



Test Report No.:		11030302	Page 1 of 36
<i>Client:</i>	Plugwise B.V. Wattstraat 56, 2171TR Sassenheim		
<i>Test Item:</i>	Energy Management System, ZigBee device		
<i>Identification:</i>	Circle	<i>Serial No.:</i>	----
<i>Project No.:</i>	11030302	<i>Date of Receipt:</i>	2011-06-01
<i>Testing Location:</i>	TÜV Rheinland EPS B.V. Smidshornerweg 18 9822 TL Niekerk		
<i>Test Specification:</i>	FCC 47 CFR Part 15, Subpart C, Section 15.247 (October 1, 2010) ANSI C63.4-2009 KDB Publication No. 558074: Measurement of Digital Transmission Systems Operating under Section 15.247 (March 23, 2005)		
<i>Test Result:</i>	The test item passed the test specification(s).		
<i>Testing Laboratory:</i>	TÜV Rheinland EPS B.V. Smidshornerweg 18 9822 TL Niekerk		
<i>Tested by:</i>		<i>Reviewed by:</i>	
2011-07-18	R. van der Meer / Inspector	2011-07-18	O. Hoekstra / Reviewer
<i>Date</i>	<i>Name/Position</i>	<i>Signature</i>	<i>Date</i>
			<i>Name/Position</i>
			<i>Signature</i>
<i>Other Aspects:</i> N/A			
<i>Abbreviations:</i> P(ass) = passed F(ail) = failed N/A = not applicable N/T = not tested			
This report shall not be reproduced, except in full, without the written permission of TÜV Rheinland EPS B.V. The test results relate only to the item(s) tested.			

Test Report No.:

11030302

Page 2 of 36

TEST SUMMARY

5.1.1 VOLTAGE REQUIREMENTS

RESULT: PASS

5.1.2 ANTENNA REQUIREMENTS

RESULT: PASS

5.1.3 RESTRICTED BANDS OF OPERATION

RESULT: PASS

5.2.1 CONDUCTED OUTPUT POWER

RESULT: PASS

5.2.2 6dB BANDWIDTH

RESULT: PASS

5.2.3 CONDUCTED SPURIOUS EMISSION

RESULT: PASS

5.2.4 PEAK POWER SPECTRAL DENSITY

RESULT: PASS

5.2.5 BAND EDGE CONDUCTED EMISSIONS

RESULT: Pass

5.2.6 RADIATED SPURIOUS EMISSIONS OF TRANSMITTER

RESULT: PASS

5.3.1 AC POWER LINE CONDUCTED EMISSION OF TRANSMITTER

RESULT: PASS

Contents

1.	GENERAL REMARKS	4
1.1	COMPLEMENTARY MATERIALS	4
2.	TEST SITES	4
2.1	TEST FACILITIES	4
2.2	LIST OF TEST AND MEASUREMENT INSTRUMENTS	5
2.3	MEASUREMENT UNCERTAINTY	6
3.	GENERAL PRODUCT INFORMATION	7
3.1	PRODUCT FUNCTION AND INTENDED USE	7
3.2	SYSTEM DETAILS	7
3.3	CLOCK FREQUENCIES	8
3.4	COUNTERMEASURES TO ACHIEVE EMC COMPLIANCE	8
4.	TEST SET-UP AND OPERATION MODES	9
4.1	TEST METHODOLOGY	9
4.2	OPERATION MODES	9
4.3	PHYSICAL CONFIGURATION FOR TESTING	9
4.4	TEST SOFTWARE	10
4.5	SPECIAL ACCESSORIES AND AUXILIARY EQUIPMENT	11
5.	TEST RESULTS RADIO	12
5.1	TECHNICAL REQUIREMENTS	12
5.1.1	<i>Voltage Requirements</i>	<i>12</i>
5.1.2	<i>Antenna Requirements</i>	<i>12</i>
5.1.3	<i>Restricted Bands of Operation</i>	<i>13</i>
5.2	CONDUCTED MEASUREMENTS AT ANTENNA PORT	14
5.2.1	<i>Conducted Output Power</i>	<i>14</i>
5.2.2	<i>6dB Bandwidth</i>	<i>16</i>
5.2.3	<i>Conducted Spurious Emission</i>	<i>19</i>
5.2.4	<i>Peak Power Spectral Density</i>	<i>23</i>
5.2.5	<i>Band Edge Conducted Emissions</i>	<i>26</i>
5.2.6	<i>Radiated Spurious Emissions of Transmitter</i>	<i>29</i>
5.3	AC POWER LINE CONDUCTED MEASUREMENTS	34
5.3.1	<i>AC Power Line Conducted Emission of Transmitter</i>	<i>34</i>
6.	LIST OF TABLES	36
7.	LIST OF FIGURES	36

Test Report No.:

11030302

Page 4 of 36

1. General Remarks

1.1 Complementary Materials

There is no attachment to this test report.

2. Test Sites

2.1 Test Facilities

The Federal Communications Commission and Industry Canada has reviewed the technical characteristics of the test facilities at TÜV Rheinland EPS B.V., located in Niekerk, 9822 TL Smidshornerweg 18, The Netherlands, and has found these test facilities to be in compliance with the requirements of 47 CFR Part 15, section 2.948, per October 23, 2000.

The description of the test facilities has been filed at the Office of the Federal Communications Commission under registration number 90828. The facility has been added to the list of laboratories performing these test services for the public on a fee basis.

The description of the test facilities has been filed to Industry Canada under registration number 2932G-1. The facility has been added to the list of laboratories performing these test services for the public on a fee basis.

Normal test conditions:

Temperature (*)	: +15°C to +35°C
Relative humidity(*)	: 20 % to 75 %
Supply voltage	: 120VAC/60Hz
Air pressure	: 950 – 1050 hPa

When it was impracticable to carry out the tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests are stated separately.

Test Report No.:

11030302

Page 5 of 36

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Kind of Equipment	Manufacturer	Model Name	Inventory number	Calibration date (mm/yyyy)	Calibration due date (mm/yyyy)
For Antenna Port Conducted Emission					
Spectrum Analyzer	Rohde & Schwarz	FSP40	99538	05/2011	05/2012
Temperature-Humiditymeter	Europe supplies	WS-7082	99613	10/2010	10/2011
For AC Power Line Conducted Emission					
LISN	EMCO	3625/2	12512	01/2010	01/2012
Measurement Receiver	Rohde & Schwarz	ESCI	99699	02/2011	02/2012
Temperature-Humiditymeter	Europe supplies	WS-7082	99548	10/2010	10/2011
Variac	RFT	LTS006	99161	N/A	N/A
For Radiated Emission					
Measurement Receiver	Rohde & Schwarz	ESCI	99699	02/2011	02/2012
Coax 5m RG213 OATS	NMi Certin B.V.	KABEL 5M OATS	99069	10/2010	10/2011
Coax 15m RG213 OATS	NMi Certin B.V.	KABEL 15M OATS	99070	10/2010	10/2011
Coax OATS ground	NMi Certin B.V.	KABEL GROND OATS	99071	10/2010	10/2011
Controller OATS	Heinrich Deisel	4630-100	99107	N/A	N/A
OATS	Comtest	FCC listed: 90828	99580	08/2008	08/2011
Spectrum Analyzer	Rohde & Schwarz	FSP40	99538	05/2011	05/2012
Controller (OATS)	EMCS	DOC202	99608	N/A	N/A
Antenna mast	EMCS	AP-4702C	99609	N/A	N/A
Temperature-Humiditymeter	Europe supplies	WS-7082	99547	10/2010	10/2011
Guidehorn 1-18 GHz	EMCO	3115	12484	04/2011	04/2012
Guidehorn 18-26.5 GHz	EMCO	RA42-K-F-4B-C	12488	09/2010	09/2011
Biconilog Testantenna	Chase	CBL 6111B	15633	02/2011	02/2012
2.4 GHz bandreject filter	BSC	XN-1783	14450	N/A	N/A
Bandpass filter 4-10 GHz	Reactel	7AS-7G-6G-511	99076	N/A	N/A
Bandpass filter 10-26 GHz	Reactel	9HS-10G/26.5G-S11	99136	N/A	N/A
Preamplifier 0.5 - 18 GHz	Miteq	AMF-5D-005180-28-13p	99596	N/A	N/A

Test Report No.:

11030302

Page 6 of 36

Kind of Equipment	Manufacturer	Model Name	Inventory number	Calibration date (mm/yyyy)	Calibration due date (mm/yyyy)

--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

Conformance of the used measurement and test equipment with the requirements of ISO/IEC 17025:2005 has been confirmed before testing.

2.3 Measurement Uncertainty

Table 2: Emission Measurement Uncertainty

Measurement Type	Frequency	Uncertainty
AC Power Line Conducted Emission	150kHz - 30MHz	±3.5dB
Antenna Port Conducted Emission	< 1GHz	±0.5dB
	> 1GHz	±0.7dB
Radiated Emission	150kHz - 30MHz	±5.0dB
	30MHz - 1GHz	±5.0dB
	> 1GHz	±5.5dB

3. General Product Information

3.1 Product Function and Intended Use

The brand Plugwise model Circle, hereafter referred to as EUT, is a digitally modulated transmitter intended to be used in an energy management system using a wireless ZigBee-mesh network. It operates in the 2400 – 2483.5 frequency band (it actually uses the frequency range of 2405 – 2480 MHz).

The content of this report and measurement results have not been changed other than the way of presenting the data.

3.2 System Details

Details and an overview of the system and all of its components, as it has been tested, may be found below.

EUT	:	Energy Management System, ZigBee device
Manufacturer	:	Applied Micro Electronics "AME" BV
Brand	:	Plugwise
Model	:	Circle
Serial number	:	--
MAC	:	000D6F0000B810C6
Voltage input rating	:	100 – 240 VAC / 50-60 Hz
Voltage output rating	:	--
Current input rating	:	--
Antenna	:	Integral, integrated on the PCB
Operating frequency	:	2405 – 2480 MHz
Modulation	:	O-QPSK
Remarks	:	n.a.

Test Report No.:

11030302

Page 8 of 36

Table 3: Interfaces present on the EUT

No.	Interface	Cable Length for Testing, Shielding	Interface Classification
1.	AC Input	N/A	AC input power port
2.	AC Output	N/A	AC output power port

3.3 Clock Frequencies

The highest clock frequency generated by the EUT is 24.000 MHz.

3.4 Countermeasures to achieve EMC Compliance

No additional measures were employed to achieve compliance.

4. Test Set-up and Operation Modes

4.1 Test Methodology

The test methodology used is based on the requirements of 47 CFR Part 15, Sections 15.31, 15.33, 15.35, 15.205, 15.207, 15.209, 15.247 and KDB Publication No. 558074: Measurement of Digital Transmission Systems Operating under Section 15.247.

The test methods, which have been used, are based on ANSI C63.4-2009.

For details, see under each test item.

4.2 Operation Modes

Testing was performed at the lowest operating frequency (2405MHz), at the operating frequency in the middle of the specified frequency band (2440MHz) and at the highest operating frequency (2480MHz).

The basic operation modes used for testing are:

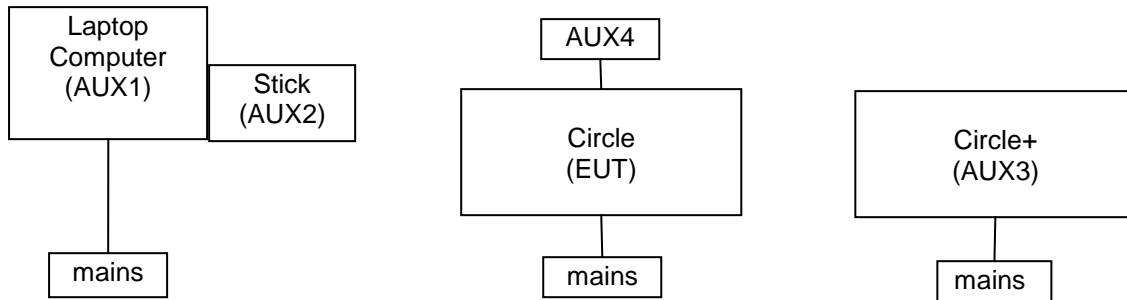
- A. EUT transmits (TX mode), with full power, at lowest channel, Channel 11 (2405MHz), a continuous modulated signal streaming called "Burst Mode".
- B. EUT transmits (TX mode), with full power, at middle channel, Channel 18 (2440MHz), a continuous modulated signal streaming called "Burst Mode".
- C. EUT transmits (TX mode), with full power, at highest channel, Channel 26 (2480MHz), a continuous modulated signal streaming called "Burst Mode".

4.3 Physical Configuration for Testing

The EUT was tested on a stand-alone basis (only attached to the test jig) and the test system was configured in a typical fashion (as a customer would normally use it).

The justification and manipulation of cables and equipment in order to simulate a worst-case behavior of the test setup has been carried out as prescribed in ANSI C63.4:2009.

Figure 1: Test Setup Diagram



Notes:

For antenna conducted measurements, the antenna was replaced by a 50Ω antenna connector and a short RF cable.

For more details, refer to the document: Test Set-Up Photographs document.

4.4 Test Software

The EUT was provided by the manufacturer with suitable software to allow operation in all the required modes.

Software used for testing: Plugwise Easy Tool Build date: 5/27/2011.

This software was running on a laptop computer (AUX1). It was used to enable the test operation modes listed in section 4.2 as appropriate.

4.5 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

1. AUX1
Product: Laptop Computer
Manufacturer: Lenovo
Model: 9456-HTG
Serial Number: L3-BF847 07/02
Remark: property TR-EPS, host for testsoftware and AUX2

2. AUX2
Product: ZigBee module, USB Stick
Manufacturer: Plugwise
Model: Stick
Rated Voltage: 3.3 - 5Vdc (USB powered)
Antenna: Internal, integrated on the PCB
Remarks: connects to AUX1

3. AUX3
Product: ZigBee module
Manufacturer: Plugwise
Model: Circle+
Rated Voltage: 100 – 240 Vac
Antenna: Internal, integrated on the PCB
Remarks: N/A

4. AUX4
Product: Test jig
Manufacturer: N/A
Model: N/A
Remarks: Used for Conducted tests between PCB and Spectrum analyzer

Test Report No.:

11030302

Page 12 of 36

5. Test Results RADIO

5.1 Technical Requirements

5.1.1 Voltage Requirements

RESULT: Pass

Requirements:

FCC 15.31(e)

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

Verdict:

The EUT has an internal voltage regulator to supply the RF circuit. Hence it complies with the power supply requirements.

5.1.2 Antenna Requirements

RESULT: Pass

Requirements:

FCC 15.203

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Verdict:

The EUT has an internal antenna which is not user accessible. Hence it complies with the requirements.

Test Report No.:

11030302

Page 13 of 36

5.1.3 Restricted Bands of Operation

RESULT: Pass

Requirements:

FCC 15.205

Only spurious emissions are permitted in any of the restricted frequency bands, unless otherwise specified.

Verdict:

The EUT operation frequency range is 2405 MHz - 2480 MHz. Therefore only spurious emissions may be found in the restricted bands of operation and the EUT complies with the restricted frequency band requirement.

5.2 Conducted Measurements at Antenna Port

5.2.1 Conducted Output Power

RESULT: Pass

Date of testing: 2011-07-08

Requirements:

FCC 15.247(b)(3)

For systems using digital modulation in the 2400-2483.5MHz band, the maximum peak output power is 1W (+30dBm).

Test procedure:

ANSI C63.4-2009 and KDB Publication No. 558074: Measurement of Digital Transmission Systems Operating under Section 15.247.

The maximum peak output power (conducted) was measured at the antenna connector with a spectrum analyzer. The final measurement takes into account the loss generated by all the involved cables.

Table 4: Conducted Output Power

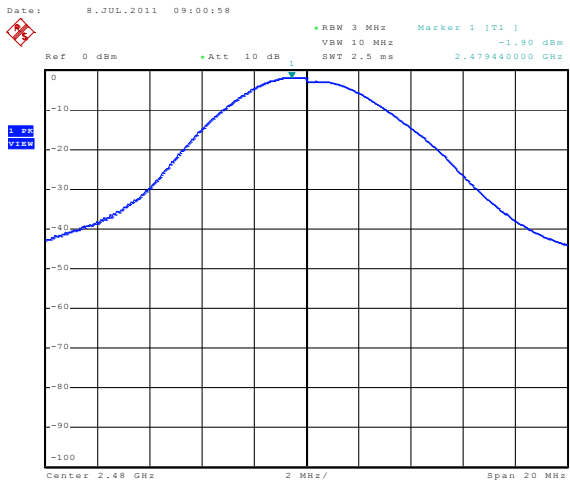
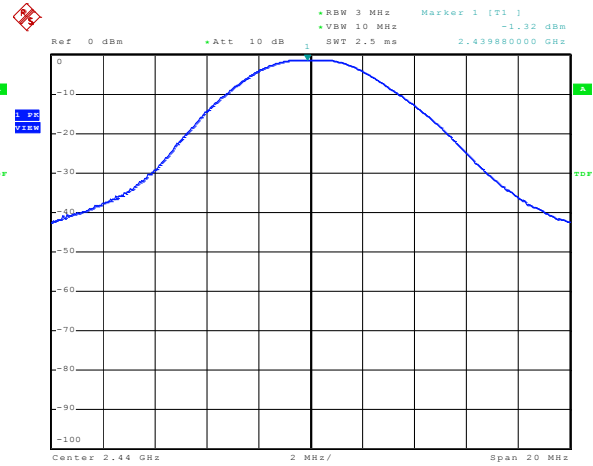
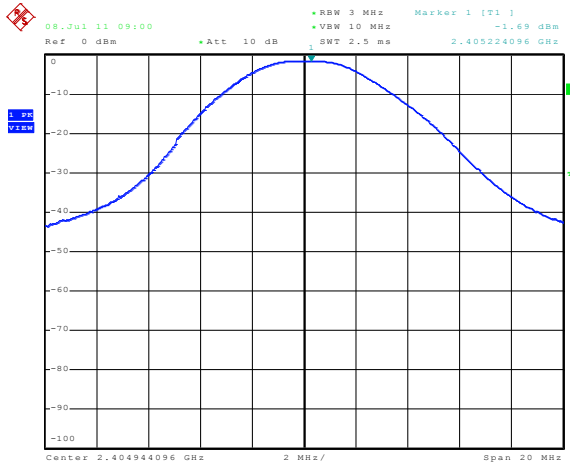
Frequency [MHz]	Reading [dBm]	Correction Factor [dB]	Output Power [dBm]	Output Power [mW]	Limit [dBm]	Limit [mW]	Margin [dB]
2405	-2.07	1.0	-1.07	0.782	+30	1000	31.07
2440	-2.32	1.0	-1.32	0.738	+30	1000	31.32
2480	-2.90	1.0	-1.90	0.646	+30	1000	31.90

Notes: Output power = Reading + Correction factor

Correction factor = Total cable loss

mW = 10 ^ (dBm/10)

dBm = 10 x log(mW)



Date: 8.JUL.2011 09:38:13

Date: 8.JUL.2011 10:48:51

Figure 2: Peak power plots,

Figures 2a, 2b and 2c showing plots of the Peak Power outputs, correction factors included in the reading.

Test Report No.:

11030302

Page 16 of 36

5.2.2 6dB Bandwidth

RESULT: Pass

Date of testing: 2011-07-08

Requirements:

FCC 15.247(a)(2)

For systems using digital modulation in the 2400-2483.5MHz band, the 6dB bandwidth shall be at least 500kHz.

Test procedure:

ANSI C63.4-2009 and KDB Publication No. 558074: Measurement of Digital Transmission Systems Operating under Section 15.247.

A spectrum analyzer was connected to the antenna port of the EUT. The spectrum analyzer resolution bandwidth was set to 100kHz and the span to 5 MHz.

Test Report No.:

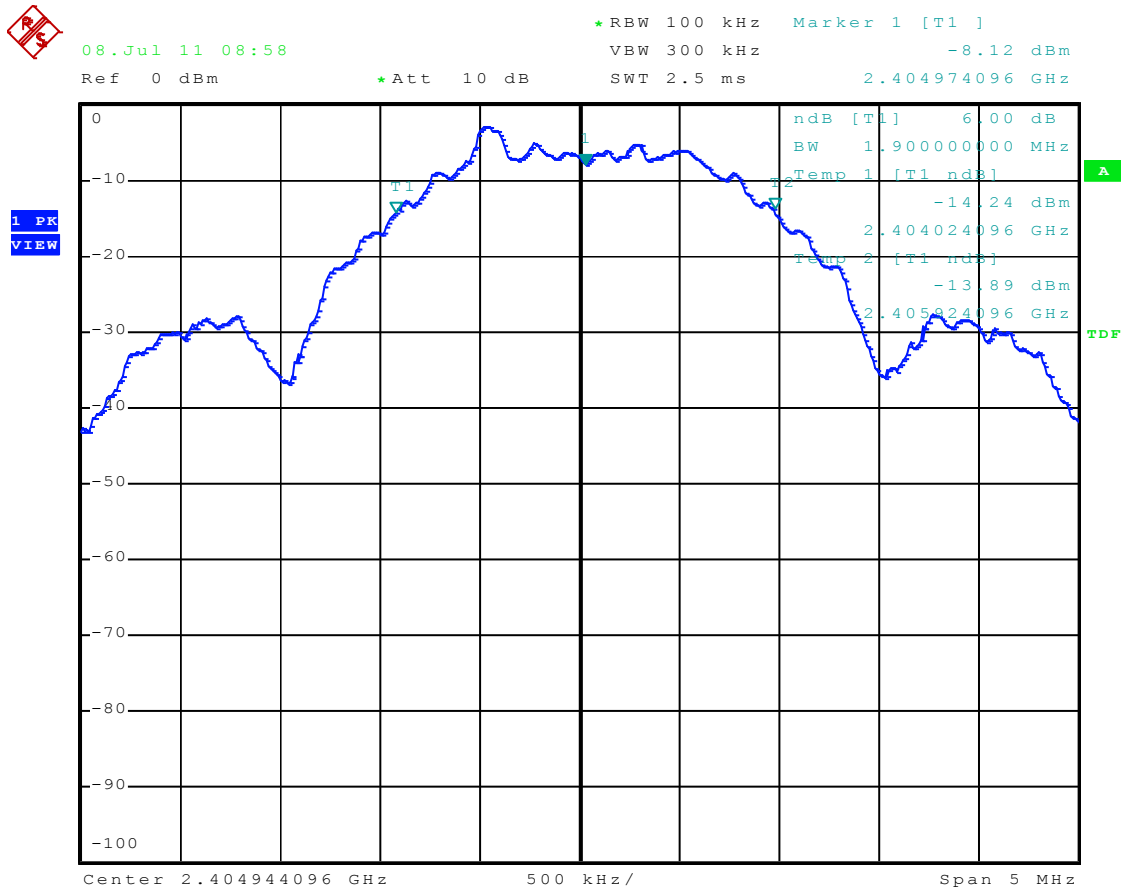
11030302

Page 17 of 36

Table 5: 6dB Bandwidth

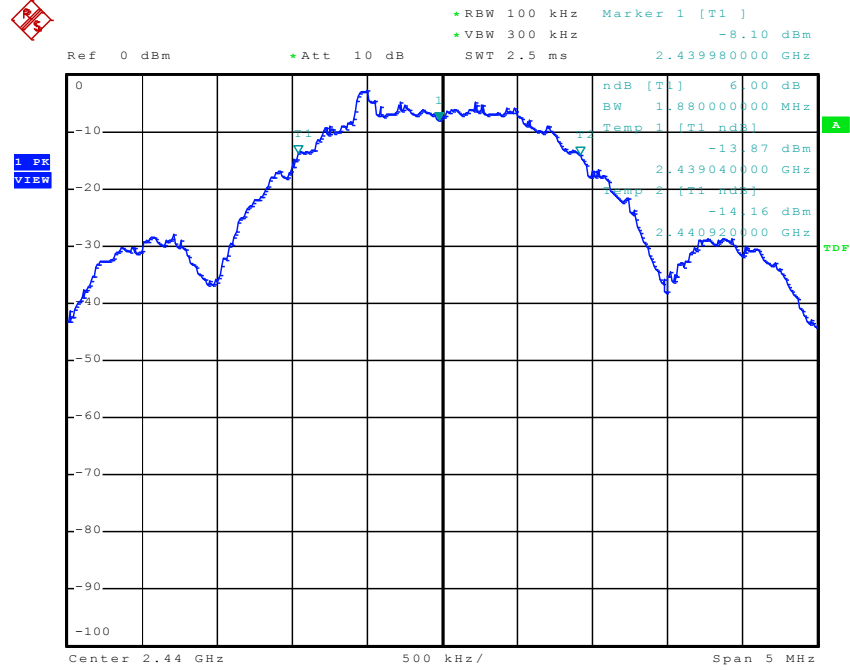
Operating Frequency [MHz]	6dB Bandwidth [kHz]	Limit [kHz]
2405	1900	500
2440	1880	500
2480	1680	500

Figure 3: 6dB Bandwidth, Mode A (2405MHz)



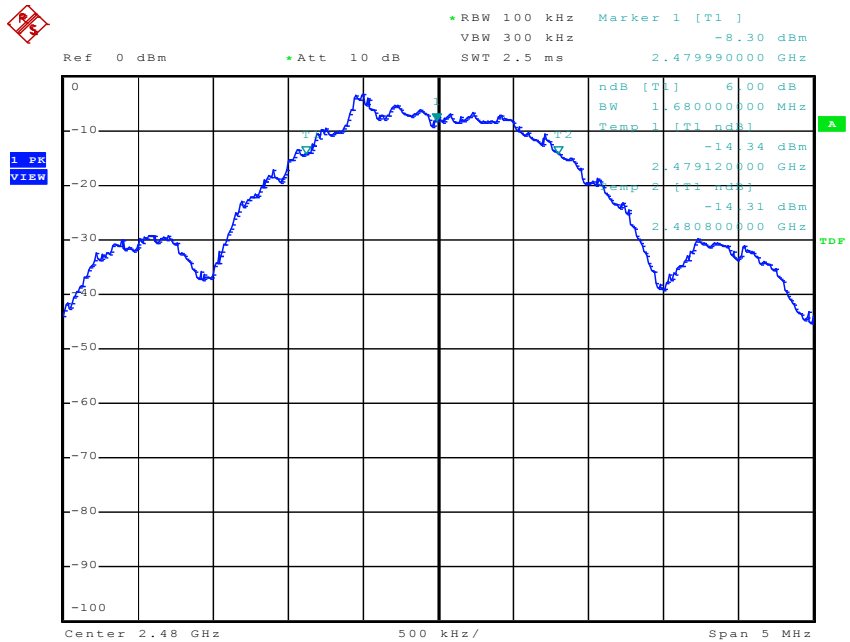
Date: 8.JUL.2011 08:58:03

Figure 4: 6dB Bandwidth, Mode B (2440MHz)



Date: 8.JUL.2011 09:35:43

Figure 5: 6dB Bandwidth, Mode C (2480MHz)



Date: 8.JUL.2011 10:46:51

Test Report No.:

11030302

Page 19 of 36

5.2.3 Conducted Spurious Emission

RESULT: Pass

Date of testing: 2011-07-08

Requirements:

FCC 15.247(d)

In any 100kHz bandwidth outside the frequency band, the RF power shall be at least 20dB below that of the maximum in-band 100kHz emission.

Test procedure:

ANSI C63.4-2009 and KDB Publication No. 558074: Measurement of Digital Transmission Systems Operating under Section 15.247.

A spectrum analyzer was connected to the antenna port of the EUT. The analyzer resolution bandwidth was set to 100kHz. For each channel investigated, the in-band and out-of-band emission measurements were performed. The out-of-band emissions were measured from 30MHz to 25GHz (10th harmonics).

The final measurement takes into account the loss generated by all the involved cables.

Figure 6: Conducted Spurious Emission, 30MHz - 25GHz, Mode A (2405MHz)



08.Jul 11 08:51

Ref 10 dBm

* Att 20 dB

* RBW 100 kHz
VBW 300 kHz

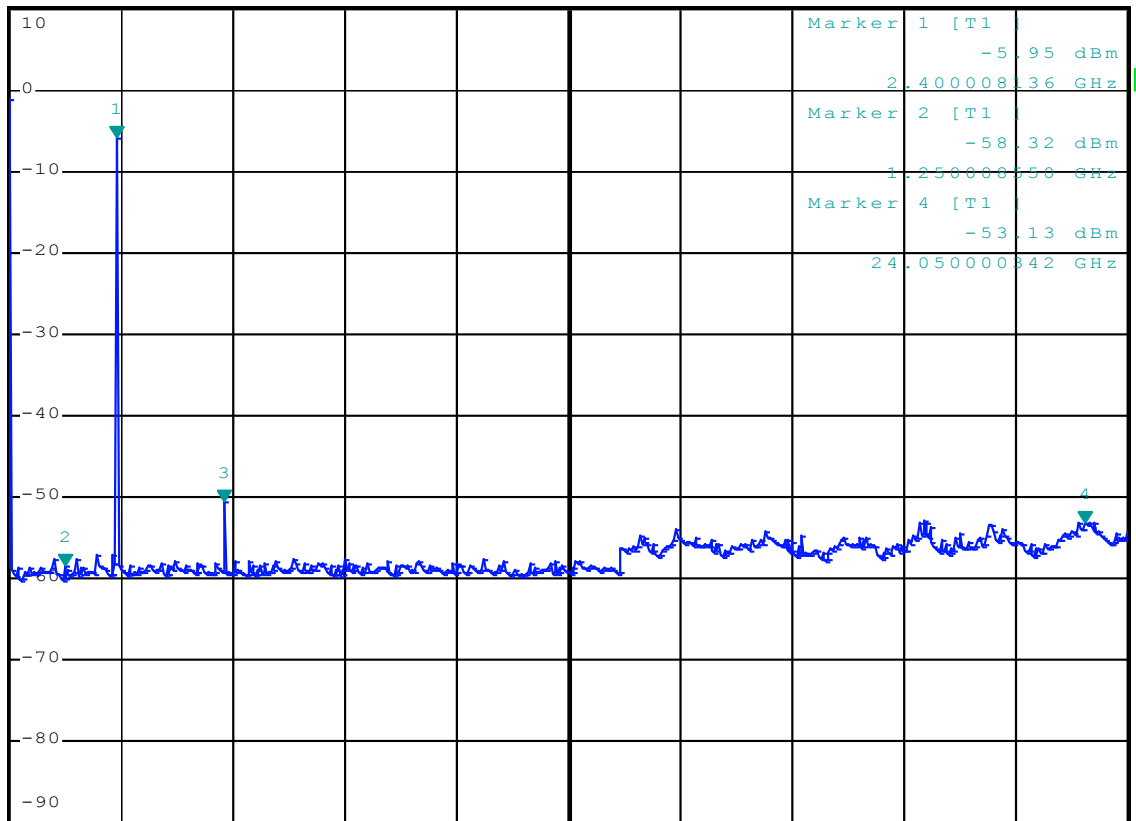
SWT 2.5 s

Marker 3 [T1]

-50.60 dBm

4.800007272 GHz

1 PK
VIEW



Center 12.5000045 GHz

2.4999991 GHz/

Span 24.999991 GHz

Date: 8.JUL.2011 08:51:00

Test Report No.:

11030302

Page 21 of 36

Figure 7: Conducted Spurious Emission, 30MHz - 25GHz, Mode B (2440MHz)



08.Jul 11 08:45

*RBW 100 kHz Marker 4 [T1]

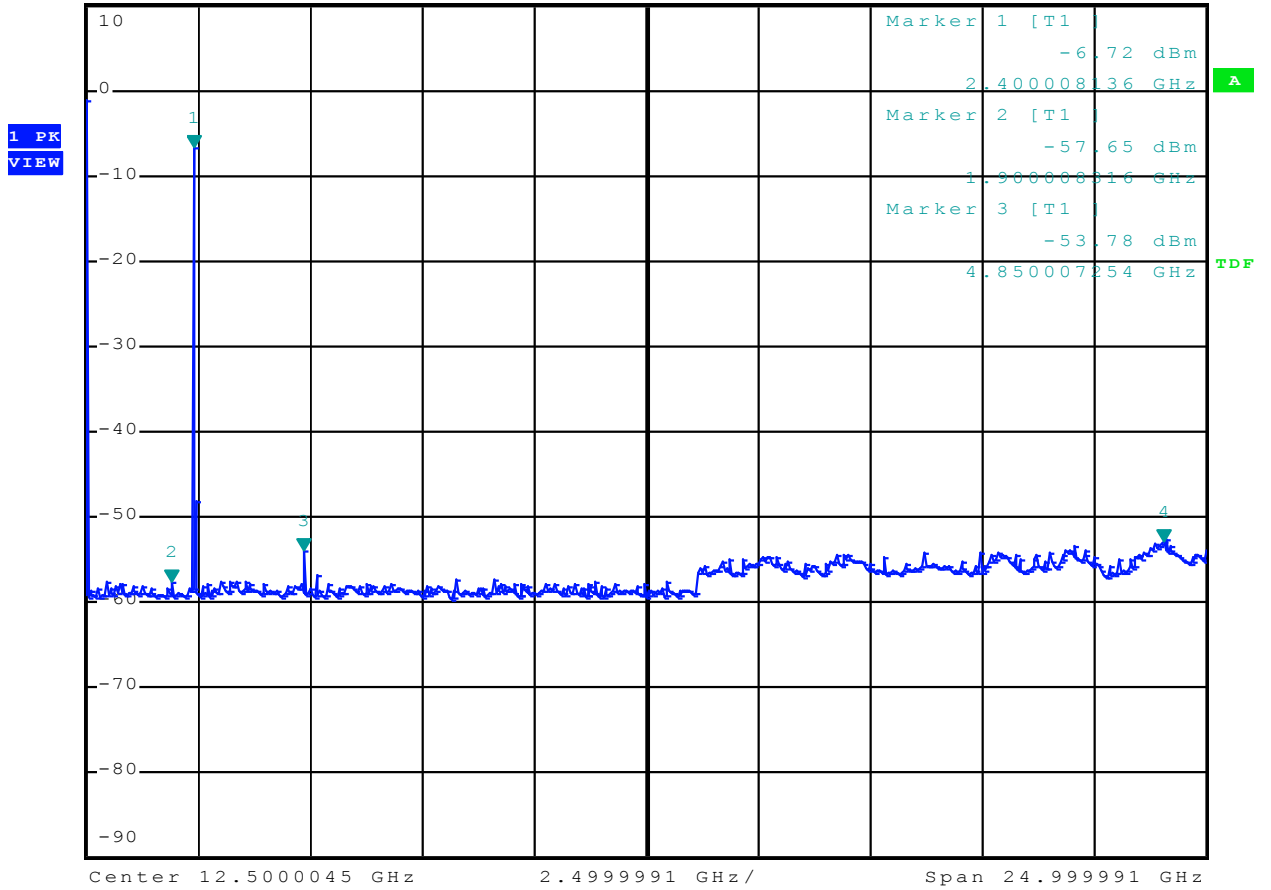
VBW 300 kHz -52.94 dBm

Ref 10 dBm

*Att 20 dB

SWT 2.5 s

24.050000342 GHz



Date: 8.JUL.2011 08:45:45

Test Report No.:

11030302

Page 22 of 36

Figure 8: Conducted Spurious Emission, 30MHz - 25GHz, Mode C (2480MHz)



07.Jul 11 16:05

*RBW 100 kHz Marker 4 [T1]

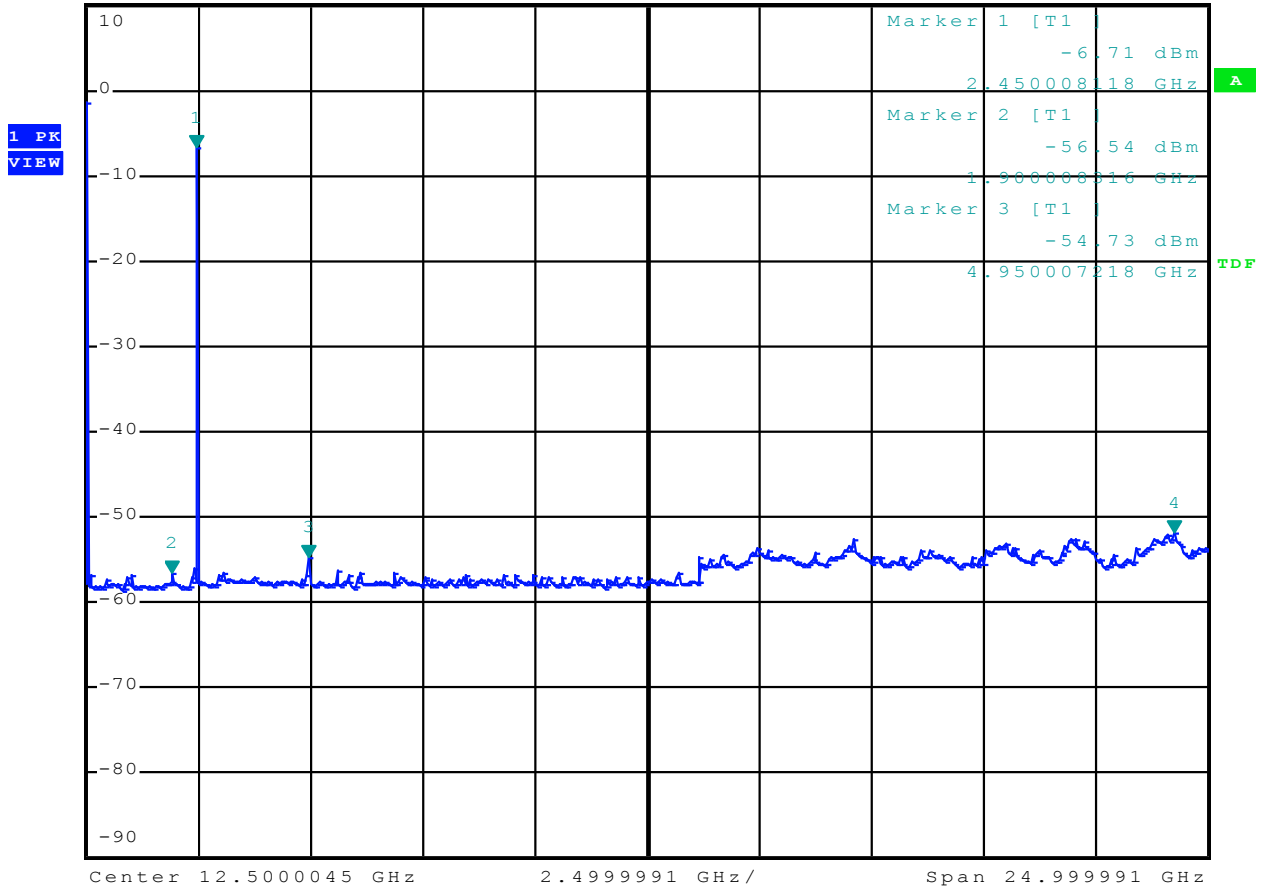
VBW 300 kHz -51.86 dBm

Ref 10 dBm

*Att 20 dB

SWT 2.5 s

24.250000270 GHz



Date: 7.JUL.2011 16:05:11

Test Report No.:

11030302

Page 23 of 36

5.2.4 Peak Power Spectral Density

RESULT: Pass

Date of testing: 2011-07-08

Requirements:

FCC 15.247(e)

For digitally modulated systems, the power spectral density (PSD) conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.

Test procedure:

ANSI C63.4-2009 and KDB Publication No. 558074: Measurement of Digital Transmission Systems Operating under Section 15.247.

A spectrum analyzer was connected to the antenna port of the EUT. The analyzer resolution bandwidth was set to 3kHz and the video bandwidth was set to 10kHz. The sweep time was set to 500s.

The final measurement takes into account the loss generated by all the involved cables.

Table 6: Peak Power Spectral Density

Operating Frequency [MHz]	Max PSD Frequency [MHz]	Reading [dBm]	Correction Factor [dB]	Max PSD [dBm]	Limit [dBm]	Margin [dB]
2405	2404.464	-17.77	1.0	-16.77	8	24.77
2440	2440.039	-17.10	1.0	-16.10	8	24.10
2480	2479.466	-17.79	1.0	-16.79	8	24.79

Notes: Power density = Reading + Correction factor
 Correction factor = Total cable loss
 Figures 9, 10 and 11 includes the correction factor

Figure 9: Power Spectral Density, Mode A (2405MHz)

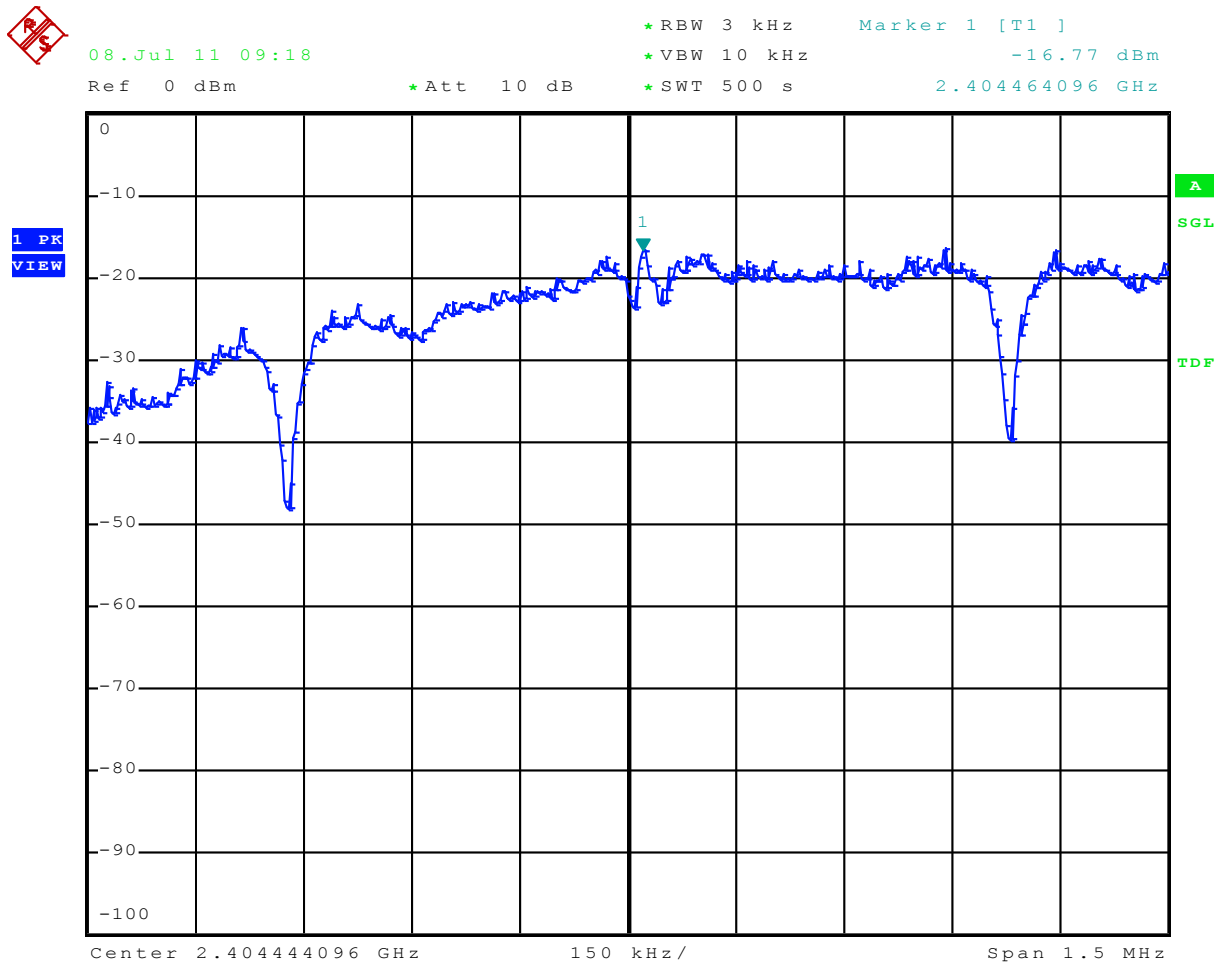
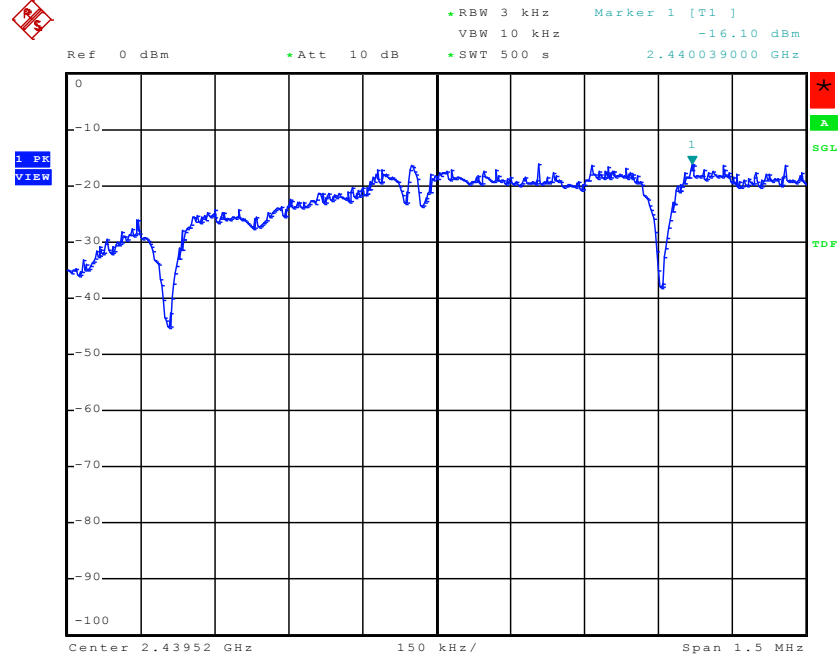
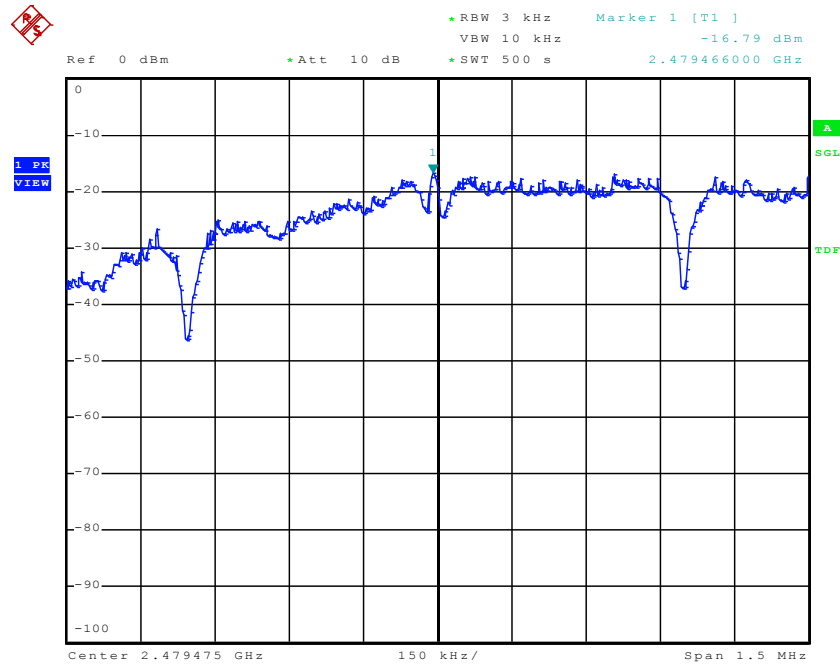


Figure 10: Power Spectral Density, Mode B (2440MHz)



Date: 8.JUL.2011 10:31:04

Figure 11: Power Spectral Density, Mode C (2480MHz)



Date: 8.JUL.2011 11:04:18

Test Report No.:

11030302

Page 26 of 36

5.2.5 Band Edge Conducted Emissions

RESULT: Pass

Date of testing: 2011-07-08

Requirements:

FCC 15.205, FCC 15.209 and FCC 15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

Test procedure:

ANSI C63.4-2009 and KDB Publication No. 558074: Measurement of Digital Transmission Systems Operating under Section 15.247.

Measurements were performed using a spectrum analyzer with a suitable span to encompass the peak of the fundamental and using the following settings:

RBW = 100kHz, VBW = 300kHz.

The highest emission amplitudes relative to the appropriate limit were measured and recorded in this report.

Results: All out of band spurious emissions are more than 20 dB below the fundamental. See Figures 12 and 13 on the following pages.

Figure 12: Band Edge Conducted Emission, Spectral Diagram, Mode A (2405MHz)



08.Jul 11 09:30

Ref 0 dBm

*Att 10 dB

*RBW 100 kHz Marker 3 [T1]

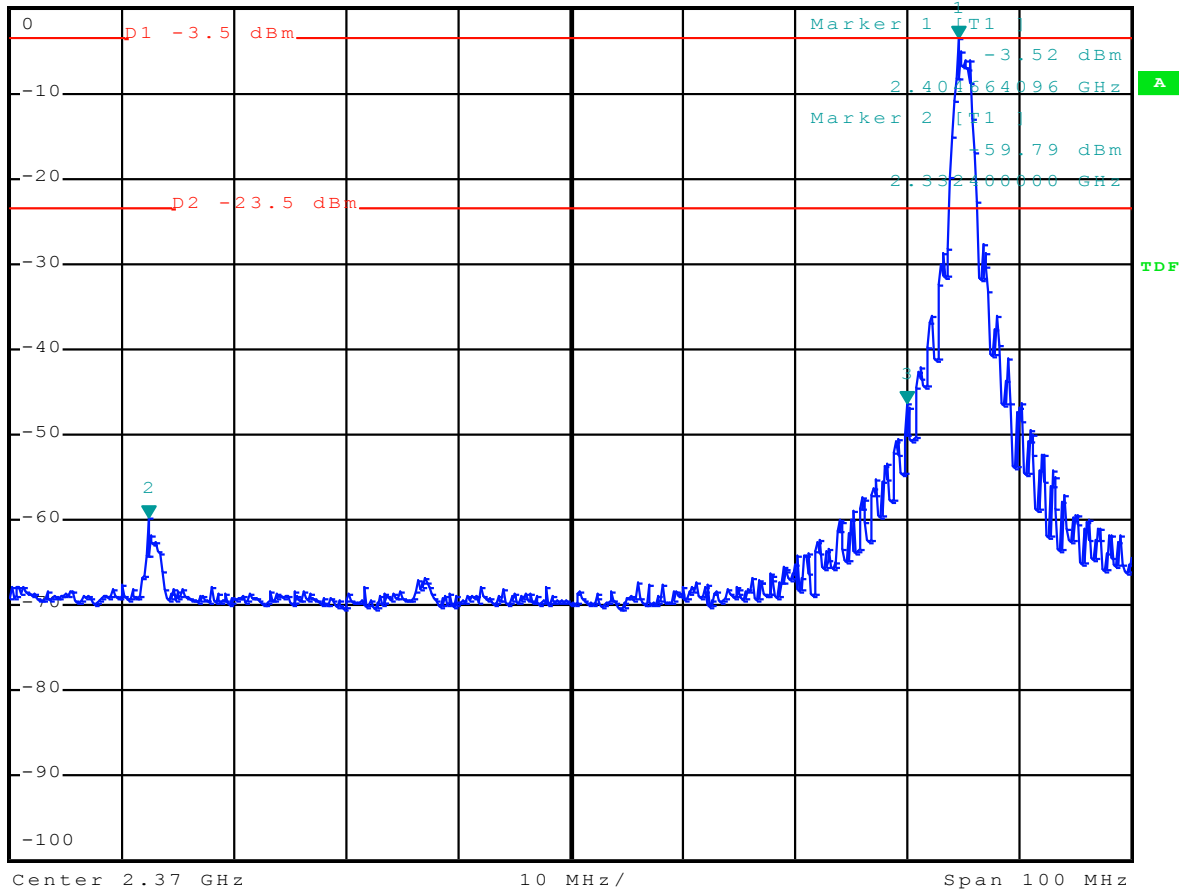
*VBW 300 kHz

*SWT 5 s

-46.42 dBm

2.400000000 GHz

1 PK
VIEW



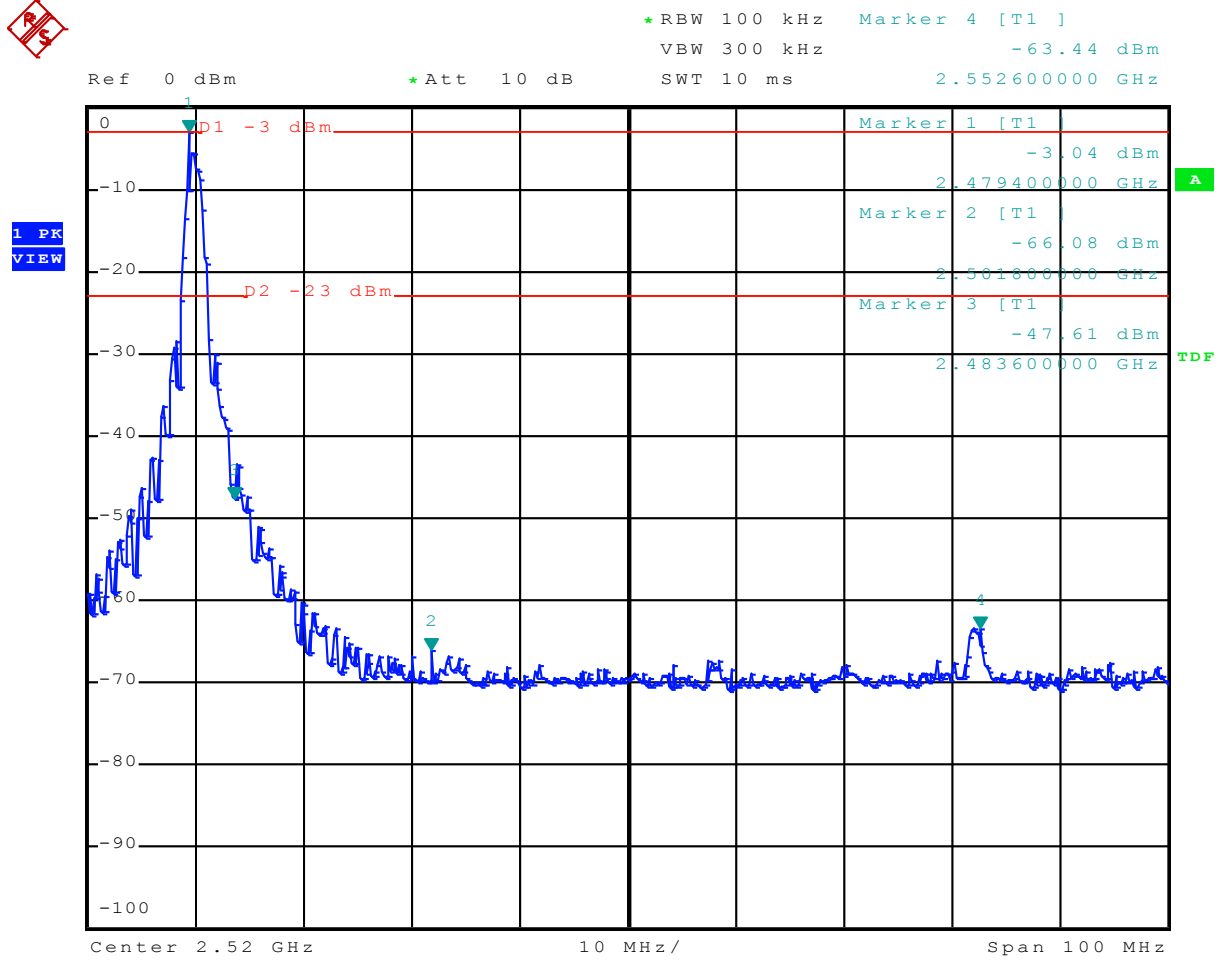
Date: 8.JUL.2011 09:30:25

Test Report No.:

11030302

Page 28 of 36

Figure 13: Band Edge Conducted Emission, Spectral Diagram, Mode C (2480MHz)



Date: 8.JUL.2011 11:07:40

Test Report No.:

11030302

Page 29 of 36

5.2.6 Radiated Spurious Emissions of Transmitter

RESULT: Pass

Date of testing: 2011-07-08

Frequency range: 30MHz - 25GHz

Requirements:

FCC 15.205, FCC 15.209 and FCC 15.247(d)

Radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a), must comply with the radiated emission limits specified in FCC 15.209(a).

Radiated emissions which fall outside the operation frequency band and outside restricted bands shall either meet the limit specified in FCC 15.209(a) or be attenuated at least 20dB below the power level in the 100kHz bandwidth within the band that contains the highest level of the desired power (the less severe limit applies).

Test procedure:

ANSI C63.4-2009 and KDB Publication No. 558074: Measurement of Digital Transmission Systems Operating under Section 15.247.

The EUT was placed on a nonconductive turntable 0.8m above the ground plane. Before final measurements of radiated emissions were performed, the EUT was scanned to determine its emission spectrum profile. The physical arrangement of the test system, the associated cabling and the EUT orientation (X, Y, Z) were varied in order to ensure that maximum emission amplitudes were attained.

The spectrum was examined from 30MHz to the 10th harmonic of the highest fundamental transmitter frequency (25GHz). Final radiated emission measurements were made at 3m distance.

At each frequency where a spurious emission was found, the EUT was rotated 360° and the antenna was raised and lowered from 1 to 4m in order to determine the emission's maximum level. Measurements were taken using both horizontal and vertical antenna polarizations.

The highest emission amplitudes relative to the appropriate limit were recorded in this report. Field strength values of radiated emissions at frequencies not listed in the tables are more than 20 dB below the applicable limit.

Test Report No.:

11030302

Page 30 of 36

Table 7: Radiated Emission, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations

Freq. [MHz]	Antenna Orientation	Reading QP [dB μ V]	Factor [dB(1/m)]	Level QP [dB μ V/m]	Limit [dB μ V/m]	Margin QP [dB]
48.925	Vertical	7.1	9.9	17.0	40.0	23.0
52.525	Vertical	7.6	8.6	16.2	40.0	23.8
65.175	Vertical	14.1	7.1	21.2	40.0	18.8
72.350	Vertical	9.3	7.8	17.1	40.0	22.9
149.50	Vertical	6.2	13.7	19.9	43.5	23.6
152.25	Vertical	6.3	13.6	19.9	43.5	23.6
259.50	Vertical	5.6	16.7	22.3	46.0	23.7

- Note:
- Level QP = Reading QP + Factor
 - Tested in Mode A (2405MHz), Mode B (2440MHz) and Mode C (2480MHz), highest values noted.
 - Quasi Peak detector used with a bandwidth of 120 kHz

Table 8: Radiated Emission, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2405MHz)

Freq. [MHz]	Antenna Orientation	Reading AV [dBμV]	Factor [dB(1/m)]	Level AV [dBμV/m]	Limit [dBμV/m]	Margin AV [dB]
4872	Vertical	-5.8	35.0	29.2	54	24.8
7215	Vertical	-9.0	38.0	29.0	54	25.0
7626	Horizontal	-7.0	38.0	31.0	54	23.0
9620	Horizontal	-9.0	38.4	29.4	54	24.6
11010	Horizontal	-3.8	39.0	35.2	54	18.8
11424	Vertical	-2.9	39.0	36.1	54	17.9
11586	Horizontal	-3.3	39.3	36.0	54	18.0
12025	Horizontal	-5.4	39.4	34.0	54	20.0
13776	Horizontal	-2.2	41.3	39.1	54	14.9
14430	Vertical	-2.5	41.3	38.8	54	15.2
14760	Vertical	-1.3	41.3	40.0	54	14.0
16835	Vertical	3.5	39.8	43.3	54	10.7
17172	Vertical	3.5	41.7	45.2	54	8.8
17532	Horizontal	1.9	41.7	43.6	54	10.4
17760	Vertical	-2.6	46.9	44.3	54	9.7
17940	Vertical	-11.7	46.9	35.2	54	18.8

Note: - Level AV = Reading AV + Factor
- Average detector used with a bandwidth of 1 MHz.

Table 9: Radiated Emission, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2405MHz)

Freq. [MHz]	Antenna Orientation	Reading PK [dBμV]	Factor [dB(1/m)]	Level PK [dBμV/m]	Limit [dBμV/m]	Margin PK [dB]
4872	Vertical	11.3	35.0	46.3	74	27.7
7215	Vertical	3.0	38.0	41.0	74	33.0
7626	Horizontal	4.5	38.0	42.5	74	31.5
9620	Horizontal	3.1	38.4	41.5	74	32.5
11010	Horizontal	8.5	39.0	47.5	74	26.5
11424	Vertical	9.0	39.0	48.0	74	26.0
11586	Horizontal	8.9	39.3	48.2	74	25.8
12025	Horizontal	4.9	39.4	44.3	74	29.7
13776	Horizontal	10.3	41.3	51.6	74	22.4
14430	Vertical	8.7	41.3	50.0	74	24.0
14760	Horizontal	10.5	41.3	51.8	74	22.2
16835	Vertical	14.5	39.8	54.3	74	19.7
17172	Horizontal	15.5	41.7	57.2	74	16.8
17532	Horizontal	14.9	41.7	56.6	74	17.4
17940	Vertical	10.4	46.9	57.3	74	27.7

Note: - Level PK = Reading PK + Factor
- Peak detector used with a bandwidth of 1 MHz

Table 10: Radiated Emission, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz)

Freq. [MHz]	Antenna Orientation	Reading AV [dBµV]	Factor [dB(1/m)]	Level AV [dBµV/m]	Limit [dBµV/m]	Margin AV [dB]
4872	Horizontal	1.5	36.2	37.7	54	16.3
7320	Horizontal	-9.6	39.3	29.7	54	24.3
9760	Horizontal	-9.2	40.0	30.8	54	23.2
11244	Horizontal	-3.7	39.0	35.3	54	18.7
11316	Horizontal	-3.8	39.0	35.2	54	18.8
11406	Horizontal	-2.3	39.0	36.7	54	17.3
11532	Vertical	-4.1	39.3	35.2	54	18.8
11604	Vertical	-2.6	39.3	36.7	54	17.3
12200	Vertical	-6.7	39.4	32.7	54	21.3
12550	Horizontal	-4.2	39.4	35.2	54	18.8
14640	Horizontal	-0.8	41.3	40.5	54	13.5
14832	Horizontal	-0.8	41.3	40.5	54	13.5
17040	Vertical	3.4	41.7	45.1	54	8.9
17136	Vertical	3.2	36.2	44.9	54	29.1
19745	Vertical	-3.8	40.2	36.4	54	17.6

Note: - Level AV = Reading AV + Factor
- Average detector used with a bandwidth of 1 MHz

Table 11: Radiated Emission, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz)

Freq. [MHz]	Antenna Orientation	Reading PK [dBµV]	Factor [dB(1/m)]	Level PK [dBµV/m]	Limit [dBµV/m]	Margin PK [dB]
4872	Horizontal	25.1	36.2	61.3	74	12.7
7320	Vertical	2.3	39.3	41.6	74	32.4
9760	Horizontal	2.9	40.0	42.9	74	31.1
11244	Horizontal	9.7	39.0	48.7	74	25.3
11316	Vertical	9.7	39.0	48.7	74	25.3
11406	Horizontal	9.7	39.0	48.7	74	25.3
11532	Vertical	10.2	39.3	49.5	74	24.5
11604	Horizontal	9.7	39.3	49.0	74	25.0
12200	Horizontal	5.3	39.4	44.7	74	29.3
12550	Vertical	7.1	39.4	46.5	74	27.5
14640	Horizontal	9.1	41.3	50.4	74	23.6
14832	Horizontal	11.6	41.3	52.9	74	21.1
17040	Vertical	16.5	41.7	58.2	74	15.8
17136	Vertical	15.7	36.2	57.4	74	16.6
19745	Vertical	1.0	40.2	41.2	74	32.8

Note: - Level PK = Reading PK + Factor
- Peak detector used with a bandwidth of 1 MHz

Test Report No.:

11030302

Page 33 of 36

Table 12: Radiated Emission, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz)

Freq. [MHz]	Antenna Orientation	Reading AV [dBµV]	Factor [dB(1/m)]	Level AV [dBµV/m]	Limit [dBµV/m]	Margin AV [dB]
4962	Vertical	-1.5	36.2	34.7	54	19.3
11442	Horizontal	-2.7	39.3	36.6	54	17.4
11694	Horizontal	-2.8	39.3	36.5	54	17.5
13944	Horizontal	-2.2	41.4	39.2	54	14.8
14136	Horizontal	-1.1	41.4	40.3	54	13.7
14244	Vertical	-1.1	41.4	40.3	54	13.7
14880	Horizontal	2.7	37.9	40.6	54	13.4
15792	Horizontal	2.0	38.2	40.2	54	13.8
16620	Horizontal	0.4	39.8	40.2	54	13.8
16788	Vertical	0.4	39.8	40.2	54	13.8
17076	Vertical	3.9	41.4	45.3	54	8.7
17196	Vertical	3.5	41.7	45.2	54	8.8
17244	Vertical	3.5	41.7	45.2	54	8.8
17360	Vertical	2.8	41.7	44.5	54	9.5
17736	Vertical	0.1	44.6	44.7	54	9.3
17976	Vertical	-1.6	46.9	45.3	54	8.7

Note: - Level AV = Reading AV + Factor
- Average detector used with a bandwidth of 1 MHz

Table 13: Radiated Emission, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz)

Freq. [MHz]	Antenna Orientation	Reading PK [dBµV]	Factor [dB(1/m)]	Level PK [dBµV/m]	Limit [dBµV/m]	Margin PK [dB]
4962	Horizontal	21.6	36.2	57.8	74	16.2
11442	Vertical	9.8	39.3	49.1	74	24.9
11694	Vertical	9.7	39.3	49.0	74	25.0
13944	Horizontal	11.1	41.4	52.5	74	21.5
14136	Horizontal	10.6	41.4	52.0	74	22.0
14244	Horizontal	11.2	41.4	52.6	74	21.4
14880	Vertical	14.3	37.9	52.2	74	21.8
15792	Vertical	13.5	38.2	51.7	74	22.3
16620	Vertical	15	39.8	54.8	74	19.2
16788	Vertical	15.9	39.8	55.7	74	18.3
17076	Horizontal	15.7	41.4	57.1	74	16.9
17196	Vertical	15.8	41.7	57.5	74	16.5
17244	Vertical	15.4	41.7	57.1	74	16.9
17360	Vertical	13.9	41.7	55.6	74	18.4
17736	Horizontal	11.1	44.6	55.7	74	18.3
17976	Vertical	11.3	46.9	58.2	74	15.8

Note: - Level PK = Reading PK + Factor
- Peak detector used with a bandwidth of 1 MHz

Test Report No.:

11030302

Page 34 of 36

5.3 AC Power Line Conducted Measurements

5.3.1 AC Power Line Conducted Emission of Transmitter

RESULT: Pass

Date of testing: 2011-04-05

Frequency range: 0.15 - 30MHz
Kind of test site: Shielded Room

Requirements:

FCC 15.207

The AC power line conducted emission on any frequency within the band 150kHz to 30MHz shall not exceed the limits specified in FCC 15.207.

Test procedure:

ANSI C63.4-2009

The EUT was placed on a wooden table raised 80cm above the reference ground plane. A vertical conducting plane of the screened room was located 40cm to the rear of the EUT. The EUT was connected to a Line Impedance Stabilization Network (LISN).

The physical arrangement of the test system and associated cabling was varied to determine the effect on the EUT's emissions in amplitude and frequency in order to ensure that maximum emission amplitudes were attained.

The measurements were performed with the measuring receiver operating in the CISPR quasi-peak and average detection modes. The analyzer's 6dB bandwidth was set to 9kHz.

Conducted emissions at frequencies not listed in the table are more than 20 dB below the applicable limit.

Test Report No.:

11030302

Page 35 of 36

Table 14: AC Power Line Conducted Emission, Quasi Peak and Average Data, 0.15 - 30MHz, Phase N (N) and L1 (L)

Freq. [MHz]	Reading L1 QP [dBµV]	Reading L1 AV [dBµV]	Level QP N(L2) [dBµV]	Level AV N(L2) [dBµV]	Limit QP [dBµV]	Limit AV [dBµV]	Margin QP [dB]	Margin AV [dB]
0.154	41.6	25.8	48.0	28.9	66.0	56.0	18.0	27.1
0.206	47.7	30.3	40.5	24.1	63.6	56.6	15.9	26.3
0.262	34.2	18.4	52.0	31.9	61.4	51.4	9.4	19.5
0.378	42.0	25.2	45.8	29.2	58.3	48.3	12.5	19.1
0.486	40.7	26.4	39.3	21.9	56.5	46.5	15.8	20.1
0.542	27.4	15.6	38.7	21.6	56.0	46.0	17.3	24.4
0.606	37.6	25.7	32.3	16.2	56.0	46.0	18.4	20.3
0.654	31.6	18.5	38.1	24.9	56.0	46.0	17.9	21.1

Note: - Level QP = Reading QP + Factor, Level AV = Reading AV + Factor
 - Tested in Mode A (2405MHz), Mode B (2440MHz) and Mode C (2480MHz), worst case values noted.
 - Margin is given in the worst case situation (L1 compared to N).

6. List of Tables

Table 1: List of Test and Measurement Equipment	5
Table 2: Emission Measurement Uncertainty	6
Table 3: Interfaces present on the EUT	8
Table 4: Conducted Output Power	14
Table 5: 6dB Bandwidth	17
Table 6: Peak Power Spectral Density.....	24
Table 7: Radiated Emission, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations	30
Table 8: Radiated Emission, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2405MHz)	31
Table 9: Radiated Emission, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2405MHz)	31
Table 10: Radiated Emission, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz)	32
Table 11: Radiated Emission, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz)	32
Table 12: Radiated Emission, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz)	33
Table 13: Radiated Emission, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz)	33
Table 14: AC Power Line Conducted Emission, Quasi Peak and Average Data, 0.15 - 30MHz, Phase N (N) and L1 (L).....	35

7. List of Figures

Figure 1: Test Setup Diagram	10
Figure 2: Peak power plots,.....	15
Figure 3: 6dB Bandwidth, Mode A (2405MHz).....	17
Figure 4: 6dB Bandwidth, Mode B (2440MHz).....	18
Figure 5: 6dB Bandwidth, Mode C (2480MHz)	18
Figure 6: Conducted Spurious Emission, 30MHz - 25GHz, Mode A (2405MHz)	20
Figure 7: Conducted Spurious Emission, 30MHz - 25GHz, Mode B (2440MHz)	21
Figure 8: Conducted Spurious Emission, 30MHz - 25GHz, Mode C (2480MHz)	22
Figure 9: Power Spectral Density, Mode A (2405MHz)	24
Figure 10: Power Spectral Density, Mode B (2440MHz)	25
Figure 11: Power Spectral Density, Mode C (2480MHz)	25
Figure 12: Band Edge Conducted Emission, Spectral Diagram, Mode A (2405MHz).....	27
Figure 13: Band Edge Conducted Emission, Spectral Diagram, Mode C (2480MHz).....	28