A RADIO TEST REPORT

FOR

QUAKE GLOBAL Inc.

ON

Q4000

DOCUMENT NO. TRA-005709-00-W-US-1

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

TRaC Wireless Test Report	**:** TRA-005709-00-W-US-1
Applicant	**:** Quake Global Inc.
Apparatus	**:** Q4000
Specification(s)	**:** CFR47 Part 25 & CFR47 Part 15
Purpose of Test	**:** Certification
FCCID	**:** PB5Q96XXCS
Authorised by	**:** 
	Radio Product Manager
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Contents

Section 1: Introduction

1.1 General

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

Test performed by:

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

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

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

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

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

Tests performed by: D. Winstanley, S. Bharat

Report author: D. Winstanley

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1.2 Tests Requested By

This testing in this report was requested by:

Quake Global Inc.
9765 Clairemont Mesa Blvd
Suite A
San Diego
California
92124
USA

1.3 Manufacturer

As Above

1.4 Apparatus Assessed

The following apparatus was assessed between 9th and 22nd December 2011:

Q4000

The Q4000 is a remote tracking device consisting of a GPS Locator, a GSM module and a Satellite communications module. This report covers Iridium satellite variant of the device and assesses the radio performance testing of the Iridium module.

The Iridium module contained within the Q4000 consists of an L-Band Transceiver (LBT) capable of simultaneous transmit and receive (duplex) operation covering the frequency range of 1616MHz to 1626.5MHz. The frequency accesses used for duplex channels are organised into sub-bands each of which contains eight frequency accesses. Each sub-band, therefore occupies 333.33 kHz (i.e. 8x41.667kHz). Up to 30 sub-bands containing 240 frequency accesses may be used for duplex channels.

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 2	FCC Part 25	Result
RF Power Output	2.1046	25.204 (a)	Pass
Emissions Limitations	2.1049	25.202 (f)	Pass
Spurious Emissions at Antenna Terminals	2.1051	25.202 (f) 25.213	Pass
Protection of the Radio Navigation Satellite Service	-	25.216(c) 25.216(f)	Pass
Spurious Emissions Radiated	2.1053	25.202 (f) 25.213	Pass
Frequency Stability Temperature	2.1055	25.202 (d)	Pass
Frequency Stability Voltage	2.1055	25.202 (d)	Pass
AC Powerline Conducted Emissions	-	15.107	N/A*
Unintentional Radiated Spurious Emissions	2.1053	15.109	Pass

*Note: Manufacturer states the device will not be connected directly or indirectly to the mains network

Abbreviations used in the above table:

CFR : Code of Federal Regulations
REFE : Radiated Electric Field Emissions
ANSI : American National Standards Institution
PLCE : Power Line Conducted Emissions

1.6 Standard References

47 CFR 2 10-1-03 Edition	Code of Federal Regulations, Title 47, Part 2, “Frequency allocations and Radio Telemetry Matters; General Rules and Regulations”
47 CFR 25 10-1-03 Edition	Code of Federal Regulations, Title 47, Part 25,”Satellite Communications” Subpart C, “Technical Matters”
47 CFR 15 20-09-07 Edition	Code of Federal Regulations, Title 47, Part 15,”Radio Frequency Devices” Subpart B, “Unintentional Radiators”
C63.4-2003	American National Standards Institute (ANSI), “Methods of Measurement of Radio Noise Emissions from Low Voltage Electrical and Electronic Equipment in the Range 9 kHz to 40 GHz”

1.7 Notes Relating To Assesment

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.

1.8 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 (Power Meter) = **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: Formal Emission Test Results

Abbreviations used in the tables in this appendix:

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

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

A1 RF Output Power

Test Details:	
Regulation	Title 47 of the CFR: Part 25.204(a)
Measurement standard	Title 47 of the CFR: Part 2.1046
EUT sample number	S08
Modification state	0
SE in test environment	S06
SE isolated from EUT	None
EUT set up	Refer to Appendix C

EUT powered by +9Vdc

Frequency MHz	Level at Power Meter (dBm)	Attenuator and cable loss (dB)	Antenna Gain (dB)	Mean Carrier Power (dBm)	Duty Cycle Factor (dB)	Peak Carrier power (dBm)	Carrier power (dBW)	Limit (dBW)
Channel 1	-21.80	42.85	3.5	24.55	10.33	34.88	4.88	40
Channel 75	-21.81	42.85	3.5	24.54	10.33	34.87	4.87	40
Channel 150	-21.85	42.85	3.5	24.50	10.33	34.83	4.83	40
Channel 240	-21.89	42.85	3.5	24.46	10.33	34.79	4.79	40

Notes: 1. Duty Cycle Factor = 10 x log (1/**X**) Where **X**= (Ton / Tframe). See appendix B for duty cycle plots
2. Correction Factor for dBm to dBW = -30dB
3. Antenna gain of 3.5dBi is the worst case gain over an isotropic antenna as declared by manufacturer

EUT powered by +32Vdc

Frequency MHz	Level at Power Meter (dBm)	Attenuator and cable loss (dB)	Antenna Gain (dB)	Mean Carrier Power (dBm)	Duty Cycle Factor (dB)	Peak Carrier power (dBm)	Carrier power (dBW)	Limit (dBW)
Channel 1	-21.80	42.85	3.5	24.56	10.33	34.89	4.89	40
Channel 75	-21.81	42.85	3.5	24.54	10.33	34.87	4.87	40
Channel 150	-21.85	42.85	3.5	24.50	10.33	34.83	4.83	40
Channel 240	-21.89	42.85	3.5	24.46	10.33	34.79	4.79	40

Notes: 1. Duty Cycle Factor = 10 x log (1/**X**) Where **X**= (Ton / Tframe). See appendix B for duty cycle plots
2. Correction Factor for dBm to dBW = -30dB
3. Antenna gain of 3.5dBi is the worst case gain over an isotropic antenna as declared by manufacturer

A2 Emissions Limitations

Test Details:	
Regulation	Title 47 of the CFR: Part 25.202(f)
Measurement standard	Title 47 of the CFR: Part 2.1049
EUT sample number	S08
Modification state	0
SE in test environment	S06
SE isolated from EUT	None
EUT set up	Refer to Appendix C

The unit was tested on four channels. The unit was put into test mode and set to operate at maximum power and with a random modulating signal using test commands sent from a PC.

To enable an average measurement to be taken the gated input trigger of the spectrum analyser was used.

The Spurious limit is as follows:

On any frequency removed from the assigned frequency by the following percentage of the authorised bandwidth

±50%	-	100%	-25 dBc
±100%	-	250 %	-35 dBc
> ±250%		At least 43 + 10 log PdB	

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

Where the Authorised Bandwidth = 41.667 kHz

Note

1. The 3 kHz to 4 kHz bandwidth correction, cable and attenuator losses and antenna gain have been taken into account in the Ref level offset figure.

Results

The Q4000 was found to comply with the limits

See plots in Appendix B.

A3 Spurious Emissions Conducted

Test Details:	
Regulation	Title 47 of the CFR: Part 25.202(f) & 25.216
Measurement standard	Title 47 of the CFR: Part 2.1051
EUT sample number	S08
Modification state	0
SE in test environment	S06
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Frequency Range (MHz)	Ch N°	Freq. of Emission	Spectrum Analyser Level (dBm)	Attenuator & Cable Losses (dB)	Spurious Emission Level (dBm)	Limit dBm
30MHz – 1559MHz	No Significant emissions detected					-13
1559MHz – 1605MHz						-40 (note 6)
1605MHz – 1610MHz						-40 (Note 4)
1626.5MHz – 16.3 GHz	1	3232.392	-61.99	-15.0	-47.01	-13
	1	4847.675	-60.40	-15.4	-44.98	-13
	1	6462.894	-64.20	-15.7	-48.52	-13
	1	8079.971	-60.69	-18.2	-42.50	-13
	240	3251.956	-57.07	-14.8	-42.29	-13
	240	4877.934	-61.02	-15.7	-45.37	-13
	240	6504.136	-62.26	-16.2	-46.02	-13
	240	8129.890	-60.35	-18.6	-41.73	-13

Result

The Q4000 Handset was found to comply with the limits

A4 Radiated Electric Field Emissions

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

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

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

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

Test Details:	
Regulation	Title 47 of the CFR: Part 25.202(f) & 25.216
Measurement standard	Title 47 of the CFR: Part 2.1053
Frequency range	30MHz – 17GHz
EUT sample number	S08
Modification state	0
SE in test environment	S06, S09, S10, TRaC Laptops
SE isolated from EUT	TRLUH100
EUT set up	Refer to Appendix C
Photographs (Appendix F)	1 & 2

FREQUENCY RANGE	FREQ. (MHz)	ERP/EIRP (dBm)	LIMIT (dBm)
30MHz – 1559MHz	No Significant Emissions		-13
1559MHz – 1605MHz			-40 Note 6
1605MHz – 1610MHz			-40 to 10 Note 4
1628.5MHz – 16.3 GHz	3252.163 4877.932 5636.314 3232.051 4848.108 6464.700 5596.233 8148.105 6503.870 8147.880	-27.7 -36.3 -41.7 -30.5 -34.9 -34.5 -43.3 -40.3 -35.7 -41.9	-13 -13 -13 -13 -13 -13 -13 -13 -13 -13

Result

The Q4000 was found to comply with the limits

Notes:

1. Emissions Checked up to 10 times Fc.
2. Scan plots of channels 1 & 240 with in Appendix B.
3. The unit was mounted on a turntable and rotated through 360^0 and in 3 orthogonal planes to find the worst case emission.
4. -40 to -10 Linearly interpolated in dBm Vs frequency offset.
5. Correction Factor for dBm to dBW = -30dB.
6. This limit reduces to -50 dBm for discrete emissions of less than 700Hz bandwidth.
7. 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

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

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

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

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

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

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

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

A5 Frequency Stability - Temperature

Test Details:	
Regulation	Title 47 of the CFR: Part 25.202(d)
Measurement standard	Title 47 of the CFR: Part 2.1055
EUT sample number	S08
Modification state	0
SE in test environment	S06
SE isolated from EUT	None
EUT set up	Refer to Appendix C

^{0}C	Frequency (MHz)							
	Channel 1		Channel 75		Channel 150		Channel 240	
	Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Vmin	Vmax
+60	1616.01986	1616.01990	1619.10337	1619.10326	1622.22829	1622.22843	1625.97839	1625.97830
+50	1616.01977	1616.01977	1619.10311	1619.10312	1622.22805	1622.22805	1625.97811	1625.97812
+40	1616.01967	1616.01957	1619.10295	1619.10303	1622.22786	1622.22785	1625.97794	1625.97798
+30	1616.01960	1616.01964	1619.10293	1619.10295	1622.22797	1622.22789	1625.97791	1625.97790
+20	1616.02085	1616.02088	1619.10414	1619.10418	1622.22914	1622.22917	1625.97914	1625.97914
+10	1616.01962	1616.01956	1619.10297	1619.10293	1622.22783	1622.22781	1625.97793	1625.97784
0	1616.01954	1616.01957	1619.10281	1619.10280	1622.22792	1622.22782	1625.97787	1625.97788
-10	1616.01976	1616.01967	1619.10295	1619.10311	1622.22812	1622.22813	1625.97804	1625.97809
-20	1616.02015	1616.02026	1619.10354	1619.10354	1622.22851	1622.22843	1625.97855	1625.97845
-30	1616.01991	1616.01982	1619.10308	1619.10308	1622.22798	1622.22802	1625.97798	1625.97802

Limit

± 10ppm (See Appendix B for frequency stability plots verses limit)

Result

The Q4000 was found to comply with the limits

A6 Frequency Stability - Voltage

Test Details:	
Regulation	Title 47 of the CFR: Part 25.202(d)
Measurement standard	Title 47 of the CFR: Part 2.1055
EUT sample number	S08
Modification state	0
SE in test environment	S06
SE isolated from EUT	None
EUT set up	Refer to Appendix C

VOLTAGE	Frequency (MHz)			
%	Channel 1	Channel 75	Channel 150	Channel 240
85 (Vmin)	1616.02082	1619.10422	1622.22915	1625.97913
90 (Vmin)	1616.02086	1619.10412	1622.22920	1625.97912
95 (Vmin)	1616.02082	1619.10414	1622.22914	1625.97915
100 (Vmin)	1616.02085	1619.10414	1622.22914	1625.97914
100 (Vmax)	1616.02088	1619.10418	1622.22917	1625.97914
105(Vmax)	1616.02083	1619.10415	1622.22915	1625.97914
110(Vmax)	1616.02083	1619.10421	1622.22915	1625.97915
115(Vmax)	1616.02099	1619.10420	1622.22918	1625.97910

Limit

± 10ppm (See Appendix B for frequency stability plots verses limit)

Result

The Q4000 was found to comply with the limits

A7 Unintentional Radiated Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric filed emission test applies to all spurious emissions on directly related to the transmitter. The maximum permitted field strength is listed in Section 15.109. The EUT was set to operate in a transmit standby / receive mode.

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

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

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

Test Details:	
Regulation	Title 47 of the CFR, Part 15 Subpart (c) Clause 15.109
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz – 16.3GHz
EUT sample number	S08
Modification state	0
SE in test environment	S06, S09, S10, TRaC Laptops
SE isolated from EUT	TRLUH100
EUT set up	Refer to Appendix C
Photographs (Appendix F)	1 & 2

The worst case radiated emission measurements for spurious emissions are listed below:

FREQ. (MHz)	QP/ Pk/ Av	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
31.05	QP	17.13	0.4	17.4	-	34.90	-	55.59	100.00
31.45	QP	19.57	0.4	17.1	-	37.10	-	71.61	100.00
32.05	QP	15.52	0.4	16.8	-	32.70	-	43.15	100.00
33.05	QP	15.32	0.4	16.3	-	32.00	-	39.81	100.00
35.10	QP	12.05	0.4	15.2	-	27.60	-	23.99	100.00
36.85	QP	10.31	0.4	14.2	-	24.90	-	17.58	100.00
37.45	QP	12.07	0.4	13.8	-	26.30	-	20.65	100.00
54.70	QP	23.01	0.4	6.2	-	29.60	-	30.20	100.00
58.60	QP	22.92	0.4	5.4	-	28.70	-	27.23	100.00
61.20	QP	20.99	0.4	5.2	-	26.60	-	21.38	100.00
85.55	QP	19.49	0.6	7.8	-	27.90	-	24.83	100.00
85.95	QP	19.91	0.6	7.9	-	28.40	-	26.30	100.00
99.90	QP	28.71	0.6	10.3	-	39.60	-	95.50	150.00
165.55	QP	16.94	0.9	9.3	-	27.10	-	22.65	150.00
233.20	QP	21.80	1.0	10.2	-	33.00	-	44.67	200.00
297.90	QP	27.72	1.1	13.0	-	41.80	-	123.03	200.00
366.45	QP	19.81	1.3	14.7	-	35.80	-	61.66	200.00
384.15	QP	21.59	1.3	15.2	-	38.10	-	80.35	200.00
399.70	QP	17.71	1.3	15.9	-	34.90	-	55.59	200.00
408.20	QP	18.38	1.3	16.3	-	36.00	-	63.10	200.00
432.10	QP	21.13	1.4	16.3	-	38.80	-	87.10	200.00
499.90	QP	23.90	1.5	17.2	-	42.60	-	134.90	200.00
511.05	QP	8.30	1.5	17.5	-	27.30	-	23.17	200.00
699.75	QP	18.98	1.7	19.2	-	39.90	-	98.86	200.00
733.05	QP	13.20	1.8	19.9	-	34.90	-	55.59	200.00
820.85	QP	6.92	1.9	20.6	-	29.40	-	29.51	200.00
832.95	QP	8.29	1.9	20.4	-	30.60	-	33.88	200.00
899.80	QP	15.86	2.0	20.8	-	38.70	-	86.10	200.00

FREQ. (MHz)	QP/ Pk/ Av	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1092.58	P	65.72	0.7	25.0	37.4	54.02	-	502.34	5000
1092.58	A	50.92	0.7	25.0	37.4	39.22	-	91.41	500
1214.98	P	55.64	0.7	25.2	37.2	44.34	-	164.82	5000
1214.98	A	48.1	0.7	25.2	37.2	36.80	-	69.18	500
1291.03	P	64.29	0.8	25.1	37.0	53.19	-	456.56	5000
1291.03	A	47.91	0.8	25.1	37.0	36.81	-	69.26	500
1399.07	P	58.31	0.8	25.6	36.8	47.91	-	248.60	5000
1399.07	A	51.96	0.8	25.6	36.8	41.56	-	119.67	500
1399.12	P	59.03	0.8	25.6	36.8	48.63	-	270.08	5000
1399.12	A	55.49	0.8	25.6	36.8	45.09	-	179.68	500
1500.00	P	58.57	0.8	25.5	36.6	48.27	-	259.12	5000
1500.00	A	42.23	0.8	25.5	36.6	31.93	-	39.49	500
1687.60	P	57.32	0.9	26.5	36.2	48.52	-	266.69	5000
1687.60	A	40.8	0.9	26.5	36.2	32.00	-	39.81	500
1695.67	P	62.9	0.9	26.5	36.2	54.10	-	506.99	5000
1695.67	A	49.66	0.9	26.5	36.2	40.86	-	110.41	500
1886.78	P	54.57	0.9	27.5	35.8	47.17	-	228.30	5000
1886.78	A	38.93	0.9	27.5	35.8	31.53	-	37.71	500
2099.31	P	59.18	1.0	27.5	35.6	52.08	-	401.79	5000
2099.31	A	42.24	1.0	27.5	35.6	35.14	-	57.15	500
2382.85	P	52.84	1.1	28.2	35.6	46.54	-	212.32	5000
2382.85	A	36.96	1.1	28.2	35.6	30.66	-	34.12	500
5596.46	P	55.8	1.6	33.9	35.8	55.50	-	595.66	5000
5596.46	A	52.7	1.6	33.9	35.8	52.40	-	416.87	500
5636.31	P	53.78	1.6	33.9	35.8	53.48	-	472.06	5000
5636.31	A	53.38	1.6	33.9	35.8	53.08	-	450.82	500

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1. For emissions below 30MHz the cable losses are assumed to be negligible.
2 In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
3 Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
4 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	RBW=VBW= 1MHz
Average	RBW=VBW= 1MHz

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 15: Clause 15.33(a) and 15.33(a)(1).

Radiated emission limits 47 CFR Part 15: Clause 15.109 for all emissions:

Frequency of emission (MHz)	Field strength μV/m	Measurement Distance m	Field strength dBμV/m
0.009-0.490	2400/F(kHz)	300	67.6/F (kHz)
0.490-1.705	24000/F(kHz)	30	87.6/F (kHz
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
Above 960	500	3	54.0

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

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

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

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

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

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

Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

(a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.

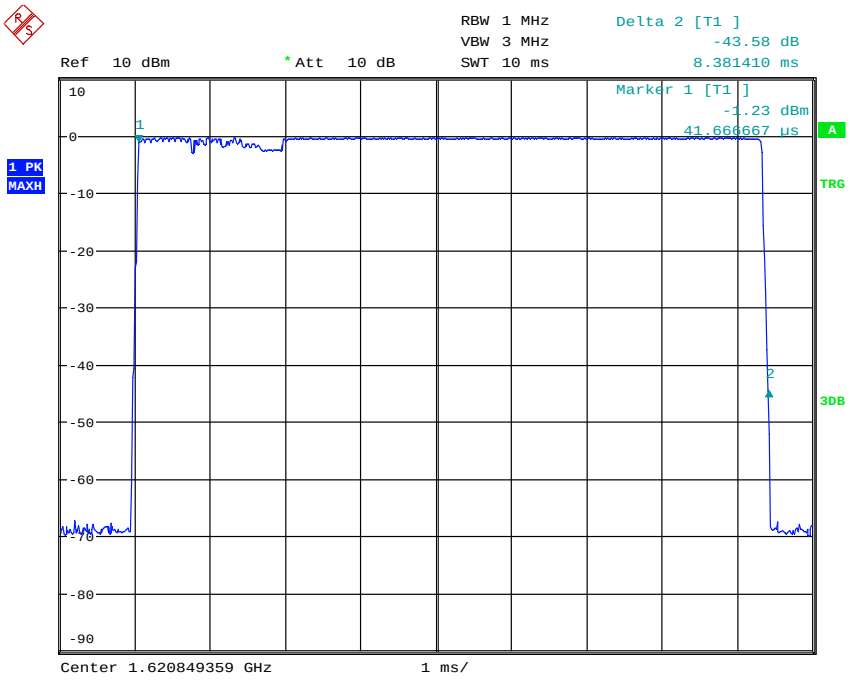
(b) The time and date on the plots do not necessarily equate to the time of the test.

(c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.

(d) Appendix C details the numbering system used to identify the sample and its modification state.

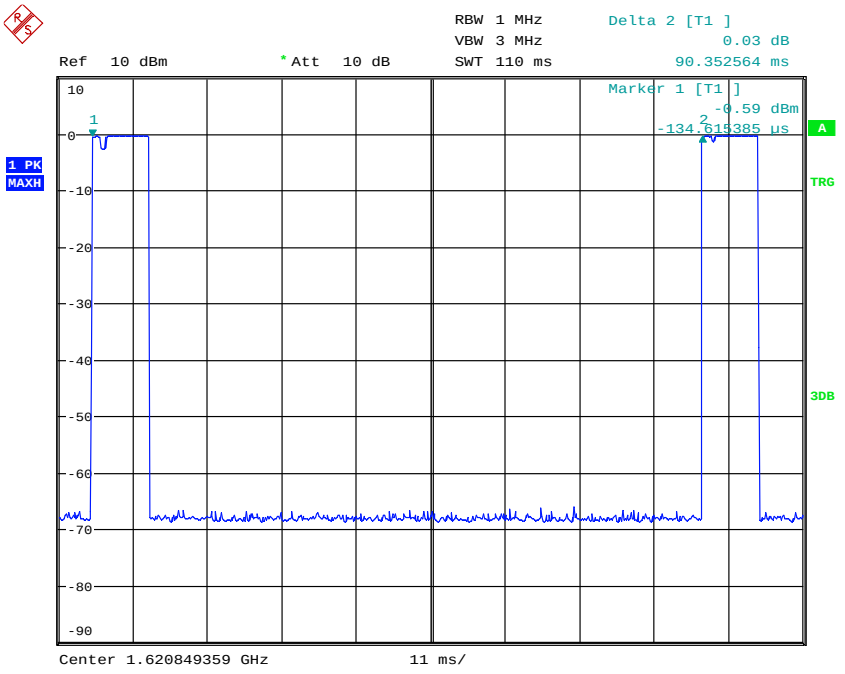
(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.

Duty Cycle Plots



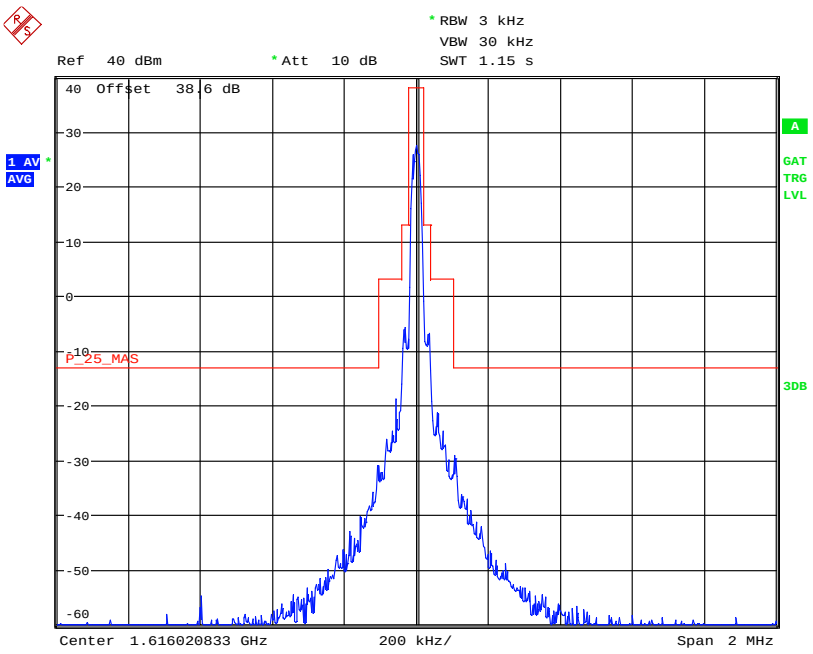
Date: 12.DEC.2011 12:56:22

T_{on} = 8.38mS



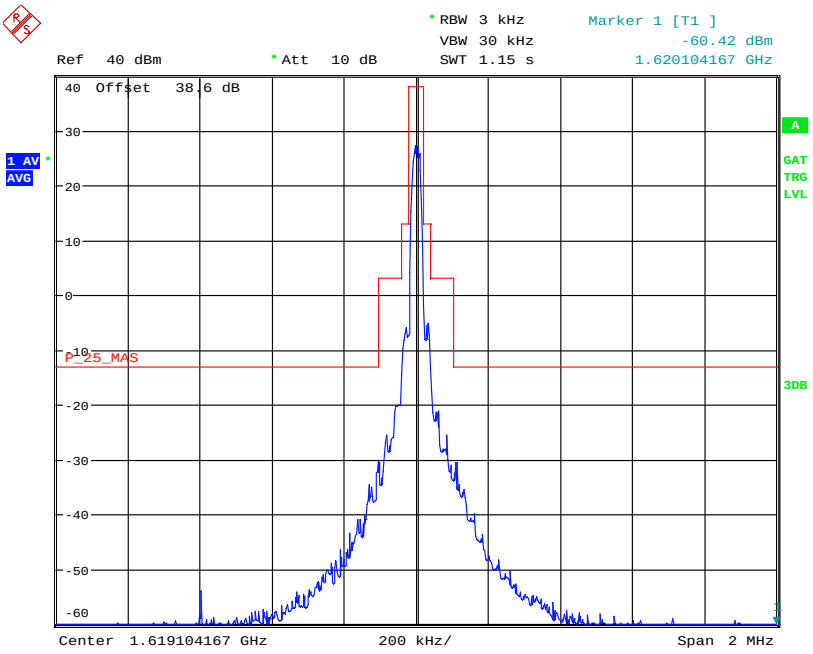
Date: 12.DEC.2011 12:57:11

T_{frame} = 90.00mS



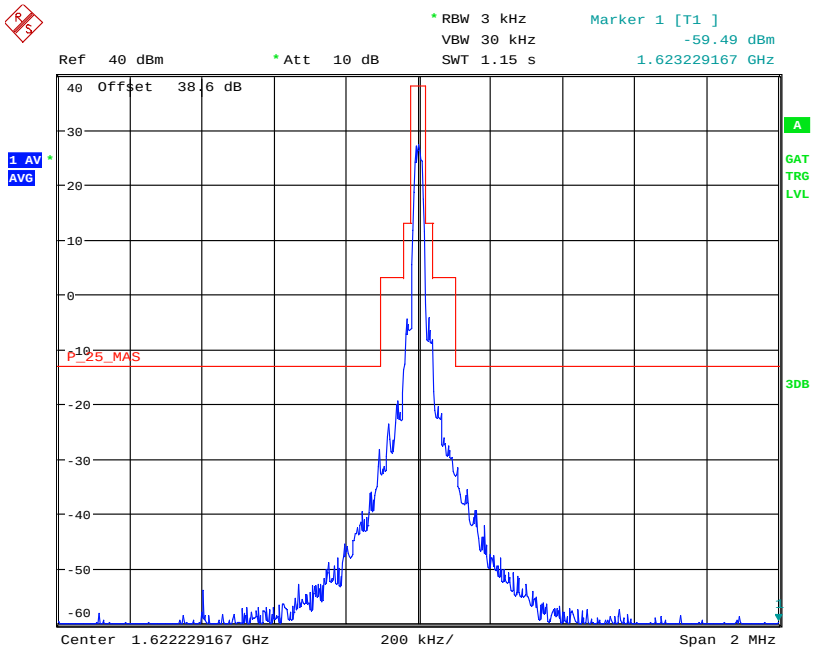
Date: 14.DEC.2011 16:08:08

Emissions Limitation Channel 1



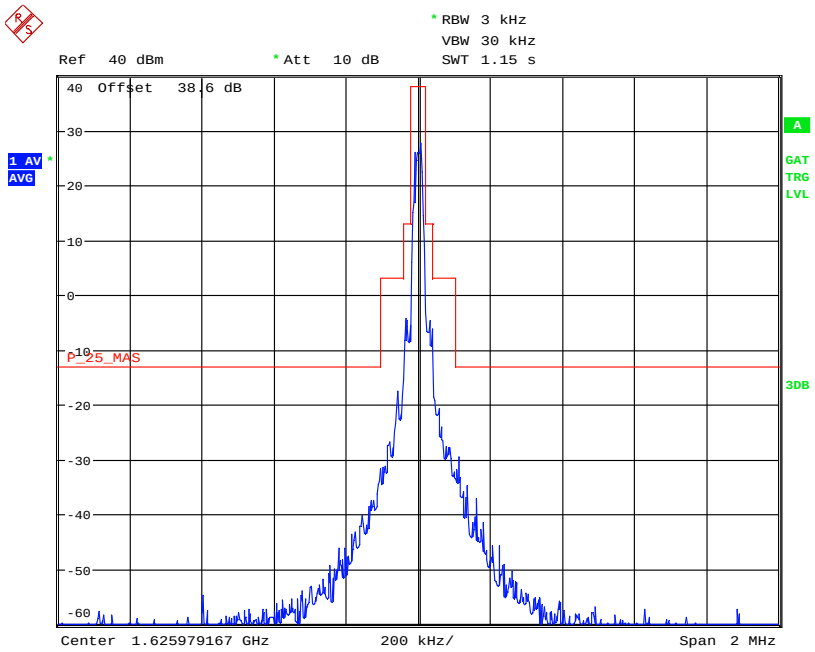
Date: 14.DEC.2011 16:04:49

Emissions Limitation Channel 75



Date: 14.DEC.2011 15:57:06

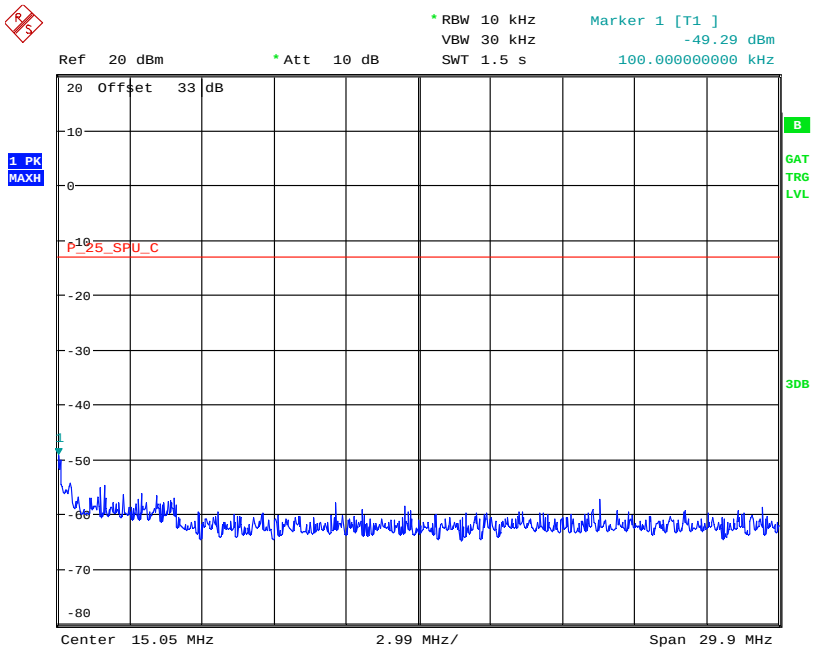
Emissions Limitation Channel 150



Date: 14.DEC.2011 15:50:10

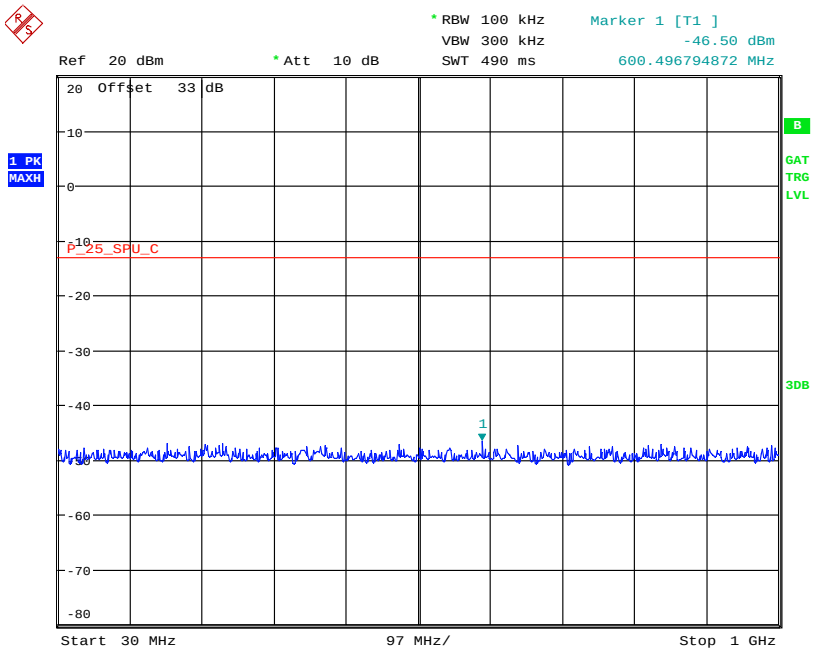
Emissions Limitation Channel 240

TRANSMITTER SPURIOUS EMISSIONS – Conducted Channel 1



Date: 13.DEC.2011 11:31:18

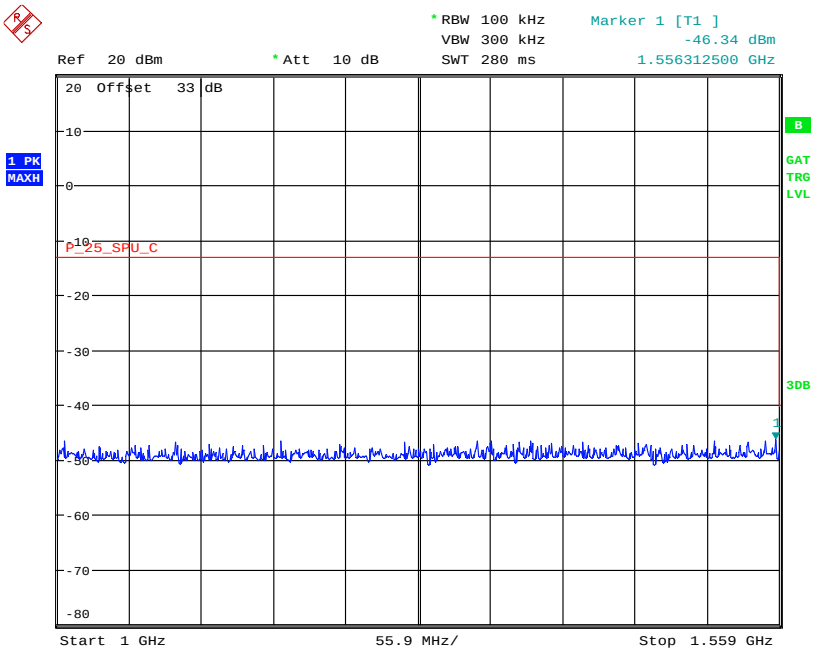
100 kHz – 30MHz



Date: 13.DEC.2011 11:31:52

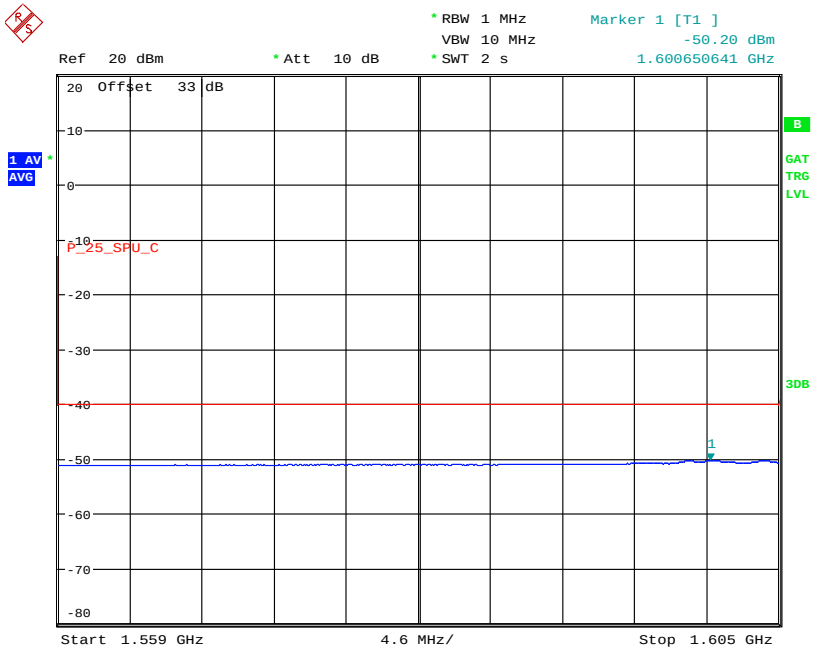
30MHz – 1000MHz

TRANSMITTER SPURIOUS EMISSIONS – Conducted Channel 1



Date: 13.DEC.2011 11:32:17

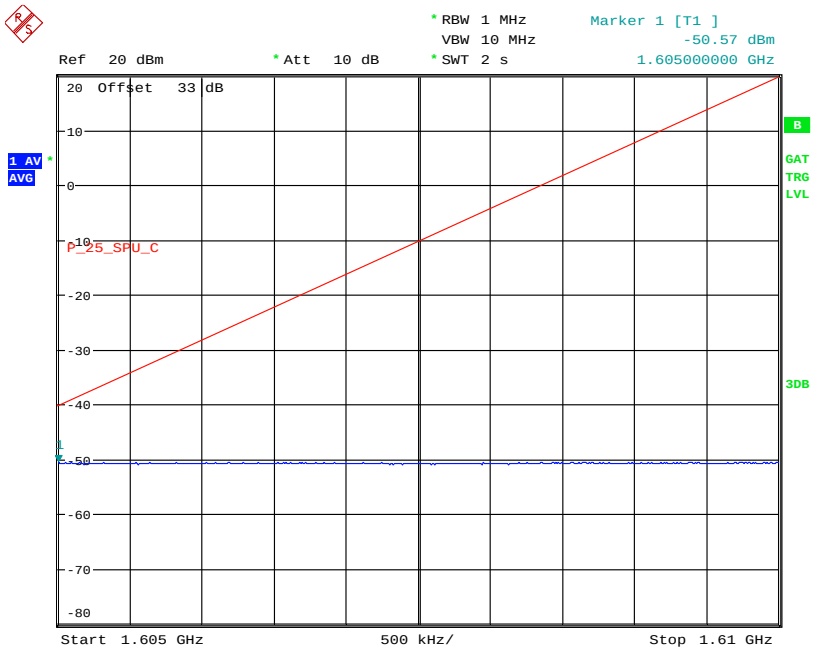
1000MHz – 1559MHz



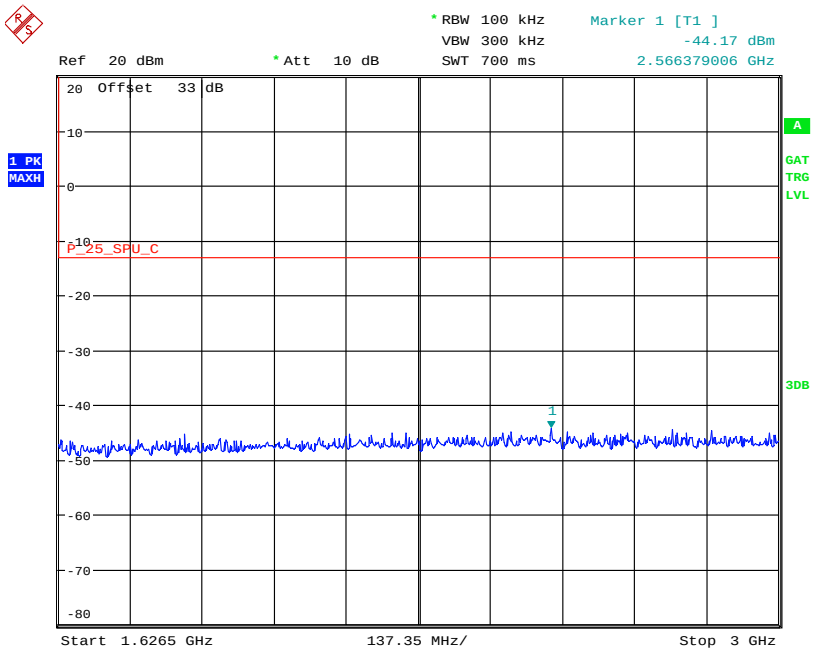
Date: 13.DEC.2011 11:43:03

1559MHz – 1605MHz

TRANSMITTER SPURIOUS EMISSIONS – Conducted Channel 1

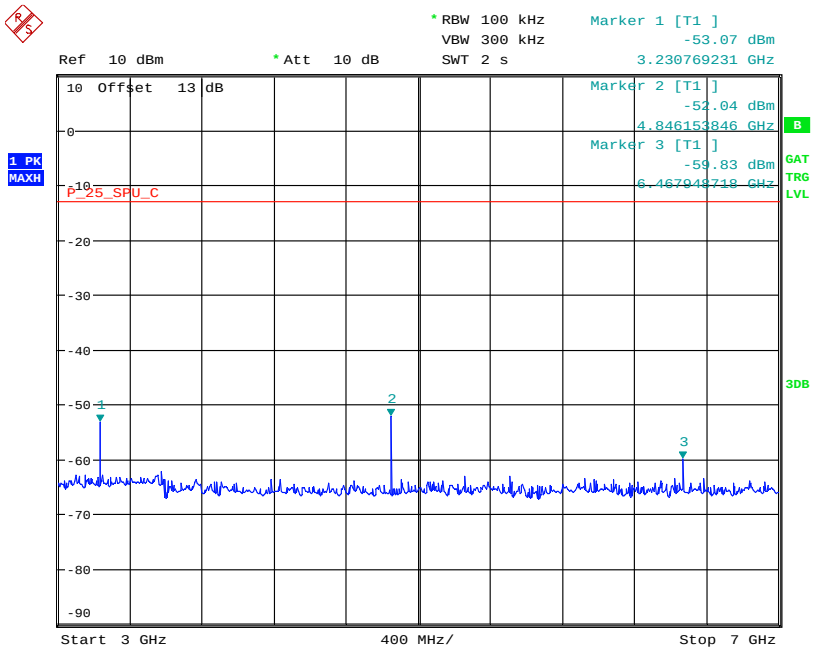


1605MHz – 1610MHz



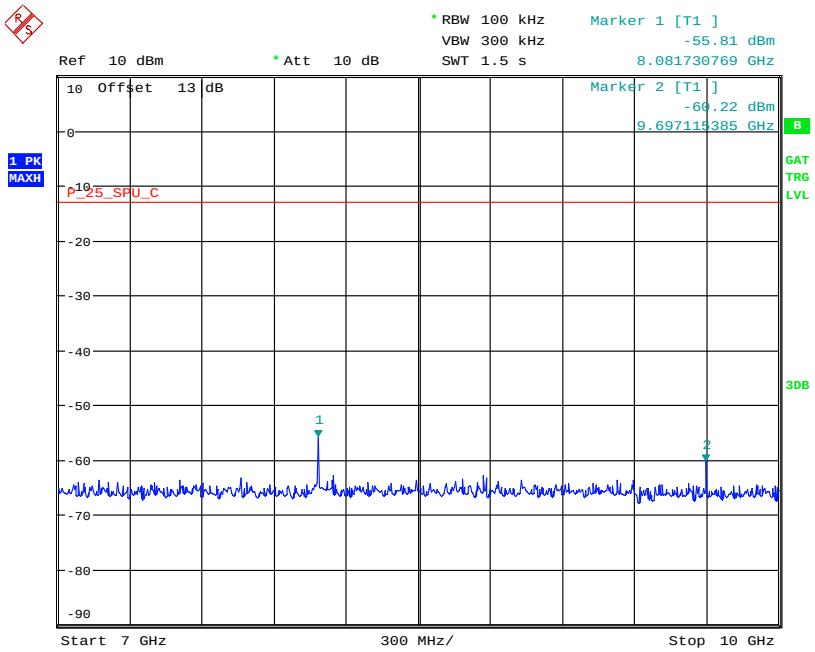
1626.5MHz – 3000MHz

TRANSMITTER SPURIOUS EMISSIONS – Conducted Channel 1



Date: 13.DEC.2011 12:08:58

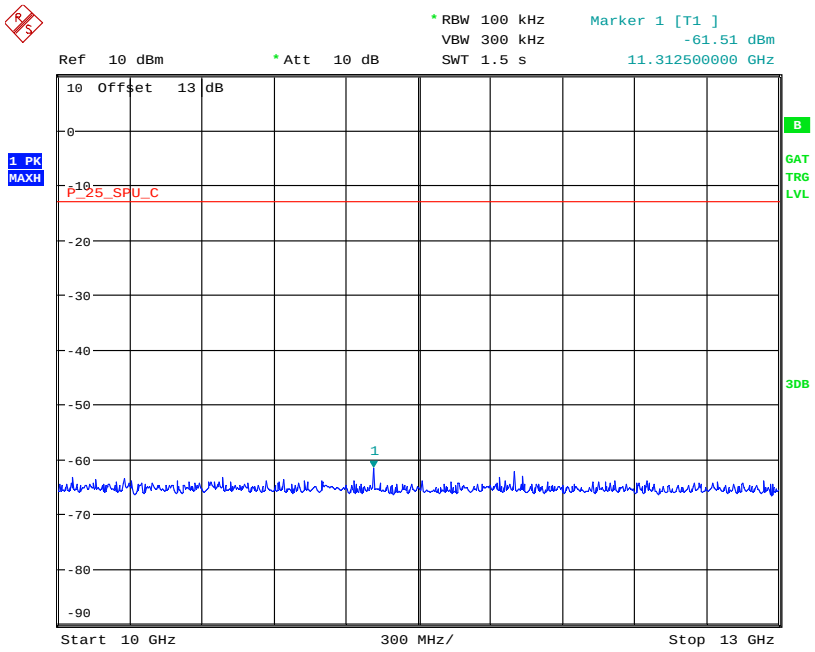
3GHz – 7GHz



Date: 13.DEC.2011 12:09:47

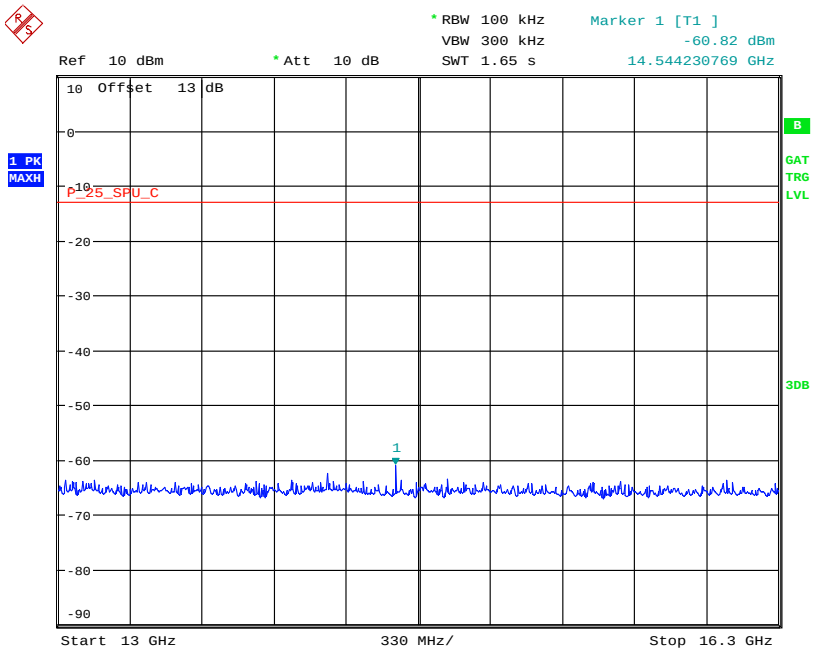
7GHz – 10GHz

TRANSMITTER SPURIOUS EMISSIONS – Conducted Channel 1



Date: 13.DEC.2011 12:11:57

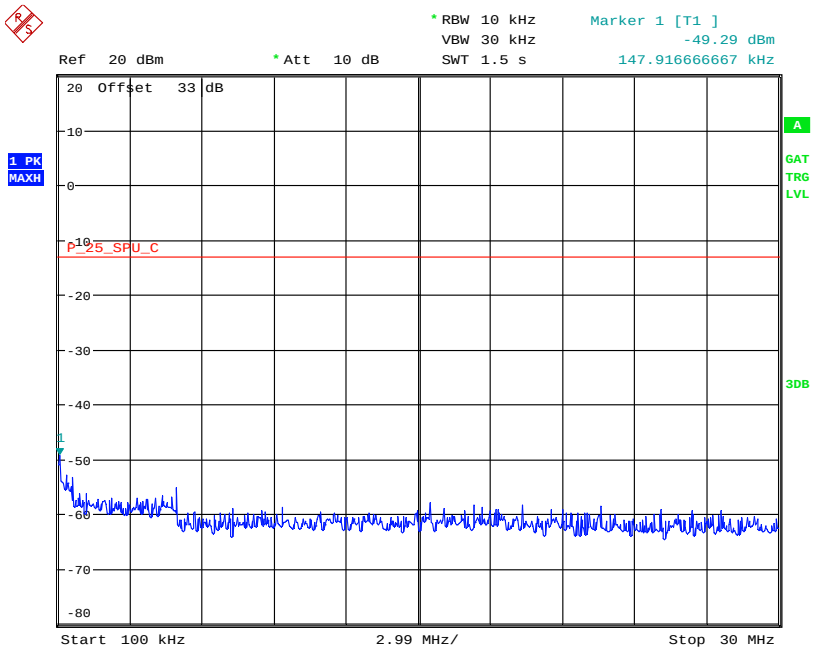
10GHz – 13GHz



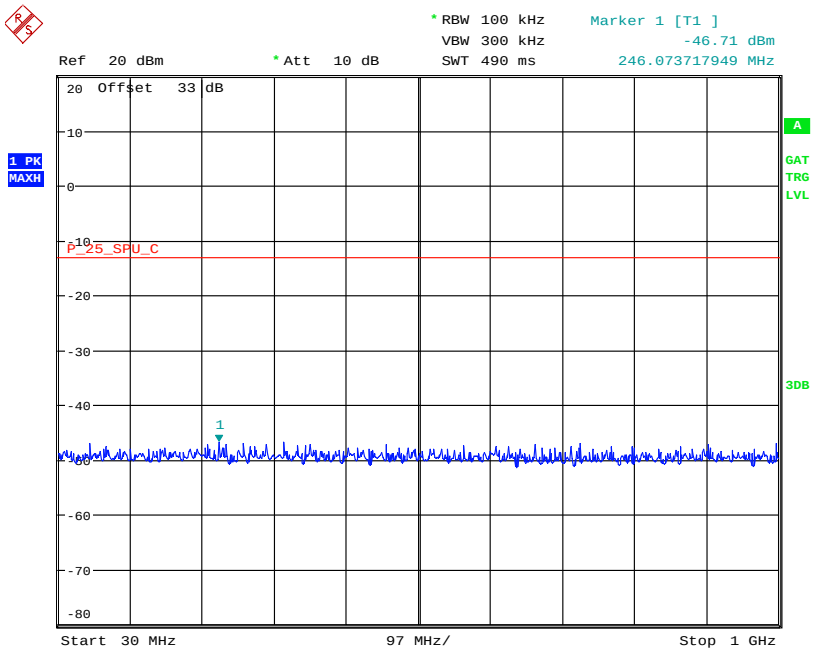
Date: 13.DEC.2011 12:13:18

13GHz – 16.3GHz

TRANSMITTER SPURIOUS EMISSIONS – Conducted Channel 240

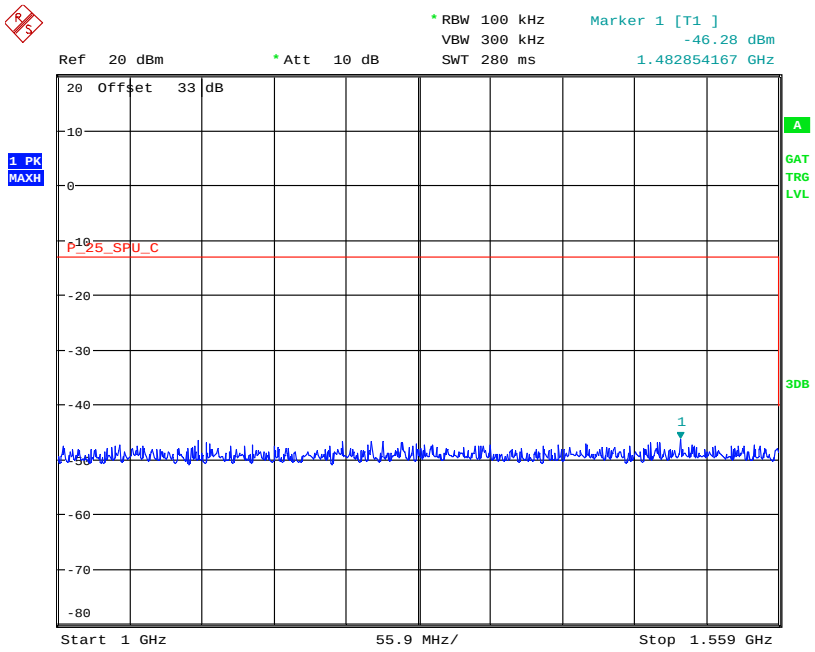


100 kHz – 30MHz



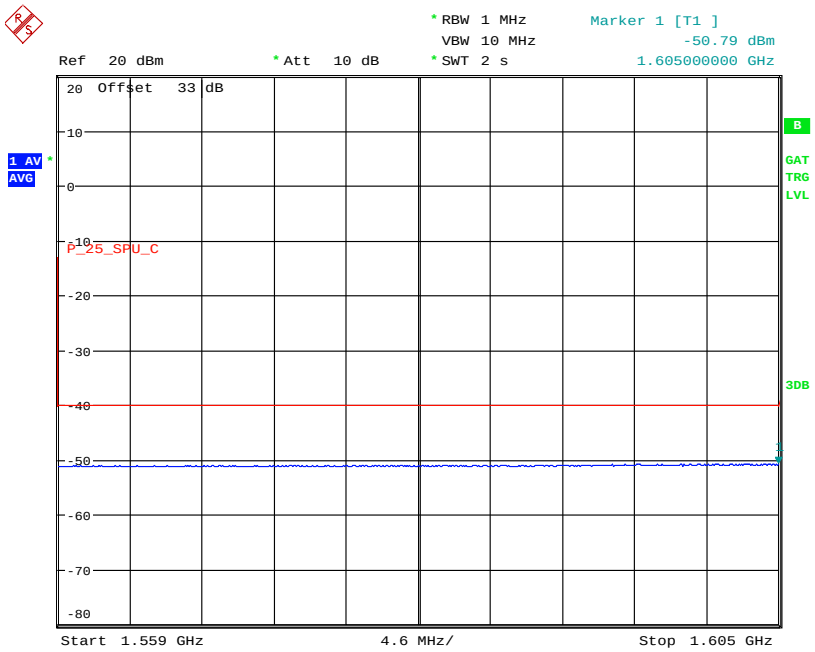
30MHz – 1000MHz

TRANSMITTER SPURIOUS EMISSIONS – Conducted Channel 240



Date: 13.DEC.2011 11:51:41

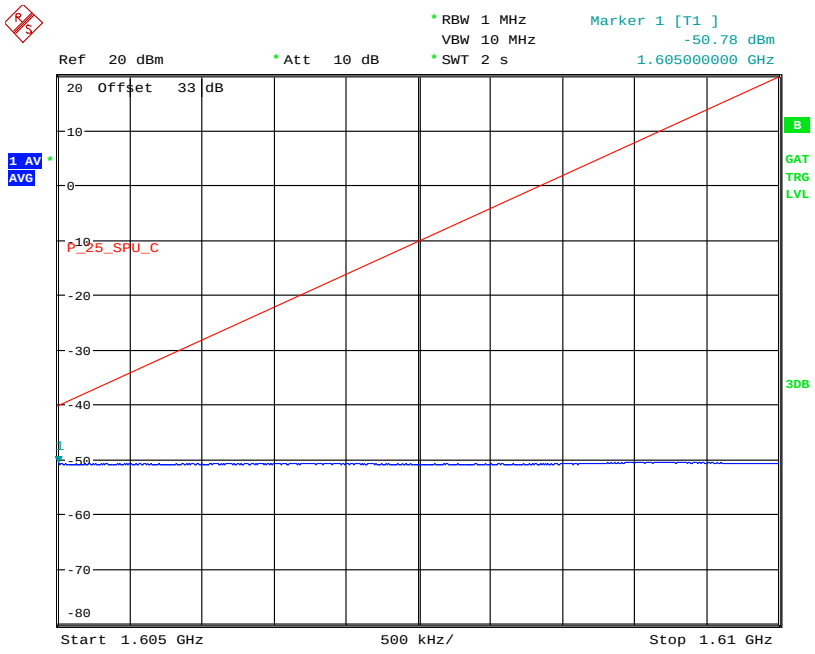
1000MHz – 1559MHz



Date: 13.DEC.2011 11:55:03

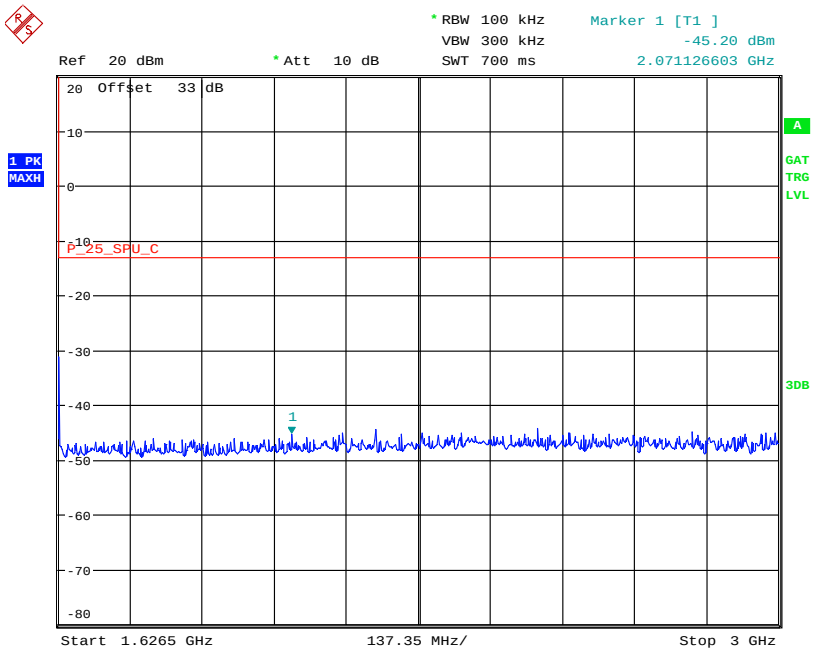
1559MHz – 1605MHz

TRANSMITTER SPURIOUS EMISSIONS – Conducted Channel 240



Date: 13.DEC.2011 11:54:15

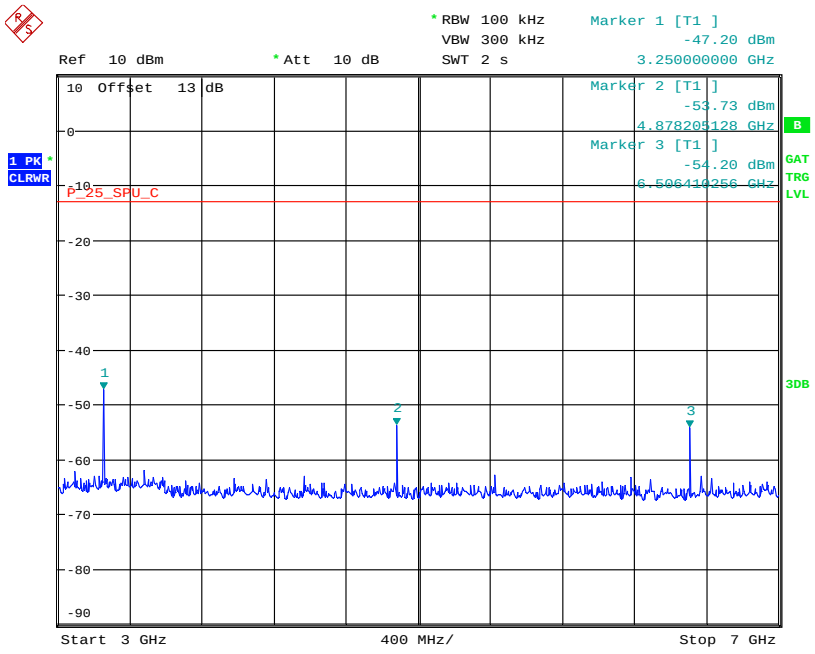
1605MHz – 1610MHz



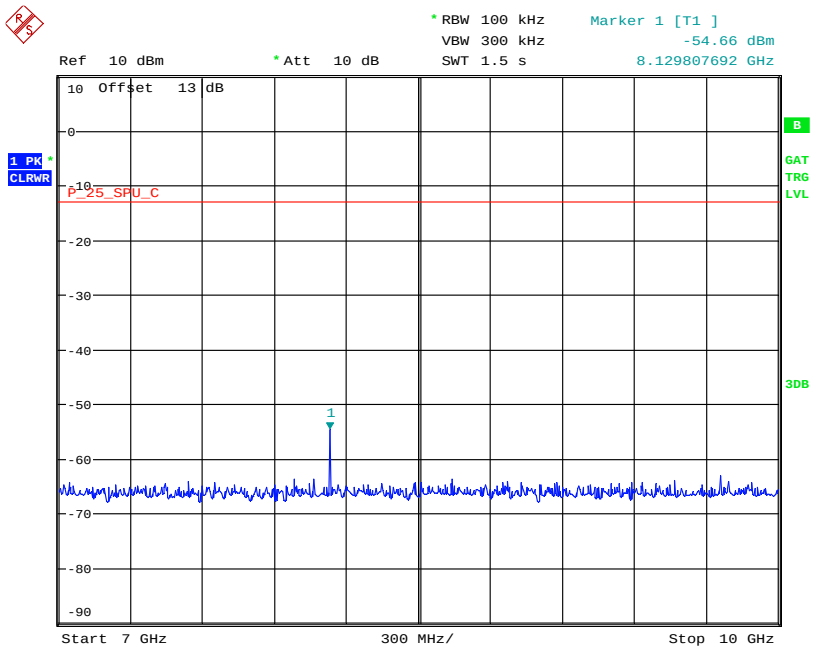
Date: 13.DEC.2011 11:50:06

1626.5MHz – 3000MHz

TRANSMITTER SPURIOUS EMISSIONS – Conducted Channel 240

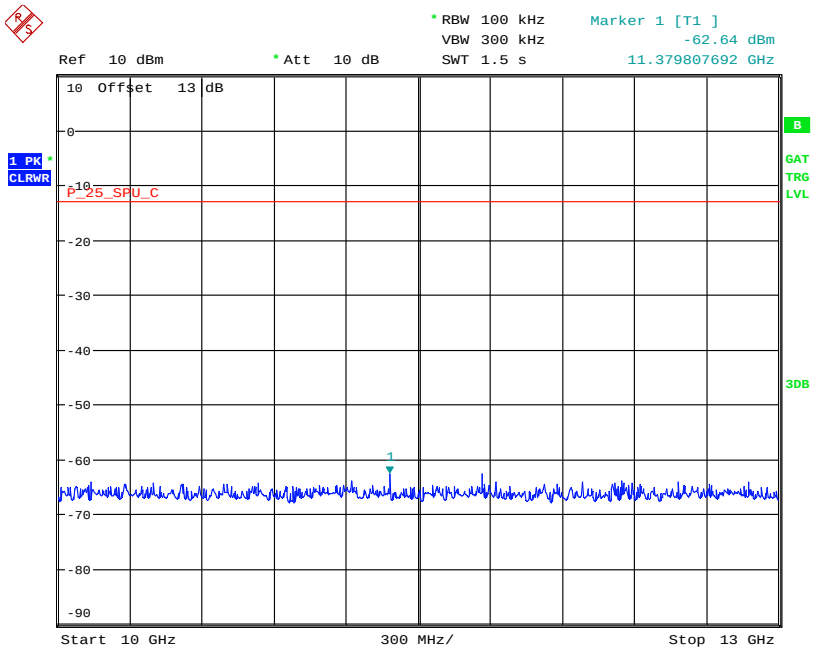


3GHz – 7GHz



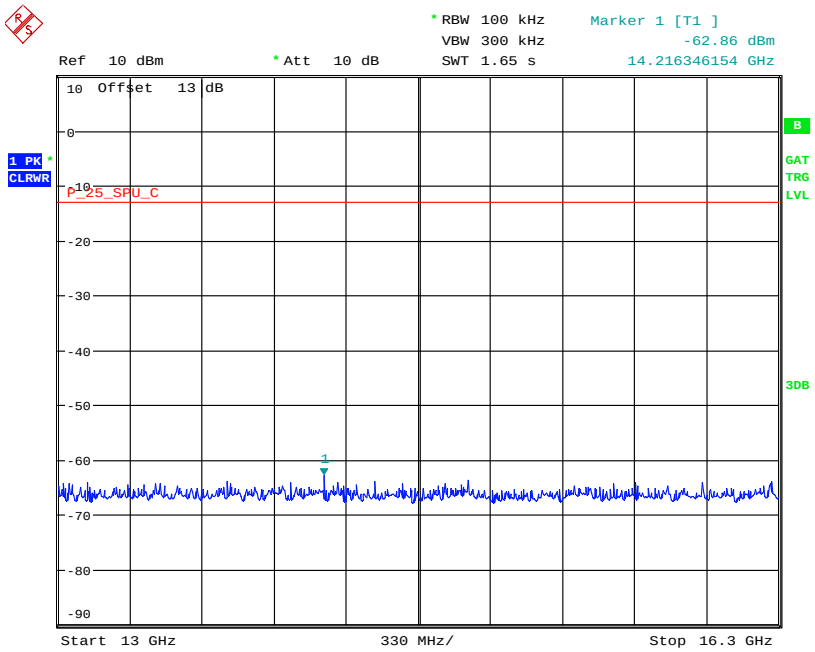
7GHz – 10GHz

TRANSMITTER SPURIOUS EMISSIONS – Conducted Channel 240



Date: 13.DEC.2011 12:01:50

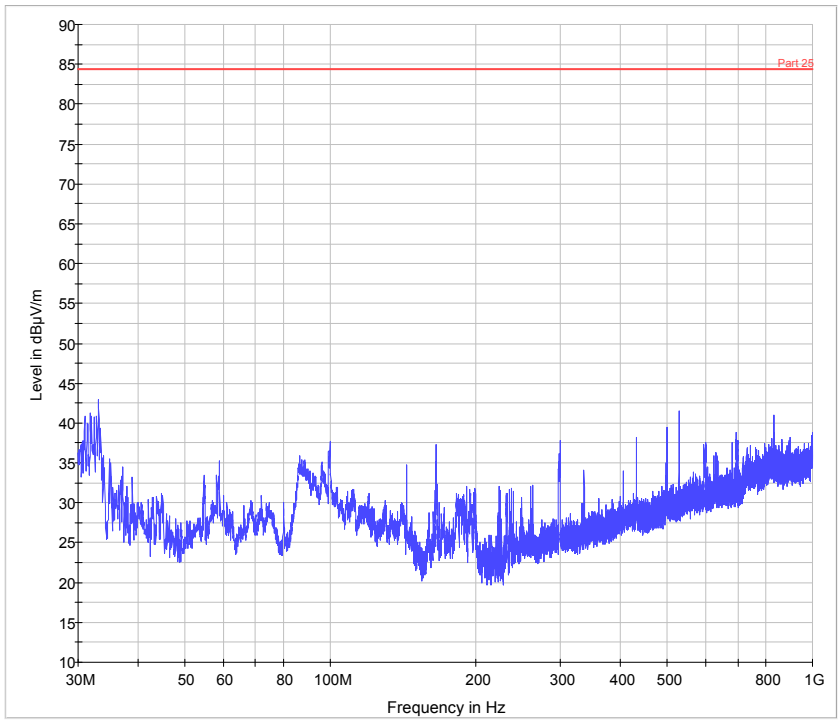
10GHz – 13GHz



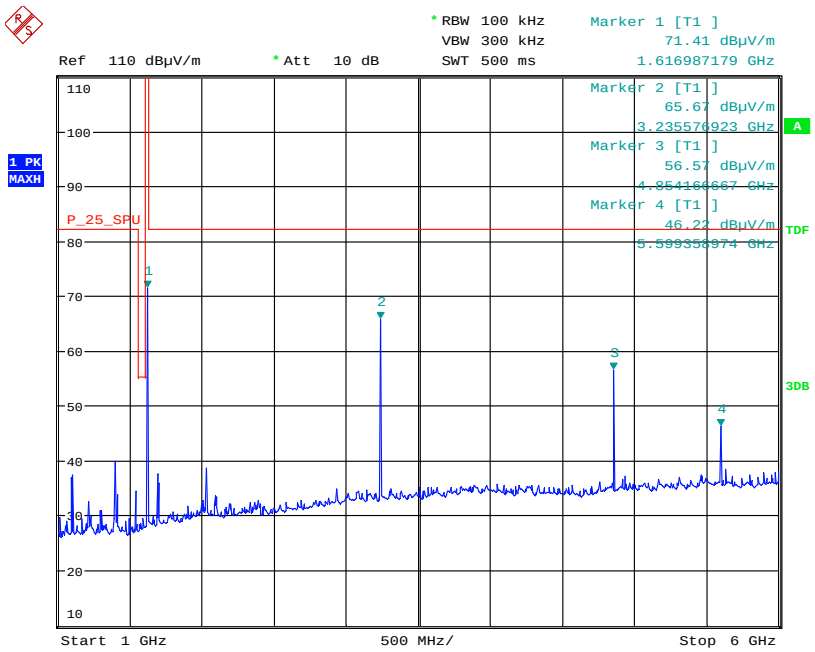
Date: 13.DEC.2011 12:02:29

13GHz – 16.3GHz

TRANSMITTER SPURIOUS EMISSIONS – Radiated Channel 1



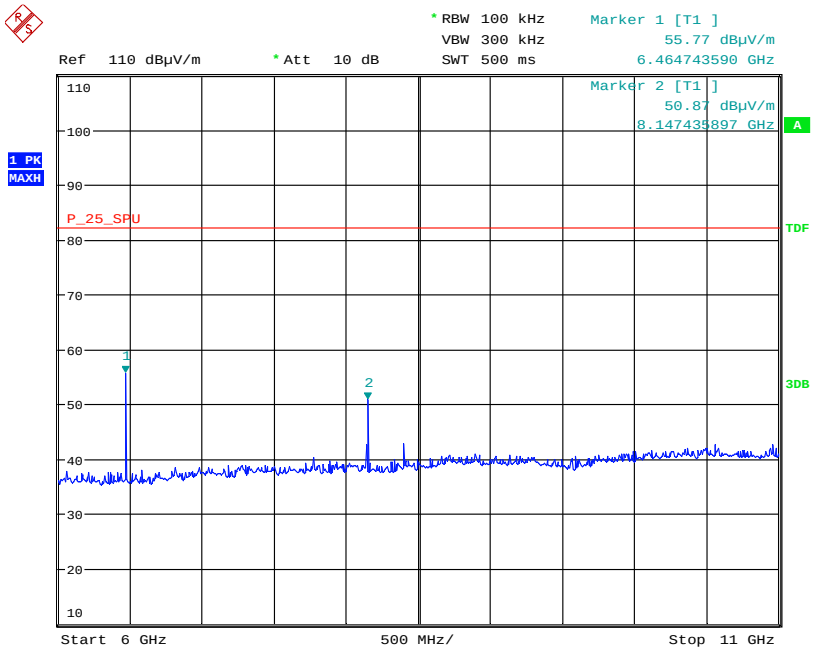
30MHz – 1000MHz



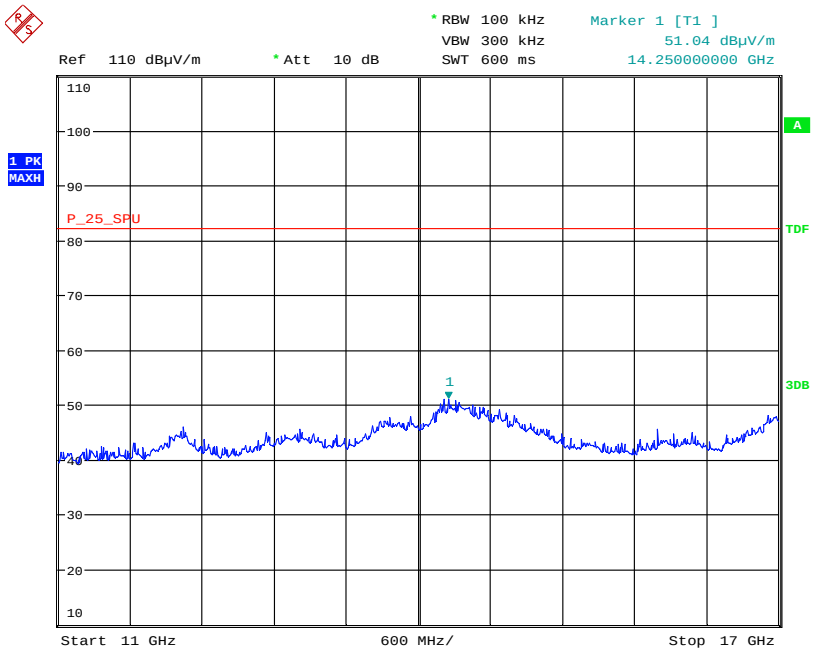
Date: 21.DEC.2011 13:58:30

1GHz – 6GHz

TRANSMITTER SPURIOUS EMISSIONS – Radiated Channel 1

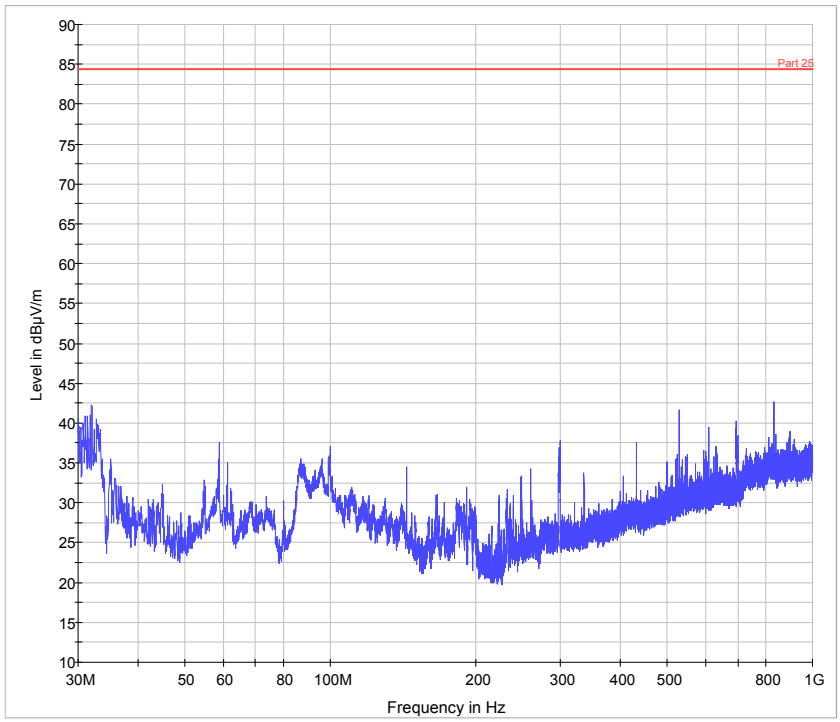


6GHz – 11GHz

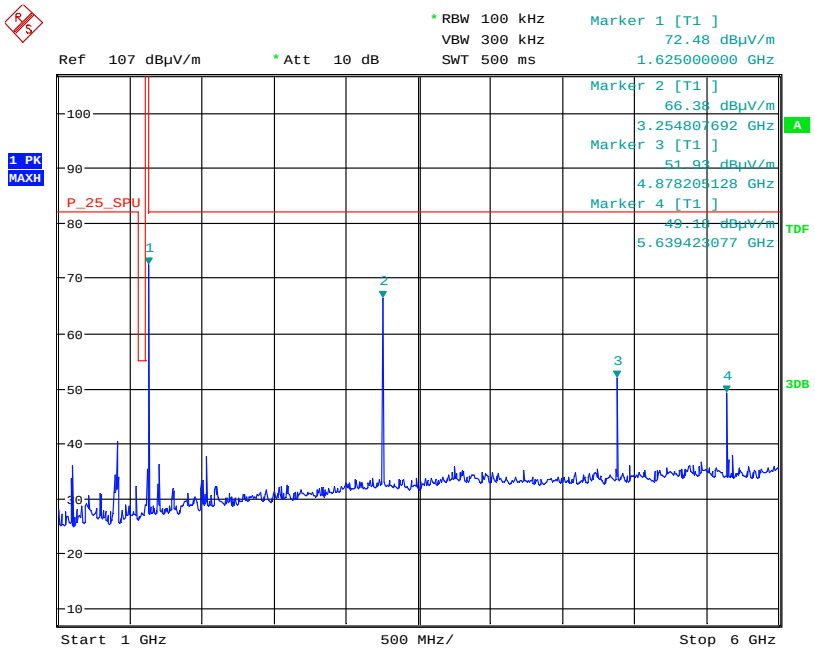


11GHz – 17GHz

TRANSMITTER SPURIOUS EMISSIONS – Radiated Channel 240



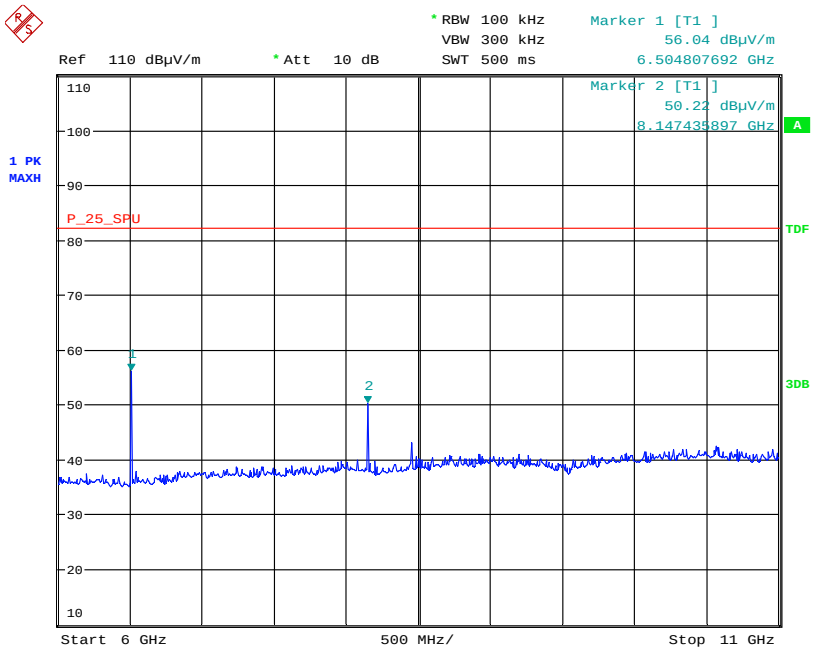
30MHz – 1000MHz



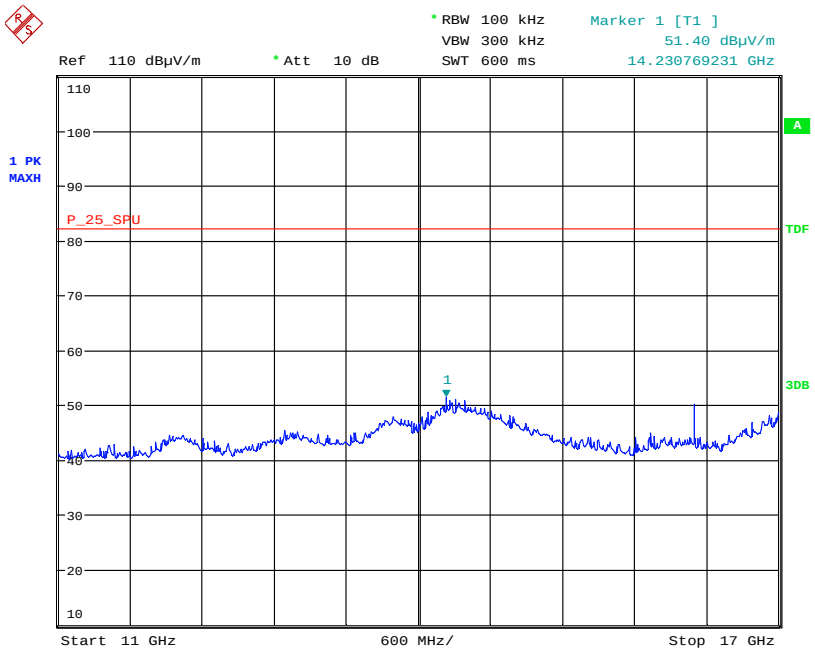
Date: 21.DEC.2011 12:26:17

1GHz – 6GHz

TRANSMITTER SPURIOUS EMISSIONS – Radiated Channel 240

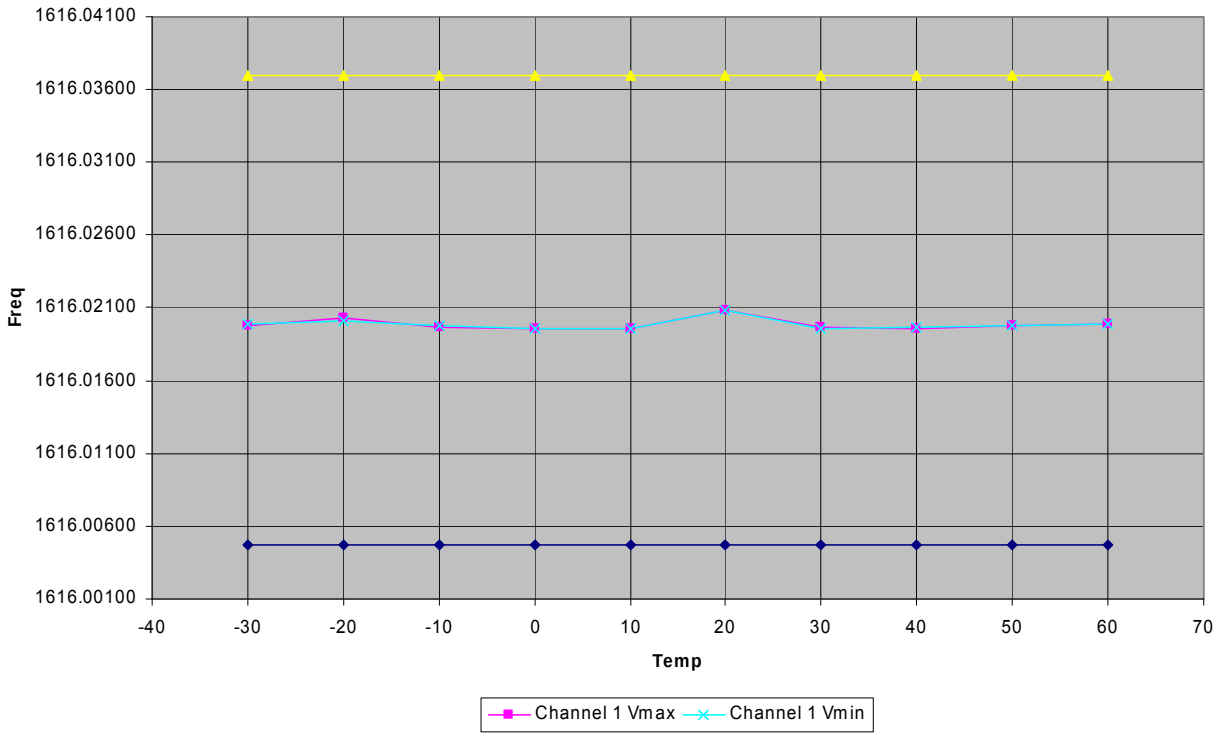


6GHz – 11GHz

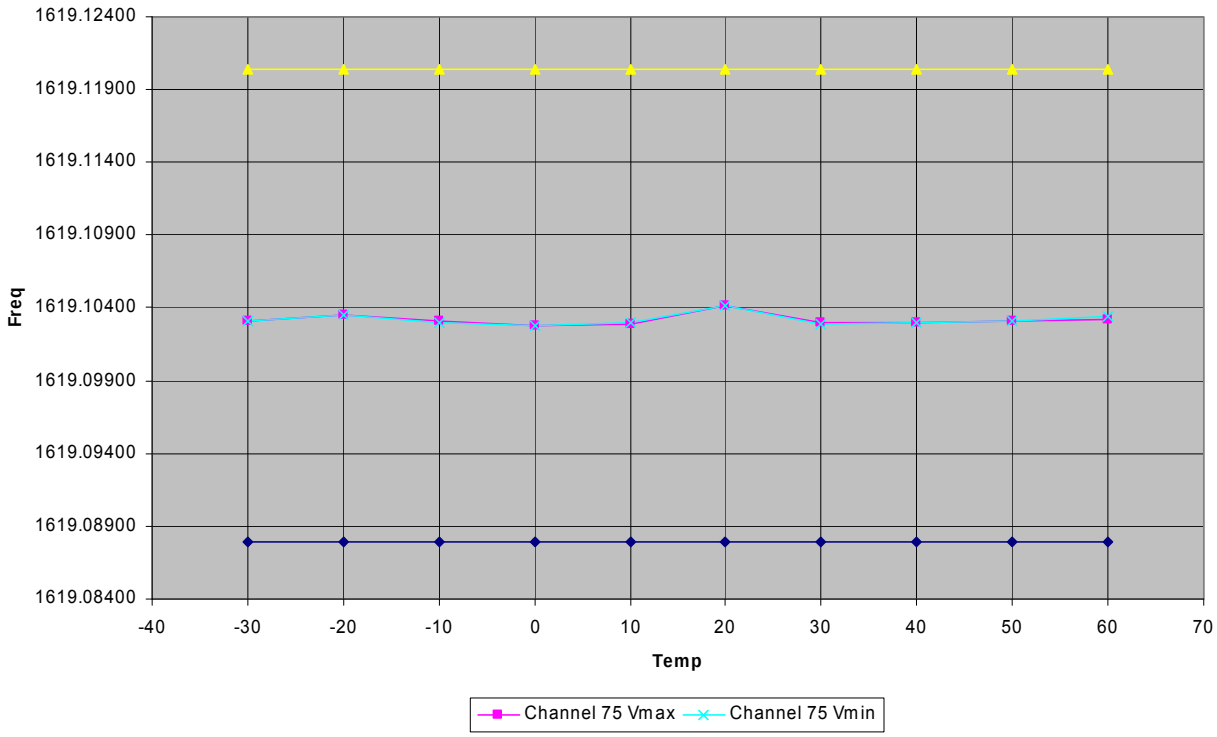


11GHz – 17GHz

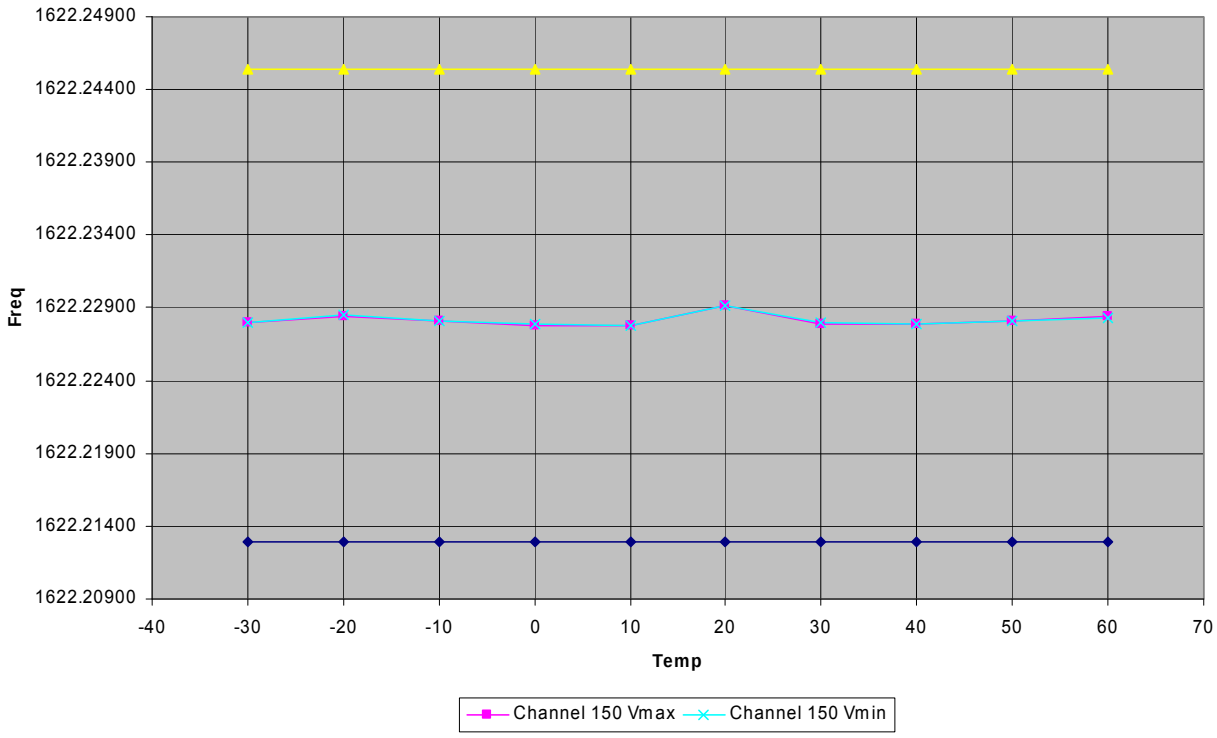
Channel 1 Frequency Stability - Temperature



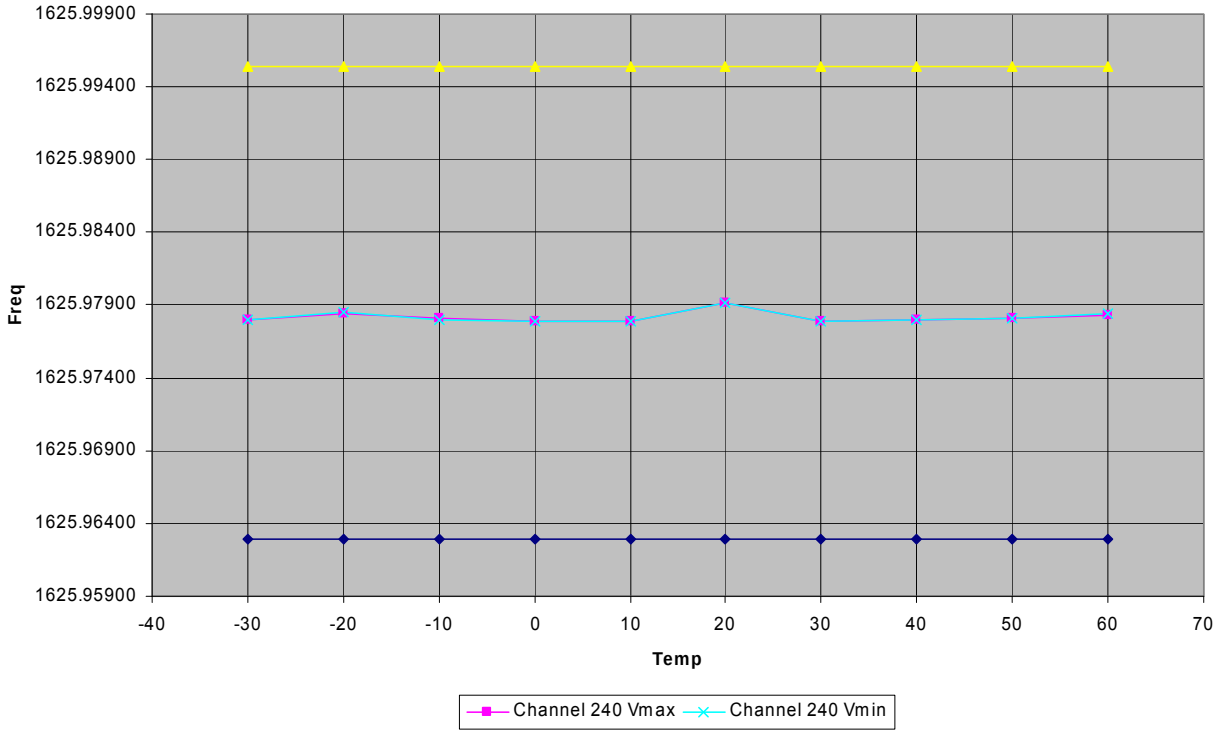
Channel 75 Frequency Stability - Temperature



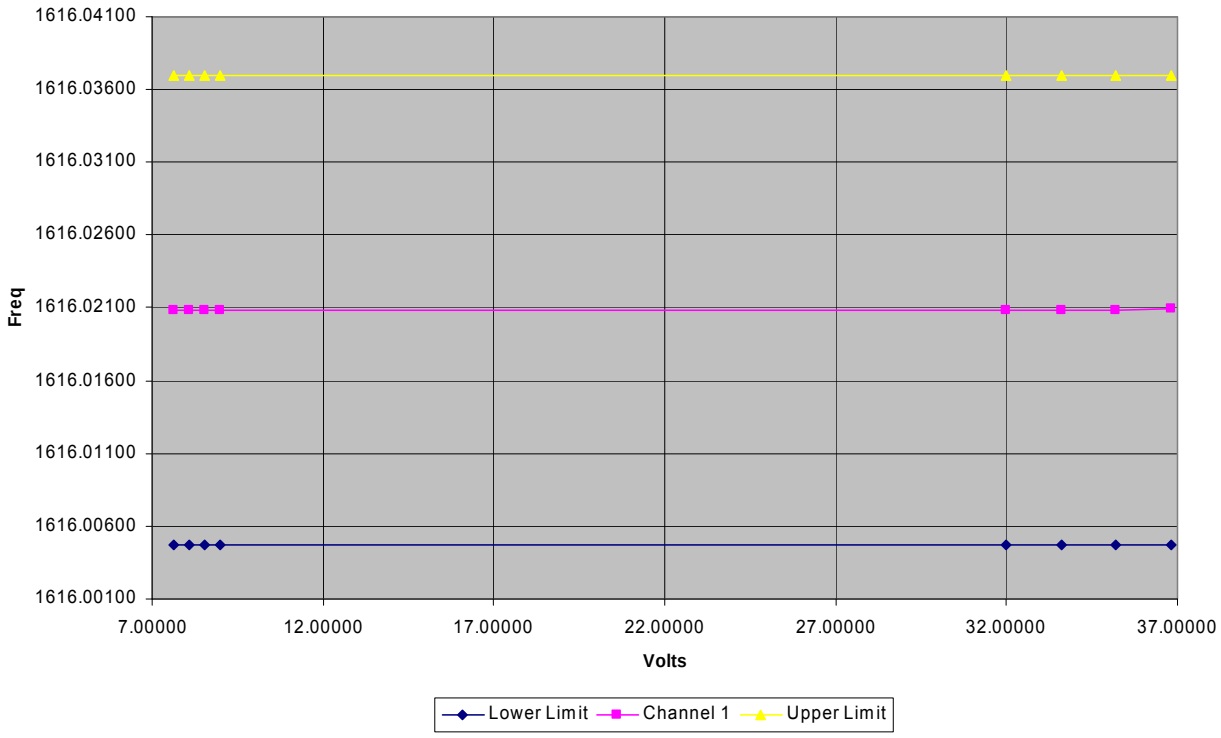
Channel 150 Frequency Stability - Temperature



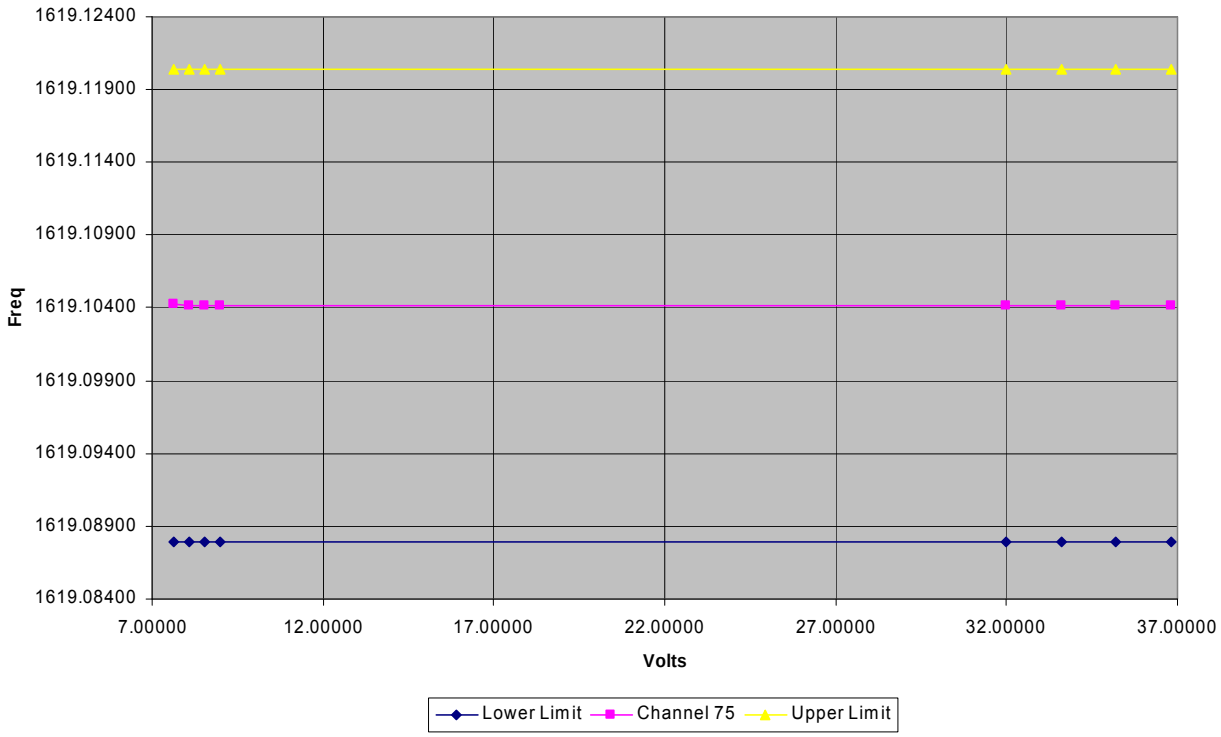
Channel 240 Frequency Stability - Temperature



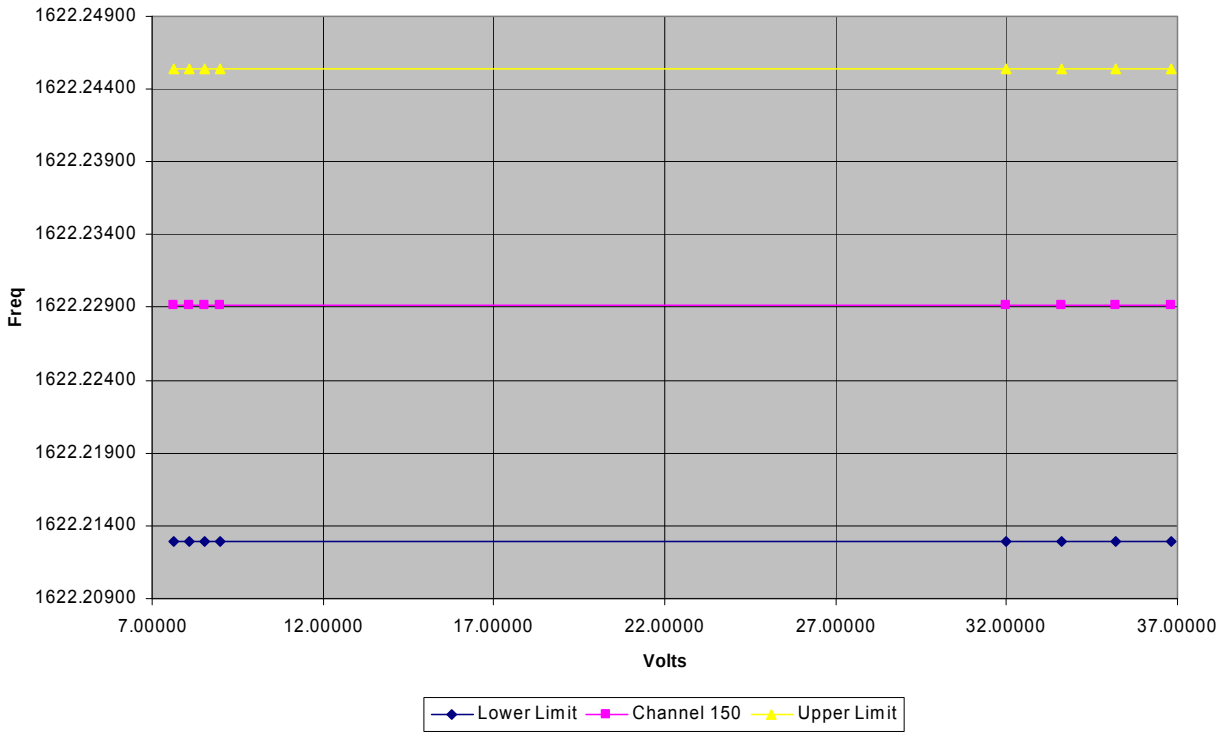
Channel 1 Frequency Stability - Voltage



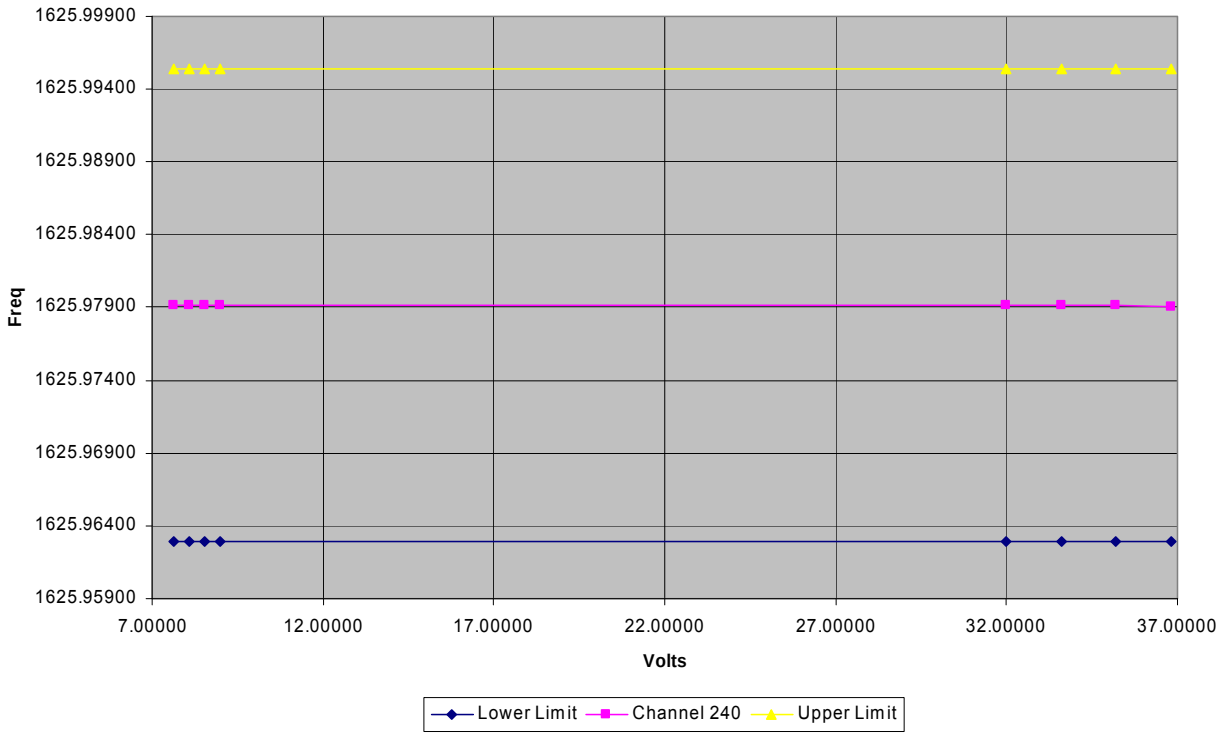
Channel 75 Frequency Stability - Voltage

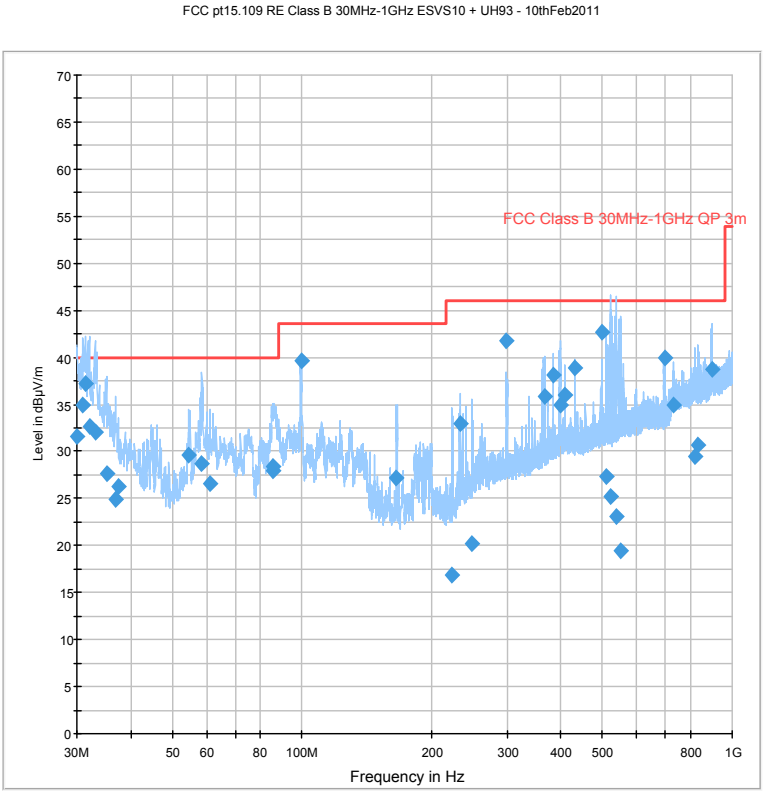


Channel 150 Frequency Stability - Voltage

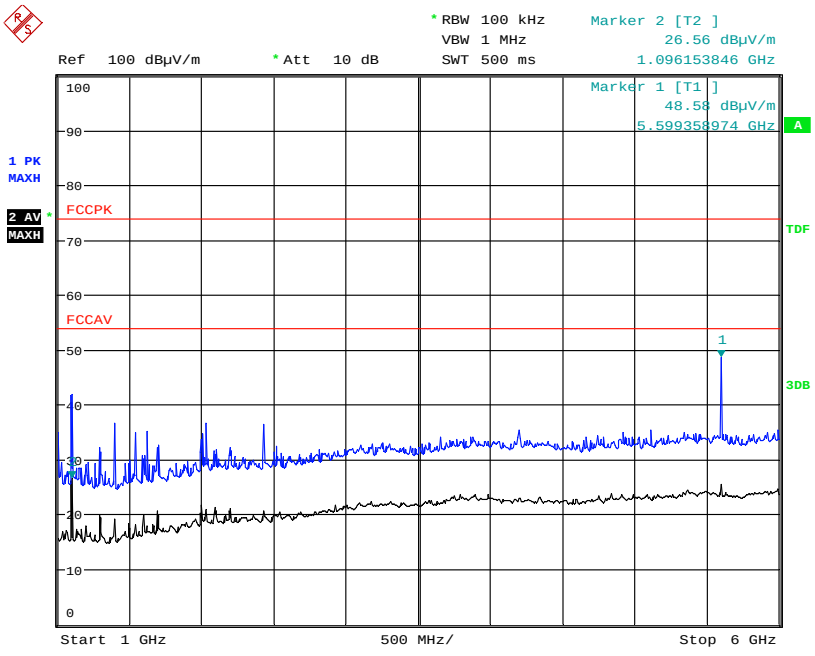


Channel 240 Frequency Stability - Voltage



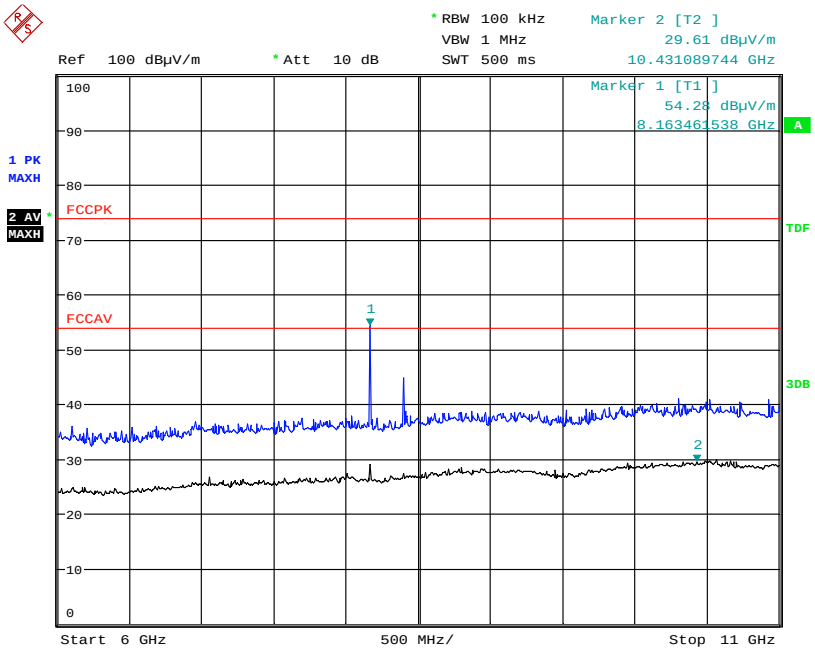


Unintentional Radiated spurious emissions 30 MHz to 1 GHz



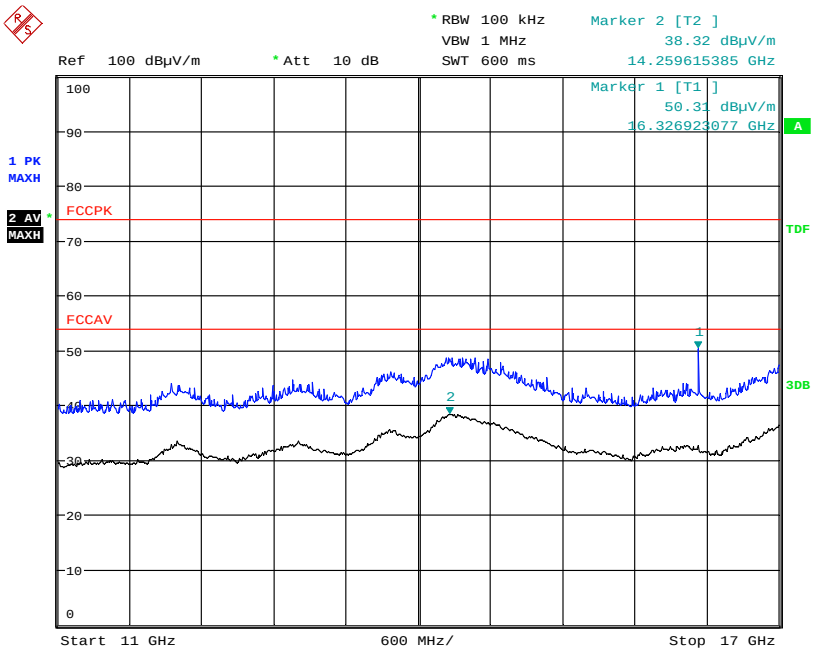
Date: 20.DEC.2011 12:35:30

Unintentional Radiated spurious emissions 1 GHz to 6 GHz



Date: 20.DEC.2011 12:36:29

Unintentional Radiated Spurious emissions 6 GHz to 11 GHz



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Unintentional Radiated Spurious emissions 11 GHz to 17 GHz

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
S08	Q4000	300234030000020

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

Sample No.	Description	Identification
S06	Q4000 Data Cable	None
S09	GPS Antenna	000289
S10	GSM Antenna	None

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

Identification	Description
N/A	TRaC Laptop (Compaq)
N/A	TRaC laptop (Toshiba)

C2 EUT operating mode during testing

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

Test	Description of Operating Mode:
Transmitter Spurious Emissions Conducted & Radiated Carrier Power	EUT transmitting a random modulated signal on the required frequency.

Test	Description of Operating Mode:
Frequency Stability Voltage/Temperature	EUT transmitting a carrier wave signal on the required frequency.

Test	Description of Operating Mode:
Receiver radiated spurious emissions	EUT active but non-transmitting.

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 : S08
Tests : Conducted

Port	Description of Cable Attached	length	Equipment Connected
Iridium Antenna Port	Coaxial Cable	0.5m	Measurement System
GPS Antenna Port	None	-	Unconnected
GSM Antenna Port	None	-	Unconnected
Data interface	40 single wires	20cm	See below

Data interface			
Port	Description of Cable Attached	length	Equipment Connected
MTS	Single core unscreened to 9-Way D-type	20cm	Un terminated
Logger	Single core unscreened to 9-Way D-type	20cm	Un terminated
GPS	Single core unscreened to 9-Way D-type	20cm	Un terminated
AUX	Single core unscreened to 9-Way D-type	20cm	* Programming PC
GSM	Single core unscreened to 9-Way D-type	20cm	Un terminated
Power supply	Single core unscreened	40cm	PSU
All other cables	Single core unscreened	20cm	Un terminated

Sample : S08
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
Iridium Antenna Port	Coaxial Cable	0.5m	Measurement System
GPS Antenna Port	Coaxial Cable	2	Antenna
GSM Antenna Port	Coaxial Cable	2	Antenna
Data interface	40 single wires	20cm	See below

Data interface			
Port	Description of Cable Attached	length	Equipment Connected
MTS	Single core unscreened to 9-Way D-type	20cm	Test Laptop
Logger	Single core unscreened to 9-Way D-type	20cm	Test Laptop
GPS	Single core unscreened to 9-Way D-type	20cm	Test Laptop
AUX	Single core unscreened to 9-Way D-type	20cm	Un terminated*
GSM	Single core unscreened to 9-Way D-type	20cm	Un terminated
Power supply	Single core unscreened	40cm	PSU
All other cables	Single core unscreened	20cm	Un terminated

All D-Type connectors were extended with a 1m serial extension cable.
* Only connected for setup.

C5 Details of Equipment Used

TRAC Ref	Type	Description	Manufacturer	Date Calibrated.
TRL11	TCC 125-815P	TEMP CHAMBER	SHARTREE	Use TRL426
TRL138	3115	HORN	EMCO	08/11/2019
TRL139	3115	HORN	EMCO	14/09/2011
TRL176	2042	SIGNAL GENERATOR	MARCONI	07/10/2011
TRL193	VHA 9103 balu	BICONE ANTENNA	CHASE	06/05/2008
TRL203	UPA6108	LOG PERIODIC	CHASE	06/05/2008
TRL220	8304-300N	ATTENUATOR	BIRD	Cal In Use
TRL222	8304-100-N	ATTENUATOR	BIRD	Cal In Use
TRL246	8304-0600N	ATTENUATOR	BIRD	Cal In Use
TRL426	52 SERIES II	TEMP INDICATOR	FLUKE	04/03/2011
TRL572	8449B	PRE AMPLIFIER	AGILENT	24/11/2010
TRLUH28	UHALP 9108	LOG PERIODIC	SCHWARZBECK	17/06/2011
TRLUH29	VHBA 9123	BICONE ANTENNA	SCHWARZBECK	04/03/2011
TRLUH41	M3004	MULTIMETER	AVOMeter	20/06/2011
TRLUH93	CBL6112	BILOG ANTENNA	Chase	15/11/2011
TRLUH96	6960B	POWER METER	MARCONI	17/06/2011
TRLUH100	PL32QMD	PSU	THANDAR	Use TRLUH41
TRLUH129	6924	POWER SENSOR	MARCONI	05/12/2011
	ESVS10	RECEIVER	R&S	
TRLUH191	CBL611/A	BILOG ANTENNA	YORK	08/11/2010
TRLUH281	FSU 46	SPECTRUM ANALYSER	R&S	10/02/2011
TRLUH287	11708A	ATTENUATOR	HP	Cal In Use
TRLUH302	8472A	CRYSTAL DETECTOR	HP	Info Only
TRLUH314	117310	DIRECTIONAL COUPLER	SINGER	Cal In Use
REF 901	2-18A-MFN-06	ATTENUATOR	BIRD	Cal In Use
REF902	2-18A-MFN-06	ATTENUATOR	BIRD	Cal In Use
REF910	FSU 46	SPECTRUM ANALYSER	R&S	13/07/2011
REF940	ATS	Chamber 6	Rainford EMC	13/07/2011
N/A	SH4141	HIGH PASS FILTER	BSC	Cal In Use
N/A	8489A	Variable Attenuator	Agilent	Cal In Use

Appendix D: Additional Information

No additional information is included within this test report.

Appendix E: Calculation of the duty cycle correction factor

Using a spectrum analyser in zero span mode, centred on the fundamental carrier frequency with a RBW of 1MHz and a video Bandwidth of 1MHz the sweep time was set accordingly to capture the pulse train. The transmit pulsewidths and period was measured. A plots of the pulse train is contained in Appendix B of this test report.

If the pulse train was less than 100 ms, including blanking intervals, the duty cycle was calculated by averaging the sum of the pulsewidths over one complete pulse train. However if the pulse train exceeds 100ms then the duty cycle was calculated by averaging the sum of the pulsewidths over the 100ms width with the highest average value. (The duty cycle is the value of the sum of the pulse widths in one period (or 100ms), divided by the length of the period (or 100ms). The duty cycle correction factor was then expressed in dB and the peak emissions adjusted accordingly to give an average value of the emission.

Correction factor dB = 10 x (Log_{10} Calculated Duty Cycle)

Therefore the calculated duty cycle was determined:

The pulse train period was greater than >100ms and in as shown from the plots in contained in appendix B of this test report.

$$\text{Duty cycle} = \frac{\text{the sum of the highest average value pulsewidths}}{\text{length of the period}}$$

e.g

$$= \frac{8.38ms}{90.35ms} = 0.09285$$

0.09285 or 9.285%

Correction factor (dB) = 10 x (Log_{10} 0.09285) = 10.33dB

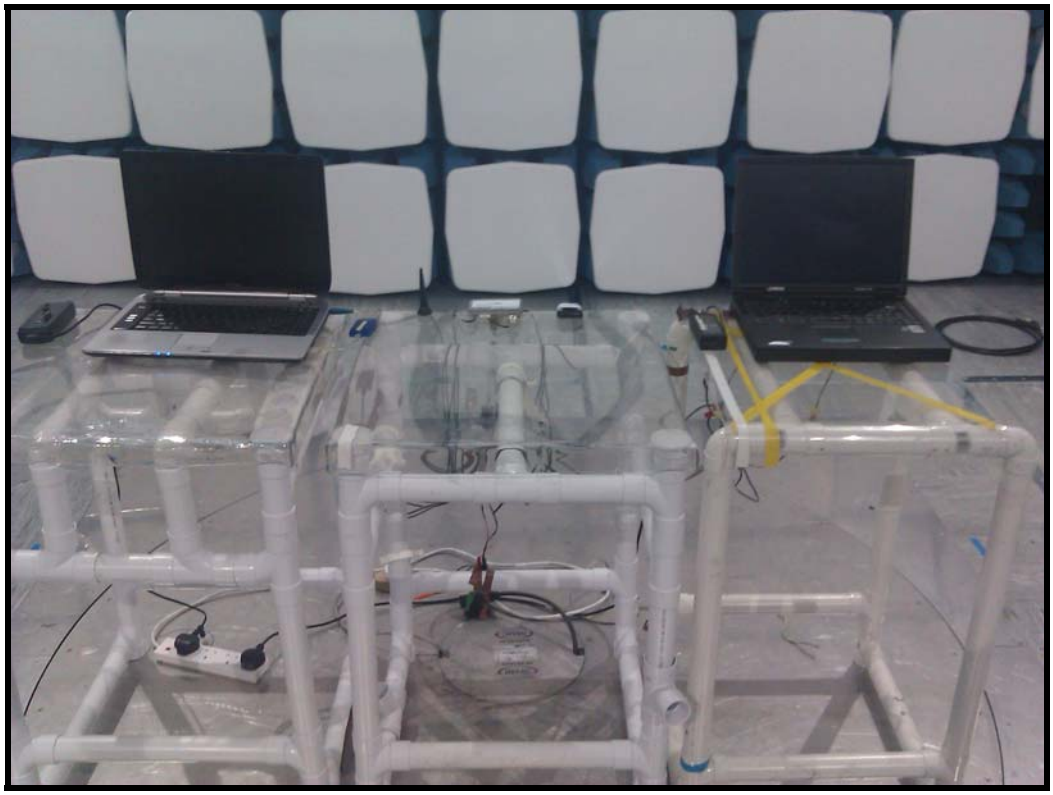
Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: Q4000 Overview
2. Radiated electric field emissions arrangement: Q4000 close up

Photograph 1

Photograph 2



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