

**A RADIO TEST REPORT**

**FOR**

**AXELL WIRELESS**

**ON**

**BSR-3308**

**DOCUMENT NO. TRA-014965-47-00-D**

**HULL**

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**TRaC Wireless Test Report** : TRA-014965-47-00-D

**Applicant** : Axell Wireless

**Apparatus** : BSR-3308

**Specification(s)** : CFR47 Part 90, Part 20 & RSS-131

**Purpose of Test** : Certification

**FCCID** : NEOBSR3308PS

**Certification Number** : 8749A-BSR3308PS

**Authorised by** :



: Radio Product Manager

**Issue Date** : 8<sup>th</sup> April 2014

**Authorised Copy Number** : PDF

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**Section 1:****Introduction****4.3 General**

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

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## **1.2 Tests Requested By**

This testing in this report was requested by :

Aerial House  
Asheridge Road  
Chesham  
Buckinghamshire  
HP5 1TU

## **1.3 Manufacturer**

Aerial House  
Asheridge Road  
Chesham  
Buckinghamshire  
HP5 1TU

## **1.4 Apparatus Assessed**

The following apparatus was assessed between 15<sup>th</sup> – 18<sup>th</sup> July 2013:

BSR-3308

The Axell BSR 3308 NFPA is a band-selective mini-repeater that supports the 800MHz band. The repeater is specifically designed for the operation of ESMR 800 MHz and is band selectable in the 800 MHz range [3 MHz, 10 MHz or 18 MHz bandwidth].

The BSR utilises a distributed antenna system (DAS).

Typically DAS systems are used for in building / tunnel distribution of signals.

## 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(d)(3)                   | 4.3               | A1 & B1            | Pass   |
| Intermodulation Spurious Emissions                        | 90.219(d)(6)                   | N/A               | A2 & B2            | Pass   |
| Occupied Bandwidth & Modulation                           | 90.219(4)(e)(iii)<br>90.210(h) | N/A               | A3 & B3            | Pass   |
| Spurious Emissions at Antenna Terminals Less than 1MHz    | 90.219(d)(3)<br>90.210(h)      | N/A               | A4 & B4            | Pass   |
| Spurious Emissions at Antenna Terminals Greater than 1MHz | 90.219(d)(3)                   | N/A               | A5 & B5            | Pass   |
| Noise At Antenna Terminals                                | 90.219(d)(6)<br>90.219(e)(2)   | N/A               | A6 & B6            | Pass   |
| Field Strength of Spurious Emissions                      | 90.219(d)(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                     | 20.21(f)(1)(ii)                | 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  
 REFE : Radiated Electric Field Emissions  
 A Uplink Results Appendix

ANSI : American National Standards Institution  
 PLCE : Power Line Conducted Emissions  
 B Downlink Results Appendix

## 1.6 Equipment Test Conditions

|                                                                                        |                              |                                                                              |
|----------------------------------------------------------------------------------------|------------------------------|------------------------------------------------------------------------------|
| Product class:                                                                         | Uplink                       | Class A <input type="checkbox"/> Class B <input checked="" type="checkbox"/> |
|                                                                                        | Downlink                     | Class A <input type="checkbox"/> Class B <input checked="" type="checkbox"/> |
|                                                                                        |                              |                                                                              |
| Product Use:                                                                           | Private Land Mobile Repeater |                                                                              |
|                                                                                        |                              |                                                                              |
| Supply Voltages:                                                                       | Vnom                         | +230Vac/110Vac                                                               |
| Note: Vnom voltages are as stated above unless otherwise shown on the test report page |                              |                                                                              |
|                                                                                        |                              |                                                                              |
| Equipment Category:                                                                    | Single channel               | <input type="checkbox"/>                                                     |
|                                                                                        | Two channel                  | <input type="checkbox"/>                                                     |
|                                                                                        | Multi-channel                | <input checked="" type="checkbox"/>                                          |
|                                                                                        |                              |                                                                              |
| Channel spacing:                                                                       | Wideband                     | Uplink                                                                       |
|                                                                                        | Wideband                     | Downlink                                                                     |
|                                                                                        |                              |                                                                              |
| Test Location                                                                          | TRaC Global                  |                                                                              |
|                                                                                        | Skelmersdale                 | <input checked="" type="checkbox"/>                                          |
|                                                                                        | Hull                         | <input type="checkbox"/>                                                     |
|                                                                                        | Other                        | <input type="checkbox"/> Please Specify                                      |

## 1.7 Standard References

|            |                                                                                                                                                                                         |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 47 CFR 2   | Code of Federal Regulations, Title 47, Part 2, "Frequency allocations and Radio Telemetry Matters;<br>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"<br>Subpart B, "Unintentional Radiators"                                                                        |
| C63.4-2003 | American National Standards Institute (ANSI), "Methods of Measurement of<br>Radio Noise Emissions from Low Voltage Electrical and Electronic<br>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<br>Apparatus                                                                                                        |



## **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 identified 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 %    |
| Barometric Pressure | : 86 to 106 kPa |

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 in accordance with note (iii) of Section 2.1 the following measurement uncertainty was calculated:

**Radio Testing – General Uncertainty Schedule**

*All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95% confidence where no required test level exists.*

**[1] Adjacent Channel Power**

Uncertainty in test result = **1.86dB**

**[2] Carrier Power**

Uncertainty in test result (Power Meter) = **1.08dB**

Uncertainty in test result (Spectrum Analyser) = **2.48dB**

**[3] Effective Radiated Power**

Uncertainty in test result = **4.71dB**

**[4] Spurious Emissions**

Uncertainty in test result = **4.75dB**

**[5] Maximum frequency error**

Uncertainty in test result (Frequency Counter) = **0.113ppm**

Uncertainty in test result (Spectrum Analyser) = **0.265ppm**

**[6] Radiated Emissions, field strength OATS 14kHz-18GHz Electric Field**

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**,

Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,

Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

**[7] Frequency deviation**

Uncertainty in test result = **3.2%**

**[8] Magnetic Field Emissions**

Uncertainty in test result = **2.3dB**

**[9] Conducted Spurious**

Uncertainty in test result – Up to 8.1GHz = **3.31dB**

Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**

Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**

Uncertainty in test result – Up to 26GHz = **3.14dB**

**[10] Channel Bandwidth**

Uncertainty in test result = **15.5%**

**[11] Amplitude and Time Measurement – Oscilloscope**

Uncertainty in overall test level = **2.1dB**,  
Uncertainty in time measurement = **0.59%**,  
Uncertainty in Amplitude measurement = **0.82%**

**[12] Power Line Conduction**

Uncertainty in test result = **3.4dB**

**[13] Spectrum Mask Measurements**

Uncertainty in test result = **2.59% (frequency)**  
Uncertainty in test result = **1.32dB (amplitude)**

**[14] Adjacent Sub Band Selectivity**

Uncertainty in test result = **1.24dB**

**[15] Receiver Blocking – Listen Mode, Radiated**

Uncertainty in test result = **3.42dB**

**[16] Receiver Blocking – Talk Mode, Radiated**

Uncertainty in test result = **3.36dB**

**[17] Receiver Blocking – Talk Mode, Conducted**

Uncertainty in test result = **1.24dB**

**[18] Receiver Threshold**

Uncertainty in test result = **3.23dB**

**[19] Transmission Time Measurement**

Uncertainty in test result = **7.98%**

## **Section 3:**

## **Modifications**

### **3.1 Modifications Performed During Assessment**

No modifications were performed during the assessment

**Appendix A:****Uplink Formal Emission Test Results**

Abbreviations used in the tables in this appendix:

|      |                                 |      |                                |
|------|---------------------------------|------|--------------------------------|
| Spec | : Specification                 | ALSR | : Absorber Lined Screened Room |
| Mod  | : Modification                  | OATS | : Open Area Test Site          |
|      |                                 | ATS  | : Alternative Test Site        |
| EUT  | : Equipment Under Test          |      |                                |
| SE   | : Support Equipment             | Ref  | : Reference                    |
|      |                                 | Freq | : Frequency                    |
| L    | : Live Power Line               |      |                                |
| N    | : Neutral Power Line            | MD   | : Measurement Distance         |
| E    | : Earth Power Line              | SD   | : Spec Distance                |
|      |                                 |      |                                |
| Pk   | : Peak Detector                 | Pol  | : Polarisation                 |
| QP   | : Quasi-Peak Detector           | H    | : Horizontal Polarisation      |
| Av   | : Average Detector              | V    | : Vertical Polarisation        |
|      |                                 |      |                                |
| CDN  | : Coupling & decoupling network |      |                                |

## A1 RF Gain and Output Power

| Test Details:          |                                                    |
|------------------------|----------------------------------------------------|
| Measurement standard   | Part 2.1046, Part 90.219(d)(3),RSS-131 Section 4.3 |
| EUT sample number      | S01                                                |
| Modification state     | 0                                                  |
| SE in test environment | None                                               |
| SE isolated from EUT   | None                                               |
| Temperature (°C)       | 22                                                 |
| Humidity (%)           | 48                                                 |
| 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 |
|---------------|----------------------------------|---------------------|--------------------------------|-----------------------------------|---------|----------------------------|-----------------------------------------|
| 806.0         | -58.50                           | 0.50                | -10.47                         | 36.7                              | 85.23   | 26.23                      | 75.81                                   |
| 815.0         | -55.00                           | 0.50                | -9.69                          | 36.7                              | 82.51   | 27.01                      | 72.75                                   |
| 824.0         | -57.00                           | 0.50                | -10.33                         | 36.7                              | 83.87   | 26.37                      | 74.21                                   |

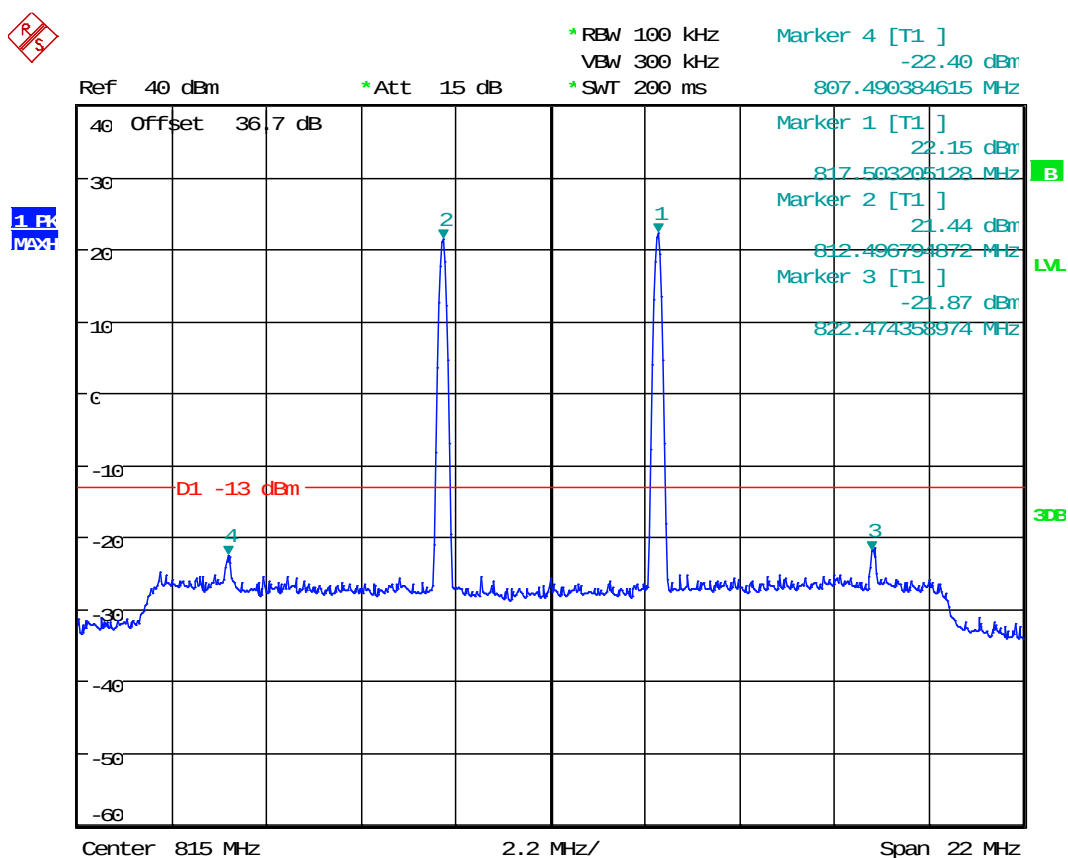
Notes: 1.The signal generator input was increased by 10dBs and the level of the output signal remeasured.

As per Annex A clause 11 of KDB 935210 D02 Signal Boosters Certification v01r01 the EUT was tested at compression and 10dB into compression to show AGC operation

| Frequency      | Frequency (MHz) | P <sub>o</sub>  | Level at Spectrum Analyser (dBm) | Output Cable & Attenuator loss (dB) | Power At Output Point (dBm) |
|----------------|-----------------|-----------------|----------------------------------|-------------------------------------|-----------------------------|
| f <sub>1</sub> | 812.5           | P <sub>01</sub> | -15.26                           | 36.7                                | 21.44                       |
| f <sub>2</sub> | 817.5           | P <sub>02</sub> | -14.55                           | 36.7                                | 22.15                       |
| f <sub>3</sub> | 807.5           | P <sub>03</sub> | -59.10                           | 36.7                                | -22.40                      |
| f <sub>4</sub> | 822.5           | P <sub>04</sub> | -58.57                           | 36.7                                | -21.87                      |

$$P_{\text{mean}} = P_{01} + 3\text{dB}$$

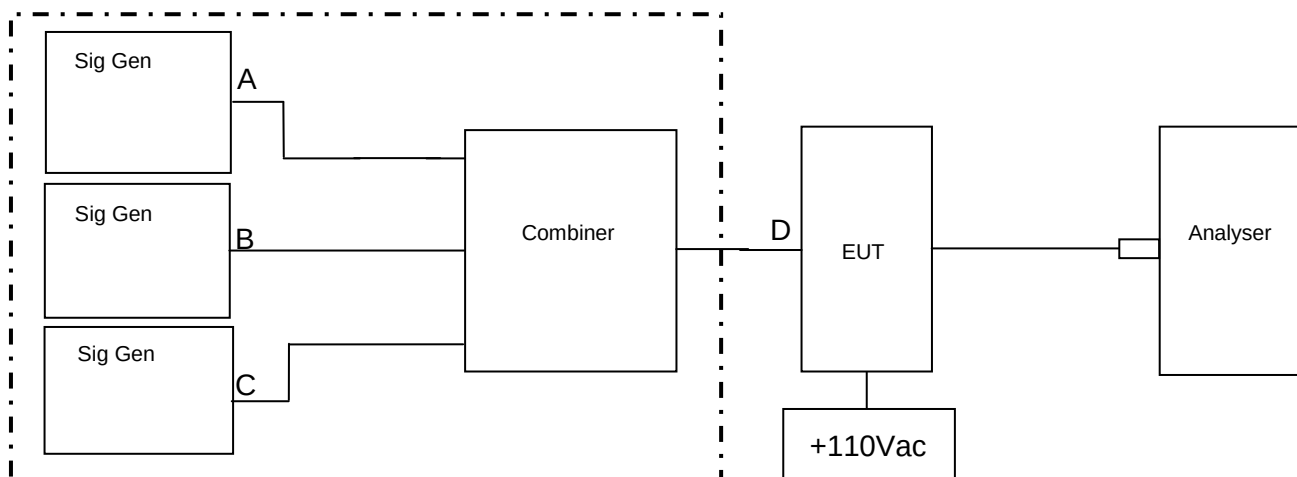
|                       |                       |                         |
|-----------------------|-----------------------|-------------------------|
| P <sub>01</sub> (dBm) | P <sub>mean</sub>     | P <sub>mean</sub> (dBm) |
| 22.15                 | P <sub>01</sub> + 3dB | 25.15                   |



Date: 16.JUL.2013 17:24:03

**A2 Amplifier Intermodulation Spurious Emissions**

| Test Details:          |                           |
|------------------------|---------------------------|
| Measurement standard   | Part 2.1053, 90.219(d)(6) |
| EUT sample number      | S01                       |
| Modification state     | 0                         |
| SE in test environment | None                      |
| SE isolated from EUT   | None                      |
| EUT set up             | Refer to Appendix C       |



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

| RF Input Frequency (MHz) |       |       | Highest Intermodulation Product Level (dBm) | Limit (dBm) |
|--------------------------|-------|-------|---------------------------------------------|-------------|
| 806.0                    | 812.0 | 824.0 | -24.46 dBm @ 818 MHz                        | -13         |

Sweep data is shown on the next page:

**Results**

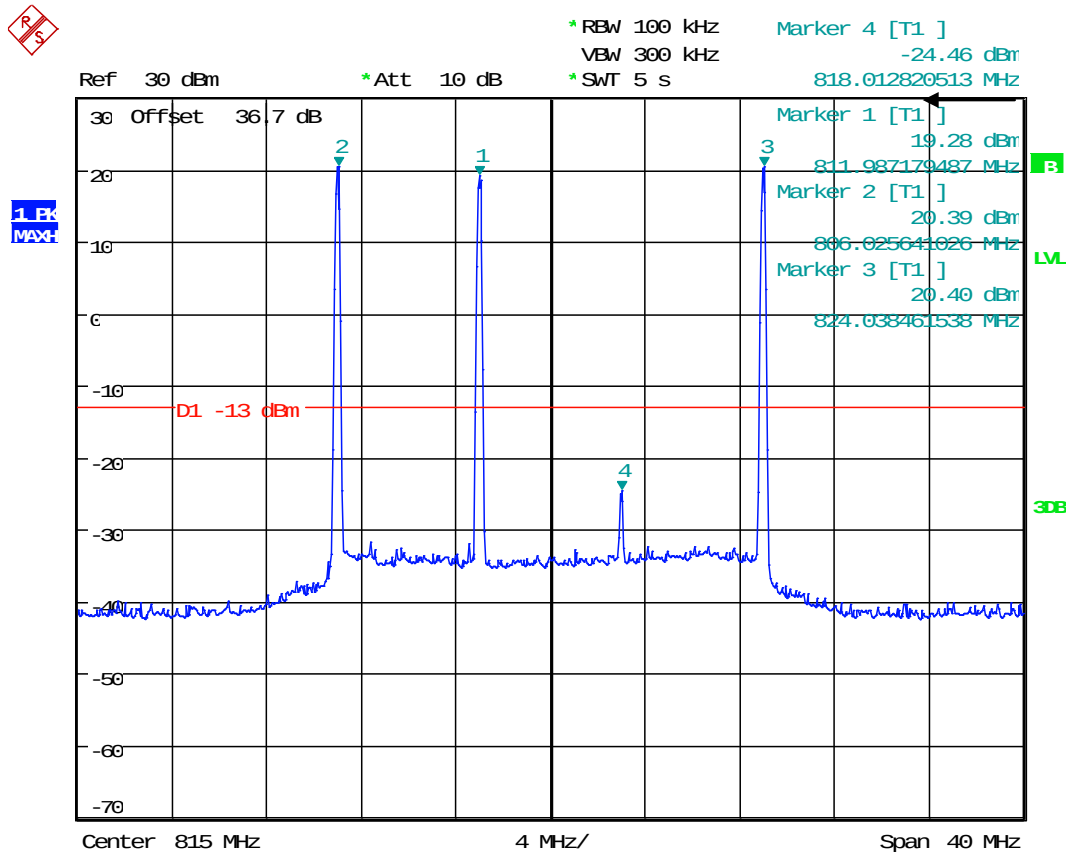
The EUT was found to comply with the limits

See plots below

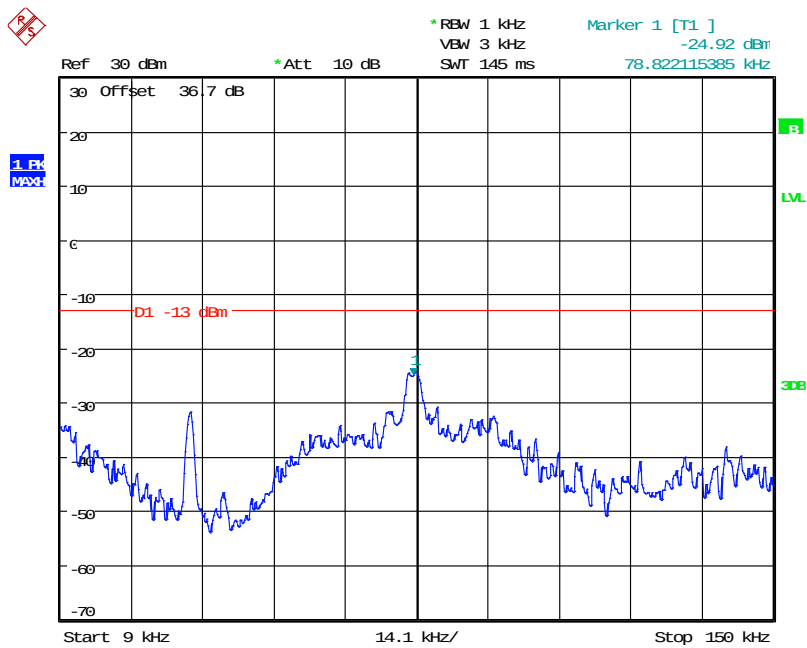
As per Annex A clause 11 of KDB 935210 D02 Signal Boosters Certification v01r01 the EUT was tested at compression and 10dB into compression to show AGC operation, worst case results taken.



# Intermodulation close View

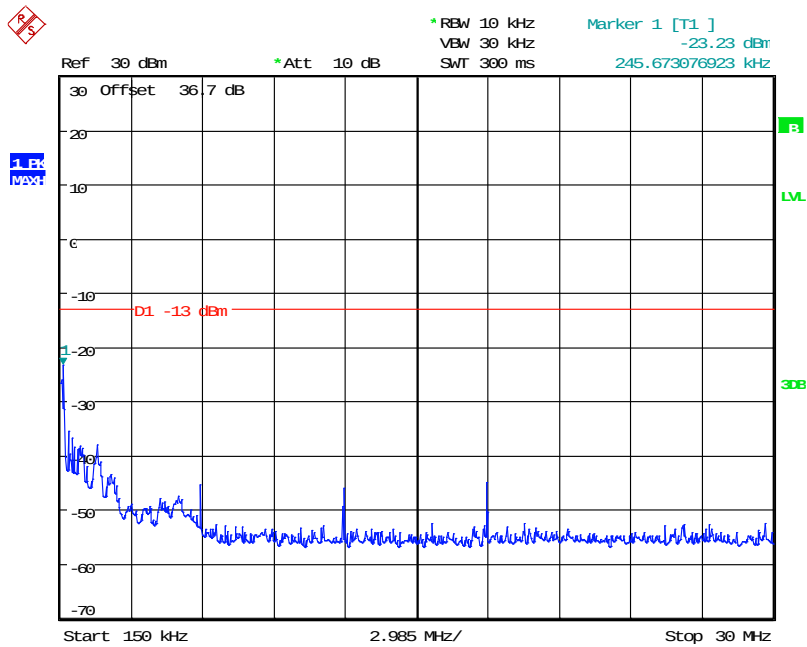


Date: 16.JUL.2013 09:52:19



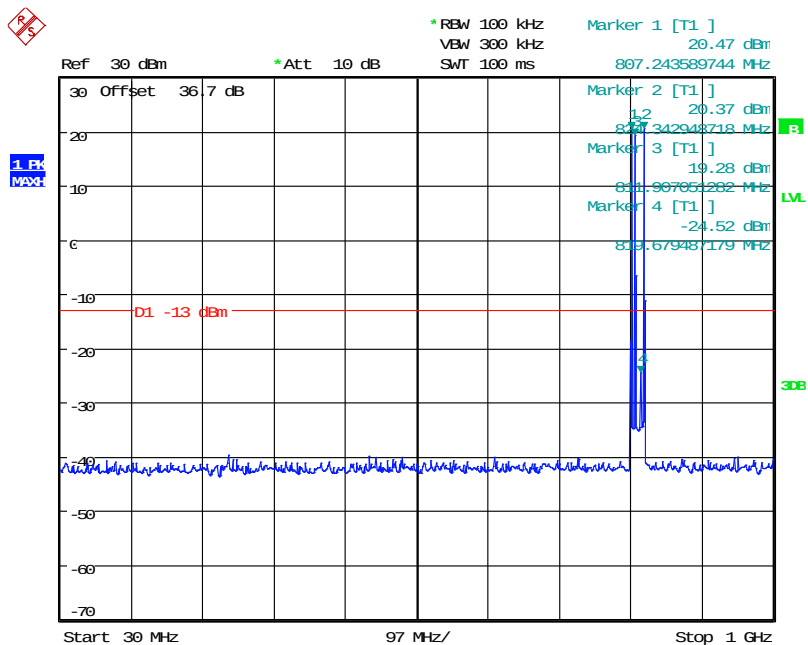
Date: 16.JUL.2013 09:53:44

9-150kHz



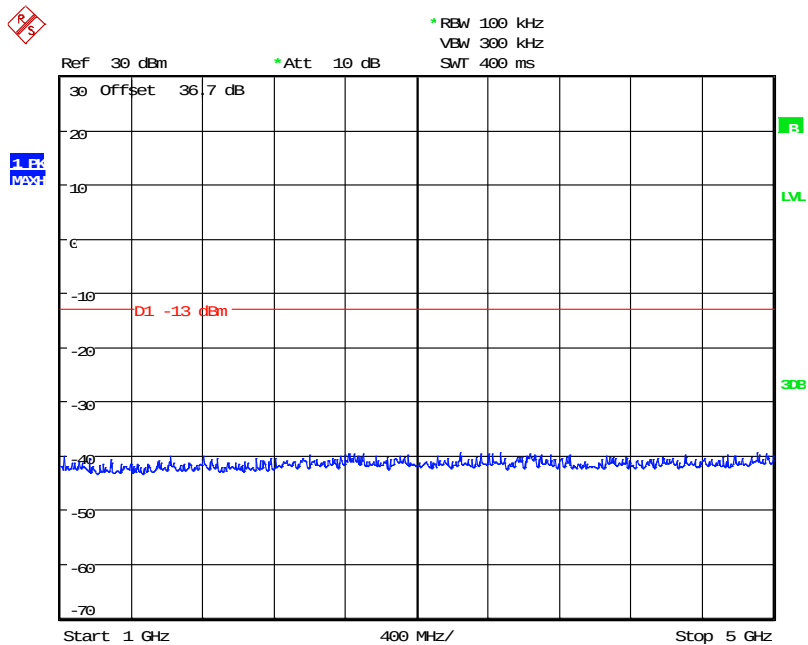
Date: 16.JUL.2013 09:54:13

150kHz – 30MHz



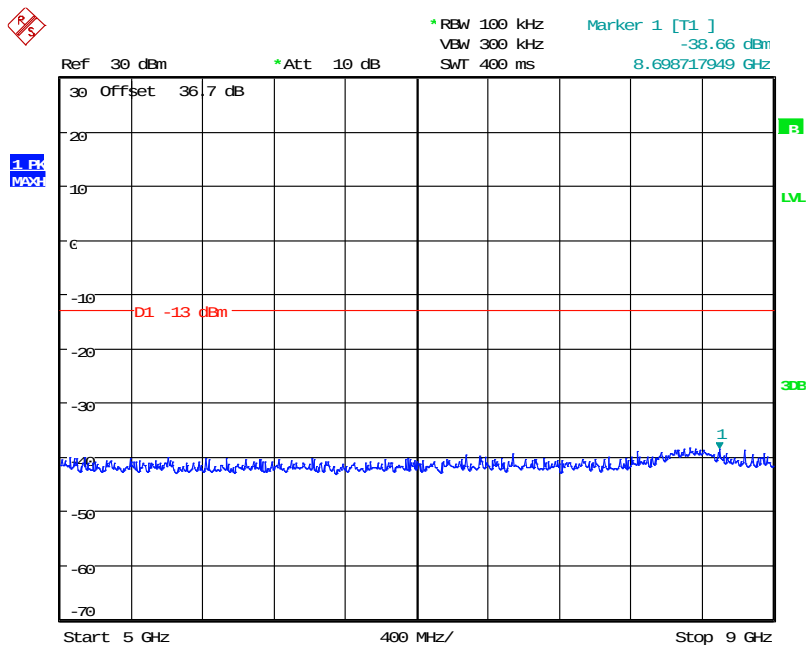
Date: 16.JUL.2013 09:53:02

30MHz – 1GHz



Date: 16.JUL.2013 09:53:17

1GHz – 5GHz



Date: 16.JUL.2013 09:53:28

5GHz – 9GHz

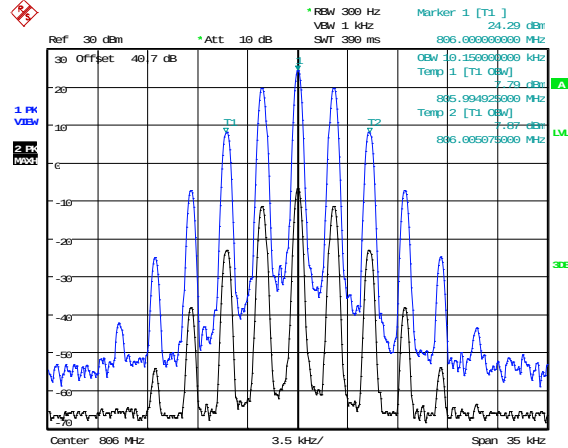
**A3 Amplifier Modulated Channel Test**

| Test Details:          |                                                |
|------------------------|------------------------------------------------|
| Measurement standard   | Part 2.1049, Part 90.219(4)(e)(iii), 90.210(h) |
| EUT sample number      | S01                                            |
| Modification state     | 0                                              |
| SE in test environment | None                                           |
| SE isolated from EUT   | None                                           |
| EUT set up             | Refer to Appendix C                            |

| Modulation Type | Frequency Of Operation Channel |           |           |
|-----------------|--------------------------------|-----------|-----------|
|                 | 806.0                          | 815.0     | 824.0     |
| Analogue        | 10.15 kHz                      | 10.15 kHz | 10.15 kHz |
| C4FM            | 8.74 kHz                       | 8.74 kHz  | 8.74 kHz  |
| P25             | 20.99 kHz                      | 20.99 kHz | 20.91 kHz |
| iDEN            | 28.85 kHz                      | 28.85 kHz | 29.01 kHz |

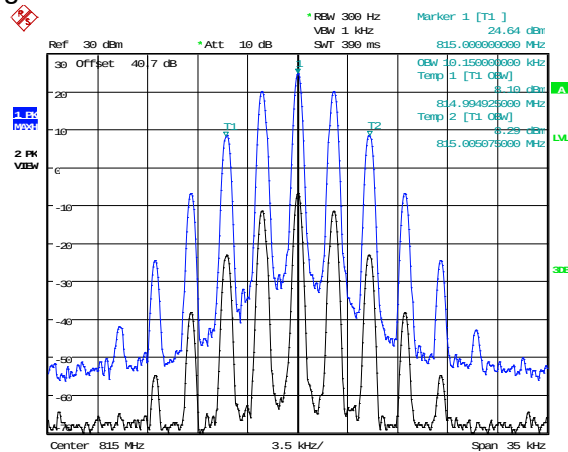
As per Annex A clause 11 of KDB 935210 D02 Signal Boosters Certification v01r01 the EUT was tested at compression and 10dB into compression to show AGC operation, worst case results taken.

## 806.0 MHz Analogue Signal Generator and EUT



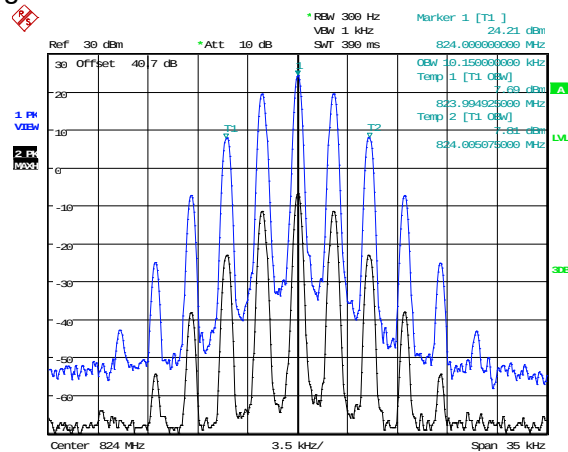
Date: 26.FEB.2014 12:01:18

## 815.0 MHz Analogue Signal Generator and EUT



Date: 26.FEB.2014 12:02:26

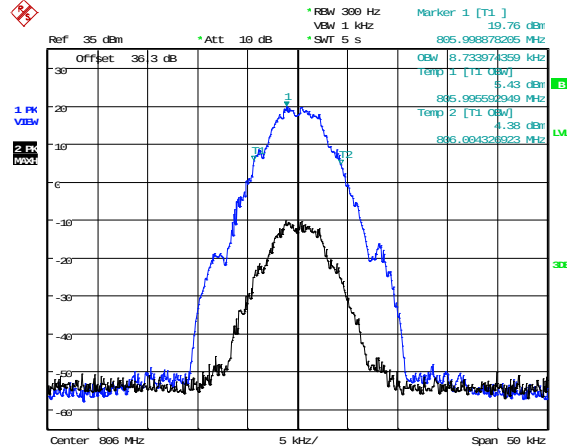
## 824.0 MHz Analogue Signal Generator and EUT



Date: 26.FEB.2014 12:03:28

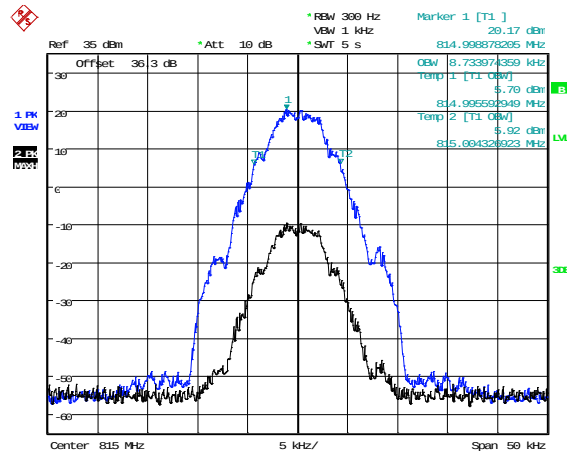
The above plots depicting the output wavelshape show no measurable distortion visible when compared to the input signal.

## 806.0 MHz C4FM Signal Generator and EUT



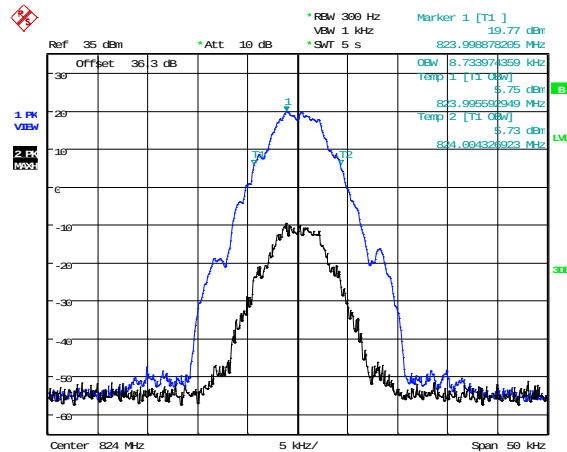
Date: 15.JUL.2013 15:53:33

## 815.0 MHz C4FM Signal Generator and EUT



Date: 15.JUL.2013 15:56:55

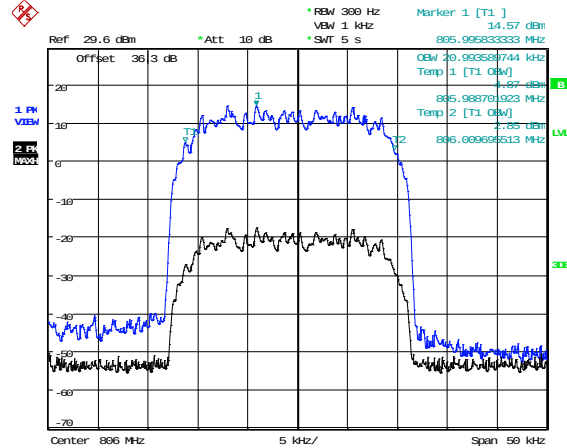
## 824.0 MHz C4FM Signal Generator and EUT



Date: 15.JUL.2013 16:04:45

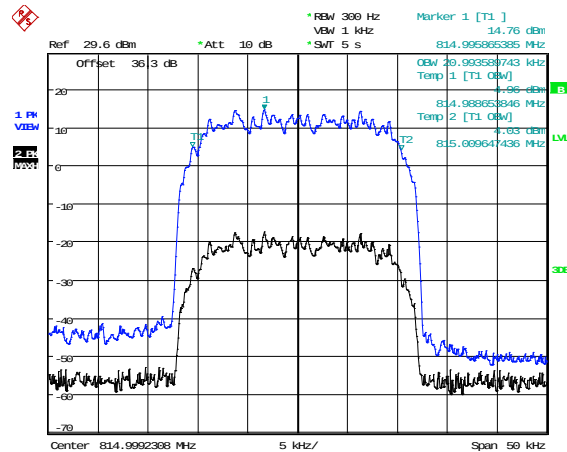
The above plots depicting the output waweshape show no measurable distortion visible when compared to the input signal.

## 806.0 MHz P25 Signal Generator and EUT



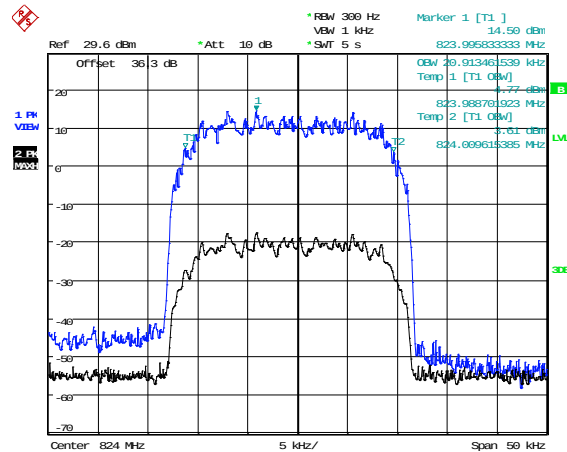
Date: 15.JUL.2013 14:42:03

## 815.0 MHz P25 Signal Generator and EUT



Date: 15.JUL.2013 14:37:52

## 824.0 MHz P25 Signal Generator and EUT

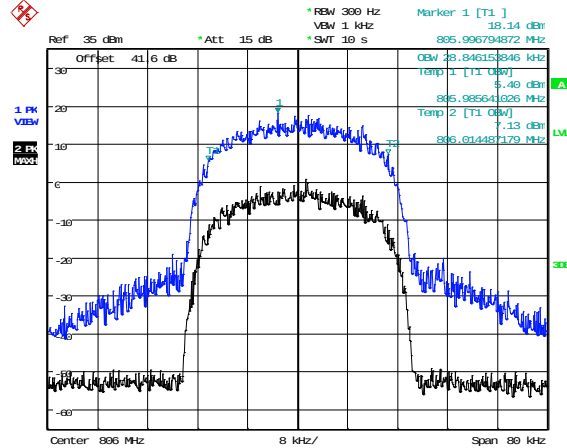


Date: 15.JUL.2013 14:47:03

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

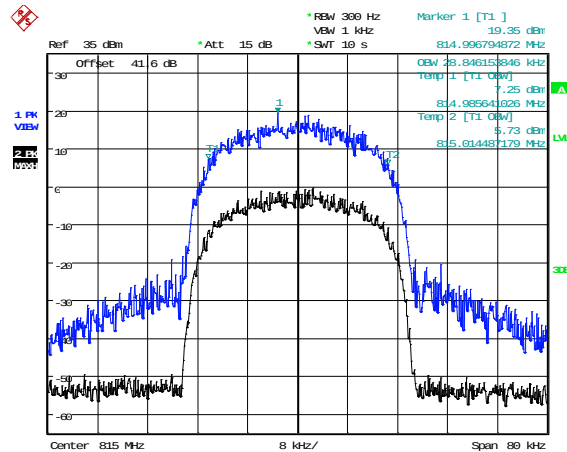


## 806.0 MHz iDEN Signal Generator and EUT



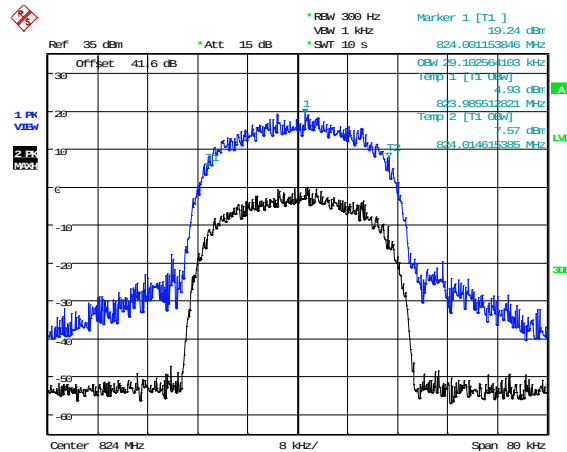
Date: 3.SEP.2013 11:26:21

## 815.0 MHz iDEN Signal Generator and EUT



Date: 3.SEP.2013 11:24:56

## 824.0 MHz iDEN Signal Generator and EUT



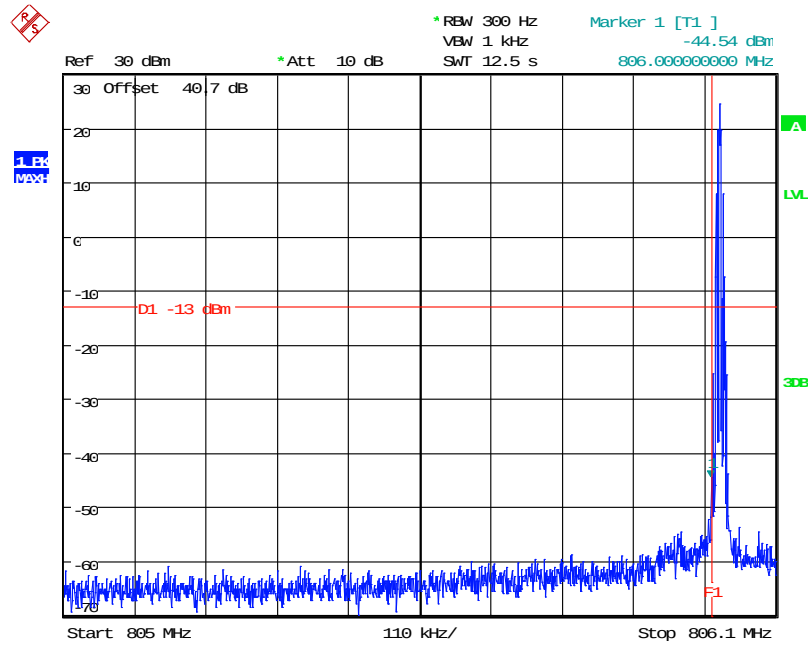
Date: 3.SEP.2013 11:27:55

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

**A4 Spurious Emissions at Antenna Terminals Less than 1MHz**

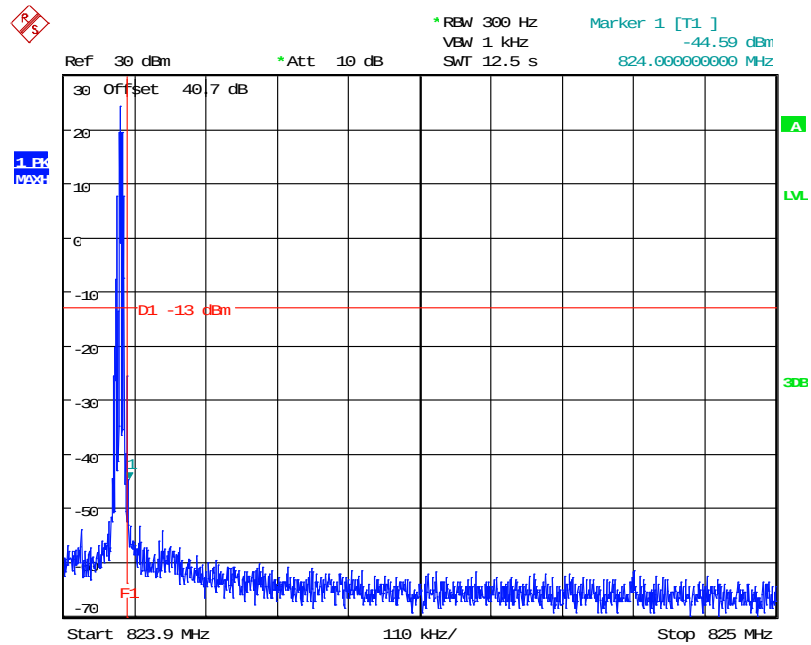
| <b>Test Details:</b>   |                                      |
|------------------------|--------------------------------------|
| Measurement standard   | Part 2.1053, 90.219(e)(3), 90.210(h) |
| EUT sample number      | S01                                  |
| Modification state     | 0                                    |
| SE in test environment | None                                 |
| SE isolated from EUT   | None                                 |
| EUT set up             | Refer to Appendix C                  |

| Modulation Type | Bandedge | Carrier Frequency (MHz) | Max Level @ bandedge (dBm) |
|-----------------|----------|-------------------------|----------------------------|
| Analogue        | Lower    | 806.01250               | -44.54                     |
|                 | Upper    | 823.98750               | -44.59                     |
| C4FM            | Lower    | 806.01250               | -50.76                     |
|                 | Upper    | 823.98750               | -48.66                     |
| P25             | Lower    | 806.01250               | -54.91                     |
|                 | Upper    | 823.98750               | -57.99                     |
| iDEN            | Lower    | 806.03125               | -30.22                     |
|                 | Upper    | 823.96875               | -29.67                     |



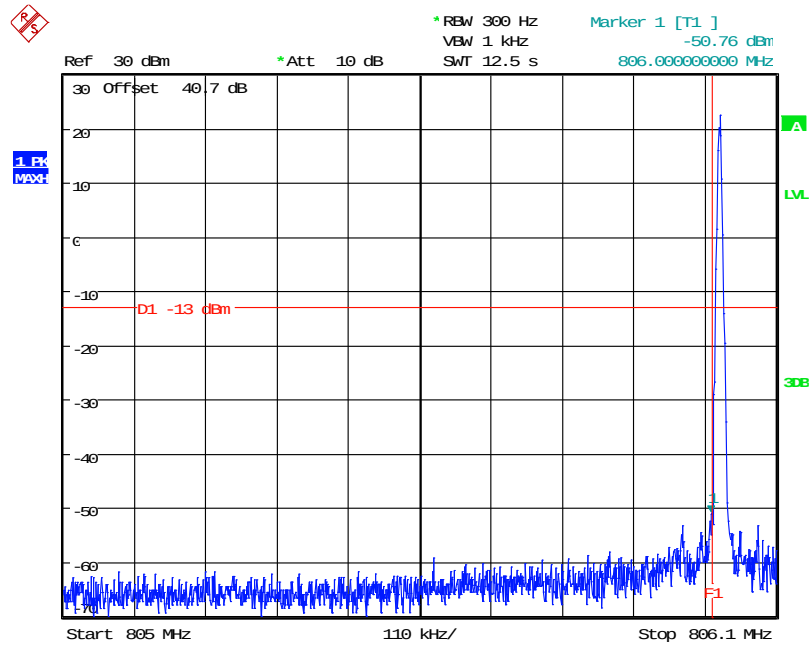
Date: 26.FEB.2014 16:33:00

### Analogue Signal – Lower Bandedge



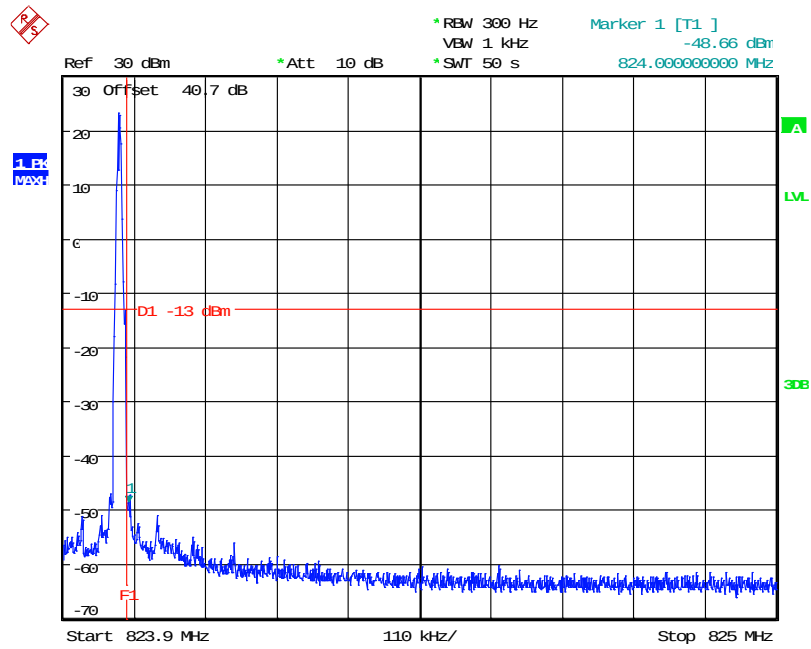
Date: 26.FEB.2014 16:09:42

### Analogue Signal – Upper Bandedge



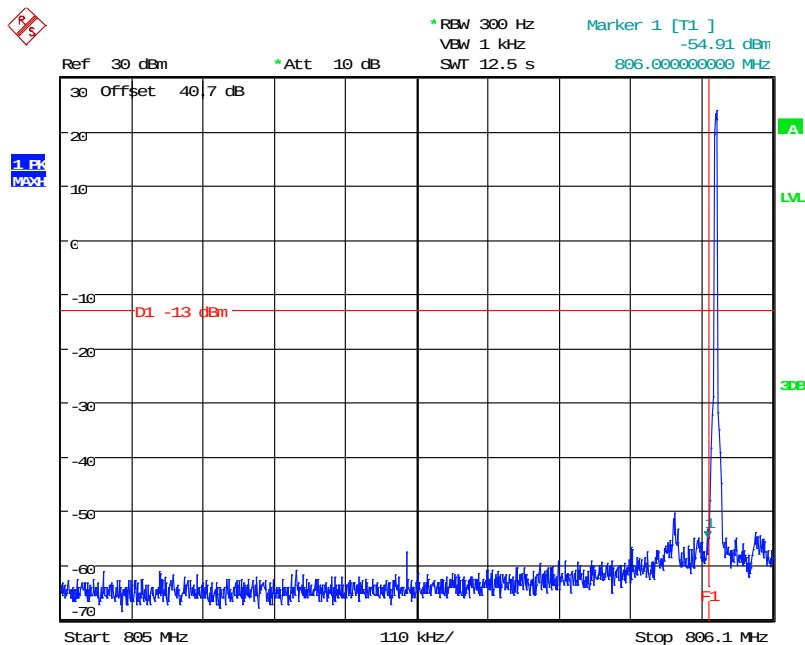
Date: 26.FEB.2014 16:31:49

### C4FM Signal – Lower Bandedge



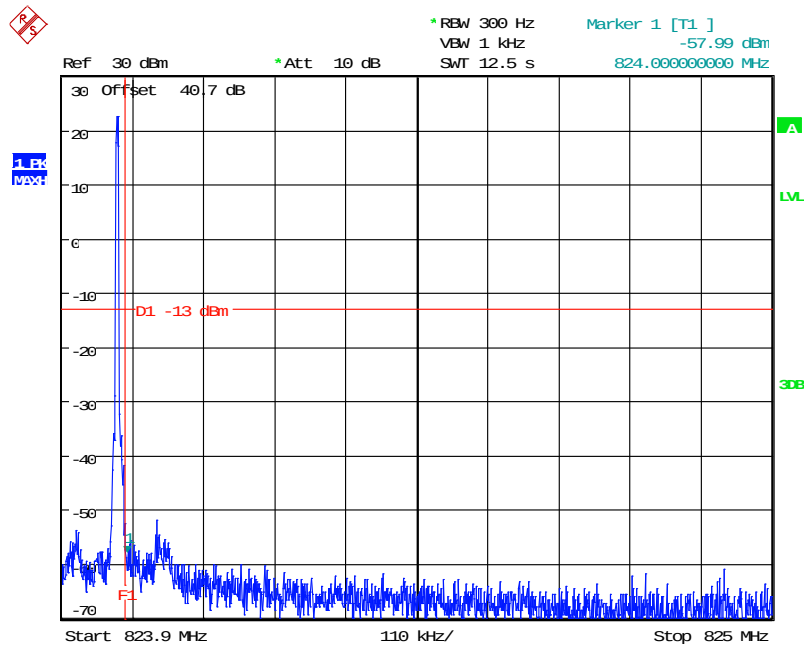
Date: 26.FEB.2014 16:08:17

### C4FM Signal – Upper Bandedge



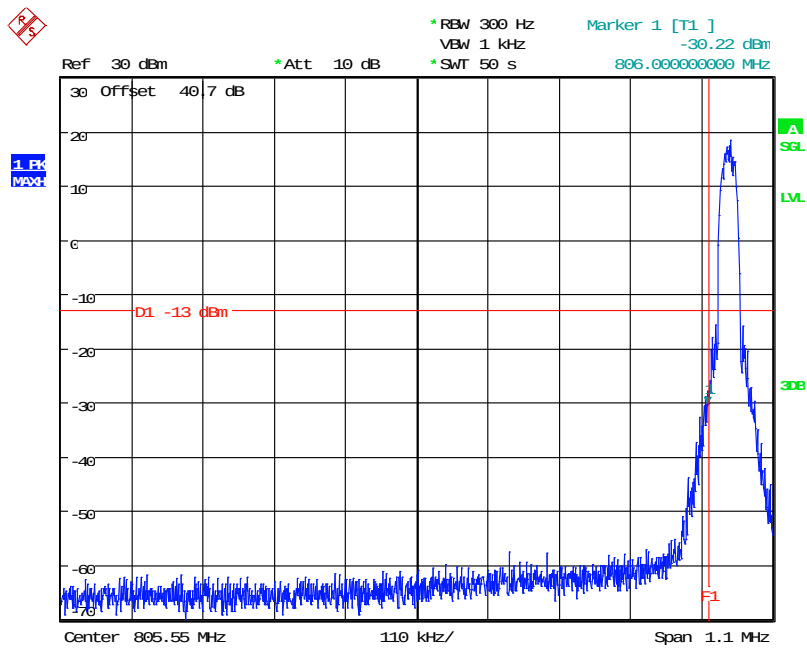
Date: 26.FEB.2014 16:30:27

P25 Signal – Lower Bandedge



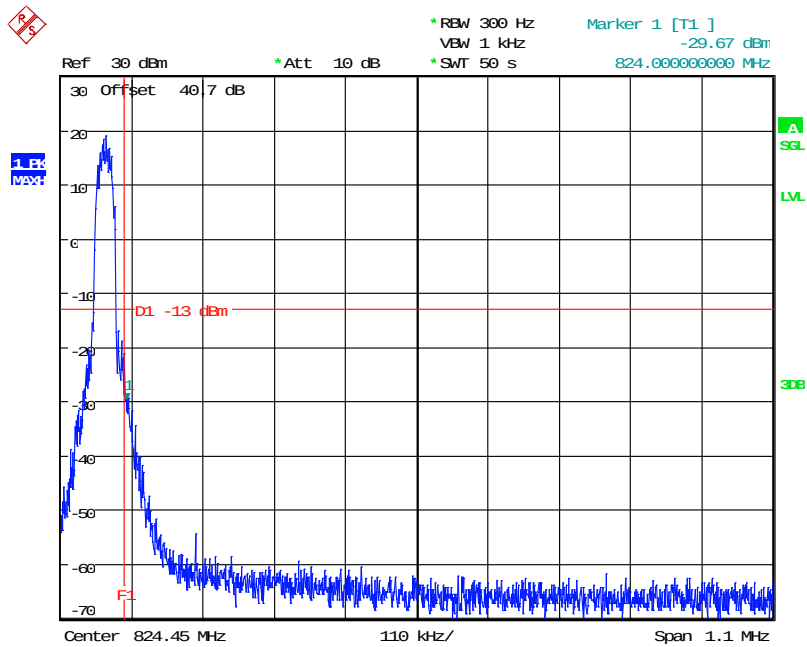
Date: 26.FEB.2014 16:27:41

P25 Signal – Upper Bandedge



Date: 27.FEB.2014 10:36:30

iDEN Signal – Lower Bandedge



Date: 27.FEB.2014 10:38:41

iDEN Signal – Upper Bandedge

**A5 Spurious Emissions at Antenna Terminals Greater than 1MHz**

| Test Details:          |                           |
|------------------------|---------------------------|
| Measurement standard   | Part 2.1053, 90.219(e)(3) |
| EUT sample number      | S01                       |
| Modification state     | 0                         |
| SE in test environment | None                      |
| SE isolated from EUT   | None                      |
| 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 |
|-----------------------|--------------------------|----------------------|--------------------------------|-------------------------------|-----------|
| 9 kHz – 9 GHz         | No Significant Emissions |                      |                                |                               | -13       |

**Middle Channel**

| Frequency Range (MHz) | Freq. of Emission (MHz)  | Measured Level (dBm) | Attenuator & Cable Losses (dB) | Spurious Emission Level (dBm) | Limit dBm |
|-----------------------|--------------------------|----------------------|--------------------------------|-------------------------------|-----------|
| 9 kHz – 9 GHz         | No Significant Emissions |                      |                                |                               | -13       |

**Top channel**

| Frequency Range (MHz) | Freq. of Emission (MHz)  | Measured Level (dBm) | Attenuator & Cable Losses (dB) | Spurious Emission Level (dBm) | Limit dBm |
|-----------------------|--------------------------|----------------------|--------------------------------|-------------------------------|-----------|
| 9 kHz – 9 GHz         | No Significant Emissions |                      |                                |                               | -13       |

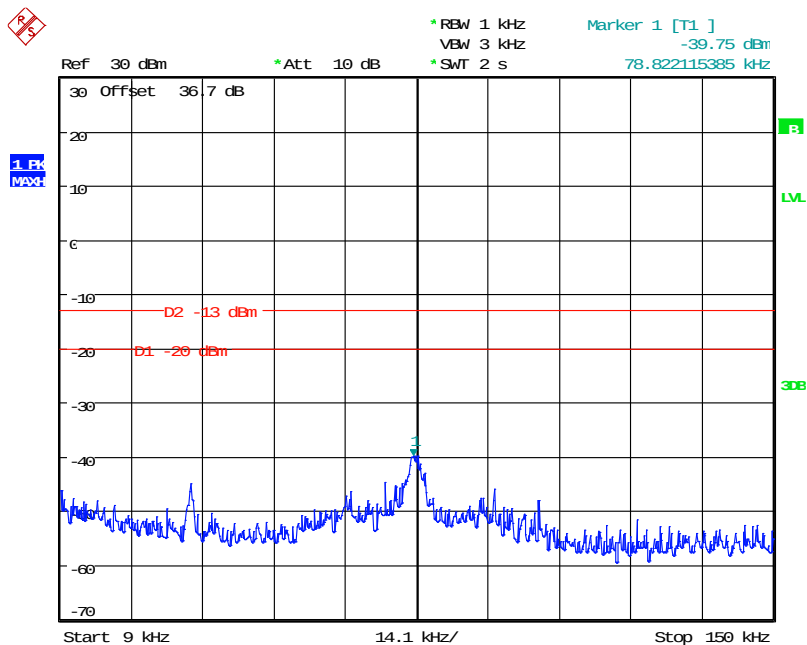
Limit is determined by the outermost step of the emissions mask and is calculated as follows:

At least  $43 + 10 \log P$  dB

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

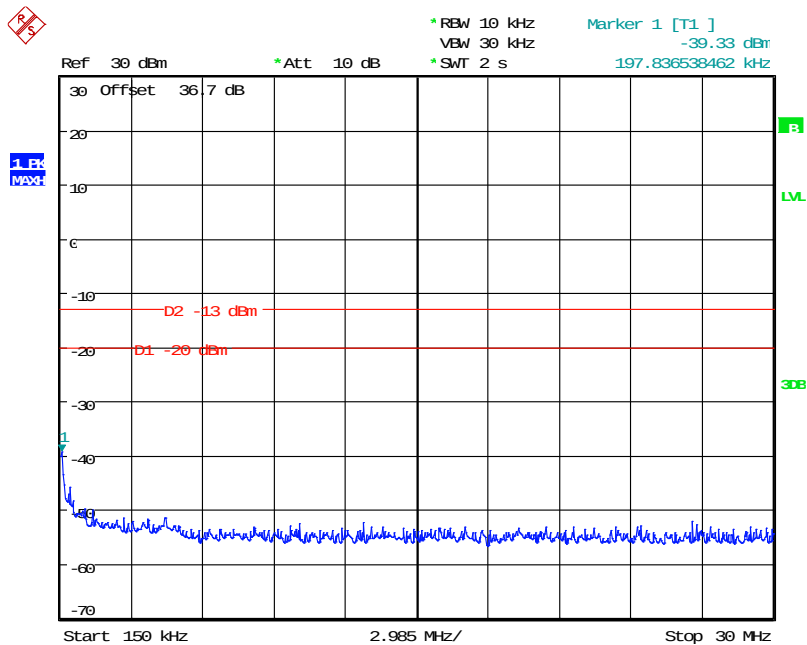
**Result**

The EUT was found to comply with the limits



Date: 15.JUL.2013 10:25:43

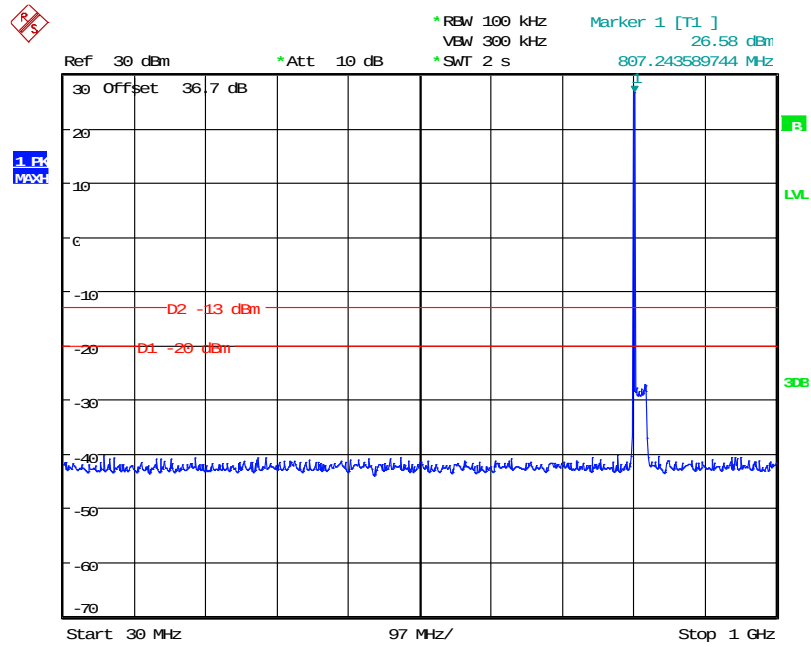
806.0 MHz - 9-150kHz



Date: 15.JUL.2013 10:22:39

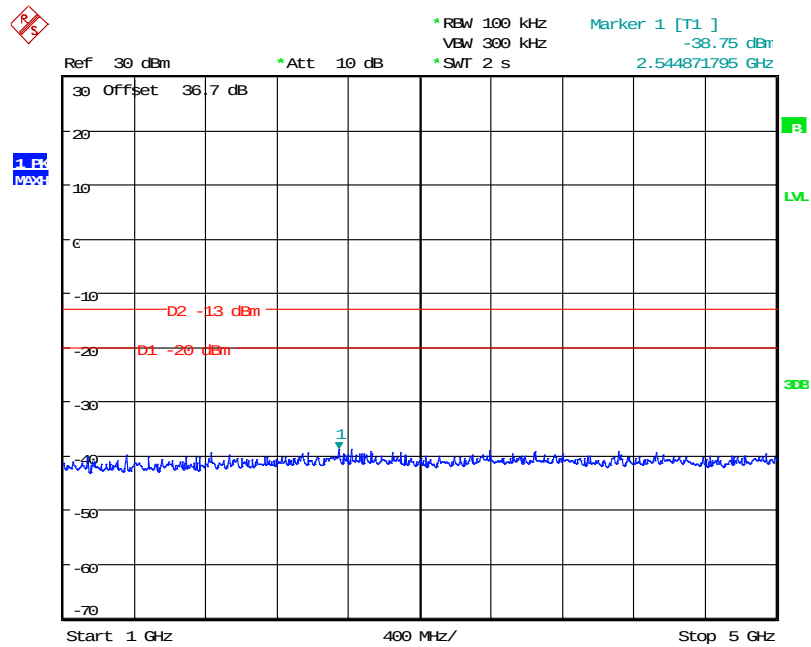
806.0 MHz - 150kHz – 30MHz





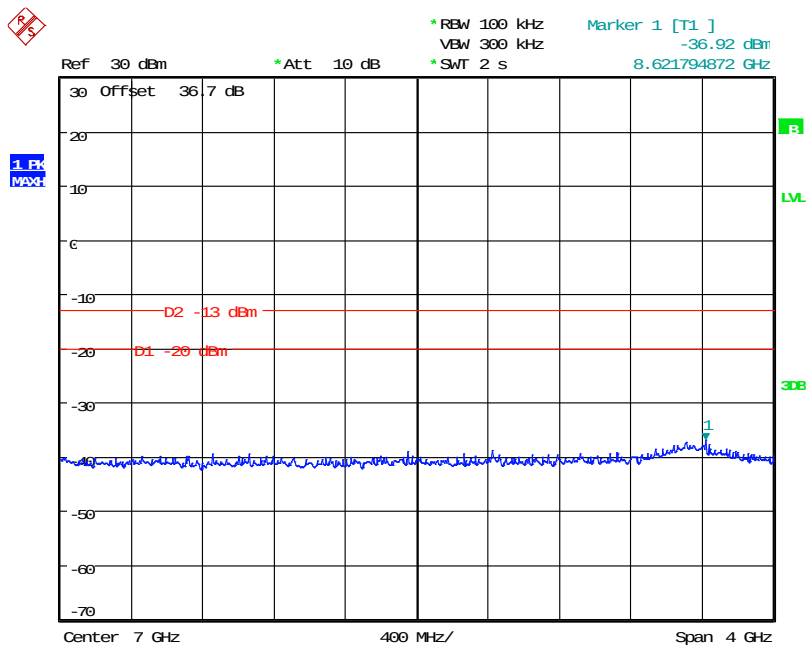
Date: 15.JUL.2013 10:22:18

806.0 MHz - 30MHz – 1GHz



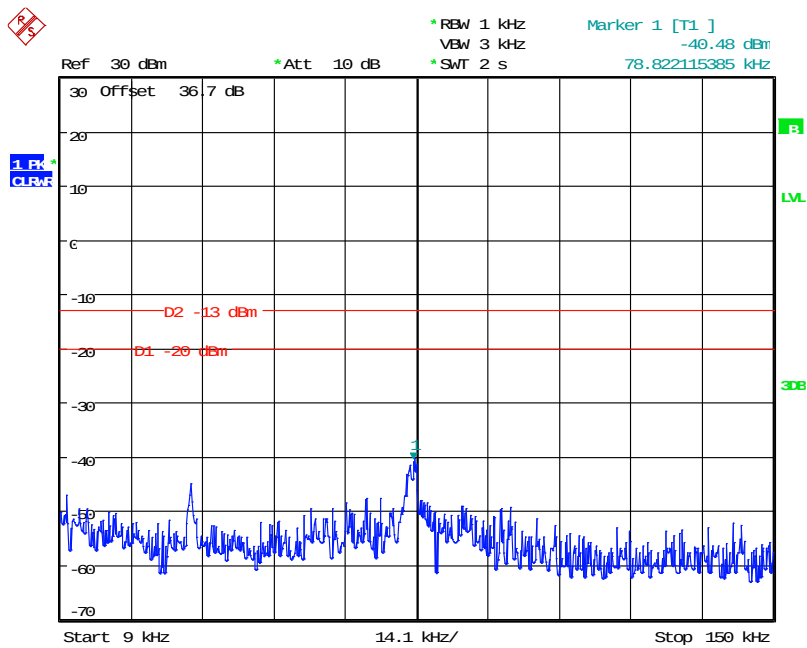
Date: 15.JUL.2013 10:21:48

806.0 MHz - 1GHz – 5GHz



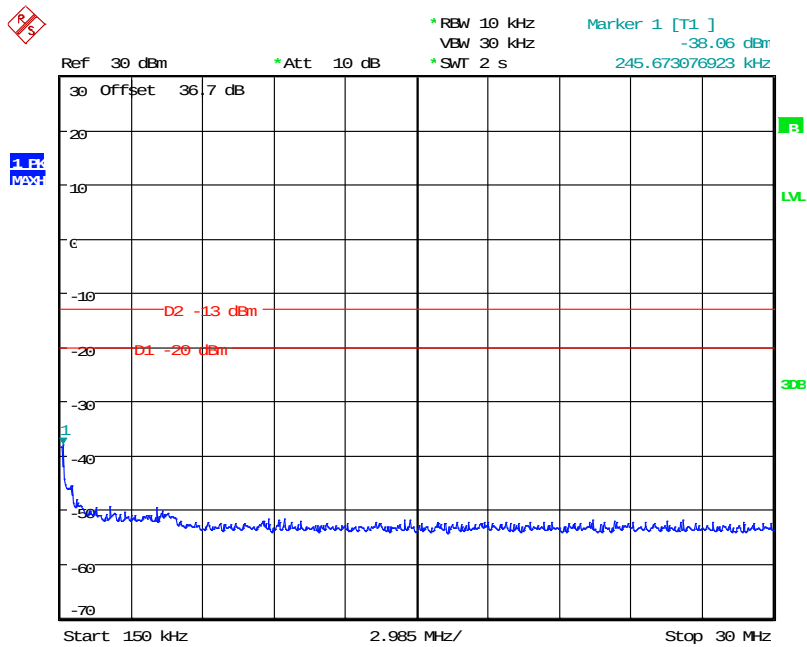
Date: 15.JUL.2013 10:21:29

806.0 MHz - 5GHz – 9GHz



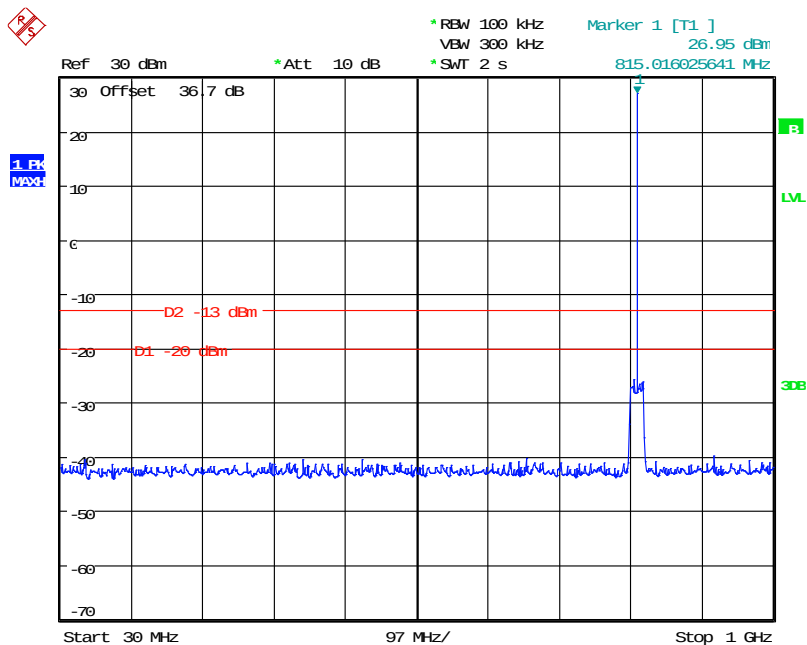
Date: 15.JUL.2013 10:13:57

815.0 MHz - 9-150kHz



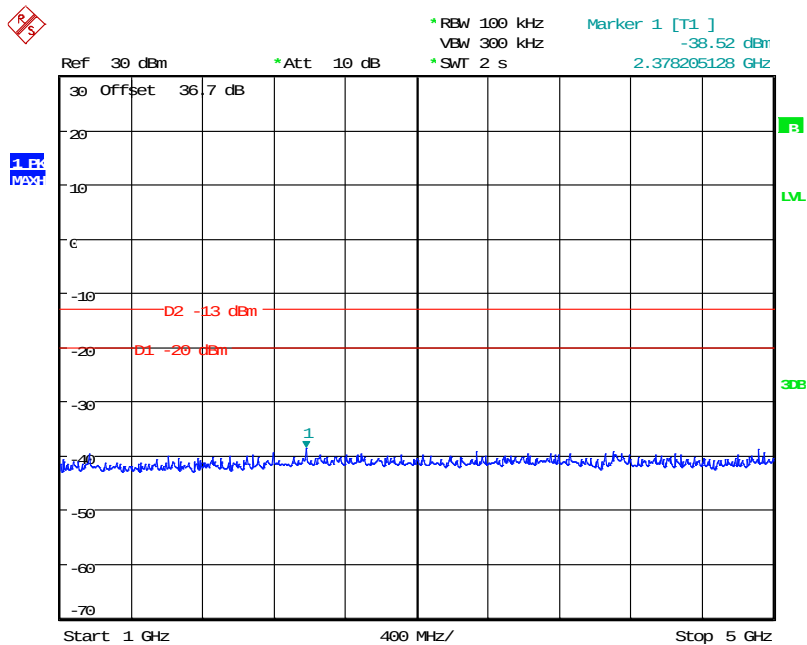
Date: 15.JUL.2013 10:19:52

815.0 MHz - 150kHz – 30MHz



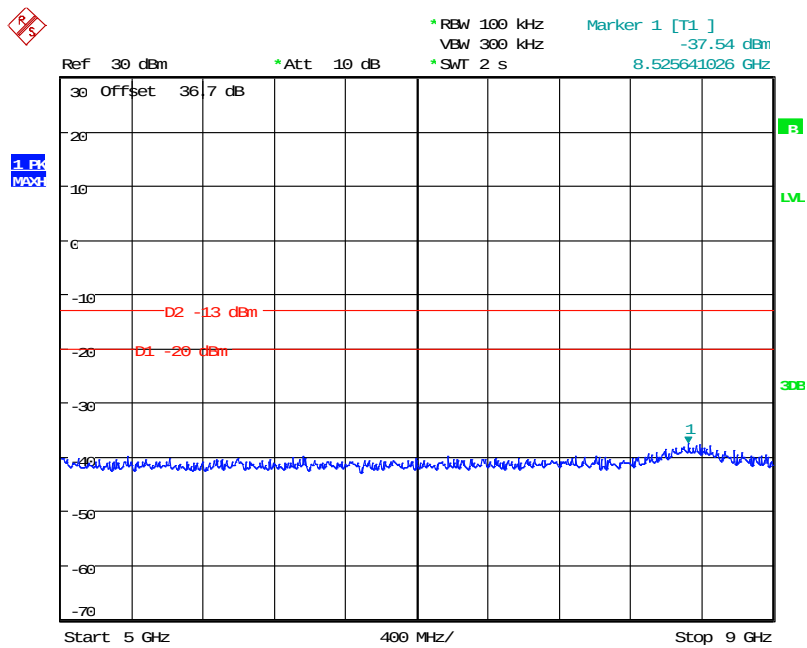
Date: 15.JUL.2013 10:20:10

815.0 MHz - 30MHz – 1GHz



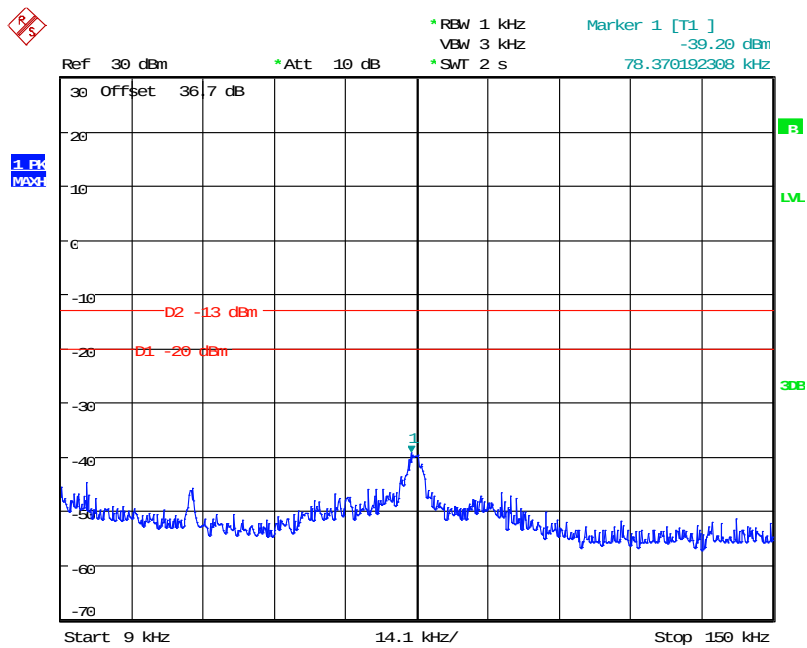
Date: 15.JUL.2013 10:20:26

815.0 MHz - 1GHz – 5GHz



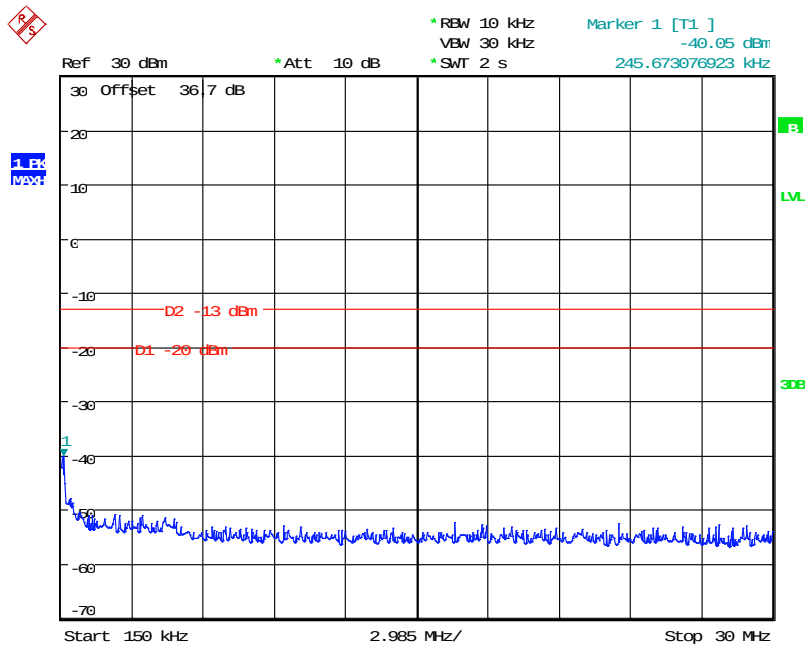
Date: 15.JUL.2013 10:20:40

815.0 MHz - 5GHz – 9GHz



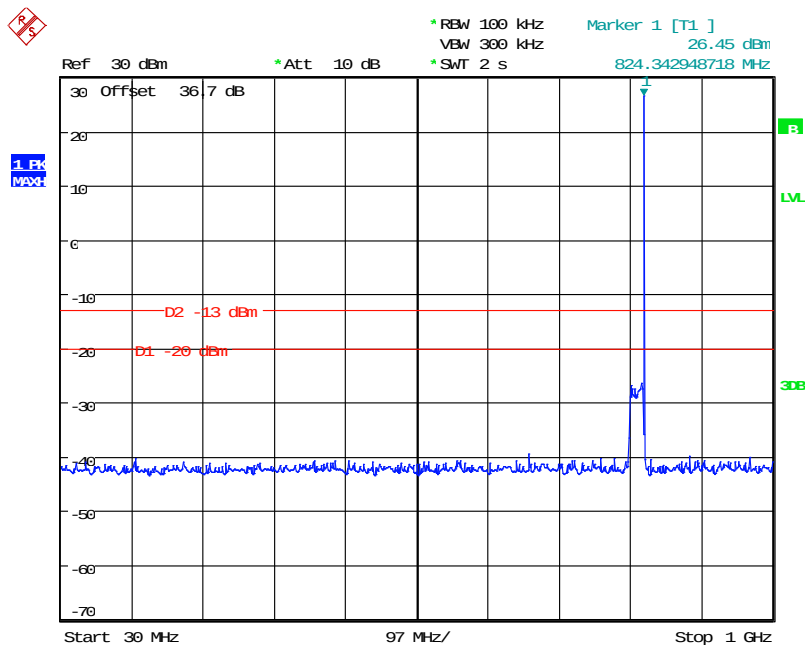
Date: 15.JUL.2013 10:26:31

824.0 MHz - 9-150kHz



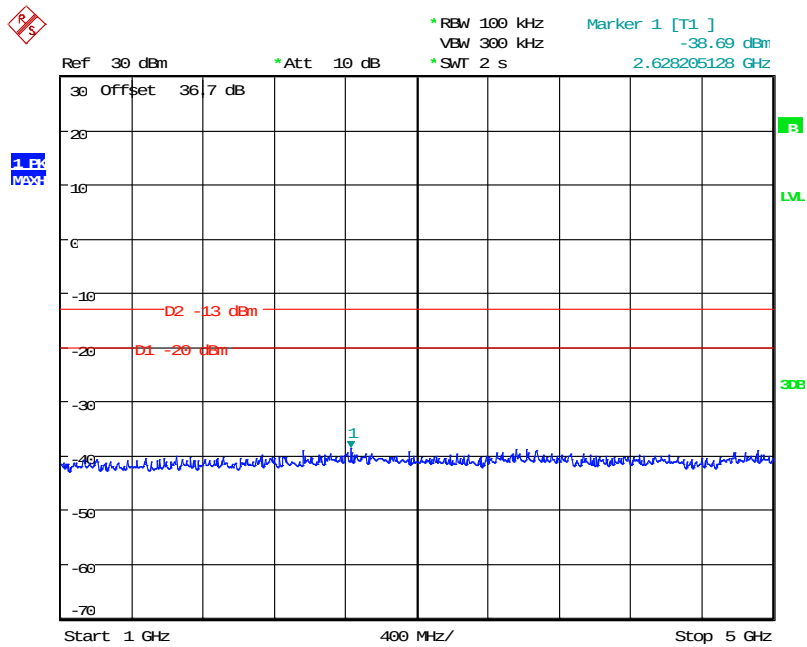
Date: 15.JUL.2013 10:27:37

824.0 MHz - 150kHz – 30MHz



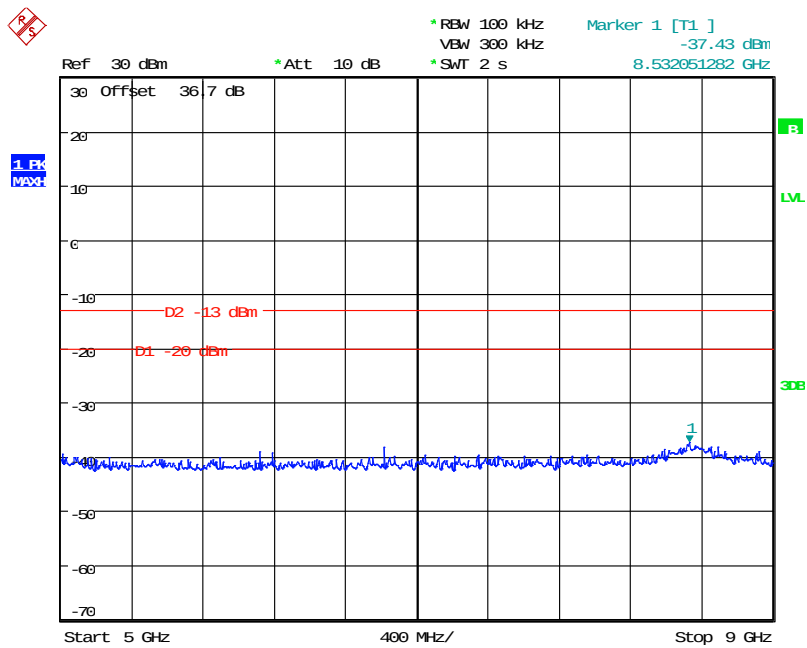
Date: 15.JUL.2013 10:28:16

824.0 MHz -30MHz – 1GHz



Date: 15.JUL.2013 10:28:37

824.0 MHz - 1GHz – 5GHz



Date: 15.JUL.2013 10:28:54

824.0 MHz - 5GHz – 9GHz

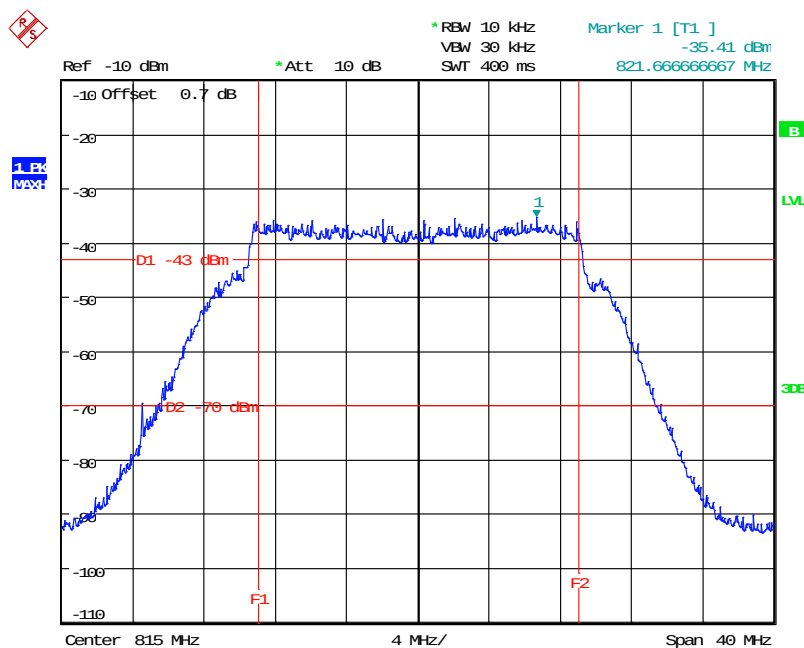


**A6 Noise at Antenna Terminals**

| Test Details:          |                            |
|------------------------|----------------------------|
| Measurement standard   | 90.219(e)(2), 90.219(d)(6) |
| EUT sample number      | S01                        |
| Modification state     | 0                          |
| SE in test environment | None                       |
| SE isolated from EUT   | None                       |
| EUT set up             | Refer to Appendix C        |

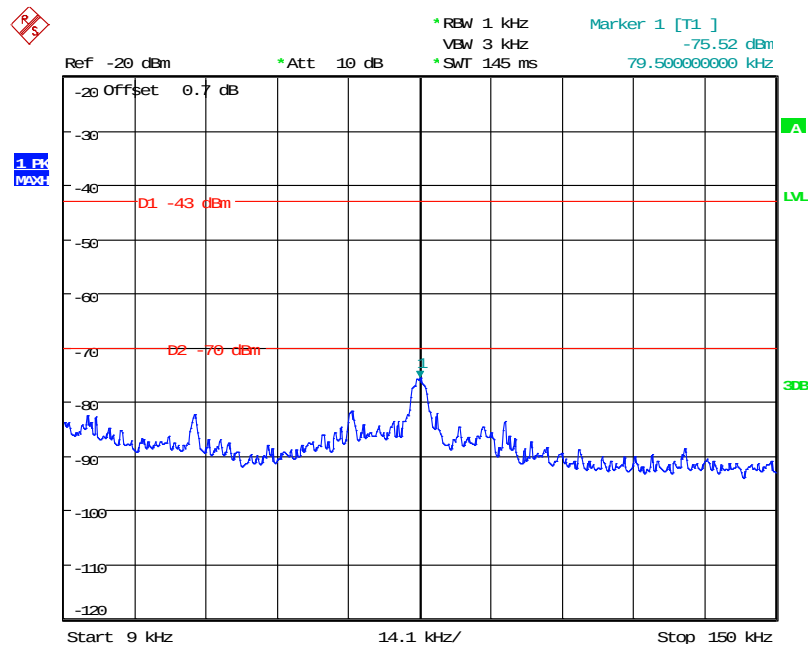
Compliance with these levels will be deemed satisfaction of the good engineering practice requirement. In a 10 kHz measurement bandwidth:

- (1) the ERP of noise within the signal booster passband should not exceed  $-43\text{dBm}$ ;
- and
- (2) the ERP of noise on spectrum more than 1 MHz outside of the signal booster passband should not exceed  $-70\text{ dBm}$ .
- (3) The noise figure of a signal booster must not exceed 9 dB in either direction

**IN BAND AMPLIFIER NOISE**

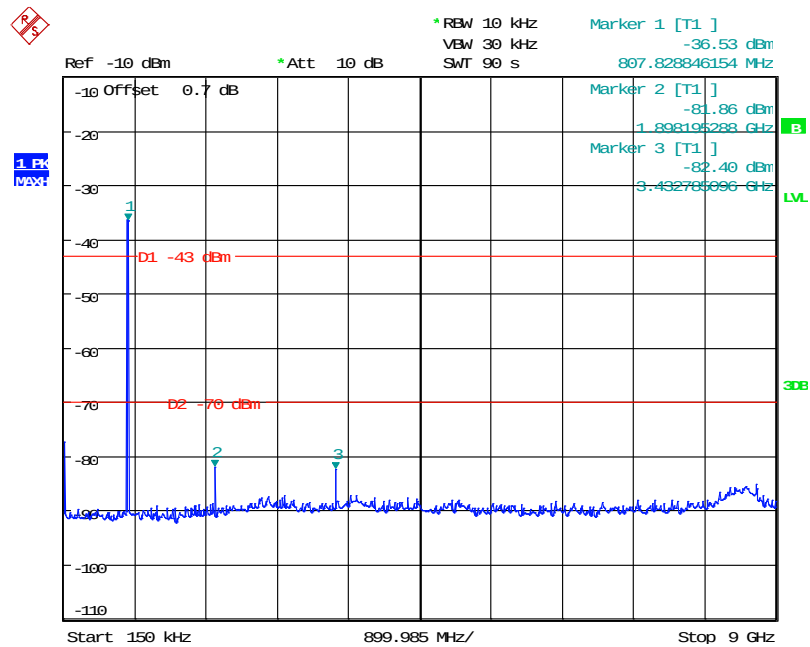
Date: 15.JUL.2013 11:10:09

### OUT OF BAND AMPLIFIER NOISE 9-150kHz



Date: 15.JUL.2013 11:10:37

### OUT OF BAND AMPLIFIER NOISE 150kHz-9GHz



Date: 15.JUL.2013 11:09:00

**Whilst the pass band noise is greater than the -43dBm limit by approximately 7dB, the manufacturer has stated that they mitigate this by using good engineering practice as follows:-**

***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 3308 signal booster has a noise level of -43 dBm in 10 kHz measurement at 1 MHz spectrum outside the passband of the signal booster.*

*It has an in-band noise level at around -37 dBm in a 10 kHz bandwidth*

*Therefore the noise at the antenna input port should be calculated based on equation (3)*

***Equation (3) - Input Noise to service antenna***

*Input Noise to service antenna:*

*-43 dBm + Service Antenna gain – Antenna splitter losses in dB – cable loss in dBs*

***Example:***

*Signal booster connected to 10 service antennas with a 100m long ½ inch cable.*

*• Losses of such a cable with the connectors = ~ 11dB.*

*• Gain = ~ 2 dBi*

*Assuming 10 service antennas: antenna splitter losses = 11 dBi*

*Based on equation (3) Input antenna noise (to the antenna) = -43+2-11 -11=-63 dBm .*

*The inband input noise to the antenna should be -37+2 -11-11= -57dbm*

*NOTE: In this example you may be required in general to add an external bandpass filter that would attenuate the out of band noise by additional 7 dbs .*

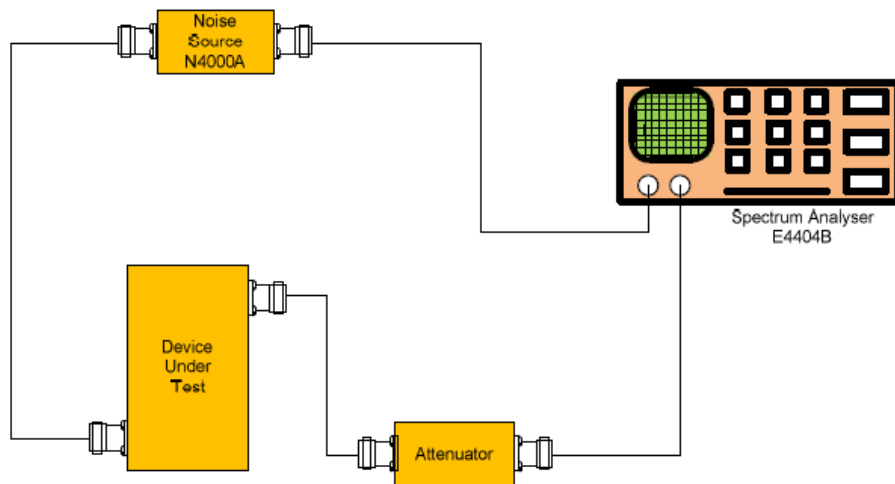
***Conclusion:***

*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 .*

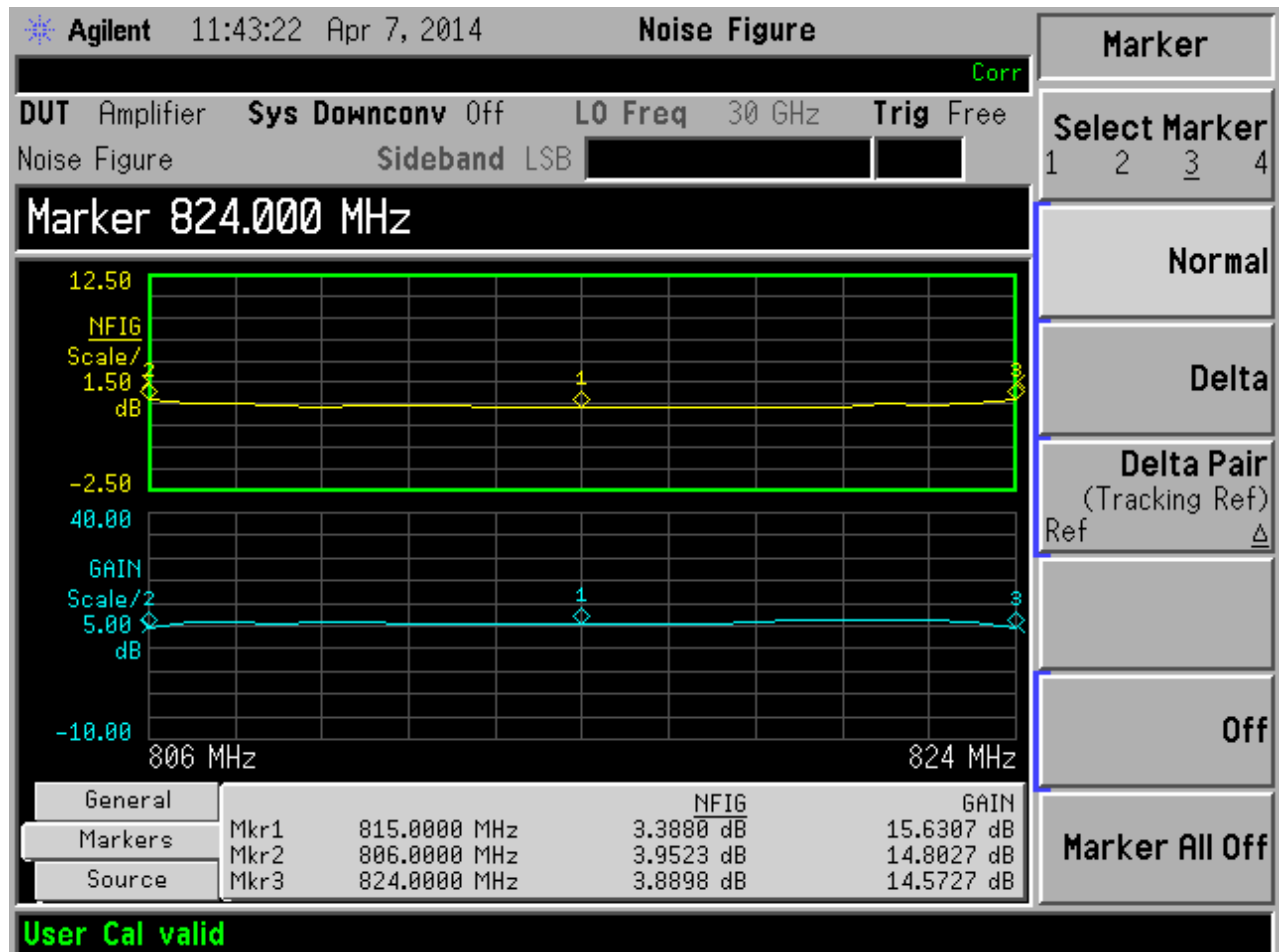
This information was extracted for the user manual.

## 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 |
|-----------------|-----------------|
| 815.0           | 3.4             |
| 806.0           | 3.95            |
| 824.0           | 4.0             |

General notes about measurement setup:

- 1) The spectrum analyser has the phase noise measuring personality enabled.

**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 : ☒

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

| Test Details:            |                                                         |
|--------------------------|---------------------------------------------------------|
| Measurement standard     | Title 47 of the CFR: Part 2.1053, RSS-131 Section 4.3.2 |
| Frequency range          | 30 MHz – 9 GHz                                          |
| EUT sample number        | S01                                                     |
| Modification state       | 0                                                       |
| SE in test environment   | None                                                    |
| SE isolated from EUT     | None                                                    |
| EUT set up               | Refer to Appendix C                                     |
| Temperature              | 23                                                      |
| Photographs (Appendix F) | 1 & 2                                                   |

**Bottom Frequency**

| FREQUENCY RANGE | FREQ. (MHz)              | ERP/EIRP (dBm) | LIMIT (dBm) |
|-----------------|--------------------------|----------------|-------------|
| 30 MHz – 9 GHz  | No Significant Emissions |                | -13         |

**Middle Frequency**

| FREQUENCY RANGE | FREQ. (MHz)              | ERP/EIRP (dBm) | LIMIT (dBm) |
|-----------------|--------------------------|----------------|-------------|
| 30 MHz – 9 GHz  | No Significant Emissions |                | -13         |

**Top Frequency**

| FREQUENCY RANGE | FREQ. (MHz)              | ERP/EIRP (dBm) | LIMIT (dBm) |
|-----------------|--------------------------|----------------|-------------|
| 30 MHz – 9 GHz  | No Significant Emissions |                | -13         |

**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° 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

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

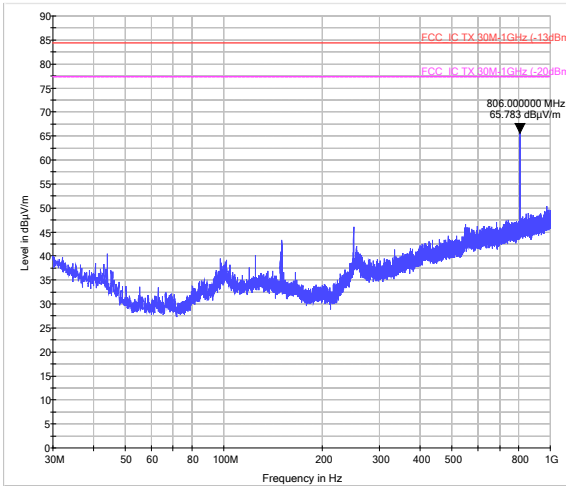
The upper and lower frequency of the measurement range was decided according to 47 CFR Part 2.1057.

- (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:

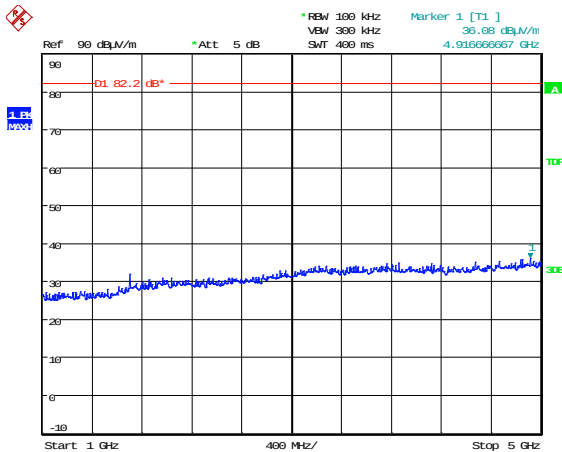
$$\text{Extrapolation (dB)} = 20 \log_{10} \left( \frac{\text{measurement distance}}{\text{specification distance}} \right)$$

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

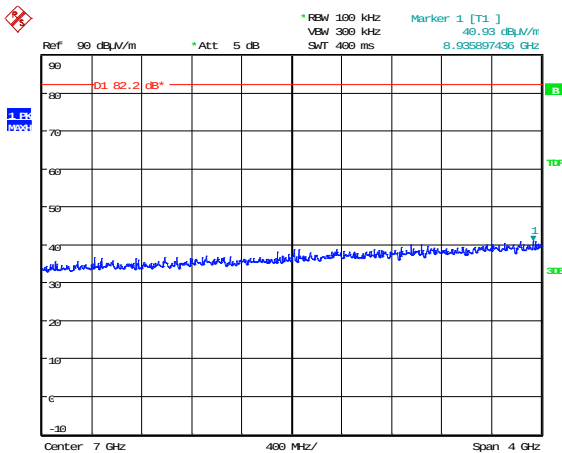


806.0 MHz - 30MHz – 1GHz



Date: 16.JUL.2013 13:02:12

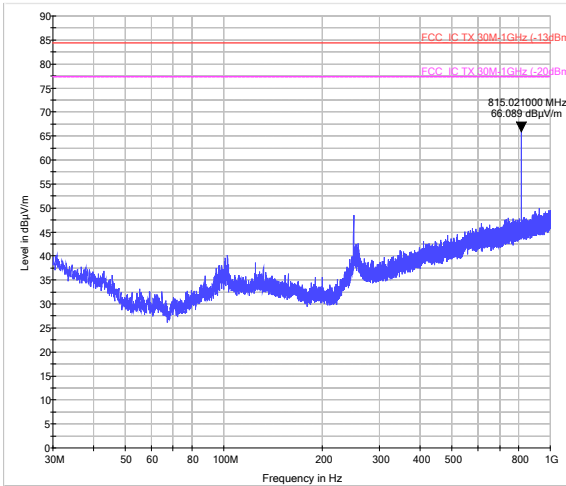
806.0 MHz - 1GHz – 5GHz



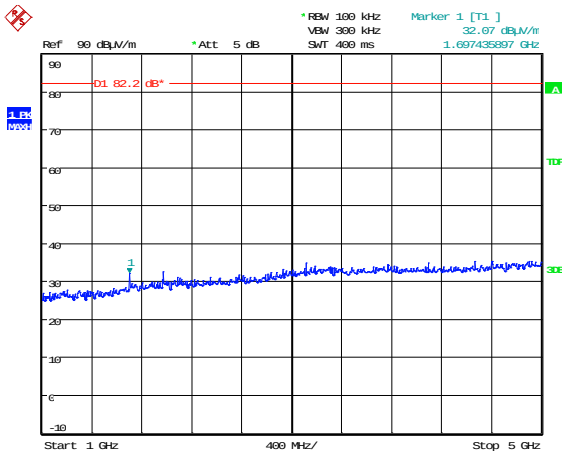
Date: 16.JUL.2013 13:02:27

806.0 MHz - 5GHz – 9GHz



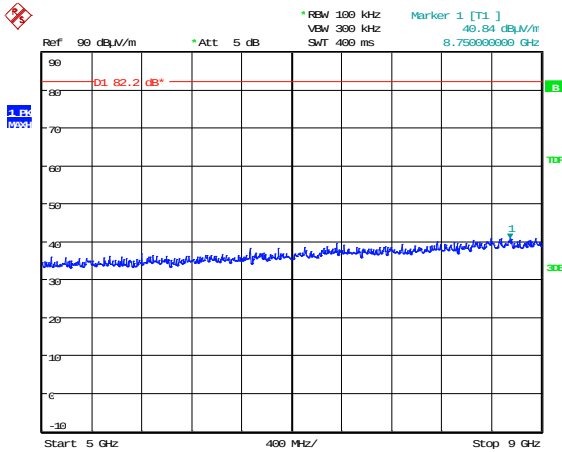


815.0 MHz - 30MHz – 1GHz



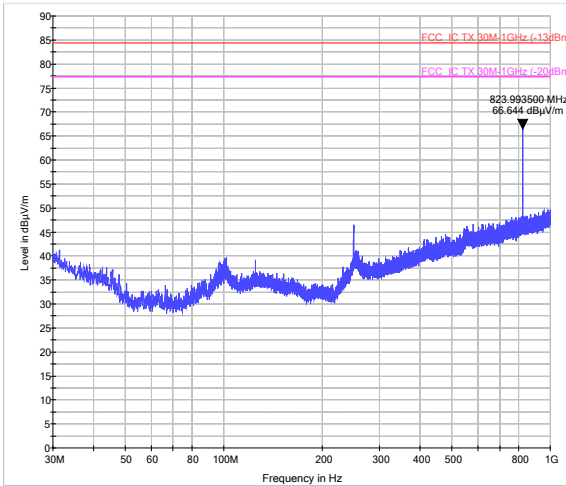
Date: 16.JUL.2013 13:05:51

815.0 MHz - 1GHz – 5GHz

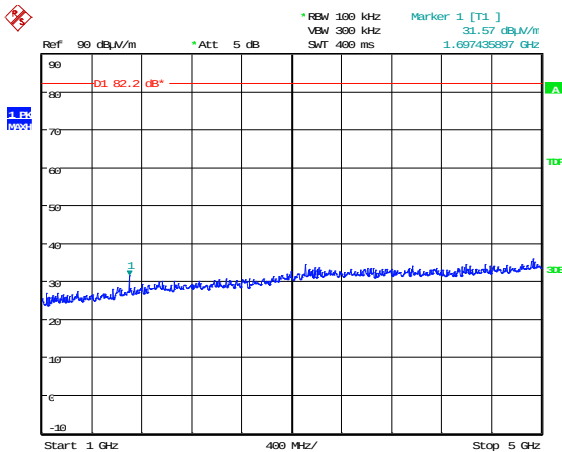


Date: 16.JUL.2013 13:04:54

815.0 MHz - 5GHz – 9GHz

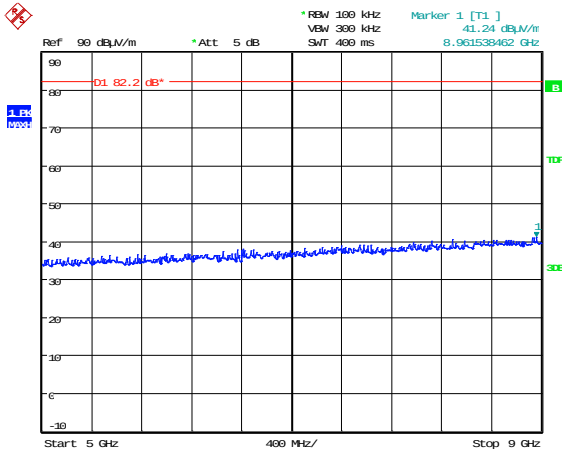


824.0 MHz - 30MHz – 1GHz



Date: 16.JUL.2013 13:06:16

824.0 MHz - 1GHz – 5GHz



Date: 16.JUL.2013 13:06:41

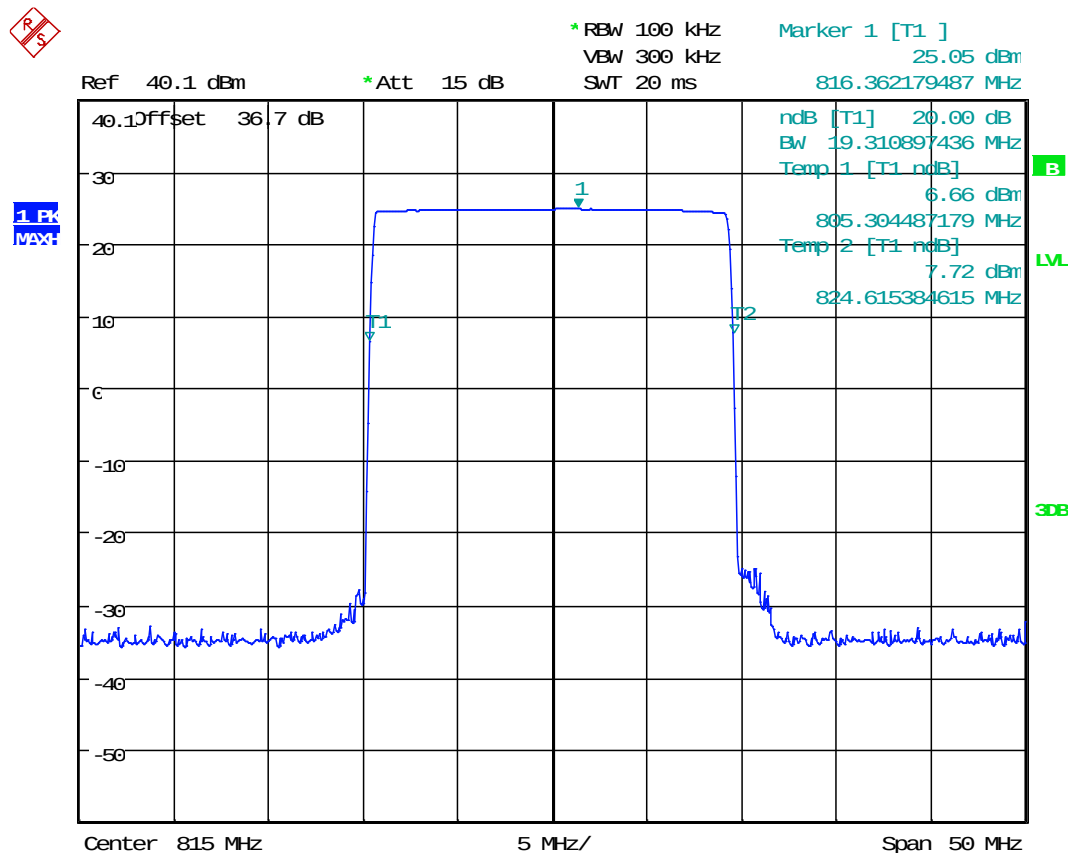
824.0 MHz - 5GHz – 9GHz

## A8 Passband Gain & Bandwidth

| Test Details:          |                     |
|------------------------|---------------------|
| Measurement standard   | RSS-131 Section 4.2 |
| EUT sample number      | S01                 |
| Modification state     | 0                   |
| SE in test environment | None                |
| SE isolated from EUT   | None                |
| EUT set up             | Refer to Appendix C |

| Frequency<br>MHz | fl      | fh      | 20 dB Bandwidth |
|------------------|---------|---------|-----------------|
| 806.0 – 824.0    | 805.304 | 824.615 | 19.310 MHz      |

1. See below for plots showing passband gain & bandwidth



Date: 16.JUL.2013 17:04:28

**Appendix B:****Downlink Formal Emission Test Results**

Abbreviations used in the tables in this appendix:

|      |                                 |      |                                |
|------|---------------------------------|------|--------------------------------|
| Spec | : Specification                 | ALSR | : Absorber Lined Screened Room |
| Mod  | : Modification                  | OATS | : Open Area Test Site          |
|      |                                 | ATS  | : Alternative Test Site        |
| EUT  | : Equipment Under Test          |      |                                |
| SE   | : Support Equipment             | Ref  | : Reference                    |
|      |                                 | Freq | : Frequency                    |
| L    | : Live Power Line               |      |                                |
| N    | : Neutral Power Line            | MD   | : Measurement Distance         |
| E    | : Earth Power Line              | SD   | : Spec Distance                |
|      |                                 |      |                                |
| Pk   | : Peak Detector                 | Pol  | : Polarisation                 |
| QP   | : Quasi-Peak Detector           | H    | : Horizontal Polarisation      |
| Av   | : Average Detector              | V    | : Vertical Polarisation        |
|      |                                 |      |                                |
| CDN  | : Coupling & decoupling network |      |                                |

**B1 RF Gain and Output Power**

| <b>Test Details:</b>   |                                                     |
|------------------------|-----------------------------------------------------|
| Measurement standard   | Part 2.1046, Part 90.219(d)(3), RSS-131 Section 4.3 |
| EUT sample number      | S01                                                 |
| Modification state     | 0                                                   |
| SE in test environment | None                                                |
| SE isolated from EUT   | None                                                |
| Temperature (°C)       | 22                                                  |
| Humidity (%)           | 48                                                  |
| EUT set up             | Refer to Appendix C                                 |

| Frequency<br>MHz | Signal<br>Generator<br>input level<br>dBm | Input<br>Cable<br>Loss<br>dB | Level at<br>Spectrum<br>Analyser<br>dBm | Output<br>Cable &<br>Attenuator<br>loss<br>dB | Gain<br>dB | Conducted<br>Output<br>Power<br>dBm | Gain after<br>10dB input<br>level<br>increase<br>dB |
|------------------|-------------------------------------------|------------------------------|-----------------------------------------|-----------------------------------------------|------------|-------------------------------------|-----------------------------------------------------|
| 851.0            | -52.00                                    | 0.70                         | -5.86                                   | 36.6                                          | 83.44      | 30.74                               | 76.56                                               |
| 860.0            | -51.00                                    | 0.70                         | -3.62                                   | 36.6                                          | 84.68      | 32.98                               | 77.76                                               |
| 869.0            | -48.00                                    | 0.70                         | -4.18                                   | 36.6                                          | 81.12      | 32.42                               | 74.21                                               |

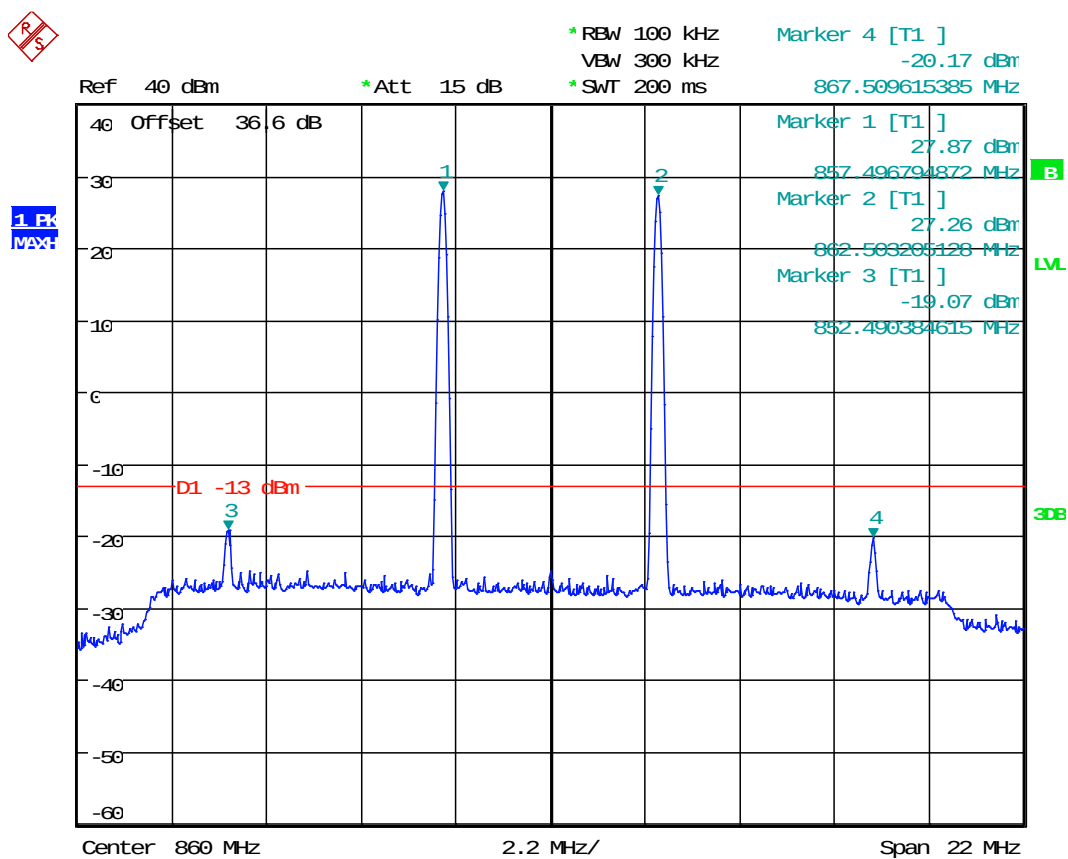
Notes: 1. The signal generator input was increased by 10dBs and the level of the output signal remeasured.

As per Annex A clause 11 of KDB 935210 D02 Signal Boosters Certification v01r01 the EUT was tested at compression and 10dB into compression to show AGC operation

| Frequency      | Frequency (MHz) | P <sub>0</sub>  | Level at Spectrum Analyser (dBm) | Output Cable & Attenuator loss (dB) | Power At Output Point (dBm) |
|----------------|-----------------|-----------------|----------------------------------|-------------------------------------|-----------------------------|
| f <sub>1</sub> | 857.5           | P <sub>01</sub> | -8.73                            | 36.6                                | 27.87                       |
| f <sub>2</sub> | 862.5           | P <sub>02</sub> | -9.34                            | 36.6                                | 27.26                       |
| f <sub>3</sub> | 852.5           | P <sub>03</sub> | -55.67                           | 36.6                                | -19.07                      |
| f <sub>4</sub> | 867.5           | P <sub>04</sub> | -56.77                           | 36.6                                | -20.17                      |

$$P_{\text{mean}} = P_{01} + 3\text{dB}$$

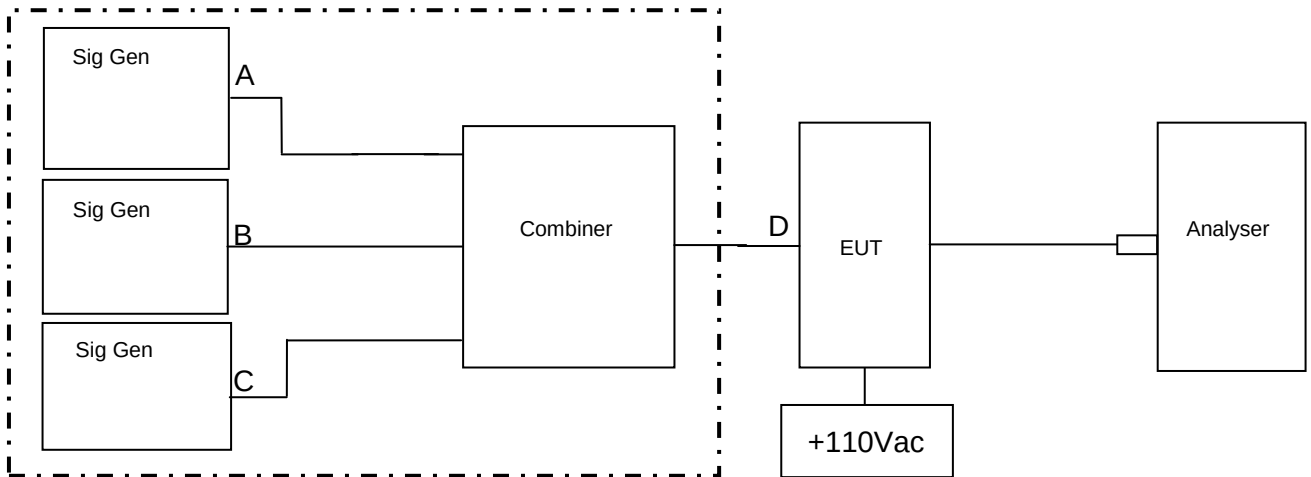
|                       |                       |                         |
|-----------------------|-----------------------|-------------------------|
| P <sub>01</sub> (dBm) | P <sub>mean</sub>     | P <sub>mean</sub> (dBm) |
| 27.87                 | P <sub>01</sub> + 3dB | 30.87                   |



Date: 16.JUL.2013 17:21:48

**B2 Amplifier Intermodulation Spurious Emissions**

| Test Details:          |                                |
|------------------------|--------------------------------|
| Measurement standard   | Part 2.1053, Part 90.219(d)(6) |
| EUT sample number      | S01                            |
| Modification state     | 0                              |
| SE in test environment | None                           |
| SE isolated from EUT   | None                           |
| EUT set up             | Refer to Appendix C            |



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

| RF Input Frequency (MHz) |       |       | Highest Intermodulation Product Level (dBm) | Limit (dBm) |
|--------------------------|-------|-------|---------------------------------------------|-------------|
| 851.0                    | 857.0 | 869.0 | -23.58 dBm @ 863.0 MHz                      | -13         |

Sweep data is shown on the next page:

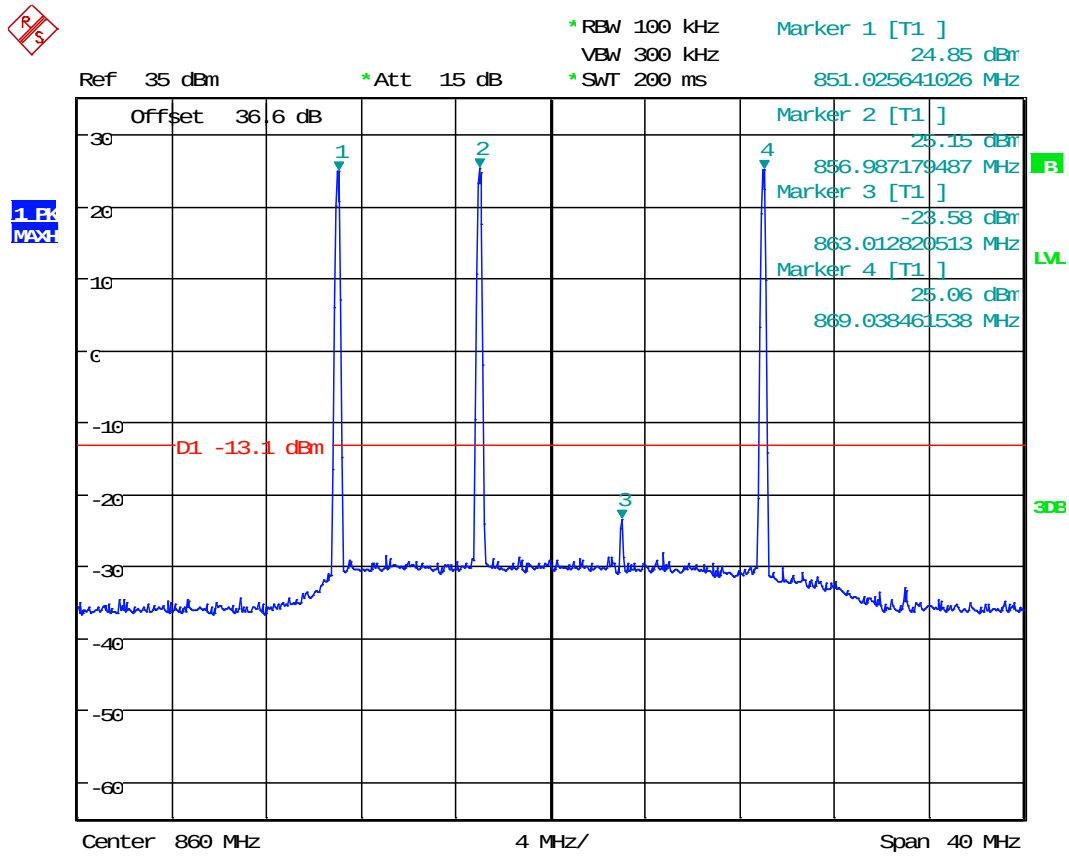
**Results**

The EUT was found to comply with the limits

See plots below

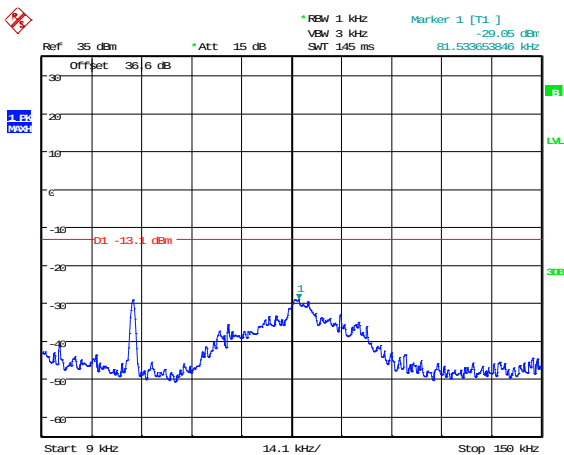
As per Annex A clause 11 of KDB 935210 D02 Signal Boosters Certification v01r01 the EUT was tested at compression and 10dB into compression to show AGC operation

# Intermodulation close View



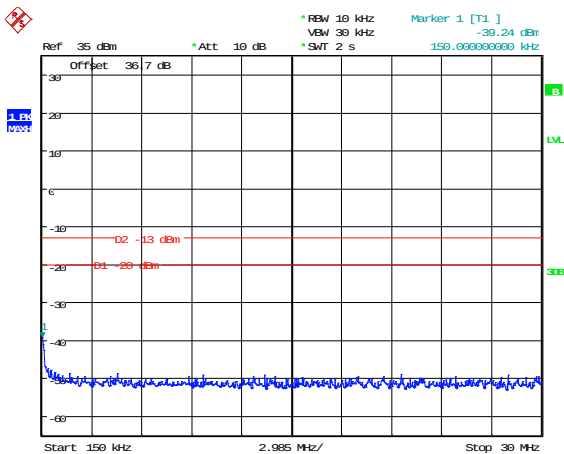
Date: 16.JUL.2013 10:19:20





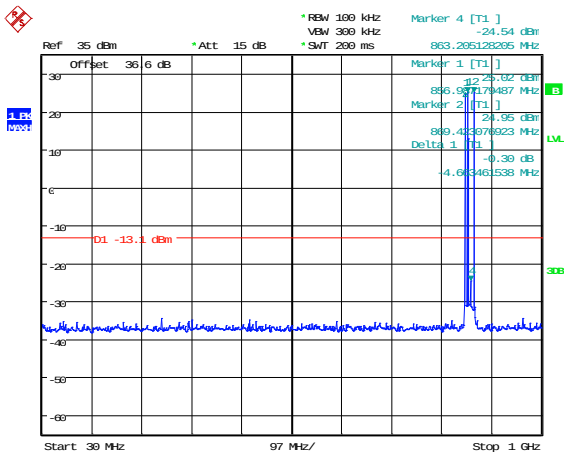
Date: 16.JUL.2013 10:37:36

9-150kHz



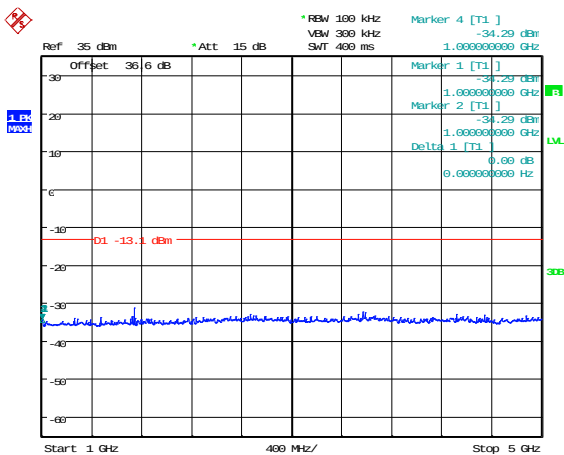
Date: 15.JUL.2013 10:34:17

150kHz – 30MHz



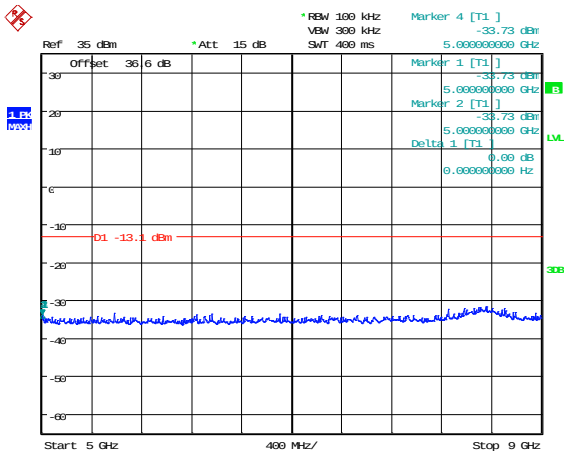
Date: 16.JUL.2013 10:20:13

30MHz – 1GHz



Date: 16.JUL.2013 10:34:45

1GHz – 5GHz



Date: 16.JUL.2013 10:37:13

5GHz – 9GHz

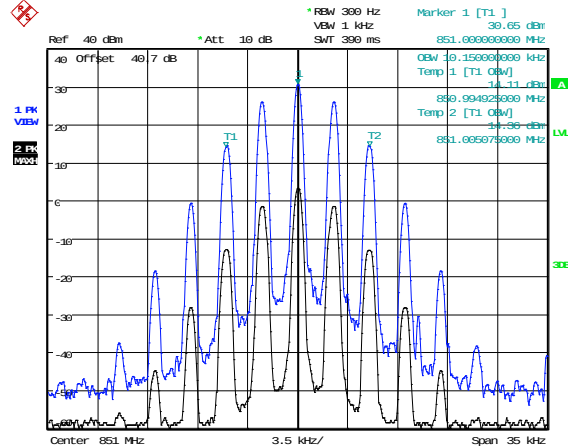
**B3 Amplifier Modulated Channel Test**

| Test Details:          |                                                |
|------------------------|------------------------------------------------|
| Measurement standard   | Part 2.1049, Part 90.219(4)(e)(iii), 90.210(h) |
| EUT sample number      | S01                                            |
| Modification state     | 0                                              |
| SE in test environment | None                                           |
| SE isolated from EUT   | None                                           |
| EUT set up             | Refer to Appendix C                            |

| Modulation Type | Frequency Of Operation Channel |           |           |
|-----------------|--------------------------------|-----------|-----------|
|                 | 851.0 MHz                      | 860.0 MHz | 869.0 MHz |
| Analogue        | 10.15 kHz                      | 10.15 kHz | 10.15 kHz |
| C4FM            | 8.74 kHz                       | 8.65 kHz  | 8.65 kHz  |
| P25             | 20.99 kHz                      | 20.99 kHz | 20.99 kHz |
| iDEN            | 28.84 kHz                      | 29.10 kHz | 28.84 kHz |

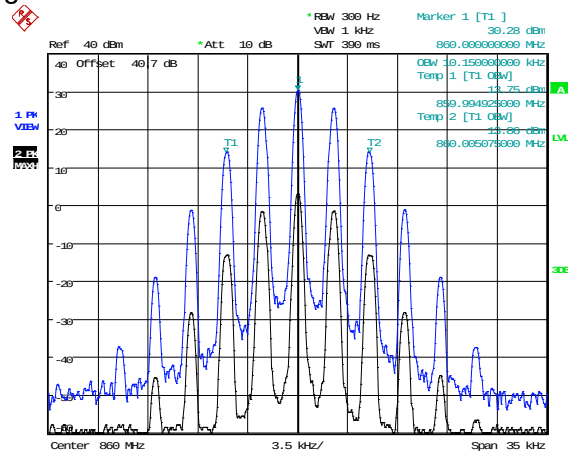
As per Annex A clause 11 of KDB 935210 D02 Signal Boosters Certification v01r01 the EUT was tested at compression and 10dB into compression to show AGC operation, worst case results taken.

## 851.0 MHz Analogue Signal Generator and EUT



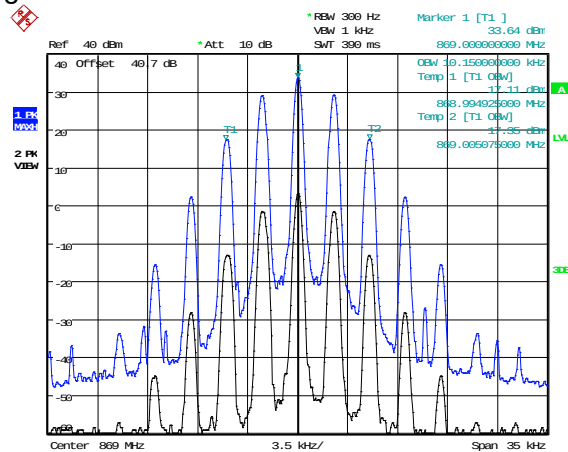
Date: 26.FEB.2014 11:56:19

## 860.0 MHz Analogue Signal Generator and EUT



Date: 26.FEB.2014 11:46:33

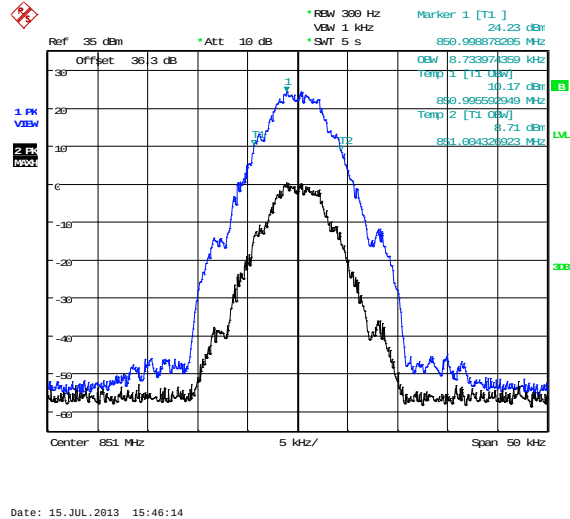
## 869.0 MHz Analogue Signal Generator and EUT



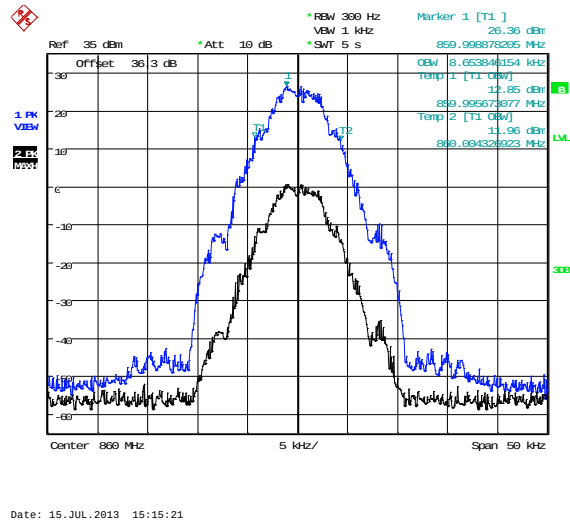
Date: 26.FEB.2014 11:54:32

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

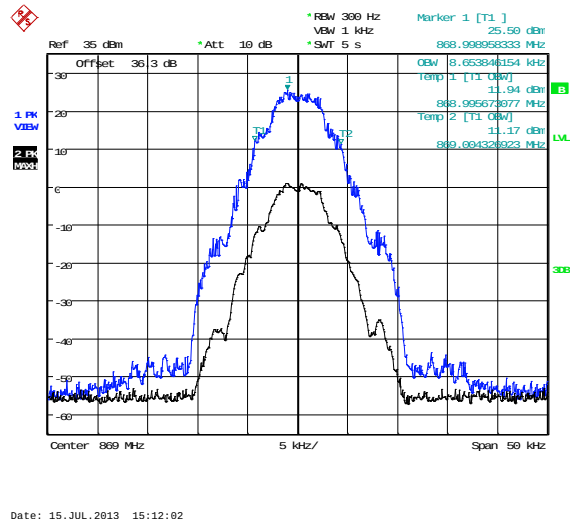
851.0 MHz C4FM Signal Generator and EUT



860.0 MHz C4FM Signal Generator and EUT

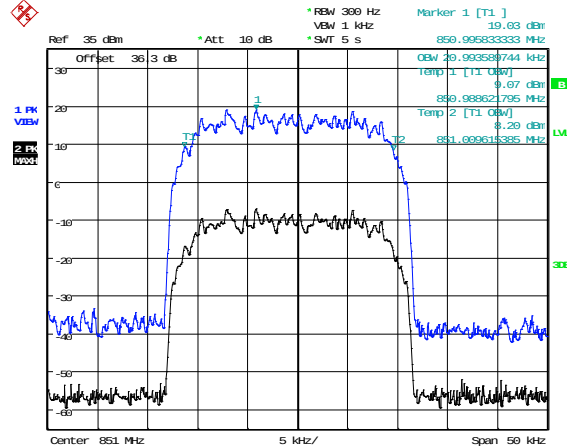


869.0 MHz C4FM Signal Generator and EUT



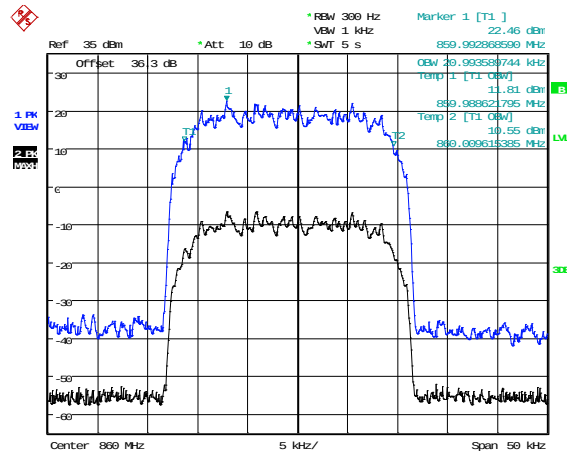
The above plots depicting the output waweshape show no measurable distortion visible when compared to the input signal.

## 851.0 MHz P25 Signal Generator and EUT



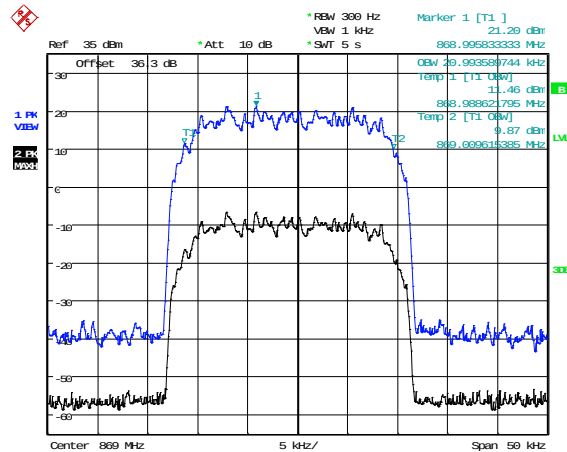
Date: 15.JUL.2013 14:55:10

## 860.0 MHz P25 Signal Generator and EUT



Date: 15.JUL.2013 14:57:06

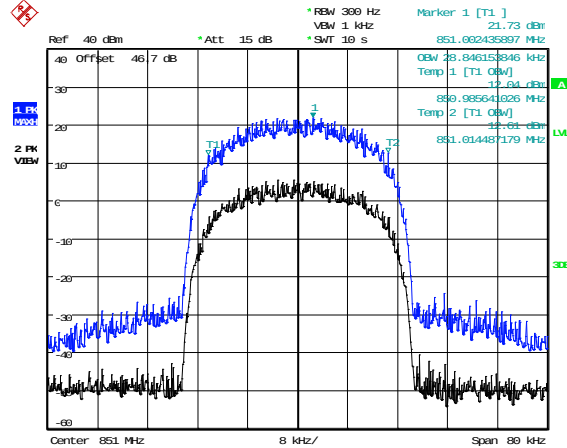
## 869.0 MHz P25 Signal Generator and EUT



Date: 15.JUL.2013 14:58:43

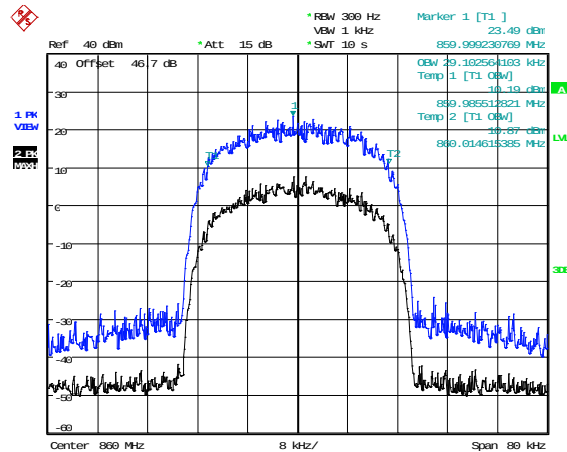
The above plots depicting the output wshapex show no measurable distortion visible when compared to the input signal.

## 851.0 MHz iDEN Signal Generator and EUT



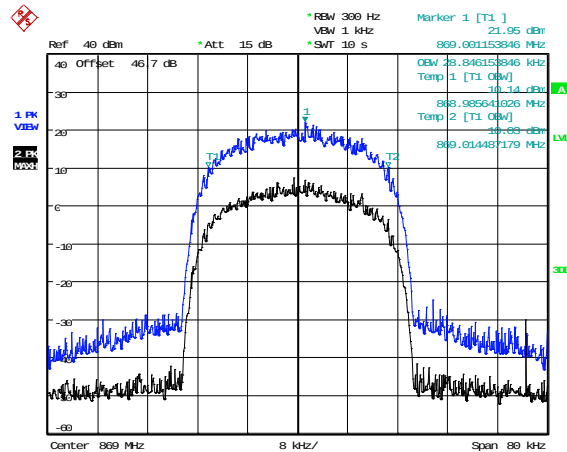
Date: 3.SEP.2013 11:18:51

## 860.0 MHz iDEN Signal Generator and EUT



Date: 3.SEP.2013 11:16:51

## 869.0 MHz iDEN Signal Generator and EUT



Date: 3.SEP.2013 11:28:57

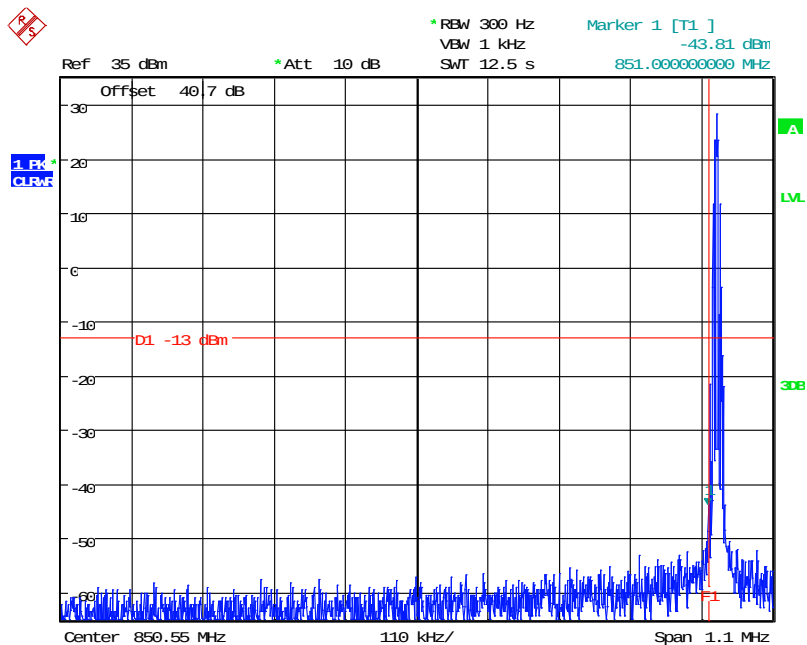
The above plots depicting the output wshapex show no measurable distortion visible when compared to the input signal.

**B4 Spurious Emissions at Antenna Terminals Less than 1MHz**

| <b>Test Details:</b>   |                                      |
|------------------------|--------------------------------------|
| Measurement standard   | Part 2.1053, 90.219(e)(3), 90.210(h) |
| EUT sample number      | S01                                  |
| Modification state     | 0                                    |
| SE in test environment | None                                 |
| SE isolated from EUT   | None                                 |
| EUT set up             | Refer to Appendix C                  |

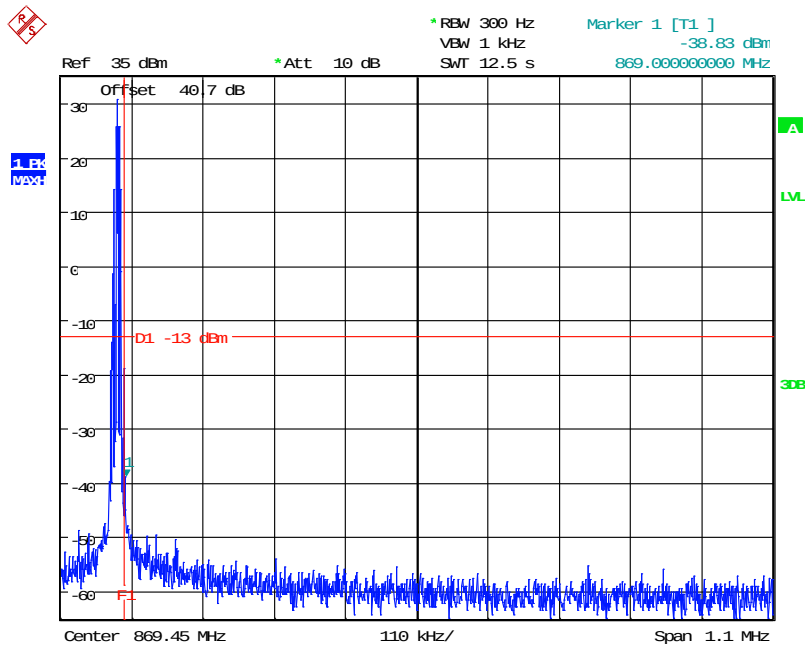
| Modulation Type | Bandedge | Carrier Frequency (MHz) | Max Level @ bandedge (dBm) |
|-----------------|----------|-------------------------|----------------------------|
| Analogue        | Lower    | 851.01250               | -43.81                     |
|                 | Upper    | 868.98750               | -38.83                     |
| C4FM            | Lower    | 851.01250               | -51.42                     |
|                 | Upper    | 868.98750               | -44.85                     |
| P25             | Lower    | 851.01250               | -45.65                     |
|                 | Upper    | 868.98750               | -39.18                     |
| iDEN            | Lower    | 851.03125               | -30.34                     |
|                 | Upper    | 868.96875               | -27.27                     |





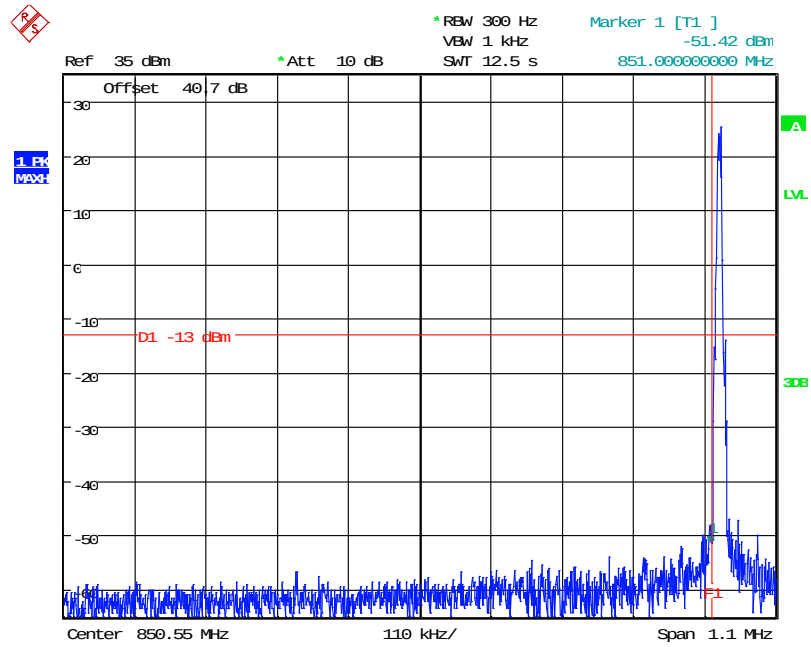
Date: 26.FEB.2014 16:36:50

Analogue Signal – Lower Bandedge



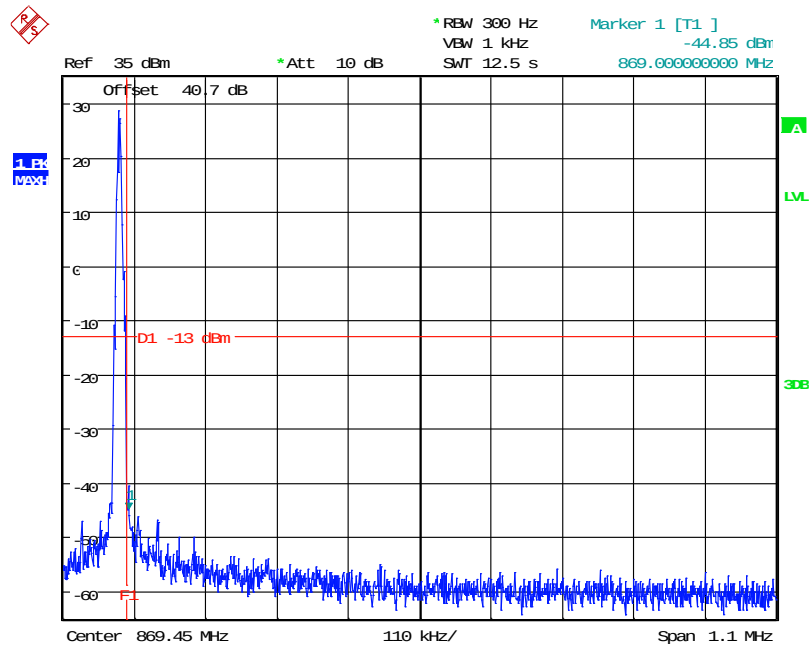
Date: 26.FEB.2014 16:43:22

Analogue Signal – Upper Bandedge



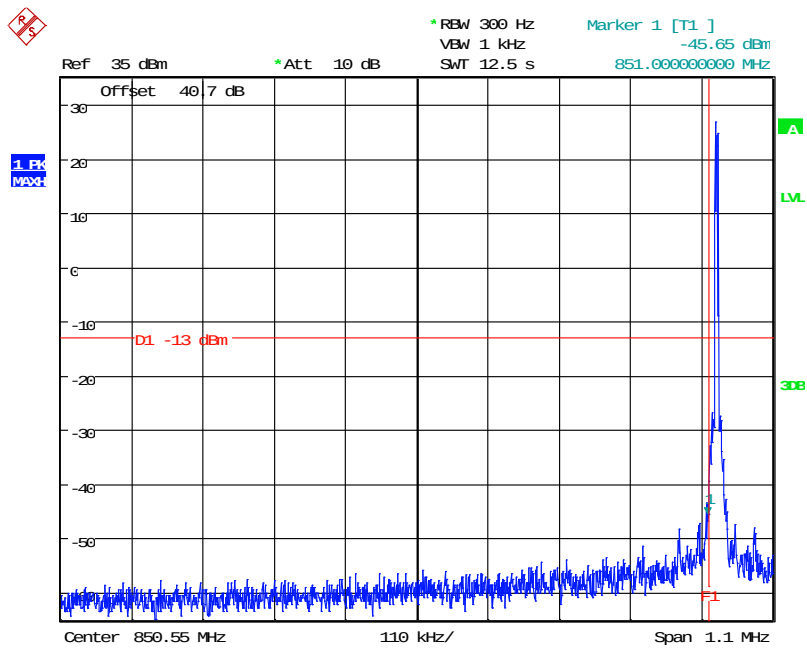
Date: 26.FEB.2014 16:37:29

### C4FM Signal – Lower Bandedge



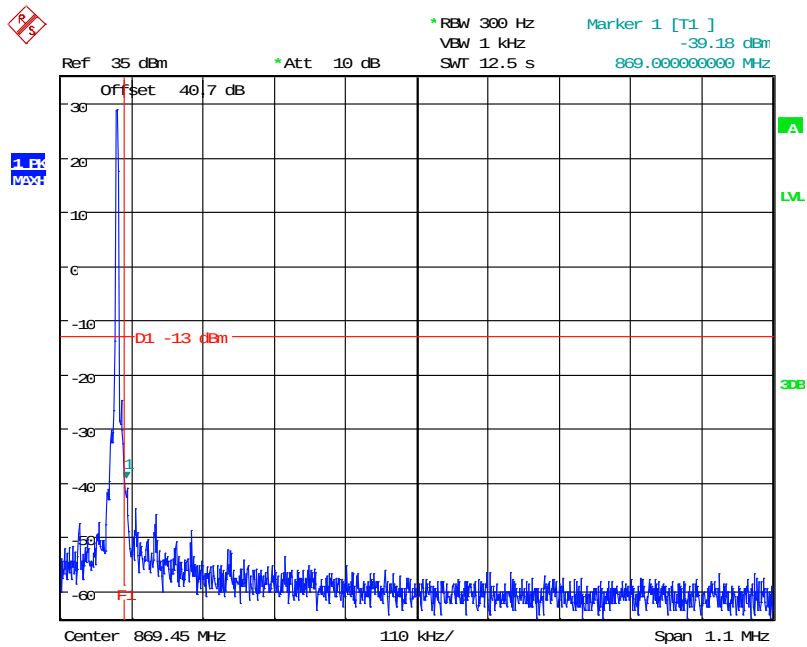
Date: 26.FEB.2014 16:41:27

### C4FM Signal – Upper Bandedge



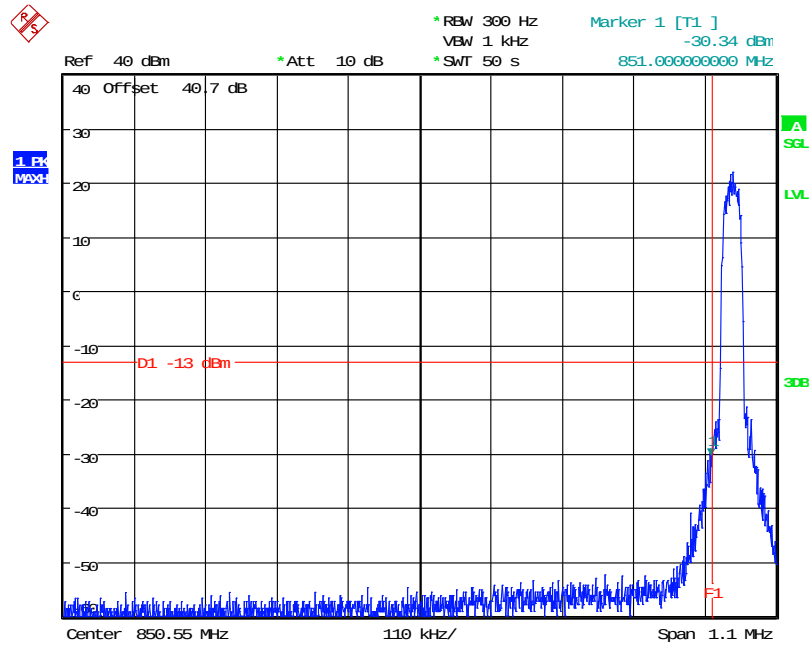
Date: 26.FEB.2014 16:38:38

P25 Signal – Lower Bandedge



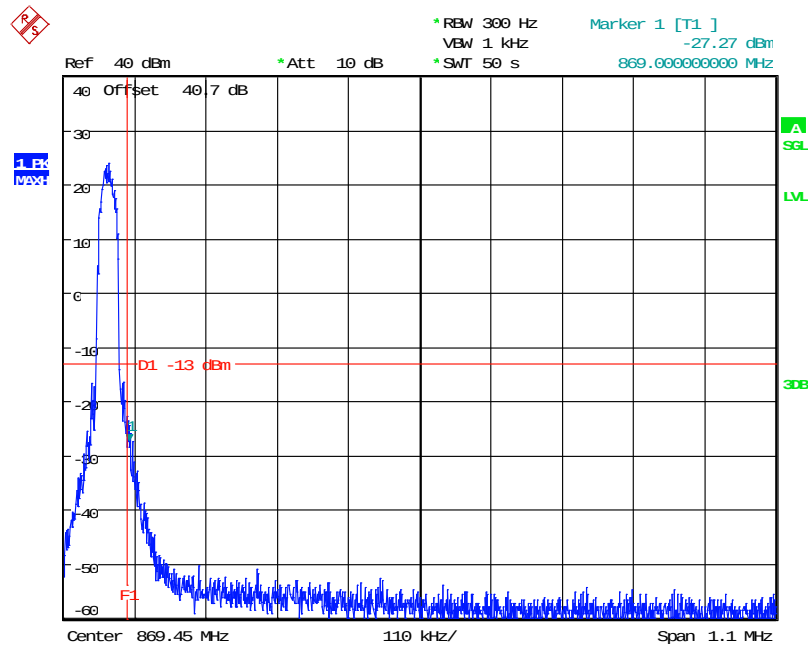
Date: 26.FEB.2014 16:40:16

P25 Signal – Upper Bandedge



Date: 27.FEB.2014 10:25:06

### iDEN Signal – Lower Bandedge



Date: 27.FEB.2014 10:18:38

### iDEN Signal – Upper Bandedge

**B5 Spurious Emissions at Antenna Terminals Greater than 1MHz**

| Test Details:          |                           |
|------------------------|---------------------------|
| Measurement standard   | Part 2.1053, 90.219(e)(3) |
| EUT sample number      | S01                       |
| Modification state     | 0                         |
| SE in test environment | None                      |
| SE isolated from EUT   | None                      |
| 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 |
|-----------------------|--------------------------|----------------------|--------------------------------|-------------------------------|-----------|
| 9 kHz – 9 GHz         | No Significant Emissions |                      |                                |                               | -13       |

**Middle Channel**

| Frequency Range (MHz) | Freq. of Emission (MHz)  | Measured Level (dBm) | Attenuator & Cable Losses (dB) | Spurious Emission Level (dBm) | Limit dBm |
|-----------------------|--------------------------|----------------------|--------------------------------|-------------------------------|-----------|
| 9 kHz – 9 GHz         | No Significant Emissions |                      |                                |                               | -13       |

**Top channel**

| Frequency Range (MHz) | Freq. of Emission (MHz)  | Measured Level (dBm) | Attenuator & Cable Losses (dB) | Spurious Emission Level (dBm) | Limit dBm |
|-----------------------|--------------------------|----------------------|--------------------------------|-------------------------------|-----------|
| 9 kHz – 9 GHz         | No Significant Emissions |                      |                                |                               | -13       |

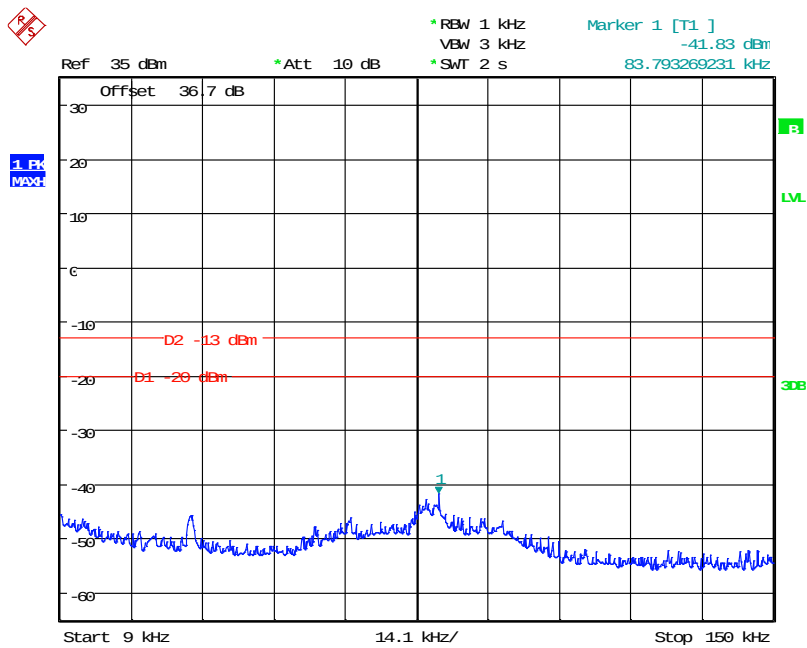
Limit is determined by the outermost step of the emissions mask and is calculated as follows:

At least  $43 + 10 \log P$  dB

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

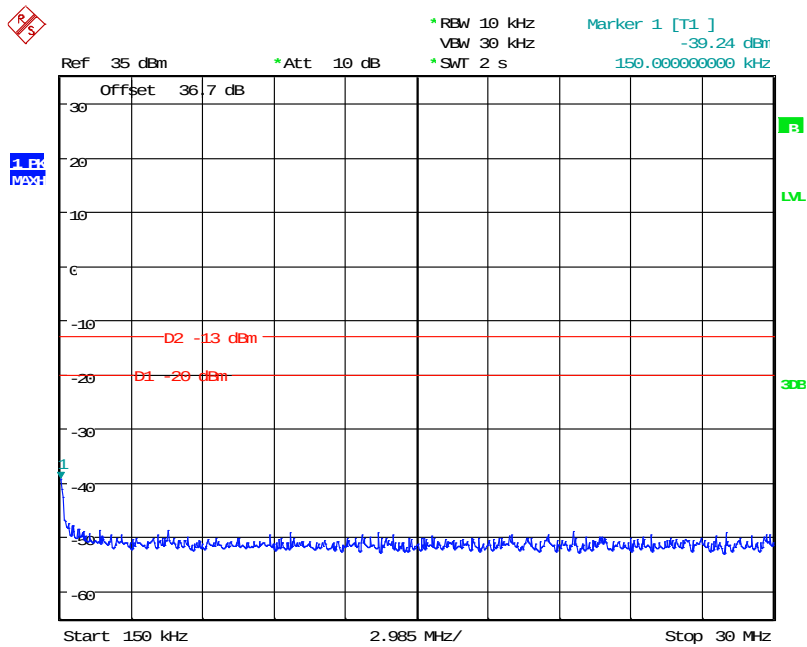
**Result**

The EUT was found to comply with the limits



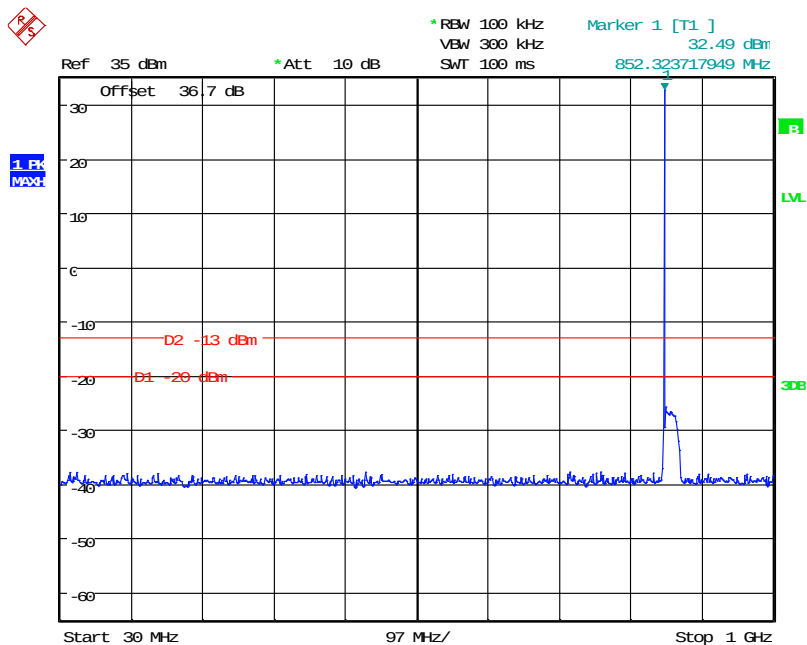
Date: 15.JUL.2013 10:33:45

851.0 MHz - 9-150kHz



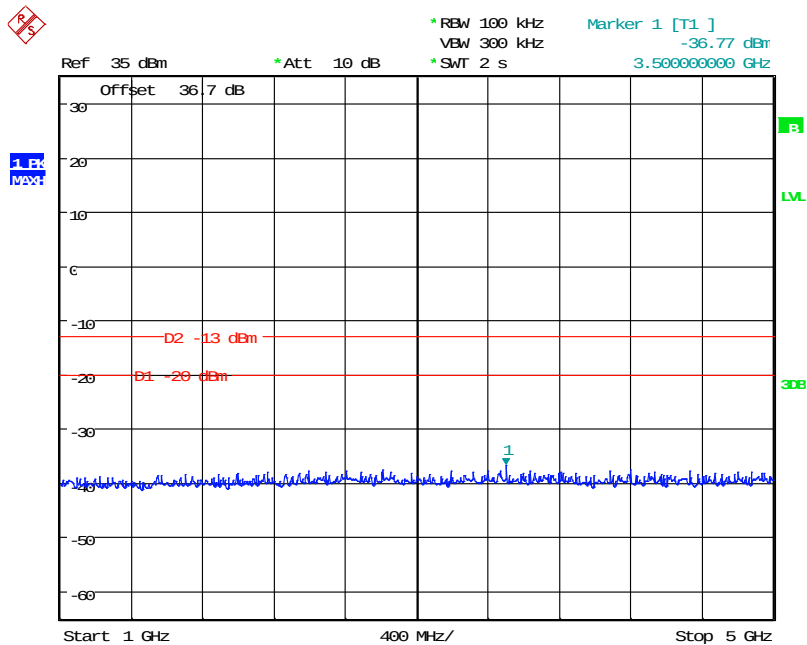
Date: 15.JUL.2013 10:34:17

851.0 MHz - 150kHz – 30MHz



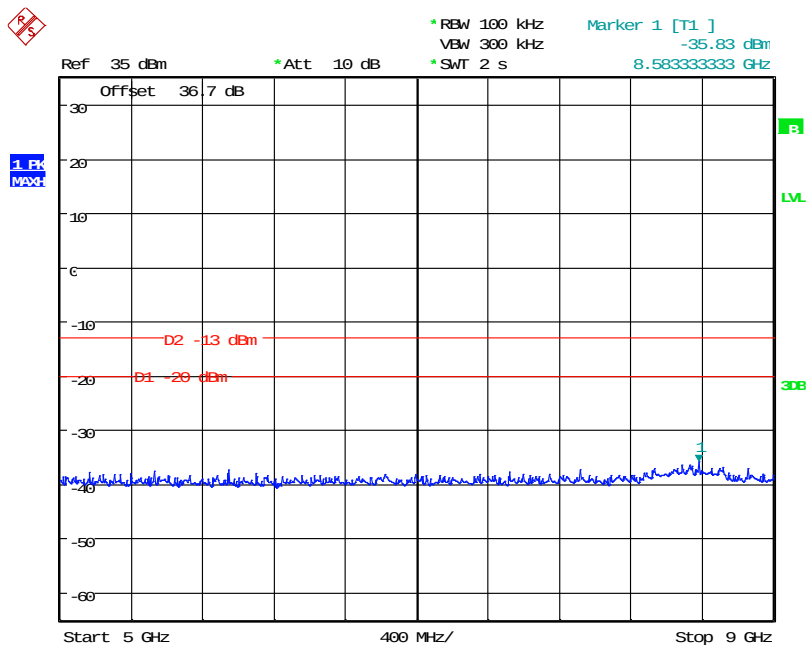
Date: 15.JUL.2013 10:31:41

851.0 MHz - 30MHz – 1GHz



Date: 15.JUL.2013 10:34:41

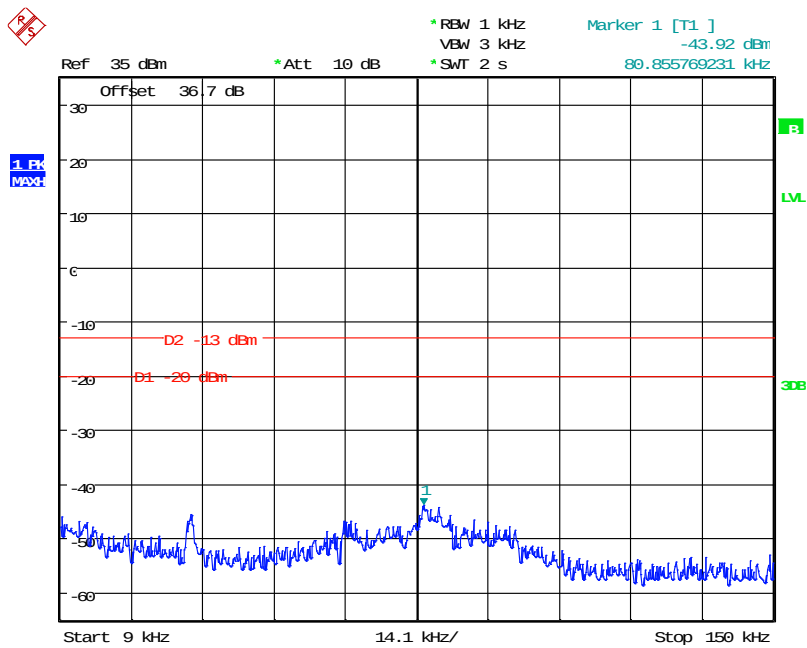
851.0 MHz - 1GHz – 5GHz



Date: 15.JUL.2013 10:35:08

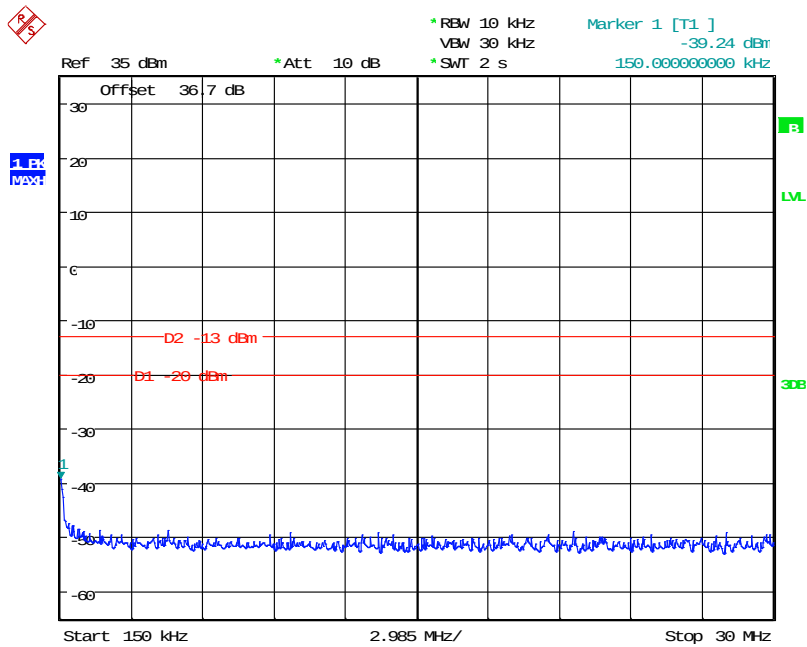
851.0 MHz - 5GHz – 9GHz





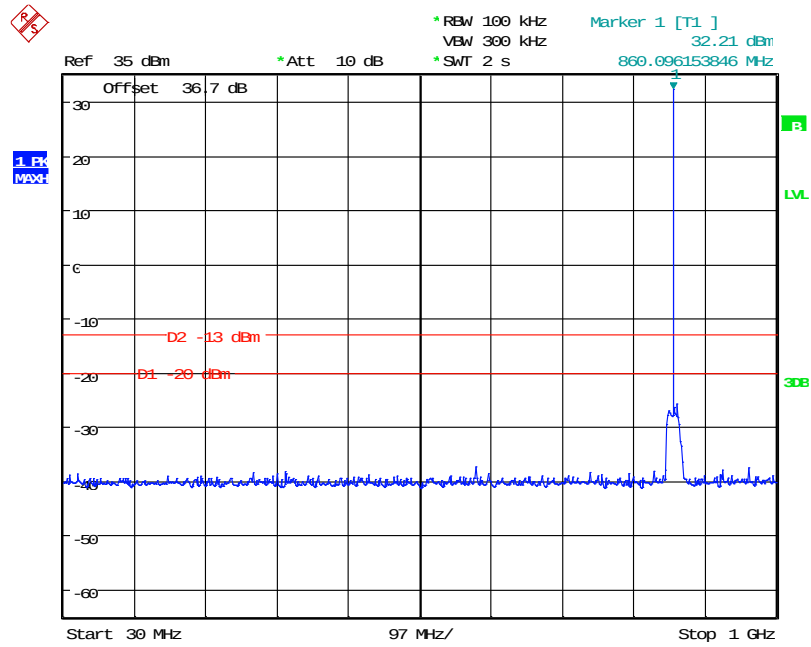
Date: 15.JUL.2013 10:39:33

860.0 MHz- 9-150kHz



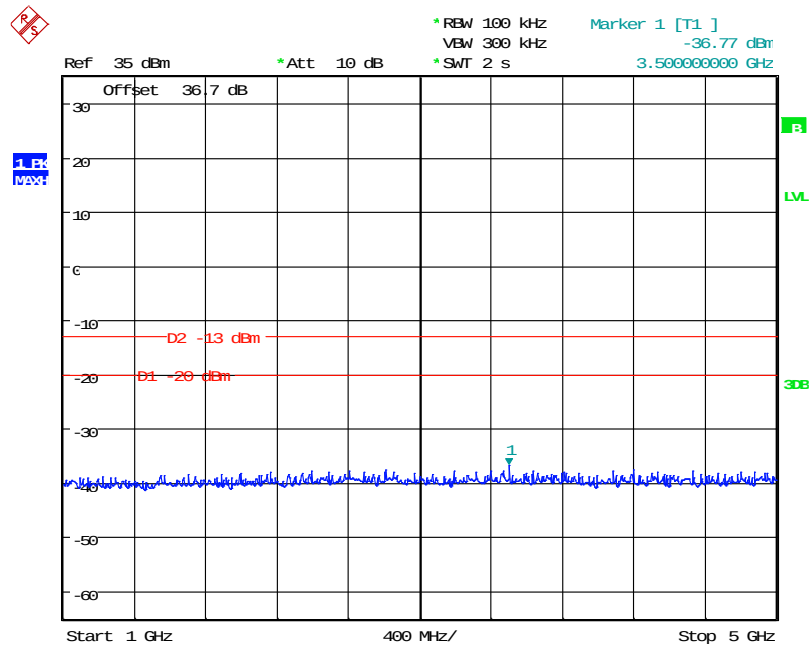
Date: 15.JUL.2013 10:34:17

860.0 MHz - 150kHz – 30MHz



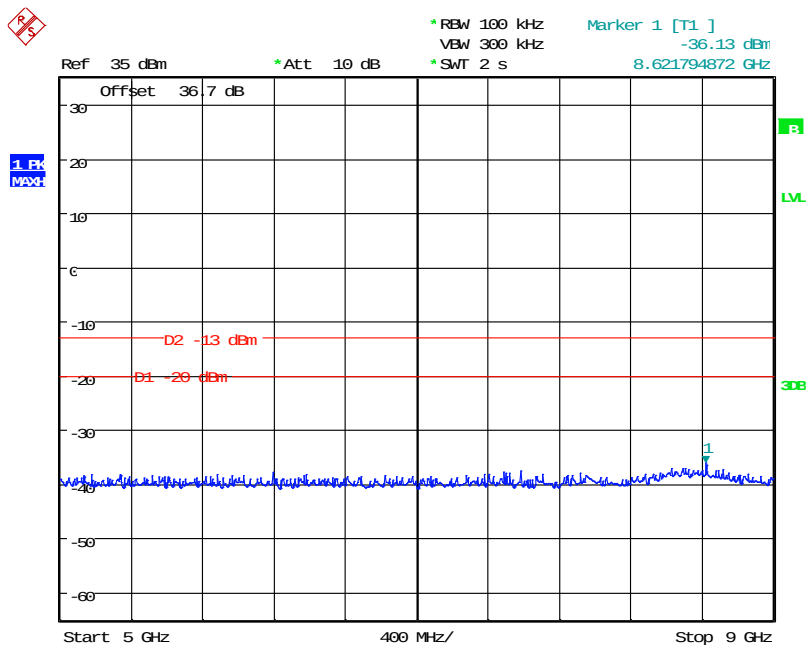
Date: 15.JUL.2013 10:36:27

860.0 MHz - 30MHz – 1GHz



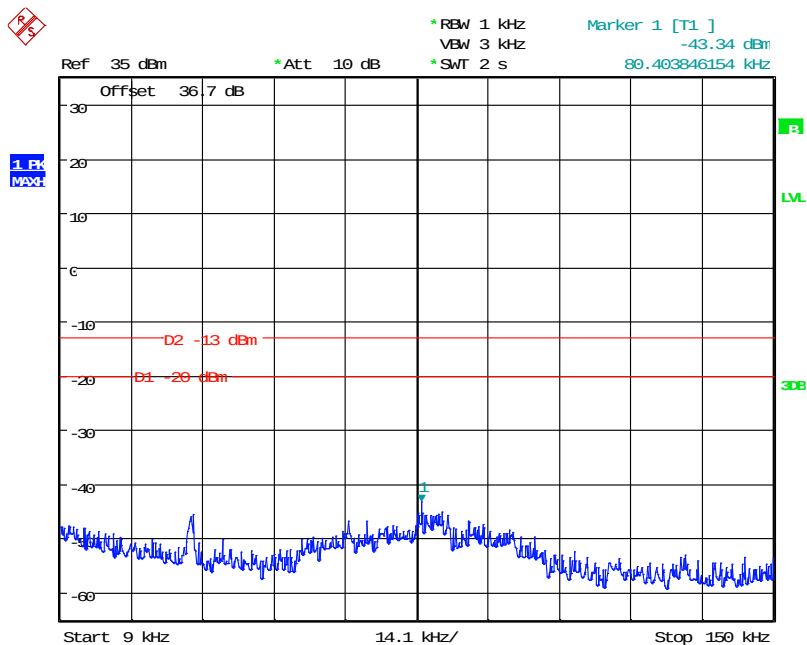
Date: 15.JUL.2013 10:34:41

860.0 MHz - 1GHz – 5GHz



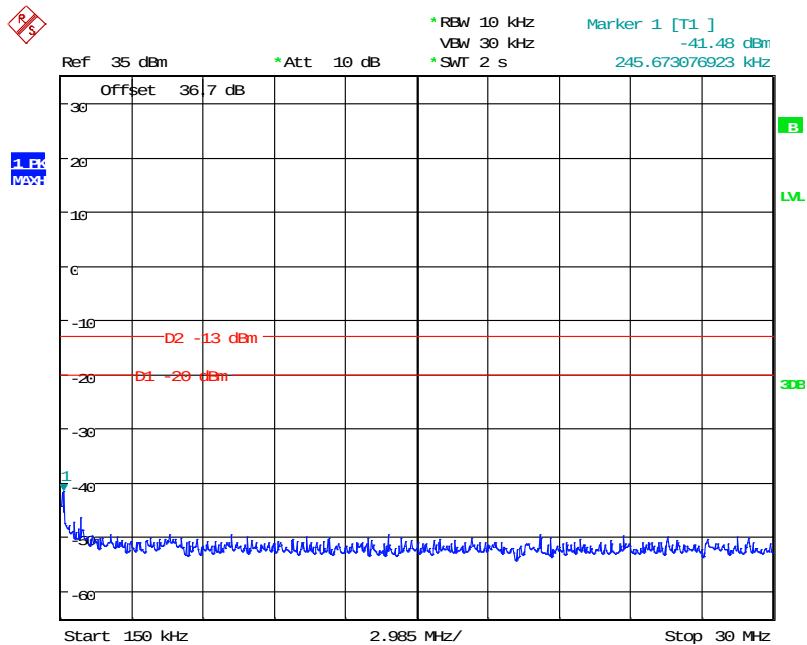
Date: 15.JUL.2013 10:35:30

860.0 MHz - 5GHz – 9GHz



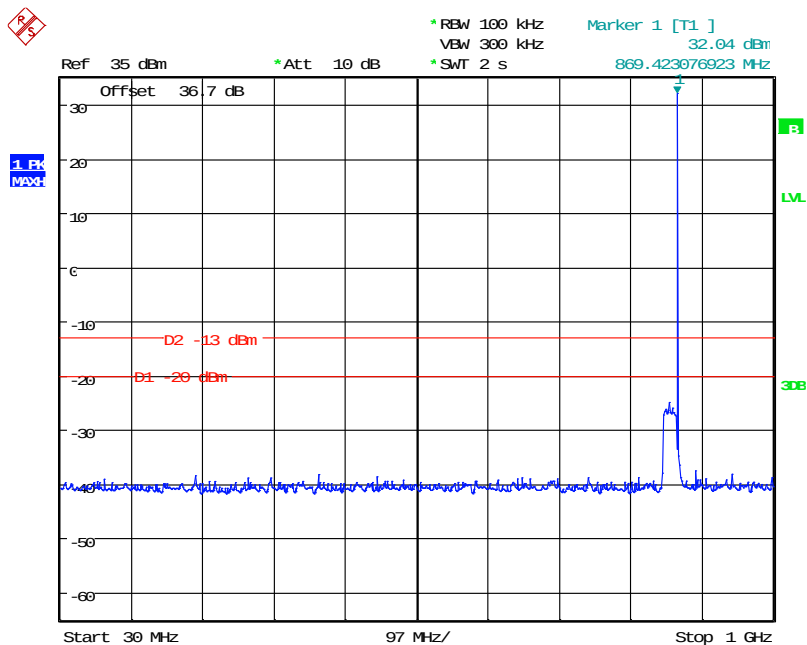
Date: 15.JUL.2013 10:39:58

869.0 MHz - 9-150kHz



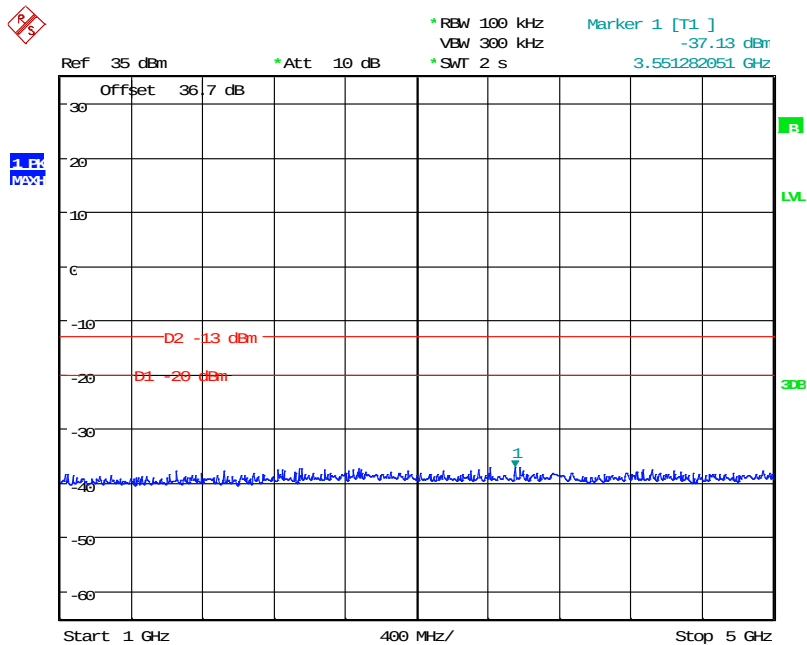
Date: 15.JUL.2013 10:41:45

869.0 MHz - 150kHz – 30MHz



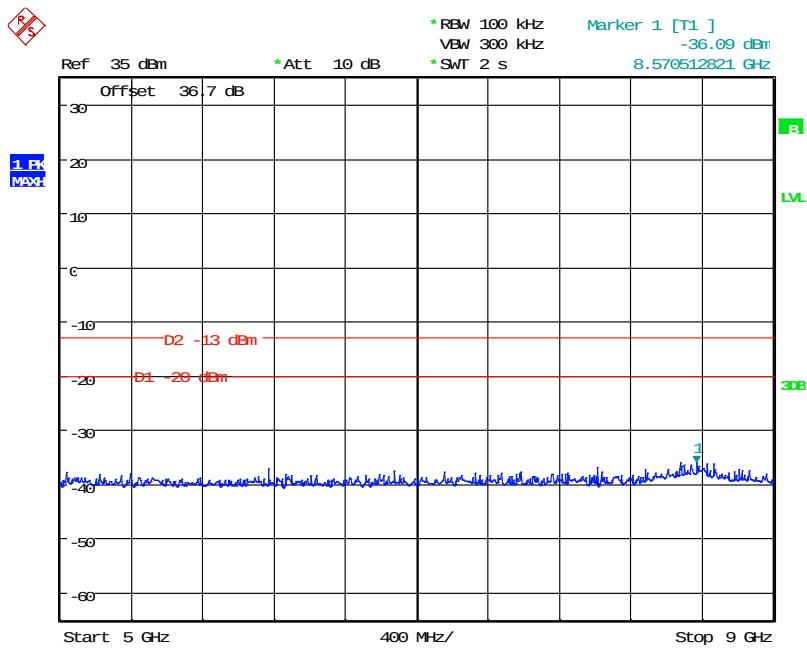
Date: 15.JUL.2013 10:42:07

869.0 MHz - 30MHz – 1GHz



Date: 15.JUL.2013 10:42:55

869.0 MHz - 1GHz – 5GHz



Date: 15.JUL.2013 10:43:17

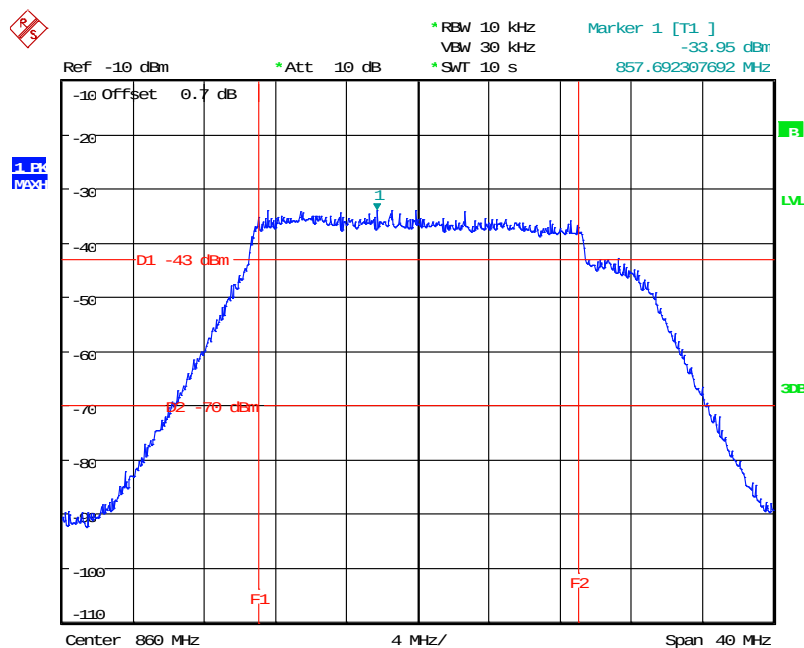
869.0 MHz - 5GHz – 9GHz

**B6 Noise at Antenna Terminals**

| Test Details:          |                            |
|------------------------|----------------------------|
| Measurement standard   | 90.219(e)(2), 90.219(d)(6) |
| EUT sample number      | S01                        |
| Modification state     | 0                          |
| SE in test environment | None                       |
| SE isolated from EUT   | None                       |
| EUT set up             | Refer to Appendix C        |

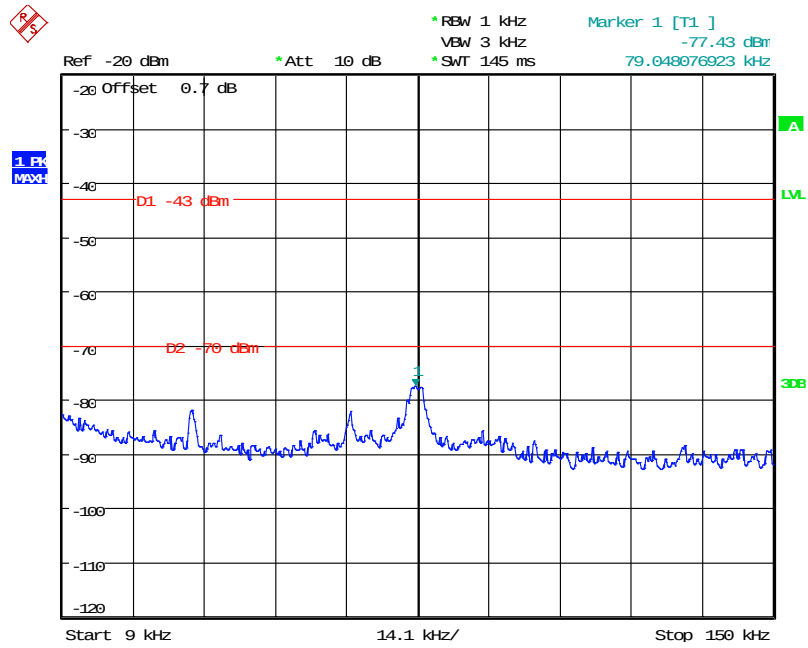
Compliance with these levels will be deemed satisfaction of the good engineering practice requirement. In a 10 kHz measurement bandwidth:

- (1) the ERP of noise within the signal booster passband should not exceed  $-43\text{dBm}$ ;  
and
- (2) the ERP of noise on spectrum more than 1 MHz outside of the signal booster passband should not exceed  $-70\text{ dBm}$ .
- (3) The noise figure of a signal booster must not exceed 9 dB in either direction

**IN BAND AMPLIFIER NOISE**

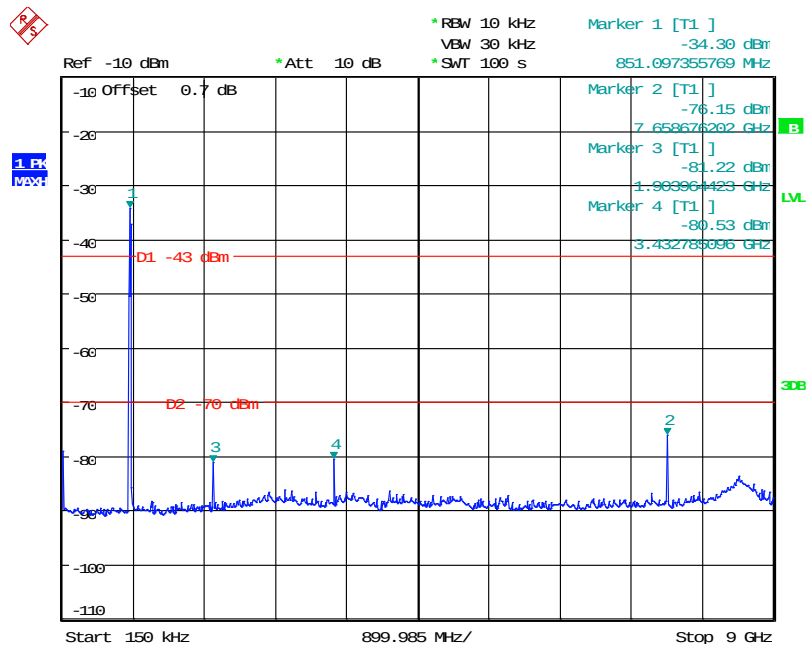
Date: 15.JUL.2013 10:46:53

# OUT OF BAND AMPLIFIER NOISE 9-150kHz



Date: 15.JUL.2013 11:04:49

# OUT OF BAND AMPLIFIER NOISE 150kHz-9GHz



Date: 15.JUL.2013 11:03:12



**Whilst the pass band noise is greater than the -43dBm limit by approximately 7dB, the manufacturer has stated that they mitigate this by using good engineering practice as follows:-**

**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 3308 signal booster has a noise level of -43 dBm in 10 kHz measurement at 1 MHz spectrum outside the passband of the signal booster.*

*It has an in-band noise level at around -37 dBm in a 10 kHz bandwidth*

*Therefore the noise at the antenna input port should be calculated based on equation (3)*

**Equation (3) - Input Noise to service antenna**

*Input Noise to service antenna:*

*-43 dBm + Service Antenna gain – Antenna splitter losses in dB – cable loss in dBs*

**Example:**

*Signal booster connected to 10 service antennas with a 100m long ½ inch cable.*

- Losses of such a cable with the connectors = ~ 11dB.*
- Gain = ~ 2 dBi*

*Assuming 10 service antennas: antenna splitter losses = 11 dBi*

*Based on equation (3) Input antenna noise (to the antenna) = -43+2-11 -11=-63 dBm .*

*The inband input noise to the antenna should be -37+2 -11-11= -57dbm*

*NOTE: In this example you may be required in general to add an external bandpass filter that would attenuate the out of band noise by additional 7 dbs .*

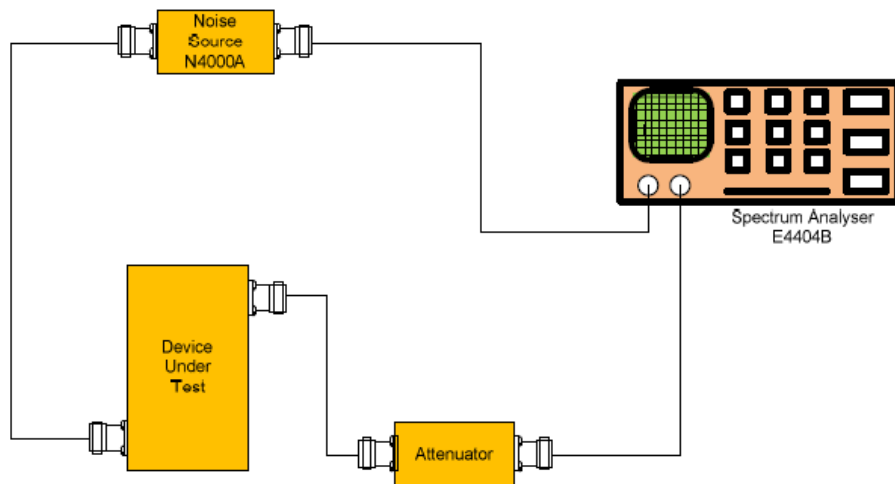
**Conclusion:**

*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 .*

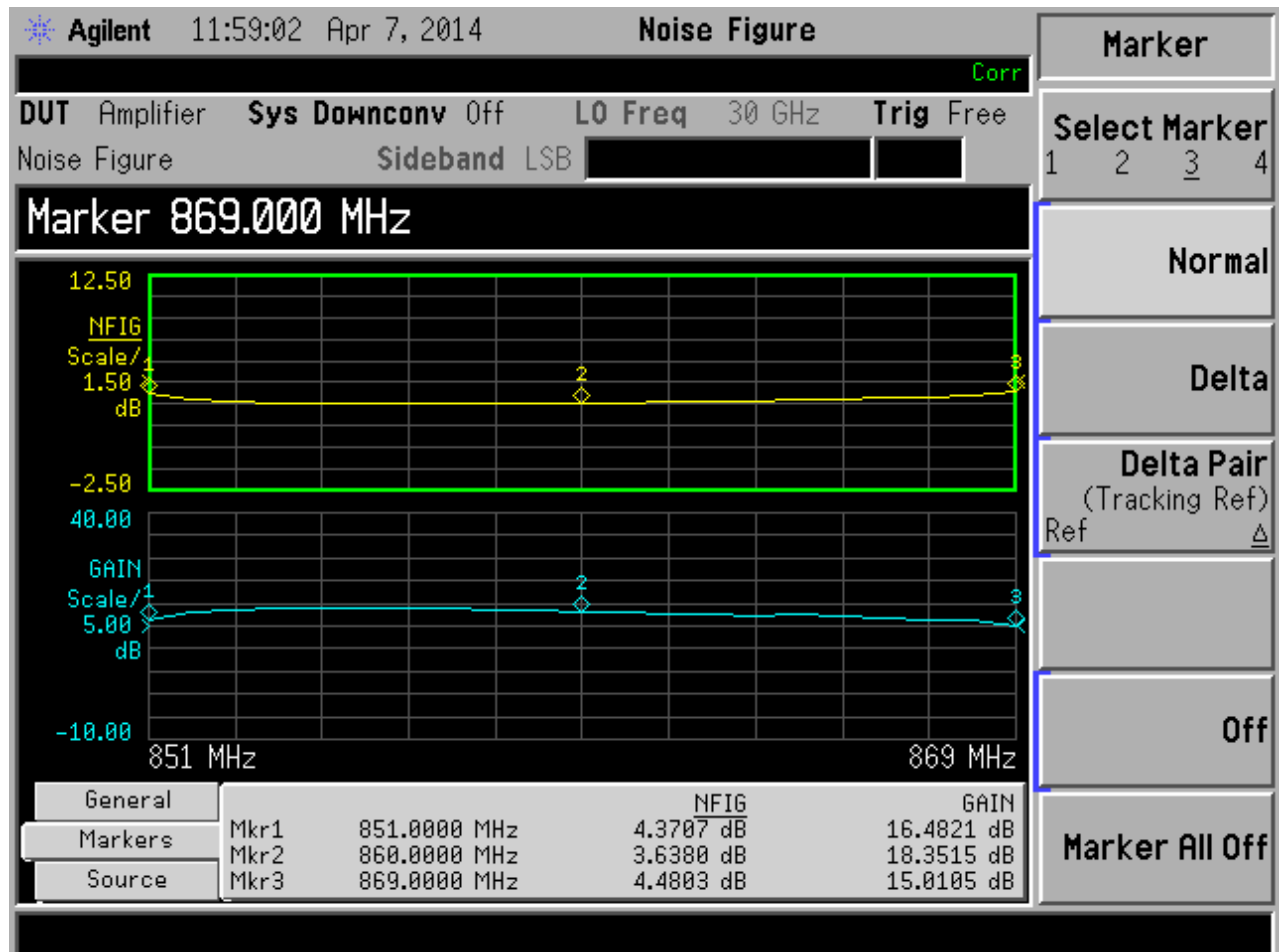
This information was extracted for the user manual.

## 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 |
|-----------------|-----------------|
| 851.0           | 4.4             |
| 860.0           | 3.6             |
| 869.0           | 4.5             |

General notes about measurement setup:

- 1) The spectrum analyser has the phase noise measuring personality enabled.

**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 : ☒

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

| Test Details:            |                                                         |
|--------------------------|---------------------------------------------------------|
| Measurement standard     | Title 47 of the CFR: Part 2.1053, RSS-131 Section 4.3.2 |
| Frequency range          | 30 MHz – 9 GHz                                          |
| EUT sample number        | S01                                                     |
| Modification state       | 0                                                       |
| SE in test environment   | None                                                    |
| SE isolated from EUT     | None                                                    |
| EUT set up               | Refer to Appendix C                                     |
| Temperature              | 23                                                      |
| Photographs (Appendix F) | 1 & 2                                                   |

**Bottom Frequency**

| FREQUENCY RANGE | FREQ. (MHz)              | ERP/EIRP (dBm) | LIMIT (dBm) |
|-----------------|--------------------------|----------------|-------------|
| 30 MHz – 9 GHz  | No Significant Emissions |                | -13         |

**Middle Frequency**

| FREQUENCY RANGE | FREQ. (MHz)              | ERP/EIRP (dBm) | LIMIT (dBm) |
|-----------------|--------------------------|----------------|-------------|
| 30 MHz – 9 GHz  | No Significant Emissions |                | -13         |

**Top Frequency**

| FREQUENCY RANGE | FREQ. (MHz)              | ERP/EIRP (dBm) | LIMIT (dBm) |
|-----------------|--------------------------|----------------|-------------|
| 30 MHz – 9 GHz  | No Significant Emissions |                | -13         |

**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° 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

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

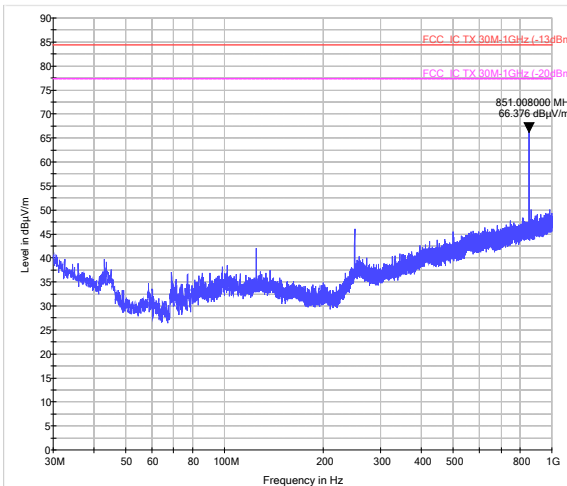
The upper and lower frequency of the measurement range was decided according to 47 CFR Part 2.1057.

- (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:

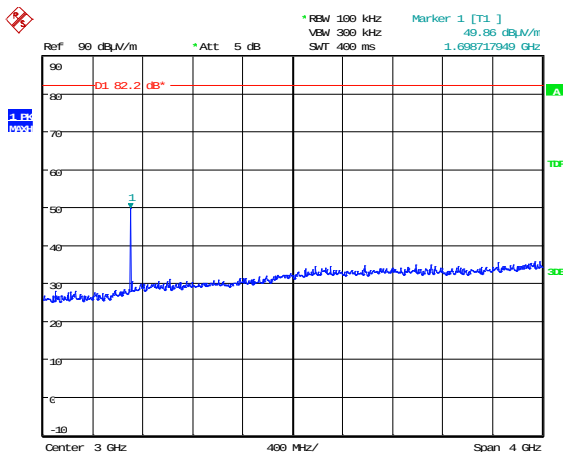
$$\text{Extrapolation (dB)} = 20 \log_{10} \left( \frac{\text{measurement distance}}{\text{specification distance}} \right)$$

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

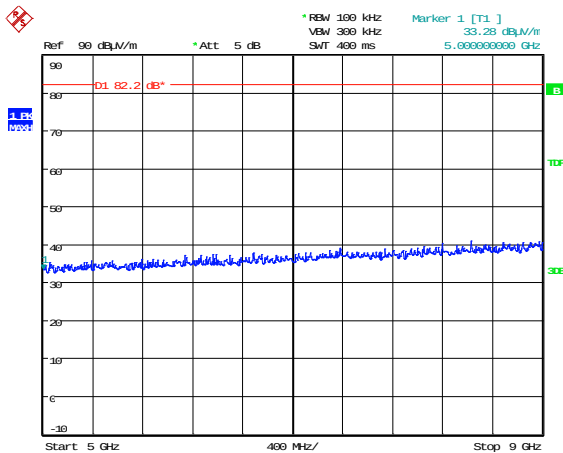


851.0 MHz 30MHz – 1GHz



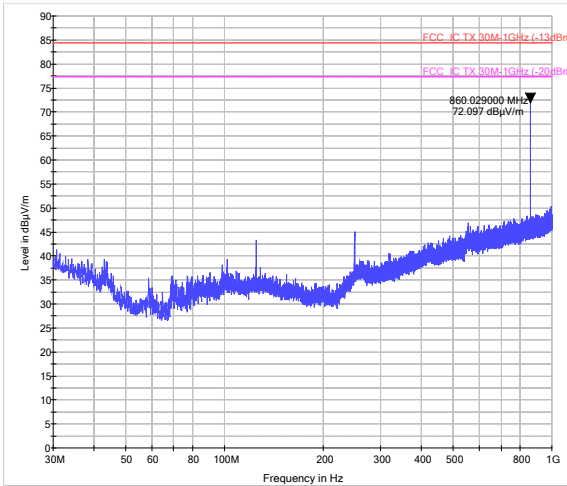
Date: 16.JUL.2013 12:50:55

851.0 MHz 1GHz – 5GHz

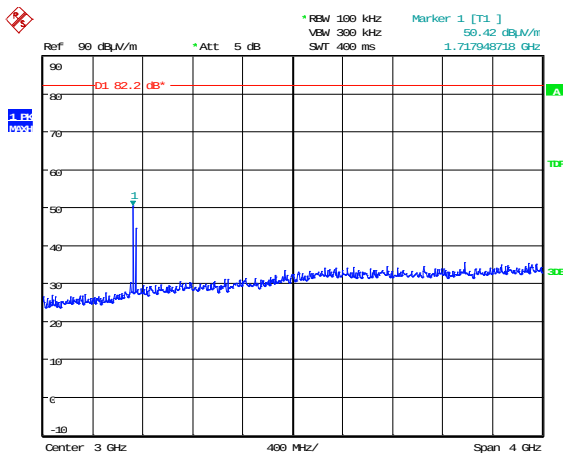


Date: 16.JUL.2013 12:51:50

851.0 MHz 5GHz – 9GHz

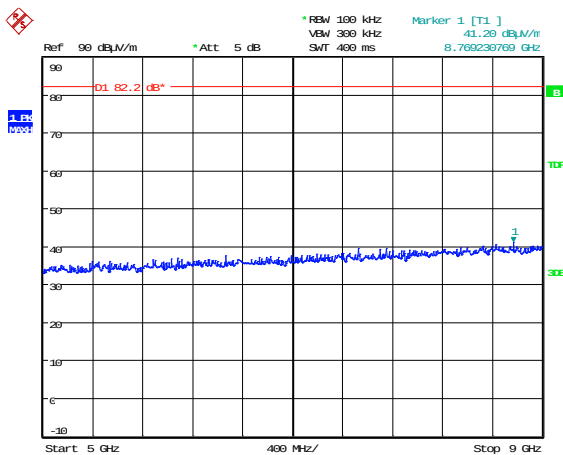


860.0 MHz 30MHz – 1GHz



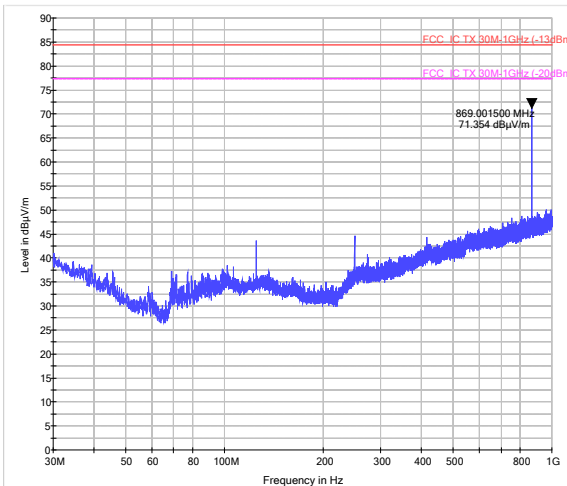
Date: 16.JUL.2013 12:55:25

860.0 MHz 1GHz – 5GHz

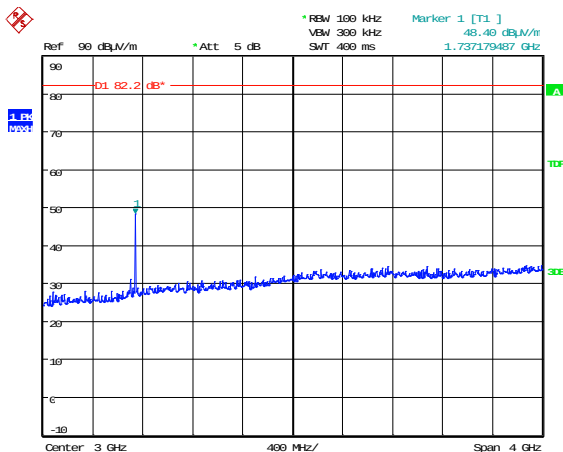


Date: 16.JUL.2013 12:54:59

860.0 MHz 5GHz – 9GHz

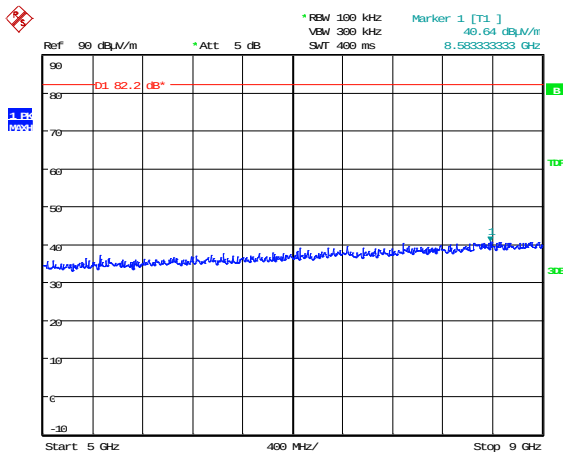


869.0 MHz 30MHz – 1GHz



Date: 16.JUL.2013 12:55:46

869.0 MHz 1GHz – 5GHz



Date: 16.JUL.2013 12:56:08

869.0 MHz 5GHz – 9GHz

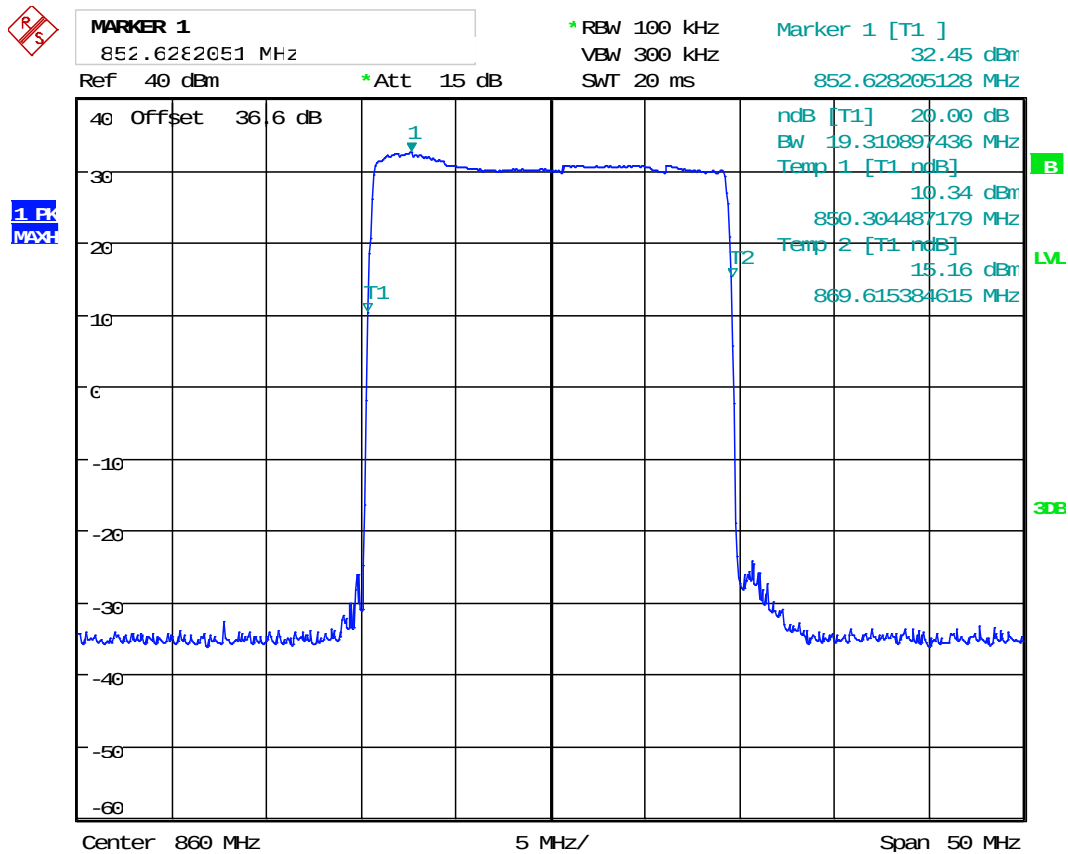


## B8 Passband Gain & Bandwidth

| Test Details:          |                     |
|------------------------|---------------------|
| Measurement standard   | RSS-131 Section 4.2 |
| EUT sample number      | S01                 |
| Modification state     | 0                   |
| SE in test environment | None                |
| SE isolated from EUT   | None                |
| EUT set up             | Refer to Appendix C |

| Frequency MHz | fl      | fh      | 20 dB Bandwidth |
|---------------|---------|---------|-----------------|
| 851.0 – 869.0 | 850.304 | 869.615 | 19.310 MHz      |

- See below for plots showing passband gain & bandwidth



Date: 16.JUL.2013 17:16:28

**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 identify 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 | Identification |
|------------|-------------|----------------|
| S01        | BSR-3308    | 12110001       |
|            |             |                |
|            |             |                |

The following samples of apparatus were submitted by the client as host, support or drive equipment (auxiliary equipment):

| Sample No. | Description | Identification |
|------------|-------------|----------------|
|            |             |                |
|            |             |                |
|            |             |                |

The following samples of apparatus were supplied by TRaC Global as support or drive equipment (auxiliary equipment):

| Identification | Description |
|----------------|-------------|
|                |             |
|                |             |
|                |             |

**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          |
|----------|-------------------------------|--------------|------------------------------|
| Mobile   | Coaxial                       | >1m          | Sig Gen or Spectrum Analyser |
| Base     | Coaxial                       | >1m          | Sig Gen or Spectrum Analyser |
| DC Power | M ulticore Mains CAble        | 30cm         | 110 – 24 Vdc converter       |
| Ethernet | Cat 5                         | >1m          | Control PC                   |

Sample : S01  
Tests : Radiated Emissions

| Port     | Description of Cable Attached | Cable length | Equipment Connected    |
|----------|-------------------------------|--------------|------------------------|
| Mobile   | Coaxial                       | >1m          | Sig Gen or 50Ω Load    |
| Base     | Coaxial                       | >1m          | Sig Gen or 50Ω Load    |
| DC Power | M ulticore Mains CAble        | 30cm         | 110 – 24 Vdc converter |
| Ethernet | Cat 5                         | >1m          | Control PC             |

\* 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          | 11/02/2013           |
| UH028   | UHALP 9108     | Log Periodic Ant        | Schwarbeck   | 08/07/2013           |
| UH29    | VHBA 9123      | Bicone Antenna          | Schwarbeck   | 19/08/2013           |
| UH093   | CBL6112B       | Bilog                   | Chase        | 08/07/2013           |
| UH096   | 6960B          | Power meter             | Marconi      | 04/11/2012           |
| UH122   | TDS520B        | Oscilloscope            | Tektronix    | 11/04/2012           |
| UH129   | 6924           | Power Sensor            | Marconi      | 03/12/2012           |
| UH187   | ESHS10         | Receiver                | R&S          | 11/02/2013           |
| UH191   | CBL611/A       | Bilog                   | Chase        | 13/12/2012           |
| UH195   | ESH3-Z5.831.5  | Lisn                    | R&S          | 03/07/2013           |
| UH228   | 6920           | Power Sensor            | Marconi      | 03/12/2012           |
| UH281   | FSU46          | Spectrum Analyser       | R&S          | 06/03/2013           |
| 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           |
| UH405   | FSU26          | Spectrum Analyser       | R&S          | 20/03/2013           |
| UH420   | CBL6112        | Bilog                   | Chase        | 06/07/2012           |
| L005    | CMTA52         | Communications Analyser | R&S          | 27/03/2013           |
| L007    | hfh2           | Loop Antenna            | R&S          | 04/11/2011           |
| L138    | 3115           | 1-18GHz Horn            | EMCO         | 08/11/2011           |
| L139    | 3115           | 1-18GHz Horn            | EMCO         | 14/09/2011           |
| L176    | 2042           | Signal Generator        | Marconi      | 20/11/2012           |
|         | E4404B         | Analyser                | Agilent      | 02/09/2014           |
|         | N4000A         | Noise Source            | Agilent      | 03/09/2014           |
| L254    | 2042           | Signal Generator        | Marconi      | 19/12/2012           |
| L193    | VHA 9103 balu  | Bicone Antenna          | Chase        | 19/06/2012           |
| L203    | UPA6108        | Log Periodic Ant        | Chase        | 19/06/2012           |
| L263/A  | 20240-20       | Horn 18-26GHz           | Flann        | 17/11/2011           |
| L290    | CBL611/A       | Bilog                   | Chase        | 13/12/2012           |
| L300    | 20240-20       | Horn 18-26GHz (&UH330)  | Flann        | 17/11/2011           |
| L317    | ESVS10         | Receiver                | R&S          | 09/01/2013           |
| L415    | ESVS20         | Receiver                | R&S          | 27/08/2013           |
| L426    | 52 Series II   | Temperature Indicator   | Fluke        | 29/04/2013           |
| L572    | 8449B          | Pre Amp                 | Agilent      | 12/12/2012           |
| L654    | 8563A          | Spectrum Analyser       | HP           | 18/10/2012           |
| REF909  | FSU26          | Spectrum Analyser       | R&S          | 04/02/2013           |
| REF916  | SMBV100A       | Signal Generator        | R&S          | 23/07/2012           |
| REF940  | ATS            | Radio Chamber - PP      | Rainford EMC | 09/07/2013           |

**Appendix D:**

**Additional Information**

No additional information is included within this test report.



## **Appendix F:**

## **Photographs and Figures**

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: BSR-3308 front view.
2. Radiated electric field emissions arrangement: BSR-3308 close up.



Photograph 1



Photograph 2

