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Appendices **-**

Number:
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240161B

Date of handing in: **23.05.2013**

Tested by:



Pekka Kälviäinen, Test Engineer

Reviewed by:



Timo Hietala, Test Specialist

SORT OF EQUIPMENT:

Radio modem module

MODEL:

SATELLINE-M3-TR3

TYPE:

SATEL-TA23

MANUFACTURER:

SATEL Oy, Finland

SERIAL NUMBER:

1320000190

CLIENT:

SATEL Oy

ADDRESS:

Meriniitynkatu 17, FIN-24100 Salo, Finland

TELEPHONE:

+358 2 777 7800 / Janne Pulkkinen

TEST LABORATORY

Nemko Oy

FCC REG. NO.

359859 October 20, 2011

IC FILE NO.

2040F-1 November 22, 2012

REMARKS:

Tested to FCC Part 90 and RSS-119 Issue 11.

The test results are valid for the tested unit only. Without a written permission of Nemko Oy it is allowed to copy this report as a whole, but not partially.

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1. General

Type:	SATEL-TA23		
Alignment range:	406.1 – 430.0 MHz and 450.0 – 470.0 MHz		
Switching range:	One channel		
Measurement	Equipment 1 Serial no. 1320000190	Equipment 2 Serial no.	Equipment 3 Serial no.
Frequencies:	1) 408.0 MHz (403.000 MHz) 2) 428.0 MHz (426.325 MHz) 3) 468.0 MHz (473.000 MHz)		
Voltages:	Normal 4.0 VDC	Minimum 4.1 VDC	Maximum 3.9 VDC
Temperatures:	+22 - 24°C	-30,0°C	+50,0°C
Humidity:	34 - 57 %		
Effective radiated power:	1 W / 100 mW	Antenna:	HIROSE U.FL, (Test jig: SMA-connector)
Number of channels:		Production model:	Production model
Channel separation:	12.5 and 25 kHz	Modulation:	Multilevel State FM (4FSK) (12,5 kHz: 9600 bps 25 kHz: 19200 bps)

The transmitter was tested in a standalone configuration.

2. Summary of performed tests and test results

(This interpretation of the test report's results does not belong to the scope of our accreditation.)

Section in CFR 47	Section in RSS-119, Issue 11		Result
90.205 & 2.1046	5.4	Transmitter power (conducted)	PASS
90.210 & 2.1049	5.5	99% Occupied bandwidth	PASS
90.210 & 2.1049	5.5	Spectrum emission mask	PASS
90.210, 2.1057 & 2.1051	5.8	Spurious emissions (conducted)	PASS
90.210, 2.1057 & 2.1053	5.8	Spurious emissions (radiated)	PASS
90.214	5.9	Transient frequency behavior	PASS
90.213 & 2.1055	5.3	Frequency stability	PASS

According to the standard the measurement results have been compared directly with the limits without considering measurement uncertainties.

Explanations:

PASS The EUT passed that particular test.
FAIL The EUT failed that particular test.

3. RF Power output

NAME OF TEST: RF Power Output	FCC PARA.NO.: 2.1046
TESTED BY: Risto Hietanen	RSS119: 5.4
	DATE: 27/06/2013

Test Results: Complies.

Rated power: highest 1W = 30.0 dBm.
lowest 100mW = 20.0 dBm

Limit: ± 1.0 dB from rated power.

Measurement Data:

Modulation Type	Frequency (MHz)	Measured Output	
		Power (dBm)	Power (mW)
FM	408.0	30.25	1060
FM	428.0	29.91	980
FM	468.0	29.03	800
FM	408.0	20.76	119
FM	428.0	20.45	111
FM	468.0	19.45	88

Equipment used: 1530-0007, 218, 328, 316, 577

**Measurement
Uncertainty:** ± 0.7 dB.

Temperature: 24 °C.

**Relative
Humidity:** 57 %.

4. 99% Occupied bandwidth

NAME OF TEST: Occupied Bandwidth

PARA.NO.: 2.1049

TESTED BY: Pekka Kälviäinen

RSS119: 5.5

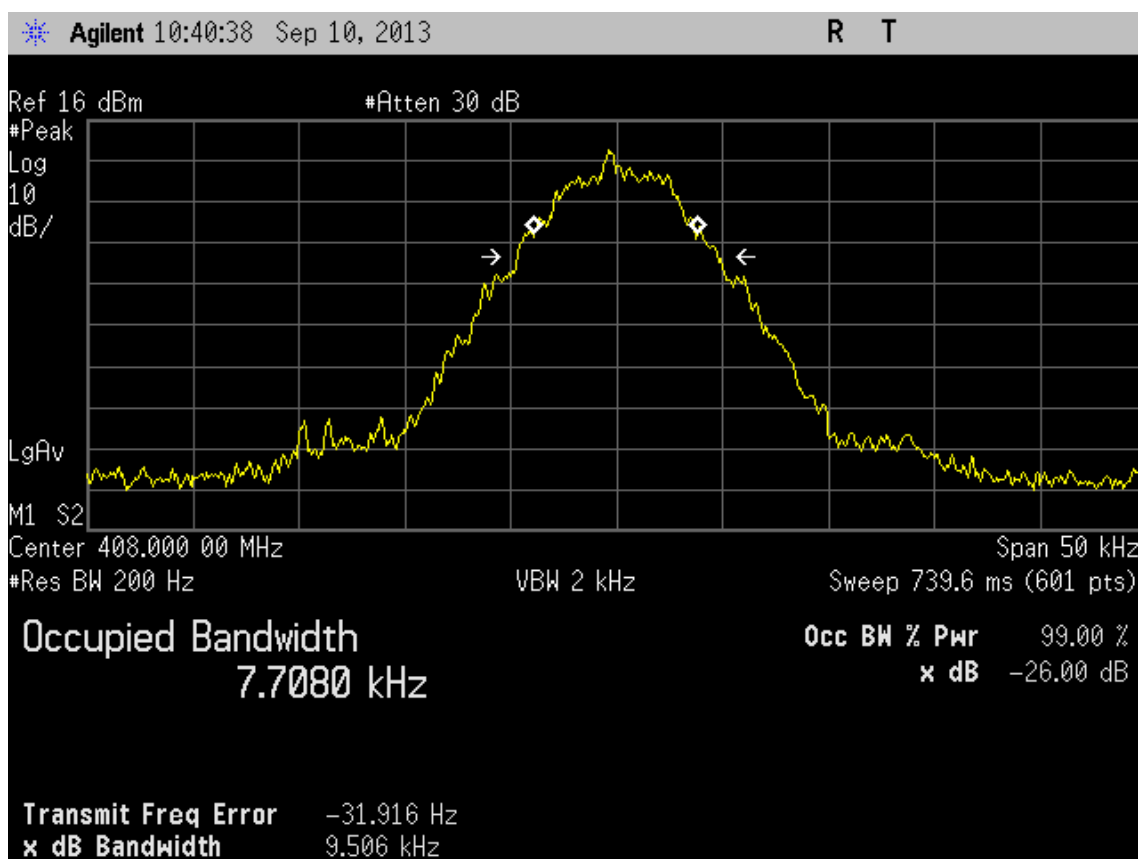
DATE: 10/09/2013

Test Results: Complies.**Test Data:** See attached plot(s).

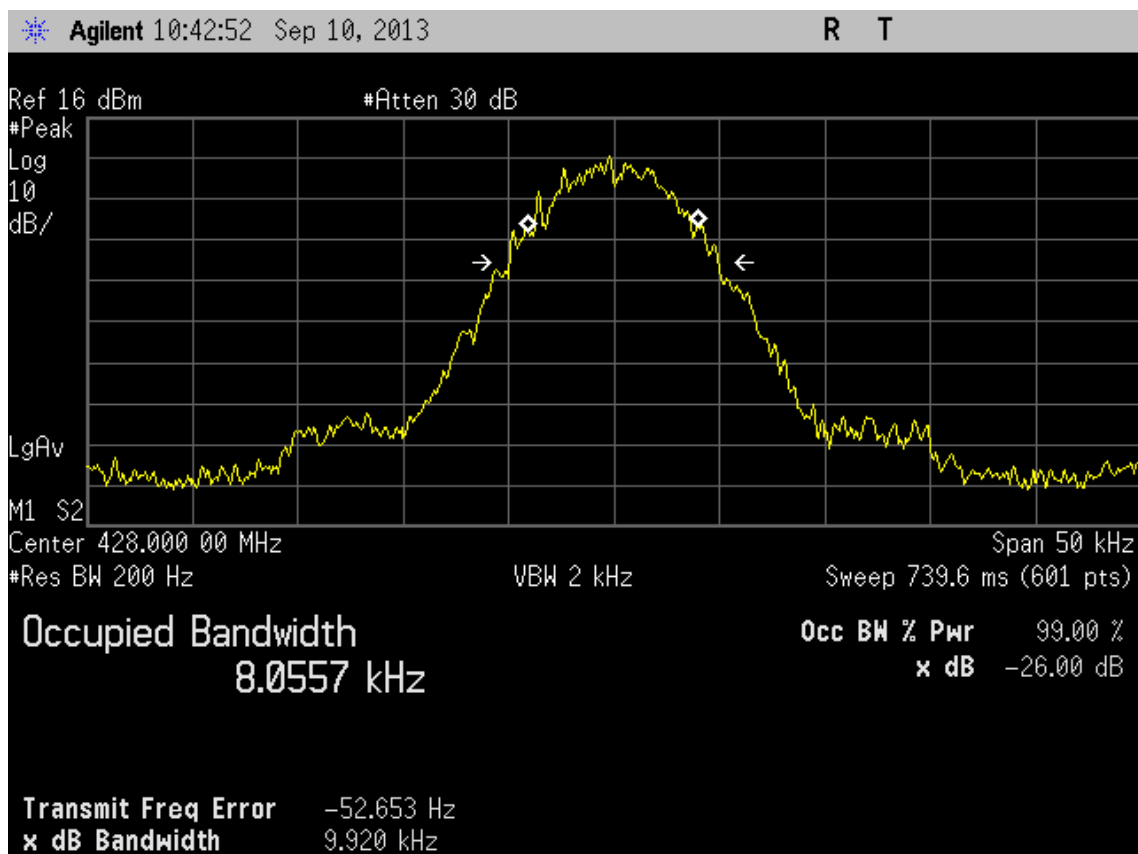
Channel spacing	Frequency (MHz)	Measured 99% Occupied Bandwidth (kHz)
12.5 kHz	408.0	7.7
12.5 kHz	428.0	8.1
12.5 kHz	468.0	7.8
25 kHz	408.0	15.1
25 kHz	428.0	15.1
25 kHz	468.0	14.8

Equipment used: 566, 328, 316, 341**Measurement
Uncertainty:** ± 85 Hz**Temperature:** 22 °C.**Relative
Humidity:** 49 %.

The 99% occupied bandwidth of the carrier emission is measured using a spectrum analyzer with Resolution Bandwidth set to 1% of the necessary bandwidth of the transmitted carrier. Transmitter was set to transmit random data file 19200 bps 25 kHz channel and 9600 bps 12.5 kHz channel.



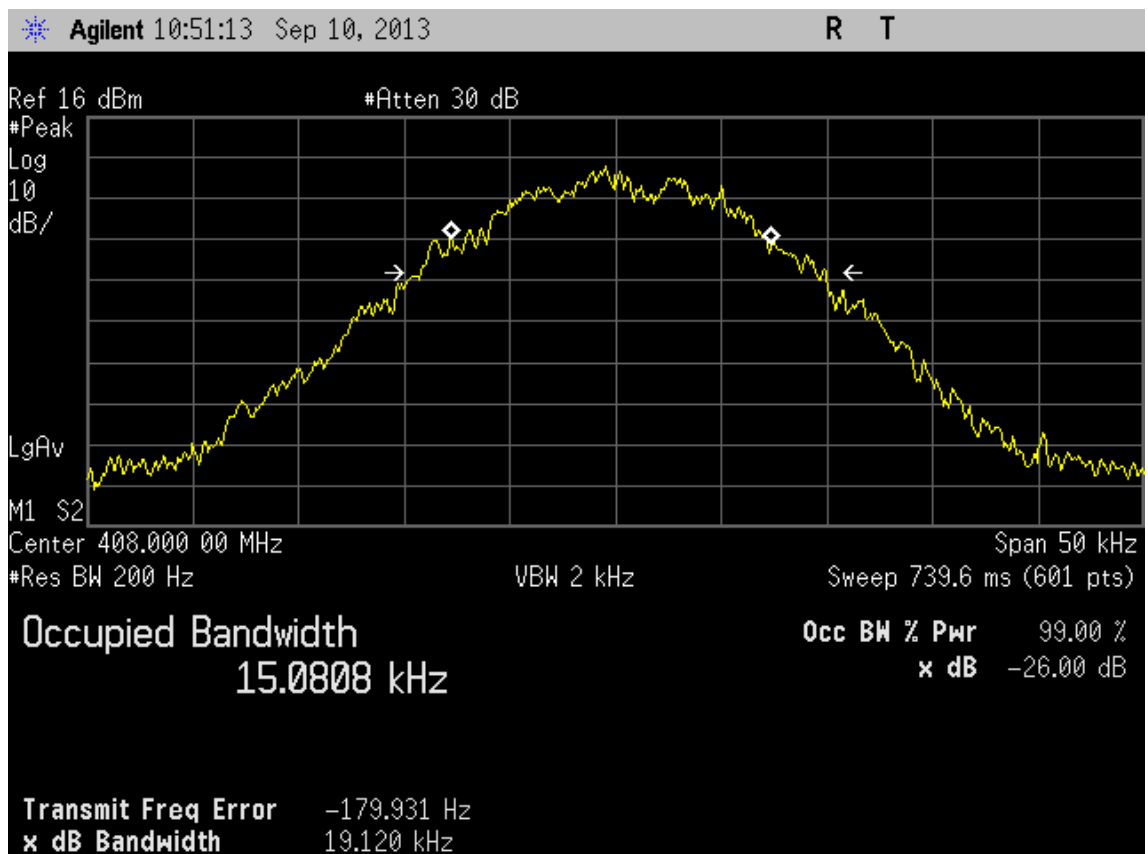
12.5 kHz channel spacing, 408 MHz



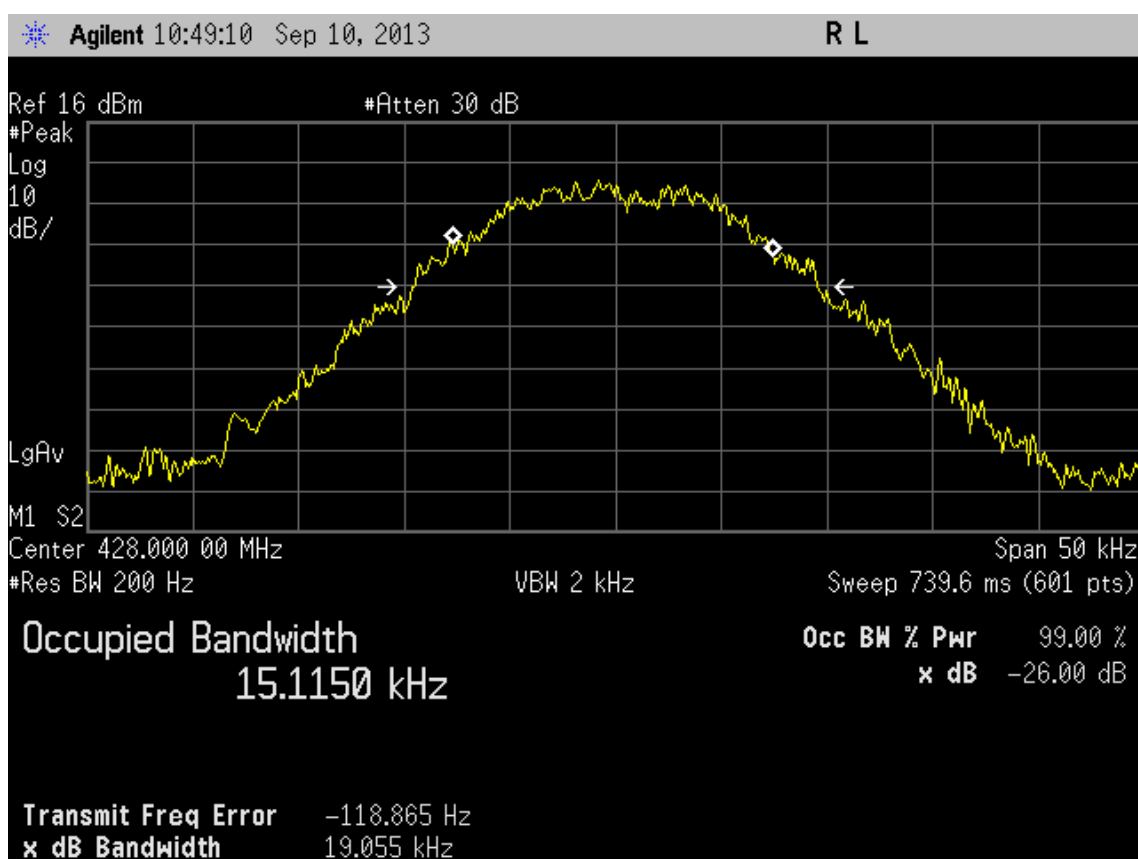
12.5 kHz channel spacing, 428 MHz



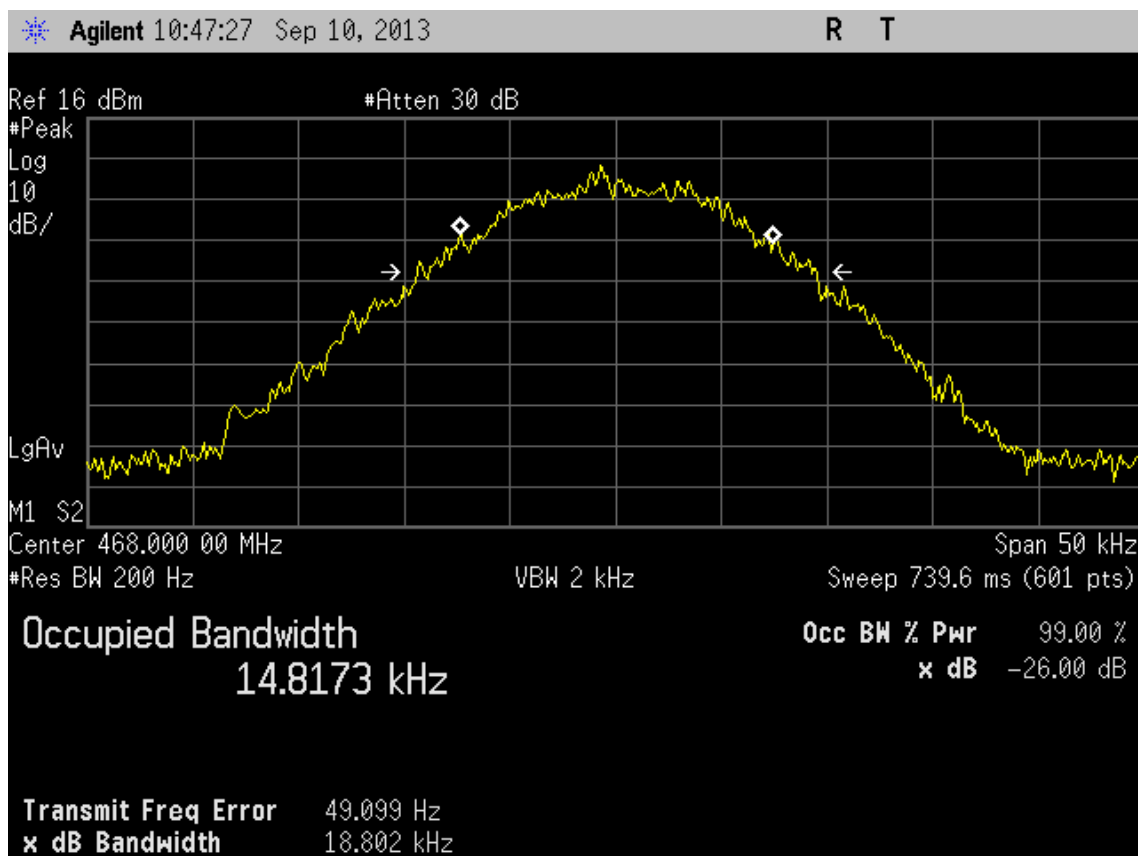
12.5 kHz channel spacing, 468 MHz



25 kHz channel spacing, 408 MHz



25 kHz channel spacing, 428 MHz



25 kHz channel spacing, 468 MHz

5. Spectrum emission mask

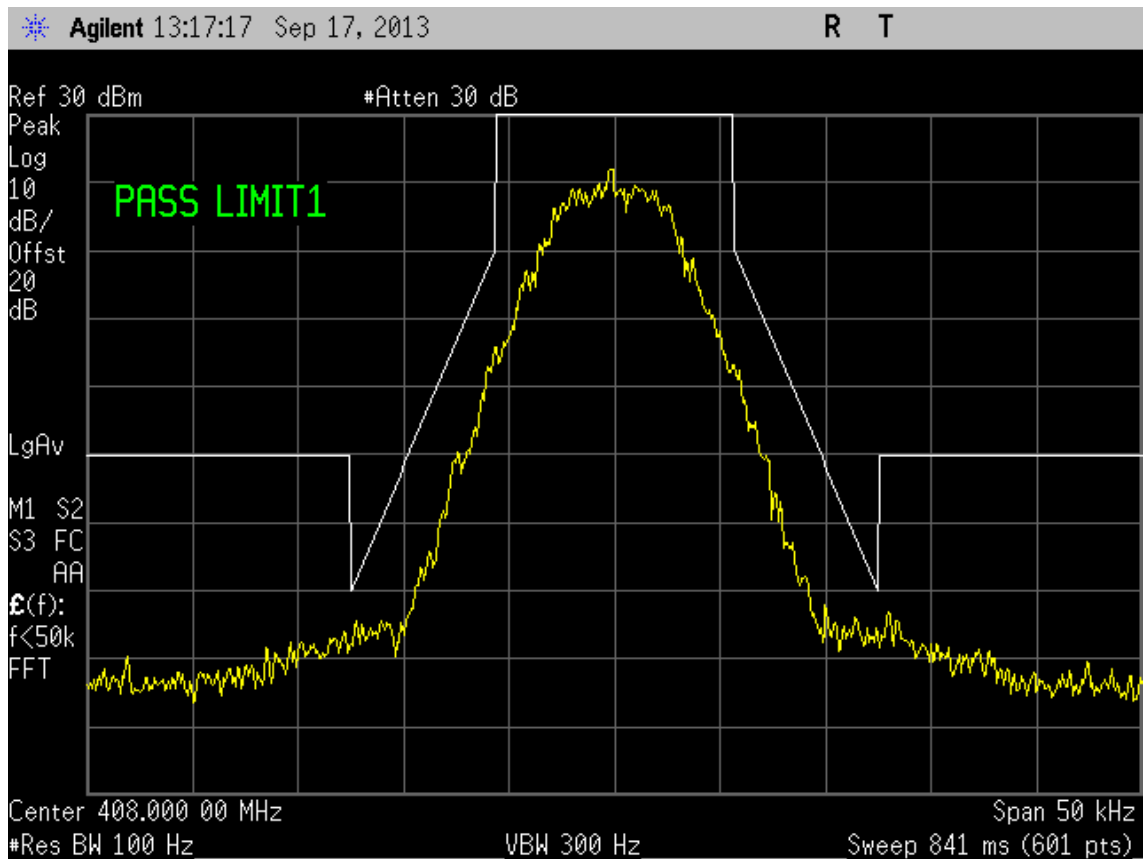
NAME OF TEST: Spectrum emission mask**PARA.NO.:** 2.1049**TESTED BY:** Pekka Kälviäinen**RSS119:** 5.5**DATE:** 10/09/2013**Test Results:** Complies.**Test Data:** See attached plot(s).

Mask C for 25kHz channel bandwidth and mask D for 12.5kHz channel bandwidth.

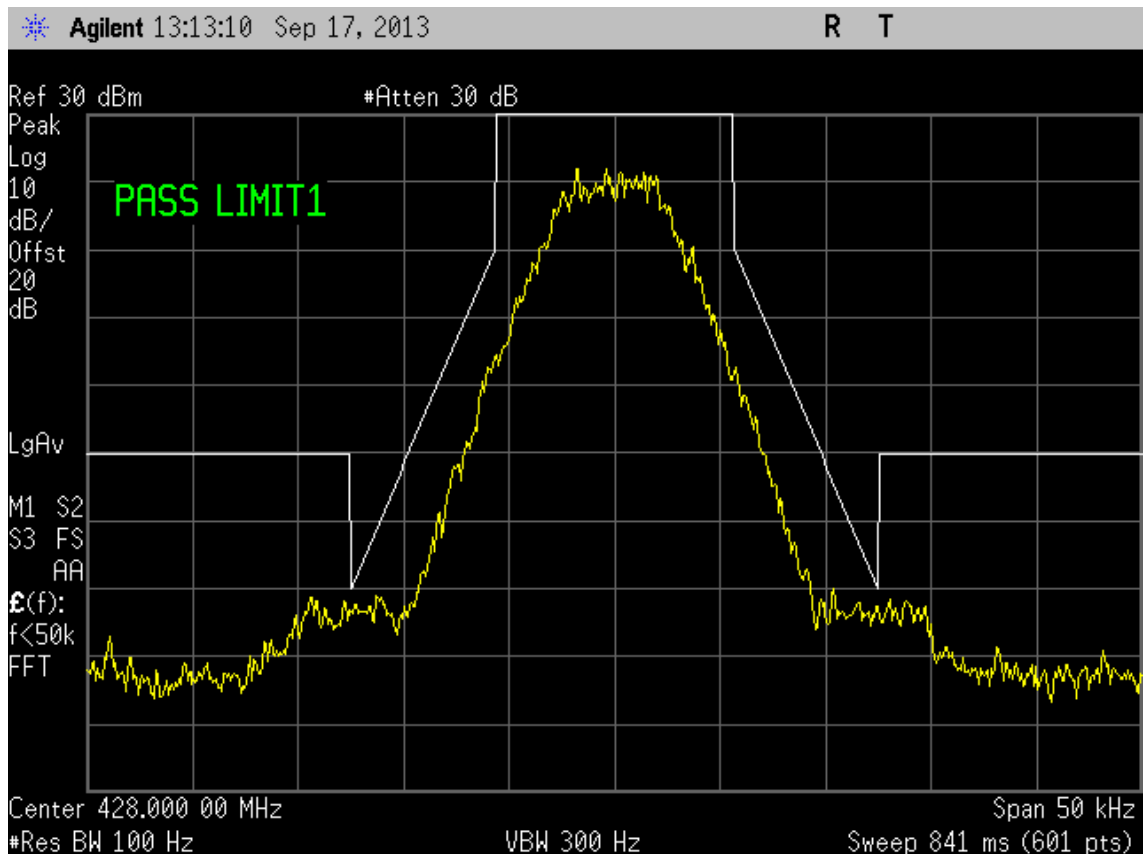
Equipment used: 566, 328, 316, 341**Measurement
Uncertainty:** ± 0.1 dB**Temperature:** 22 °C.**Relative
Humidity:** 49 %.

The emission mask of the modulated carrier is measured by using a spectrum analyzer with resolution bandwidth set to 300 Hz for emission mask C (25kHz bandwidth) and 100 Hz for emission mask D (12.5kHz bandwidth).

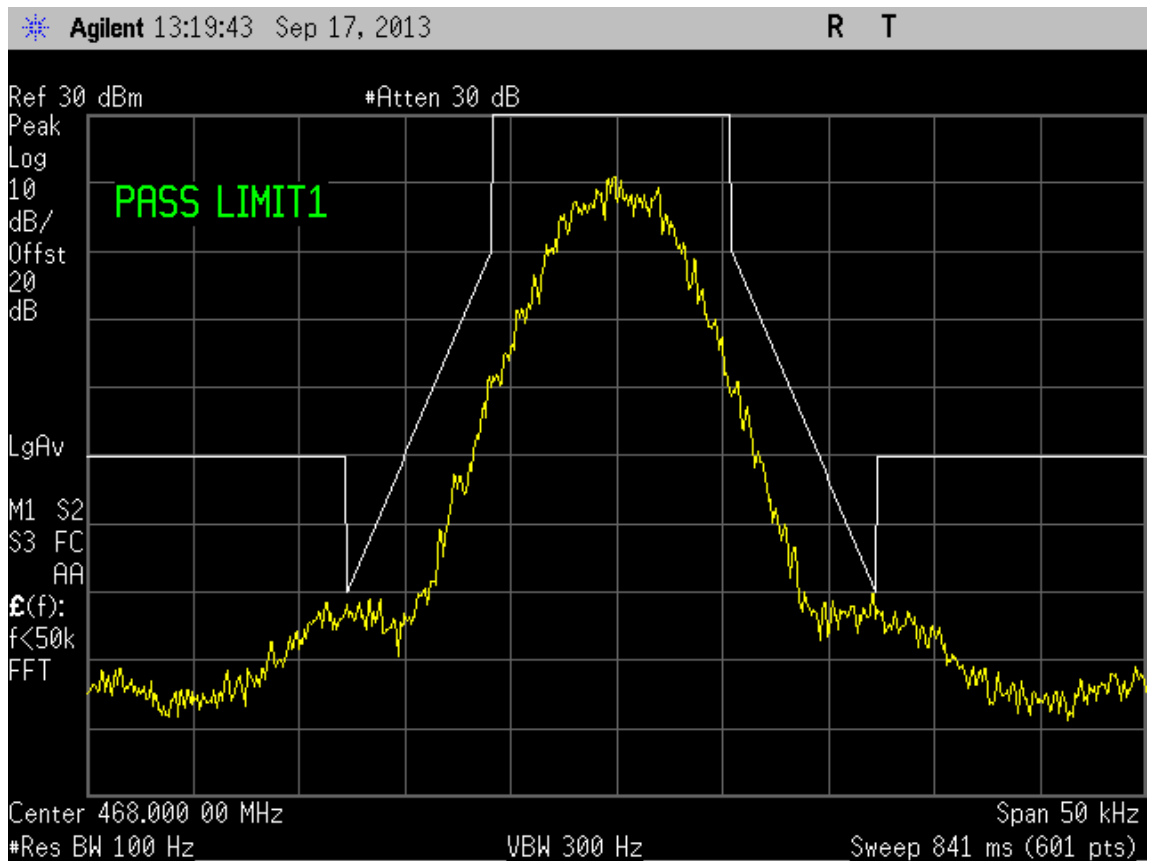
Transmitter was set to transmit random data file 19200 bps 25kHz channel and 9600 bps 12.5kHz channel.



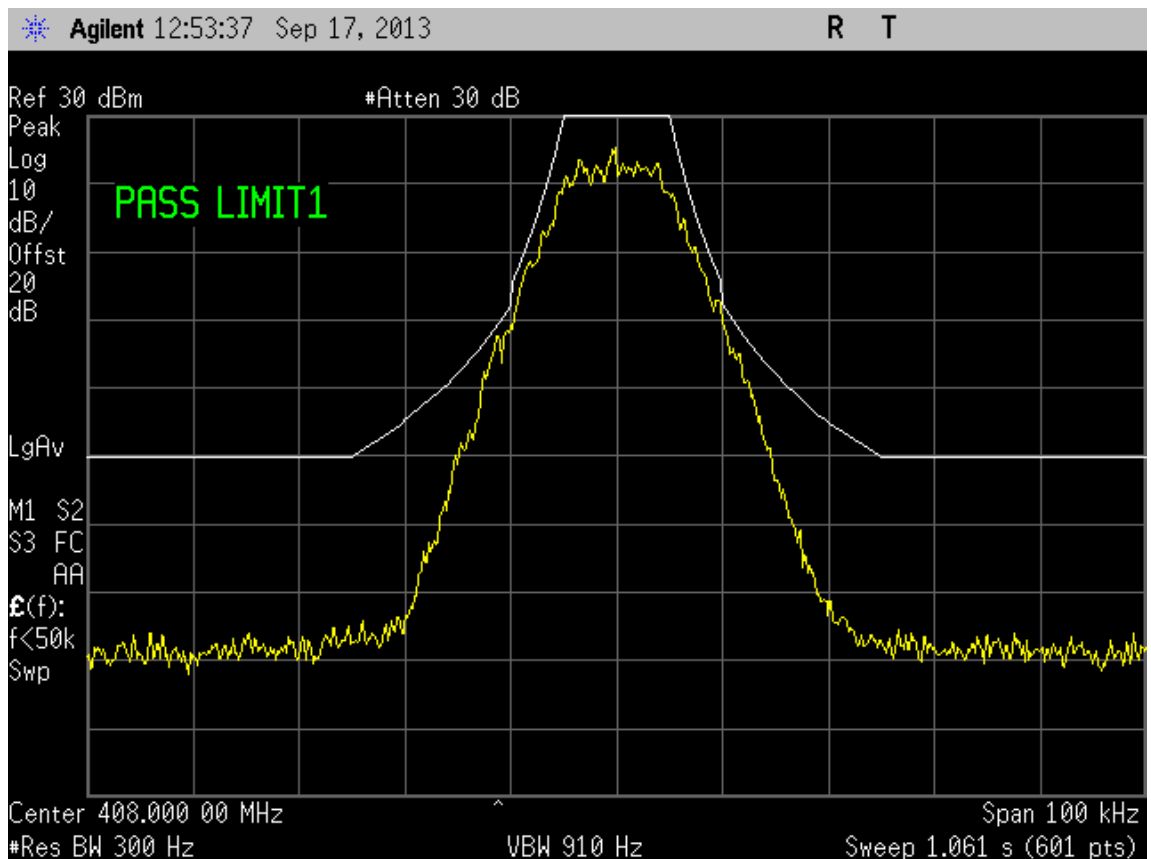
12.5 kHz channel spacing MASK D, 408 MHz, 1 W power



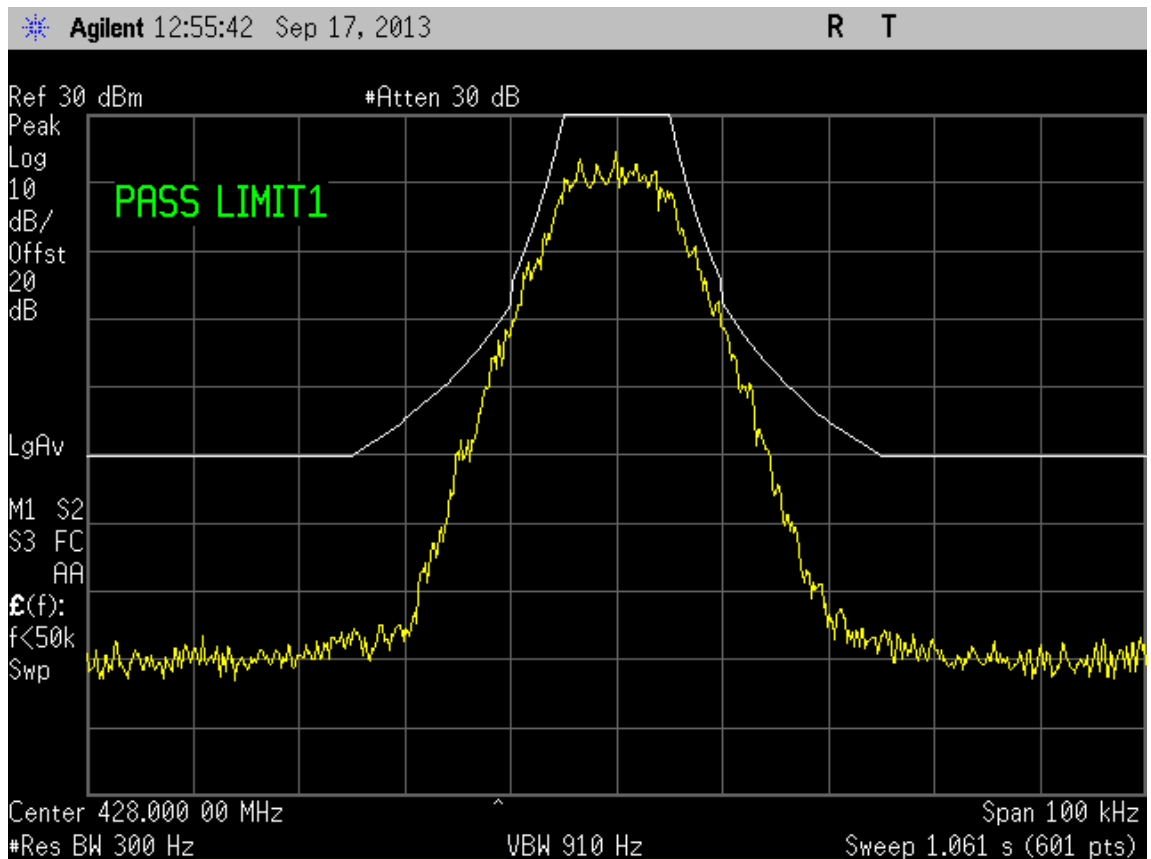
12.5 kHz channel spacing MASK D, 428 MHz, 1 W power



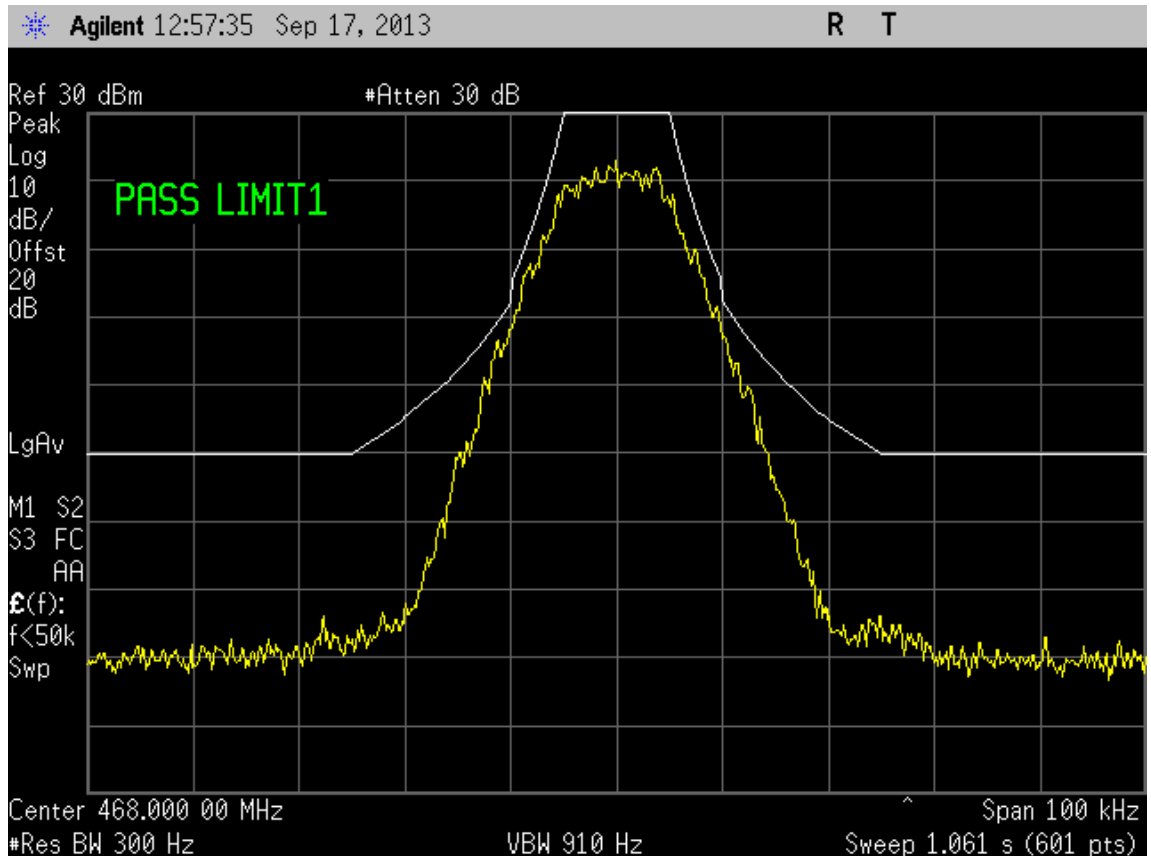
12.5 kHz channel spacing MASK D, 468 MHz, 1 W power



25 kHz channel spacing MASK C, 408 MHz, 1 W power



25 kHz channel spacing MASK C, 428 MHz, 1 W power



25 kHz channel spacing MASK C, 468 MHz, 1 W power

6. Transmitter spurious emissions (Conducted)

NAME OF TEST:	Spurious Emissions conducted	PARA.NO.: 2.1051
		RSS119: 5.8
TESTED BY: Pekka Kälviäinen		DATE: 10/09/2013

Test Results: Complies.

Test Data: See attached plots.

Requirement: $43 + 10 \log (P)$ dB, (-13 dBm)

Method of measurement: TIA-603

Transmitter tuned at 408, 428 and 468 MHz

Highest results:

Channel 408.0 MHz		Channel 428.0 MHz		Channel 468.0 MHz	
Frequency (MHz)	Level (dBm)	Frequency (MHz)	Level (dBm)	Frequency (MHz)	Level (dBm)
384.35	-38.6	420.45	-38.9	428.05	-39.3

Equipment used: 566, 328, 571, 316, 341

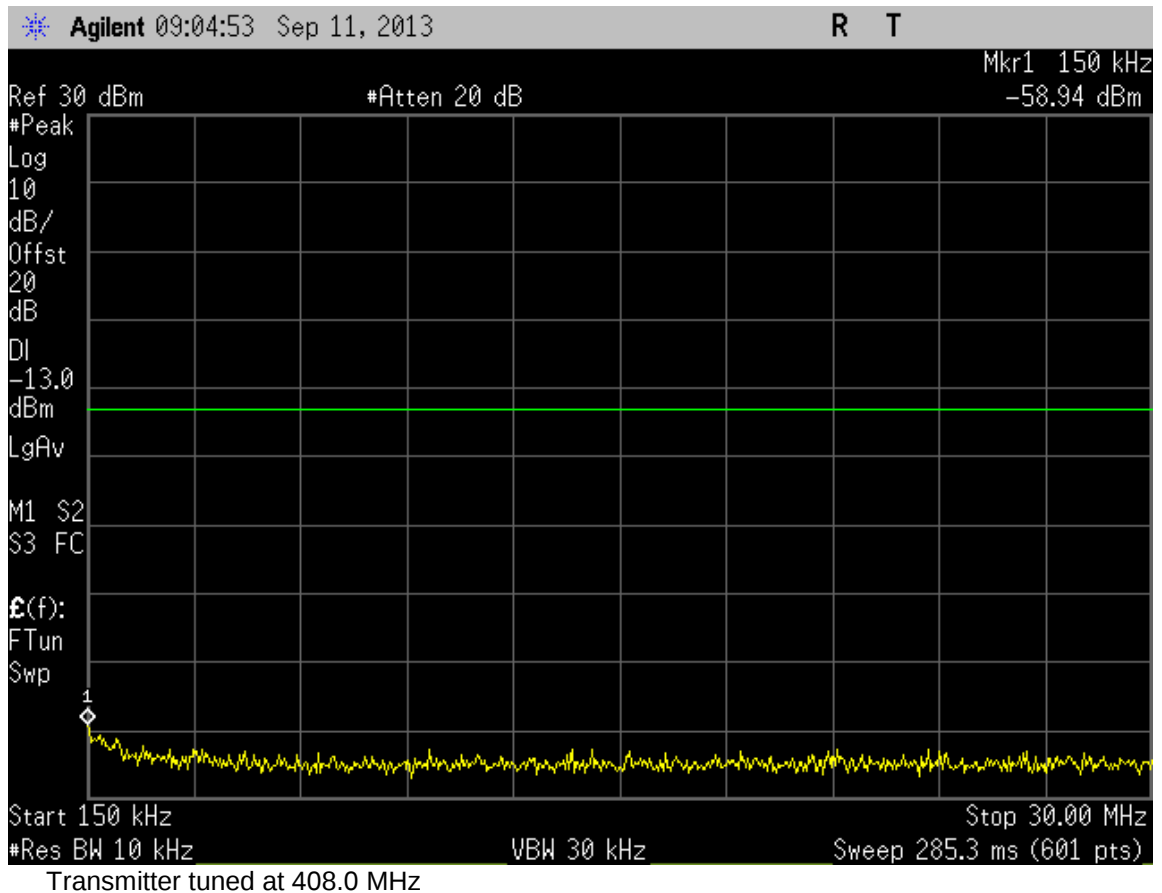
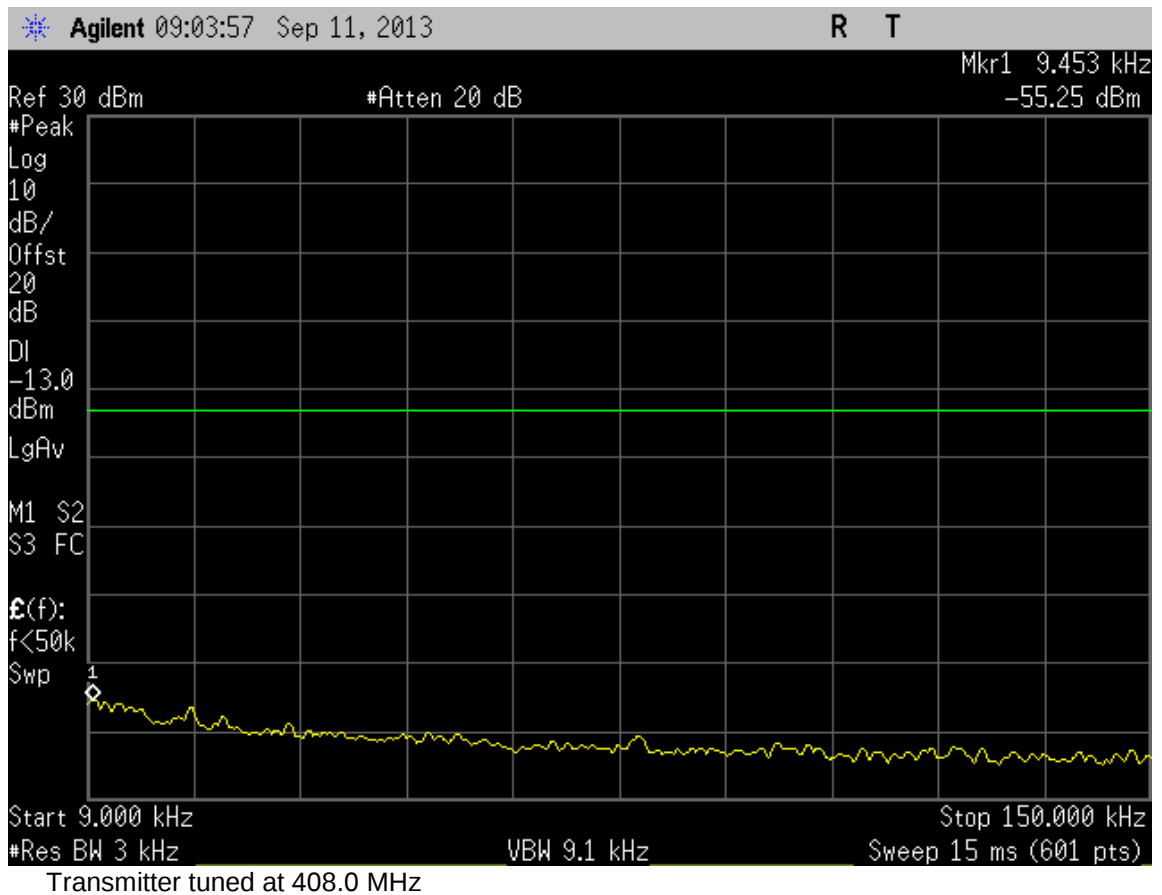
Measurement Uncertainty: ± 1.8 dB.

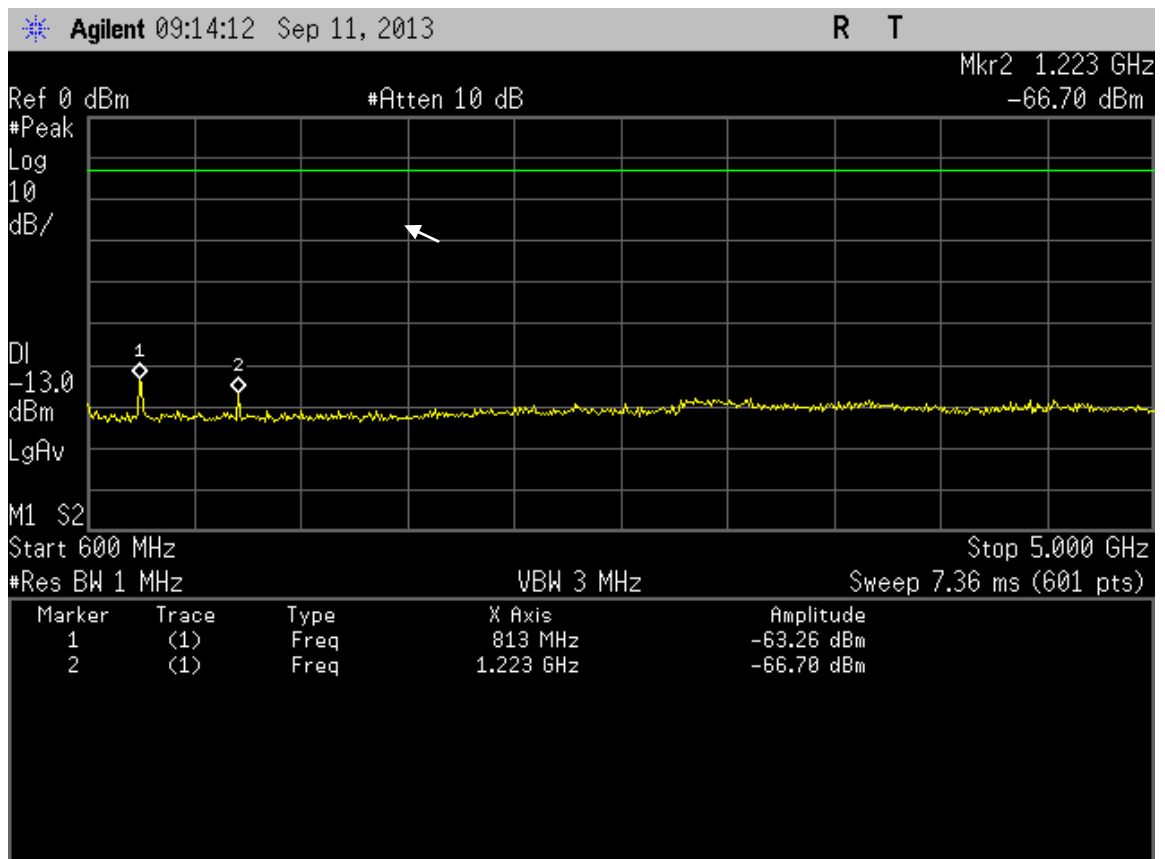
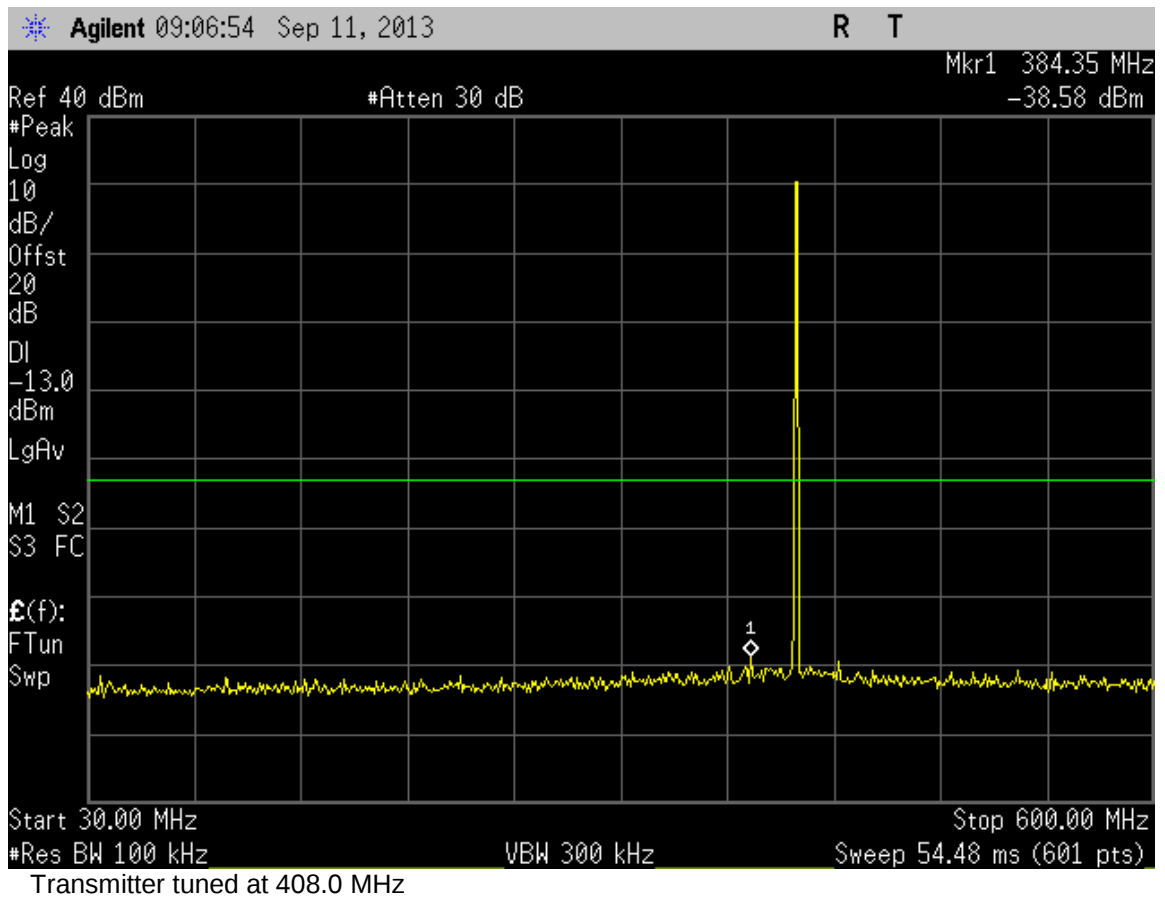
Temperature: 22 °C.

Relative Humidity: 49 %.

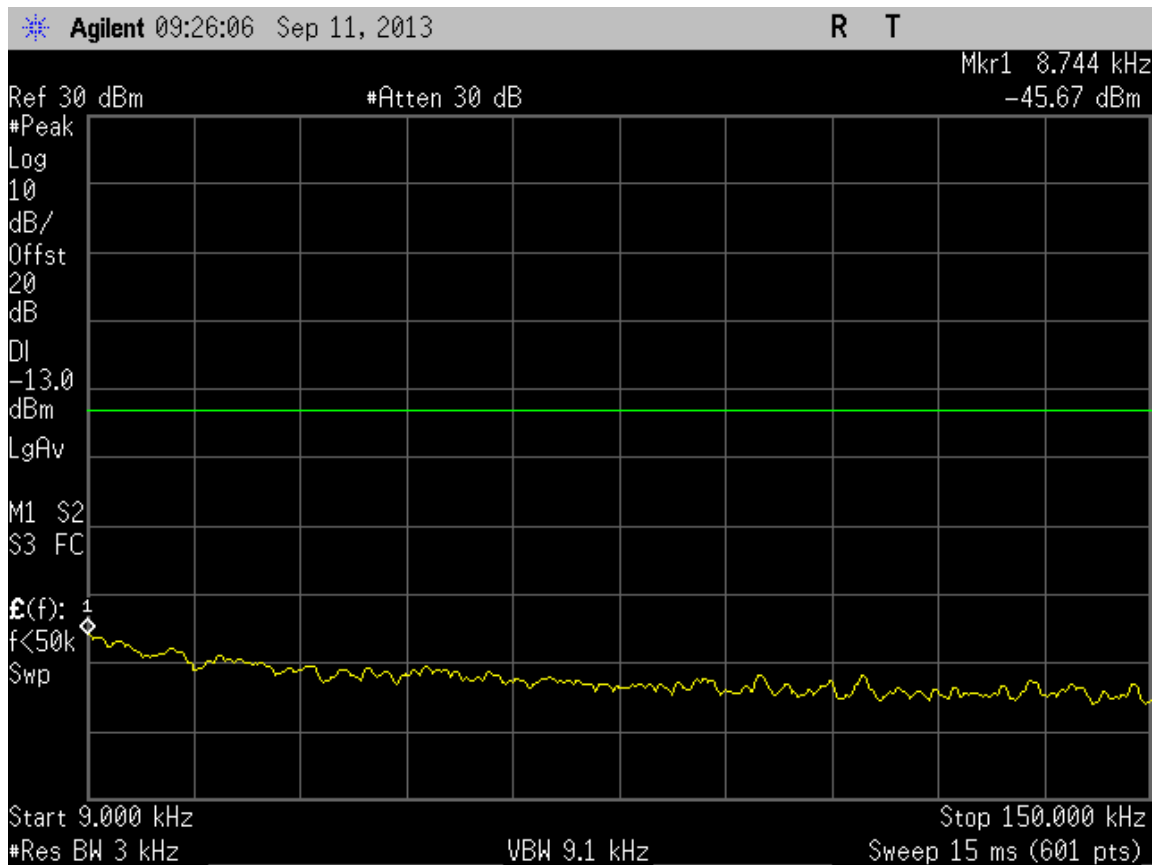
The spectrum was searched from 9 kHz to the 10th harmonic of the carrier (5GHz).

Rated output power: 1W

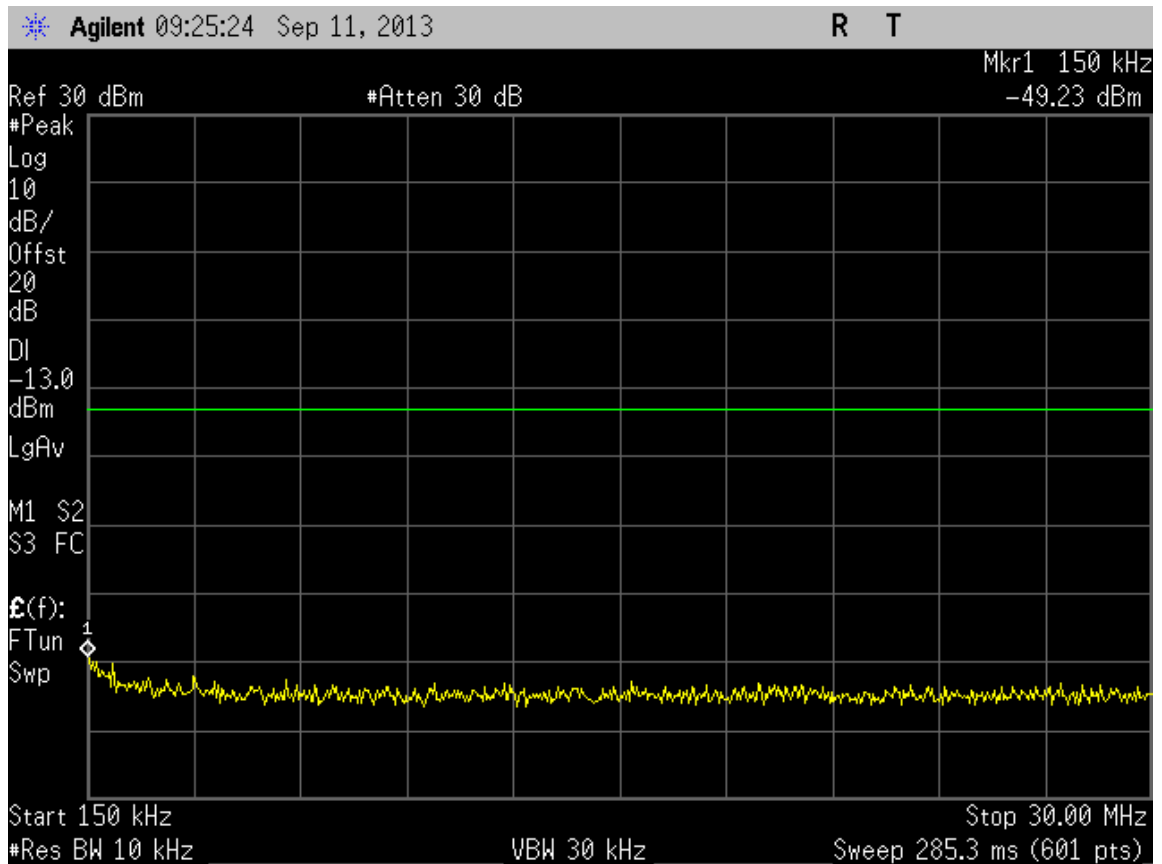




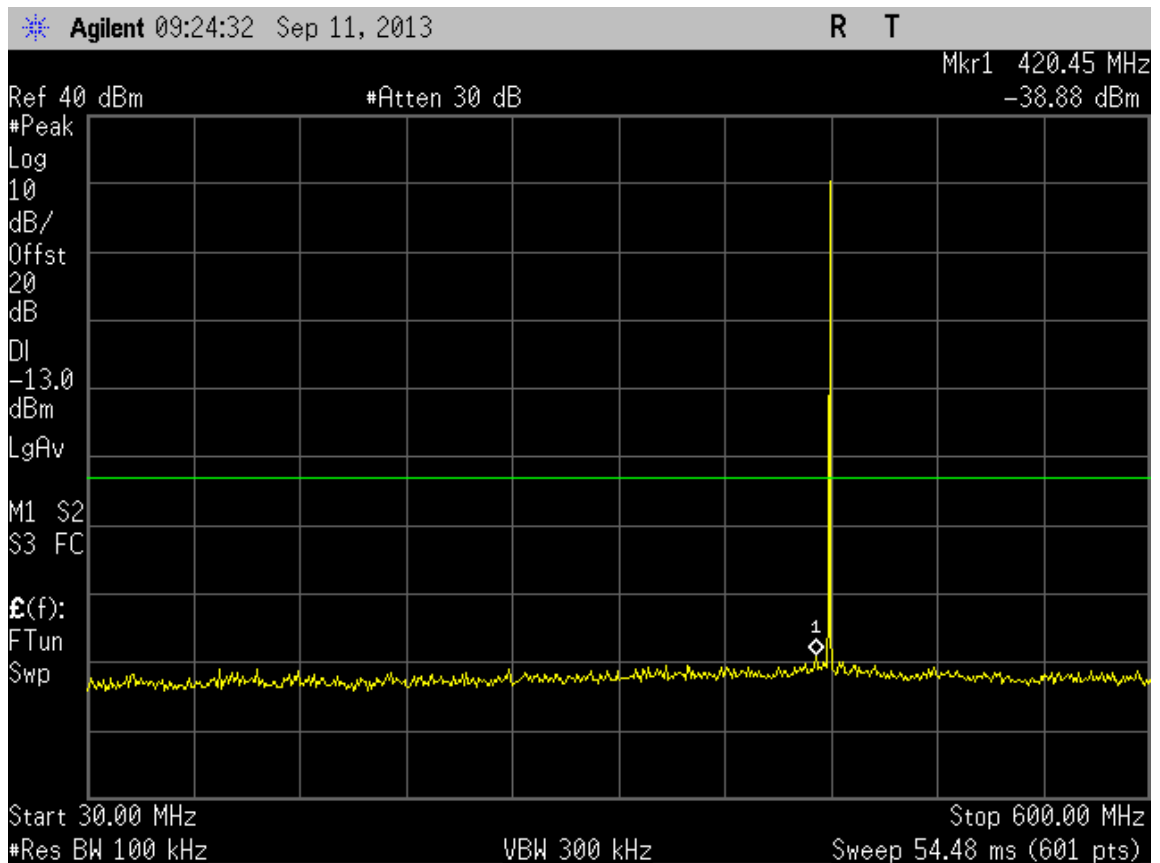
Transmitter tuned at 408.0 MHz



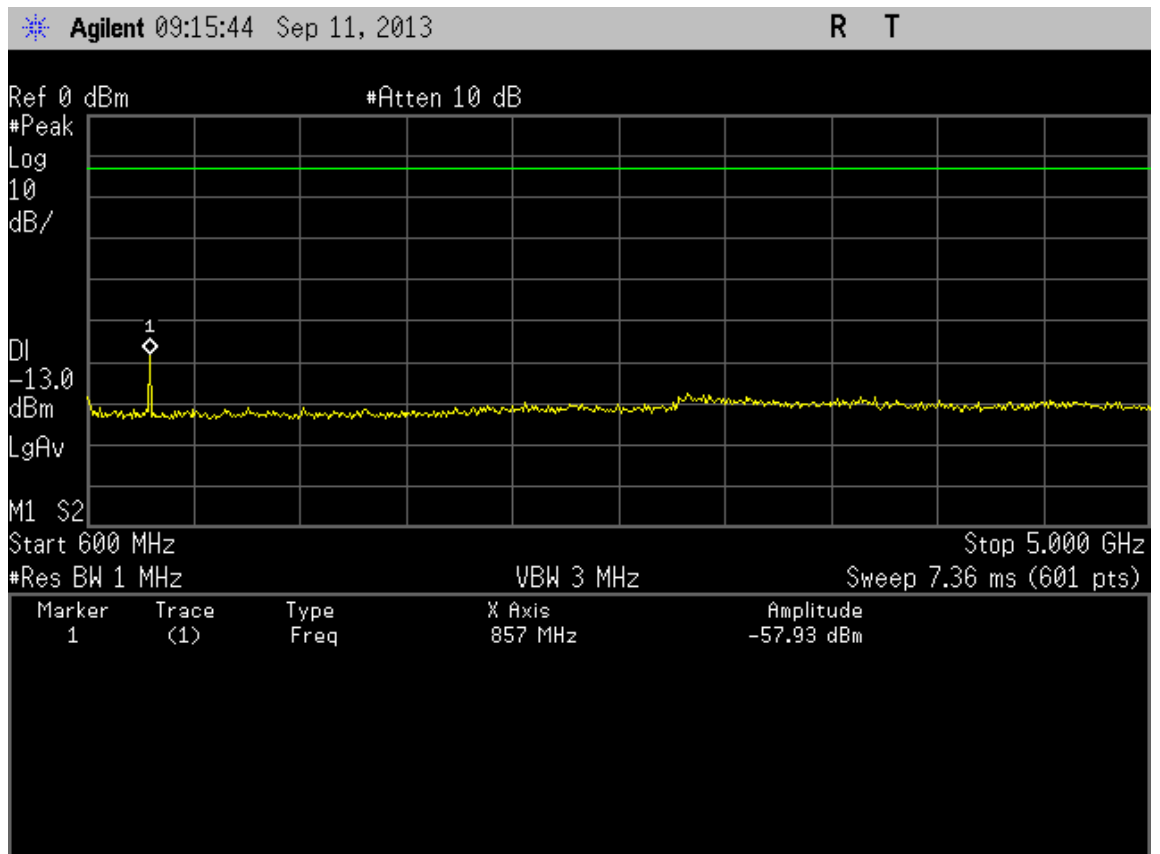
Transmitter tuned at 428.0 MHz



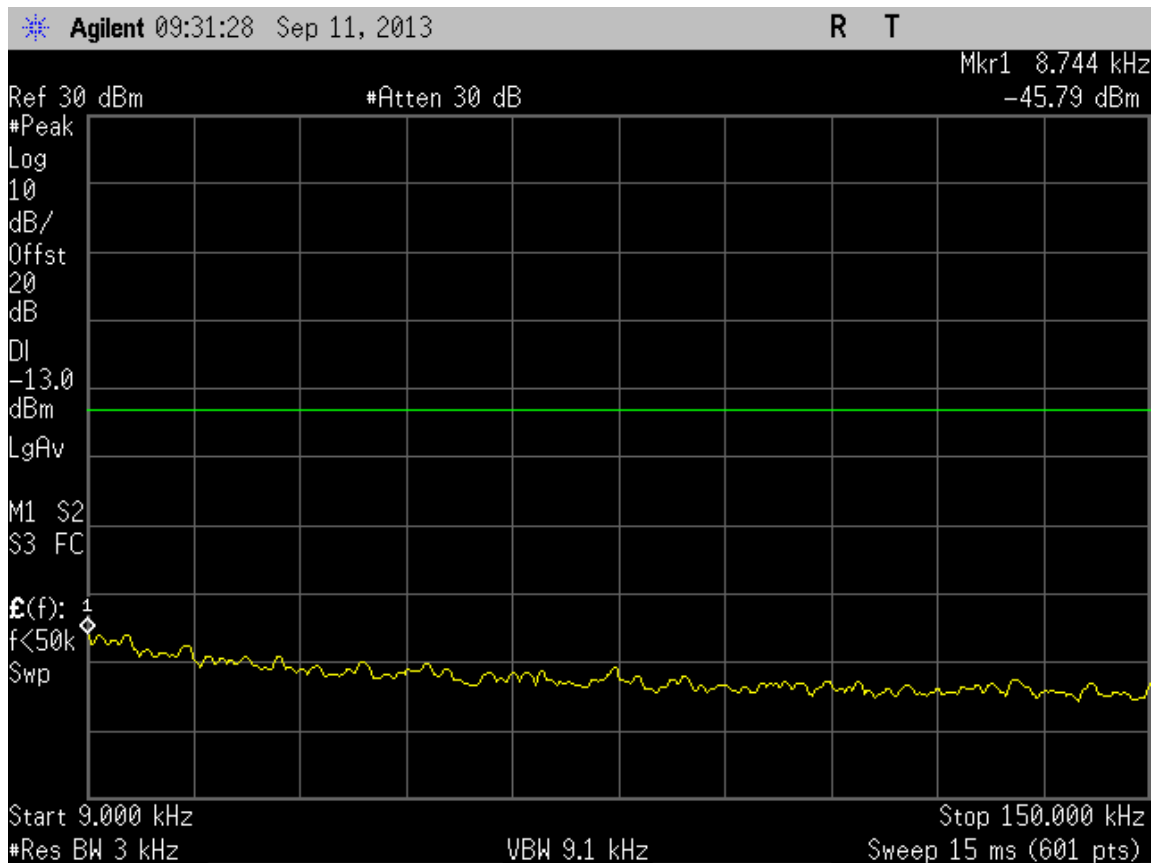
Transmitter tuned at 428.0 MHz



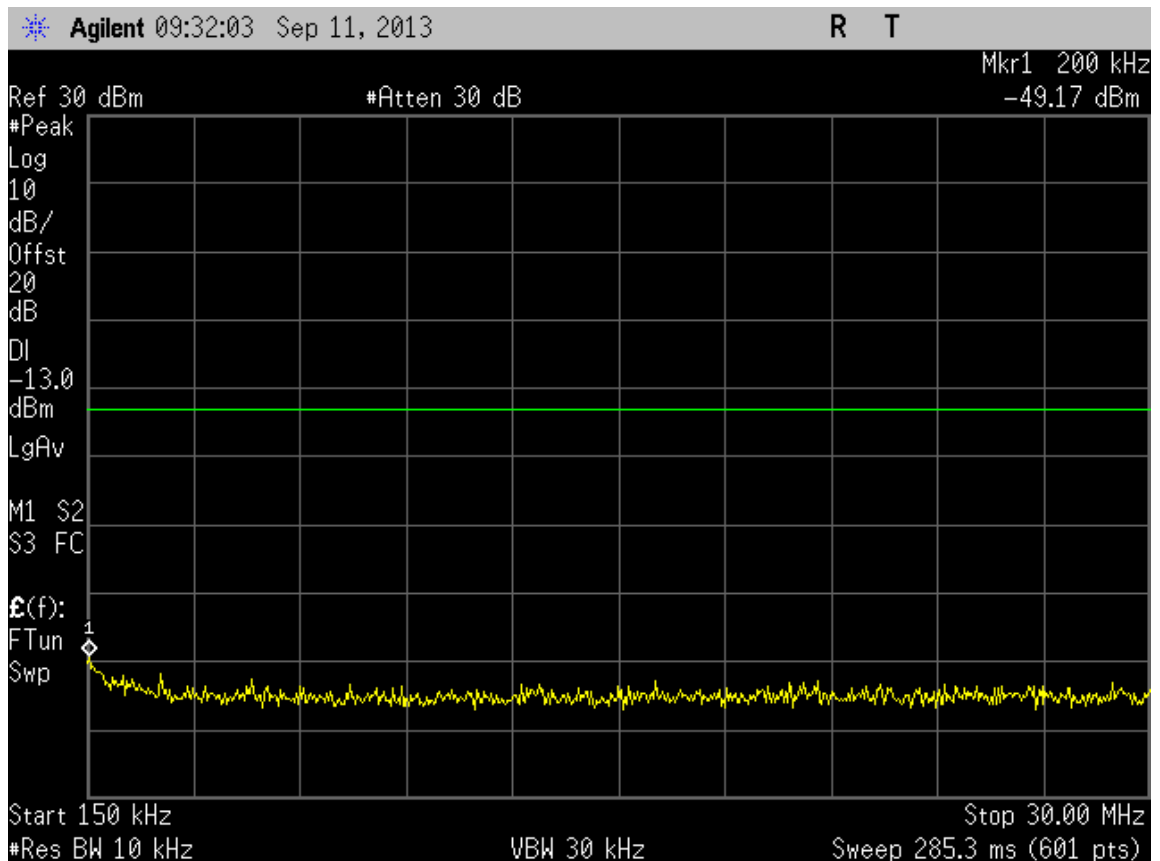
Transmitter tuned at 428.0 MHz



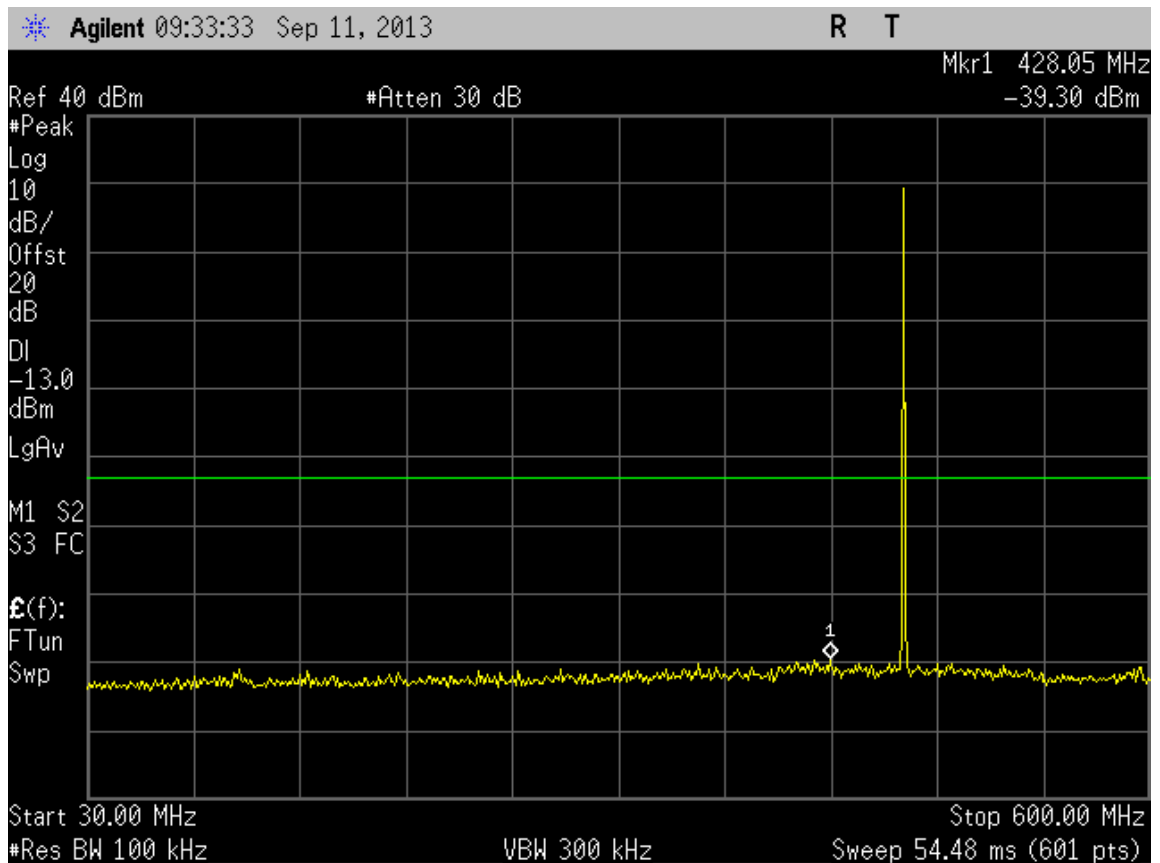
Transmitter tuned at 428.0 MHz



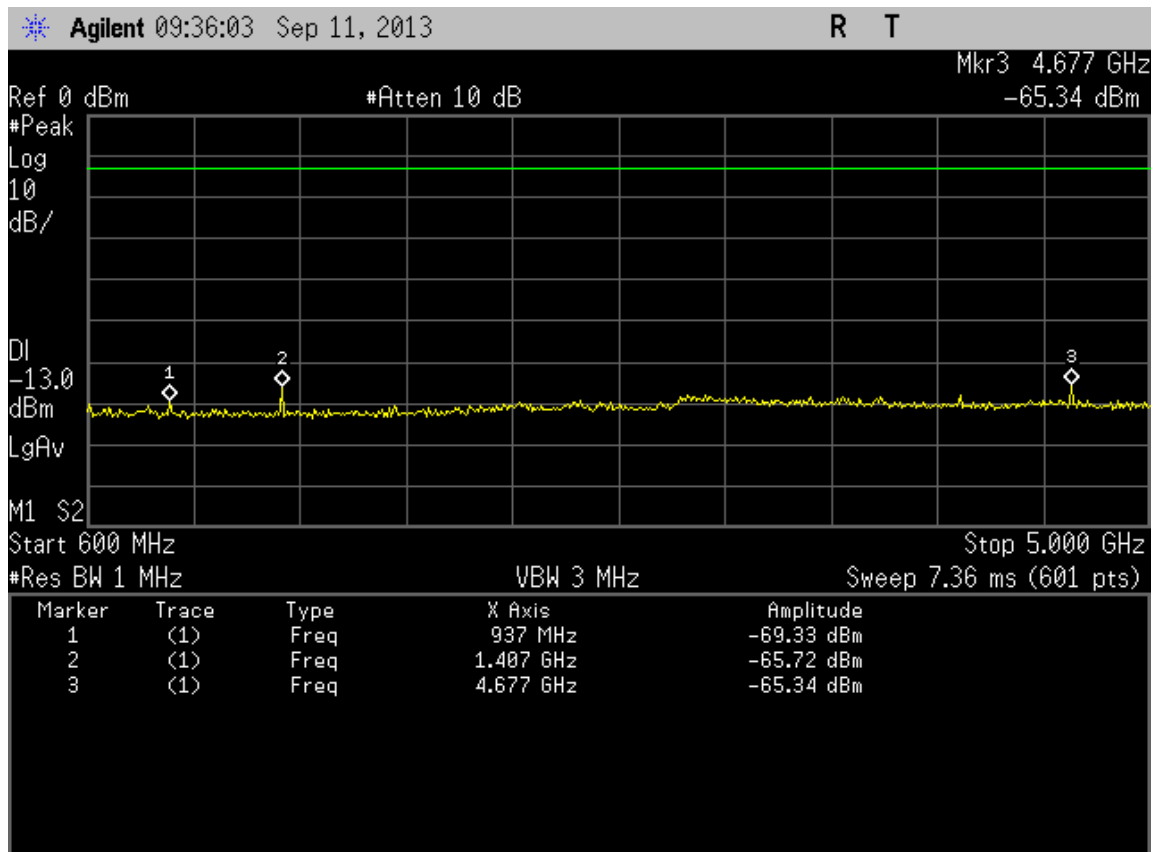
Transmitter tuned at 468.0 MHz



Transmitter tuned at 468.0 MHz



Transmitter tuned at 468.0 MHz



Transmitter tuned at 468.0 MHz

7. Transmitter spurious emissions (Radiated)

NAME OF TEST:	Field Strength of Spurious Emissions	PARA.NO.: 2.1053
		RSS119: 5.8
TESTED BY: Risto Hietanen		DATE: 14/06/2013

Test Results: Complies.

Requirement: $43 + 10 \log (P)$ dB, (-13 dBm) / $50 + 10 \log (P)$ dB, (-20 dBm)

Transmitter tuned at 408, 428 and 468 MHz

Test Data:

Channel 408.0 MHz		Channel 428.0 MHz		Channel 468.0 MHz	
Frequency (MHz)	Level (dBm)	Frequency (MHz)	Level (dBm)	Frequency (MHz)	Level (dBm)
1209.00	-39.0	30-5000	*	30-5000	*
others 30-5000	*				

* Measured level was more than 20 dB below the limit value (-20 dBm) in the frequency range 30-5000 MHz at the channels of 408 MHz, 428 MHz and 468 MHz.

Equipment used: 566, 564, 544, 571, 145, 525, 542, 319, 417, 350, 316, 577, 131

Measurement

Uncertainty: + 3.4 dB, -4.4 dB

Temperature: 24 °C.

Relative Humidity: 44 %.

The spectrum was searched from 30 MHz to the 10th harmonic of the carrier (5GHz).

The test was performed in a semi-anechoic shielded room. The EUT was placed on a non-conductive 0.8 m high table standing on the turntable. During the test in the frequency range 30-5000 MHz the distance from the EUT to the measuring antenna was 3 m. In order to find the maximum levels of the disturbance radiation the angle of the turntable, the height of the measuring antenna were varied during the tests. The test was performed with the measuring antenna being both in horizontal and vertical polarizations. Spectrum analyzer settings were: 30MHz-1000MHz RBW 100kHz, 1000-5000MHz RBW 1MHz.

Vertical and horizontal polarizations in the frequency range 30 – 5000 MHz was first measured by using the peak detector. During the peak detector scan the turntable was rotated from 0° to 360° with 30° step with the antenna heights 1.0 m and 2.5 m.

The limit of -13 dBm has been calculated to correspond 84.4 dB(μV/m).

Spurious emissions closer than 20 dB to the limit were measured with average detector.

The antenna substitution method was used to determine the equivalent radiated power at spurious frequencies. The EUT was replaced with a reference substitution antenna with a known gain referenced to an isotropic radiator $G_{Antenna[dBi]}$. This antenna was fed with a signal at the spurious frequency $P_{Gen[dBm]}$. The level of the signal was adjusted to repeat the previously measured level. The resulting EIRP is the signal level fed to the reference antenna corrected for gain referenced to an isotropic. The formula below was used to calculate the EIRP of the EUT.

$$P_{EIRP[dbm]} = P_{Gen[dBm]} - L_{Cable[dB]} + G_{Antenna[dBi]}$$

8. Transient behaviour of the transmitter**NAME OF TEST:** Transient behaviour of the transmitter**PARA.NO.:** 90.214**TESTED BY:** Risto Hietanen**RSS119:** 5.9**DATE:** 19/06/2013**Test Results:** Complies.**Test Data:** See attached plots**Requirement:**

Measurement	Maximum frequency difference (kHz)	Transient duration limit (ms)
T1	± 25	10
T2	± 12.5	25
T3	± 25	10

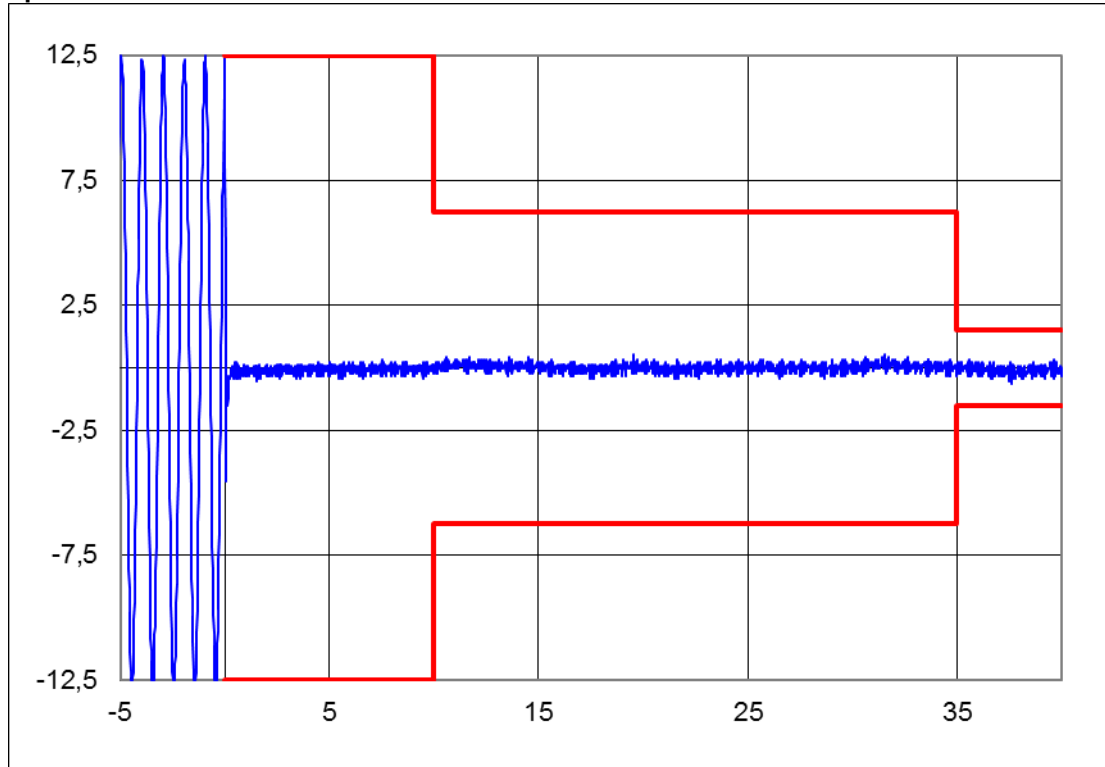
TEST EQUIPMENT USED: 566, 10, 567, 317, 62, 337, 328, 385, 389, 135, 301, 100, 99, 316, 341**Measurement****Uncertainty:** ± 200 Hz (freq.) ± 0.8 dB (power)**Temperature:** 23 °C.**Relative Humidity:** 34 %.

Graphs of the transient behaviour of the transmitter

Transient behaviour of the transmitter switch-on

Frequency: 408.000 MHz

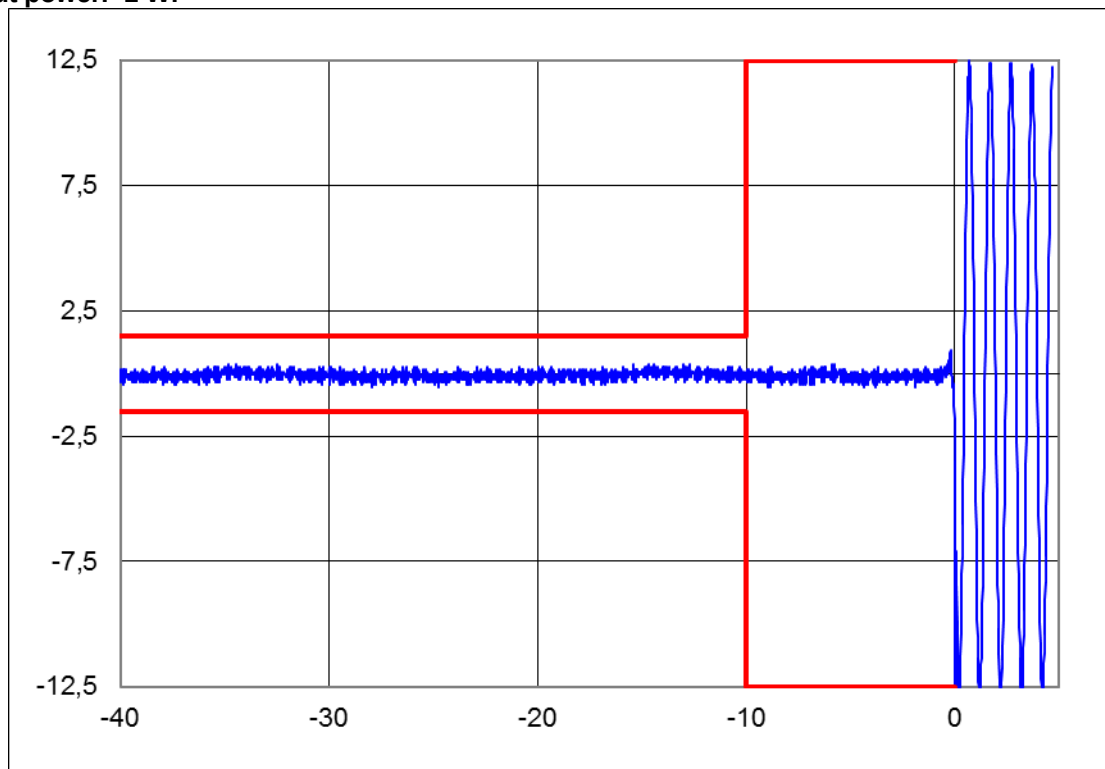
Output power: 1 W.



Transient behaviour of the transmitter switch-off

Frequency: 408.000 MHz

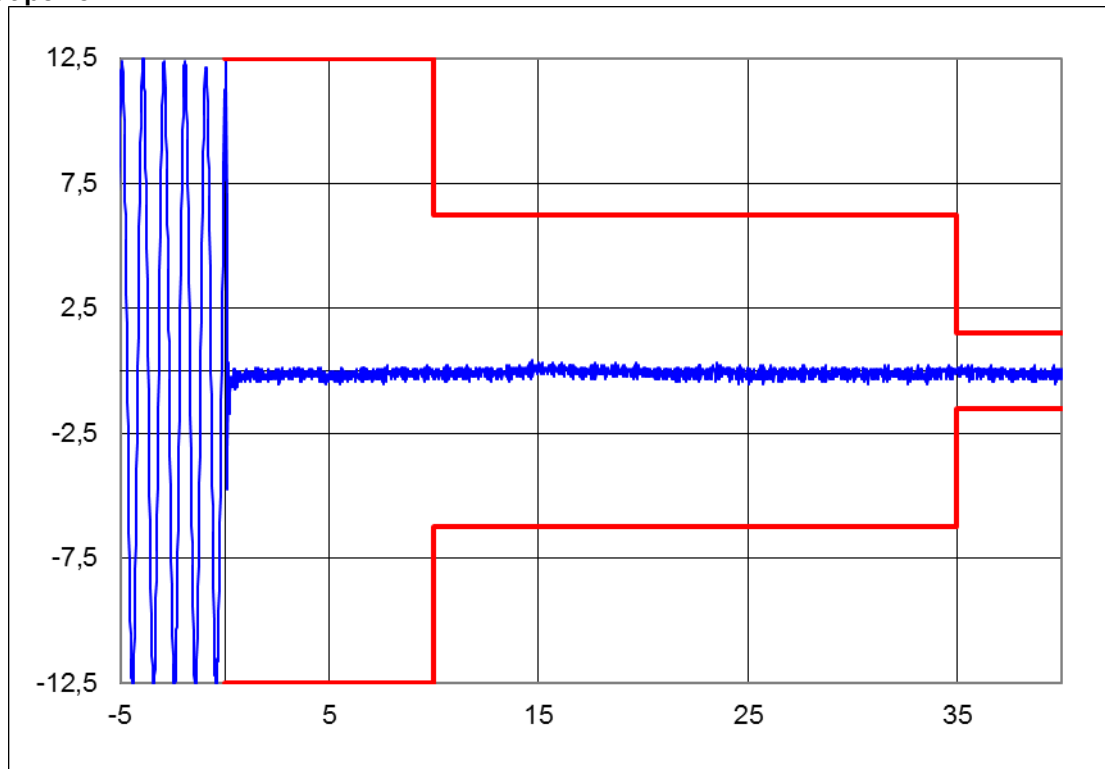
Output power: 1 W.



Transient behaviour of the transmitter switch-on

Frequency: 428.000 MHz

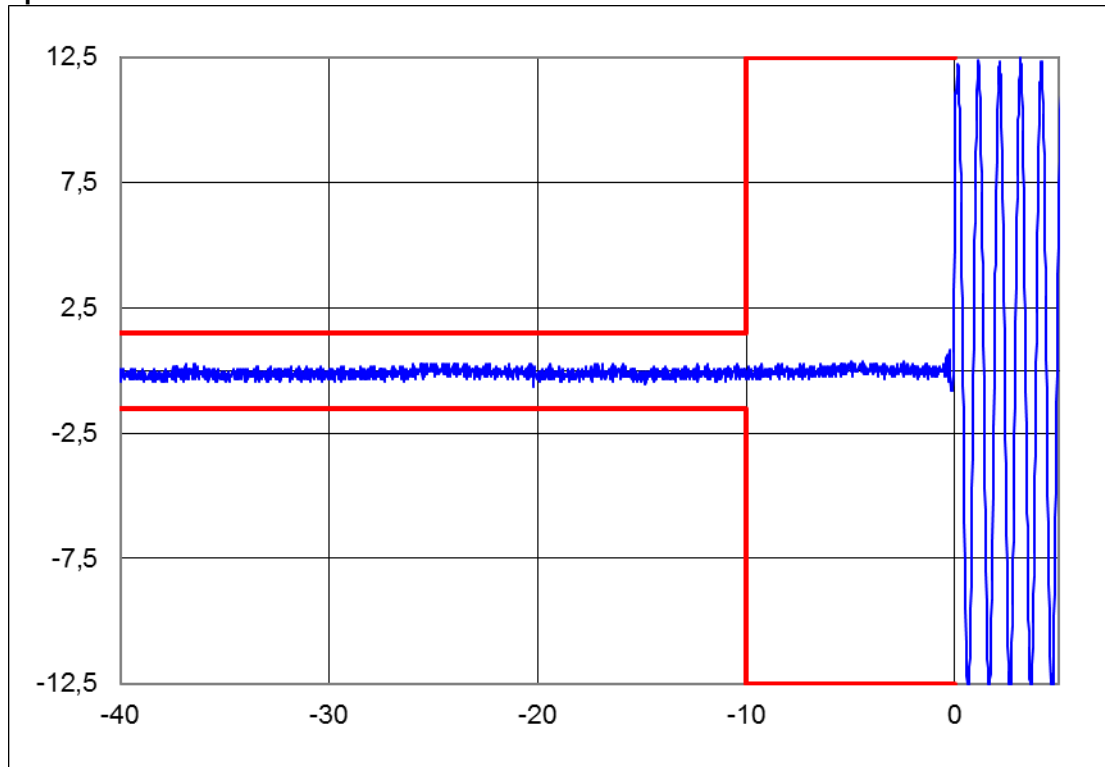
Output power: 1 W.



Transient behaviour of the transmitter switch-off

Frequency: 428.000 MHz

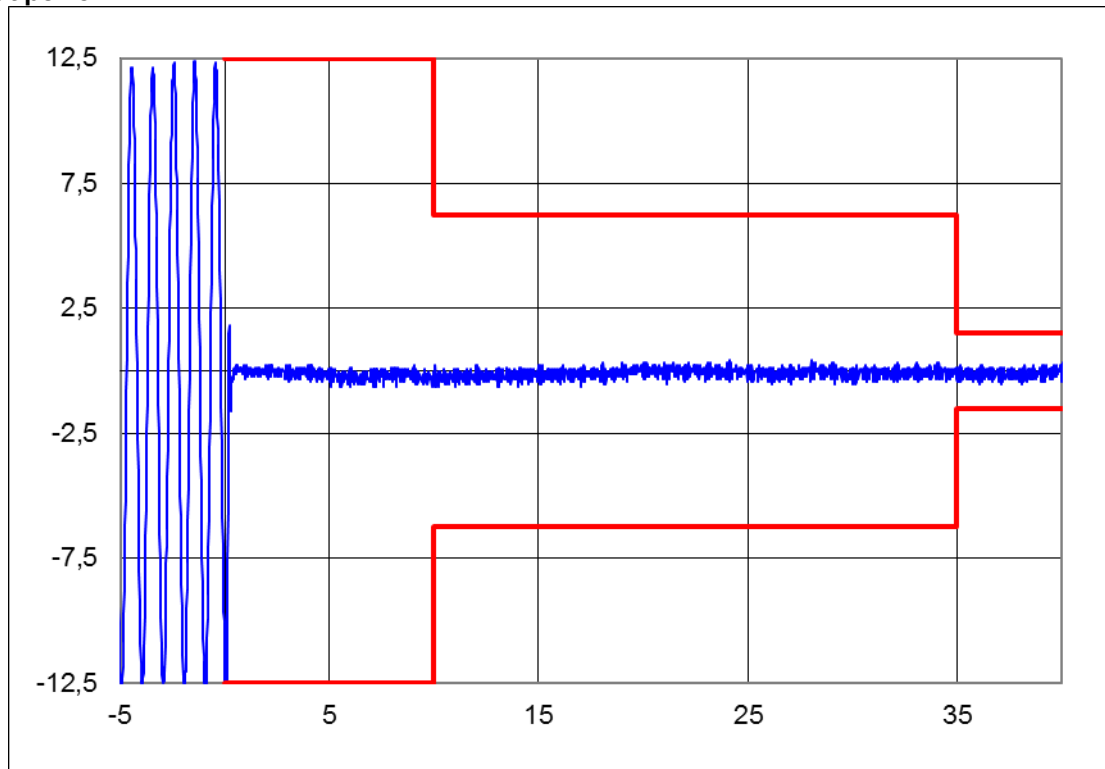
Output power: 1 W.



Transient behaviour of the transmitter switch-on

Frequency: 468.000 MHz

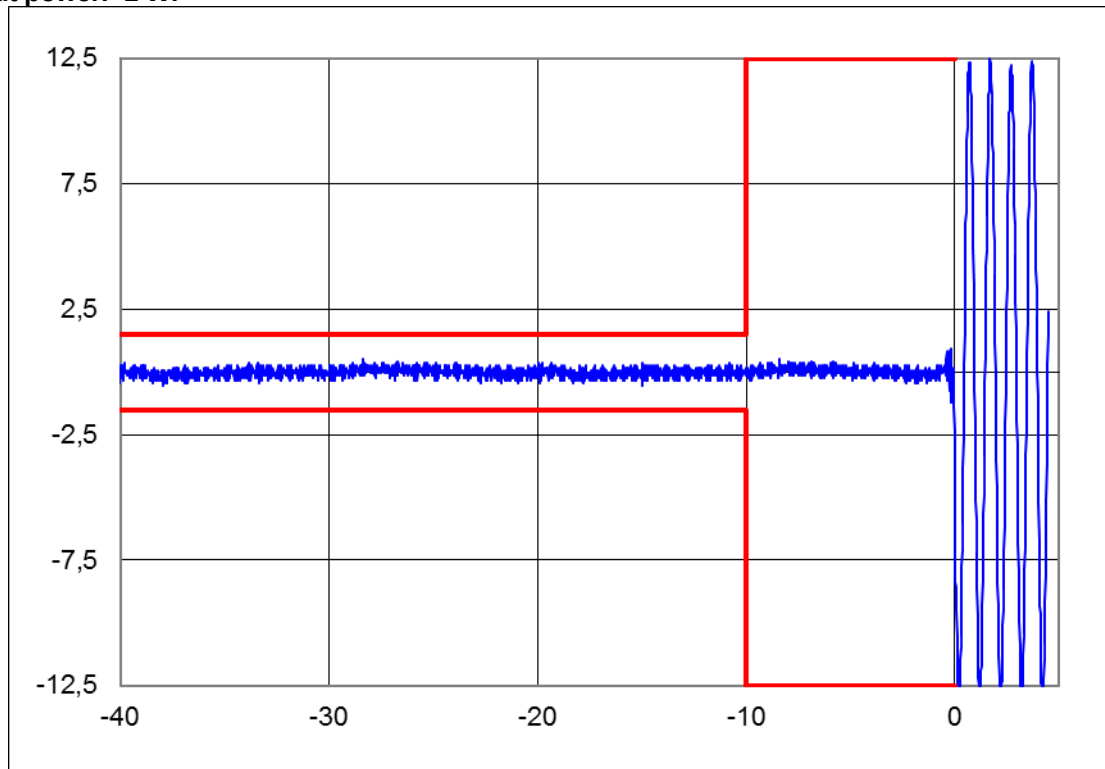
Output power: 1 W.



Transient behaviour of the transmitter switch-off

Frequency: 468.000 MHz

Output power: 1 W.



9. Frequency stability

NAME OF TEST: Frequency Stability

PARA.NO.: 2.1055

TESTED BY: Pekka Kälviäinen

RSS119: 5.3

DATE: 11/09/2013

Test Results: Complies.

Limit: ± 1.5 ppm.

Test performed at transmitter frequency: 428.0 MHz

Test Data:

a) Frequency stability vs. voltage variations

Temperature °C	Voltage V	Frequency MHz	Error ppm
20	3.9	427.999975	-0.058
20	4.0	427.999975	-0.058
20	4.1	427.999975	-0.058

b) Frequency stability vs. temperature variations

Temperature °C	Voltage V	Frequency MHz	Error ppm
50	4.0	427.999948	-0.121
40	4.0	427.999966	-0.079
30	4.0	427.999977	-0.054
20	4.0	427.999975	-0.058
10	4.0	427.999939	-0.143
0	4.0	427.999878	-0.285
-10	4.0	427.999856	-0.336
-20	4.0	427.999856	-0.336
-30	4.0	427.999632	-0.860

Equipment used: 2079, 328, 307, 563, 316, 341

Measurement

Uncertainty: ± 28 Hz

Temperature: 23 °C.

Relative

Humidity: 50 %.

10. List of measuring equipment:

Nr.	Equipment	Type	Manufacturer	Serial number	Cal date	Cal due
10	Oscilloscope	9400A	LeCroy	8878	*)	*)
62	Audio amplifier	PRL	Self made	63	*)	*)
99	Hybrid	H 9	Anzac		*)	*)
100	Hybrid	H 9	Anzac		*)	*)
131	Termination 50 Ω	908A	Hewlett Packard		10.12.2012	12.2014
135	Termination 50 Ω	370 BNM	Narda		12.12.2011	12.2013
145	Notch Filter	TTR - 375 - 3EE	Telonic	3062 - 1	-	-
218	Power sensor	HP 8485A	Hewlett Packard	2942A08711	23.8.2012	8.2013
301	Termination 50 Ω BNC	HP 11593A	Hewlett Packard	-	9.12.2011	12.2013
307	Temp. test chamber	VMT 04/140	Heraeus VÖTCH GmbH	27045	-	-
316	Power supply	HP 6032A	Hewlett Packard	2517A-00654	-	-
317	RF generator	2052	Marconi	119754/058	7.9.2012	9.2013
319	Antenna	CBL6112	Chase	2018	12.7.2012	1.2014
328	Power attenuator	765-20	Narda	-	7.12.2011	12.2013
337	Modulation analyzer	HP 8901B	Hewlett Packard	3538A05622	1.3.2012	3.2014
341	Multimeter	Fluke 87	Fluke	593100386	10.7.2013	7.2015
350	Semianechoic shielded room	RFD-F-100	Euroshield Oy	1327	26.10.2012	10.2014
385	RF attenuator PAD	WA2-3	Weinschel	3779	12.12.2011	12.2013
389	RF attenuator PAD	WA2-10	Weinschel	3783	12.12.2011	12.2013
417	Antenna, bilog	CBL 6141	Chase	4028	26.10.2012	4.2014
525	Double-Ridged Horn	3115	Emco	6691	10.10.2012	4.2014
542	Double-Ridged Horn	3115	Emco	00023905	10.10.2012	4.2014
544	RF-amplifier	ZFL-1000VH2	Mini-Circuits	QA0749010	9.1.2013	1.2014
563	Thermometer	52 II	Fluke	19300005	2.4.2013	4.2014
564	RF amplifier	CA018-4010	CIAO Wireless	132	9.1.2013	1.2014
566	Spectrum analyzer	E4448A	Agilent	US42510236	17.4.2013	4.2014
567	RF generator	E8257C	Agilent	MY43320736	25.2.2013	2.2014
571	High Pass Filter	WHK0.6/13G-10SS	Wainwright Instruments	1	7.12.2011	12.2013
577	True RMS Multimeter	189	Fluke	92840060	8.8.2012	8.2013
1530-0007	Power meter	436A	Hewlett Packard	2031U01753	7.12.2011	12.2013
2079	Universal counter	53132A	Hewlett Packard	3546A01868	2.9.2013	9.2014

*) measuring equipment 10, 62, 99 and 100 will be calibrated in each measurement as a system by setting the correct levels with the calibrated signal generator (317).