

Report on the Radio Testing
For
SmarDTV (UK) Limited
on
Project N63
Report no. TRA-029575-02-45-01B
2nd December 2016

RF916 6.0



Report Number: TRA-029575-02-45-01B
Issue: B

REPORT ON THE RADIO TESTING OF A
SmarDTV (UK) Limited
Project N63
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247 & IC RSS-247

TEST DATE: 25th Apr - 26th Sep 2016

Tested by: A Longley

A Longley – A Wong
Radio Test Engineers

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Date: 2nd December 2016

Disclaimers:

- [1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

RF916 6.0

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	17 th October 2016	Original
B	2 nd December 2016	Update to product name

2 Summary

TEST REPORT NUMBER:	TRA-029575-02-45-01B
WORKS ORDER NUMBER	TRA-029575-02
PURPOSE OF TEST:	Certification
TEST SPECIFICATION(S):	47CFR15.247 & RSS-247
EQUIPMENT UNDER TEST (EUT):	Project N63
FCC IDENTIFIER:	DKN-AVBX1
EUT SERIAL NUMBER:	1604210679 & 14604210698
MANUFACTURER/AGENT:	SmarDTV (UK) Limited
ADDRESS:	Beckside Design Centre Millennium Business Park Station Rd Steeton Keighley West Yorkshire BD20 6QW United Kingdom
CLIENT CONTACT:	Chris Wordley ☎ 01535 659000 ✉ chris.wordley@smardtv.com
ORDER NUMBER:	POR01251
TEST DATE:	25th Apr - 26th Sep 2016
TESTED BY	A Longley – A Wong Element

2.1 Test Summary

Test Method and Description	Requirement Clause		Applicable to this equipment	Result / Note
	RSS	47CFR15		
Radiated spurious emissions (restricted bands of operation and cabinet radiation)	Gen, 8.10	15.205	☒	Pass
AC power line conducted emissions	Gen, 8.8	15.207	☐	Note 1
Carrier frequency separation	247, 5.1 (2)	15.247(a)(1)	☒	Pass
Number of hopping channels	247, 5.1 (3), (4) and (5)	15.247(a)(1) (i), (ii) and (iii)	☒	Pass
Average time of occupancy	247, 5.1 (3), (4) and (5)	15.247(a)(1) (i), (ii) and (iii)	☒	Pass
Maximum peak conducted output power	247, 5.4 (1), (2) and (3)	15.247 (a)(1), (b)(1) and (b)(2)	☒	Pass
20dB emission bandwidth	247, 5.1 (1)	15.247(a)(1) (i) and (ii)	☒	Pass
Out-of-band emissions	247, 5.5	15.247(d)	☒	Pass

Note s:

1. See Test report TRA-029575-02-45-05A

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

3 Contents

1	Revision Record	3
2	Summary	4
2.1	Test Summary	5
3	Contents	6
4	Introduction	8
5	Test Specifications	9
5.1	Normative References	9
5.2	Deviations from Test Standards	9
6	Glossary of Terms	10
7	Equipment Under Test	11
7.1	EUT Identification	11
7.2	System Equipment	11
7.3	EUT Mode of Operation	11
7.3.1	Transmission	11
7.3.2	Reception	11
7.4	EUT Radio Parameters	12
7.4.1	General	12
7.4.2	Antennas	12
7.4.3	Product specific declarations	13
7.5	EUT Description	13
8	Modifications	14
9	EUT Test Setup	15
9.1	Block Diagram	15
10	General Technical Parameters	16
10.1	Normal Conditions	16
10.2	Varying Test Conditions	16
11	Radiated emissions	17
11.1	Definitions	17
11.2	Test Parameters	17
11.3	Test Limit	17
11.4	Test Method	18
11.5	Test Set-up Photograph	19
11.6	Test Equipment	19
11.7	Test Results	20
12	Carrier frequency separation	59
12.1	Definition	59
12.2	Test Parameters	59
12.3	Test Limit	59
12.4	Test Method	60
12.5	Test Equipment	60
12.6	Test Results	61
13	Number of hopping frequencies	62
13.1	Definition	62
13.2	Test Parameters	62
13.3	Test Limit	62
13.4	Test Method	63
13.5	Test Equipment	63
13.6	Test Results	64
14	Average channel occupancy	65
14.1	Definition	65
14.2	Test Parameters	65
14.3	Test Limit	65
14.4	Test Method	66
14.5	Test Equipment	66
14.6	Test Results	66
15	Maximum peak conducted output power	67
15.1	Definition	67
15.2	Test Parameters	67
15.3	Test Limit	67
15.4	Test Method	68
15.5	Test Equipment	68
15.6	Test Results	69
16	Occupied Bandwidth	70

16.1	Definition	70
16.2	Test Parameters	70
16.3	Test Limit.....	70
16.4	Test Method.....	71
16.5	Test Equipment.....	71
16.6	Test Results.....	72
17	Out-of-band and conducted spurious emissions	78
17.1	Definition	78
17.2	Test Parameters	78
17.3	Test Limits.....	78
17.4	Test Method.....	79
17.5	Test Equipment.....	79
17.6	Test Results.....	80
18	Measurement Uncertainty.....	125

4 Introduction

This report TRA-029575-02-45-01B presents the results of the Radio testing on a SmarDTV (UK) Limited, Project N63 to specification 47CFR15 Radio Frequency Devices and RSS-247 Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.

The testing was carried out for SmarDTV (UK) Limited by Element, at the address(es) detailed below.

☒	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	☐	Element Skelmersdale Unit 1 Pendle Place Skelmersdale West Lancashire WN8 9PN UK
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This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

Throughout this report EUT denotes equipment under test.

FCC Site Listing:

Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

IC Registration Number(s):

Element Hull	3483A
Element North West	3930B

The test site requirements of ANSI C63.4-2014 are met up to 1GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- Industry Canada RSS-247, Issue 1, May 2015 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
- Industry Canada RSS-Gen, Issue 4, November 2014 – General Requirements for Compliance of Radio Apparatus.

5.2 Deviations from Test Standards

There were no deviations from the test standard.

6 Glossary of Terms

S	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada
ITU	International Telecommunication Union
LBT	Listen Before Talk
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
Tx	transmitter
UKAS	United Kingdom Accreditation Service
V	volt
W	watt
Ω	ohm

7 Equipment Under Test

7.1 EUT Identification

- Name: Project N63
- Serial Number: 1604210679 & 14604210698
- Model Number: S60
- Software Revision: Not Applicable
- Build Level / Revision Number: Not Applicable

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

Sample No.	Description	Model No.	Serial No.
S08	EUT 12 Vdc Power Adapter	EADP-40MB A	HBBD45F00A7
S11	Lenovo ThinkPad	E560	34546
S14	Thurlby Thandar Audio Generator	TF215	045441
S15	LG TV	M227WDL	002MAAK4P824
S17	Channel Master DVR	CM-7500TB1	R5YFKZ00228D
S27	Dlink USB to Ethernet adapter	DUB-E100	Q8041AA002873

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for transmitter tests was as follows...
EUT was operated on a single frequency (Top, Middle or Bottom) or hopping over all channels as required. The EUT was modulated with GFSK, QPSK and 8PSK.

7.3.2 Reception

This report covers transmitter operation only. Results for unintentional emissions can be found in test report TRA-029575-44-00B.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	2400 – 2483.5 MHz
Modulation type(s):	GFSK, QPSK, 8PSK
Occupied channel bandwidth(s):	1 MHz
Channel spacing:	1 MHz
ITU emission designator(s):	G1D
Declared output power(s):	<+10 dBm
Nominal Supply Voltage:	11.1V (battery) / 12.0V (external PSU) 100-240Vac

7.4.2 Antennas

Type:	PCB Trace
Frequency range:	2400 – 2483.5 MHz
Impedance:	50 Ohms
Gain:	See Table
Polarisation:	Omni
Connector type:	U-FL

Frequency [MHz]	BT [dBm]
2400	4.4
2410	4.4
2420	4.6
2430	4.7
2440	4.9
2450	5
2460	5
2470	4.7
2480	4.5
2490	4.5
Average	4.7

7.4.3 Product specific declarations

Multiple antenna configuration(s), e.g. MIMO:	Not Applicable
Fixed pt-pt operations (yes/no):	No
Installation manual advice on pt-pt operational restrictions (yes/no):	No
Fixed pt-mpt operations (yes/no):	No
Simultaneous tx (yes/no):	No

7.5 EUT Description

Error! Reference source not found. One module contains a 5 GHz Wi-Fi Access Point, and the other module contains a dual-band Wi-Fi Client and a dual-mode Bluetooth radio. All radios within the device are capable of simultaneous transmission. It is intended for both indoor and outdoor use (mobile, not portable).

This report only covers Bluetooth classic operation.

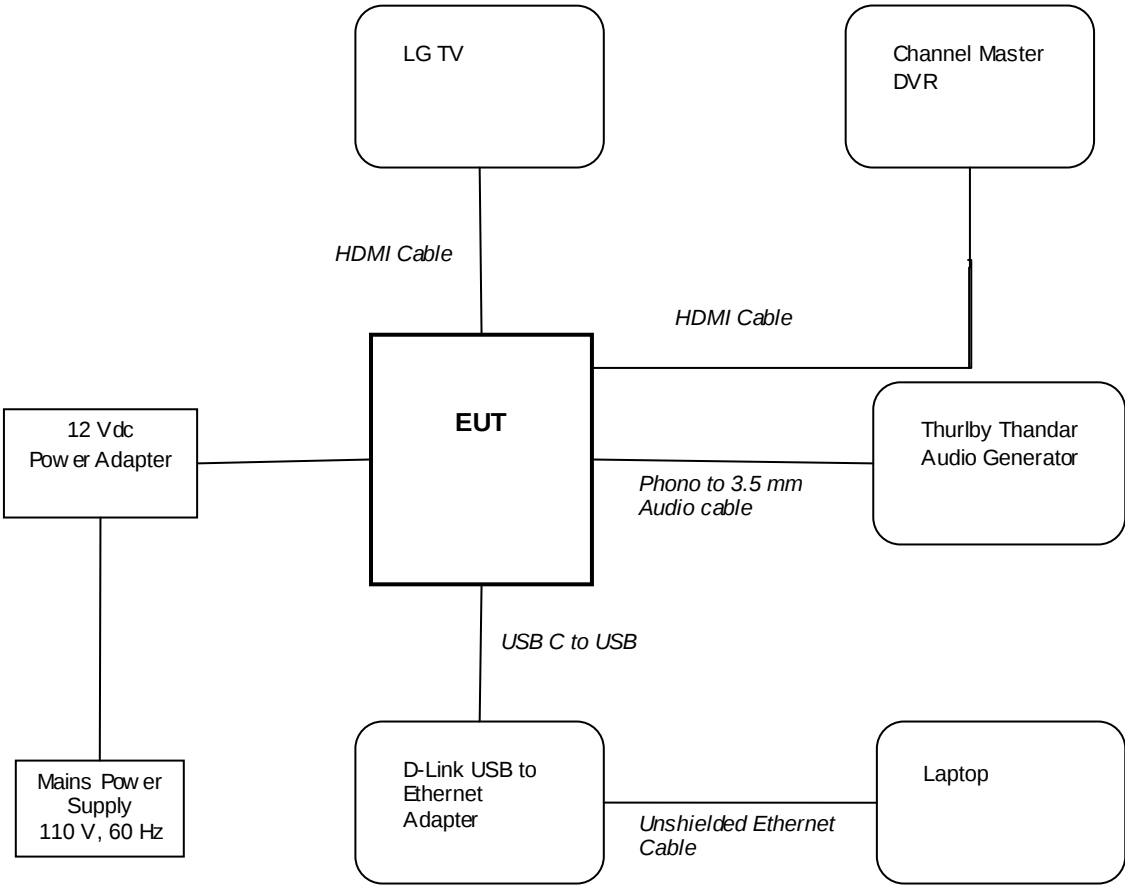
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



10 General Technical Parameters

10.1 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was approx. 110 V ac, 60 Hz, from the mains.

10.2 Varying Test Conditions

There are no specific frequency stability requirements for the type of device. The results contained in this report demonstrate that the occupied bandwidth is contained within the authorised band and the manufacturer has declared sufficient frequency stability (refer to section 7.4).

Variation of supply voltage is required to ensure stability of the declared output power. During carrier power testing the following variations were made:

	<i>Category</i>	<i>Nominal</i>	<i>Variation</i>
☒	Mains	110 V ac +/- 2 %	85 % and 115 %
☐	Battery	New battery	N/A

11 Radiated emissions

11.1 Definitions

Spurious emissions

Emissions on a frequency or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Restricted bands

A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

11.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab 16
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	1 MHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 38 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 Vac	

11.3 Test Limit

Unwanted emissions that fall within the restricted frequency bands shall comply with the limits specified:

General Field Strength Limits for License-Exempt Transmitters at Frequencies above 30 MHz

Frequency (MHz)	Field Strength ($\mu\text{V/m}$ at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver.

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360 degrees in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in dBμV/m at the regulatory distance, using:

$$FS = PR + CL + AF - PA + DC - CF$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dBμV;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

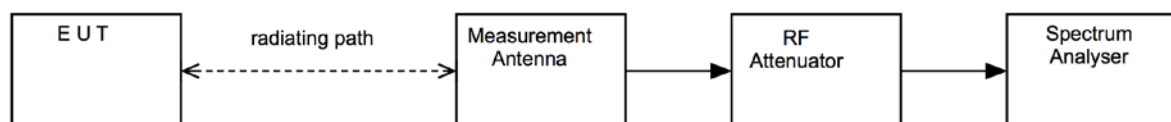
PA is the pre-amplifier gain in dB (where used);

DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);

CF is the distance factor in dB (where measurement distance different to limit distance);

This field strength value is then compared with the regulatory limit.

Figure i Test Setup



11.5 Test Set-up Photograph

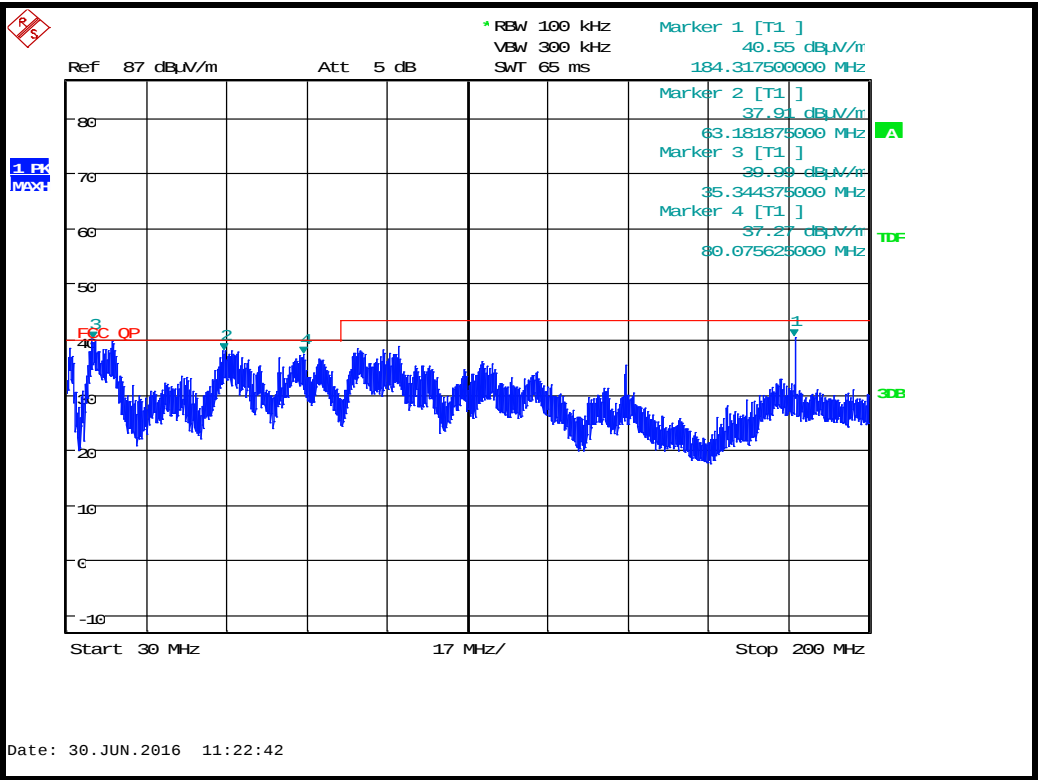
Test Photograph removed for confidentiality

11.6 Test Equipment

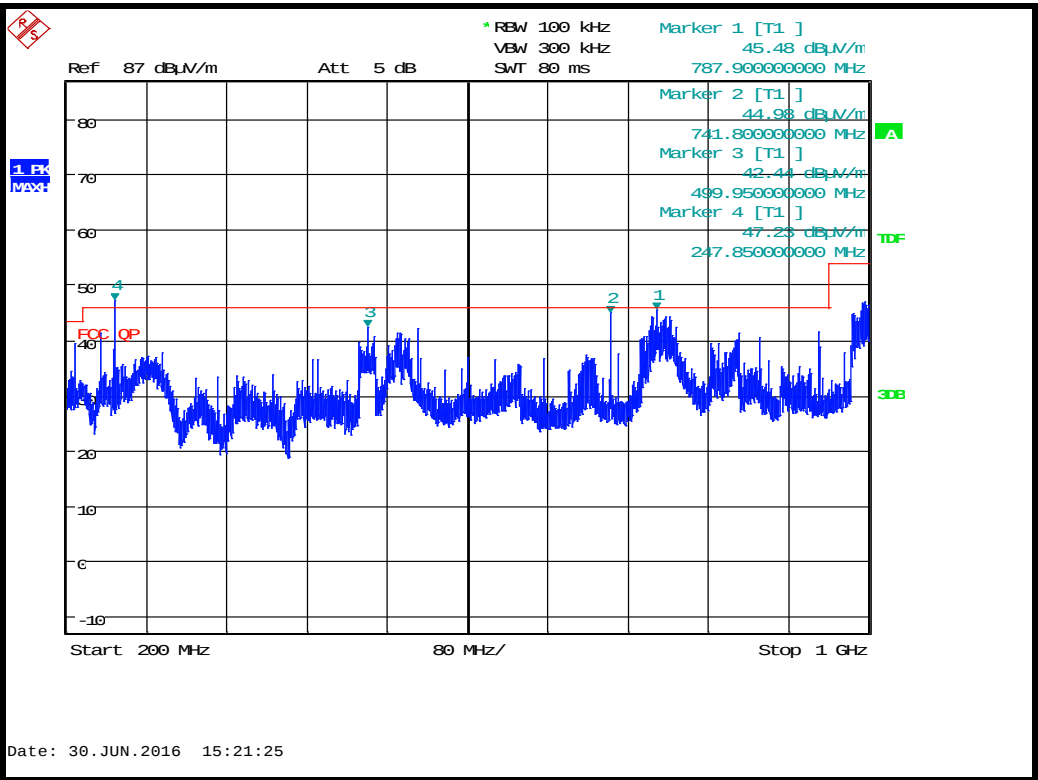
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ATS	Rainford	Ferrite Lined Chamber	REF886	21/07/2017
3109	EMCO	Biconical Antenna	RFG095	17/05/2019
3146	EMCO	Log Periodic Antenna	RFG191	17/05/2019
3115	EMCO	Horn Antenna	RFG129	09/02/2018
	Q-Par	Horn Antenna	RFG629	30/09/2017
310	Sonoma	Pre-Amp (9kHz – 1GHz)	REF927	30/06/2018
8449B	Agilent	Pre-Amp (1 – 26.5GHz)	REF913	02/02/2018
FSU26	R&S	Spectrum Analyser	REF909	26/04/2017

11.7 Test Results

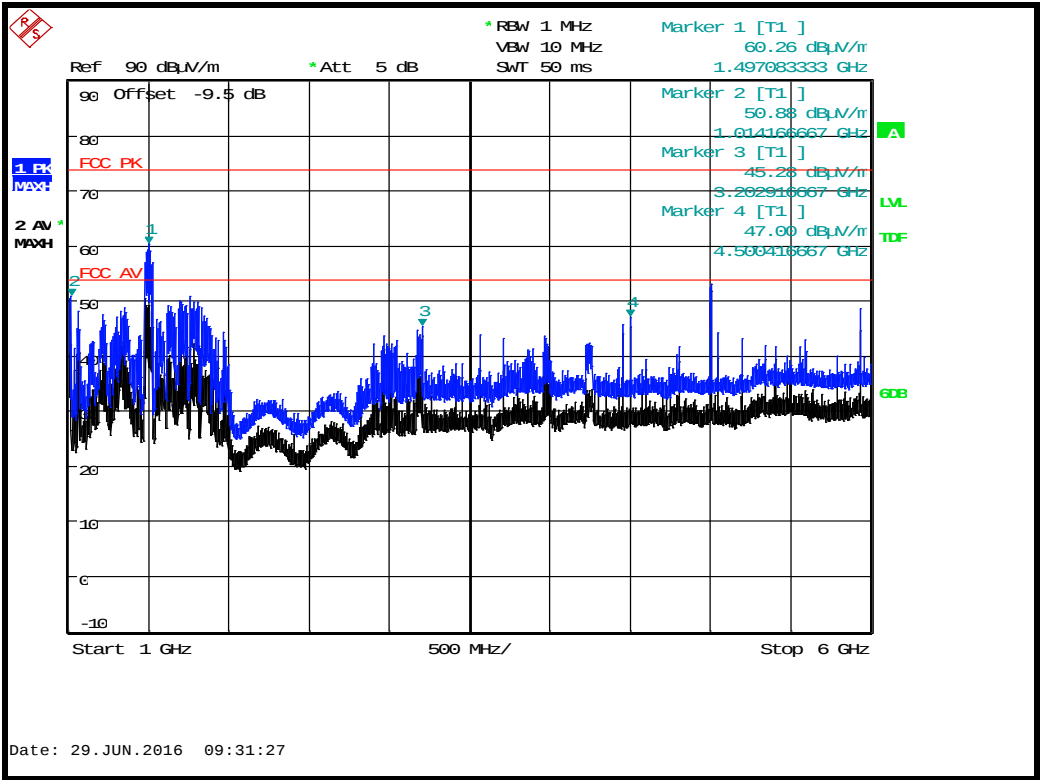
Frequency: 2402 MHz ; Modulation: GFSK										
Detector	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
QP	248.453	62.4	1.9	11.3	32.4	0	0	43.2	144.5	200



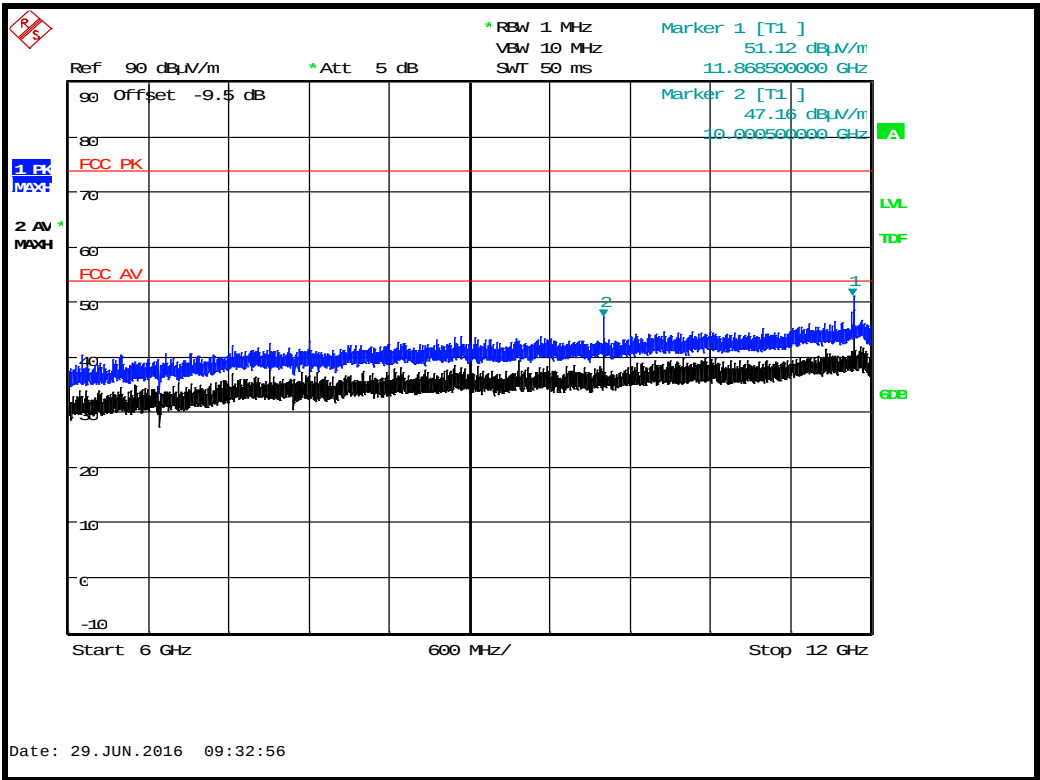
GFSK Tx 2402 MHz : 30 MHz to 200 MHz



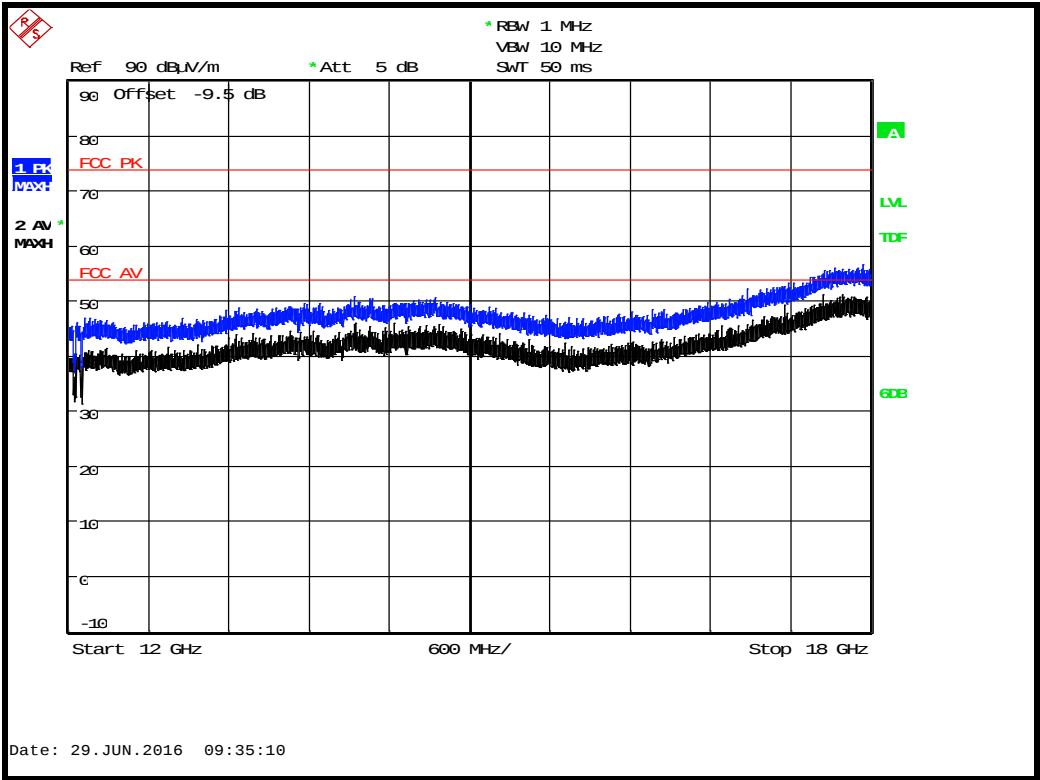
GFSK Tx 2402 MHz : 200 MHz to 1000 MHz



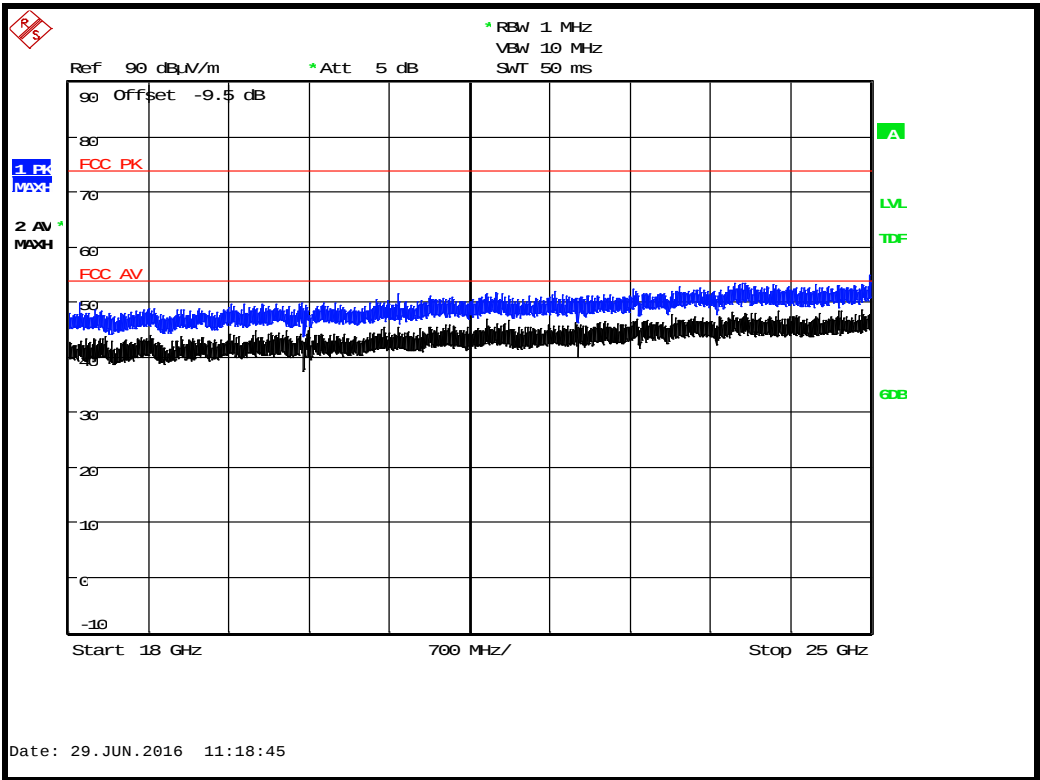
GFSK Tx 2402 MHz : 1 GHz to 6 GHz



GFSK Tx 2402 MHz : 6 GHz to 12 GHz

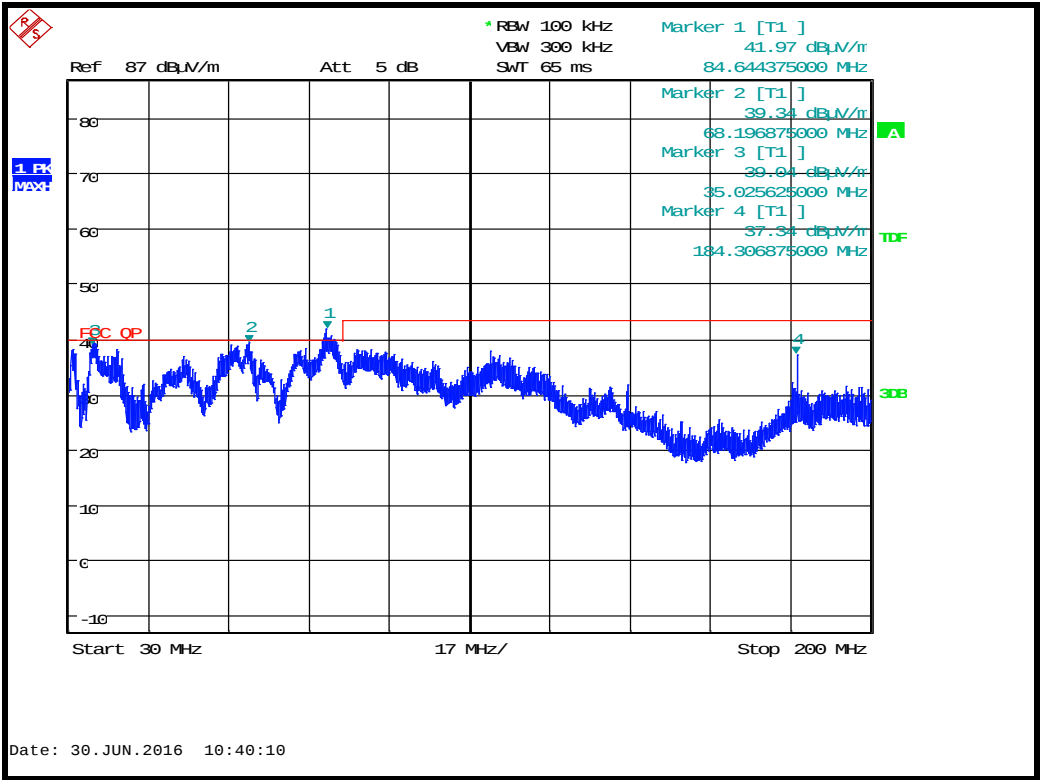


GFSK Tx 2402 MHz : 12 GHz to 18 GHz

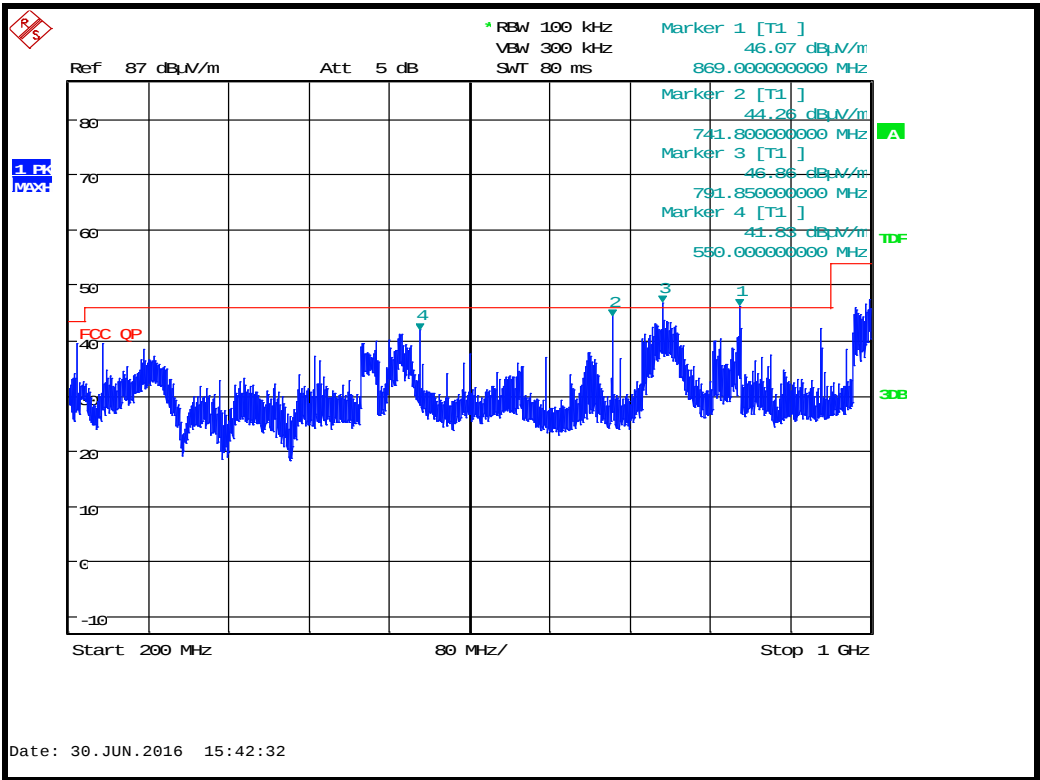


GFSK Tx 2402 MHz : 18 GHz to 25 GHz

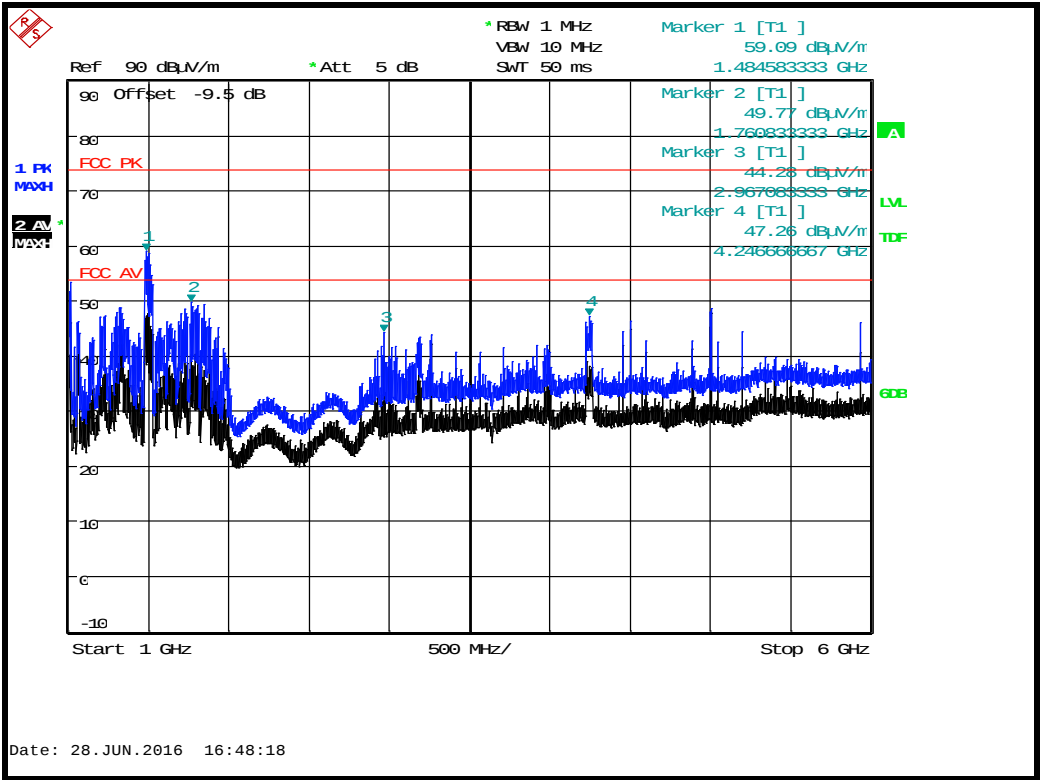
<i>Frequency: 2442 MHz ; Modulation: GFSK</i>										
<i>Detector</i>	<i>Freq. (MHz)</i>	<i>Meas'd Emission (dBμV)</i>	<i>Cable Loss (dB)</i>	<i>Antenna Factor (dB/m)</i>	<i>Pre-amp Gain (dB)</i>	<i>Duty Cycle Corr'n (dB)</i>	<i>Distance Extrap'n Factor (dB)</i>	<i>Field Strength (dBμV/m)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
QP	250.478	62.6	1.9	11.4	32.4	0	0	43.5	149.6	200
PK	4884.322	46.15	5.6	33.4	34.59	0	0	50.6	338.8	5011
AV	4884.322	35.32	5.6	33.4	34.59	0	0	39.7	96.6	500



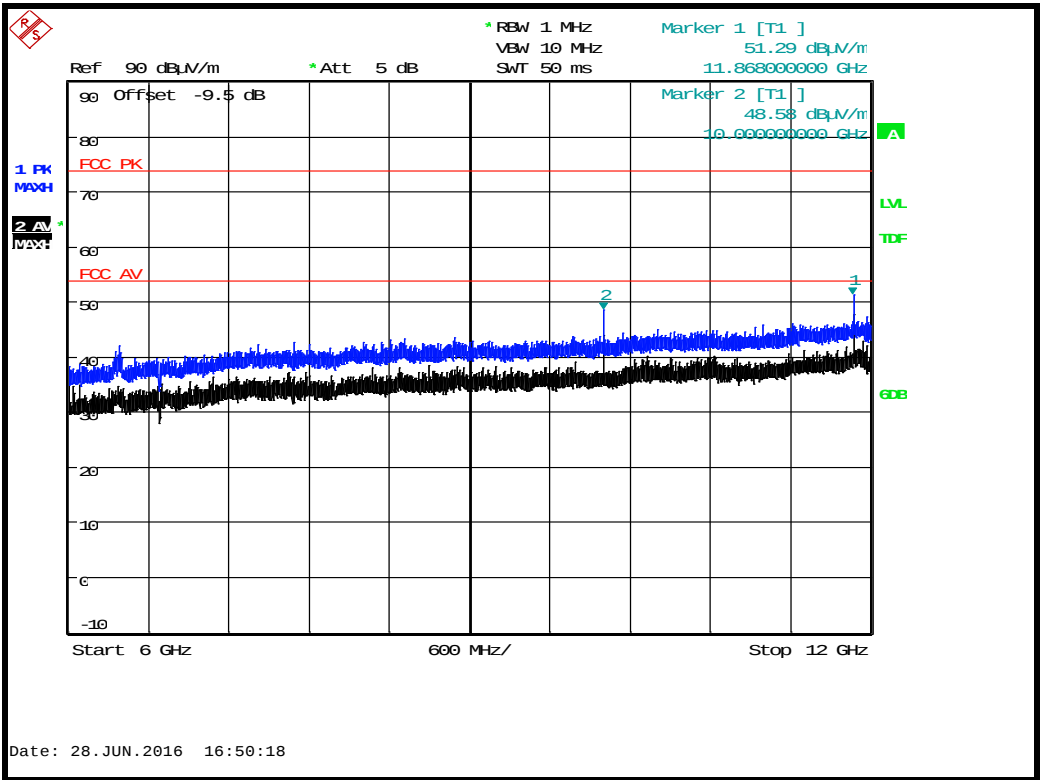
GFSK Tx 2442 MHz : 30 MHz to 200 MHz



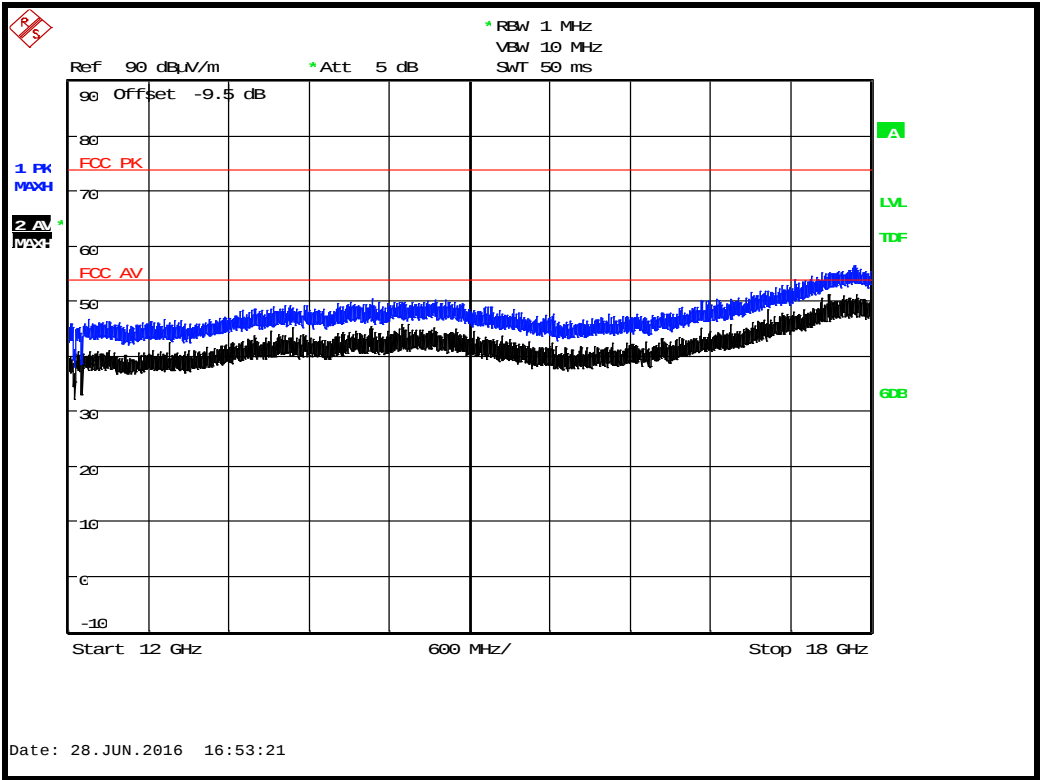
GFSK Tx 2442 MHz : 200 MHz to 1000 MHz



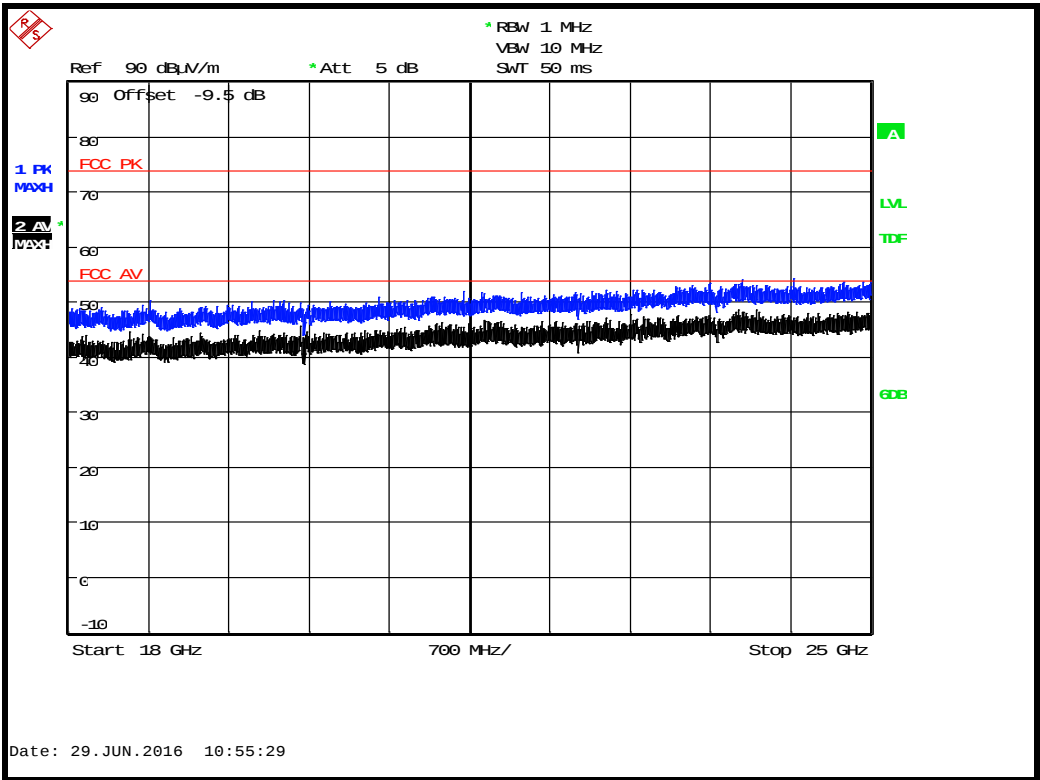
GFSK Tx 2442 MHz : 1 GHz to 6 GHz



GFSK Tx 2442 MHz : 6 GHz to 12 GHz

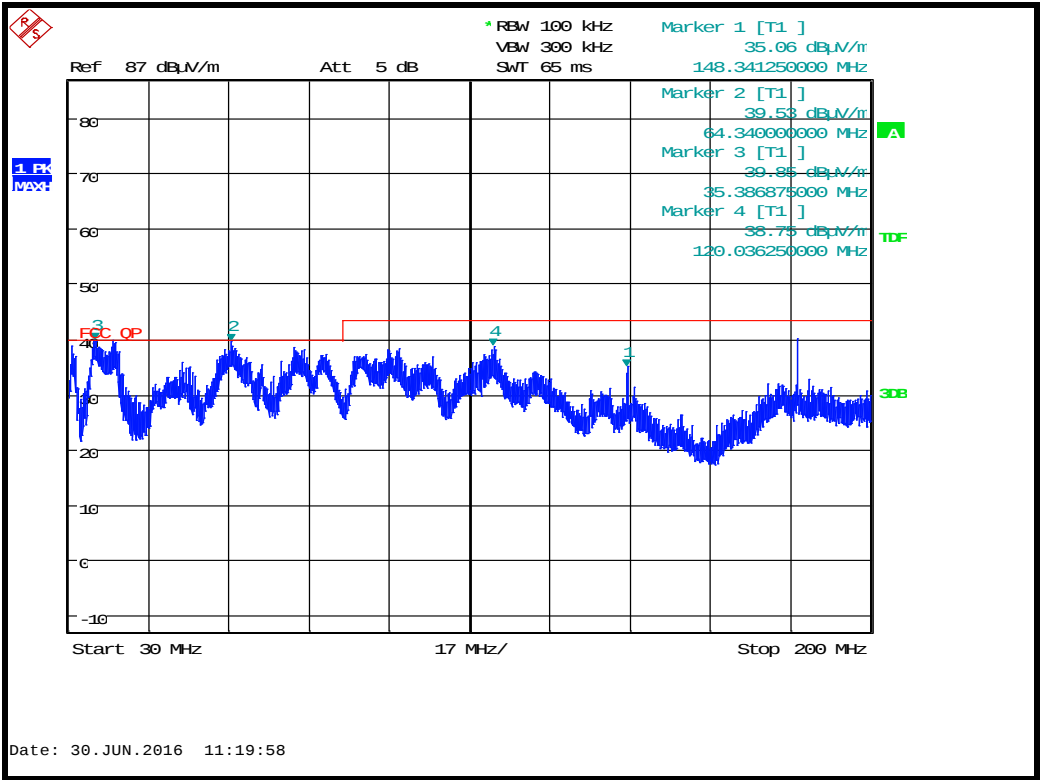


GFSK Tx 2442 MHz : 12 GHz to 18 GHz

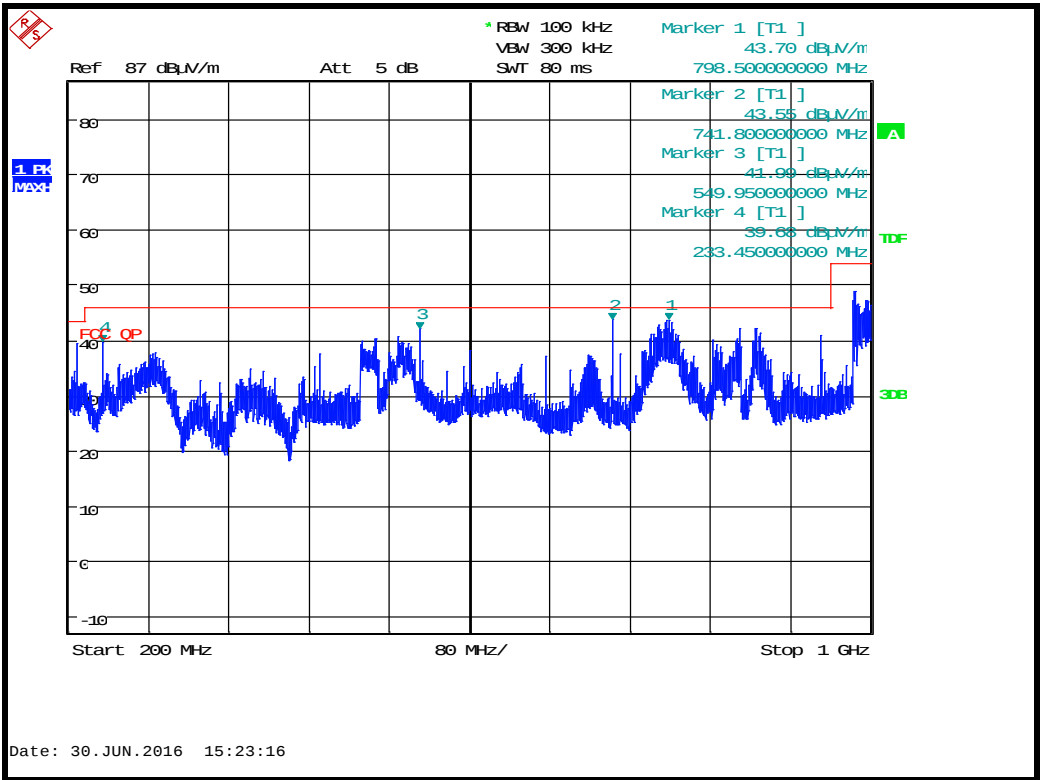


GFSK Tx 2442 MHz : 18 GHz to 25 GHz

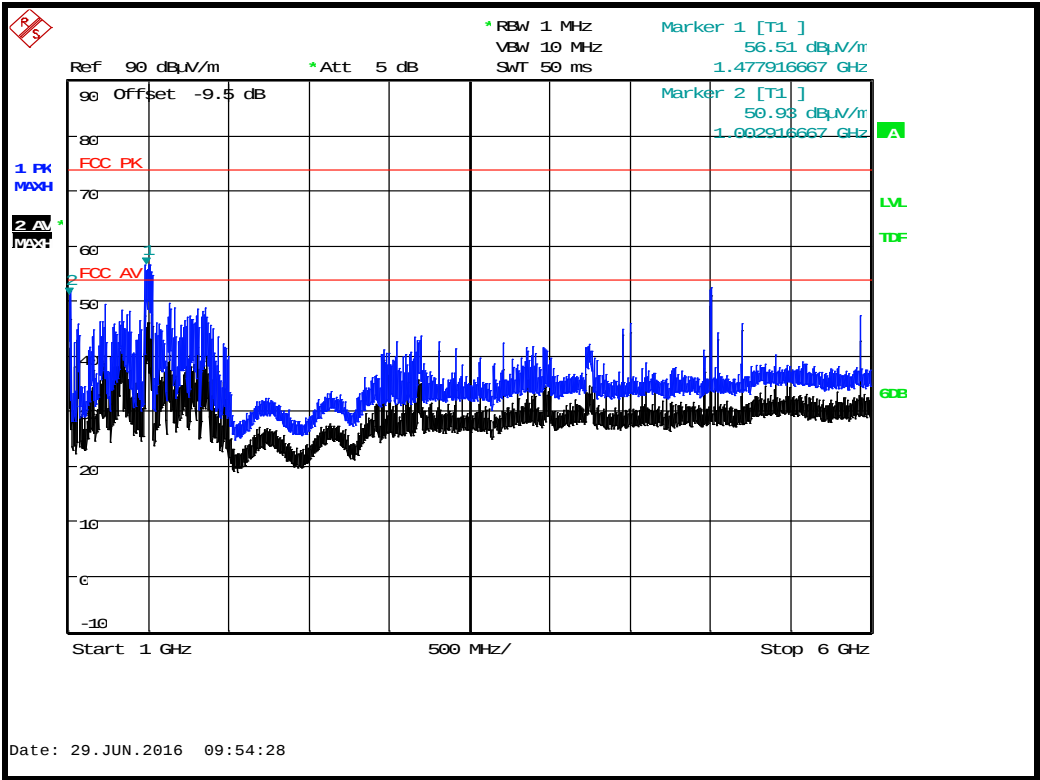
Frequency: 2480 MHz ; Modulation: GFSK										
Detector	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
No Significant Emissions Within 10 dB of the limit										



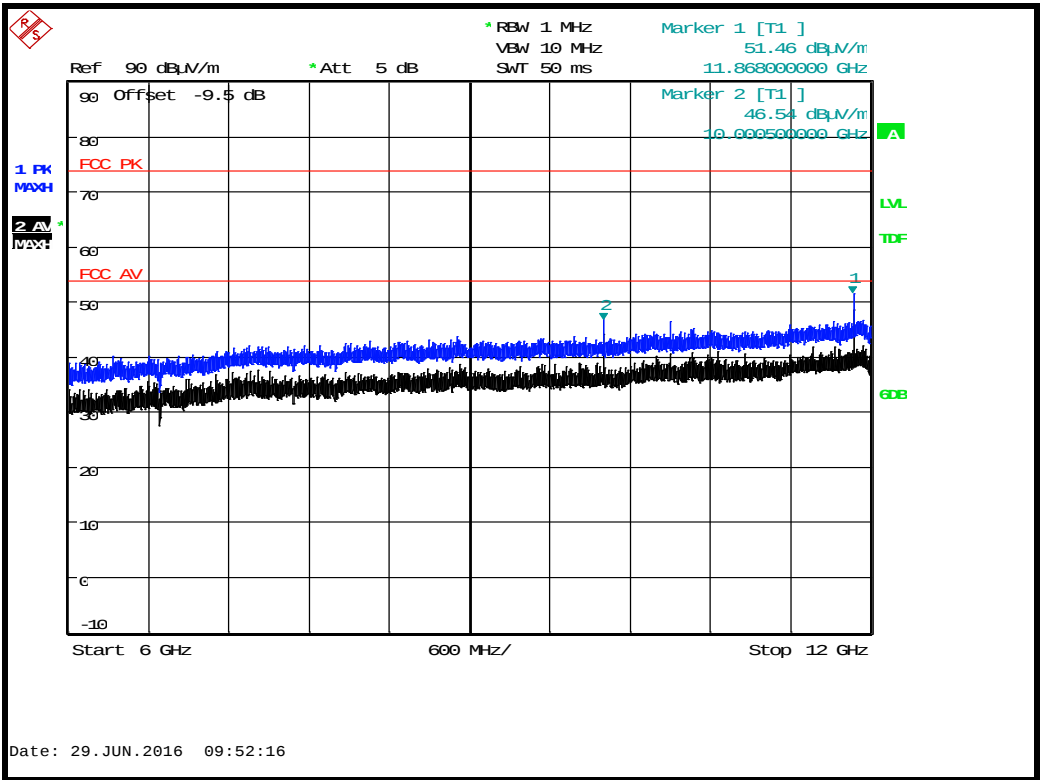
GFSK Tx 2480 MHz : 30 MHz to 200 MHz



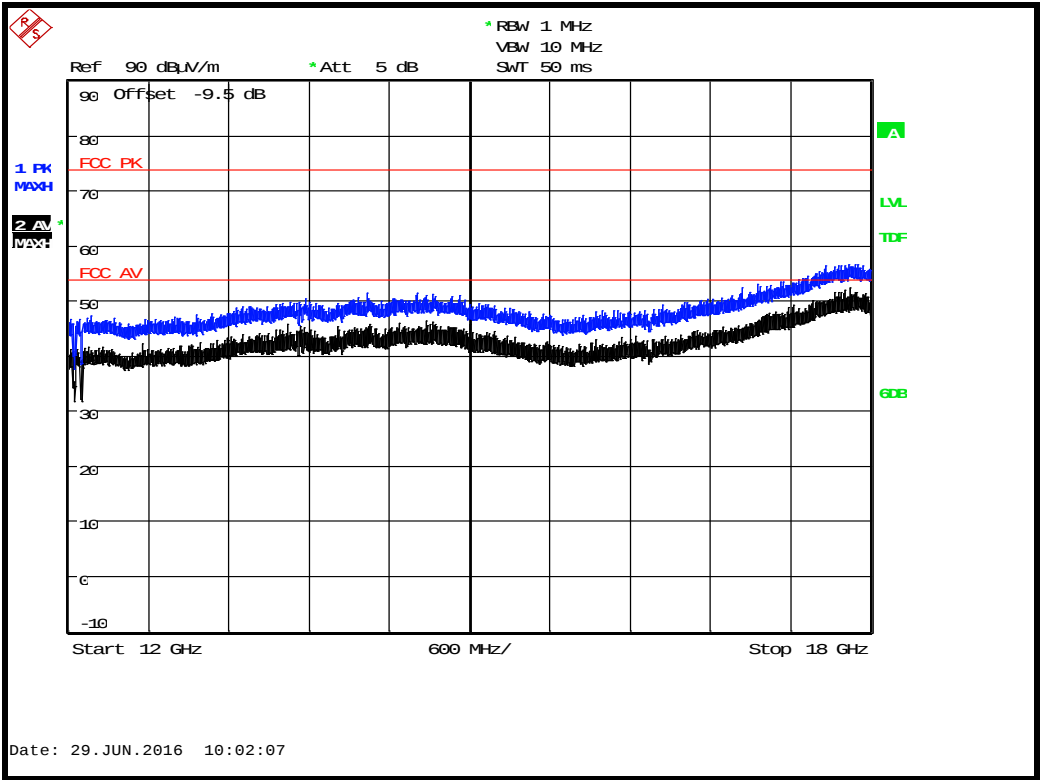
GFSK Tx 2480 MHz : 200 MHz to 1000 MHz



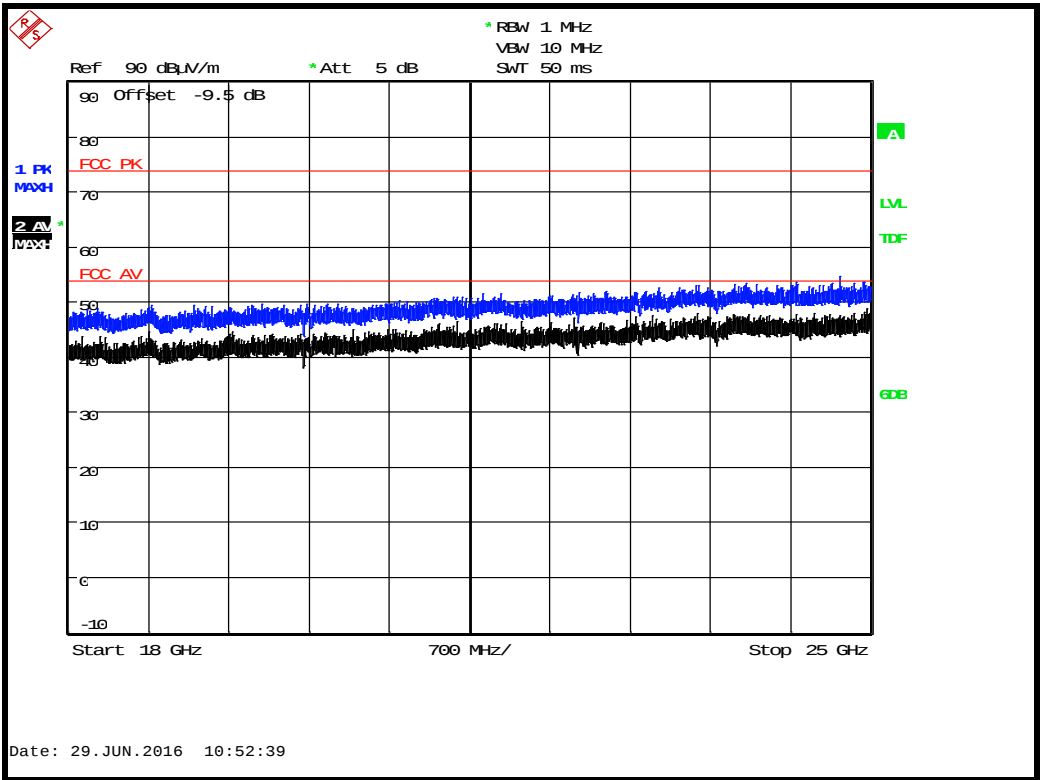
GFSK Tx 2480 MHz : 1 GHz to 6 GHz



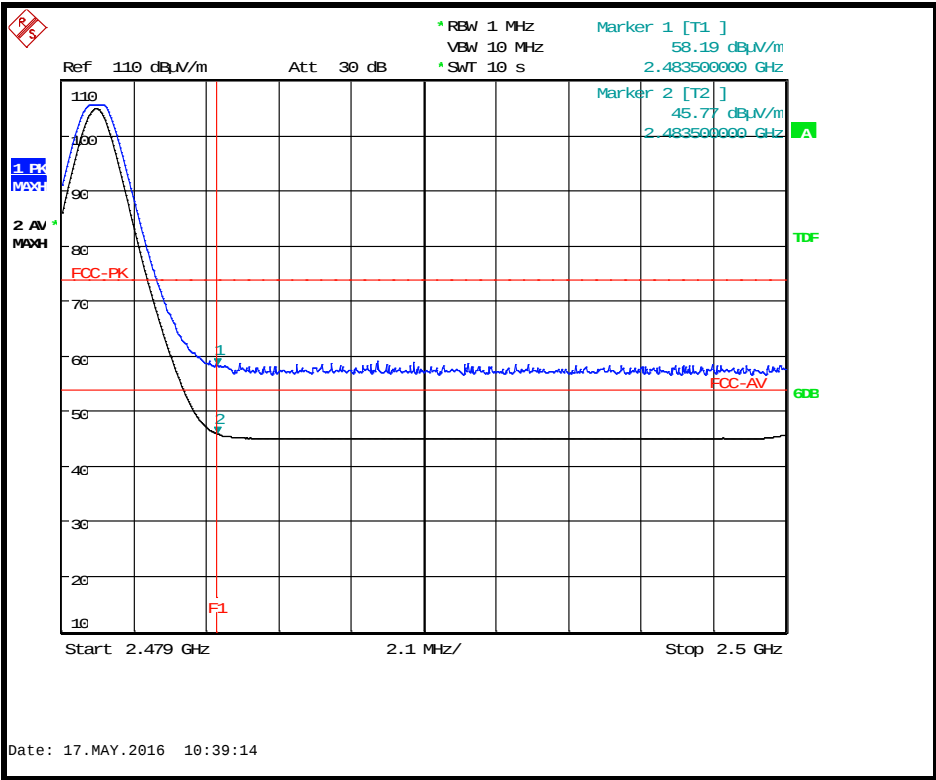
GFSK Tx 2480 MHz : 6 GHz to 12 GHz



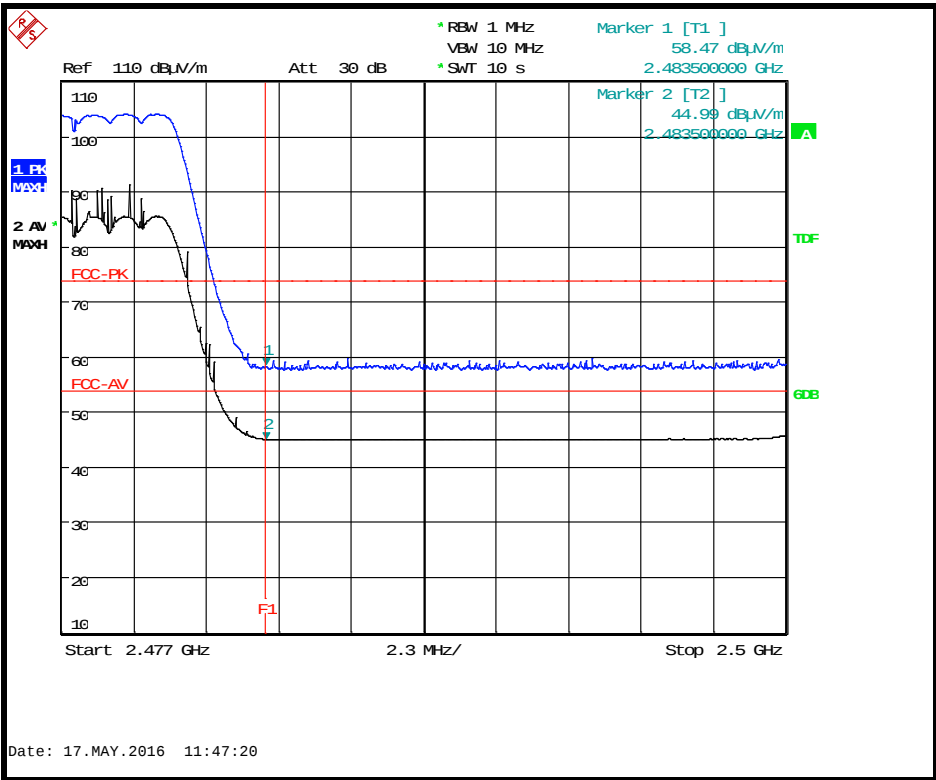
GFSK Tx 2480 MHz : 12 GHz to 18 GHz



GFSK Tx 2480 MHz : 18 GHz to 25 GHz

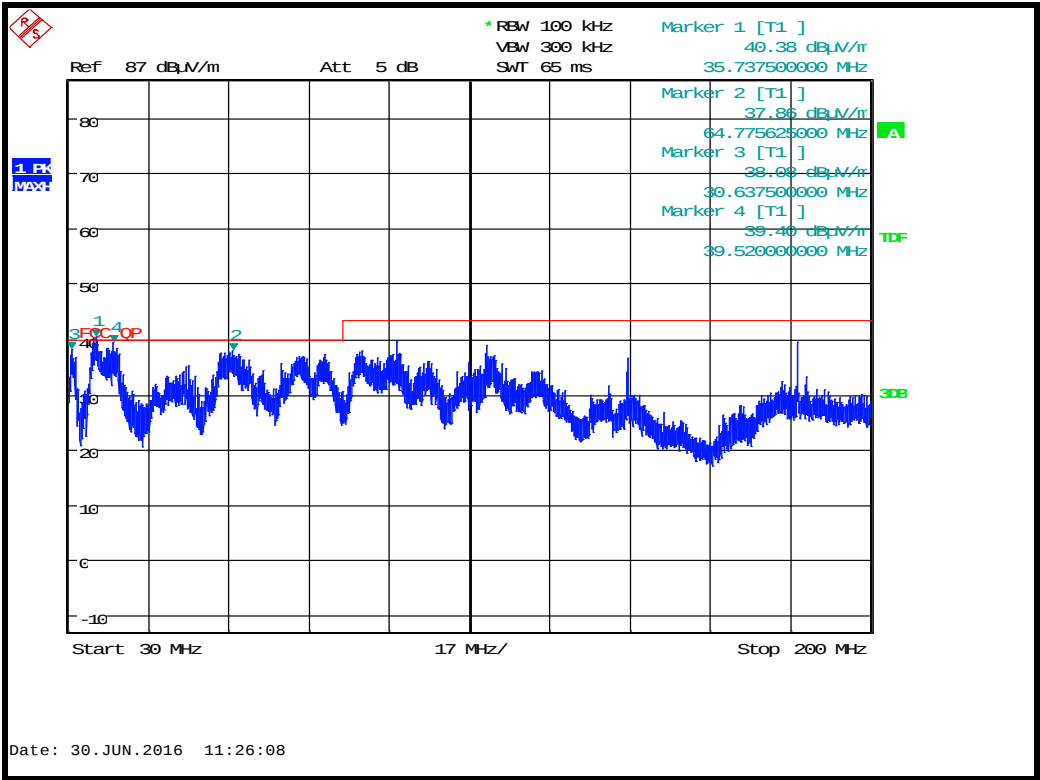


GFSK Tx 2480 MHz : Bandedge Compliance : Single Channel

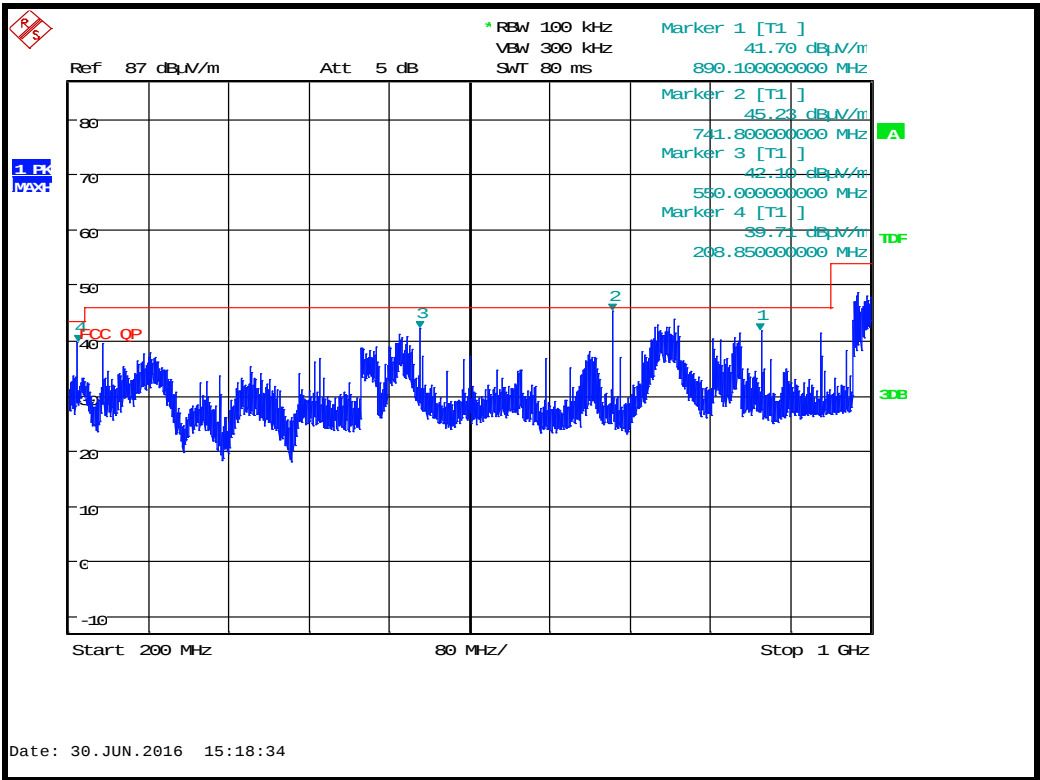


GFSK Tx 2480 MHz : Bandedge Compliance : Hopping

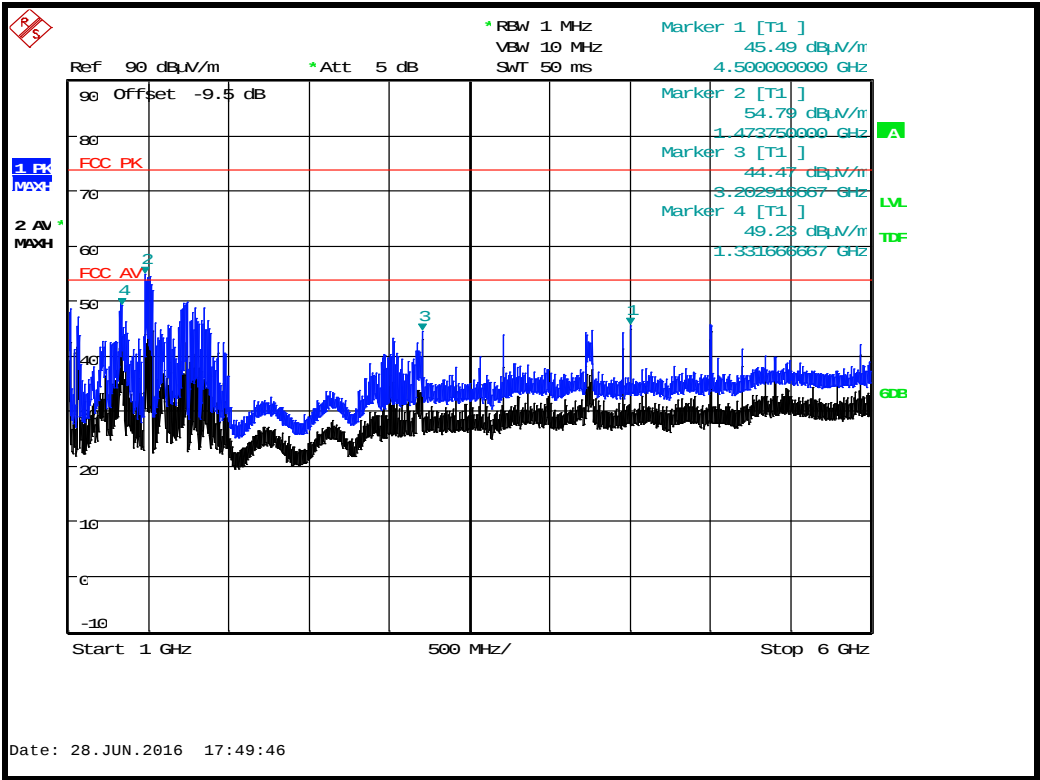
Frequency: 2402 MHz ; Modulation: QPSK										
Detector	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
No Significant Emissions Within 10 dB of the limit										



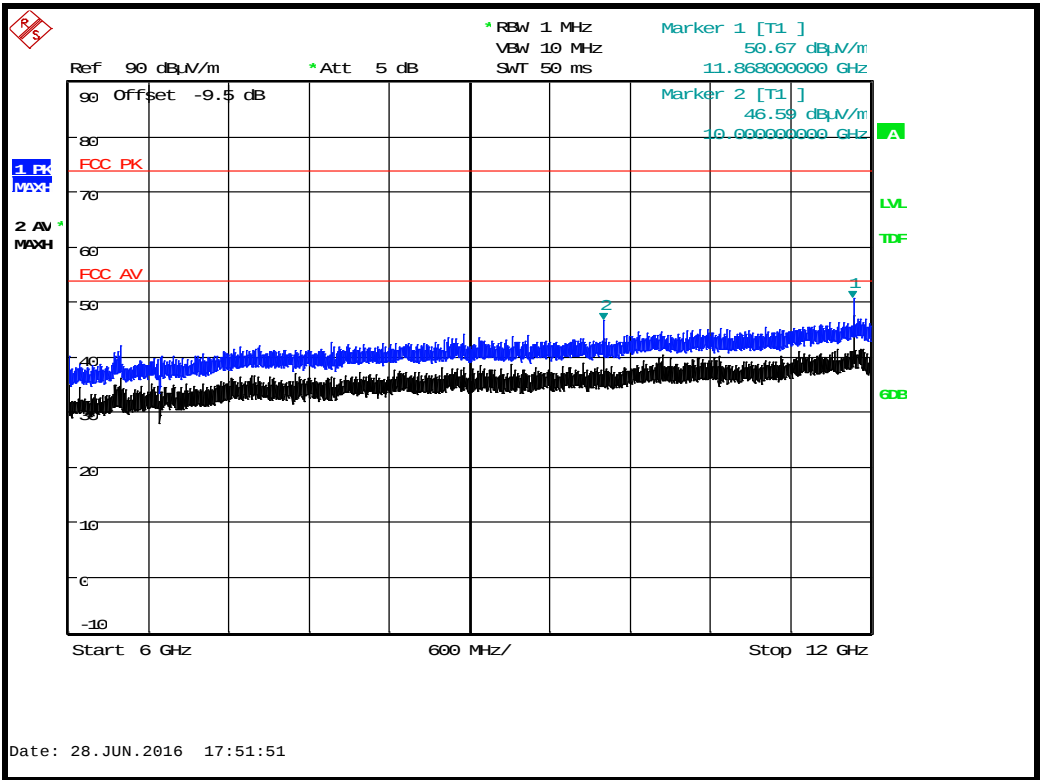
QPSK Tx 2402 MHz : 30 MHz to 200 MHz



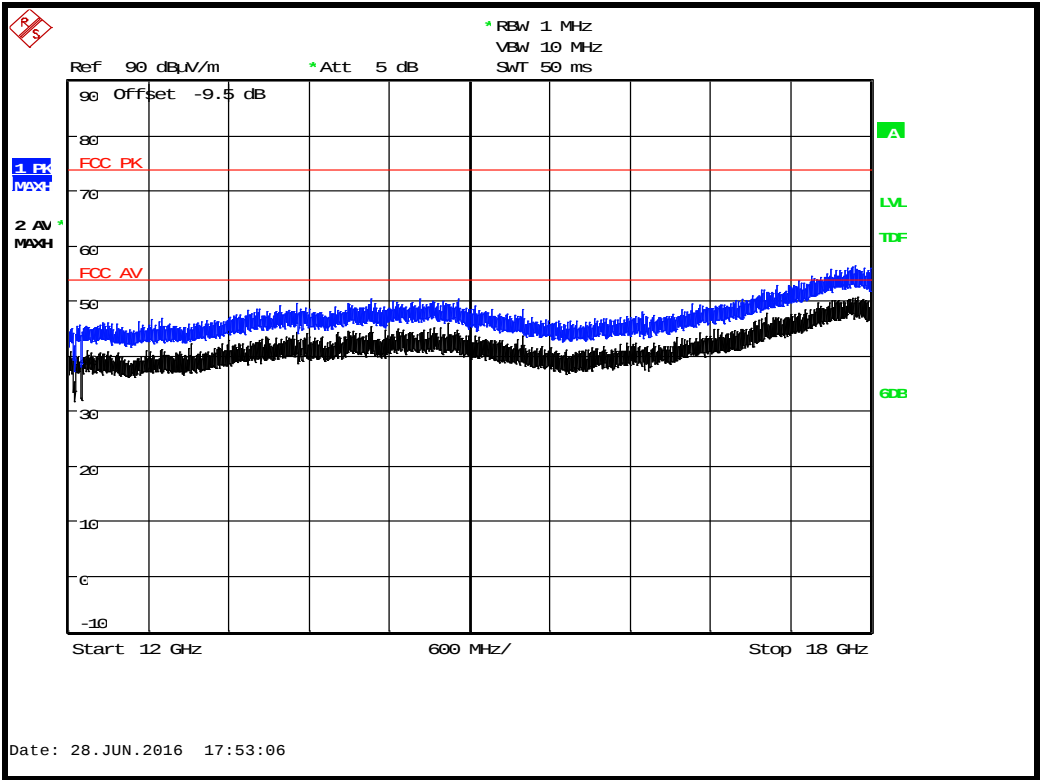
QPSK Tx 2402 MHz : 200 MHz to 1000 MHz



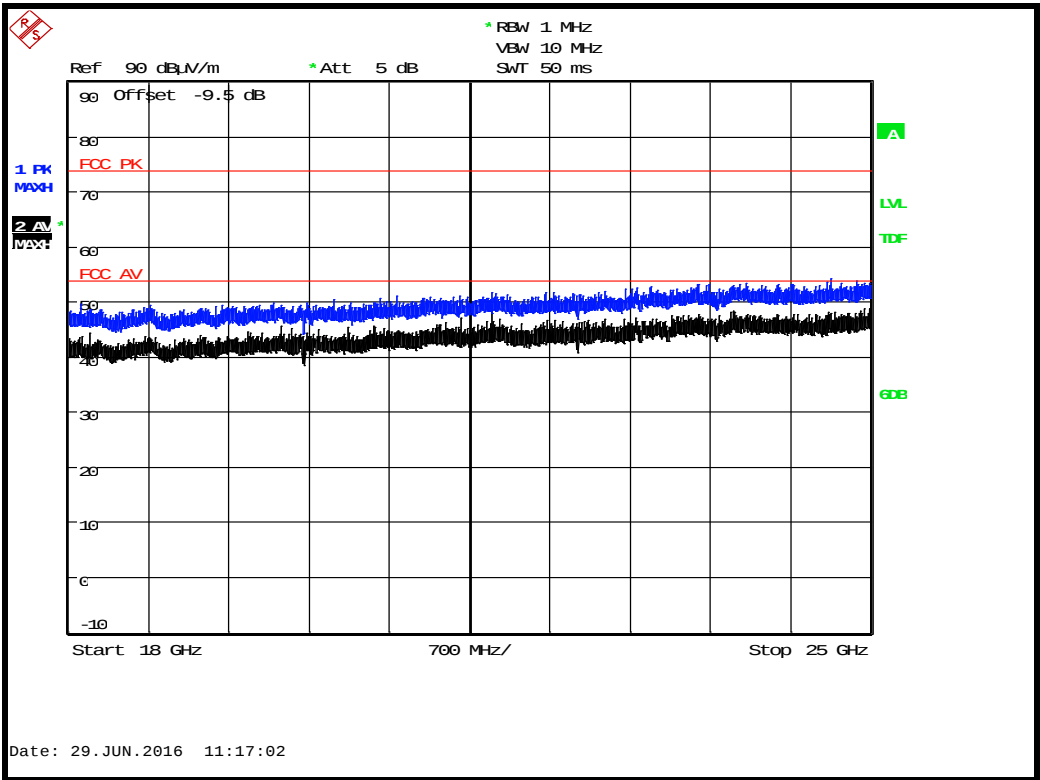
QPSK Tx 2402 MHz : 1 GHz to 6 GHz



QPSK Tx 2402 MHz : 6 GHz to 12 GHz

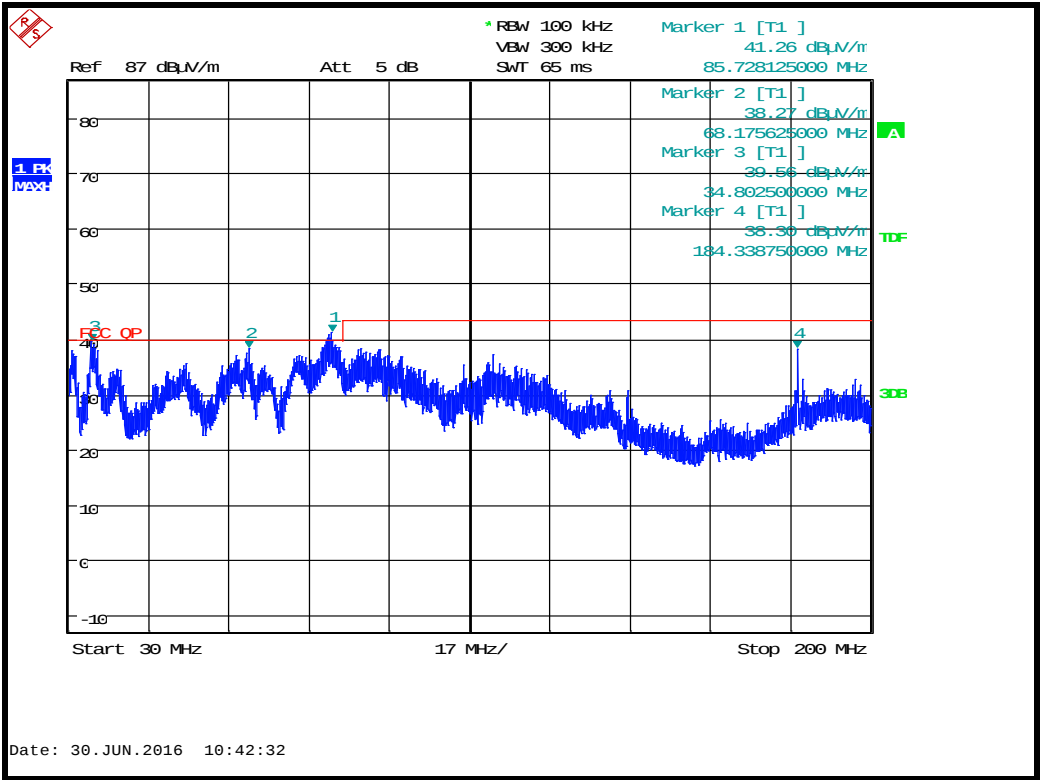


QPSK Tx 2402 MHz : 12 GHz to 18 GHz

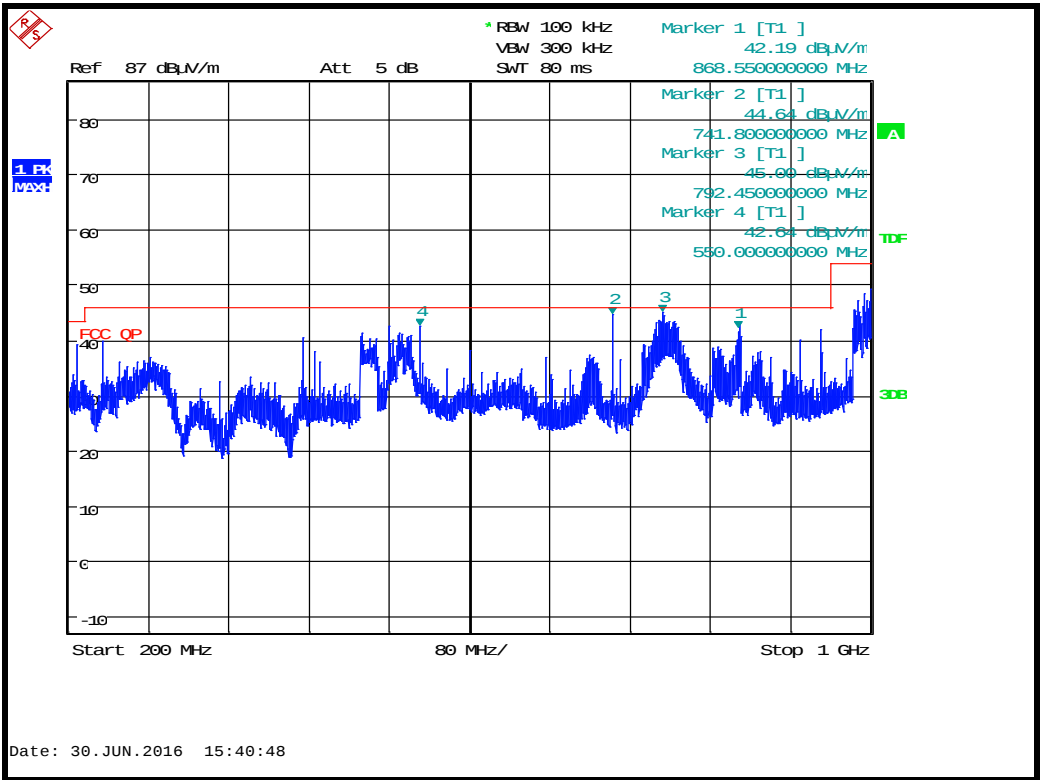


QPSK Tx 2402 MHz : 18 GHz to 25 GHz

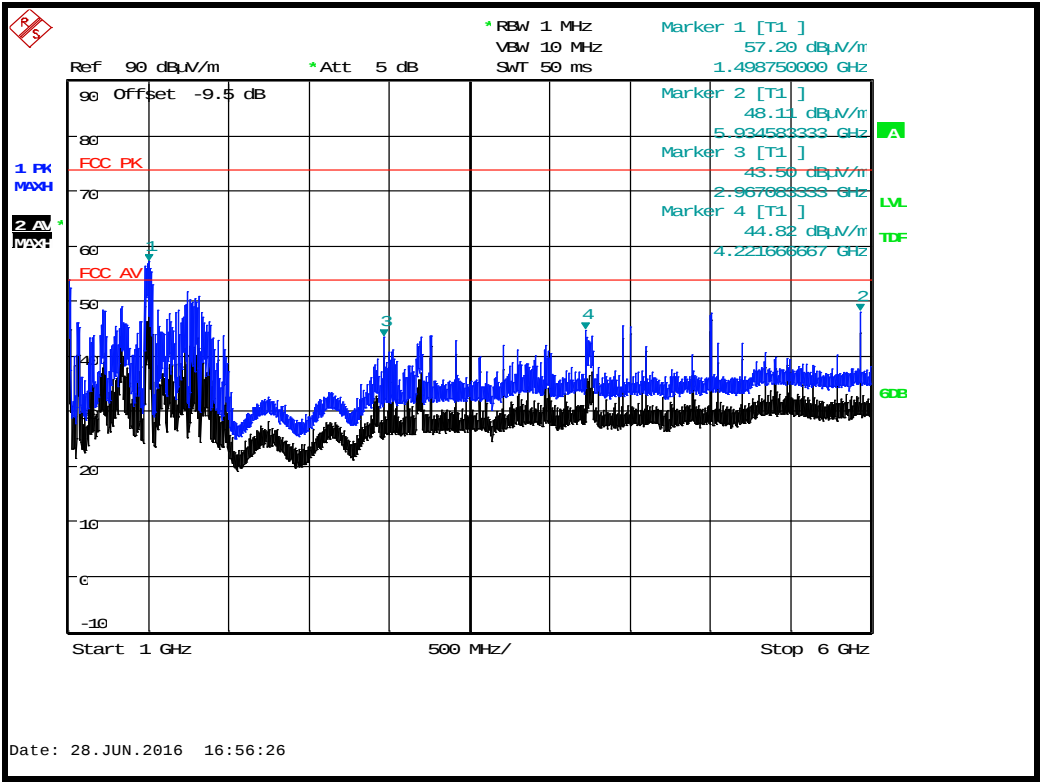
Frequency: 2442 MHz ; Modulation: QPSK										
Detector	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
Pk	4884.454	45.34	5.6	33.4	34.59	0	0	49.8	309.0	5011.8
Av	4884.454	33.2	5.6	33.4	34.59	0	0	37.6	75.9	500



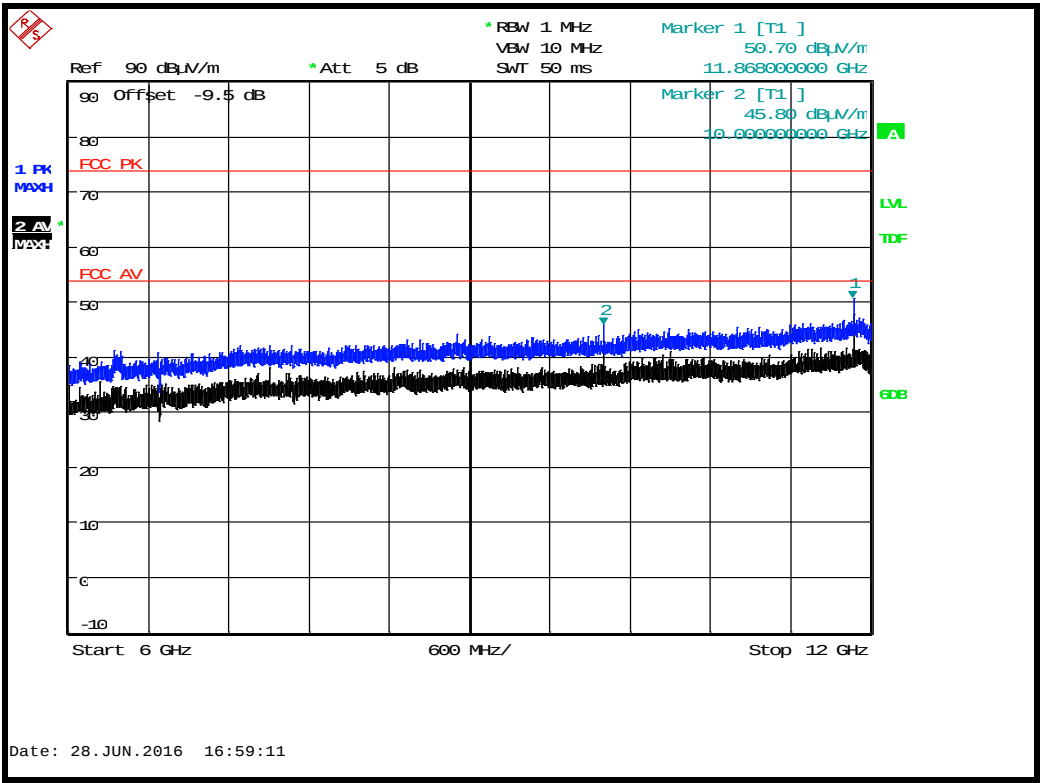
QPSK Tx 2442 MHz : 30 MHz to 200 MHz



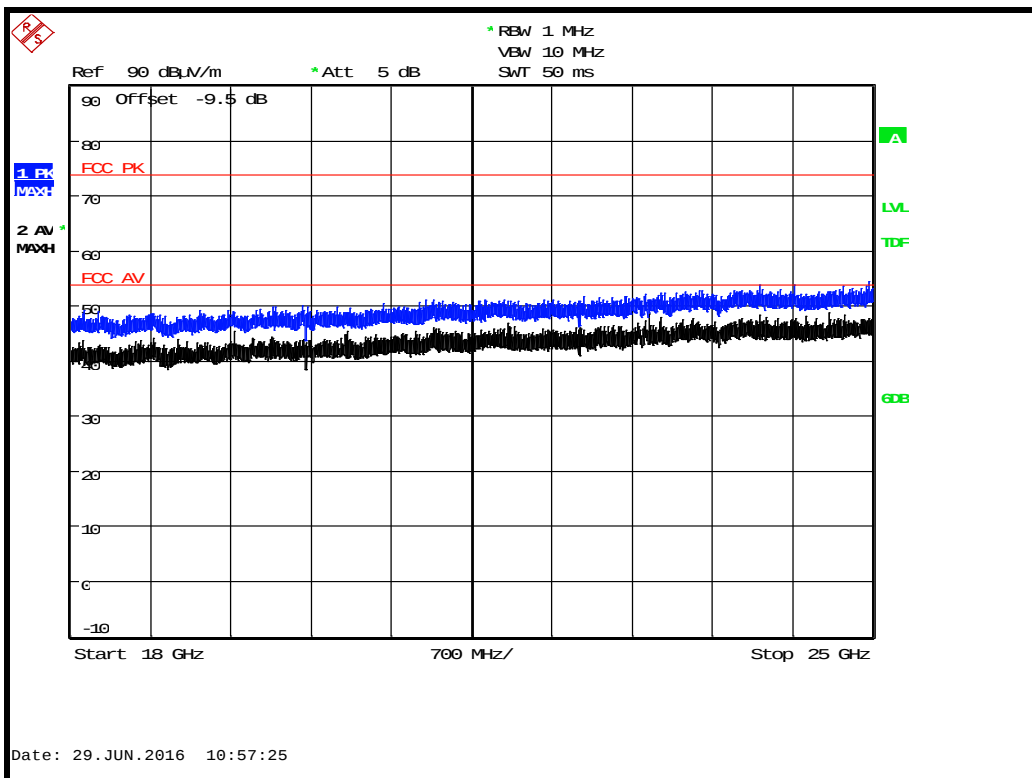
QPSK Tx 2442 MHz : 200 MHz to 1000 MHz



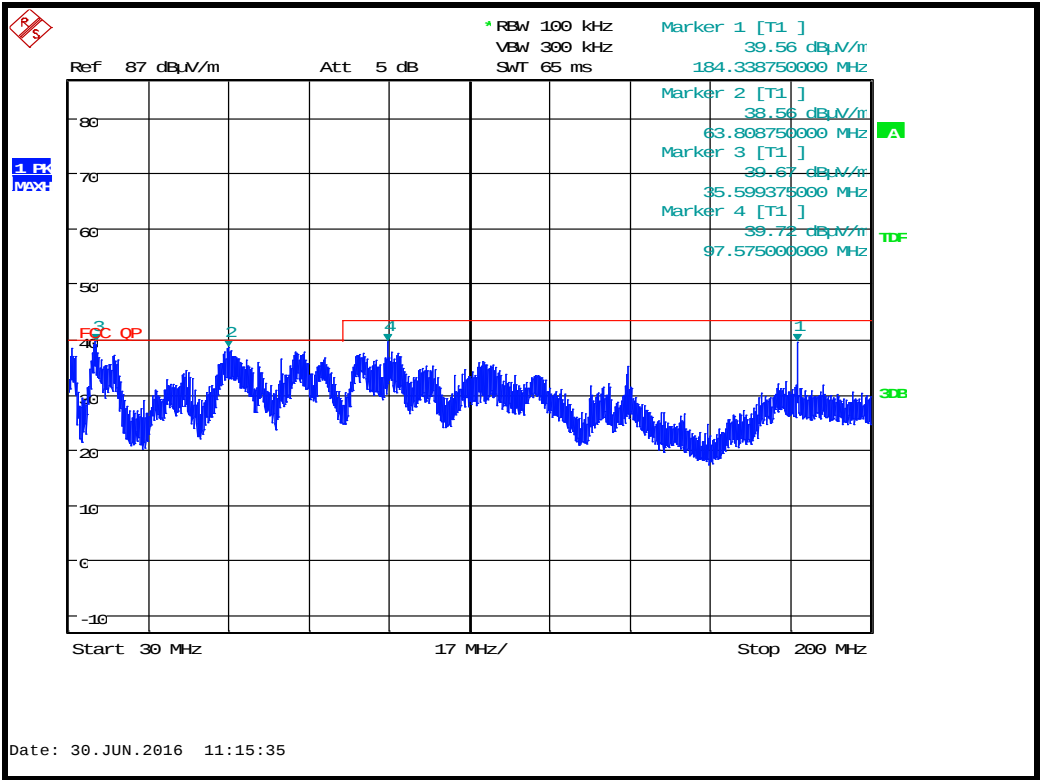
QPSK Tx 2442 MHz : 1 GHz to 6 GHz



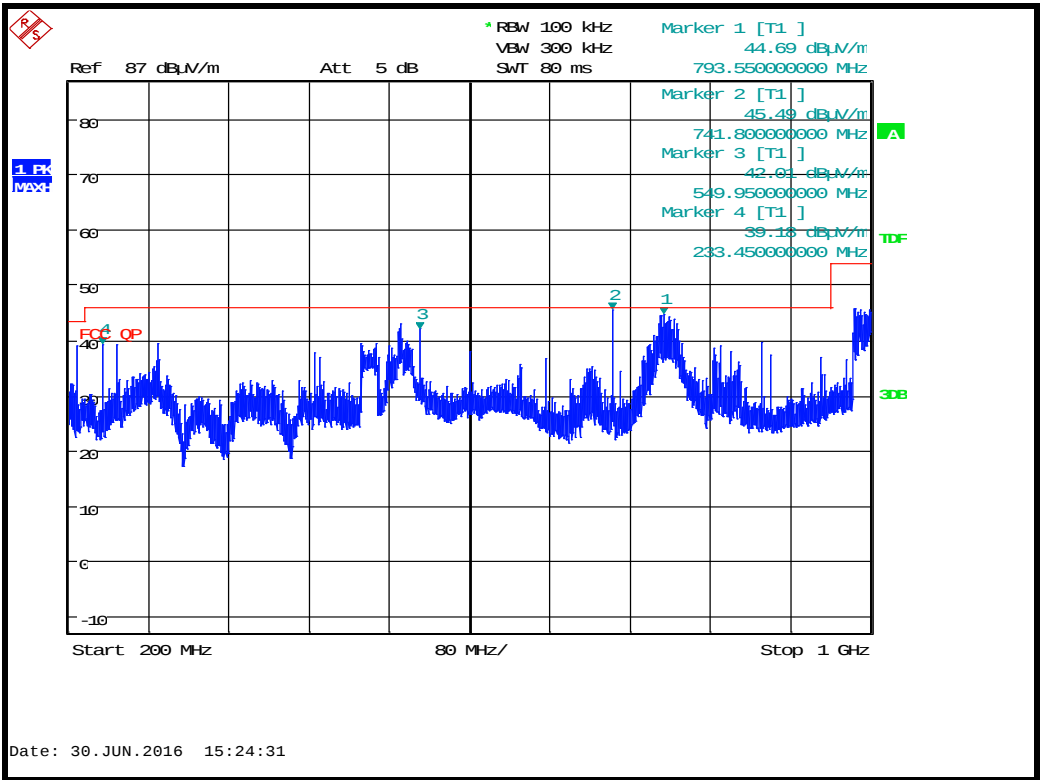
QPSK Tx 2442 MHz : 6 GHz to 12 GHz



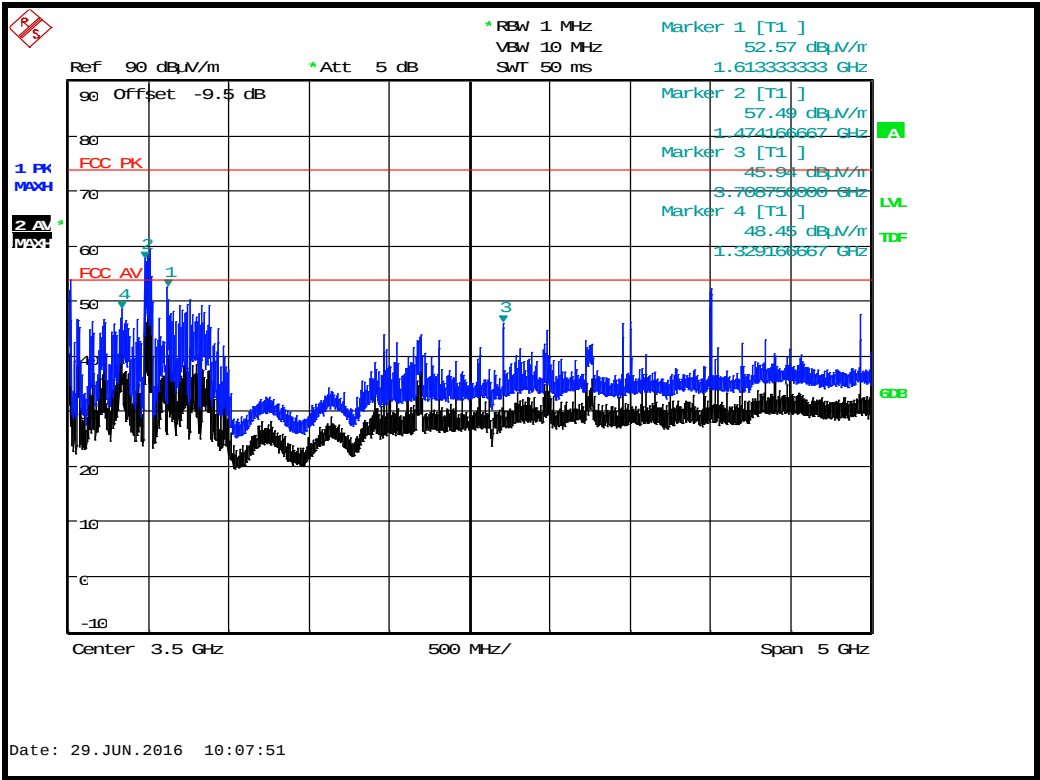
Frequency: 2480 MHz ; Modulation: QPSK										
Detector	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
No Significant Emissions Within 10 dB of the limit										



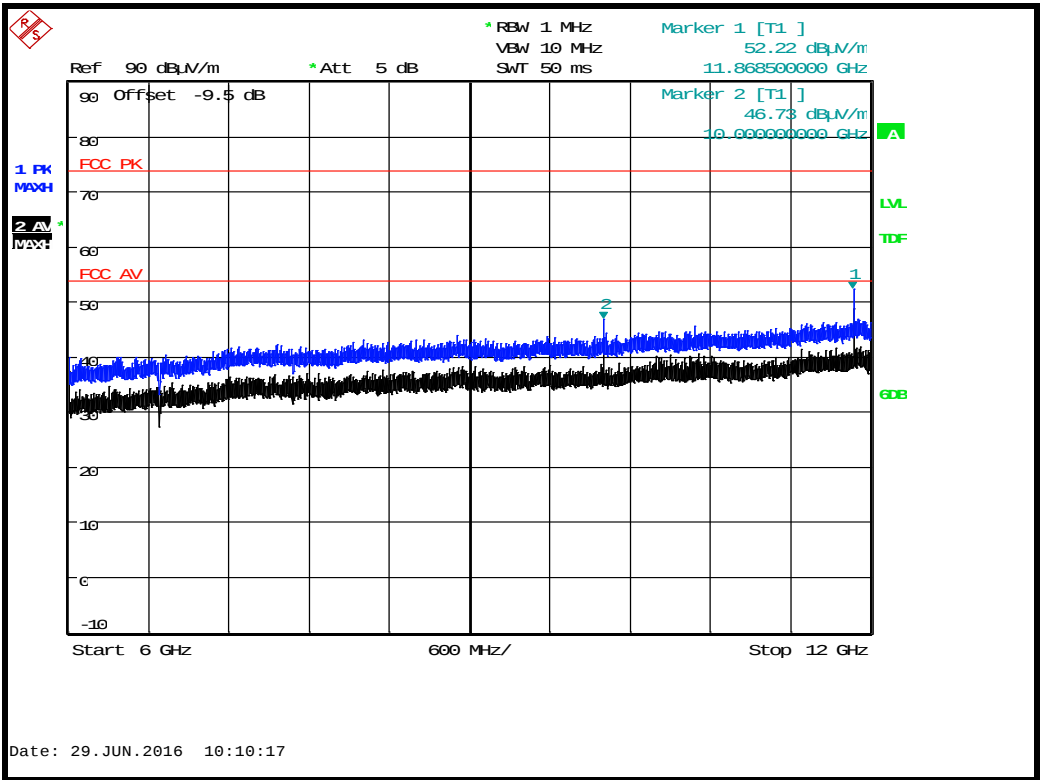
QPSK Tx 2480 MHz : 30 MHz to 200 MHz



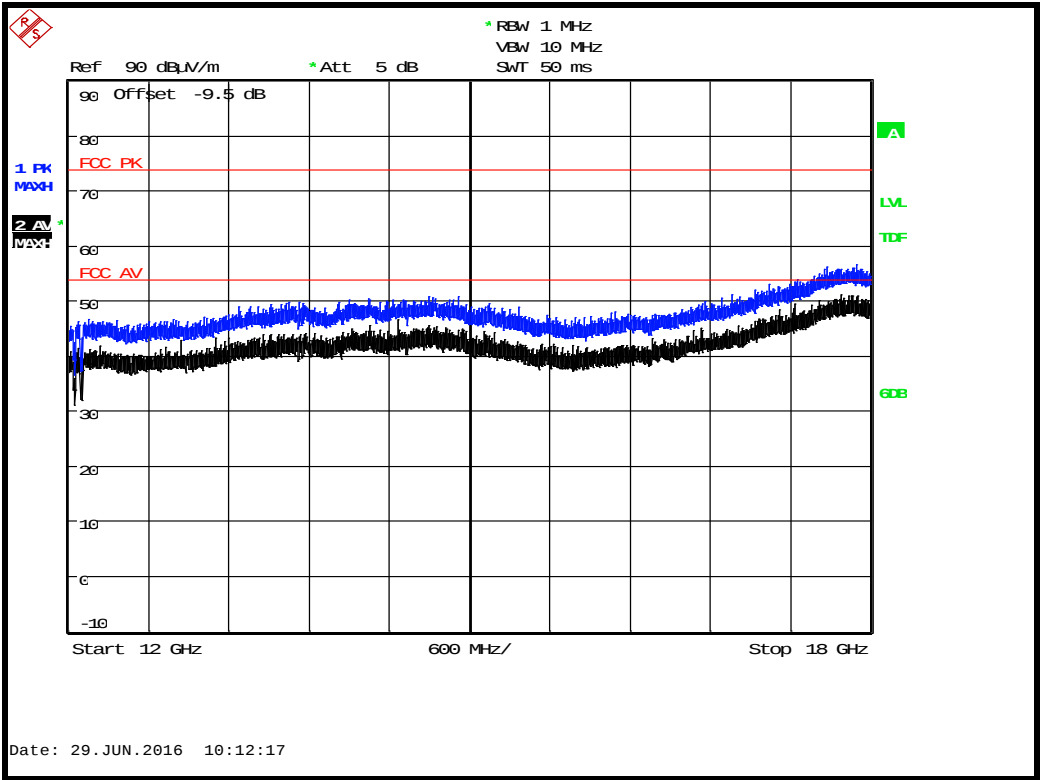
QPSK Tx 2480 MHz : 200 MHz to 1000 MHz



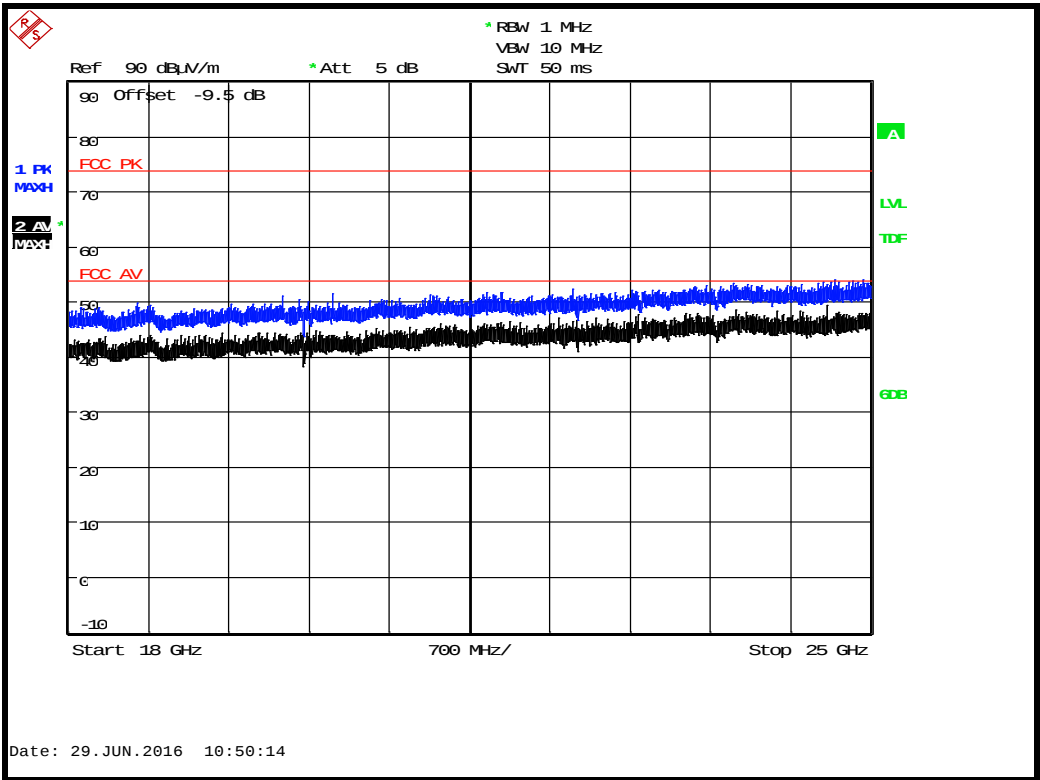
QPSK Tx 2480 MHz : 1 GHz to 6 GHz



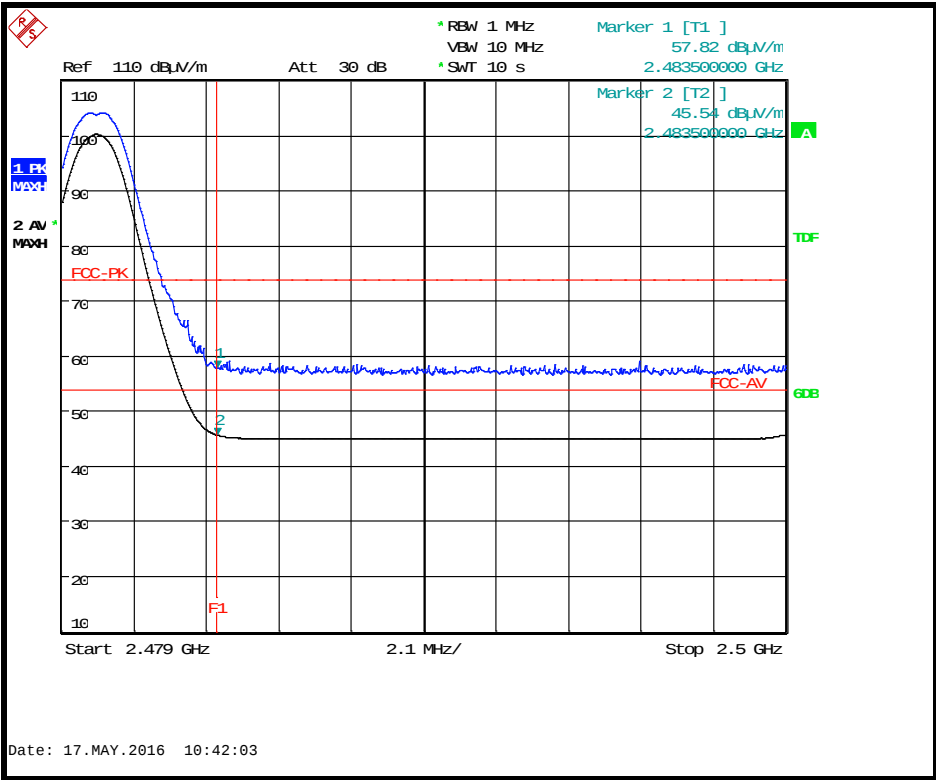
QPSK Tx 2480 MHz : 6 GHz to 12 GHz



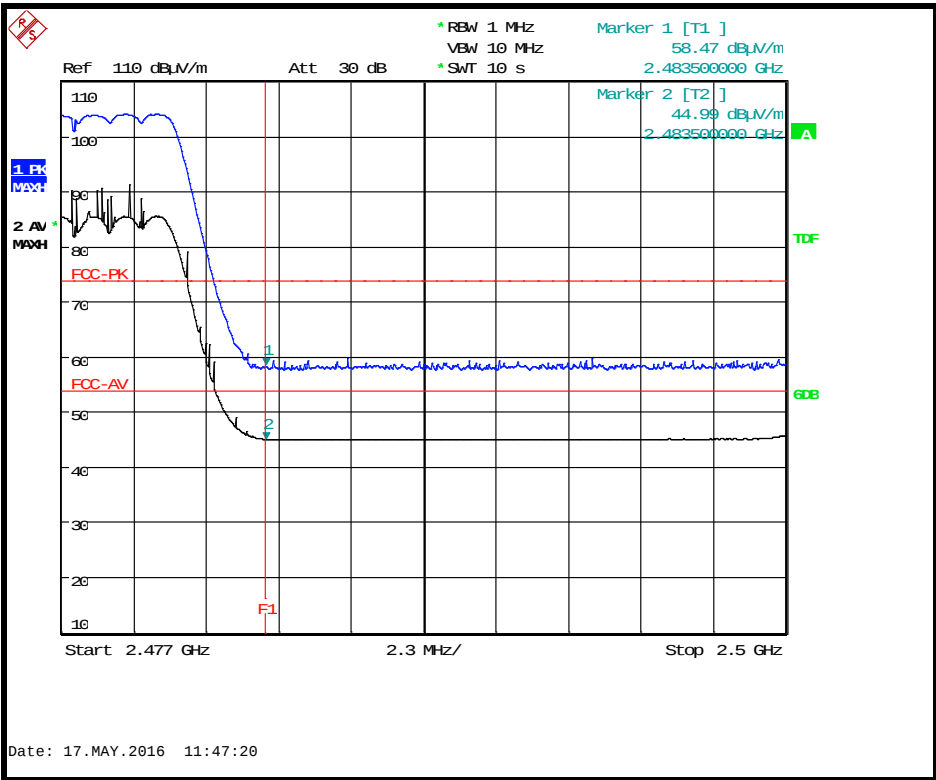
QPSK Tx 2480 MHz : 12 GHz to 18 GHz



QPSK Tx 2480 MHz : 18 GHz to 25 GHz

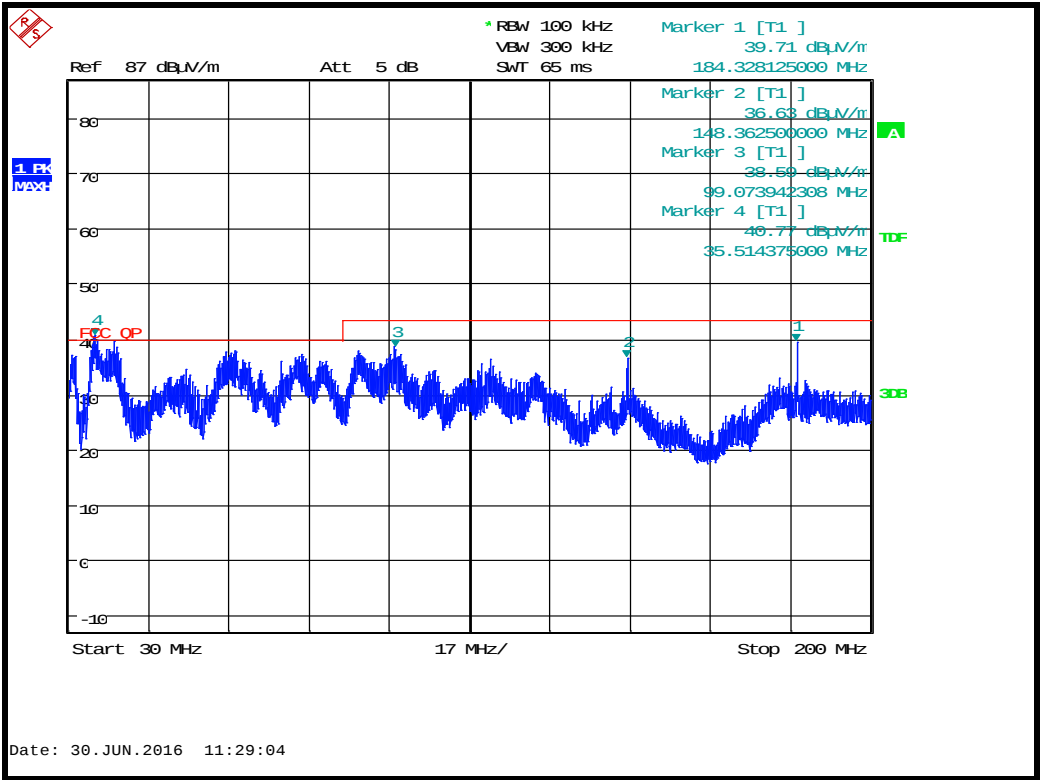


QPSK Tx 2480 MHz : Bandedge Compliance : Single Channel

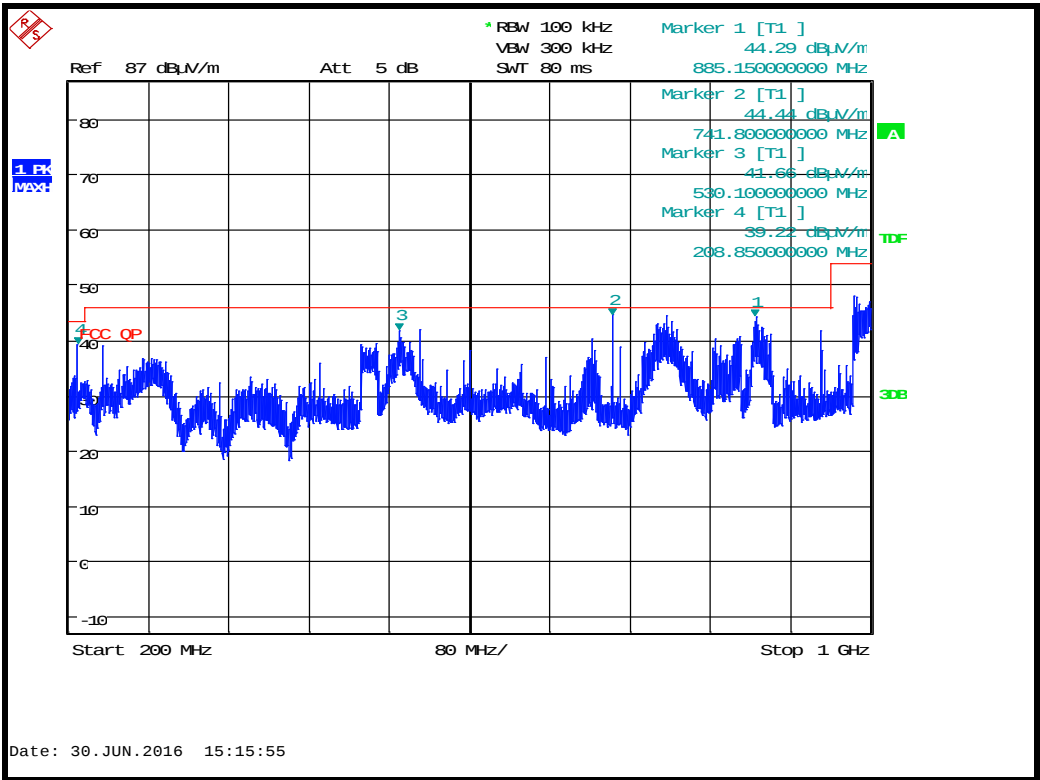


QPSK Tx 2480 MHz : Bandedge Compliance : Hopping

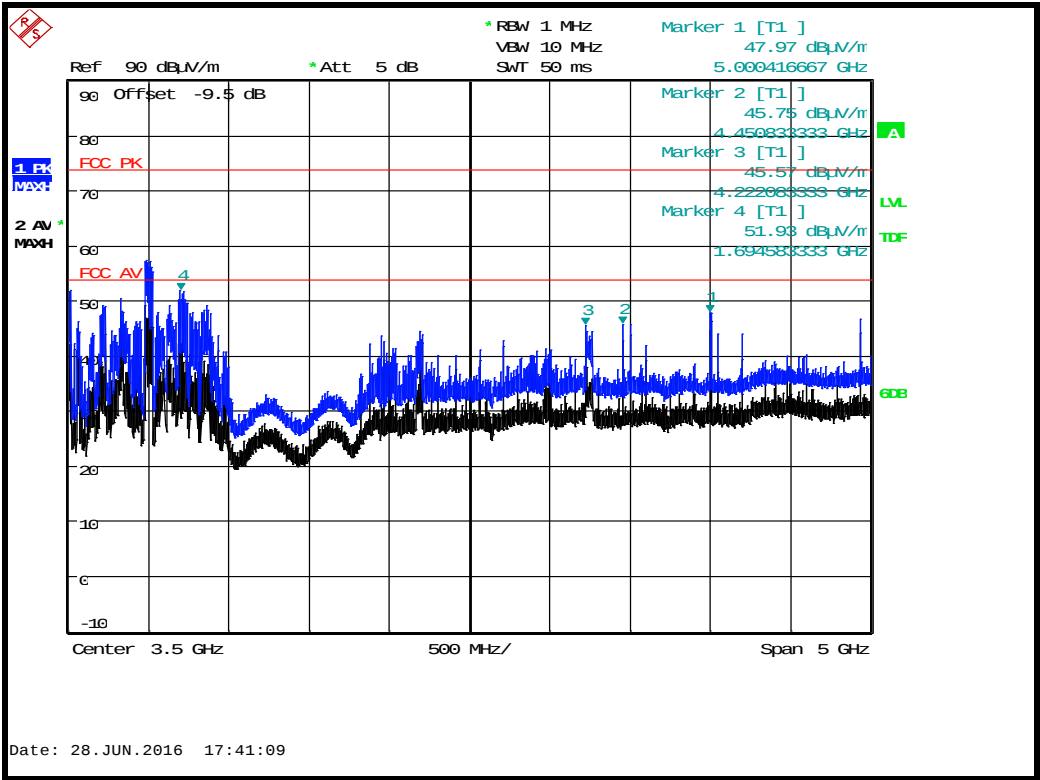
Frequency: 2402 MHz ; Modulation: 8PSK										
Detector	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
No Significant Emissions Within 10 dB of the limit										



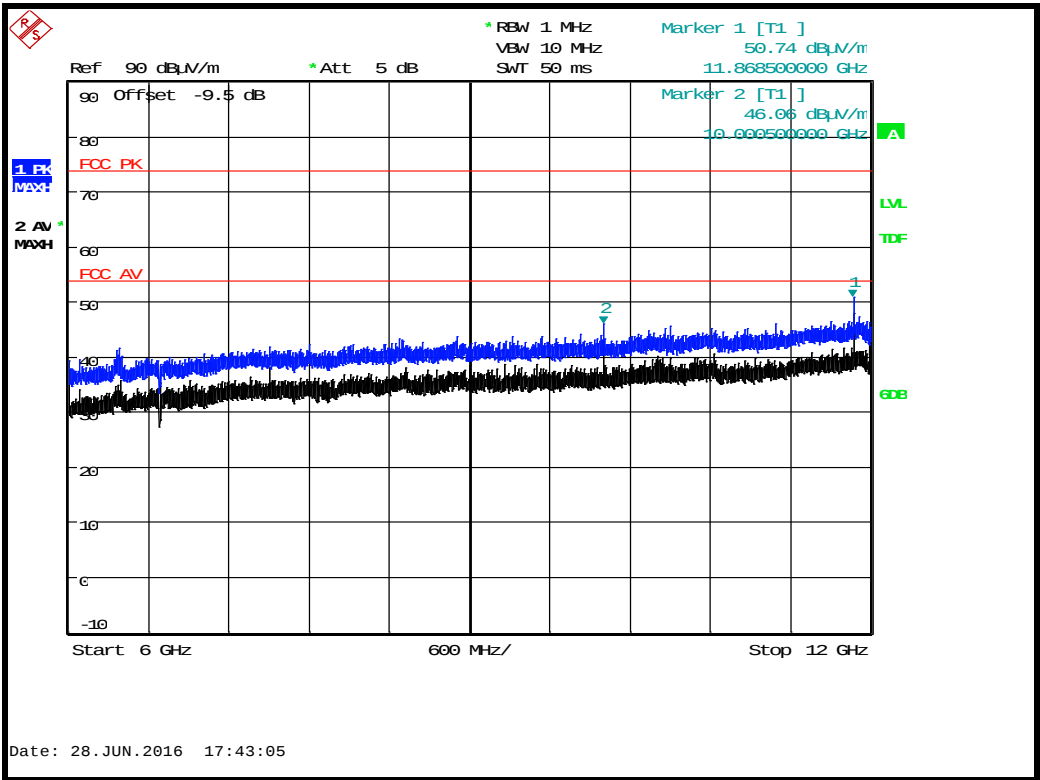
8PSK Tx 2402 MHz : 30 MHz to 200 MHz



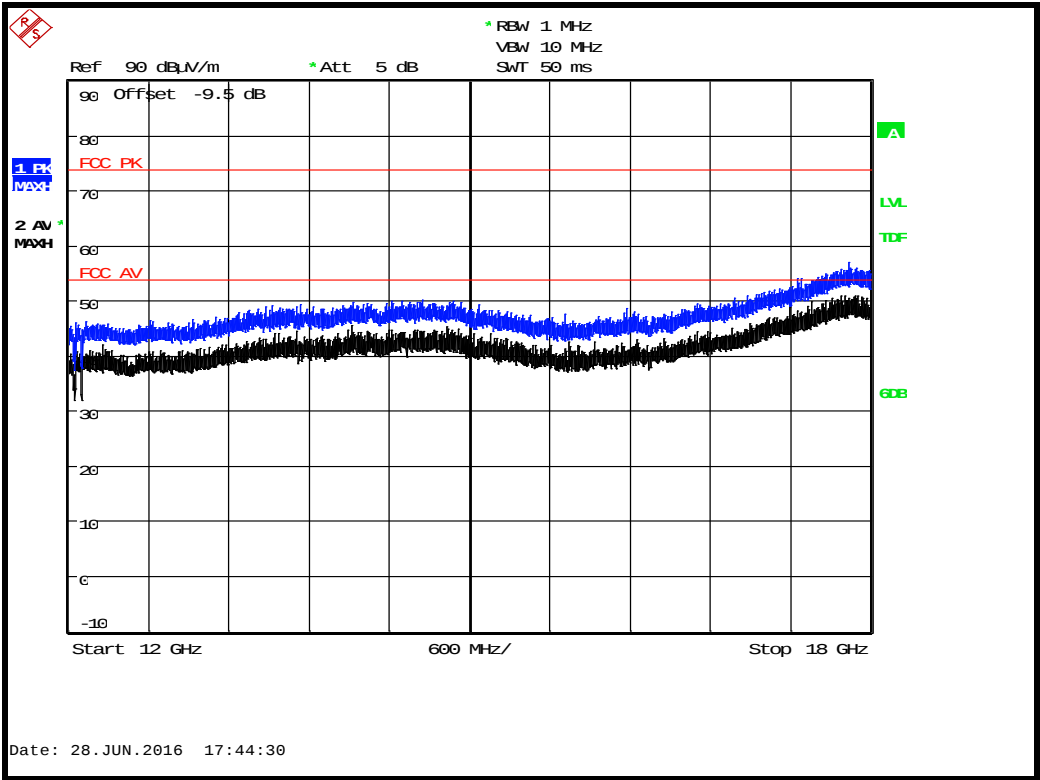
8PSK Tx 2402 MHz : 200 MHz to 1000 MHz



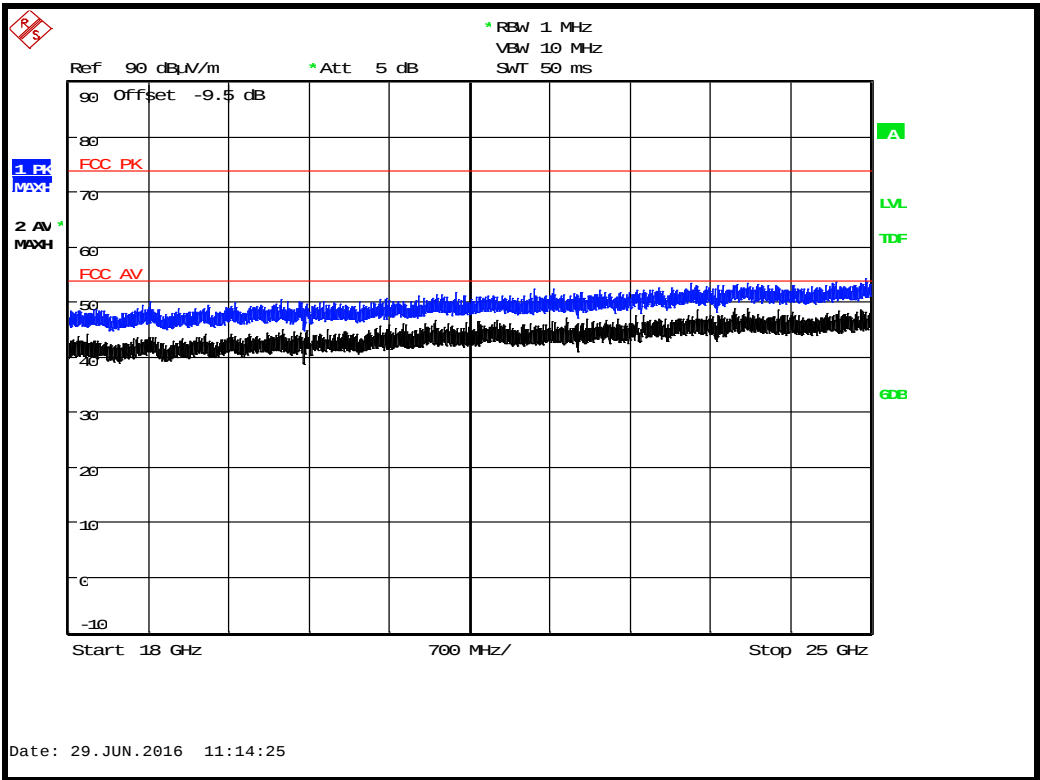
8PSK Tx 2402 MHz : 1 GHz to 6 GHz



8PSK Tx 2402 MHz : 6 GHz to 12 GHz

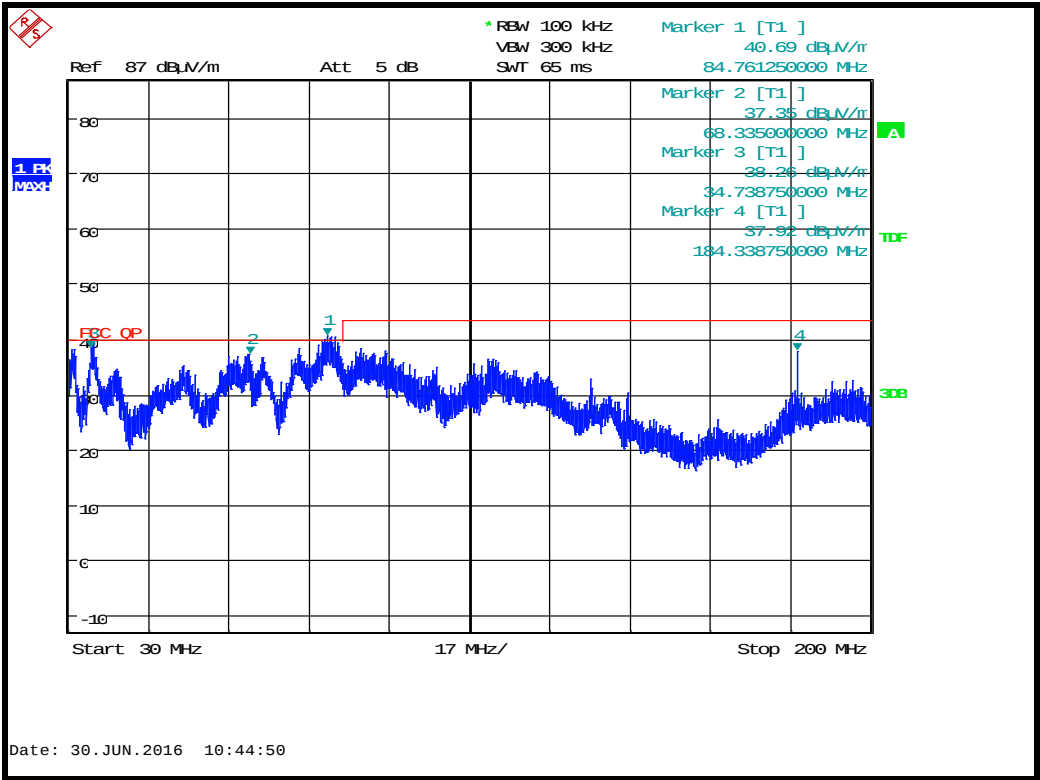


8PSK Tx 2402 MHz : 12 GHz to 18 GHz

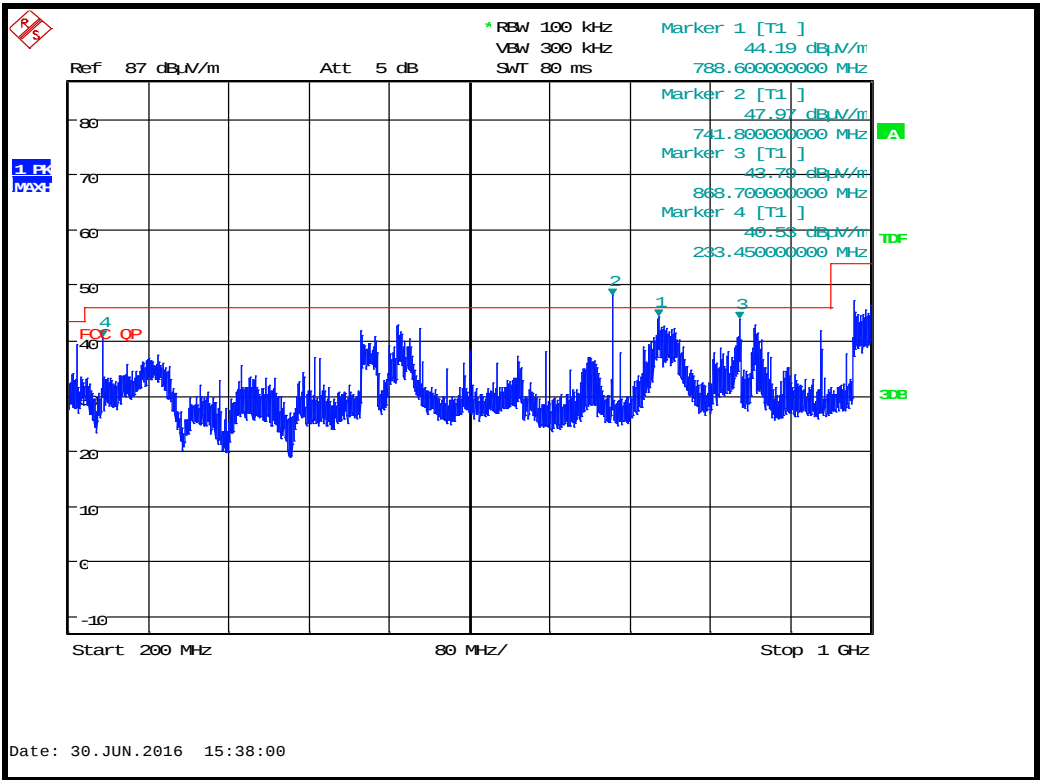


8PSK Tx 2402 MHz : 18 GHz to 25 GHz

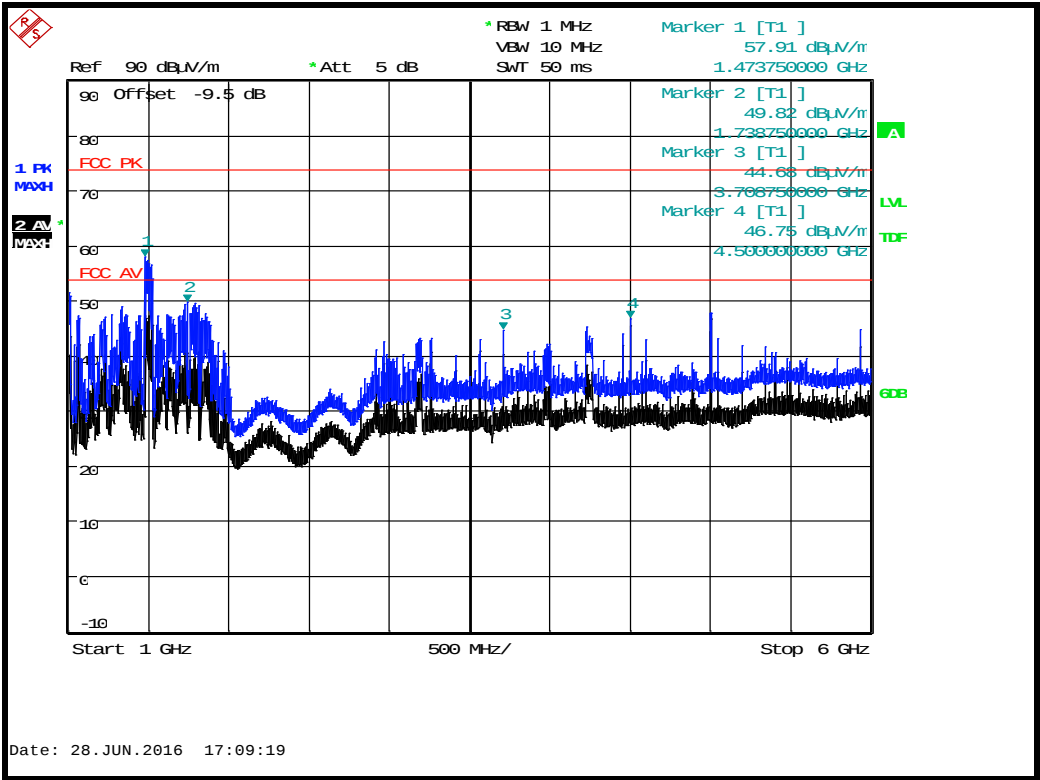
Frequency: 2442 MHz ; Modulation: 8PSK										
Detector	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
Pk	4884.000	46.92	5.6	33.4	34.59	0	0	51.3	367.3	5011
Av	4884.000	34.96	5.6	33.4	34.59	0	0	39.4	93.3	500



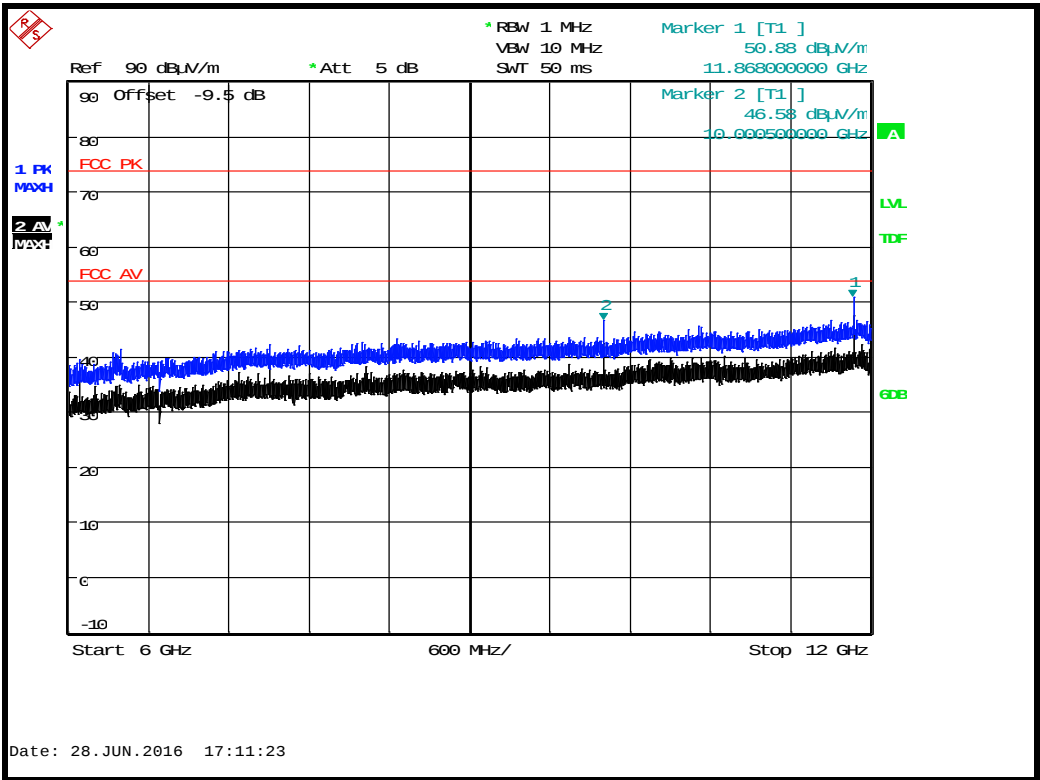
8PSK Tx 2442 MHz : 30 MHz to 200 MHz



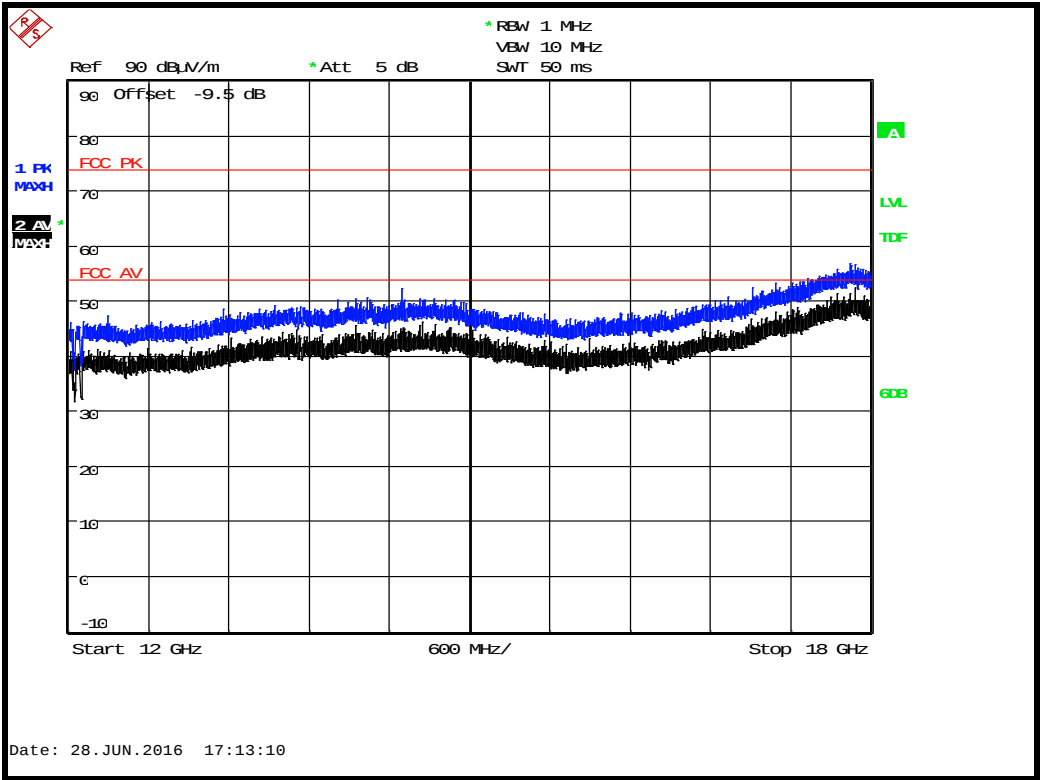
8PSK Tx 2442 MHz : 200 MHz to 1000 MHz



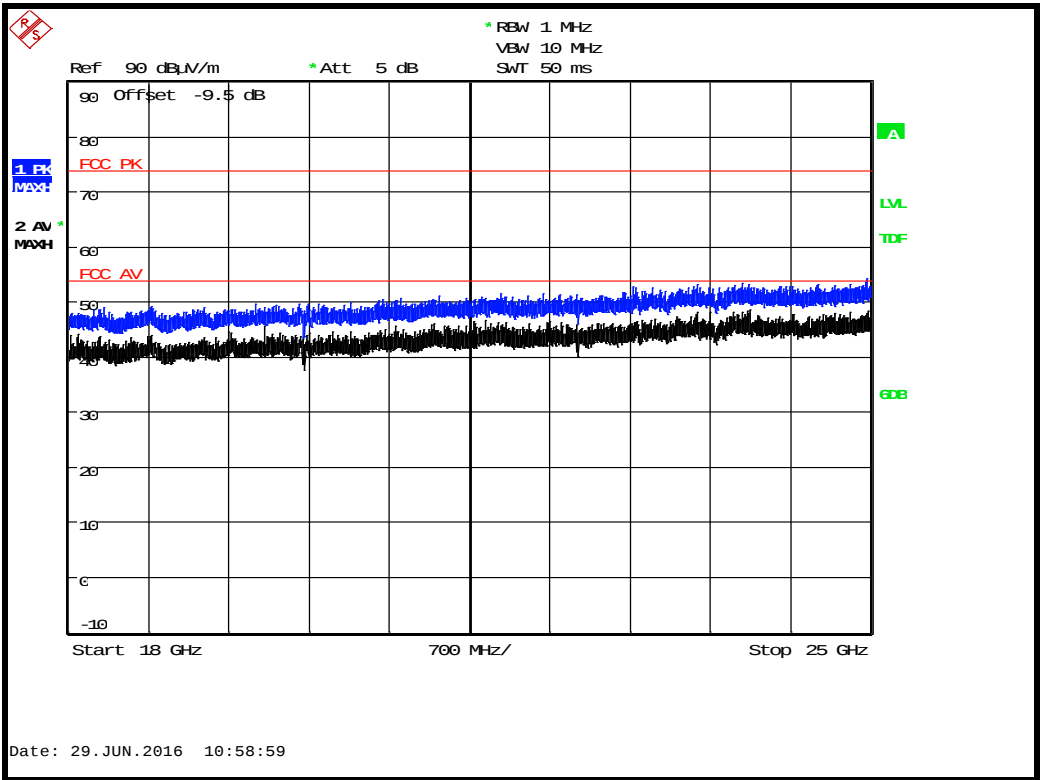
8PSK Tx 2442 MHz : 1 GHz to 6 GHz



8PSK Tx 2442 MHz : 6 GHz to 12 GHz

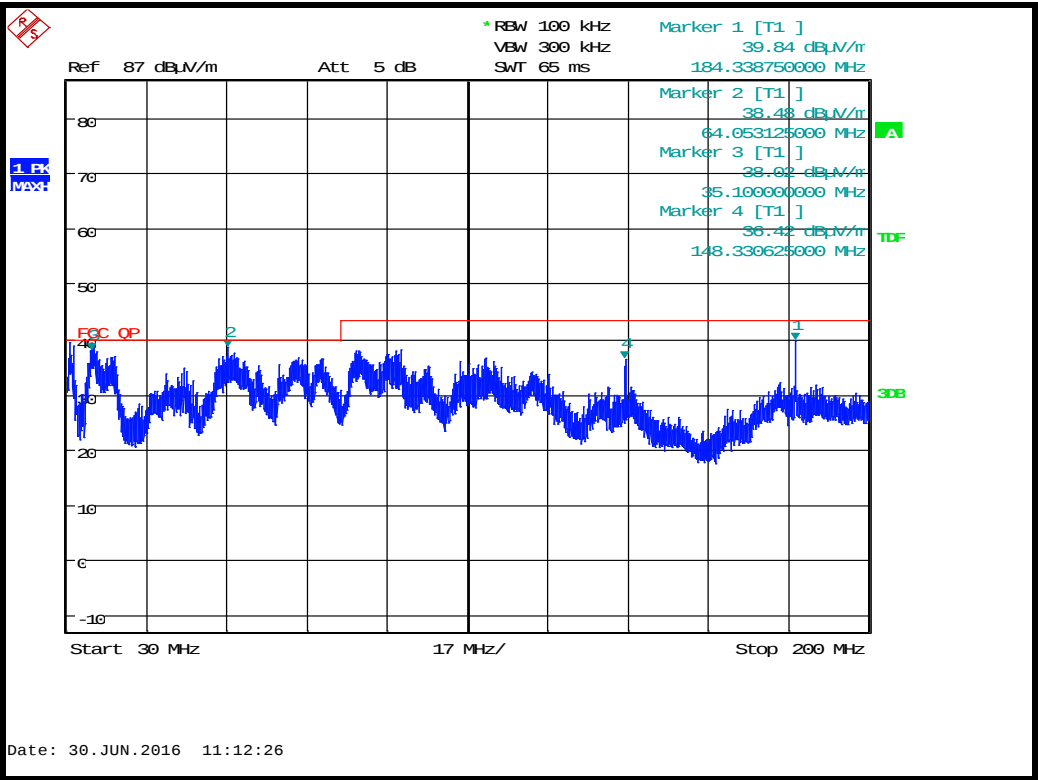


8PSK Tx 2442 MHz : 12 GHz to 18 GHz

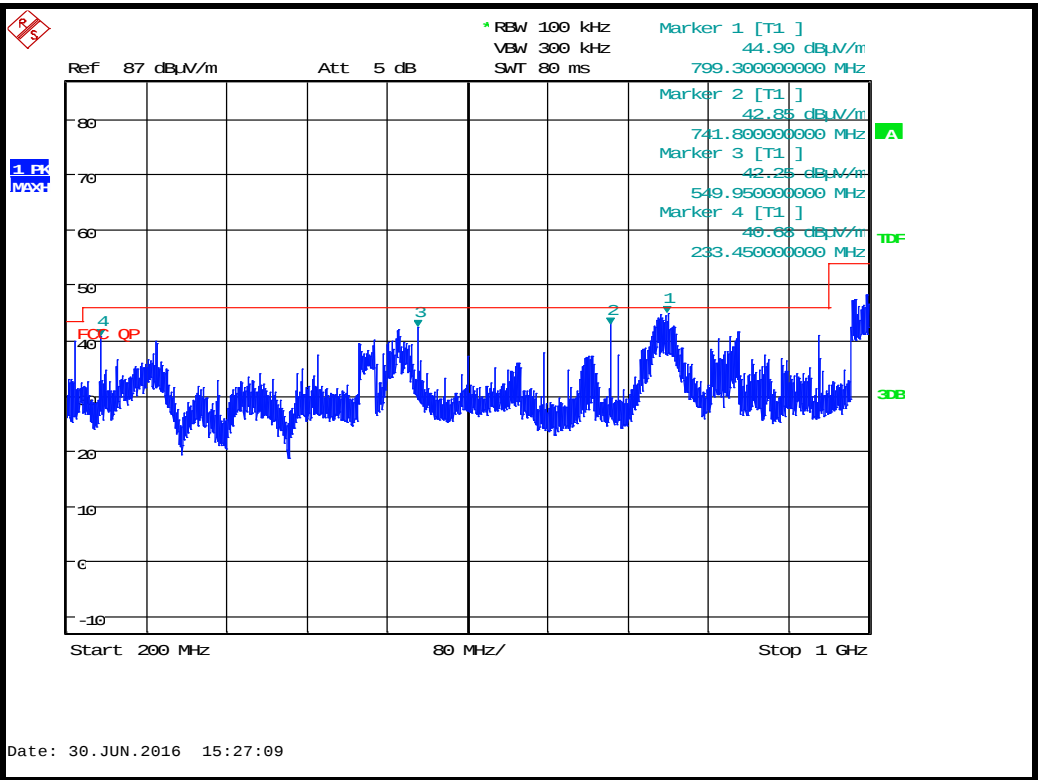


8PSK Tx 2442 MHz : 18 GHz to 25 GHz

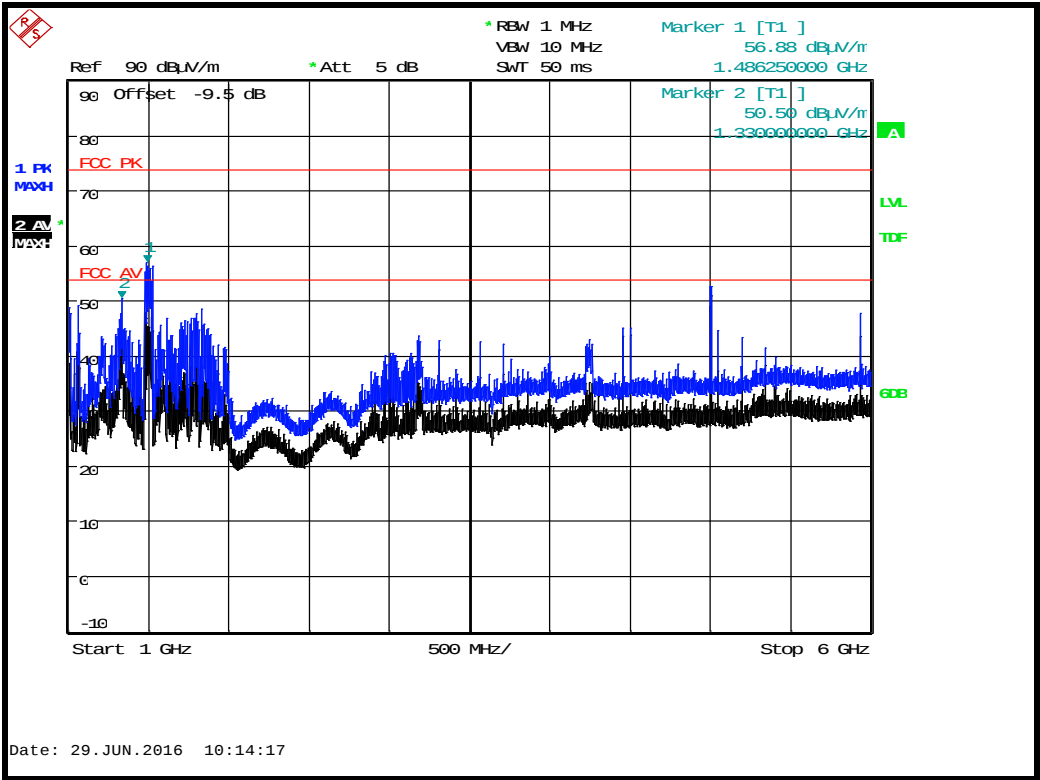
Frequency: 2480 MHz ; Modulation: 8PSK										
Detector	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
No Significant Emissions Within 10 dB of the limit										



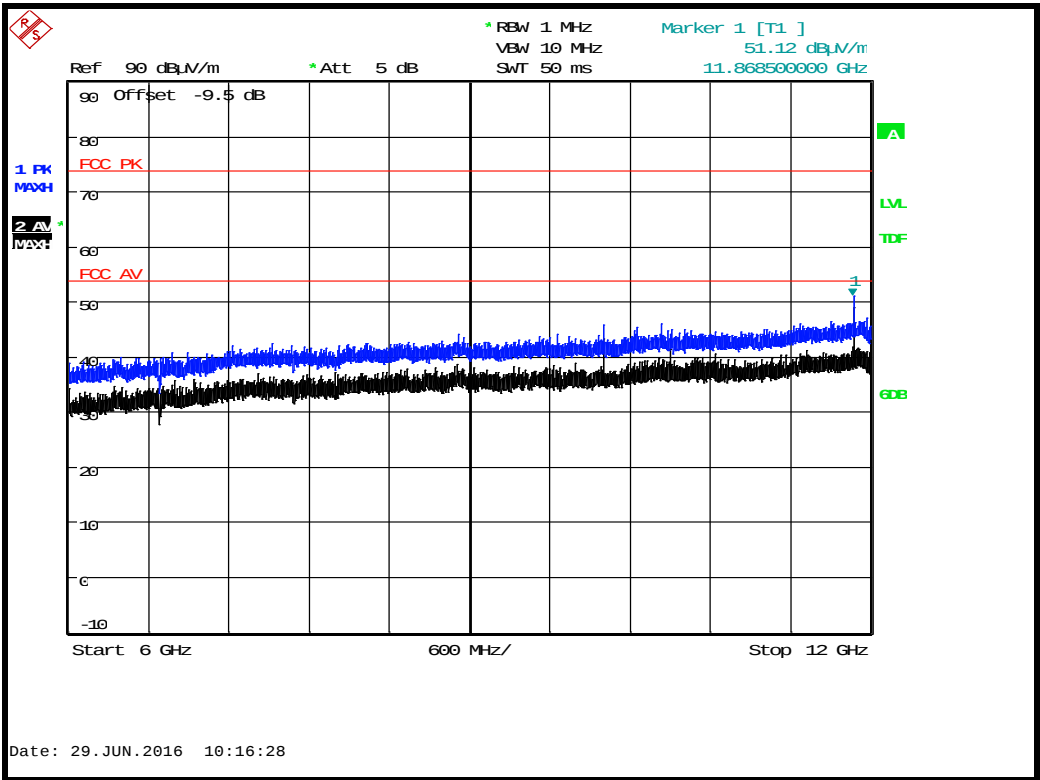
8PSK Tx 2480 MHz : 30 MHz to 200 MHz



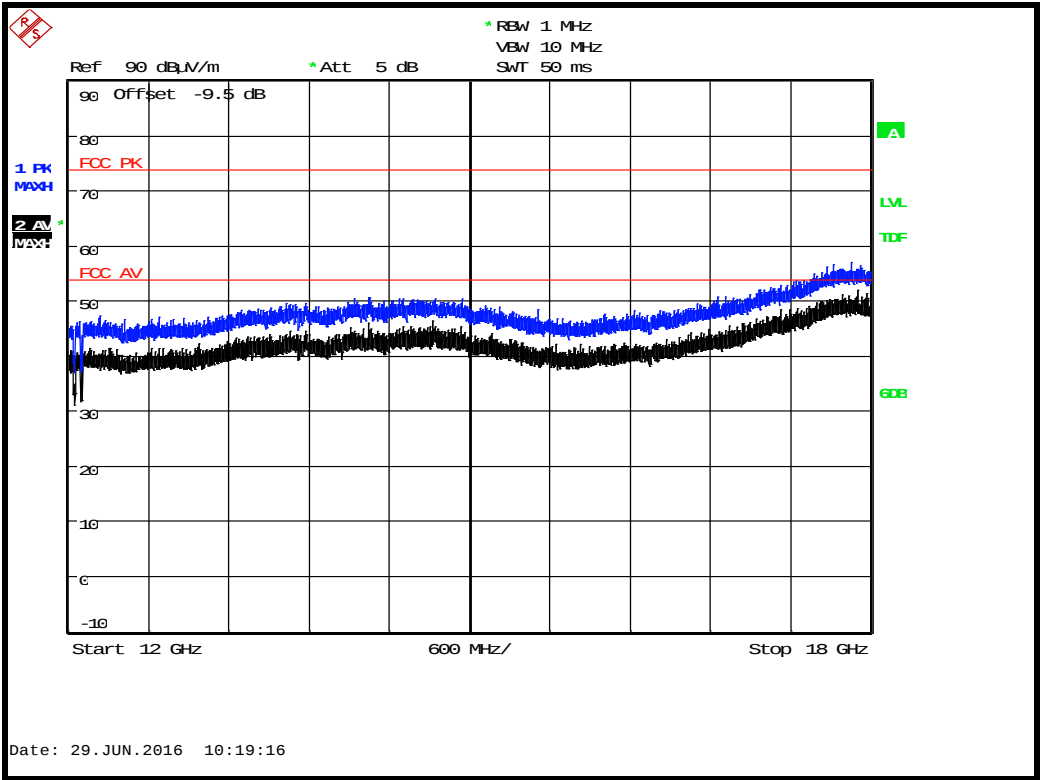
8PSK Tx 2480 MHz : 200 MHz to 1000 MHz



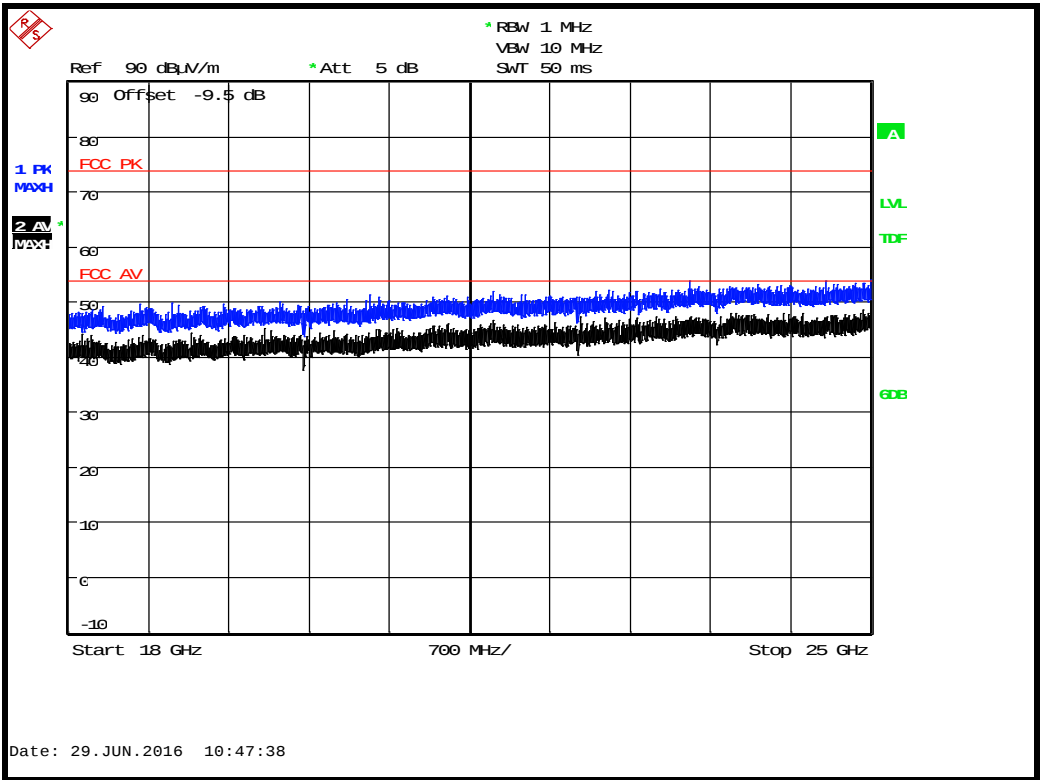
8PSK Tx 2480 MHz : 1 GHz to 6 GHz



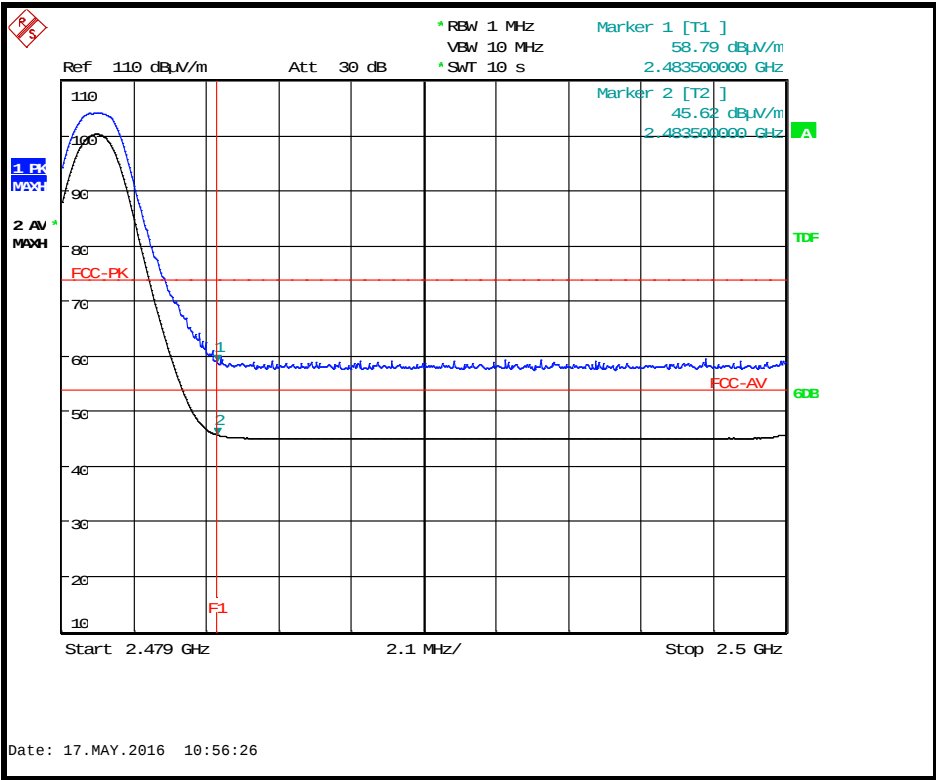
8PSK Tx 2480 MHz : 6 GHz to 12 GHz



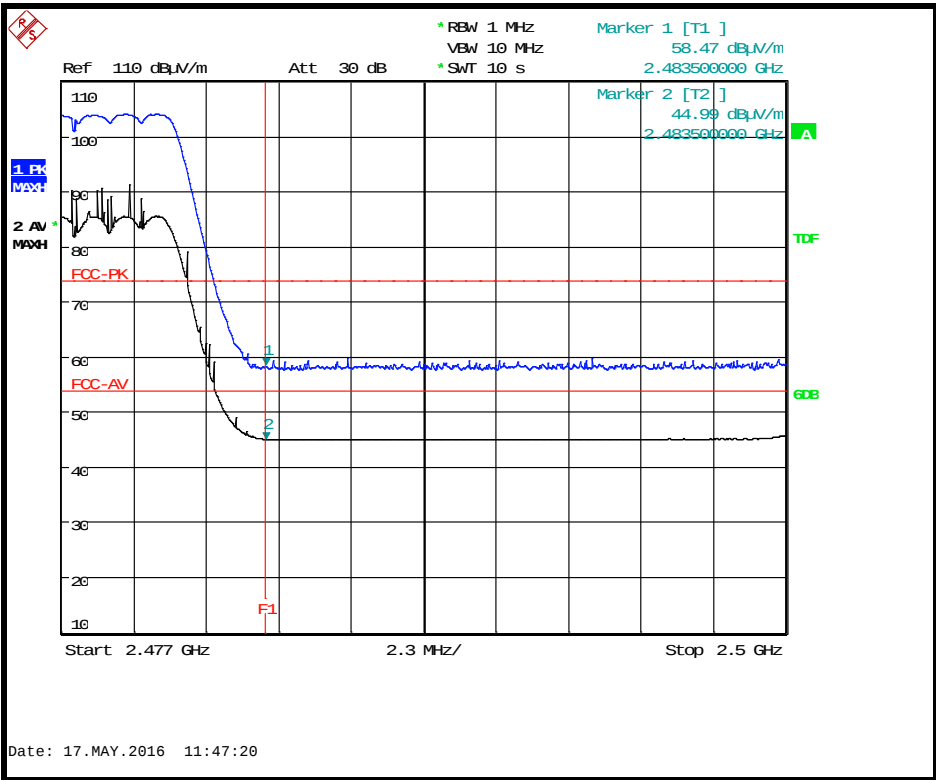
8PSK Tx 2480 MHz : 12 GHz to 18 GHz



8PSK Tx 2480 MHz : 18 GHz to 25 GHz



8PSK Tx 2480 MHz : Bandedge Compliance : Single Channel



8PSK Tx 2480 MHz : Bandedge Compliance : Hopping

12 Carrier frequency separation

12.1 Definition

The carrier frequency separation is the frequency separation between two adjacent hopping frequencies.

12.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab4
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.2
EUT Channels / Frequencies Measured:	All; 2405 to 2480 MHz
EUT 20dB Bandwidth:	GFSK 937.5 kHz; QPSK 1389 kHz; 8PSK 1379 kHz
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	30 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 36 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	

12.3 Test Limit

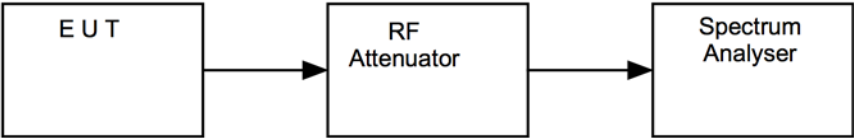
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400 to 2483.5 MHz may have hopping channel carrier frequencies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

12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, the emissions of the EUT were measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each nominal bandwidth.

Figure iii Test Setup

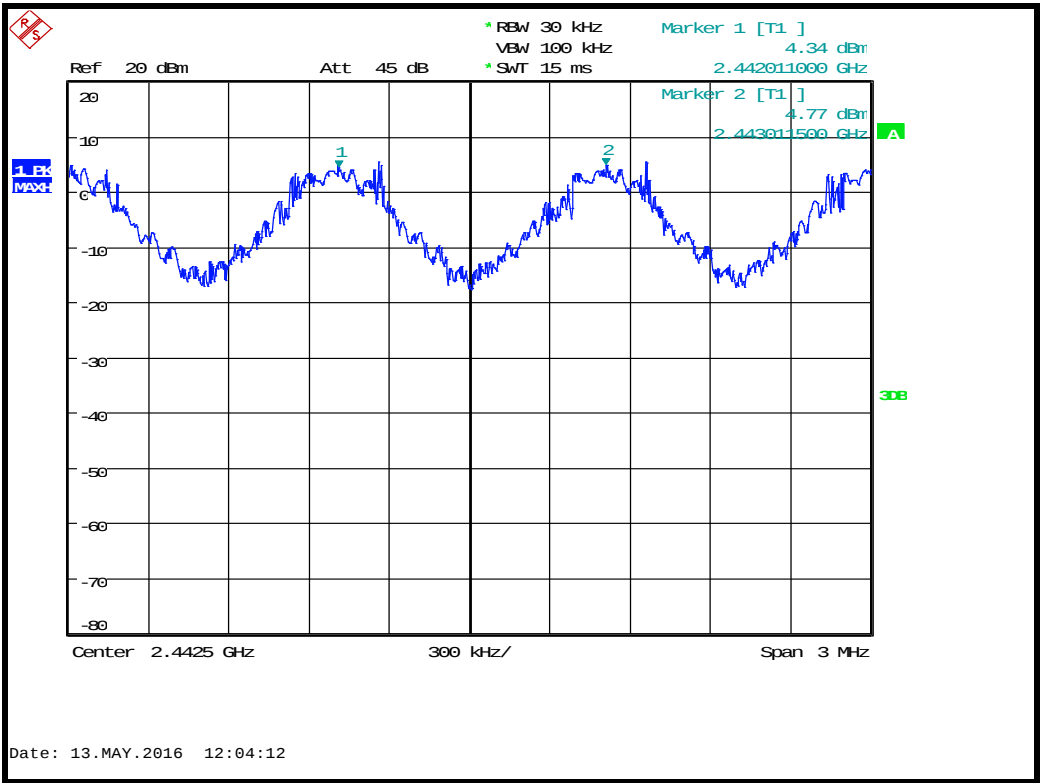


12.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	U405	02/06/2017

12.6 Test Results

Data Rate	F1 _c (MHz)	F2 _c (MHz)	Channel Separation, F2 _c – F1 _c (kHz)	Result
GFSK	2442.0110	2443.0115	1.005	PASS



13 Number of hopping frequencies

13.1 Definition

The total number of hopping frequencies (the centre frequencies defined within the hopping sequence of a FHSS equipment) which are randomly sequenced in order to spread the transmission.

13.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab4
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.3
EUT Channels / Frequencies Measured:	All; 2402 – 2480 MHz
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	1.0 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 36 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 Vac	

13.3 Test Limit

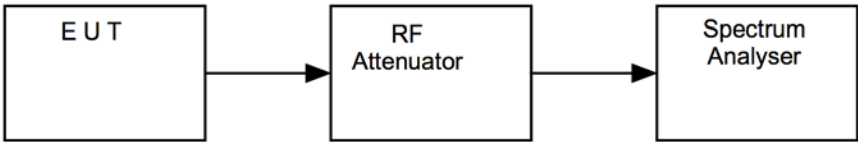
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels;
If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels;
- Frequency hopping systems operating in the band 2400 to 2483.5 MHz shall use at least 15 hopping channels;
- Frequency hopping systems operating in the band 5725 to 5850 MHz shall use at least 75 hopping channels.

13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the emissions of the EUT were measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each nominal bandwidth.

Figure iv Test Setup

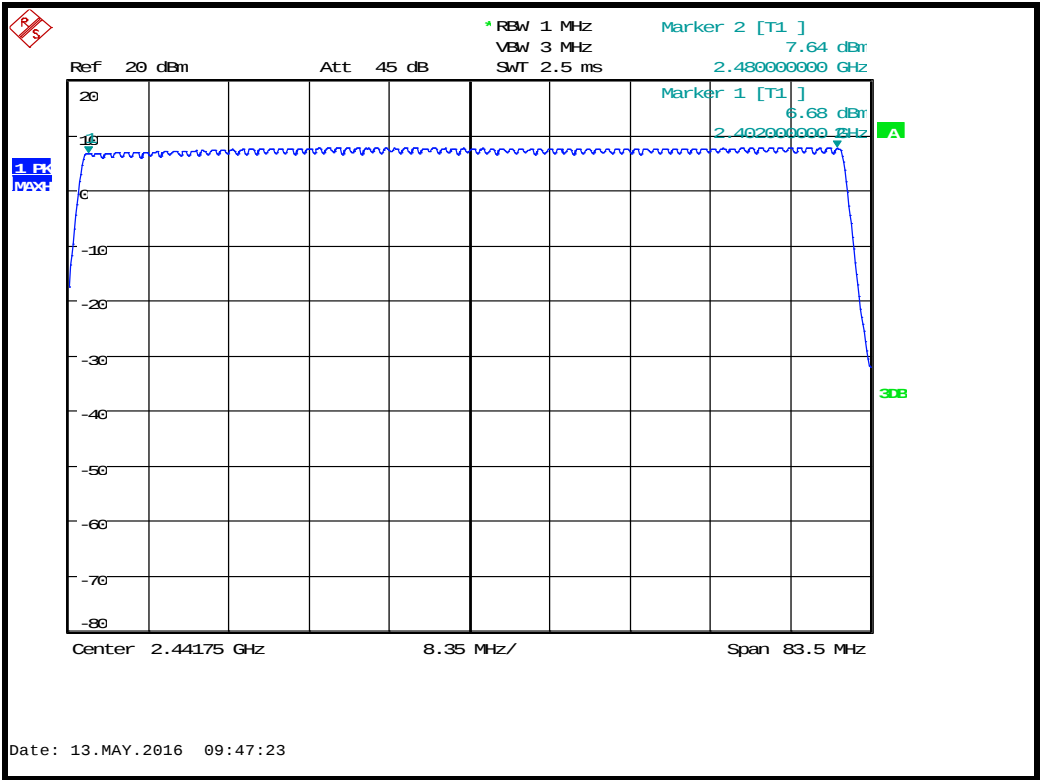


13.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	U405	02/06/2017

13.6 Test Results

Lowest channel, F_{CL} (MHz)	Highest channel, F_{CH} (MHz)	Number of channels observed	Result
2402	2480	79	PASS



14 Average channel occupancy

14.1 Definition

The channel occupancy is the total of the transmitter 'on' times, during an observation period, on a particular hopping frequency.

14.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab 4
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.4
EUT Channels / Frequencies Measured:	Mid
EUT 20dB bandwidth:	1389.423077 kHz
EUT Number of hopping channels:	79
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	1 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 36 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	

14.3 Test Limit

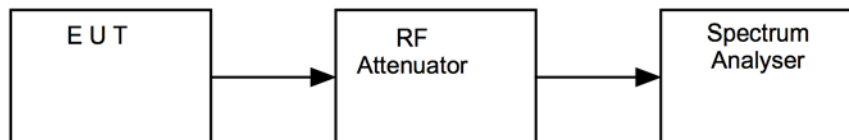
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20 second period; If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10 second period;
- Frequency hopping systems operating in the band 2400 to 2483.5 MHz: 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;
- Frequency hopping systems operating in the band 5725 to 5850 MHz: The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the emissions of the EUT were measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. A number of hops were observed to confirm consistency of the dwell time / observe the worst case. All modulation schemes, data rates and power settings were used to observe the worst-case configuration.

Figure v Test Setup



14.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	U405	02/06/2017

14.6 Test Results

Modulation: QPSK ; Power setting: .Full					
Data Rate	Individual occupancy time (us)	Observation period (s)	Number of hops observed	Average time of occupancy (s)	Result
2 Mb/s	175.96	31.6	129	0.02269	PASS

15 Maximum peak conducted output power

15.1 Definition

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the signal bandwidth.

15.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab4
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.5
EUT Channels / Frequencies Measured:	Low / Mid / High – hopping disabled.
EUT Channel Bandwidths:	1 MHz
Deviations From Standard:	None
Measurement BW:	N/A (power meter used)
Spectrum Analyzer Video BW:	N/A (power meter used)
Measurement Detector:	Peak
Voltage Extreme Environment Test Range:	Mains Power = 85 % and 115 % of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 34 % RH	20 % RH to 75 % RH (as declared)

15.3 Test Limit

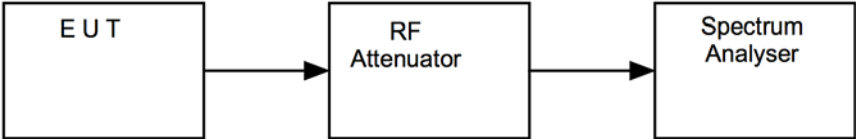
- For frequency hopping systems operating in the band 902 to 928 MHz, the maximum peak conducted output power shall not exceed 1 W, and the e.i.r.p. shall not exceed 4 W, if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W, and the e.i.r.p. shall not exceed 1 W, if the hopset uses less than 50 hopping channels.
- For frequency hopping systems operating in the band 2400 to 2483.5 MHz and employing at least 75 hopping channels, the power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W. The e.i.r.p. shall not exceed 4 W.
- For frequency hopping systems operating in the band 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W.
- Point-to-point systems in the bands 2400-2483.5 MHz and 5725 to 5850 MHz are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers.

15.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vi, the resolution bandwidth of the spectrum analyser was increased above the EUT occupied bandwidth and the peak emission data noted.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure vi Test Setup



15.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
RPR3006W	Dare	Power Meter	REF2112	22/03/2017

15.6 Test Results

Modulation: BT GFSK; Data rate: 1 Mb/s; Power setting: Power table index 0						
Channel Frequency (MHz)	Analyzer Level (dBm)	Cable loss (dB)	Maximum peak conducted output power (mW)	Antenna gain (dBi)	E.I.R.P. (W)	Result
2402	6.9	0	4.90	4.4	0.0135	PASS
2442	7.3	0	5.37	4.9	0.0166	PASS
2480	7.0	0	5.01	4.5	0.0141	PASS

Modulation: QPSK; Data rate: 2 Mb/s; Power setting: Power table index 0						
Channel Frequency (MHz)	Analyzer Level (dBm)	Cable loss (dB)	Maximum peak conducted output power (mW)	Antenna gain (dBi)	E.I.R.P. (W)	Result
2402	4.3	0	2.69	4.4	0.0074	PASS
2442	4.7	0	2.95	4.9	0.0091	PASS
2480	4.2	0	2.63	4.5	0.0074	PASS

Modulation: 8PSK; Data rate: 3 Mb/s; Power setting: Power table index 0						
Channel Frequency (MHz)	Analyzer Level (dBm)	Cable loss (dB)	Maximum peak conducted output power (mW)	Antenna gain (dBi)	E.I.R.P. (W)	Result
2402	4.4	0	2.75	4.4	0.0076	PASS
2442	4.7	0	2.95	4.9	0.0091	PASS
2480	4.2	0	2.63	4.5	0.0074	PASS

16 Occupied Bandwidth

16.1 Definition

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal.

16.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab 4
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Channels / Frequencies Measured:	Low / Mid / High – hopping stopped.
EUT Channel Bandwidths:	1 MHz
EUT Test Modulations:	GFSK, QPSK and PSK
Deviations From Standard:	None
Measurement BW: (requirement: 1 % to 5 % OBW)	10 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	30 kHz
Measurement Span: (requirement 2 to 5 times OBW)	3 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 36 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	

16.3 Test Limit

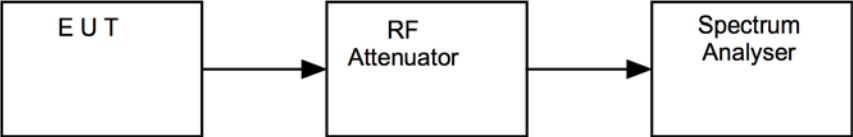
- For frequency hopping systems in the band 902 to 928 MHz: The maximum allowed -20 dB bandwidth of the hopping channel is 500 kHz.
- Frequency hopping systems operating in the band 5725 to 5850 MHz: The maximum -20 dB bandwidth of the hopping channel shall be 1 MHz

16.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vii, the bandwidth of the EUT was measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure vii Test Setup

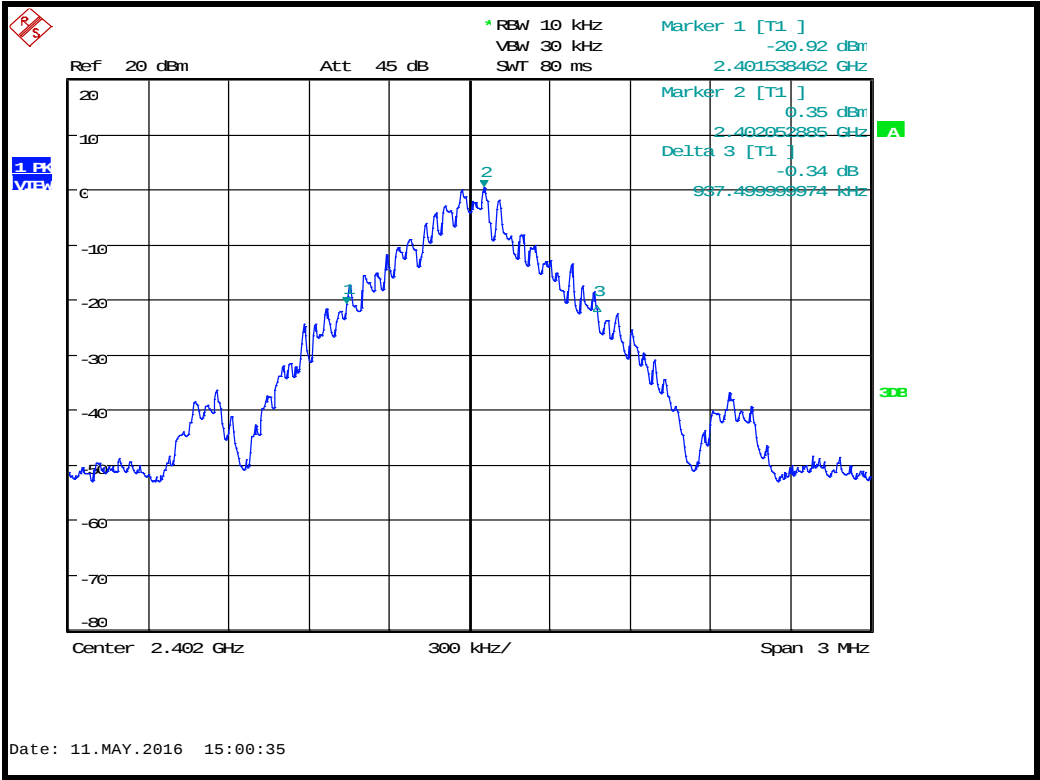


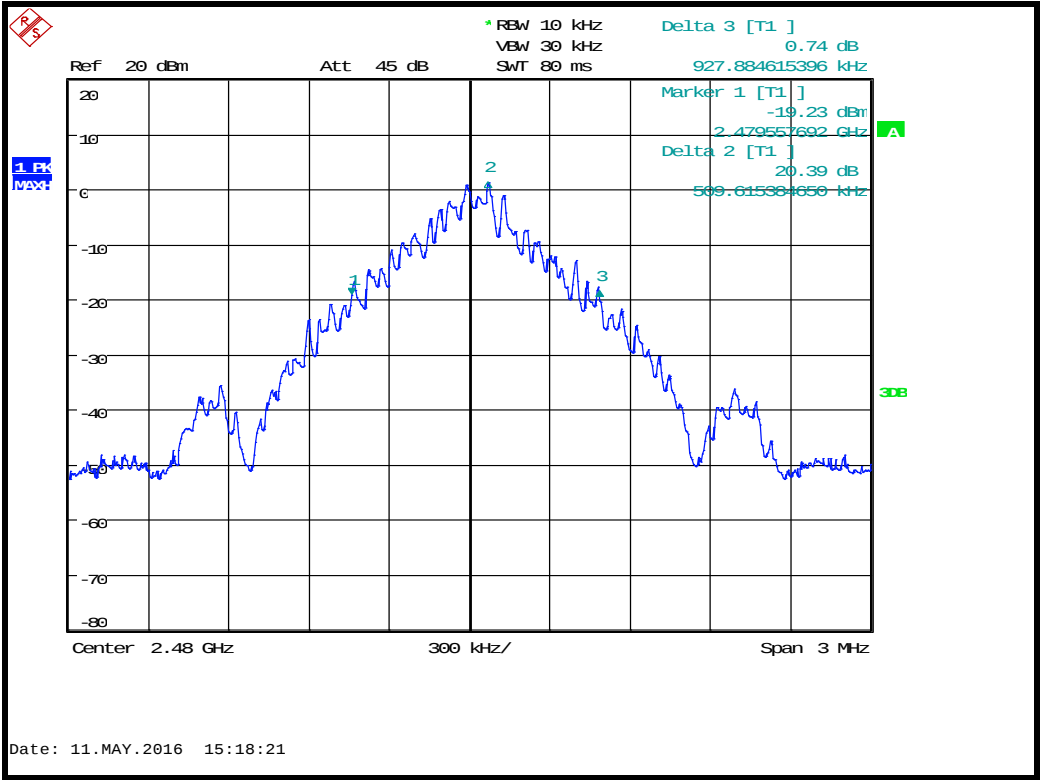
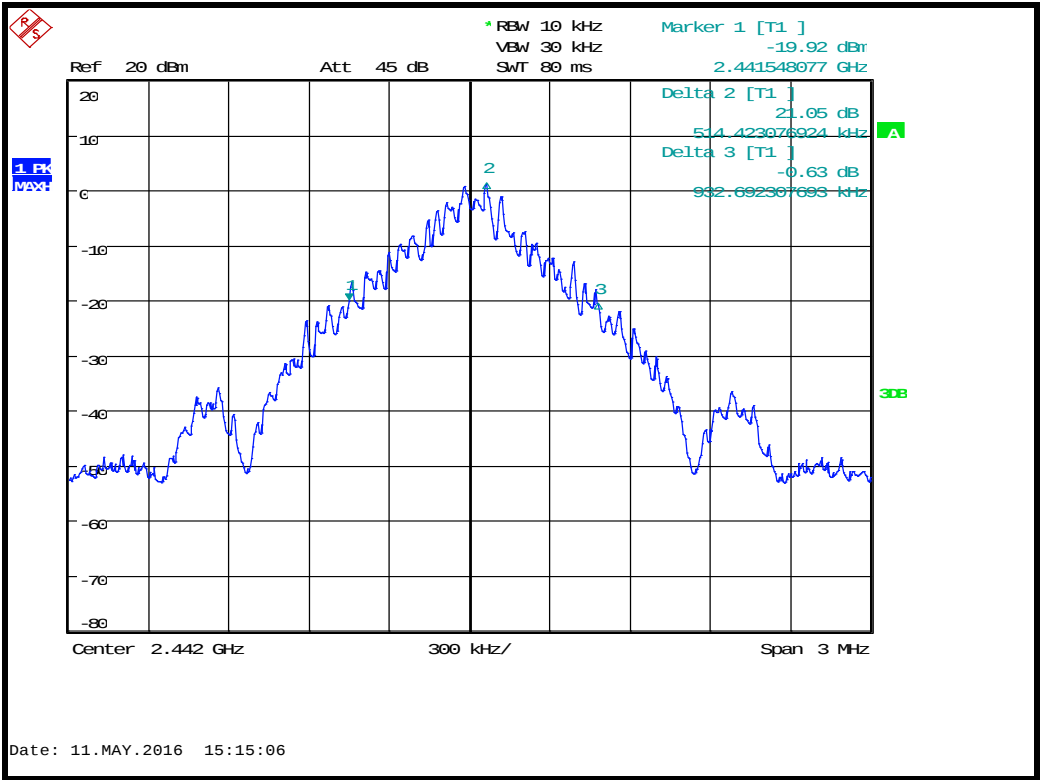
16.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	REF909	26/04/2017

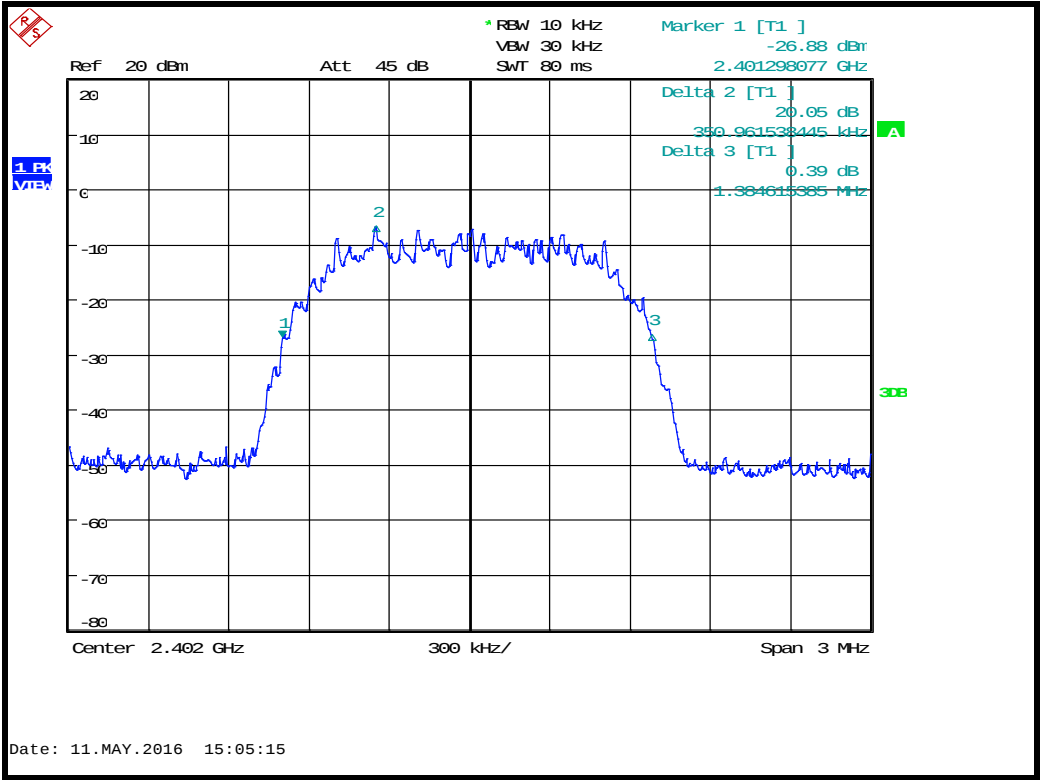
16.6 Test Results

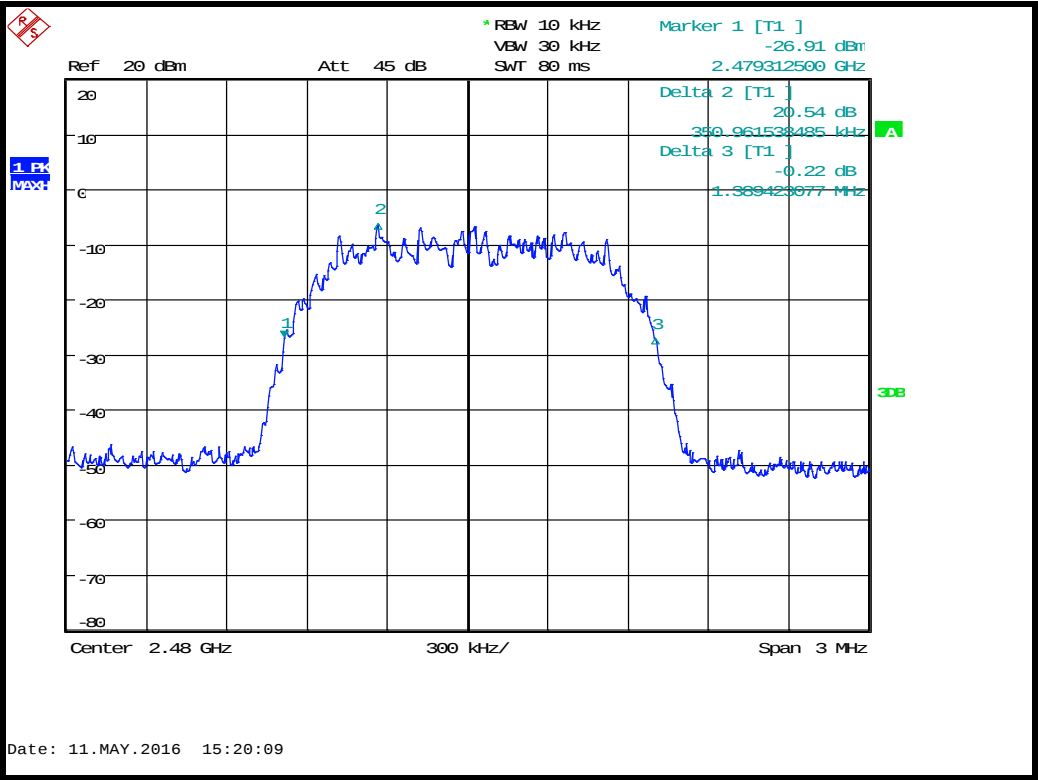
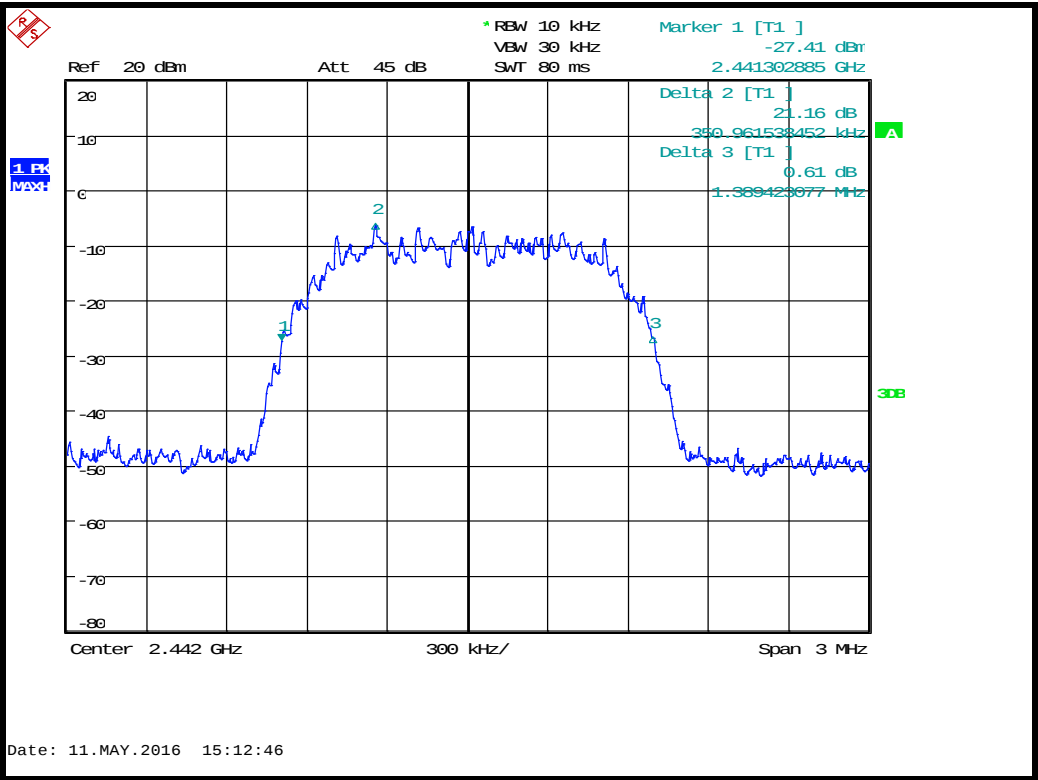
Modulation: GFSK; Data rate: 1 Mb/s; Power setting: Full				
Channel Frequency (MHz)	F _L (MHz)	F _H (MHz)	20dB Bandwidth (kHz)	Result
2402	2401.538462	2402.475962	937.499999974	PASS
2442	2441.548077	2442.480769	932.692307693	PASS
2480	2479.557692	2480.485577	927.884615396	PASS



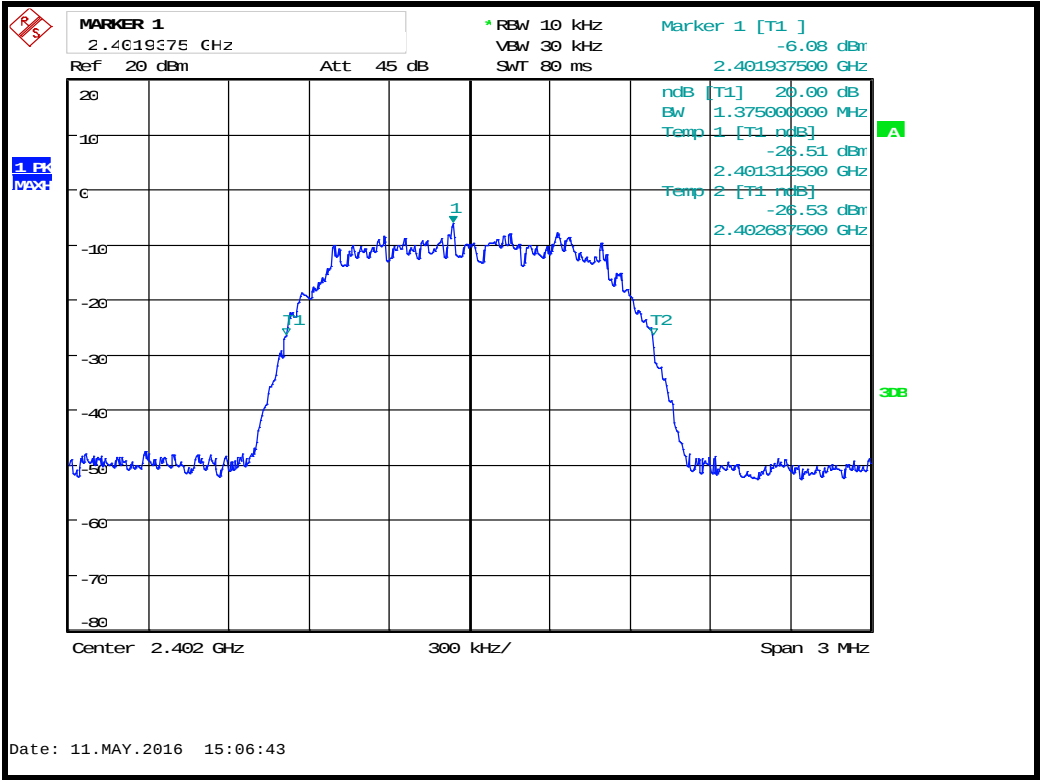


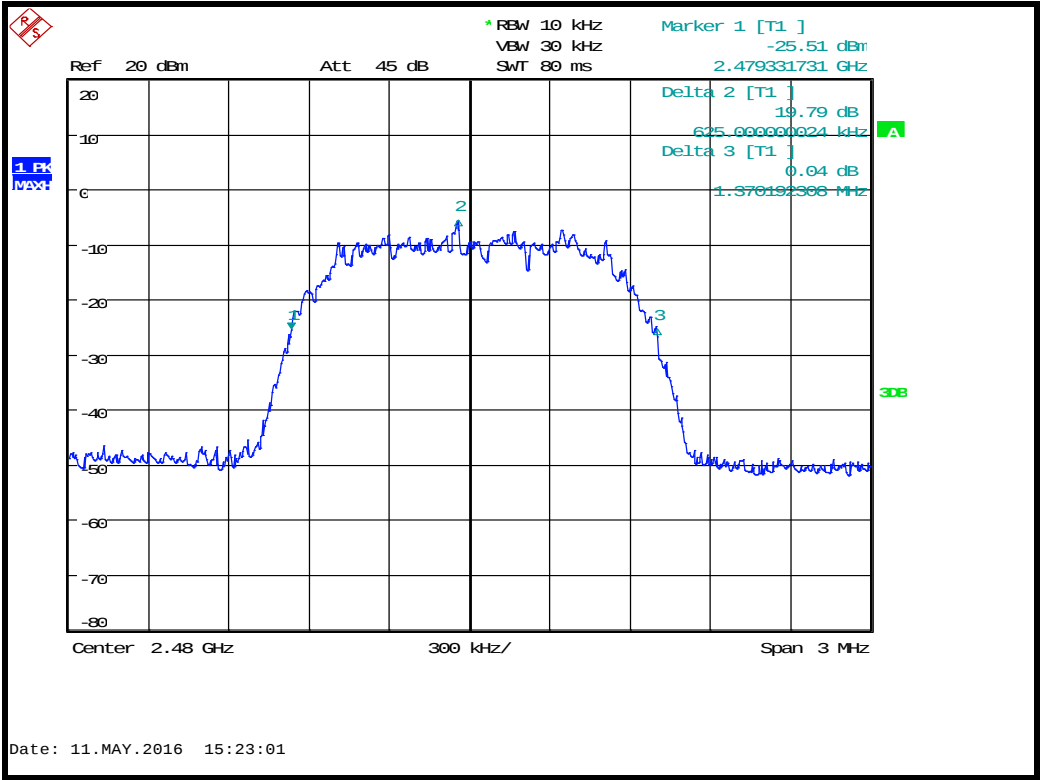
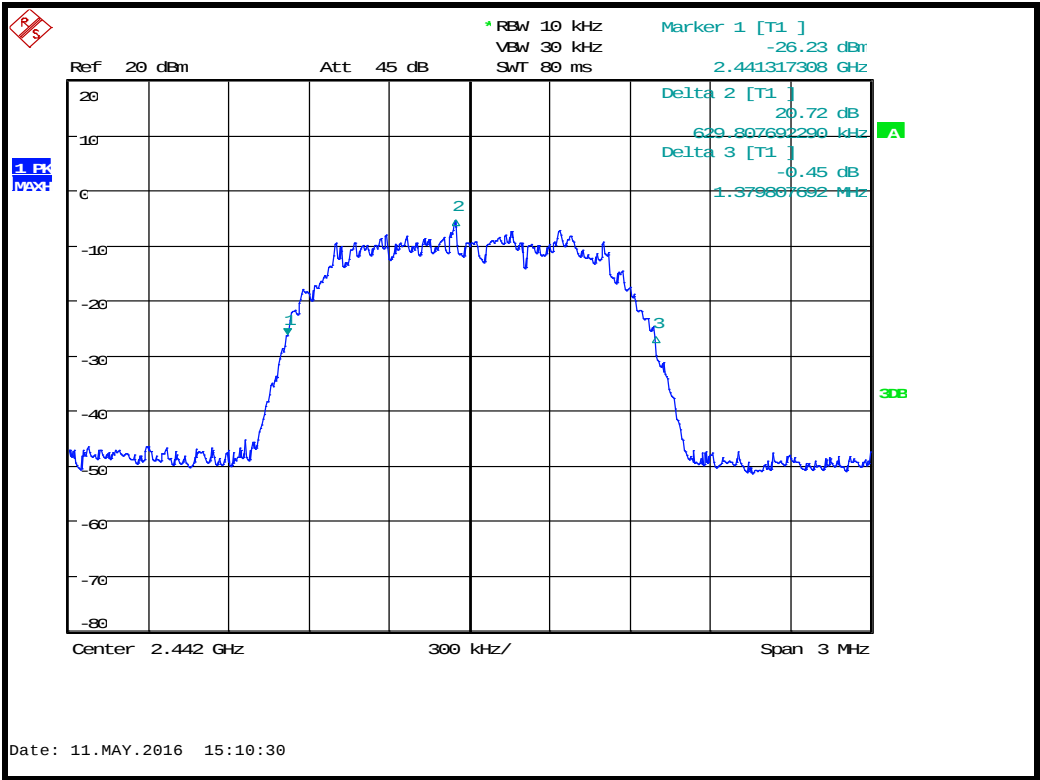
Modulation: QPSK; Data rate: 2 Mb/s; Power setting: Full				
Channel Frequency (MHz)	F _L (MHz)	F _H (MHz)	20dB Bandwidth (kHz)	Result
2402	2401.298077	2402.682692	1384.615385	PASS
2442	2441.302885	2442.692308	1389.423077	PASS
2480	2479.312500	2480.701923	1389.423077	PASS





Modulation: 8PSK; Data rate: 3 Mb/s; Power setting: Full				
Channel Frequency (MHz)	F _L (MHz)	F _H (MHz)	20dB Bandwidth (kHz)	Result
2402	2401.312500	2402.687500	1375.000000	PASS
2442	2441.317308	2442.697116	1379.807692	PASS
2480	2479.331731	2480.701923	1370.192308	PASS





17 Out-of-band and conducted spurious emissions

17.1 Definition

Out-of-band emission.

Emission on a frequency or frequencies immediately outside the necessary bandwidth that results from the modulation process but excluding spurious emissions.

Spurious emission.

Emission on a frequency or frequencies that are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, but exclude out-of-band emissions.

17.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab 4
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.8
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	1 MHz
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300 kHz
Measurement Detector:	Peak
Measurement Range:	30 MHz to 26.5 GHz

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 36 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	

17.3 Test Limits

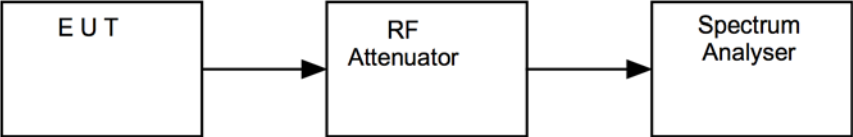
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in FCC 47CFR15.209(a) / RSS-Gen is not required.

17.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure viii, the emissions from the EUT were measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

Figure viii Test Setup

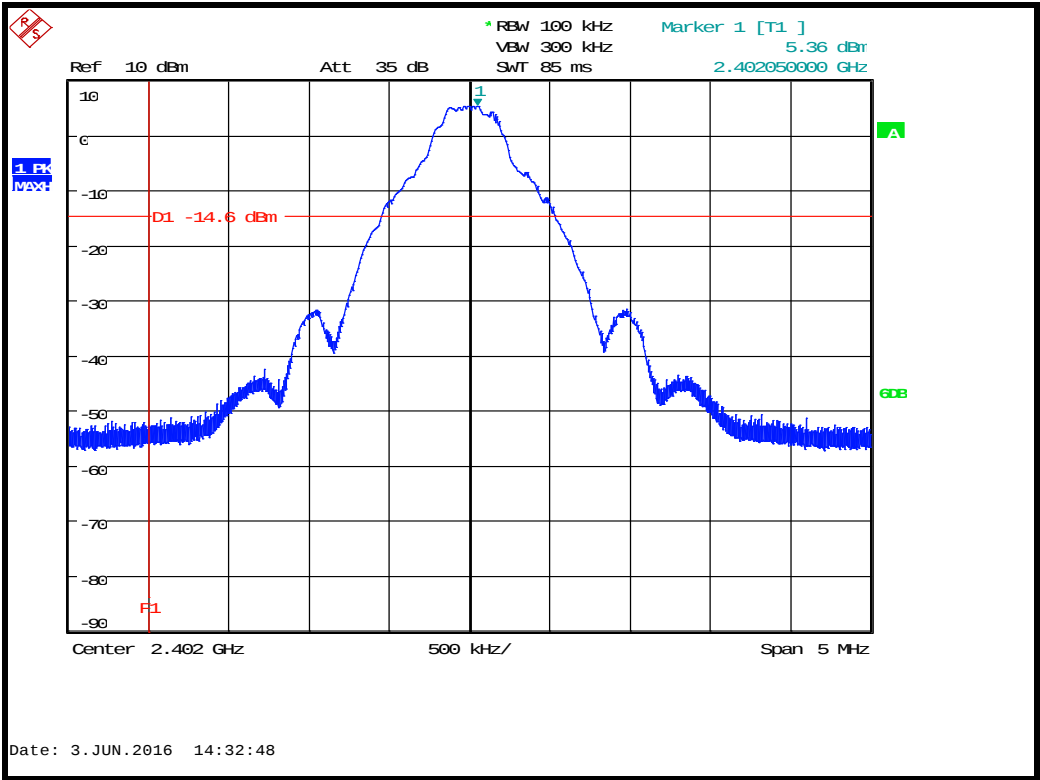


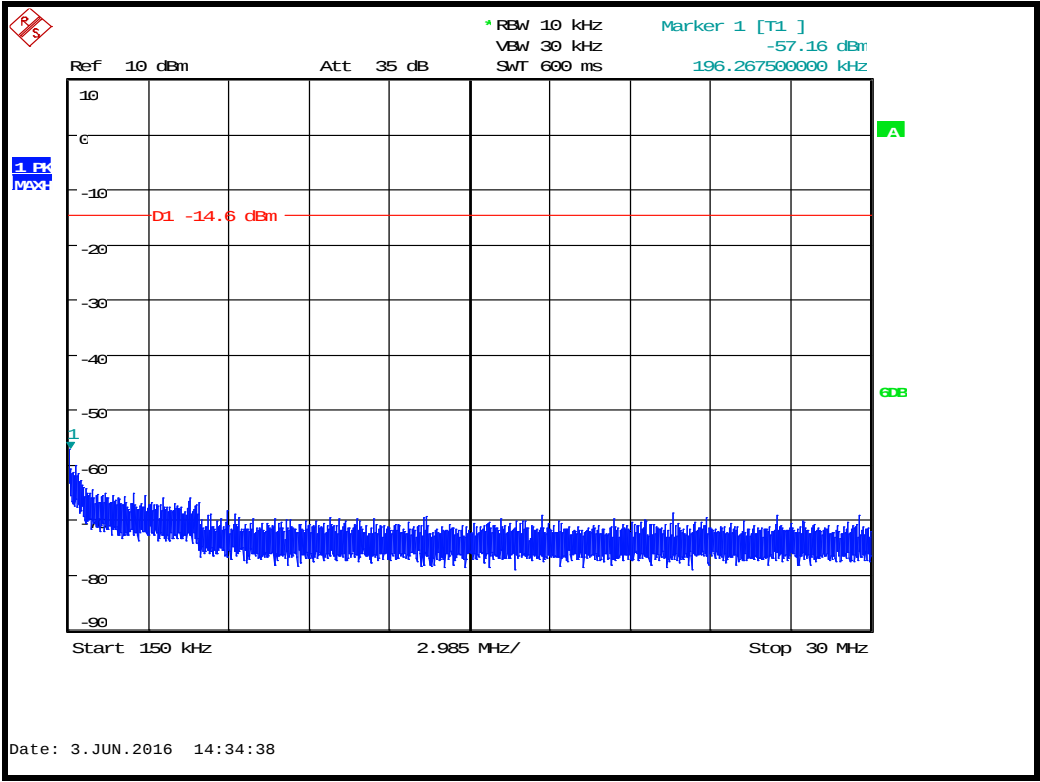
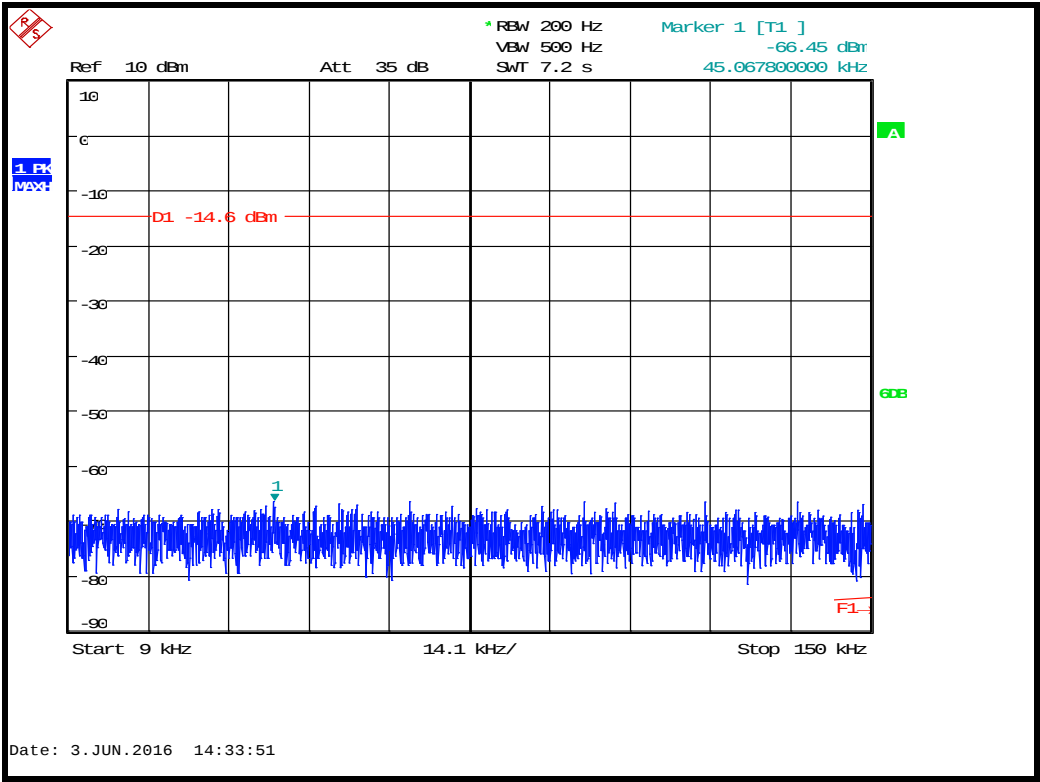
17.5 Test Equipment

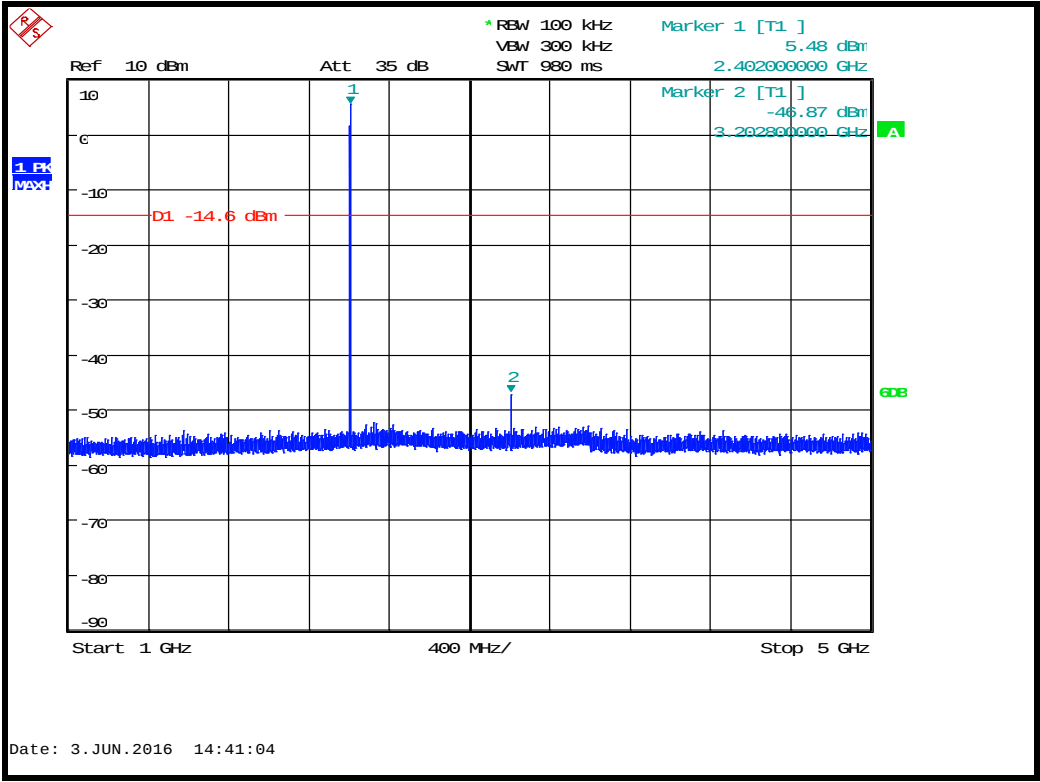
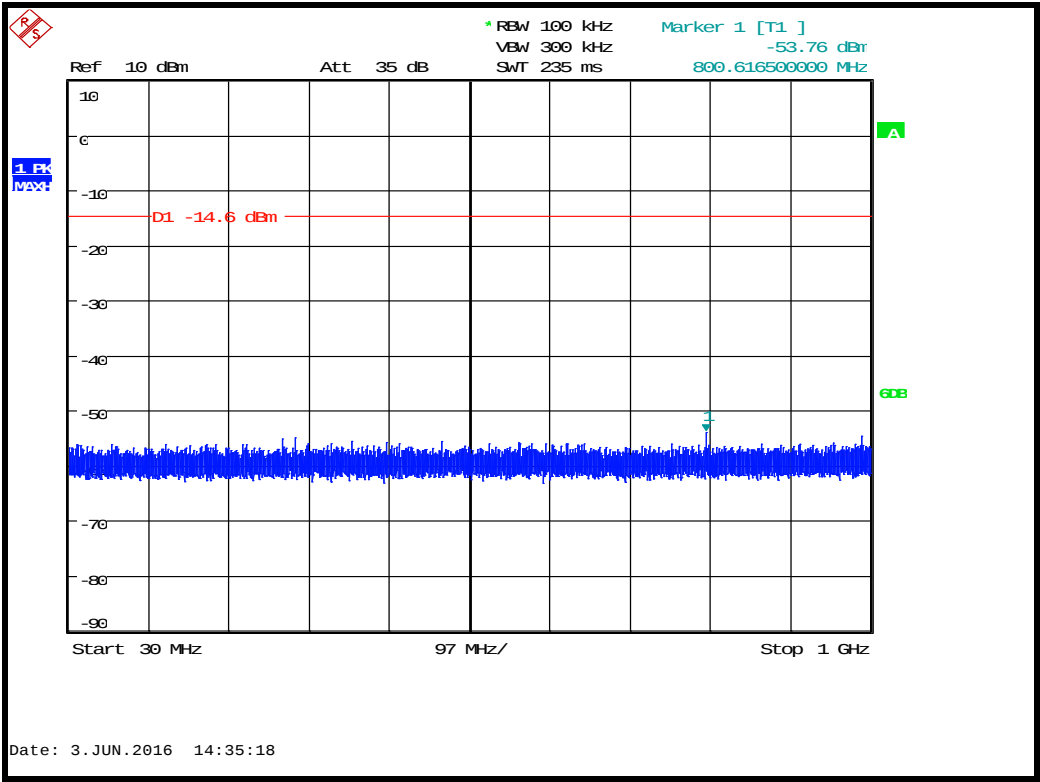
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	REF909	26/04/2017

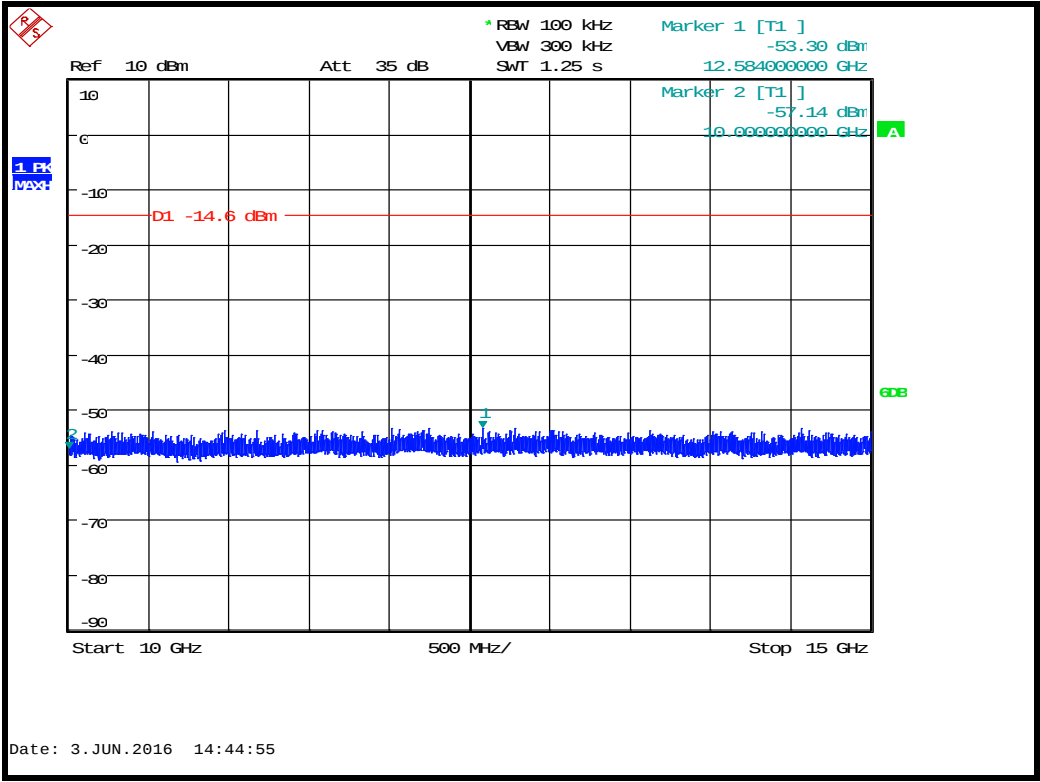
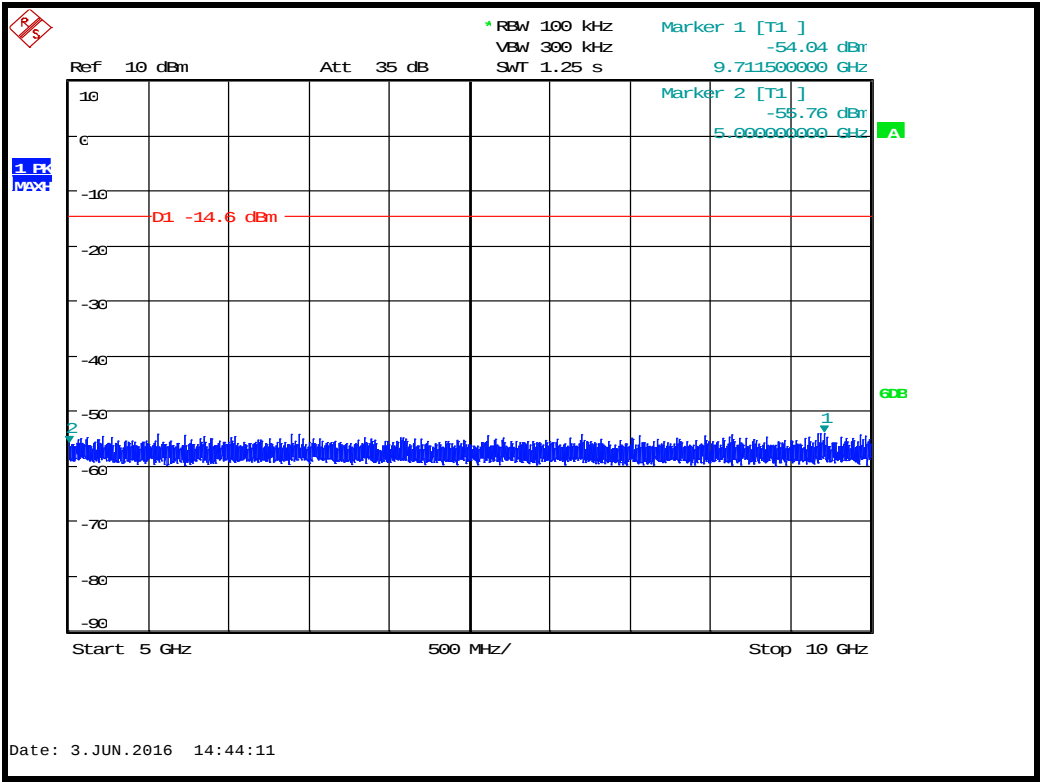
17.6 Test Results

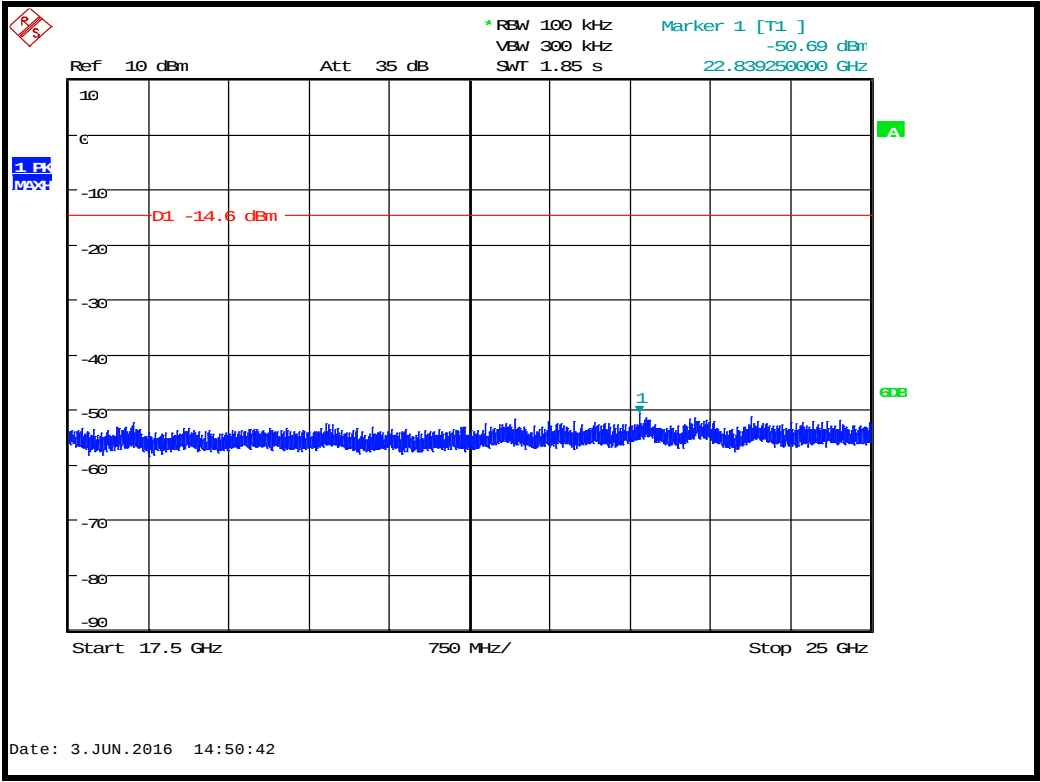
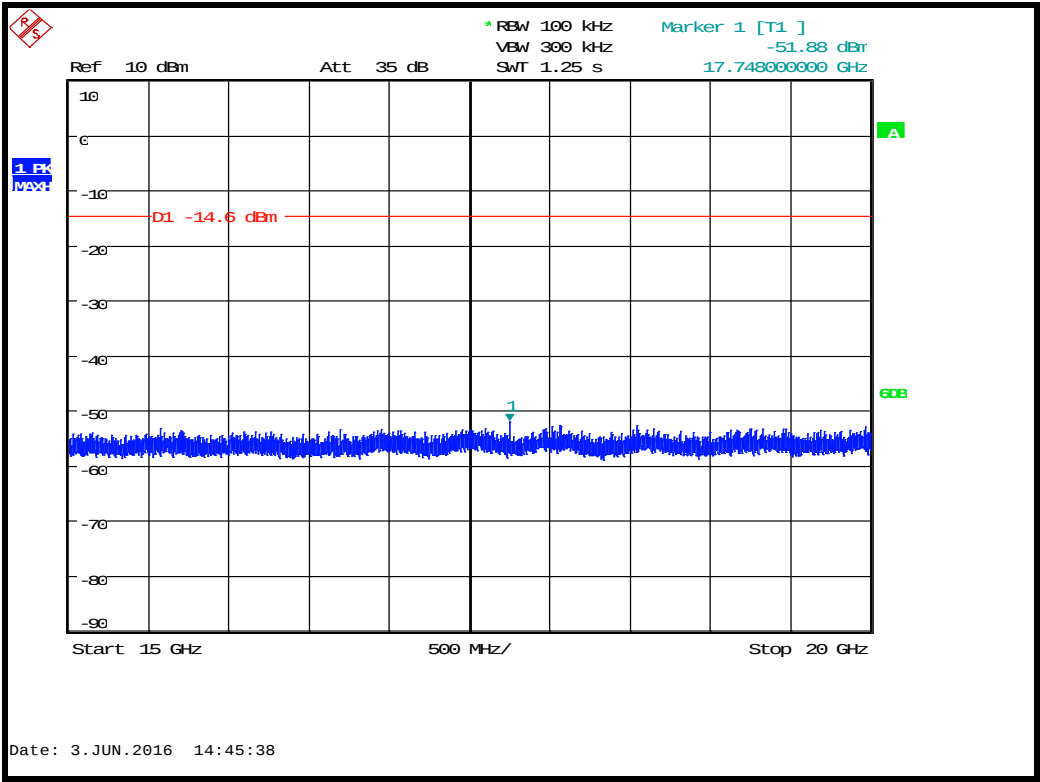
Modulation: GFSK; Data rate: 1 Mb/s; Power setting: Full						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2402	2402.050	5.36	5.36	-14.6	ref	N/A
There were no emissions detected within 20 dB of the limit.						PASS



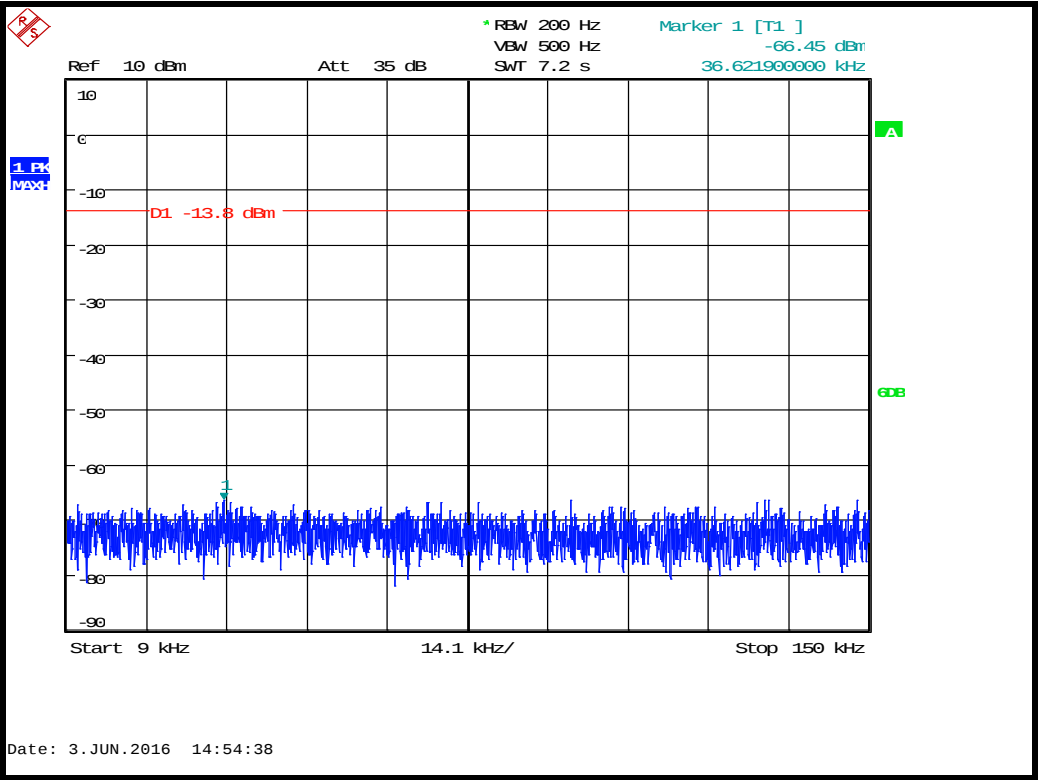
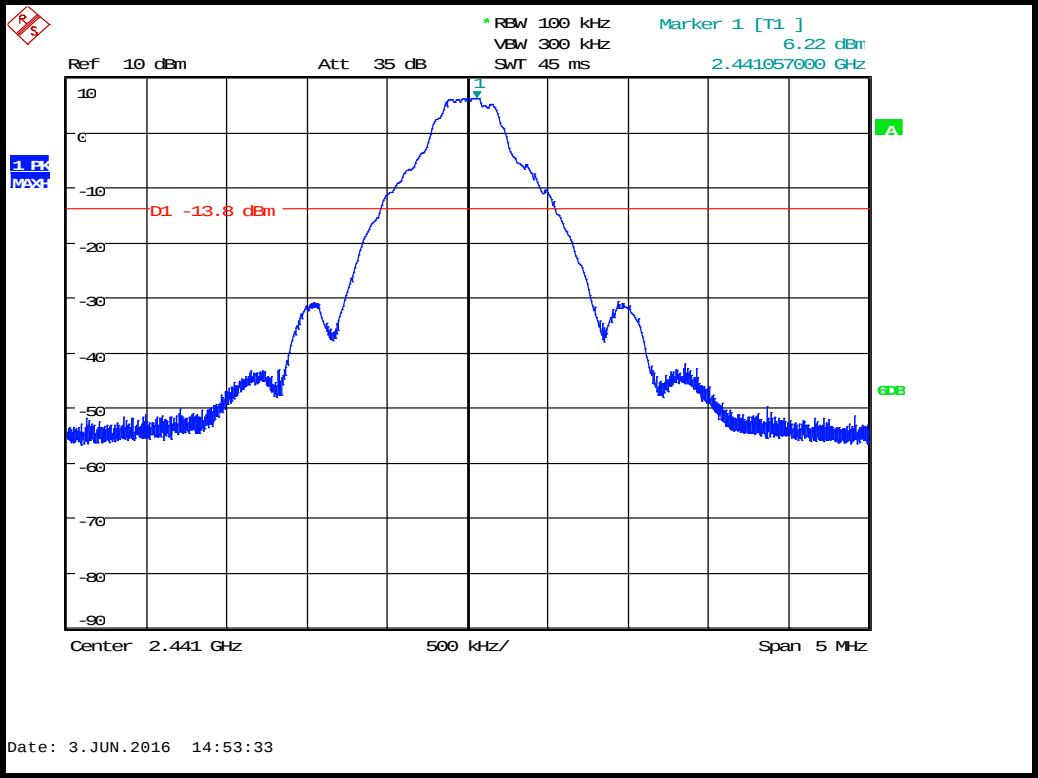


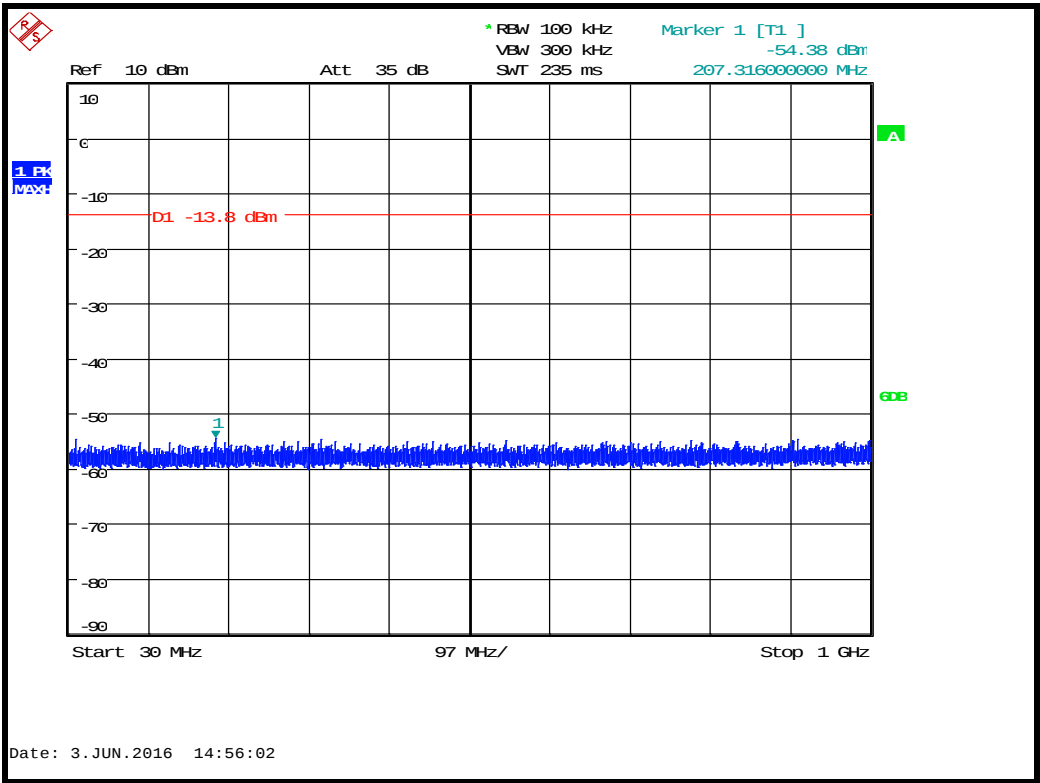
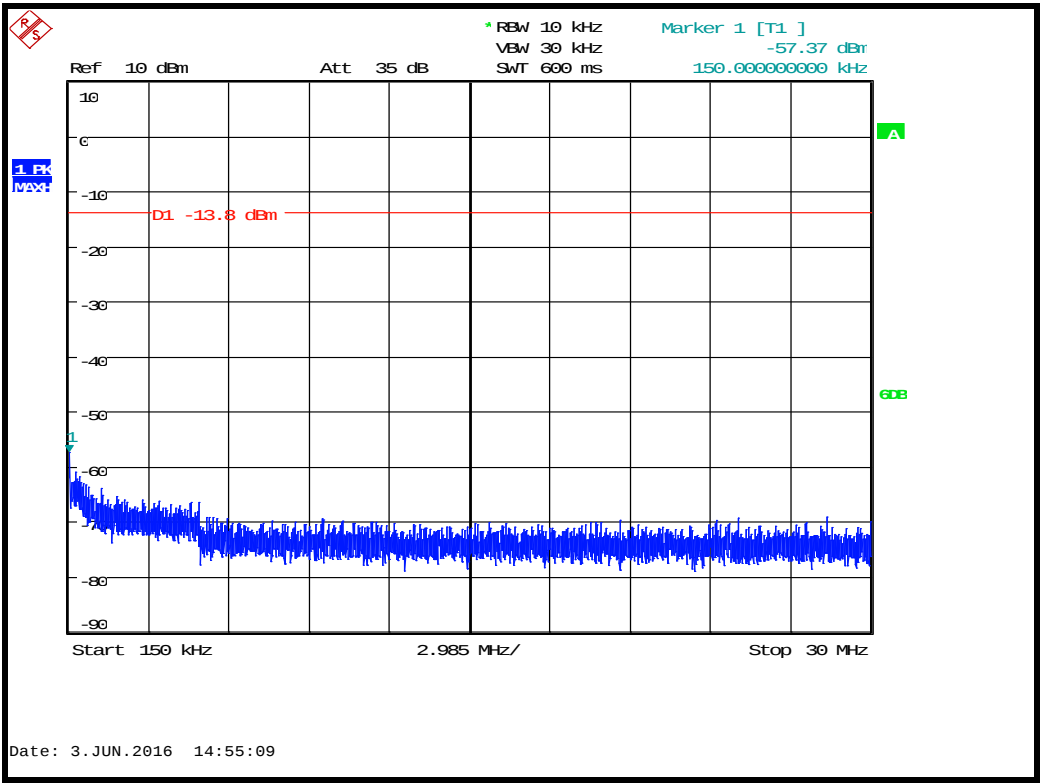


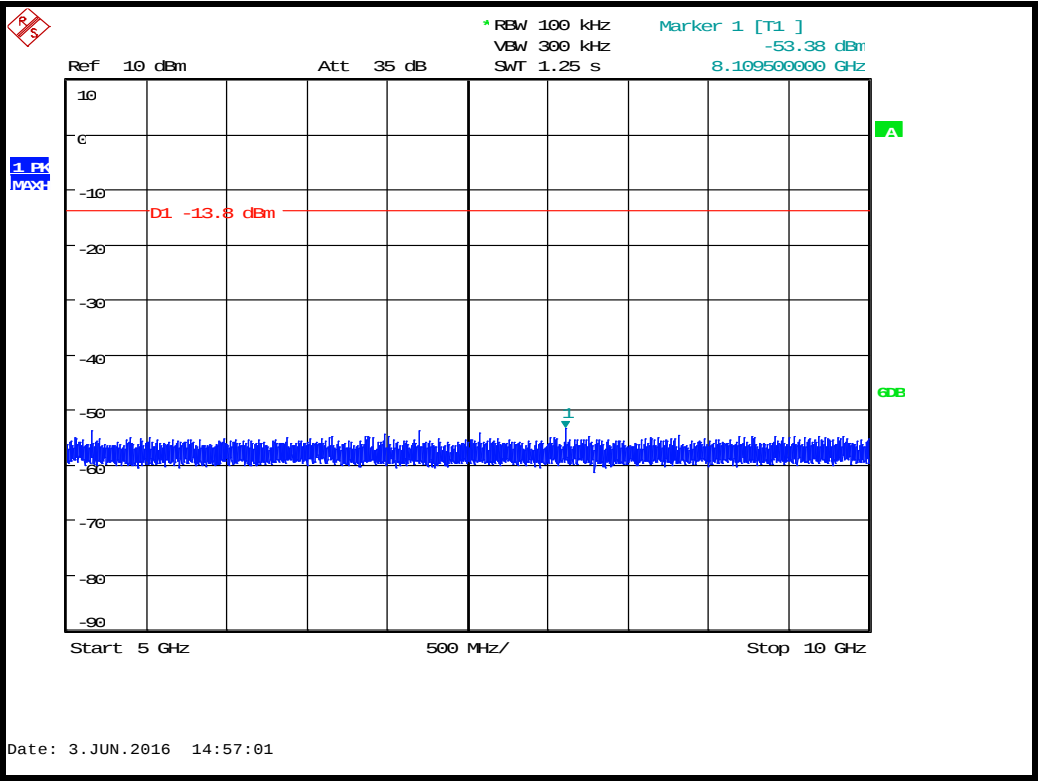
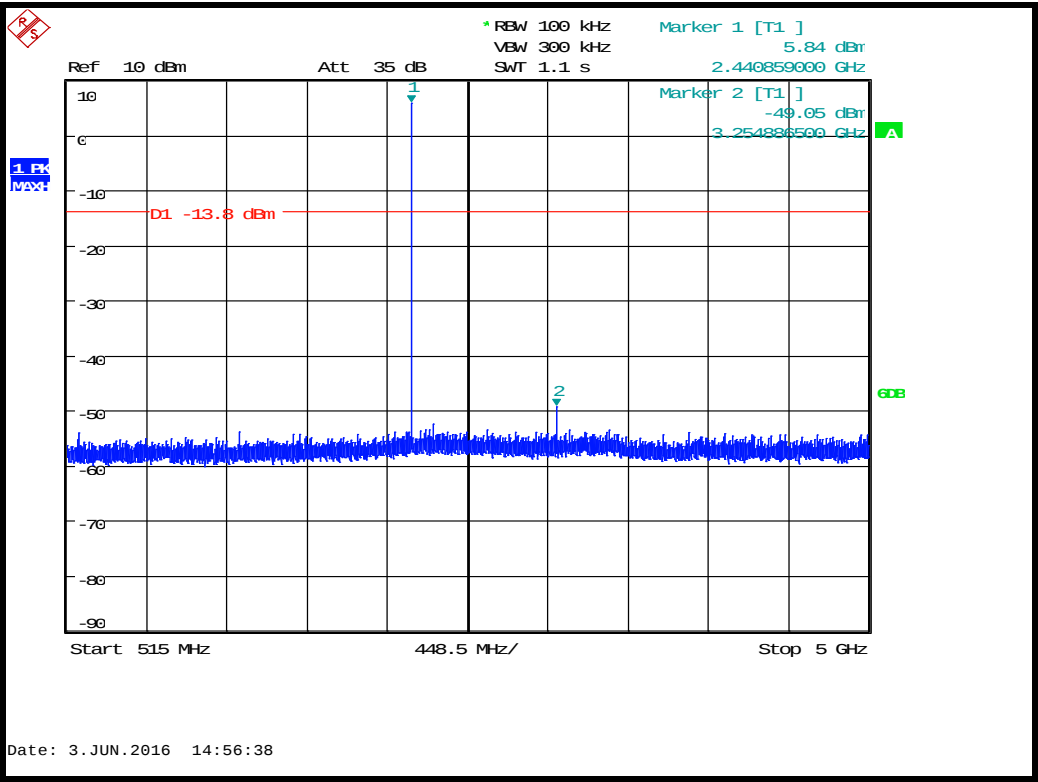


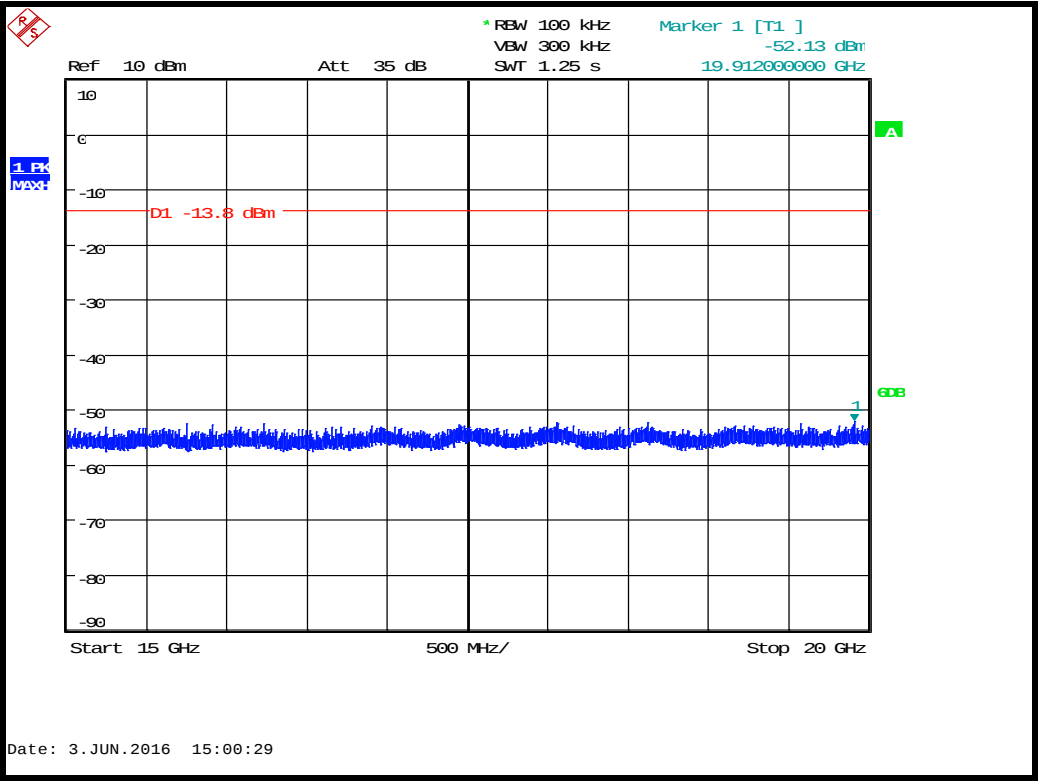
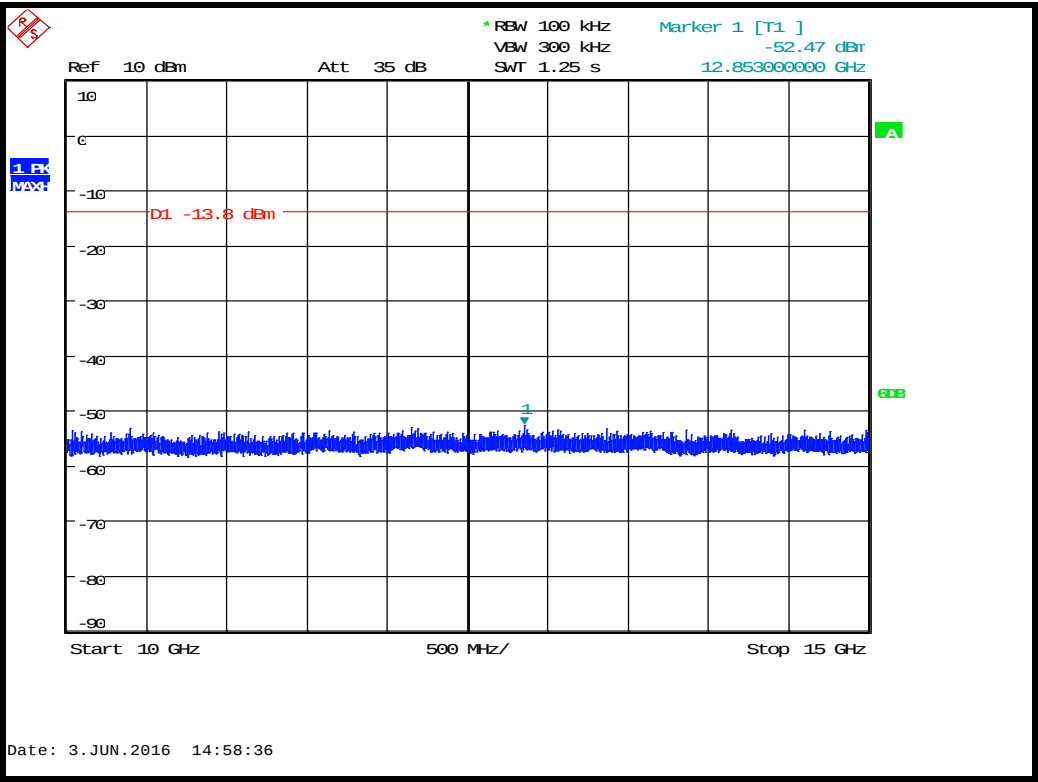


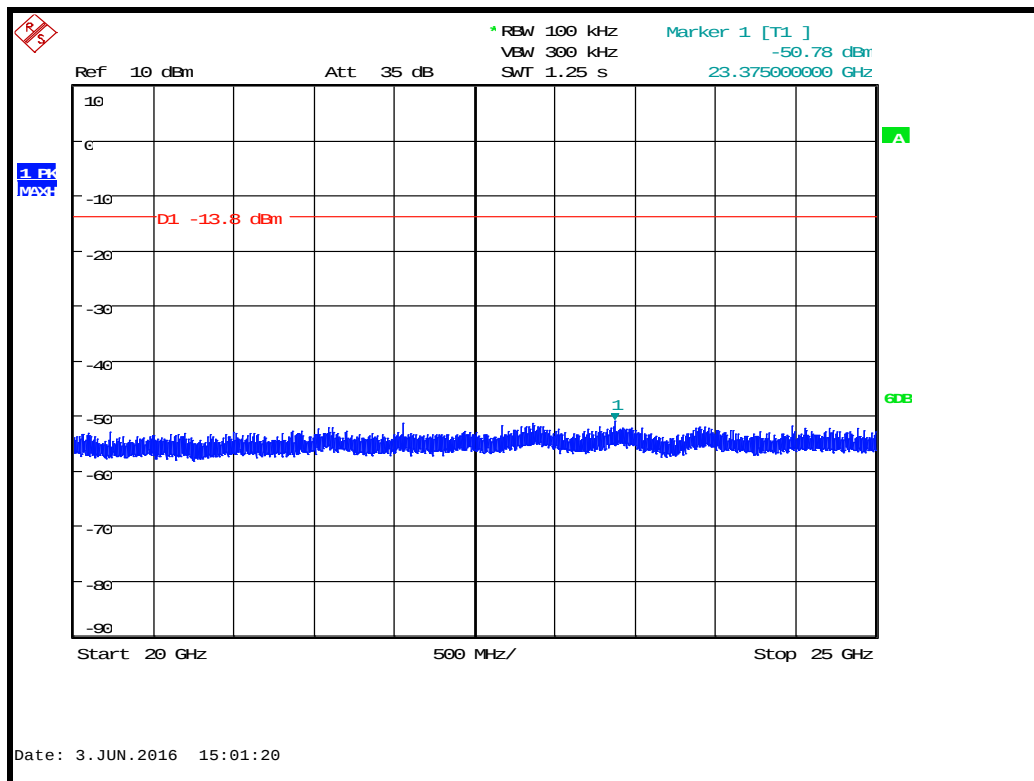
Modulation: GFSK; Data rate: 1 Mb/s; Power setting: Full						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2441	2441.057	6.22	6.22	-13.8	ref	N/A
There were no emissions detected within 20 dB of the limit.						PASS



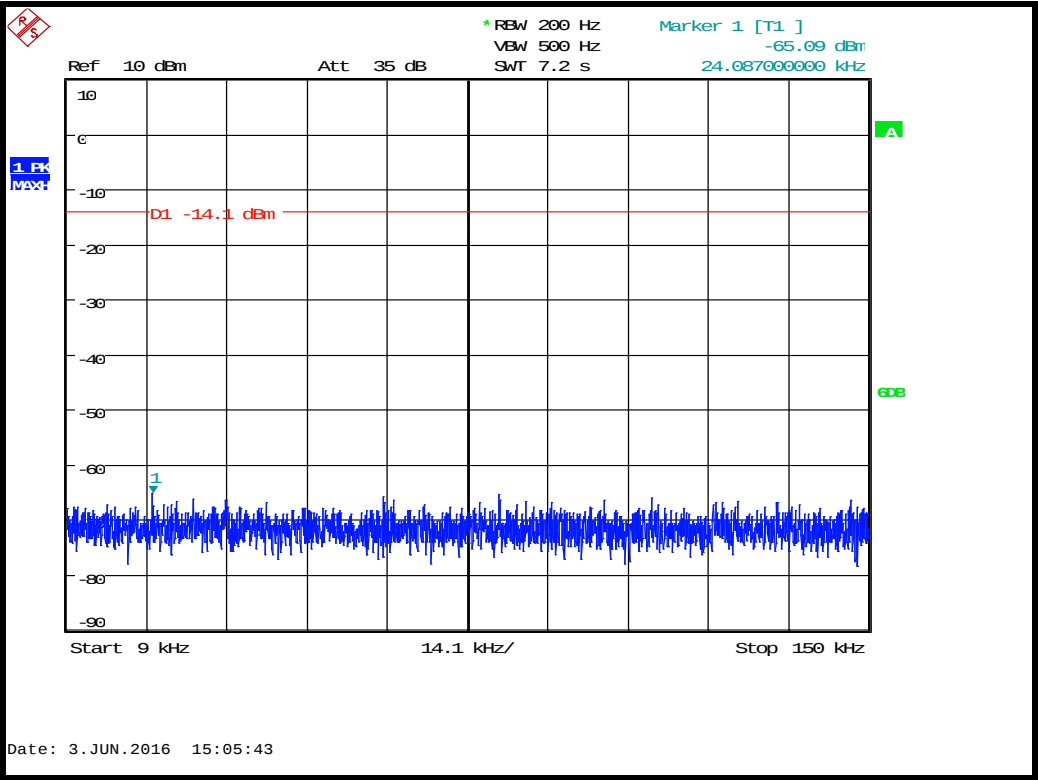
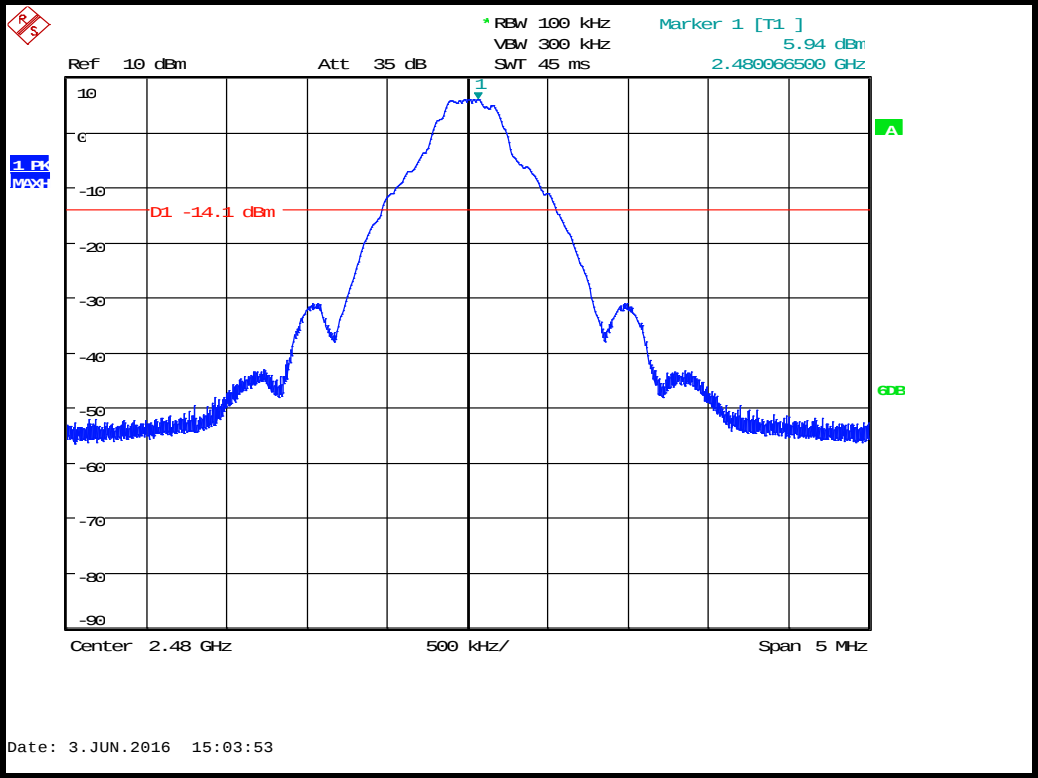


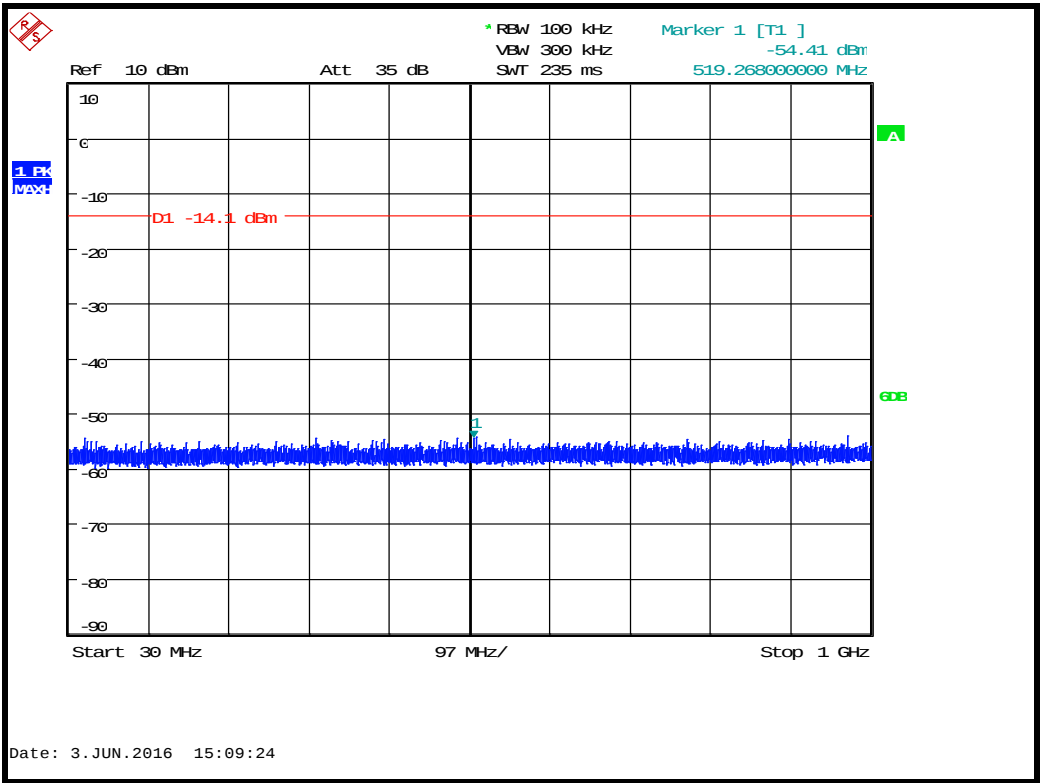
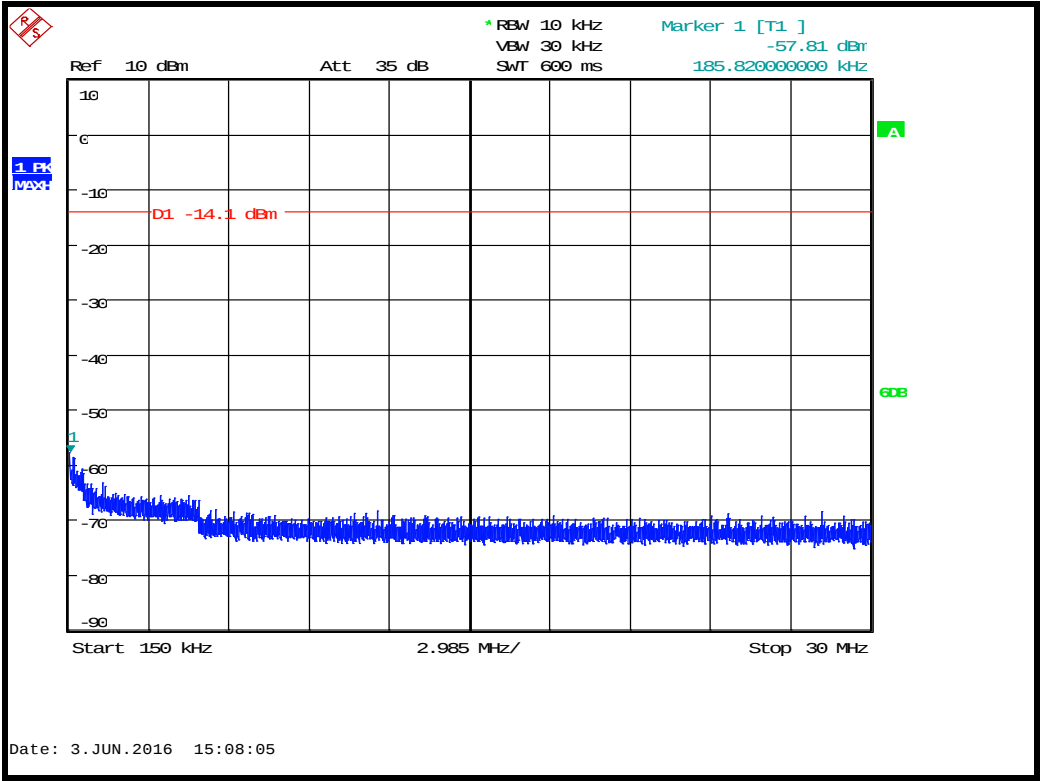


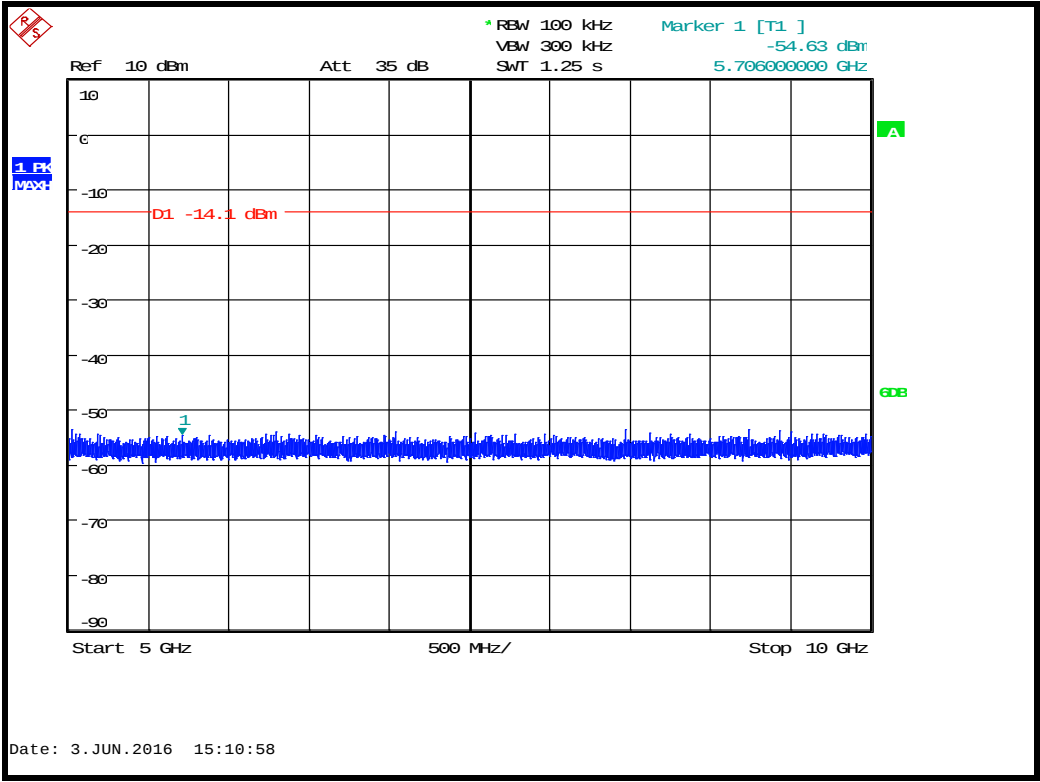
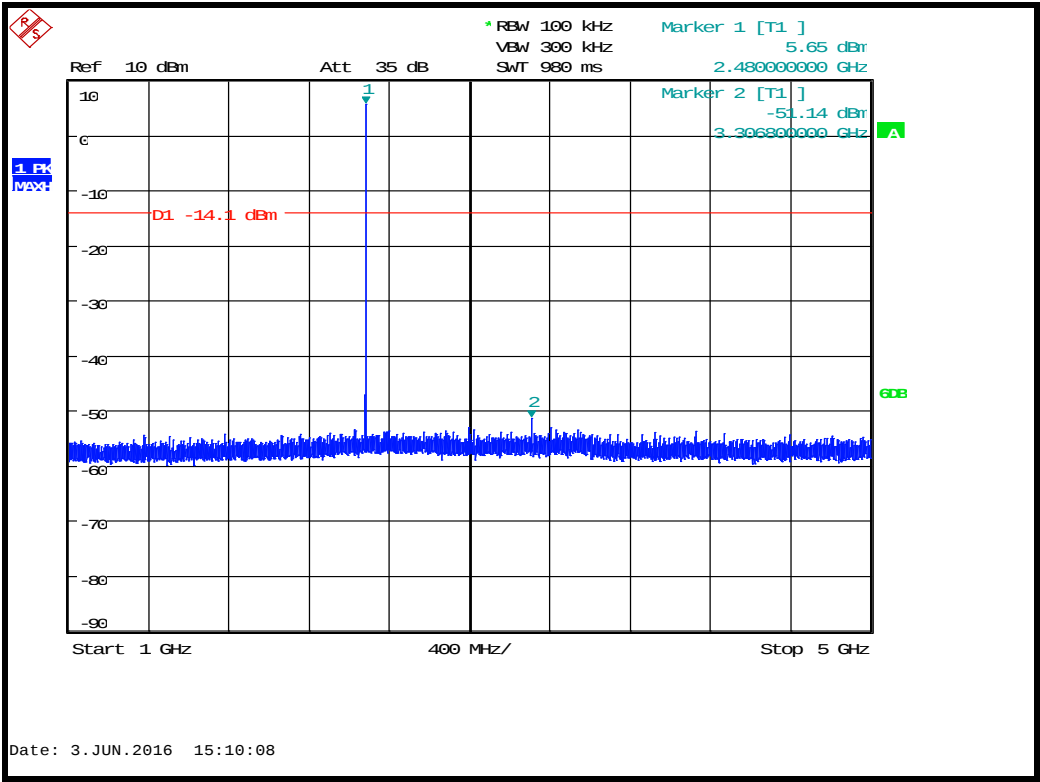


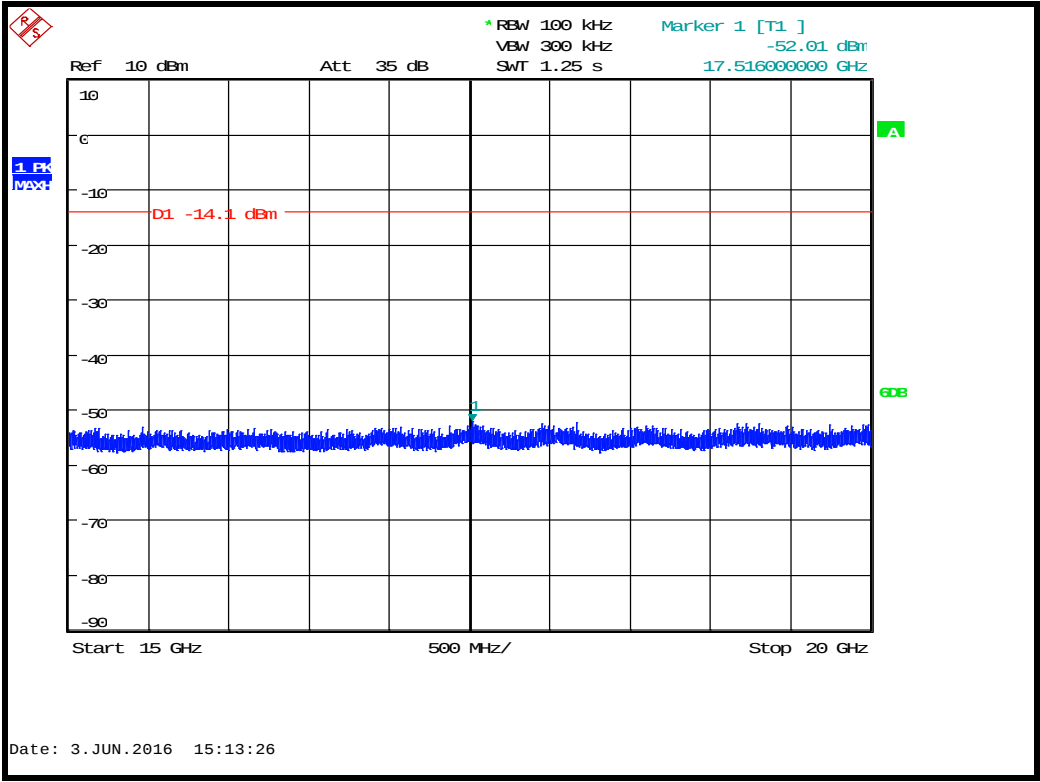
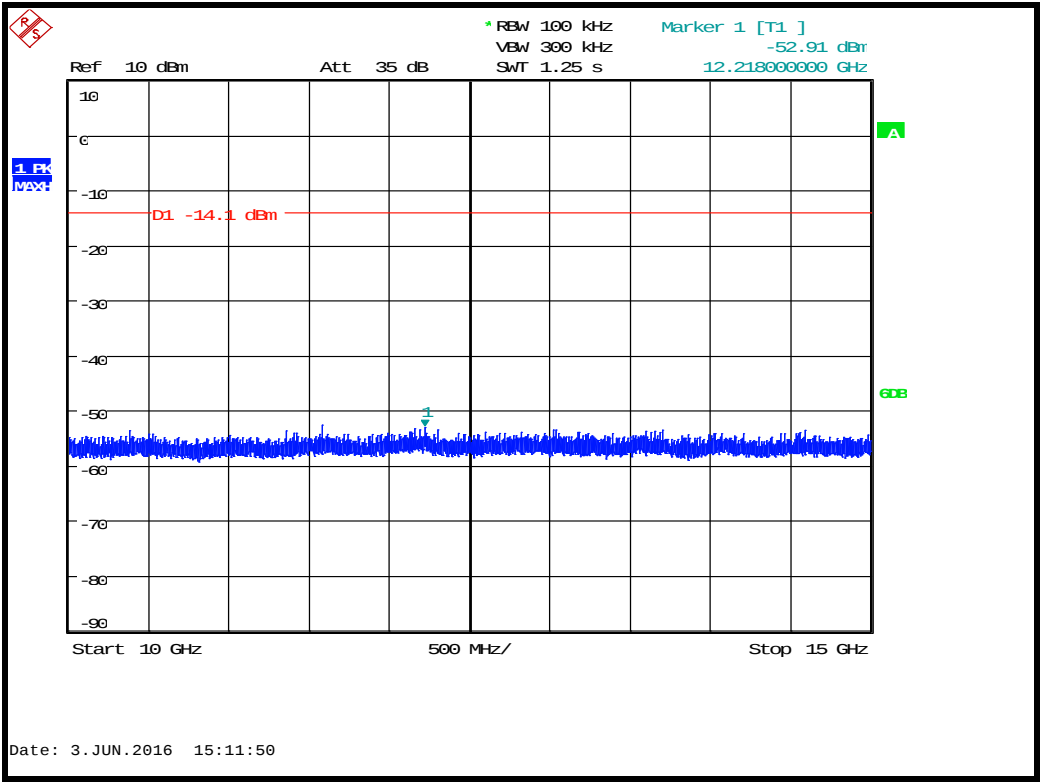


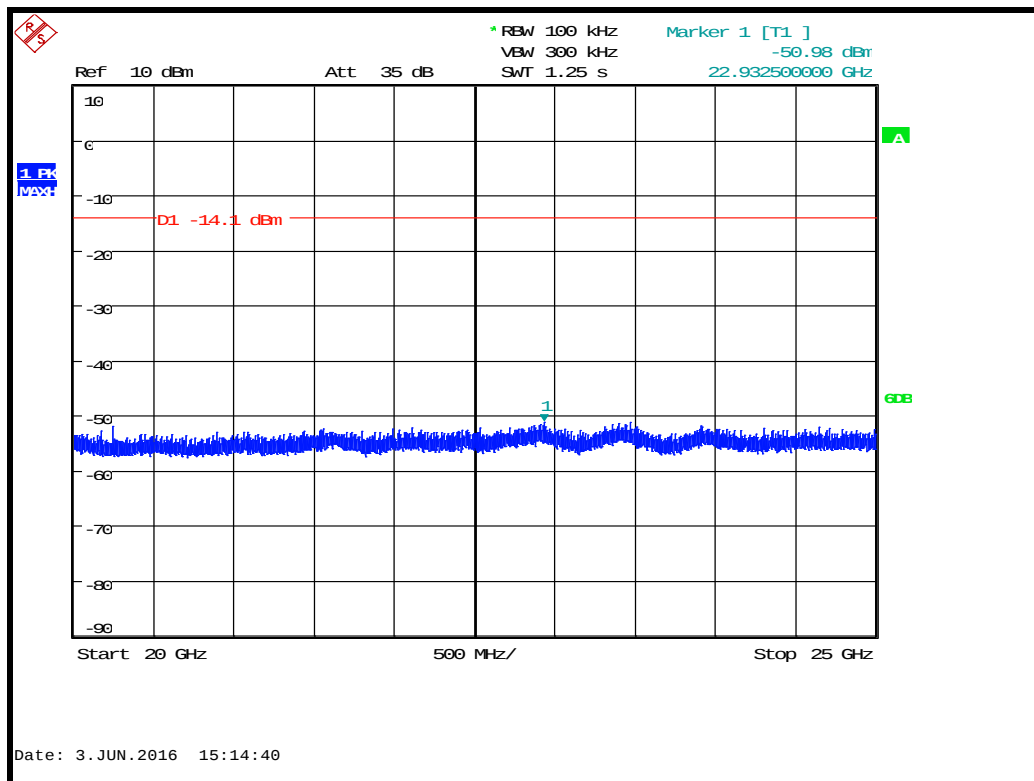
Modulation: GFSK; Data rate: 1 Mb/s; Power setting: Full						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2480	2480.067	5.94	5.94	-14.1	ref	N/A
There were no emissions detected within 20 dB of the limit.						PASS



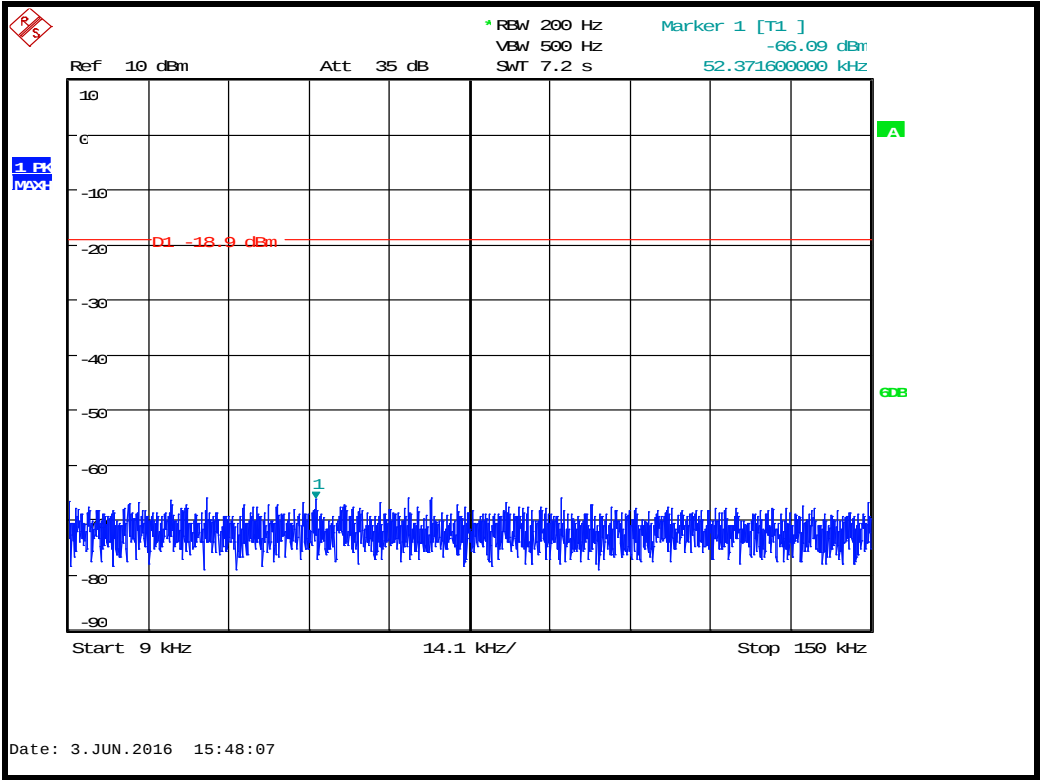
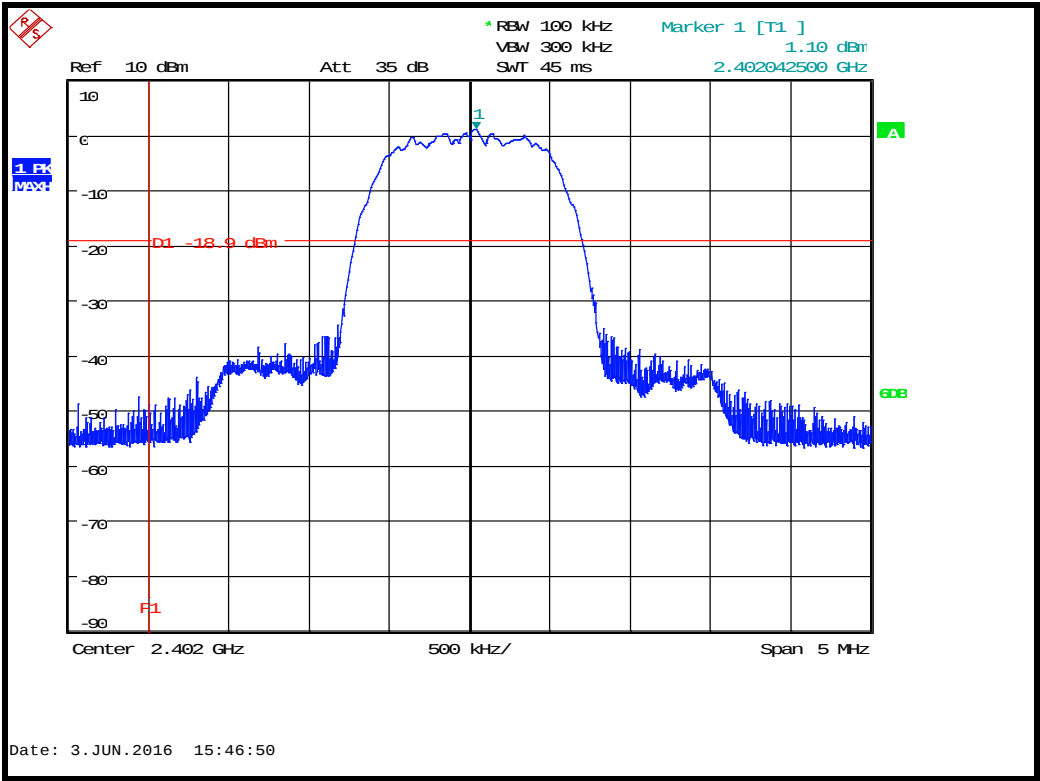


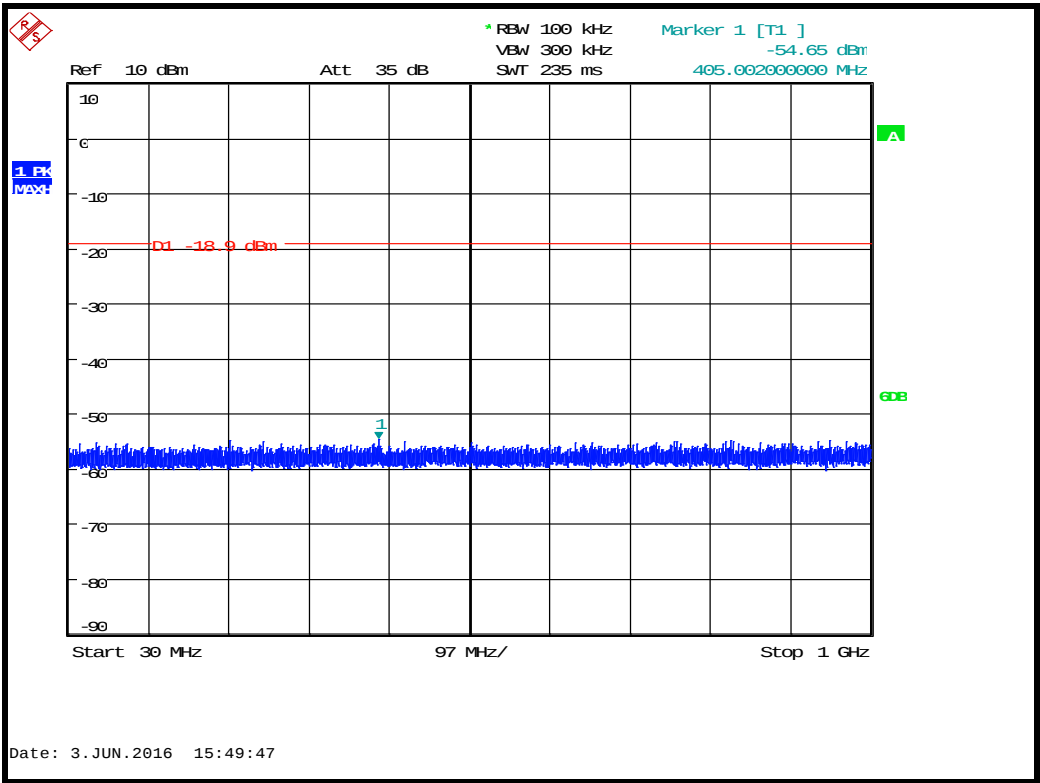
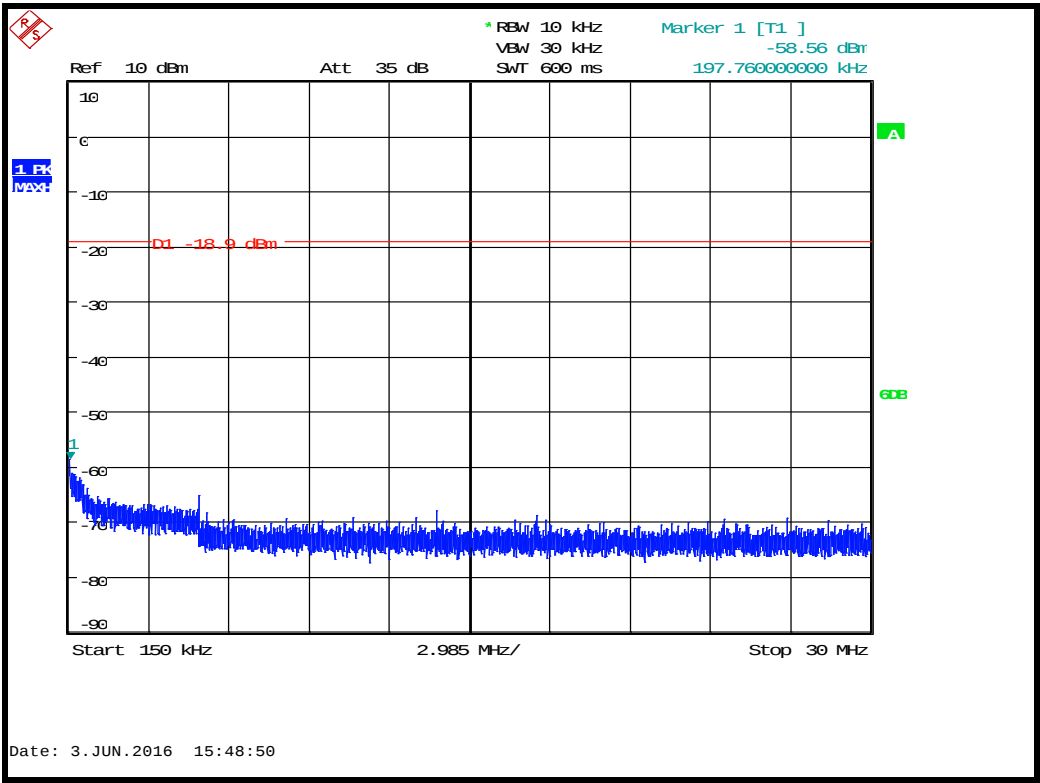


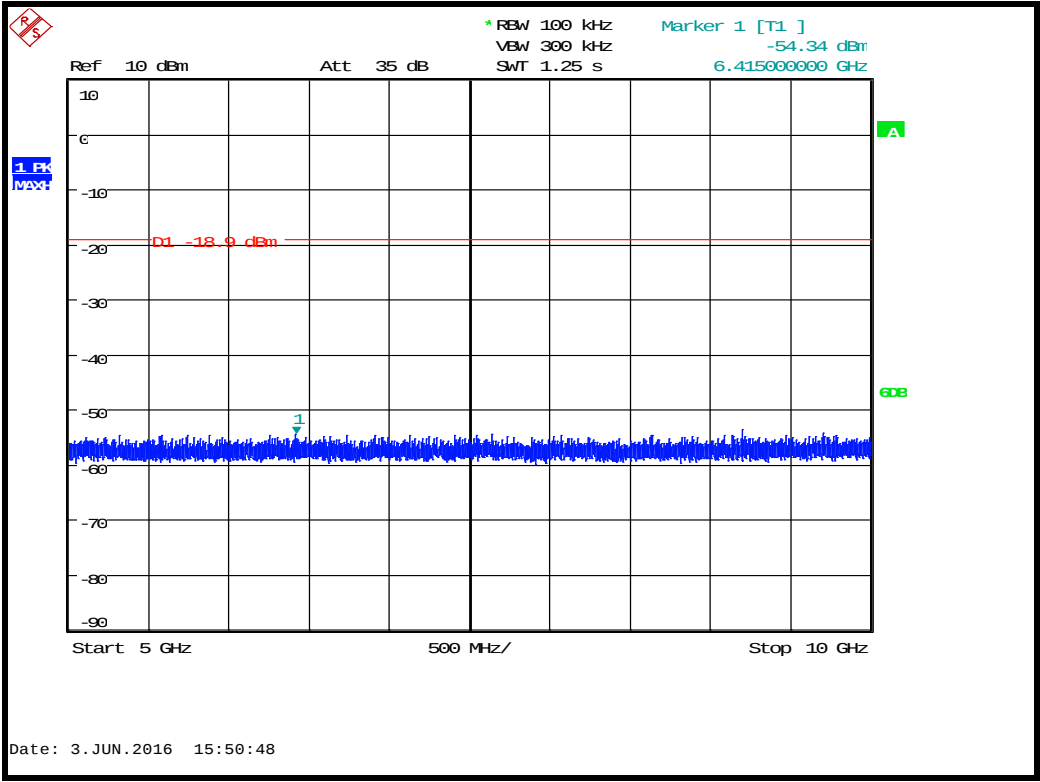
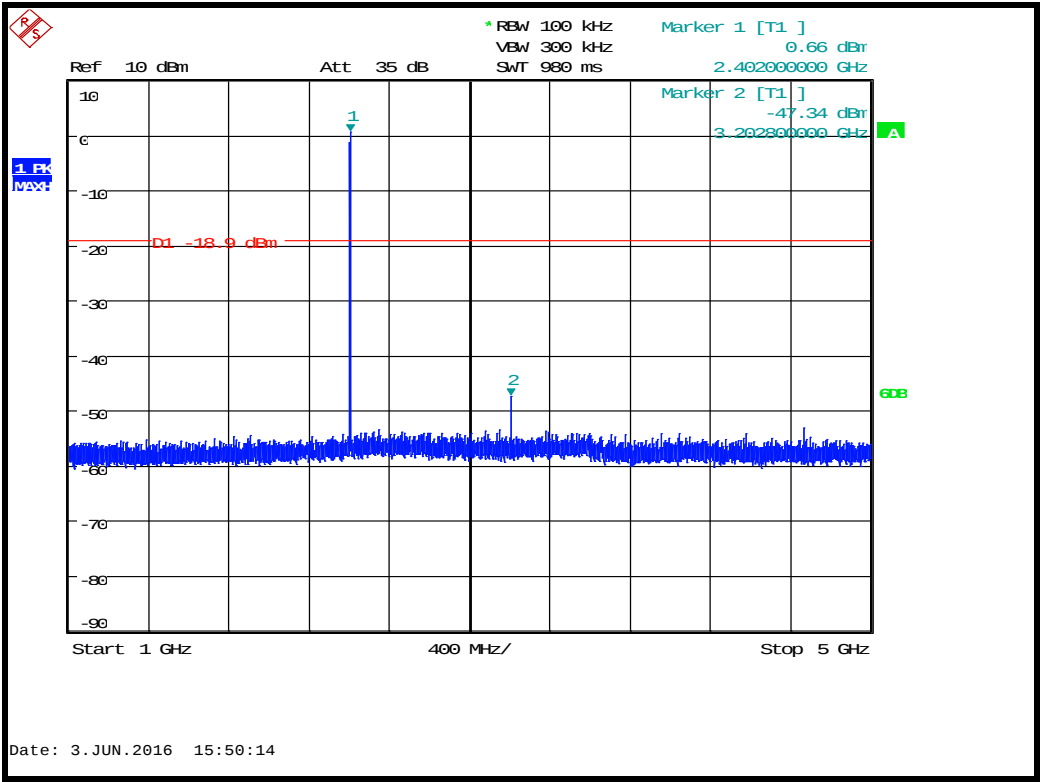


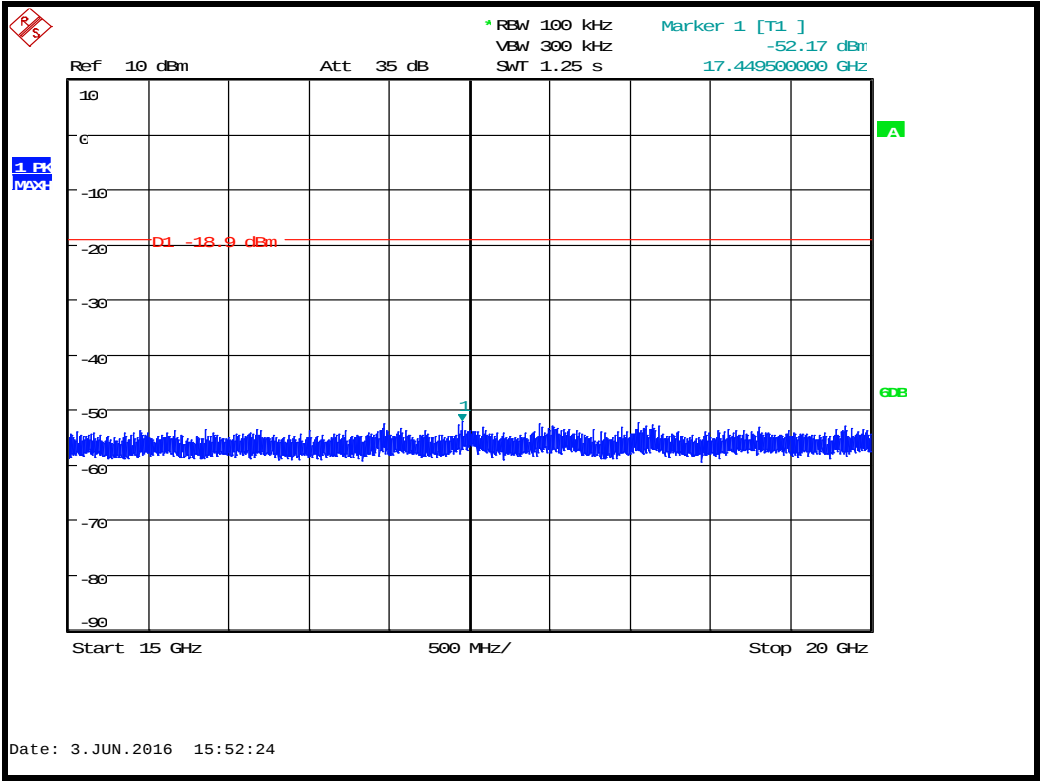
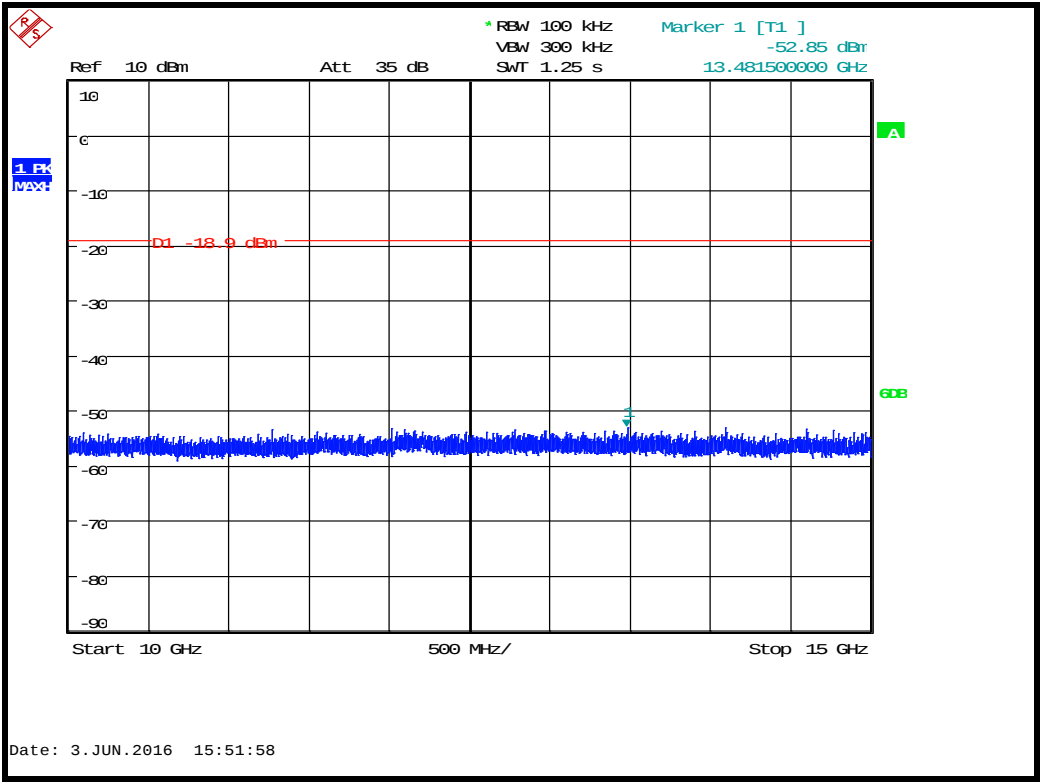


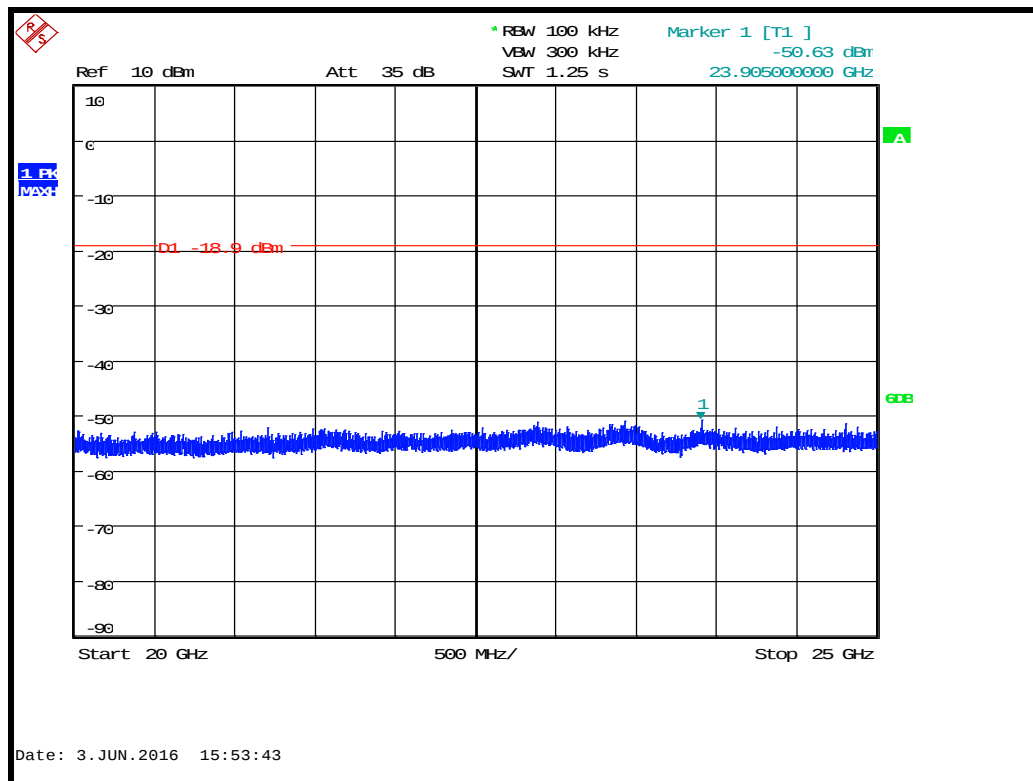
Modulation: QPSK; Data rate: 1 Mb/s; Power setting: Full						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2402	2402.043	1.10	1.10	-18.9	ref	N/A
There were no emissions detected within 20 dB of the limit.						PASS











Modulation: QPSK; Data rate: 1 Mb/s; Power setting: Full						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2441	2441.041	1.64	1.64	-18.4	ref	N/A
There were no emissions detected within 20 dB of the limit.						PASS

