IMPINJ INC. TEST REPORT

FOR THE

RFID READER CORE, IPJ-R1000-USA1M

FCC PART 15 SUBPART C SECTIONS 15.247

TESTING

DATE OF ISSUE: OCTOBER 9, 2007

PREPARED FOR:

Impinj Inc.
701 N. 34th Street
Seattle, WA 98103

PREPARED BY:

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P.O. No.: 02082
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Date of test: September 17 – October 9, 2007

Report No.: FC06-010G

TABLE OF CONTENTS

ADMINISTRATIVE INFORMATION

DATE OF TEST: September 17 – October 9, 2007

DATE OF RECEIPT: September 17, 2007

REPRESENTATIVE: Mike Thomas

MANUFACTURER:
Impinj Inc.
701 N. 34th Street
Seattle, WA 98103

TEST LOCATION:
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

TEST METHOD: ANSI C63.4 (2003)

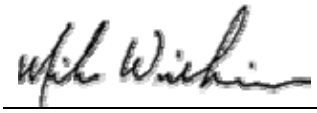
PURPOSE OF TEST:
Original Report: To demonstrate the compliance of the Speedway Reader, IPJ-R1000, with the requirements for FCC part 15 Subpart B sections 15.107 & 15.109 Class B, Subpart C Sections 15.207, 15.209 &15.247 and RSS-210 devices.
Addendum A: To clarify the plot on page 21 with no new testing.
Addendum B: To demonstrate the compliance of the RFID Reader, IPJ-R1000, with partial re-testing for FCC Part 15 Subpart C Sections 15.209 and 15.247 after component changes in the EUT.
Addendum C is to add limit lines to the band edge plots and revise the frequency range on page 5.
Addendum D: To demonstrate the compliance of the RFID Reader Antenna (Brickyard), IPJ-A0400-USA; RFID Reader Antenna (Guardwall), IPJ-A0401-USA and RFID Reader Antenna (Mini-Guardrail), IPJ-A0301-USA with the requirements for FCC Part 15 Subpart C Sections 15.209 & 15.247 devices with testing of new antennas.
Addendum E: To correct sequence 7 on page 12 and sequence 6 on page 18 with no new testing.
Addendum F: To demonstrate the compliance of the RFID Reader Core, IPJ-R1000-USA-0-01-01 with the requirements for FCC Part 15 Subpart C Section 15.247 devices. This EUT was re-tested with a cable attached. It will be professionally installed and the power output was measured at the end of the cable. Additional data from FC06-010A (Number of Hopping Channels, Dwell Time and Average Time of Occupancy) is included in this report because these sections were not affected by the re-testing.
Addendum G: To perform partial testing to demonstrate the RFID Reader Core, IPJ-R1000-USA1M still complies with the requirements for FCC Part 15 Subpart C Section 15.247 for: 1) hopping channel bandwidth and band-edge spurious for modify transmit data format (highest data rate mode only) and 2) reduced power channels. Both due to firmware changes only.

APPROVALS

Steve Behm, Director of Engineering Services

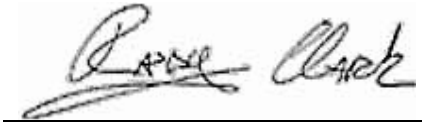
QUALITY ASSURANCE:

Joyce Walker, Quality Assurance Administrative Manager



Mike Wilkinson, EMC Engineer/Lab Manager

TEST PERSONNEL:



Randy Clark, EMC Engineer

CONDITIONS DURING TESTING

No modifications to the EUT were necessary during testing.

EQUIPMENT UNDER TEST (EUT) DESCRIPTION

The customer declares the EUT tested by CKC Laboratories was representative of a production unit.

EQUIPMENT UNDER TEST

RFID Reader Core
Manuf: Impinj
Model: IPJ-R1000-USA1M
Serial: 40306471536

EUT Power Supply
Manuf: CUI Inc
Model: DSA-60W-20 1 24060
Serial: 4406

PERIPHERAL DEVICES

The EUT was tested with the following peripheral device(s):

Router
Manuf: Lynksys
Model: BEFSF41
Serial: CB900E900020

Laptop Computer
Manuf: Toshiba
Model: PS426U-0M1538
Serial: 50683063U

Router Power Supply
Manuf: Lynksys
Model: D12-1A
Serial: NA

Mouse
Manuf: Microsoft
Model: Intellimouse
Serial: 00426696

Laptop Power Supply
Manuf: Toshiba
Model: PA3201U-1ACA
Serial: 03XV10568

REPORT OF EMISSIONS MEASUREMENTS

TESTING PARAMETERS

TEMPERATURE AND HUMIDITY DURING TESTING

The temperature during testing was within +15°C and + 35°C.
The relative humidity was between 20% and 75%.

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.

SAMPLE CALCULATIONS		
	Meter reading	(dBµV)
+	Antenna Factor	(dB)
+	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. 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. When conducted emissions testing was performed, a 10 dB external attenuator was used with internal offset correction in the analyzer.

MEASURING EQUIPMENT BANDWIDTH SETTINGS PER FREQUENCY RANGE			
TEST	BEGINNING FREQUENCY	ENDING FREQUENCY	BANDWIDTH SETTING
CONDUCTED 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 "Peak" mode. Whenever a "Quasi-Peak" or "Average" reading is listed as one of the highest readings, this is indicated as a "QP" or an "Ave" on the appropriate rows of the data sheets. 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/receiver readings were recorded all emissions at their peak value as the frequency band selected was scanned. By combining this function with another feature of the measuring device called "peak hold," the measuring device had the ability to measure transients 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

When the true peak values exceeded or were within 2 dB of the specification limit, quasi-peak measurements were taken using the quasi-peak detector.

Average

For certain frequencies, average measurements may be made using the spectrum analyzer/receiver. 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.

FCC Part 15.247(a) OCCUPIED BANDWIDTH

Test Equipment

Function	S/N	Calibration Date	Cal Due Date	Asset #
Agilent E4446A SA	US44300407	01/03/2007	01/03/2009	02660
Cable, SMElectronics	432007	04/23/2007	04/23/2009	P05178
Attenuator 30dB, Bird 25A-MFN-30	9724	05/18/2005	05/18/2007	P01577

Test Conditions

RFID reader is connected to laptop via the router. Laptop is used for configuration of the EUT. RF port 1 connected with suitable attenuation to Spectrum Analyzer via provided RF cable. Normal power mode investigated. Interrogator transmitting at max power with modulation. Reader set up in bench area.
Low Channel: 902.75 MHz
Mid Channel: 914.75 MHz
High Channel: 927.25 MHz

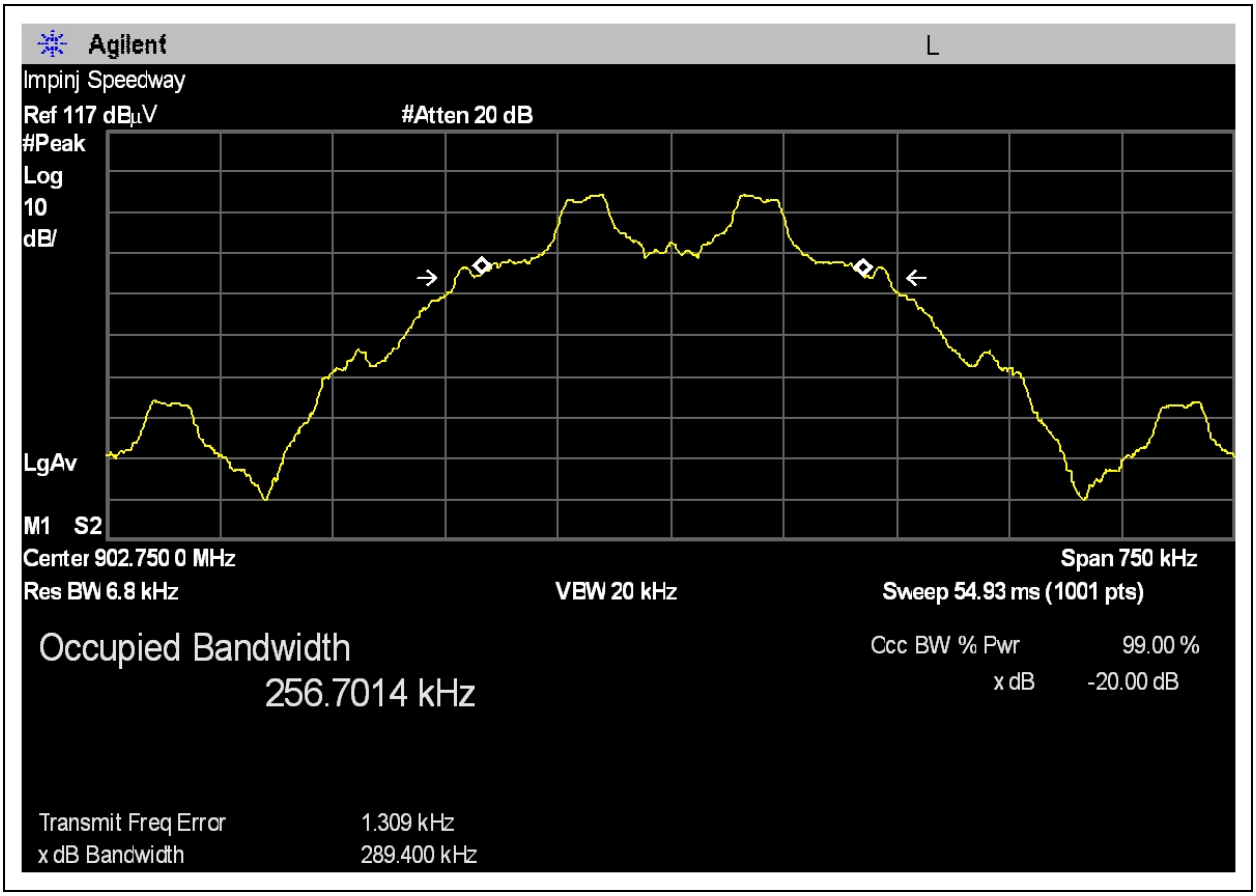
Transmitter mode is set for the highest data rate. Equipment contains other data rates with bandwidth <250 kHz. Therefore, the more stringent requirements are applied to the 15.247(a) average time of occupancy requirements.

Frequency range under investigation: 902 MHz - 928 MHz

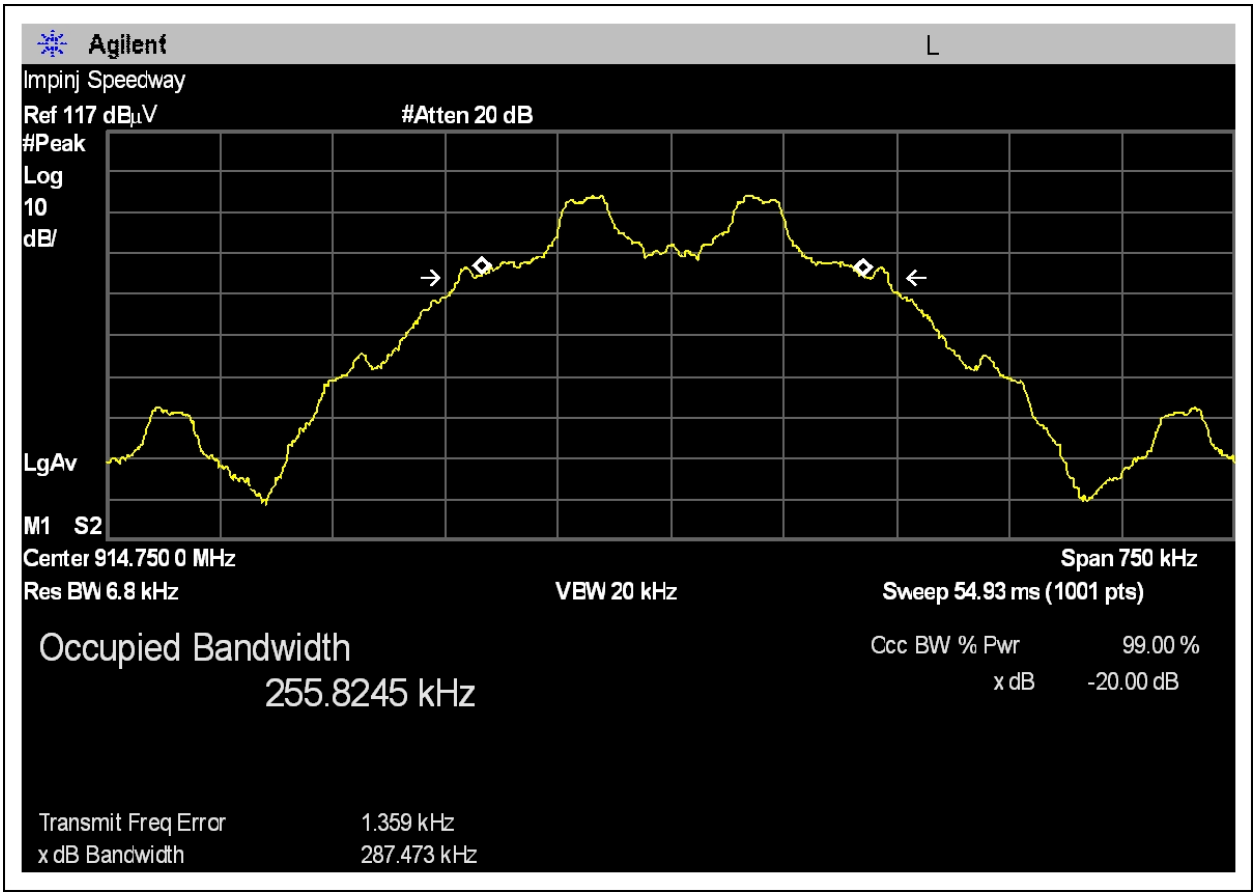
Test Setup Photos

Test Plots

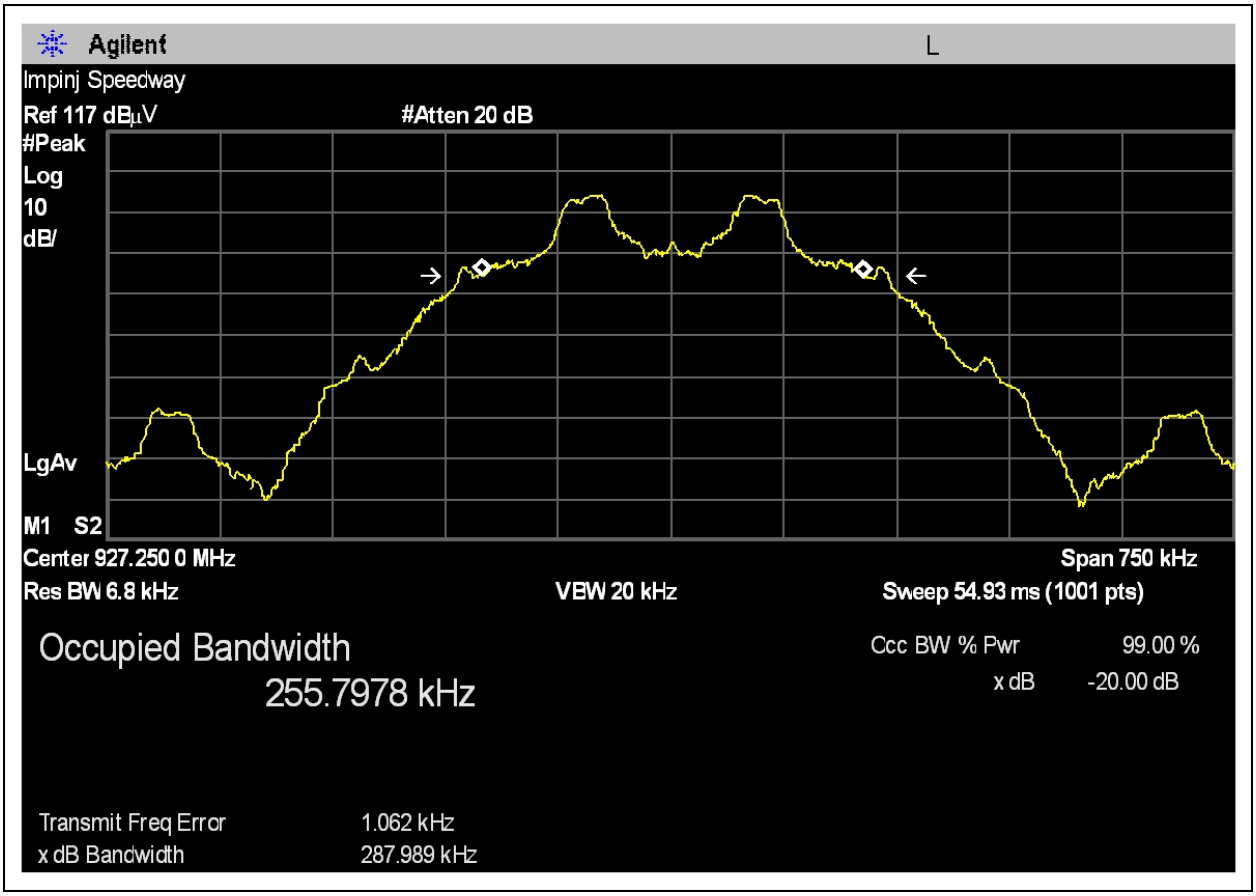
OCCUPIED BANDWIDTH - LOW CHANNEL



OCCUPIED BANDWIDTH - MID CHANNEL



OCCUPIED BANDWIDTH - HIGH CHANNEL



FCC Part 15.247(a) BAND EDGE

Test Equipment

Function	S/N	Calibration Date	Cal Due Date	Asset #
Agilent E4446A SA	US44300407	01/03/2007	01/03/2009	02660
Cable, SMElectronics	432007	04/23/2007	04/23/2009	P05178
Attenuator 30dB, Bird 25A-MFN-30	9724	05/18/2005	05/18/2007	P01577

Test Conditions

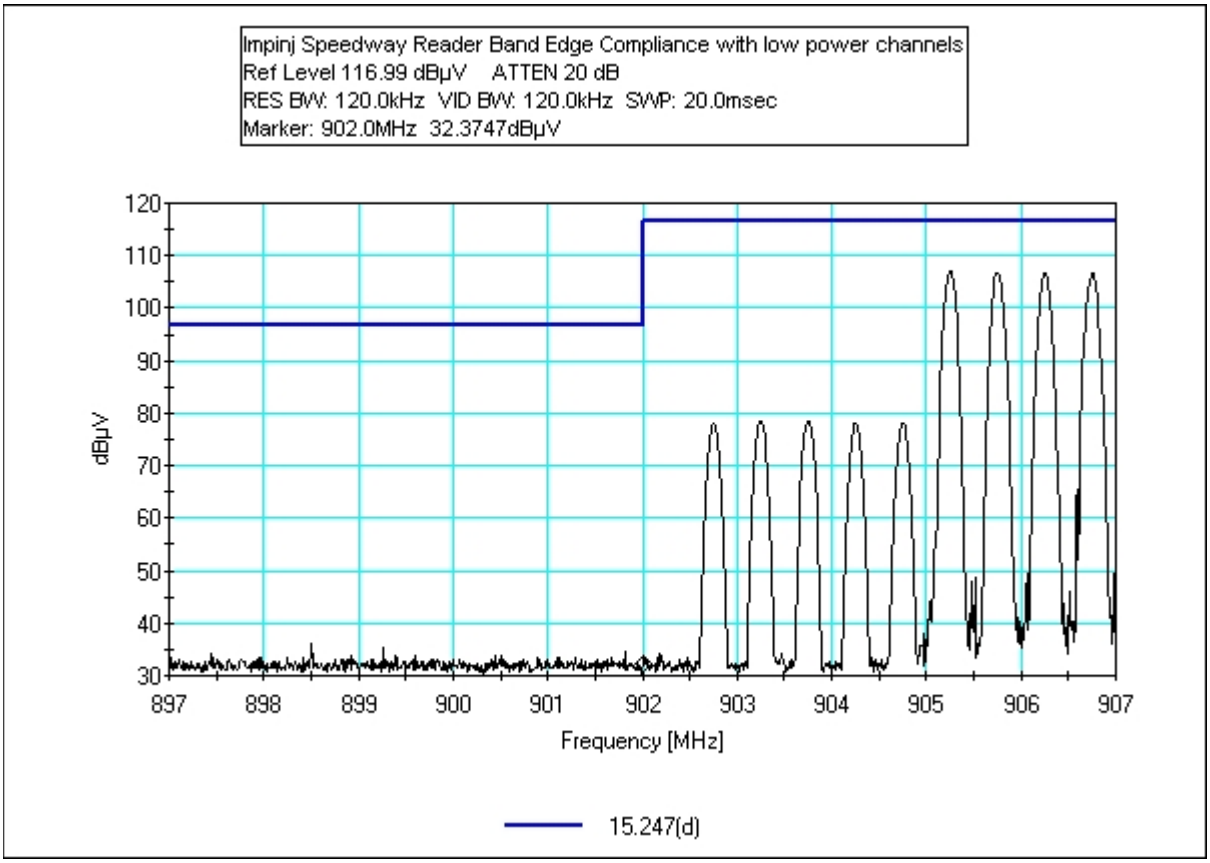
RFID reader is connected to laptop via the router. Laptop is used for configuration of the EUT. RF port 1 connected with suitable attenuation to Spectrum Analyzer via provided RF cable. Both normal power and low power modes investigated. Interrogator transmitting with modulation. Reader set up in bench area.

Frequency range under investigation: Band Edge

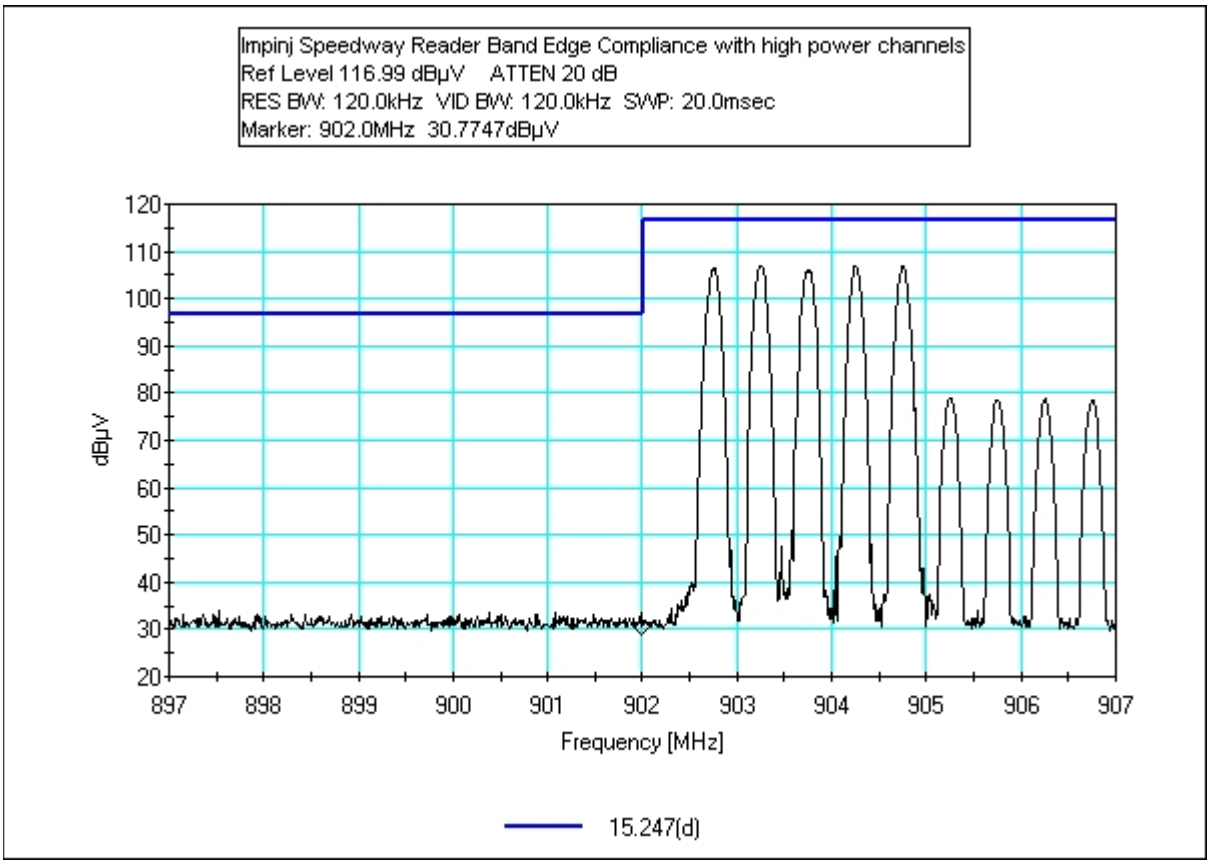
Test Setup Photos

Test Plots

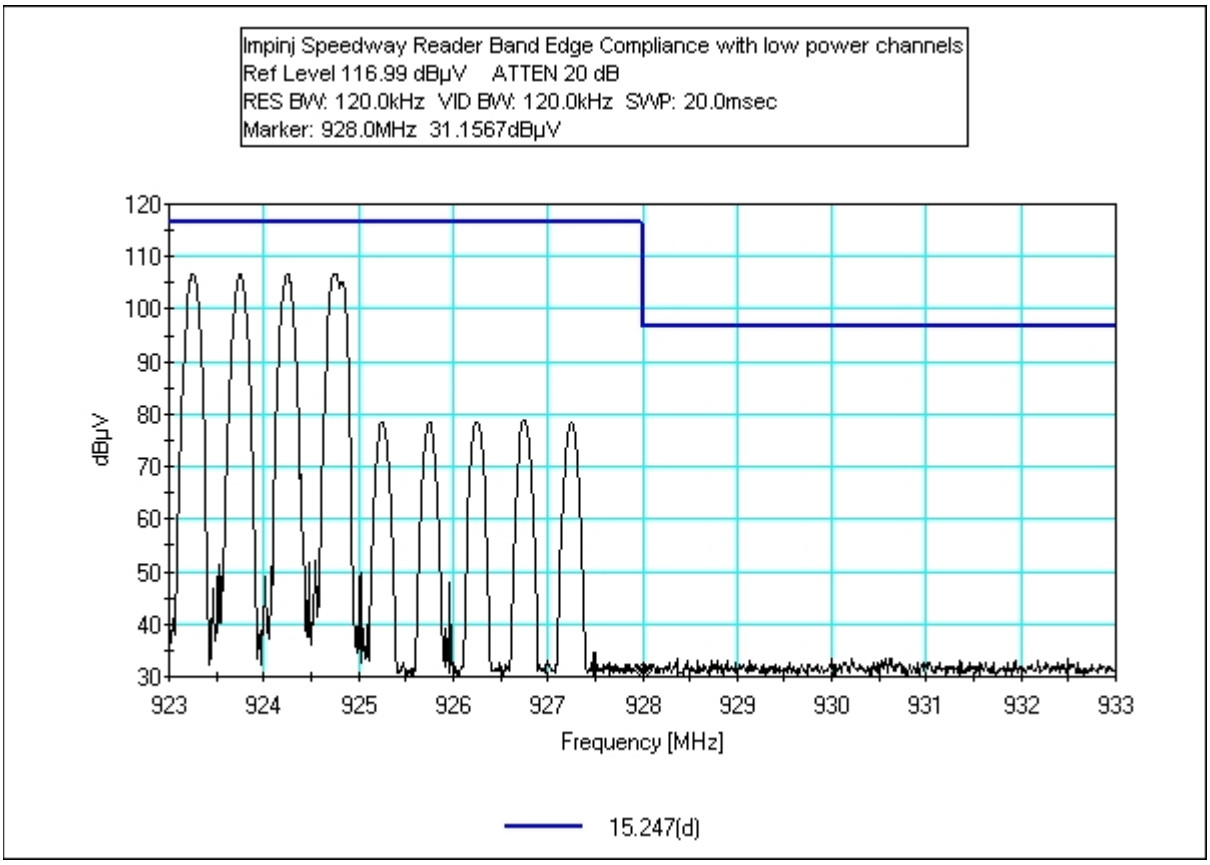
BAND EDGE - LOW CHANNEL LOW POWER



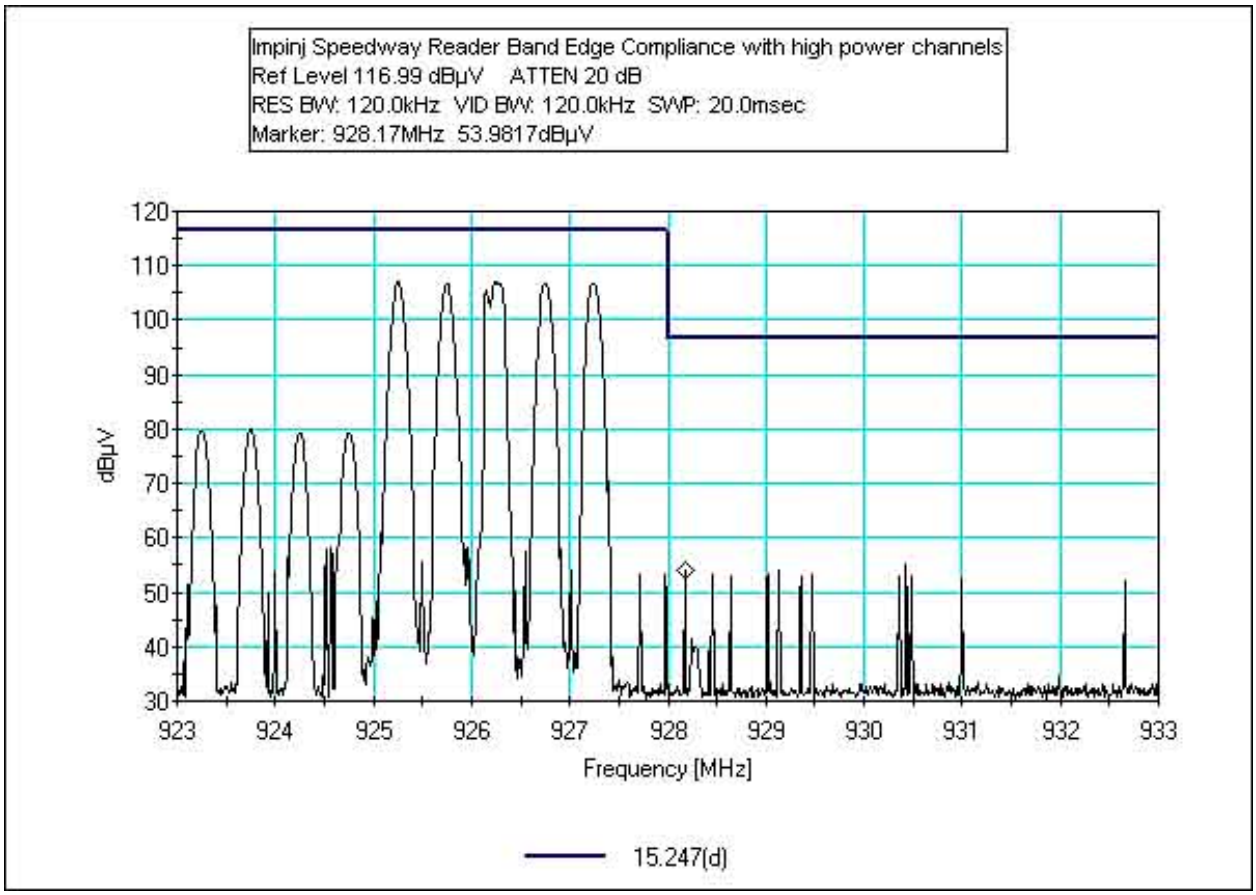
BAND EDGE - LOW CHANNEL HIGH POWER



BAND EDGE - HIGH CHANNEL LOW POWER



BAND EDGE - HIGH CHANNEL HIGH POWER



FCC Part 15.247(a) DWELL TIME

Test Equipment

Function	S/N	Calibration Date	Cal Due Date	Asset #
Agilent E4446A SA	US44300407	01/03/2007	01/03/2009	02660
Cable, SMElectronics	432007	04/23/2007	04/23/2009	P05178
Attenuator 30dB, Bird 25A-MFN-30	9724	05/18/2005	05/18/2007	P01577

Test Conditions

RFID reader is connected to laptop via the router. Laptop is used for configuration of the EUT. RF port 1 connected with suitable attenuation to Spectrum Analyzer via provided RF cable. Both normal power and low power modes investigated. Interrogator transmitting at max power with modulation. Reader set up in bench area
Mid Channel: 914.75 MHz
Frequency range under investigation: 902-928MHz

The analyzer is set to video trigger at 20dB below the carrier output level.

Low power mode:
The low power mode dwell time varies depending on the number of low power channels chosen.

The minimum number of low power channels allowed by the manufacturer is 2 in which the following is measured: There is a pulse train repetition which repeats approximately every 10.28 seconds. There are therefore 1.946 pulse trains per 20 second window. There are 20 individual pulses per pulse train. Each individual pulse has an average duration of 10.056ms. The pulses were averaged using video trace averaging over 200 samples. Therefore the average on time in any 20 second window is 1.946*10.056*ms*20 = 391.28ms . This satisfies the 400ms on time requirement in any 20 second window.

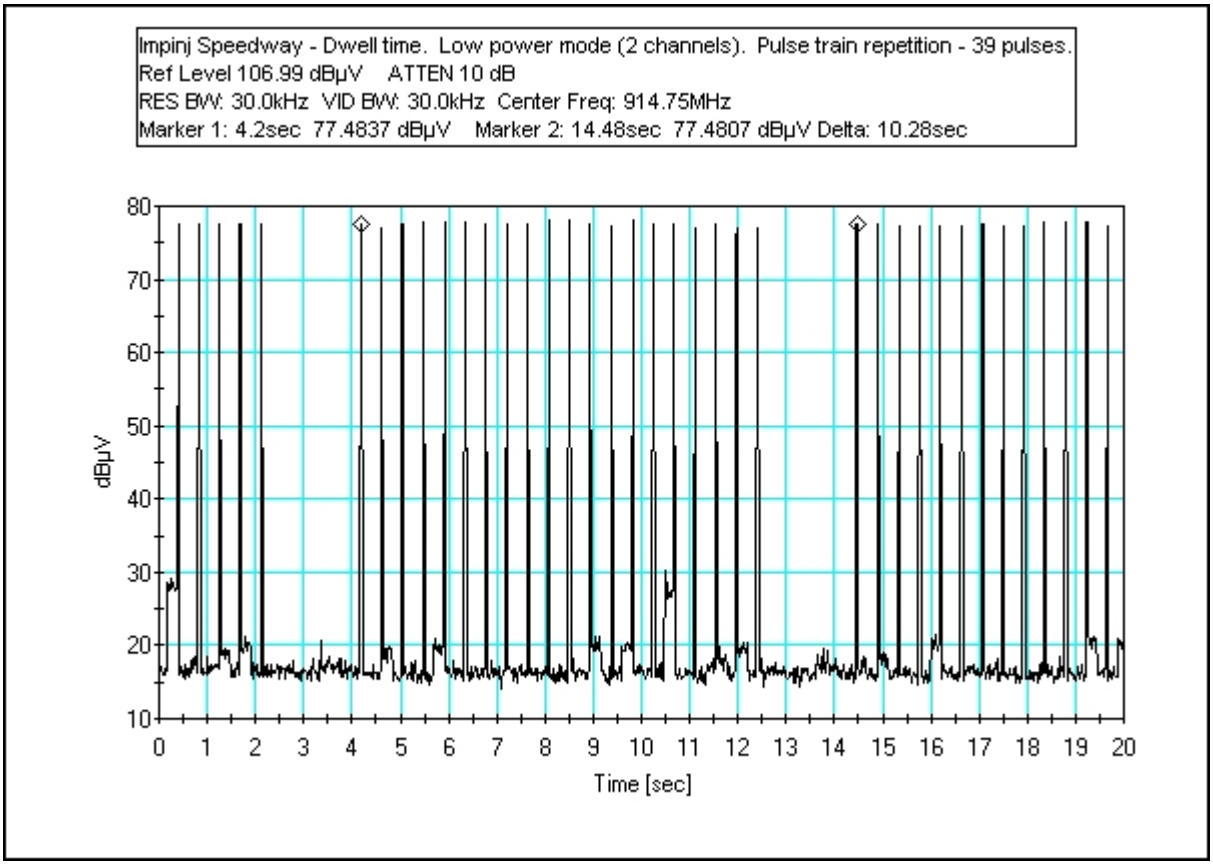
The maximum number of low power channels allowed by the manufacturer is 16 in which the following is measured: There is a pulse repetition which repeats approximately every 10.18 seconds. There are two pulses which occur within the pulse train with periods of 5.3 and 4.9 seconds respectively. There are therefore 3.93 pulses per 20 second window. Each pulse has an average duration of 99.99ms. The pulses were averaged using video trace averaging over 150 samples. Therefore the average on time in any 20 second window is 3.93*99.99 = 392.96ms. This satisfies the 400ms on time requirement in any 20 second window.

High power mode:
There is a pulse repetition which repeats approximately every 10.2 seconds. There are therefore 1.96 pulses per 20 second window. The average on time per pulse is 201.23ms (averaged over 10 pulses). Therefore the average on time in any 20 second window is 1.96*201.23 = 394.56ms. This satisfies the 400ms on time requirement in any 20 second window.

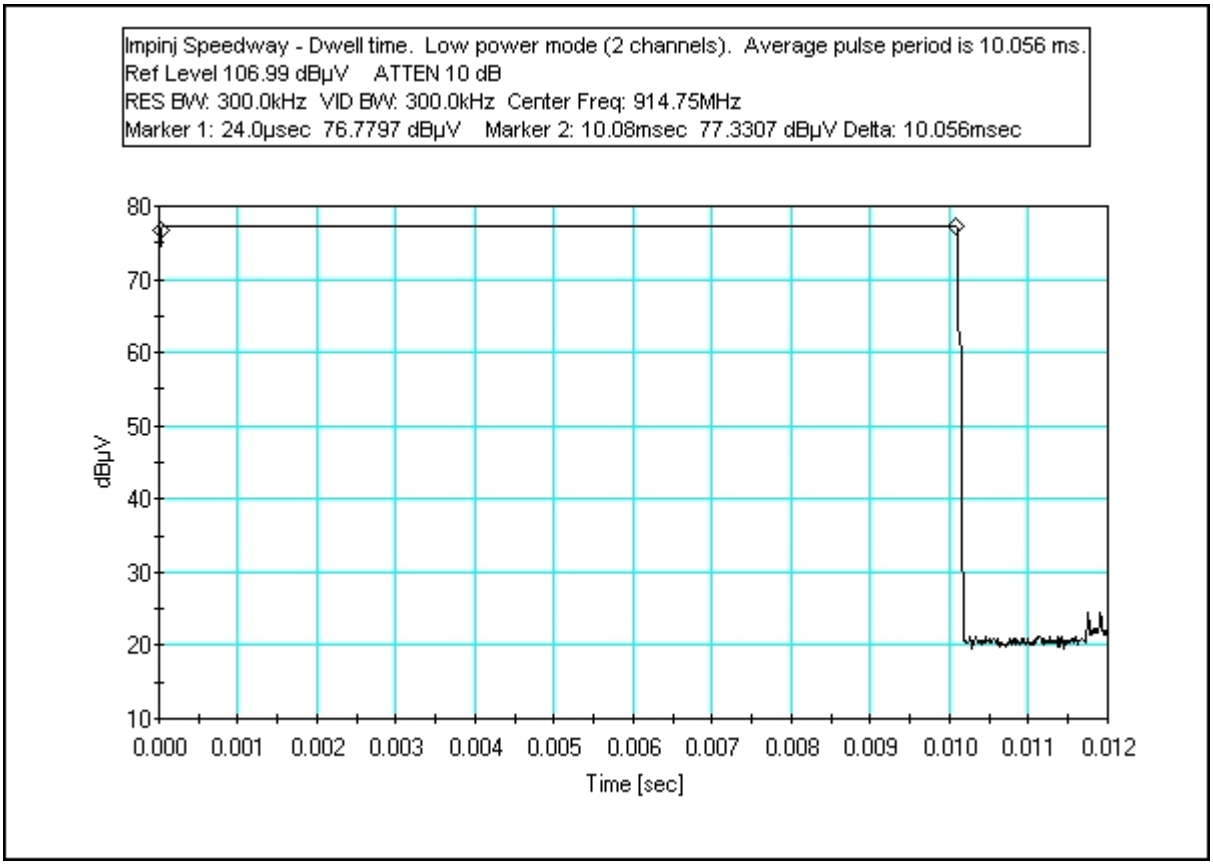
Test Setup Photos

Test Plots

DWELL TIME - LOW POWER 2 CHANNELS 20sec

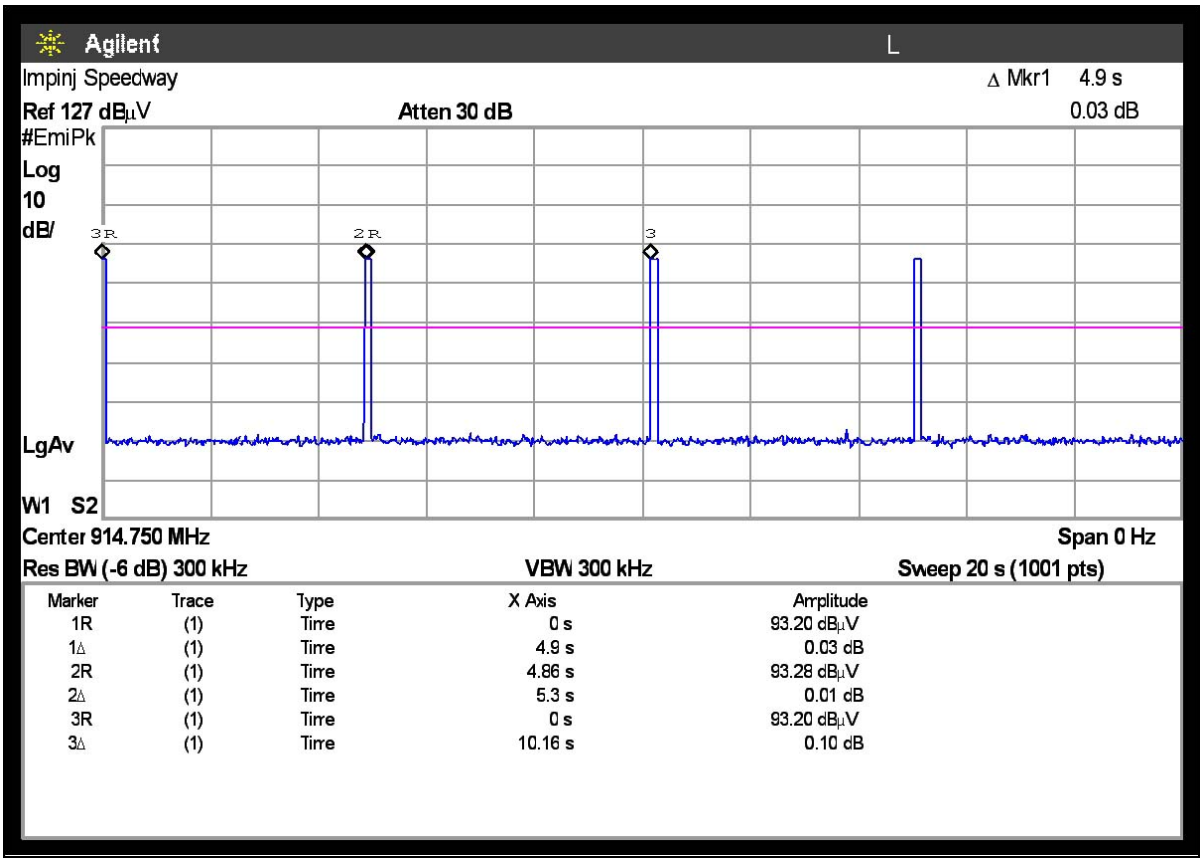


DWELL TIME - LOW POWER 2 CHANNELS 12ms

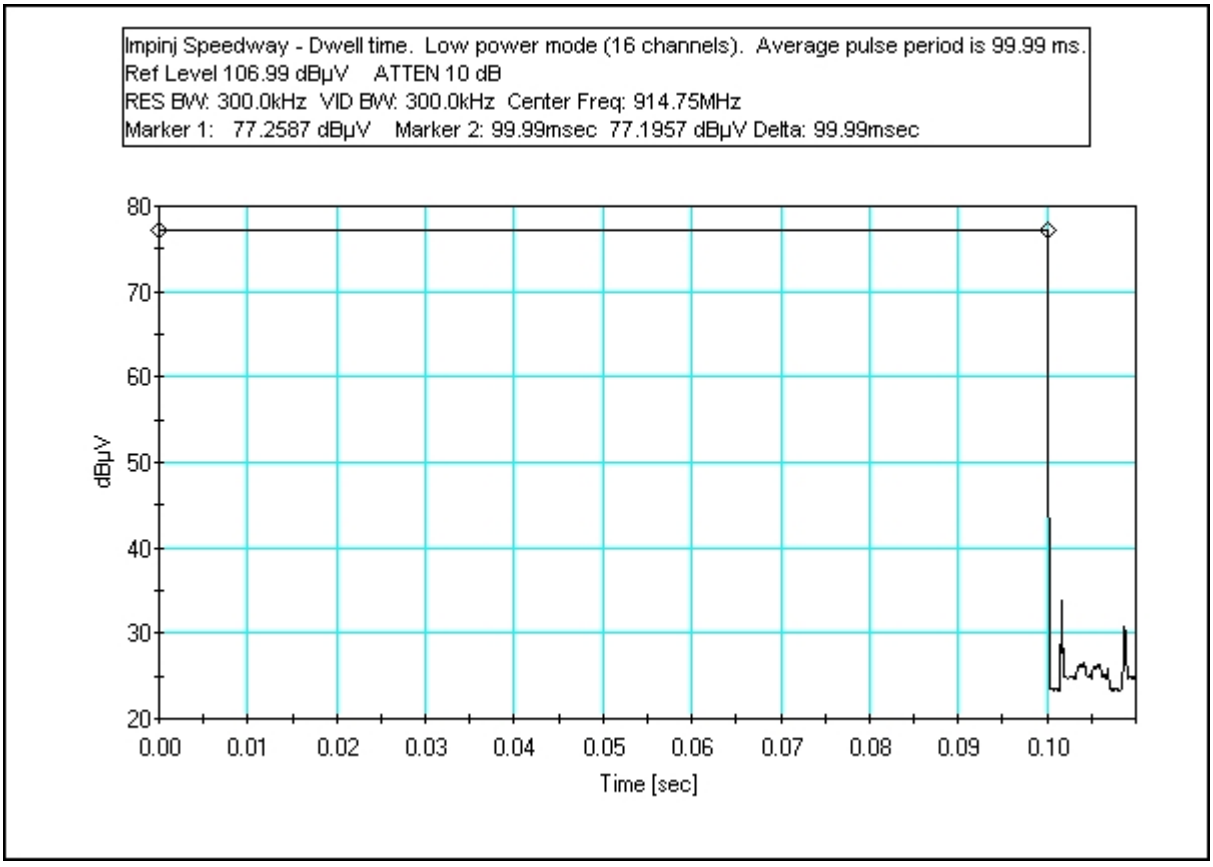


DWELL TIME - LOW POWER 16 CHANNELS 20sec

Note: See explanation on page 17.

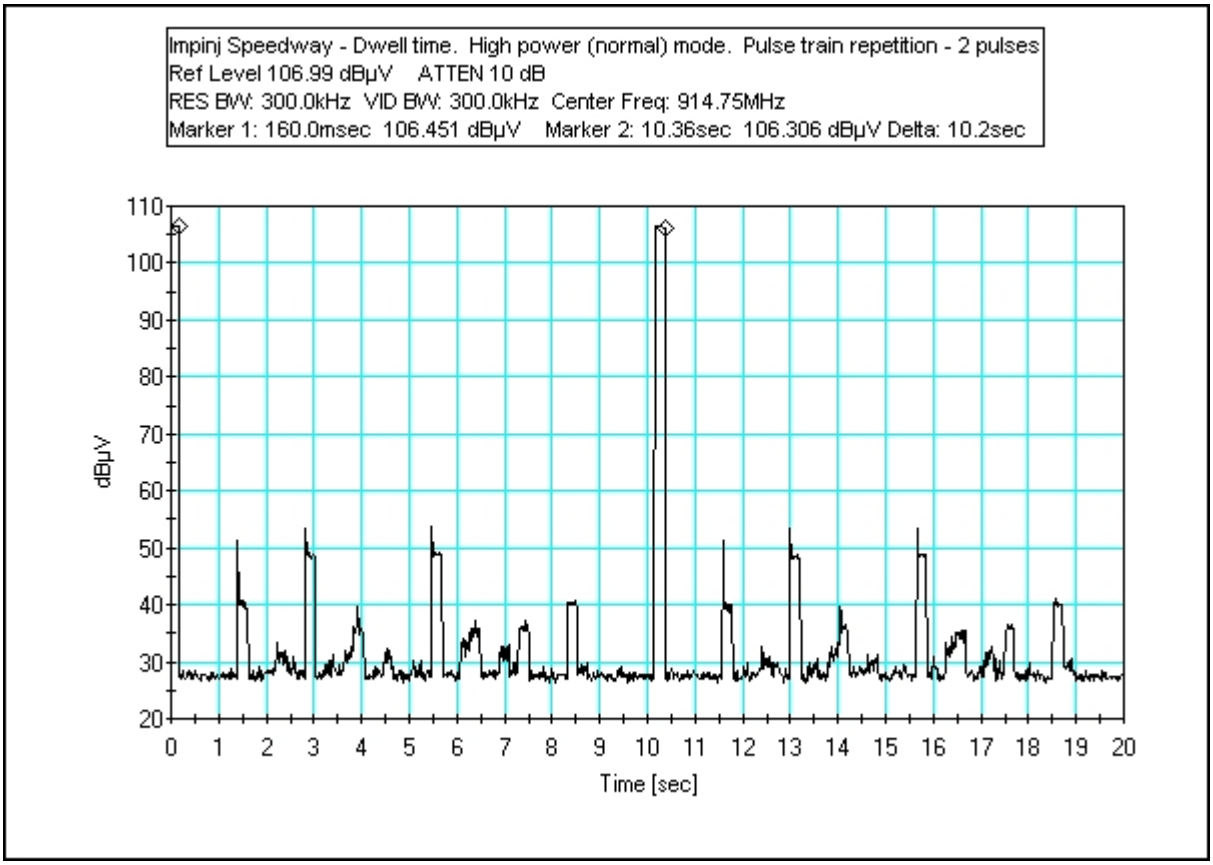


DWELL TIME - LOW POWER 16 CHANNELS 110ms

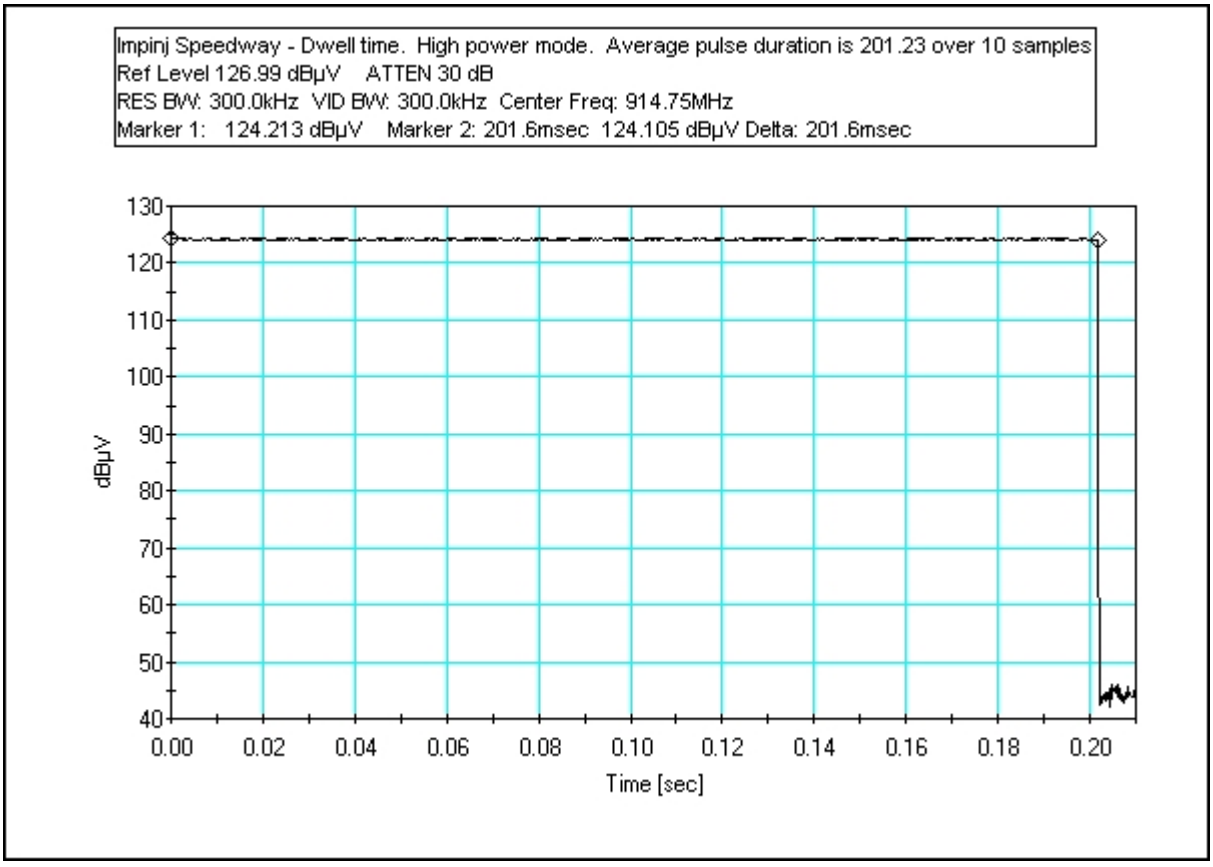


DWELL TIME - HIGH POWER 20sec

Note: See explanation on page 17.



DWELL TIME - HIGH POWER 201ms



FCC Part 15.247(a) NUMBER OF HOPPING CHANNELS

Test Equipment

Function	S/N	Calibration Date	Cal Due Date	Asset #
Agilent E4446A SA	US44300407	01/03/2007	01/03/2009	02660
Cable, SMElectronics	432007	04/23/2007	04/23/2009	P05178
Attenuator 30dB, Bird 25A-MFN-30	9724	05/18/2005	05/18/2007	P01577

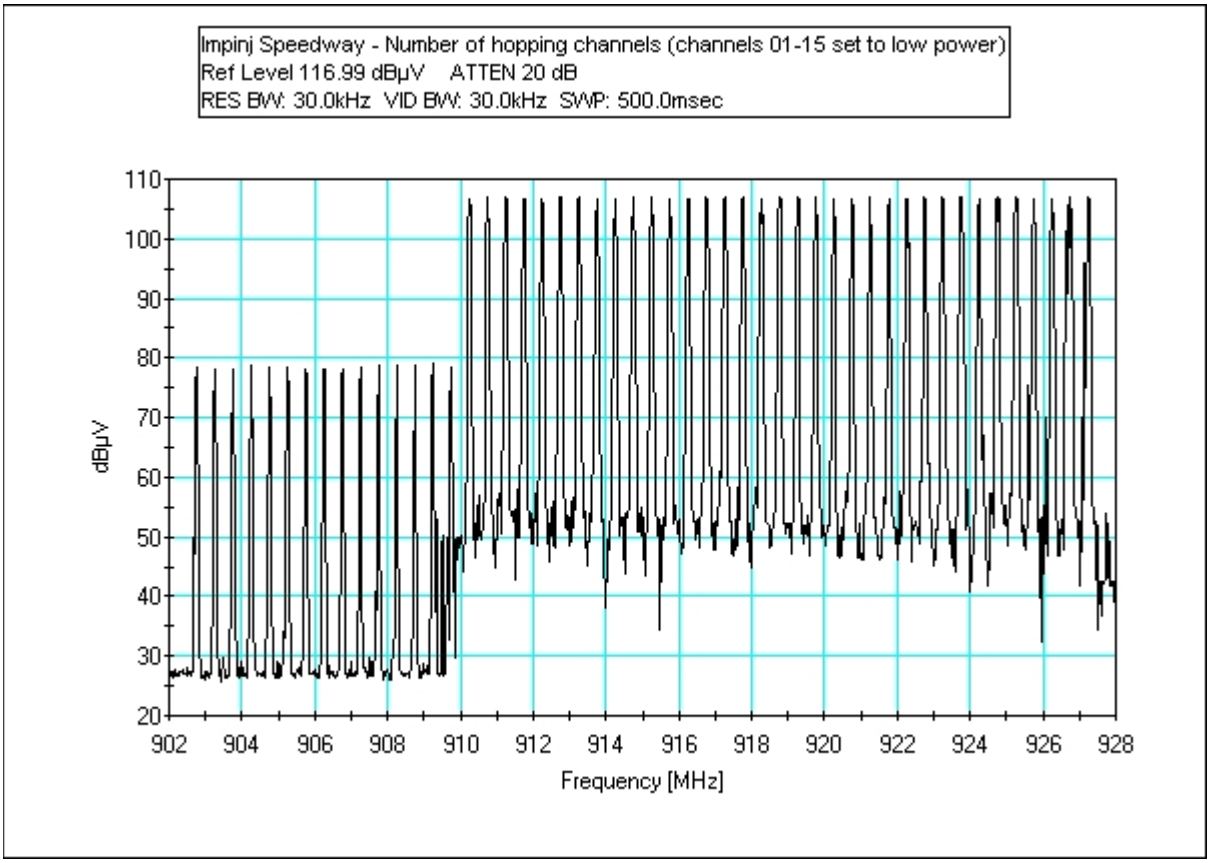
Test Conditions

RFID reader is connected to laptop via the router. Laptop is used for configuration of the EUT. RF port 1 connected with suitable attenuation to Spectrum Analyzer via provided RF cable. Both normal power and low power modes investigated. Interrogator transmitting with modulation. Reader set up in bench area.
Frequency range under investigation: 902-928 MHz

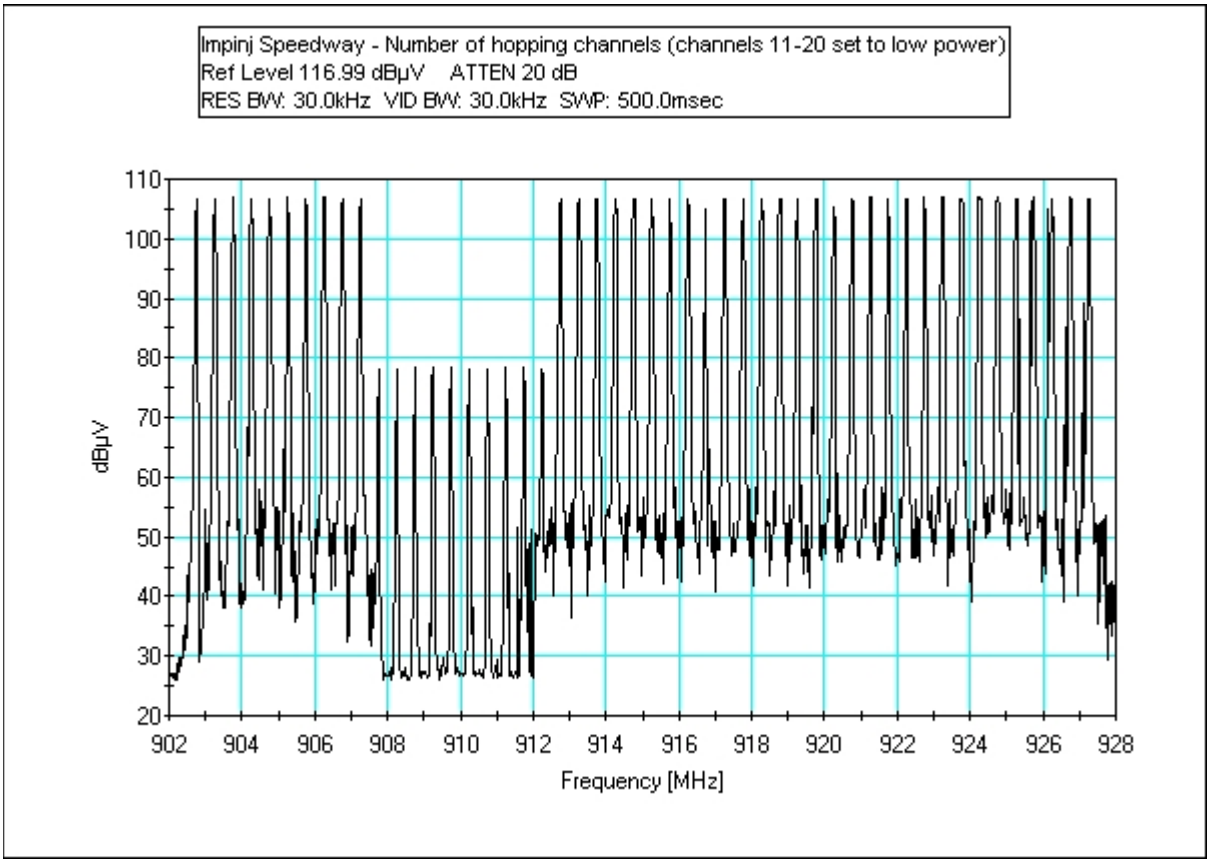
Test Setup Photos

Test Plots

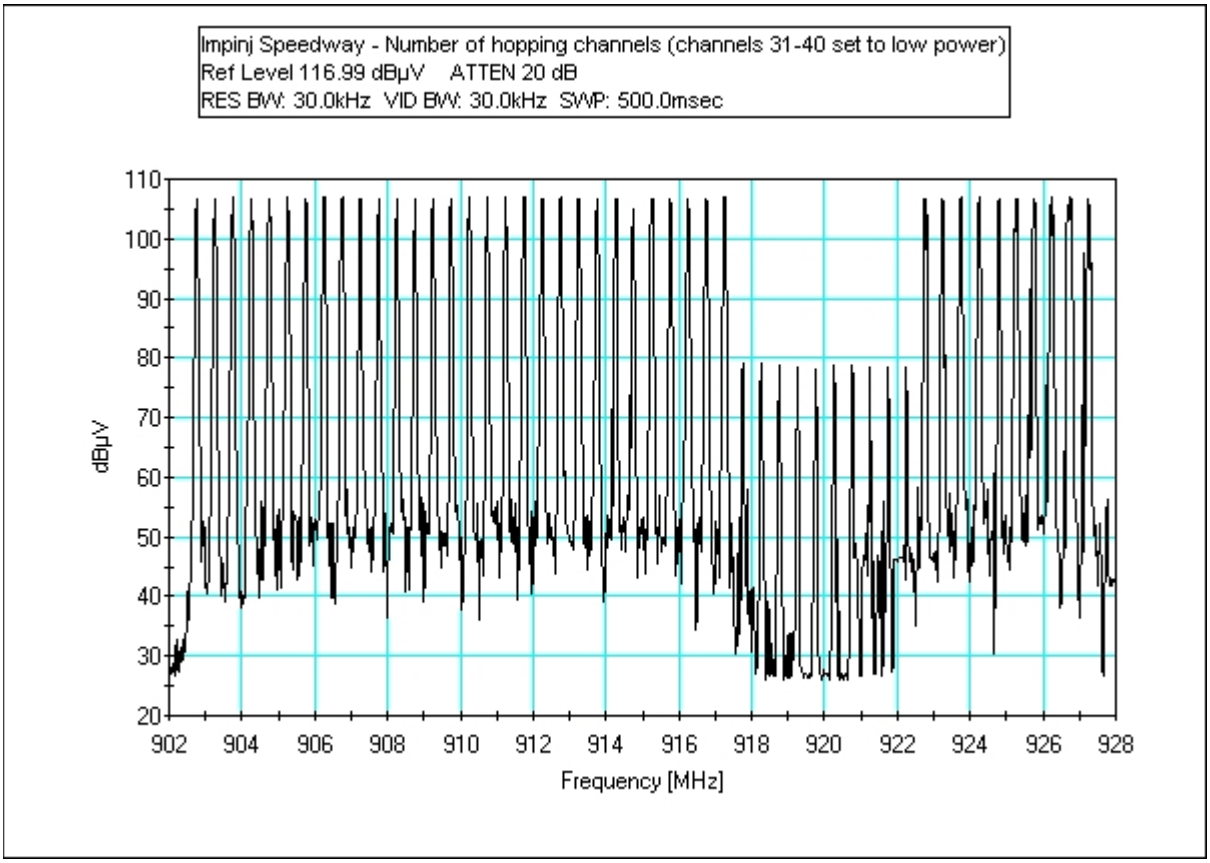
NUMBER OF HOPPING CHANNELS 01-15 SET TO LOW POWER



NUMBER OF HOPPING CHANNELS 11-20 SET TO LOW POWER



NUMBER OF HOPPING CHANNELS 31-40 SET TO LOW POWER



FCC 15.247(b) ANTENNA CONDUCTED SPURIOUS EMISSIONS

Test Setup Photos

Test Data Sheets

Test Location: CKC Laboratories, Inc. •4933 Sierra Pines Dr. • Mariposa, CA 95338 • 1-800-500-4EMC (4362)

Customer:	**Impinj Inc.**		
Specification:	**15.247(b)(3)**		
Work Order #:	**86329**	Date:	9/17/2007
Test Type:	**Antenna Conducted**	Time:	09:46:13
Equipment:	**RFID Reader Core**	Sequence#:	1
Manufacturer:	Impinj	Tested By:	Randal Clark
Model:	IPJ-R1000-USA1M		120V 60Hz
S/N:	40306471536		

***Test Equipment*:**

Function	S/N	Calibration Date	Cal Due Date	Asset #
Agilent E4446A SA	US44300407	01/03/2007	01/03/2009	02660
Cable, SMElectronics	432007	04/23/2007	04/23/2009	P05178
Attenuator 30dB, Bird 25A-MFN-30	9724	05/09/2007	05/09/2009	P01577

***Equipment Under Test* (* = EUT):**

Function	Manufacturer	Model #	S/N
RFID Reader Core*	Impinj	IPJ-R1000-USA1M	40306471536
EUT Power Supply	CUI Inc	DSA-60W-20 1 24060	4406

Support Devices:

Function	Manufacturer	Model #	S/N
Router	Lynksys	BEFSF41	CB900E900020
Router Power Supply	Lynksys	D12-1A	NA
Laptop Computer	Toshiba	PS426U-0M1538	50683063U
Laptop Power Supply	Toshiba	PA3201U-1ACA	03XV10568
Mouse	Microsoft	Intellimouse	00426696

Test Conditions / Notes:

RFID reader is connected to laptop via the router. Laptop is used for configuration of the EUT. RF port 1 connected with suitable attenuation to Spectrum Analyzer via provided RF cable. Both normal power and low power modes investigated. Interrogator transmitting at max power with modulation. Reader set up in bench area Low Channel: 902.75 MHz, Mid Channel: 914.75 MHz, High Channel: 927.25 MHz. Measuring RF Power Output. Frequency range under investigation: 902 MHz - 928 MHz RBW = 1MHz; VBW = 1MHz.

Transducer Legend:

T1=Cable Sun Moon 12" 40GHz P05178 T2=Pad 30dB P1577

Measurement Data: Reading listed by margin. Test Lead: Antenna 1

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
1	902.750M	106.3	+0.2	+30.2			+0.0	136.7	137.0	-0.3	Anten
2	927.250M	106.3	+0.2	+30.2			+0.0	136.7	137.0	-0.3	Anten
3	914.750M	106.3	+0.2	+30.2			+0.0	136.7	137.0	-0.3	Anten
4	927.250M	78.9	+0.2	+30.2			+0.0	109.3	137.0 Low Power Mode	-27.7	Anten
5	914.750M	78.2	+0.2	+30.2			+0.0	108.6	137.0 Low Power Mode	-28.4	Anten
6	902.750M	78.1	+0.2	+30.2			+0.0	108.5	137.0 Low Power Mode	-28.5	Anten