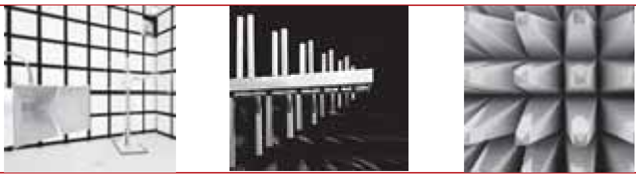

CETECOM™
CETECOM ICT Services
consulting - testing - certification >>>

TEST REPORT

Test report no.: 1-0047/15-02-06-A

ilac-MRA | DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-01

Testing laboratory

CETECOM ICT Services GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: http://www.cetecom.com
e-mail: ict@cetecom.com

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-01

Applicant

Ericsson AB
Lindholmspiren 11
417 56 Göteborg / SWEDEN
Phone: +46 10 719 0000
Fax: +46 10 712 9999
Contact: Sanel Dervisevic
e-mail: sanel.dervisevic@ericsson.com
Phone: +46 10 712 0056

Manufacturer

Ericsson AB
Lindholmspiren 11
417 56 Göteborg / SWEDEN

Test standard/s

CFR 47 Part 15	Code of Federal Regulations Title 47: Telecommunication Part 15 – Radio frequency devices
RSS-210	Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
RSS-Gen	General Requirements for Compliance of Radio Apparatus

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item:	**60 GHz point-to-point fixed digital microwave link**
Model name:	**MINI-LINK 6351 60/BCD**
FCC ID:	**TA8AUKL50158-21H**
IC:	**287AB-AN5015821H**
Frequency:	59.0 GHz to 62.0 GHz
Power supply:	100 V to 240 V AC, 50/60 Hz via PoE+
Temperature range:	-33°C to +55°C

This test report is electronically signed and valid without handwriting signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorized:

Geraldy Karsten

DN: cn=Karsten Geraldy, o=CETECOM ICT Services GmbH, ou=GER-151201, email=karsten.geraldy@cetecom.com, c=DE
Datum: 2016.09.16 14:38:47 +02'00'

Karsten Geraldy
Lab Manager
Radio Communications & EMC

Test performed:

p.o. M. Walla

Digital unterschrieben von Meheza Walla
DN: cn=Meheza Walla, o=CETECOM ICT Services GmbH, ou=WAL-151005, email=Meheza.Walla@cetecom.com, c=DE
Datum: 2016.09.16 14:38:15 +02'00'

Benedikt Gerber
Testing Manager
Radio Communications & EMC

1 Table of contents

2 General information

2.1 Notes and disclaimer

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This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2015-10-13
Date of receipt of test item:	-/-
Start of test:	2016-06-06
End of test:	2016-06-14
Person(s) present during the test:	-/-

3 Test laboratories sub-contracted

Ericsson AB
Lindholmspiren 11
417 56 Göteborg / SWEDEN
Phone: +46 10 719 0000
Fax: +46 10 712 9999
Contact: Sanel Dervisevic
e-mail: sanel.dervisevic@ericsson.com
Phone: +46 10 712 0056

4 Test standard/s

Test standard	Date	Test standard description
CFR 47 Part 15	2015-10	Code of Federal Regulations Title 47: Telecommunication Part 15 – Radio frequency
RSS-210	2010-12 2015-05	Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
RSS-Gen	2014-11	General Requirements for Compliance of Radio Apparatus

5 Referenced test standards

Test standard	Date	Test standard description
CFR 47 Part 1	2014-10	Code of Federal Regulations Title 47: Telecommunication Part 1 - Practice and procedure
CFR 47 Part 2	2014-10	Code of Federal Regulations Title 47: Telecommunication Part 2 - Frequency allocations and radio treaty matters; General rules and regulations
RSP-100	2014-11	Certification of Radio Apparatus
RSP-113	2007-10	Application Procedures for Planned Radio Stations Above 960 MHz in the Fixed Service
RSS-102	2015-03	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
SP 47 GHz	2001-01	Spectrum Utilization Policy for Licence Exempt Wireless Devices in the Bands 46.7-46.9 GHz, 57-64 GHz and 76-77 GHz
TRC-43	2012-11	Designation of Emissions (Including Necessary Bandwidth and Classification), Class of Station and Nature of Service
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
ANSI C63.10-2013	-/-	American national standard of procedures for compliance testing of unlicensed wireless devices
RESOLUTION No. 506	2008-07	NATIONAL TELECOMMUNICATIONS AGENCY (ANATEL) (Section XVII Systems Operating in the 57-64 GHz Band, At. 73 to 77 are applicable

6 Test environment

Temperature :	T_{nom} T_{max} T_{min}	+20 °C during room temperature tests +55 °C during high temperature tests -33 °C during low temperature tests
Relative humidity content :		55 %
Power supply :	V_{nom} V_{max} V_{min}	115 V AC, 50/60 Hz 132 V 98 V

7 Test item

7.1 General description

Kind of test item :	60 GHz point-to-point fixed digital microwave link
Type identification :	MINI-LINK 6351 60/BCD
HMN :	N/A
PMN :	MINI-LINK 6351
HVIN :	MINI-LINK 6351 60/21H
FVIN :	N/A
S/N serial number :	see table below
HW hardware status :	see table below
SW software status :	CXP 902 6698/3 R7D04
Frequency band :	Low band: 59.000 GHz – 60.000 GHz High band: 61.000 GHz – 62.000 GHz
Duplex separation:	2000 (1000-3000) MHz
Type of modulation :	4/16/32/64/128/256 QAM
Antenna :	Integrated antenna
Power supply :	100 V to 240 V AC, 50/60 Hz via PoE+
Temperature range :	-33°C to +55°C

7.2 List of tested components

Product name	Product number	Serial Number	Revision	Remark
MINI-LINK 6351 60/21H	UKL 501 58/21H	A2310FEUA9	R1B	1)
MINI-LINK 6351 60/21L	UKL 501 58/21L	A2310F5X62	R1B	2)

Remarks:
1) EUT (high band)
2) Transmitter (low band, counterpart)

7.3 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

The spurious emissions conducted, the spurious emissions radiated and the AC power line conducted emissions were performed at CETECOM ICT testing laboratory and all the other tests were performed at Qamcom Research & Technology AB laboratory.

Test setup- and EUT-photos are included in test report: 1-0047/15-02-01_AnnexA
1-0047/15-02-01_AnnexC

7.4 Adaptive Frame Formats to be tested

Radio Unit	CS	Modulation	PL Cap Mbit/s	RF Spectrum Mask
ML 6351	50 MHz	4 QAM	≤75	1-3
ML 6351		16 QAM	≤151	4L-4H
ML 6351		32 QAM	≤188	4L-4H
ML 6351		64 QAM	≤226	5L-5H
ML 6351		128 QAM	≤264	5L-5H
ML 6351		256 QAM	≤302	5L-5H
ML 6351	100 MHz	4 QAM	≤154	1-3
ML 6351		16 QAM	≤308	4L-4H
ML 6351		32 QAM	≤386	4L-4H
ML 6351		64 QAM	≤463	5L-5H
ML 6351		128 QAM	≤541	5L-5H
ML 6351		256 QAM	≤618	5L-5H
ML 6351	150 MHz	4 QAM	≤232	1-3
ML 6351		16 QAM	≤465	4L-4H
ML 6351		32 QAM	≤582	4L-4H
ML 6351		64 QAM	≤698	5L-5H
ML 6351		128 QAM	≤815	5L-5H
ML 6351	200 MHz	4 QAM	≤305	1-3
ML 6351		16 QAM	≤612	4L-4H
ML 6351		32 QAM	≤765	4L-4H
ML 6351		64 QAM	≤919	5L-5H
ML 6351		128 QAM	≤1000	5L-5H
ML 6351	250 MHz	4 QAM	≤385	1-3
ML 6351		16 QAM	≤771	4L-4H
ML 6351		32 QAM	≤964	4L-4H
ML 6351		64 QAM	≤1000	5L-5H

7.5 ML 6351 Frequency Ranges, Channel Spacing & Duplex Separation:

Product / Index (Frequency step)	Channel Spacing (MHz)	Frequency Range, Min & Max (MHz)	Duplex Separation (MHz)
6351/BCD B11 (1 MHz)	Min / max f range	59000.00 - 60000.00 paired with 61000.00 - 62000.00	2000 (1000-3000)
	50	59025.00 - 59975.00 paired with 61025.00 - 61975.00	
	100	59050.00 - 59950.00 paired with 61050.00 - 61950.00	
	150	59075.00 - 59925.00 paired with 61075.00 - 61925.00	
	200	59100.00 - 59900.00 paired with 61100.00 - 61900.00	
	250	59125.00 - 59875.00 paired with 61125.00 - 61875.00	

7.6 Operating conditions during tests

Test Case	Frame Formats	CS	EUT*
Bandwidth / Occupied bandwidth / Spectral efficiency / Emission Designator	4/16/32 /64/128/256 QAM	50/100/150/200/250 MHz	M
Power density of any emission/ In-Band Power Density Limits/ In-Band Emissions	4/16/32 /64/128/256 QAM	50/100/150/200/250 MHz	M
Emission limitations (RF spectrum mask) / Spurious emissions at antenna terminals	4/16/32 /64/128/256 QAM	50/100/150/200/250 MHz	BMT
Limits on Spurious Emission (Spurious emissions – conducted, Spurious emissions at antenna terminals)/ Spurious Emission Limits	4QAM	50 MHz	BMT
Limits on Spurious Emission (Spurious emissions – radiated, Field strength of spurious radiation)/ Spurious Emission Limits	4QAM	50 MHz	BMT
Transmitter Output Power / Peak Tx Output Power	4/16/32 /64/128/256 QAM	50/250 MHz	BMT
Frequency stability	unmodulated	50 MHz	BMT
Antenna Gain	-/-	-/-	BMT
Conducted limits / AC Power Line Conducted Emissions Limits	4QAM	50 MHz	M

*B: bottom channel, M: middle channel, T: Top channel, ref: reference climatic conditions, extr: extreme climatic conditions

Additional comments: Uninterrupted operation for Tx and Rx.
All tests were performed on MINI-LINK 6351 60/21H (high band).

8 Measurement and test set-up, measurement uncertainties

Measurement uncertainties:

Power	± 0.4 dB
Frequency	± 0.01 ppm
Spectrum masks	± 1.9 dB; ± 0.01 ppm
Spurious emissions	± 3.0 dB; ± 0.01 ppm

9 Description of the test setup

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

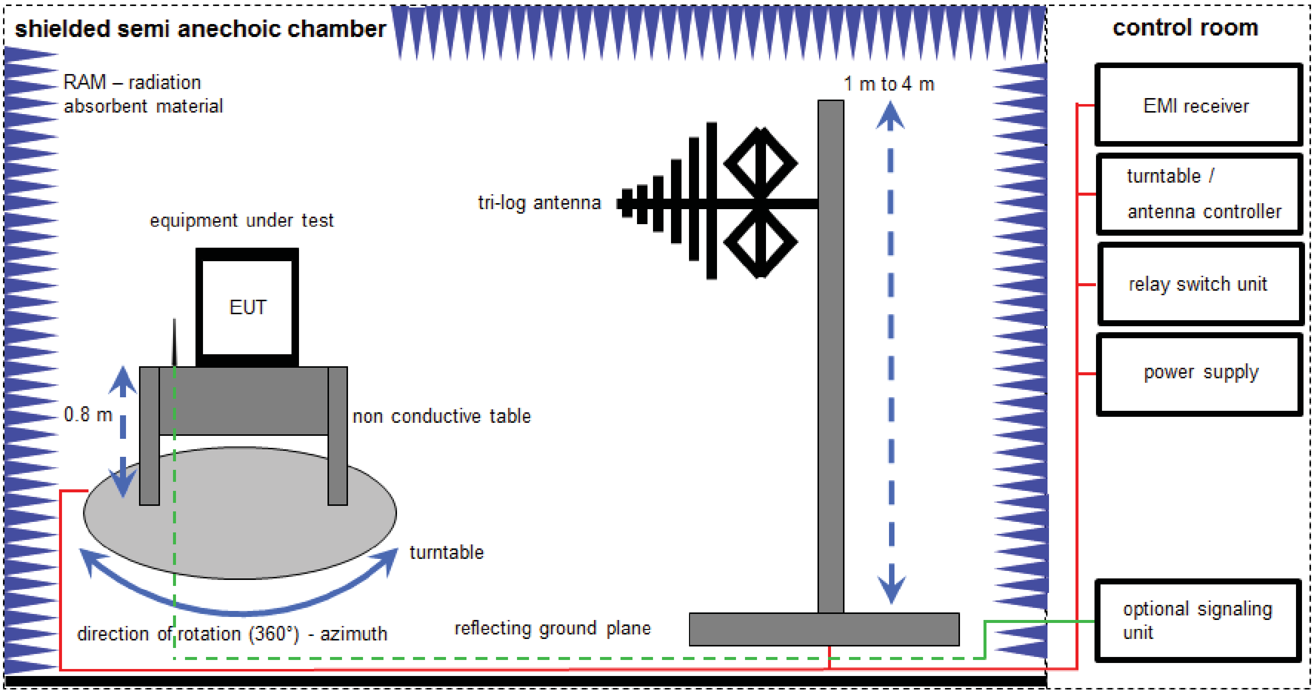
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

k	calibration / calibrated	EK	limited calibration
ne	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
ev	periodic self verification	izw	internal cyclical maintenance
Ve	long-term stability recognized	g	blocked for accredited testing
vlkI!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress

9.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 9 kHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are confirmed with specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: tri-log antenna 10 meter

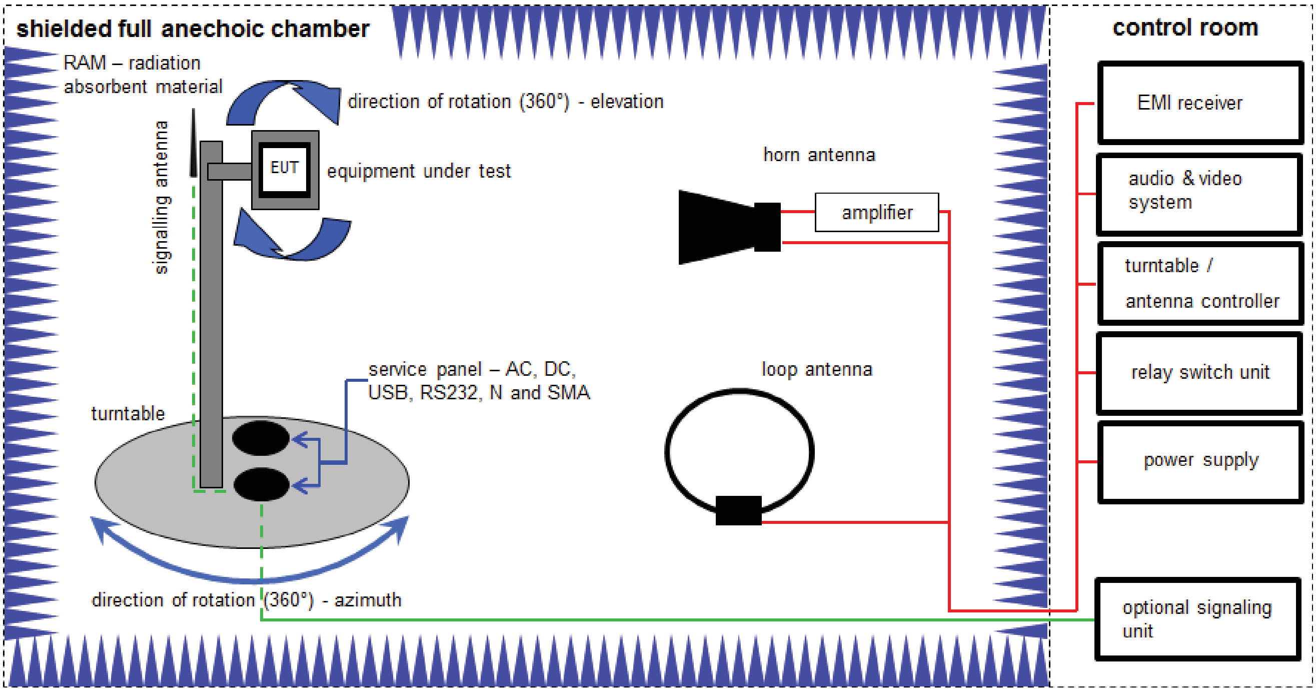
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufact.	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Switch / Control Unit	3488A	HP		300000929	ne		
2	n. a.	Directional Coupler	101020010	Krytar	70215	300002840	ev		
3	n. a.	DC-Blocker	8143	Inmet Corp.	none	300002842	ne		
4	n. a.	Powersplitter	6005-3	Inmet Corp.		300002841	ev		
5	n. a.	Temperature Test Chamber	VT 4002	Heraeus Voetsch	58566046820010	300003019	ev	03.09.2015	03.09.2017
6	n. a.	System DC Power Supply	N5767A	Agilent Technologies	US14J1569P	300004851	vIKI!	04.09.2014	04.09.2016
7	n. a.	Signal Analyzer 30GHz	FSV30	R&S	103170	300004855	k	25.01.2016	25.01.2017
8	n. a.	Power Sensor	NRP-Z81	R&S	100010	300003780	k	25.01.2016	25.01.2017
9	AC2-C01	RF-Cable	ST18/SMAm/SMAm/72	Huber & Suhner	Batch no. 605505	400001187	ev		
10	AC2-C02	RF-Cable	Sucoflex 104	Huber & Suhner	147636/4	400001188	ev		

9.2 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter

FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

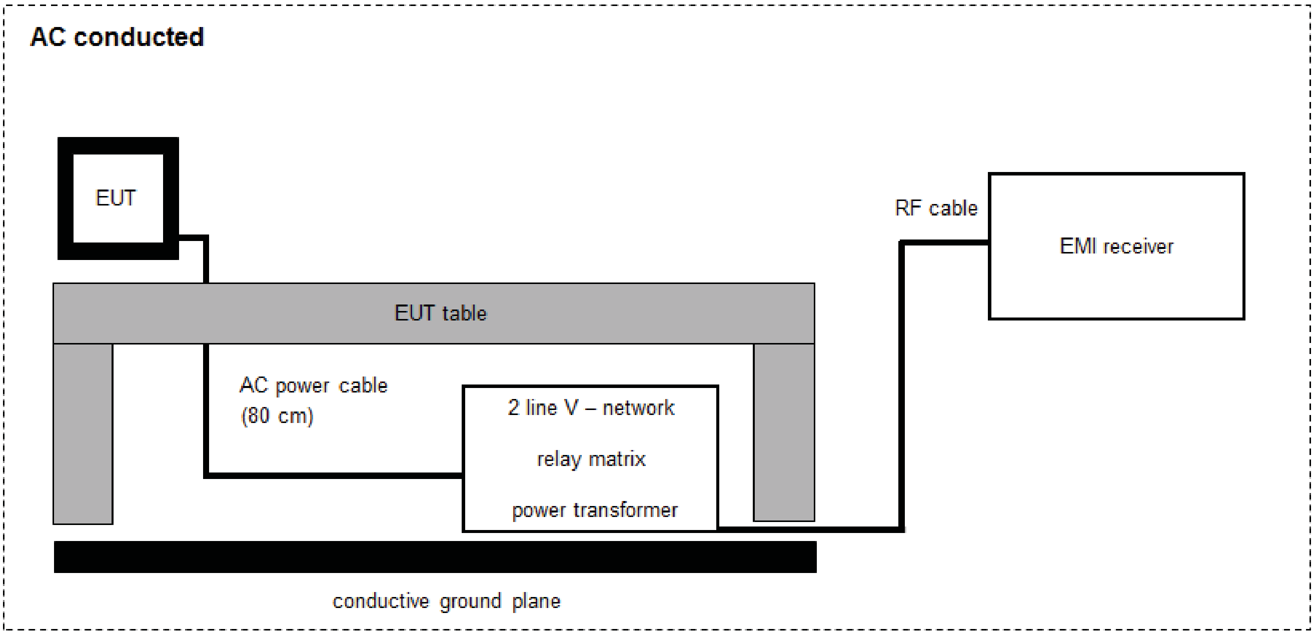
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -39.0 [dBm] + 57.0 [dB] - 12.0 [dBi] + (-36.0) [dB] = -30 [dBm] (1 µW)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	Ve	20.01.2015	20.01.2018
2	n. a.	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3088	300001032	vIKI!	20.05.2015	20.05.2017
3	n. a.	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev		
4	n. a.	Switch / Control Unit	3488A	HP	*	300000199	ne		
5	9	Variable isolating transformer	MPL IEC625 Bus Variable isolating transformer	Erfi	91350	300001155	ne		
6	90	Active Loop Antenna 10 kHz to 30 MHz	6502	EMCO/2	8905-2342	300000256	k	24.06.2015	24.06.2017
7	n. a.	Amplifier	js42-00502650-28-5a	Parzich GMBH	928979	300003143	ne		
8	n. a.	Band Reject filter	WRCG1855/1910-1835/1925-40/8SS	Wainwright	7	300003350	ev		
9	n. a.	Band Reject filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	11	300003351	ev		
10	n. a.	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	18	300003789	ne		
11	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	371	300003854	vIKI!	29.10.2014	29.10.2017
12	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne		
13	n. a.	EMI Test Receiver 9kHz-26,5GHz	ESR26	R&S	101376	300005063	k	04.09.2015	04.09.2016

9.3 AC conducted



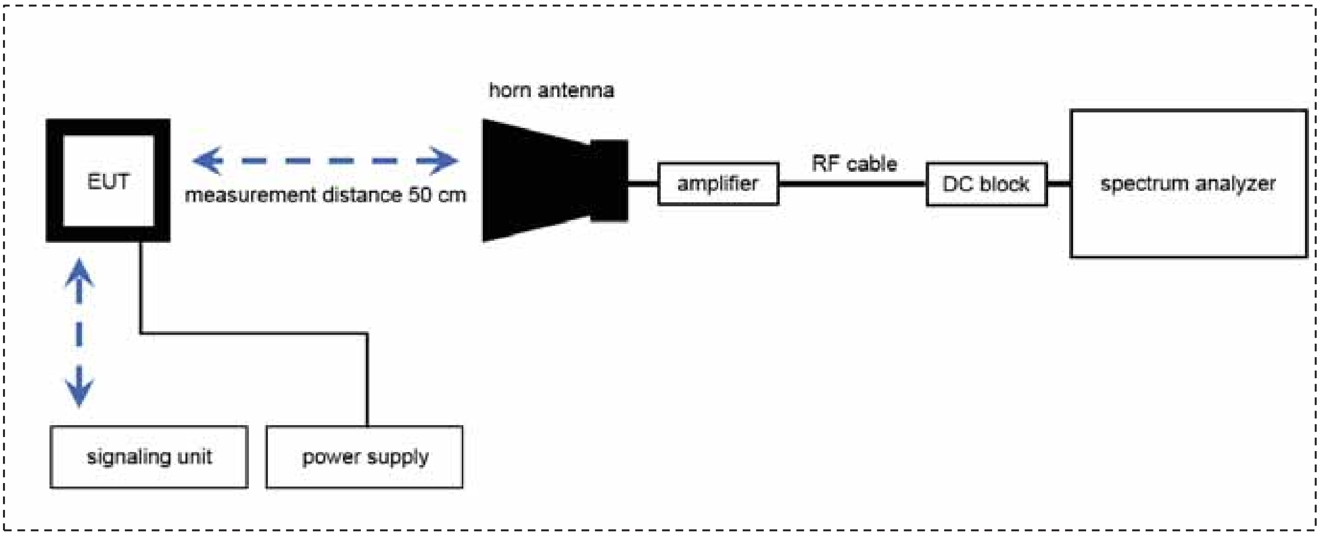
FS = UR + CF + VC
(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

Example calculation:
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/m)

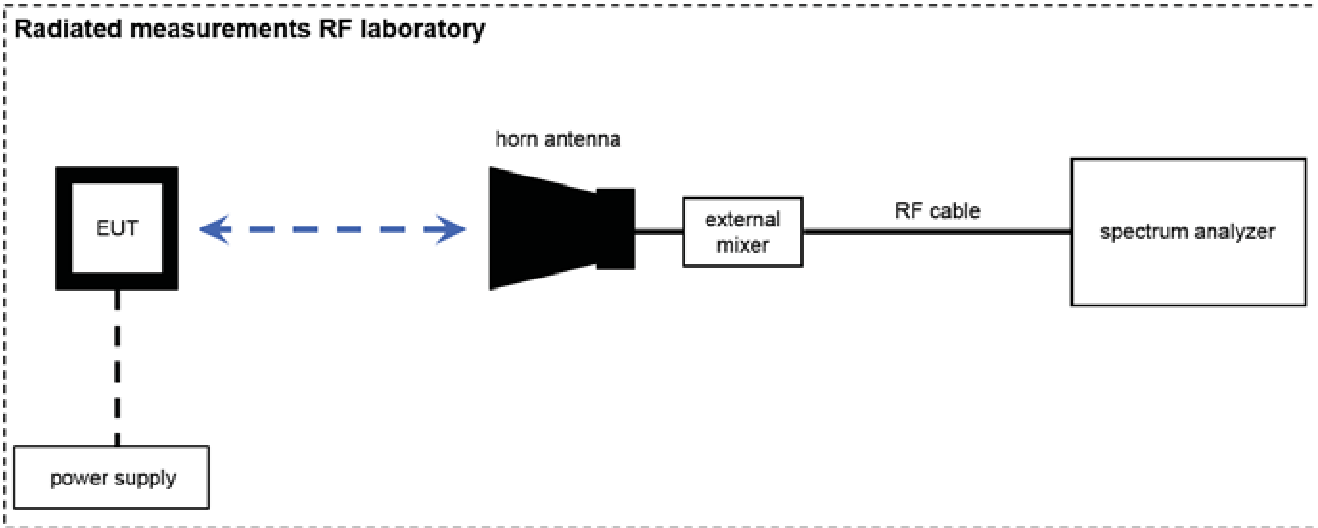
Equipment table:

No.	Lab / Item	Equipment	Type	Manufact.	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	R&S	892475/017	300002209	k	17.06.2014	17.06.2016
2	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	Ve	02.02.2016	02.02.2018
3	n. a.	MXE EMI Receiver 20 Hz to 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405	k	04.02.2016	04.02.2017

9.4 Radiated measurements > 18 GHz



9.5 Radiated measurements > 50 GHz



OP = AV + D - G
(OP-rad. output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain)

Example calculation:
OP [dBm] = -54.0 [dBm] + 64.0 [dB] - 20.0 [dBi] = -10 [dBm] (100 µW)

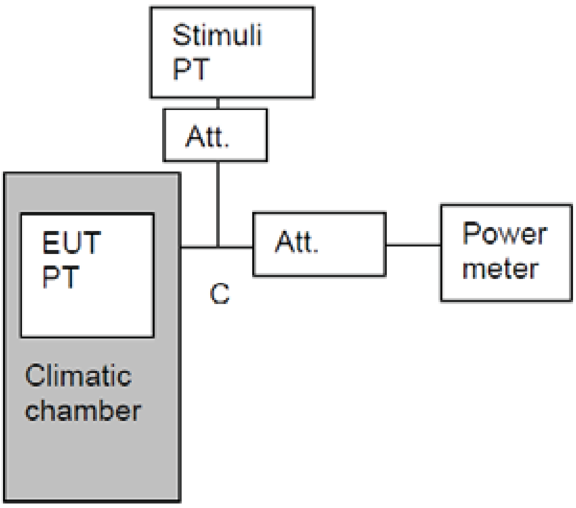
Note: conversion loss of mixer is already included in analyzer value.

Equipment table:

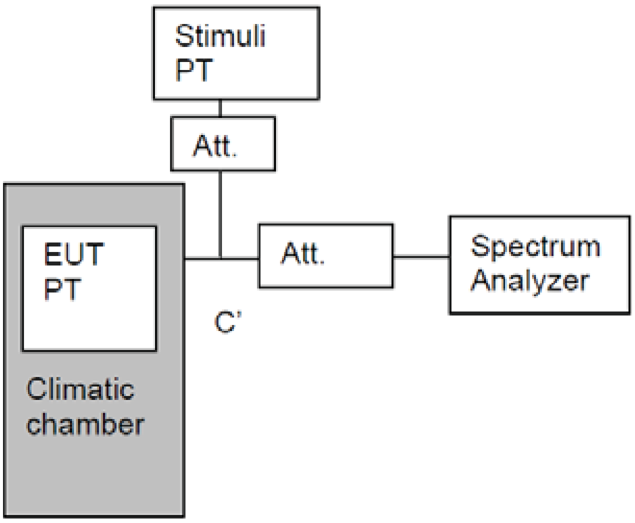
See next page!

9.6 Conducted Measurements

Test set-up No. 1: Output Power measurement



Test set-up No. 2: Spectrum Mask measurement



Equipment table:

No.	Lab / Item	Equipment	Type	Manufact.	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A023	Std. Gain Horn Antenna 39.3-59.7 GHz	2424-20	Flann	75	300001979	ne		
2	A025	Std. Gain Horn Antenna 49.9-75.8 GHz	2524-20	Flann	*	300001983	ne		
3	A026	Std. Gain Horn Antenna 49.9-75.8 GHz	2524-20	Flann	*	300001986	ne		
4	A027	Std. Gain Horn Antenna 73.8-112 GHz	2724-20	Flann	*	300001988	ne		
5	A028	Std. Gain Horn Antenna 73.8-112 GHz	2724-20	Flann	*	300001991	ne		
6		Std. Gain Horn Antenna 12.4 to 18.0 GHz	639	Narda	8402	300000787	k	14.08.2015	14.08.2017
7		Std. Gain Horn Antenna 18.0 to 26.5 GHz	638	Narda		300000486	k	10.09.2015	10.09.2017
8	A031	Std. Gain Horn Antenna 26.5 to 40.0 GHz	V637	Narda	82-16	300000510	k	14.08.2015	14.08.2017
9	n. a.	Spectrum Analyzer 20 Hz - 50 GHz	FSU50	R&S	200012	300003443	Ve	02.10.2014	02.10.2016
10	n. a.	Harmonic Mixer 2-Port, 50-75 GHz	FS-Z75	R&S	100099	300003949	k	09.03.2016	09.03.2017
11	n. a.	PXA Spectrum Analyzer 3Hz to 50GHz	N9030A PXA Signal Analyzer	Agilent Technologies	US51350267	300004338	k	09.02.2016	09.02.2017
12	n. a.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev		
13	n. a.	Harmonic Mixer 3-Port, 75-110 GHz	FS-Z110	R&S	101411	300004959	k	12.05.2016	12.05.2017
14	n. a.	Waveguide Harmonic Mixer, 75-110 GHz	M1970W	KEYSIGHT	MY51430848	300005115	k	25.02.2016	25.02.2018
15	n. a.	Waveguide Harmonic Mixer, 50-80 GHz	M1970V	KEYSIGHT	MY51390914	300005116	k	05.02.2016	05.02.2018
16	n. a.	Temperature Test Chamber	T-40/50	CTS GmbH	053031	300003592	ev	03.09.2015	03.09.2017

Equipment table: from Qamcom

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No	Kind of Calibration	Last Calibration	Next Calibration
1		Temperature and climatic Test Chamber	Clima Temperature Systeme	CTS Climate Test Systems AB	-/-	-/-	k	2015-11	2016-11
2		Spectrum Analyzer 20 Hz – 67 GHz	FSW 67	R&S	1312.8000K67-1001168-jw	QAT-35	k	2014-10	2016-10
3		Power meter	N 1914A	Agilent Technologies	MY453060007	QAT-29	k	05.08.2015	05.08.2016
4		Power Sensor	V8486A 50 GHz – 75 GHz	Agilent Technologies	MY453060007	-/-	ev		
5		10 dB Directional Coupler	559V-10/385	TRG	470	-/-	ev		
6		10 dB Directional Coupler	559V-10/385	TRG	540	-/-	ev		
7		Wave Guide adapter	25094	Flann	213521	-/-	ev		

10 Sequence of testing

10.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1.5 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

Final measurement

- Identified emissions during the premeasurement are maximized by the software by rotating the turntable from 0° to 360°. In case of the 2-axis positioner is used the elevation axis is also rotated from 0° to 360°.
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

10.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

10.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

10.4 Sequence of testing radiated spurious above 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate (e.g. 0.5 m).
- The EUT is set into operation.

Premeasurement

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

10.5 Sequence of testing radiated spurious above 50.0 GHz with external mixers

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate for far field (e.g. 0.25 m).
- The EUT is set into operation.

Premeasurement

- The test antenna with external mixer is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.
- Caution is taken to reduce the possible overloading of the external mixer.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- As external mixers may generate false images care is taken to ensure that any emission measured by the spectrum analyzer does indeed originate in the EUT. Signal identification feature of spectrum analyzer is used to eliminate false mixer images (i.e., it is not the fundamental emission or a harmonic falling precisely at the measured frequency).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

11 Summary of measurement results

☒	**No deviations from the technical specifications were ascertained**
☐	There were deviations from the technical specifications ascertained

TC identifier	Description	Verdict	Date	Remark
RF-Testing	FCC 47 CFR Part 2, Part 15 RSS-210 Issue 8, RSS-Gen Issue 5	see table	2016-09-16	-/-

Test specification clause	Test Case	Temperature conditions	Pass	Fail	NA	NP	Results (max.)
§2.1046, §15.255(e)(1),(2)&(3) RSS-210 A13.2.3(1)&(2), RSS-Gen 6.12	Transmitter Output Power / Peak Tx Output Power	Extreme	☒	☐	☐	☐	complies
§1.1307, §1.1310, §2.1093, §15.255(b)(1)(i)(ii)&(g)/ RSS-210 A13.2.2(1)(i)/ RSS-Gen 3.2/ RSS-102,4.2 & 4.4	Power density of any emission/ In-Band Power Density Limits/ In-Band Emissions	Nominal	☒	☐	☐	☐	complies
§15.255(b)(1)(i)(ii) RSS-Gen, 8.3	Antenna Gain	Nominal	☒	☐	☐	☐	complies
§2.1049 RSS-Gen 6.6	Occupied bandwidth / Spectral efficiency	Nominal	☒	☐	☐	☐	complies
§2.1051, §15.255(e)(1),(2)&(3) RSS-210 A13.2.3(1)&(2) & A13.2.4(3)	Emission limitations (RF spectrum mask) / Spurious emissions at antenna terminals	Nominal	☒	☐	☐	☐	complies
§2.1051, §15.255(c)(1),(3)&(4) RSS-210 A13.2.2(2)(ii) & A13.2.4(3), RSS-Gen 6.13, 7.1	Limits on Spurious Emissions (Spurious emissions – conducted, Spurious emissions at antenna terminals)	Nominal	☒	☐	☐	☐	complies
§2.1053, §15.255(c) (1),(2),(3),(4), §15.209 RSS-210 A13.2.2(2)(i)&(ii), RSS-Gen 6.13, 7.1 & 8.9	Limits on Spurious Emissions (Spurious emissions – radiated, Field strength of spurious radiation)/	Nominal	☒	☐	☐	☐	complies
§2.1055, §15.255(f) RSS-210 A13.2.5 RSS-Gen, 6.11 & 8.11	Frequency stability	Nominal & Extreme	☒	☐	☐	☐	complies
§15.207(a) RSS-Gen 8.8	Conducted limits / AC Power line conducted emissions limits	Nominal	☒	☐	☐	☐	complies

Note:
NA = Not applicable; NP = Not performed

12 Measurement results

12.1 Transmitter Output Power

Measurement conditions:

Frequency	f_{bottom}	= see 7.3
	f_{middle}	= see 7.3
	f_{top}	= see 7.3
Modulation	M	= see table
Temperature	t	= see table

Test set-up No. 9.6 (1)

Limit: §2.1046, §15.255(e)(1),(2)&(3), RSS-210 A13.2.3(1)&(2), RSS-Gen 6.12

Note:

Output Power Limit calculation:

"Transmitters with emission bandwidth smaller than 100 MHz, must limit the peak output power in 500 mW multiplied by the bandwidth of the emission and divided by 100 MHz…"

OBW: (see also Chapter 12.4):

OBW_{min} = 48.1 MHz

P_{limit} [mW] = 500 mW·48.1 MHz/100MHz = 240.5 mW
P_{limit} [dBm] = 10·$\log_{10}$(240.5) dBm = **23.8 dBm**

Measurement results:

Radio Unit	CS	Mod	Frequency	Pout [dBm]		
				-33°C	+20°C	+55°C
ML 6351/21H	50 MHz	4 QAM	bottom	8.4	7.8	7.7
		16 QAM		8.4	8.0	7.9
		32 QAM		7.3	7.0	6.9
		64 QAM		7.3	7.1	6.9
		128 QAM		6.2	6.0	5.9
		256 QAM		6.3	6.0	5.9
		4 QAM	mid	8.2	7.9	7.8
		16 QAM		8.3	8.1	7.9
		32 QAM		7.3	7.0	6.9
		64 QAM		7.2	7.0	7.0
		128 QAM		6.2	6.0	6.0
		256 QAM		6.3	6.1	6.0
		4 QAM	top	7.6	7.9	7.9
		16 QAM		7.8	8.1	8.1
		32 QAM		6.8	7.0	7.1
		64 QAM		6.8	7.0	7.1
		128 QAM		5.7	6.0	6.1
		256 QAM		5.8	6.0	6.1

Radio Unit	CS	Mod	Frequency	Pout [dBm]		
				-33°C	+20°C	+55°C
ML 6351/21H	250 MHz	4 QAM	bottom	7.8	7.8	7.9
		16 QAM		8.0	7.8	8.0
		32 QAM		7.0	6.8	6.9
		64 QAM		7.0	6.9	6.9
		4 QAM	mid	8.2	8.0	8.0
		16 QAM		8.2	8.0	8.0
		32 QAM		7.3	7.1	7.0
		64 QAM		7.2	7.0	7.0
		4 QAM	top	7.7	7.9	8.0
		16 QAM		7.8	8.0	8.0
		32 QAM		6.9	7.0	7.0
		64 QAM		6.8	7.0	7.0

<u>**Verdict:**</u> **Complies**

12.2 Power density of any emissions / EIRP

Measurement conditions:

Frequency	f_{bottom}	= see 7.3
	f_{middle}	= see 7.3
	f_{top}	= see 7.3
Modulation	M	= see table
Temperature	t	= +20°C

Test set-up No. 9.6 (2)

Limit: §1.1307, §1.1310, §2.1093, §15.255(b)(1)(i)(ii)&(g),
RSS-210 A13.2.2(1)(i), RSS-Gen 3.2, RSS-102 4.2 & 4.4
max average power density: 9 µW/cm² (40 dBm) / max. Peak Power Density: 18 µW/cm² (43 dBm)

NOTE:

Calculation of power density limit at 3 m in EIRP [dBm]:

E.I.R.P corresponds to power density at a distance r (r = 3m), integrated over the surface of a sphere with radius r.

$A_{3m} = 4\pi \cdot (300)^2\ cm^2 = 113.04 \cdot 10^4\ cm^2$

- **max average power density: 9 µW/cm² at 3 m distance**

  $P_{total} = 9\ \mu W/cm^2 \cdot A_{3m} = 10.174\ W = 10174\ mW$

  $P_{EIRP}[dBm] = 10 \cdot \log_{10}(10174)\ dBm =$ **40.07 dBm**

- **max. Peak Power Density: 18 µW/cm² at 3 m distance**

  $P_{total} = 18\ \mu W/cm^2 \cdot A_{3m} = 20.347\ W = 20347\ mW$

  $P_{EIRP}[dBm] = 10*\log10(P_{total})\ dBm =$ **43.09 dBm**

Measurement results: (applicant declared a maximum antenna gain of: 32.6 dBi)

Radio Unit	CS	Mod	Frequency	Peak Power Density [dBm]	Plot No.
ML 6351/21L	50 MHz	4 QAM	middle	32.36	16
		16 QAM		32.63	17
		32 QAM		31.36	18
		64 QAM		31.34	19
		128 QAM		30.75	20
		256 QAM		30.32	21
	100 MHz	4 QAM		29.77	22
		16 QAM		29.71	23
		32 QAM		28.46	24
		64 QAM		28.55	25
		128 QAM		27.55	26
		256 QAM		27.52	27
	150 MHz	4 QAM		25.42	28
		16 QAM		25.50	29
		32 QAM		25.76	30
		64 QAM		24.45	31
		128 QAM		24.69	32
	200 MHz	4 QAM		26.46	33
		16 QAM		26.56	34
		32 QAM		26.45	35
		64 QAM		25.51	36
		128 QAM		25.57	37
	250 MHz	4 QAM		27.69	38
		16 QAM		26.83	39
		32 QAM		27.21	40
		64 QAM		26.84	41

Note:

Compared to Average measurement values the measured Peak values describe the worst case.
As above listed Peak values meet the requirements for Peak Power Density as well as the requirements for Average Power Density both requirements are met.

Verdict: Complies

12.3 Antenna gain and EIRP density mask

The SFA04-600BERC antennas have to meet the customer specification *"10262-UKY23031_SC10_PB3".*

· Frequency band: 57-64GHz
· Frequency range: Range 6
· Minimum Gain: 30 dBi
· Minimum Gain: 27 dBi @ +/-2.5° beamwidth
· RPE class: Class 2
· XPD : no requirement
· Min. Return loss: -14 dB

The RPE tolerance on given value is 3 dB in an angular region of ±100° and 2 dB from 100° to 180° and the tolerance for the antenna gain is ±0.5 dB.

Limit: §15.255(b)(1)(i)(ii), RSS-Gen, 8.3

Reference document of the customer: RFS Test Report No. TAR 10000014147 of 2015-11-10

RFS

V - Measurements results

5.1. Return loss Results of the SFA04-600BERC

The SFA04-600BERC antenna is measured in the final configuration described above with feed, reflector and radome. A sampling of 5 parts have been manufactured and tested. All values are better than -16dB. The figure 4 presents the typical return loss result with a minimum return loss of -17.55dB in the 57-64GHz frequency range. The return loss is compliant with the customer specification of -16dB in the V-band.

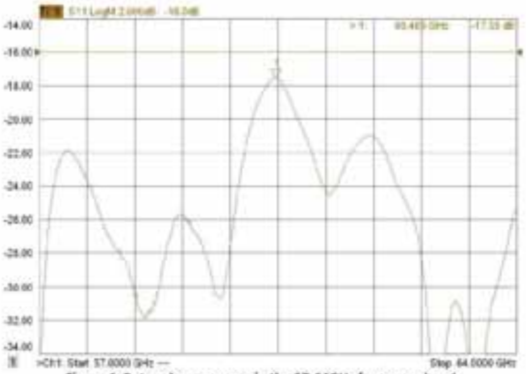


Figure 4: Return loss measure in the 57-64GHz frequency band

5.2. Radiation Pattern Results of SFA04-600BERC antenna

The SFA04-600BERC antenna is measured following the figure 1 configuration. The figures 5 and 6 present the radiation patterns of the co-polarization for respectively H and V polarizations at the 57GHz low frequency, 60.5GHz middle frequency and 64GHz high frequency and are compared to the R6C2 ETSI standard defined for the maximum gain. The cross-polarization are also shown in the figures 7 and 8, and compared to the R6C2 ETSI standard for reference purposes only. The table 1, hereafter, recaps the results.

	Specification	Result	Compliance
Radiation pattern	Range 6 Class 2	See Pattern	Yes
Crosspolar discrimination (XPD)	No requirement	> 27 dB (See Pattern)	Yes

Table 1: Radiation pattern performances

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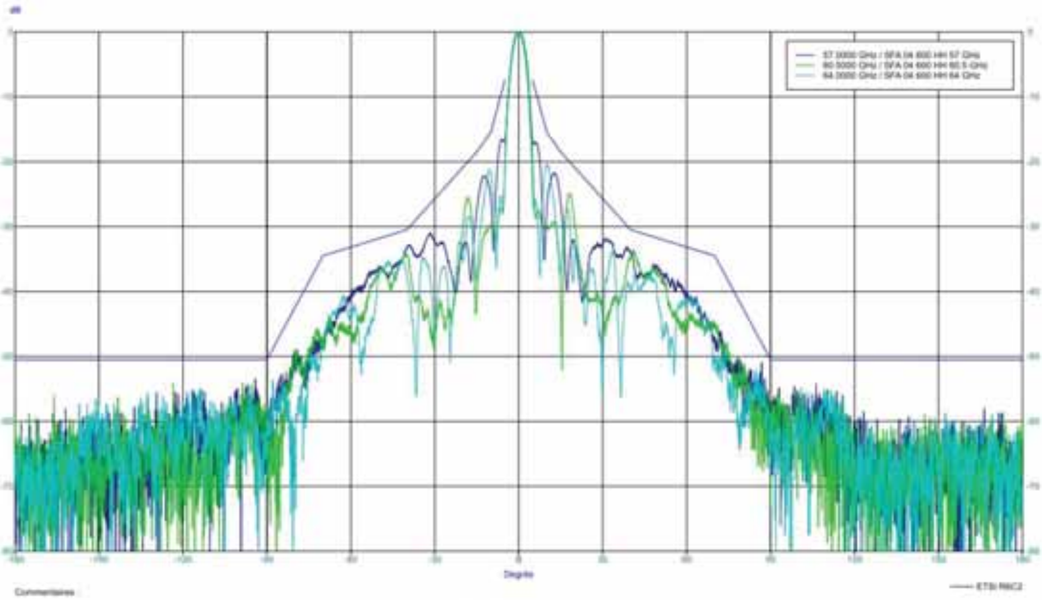

Figure 5: Co-polarization H-H in the azimuth plan

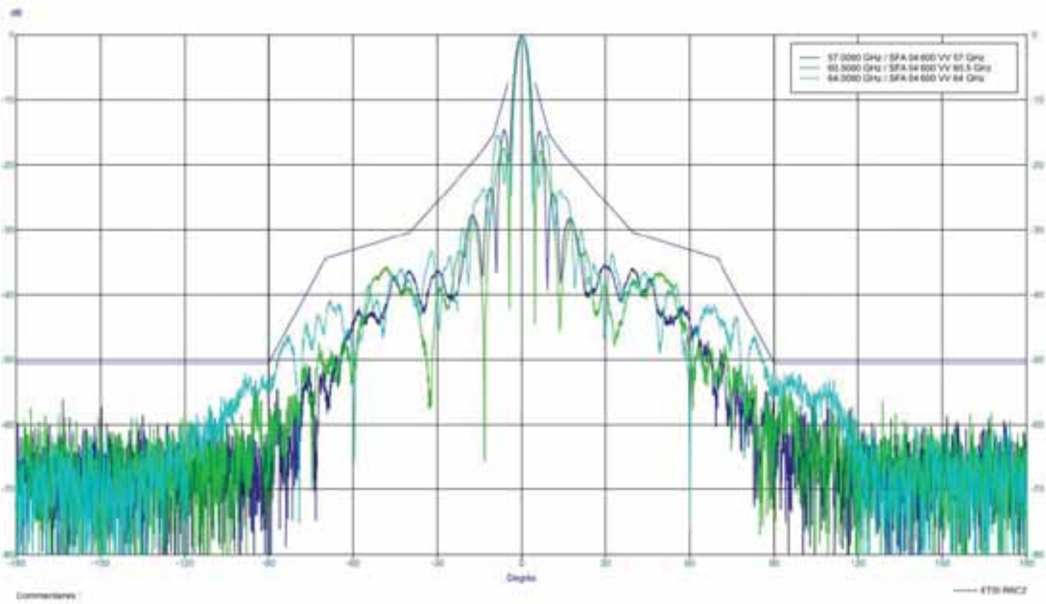

Figure 6: Co-polarization V-V in the azimuth plan

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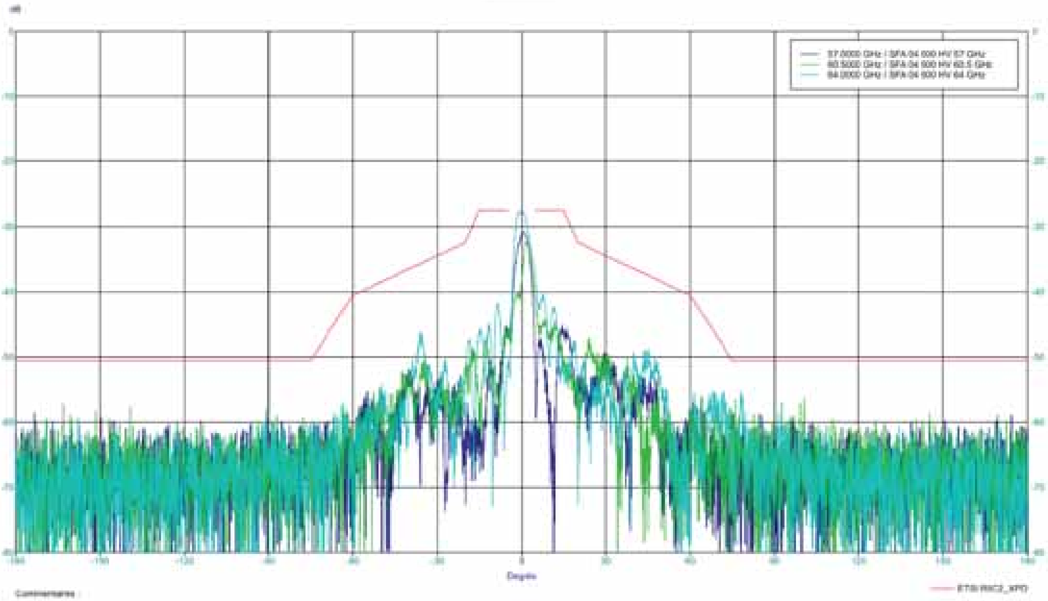

Figure 7: Cross-polarization H-V in the azimuth plan

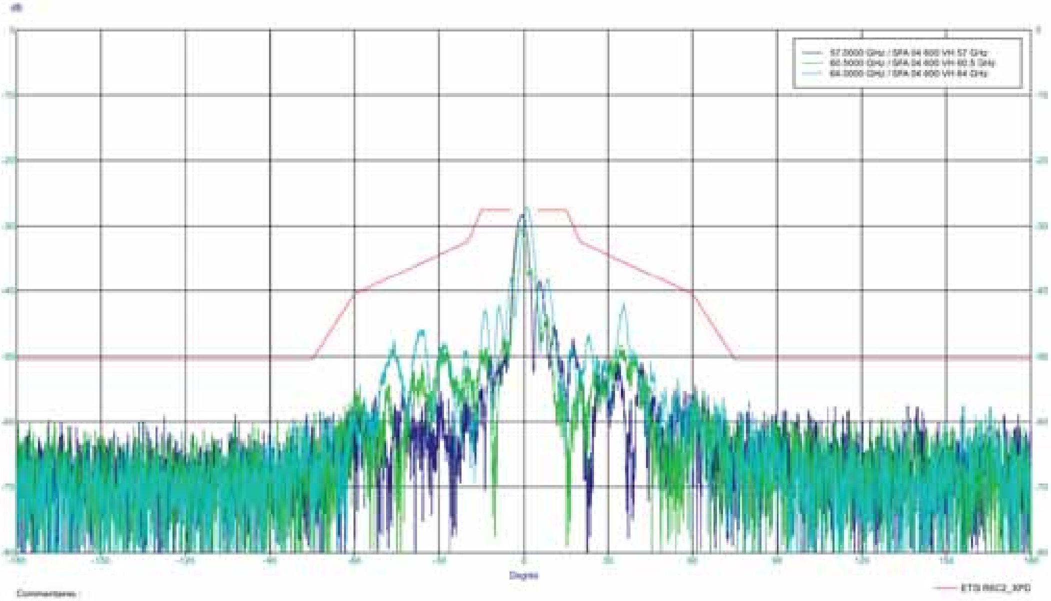

Figure 8: Cross-polarization V-H in the azimuth plan

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5.3. Gain Results of SFA04-600BERC antenna

The gain measure is performed with the final configuration (figure 1) and the values are presented in the table 2 for the verification frequencies and the curve in the figure 9 on the full frequency band (57-64GHz). All values are better than the minimum specification of 30dBi.

Frequency band	Specification	Result	Compliance
Low band 57GHz	30dBi	31.4dBi	Yes
Mid band 60.5GHz	30dBi	32.6dBi	Yes
High band 64GHz	30dBi	32.6dBi	Yes

Table 2: Gain performances

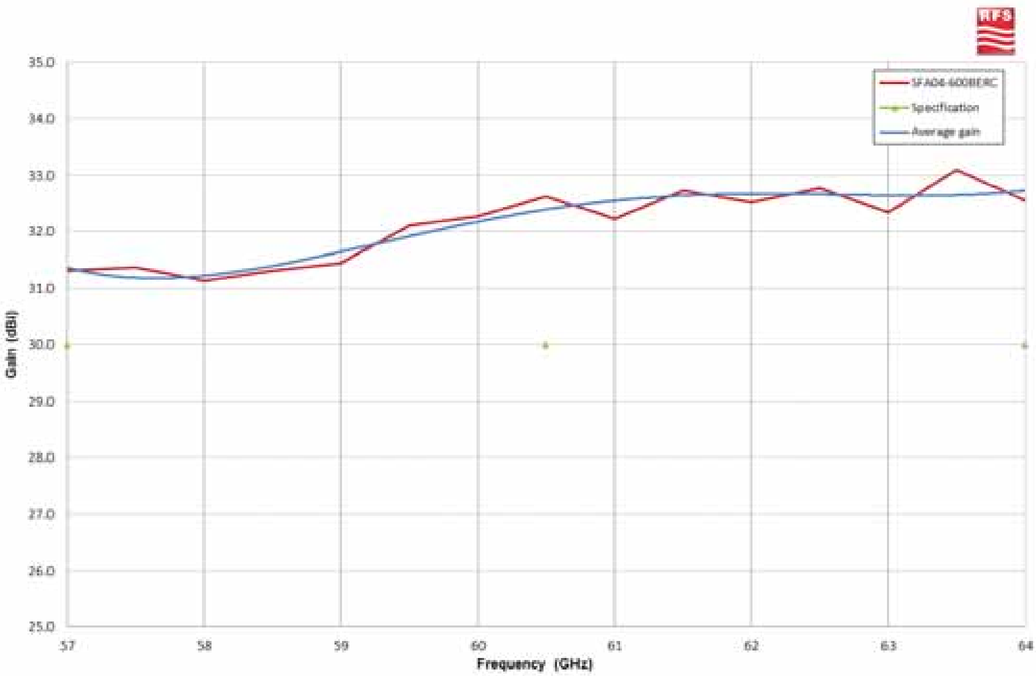

Figure 9: Gain measurement in the 57-64 frequency band

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5.4. RF Performances summary

The table 3 presents the RF performances of the SFA04-600BERC in the 57-64GHz frequency range. The minimum gain for an angular deviation of +/-2.5° is 27.6dBi at the low frequency for the horizontal polarization (H-plan) and is compliant with the specification. Nevertheless, the minimum gain at +/-2.5° for the vertical polarization is under the 27dBi specification with a minimum value of 25.8dBi at the high frequency.

Frequency (GHz)	57.0		60.5		64.0	
Return loss	< -16dB					
Gain (dBi)	31.4		32.6		32.6	
HPBW (°)	H-plan	E-plan	H-plan	E-plan	H-plan	E-plan
	4.4	4.1	4.4	3.4	4.4	3.4
Gain (dBi) @ +/-2.5° (5.0° beamwidth)	27.6	27.1	28.6	25.8	28.6	25.8
ETSI Regulation R6C2	☑	☑	☑	☑	☑	☑
XPD (dB)	31	28	32	30	27	27

Table 3: RF performances

VI - Conclusion

The SFA04-600BERC antennas in the configuration for the V-band (57-64GHz) are compliant with the ETSI specifications. All the tests performed on the SFA04-600BERC antenna show that:

- The radio electrical performances are in line with the ETSI specifications
- The gain is better than the customer specification
- The return loss performances are compliant with the -16dB specification

The minimum gain level inside a beamwidth of 5° (+/- 2.5°) is not fully compliant with the requirement level but nevertheless close to the 27dBi.

VII - Evolution of document

• Index A : Creation.

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Maximum Antenna gain = 32.6 dBi

Verdict: Complies

12.4 Occupied bandwidth / Spectral efficiency

Measurement conditions:

Frequency	f_{middle}	= see 7.3
Modulation	M	= see table
Temperature	t	= +20°C

Test set-up No. 9.6 (2)

Limit: §2.1049, RSS-Gen 6.6

Note:

The occupied bandwidth, is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

Plots show that the occupied bandwidth, measured by this definition leads to comparable results as a 6 dB bandwidth, which is defined as follows:

The bandwidth of emission is defined as the band occupied by the instantly radiated signal, in a permanent state, in which the power spectral density must not exceed the reference level (6dB lower than the maximum value of the spectral density of radiated power in the operating range).

Measurement results:

CS	Modulation	Frequency [GHz]	PL Cap Mbit/s	Occupied bandwidth [MHz]	Spectral efficiency [bit/s/Hz]	Plot No.
50 MHz	4 QAM	middle	≤75	48.00	1.5	16
	16 QAM		≤151	47.80	3.1	17
	32 QAM		≤188	47.80	3.9	18
	64 QAM		≤226	48.00	4.6	19
	128 QAM		≤264	48.00	5.4	20
	256 QAM		≤302	47.80	6.3	21
100 MHz	4 QAM		≤154	96.00	1.6	22
	16 QAM		≤308	96.00	3.2	23
	32 QAM		≤386	96.00	4.0	24
	64 QAM		≤463	96.00	4.8	25
	128 QAM		≤541	96.50	5.6	26
	256 QAM		≤618	96.00	6.4	27
150 MHz	4 QAM		≤232	143.00	1.6	28
	16 QAM		≤465	143.00	3.2	29
	32 QAM		≤582	143.00	4.1	30
	64 QAM		≤698	143.00	4.9	31
	128 QAM		≤815	143.00	5.7	32
200 MHz	4 QAM		≤305	189.00	1.6	33
	16 QAM		≤612	189.00	3.2	34
	32 QAM		≤765	189.00	4.0	35
	64 QAM		≤919	189.00	4.8	36
	128 QAM		≤1000	189.00	5.3	37
250 MHz	4 QAM		≤385	234.00	1.6	38
	16 QAM		≤771	236.00	3.2	39
	32 QAM		≤964	236.00	4.0	40
	64 QAM		≤1000	236.00	4.2	41

Verdict: Complies

12.5 Emission limitations – RF Spectrum masks

Measurement conditions:

Frequency	bottom	= see 6.4
	middle	= see 6.4
	top	= see 6.4
Channel spacing	CS	= see table
Modulation	M	= see table
Temperature	t	= see table

Test set-up No. 9.6 (2)

Limit: §2.1051, §15.255(e)(1),(2)&(3), RSS-210 A13.2.3(1)&(2) & A13.2.4(3)

Measurement results:

CS	Modulation	Frequency	Temperature [°C]	Plot No.
50 MHz	4 -256 QAM	top	20	1
	4 -256 QAM	middle		2
	4 -256 QAM	bottom		3
100 MHz	4 -256 QAM	top		4
	4 -256 QAM	middle		5
	4 -256 QAM	bottom		6
150 MHz	4 -256 QAM	top		7
	4 -256 QAM	middle		8
	4 -256 QAM	bottom		9
200 MHz	4 -128 QAM	top		10
	4 -128 QAM	middle		11
	4 -128 QAM	bottom		12
250 MHz	4 -64 QAM	top		13
	4 -64 QAM	middle		14
	4 -64 QAM	bottom		15

Verdict: Complies

12.6 Limits on Spurious Emissions (Spurious emissions – conducted)

Measurement conditions:

Frequency	f	= see below
Channel spacing	CS	= 50 MHz
Modulation	M	= 4 QAM
Temperature	t	= +20 °C

Test set-up No. 9.6 (2)

Limit: §2.1051, §15.255(c)(1),(3)&(4), RSS-210 A13.2.2(2)(ii) & A13.2.4(3),, RSS-Gen 6.13, 7.1

Note:
As a channel spacing of 50 MHz yields to the highest output power spectral density (see also chap. 12.2) and the modulation has no significant effect on the output power spectral density within the limits of accuracy (see also chap. 8), a CS of 50 MHz and a 4 QAM modulation scheme is used as a worst case scenario for spurious measurements.

Measurement results:

- **f** **bottom**

Frequency Range [GHz]	Limit [dBm]	Res. BW [MHz]	Spurious [GHz]	Emissions [dBm]	Plot No.
28.00 – 50.00	-13.0	1.0	n.f.	< limit	42
50.0 – 61.8625	-13.0	1.0	n.f.	< limit	43
61.9875 – 75.0	-13.0	1.0	n.f.	< limit	44
75.00 – 110.0	-13.0	1.0	n.f.	< limit	45
110.0 – 170.0	-13.0	1.0	n.f.	< limit	46
170.0 – 220.0	-13.0	1.0	n.f.	< limit	47

n.f. = nothing found

- **f** **middle**

Frequency Range [GHz]	Limit [dBm]	Res. BW [MHz]	Spurious [GHz]	Emissions [dBm]	Plot No.
28.00 – 50.00	-13.0	1.0	n.f.	< limit	48
50.0 – 62.275	-13.0	1.0	n.f.	< limit	49
62.525 – 75.0	-13.0	1.0	n.f.	< limit	50
75.00 – 110.0	-13.0	1.0	n.f.	< limit	51
110.0 – 170.0	-13.0	1.0	n.f.	< limit	52
170.0 – 220.0	-13.0	1.0	n.f.	< limit	53

- **f** **top**

Frequency Range [GHz]	Limit [dBm]	Res. BW [MHz]	Spurious [GHz]	Emissions [dBm]	Plot No.
28.00 – 50.00	-13.0	1.0	n.f.	< limit	54
50.0 – 62.8125	-13.0	1.0	n.f.	< limit	55
62.9375 – 75.0	-13.0	1.0	n.f.	< limit	56
75.00 – 110.0	-13.0	1.0	n.f.	< limit	57
110.0 – 170.0	-13.0	1.0	n.f.	< limit	58
170.0 – 220.0	-13.0	1.0	n.f.	< limit	59

Verdict: Complies

12.7 Limits on Spurious Emissions (Spurious emissions – radiated)

Measurement conditions:

Frequency	f	= middle frequency
Channel spacing	CS	= 50 MHz
Modulation	M	= 4 QAM
Temperature	t	= +20 °C

Test set-up No. 9.1 – 9.4

Limit: §2.1053, §15.255(c)(1),(2),(3),(4), §15.209, RSS-210 A13.2.2(2)(i)&(ii), RSS-Gen 6.13, 7.1 & 8.9

Note:
As a channel spacing of 50 MHz yields to the highest output power spectral density (see also chap. 12.2) and the modulation has no significant effect on the output power spectral density within the limits of accuracy (see also chap. 8), a CS of 50 MHz and a 4 QAM modulation scheme is used as a worst case scenario for spurious measurements.

Measurement results:

Frequency Range	Limit	Res. BW	Spurious [GHz]	Emissions [dBm]	Plot No.
9. kHz – 30 MHz	see §15.209	see §15.209	n.f.	< limit	60
30.0 MHz – 1.000 GHz			See plot below	< limit	61
1.000 GHz – 12.75 GHz	54 dBµV	1.0	n.f.	< limit	62
12.00 GHz – 18.00 GHz	54 dBµV	1.0	n.f.	< limit	63
18.00 GHz – 26.50 GHz	54 dBµV	1.0	n.f.	< limit	64
26.50 GHz – 40.00 GHz	54 dBµV	1.0	n.f.	< limit	65
40.00 GHz – 50.00 GHz	-10 dBm	1.0	n.f.	< limit	66
50.00 GHz – 75.00 GHz	-10 dBm	1.0	n.f.	< limit	67
75.00 GHz – 110.0 GHz	-10 dBm	1.0	n.f.	< limit	68
110.0 GHz – 170.0 GHz	-10 dBm	1.0	n.f.	< limit	69
170.0 GHz – 220.0 GHz	-10 dBm	1.0	n.f.	< limit	70

n.f. = no critical peaks found

Spurious 30 MHz – 1 GHz:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
37.463700	20.62	30.00	9.38	1000.0	120.000	174.0	V	117.0	13.9
70.539900	21.36	30.00	8.64	1000.0	120.000	273.0	V	85.0	8.4
474.984750	30.90	36.00	5.10	1000.0	120.000	400.0	V	1.0	18.2
700.002150	27.68	36.00	8.32	1000.0	120.000	100.0	H	187.0	21.5
733.361550	31.35	36.00	4.65	1000.0	120.000	103.0	H	163.0	22.3
800.014800	35.99	36.00	0.01	1000.0	120.000	200.0	V	277.0	22.7

Verdict: Complies

12.8 Frequency stability

Measurement conditions:

Frequency	f	= see table
Modulation	M	= off
Temperature	t	= see table
Power supply	U_{DC}	= see table
Measurement at	C'	

Test set-up No. 9.6 (2)

Limit: §2.1055, §15.255(f), RSS-210 A13.2.5, RSS-Gen, 6.11 & 8.11

Measurement results:

- **f_{bottom} = 61.025 GHz**

Temperature [°C]	nominal frequency [GHz]	measured frequency [GHz]	Difference [ppm]
+20	61.025 000 000	61.025 012 778	+ 0.21
-33		61.025 018 638	+ 0.30
+55		61.025 033 111	+ 0.54

- **f_{middle} = 61.500 GHz**

Temperature [°C]	nominal frequency [GHz]	measured frequency [GHz]	Difference [ppm]
+20	61.500 000 000	61.500 012 902	+ 0.21
-33		61.500 018 787	+ 0.30
+55		61.500 033 359	+ 0.54

- **f_{top} = 61.975 GHz**

Temperature [°C]	nominal frequency [GHz]	measured frequency [GHz]	Difference [ppm]
+20	61.975 000 000	61.975 012 994	+ 0.21
-33		61.975 018 925	+ 0.30
+55		61.975 033 616	+ 0.54

Verdict: Complies

12.9 AC Power line conducted emissions

Measurement conditions:

Frequency	f	= middle frequency
Channel spacing	CS	= 50 MHz
Modulation	M	= 4 QAM
Temperature	t	= +20°C
Voltage	U	= 115 V AC

Test set-up No. 9.5

Limit: § 15.207(a) / RSS-Gen 8.8

Measurement results:

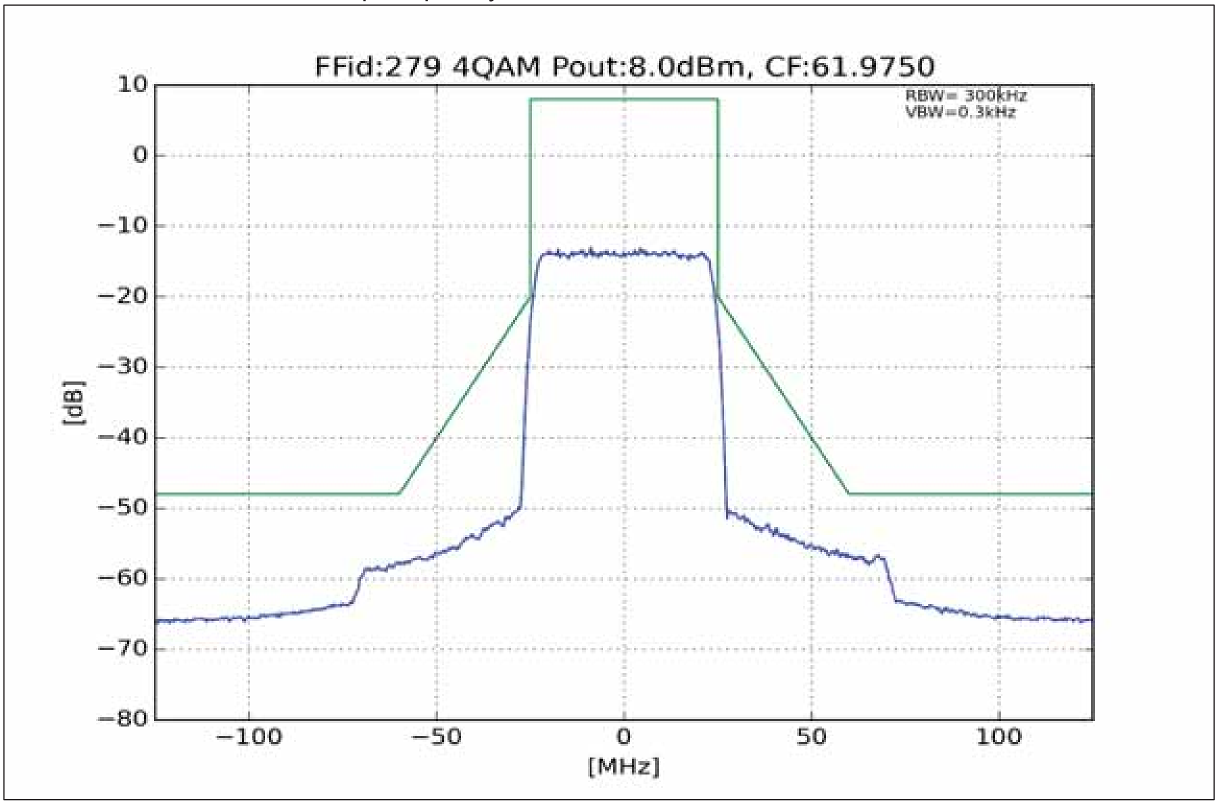
Frequency Range [GHz]	Limit	Res. BW [kHz]	Spurious [GHz]	Emissions [dBm]	Plot No.
0.0015 – 0.03	See §15.207	F<150 kHz: 1 F>150 kHz: 100	n.f.	< limit	71 / 72

n.f. = no critical peaks found

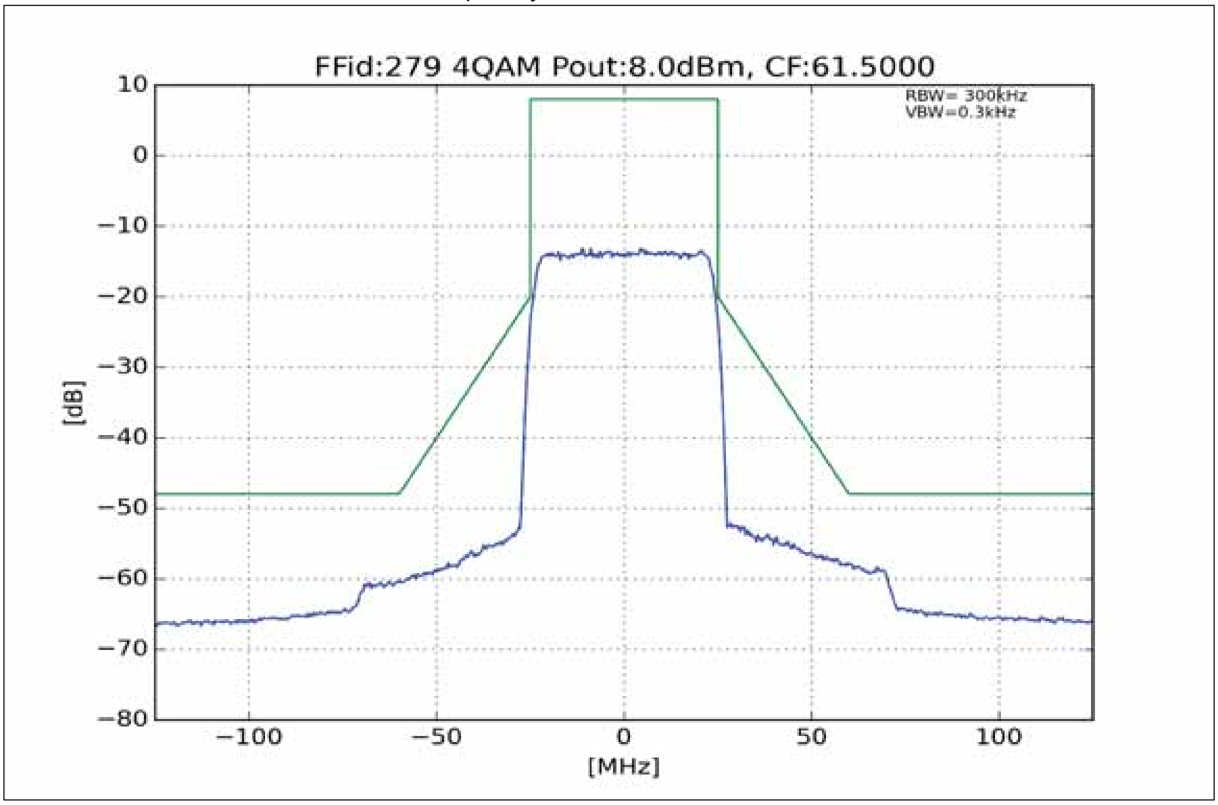
<u>Verdict:</u> Complies

12.10 Plots

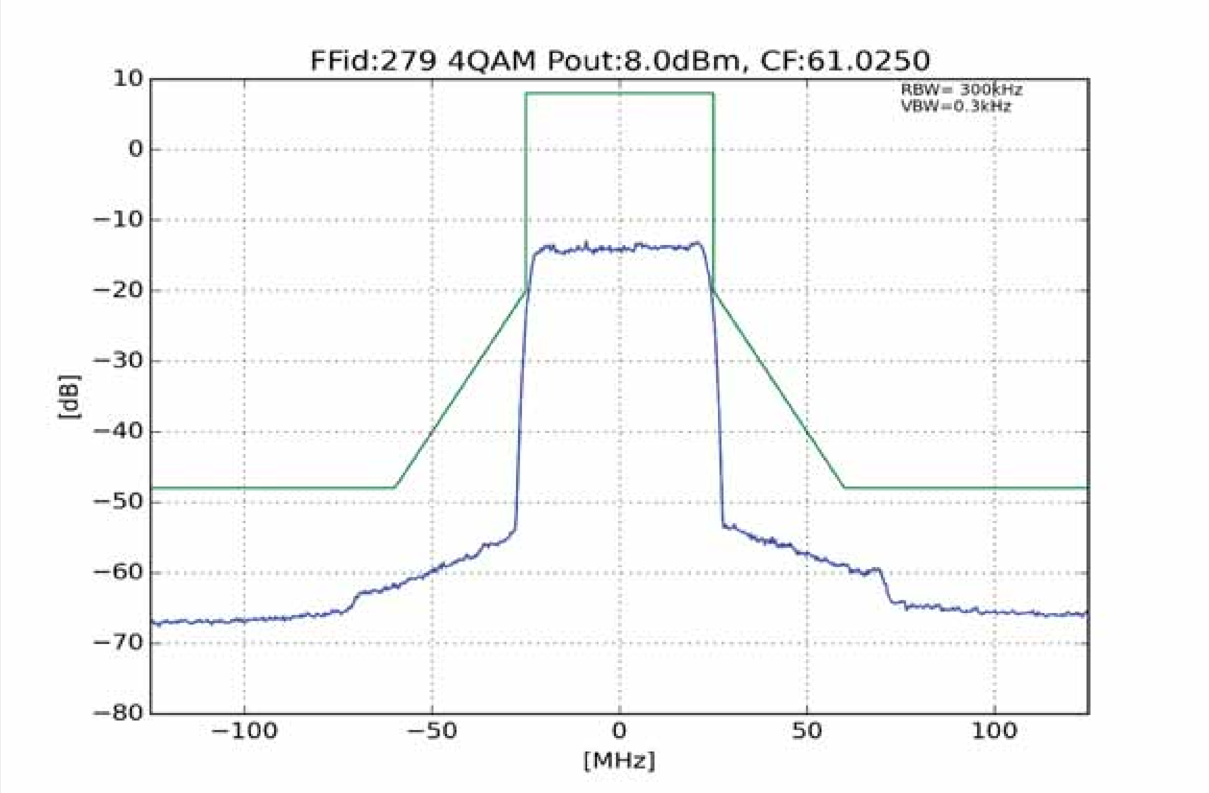
Plot 1: CS: 50 MHz, 4-256 QAM, top frequency, 20 °C



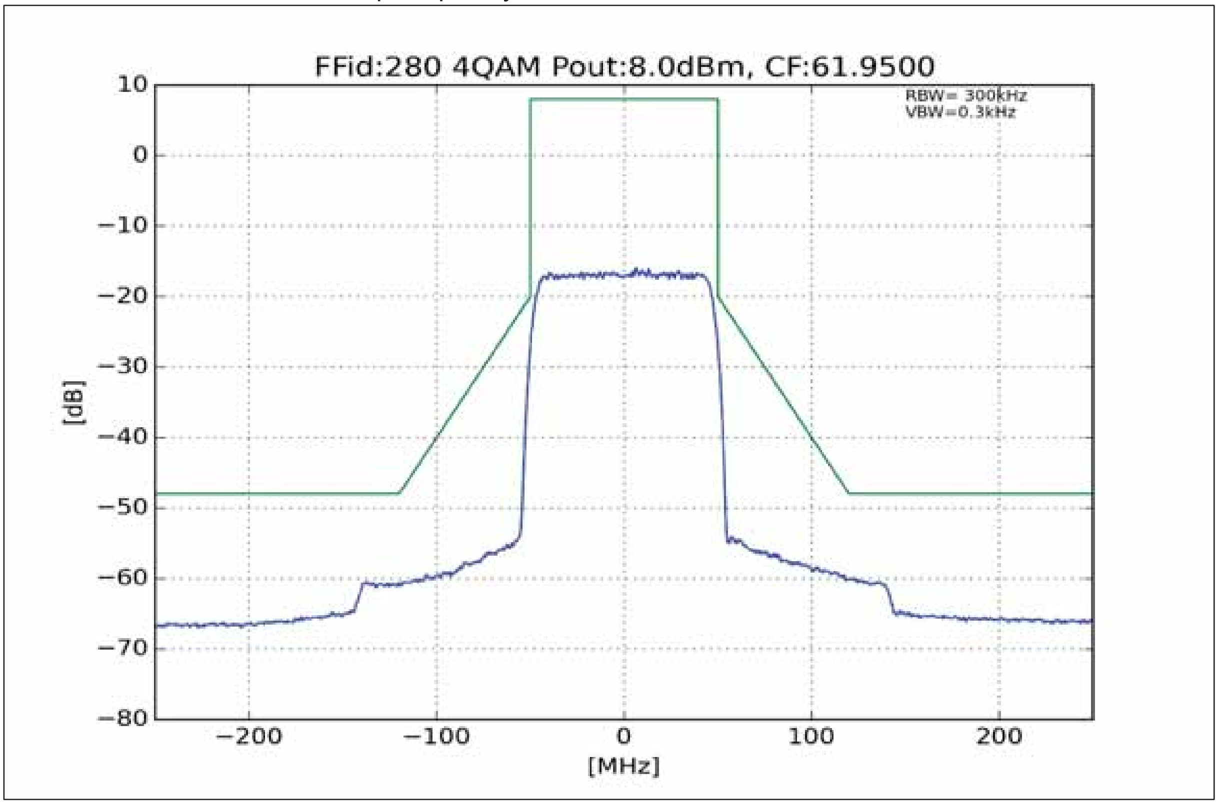
Plot 2: CS: 50 MHz, 4-256 QAM, middle frequency, 20 °C



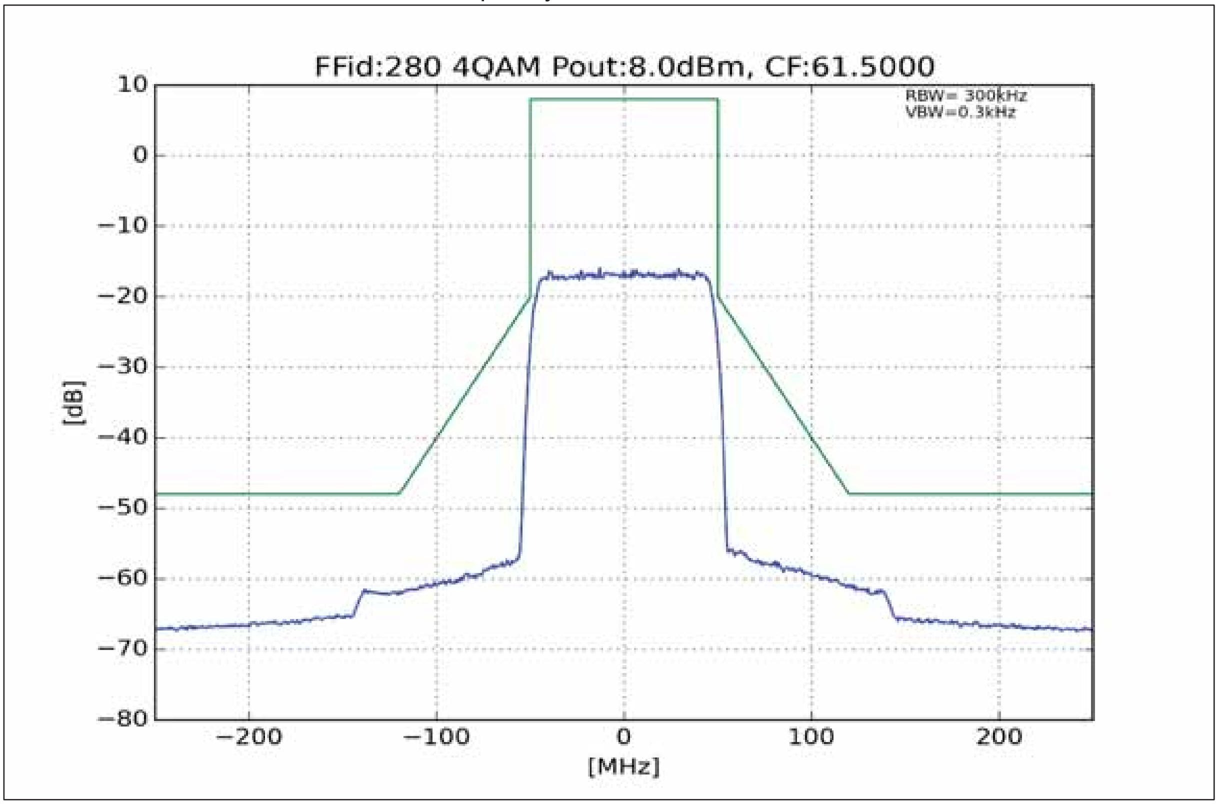
Plot 3: CS: 50 MHz, 4-256 QAM, bottom frequency, 20 °C



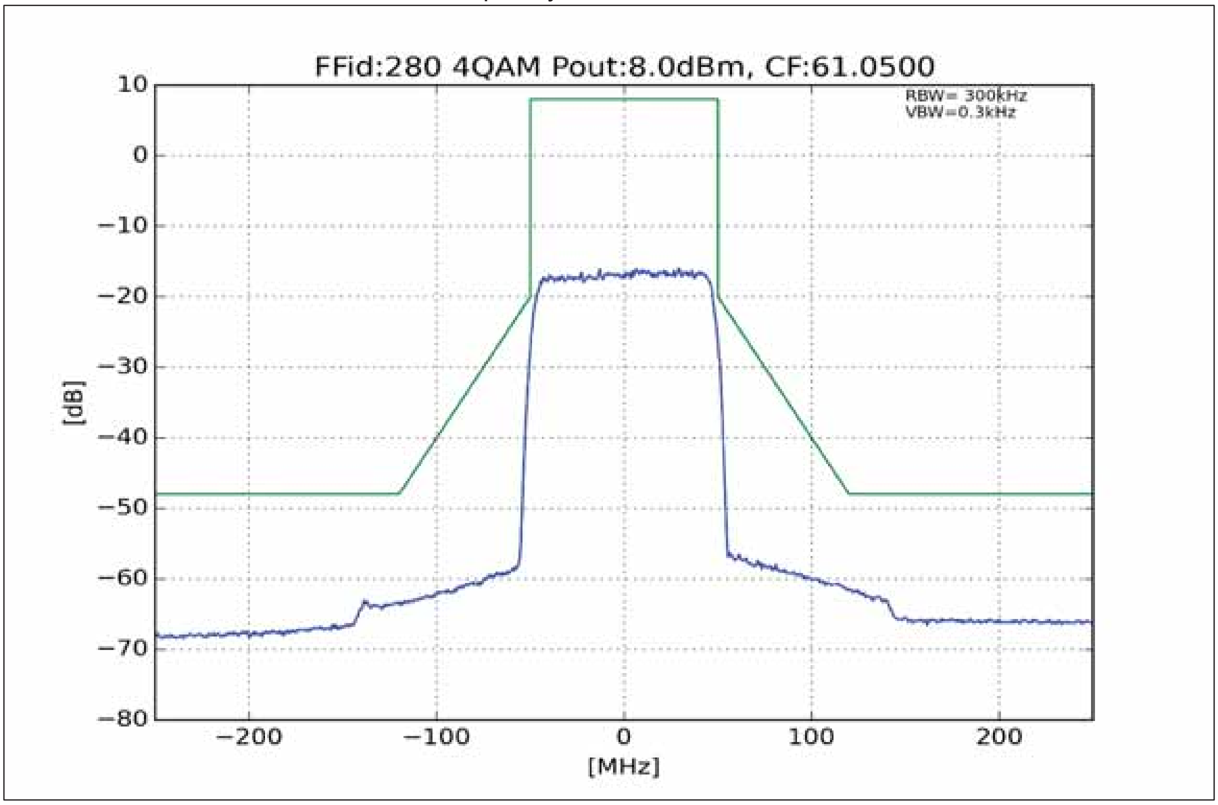
Plot 4: CS: 100 MHz, 4-256 QAM, top frequency, 20 °C



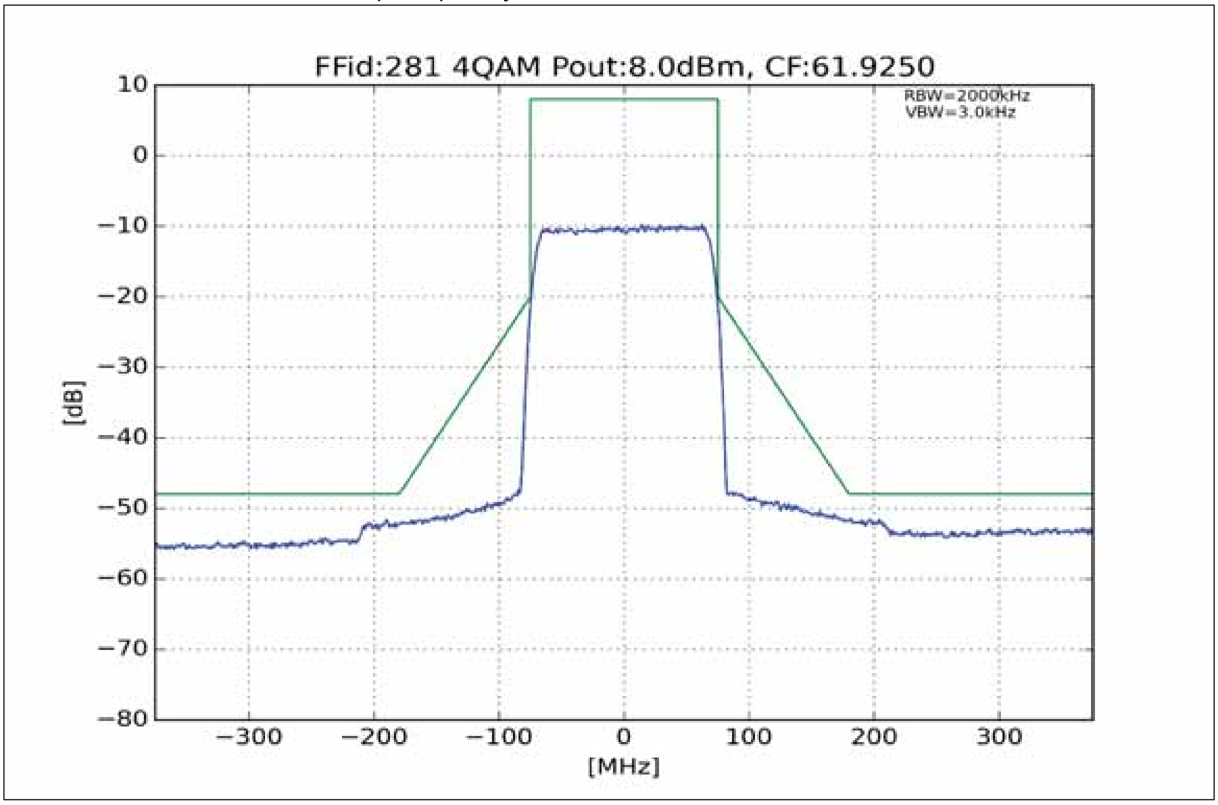
Plot 5: CS: 100 MHz, 4-256 QAM, middle frequency, 20 °C



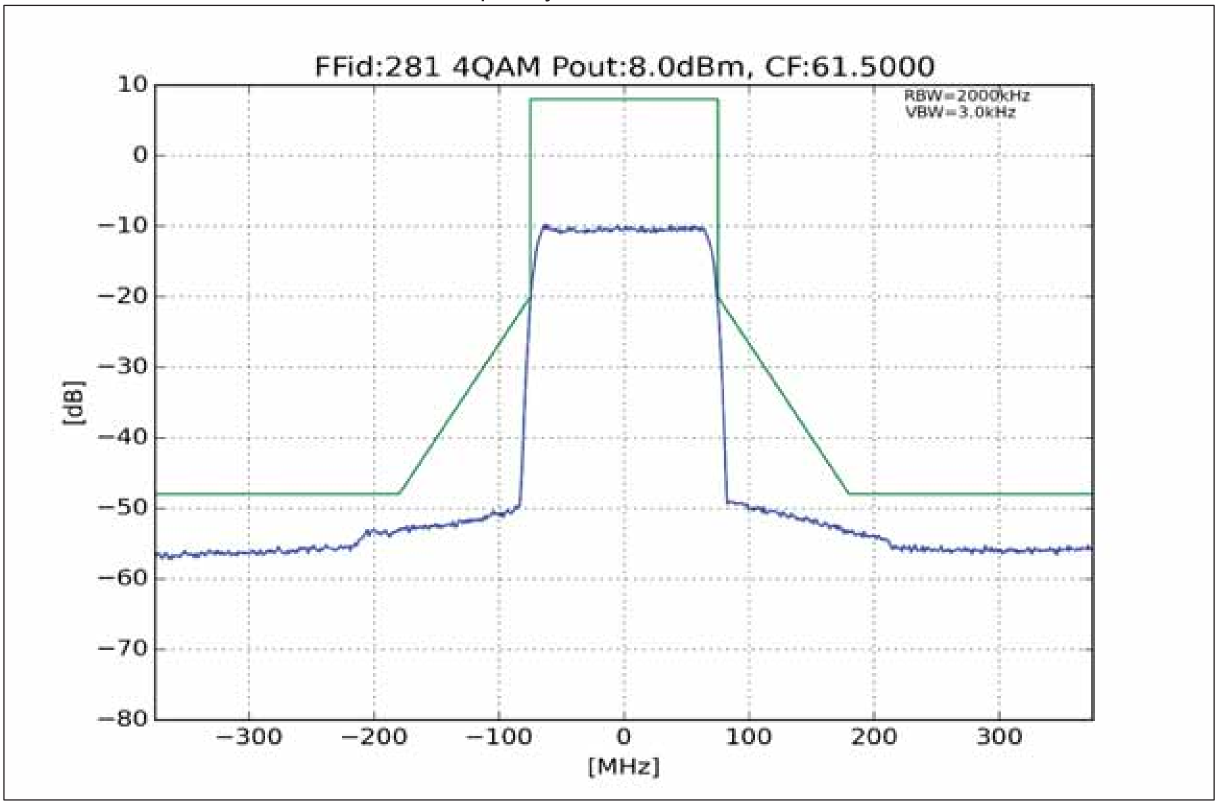
Plot 6: CS: 100 MHz, 4-256 QAM, bottom frequency, 20 °C



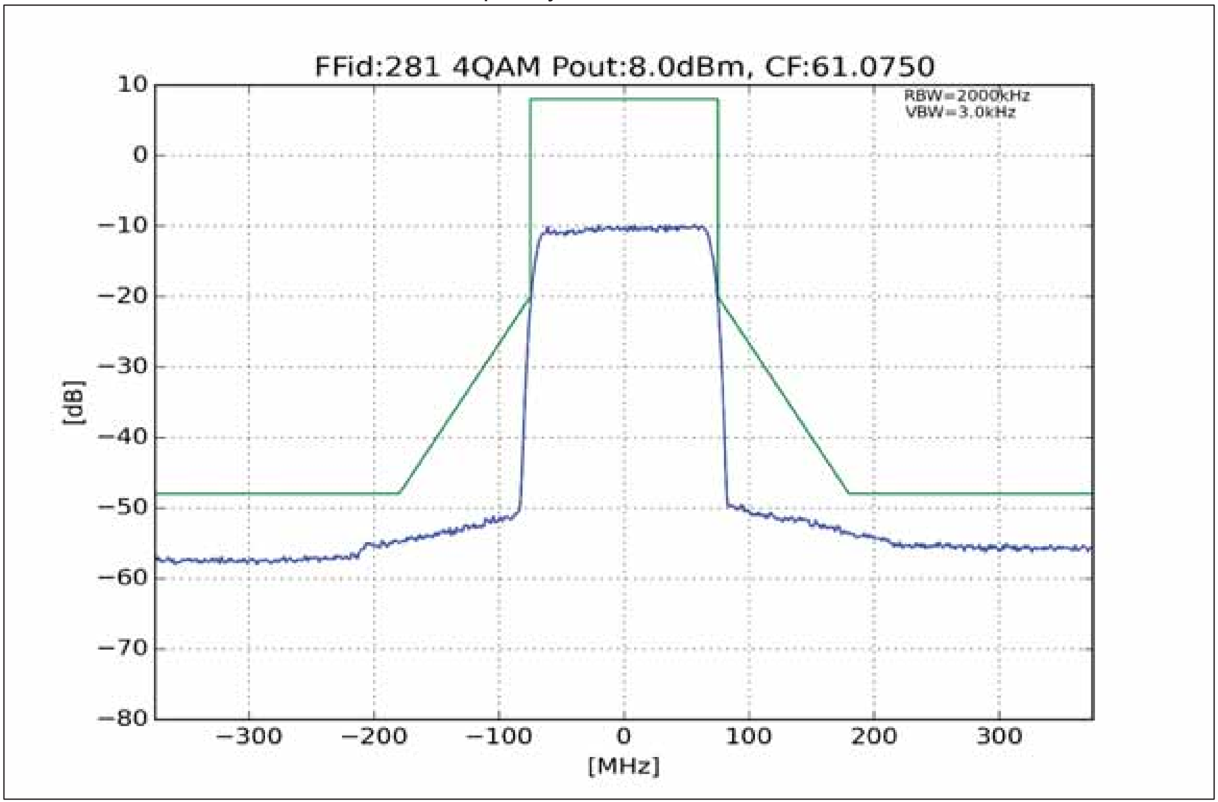
Plot 7: CS: 150 MHz, 4-256 QAM, top frequency, 20 °C



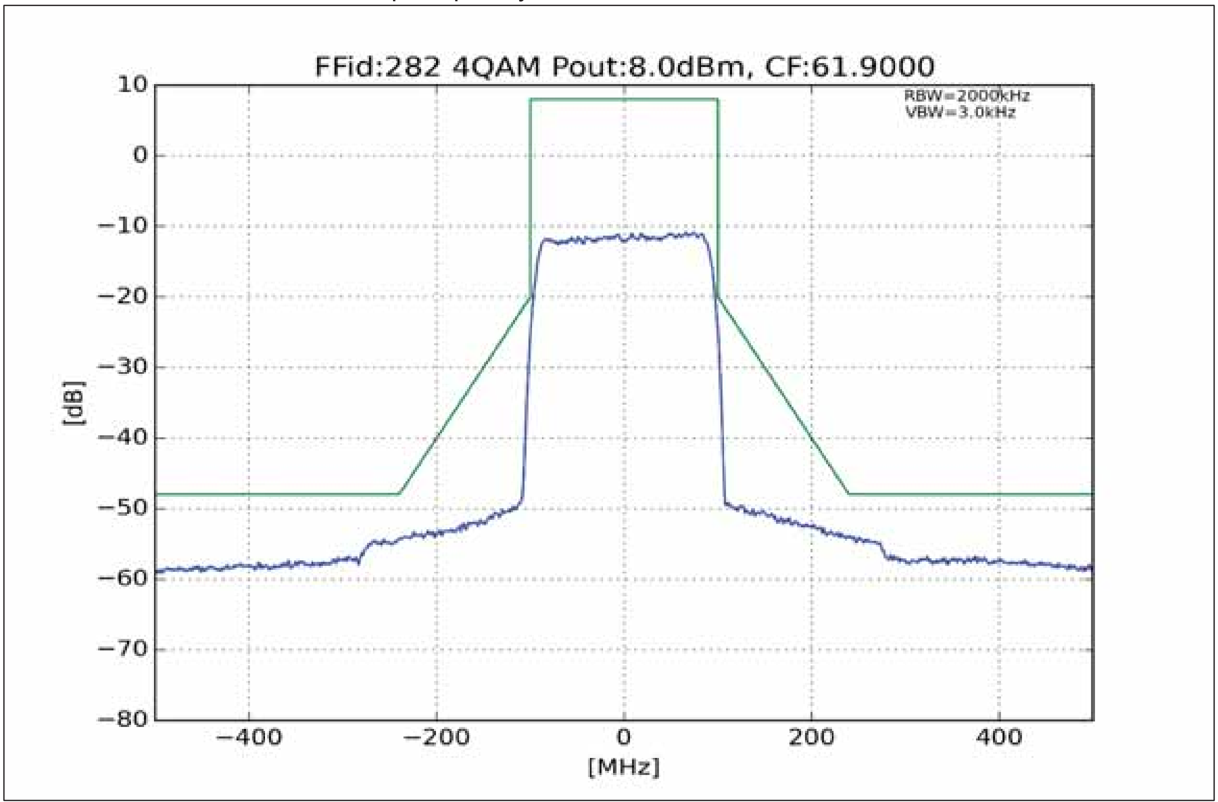
Plot 8: CS: 150 MHz, 4-256 QAM, middle frequency, 20 °C



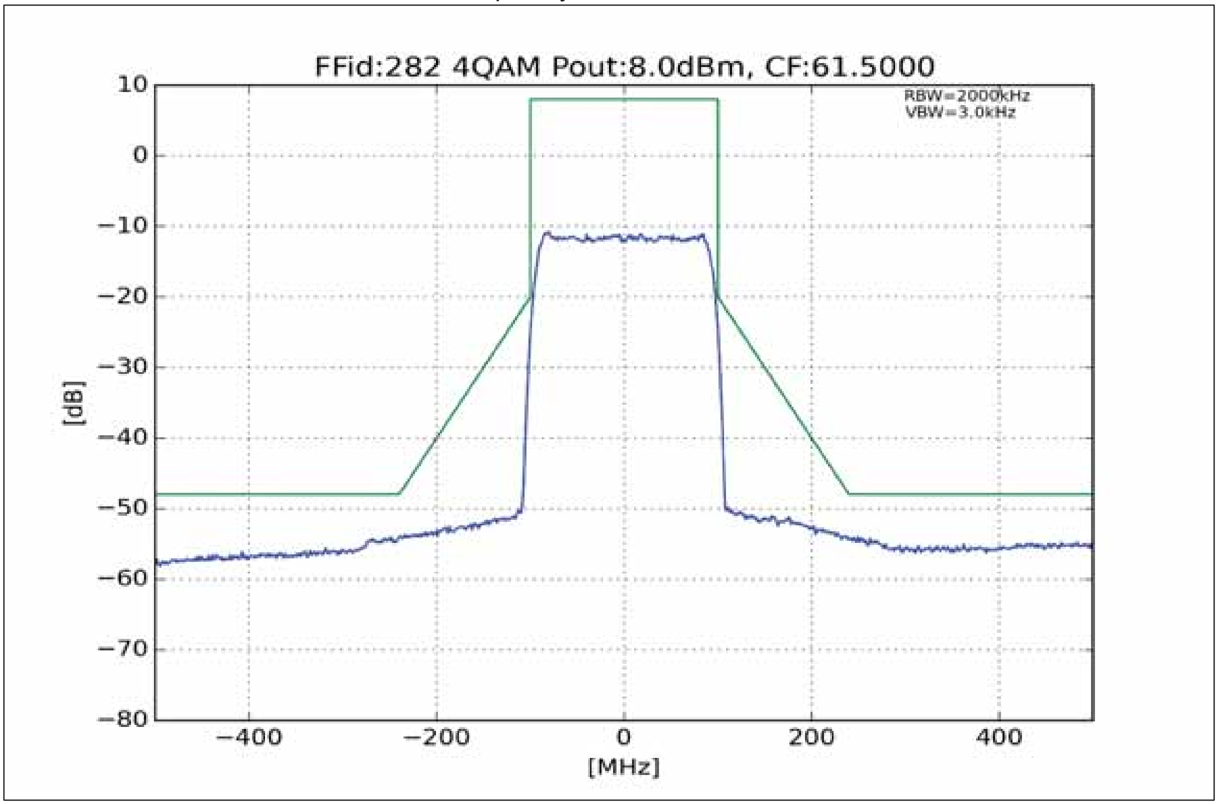
Plot 9: CS: 150 MHz, 4-256 QAM, bottom frequency, 20 °C



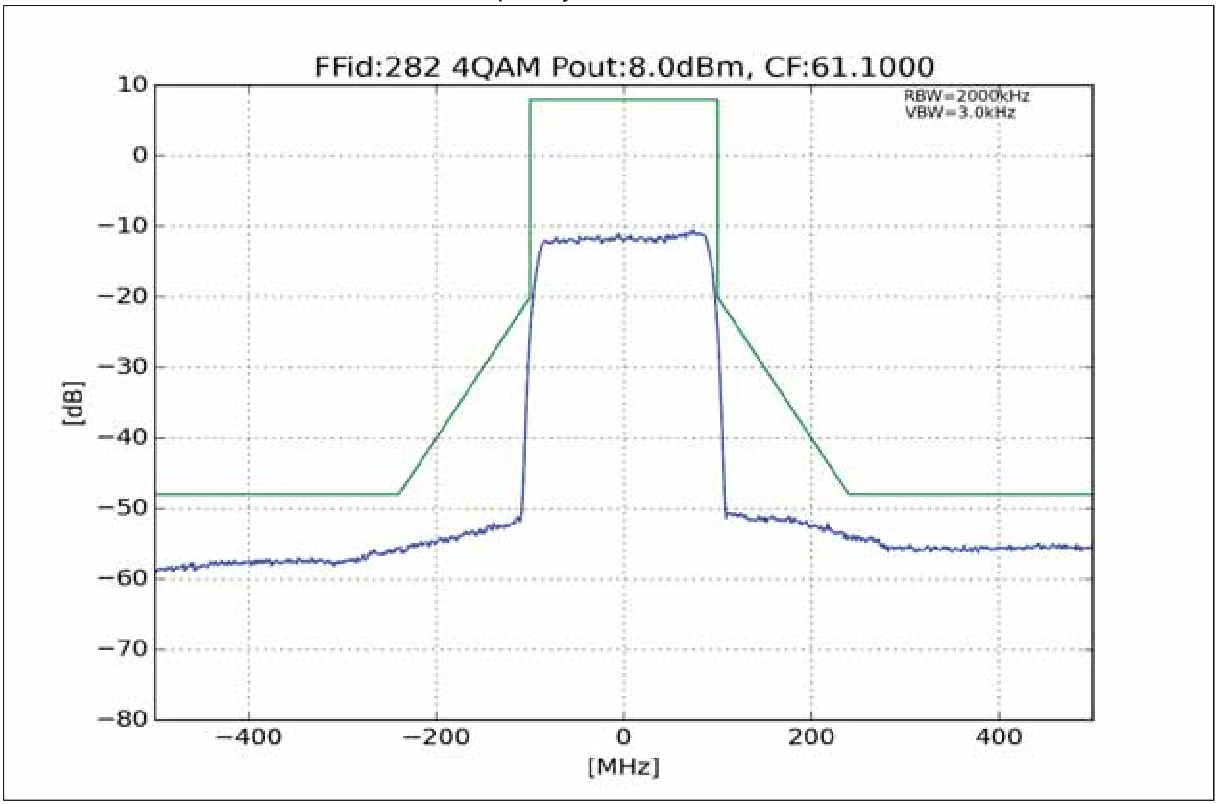
Plot 10: CS: 200 MHz, 4-128 QAM, top frequency, 20 °C



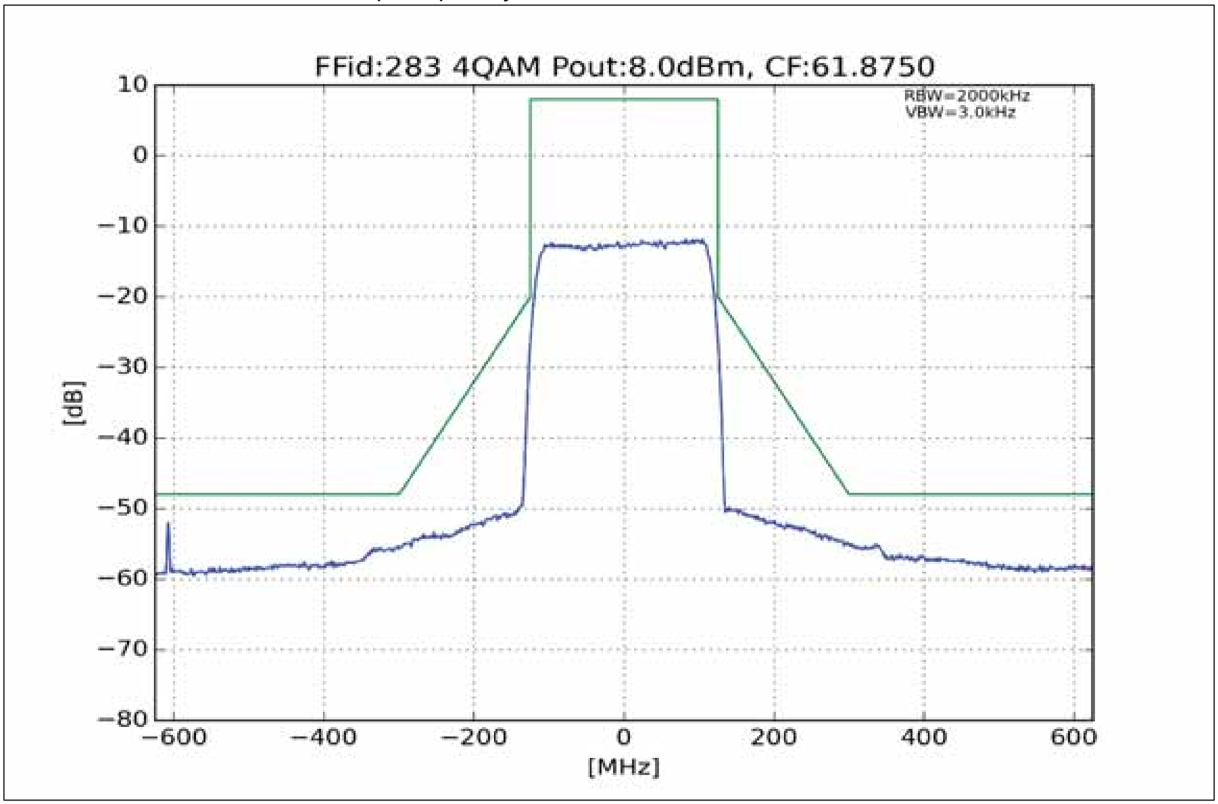
Plot 11: CS: 200 MHz, 4-128 QAM, middle frequency, 20 °C



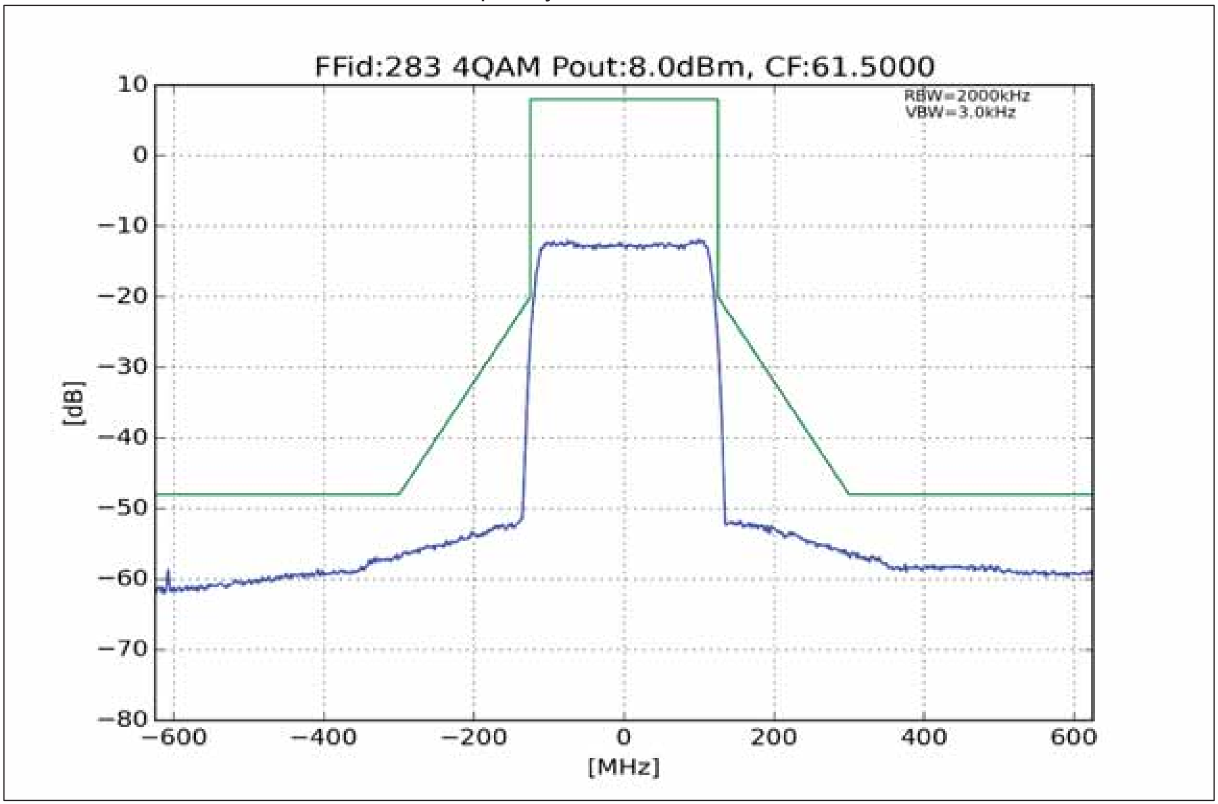
Plot 12: CS: 200 MHz, 4-128 QAM, bottom frequency, 20 °C



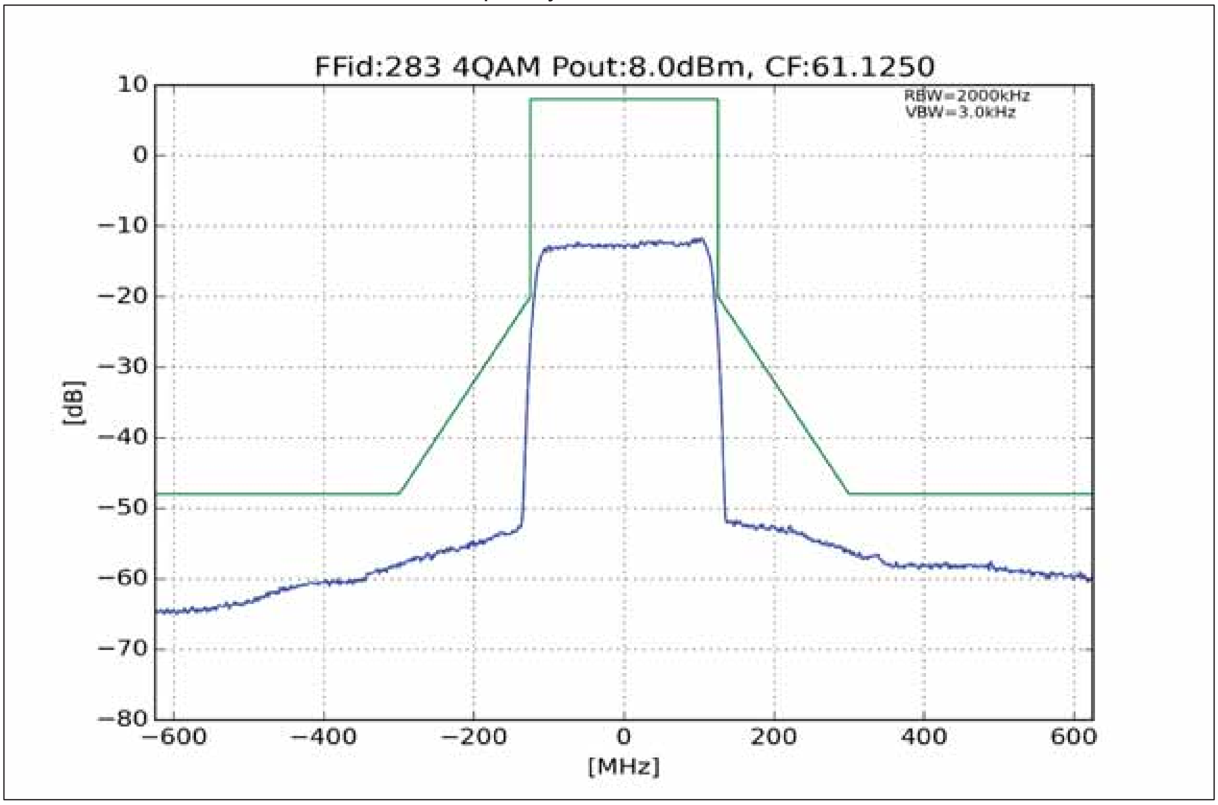
Plot 13: CS: 250 MHz, 4-64 QAM, top frequency, 20 °C



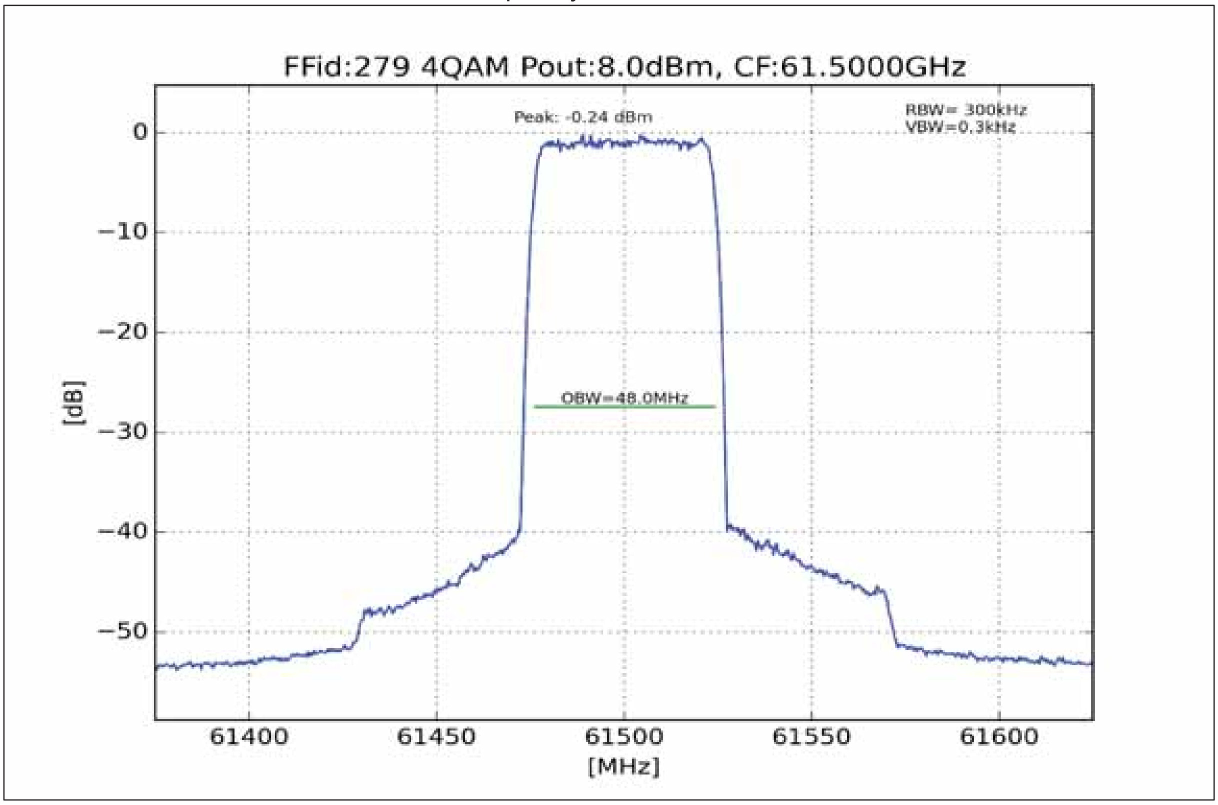
Plot 14: CS: 250 MHz, 4-64 QAM, middle frequency, 20 °C



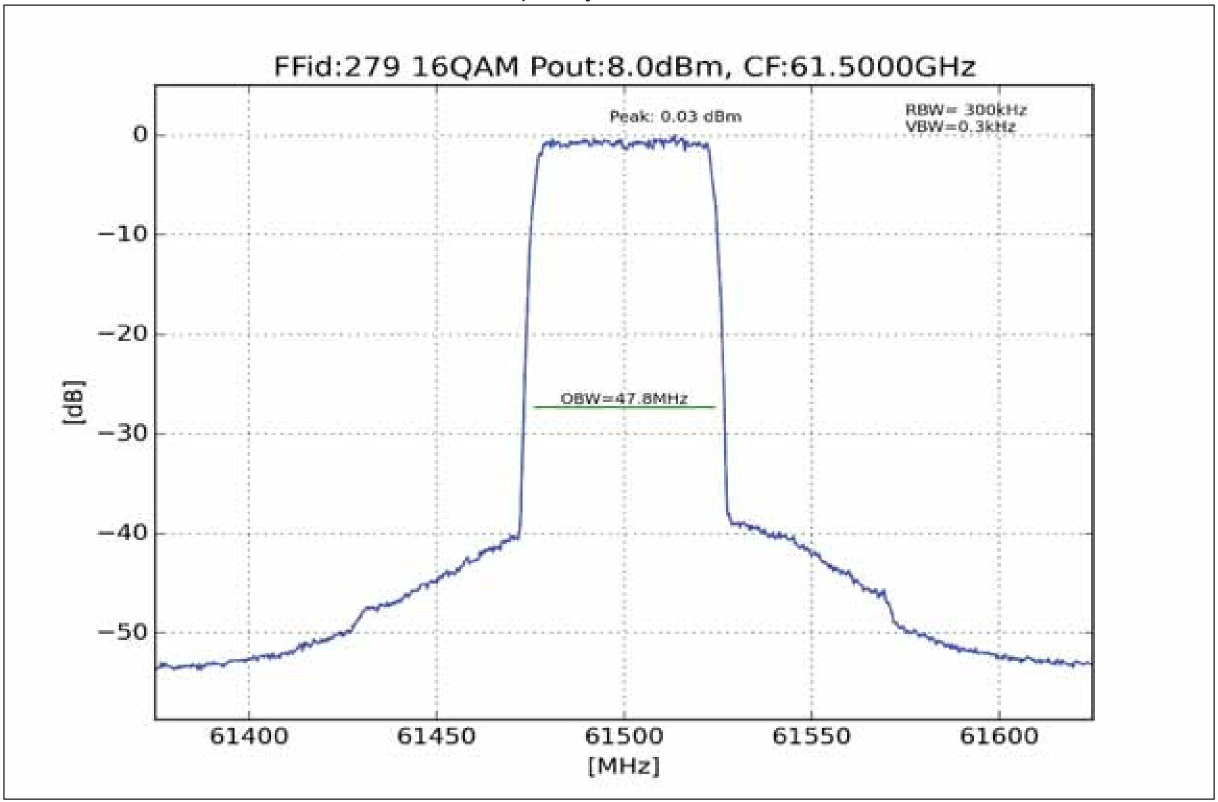
Plot 15: CS: 250 MHz, 4-64 QAM, bottom frequency, 20 °C



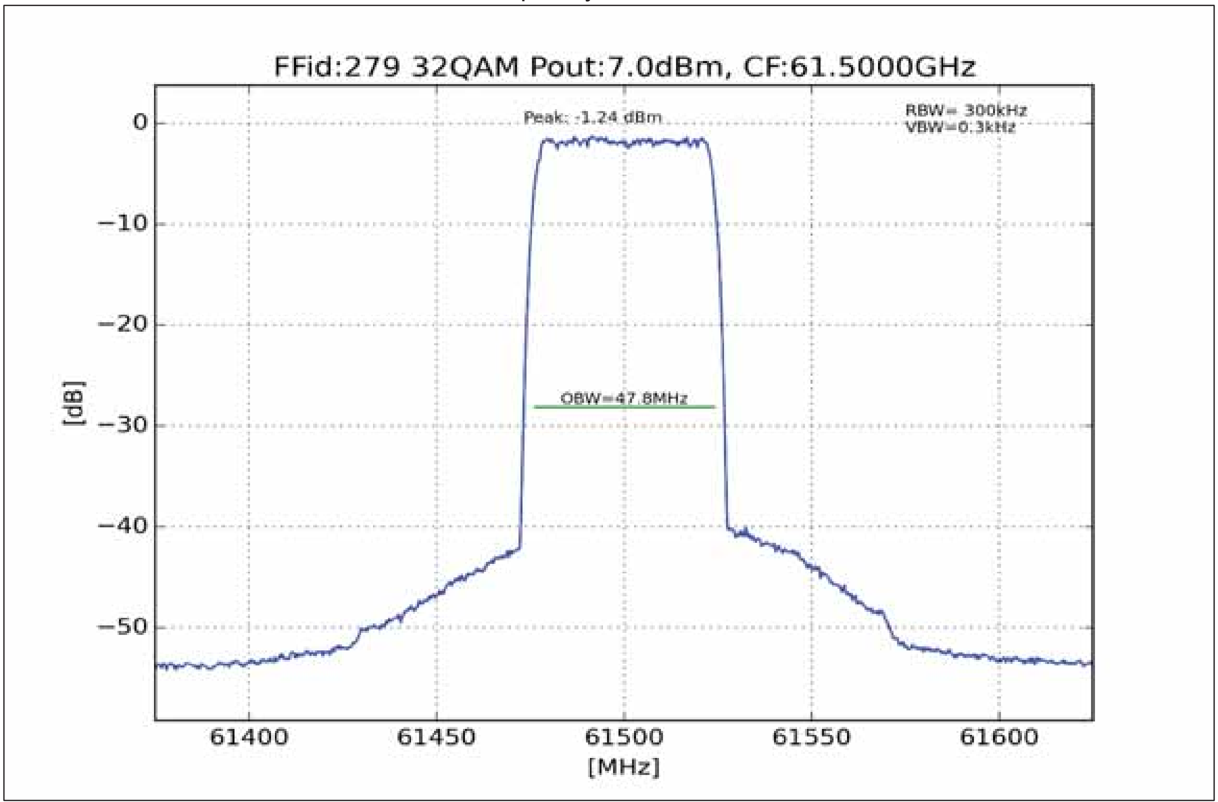
Plot 16: CS: 50 MHz, 4 QAM, OBW, middle frequency



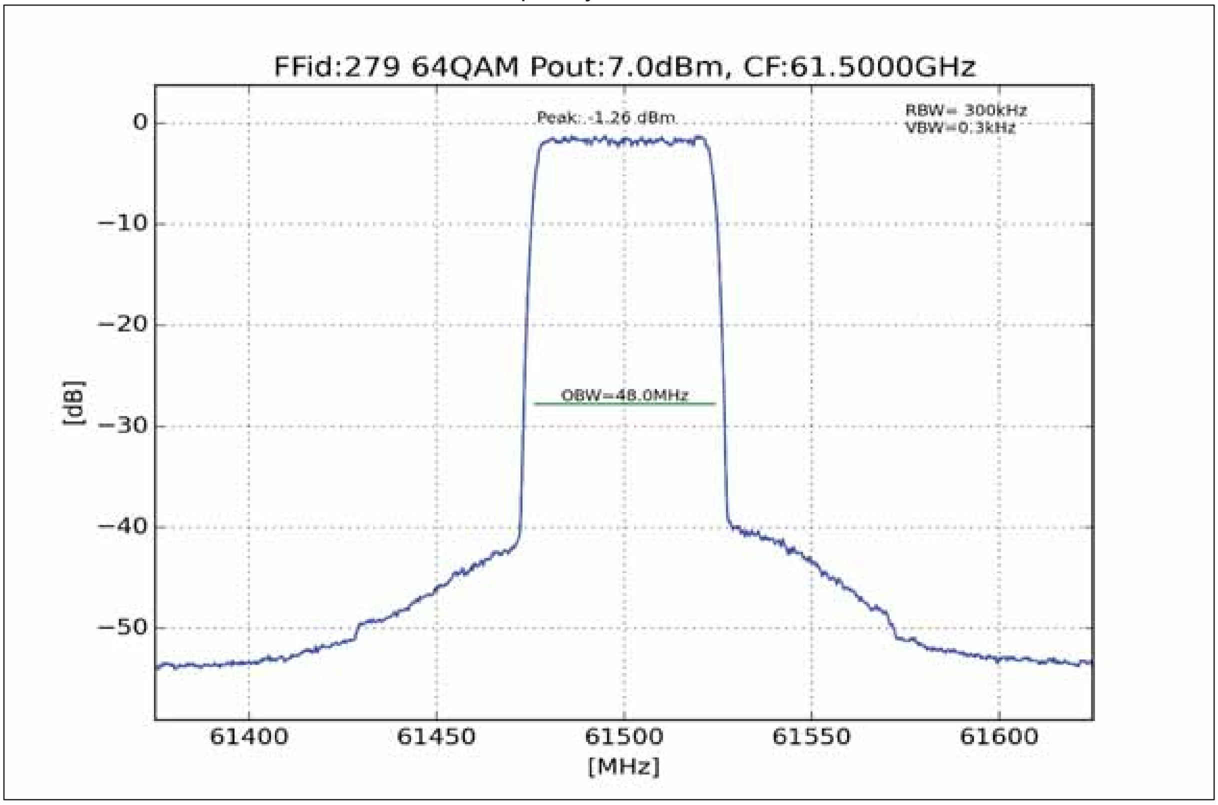
Plot 17: CS: 50 MHz, 16 QAM, OBW, middle frequency



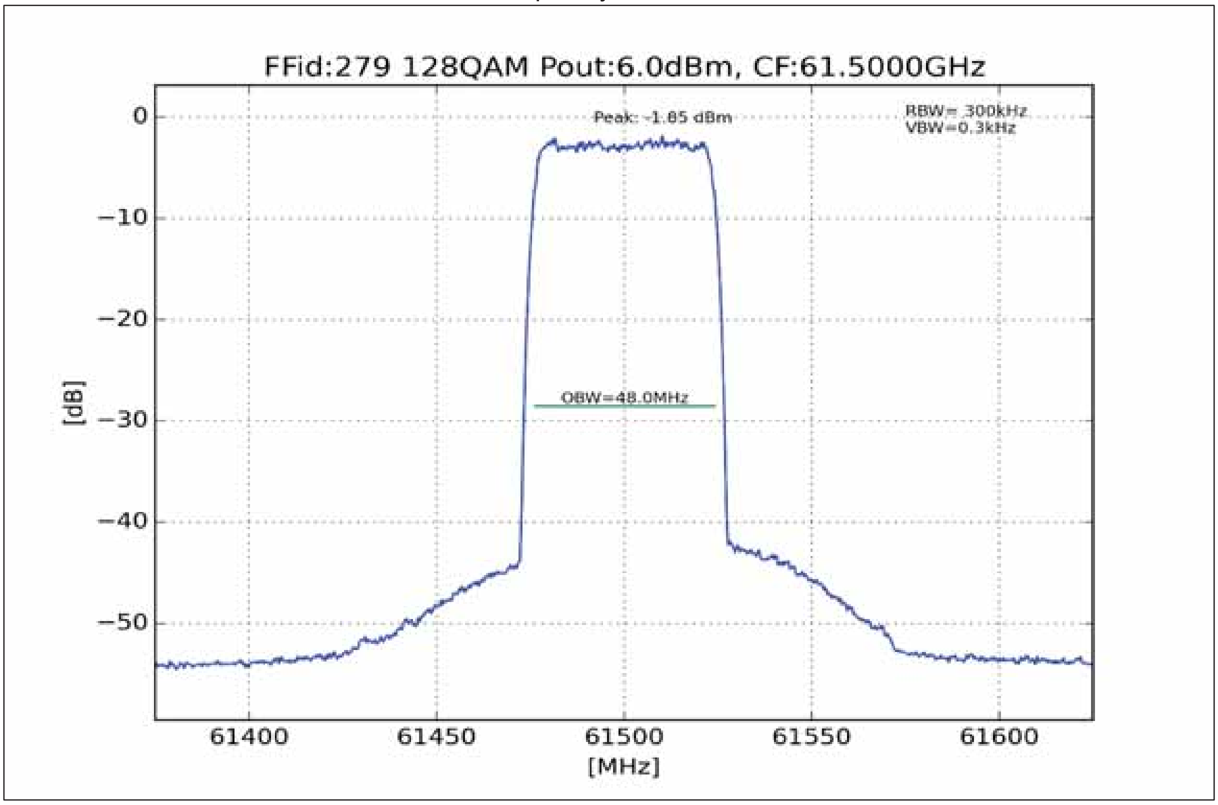
Plot 18: CS: 50 MHz, 32 QAM, OBW, middle frequency



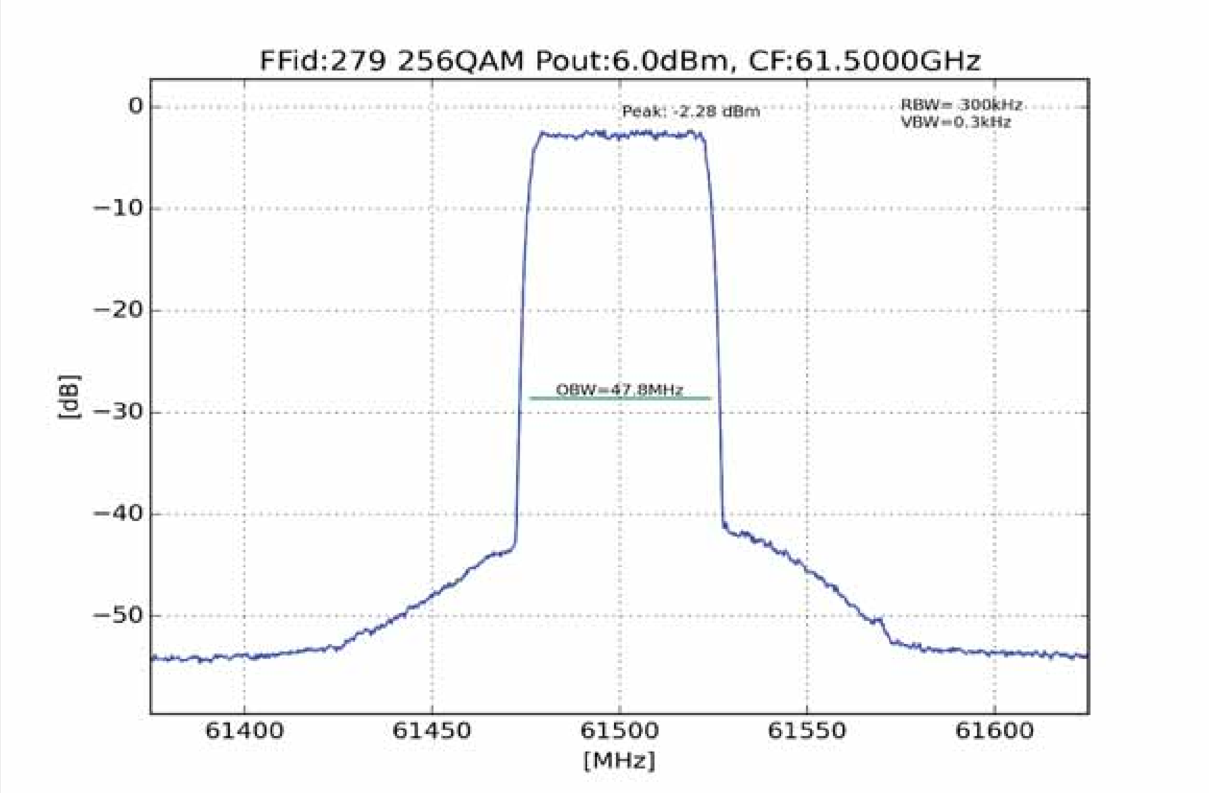
Plot 19: CS: 50 MHz, 64 QAM, OBW, middle frequency



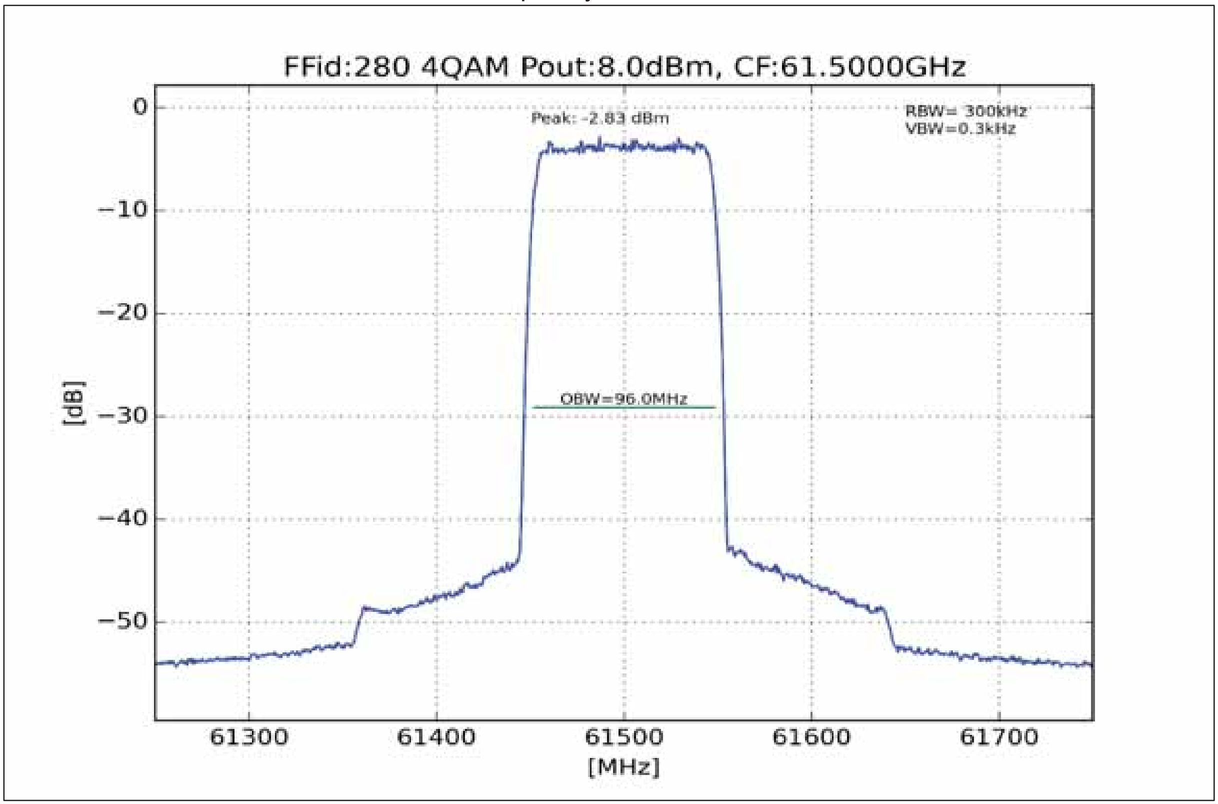
Plot 20: CS: 50 MHz, 128 QAM, OBW, middle frequency



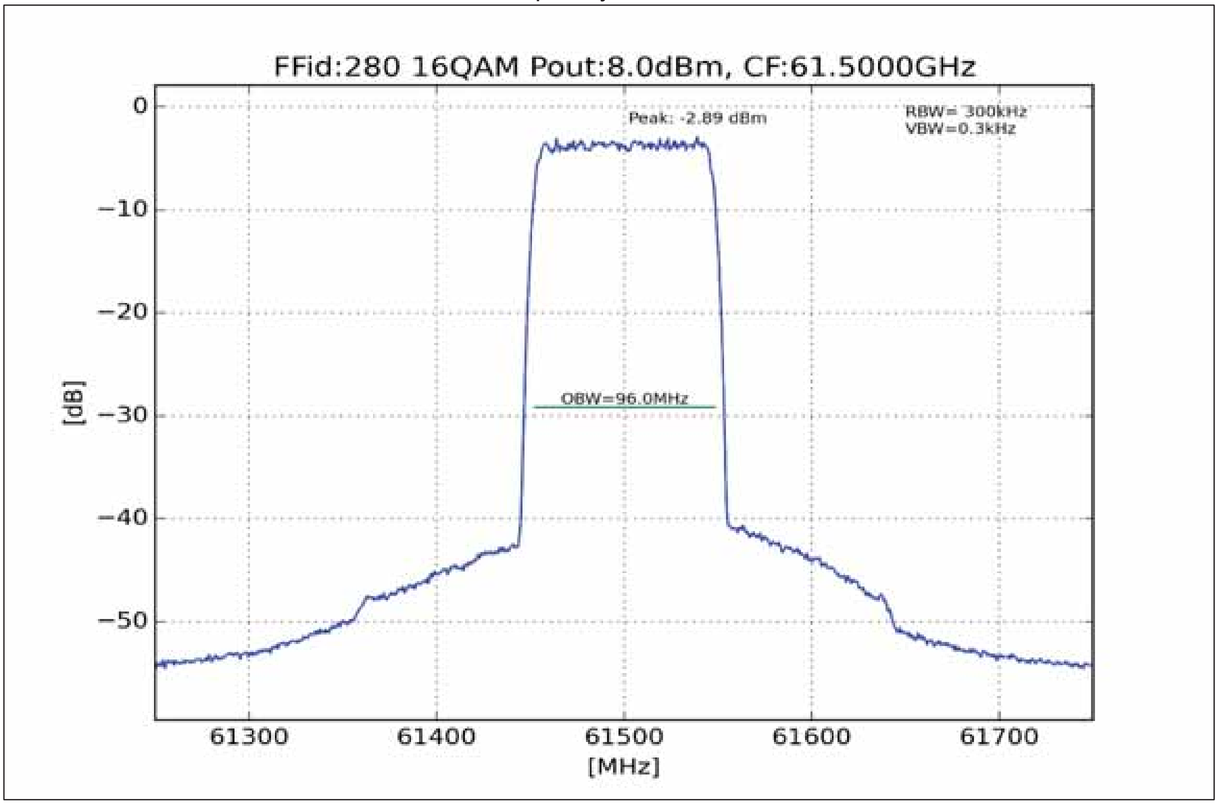
Plot 21: CS: 50 MHz, 256 QAM, OBW, middle frequency



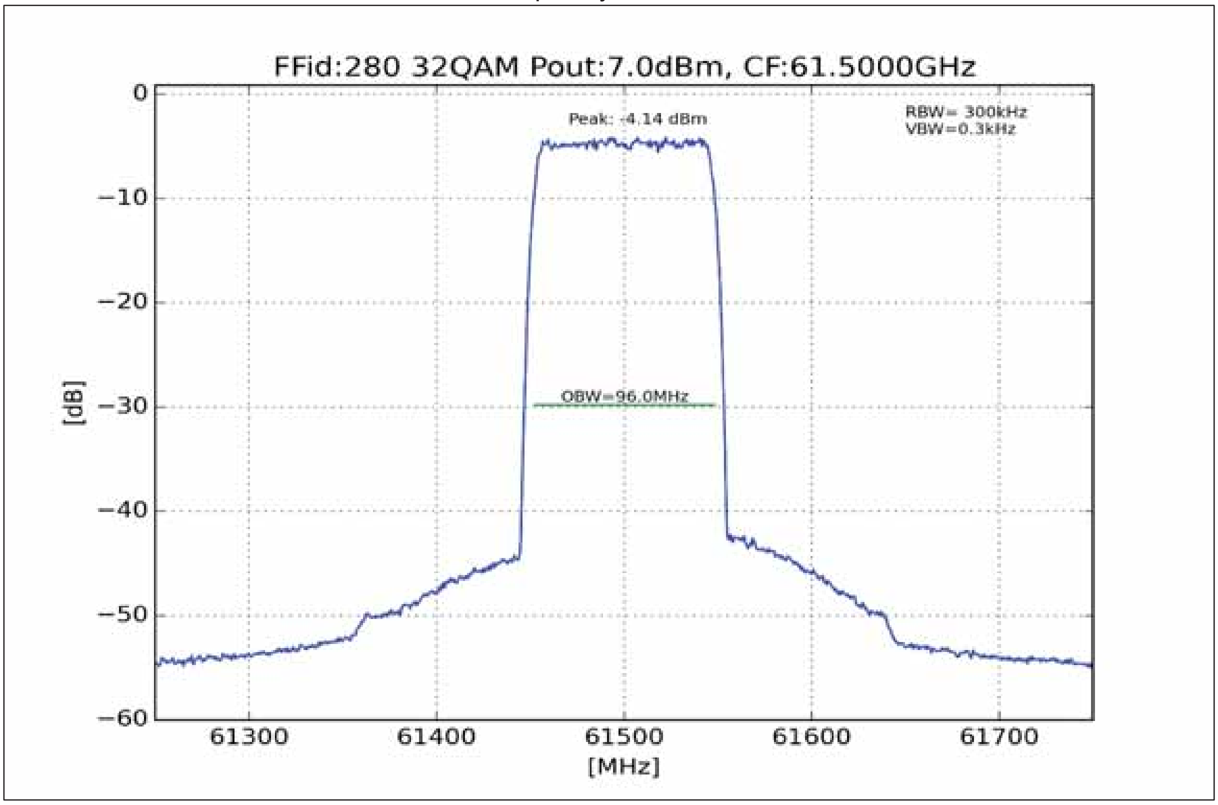
Plot 22: CS: 100 MHz, 4 QAM, OBW, middle frequency



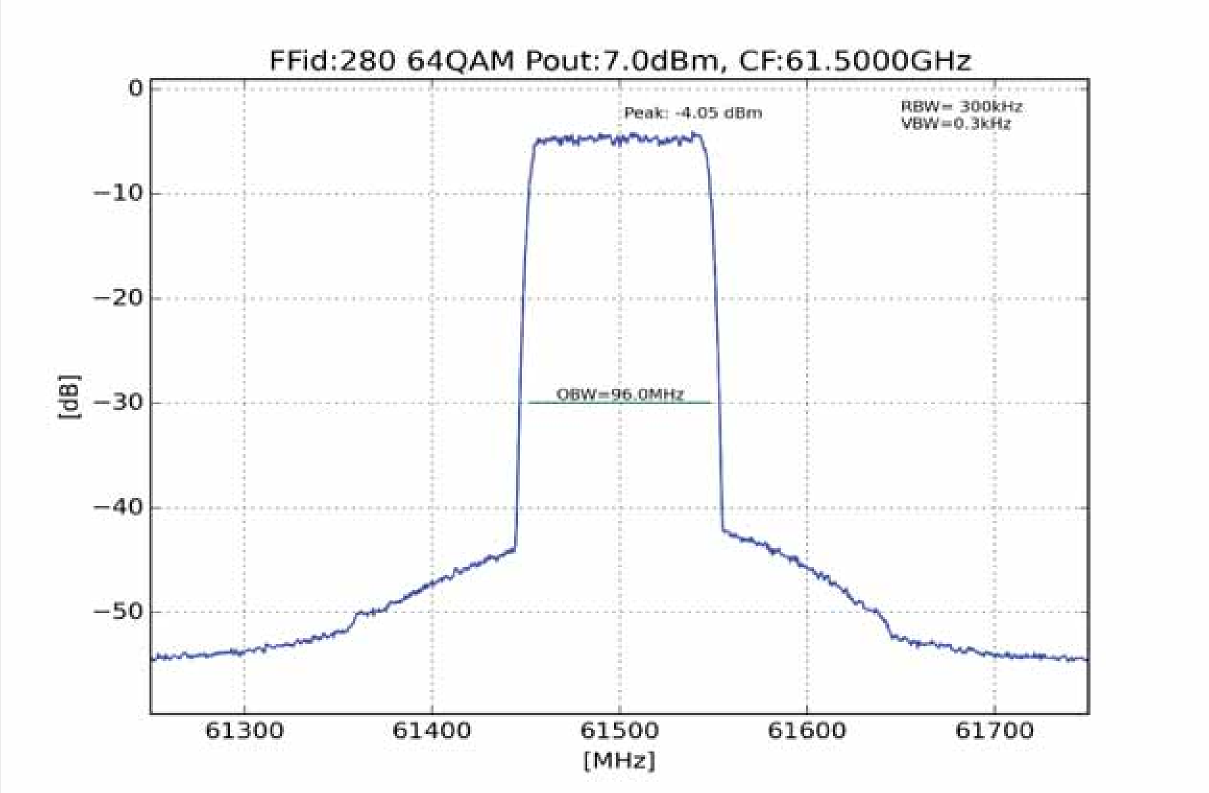
Plot 23: CS: 100 MHz, 16 QAM, OBW, middle frequency



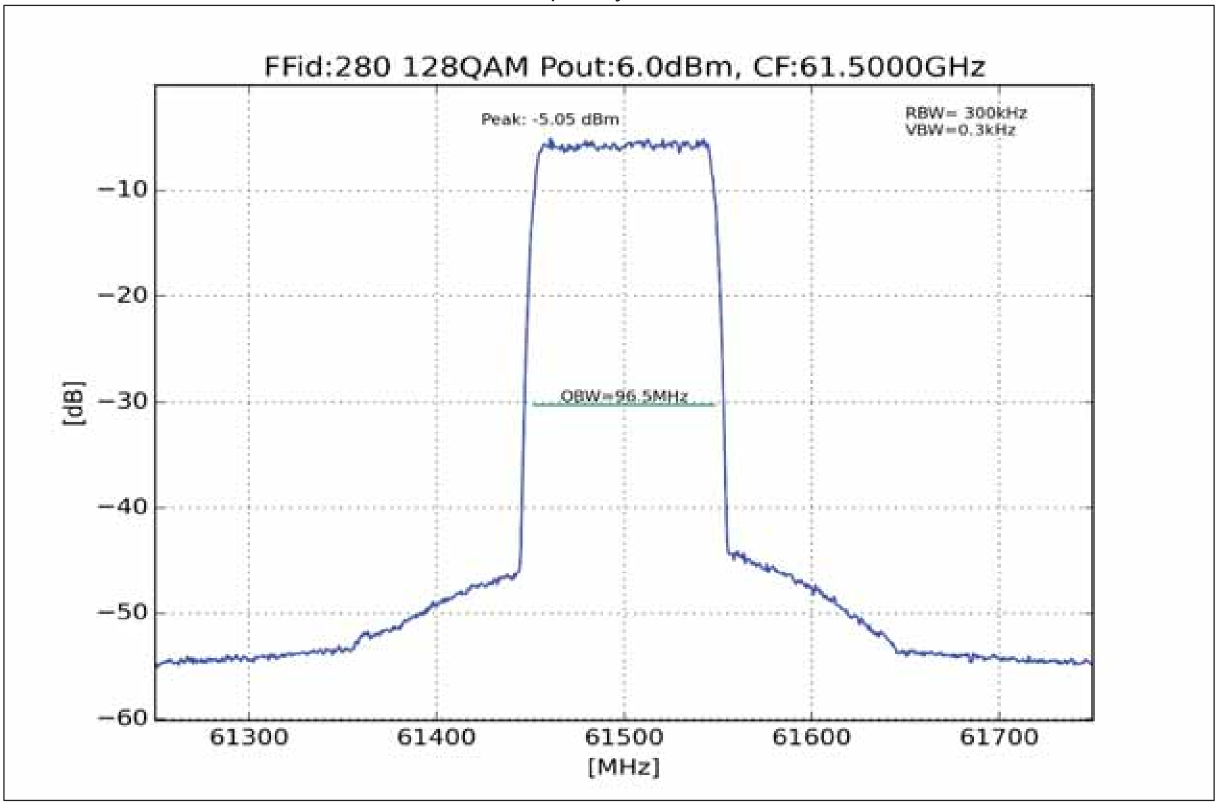
Plot 24: CS: 100 MHz, 32 QAM, OBW, middle frequency



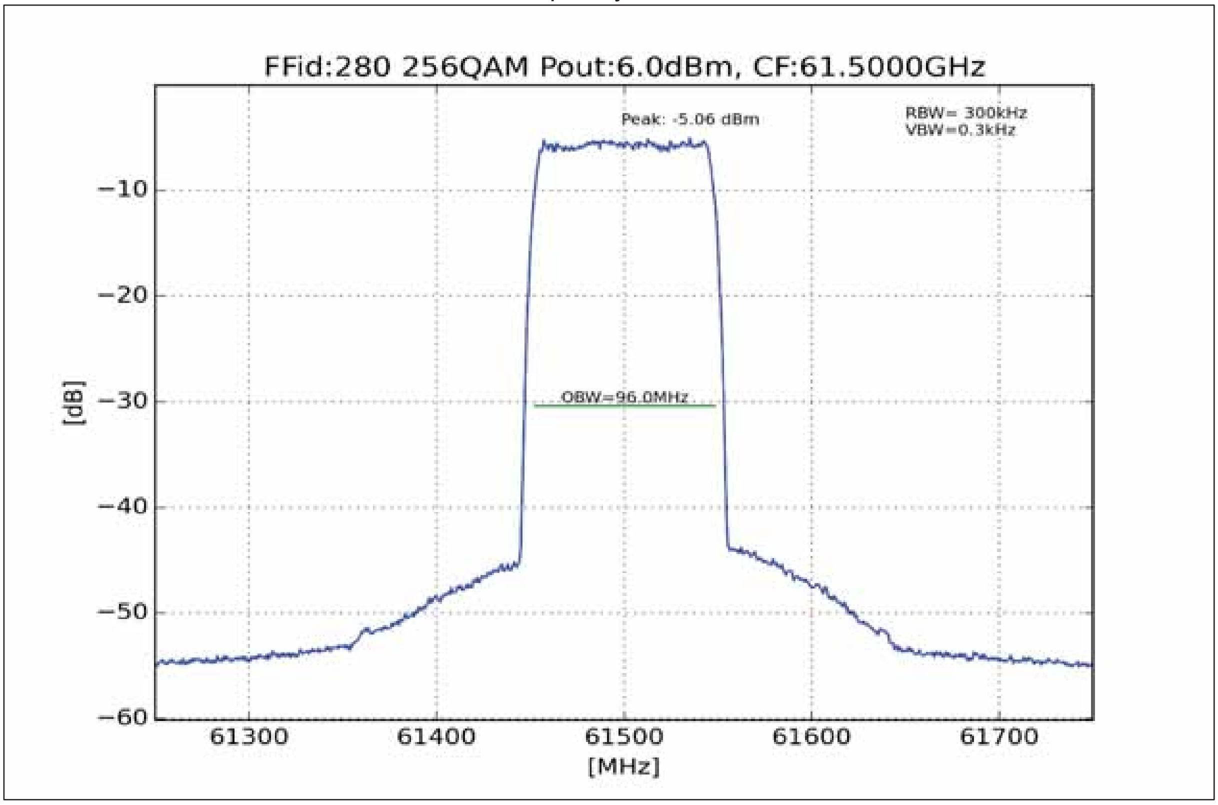
Plot 25: CS: 100 MHz, 64 QAM, OBW, middle frequency



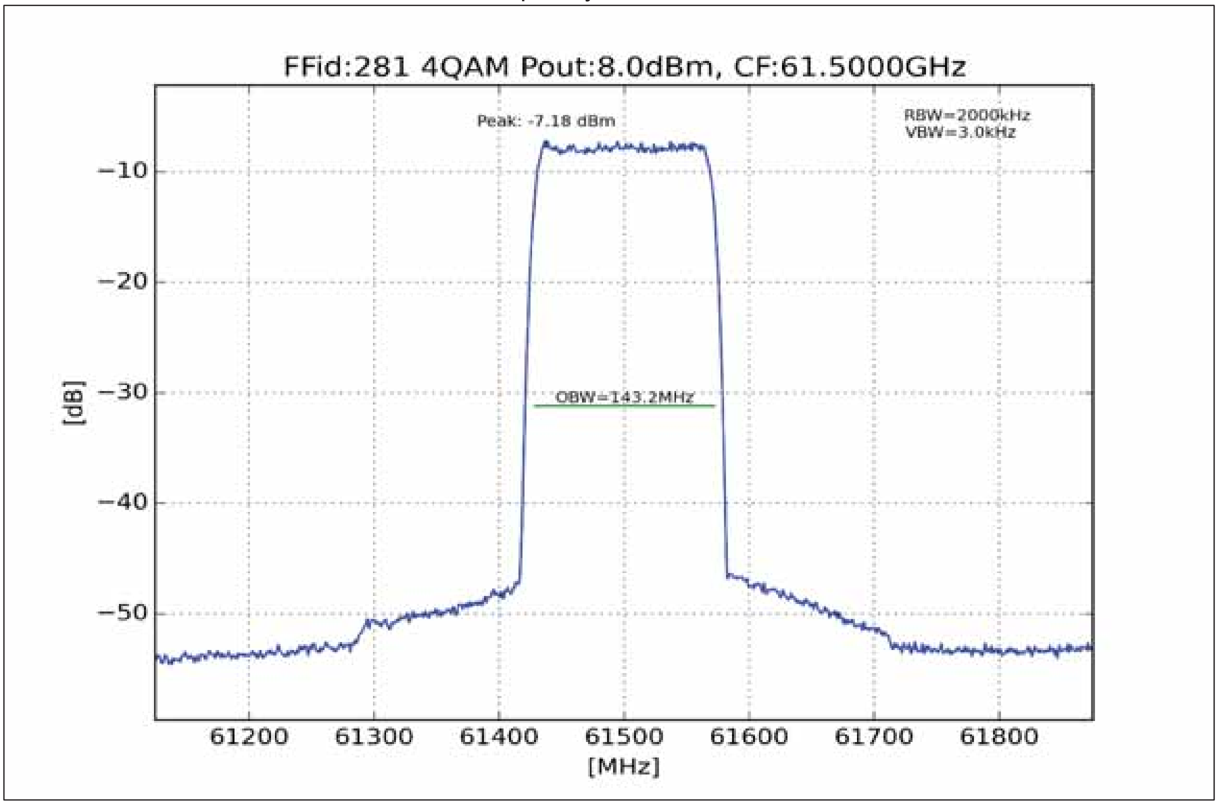
Plot 26: CS: 100 MHz, 128 QAM, OBW, middle frequency



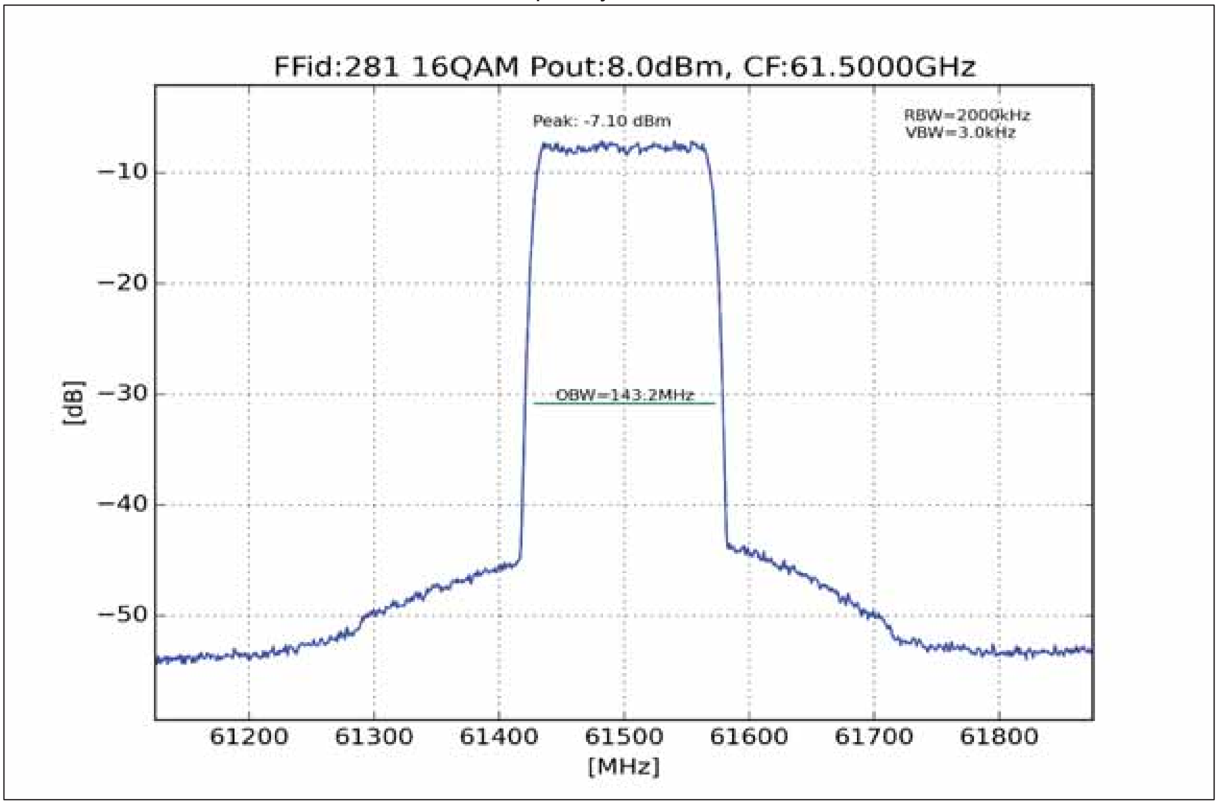
Plot 27: CS: 100 MHz, 256 QAM, OBW, middle frequency



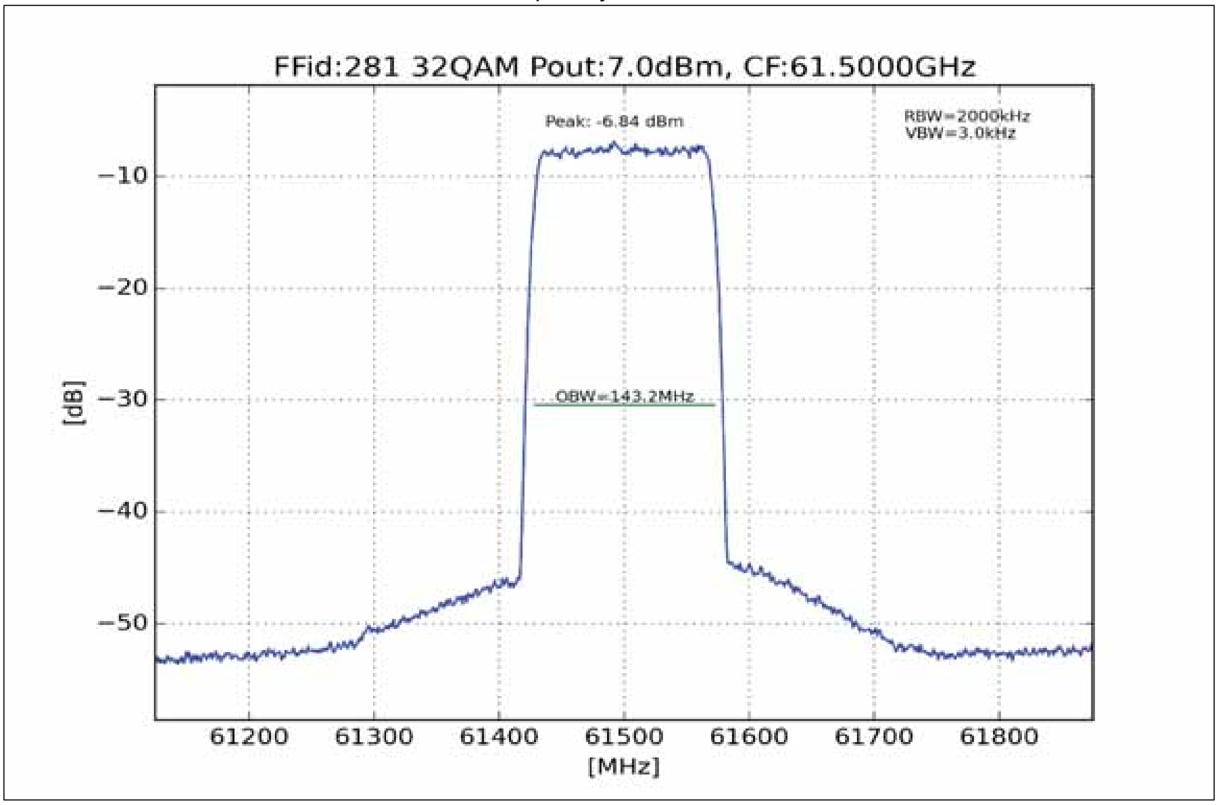
Plot 28: CS: 150 MHz, 4 QAM, OBW, middle frequency



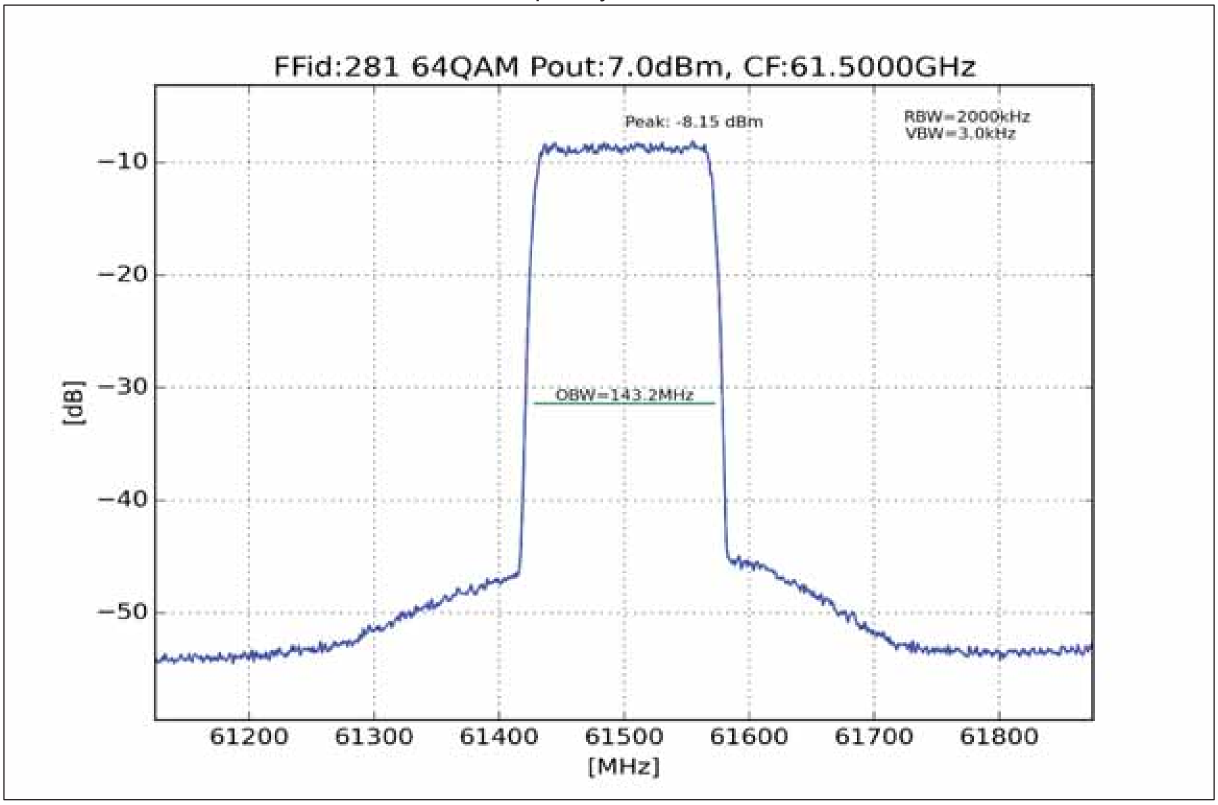
Plot 29: CS: 150 MHz, 16 QAM, OBW, middle frequency



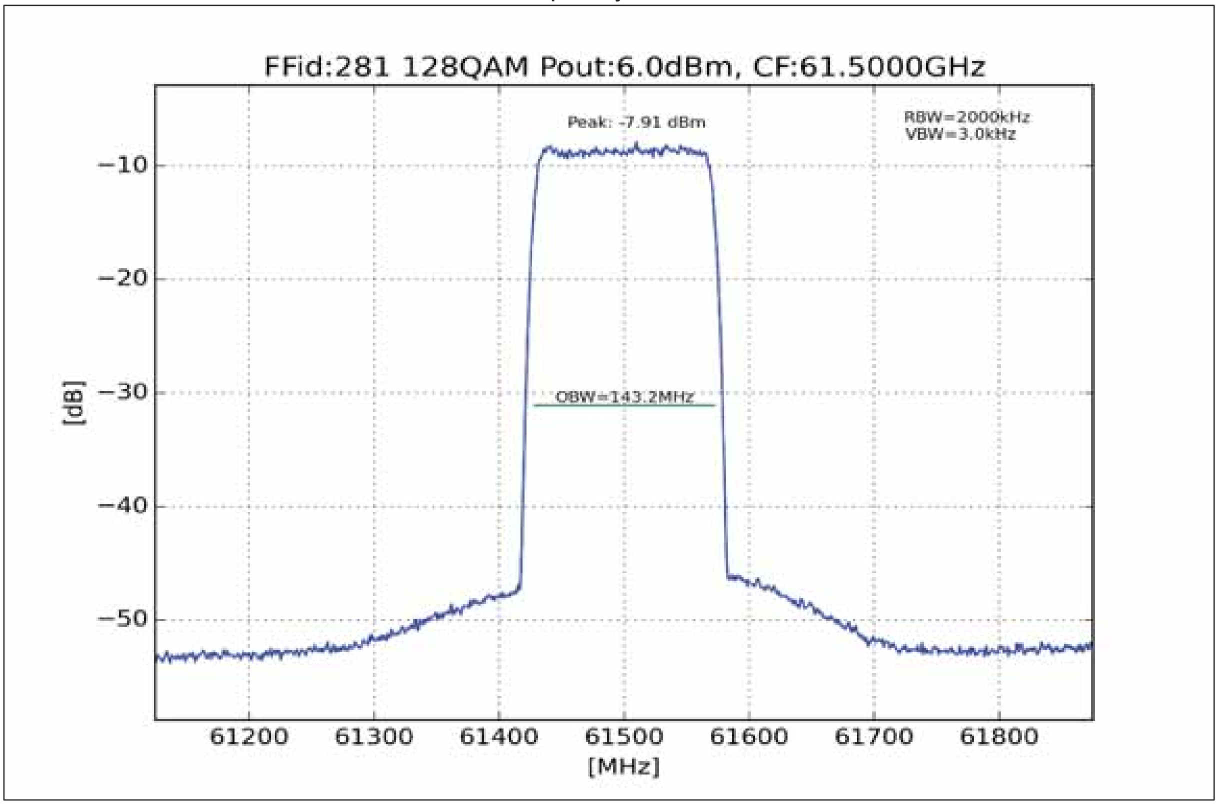
Plot 30: CS: 150 MHz, 32 QAM, OBW, middle frequency



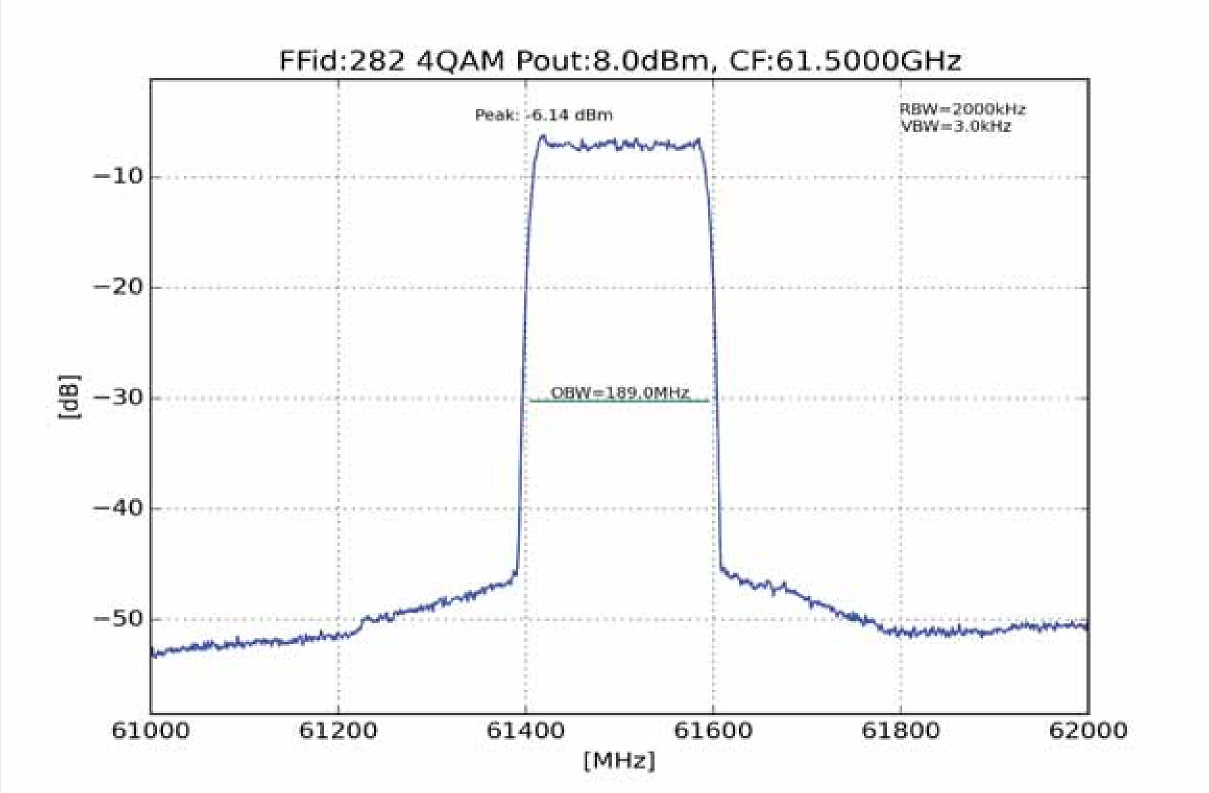
Plot 31: CS: 150 MHz, 64 QAM, OBW, middle frequency



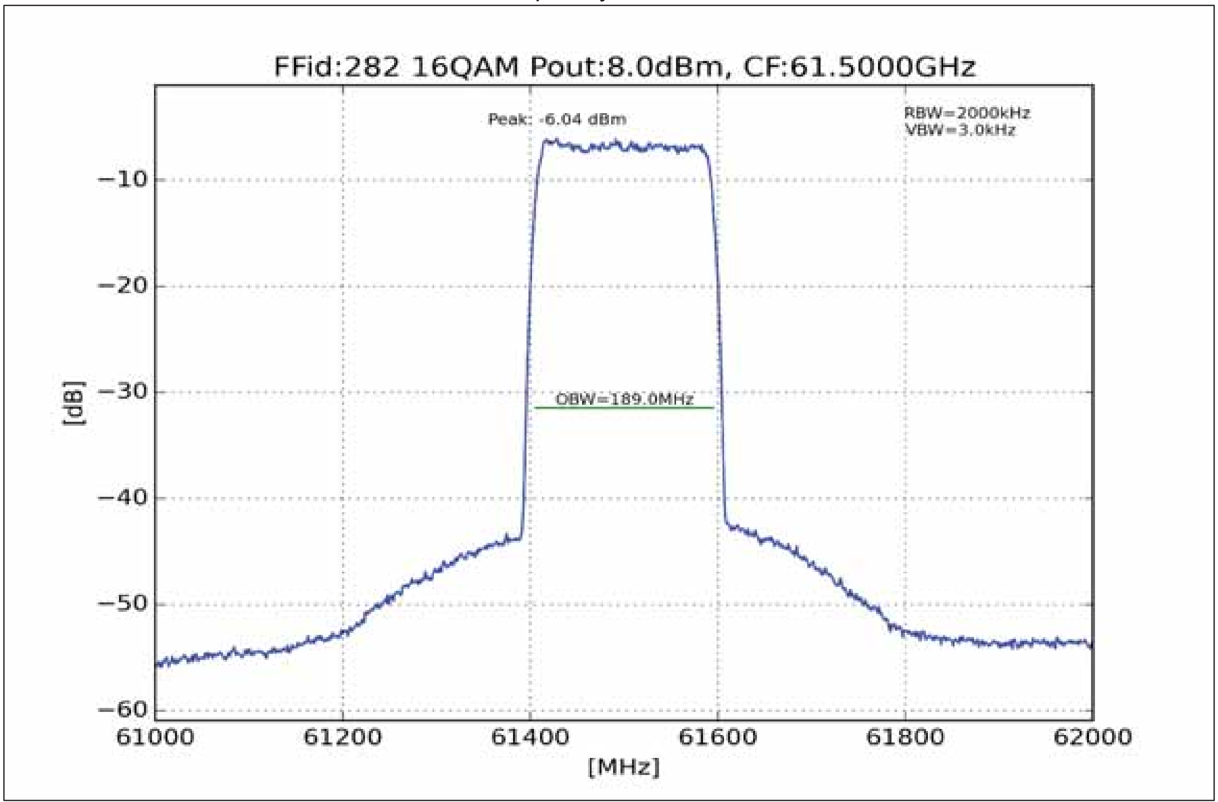
Plot 32: CS: 150 MHz, 128 QAM, OBW, middle frequency



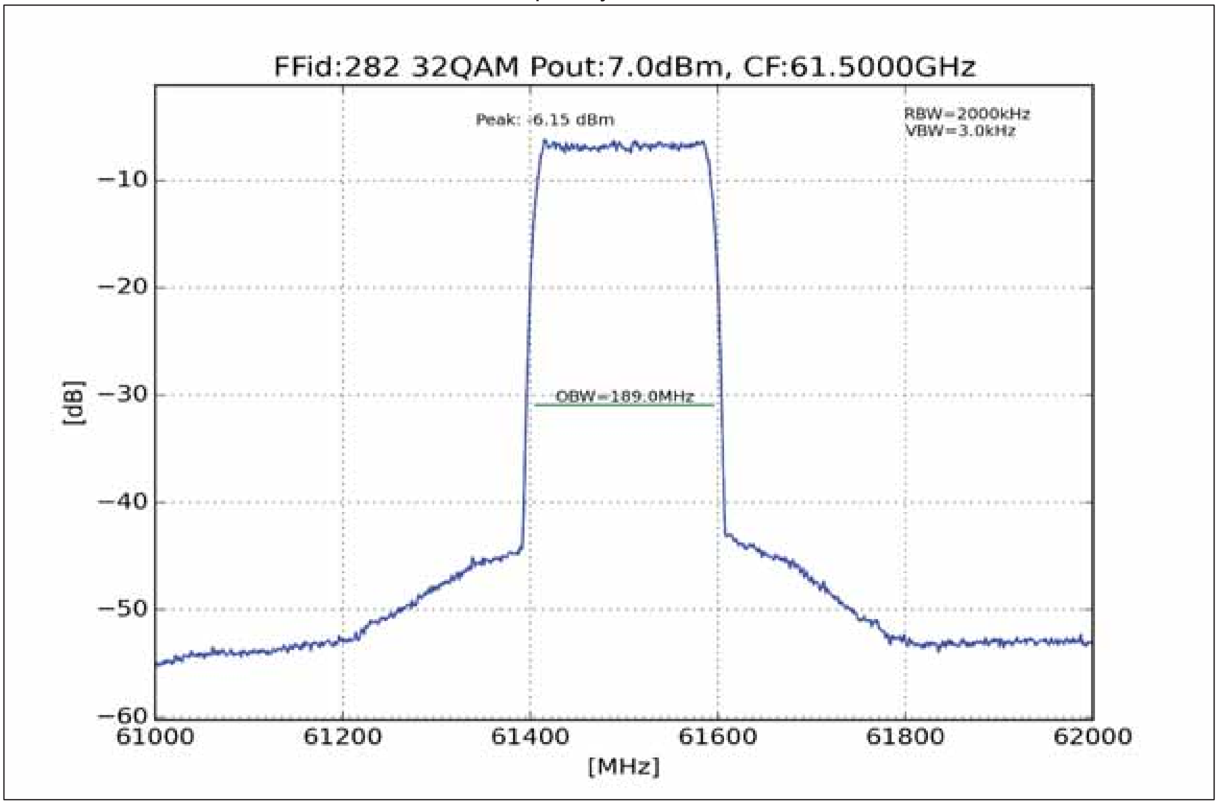
Plot 33: CS: 200 MHz, 4 QAM, OBW, middle frequency



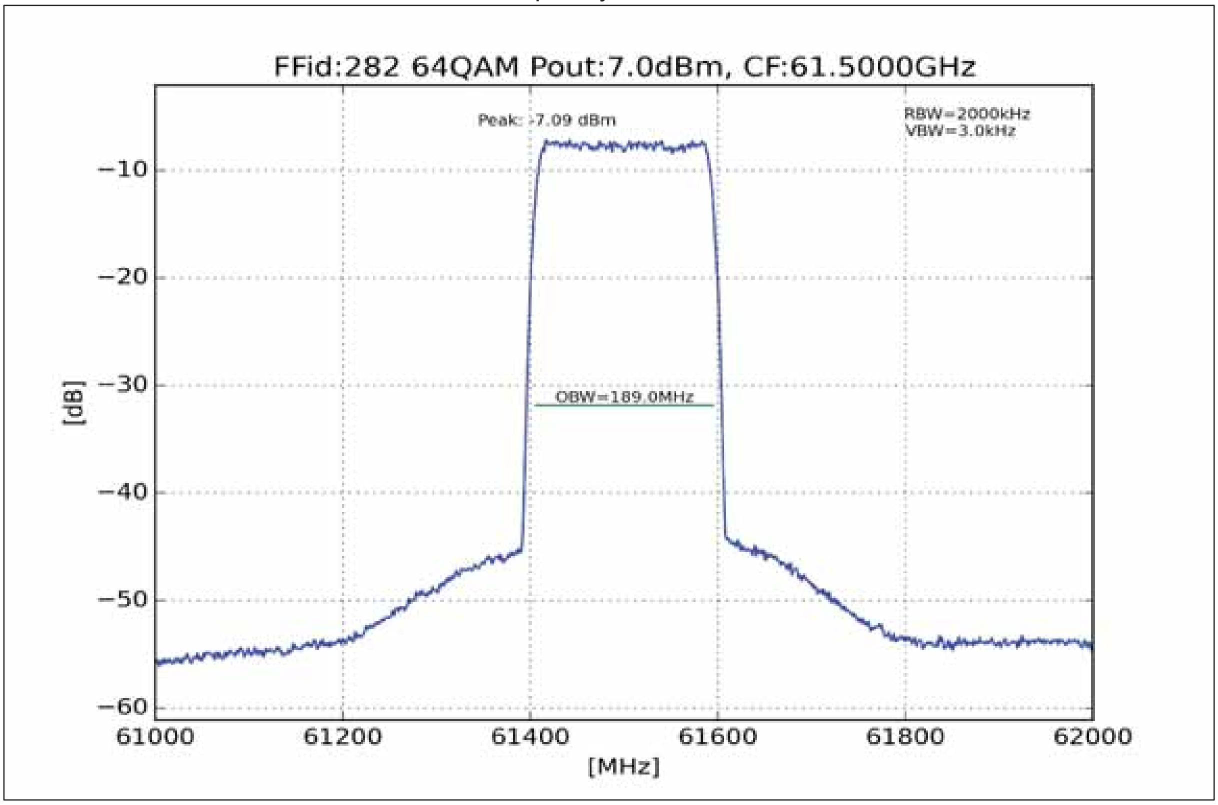
Plot 34: CS: 200 MHz, 16 QAM, OBW, middle frequency



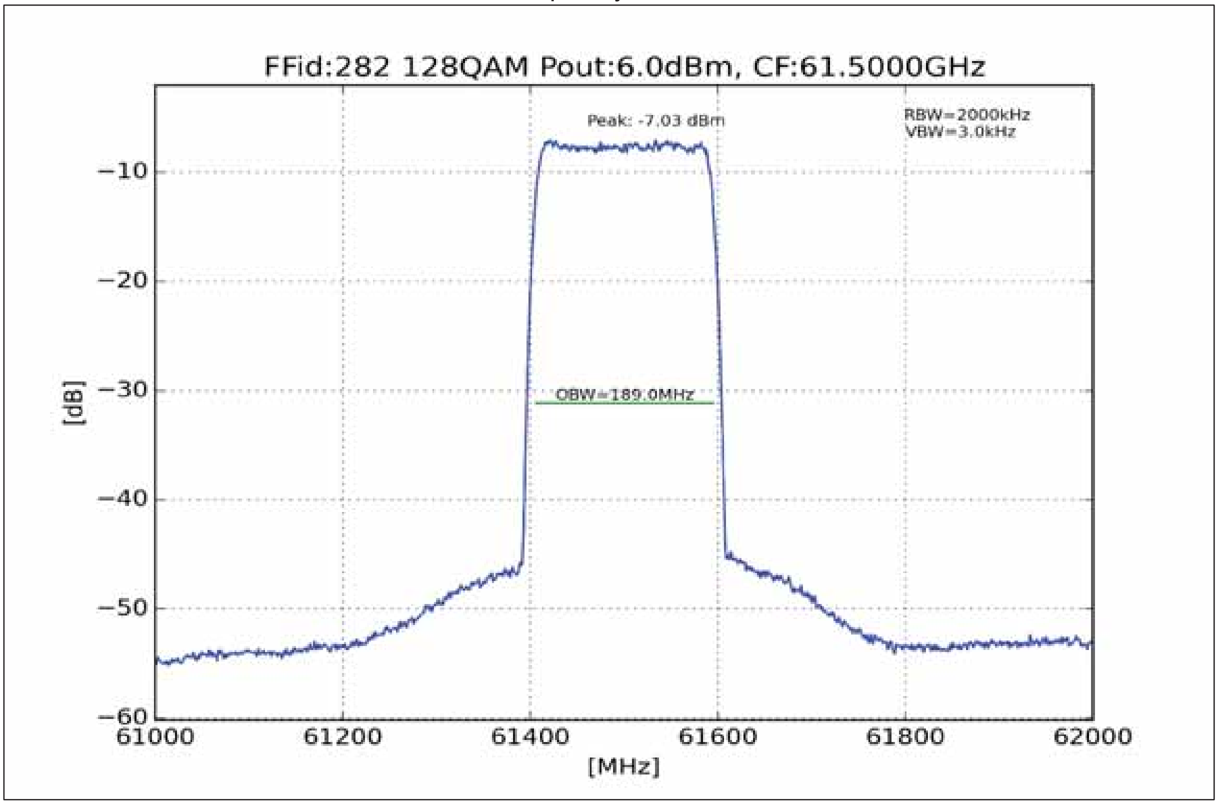
Plot 35: CS: 200 MHz, 32 QAM, OBW, middle frequency



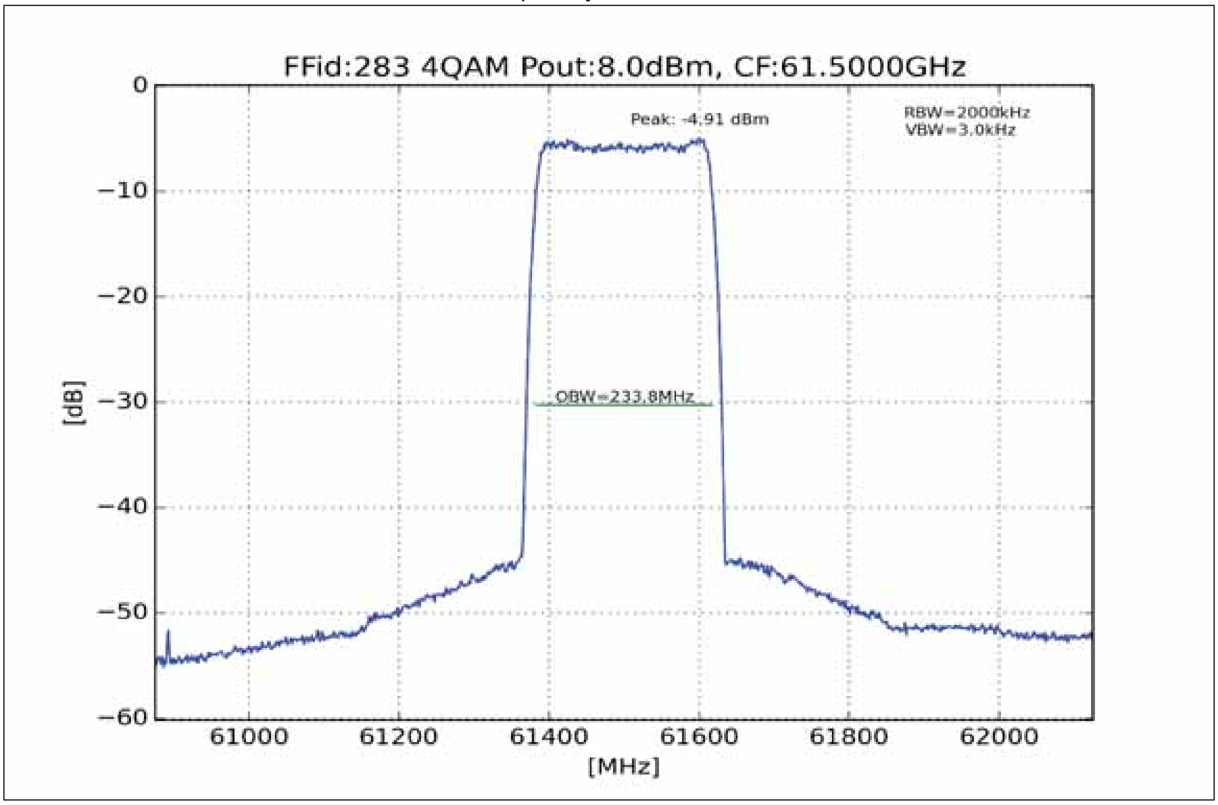
Plot 36: CS: 200 MHz, 64 QAM, OBW, middle frequency



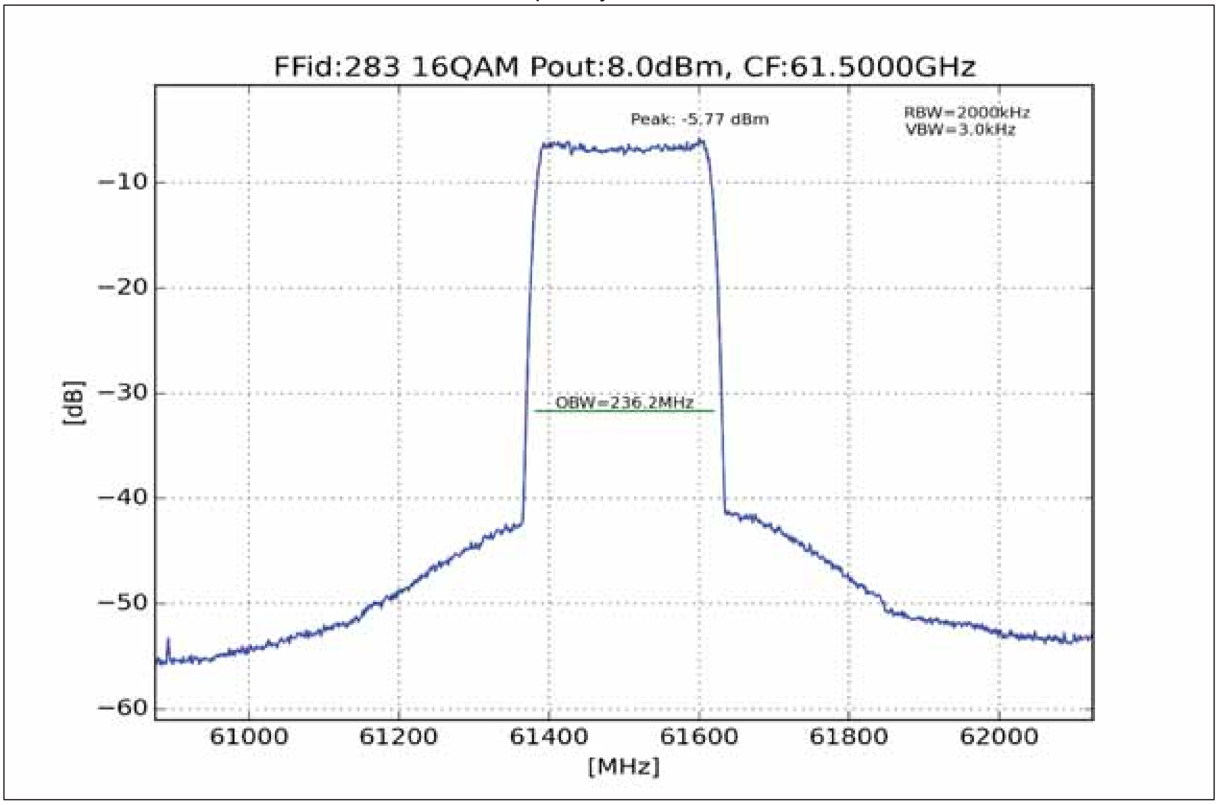
Plot 37: CS: 200 MHz, 128 QAM, OBW, middle frequency



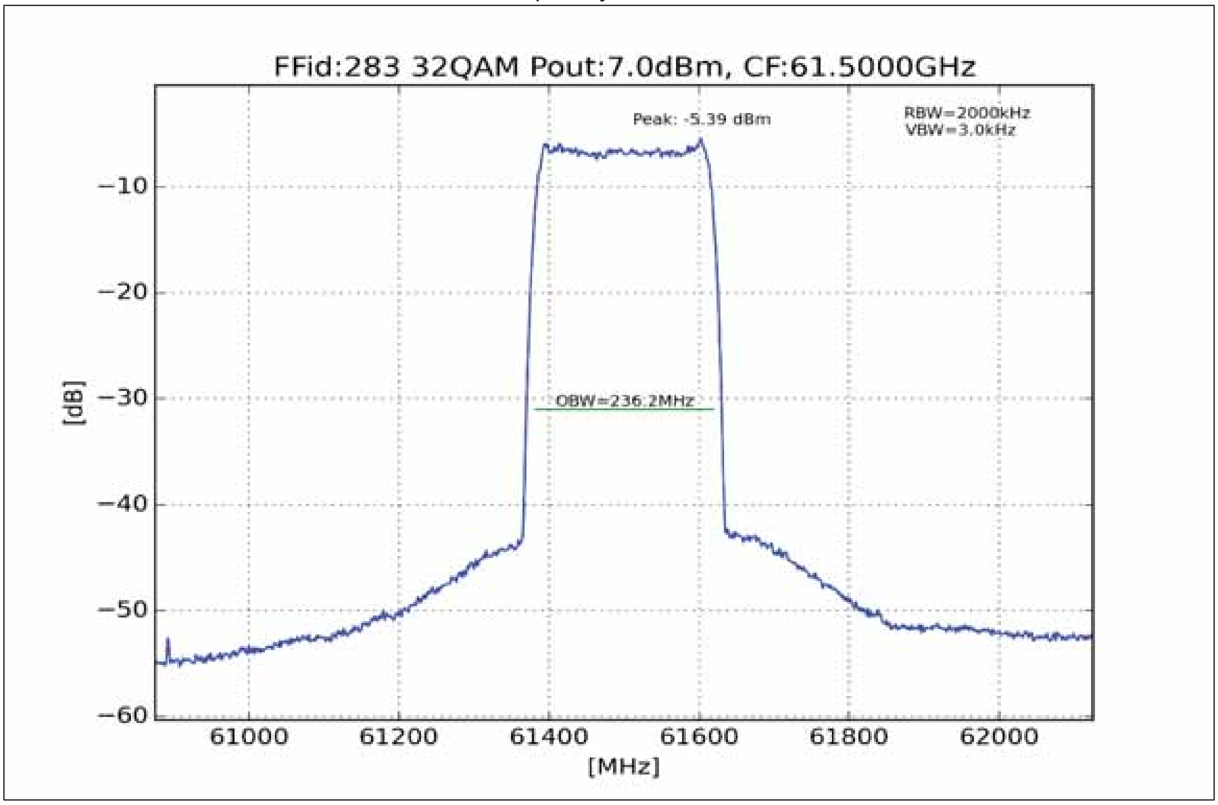
Plot 38: CS: 250 MHz, 4 QAM, OBW, middle frequency



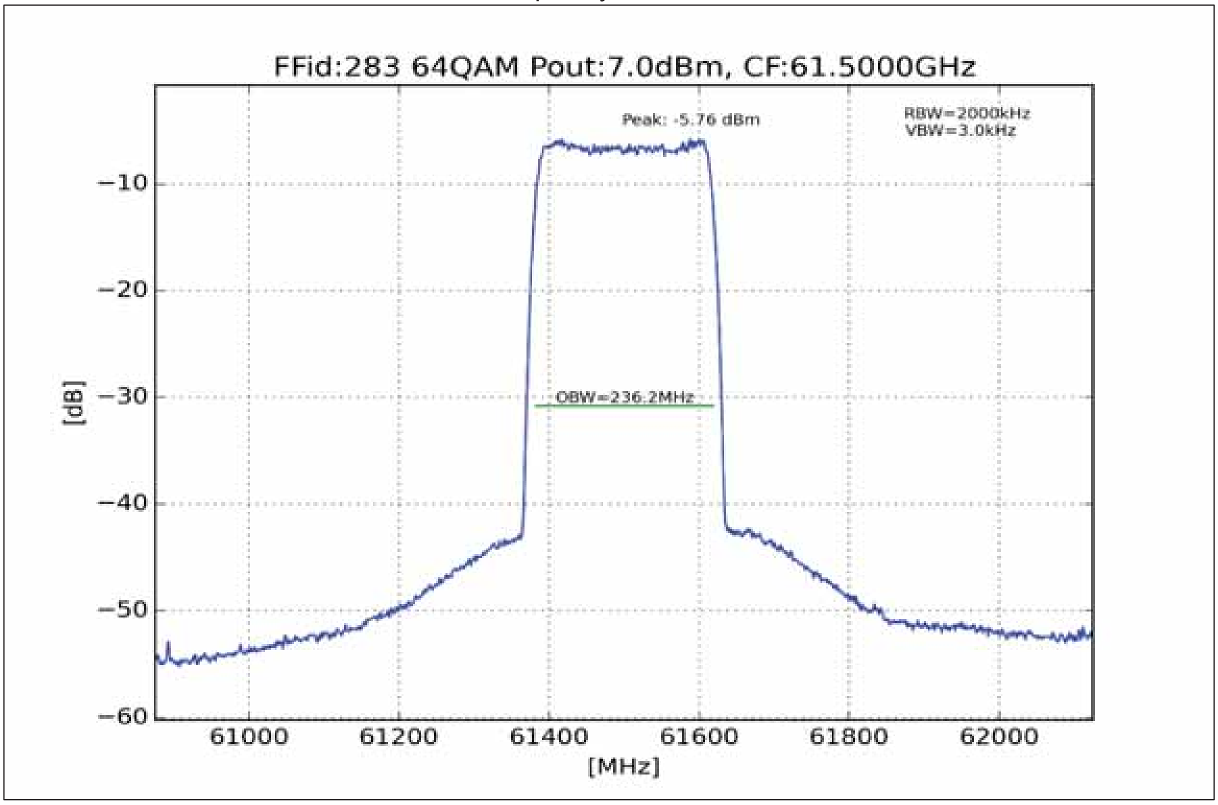
Plot 39: CS: 250 MHz, 16 QAM, OBW, middle frequency



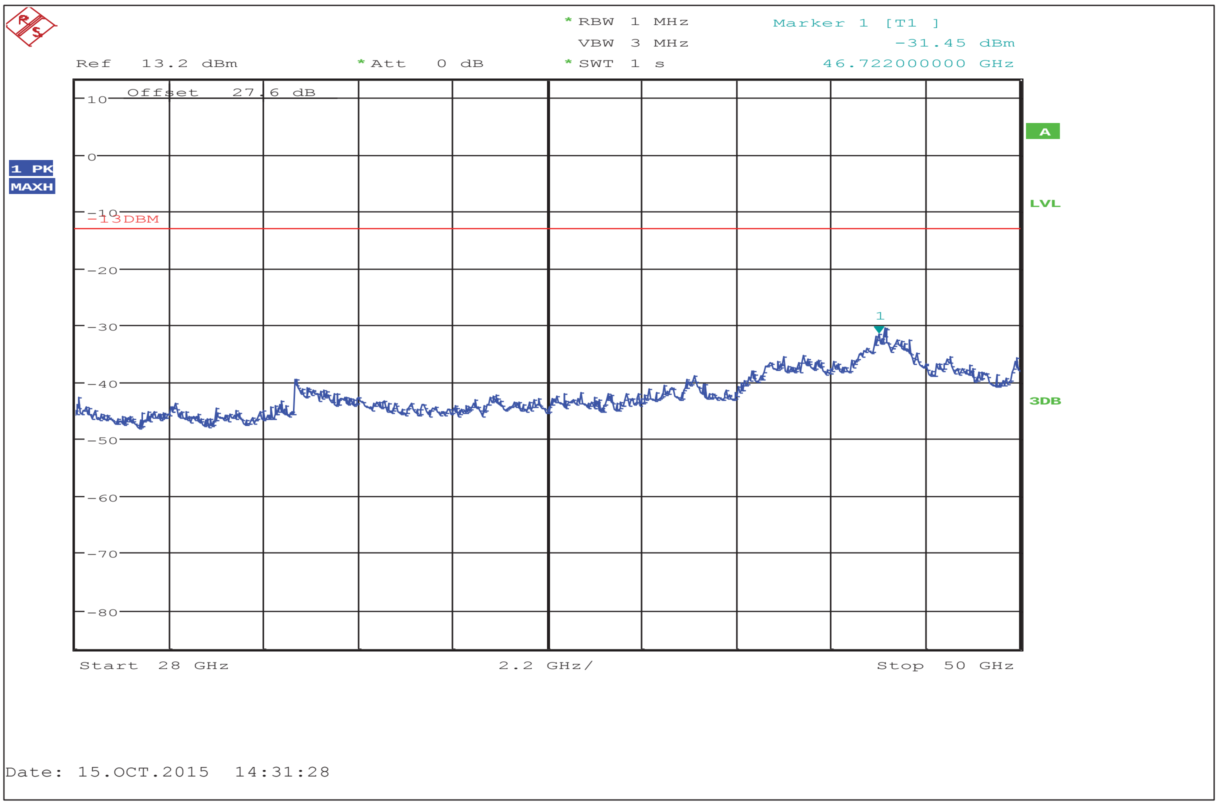
Plot 40: CS: 250 MHz, 32 QAM, OBW, middle frequency



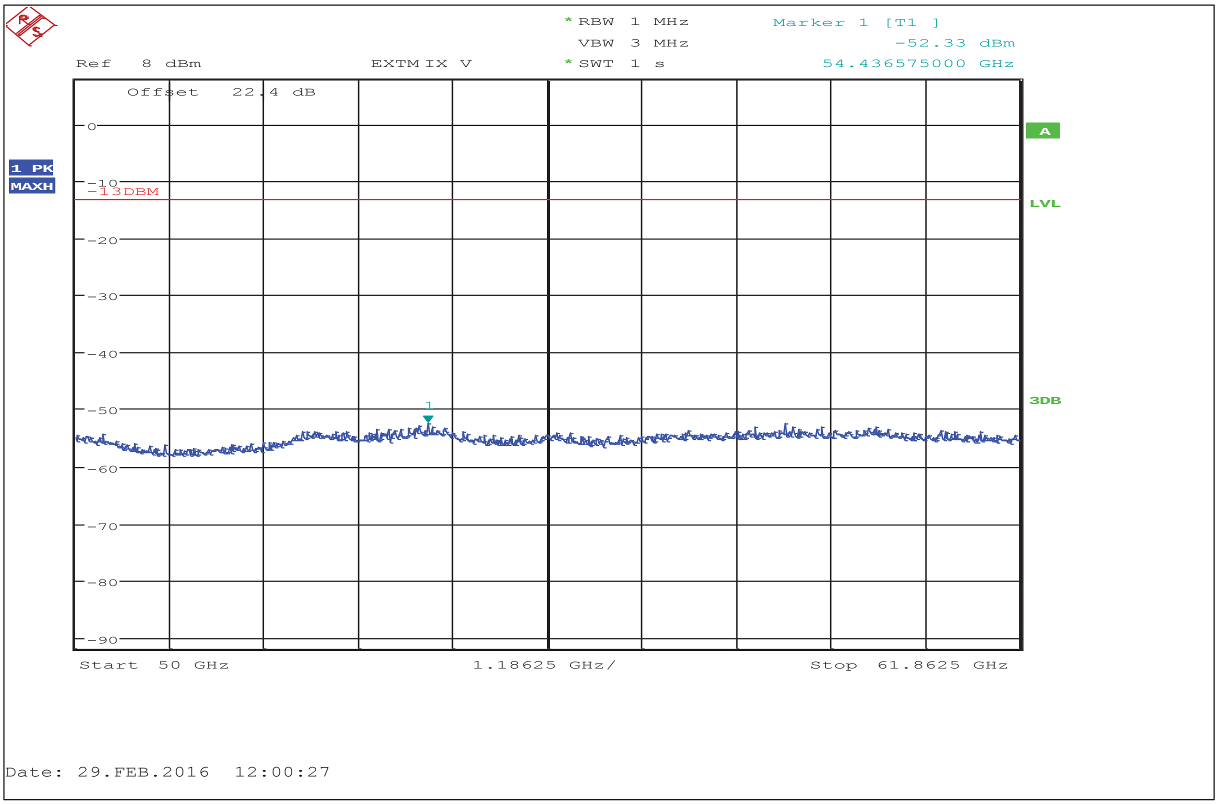
Plot 41: CS: 250 MHz, 64 QAM, OBW, middle frequency



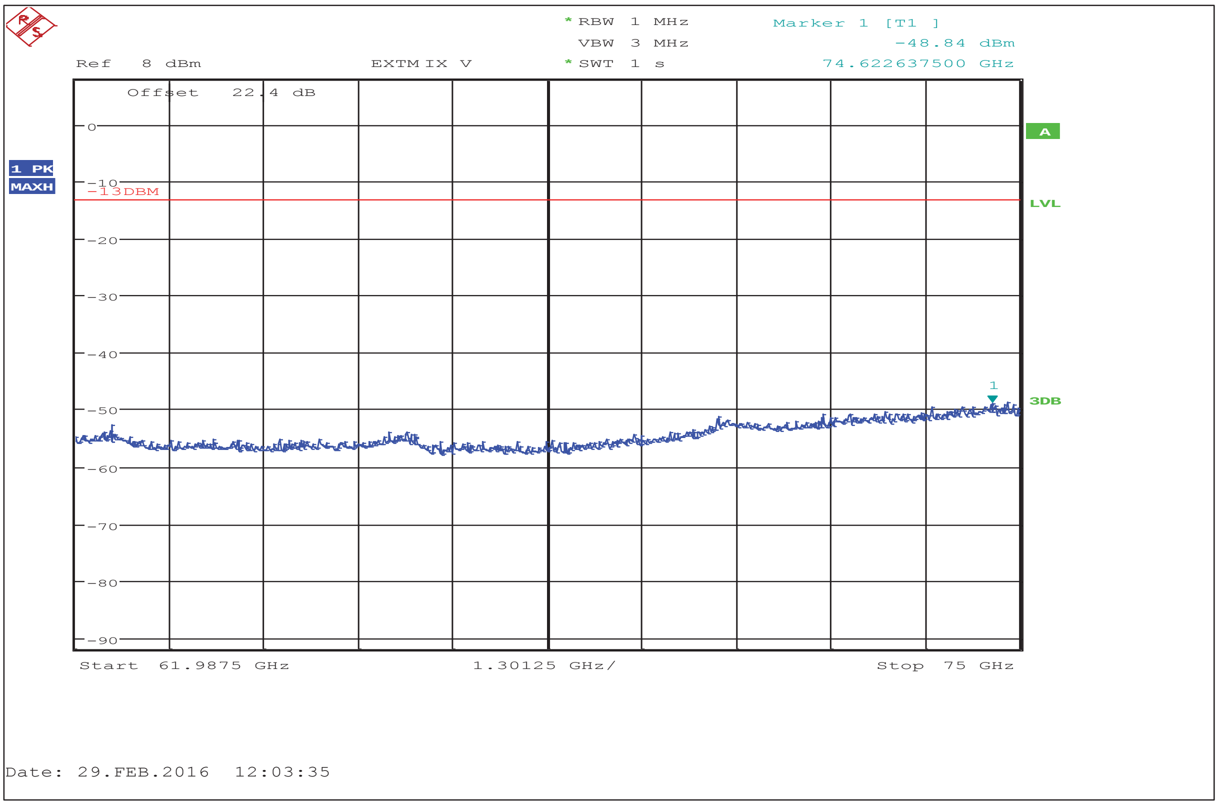
Plot No. 42



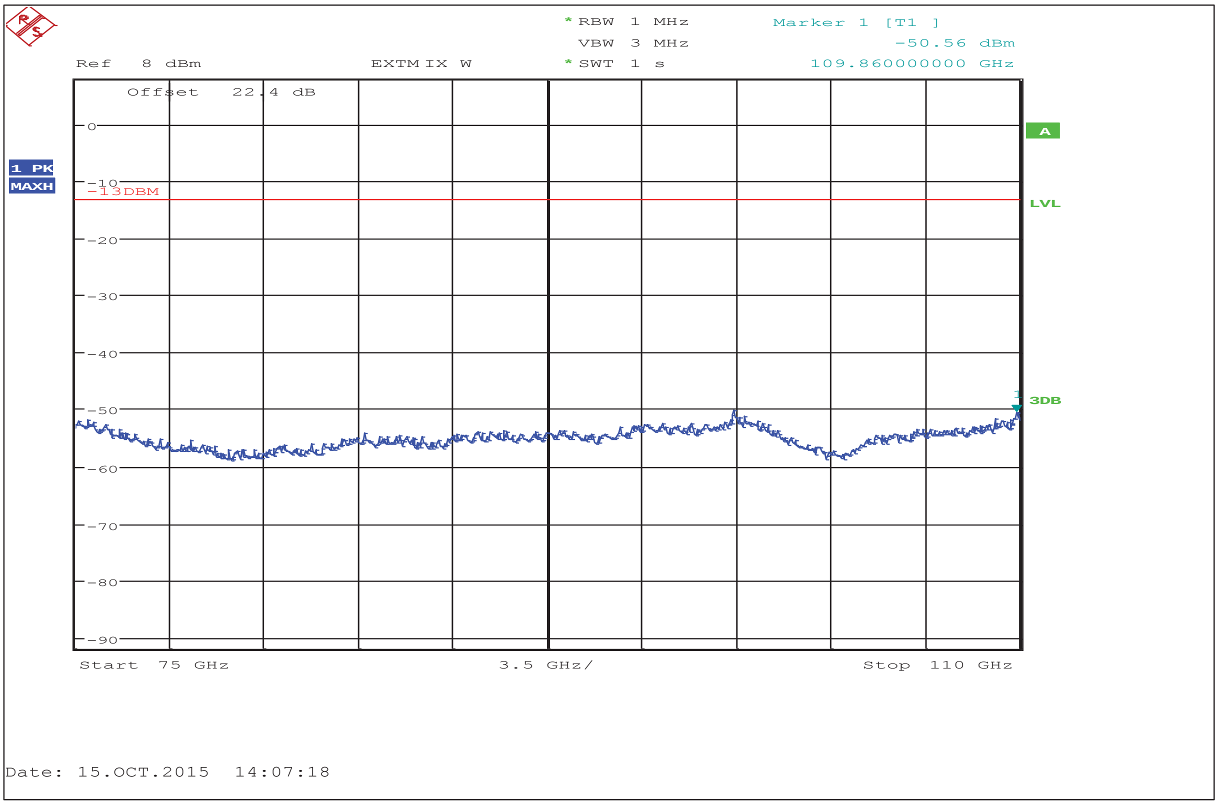
Plot No. 43



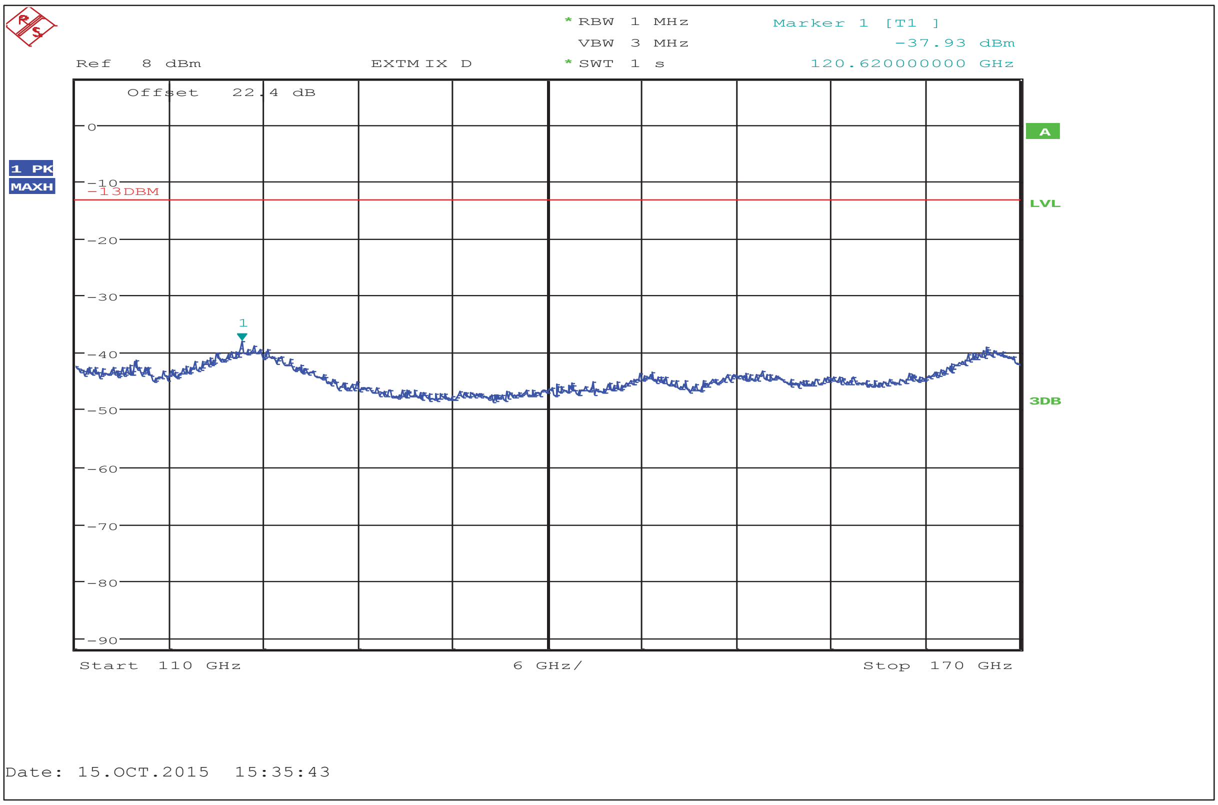
Plot No. 44



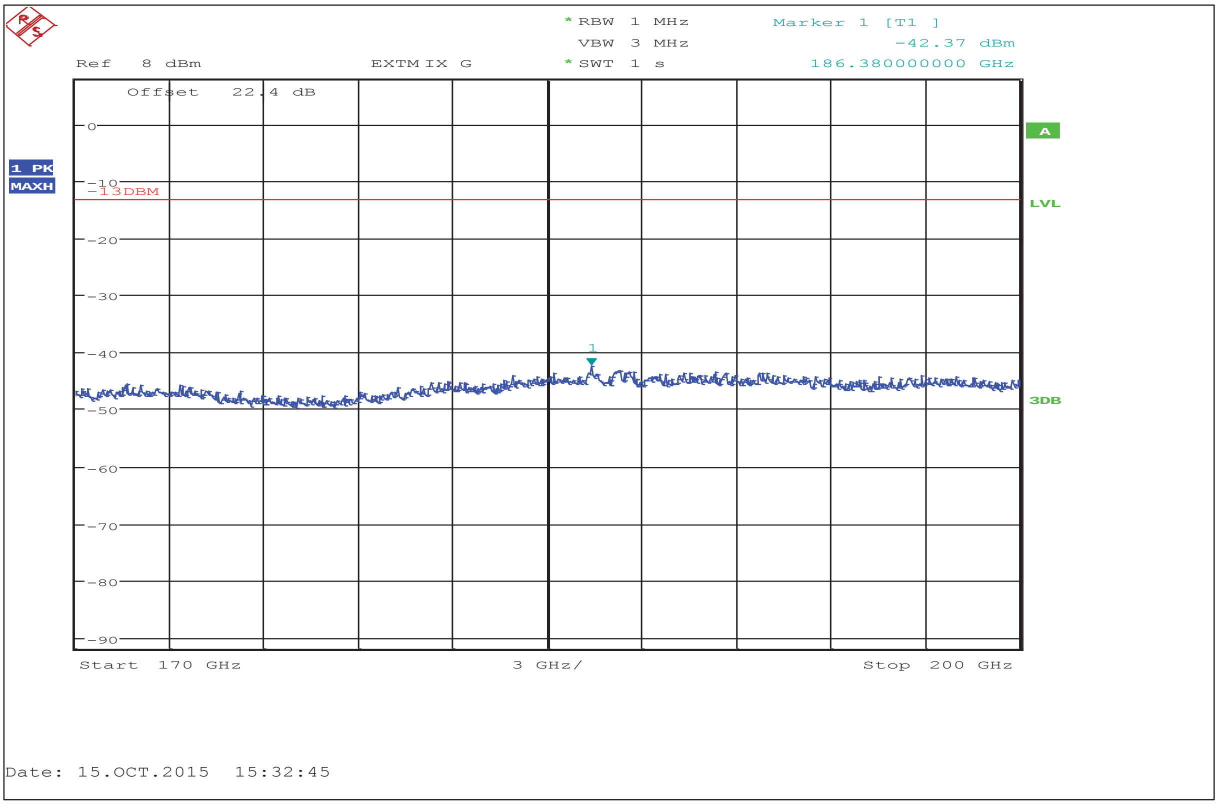
Plot No. 45



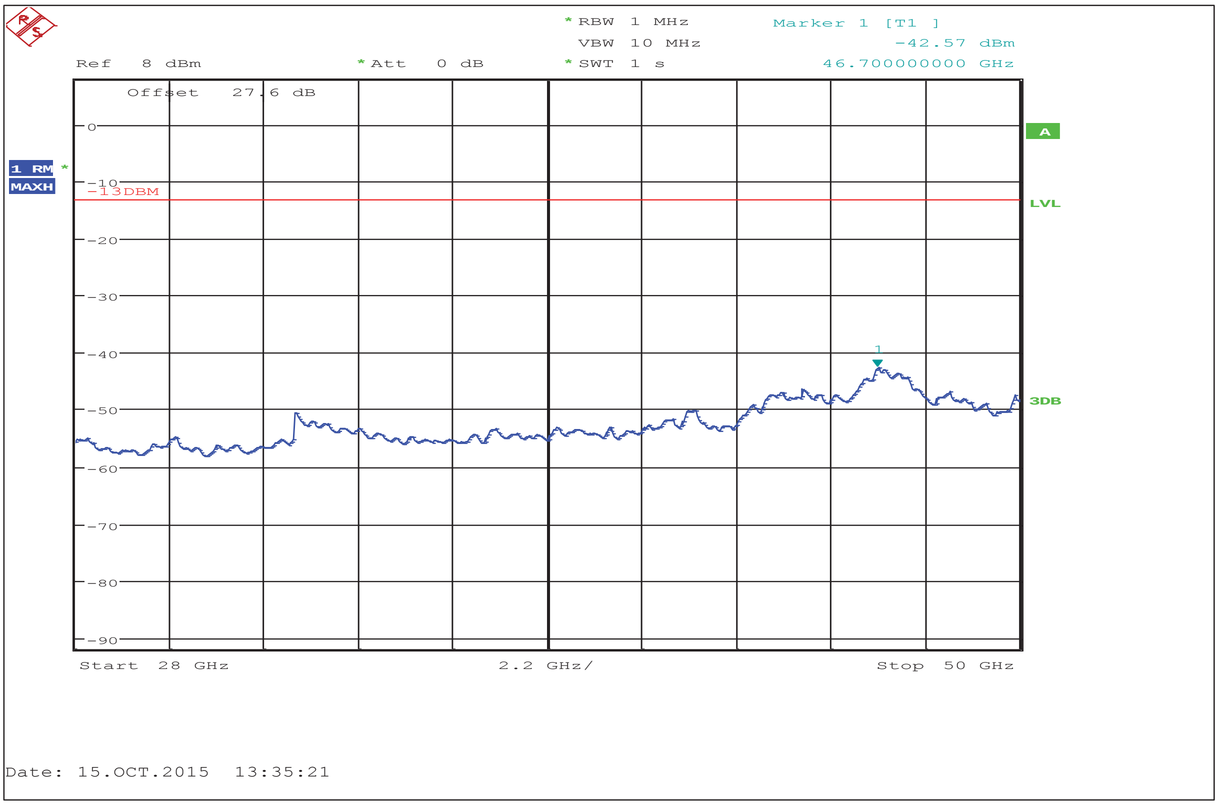
Plot No. 46



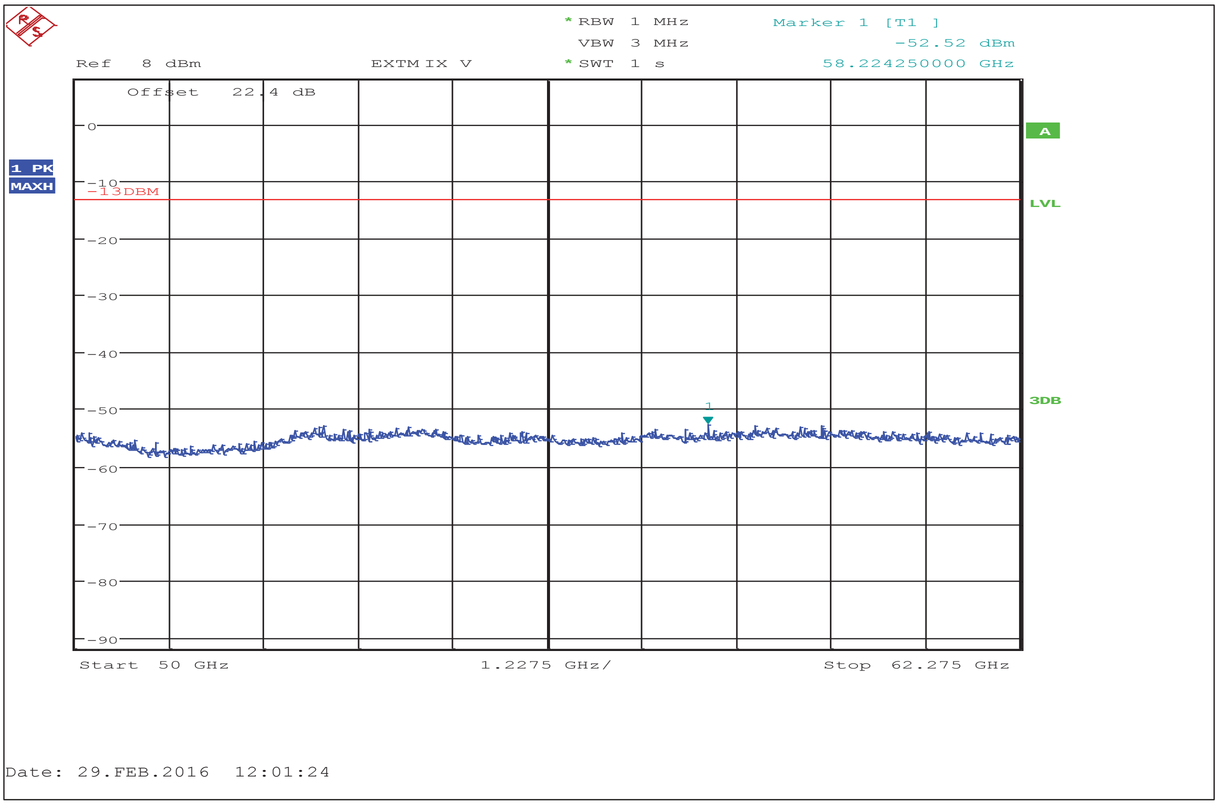
Plot No. 47



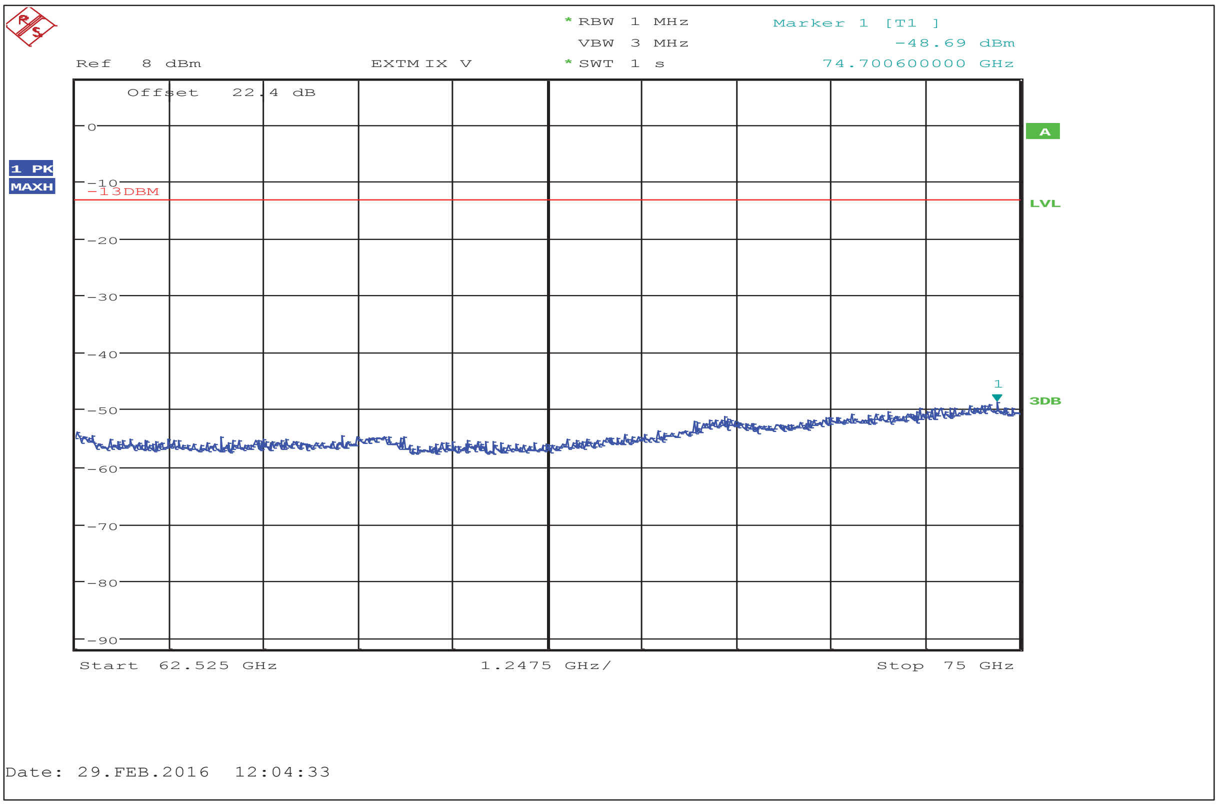
Plot No. 48



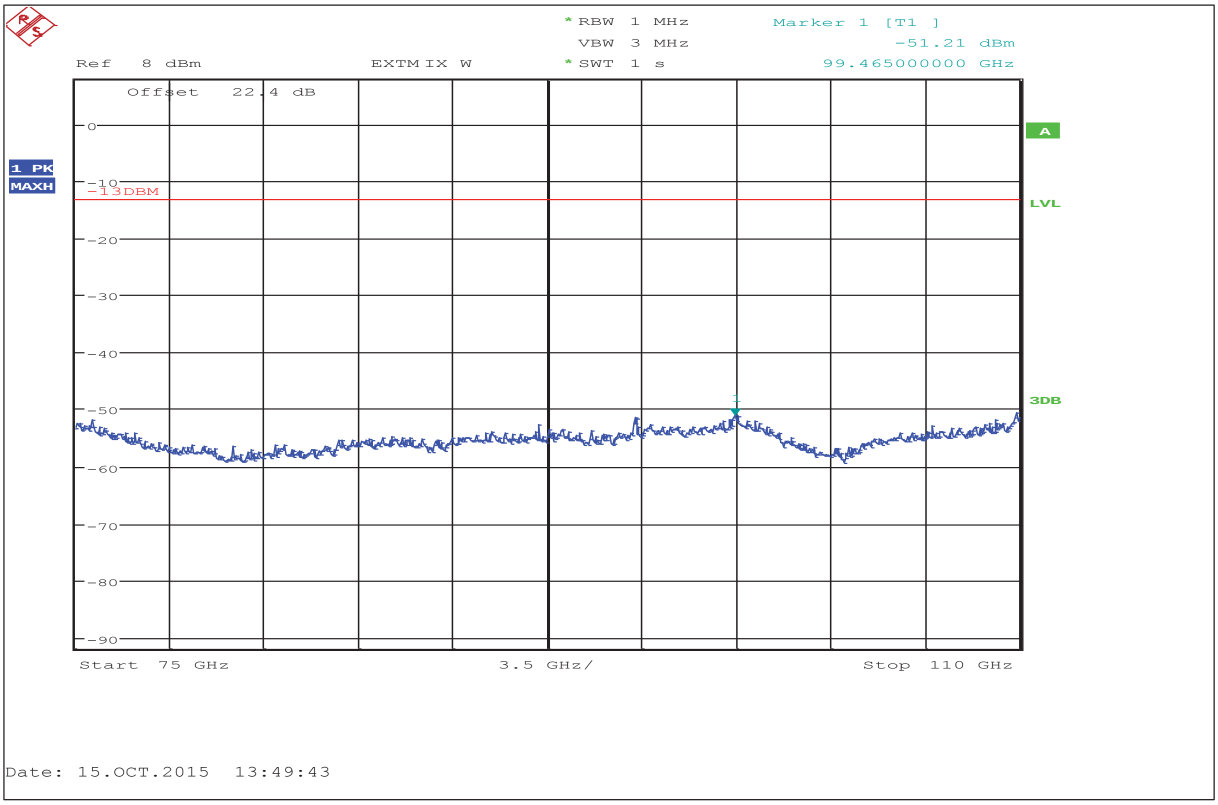
Plot No. 49



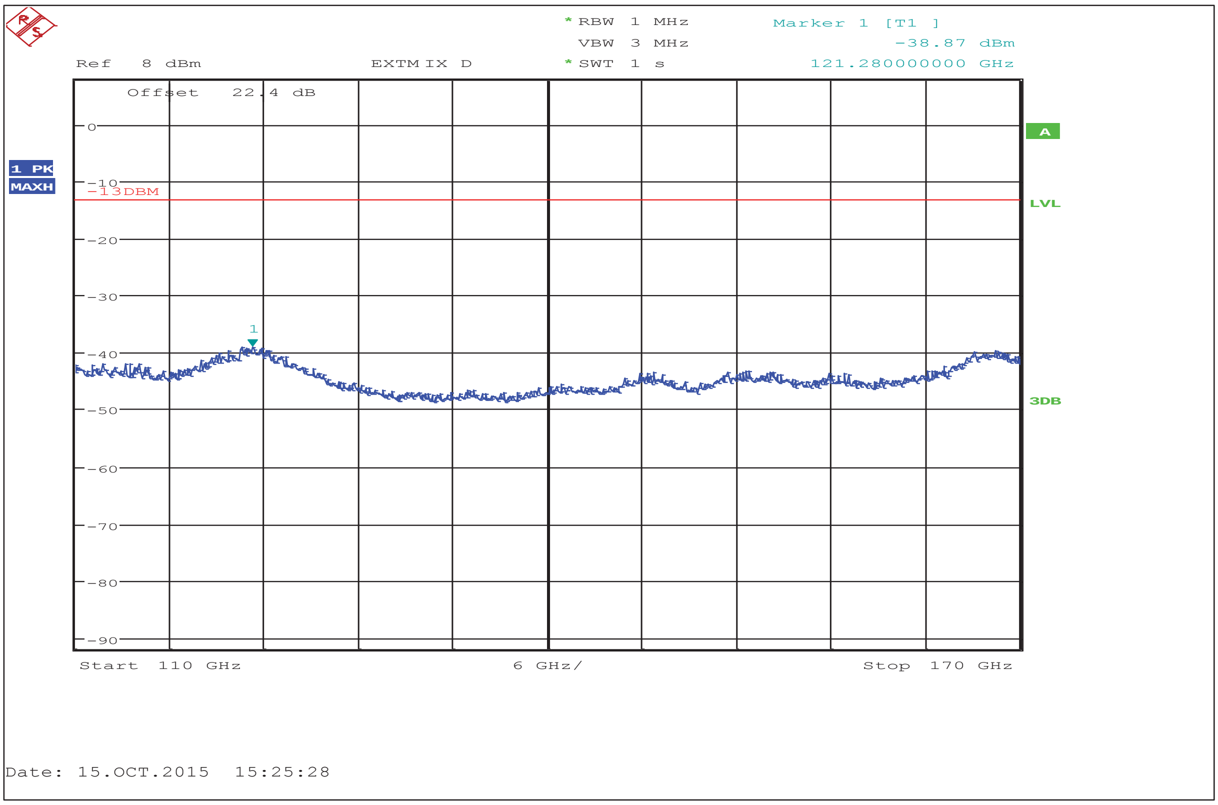
Plot No. 50



Plot No. 51



Plot No. 52



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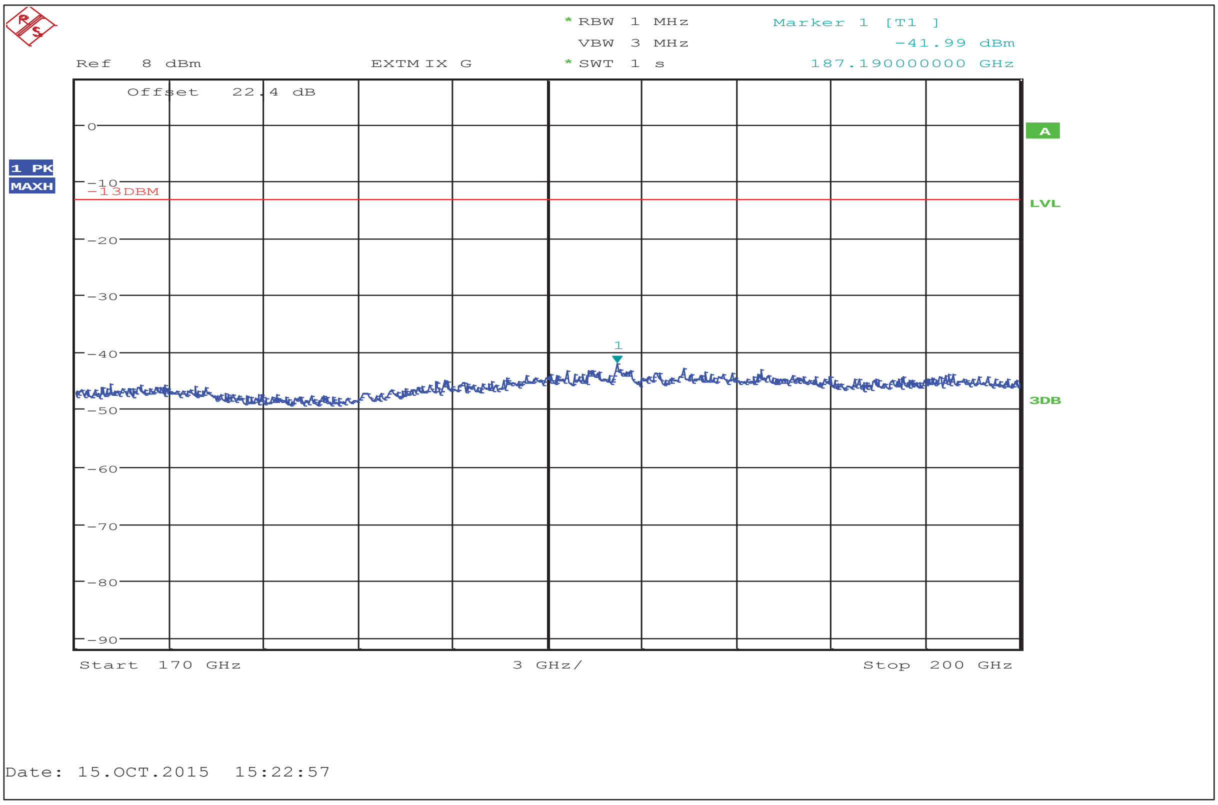

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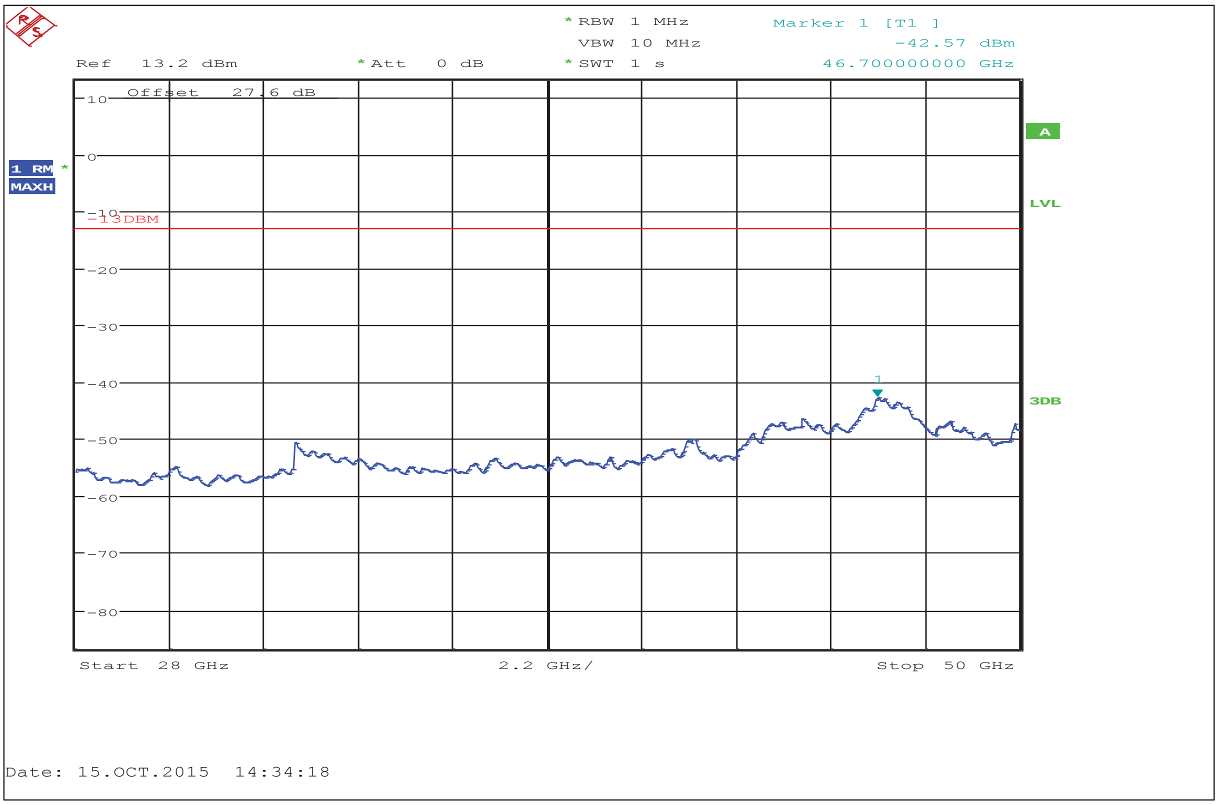

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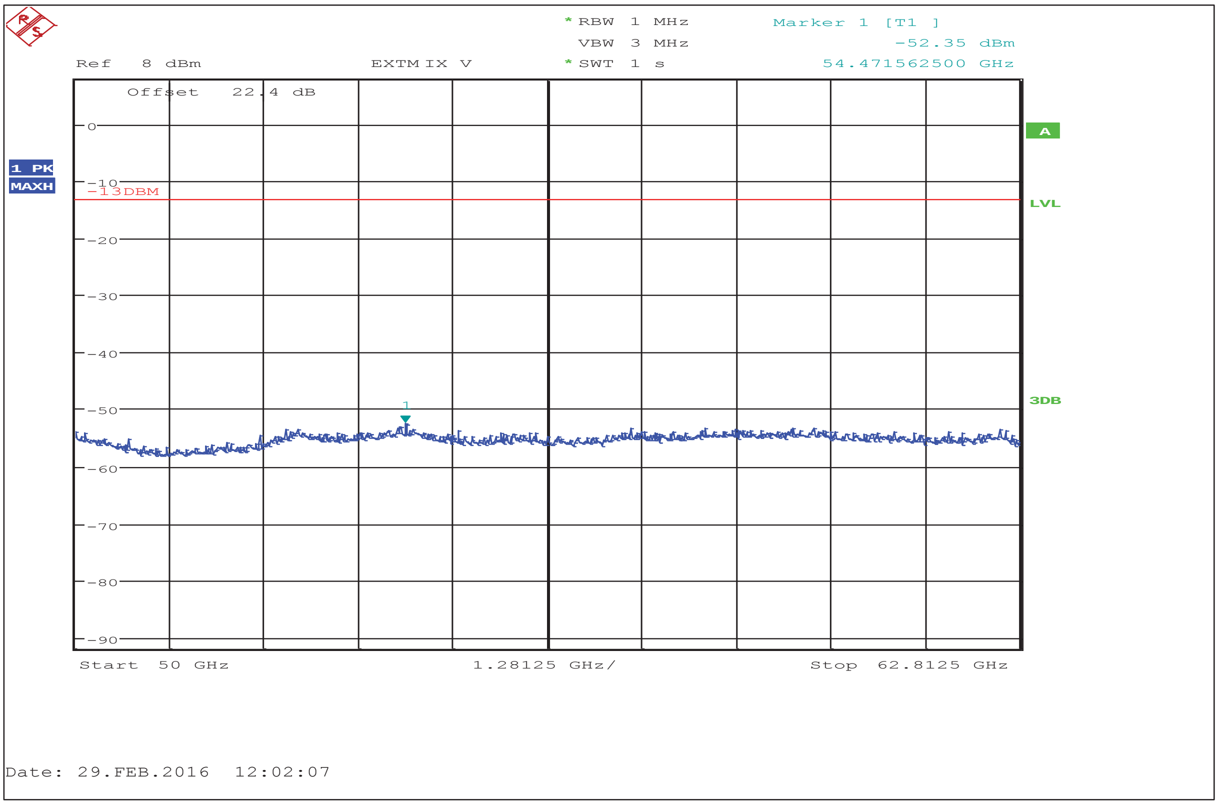

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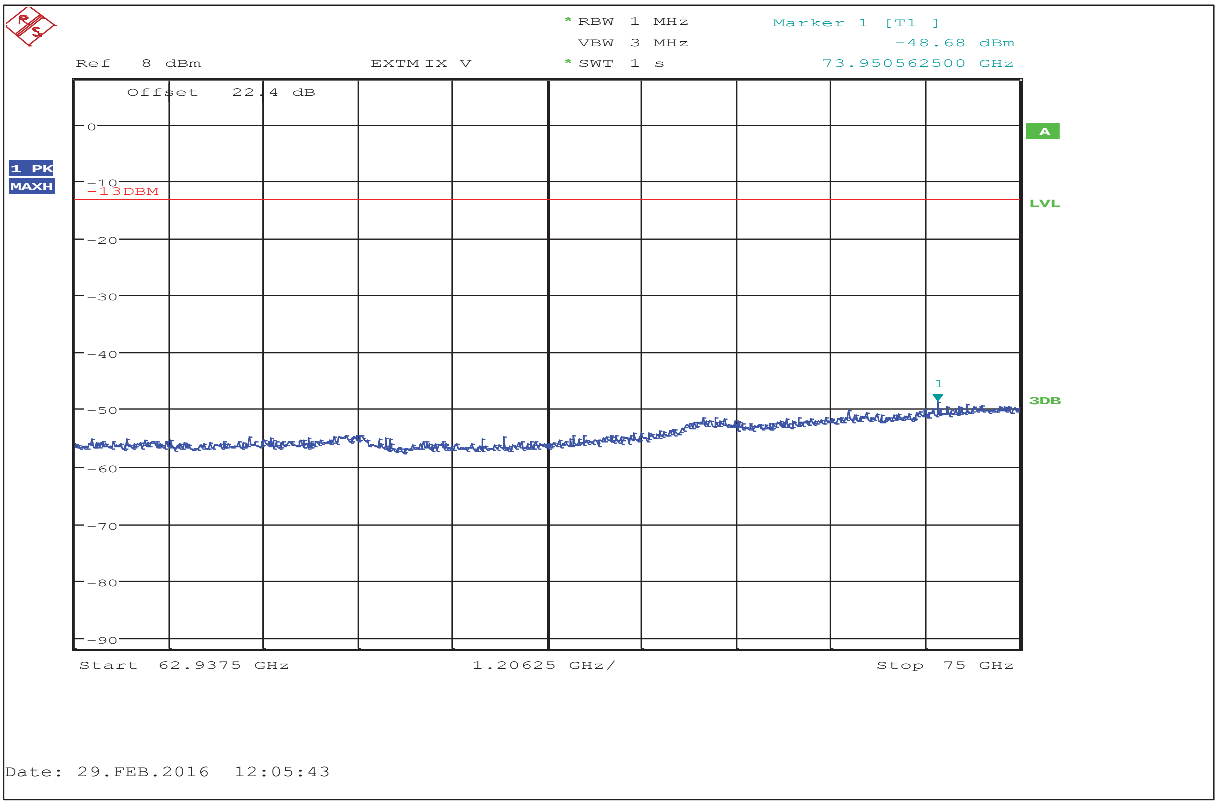

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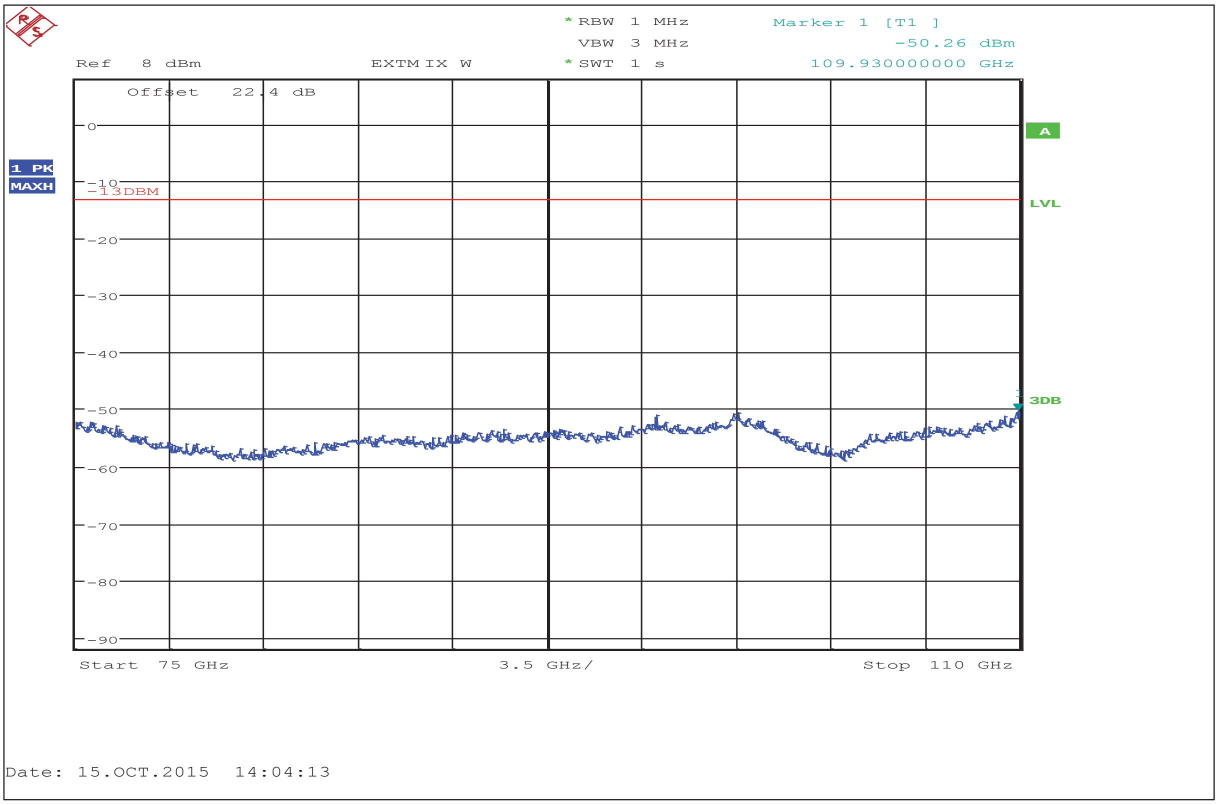

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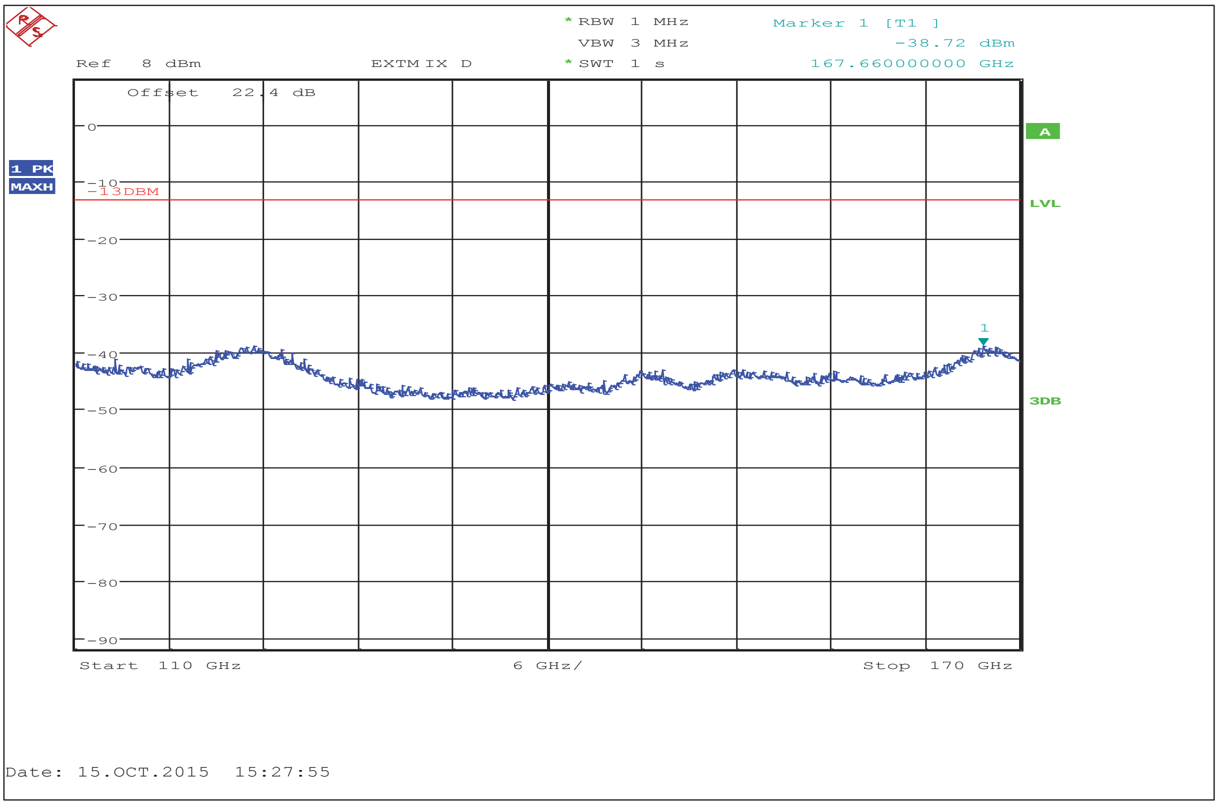

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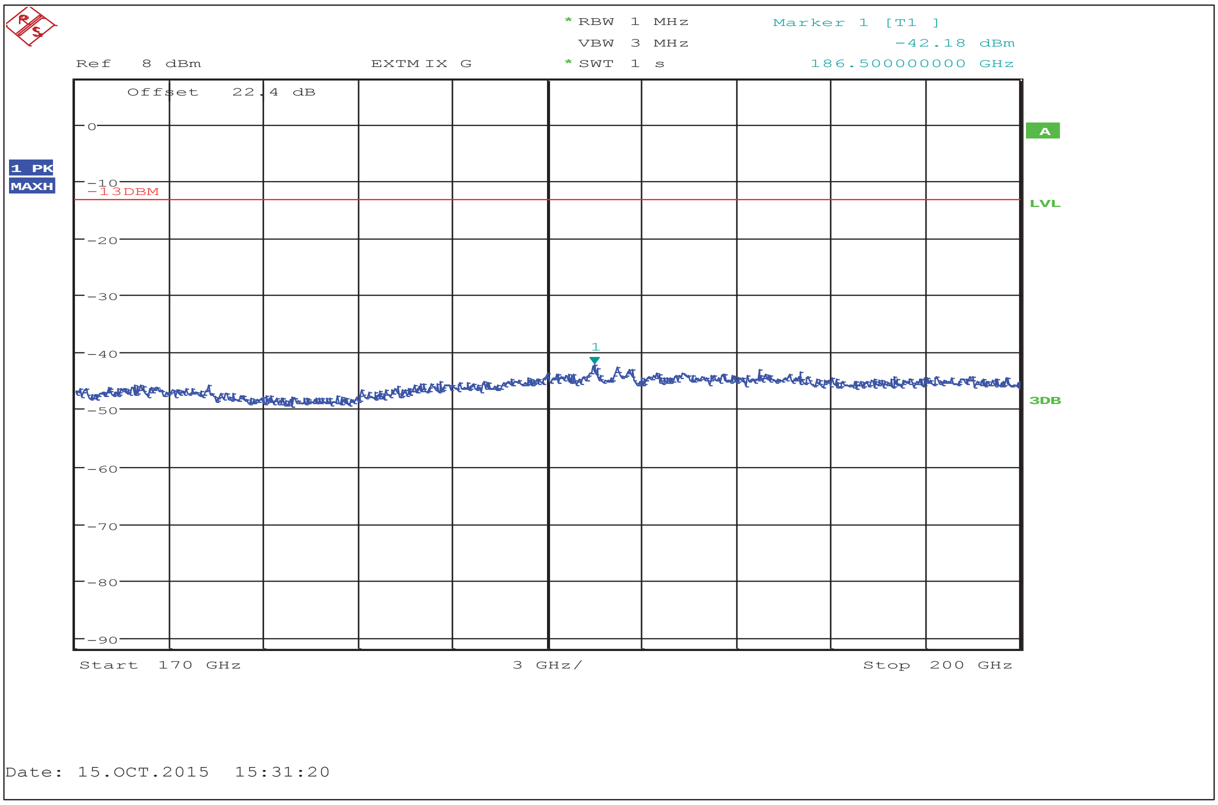

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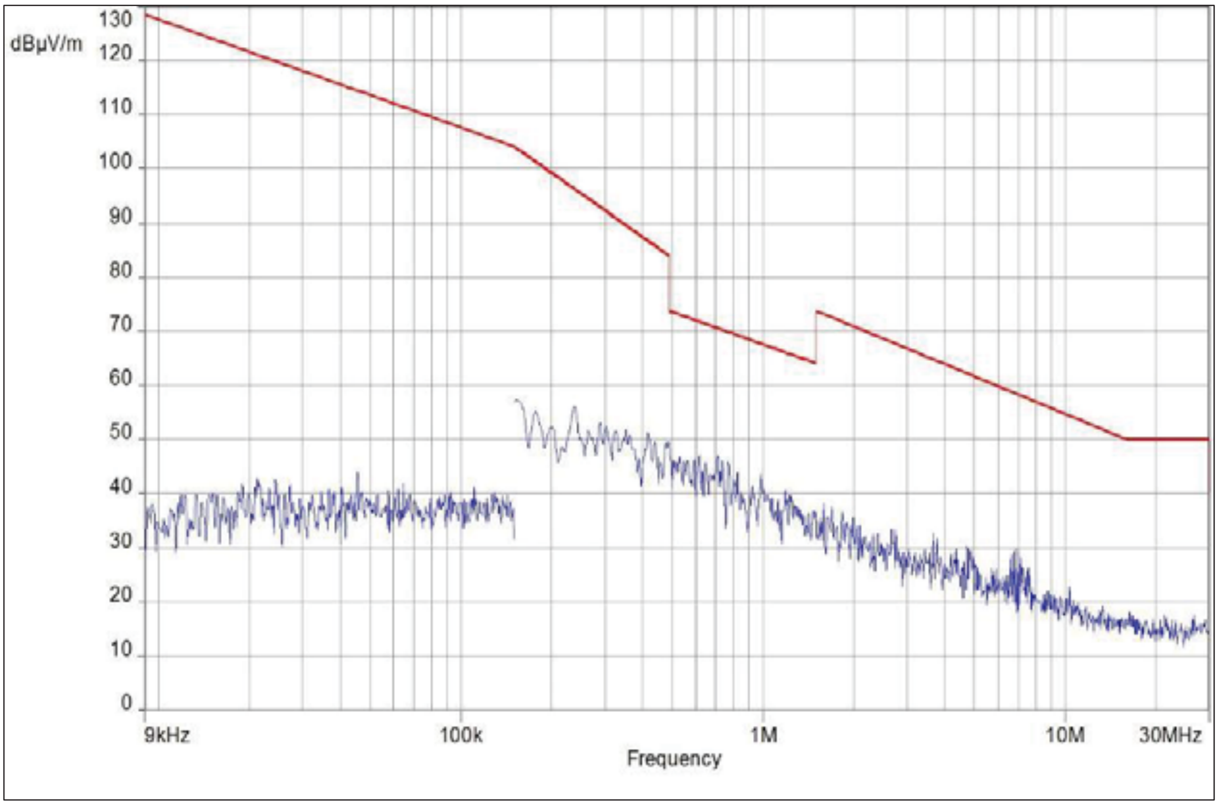

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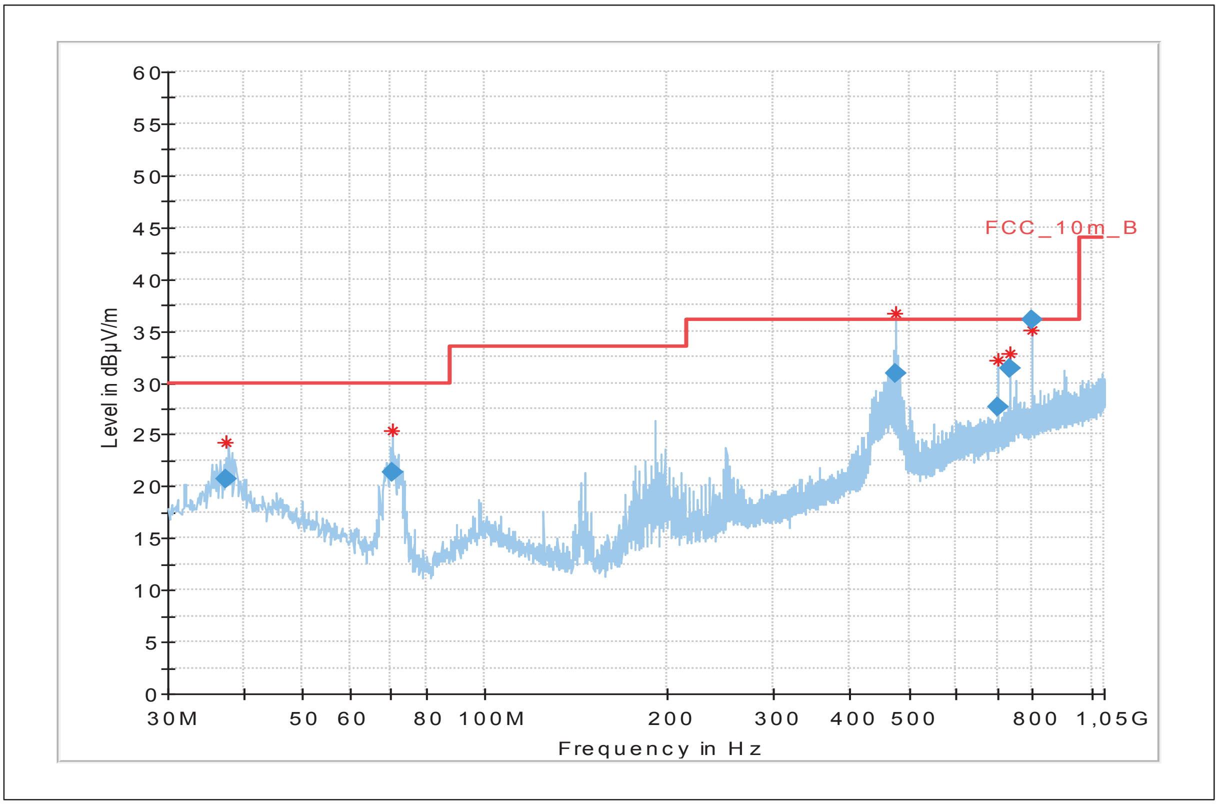

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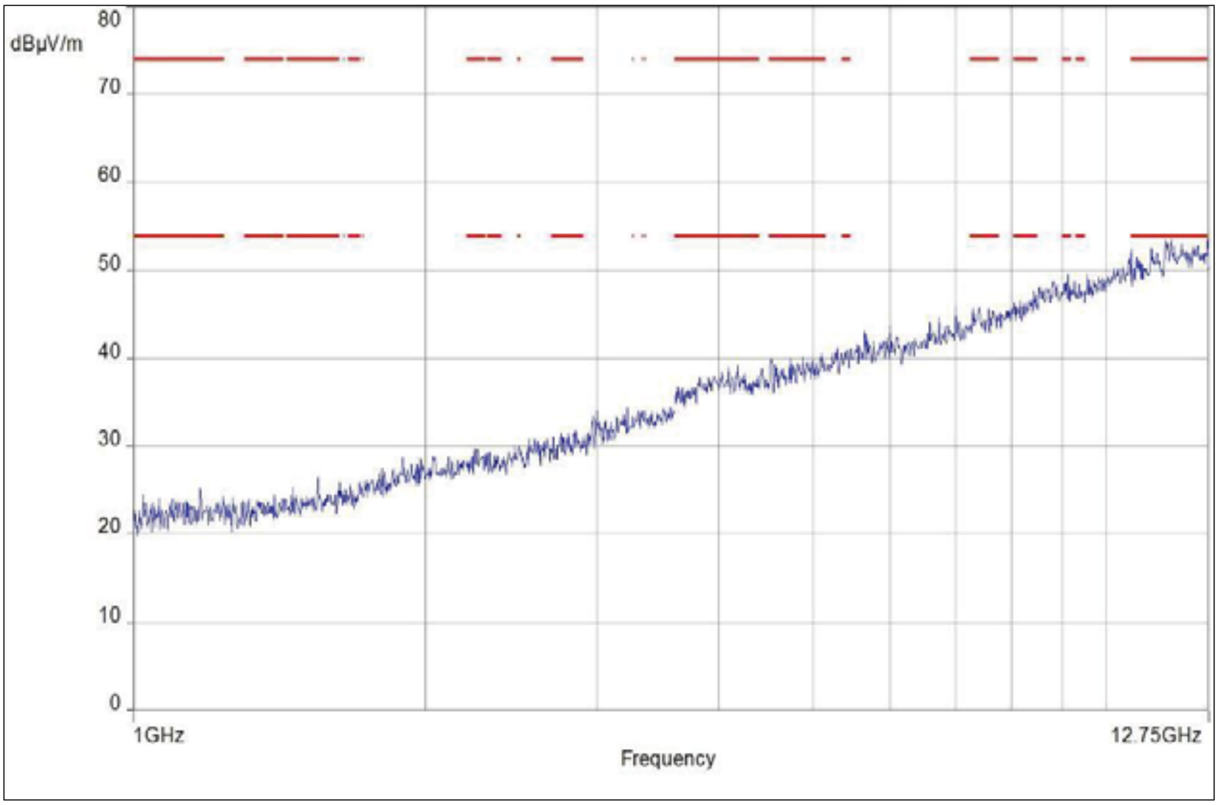

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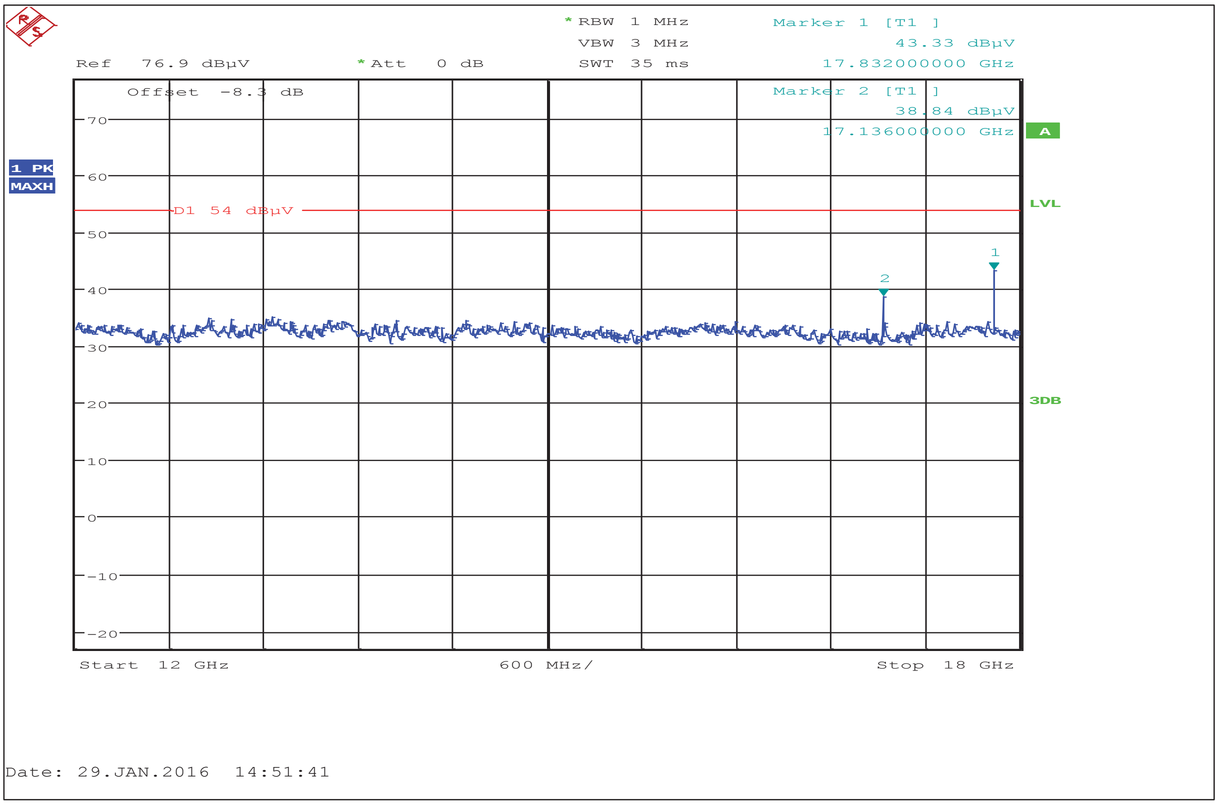

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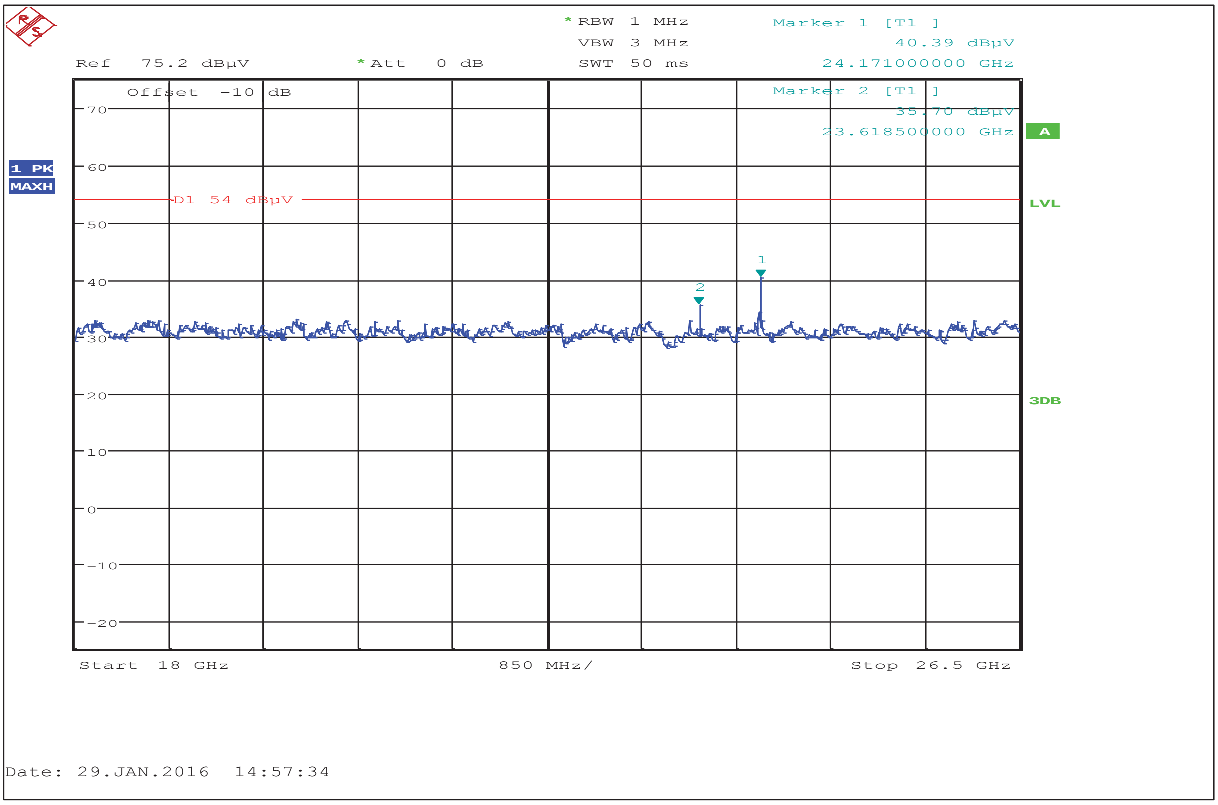

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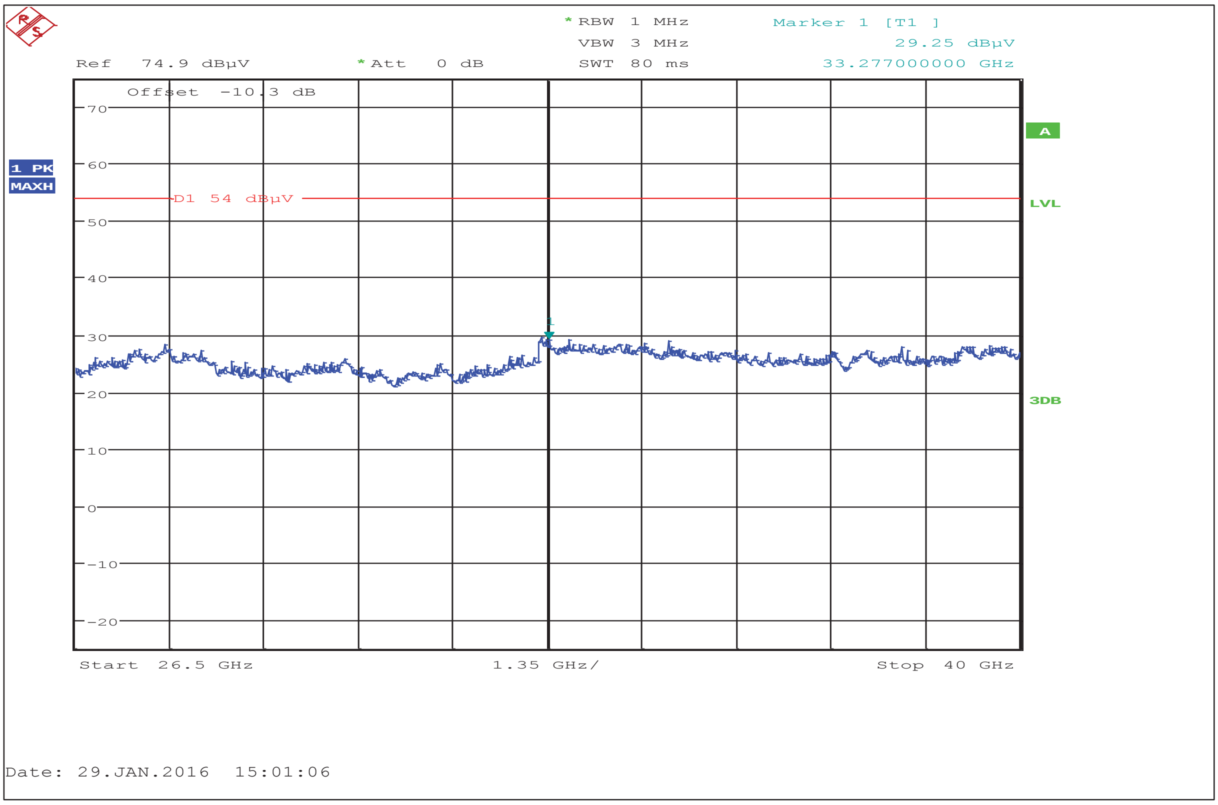

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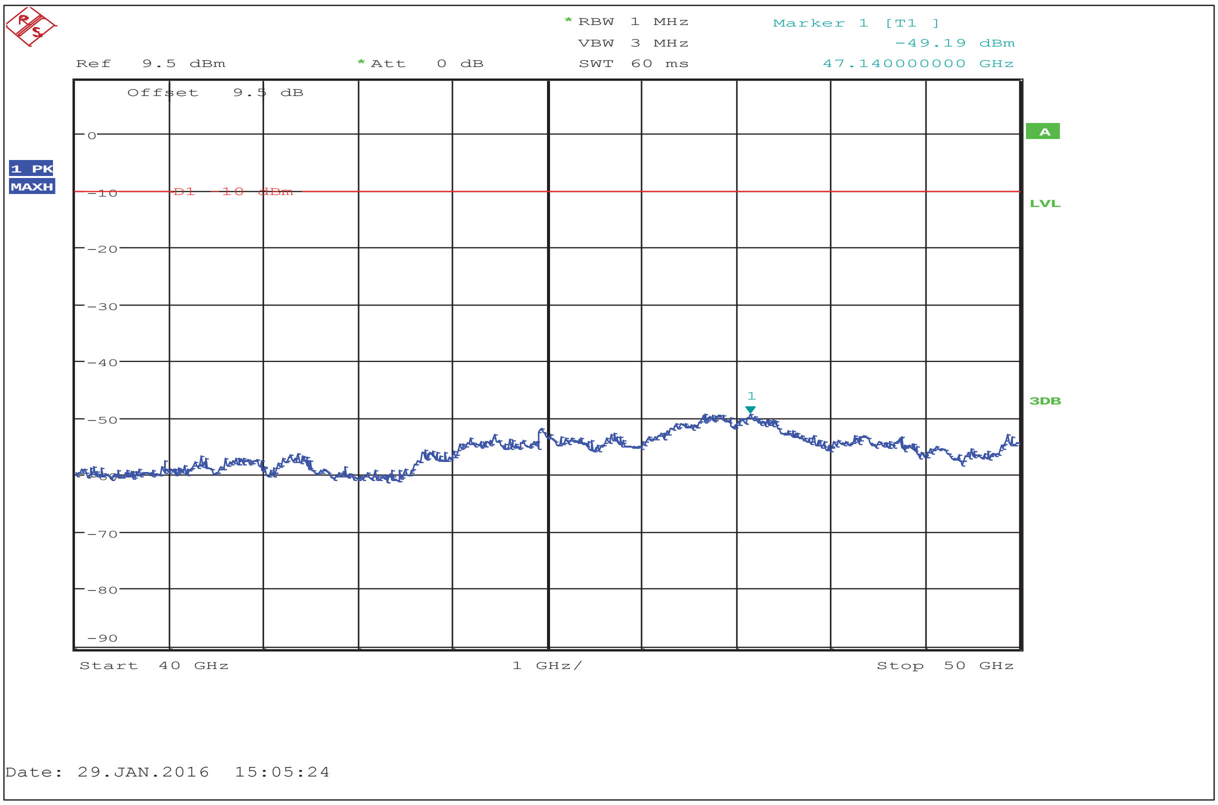

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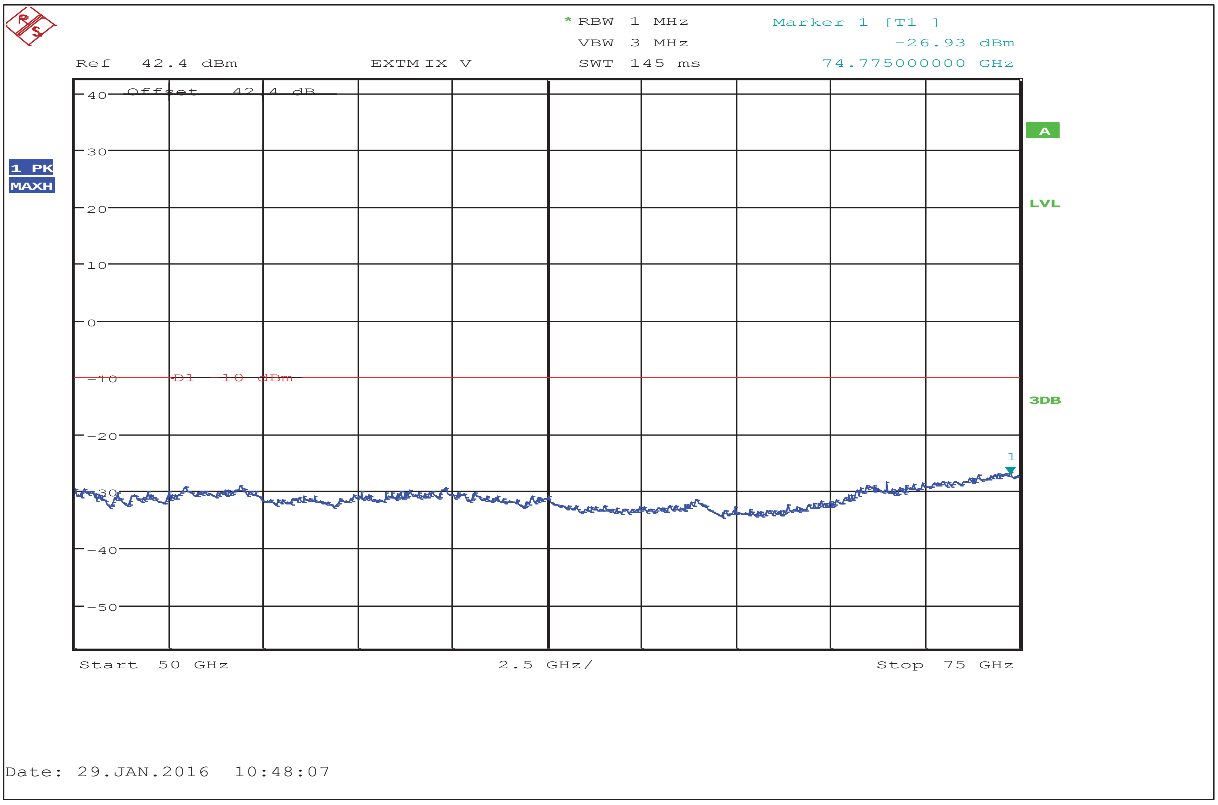

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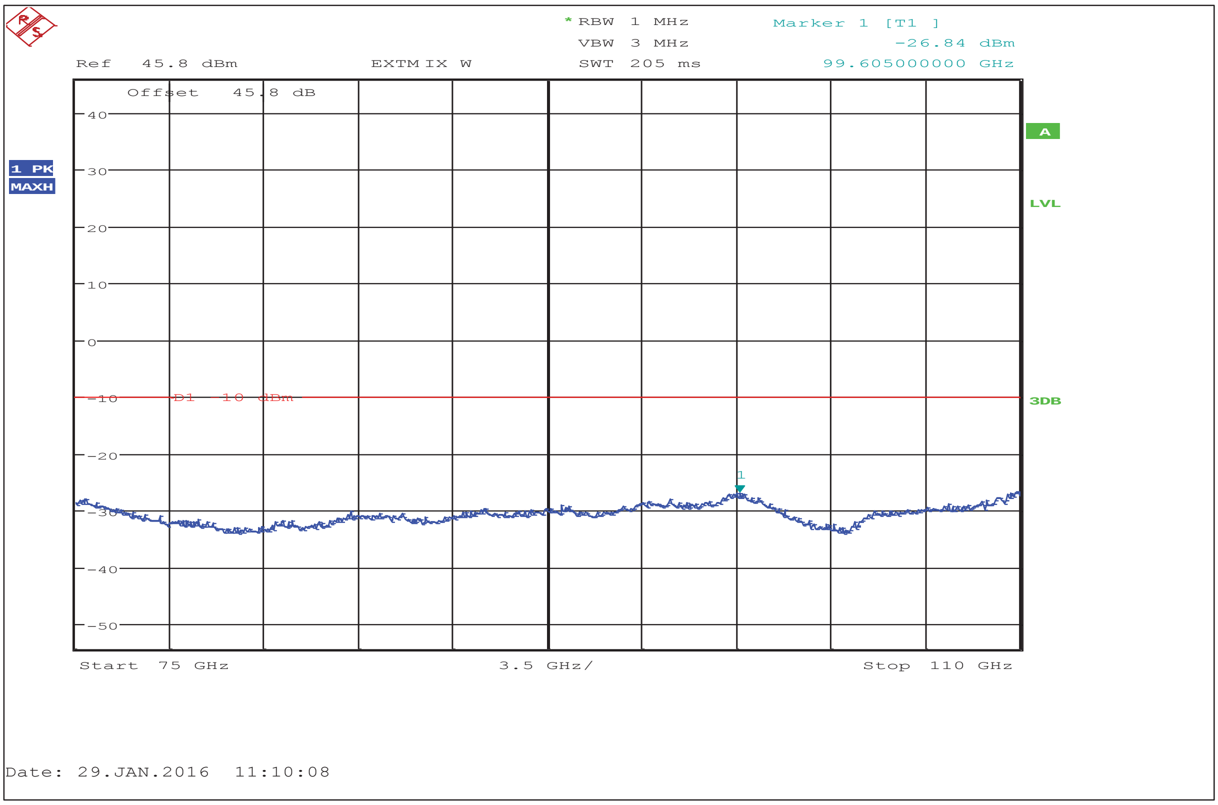

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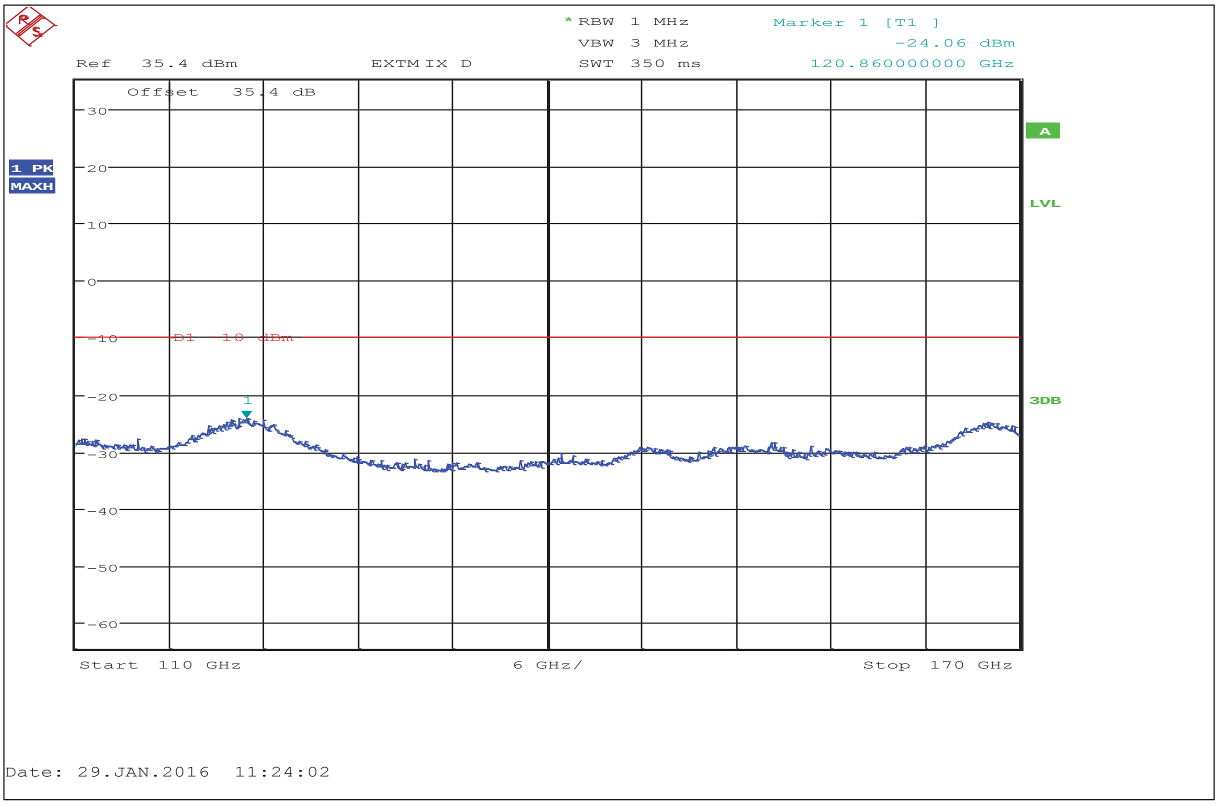

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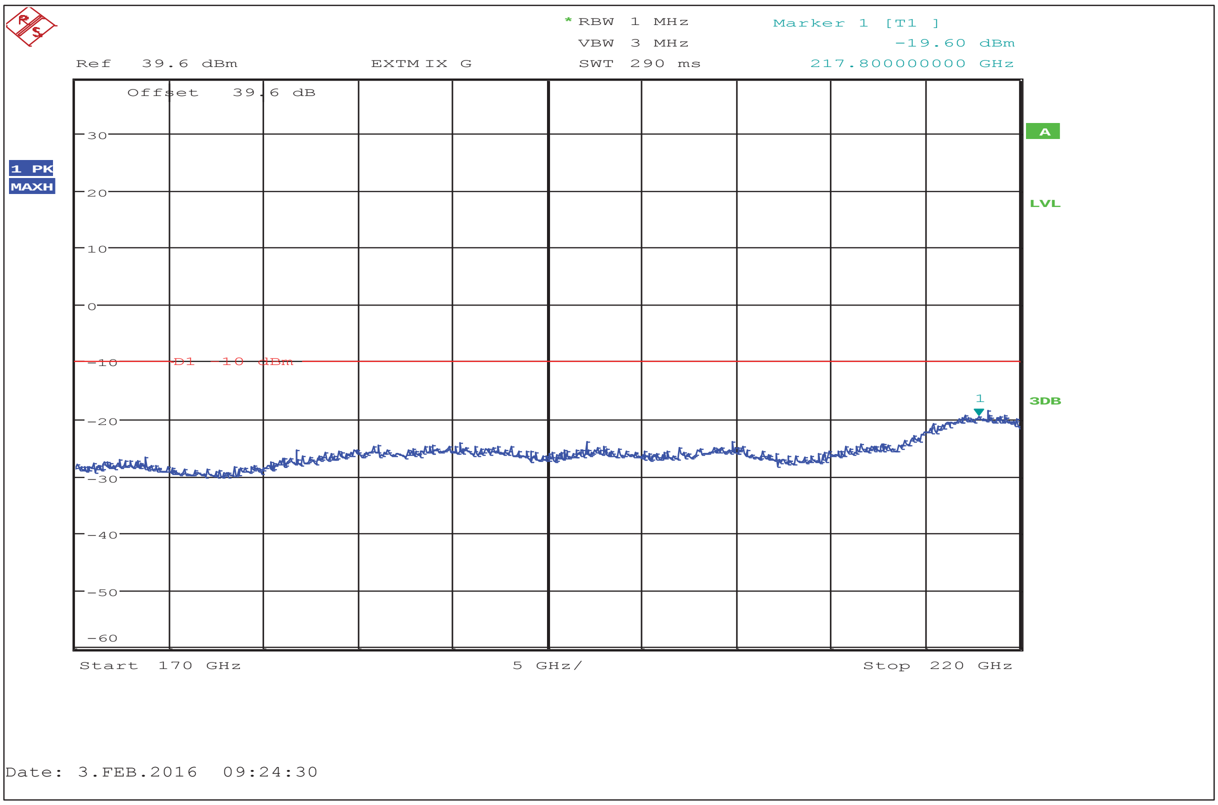

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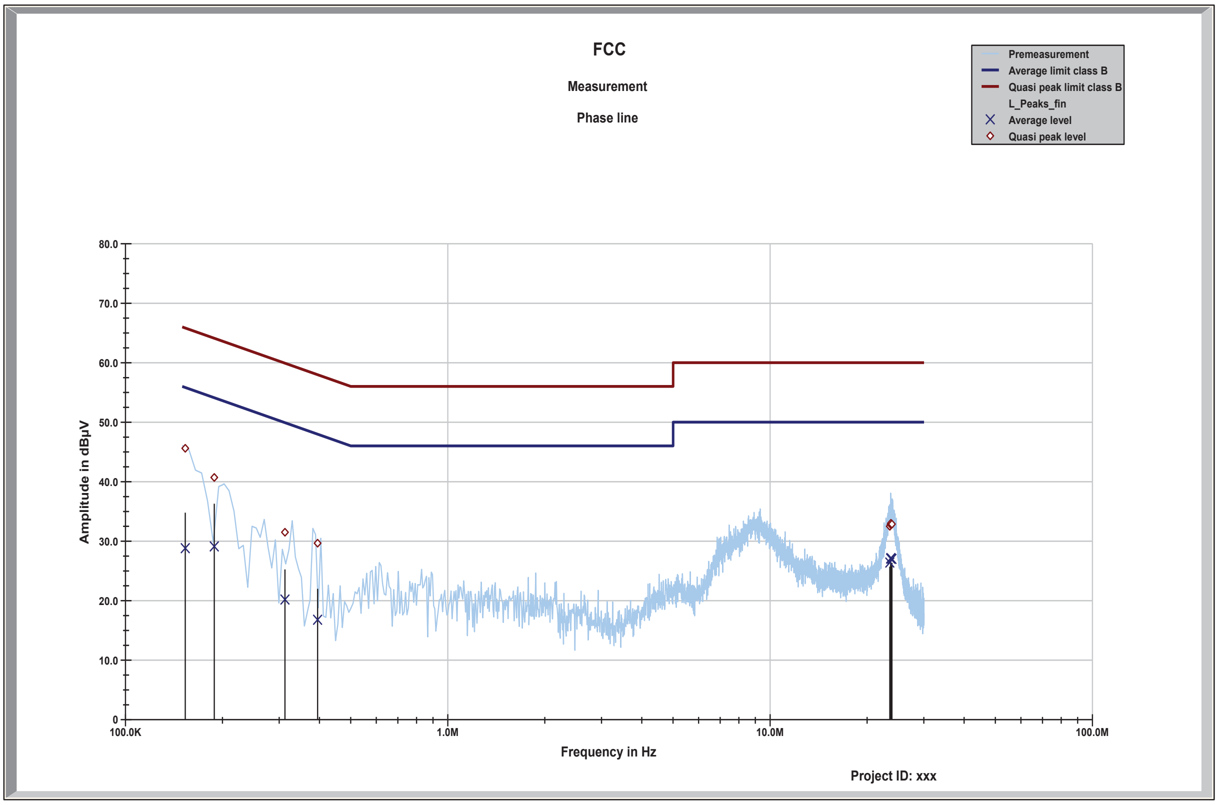

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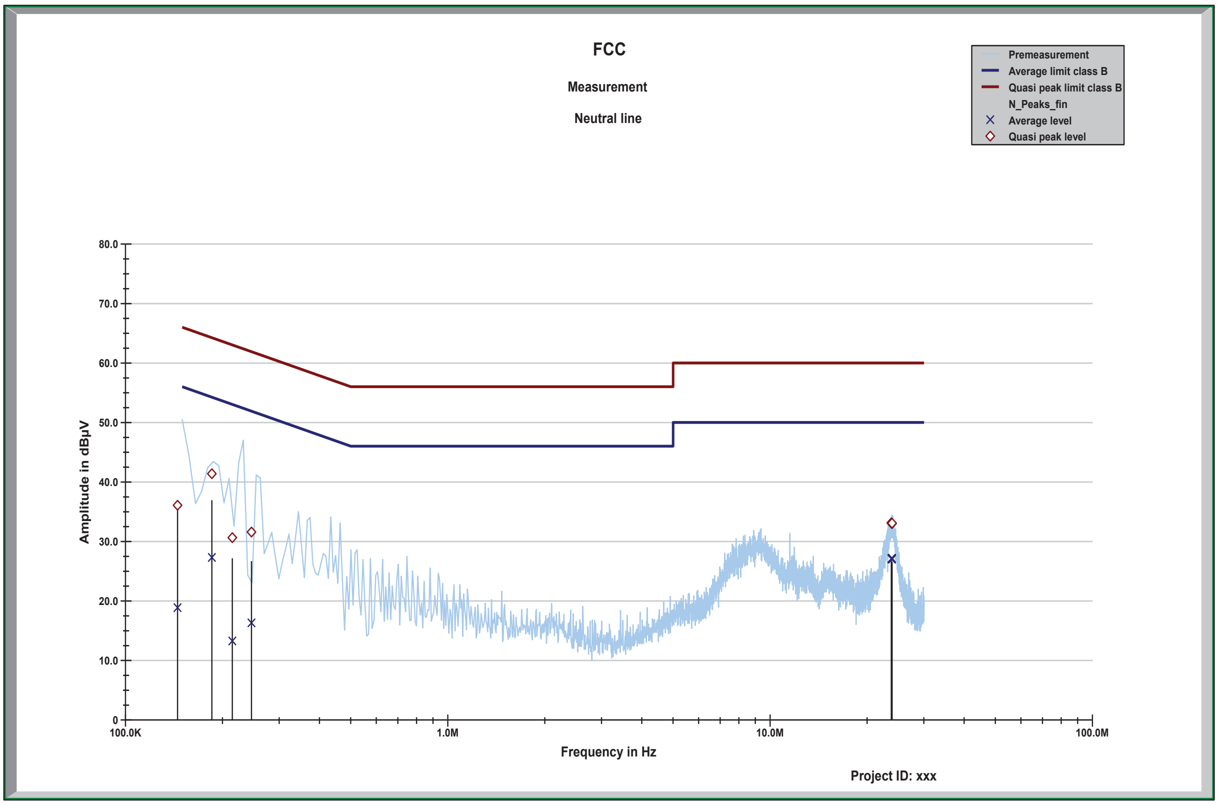

Annex A Document history

Version	Applied changes	Date of release
	DRAFT	2016-07-13
	Initial release	2016-07-26
-A	FCC ID, IC ID, HVIN corrected	2016-09-16

Annex B Further information

Glossary

AVG - Average
DUT - Device under test
EMC - Electromagnetic Compatibility
EN - European Standard
EUT - Equipment under test
ETSI - European Telecommunications Standard Institute
FCC - Federal Communication Commission
FCC ID - Company Identifier at FCC
HW - Hardware
IC - Industry Canada
Inv. No. - Inventory number
N/A - Not applicable
PP - Positive peak
QP - Quasi peak
S/N - Serial number
SW - Software
PMN - Product marketing name
HMN - Host marketing name
HVIN - Hardware version identification number
FVIN - Firmware version identification number

Annex C Accreditation Certificate

Front side of certificate

DAkkS
Deutsche Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH

Beliehene gemäß § 8 Absatz 1 AkkStelleG i.V.m. § 1 Absatz 1 AkkStelleGBV
Unterzeichnerin der Multilateralen Abkommen
von EA, ILAC und IAF zur gegenseitigen Anerkennung

Akkreditierung

Die Deutsche Akkreditierungsstelle GmbH bestätigt hiermit, dass das Prüflaboratorium

CETECOM ICT Services GmbH
Untertürkheimer Straße 6-10, 66117 Saarbrücken

die Kompetenz nach DIN EN ISO/IEC 17025:2005 besitzt, Prüfungen in folgenden Bereichen durchzuführen:

Funk
Mobilfunk (GSM / DCS) + OTA
Elektromagnetische Verträglichkeit (EMV)
Produktsicherheit
SAR / EMF
Umwelt
Smart Card Technology
Bluetooth®
Automotive
Wi-Fi-Services
Kanadische Anforderungen
US-Anforderungen
Akustik
Near Field Communication (NFC)

Die Akkreditierungsurkunde gilt nur in Verbindung mit dem Bescheid vom 04.05.2016 mit der Akkreditierungsnummer D-PL-12076-01 und ist gültig bis 17.01.2018. Sie besteht aus diesem Deckblatt, der Rückseite des Deckblatts und der folgenden Anlage mit insgesamt 63 Seiten.

Registrierungsnummer der Urkunde: **D-PL-12076-01-01**

Frankfurt, 04.05.2016

Im Auftrag Dipl.-Ing. (FH) Ralf Egner
Abteilungsleiter

Back side of certificate

Deutsche Akkreditierungsstelle GmbH

Standort Berlin [illegible]
Standort Frankfurt am Main [illegible]
Standort Braunschweig [illegible]

[illegible]

EA: www.european-accreditation.org
ILAC: www.ilac.org
IAF: www.iaf.nu

Note:
The current certificate including annex can be received from CETECOM ICT Services GmbH on request.