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Report On

FCC Testing of the Sharp SHL25 Dual-band CDMA (BC0, BC6) & Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900) & Dual-band UMTS (FDD I, FDD V) & Quad-band LTE (B1, B3, B17, B18) & AXGP (TDD 41) multi mode cellular phone with Bluetooth, ANT+, WLAN, SRD (NFC, FeliCa) and GPS
In accordance with FCC CFR 47 Part 15C (Bluetooth)

COMMERCIAL-IN-CONFIDENCE
FCC ID: APYHRO00206

Document 75925936 Report 11 Issue 1 May 2014

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REPORT ON

FCC Testing of the Sharp SHL25 Dual-band CDMA (BC0, BC6) & Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900) & Dual-band UMTS (FDD I, FDD V) & Quad-band LTE (B1, B3, B17, B18) & AXGP (TDD 41) multi mode cellular phone with Bluetooth, ANT+, WLAN, SRD (NFC, FeliCa) and GPS
In accordance with FCC CFR 47 Part 15C (Bluetooth)

Document 75925936 Report 11 Issue 1

May 2014

PREPARED FOR

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PREPARED BY

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Senior Administrator, Technical Solutions

APPROVED BY

Nic Forsyth
Authorised Signatory

DATED 12 May 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);

T Guy S Milliken A Galpin G Lawler

Product Service

CONTENTS

Product Service

SECTION 1

REPORT SUMMARY

FCC Testing of the
Sharp SHL25 Dual-band CDMA (BC0, BC6) & Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900) & Dual-band UMTS (FDD I, FDD V) & Quad-band LTE (B1, B3, B17, B18) & AXGP (TDD 41) multi mode cellular phone with Bluetooth, ANT+, 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 the verification of FCC Testing of the Sharp SHL25 Dual-band CDMA (BC0, BC6) & Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900) & Dual-band UMTS (FDD I, FDD V) & Quad-band LTE (B1, B3, B17, B18) & AXGP (TDD 41) multi mode cellular phone with Bluetooth, ANT+, 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)	SHL25
Serial Number(s)	IMEI 004401115170256 IMEI 004401115170694
Number of Samples Tested	2
Test Specification/Issue/Date	FCC CFR 47 Part 15C (2013)
Incoming Release Date	Application Form 24 March 2014
Disposal Reference Number Date	Held Pending Disposal Not Applicable Not Applicable
Order Number Date	10070 10 March 2014
Start of Test	31 March 2014
Finish of Test	19 April 2014
Name of Engineer(s)	T Guy S Milliken A Galpin G Lawler
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	SHL25	
Part Number	CA268	
FCC ID (if applicable)	APYHRO00206	
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/B17/B18), Dual-band WCDMA(FDD-I/V), Quad-band GSM(850/900/1800/1900), Dual-band CDMA2000(800MHz_BC0, 1900MHz _BC6), Multimode Smartphone with BT, ANT+, WLAN, SRD 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	2402 to 2480 MHz	2402 to 2480 MHz
WLAN	2412 to 2462 MHz	2412 to 2472 MHz
FCC and/or Industry Canada (only)		
Highest Internally Generated Frequency 2150.4 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)				5.0m	W			
Minimum Rated Transmitter Output								
Effective radiated power (for equipment with antenna connector)					W			
Effective radiated power (for equipment with integral antenna)				1.0m	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: H Murakami Name: Hiroyuki Murakami

Position held: Supervisor Date: 24th March, 2014

1.4 PRODUCT INFORMATION

1.4.1 Technical Description

The Equipment Under Test (EUT) was a Sharp SHL25 Dual-band CDMA (BC0, BC6) & Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900) & Dual-band UMTS (FDD I, FDD V) & Quad-band LTE (B1, B3, B17, B18) & AXGP (TDD 41) multi mode cellular phone with Bluetooth, ANT+, 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.

Product Service

SECTION 2

TEST DETAILS

FCC Testing of the
Sharp SHL25 Dual-band CDMA (BC0, BC6) & Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900) & Dual-band UMTS (FDD I, FDD V) & Quad-band LTE (B1, B3, B17, B18) & AXGP (TDD 41) multi mode cellular phone with Bluetooth, ANT+, 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

SHL25 S/N: IMEI 004401115170256 - Modification State 0

2.1.3 Date of Test

19 April 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

A test environment and testing arrangement meeting the specification of ANSI C63.4 was used during all testing. The Equipment Under Test (EUT) was set upon a non-conducting platform at an elevation of 80 cm above a horizontal reference ground plane. A vertical reference ground plane was situated 40 cm from the EUT and bonded to the horizontal reference ground plane.

The EUT was powered by a Line Impedance Stabilization Network (LISN), whereby emissions measurements of the current-carrying conductors were made through this LISN. The LISN was bonded to the horizontal reference ground plane with a separation distance greater than 80 cm from the EUT. A mains supply cable of 1 m length was used to supply mains power to the EUT from the LISN.

A preliminary emissions scan was conducted for each current-carrying conductor of the EUT, using a peak detector over a frequency range of 150 kHz to 30 MHz. At least six of the greatest peak emissions, frequency positions were selected from each preliminary emissions scan for further evaluation as final measuring points.

Final measurement points were measured using quasi-peak and average detectors. All final measurements were assessed against the emission limits in Clause 15.207 of FCC CFR 47 FCC Part 15.

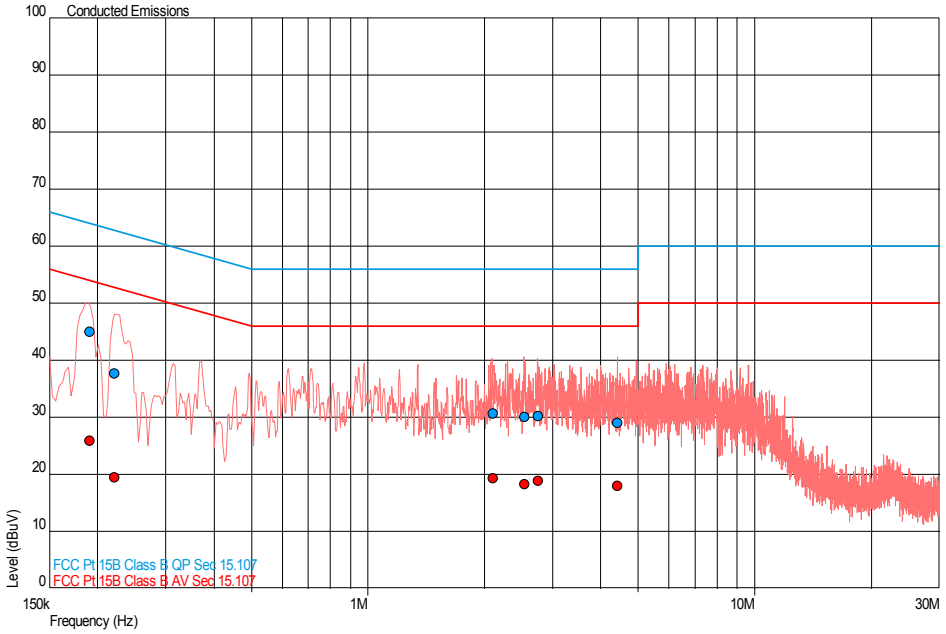
2.1.6 Environmental Conditions

Ambient Temperature	19.7°C
Relative Humidity	27.0%

Product Service

2.1.7 Test Results

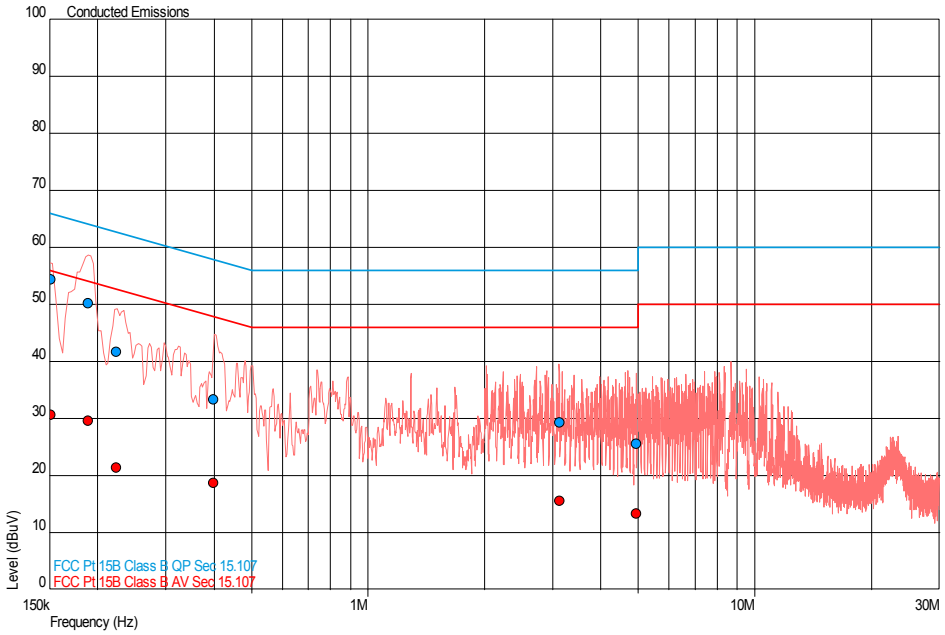
Live Line



Frequency (MHz)	QP Level (dBµV)	QP Limit (dBµV)	QP Margin (dBµV)	AV Level (dBµV)	AV Limit (dBµV)	AV Margin (dBµV)
0.191	45.0	64.0	-19.0	25.9	54.0	-28.1
0.221	37.8	62.8	-25.0	19.5	52.8	-33.3
2.100	30.7	56.0	-25.3	19.4	46.0	-26.6
2.534	30.0	56.0	-26.0	18.3	46.0	-27.7
2.748	30.3	56.0	-25.7	18.9	46.0	-27.1
4.407	29.1	56.0	-26.9	18.0	46.0	-28.0

Product Service

Neutral Line



Frequency (MHz)	QP Level (dBµV)	QP Limit (dBµV)	QP Margin (dBµV)	AV Level (dBµV)	AV Limit (dBµV)	AV Margin (dBµV)
0.151	54.5	65.9	-11.5	30.7	55.9	-25.2
0.189	50.2	64.1	-13.9	29.7	54.1	-24.4
0.223	41.7	62.7	-21.0	21.4	52.7	-31.3
0.399	33.4	57.9	-24.5	18.8	47.9	-29.1
3.121	29.4	56.0	-26.6	15.6	46.0	-30.4
4.941	25.6	56.0	-30.4	13.3	46.0	-32.7

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

SHL25 S/N: IMEI 004401115170694 - Modification State 0

2.2.3 Date of Test

3 April 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 test was applied in accordance with the test method requirements of FCC CFR 47 Part 15.247 (a) and Part 15.215 (c).

The EUT was transmitted at maximum power on bottom, middle and top hopping frequency channels for DH5, 2DH5 and 3DH5 packet types. The EUT was connected to a spectrum analyser via a cable and attenuator. The Analyser settings were adjusted to display the resultant trace on screen with an RBW of 10 kHz. The peak point of the trace was measured and the markers positioned to give the -20 dBc points of the displayed spectrum.

The EUT was then configured to transmit over all hopping frequencies. 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	23.4°C
Relative Humidity	39.3%

Product Service

2.2.7 Test Results

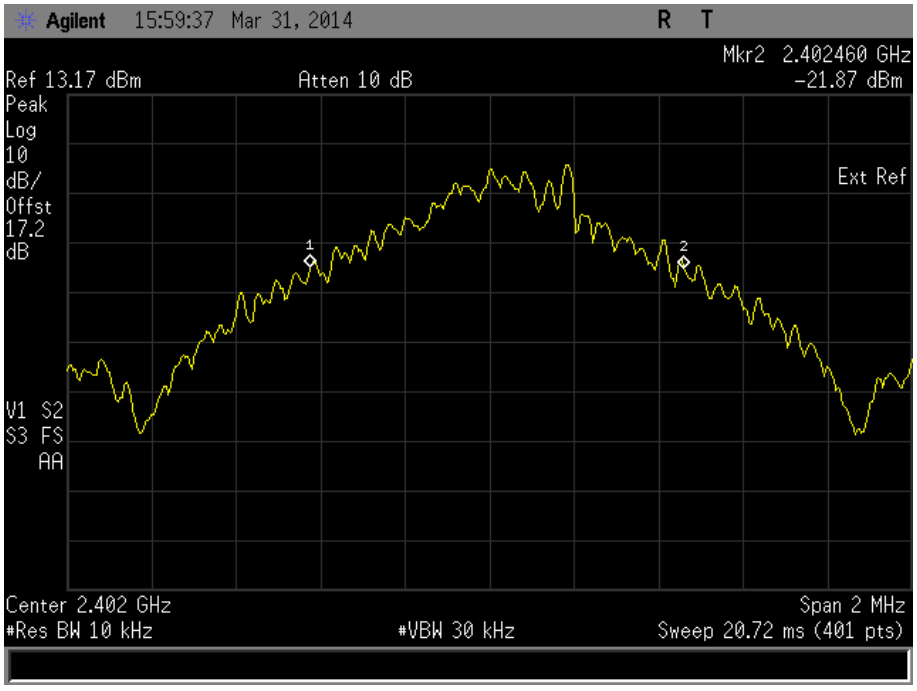
4.0 V DC Supply

20dB Bandwidth

2402 MHz

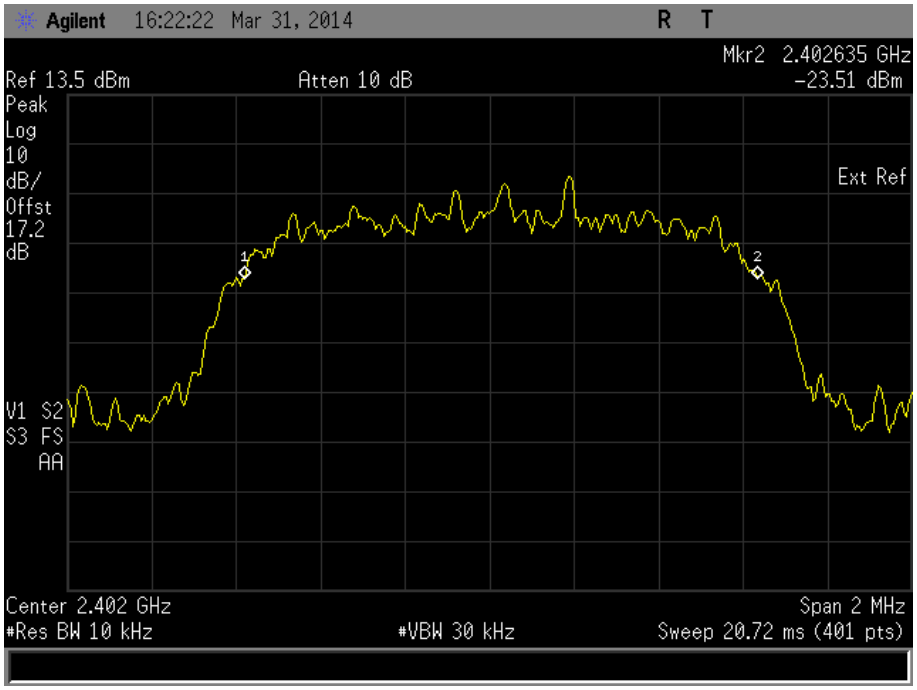
Data Rate (Mbps)	20dB Bandwidth (kHz)
DH5	885
2DH5	1215
3DH5	1250

DH5

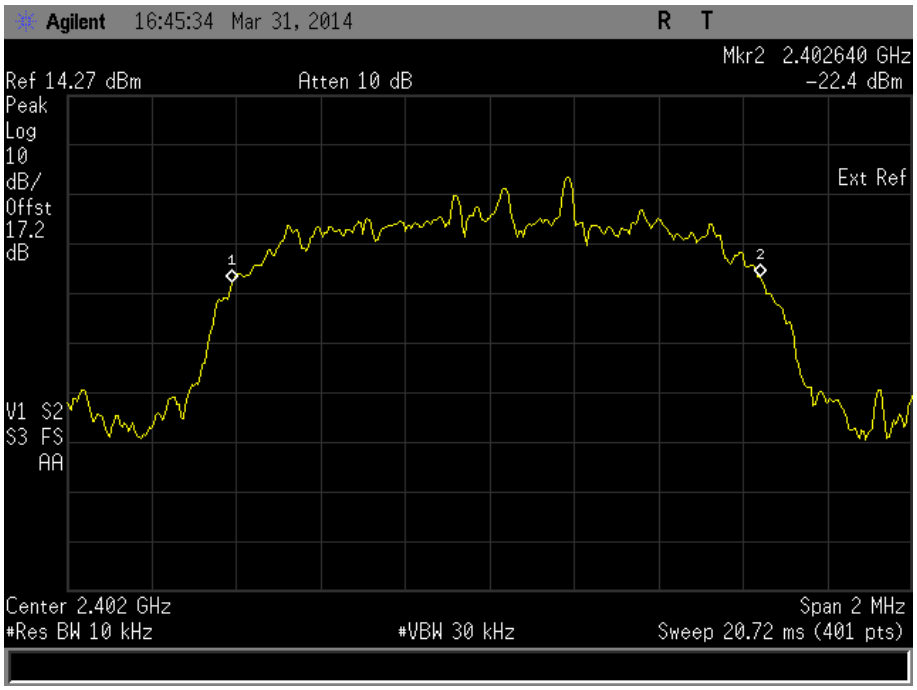


Product Service

2DH5



3DH5

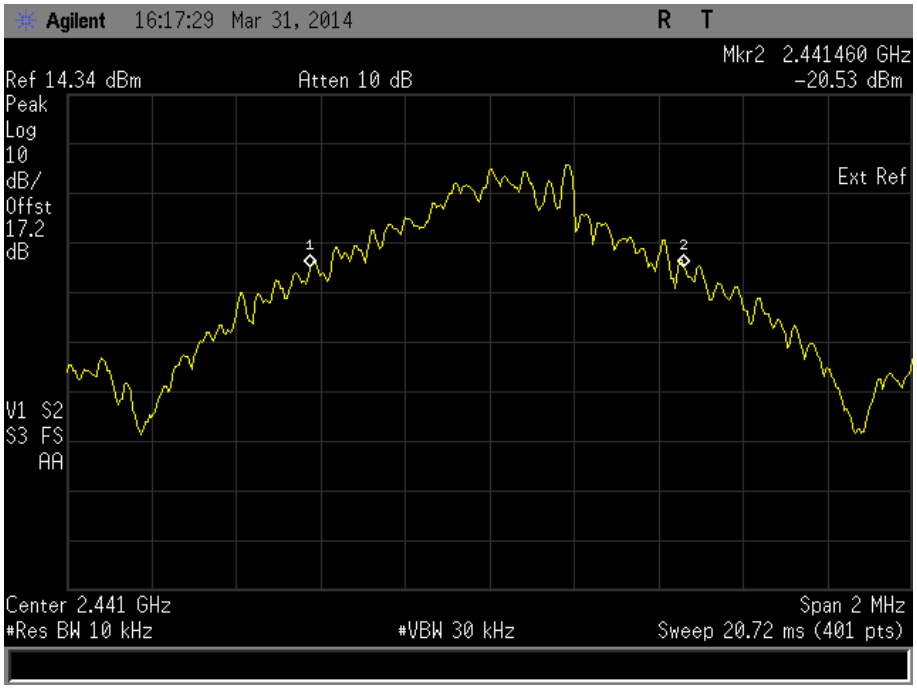


Product Service

2441 MHz

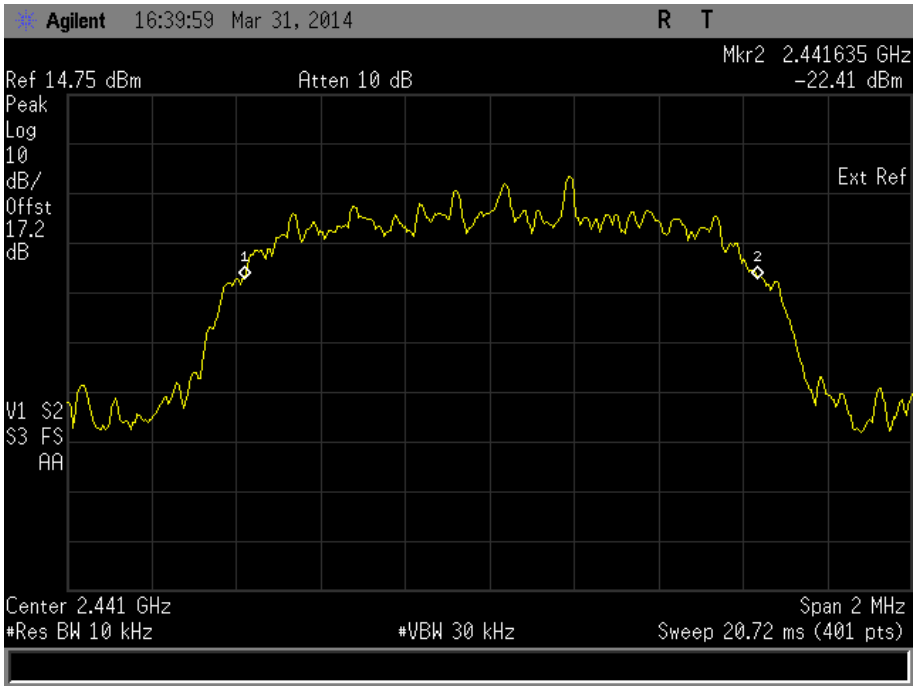
Data Rate (Mbps)	20dB Bandwidth (kHz)
DH5	885
2DH5	1215
3DH5	1240

DH5

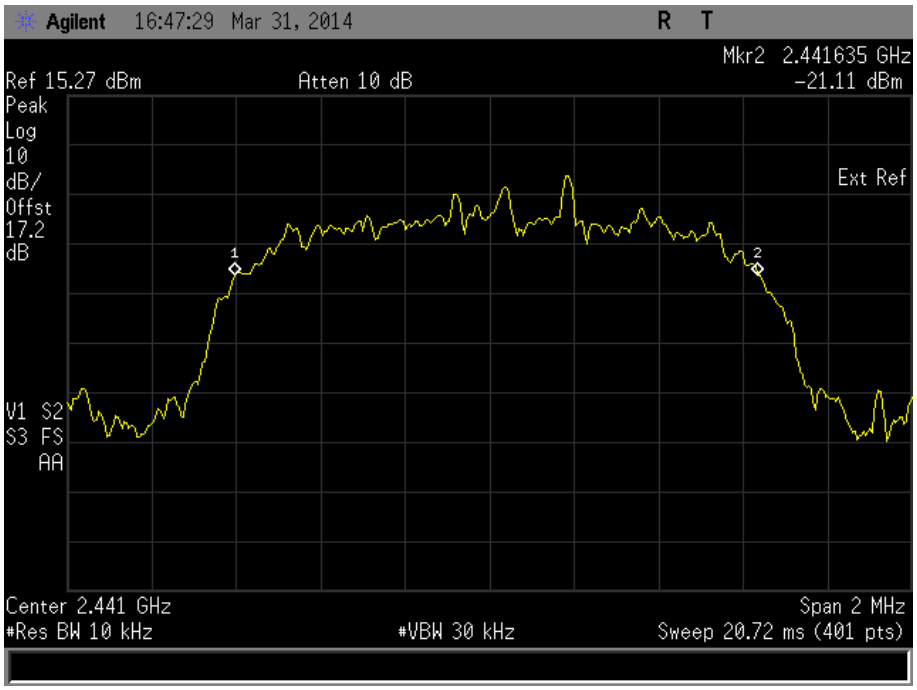


Product Service

2DH5



3DH5

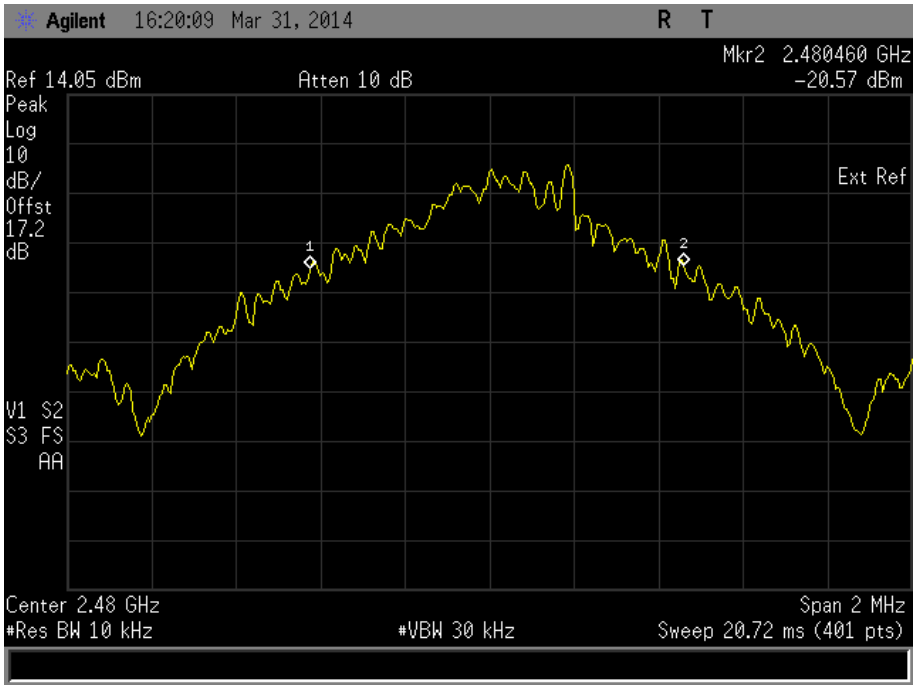


Product Service

2480 MHz

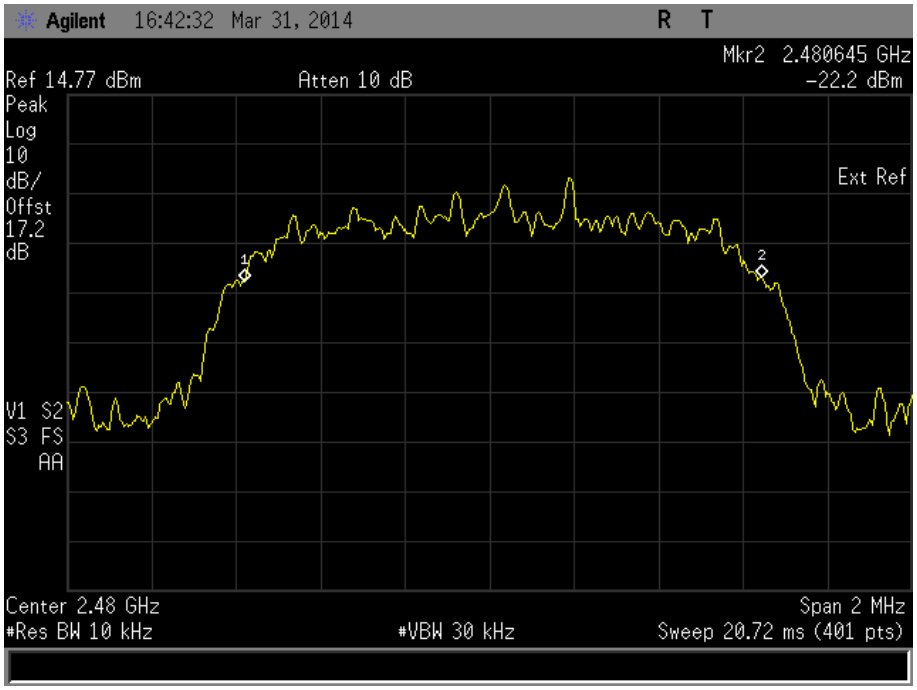
Data Rate (Mbps)	20dB Bandwidth (kHz)
DH5	885
2DH5	1215
3DH5	1240

DH5

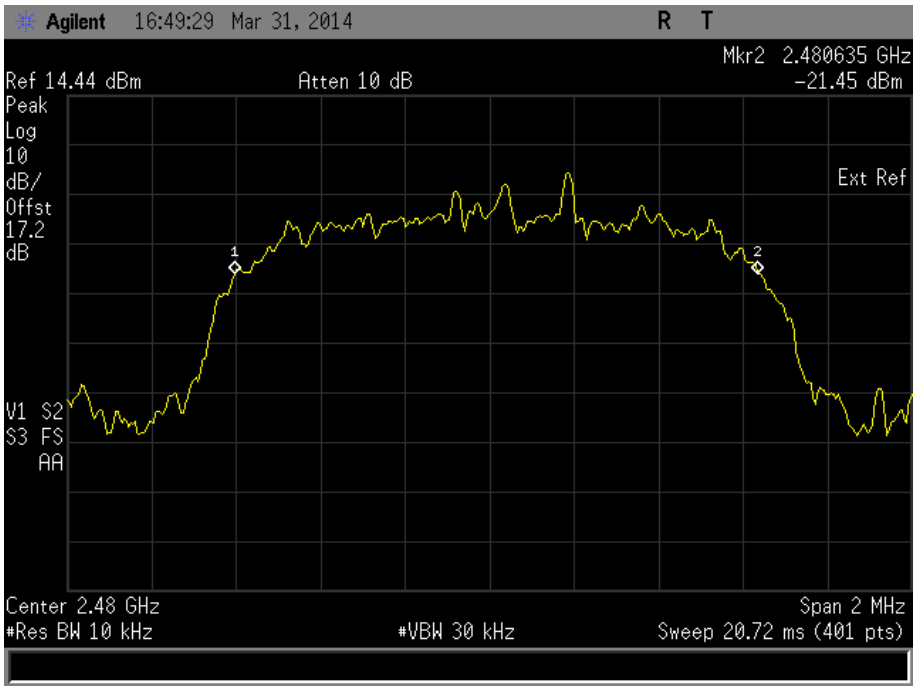


Product Service

2DH5



3DH5



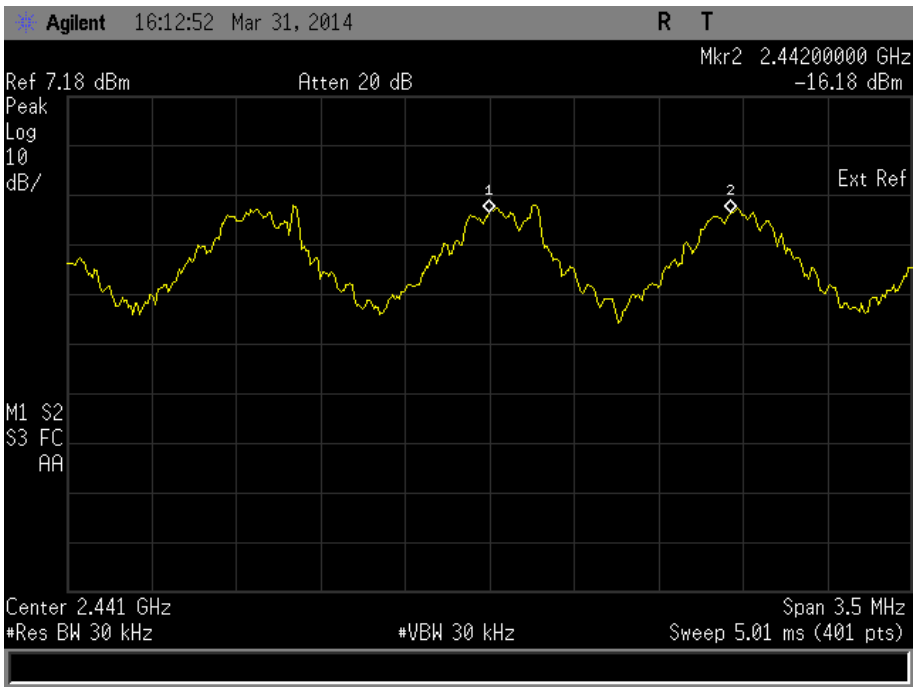
Limit Clause

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

SHL25 S/N: IMEI 004401115170694 - Modification State 0

2.3.3 Date of Test

7 April 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

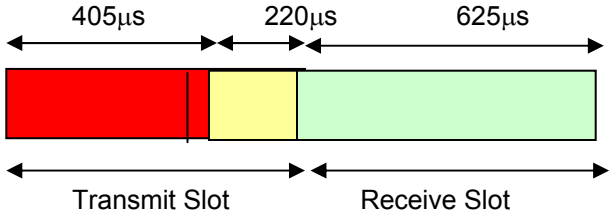
The Bluetooth system hops at a rate of 1600 times per second. Thus, this equates to 1600 timeslots in 1 second.

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:

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

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



DH1 Timeslot Arrangement Showing One Complete Transmit and Receive Cycle

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

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

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

32 x 4.05ms = 0.1296 seconds

DH3

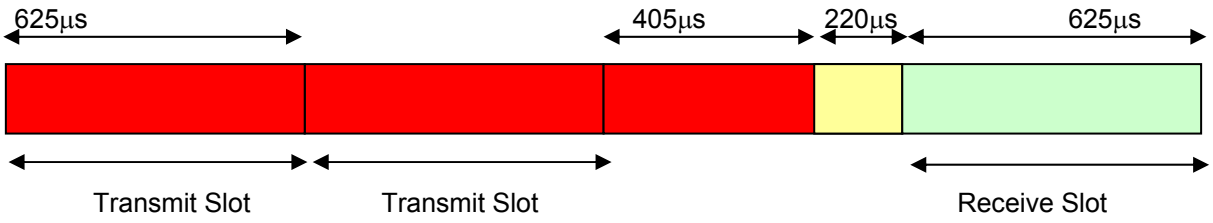
With data rate DH3, the data payload is higher and can use up to 3 timeslots. When more than one timeslot is used, the frequency does not hop and transmission is continuous on all 3 slots, (ie. no receive slot in-between the 3 transmit slots). The 220μs off time for synthesizer re-tuning at the end of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

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

Thus:

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

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



Product Service

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

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

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

So:

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

Thus: 0.5 + 0.162 = 0.662 seconds

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

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

32 x 8.275ms = 0.2648 seconds

DH5

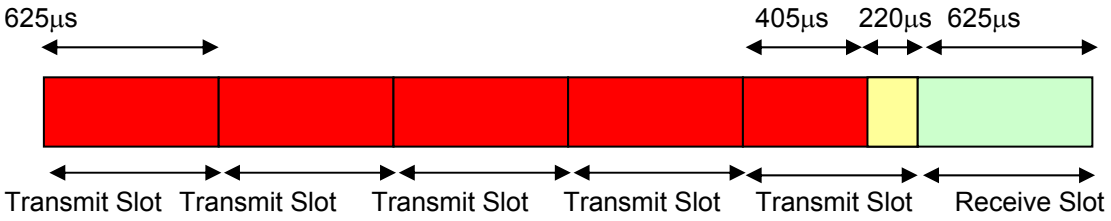
With data rate DH5, the data payload is higher and can use up to 5 timeslots. When more than one timeslot is used, the frequency does not hop and transmission is continuous on all 5 slots, (ie. no receive slot in-between the 5 transmit slots). The 220μs off time for synthesizer re-tuning at the end of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

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

Thus:

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

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



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

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

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

So:

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

Thus: 0.666 + 0.108 = 0.774 seconds

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

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

32 x 9.675ms = 0.31 seconds

2.3.6 Environmental Conditions

Ambient Temperature	22.8°C
Relative Humidity	47.6%

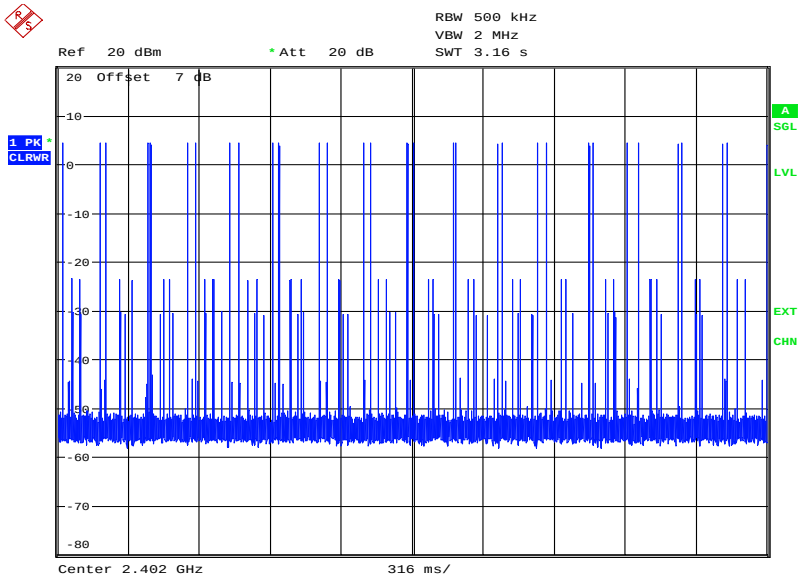
2.3.7 Test Results

4.0 V DC Supply

Channel Dwell Time

DH1

158.888 ms

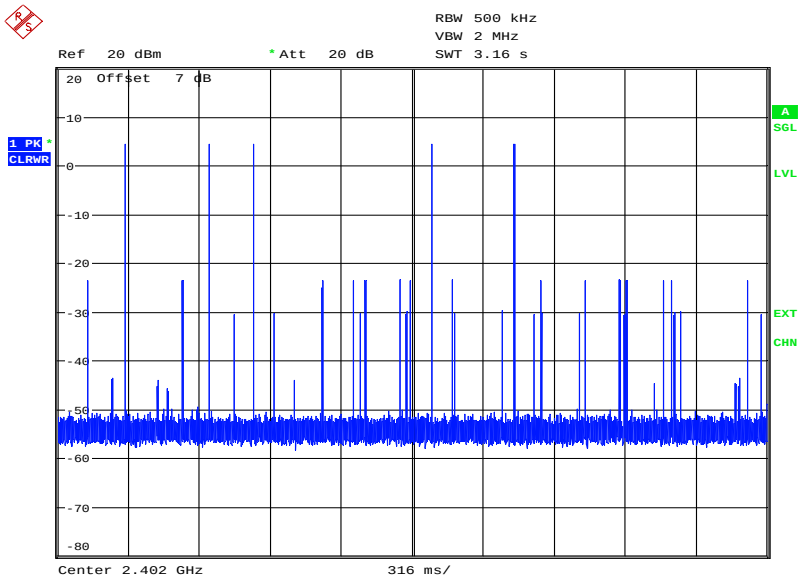


Date: 7.APR.2014 11:22:47

Product Service

DH3

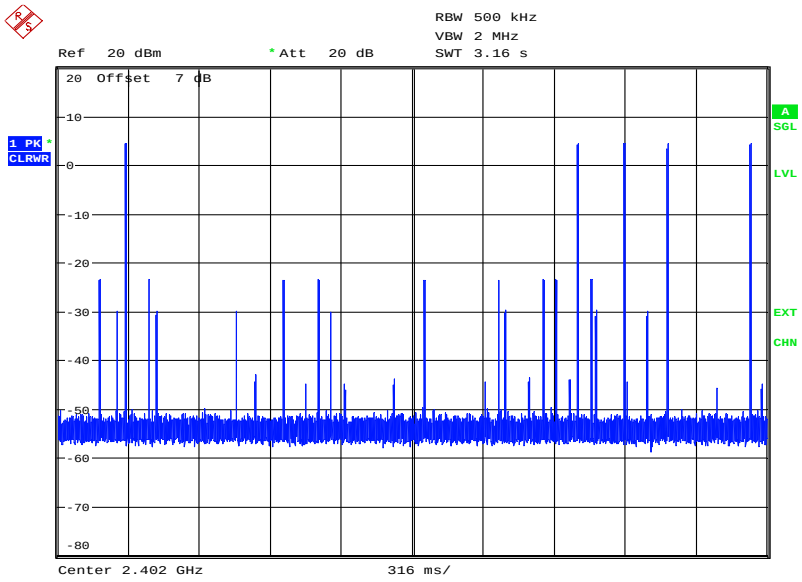
88.477 ms



Date: 7.APR.2014 11:24:54

DH5

148.515 ms



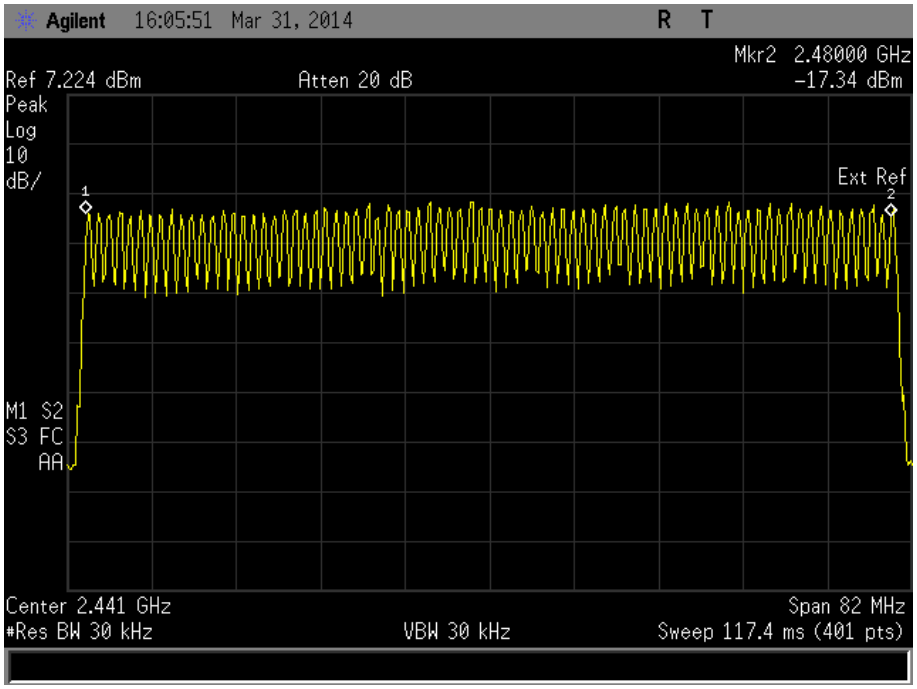
Date: 7.APR.2014 11:25:17

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

SHL25 S/N: IMEI 004401115170694 - Modification State 0

2.4.3 Date of Test

31 March 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 test was applied in accordance with the test method requirements of FCC CFR 47 Part 15.247 (b) and KDB 558074.

The EUT was connected to a broadband peak RF power meter via a cable and attenuator. The EUT was transmitting at maximum power, for bottom, middle and top channels on DH1, DH3 and DH5 packet types. The path loss between the EUT and sensor was measured and entered as a reference level offset. The peak power was recorded for measurements on the bottom, middle and top channels on DH1, DH3 and DH5 packet types

2.4.6 Environmental Conditions

Ambient Temperature	23.4°C
Relative Humidity	39.3%

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	3.84	5.11	4.79	2.42	3.24	3.01
DH3	3.73	5.08	4.77	2.36	3.22	3.00
DH5	3.75	5.04	4.77	2.37	3.19	3.00

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

SHL25 S/N: IMEI 004401115170256 - Modification State 0

2.5.3 Date of Test

8 April 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

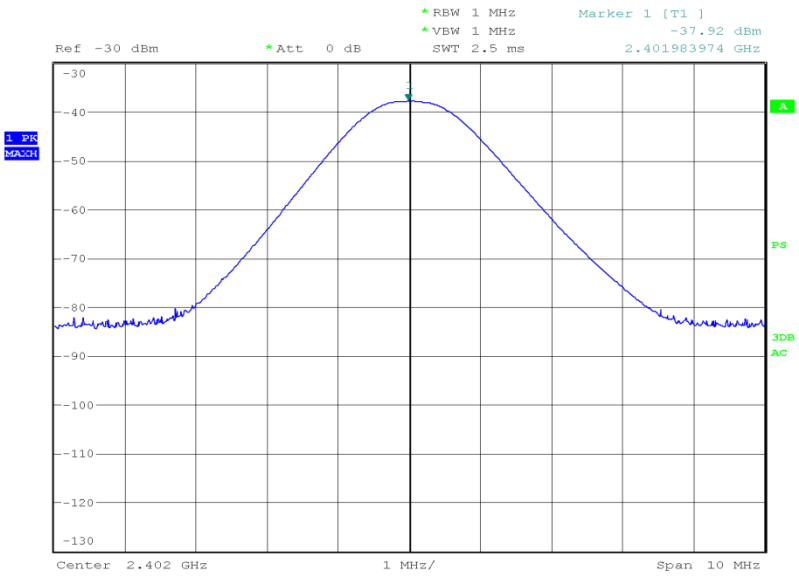
Ambient Temperature	20.9°C
Relative Humidity	30.0%

Product Service

2.5.7 Test Results

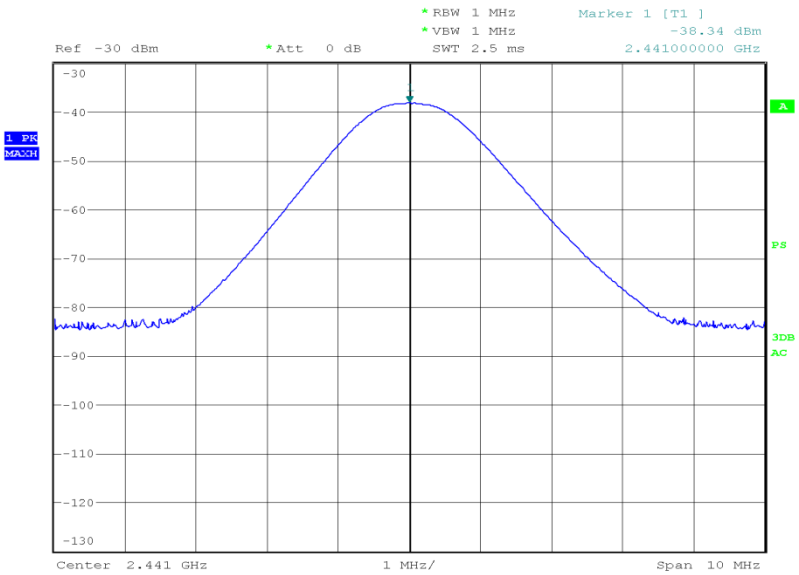
2402 MHz

EIRP (dBm)	EIRP (mW)
3.52	2.25



2441 MHz

EIRP (dBm)	EIRP (mW)
3.42	2.20



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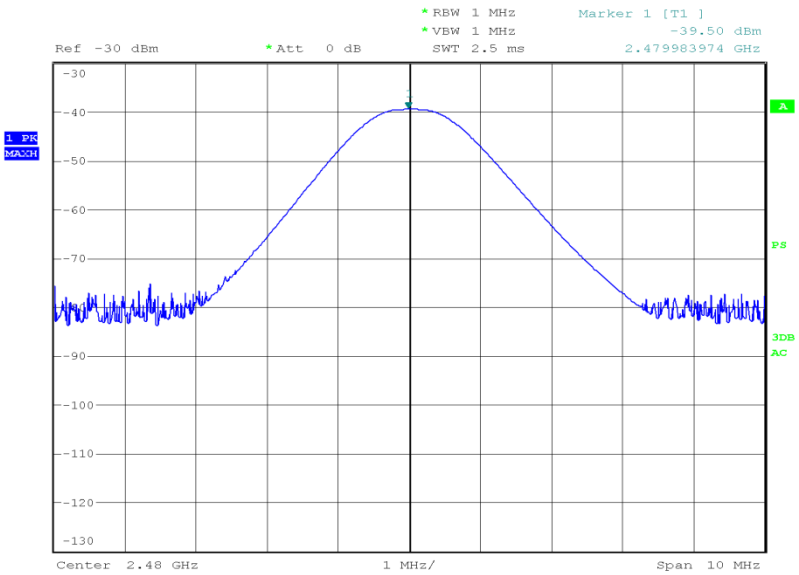
Product Service

2480 MHz

EIRP (dBm)	EIRP (mW)
2.60	1.82



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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

SHL25 S/N: IMEI 004401115170256 - Modification State 0

2.6.3 Date of Test

3 April 2014, 8 April 2014 & 9 April 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

The test was applied in accordance with the test method requirements of FCC CFR 47 Part 15.247 (d) and KDB 558074.

For conducted emissions, the EUT was set to operate at maximum power on the bottom, middle and top channels for the data rate which resulted in the highest peak output power. The power of each fundamental frequency was measured in 100 kHz RBW, the resultant limit line on the trace was set at -20 dBc of this value. The measurement path loss in each relevant frequency band was measured and entered as a reference level offset. The test was performed from 9 kHz to 25 GHz.

Radiated Emissions

A preliminary profile of the Spurious Radiated Emissions is obtained up to the 10th harmonic of the EUT's fundamental frequency. For frequencies from 30MHz to 18GHz the EUT is placed on a test table 800mm above the ground plane. For frequencies above 18GHz, the EUT height is increased by 200mm to a height of 1000mm. This is to ensure the beam width of the measuring antenna gives sufficient vertical coverage of the EUT.

During characterisation the turntable azimuth is adjusted from 0 to 360 degrees with the measuring antenna in one polarity. It is then repeated for the other polarity. Any frequencies of interest are noted for formal measuring later. The distance from the measuring antenna to the boundary of the EUT is 3m. Above 18GHz this distance may be reduced to 1m.

During formal measurement the spectrum analyser is tuned to the frequency of the emission. The turntable azimuth is adjusted from 0 to 360 degrees to determine the point at which the maximum emission level occurs. Then the height of the measuring antenna is adjusted from a height of 1m to 4m to determine the height at which the maximum emission level occurs. Once the point of maximum emission has been determined the emission is measured. Emissions in the 30MHz to 1GHz range are measured using a CISPR Quasi – Peak detector function in a 120kHz bandwidth. Emissions in the range 1GHz to 40GHz require Peak and Average measurements. The Peak measurements are made using a peak detector with 1MHz Resolution and Video bandwidths.

The average measurements employ a peak detector with a Resolution bandwidth of 1MHz and a Video bandwidth of 10Hz. If measurements are made at a 1m measuring distance, then 10dB is added to the specification limit.

2.6.6 Environmental Conditions

Ambient Temperature	20.9 - 24.6°C
Relative Humidity	30.0 - 41.3%

2.6.7 Test Results

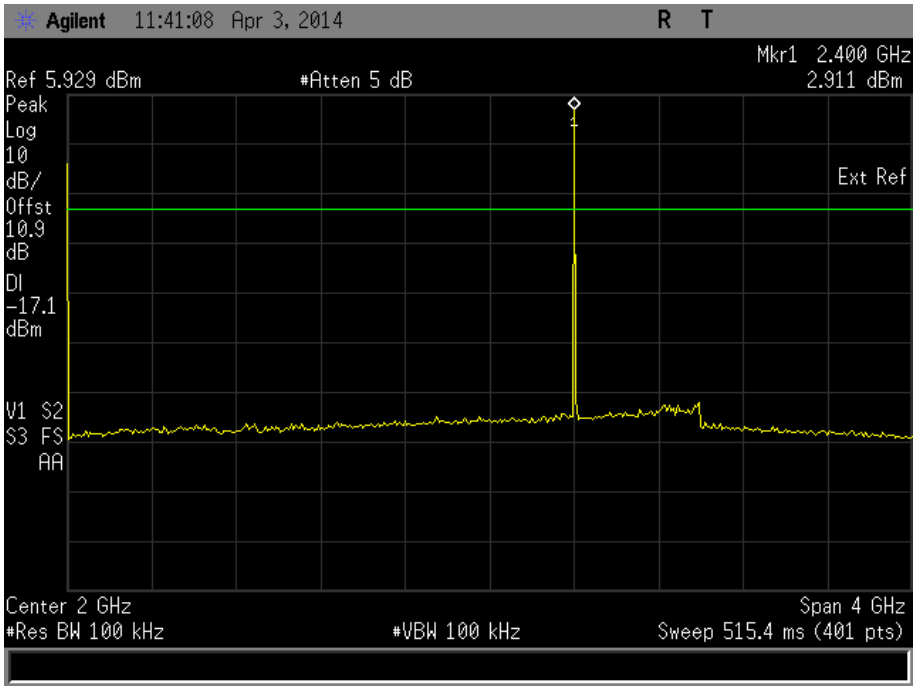
4.0 V DC Supply

Spurious Conducted Emissions

DH5

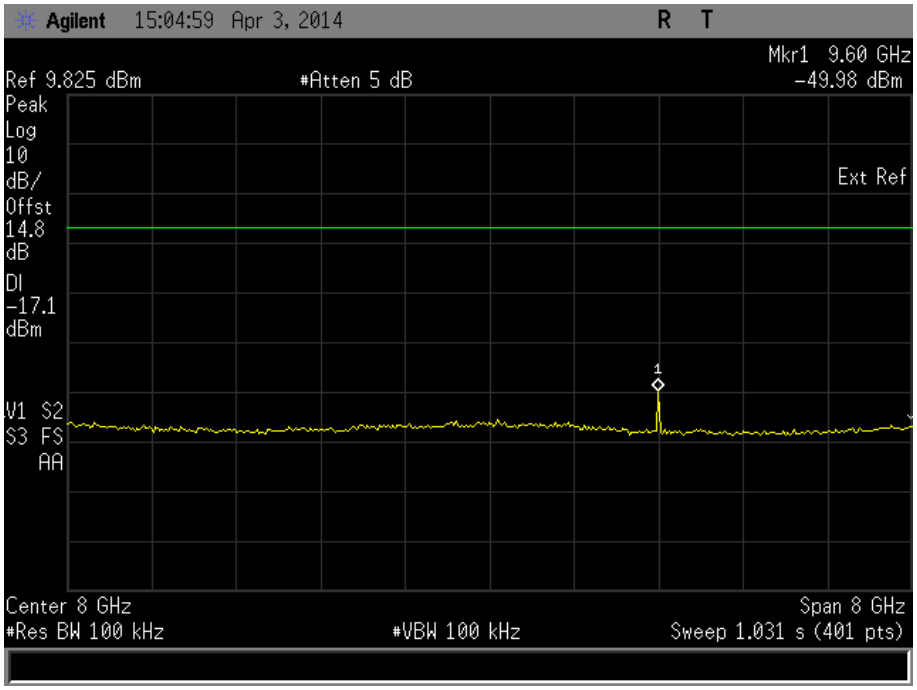
2402 MHz

9 kHz to 4 GHz

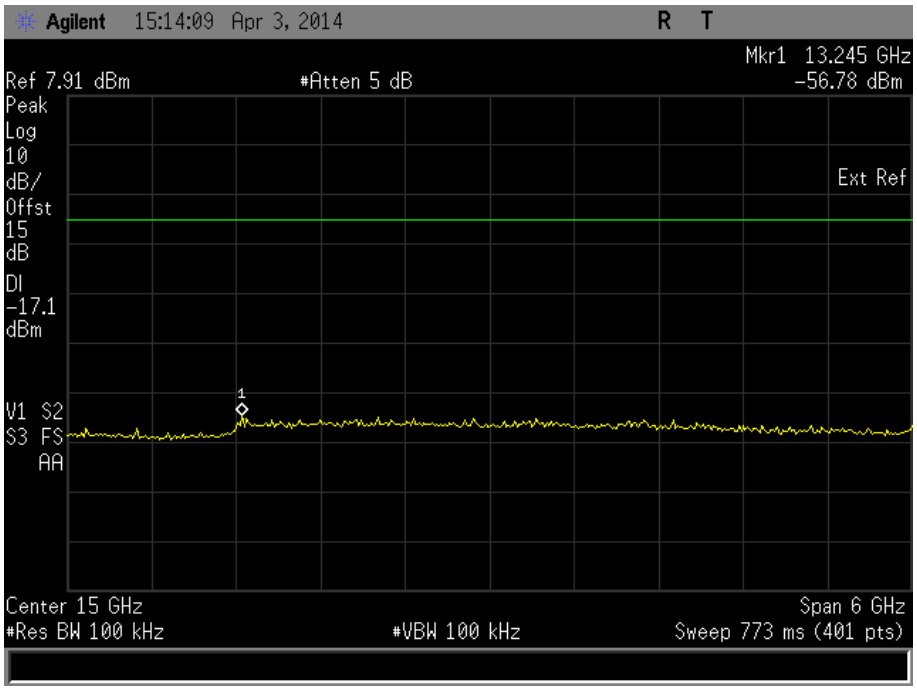


Product Service

4 GHz to 12 GHz

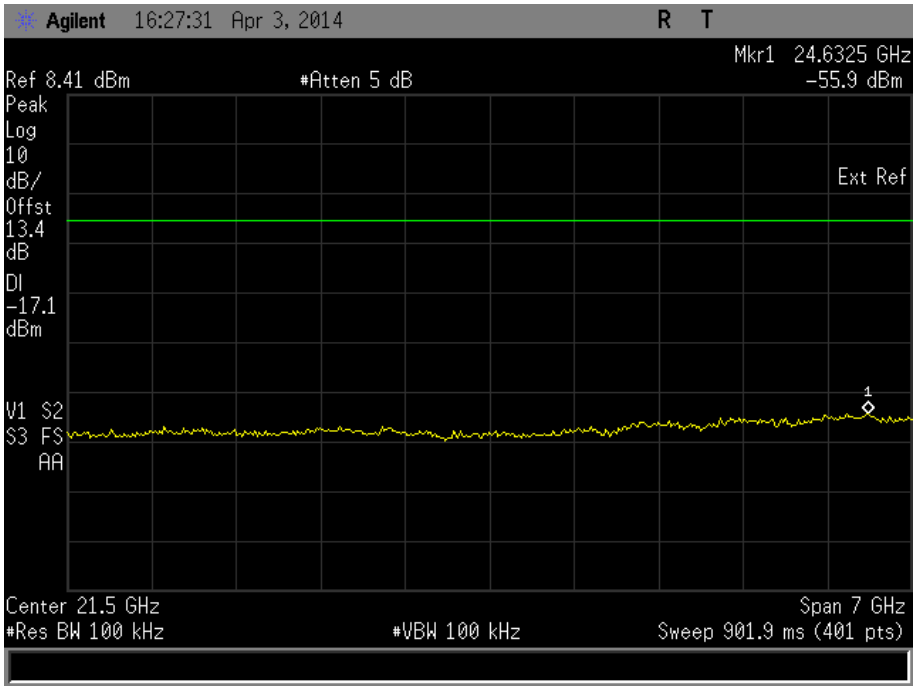


12 GHz to 18 GHz



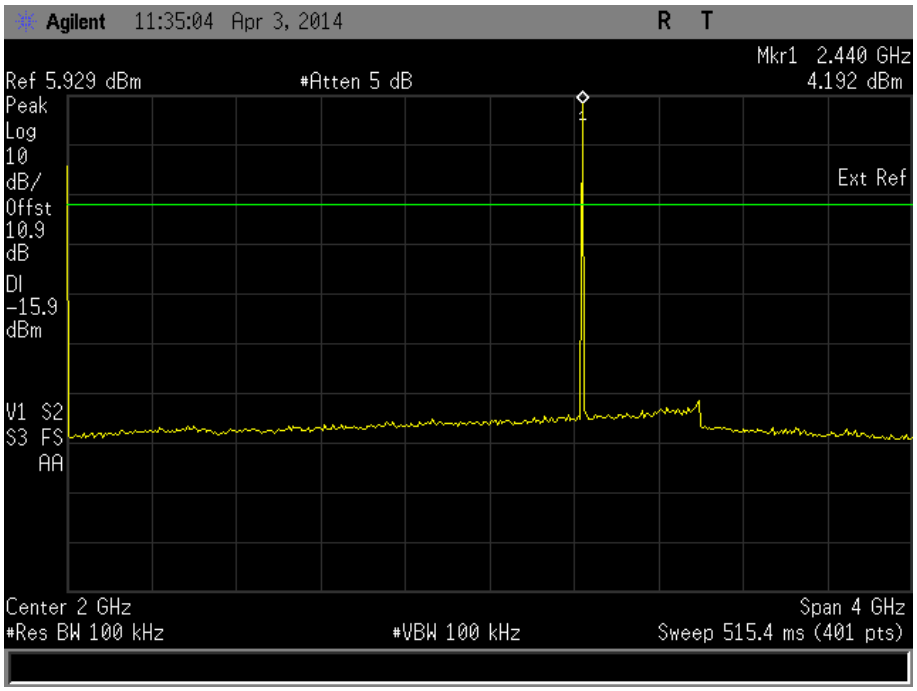
Product Service

18 GHz to 25 GHz



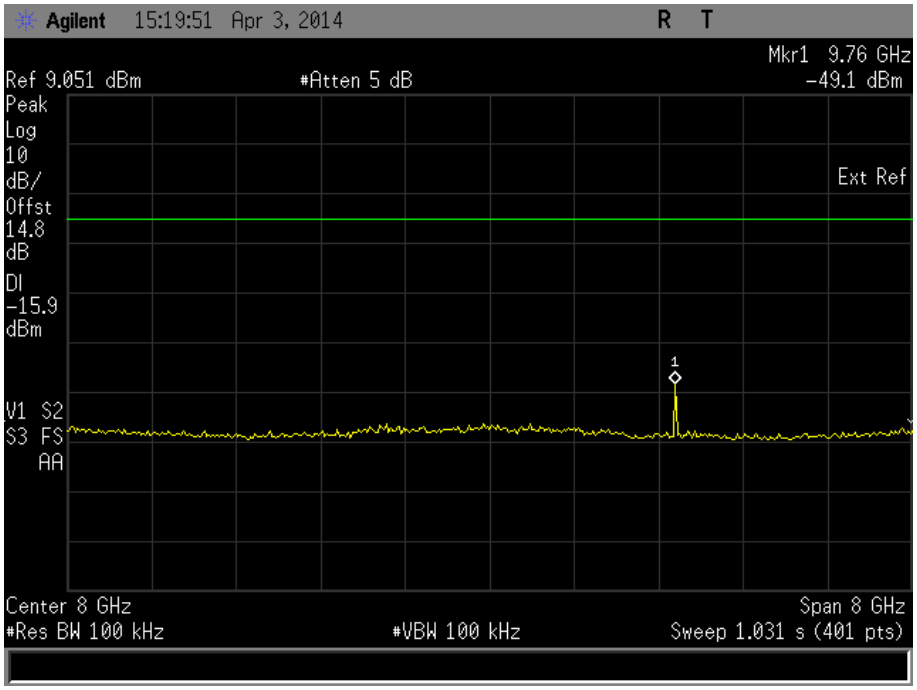
2441 MHz

9 kHz to 4 GHz

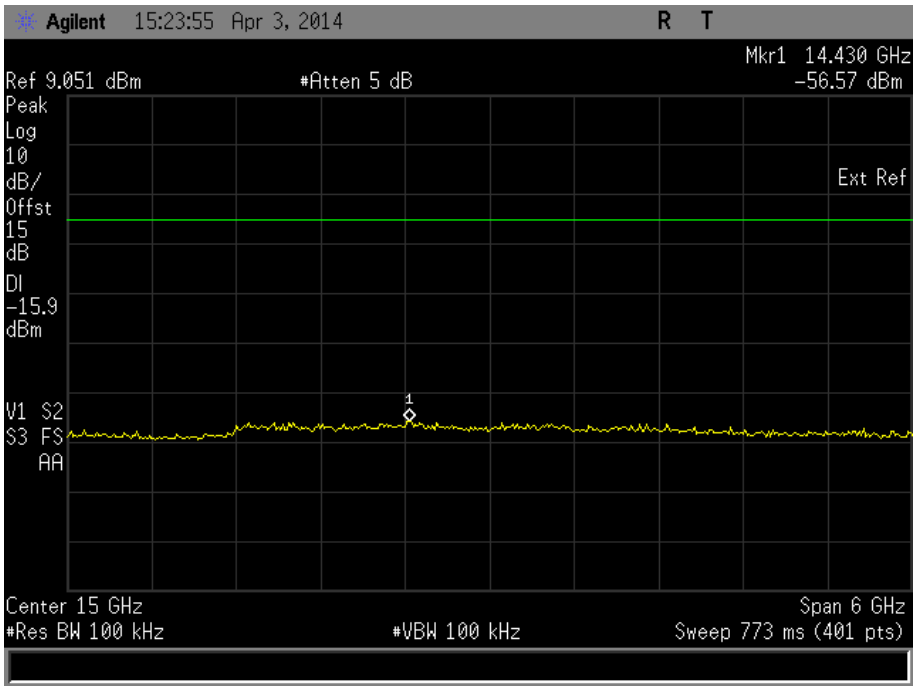


Product Service

4 GHz to 12 GHz

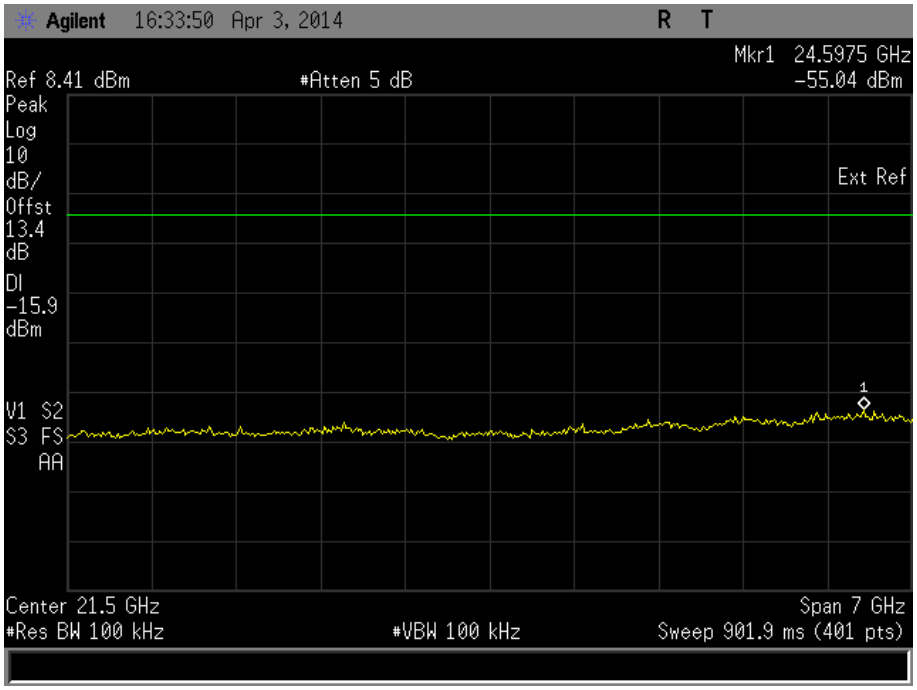


12 GHz to 18 GHz



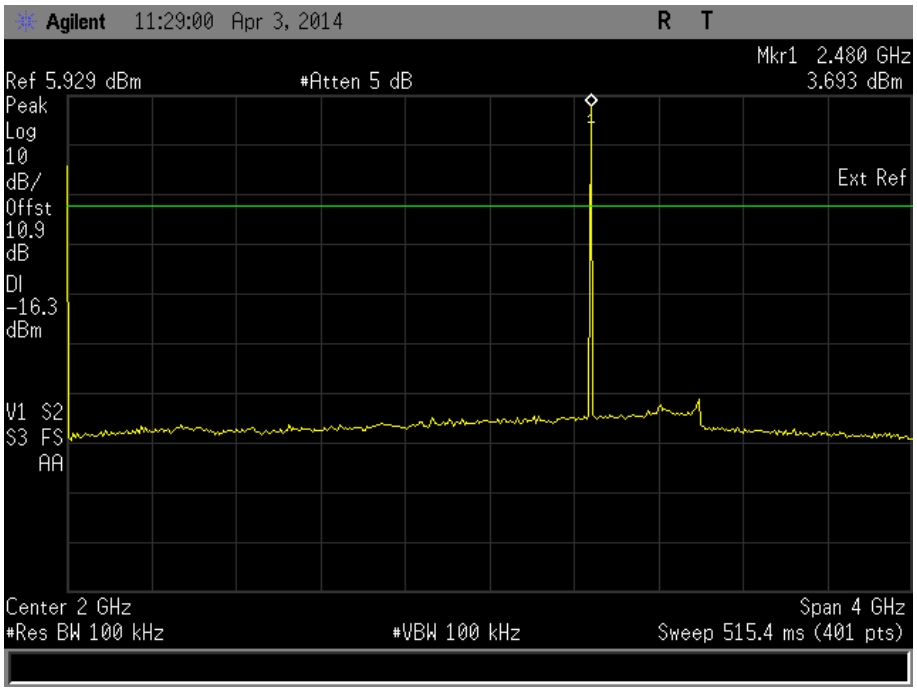
Product Service

18 GHz to 25 GHz



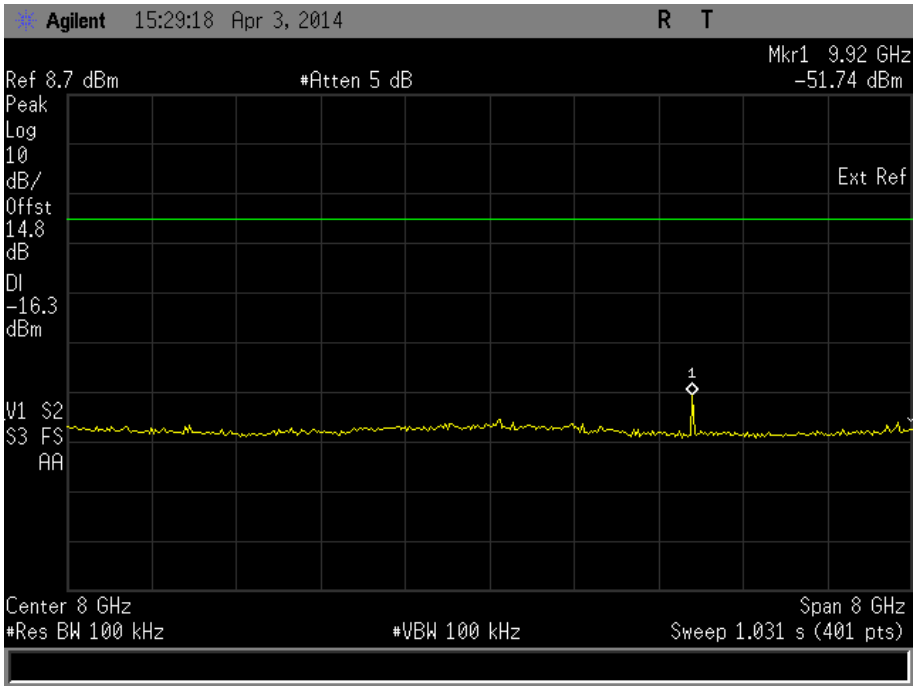
2480 MHz

9 kHz to 4 GHz

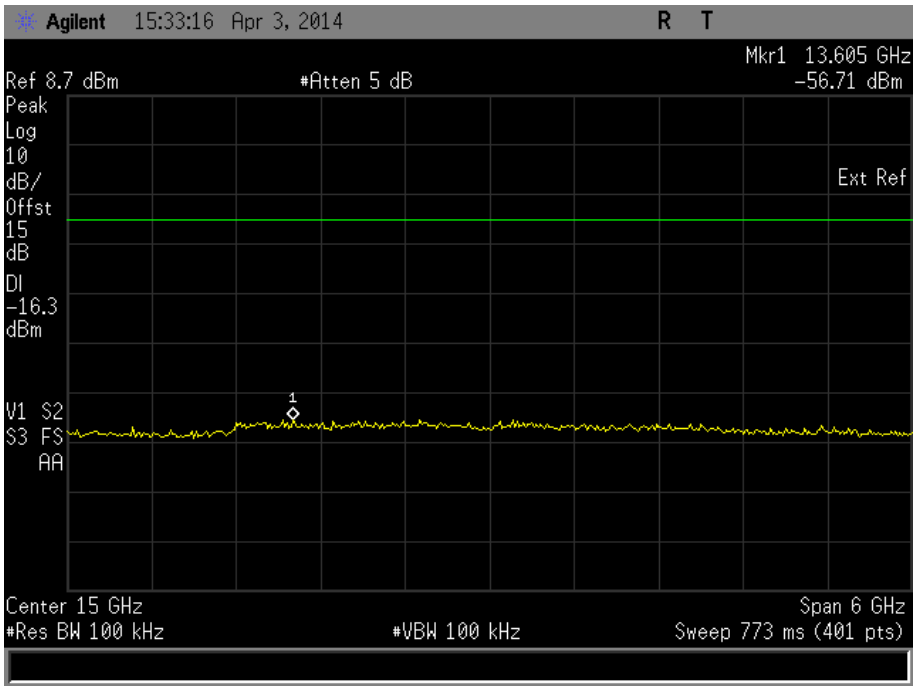


Product Service

4 GHz to 12 GHz

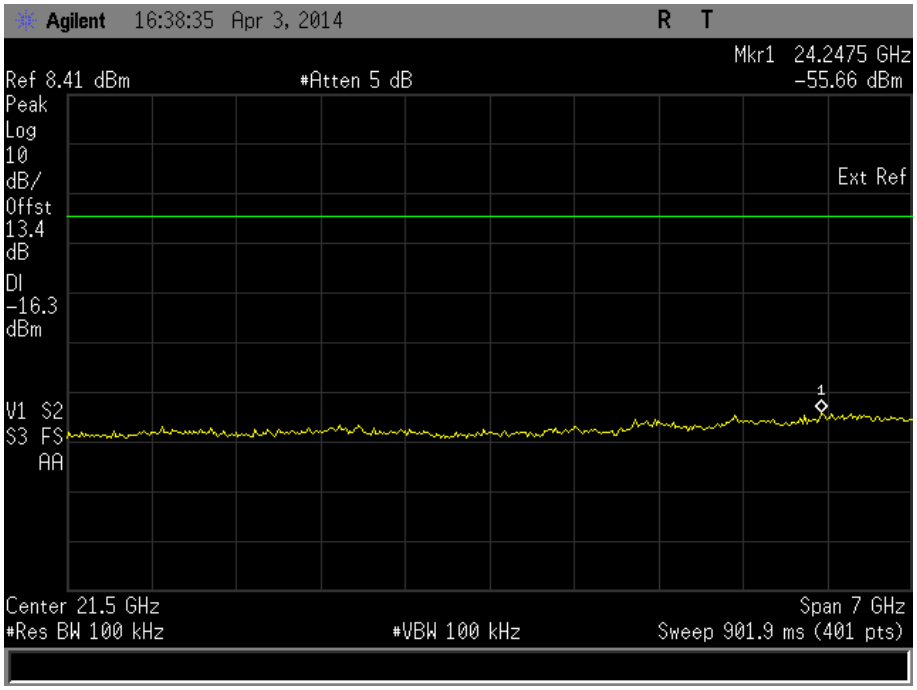


12 GHz to 18 GHz



Product Service

18 GHz to 25 GHz



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.

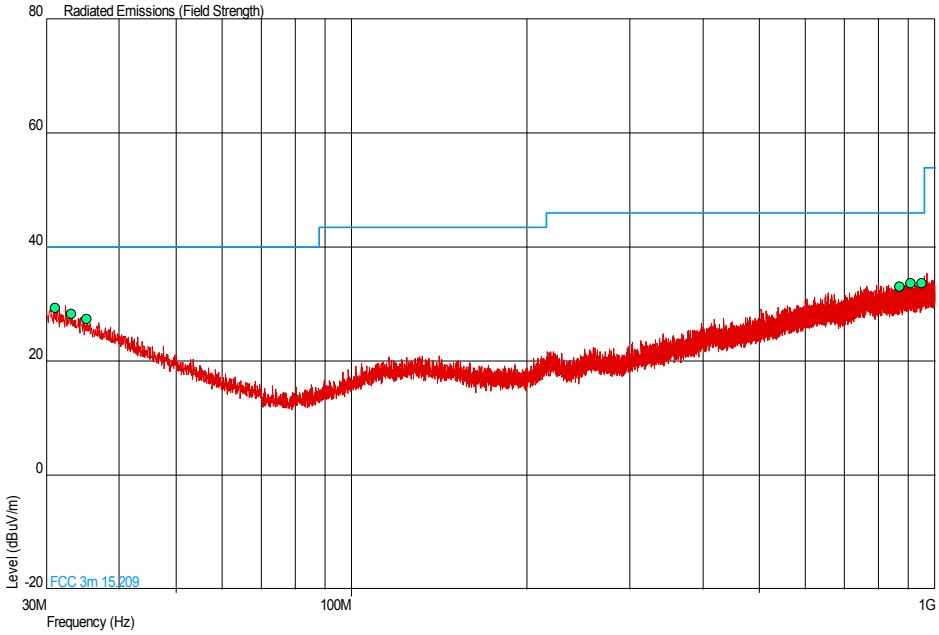
If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval the attenuation required shall be 30 dB instead of 20 dB.

Product Service

Spurious Radiated Emissions

2402 MHz

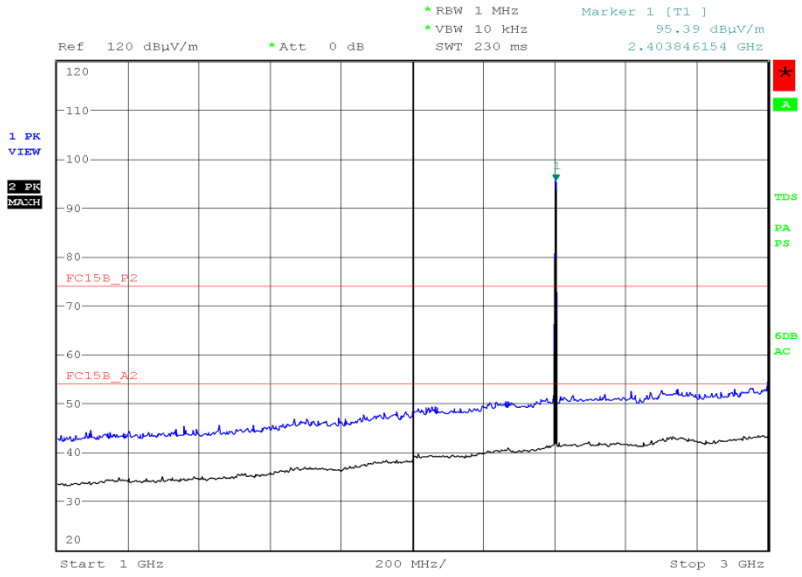
30 MHz to 1 GHz



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
31.116	29.3	29.2	40.0	100	-10.7	70.8	45	1.00	Vertical
33.104	28.2	25.7	40.0	100	-11.8	74.3	0	1.00	Vertical
35.190	27.4	23.4	40.0	100	-12.6	76.6	45	1.00	Vertical
869.487	33.0	44.7	46.0	200	-13.0	155.3	0	1.00	Vertical
908.869	33.6	47.9	46.0	200	-12.4	152.1	0	1.00	Vertical
948.639	33.7	48.4	46.0	200	-12.3	151.6	45	1.00	Vertical

Product Service

1 GHz to 3 GHz



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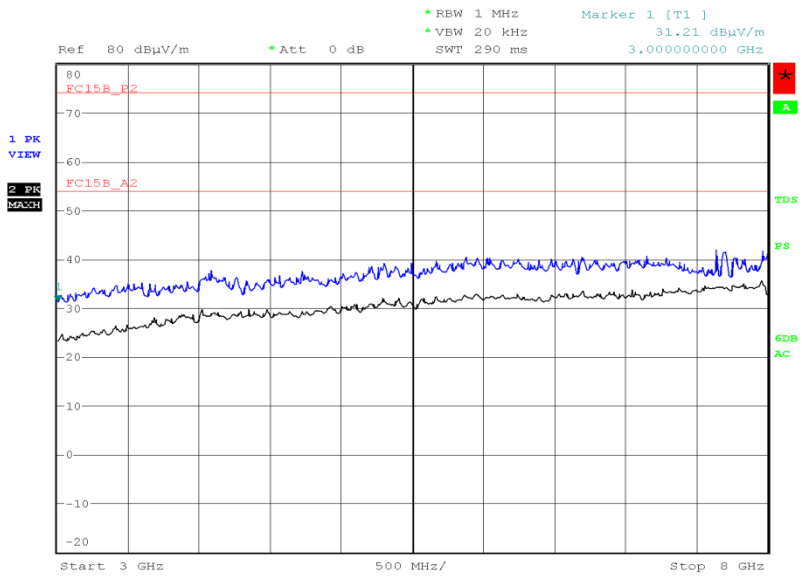
3 GHz to 8 GHz



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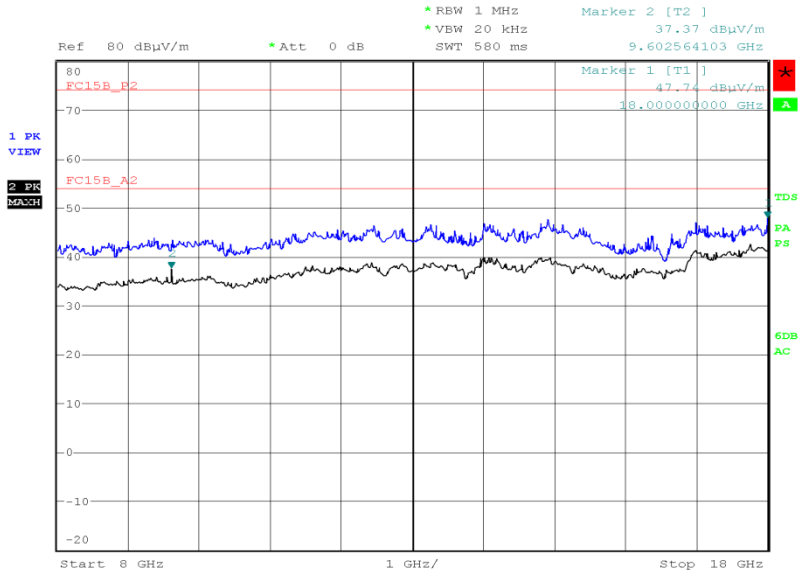
Product Service

8 GHz to 18 GHz



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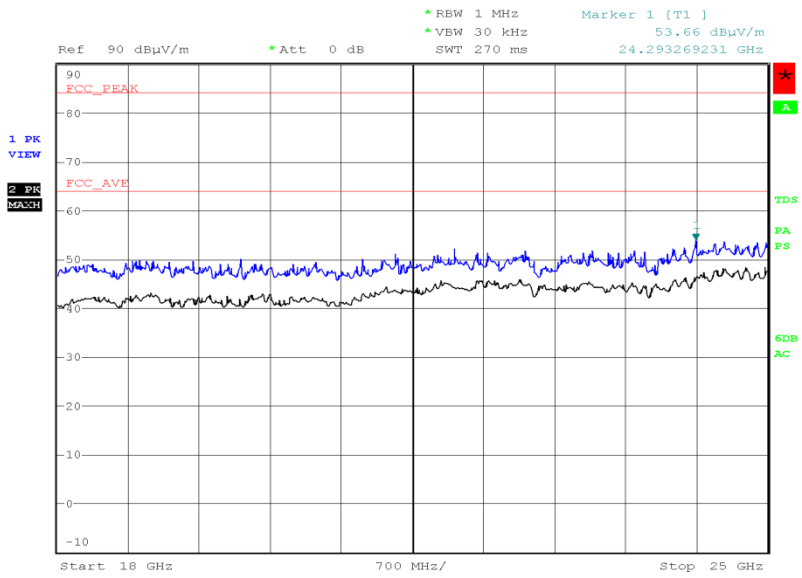
18 GHz to 25 GHz



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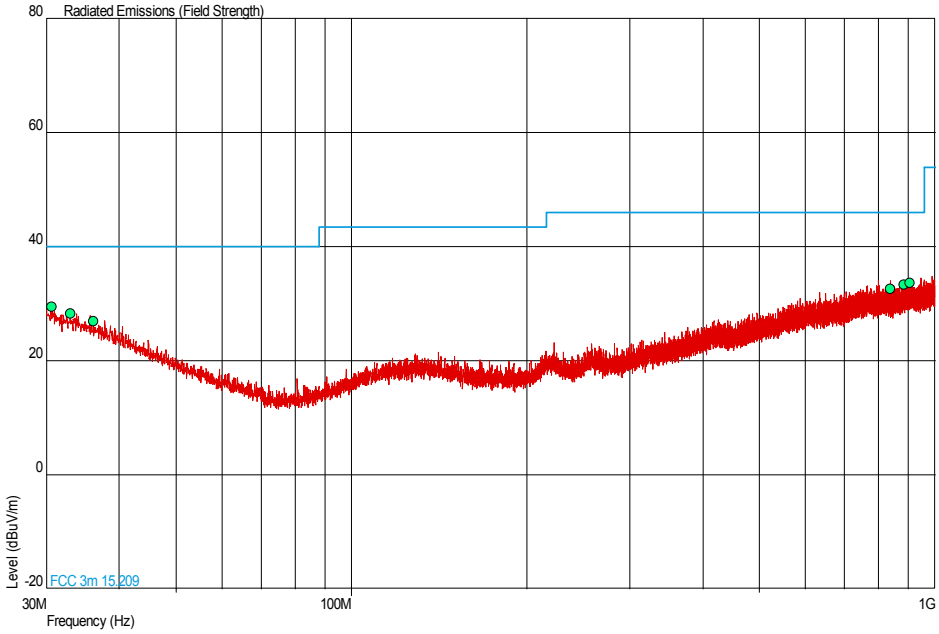
Product Service

2441 MHz

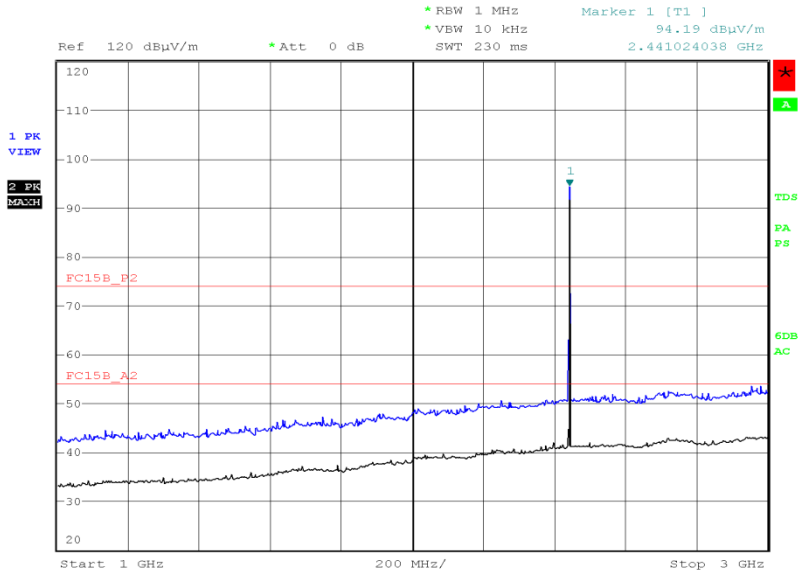
30 MHz to 1 GHz



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
30.679	29.5	29.9	40.0	100	-10.5	70.1	0	1.00	Vertical
32.959	28.3	26.0	40.0	100	-11.7	74.0	45	1.00	Vertical
36.160	27.0	22.4	40.0	100	-13.0	77.6	45	1.00	Vertical
839.562	32.7	43.2	46.0	200	-13.3	156.8	0	1.00	Vertical
883.794	33.4	46.8	46.0	200	-12.6	153.2	45	1.00	Vertical
907.123	33.6	47.9	46.0	200	-12.4	152.1	0	1.00	Vertical

Product Service

1 GHz to 3 GHz



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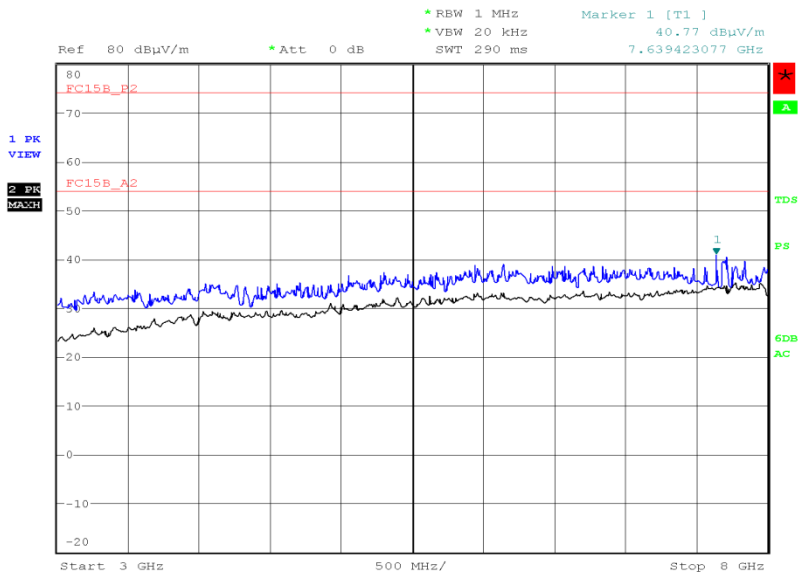
3 GHz to 8 GHz



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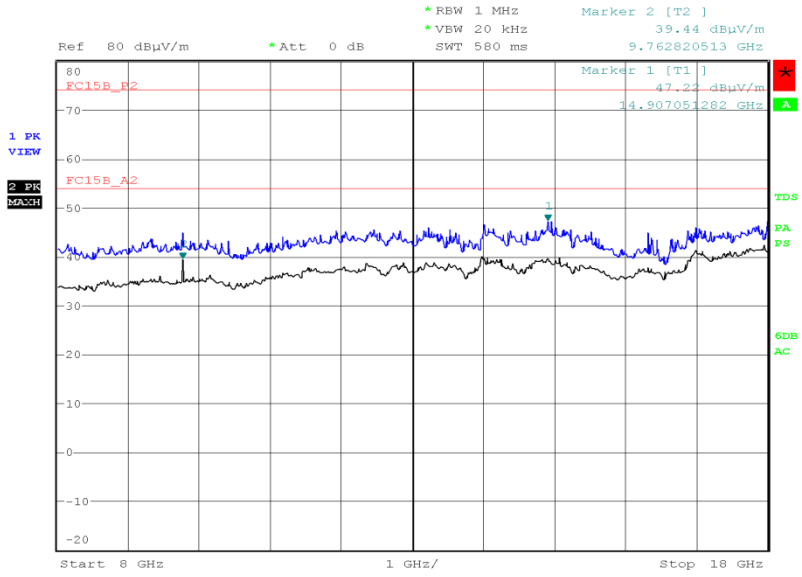
Product Service

8 GHz to 18 GHz



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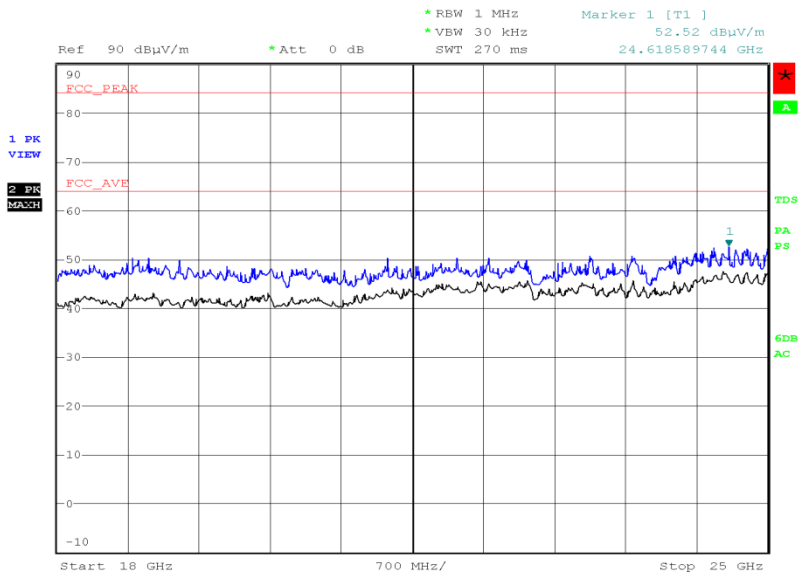
18 GHz to 25 GHz



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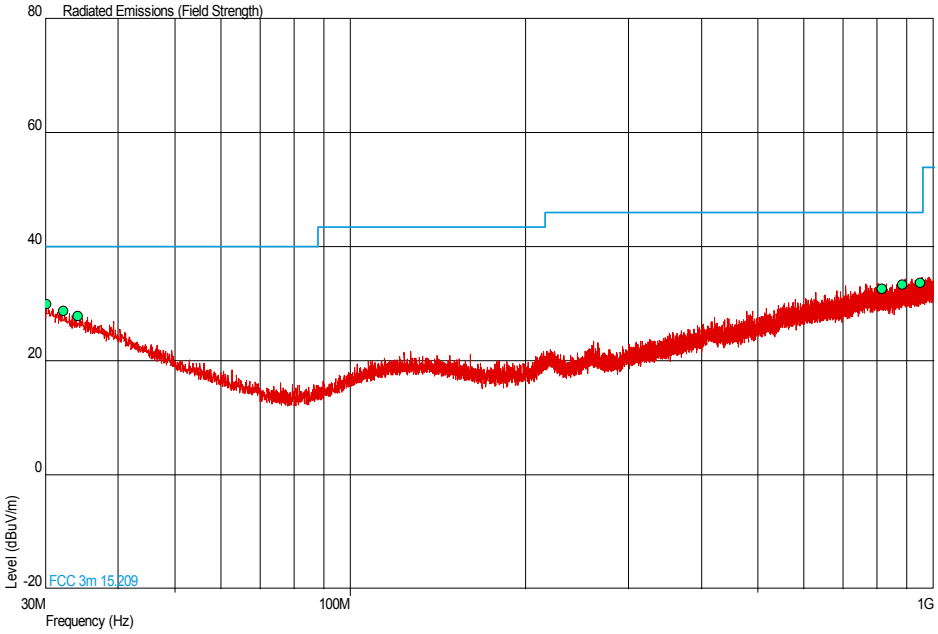
Product Service

2480 MHz

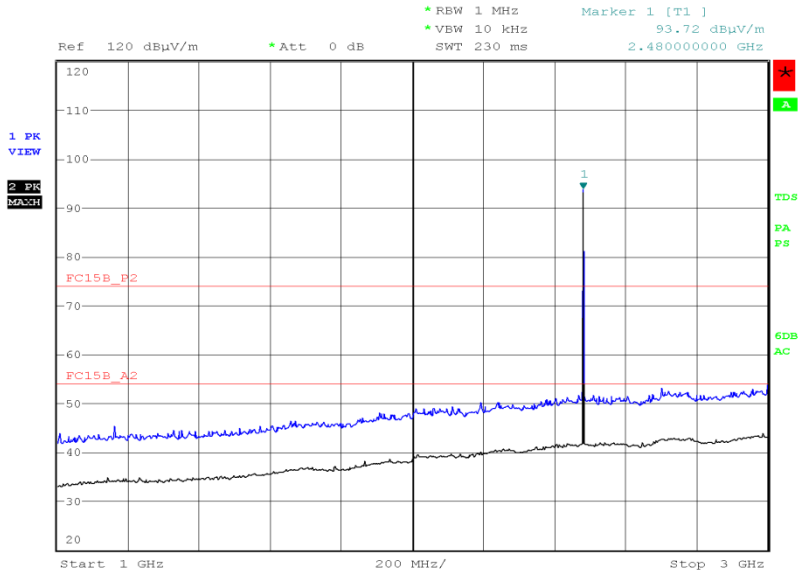
30 MHz to 1 GHz



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
30.194	30.0	31.6	40.0	100	-10.0	68.4	0	1.00	Vertical
32.231	28.8	27.5	40.0	100	-11.2	72.5	45	1.00	Vertical
34.123	27.8	24.5	40.0	100	-12.2	75.5	45	1.00	Vertical
816.719	32.7	43.2	46.0	200	-13.3	156.8	45	1.00	Horizontal
886.074	33.3	46.2	46.0	200	-12.7	153.8	0	1.00	Vertical
950.579	33.7	48.4	46.0	200	-12.3	151.6	45	1.00	Horizontal

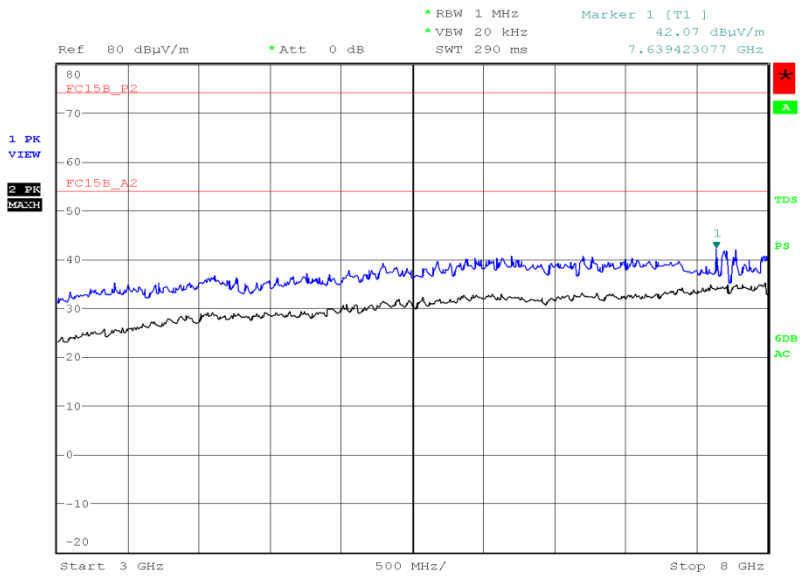
Product Service

1 GHz to 3 GHz



Date: 8.APR.2014 18:49:32

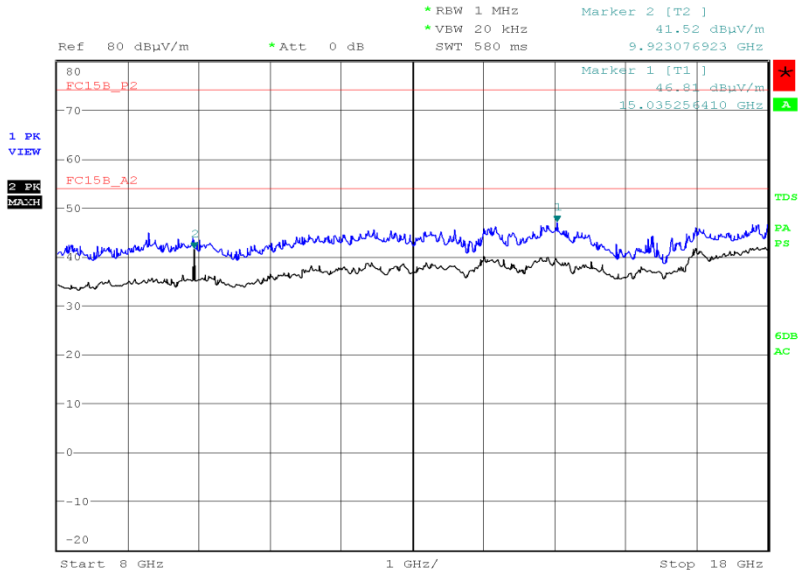
3 GHz to 8 GHz



Date: 8.APR.2014 20:18:51

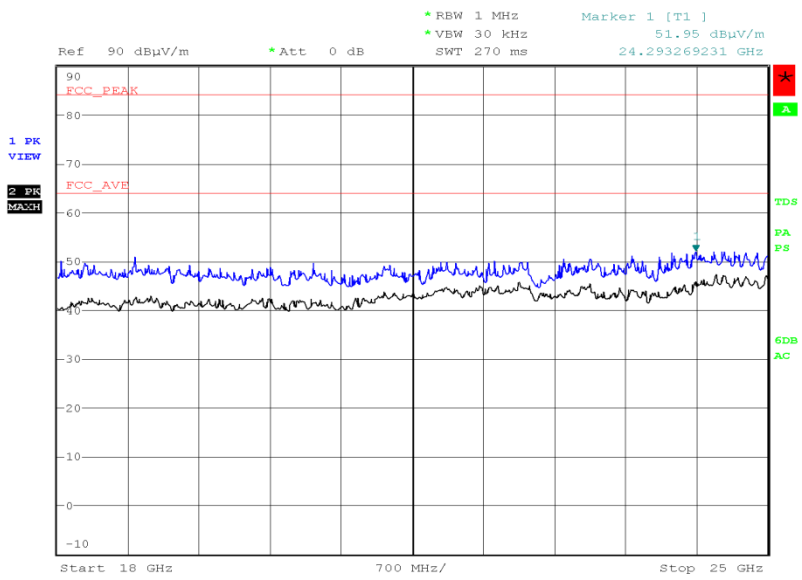
Product Service

8 GHz to 18 GHz



Date: 8.APR.2014 22:05:02

18 GHz to 25 GHz



Date: 9.APR.2014 21:52:41

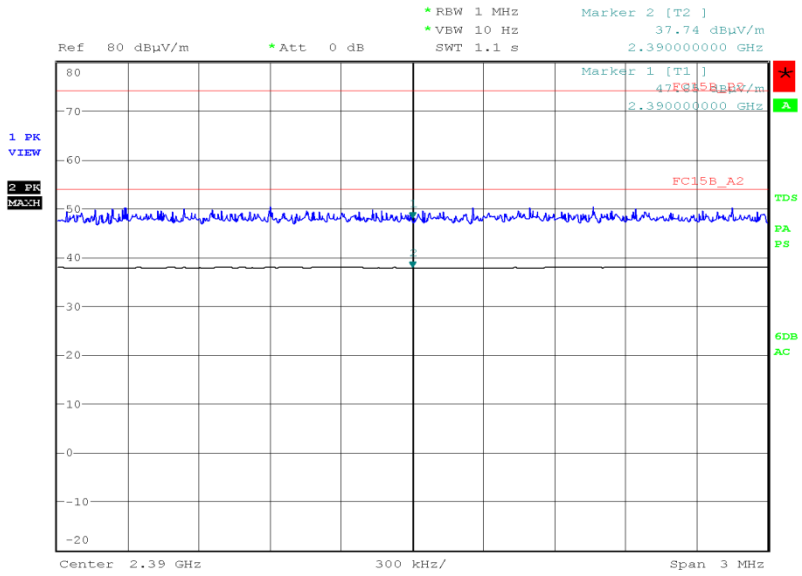
Limit

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

Band Edge Emissions

2402 MHz

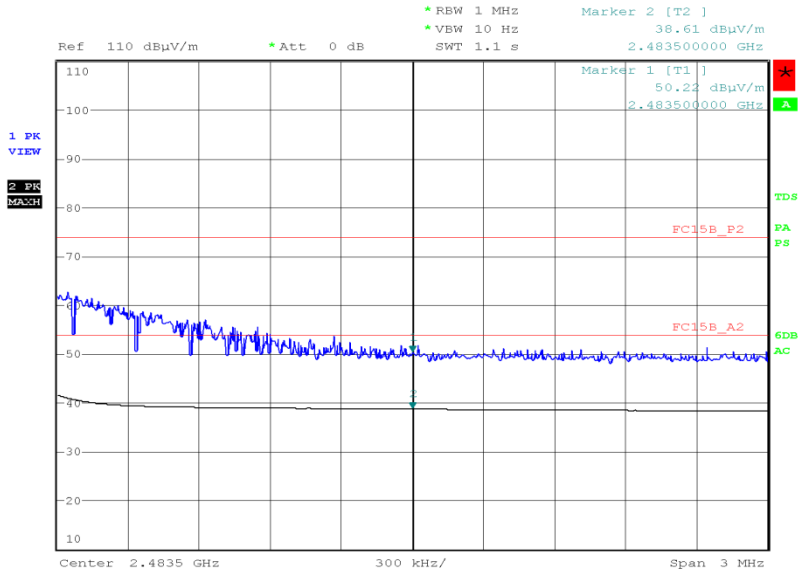
Polarisation	Final Peak (dBµV/m)	Final Average (dBµV/m)
Horizontal	47.85	37.74



Date: 8.APR.2014 18:16:13

2480 MHz

Polarisation	Final Peak (dBµV/m)	Final Average (dBµV/m)
Horizontal	50.22	38.61



Date: 8.APR.2014 18:56:50

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					
Transient Limiter	Hewlett Packard	11947A	15	12	10-Dec-2014
LISN (1 Phase)	Chase	MN 2050	336	12	28-Mar-2015
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Oct-2014
Section 2.2 - Frequency Hopping Systems - 20dB Bandwidth and Channel Separation					
Power Splitter	Weinschel	1506A	607	12	21-Mar-2015
Spectrum Analyser	Agilent Technologies	E4407B	1154	12	13-Aug-2014
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	22-Jul-2014
Power Supply	Farnell	LT30-2	2903	-	TU
Multimeter	Fluke	79 Series II	3057	12	24-Sep-2014
Hygrometer	Rotronic	I-1000	3220	12	16-Jul-2014
Attenuator (10dB, 20W)	Lucas Weinschel	1	3225	12	12-Dec-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	13-Sep-2014
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	18-Sep-2014
Frequency Standard	Spectracom	Secure Sync 1200-0408-0601	4393	6	22-Jul-2014
Section 2.3 - Frequency Hopping Systems - Channel Dwell Time and Number of Hopping Channels					
Power Splitter	Weinschel	1506A	607	12	21-Mar-2015
Spectrum Analyser	Agilent Technologies	E4407B	1154	12	13-Aug-2014
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	22-Jul-2014
High Pass Filter (4GHz)	RLC Electronics	F-100-4000-5-R	2773	12	4-Feb-2015
Power Supply	Farnell	LT30-2	2903	-	TU
Multimeter	Fluke	79 Series II	3057	12	24-Sep-2014
Hygrometer	Rotronic	I-1000	3220	12	16-Jul-2014
Attenuator (10dB, 20W)	Lucas Weinschel	1	3225	12	12-Dec-2014
Signal Analyser	Rohde & Schwarz	FSQ 26	3545	12	4-Jul-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	13-Sep-2014
Micro USB breakout box	TUV SUD Product Service	n/a	4360	-	TU
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	18-Sep-2014
Frequency Standard	Spectracom	Secure Sync 1200-0408-0601	4393	6	22-Jul-2014
Section 2.4 - Maximum Peak Conducted Output Power					
Power Splitter	Weinschel	1506A	607	12	21-Mar-2015
Spectrum Analyser	Agilent Technologies	E4407B	1154	12	13-Aug-2014
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	22-Jul-2014
Power Supply	Farnell	LT30-2	2903	-	TU
Multimeter	Fluke	79 Series II	3057	12	24-Sep-2014
Hygrometer	Rotronic	I-1000	3220	12	16-Jul-2014
Attenuator (10dB, 20W)	Lucas Weinschel	1	3225	12	12-Dec-2014
Power Meter	Rohde & Schwarz	NRP	3491	12	18-Apr-2014
Wideband Power Sensor, 50MHz - 18GHz	Rohde & Schwarz	NRP-Z81	3492	12	18-Apr-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	13-Sep-2014
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	18-Sep-2014
Frequency Standard	Spectracom	Secure Sync 1200-0408-0601	4393	6	22-Jul-2014

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Section 2.5 - EIRP Peak Power					
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	234	12	3-May-2014
Signal Generator (10MHz to 40GHz)	Rohde & Schwarz	SMR40	1002	12	18-Sep-2014
Screened Room (5)	Rainford	Rainford	1545	24	10-Jan-2015
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Antenna (DRG Horn)	ETS-LINDGREN	3115	3125	12	17-Jul-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
9m RF Cable (N Type)	Rhophase	NPS-2303-9000-NPS	3791	-	TU
Tilt Antenna Mast	maturo Gmbh	TAM 4.0-P	3916	-	TU
Mast Controller	maturo Gmbh	NCD	3917	-	TU
Section 2.6 - Spurious and Band Edge Emissions					
Antenna (Double Ridge Guide)	Link Microtek Ltd	AM180HA-K-TU2	230	24	26-Nov-2015
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	234	12	3-May-2014
Spectrum Analyser	Agilent Technologies	E4407B	1154	12	13-Aug-2014
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	22-Jul-2014
Pre-Amplifier	Phase One	PS04-0086	1533	12	19-Dec-2014
Pre-Amplifier	Phase One	PSO4-0087	1534	12	30-Sep-2014
Screened Room (5)	Rainford	Rainford	1545	24	10-Jan-2015
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Power Supply	Farnell	LT30-2	2903	-	TU
Antenna (Bilog)	Chase	CBL6143	2904	24	10-Jun-2015
Multimeter	Fluke	79 Series II	3057	12	24-Sep-2014
Hygrometer	Rotronic	I-1000	3220	12	16-Jul-2014
Attenuator (10dB, 20W)	Lucas Weinschel	1	3225	12	12-Dec-2014
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Oct-2014
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	13-Sep-2014
9m RF Cable (N Type)	Rhophase	NPS-2303-9000-NPS	3791	-	TU
Tilt Antenna Mast	maturo Gmbh	TAM 4.0-P	3916	-	TU
Mast Controller	maturo Gmbh	NCD	3917	-	TU
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
Frequency Standard	Spectracom	Secure Sync 1200-0408-0601	4393	6	22-Jul-2014
Suspended Subtrate Highpass Filter	Advance Power Components	11SH10-3000/X18000-O/O	4411	12	21-Mar-2015
Suspended Substrate Highpass Filter	Advance Power Components	11SH10-3000/X18000-O/O	4412	12	21-Mar-2015

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

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).