

Date: ESPOO 31.07.2009Page: 1 (32)Appendices -Number:
No. 1 / 1**119457A**Date of handing in: 10.11.2008

Tested by:



Timo Hietala, Test Engineer

Reviewed by:



Timo Leismala, Test Manager



SORT OF EQUIPMENT:

Transmitter of the radio modem (PCB-unit)

TYPE:

SATEL-TA11

BRAND NAMES:

SATELLINE M3-T1 / SLR1

MANUFACTURER:

Satel Oy, Finland

SERIAL NUMBER:

-

CLIENT:

Satel Oy

ADDRESS:

Meriniitynkatu 17, FIN-24100 Salo, Finland

TELEPHONE:

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TEST LABORATORY

Nemko Oy

FCC REG. NO.

359859 November 26, 2008

IC FILE NO.

2040F-1 December 15, 2008

REMARKS:

Tested to FCC Part 90 and RSS-119 Issue 9.

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:	SATELLINE M3-T1 / SLR1		
Alignment range:	406.1 – 470 MHz		
Switching range:	One channel		
Measurement	Equipment 1 Serial no. -	Equipment 2 Serial no. -	Equipment 3 Serial no. -
Frequencies:	1) 406,100 MHz 2) 430,000 MHz 3) 470,000 MHz	1) 418,000 MHz 2) 460,000 MHz	)
Voltages:	Normal 6,0 VDC	Minimum 5,1 VDC	Maximum 6,9 VDC
Temperatures:	23,0°		
Humidity:	35 %		
Effective radiated power:	1 W / 100 mW	Antenna:	50 ohm
Number of channels:	1	Production model:	Pre-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, board only, no housing.

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 9		Result
90.205 & 2.1046	5.4	Transmitter power (conducted)	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
90.213 & 2.1055	5.3	Frequency stability	PASS
90.210 & 2.1049	5.5	99% Occupied bandwidth	PASS
90.210 & 2.1049	5.5	Spectrum emission mask	PASS
90.214	5.9	Transient frequency behavior	PASS
15.107 (a)	RSS-Gen 7.2.2	Conducted emissions at mains ports	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. Conducted disturbance at mains ports emission test

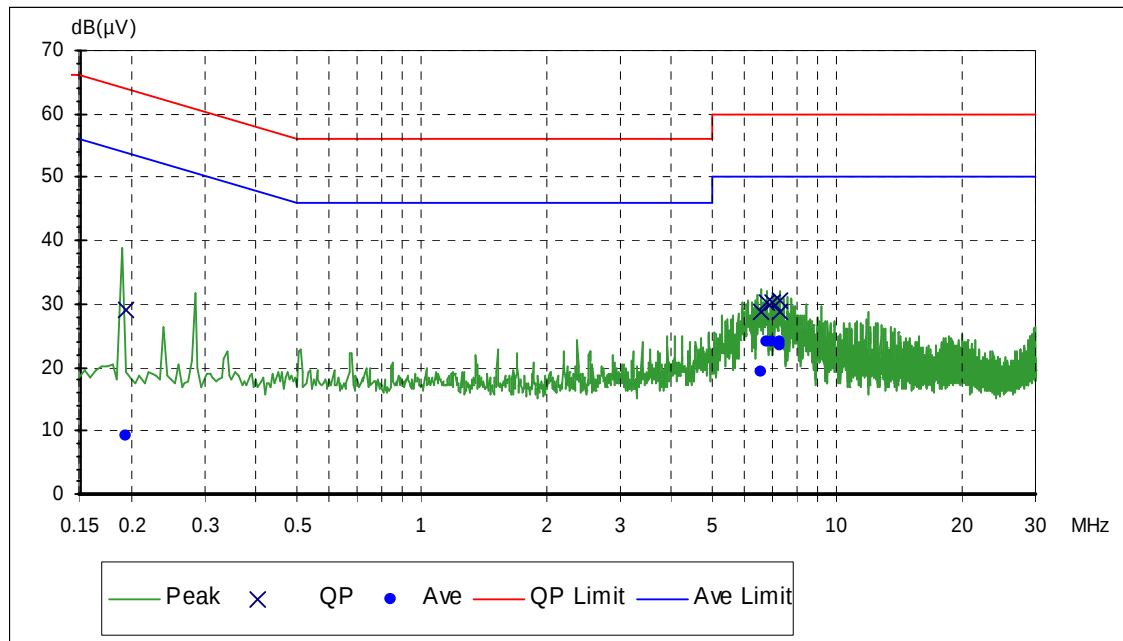
The test was performed as a compliance test. The test parameters concerned were as follows:

Parameter	Specification
Test method	CISPR 22
Frequency range	0.150 – 30 MHz
Site name	Nemko Oy / Perkkää
Date of testing	09.06.2008
Test equipment	5, 168, 184, 348
Test uncertainty U95	+2.4 dB / -3.0 dB
Test conditions	22 °C, 45 % RH

The test was performed inside a shielded room where one of the walls and the floor comprised the reference ground plane (RGP). For the duration of the test the EUT was placed on a non-conductive table 0.8 m above the metallic ground plane (see photograph 1). The excess lengths of the cables of the EUT were made into bundles 30-40 cm in length. The DC power input cable of the EUT was connected to an artificial mains network. The test was performed separately on the live and also on the neutral wire.

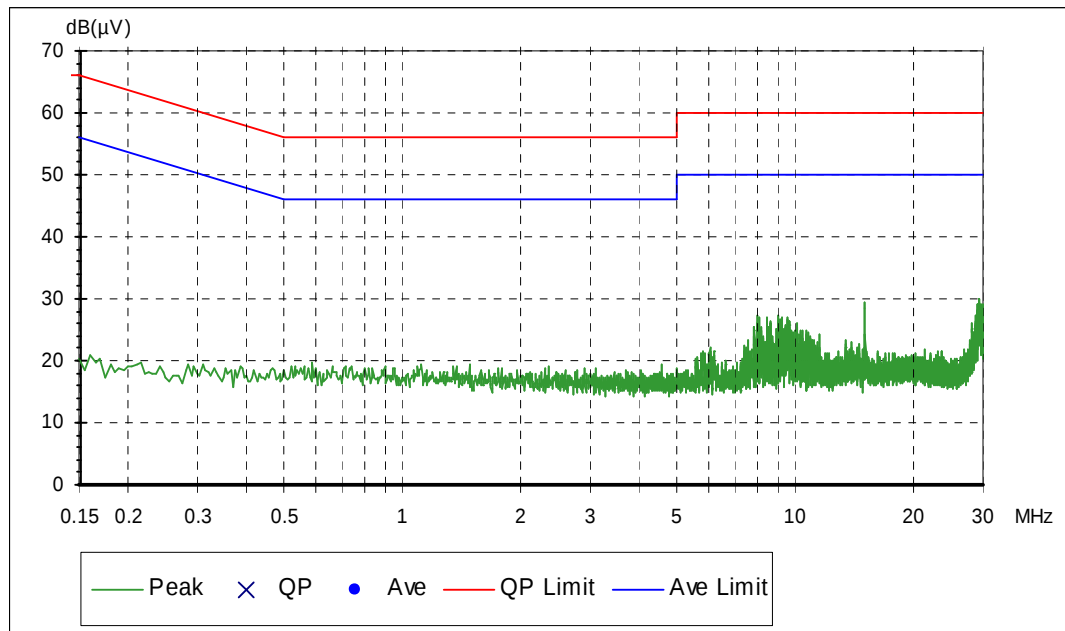
The disturbances were first examined by performing a spectrum scan by using a peak detector. The general procedure in the conducted disturbance emission test is that no further measurements are necessary if the disturbance levels measured by using the peak detector are below the limit value defined for the measurement performed by using an average detector. If not, then at the test frequencies concerned the measurement is performed also by using a quasi-peak detector. If the disturbance levels measured by using the quasi-peak detector are below the limit value defined for the measurement performed by using an average detector, then measurements by using the average detector are not necessary.

3.1.1 Test results conducted disturbance at mains ports emission test



The graphs of the disturbances measured by using a peak detector in the frequency range of 0.150 - 30 MHz, positive. The highest emissions were measured by using the quasi-peak and average detectors, refer below.

Frequency MHz	Phase	Conducted disturbance				Conclusion Pass/Fail
		Result Quasi-peak dB(μV)	Limit value Quasi-peak dB(μV)	Result Average dB(μV)	Limit value Average dB(μV)	
0.1940	pos	29.2	63.9	9.1	53.9	Pass
6.5740	pos	28.8	60.0	19.4	50.0	Pass
6.7870	pos	30.4	60.0	24.1	50.0	Pass
6.9600	pos	30.4	60.0	24.1	50.0	Pass
7.2500	pos	28.7	60.0	23.4	50.0	Pass
7.2960	pos	30.5	60.0	24.0	50.0	Pass



The graphs of the disturbances measured by using a peak detector in the frequency range of 0.150 - 30 MHz, negative line. The highest emissions were measured by using the quasi-peak and average detectors.

4. RF Power Output

NAME OF TEST: RF Power Output	FCC PARA.NO.: 2.1046
TESTED BY: Timo Hietala	RSS119: 5.4
	DATE: 15/06/2009

Test Results: Complies.

Measurement Data: Refer to attached plot.

Rated power: 1W.

Limit: ± 1.0 dB from rated power.

Modulation Type	Frequency (MHz)	Measured Output	
		Power (dBm)	Power (W)
FM	406.1	30.57	1.140
FM	430.0	30.75	1.189
FM	470.0	30.20	1.047

Equipment used: 566, 322

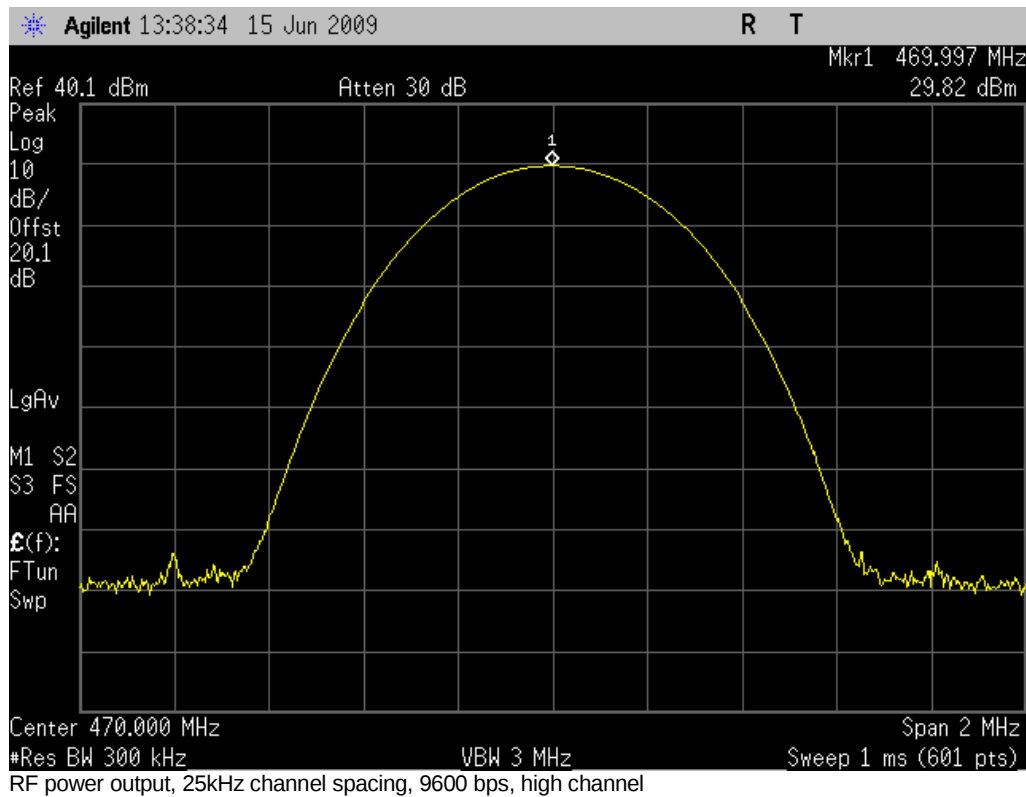
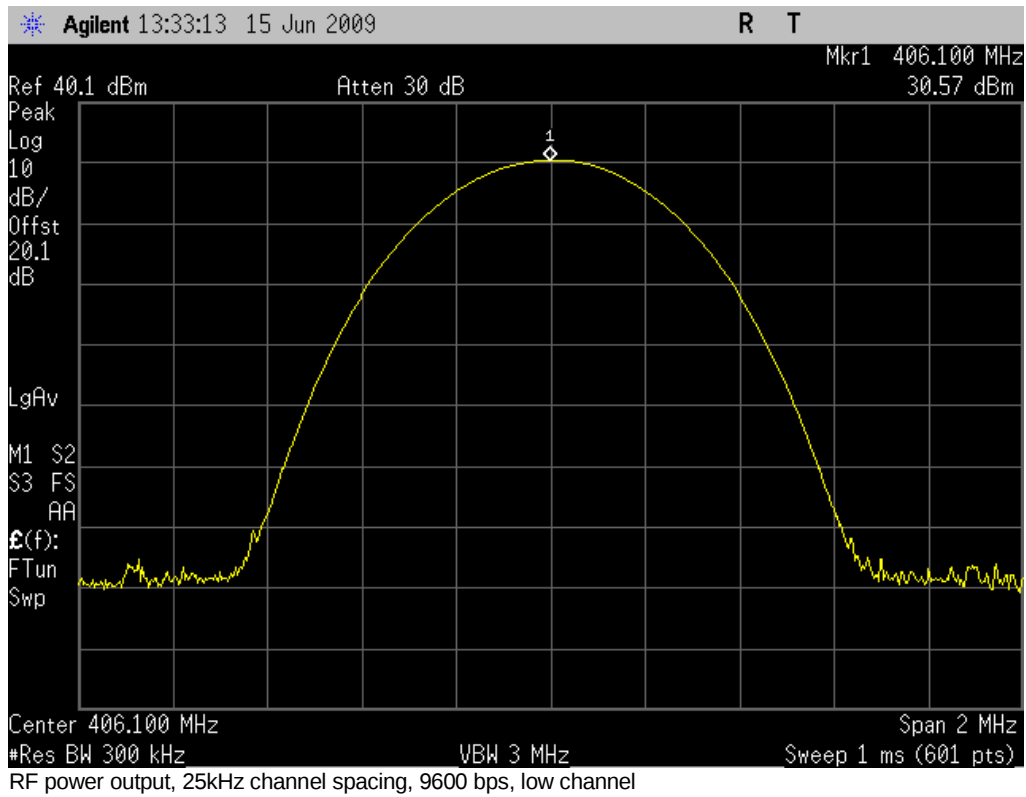
**Measurement
Uncertainty:** ± 0.7 dB.

Temperature: 23 °C.

**Relative
Humidity:** 35 %.

Antenna terminal:

The power at antenna terminal is measured by using the spectrum analyzer with peak detector.



5. 99% Occupied Bandwidth

NAME OF TEST: Occupied Bandwidth	PARA.NO.: 2.1049
TESTED BY: Timo Hietala	RSS119: 5.5
	DATE: 18/06/2009

Test Results: Complies.

Test Data: See attached plot(s).

Channel spacing	Frequency (MHz)	Measured 99% Occupied Bandwidth (kHz)
25 kHz	418.0	14.7
25 kHz	460.0	15.2
12.5 kHz	418.0	8.0
12.5 kHz	460.0	8.2

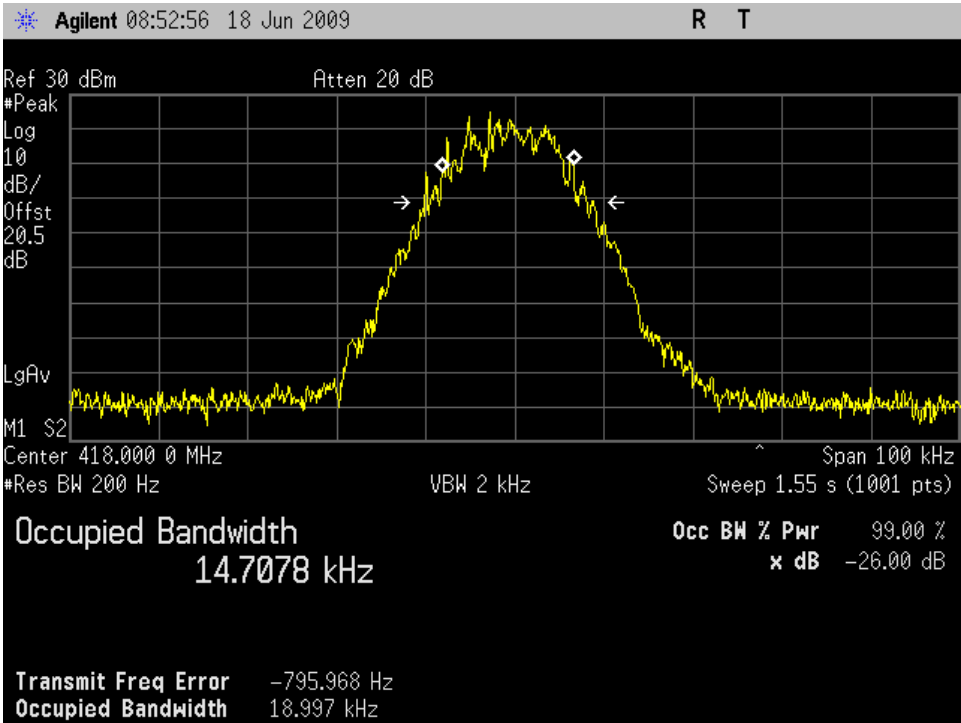
Equipment used: 566, 322

**Measurement
Uncertainty:** ± 0.7 dB.

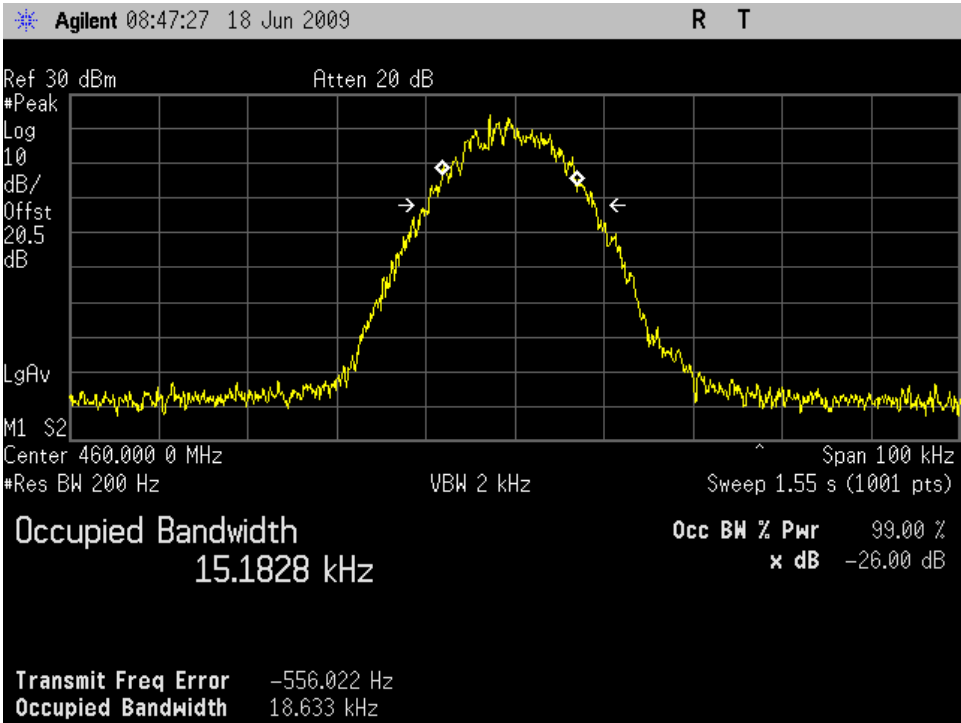
Temperature: 23 °C.

**Relative
Humidity:** 35 %.

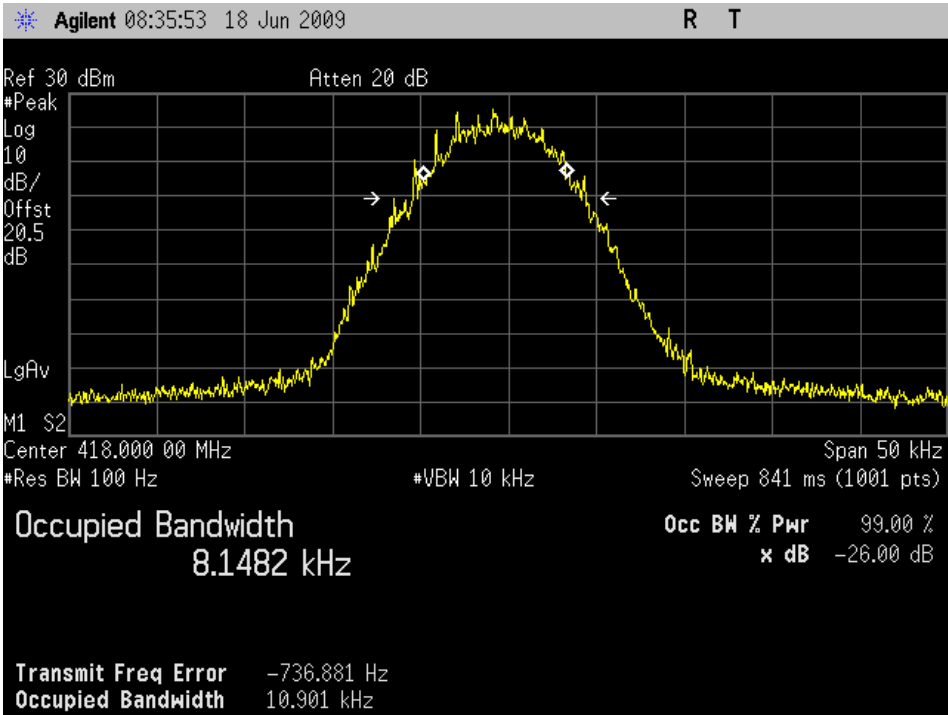
The 99% occupied bandwidth of the carrier emission is measured using a spectrum analyzer with Resolution Bandwidth set to 1% of the necessary bandwidth of the transmitted carrier. Transmitter was set to transmit random data file 19200 bps 25kHz channel and 9600 bps 12.5kHz channel.



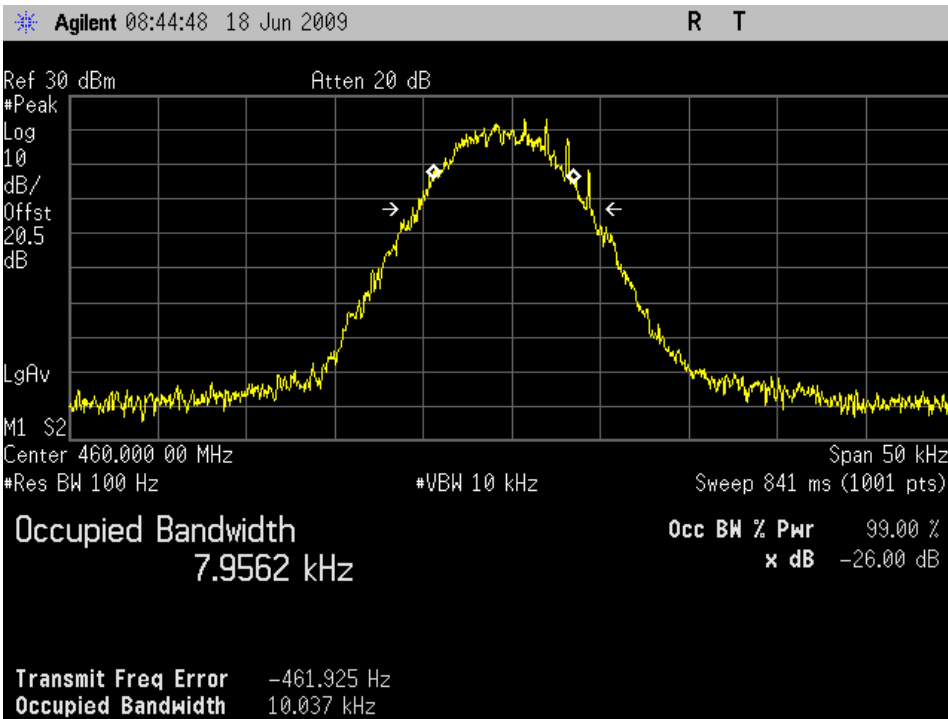
25kHz channel spacing, 418 MHz



25kHz channel spacing, 460 MHz



12.5kHz channel spacing, 418 MHz



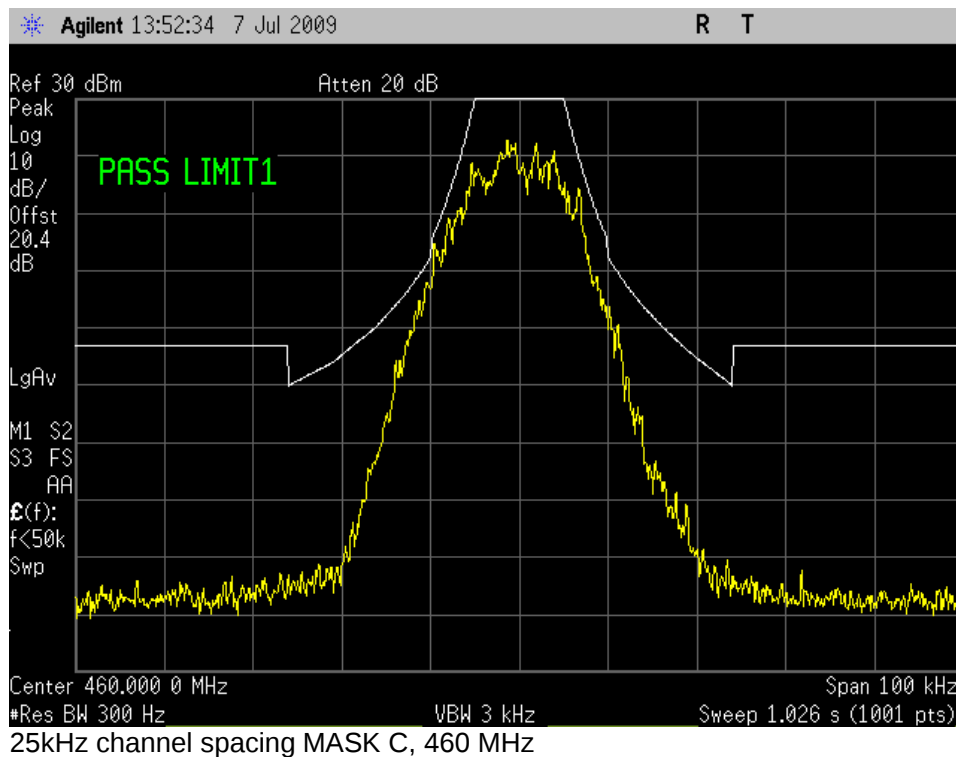
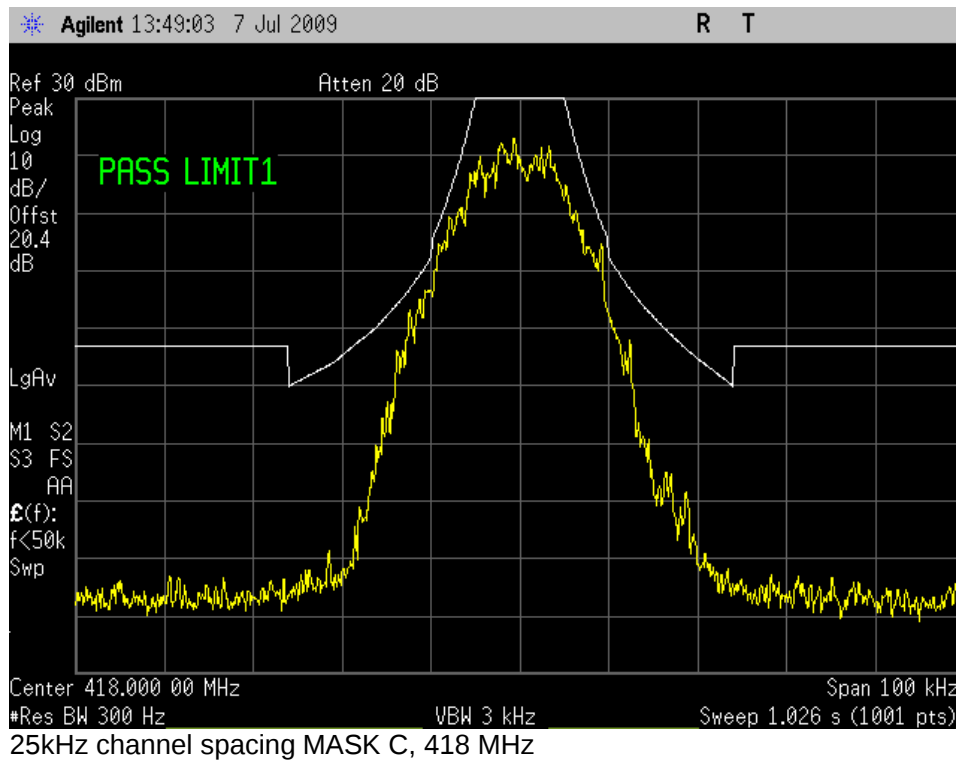
12.5kHz channel spacing, 460 MHz

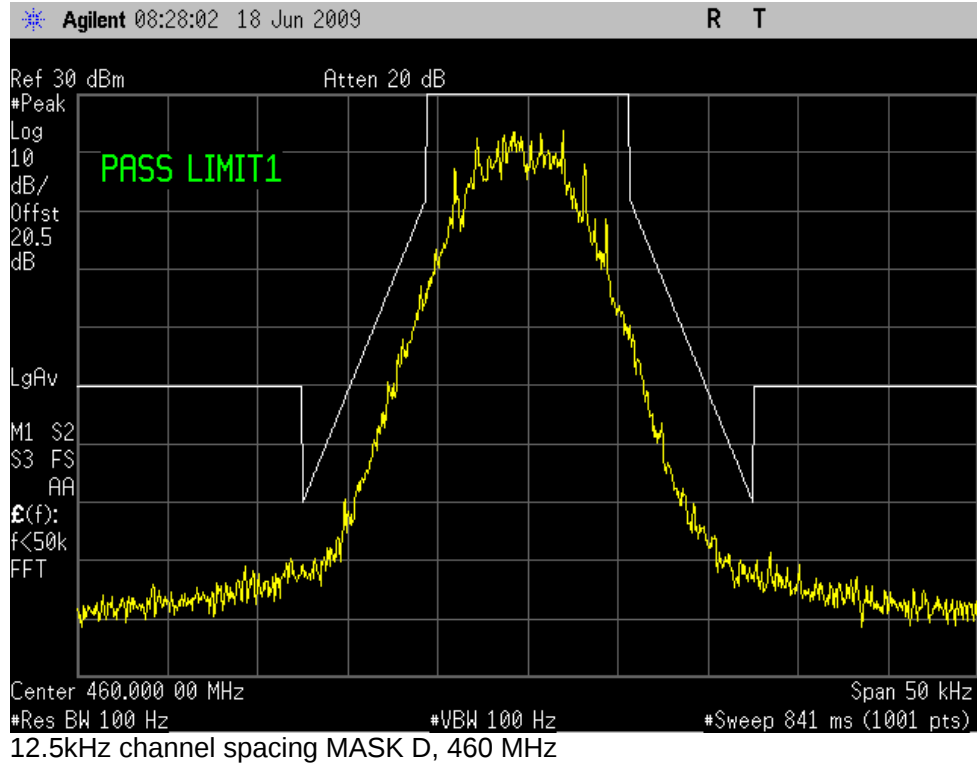
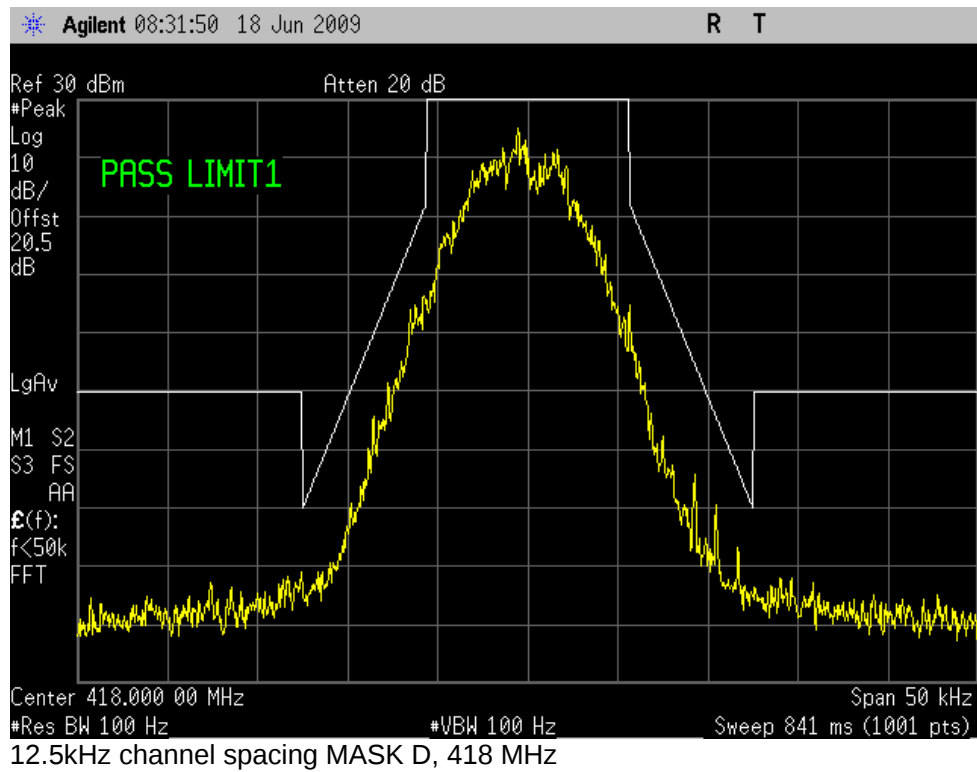
6. Spectrum Emission mask

NAME OF TEST: Spectrum emission mask	PARA.NO.: 2.1049
TESTED BY: Timo Hietala	RSS119: 5.5
	DATE: 18/06/2009

Test Results:	Complies.
Test Data:	See attached plot(s).
Limit:	Mask C for 25kHz channel bandwidth and mask D for 12.5kHz channel bandwidth.
Equipment used:	566, 322
Measurement Uncertainty:	± 0.7 dB.
Temperature:	23 °C.
Relative Humidity:	35 %.

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.





7. Transmitter Spurious Emissions (Conducted)

NAME OF TEST: Spurious Emissions conducted	PARA.NO.: 2.1051
TESTED BY: Timo Hietala	RSS119: 5.8
	DATE: 15/06/2009

Test Results: Complies.

Test Data: See attached plots.

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

Method of measurement: TIA-603

Transmitter tuned at 406.1, 430 and 470 MHz

Frequency (MHz)	Spurious Emission (dBm) ave
All	More than 20 dB below limit -13 dBm

Equipment used: 566, 328, 571, 145, 316, 341

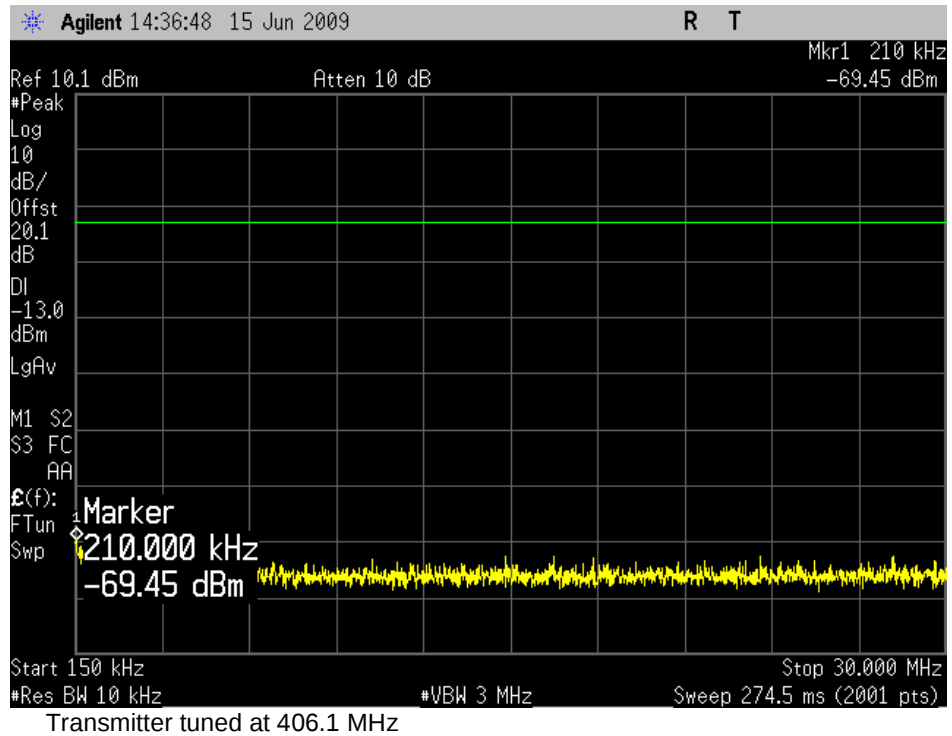
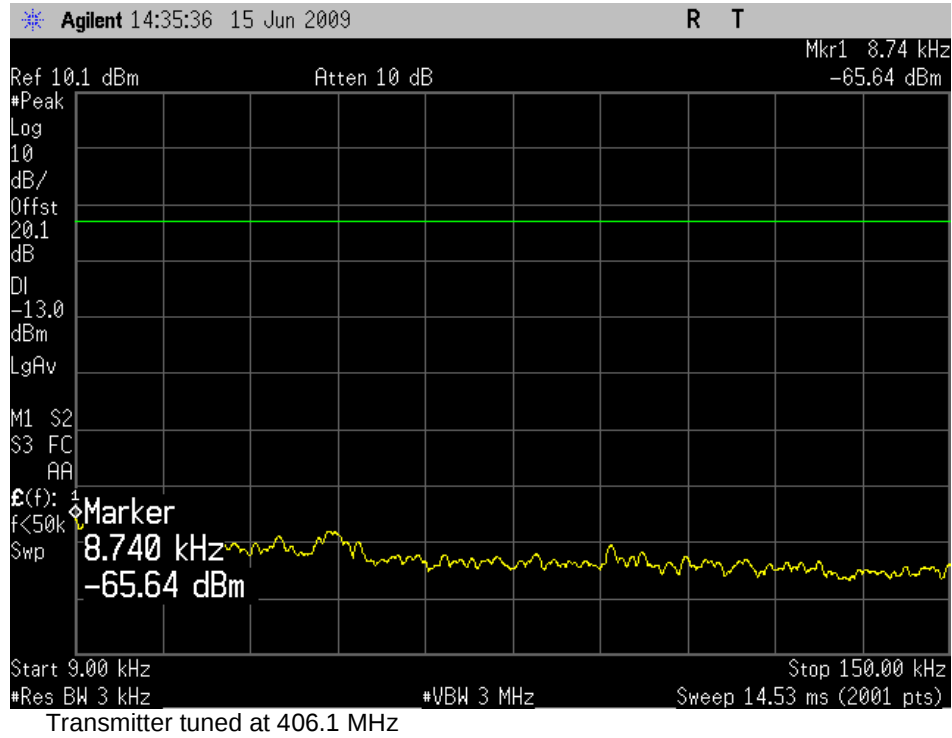
**Measurement
Uncertainty:** ± 1.8 dB.

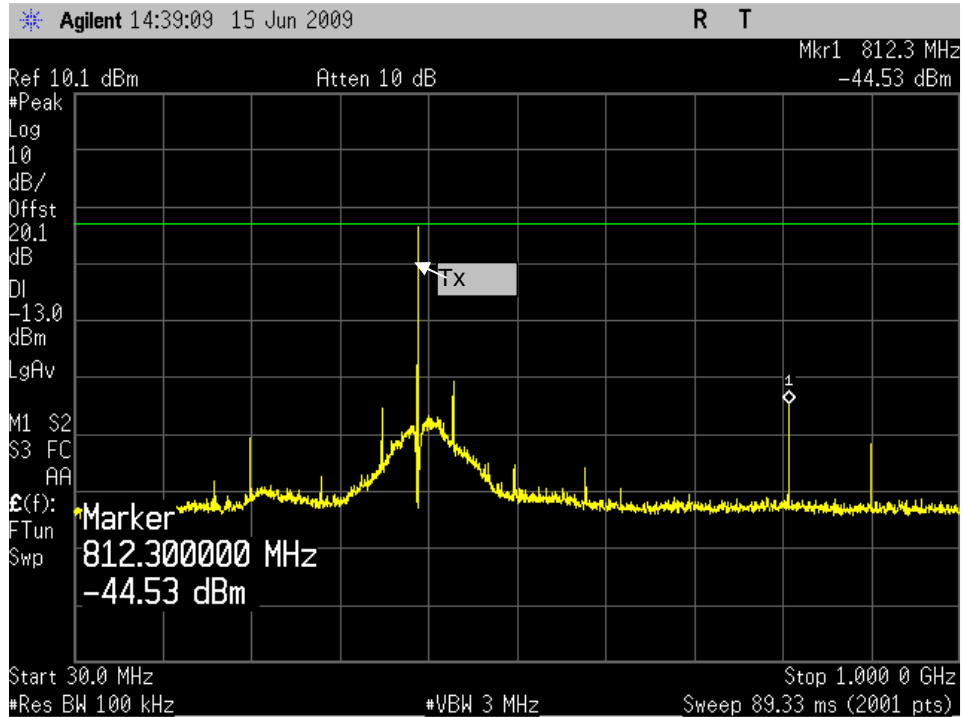
Temperature: 23 °C.

**Relative
Humidity:** 35 %.

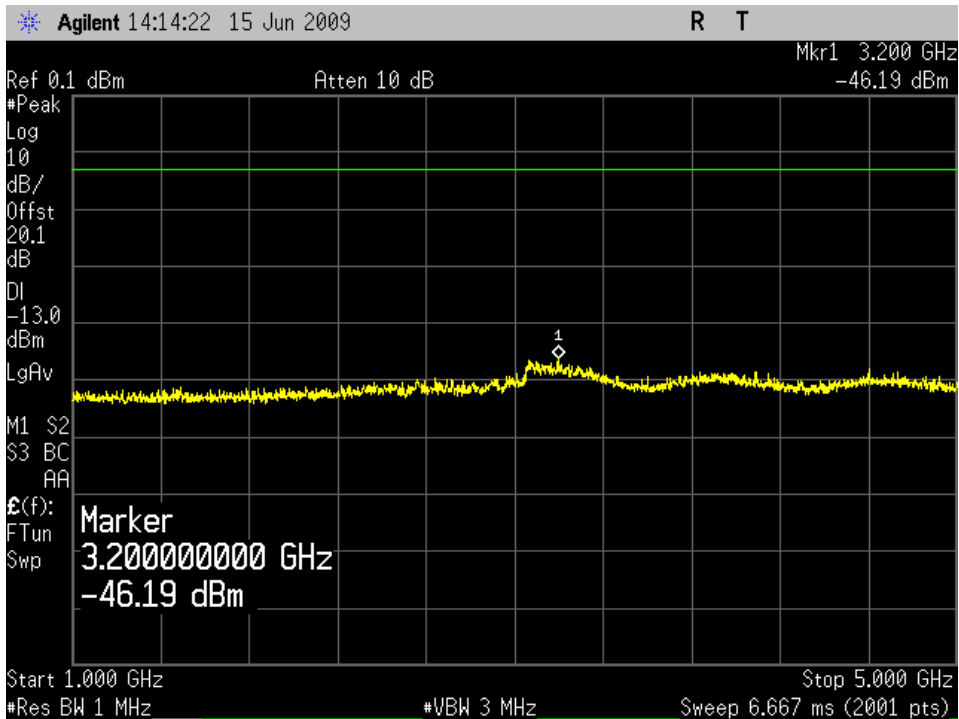
The spectrum was searched from 30 MHz to the 10th harmonic of the carrier (5GHz).

Rated output power: 1W

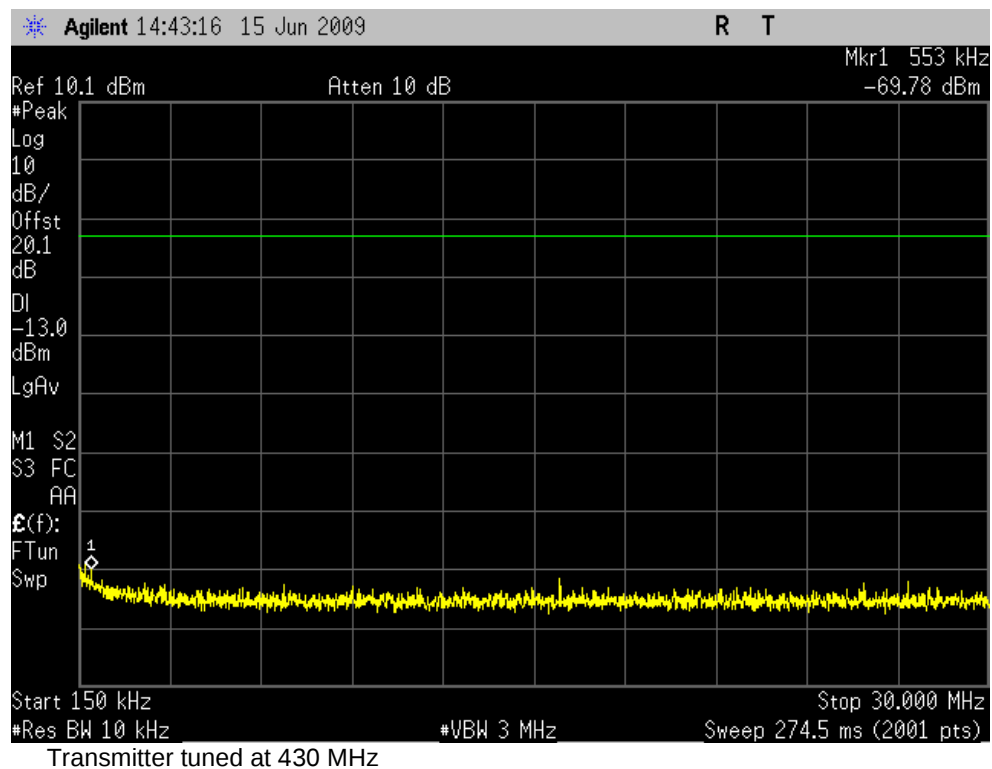
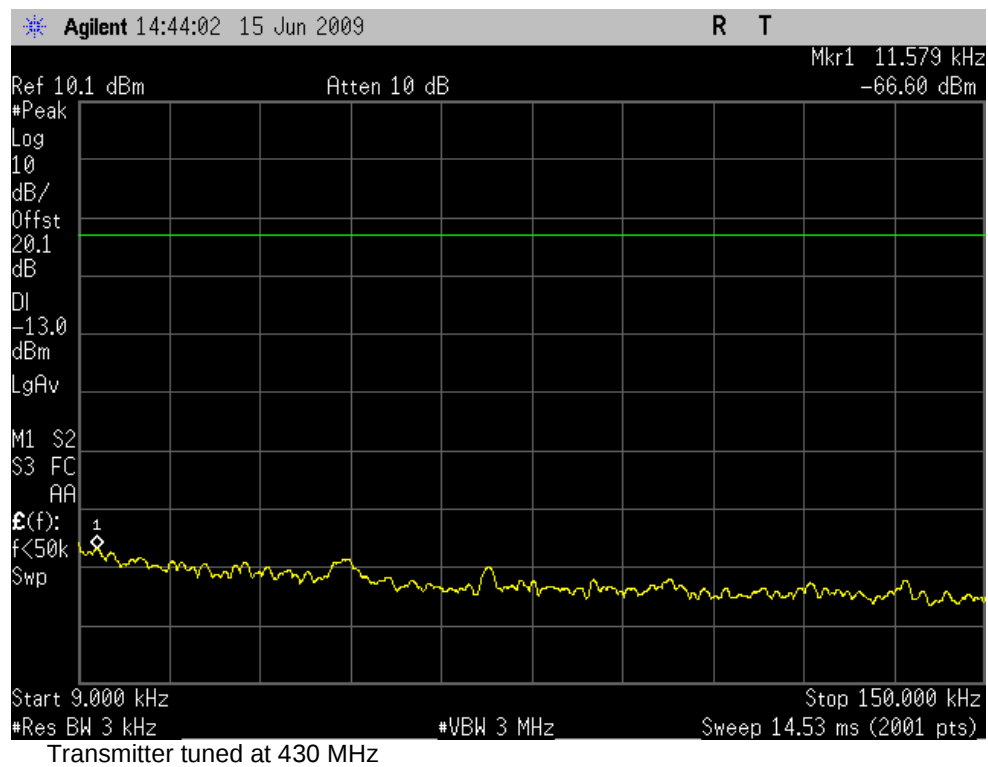


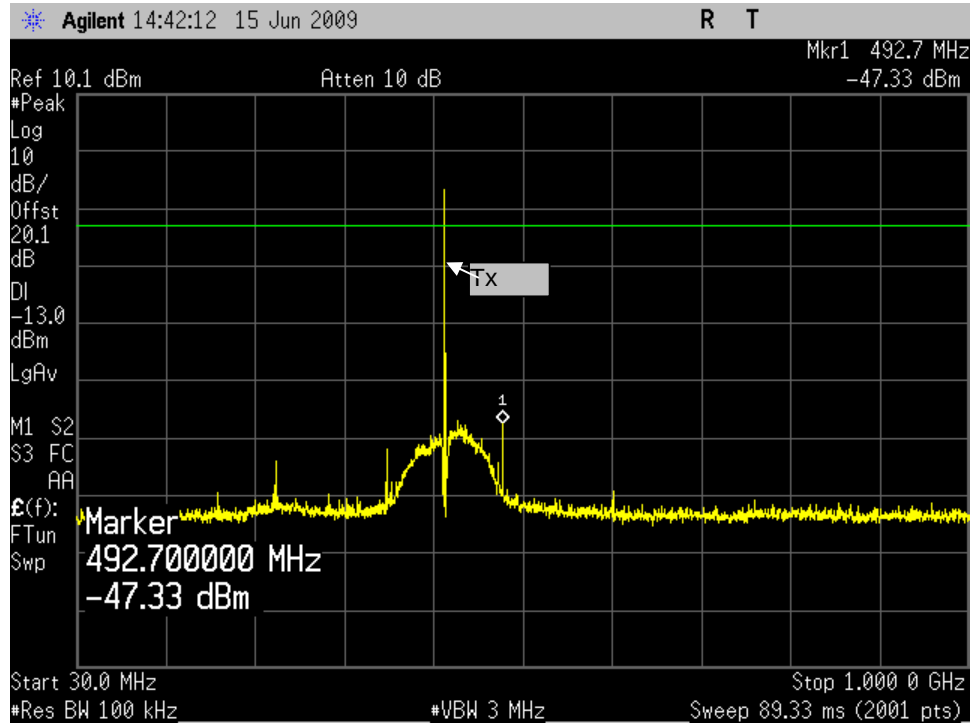


Transmitter tuned at 406.1 MHz

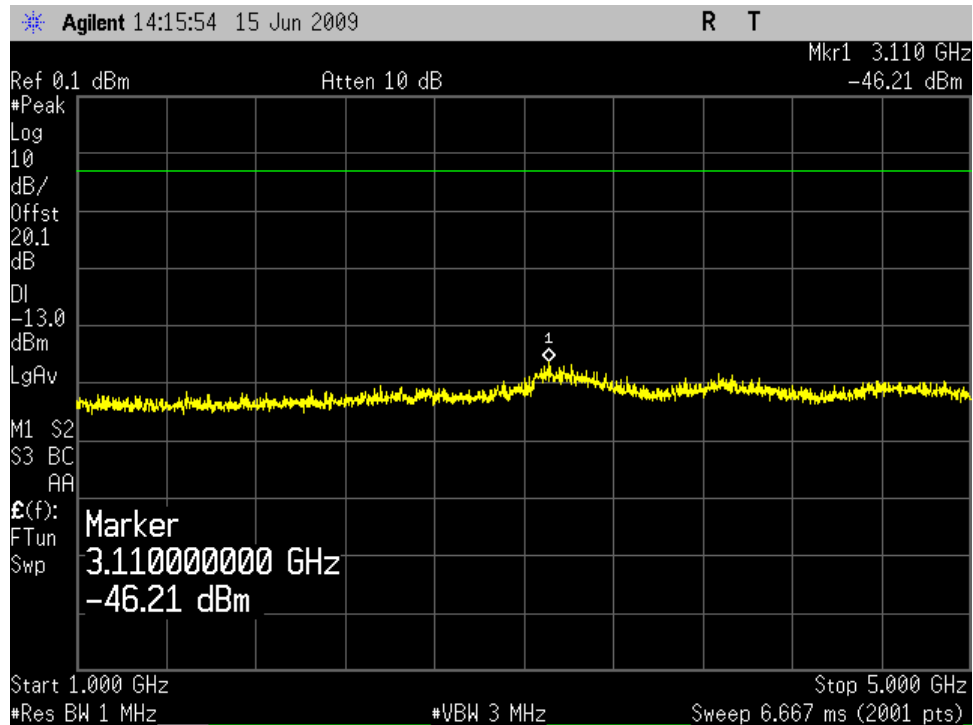


Transmitter tuned at 406.1 MHz

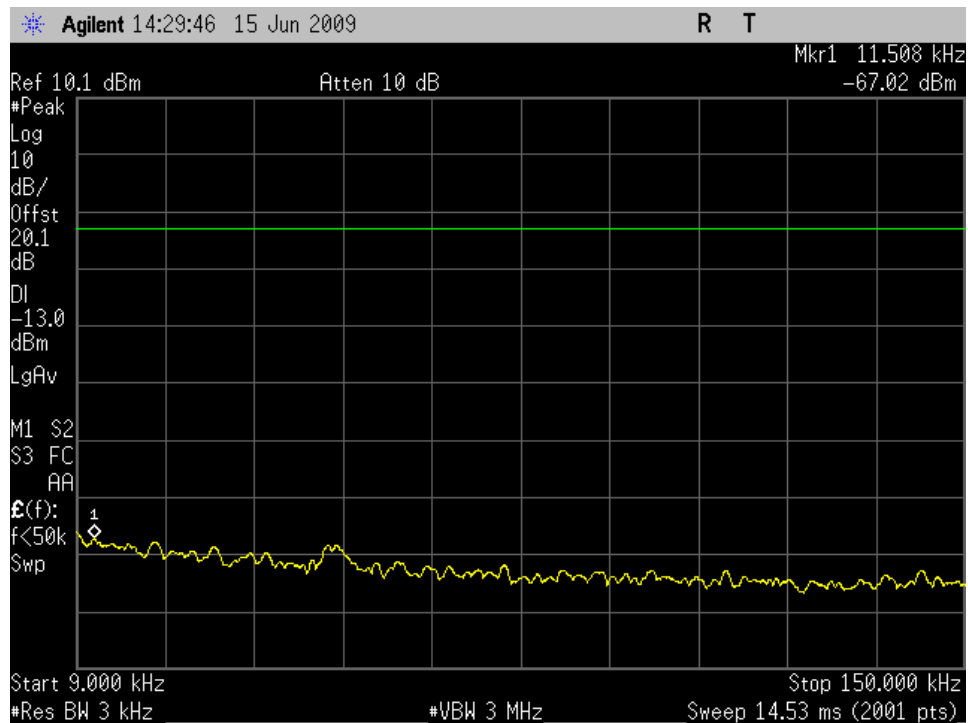




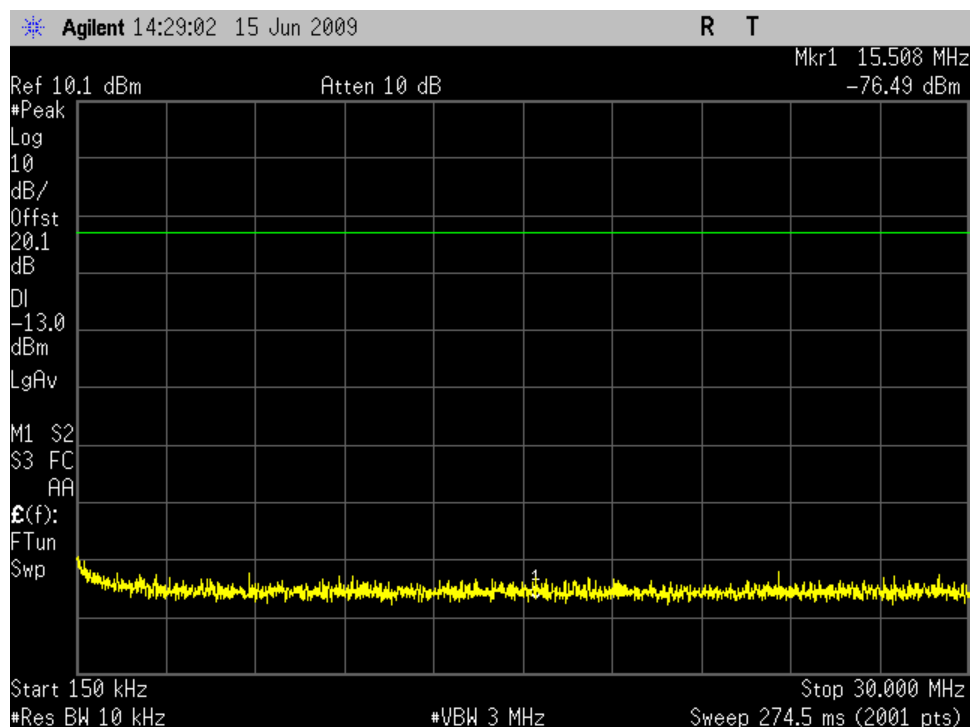
Transmitter tuned at 430 MHz



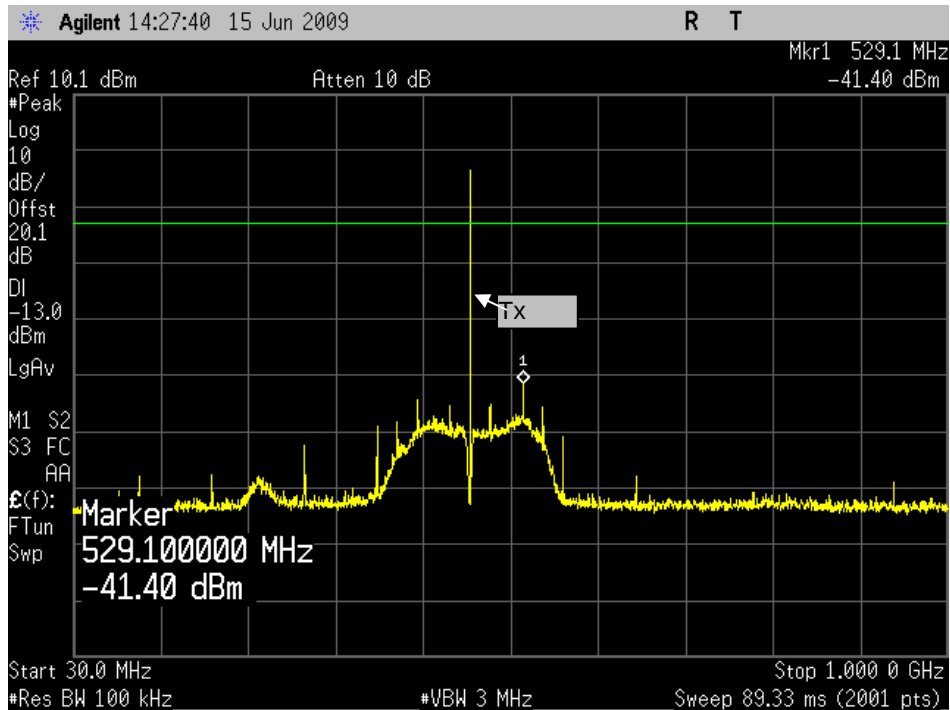
Transmitter tuned at 430 MHz



Transmitter tuned at 470 MHz



Transmitter tuned at 470 MHz



Transmitter tuned at 470 MHz



Transmitter tuned at 470 MHz

8. Transmitter Spurious Emissions (Radiated)

NAME OF TEST: Field Strength of Spurious Emissions	PARA.NO.: 2.1053
TESTED BY: Timo Hietala	RSS119: 5.8
	DATE: 15/06/2009

Test Results: Complies.

Test Data: See attached table.

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

Transmitter tuned at 406.1, 430 and 470 MHz

Frequency (MHz)	Spurious Emission EIRP (dBm) ave
All	More than 20 dB below limit -13 dBm

Equipment used: 566, 564, 571, 525, 417, 544, 145

Measurement Uncertainty: ± 5.2 dB.

Temperature: 23 °C.

Relative Humidity: 35 %.

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

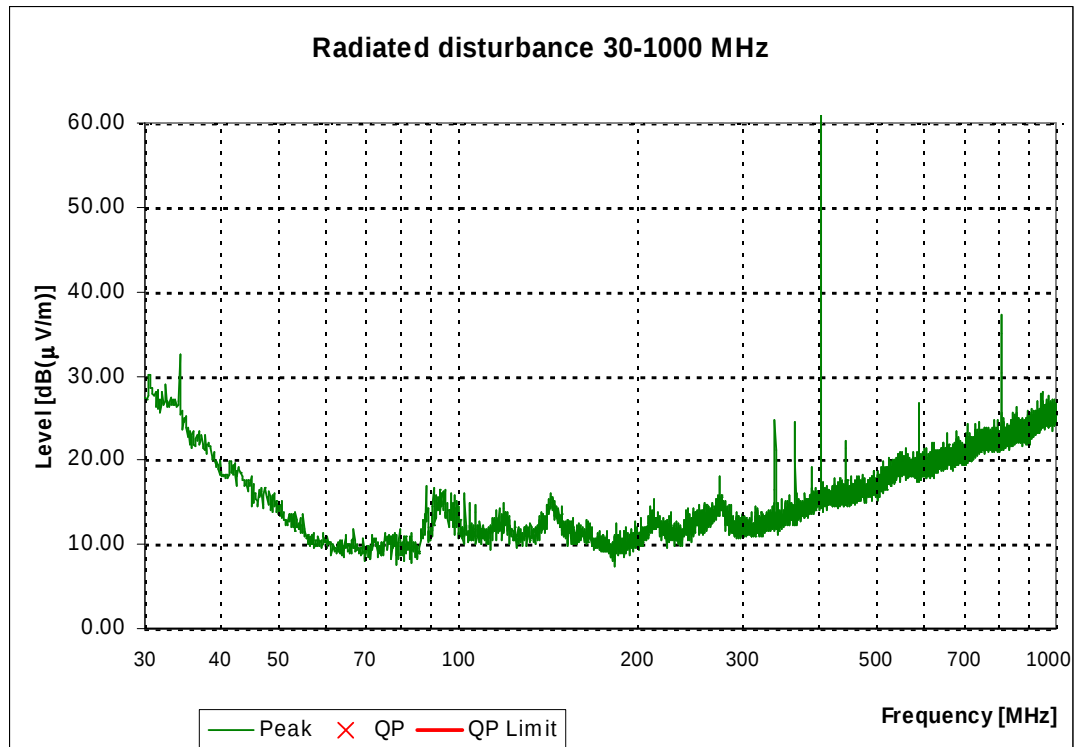
The test was performed in a semi-anechoic shielded room. The EUT was placed on a non-conductive 0.8 m high table standing on the turntable. During the test in the frequency range 30-5000 MHz the distance from the EUT to the measuring antenna was 3 m. In order to find the maximum levels of the disturbance 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.

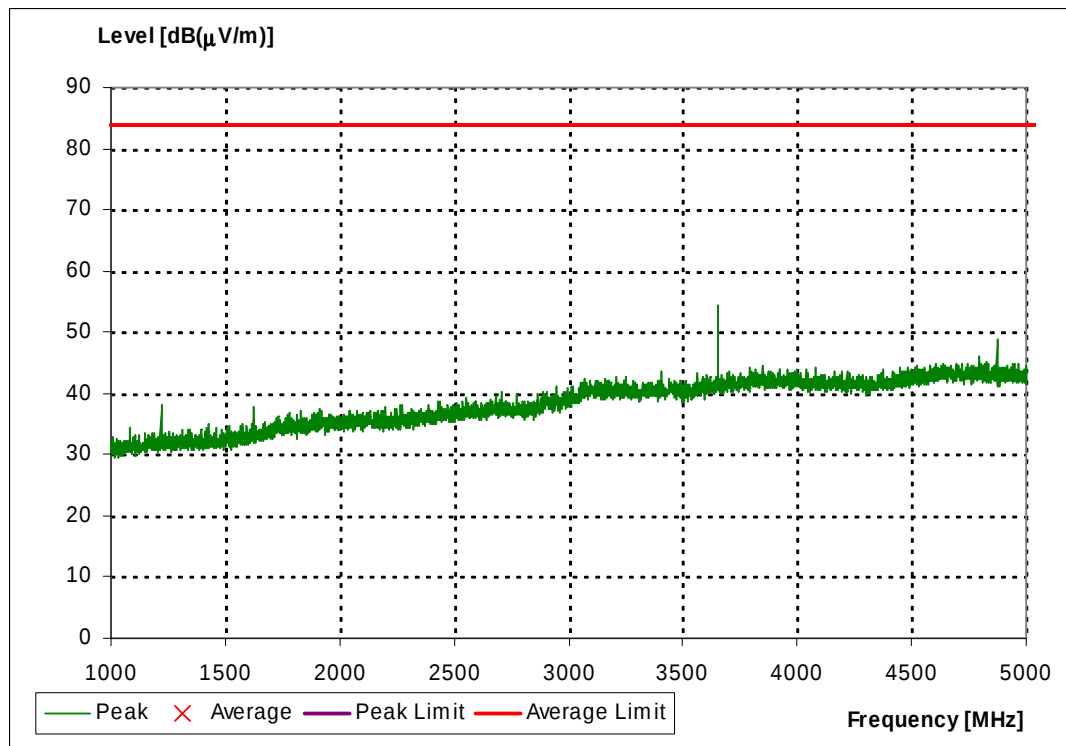
The limit of -13 dBm has been calculated to correspond 84.4 dB(μV/m).
Spurious emissions closer than 20 dB to the limit were measured with average detector.

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.

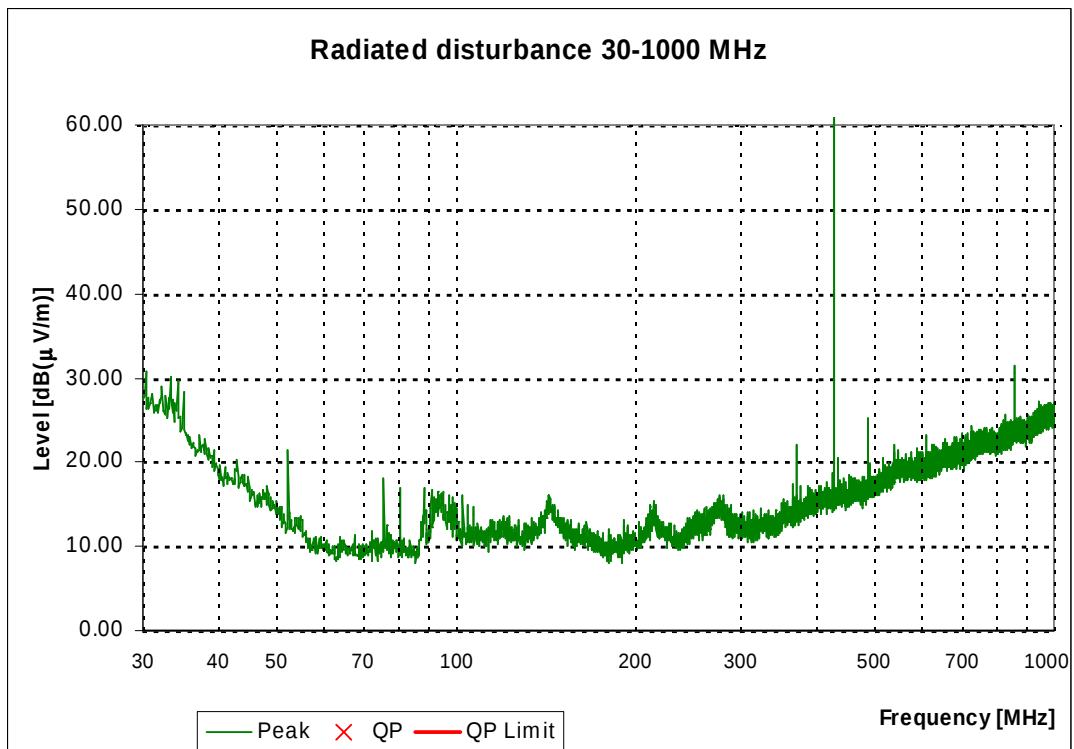
$$P_{EIRP[dBm]} = P_{Gen[dBm]} - L_{Cable[dB]} + G_{Antenna[dBi]}$$



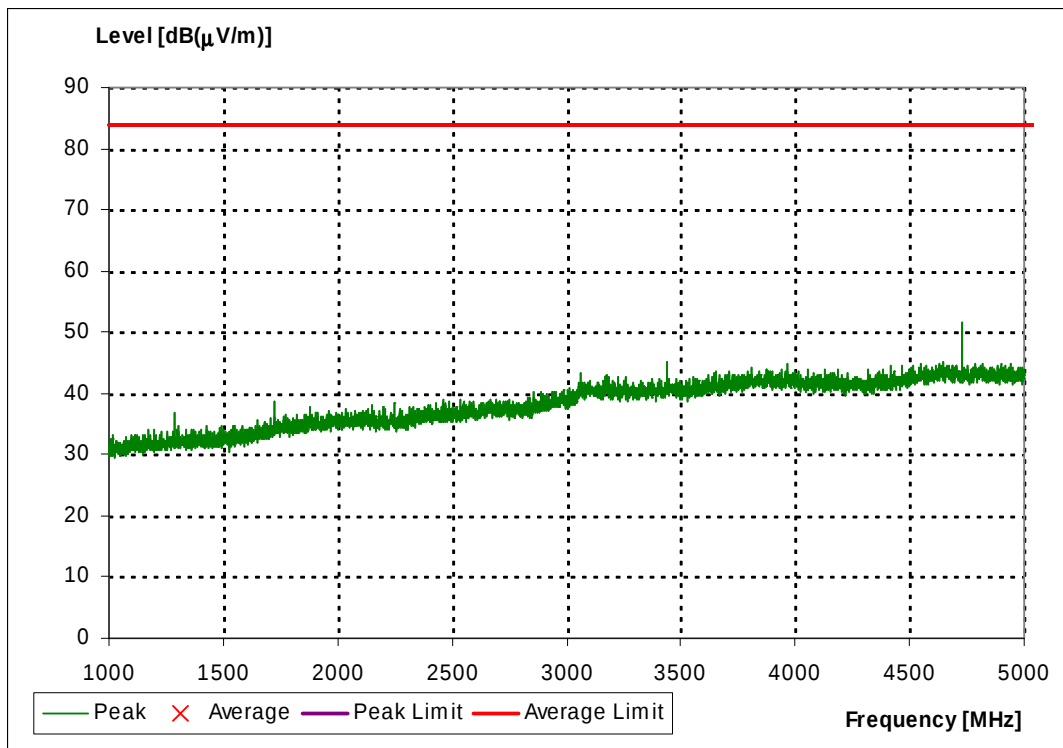
Transmitter tuned at 406.1 MHz



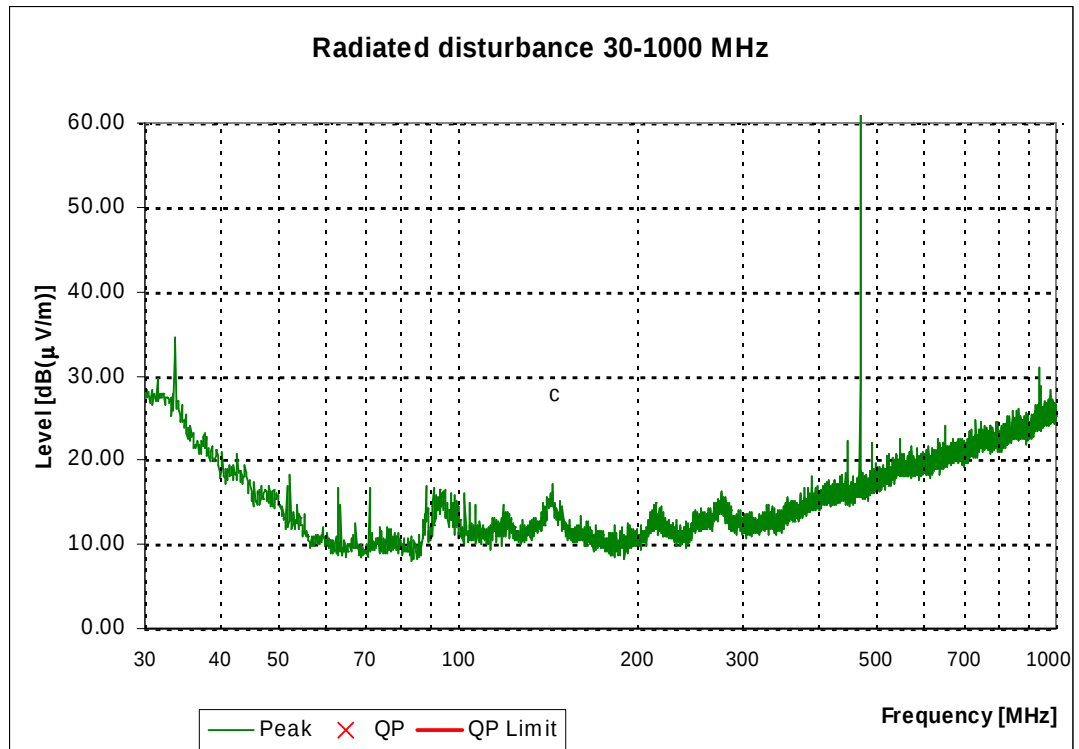
Transmitter tuned at 406.1 MHz



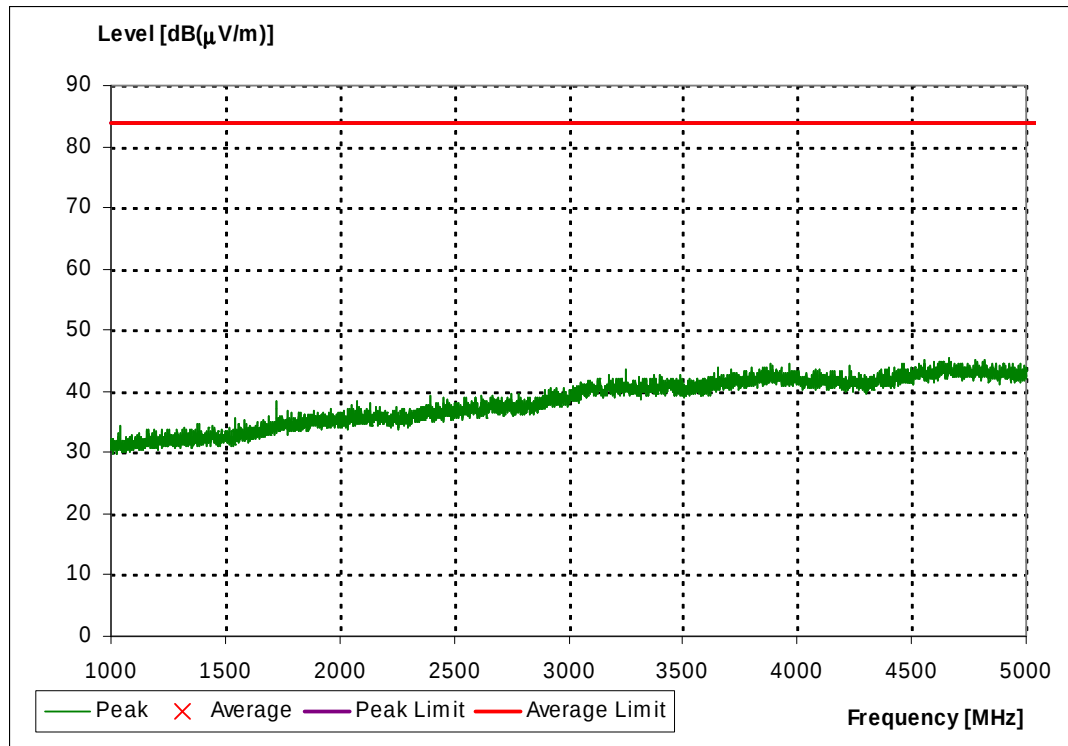
Transmitter tuned at 430 MHz



Transmitter tuned at 430 MHz



Transmitter tuned at 470 MHz



Transmitter tuned at 470 MHz

9. Transient behaviour of the transmitter

Date: 27.11.2008

Method of measurement: TIA-603

Requirement:

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

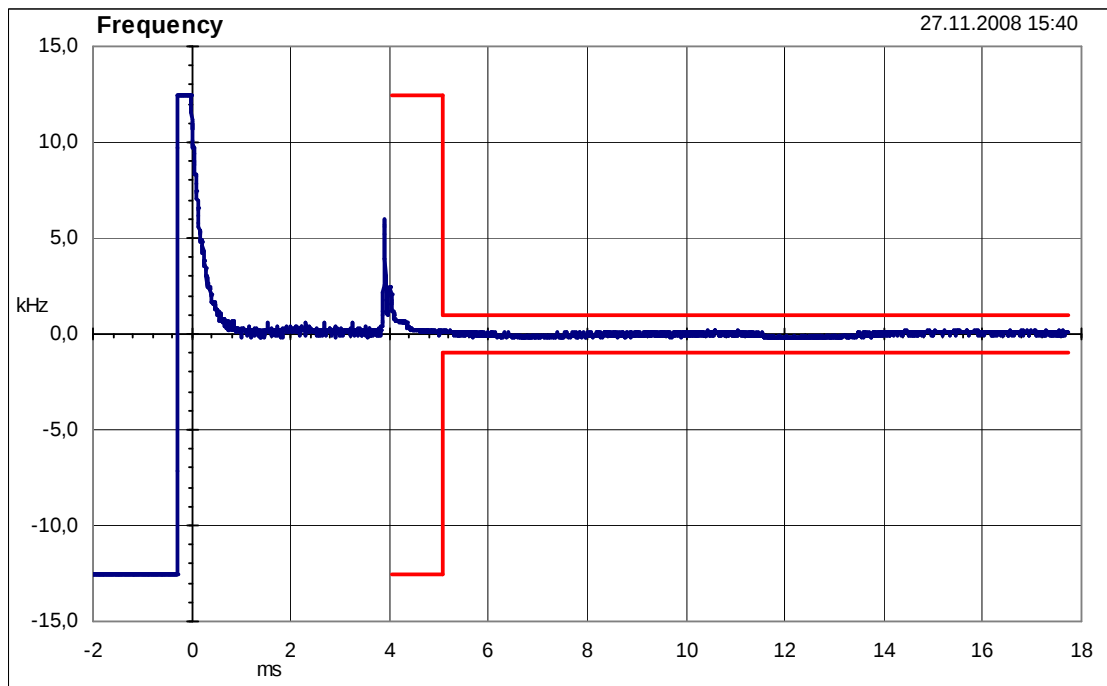
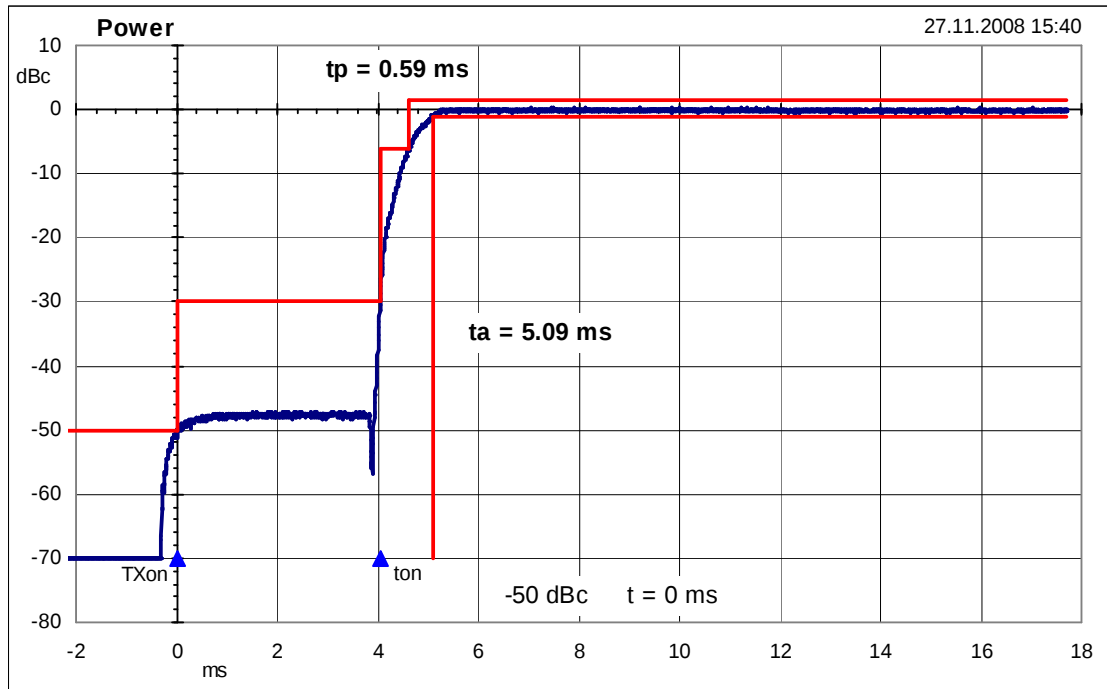
Measurement	Frequency error		
	406.1 MHz		470.0 MHz
T1	7 kHz		7 kHz
T2	2 kHz		2 kHz
T3	2 kHz		2 kHz

TEST EQUIPMENT USED: 335, 332, 334, 43, 42, 10, 201, 133, 146, 328, 386, 390, 392, 394, 316, 341

Graphs of the transient behaviour of the transmitter **Rated output power 1 W**

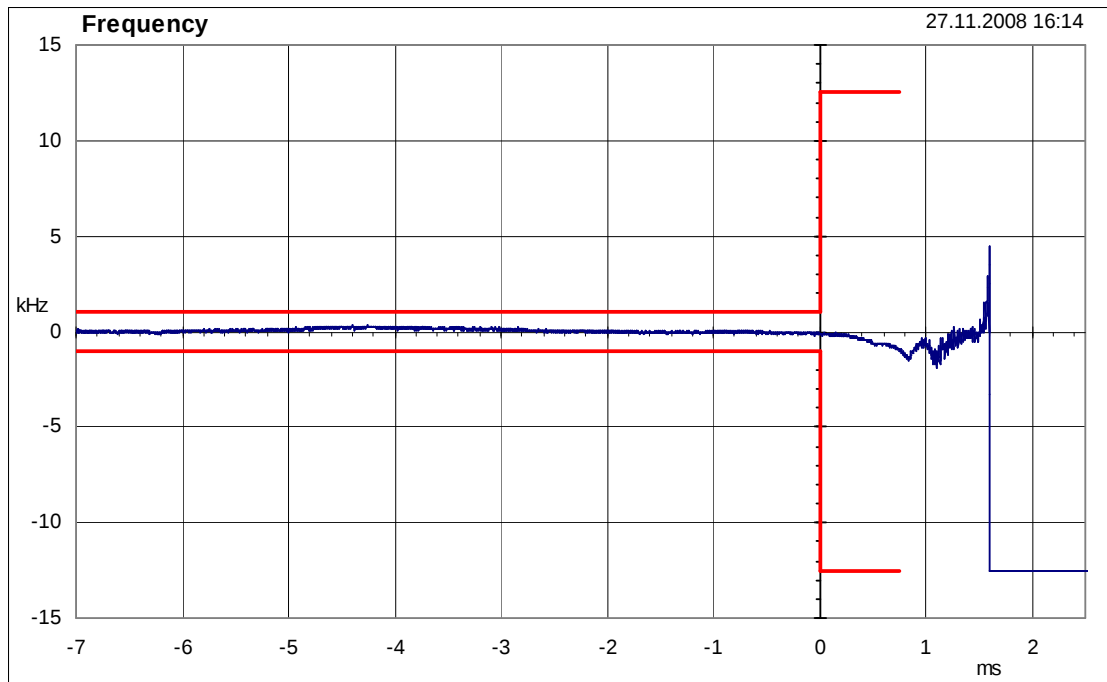
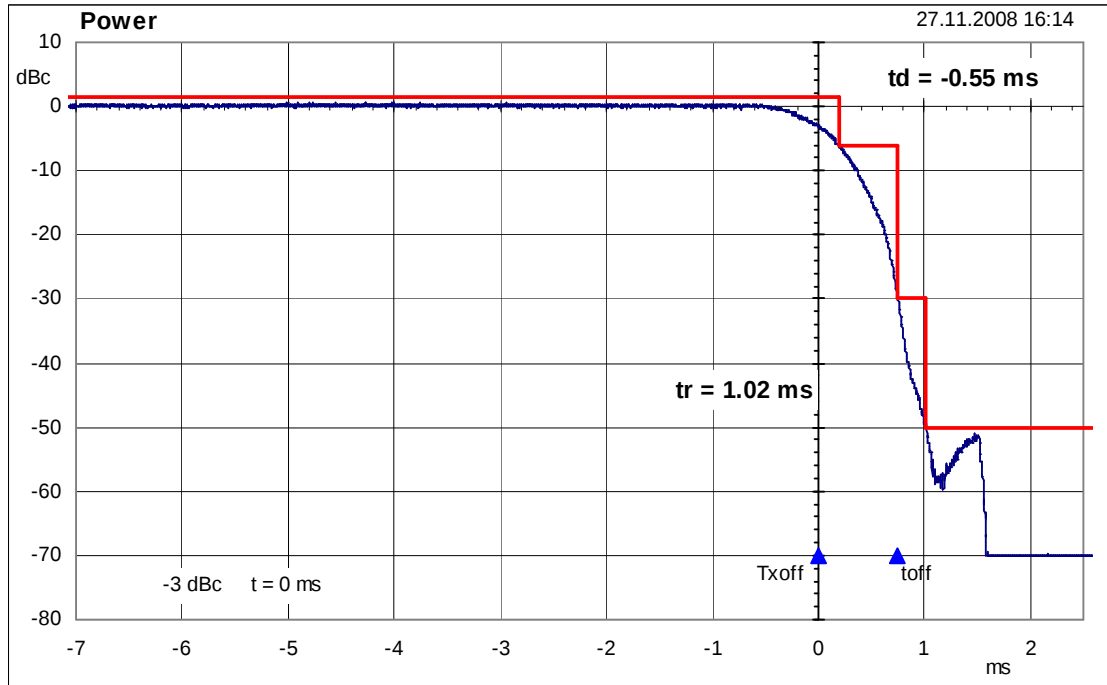
Transmitter attack time (406.1 MHz)
(Transient behaviour of the transmitter switch-on)

Output power: 1 W.



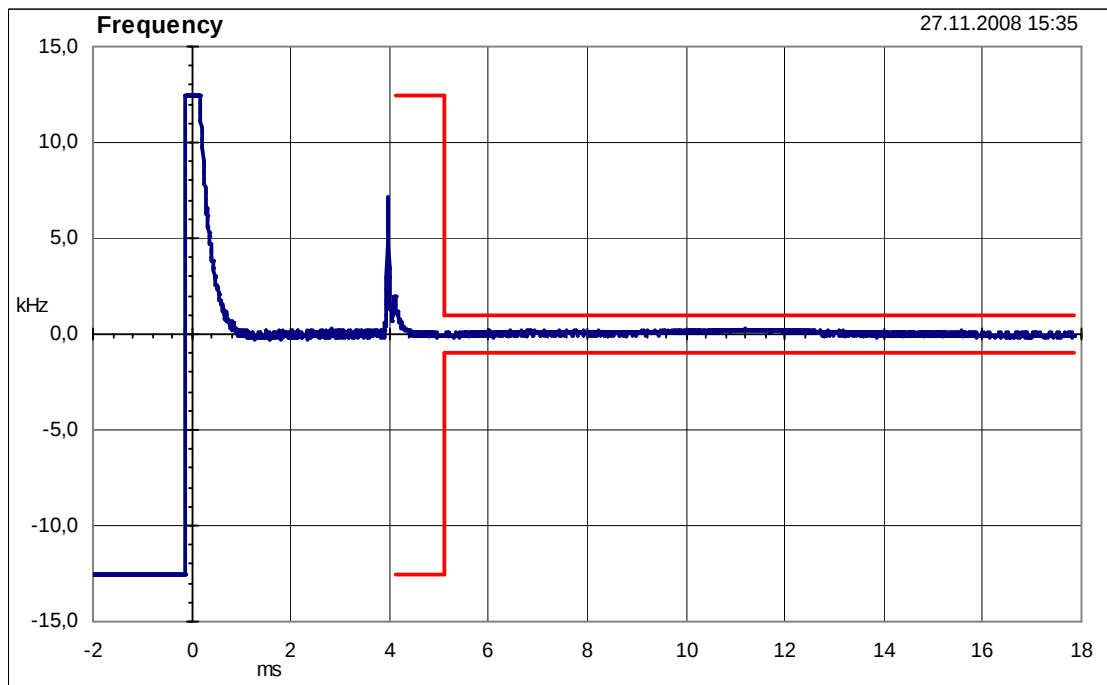
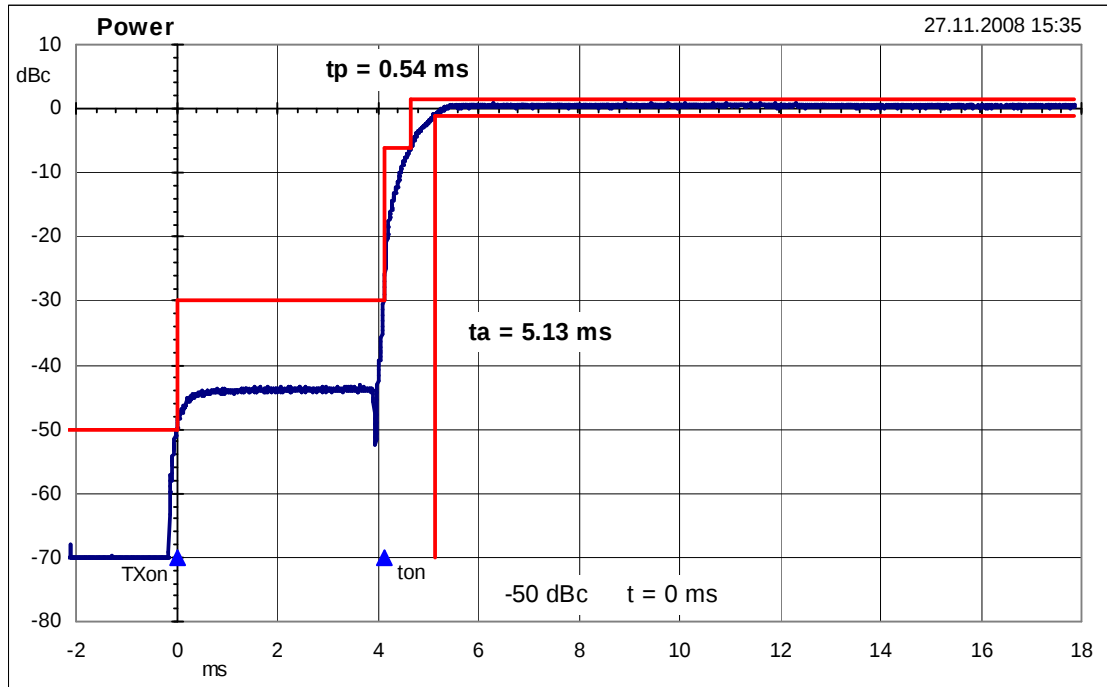
Transmitter release time (406.1 MHz)
(Transient behaviour of the transmitter switch-off)

Output power: 1 W.



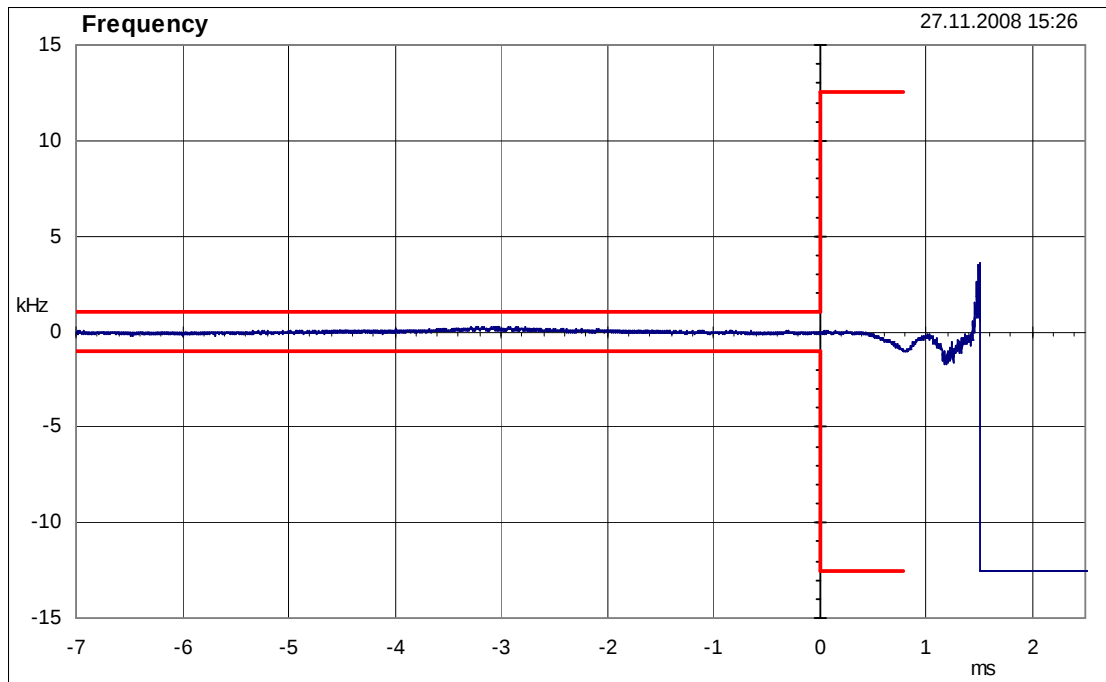
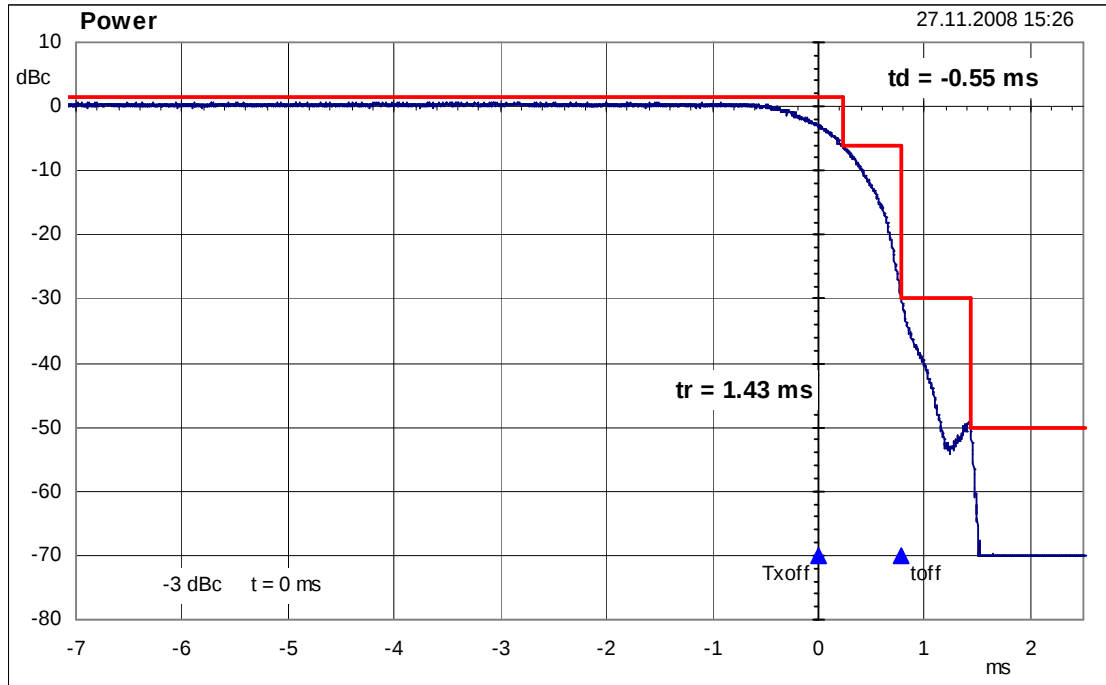
Transmitter attack time (470 MHz)
(Transient behaviour of the transmitter switch-on)

Output power: 1 W.



Transmitter release time (470 MHz)
(Transient behaviour of the transmitter switch-off)

Output power: 1 W.



9.1 Frequency stability

TESTS PERFORMED: Frequency Stability vs. temperature and voltage variations
TEST STANDARD: acc. to 47 CFR 2.1055.
TEST PERIOD: 23.06.2009
TEST SITE: Satel / R&D Dept., Salo, Finland
TESTS PERFORMED BY: Timoteus Marttila

LIST OF MEASURING EQUIPMENT:

- Power supply Thurlby Thandar Instruments EX354T Serial nro. 140816
- Temperature test chamber Vötsch VT4002 Serial nro. 58566085500010
- Spectrum analyzer Rohde & Schwarz FSEA Serial nro. 826029/013

TEST RESULTS

Test performed at transmitter frequency 436.5 MHz.

a) Frequency stability vs. voltage variations

Temperature	Voltage	Frequency	ppm error
+20 °C	5,1 V	436.50002	0.05ppm
+20 °C	6,0 V	436.49992	-0.18ppm
+20 °C	6,9 V	436.49992	-0.18ppm

b) Frequency stability vs. temperature variations

Temperature	Voltage	Frequency	ppm error
-30°C	6,0 V	436.50052	1.19ppm
-20°C	6,0 V	436.50012	0.27ppm
-10°C	6,0 V	436.50002	0.05ppm
± 0°C	6,0 V	436.49989	-0.25ppm
+10°C	6,0 V	436.49984	-0.37ppm
+20°C	6,0 V	436.49992	-0.18ppm
+30°C	6,0 V	436.49995	-0.11ppm
+40°C	6,0 V	436.49998	-0.05ppm
+50°C	6,0 V	436.49998	-0.05ppm

10. List of measuring equipment:

No.	Equipment	Type	Manufacturer	Serial Number
5	Test receiver	ESH-3	Rohde & Schwarz	894718/01510
10	Oscilloscope	9400A	LeCroy	8878
42	Spectrum analyzer	8566B	Hewlett Packard	2637A04102
43	Spectrum analyzer	8568B	Hewlett Packard	2039A01256
62	Audio amplifier	PRL x	Self made	
89	Antenna	3147	EMCO	9202-1078
102	Hybrid	H 9	Anzac	
133	Termination 50Ω	370 BNM	Narda	
145	Notch Filter	TTR - 375 - 3EE	Telonic	3062 - 1
146	Dual directional coupler	778D	Hewlett Packard	1144A02333
157	Temp. test chamber	VMT 04/240	Vötsch	31884
168	Artificial Mains	NSLK 8127	Schwartzbeck	8127162
176	Anechoic chamber	888 cm x 585 cm x 416 cm	length of absorber 66 cm	
185	Antenna	PRL LogPer	Self made	1A93
201	RF-Generator	2042	Marconi	119571/062
205	RF-Amplifier	ZHL-1042J	Mini-Circuits	012288-11
316	Power supply	HP 6032A	Hewlett Packard	2517A-00654
319	Antenna	CBL6112	Chase	2018
328	Power attenuator	765-20	Narda	-
332	IF-filter	10.7MHz/25kHz	Ultracom Oy	-
334	IF-filter	10.7MHz/12.5kHz	Ultracom Oy	-
335	Mixer	ZFM-150	Mini-Circuits	-
337	Modulation analyzer	HP 8901B	Hewlett Packard	3538A05622
341	Multimeter	Fluke 87	Fluke	593100386
350	Semianechoic shielded room	RFD-F-100	Euroshield Oy	1327
386	RF attenuator PAD	WA2-3	Weinschel	3780
390	RF attenuator PAD	WA2-10	Weinschel	3784
392	RF attenuator PAD	1A (6dB)	Weinschel	
394	RF attenuator PAD	1A (20dB)	Weinschel	
417	Antenna, bilog	CBL 6141	Chase	4028
525	Double-Ridged Horn	3115	Emco	6691
544	RF-amplifier	ZFL-1000VH2	Mini-Circuits	D01080
563	Thermometer	52 II	Fluke	81210080
564	RF amplifier	CA018-4010	CIAO Wireless	101
566	Spectrum analyzer	E4448A	Agilent	US42510236
567	RF generator	E8257C	Agilent	MY43320736
571	High Pass Filter	WHK0.6/13G-10SS	Wainwright Instruments	1
2039	Power sensor	8482A	Hewlett Packard	1925A03475
2040	Power meter	438A	Hewlett Packard	2517U00427
2046	Counter	5351B	Hewlett Packard	2844U00220