

Raytheon Company

TEST REPORT FOR

**DSRC Reader
Model: M215-A2A**

Tested To The Following Standards:

FCC Part 90I

Report No.: 93870-7

Date of issue: March 25, 2013



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 EMC 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:

Raytheon Company
1801 Hughes Drive
Bldg. 675 -D241 Dist. Center
Fullerton, CA 92834-3310

Representative: Mike Mikasa
Customer Reference Number: 4200632228

DATE OF EQUIPMENT RECEIPT:

DATE(S) OF TESTING:

REPORT PREPARED BY:

Dianne Dudley
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 93870

March 12, 2013

March 12-14, 2013

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the sample equipment 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.
110 Olinda Place
Brea, CA 92823

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.00.14
Immunity	5.00.07

Site Registration & Accreditation Information

Location	CB #	TAIWAN	CANADA	FCC	JAPAN
Bothell	US0081	SL2-IN-E-1145R	3082C-1	318736	A-0148

SUMMARY OF RESULTS

Standard / Specification: FCC Part 90I

Description	Test Procedure/Method	Results
RF Output Power	FCC Part 90I / 90.205	Pass
Occupied Bandwidth	FCC Part 90I / 2.1049	Pass
FCC Bandedge	FCC Part 90I / 90.210(k)5	Pass
Conducted Spurious Emissions	FCC 90I / 90.210(k)	Pass
Radiated Spurious Emissions	FCC 90I / 90.210(k)	Pass
Emissions Mask	FCC Part 90I / 90.205	Pass

Conditions During Testing

This list is a summary of the conditions noted for or modifications made to the equipment during testing.

Summary of Conditions
Modifications to EUT during testing: A 0.1uF capacitor added to the T/R control line C196.

EQUIPMENT UNDER TEST (EUT)

EQUIPMENT UNDER TEST

DSRC Reader

Manuf: Raytheon Company
Model: M215-A2A
Serial: 001

PERIPHERAL DEVICES

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

Laptop

Manuf: Dell
Model: PPX
Serial: 72MUFA00H

Power Supply

Manuf: Lambda
Model: LNS-X-12
Serial: NA

FCC PART 90I

This report contains EMC emissions test results under United States Federal Communications Commission (FCC) 47 CFR Part 90I requirements for radio communications systems licensed and used in the Public Safety, Industrial/Business Radio Pool, and Radiolocation Radio Services.

RF Power Output

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • (714) 993-6112

Customer: **Raytheon Company**
Specification: **FCC 90.205 RF Output Power**
Work Order #: **93870**

Date: 3/13/2013

Time: 13:39:22

Equipment: **DSRC Reader**
Manufacturer: Raytheon Company
Model: M215-A2A
S/N: 001

Sequence#: 3

Tested By: E. Wong
12VDC

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	2/6/2013	2/6/2015
T1	ANP06153	Cable	16301	10/27/2011	10/27/2013

Equipment Under Test (* = EUT):

Function	Manufacturer	Model #	S/N
DSRC Reader*	Raytheon Company	M215-A2A	001

Support Devices:

Function	Manufacturer	Model #	S/N
Laptop	Dell	PPX	72MUFA00H
Power Supply	Lambda	LNS-X-12	NA

Test Conditions / Notes:

The EUT is placed on the test bench. RS232 port is connected to a support laptop. All other ports are left unpopulated for evaluation of RF signal at the antenna port. The spectrum analyzer is connected to Port 1 of the EUT. Port 1 thru Port 4 utilizes the same RF circuit.

Digital attenuator set to: 9

Freq: 905MHz, 915MHz, 925MHz

Modulation: OOK.

Measured Peak Power= 29.04dBm, **29.92dBm**, 29.18dBm (0.80 W, 0.98W, 0.83W)

Antenna to be used with this product:

Sirit, single-element patch antenna, ANTENNA-024 Gain:15dBi

Transcore, Universal Toll Antenna, AA3152 Gain: 14dBi

Frequency range of measurement = Fundamental

Test environment conditions: 25°C, 45% Relative Humidity, 100kPa

The EUT obtains 12V DC power from a support DC Power supply.

Modification: 0.1uF capacitor added to the T/R control line C196.

Center frequency was set to 905MHz, 915MHz and 925MHz. The licensee will adjust the transmit frequency according to appropriate frequency plan at the time of licensing.

Test Data

Sirit, single-element patch antenna, ANTENNA-024 Gain: 15dBi

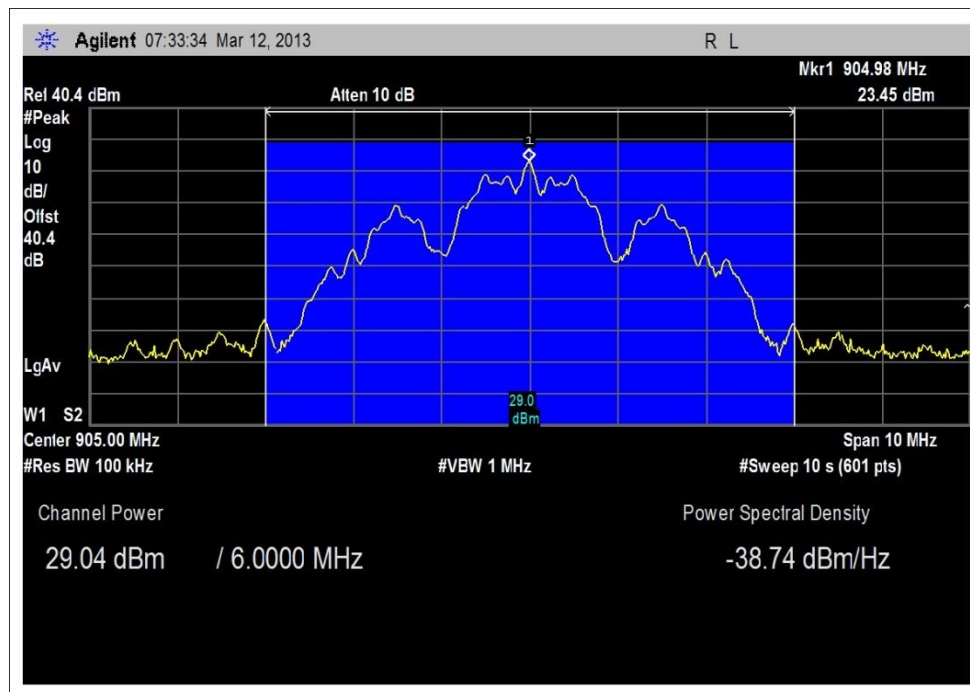
Freq	Conducted Peak power	Antenna gain dBi	Antenna gain dBd =dBi-2.15	ERP dBm	ERP Watt
905	29.04	15	12.85	41.89	15.5
915	29.92	15	12.85	42.77	18.9
925	29.18	15	12.85	42.03	16.0

ERP =conducted power (dBm) + antenna gain (dBd)

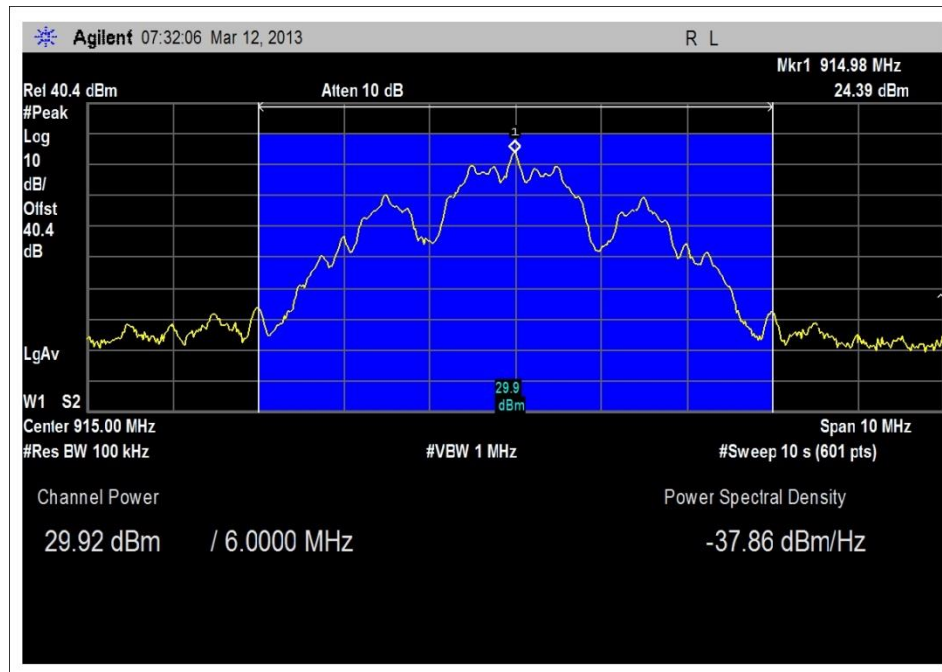
Transcore, Universal Toll Antenna, AA3152 Gain: 14dBi

Freq	Conducted Peak power	Antenna gain dBi	Antenna gain dBd =dBi-2.15	ERP dBm	ERP Watt
905	29.04	14	11.85	40.89	12.3
915	29.92	14	11.85	41.77	15.0
925	29.18	14	11.85	41.03	12.7

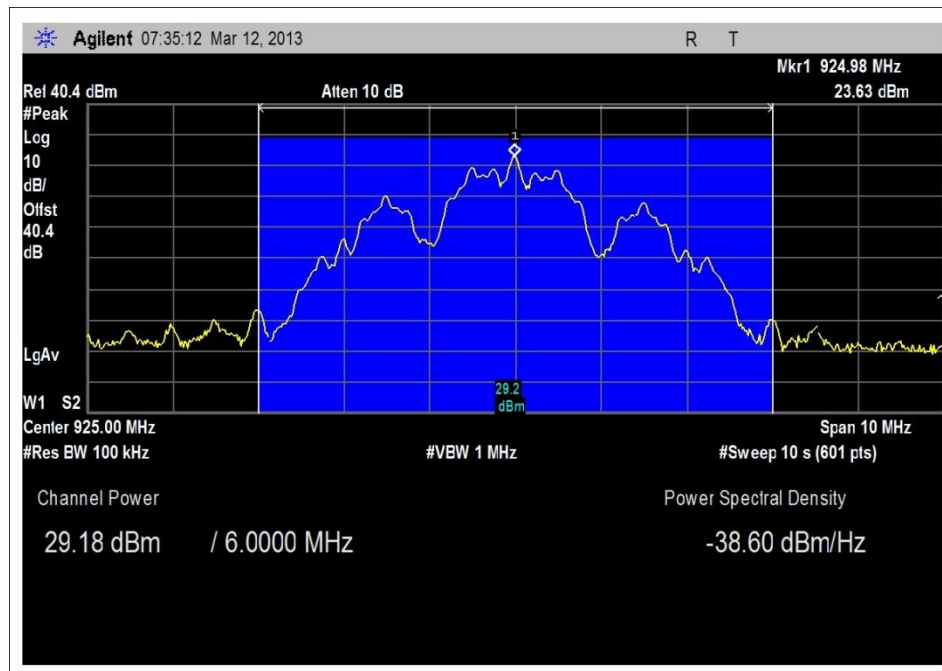
ERP =conducted power (dBm) + antenna gain (dBd)



905MHz

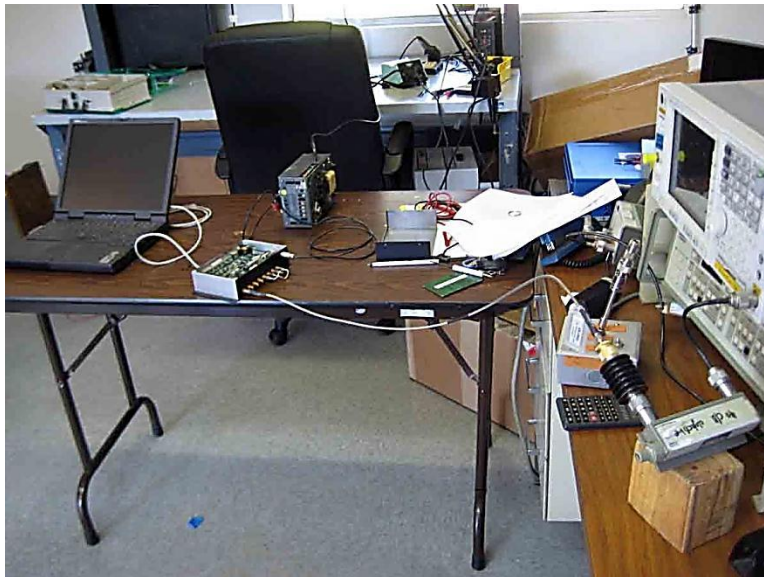


915MHz



925MHz

Test Setup Photos



Occupied Bandwidth

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • (714) 993-6112

Customer: **Raytheon Company**
Specification: **FCC 2.1049 Occupied bandwidth -23dBc**
Work Order #: **93870**

Date: 3/13/2013

Time: 13:39:22

Equipment: **DSRC Reader**
Manufacturer: Raytheon Company
Model: M215-A2A
S/N: 001

Sequence#: 3
Tested By: E. Wong
12VDC

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	2/6/2013	2/6/2015
T1	ANP06153	Cable	16301	10/27/2011	10/27/2013

Equipment Under Test (* = EUT):

Function	Manufacturer	Model #	S/N
DSRC Reader*	Raytheon Company	M215-A2A	001

Support Devices:

Function	Manufacturer	Model #	S/N
Laptop	Dell	PPX	72MUFA00H
Power Supply	Lambda	LNS-X-12	NA

Test Conditions / Notes:

The EUT is placed on the test bench. RS232 port is connected to a support laptop. All other ports are left unpopulated for evaluation of RF signal at the antenna port. The spectrum analyzer is connected to Port 1 of the EUT. Port 1 thru Port 4 utilizes the same RF circuit.

Digital attenuator set to : 9

Freq: 905MHz, 915MHz, 925MHz

Modulation: OOK.

Measured Peak Power= 29.04dBm, 29.92dBm, 29.18dBm (0.80 W, 0.98W, 0.83W)

Antenna to be used with this product:

Sirit, single-element patch antenna, ANTENNA-024 Gain:15dBi

Transcore, Universal Toll Antenna, AA3152 Gain: 14dBi

Frequency range of measurement = Fundamental

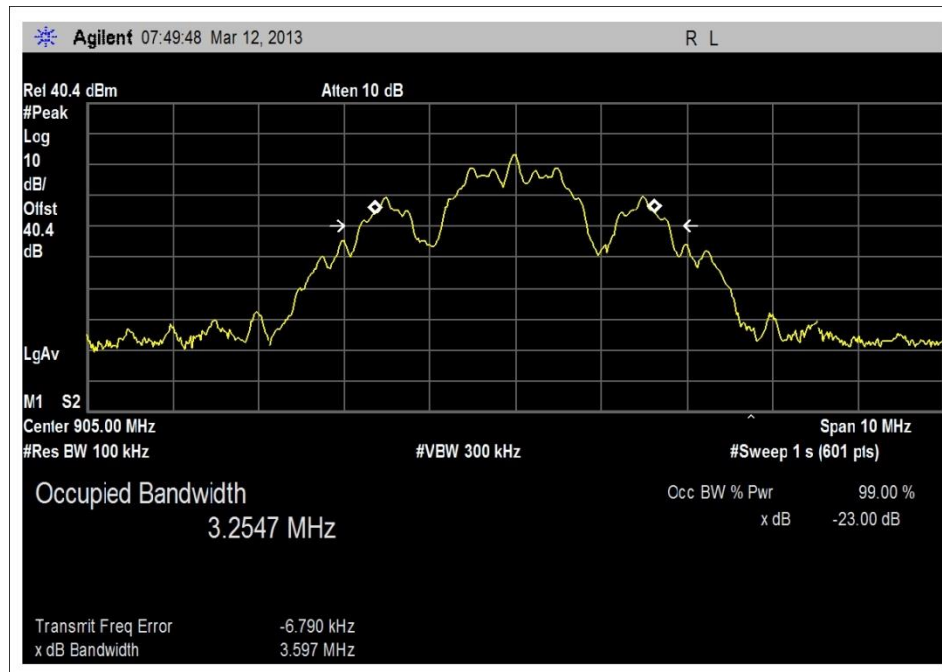
Test environment conditions: 25°C, 45% Relative Humidity, 100kPa

The EUT obtains 12V DC power from a support DC Power supply.

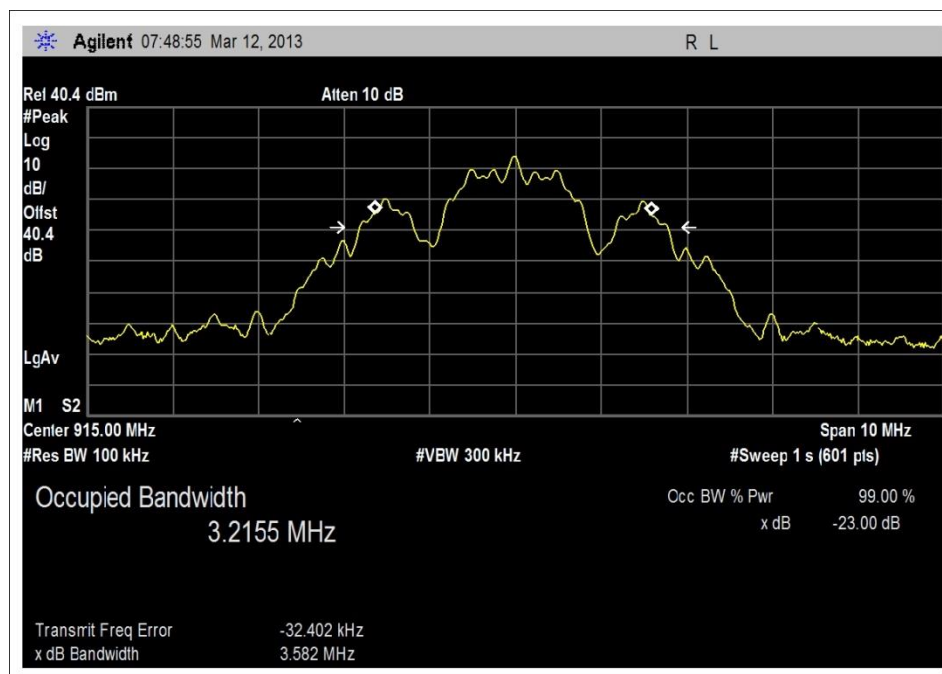
Modification: 0.1uF capacitor added to the T/R control line C196.

Center frequency was set to 905MHz, 915MHz and 925MHz. The licensee will adjust the transmit frequency according to appropriate frequency plan at the time of licensing.

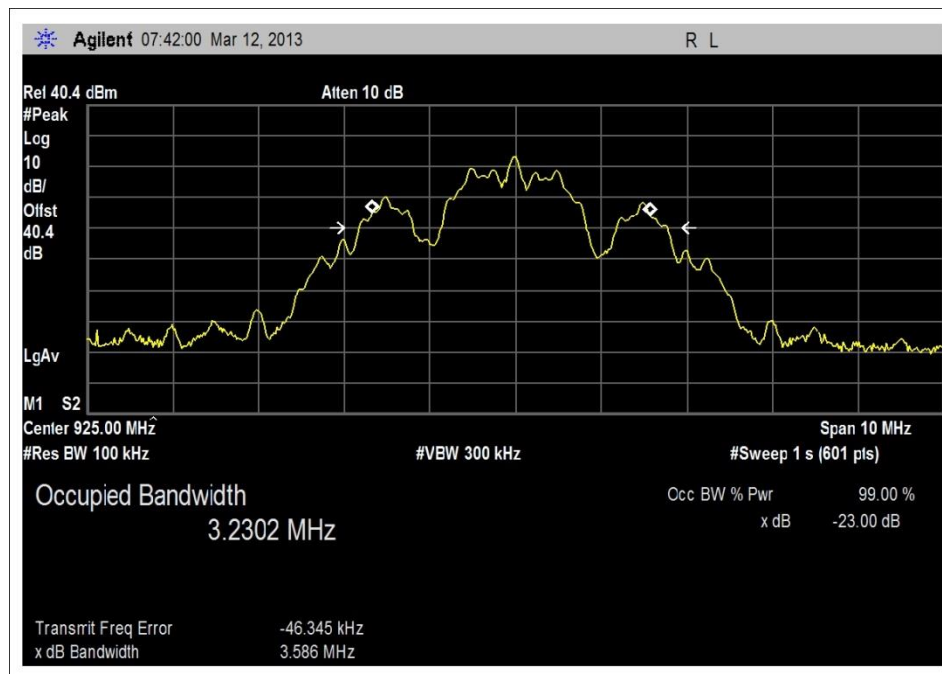
Test Plots



905MHz

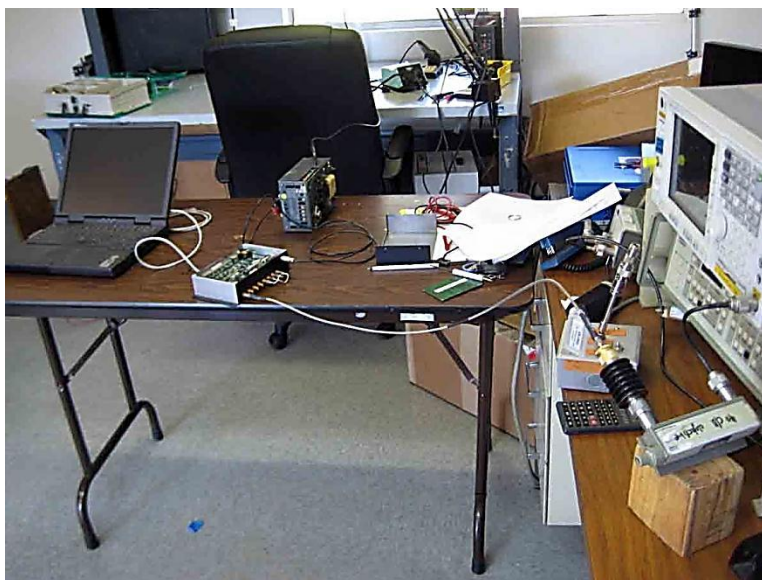


915MHz



925MHz

Test Setup Photos



Bandedge

Test Location: **CKC Laboratories, Inc. • 1110 N. Linda Place • Brea, CA 92823 • (714) 993-6112**

Customer: **Raytheon Company**
 Specification: **FCC Band-edge plot, 90.210(k)5**
 Work Order #: **93870** Date: 3/13/2013
 Test Type: **Conducted Emissions** Time: 13:39:22
 Equipment: **DSRC Reader** Sequence#: 3
 Manufacturer: Raytheon Company Tested By: E. Wong
 Model: M215-A2A 12VDC
 S/N: 001

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	2/6/2013	2/6/2015
T1	ANP06153	Cable	16301	10/27/2011	10/27/2013

Equipment Under Test (* = EUT):

Function	Manufacturer	Model #	S/N
DSRC Reader*	Raytheon Company	M215-A2A	001

Support Devices:

Function	Manufacturer	Model #	S/N
Laptop	Dell	PPX	72MUFA00H
Power Supply	Lambda	LNS-X-12	NA

Test Conditions / Notes:

The EUT is placed on the test bench. RS232 port is connected to a support laptop. All other ports are left unpopulated for evaluation of RF signal at the antenna port. The spectrum analyzer is connected to Port 1 of the EUT. Port 1 thru Port 4 utilizes the same RF circuit.

Digital attenuator set to : 9

Freq: 905MHz, 915MHz, 925MHz

Modulation: OOK.

Measured Peak Power= 29.04dBm, 29.92dBm, 29.18dBm (0.80 W, 0.98W, 0.83W)

Antenna to be used with this product:

Sirit, single-element patch antenna, ANTENNA-024 Gain: 15dBi

Transcore, Universal Toll Antenna, AA3152 Gain: 14dBi

Frequency range of measurement = Fundamental

Test environment conditions: 25°C, 45% Relative Humidity, 100kPa

The EUT obtains 12V DC power from a support DC Power supply.

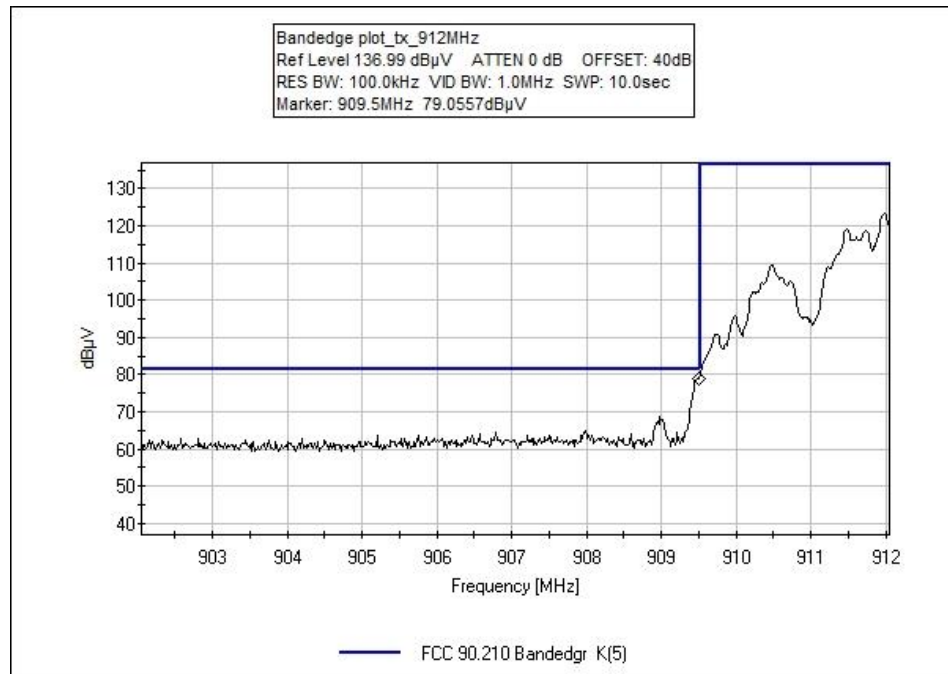
Modification: 0.1uF capacitor added to the T/R control line C196.

Center frequency was set to 905MHz, 915MHz and 925MHz. The licensee will adjust the transmit frequency according to appropriate frequency plan at the time of licensing.

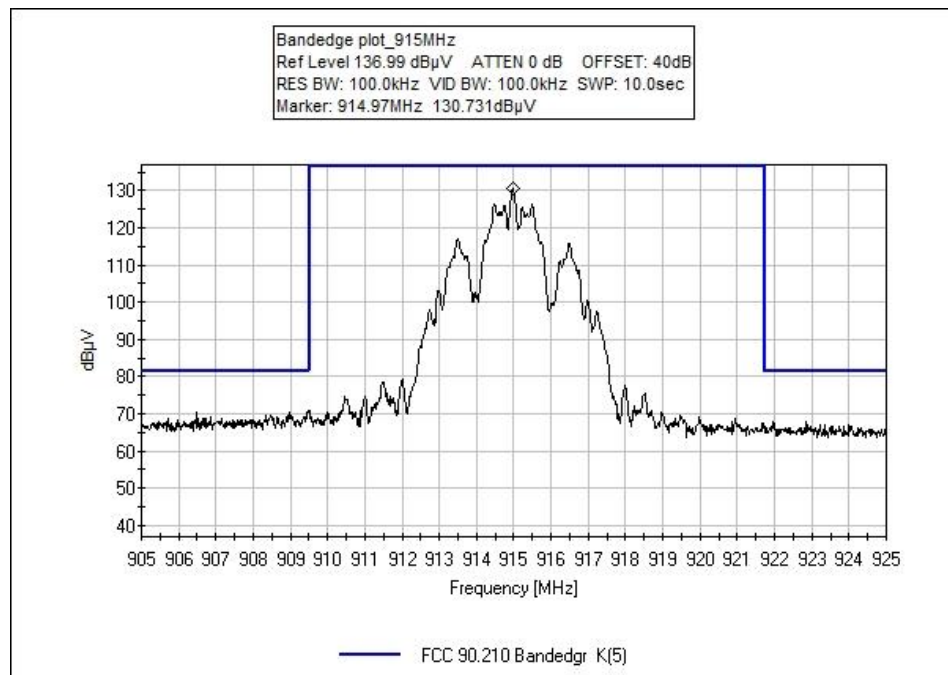
At transmit frequency of 915MHz, the device complies with 902(k)(6) requirements.

90.210(k) (6) The LMS sub-band edges for non-multi-alteration systems for which emissions must be attenuated are 902.00, 904.00, 909.5 and 921.75 MHz.

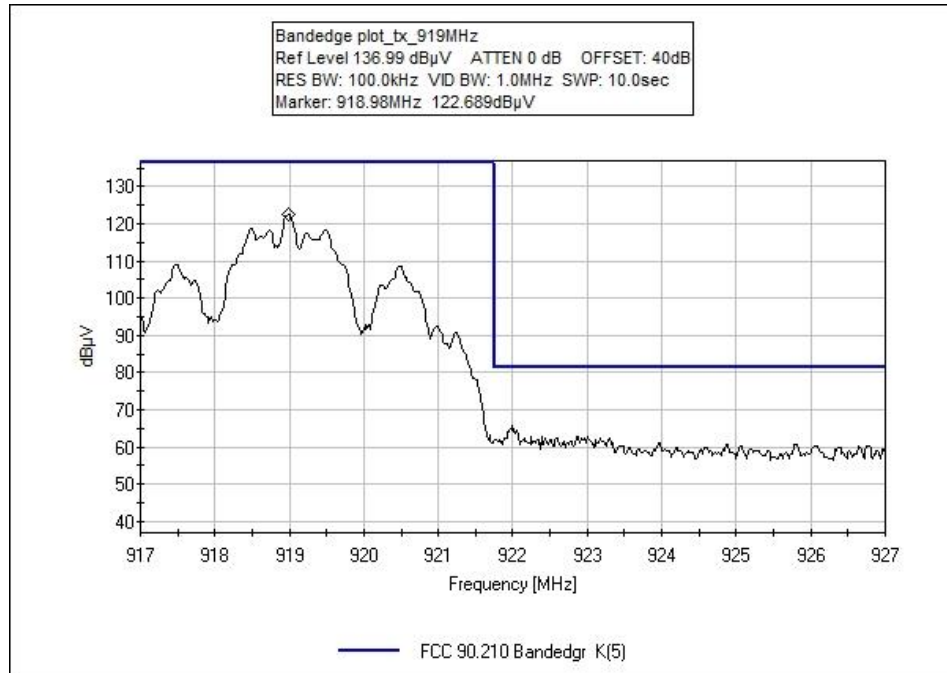
Test Data



912MHz

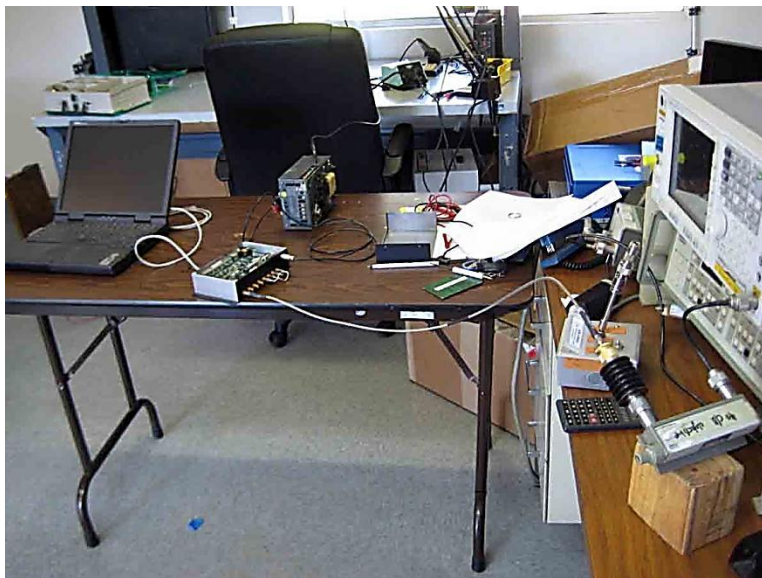


915MHz



919MHz

Test Setup Photos



Conducted Spurious Emissions

Test Location: Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • (714) 993-6112

Customer: **Raytheon Company**

Specification: **FCC 90.210 (k)**

Work Order #: **93870**

Test Type: **Conducted Emissions**

Equipment: **DSRC Reader**

Manufacturer: Raytheon Company

Model: M215-A2A

S/N: 001

Date: 3/13/2013

Time: 13:39:22

Sequence#: 3

Tested By: E. Wong

12VDC

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	2/12/2011	2/12/2013
T1	ANP06153	Cable	16301	10/27/2011	10/27/2013

Equipment Under Test (* = EUT):

Function	Manufacturer	Model #	S/N
DSRC Reader*	Raytheon Company	M215-A2A	001

Support Devices:

Function	Manufacturer	Model #	S/N
Laptop	Dell	PPX	72MUFA00H
Power Supply	Lambda	LNS-X-12	NA

Test Conditions / Notes:

The EUT is placed on the test bench. RS232 port is connected to a support laptop. All other ports are left unpopulated for evaluation of RF signal at the antenna port. The spectrum analyzer is connected to Port 1 of the EUT. Port 1 thru Port 4 utilizes the same RF circuit.

Digital attenuator set to : 9

Freq: 905MHz, 915MHz, 925MHz

Modulation: OOK.

Power= 29.04dBm, 29.92dBm, 29.18dBm (0.80 W, 0.98W, 0.83W)

Antenna to be used with this product:

Sirit, single-element patch antenna , ANTENNA-024 Gain: 15dBi

Transcore, Universal Toll Antenna , AA3152 Gain: 14dBi

Frequency range of measurement = 9 kHz- 10 GHz.

9kHz -150kHz; RBW=200Hz, VBW=200Hz; 150kHz-30MHz; RBW=9kHz, VBW=9kHz; 30MHz-1000MHz;

RBW=120kHz, VBW=120 kHz, 1000MHz-10000MHz; RBW=1 MHz, VBW=1 MHz.

Test environment conditions: 25°C, 45% Relative Humidity, 100kPa

The EUT obtains 12V DC power from a support DC Power supply.

Modification: adding a 0.1uF capacitor to the T/R control line C196.

Center frequency was set to 905MHz, 915MHz and 925MHz. The licensee will adjust the transmit frequency according to appropriate frequency plan at the time of licensing.

LIMIT LINE FOR SPURIOUS CONDUCTED EMISSION

$$\text{REQUIRED ATTENUATION} = 55 + 10 \log P \text{ DB}$$

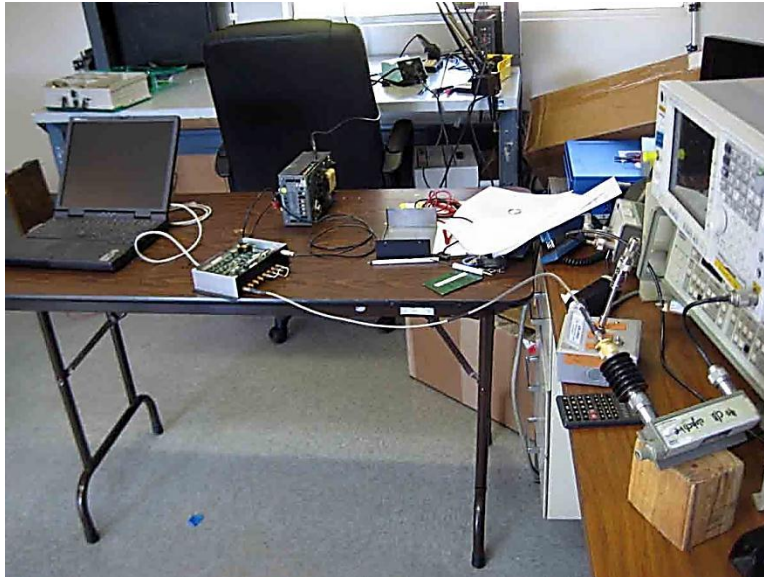
$$\text{Limit line (dBuV)} = V_{\text{dBuV}} - \text{Attenuation}$$

$$\begin{aligned} V_{\text{dBuV}} &= 20 \log \frac{V}{1 \times 10^{-6}} \\ &= 20 (\log V - \log 1 \times 10^{-6}) \\ &= 20 \log V - 20 \log 1 \times 10^{-6} \\ &= 20 \log V - 20(-6) \\ &= 20 \log V + 120 \end{aligned}$$

$$\begin{aligned} \text{Attenuation} &= 55 + 10 \log P \\ &= 55 + 10 \log \frac{V^2}{R} \\ &= 55 + 10 (\log V^2 - \log R) \\ &= 55 + 10 (2 \log V - \log R) \\ &= 55 + 20 \log V - 10 \log R \end{aligned}$$

$$\begin{aligned} \text{Limit line} &= V_{\text{dBuV}} - \text{Attenuation} \\ &= 20 \log V + 120 - (55 + 20 \log V - 10 \log R) \\ &= 20 \log V + 120 - 55 - 20 \log V + 10 \log R \\ &= 20 \log V + 120 - 55 - 20 \log V + 10 \log R \\ &= 120 - 55 + 10 \log 50 \quad \text{Note: } R = 50 \Omega \\ &= 120 - 55 + 16.897 \\ &= 82 \text{ dBuV at any power level} \end{aligned}$$

Test Setup Photos



Radiated Spurious Emissions

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • (714) 993-6112

Customer:	Raytheon Company		
Specification:	FCC 90.210(k) Radiated Spurious Emission		
Work Order #:	93870	Date:	3/14/2013
Test Type:	Radiated	Time:	09:37:01
Equipment:	DSRC Reader	Sequence#:	4
Manufacturer:	Raytheon Company	Tested By:	E. Wong
Model:	M215-A2A		
S/N:	001		

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	2/6/2013	2/6/2015
T2	AN00787	Preamp	83017A	4/8/2011	4/8/2013
T3	AN01646	Horn Antenna	3115	4/13/2012	4/13/2014
T4	AN02947	Cable	32022-29094K-29094K-72TC	8/8/2011	8/8/2013
T5	ANP06360	Cable	L1-PNMNM-48	8/29/2012	8/29/2014
T6	ANP04382	Cable	LDF-50	8/30/2012	8/30/2014
	AN00010	Preamp	8447D	3/29/2012	3/29/2014
	AN00851	Biconilog Antenna	CBL6111C	5/16/2012	5/16/2014
	ANP05555	Cable	RG223/U	6/19/2012	6/19/2014
	ANP05569	Cable	RG-214/U	6/19/2012	6/19/2014
	AN00314	Loop Antenna	6502	6/29/2012	6/29/2014

Equipment Under Test (* = EUT):

Function	Manufacturer	Model #	S/N
DSRC Reader*	Raytheon Company	M215-A2A	001

Support Devices:

Function	Manufacturer	Model #	S/N
Laptop	Dell	PPX	72MUFA00H
Power Supply	Lambda	LNS-X-12	NA

Test Conditions / Notes:

The EUT is placed on the test bench lined with Styrofoam of 10 cm thickness. RS232 port is connected to a support laptop. All ports except for Service port are terminated with sections of cable. Port 1 thru Port 4 utilizes the same RF circuit via RF selector switch are connected to 50 ohm load, Port 1 is connected to 50 ohm load via a section of RF cable.

Digital attenuator set to : 9

Power= 29.04dBm, 29.92dBm, 29.18dBm (0.80 W, 0.98W, 0.83W)

Freq: 905,MHz, 915MHz,925MHz

Modulation: OOK.

Antenna to be used with this product:

Sirit, single-element patch antenna , ANTENNA-024 Gain: 15 dBi

Transcore, Universal Toll Antenna , AA3152 Gain: 14dBi

Frequency range of measurement = 9 kHz- 10 GHz.

9kHz -150kHz; RBW=200Hz, VBW=200Hz; 150kHz-30MHz; RBW=9kHz, VBW=9kHz; 30MHz-1000MHz; RBW=120kHz, VBW=120 kHz, 1000MHz-10000MHz; RBW=1MHz, VBW=1MHz.

Test environment conditions: 25°C, 45% Relative Humidity, 100kPa

The EUT obtains 12V DC power from a support DC Power supply.

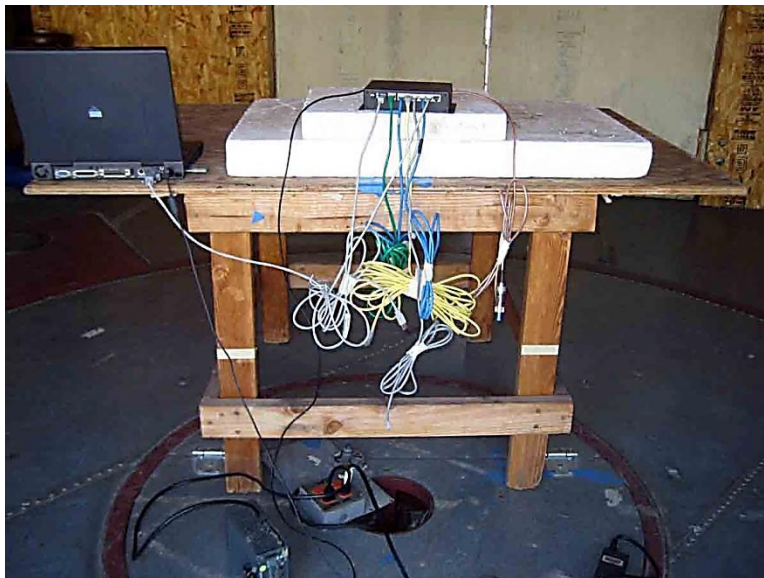
Modification: added a 0.1uF capacitor to the T/R control line C196.

Center frequency was set to 905MHz, 915MHz and 925MHz. The licensee will adjust the transmit frequency according to appropriate frequency plan at the time of licensing.

Operating Frequency: 905-925
Channels: OOK
Highest Measured Output
Power: 30.00 (dBm)= 1 (Watts)
Distance: 3 meters
Limit: $55+10\log(P)=$ 55.00 dBc

Freq. (MHz)	Reference Level (dBm)	Antenna Polarity (H/V)		dBc
1,829.99	-49.6	Horiz	Horiz	79.60
1,857.70	-49.8	Vert	Vert	79.80
1,849.87	-52.6	Horiz	Horiz	82.60
1,295.20	-53.2	Vert	Vert	83.20
1,830.00	-54	Vert	Vert	84.00
1,849.94	-54	Vert	Vert	84.00
2,112.30	-54.4	Vert	Vert	84.40
2,517.40	-54.8	Vert	Vert	84.80
1,805.92	-55.4	Horiz	Horiz	85.40

Test Setup Photos



Emissions Mask

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • (714) 993-6112

Customer: **Raytheon Company**
Specification: **FCC 90.205 Emission mask**
Work Order #: **93870**

Date: 3/13/2013

Time: 13:39:22

Equipment: **DSRC Reader**
Manufacturer: Raytheon Company
Model: M215-A2A
S/N: 001

Sequence#: 3
Tested By: E. Wong
12VDC

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	2/6/2013	2/6/2015
T1	ANP06153	Cable	16301	10/27/2011	10/27/2013

Equipment Under Test (* = EUT):

Function	Manufacturer	Model #	S/N
DSRC Reader*	Raytheon Company	M215-A2A	001

Support Devices:

Function	Manufacturer	Model #	S/N
Laptop	Dell	PPX	72MUFA00H
Power Supply	Lambda	LNS-X-12	NA

Test Conditions / Notes:

The EUT is placed on the test bench. RS232 port is connected to a support laptop. All other ports are left unpopulated for evaluation of RF signal at the antenna port. The spectrum analyzer is connected to Port 1 of the EUT. Port 1 thru Port 4 utilizes the same RF circuit.

Digital attenuator set to: 9

Freq: 905MHz, 915MHz, 925MHz

Modulation: OOK.

Measured Peak Power= 29.04dBm, 29.92dBm, 29.18dBm (0.80 W, 0.98W, 0.83W)

Antenna to be used with this product:

Sirit, single-element patch antenna, ANTENNA-024 Gain: 15dBi

Transcore, Universal Toll Antenna, AA3152 Gain: 14dBi

Frequency range of measurement = Fundamental

Test environment conditions: 25°C, 45% Relative Humidity, 100kPa

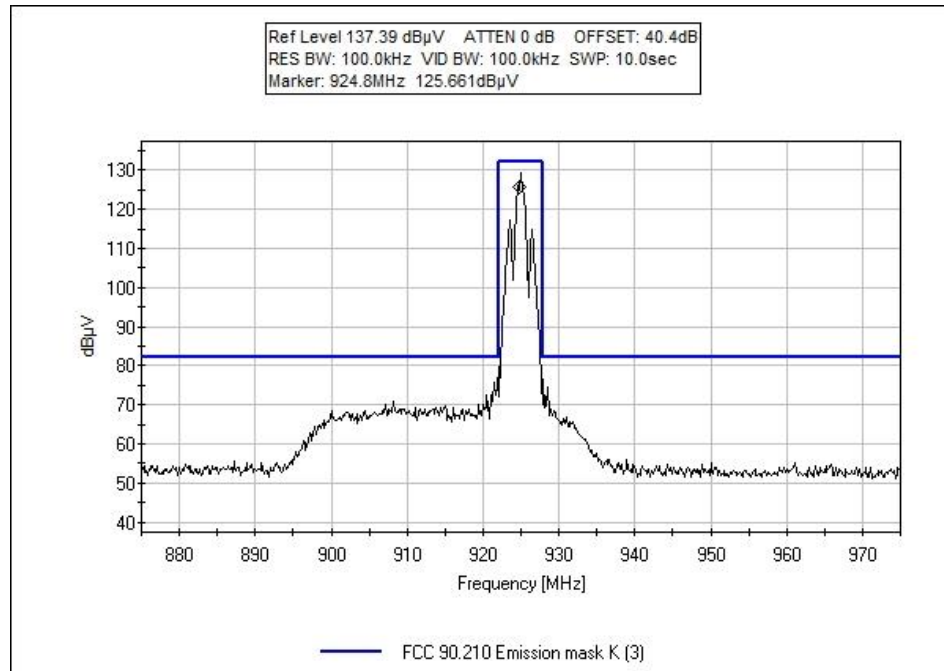
The EUT obtains 12V DC power from a support DC Power supply.

Modification: 0.1uF capacitor added to the T/R control line C196.

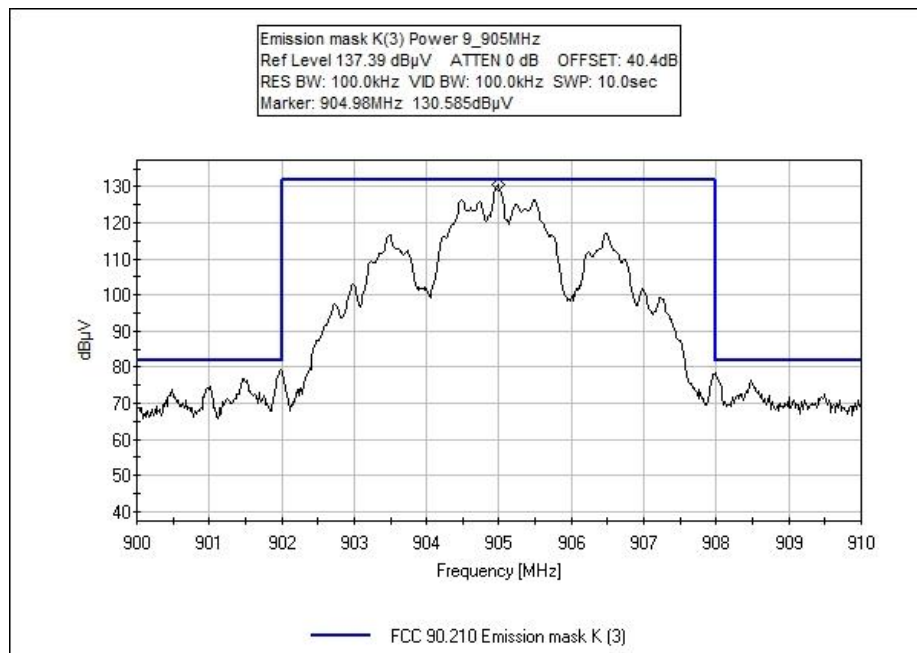
Center frequency was set to 905MHz, 915MHz and 925MHz. The licensee will adjust the transmit frequency according to appropriate frequency plan at the time of licensing.

Additional emission masks (915MHz) were captured at Antenna port 2, antenna port3 and antenna port 4. No deviation in signal characteristic.

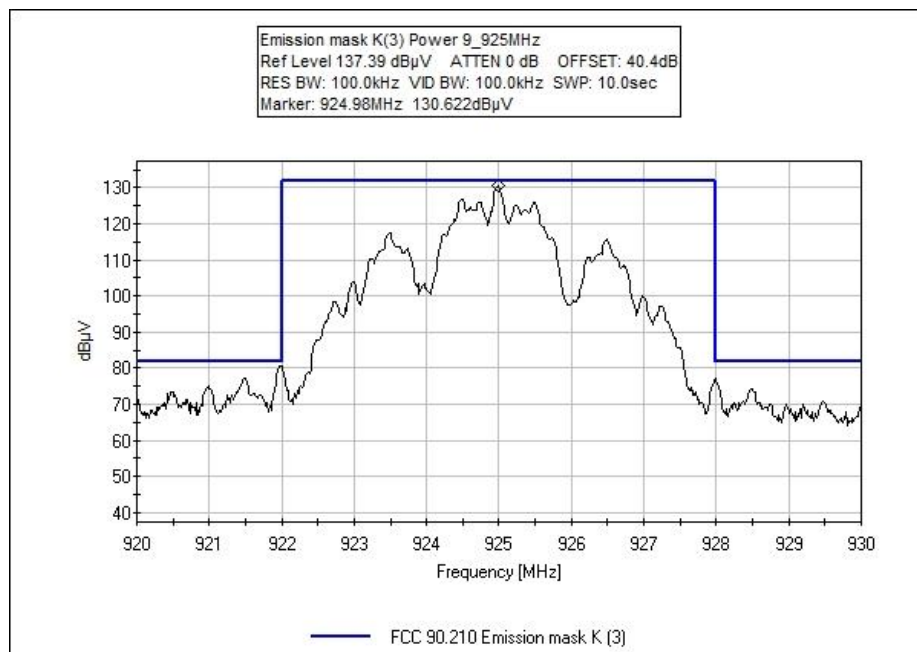
Test Data



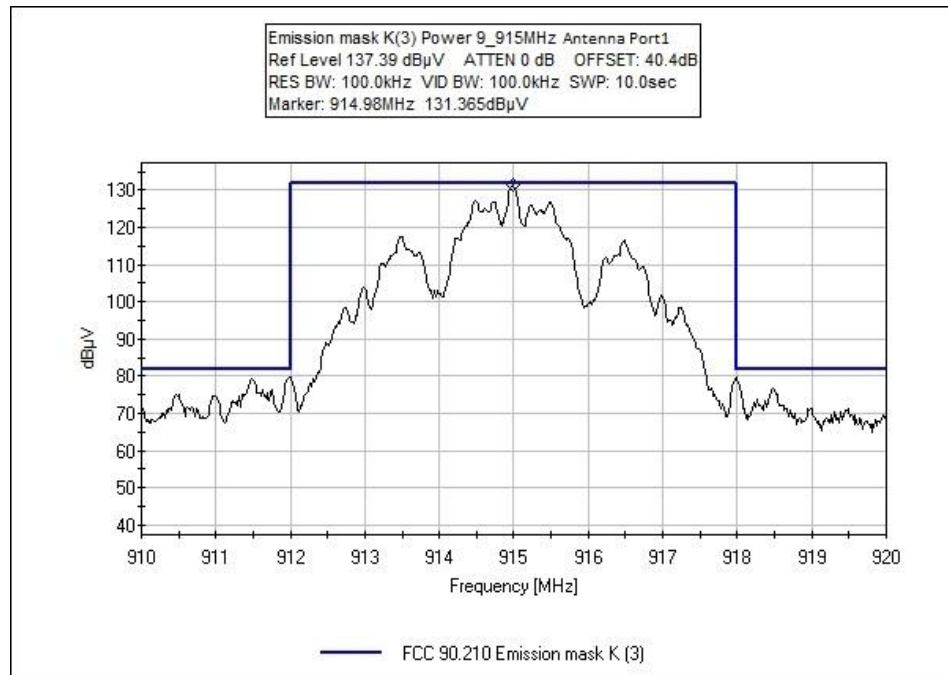
Wide Span Emission



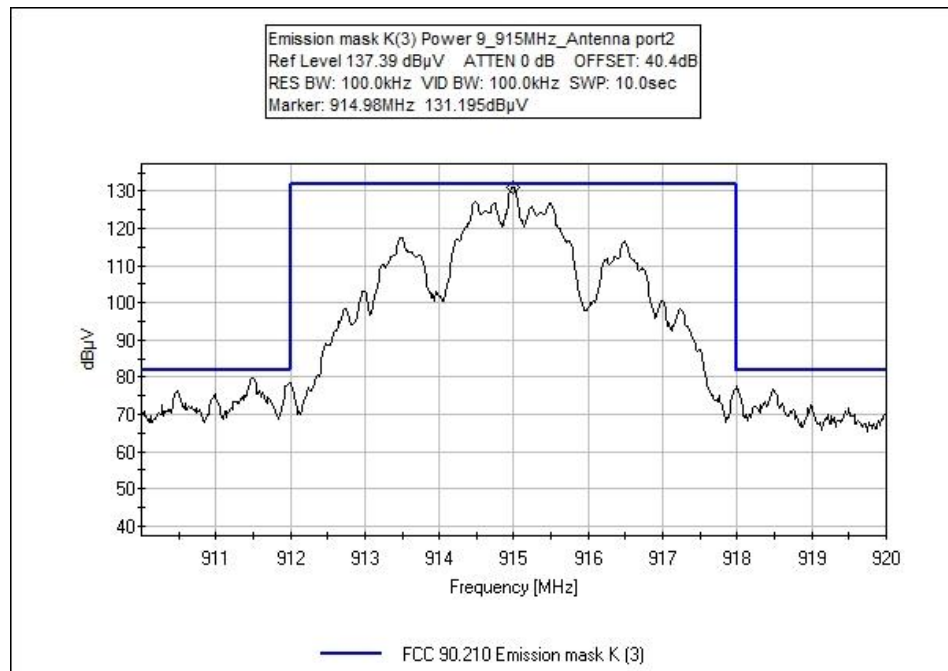
905MHz



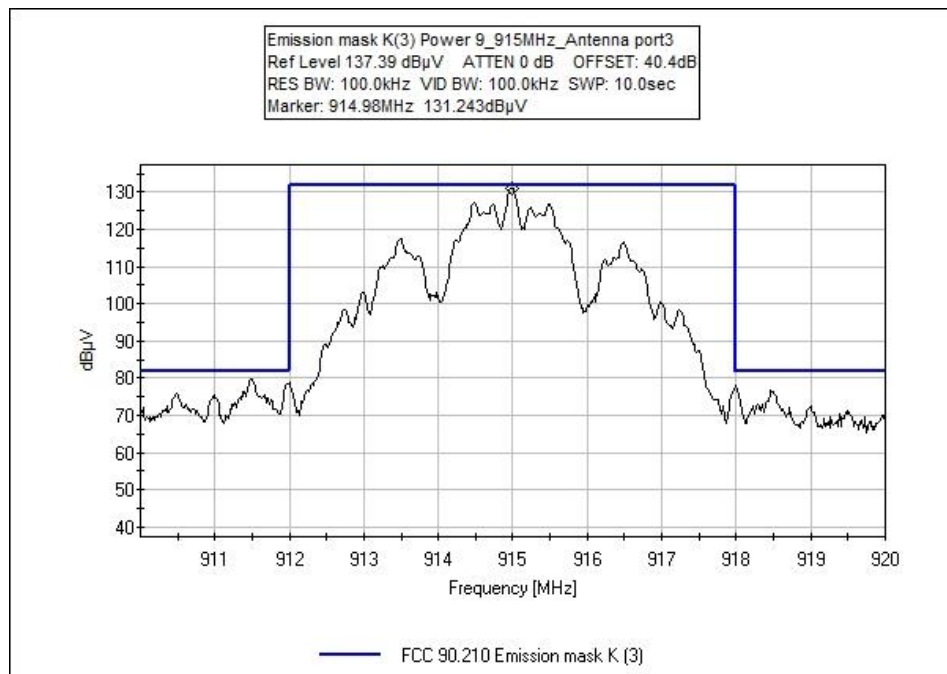
925MHz



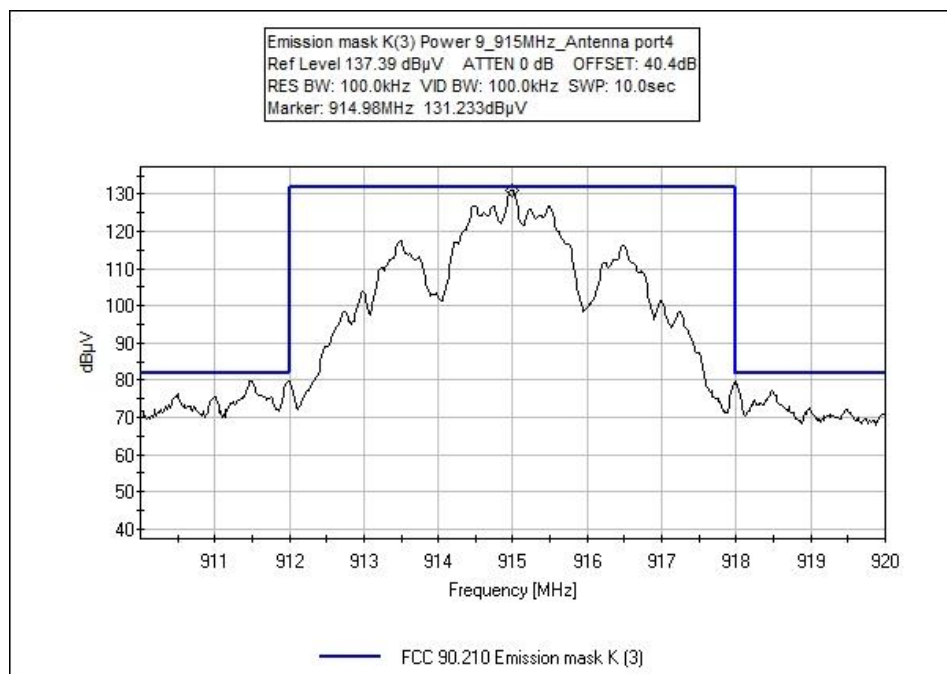
915MHz, Antenna Port 1



915MHz, Antenna Port 2

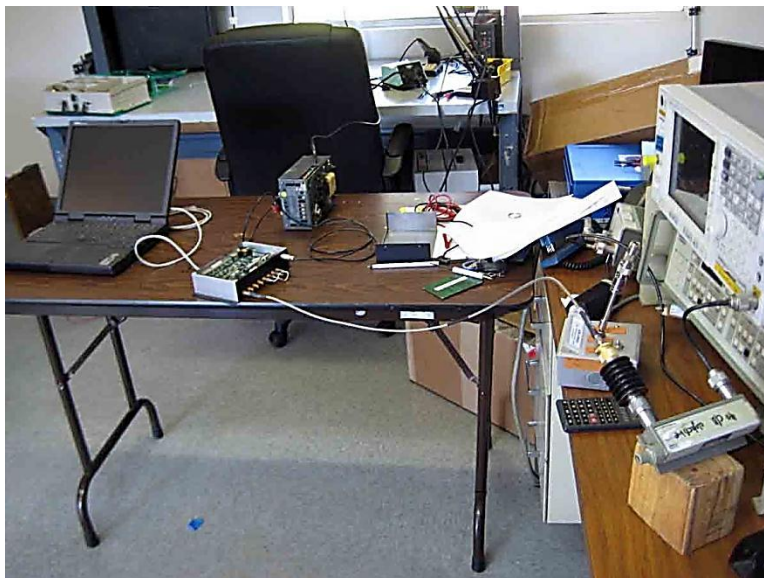


915MHz, Antenna Port 3



915MHz, Antenna Port 4

Test Setup Photos



SUPPLEMENTAL INFORMATION

Measurement Uncertainty

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

The reported measurement uncertainties are calculated based on the worst case of all laboratory environments from CKC Laboratories, Inc. test sites. Only those parameters which require estimation of measurement uncertainty are reported. The reported worst case measurement uncertainty is less than the maximum values derived in CISPR 16-4-2. Reported uncertainties 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.