Report On

FCC and Industry Canada Testing of the
Frontier Silicon Ltd Tuscany FS2230 Module
In accordance with FCC CFR 47 Part 15C, Industry Canada RSS-210 and Industry Canada RSS-GEN

COMMERCIAL-IN-CONFIDENCE

FCC ID: YYX-HA-FS2230-F

Document 75923564 Report 04 Issue 2 August 2013

Product Service

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REPORT ON

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Frontier Silicon Ltd Tuscany FS2230 Module
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Document 75923564 Report 04 Issue 2

August 2013

PREPARED FOR

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PREPARED BY

Natalie Bennett
Senior Administrator (Technical)

APPROVED BY

Simon Bennett
Authorised Signatory

DATED 28 August 2013

This report has been up-issued to Issue 2 to correct typographical errors.

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC CFR 47 Part 15C, Industry Canada RSS-210 and Industry Canada RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

Test Engineer(s);

G Lawler M Russell

UKAS TESTING 0141

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CONTENTS

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SECTION 1

REPORT SUMMARY

FCC and Industry Canada Testing of the
Frontier Silicon Ltd Tuscany FS2230 Module
In accordance with FCC CFR 47 Part 15C, Industry Canada RSS-210 and Industry Canada RSS-GEN

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the FCC and Industry Canada Testing of the Frontier Silicon Ltd Tuscany FS2230 Module to the requirements of FCC CFR 47 Part 15C, Industry Canada RSS-210 and Industry Canada RSS-GEN.

Objective	To perform FCC and Industry Canada Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Frontier Silicon Ltd
Model Number(s)	FS2230
Serial Number(s)	RAD104661 RAD104669
Number of Samples Tested	2
Test Specification/Issue/Date	FCC CFR 47 Part 15C (2012) Industry Canada RSS-210 (2012) Industry Canada RSS-GEN (2010)
Incoming Release Date	Application Form 20 August 2013
Disposal Reference Number Date	Held Pending Disposal Not Applicable Not Applicable
Order Number Date	FS130751 18 July 2013
Start of Test	12 August 2013
Finish of Test	14 August 2013
Name of Engineer(s)	G Lawler M Russell
Related Document(s)	ANSI C63.10: 2009

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1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC CFR 47 Part 15C, Industry Canada RSS-210 and Industry Canada RSS-GEN is shown below.

Section	Spec Clause			Test Description	Result	Comments/Base Standard
	Pt 15C	RSS-210	RSS-GEN			
Bluetooth						
2.1	15.207	-	7.2.4	AC Line Conducted Emissions	Pass	
2.2	15.247 (b)(3)	A8.4 (2)	-	Maximum Peak Conducted Output Power	Pass	
2.3	15.247 (a)(1)	A8.1 (a)(b)	-	Frequency Hopping Systems - 20 dB Bandwidth and Channel Separation	Pass	
2.4	15.247 (a)(1)(iii)	A8.1 (d)	-	Frequency Hopping Systems - Dwell Time & No of Hopping Channels	Pass	
2.5	15.247 (b)(4)	A8.4 (4)	-	EIRP Peak Power	Pass	
2.6	15.247 (d)	A8.5	2.2	Spurious and Band Edge Emissions	Pass	

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1.3 APPLICATION FORM

EQUIPMENT DESCRIPTION		
Model Name/Number	Tuscany FS2230	
Part Number	HA-FS2230-aaaaaa (where aaaaaa indicates variant number)	
FCC ID (if applicable)		YYX-HA-FS2230-F
Industry Canada ID (if applicable)		
Technical Description (Please provide a brief description of the intended use of the equipment)		The Tuscany FS2230 module is an integrated wireless speaker module from Frontier Silicon. Tuscany FS2230 Module's flexible design enables production of audio devices featuring a combination of high-performance Bluetooth®, dual-band DAB/DAB+, FM with RDS and USB docking at low-cost. The module provides all interfaces necessary for a fully functional Bluetooth wireless speaker system with docking capability and digital /analogue radio, needing only power supply, display, keypad, audio amplifier and speakers to complete a product.

Types of Modulations used by the Equipment	
☒	FHSS
☐	Other forms of modulation
In case of FHSS Modulation	
In case of non-Adaptive Frequency Hopping equipment:	
	Number of Hopping Frequencies: 79
In case of Adaptive Frequency Hopping Equipment:	
	Maximum number of Hopping Frequencies: 79
	Minimum number of Hopping Frequencies: 20
Dwell Time: DH1: 405 µsec, DH3: 1.655 msec, DH5: 2.905 msec	
Minimum Channel Occupation Time: DH1: 405 µsec, DH3: 1.655 msec, DH5: 2.905 msec	
Adaptive / non-adaptive equipment:	
☐	non-adaptive Equipment
☐	adaptive Equipment without the possibility to switch to a non-adaptive mode
☒	adaptive Equipment which can also operate in a non-adaptive mode
In case of adaptive equipment:	
The Channel Occupancy Time implemented by the equipment: 405 µs to 2.905 ms	
☐	The equipment has implemented an LBT based DAA mechanism
In case of equipment using modulation different from FHSS:	
☐	The equipment is Frame Based equipment
☐	The equipment is Load Based equipment
☐	The equipment can switch dynamically between Frame Based and Load Based equipment
The CCA time implemented by the equipment: µs	
The value q as referred to in clause 4.3.2.5.2.2.2	
☒	The equipment has implemented an non-LBT based DAA mechanism
☐	The equipment can operate in more than one adaptive mode

Product Service

In case of non-adaptive Equipment:		
The maximum RF Output Power (e.i.r.p.): 12 dBm		
The maximum (corresponding) Duty Cycle: 77 %		
Equipment with dynamic behaviour, that behaviour is described here. (e.g. the different combinations of duty cycle and corresponding power levels to be declared):		
N/A		
The worst case operational mode for each of the following tests:		
RF Output Power: DH1/DH3/DH5		
Power Spectral Density: DH1/DH3/DH5		
Duty cycle, Tx-Sequence, Tx-gap: DH5		
Dwell time, Minimum Frequency Occupation & Hopping Sequence (only for FHSS equipment): DH1		
Hopping Frequency Separation (only for FHSS equipment): DH1/DH3/DH5		
Medium Utilisation: DH5		
Adaptivity & Receiver Blocking: DH5		
Occupied Channel Bandwidth: 3DH1/3DH3/3DH5		
Transmitter unwanted emissions in the OOB domain: DH5		
Transmitter unwanted emissions in the spurious domain: DH5		
Receiver spurious emissions: N/A		
The different transmit operating modes (tick all that apply):		
☒	Operating mode 1: Single Antenna Equipment	
	☒	Equipment with only 1 antenna
	☐	Equipment with 2 diversity antennas but only 1 antenna active at any moment in time
	☐	Smart Antenna Systems with 2 or more antennas, but operating in a (legacy) mode where only 1 antenna is used. (e.g. IEEE 802.11™ [i.3] legacy mode in smart antenna systems)
☐	Operating mode 2: Smart Antenna Systems - Multiple Antennas without beam forming	
	☐	Single spatial stream / Standard throughput / (e.g. IEEE 802.11™ [i.3] legacy mode)
	☐	High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 1
	☐	High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 2
NOTE: Add more lines if more channel bandwidths are supported.		
☐	Operating mode 3: Smart Antenna Systems - Multiple Antennas with beam forming	
	☐	Single spatial stream / Standard throughput (e.g. IEEE 802.11™ [i.3] legacy mode)
	☐	High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 1
	☐	High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 2
NOTE: Add more lines if more channel bandwidths are supported.		
In case of Smart Antenna Systems:		
The number of Receive chains: N/A		
The number of Transmit chains: N/A		
☐	symmetrical power distribution	
☐	asymmetrical power distribution	
In case of beam forming, the maximum beam forming gain:		
NOTE: Beam forming gain does not include the basic gain of a single antenna.		

Product Service

Operating Frequency Range(s) of the equipment:	
Operating Frequency Range 1: 2402 MHz to 2480 MHz	BT for EU, FCC and Industry Canada (e.g Bluetooth for EU)
Operating Frequency Range 2: MHz to MHz	(e.g WLAN for EU)
Operating Frequency Range 3: MHz to MHz	(e.g Bluetooth for FCC and/or Industry Canada)
Operating Frequency Range 4: MHz to MHz	(e.g WLAN for FCC and/or Industry Canada)
NOTE: Add more lines if more Frequency Ranges are supported.	
Occupied Channel Bandwidth(s):	
Occupied Channel Bandwidth1: 0.8 MHz to 1.2 MHz	
Occupied Channel Bandwidth2: MHz to MHz	
NOTE: Add more lines if more channel bandwidths are supported.	
Type of Equipment (stand-alone, combined, plug-in radio device, etc.):	
☐ Stand-alone	
☐ Combined Equipment (Equipment where the radio part is fully integrated within another type of equipment)	
☒ Plug-in radio device (Equipment intended for a variety of host systems)	
☐ Other	
The extreme operating conditions that apply to the equipment:	
Operating temperature range: -20 °C to +70 °C	
Operating voltage range: 2.97 V, 1.14 V V to 3.6 V, 1.26 V	☐ AC ☒ DC
Details provided are for the:	
☒ stand-alone equipment	
☒ combined (or host) equipment	
☒ test jig	

Product Service

The intended combination(s) of the radio equipment power settings and one or more antenna assemblies and their corresponding e.i.r.p levels:			
Antenna Type:			
☒ Integral Antenna			
Antenna Gain: 4 dBi			
If applicable, additional beamforming gain (excluding basic antenna gain): dB			
☒ Temporary RF connector provided			
☐ No temporary RF connector provided			
☐ Dedicated Antennas (equipment with antenna connector)			
☐ Single power level with corresponding antenna(s)			
☐ Multiple power settings and corresponding antenna(s)			
Number of different Power Levels:			
Power Level 1: dBm			
Power Level 2: dBm			
Power Level 3: dBm			
Power Level 4: dBm			
NOTE 1: Add more lines in case the equipment has more power levels.			
NOTE 2: These power levels are conducted power levels (at antenna connector).			
For each of the Power Levels, provide the intended antenna assemblies, their corresponding gains (G) and the resulting e.i.r.p. levels also taking into account the beamforming gain (Y) if applicable			
Power Level 1: 8 dBm			
Number of antenna assemblies provided for this power level:			
Assembly #	**Gain (dBi)**	**e.i.r.p (dBm)**	**Part number or model number**
1	**4**	**12**	**On Board PIFA**
2			
3			
4			
NOTE: Add more rows in case more antenna assemblies are supported for this power level.			
Power Level 2: dBm			
Number of antenna assemblies provided for this power level:			
Assembly #	**Gain (dBi)**	**e.i.r.p (dBm)**	**Part number or model number**
1			
2			
3			
4			
NOTE: Add more rows in case more antenna assemblies are supported for this power level.			
Power Level 3: dBm			
Number of antenna assemblies provided for this power level:			
Assembly #	**Gain (dBi)**	**e.i.r.p (dBm)**	**Part number or model number**
1			
2			
3			
4			
NOTE: Add more rows in case more antenna assemblies are supported for this power level.			

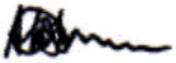
Product Service

The nominal voltages of the stand-alone radio equipment or the nominal voltages of the combined (host) equipment or test jig in case of plug-in devices:	
Details provided are for the: ☒ stand-alone equipment	
☒ combined (or host) equipment	
☒ test jig	
Supply Voltage ☐ AC mains State AC voltage	
☒ State DC voltage 3.3 V and 1.2 V	
In case of DC, indicate the type of power source	
☐ Internal Power Supply	
☒ External Power Supply or AC/DC adapter	
☐ Battery	
☐ Other:	
Describe the test modes available which can facilitate testing:	
CSR BTCLI Software	
The equipment type (e.g. Bluetooth®, IEEE 802.11™ [i.3], proprietary, etc.):	
Bluetooth	
Combination for testing (see clause 5.1.3.3 of EN 300 328 V1.8.1)	
From all combinations of conducted power settings and intended antenna assembly(ies) specified in clause 3.1 m), specify the combination resulting in the highest e.i.r.p. for the radio equipment. Unless otherwise specified in EN 300 328, this power setting is to be used for testing against the requirements of EN 300 328. In case there is more than one such conducted power setting resulting in the same (highest) e.i.r.p. level, the highest power setting is to be used for testing. See also EN 300 328, clause 5.1.3.3.	
Highest overall e.i.r.p. value: 14 dBm	
Corresponding Antenna assembly gain: 4 dBi	Antenna Assembly #: 1
Corresponding conducted power setting: 8 dBm	Listed as Power Setting #: Maximum
(also the power level to be used for testing) Maximum	
Additional information provided by the applicant	
Modulation	
ITU Class(es) of emission: 840KF9W / IM2G9W / IM2G9W	
Can the transmitter operate unmodulated? ☒ Yes ☐ No	
Duty Cycle	
The transmitter is intended for:	
☐ Continuous duty	
☐ Intermittent duty	
☒ Continuous operation possible for testing purposes	
About the UUT	
☐ The equipment submitted are representative production models	
☒ If not, the equipment submitted are pre-production models ?	
☒ If pre-production equipment are submitted, the final production equipment will be identical in all respects with the equipment tested	
☐ If not, supply full details	
☐ The equipment submitted is CE marked	
☐ In addition to the CE mark, the Class-II identifier (Alert Sign) is affixed.	

Product Service

	Additional items and/or supporting equipment provided
☐	Spare batteries (e.g. for portable equipment)
☐	Battery charging device
☒	External Power Supply or AC/DC adapter
☒	Test Jig or interface box
☒	RF test fixture (for equipment with integrated antennas)
☒	Host System
	Manufacturer
	Model
	Model Name
☐	Combined equipment
	Manufacturer
	Model
	Model Name
☐	User Manual
☐	Technical documentation (Handbook and circuit diagrams)

I hereby declare that I am entitled to sign on behalf of the applicant and that the information supplied is correct and complete.

Signature:  Name: Abdul Wahed Dewan

Position held: Principal RF Engineer Date: 20 August 2013

Product Service

1.4 PRODUCT INFORMATION

1.4.1 Technical Description

The Equipment Under Test (EUT) was a Frontier Silicon Ltd Tuscany FS2230 Module. A full technical description can be found in the manufacturer's documentation.

1.5 TEST CONDITIONS

For all tests the EUT was set up in accordance with the relevant test standard and to represent typical operating conditions. Tests were applied with the EUT situated in a shielded enclosure.

The EUT was powered from a 3.3 V DC and 1.2 V DC supply.

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

1.6 DEVIATIONS FROM THE STANDARD

No deviations from the applicable test standards were made during testing.

1.7 MODIFICATION RECORD

Modification 0 - No modifications were made to the test sample during testing.

Product Service

SECTION 2

TEST DETAILS

FCC and Industry Canada Testing of the
Frontier Silicon Ltd Tuscany FS2230 Module
In accordance with FCC CFR 47 Part 15C, Industry Canada RSS-210 and Industry Canada RSS-GEN

2.1 AC LINE CONDUCTED EMISSIONS

2.1.1 Specification Reference

FCC CFR 47 Part 15C, Clause 15.207
Industry Canada RSS-GEN, Clause 7.2.4

2.1.2 Equipment Under Test and Modification State

Tuscany FS2230 Module S/N: RAD104661 - Modification State 0

2.1.3 Date of Test

14 August 2013

2.1.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.5 Test Procedure

The EUT is set up on a test table 800mm above a horizontal ground plane. A vertical ground plane is also required and is placed 400mm from the EUT. Where a EUT is floor standing it will be stood on but insulated from the ground plane by up to 12mm.

The EUT is powered through a Line Impedance Stabilisation Network (LISN) which is bonded to the ground plane. The EUT is located so that the distance between the EUT and the LISN is no less than 800mm. Where possible the cable between the mains input of the EUT and the LISN is 1m. Where this is not possible the cable is non inductively bundled with the bundle not exceeding 400mm in length.

A preliminary profile of the Conducted Emissions is obtained over the frequency range 150kHz to 30MHz. Any points of interest are noted for formal measurements.

During formal measurements, the measuring receiver is tuned to the emission of interest where Quasi – Peak and Average measurements are performed in a 9kHz Video and Resolution Bandwidth.

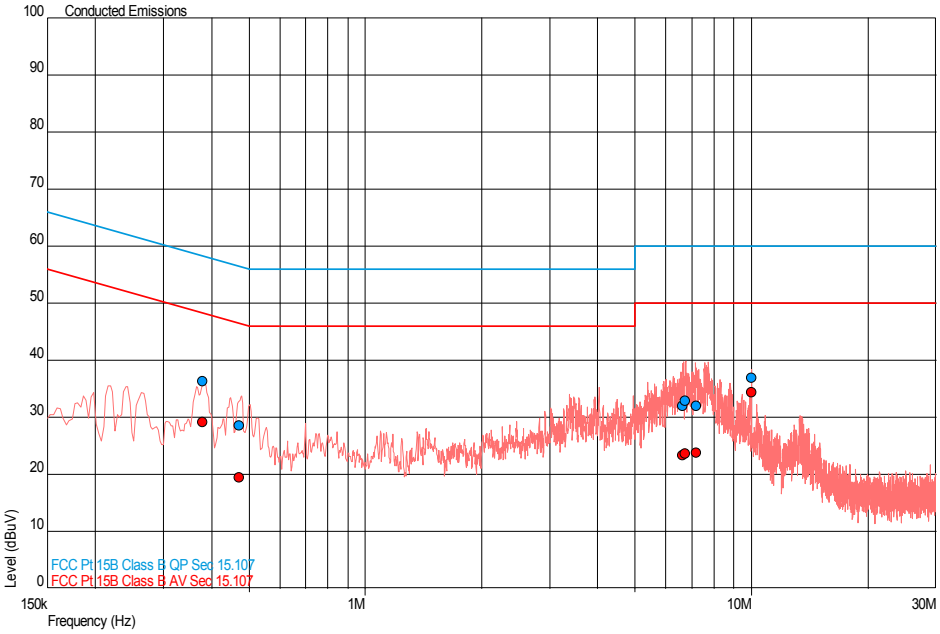
2.1.6 Environmental Conditions

Ambient Temperature	24.1°C
Relative Humidity	42.0%

Product Service

2.1.7 Test Results

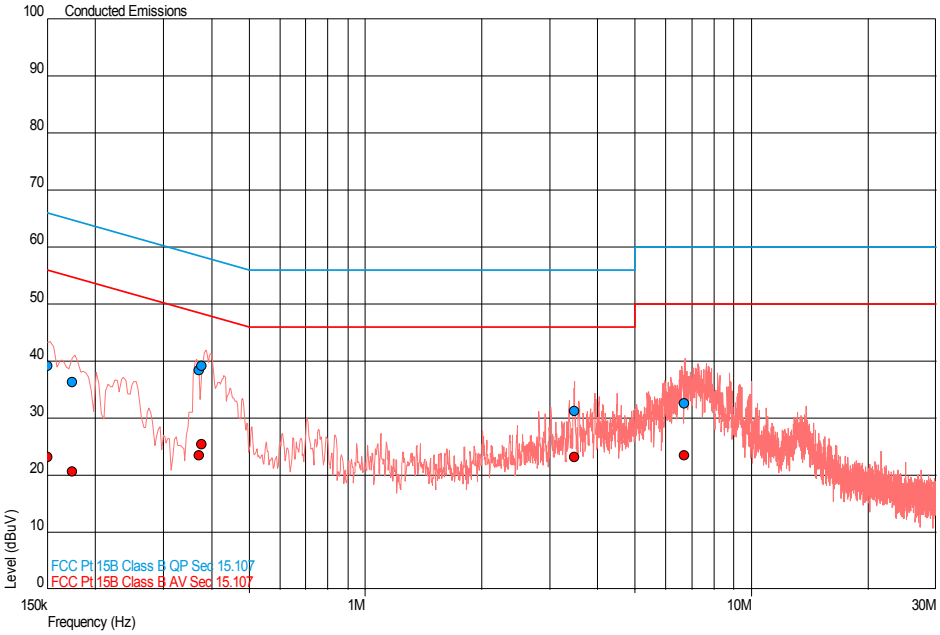
Live Line



Frequency (MHz)	QP Level (dBµV)	QP Limit (dBµV)	QP Margin (dBµV)	AV Level (dBµV)	AV Limit (dBµV)	AV Margin (dBµV)
0.379	36.4	58.3	-21.9	29.2	48.3	-19.1
0.470	28.5	56.5	-28.0	19.5	46.5	-27.0
6.626	32.1	60.0	-27.9	23.3	50.0	-26.7
6.739	32.9	60.0	-27.1	23.7	50.0	-26.3
7.172	32.1	60.0	-27.9	23.8	50.0	-26.2
10.000	36.9	60.0	-23.1	34.4	50.0	-15.6

Product Service

Neutral Line



Frequency (MHz)	QP Level (dBµV)	QP Limit (dBµV)	QP Margin (dBµV)	AV Level (dBµV)	AV Limit (dBµV)	AV Margin (dBµV)
0.150	39.1	66.0	-26.9	23.3	56.0	-32.7
0.174	36.3	64.8	-28.5	20.7	54.8	-34.1
0.371	38.4	58.5	-20.1	23.5	48.5	-25.0
0.376	39.1	58.4	-19.2	25.5	48.4	-22.9
3.472	31.2	56.0	-24.8	23.2	46.0	-22.8
6.711	32.6	60.0	-27.4	23.6	50.0	-26.4

2.2 MAXIMUM PEAK CONDUCTED OUTPUT POWER

2.2.1 Specification Reference

FCC CFR 47 Part 15C, Clause 15.247 (b)(3)
Industry Canada RSS-210, Clause A8.4 (2)

2.2.2 Equipment Under Test and Modification State

Tuscany FS2230 Module S/N: RAD104669 - Modification State 0

2.2.3 Date of Test

13 August 2013

2.2.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.5 Test Procedure

The EUT was transmitted at maximum power via a cable to a Peak Power Meter. The path loss between the EUT and the power sensor was measured and entered as an offset. Measurements were conducted on the bottom, middle and top transmission frequencies on the worst case modulation schemes.

2.2.6 Environmental Conditions

Ambient Temperature	22.6°C
Relative Humidity	51.0%

Product Service

2.2.7 Test Results

3.3 V DC and 1.2 V DC Supply

Packet Type	Maximum Peak Conducted Output Power					
	dBm			mW		
	2402 MHz	2441 MHz	2480 MHz	2402 MHz	2441 MHz	2480 MHz
DH1	5.93	7.95	8.70	3.92	6.23	7.40
DH3	5.87	10.00	10.23	3.86	10.00	10.53
DH5	5.85	9.95	8.61	3.84	9.88	7.27

Limit Clause

The maximum peak conducted output power of the intentional radiator shall not exceed the following:

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non overlapping hopping channels, and all frequency hopping systems in the 5725-5850MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

2.3 FREQUENCY HOPPING SYSTEMS - 20 dB BANDWIDTH AND CHANNEL SEPARATION

2.3.1 Specification Reference

FCC CFR 47 Part 15C, Clause 15.247 (a)(1)
Industry Canada RSS-210, Clause A8.1 (a)(b)

2.3.2 Equipment Under Test and Modification State

Tuscany FS2230 Module S/N: RAD104669 - Modification State 0

2.3.3 Date of Test

13 August 2013

2.3.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.3.5 Test Procedure

20 dB Bandwidth

The EUT was transmitted at maximum power via a cable to the Spectrum Analyser. The Analyser settings were adjusted to display the resultant trace on screen. The peak point of the trace was measured and the markers positioned to give the -20dBc points of the displayed spectrum.

Channel Separation

The EUT was transmitted at maximum power into a Spectrum Analyser. The trace was set to Max Hold to store several adjacent channels on screen. Using the marker delta function, the markers were positioned to show the separation between adjacent channels.

2.3.6 Environmental Conditions

Ambient Temperature	22.6°C
Relative Humidity	51.0%

Product Service

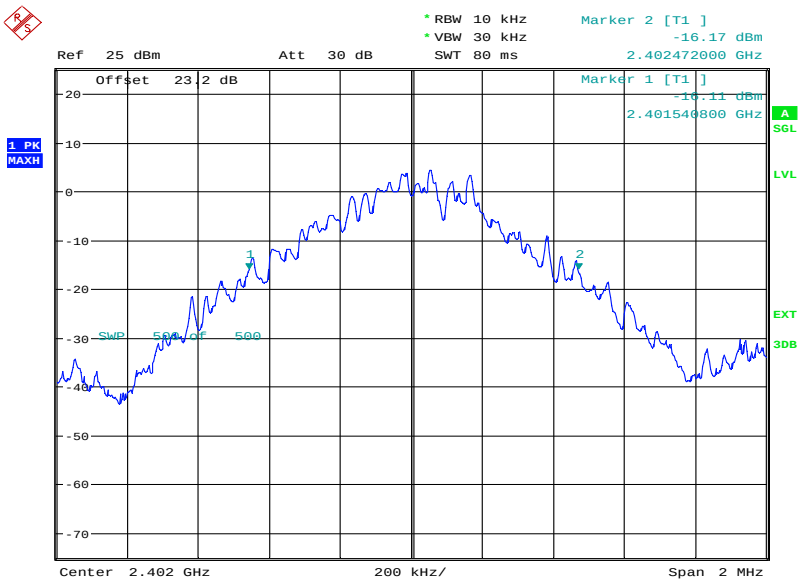
2.3.7 Test Results

3.3 V DC and 1.2 V DC Supply

20dB Bandwidth

2402 MHz

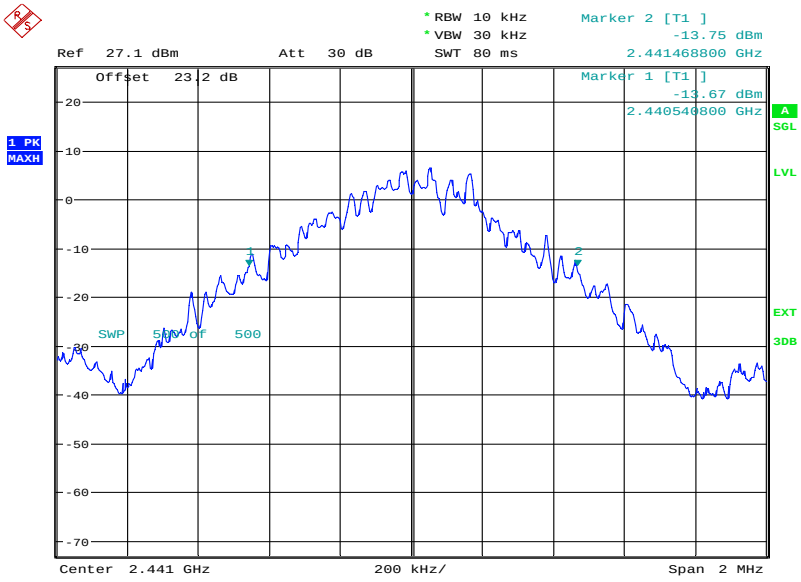
Data Rate (Mbps)	20dB Bandwidth (kHz)
DH5	931.2



Date: 13.AUG.2013 10:03:06

2441 MHz

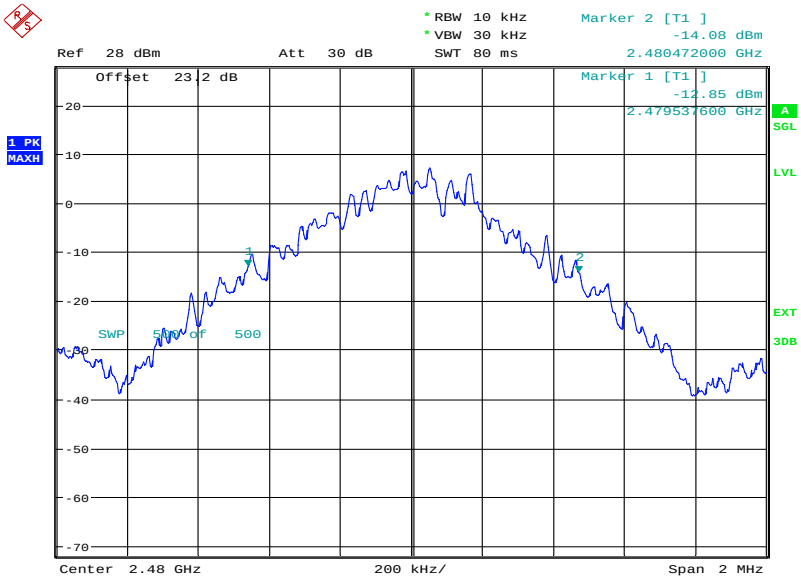
Data Rate (Mbps)	20dB Bandwidth (kHz)
DH5	928.0



Date: 13.AUG.2013 12:00:49

2480 MHz

Data Rate (Mbps)	20dB Bandwidth (kHz)
DH5	934.4



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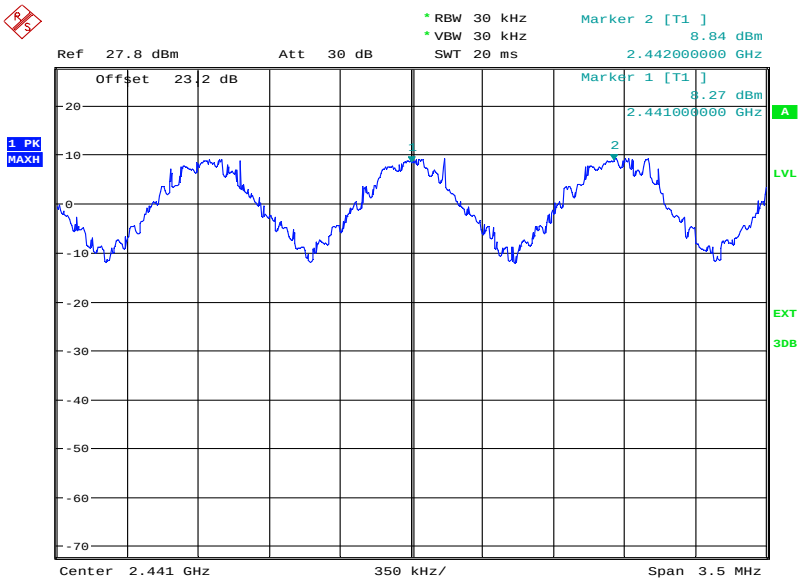
Limit Clause

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

Channel Separation

Channel Separation: 1 MHz



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Limit Clause

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively, frequency hopping systems operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 0.125 W.

The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Product Service

2.4 FREQUENCY HOPPING SYSTEMS – CHANNEL DWELL TIME AND NUMBER OF HOPPING CHANNELS

2.4.1 Specification Reference

FCC CFR 47 Part 15C, Clause 15.247 (a)(1)(iii)
Industry Canada RSS-210, Clause A8.1 (d)

2.4.2 Equipment Under Test and Modification State

Tuscany FS2230 Module S/N: RAD104669 - Modification State 0

2.4.3 Date of Test

13 August 2013

2.4.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.4.5 Test Procedure

DH1

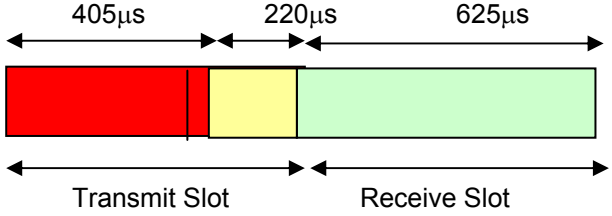
The Bluetooth system hops at a rate of 1600 times per second. Thus, this equates to 1600 timeslots in 1 second.

The DH1 data rate operates on a Transmit on 1 timeslot and Receive on 1 timeslot basis. Thus, in 1 second, there are 800 Transmit timeslots and 800 Receive timeslots.

Thus:

$$1 \text{ Timeslot} = \frac{1}{1600} = 625\mu s$$

In 1 transmit timeslot, the transmit on time is only 405μs. 220μs is reserved as off time for the synthesizer to re-tune ready for the next transmit frequency. The following timeslot is a receive slot. This process continues assuming the data rate remains the same.



DH1 Timeslot Arrangement Showing One Complete Transmit and Receive Cycle

So, with 800 Tx and 800 Rx timelsots, the transmitter is on for 800 x 405μs = 0.324 seconds.

$$\therefore \quad \frac{\text{Total Tx Time On}}{\text{No of Channels}} = \frac{0.324}{80} = 4.05\text{ms}$$

So, in 32 seconds, the transmitter dwell time per channel is:

32 x 4.05ms = 0.1296 seconds

DH3

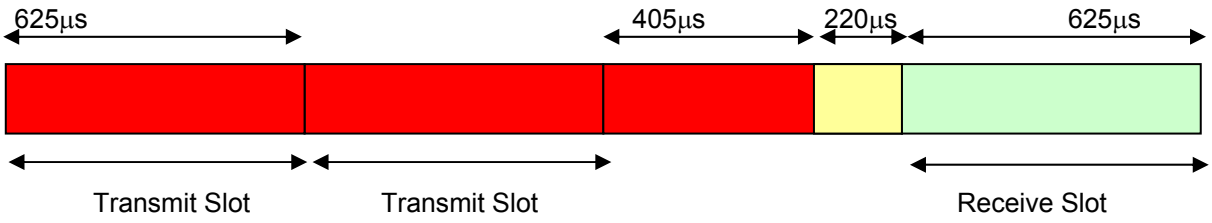
With data rate DH3, the data payload is higher and can use up to 3 timeslots. When more than one timeslot is used, the frequency does not hop and transmission is continuous on all 3 slots, (ie. no receive slot in-between the 3 transmit slots). The 220μs off time for synthesizer re-tuning at the end of a slot is only used on the final slot. Thus, for one cycle, there are 3 transmit timeslots. 2 are 625μs long and the final slot is transmitting for 405μs.

The DH3 data rate operates on a Transmit on 3 timeslots and Receives on 1 timeslot basis, (assuming maximum data payload). The frequency-hopping rate is the same. Thus, in 1 second, there are 1200 Transmit timeslots and 400 Receive timeslots.

Thus:

$$1\text{ Timeslot} = \frac{1}{1600} = 625\mu\text{s}$$

The first 2 Transmit timeslots are transmitting for the complete 625μs. In the third transmit slot, the transmit on time is only 405μs. 220μs is reserved as off time for the synthesizer to re-tune ready for the next transmit frequency. The following timeslot is a receive slot. This process continues assuming the data rate remains the same.



Product Service

DH3 Timeslot Arrangement Showing One Complete Transmit and Receive Cycle, (Maximum Payload)

Thus, the transmitter for one complete transmit and receive cycle would be on for:

Tx (2 x 625μs) + (1 x 405μs) = 1.655ms

So:

800 x 625μs = 0.5 seconds
400 x 405μs = 0.162 seconds

Thus: 0.5 + 0.162 = 0.662 seconds

$$\therefore \quad \frac{\text{Total Tx Time On}}{\text{No Of Channels}} = \frac{0.662}{80} = 8.275\text{ms}$$

So, in 32 seconds, the transmitter dwell time per channel is:

32 x 8.275ms = 0.2648 seconds

DH5

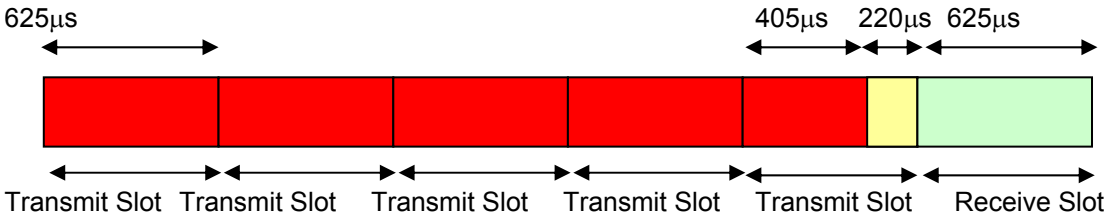
With data rate DH5, the data payload is higher and can use up to 5 timeslots. When more than one timeslot is used, the frequency does not hop and transmission is continuous on all 5 slots, (ie. no receive slot in-between the 5 transmit slots). The 220μs off time for synthesizer re-tuning at the end of a slot is only used on the final slot. Thus, for one cycle, there are 5 transmit timeslots. 4 are 625μs long and the final slot is transmitting for 405μs.

The DH5 data rate operates on a Transmit on 5 timeslots and Receives on 1 timeslot basis, (assuming maximum data payload). The frequency-hopping rate is the same. Thus, in 1 second, there are 1333.3 Transmit timeslots and 266.7 Receive timeslots.

Thus:

$$1\text{ Timeslot} = \frac{1}{1600} = 625\mu\text{s}$$

The first 4 Transmit timeslots are transmitting for the complete 625μs. In the fifth transmit slot, the transmit on time is only 405μs. 220μs is reserved as off time for the synthesizer to re-tune ready for the next transmit frequency. The following timeslot is a receive slot. This process continues assuming the data rate remains the same.



DH5 Timeslot Arrangement Showing One Complete Transmit and Receive Cycle, (Maximum Payload)

Thus, the transmitter for one complete transmit and receive cycle would be on for:

Tx (2 x 625μs) + (1 x 405μs) = 2.905ms

So:

1066.7 x 625μs = 0.666 seconds
266.7 x 405μs = 0.108 seconds

Thus: 0.666 + 0.108 = 0.774 seconds

$\therefore$ $\frac{\text{Total Tx Time On}}{\text{No Of Channels}} = \frac{0.774}{80} = 9.675\text{ms}$

So, in 32 seconds, the transmitter dwell time per channel is:

32 x 9.675ms = 0.31 seconds

2.4.6 Environmental Conditions

Ambient Temperature	22.6°C
Relative Humidity	51.0%

Product Service

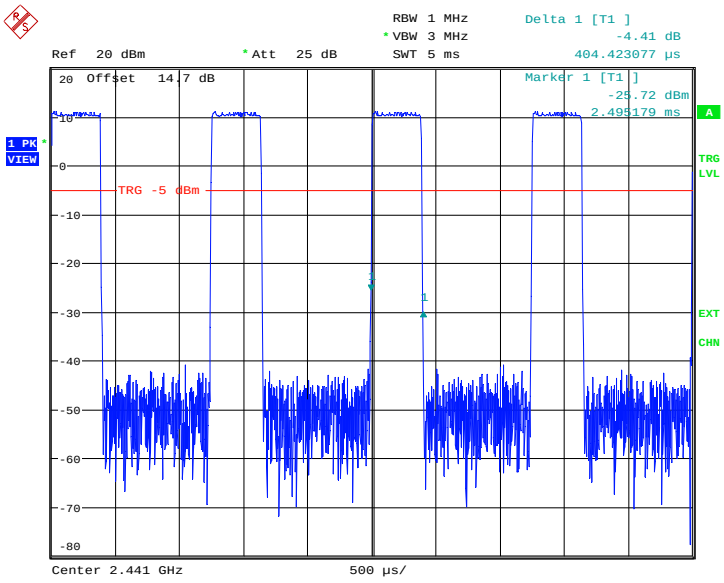
2.4.7 Test Results

3.3 V DC and 1.2 V DC Supply

Channel Dwell Time

DH1

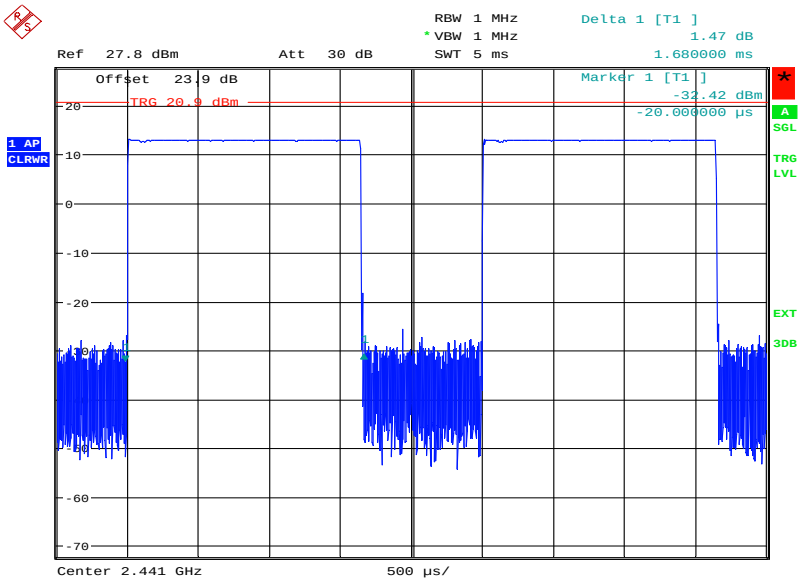
0.404 ms



Date: 20.AUG.2013 15:44:14

DH3

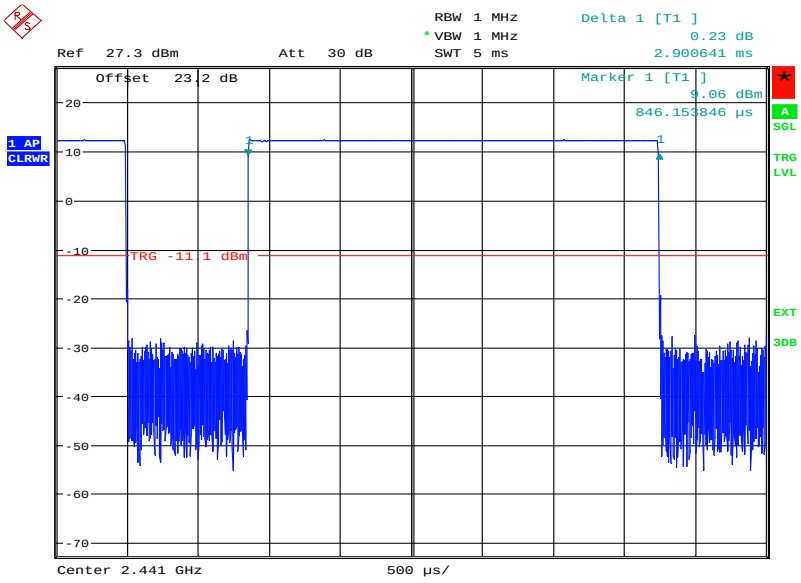
1.68 ms



Date: 13.AUG.2013 11:09:12

DH5

2.89 ms



Date: 13.AUG.2013 10:28:01

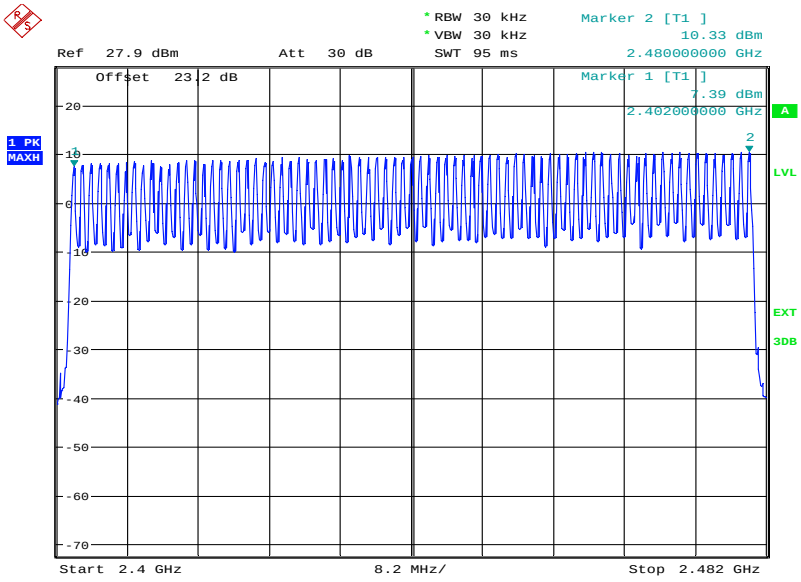
Limit

Product Service

Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Number of Hopping Channels

79 channels



Date: 13.AUG.2013 10:13:28

Limit

≥ 15 channels

2.5 EIRP PEAK POWER

2.5.1 Specification Reference

FCC CFR 47 Part 15C, Clause 15.247 (b)(4)
Industry Canada RSS-210, Clause A8.4 (4)

2.5.2 Equipment Under Test and Modification State

Tuscany FS2230 Module S/N: RAD104661 - Modification State 0

2.5.3 Date of Test

12 August 2013

2.5.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.5.5 Test Procedure

The EUT was placed on a non-conducting support in a semi-anechoic chamber. The measuring antenna was set at a 3meter distance from the EUT. The EUT was set to transit on maximum power on the worst case modulation scheme.

Initial investigations were carried out to ensure the EUT orientation produced the maximum emission level. The fundamental emission was then maximised by rotating the turntable through 360° and height searching the mask between 1 meter and 4 meters.

This exercise was repeated for bottom, middle and top frequencies in both horizontal and vertical polarisations.

The EUT was replaced with a calibrated antenna and the measurement results were substituted.

2.5.6 Environmental Conditions

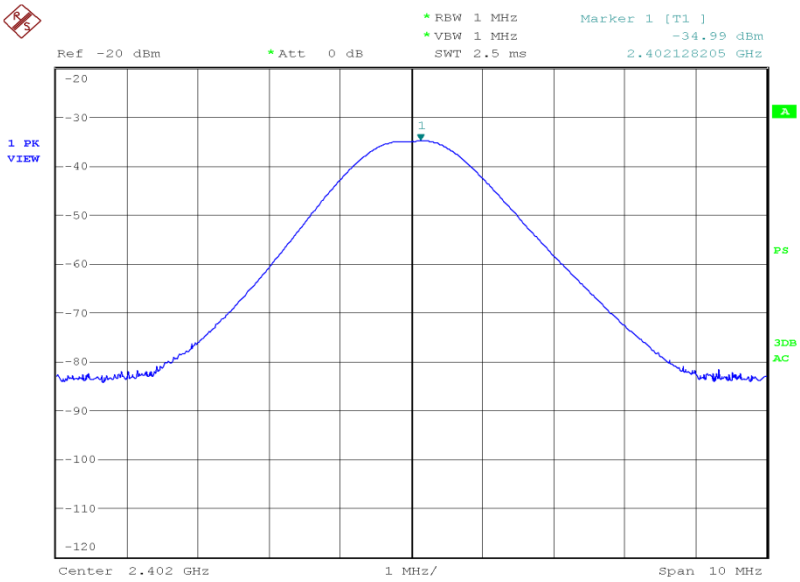
Ambient Temperature	24.2°C
Relative Humidity	33.0%

Product Service

2.5.7 Test Results

2402 MHz

EIRP (dBm)	EIRP (mW)
8.64	7.311

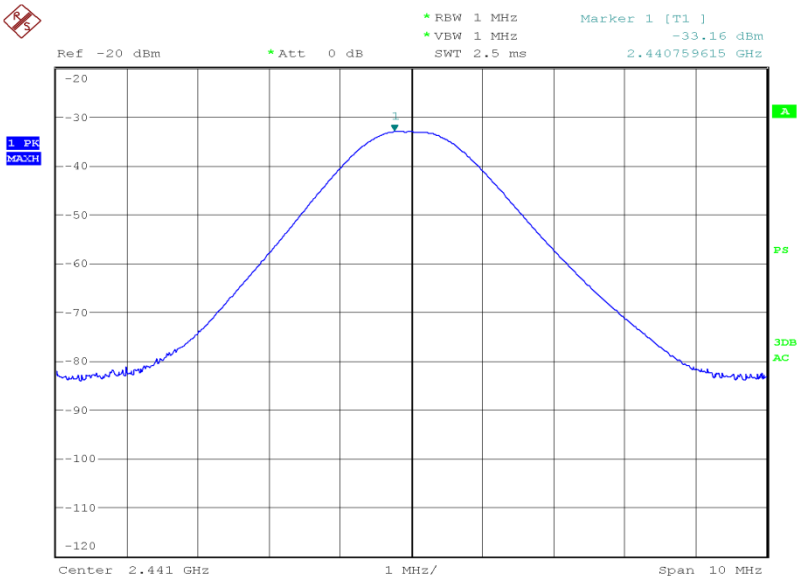


Date: 12.AUG.2013 18:12:10

Product Service

2441 MHz

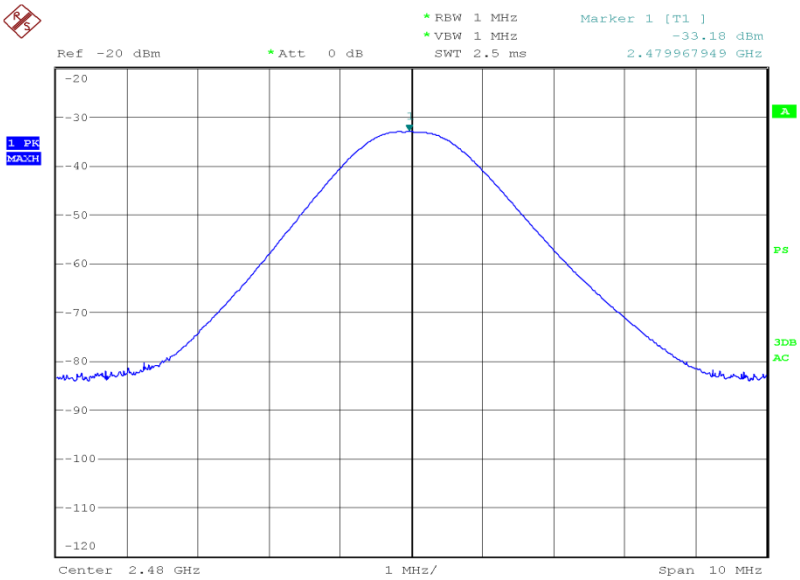
EIRP (dBm)	EIRP (mW)
10.95	12.445



Date: 12.AUG.2013 20:01:34

2480 MHz

EIRP (dBm)	EIRP (mW)
10.86	12.190



Date: 12.AUG.2013 20:12:25

Limit

Limit EIRP (dBm)	Limit EIRP (W)
36.0	4

2.6 SPURIOUS AND BAND EDGE EMISSIONS

2.6.1 Specification Reference

FCC CFR 47 Part 15C, Clause 15.247 (d)
Industry Canada RSS-210, Clause A8.5
Industry Canada RSS-GEN, Clause 2.2

2.6.2 Equipment Under Test and Modification State

Tuscany FS2230 Module S/N: RAD104661 - Modification State 0

2.6.3 Date of Test

12 August 2013 & 13 August 2013

2.6.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.6.5 Test Procedure

For conducted emissions, the EUT was set to operate at maximum power on the worst case data rate. The test was performed on the bottom, middle and top channels. The test was performed from 9 kHz to 25 GHz. Firstly, the power of each fundamental frequency was measured in 100 kHz bandwidth and this was used to show a -20 dBc limit line on the trace. The measurement path loss in each relevant frequency band was measured and entered a s a reference level offset.

For radiated emissions, the test method described above was also used. However, the measurement was performed from 30 MHz to 25 GHz and the path loss is incorporated as a transducer factor and entered into the spectrum analyser.

The band edge measurements were performed in accordance with ANSI C63.10, Clause 6.9.3. The results were analysed to ensure compliance with restricted bands. The EUT was set to the lowest and highest operating frequencies.

2.6.6 Environmental Conditions

Ambient Temperature	22.6 - 24.2°C
Relative Humidity	33.0 - 50.1%

Product Service

2.6.7 Test Results

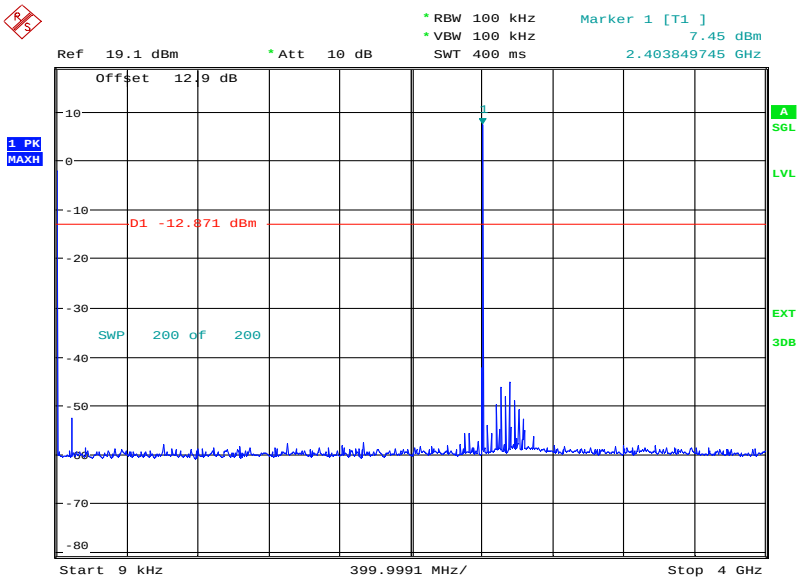
3.3 V DC and 1.2 V DC Supply

Spurious Conducted Emissions

2402 MHz

DH5

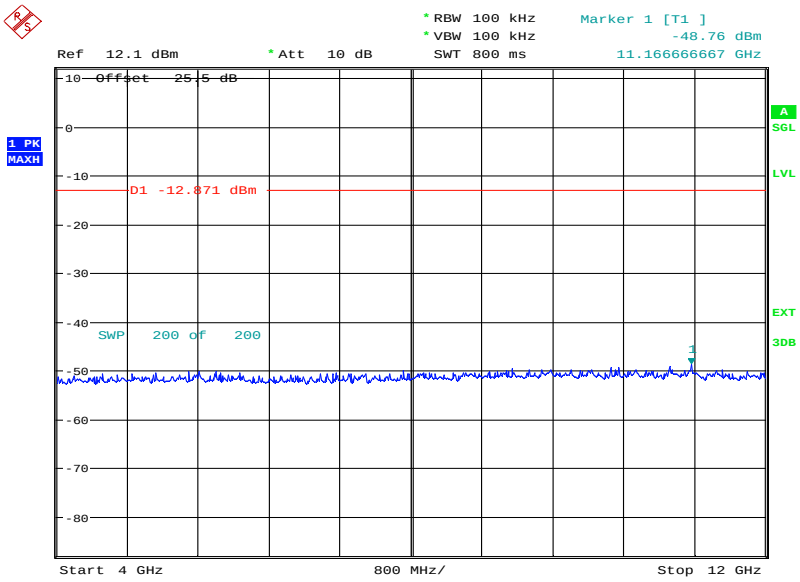
9 kHz to 4 GHz



Date: 13.AUG.2013 11:13:55

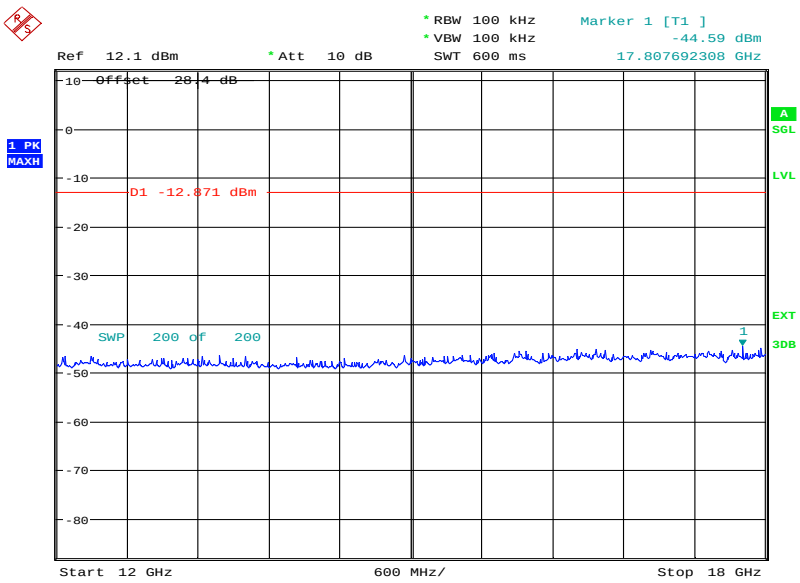
Product Service

4 GHz to 12 GHz



Date: 13.AUG.2013 11:36:48

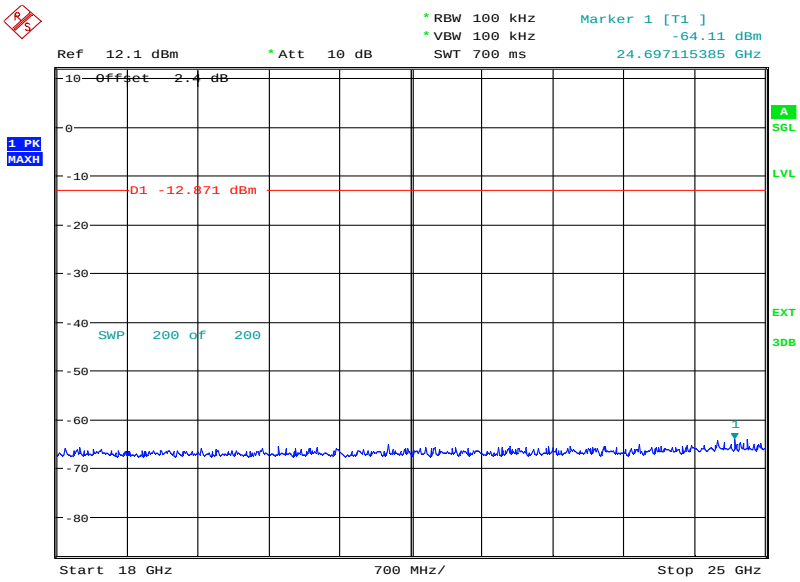
12 GHz to 18 GHz



Date: 13.AUG.2013 11:39:14

Product Service

18 GHz to 25 GHz

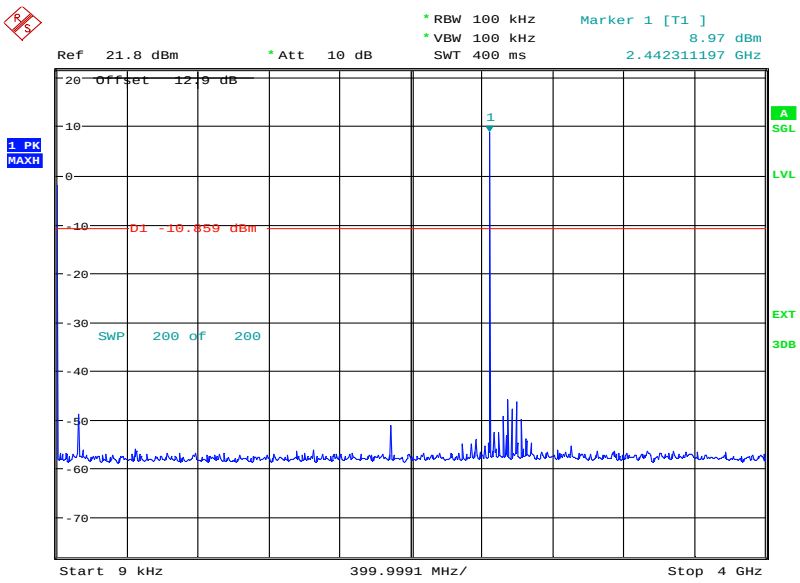


Date: 13.AUG.2013 11:52:45

Product Service

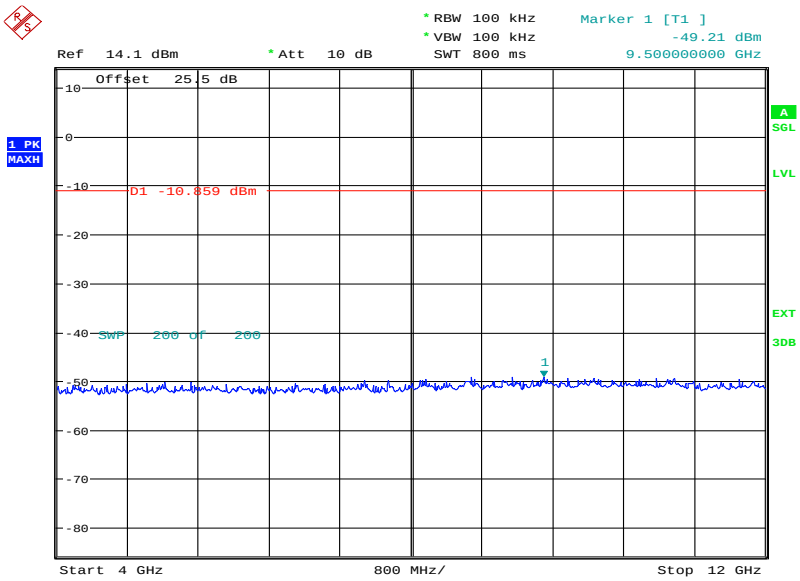
2441 MHz

9 kHz to 4 GHz



Date: 13.AUG.2013 11:17:22

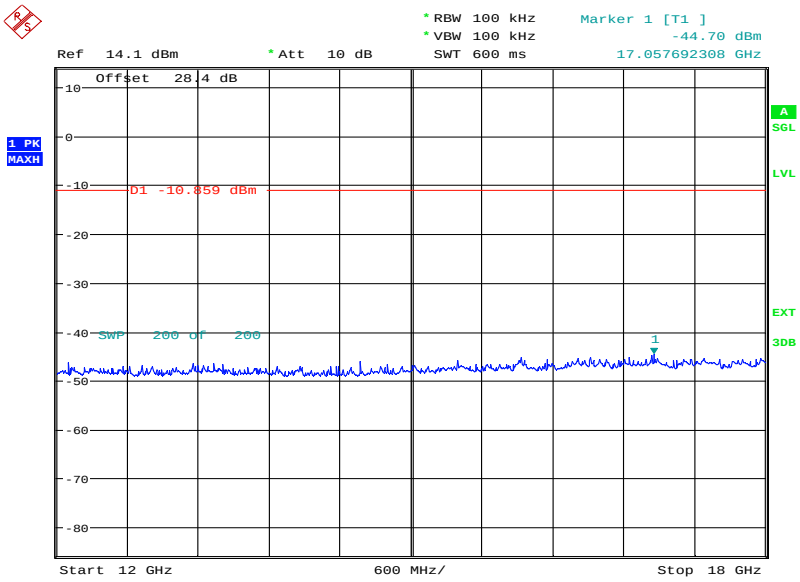
4 GHz to 12 GHz



Date: 13.AUG.2013 11:42:39

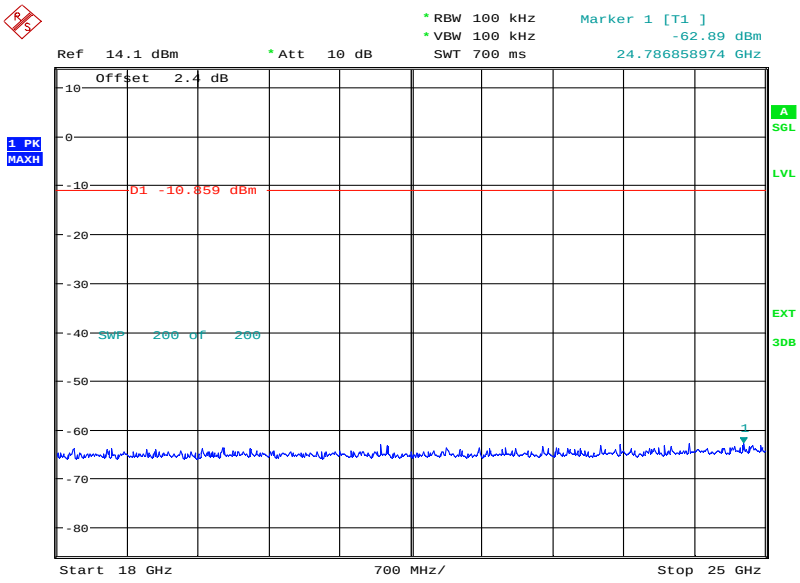
Product Service

12 GHz to 18 GHz



Date: 13.AUG.2013 11:45:09

18 GHz to 25 GHz

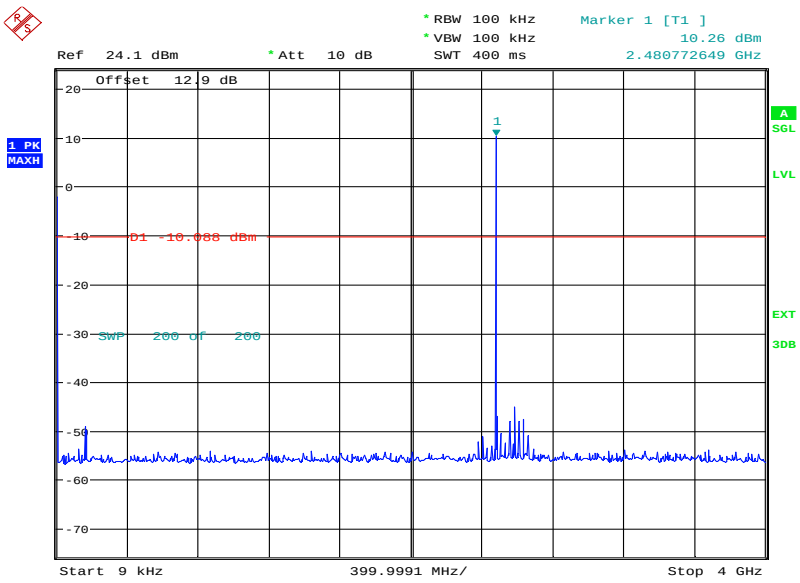


Date: 13.AUG.2013 11:49:39

Product Service

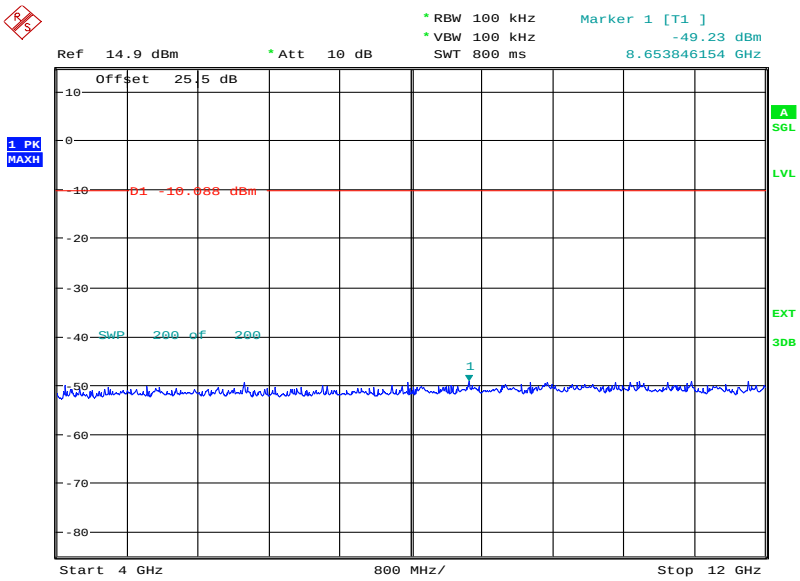
2480 MHz

9 kHz to 4 GHz



Date: 13.AUG.2013 11:19:59

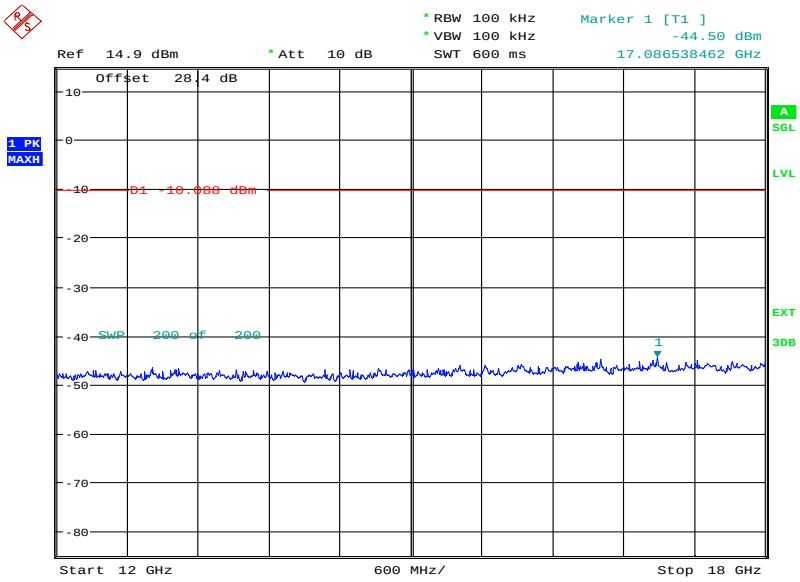
4 GHz to 12 GHz



Date: 13.AUG.2013 11:28:59

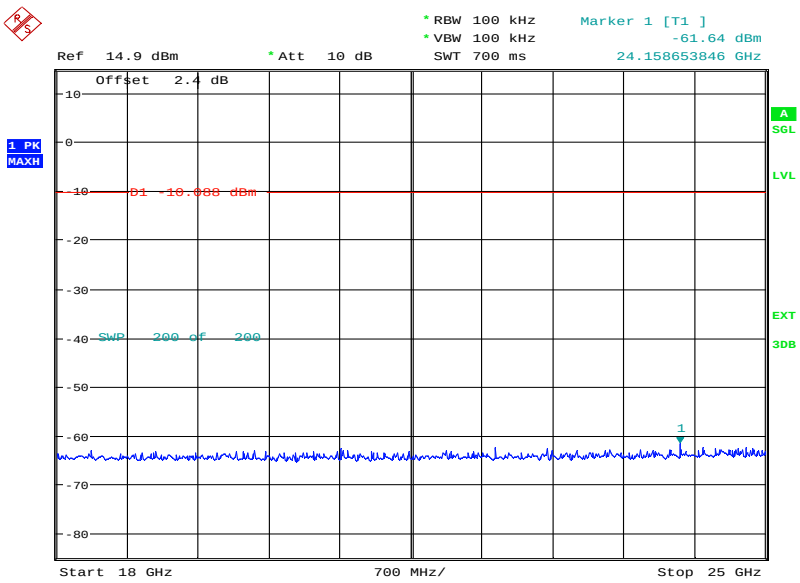
Product Service

12 GHz to 18 GHz



Date: 13.AUG.2013 11:33:23

18 GHz to 25 GHz



Date: 13.AUG.2013 11:55:47

Limit Clause

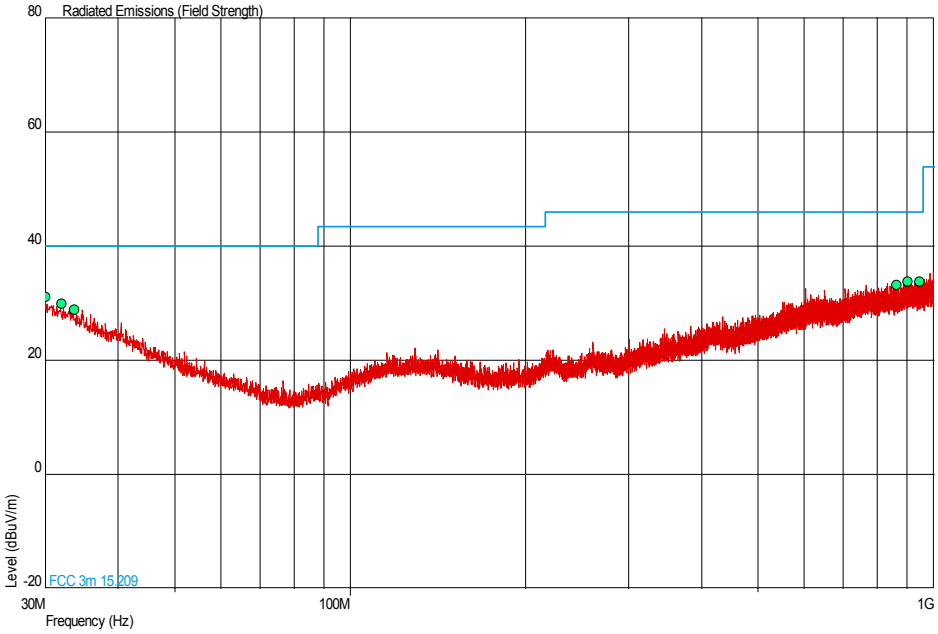
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the 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.

If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval the attenuation required shall be 30 dB instead of 20 dB.

Spurious Radiated Emissions

2402 MHz

30 MHz to 1 GHz

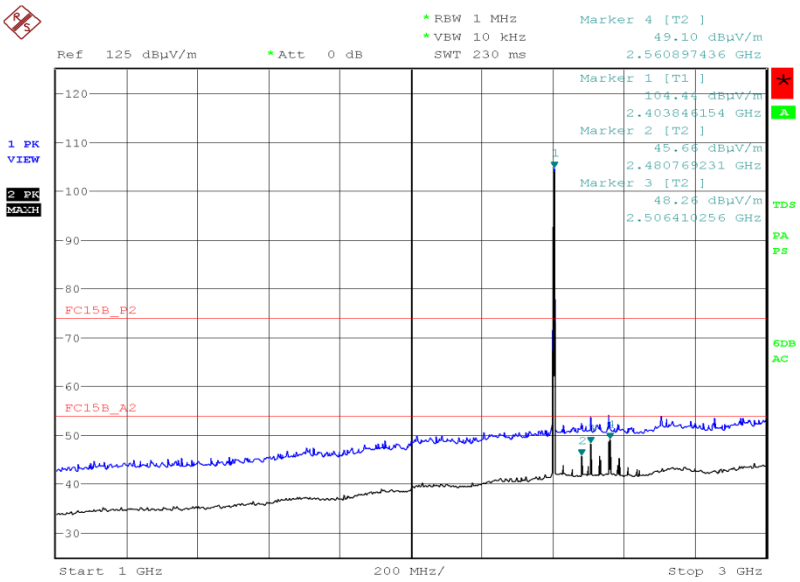


Frequency (MHz)	QP Level (dBµV/m)	QP Level (uV/m)	QP Limit (dBµV/m)	QP Limit (uV/m)	QP Margin (dBµV/m)	QP Margin (uV/m)	Angle (Deg)	Height (m)	Polarity
30.000	31.1	35.9	40.0	100	-8.9	64.1	90	1.00	Vertical
31.989	30.0	31.6	40.0	100	-10.0	68.4	90	1.00	Vertical
33.686	28.9	27.9	40.0	100	-11.1	72.1	90	1.00	Vertical
863.715	33.3	46.2	46.0	200	-12.7	153.8	0	1.00	Vertical
903.097	33.8	49.0	46.0	200	-12.2	151.0	90	1.00	Vertical
944.759	33.7	48.4	46.0	200	-12.3	151.6	90	1.00	Vertical

1GHz to 25GHz

Frequency (GHz)	Antenna Polarisation	Antenna Height (cm)	EUT Arc (degrees)	Final Peak (dBµV/m)	Final Average (dBµV/m)
4.804	Horizontal	122	222	54.91	46.66

1 GHz to 3 GHz



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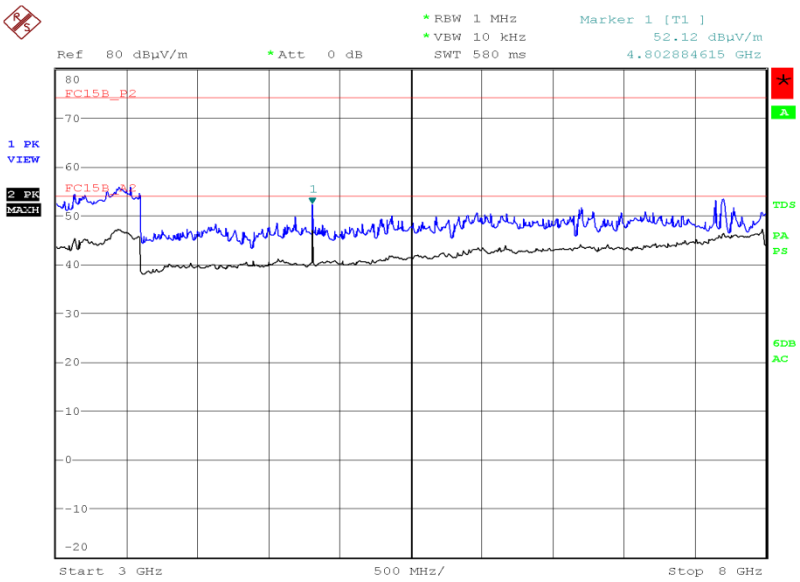
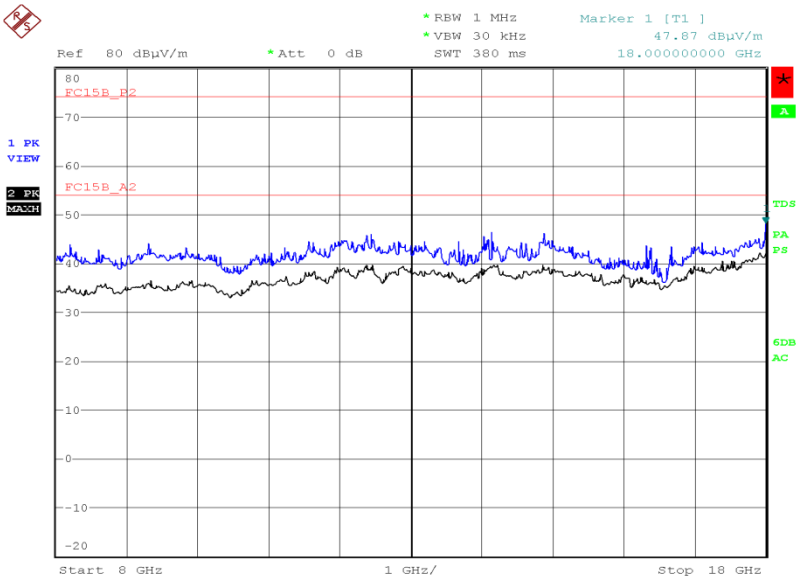
3 GHz to 8 GHz



Date: 12.AUG.2013 19:17:41

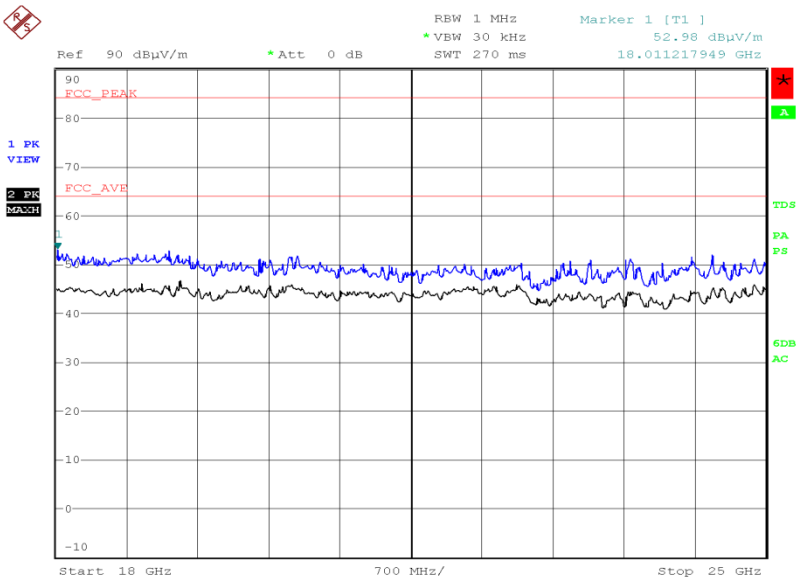
Product Service

8 GHz to 18 GHz



Date: 12.AUG.2013 21:59:17

18 GHz to 25 GHz

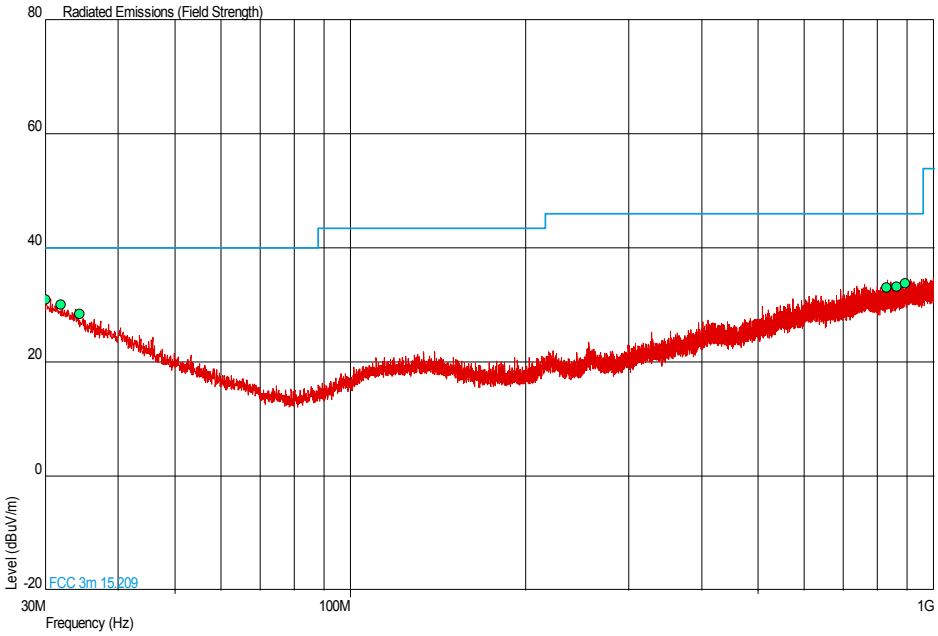


Date: 12.AUG.2013 23:10:40

Product Service

2441 MHz

30 MHz to 1 GHz



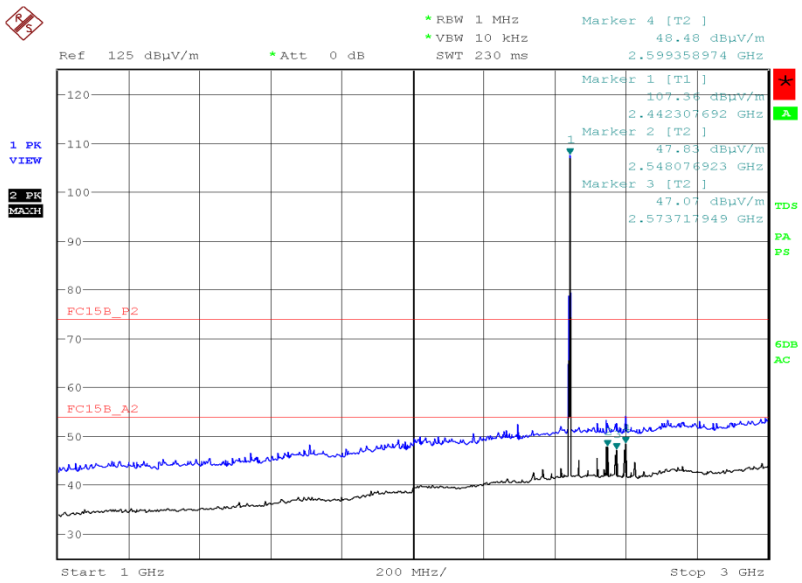
Frequency (MHz)	QP Level (dBµV/m)	QP Level (uV/m)	QP Limit (dBµV/m)	QP Limit (uV/m)	QP Margin (dBµV/m)	QP Margin (uV/m)	Angle (Deg)	Height (m)	Polarity
30.049	30.9	35.1	40.0	100	-9.1	64.9	45	1.00	Horizontal
31.892	30.0	31.6	40.0	100	-10.0	68.4	45	1.00	Horizontal
34.317	28.4	26.3	40.0	100	-11.6	73.7	45	1.00	Vertical
828.747	33.1	45.2	46.0	200	-12.9	154.8	45	1.00	Vertical
863.909	33.3	46.2	46.0	200	-12.7	153.8	45	1.00	Horizontal
892.282	33.8	49.0	46.0	200	-12.2	151.0	45	1.00	Vertical

Product Service

1GHz to 25GHz

Frequency (GHz)	Antenna Polarisation	Antenna Height (cm)	EUT Arc (degrees)	Final Peak (dBµV/m)	Final Average (dBµV/m)
4.884	Horizontal	122	217	56.39	48.10

1 GHz to 3 GHz



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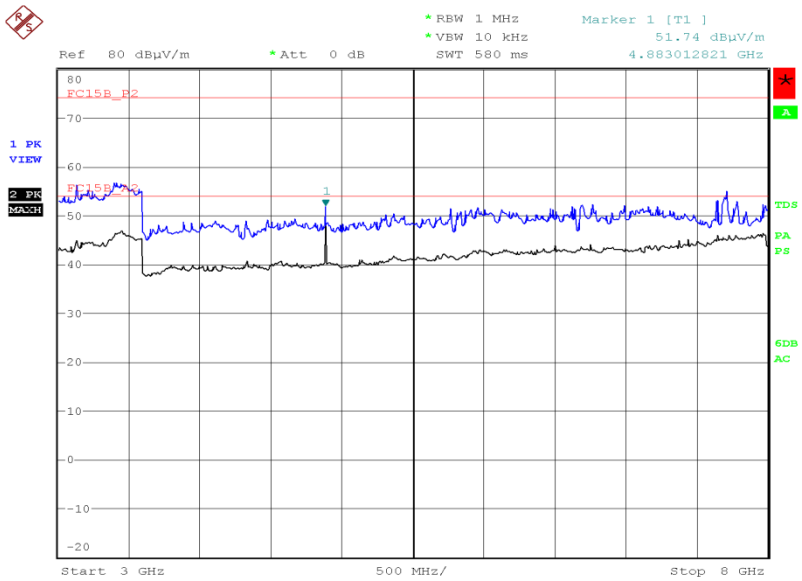
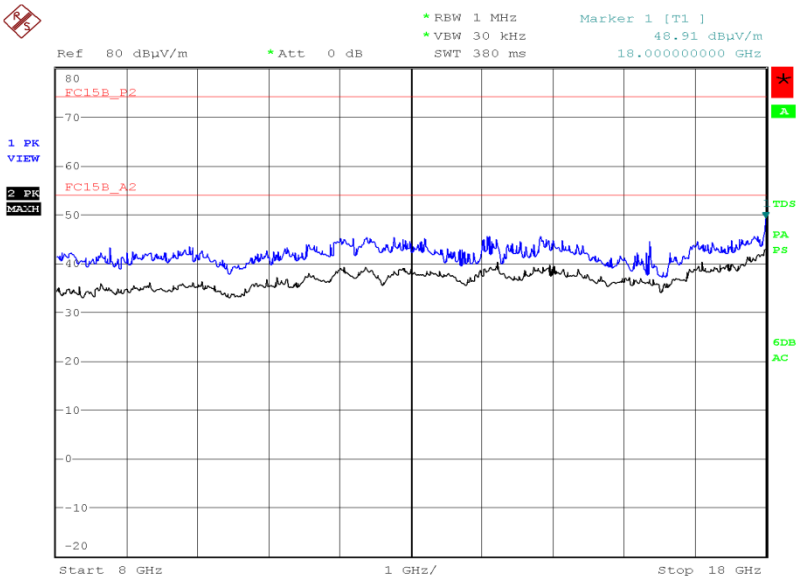
3 GHz to 8 GHz



Date: 12.AUG.2013 19:38:15

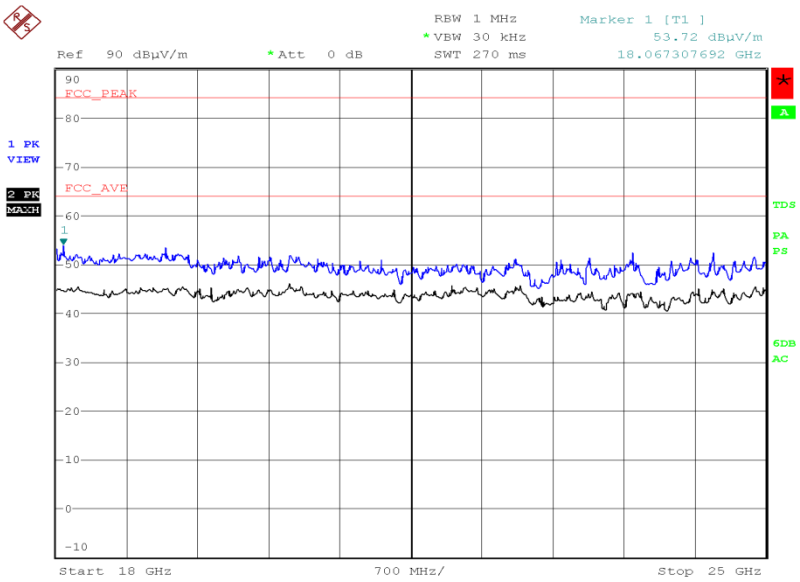
Product Service

8 GHz to 18 GHz



Date: 12.AUG.2013 22:06:21

18 GHz to 25 GHz

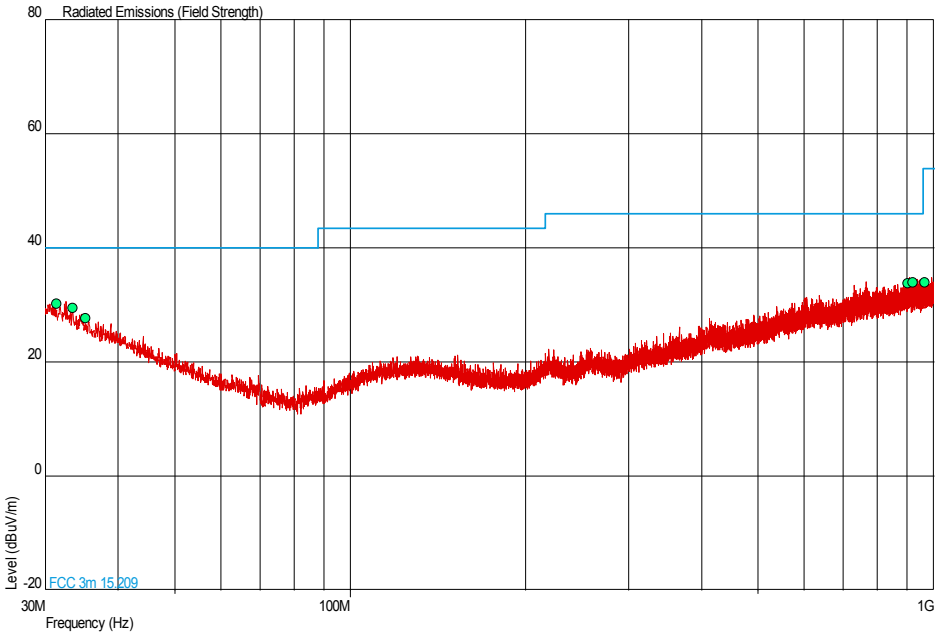


Date: 12.AUG.2013 23:06:24

Product Service

2480 MHz

30 MHz to 1 GHz



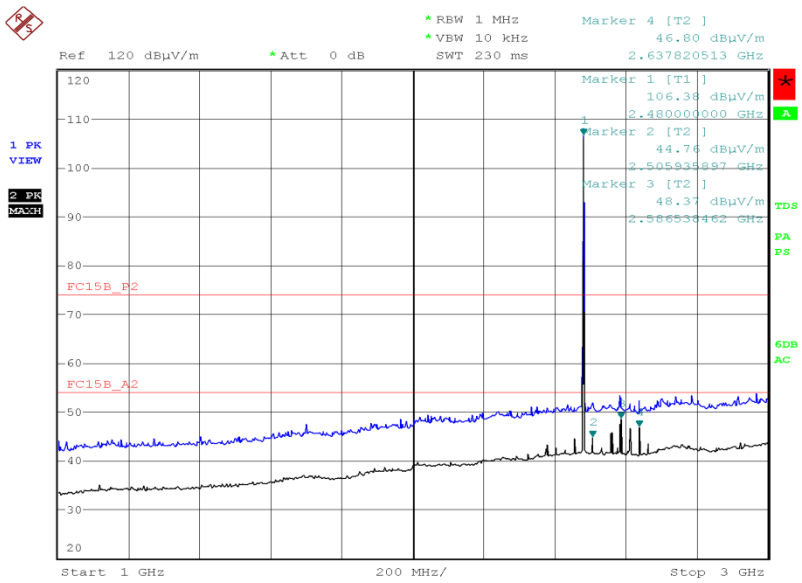
Frequency (MHz)	QP Level (dBµV/m)	QP Level (uV/m)	QP Limit (dBµV/m)	QP Limit (uV/m)	QP Margin (dBµV/m)	QP Margin (uV/m)	Angle (Deg)	Height (m)	Polarity
31.407	30.3	32.7	40.0	100	-9.7	67.3	45	1.00	Vertical
33.444	29.5	29.9	40.0	100	-10.5	70.1	0	1.00	Vertical
35.190	27.7	24.3	40.0	100	-12.3	75.7	0	1.00	Vertical
903.049	33.8	49.0	46.0	200	-12.2	151.0	45	1.00	Vertical
920.460	33.9	49.5	46.0	200	-12.1	150.5	0	1.00	Vertical
963.819	34.0	50.1	54.0	500	-20.0	449.9	0	1.00	Vertical

Product Service

1GHz to 25GHz

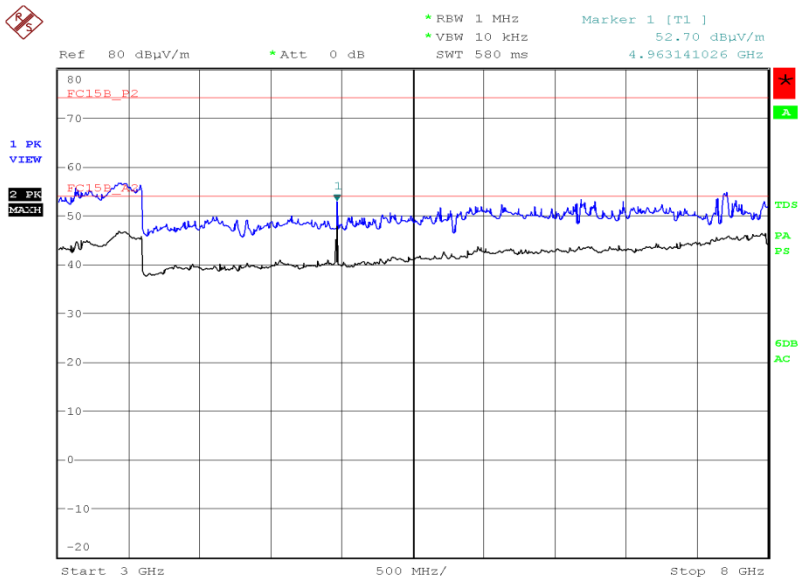
Frequency (GHz)	Antenna Polarisation	Antenna Height (cm)	EUT Arc (degrees)	Final Peak (dBµV/m)	Final Average (dBµV/m)
4.960	Horizontal	117	215	56.25	47.50

1 GHz to 3 GHz



Date: 12.AUG.2013 20:25:56

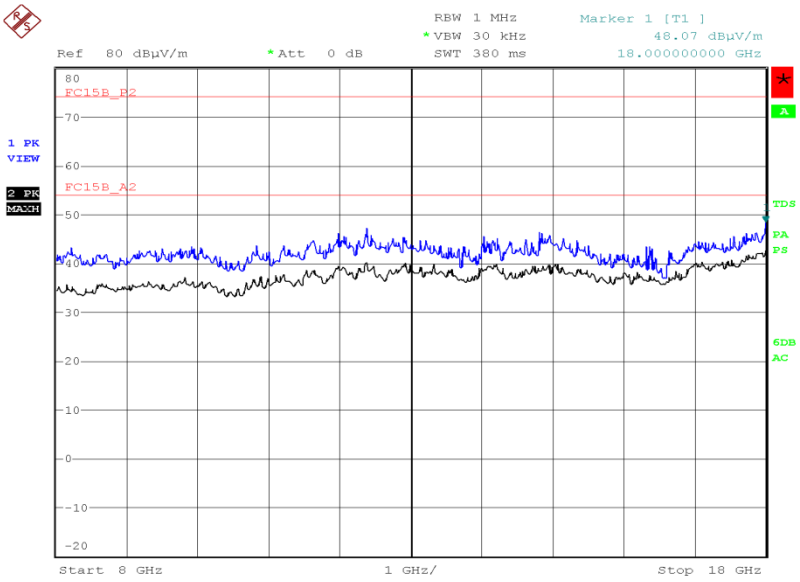
3 GHz to 8 GHz



Date: 12.AUG.2013 20:46:25

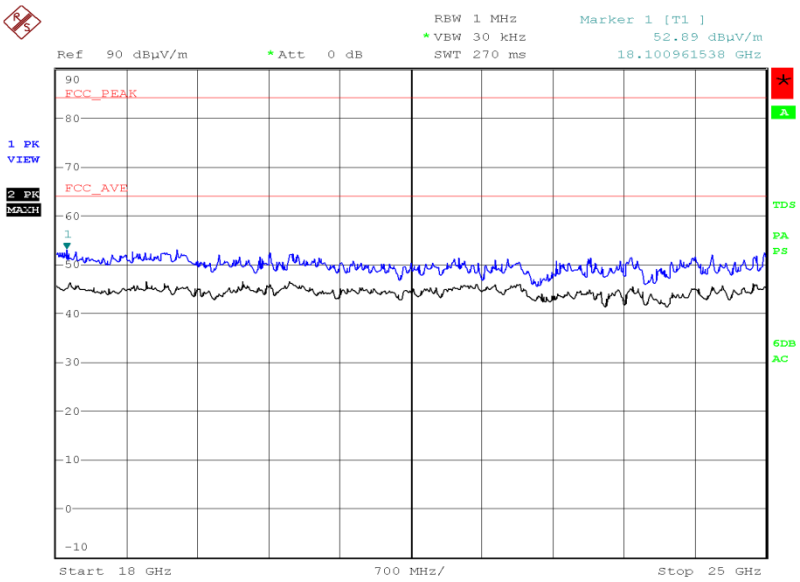
Product Service

8 GHz to 18 GHz



Date: 12.AUG.2013 22:41:58

18 GHz to 25 GHz



Date: 12.AUG.2013 23:00:41

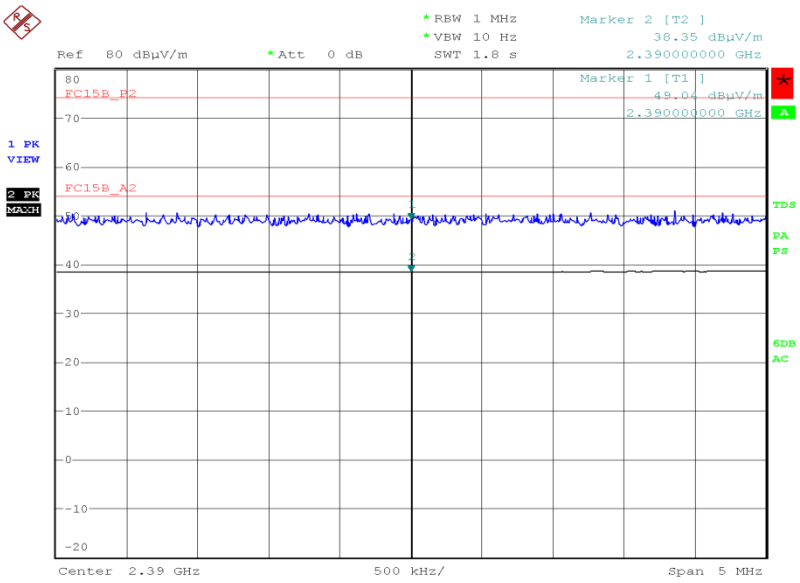
Limit

Peak (dBµV/m)	Average (dBµV/m)
74.0	54.0

Band Edge Emissions

2402 MHz

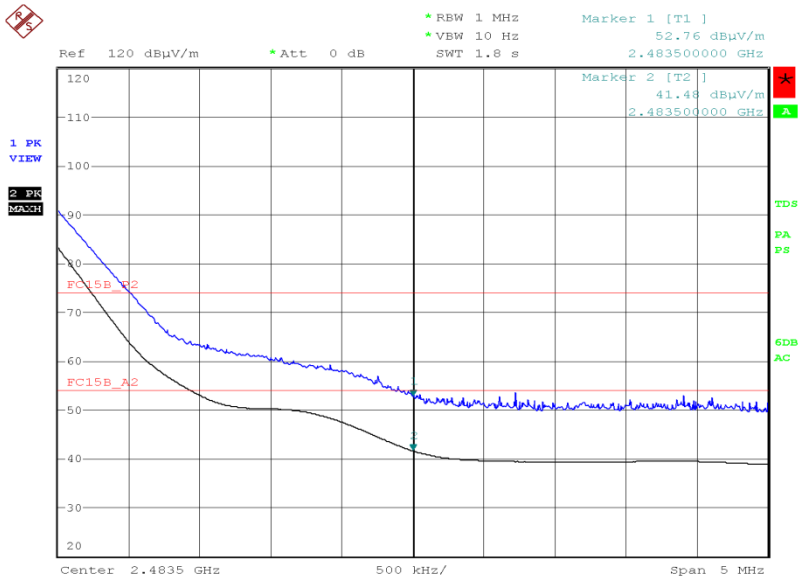
Polarisation	Final Peak (dBµV/m)	Final Average (dBµV/m)
Vertical	49.04	38.35



Product Service

2480 MHz

Polarisation	Final Peak (dBµV/m)	Final Average (dBµV/m)
Vertical	52.76	41.48



Date: 12.AUG.2013 20:20:51

Limit

Peak (dBµV/m)	Average (dBµV/m)
74.0	54.0

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Product Service

SECTION 3

TEST EQUIPMENT USED

Product Service

3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Section 2.1– AC Line Conducted Emissions					
Power Supply Unit	Farnell	LT-30-2	41	-	O/P Mon
LISN (1 Phase)	Chase	MN 2050	336	12	28-Mar-2014
Screened Room (5)	Rainford	Rainford	1545	36	25-Dec-2013
Transient Limiter	Hewlett Packard	11947A	2377	12	13-Feb-2014
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	11-Oct-2013
7m Armoured RF Cable	SSI Cable Corp.	1501-13-13-7m WA(-)	3600	-	TU
Section 2.2 - Maximum Peak Conducted Output Power					
Attenuator (10dB, 10W)	Texscan	HFP-50N	468	12	27-Jun-2014
Power Supply Unit	Farnell	D302T	609	-	O/P Mon
GPS Frequency Standard	Rapco	GPS-804/3	1312	6	24-Jan-2014
Multimeter	Iso-tech	IDM101	2419	12	3-Oct-2013
Signal Analyser	Rohde & Schwarz	FSQ 26	3545	12	4-Jul-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	31-Aug-2013
Combiner/Splitter	Weinschel	1506A	3878	12	19-Mar-2014
P-Series Power Meter	Agilent	N1911A	3981	12	17-Sep-2013
50 MHz-18 GHz Wideband Power Sensor	Agilent	N1921A	3982	12	17-Sep-2013
1 Metre K Type Cable	Rhophase	KPS-1501A-1000-KPS	4105	12	25-Oct-2013
Section 2.3 - Frequency Hopping Systems - 20dB Bandwidth and Channel Separation					
Attenuator (10dB, 10W)	Texscan	HFP-50N	468	12	27-Jun-2014
Power Supply Unit	Farnell	D302T	609	-	O/P Mon
GPS Frequency Standard	Rapco	GPS-804/3	1312	6	24-Jan-2014
Multimeter	Iso-tech	IDM101	2419	12	3-Oct-2013
Signal Analyser	Rohde & Schwarz	FSQ 26	3545	12	4-Jul-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	31-Aug-2013
Combiner/Splitter	Weinschel	1506A	3878	12	19-Mar-2014
P-Series Power Meter	Agilent	N1911A	3981	12	17-Sep-2013
50 MHz-18 GHz Wideband Power Sensor	Agilent	N1921A	3982	12	17-Sep-2013
1 Metre K Type Cable	Rhophase	KPS-1501A-1000-KPS	4105	12	25-Oct-2013
Section 2.4 - Frequency Hopping Systems - Channel Dwell Time and Number of Hopping Channels					
Attenuator (10dB, 10W)	Texscan	HFP-50N	468	12	27-Jun-2014
Power Supply Unit	Farnell	D302T	609	-	O/P Mon
GPS Frequency Standard	Rapco	GPS-804/3	1312	6	24-Jan-2014
Multimeter	Iso-tech	IDM101	2419	12	3-Oct-2013
Signal Analyser	Rohde & Schwarz	FSQ 26	3545	12	4-Jul-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	31-Aug-2013
Combiner/Splitter	Weinschel	1506A	3878	12	19-Mar-2014
P-Series Power Meter	Agilent	N1911A	3981	12	17-Sep-2013
50 MHz-18 GHz Wideband Power Sensor	Agilent	N1921A	3982	12	17-Sep-2013
1 Metre K Type Cable	Rhophase	KPS-1501A-1000-KPS	4105	12	25-Oct-2013

Product Service

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Section 2.5 - EIRP Peak Power					
Antenna (Double Ridge Guide)	EMCO	3115	34	12	9-Nov-2013
Spectrum Analyser	Rohde & Schwarz	FSEM	37	12	22-May-2014
Signal Generator (10MHz to 40GHz)	Rohde & Schwarz	SMR40	1002	12	6-Sep-2013
Antenna (DRG Horn)	ETS-LINDGREN	3115	3125	12	17-Jul-2014
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	234	12	3-Apr-2014
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	235	12	9-Nov-2013
Signal Generator (10MHz to 40GHz)	Rohde & Schwarz	SMR40	1002	12	6-Sep-2013
Screened Room (5)	Rainford	Rainford	1545	36	25-Dec-2013
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	11-Oct-2013
9m RF Cable (N Type)	Rhophase	NPS-2303-9000-NPS	3791	-	TU
Tilt Antenna Mast	maturo Gmbh	TAM 4.0-P	3916	-	TU
Mast Controller	maturo Gmbh	NCD	3917	-	TU
Section 2.6 - Spurious and Band Edge Emissions					
Antenna (Double Ridge Guide)	Link Microtek Ltd	AM180HA-K-TU2	230	24	13-Sep-2013
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	234	12	3-Apr-2014
Antenna (Bilog)	Schaffner	CBL6143	287	24	18-Jan-2014
Filter (High Pass)	Lorch	SHP7-7000-SR	566	12	20-Feb-2014
Signal Generator (10MHz to 40GHz)	Rohde & Schwarz	SMR40	1002	12	6-Sep-2013
Pre-Amplifier	Phase One	PS04-0086	1533	12	27-Sep-2013
Pre-Amplifier	Phase One	PSO4-0087	1534	12	28-Sep-2013
Screened Room (5)	Rainford	Rainford	1545	36	25-Dec-2013
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Amplifier (1 - 8GHz)	Phase One	PS06-0060	3175	12	9-Aug-2014
Amplifier (8 - 18GHz)	Phase One	PS06-0061	3176	12	9-Aug-2014
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	11-Oct-2013
3 GHz High Pass Filter	K&L Microwave	11SH10-3000/X18000-O/O	3552	12	1-Feb-2014
9m RF Cable (N Type)	Rhophase	NPS-2303-9000-NPS	3791	-	TU
Tilt Antenna Mast	maturo Gmbh	TAM 4.0-P	3916	-	TU
Mast Controller	maturo Gmbh	NCD	3917	-	TU

TU – Traceability Unscheduled
O/P MON – Output Monitored with Calibrated Equipment

Product Service

3.2 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are:-

Test Discipline	MU
Spurious and Band Edge Emissions	30MHz to 1GHz: ± 5.1 dB 1GHz to 40GHz: ± 6.3 dB
Frequency Hopping Systems - 20 dB Bandwidth and Channel Separation	± 16.74 kHz
EIRP Peak Power	30MHz to 1GHz: ± 5.1 dB 1GHz to 40GHz: ± 6.3 dB
Frequency Hopping Systems - Dwell Time & No of Hopping Channels	-
Maximum Peak Conducted Output Power	± 0.70 dB
AC Line Conducted Emissions	± 3.2 dB

Product Service

SECTION 4

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

4.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

This report relates only to the actual item/items tested.

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation.

Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).