

Test Report

Report Number:

F172629E1

Equipment under Test (EUT):

**Dual Band Radio Modem
SATEL-TR49**

Applicant:

SATEL OY

Manufacturer:

SATEL OY





Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

REFERENCES

- [1] **FCC CFR 47 Part 90:** Private Land Mobile Radio Services
- [2] **FCC CFR 47 Part 2:** Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
- [3] **RSS-119 Issue 12 (May 2015):** Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 MHz
- [4] **RSS-Gen Issue 5 (April 2018):** General Requirements for Compliance of Radio Apparatus
- [5] **ANSI C63.26-2015:** American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

TEST RESULT

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test.
The complete test results are presented in the following.

Tested and written by:	Wolfgang KASALOWSKY Name	 Signature	06.12.2018 Date
Reviewed and approved by:	Bernd STEINER Name	 Signature	06.12.2018 Date

This test report is only valid in its original form.

Any reproduction of its contents in extracts without written permission of the accredited test laboratory PHOENIX TESTLAB GmbH is prohibited.

The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalizations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

Contents:	Page
1.1 Applicant	4
1.2 Manufacturer	4
1.3 Test laboratory	4
1.4 EUT (Equipment Under Test)	5
1.5 Technical data of equipment	6
1.6 Dates	6
2 Operational states	7
3 Additional information	7
4 Overview	8
5 Test results	9
5.1 Transmitter output power	9
5.1.1 Method of measurement	9
5.1.2 Test result	10
5.2 Occupied bandwidth	11
5.2.1 Method of measurement	11
5.2.2 Test result	12
5.3 Emission masks	17
5.3.1 Method of measurement	17
5.3.2 Test Results	18
5.3.2.1 Channel Spacing 12.5 kHz	18
5.3.2.2 Channel Spacing 25 kHz	21
5.4 Spurious emissions (conducted)	24
5.4.1 Method of measurement	24
5.4.2 Test Results	25
5.4.2.1 Channel Spacing 12.5 kHz	25
5.4.2.2 Channel Spacing 25 kHz	34
5.5 Spurious emissions (radiated)	43
5.5.1 General method of measurement	43
5.5.2 Preliminary radiated emission measurement	49
5.5.3 Final Results	59
5.5.3.1 Final radiated emission measurement (30 MHz to 1 GHz)	59
5.5.3.2 Channel Spacing 25 kHz	63
5.6 Frequency Stability	64
5.6.1 Method of measurement	64
5.6.1.1 Test results	64
5.7 Transient frequency behaviour	67
5.7.1 Method of measurement	67
5.7.2 Test Results	68
6 Test equipment used for tests	77
7 Report history	78
8 List of annexes	79

Identification

1.1 Applicant

Name:	SATEL OY
Address:	Meriniitynkatu 17 24100 Salo
Country:	Finland
Name for contact purposes:	Mr. Pekka SUOMINEN
Phone:	+358 2 777 7800
Fax:	+358-2 777 7810
eMail Address:	pekka.suominen@satel.com
Applicant represented during the test by the following person:	none

1.2 Manufacturer

Name:	SATEL OY
Address:	Meriniitynkatu 17 24100 Salo
Country:	Finland
Name for contact purposes:	Mr. Pekka SUOMINEN
Phone:	+358 2 777 7800
Fax:	+358-2 777 7810
eMail Address:	pekka.suominen@satel.com
Applicant represented during the test by the following person:	none

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

Accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-02, FCC Test Firm Accreditation with the registration number 469623, designation number DE0004 and Industry Canada Test site registration SITE# IC3469A-1.

1.4 EUT (Equipment Under Test)

Test object: *	Dual band radio modem
HVIN: *	SATEL-TR49
Type / PMN: *	SATEL-TA37
FCC ID: *	MRBSATEL-TA37
IC: *	2422A-SATELTA37
HW version: *: *	SPL0060a 1.01
FW version: *	07.45.2.3.2.0_rc16
Serial number: *	1801000002

* declared by the applicant.

1.5 Technical data of equipment

400MHz mode

Alignment range: *	410 – 475 MHz		
Switching range: *	410 – 430 MHz and 450 – 470 MHz		
Channel spacing: *	12.5 kHz, 25 kHz		
Modulation: *	4-GFSK		
Radio link data rate: *	ChSp = 12.5 kHz	ChSp = 25 kHz	
	9600 bit/s	19200 bit/s	
Rated Power: *	10 mW, 20 mW, 50 mW, 100 mW, 200 mW, 500 mW, 1000 mW		
Supply Voltage: *	Evaluation board:	$V_{\min} = 9\ V_{\text{DC}}$	$V_{\max} = 16\ V_{\text{DC}}$
	EUT:	$V_{\min} = 3.7\ V_{\text{DC}}$	$V_{\max} = 5.5\ V_{\text{DC}}$
Audio Filter: *	None		
Temperature range: *	- 40°C to + 70°C		
Clock frequency: *	32 MHz		

* declared by the applicant.

Ancillary devices:	
Test Laptop	Fujitsu LIFEBOOK E780 (provided by the laboratory)

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
RS232	"RS-232" connection @ eval board	RS232 interface @ test laptop	2 m *
DC in	"9 – 16 V DC" connection @ eval board	DC Power supply	2 m *
Antenna	TNC connector	Attenuator, Spectrum Analyser / Dummy Load, Antenna	0.5 m *

*: Length during the test if no other specified.

1.6 Dates

Date of receipt of test sample:	15.01.2018
Start of test:	05.02.2018
End of test:	05.06.2018

2 Operational states

The EUT is a radio modem transceiver operating in the frequency range 410 MHz to 475.0 MHz with 12.5 kHz or 25 kHz channel spacing.

The module is intended for implementation into various final applications.

The antenna port conducted tests were performed on the TNC interface, the radiated tests were performed with a terminated antenna port.

The test modes were set with the aid of a Laptop PC connected to the evaluation board via a RS-232 connection. A test-software provided by the applicant called "TypeApproval_TR49_UI_V018_03012018.exe" was used to set the test modes.

The output power was set to 1 W for all tests.

All tests were carried out with an unmodified sample.

During the tests the evaluation board with the test sample was powered with 12 V DC if not otherwise stated.

3 Additional information

This test report only gives attention to the 400 MHz part of the EUT
The EUT is also able to operate in the frequency range 902 MHz to 928 MHz.
The results of this operation mode are subject of a separate test report.

4 Overview

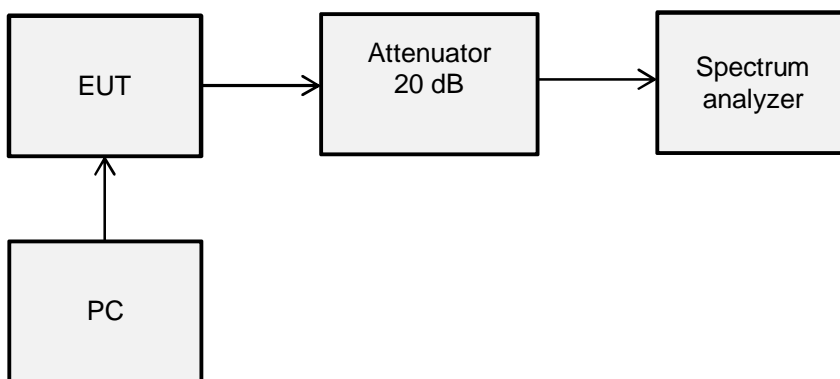
Application	FCC CFR 47	RSS 119, Issue 12	Status	Refer page
Transmitter output power (conducted)	90.205	5.4	Passed	9 et seq.
Occupied bandwidth	90.210	5.5	Passed	11 et seq.
Spectrum emission mask	90.210	5.5	Passed	17 et seq.
Spurious emissions (conducted)	90.210	5.8	Passed	24 et seq.
Spurious emissions (radiated)	90.210	5.8	Passed	43 et seq.
Frequency stability	90.213	5.3	Passed	64 et seq.
Transient frequency behaviour	90.214	5.9	Passed	67 et seq.

5 Test results

5.1 Transmitter output power

5.1.1 Method of measurement

Test setup:



The following spectrum analyser settings were used:

- Span: 150kHz
- Resolution bandwidth: 50 kHz
- Video bandwidth: 500 kHz
- Mode: Auto FFT
- Sweep time: 83.1 μ s
- Detector function: Peak (Channel spacing 12.5 kHz)
RMS (Channel spacing 25 kHz)
- Trace mode: Max hold

The EUT was set via the PC to transmitting a pseudo random data file.

The output power was set to 10 mW, 20 mW, 50 mW, 100 mW and 200 mW, 500 mW, 1000 mW.

The channel spacing was set to 12.5 kHz and 25 kHz.

5.1.2 Test result

Ambient temperature	22 °C	Relative humidity	21 %
---------------------	-------	-------------------	------

Frequency [MHz]	Measured output power [dBm]		Limit [dBm]
	Ch spacing = 12.5 kHz	Ch spacing = 25 kHz	
410.0	10.2	10.2	10.0 ±1
429.5	10.5	10.5	
450.5	10.0	10.1	
469.5	10.5	10.5	
410.0	13.7	13.7	13.0 ±1
429.5	13.2	13.2	
450.5	12.7	12.7	
469.5	12.4	12.4	
410.0	17.5	17.5	17.0 ±1
429.5	17.0	17.0	
450.5	16.5	16.5	
469.5	16.1	16.1	
410.0	20.2	20.2	20.0 ±1
429.5	20.5	20.5	
450.5	19.9	19.9	
469.5	19.8	19.9	
410.0	23.5	23.6	23.0 ±1
429.5	23.0	23.0	
450.5	22.6	22.6	
469.5	22.3	22.3	
410.0	26.8	26.8	27.0 ±1
429.5	26.7	27.1	
450.5	26.5	26.5	
469.5	26.5	26.5	
410.0	30.4	30.3	30.0 ±1
429.5	30.3	30.3	
450.5	30.4	30.4	
469.5	30.3	30.3	
Measurement uncertainty: +0.66 dB / -0.72 dB			

Limit:

The output power shall be within ±1 dB of the manufacturer's rated power listed in the equipment specifications.

Test: Passed

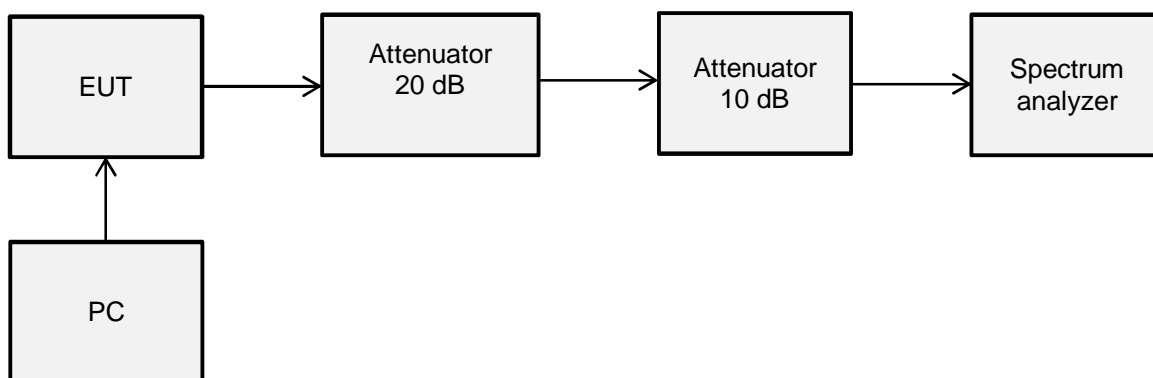
Test equipment used (refer clause 6):

22, 26, 32, 33, 34

5.2 Occupied bandwidth

5.2.1 Method of measurement

Test setup:



The following spectrum analyser settings were used:

Channel spacing:	12.5 kHz	25 kHz
- Span:	37.5 kHz	75 kHz
- Resolution bandwidth:	300 Hz	500 Hz
- Video bandwidth:	1 kHz	2 kHz
- Mode:	Sweep	Sweep
- Sweep time:	41.7 ms	30.0 ms
- Detector function:	Peak	Peak
- Trace mode:	Max hold	Max hold

The EUT was set via the PC to transmitting a pseudo random data file.
The output power was set to 1000 mW.
The channel spacing was set to 12.5 kHz and 25 kHz.

5.2.2 Test result

Ambient temperature	22 °C	Relative humidity	21 %
---------------------	-------	-------------------	------

Channel spacing: 12.5 kHz			
Frequency [MHz]	Modulation	Measured 99% bandwidth [kHz]	Limit [kHz] (Authorized bandwidth)
410.0	4-GFSK	7.47	11.25
429.5		7.42	
450.5		7.46	
469.5		7.41	
Measurement uncertainty: <10 ⁻⁷ (frequency), 0.66 dB / -0.72 dB (level)			

Channel spacing: 25 kHz			
Frequency [MHz]	Modulation	Measured 99% bandwidth [kHz]	Limit [kHz] (Authorized bandwidth)
410.0	4-GFSK	14.61	20
429.5		14.38	
450.5		14.42	
469.5		14.28	
Measurement uncertainty: <10 ⁻⁷ (frequency), 0.66 dB / -0.72 dB (level)			

Limit:

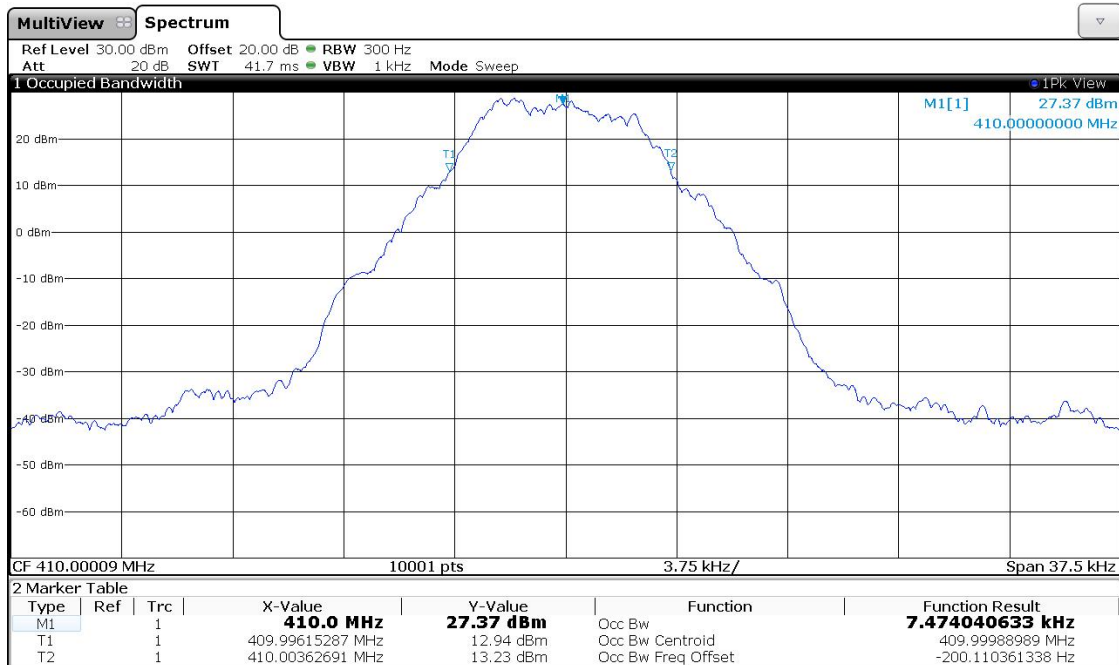
The maximum permissible occupied bandwidth shall not exceed the authorized bandwidth. The authorized bandwidth is defined as the maximum width of the band of frequencies used to derive spectrum masks and is not necessarily equivalent to the bandwidth found on radio and spectrum licenses.

Frequency Band (MHz)	Channel Spacing (kHz)	Authorized Bandwidth (kHz)	Spectrum Masks for Equipment With Audio Filter	Spectrum Masks for Equipment Without Audio Filter
406.1-430 and 450-470	25	20 22	B Y	C (G) * Y
	12.5	11.25	D	D

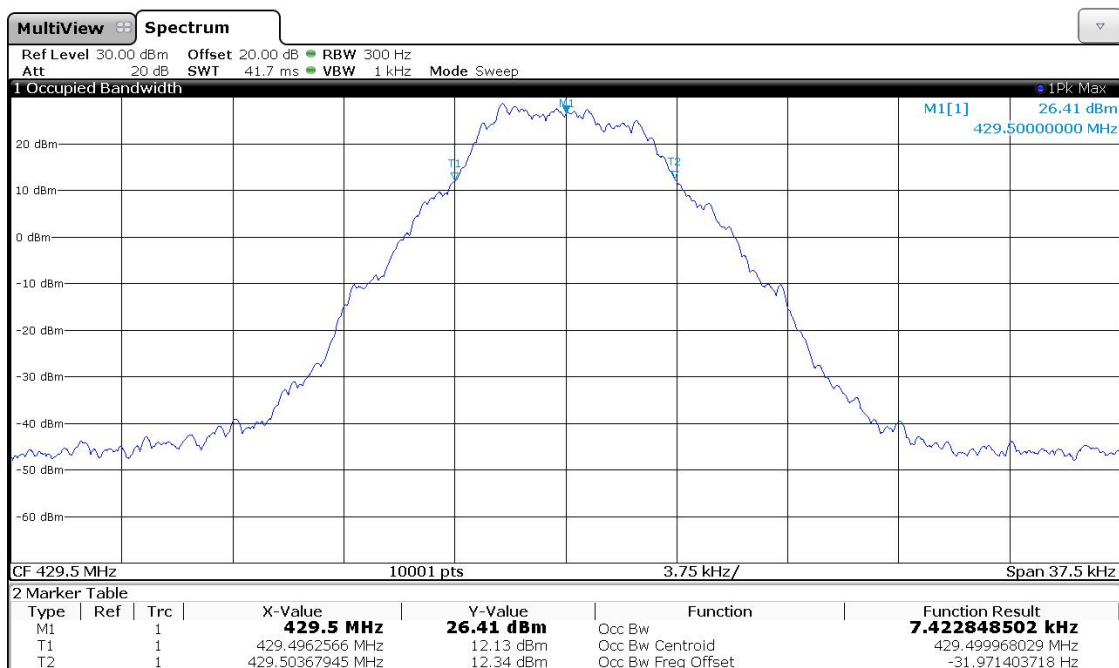
* Paging transmitters in the bands 406.1-430 MHz and 450-470 MHz are to use mask G.

Test: Passed

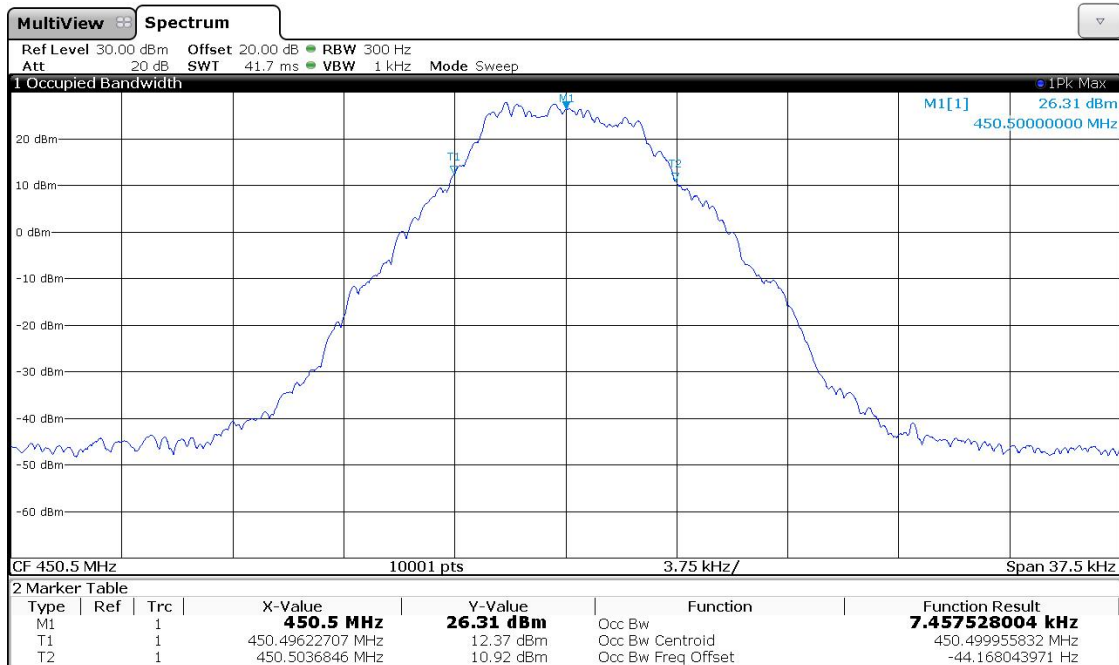
OBW_410M_12.5k.PNG



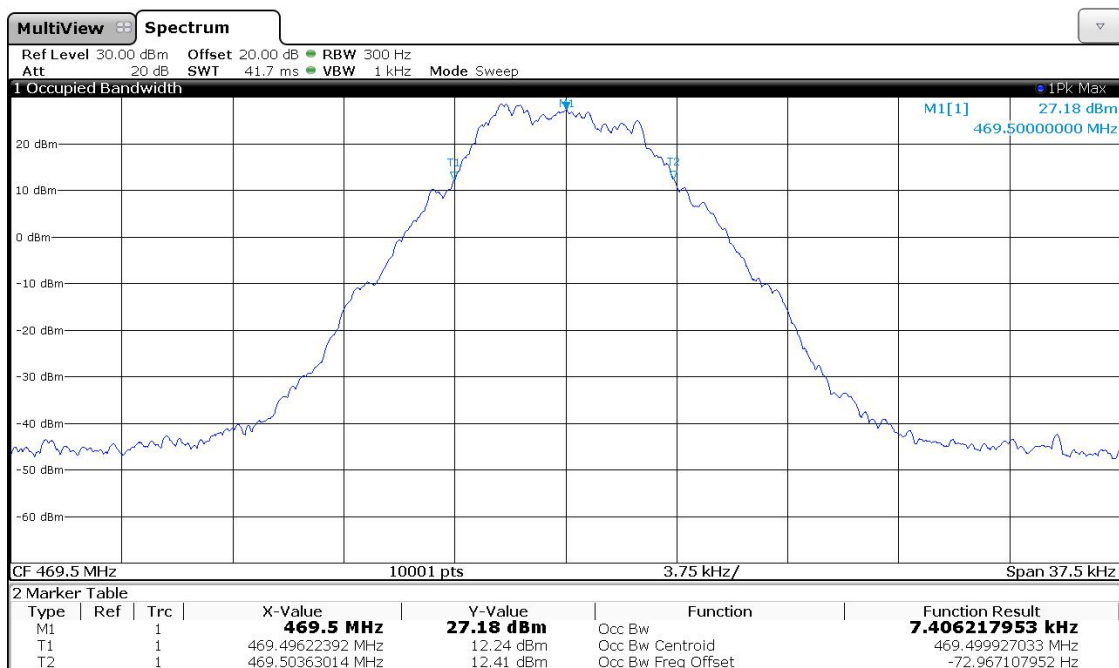
OBW_429M5_12.5k.PNG



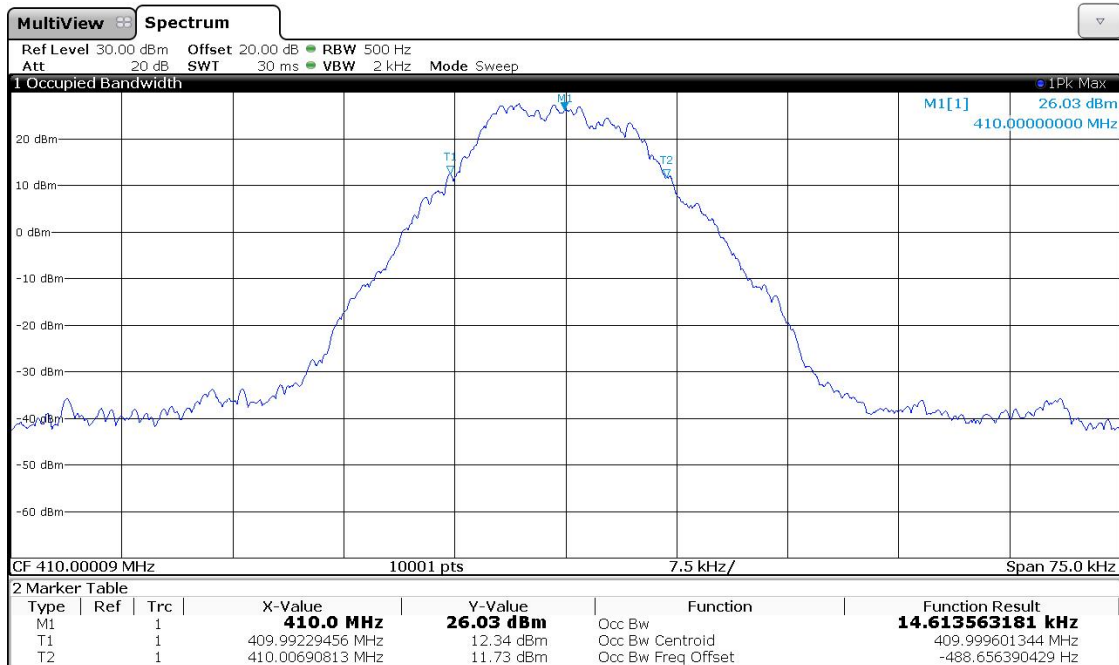
OBW_450M5_12.5k.PNG



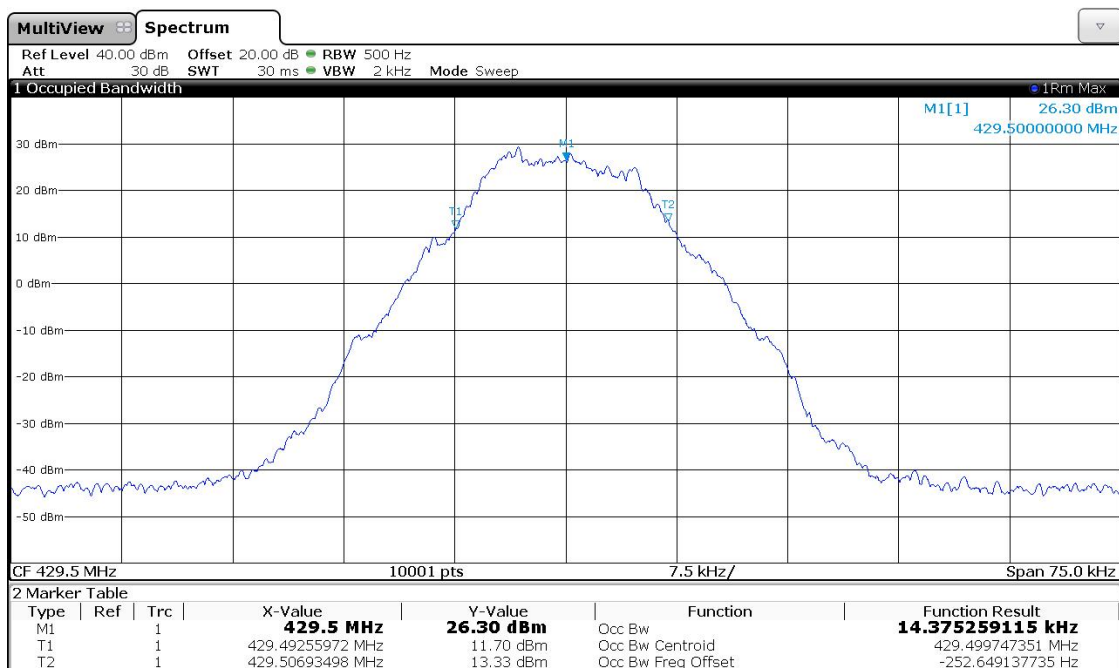
OBW_469M5_12.5k.PNG



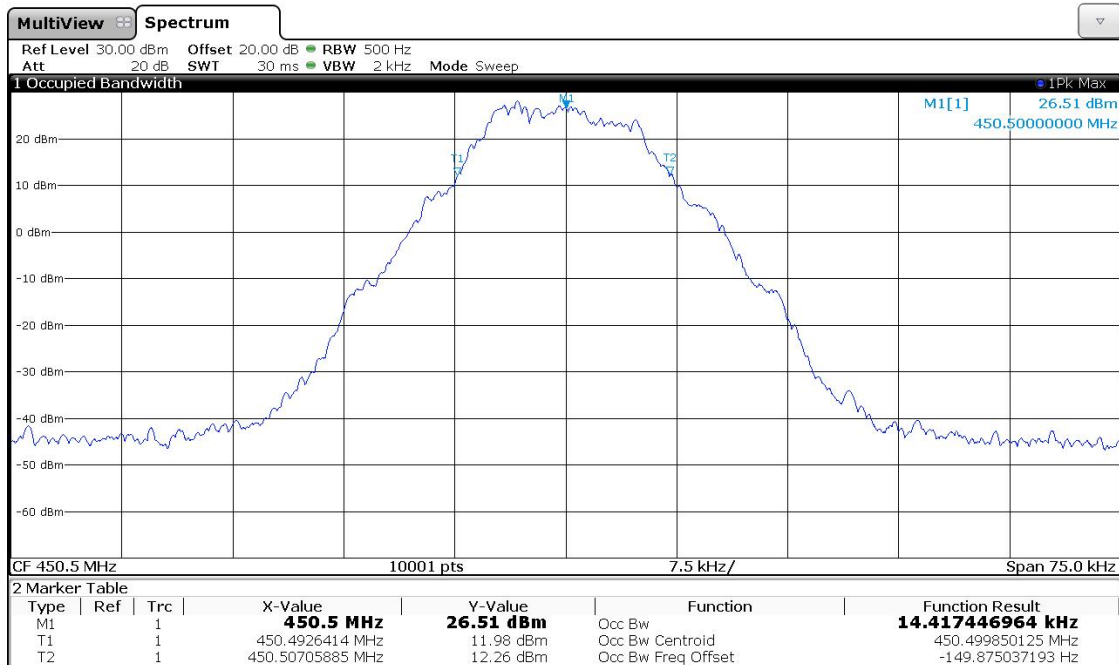
OBW_410M_25k.PNG



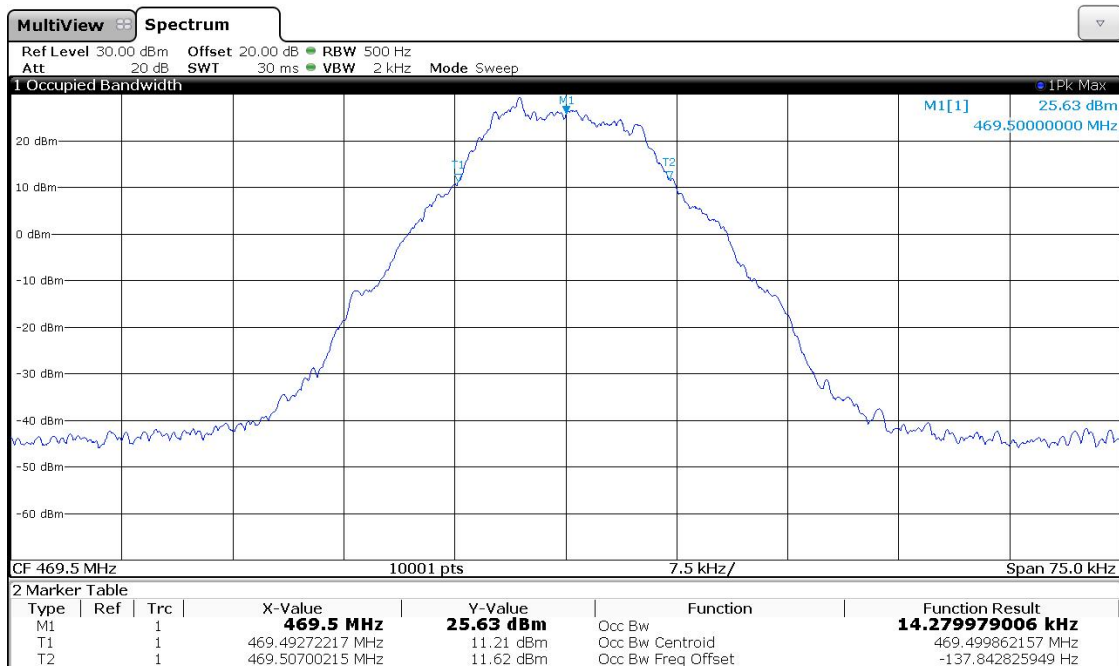
OBW_429M5_25k.PNG



OBW_450M5_25k.PNG



OBW_469M5_25k.PNG



Test equipment used (refer clause 6):

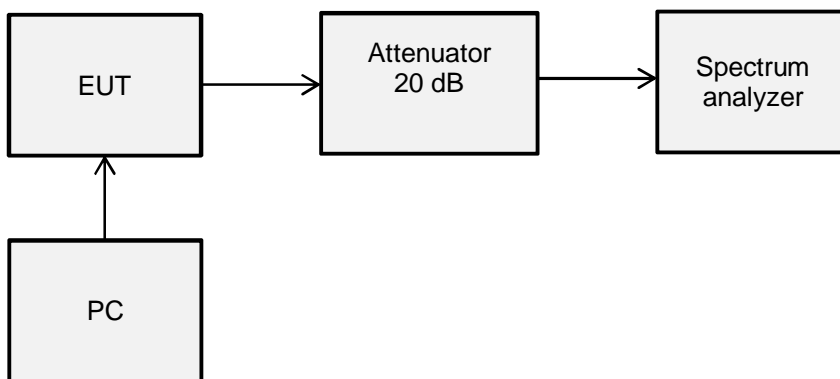
22, 26, 32, 33, 34

5.3 Emission masks

Because the EUT does not produce a full power unmodulated carrier, the reference power was set to 30 dBm which refers to the power measured in chapter 5.1.

5.3.1 Method of measurement

Test setup:



The following spectrum analyser settings were used:

Channel spacing:	12.5 kHz	25 kHz
- Span:	50 kHz	100 kHz
- Resolution bandwidth:	100 Hz	300 Hz
- Video bandwidth:	300 Hz	1 kHz
- Mode:	Auto sweep	Auto sweep
- Sweep time:	500 ms	1 s
- Detector function:	Peak	RMS
- Trace mode:	Max hold	Max hold

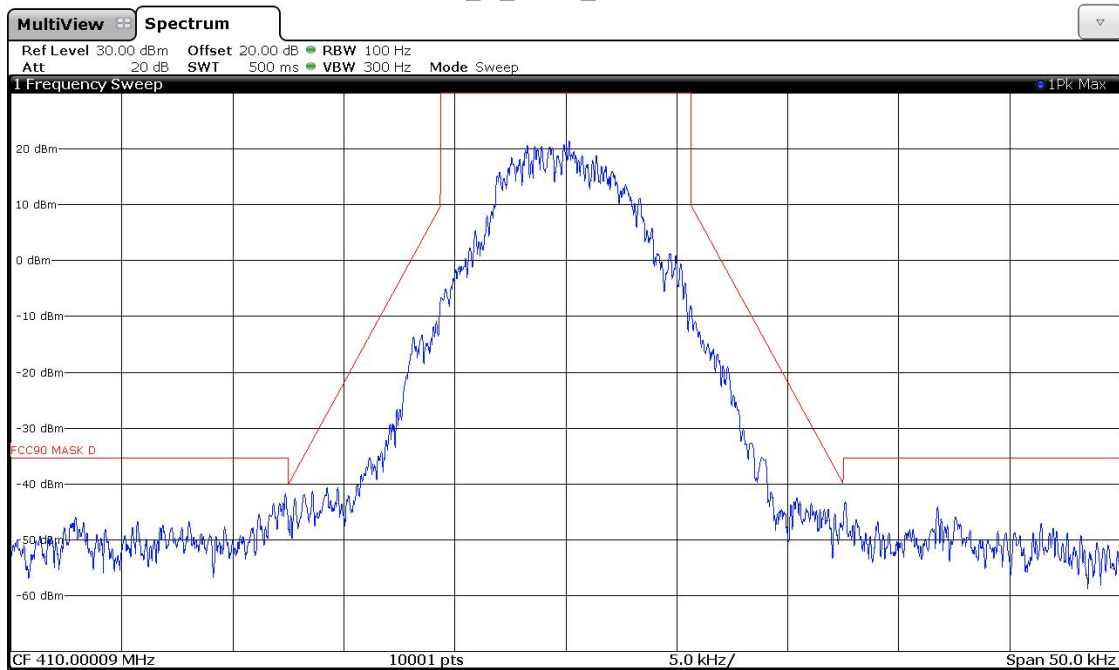
The EUT was set via the PC to transmitting a pseudo random data file.
The output power setting was 1000 mW.
The channel spacing was set to 12.5 kHz and 25 kHz.

5.3.2 Test Results

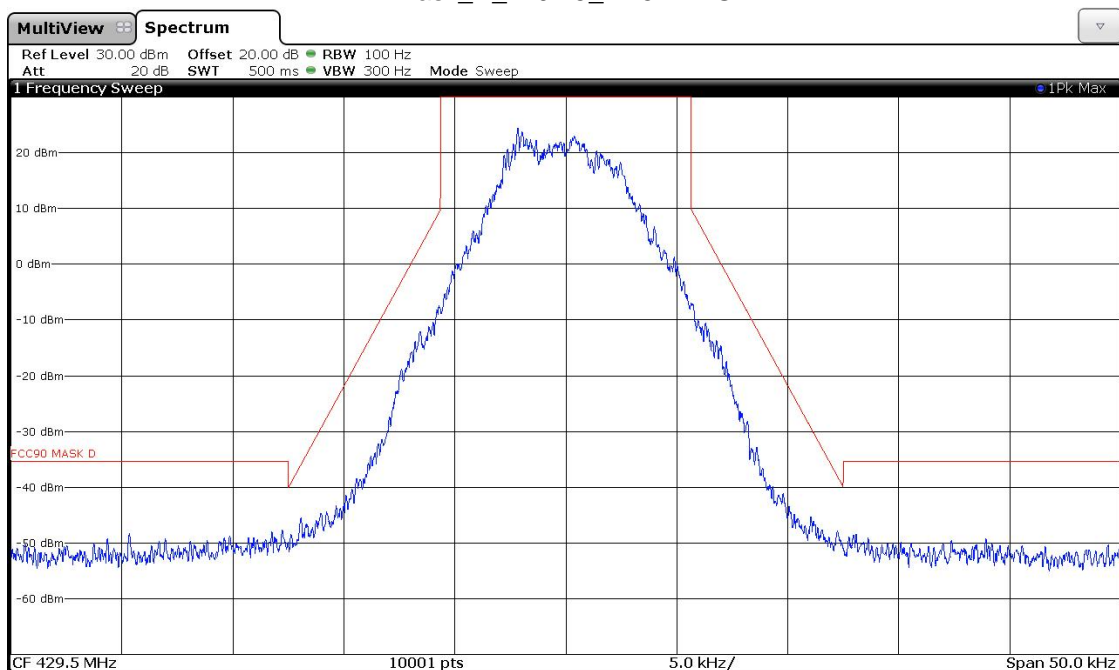
Ambient temperature	22 °C	Relative humidity	21 %
---------------------	-------	-------------------	------

5.3.2.1 Channel Spacing 12.5 kHz

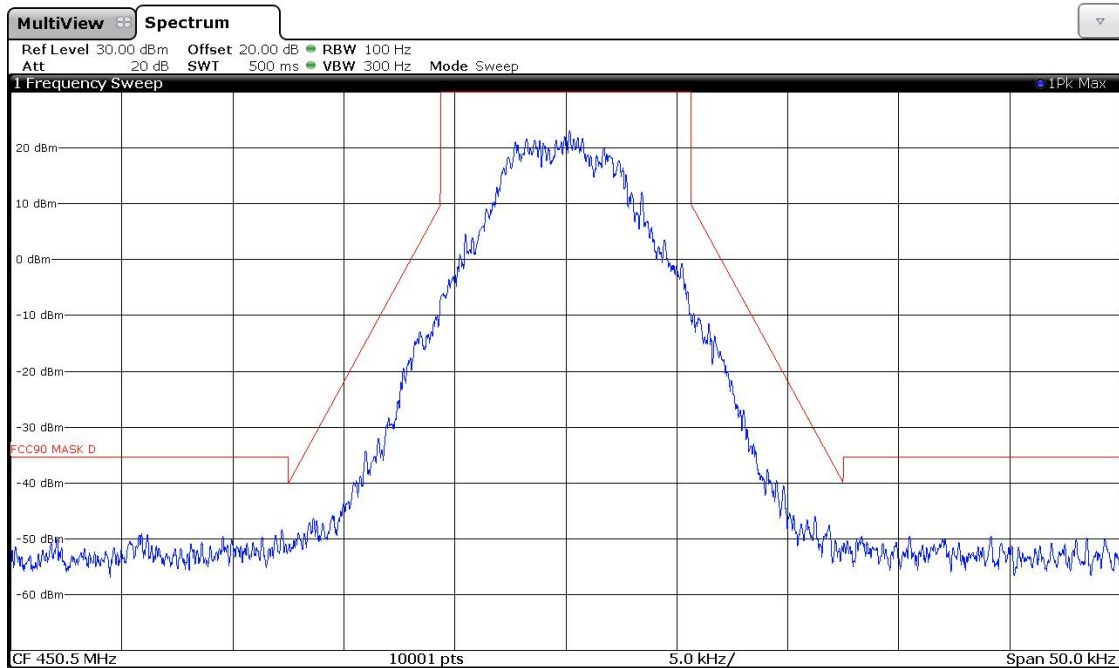
Mask_D_410M_12.5k.PNG



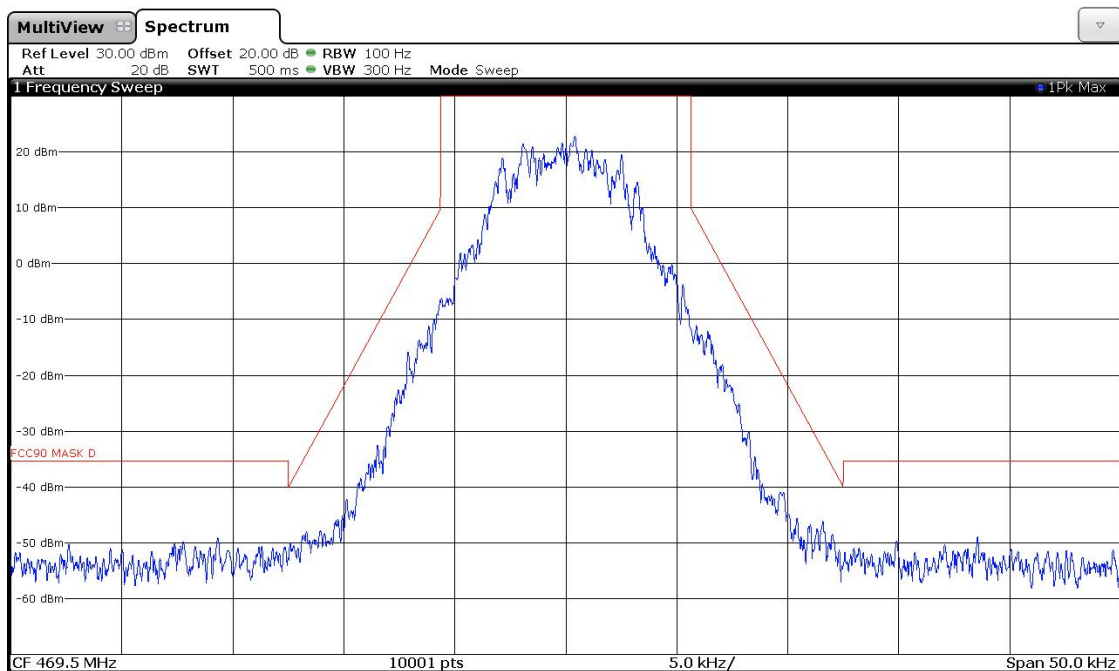
Mask_D_429M5_12.5k.PNG



Mask_D_450M5_12.5k.PNG



Mask_D_469M5_12.5k.PNG



Limit:

Emission Mask D—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

- (1) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0 : Zero dB.
- (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least $7.27(f_d - 2.88 \text{ kHz})$ dB.
- (3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least $50 + 10 \log(P)$ dB or 70 dB, whichever is the lesser attenuation.
- (4) The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide (usually two or three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emission mask up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For emissions beyond 50 kHz from the edge of the authorized bandwidth, see paragraph (o) of this section. If it can be shown that use of the above instrumentation settings do not accurately represent the true interference potential of the equipment under test, an alternate procedure may be used provided prior Commission approval is obtained.

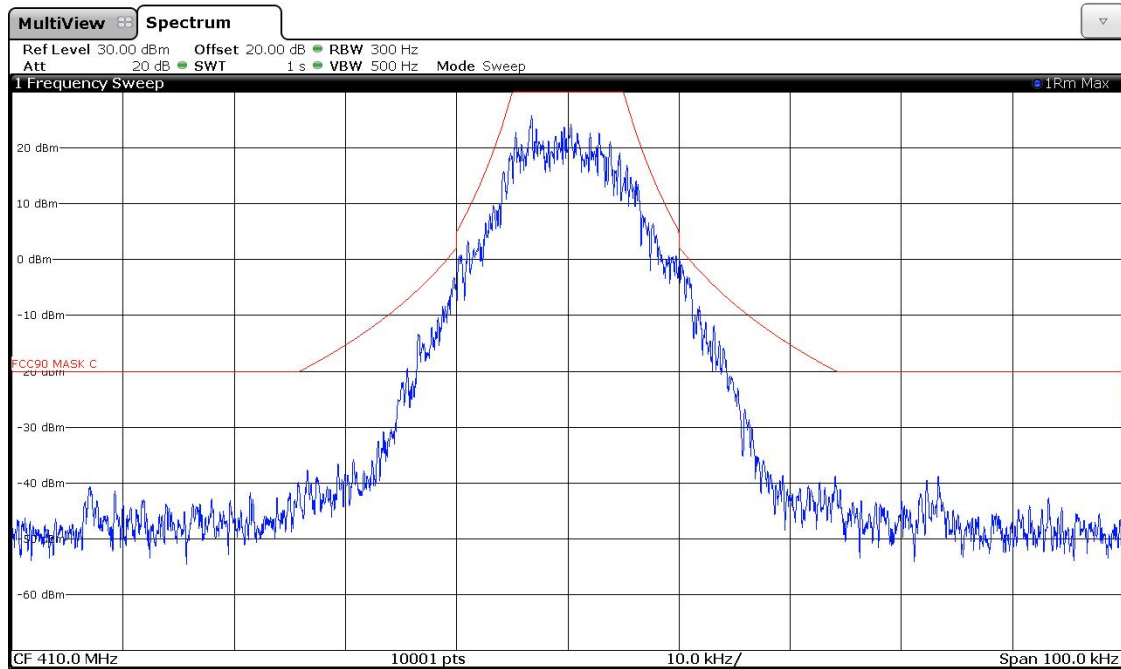
Test: Passed

Test equipment used (refer clause 6):

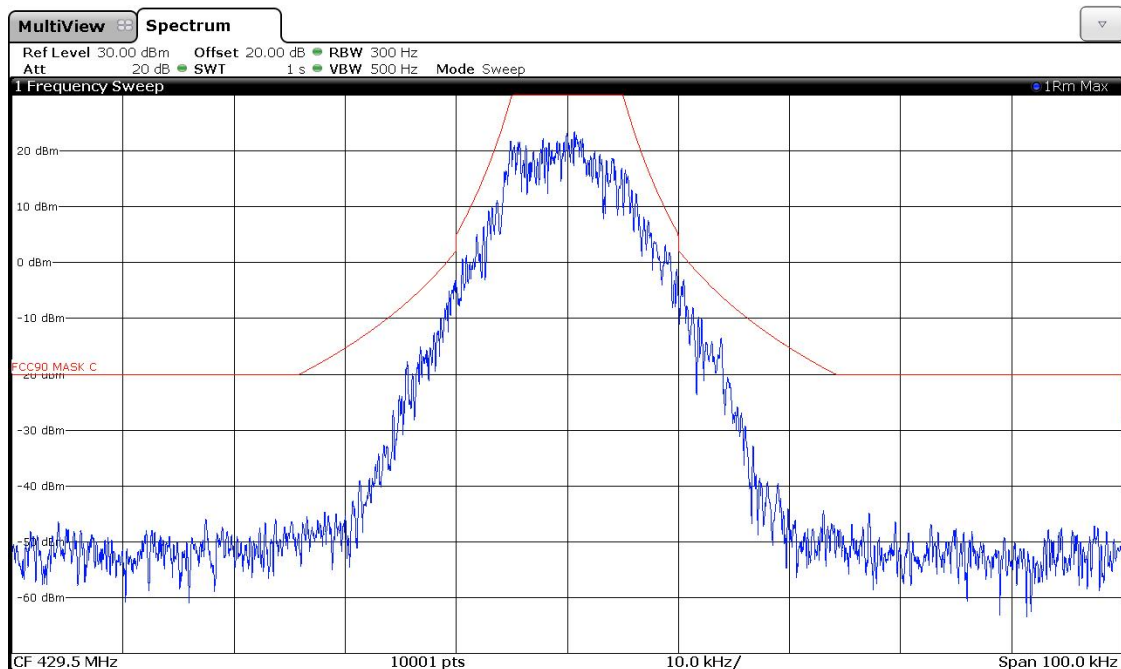
22, 26, 32, 33, 34

5.3.2.2 Channel Spacing 25 kHz

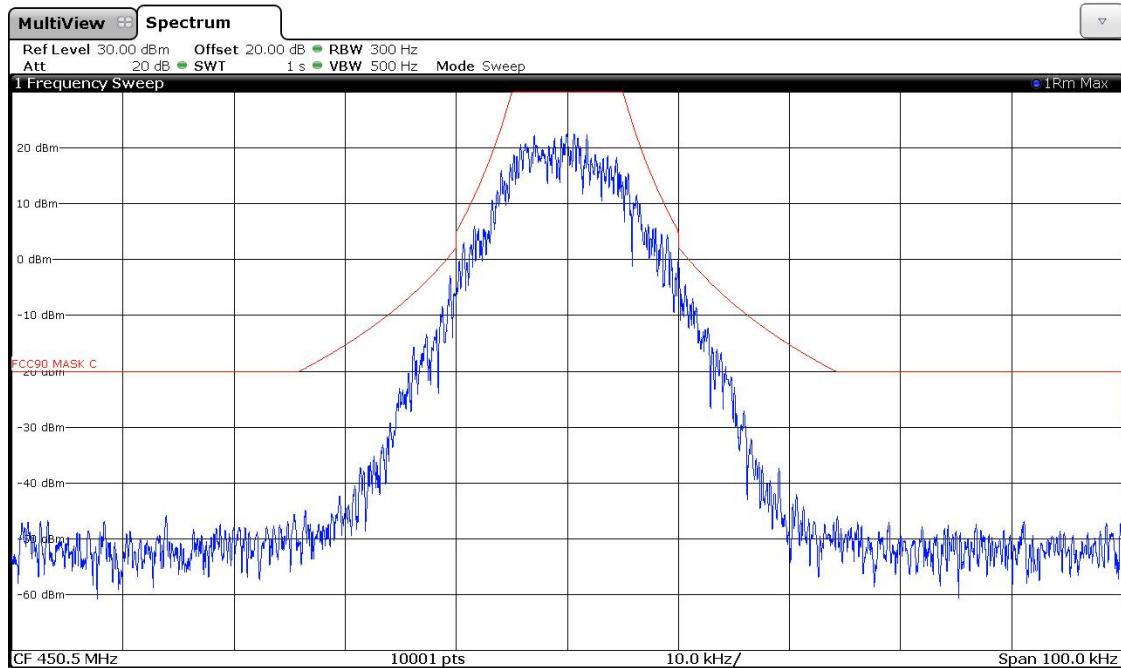
Mask_C_410M_25k.PNG



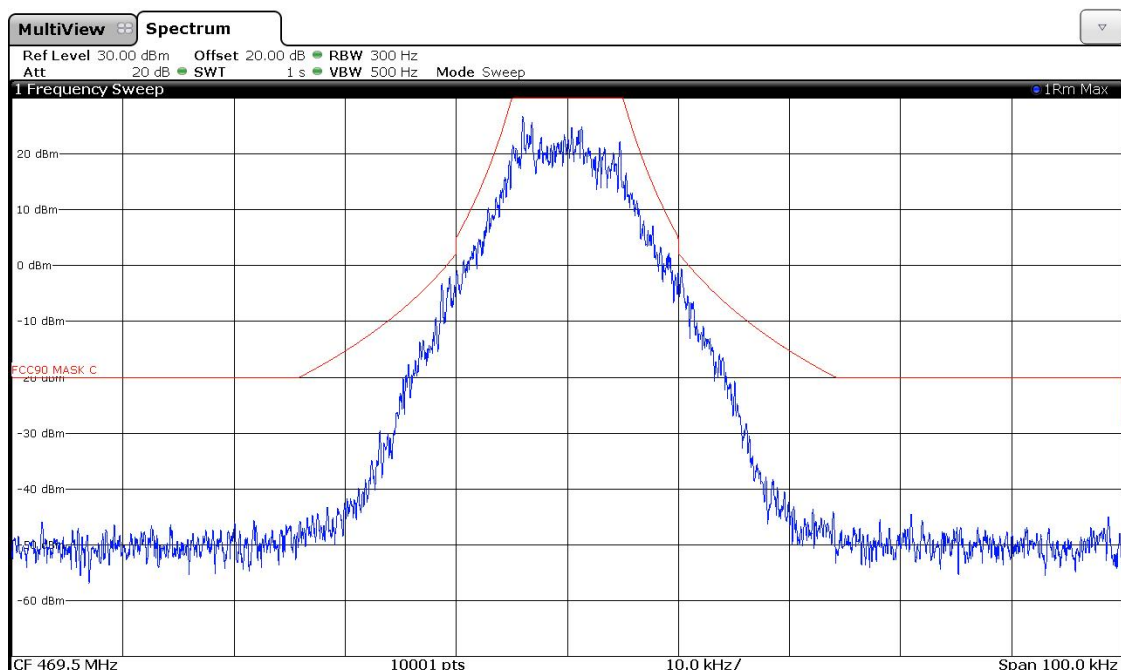
Mask_C_429M5_25k.PNG



Mask_C_450M5_25k.PNG



Mask_C_469M5_25k.PNG



Limit:

Emission Mask C. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

- (1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz, but not more than 10 kHz: At least $83 \log(f_d/5)$ dB;
- (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least $29 \log(f_d^2/11)$ dB or 50 dB, whichever is the lesser attenuation;
- (3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log(P)$ dB.

Test: Passed

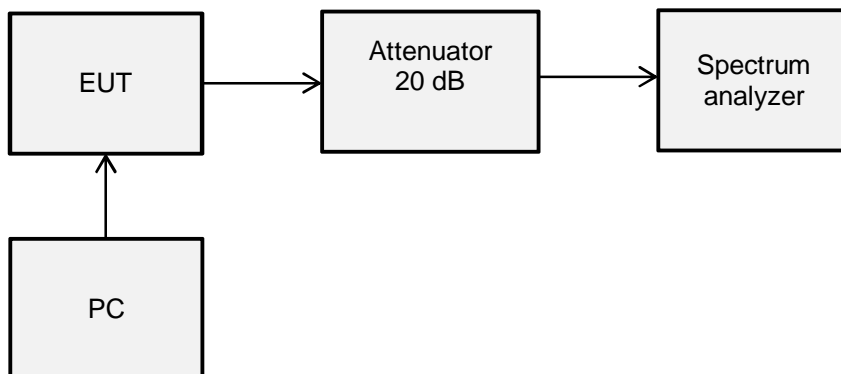
Test equipment used (refer clause 6):

22, 26, 32, 33, 34

5.4 Spurious emissions (conducted)

5.4.1 Method of measurement

Test setup:



The TX frequency was set to 410.0 MHz, 429.5 MHz, 450.5 MHz and 469.5 MHz via the PC. The output power was set to 1 W and the channel spacing to 12.5 kHz and 25 kHz.

5.4.2 Test Results

Ambient temperature	22 °C	Relative humidity	15 %
---------------------	-------	-------------------	------

5.4.2.1 Channel Spacing 12.5 kHz

TX frequency (MHz)	Channel spacing (kHz)	Frequency (MHz)	Level (dBm)	Limit (dBm)
410.0	12.5	819.953	-34.04	-20
429.5		858.993	-31.06	
450.5		900.992	-30.98	
469.5		938.966	-32.83	
Measurement uncertainty			+0.66 dB / -0.72 dB	

Limit:

On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least $50 + 10 \log(P)$ dB or 70 dB, whichever is the lesser attenuation.

Attenuation for 1 W carrier power: $50 + 10 \log(P)$ dB = $50 + 10 \log(1)$ dB = 50 dB

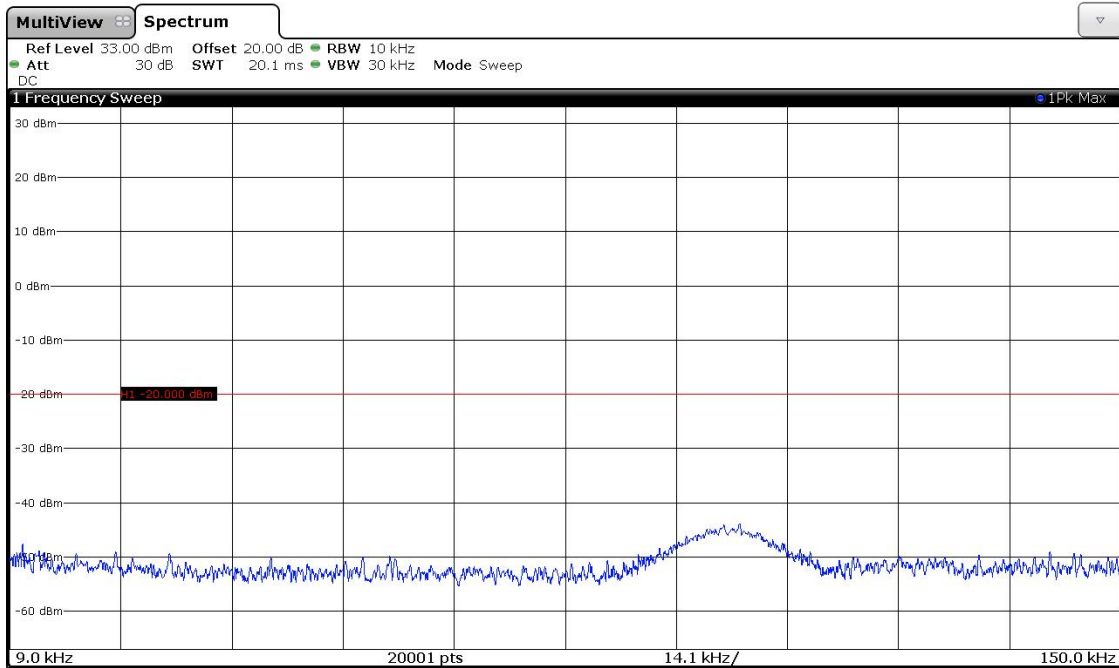
RF Power limit for any spurious emission: 30 dBm - 50 dB = -20 dBm

Test: Passed

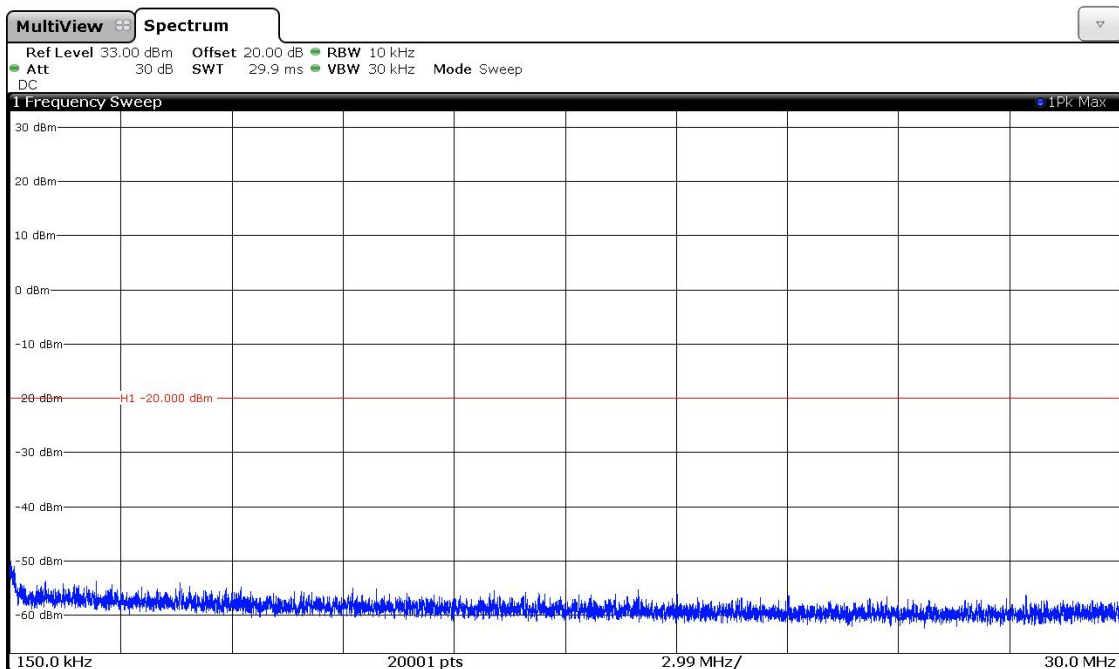
Test equipment used (refer clause 6):

22, 26, 32, 33, 34

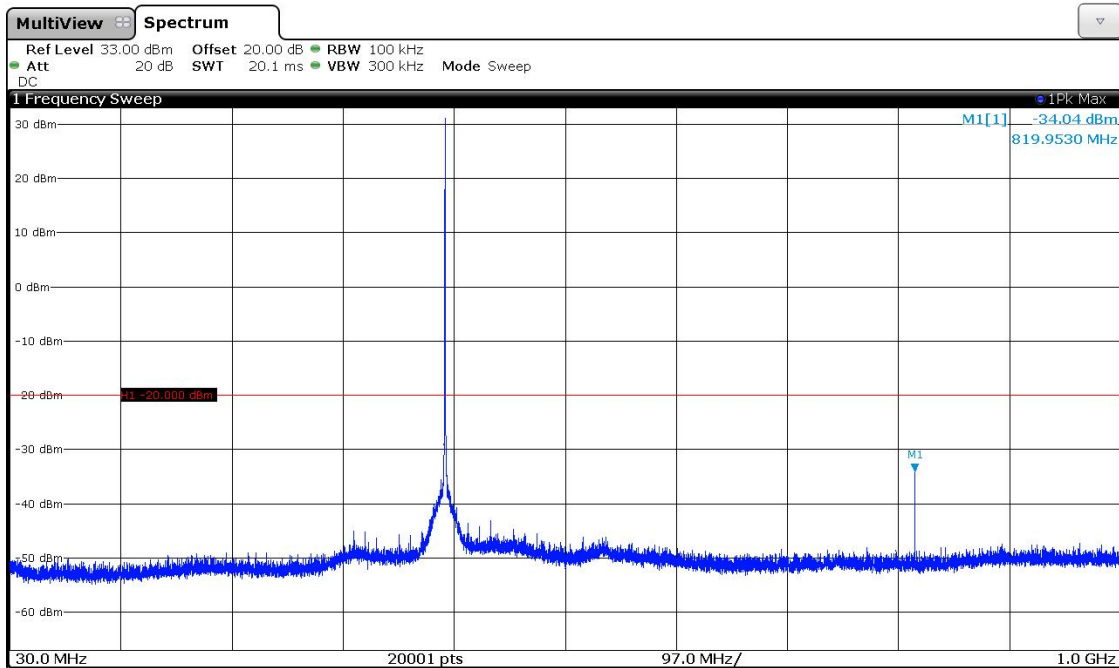
Spur_9-150k_410M_12k5.PNG



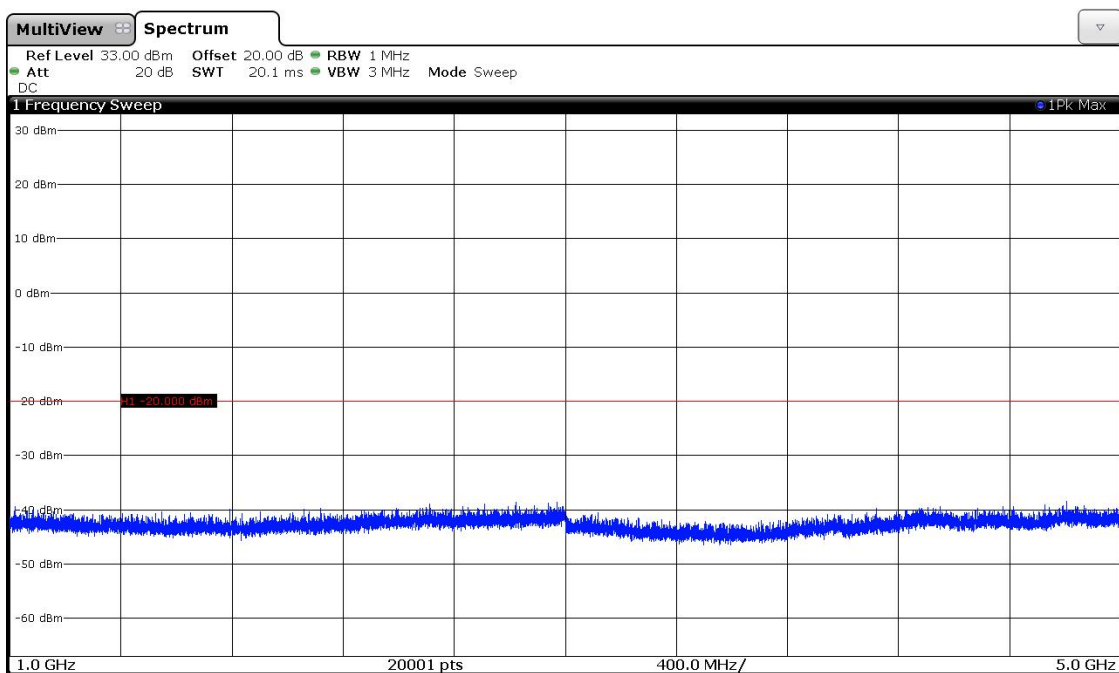
Spur_150k-30M_410M_12k5.PNG



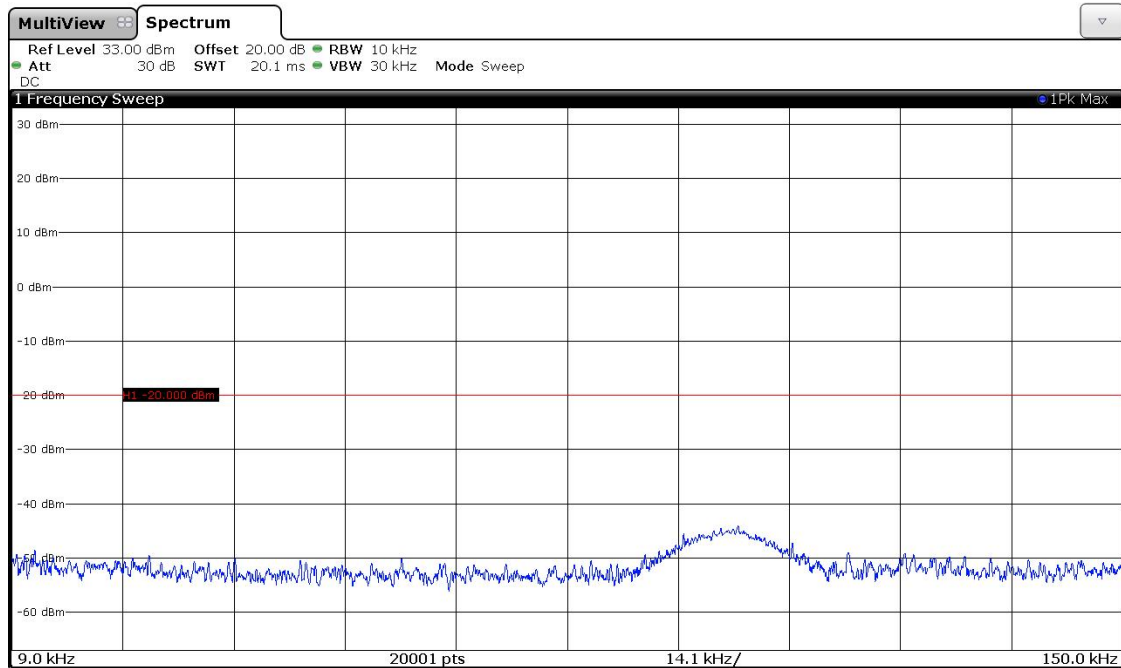
Spur_30M-1G_410M_12k5.PNG



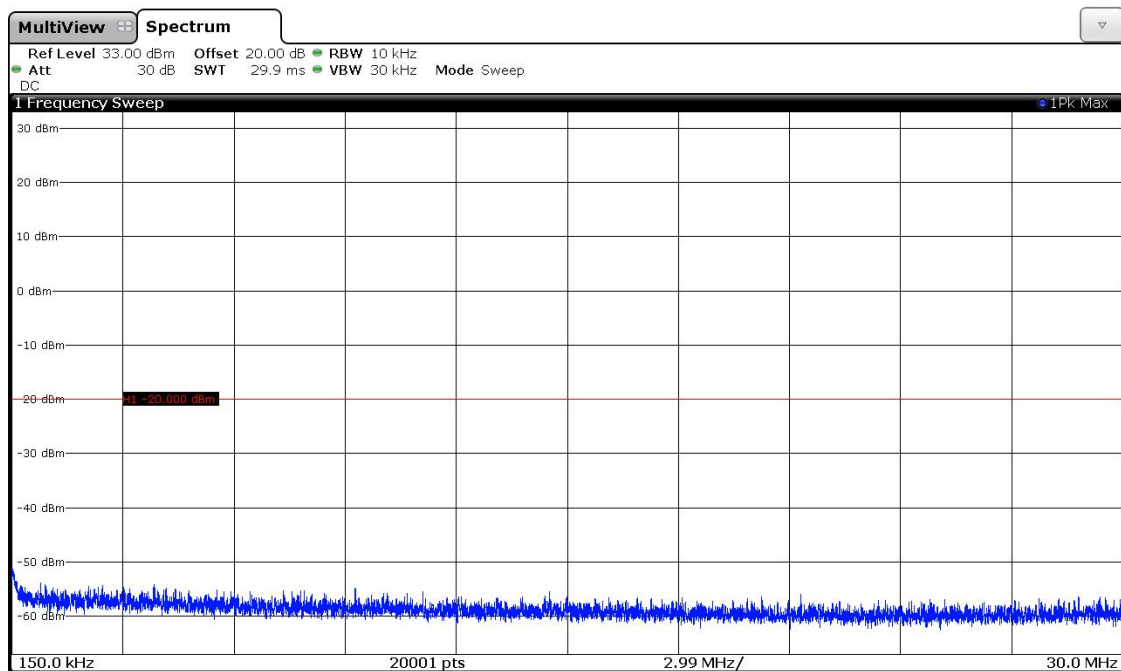
Spur_1-5G_410M_12k5.PNG



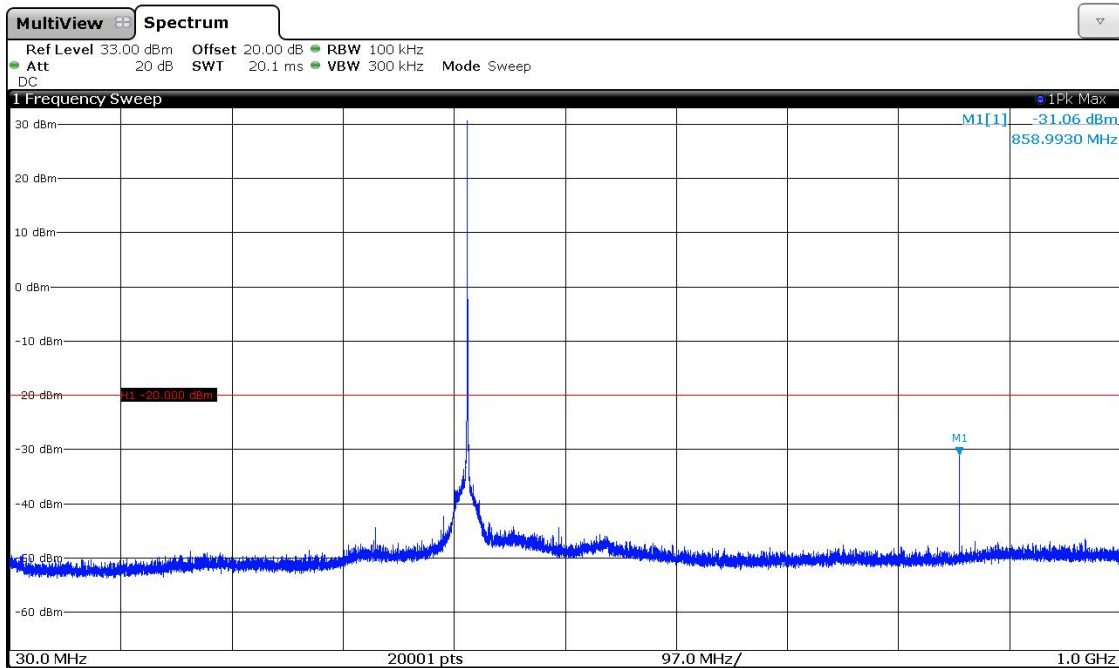
Spur_9-150k_429M5_12k5.PNG



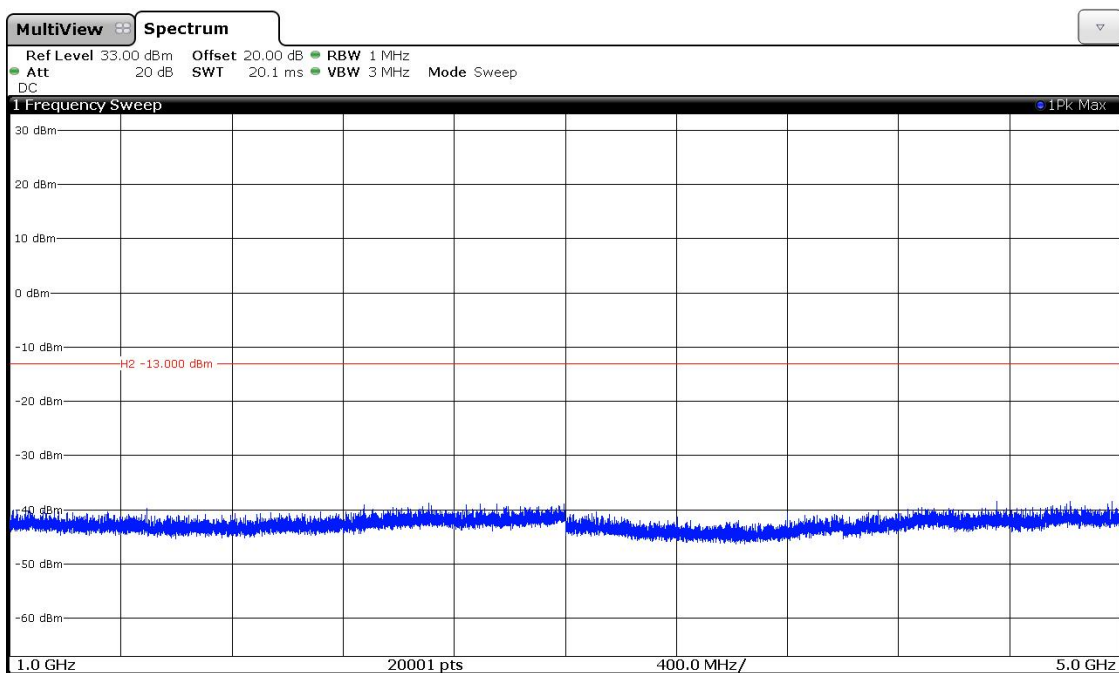
Spur_150k-30M_429M5_12k5.PNG



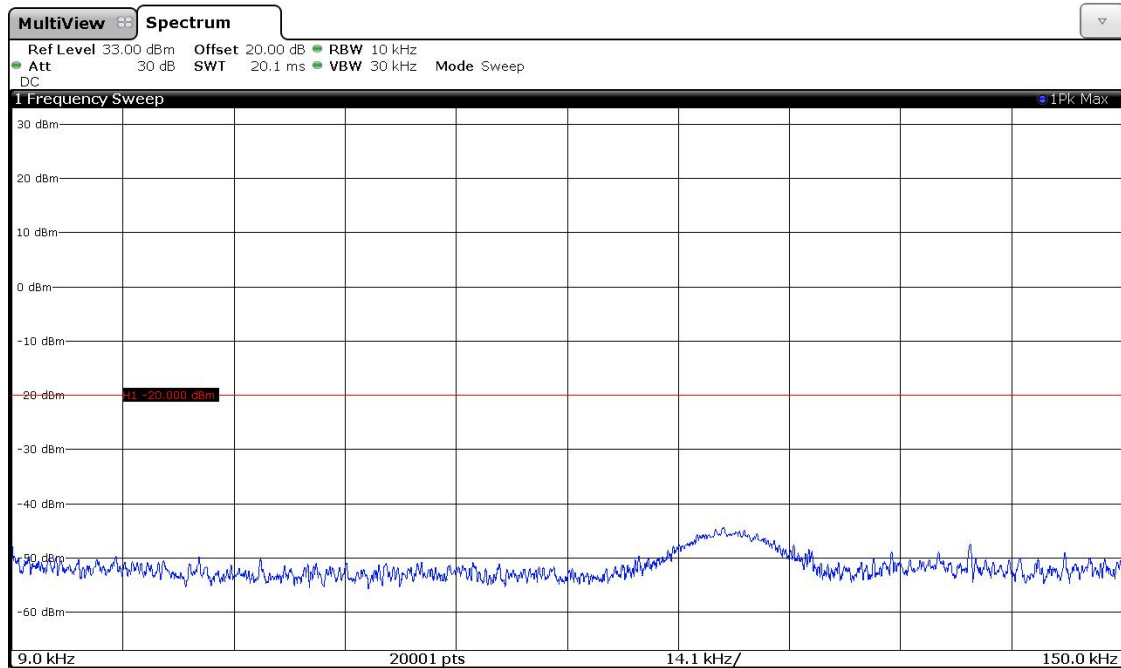
Spur_30M-1G_429M5_12k5.PNG



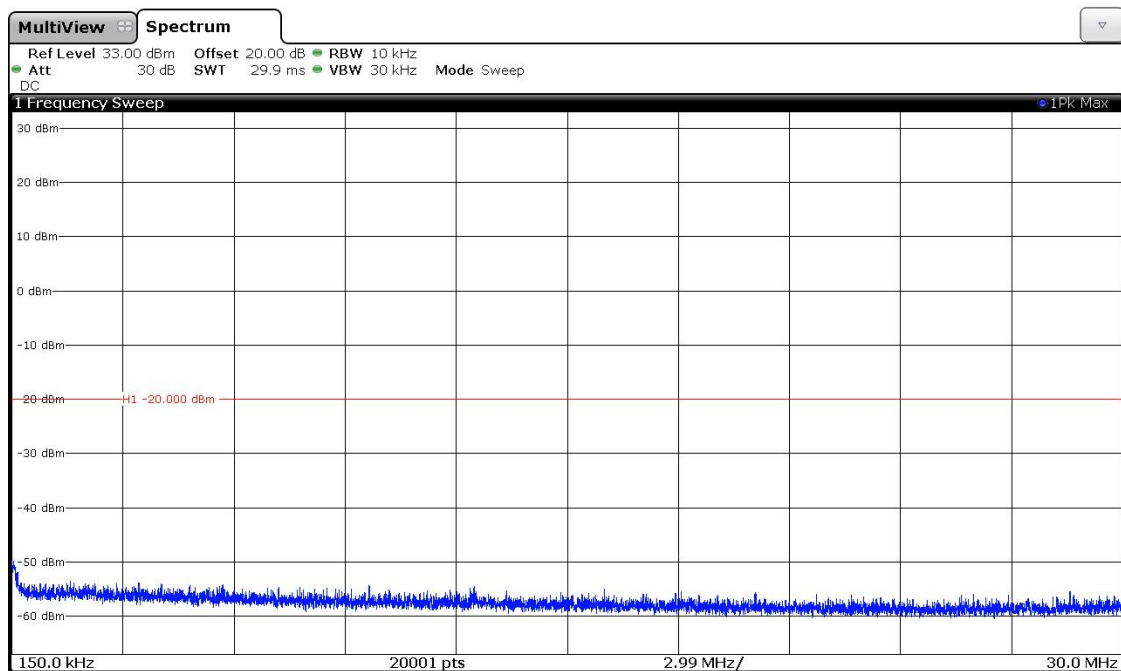
Spur_1-5G_429M5_12k5.PNG



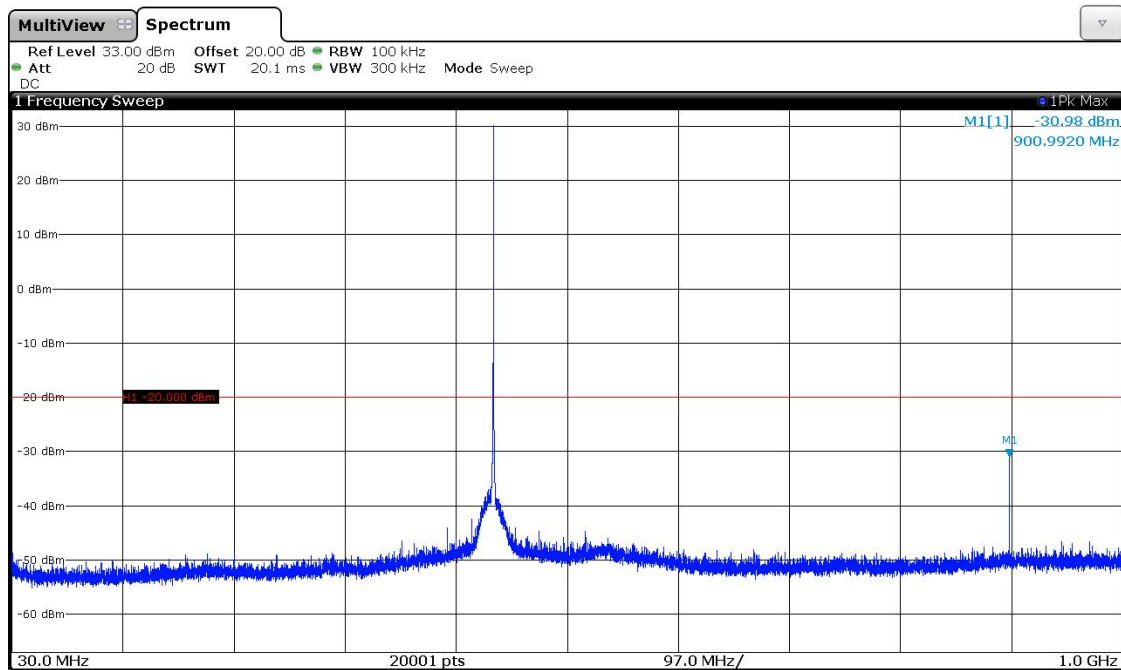
Spur_9-150k_450M5_12k5.PNG



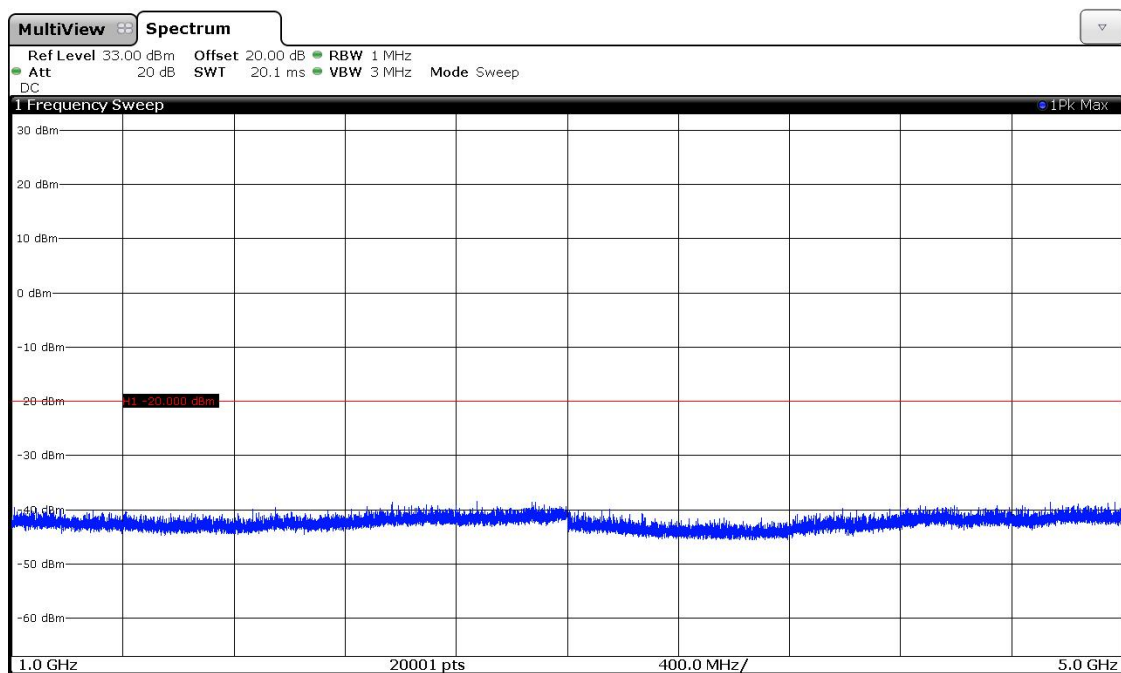
Spur_150k-30M_450M5_12k5.PNG



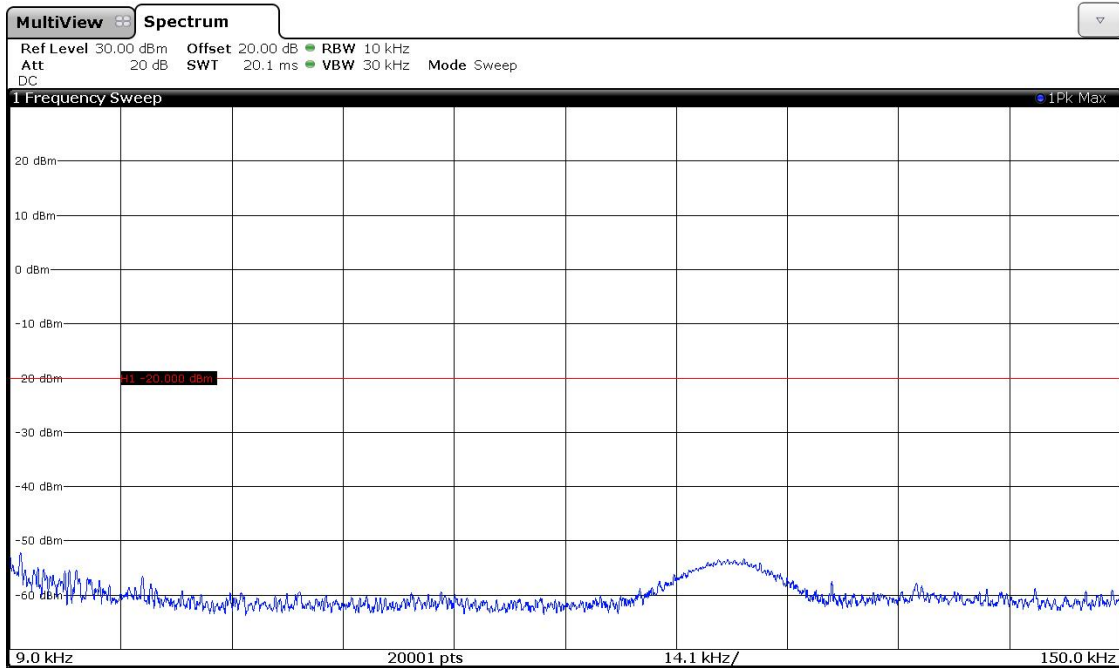
Spur_30M-1G_450M5_12k5.PNG



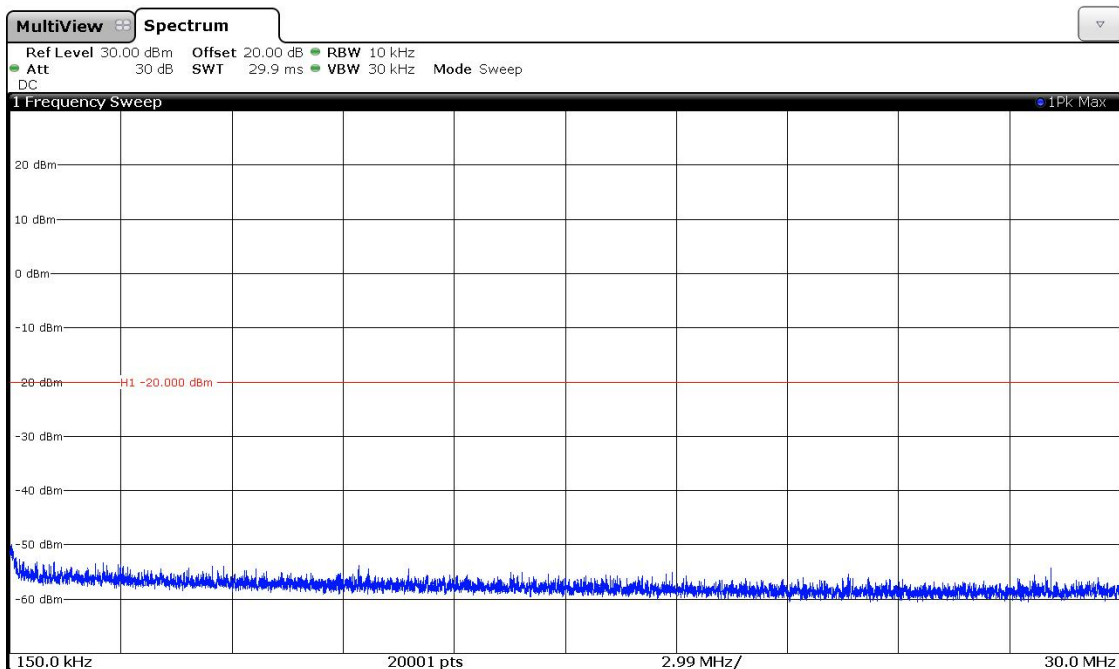
Spur_1-5G_450M5M_12k5.PNG



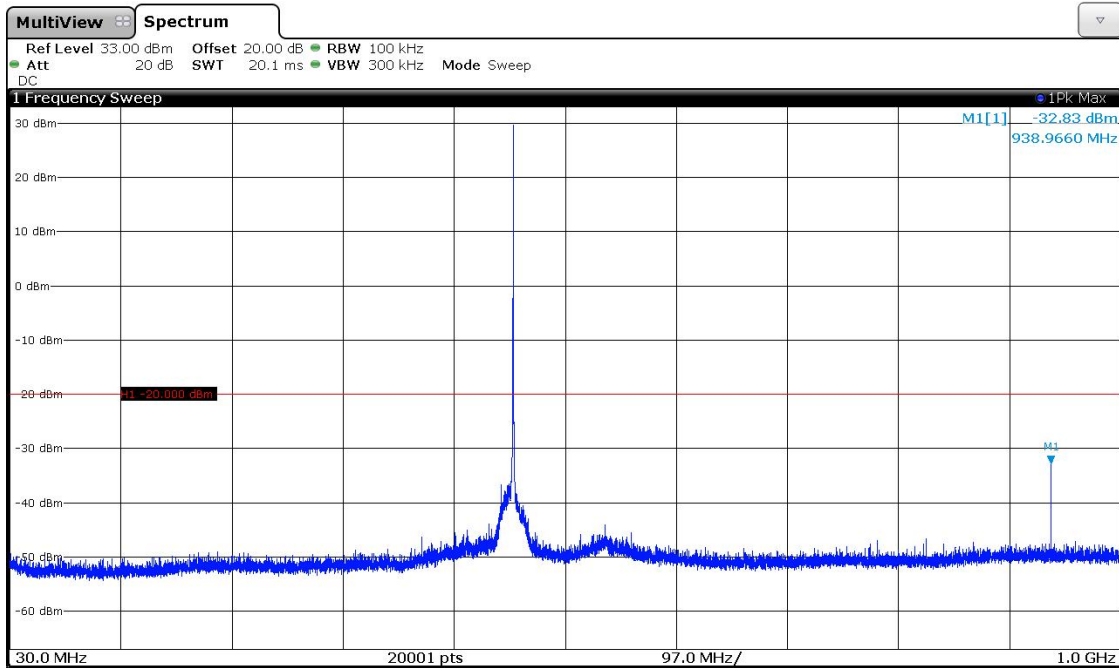
Spur_9-150k_469.5M_12.5k.PNG



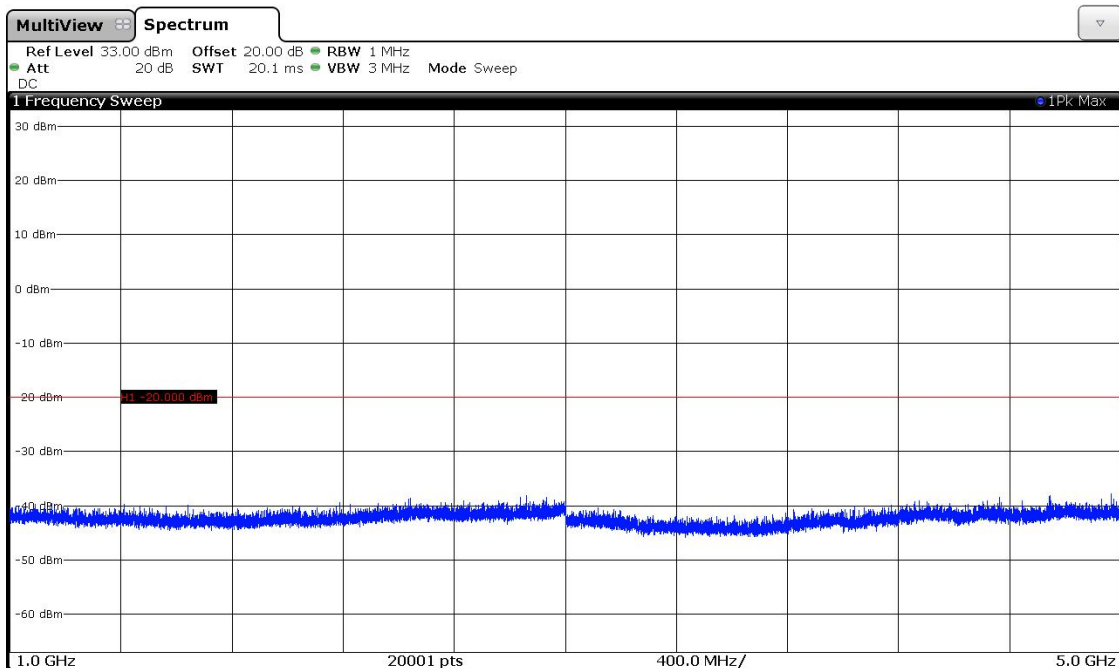
Spur_150k-30M_469.5M_12.5k.PNG



Spur_30M-1G_469.5M_12.5k.PNG



Spur_1-5G_469.5M_12.5k.PNG



5.4.2.2 Channel Spacing 25 kHz

TX frequency (MHz)	Channel spacing (kHz)	Frequency (MHz)	Level (dBm)	Limit (dBm)
410.0	25	819.953	-33.92	-13
429.5		858.993	-30.96	
450.5		900.992	-30.76	
469.5		938.966	-32.91	
Measurement uncertainty			+0.66 dB / -0.72 dB	

Limit:

On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB.

Attenuation for 1 W carrier power: $43 + 10 \log (1)$ dB = $43 + 10 \log (1)$ dB = 43 dB

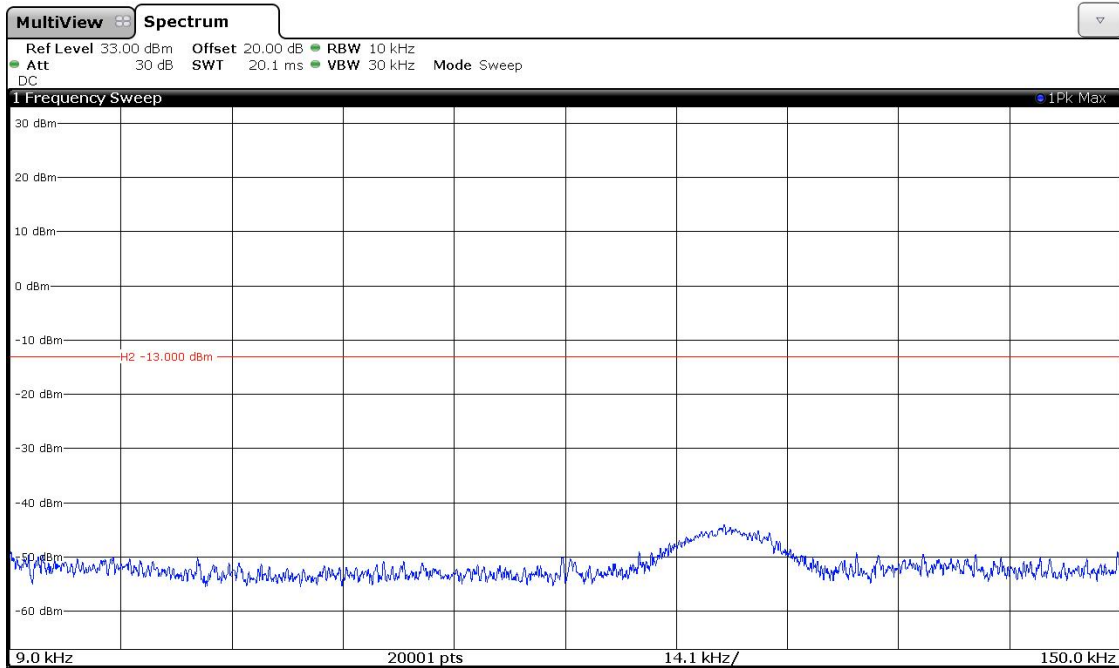
RF power limit for any emission: 30 dBm - 43 dB = -13 dBm

Test: Passed

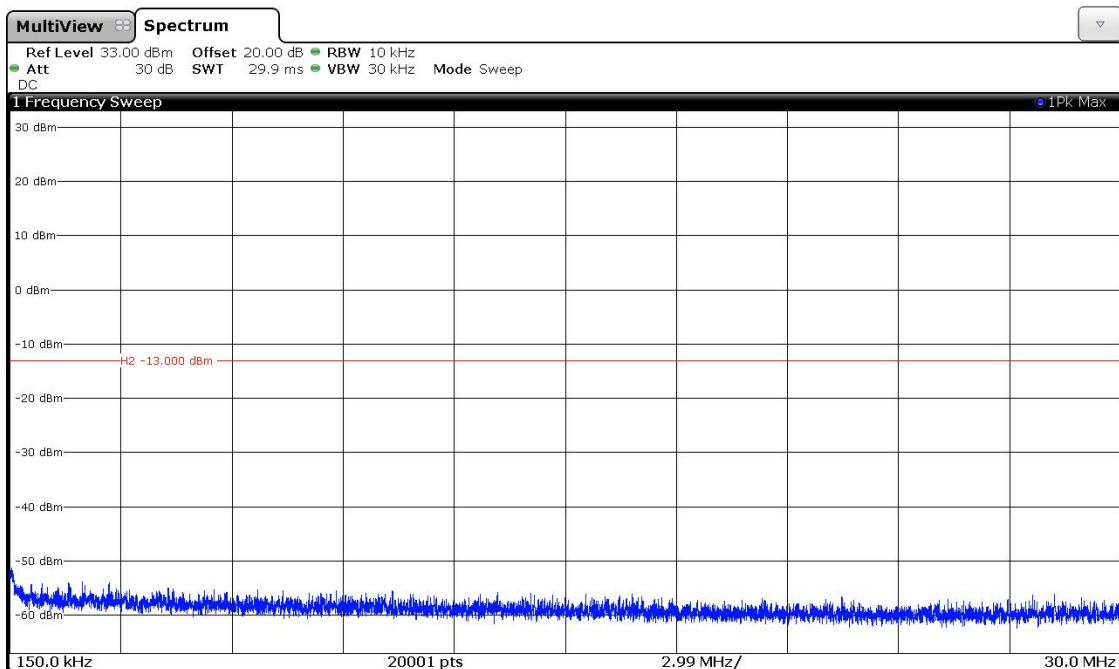
Test equipment used (refer clause 6):

22, 26, 32, 33, 34

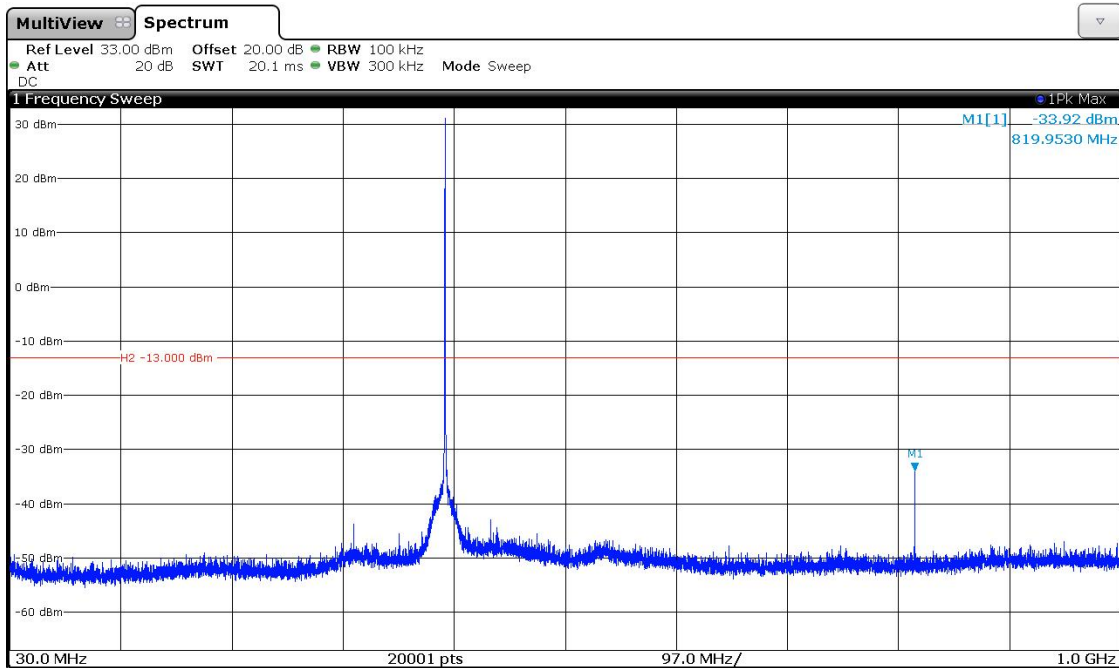
Spur_9-150k_410M_25k.PNG



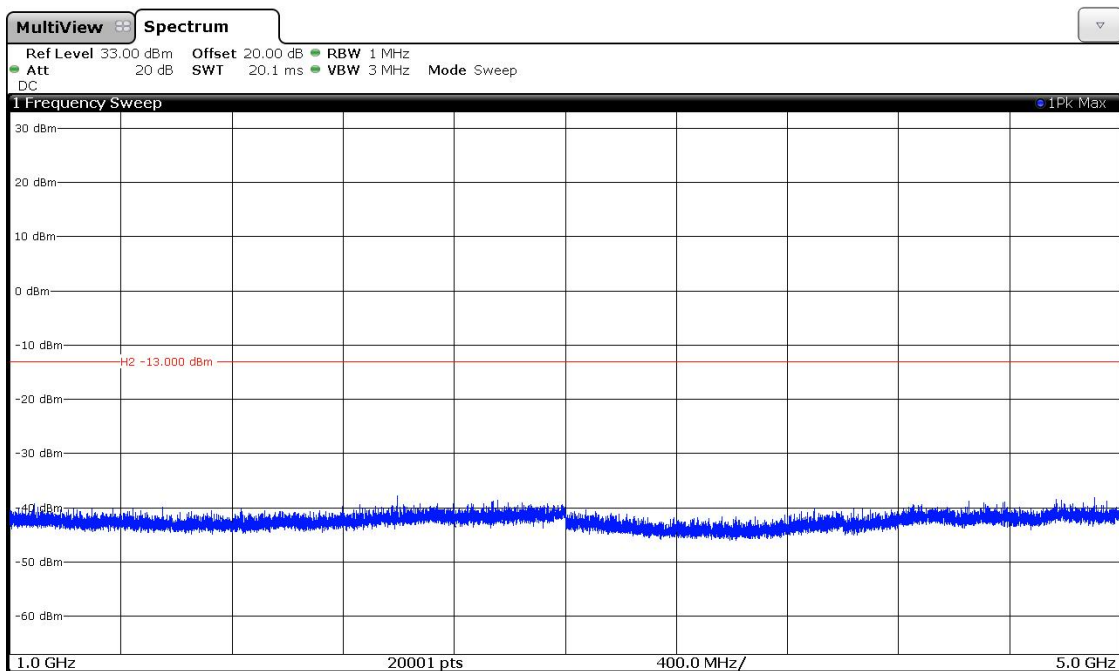
Spur_150k-30M_410M_25k.PNG



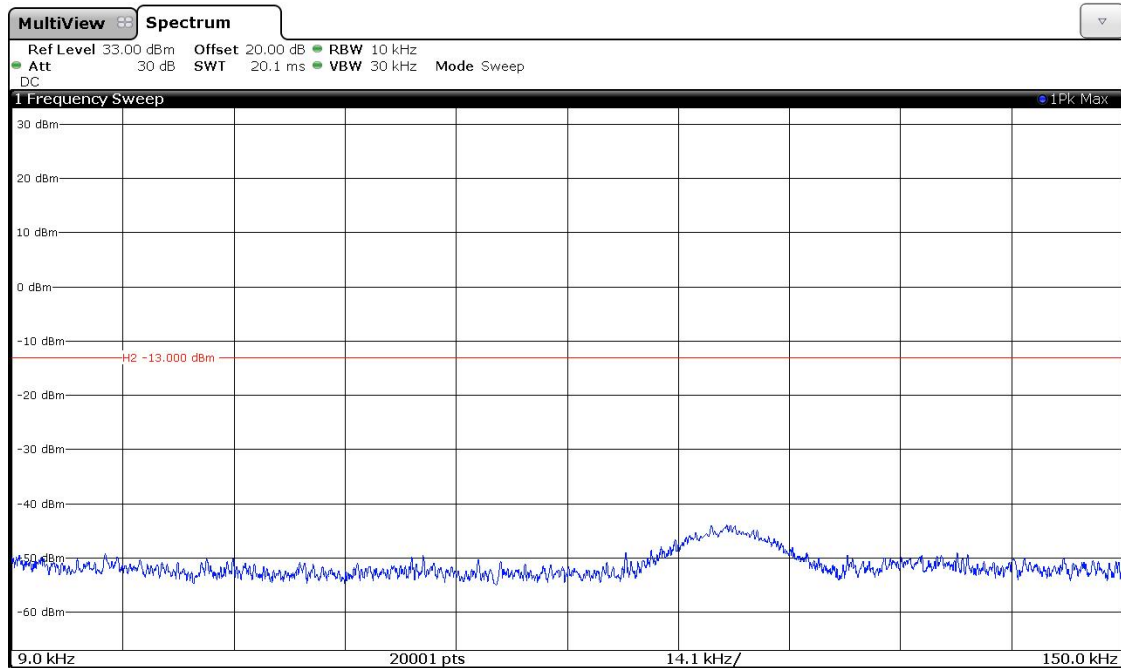
Spur_30M-1G_410M_25k.PNG



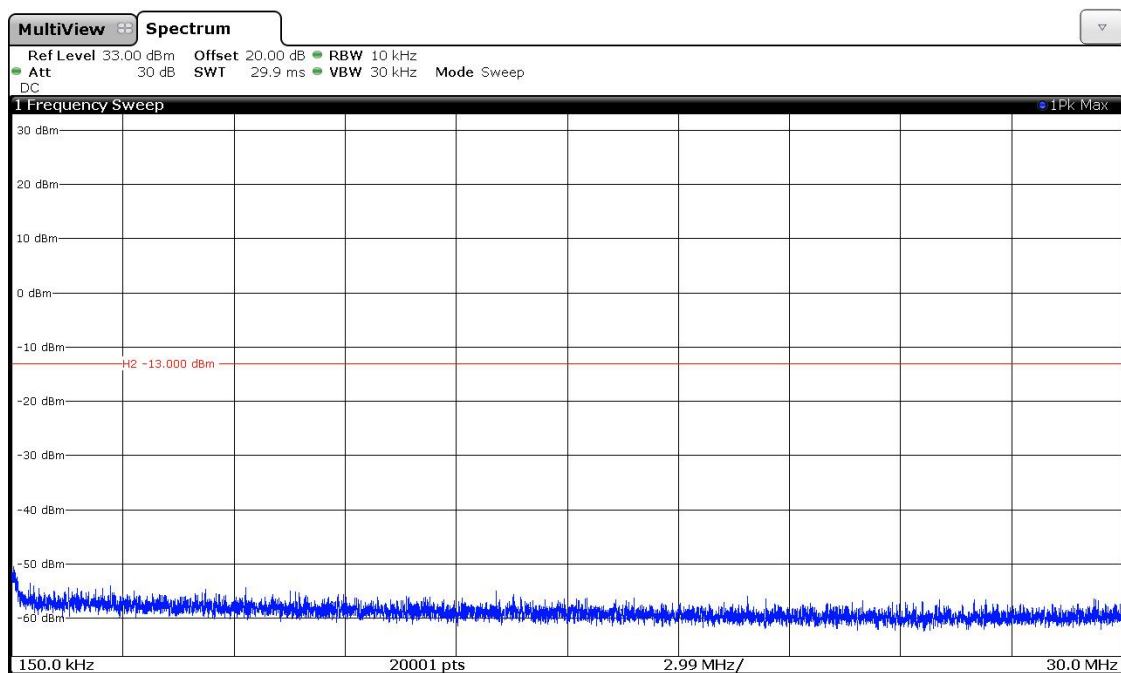
Spur_1-5G_410M_25k.PNG



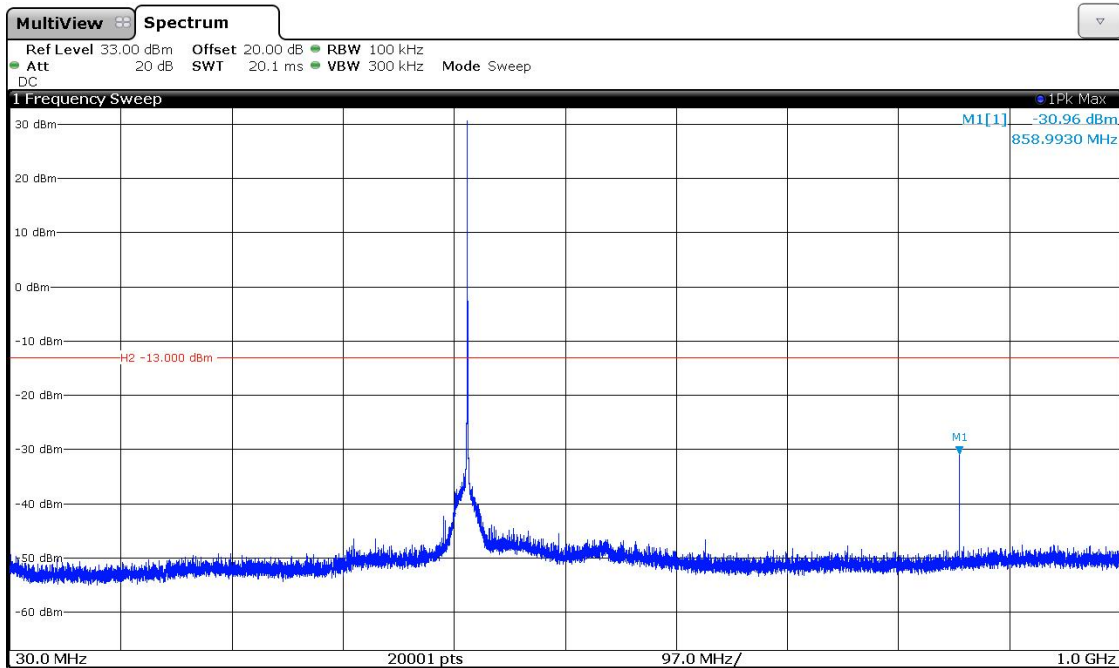
Spur_9-150k_429M5_25k.PNG



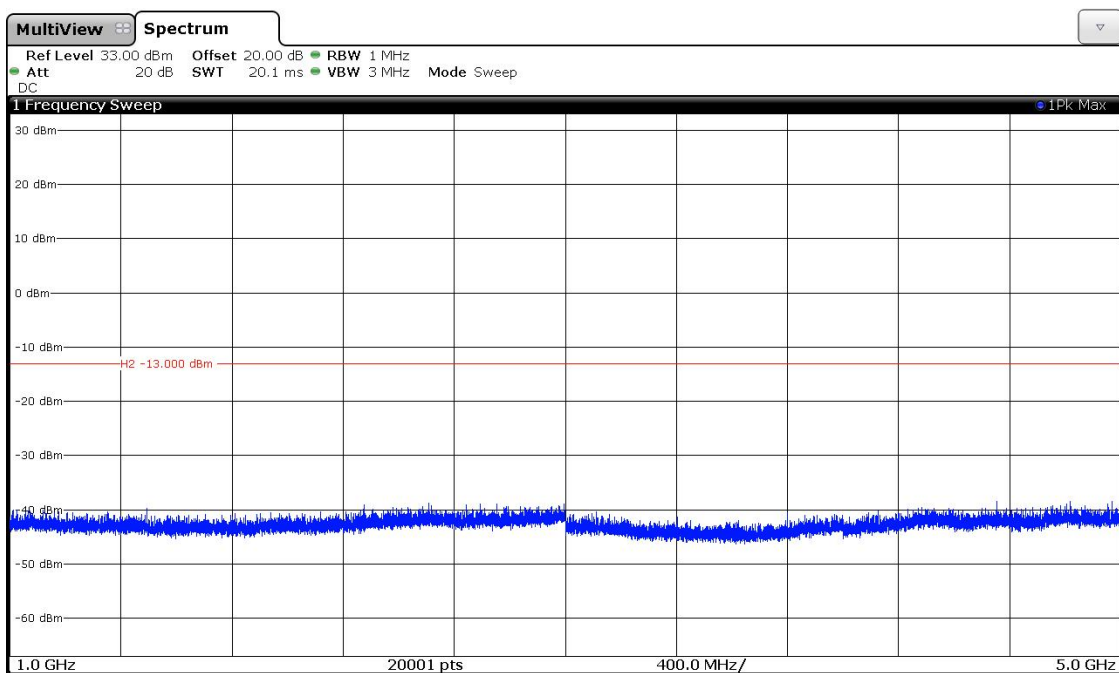
Spur_150k-30M_429M5_25k.PNG



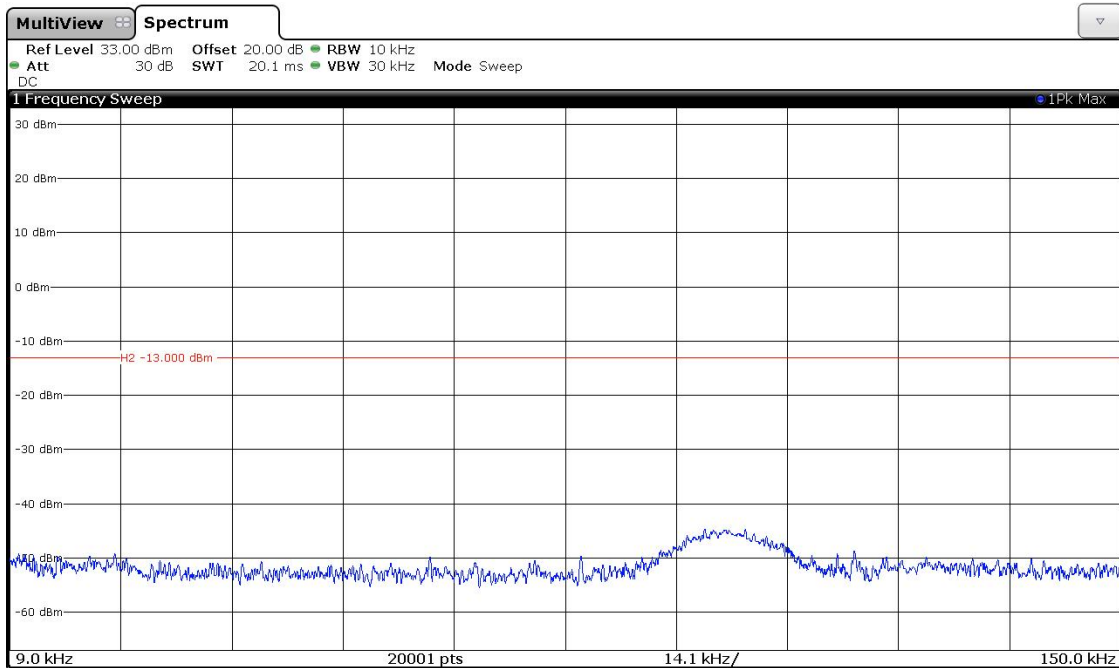
Spur_30M-1G_429M5_25k.PNG



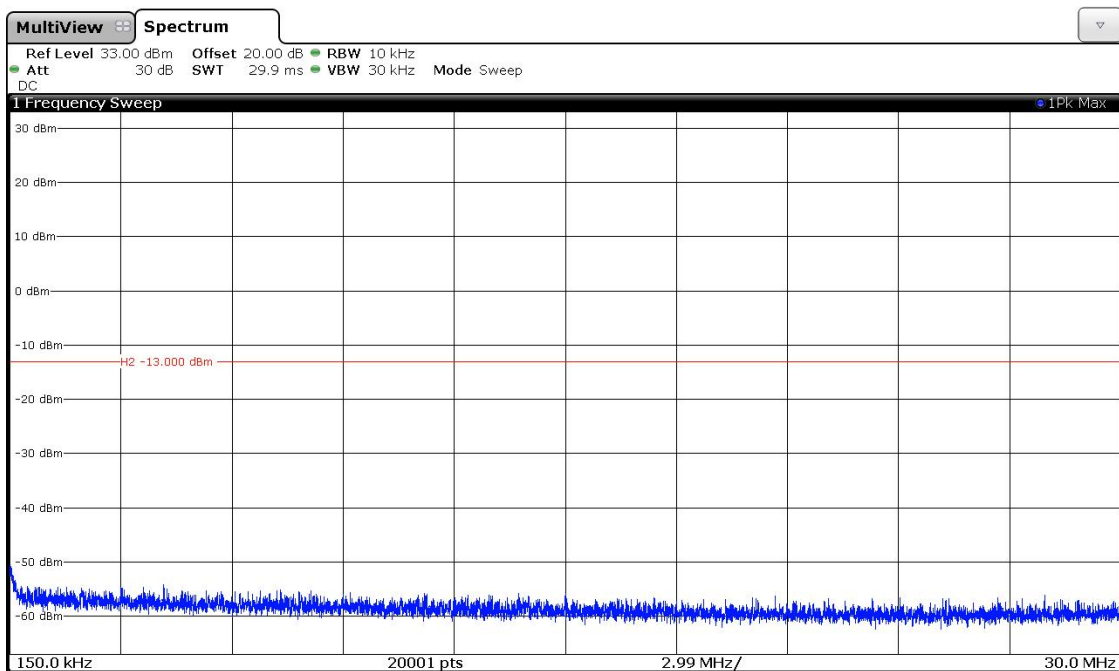
Spur_1-5G_429M5_25k.PNG



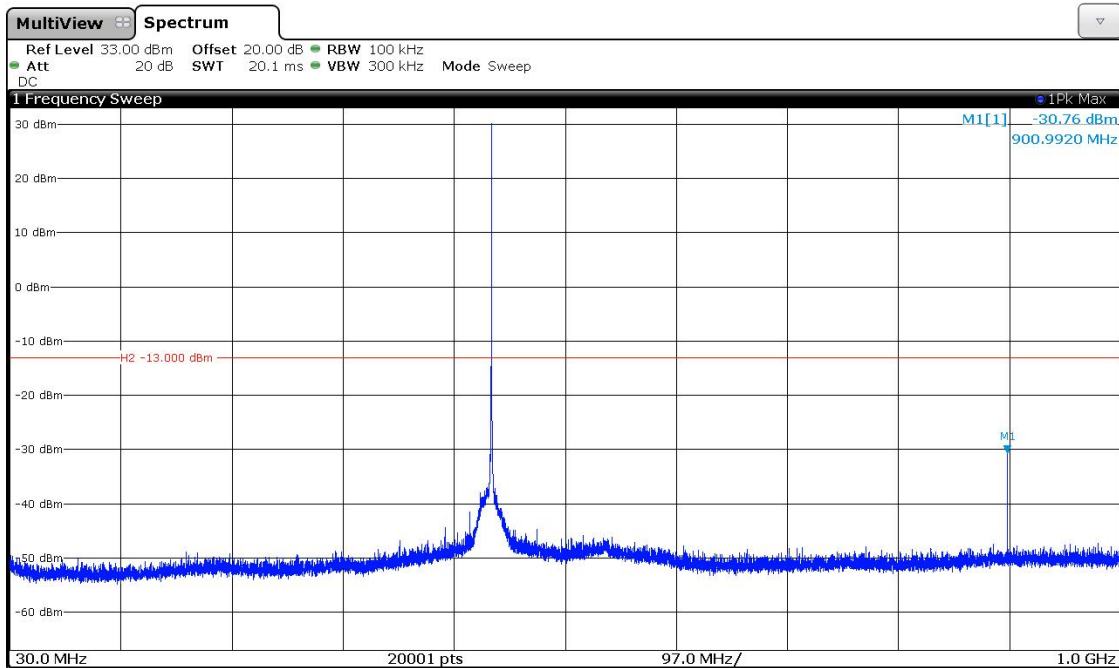
Spur_9-150k_450M5_25k.PNG



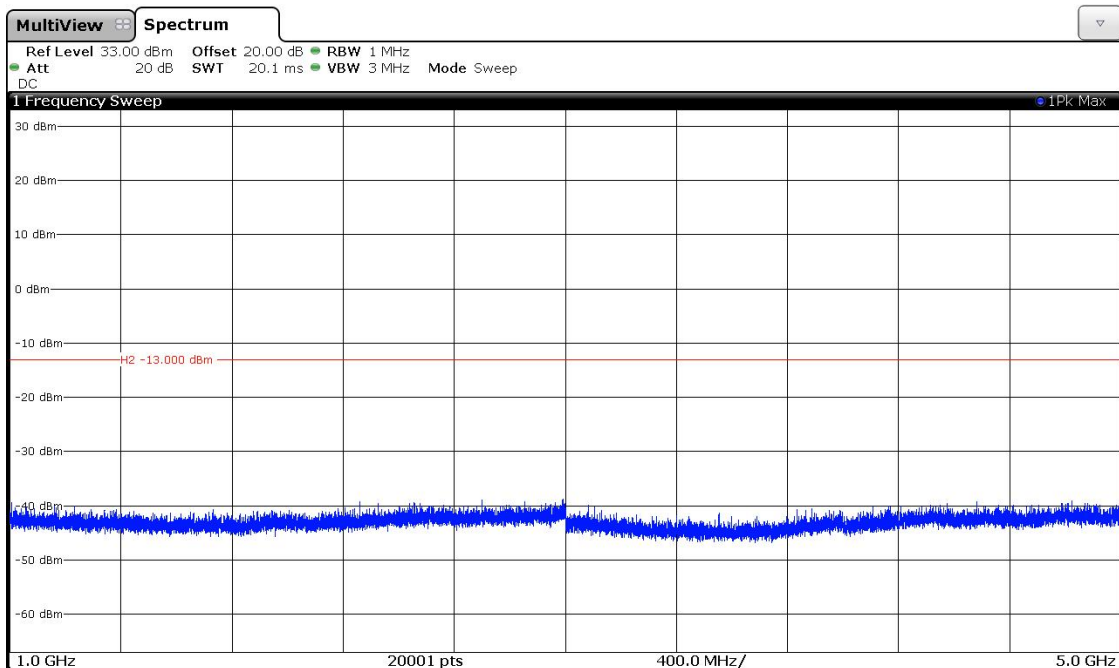
Spur_150k-30M_450M5_25k.PNG



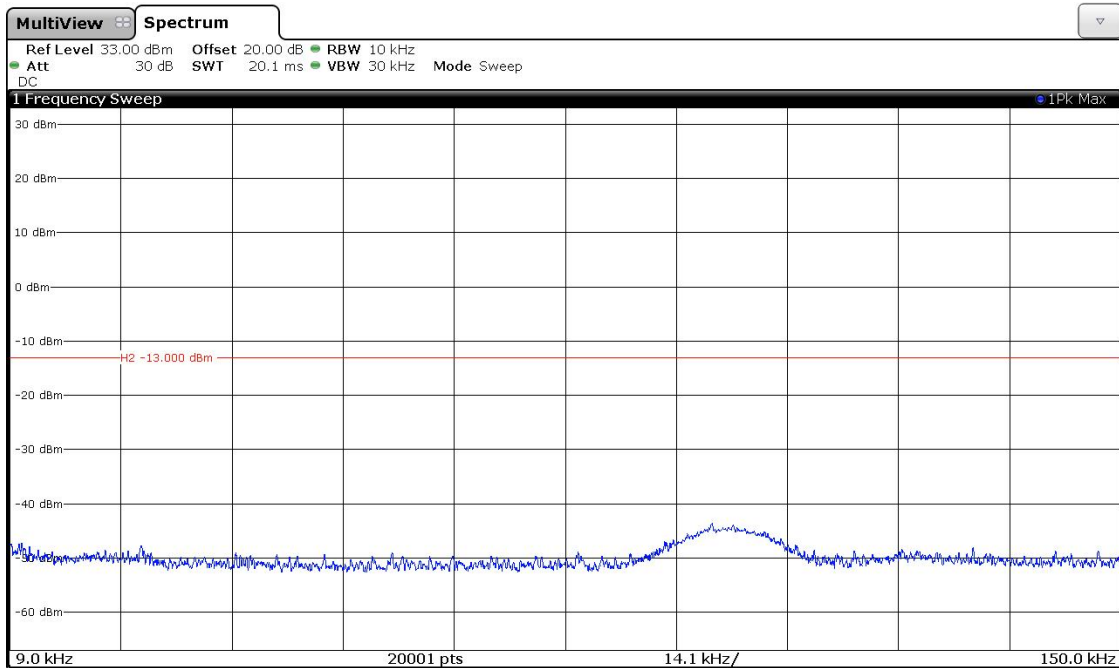
Spur_30M-1G_450M5_25k.PNG



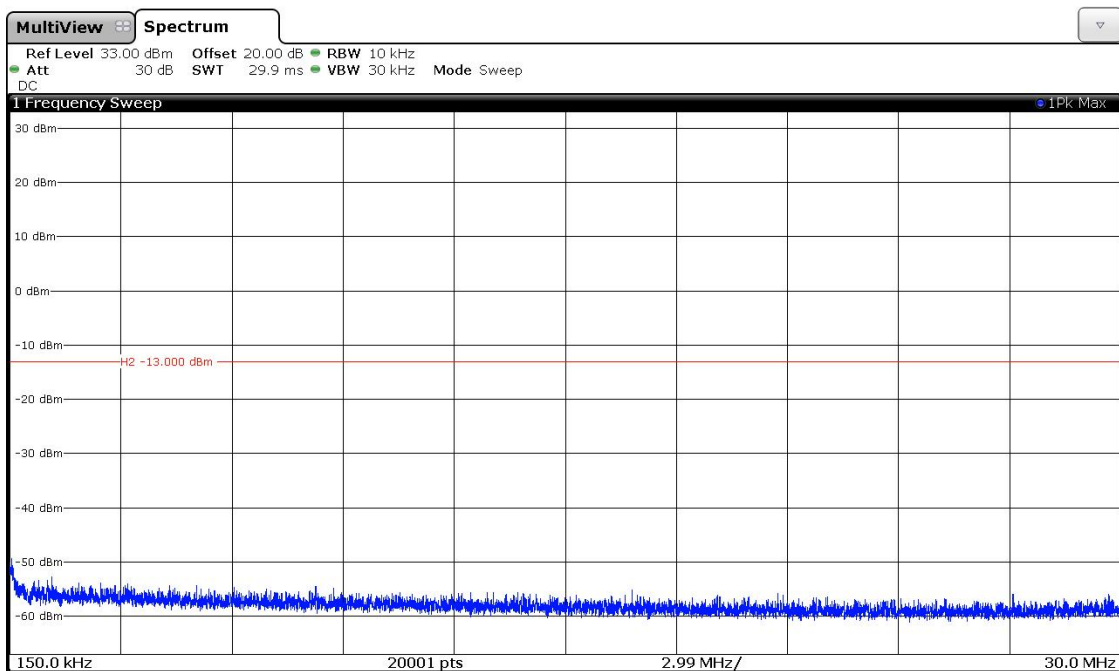
Spur_1-5G_450M5_25k.PNG



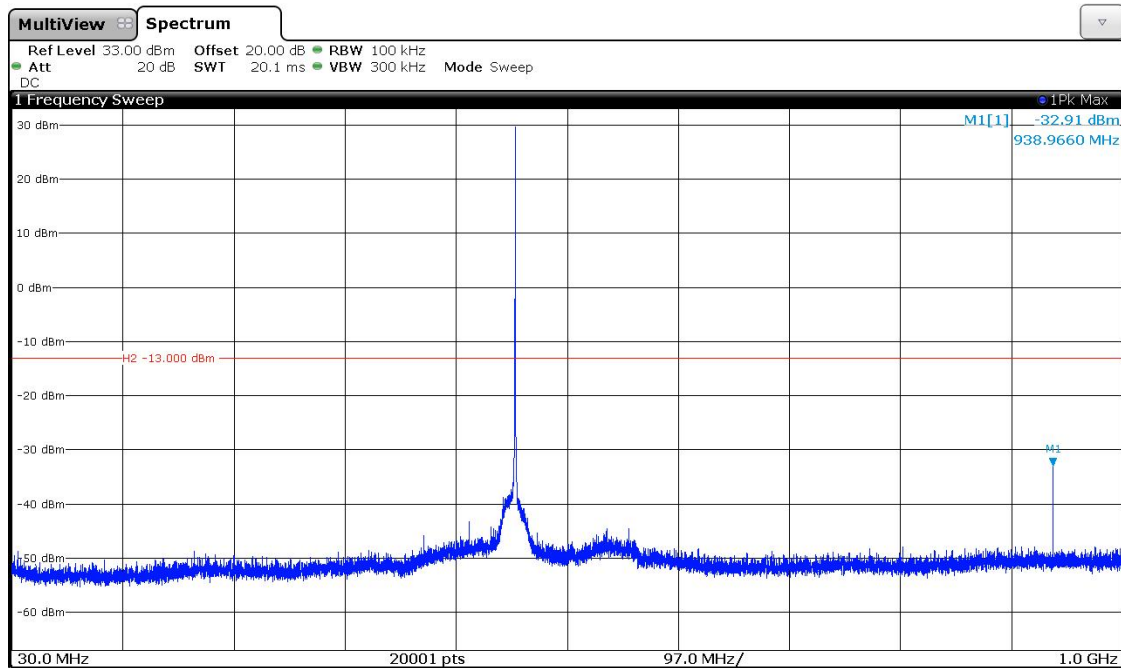
Spur_9-150k_469M5_25k.PNG



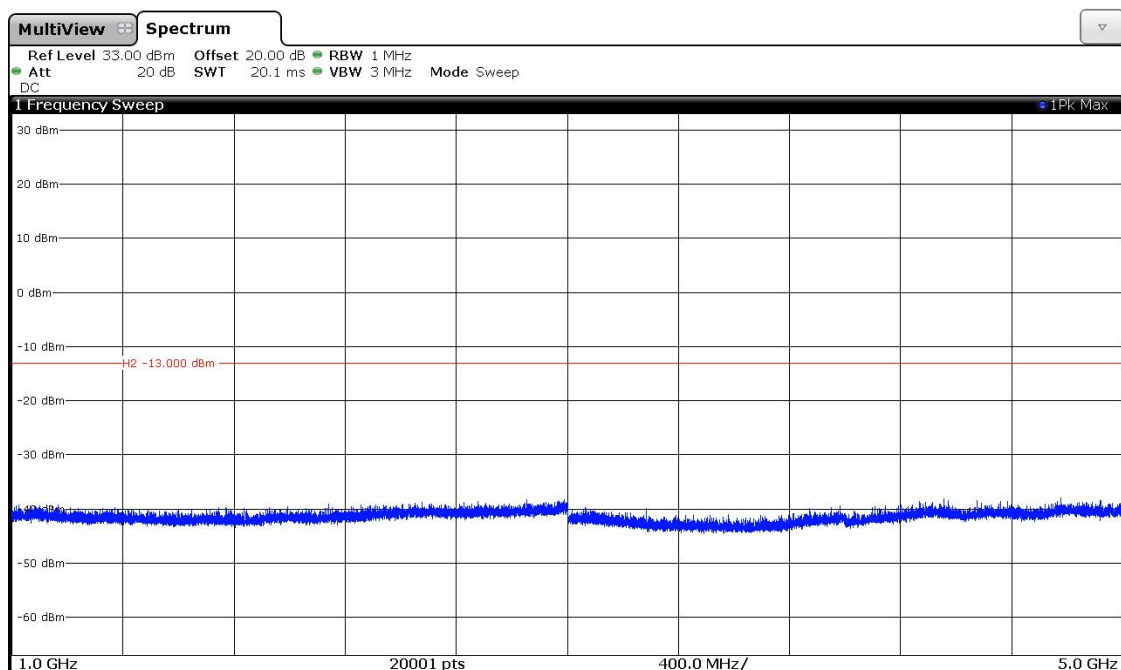
Spur_150k-30M_469M5_25k.PNG



Spur_30M-1G_469M5_25k.PNG



Spur_1-5G_469.5M_25k.PNG



5.5 Spurious emissions (radiated)

5.5.1 General method of measurement

The radiated emission measurement is subdivided into five stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 9 kHz to 1 GHz.
- A final measurement carried out on an outdoor test site without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- A final measurement carried out on an open area test site with reflecting ground plane and various antenna height in the frequency range 30 MHz to 1 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with a variable antenna distance and height in the frequency range 1 GHz to 5 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 5 GHz.

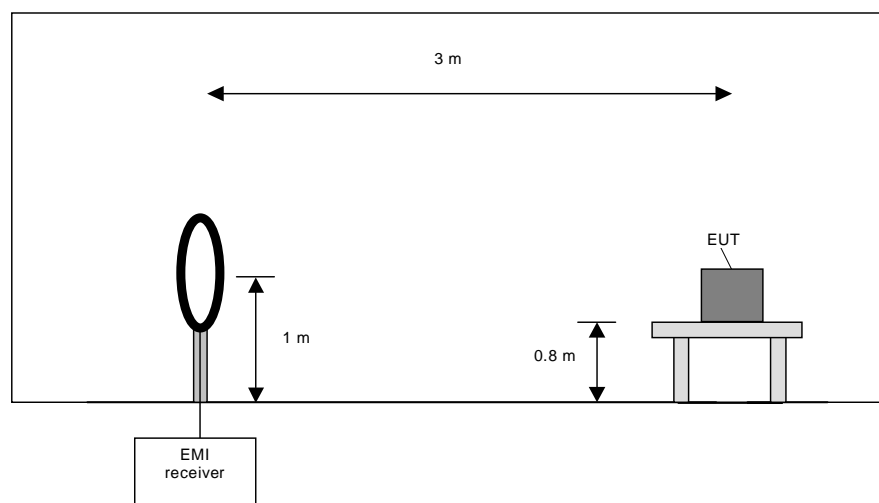
Preliminary measurement (9 kHz to 30 MHz):

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. Table-top devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The setup of the Equipment under test will be in accordance to [5].

The frequency range 9 kHz to 30 MHz will be monitored with a spectrum analyser while the system and its cables will be manipulated to find out the configuration with the maximum emission levels if applicable. The EMI Receiver will be set to MAX Hold mode. The EUT and the measuring antenna will be rotated around their vertical axis to found the maximum emissions.

The resolution bandwidth of the spectrum analyser will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



Preliminary measurement procedure:

Prescans were performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

The following procedure will be used:

- 1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
- 2) Manipulate the system cables within the range to produce the maximum level of emission.
- 3) Rotate the EUT by 360 ° to maximize the detected signals.
- 4) Make a hardcopy of the spectrum.
- 5) Measure the frequencies of highest detected emission with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
- 6) Repeat steps 1) to 5) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).
- 7) Rotate the measuring antenna and repeat steps 1) to 5).

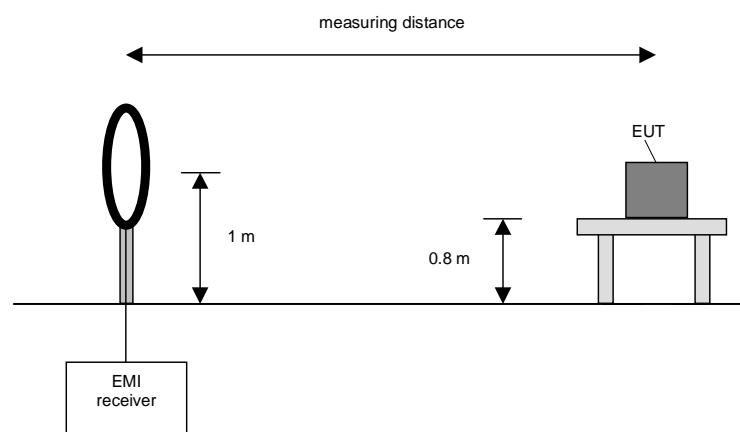
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane in a measuring distances of 3 m, 10 m and 30 m

On the frequencies, which were detected during the preliminary measurements, the final measurement will be performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum value is found.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



Final measurement procedure:

The following procedure will be used:

- 1) Monitor the frequency range with the measuring antenna at vertical orientation parallel to the EUT at an azimuth of 0 °.
- 2) Rotate the EUT by 360 ° to maximize the detected signals and note the azimuth and orientation.
- 3) Rotate the measuring antenna to find the maximum and note the value.
- 4) Rotate the measuring antenna and repeat steps 1) to 3) until the maximum value is found.
- 5) If the EUT is a module and might be used in a handheld equipment application:
Repeat steps 1) to 4) with the other orthogonal axes of the EUT.

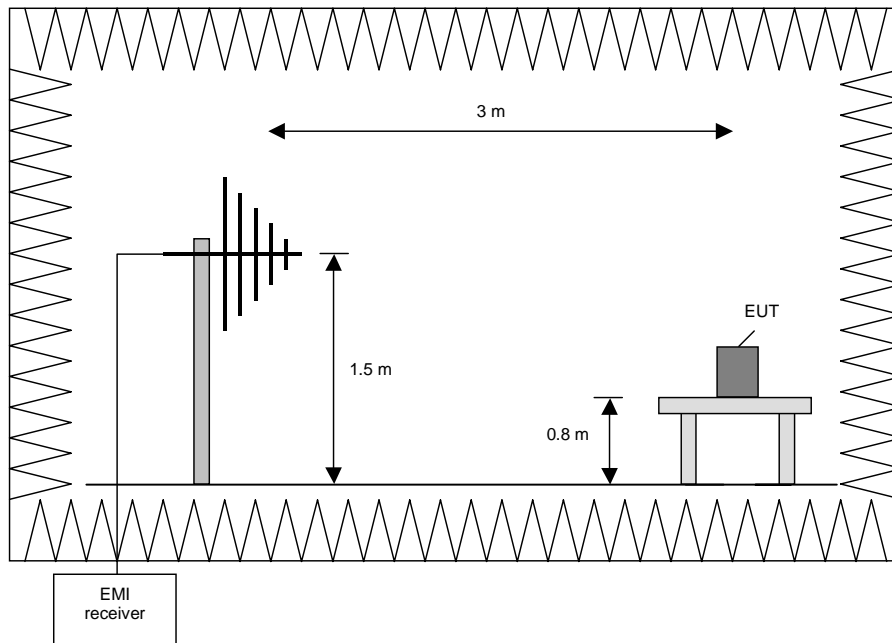
Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Table top devices will set up on a non-conducting table on the height of 0.8 m. Floor-standing devices will be placed directly on the turntable/ground plane.

The frequency range 30 MHz to 1 GHz will be measured with an EMI Receiver set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 230 MHz	100 kHz
230 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 1 GHz.

The following procedure will be used:

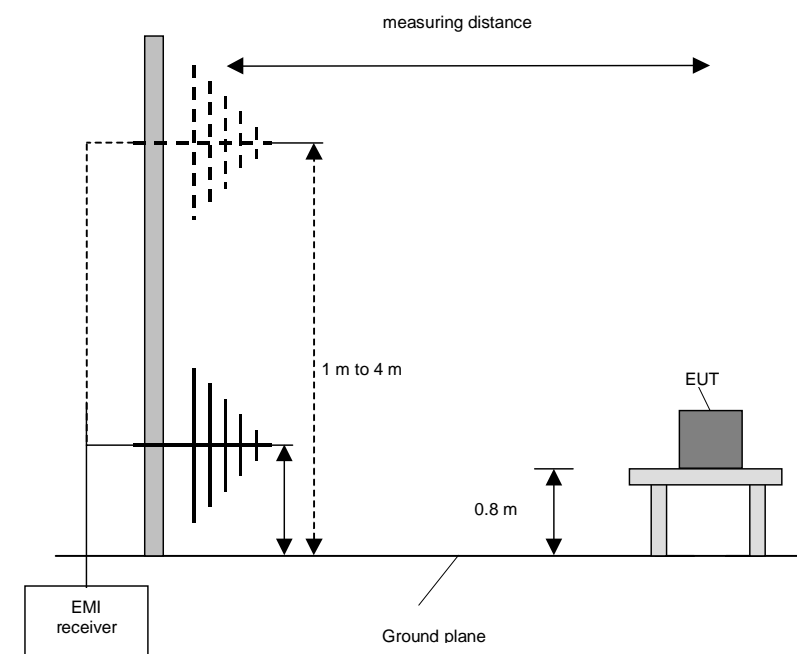
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
6. Repeat 1) to 4) for each orthogonal axes of the EUT (only if the EUT is a module or is used in a handheld application).
7. Repeat 1) to 5) with the vertical polarisation of the measuring antenna.

Final measurement (30 MHz to 1 GHz)

A final measurement on an open area test site will be performed on selected frequencies found in the preliminary measurement. During this test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarisation and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

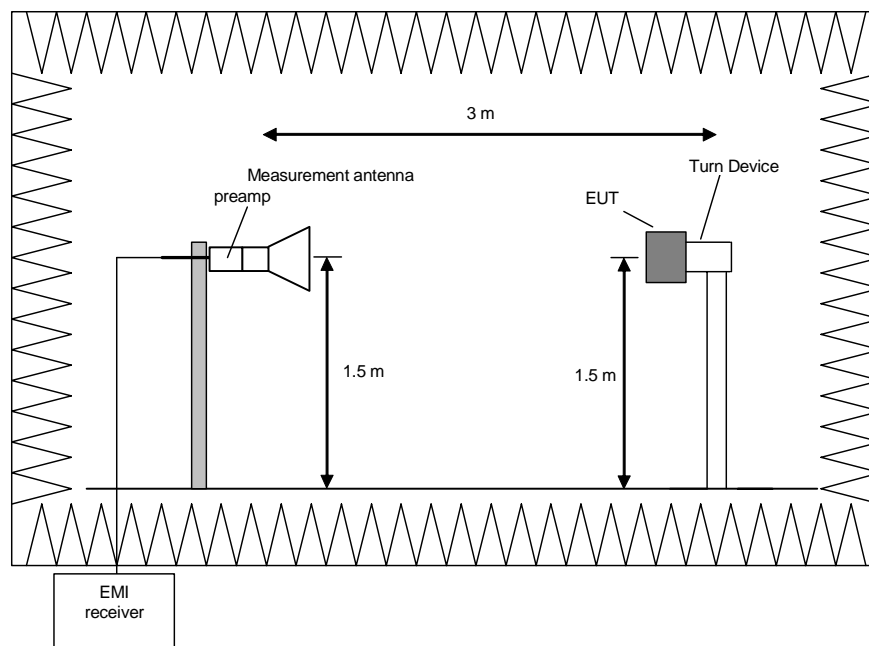
- 1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
- 2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
- 3) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
- 4) Repeat 1) to 3) for the other orthogonal antenna polarization.
- 5) Move the antenna and the turntable to the position where the maximum value is detected.
- 6) Measure while moving the antenna slowly +/- 1 m.
- 7) Set the antenna to the position where the maximum value is found.
- 8) Measure while moving the turntable +/- 45 °.
- 9) Set the turntable to the azimuth where the maximum value is found.
- 10) Measure with Final detector (QP and AV) and note the value.
- 11) Repeat 5) to 10) for each frequency.
- 12) Repeat 1) to 11) for each orthogonal axes of the EUT, if the EUT is a module and might be used in a handheld equipment application).

Preliminary and final measurement (1 GHz to 5 GHz)

This measurement will be performed according to [5] 4.6.2.3 in a fully anechoic chamber. The EUT will be set up on a non-conducting turn device on the height of 1.5 m. Due to the fact that the dimensions of the EUT are small a set-up described in ANSI 63.10 – 2013 chapter 6.6.5 is used.

Preliminary measurement (1 GHz to 5 GHz)

The spectrum analyser is set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30 ° steps.



Procedure preliminary measurement:

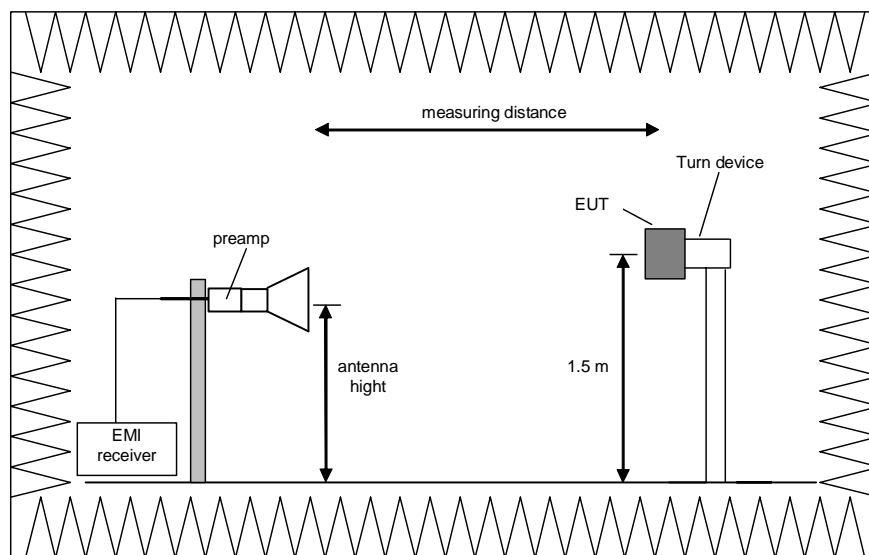
Prescans were performed in the frequency range 1 to 40 GHz.

The following procedure will be used:

1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°).
6. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
7. The measurement antenna polarisation, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The six closest values to the applicable limit will be used for the final measurement.

Final measurement (1 GHz to 5 GHz)

The EMI Receiver is set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed by rotating the turntable from 0 to 360° in the worst-case EUT orientation which was obtained during the preliminary measurements.



Procedure of measurement:

The measurements were performed in the frequency range 1 GHz to 5 GHz.

The following procedure will be used:

- 1) Set the turntable and the turn device to obtain the worst-case emission for the first frequency identified in the preliminary measurements.
- 2) Set the measurement antenna polarisation to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
- 3) Set the spectrum analyser to EMI mode with peak and average detector activated.
- 4) Rotate the turntable from 0° to 360° to find the EUT angle that produces the highest emissions.
- 5) Note the highest displayed peak and average values
- 6) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

5.5.2 Preliminary radiated emission measurement

Ambient temperature	22 °C	Relative humidity	14 %
---------------------	-------	-------------------	------

Position of EUT: The EUT was set-up on a non-conducting table at a height of 0.8 m below 1 GHz and on a positioner at a height of 1,5 m above 1 GHz. The positioner was set to 0°, 30°, 60°, 90°, 120° and 150°. The distance between EUT and antenna was 3 m.

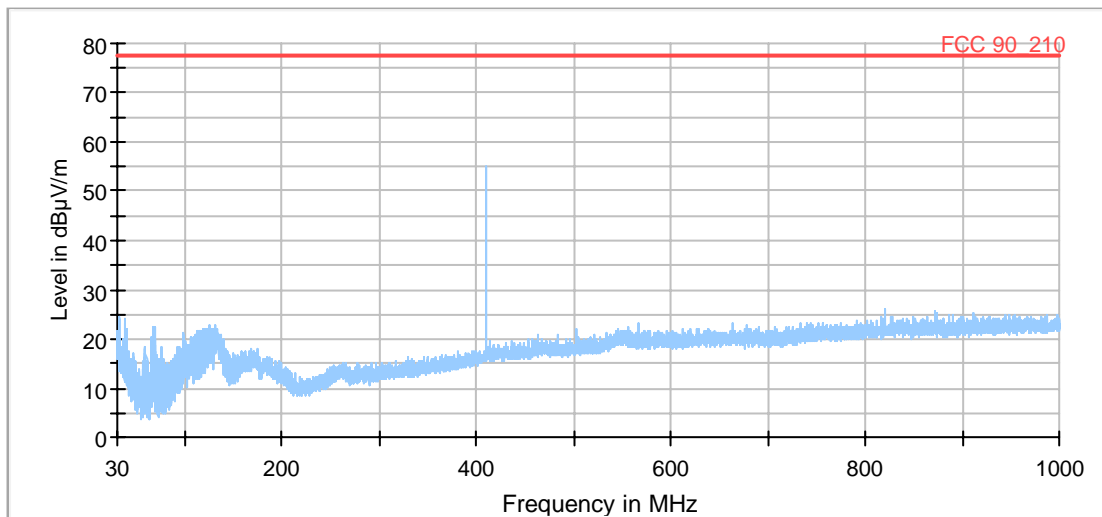
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in Annex A.

Test record: All results are shown in the following.

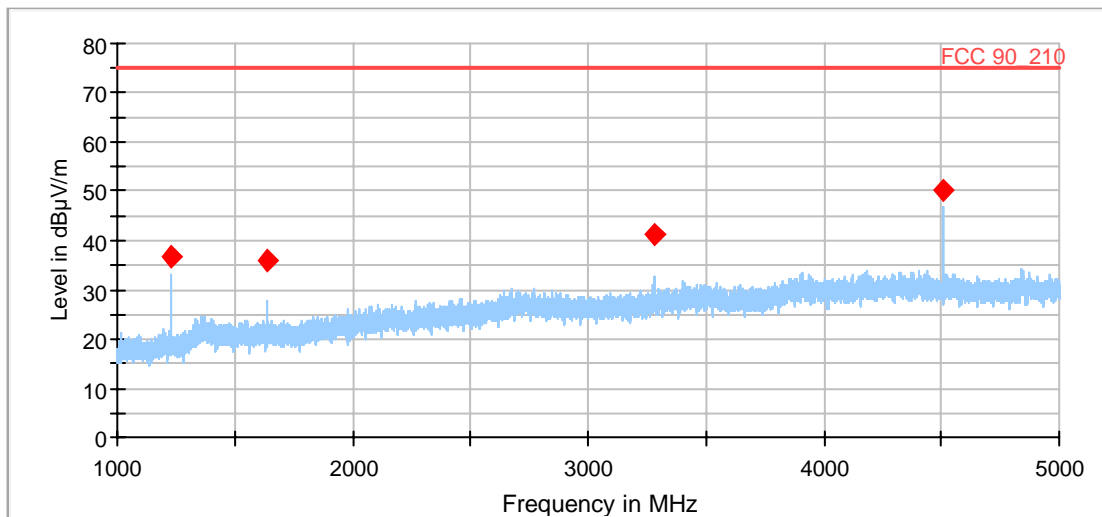
Supply voltage: During all measurements the EUT was powered with 12 V DC by laboratory power supply.

Remark: The antenna terminal was terminated with 50 ohms.

TX 410 MHz, 12.5k

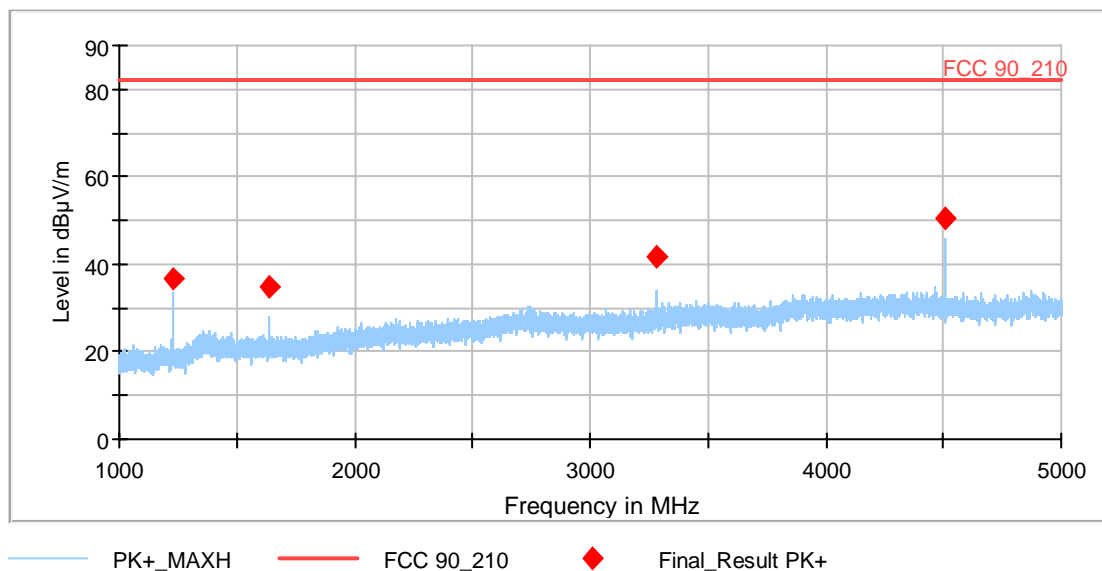
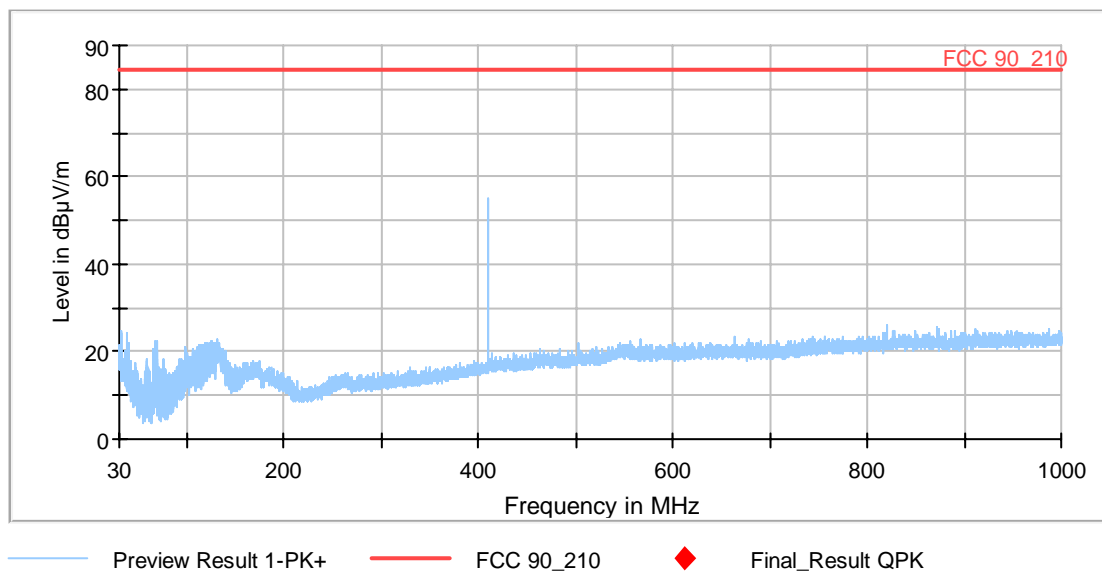


— Preview Result 1-PK+ — FCC 90_210 ◆ Final_Result QPK

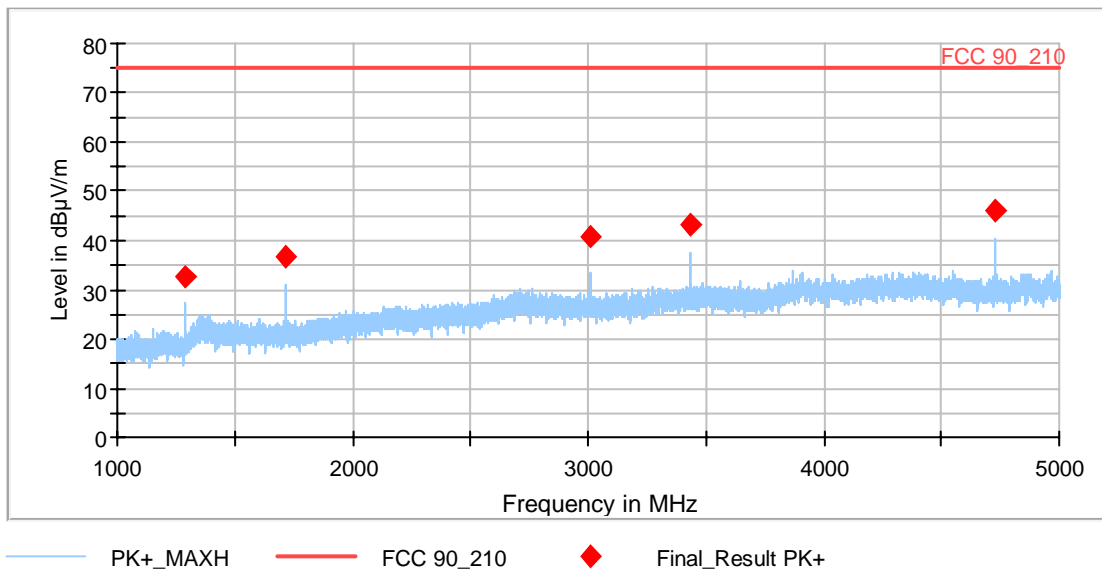
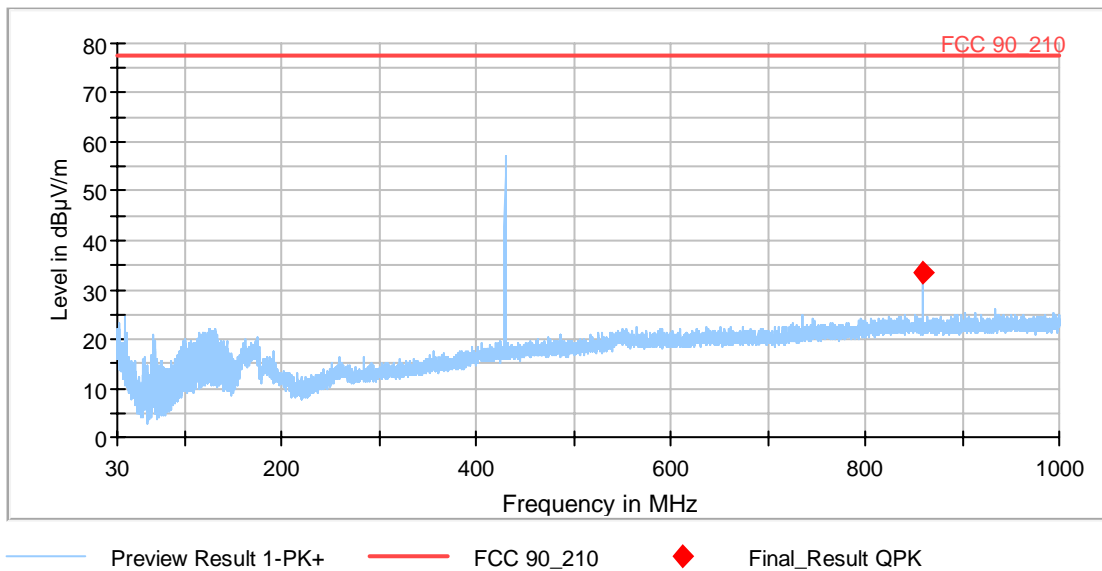


— PK+_MAXH — FCC 90_210 ◆ Final_Result PK+

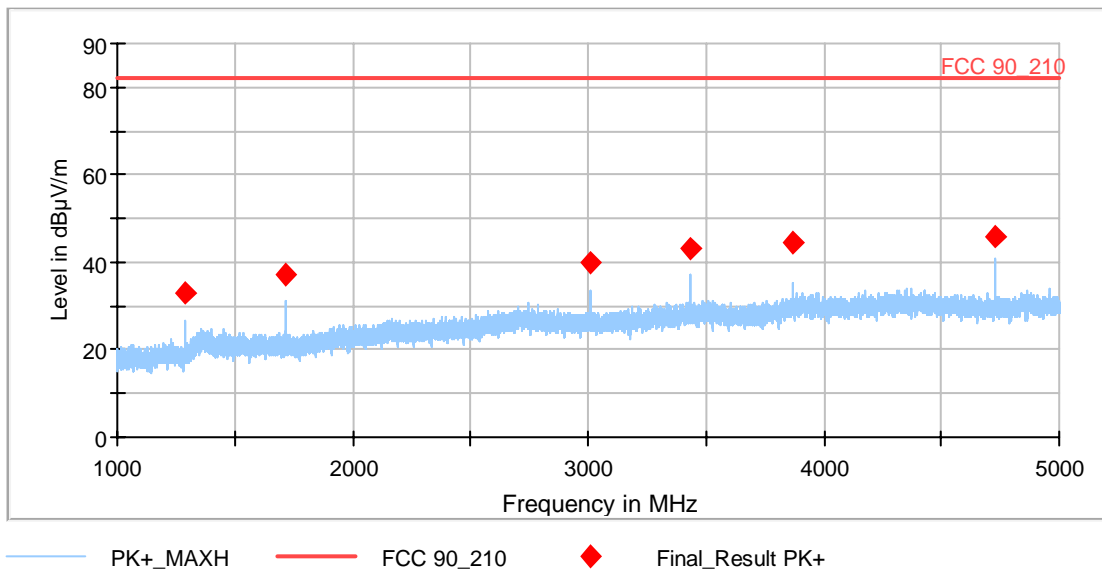
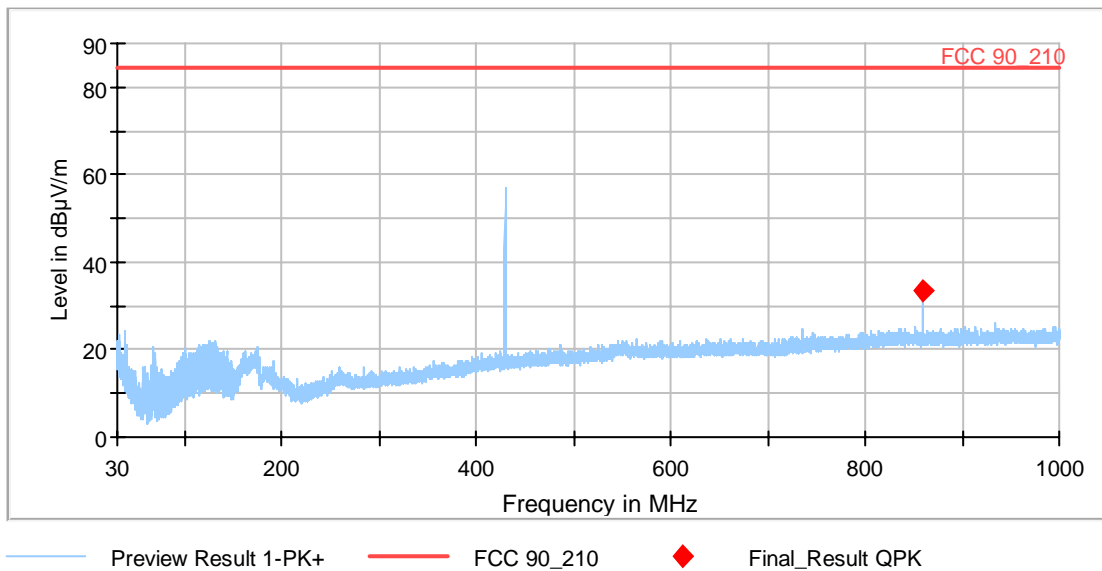
TX 410 MHz, 25k



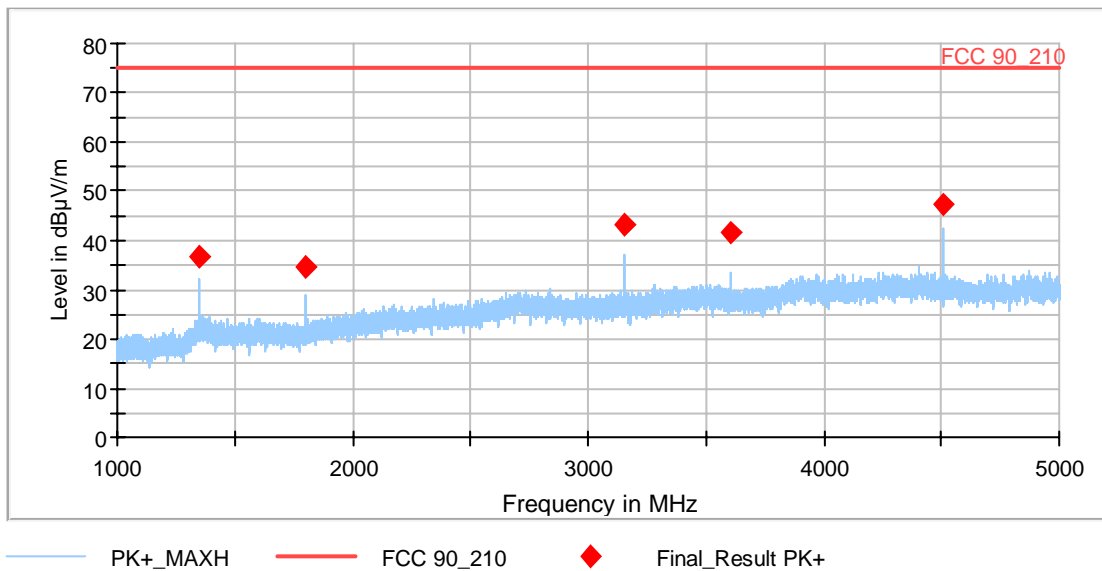
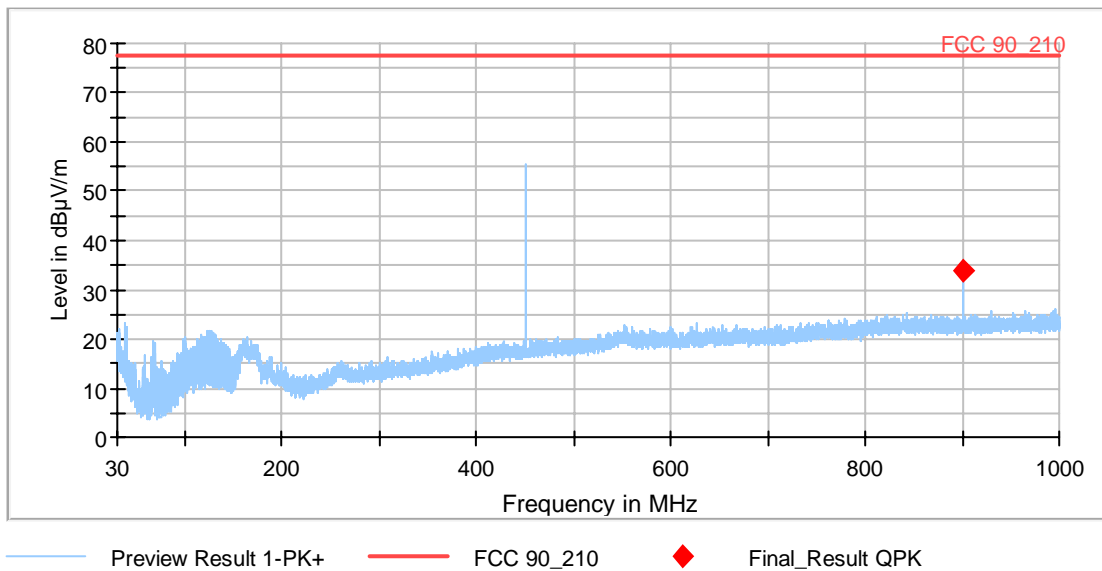
TX 429.5 MHz, 12.5 kHz



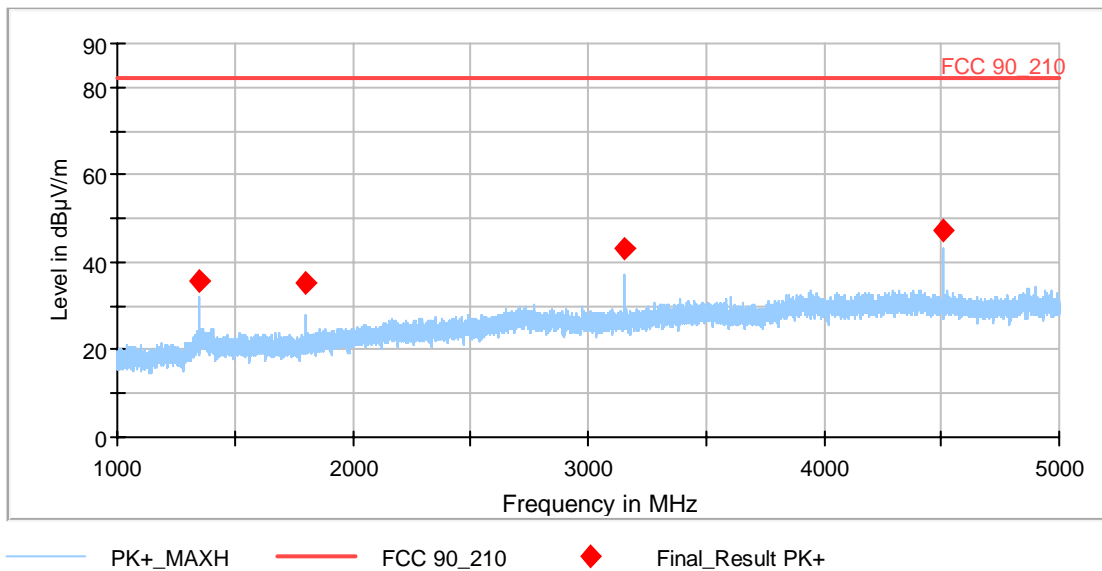
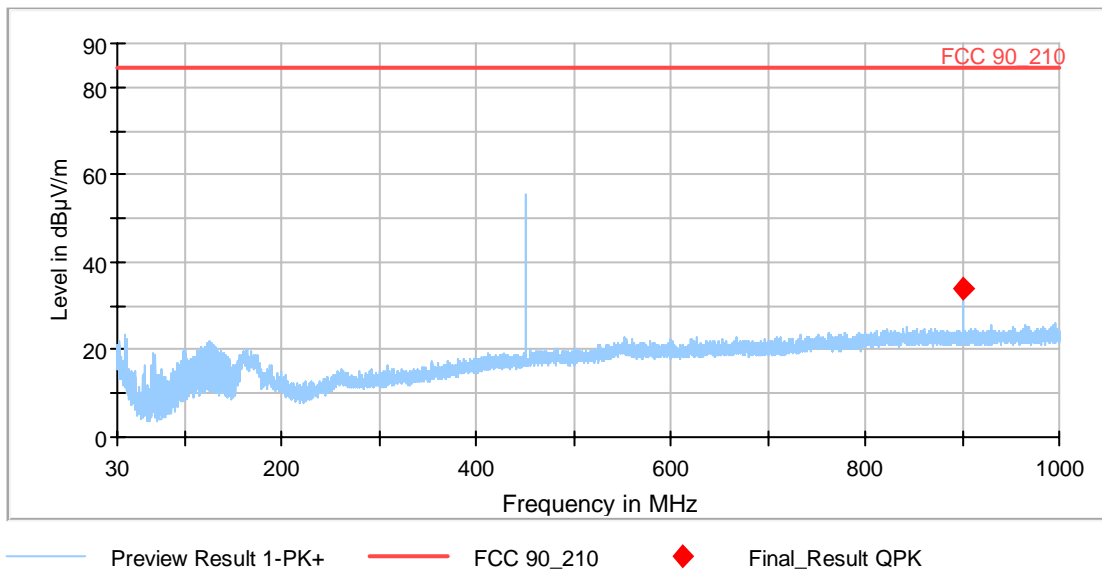
TX 429.5 MHz, 25 kHz



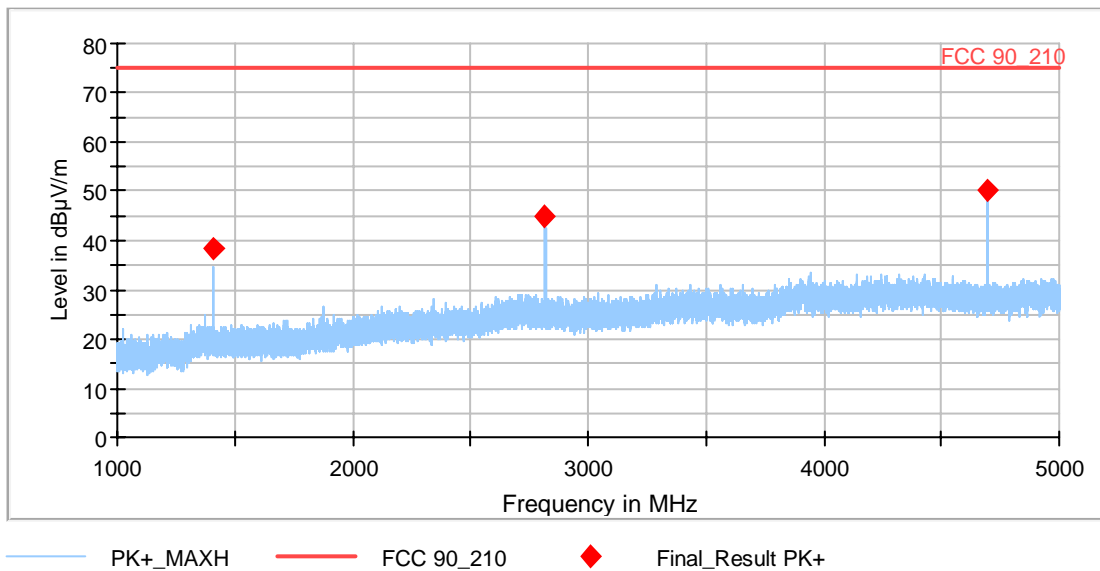
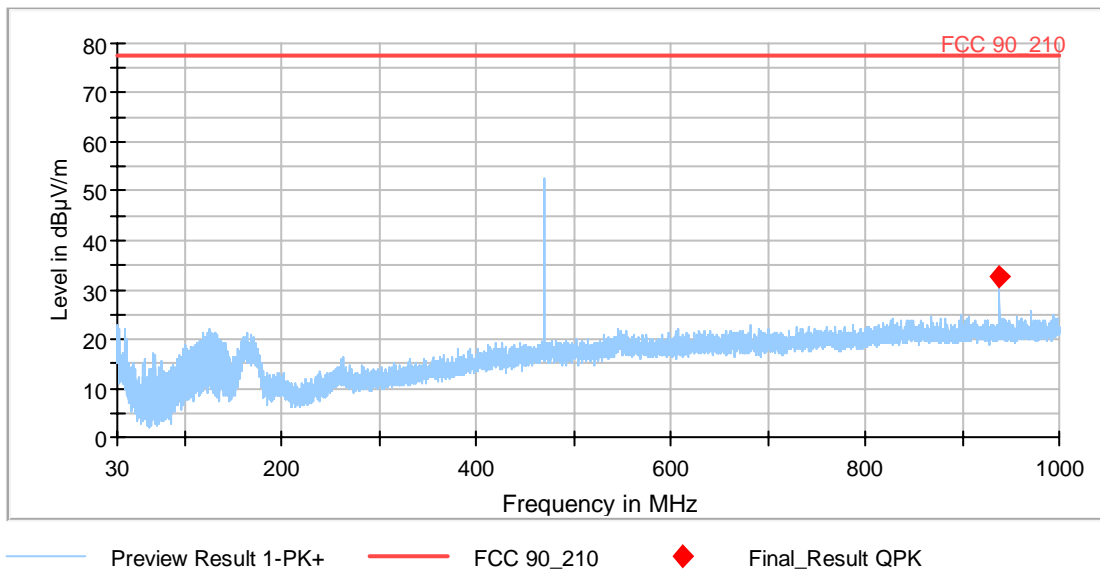
TX 450.5 MHz, 12.5 kHz



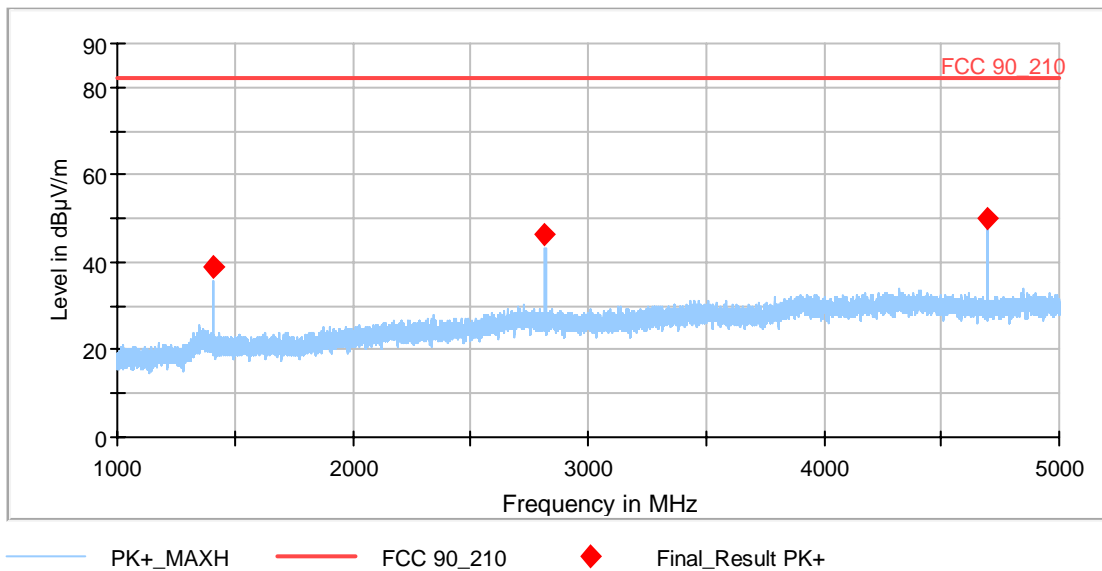
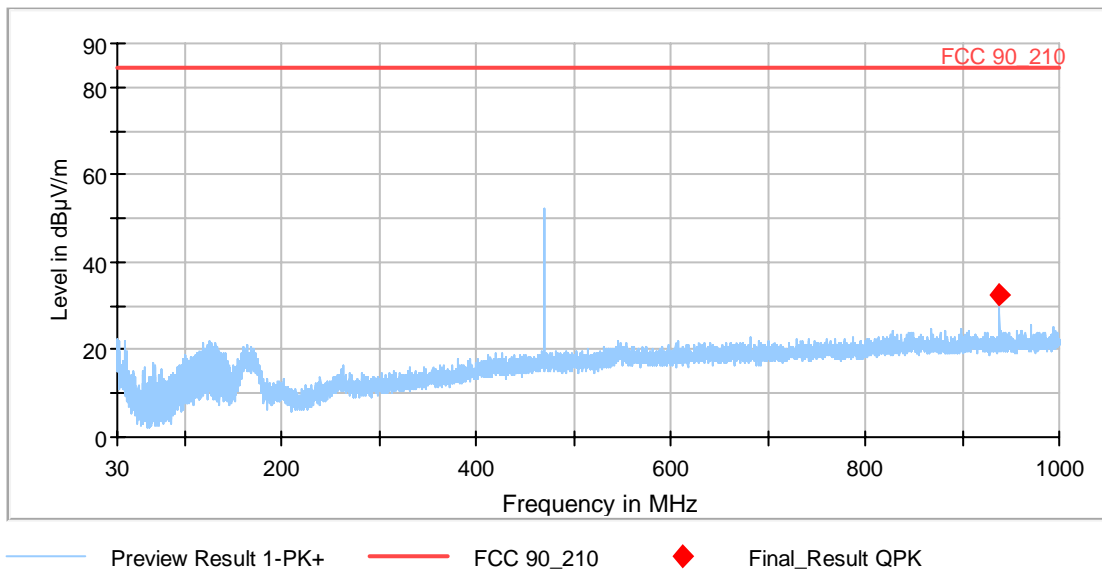
TX 450.5 MHz, 25 kHz



TX 469.5 MHz, 12.5 kHz



TX 469.5 MHz, 25 kHz



Following frequencies were found during the preliminary radiated emission test:

$f_{TX} = 410 \text{ MHz}$	$f_{TX} = 429.5 \text{ MHz}$	$f_{TX} = 450.5 \text{ MHz}$	$f_{TX} = 469.5 \text{ MHz}$
1230.000 MHz	859.011 MHz	901.012 MHz	938.987 MHz
1640.000 MHz	1288.457 MHz	1351.486 MHz	1408.486 MHz
3279.971 MHz	1718.000 MHz	1802.000 MHz	2817.000 MHz
4510.029 MHz	3006.486 MHz	3153.486 MHz	4694.971 MHz
-	3435.971 MHz	4505.000 MHz	-
-	3865.486 MHz	-	-
-	4724.543 MHz	-	-

These frequencies have to be measured in a final measurement.
The results are presented in the following.

Test equipment used (refer clause 6):

7, 8, 10 – 14, 17, 18, 19, 22, 24, 25, 33, 35, 37, 38

5.5.3 Final Results

5.5.3.1 Final radiated emission measurement (30 MHz to 1 GHz)

Ambient temperature	22 °C	Relative humidity	55 %
---------------------	-------	-------------------	------

Position of EUT: The EUT was set-up on a non-conducting table at a height of 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 12 V_{DC} by laboratory power supply.

Resolution bandwidth: For all measurements a resolution bandwidth of 100 kHz was used.

Channel Spacing 12.5 kHz

TX Frequency [MHz]	Frequency [MHz]	QuasiPeak [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]
410.0	-	-	77.5	-	1000	120		-	-	-
429.5	859.0	34.0	77.5	43.5	1000	120	150.0	V	182.0	30.2
450.5	901.0	34.6	77.5	42.9	1000	120	111.0	V	0.0	30.4
469.5	939.0	32.7	77.5	44.8	1000	120	120.0	V	0.0	30.8

Limit:

The power of any emission on any frequency removed from the centre of the authorized bandwidth by more than 250 percent of the authorized bandwidth shall be attenuated at least $50 + 10 \log (P)$ dB.

Attenuation for 1 W carrier power: $50 + 10 \log (P)$ dB = $50 + 10 \log (1)$ dB = 50 dB

ERP limit for any emission: 30 dBm - 50 dB = -20 dBm

Field strength limit: E (dBμV/m) = ERP (dBm) - 20 log (D) + 107; where D is the measurement distance.

E (dBμV/m) = -20 - 20 log (3) + 107 = 77.5 dBμV/m

Test: Passed

Test equipment used (refer clause 6):

1 – 7, 25, 32, 33

Channel Spacing 25 kHz

TX Frequency [MHz]	Frequency [MHz]	QuasiPeak [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]
410.0	-	-	84.5	-	1000	120		-	-	-
429.5	859.0	34.0	84.5	50.5	1000	120	150.0	V	182.0	30.2
450.5	901.0	34.6	84.5	49.9	1000	120	111.0	V	0.0	30.4
469.5	939.0	32.7	84.5	51.8	1000	120	120.0	V	0.0	30.8

Limit:

The power of any emission beyond 50 kHz from the edge of the authorized bandwidth shall be attenuated at least: $43 + 10 \log (P)$ dB.

Attenuation for 1 W carrier power: $43 + 10 \log (P)$ dB = $43 + 10 \log (1)$ dB = 43 dB

ERP limit for any emission: 30 dBm - 53 dB = -13 dBm

Field strength limit: E (dBμV/m) = ERP (dBm) - 20 log (D) + 107; where D is the measurement distance.

E (dBμV/m) = -13 - 20 log (3) + 107 = 84.5 dBμV/m

Test: Passed

Test equipment used (refer clause 6):

1 – 7, 25, 32, 33

5.5.3.2 Final radiated emission measurement (1 GHz to 5 GHz)

Ambient temperature	22 °C	Relative humidity	14 %
---------------------	-------	-------------------	------

Position of EUT:	The EUT was set-up on a positioner at a height of 1.5 m. The positioner was set to the angle for worst case emission found in the preliminary measurement. The distance between EUT and antenna was 3 m.
Cable guide:	For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.
Test record:	All results are shown in the following.
Supply voltage:	During all measurements the EUT was supplied with 12 V _{DC} by laboratory power supply.
Resolution bandwidth:	For all measurements a resolution bandwidth of 1 MHz was used.

Channel Spacing 12.5 kHz

TX Frequency [MHz]	Frequency [MHz]	MaxPeak [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Pol	Azimuth [deg]	Elevation [deg]	Corr. [dB]
410.0	1230.000	36.7	75.3	38.6	H	230.0	90.0	-16.3
	1640.000	35.8	75.3	39.5	H	230.0	90.0	-13.6
	3279.971	41.3	75.3	34.0	H	308.0	90.0	-6.5
	4510.000	50.2	75.3	25.1	H	261.0	90.0	-3.0
429.5	1288.486	32.5	75.3	42.8	V	219.0	0.0	-16.2
	1718.000	36.7	75.3	38.6	H	221.0	90.0	-13.2
	3006.486	41.0	75.3	34.3	H	203.0	120.0	-7.8
	3435.971	43.1	75.3	32.2	H	203.0	60.0	-5.8
	4724.486	46.1	75.3	29.2	H	272.0	90.0	-2.4
450.5	1351.486	36.8	75.3	38.5	H	272.0	90.0	-15.5
	1801.971	34.9	75.3	40.4	V	174.0	30.0	-13.0
	3153.486	43.4	75.3	31.9	H	308.0	90.0	-6.9
	3604.000	41.4	75.3	33.9	H	308.0	90.0	-6.2
	4505.000	47.2	75.3	28.1	H	262.0	60.0	-3.0
469.5	1408.486	38.3	75.3	37.0	H	328.0	90.0	-15.1
	2817.000	45.0	75.3	30.3	H	252.0	90.0	-8.0
	4694.971	50.4	75.3	24.9	H	260.0	90.0	-2.7
Measurement uncertainty: +2.2 dB / -3.6 dB								

Limit:

The power of any emission on any frequency removed from the centre of the authorized bandwidth by more than 250 percent of the authorized bandwidth shall be attenuated at least $50 + 10 \log (P)$ dB.

Attenuation for 1 W carrier power: $50 + 10 \log (P)$ dB = $50 + 10 \log (1)$ dB = 50 dB

ERP limit for any emission: 30 dBm - 50 dB = -20 dBm

Field strength limit: E (dBμV/m) = $EIRP$ (dBm) - $20 \log (D)$ + 104.8; where D is the measurement distance.

E (dBμV/m) = $-20 - 20 \log (3) + 104.8 = 75.3$ dBμV/m

Test: Passed

Test equipment used (refer clause 6):

7 – 14, 16, 18, 19, 32, 33, 35, 37, 38

5.5.3.3 Channel Spacing 25 kHz

TX Frequency [MHz]	Frequency [MHz]	MaxPeak [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Pol	Azimuth [deg]	Elevation [deg]	Corr. [dB]
410.0	1230.000	36.7	82.3	45.6	H	230.0	59.0	-16.3
	1640.000	34.8	82.3	47.5	H	237.0	90.0	-13.6
	3279.971	41.6	82.3	40.7	H	212.0	60.0	-6.5
	4510.029	50.4	82.3	31.9	H	264.0	60.0	-3.0
429.5	1288.457	33.1	82.3	49.2	H	196.0	59.0	-16.2
	1718.000	37.0	82.3	45.3	H	223.0	120.0	-13.2
	3006.486	39.8	82.3	42.5	H	214.0	59.0	-7.8
	3435.971	43.4	82.3	38.9	H	214.0	59.0	-5.8
	3865.486	44.6	82.3	37.7	H	283.0	90.0	-4.0
	4724.543	33.1	82.3	49.2	H	260.0	90.0	-2.4
450.5	1351.486	35.9	82.3	46.4	H	272.0	90.0	-15.5
	1802.000	35.2	82.3	47.1	H	231.0	90.0	-13.0
	3153.486	43.3	82.3	39.0	H	308.0	90.0	-6.9
	4505.000	47.4	82.3	34.9	H	262.0	90.0	-3.0
469.5	1408.486	38.9	82.3	43.4	H	323.0	90.0	-15.1
	2817.000	46.2	82.3	36.1	H	203.0	120.0	-8.0
	4695.000	50.2	82.3	32.1	H	262.0	89.0	-2.7
Measurement uncertainty: +2.2 dB / -3.6 dB								

Limit:

The power of any emission beyond 50 kHz from the edge of the authorized bandwidth shall be attenuated at least: $43 + 10 \log (P)$ dB.

Attenuation for 1 W carrier power: $43 + 10 \log (P)$ dB = $43 + 10 \log (1)$ dB = 43 dB

ERP limit for any emission: 30 dBm - 43 dB = -13 dBm

Field strength limit: E (dBμV/m) = EIRP (dBm) - $20 \log (D)$ + 104.8; where D is the measurement distance.

E (dBμV/m) = -13 - $20 \log (3)$ + 104.8 = 82.3 dBμV/m

Test: Passed

Test equipment used (refer clause 6):

7 – 14, 16, 18, 19, 32, 33, 35, 37, 38
--

5.6 Frequency Stability

5.6.1 Method of measurement

Test setup:



Test was performed at 410.0 MHz and 469.5 MHz at 1 W unmodulated.

5.6.1.1 Test results

Ambient temperature	22 °C	Relative humidity	16 %
---------------------	-------	-------------------	------

Frequency stability versus voltage variations

Voltage	Frequency (MHz)		Frequency error			
	measured	nominal	(Hz)	(ppm)	Limit (ppm)	
					ABW = 11.25 kHz	ABW = 20 kHz
Nominal voltage (12 V)	410.000133	410.000000	133	0.32	±2.5	±5.0
85% of nominal voltage	410.000133	410.000000	133	0.32		
115% of nominal voltage	410.000133	410.000000	133	0.32		
Minimal voltage (9 V)	410.000133	410.000000	133	0.32		
Maximal voltage (16 V)	410.000133	410.000000	133	0.32		
Measurement uncertainty: <10 ⁻⁷ (frequency), +0.66 dB / -0.72 dB (level)						

Voltage	Frequency (MHz)		Frequency error			
	measured	nominal	(Hz)	(ppm)	Limit (ppm)	
					ABW = 11.25 kHz	ABW = 20 kHz
Nominal voltage (12 V)	469.500062	469.500000	62	0.13	±2.5	±5.0
85% of nominal voltage	469.500062	469.500000	62	0.13		
115% of nominal voltage	469.500062	469.500000	62	0.13		
Minimal voltage (9 V)	469.500062	469.500000	62	0.13		
Maximal voltage (16 V)	469.500062	469.500000	62	0.13		
Measurement uncertainty: <10 ⁻⁷ (frequency)						

Frequency stability versus temperature variations

Temperature (°C)	Frequency (MHz)		Frequency error			
	measured	nominal	(Hz)	(ppm)	Limit (ppm)	
					ABW = 11.25 kHz	ABW = 20 kHz
70	409.999932	410.000000	-68	-0.17	±2.5	±5.0
60	409.999954	410.000000	-54	-0.13		
50	409.999933	410.000000	-67	-0.16		
40	409.999958	410.000000	-42	-0.10		
30	410.000146	410.000000	+146	+0.35		
20	410.000133	410.000000	+133	+0.32		
10	410.000074	410.000000	+74	+0.18		
0	409.999922	410.000000	-78	-0.19		
-10	409.999922	410.000000	-78	-0.19		
-20	409.999925	410.000000	-75	-0.18		
-30	410.000126	410.000000	+126	+0.31		
-40	410.000125	410.000000	+125	+0.30		
Measurement uncertainty: <10 ⁻⁷ (frequency)						

Temperature (°C)	Frequency (MHz)		Frequency error			
	measured	nominal	(Hz)	(ppm)	Limit (ppm)	
					ABW = 11.25 kHz	ABW = 20 kHz
70	469.499874	469.5	-126	-0.27	±2.5	±5.0
60	469.499883	469.5	-117	-0.25		
50	469.499892	469.5	-108	-0.23		
40	469.500047	469.5	+47	+0.10		
30	469.500122	469.5	+122	+0.26		
20	469.500062	469.5	+62	+0.13		
10	469.499987	469.5	-13	-0.03		
0	469.499897	469.5	-103	-0.22		
-10	469.499884	469.5	-116	-0.25		
-20	469.499941	469.5	-59	-0.13		
-30	469.500085	469.5	+85	+0.18		
-40	469.500101	469.5	+102	+0.22		
Measurement uncertainty: <10 ⁻⁷ (frequency)						

Limit:

The equipment tested shall not deviate more than 2.5 ppm from the nominal frequency for Authorized bandwidth of 11.25 kHz.

The equipment tested shall not deviate more than 5 ppm from the nominal frequency for Authorized bandwidth of 20 kHz.

Test: Passed

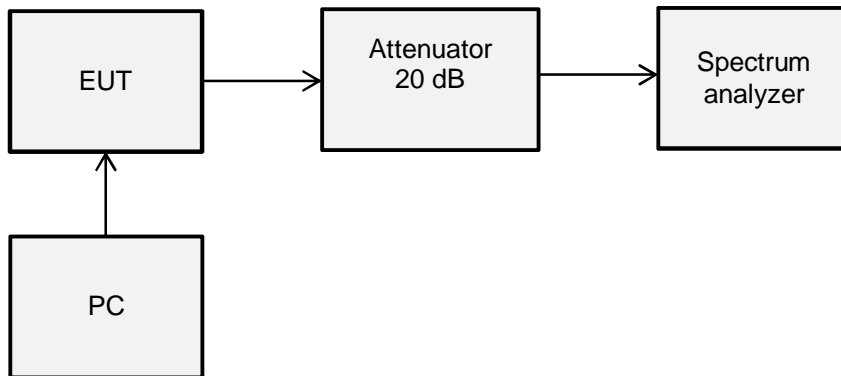
Test equipment used (refer clause 6):

26, 32 – 34, 36

5.7 Transient frequency behaviour

5.7.1 Method of measurement

Test setup:



The following spectrum analyser settings were used:

- Mode: Analog Demodulation
- Demodulation bandwidth: 100 kHz
- Video bandwidth: 500 kHz
- Sweep Mode: Single sweep
- Acquisition time: 49.984 ms
- Detector function: Peak
- Trace mode: Max hold

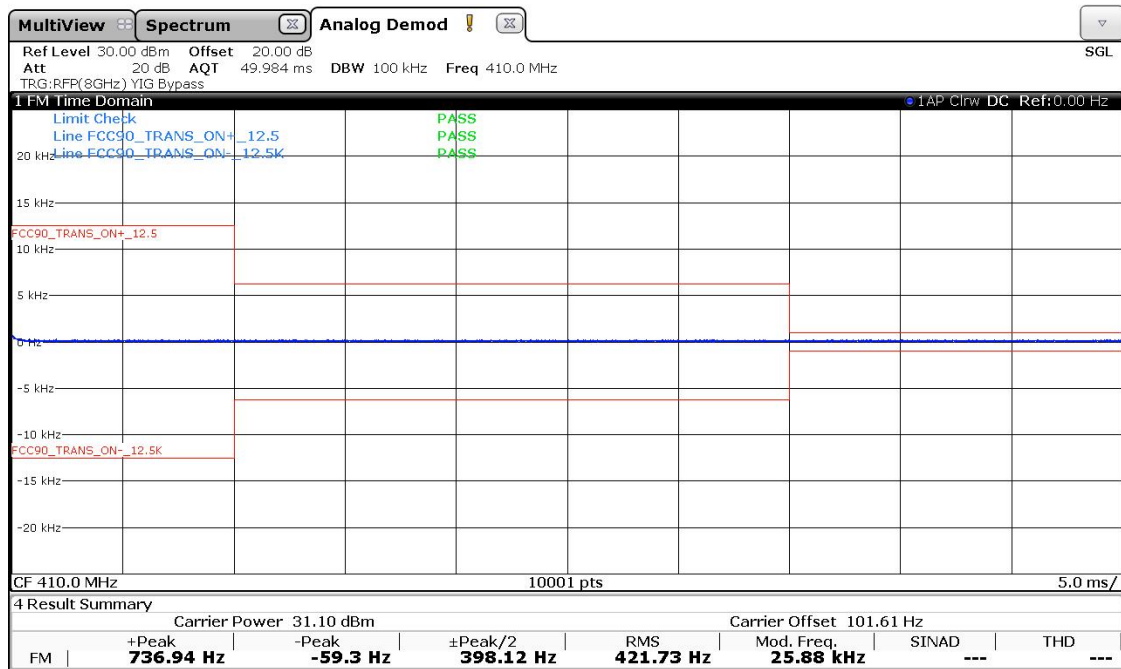
By the PC the EUT was set to transmit at 406.5 MHz and 469.5 MHz unmodulated. The output power was set to 1 W and the channel spacing to 12.5 kHz and 25 kHz.

5.7.2 Test Results

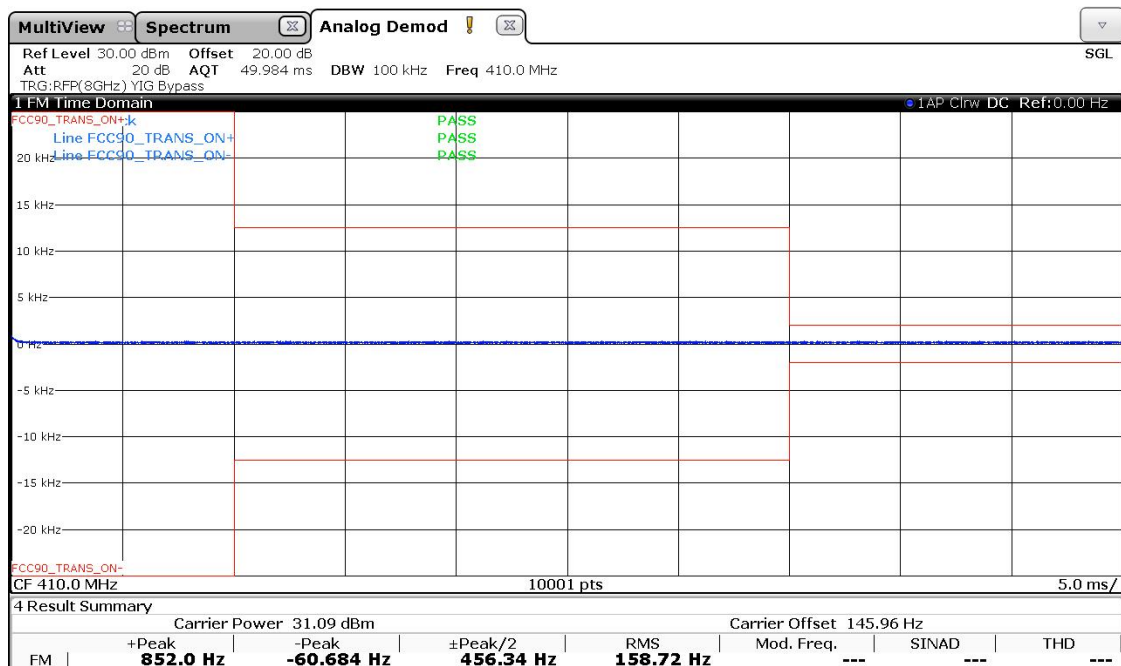
Ambient temperature	22 °C	Relative humidity	15 %
---------------------	-------	-------------------	------

TX off to TX on

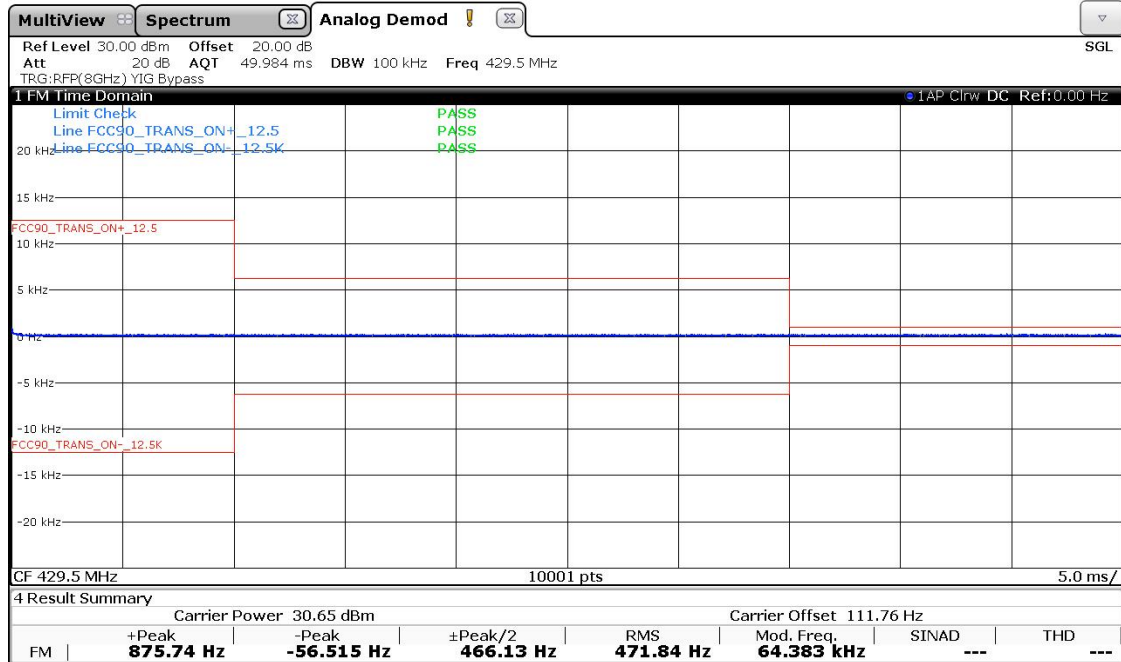
$f_{TX} = 410.0 \text{ MHz}$, CSP = 12.5 KHz



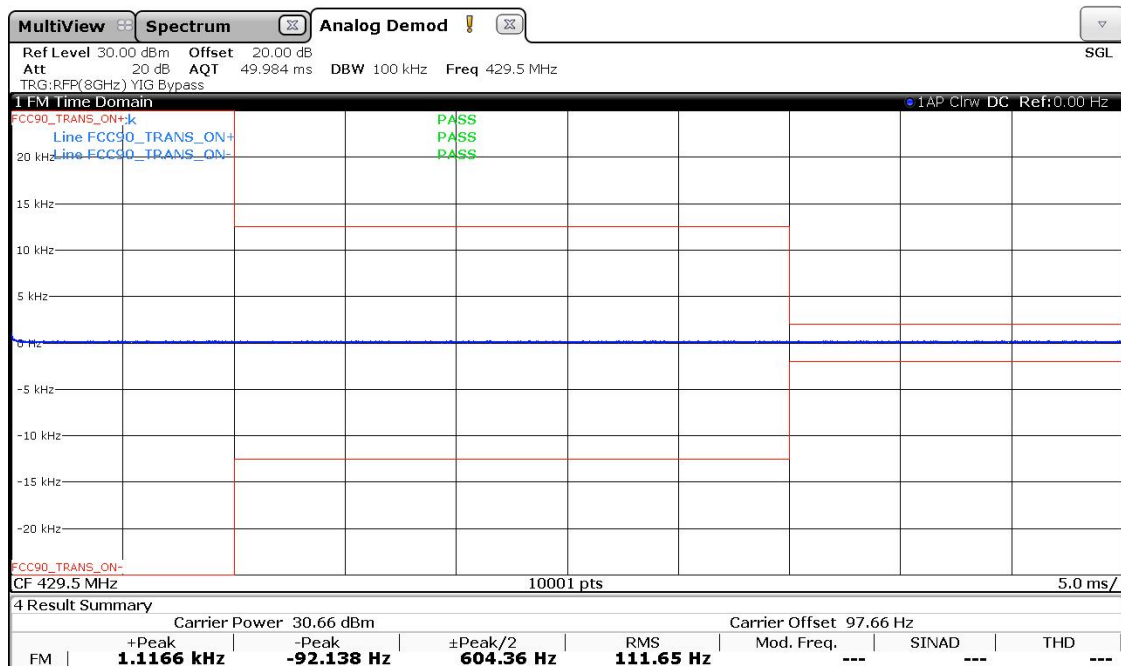
$f_{TX} = 410.0 \text{ MHz}$, CSP = 25 KHz



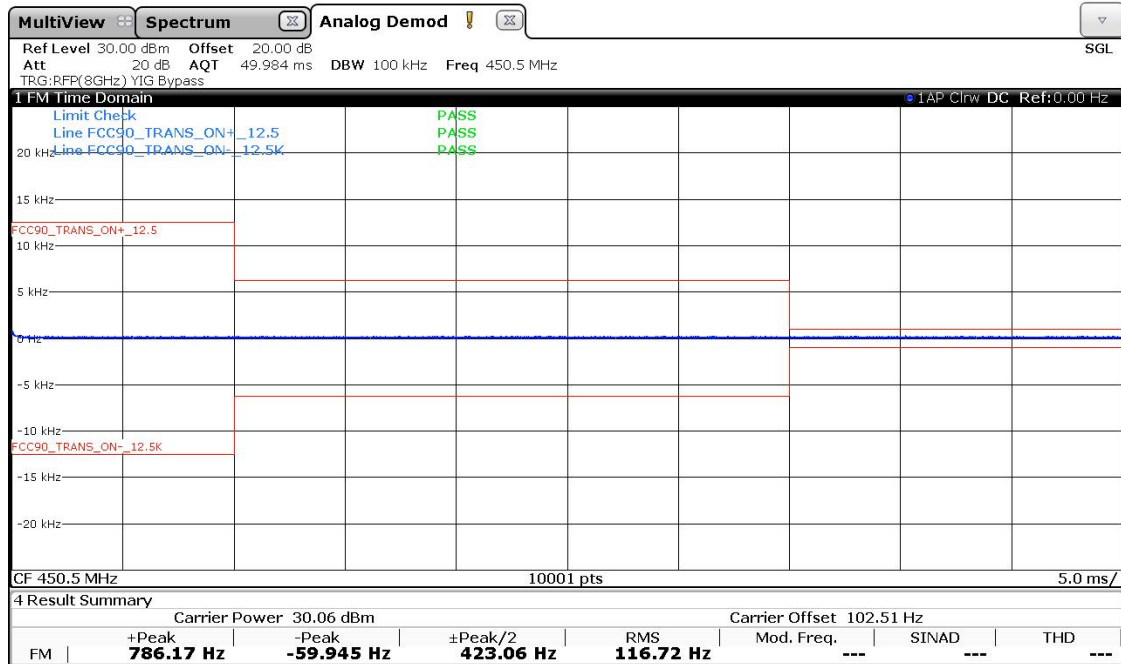
$f_{TX} = 429.5 \text{ MHz}$, $CSP = 12.5 \text{ KHz}$



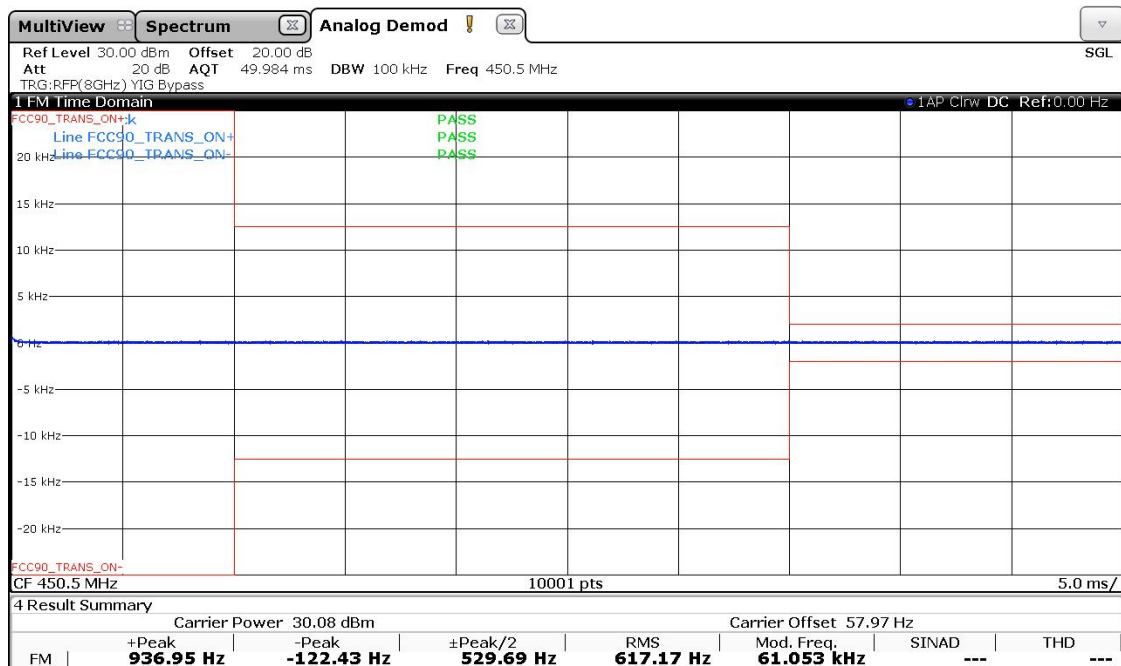
$f_{TX} = 429.5 \text{ MHz}$, $CSP = 25 \text{ KHz}$



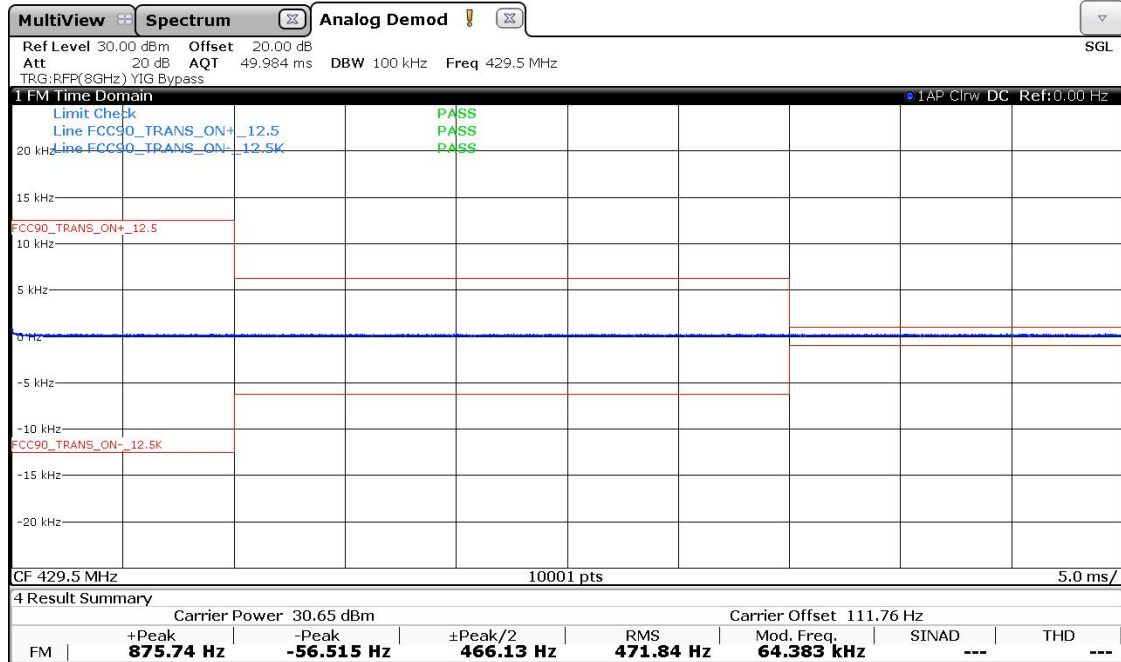
$f_{TX} = 450.5 \text{ MHz}$, $CSP = 12.5 \text{ KHz}$



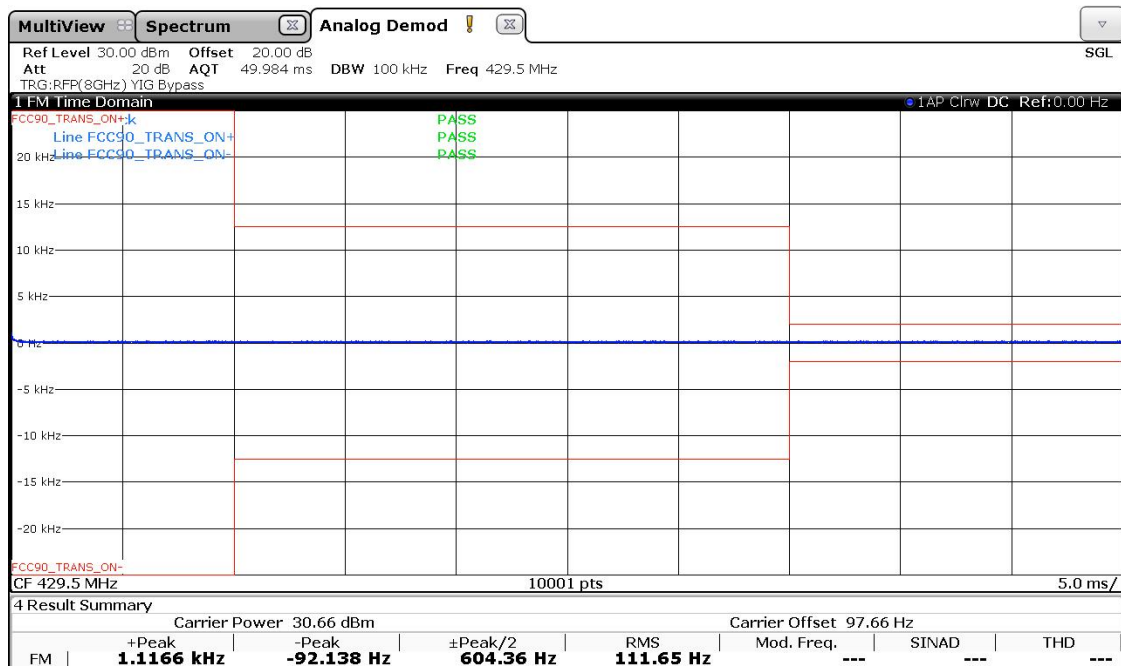
$f_{TX} = 450.5 \text{ MHz}$, $CSP = 25 \text{ KHz}$



$f_{TX} = 469.5 \text{ MHz}$, $CSP = 12.5 \text{ KHz}$

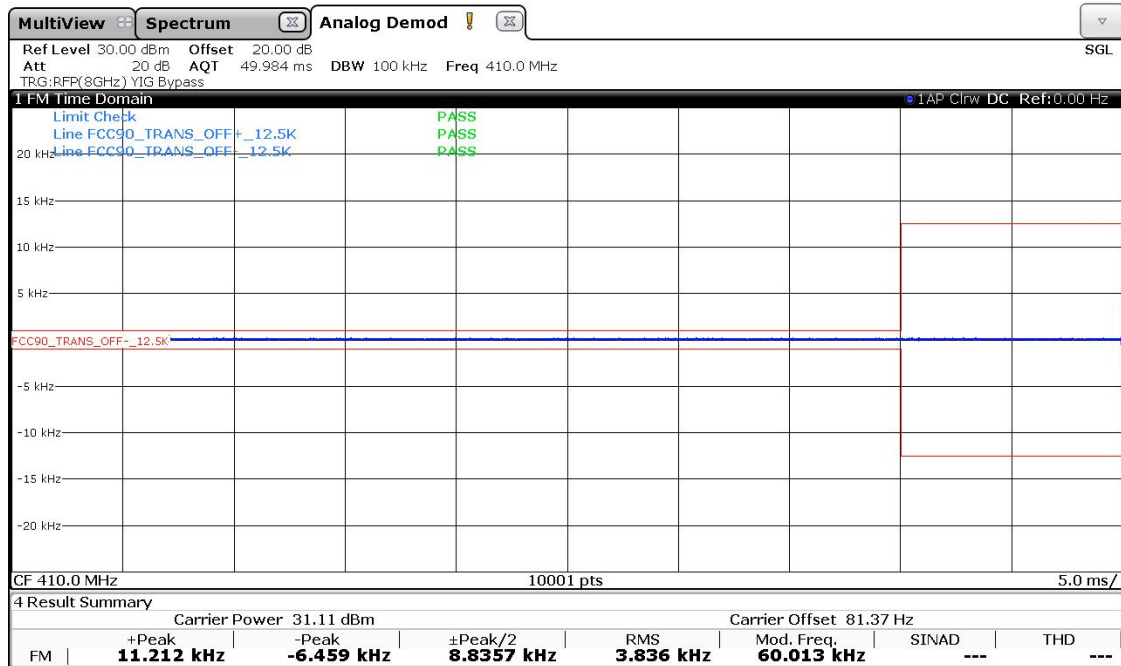


$f_{TX} = 469.5 \text{ MHz}$, $CSP = 25 \text{ KHz}$

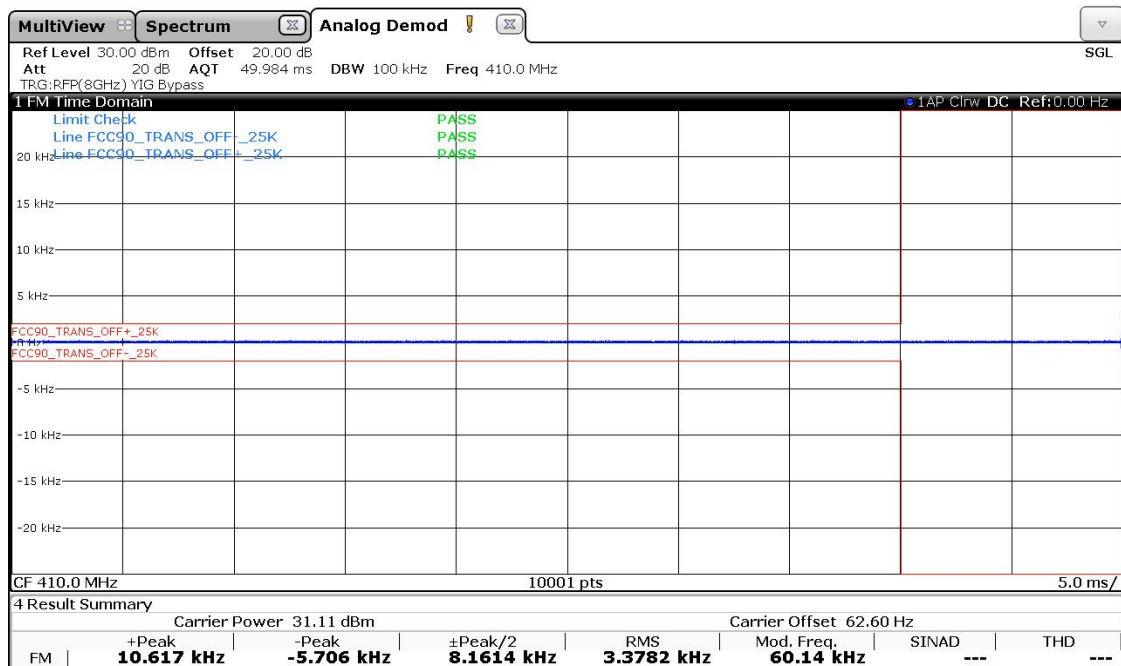


TX on to TX off

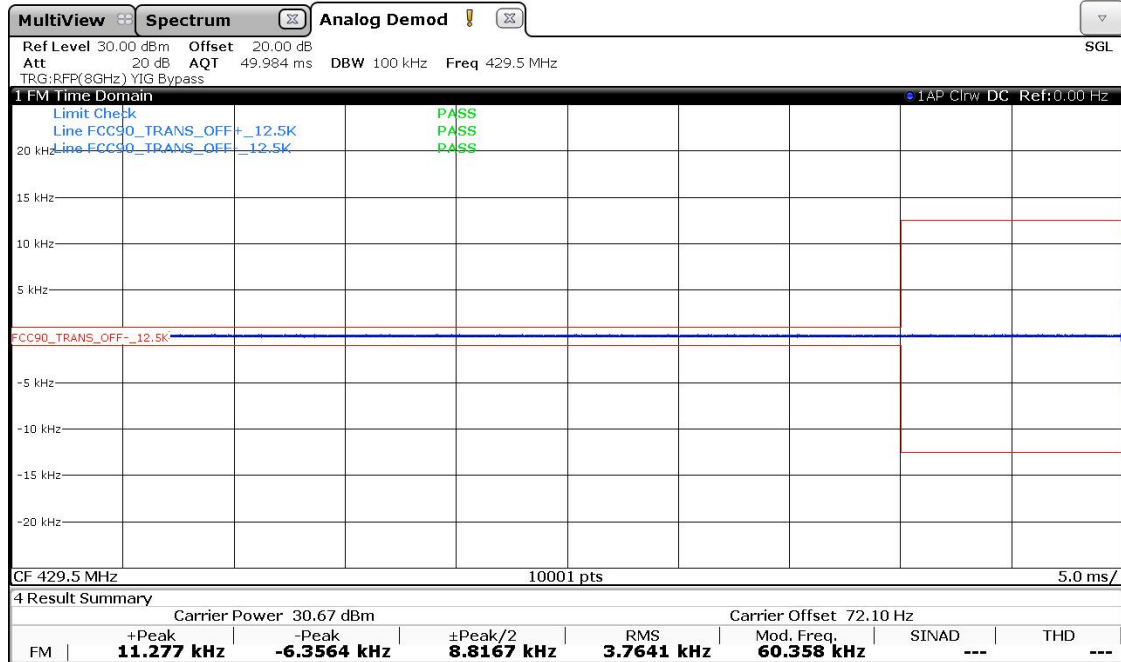
$f_{TX} = 410.0 \text{ MHz}$, $CSP = 12.5 \text{ KHz}$



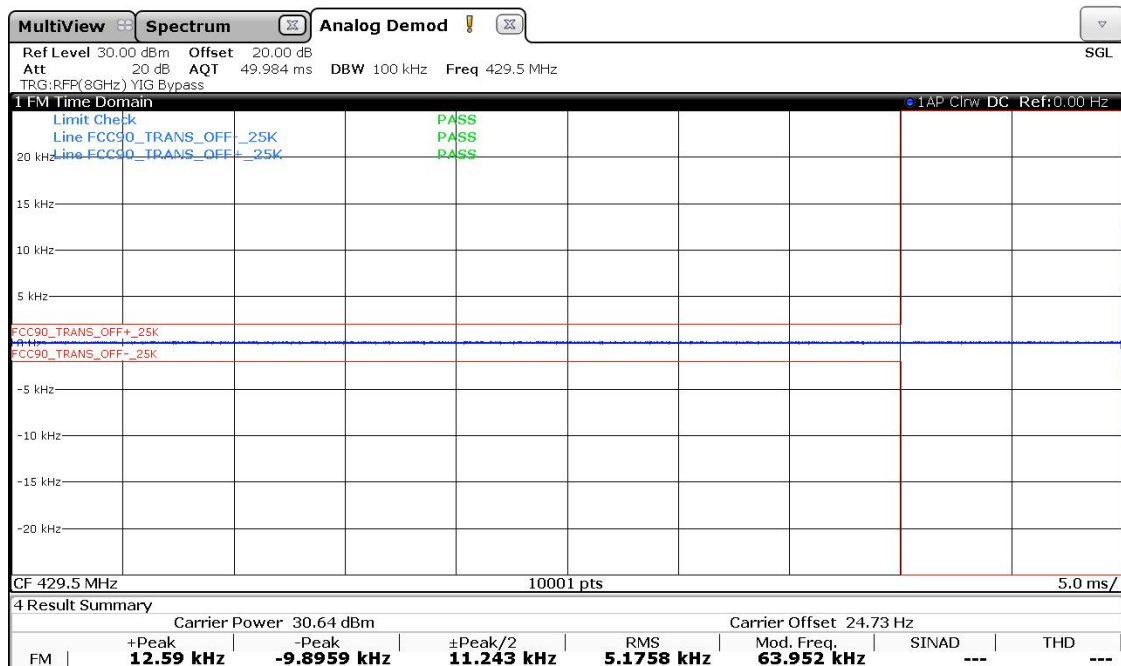
$f_{TX} = 410.0 \text{ MHz}$, $CSP = 25 \text{ KHz}$



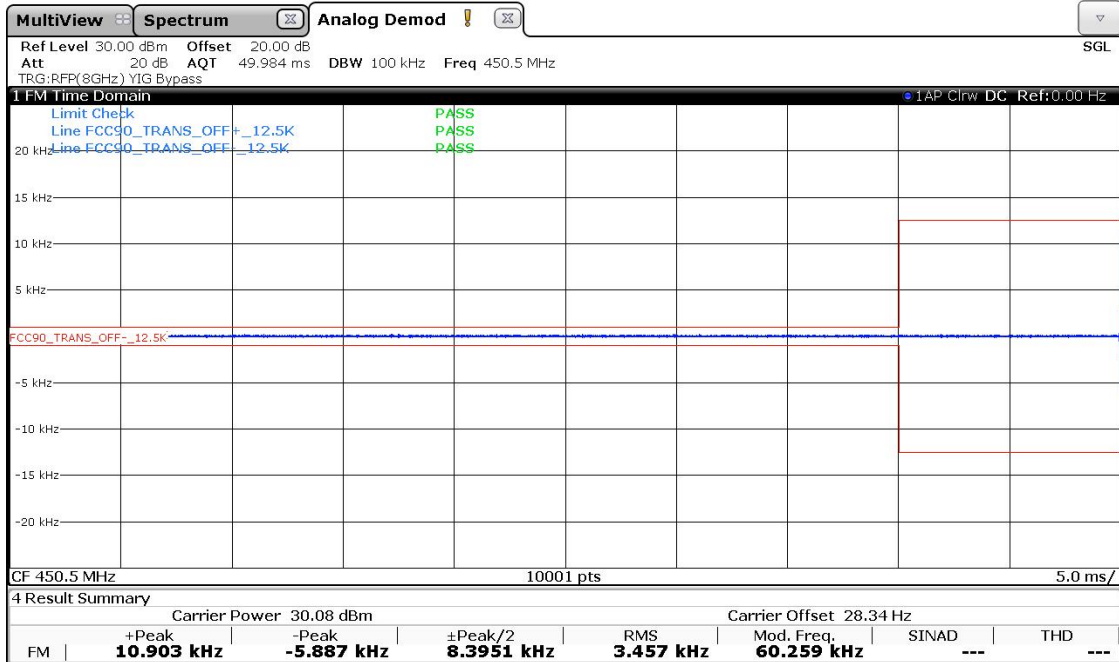
$f_{TX} = 429.5 \text{ MHz}$, $CSP = 12.5 \text{ KHz}$



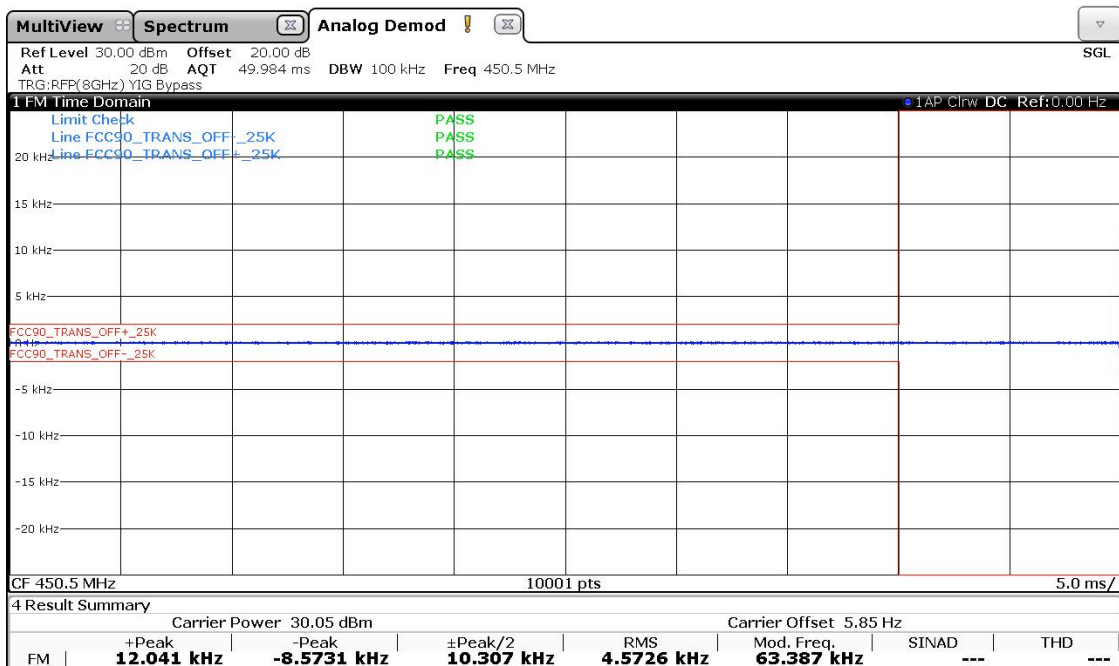
$f_{TX} = 429.5 \text{ MHz}$, $CSP = 25 \text{ KHz}$



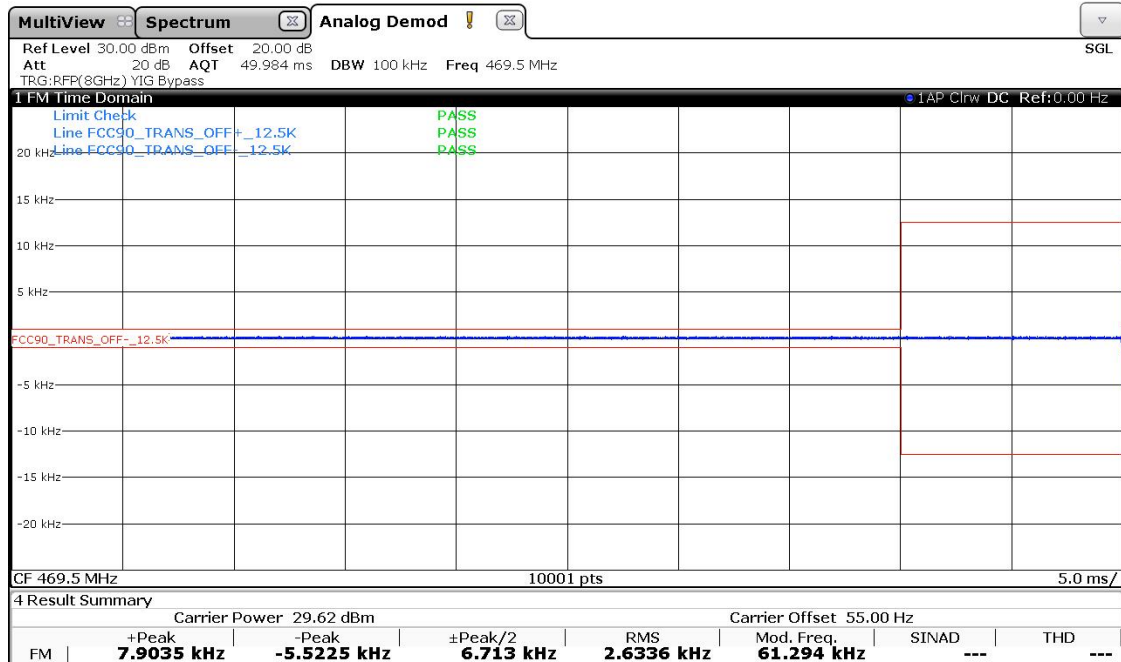
$f_{TX} = 450.5 \text{ MHz}$, $CSP = 12.5 \text{ KHz}$



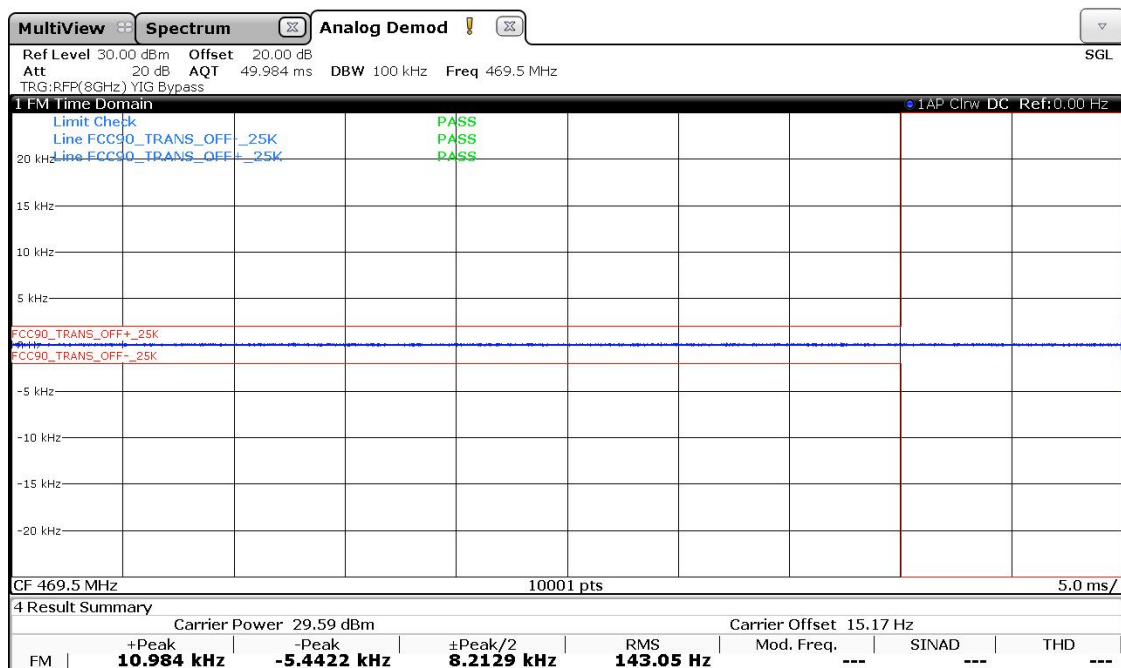
$f_{TX} = 450.5 \text{ MHz}$, $CSP = 25 \text{ KHz}$



$f_{TX} = 469.5 \text{ MHz}$, $CSP = 12.5 \text{ KHz}$



$f_{TX} = 469.5 \text{ MHz}$, $CSP = 25 \text{ KHz}$



Limit:

The limit specified in the table below shall not exceed.

Channel Spacing (kHz)	Time Intervals	Maximum Frequency Difference (kHz)	Transient Duration Limit (ms)
25	t_1	± 25	10
	t_2	± 12.5	25
	t_3	± 25	10
12.5	t_1	± 12.5	10
	t_2	± 6.25	25
	t_3	± 12.5	10

t_1 : the time period immediately following t_{on} .

t_2 : the time period immediately following t_1 .

t_3 : the time period from the instant when the transmitter is turned off until t_{off} .

Test: Passed

Test equipment used (refer clause 6):

26, 32 – 34

6 Test equipment used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Open area test site M6	OATS M6	Phoenix Contact	-	480085	Calibration not necessary	
2	EMI Receiver	ESIB 7	Rohde & Schwarz	100304	480521	26.02.2018	02.2020
3	Controller	HD100	Deisel	100/349	480139	Calibration not necessary	
4	Turntable	DS412	Deisel	412/316	480087	Calibration not necessary	
5	Antenna mast	MA240-0	Inn-Co GmbH	MA240-0/030/6600603	480086	Calibration not necessary	
6	Antenna (Bilog)	CBL6111D	Schaffner Elektrottest GmbH / Teseq GmbH	25761	480894	19.10.2017	10.2020
7	Software	EMC32	Rohde & Schwarz	100061	481022	Calibration not necessary	
8	Fully anechoic chamber M20	B83117-E2439-T232	Albatross Projects	103	480303	Calibration not necessary	
9	EMI Receiver / Spectrum Analyser	ESI 40	Rohde & Schwarz	100064/040	480355	27.02.2018	02.2019
10	Multiple Control Unit	MCU	Maturo GmbH	MCU/043/971107	480832	Calibration not necessary	
11	Turntable	DS420 HE	Deisel	420/620/00	480315	Calibration not necessary	
12	Antenna mast	AS615P	Deisel	615/310	480187	Calibration not necessary	
13	Positioners	TDF 1.5- 10Kg	Maturo	15920215	482034	Calibration not necessary	
14	Antenna (Bilog)	CBL6112B	Schaffner EMV GmbH (-Chase)	2688	480328	19.06.2017	06.2020
15	Antenna (Horn)	3115	EMCO Elektronik GmbH	9609-4918	480183	05.02.2018	02.2021
16	Highpass Filter	WHJS1000C11/6 0EF	Wainwright Instruments GmbH	1	480413	Calibration not necessary	
17	RF-cable No.36	Sucoflex 106B	Suhner	0587/6B / Kabel 36	480865	Calibration not necessary	
18	RF-cable No.3	Sucoflex 106B	Suhner	0563/6B / Kabel 3	480670	Calibration not necessary	
19	RF-Cable No. 40	Sucoflex 106B	Suhner	0708/6B / Kabel 40	481330	Calibration not necessary	
20	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	23.02.2018	02.2020
21	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586 & 100926	481720	15.03.2018	03.2020
22	Notebook	15,4 Zoll	Fujitsu	YL4A022034	201167	Calibration not necessary	
23	Lowpass Filter	TP-250	Dirk Fischer Elektronik	-	480582	Calibration not necessary	
24	Highpass Filter	WHF800-6HH/1000	Wainwright Instruments GmbH	3	480954	Calibration not necessary	
25	Notch Filter	TTR 375-3EE	Telonic Berkeley Inc.	375-3EE	480330	Calibration not necessary	
26	Coaxial-Attenuator	WA47-20-34	Weinschel	#A1169	481452	Calibration not necessary	
27	Coaxial-Attenuator	WA8 / 18-10-34	Weinschel	-	481449	Calibration not necessary	

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
28	Precision Dipole	HZ-12	Rohde & Schwarz	831781/02	480061	Calibration not necessary	
29	Precision Dipole	HZ-13	Rohde & Schwarz	831782/02	480062	Calibration not necessary	
30	Antenna (Horn)	3115	EMCO Elektronik GmbH	9609-4922	480184	06.09.2016	09.2019
31	CW Generator Microwave	83650L	Agilent	3844A00554	480333	01.03.2018	03.2019
32	Multimeter	971A	Hewlett Packard	JP40010640	480724	31.01.2018	01.2020
33	DC power supply	TOE8951	Toellner	81995	481252	Calibration not necessary	
34	Spectrum Analyser	FSU46	Rohde & Schwarz	200125	480956	01.03.2018	03.2019
35	EMI Receiver / Spectrum Analyser	ESW	Rohde & Schwarz	101635	482467	22.06.2017	06.2019
36	Climatic chamber	MK 240	BINDER	05-79022	480462	08.02.2017	08.2018
37	Antenna (Log.Per.)	HL050	Rohde & Schwarz	100438	481170	09.10.2017	10.2020
38	Preamplifier 100 MHz – 16 GHz	AFS6	Narda MITEQ	2011215	482333	23.11.2016	11.2018

7 Report history

Report Number	Date	Comment
F172629E1	06.12.2018	Initial report
-	-	-
-	-	-

8 List of annexes

Annex A	Test Setup Photos	4 Pages
	172629_01.JPG: Test setup - Radiated emission (fully anechoic chamber)	
	172629_02.JPG: Test setup - Radiated emission (fully anechoic chamber)	
	172629_03.JPG: Test setup - Radiated emission (OATS)	
	172629_04.JPG: Temperature chamber	
Annex B	External Photos	8 Pages
	172629_06.jpg: EUT – top view	
	172629_07.jpg: EUT – bottom view	
	172629_05.jpg: EUT at eval board	
	172629_09.jpg: EUT, evaluation board, interface board, housing	
	172629_12.jpg: Evaluation board – top view	
	172629_13.jpg: Evaluation board – bottom view	
	172629_14.jpg: Interface board – top view	
	172629_15.jpg: Interface board – bottom view	
Annex C	Internal Photos	2 Pages
	172629_10.jpg: EUT – top view, shielding removed	
	172629_11.jpg: EUT – bottom view, shielding removed	