A RADIO TEST REPORT

FOR

Axell Wireless Limited

ON

55-227901 Dual – Band UHF Repeater

DOCUMENT NO. TRA-017602-47-00-C

HULL
Unit E, South Orbital Trading Park, Hedon Road, Hull, HU9 1NJ, UK.
T +44 (0)1482 801801 **F** +44 (0)1482 801806 **E** test@tracglobal.com
www.tracglobal.com

TRaC Wireless Test Report	**:** TRA-017602-47-00-C
Applicant	**:** Axell Wireless Limited
Apparatus	**:** 55-227901
Specification(s)	**:** CFR47 Part 90 & RSS-131
Purpose of Test	**:** Certification
FCCID	**:** NEO55-2279SERIES
Authorised by	**:** 
	: Radio Product Manager
Issue Date	**: 29th May 2014**
Authorised Copy Number	**:** *PDF*

Total number of pages: 134

Contents

Section 1: Introduction

1.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on samples submitted to the Laboratory.

Test performed by:

TRaC Global [ ]
Unit E
South Orbital Trading Park
Hedon Road
Hull, HU9 1NJ.
United Kingdom.

Telephone: +44 (0) 1482 801801
Fax: +44 (0) 1482 801806

TRaC Global [X]
Unit 1
Pendle Place
Skelmersdale
West Lancashire, WN8 9PN
United Kingdom

Telephone: +44 (0) 1695 556666
Fax: +44 (0) 1695 577077

Email: test@tracglobal.com
Web site: http://www.tracglobal.com

Tests performed by: S Hodgkinson

Report author: S Hodgkinson

1.2 Tests Requested By

This testing in this report was requested by :

Axell Wireless
Limited
Aerial House
Asherbridge Road
Chesham
Bucks
GB
HP5 2QD

1.3 Manufacturer

Axell Wireless Limited
Aerial House
Asherbridge Road
Chesham
Bucks
GB
HP5 2QD

1.4 Apparatus Assessed

The following apparatus was assessed between 11th March – 17th March 2014

55-227901 Dual band UHF repeater, covering the bands
489.5MHz - 491.0MHz, 496.0MHz – 496.9MHz in the downlink direction
and 492.5MHz – 494.0MHz, 499.0MHz – 499.9MHz in the Uplink direction.

1.5 Test Result Summary

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

The statements relating to compliance with the standards below apply ONLY as qualified in the notes and deviations stated in sections 1.6 to 1.7 of this test report.

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

Test Type	FCC Part	RSS-131 Rule Part	Appendix in Report	Result
RF Gain and Power Output	90.219(e)(3)	4.3	A1 & B1	Pass
Intermodulation Spurious Emissions	90.219(e)(3)	N/A	A2 & B2	Pass
Occupied Bandwidth & Modulation	90.219(a) 90.219(e)(4)(ii) 90.210(d)	N/A	A3 & B3	Pass
Spurious Emissions at Antenna Terminals Less than 1MHz	90.219(e)(3) 90.210(d)	N/A	A4 & B4	Pass
Spurious Emissions at Antenna Terminals Greater than 1MHz	90.219(e)(3)	N/A	A5 & B5	Pass
Noise At Antenna Terminals	90.219(e)(3) 90.219(e)(2)	N/A	A6 & B6	Pass
Field Strength of Spurious Emissions	90.219(e)(3)	4.3.2	A7 & B7	Pass
Passband Gain & 20dB bandwidth	N/A	4.2	A8 & B8	Pass
Frequency Stability	90.213	4.4	N/A(note 1)	N/A
Transient behaviour	90.214	4.4	N/A(note 2)	N/A
Audio Frequency Response (a)	TIA EIA-603.3.2.6	4.5	N/A	N/A
Modulation Limiting	TIA EIA-603.3.2.6	N/A	N/A	N/A
Signal Booster Labelling Requirements	90.219(e)(5)(4)	5.2	N/A	N/A

Notes:
1 The EUT does not contain modulation circuitry; therefore the test was not performed.
2 The EUT is not a keyed carrier system; therefore the test was not performed.

Abbreviations used in the above table:

CFR	: Code of Federal Regulations	ANSI	: American National Standards Institution
REFE	: Radiated Electric Field Emissions	PLCE	: Power Line Conducted Emissions
A	Uplink Results Appendix	B	Downlink Results Appendix

1.6 Equipment Test Conditions

Product class:	Uplink	Class A [ ] Class B [X]
	Downlink	Class A [ ] Class B [X]
Product Use:	Private Land Mobile Repeater	
Supply Voltages:	Vnom	110Vac
Note: Vnom voltages are as stated above unless otherwise shown on the test report page		
Equipment Category:	Single channel	[ ]
	Two channel	[ ]
	Multi-channel	[X]
Channel spacing:	Uplink	Wideband
	Downlink	Wideband
Test Location	TRaC Global	
	Skelmersdale	[X]
	Hull	[ ]
	Other	[ ] Please Specify

1.7 Standard References

47 CFR 2	Code of Federal Regulations, Title 47, Part 2, “Frequency allocations and Radio Telemetry Matters; General Rules and Regulations”
47 CFR 90	Code of Federal Regulations, Title 47, Part 90,”Land Mobile Radio Service”
47 CFR 15	Code of Federal Regulations, Title 47, Part 15,”Radio Frequency Devices” Subpart B, “Unintentional Radiators”
C63.4-2003	American National Standards Institute (ANSI), “Methods of Measurement of Radio Noise Emissions from Low Voltage Electrical and Electronic Equipment in the Range 9 kHz to 40 GHz”
RSS-131	Zone Enhancers for the Land Mobile Service
RSS-GEN	General Requirements and Information for the Certification of Radio Apparatus
TIA EIA-603-D	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

1.8 Notes Relating To Assessment

With regard to this assessment, the following points should be noted:

The results contained in this report relate only to the items tested 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.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where modified in Section 1.7 of this test report (Deviations from Test Standards).

For emissions testing, throughout this test report, “Pass” indicates that the results for the sample as tested were below the specified limit (refer also to Section 2, Measurement Uncertainty).

Where relevant, the apparatus was only assessed using the monitoring methods and susceptibility criteria defined in this report.

All testing with the exception of testing at the Open Area Test Site was performed under the following environmental conditions:

Temperature	: 17 to 23 °C
Humidity	: 45 to 75 %

All dates used in this report are in the format dd/mm/yy.

This assessment has been performed in accordance with the requirements of ISO/IEC 17025.

1.9 Deviations from Test Standards

There were no deviations from the standards tested to.

Section 2: Measurement Uncertainty

2.1 Measurement Uncertainty Values

For the test data recorded the following measurement uncertainty was calculated:

Section 3: Modifications

3.1 Modifications Performed During Assessment

No modifications were performed during the assessment

Appendix A: Downlink Formal Emission Test Results

Abbreviations used in the tables in this appendix:

Spec	: Specification
Mod	: Modification
EUT	: Equipment Under Test
SE	: Support Equipment
L	: Live Power Line
N	: Neutral Power Line
E	: Earth Power Line
Pk	: Peak Detector
QP	: Quasi-Peak Detector
Av	: Average Detector
CDN	: Coupling & decoupling network

ALSR	: Absorber Lined Screened Room
OATS	: Open Area Test Site
ATS	: Alternative Test Site
Ref	: Reference
Freq	: Frequency
MD	: Measurement Distance
SD	: Spec Distance
Pol	: Polarisation
H	: Horizontal Polarisation
V	: Vertical Polarisation

A1 RF Gain and Output Power

Test Details: Downlink	
Measurement standard	Part 2.1046, Part 90.219(e)(3),RSS-131 Section 4.3
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
Temperature (^{o}C)	24
Humidity (%)	34
EUT set up	Refer to Appendix C

Downlink 489.5MHz – 491.0MHz

Frequency MHz	Signal Generator input level dBm	Input Cable Loss dB	Level at Spectrum Analyser dBm	Output Cable & Attenuator loss dB	Gain dB	Conducted Output Power dBm	Gain after 10dB input level increase dB
489.5000	-21.72	0.30	-13.10	39.6	48.52	26.50	38.31
490.2500	-21.92	0.30	-13.30	39.6	48.52	26.30	38.50
491.0000	-20.22	0.30	-14.09	39.6	46.03	25.51	35.97

Downlink 496.0MHz – 496.9MHz

Frequency MHz	Signal Generator input level dBm	Input Cable Loss dB	Level at Spectrum Analyser dBm	Output Cable & Attenuator loss dB	Gain dB	Conducted Output Power dBm	Gain after 10dB input level increase dB
496.0000	-18.88	0.30	-13.11	39.5	45.55	26.37	35.55
496.4500	-20.82	0.30	-13.69	39.5	46.91	25.79	36.91
496.9000	-20.94	0.30	-14.45	39.5	46.27	25.03	36.27

Notes: 1.The signal generator input was increased by 10dBs and the level of the output signal remeasured.

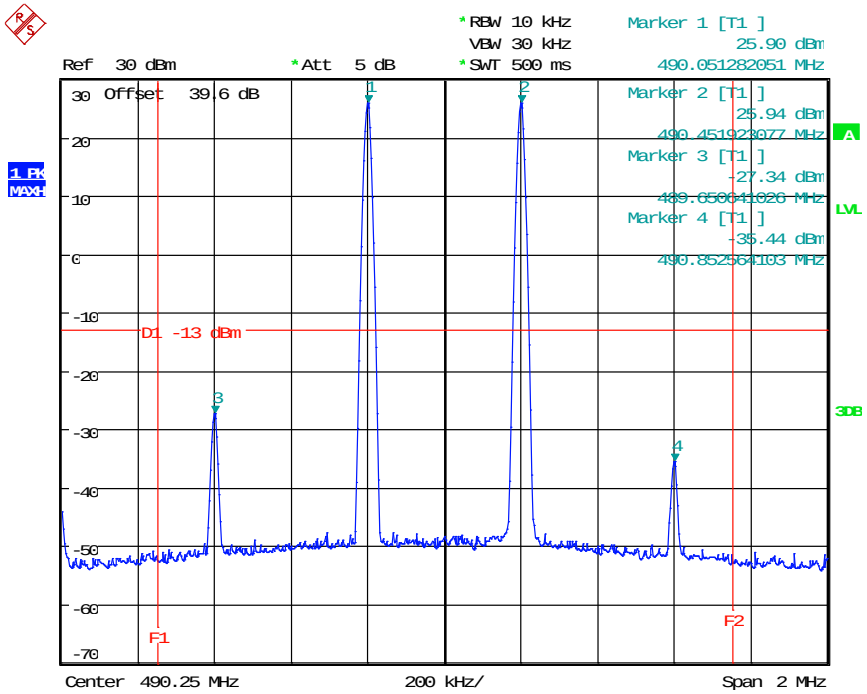
As per D.3 Policies + Procedures (k) of KDB 935210 D02 Signal Boosters Certification v02 the EUT was tested at compression and 10dB into compression to show AGC operation

Downlink 489.5MHz – 491.0MHz

Frequency	Frequency (MHz)	P_o	Level at Spectrum Analyser (dBm)	Output Cable & Attenuator loss (dB)	Power At Output Point (dBm)
f_1	490.05	P_{o2}	-13.70	39.6	25.90
f_2	490.45	P_{o1}	-13.66	39.6	25.94
f_3	489.65	P_{o3}	-66.94	39.6	-27.34
f_4	490.85	P_{o4}	-75.04	39.6	-35.44

$P_{mean} = P_{o1} + 3dB$

P_{o1} (dBm)	P_{mean}	P_{mean} (dBm)
25.94	$P_{o1} + 3dB$	28.94

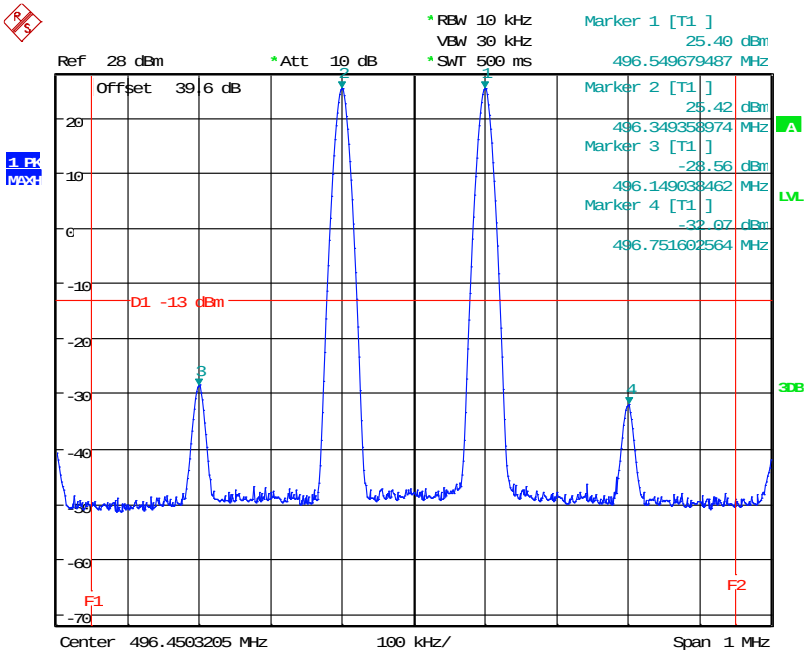


Date: 17.MAR.2014 14:14:04

Downlink 496.0MHz – 496.9MHz

Frequency	Frequency (MHz)	P_o	Level at Spectrum Analyser (dBm)	Output Cable & Attenuator loss (dB)	Power At Output Point (dBm)
f_1	496.35	P_{o2}	-14.18	39.6	25.42
f_2	496.55	P_{o1}	-14.20	39.6	25.40
f_3	496.14	P_{o3}	-68.16	39.6	-28.56
f_4	496.75	P_{o4}	-71.67	39.6	-32.07

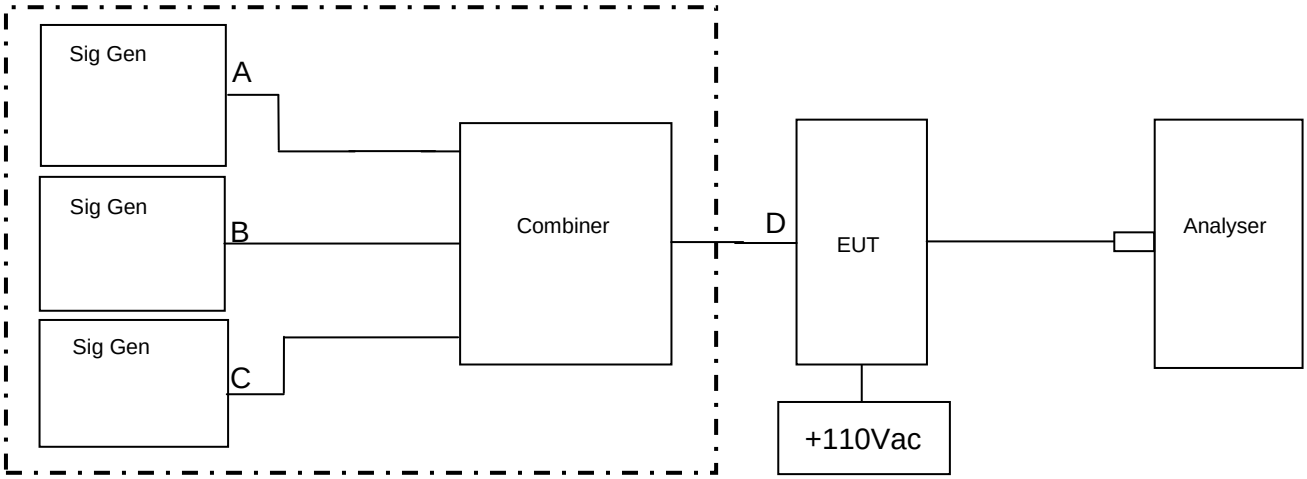
$P_{mean} = P_{o1} + 3dB$	P_{o1} (dBm)	P_{mean}	P_{mean} (dBm)
	25.42	$P_{o1} + 3dB$	28.42



Date: 17.MAR.2014 14:26:06

A2 Amplifier Intermodulation Spurious Emissions

Test Details:Downlink	
Measurement standard	Part 2.1053, 90.219(e)(3)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C



Signal Generator B was varied in frequency to check if intermodulation products where produced.

489.5MHz-491.0MHz

RF Input Frequency (MHz)			Highest Intermodulation Product Level (dBm)	Limit (dBm)
489.5	489.5	491.0	490.00MHz @ -20.95dBm	-13

496.0MHz-496.9MHz

RF Input Frequency (MHz)			Highest Intermodulation Product Level (dBm)	Limit (dBm)
496.0	496.3	496.9	496.6MHz @ -20.63dBm	-13

Sweep data is shown on the next page:

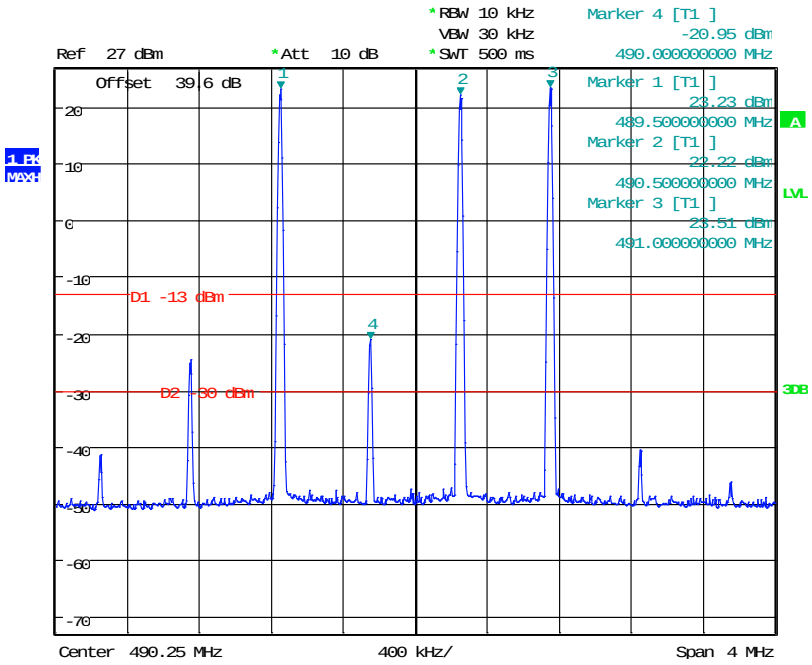
Results

The EUT was found to comply with the limits

See plots below

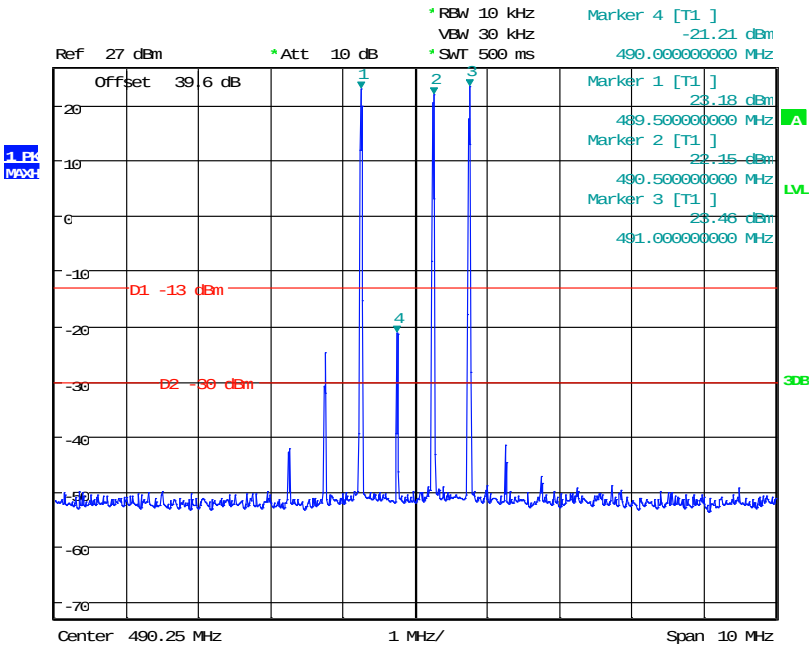
As per D.3 Policies + Procedures (k) of KDB 935210 D02 Signal Boosters Certification v02 the EUT was tested at compression and 10dB into compression to show AGC operation, worst case results taken.

Intermodulation close View 489.5MHz - 491.0MHz Downlink



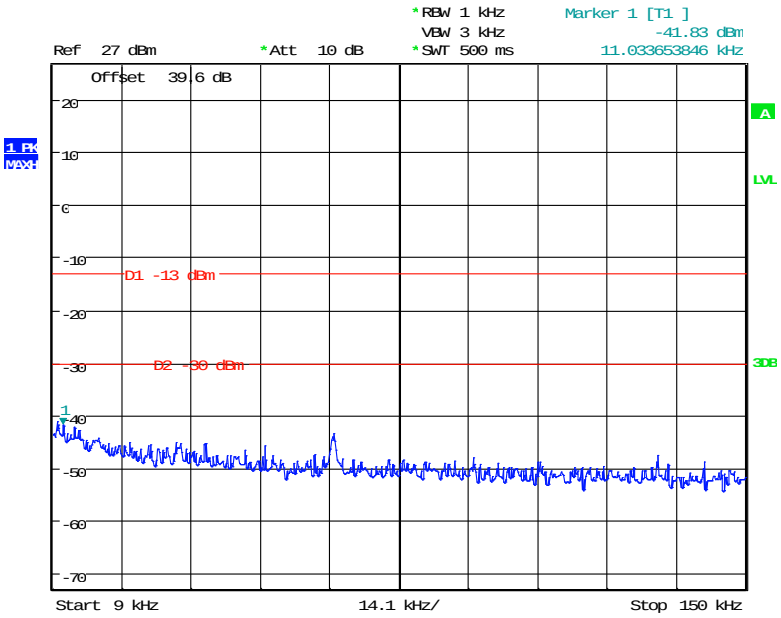
Date: 12.MAR.2014 11:15:55

Intermodulation Wide View



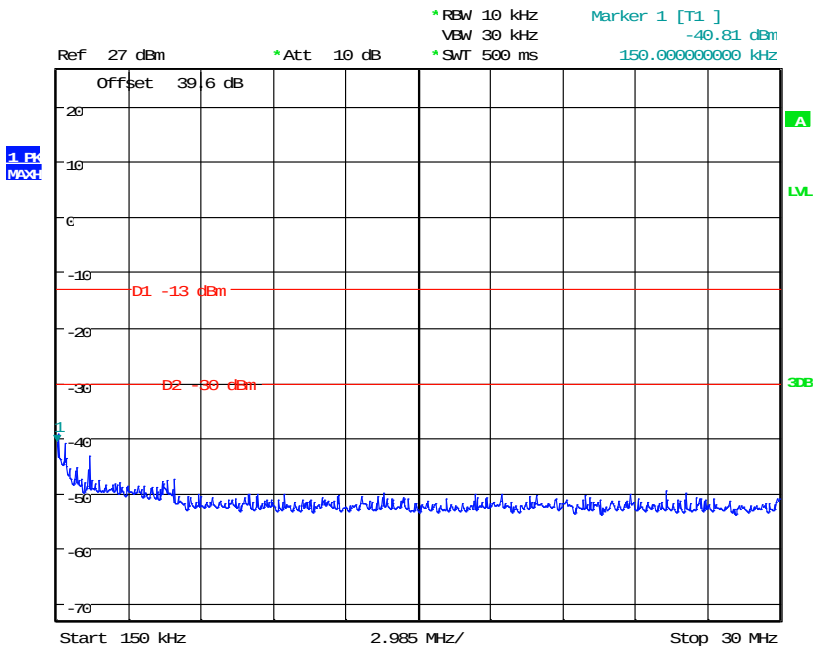
Date: 12.MAR.2014 11:16:37

9-150kHz



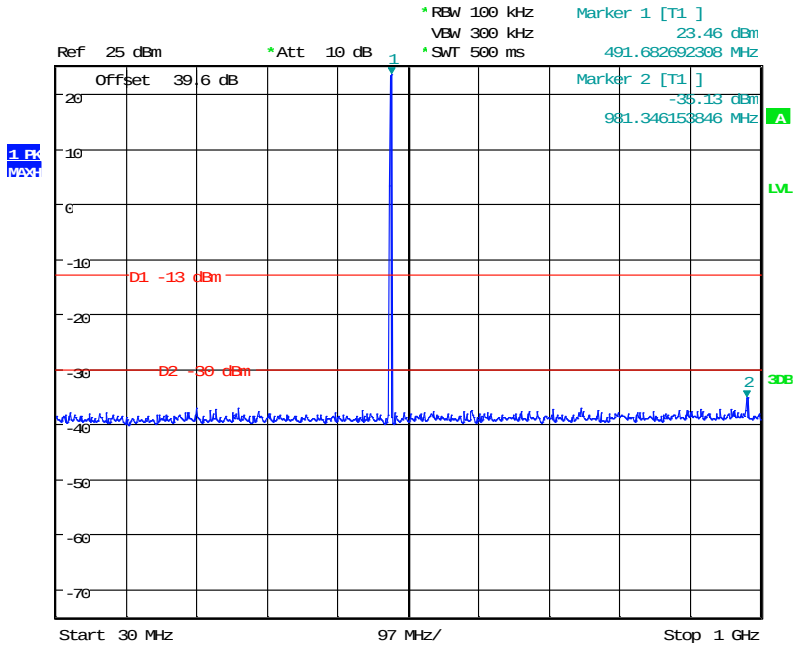
Date: 12.MAR.2014 11:17:39

150kHz – 30MHz



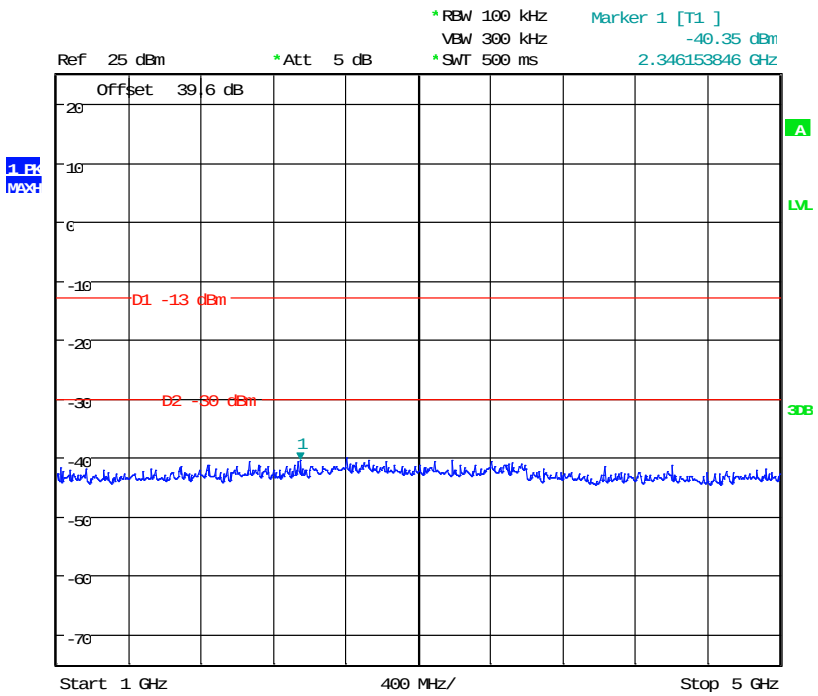
Date: 12.MAR.2014 11:18:14

30MHz – 1GHz



Date: 12.MAR.2014 11:20:18

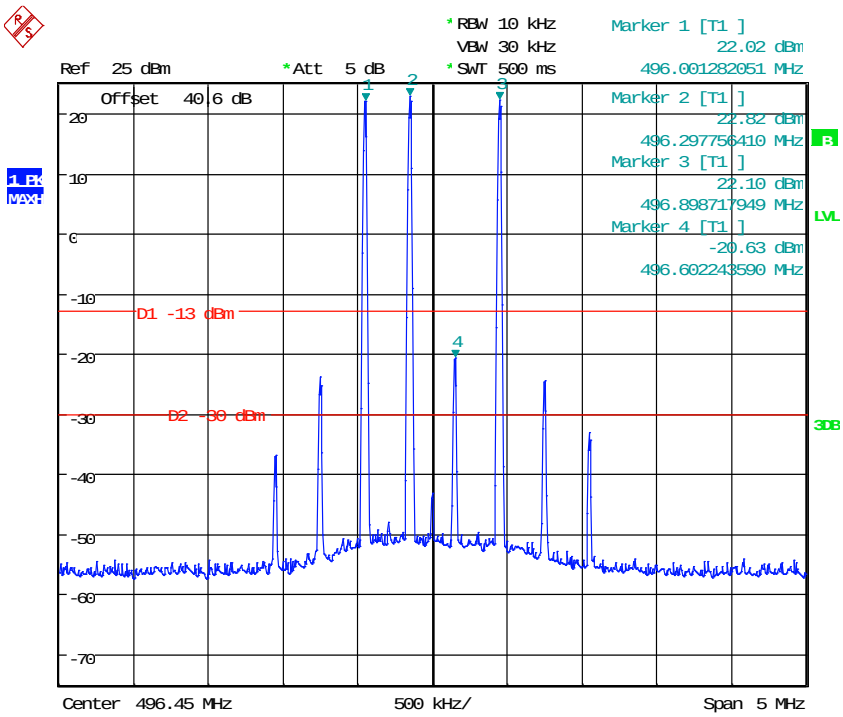
1GHz – 5GHz



Date: 12.MAR.2014 11:21:35

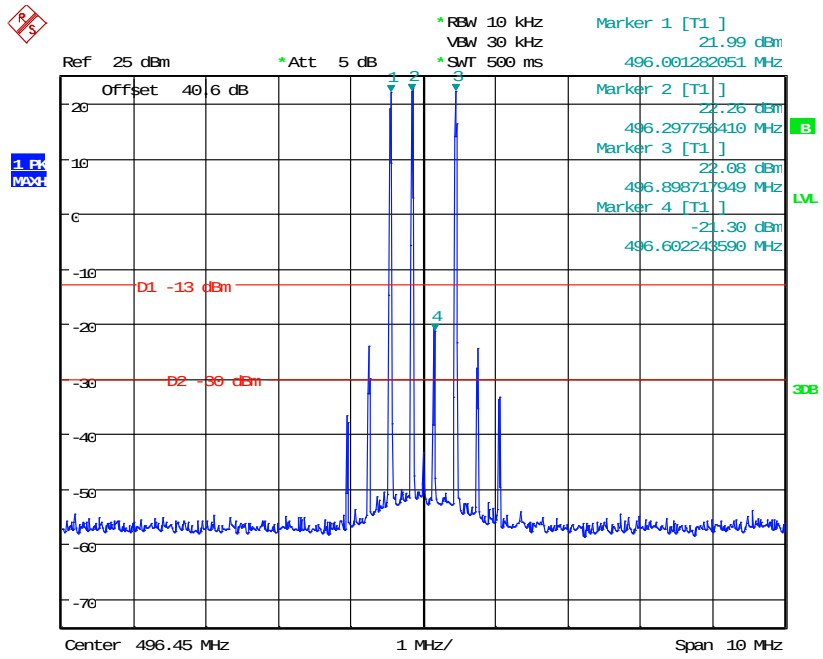
.

Intermodulation Close View 496.0MHz - 496.9MHz Downlink



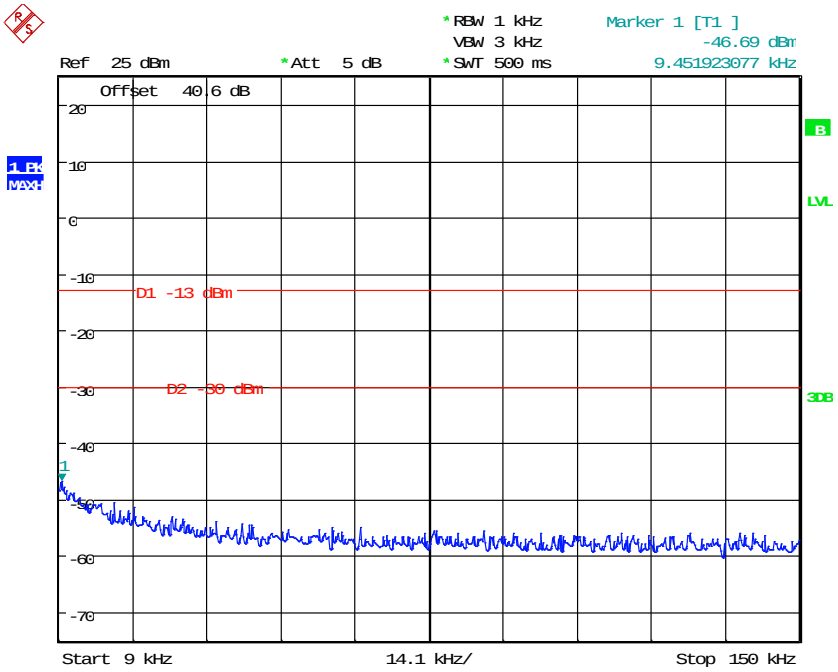
Date: 28.MAR.2014 12:56:31

Intermodulation Wide View



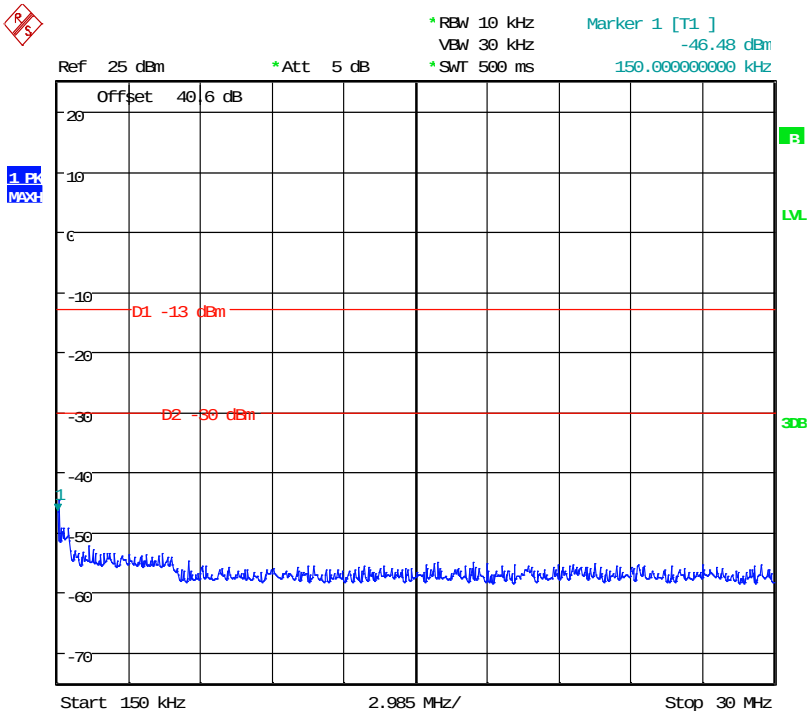
Date: 28.MAR.2014 12:56:57

9-150kHz



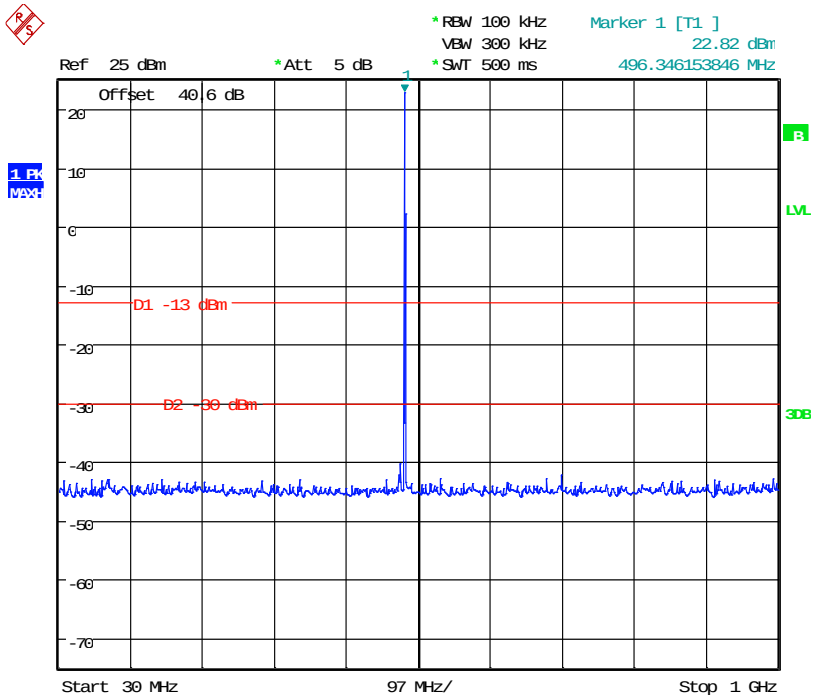
Date: 28.MAR.2014 12:58:18

150kHz – 30MHz



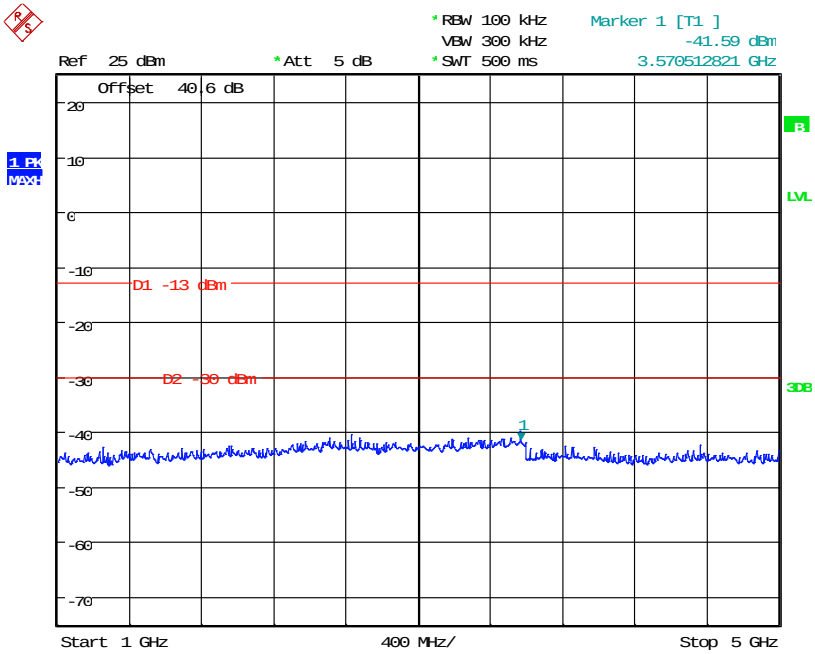
Date: 28.MAR.2014 12:58:55

30MHz – 1GHz



Date: 28.MAR.2014 12:59:41

1GHz – 5GHz



Date: 28.MAR.2014 13:00:12

A3 Amplifier Modulated Channel Test

Test Details: Downlink	
Measurement standard	Part 2.1049, Part 90.219(a) 90.219(e)(4)(ii), 90.210(d)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

489.5MHz – 491.0MHz

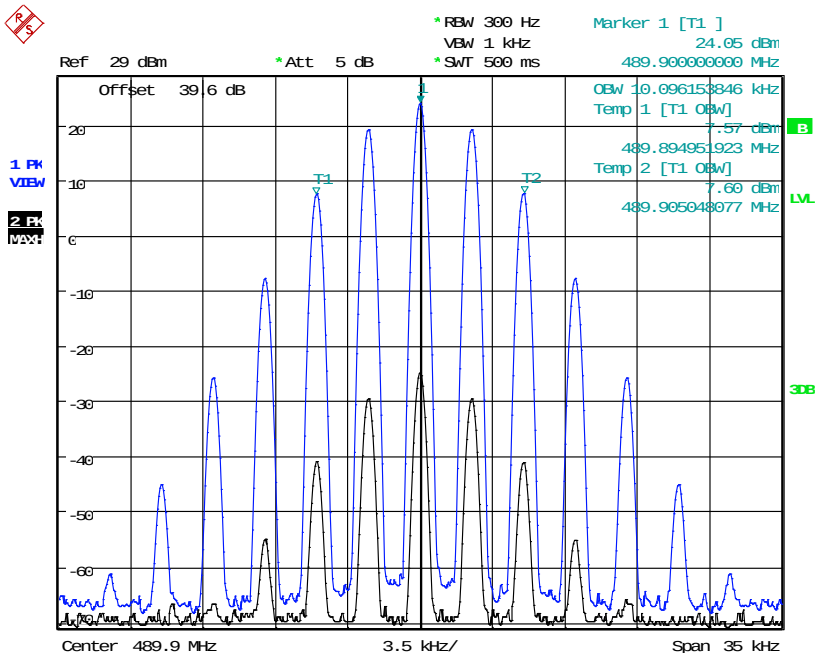
Modulation Type	Frequency Of Operation Channel		
	489.5MHz	490.25MHz	491.0MHz
Analogue (99% BW)	10.096kHz	10.096kHz	9.983kHz
P25 (99% BW)	8.333kHz	8.413kHz	8.413kHz

496.0 – 496.9MHz

Modulation Type	Frequency Of Operation Channel		
	496.0MHz	496.45	496.9MHz
Analogue (99% BW)	10.096kHz	10.096kHz	10.096kHz
P25 (99% BW)	8.333kHz	8.333kHz	8.333kHz

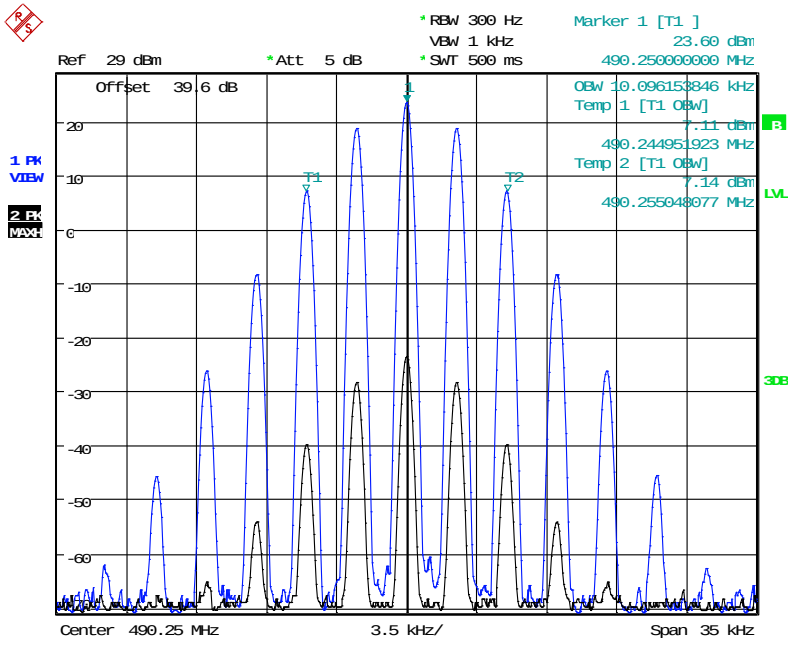
As per D.3 Policies + Procedures (k) of KDB 935210 D02 Signal Boosters Certification v02 the EUT was tested at compression and 10dB into compression to show AGC operation, worst case results taken.

489.5MHz Analogue Signal Generator and EUT



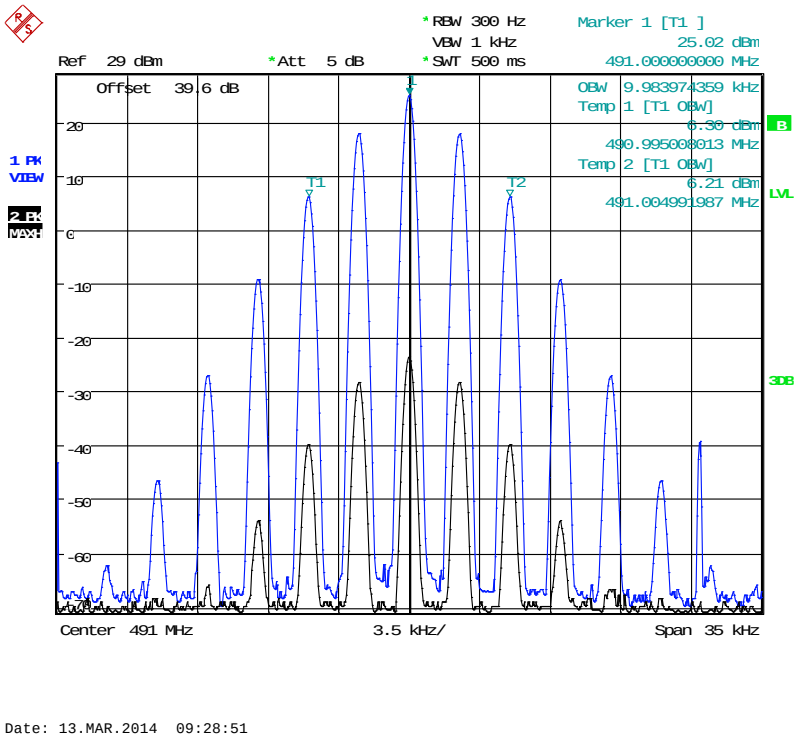
Date: 13.MAR.2014 09:17:24

490.25MHz Analogue Signal Generator and EUT



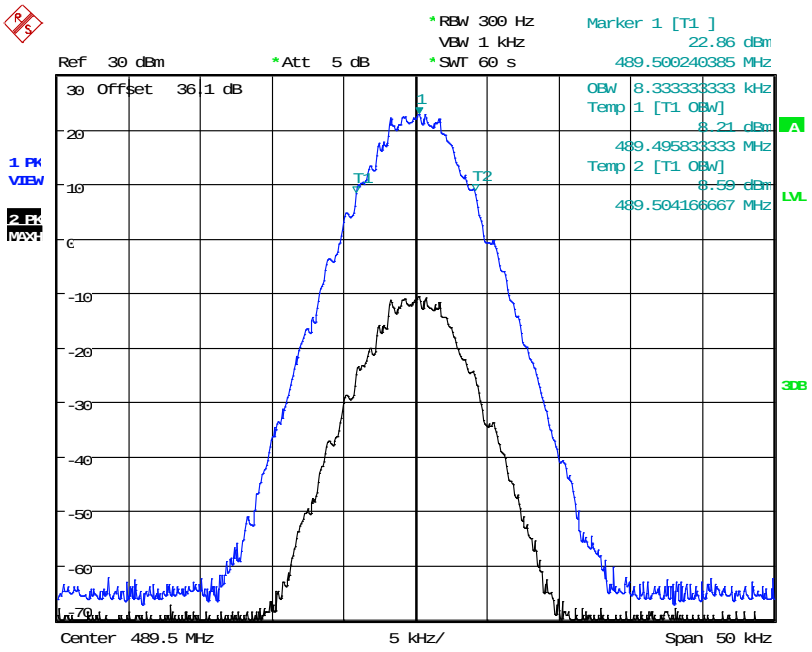
Date: 13.MAR.2014 09:24:53

491.0MHz Analogue Signal Generator and EUT



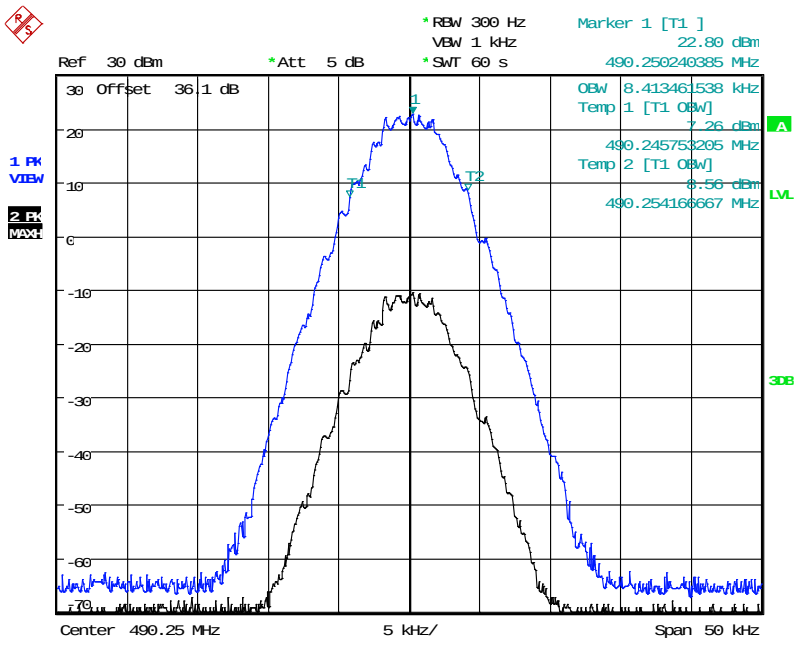
The above plots depicting the output waveshape show no measurable distortion visible when compared to the input signal.

489.5MHz P25 Signal Generator and EUT



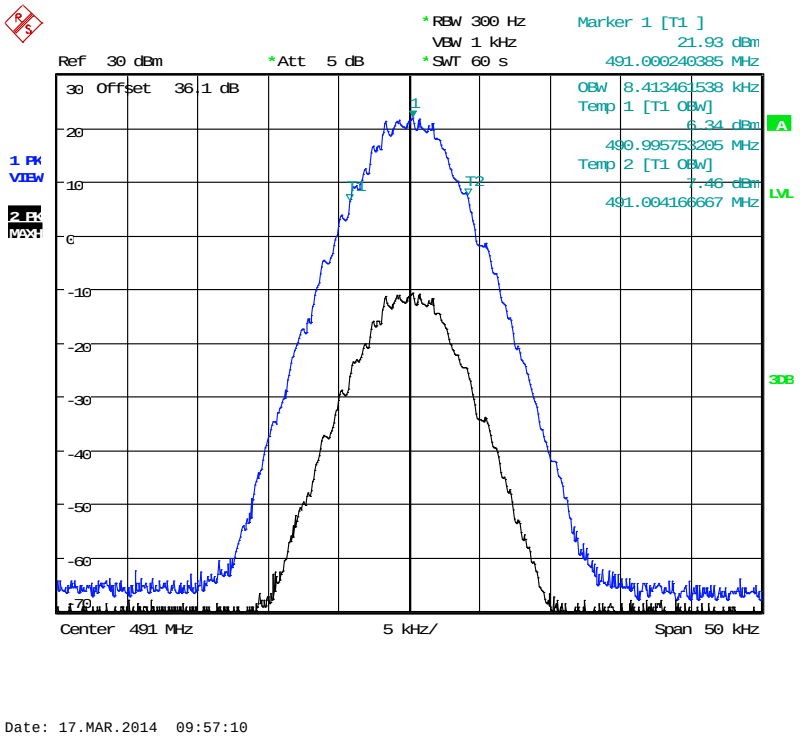
Date: 17.MAR.2014 09:47:39

490.25MHz P25 Signal Generator and EUT



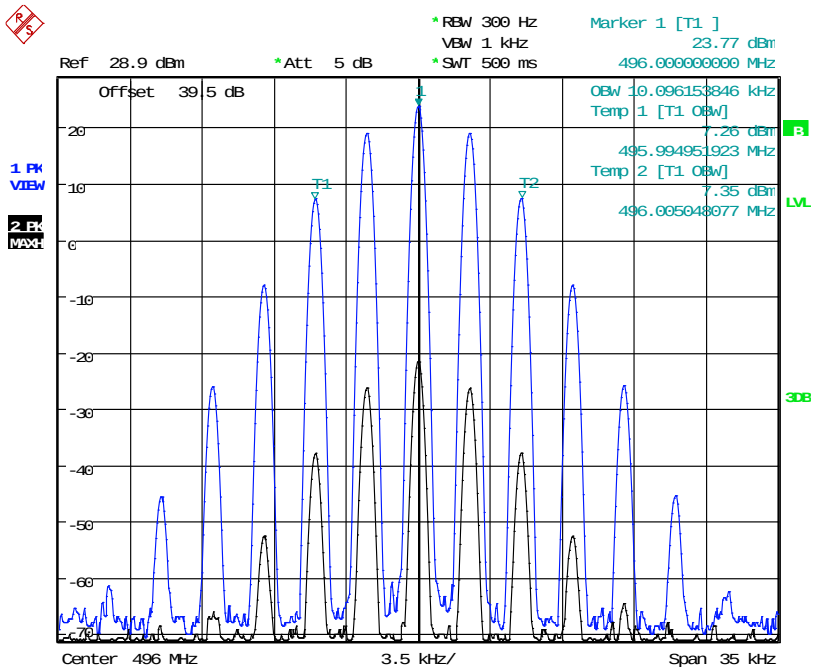
Date: 17.MAR.2014 09:52:35

491.0MHz P25 Signal Generator and EUT



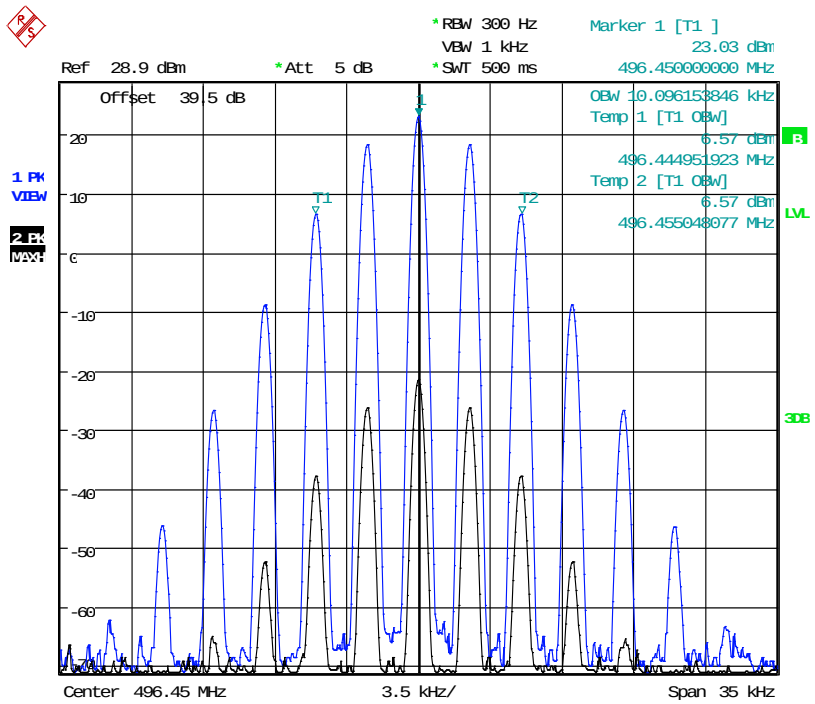
The above plots depicting the output waveshape show no measurable distortion visible when compared to the input signal.

496.00MHz Analogue Signal Generator and EUT



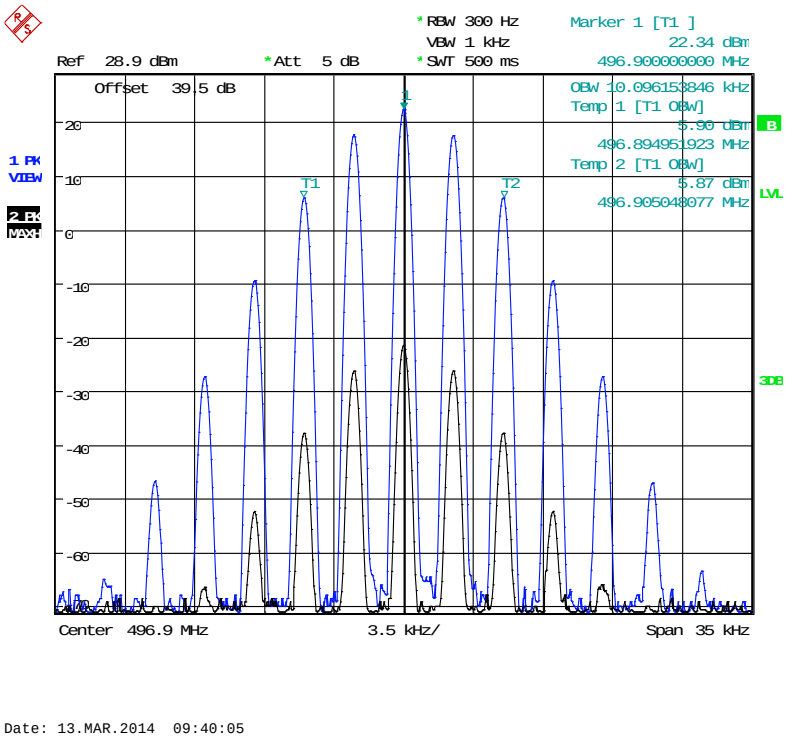
Date: 13.MAR.2014 09:33:29

496.45MHz Analogue Signal Generator and EUT



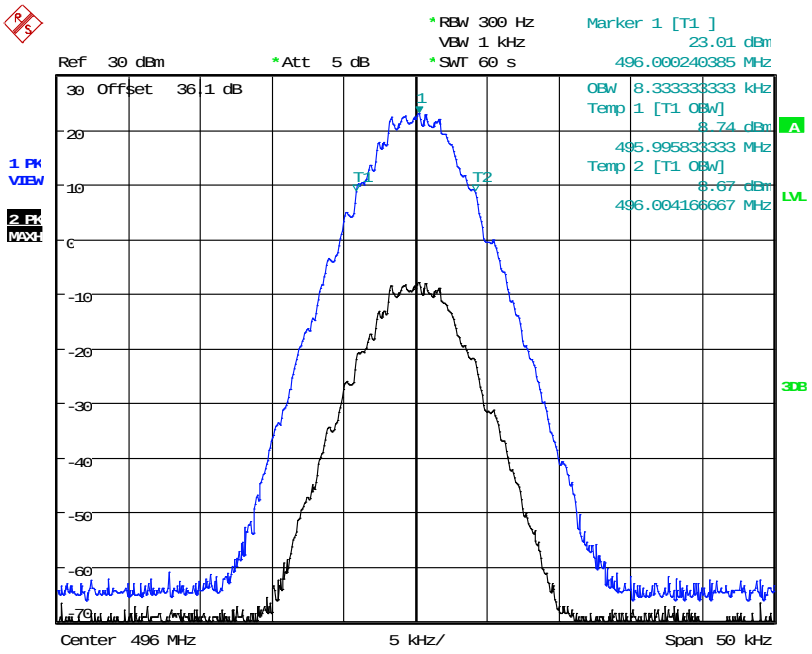
Date: 13.MAR.2014 09:35:49

496.90MHz Analogue Signal Generator and EUT



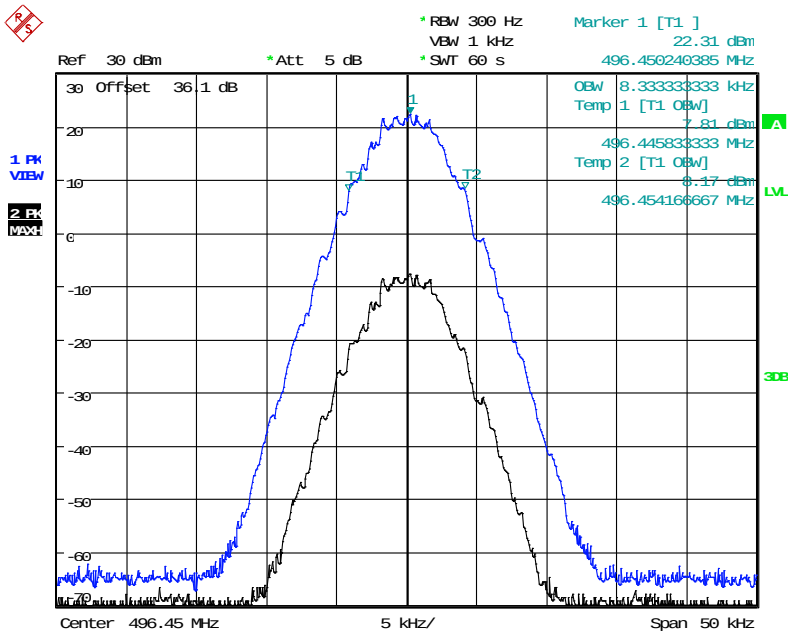
Date: 13.MAR.2014 09:40:05

496.00MHz P25 Signal Generator and EUT



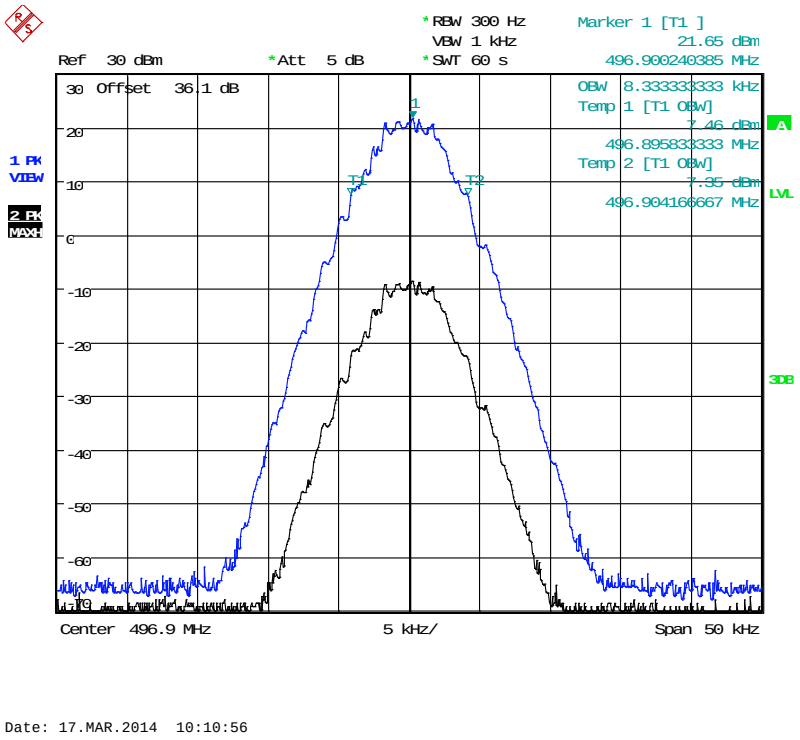
Date: 17.MAR.2014 10:05:49

496.45MHz P25 Signal Generator and EUT



Date: 17.MAR.2014 10:17:56

496.90MHz P25 Signal Generator and EUT



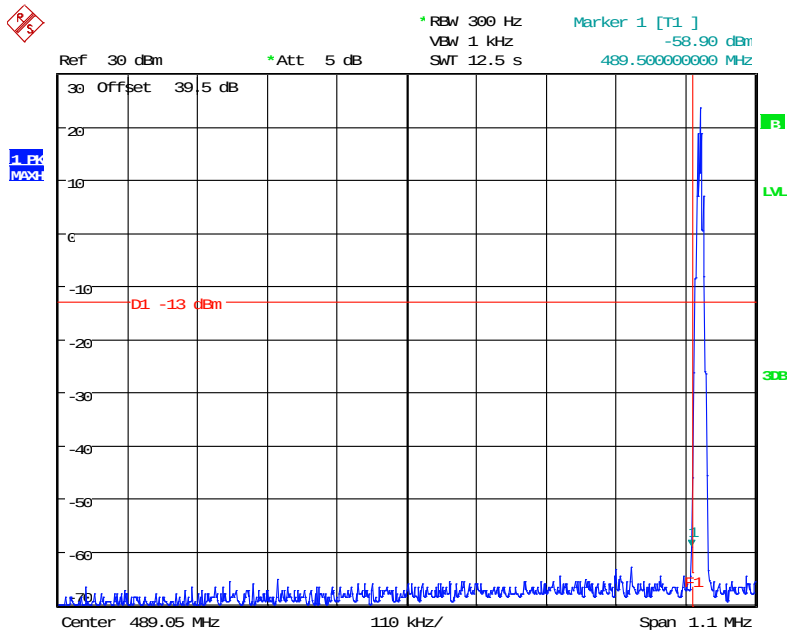
The above plots depicting the output waveshape show no measurable distortion visible when compared to the input signal.

A4 Spurious Emissions at Antenna Terminals Less than 1MHz

Test Details: Downlink	
Measurement standard	Part 2.1053, 90.219(e)(3), 90.210(d)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

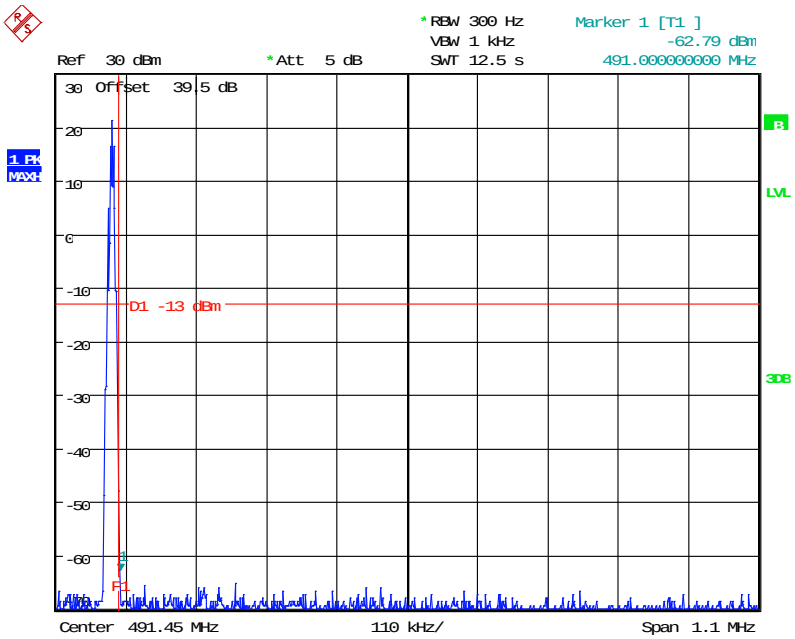
Modulation Type	Bandedge	Carrier Frequency (MHz)	Max Level @ bandedge (dBm)
Analogue Low	Lower	489.5	-58.90
	Upper	491.0	-62.79
Analogue Hi	Lower	496.0	-63.20
	Upper	496.9	-59.43
P25 Low	Lower	489.5	-55.54
	Upper	491.0	-54.61
P25 Hi	Lower	496.0	-55.71
	Upper	496.9	-55.65

489.5MHz – 491.0MHz Analogue Signal – Lower Bandedge



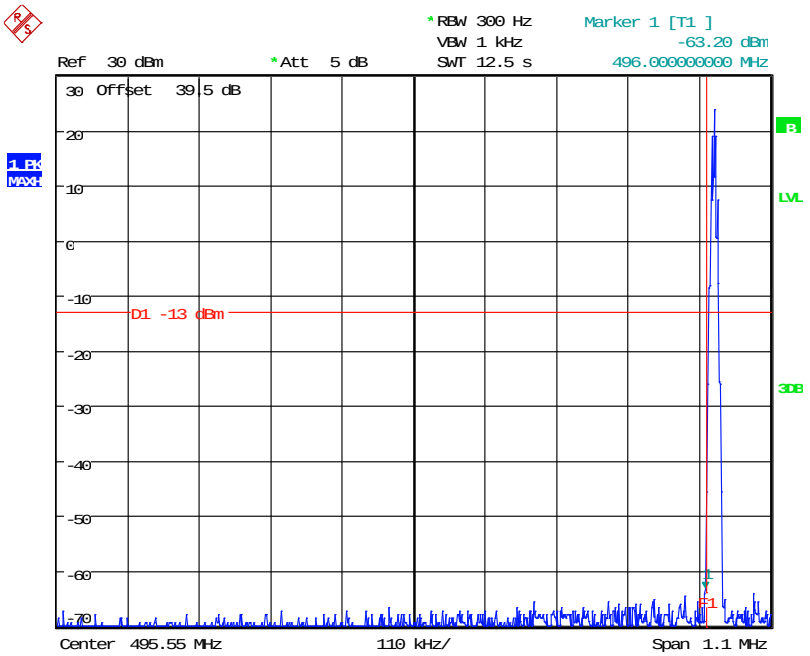
Date: 14.MAR.2014 11:47:26

Analogue Signal – Upper Bandedge



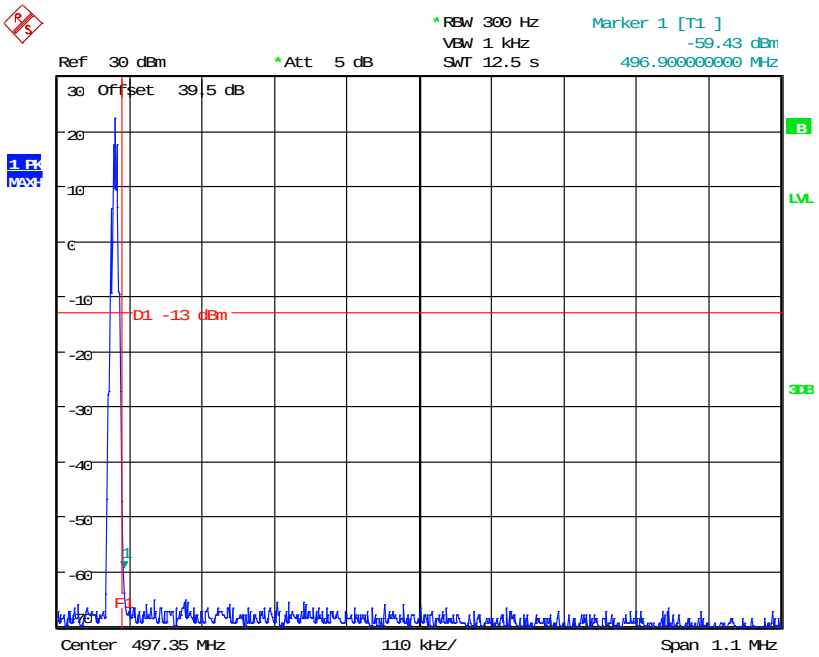
Date: 14.MAR.2014 11:48:47

496.0MHz – 496.9MHz Analogue Signal – Lower Bandedge



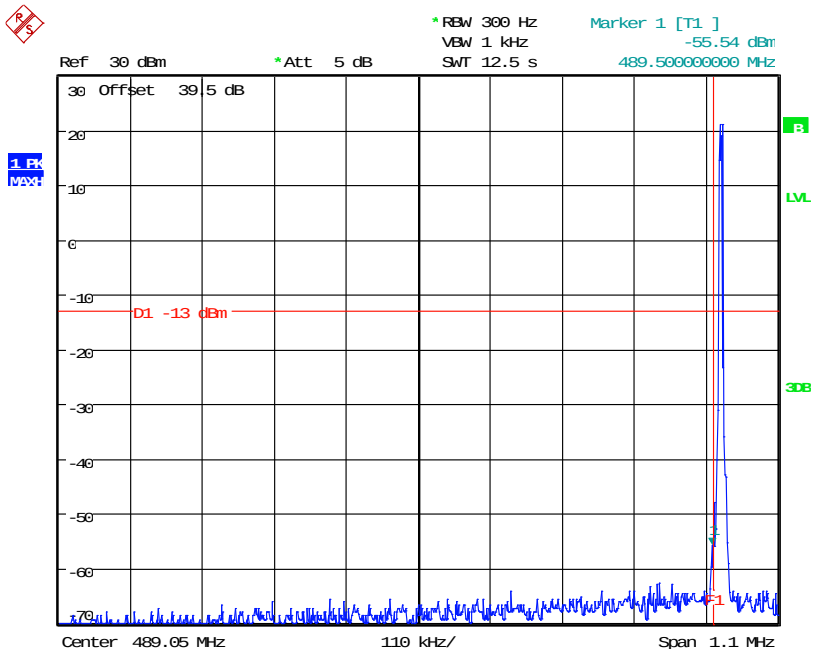
Date: 14.MAR.2014 11:50:08

Analogue Signal – Upper Bandedge



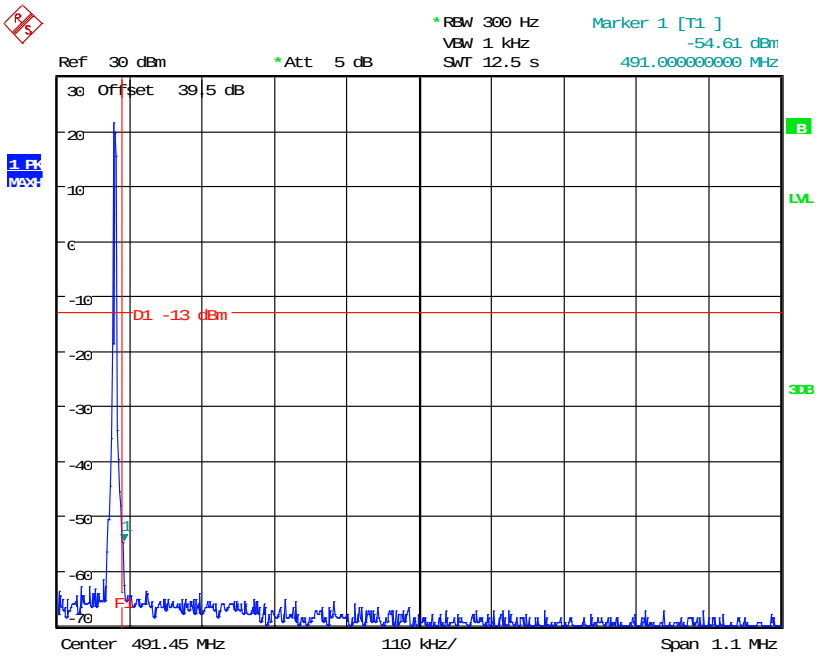
Date: 14.MAR.2014 11:51:23

489.5MHz – 491.0MHz P25 Signal – Lower Bandedge



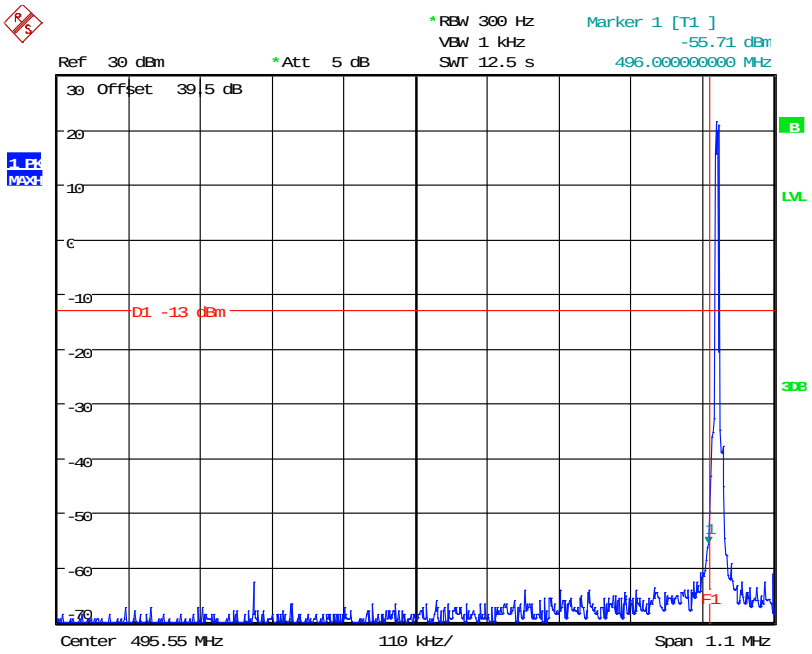
Date: 14.MAR.2014 11:56:04

Signal – P25 Upper Bandedge



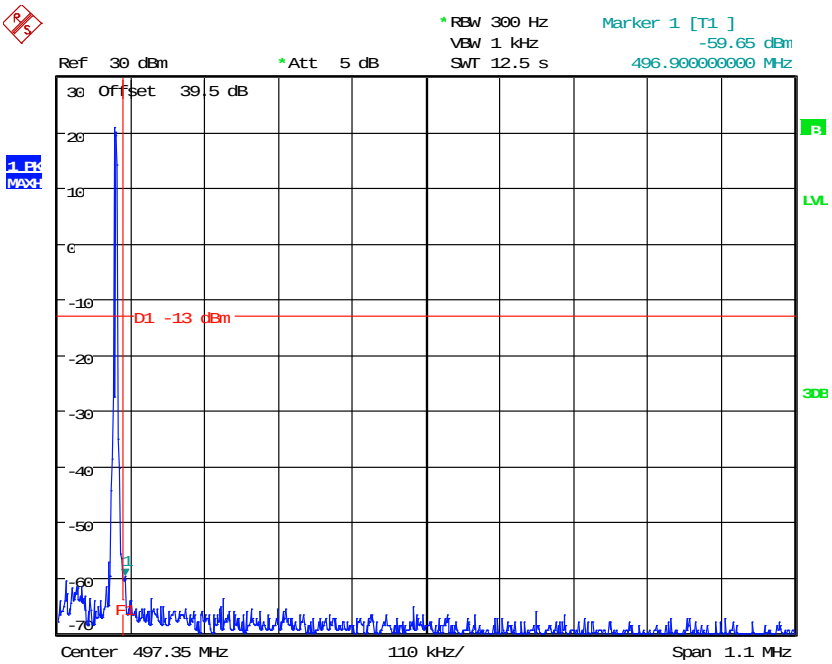
Date: 14.MAR.2014 11:55:06

496.0MHz – 496.9. MHz P25 Signal – Lower Bandedge



Date: 14.MAR.2014 11:53:58

P25 Signal – Upper Bandedge



Date: 14.MAR.2014 11:52:52

A5 Spurious Emissions at Antenna Terminals Greater than 1MHz

Test Details: Downlink 489.5MHz – 491.0MHz	
Measurement standard	Part 2.1053, 90.219(e)(3)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

Bottom Channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No spurious emissions that fall within 20dB of the limit				-13

Middle Channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No spurious emissions that fall within 20dB of the limit				-13

Top channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No spurious emissions that fall within 20dB of the limit				-13

Limit is determined by the outermost step of the emissions mask and is calculated as follows:

At least 43 + 10 log P dB

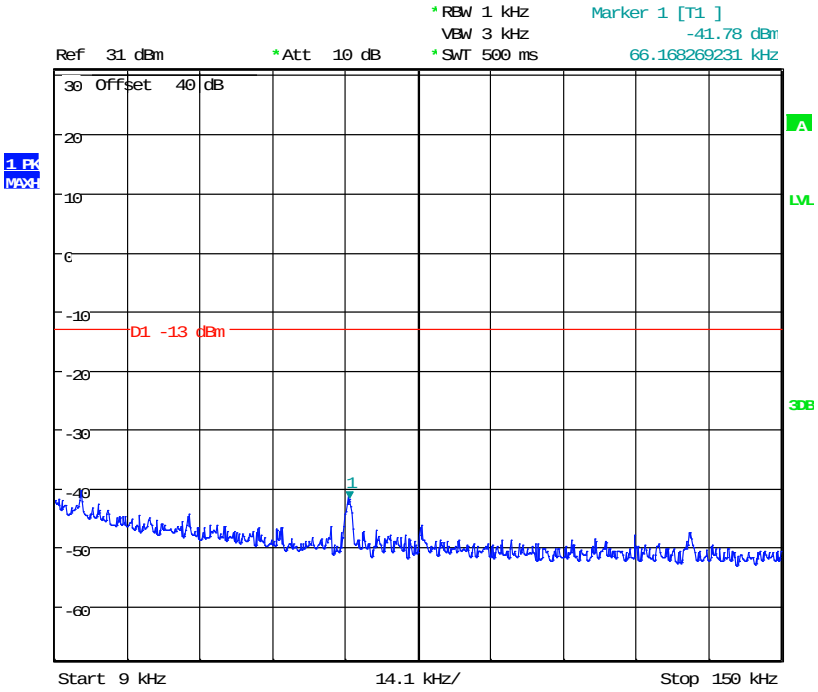
$(10\log P_{watts}) - (43+10\log (P_{watts} * 1000)) =$ LIMIT =-13 dBm

Result

The EUT was found to comply with the limits

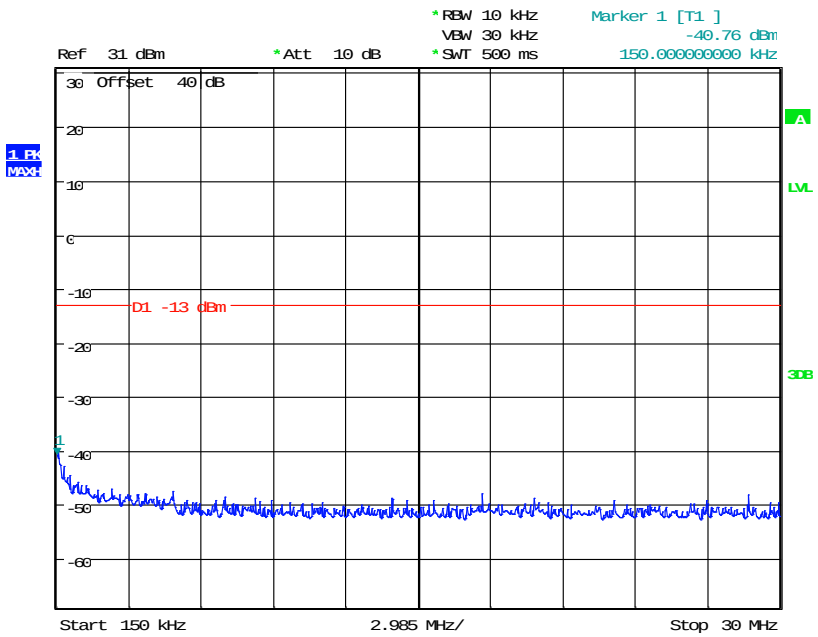
Spurious Emissions at Antenna Terminals Greater than 1MHz Bottom channel

9-150kHz



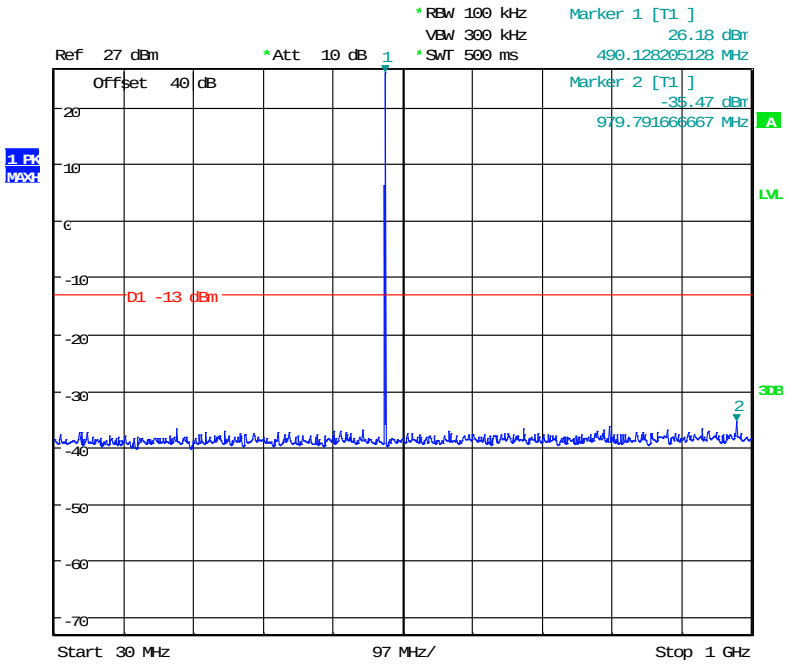
Date: 11.MAR.2014 16:04:23

150kHz – 30MHz



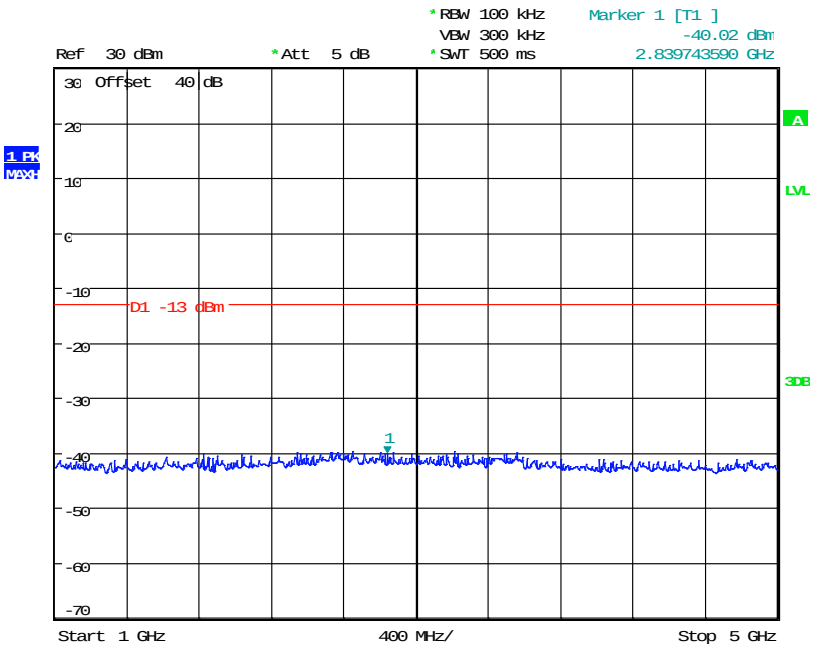
Date: 11.MAR.2014 16:05:19

30MHz – 1GHz



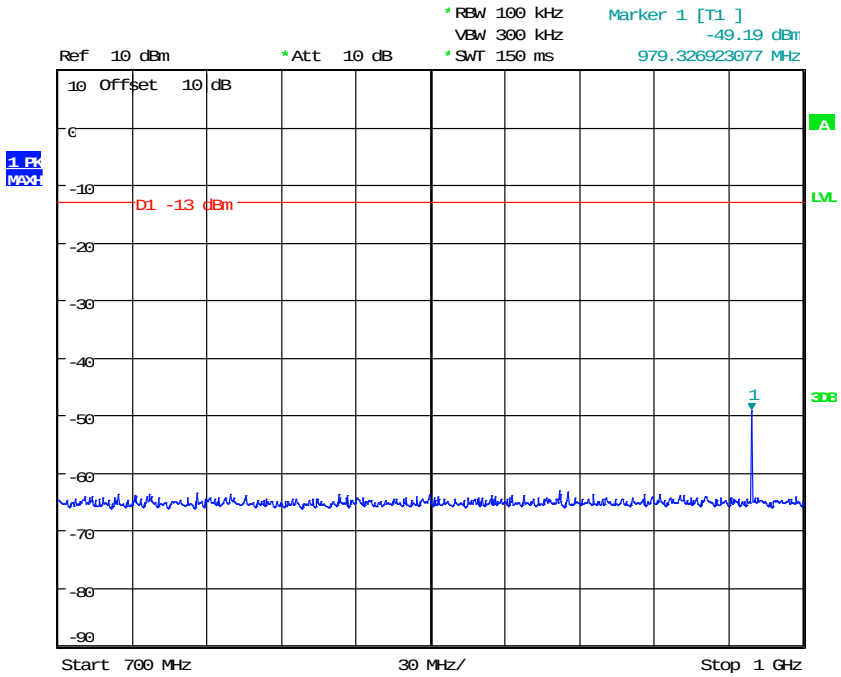
Date: 11.MAR.2014 16:11:13

1GHz – 5GHz



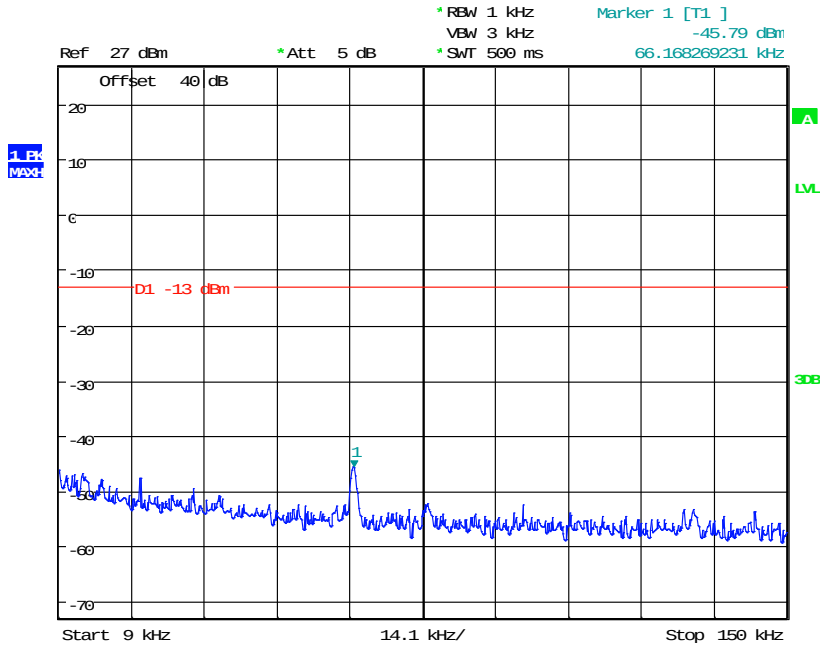
Date: 11.MAR.2014 16:11:59

700MHz – 1GHz (Highpass filter used, ref level offset used to determine the Harmonic spurious level).



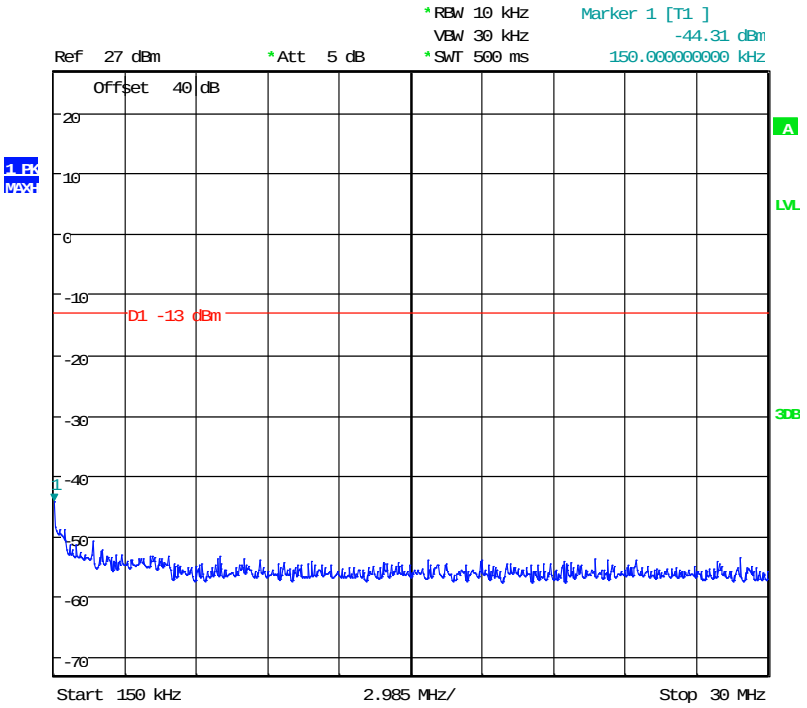
Spurious Emissions at Antenna Terminals Greater than 1MHz Middle channel

9-150kHz



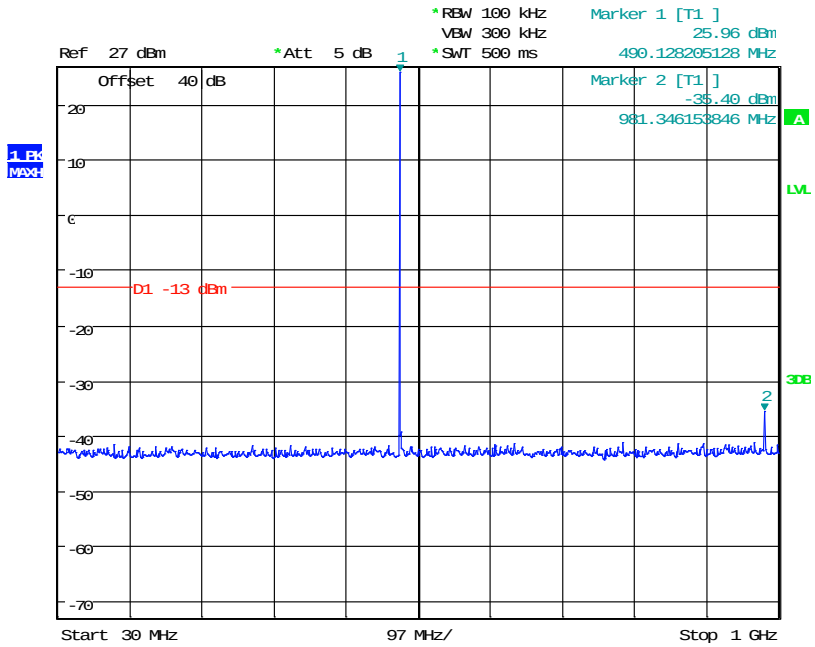
Date: 11.MAR.2014 16:16:48

150kHz – 30MHz



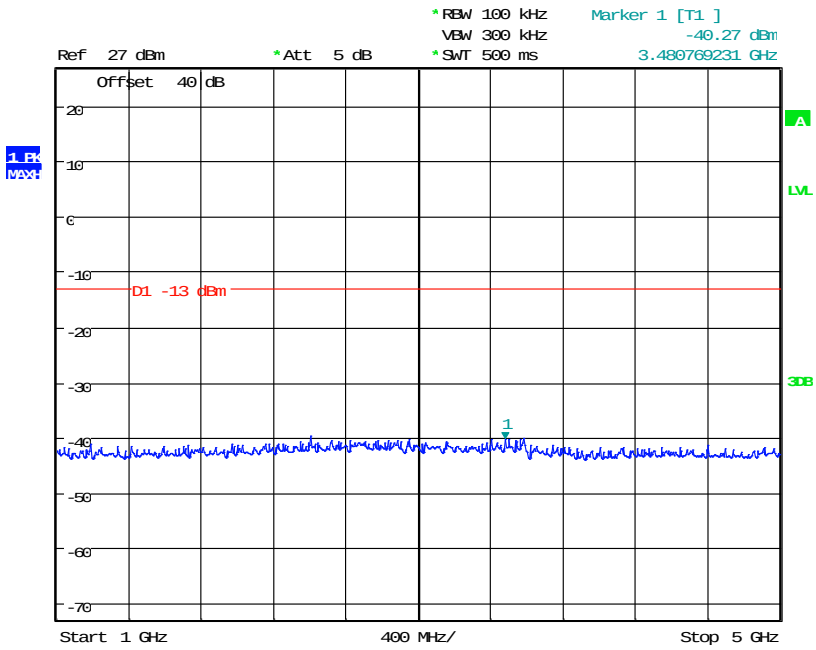
Date: 11.MAR.2014 16:17:23

30MHz – 1GHz



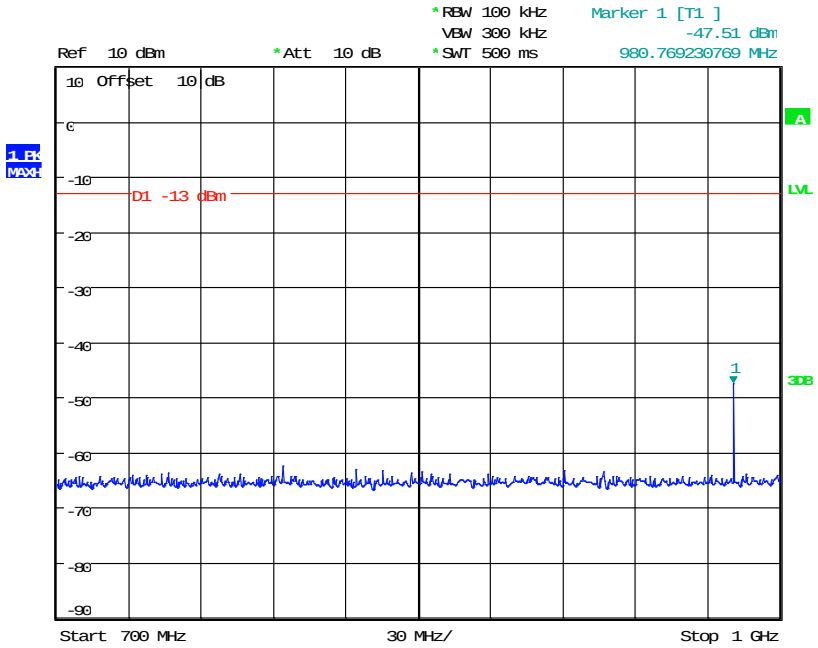
Date: 11.MAR.2014 16:18:01

1GHz – 5GHz



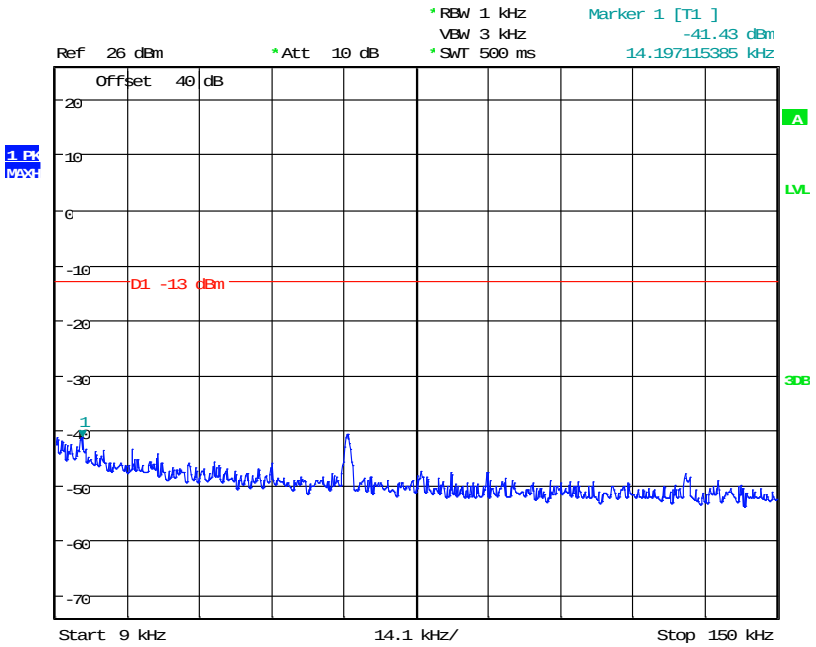
Date: 11.MAR.2014 16:18:32

700MHz – 1GHz (Highpass filter used, ref level offset used to determine the Harmonic spurious level).



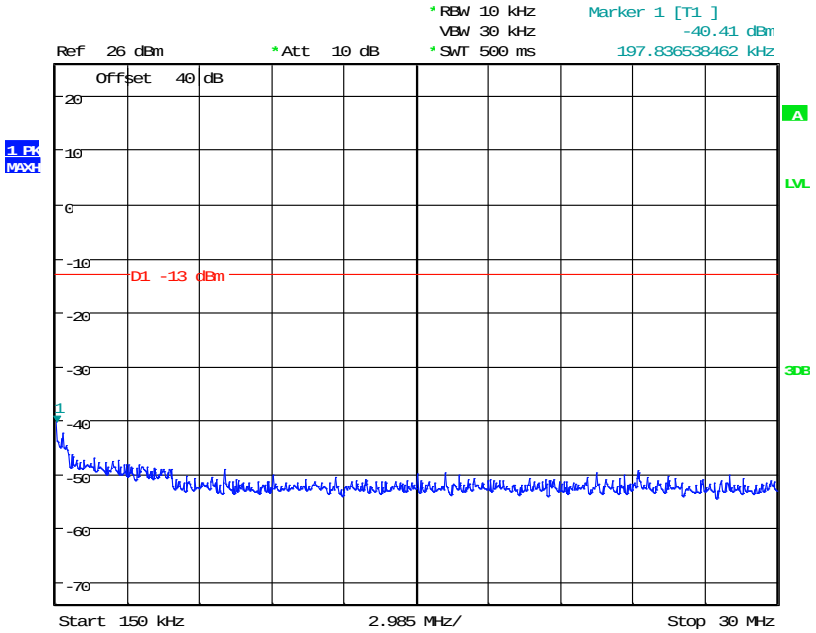
Spurious Emissions at Antenna Terminals Greater than 1MHz Top channel

9-150kHz



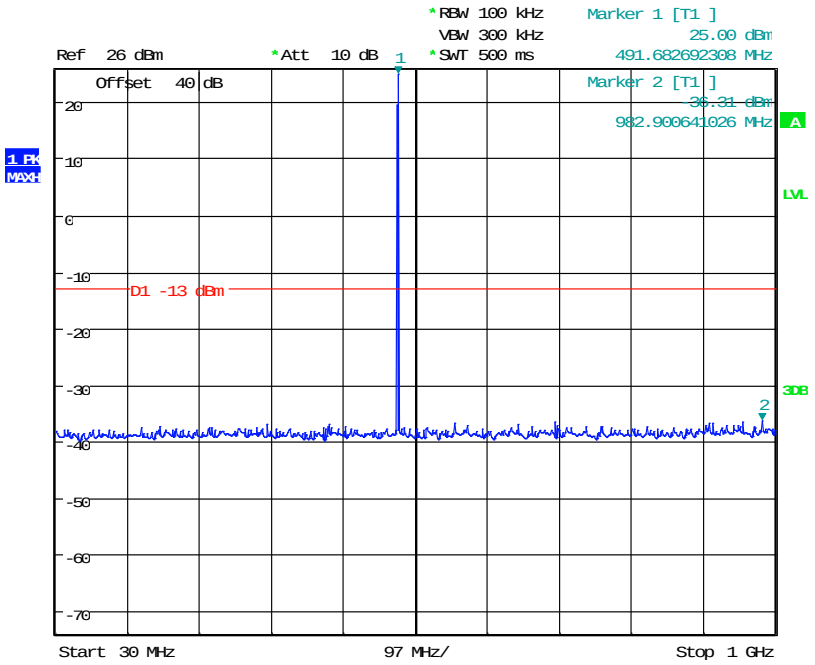
Date: 11.MAR.2014 16:28:04

150kHz – 30MHz



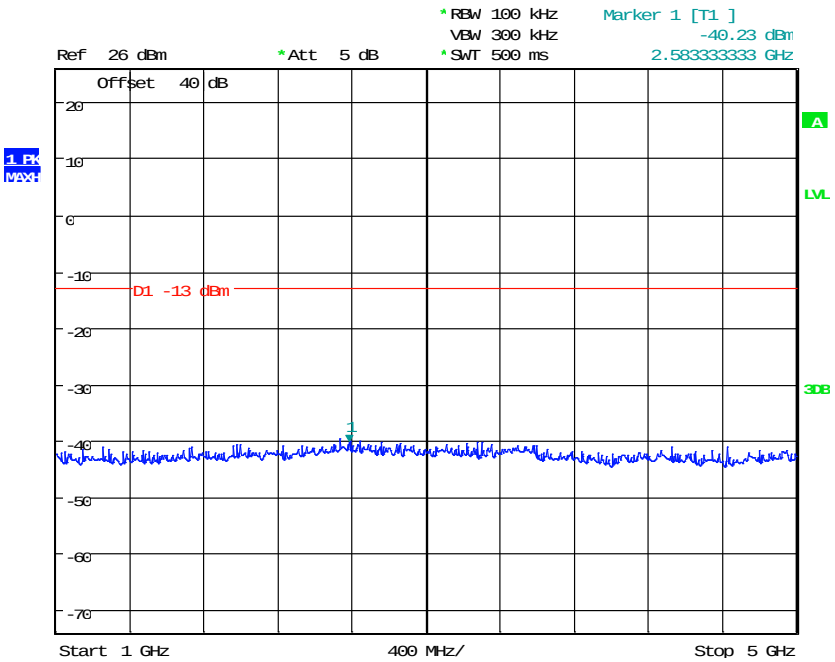
Date: 11.MAR.2014 16:28:35

30MHz – 1GHz



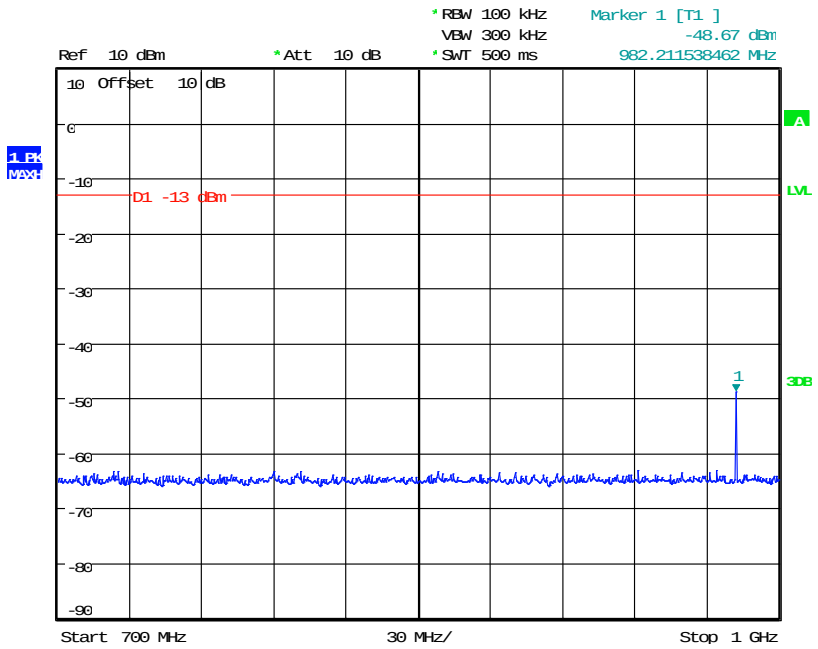
Date: 11.MAR.2014 16:27:27

1GHz – 5GHz



Date: 11.MAR.2014 16:29:22

700MHz – 1GHz (Highpass filter used, ref level offset used to determine the Harmonic spurious level).



Test Details:Downlink 496.0MHz – 496.9MHz	
Measurement standard	Part 2.1053, 90.219(e)(3)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

Bottom Channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No spurious emissions that fall within 20dB of the limit				-13

Middle Channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No spurious emissions that fall within 20dB of the limit				-13

Top channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No spurious emissions that fall within 20dB of the limit				-13

Limit is determined by the outermost step of the emissions mask and is calculated as follows:

At least 43 + 10 log P dB

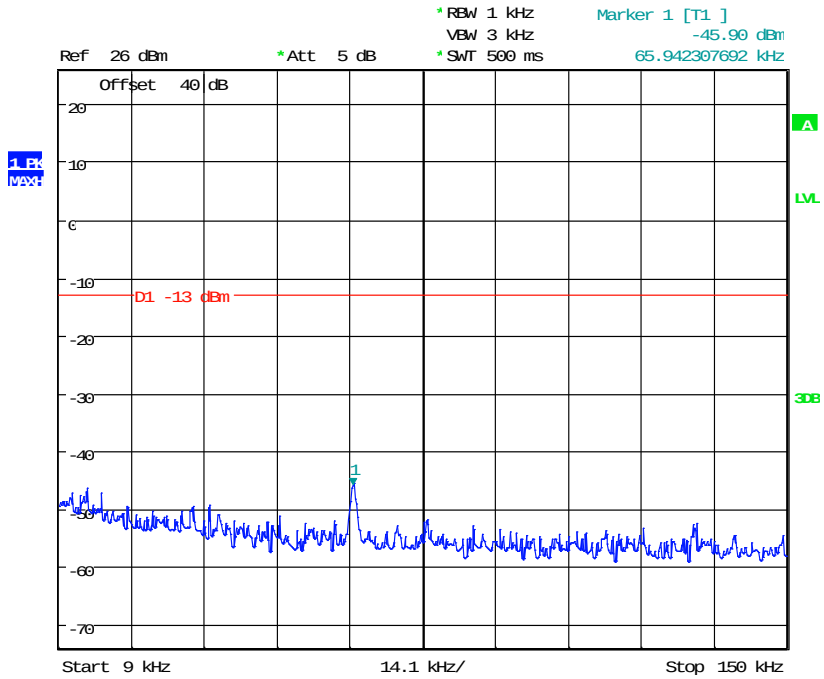
$(10\log P_{watts}) - (43+10\log (P_{watts} * 1000)) =$ LIMIT =-13 dBm

Result

The EUT was found to comply with the limits

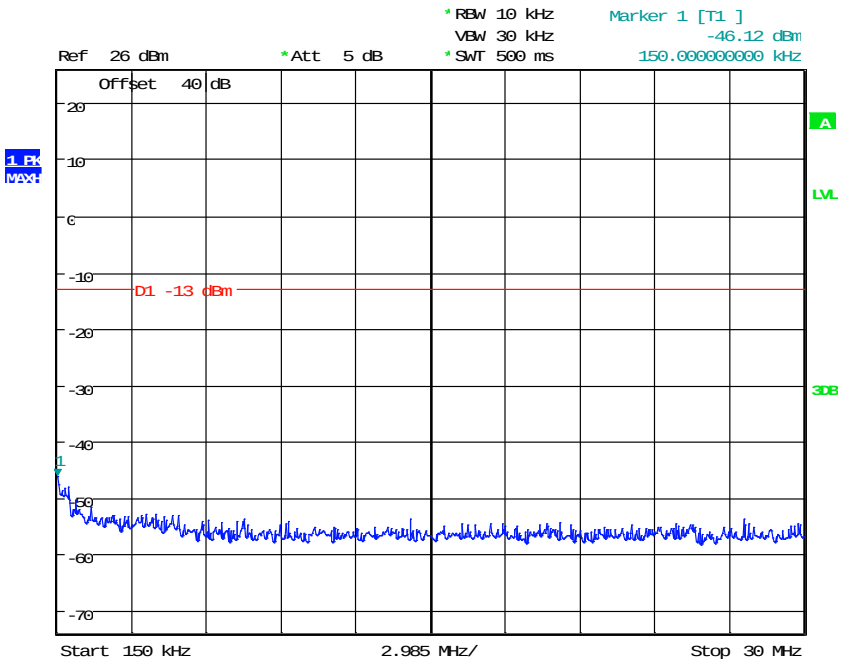
Spurious Emissions at Antenna Terminals Greater than 1MHz Bottom channel

9-150kHz



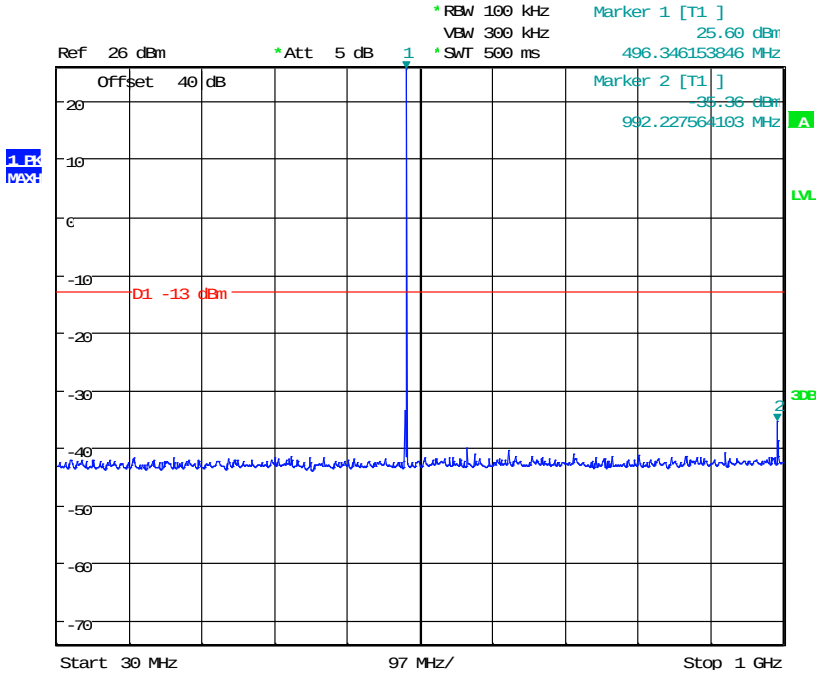
Date: 11.MAR.2014 16:36:03

150kHz – 30MHz



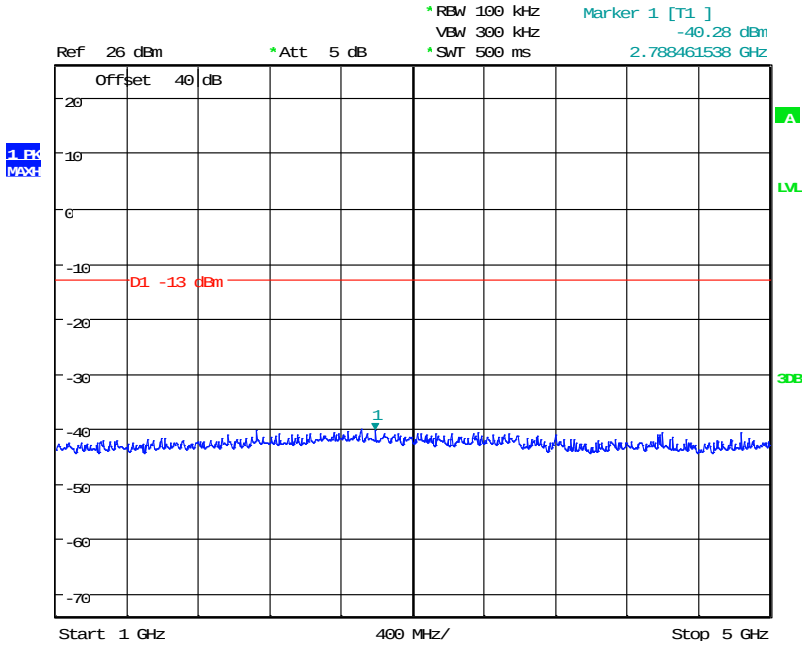
Date: 11.MAR.2014 16:36:41

30MHz – 1GHz



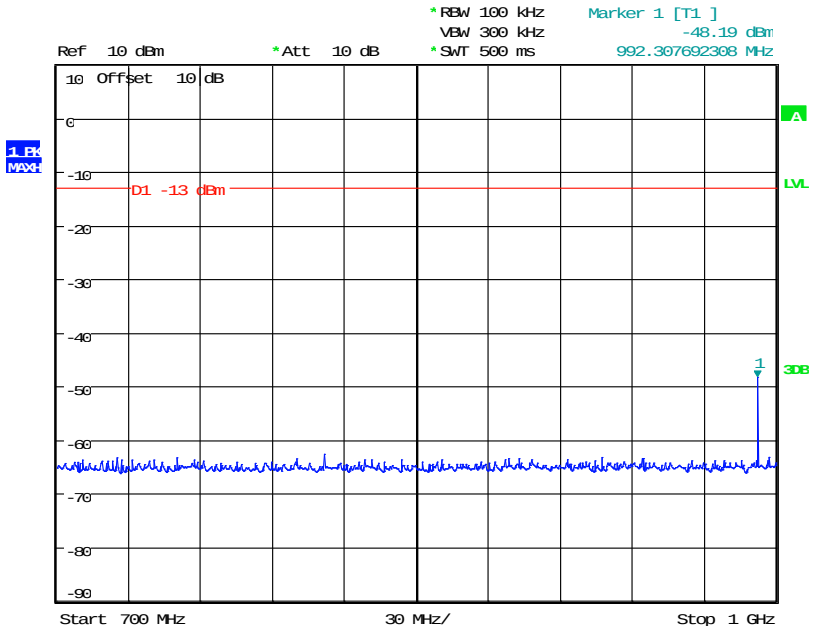
Date: 11.MAR.2014 16:34:42

1GHz – 5GHz



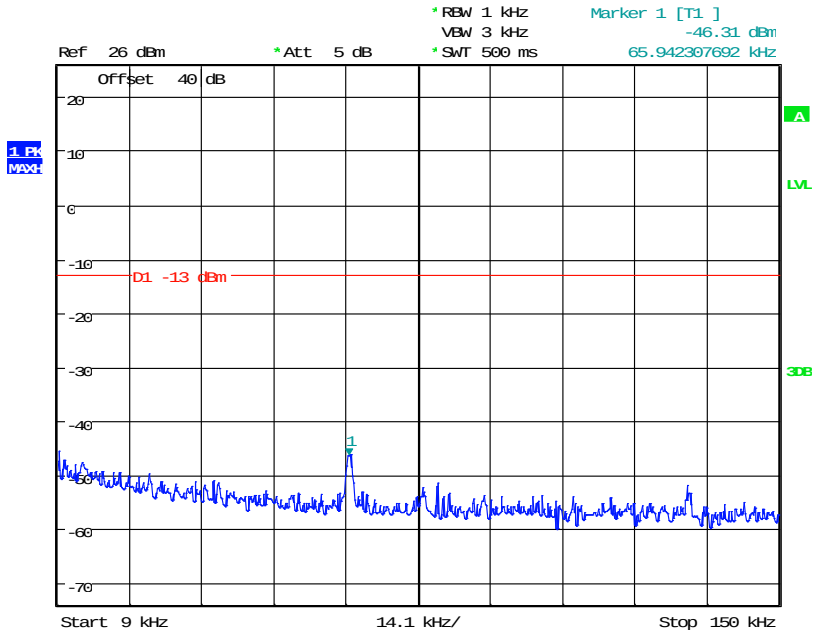
Date: 11.MAR.2014 16:35:35

700MHz – 1GHz (Highpass filter used, ref level offset used to determine the Harmonic spurious level).



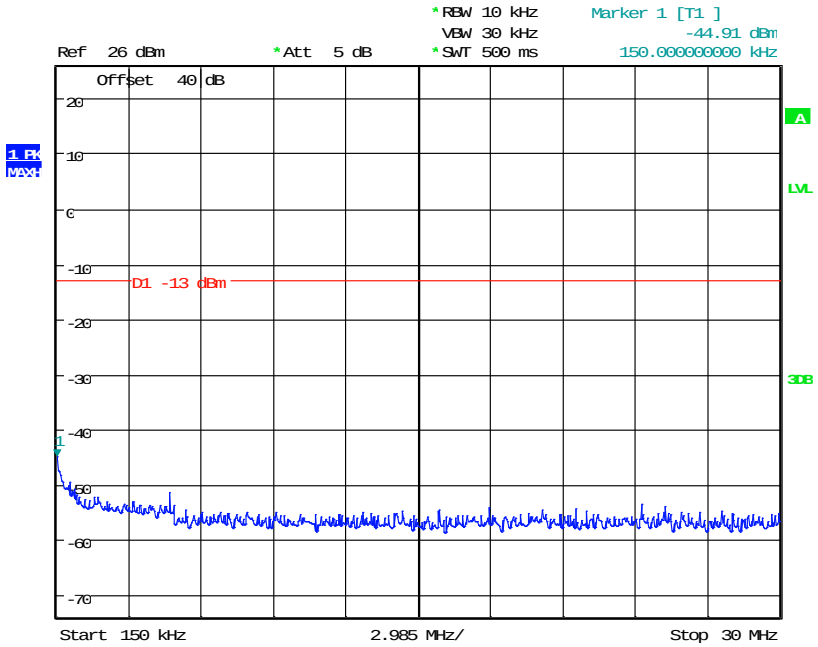
Spurious Emissions at Antenna Terminals Greater than 1MHz Middle channel

9-150kHz



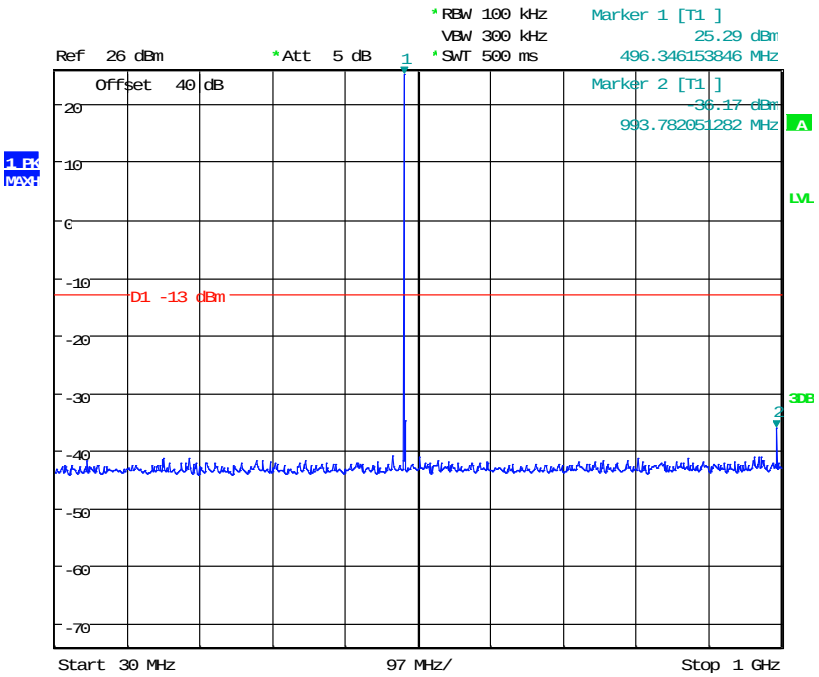
Date: 11.MAR.2014 16:58:38

150kHz – 30MHz



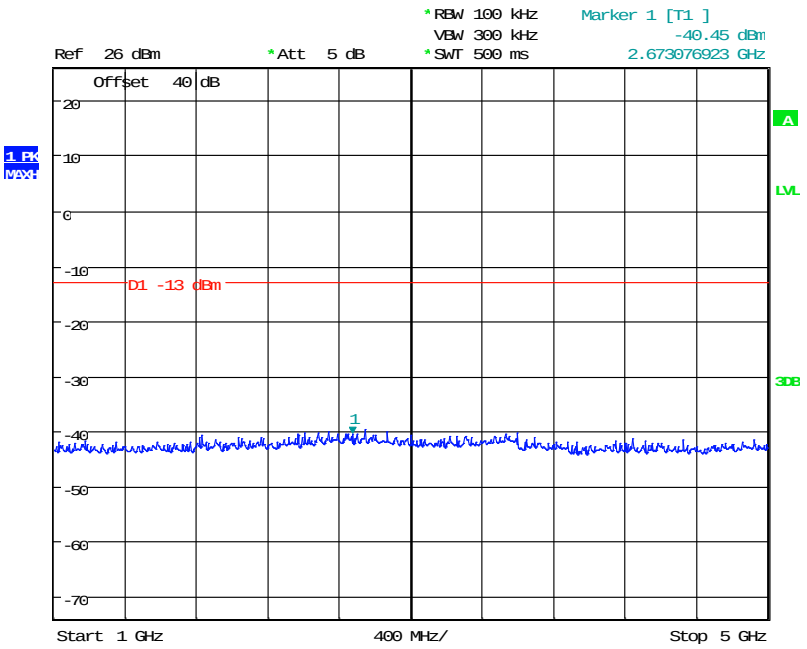
Date: 11.MAR.2014 16:58:59

30MHz – 1GHz



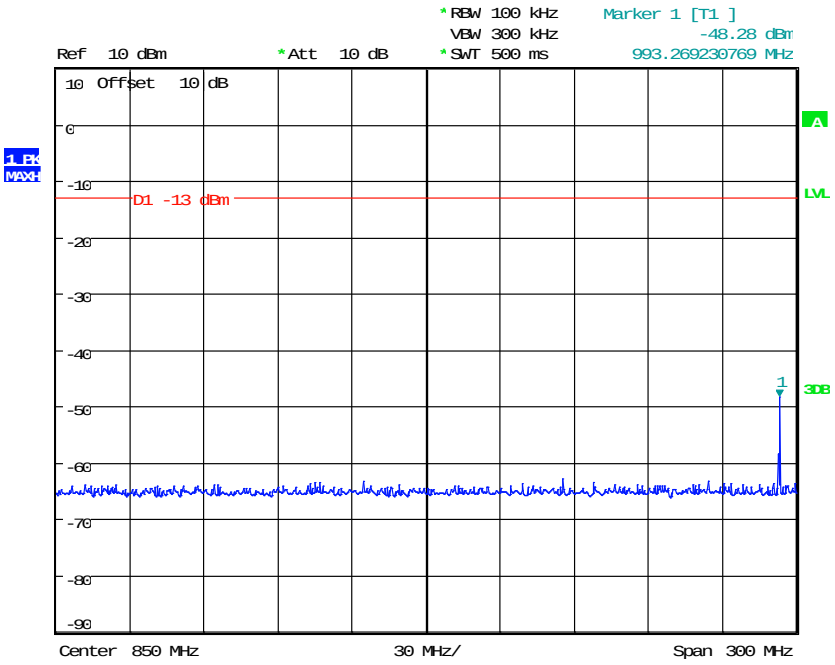
Date: 11.MAR.2014 16:58:11

1GHz – 5GHz



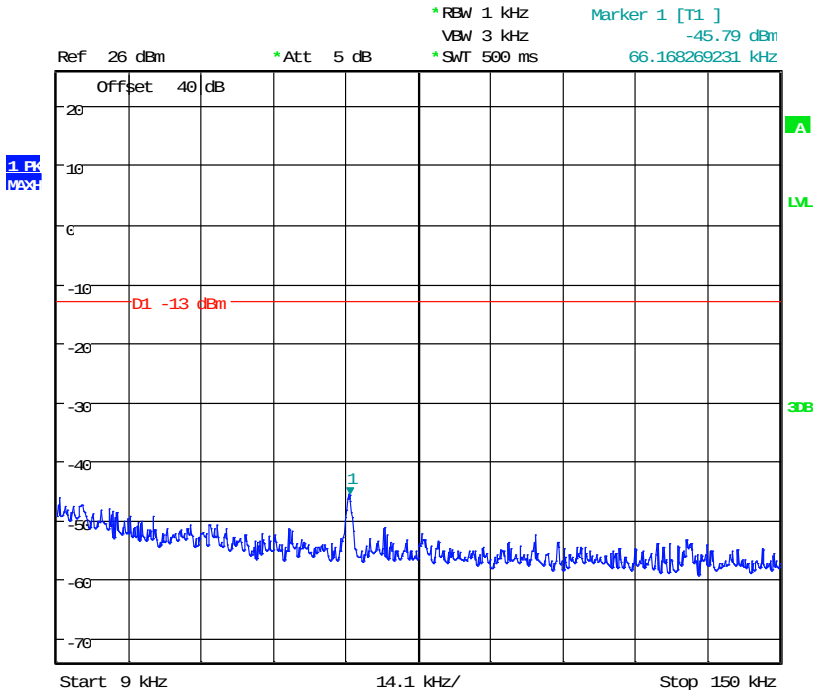
Date: 11.MAR.2014 17:00:02

700MHz – 1GHz (Highpass filter used, ref level offset used to determine the Harmonic spurious level).



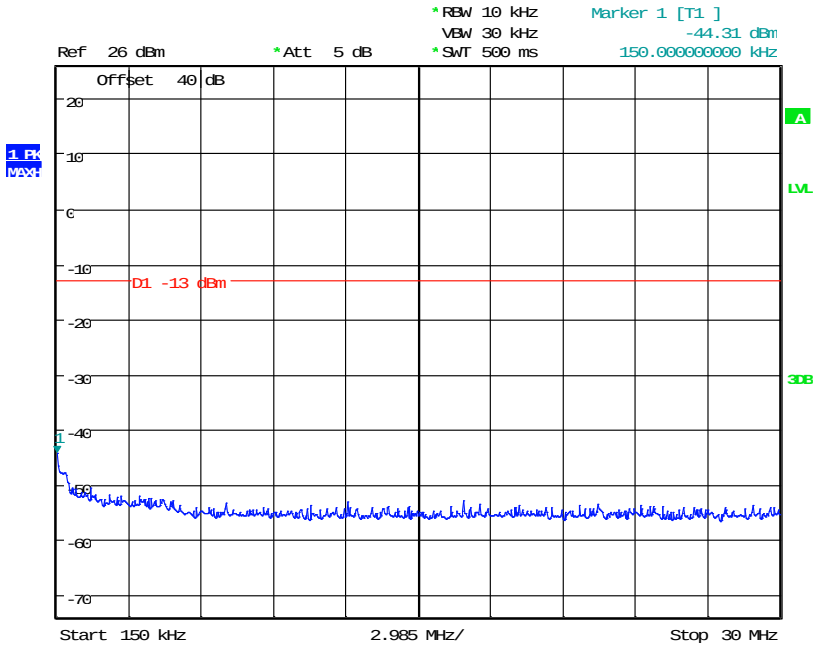
Spurious Emissions at Antenna Terminals Greater than 1MHz Top channel

9-150kHz



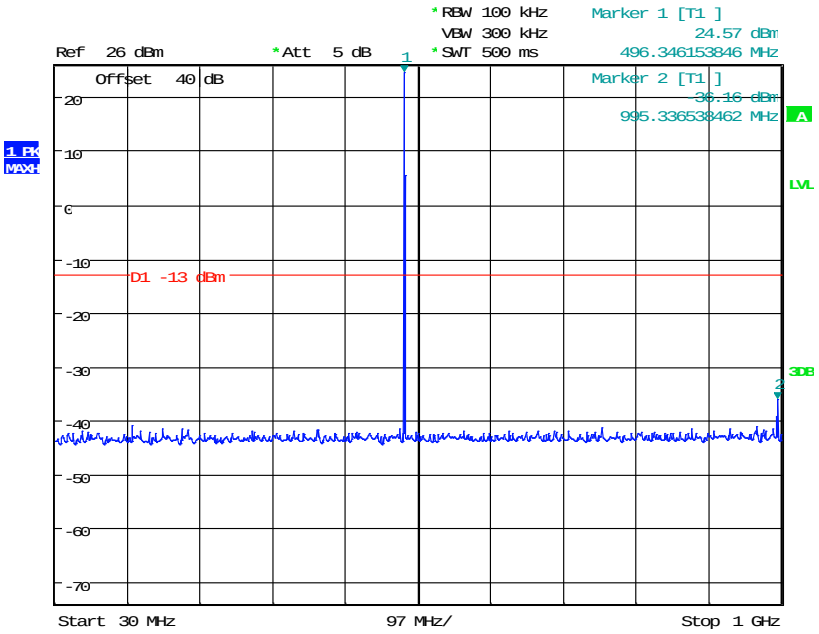
Date: 11.MAR.2014 17:04:10

150kHz – 30MHz



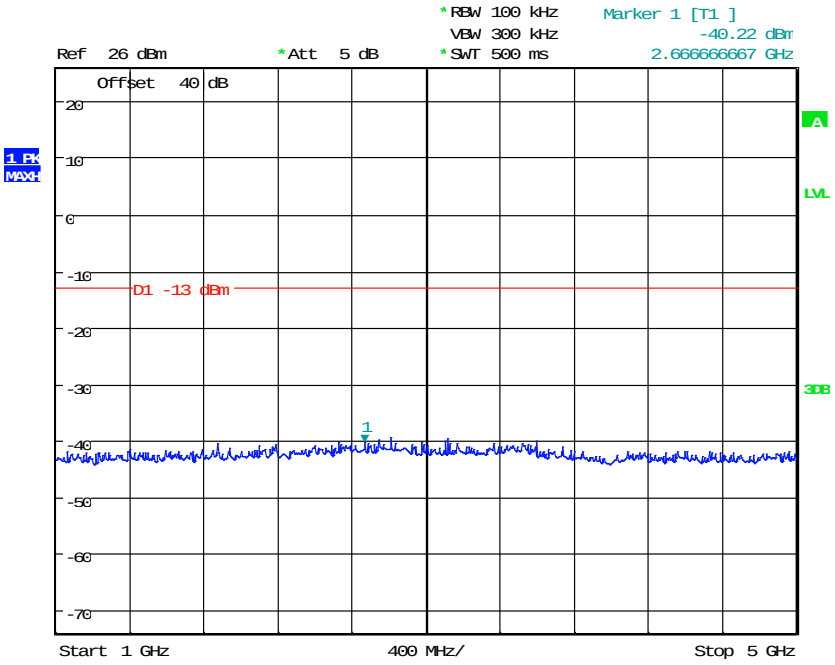
Date: 11.MAR.2014 17:06:22

30MHz – 1GHz



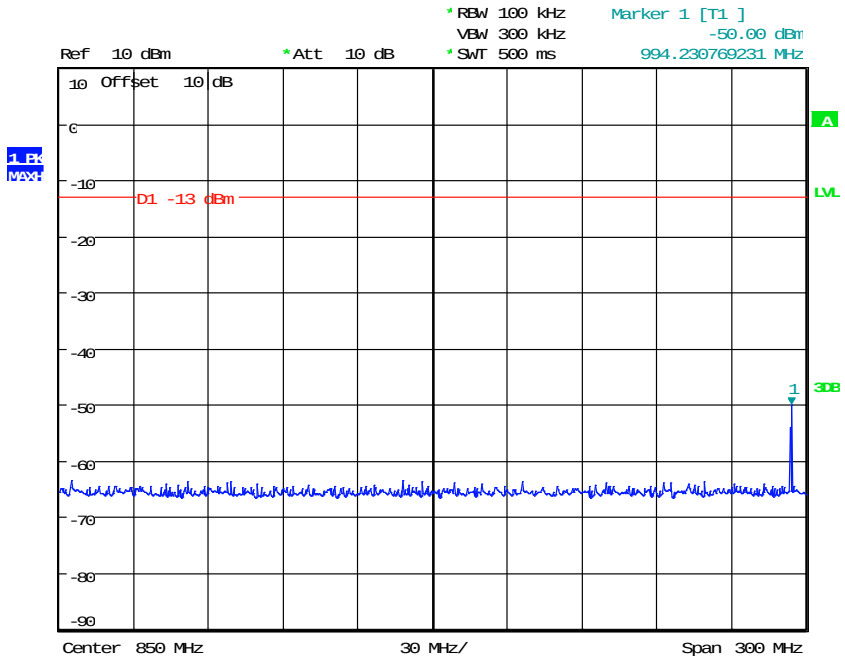
Date: 11.MAR.2014 17:07:04

1GHz – 5GHz



Date: 11.MAR.2014 17:07:36

700MHz – 1GHz (Highpass filter used, ref level offset used to determine the Harmonic spurious level).



A6 Noise at Antenna Terminals

Test Details:	
Measurement standard	90.219(e)(2), 90.219(e)(3)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

Compliance with these levels will be deemed satisfaction of the good engineering practice requirement. In a 10 kHz measurement bandwidth:

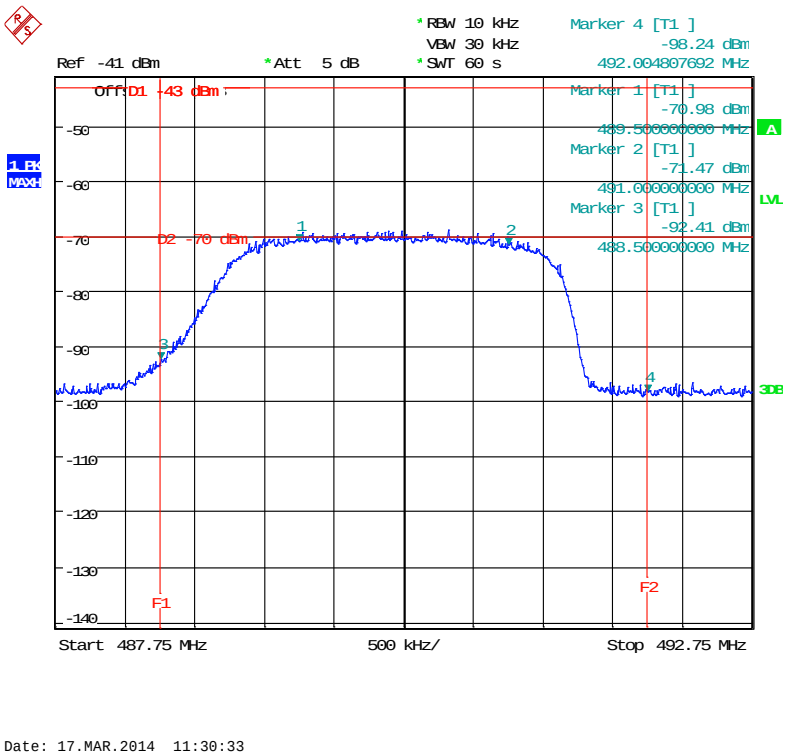
(1) the ERP of noise within the signal booster passband should not exceed –43dBm;

and

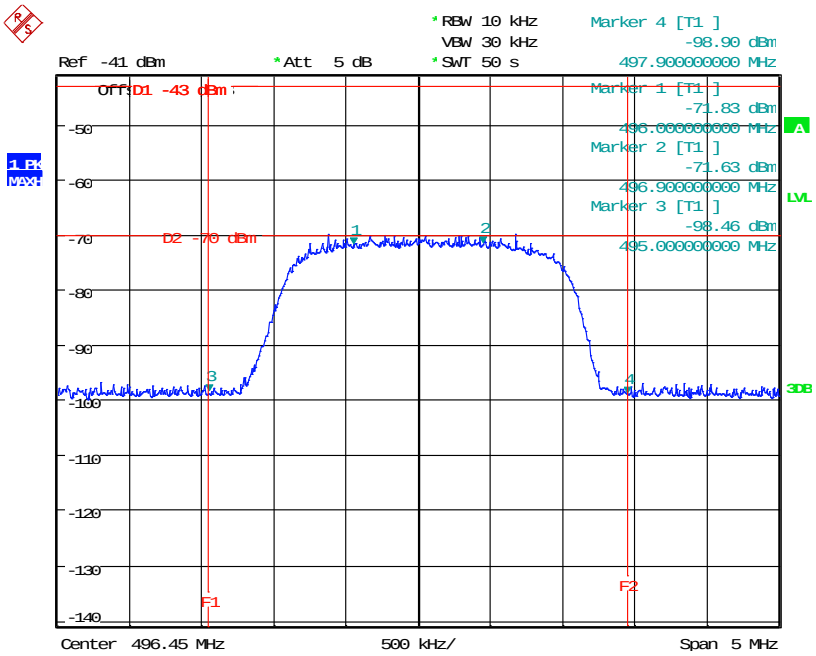
(2) the ERP of noise on spectrum more than 1 MHz outside of the signal booster passband should not exceed –70 dBm.

(3) The noise figure of a signal booster must not exceed 9 dB in either direction

489.5MHz - 491.0MHz IN BAND AMPLIFIER NOISE

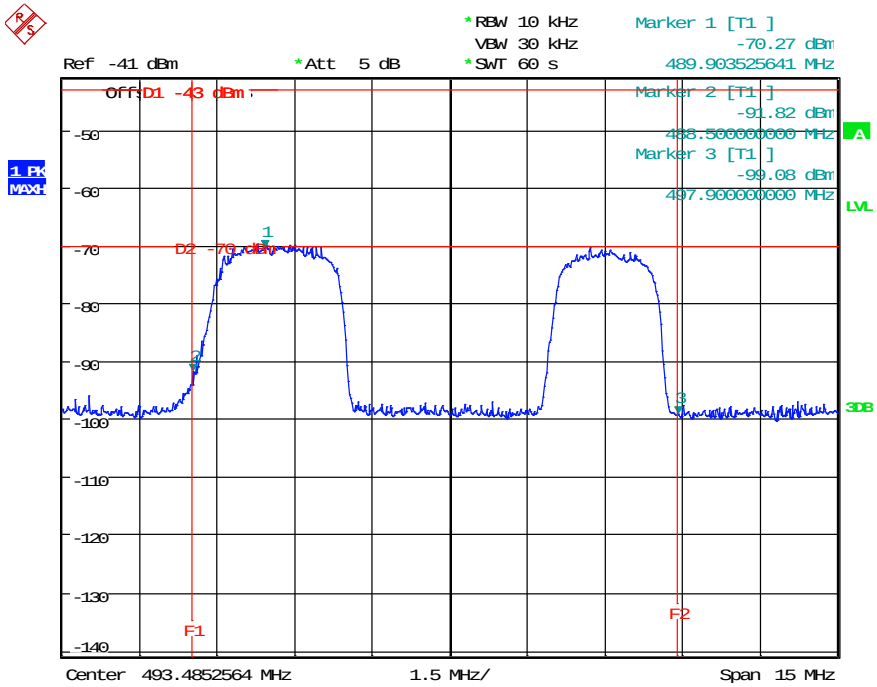


496.0MHz - 496.9MHz IN BAND AMPLIFIER NOISE



Date: 17.MAR.2014 11:35:18

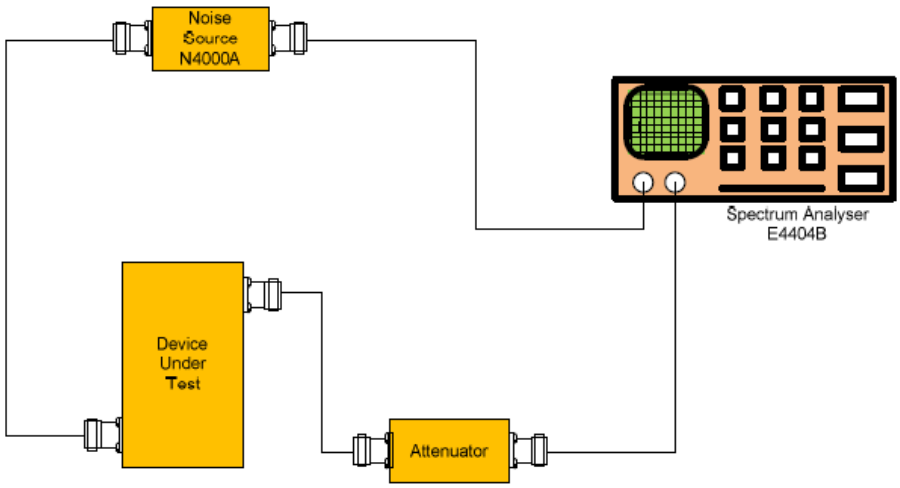
BOTH DOWNLINK BANDS IN BAND AMPLIFIER NOISE



Date: 17.MAR.2014 11:43:44

Signal booster noise figure

Test equipment set up:-



Result

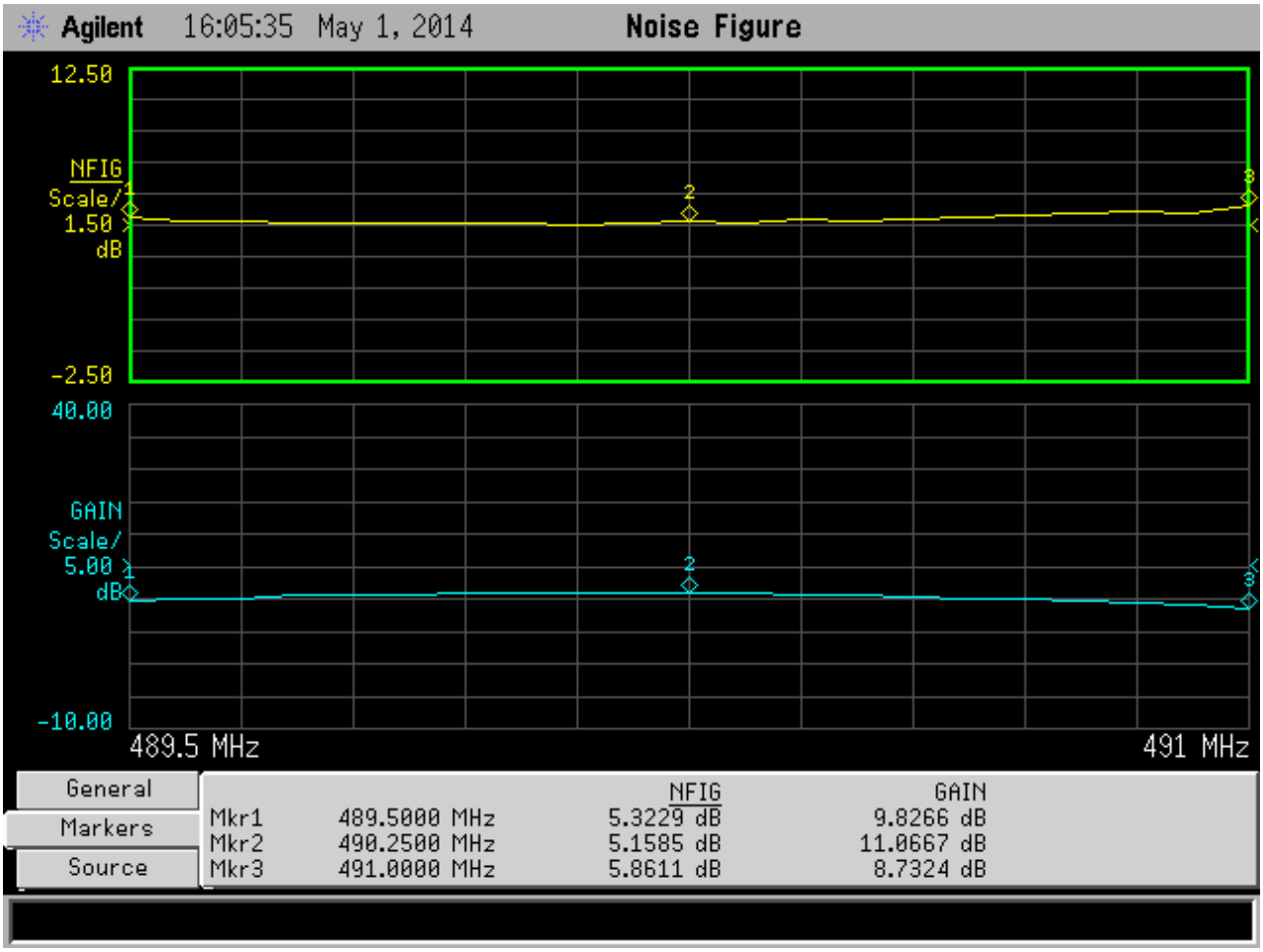
Plots for noise figure, taken with the 18MHz filter applied at maximum gain with 70dB external attenuators in the test set up

Frequency (MHz)	Noise Figure dB
489.5MHz - 491.0MHz	5.1
496.0MHz - 496.9MHz	5.35

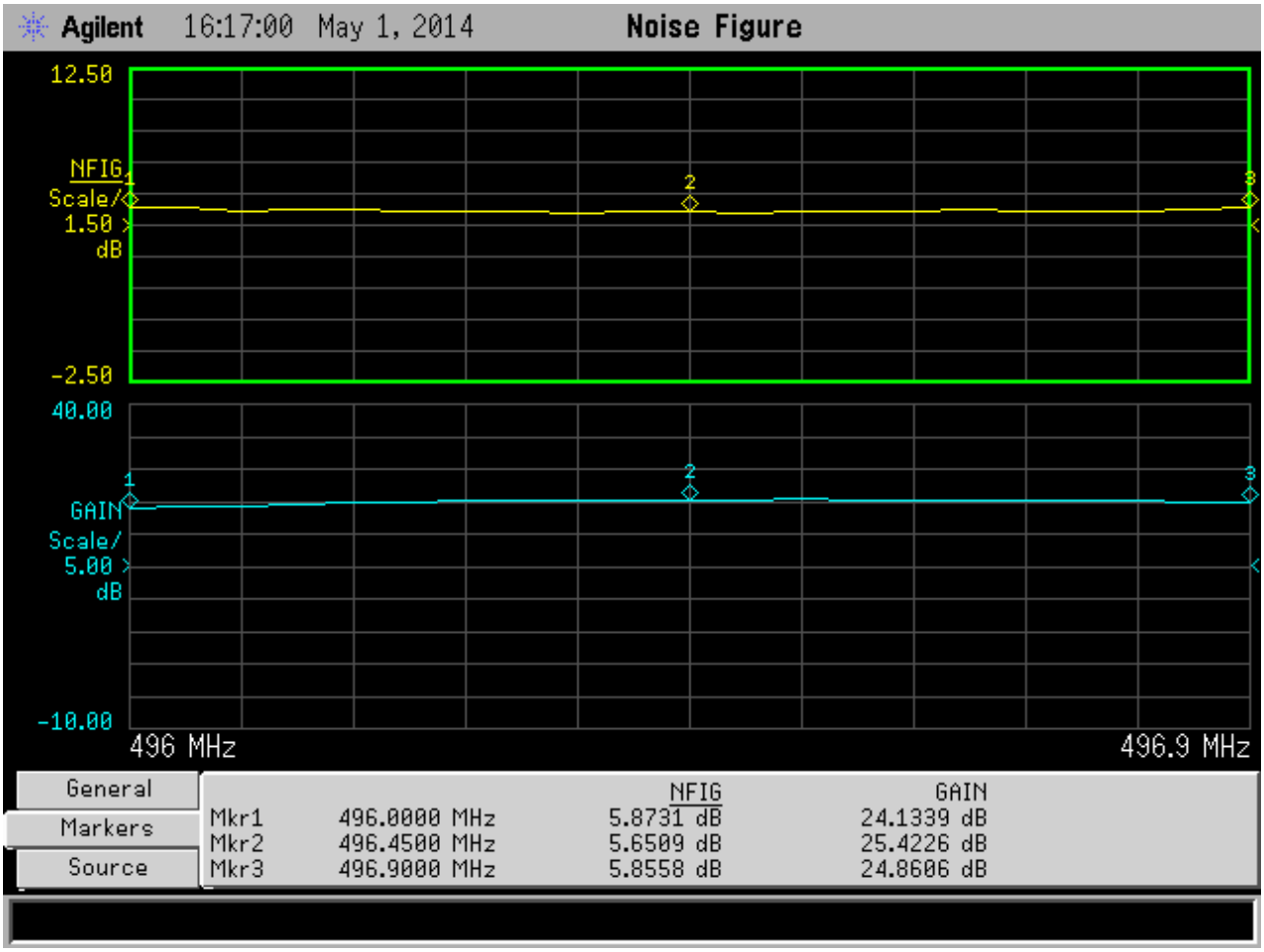
General notes about measurement setup:

1) The spectrum analyser has the noise figure measurement personality enabled.

Noise Figure – 489.5MHz - 491.0MHz



Noise Figure – 496.0MHz - 496.9MHz


Agilent 16:17:00 May 1, 2014
Noise Figure
12.50
NFIG
Scale/
1.50
dB
-2.50
40.00
GAIN
Scale/
5.00
dB
-10.00
496 MHz
496.9 MHz
General
Markers
Source
NFIG
GAIN
Mkr1 496.0000 MHz 5.8731 dB 24.1339 dB
Mkr2 496.4500 MHz 5.6509 dB 25.4226 dB
Mkr3 496.9000 MHz 5.8558 dB 24.8606 dB

A7 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric field emission test applies to all spurious and harmonic emissions . The EUT was set to transmit as required.

The following test site was used for final measurements as specified by the standard tested to:

3m open area test site : [ ] 3m alternative test site : [X]

The effect of the EUT set-up on the measurements is summarised in note (c) below.

Test Details: Downlink	
Measurement standard	Title 47 of the CFR: Part 2.1053, RSS-131 Section 4.3.2
Frequency range	30MHz-5GHz
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C
Temperature	23°C
Photographs (Appendix F)	

Bottom Frequency 489.5MHz and 496.0MHz

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
30MHz-5GHz	No Significant emissions within 20dB of the limit		-13

Middle Frequency 490.25MHz and 496.45MHz

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
30MHz-5GHz	No Significant emissions within 20dB of the limit		-13

Top Frequency 491.0MHz and 496.9MHz

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
30MHz-5GHz	No Significant emissions within 20dB of the limit		-13

Note: The results above are obtained with a bottom, middle, top carrier active in each of the downlink bands simultaneously.

Result

The EUT was found to comply with the limits

Notes:

1. Emissions Checked up to 10 times Fc.

2. The unit was mounted on a turntable and rotated through 360^0 and in 3 orthogonal planes to find the worst case emission.

3. For Frequencies below 1 GHz, RBW = 120 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

   Peak Detector RBW = 1MHz; VBW = ≥RBW

4. Limit is determined as the outermost step of the emissions mask and is calculated as follows.

   At least 43 + 10 log P dB

   $(10\log P_{watts}) - (43+10\log (P_{watts} * 1000)) =$ LIMIT =-13 dBm

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 2.1057.

(a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation}\,(\text{dB}) = 20\log_{10}\left(\frac{\text{measurement distance}}{\text{specification distance}}\right)$$

(b) The levels may have been rounded for display purposes.

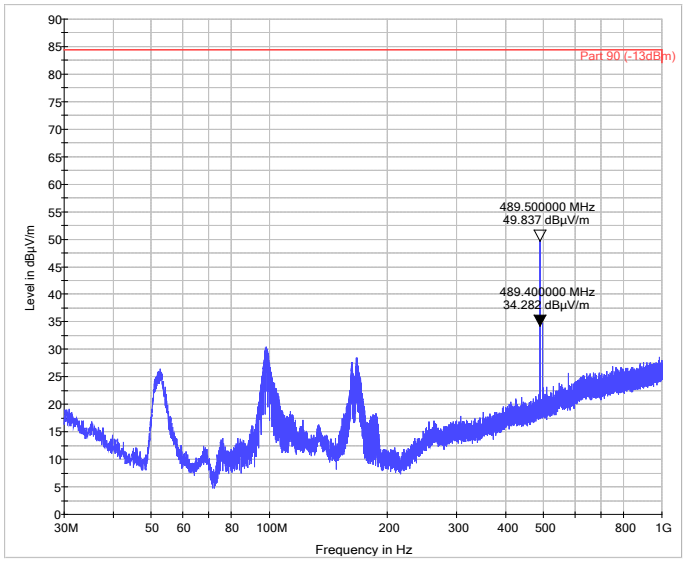
(c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓			
Effect of EUT internal configuration on emission levels	✓			
Effect of Position of EUT cables & samples on emission levels	✓			

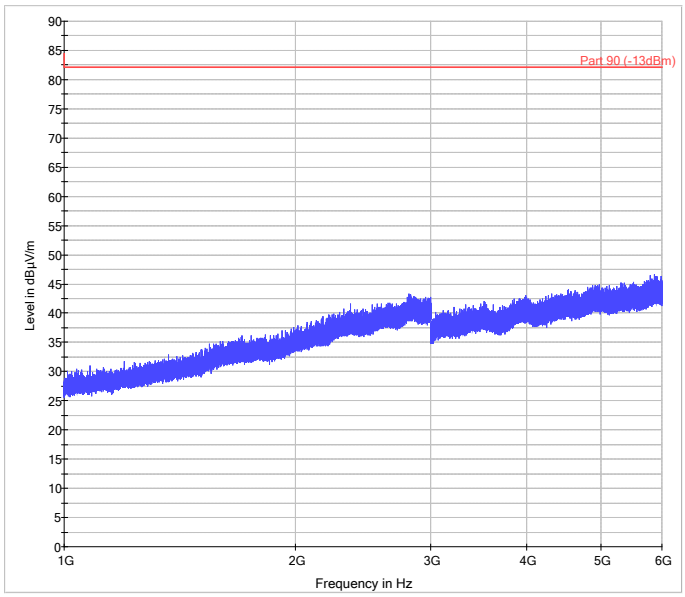
(i) Parameter defined by standard and / or single possible, refer to Appendix D
(ii) Parameter defined by client and / or single possible, refer to Appendix D
(iii) Parameter had a negligible effect on emission levels, refer to Appendix D
(iv) Worst case determined by initial measurement, refer to Appendix D

Radiated Electric Field Emissions Downlink bottom channel

30MHz – 1GHz

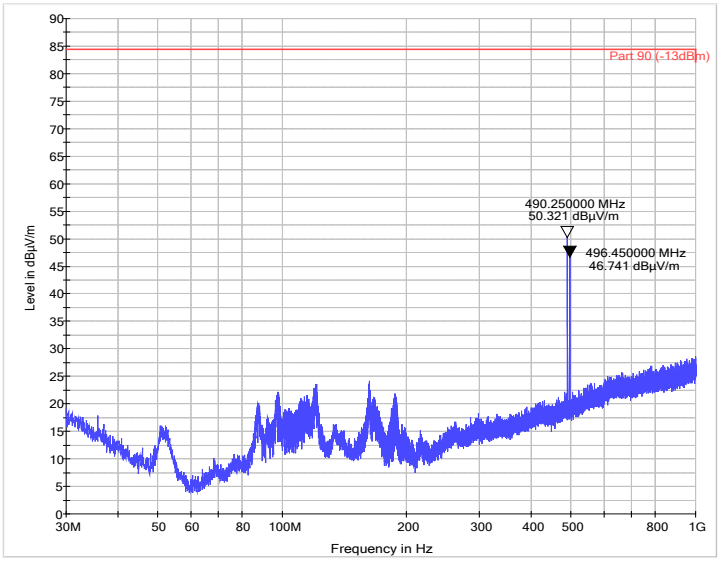


1GHz – 5GHz

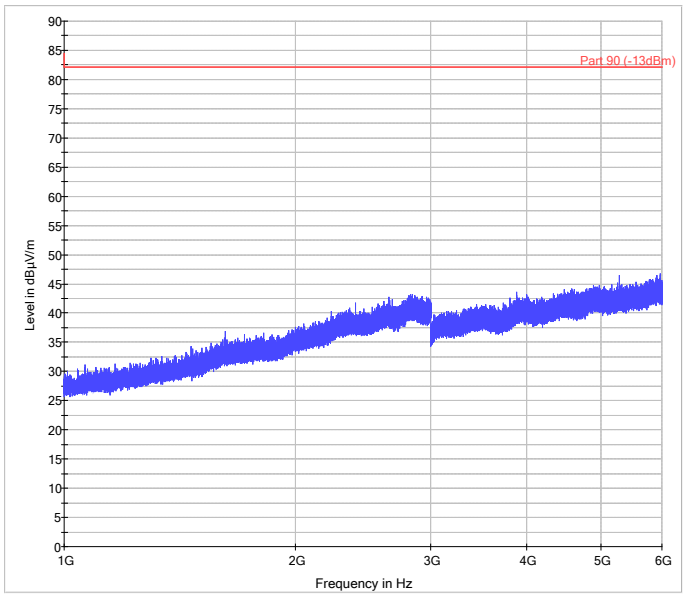


Radiated Electric Field Emissions Middle channel

30MHz – 1GHz

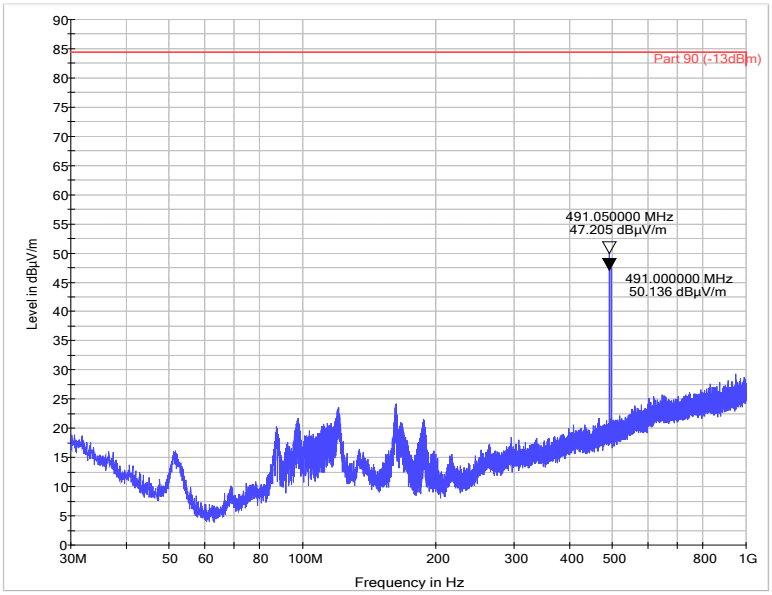


1GHz – 5GHz

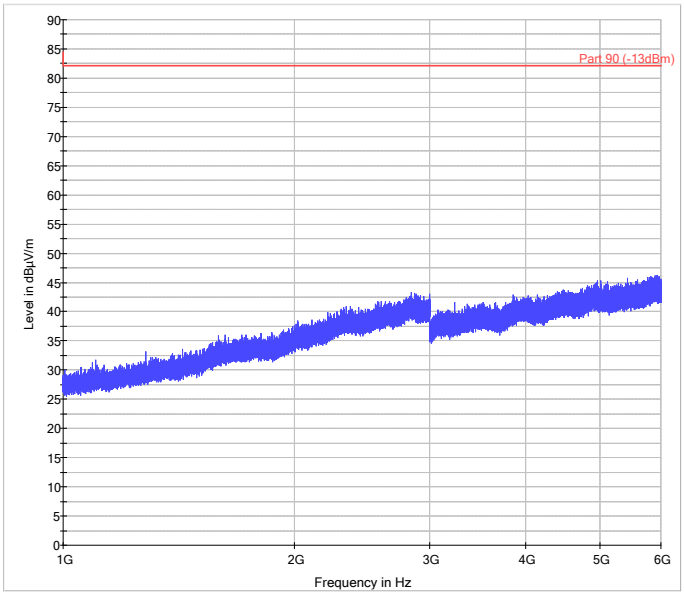


Radiated Electric Field Emissions Top channel

30MHz – 1GHz



1GHz – 5GHz



A8 Passband Gain & Bandwidth

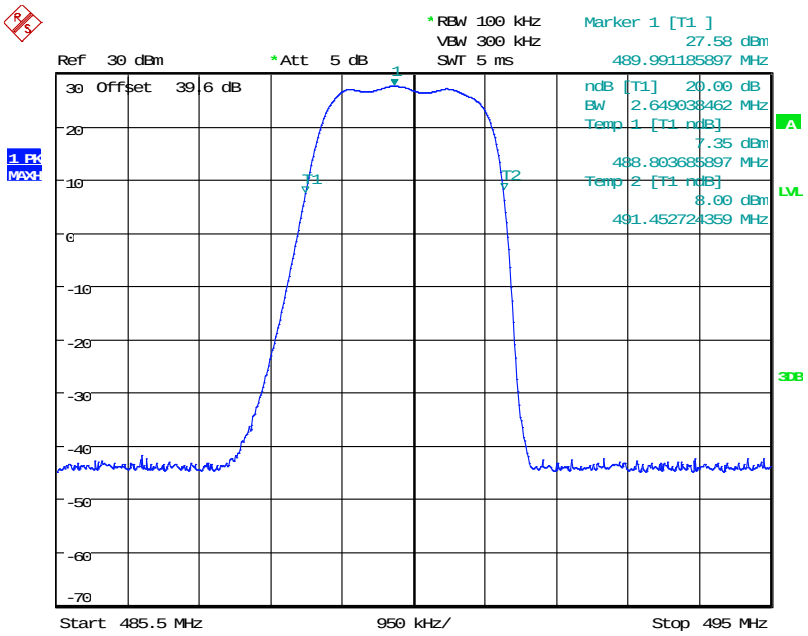
Test Details:Downlink	
Measurement standard	RSS-131 Section 4.2
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

Frequency MHz	fl	fh	20 dB Bandwidth
489.5MHz – 491.0MHz	488.803685	491.452724	2.649038MHz

Frequency MHz	fl	fh	20 dB Bandwidth
496.0MHz – 496.9MHz	495.475641	497.591826	2.116185

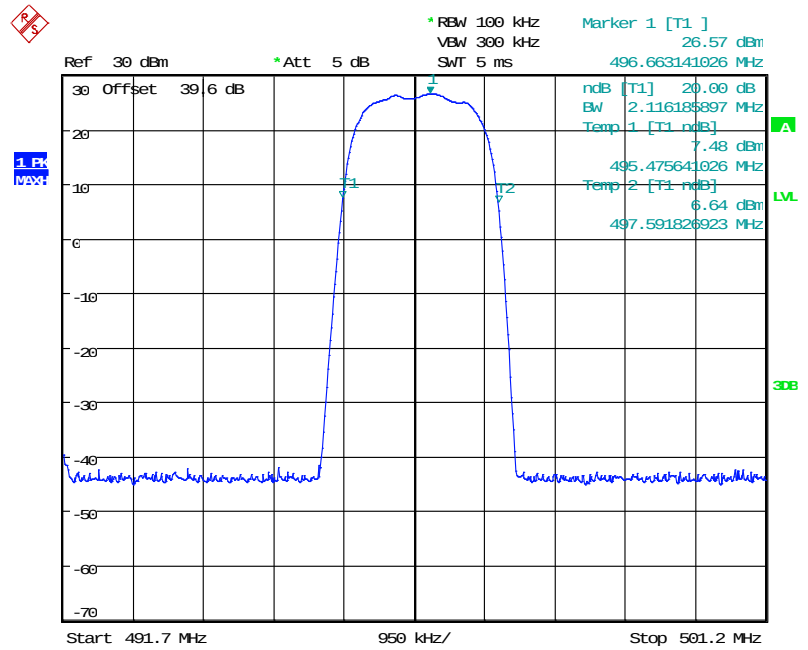
See below for plots showing passband gain & bandwidth

Downlink 489.5MHz – 491.0MHz



Date: 17.MAR.2014 16:12:47

Downlink 496.0MHz – 496.9MHz



Date: 17.MAR.2014 16:19:46

Appendix B: Uplink Formal Emission Test Results

Abbreviations used in the tables in this appendix:

Spec	: Specification
Mod	: Modification
EUT	: Equipment Under Test
SE	: Support Equipment
L	: Live Power Line
N	: Neutral Power Line
E	: Earth Power Line
Pk	: Peak Detector
QP	: Quasi-Peak Detector
Av	: Average Detector
CDN	: Coupling & decoupling network

ALSR	: Absorber Lined Screened Room
OATS	: Open Area Test Site
ATS	: Alternative Test Site
Ref	: Reference
Freq	: Frequency
MD	: Measurement Distance
SD	: Spec Distance
Pol	: Polarisation
H	: Horizontal Polarisation
V	: Vertical Polarisation

B1 RF Gain and Output Power

Test Details:Uplink	
Measurement standard	Part 2.1046, Part 90.219(e)(3), RSS-131 Section 4.3
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
Temperature (^{o}C)	24
Humidity (%)	34
EUT set up	Refer to Appendix C

Frequency MHz	Signal Generator input level dBm	Input Cable Loss dB	Level at Spectrum Analyser dBm	Output Cable & Attenuator loss dB	Gain dB	Conducted Output Power dBm	Gain after 10dB input level increase dB
492.5000	-34.74	0.32	-19.78	39.5	54.75	19.69	44.77
493.2500	-36.48	0.32	-19.28	39.5	56.99	20.19	47.01
494.0000	-34.94	0.32	-19.77	39.5	54.96	19.70	44.98

Frequency MHz	Signal Generator input level dBm	Input Cable Loss dB	Level at Spectrum Analyser dBm	Output Cable & Attenuator loss dB	Gain dB	Conducted Output Power dBm	Gain after 10dB input level increase dB
499.0000	-34.08	0.35	-19.19	39.5	54.74	20.31	44.72
499.4500	-34.68	0.35	-19.29	39.5	55.24	20.21	45.15
499.9000	-34.00	0.35	-19.14	39.5	54.71	20.36	44.69

Notes: 1.The signal generator input was increased by 10dBs and the level of the output signal remeasured.

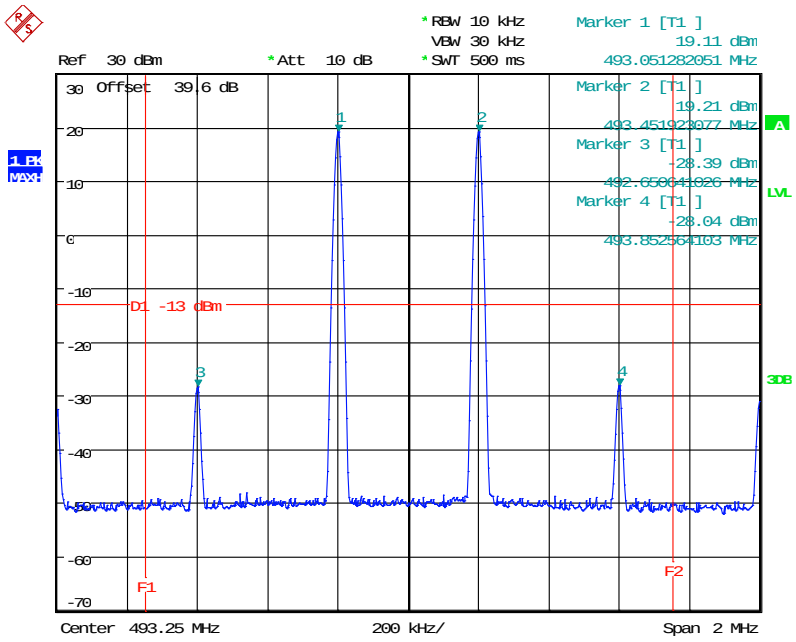
As per D.3 Policies + Procedures (k) of KDB 935210 D02 Signal Boosters Certification v02 the EUT was tested at compression and 10dB into compression to show AGC operation

Uplink 492.5MHz – 494.0MHz

Frequency	Frequency (MHz)	P_o	Level at Spectrum Analyser (dBm)	Output Cable & Attenuator loss (dB)	Power At Output Point (dBm)
f_1	493.05	P_{o1}	-20.49	39.6	19.11
f_2	493.45	P_{o2}	-20.39	39.6	19.21
f_3	492.65	P_{o3}	-67.99	39.6	-28.39
f_4	493.85	P_{o4}	-67.64	39.6	-28.04

$P_{mean} = P_{o1} + 3dB$

P_{o1} (dBm)	P_{mean}	P_{mean} (dBm)
19.21	$P_{o1} + 3dB$	22.21



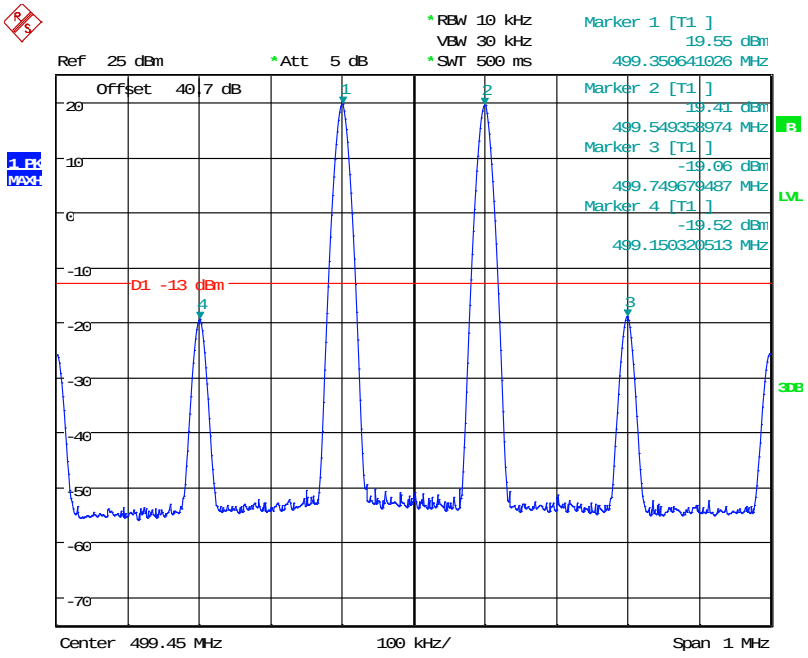
Date: 17.MAR.2014 15:03:14

Uplink 499.0MHz – 499.9MHz

Frequency	Frequency (MHz)	P_o	Level at Spectrum Analyser (dBm)	Output Cable & Attenuator loss (dB)	Power At Output Point (dBm)
f_1	499.35	P_{o1}	-21.15	40.7	19.55
f_2	499.55	P_{o2}	-21.29	40.7	19.41
f_3	499.75	P_{o3}	-59.76	40.7	-19.06
f_4	499.15	P_{o4}	-60.22	40.7	-19.52

$P_{mean} = P_{o1} + 3dB$

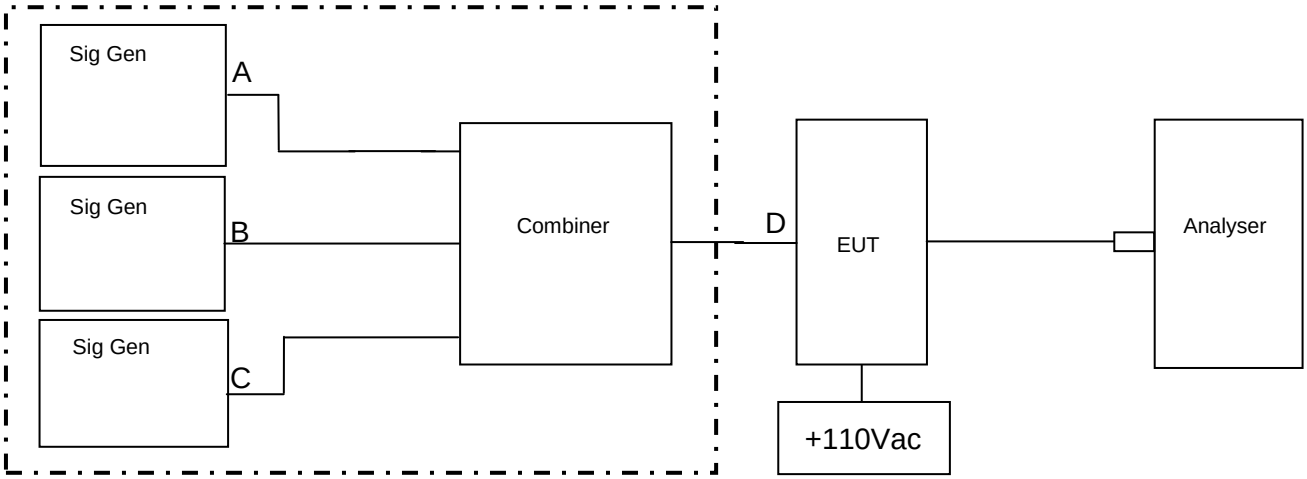
P_{o1} (dBm)	P_{mean}	P_{mean} (dBm)
19.55	$P_{o1} + 3dB$	22.55



Date: 31.MAR.2014 14:53:29

B2 Amplifier Intermodulation Spurious Emissions

Test Details:Uplink	
Measurement standard	Part 2.1053, Part 90.219(e)(3)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C



Signal Generator B was varied in frequency to check if intermodulation products where produced.

492.5MHz-494.0MHz

RF Input Frequency (MHz)			Highest Intermodulation Product Level (dBm)	Limit (dBm)
492.5	493.0	494.0	493.5 @ -14.27dBm	-13

499.0MHz-499.9MHz

RF Input Frequency (MHz)			Highest Intermodulation Product Level (dBm)	Limit (dBm)
499.0	499.6	499.9	498.7MHz @ -15.48dBm	-13

Sweep data is shown on the next page:

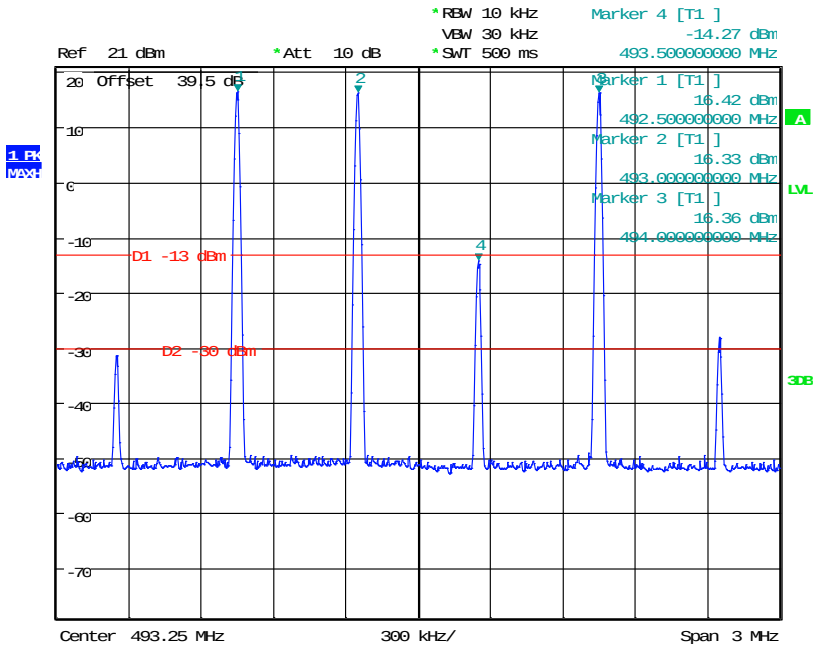
Results

The EUT was found to comply with the limits

See plots below

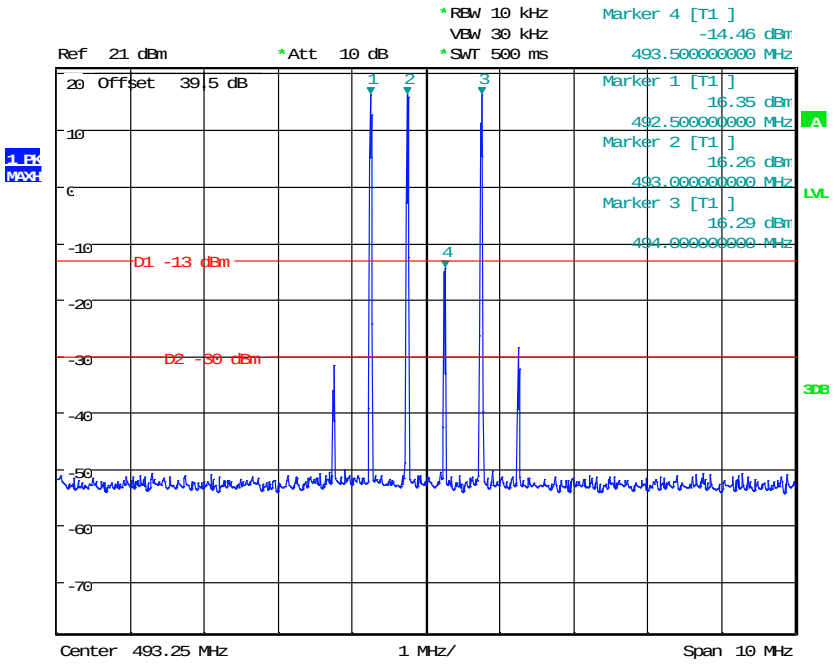
As per D.3 Policies + Procedures (k) of KDB 935210 D02 Signal Boosters Certification v02 the EUT was tested at compression and 10dB into compression to show AGC operation

Intermodulation Close View 492.5MHz - 494.0MHz Uplink



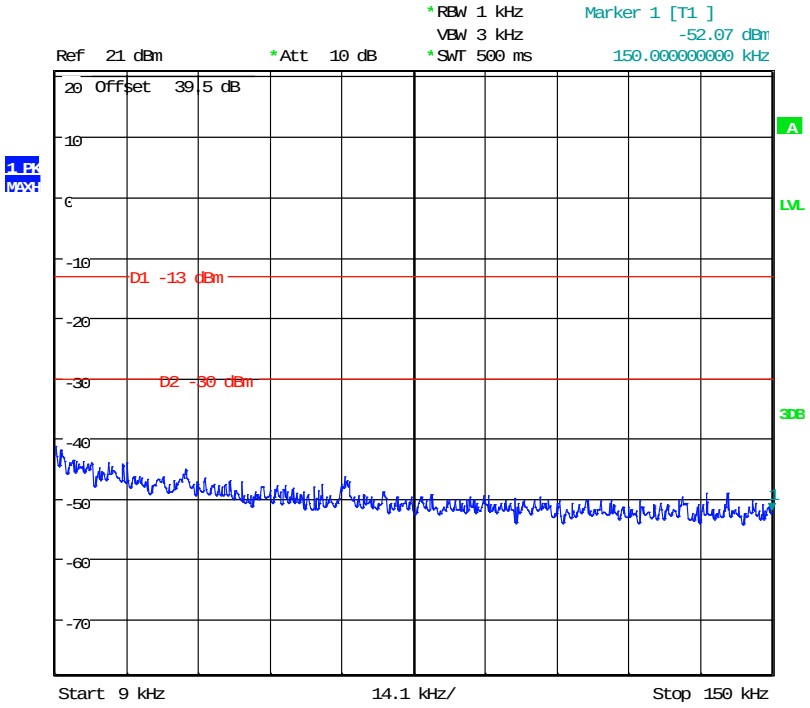
Date: 12.MAR.2014 12:41:07

Intermodulation Wide View



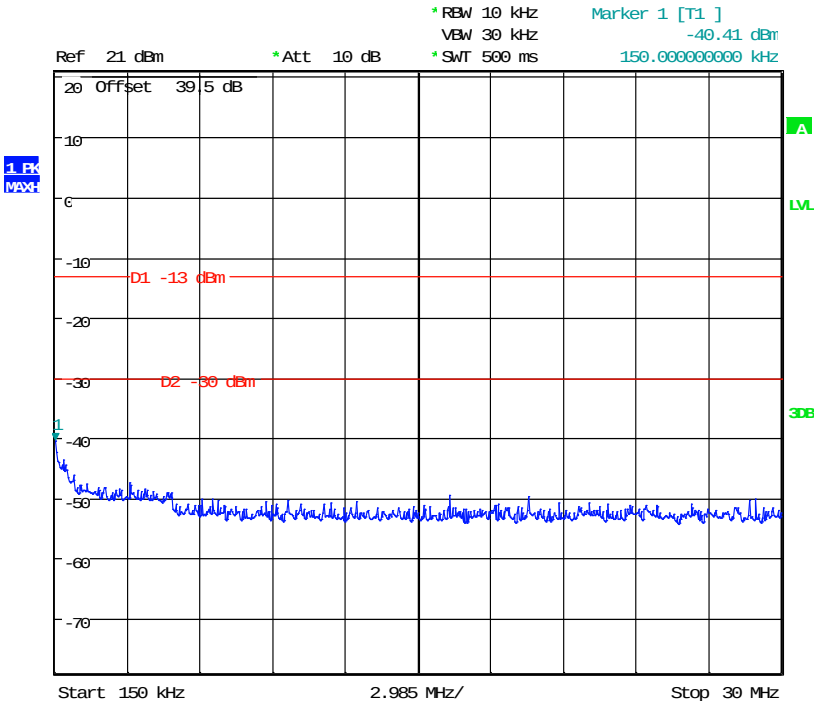
Date: 12.MAR.2014 12:41:39

9-150kHz



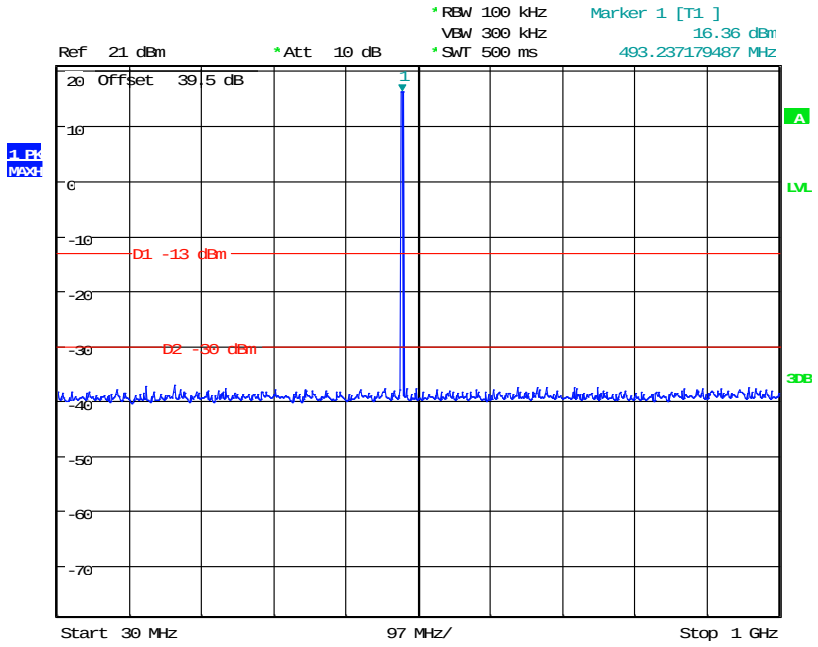
Date: 12.MAR.2014 12:43:09

150kHz – 30MHz



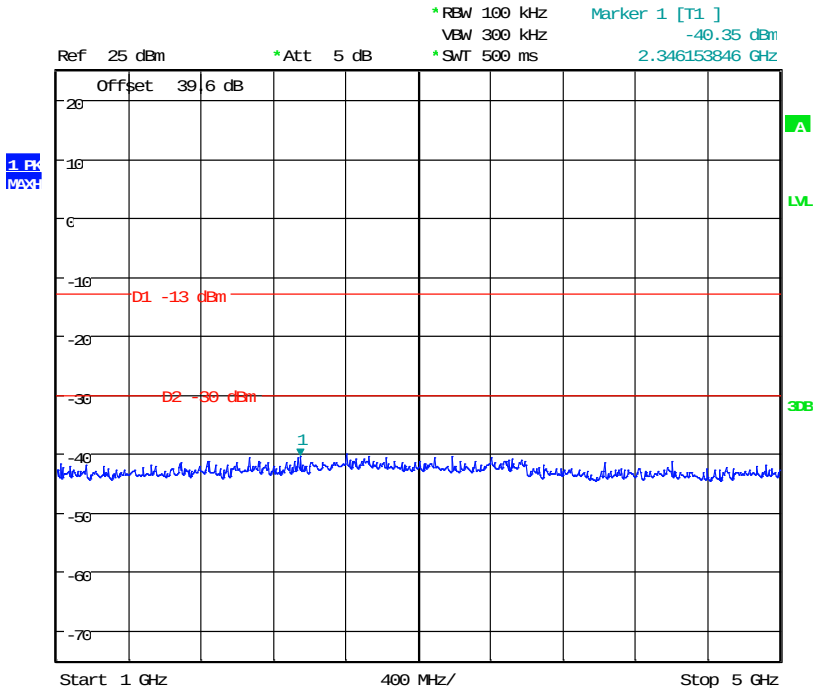
Date: 12.MAR.2014 12:44:08

30MHz – 1GHz



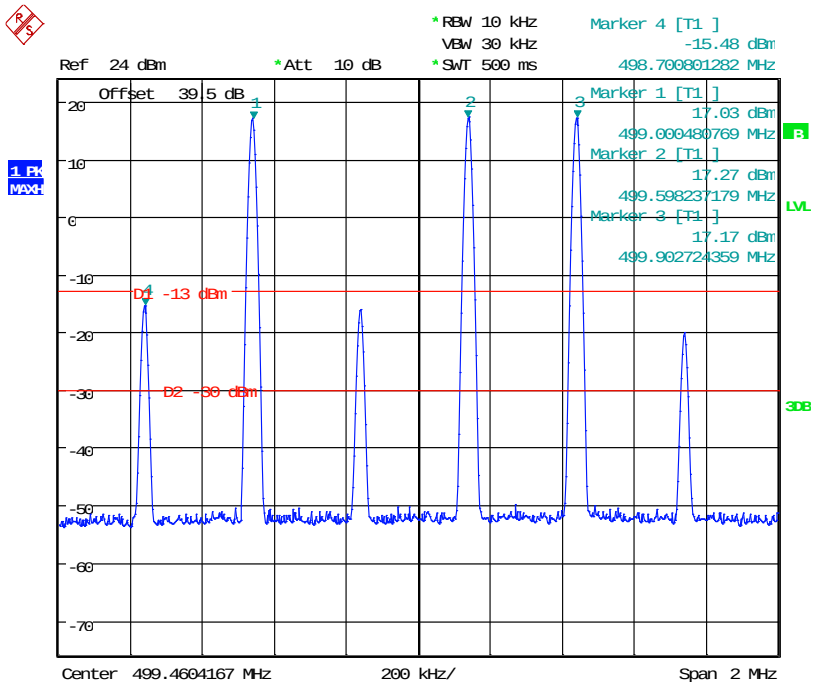
Date: 12.MAR.2014 12:42:29

1GHz – 5GHz



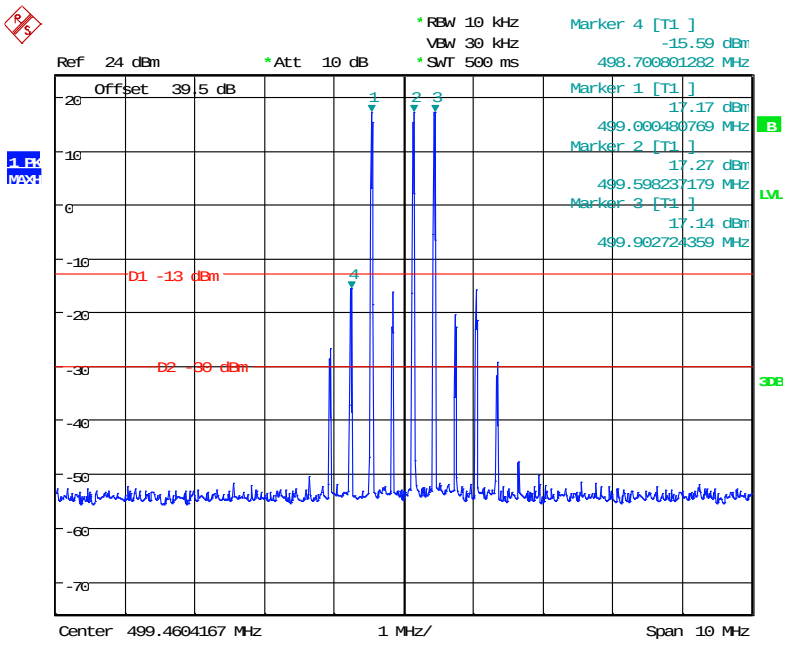
Date: 12.MAR.2014 11:21:35

Intermodulation close View 499.0MHz - 499.9MHz Uplink



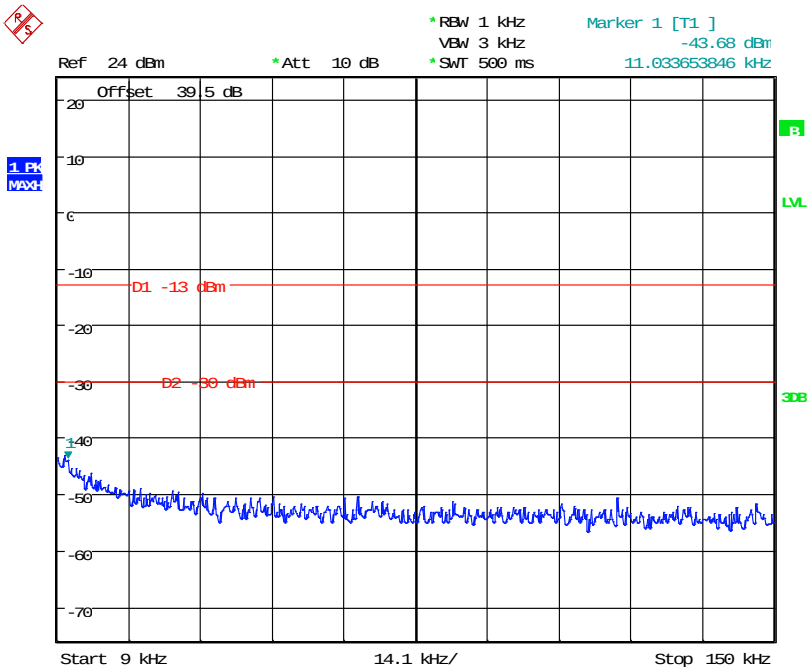
Date: 12.MAR.2014 16:46:24

Intermodulation Wide View



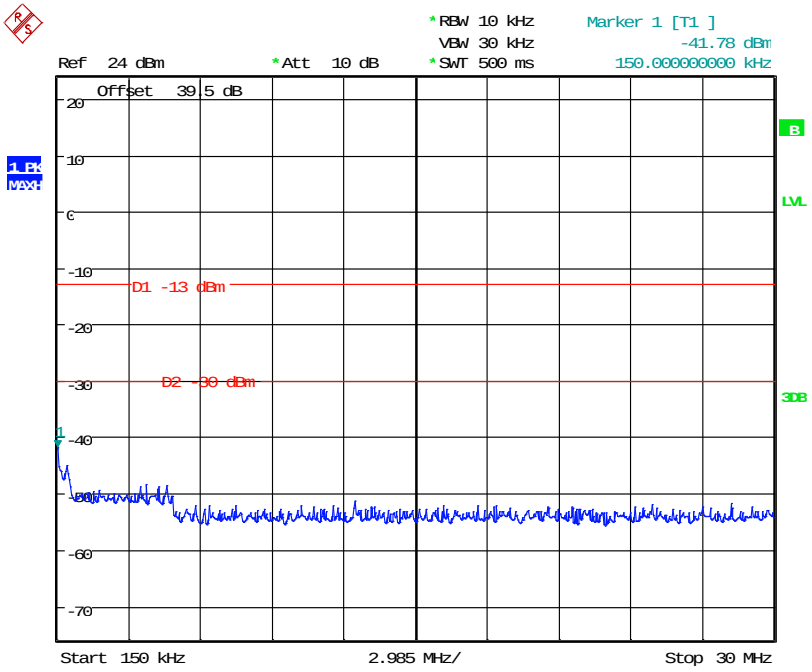
Date: 12.MAR.2014 16:46:45

9-150kHz



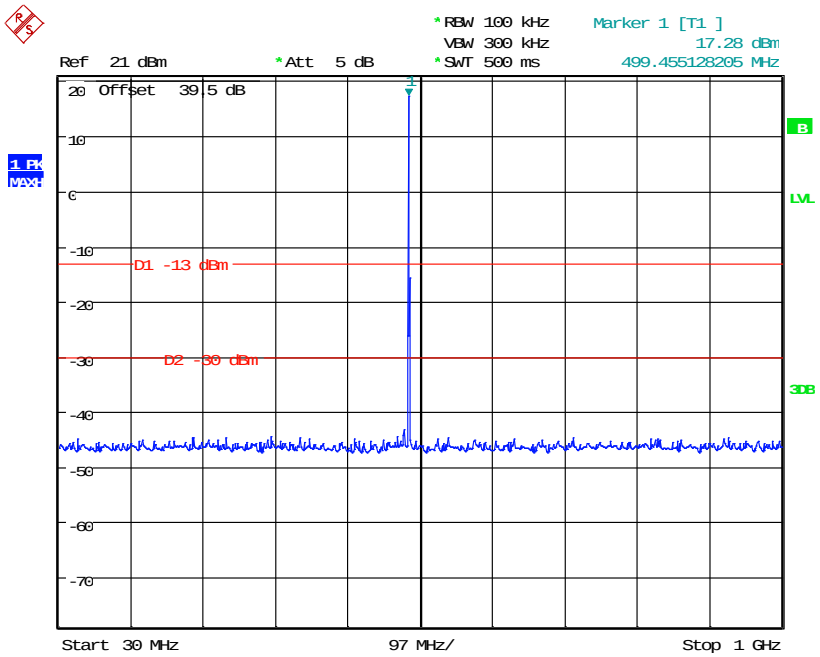
Date: 12.MAR.2014 16:47:43

150kHz – 30MHz



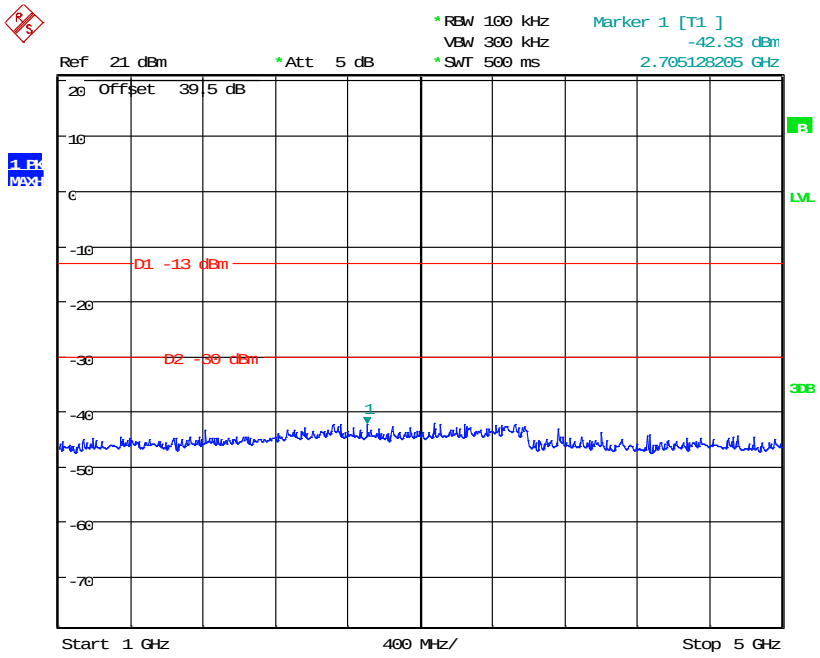
Date: 12.MAR.2014 16:48:17

30MHz – 1GHz



Date: 12.MAR.2014 16:49:07

1GHz – 5GHz



Date: 12.MAR.2014 16:49:33

B3 Amplifier Modulated Channel Test

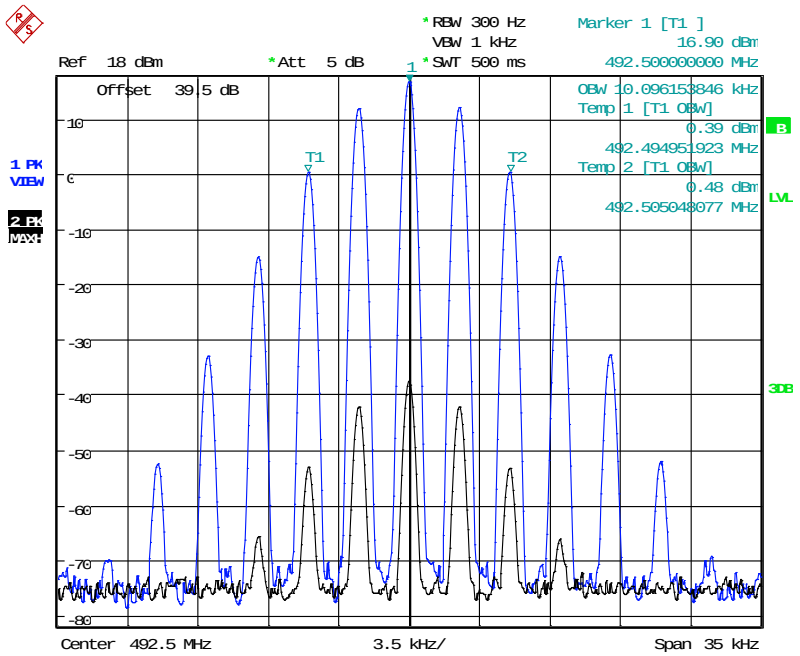
Test Details:Uplink	
Measurement standard	Part 2.1049, Part 90.219(a) 90.219(e)(4)(ii), 90.210(d)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

Modulation Type	Frequency Of Operation Channel		
	492.50MHz	493.25MHz	494.00MHz
Analogue (99%BW)	10.096kHz	10.096kHz	10.096kHz
P25 (99% BW)	8.333kHz	8.333kHz	8.413kHz

Modulation Type	Frequency Of Operation Channel		
	499.0MHz	499.45MHz	499.9MHz
Analogue (99% BW)	10.096kHz	10.096kHz	10.096kHz
P25 (99% BW)	8.333kHz	8.333kHz	8.413kHz

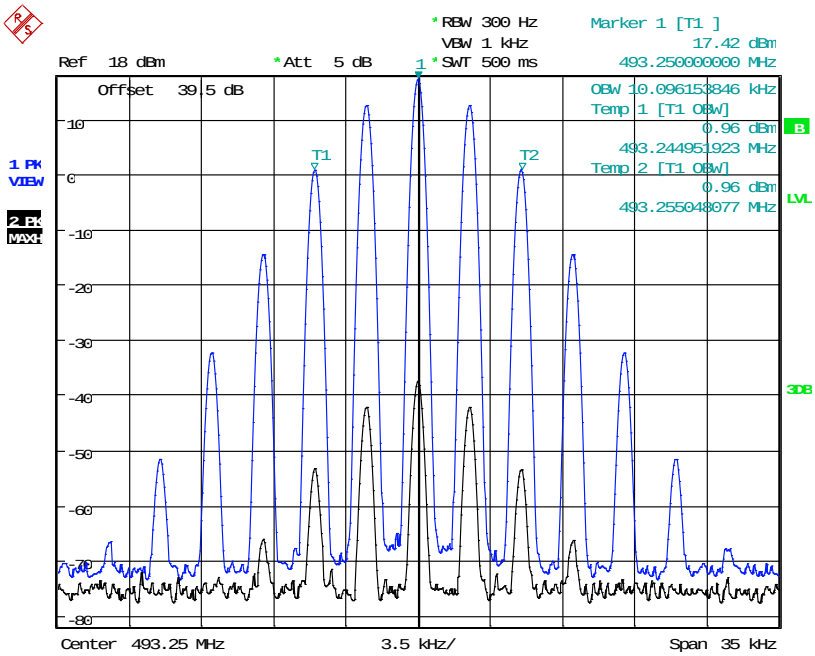
As per D.3 Policies + Procedures (k) of KDB 935210 D02 Signal Boosters Certification v02 the EUT was tested at compression and 10dB into compression to show AGC operation, worst case results taken.

492.50MHz - Analogue Signal Generator and EUT



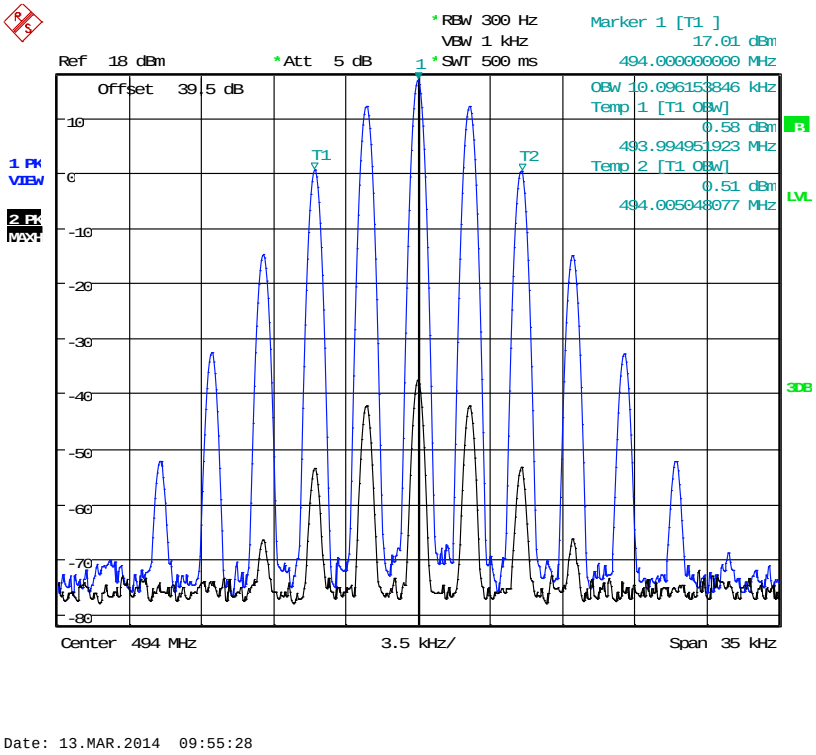
Date: 13.MAR.2014 09:49:31

493.25MHz - Analogue Signal Generator and EUT



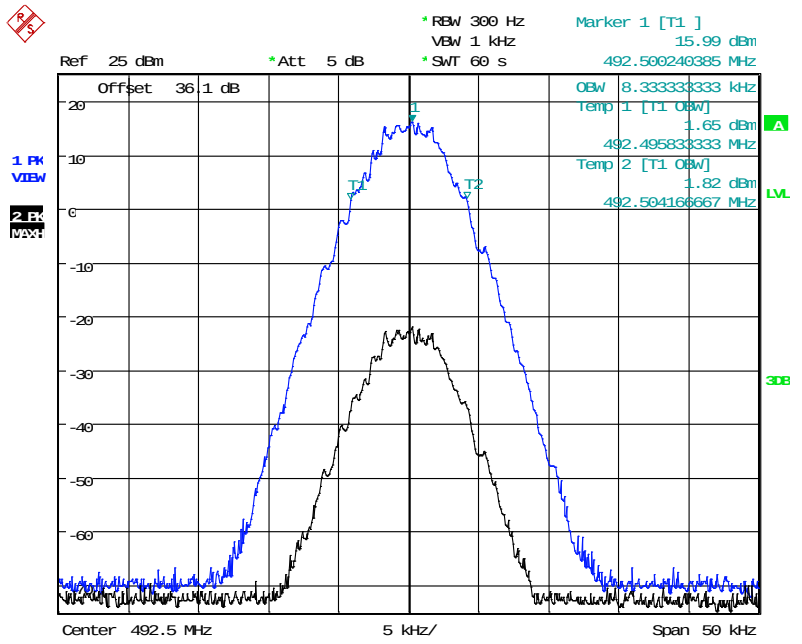
Date: 13.MAR.2014 09:53:32

494.00MHz - Analogue Signal Generator and EUT



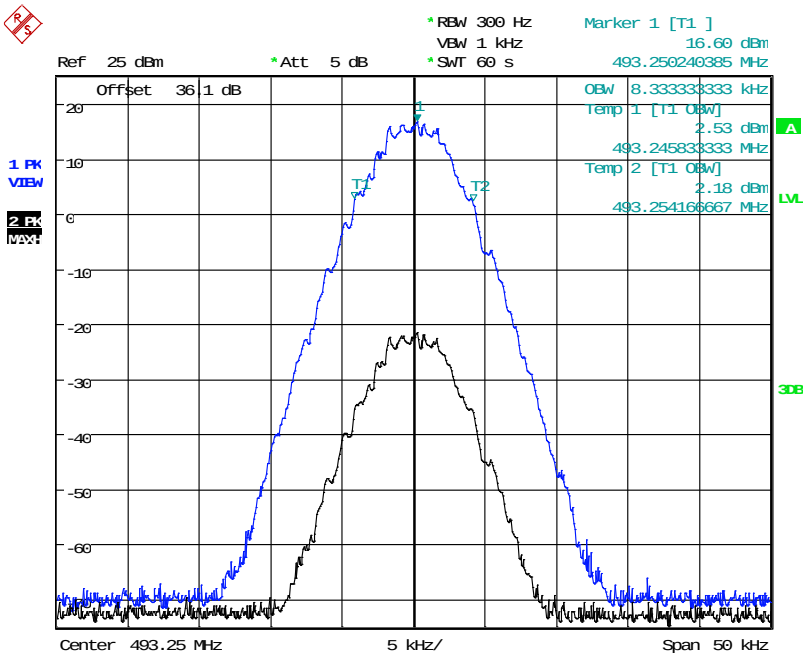
The above plots depicting the output waveshape show no measurable distortion visible when compared to the input signal.

492.50MHz - P25 Signal Generator and EUT



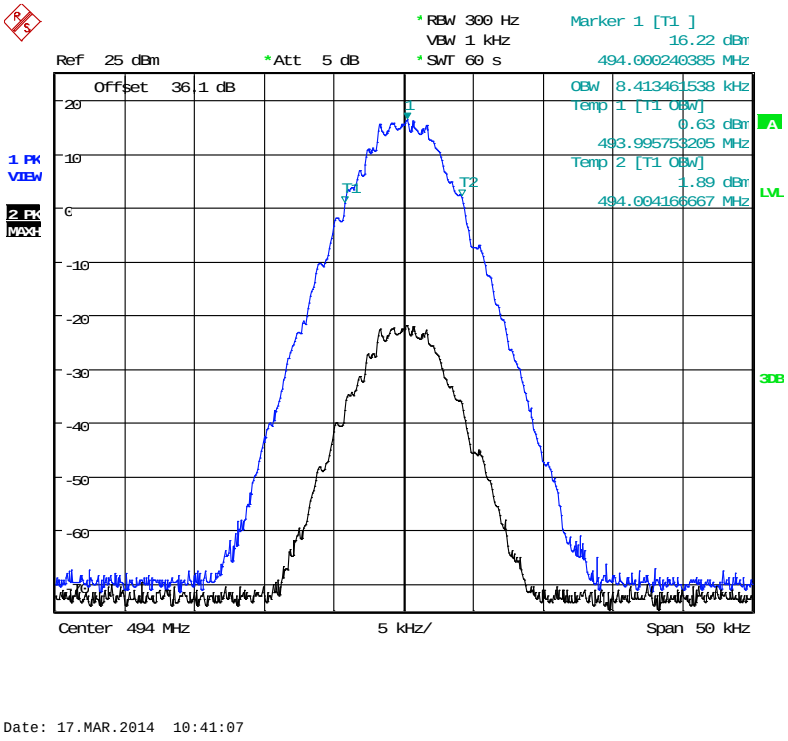
Date: 17.MAR.2014 10:27:36

493.25MHz - P25 Signal Generator and EUT



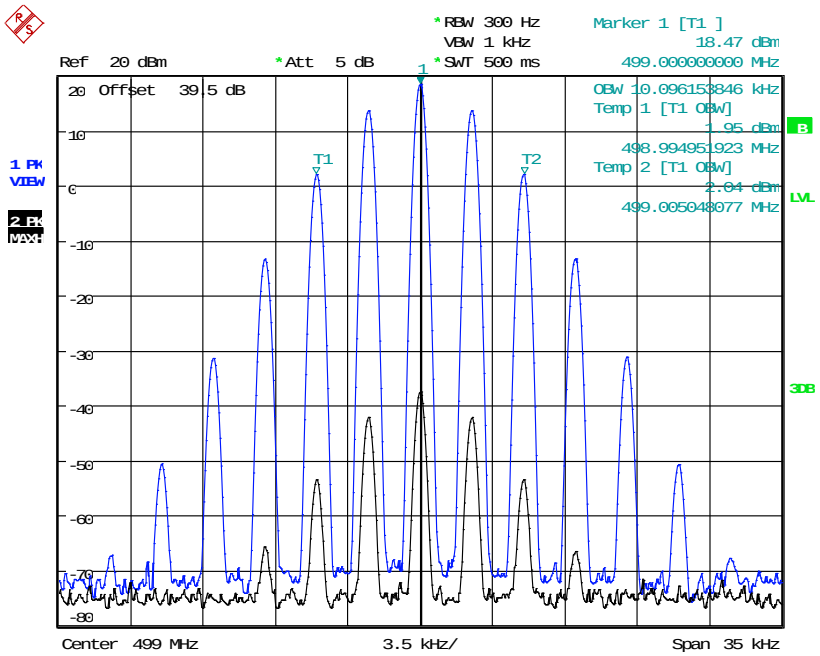
Date: 17.MAR.2014 10:35:02

494.00MHz - P25 Signal Generator and EUT



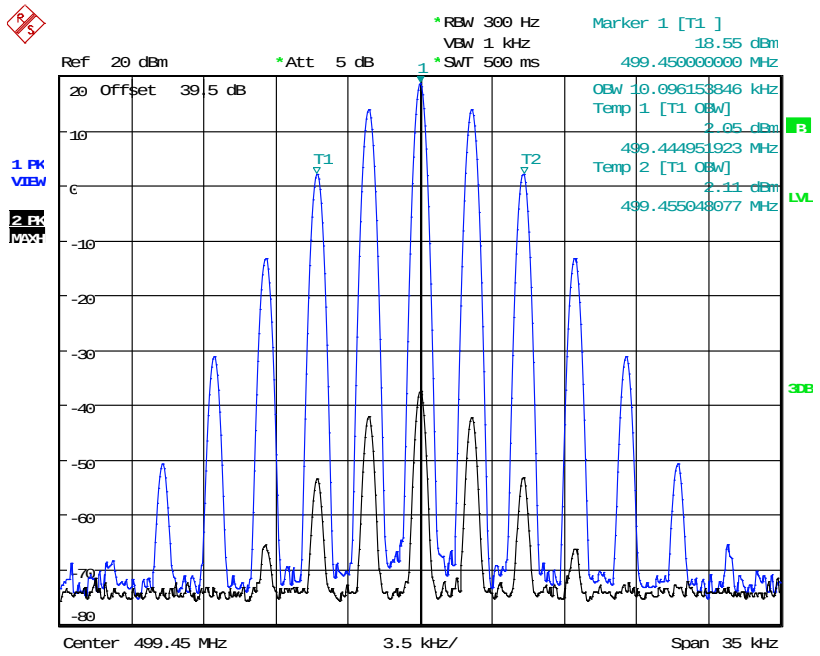
The above plots depicting the output waveshape show no measurable distortion visible when compared to the input signal.

499.0MHz - Analogue Signal Generator and EUT



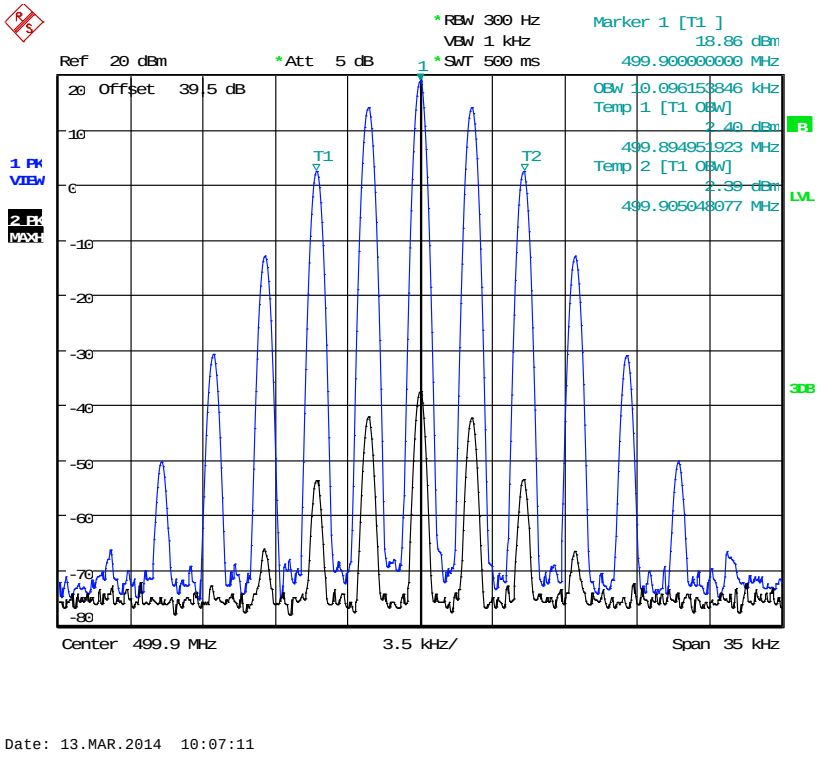
Date: 13.MAR.2014 10:01:13

499.45MHz - Analogue Signal Generator and EUT



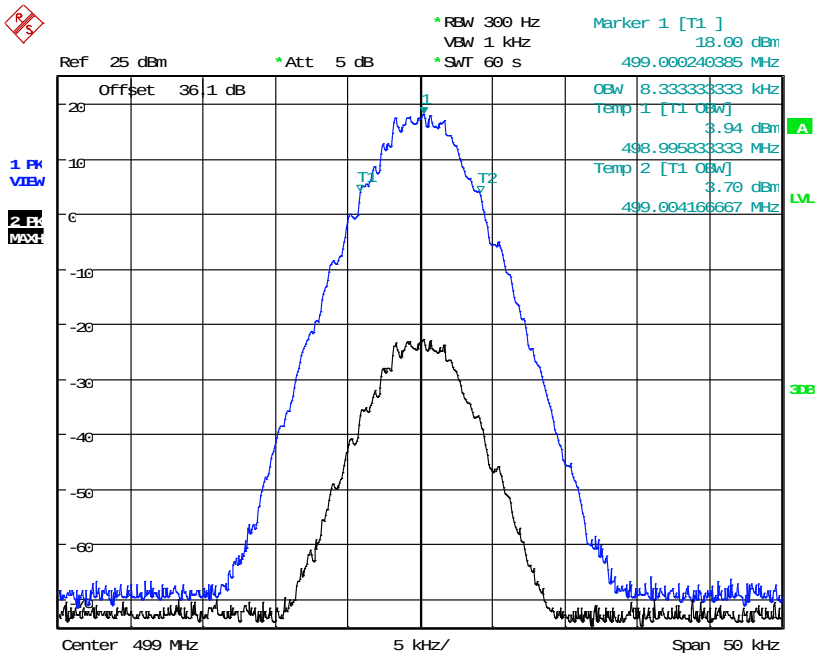
Date: 13.MAR.2014 10:04:48

499.9MHz - Analogue Signal Generator and EUT



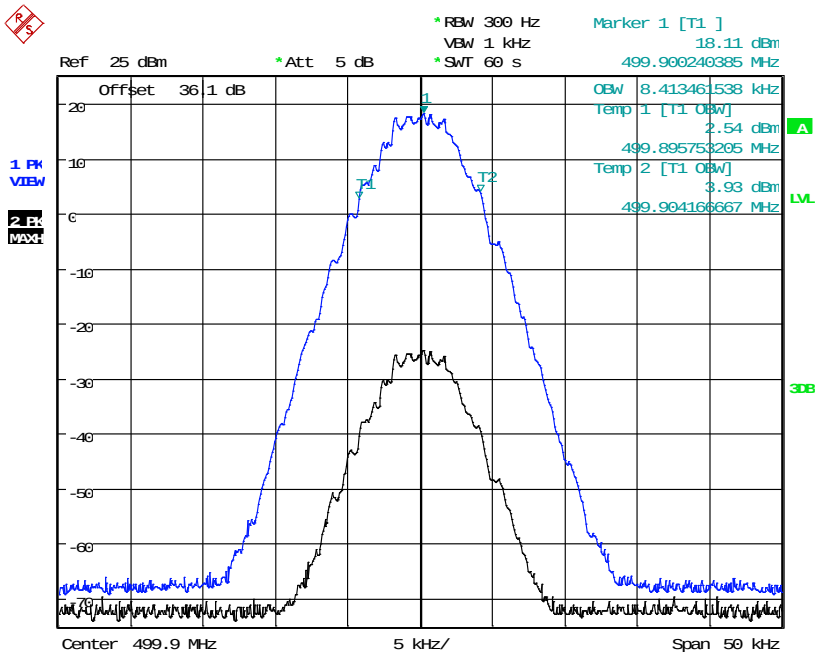
The above plots depicting the output waveshape show no measurable distortion visible when compared to the input signal.

499.0MHz - P25 Signal Generator and EUT



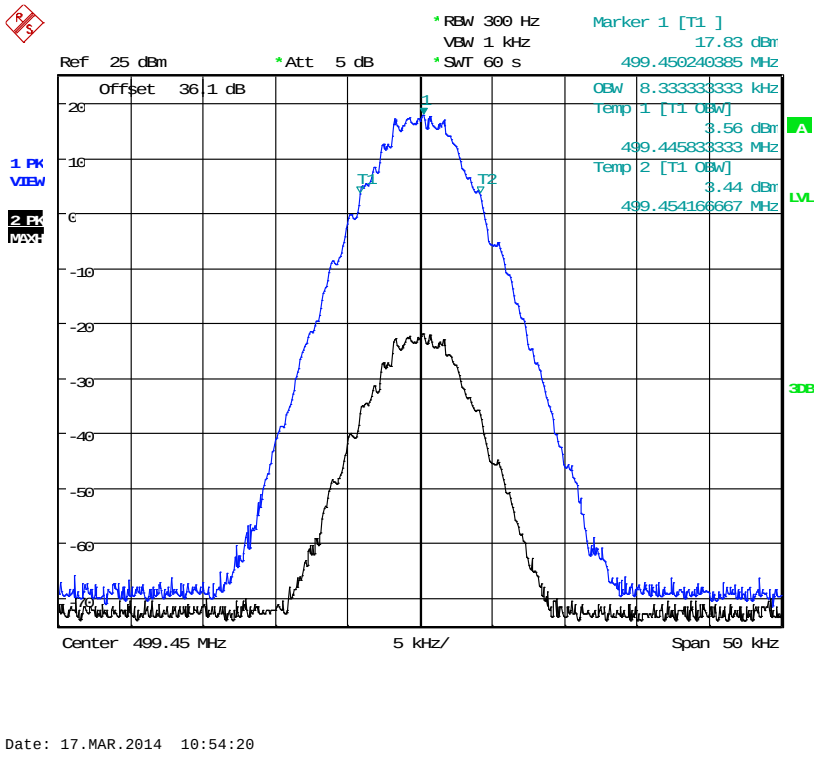
Date: 17.MAR.2014 10:48:44

499.45MHz - P25 Signal Generator and EUT



Date: 17.MAR.2014 11:18:14

499.9MHz - P25 Signal Generator and EUT



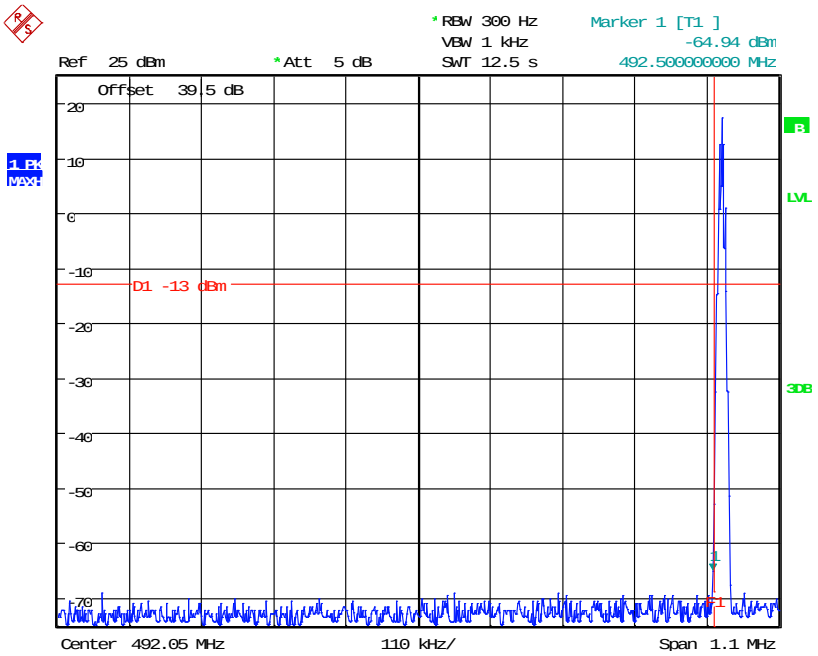
The above plots depicting the output waveshape show no measurable distortion visible when compared to the input signal.

B4 Spurious Emissions at Antenna Terminals Less than 1MHz

Test Details:Uplink	
Measurement standard	Part 2.1053, 90.219(e)(3), 90.210(d)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

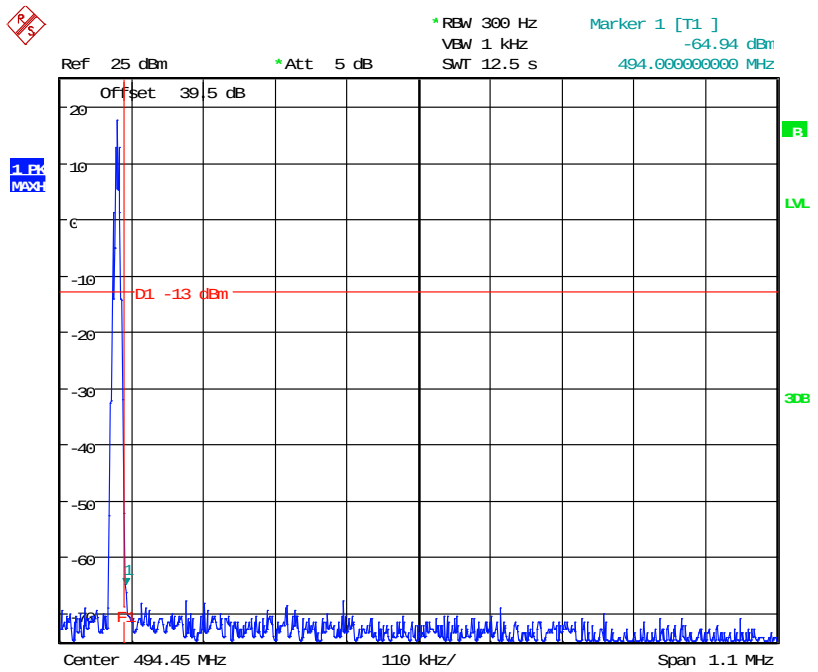
Modulation Type	Bandedge	Carrier Frequency (MHz)	Max Level @ bandedge (dBm)
Analogue Low	Lower	492.5	-69.54
	Upper	494.0	-64.94
Analogue Hi	Lower	496.0	-63.45
	Upper	496.9	-61.04
P25 Low	Lower	492.5	-62.18
	Upper	494.0	-59.04
P25 Hi	Lower	496.0	-55.28
	Upper	496.9	-53.81

492.5MHz – 494.0MHz Analogue Signal – Lower Bandedge



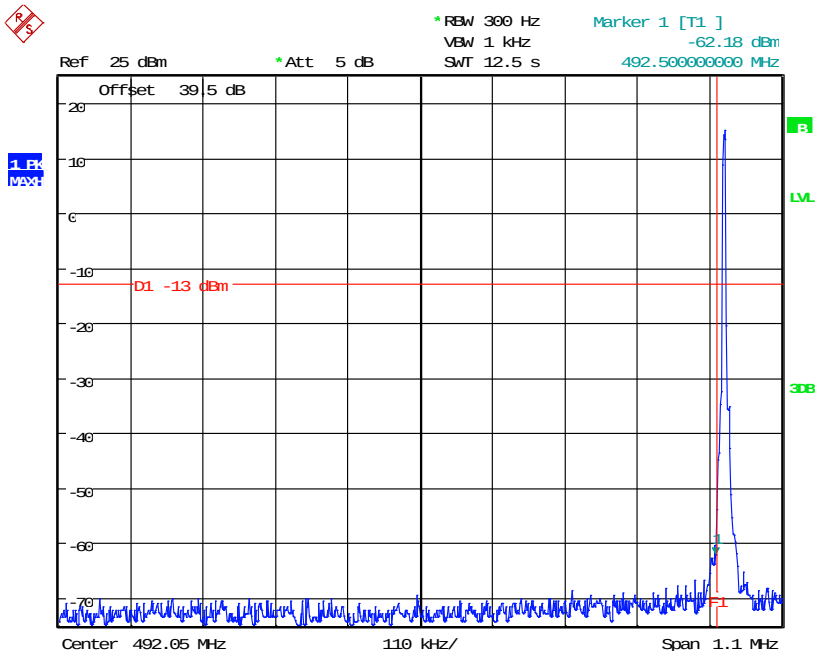
Date: 14.MAR.2014 12:28:48

Analogue Signal – Upper Bandedge



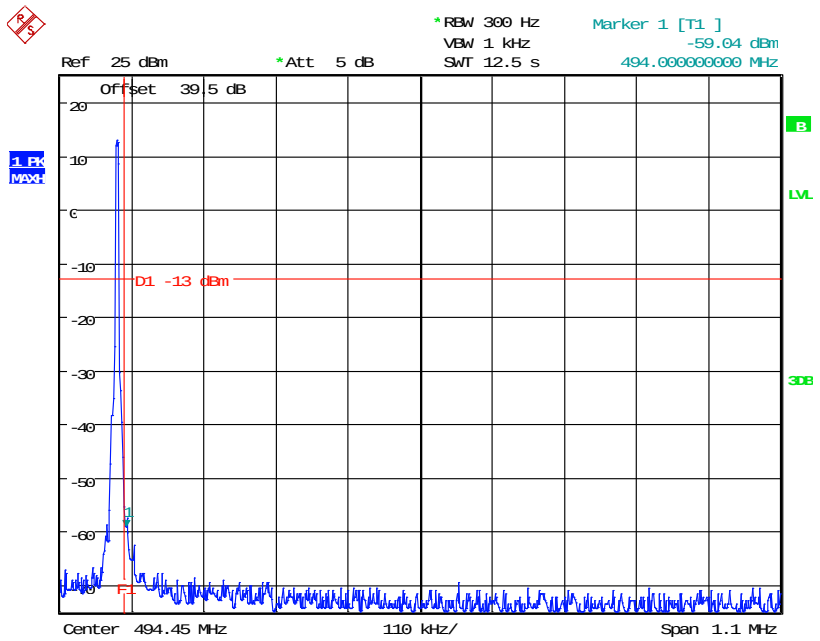
Date: 14.MAR.2014 12:27:41

P25 Signal – Lower Bandedge



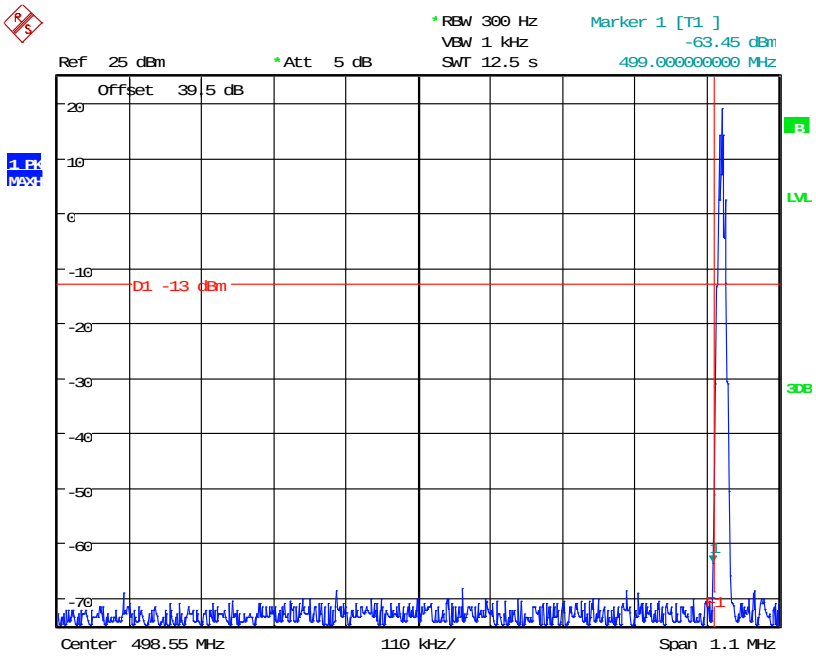
Date: 14.MAR.2014 12:29:36

P25 Signal Signal – Upper Bandedge



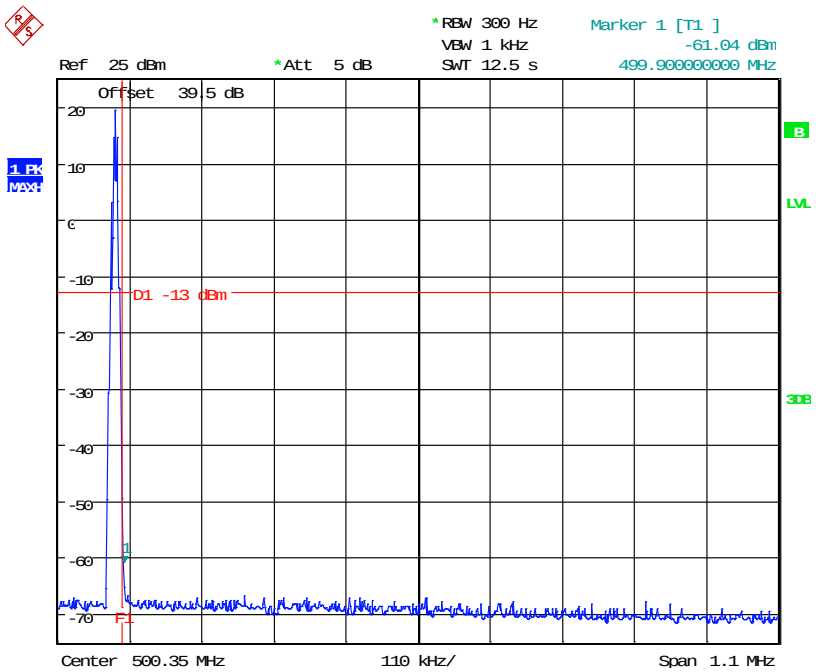
Date: 14.MAR.2014 12:27:08

499.0MHz – 499.9MHz Analogue Signal – Lower Bandedge



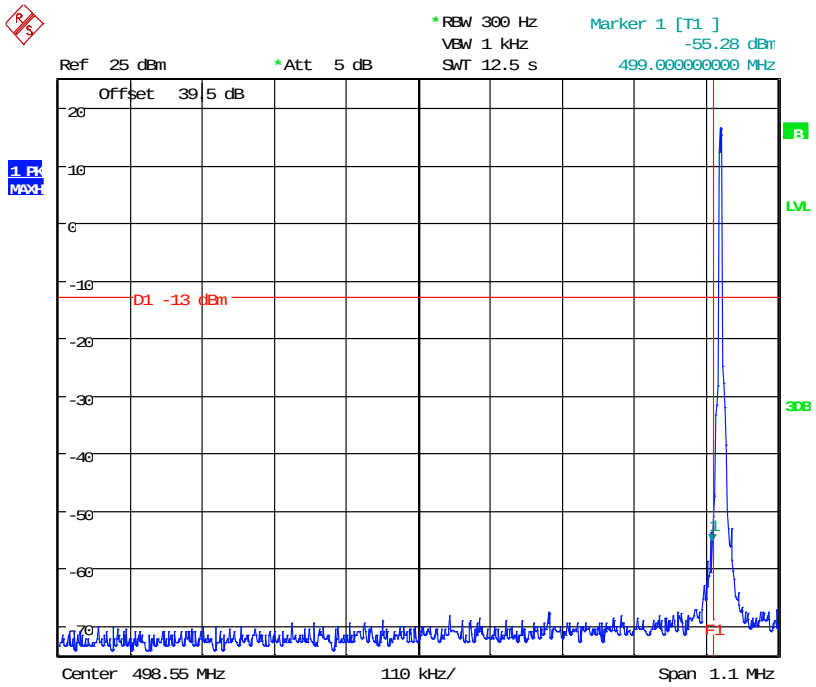
Date: 14.MAR.2014 12:04:34

Analogue Signal Signal – Upper Bandedge



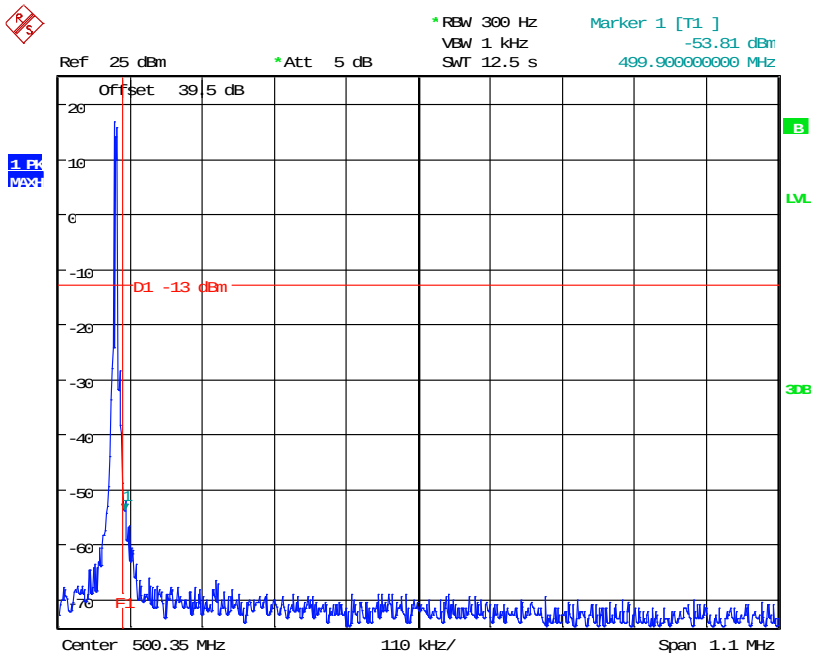
Date: 14.MAR.2014 12:25:25

499.0MHz – 499.9MHz P25 Signal – Lower Bandedge



Date: 14.MAR.2014 12:03:49

P25 Signal – Upper Bandedge



Date: 14.MAR.2014 12:26:10

B5 Spurious Emissions at Antenna Terminals Greater than 1MHz

Test Details:429.5MHz – 494.0MHz	
Measurement standard	Part 2.1053, 90.219(e)(3)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

Bottom Channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No Significant emissions within 20dB of the limit				-13

Middle Channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No Significant emissions within 20dB of the limit				-13

Top channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No Significant emissions within 20dB of the limit				-13

Limit is determined by the outermost step of the emissions mask and is calculated as follows:

At least 43 + 10 log P dB

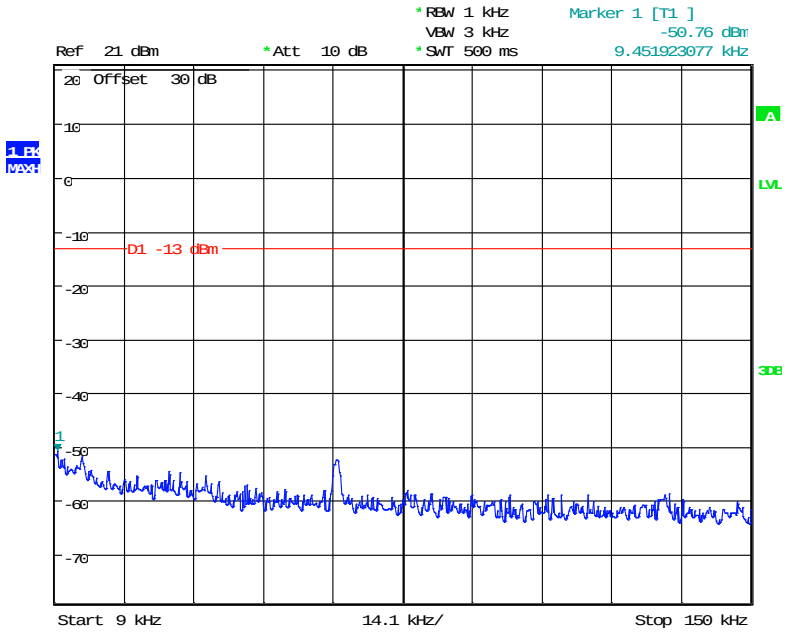
$(10\log P_{watts}) - (43+10\log (P_{watts} * 1000)) =$ LIMIT =-13 dBm

Result

The EUT was found to comply with the limits

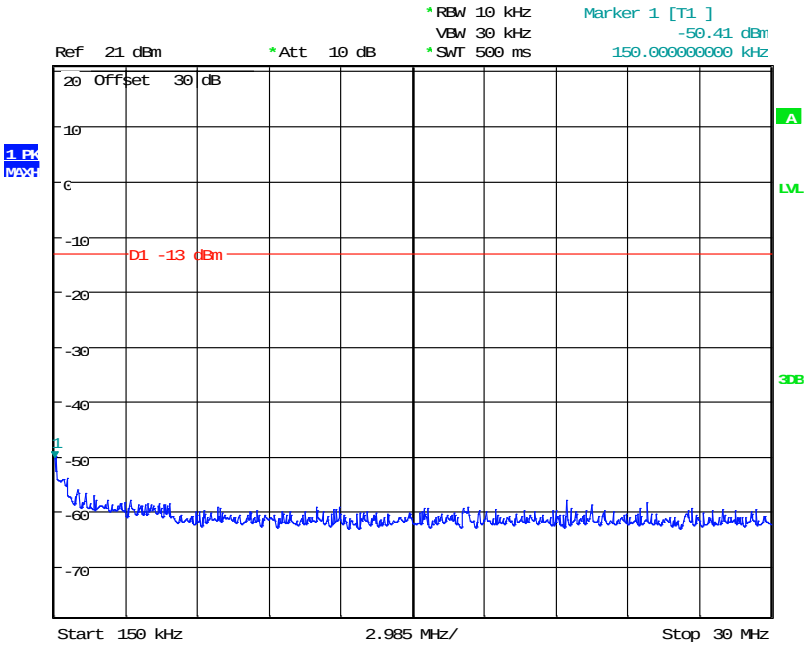
Spurious Emissions at Antenna Terminals Greater than 1MHz Bottom channel

9-150kHz



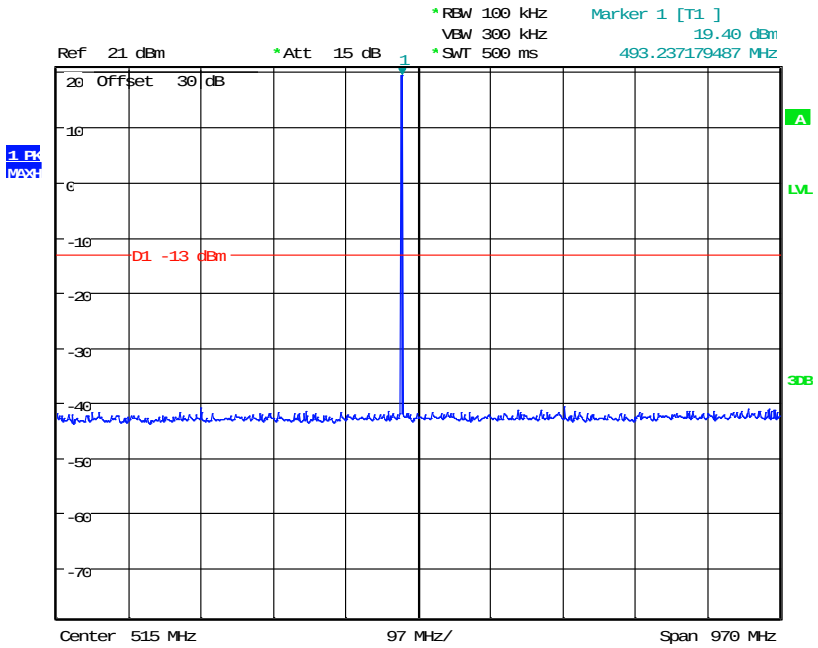
Date: 11.MAR.2014 17:17:28

150kHz – 30MHz



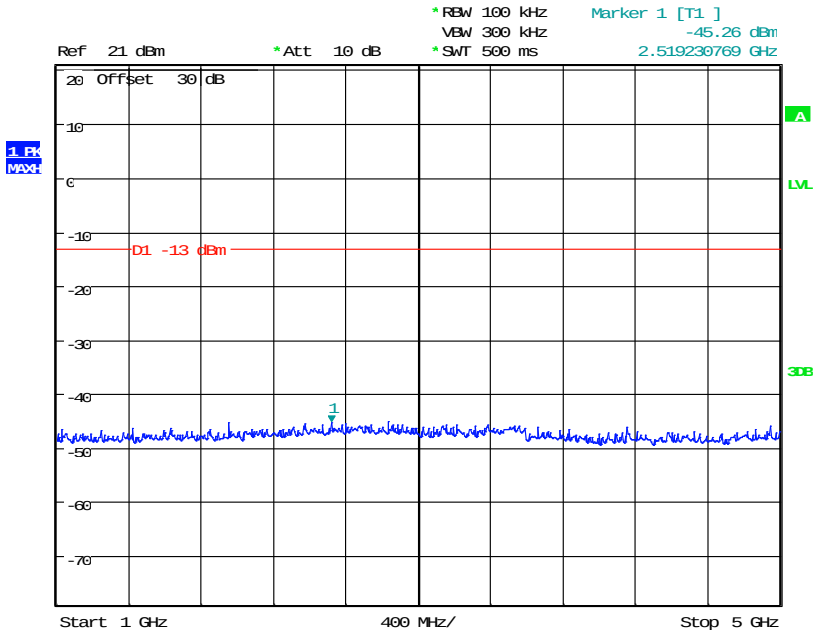
Date: 11.MAR.2014 17:18:00

30MHz – 1GHz



Date: 12.MAR.2014 09:53:49

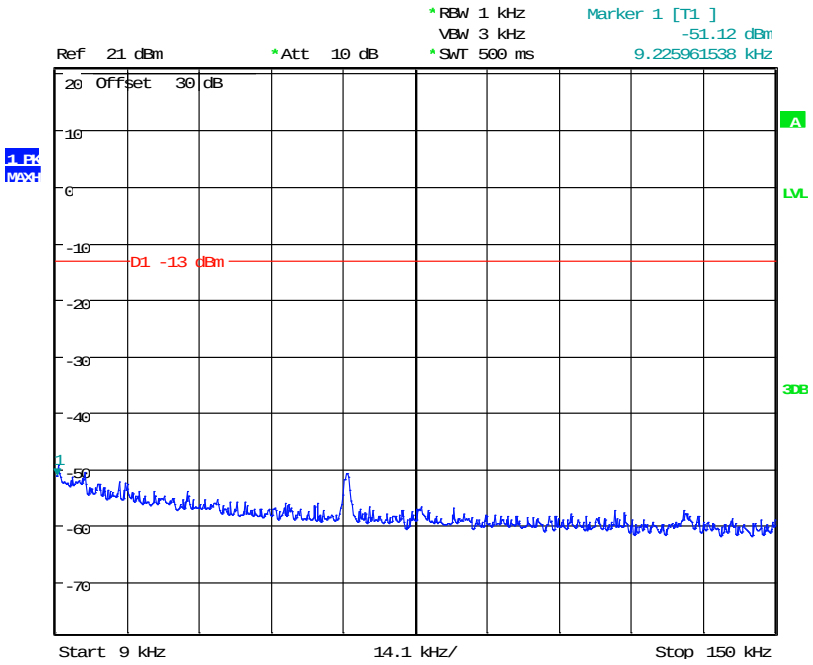
1GHz – 5GHz



Date: 11.MAR.2014 17:19:20

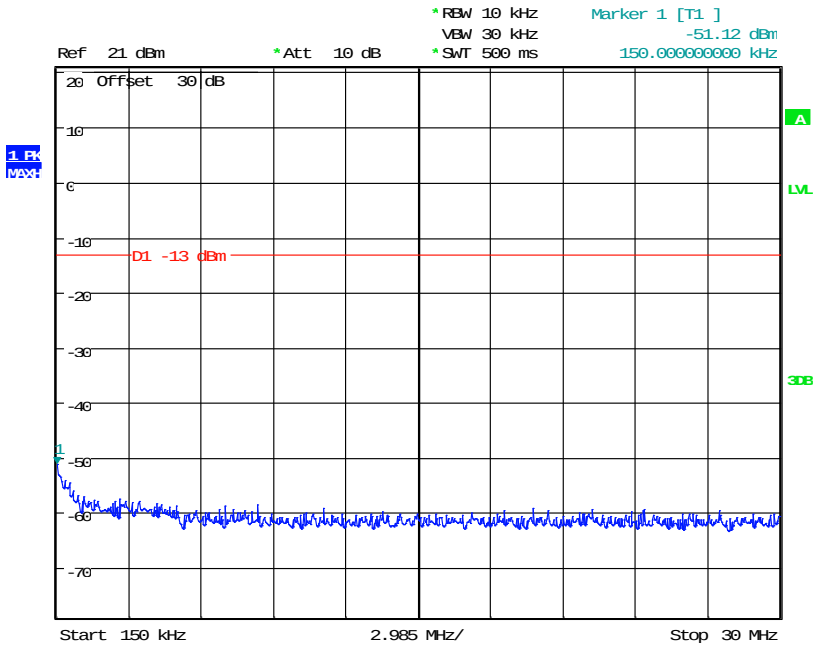
Spurious Emissions at Antenna Terminals Greater than 1MHz Uplink middle channel

9-150kHz



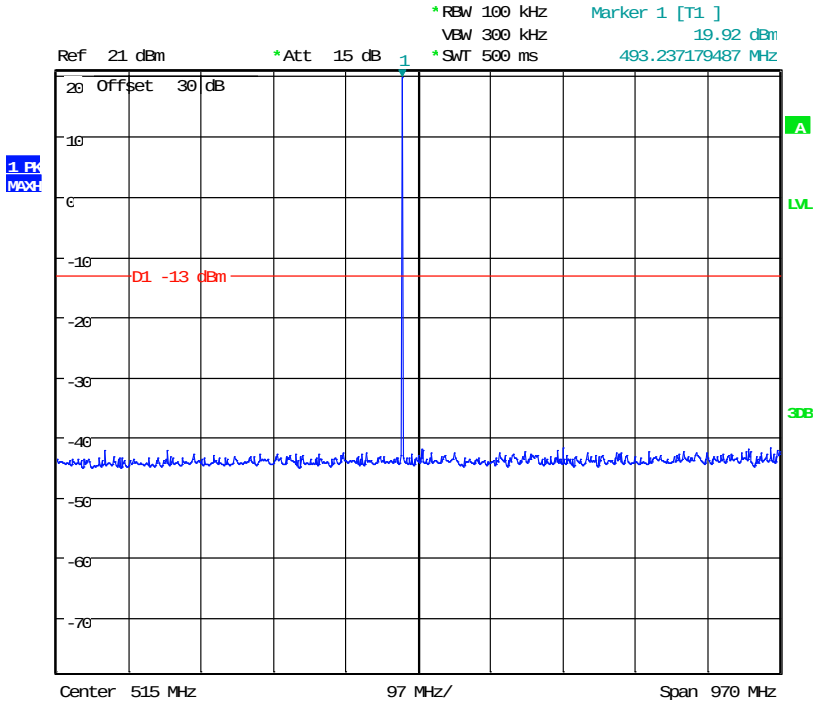
Date: 12.MAR.2014 09:43:58

150kHz – 30MHz



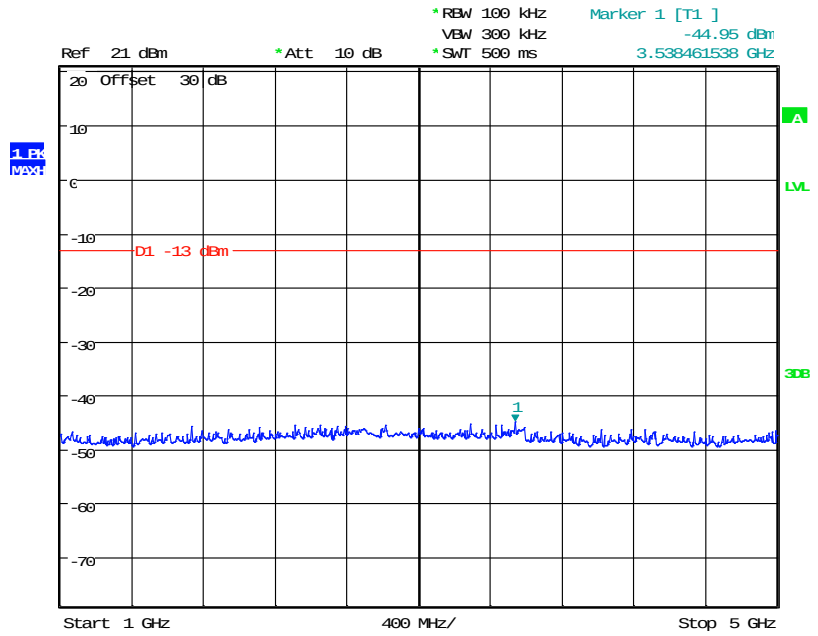
Date: 12.MAR.2014 09:44:29

30MHz – 1GHz



Date: 12.MAR.2014 09:40:40

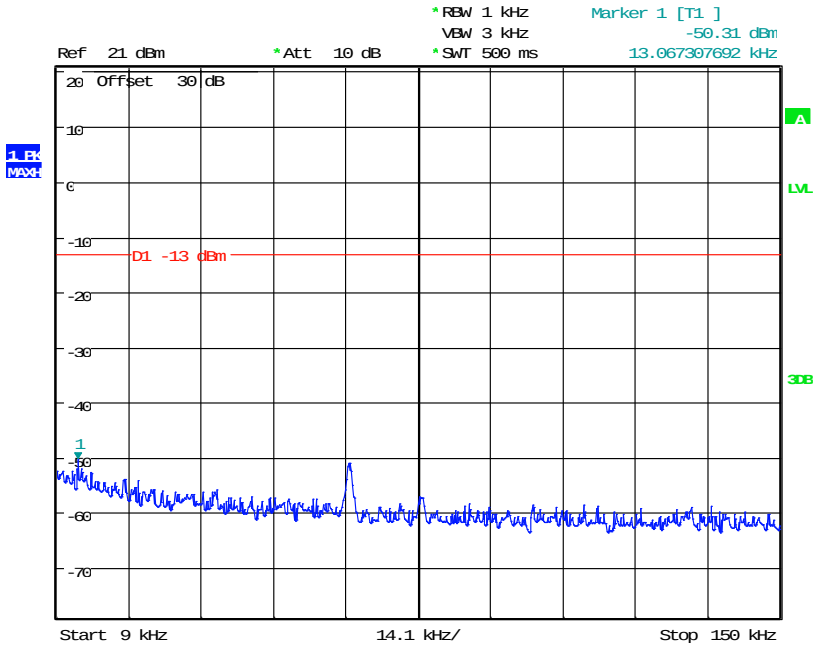
1GHz – 5GHz



Date: 12.MAR.2014 09:45:00

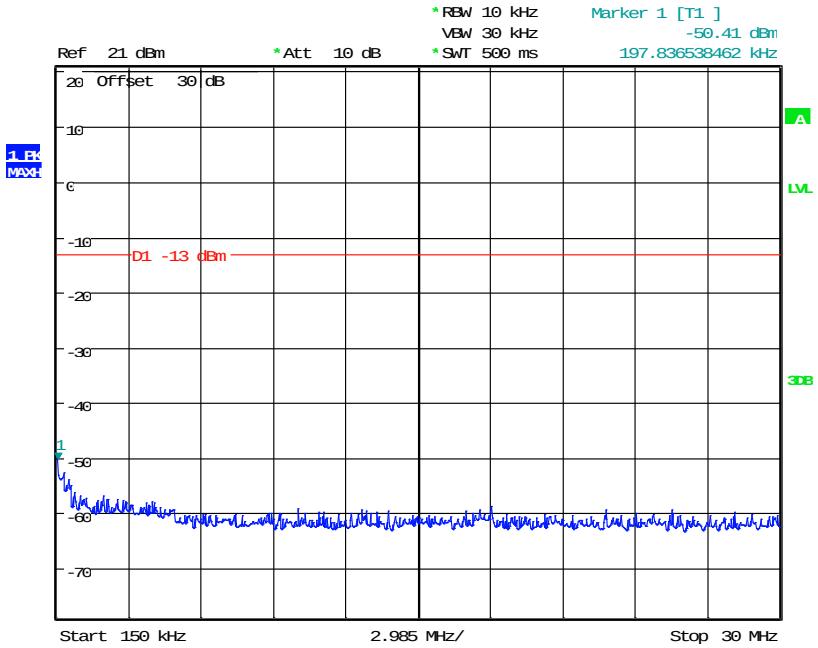
Spurious Emissions at Antenna Terminals Greater than 1MHz Uplink Top channel

9-150kHz



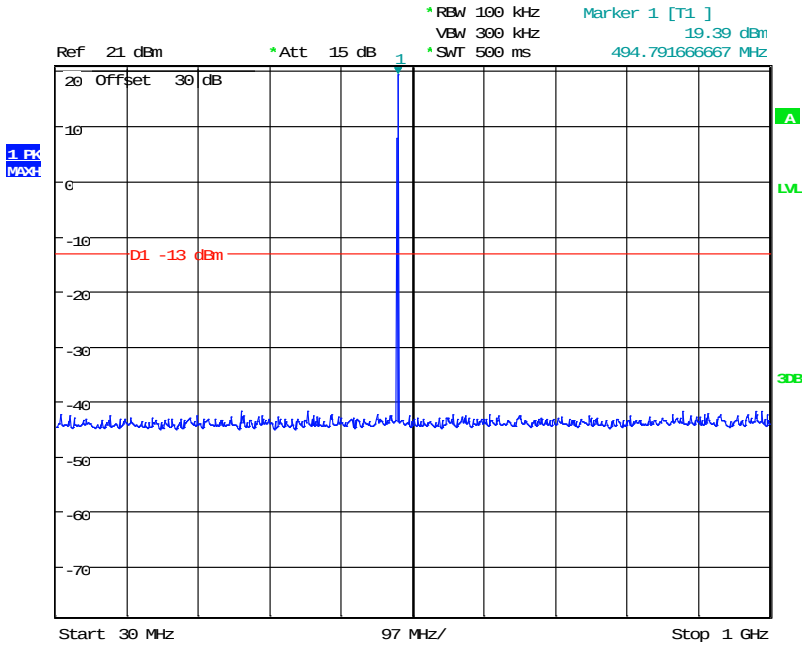
Date: 12.MAR.2014 10:04:03

150kHz – 30MHz



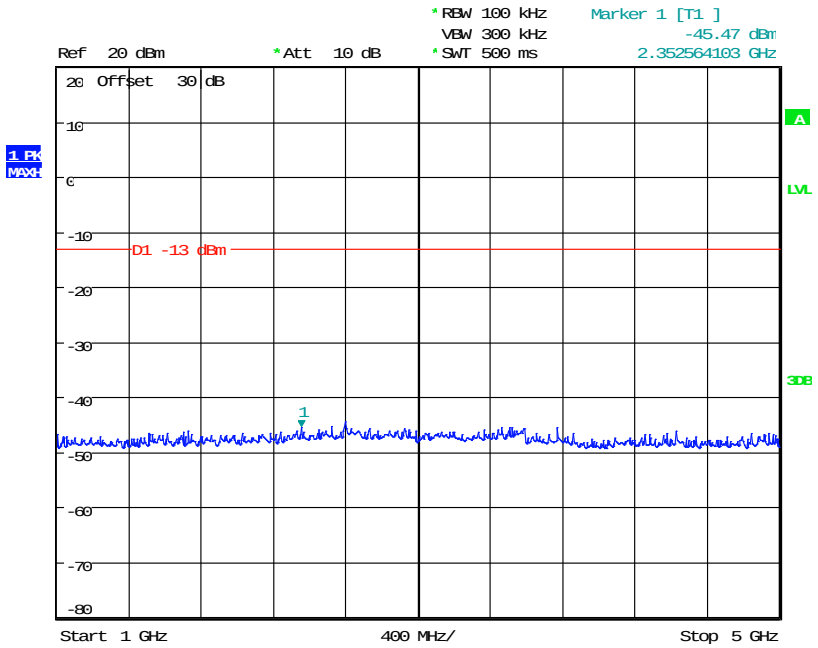
Date: 12.MAR.2014 10:04:31

30MHz – 1GHz



Date: 12.MAR.2014 10:05:06

1GHz – 5GHz



Date: 12.MAR.2014 10:05:48

Test Details:499.0MHz – 499.9MHz	
Measurement standard	Part 2.1053, 90.219(e)(3)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

Bottom Channel 492.5MHz - 499.0MHz

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No Significant emissions within 20dB of the limit				-13

Middle Channel

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No Significant emissions within 20dB of the limit				-13

Top channel 494.0MHz – 499.9MHz

Frequency Range (MHz)	Freq. of Emission (MHz)	Measured Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
9kHz-5GHz	No Significant emissions within 20dB of the limit				-13

Limit is determined by the outermost step of the emissions mask and is calculated as follows:

At least 43 + 10 log P dB

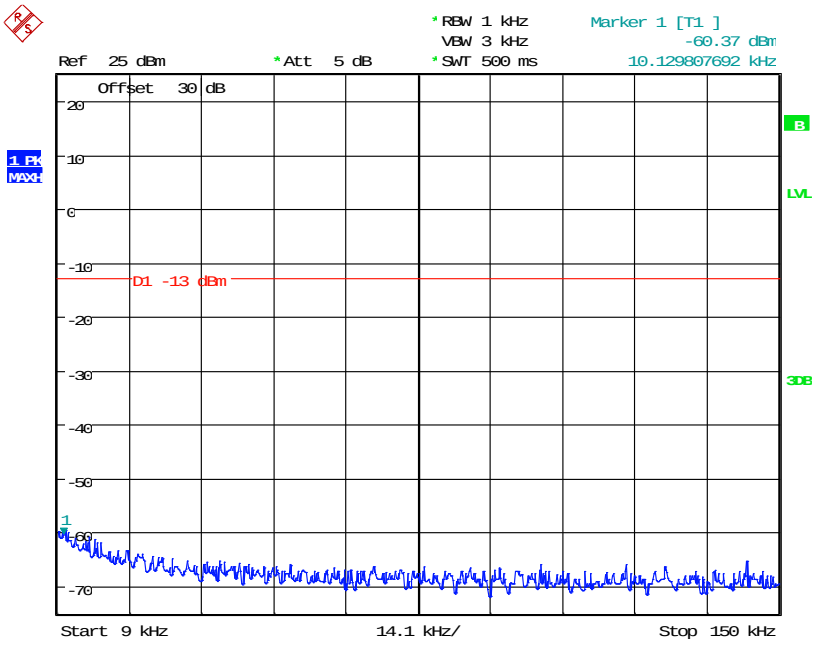
$(10\log P_{watts}) – (43+10\log (P_{watts} * 1000)) =$ LIMIT =-13 dBm

Result

The EUT was found to comply with the limits

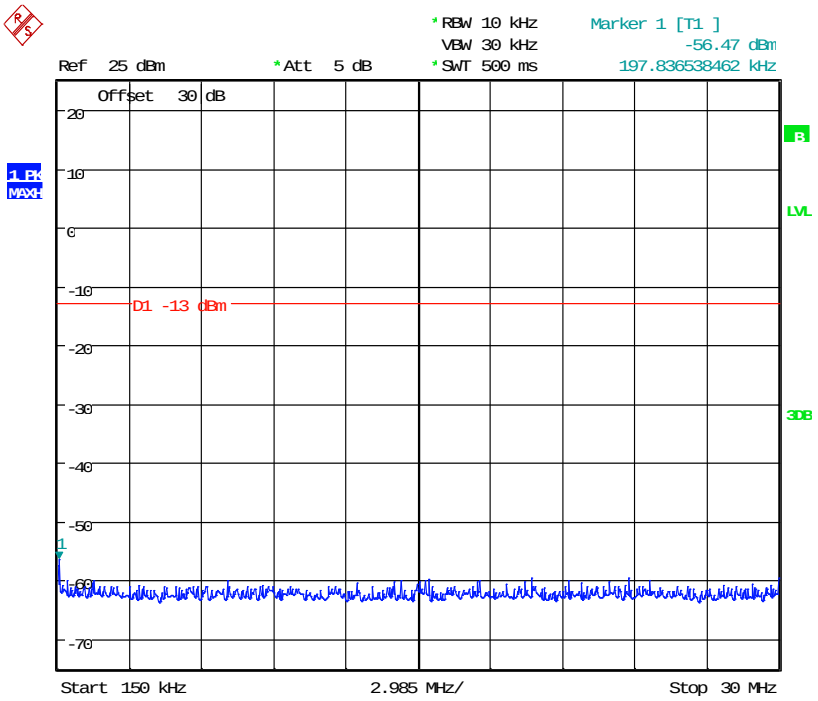
Spurious Emissions at Antenna Terminals Greater than 1MHz Bottom channel

9-150kHz



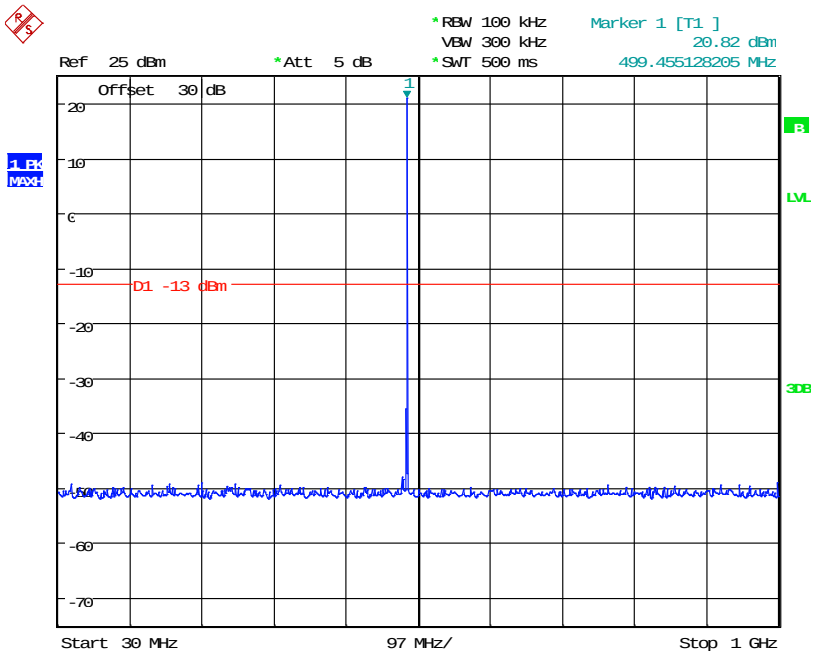
Date: 31.MAR.2014 11:17:28

150kHz – 30MHz



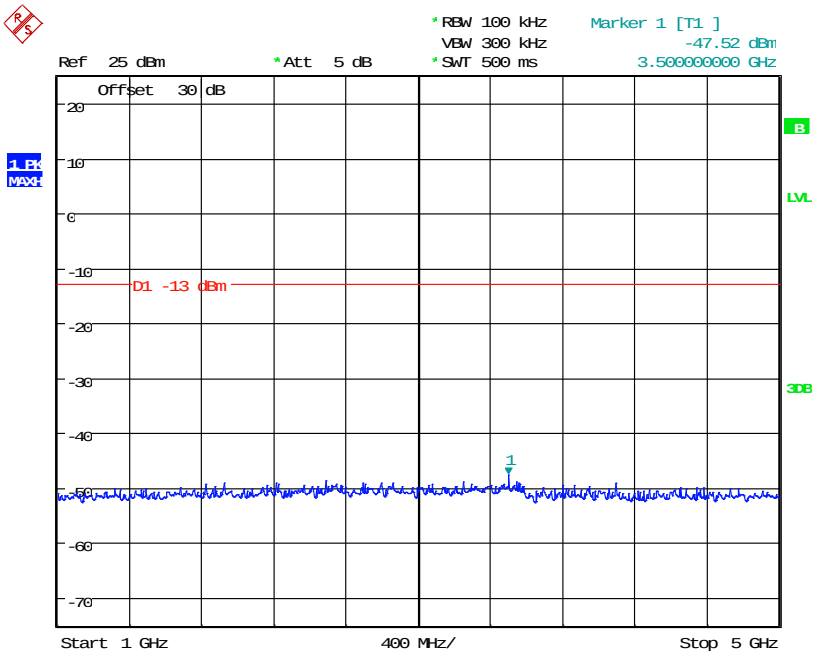
Date: 31.MAR.2014 11:17:56

30MHz – 1GHz



Date: 31.MAR.2014 11:16:51

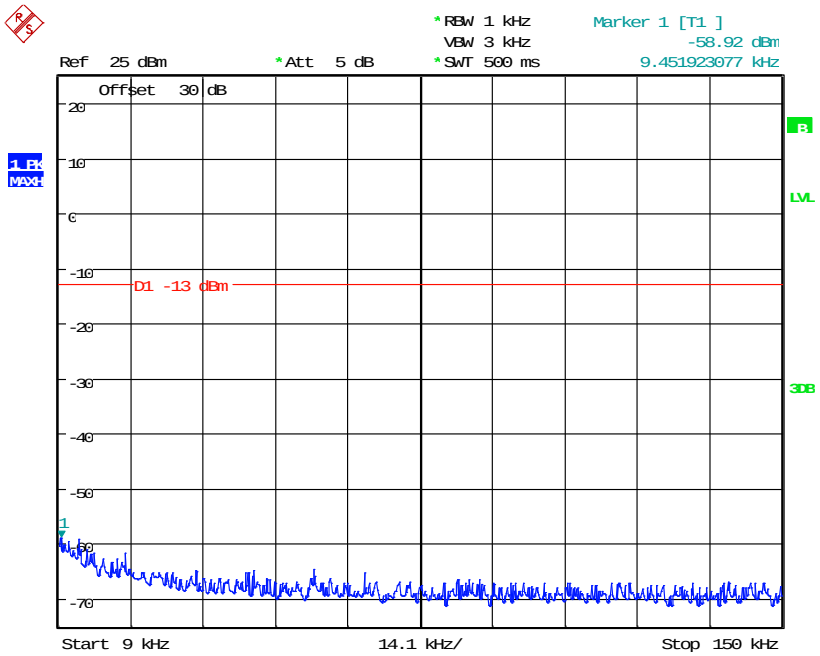
1GHz – 5GHz



Date: 31.MAR.2014 11:18:23

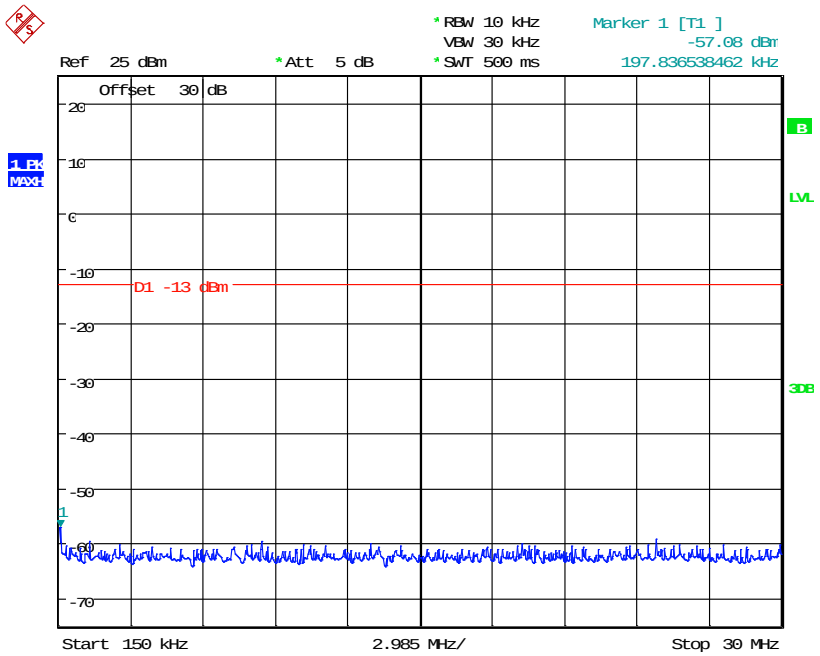
Spurious Emissions at Antenna Terminals Greater than 1MHz Middle channel

9-150kHz



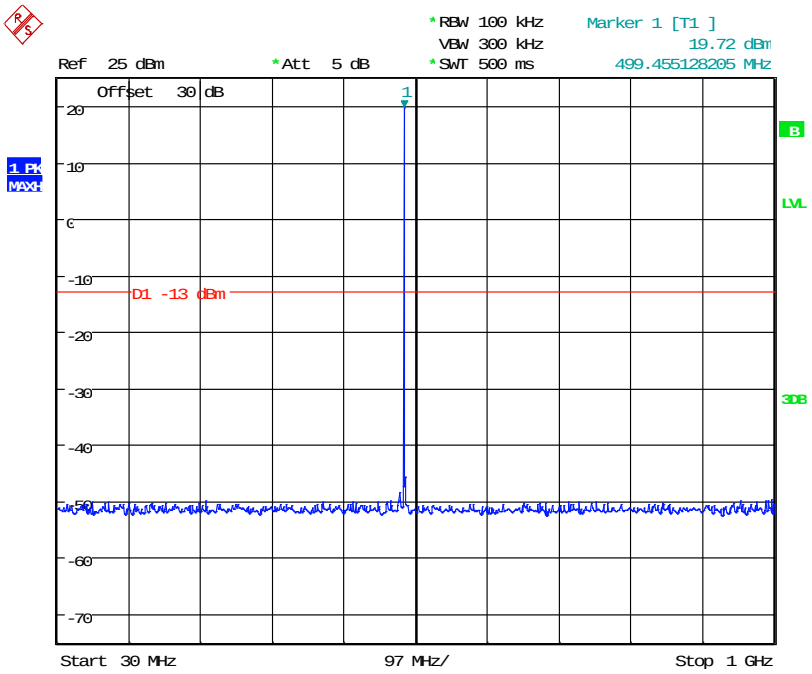
Date: 31.MAR.2014 11:20:25

150kHz – 30MHz



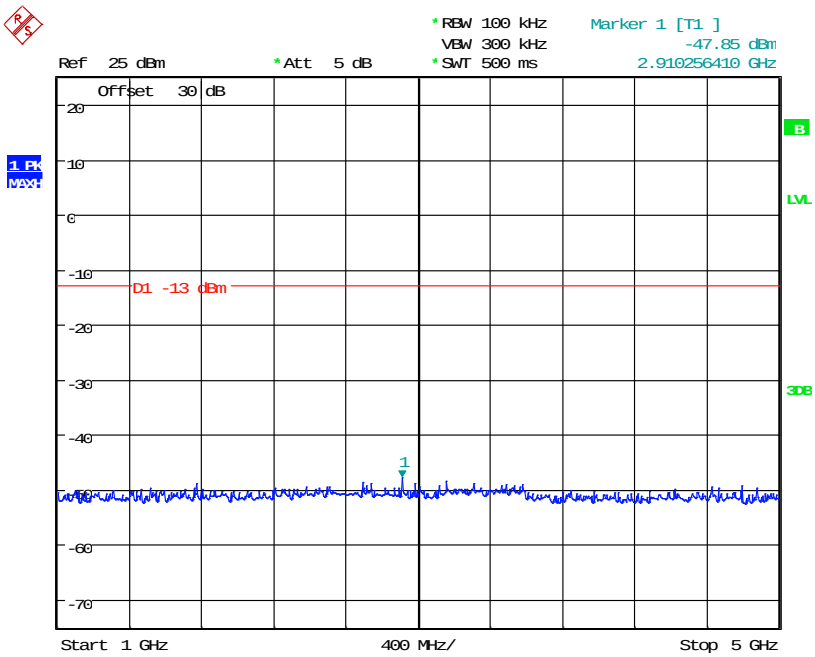
Date: 31.MAR.2014 11:20:51

30MHz – 1GHz



Date: 31.MAR.2014 11:21:17

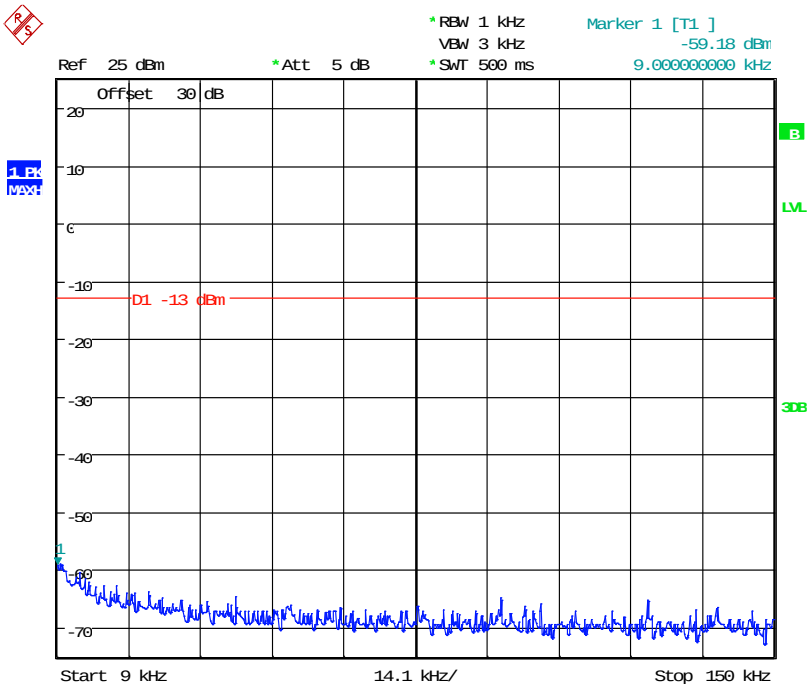
1GHz – 5GHz



Date: 31.MAR.2014 11:21:38

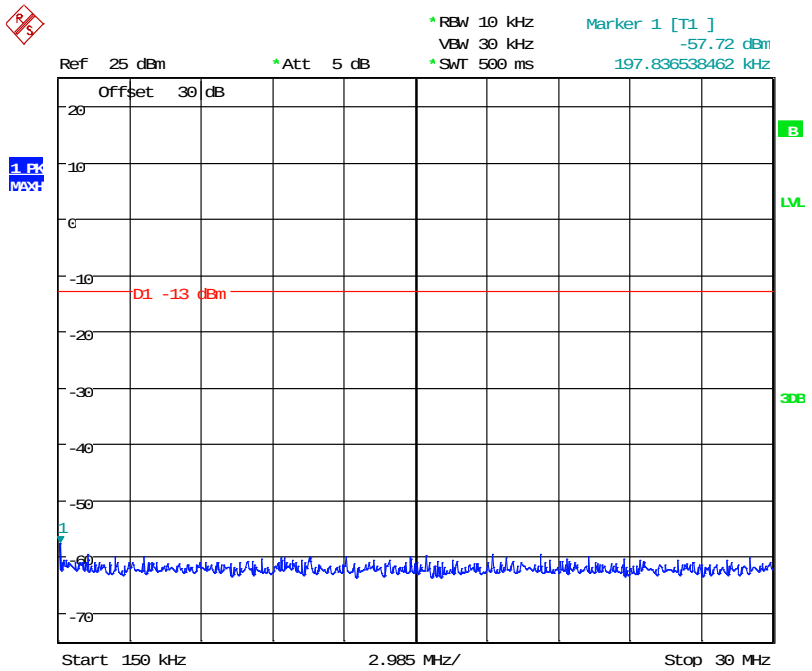
Spurious Emissions at Antenna Terminals Greater than 1MHz Top channel

9-150kHz



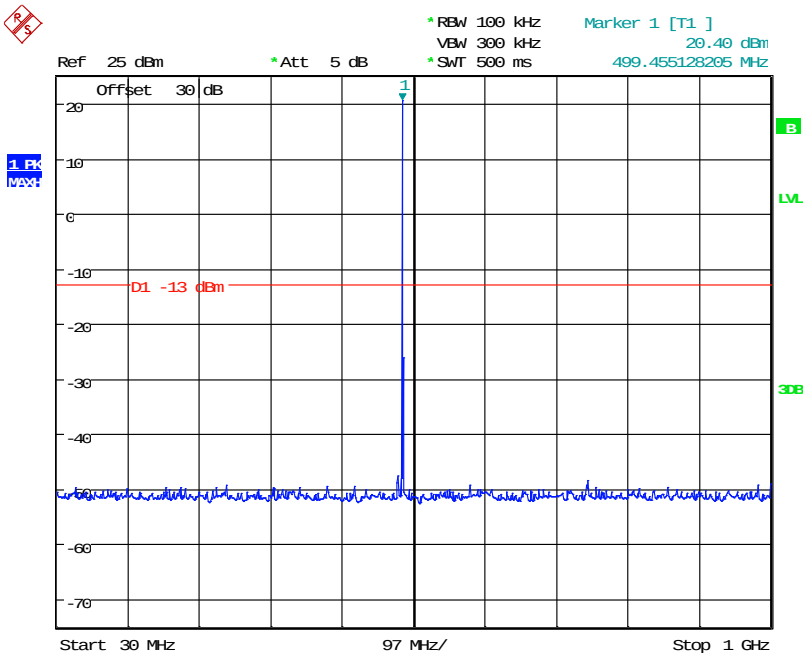
Date: 31.MAR.2014 11:22:44

150kHz – 30MHz



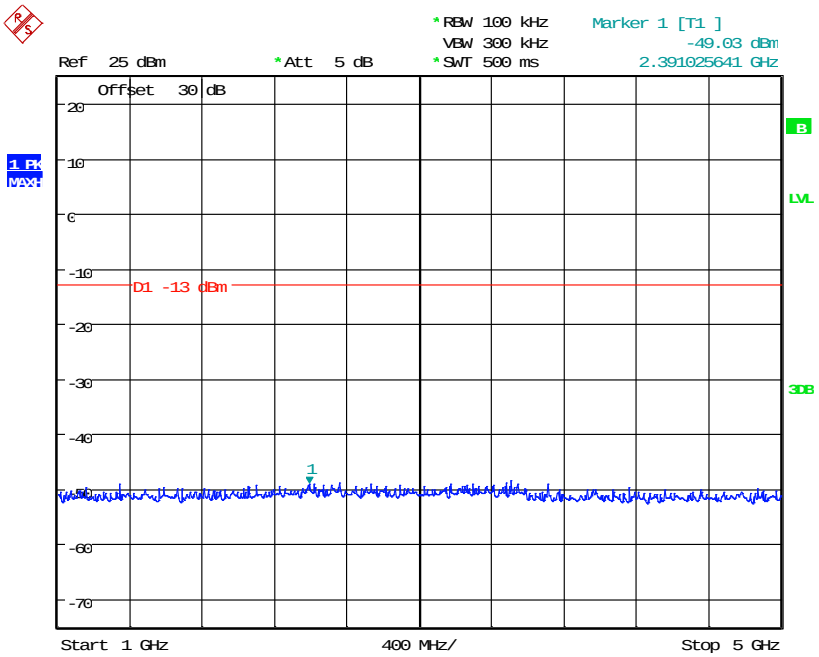
Date: 31.MAR.2014 11:23:14

30MHz – 1GHz



Date: 31.MAR.2014 11:22:18

1GHz – 5GHz



Date: 31.MAR.2014 11:23:40

B6 Noise at Antenna Terminals

Test Details:Uplink	
Measurement standard	90.219(e)(2), 90.219(e)(3)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

Compliance with these levels will be deemed satisfaction of the good engineering practice requirement. In a 10 kHz measurement bandwidth:

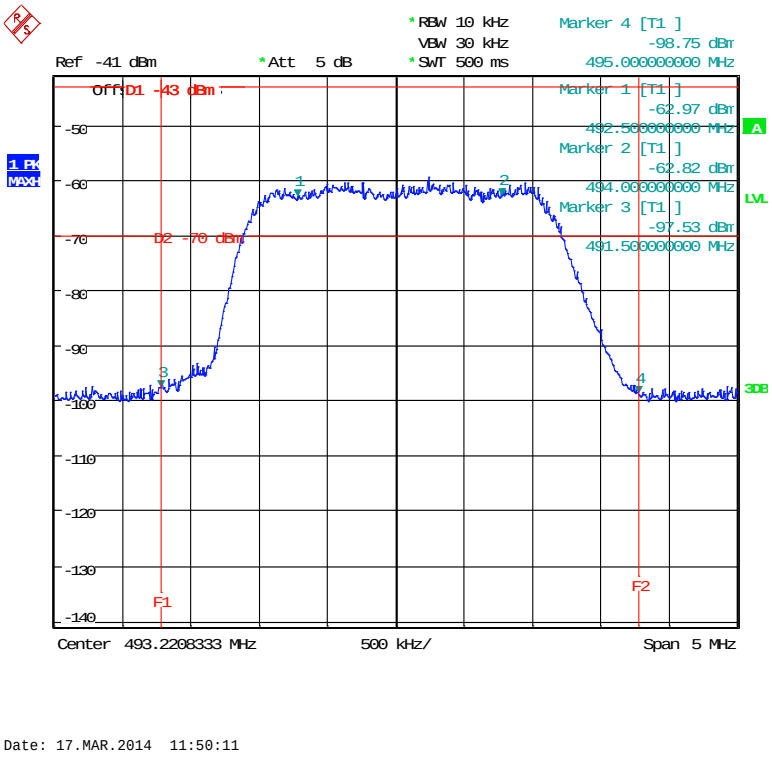
(1) the ERP of noise within the signal booster passband should not exceed –43dBm;

and

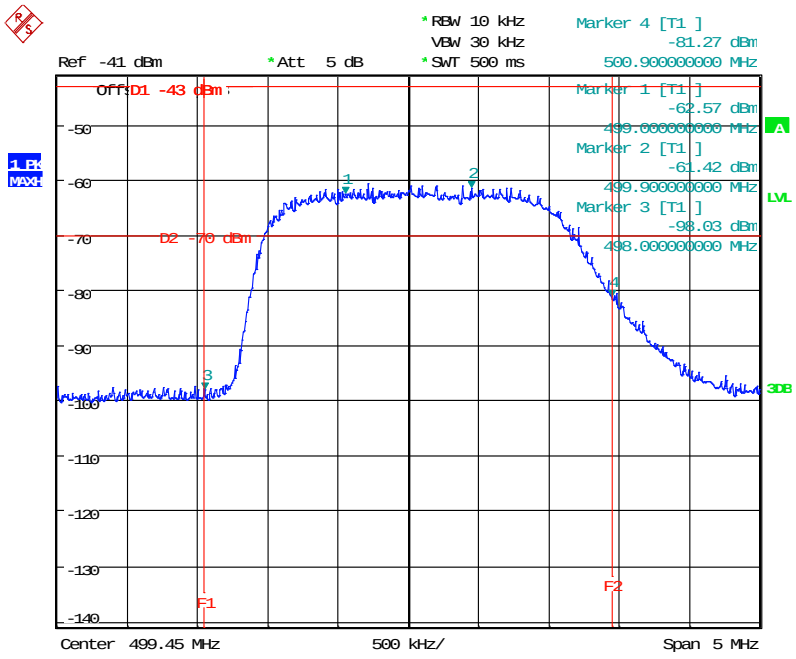
(2) the ERP of noise on spectrum more than 1 MHz outside of the signal booster passband should not exceed –70 dBm.

(3) The noise figure of a signal booster must not exceed 9 dB in either direction

492.5 – 494.0MHz IN BAND AMPLIFIER NOISE

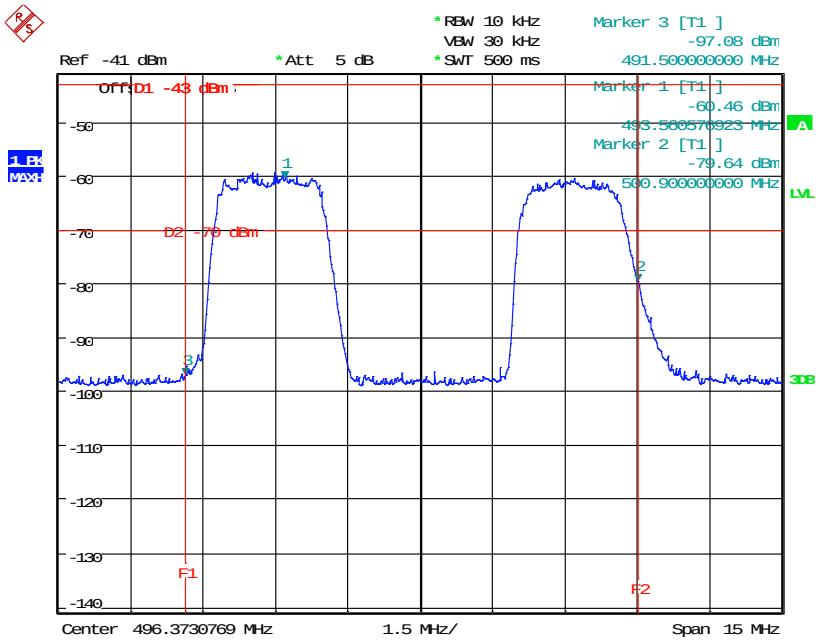


499.0 – 499.9 MHz IN BAND AMPLIFIER NOISE



Date: 17.MAR.2014 11:54:27

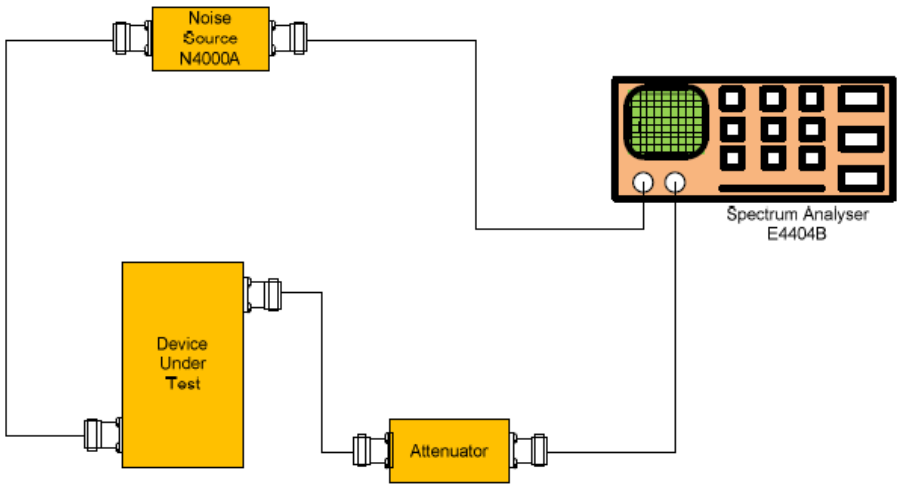
BOTH UPLINK BANDS IN BAND AMPLIFIER NOISE



Date: 17.MAR.2014 12:07:36

Signal booster noise figure

Test equipment set up:-



Result

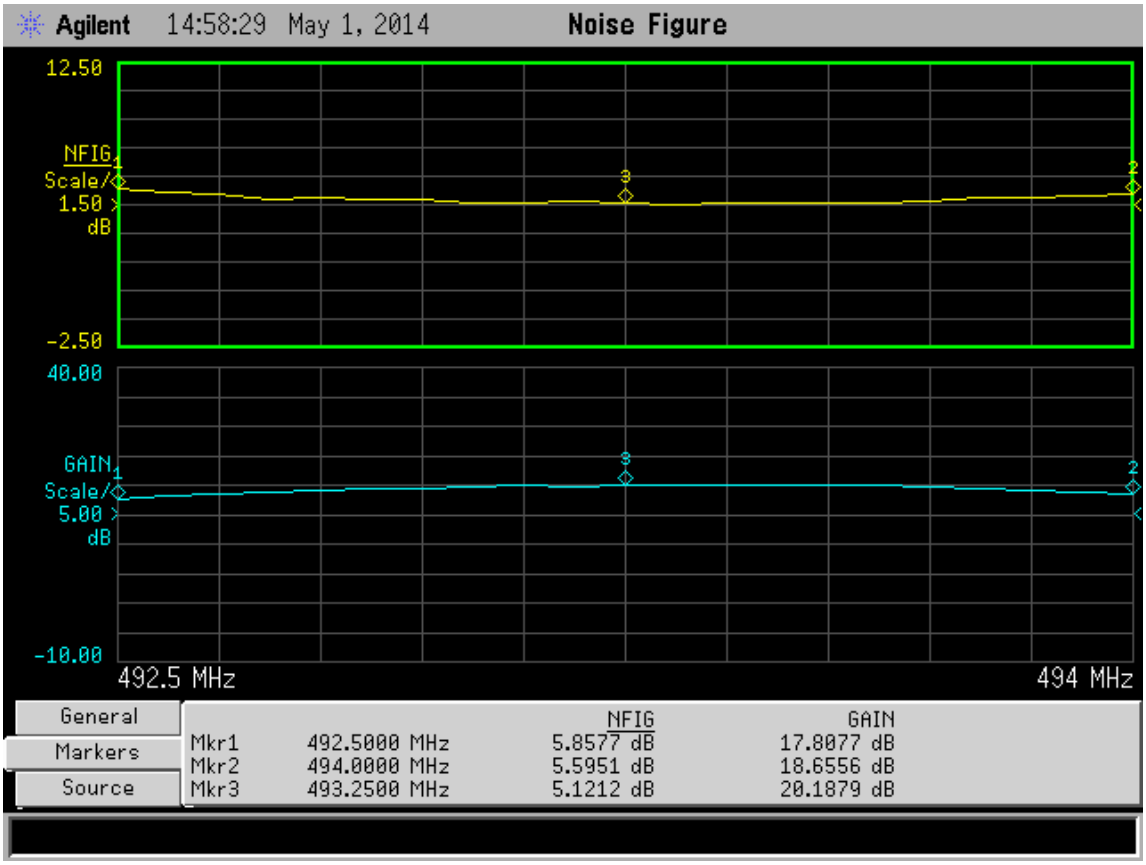
Plots for noise figure, taken with the 18MHz filter applied at maximum gain with 70dB external attenuators in the test set up

Frequency (MHz)	Noise Figure dB
492.5 – 494.0MHz	5.59
499.0 – 499.9 MHz	5.76

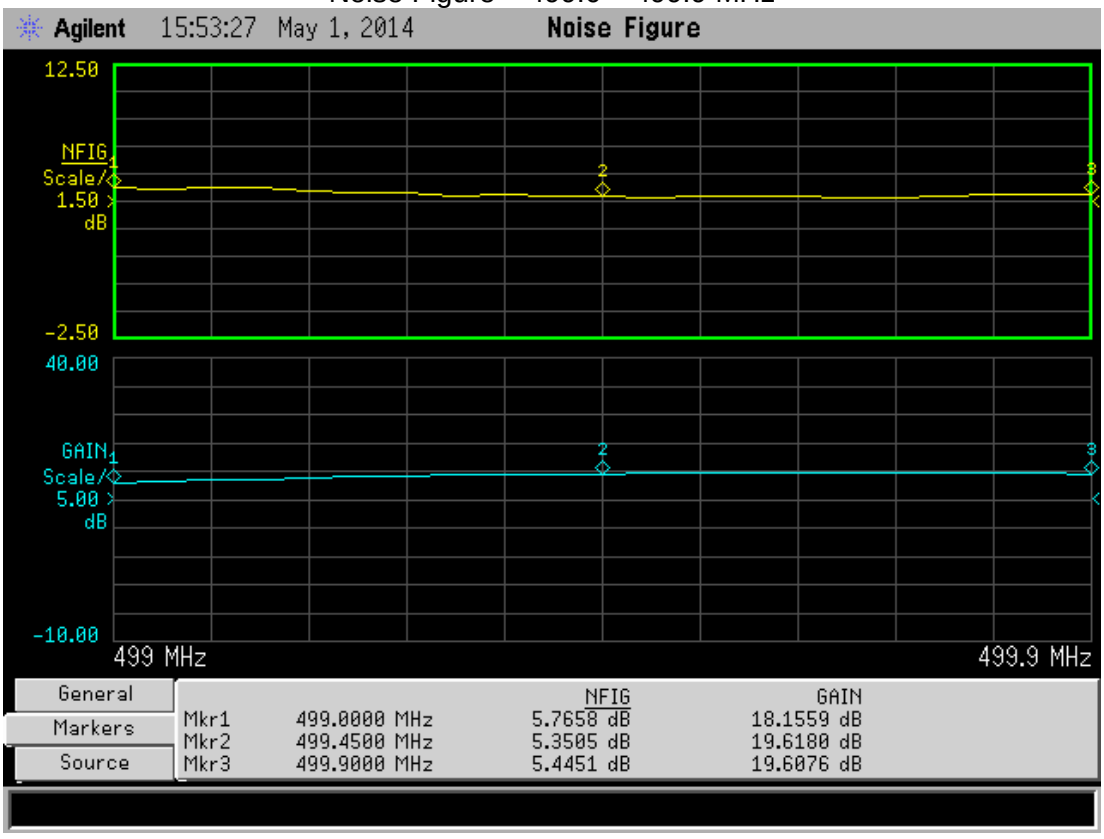
General notes about measurement setup:

1) The spectrum analyser has the noise figure measurement personality enabled.

Noise Figure – 492.5 – 494.0MHz



Noise Figure – 499.0 – 499.9 MHz



B7 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric field emission test applies to all spurious and harmonic emissions . The EUT was set to transmit as required.

The following test site was used for final measurements as specified by the standard tested to:

3m open area test site : [ ] 3m alternative test site : [X]

The effect of the EUT set-up on the measurements is summarised in note (c) below.

Test Details:Uplink	
Measurement standard	Title 47 of the CFR: Part 2.1053, RSS-131 Section 4.3.2
Frequency range	30MHz – 5GHz
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C
Temperature	23°C
Photographs (Appendix F)	1 & 2

Bottom Frequencies 492.5MHz – 499.0MHz

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
30MHz – 5GHz	No significant emissions within 20dB of the limit		-13

Middle Frequencies 493.25MHz – 499.45MHz

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
30MHz – 5GHz	No significant emissions within 20dB of the limit		-13

Top Frequencies 494.0MHz – 499.9MHz

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
30MHz – 5GHz	No significant emissions within 20dB of the limit		-13

Note: The results above are obtained with a bottom, middle, top carrier active in each of the Uplink bands simultaneously.

Result

The EUT was found to comply with the limits

Notes:

1. Emissions Checked up to 10 times Fc.

2. The unit was mounted on a turntable and rotated through 360^0 and in 3 orthogonal planes to find the worst case emission.

3. For Frequencies below 1 GHz, RBW = 120 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

   Peak Detector RBW = 1MHz; VBW = ≥RBW

4. Limit is determined as the outermost step of the emissions mask and is calculated as follows.

   At least 43 + 10 log P dB

   $(10\log P_{watts}) - (43+10\log (P_{watts} * 1000)) =$ LIMIT =-13 dBm

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 2.1057.

(a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation}\,(\text{dB}) = 20\log_{10}\left(\frac{\text{measurement distance}}{\text{specification distance}}\right)$$

(b) The levels may have been rounded for display purposes.

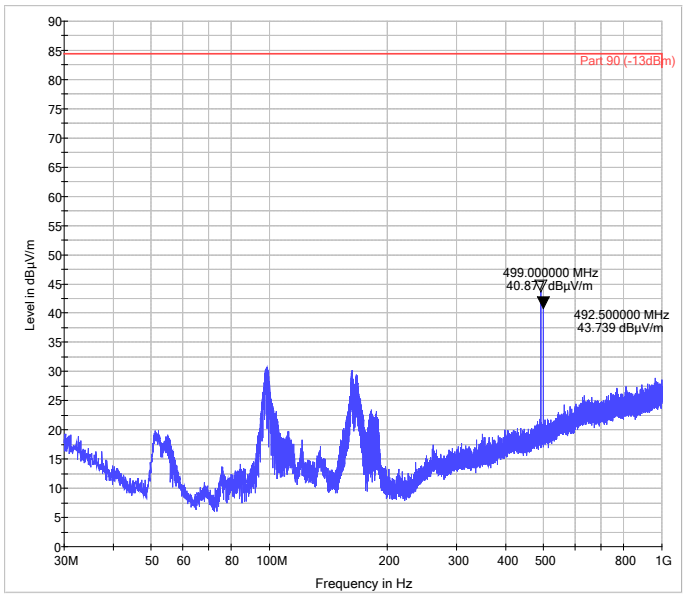
(c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓			
Effect of EUT internal configuration on emission levels	✓			
Effect of Position of EUT cables & samples on emission levels	✓			

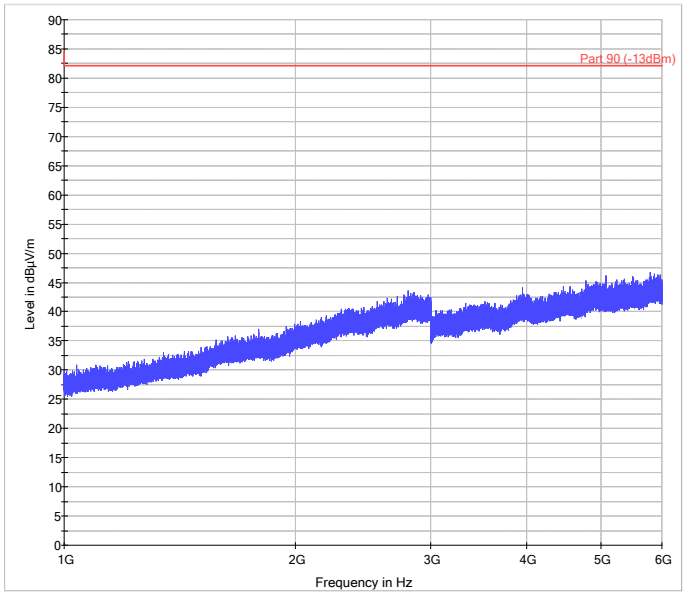
(i) Parameter defined by standard and / or single possible, refer to Appendix D
(ii) Parameter defined by client and / or single possible, refer to Appendix D
(iii) Parameter had a negligible effect on emission levels, refer to Appendix D
(iv) Worst case determined by initial measurement, refer to Appendix D

Radiated Electric Field Emissions Bottom channels

30MHz – 1GHz

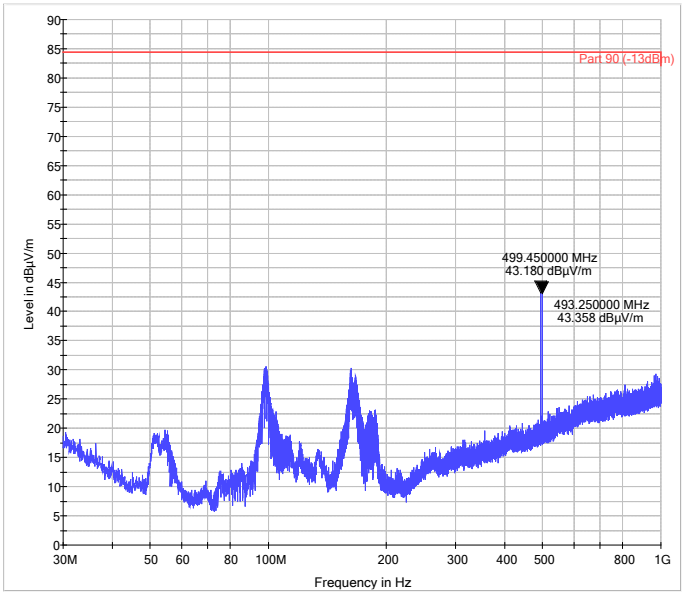


1GHz – 5GHz

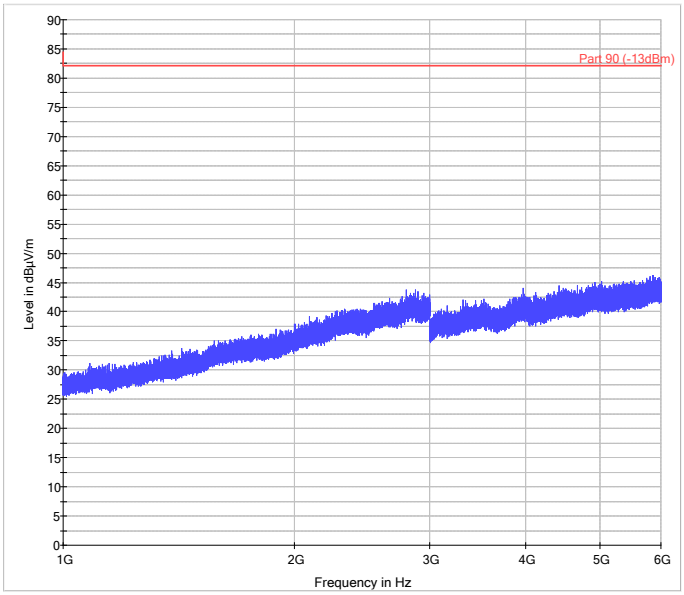


Radiated Electric Field Emissions Middle channels

30MHz – 1GHz

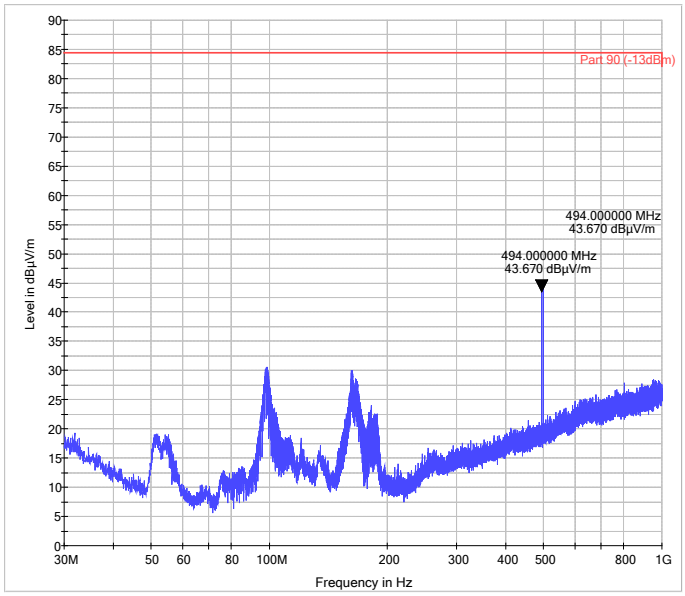


1GHz – 5GHz

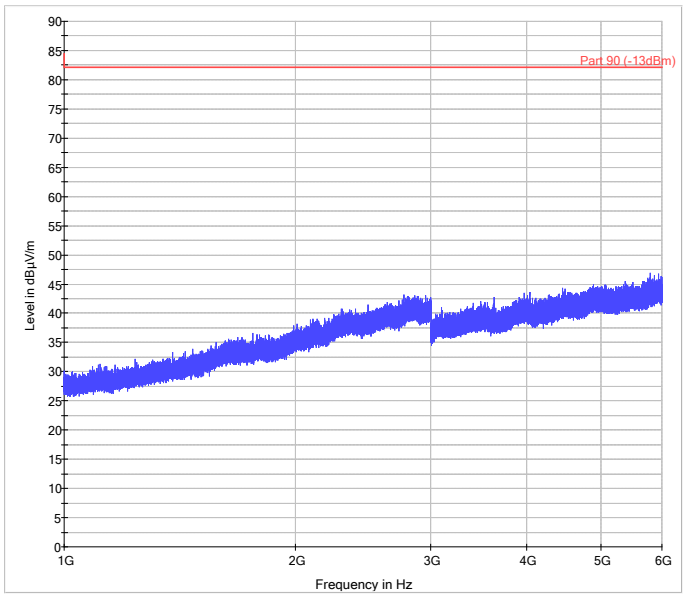


Radiated Electric Field Emissions Top channels

30MHz – 1GHz



1GHz – 5GHz



B8 Passband Gain & Bandwidth

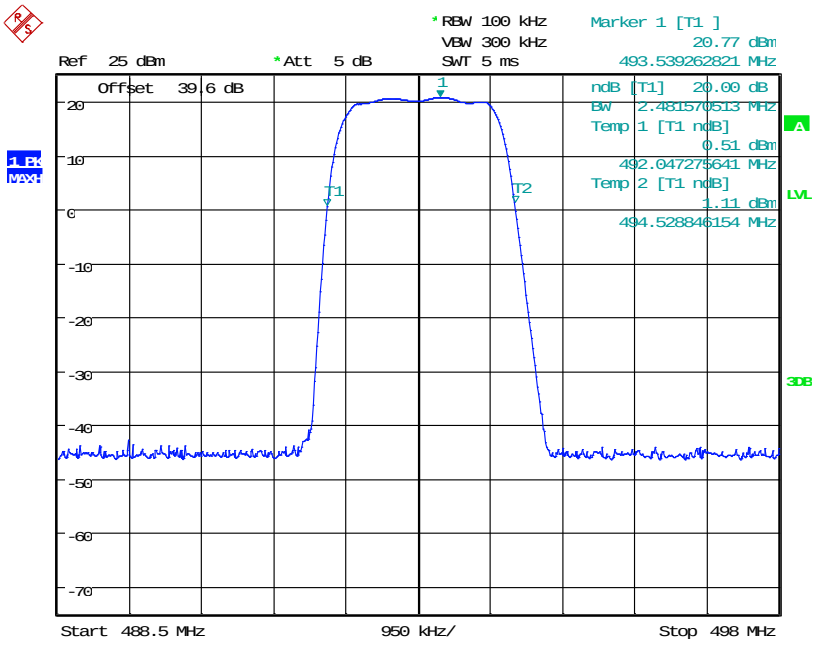
Test Details:Uplink	
Measurement standard	RSS-131 Section 4.2
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C

Frequency MHz	fl	fh	20 dB Bandwidth
492.5 – 494.0MHz	492.047275	494.528846	2.481570

Frequency MHz	fl	fh	20 dB Bandwidth
499.0 – 499.9MHz	498.366666	500.772916	2.406250

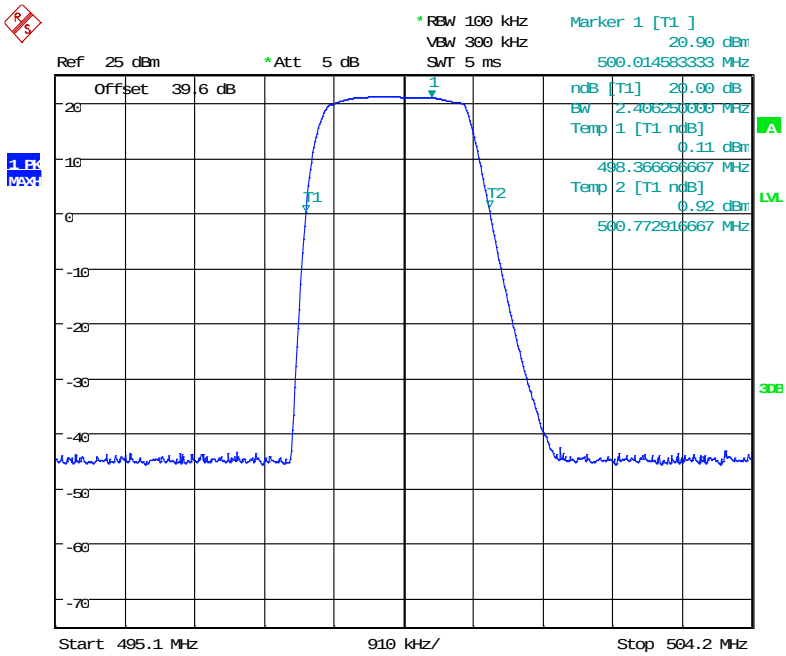
See below for plots showing passband gain & bandwidth

Uplink 492.5 – 494.0MHz



Date: 17.MAR.2014 16:32:36

Uplink 499.0 – 499.9MHz



Date: 17.MAR.2014 16:53:11

Appendix C: Additional Test and Sample Details

This appendix contains details of:

1. The samples submitted for testing.
2. Details of EUT operating mode(s)
3. Details of EUT configuration(s) (see below).
4. EUT arrangement (see below).

Throughout testing, the following numbering system is used to modify the sample and it's modification state:

Sample No: Sxx Mod w

where:

xx = sample number eg. S01
w = modification number eg. Mod 2

The following terminology is used throughout the test report:

Support Equipment (SE) is any additional equipment required to exercise the EUT in the applicable operating mode. Where relevant SE is divided into two categories:

SE in test environment: The SE is positioned in the test environment and is not isolated from the EUT (e.g. on the table top during REFE testing).

SE isolated from the EUT: The SE is isolated via filtering from the EUT. (e.g. equipment placed externally to the ALSR during REFE testing).

EUT configuration refers to the internal set-up of the EUT. It may include for example:

Positioning of cards in a chassis.
Setting of any internal switches.
Circuit board jumper settings.
Alternative internal power supplies.

Where no change in EUT configuration is **possible**, the configuration is described as “single possible configuration”.

EUT arrangement refers to the termination of EUT ports / connection of support equipment, and where relevant, the relative positioning of samples (EUT and SE) in the test environment.

For further details of the test procedures and general test set ups used during testing please refer to the related document "EMC Test Methods - An Overview", which can be supplied by TRaC Global upon request.

C1) Test samples

The following samples of the apparatus were submitted by the client for testing :

Sample No.	Description	
S01	Dual band UHF repeater	55-227901

C2) EUT Operating Mode During Testing.

During testing, the EUT was exercised as described in the following tables :

Test	Description of Operating Mode
All tests detailed in this report	Receiving a signal to ensure EUT is operating a maximum gain and maximum output power.

C3) EUT Configuration Information.

The EUT was submitted for testing in one single possible configuration.

C4) List of EUT Ports

The tables below describe the termination of EUT ports:

Sample : S01
Tests : Conducted

Port	Description of Cable Attached	Cable length	Equipment Connected
	Not applicable , no support equipment connected		

Sample : S01
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
	Not applicable , no support equipment connected		

* Only connected during setup.

C5 Details of Equipment Used

TRaC No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration
UH003	ESHS10	Receiver	R&S	08/05/2013
UH004	ESVS10	Receiver	R&S	27/02/2014
UH028	UHALP 9108	Log Periodic Ant	Schwarbeck	08/07/2013
UH029	VHBA 9123	Bicone Antenna	Schwarbeck	19/08/2013
UH093	CBL6112B	Bilog	Chase	08/07/2013
UH096	6960B	Power meter	Marconi	16/12/2013
UH122	TDS520B	Oscilloscope	Tektronix	11/04/2012
UH129	6924	Power Sensor	Marconi	16/12/2013
UH187	ESHS10	Receiver	R&S	19/02/2014
UH191	CBL611/A	Bilog	Chase	13/12/2012
UH195	ESH3-Z5.831.5	Lisn	R&S	03/07/2013
UH228	6920	Power Sensor	Marconi	16/12/2013
UH281	FSU46	Spectrum Analyser	R&S	26/03/2014
UH287	6920	30 dB reference Attenuator	HP	16/12/2013
UH385	HL 050	Log Periodic Antenna	R&S	16/07/2012
UH387	ATS	Chamber 1	Rainford EMC	04/07/2013
UH388	ATS	Chamber 2	Rainford EMC	04/07/2013
UH396	ENV216	Lisn	R&S	30/04/2013
UH403	ESCI 7	Recevier	R&S	12/08/2013
UH405	FSU26	Spectrum Analyser	R&S	20/03/2013
UH420	CBL6112	Bilog	Chase	06/07/2012
L005	CMTA52	Communications Analyser	R&S	02/12/2013
L007	hfh2	Loop Antenna	R&S	17/10/2013
L138	3115	1-18GHz Horn	EMCO	17/10/2013
L139	3115	1-18GHz Horn	EMCO	20/09/2013
L176	2042	Signal Generator	Marconi	29/11/2013
L254	2042	Signal Generator	Marconi	08/01/2014
L193	VHA 9103 balu	Bicone Antenna	Chase	19/06/2012
L203	UPA6108	Log Periodic Ant	Chase	19/06/2012
L290	CBL611/A	Bilog	Chase	13/12/2012
L300	20240-20	Horn 18-26GHz (&UH330)	Flann	10/02/2014
L317	ESVS10	Receiver	R&S	12/02/2014
L352	ESVS10	Receiver	R&S	21/03/2014
L426	52 Series II	Temperature Indicator	Fluke	29/04/2013
L572	8449B	Pre Amp	Agilent	12/12/2012
REF909	FSU26	Spectrum Analyser	R&S	12/02/2014
REF916	SMBV100A	Signal Generator	R&S	19/02/2014
REF940	ATS	Radio Chamber - PP	Rainford EMC	09/07/2013
REF976	34405a	Multimeter	Agilent	26/04/2013
REF977	SH4141	High Pass Filter	BSC	25/02/2013

Appendix D: **Additional Information**

Compliance with FCC

Part 90 Signal Boosters

WARNING. This is **NOT** a **CONSUMER** device. It is designed for installation by **FCC LICENSEES** and **QUALIFIED INSTALLERS**. You **MUST** have an **FCC LICENSE** or express consent of an FCC Licensee to operate this device. You **MUST** register Class B signal boosters (as defined in 47 CFR 90.219) online at **www.fcc.gov/signal-boosters/registration**. Unauthorized use may result in significant forfeiture penalties, including penalties in excess of $100,000 for each continuing violation.

FCC Part 15

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

If not installed and used in accordance with the instructions, this equipment generates, uses and can radiate radio frequency energy. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to RF reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Ensure that the input levels to the BDA are correct and that the equipment gain is not excessive.

Isolate or Relocate the Server Radiating antenna cable.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Unauthorized Changes to Equipment

Changes or Modifications not expressly approved by the manufacturer responsible for compliance could void the user's authority to operate the equipment

FCC RF Exposure Limits

This unit complies with FCC RF exposure limits for an uncontrolled environment. This equipment can only be installed in in-building or tunnel applications and must be used as a line driver amplifier to drive radiating cable systems. There are no antennas used for the radiation, Radiating cables have a low level of coupling an as such the RF exposure is extremely low. As a precaution it is recommended that the radiating cable is operated at a minimum distance of 10 cm between the cable radiator and any person's body.

Radiating Antenna Installation

CAUTION! This Equipment is designed as an in-line Radiating Cable booster and must not be used as a Class B Off Air repeater.

Installation of a radiating cable antenna must comply with the FCC RF exposure requirements. The radiating cable used for this transmitter must be mounted on permanent structures.

The FCC regulations mandate that the EIRP of type B signal boosters should not exceed 5W.

The radiating cable associated with In-Line Boosters has a high attenuation of coupling and as such a negative gain. The BDA has a maximum amplifier P1dB of +37dBm (5w), the radiating cable is typically -50dB radiating loss and therefore provides a maximum EIRP of -13dbm.

Equation (1) - Max SERVICE antenna gain

Not Applicable – Radiating cable fed equipment.

Equation (2) - Max DONOR antenna gain

Not Applicable – Radiating cable fed equipment

Compliance with FCC deployment rule regarding the radiation of noise

Good engineering practice must be used in regard to the signal booster's noise radiation. Thus, the gain of the signal booster should be set so that the EIRP of the output noise from the signal booster should not exceed the level of -43 dBm in 10 kHz measurement bandwidth.

In the event that the noise level measured exceeds the aforementioned value, the signal booster gain should be decreased accordingly.

In general, the ERP of noise on a spectrum more than 1 MHz outside of the pass band should not exceed -70 dBm in a 10 kHz measurement bandwidth.

The WMATA Line Amplifier (55-227901) signal booster has a noise level of below -90 dBm in 10 kHz measurement at 1 MHz spectrum outside the passband of the signal booster and an *in-band* noise level of -60 dBm (worst case) in a 10 kHz bandwidth.

Conclusion:

Good engineering practice requires that in general when the out of band noise measured at the service antenna input is more than -70 dBm per 10 kHz measurement bandwidth, an external band pass filter should be added to attenuate the out of band noise level. However, in this application using radiating cables, No further filtering will be required because of the cable coupling attenuation.

1.2 Service Antenna Requirements

WARNING!!!

a. The installer is held accountable for implementing the rules required for deployment.
b. Good engineering practice must be used to avoid interference.
c. Output power should be reduced to solve any IMD interference issues"

This product is designed as an in-line amplifier repeater to extend the signal coverage distance of a radiating cable system and must not be used as an off air repeater.

1.2.1 Required Radiating Antenna Information

The following antenna requirements, specifications and site considerations should be met:

- Service area type and size
- Radiating Cable Coupling factor and longitudinal Attenuation
- Distance from Mobile

Mobile Signal = BDA Output – cable attenuation dB/100ft – cable coupling dB – distance correction.
e.g. Typical 7/8" cable = loss 0.7dB / 100' with Coupling Loss 80dB @ 6'

Thus for an 800' cable with +10dBm input we have:
+10 – (0.7*8) – 80 = -75.6dBm radiated signal from the cable at 6' distance.

1.3 RF Cabling Requirements

- For all coaxial connections to/from the Repeater - high performance, flexible, low loss 50Ω coaxial communications cable.
- All cables shall be weather-resistant type.
- Make sure that cable and connector are compatible. Using cables and connectors from the same manufacturer is helpful.
- All connectors must be clean and dry
- Waterproof all outdoor connections using silicone, vulcanizable tape or other suitable substance as moisture and dust can impair RF characteristics.
- Make sure enough room has been allocated for the bending radius of the cable. RF cables must not be kinked, cut or damaged in any way
- Use jumper cable for easy installation. The RF Coaxial cable can be substituted at each end with a jumper cable.

Appendix F: **Photographs and Figures**

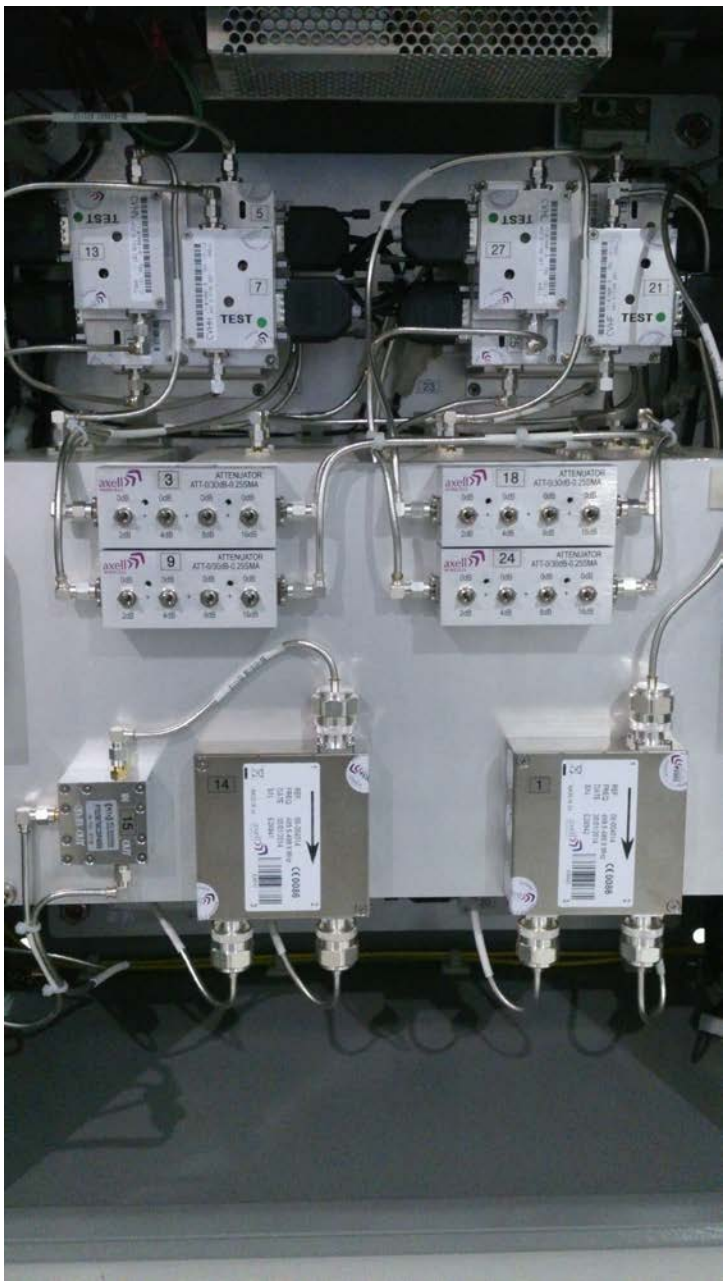
The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement
2. Radiated electric field emissions arrangement
3. Internal overview

Photograph 1

Photograph 2

Photograph 3



TRAC
testing regulatory and compliance