TEST REPORT

Date: **ESPOO 18.08.2010**

Page: **1 (32)**

Appendices **-**

Number: **155850**
No. 1 / 1

Date of handing in: **01.06.2010**

Tested by:

Timo Hietala, Test Engineer

FINAS
Finnish Accreditation Service
T017 (EN ISO/IEC 17025)

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:	**102447193**
CLIENT:	**Satel Oy**
ADDRESS:	**Meriniitynkatu 17, FIN-24100 Salo, Finland**
TELEPHONE:	**+358 2 777 7835 / Timoteus Marttila**
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 10.

Nemko Oy • P.O.Box 19, FI-02601 Espoo, Finland
Street address: Perkkaantie 11, FI-02600 Espoo
Telephone +358 424 5454 1 • Telefax +358 9 5489 6371

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1. General

Type:	**SATELLINE M3-T1 / SLR1**
Alignment range:	**406.1 – 470 MHz**
Switching range:	**One channel**

Measurement	Equipment 1	Equipment 1	Equipment 1
	Serial no. **102447193**	Serial no. **102447193**	Serial no. **102447193**
Frequencies:	1) **406.100 MHz (*** 2) **430.000 MHz (*** 3) **470.000 MHz (***	1) **418.000 MHz (**** 2) **460.000 MHz (****	1 **436.500 MHz (*****

	Normal	Minimum	Maximum
Voltages:	**12.0 VDC**	**6 VDC**	**30 VDC**
Temperatures:	**23,0°**		
Humidity:	**35 %**		

Effective radiated power:	**1 W / 100 mW**	Antenna:	**50 ohm**
		Production model:	**Production model**
Number of channels:		Modulation:	**Multilevel State FM (4FSK)**
Channel separation:	**12,5 and 25 kHz**		**(12,5 kHz: 9600 bps 25 kHz: 19200 bps)**

*) Measurements 5.4, 5.8 and 5.9 (frequencies 1 and 3)
**) Measurements 5.5
***) Measurements 5.3

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 10*		*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

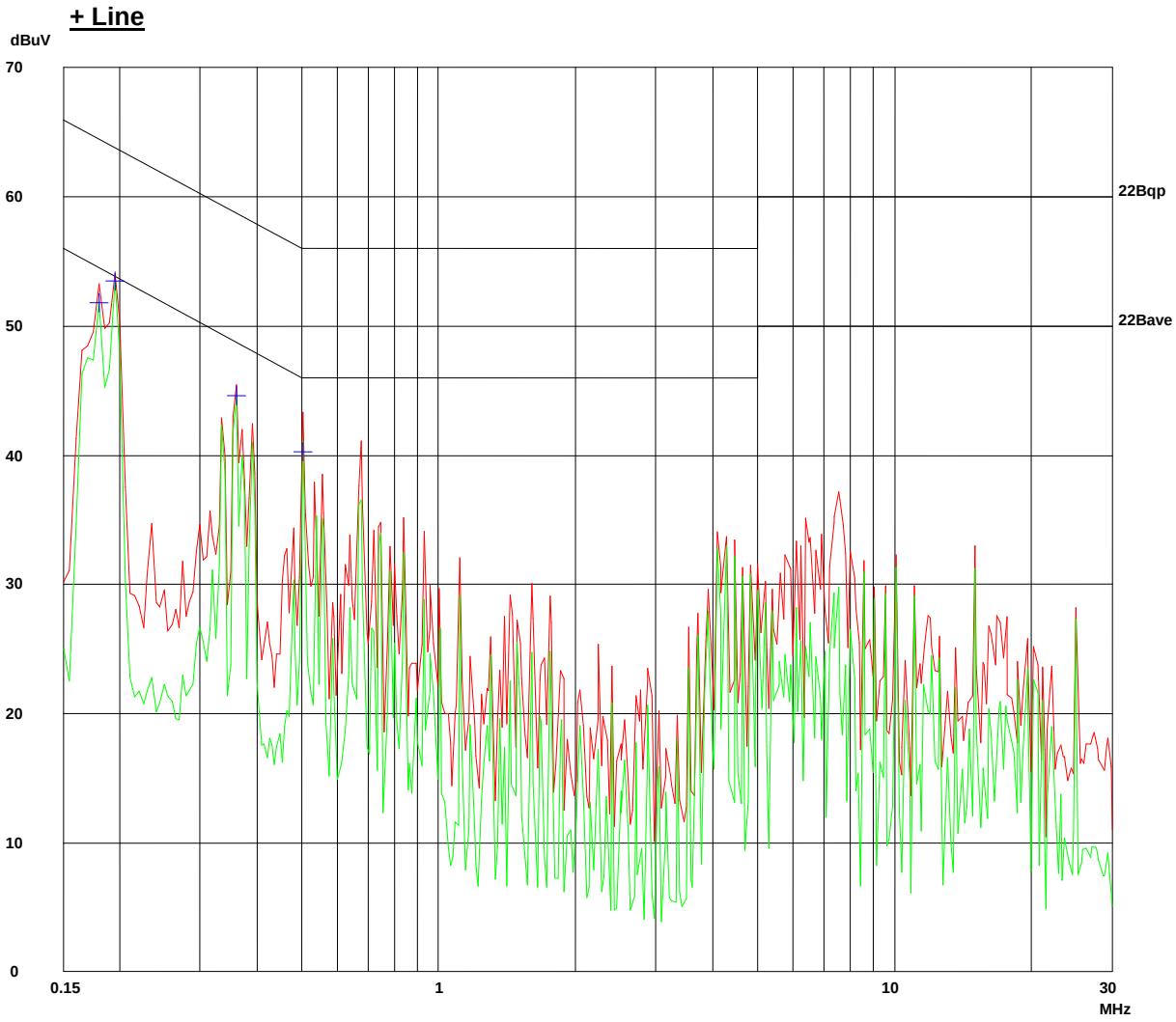
The test was performed as a compliance test. The test parameters concerned were as follows:

Parameter	Specification
Test method	CISPR 22
Frequency range	0.150 – 30 MHz
Test mode	Tx 430 MHz, 12.5 / 25 kHz
Site name	Nemko Oy / Perkkaa
Date of testing	22.07.2010
Test equipment	168, 184, 338, 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.

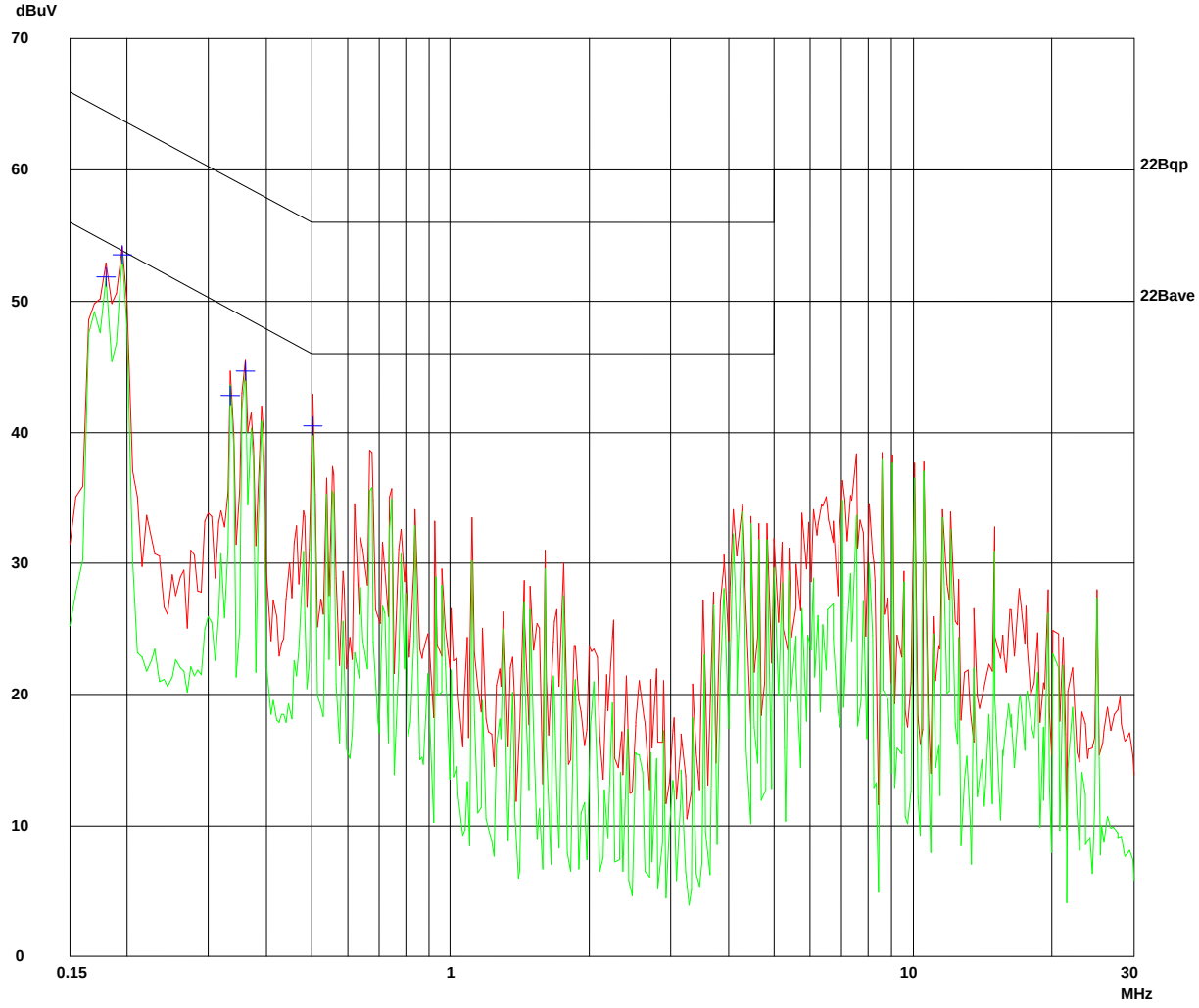
3.1.1 Test results conducted disturbance at mains ports emission test



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)	
0.1800	pos	-	64.5	51.9	54.5	Pass
0.1950	pos	-	63.9	53.6	53.9	Pass
0.3600	pos	-	58.7	44.7	48.7	Pass
0.5050	pos	-	56.0	40.3	46.0	Pass

- **Line**



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.

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)	
0.1800	Neg.	-	64.5	51.8	54.5	Pass
0.1950	Neg.	-	63.9	53.5	53.9	Pass
0.3350	Neg.	-	59.4	42.8	49.4	Pass
0.3600	Neg.	-	58.7	44.6	48.7	Pass
0.5050	Neg.	-	56.0	40.4	46.0	Pass

4. RF Power Output

NAME OF TEST: RF Power Output	FCC PARA.NO.: 2.1046 RSS119: 5.4
TESTED BY: Timo Hietala	DATE: 18/08/2010

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	**30.14**	**1.03**
FM	430.0	**29.99**	**0.99**
FM	470.0	**29.46**	**0.92**

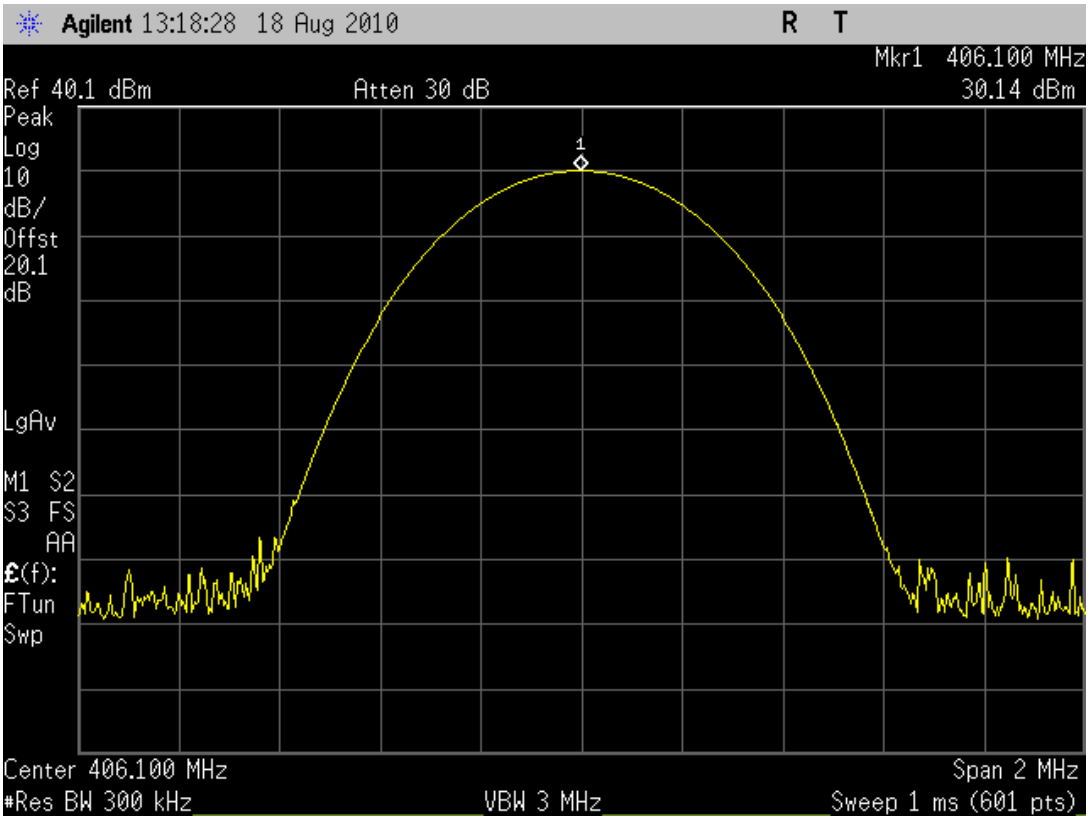
Equipment used: 566, 327

Measurement Uncertainty: ± 0.7 dB.

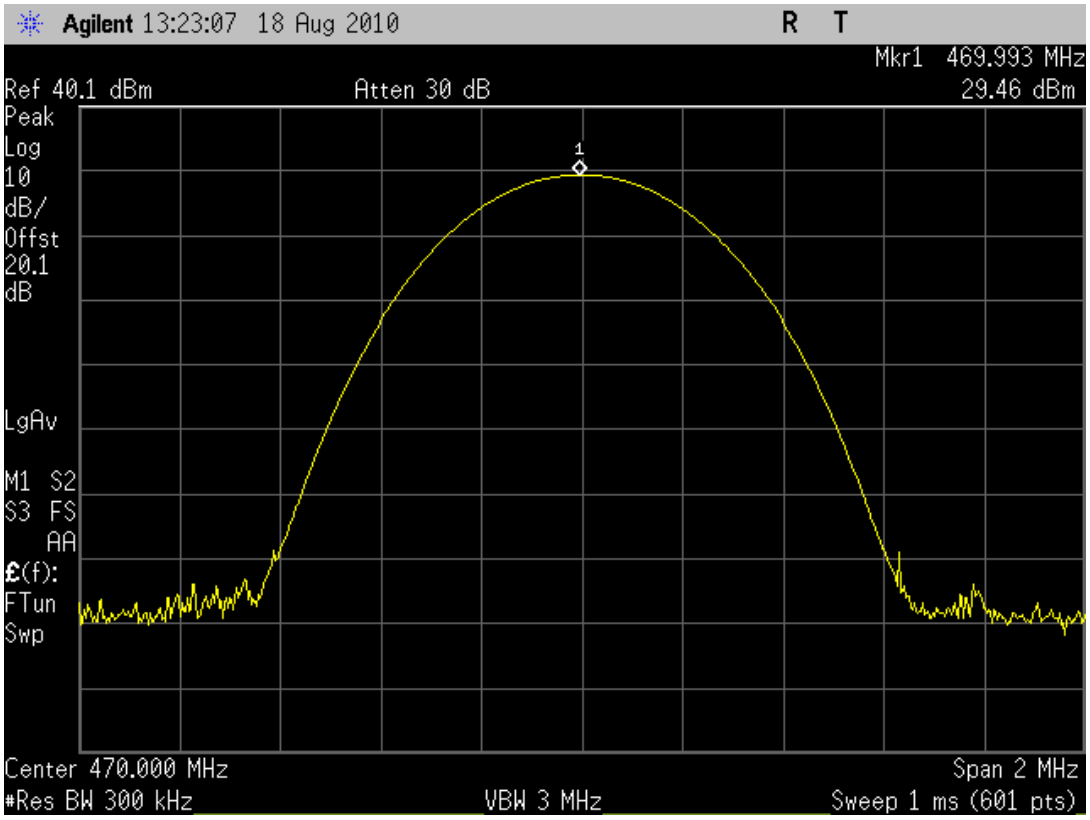
Temperature: 23 °C.

Relative Humidity: 50 %.

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



RF power output, 25kHz channel spacing, 19200 bps, low channel



RF power output, 25kHz channel spacing, 19200 bps, high channel

5. 99% Occupied Bandwidth

NAME OF TEST: Occupied Bandwidth	PARA.NO.: 2.1049 RSS119: 5.5
TESTED BY: Timo Hietala	DATE: 12/08/2010

Test Results: Complies.

Test Data: See attached plot(s).

Channel spacing	Frequency (MHz)	Measured 99% Occupied Bandwidth (kHz)
25 kHz	418.0	**15.1**
25 kHz	460.0	**15.0**
12.5 kHz	418.0	**8.1**
12.5 kHz	460.0	**8.0**

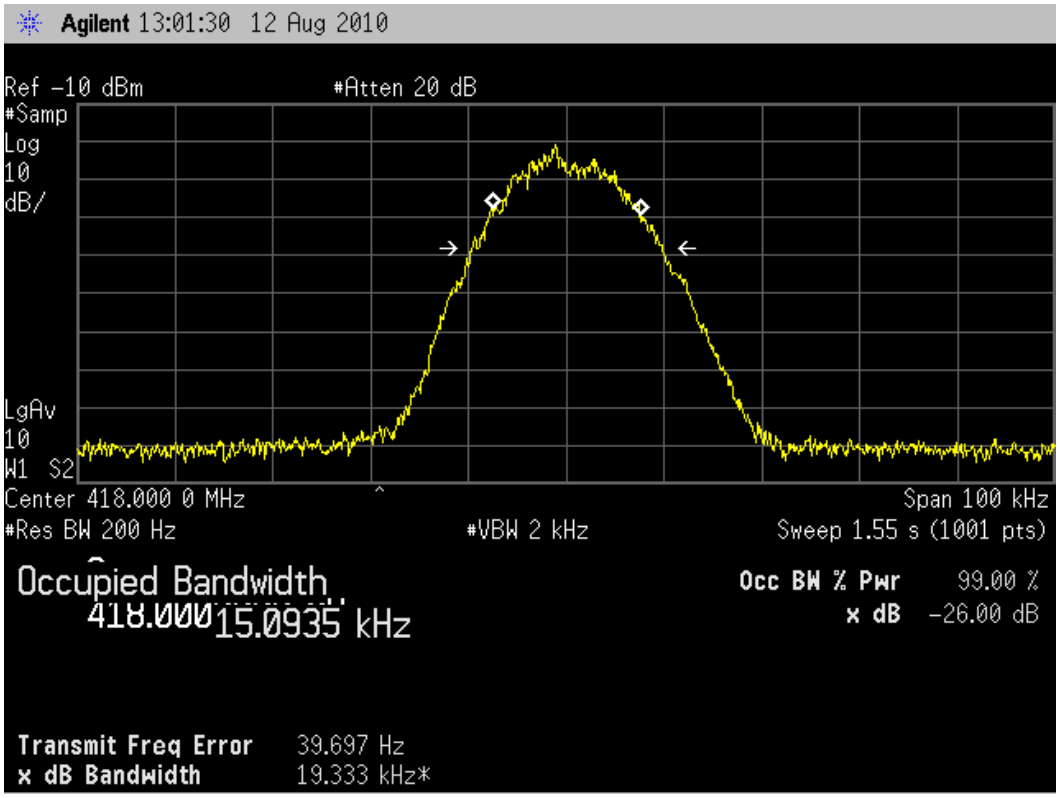
Equipment used: 566, 316, 341, 327

Measurement Uncertainty: ± 0.7 dB.

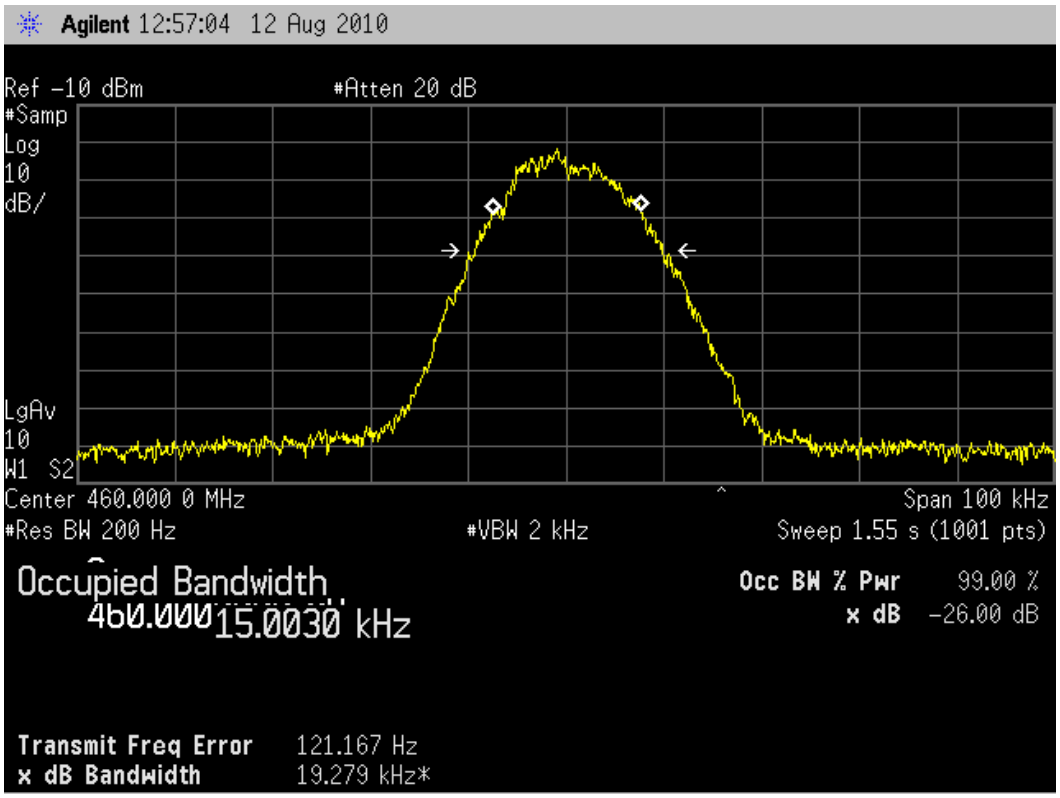
Temperature: 23 °C.

Relative Humidity: 35 %.

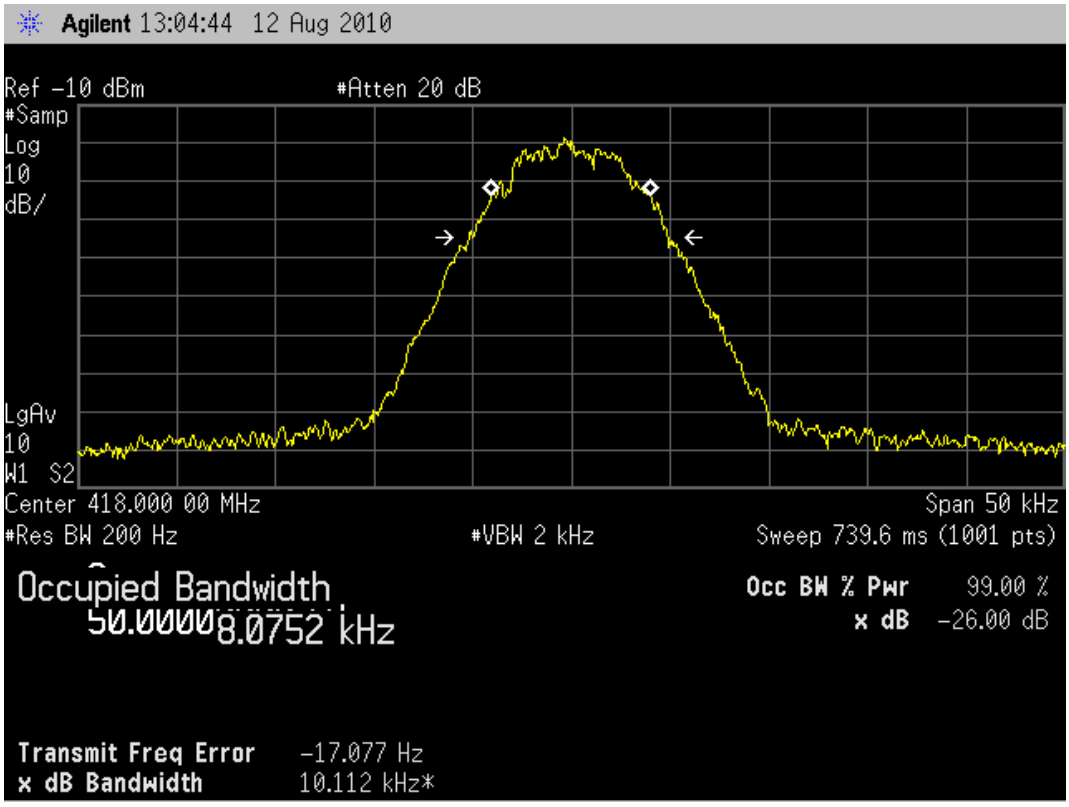
The 99% occupied bandwidth of the carrier emission is measured using a spectrum analyzer with Resolution Bandwidth set to 1% of the necessary bandwidth of the transmitted carrier. Transmitter was set to transmit random data file 19200 bps 25kHz channel and 9600 bps 12.5kHz channel.



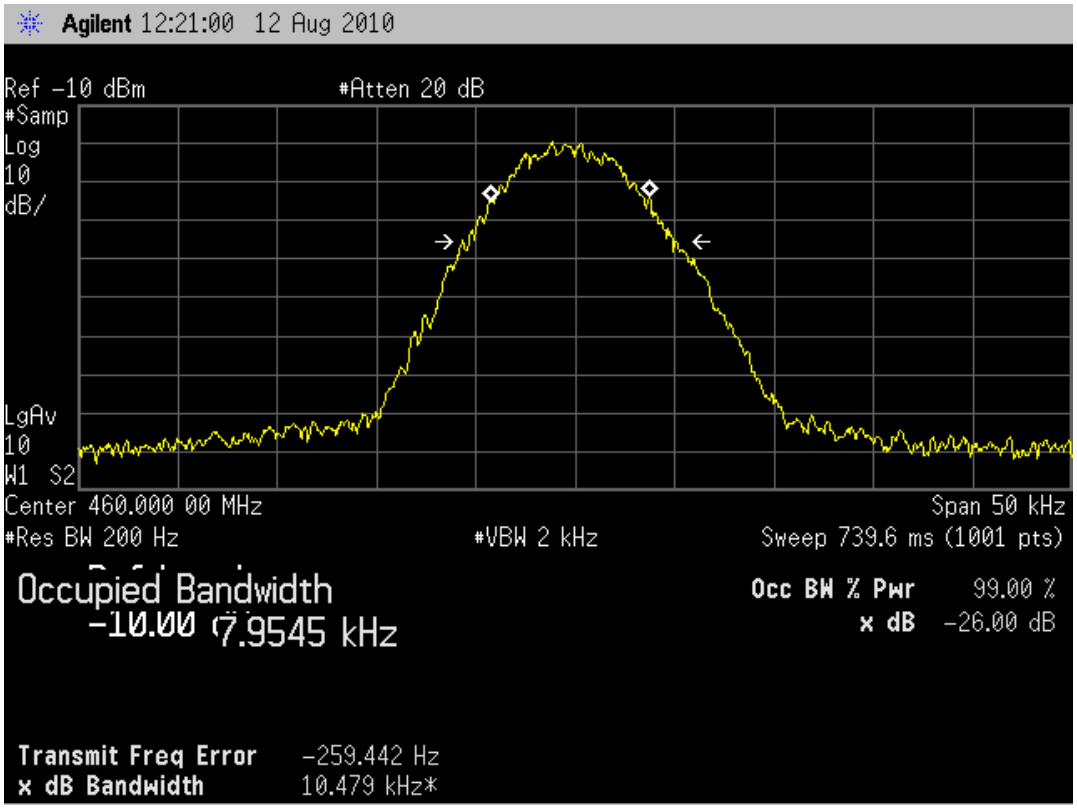
25kHz channel spacing, 418 MHz



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 RSS119: 5.5
TESTED BY: Timo Hietala	DATE: 18/08/2010

Test Results: Complies.

Test Data: See attached plot(s).

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

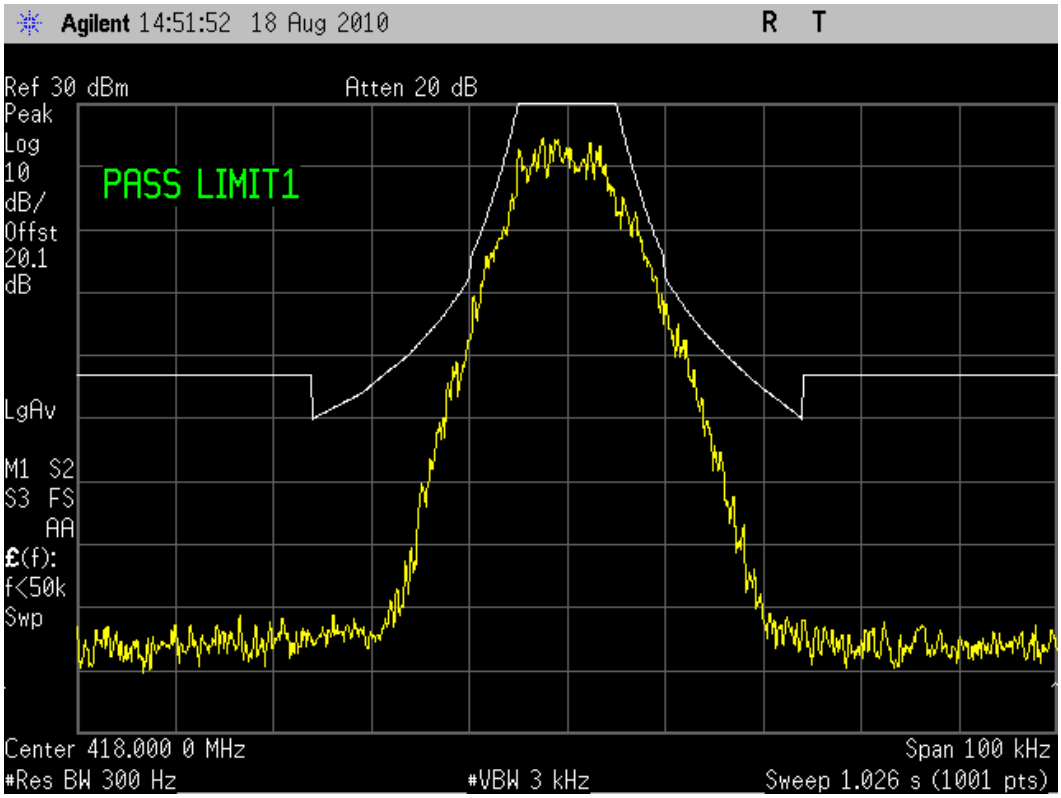
Equipment used: 566, 327

Measurement Uncertainty: ± 0.7 dB.

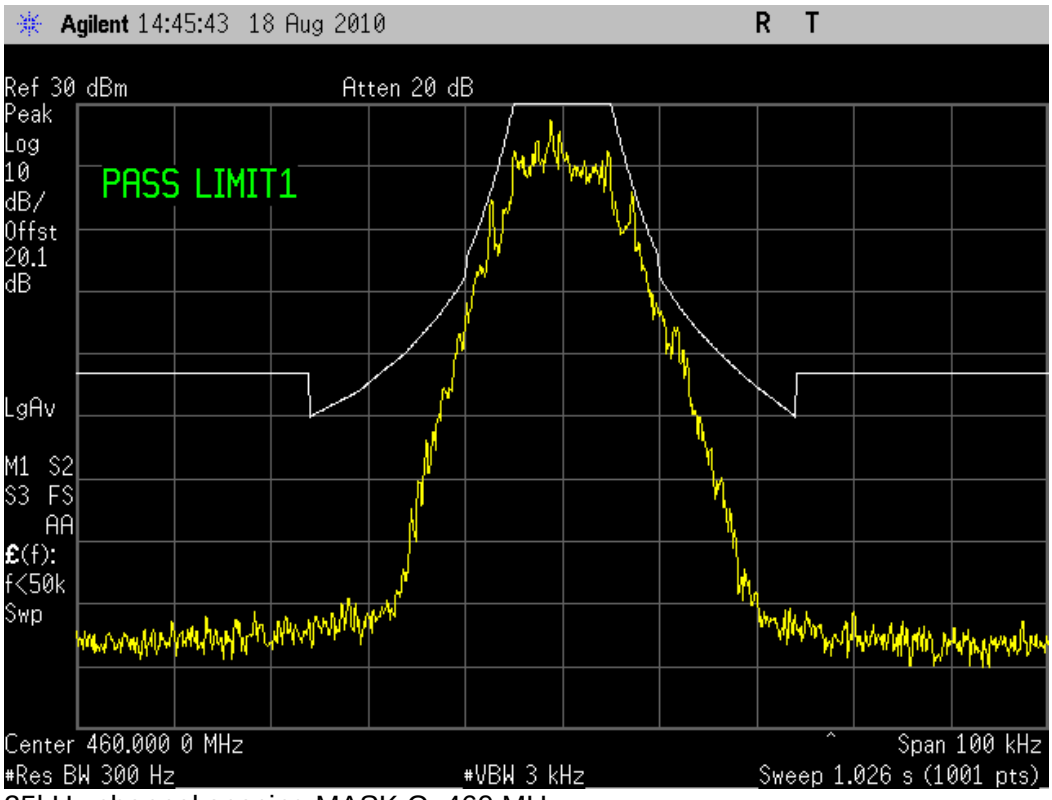
Temperature: 23 °C.

Relative Humidity: 50 %.

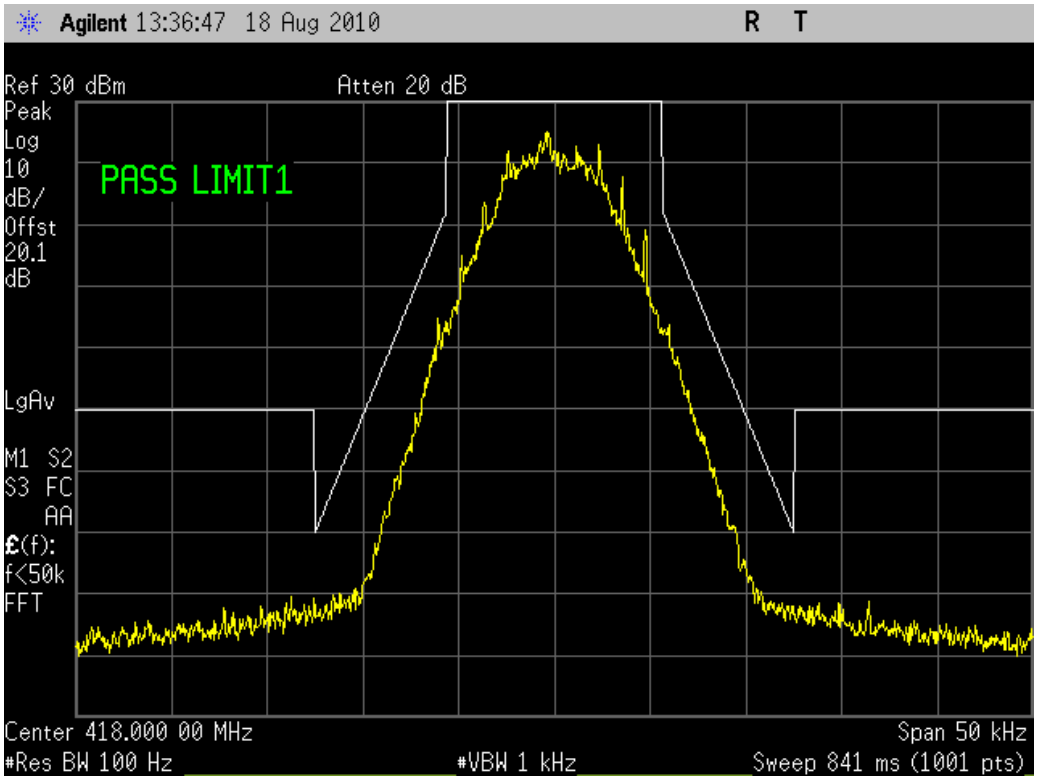
The emission mask of the modulated carrier is measured by using a spectrum analyzer with resolution bandwidth set to 300 Hz for emission mask C (25kHz bandwidth) and 100 Hz for emission mask D (12.5kHz bandwidth).
Transmitter was set to transmit random data file 19200 bps 25kHz channel and 9600 bps 12.5kHz channel.



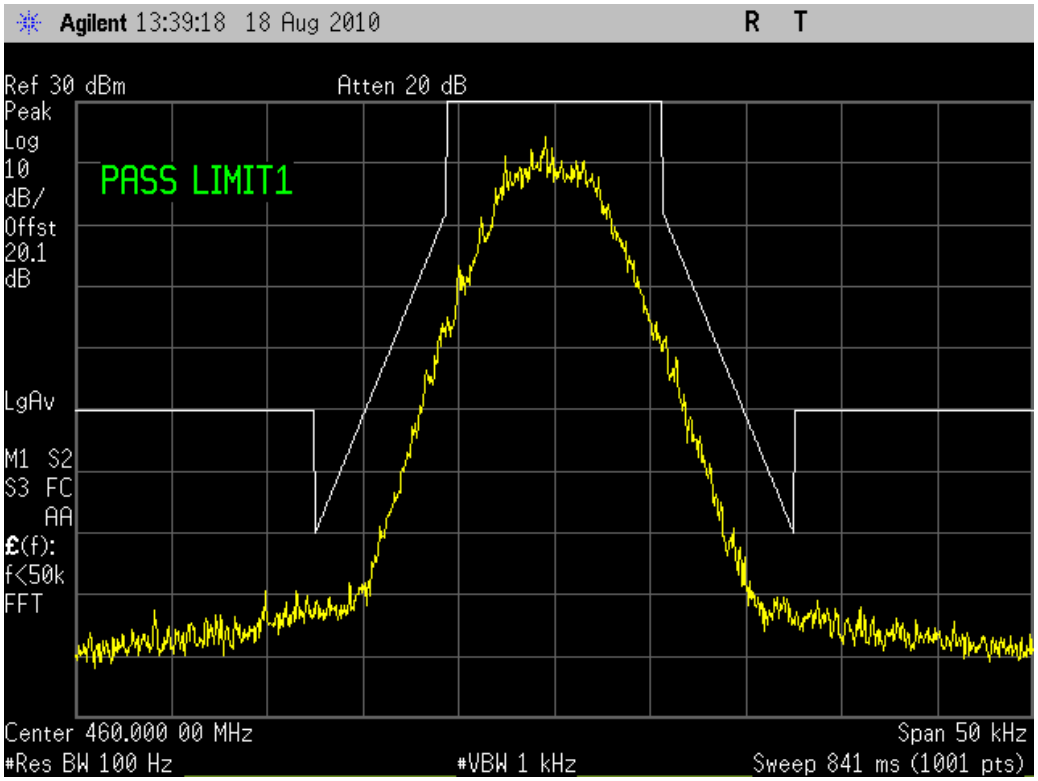
25kHz channel spacing MASK C, 418 MHz



25kHz channel spacing MASK C, 460 MHz



12.5kHz channel spacing MASK D, 418 MHz



12.5kHz channel spacing MASK D, 460 MHz

7. Transmitter Spurious Emissions (Conducted)

NAME OF TEST: Spurious Emissions conducted	PARA.NO.:, 2.1051 RSS119: 5.8
TESTED BY: Timo Hietala	DATE: 18/08/2010

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, 327, 571, 145, 316, 341

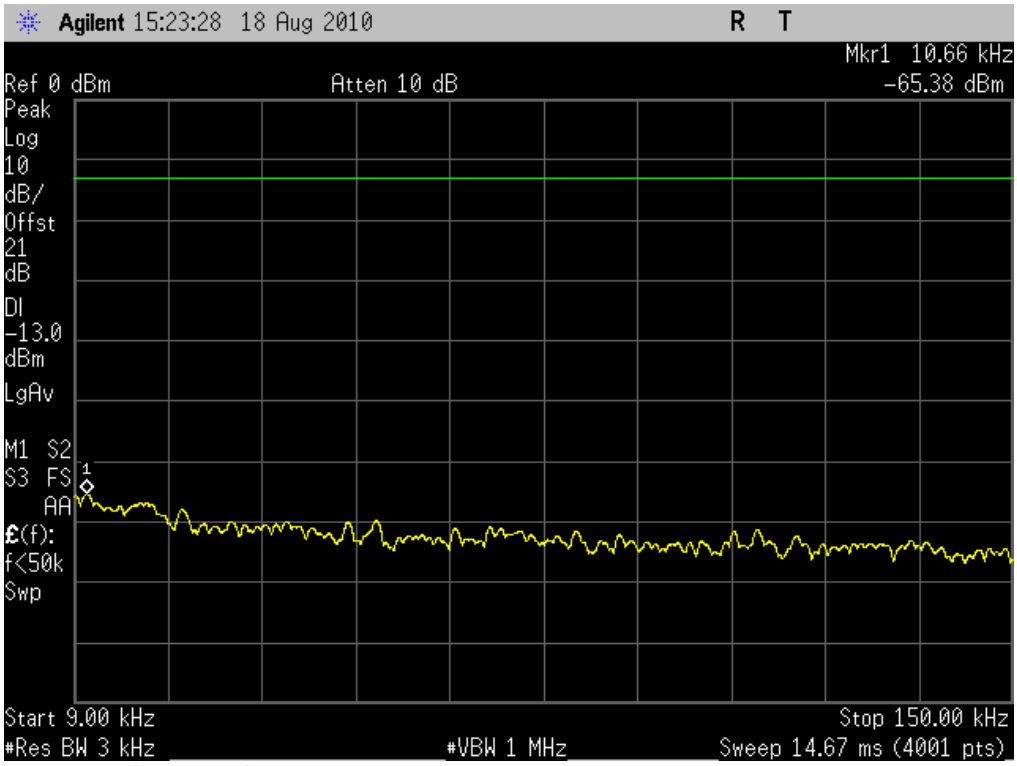
Measurement Uncertainty: ± 1.8 dB.

Temperature: 23 °C.

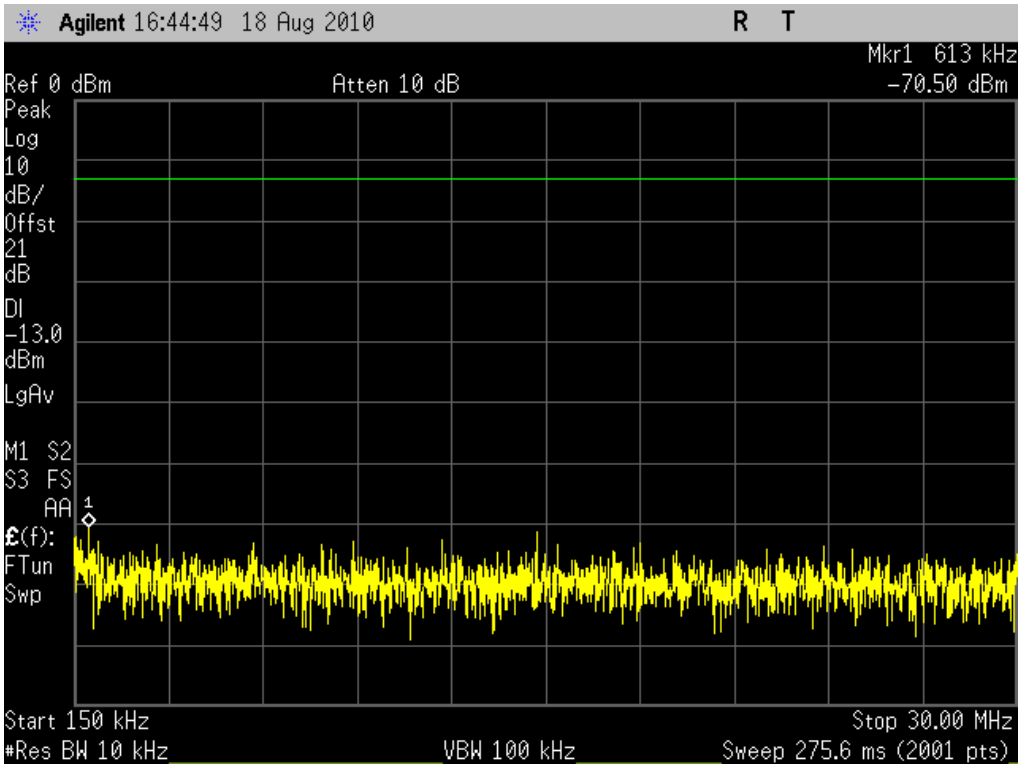
Relative Humidity: 50 %.

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

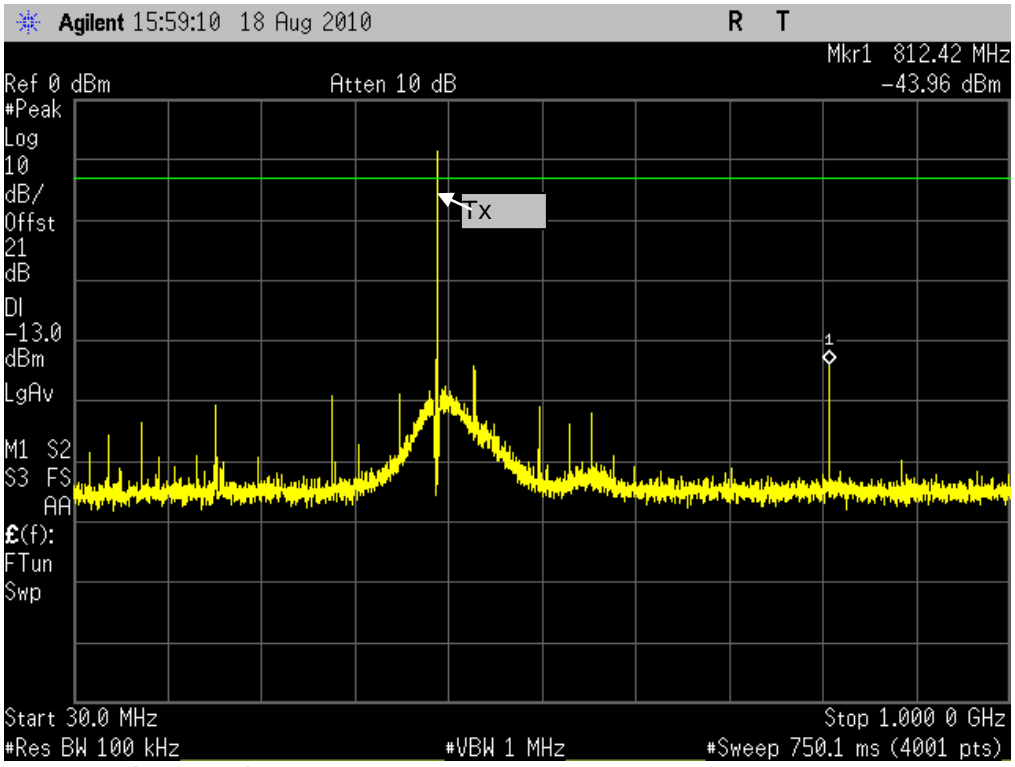
Rated output power: 1W



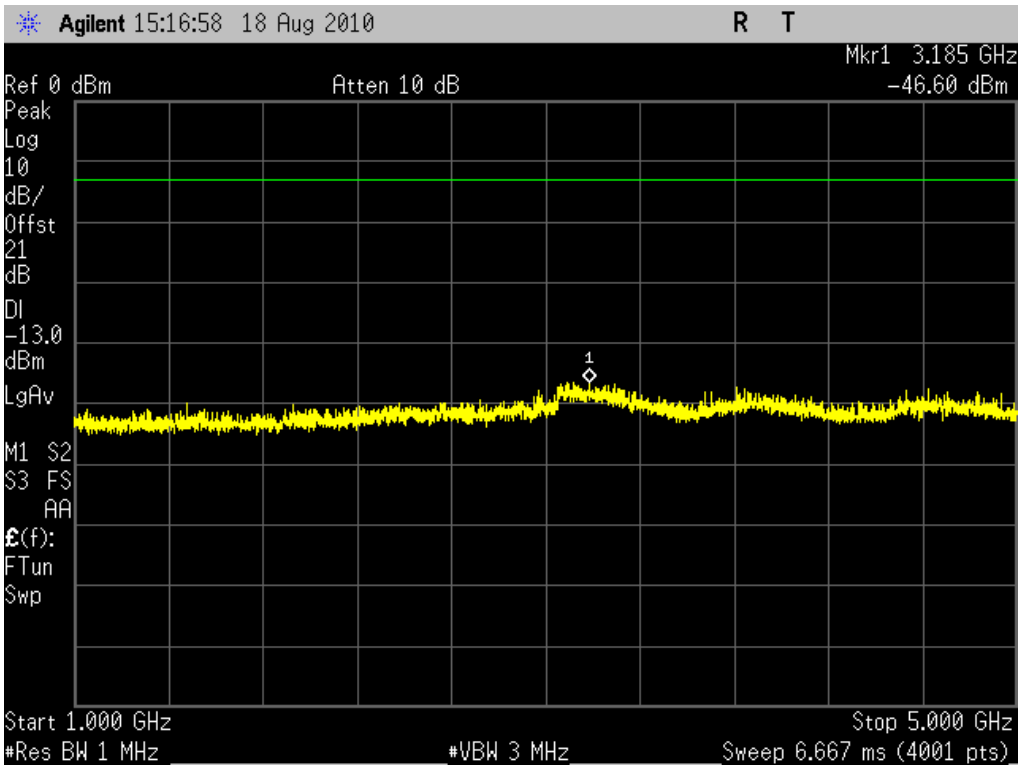
Transmitter tuned at 406.1 MHz



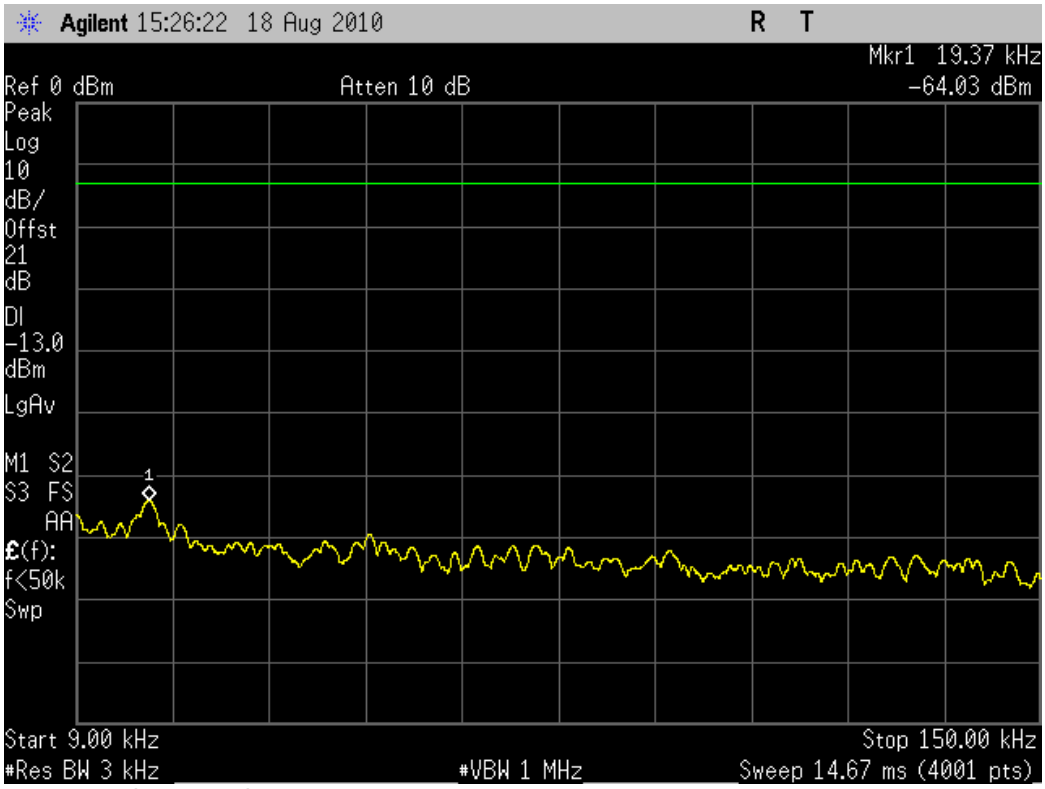
Transmitter tuned at 406.1 MHz



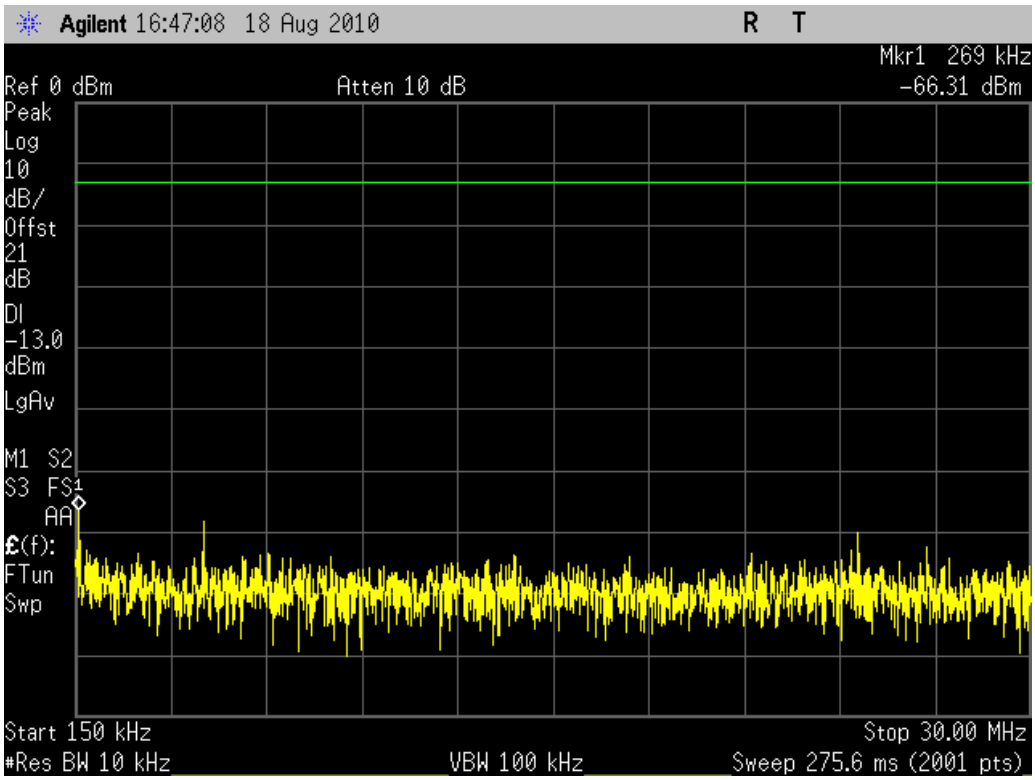
Transmitter tuned at 406.1 MHz



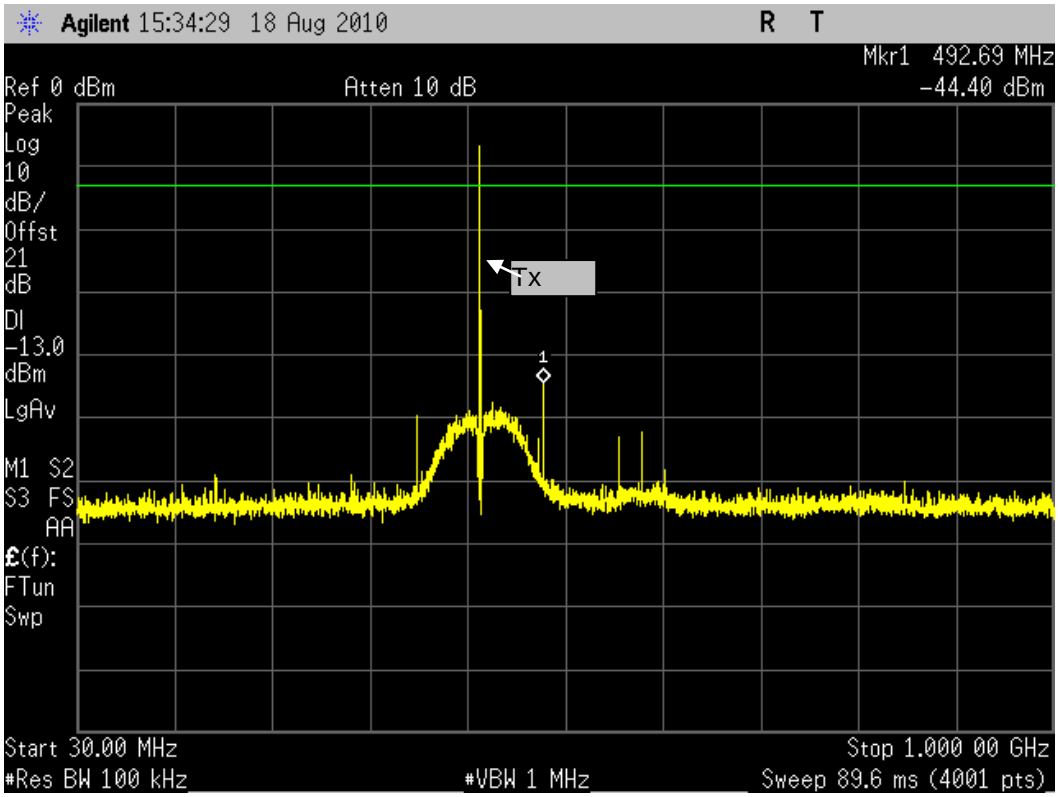
Transmitter tuned at 406.1 MHz



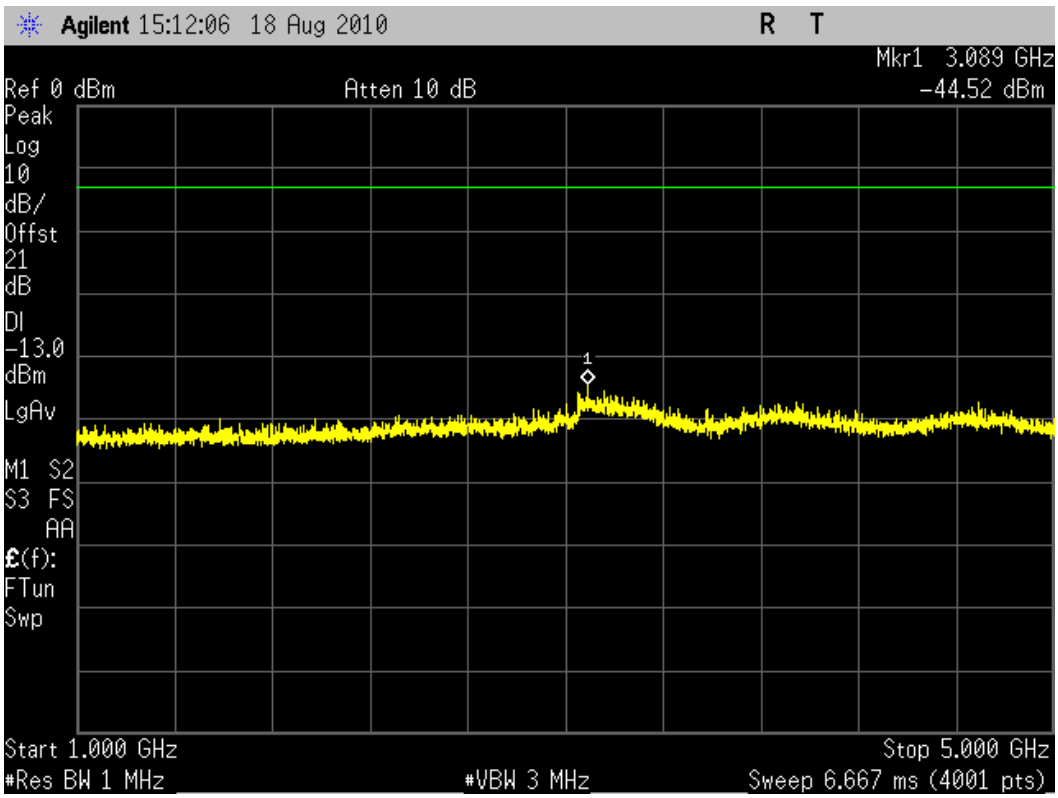
Transmitter tuned at 430 MHz



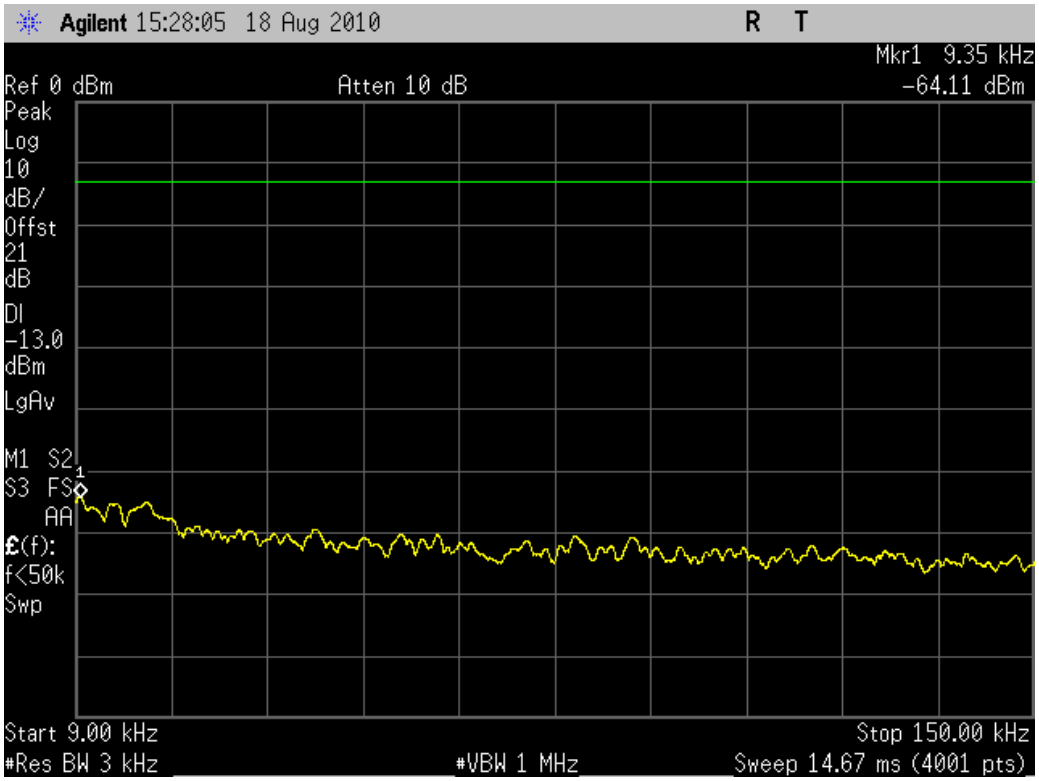
Transmitter tuned at 430 MHz



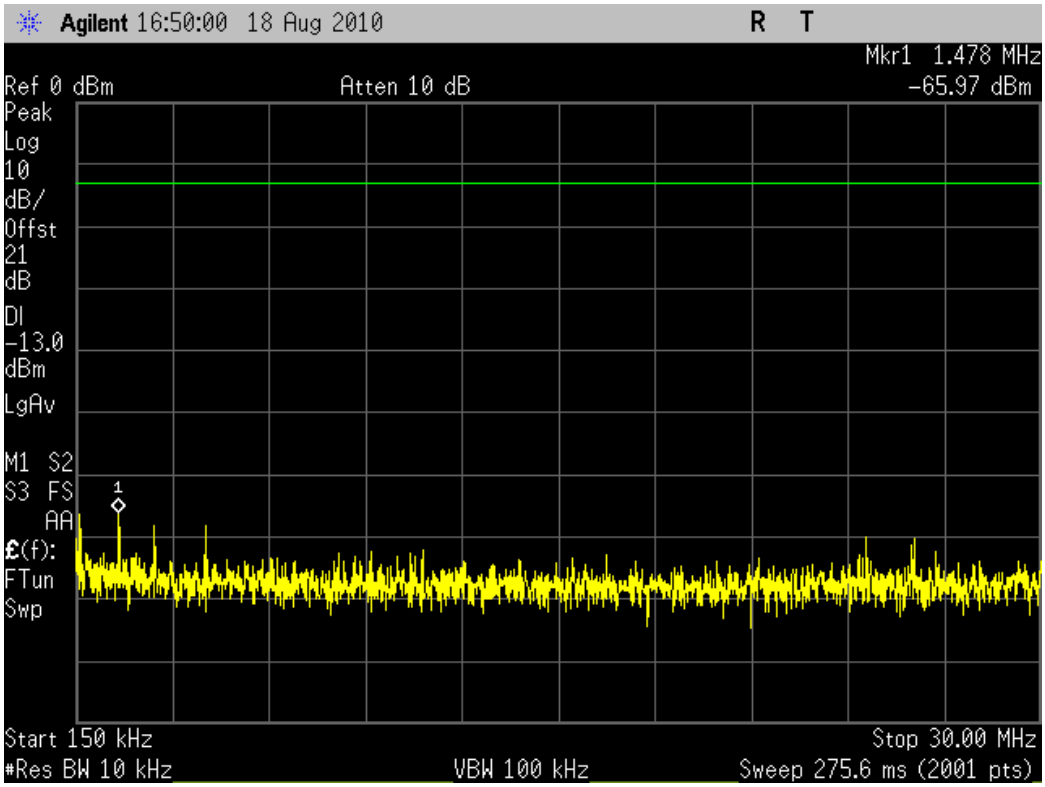
Transmitter tuned at 430 MHz



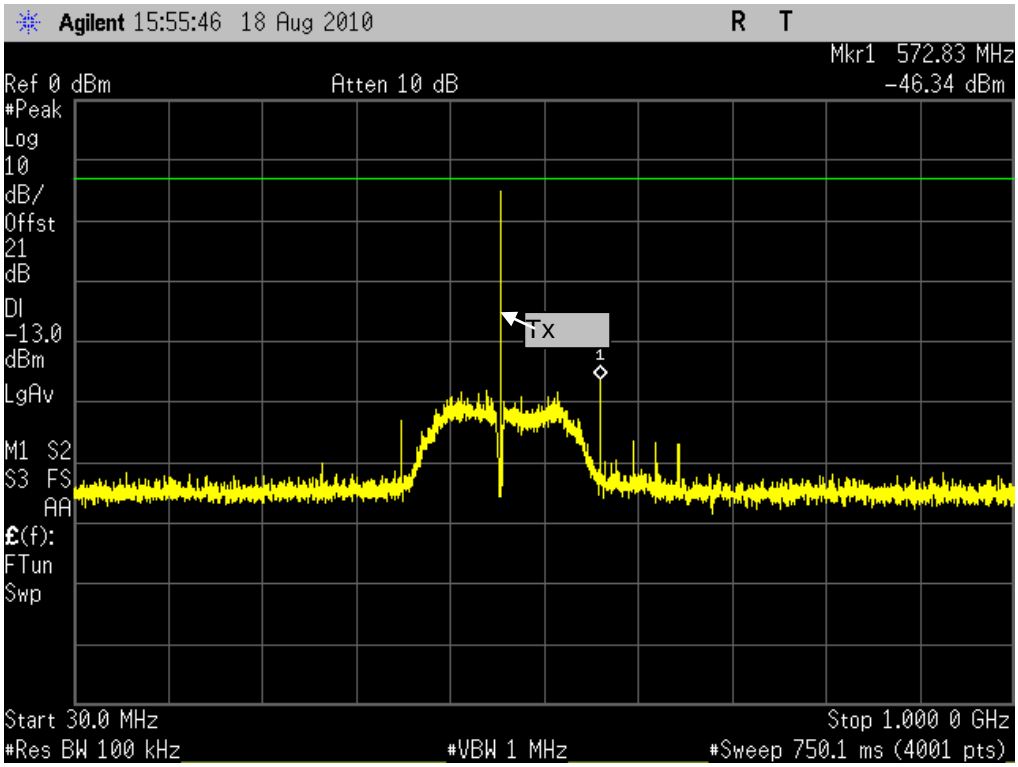
Transmitter tuned at 430 MHz



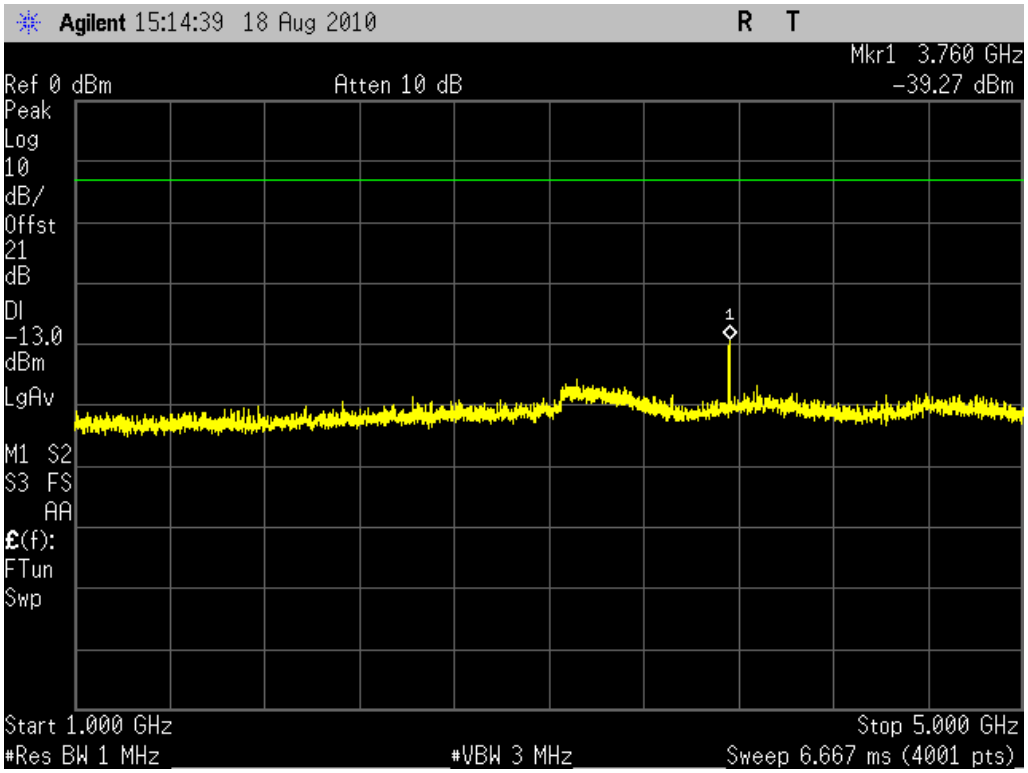
Transmitter tuned at 470 MHz



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 RSS119: 5.8
TESTED BY: Kari Kallio	DATE: 22/07/2010

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: 22 °C.

Relative Humidity: 40 %.

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

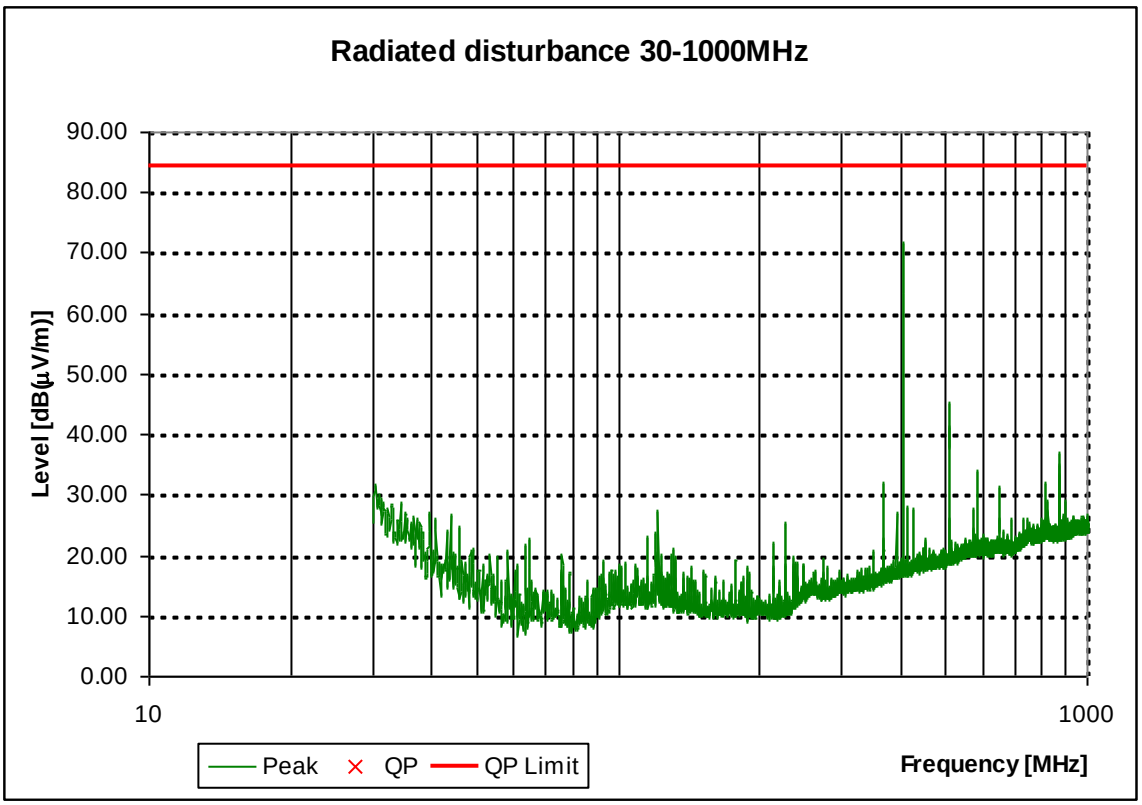
The test was performed in a semi-anechoic shielded room. The EUT was placed on a non-conductive 0.8 m high table standing on the turntable. During the test in the frequency range 30-5000 MHz the distance from the EUT to the measuring antenna was 3 m. In order to find the maximum levels of the disturbance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

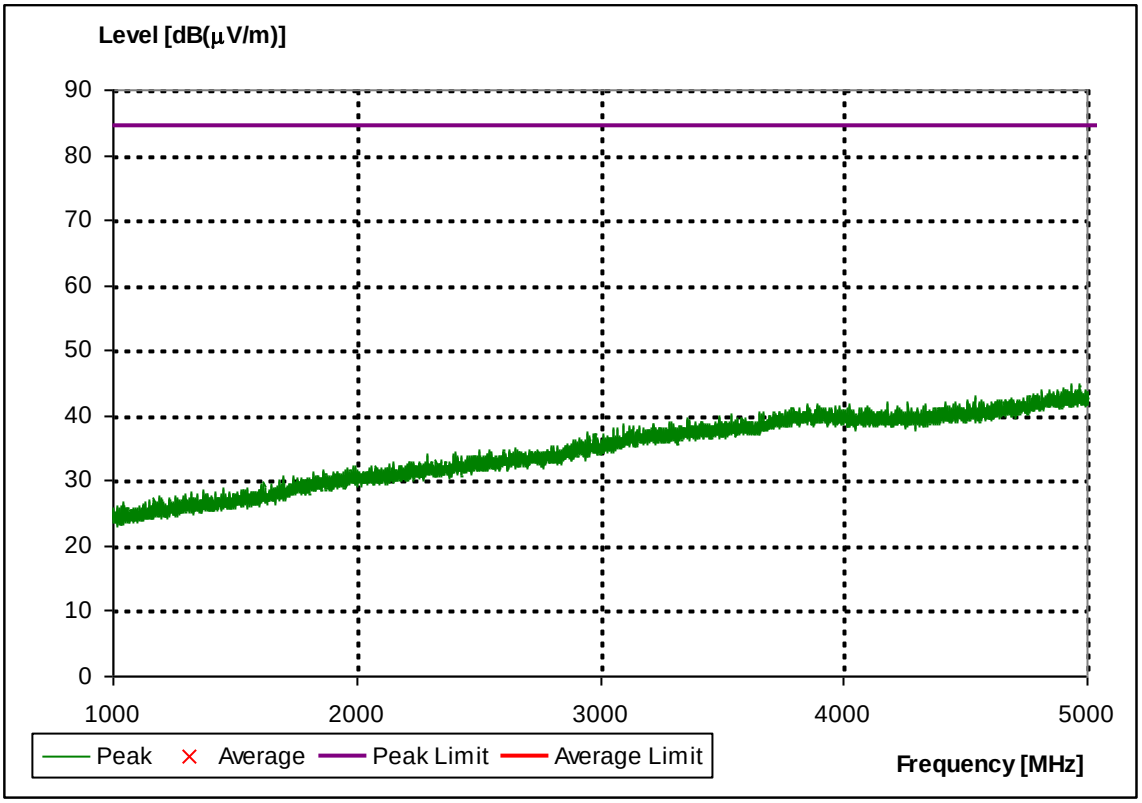
The limit of -13 dBm has been calculated to correspond 84.4 dB(µV/m).
Spurious emissions closer than 20 dB to the limit were measured with average detector.

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.

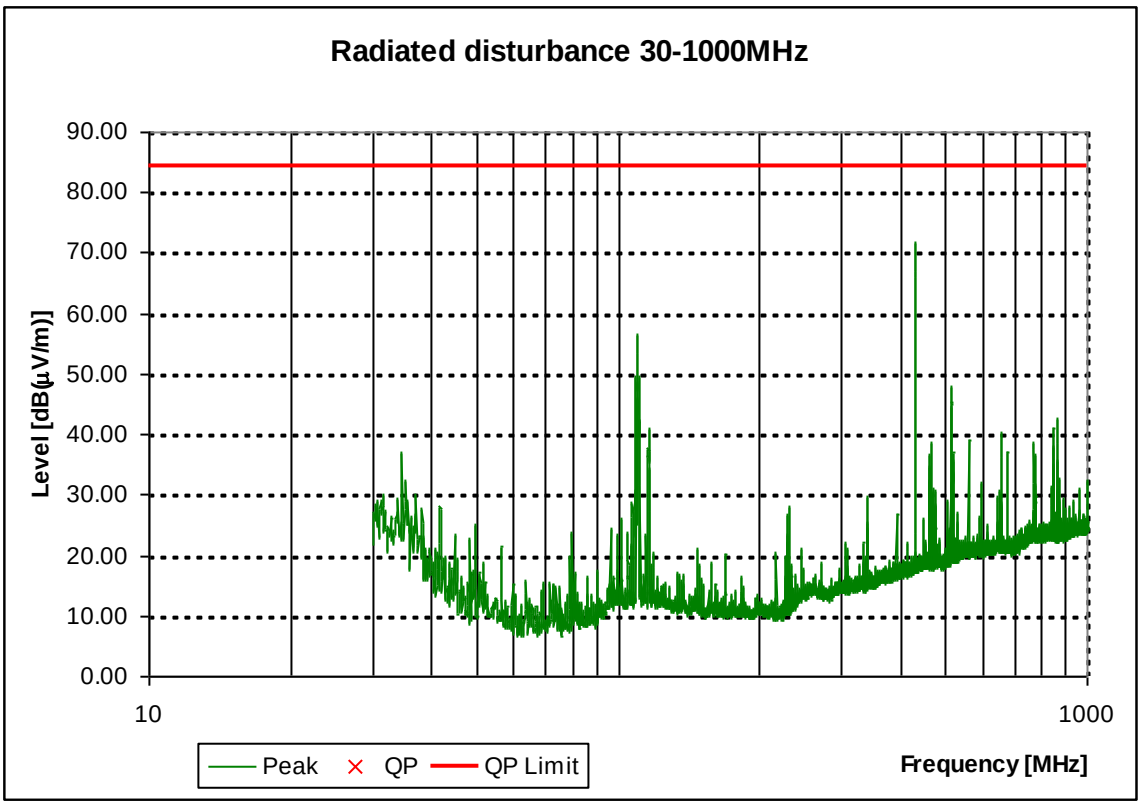
$$P_{EIRP[dbm]} = P_{Gen[dBm]} - L_{Cable[dB]} + G_{Antenna[dBi]}$$



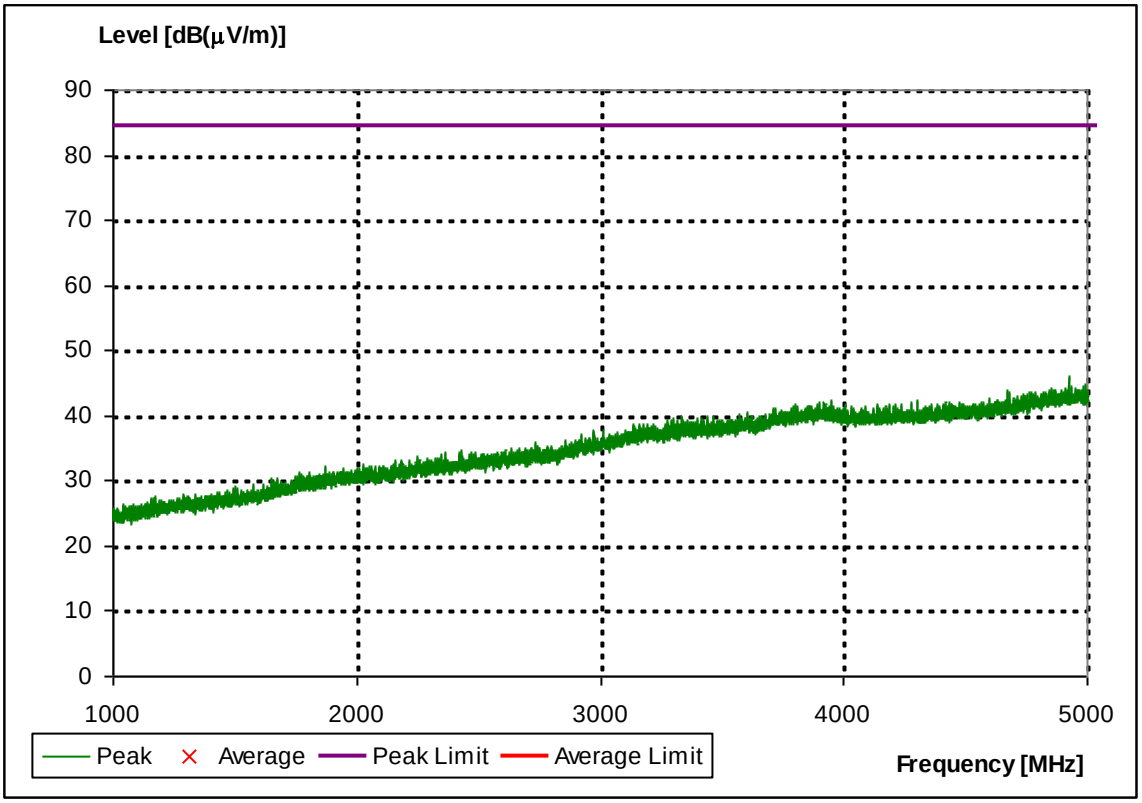
Transmitter tuned at 406.1 MHz



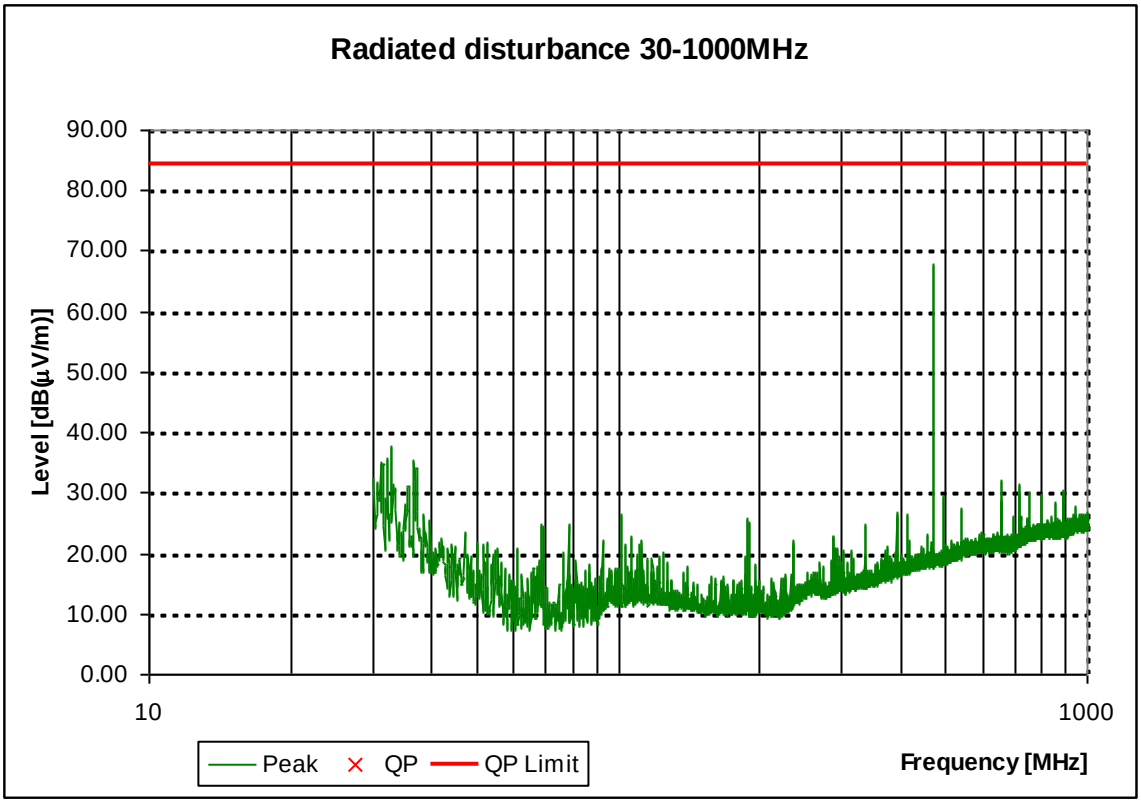
Transmitter tuned at 406.1 MHz



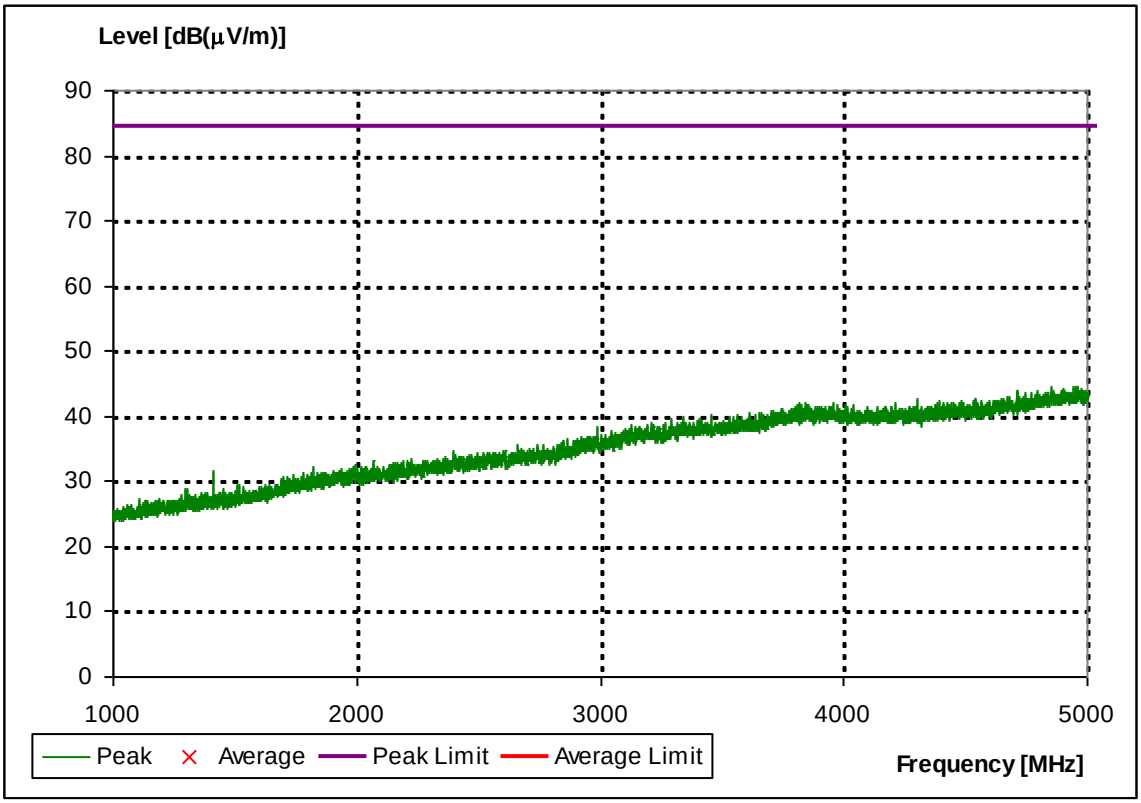
Transmitter tuned at 430 MHz



Transmitter tuned at 430 MHz



Transmitter tuned at 470 MHz



Transmitter tuned at 470 MHz

9. Transient behaviour of the transmitter

Date: 11.08.2010
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

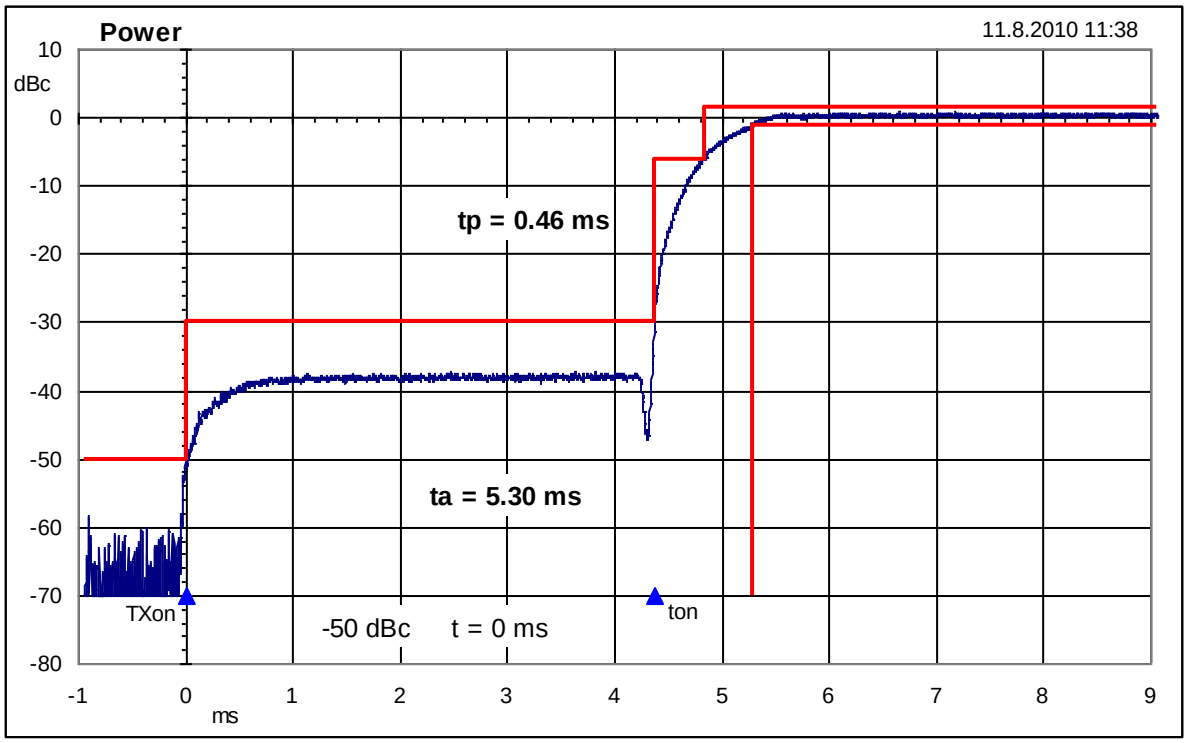
Measurement	Frequency error		
	406.1 MHz		470.0 MHz
T1	3.5 kHz		3.3 kHz
T2	< 0.5 kHz		< 0.5 kHz
T3	< 0.5 kHz		< 0.5 kHz

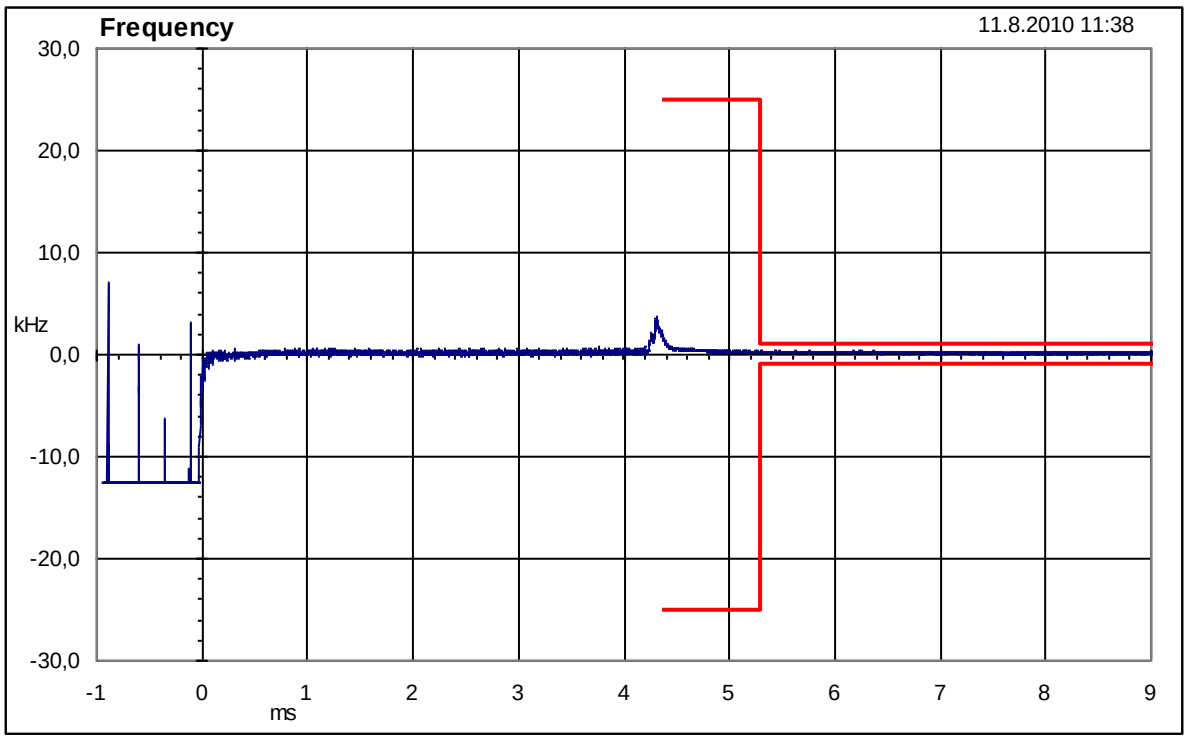
TEST EQUIPMENT USED: 42, 10, 33, 314, 337, 99, 100, 327, 386, 391, 392, 395, 133, 135, 316, 341

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)

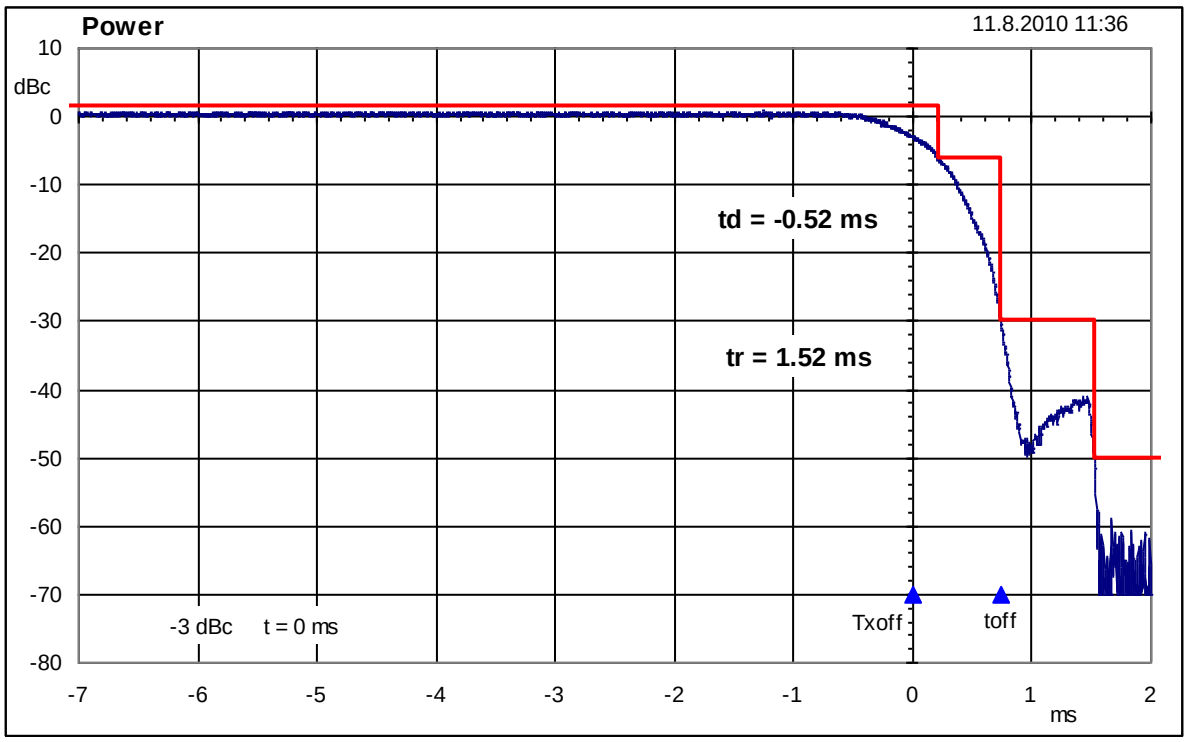
Output power: 1 W.

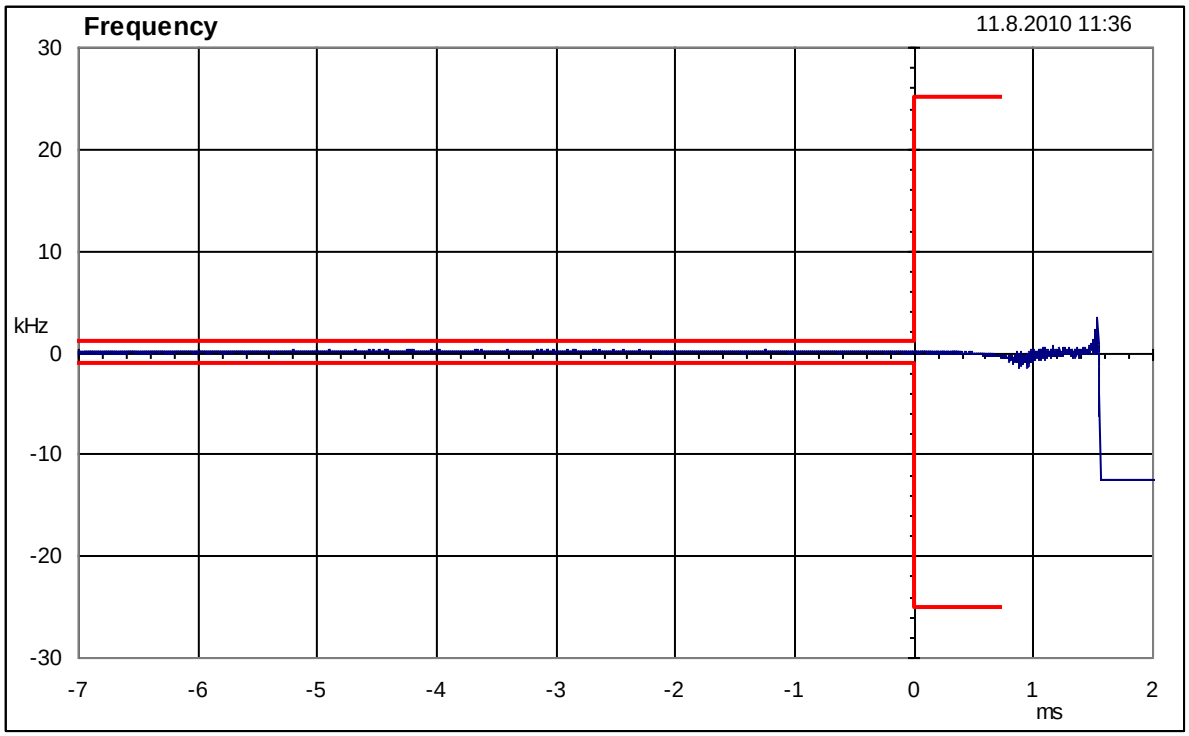




Transmitter release time (406.1 MHz)
(Transient behaviour of the transmitter switch-off)

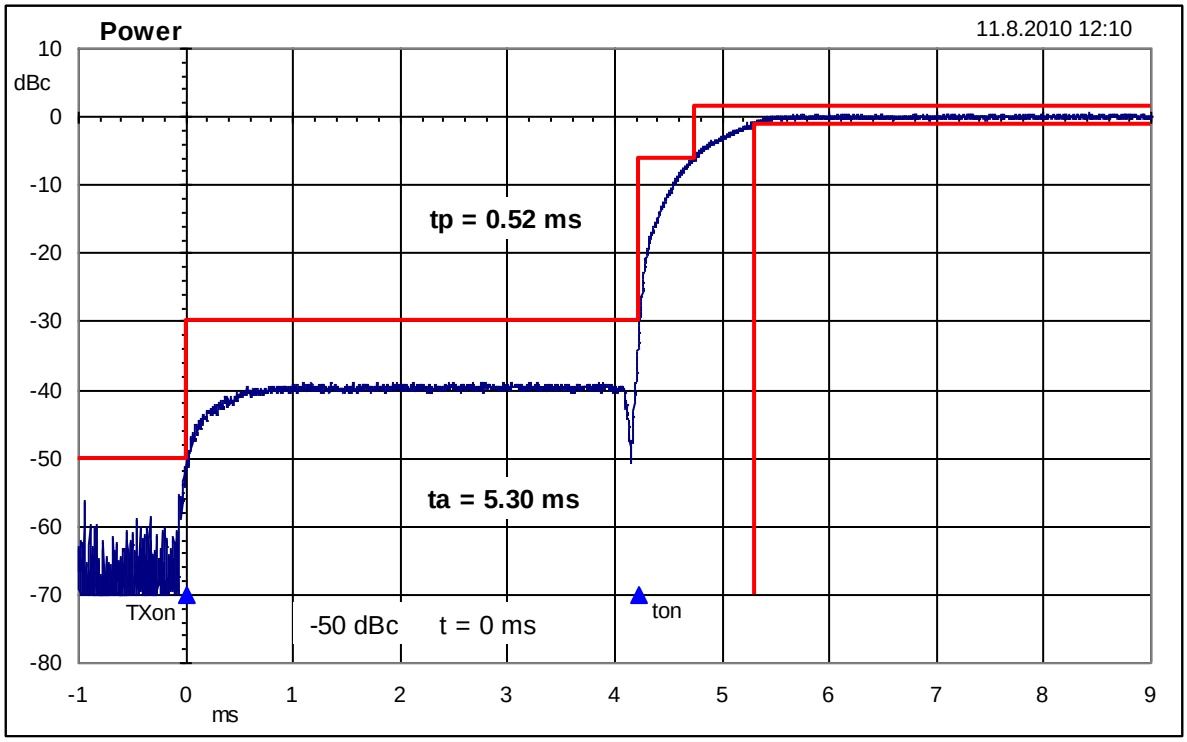
Output power: 1 W.

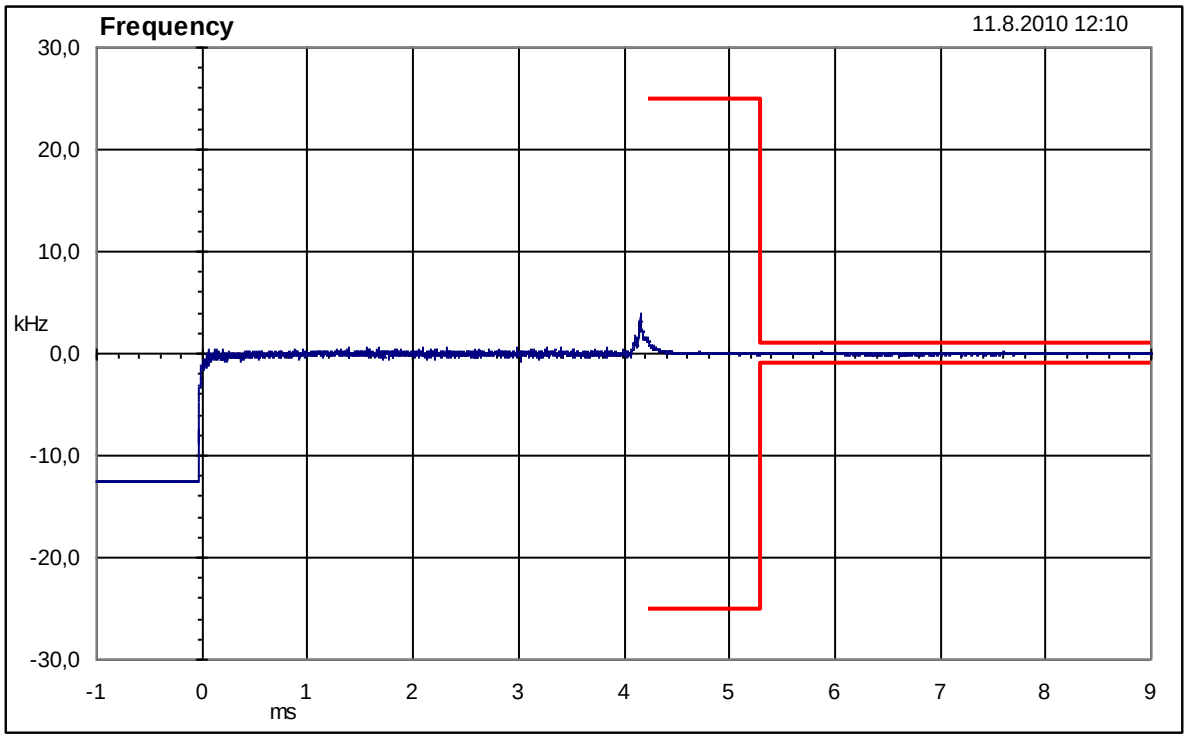




Transmitter attack time (470 MHz)
(Transient behaviour of the transmitter switch-on)

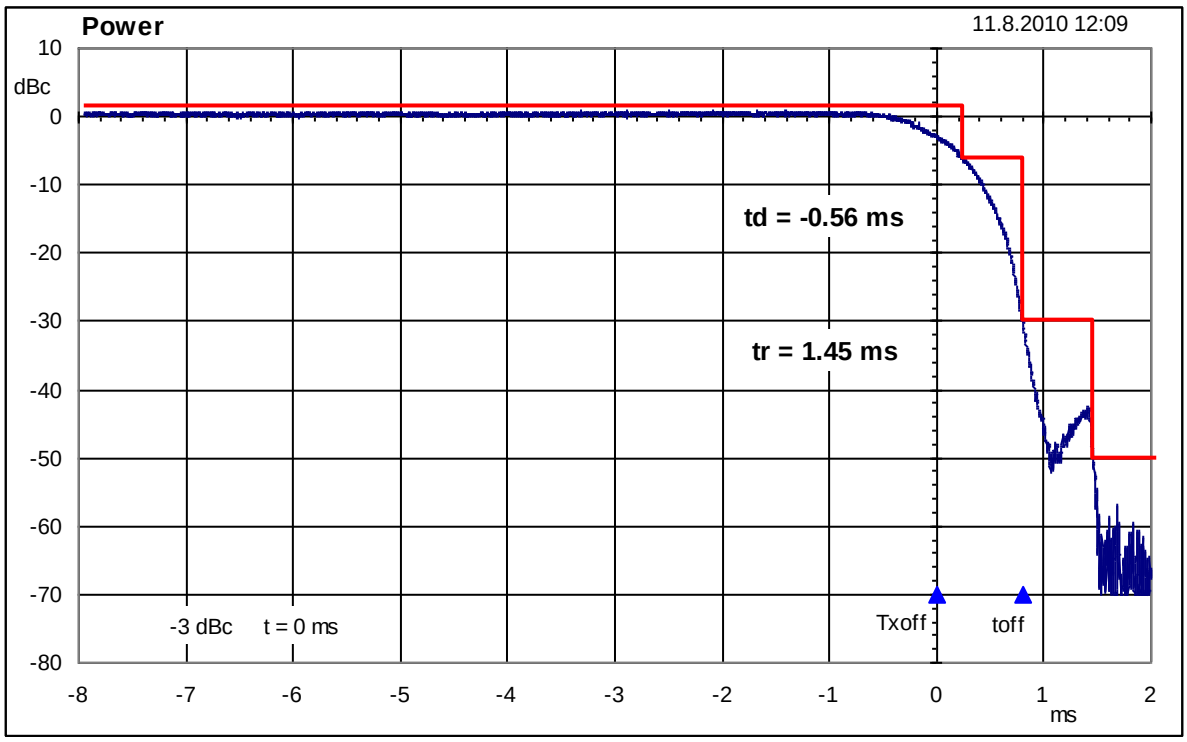
Output power: 1 W.

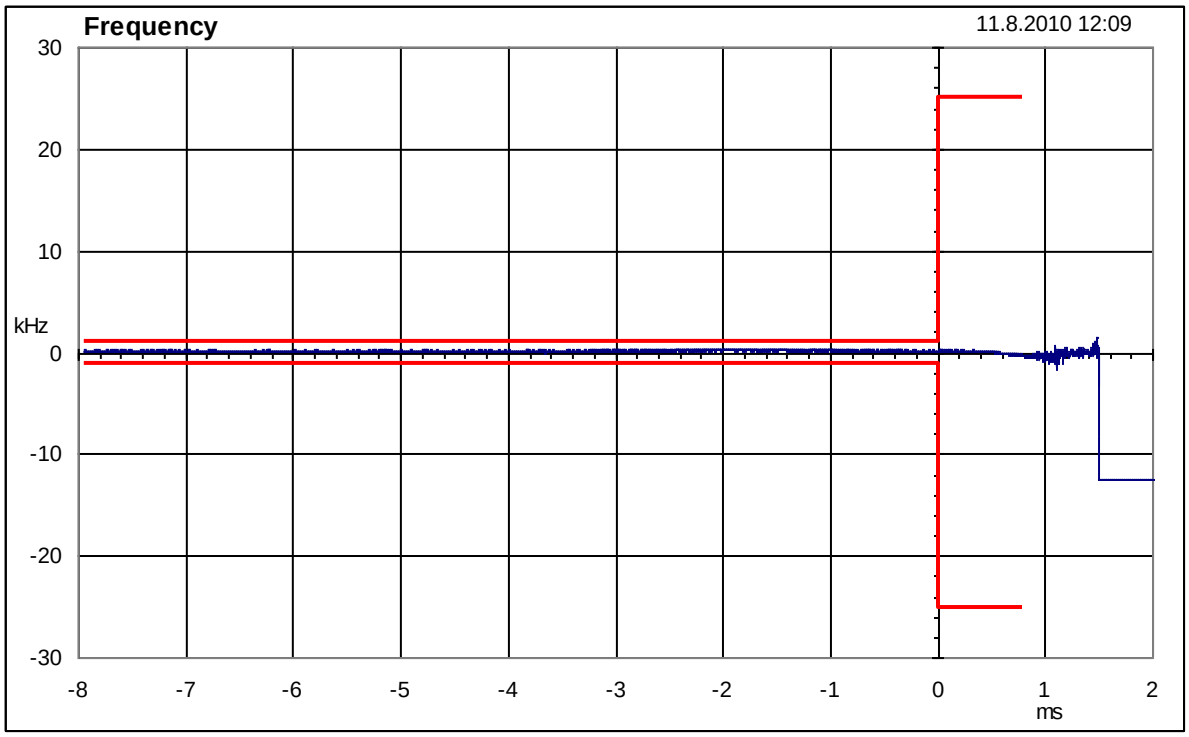




Transmitter release time (470 MHz)
(Transient behaviour of the transmitter switch-off)

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: 17.-18.08.2010
TEST SITE: Nemko / Perkkaa, Espoo, Finland
TESTS PERFORMED BY: Pekka Kälviäinen

LIST OF MEASURING EQUIPMENT:
• 2045, 341, 157, 327, 394, 316

TEST RESULTS

Test performed at transmitter frequency 436.5 MHz, 12.5 kHz channel spacing

a) Frequency stability vs. voltage variations

Temperature	Voltage	Frequency	ppm error	limit
+20 °C	6.0 V	436.49990	-0.23ppm	1.5ppm
+20 °C	12.0 V	436.49989	-0.25ppm	1.5ppm
+20 °C	30.0 V	436.49989	-0.23ppm	1.5ppm

b) Frequency stability vs. temperature variations

Temperature	Voltage	Frequency	ppm error	limit
-30°C	6.0 V	436.49989	-0.25ppm	1.5ppm
-20°C	6.0 V	436.49999	0.02ppm	1.5ppm
-10°C	6.0 V	436.50002	0.05ppm	1.5ppm
± 0°C	6.0 V	436.49999	-0.02ppm	1.5ppm
+10°C	6.0 V	436.50000	0.00ppm	1.5ppm
+20°C	6.0 V	436.50001	0.02ppm	1.5ppm
+30°C	6.0 V	436.49994	-0.14ppm	1.5ppm
+40°C	6.0 V	436.49987	-0.30ppm	1.5ppm
+50°C	6.0 V	436.49984	-0.37ppm	1.5ppm

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
33	RF generator	8642B	Hewlett Packard	2521A00232
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
99	Hybrid	H 9	Anzac	
100	Hybrid	H 9	Anzac	
102	Hybrid	H 9	Anzac	
133	Termination 50	370 BNM	Narda	
135	Termination 50	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	Vötch	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
314	RF generator	HP 8642B	Hewlett Packard	2535A00464
316	Power supply	HP 6032A	Hewlett Packard	2517A-00654
319	Antenna	CBL6112	Chase	2018
327	Power attenuator	765-20	Narda	-
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
338	Test receiver	ESS	Rohde & Schwarz	847151/009
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
391	RF attenuator PAD	1A (3dB)	Weinschel	
392	RF attenuator PAD	1A (6dB)	Weinschel	
394	RF attenuator PAD	1A (20dB)	Weinschel	
395	RF attenuator PAD	757 C - 10 dB	Narda	
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
629				
2039	Power sensor	8482A	Hewlett Packard	1925A03475
2040	Power meter	438A	Hewlett Packard	2517U00427
2045	Counter	53181A	Hewlett Packard	3548A01712
2046	Counter	5351B	Hewlett Packard	2844U00220