EN 300 328 v1.7.1

TEST REPORT

FOR

Bluetooth® 4.0 Low Energy Single Mode Module

MODEL NUMBER: BR-LE4.0-S2

REPORT NUMBER: 11U13712-2

ISSUE DATE: 2011-07-15
REVISION DATE: 2011-08-04

Prepared for
BlueRadios, Inc.
7173 S. Havana Street, Suite 600
Englewood
CO, 80112, USA

Prepared by
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NVLAP LAB CODE 100255-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	2011-06-15	Initial Issue	B. DeLisi
1	2011-08-04	Corrected EIRP antenna gain value	B. DeLisi

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: BlueRadios, Inc.
7173 S. Havana Street, Suite 600
Englewood
CO, 80112, USA

EUT DESCRIPTION: Bluetooth® 4.0 Low Energy Single Mode Module

MODEL: BR-LE4.0-S2

SERIAL NUMBER: None

DATE TESTED: 2011-04-27 to 2011-06-16

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
EN 300 328 v1.7.1	Pass

Underwriters Laboratories Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For UL By:

Joseph Danisi
Lead Engineering Associate
UL

Tested By:

Bob DeLisi
Sr. Staff Engineer
UL

2. TEST METHODOLOGY

All tests were performed in accordance with the procedures documented in EN 300 328 v1.7.1.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 1285 Walt Whitman Rd. Melville, NY 11747, USA.

UL Melville is accredited by NVLAP, Laboratory Code 100255-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/1002550.htm

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Radio Frequency	±3.5 x 10^(-8)
Total RF power, conducted	±0.47 dB
RF power density, conducted	±0.55 dB
Spurious emissions, conducted	±1.6 dB
All emissions, radiated	±4dB
Temperature	±0.066 deg C
Humidity	±4.5 % RH
DC and low frequency voltages	±0.5 %

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is an Bluetooth transceiver BR-LE4.0-S2.

The radio module is manufactured by BlueRadio Inc.

5.2. MAXIMUM OUTPUT POWER

The highest conducted output power under normal environmental conditions in each mode is as follows:

Frequency Band (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2402 - 2480	LE	4.18	2.6

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a chip antenna with a maximum gain of 3 dBi.

5.4. SOFTWARE AND FIRMWARE

The test utility software used during testing was Texas Instruments, Smart RF Studio rev. 1.4.9.

5.5. WORST-CASE CONFIGURATIONS

All final tests in the LE mode were made at 1 Mb/s.

For radiated emissions below 1 GHz the worst-case configuration is determined to be the mode and channel with the highest output power.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST			
Description	**Manufacturer**	**Model**	**Serial Number**
Test Board	BlueRadios Inc.	BR-BOB Rev 2	-
Debugger	Texas Instruments	CC Debugger	10550
Laptop	Lenovo	T410	R801EHLE-10/10
Laptop AC Adapter	Lenovo	92P1156	11S92P1156Z1ZDXN0612XM

I/O CABLES

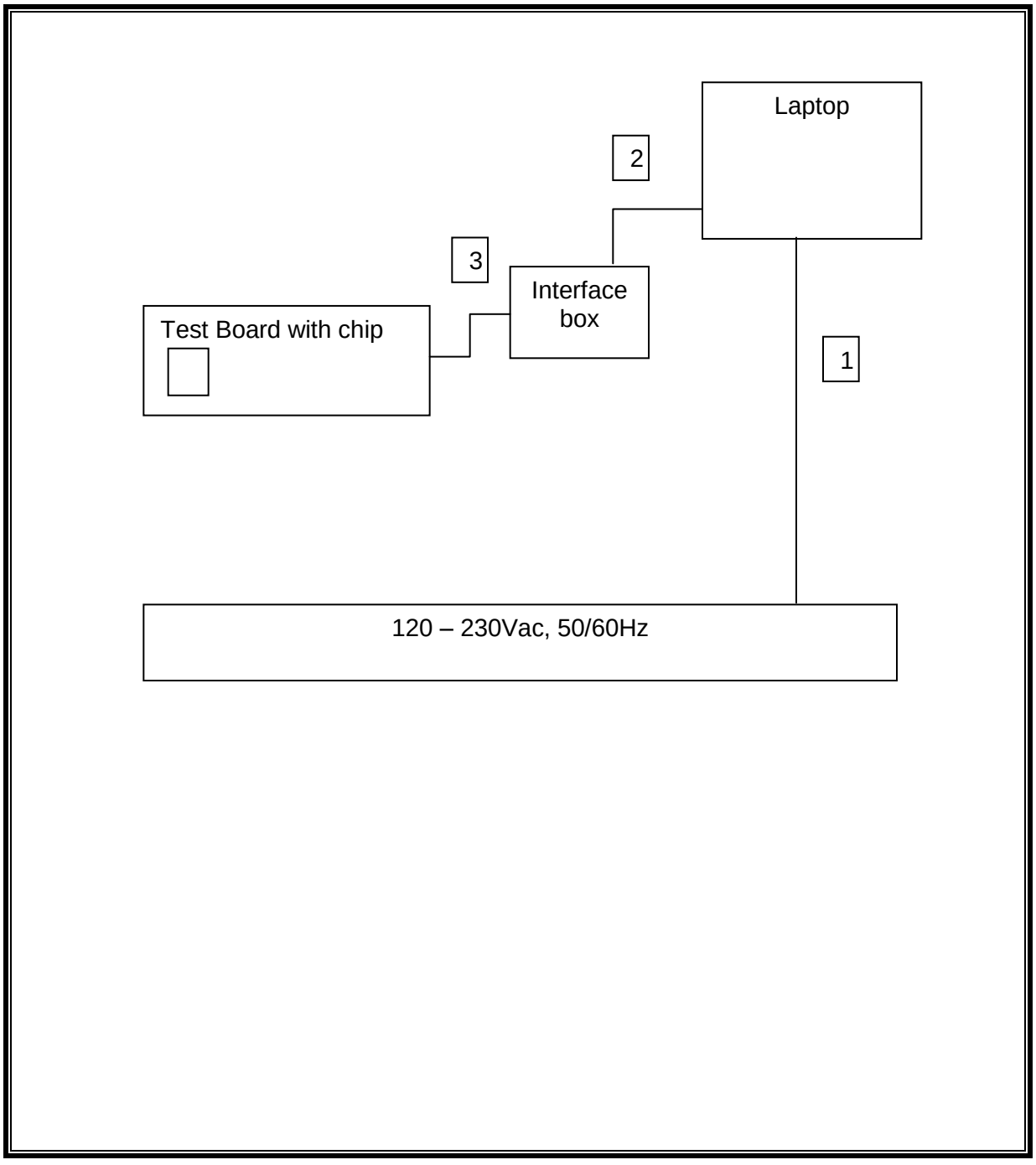
I/O CABLE LIST						
Cable No.	**Port**	**# of Identica Ports**	**Connector Type**	**Cable Type**	**Cable Length**	**Remarks**
1	AC	1	AC	Unshielded	1.8m	AC Power for Laptop only
2	USB	1	USB	Shielded	1.8m	None
3	Ribbon	1	10pin	Unshielded	0.13m	None

TEST SETUP

The EUT is installed on an adapter board during the tests. Test software exercised the radio.

The EUT was preliminary tested in the X, Y and Z axis for radiated testing. The Y axis was determined to represent the worst case configuration. All radiated testing was done in the orientation.

SETUP DIAGRAM FOR TESTS



6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment List					
Description	Manufacturer	Model	Identifier	Cal Date	Cal Due Date
30-1000MHz					
EMI Receiver	Rohde & Schwarz	ESIB40	34968	2011-03-01	2012-03-01
Log-P Antenna	Schaffner	UPA6109	44068	2010-04-05	2011-04-30
Bicon Antenna	Schaffner	VBA6106A	54	2010-04-05	2011-04-30
Log-P Antenna	Schaffner	UPA6109	AT0030	2010-06-28	2011-06-28
Bicon Antenna	Schaffner	VBA6106A	43441	2010-09-09	2011-09-09
Bias Tee	Miteq	AM-1523-7687	44392	N/A	N/A
Bias Tee	Miteq	AM-1523-7687	44393	N/A	N/A
Preamp	Miteq	AM-3A-000110-7687	44391	N/A	N/A
Preamp	Miteq	AM-3A-000110-7687	44394	N/A	N/A
Switch Driver	HP	11713A	ME7A-627	N/A	N/A
System Controller	Sunol Sciences	SC99V	44396	N/A	N/A
Camera Controller	Panasonic	WV-CU254	44395	N/A	N/A
RF Switch Box	UL	1	44398	N/A	N/A
Measurement Software	UL	Version 9.3	44740	N/A	N/A
Temp/Humidity/Pressure Meter	Cole Parmer	99760-00	4268	2010-12-07	2012-12-07
Multimeter	Fluke	87V	44547	2011-02-01	2012-02-28
Above 1GHz (Band Optimized System)					
EMI Receiver	Rohde & Schwarz	ESIB40	34968	2011-03-01	2012-03-01
Horn Antenna (1-2 GHz)	ETS	3161-01	51442	2008-03-28	See * below
Horn Antenna (2-4 GHz)	ETS	3161-02	48107	2007-09-27	See * below
Horn Antenna (4-8 GHz)	ETS	3161-03	48106	2007-09-27	See * below
Horn Antenna (8-12 GHz)	ETS	3160-07	8933	2008-11-24	See * below
Horn Antenna (12-18 GHz)	ETS	3160-08	8932	2007-09-27	See * below
Horn Antenna	EMCO	3115	5A766	2010-11-05	2012-11-05
Signal Generator	Anritsu	68369B	63761	2011-02-02	2012-02-09
Signal Path Controller	HP	11713A	50250	N/A	N/A
Gain Controller	HP	11713A	50251	N/A	N/A
RF Switch / Preamp Fixture	UL	BOMS1	50249	N/A	N/A
System Controller	UL	BOMS2	50252	N/A	N/A
Temp/Humidity/Pressure Meter	Cole Parmer	99760-00	4268	2010-12-07	2012-12-07
Multimeter	Fluke	87V	44547	2011-02-01	2012-02-28

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal Date	Cal Due Date
Conducted Antenna Port Tests					
EMI Receiver	Agilent	E4446A	70728	2011-02-04	2013-02-04
Pick-up loop antenna	Com-Power	PS-400	7A930	N/A	N/A
Temp/Humidity/Pressure Meter	Cole Parmer	99760-00	4268	2010-12-07	2012-12-07
Multimeter	Fluke	87V	44547	2011-02-01	2012-02-28
Environmental Chamber/Controller	Thermotron	FA-35-CH-5-5	6-301	2010-07-13	2011-07-13

7. TEST RESULTS

7.1. NORMAL AND EXTREME CONDITIONS

LIMITS

None; for reporting purposes only.

RESULTS

Normal conditions are 25 deg C, 3.3Vdc.
The low temperature condition is 0 deg C.
The high temperature condition is 35 deg C.
The low voltage condition is 2Vdc.
The high voltage condition is 3.6Vdc.

7.2. DUTY CYCLE

LIMITS

None; for reporting purposes only.

RESULTS

Mode	Tx on (usec)	Tx on + Tx off (usec)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
LE	*	*	100.00	0.00

* Channel under test is always on with modulation. Duty cycle is 100%.

7.3. EFFECTIVE RADIATED POWER

LIMIT

ETSI EN 300 328 Clause 4.3.1.2

The equivalent isotropic radiated power (e.i.r.p.) shall be equal to or less than 100 mW (20 dBm) over normal and extreme conditions. This limit shall apply for any combination of power level and intended antenna assembly.

TEST PROCEDURE

ETSI EN 300 328 Clause 5.7.2

CALCULATIONS

Output Power = Measured Power + Test Cable Loss + Duty Cycle Factor

EIRP = Output Power + EUT Antenna Gain

RESULTS

7.3.1. LE MODE

EUT Antenna Gain (dBi) =	3.0
Duty Cycle Factor (dB) =	0.0
Test Cable Loss (dB) =	13.3

Condition	Measured Power (dBm)	Output Power (dBm)	EIRP (dBm)	Limit (dBm)	Margin (dB)
2402 MHz					
Normal	-9.12	4.18	7.18	20	-12.82
Extreme T low, V low	-7.5	5.8	8.80	20	-11.20
Extreme T low, V high	-7.54	5.76	8.76	20	-11.24
Extreme T high V low	-11.66	1.64	4.64	20	-15.36
Extreme T high, V high	-11.8	1.5	4.50	20	-15.50
2440 MHz					
Normal	-9.13	4.17	7.17	20	-12.83
Extreme T low, V low	-7.39	5.91	8.91	20	-11.09
Extreme T low, V high	-7.43	5.87	8.87	20	-11.13
Extreme T high V low	-11.02	2.28	5.28	20	-14.72
Extreme T high, V high	-11.23	2.07	5.07	20	-14.93
2480 MHz					
Normal	-9.22	4.08	7.08	20	-12.92
Extreme T low, V low	-7.35	5.95	8.95	20	-11.05
Extreme T low, V high	-7.41	5.89	8.89	20	-11.11
Extreme T high V low	-11.97	1.33	4.33	20	-15.67
Extreme T high, V high	-12.08	1.22	4.22	20	-15.78

7.4. SPECTRAL POWER DENSITY

LIMIT

ETSI EN 300 328 Clause 4.3.2.2

For wide band modulations other then FHSS (e.g. DSSS, OFDM, etc.), the maximum e.i.r.p. spectral density is limited to 10 mW (10 dBm) per MHz.

TEST PROCEDURE

ETSI EN 300 328 Clause 5.7.3.1

CALCULATIONS

Power Density (dBm/MHz) EIRP =
Measured Power Density (dBm/MHz) + Duty Cycle Factor (dB) + EUT Antenna Gain (dBi)

RESULTS

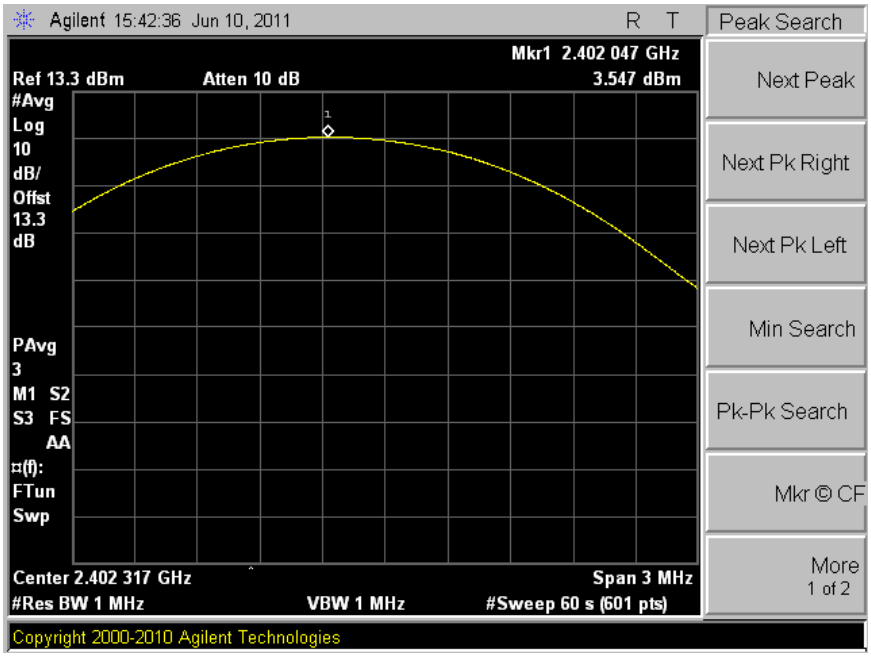
7.4.1. LE MODE

EUT Antenna Gain (dBi) =	**3.0**
Duty Cycle Factor (dB) =	**0.00**

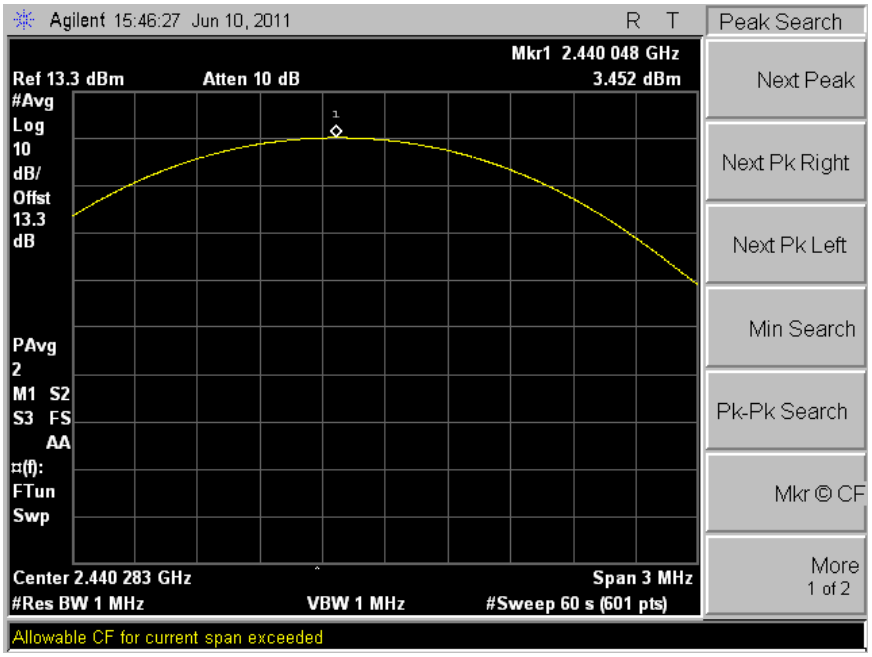
Frequency (MHz)	Measured Density (dBm/MHz)	Power Density (dBm/MHz) EIRP	Limit (dBm/MHz) EIRP	Margin (dB)
2412	3.57	6.57	10	-3.43
2442	3.45	6.45	10	-3.55
2472	3.35	6.35	10	-3.65

POWER DENSITY

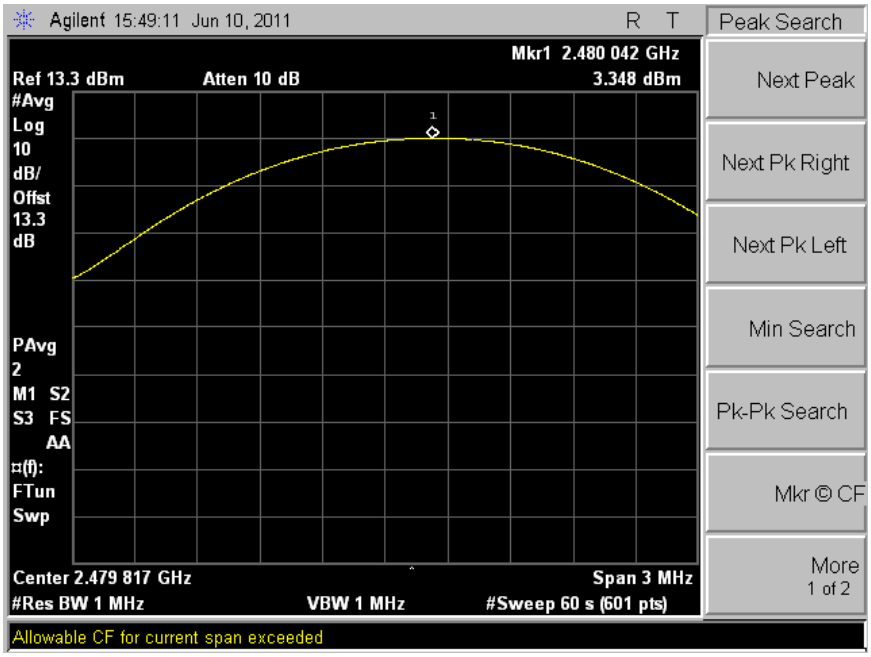
POWER DENSITY LOW



POWER DENSITY MID



POWER DENSITY HIGH



7.5. FREQUENCY RANGE

LIMIT

ETSI EN 300 328 Clause 4.3.3.2

For all equipment the frequency range shall lie within the band 2,4 GHz to 2,4835 GHz (f_L > 2,4 GHz and f_H < 2,4835 GHz), over Normal and Extreme conditions.

TEST PROCEDURE

ETSI EN 300 328 Clause 5.7.4.1

REF LEVEL OFFSET = EUT Antenna Gain + Test Cable Loss + Attenuator + Duty Cycle Factor

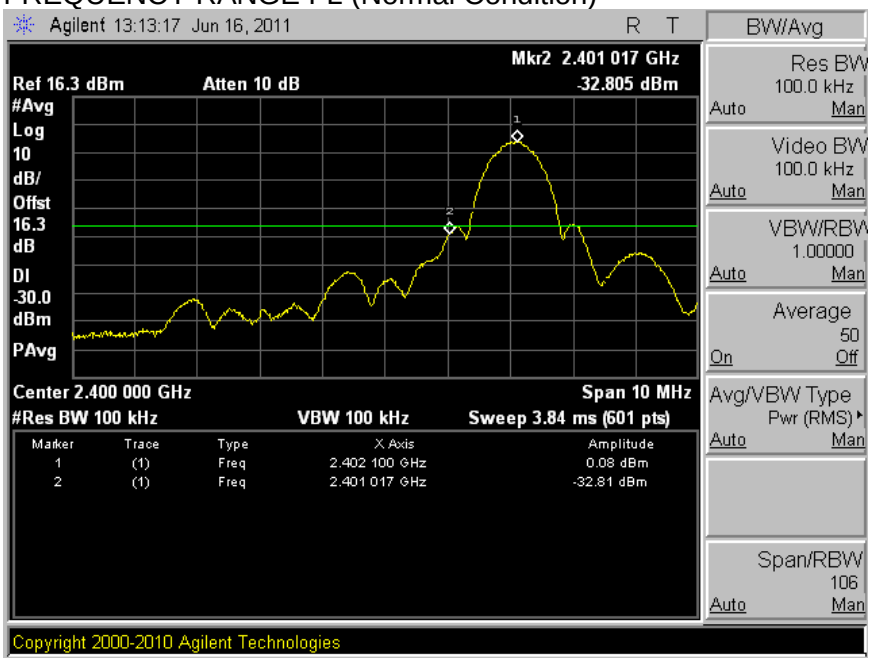
RESULTS

7.5.1. LE MODE

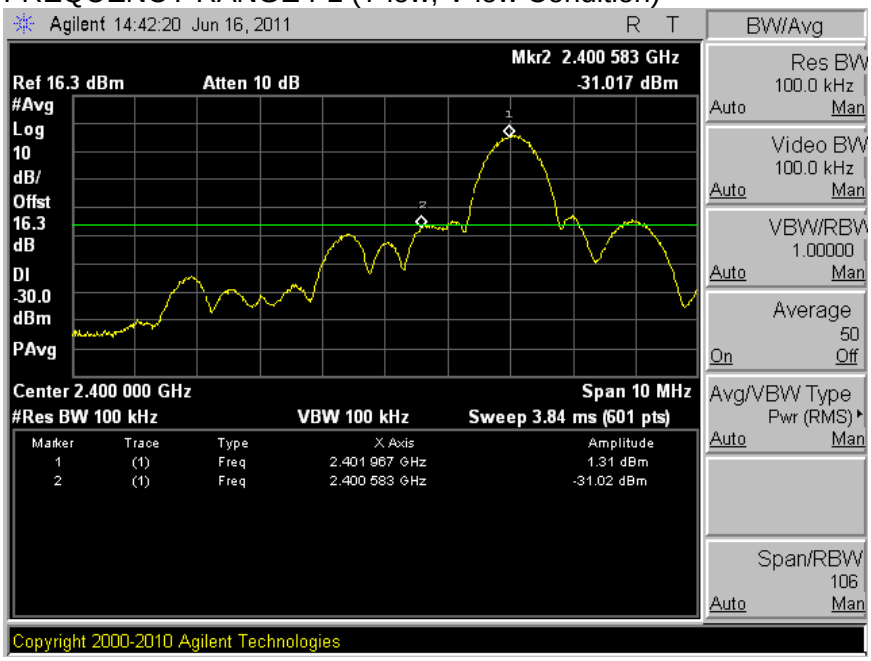
Limit	2400 Minimum	2483.5 Maximum
Condition	F low (MHz)	F high (MHz)
Normal	2401.02	2481.08
Extreme T low, V low	2400.58	2481.10
Extreme T low, V high	2400.57	2481.12
Extreme T high V low	2401.35	2480.77
Extreme T high, V high	2401.35	2480.78

FREQUENCY RANGE F LOW

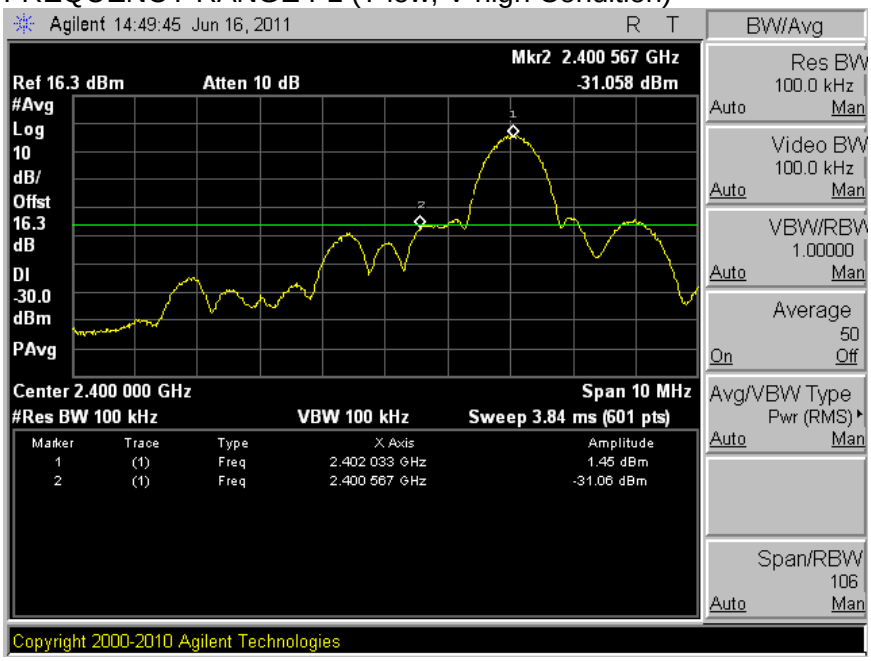
FREQUENCY RANGE FL (Normal Condition)



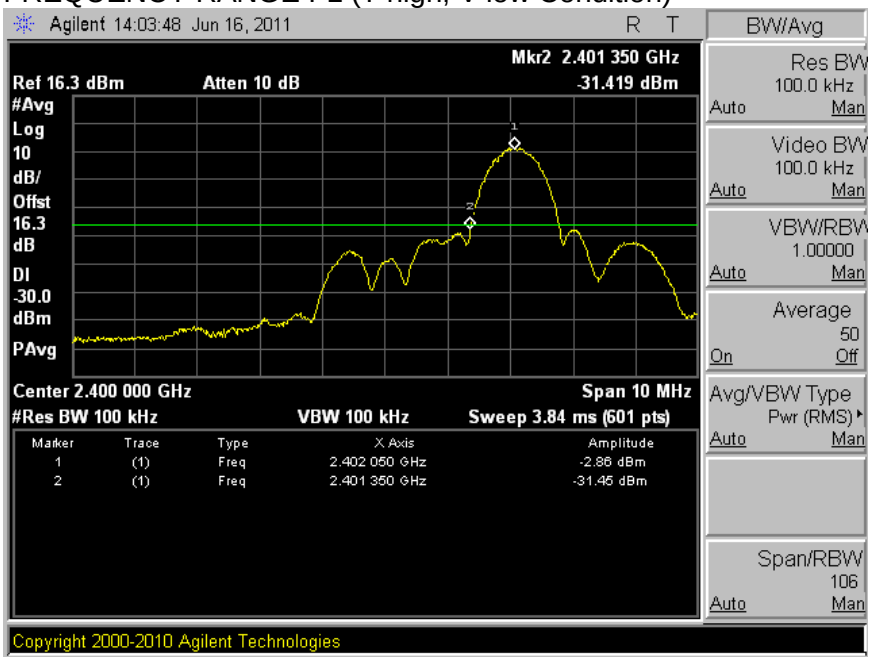
FREQUENCY RANGE FL (T low, V low Condition)



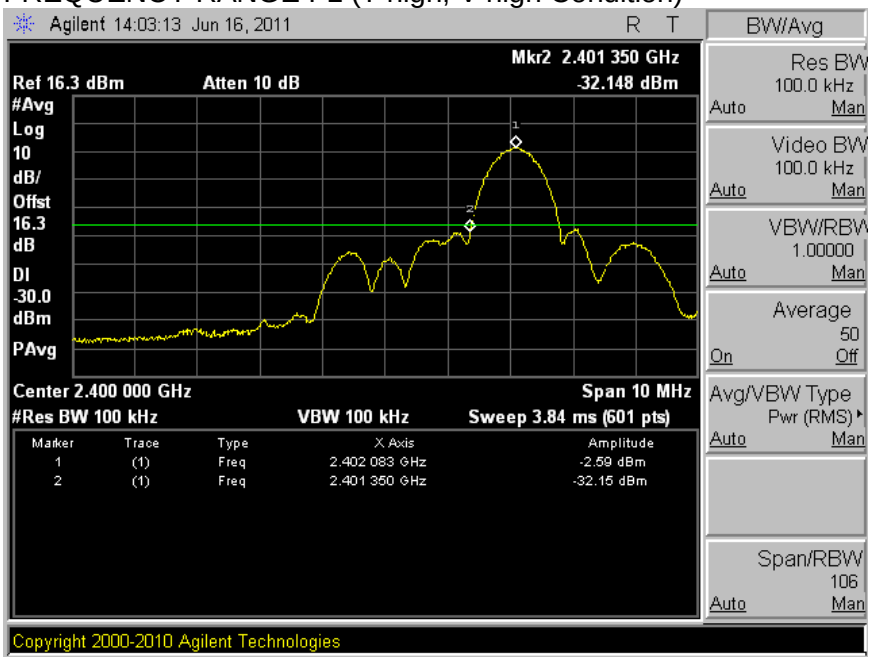
FREQUENCY RANGE FL (T low, V high Condition)



FREQUENCY RANGE FL (T high, V low Condition)

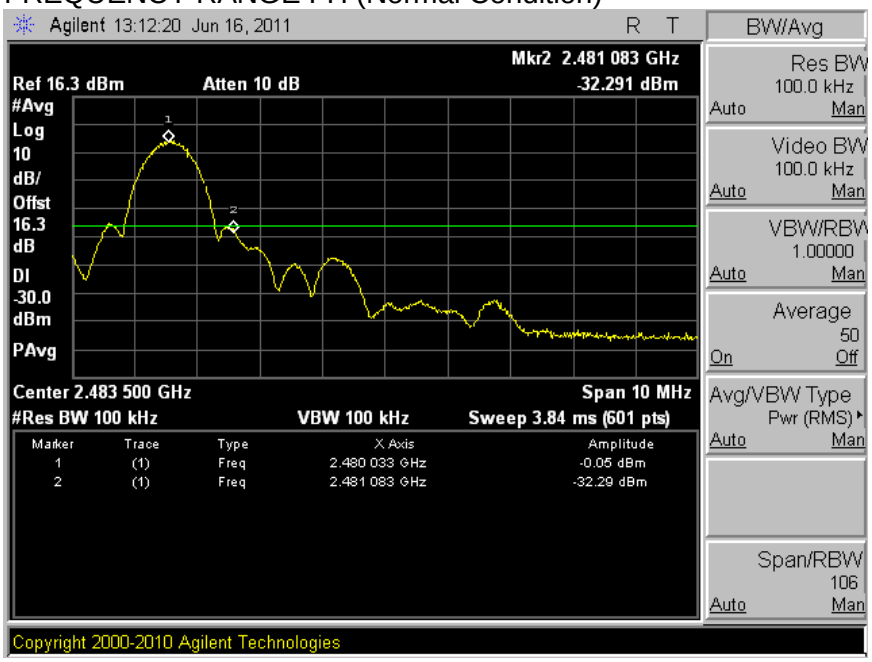


FREQUENCY RANGE FL (T high, V high Condition)

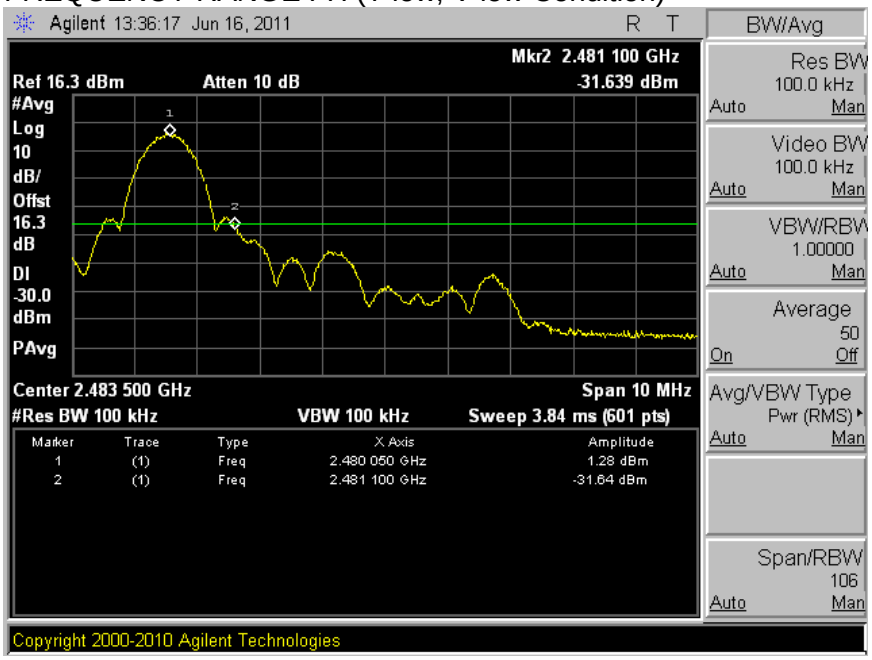


FREQUENCY RANGE F HIGH

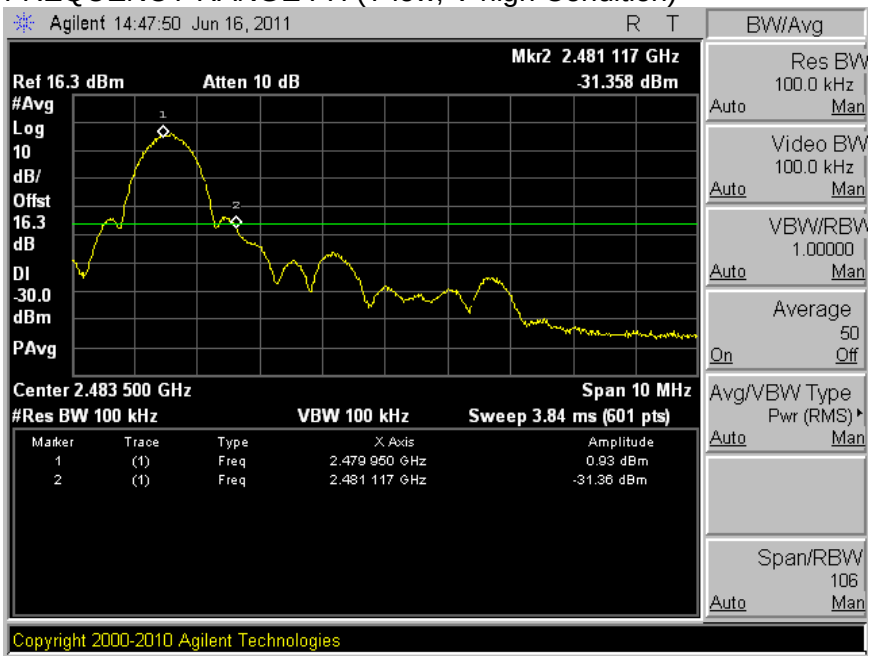
FREQUENCY RANGE FH (Normal Condition)



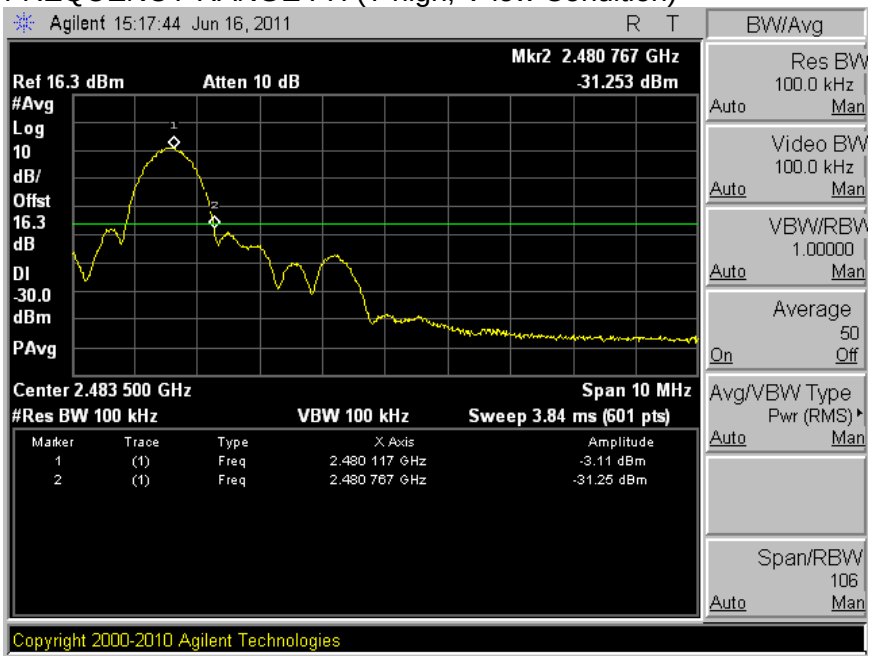
FREQUENCY RANGE FH (T low, V low Condition)



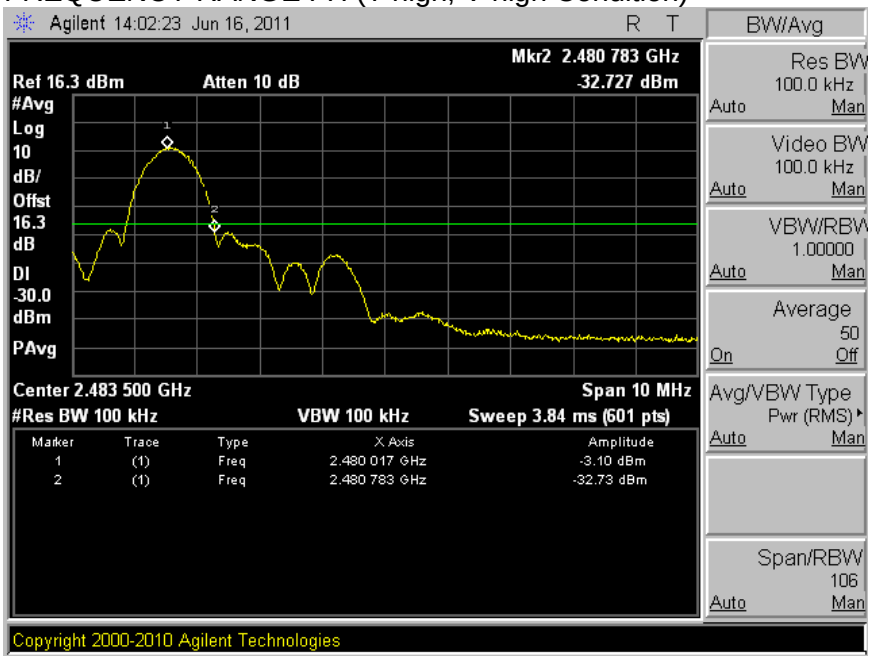
FREQUENCY RANGE FH (T low, V high Condition)



FREQUENCY RANGE FH (T high, V low Condition)



FREQUENCY RANGE FH (T high, V high Condition)



7.6. TRANSMITTER SPURIOUS EMISSIONS

LIMIT

ETSI EN 300 328 Clause 4.3.6.2

Table 2: Transmitter Limits for Narrowband Spurious Emissions

Frequency Range	Limit when operating	Limit when in standby
30 MHz to 1.0 GHz	-36 dBm	-57 dBm
1.0 GHz to 12.75 GHz	-30 dBm	-47 dBm
1.8 GHz to 1.9 GHz 5.15 GHz to 5.3 GHz	-47 dBm	-47 dBm

Table 3: Transmitter Limits for Wideband Spurious Emissions

Frequency Range	Limit when operating	Limit when in standby
30 MHz to 1.0 GHz	-86 dBm/Hz	-107 dBm/Hz
1.0 GHz to 12.75 GHz	-80 dBm/Hz	-97 dBm/Hz
1.8 GHz to 1.9 GHz 5.15 GHz to 5.3 GHz	-97 dBm/Hz	-97 dBm/Hz

TEST PROCEDURE

ETSI EN 300 328 Clause 5.7.5

TEST PROTOCOL

EN 300 328 Clause 5.7.5

The levels of spurious emissions are measured as

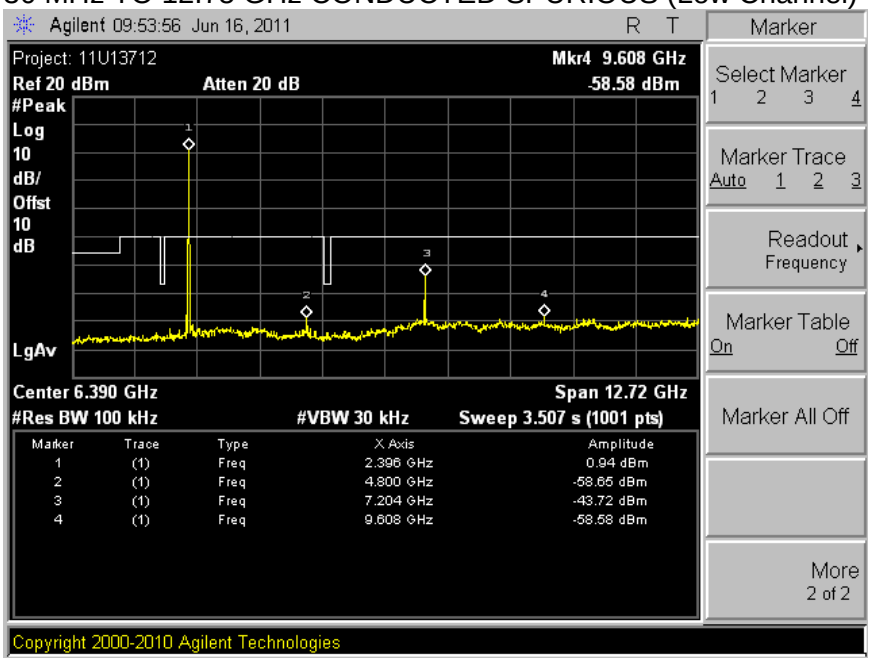
their power in a specified load (conducted spurious emissions); and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation).

RESULTS

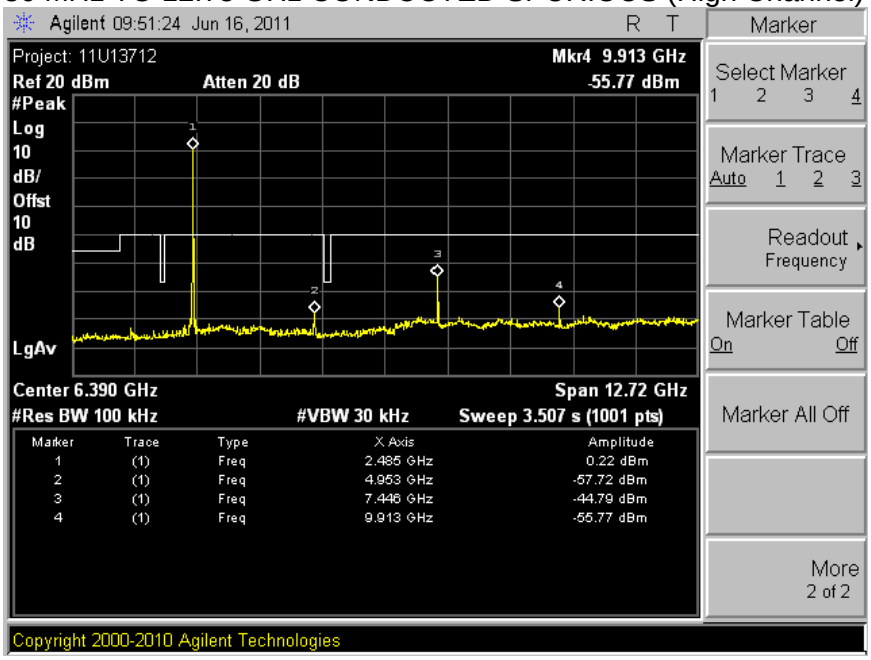
7.6.1. LE MODE

CONDUCTED SPURIOUS EMISSIONS

30 MHz TO 12.75 GHz CONDUCTED SPURIOUS (Low Channel)



30 MHz TO 12.75 GHz CONDUCTED SPURIOUS (High Channel)



RADIATED SPURIOUS EMISSIONS BELOW 1 GHz

Antenna Polarization	Frequency MHz	Target dBuV	Sig Gen to Ant dBm	Ant Gain dBi	Cable losses dB	ERP dBm	ERPLimit (dBm)	ERP Margin (dBm)
Horiz	47.860	29.1	-48.60	-7.5	0.4	-58.69	-36.00	-22.69
Horiz	119.170	17.08	-71.20	-1.2	0.8	-75.35	-36.00	-39.35
Horiz	125.130	18.47	-66.20	-1.5	0.8	-70.65	-36.00	-34.65
Horiz	139.760	17.43	-67.80	-1.3	0.9	-72.15	-36.00	-36.15
Vert	47.870	35.5	-41.80	-7.5	0.4	-51.89	-36.00	-15.89
Vert	239.810	19.96	-80.00	6.6	1.1	-76.65	-36.00	-40.65

RADIATED SPURIOUS EMISSIONS ABOVE 1 GHz

Low Channel

Antenna	Frequency	Target	Sig Gen	Ant Gain	Cable losses	EiRP	ERP	ERPLimit	ERP Margin	ERPLimit	ERP Margin
Polarization	MHz	dBuV	to Ant dBm	dBi	dB	dBm	dBm	(dBm)	(dBm)	(mW)	(mW)
Horiz	4806.110	67.55	-59.90	10.807	2.085	-51.18	-53.33	-30.00	-23.33	0.00000400	0.00000065
Horiz	7205.520	69.39	-51.50	11.098	2.929	-43.33	-45.48	-30.00	-15.48	0.00025000	-0.00022169
Vert	4806.120	67.08	-60.50	10.842	2.085	-51.74	-53.89	-30.00	-23.89	0.00000400	0.00000008
Vert	7206.840	61.41	-59.30	11.083	2.929	-51.15	-53.30	-30.00	-23.30	0.00025000	-0.00024532

High Channel

Antenna	Frequency	Target	Sig Gen	Ant Gain	Cable losses	ERP	ERPLimit	ERP Margin	ERPLimit	ERP Margin
Polarization	MHz	dBuV	to Ant dBm	dBi	dB	dBm	(dBm)	(dBm)	(mW)	(mW)
Horiz	4958.11	65.92	-60.70	10.942	2.697	-54.61	-30.00	-24.61	0.00000400	-0.00000054
Horiz	7439.52	72.04	-48.50	10.799	3.132	-42.98	-30.00	-12.98	0.00025000	-0.00019968
Vert	4958.08	65.23	-61.50	10.799	2.697	-55.55	-30.00	-25.55	0.00000400	-0.00000121
Vert	7439.51	64.18	-56.00	10.686	3.132	-50.60	-30.00	-20.60	0.00025000	-0.00024128

7.7. RECEIVER SPURIOUS EMISSIONS

LIMIT

ETSI EN 300 328 Clause 4.3.7.2

Table 4: Narrowband Spurious Emissions Limits for Receivers

Frequency Range	Limit
30 MHz to 1.0 GHz	-57 dBm
1.0 GHz to 12.75 GHz	-47 dBm

Table 5: Wideband Spurious Emissions Limits for Receivers

Frequency Range	Limit
30 MHz to 1.0 GHz	-107 dBm/Hz
1.0 GHz to 12.75 GHz	-97 dBm/Hz

TEST PROCEDURE

EN 300 328 Clause 5.7.6

TEST PROTOCOL

EN 300 328 Clause 5.7.6

The levels of spurious emissions are measured as

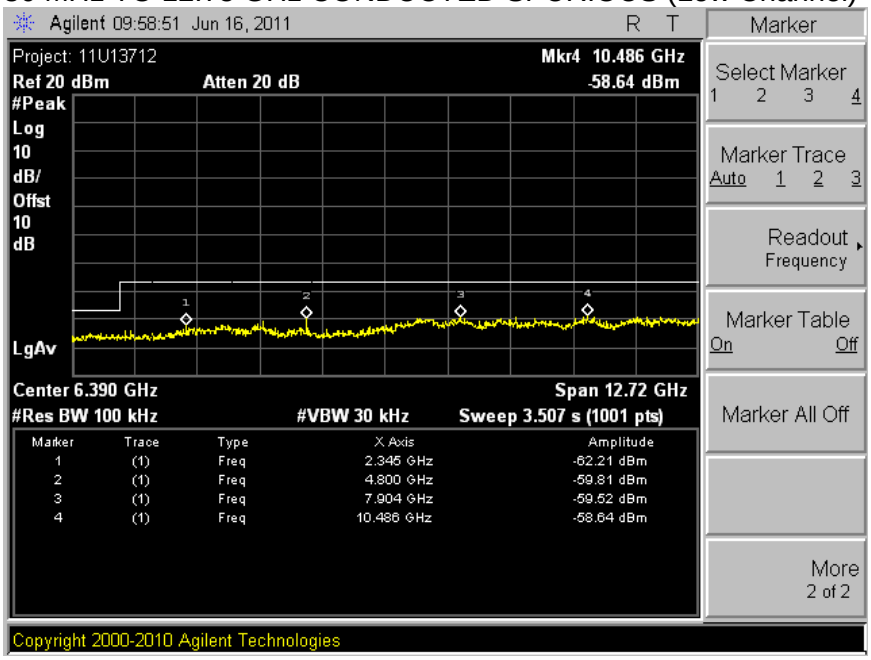
their power in a specified load (conducted spurious emissions); and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation).

RESULTS

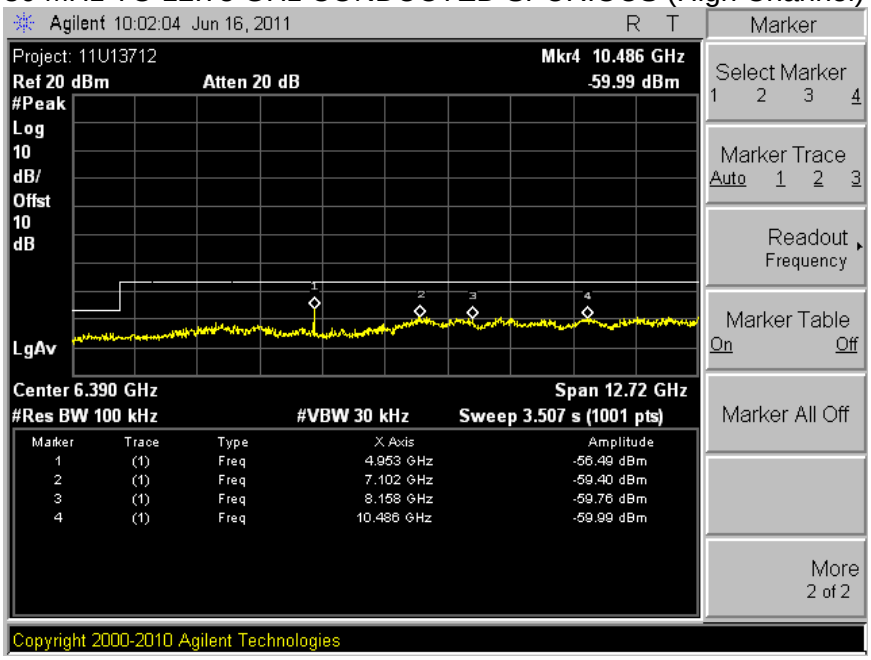
7.7.1. LE MODE

CONDUCTED SPURIOUS EMISSIONS

30 MHz TO 12.75 GHz CONDUCTED SPURIOUS (Low Channel)



30 MHz TO 12.75 GHz CONDUCTED SPURIOUS (High Channel)



RADIATED SPURIOUS EMISSIONS BELOW 1 GHz

Antenna Polarization	Frequency MHz	Target dBuV	Sig Gen to Ant dBm	Ant Gain dBi	Cable losses dB	ERP dBm	ERPLimit (dBm)	ERP Margin (dBm)
Horiz	48.000	31.32	-46.10	-7.5	0.4	-56.19	-57.00	0.81
Horiz	240.000	22.09	-80.00	6.5	6.5	-82.15	-57.00	-25.15
Vert	48.000	36.26	-41.00	-7.5	0.4	-51.09	-57.00	5.91
Vert	456.040	17.71	-80.00	6.7	6.7	-82.15	-57.00	-25.15
Vert	467.880	16.94	-80.00	6.8	6.8	-82.15	-57.00	-25.15
Vert	480.000	20.21	-80.00	6.7	6.7	-82.15	-57.00	-25.15

* 48MHz deteremined to be laptop computer and not EUT.

RADIATED SPURIOUS EMISSIONS ABOVE 1 GHz

Low Channel

Antenna Polarization	Frequency MHz	Target dBuV	Sig Gen to Ant dBm	Ant Gain dBi	Cable losses dB	ERP dBm	ERPLimit (dBm)	ERP Margin (dBm)
Horiz	1730.390	61.53	-65.80	8.7	2.7	-62.00	-47.00	-15.00
Horiz	4806.080	69.18	-57.40	10.8	4.8	-53.55	-47.00	-6.55
Vert	1593.540	57.74	-73.70	9.0	2.6	-69.45	-47.00	-22.45
Vert	2336.160	51.38	-76.00	9.4	3.2	-71.95	-47.00	-24.95
Vert	4806.090	68	-58.00	10.8	4.8	-54.15	-47.00	-7.15
Vert	5818.980	51.04	-76.00	11.3	5.1	-71.95	-47.00	-24.95

High Channel

Antenna Polarization	Frequency MHz	Target dBuV	Sig Gen to Ant dBm	Ant Gain dBi	Cable losses dB	ERP dBm	ERPLimit (dBm)	ERP Margin (dBm)
Horiz	1329.33	51.2	-76.50	7.5	2.4	-73.55	-47.00	-26.55
Horiz	1730.73	58.05	-69.70	8.7	2.7	-65.85	-47.00	-18.85
Horiz	4957.97	68.61	-57.90	10.8	4.8	-54.05	-47.00	-7.05
Vert	1593.59	53.36	-75.00	8.8	2.6	-70.95	-47.00	-23.95
Vert	1730.73	62.52	-66.60	8.7	2.7	-62.75	-47.00	-15.75
Vert	4957.97	66.27	-60.60	10.8	4.8	-56.75	-47.00	-9.75

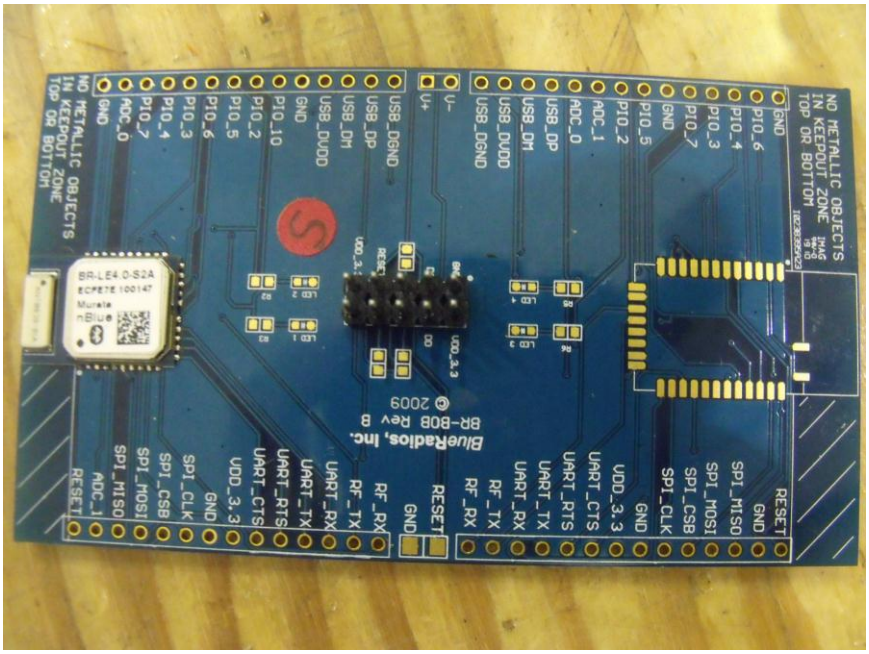
8. EXTERNAL AND INTERNAL PHOTOS

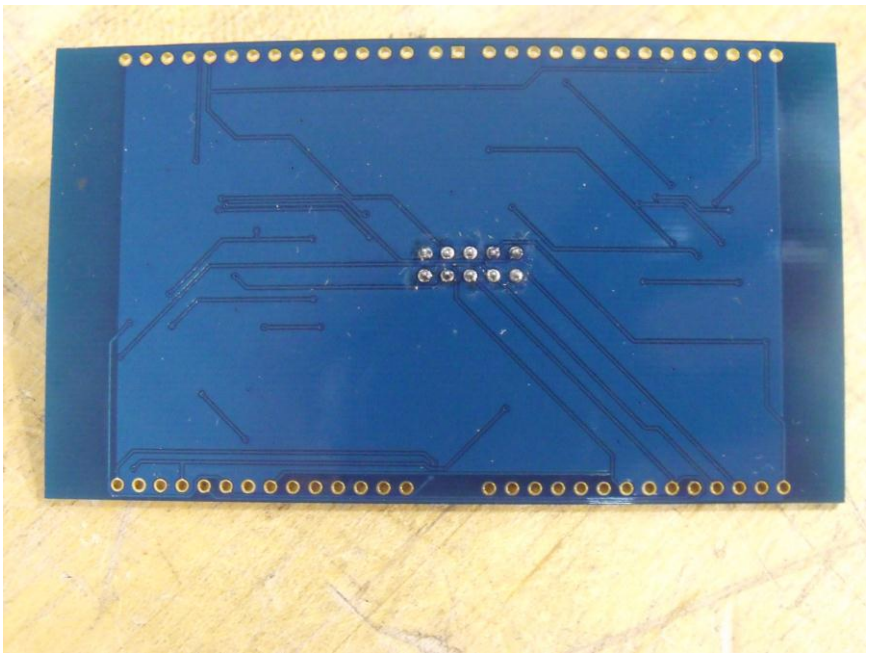
EXTERNAL PHOTOS

EUT is a module. See internal photos

INTERNAL PHOTOS

TOP VIEW

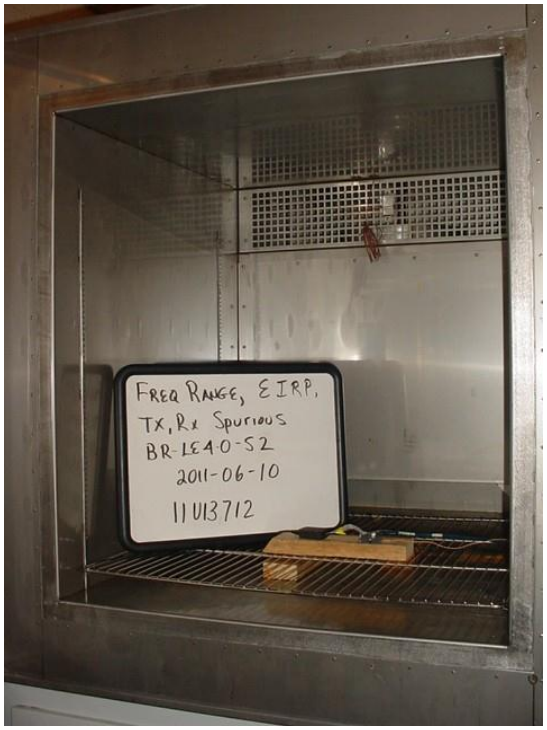




9. SETUP PHOTOS

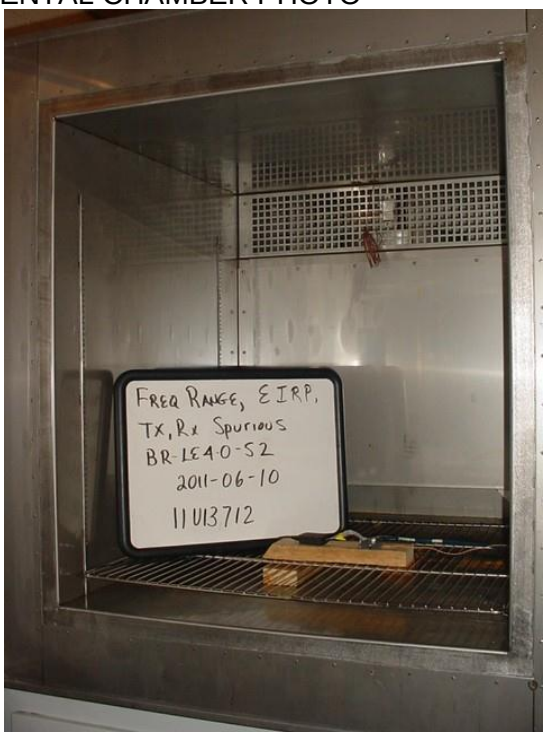
RF CONDUCTED MEASUREMENT AT ANTENNA PORT

ANTENNA PORT CONDUCTED PHOTO



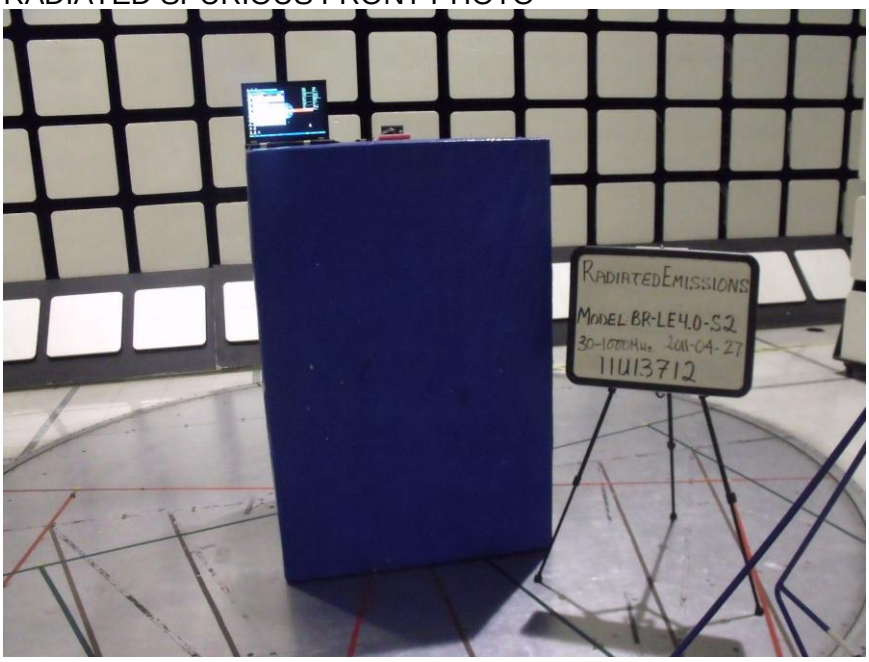
ENVIRONMENTAL CHAMBER SETUP

ENVIRONMENTAL CHAMBER PHOTO



RADIATED SPURIOUS EMISSIONS

RADIATED SPURIOUS FRONT PHOTO



RADIATED SPURIOUS BACK PHOTO

END OF REPORT