54.0 Low	-8.4	Horiz 154
7	4513.512M	40.4	-33.1 +0.9 +0.0	+31.9 +0.0 +0.0	+3.9 +0.8 +0.0	+0.5 +0.0	+0.0 74	45.3	54.0 Low	-8.7	Vert 147
8	3709.000M	41.8	-33.4 +0.6 +0.0	+30.9 +0.0 +0.0	+3.8 +0.9 +0.0	+0.4 +0.0	+0.0 181	45.0	54.0 High	-9.0	Vert 151

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

Band Edge

Band Edge Summary – Configuration 1

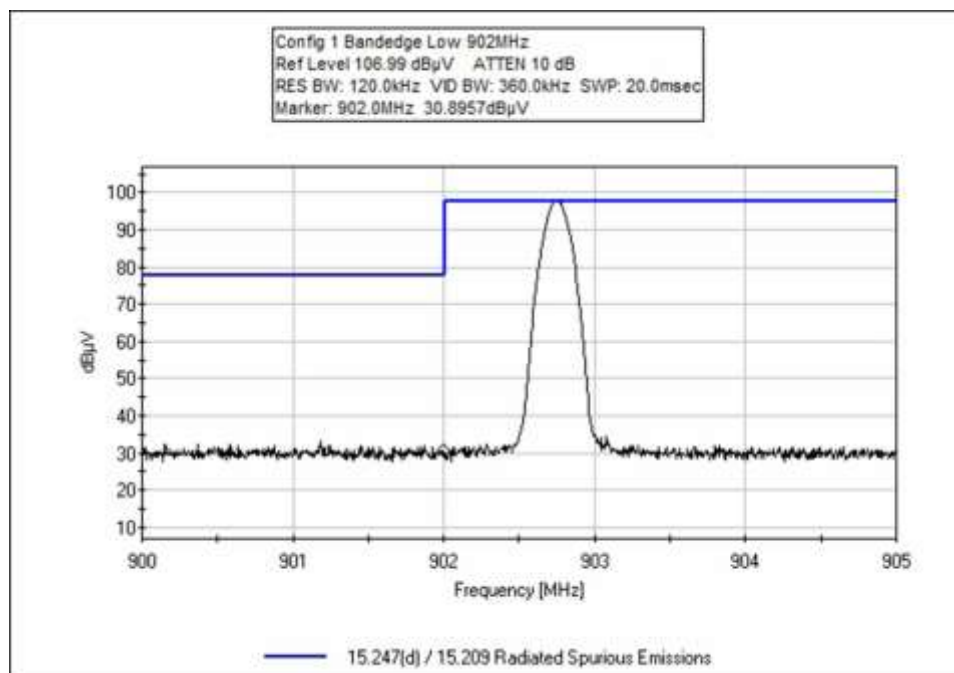
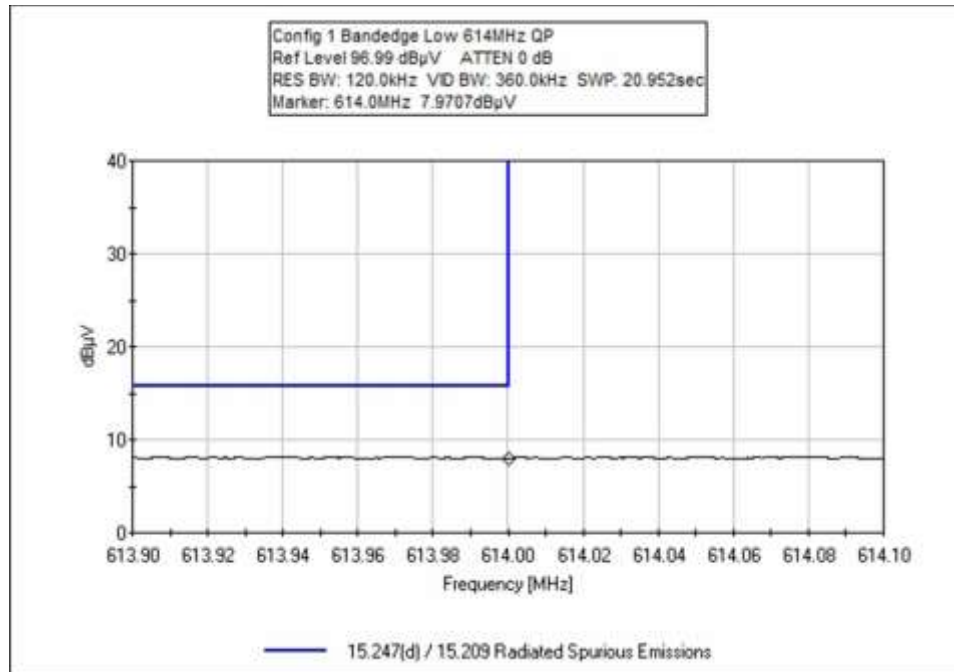
Frequency (MHz)	Modulation	Ant. Type	Field Strength (dBuV/m @3m)	Limit (dBuV/m @3m)	Results
614	ASK	Circular Polarized UHF Antenna Slimline A5010, 8.5dBiC	38.2	<54	Pass
902	ASK	Circular Polarized UHF Antenna Slimline A5010, 8.5dBiC	64.4	<111.2	Pass
928	ASK	Circular Polarized UHF Antenna Slimline A5010,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

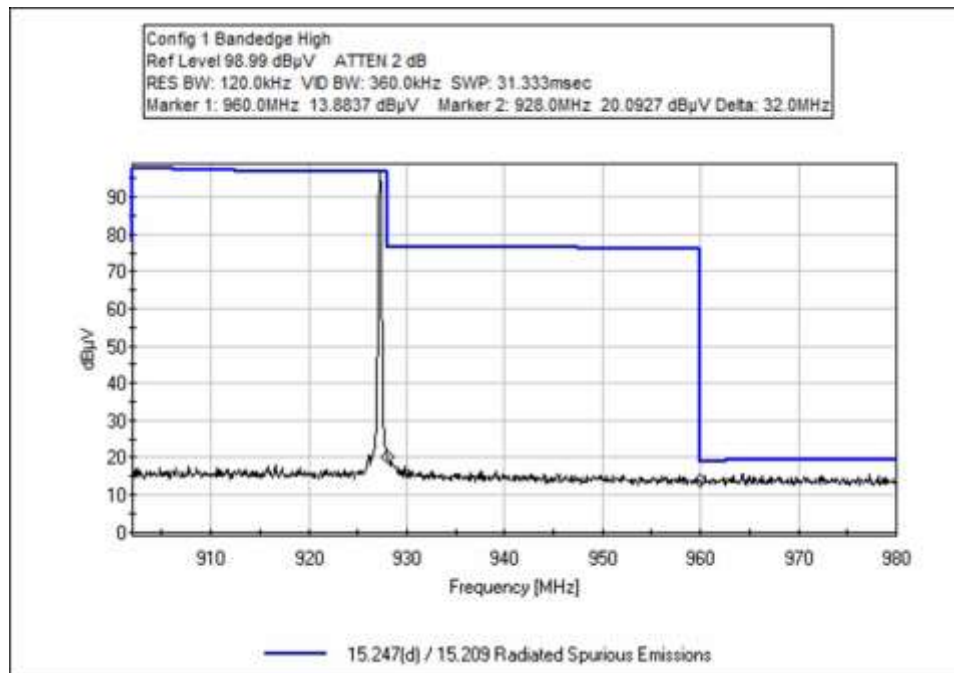
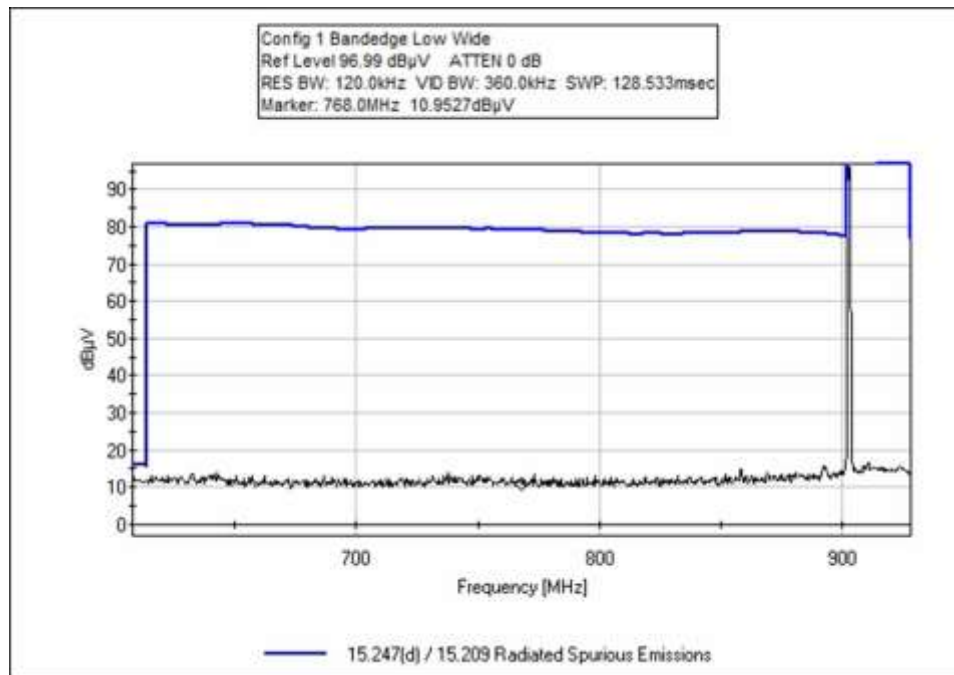
Band Edge Summary – Configuration 2

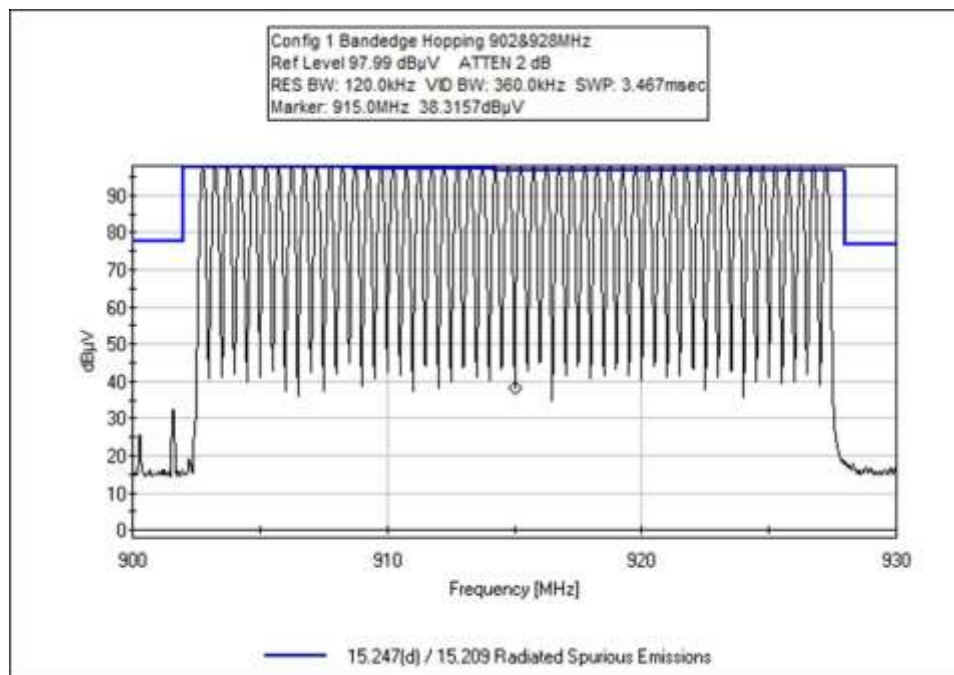
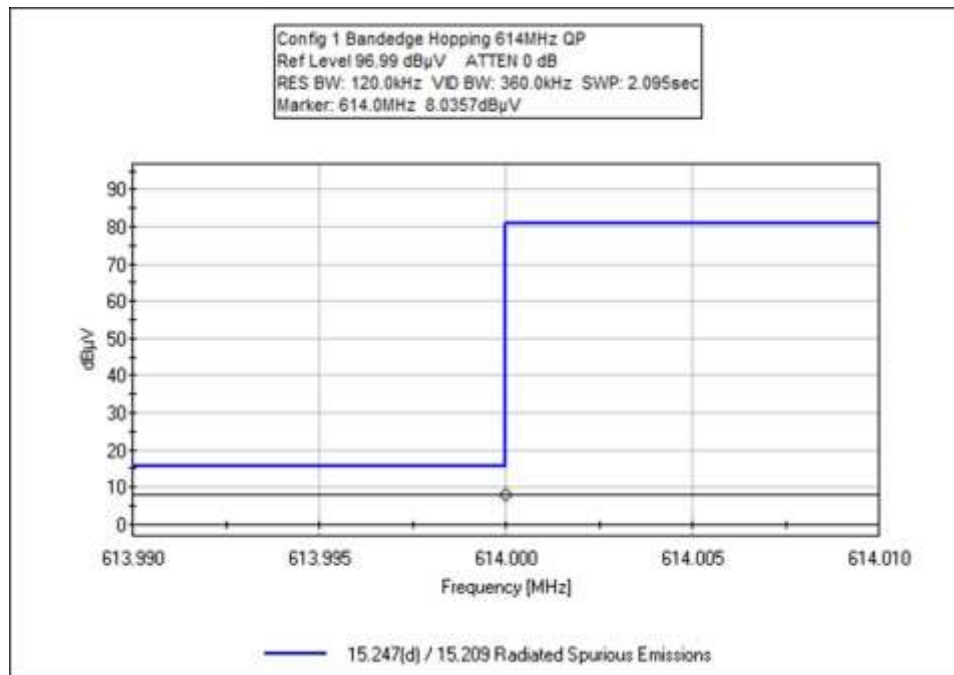
Frequency (MHz)	Modulation	Ant. Type	Field Strength (dBuV/m @3m)	Limit (dBuV/m @3m)	Results
614	ASK	Circular Polarized UHF Antenna Slimline A5020, 5.5dBiC	38.2	<54	Pass
902	ASK	Circular Polarized UHF Antenna Slimline A5020, 5.5dBiC	50.7	<108.2	Pass
928	ASK	Circular Polarized UHF Antenna Slimline A5020,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

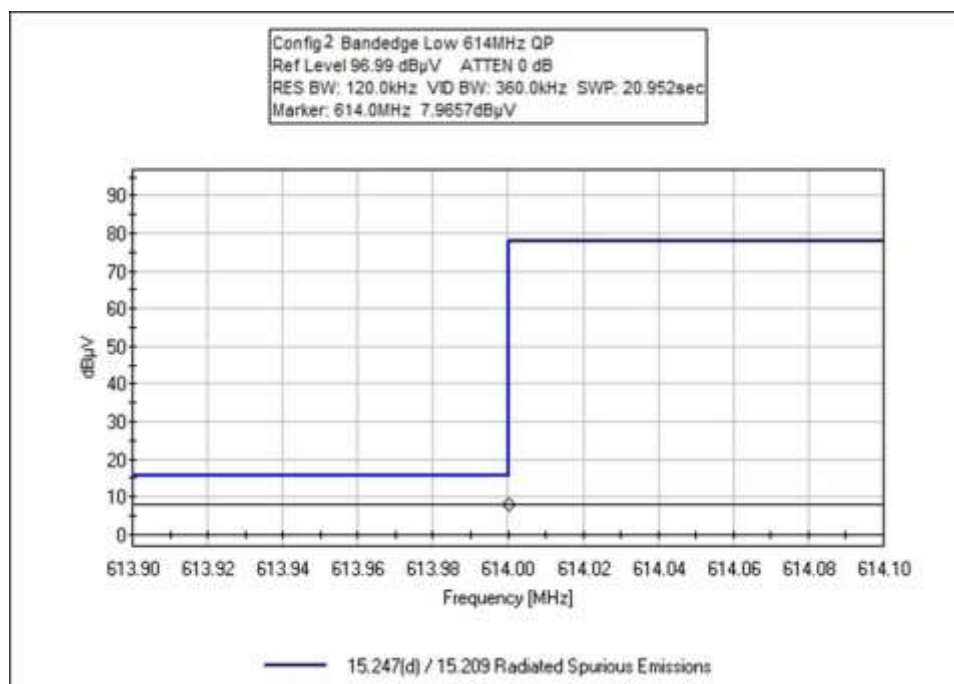
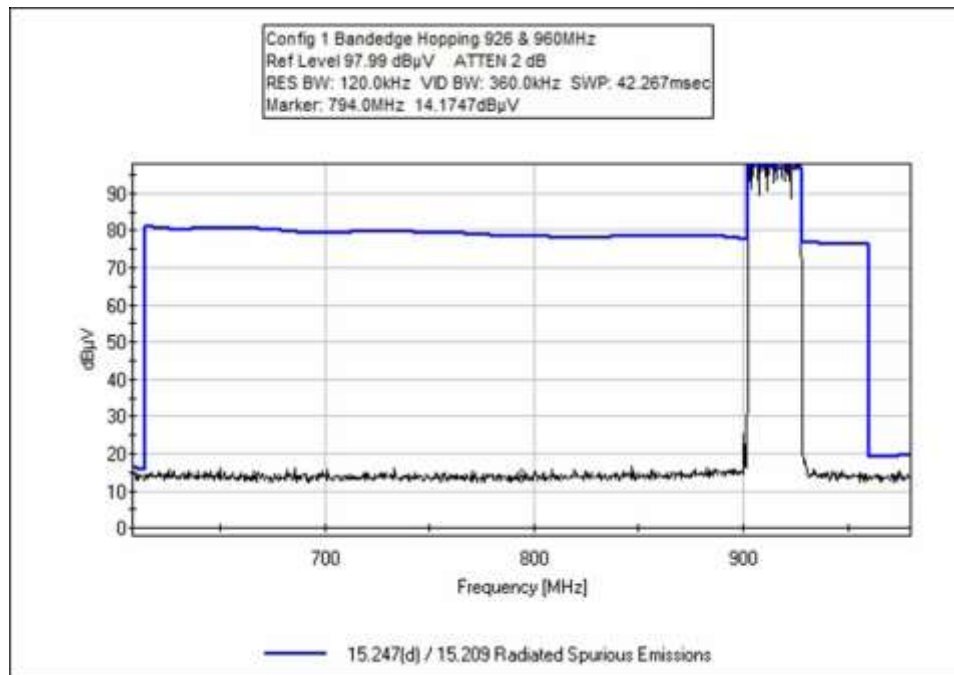
Band Edge Plots

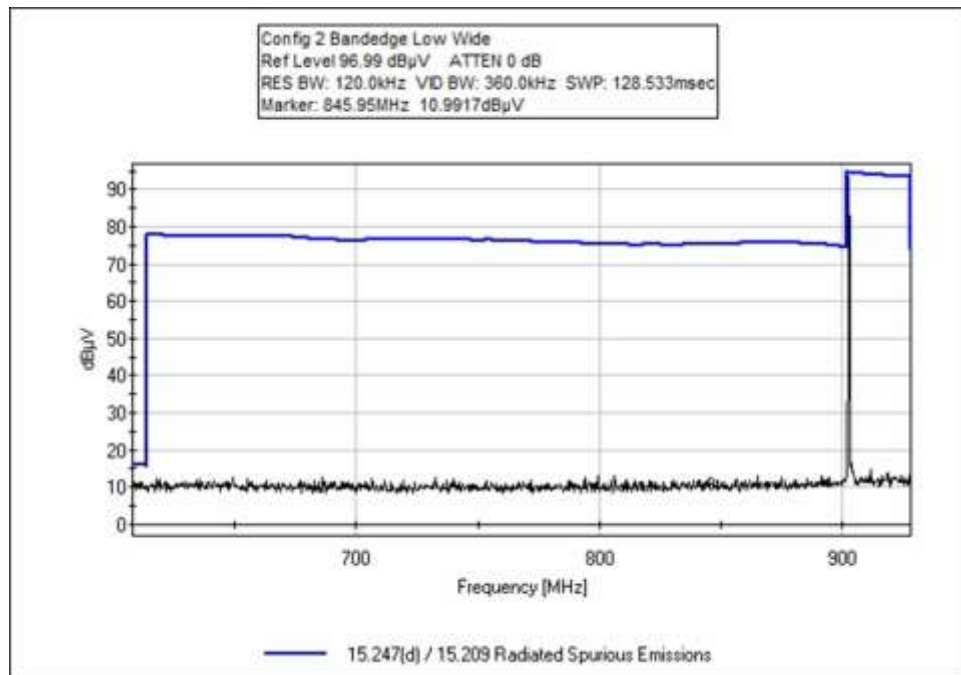
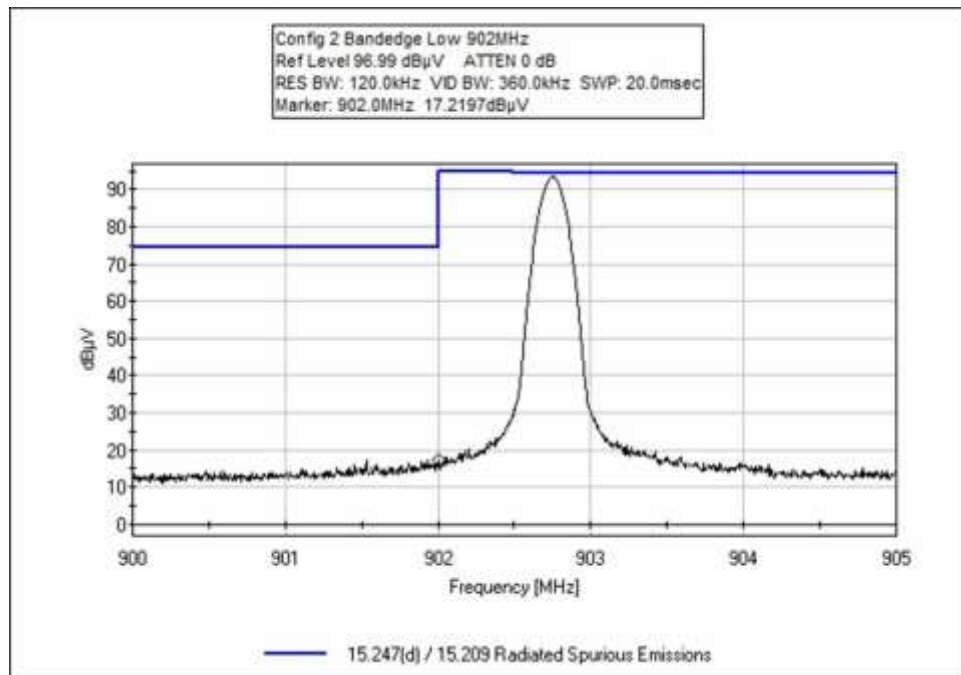
Plots show raw data with the limit line being corrected for all transducers

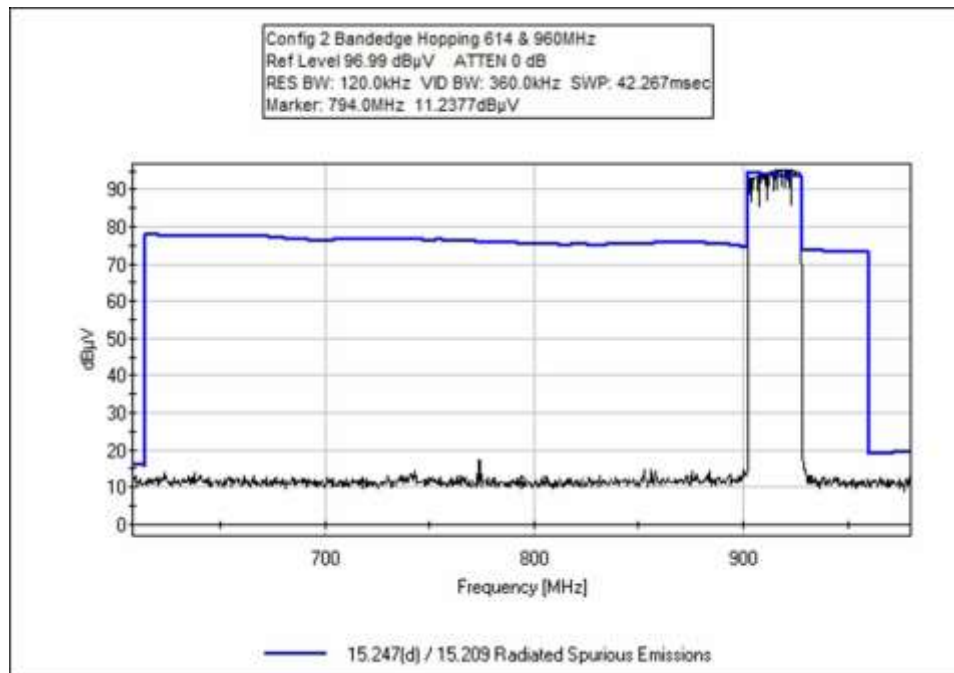
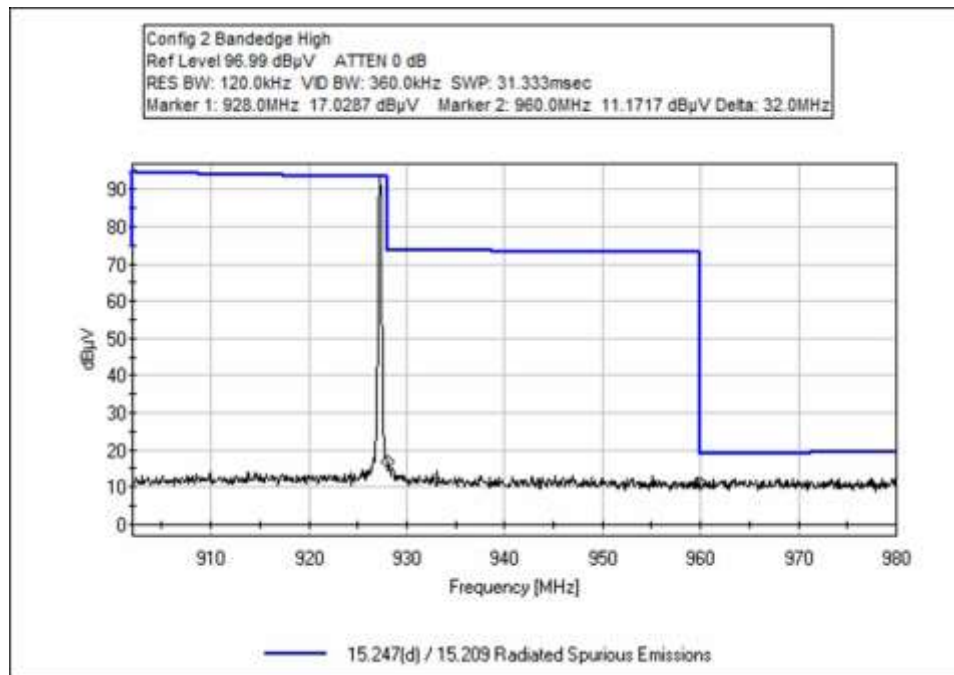


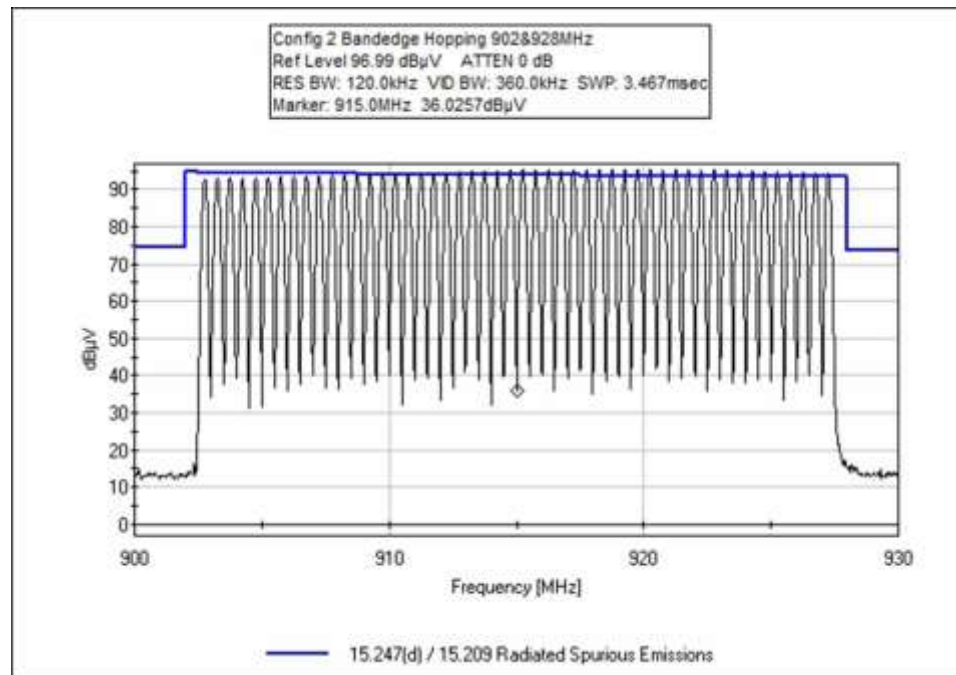












Test Setup / Conditions / Data

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 (°C): 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	Helix	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	dB μ V	dB	dB	dB	dB	Table	dB μ V/m	dB μ V/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 (°C): 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	Helix	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	dB μ V	dB	dB	dB	dB	Table	dB μ V/m	dB μ V/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
^	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 $\text{dB}\mu\text{V}/\text{m}$, the spectrum analyzer reading in $\text{dB}\mu\text{V}$ 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	($\text{dB}\mu\text{V}$)
+	Antenna Factor	(dB/m)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	($\text{dB}\mu\text{V}/\text{m}$)

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.