Product Service

Choose certainty.
Add value.

Report On

FCC Testing of the Sharp SHL23 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)

COMMERCIAL-IN-CONFIDENCE

FCC ID: APYHRO00196

Document 75923862 Report 13 Issue 2 November 2013

Product Service

TÜV SÜD Product Service, Octagon House, Concorde Way, Segensworth North,
Fareham, Hampshire, United Kingdom, PO15 5RL
Tel: +44 (0) 1489 558100. Website: www.tuv-sud.co.uk

REPORT ON

FCC Testing of the
Sharp SHL23 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)

Document 75923862 Report 13 Issue 2

November 2013

PREPARED FOR

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PREPARED BY

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Senior Administrator, Test Solutions

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Mark Jenkins
Technical Specialist

DATED 04 November 2013

This report has been up-issued to Issue 2 to amend the model description.

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);

T Guy S Milliken

UKAS TESTING 0141

Product Service

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Product Service

SECTION 1

REPORT SUMMARY

FCC Testing of the
Sharp SHL23 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)

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the FCC Testing of the Sharp SHL23 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)	SHL23
Serial Number(s)	IMEI 004401114892827 IMEI 004401114893122
Number of Samples Tested	2
Test Specification/Issue/Date	FCC CFR 47 Part 15C (2012)
Incoming Release Date	Application Form 24 September 2013
Disposal Reference Number Date	Held Pending Disposal Not Applicable Not Applicable
Order Number Date	9860 25 September 2013
Start of Test	1 October 2013
Finish of Test	12 October 2013
Name of Engineer(s)	T Guy S Milliken
Related Document(s)	ANSI C63.10: 2009

Product Service

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	

Product Service

1.3 APPLICATION FORM

EQUIPMENT DESCRIPTION	
Model Name/Number	SHL23
Part Number	
FCC ID (if applicable)	APYHRO00196
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
☐ -20°C to +55°C
☒ Other (2)
☐ 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
☒ Integral
Temporary RF connector provided: ☒ Yes ☐ No
☐ Antenna connector
☐ 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
dBi for assembly identified as
dBi for assembly identified as
dBi for assembly identified as

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

Product Service

SPREAD SPECTRUM PARAMETERS	
☒ **Bluetooth**	Version: 4.0
FHSS: Channel ☒ 79 Other	EDR ☒ Yes ☐ No
Medium Access Protocol (Customer Declaration)	
"We have implemented Bluetooth protocol which satisfies the medium access protocol requirement of EN 300 328".	

☒ **WLAN**		
IEEE 802.11(b) – DSSS ☒		
IEEE 802.11(g) – OFDM ☒		
IEEE 802.11(n) – OFDM ☒		
Supported Spatial Streams	2.4 GHz	5GHz
Transmitter (Tx)	1	1
Receiver (Rx)	1	1
GI (Guard Interval) ☒ 800 ns ☐ 400 ns		
Band Width ☒ 20 MHz ☐ 40 MHz		
Medium Access Protocol (Customer Declaration)		
"We have implemented IEEE 802.11 (b/g/n) protocol which satisfies the medium access protocol requirement of EN 300 328".		

☐ **Other Technology**		
☐ Direct Sequence ☐ Frequency Hopping ☐ Combined ☐ 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		
Medium Access Protocol (Customer Declaration)		
"We have implemented a protocol which satisfies the medium access protocol requirement of EN 300 328".		

Product Service

TRANSMITTER POWER CHARACTERSITICS					
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			☒	Yes	☐ No
Intermittent duty			☐	Yes	☐ No
If intermittent state DUTY CYCLE					
Transmitter ON seconds	Transmitter OFF	minutes			
Is continuous operation possible for testing purposes?			☒	Yes	☐ No
Is transmitter output power variable:			☒	Yes	☐ No
State during the test:					
Transmitter duty cycle Tx on	Seconds	Tx Off	Seconds		
Duty cycle (Tx on /(Tx on +Tx off))	%				
☐ Continuously variable	☐ 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			☒	Yes	☐ No
Intermittent duty			☐	Yes	☐ No
If intermittent state DUTY CYCLE					
Transmitter ON seconds	Transmitter OFF	minutes			
Is continuous operation possible for testing purposes?			☒	Yes	☐ No
Is transmitter output power variable:			☒	Yes	☐ No
State during the test:					
Transmitter duty cycle Tx on	Seconds	Tx Off	Seconds		
Duty cycle (Tx on /(Tx on +Tx off))	%				
☐ Continuously variable	☐ Stepped				
dB per step					

Product Service

TRANSMITTER POWER SOURCE (3)				
☒ Common power source for transmitter and receiver				
☐ AC mains		State voltage		
AC supply frequency	(Hz)	VAC	Max Current	Hz
☐ Single phase		☐ Three phase		
And / Or				
☐ External DC supply				
Nominal voltage		Max Current	A	
Extreme upper voltage		Extreme lower voltage		
Battery				
☐ Nickel Cadmium				
☐ Lead acid (Vehicle regulated)				
☐ Alkaline				
☒ Lithium				
☐ 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.

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.		
☒ Applies	3.35	V cut-off voltage
☐ Does not apply		

Product Service

RECEIVER POWER SOURCE (4)			
☐ AC mains		State voltage	
AC supply frequency	(Hz)	VAC	Max Current Hz
☐ Single phase		☐ Three phase	
And / Or			
☐ External DC supply			
Nominal voltage		Max Current	A
Extreme upper voltage		Extreme lower voltage	
Battery			
☐ Nickel Cadmium			
☐ Lead acid (Vehicle regulated)			
☐ Alkaline			
☐ Lithium			
☐ 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.	
☐ Applies	V cut-off voltage
☐ 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: Hachiro Hidaka

Position held: Asst. Manager Date: 24th September, 2013

1.4 PRODUCT INFORMATION

1.4.1 Technical Description

The Equipment Under Test (EUT) was a Sharp SHL23 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 Accreditation
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.

Product Service

SECTION 2

TEST DETAILS

FCC Testing of the
Sharp SHL23 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

SHL23 S/N: IMEI 004401114892827 - Modification State 0

2.1.3 Date of Test

11 October 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.

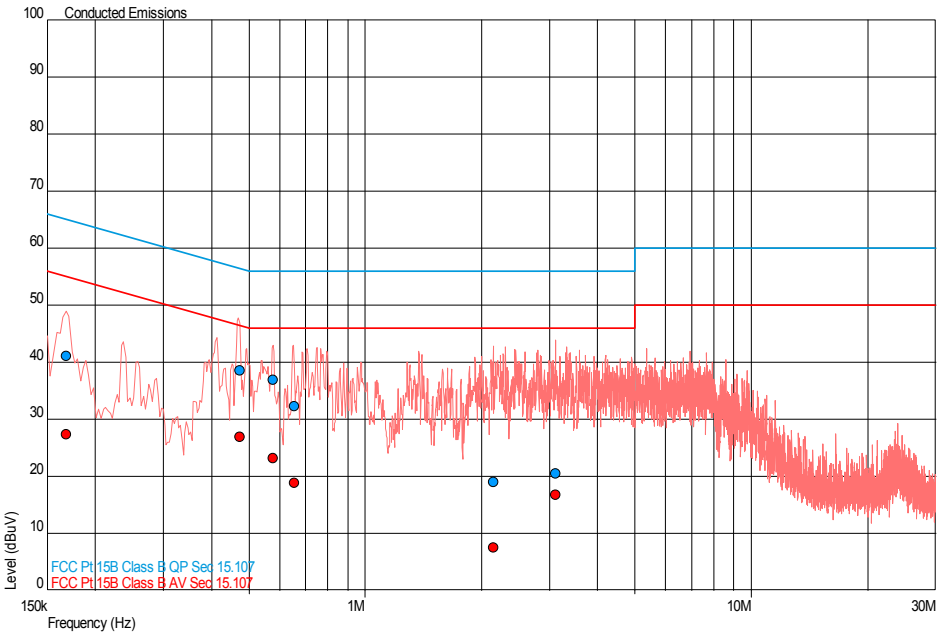
2.1.6 Environmental Conditions

Ambient Temperature	20.5°C
Relative Humidity	43.0%

Product Service

2.1.7 Test Results

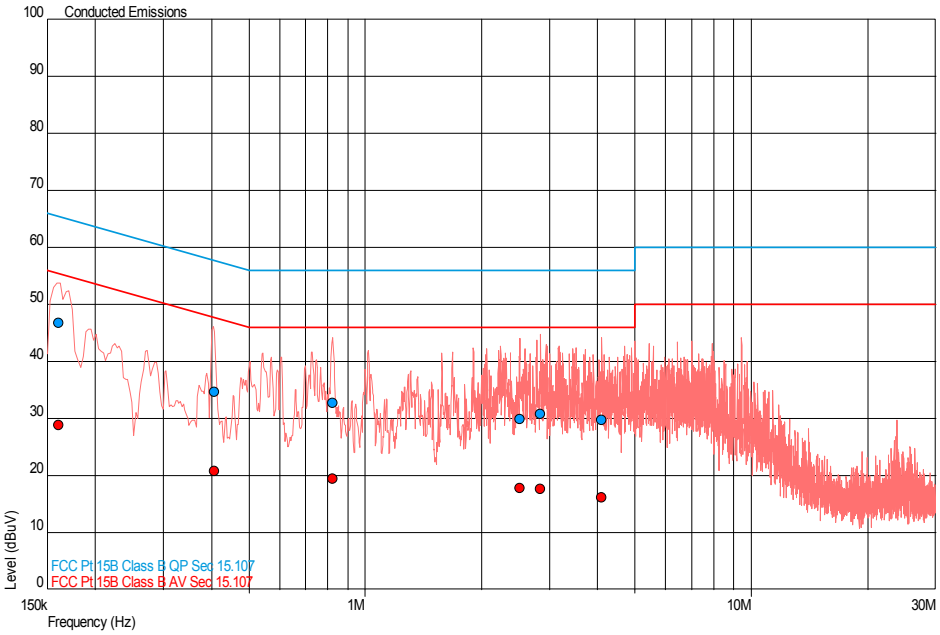
Live Line



Frequency (MHz)	QP Level (dBµV)	QP Limit (dBµV)	QP Margin (dBµV)	AV Level (dBµV)	AV Limit (dBµV)	AV Margin (dBµV)
0.168	41.1	65.0	-24.0	27.4	55.0	-27.7
0.474	38.6	56.4	-17.8	26.9	46.4	-19.5
0.578	36.9	56.0	-19.1	23.2	46.0	-22.8
0.654	32.2	56.0	-23.8	18.9	46.0	-27.1
2.145	19.0	56.0	-37.0	7.6	46.0	-38.4
3.107	20.5	56.0	-35.5	16.7	46.0	-29.3

Product Service

Neutral Line



Frequency (MHz)	QP Level (dBµV)	QP Limit (dBµV)	QP Margin (dBµV)	AV Level (dBµV)	AV Limit (dBµV)	AV Margin (dBµV)
0.160	46.8	65.4	-18.7	28.9	55.4	-26.6
0.406	34.7	57.7	-23.1	20.8	47.7	-26.9
0.821	32.8	56.0	-23.2	19.5	46.0	-26.5
2.511	29.9	56.0	-26.1	17.8	46.0	-28.2
2.843	30.8	56.0	-25.2	17.7	46.0	-28.3
4.091	29.8	56.0	-26.2	16.1	46.0	-29.9

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

SHL23 S/N: IMEI 004401114893122 - Modification State 0

2.2.3 Date of Test

1 October 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 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	22.5°C
Relative Humidity	57.1%

Product Service

2.2.7 Test Results

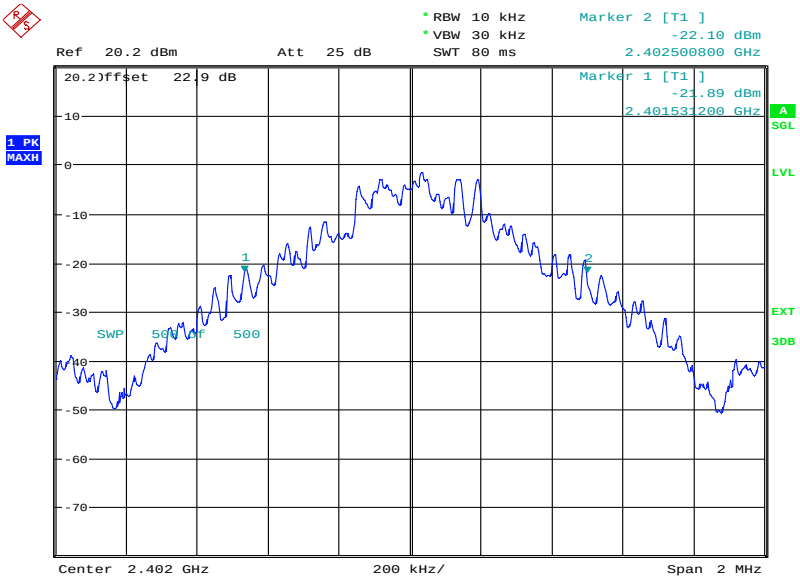
4.0 V DC Supply

20dB Bandwidth

2402 MHz

Data Rate (Mbps)	20dB Bandwidth (kHz)
DH1	969.6
DH3	934.4
DH5	886.4

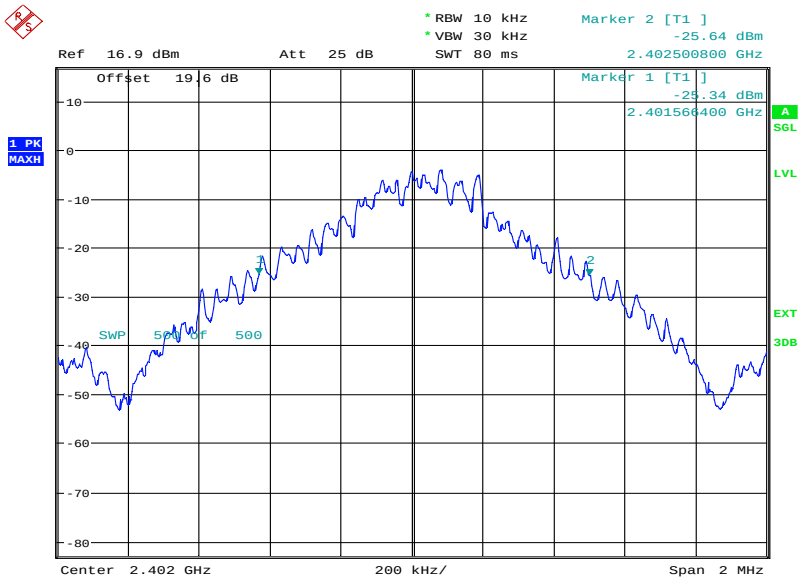
DH1



Date: 1.OCT.2013 12:32:32

Product Service

DH3



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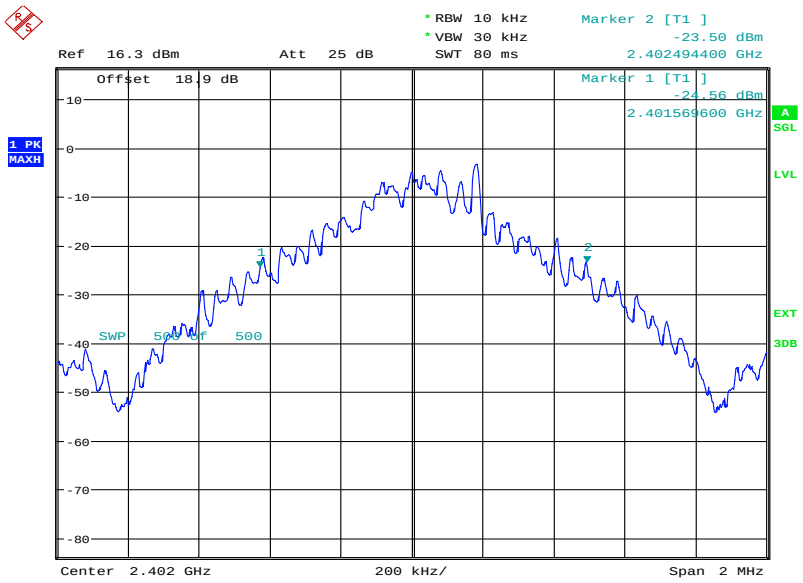
DH5



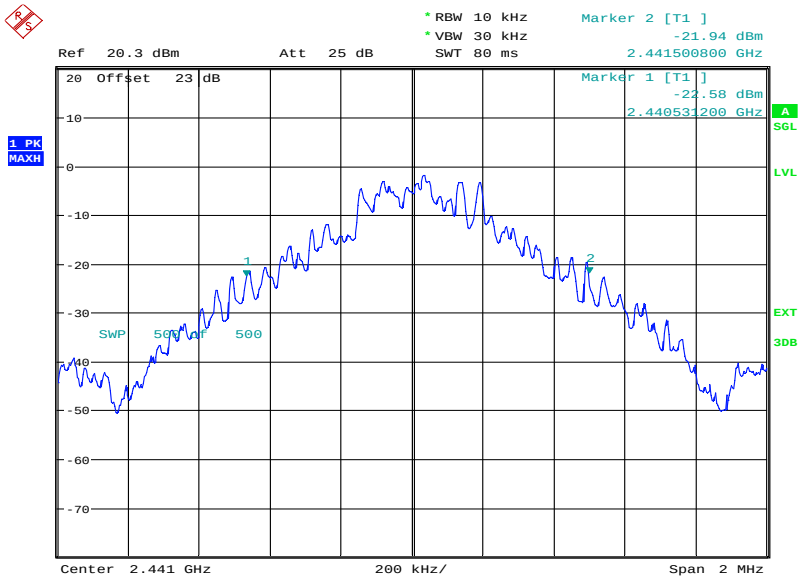
Date: 1.OCT.2013 12:59:07

Product Service

2441 MHz

Data Rate (Mbps)	20dB Bandwidth (kHz)
DH1	969.6
DH3	931.2
DH5	886.4

DH1



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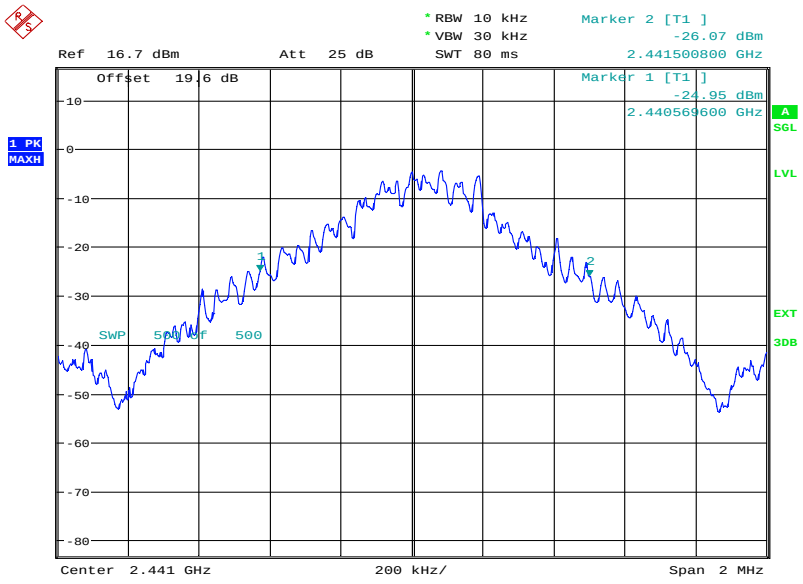
Product Service

DH3



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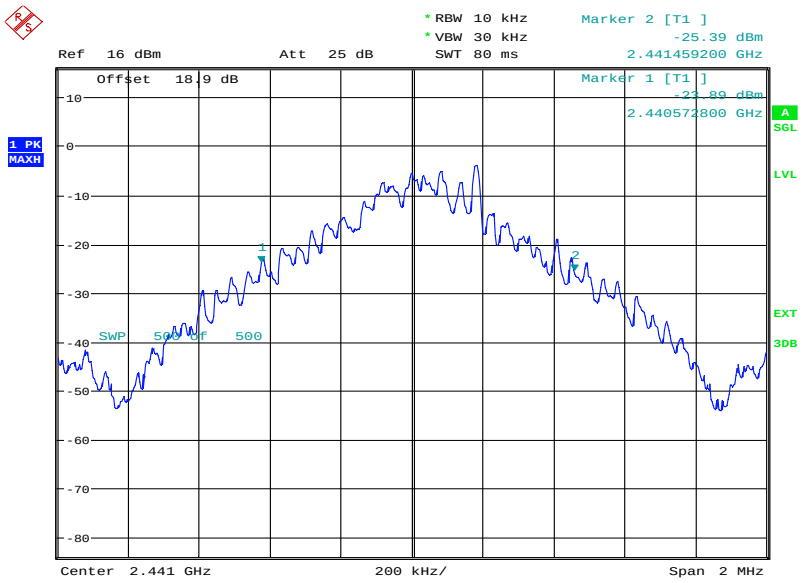
DH5



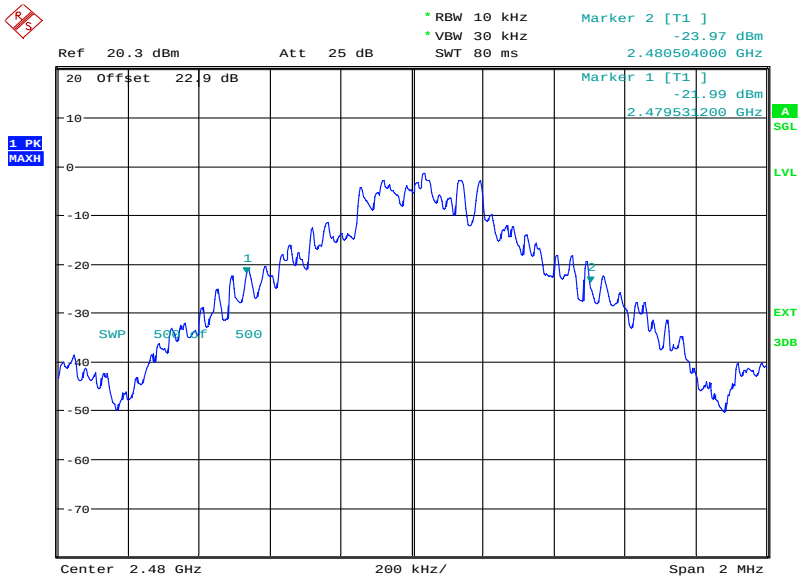
Date: 1.OCT.2013 13:01:34

Product Service

2480 MHz

Data Rate (Mbps)	20dB Bandwidth (kHz)
DH1	972.8
DH3	931.2
DH5	886.4

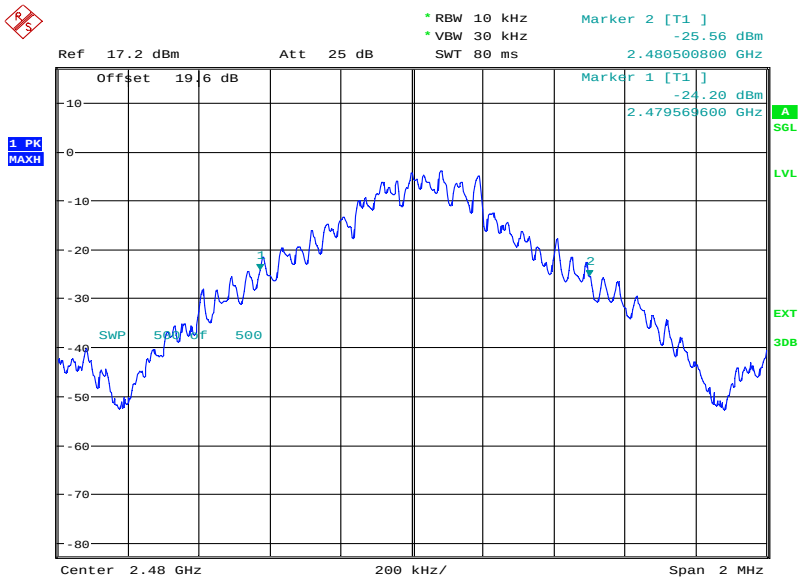
DH1



Date: 1.OCT.2013 12:37:34

Product Service

DH3



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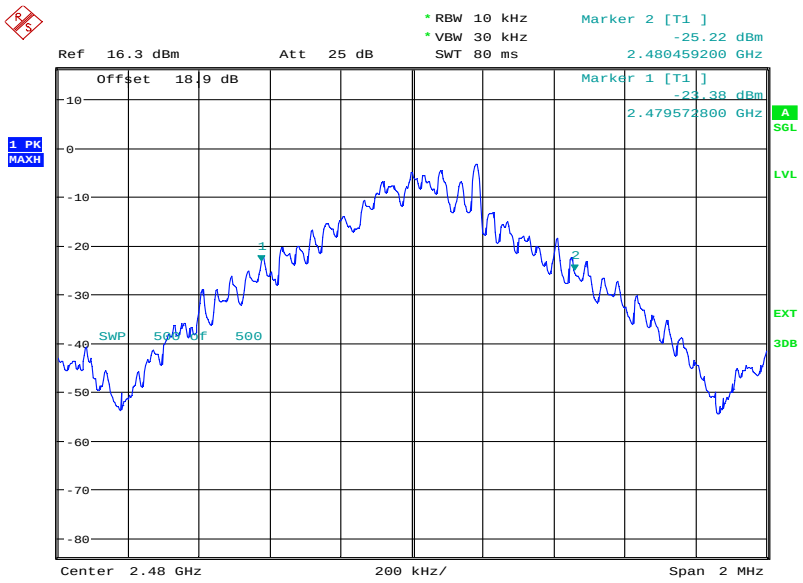
DH5



Date: 1.OCT.2013 13:03:53

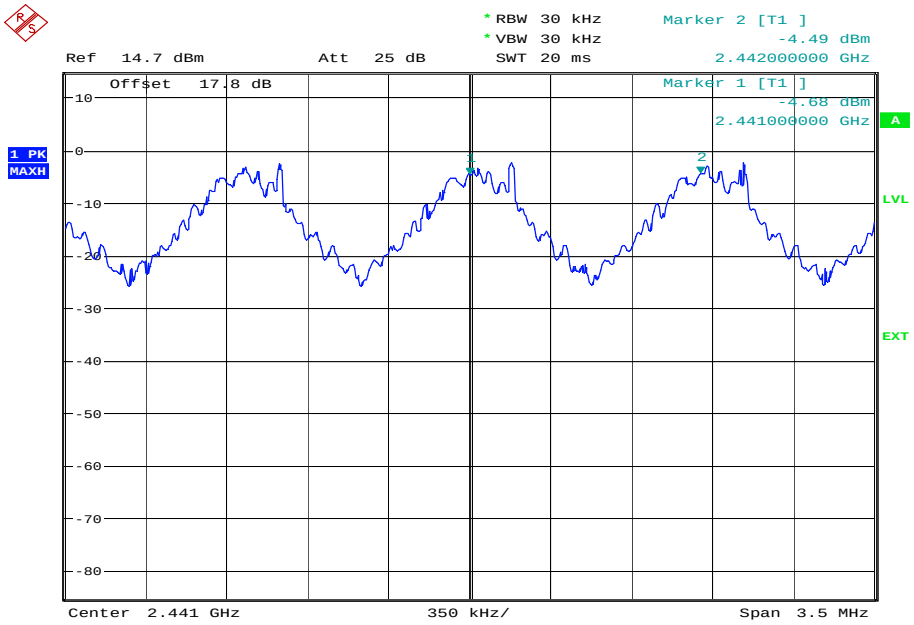
Limit Clause

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.

Product Service

Channel Separation

Channel Separation: 1 MHz



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.

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

SHL23 S/N: IMEI 004401114893122 - Modification State 0

2.3.3 Date of Test

10 October 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

DH1

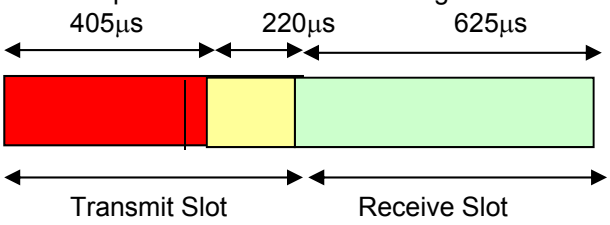
The Bluetooth system hops at a rate of 1600 times per second. Thus, this equates to 1600 timeslots in 1 second.

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.



Product Service

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

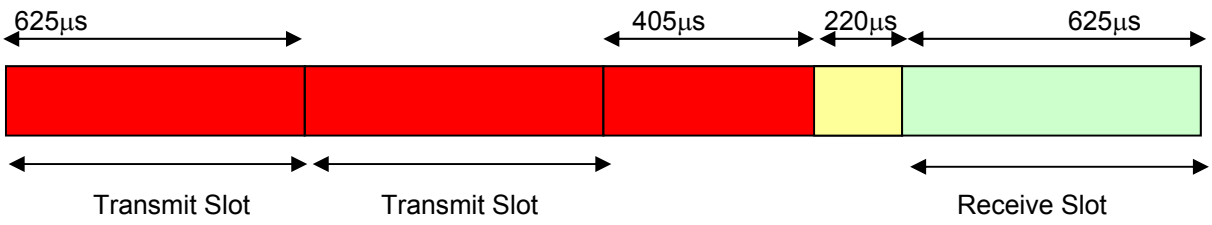
With data rate DH3, the data payload is higher and can use up to 3 timeslots. When more than one timeslot is used, the frequency does not hop and transmission is continuous on all 3 slots, (ie. no receive slot in-between the 3 transmit slots). The 220µs off time for synthesizer re-tuning at the end of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

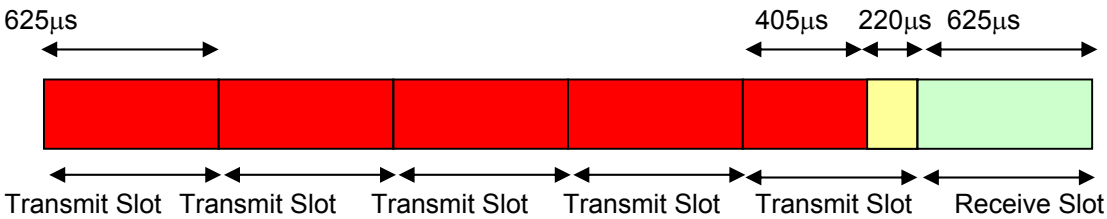
With data rate DH5, the data payload is higher and can use up to 5 timeslots. When more than one timeslot is used, the frequency does not hop and transmission is continuous on all 5 slots, (ie. no receive slot in-between the 5 transmit slots). The 220µs off time for synthesizer re-tuning at the end of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



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:

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

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

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

32 x 9.675ms = 0.31 seconds

2.3.6 Environmental Conditions

Ambient Temperature 21.7°C
Relative Humidity 41.1%

Product Service

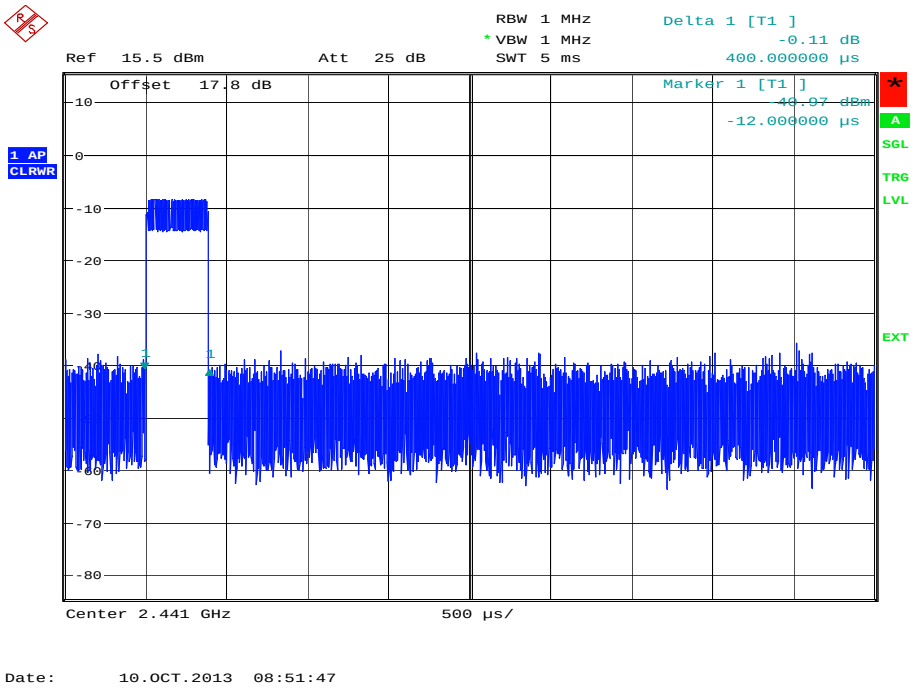
2.3.7 Test Results

4.0 V DC Supply

Channel Dwell Time

DH1

0.400 ms

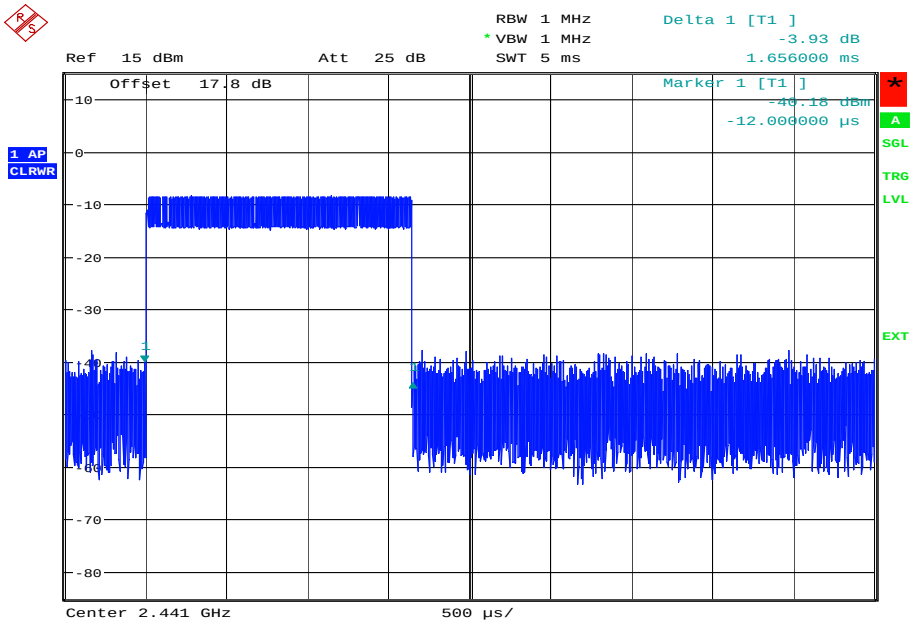


Date: 10.OCT.2013 08:51:47

Product Service

DH3

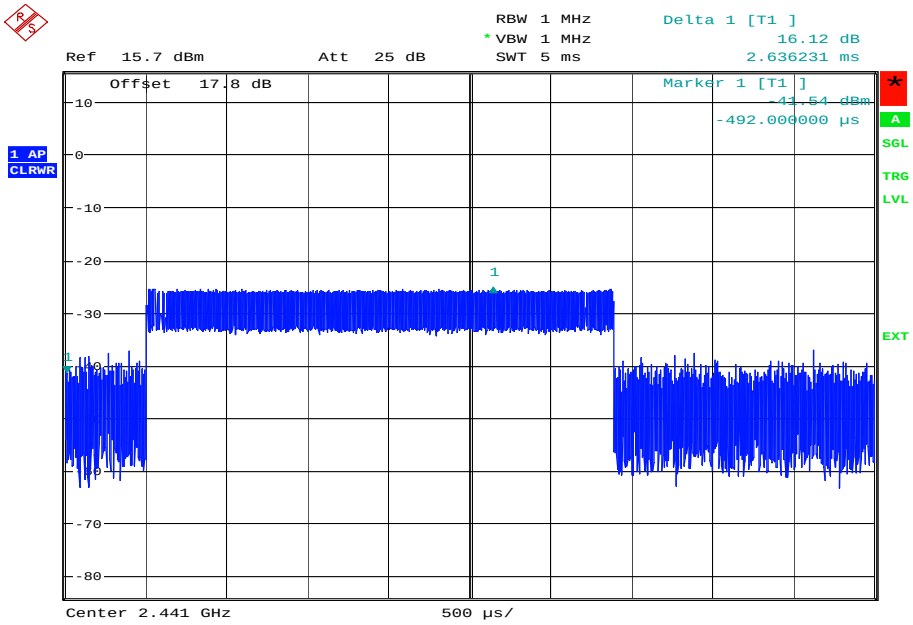
1.656 ms



Date: 10.OCT.2013 08:46:37

DH5

2.636 ms



Date: 10.OCT.2013 08:37:02

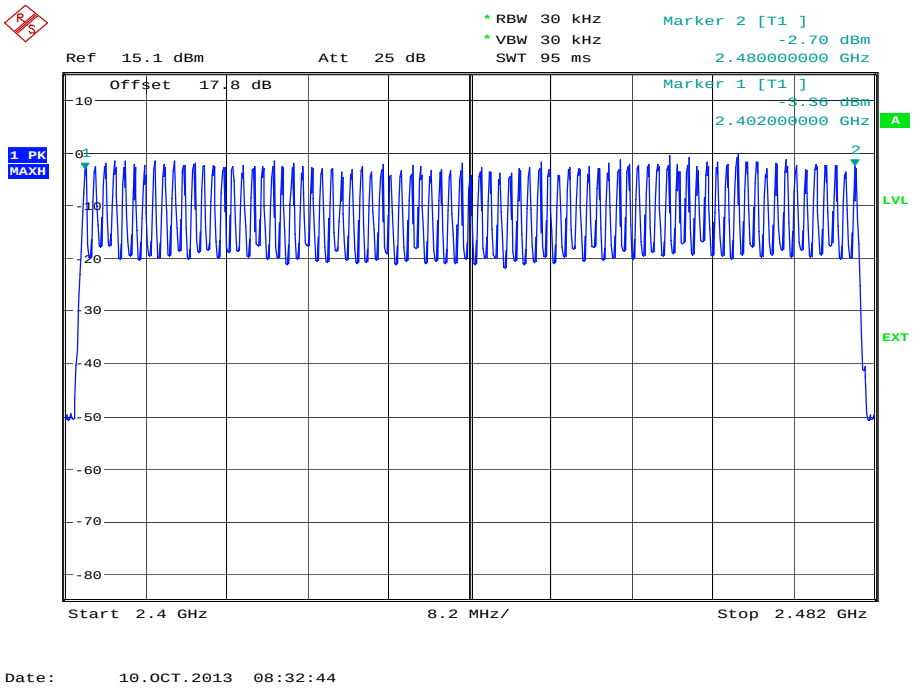
Product Service

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



Limit

≥ 15 channels

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

SHL23 S/N: IMEI 004401114893122 - Modification State 0

2.4.3 Date of Test

1 October 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

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	22.5°C
Relative Humidity	57.1%

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	0.94	1.25	1.77	1.242	1.334	1.503
DH3	1.05	1.36	1.75	1.274	1.368	1.496
DH5	0.95	1.47	1.75	1.245	1.402	1.496

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.

2.5 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

SHL23 S/N: IMEI 004401114892827 - Modification State 0

2.5.3 Date of Test

4 October 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 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

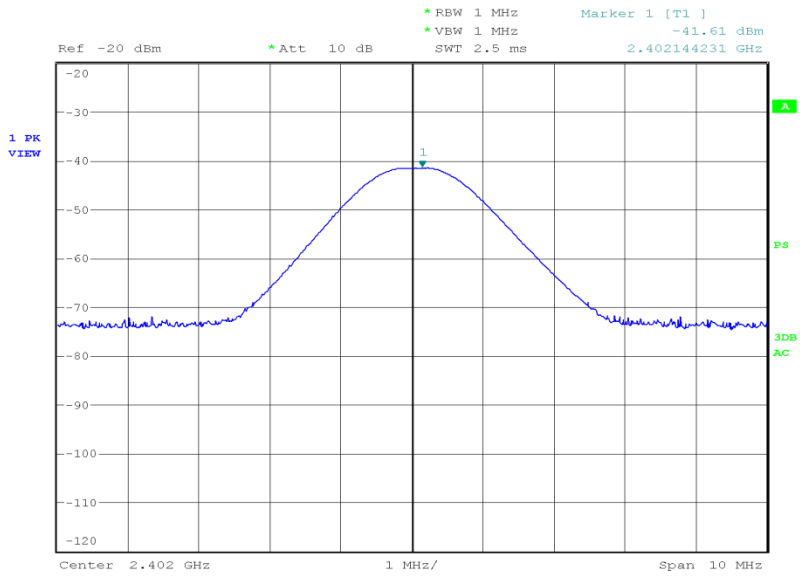
Ambient Temperature	21.3 - 21.8°C
Relative Humidity	68.0%

Product Service

2.5.7 Test Results

2402 MHz

EIRP (dBm)	EIRP (mW)
2.21	1.66

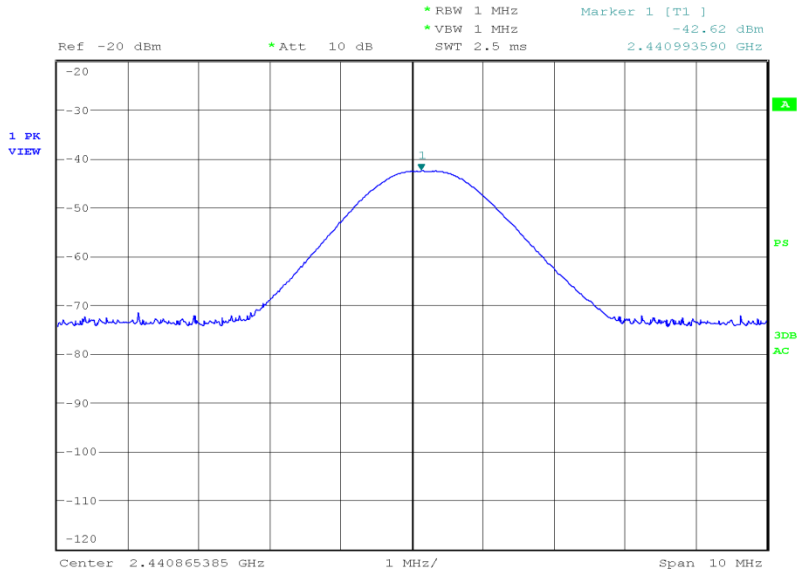


Date: 4.OCT.2013 01:29:33

Product Service

2441 MHz

EIRP (dBm)	EIRP (mW)
-0.29	0.94

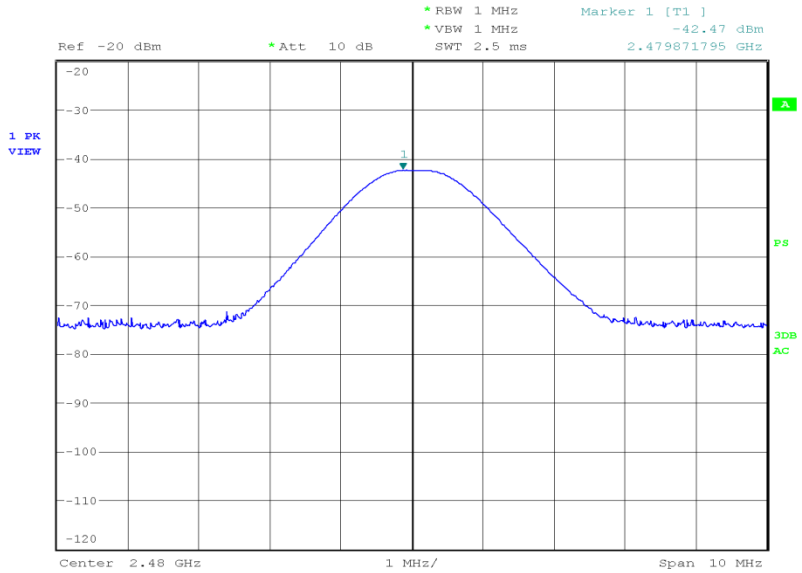


Date: 4.OCT.2013 01:20:57

Product Service

2480 MHz

EIRP (dBm)	EIRP (mW)
0.0	1.0



Date: 4.OCT.2013 01:32:16

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

SHL23 S/N: IMEI 004401114893122 - Modification State 0

2.6.3 Date of Test

4 October 2013, 5 October 2013, 11 October 2013 & 12 October 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	19.8 - 22.8°C
Relative Humidity	28.7 - 68.0%

Product Service

2.6.7 Test Results

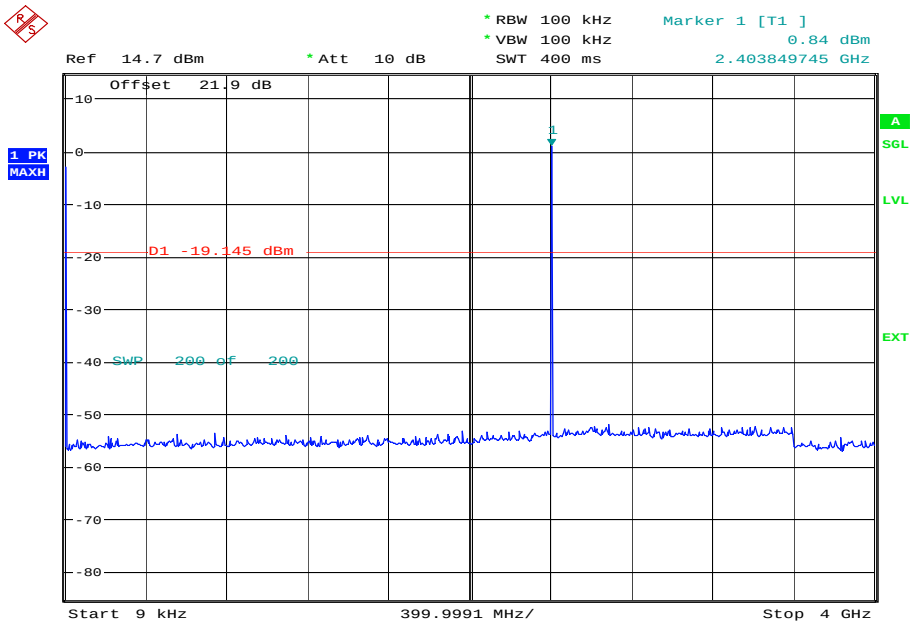
4.0 V DC Supply

Spurious Conducted Emissions

DH5

2402 MHz

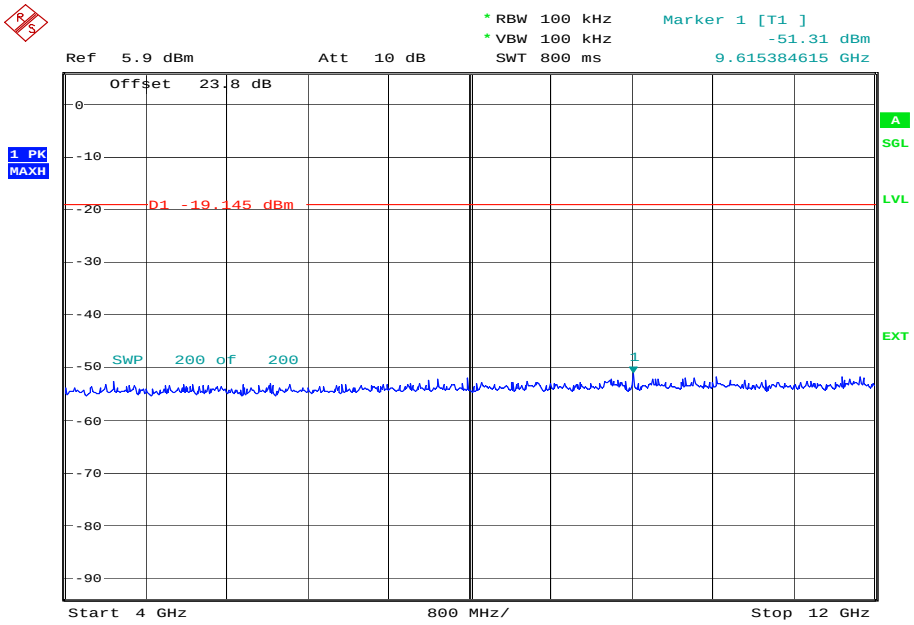
9 kHz to 4 GHz



Date: 10.OCT.2013 12:43:23

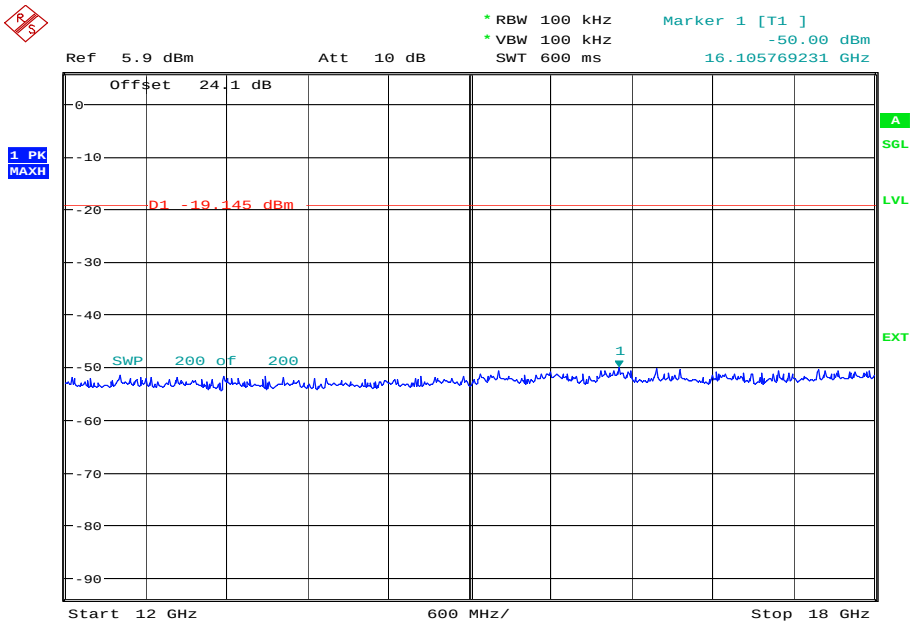
Product Service

4 GHz to 12 GHz



Date: 10.OCT.2013 12:49:17

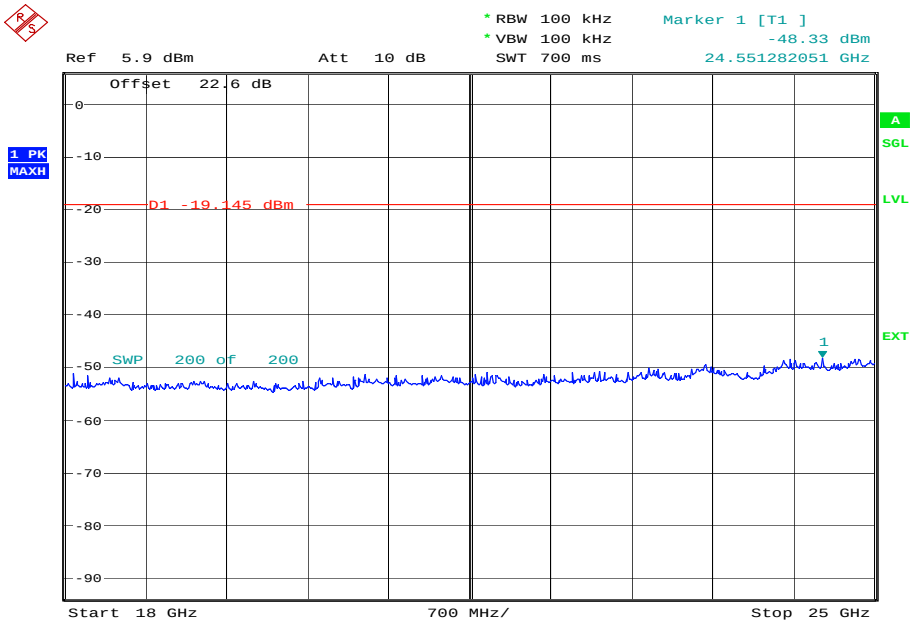
12 GHz to 18 GHz



Date: 10.OCT.2013 12:53:23

Product Service

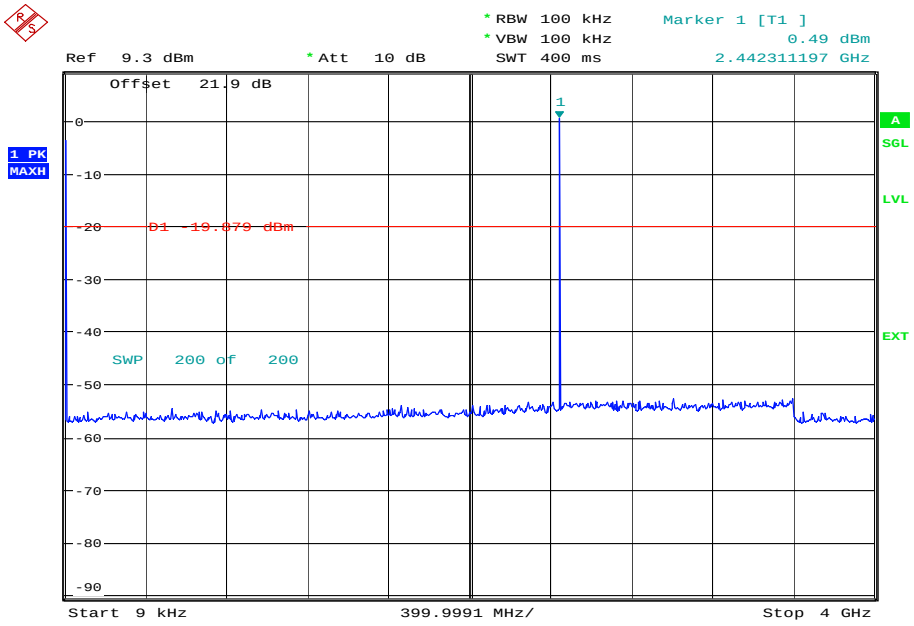
18 GHz to 25 GHz



Date: 11.OCT.2013 09:08:19

2441 MHz

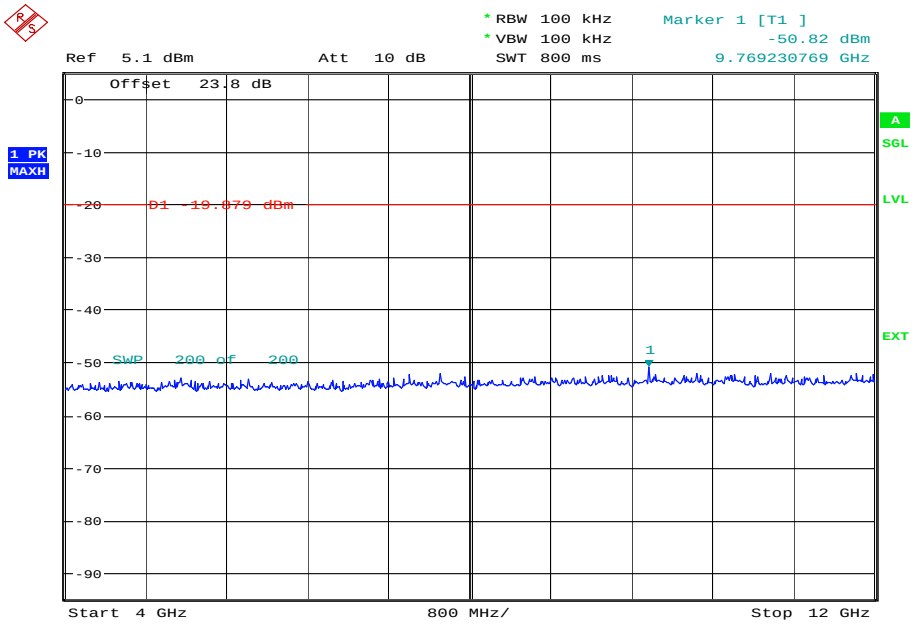
9 kHz to 4 GHz



Date: 10.OCT.2013 13:09:35

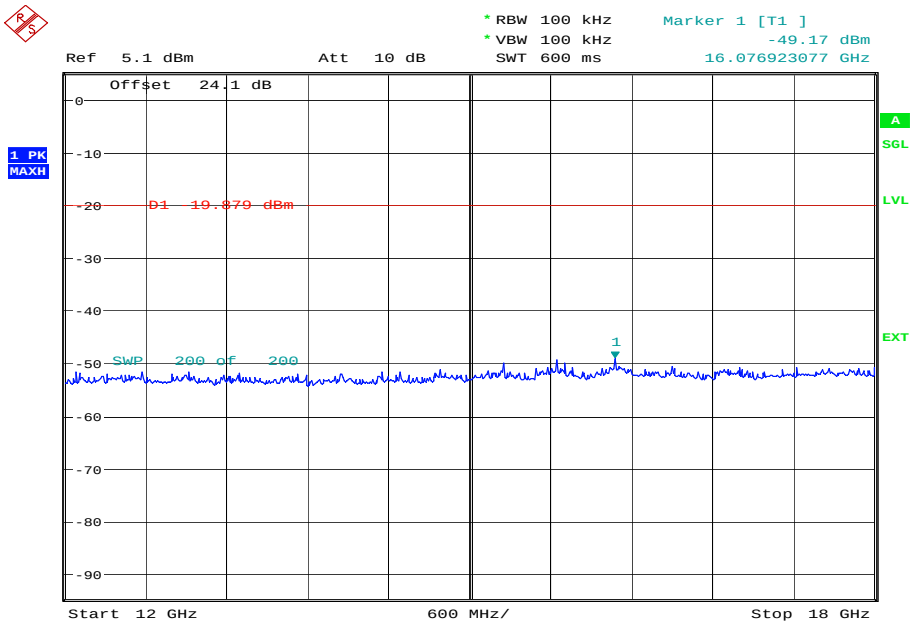
Product Service

4 GHz to 12 GHz



Date: 10.OCT.2013 13:16:20

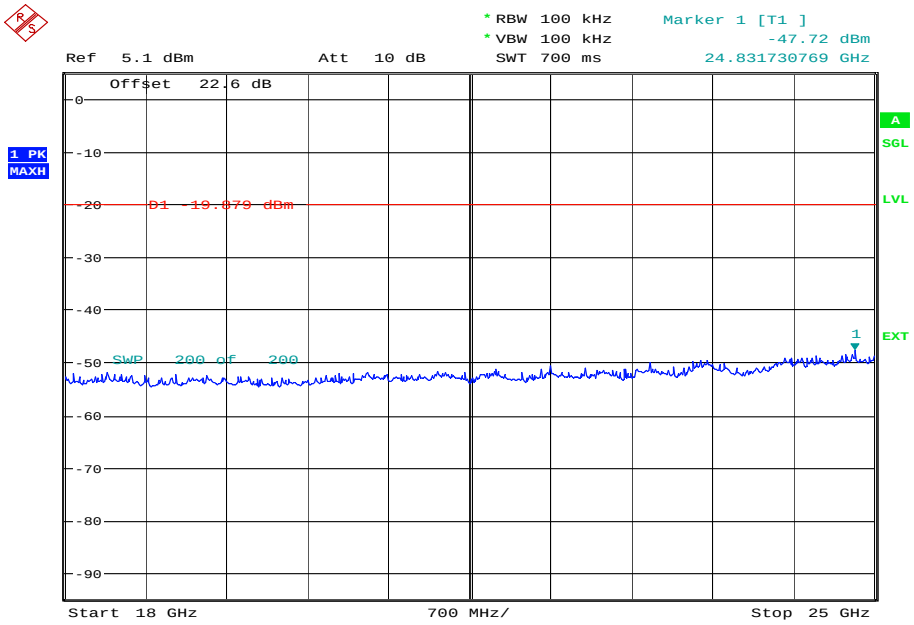
12 GHz to 18 GHz



Date: 10.OCT.2013 13:22:52

Product Service

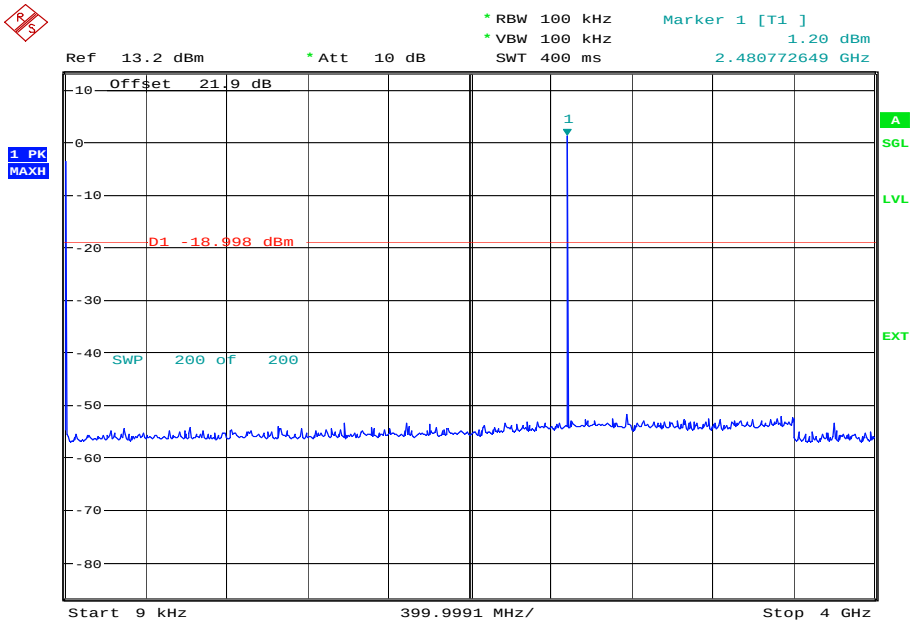
18 GHz to 25 GHz



Date: 11.OCT.2013 08:56:30

2480 MHz

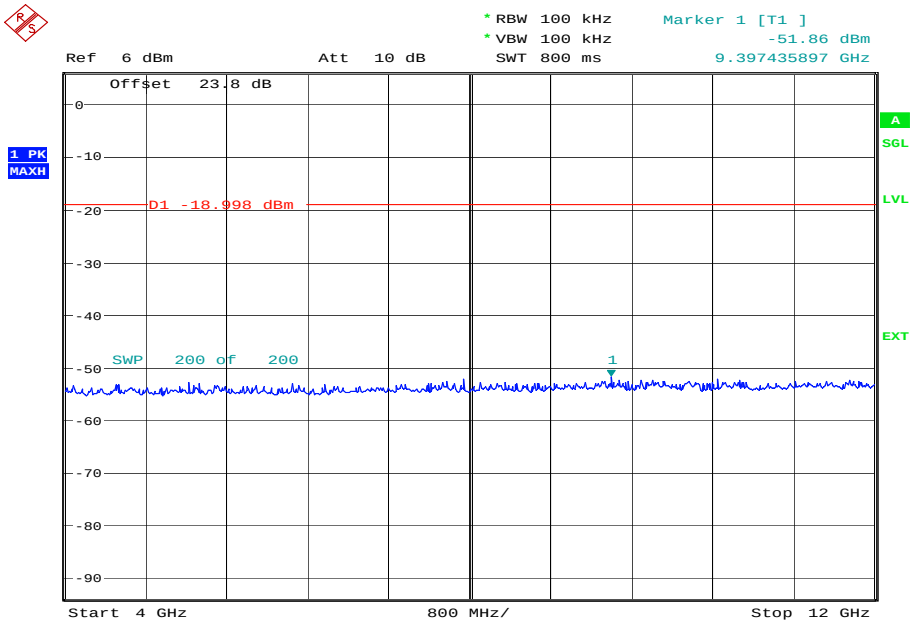
9 kHz to 4 GHz



Date: 11.OCT.2013 10:07:56

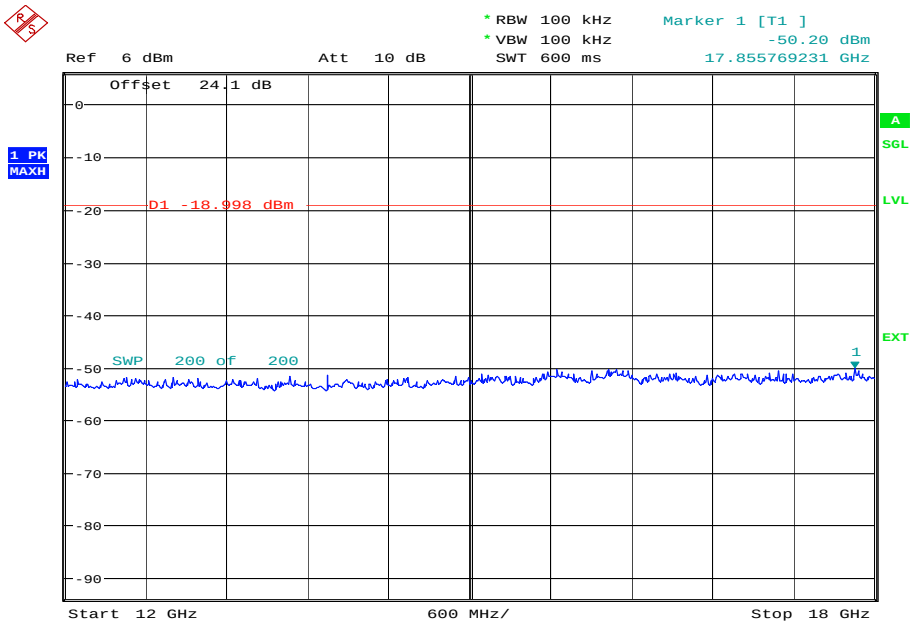
Product Service

4 GHz to 12 GHz



Date: 11.OCT.2013 10:17:39

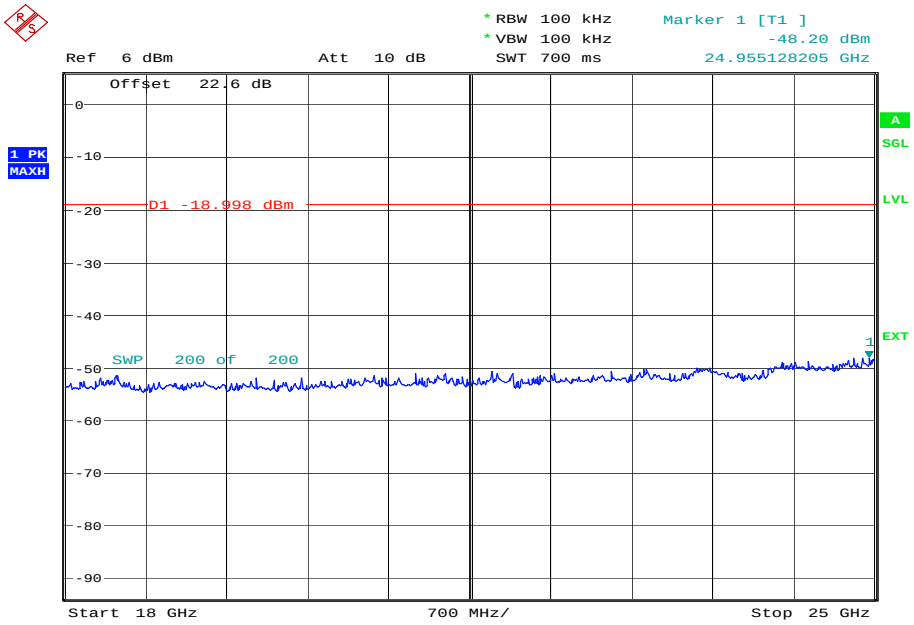
12 GHz to 18 GHz



Date: 11.OCT.2013 10:21:17

Product Service

18 GHz to 25 GHz



Date: 11.OCT.2013 10:28:48

Limit Clause

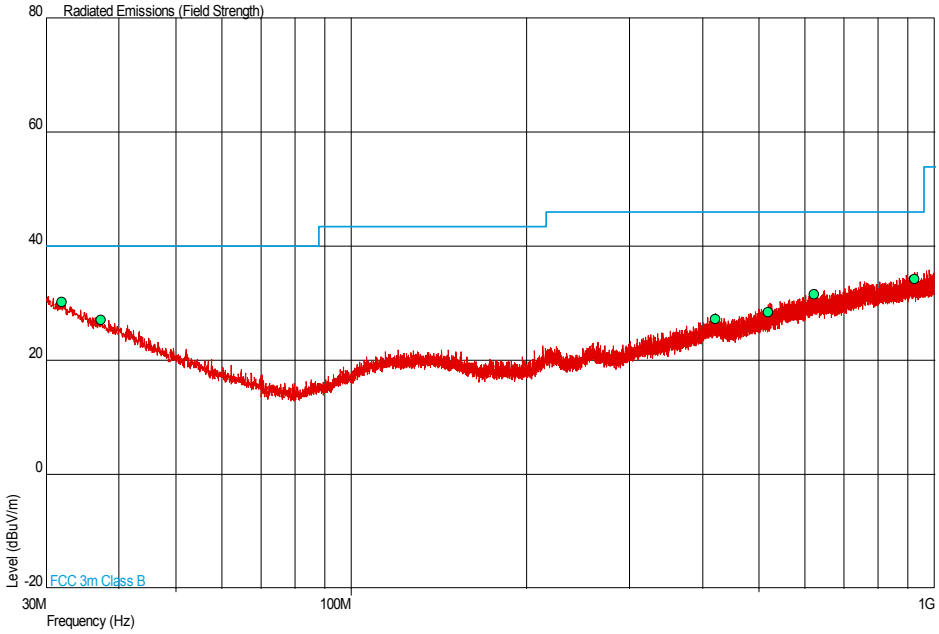
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the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

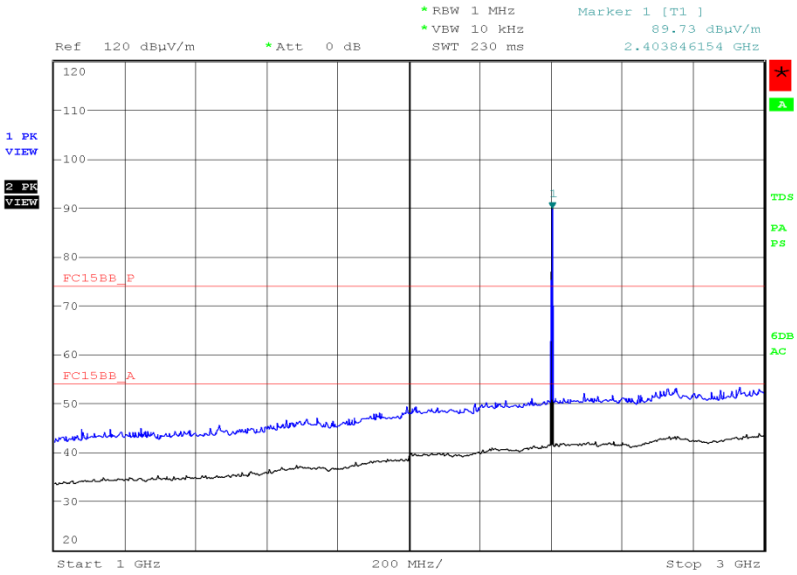
30 MHz to 1 GHz



Frequency (MHz)	QP Level (dBµV/m)	QP Level (µV/m)	QP Limit (dBµV/m)	QP Limit (µV/m)	QP Margin (dBµV/m)	QP Margin (µV/m)	Angle (Deg)	Height (m)	Polarity
31.976	30.2	32.4	40.0	100	-9.8	67.6	289	1.00	Horizontal
37.264	27.0	22.4	40.0	100	-13.0	77.6	0	3.87	Horizontal
420.535	27.3	23.2	46.0	200	-18.7	176.8	96	3.36	Vertical
517.903	28.5	26.6	46.0	200	-17.5	173.4	221	4.00	Vertical
622.205	31.5	37.6	46.0	200	-14.5	162.4	13	1.00	Horizontal
924.825	34.2	51.3	46.0	200	-11.8	148.7	360	1.00	Horizontal

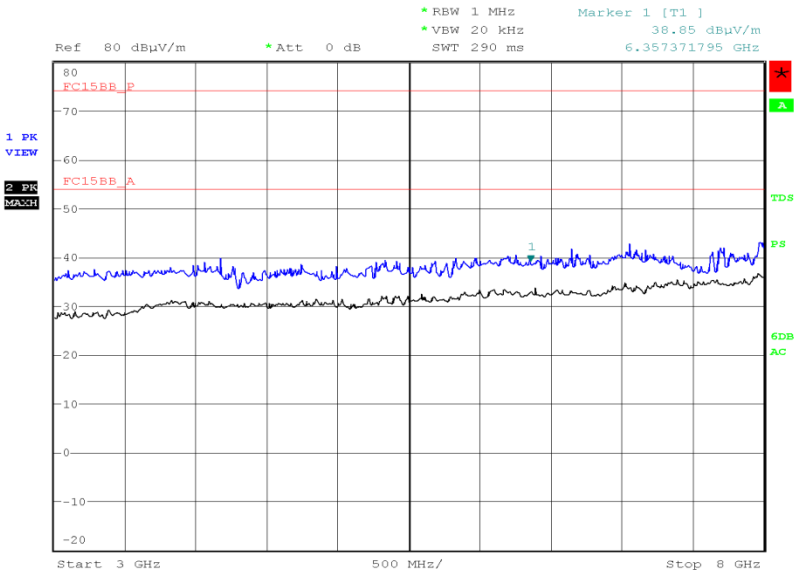
Product Service

1 GHz to 3 GHz



Date: 4.OCT.2013 02:10:57

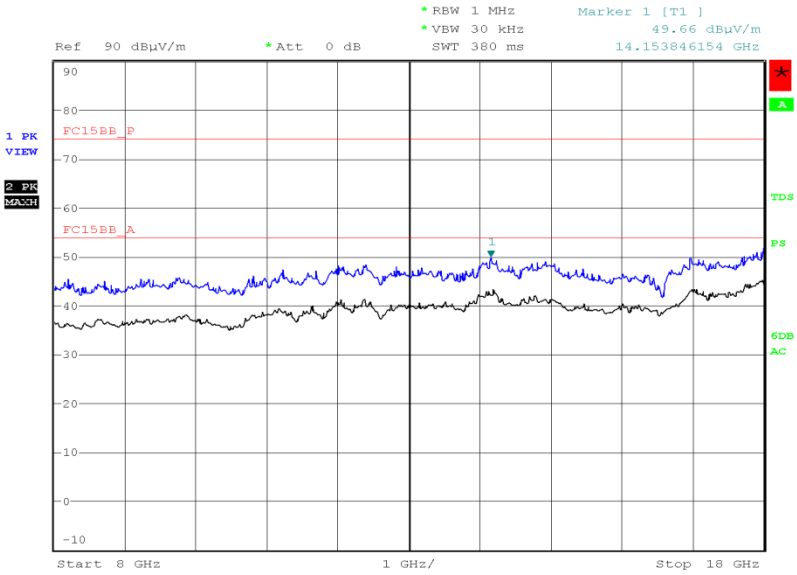
3 GHz to 8 GHz



Date: 5.OCT.2013 03:05:23

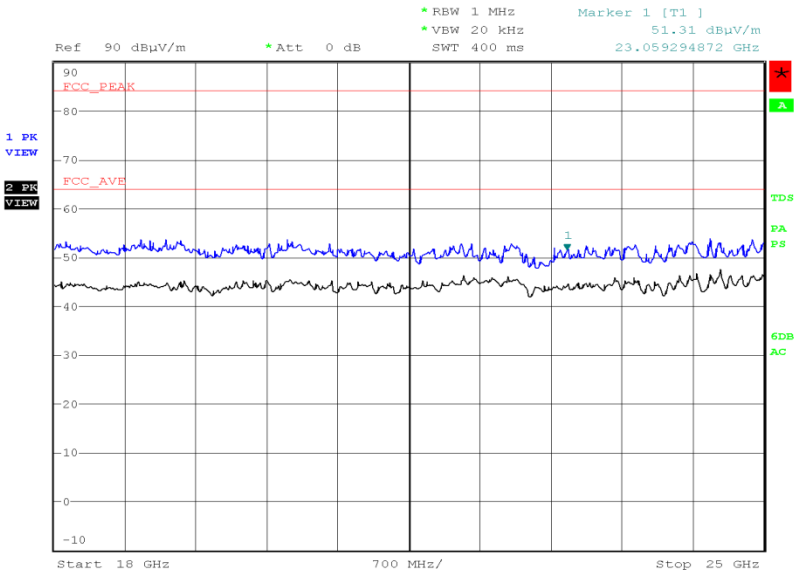
Product Service

8 GHz to 18 GHz



Date: 5.OCT.2013 02:02:47

18 GHz to 25 GHz

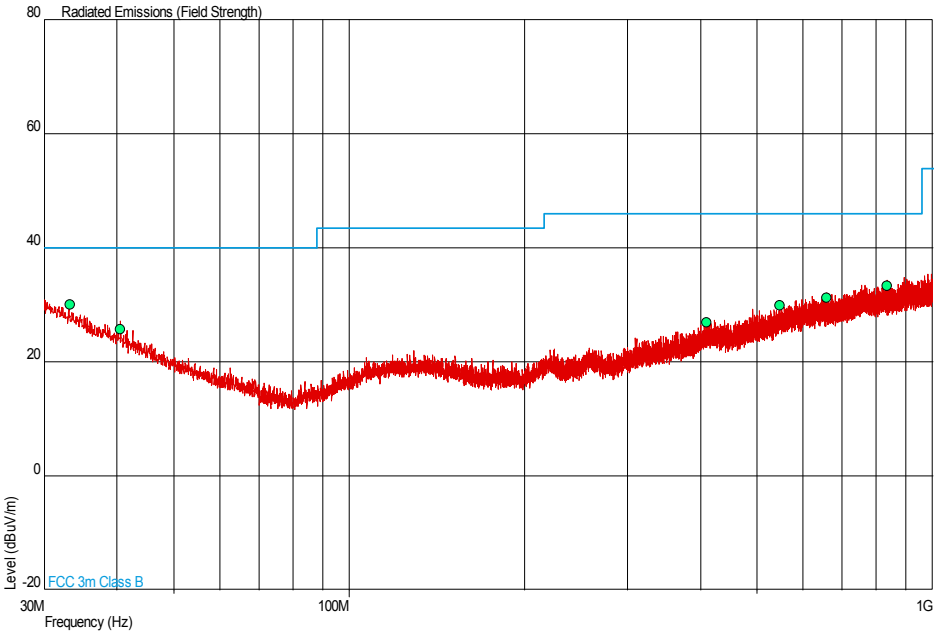


Date: 12.OCT.2013 22:26:43

Product Service

2441 MHz

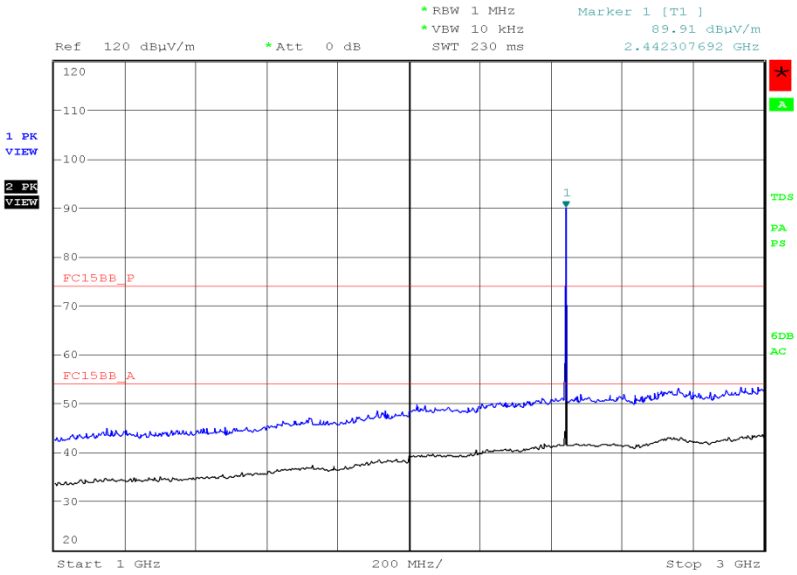
30 MHz to 1 GHz



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
33.223	30.1	32.0	40.0	100	-9.9	68.0	335	1.00	Horizontal
40.572	25.7	19.3	40.0	100	-14.3	80.7	81	1.00	Vertical
409.890	27.0	22.4	46.0	200	-19.0	177.6	65	1.00	Vertical
546.600	29.9	31.3	46.0	200	-16.1	168.7	190	3.11	Vertical
657.352	31.2	36.3	46.0	200	-14.8	163.7	347	1.00	Vertical
834.893	33.3	46.2	46.0	200	-12.7	153.8	65	1.00	Vertical

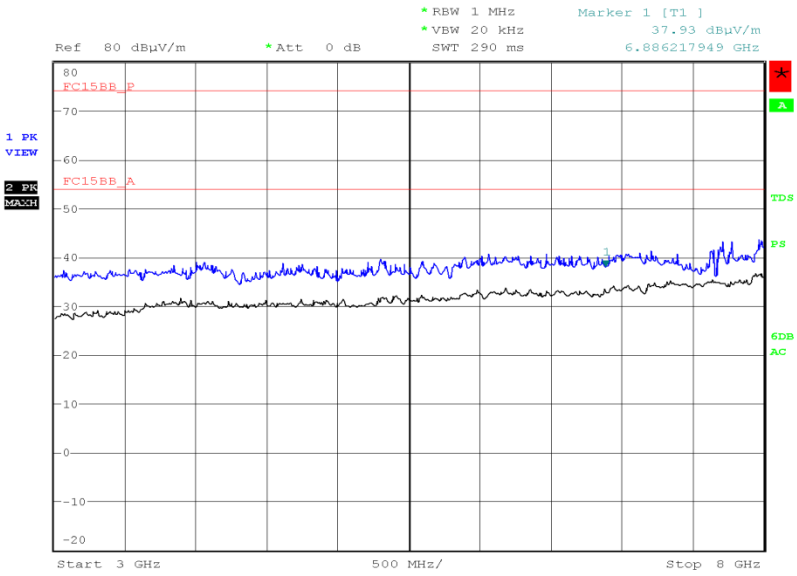
Product Service

1 GHz to 3 GHz



Date: 4.OCT.2013 02:04:55

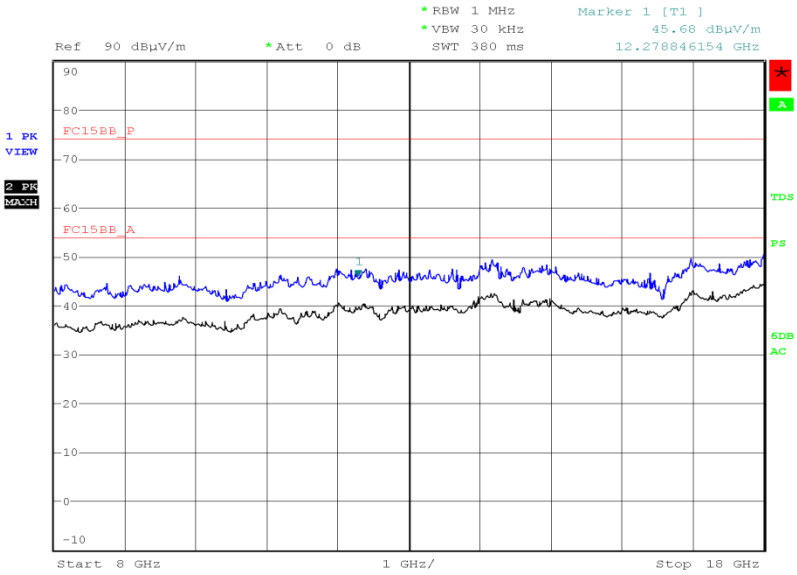
3 GHz to 8 GHz



Date: 5.OCT.2013 03:01:53

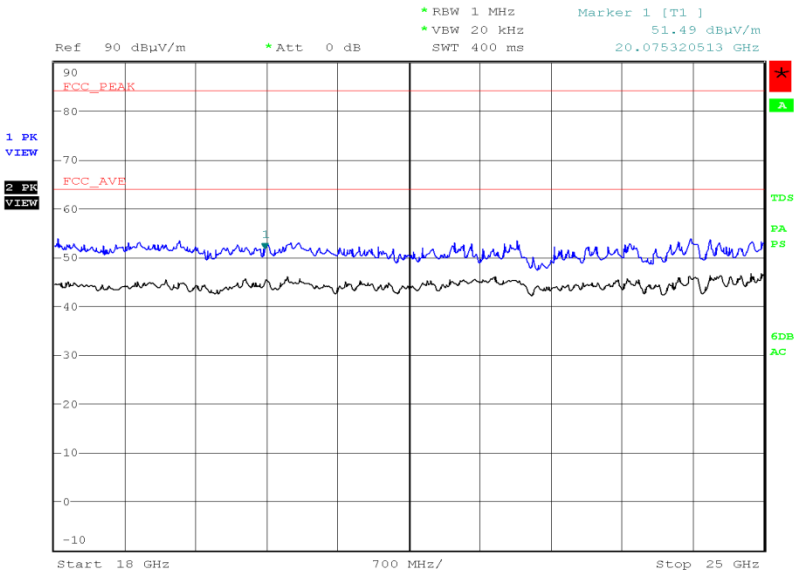
Product Service

8 GHz to 18 GHz



Date: 5.OCT.2013 02:09:41

18 GHz to 25 GHz

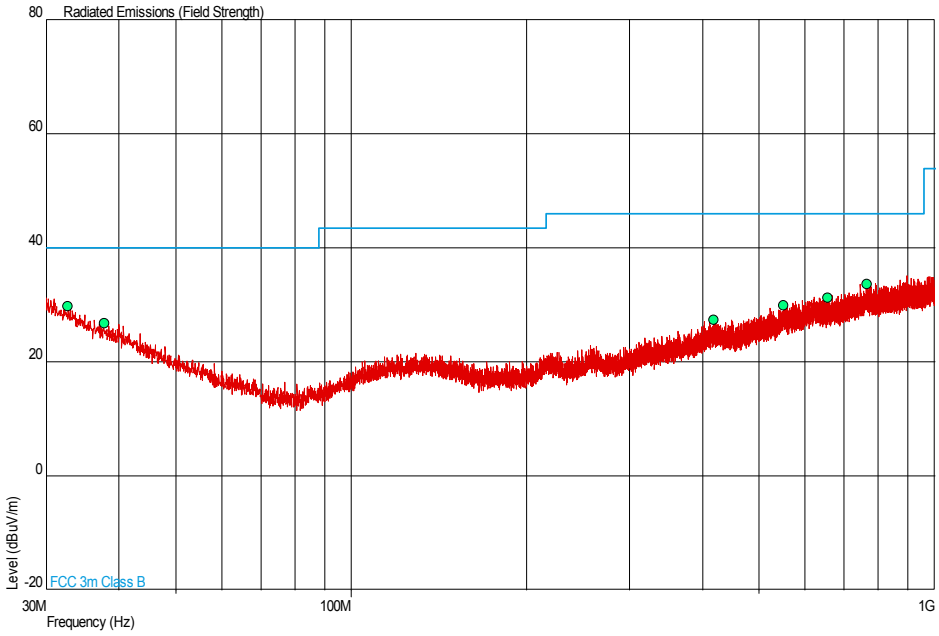


Date: 12.OCT.2013 22:13:30

Product Service

2480 MHz

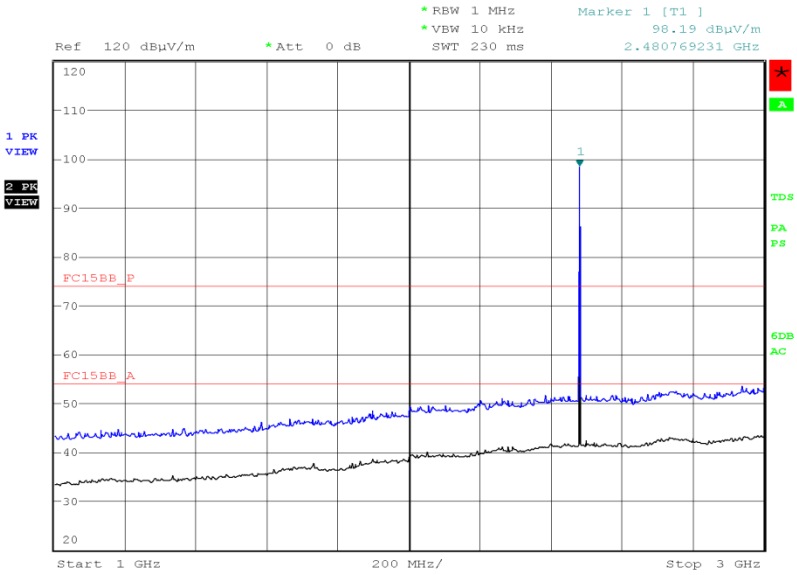
30 MHz to 1 GHz



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
32.719	29.8	30.9	40.0	100	-10.2	69.1	338	1.00	Vertical
37.729	26.8	21.9	40.0	100	-13.2	78.1	140	3.99	Vertical
418.741	27.4	23.4	46.0	200	-18.6	176.6	166	1.00	Vertical
550.357	29.9	31.3	46.0	200	-16.1	168.7	55	1.00	Vertical
656.255	31.2	36.3	46.0	200	-14.8	163.7	107	1.42	Vertical
766.000	33.6	47.9	46.0	200	-12.4	152.1	175	1.00	Vertical

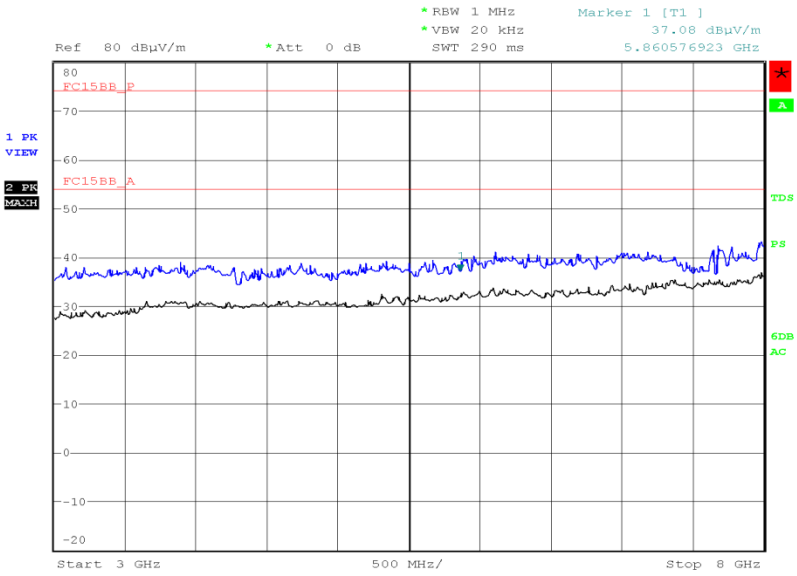
Product Service

1 GHz to 3 GHz



Date: 4.OCT.2013 01:59:27

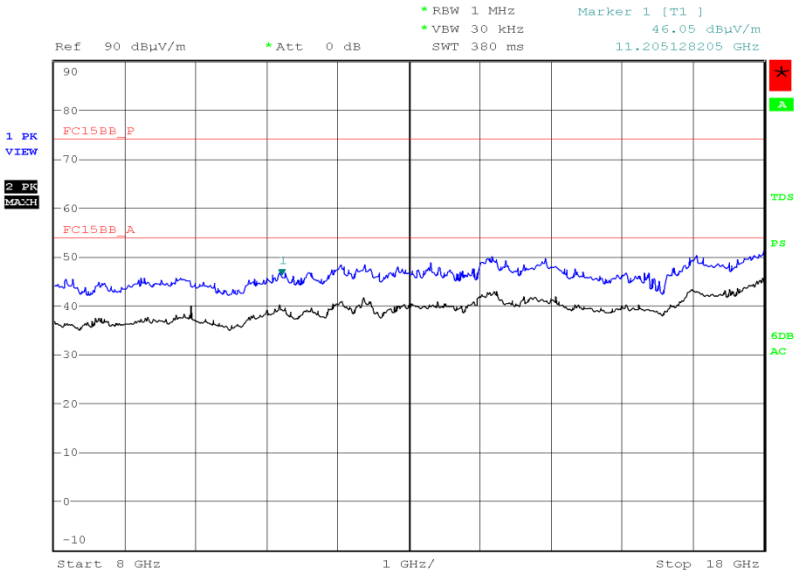
3 GHz to 8 GHz



Date: 5.OCT.2013 02:58:42

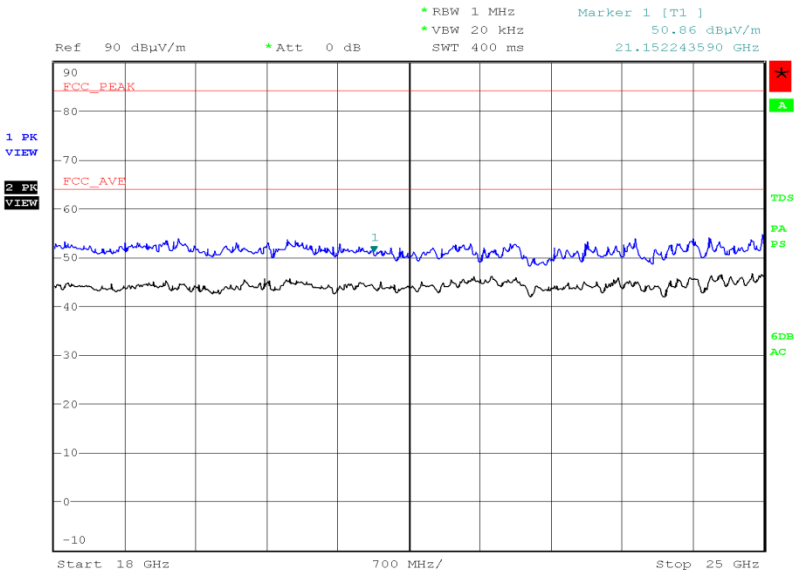
Product Service

8 GHz to 18 GHz



Date: 5.OCT.2013 02:18:22

18 GHz to 25 GHz



Date: 12.OCT.2013 22:21:08

Limit

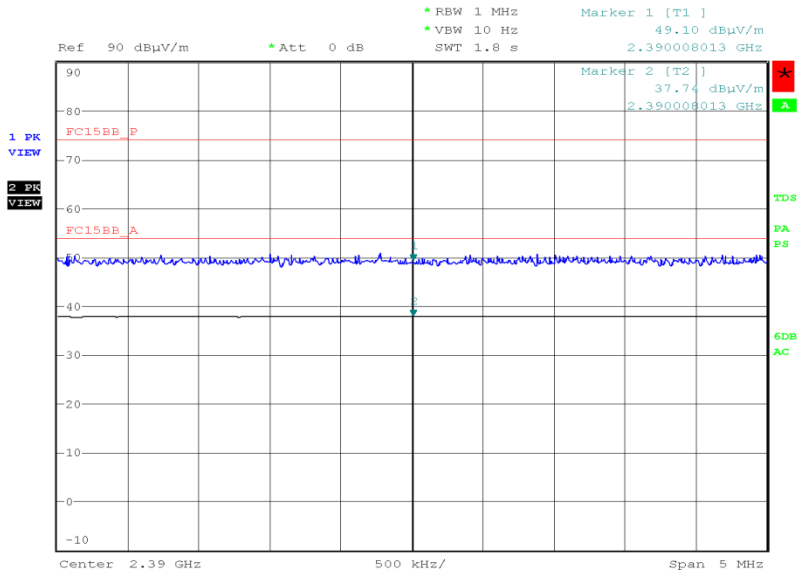
Peak (dBµV/m)	Average (dBµV/m)
74.0	54.0

Product Service

Band Edge Emissions

2402 MHz

Polarisation	Final Peak (dBµV/m)	Final Average (dBµV/m)
Horizontal	49.10	37.74

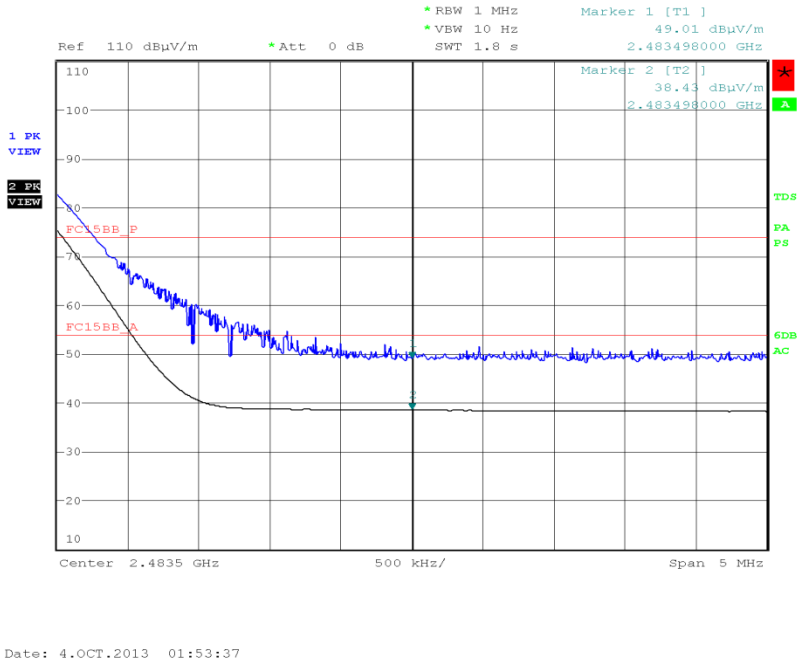


Date: 4.OCT.2013 02:25:26

Product Service

2480 MHz

Polarisation	Final Peak (dBµV/m)	Final Average (dBµV/m)
Horizontal	49.01	38.43



Limit

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

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					
LISN (1 Phase)	Chase	MN 2050	336	12	28-Mar-2014
Transient Limiter	Hewlett Packard	11947A	2377	12	13-Feb-2014
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	11-Oct-2013
Test Receiver	Rohde & Schwarz	ESIB	2941	12	23-Oct-2013
Section 2.2 - Frequency Hopping Systems - 20dB Bandwidth and Channel Separation					
Multimeter	White Gold	WG022	190	12	30-Oct-2013
GPS Frequency Standard	Rapco	GPS-804/3	1312	6	24-Jan-2014
Power Supply	Hewlett Packard	6104A	1948	-	TU
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	30-Nov-2013
Attenuator (10dB, 50W)	Aeroflex / Weinschel	47-10-34	3166	12	12-Sep-2014
Hygrometer	Rotronic	I-1000	3220	12	16-Jul-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	13-Sep-2014
1 Metre SMA Cable	Rhophase	3PS-1801A-1000-3PS	4099	12	26-Oct-2013
Attenuator (20dB/100W)	Weinschel	48-20-43	4138	9	8-Nov-2013
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	18-Sep-2014
Section 2.3 - Frequency Hopping Systems - Channel Dwell Time and Number of Hopping Channels					
Multimeter	White Gold	WG022	190	12	30-Oct-2013
GPS Frequency Standard	Rapco	GPS-804/3	1312	6	24-Jan-2014
Power Supply	Hewlett Packard	6104A	1948	-	TU
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	30-Nov-2013
Attenuator (10dB, 50W)	Aeroflex / Weinschel	47-10-34	3166	12	12-Sep-2014
Hygrometer	Rotronic	I-1000	3220	12	16-Jul-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	13-Sep-2014
1 Metre SMA Cable	Rhophase	3PS-1801A-1000-3PS	4099	12	26-Oct-2013
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	18-Sep-2014
Section 2.4 - Maximum Peak Conducted Output Power					
Multimeter	White Gold	WG022	190	12	30-Oct-2013
GPS Frequency Standard	Rapco	GPS-804/3	1312	6	24-Jan-2014
Power Supply	Hewlett Packard	6104A	1948	-	TU
Attenuator (10dB, 50W)	Aeroflex / Weinschel	47-10-34	3166	12	12-Sep-2014
Hygrometer	Rotronic	I-1000	3220	12	16-Jul-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	13-Sep-2014
P-Series Power Meter	Agilent Technologies	N1911A	3981	12	18-Sep-2014
50 MHz-18 GHz Wideband Power Sensor	Agilent Technologies	N1921A	3983	12	18-Sep-2014
1 Metre SMA Cable	Rhophase	3PS-1801A-1000-3PS	4099	12	26-Oct-2013
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	18-Sep-2014
Section 2.5 – EIRP Peak Power					
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	234	12	3-Apr-2014
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	11-Oct-2013
Test Receiver	Rohde & Schwarz	ESIB	2941	12	23-Oct-2013
Tilt Antenna Mast	maturo Gmbh	TAM 4.0-P	3916	-	TU
Mast Controller	maturo Gmbh	NCD	3917	-	TU

Product Service

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Section 2.6 - Spurious and Band Edge Emissions					
Multimeter	White Gold	WG022	190	12	30-Oct-2013
GPS Frequency Standard	Rapco	GPS-804/3	1312	6	24-Jan-2014
Power Supply	Hewlett Packard	6104A	1948	-	TU
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	30-Nov-2013
High Pass Filter (4GHz)	RLC Electronics	F-100-4000-5-R	2773	12	1-Feb-2014
Hygrometer	Rotronic	I-1000	3220	12	16-Jul-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	25-Oct-2013
'2.92mm' - '2.92mm' RF Cable (2m)	Rhophase	KPS-1503-2000-KPS	3695	12	15-Oct-2013
1 Metre SMA Cable	Rhophase	3PS-1801A-1000-3PS	4099	12	26-Oct-2013
Attenuator (20dB/100W)	Weinschel	48-20-43	4138	9	8-Nov-2013
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	18-Sep-2014

TU – Traceability Unscheduled

Product Service

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

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).

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