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## Report On

FCC Testing of the Sharp SHL24 Dual-band CDMA (BC0, BC6), Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900), Dual-band UMTS (FDDI, FDDV), Quad-band LTE (B1, B3, B11, B18), Multi mode cellular phone with Bluetooth, WLAN, SRD(NFC,FeliCa) and GPS  
In accordance with FCC CFR 47 Part 15C (Bluetooth)

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FCC ID: APYHRO00201

Document 75924750 Report 10 Issue 1

February 2014



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COMMERCIAL-IN-CONFIDENCE

REPORT ON

FCC Testing of the  
Sharp SHL24 Dual-band CDMA (BC0, BC6), Quad-band GSM  
(GSM850/GSM900/DCS1800/PCS1900), Dual-band UMTS (FDDI,  
FDDV), Quad-band LTE (B1, B3, B11, B18), Multi mode cellular  
phone with Bluetooth, WLAN, SRD(NFC,FeliCa) and GPS  
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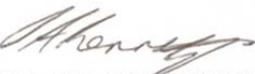
PREPARED FOR

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PREPARED BY

  
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APPROVED BY

  
**Simon Bennett**  
Authorised Signatory

DATED

03 February 2014

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. The sample tested was found to comply with the requirements defined in the applied rules.

Test Engineer(s);

  
N Rousell

  
G Lawler



  
T Guy

  
A Galpin



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## **SECTION 1**

### **REPORT SUMMARY**

FCC Testing of the  
Sharp SHL24 Dual-band CDMA (BC0, BC6), Quad-band GSM  
(GSM850/GSM900/DCS1800/PCS1900), Dual-band UMTS (FDDI, FDDV), Quad-band LTE  
(B1, B3, B11, B18), Multi mode cellular phone with Bluetooth, WLAN, SRD(NFC, FeliCa) and  
GPS

In accordance with FCC CFR 47 Part 15C (Bluetooth)



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## 1.1 INTRODUCTION

The information contained in this report is intended to show verification of the FCC Testing of the Sharp SHL24 Dual-band CDMA (BC0, BC6), Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900), Dual-band UMTS (FDDI, FDDV), Quad-band LTE (B1, B3, B11, B18), Multi mode cellular phone with Bluetooth, WLAN, SRD(NFC, FeliCa) and GPS to the requirements of FCC CFR 47 Part 15C.

Objective	To perform FCC Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Sharp Corporation
Model Number(s)	SHL24
Serial Number(s)	IMEI 004401115003556 IMEI 004401115003390
Number of Samples Tested	2
Test Specification/Issue/Date	FCC CFR 47 Part 15C (2012)
Incoming Release Date	Application Form 09 December 2013
Disposal Reference Number Date	Held Pending Disposal Not Applicable Not Applicable
Order Number Date	9952 25 November 2013
Start of Test	5 January 2014
Finish of Test	12 January 2014
Name of Engineer(s)	N Rousell G Lawler T Guy A Galpin
Related Document(s)	ANSI C63.10: 2009



## 1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC CFR 47 Part 15C is shown below.

Section	Spec Clause	Test Description	Result	Comments/Base Standard
Bluetooth				
2.1	15.207	AC Line Conducted Emissions	Pass	
2.2	15.247 (a)(1)	Frequency Hopping Systems - 20dB Bandwidth and Channel Separation	Pass	
2.3	15.247 (a)(1)(iii)	Frequency Hopping Systems - Channel Dwell Time and Number of Hopping Channels	Pass	
2.4	15.247 (b)(3)	Maximum Peak Conducted Output Power	Pass	
2.5	15.247 (b)(4)	EIRP Peak Power	Pass	
2.6	15.247 (d)	Spurious and Band Edge Emissions	Pass	



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**1.3 APPLICATION FORM**

EQUIPMENT DESCRIPTION	
Model Name/Number	SHL2 4
Part Number	
FCC ID (if applicable)	APYHRO00201
Industry Canada ID (if applicable)	N/A
Technical Description (Please provide a brief description of the intended use of the equipment)	Quad-band LTE(B1/B3/B11/B18), Dual-band WCDMA ( FDDI/V), Quad-band GSM(850/900/1800/1900), Dual-band CDMA(BC0/BC6) Cellular Phone with Bluetooth, WLAN, NFC and GPS

EXTREME TEMPERATURE RANGE over which the equipment is to be type tested	
<input type="checkbox"/> -20°C to +55°C	
<input checked="" type="checkbox"/> Other (2)	
<input type="checkbox"/> Not applicable (no extreme temperature testing required)	
Extreme temperature range for the host(s):	-10C to 55C

- (2) The equipment shall be tested over the following temperature ranges :
- a) 0°C to +35°C for equipment for indoor use only, or intended for used in areas where the temperature is controlled within this range.
  - b) Over the extremes of the temperature range(s) of the declared host equipment(s) in case of plug-in radio devices.

TYPE OF ANTENNA	
<input checked="" type="checkbox"/> Integral	
Temporary RF connector provided:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Antenna connector	
<input type="checkbox"/> Number of antenna assembly(ies) submitted	
Gain of the antenna intended for normal use:	
0 dBi for assembly identified as Bluetooth/WLAN	
dBi for assembly identified as	

TRANSMITTER TECHNICAL CHARACTERISTICS		
TRANSMITTER OPERATING FREQUENCY RANGE(S)		
	FCC and/or Industry Canada	EU
<b>Bluetooth</b>	2402 to 2480 MHz	2402 to 2480 MHz
<b>WLAN</b>	2412 to 2462 MHz	2412 to 2472 MHz
FCC and/or Industry Canada (only)		
Highest Internally Generated Frequency 2150.4 MHz		



SPREAD SPECTRUM PARAMETERS		
<input checked="" type="checkbox"/> <b>Bluetooth</b>	Version: 4.0	
FHSS: Channel <input checked="" type="checkbox"/> 79 Other	EDR <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
<b>Medium Access Protocol (Customer Declaration)</b>		
"We have implemented Bluetooth protocol which satisfies the medium access protocol requirement of EN 300 328".		
<input checked="" type="checkbox"/> <b>WLAN</b>		
IEEE 802.11(b) – DSSS <input checked="" type="checkbox"/>		
IEEE 802.11(g) – OFDM <input checked="" type="checkbox"/>		
IEEE 802.11(n) – OFDM <input checked="" type="checkbox"/>		
Supported Spatial Streams	2.4 GHz	5GHz
Transmitter (Tx)	1	1
Receiver (Rx)	1	1
GI (Guard Interval) <input checked="" type="checkbox"/> 800 ns <input type="checkbox"/> 400 ns		
Band Width <input checked="" type="checkbox"/> 20 MHz <input type="checkbox"/> 40 MHz		
<b>Medium Access Protocol (Customer Declaration)</b>		
"We have implemented IEEE 802.11 (b/g/n) protocol which satisfies the medium access protocol requirement of EN 300 328".		
<input type="checkbox"/> <b>Other Technology</b>		
<input type="checkbox"/> Direct Sequence	<input type="checkbox"/> Frequency Hopping	<input type="checkbox"/> Combined <input type="checkbox"/> Other
DSSS	Chip Sequence Length	bit
	Spectrum Width	MHz
FHSS	Total Number of Hops	
	Dwell Time	ms
	Bandwidth Per Hop	MHz
	Maximum Separation of Hops	MHz for ETSI EN 300 328
Other		
<b>Medium Access Protocol (Customer Declaration)</b>		
"We have implemented a protocol which satisfies the medium access protocol requirement of EN 300 328".		



TRANSMITTER POWER CHARACTERISTICS				
Bluetooth				
Maximum Rated Transmitter Output				
Effective radiated power (for equipment with antenna connector)				W
Effective radiated power (for equipment with integral antenna)	2.5m			W
Minimum Rated Transmitter Output				
Effective radiated power (for equipment with antenna connector)				W
Effective radiated power (for equipment with integral antenna)	0.25m			W
Is transmitter intended for :				
Continuous duty		<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/> No
Intermittent duty		<input type="checkbox"/>	Yes	<input type="checkbox"/> No
If intermittent state DUTY CYCLE				
Transmitter ON	seconds	Transmitter OFF		minutes
Is continuous operation possible for testing purposes?				
		<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/> No
Is transmitter output power variable:				
		<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/> No
State during the test:				
Transmitter duty cycle	Tx on	Seconds	Tx Off	Seconds
Duty cycle (Tx on / (Tx on +Tx off))				
		%		
<input type="checkbox"/> Continuously variable		<input type="checkbox"/> Stepped		
	dB per step			
WLAN				
Maximum Rated Transmitter Output				
Effective radiated power (for equipment with antenna connector)				W
Effective radiated power (for equipment with integral antenna)	0.1			W
Minimum Rated Transmitter Output				
Effective radiated power (for equipment with antenna connector)				W
Effective radiated power (for equipment with integral antenna)				W
Is transmitter intended for :				
Continuous duty		<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/> No
Intermittent duty		<input type="checkbox"/>	Yes	<input type="checkbox"/> No
If intermittent state DUTY CYCLE				
Transmitter ON	seconds	Transmitter OFF		minutes
Is continuous operation possible for testing purposes?				
		<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/> No
Is transmitter output power variable:				
		<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/> No
State during the test:				
Transmitter duty cycle	Tx on	Seconds	Tx Off	Seconds
Duty cycle (Tx on / (Tx on +Tx off))				
		%		
<input type="checkbox"/> Continuously variable		<input type="checkbox"/> Stepped		
	dB per step			



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<b>TRANSMITTER POWER SOURCE (3)</b>				
<input checked="" type="checkbox"/> Common power source for transmitter and receiver				
<input type="checkbox"/> AC mains				
AC supply frequency	(Hz)	VAC	Max Current	Hz
<input type="checkbox"/> Single phase		<input type="checkbox"/> Three phase		
And / Or				
<input type="checkbox"/> External DC supply				
Nominal voltage		Max Current A		
Extreme upper voltage		Extreme lower voltage		
Battery				
<input type="checkbox"/> Nickel Cadmium				
<input type="checkbox"/> Lead acid (Vehicle regulated)				
<input type="checkbox"/> Alkaline				
<input checked="" type="checkbox"/> Lithium				
<input type="checkbox"/> Other Details :				
4.0 Volts nominal.				
End point voltage as quoted by equipment manufacturer		3.7 V		

(3) If a transmitter and receiver use the same power source, this should be declared. In such cases only the box for the transmitter power source should be filled in.

<b>AUTOMATIC EQUIPMENT SWITCH OFF</b>	
If the equipment is designed to automatically switch off at a predetermined voltage level which is higher or lower in value than the battery minimum and minimum calculated values this shall be clearly stated.	
<input checked="" type="checkbox"/> Applies	3.35 V cut-off voltage
<input type="checkbox"/> Does not apply	



Product Service

RECEIVER POWER SOURCE (4)				
<input type="checkbox"/> AC mains		State voltage		
AC supply frequency	(Hz)	VAC	Max Current	Hz
<input type="checkbox"/> Single phase		<input type="checkbox"/> Three phase		
And / Or				
<input type="checkbox"/> External DC supply				
Nominal voltage		Max Current		A
Extreme upper voltage		Extreme lower voltage		
Battery				
<input type="checkbox"/> Nickel Cadmium				
<input type="checkbox"/> Lead acid (Vehicle regulated)				
<input type="checkbox"/> Alkaline				
<input type="checkbox"/> Lithium				
<input type="checkbox"/> Other Details :				
	Volts nominal.			
End point voltage as quoted by equipment manufacturer				V

(4) If a transmitter and receiver use the same power source, this should be declared. In such cases only the box for the transmitter power source should be filled in.

AUTOMATIC EQUIPMENT SWITCH OFF	
If the equipment is designed to automatically switch off at a predetermined voltage level which is higher or lower in value than the battery minimum and minimum calculated values this shall be clearly stated.	
<input type="checkbox"/> Applies	V cut-off voltage
<input type="checkbox"/> Does not apply	

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: Hiroyuki Murakami  
 Position held: Supervisor | Date: 9<sup>th</sup> December, 2013



Product Service

## **1.4 PRODUCT INFORMATION**

### **1.4.1 Technical Description**

The Equipment Under Test (EUT) was a Sharp SHL24 Dual-band CDMA (BC0, BC6), Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900), Dual-band UMTS (FDDI, FDDV), Quad-band LTE (B1, B3, B11, B18), Multi mode cellular phone with Bluetooth, WLAN, SRD(NFC, FeliCa) and GPS. 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 4.0 V DC supply.

FCC Measurement Facility Registration Number  
90987 Octagon House, Fareham Test Laboratory

## **1.6 DEVIATIONS FROM THE STANDARD**

No deviations from the applicable test standard or test plan were made during testing.

## **1.7 MODIFICATION RECORD**

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



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## **SECTION 2**

### **TEST DETAILS**

FCC Testing of the  
Sharp SHL24 Dual-band CDMA (BC0, BC6), Quad-band GSM  
(GSM850/GSM900/DCS1800/PCS1900), Dual-band UMTS (FDDI, FDDV), Quad-band LTE  
(B1, B3, B11, B18), Multi mode cellular phone with Bluetooth, WLAN, SRD(NFC, FeliCa) and  
GPS

In accordance with FCC CFR 47 Part 15C (Bluetooth)



## **2.1 AC LINE CONDUCTED EMISSIONS**

### **2.1.1 Specification Reference**

FCC CFR 47 Part 15C, Clause 15.207

### **2.1.2 Equipment Under Test and Modification State**

SHL24 S/N: IMEI 004401115003556 - Modification State 0

### **2.1.3 Date of Test**

12 January 2014

### **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 was set up on a test table 800mm above a horizontal ground plane. A vertical ground plane is also required and was placed 400mm from the EUT.

The EUT is powered through a Line Impedance Stabilisation Network (LISN) which was bonded to the ground plane. The EUT was 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 were noted for formal measurements.

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

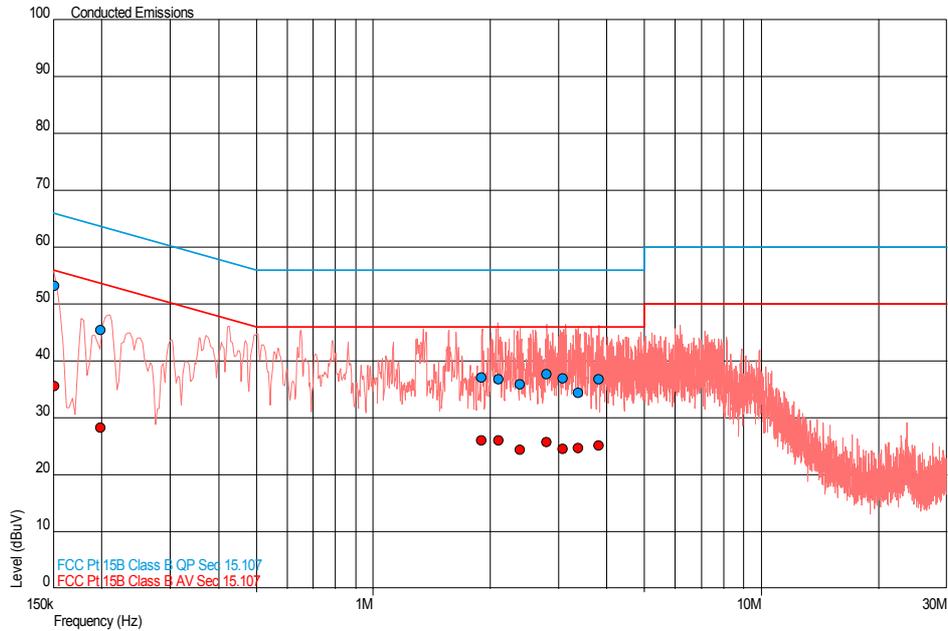
### **2.1.6 Environmental Conditions**

Ambient Temperature	22.6°C
Relative Humidity	24.0%



2.1.7 Test Results

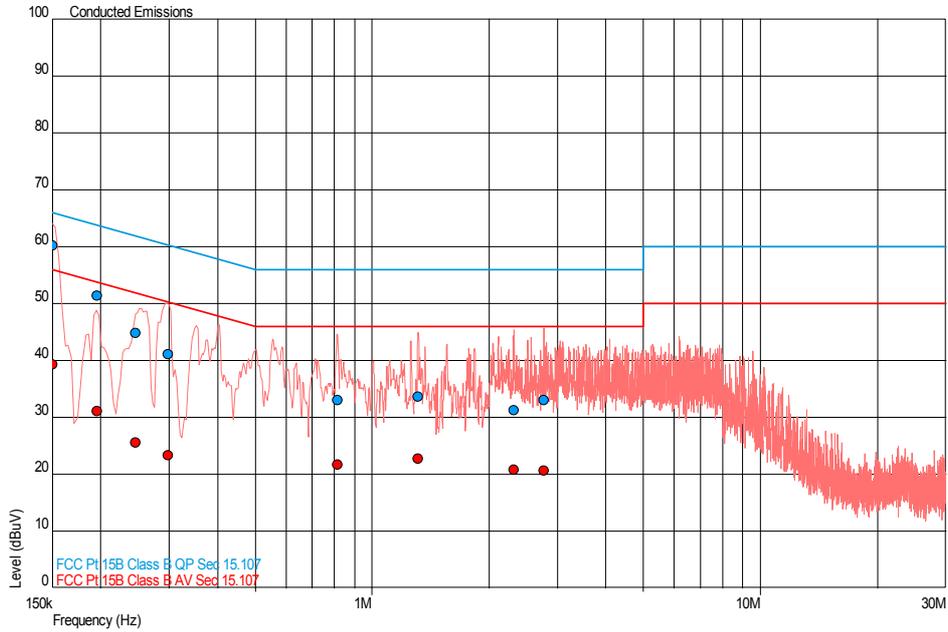
Live Line



Frequency (MHz)	QP Level (dBμV)	QP Limit (dBμV)	QP Margin (dBμV)	AV Level (dBμV)	AV Limit (dBμV)	AV Margin (dBμV)
0.151	53.2	66.0	-12.8	35.6	56.0	-20.4
0.198	45.5	63.7	-18.2	28.4	53.7	-25.3
1.907	37.1	56.0	-18.9	26.0	46.0	-20.0
2.100	36.8	56.0	-19.2	26.0	46.0	-20.0
2.387	35.8	56.0	-20.2	24.4	46.0	-21.6
2.803	37.7	56.0	-18.3	25.8	46.0	-20.2
3.085	36.9	56.0	-19.1	24.5	46.0	-21.5
3.374	34.4	56.0	-21.6	24.7	46.0	-21.3
3.819	36.8	56.0	-19.2	25.1	46.0	-20.9



Neutral Line



Frequency (MHz)	QP Level (dBµV)	QP Limit (dBµV)	QP Margin (dBµV)	AV Level (dBµV)	AV Limit (dBµV)	AV Margin (dBµV)
0.150	60.2	66.0	-5.8	39.3	56.0	-16.6
0.196	51.4	63.8	-12.4	31.2	53.8	-22.6
0.246	44.8	61.9	-17.0	25.5	51.9	-26.3
0.298	41.2	60.3	-19.1	23.4	50.3	-26.9
0.813	33.1	56.0	-22.9	21.8	46.0	-24.2
1.316	33.7	56.0	-22.3	22.8	46.0	-23.2
2.320	31.3	56.0	-24.7	20.8	46.0	-25.2
2.773	33.0	56.0	-23.0	20.7	46.0	-25.3



## **2.2 FREQUENCY HOPPING SYSTEMS - 20dB BANDWIDTH AND CHANNEL SEPARATION**

### **2.2.1 Specification Reference**

FCC CFR 47 Part 15C, Clause 15.247 (a)(1)

### **2.2.2 Equipment Under Test and Modification State**

SHL24 S/N: IMEI 004401115003390 - Modification State 0

### **2.2.3 Date of Test**

8 January 2014

### **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 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.

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.

### **2.2.6 Environmental Conditions**

Ambient Temperature	24.2°C
Relative Humidity	37.6%



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**2.2.7 Test Results**

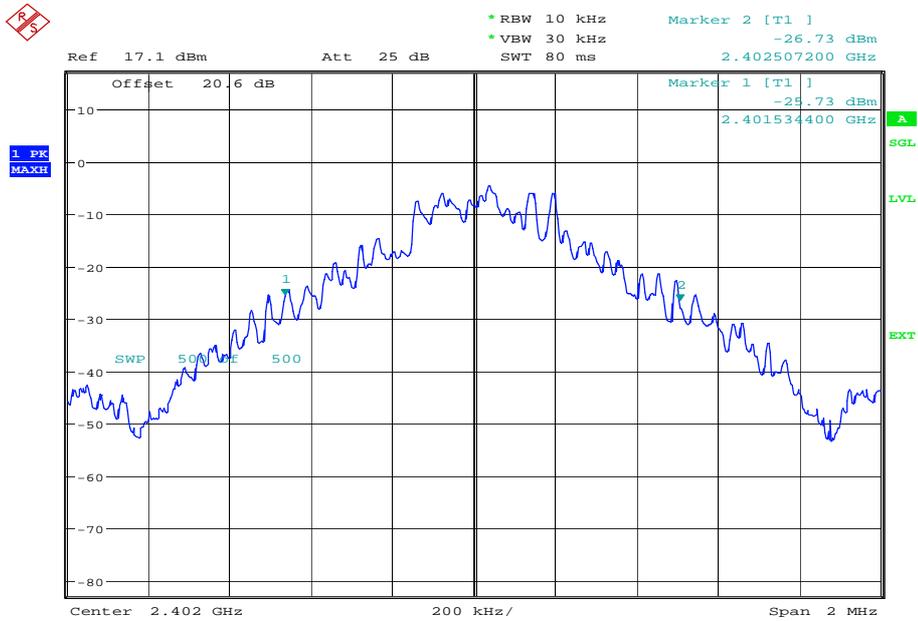
4.0 V DC Supply

20dB Bandwidth

2402 MHz

Data Rate (Mbps)	20dB Bandwidth (kHz)
DH1	972.8
DH3	928.0
DH5	886.4

DH1

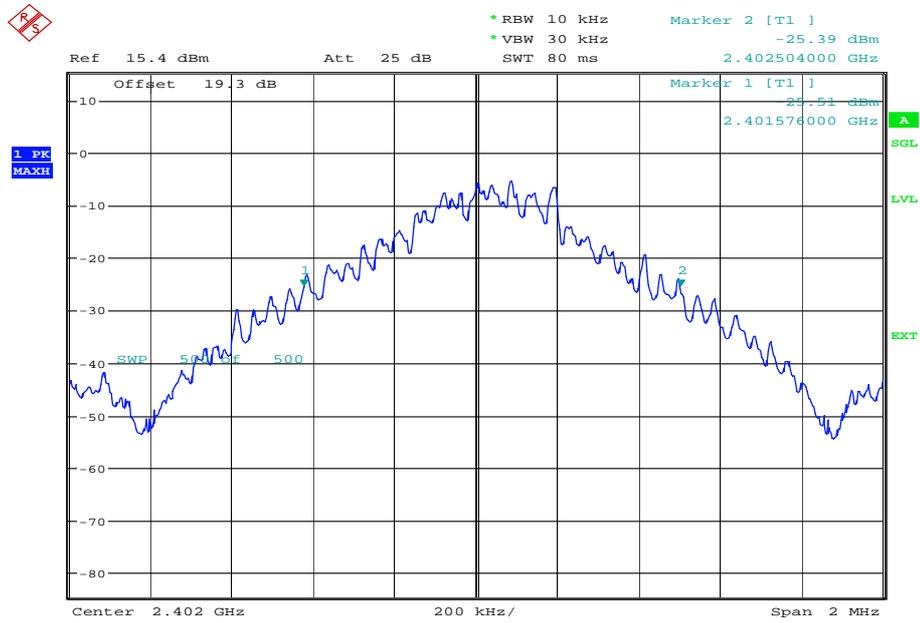


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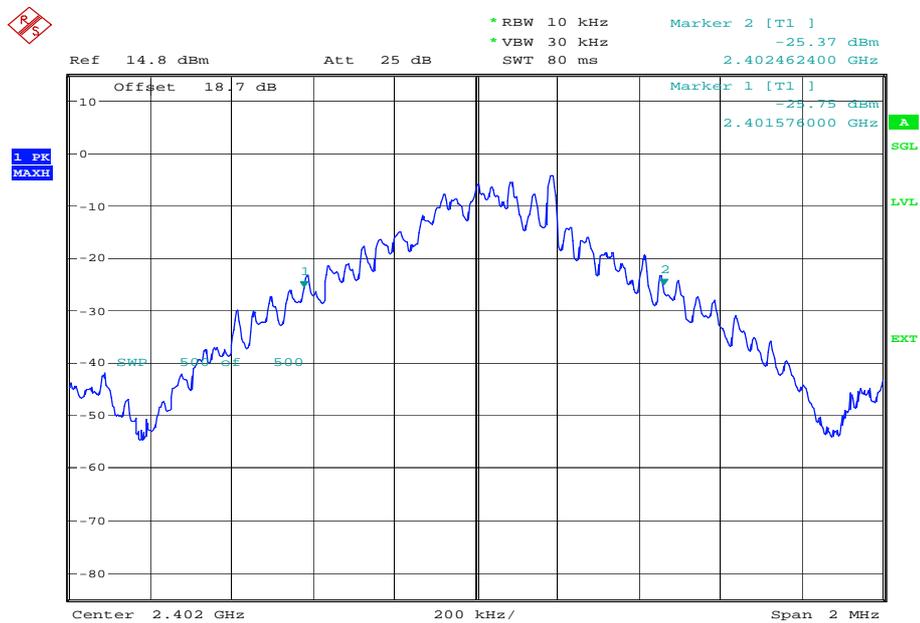
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DH3



Date: 8.JAN.2014 10:50:54

DH5



Date: 8.JAN.2014 10:49:09

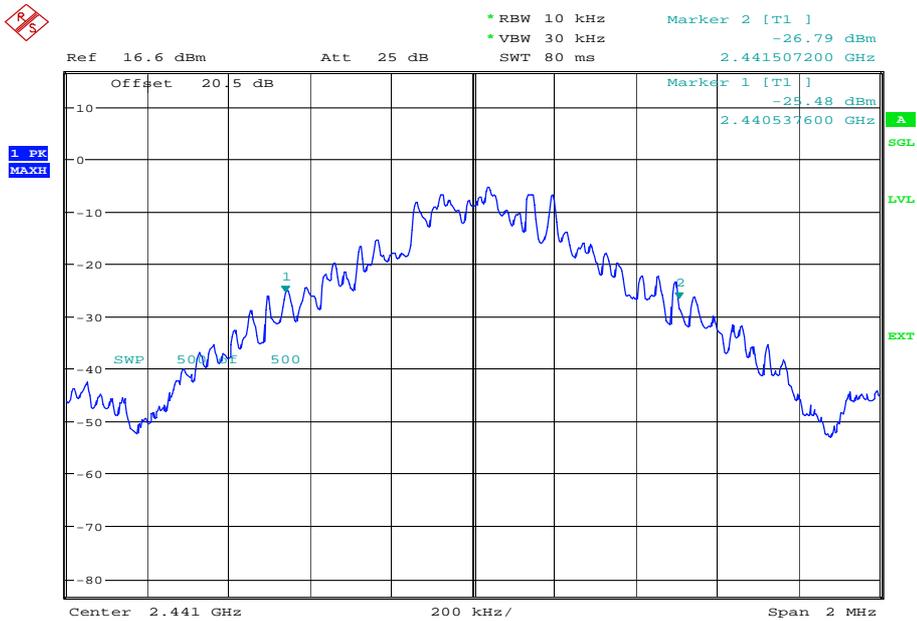


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2441 MHz

Data Rate (Mbps)	20dB Bandwidth (kHz)
DH1	969.6
DH3	931.2
DH5	889.6

DH1

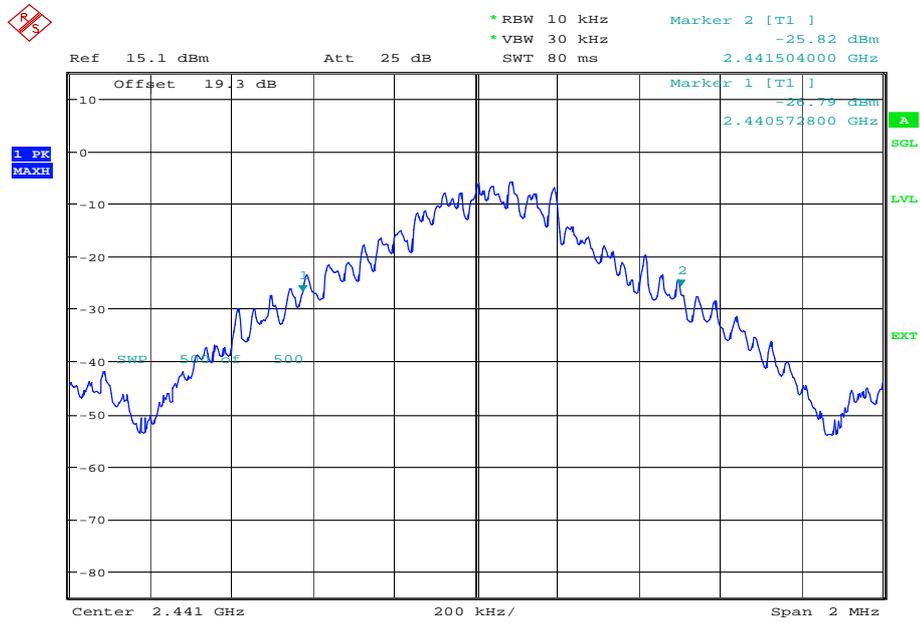


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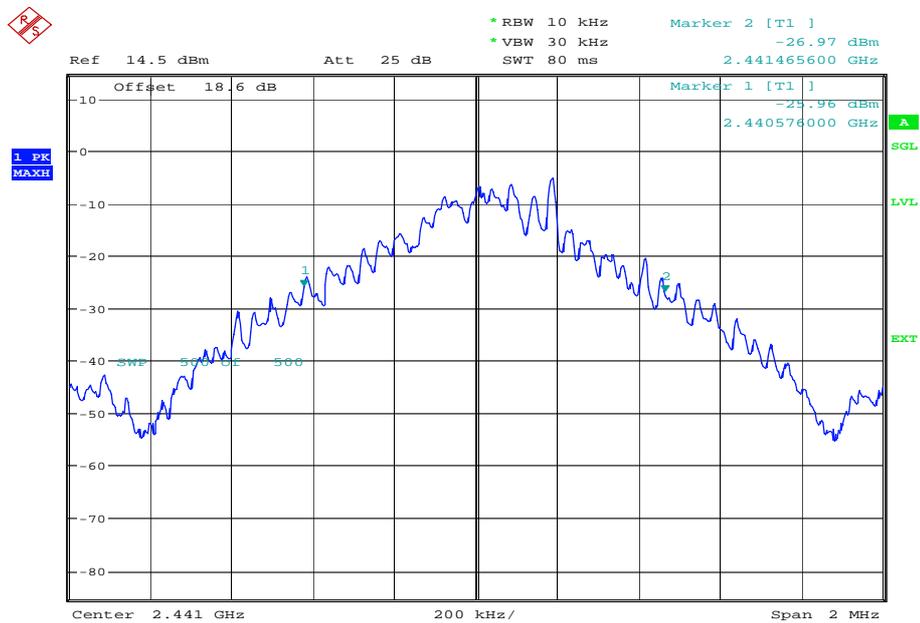
Product Service

DH3



Date: 8.JAN.2014 10:54:57

DH5



Date: 8.JAN.2014 10:46:41

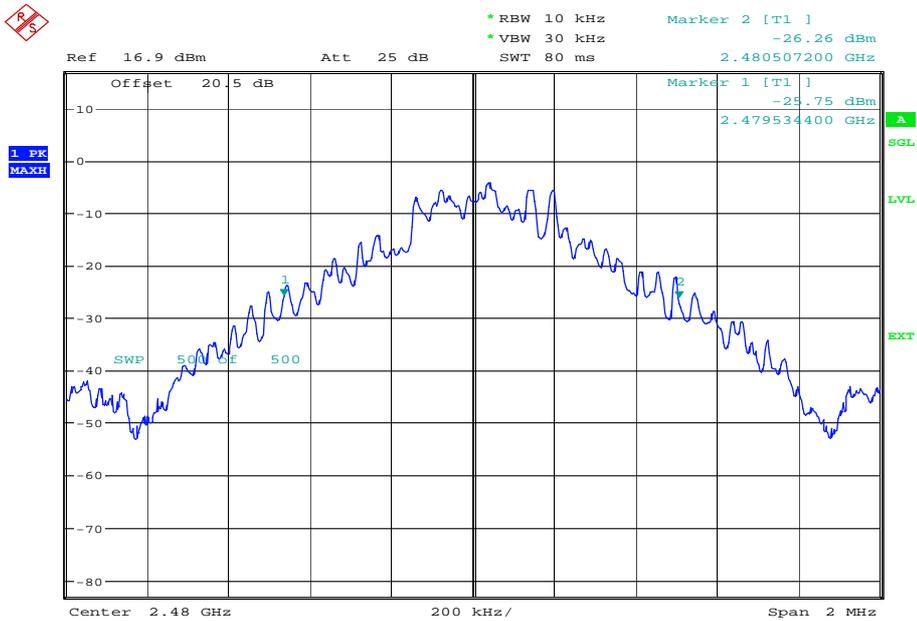


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2480 MHz

Data Rate (Mbps)	20dB Bandwidth (kHz)
DH1	972.8
DH3	931.2
DH5	889.6

DH1

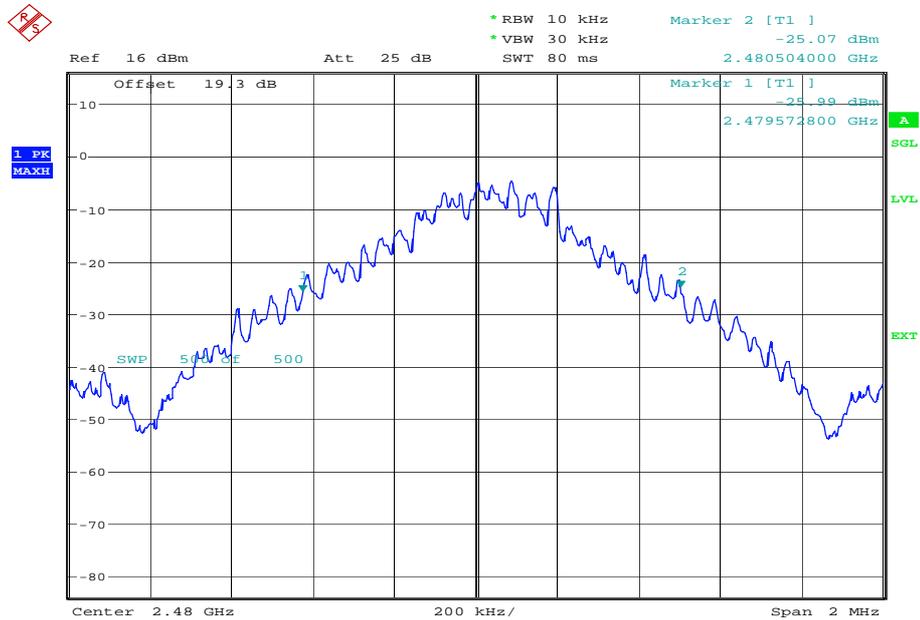


Date: 7.JAN.2014 18:02:06



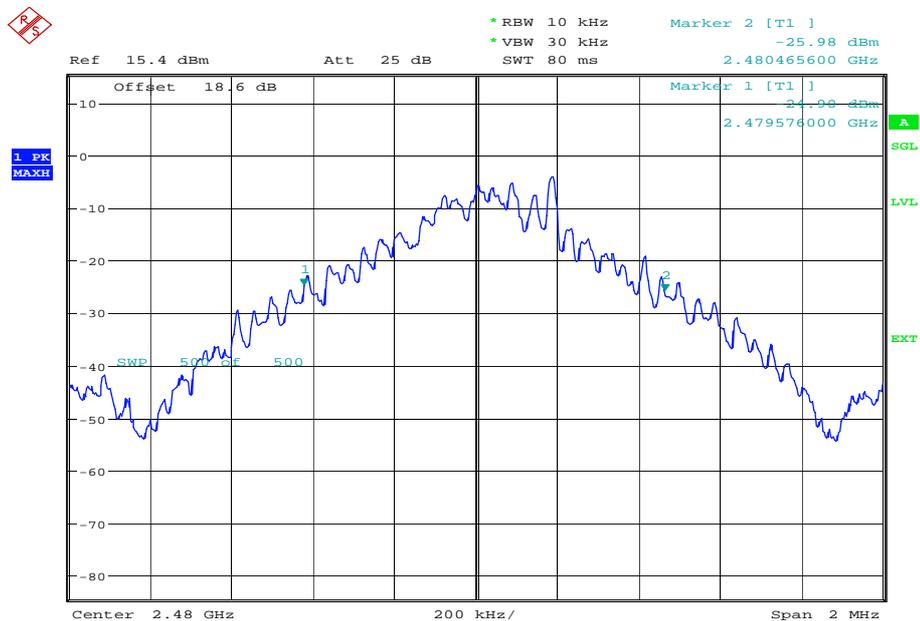
Product Service

DH3



Date: 8.JAN.2014 10:56:57

DH5



Date: 8.JAN.2014 10:42:38

Limit Clause

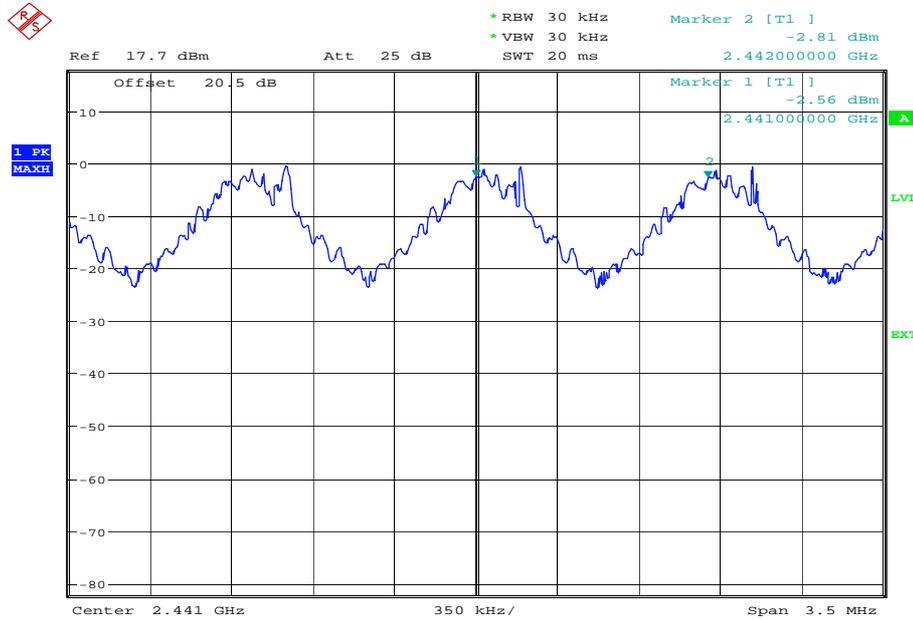
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater.



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Channel Separation

Channel Separation: 1.00 MHz



Date: 8.JAN.2014 10:38:59

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

**2.3 FREQUENCY HOPPING SYSTEMS - CHANNEL DWELL TIME AND NUMBER OF HOPPING CHANNELS**

**2.3.1 Specification Reference**

FCC CFR 47 Part 15C, Clause 15.247 (a)(1)(iii)

**2.3.2 Equipment Under Test and Modification State**

SHL24 S/N: IMEI 004401115003390 - Modification State 0

**2.3.3 Date of Test**

7 January 2014

**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**

DH1

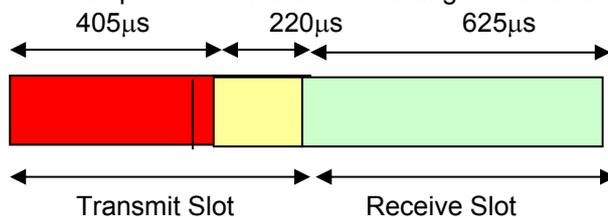
The Bluetooth system hops at a rate of 1600 times per second. Thus, this equates to 1600 timeslots in 1 second.

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:

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

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.





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DH1 Timeslot Arrangement Showing One Complete Transmit and Receive Cycle

So, with 800 Tx and 800 Rx timeslots, the transmitter is on for  $800 \times 405\mu\text{s} = 0.324$  seconds.

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

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

$$32 \times 4.05\text{ms} = 0.1296 \text{ seconds}$$

DH3

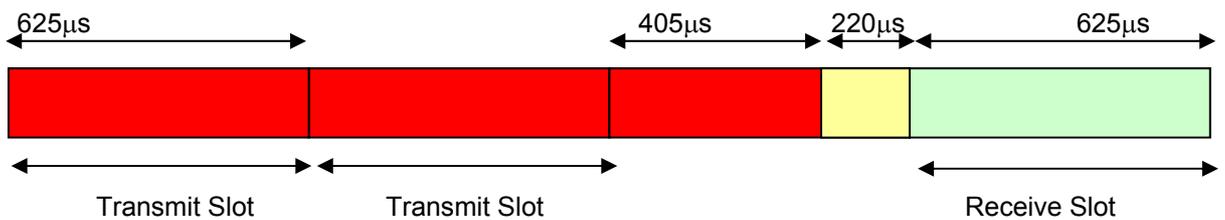
With data rate DH3, the data payload is higher and can use up to 3 timeslots. When more than one timeslot is used, the frequency does not hop and transmission is continuous on all 3 slots, (ie. no receive slot in-between the 3 transmit slots). The  $220\mu\text{s}$  off time for synthesizer re-tuning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

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  $625\mu\text{s}$ . In the third transmit slot, the transmit on time is only  $405\mu\text{s}$ .  $220\mu\text{s}$  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:

$$\text{Tx} \quad (2 \times 625\mu\text{s}) + (1 \times 405\mu\text{s}) = 1.655\text{ms}$$

So:

$$\begin{aligned} 800 \times 625\mu\text{s} &= 0.5 \text{ seconds} \\ 400 \times 405\mu\text{s} &= 0.162 \text{ seconds} \end{aligned}$$

Thus:  $0.5 + 0.162 = 0.662 \text{ seconds}$

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

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

$$32 \times 8.275\text{ms} = 0.2648 \text{ seconds}$$

DH5

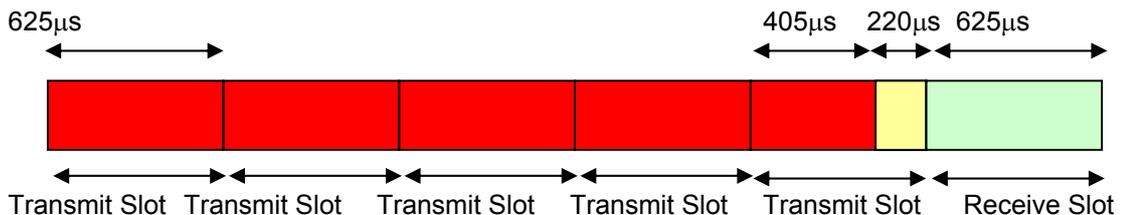
With data rate DH5, the data payload is higher and can use up to 5 timeslots. When more than one timeslot is used, the frequency does not hop and transmission is continuous on all 5 slots, (ie. no receive slot in-between the 5 transmit slots). The 220µs off time for synthesizer re-tuning at the end of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





Product Service

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:

$$\text{Tx} \quad (2 \times 625\mu\text{s}) + (1 \times 405\mu\text{s}) \quad = \quad 2.905\text{ms}$$

So:

$$1066.7 \times 625\mu\text{s} \quad = \quad 0.666 \text{ seconds}$$

$$266.7 \times 405\mu\text{s} \quad = \quad 0.108 \text{ seconds}$$

$$\text{Thus:} \quad 0.666 + 0.108 = 0.774 \text{ seconds}$$

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

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

$$32 \times 9.675\text{ms} = \quad 0.31 \text{ seconds}$$

### 2.3.6 Environmental Conditions

Ambient Temperature      24.2°C

Relative Humidity          37.6%



Product Service

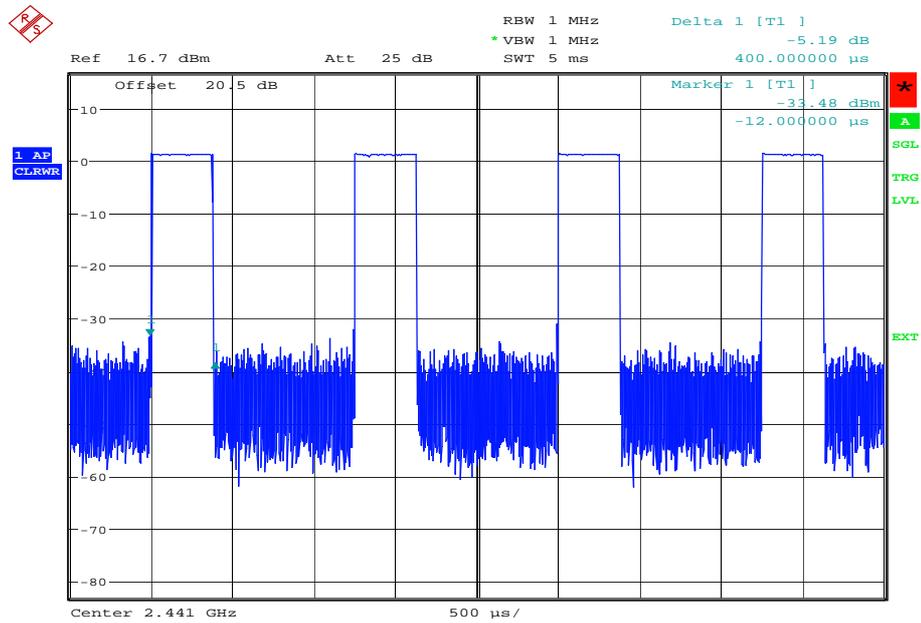
### 2.3.7 Test Results

4.0 V DC Supply

Channel Dwell Time

DH1

0.40 ms

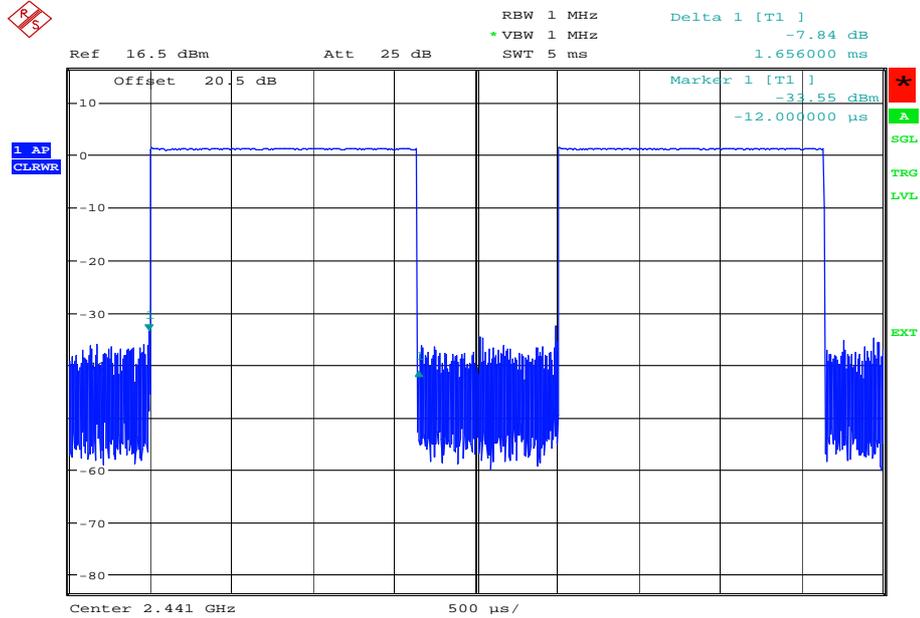




Product Service

DH3

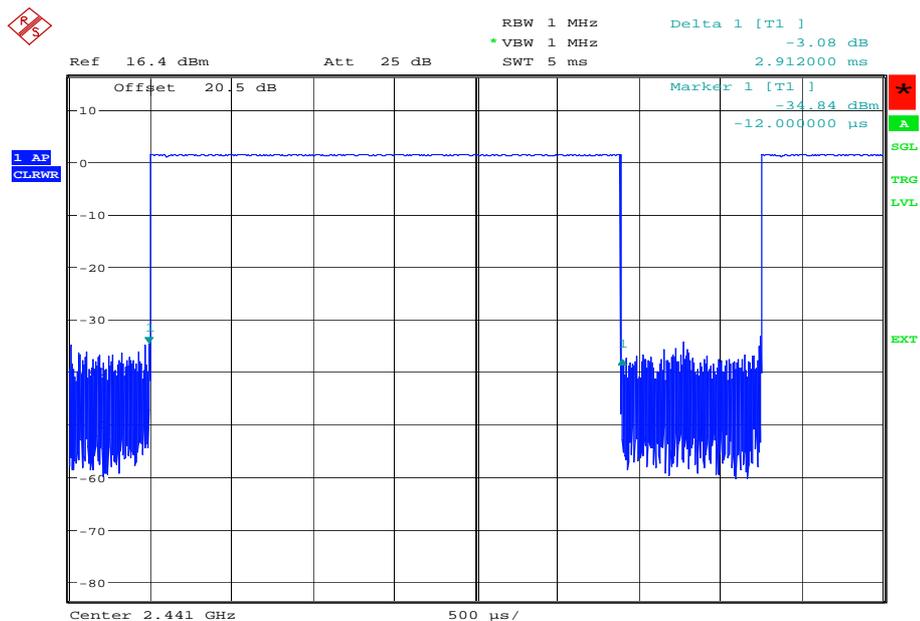
1.656 ms



Date: 7.JAN.2014 18:07:59

DH5

2.912 ms



Date: 8.JAN.2014 10:26:13



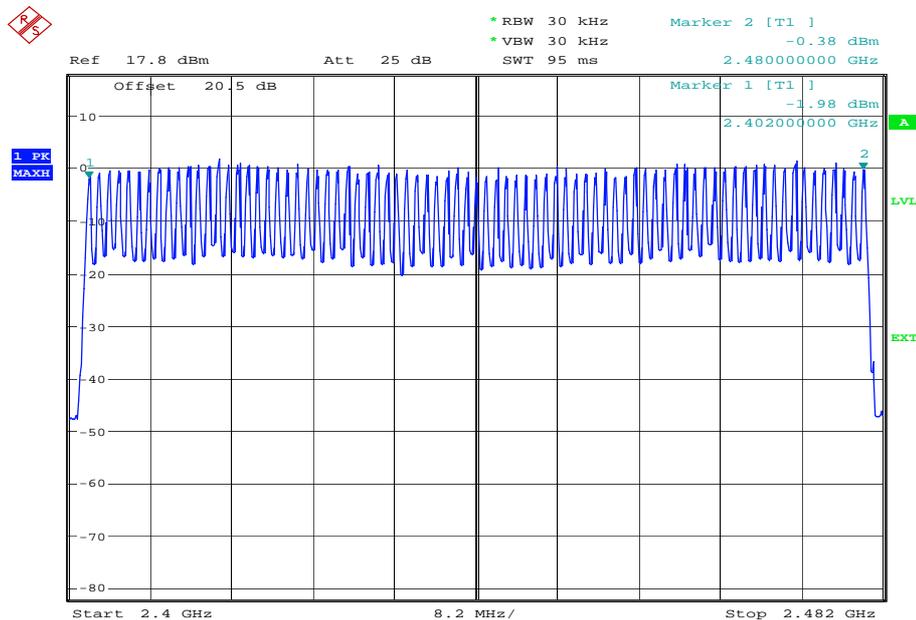
Product Service

Limit

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



Date: 8.JAN.2014 10:34:30

Limit

≥ 15 channels



Product Service

## **2.4 MAXIMUM PEAK CONDUCTED OUTPUT POWER**

### **2.4.1 Specification Reference**

FCC CFR 47 Part 15C, Clause 15.247 (b)(3)

### **2.4.2 Equipment Under Test and Modification State**

SHL24 S/N: IMEI 004401115003390 - Modification State 0

### **2.4.3 Date of Test**

8 January 2014

### **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**

The EUT was connected to a Peak Power Meter via a cable and attenuator. The path loss between the EUT and sensor was measured and entered as an offset. Measurements were made on the bottom, middle and top channels on all supported data rates.

### **2.4.6 Environmental Conditions**

Ambient Temperature	24.2°C
Relative Humidity	37.6%



Product Service

**2.4.7 Test Results**

4.0 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	0.54	0.37	0.19	1.134	1.088	1.046
DH3	0.75	0.17	0.24	1.188	1.040	1.058
DH5	0.72	0.07	0.28	1.180	1.016	1.066

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.



Product Service

## **2.5 EIRP PEAK POWER**

### **2.5.1 Specification Reference**

FCC CFR 47 Part 15C, Clause 15.247 (b)(4)

### **2.5.2 Equipment Under Test and Modification State**

SHL24 S/N: IMEI 004401115003556 - Modification State 0

### **2.5.3 Date of Test**

10 January 2014

### **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 transmitted at maximum power via a cable to the Spectrum Analyser. The Analyser settings were adjusted to display the resultant trace on screen and a resolution bandwidth and video bandwidth of 1 MHz were used to perform the measurement. The level on the spectrum analyser was maximised by rotating the EUT through 360° and a height search of the measuring antenna. A substitution was then performed using a suitable calibrated antenna and signal generator.

This level was maximised by adjusting the height of the measuring antenna once more. The level from the signal generator was then adjusted to achieve the same raw result as with the EUT. This level was then corrected to account for cable loss and antenna factor. A peak power analyser was also used to obtain a correction factor for the wideband signal.

A calculation was then performed to obtain the final figure.

### **2.5.6 Environmental Conditions**

Ambient Temperature	18.5 - 19.7°C
Relative Humidity	47.0%

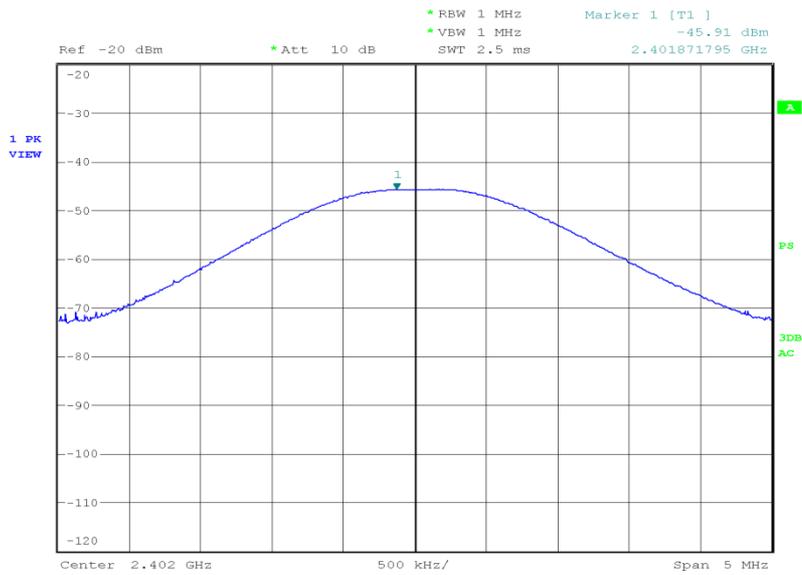


Product Service

2.5.7 Test Results

2402 MHz

EIRP (dBm)	EIRP (mW)
-3.78	0.418



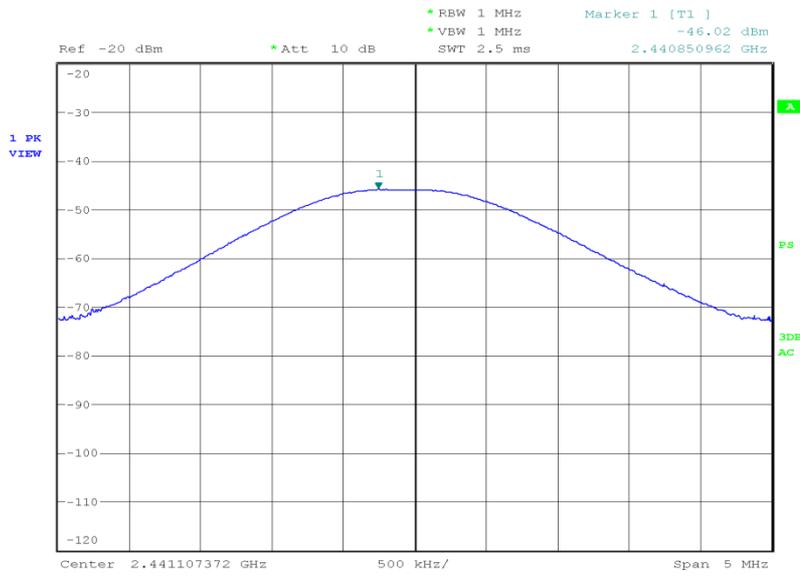
Date: 9.JAN.2014 23:27:36



Product Service

2441 MHz

EIRP (dBm)	EIRP (mW)
-3.29	0.468



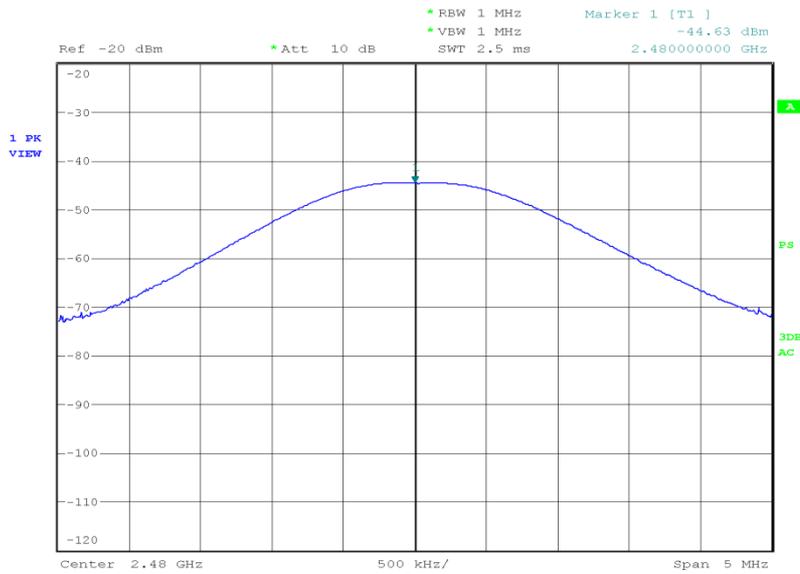
Date: 9.JAN.2014 23:48:20



Product Service

2480 MHz

EIRP (dBm)	EIRP (mW)
-2.71	0.535



Date: 9.JAN.2014 23:41:22

Limit

EIRP (dBm)	EIRP (mW)
36.0	4000



## 2.6 SPURIOUS AND BAND EDGE EMISSIONS

### 2.6.1 Specification Reference

FCC CFR 47 Part 15C, Clause 15.247 (d)

### 2.6.2 Equipment Under Test and Modification State

SHL24 S/N: IMEI 004401115003556 - Modification State 0

### 2.6.3 Date of Test

8 January 2014, 9 January 2014, 10 January 2014 & 11 January 2014

### 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 as 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 6.9.2. 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	19.5 - 27.6°C
Relative Humidity	25.0 - 48.0%



Product Service

### 2.6.7 Test Results

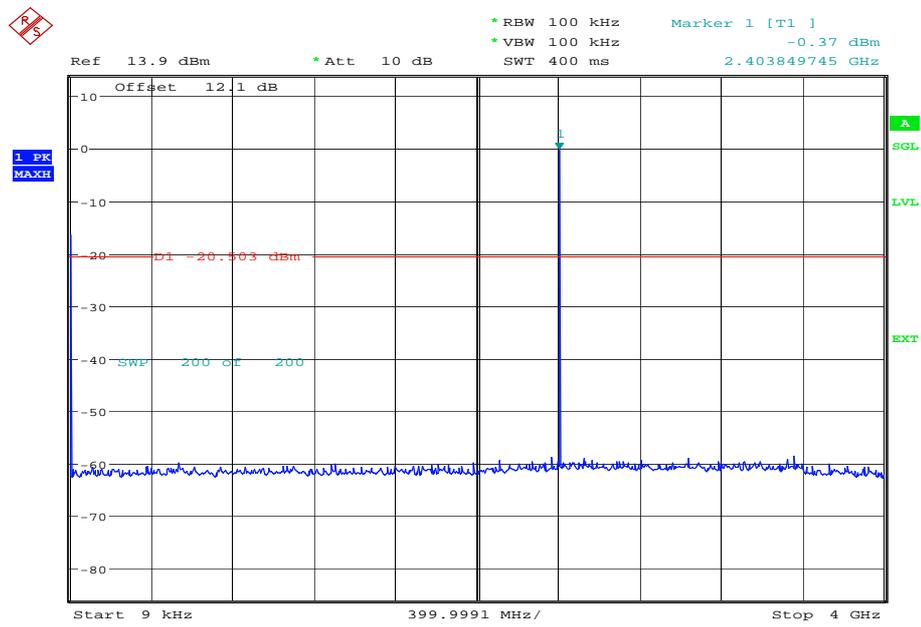
4.0 V DC Supply

Spurious Conducted Emissions

DH5

2402 MHz

9 kHz to 4 GHz

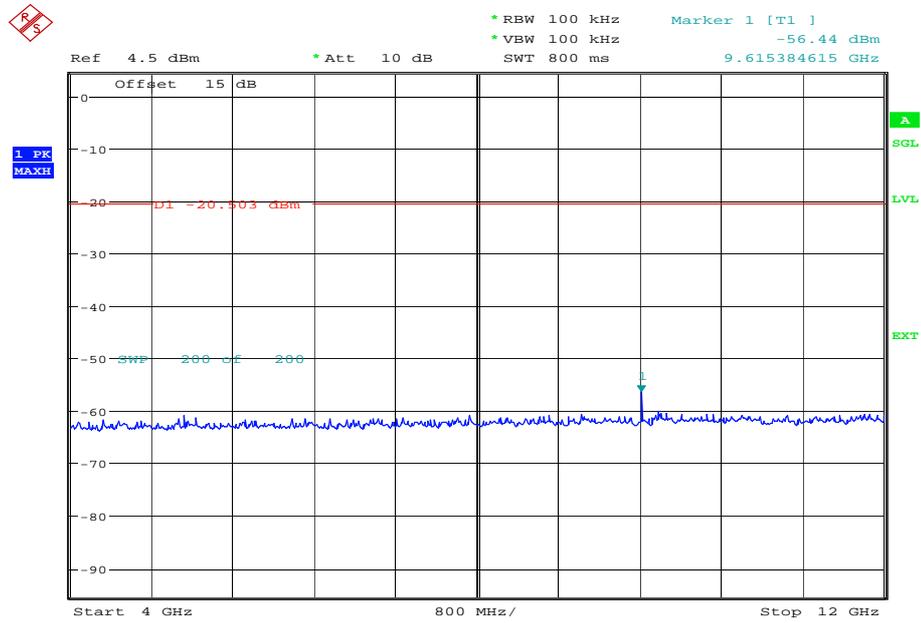


Date: 8.JAN.2014 17:02:37



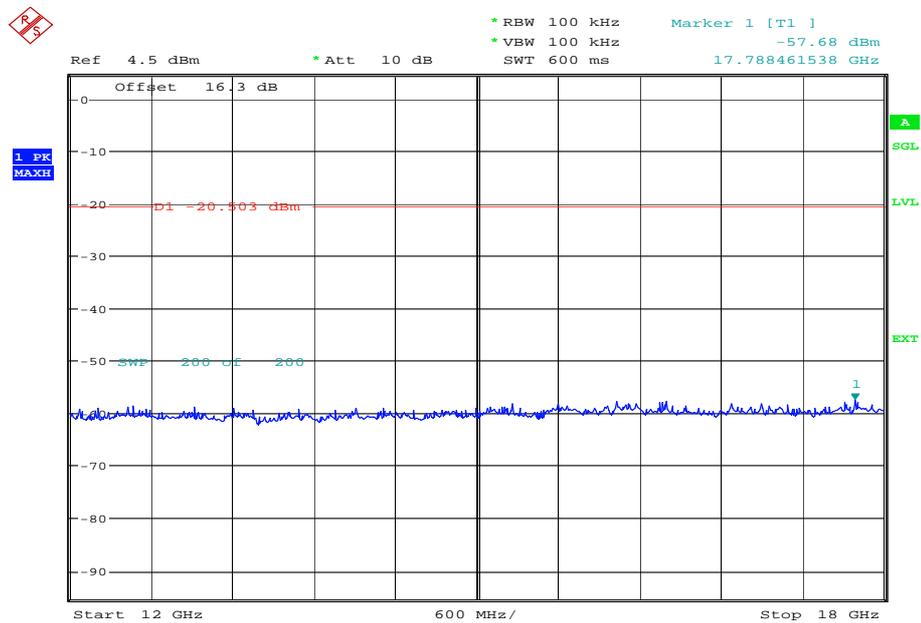
Product Service

### 4 GHz to 12 GHz



Date: 9.JAN.2014 16:11:35

### 12 GHz to 18 GHz

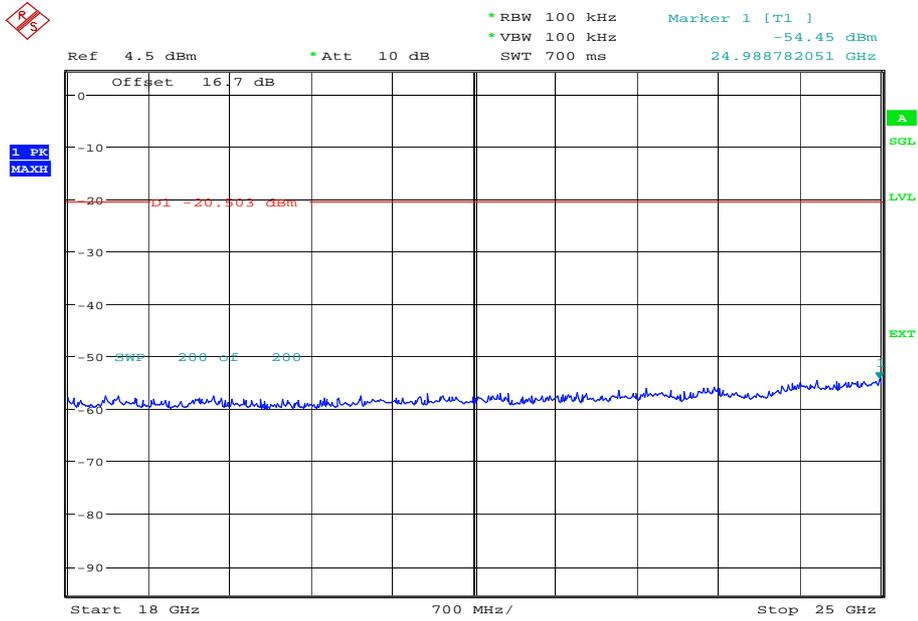


Date: 9.JAN.2014 15:27:19



Product Service

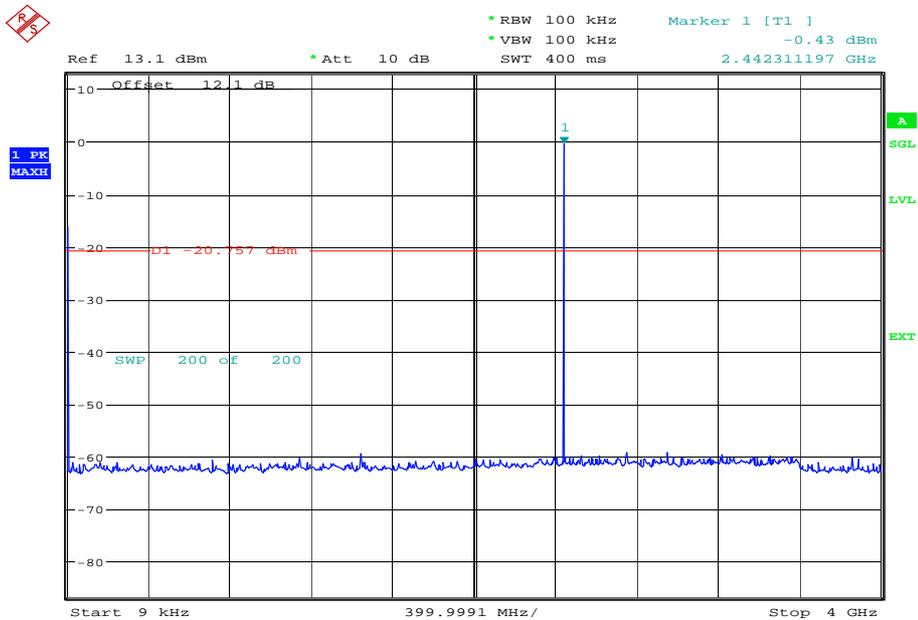
18 GHz to 25 GHz



Date: 8.JAN.2014 17:27:10

2441 MHz

9 kHz to 4 GHz

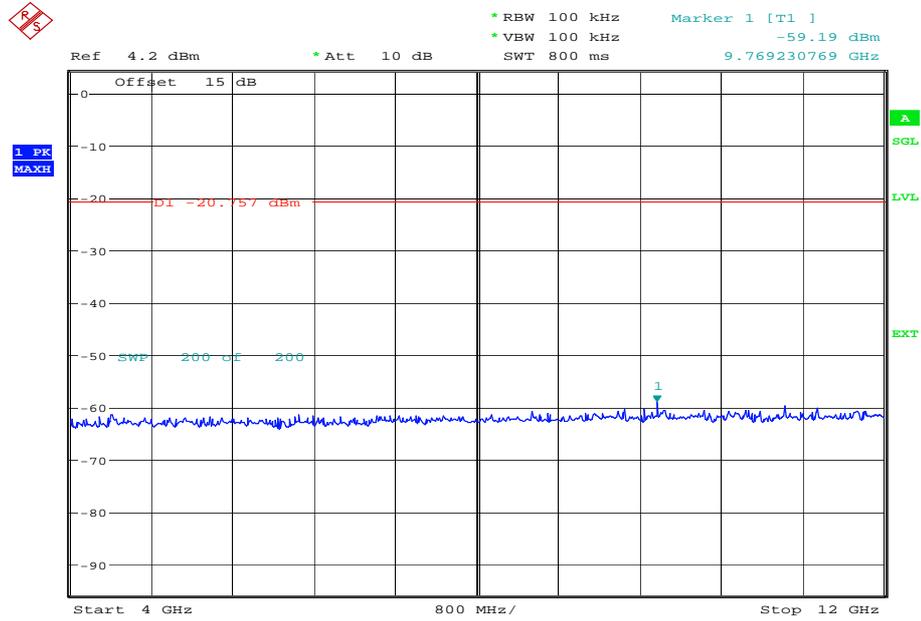


Date: 8.JAN.2014 17:07:39

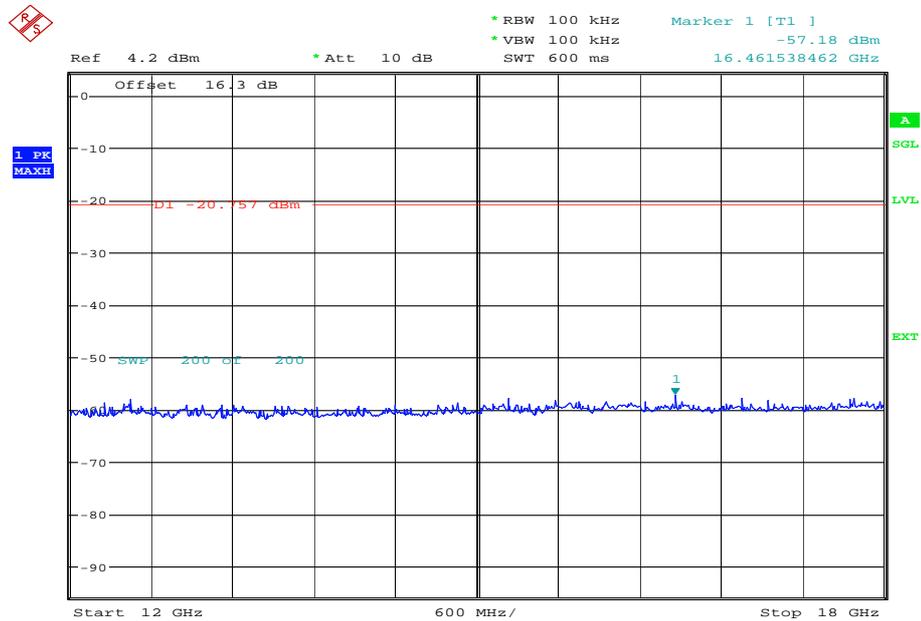


Product Service

4 GHz to 12 GHz



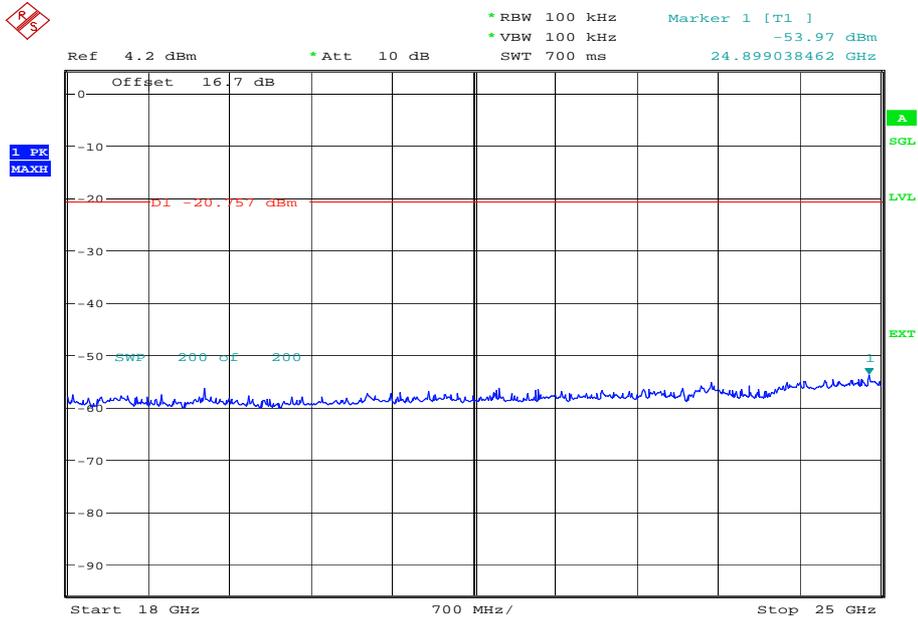
12 GHz to 18 GHz





Product Service

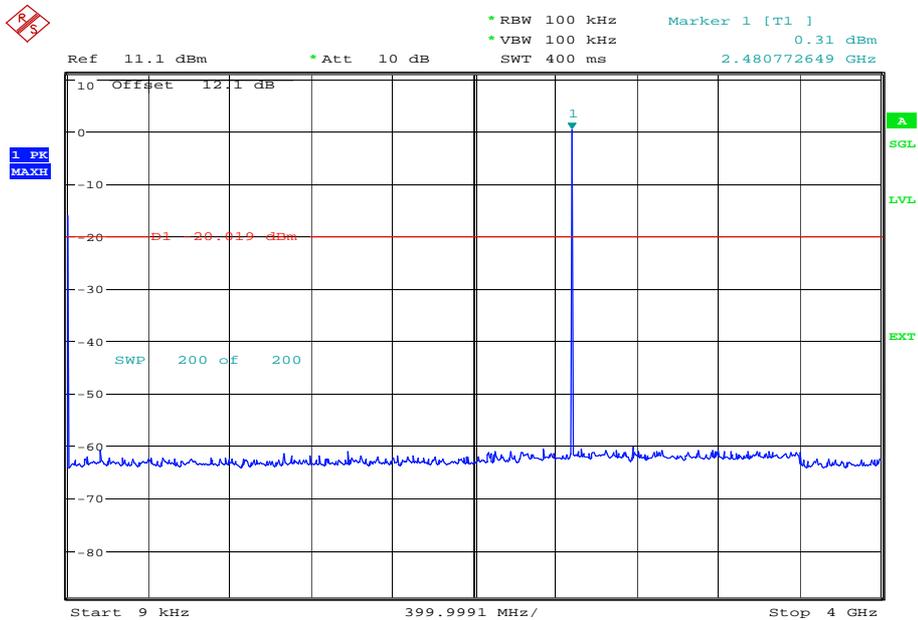
18 GHz to 25 GHz



Date: 8.JAN.2014 17:23:49

2480 MHz

9 kHz to 4 GHz

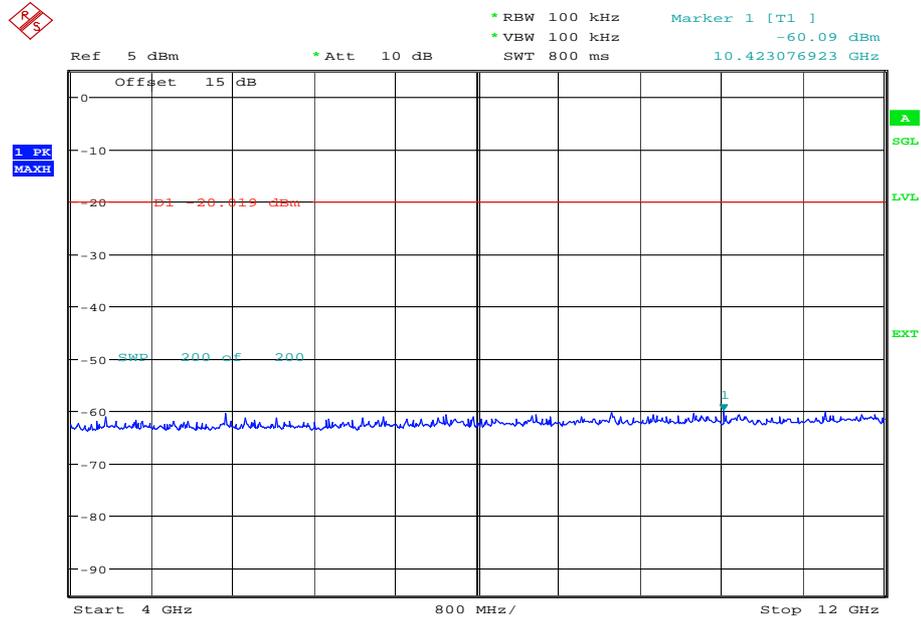


Date: 8.JAN.2014 17:10:27



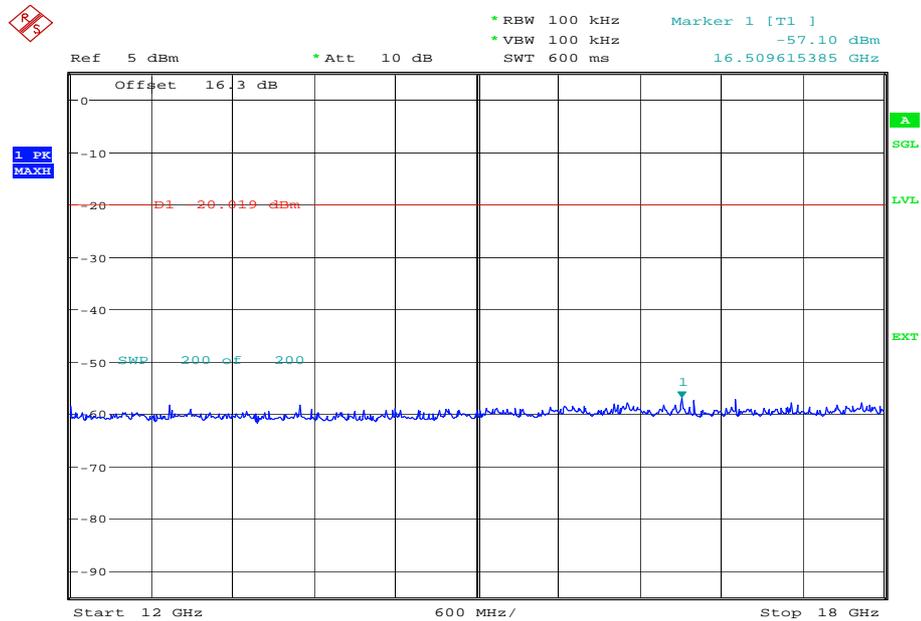
Product Service

### 4 GHz to 12 GHz



Date: 9.JAN.2014 15:44:00

### 12 GHz to 18 GHz

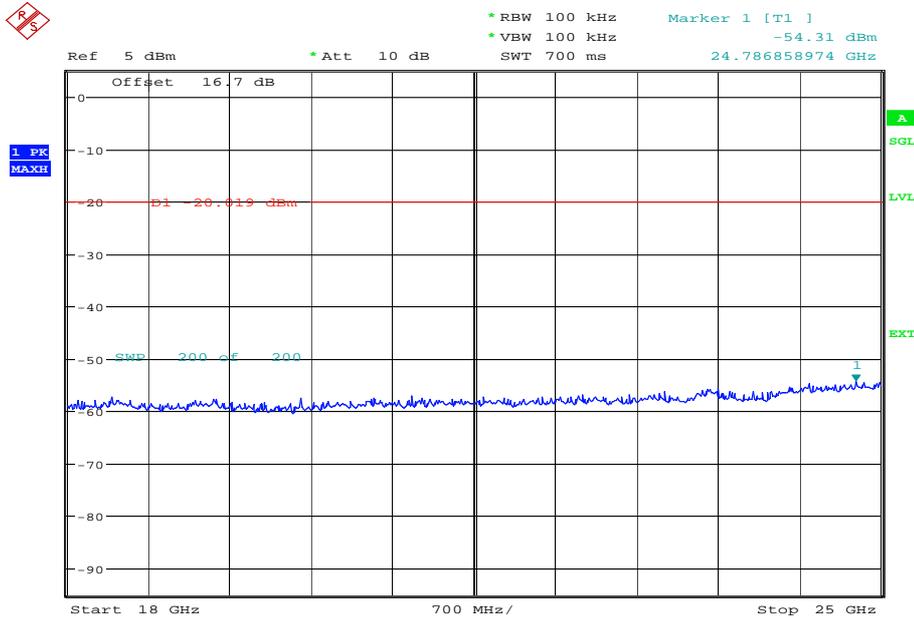


Date: 9.JAN.2014 15:46:42



Product Service

18 GHz to 25 GHz



Date: 8.JAN.2014 17:19:47

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.

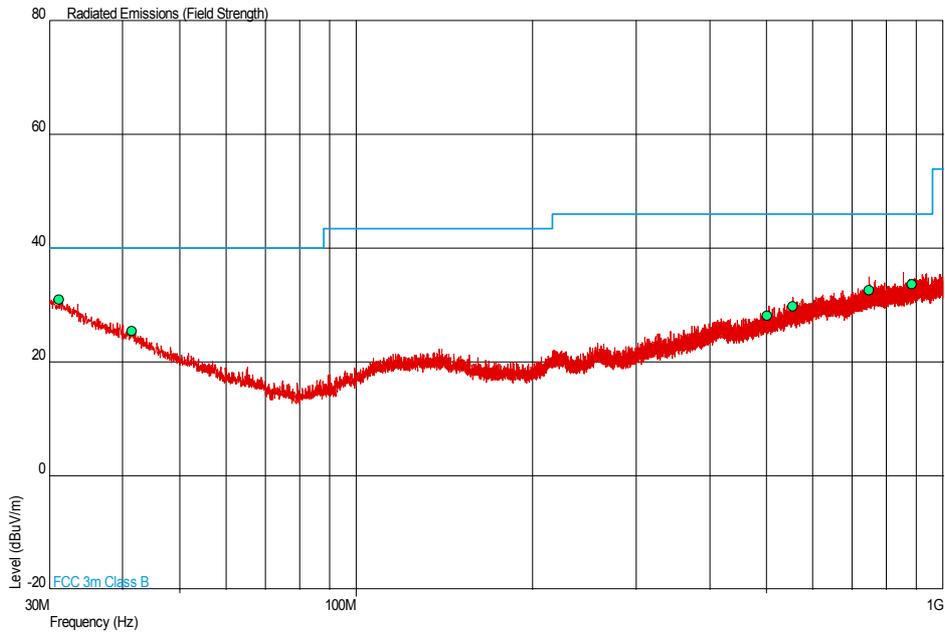
If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval the attenuation required shall be 30 dB instead of 20 dB.



Spurious Radiated Emissions

2402 MHz

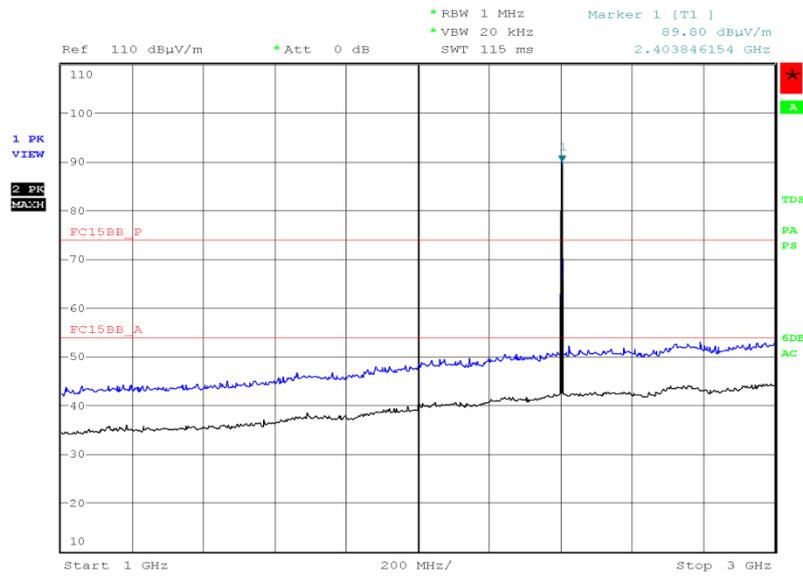
30 MHz to 1 GHz



Frequency (MHz)	QP Level (dBuV/m)	QP Level (uV/m)	QP Limit (dBuV/m)	QP Limit (uV/m)	QP Margin (dBuV/m)	QP Margin (uV/m)	Angle (Deg)	Height (m)	Polarity
31.163	31.0	35.5	40.0	100	-9.0	64.5	71	2.82	Horizontal
41.495	25.5	18.8	40.0	100	-14.5	81.2	360	1.00	Horizontal
502.194	28.1	25.4	46.0	200	-17.9	174.6	156	1.00	Horizontal
553.928	29.7	30.5	46.0	200	-16.3	169.5	238	1.00	Vertical
746.780	32.7	43.2	46.0	200	-13.3	156.8	58	1.00	Vertical
885.814	33.7	48.4	46.0	200	-12.3	151.6	196	3.82	Horizontal

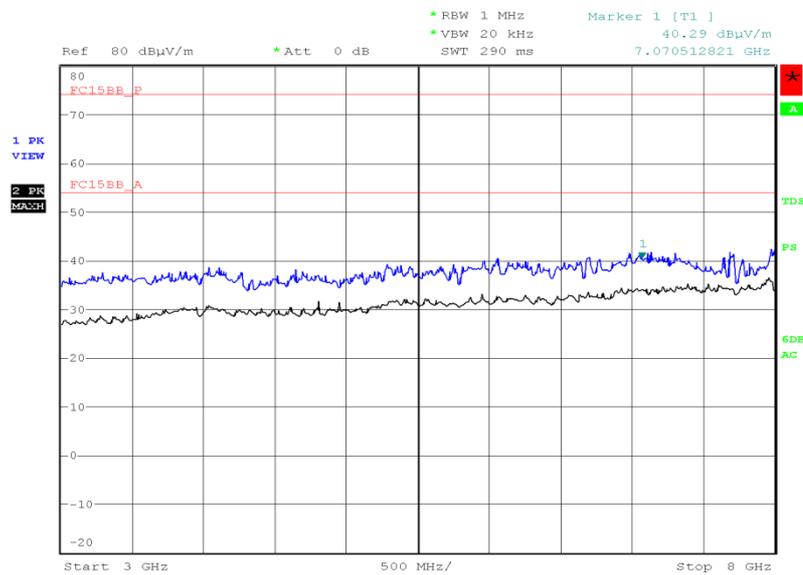


1 GHz to 3 GHz



Date: 10.JAN.2014 00:59:47

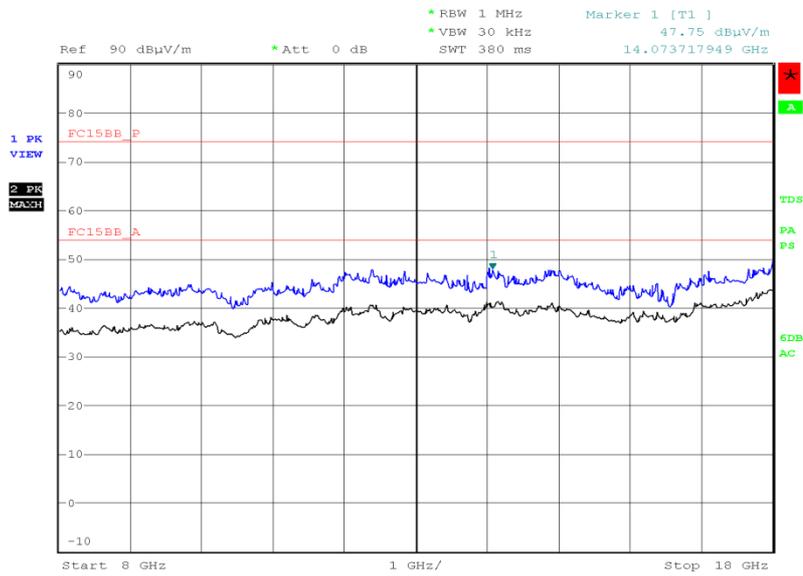
3 GHz to 8 GHz



Date: 10.JAN.2014 21:17:34

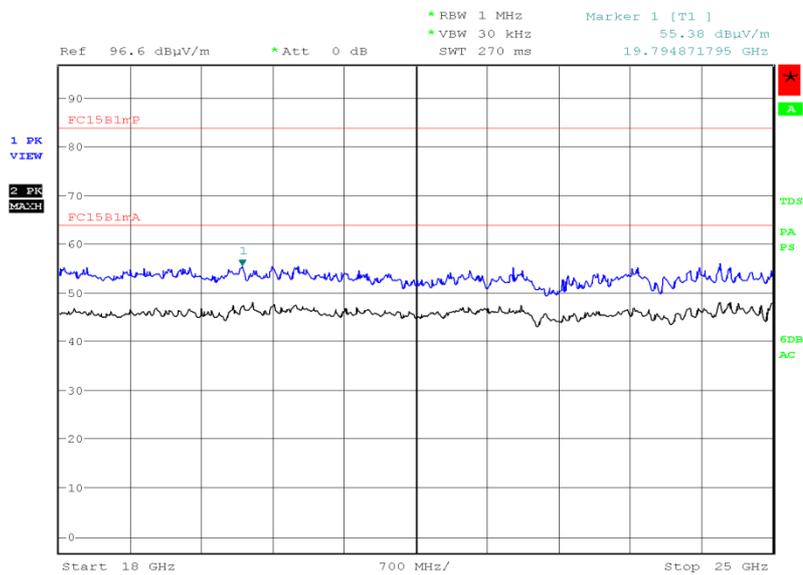


8 GHz to 18 GHz



Date: 11.JAN.2014 01:05:19

18 GHz to 25 GHz

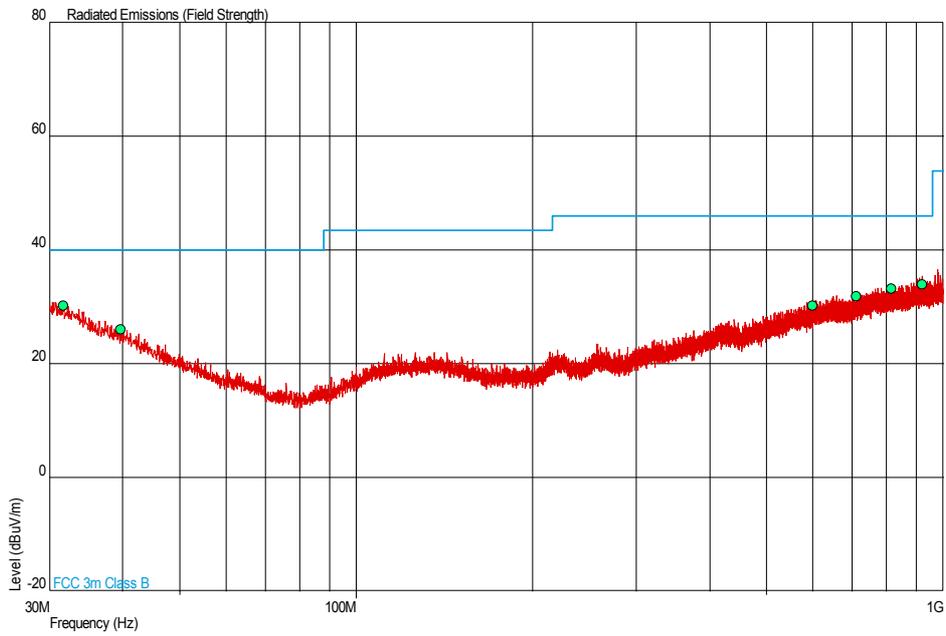


Date: 11.JAN.2014 02:15:32



2441 MHz

30 MHz to 1 GHz

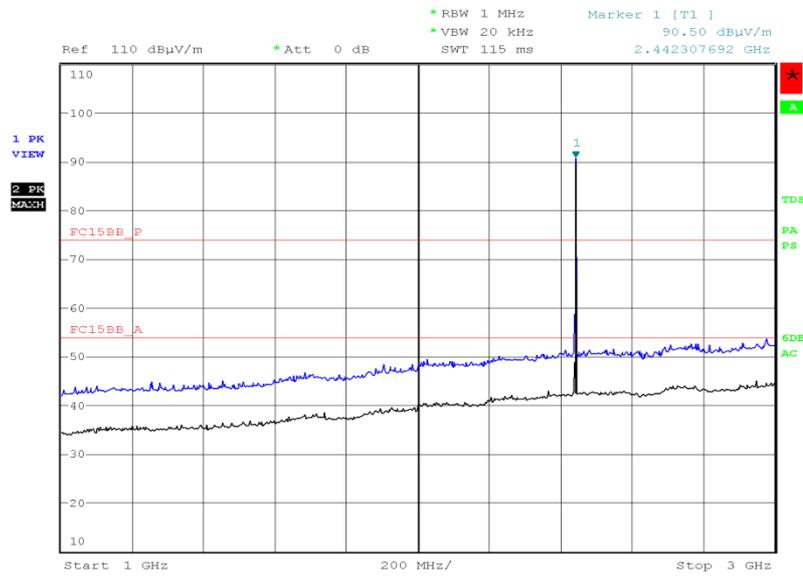


Frequency (MHz)	QP Level (dBµV/m)	QP Level (µV/m)	QP Limit (dBµV/m)	QP Limit (µV/m)	QP Margin (dBµV/m)	QP Margin (µV/m)	Angle (Deg)	Height (m)	Polarity
31.699	30.3	32.7	40.0	100	-9.7	67.3	360	2.46	Horizontal
39.716	26.1	20.2	40.0	100	-13.9	79.8	106	1.54	Horizontal
599.119	30.2	32.4	46.0	200	-15.8	167.6	171	3.21	Horizontal
712.030	31.9	39.4	46.0	200	-14.1	160.6	202	1.00	Vertical
815.696	33.2	45.7	46.0	200	-12.8	154.3	163	1.00	Vertical
919.642	34.0	50.1	46.0	200	-12.0	149.9	360	1.00	Horizontal



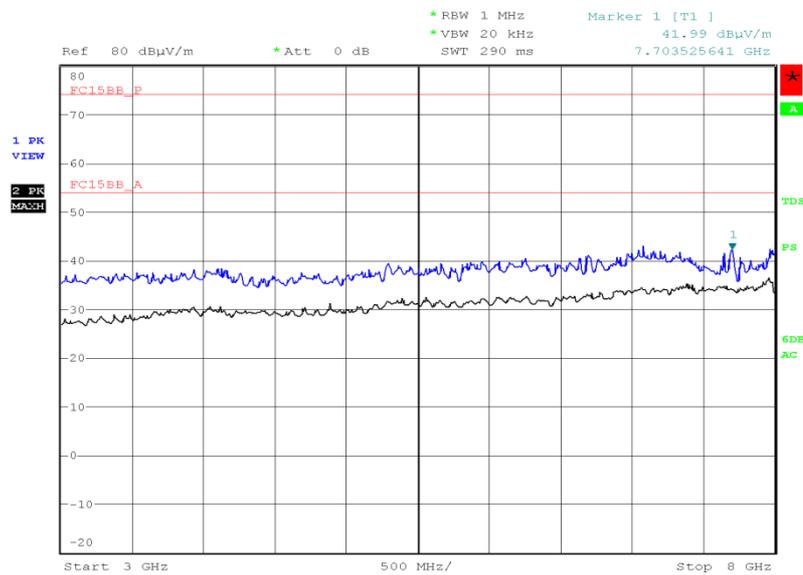
Product Service

1 GHz to 3 GHz



Date: 10.JAN.2014 00:52:29

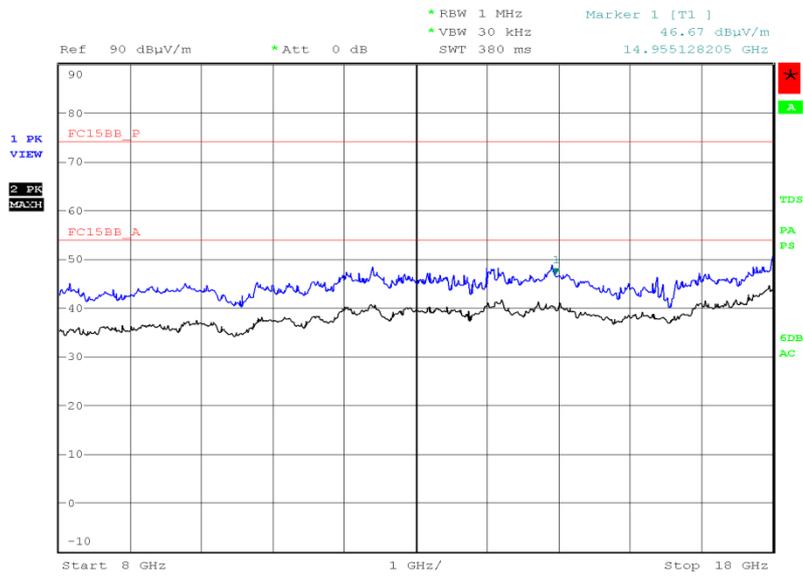
3 GHz to 8 GHz



Date: 10.JAN.2014 21:12:56

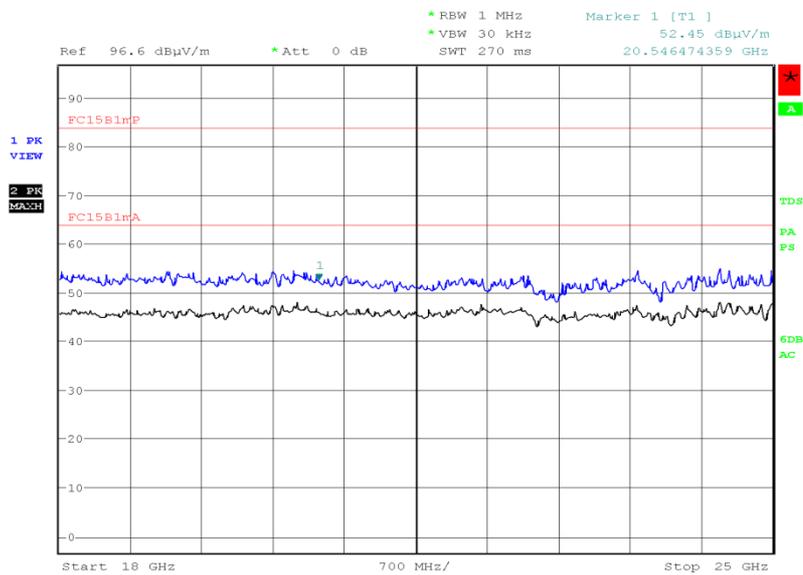


8 GHz to 18 GHz



Date: 11.JAN.2014 01:15:09

18 GHz to 25 GHz

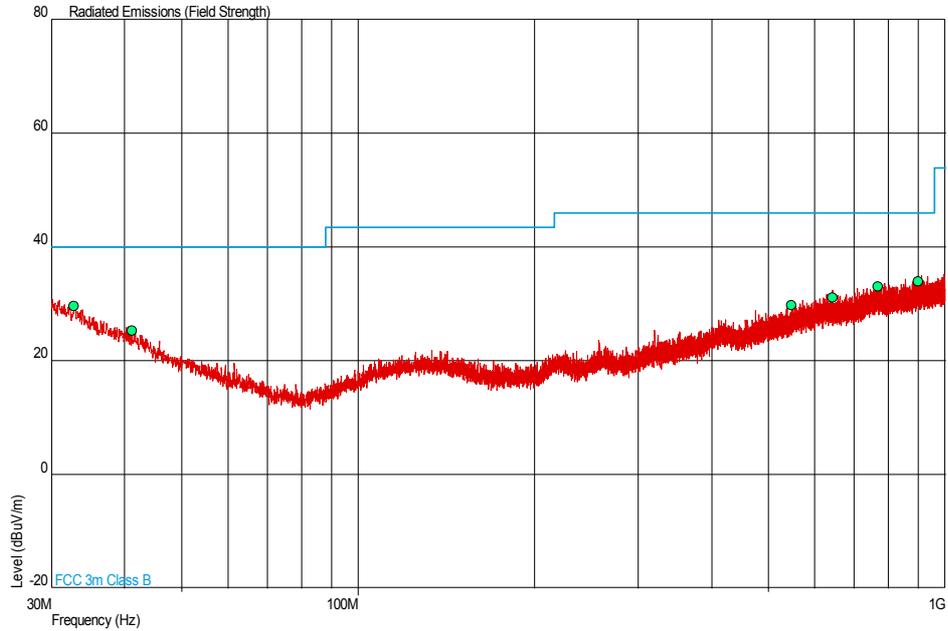


Date: 11.JAN.2014 02:21:49



2480 MHz

30 MHz to 1 GHz



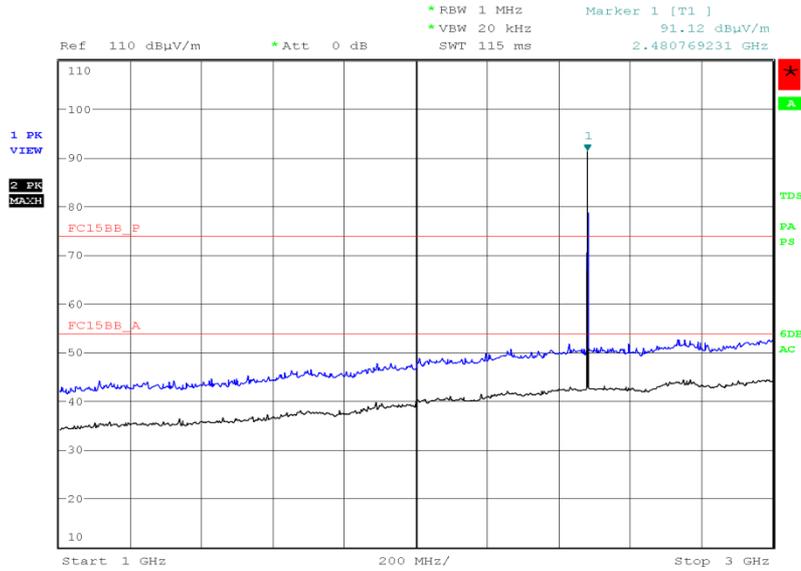
Frequency (MHz)	QP Level (dBµV/m)	QP Level (µV/m)	QP Limit (dBµV/m)	QP Limit (µV/m)	QP Margin (dBµV/m)	QP Margin (µV/m)	Angle (Deg)	Height (m)	Polarity
32.816	29.7	30.5	40.0	100	-10.3	69.5	89	1.00	Horizontal
41.261	25.3	18.4	40.0	100	-14.7	81.6	286	1.42	Horizontal
546.746	29.8	30.9	46.0	200	-16.2	169.1	67	2.41	Vertical
643.009	31.2	36.3	46.0	200	-14.8	163.7	274	2.80	Horizontal
768.693	33.1	45.2	46.0	200	-12.9	154.8	4	1.00	Vertical
900.591	34.0	50.1	46.0	200	-12.0	149.9	299	1.00	Horizontal



1 GHz to 25 GHz

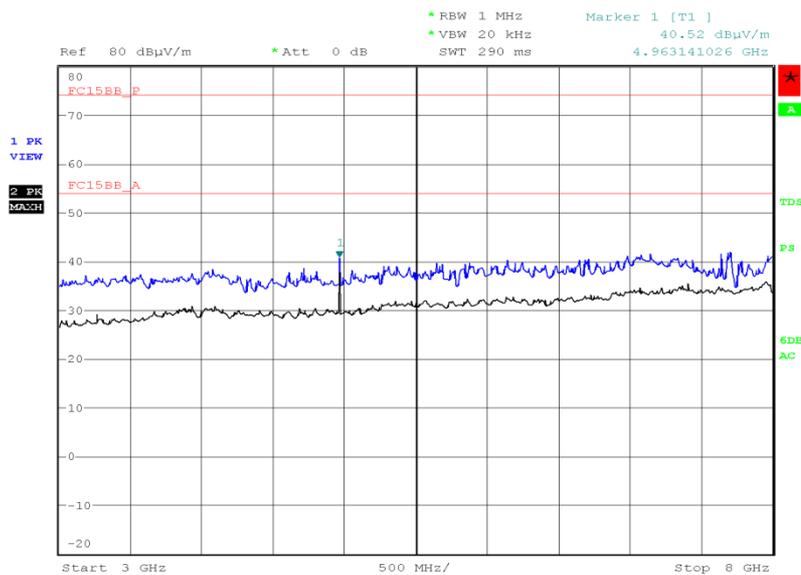
Frequency (GHz)	Antenna Polarisation	Antenna Height (cm)	EUT Arc (degrees)	Final Peak (dBµV/m)	Final Average (dBµV/m)
4.960	Horizontal	110	55	47.3	41.1

1 GHz to 3 GHz



Date: 10.JAN.2014 00:45:20

3 GHz to 8 GHz

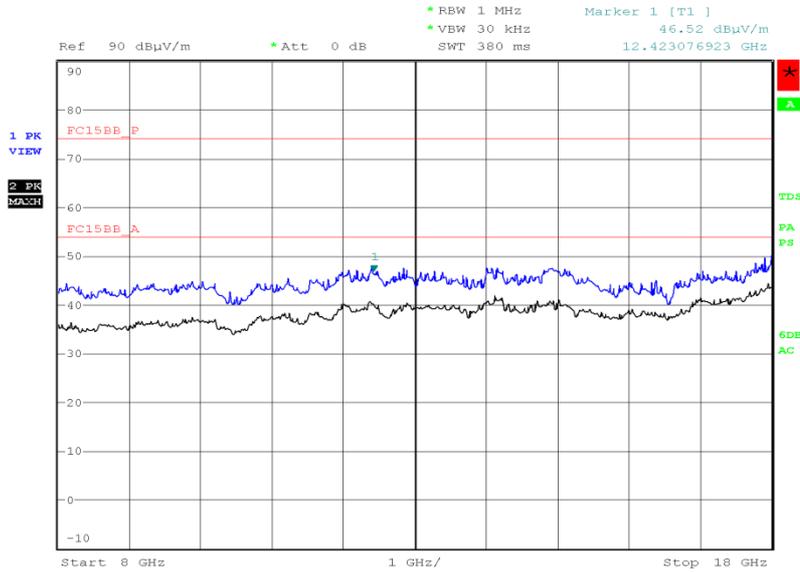


Date: 10.JAN.2014 21:25:41



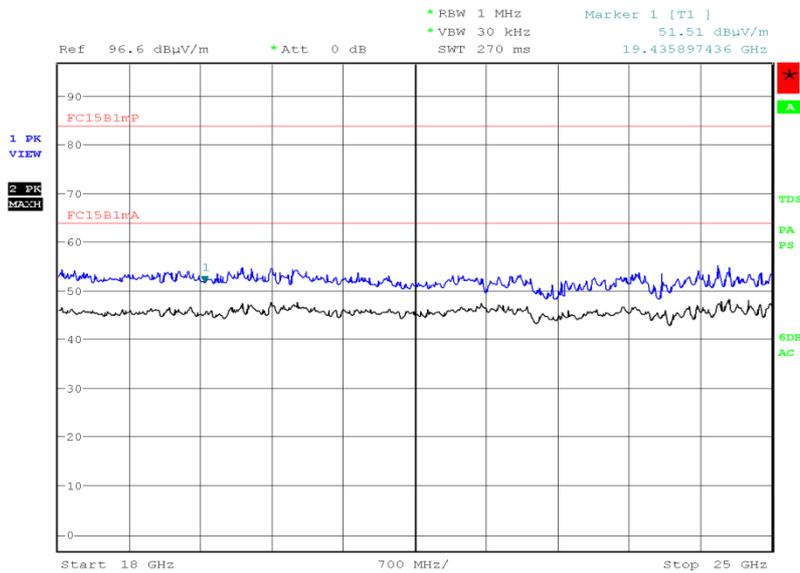
Product Service

8 GHz to 18 GHz



Date: 11.JAN.2014 01:21:36

18 GHz to 25 GHz



Date: 11.JAN.2014 02:26:27

Limit

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

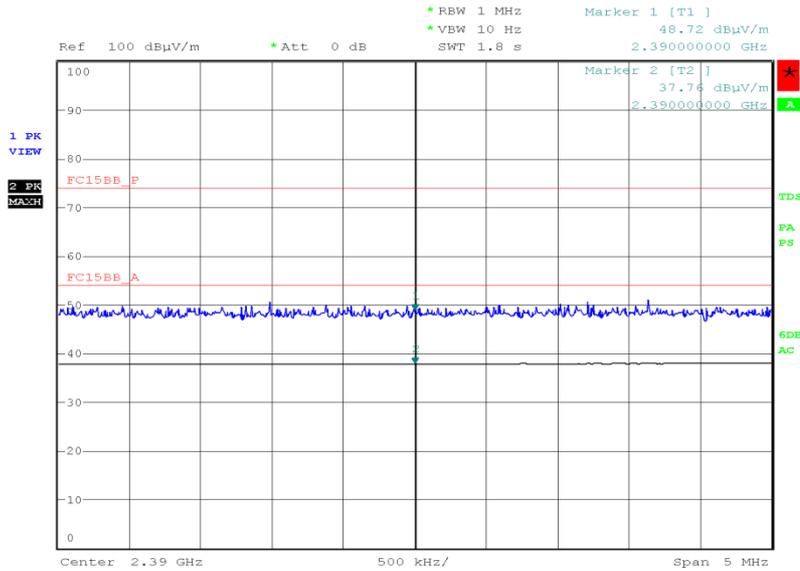


Product Service

Band Edge Emissions

2402 MHz

Polarisation	Final Peak (dBµV/m)	Final Average (dBµV/m)
Horizontal	48.72	37.76

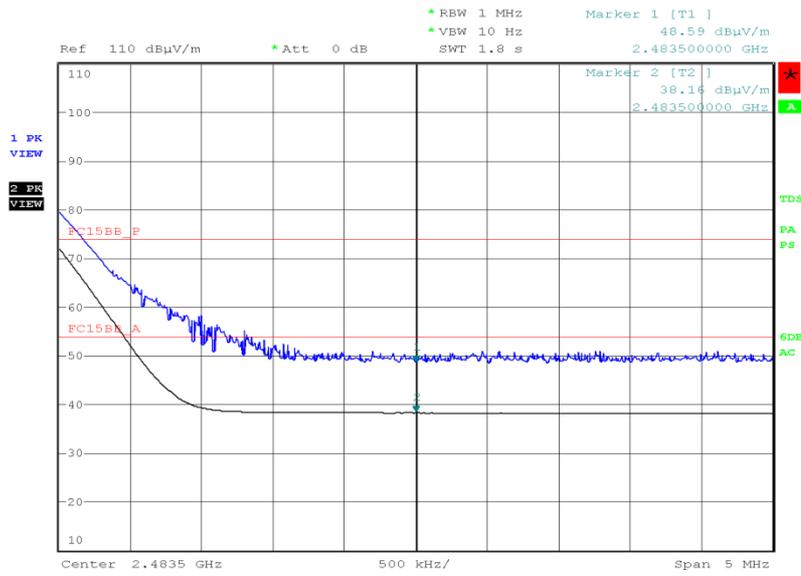


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2480 MHz

Polarisation	Final Peak (dBµV/m)	Final Average (dBµV/m)
Horizontal	48.59	38.16



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Limit

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



Product Service

### **SECTION 3**

#### **TEST EQUIPMENT USED**



### 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
<b>Section 2.1 – AC Line Conducted Emissions</b>					
Amplifier (18GHz-26.5GHz)	Avantek	AMT-26177-33	236	12	TU
LISN (1 Phase)	Chase	MN 2050	336	12	28-Mar-2014
Screened Room (5)	Rainford	Rainford	1545	36	25-Jan-2014
Transient Limiter	Hewlett Packard	11947A	2377	12	13-Feb-2014
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Oct-2014
7m Armoured RF Cable	SSI Cable Corp.	1501-13-13-7m WA(-)	3600	-	TU
<b>Section 2.2 - Frequency Hopping Systems - 20dB Bandwidth and Channel Separation</b>					
Power Supply Unit	Farnell	LT-30-2	41	-	O/P Mon
GPS Frequency Standard	Rapco	GPS-804/3	1312	6	24-Jan-2014
Digital Multimeter	Fluke	75 Series II	2360	12	30-Apr-2014
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	15-Nov-2014
Hygrometer	Rotronic	I-1000	3220	12	16-Jul-2014
Power Divider (N) 1W	Weinschel	1506A	3344	12	28-Jun-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	13-Sep-2014
P-Series Power Meter	Agilent Technologies	N1911A	3980	12	18-Sep-2014
50 MHz-18 GHz Wideband Power Sensor	Agilent Technologies	N1921A	3982	12	18-Sep-2014
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	18-Sep-2014
<b>Section 2.3 - Frequency Hopping Systems - Channel Dwell Time and Number of Hopping Channels</b>					
Power Supply Unit	Farnell	LT-30-2	41	-	O/P Mon
GPS Frequency Standard	Rapco	GPS-804/3	1312	6	24-Jan-2014
Digital Multimeter	Fluke	75 Series II	2360	12	30-Apr-2014
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	15-Nov-2014
Hygrometer	Rotronic	I-1000	3220	12	16-Jul-2014
Power Divider (N) 1W	Weinschel	1506A	3344	12	28-Jun-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	13-Sep-2014
P-Series Power Meter	Agilent Technologies	N1911A	3980	12	18-Sep-2014
50 MHz-18 GHz Wideband Power Sensor	Agilent Technologies	N1921A	3982	12	18-Sep-2014
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	18-Sep-2014
<b>Section 2.4 - Maximum Peak Output Power</b>					
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	234	12	3-Apr-2014
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Radio Communications Test Set	Rohde & Schwarz	CMU 200	3035	12	25-Oct-2014
Signal Generator (10MHz to 40GHz)	Rohde & Schwarz	SMR40	3171	12	10-Sep-2014
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Oct-2014
Tilt Antenna Mast	maturo GmbH	TAM 4.0-P	3916	-	TU
Mast Controller	maturo GmbH	NCD	3917	-	TU



Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
<b>Section 2.5 - EIRP Peak Power</b>					
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	234	12	3-Apr-2014
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
GPS/SBAS Simulator	Spirent	STR4500	3056	-	TU
Antenna (DRG Horn)	ETS-LINDGREN	3115	3125	12	17-Jul-2014
Signal Generator (10MHz to 40GHz)	Rohde & Schwarz	SMR40	3171	12	10-Sep-2014
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Oct-2014
Tilt Antenna Mast	matur GmbH	TAM 4.0-P	3916	-	TU
Mast Controller	matur GmbH	NCD	3917	-	TU
<b>Section 2.6 - Spurious and Band Edge Emissions</b>					
Power Supply Unit	Farnell	LT-30-2	41	-	O/P Mon
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	234	12	3-Apr-2014
Antenna (Bilog)	Schaffner	CBL6143	287	24	18-Jan-2014
Antenna (Double Ridge Guide)	Q-Par Angus Ltd	QSH 180K	1511	24	7-Nov-2014
Pre-Amplifier	Phase One	PS04-0086	1533	12	19-Dec-2014
Pre-Amplifier	Phase One	PS04-0087	1534	12	30-Sep-2014
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Digital Multimeter	Fluke	75 Series II	2360	12	30-Apr-2014
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	15-Nov-2014
High Pass Filter (4GHz)	RLC Electronics	F-100-4000-5-R	2773	12	1-Feb-2014
Filter (Hi Pass)	Lorch	9HP7-7000-SR	2833	12	1-Feb-2014
Attenuator (10dB, 50W)	Aeroflex / Weinschel	47-10-34	3166	12	12-Sep-2014
Hygrometer	Rotronic	I-1000	3220	12	16-Jul-2014
High Pass Filter (3GHz)	RLC Electronics	F-100-3000-5-R	3349	12	30-May-2014
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Oct-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	13-Sep-2014
'2.92mm' - '2.92mm' RF Cable (2m)	Rhophase	KPS-1503-2000-KPS	3694	12	5-Nov-2014
'2.92mm' - '2.92mm' RF Cable (2m)	Rhophase	KPS-1503-2000-KPS	3695	12	16-Oct-2014
'3.5mm' - '3.5mm' RF Cable (1m)	Rhophase	3PS-1803-1000-3PS	3697	12	25-Jan-2014
Tilt Antenna Mast	matur GmbH	TAM 4.0-P	3916	-	TU
Mast Controller	matur GmbH	NCD	3917	-	TU
1 Metre K Type Cable	Rhophase	KPS-1501A-1000-KPS	4105	12	5-Nov-2014
1GHz to 8GHz Low Noise Amplifier	Wright Technologies	APS04-0085	4365	12	1-Oct-2014
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	18-Sep-2014

TU – Traceability Unscheduled

O/P MON – Output Monitored with Calibrated Equipment



### 3.2 MEASUREMENT UNCERTAINTY

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

Test Discipline	MU
Frequency Hopping Systems - 20dB Bandwidth and Channel Separation	± 16.74 kHz
Frequency Hopping Systems - Channel Dwell Time and Number of Hopping Channels	-
EIRP Peak Power	30MHz to 1GHz: ± 5.1 dB 1GHz to 40GHz: ± 6.3 dB
Maximum Peak Conducted Output Power	± 0.70 dB
Spurious and Band Edge Emissions	30MHz to 1GHz: ± 5.1 dB 1GHz to 40GHz: ± 6.3 dB
AC Line Conducted Emissions	± 3.2 dB



Product Service

## **SECTION 4**

### **ACCREDITATION, DISCLAIMERS AND COPYRIGHT**



Product Service

#### 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).

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