

Königswinkel 10

32825 Blomberg, Germany

Phone: +49 (0) 52 35 / 95 00-0

Fax: +49 (0) 52 35 / 95 00-10

office@phoenix-testlab.de

www.phoenix-testlab.de

Test Report

Report Number:

F160575E1

Equipment under Test (EUT):

SATELLINE-4Pro

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 (April 18, 2016)** Private Land Mobile Radio Services
- [2] **FCC CFR 47 Part 2 (April 18, 2016)** Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
- [3] **RSS-119 Issue 12 (November 2014)** Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 MHz
- [4] **RSS-Gen Issue 4 (November 2014)** 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.

Test engineer:	Wolfgang KASALOWSKY		21.06.2016
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		21.06.2016
	Name	Signature	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 Identification.....	4
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.....	5
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	30
5.3.1 Method of measurement.....	30
5.3.2 Test Results	31
5.3.2.1 Channel Spacing 12.5 kHz	31
5.3.2.2 Channel Spacing 25 kHz	48
5.4 Spurious emissions (conducted)	63
5.4.1 Method of measurement.....	63
5.4.2 Test Results	64
5.4.2.1 Channel Spacing 12.5 kHz	64
5.4.2.2 Channel Spacing 25 kHz	77
5.5 Spurious emissions (radiated)	90
5.5.1 General method of measurement	90
5.5.2 Preliminary radiated emission measurement.....	96
5.5.3 Final Results	103
5.5.3.1 Final radiated emission measurement (9 kHz to 1 GHz).....	103
5.5.3.3 Channel Spacing 12.5 kHz	104
5.5.3.4 Channel Spacing 25 kHz	105
5.6 Frequency Stability.....	106
5.6.1 Method of measurement.....	106
5.6.1.1 Test results.....	106
5.7 Transient frequency behaviour	108
5.7.1 Method of measurement.....	108
5.7.2 Test Results	109
6 Test equipment used for tests	118
7 Report history.....	119
8 List of annexes.....	120

1 Identification

1.1 Applicant

Name:	Satel Oy
Address:	Meriniitynkatu 17 24101 Salo
Country:	Finland
Name for contact purposes:	Mr. Pekka Suominen
Phone:	+358 2 777 7800
Fax:	---
eMail Address:	pekka.suominen@satel.com
Applicant represented during the test by the following person:	Mr. Pekka Suominen

1.2 Manufacturer

Name:	Satel Oy
Address:	Meriniitynkatu 17 24101 Salo
Country:	Finland
Name for contact purposes:	Mr. Pekka Suominen
Phone:	+358 2 777 7800
Fax:	---
eMail Address:	pekka.suominen@satel.com
Applicant represented during the test by the following person:	Mr. Pekka Suominen

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 site registration number
90877 and Industry Canada Test site registration IC3469A-1.

1.4 EUT (Equipment Under Test)

Test object: *	UHF radio modem
HVIN: *	SATEL-TA30
PMN: *	SATELLINE-4Pro
FCC ID: *	MRBSATEL-TA30
IC: *	2422A-SATELTA30
Serial number: *	1615000001

* declared by the applicant.

1.5 Technical data of equipment

Alignment range: *	403 – 473 MHz		
Switching range: *	406.1 – 430 MHz and 450 – 470 MHz		
Channel spacing: *	12.5 kHz, 25 kHz		
Modulation: *	4FSK, 8FSK, 16FSK; GMSK		
Radio link data rate: *		ChSp = 12.5 kHz	ChSp = 25 kHz
	GMSK	4800 bit/s	9600 bit/s
	4FSK	9600 bit/s	19200 bit/s
	8FSK	9600 bit/s	19200 bit/s
	16FSK	14400 bit/s	28800 bit/s
Rated Power: *	2 W, 10 W, 20 W, 25 W, 35 W		
Supply Voltage: *	$V_{nom} = 12 V_{DC}$	$V_{min} = 9 V_{DC}$	$V_{max} = 16 V_{DC}$
Audio Filter: *	None		
Temperature range: *	- 30°C to + 60°C		
Clock frequency: *	24 MHz		

* declared by the applicant.

RF-cables: *	Type	Description	Length	Note
	CRF-1	Cable with TNC m/TNC f-connectors	1 m	RG58 (3 dB/10 m)
	CRF-5F	Cable with TNC m/TNC f-connectors	5 m	RG58 (3 dB/10 m)
	CRF-5M	Cable with TNC m/TNC f-connectors	5 m	RG58 (3 dB/10 m)
	CRF-15	Cable with TNC f/TNC f 90-degree connector	15 cm	RG58 (3 dB/10 m)
	RG213	Low loss cable	X	1.6 dB/10 m
	ECOFLEX10	Low loss cable	X	0.9 dB/10 m
	AIRCOM+	Low loss cable	X	0.8 dB/10 m
	ECOFLEX15	Low loss cable	X	0.6 dB/10 m

* declared by the applicant.

Antennas: *	Type	Description
	CA420O	Omnidirectional coaxial dipole, 2 dBi, 405-440 MHz
	CA450O	Omnidirectional coaxial dipole, 2 dBi, 440-475 MHz
	CA405GP+	Omnidirectional ground plane, 6 dBi, 401-409 MHz
	CA410GP+	Omnidirectional ground plane, 6 dBi, 406-414 MHz
	CA420GP+	Omnidirectional ground plane, 6 dBi, 416-424 MHz
	CA430GP+	Omnidirectional ground plane, 6 dBi, 426-434 MHz
	CA435GP+	Omnidirectional ground plane, 6 dBi, 431-439 MHz
	CA440GP+	Omnidirectional ground plane, 6 dBi, 436-444 MHz
	CA445GP+	Omnidirectional ground plane, 6 dBi, 441-449 MHz
	CA450GP+	Omnidirectional ground plane, 6 dBi, 446-454 MHz
	CA460GP+	Omnidirectional ground plane, 6 dBi, 456-464 MHz
	CA470GP+	Omnidirectional ground plane, 6 dBi, 465-475 MHz
	CA400Y	Directional yagi, 6 dBi, 380-410 MHz
	CA420Y	Directional yagi, 6 dBi, 405-440 MHz
	CA450Y	Directional yagi, 6 dBi, 440-475 MHz
	CA400Y+	Directional yagi, 8 dBi, 380-410 MHz
	CA420Y+	Directional yagi, 8 dBi, 405-440 MHz
	CA450Y+	Directional yagi, 8 dBi, 440-475 MHz

* declared by the applicant.

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
DC in	4 pin ODU	Laboratory power supply	2 m *
RS 232 Interface	8 pin ODU	Laptop PC	2 m *
Antenna	TNC connector	Attenuator, Spectrum Analyser / Dummy Load	0.5 m *

*: Length during the test if no other specified.

1.6 Dates

Date of receipt of test sample:	18.04.2016
Start of test:	18.04.2016
End of test:	29.04.2016

2 Operational states

The EUT is an UHF radio modem transceiver operating in the frequency range 406.1 MHz to 470.0 MHz with 12.5 kHz or 25 kHz channel spacing. 2 W, 10 W, 20 W, 25 W or 35 W RF power output can be configured. Operation is possible in 4FSK, 8FSK, 16FSK or GMSK modulation.

All tests were carried out with an unmodified sample.

During the tests the test sample was powered with 12 volts DC if not otherwise stated..



EUT

3 Additional information

None

4 Overview

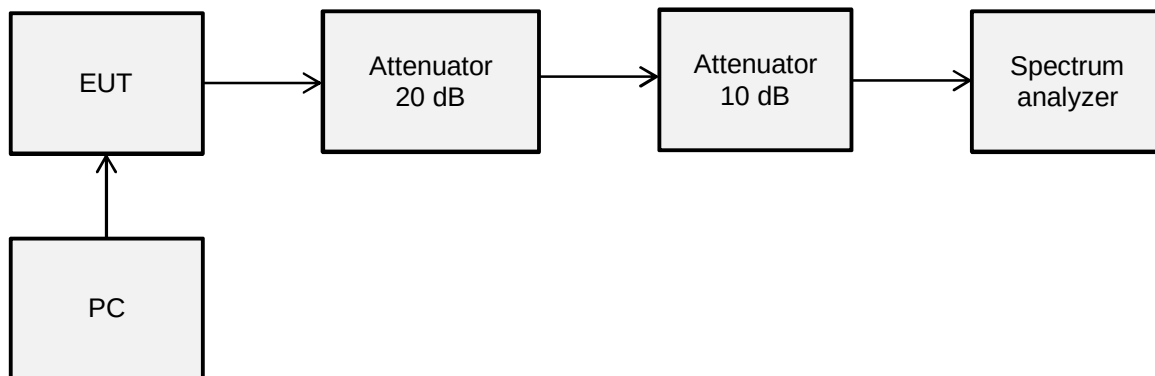
Application	FCC CFR 47	RSS 119, Issue 12	Status	Refer page
Transmitter output power (conducted)	90.205	5.4	Passed	9 et seq.
Occupied bandwidth	90.210	5.5	Passed	11 et seq.
Spectrum emission mask	90.210	5.5	Passed	30 et seq.
Spurious emissions (conducted)	90.210	5.8	Passed	63 et seq.
Spurious emissions (radiated)	90.210	5.8	Passed	90 et seq..
Frequency stability	90.213	5.3	Passed	106 et seq.
Transient frequency behaviour	90.214	5.9	Passed	108 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: RMS
- Trace mode: Max hold

The EUT was set to 16FSK mode transmitting a pseudo random data file via the PC. The output power was set to 2W, 10W, 20W, 25W and 35W and the channel spacing to 12.5 kHz and 25 kHz.

5.1.2 Test result

Ambient temperature	23 °C	Relative humidity	22 %
---------------------	-------	-------------------	------

Frequency [MHz]	Measured output power [dBm]		Limit [dBm]
	Ch spacing = 12.5 kHz	Ch spacing = 25 kHz	
406.5	33.3	33.4	33.0 ±1
429.5	33.5	33.5	
450.5	33.4	33.6	
469.5	33.3	33.4	
406.5	39.8	39.4	40.0 ±1
429.5	40.1	40.1	
450.5	40.0	40.2	
469.5	39.8	39.9	
406.5	42.9	42.9	43.0 ±1
429.5	43.0	43.0	
450.5	42.9	43.0	
469.5	43.0	43.0	
406.5	43.8	44.0	44.0 ±1
429.5	44.0	44.0	
450.5	44.0	44.1	
469.5	43.9	44.0	
406.5	45.2	45.3	45.4 ±1
429.5	45.3	45.2	
450.5	45.5	45.6	
469.5	45.5	45.6	
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

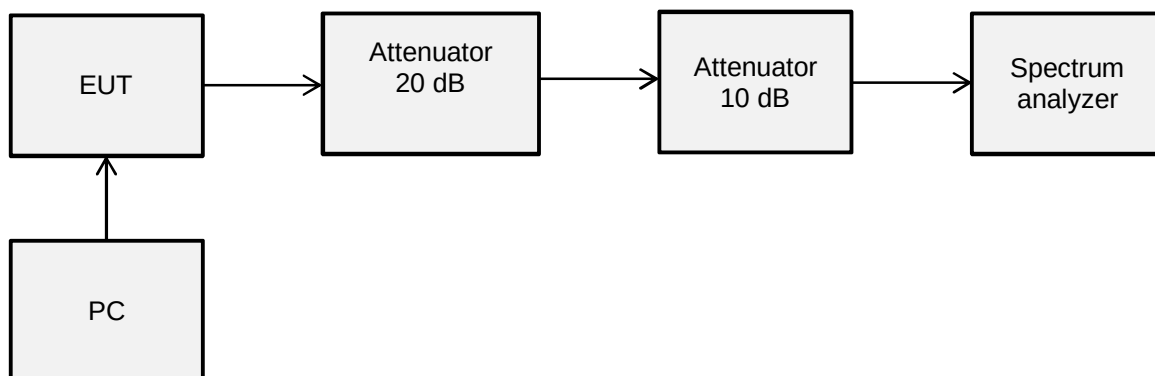
Test equipment used (refer clause 6):

23, 24, 29, 30, 35, 36

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:	Auto FFT	Auto FFT
- Sweep time:	14 ms	8.37 ms
- Detector function:	Peak	Peak
- Trace mode:	Max hold	Max hold

The EUT was set to 4FSK, 8FSK, 16FSK and GMSK mode transmitting a pseudo random data file via the PC. The output power was set to 35W and the channel spacing to 12.5 kHz and 25 kHz.

5.2.2 Test result

Ambient temperature	23 °C	Relative humidity	22 %
---------------------	-------	-------------------	------

Channel spacing: 12.5 kHz			
Frequency [MHz]	Modulation	Measured 99% bandwidth [kHz]	Limit [kHz] (Authorized bandwidth)
406.5	4FSK	8.34	11.25
	8FSK	7.60	
	16FSK	7.90	
	GMSK	8.44	
429.5	4FSK	8.32	
	8FSK	7.88	
	16FSK	7.62	
	GMSK	8.42	
450.5	4FSK	8.14	
	8FSK	7.89	
	16FSK	7.74	
	GMSK	8.48	
469.5	4FSK	8.43	
	8FSK	7.75	
	16FSK	7.60	
	GMSK	8.47	
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)
406.5	4FSK	16.41	20
	8FSK	17.04	
	16FSK	16.83	
	GMSK	9.65	
429.5	4FSK	16.38	
	8FSK	17.27	
	16FSK	15.81	
	GMSK	9.65	
450.5	4FSK	16.81	
	8FSK	17.10	
	16FSK	16.61	
	GMSK	9.63	
469.5	4FSK	16.06	
	8FSK	17.14	
	16FSK	16.80	
	GMSK	9.68	
Measurement uncertainty: <10 ⁻⁷ (frequency), 0.66 dB / -0.72 dB (level)			

Limit:

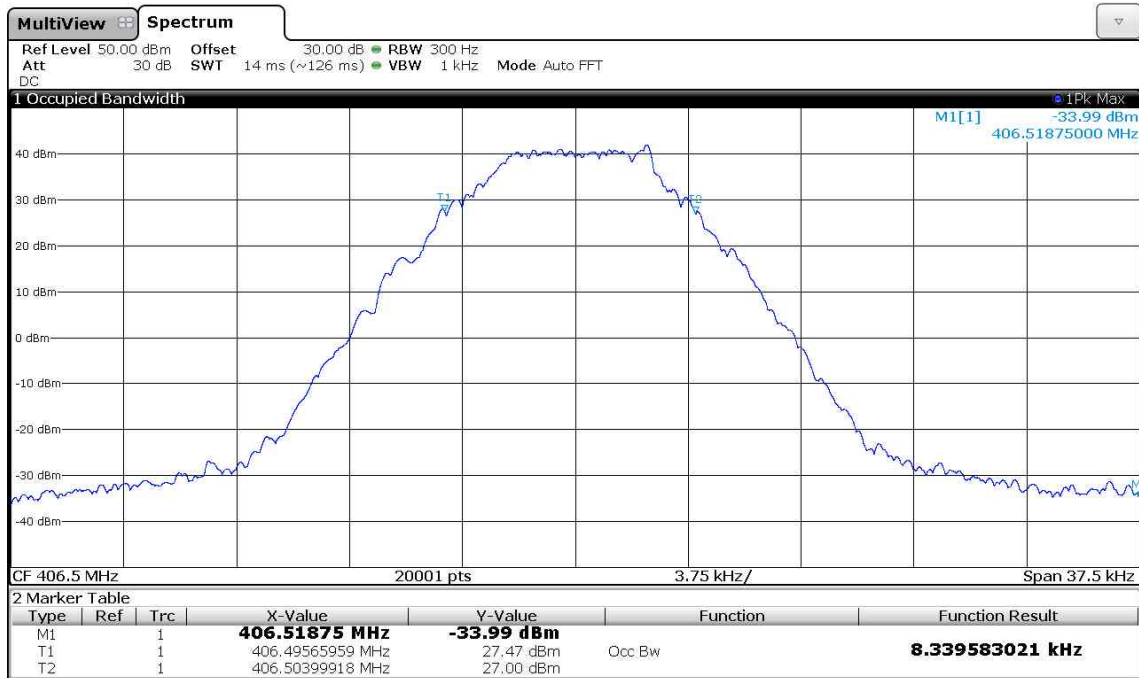
The maximum permissible occupied bandwidth shall not exceed the authorized bandwidth. The authorized bandwidth is defined as the maximum width of the band of frequencies used to derive spectrum masks and is not necessarily equivalent to the bandwidth found on radio and spectrum licenses.

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

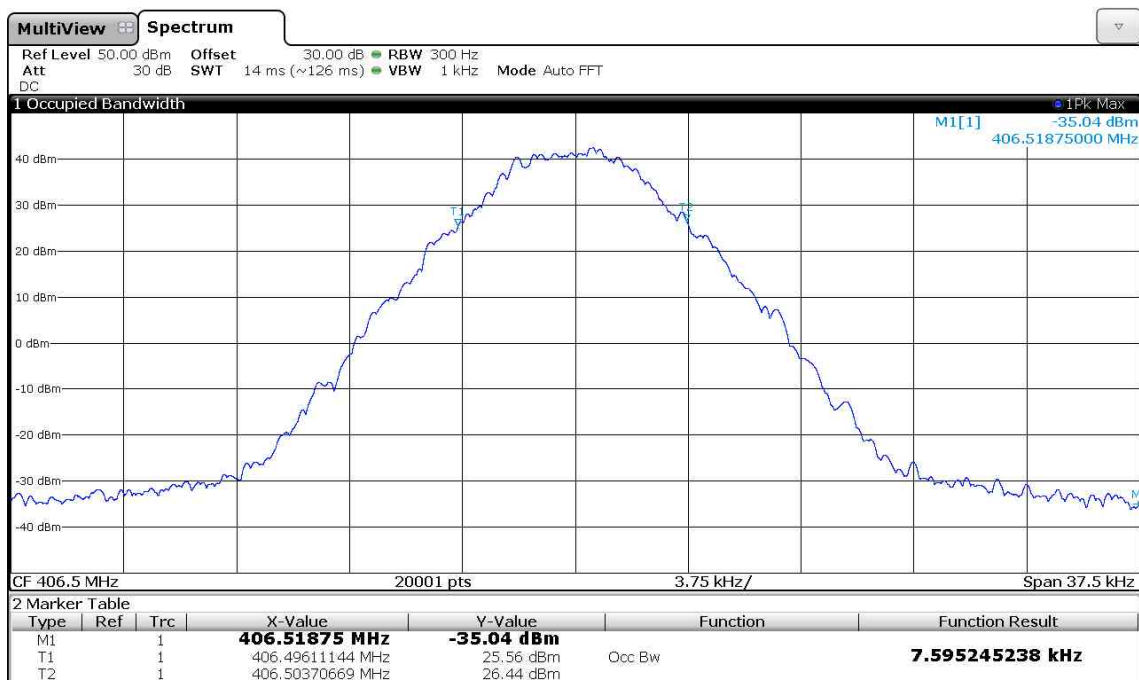
* Paging transmitters in the bands 406.1-430 MHz and 450-470 MHz are to use mask G.

Test: Passed

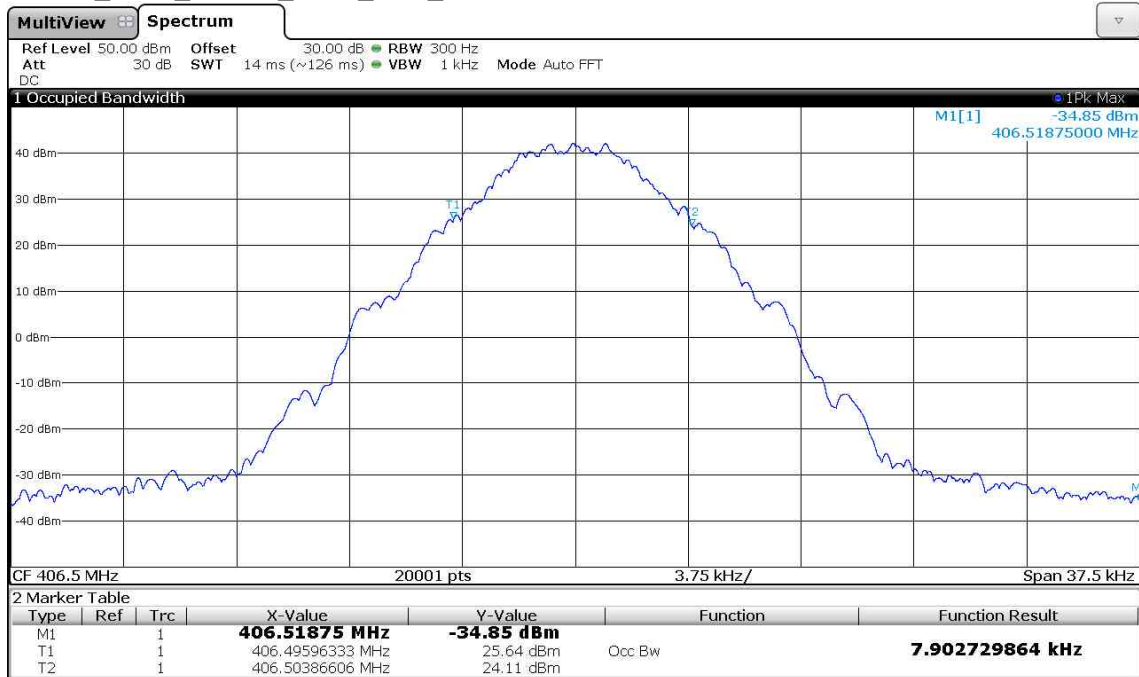
160575_OBW_406.5M_12.5k_35W_4FSK.PNG



160575_OBW_406.5M_12.5k_35W_8FSK.PNG



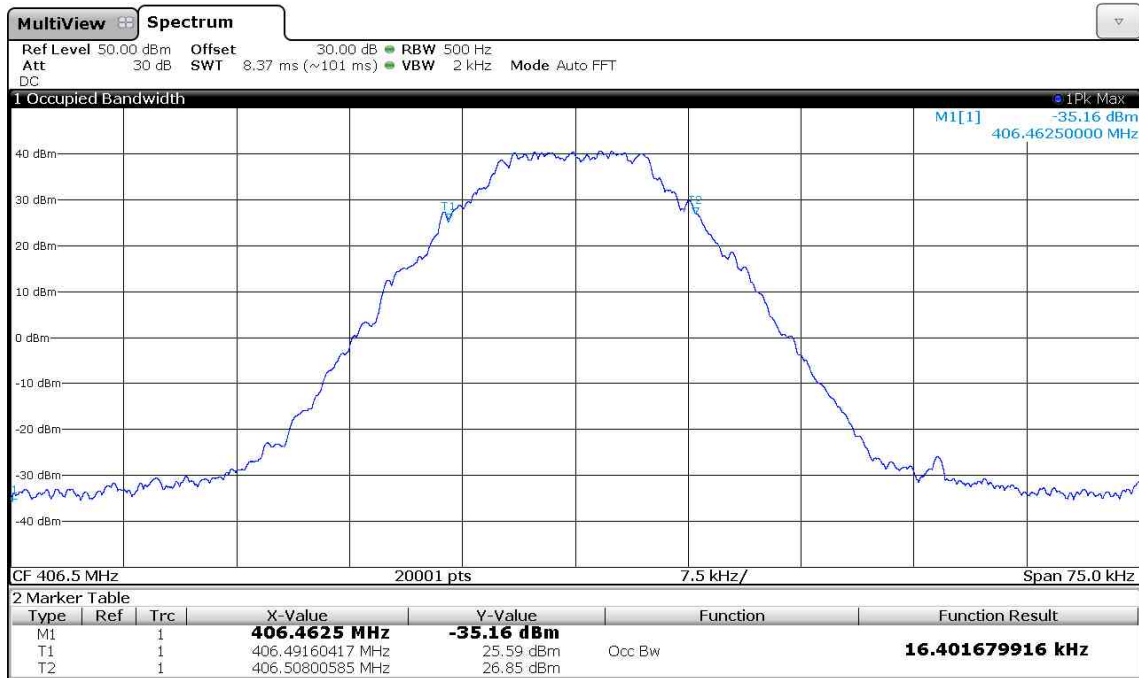
160575_OBW_406.5M_12.5k_35W_16FSK.PNG



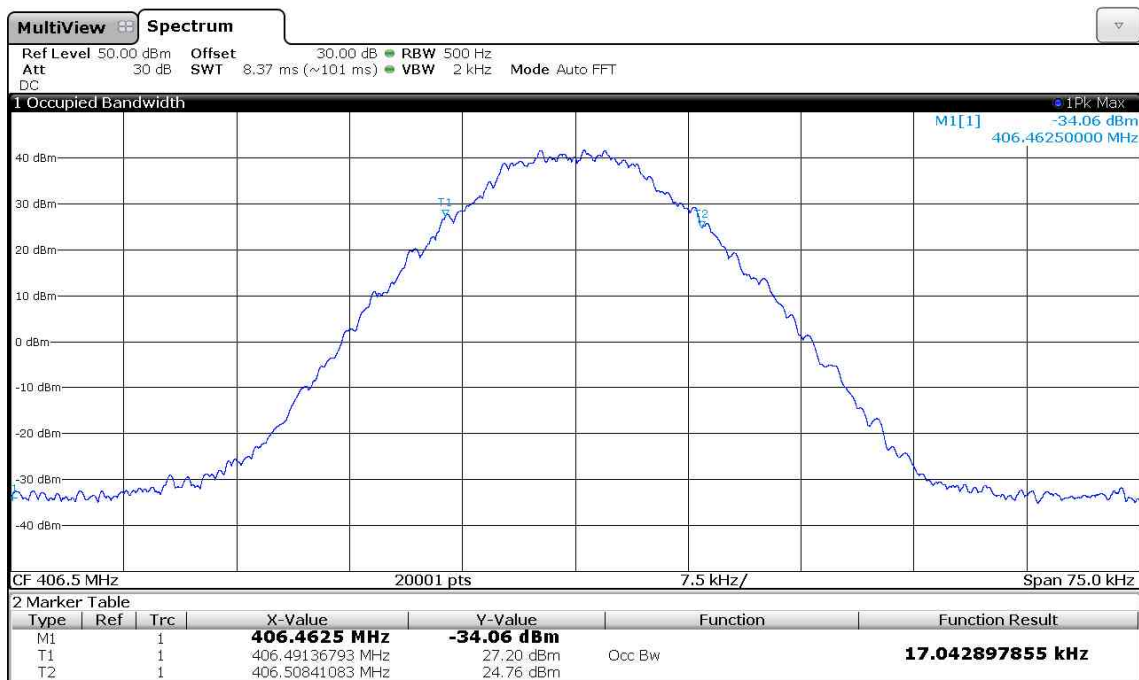
160575_OBW_406.5M_12.5k_35W_GMSK.PNG



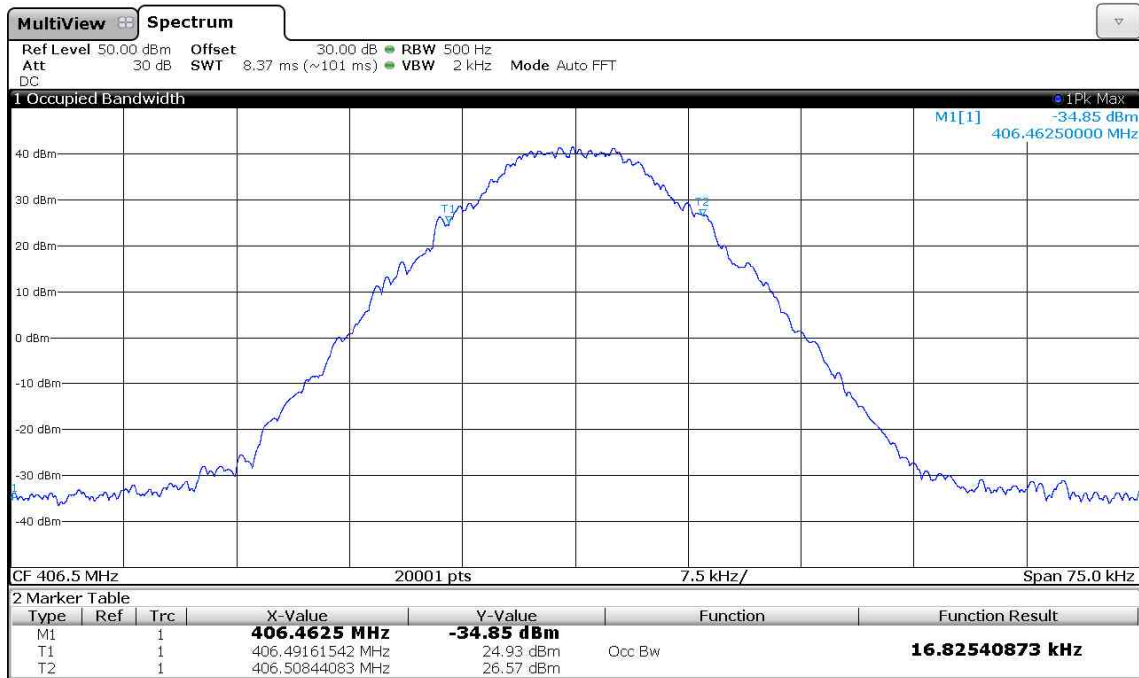
160575_OBW_406.5M_25k_35W_4FSK.PNG



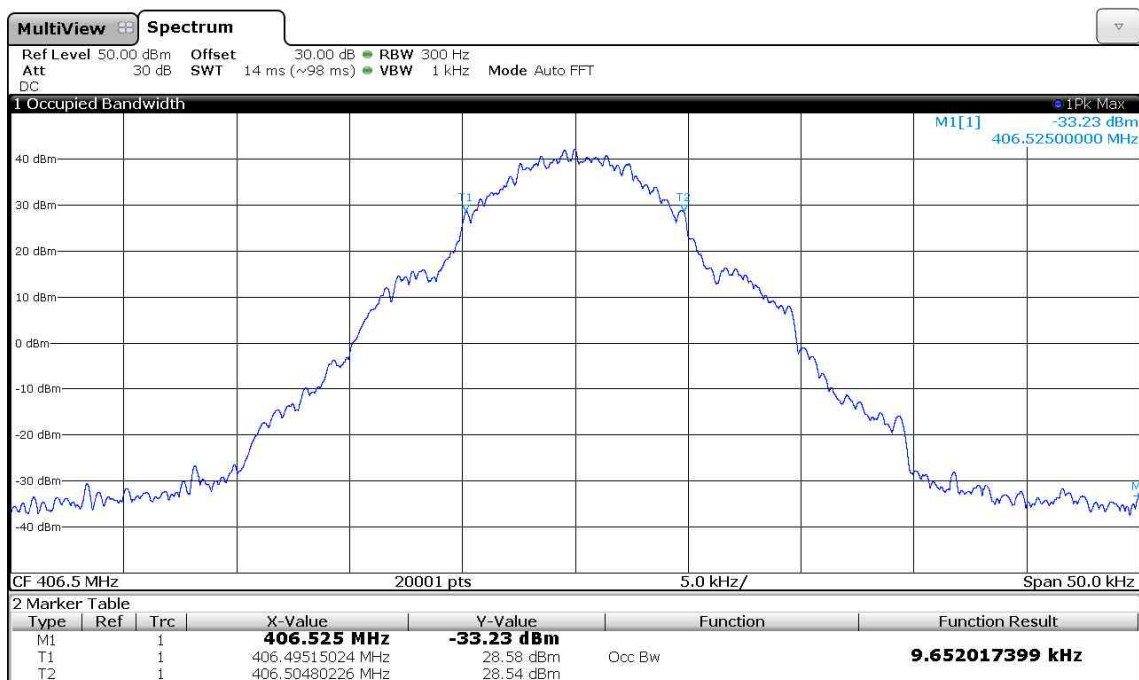
160575_OBW_406.5M_25k_35W_8FSK.PNG



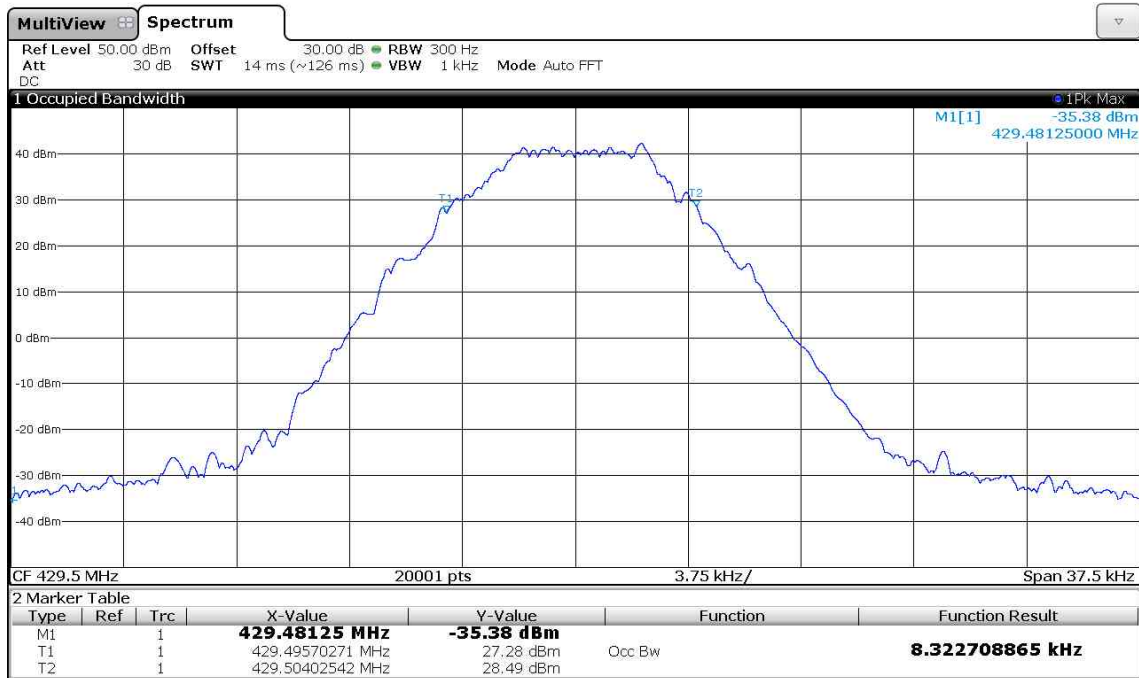
160575_OBW_406.5M_25k_35W_16FSK.PNG



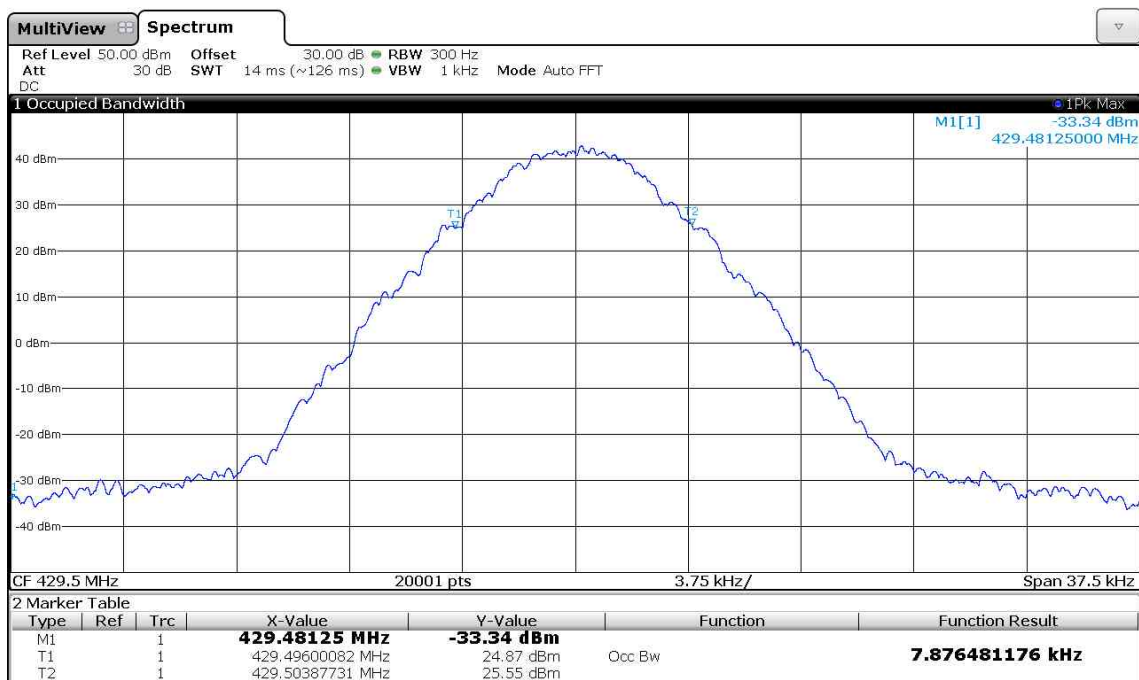
160575_OBW_406.5M_25k_35W_GMSK.PNG



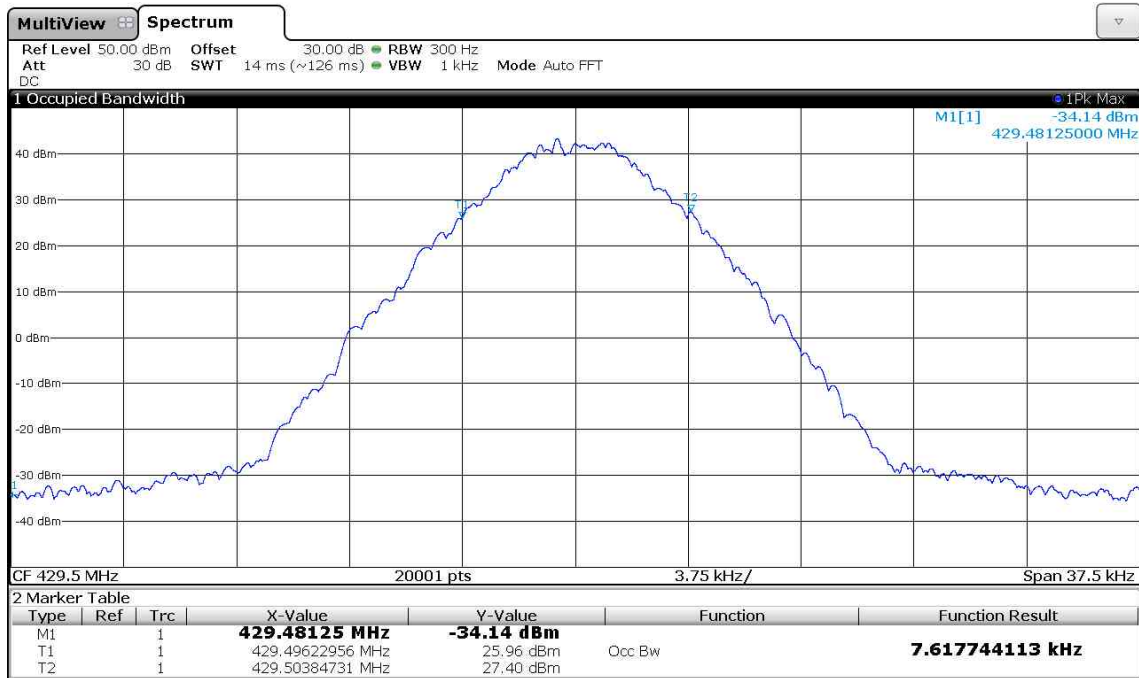
160575_OBW_429.5M_12.5k_35W_4FSK.PNG



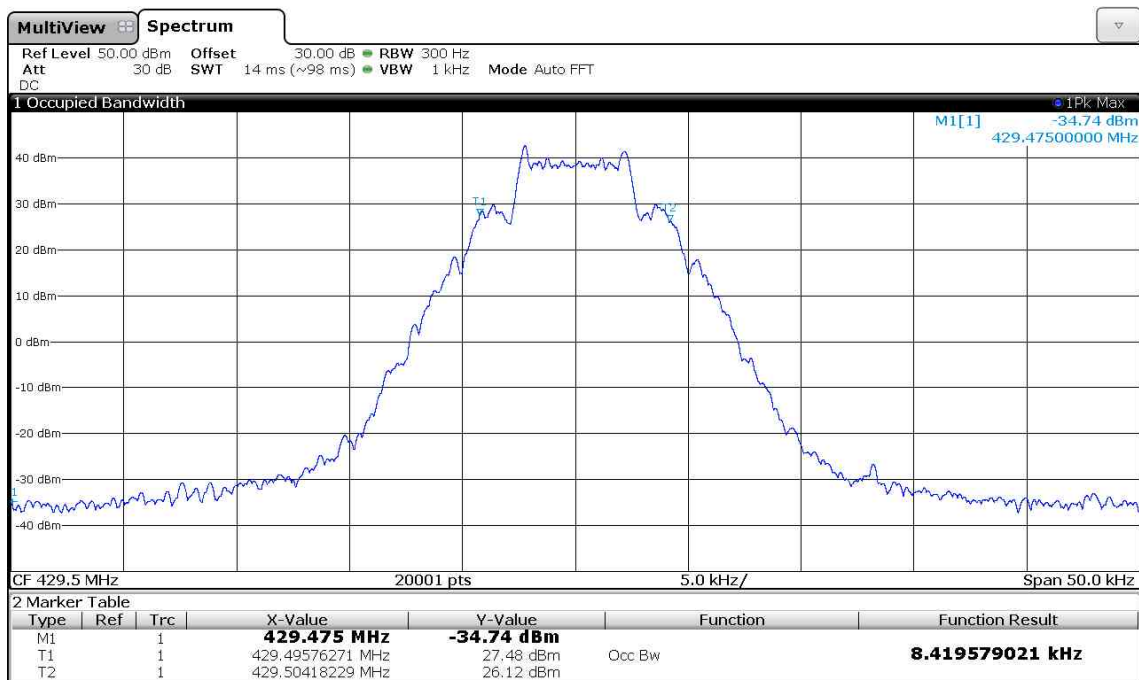
160575_OBW_429.5M_12.5k_35W_8FSK.PNG



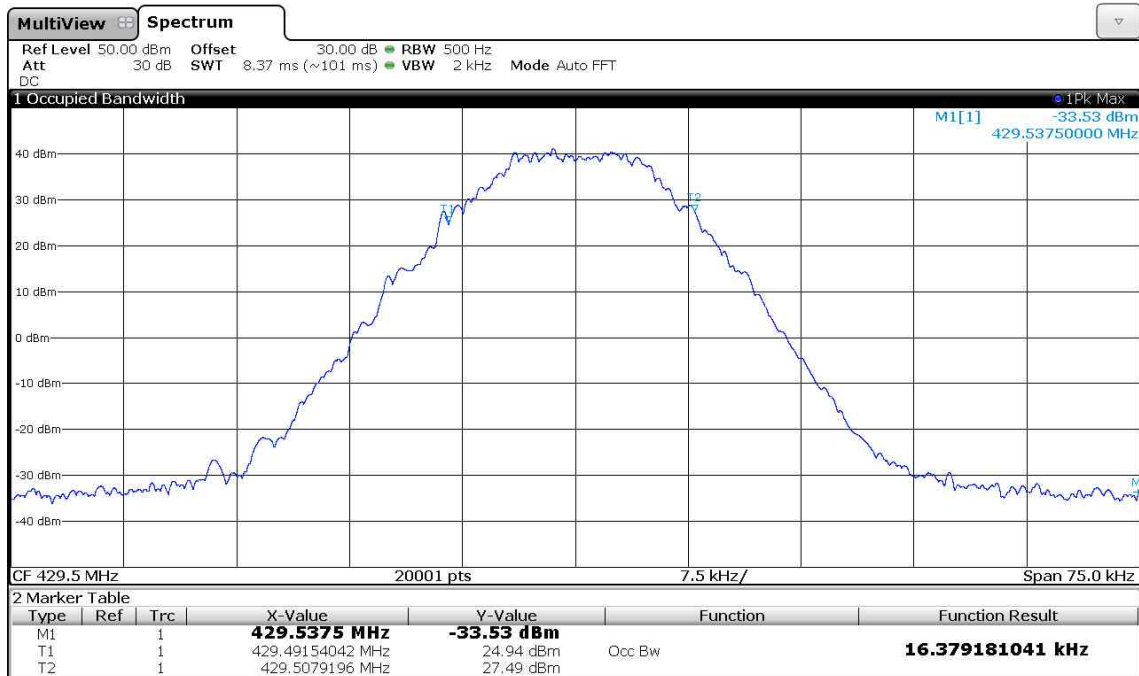
160575_OBW_429.5M_12.5k_35W_16FSK.PNG



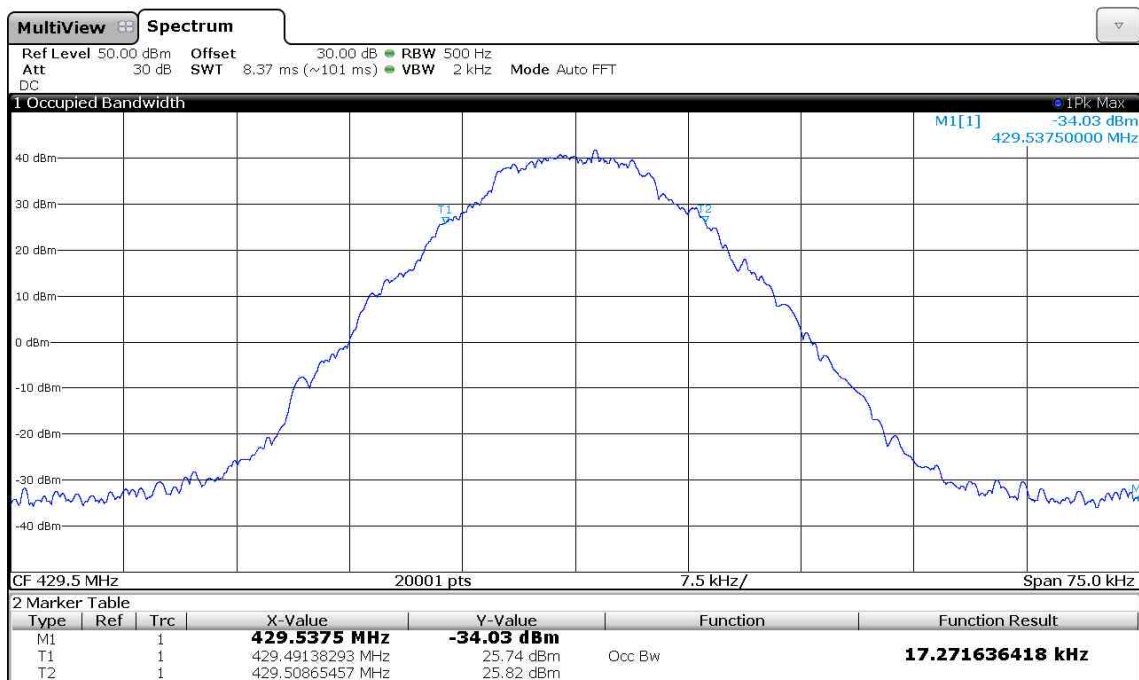
160575_OBW_429.5M_12.5k_35W_GMSK.PNG



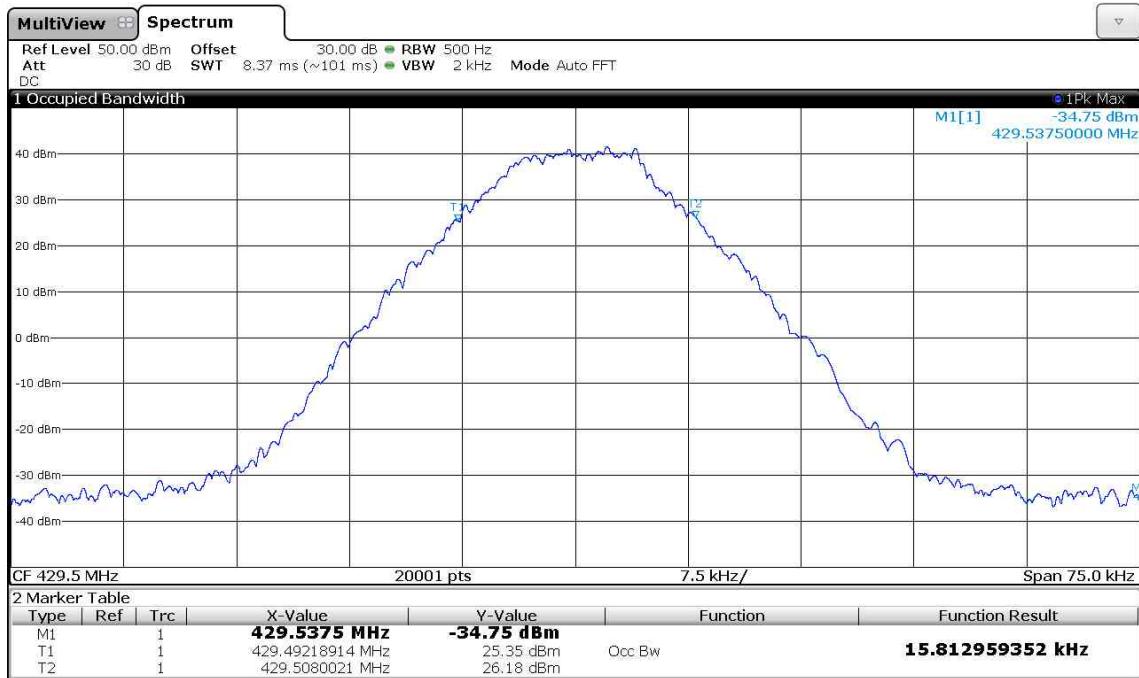
160575_OBW_429.5M_25k_35W_4FSK.PNG



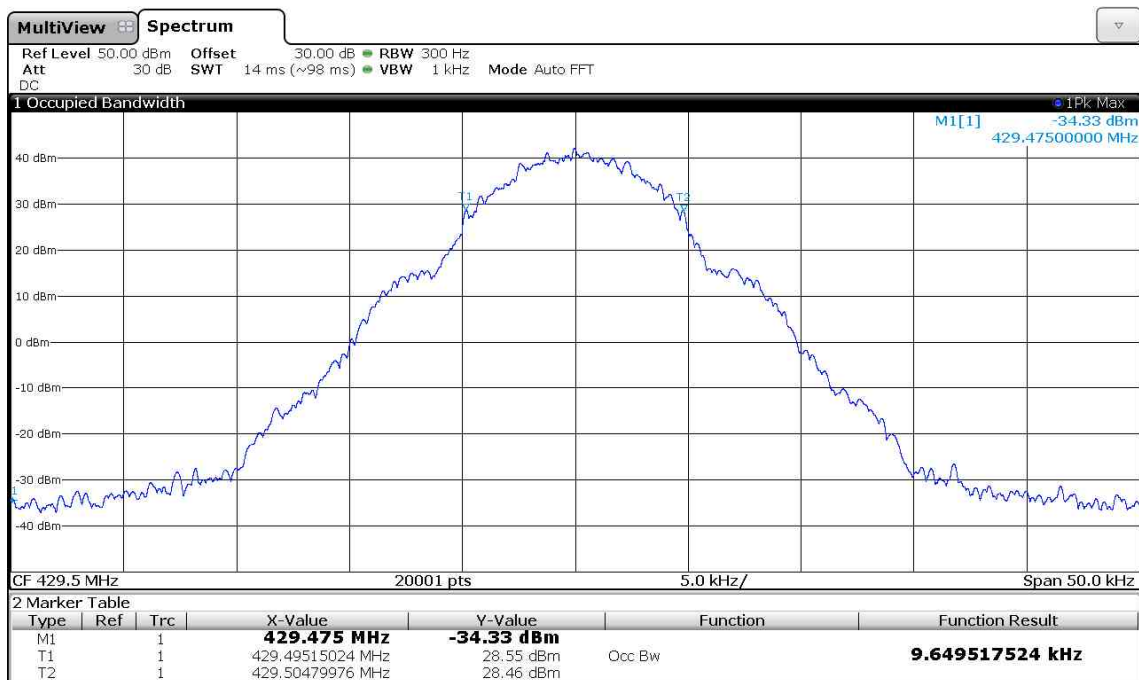
160575_OBW_429.5M_25k_35W_8FSK.PNG



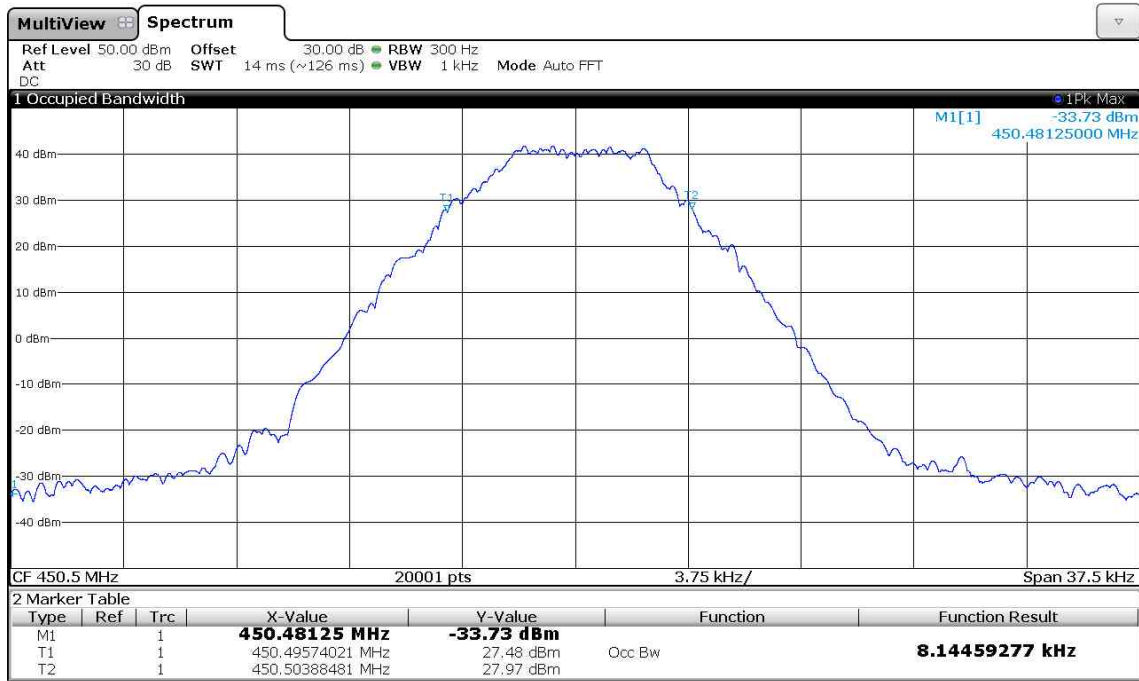
160575_OBW_429.5M_25k_35W_16FSK.PNG



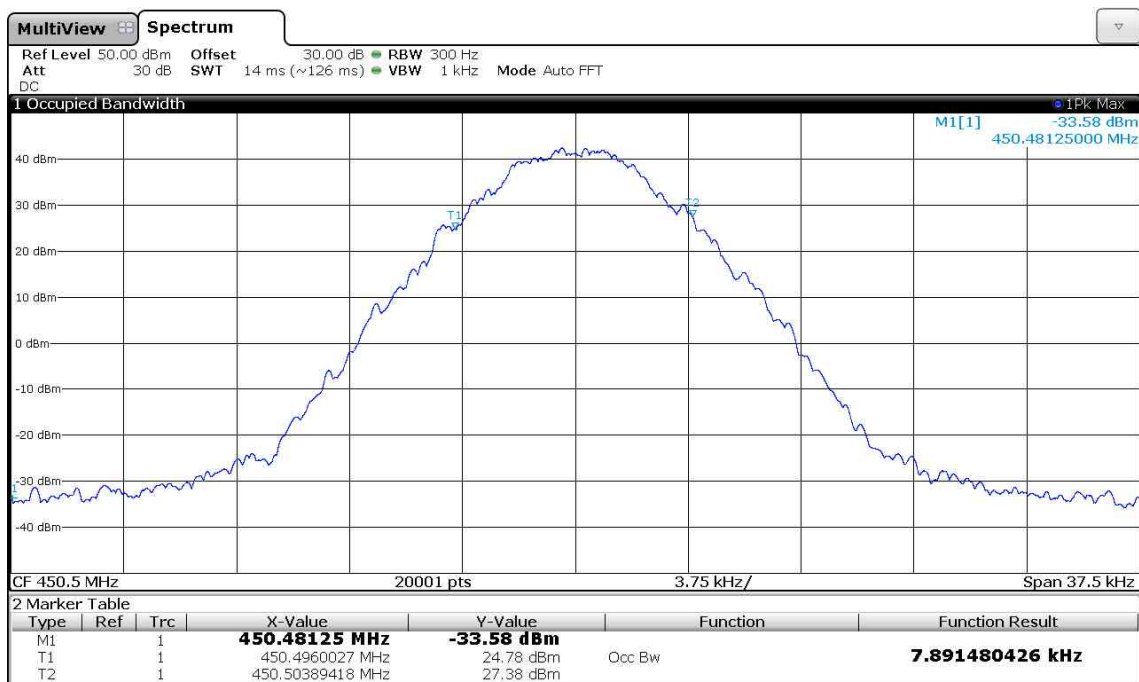
160575_OBW_429.5M_25k_35W_GMSK.PNG



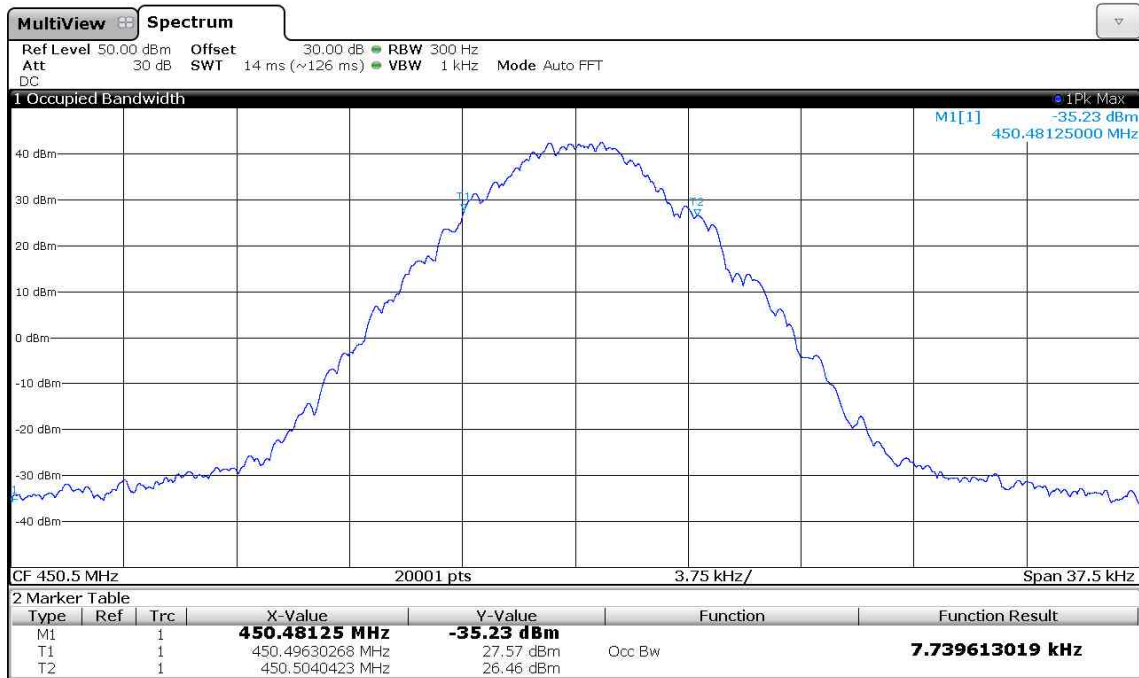
160575_OBW_450.5M_12.5k_35W_4FSK.PNG



160575_OBW_450.5M_12.5k_35W_8FSK.PNG



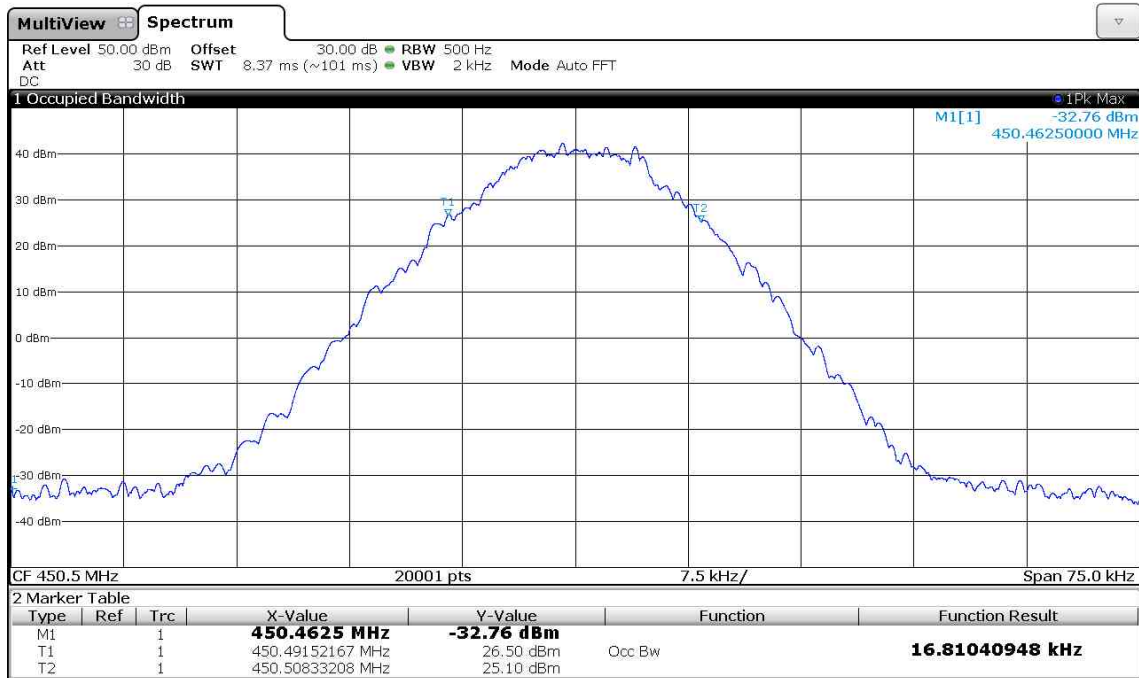
160575_OBW_450.5M_12.5k_35W_16FSK.PNG



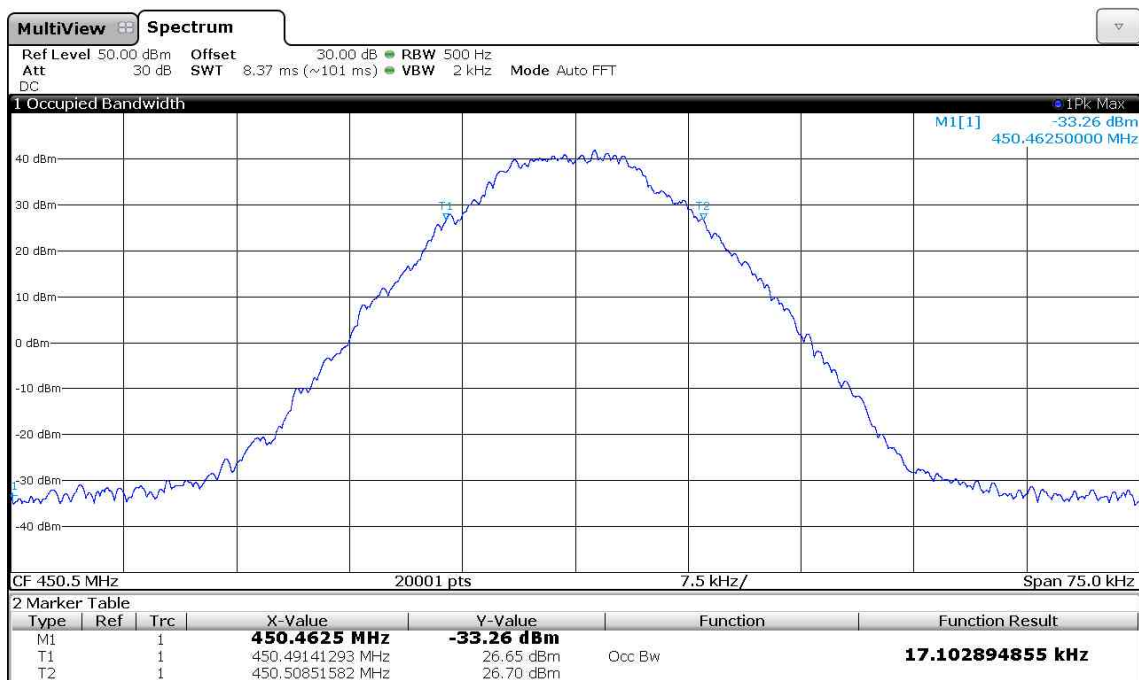
160575_OBW_450.5M_12.5k_35W_GMSK.PNG



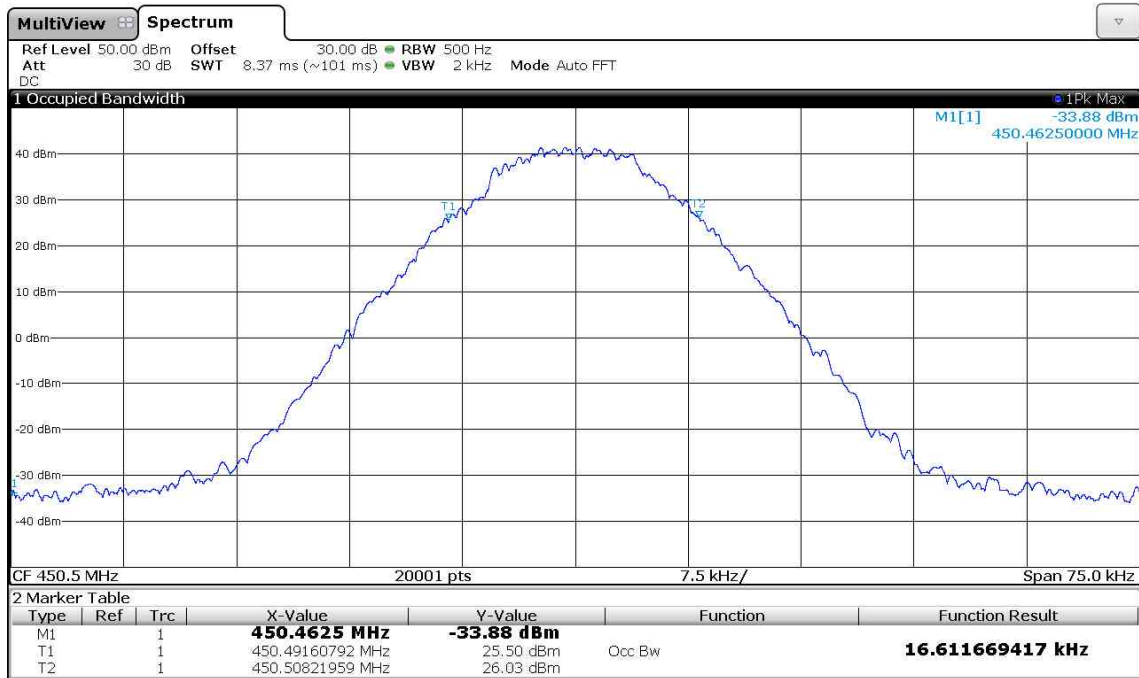
160575_OBW_450.5M_25k_35W_4FSK.PNG



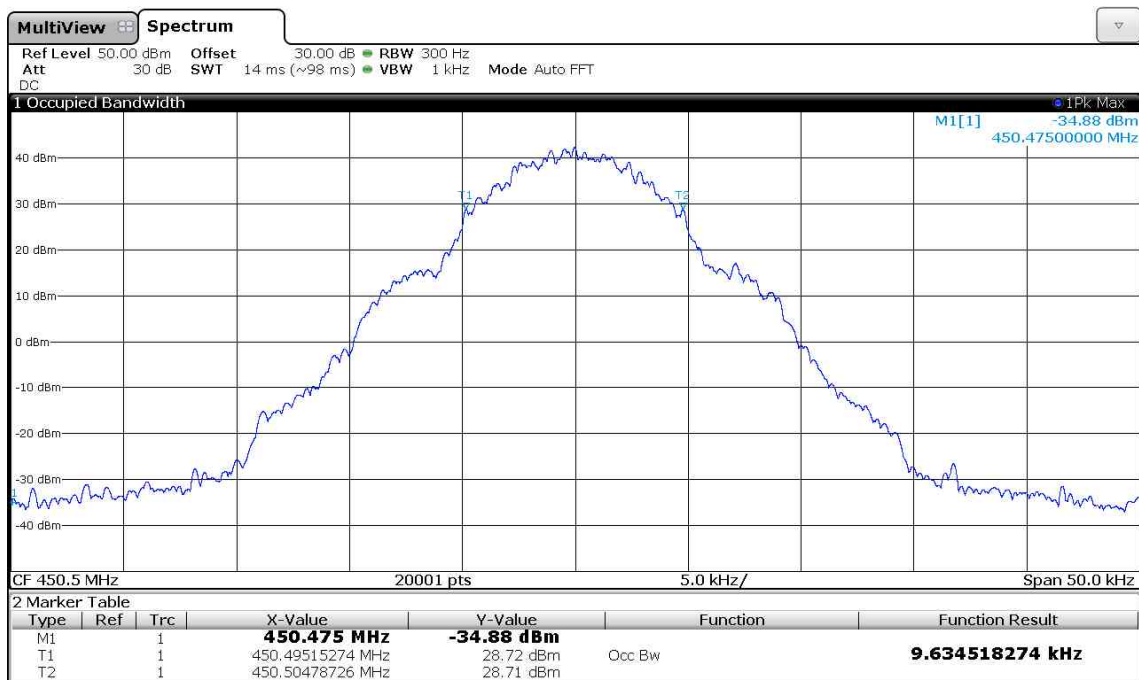
160575_OBW_450.5M_25k_35W_8FSK.PNG



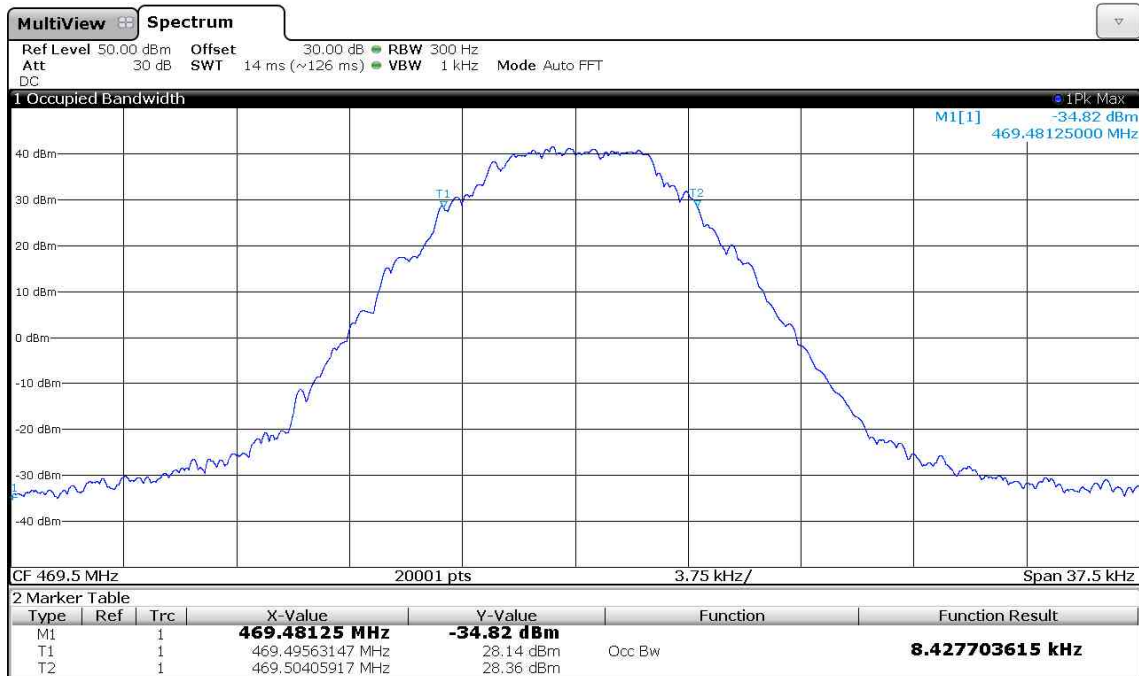
160575_OBW_450.5M_25k_35W_16FSK.PNG



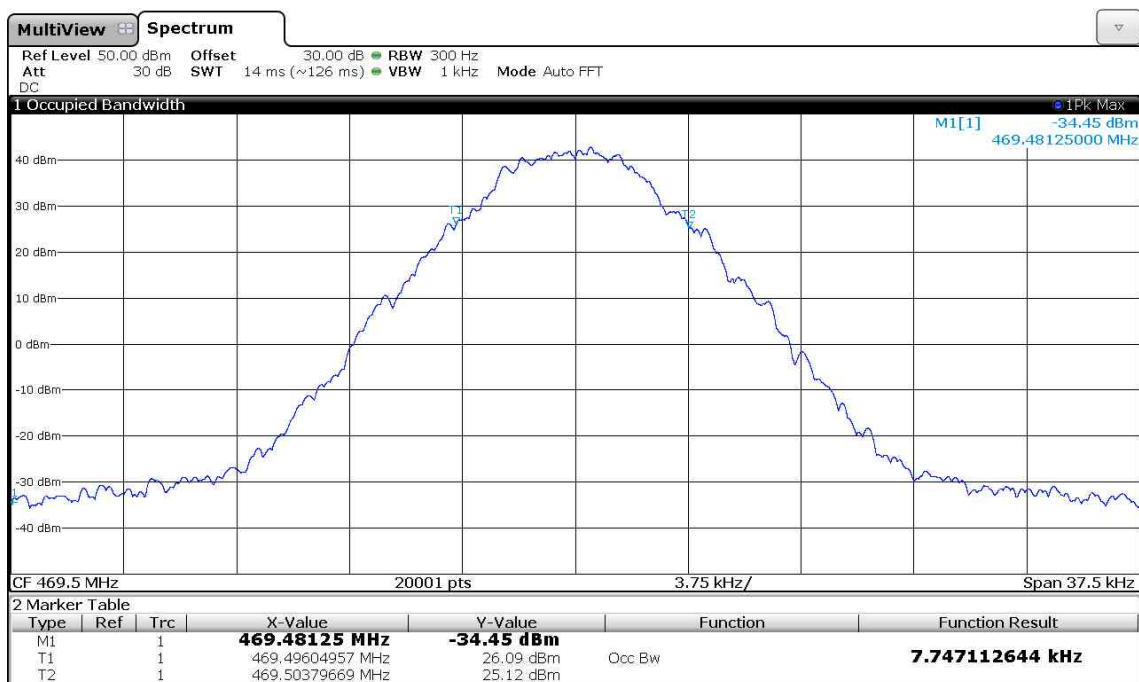
160575_OBW_450.5M_25k_35W_GMSK.PNG



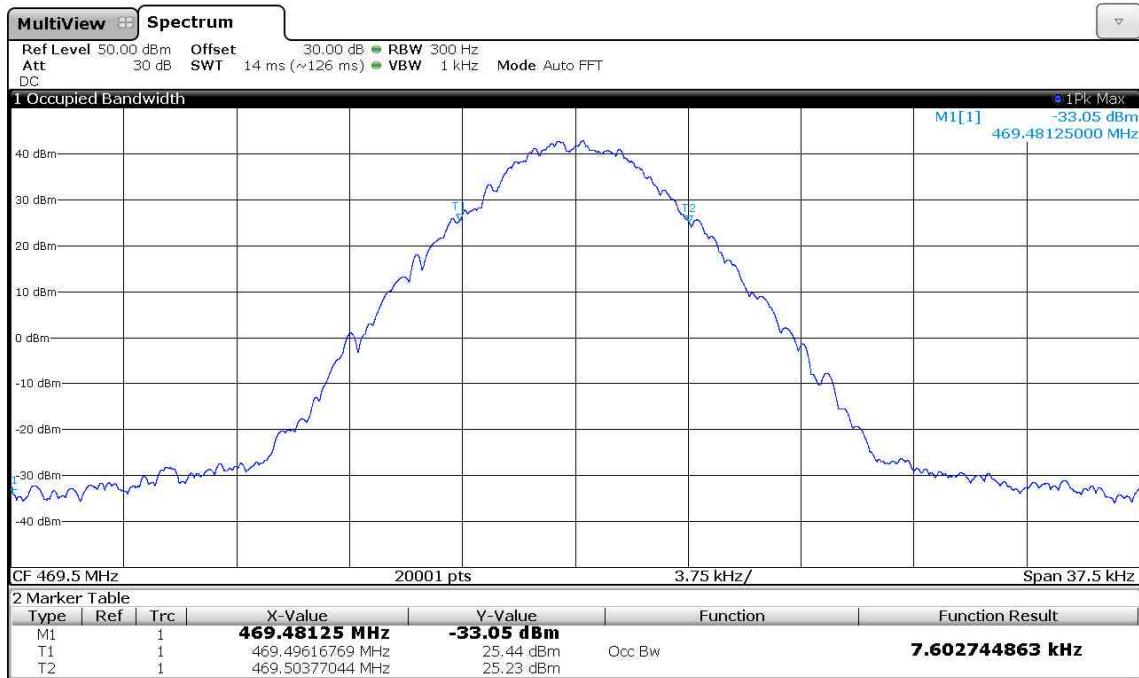
160575_OBW_469.5M_12.5k_35W_4FSK.PNG



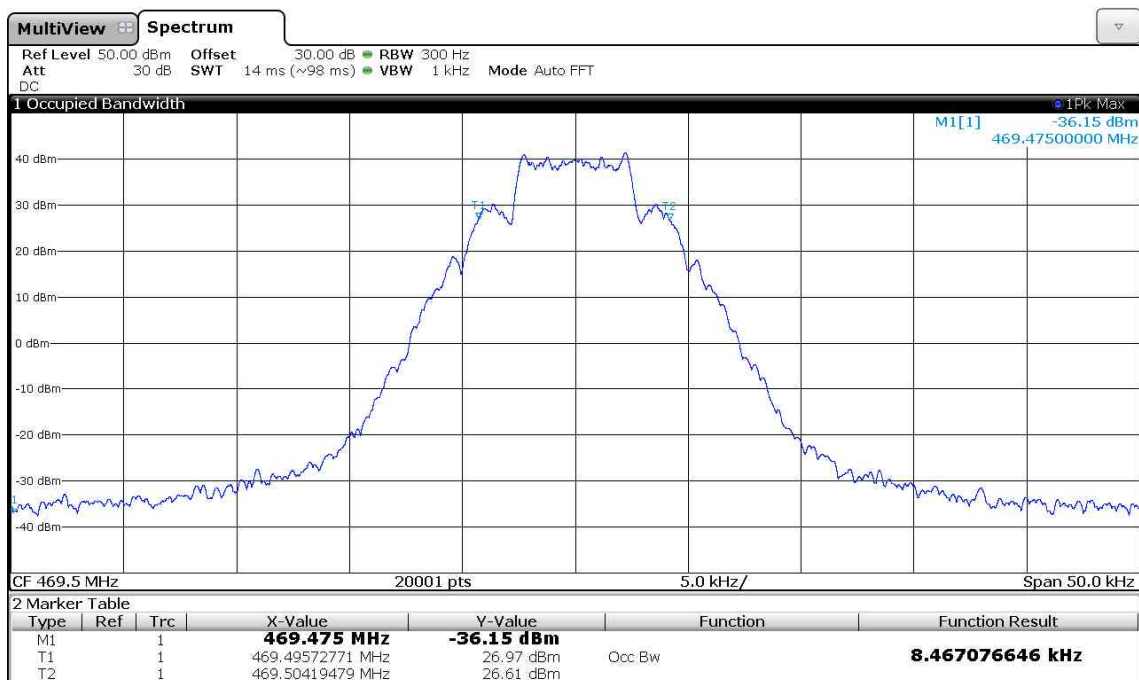
160575_OBW_469.5M_12.5k_35W_8FSK.PNG



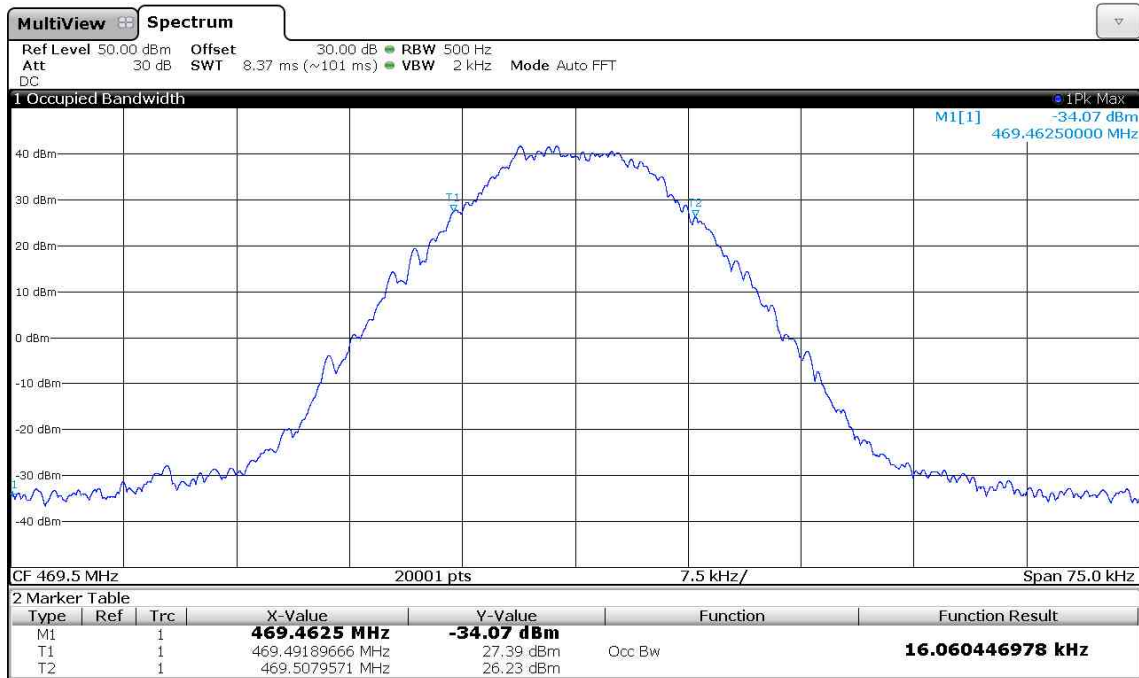
160575_OBW_469.5M_12.5k_35W_16FSK.PNG



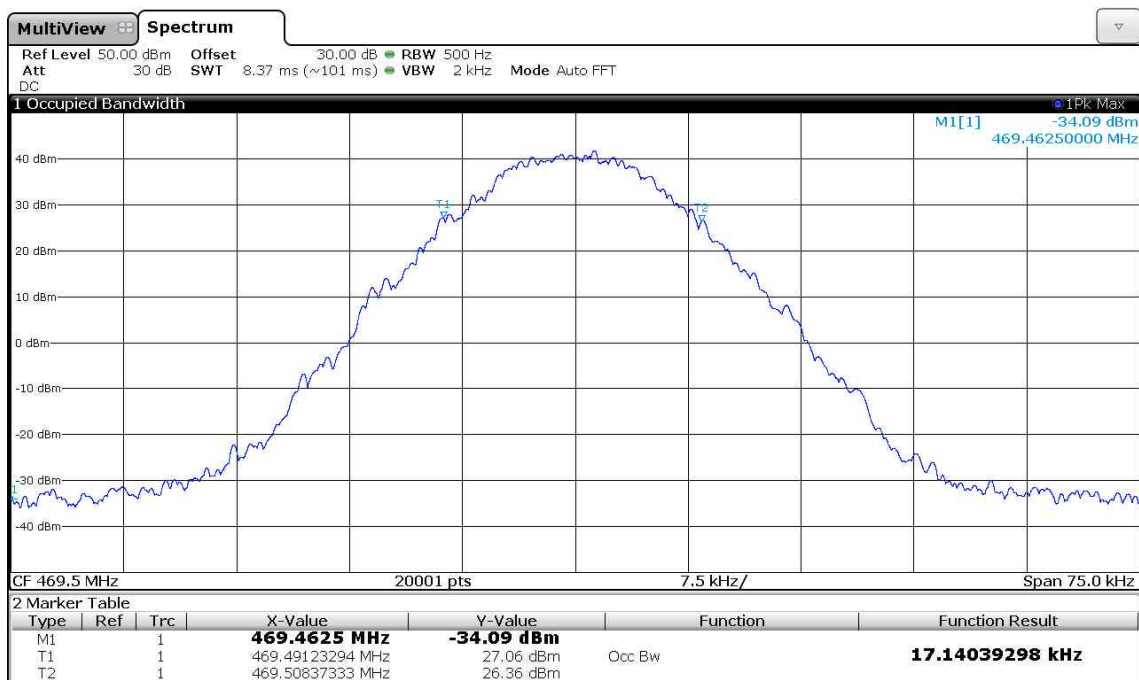
160575_OBW_469.5M_12.5k_35W_GMSK.PNG



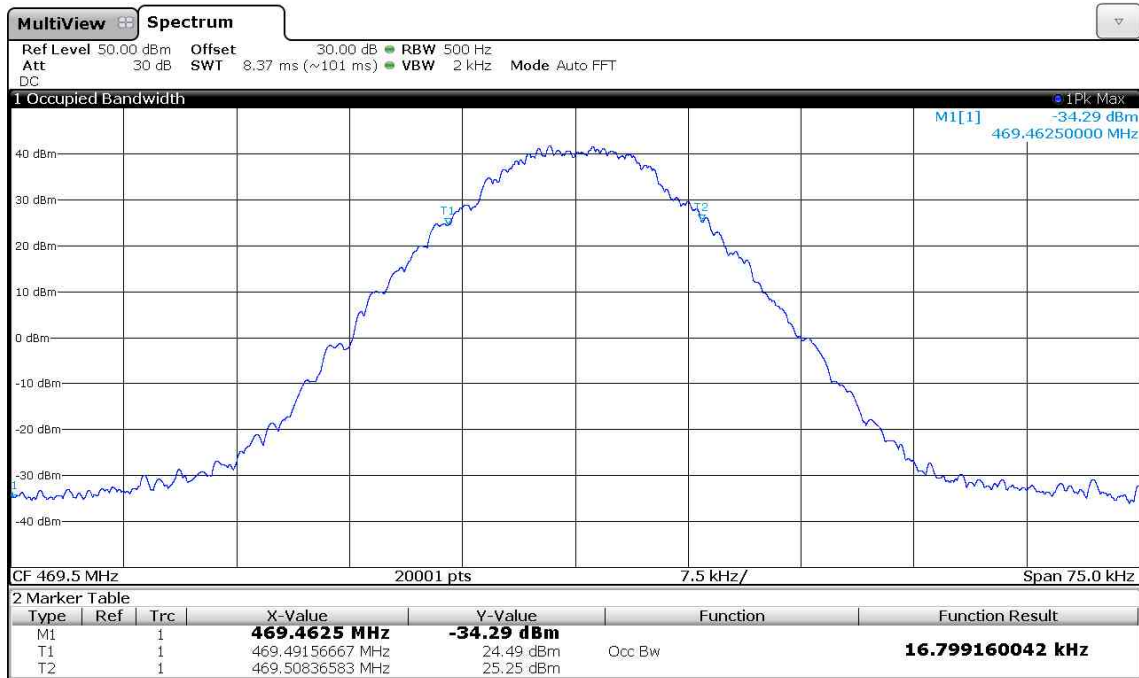
160575_OBW_469.5M_25k_35W_4FSK.PNG



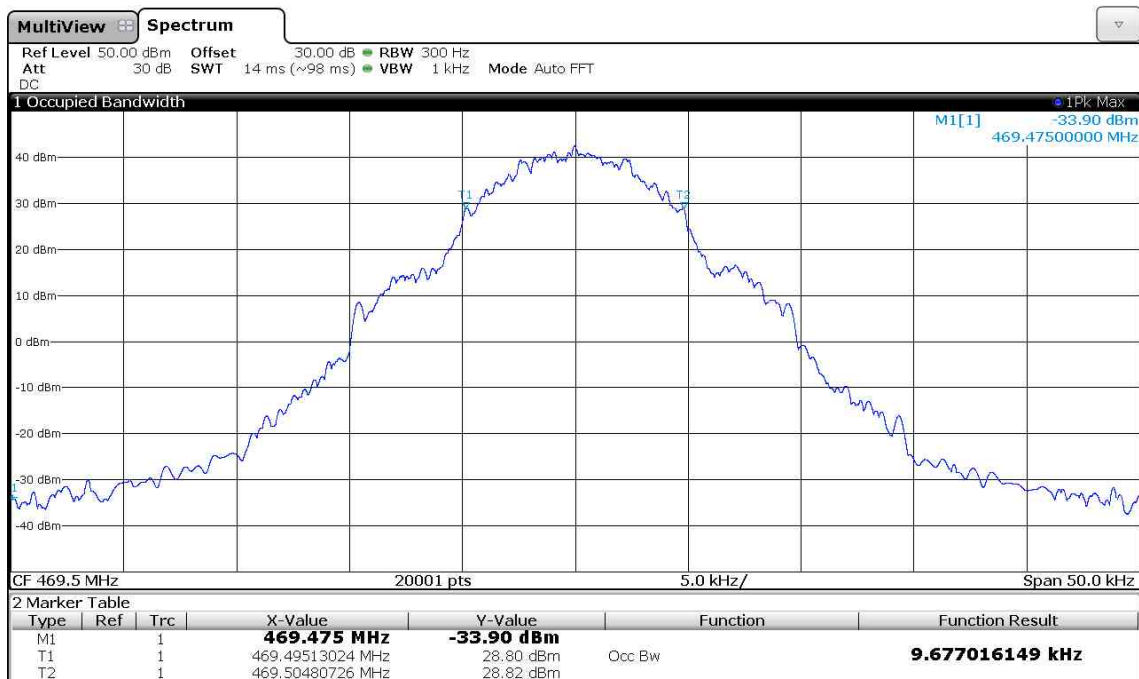
160575_OBW_469.5M_25k_35W_8FSK.PNG



160575_OBW_469.5M_25k_35W_16FSK.PNG



160575_OBW_469.5M_25k_35W_GMSK.PNG



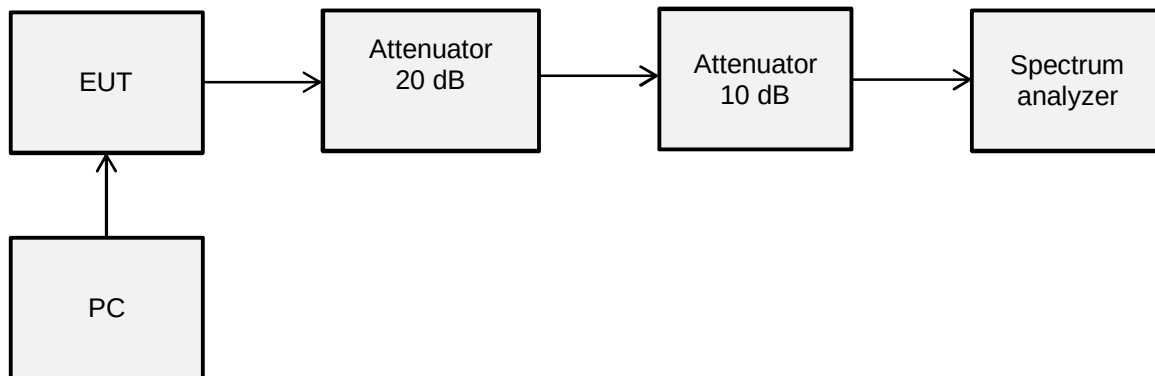
Test equipment used (refer clause 6):

23, 24, 29, 30, 35, 36

5.3 Emission masks

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

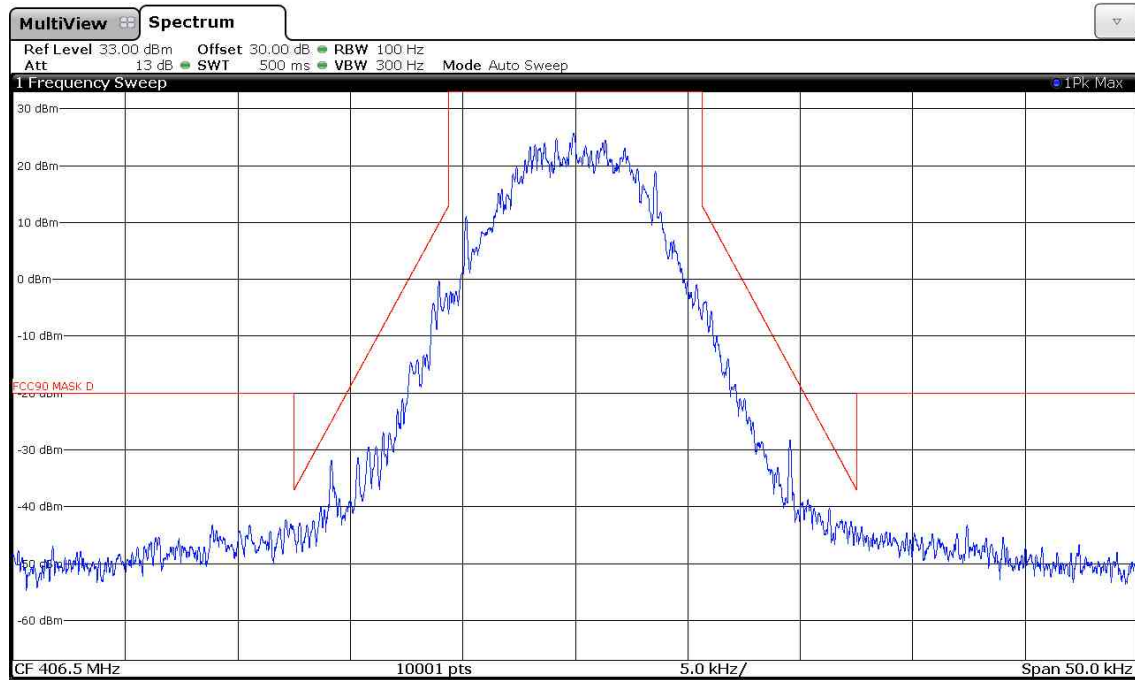
The EUT was set to 4FSK, 8FSK, 16FSK and GMSK mode transmitting a pseudo random data file via the PC. The output power was set to 2 W and 35 W and the channel spacing to 12.5 kHz and 25 kHz.

5.3.2 Test Results

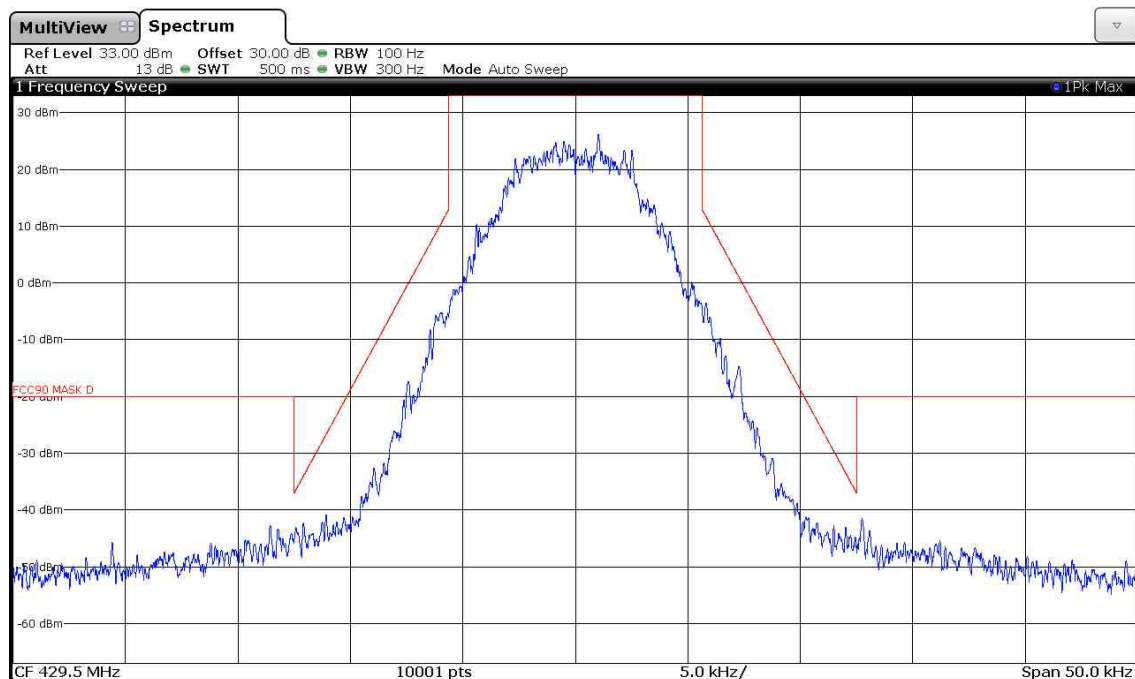
Ambient temperature	23 °C	Relative humidity	22 %
---------------------	-------	-------------------	------

5.3.2.1 Channel Spacing 12.5 kHz

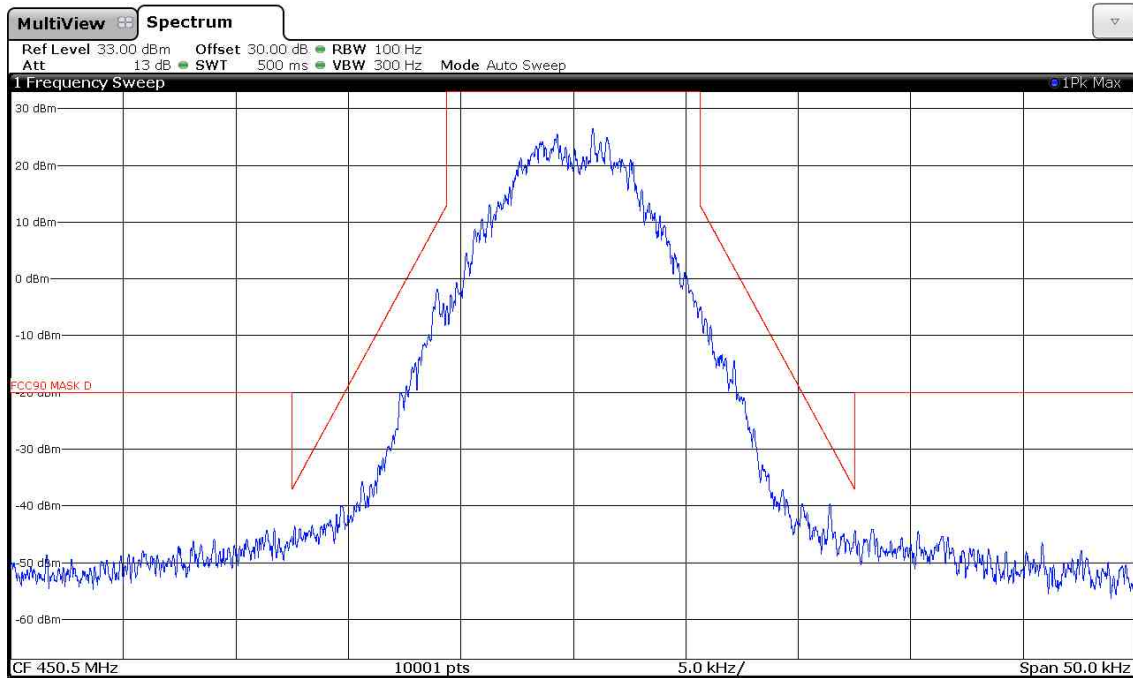
160575_2W_4FSK_406.5MHz_mask_D



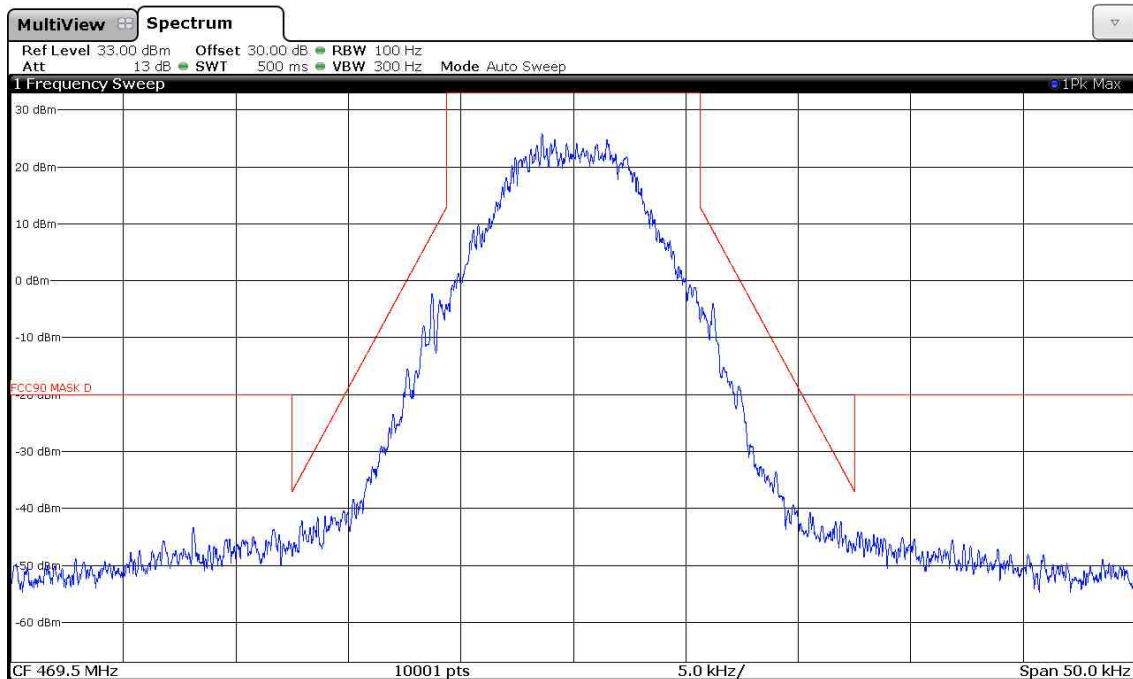
160575_2W_4FSK_429.5MHz_mask_D



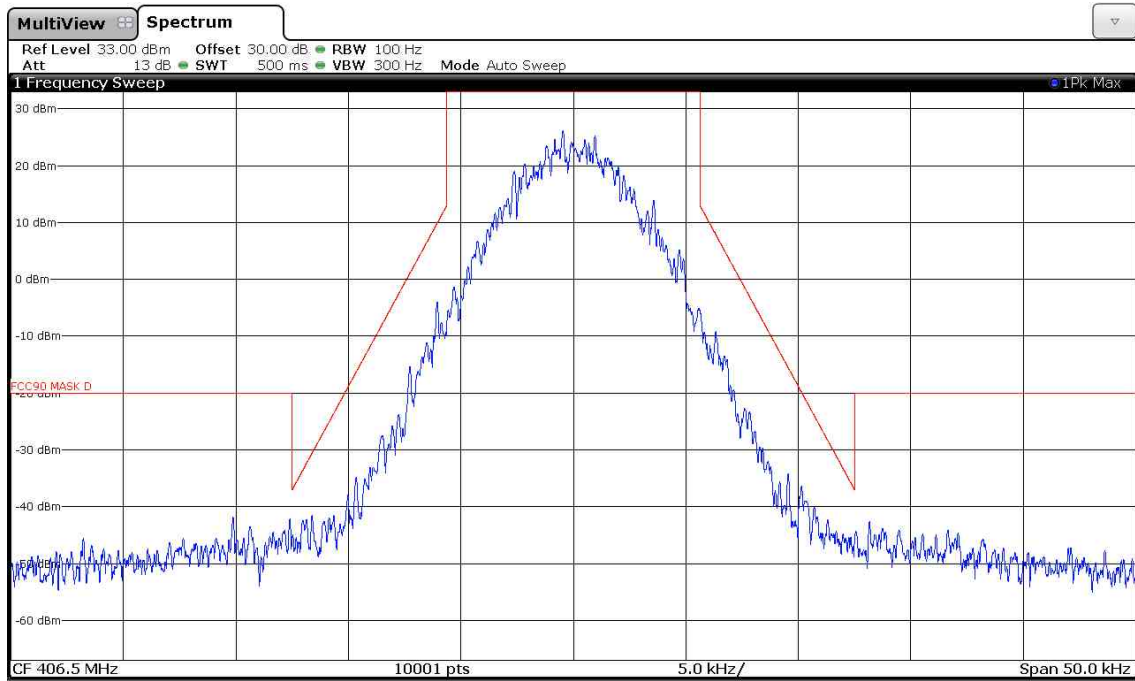
160575_2W_4FSK_450.5MHz_mask_D



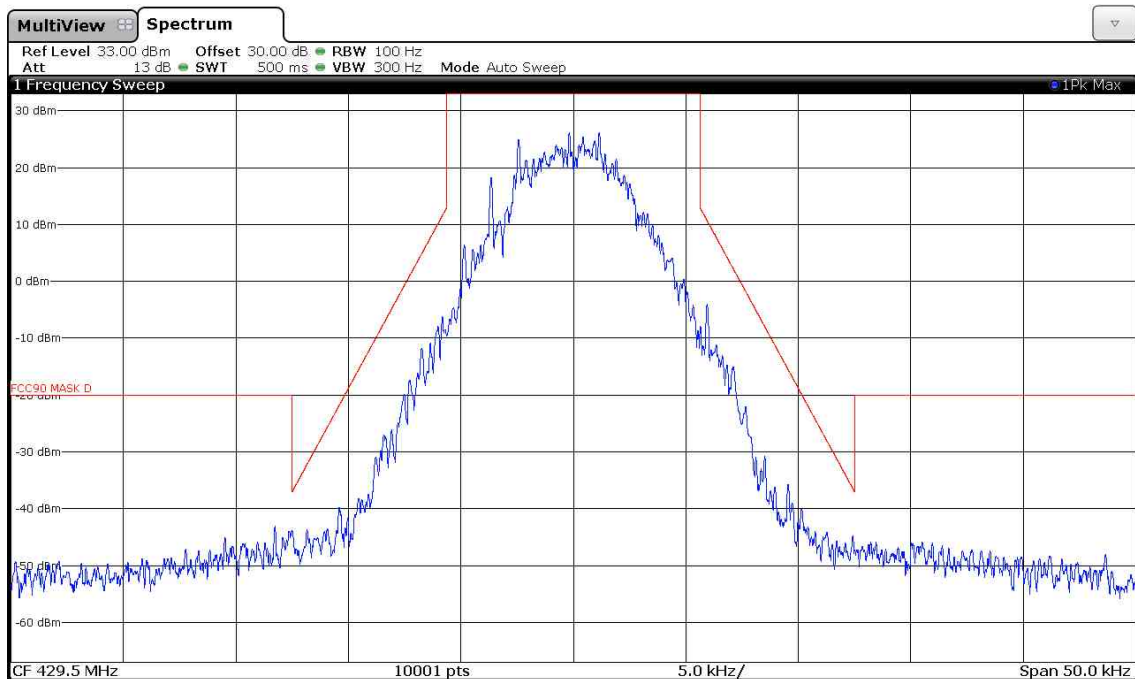
160575_2W_4FSK_469.5MHz_mask_D



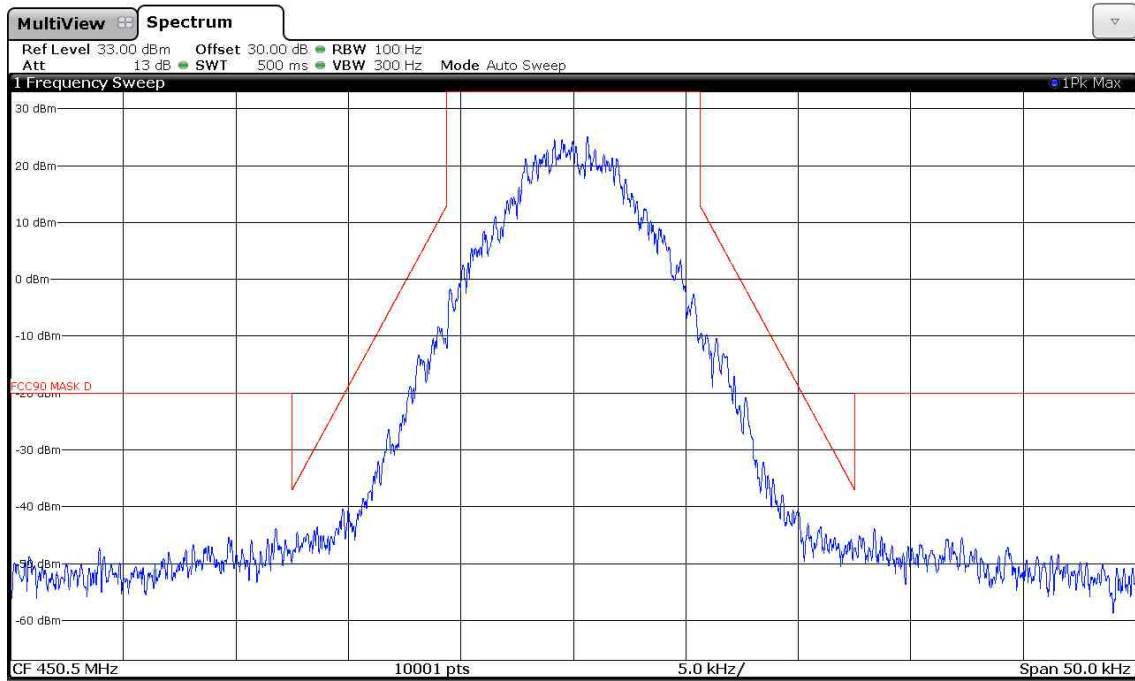
160575_2W_8FSK_406.5MHz_mask_D



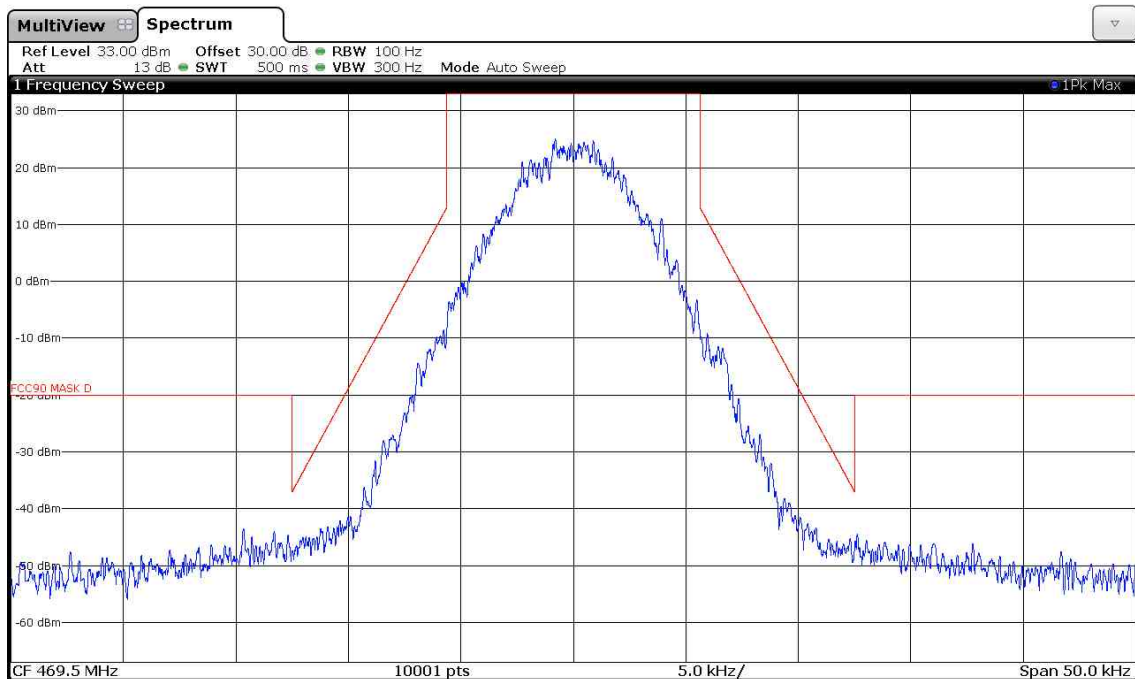
160575_2W_8FSK_429.5MHz_mask_D



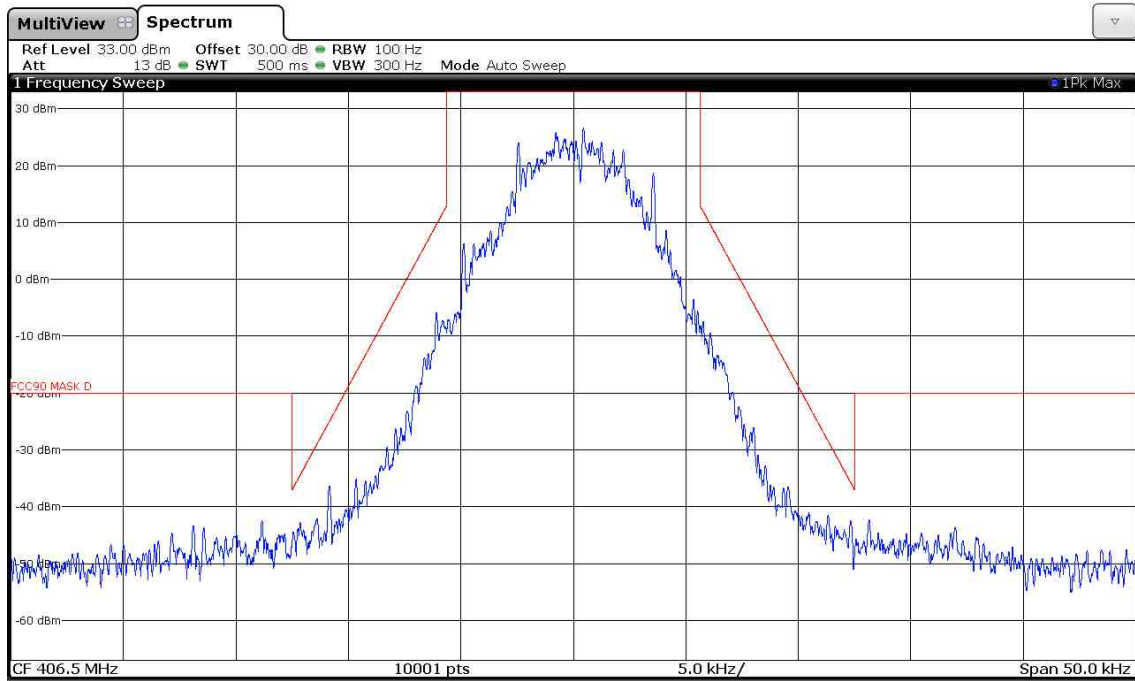
160575_2W_8FSK_450.5MHz_mask_D



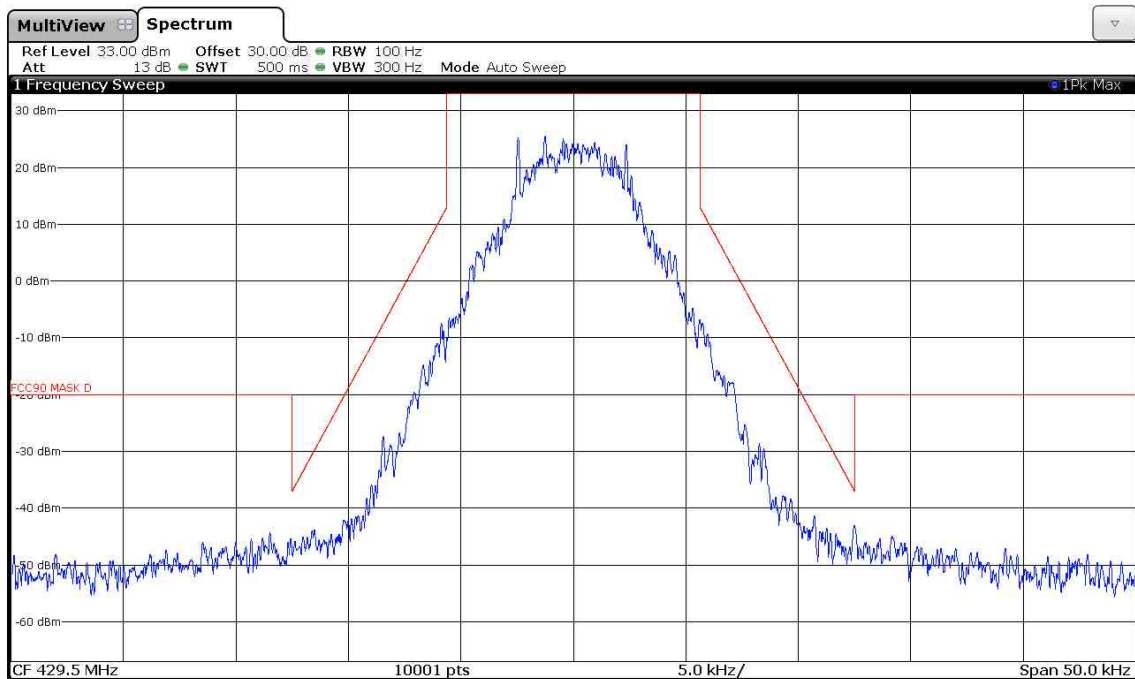
160575_2W_8FSK_469.5MHz_mask_D



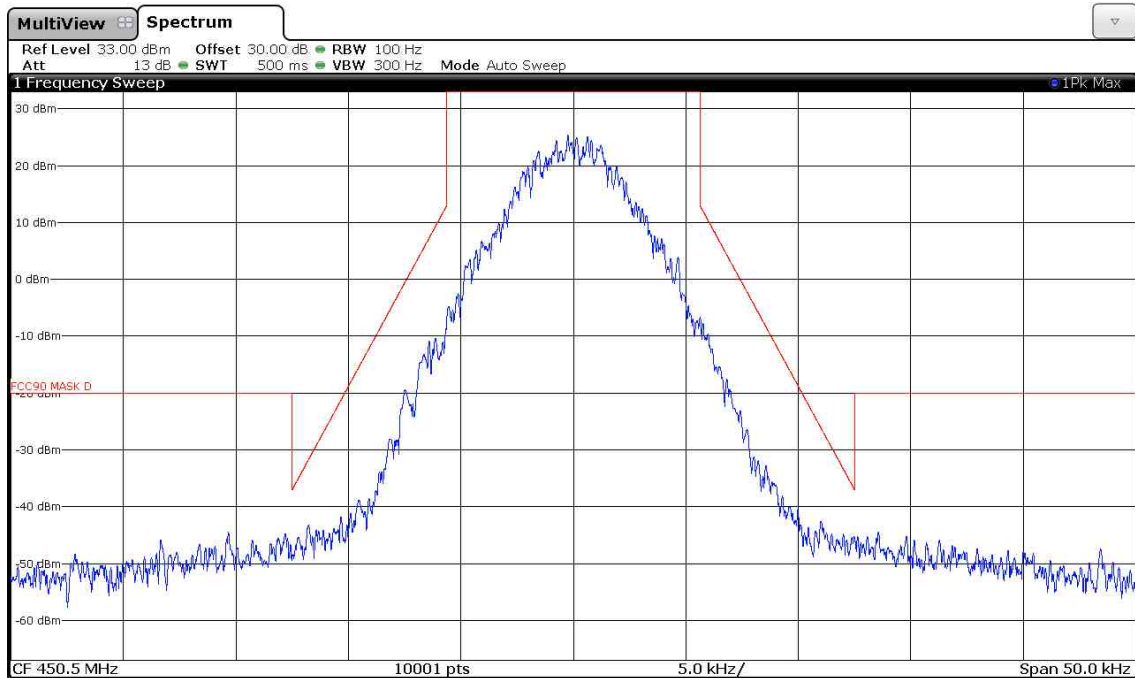
160575_2W_16FSK_406.5MHz_mask_D



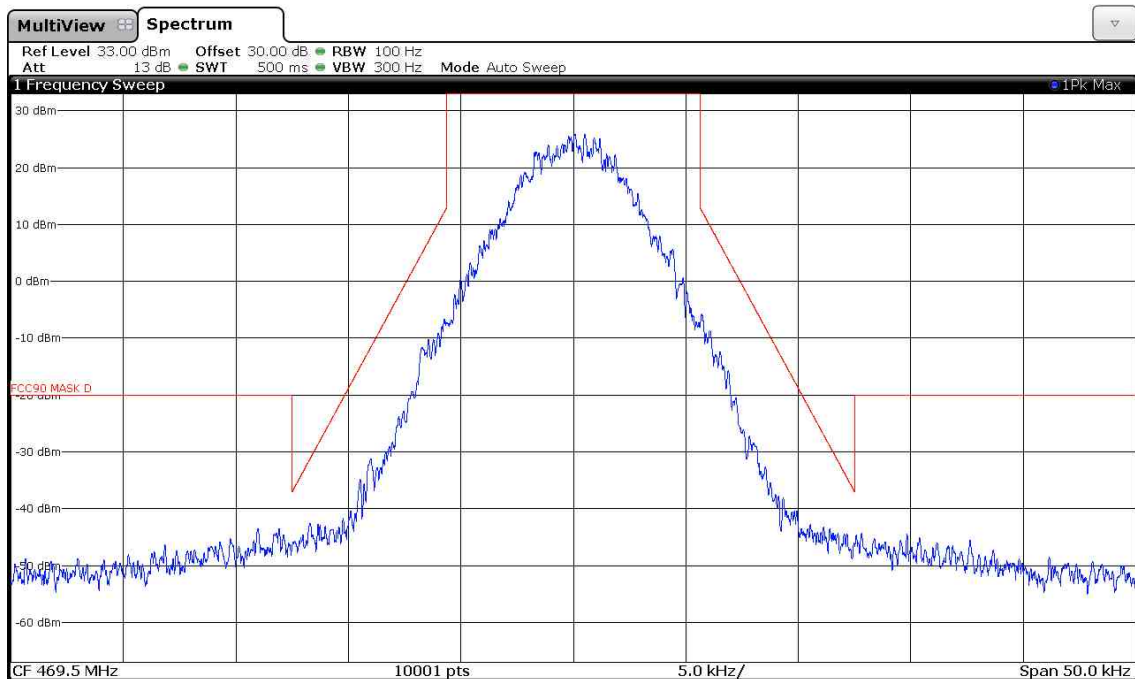
160575_2W_16FSK_429.5MHz_mask_D



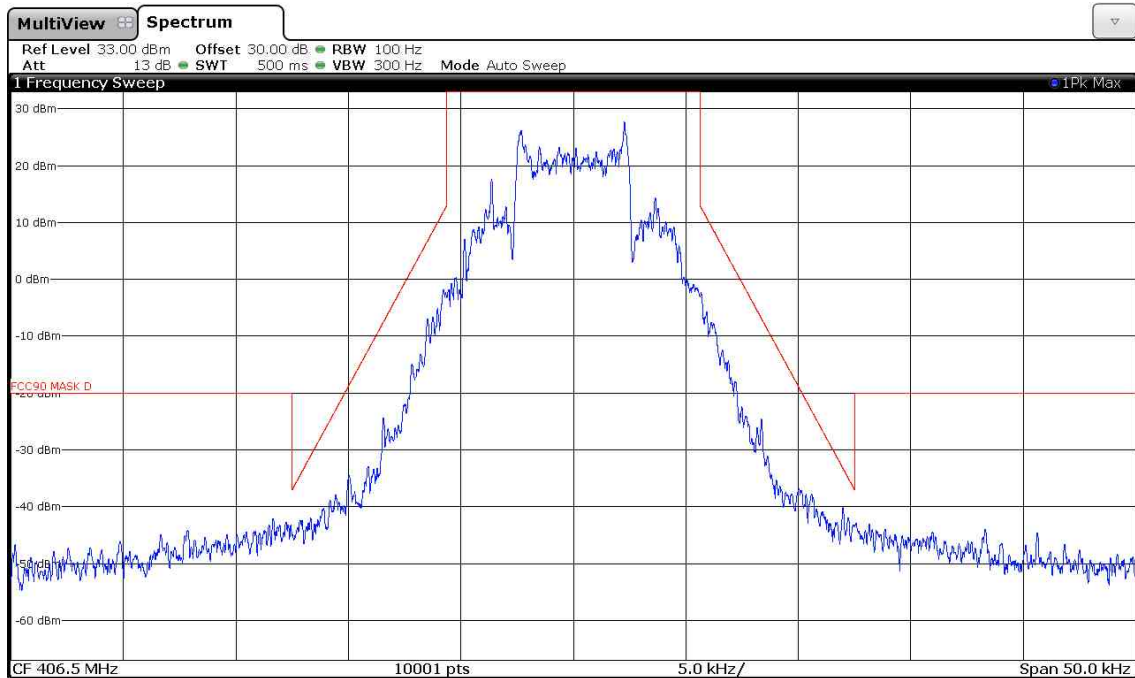
160575_2W_16FSK_450.5MHz_mask_D



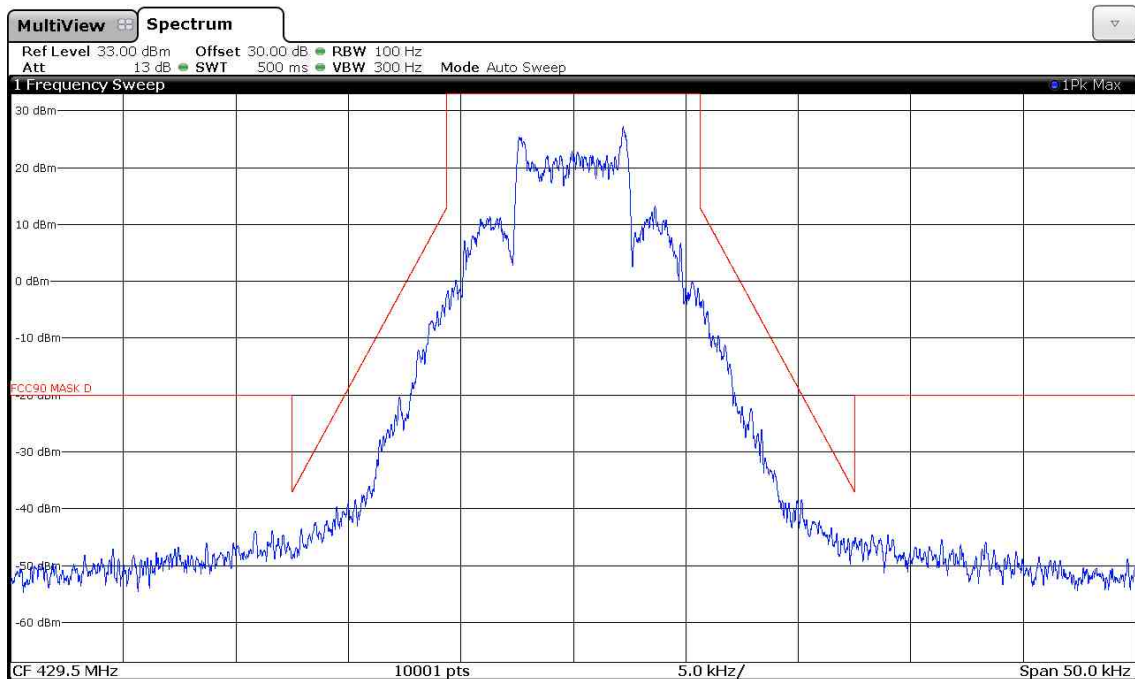
160575_2W_16FSK_469.5MHz_mask_D



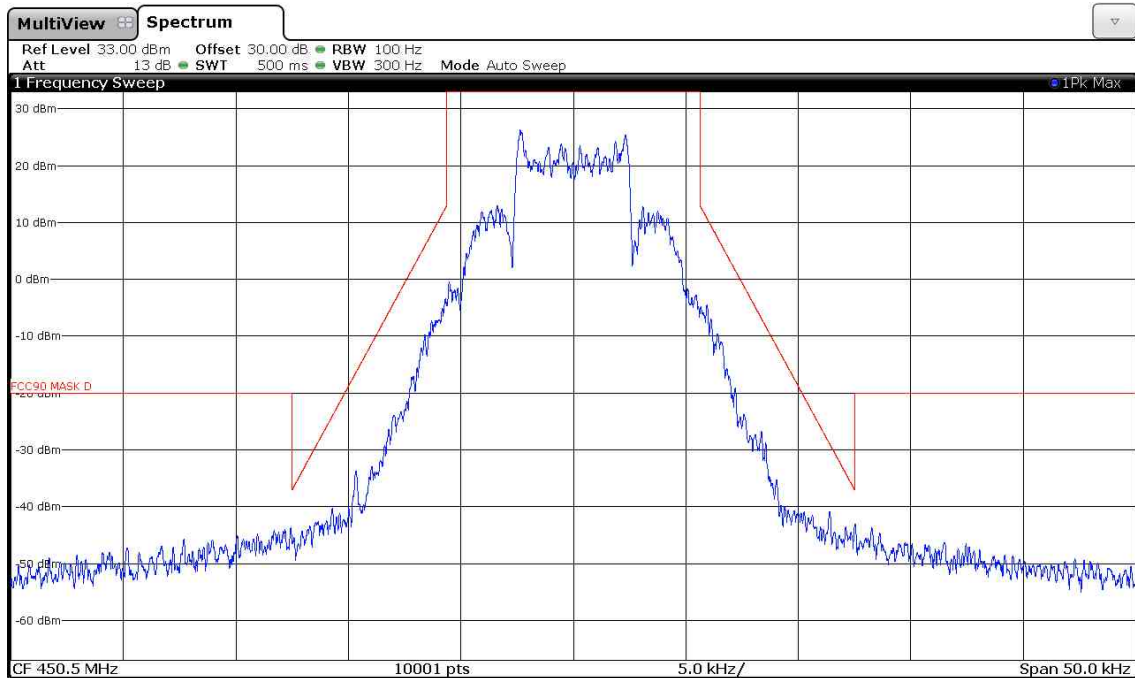
160575_2W_GMSK_406.5MHz_mask_D



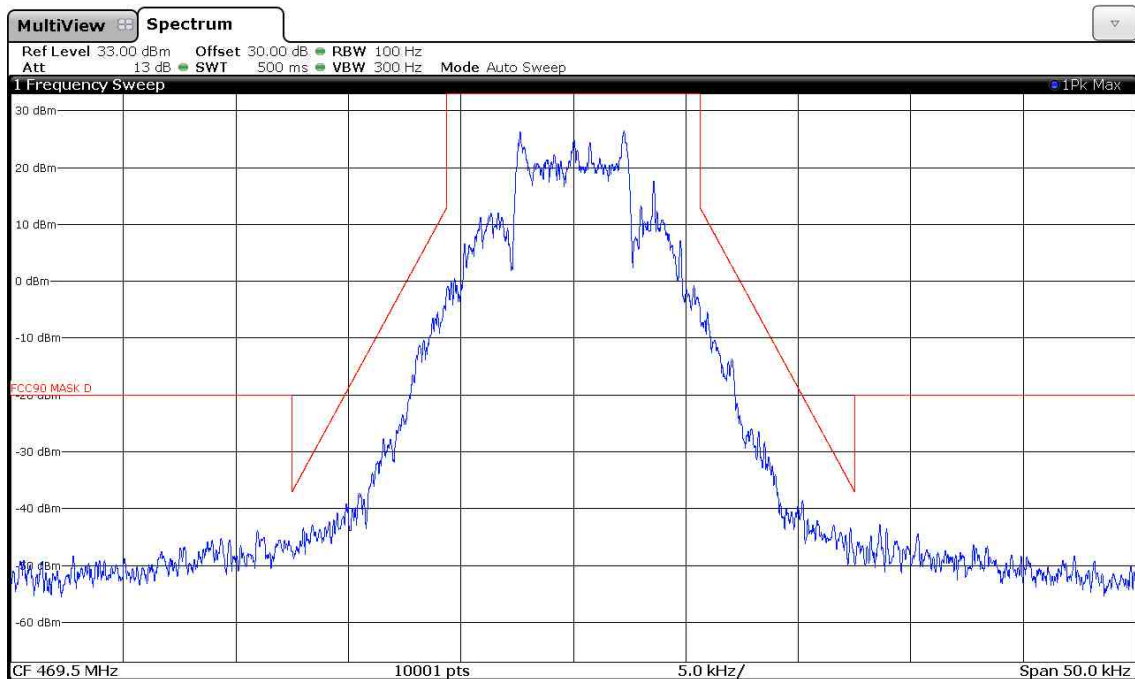
160575_2W_GMSK_429.5MHz_mask_D



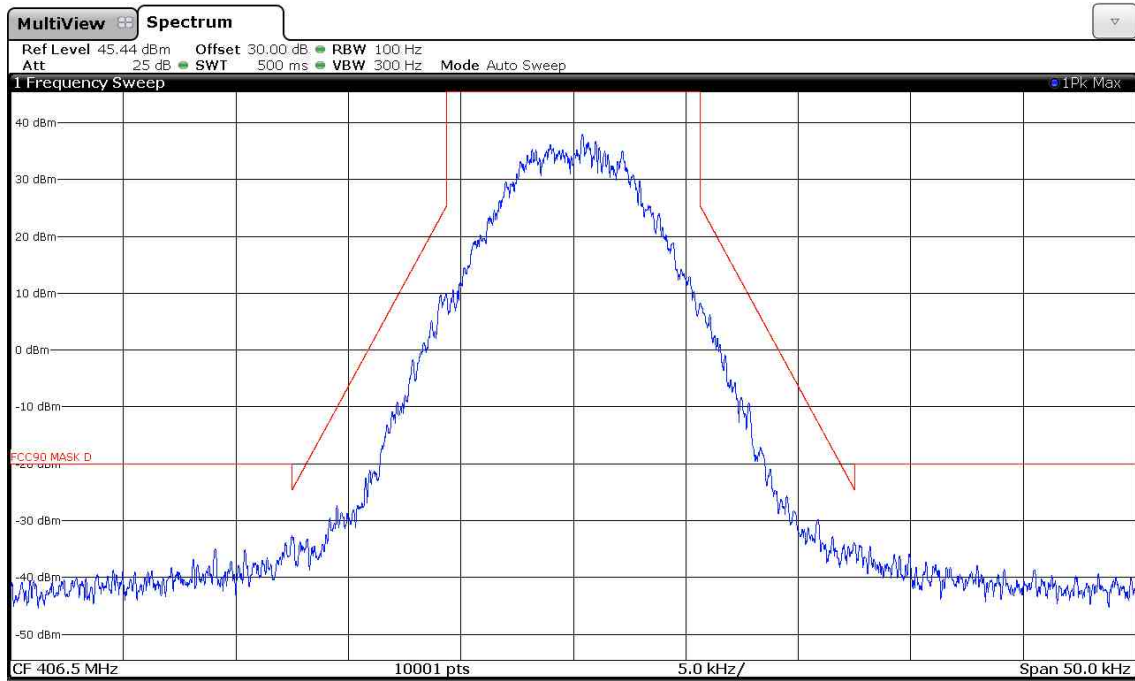
160575_2W_GMSK_450.5MHz_mask_D



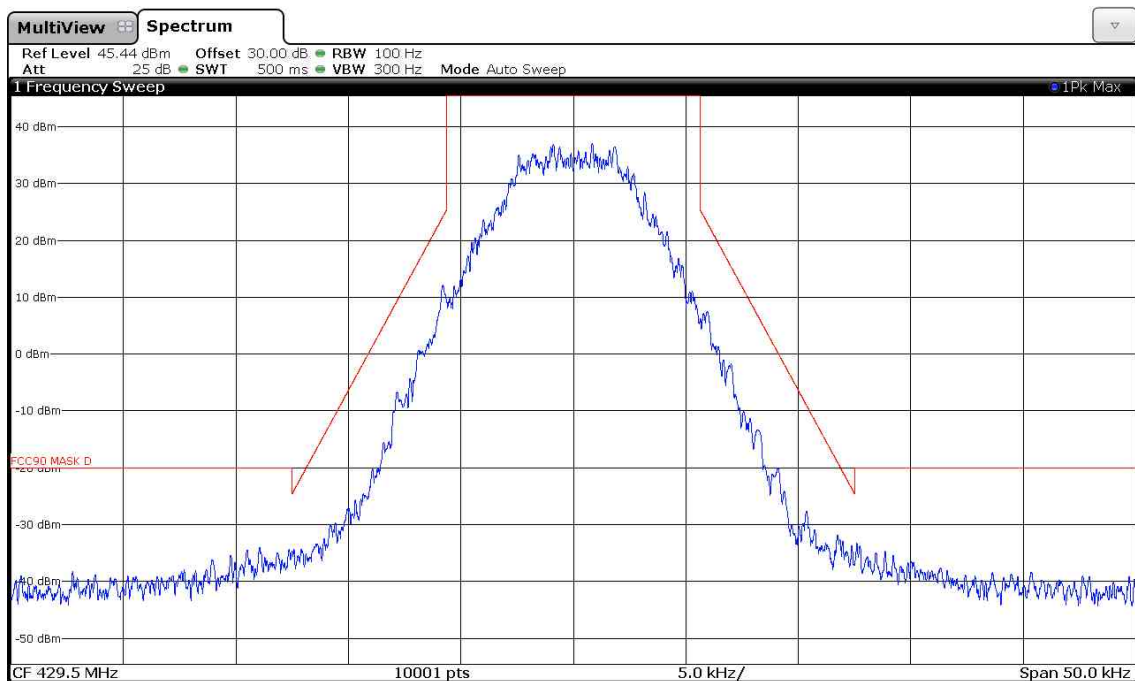
160575_2W_GMSK_469.5MHz_mask_D



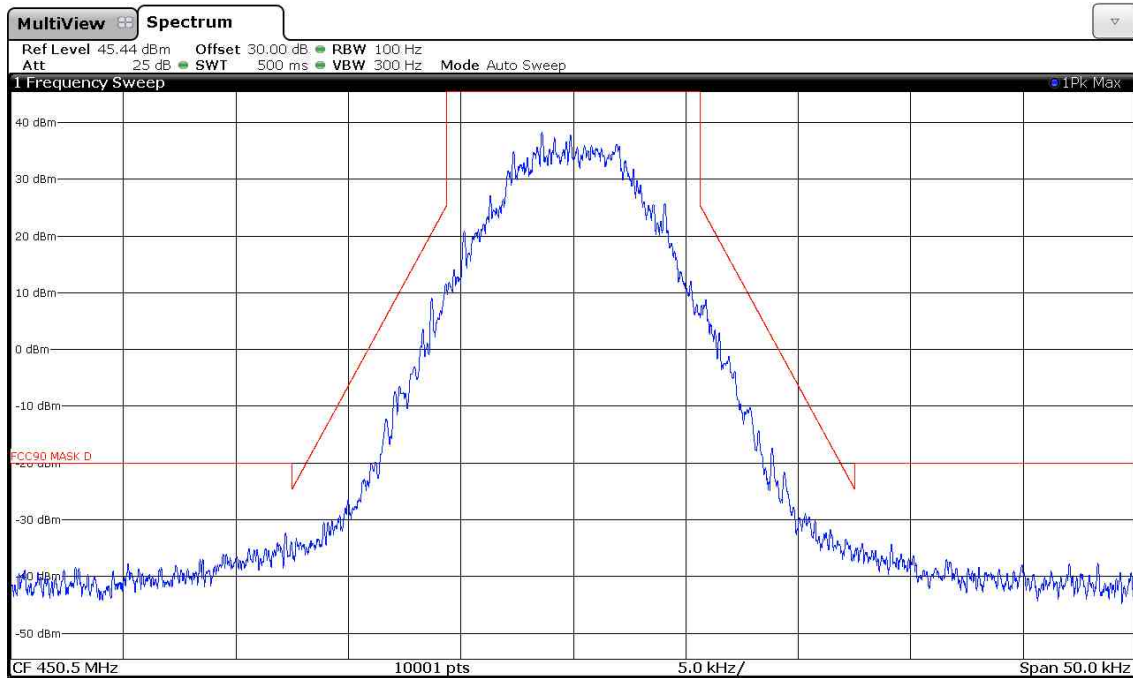
160575_35W_4FSK_406.5MHz_mask_D



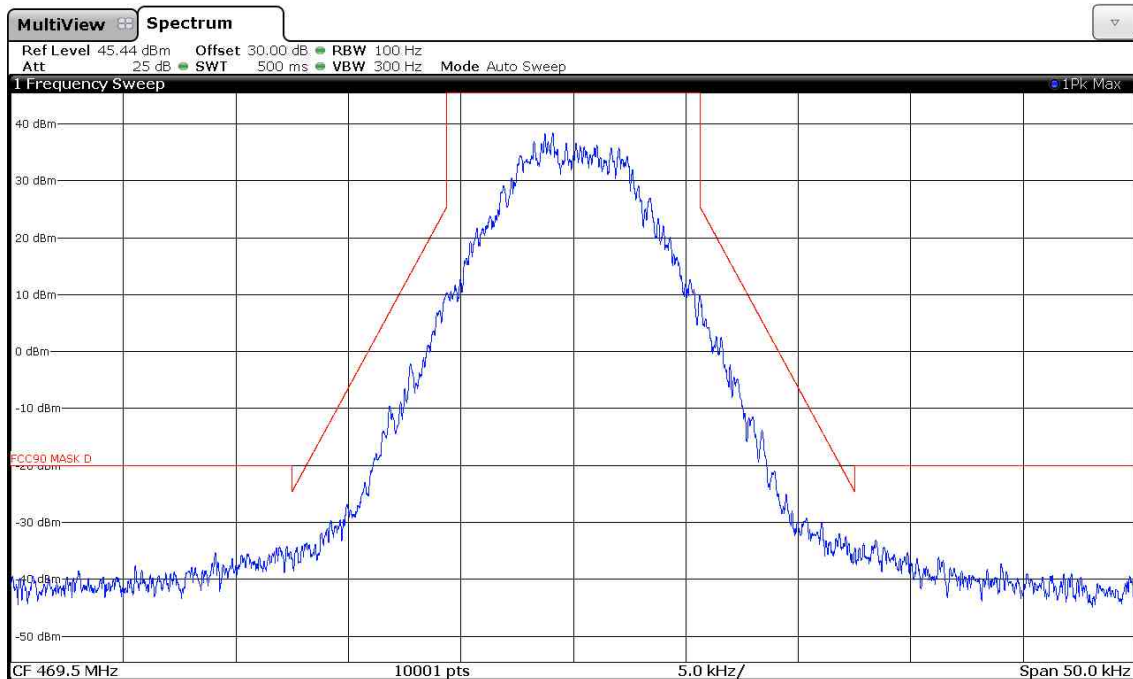
160575_35W_4FSK_429.5MHz_mask_D



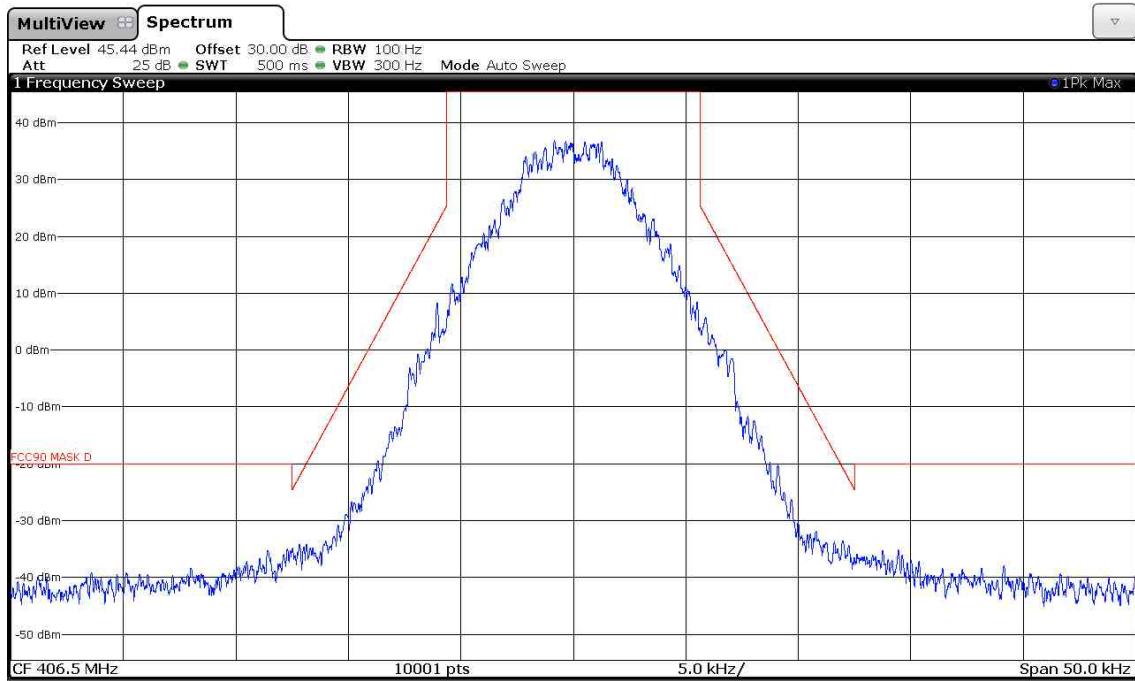
160575_35W_4FSK_450.5MHz_mask_D



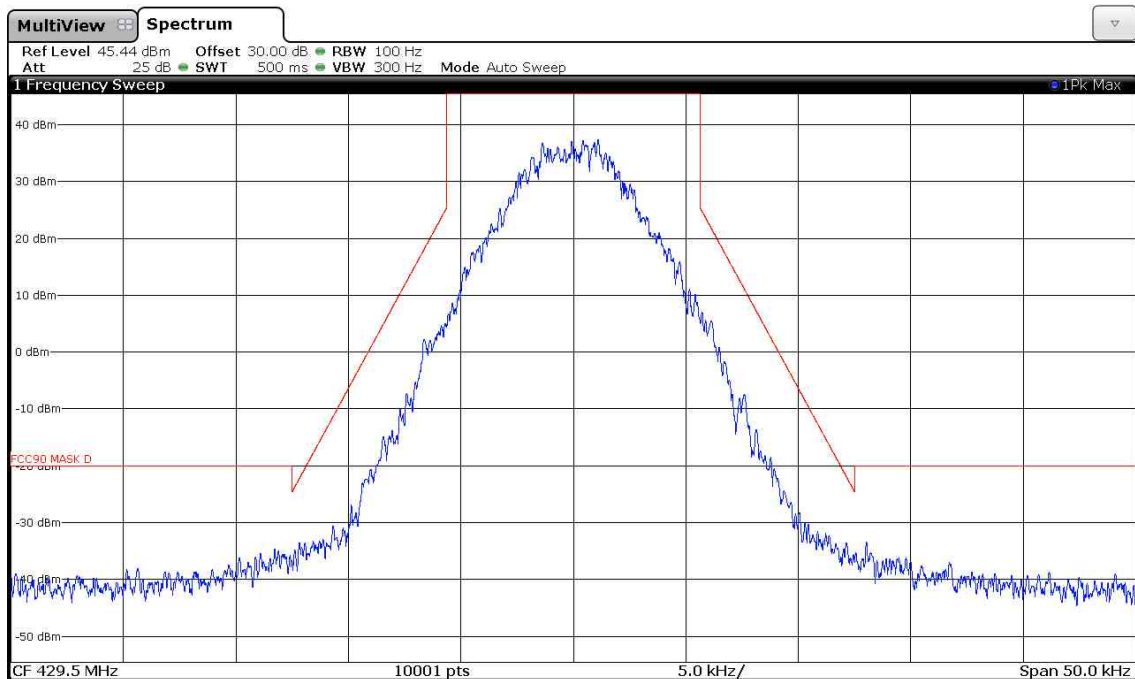
160575_35W_4FSK_469.5MHz_mask_D



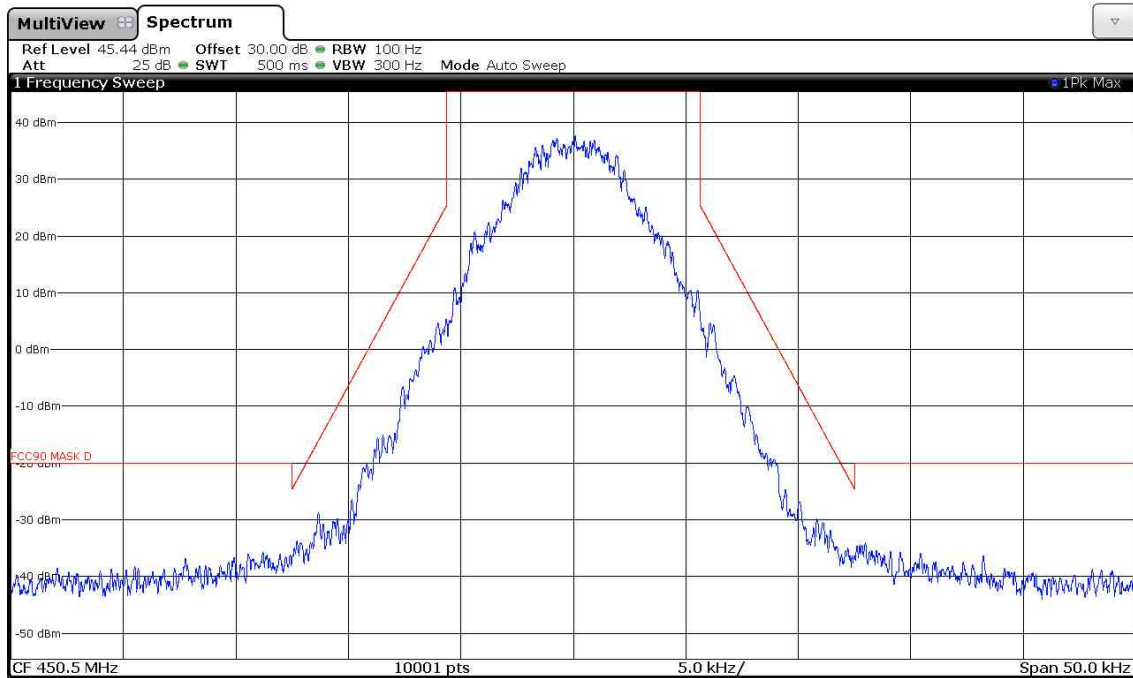
160575_35W_8FSK_406.5MHz_mask_D



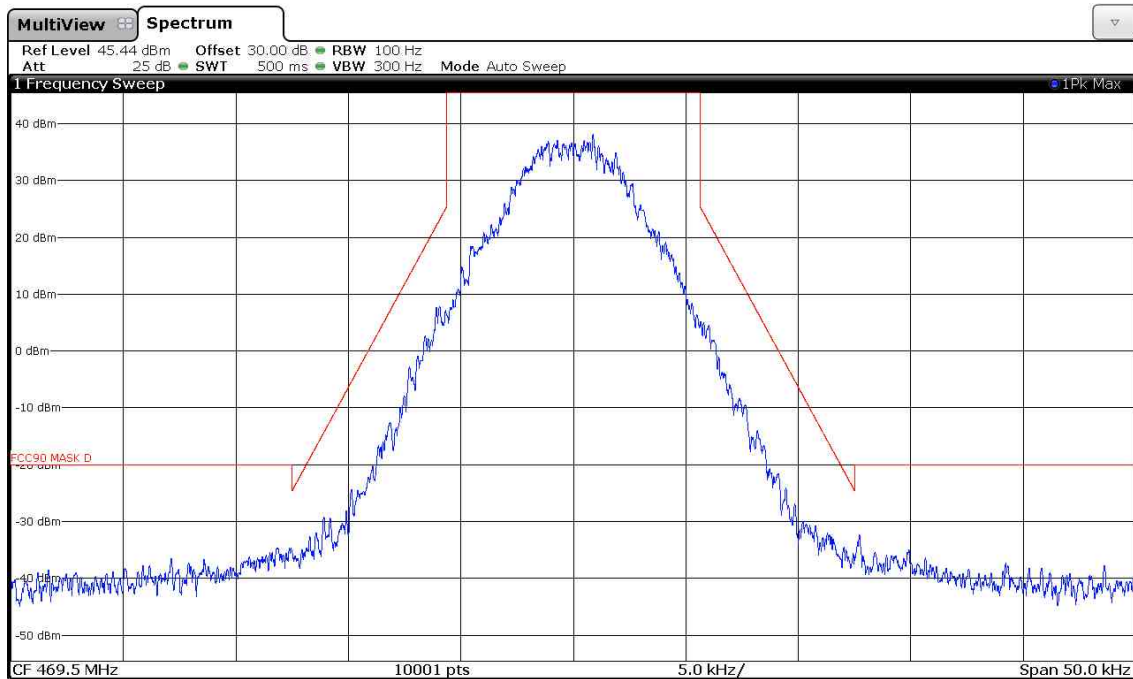
160575_35W_8FSK_429.5MHz_mask_D



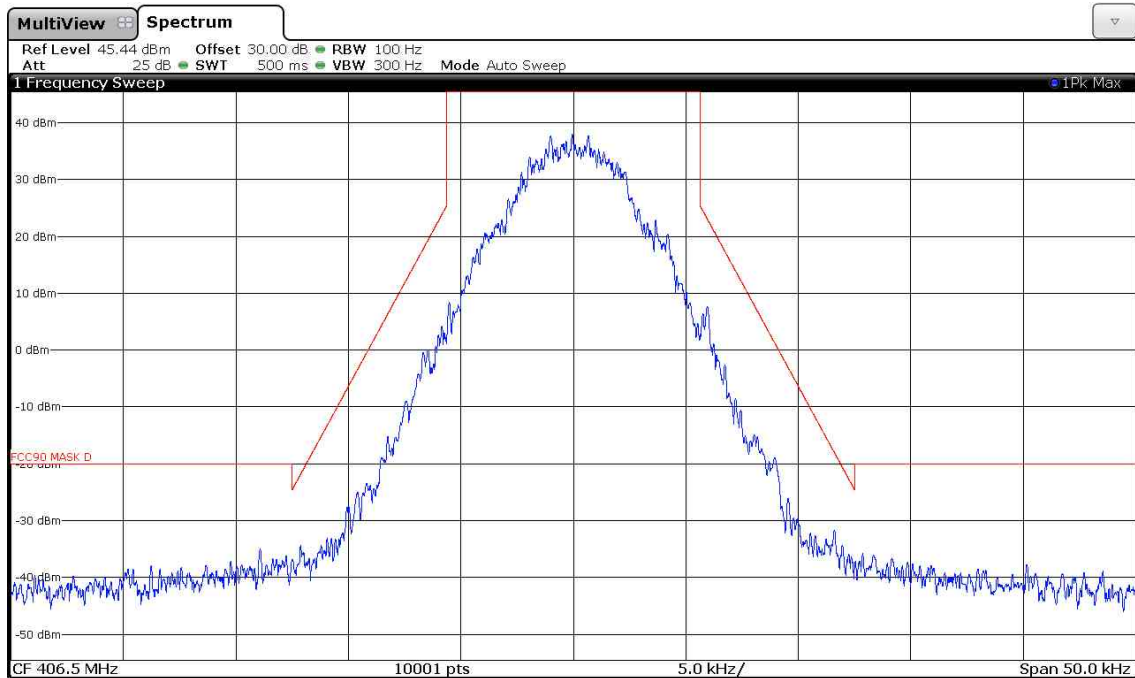
160575_35W_8FSK_450.5MHz_mask_D



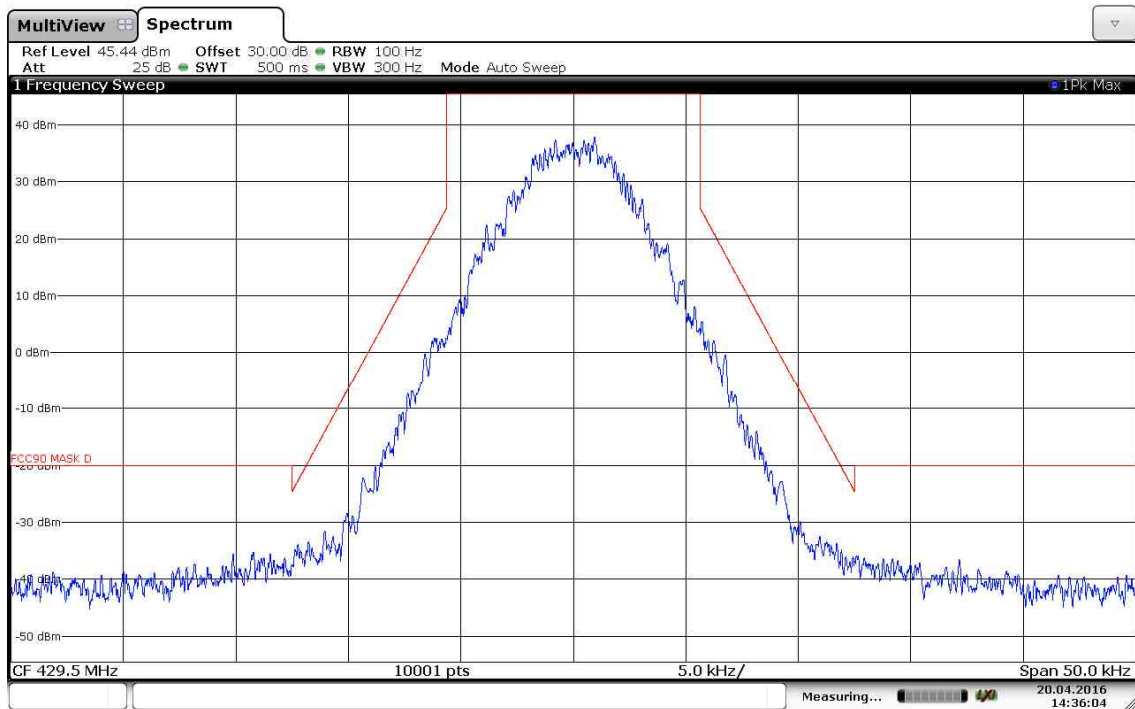
160575_35W_8FSK_469.5MHz_mask_D



160575_35W_16FSK_406.5MHz_mask_D

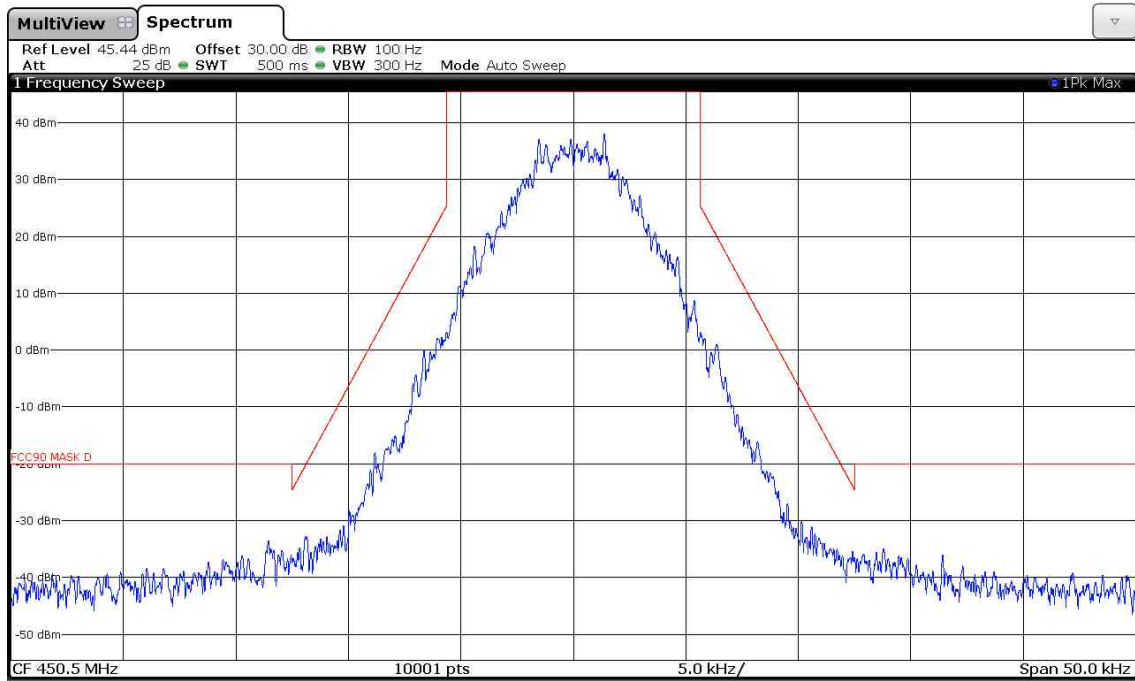


160575_35W_16FSK_429.5MHz_mask_D

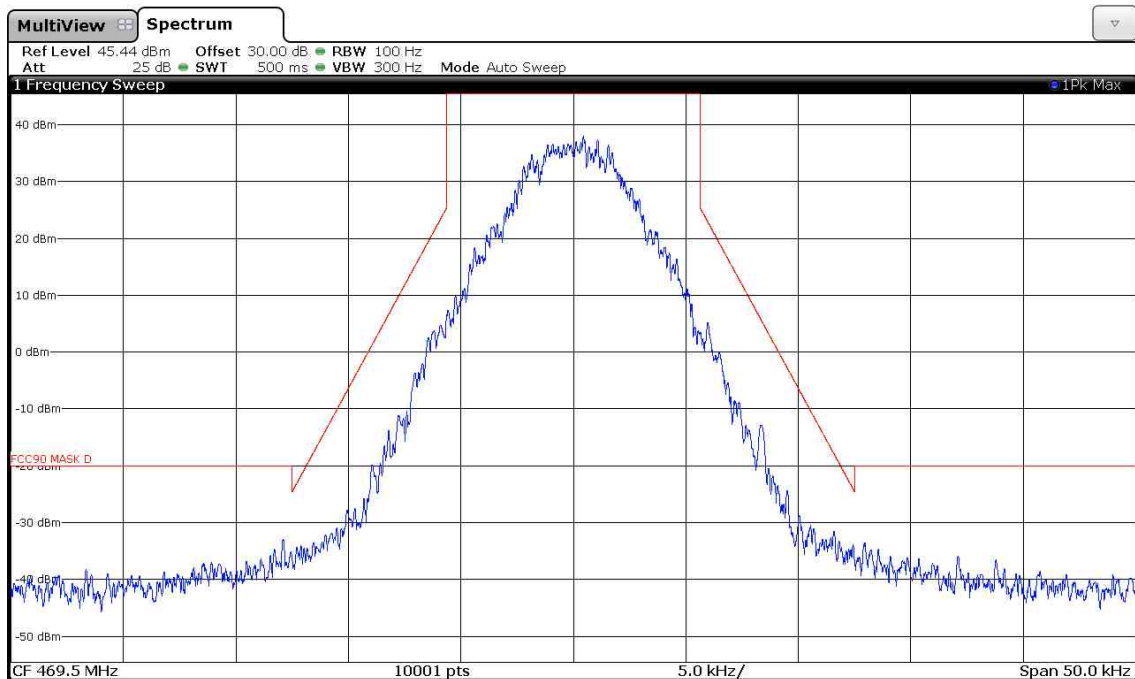


Date: 20.APR.2016 14:36:03

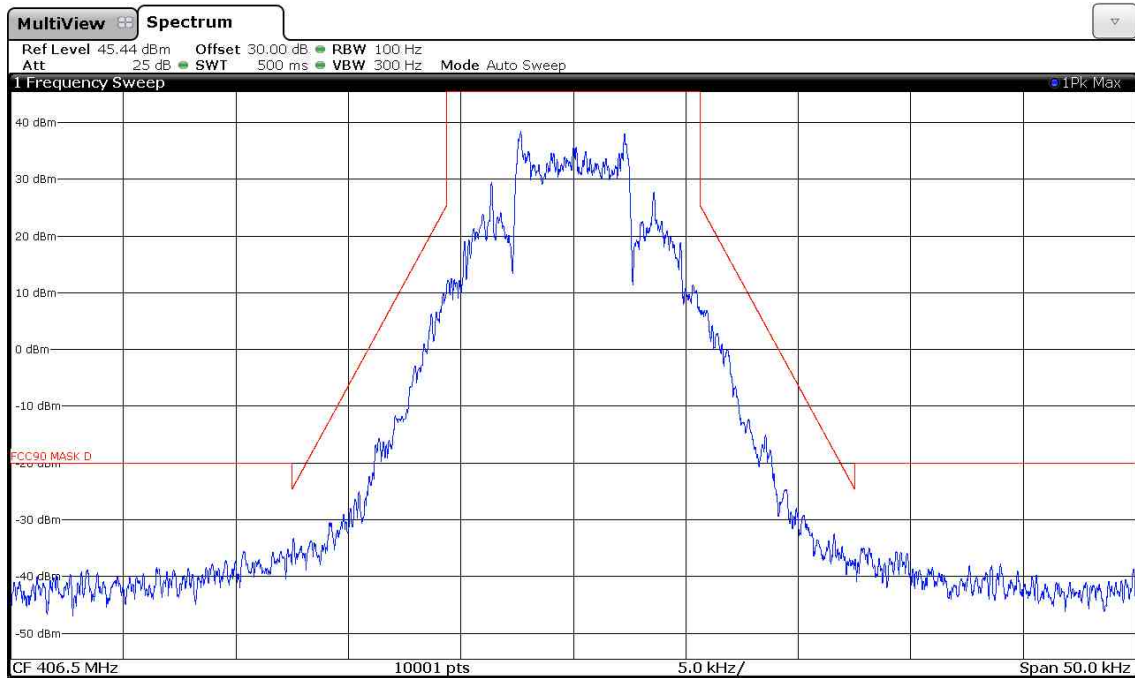
160575_35W_16FSK_450.5MHz_mask_D



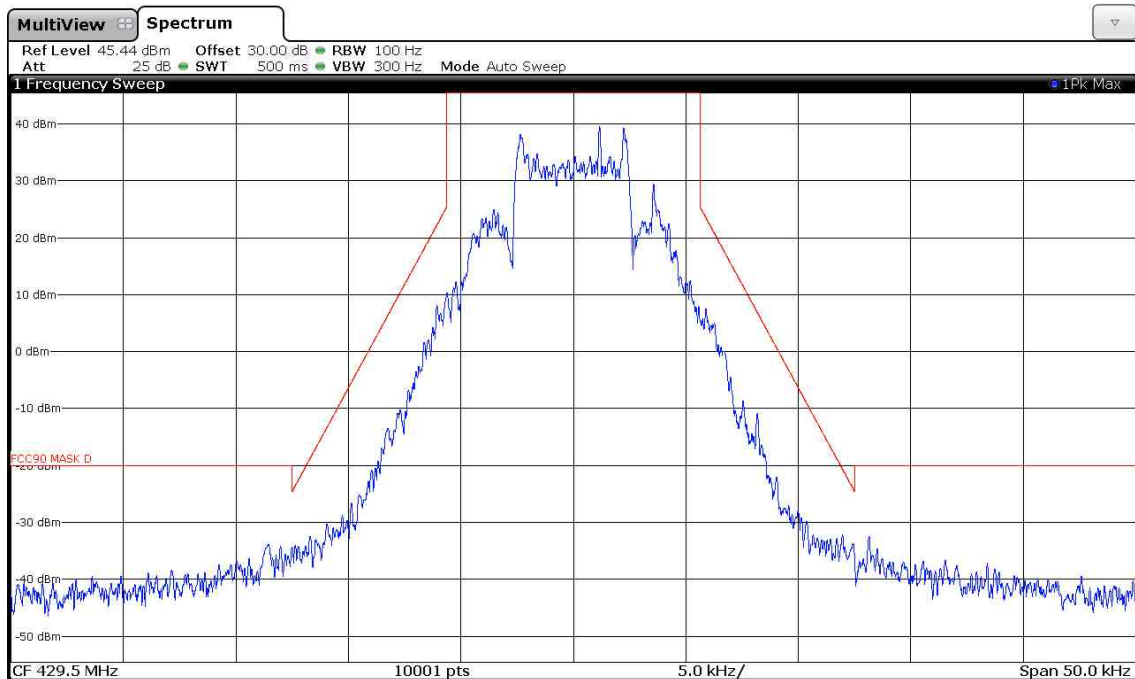
160575_35W_16FSK_469.5MHz_mask_D



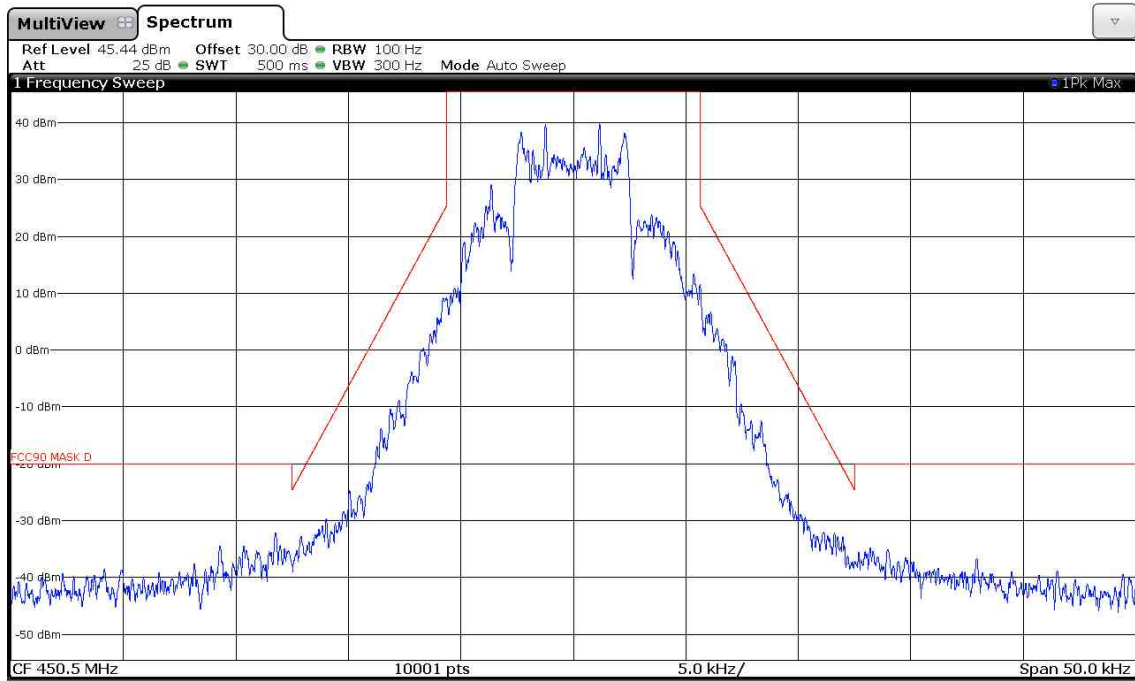
160575_35W_GMSK_406.5MHz_mask_D



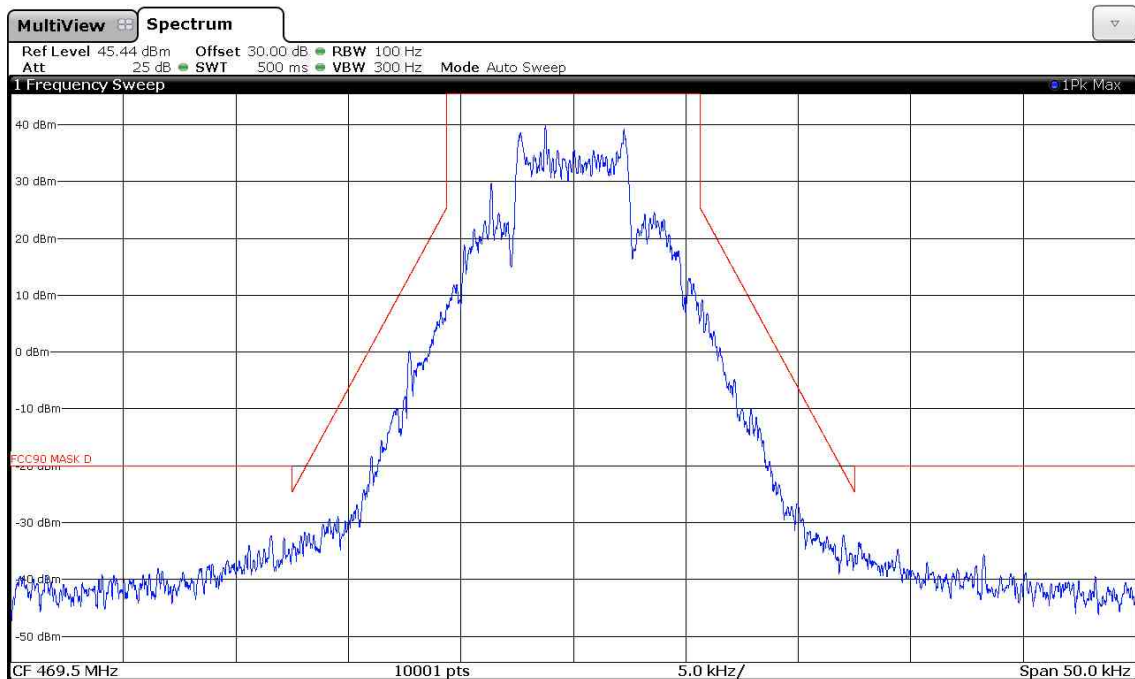
160575_35W_GMSK_429.5MHz_mask_D



160575_35W_GMSK_450.5MHz_mask_D



160575_35W_GMSK_469.5MHz_mask_D



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.

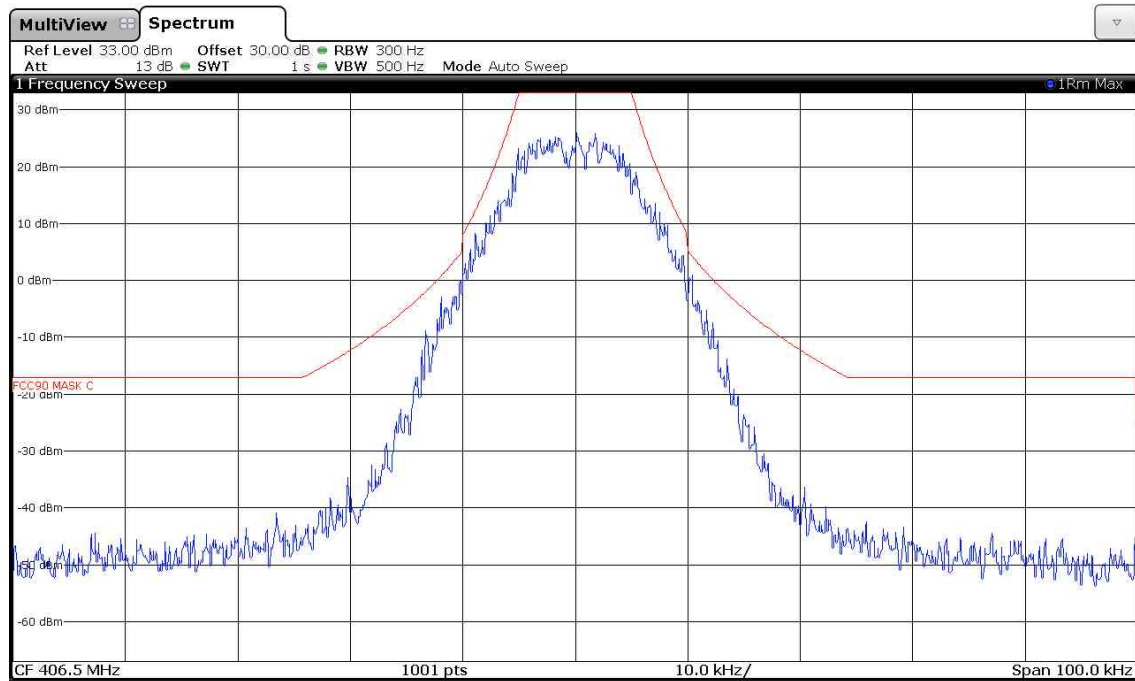
Test: Passed

Test equipment used (refer clause 6):

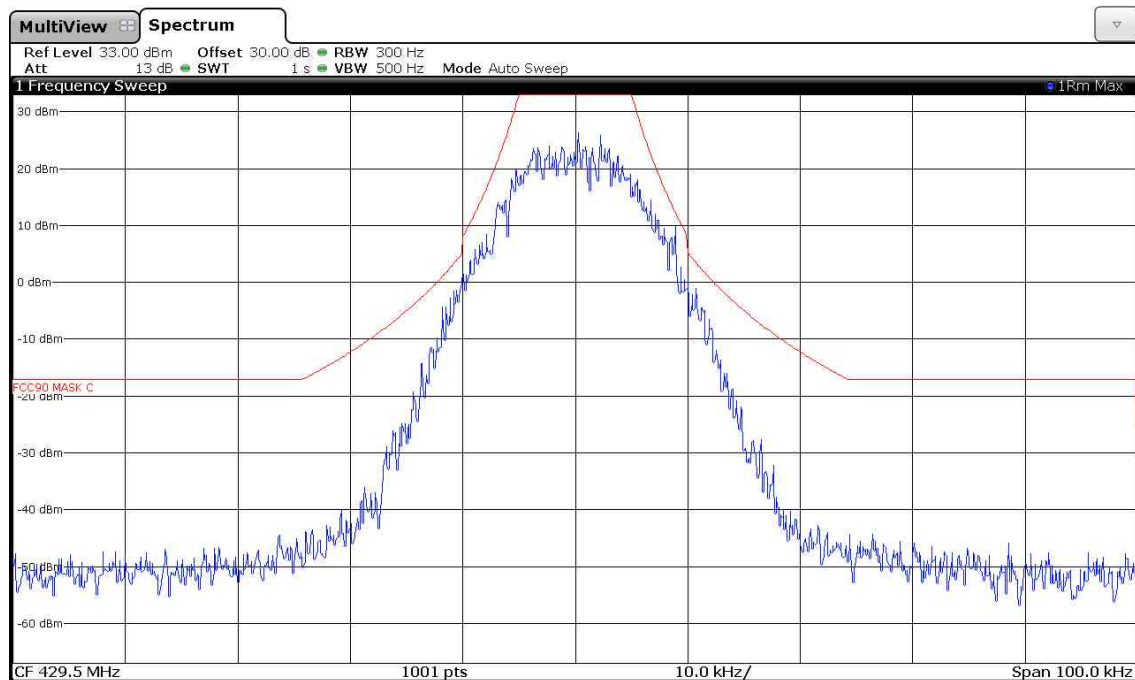
23, 24, 29, 30, 35, 36

5.3.2.2 Channel Spacing 25 kHz

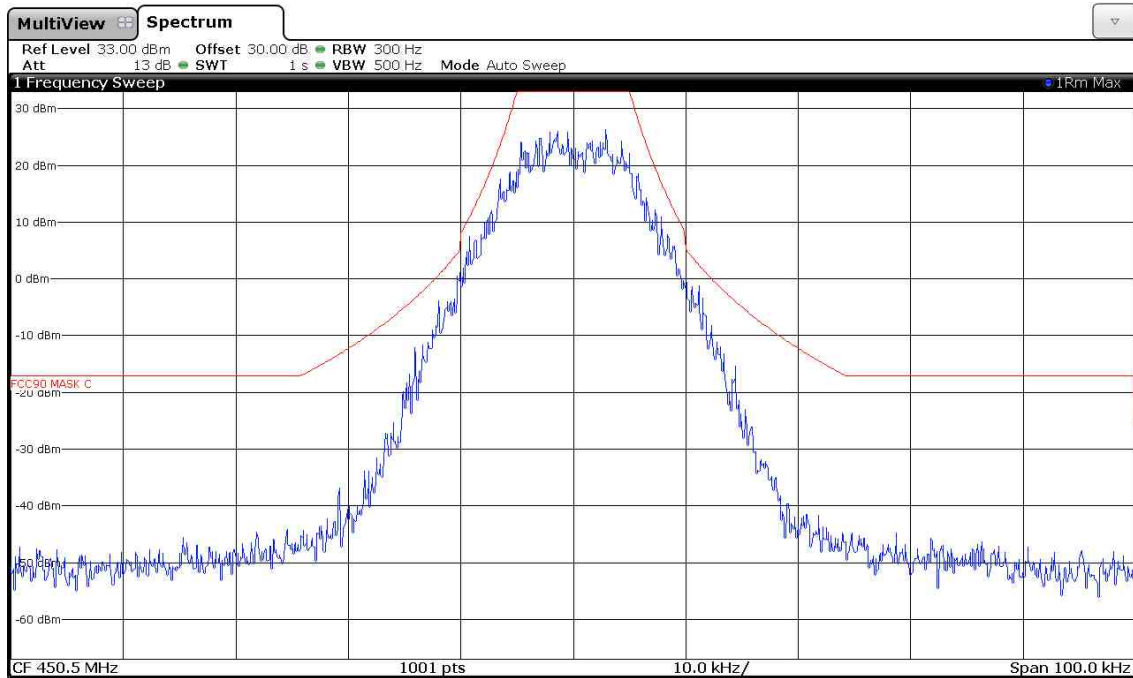
160575_2W_4FSK_406.5MHz_mask_C



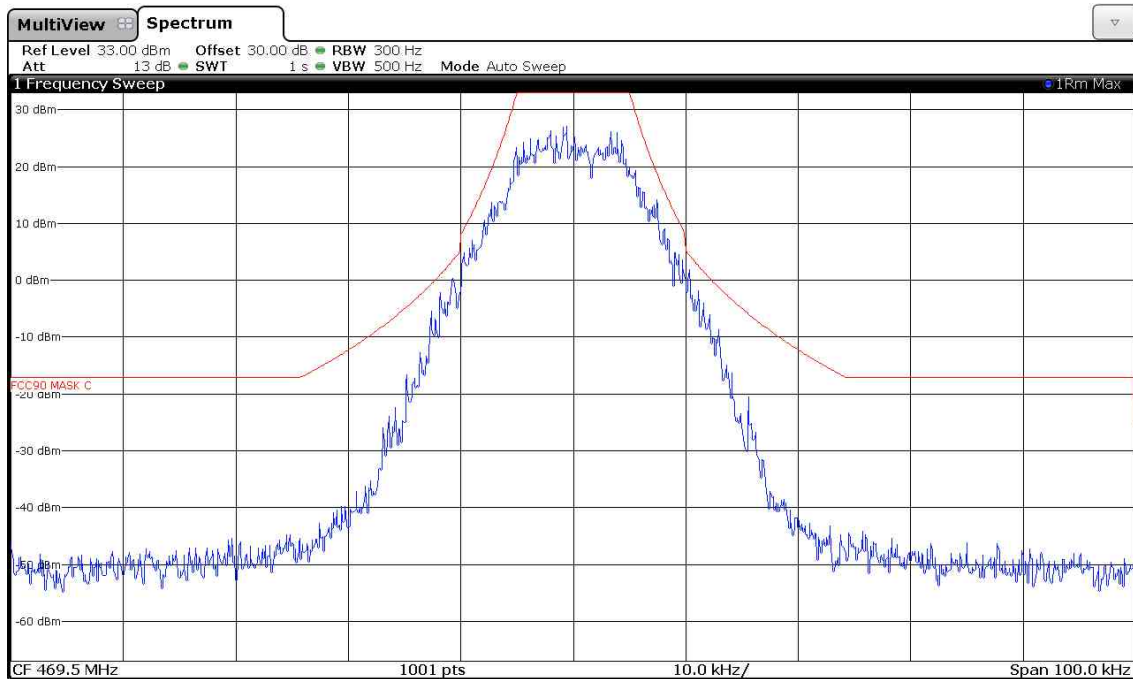
160575_2W_4FSK_429.5MHz_mask_C



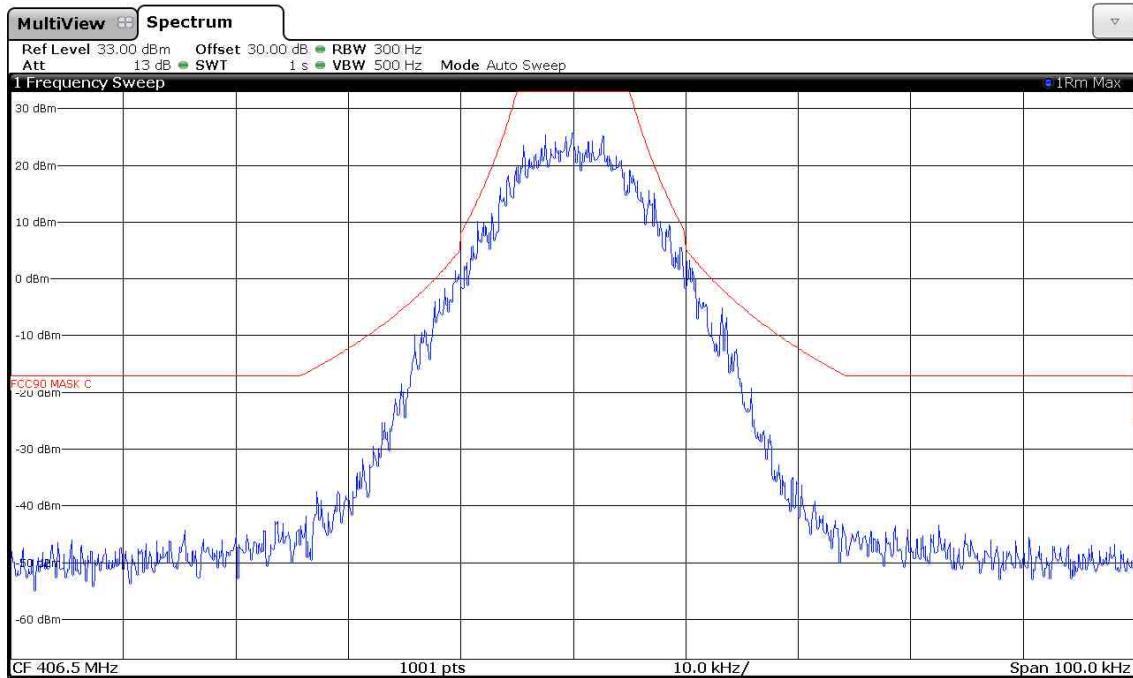
160575_2W_4FSK_450.5MHz_mask_C



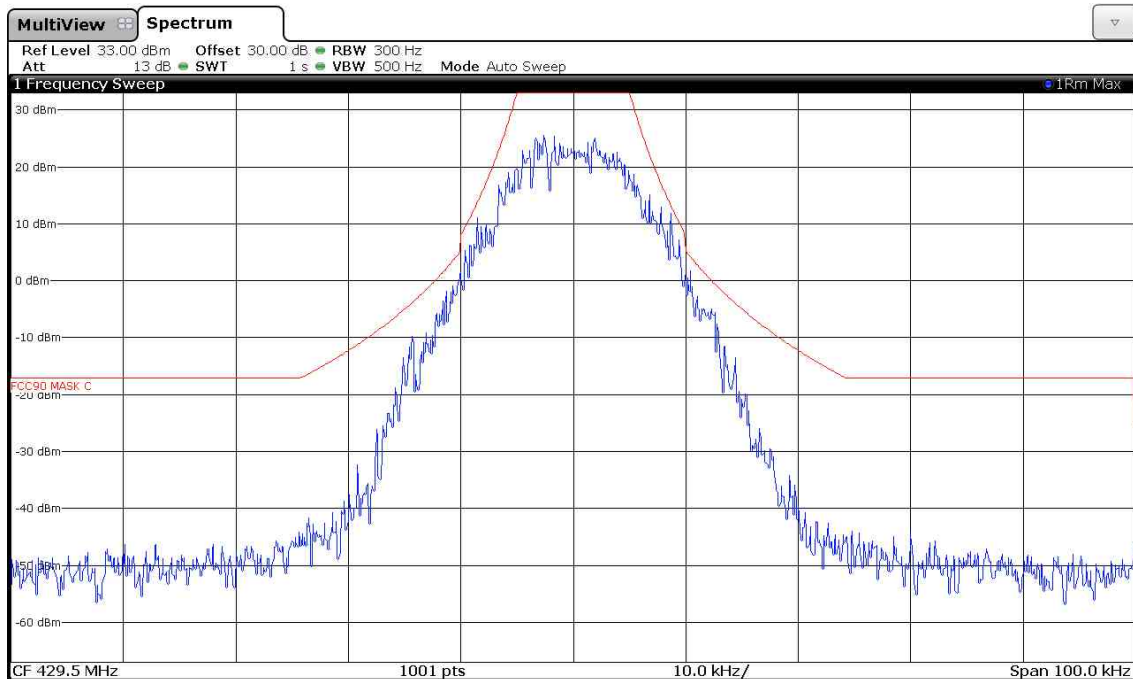
160575_2W_4FSK_469.5MHz_mask_C



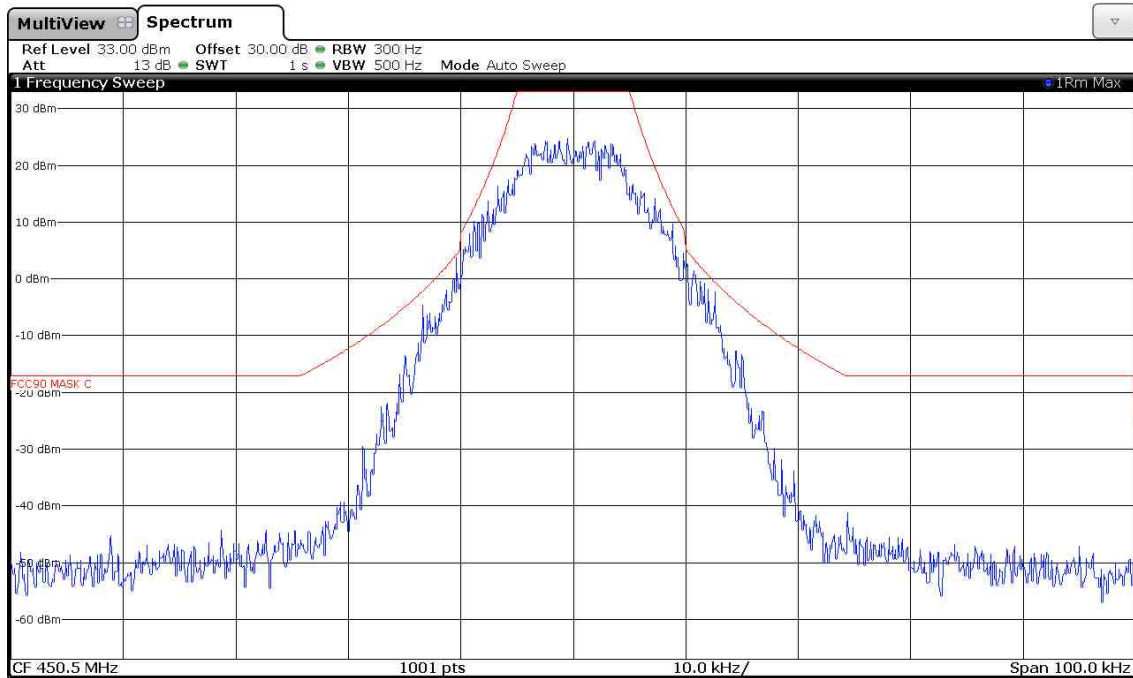
160575_2W_8FSK_406.5MHz_mask_C



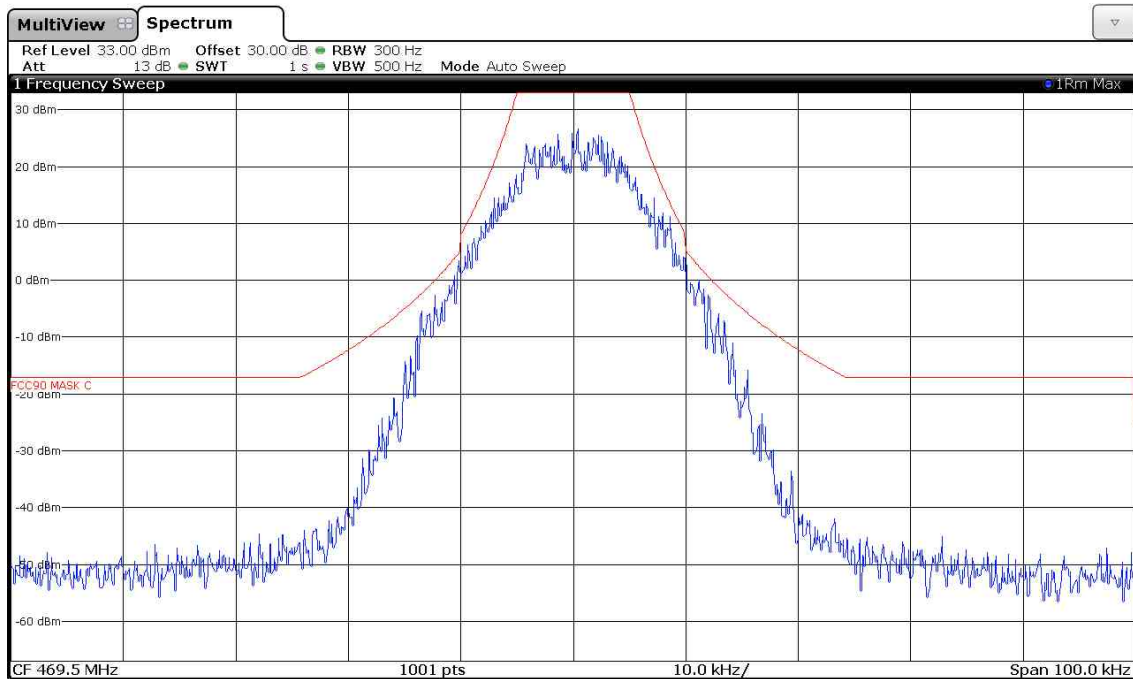
160575_2W_8FSK_429.5MHz_mask_C



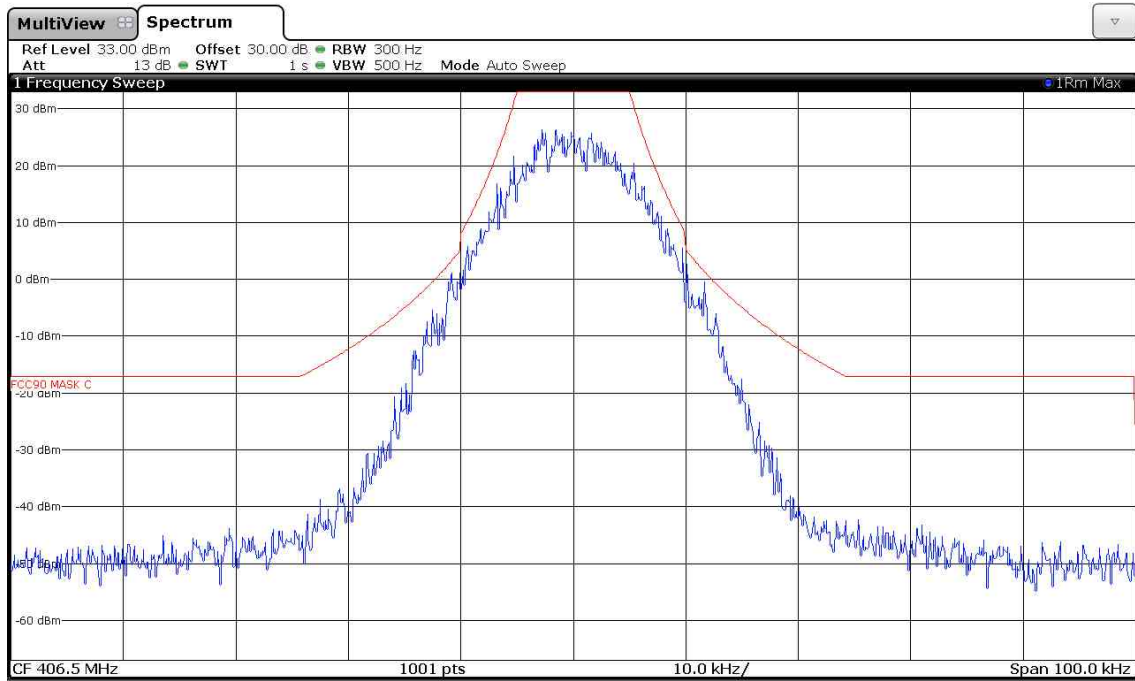
160575_2W_8FSK_450.5MHz_mask_C



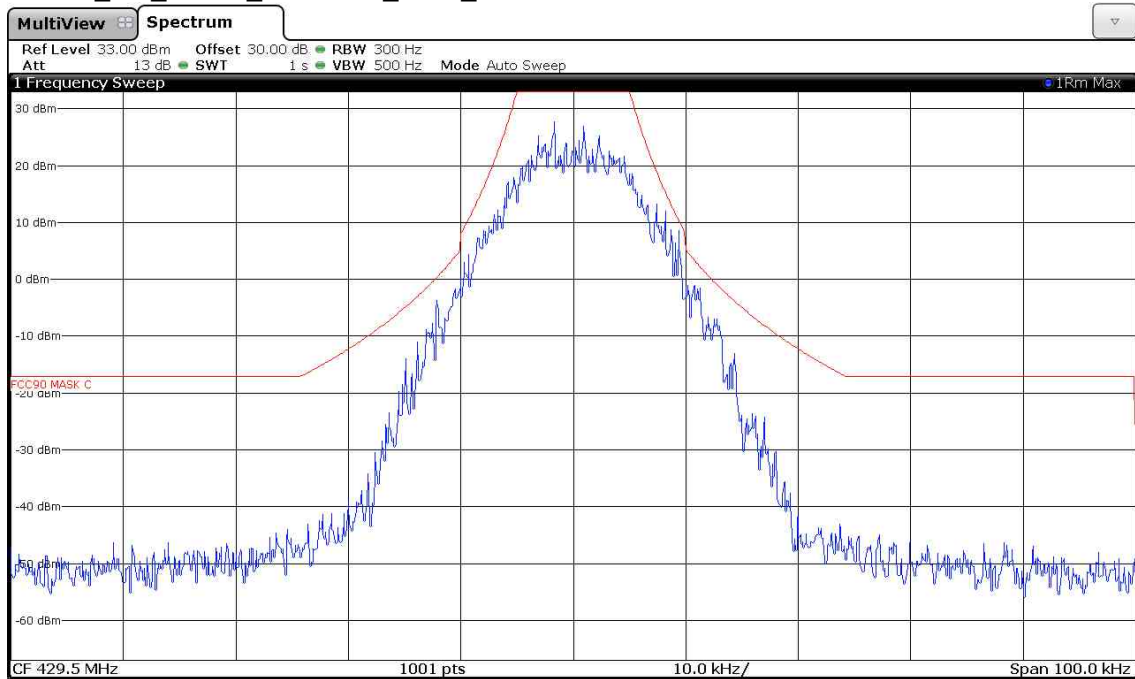
160575_2W_8FSK_469.5MHz_mask_C



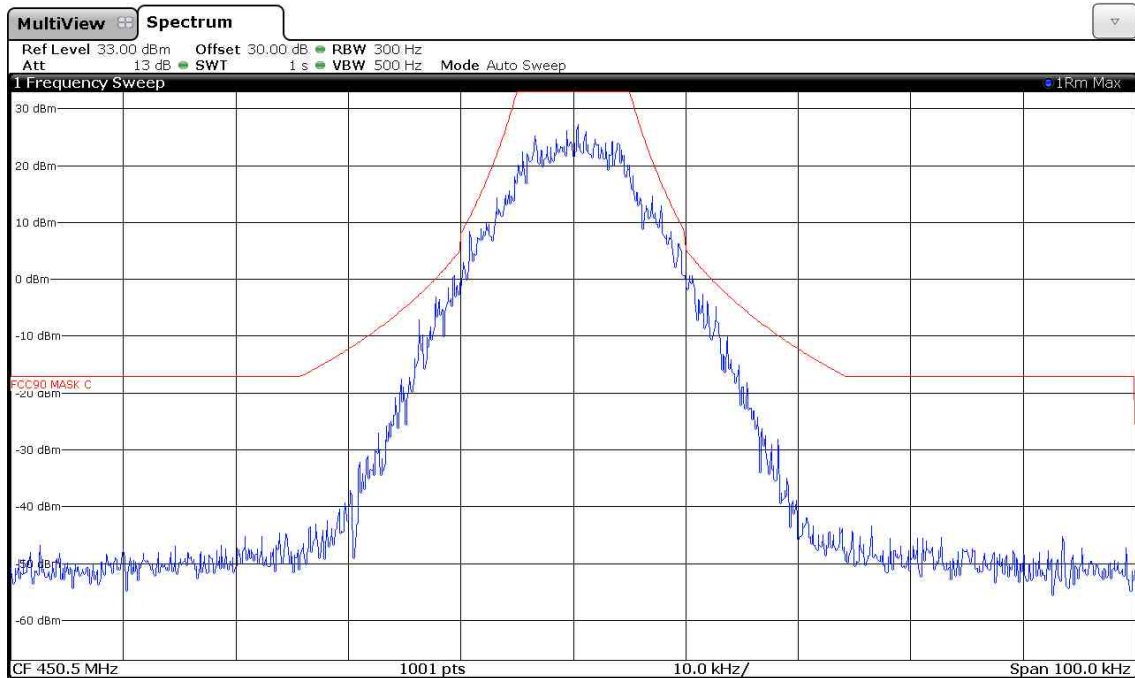
160575_2W_16FSK_406.5MHz_mask_C



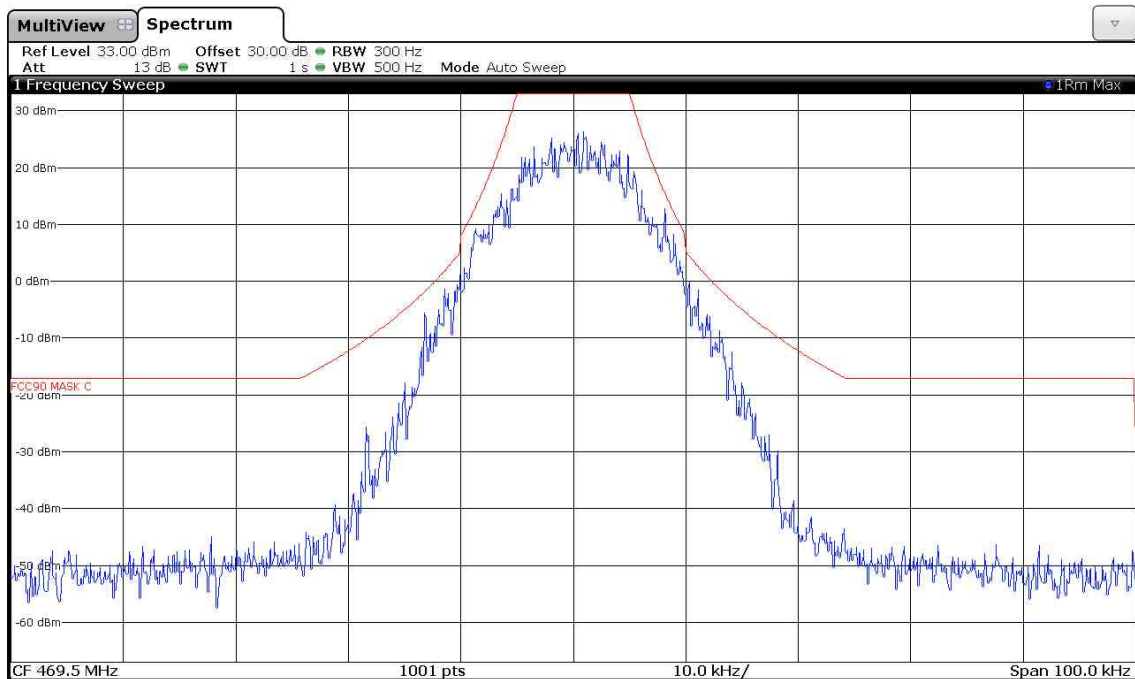
160575_2W_16FSK_429.5MHz_mask_C



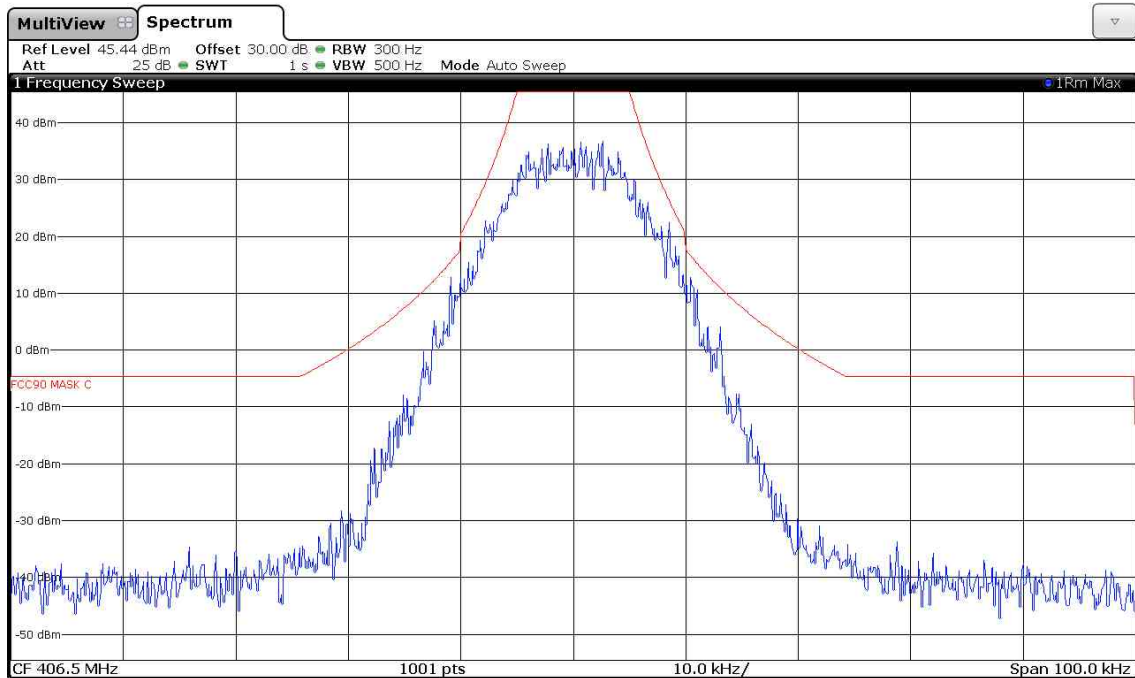
160575_2W_16FSK_450.5MHz_mask_C



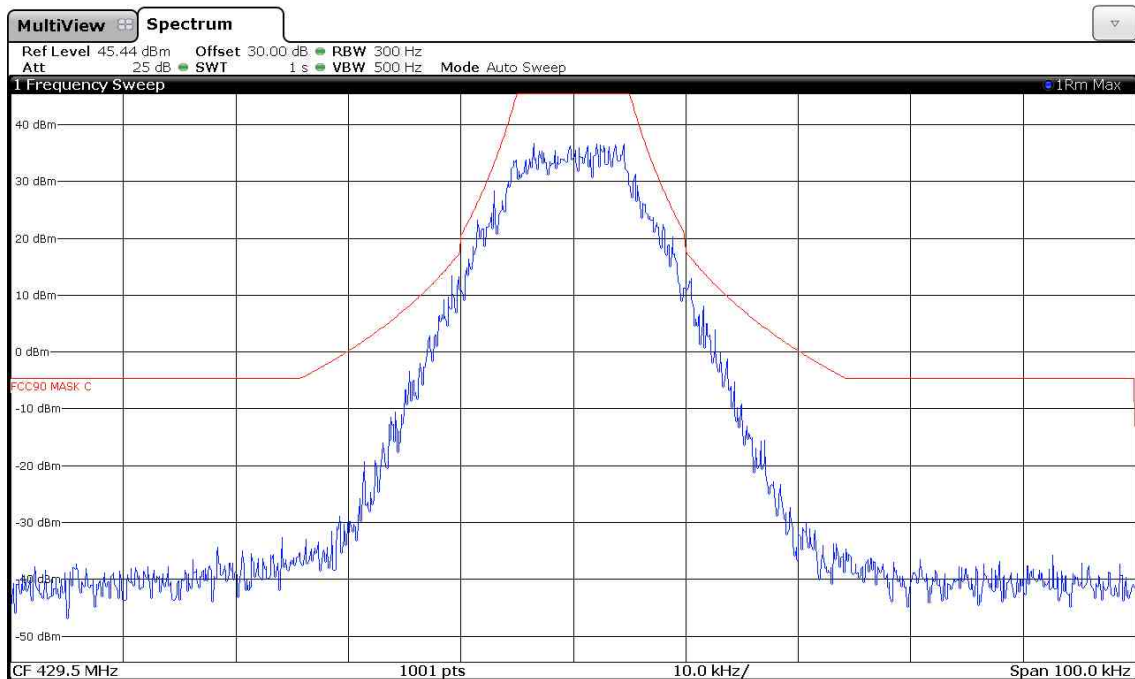
160575_2W_16FSK_469.5MHz_mask_C



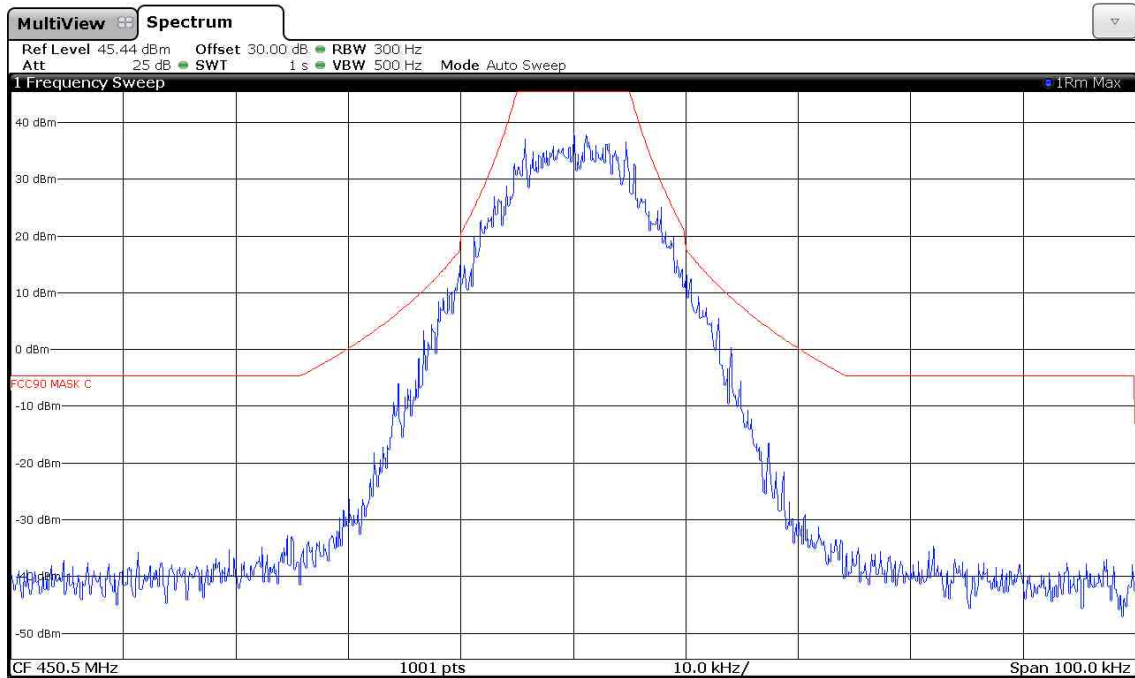
160575_35W_4FSK_406.5MHz_mask_C



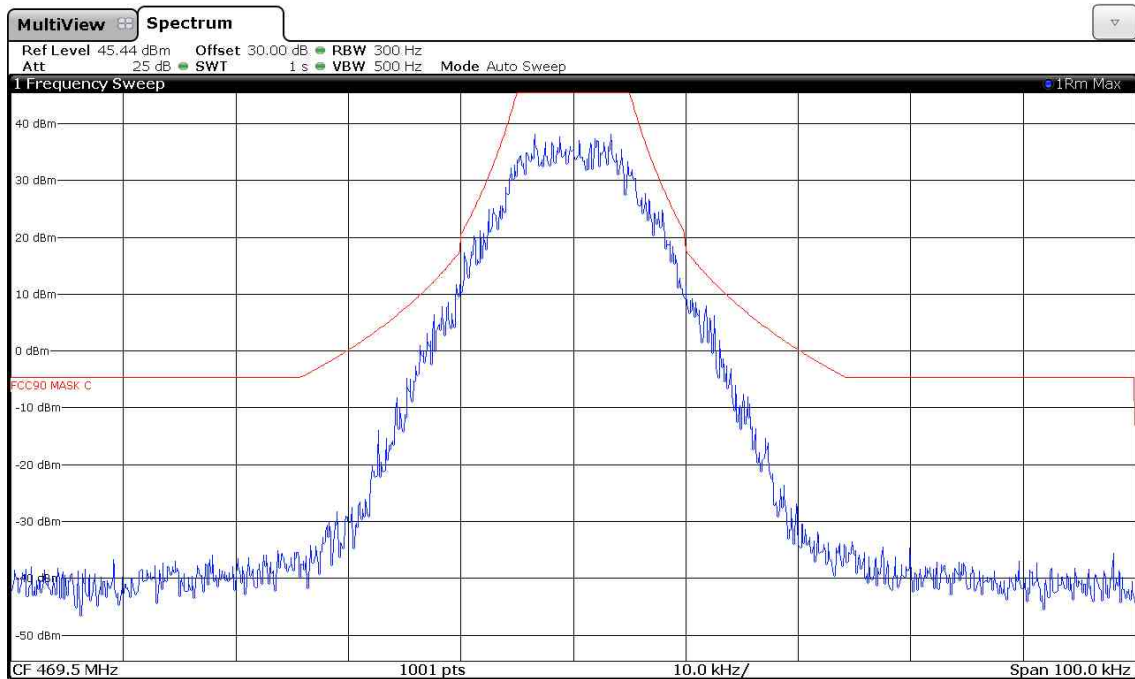
160575_35W_4FSK_429.5MHz_mask_C



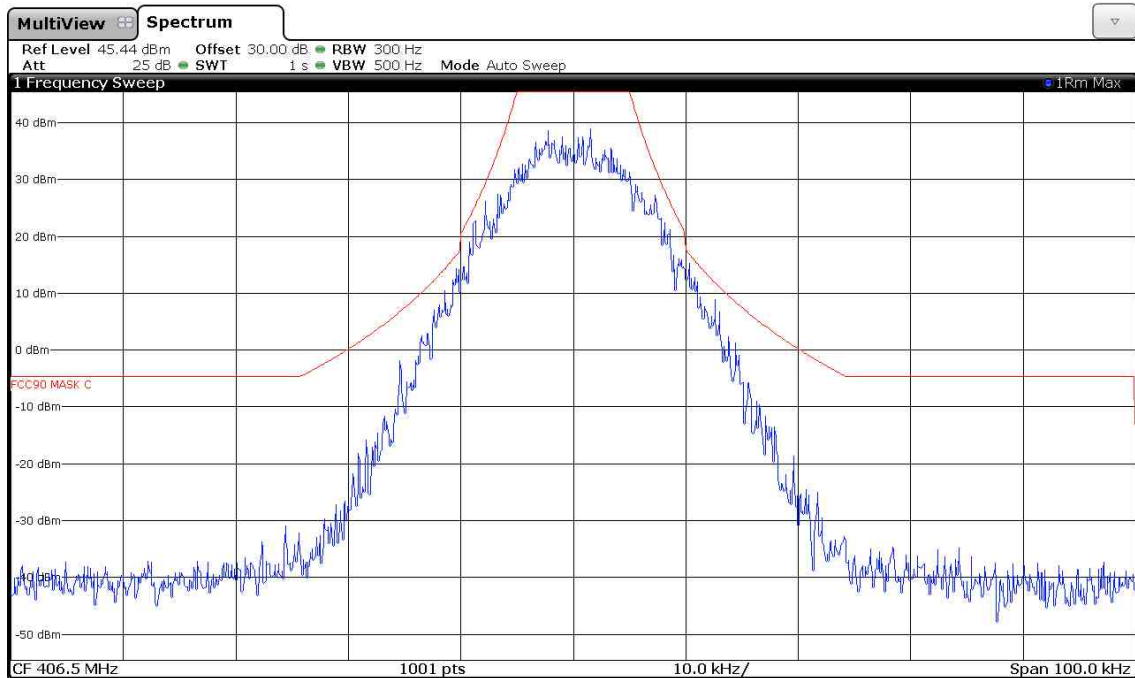
160575_35W_4FSK_450.5MHz_mask_C



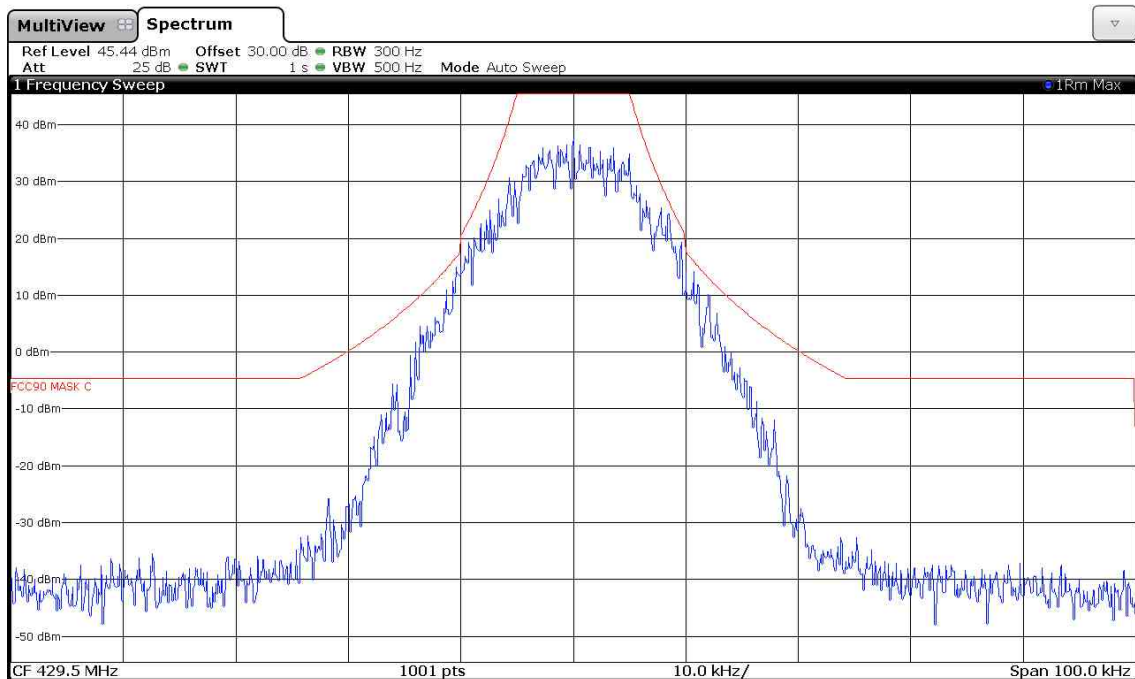
160575_35W_4FSK_469.5MHz_mask_C



160575_35W_8FSK_406.5MHz_mask_C

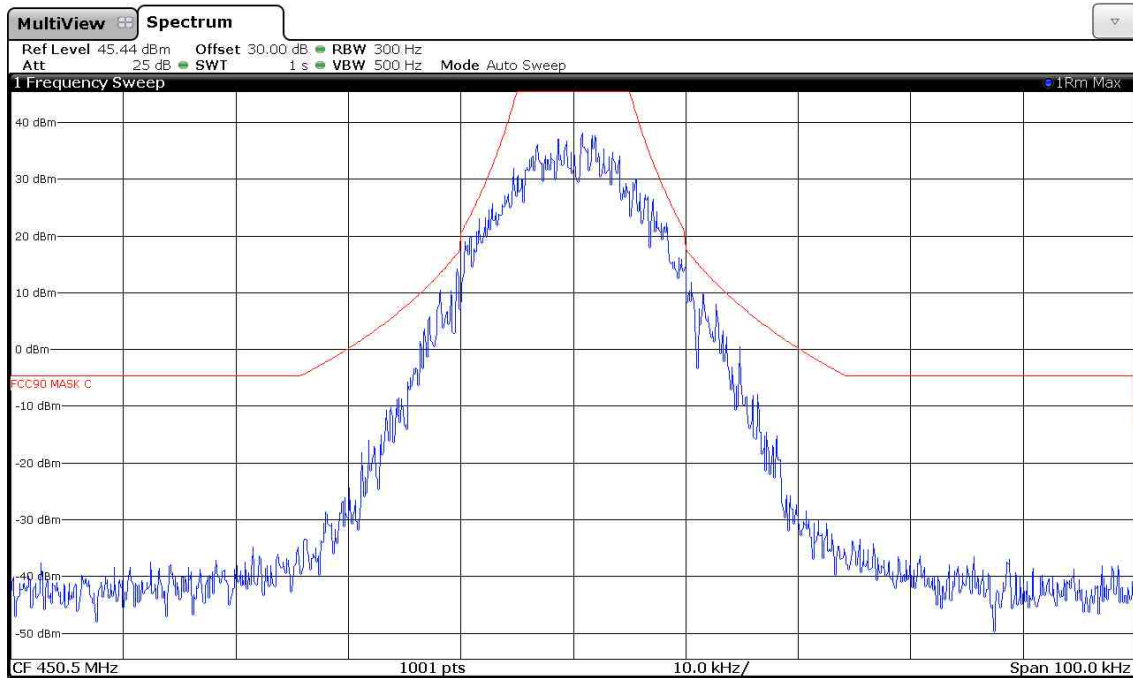


160575_35W_8FSK_429.5MHz_mask_C

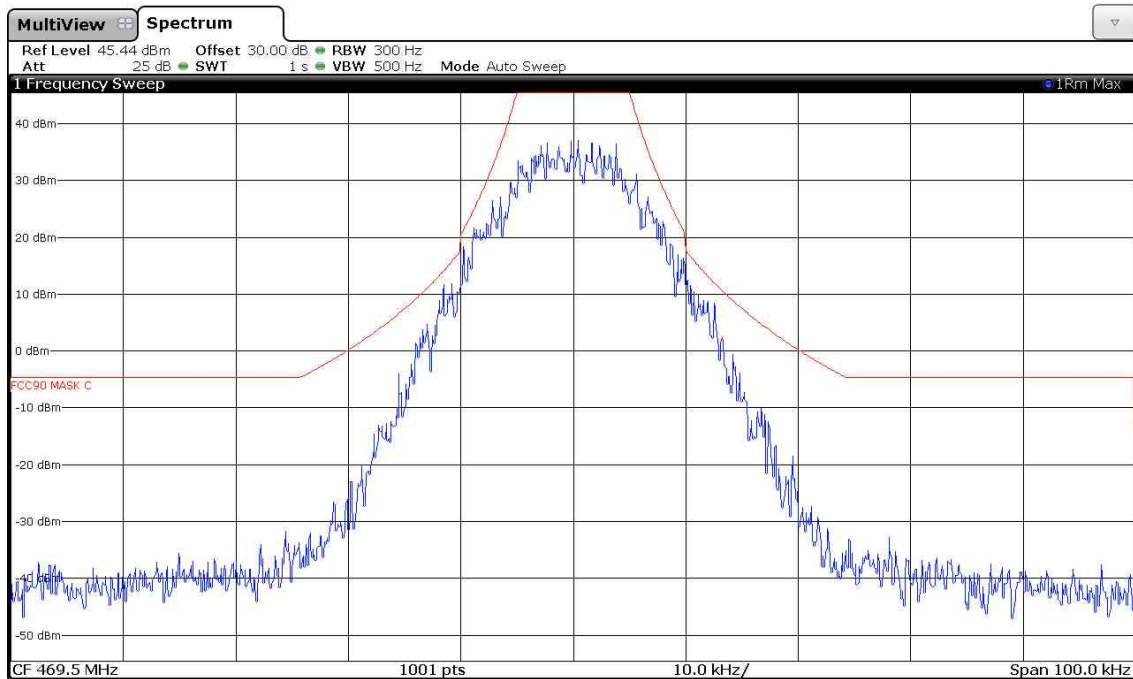


160575_35W_8FSK_429.5MHz_mask_C

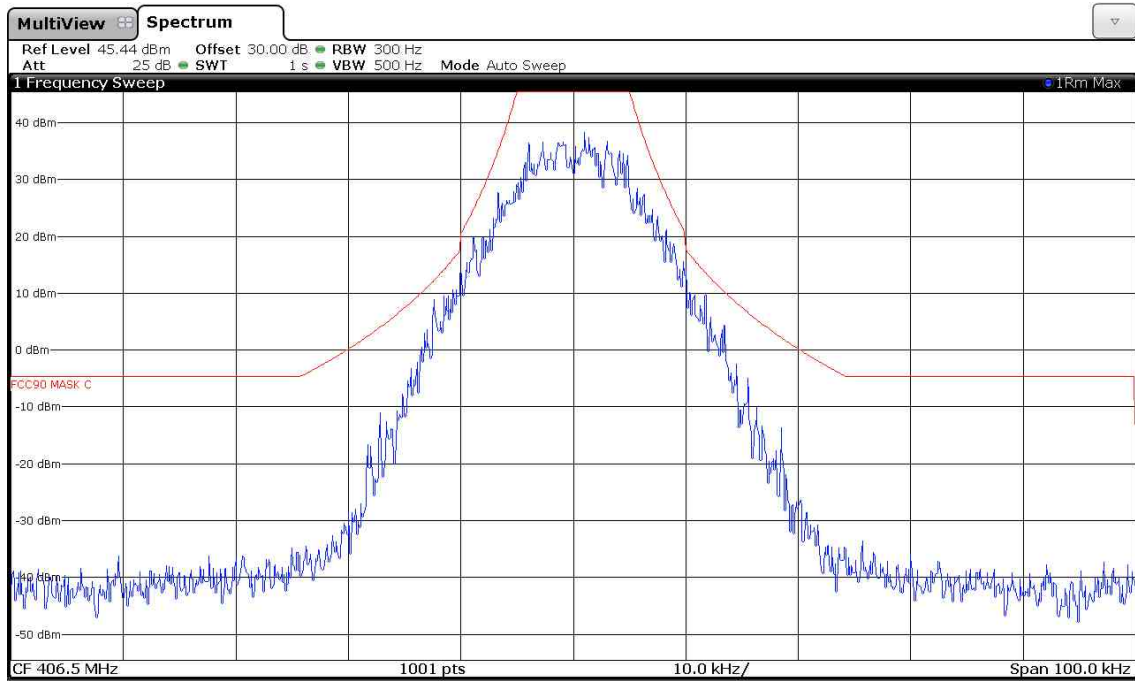
160575_35W_8FSK_450.5MHz_mask_C



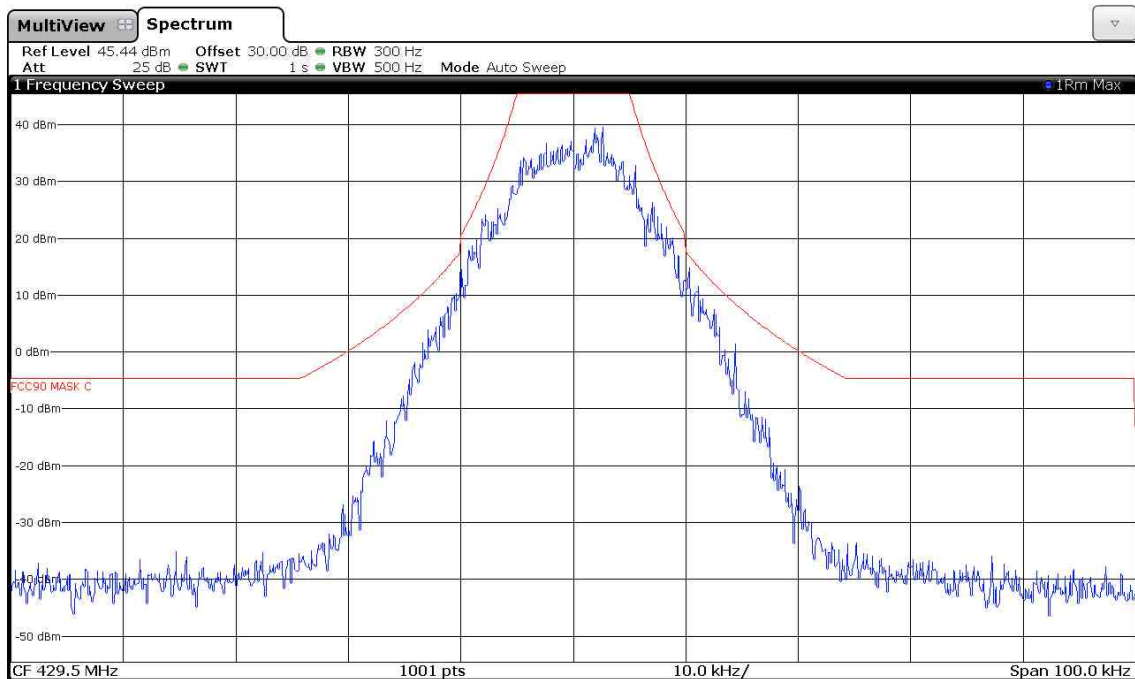
160575_35W_8FSK_469.5MHz_mask_C



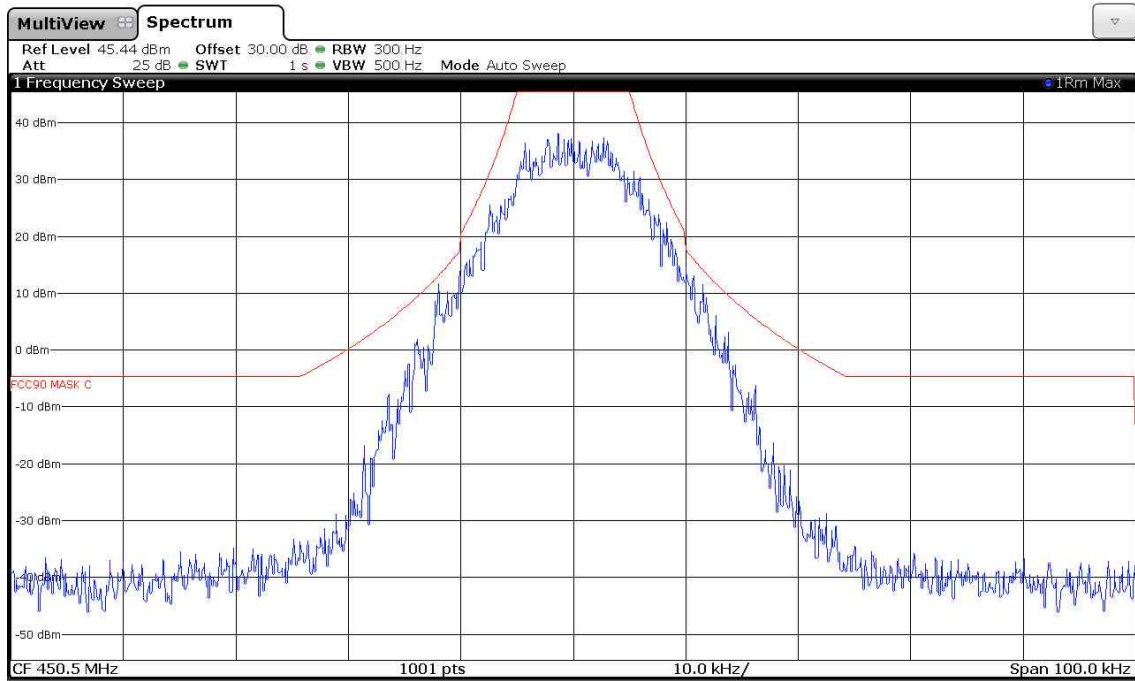
160575_35W_16FSK_406.5MHz_mask_C



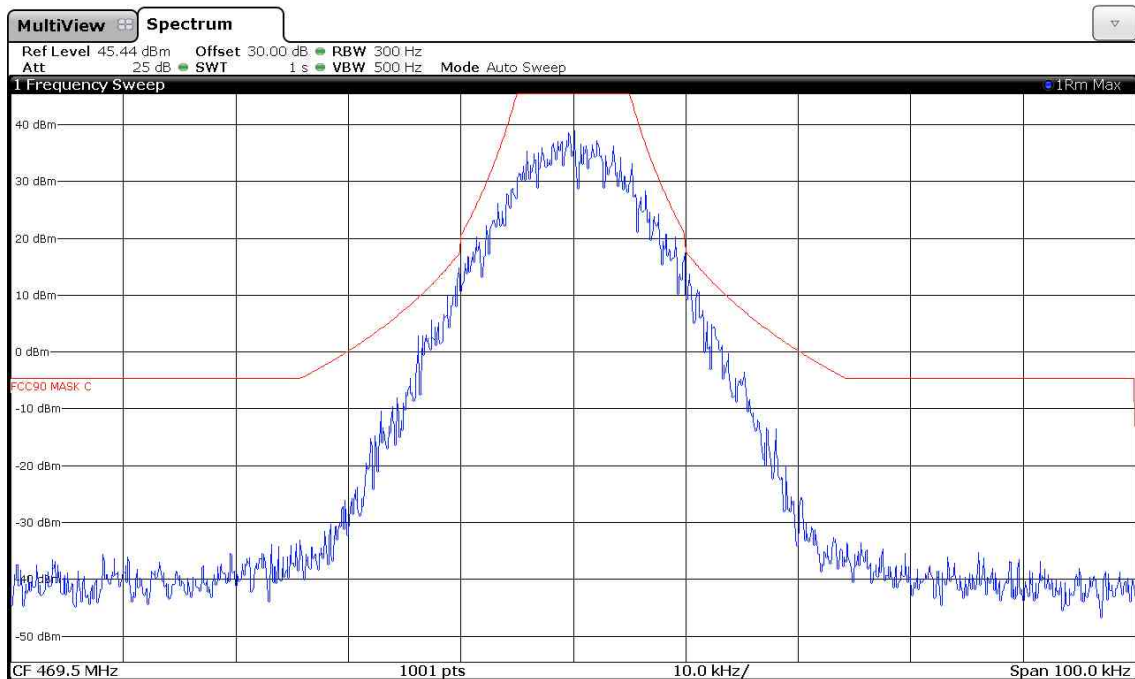
160575_35W_16FSK_429.5MHz_mask_C



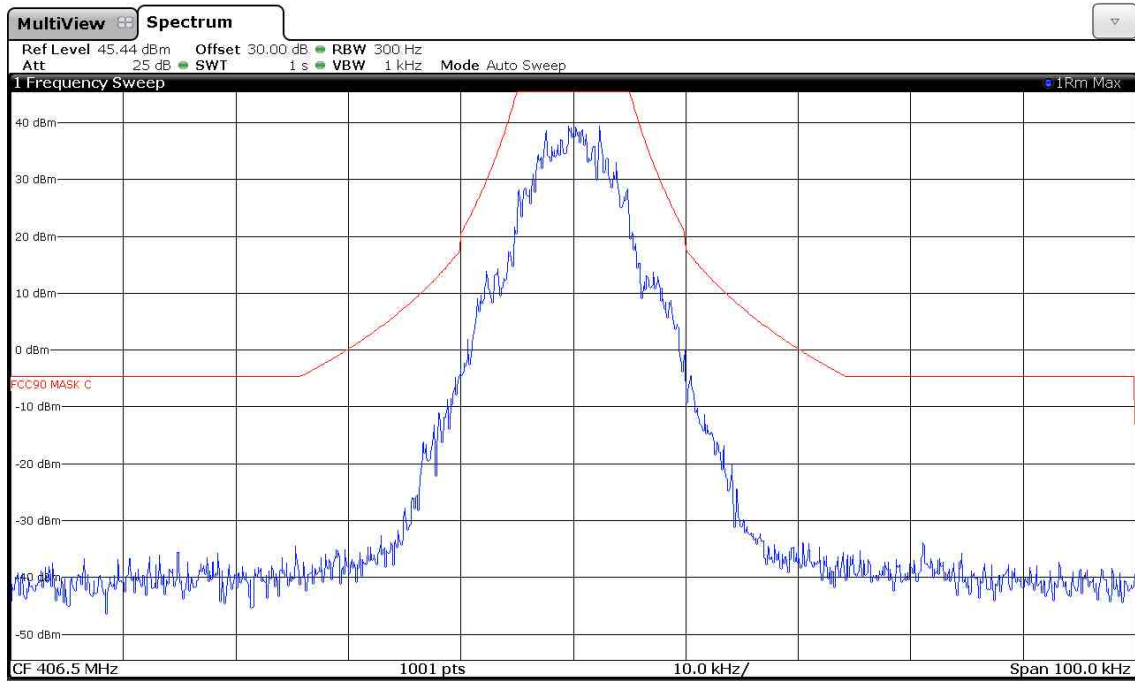
160575_35W_16FSK_450.5MHz_mask_C



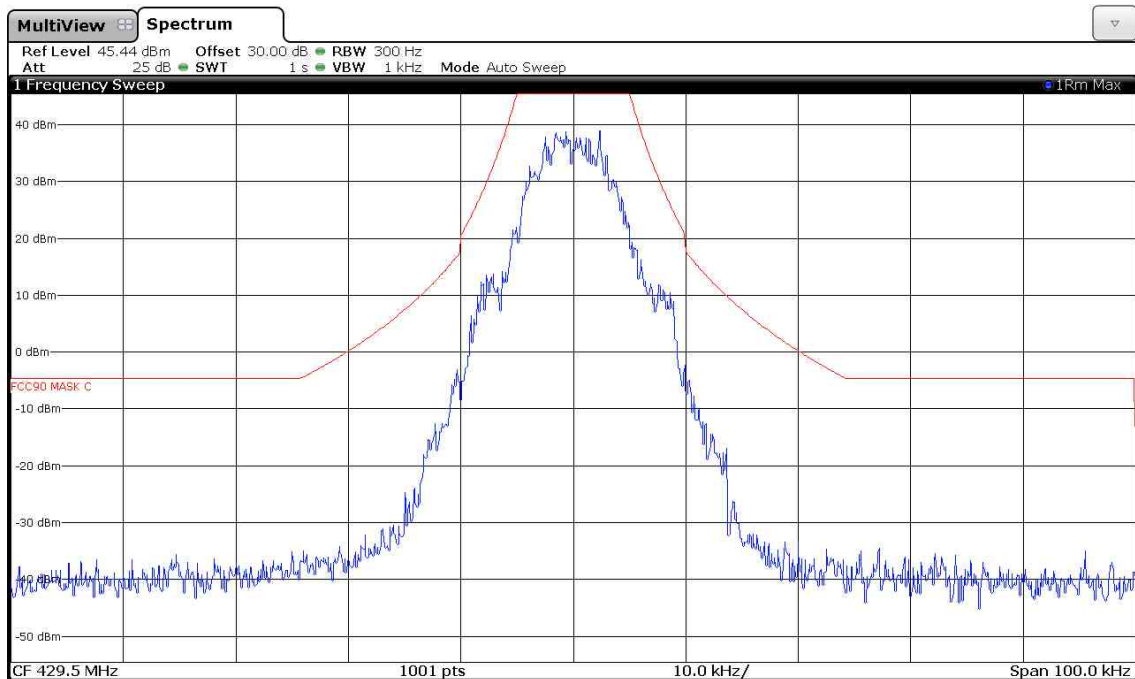
160575_35W_16FSK_469.5MHz_mask_C



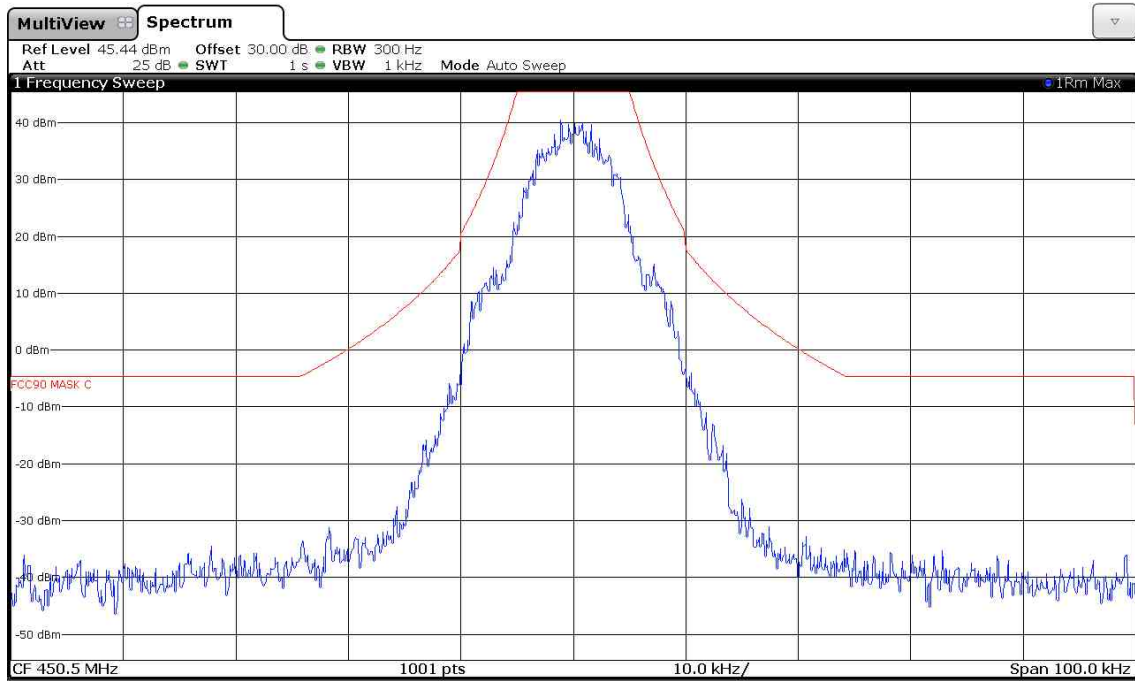
160575_35W_GMSK_406.5MHz_mask_C



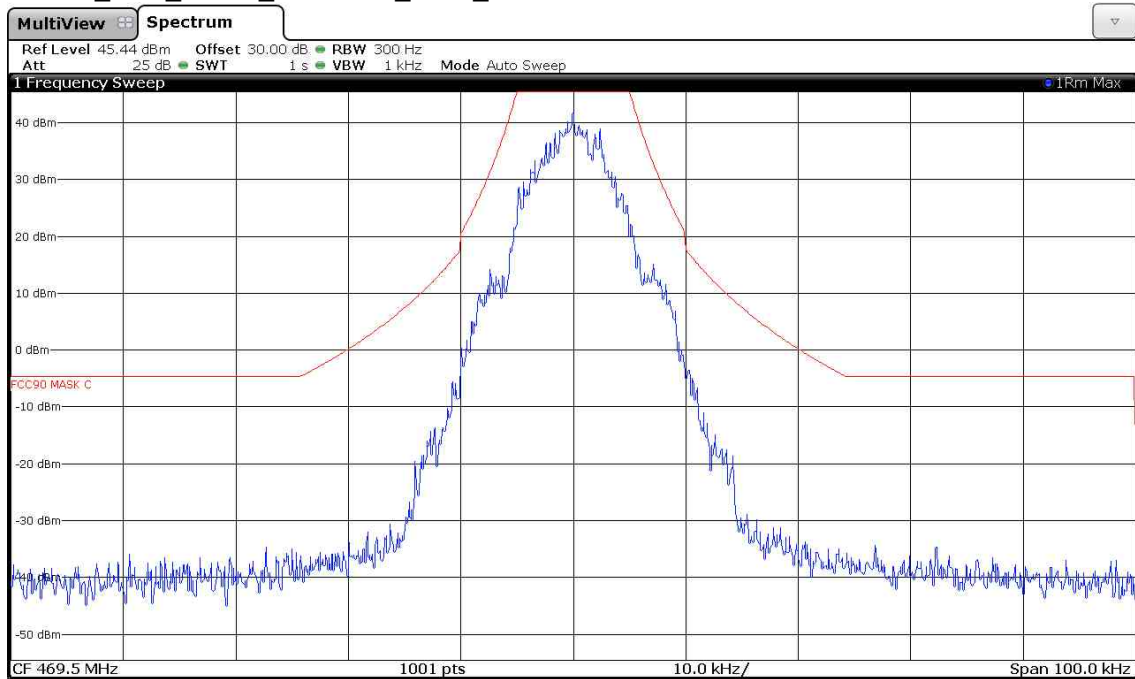
160575_35W_GMSK_429.5MHz_mask_C



160575_35W_GMSK_450.5MHz_mask_C



160575_35W_GMSK_469.5MHz_mask_C



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 $29 \log(f_d/11)$ 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

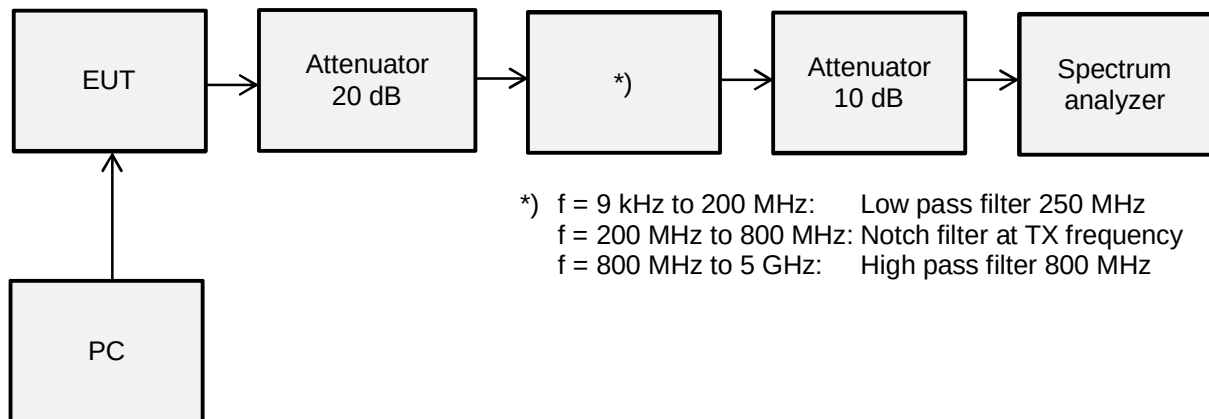
Test equipment used (refer clause 6):

23, 24, 29, 30, 35, 36

5.4 Spurious emissions (conducted)

5.4.1 Method of measurement

Test setup:



The TX frequency was set to 406.5 MHz, 429.5 MHz, 450.5 MHz and 469.5 MHz via the PC.
 The output power was set to 35 W and the channel spacing to 12.5 kHz and 25 kHz.
 Modulation was set to 16FSK which was found to be the worst case.

5.4.2 Test Results

Ambient temperature	23 °C	Relative humidity	29 %
---------------------	-------	-------------------	------

5.4.2.1 Channel Spacing 12.5 kHz

TX frequency (MHz)	Channel spacing (kHz)	Frequency (MHz)	Level (dBm)	Limit (dBm)
406.5	12.5	1219.69	-31.44	-20
429.5		1288.45	-37.76	
450.5		1351.48	-32.83	
469.5		1408.48	-35.95	
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 35 W carrier power: $50 + 10 \log(P)$ dB = $50 + 10 \log(35)$ dB = 65.44 dB

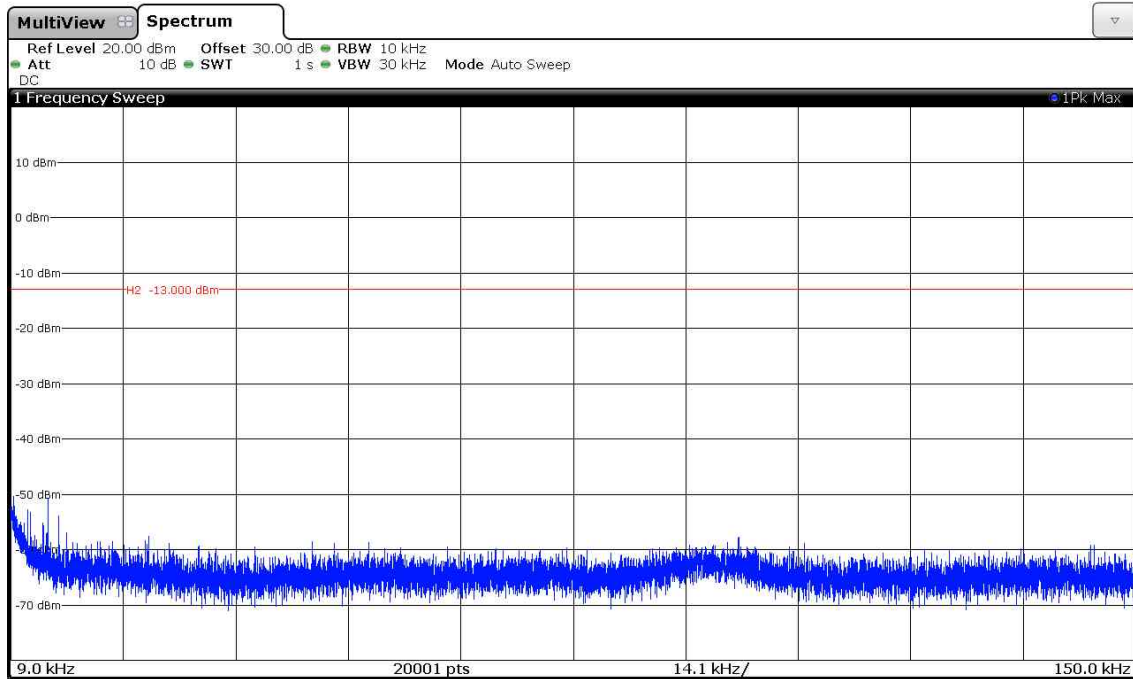
RF Power limit for any spurious emission: 45.44 dBm - 65.44 dB = -20 dBm

Test: Passed

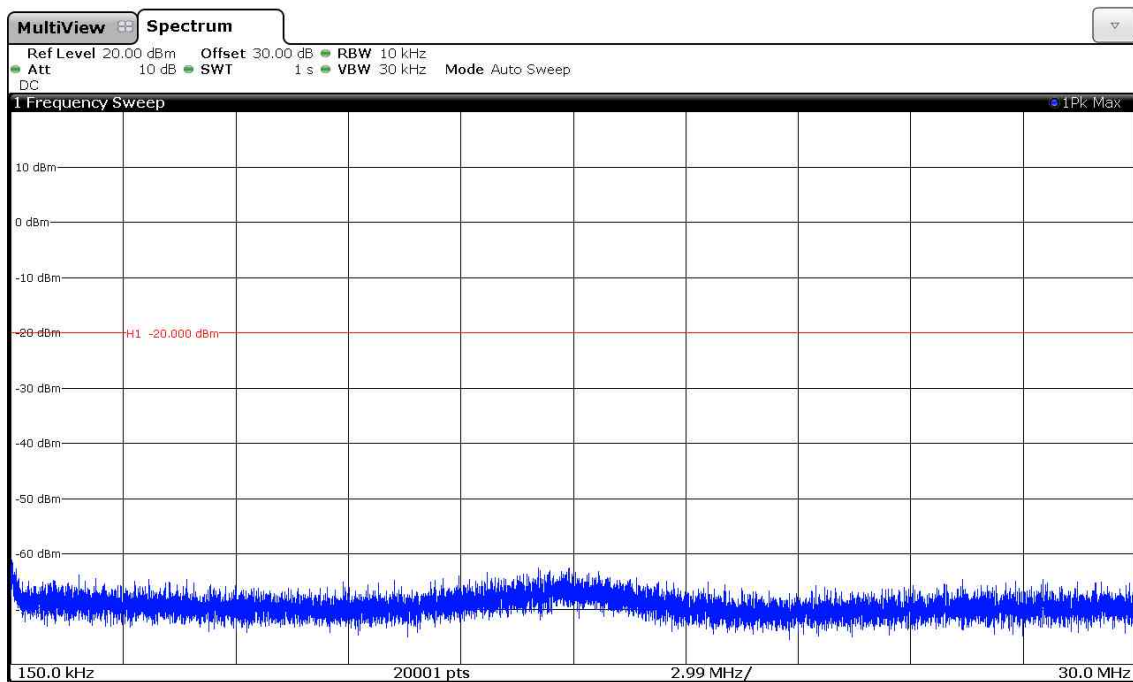
Test equipment used (refer clause 6):

23 - 27, 29, 30, 35, 36

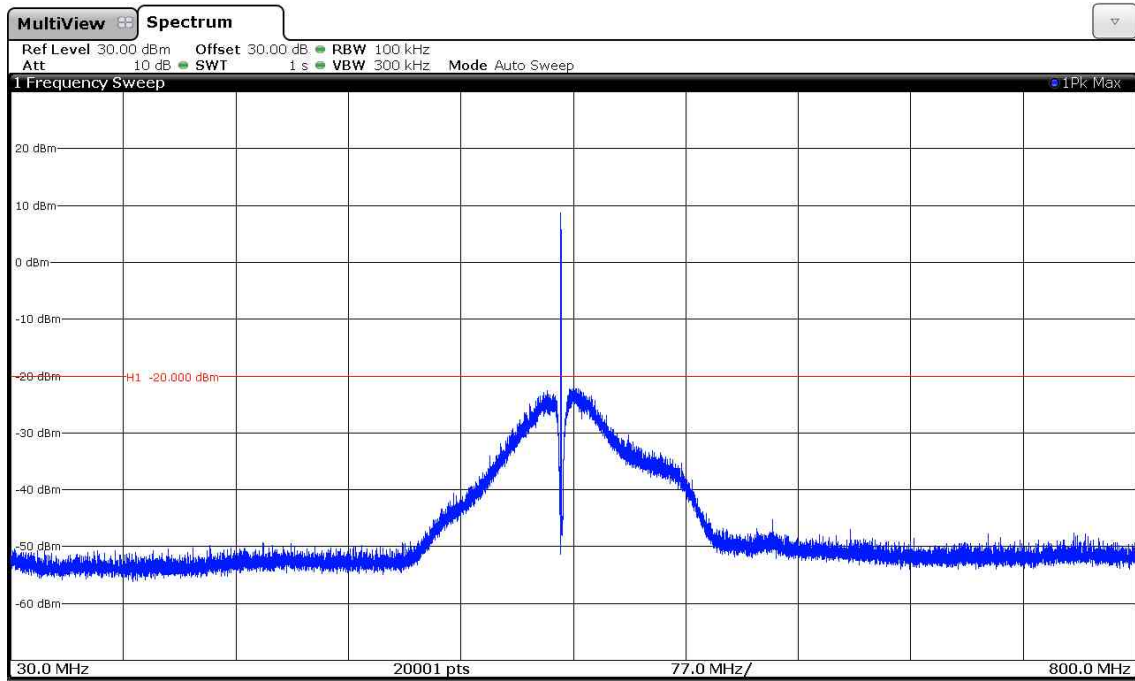
160575_406.5MHz_35W_12.5k_9k-150k



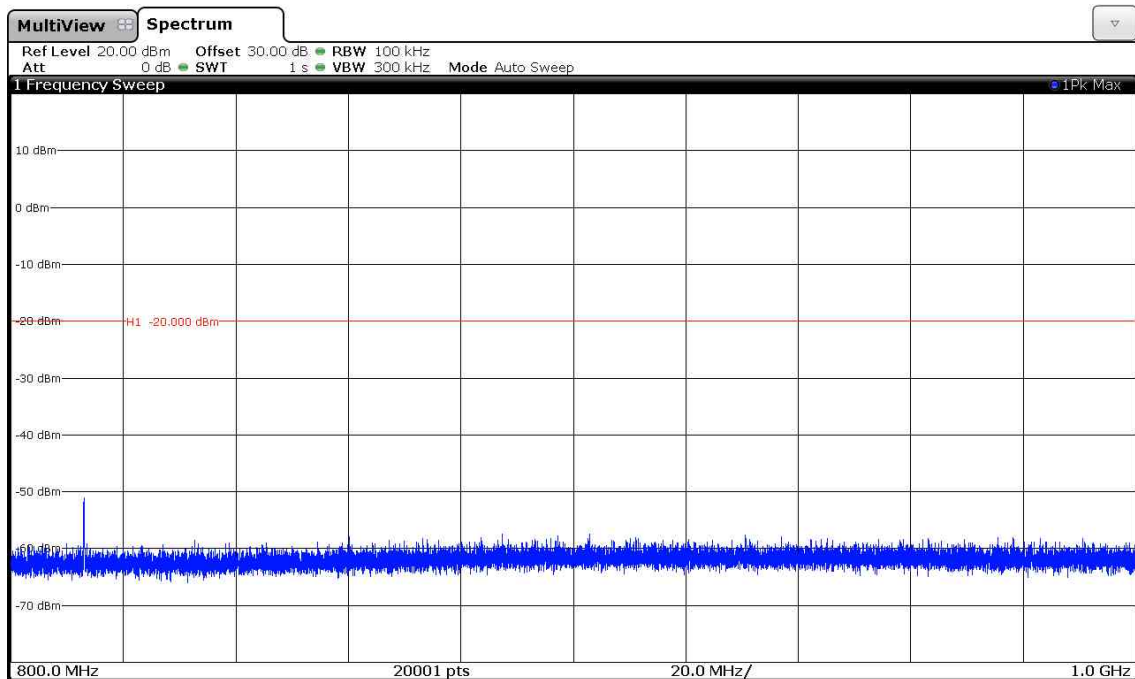
160575_406.5MHz_35W_12.5k_150k-30M



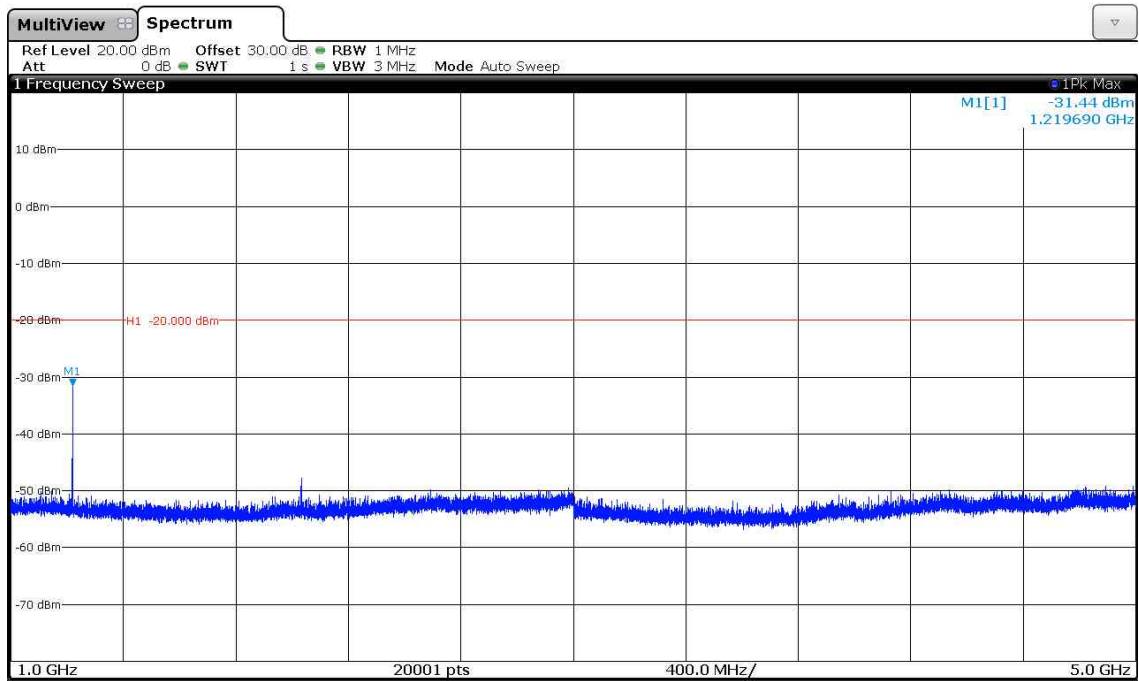
160575_406.5MHz_35W_12.5k_30M-800M (carrier notched)



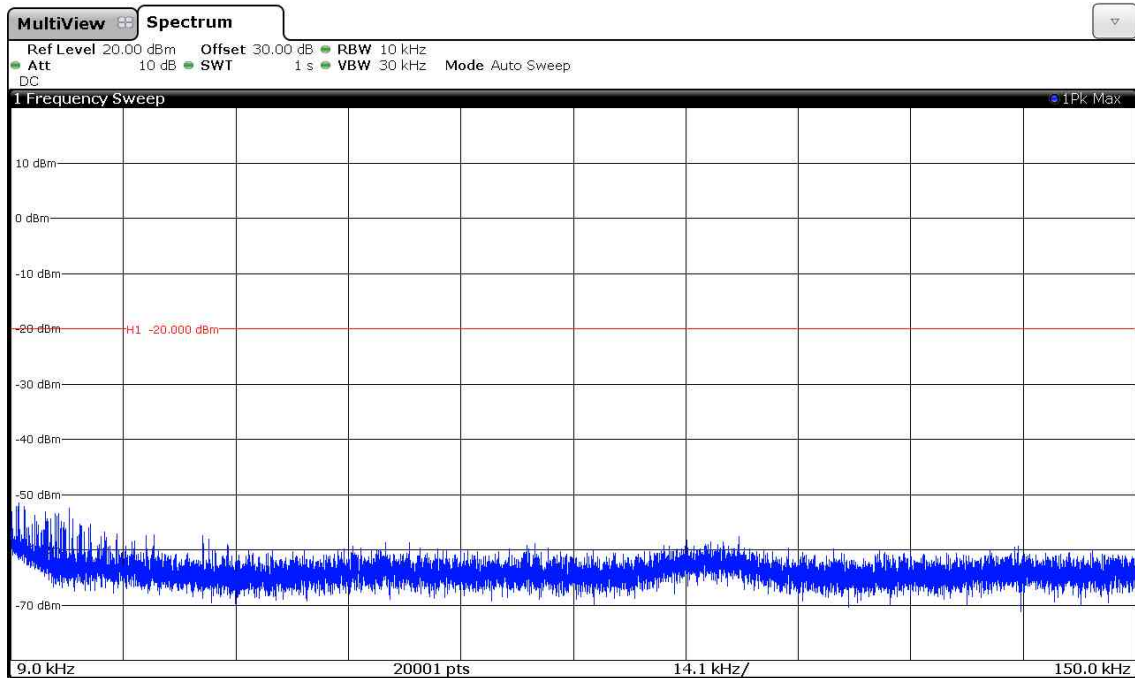
160575_406.5MHz_35W_12.5k_800M-1G



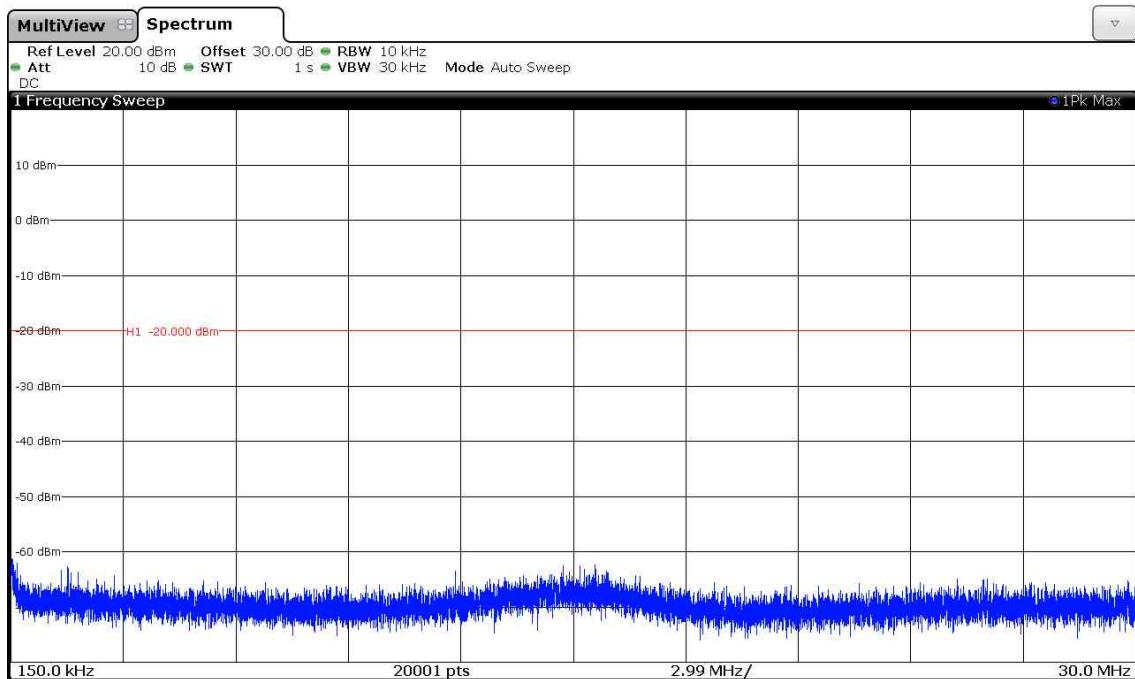
160575_406.5MHz_35W_12.5k_1G-5G



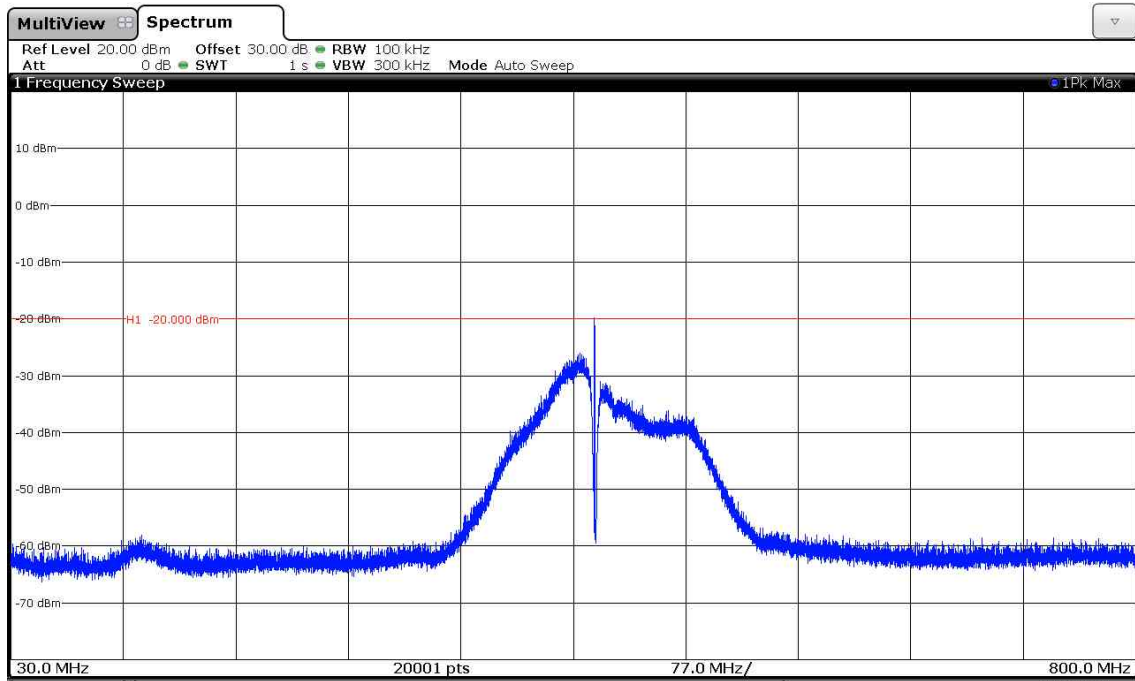
160575_429.5MHz_35W_12.5k_9k-150k



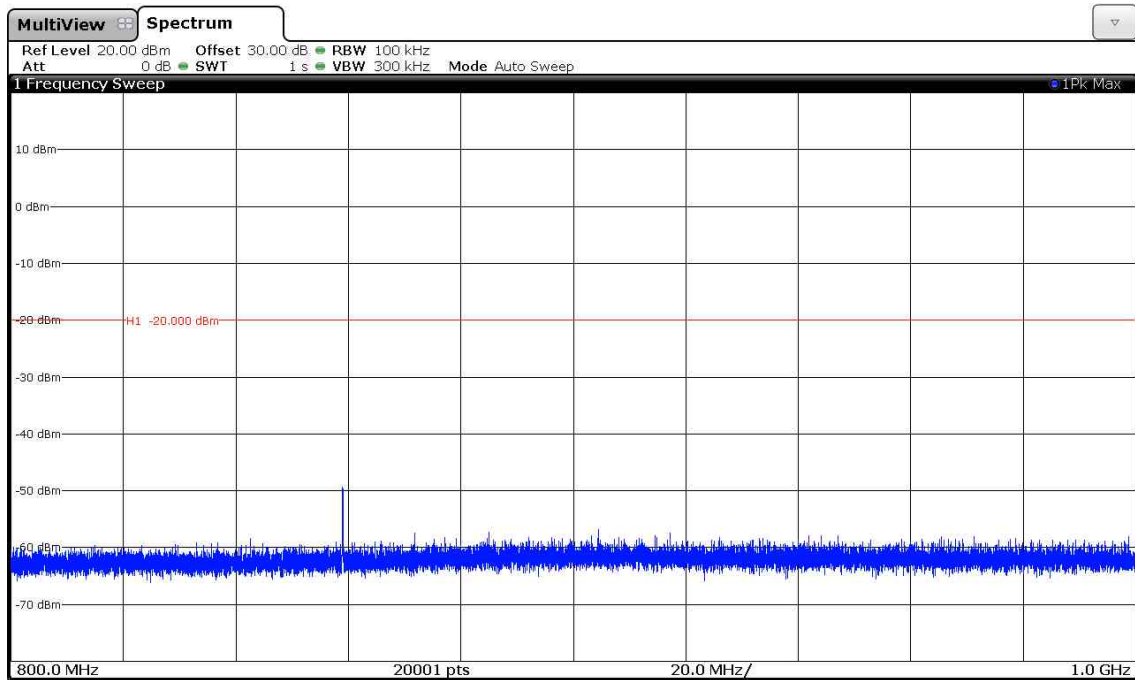
160575_429.5MHz_35W_12.5k_150k-30M



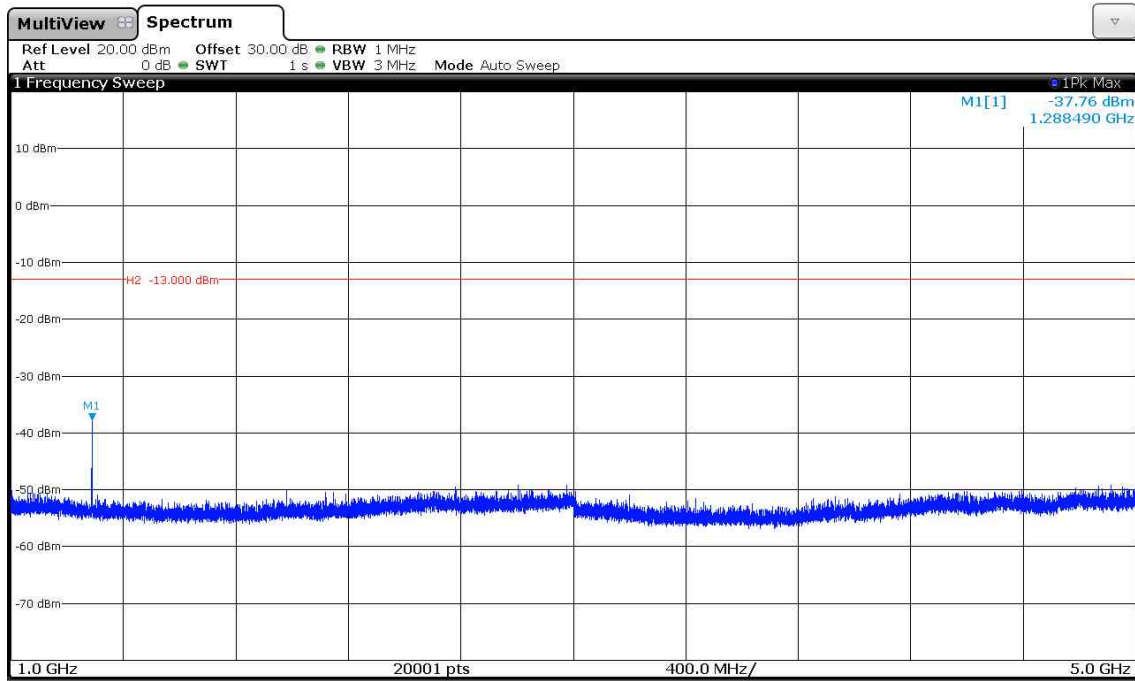
160575_429.5MHz_35W_12.5k_30M-800M (Carrier notched)



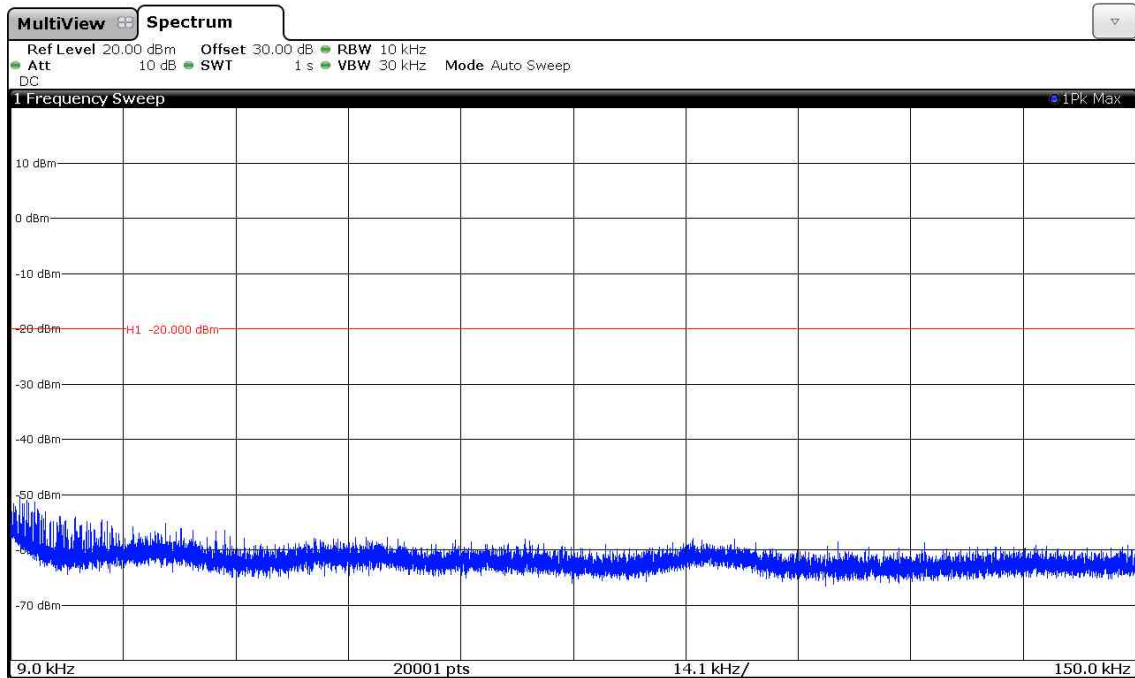
160575_429.5MHz_35W_12.5k_800M-1G



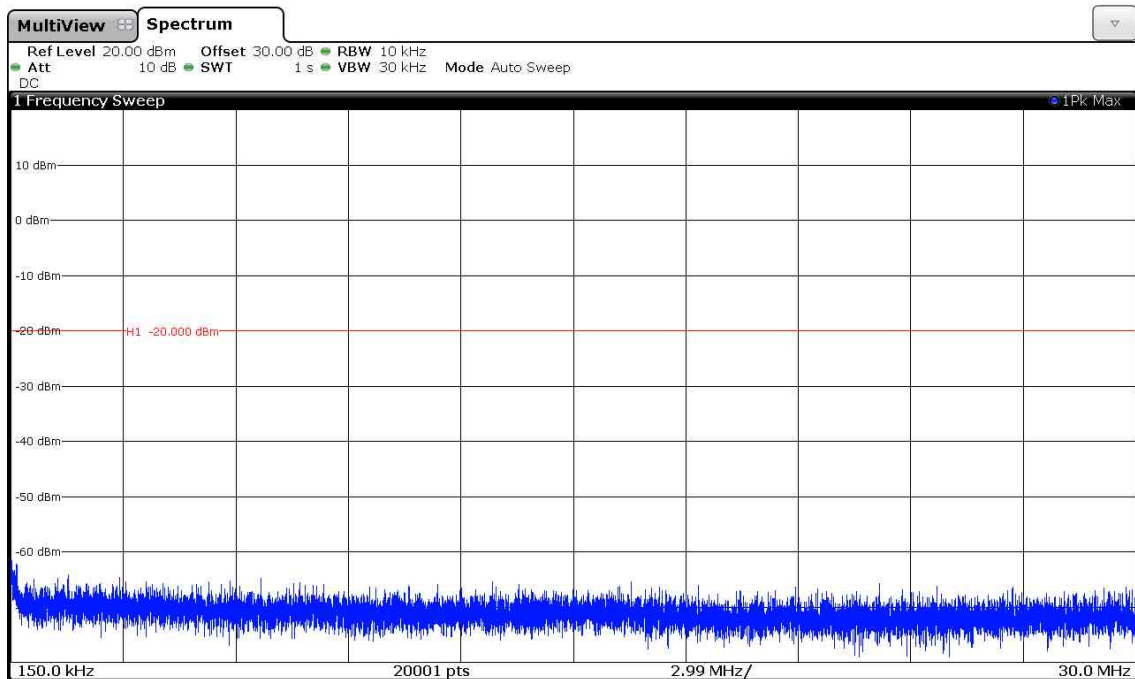
160575_429.5MHz_35W_12.5k_1G-5G



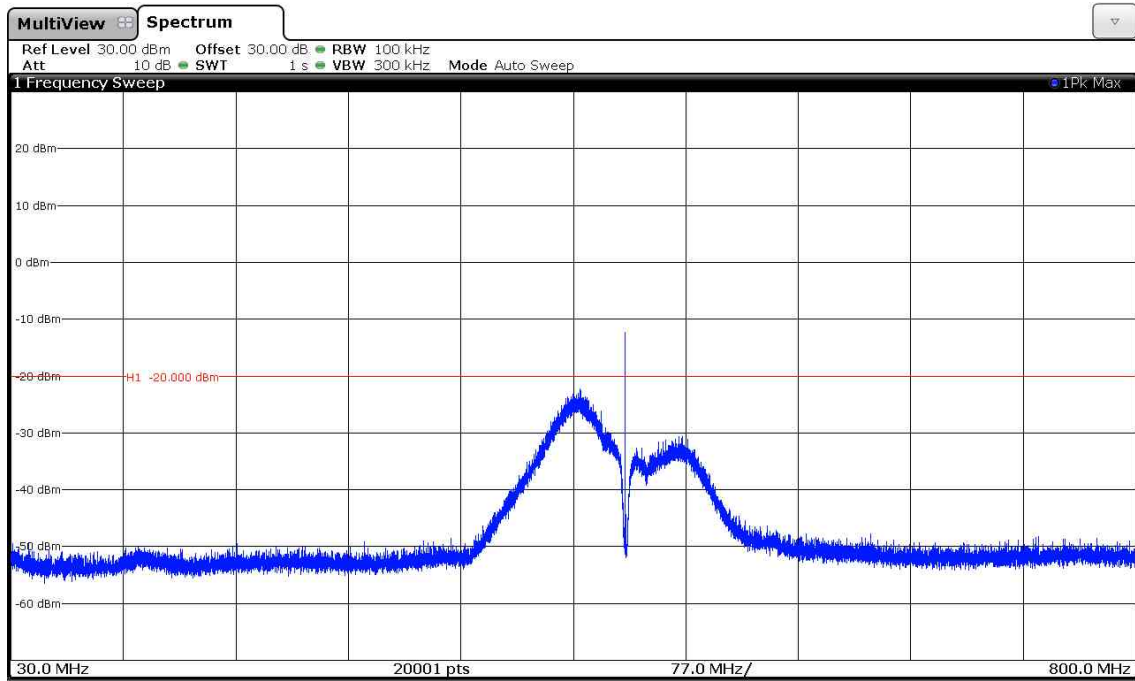
160575_450.5MHz_35W_12.5k_9k-150k



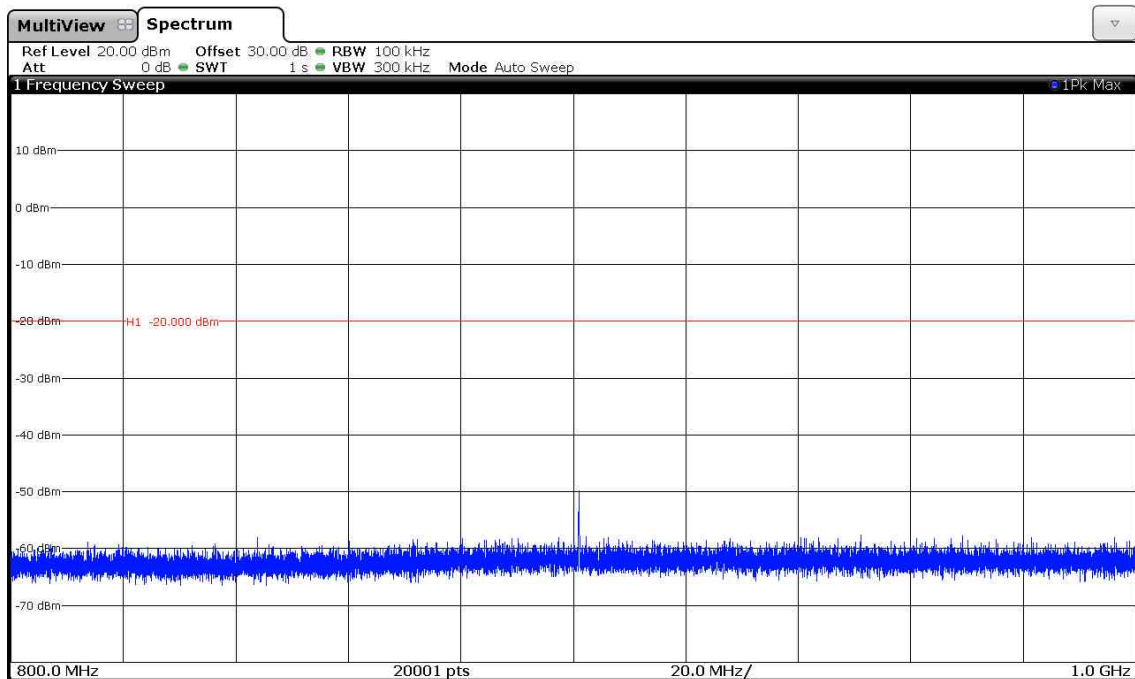
160575_450.5MHz_35W_12.5k_150k-30M



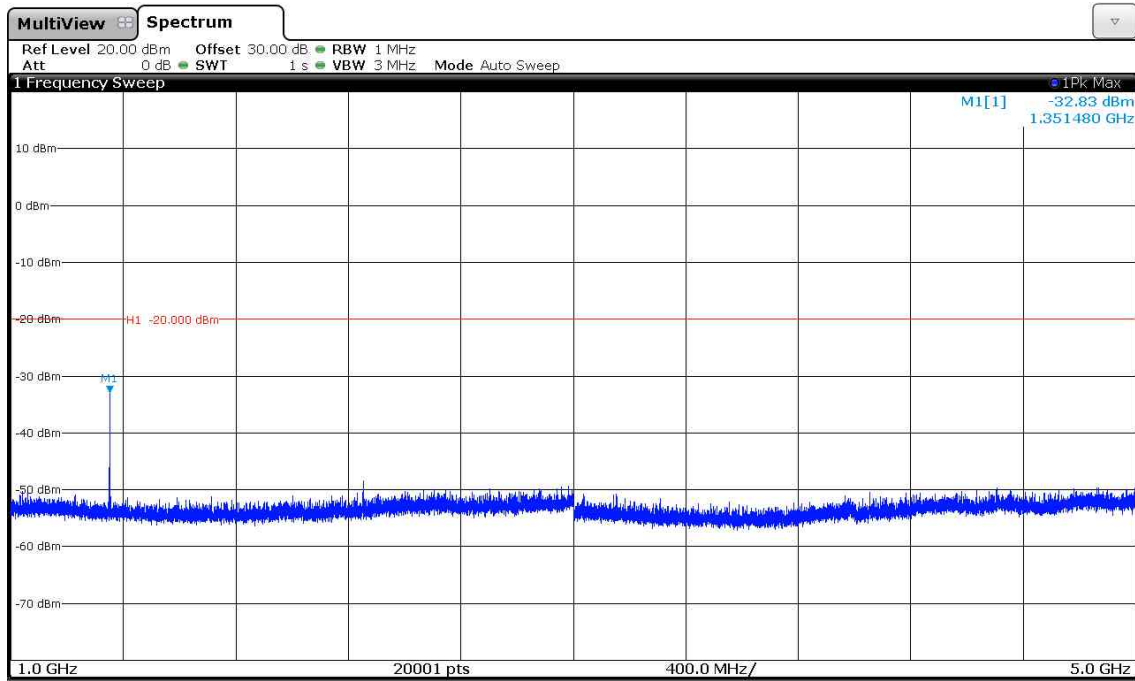
160575_450.5MHz_35W_12.5k_30M-800M (carrier notched)



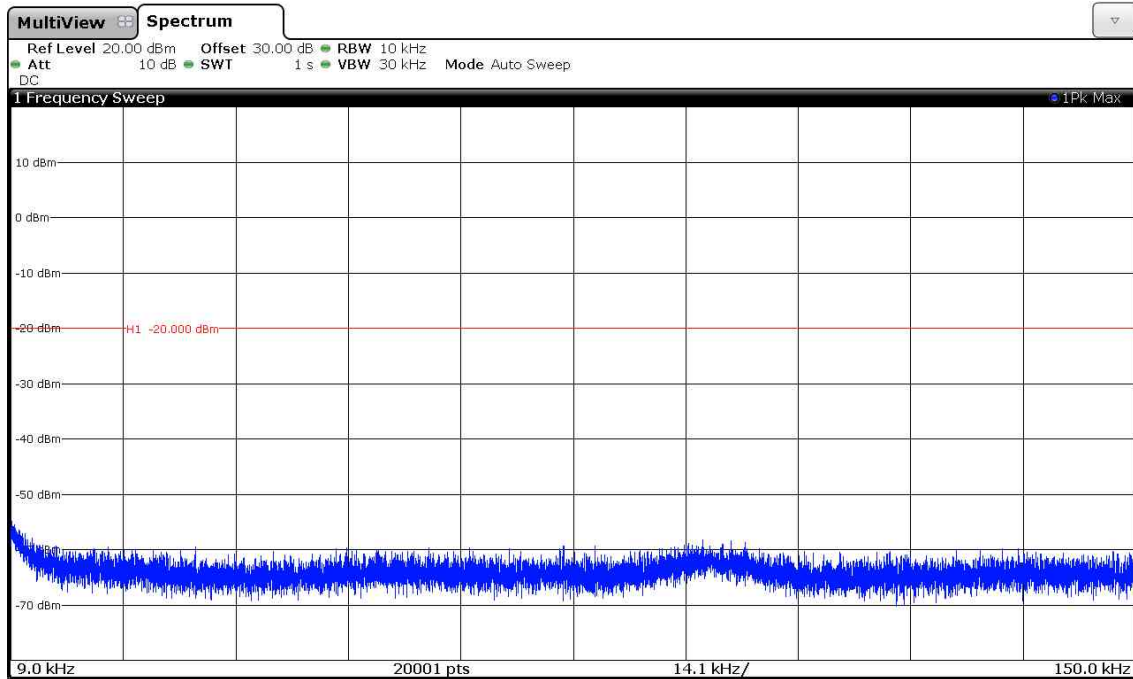
160575_450.5MHz_35W_12.5k_800M-1G



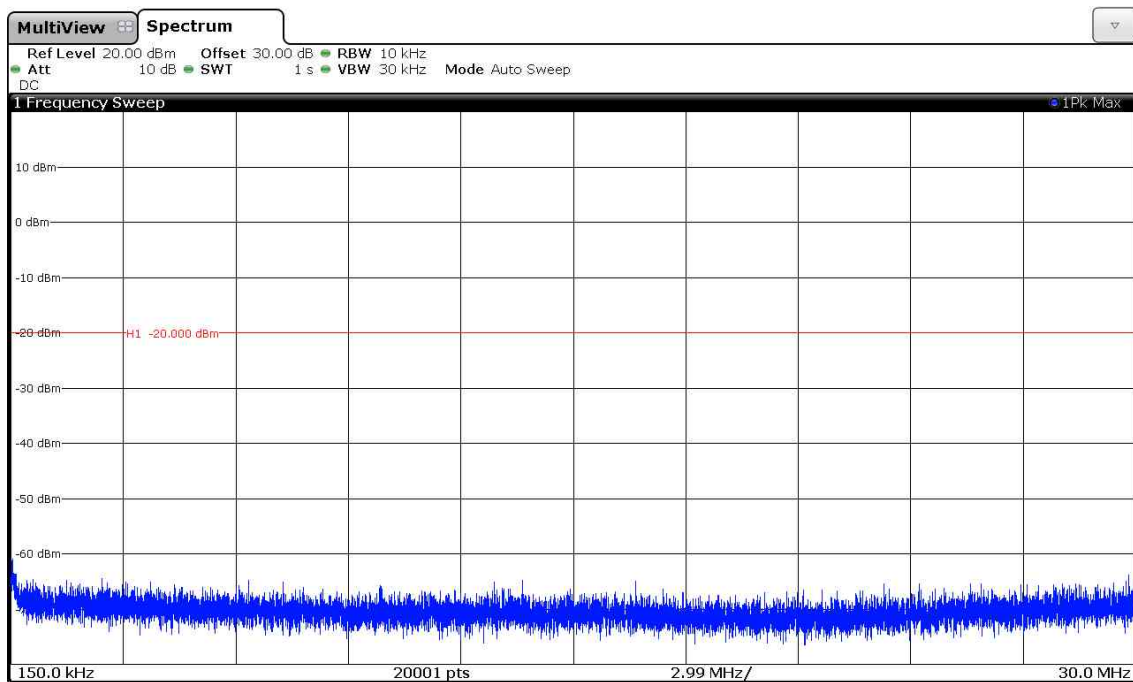
160575_450.5MHz_35W_12.5k_1G-5G



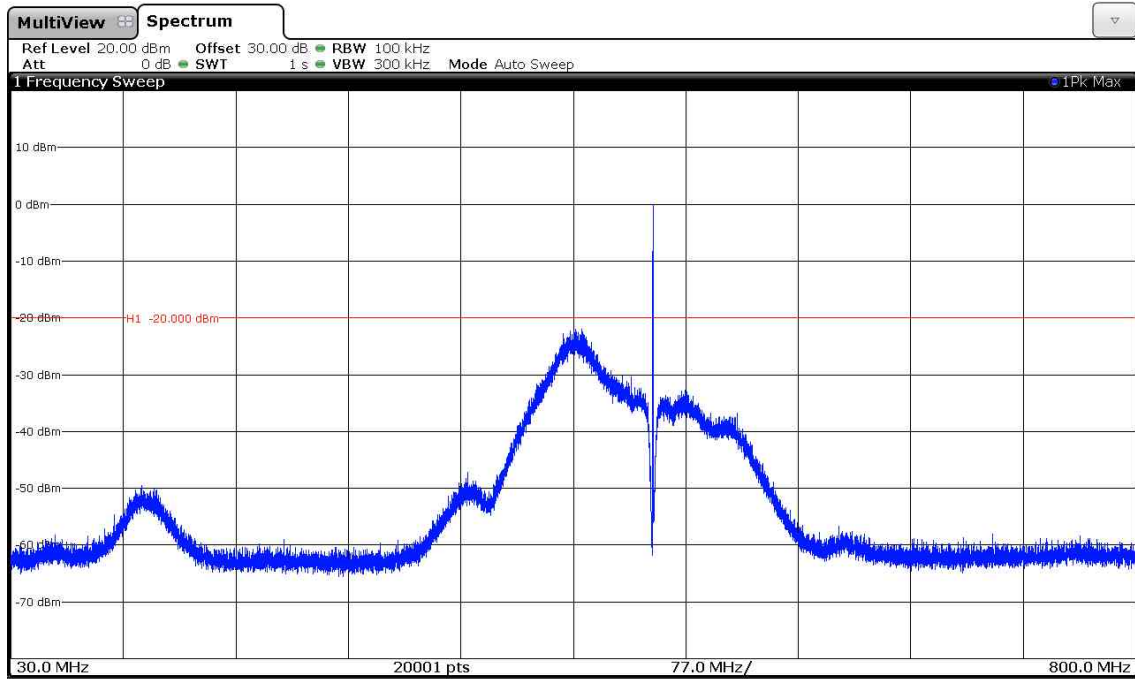
160575_469.5MHz_35W_12.5k_9k-150k



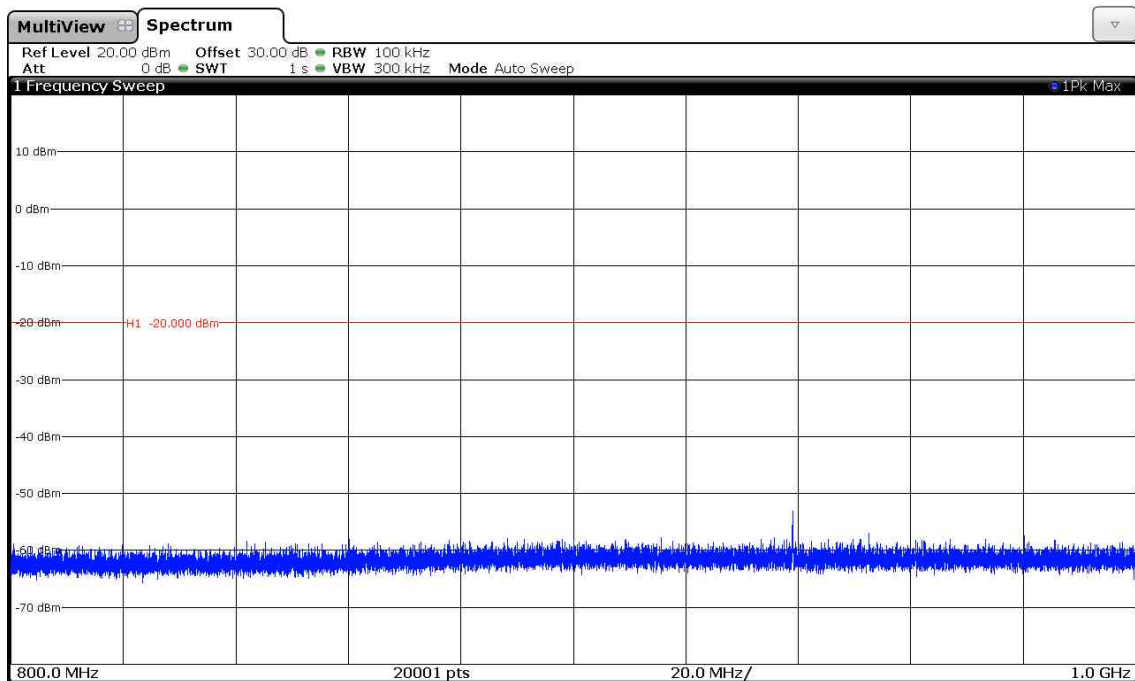
160575_469.5MHz_35W_12.5k_150k-30M



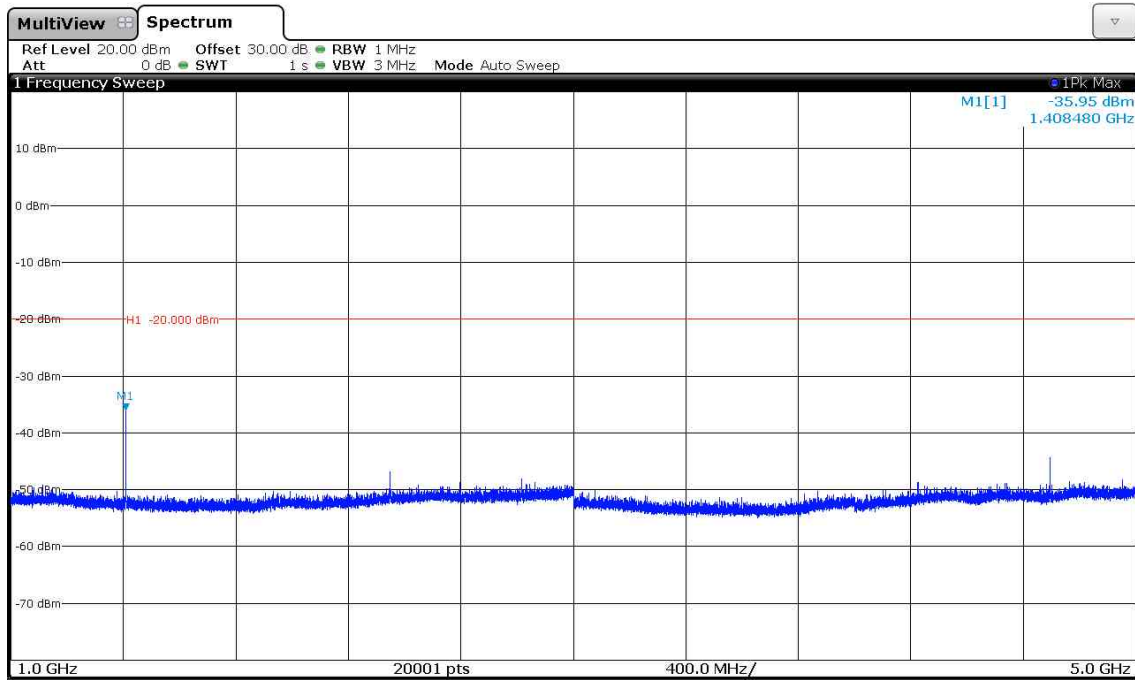
160575_469.5MHz_35W_12.5k_30M-800M (carrier notched)



160575_469.5MHz_35W_12.5k_800M-1G



160575_469.5MHz_35W_12.5k_1G-5G



5.4.2.2 Channel Spacing 25 kHz

TX frequency (MHz)	Channel bandwidth (kHz)	Frequency (MHz)	Level (dBm)	Limit (dBm)
406.5	25	1219.69	-38.71	-13
429.5		1288.45	-36.52	
450.5		1351.48	-33.72	
469.5		1408.48	-37.33	
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 35 W carrier power: $43 + 10 \log (P)$ dB = $43 + 10 \log (35)$ dB = 58.44 dB

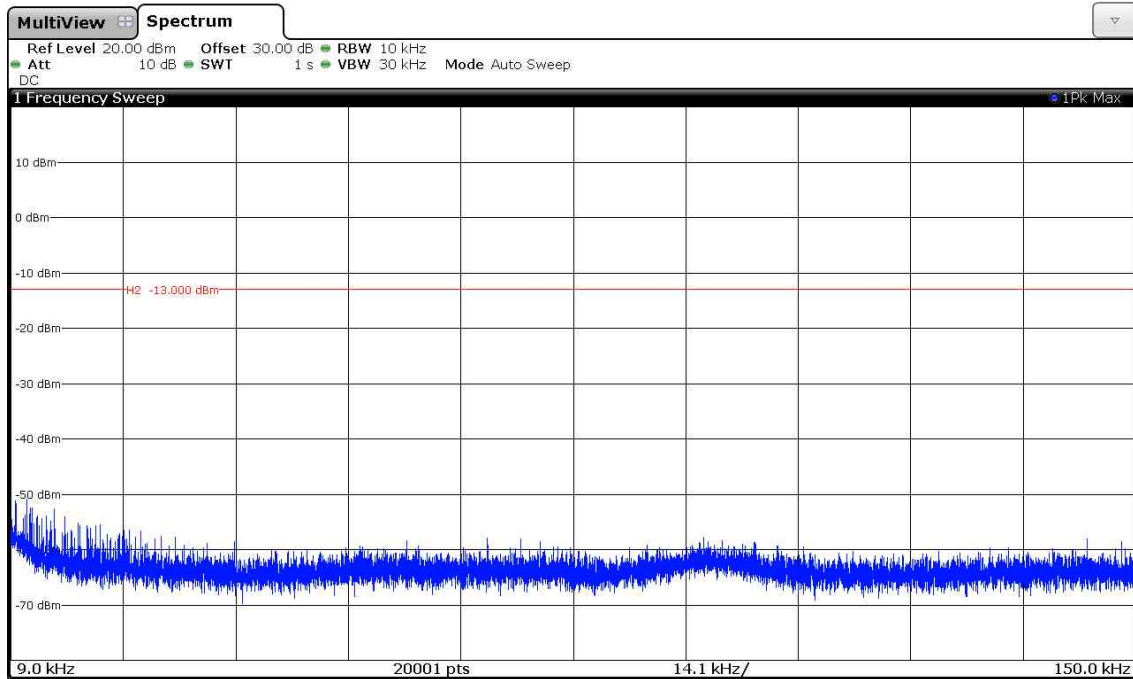
RF power limit for any emission: 58.44 dBm - 65.44 dB = -13 dBm

Test: Passed

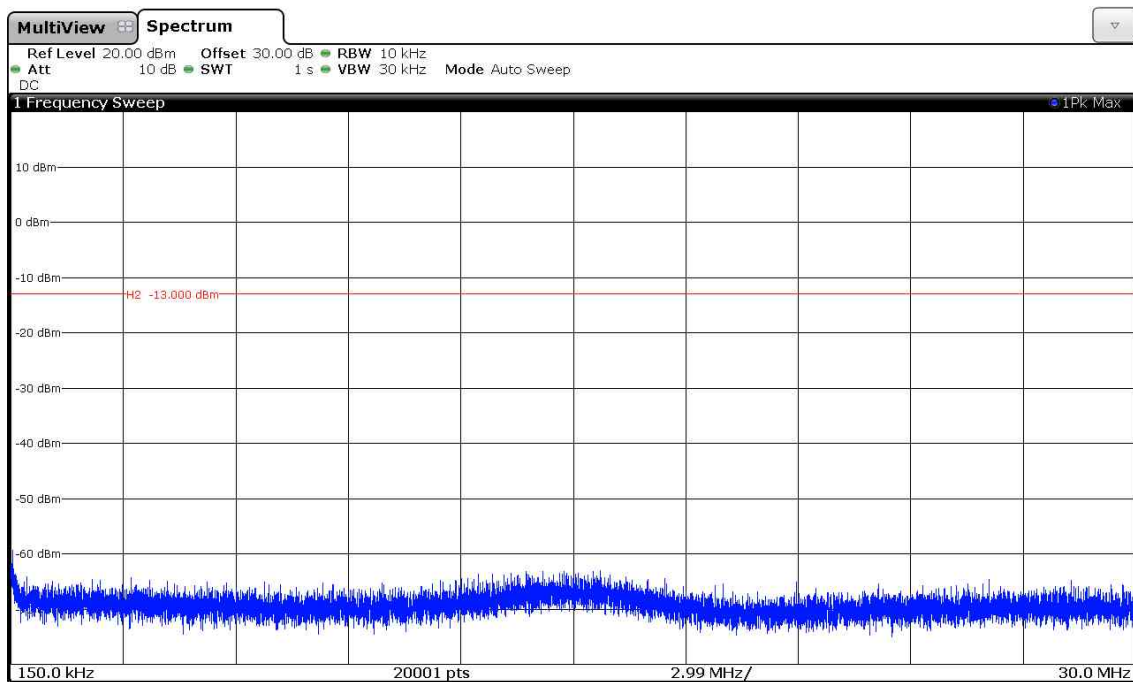
Test equipment used (refer clause 6):

23 - 27, 29, 30, 35, 36

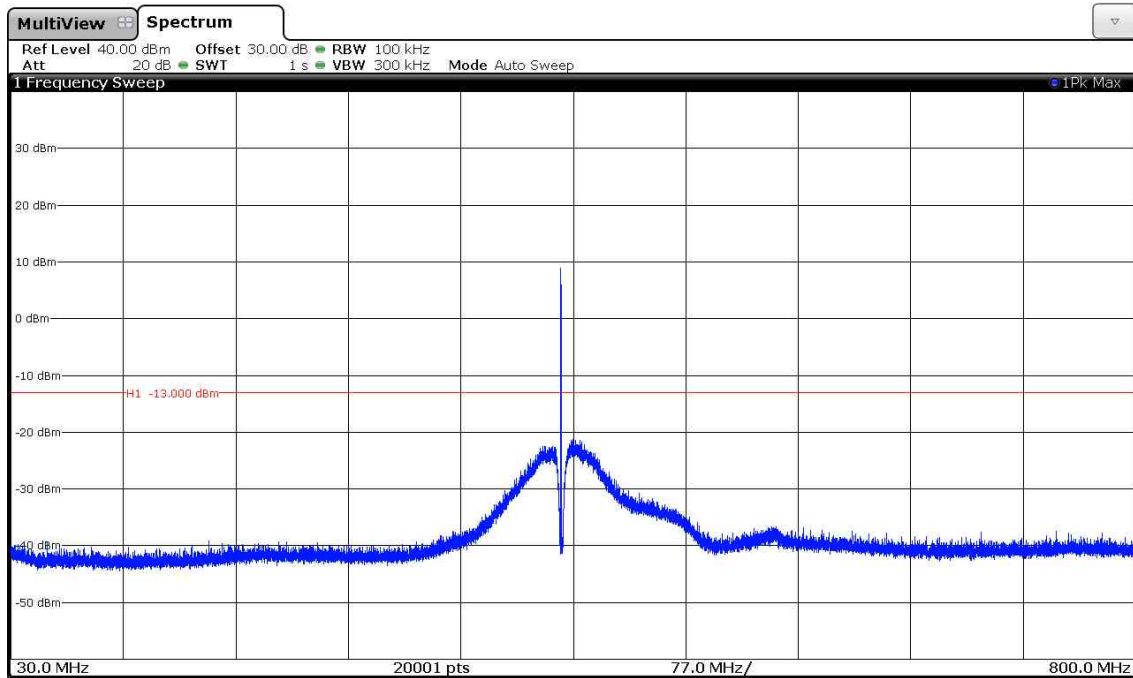
160575_406.5MHz_35W_25k_9k-150k



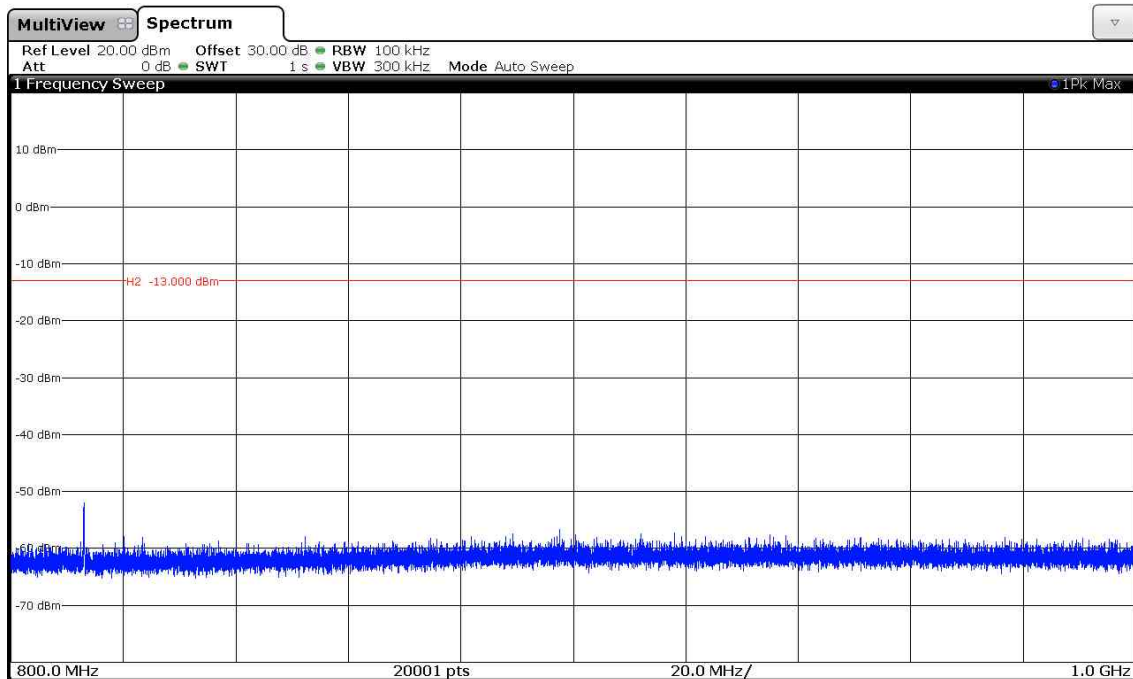
160575_406.5MHz_35W_25k_150k-30M



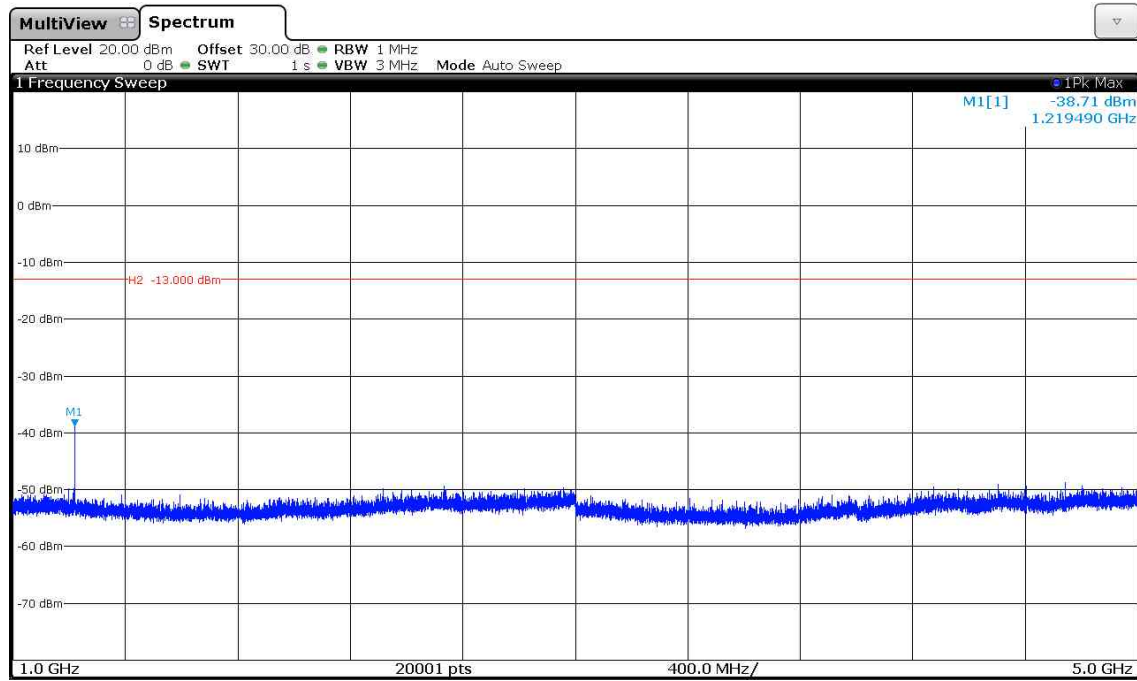
160575_406.5MHz_35W_30M-800M (carrier notched)



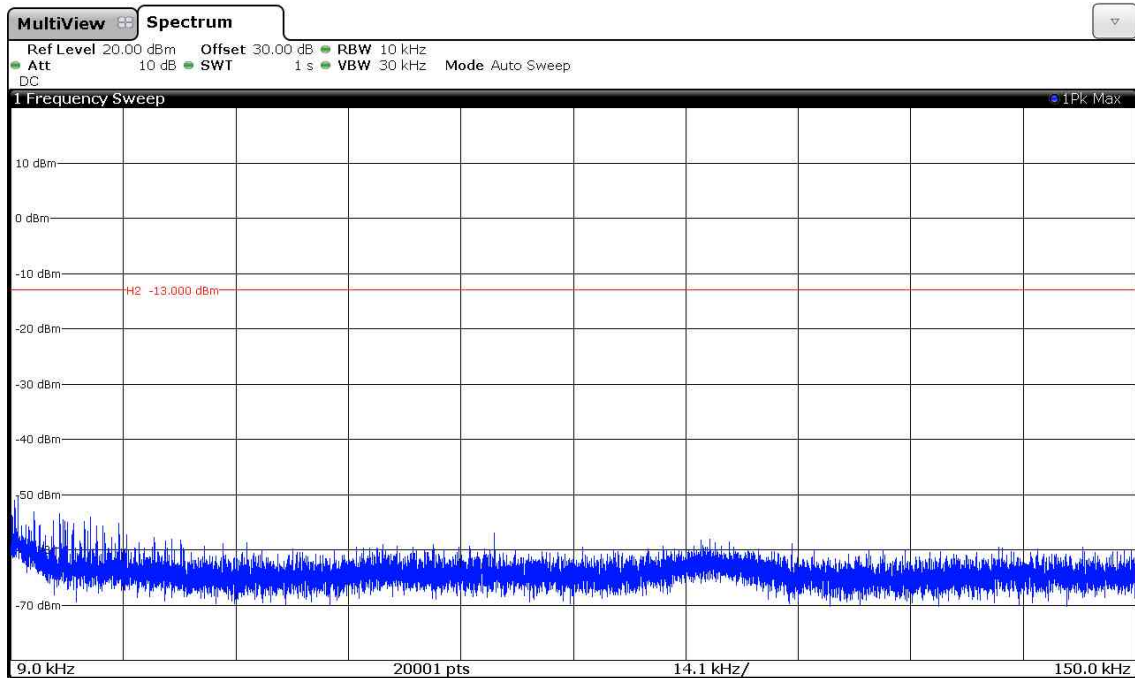
160575_406.5MHz_35W_25k_800M-1G



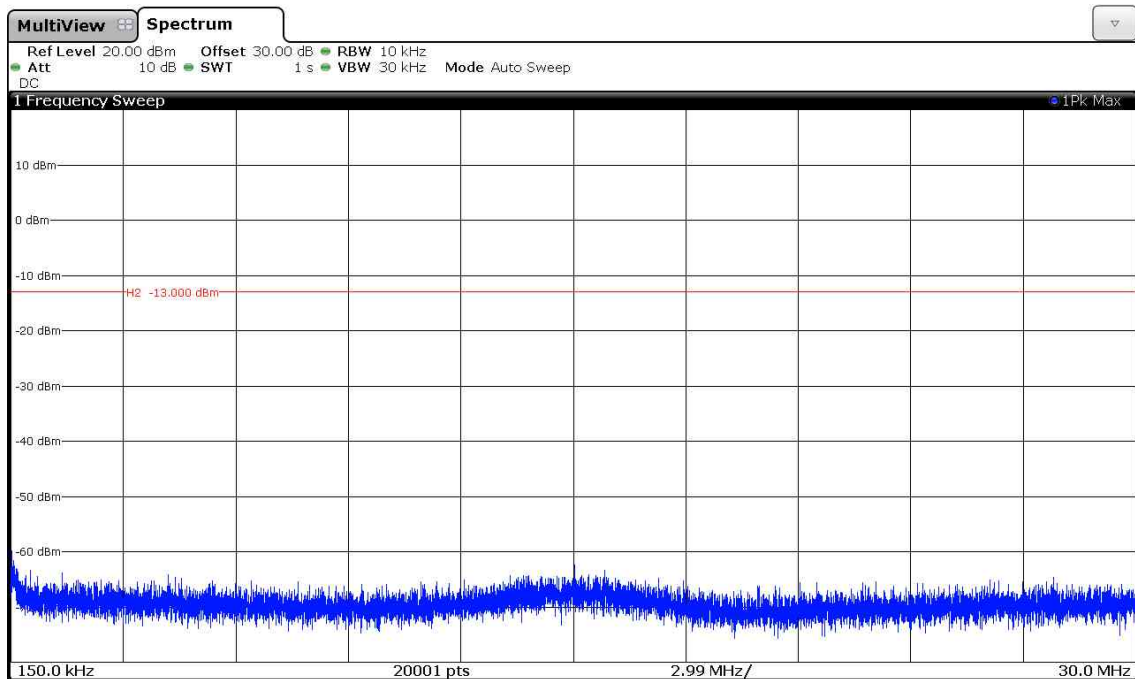
160575_406.5MHz_35W_25k_1G-5G



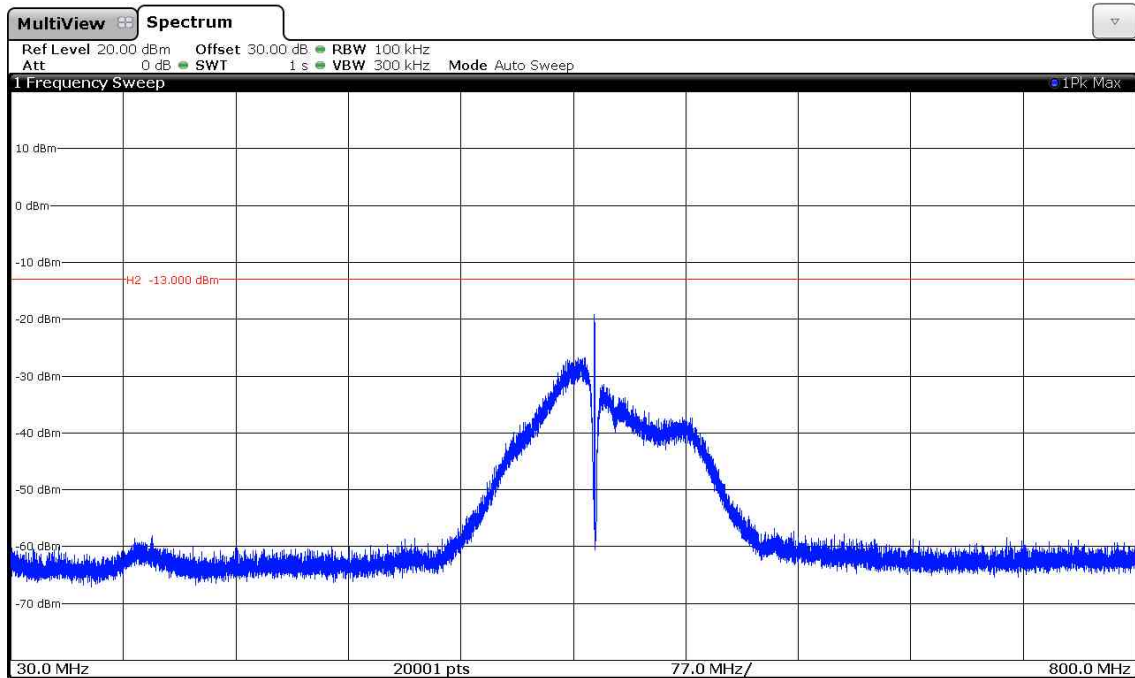
160575_429.5MHz_35W_25k_9k-150k



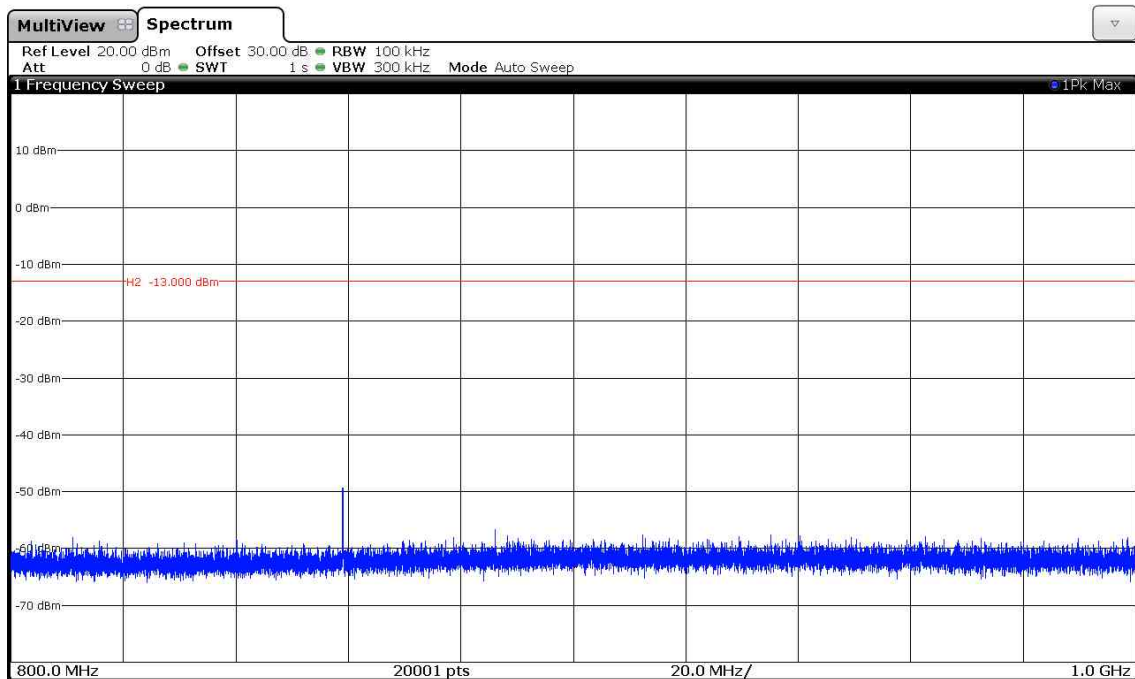
160575_429.5MHz_35W_25k_150k-30M



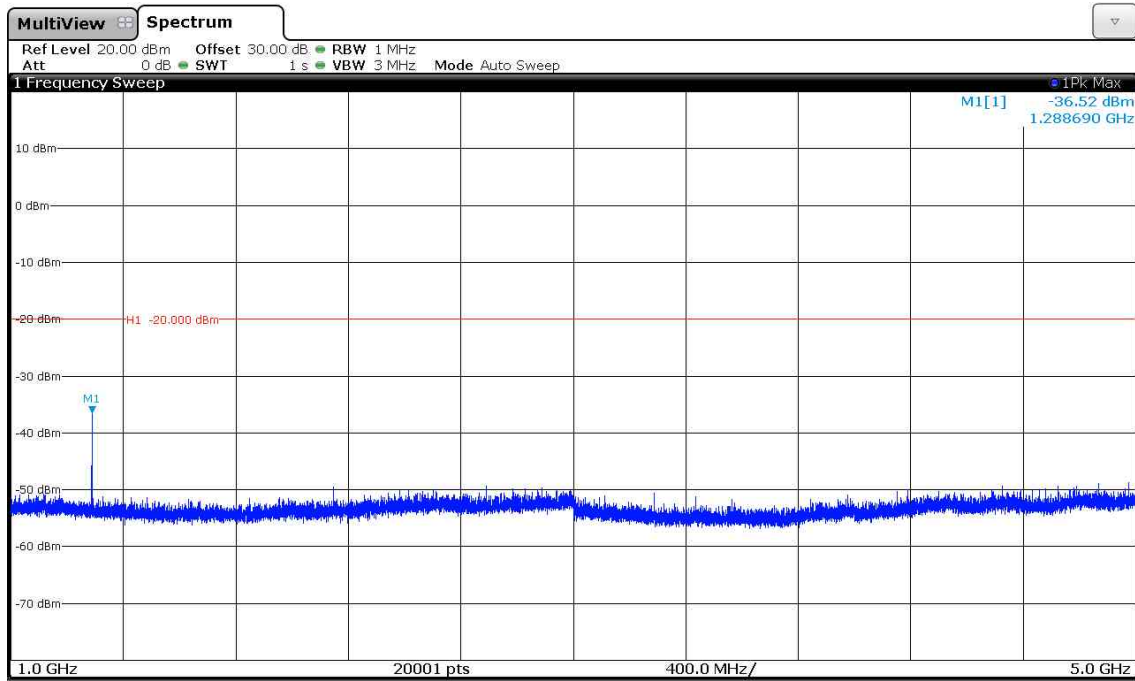
8 160575_429.5MHz_35W_25k_30M-800M (carrier notched)



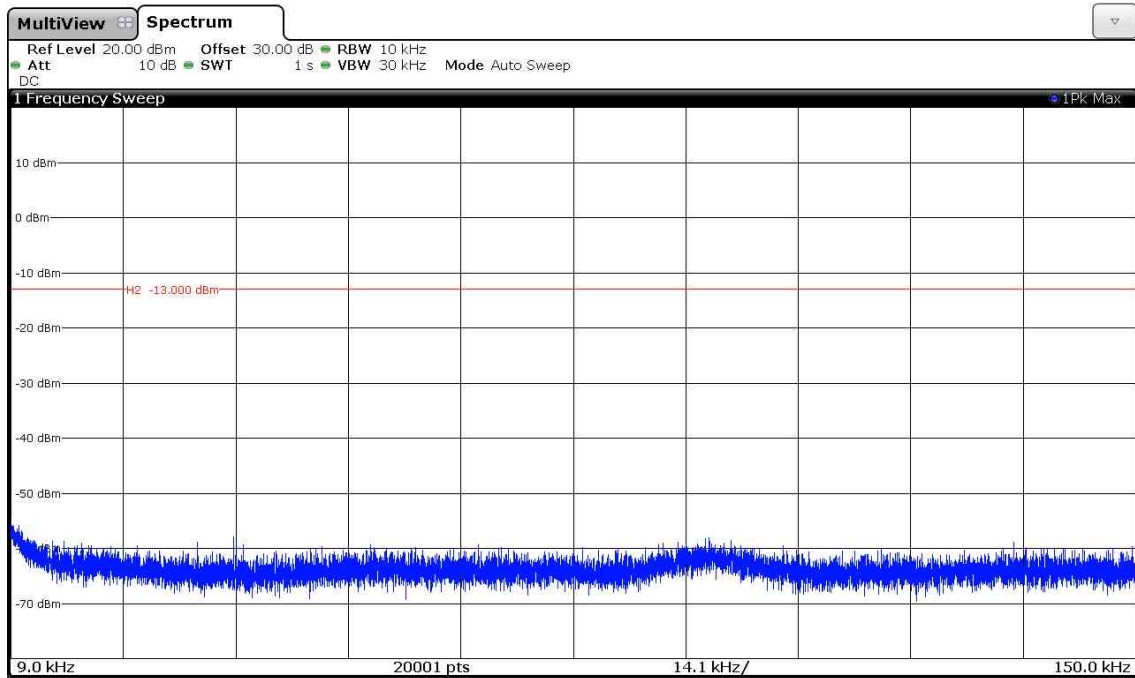
160575_429.5MHz_35W_25k_800M-1G



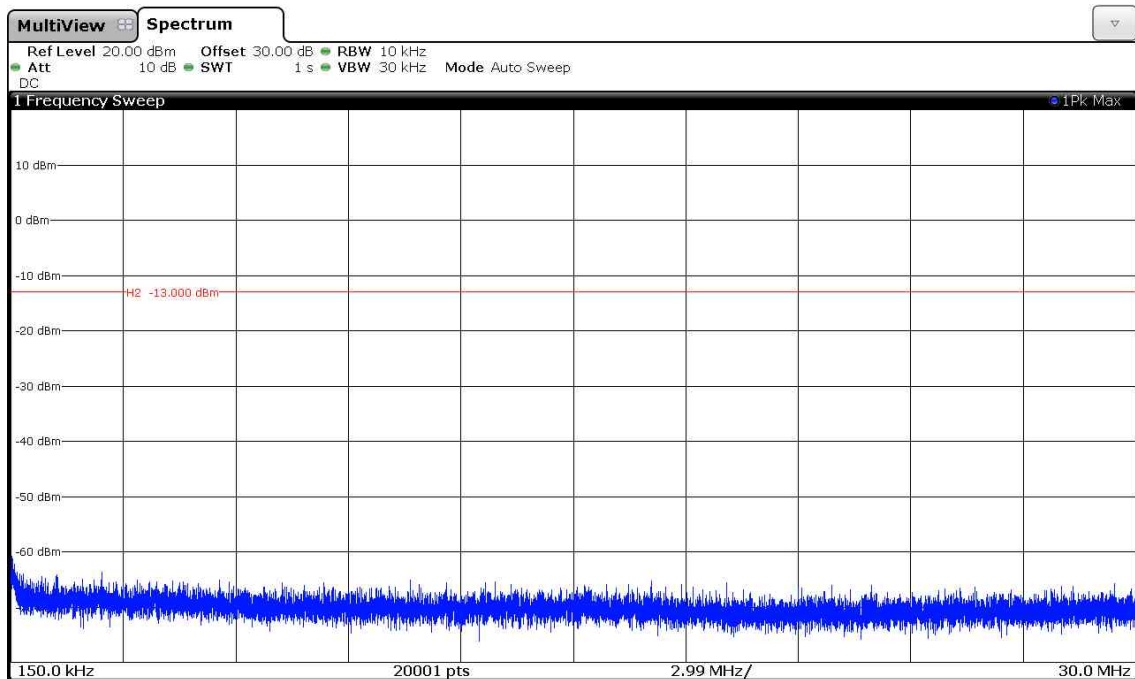
160575_429.5MHz_35W_25k_1G-5G



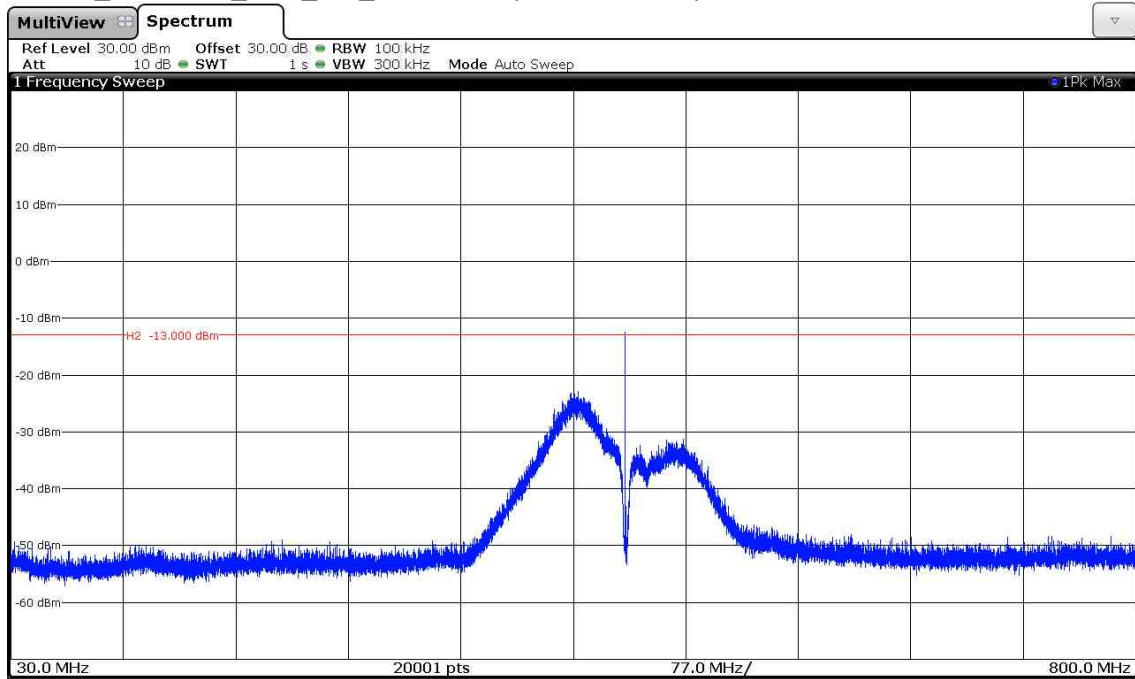
160575_450.5MHz_35W_25k_9k-150k



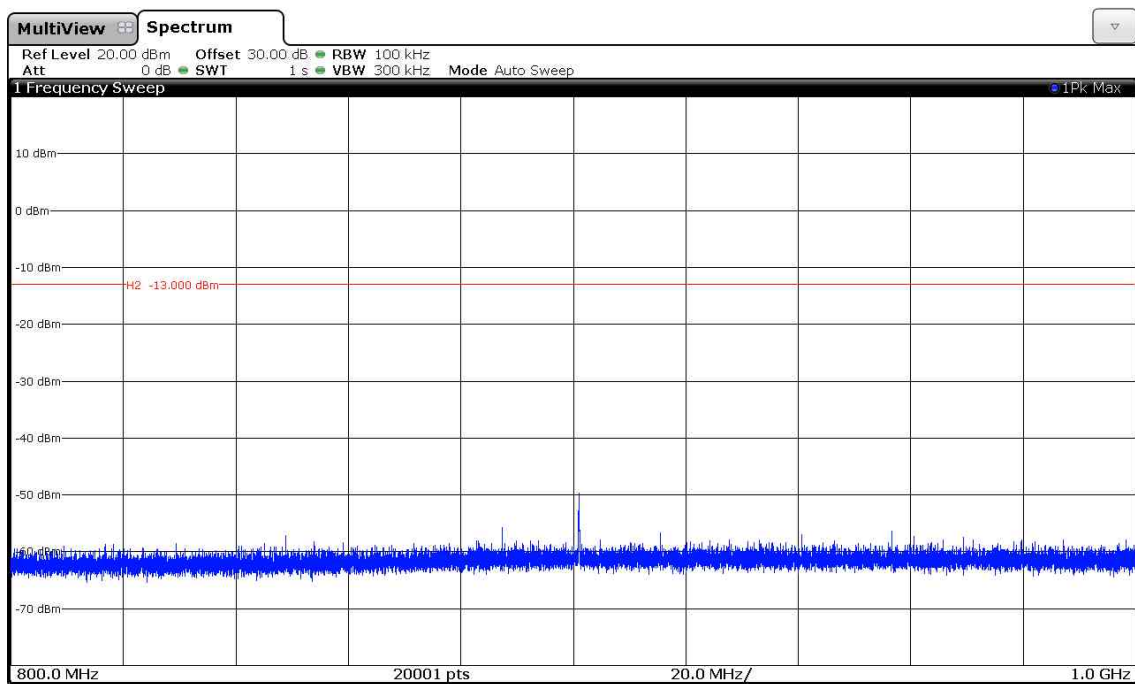
160575_450.5MHz_35W_25k_150k-30M



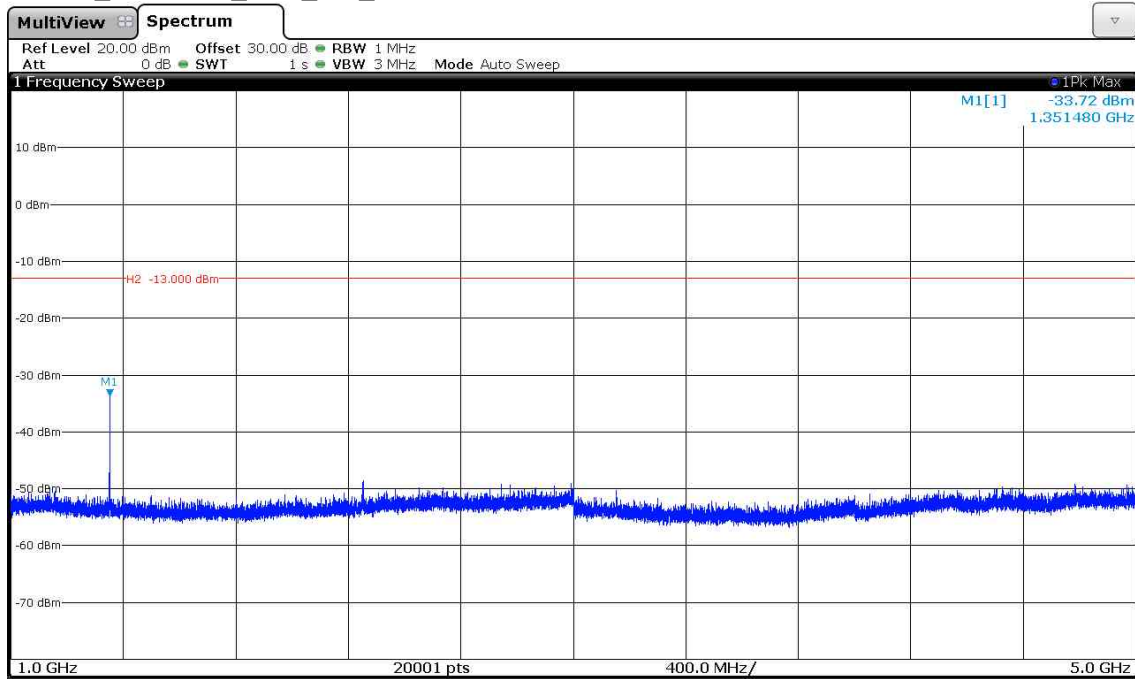
160575_450.5MHz_35W_25k_30M-800M (carrier notched)



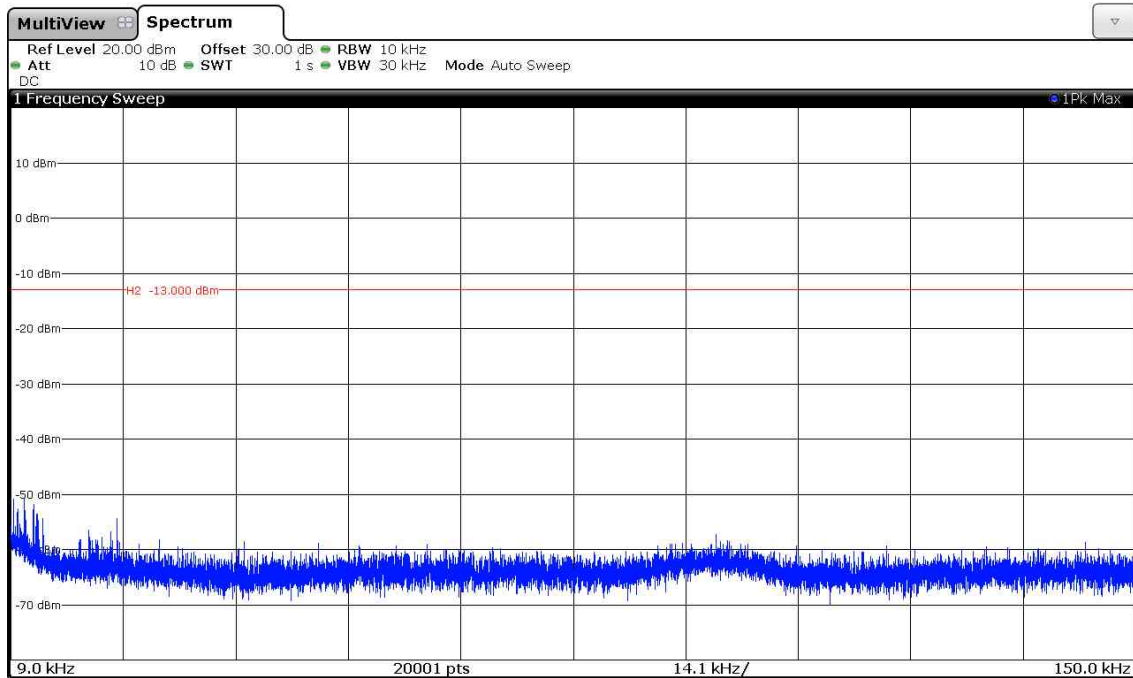
160575_450.5MHz_35W_25k_800M-1G



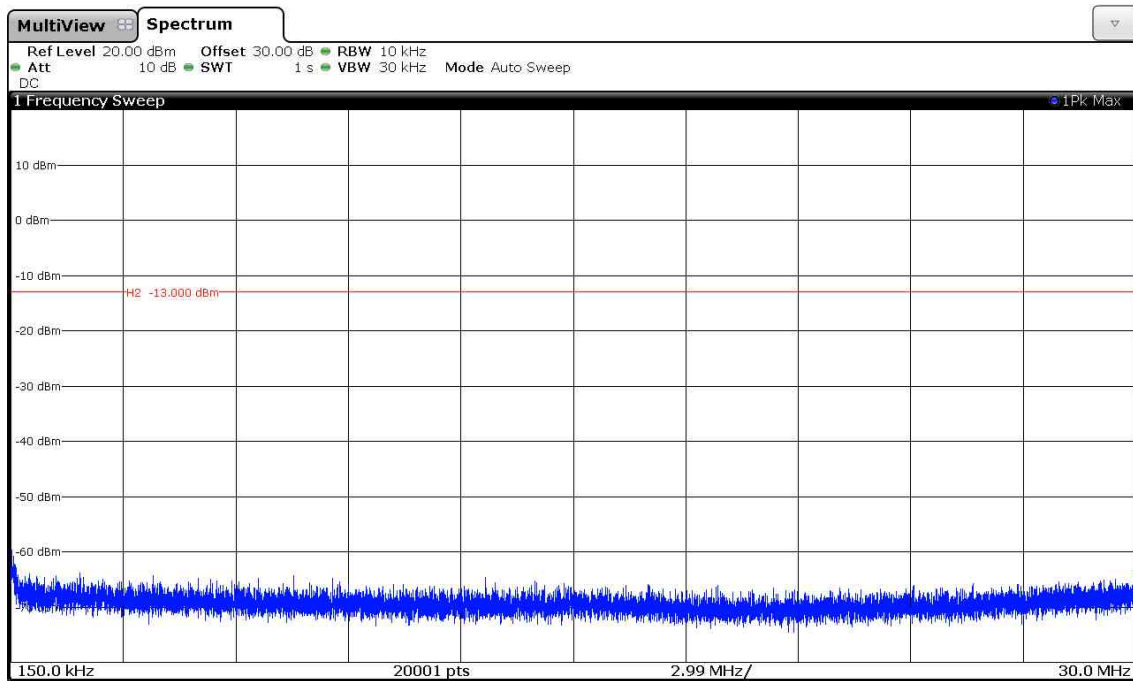
160575_450.5MHz_35W_25k_1G-5G



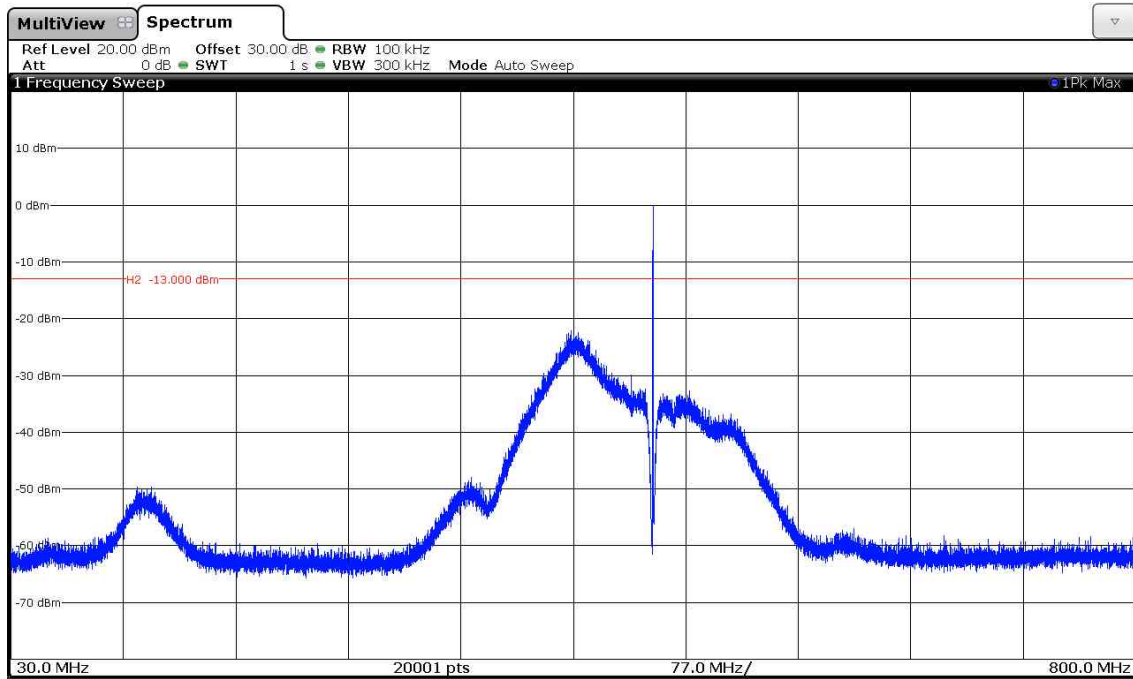
160575_469.5MHz_35W_25k_9k-150k



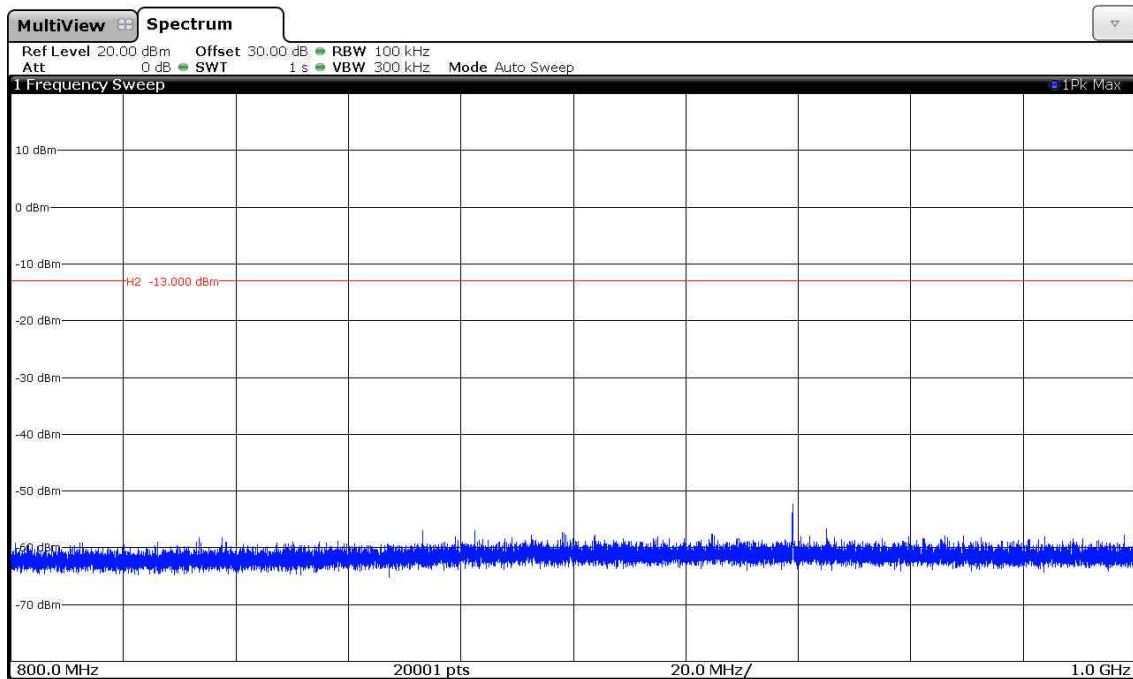
160575_469.5MHz_35W_25k_150k-30M



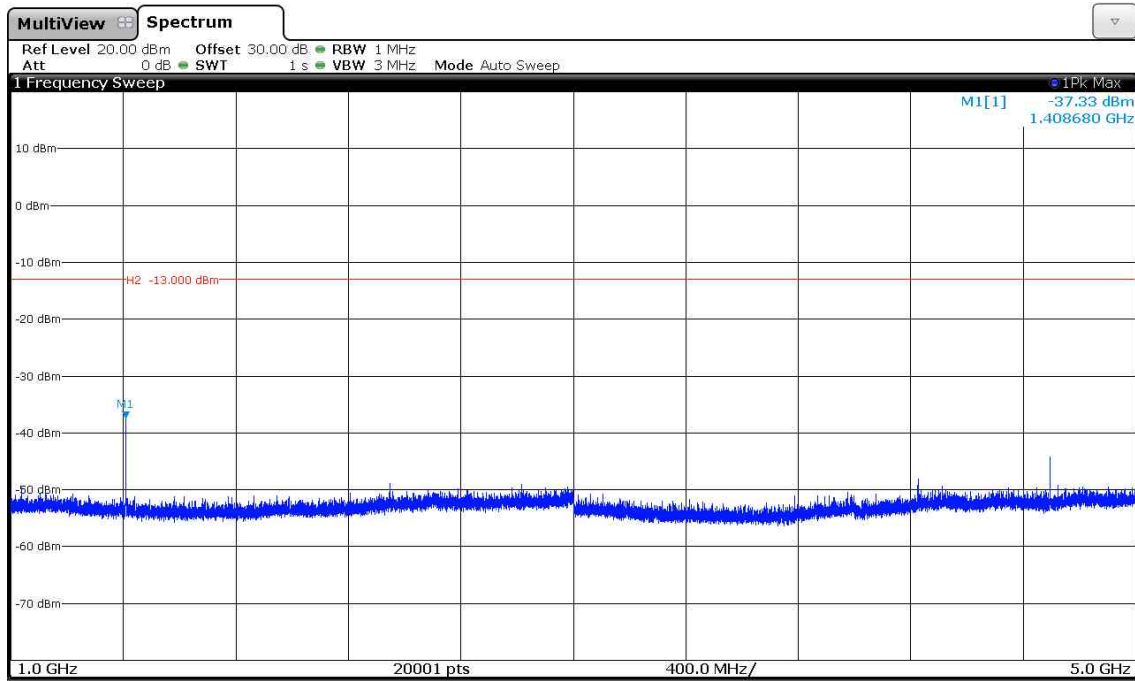
160575_469.5MHz_35W_25k_30M-800M (carrier notched)



160575_469.5MHz_35W_25k_800M-1G



160575_469.5MHz_35W_25k_1G-5G



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.

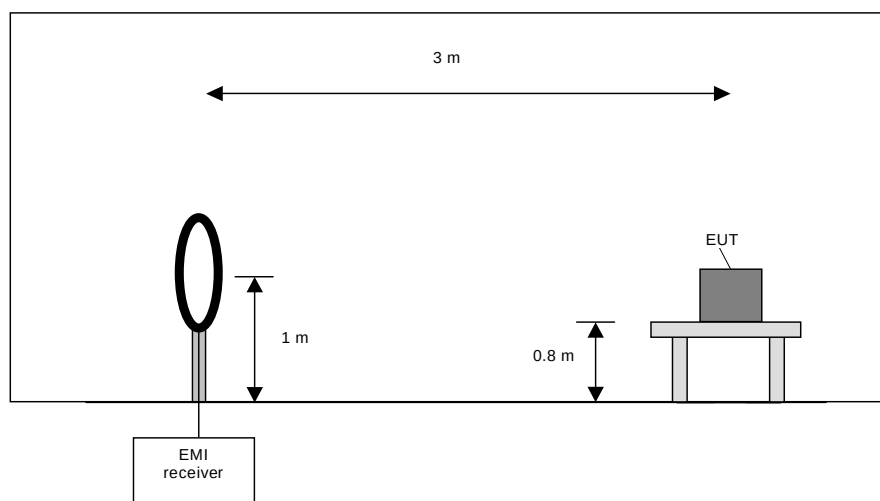
Preliminary measurement (9 kHz to 30 MHz):

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).

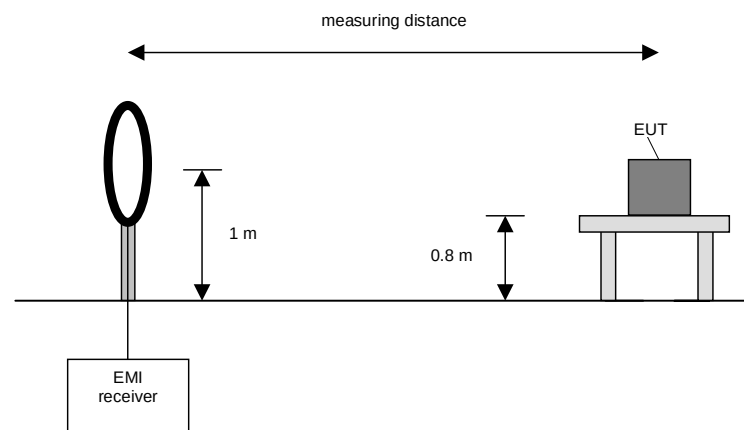
Final measurement (9 kHz to 30 MHz):

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.

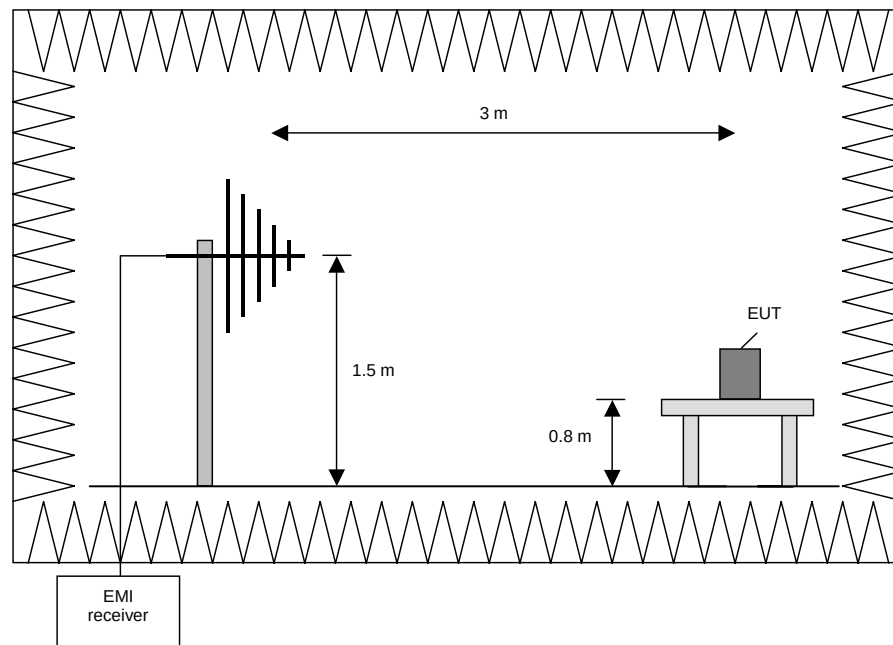
Preliminary measurement (30 MHz to 1 GHz)

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:

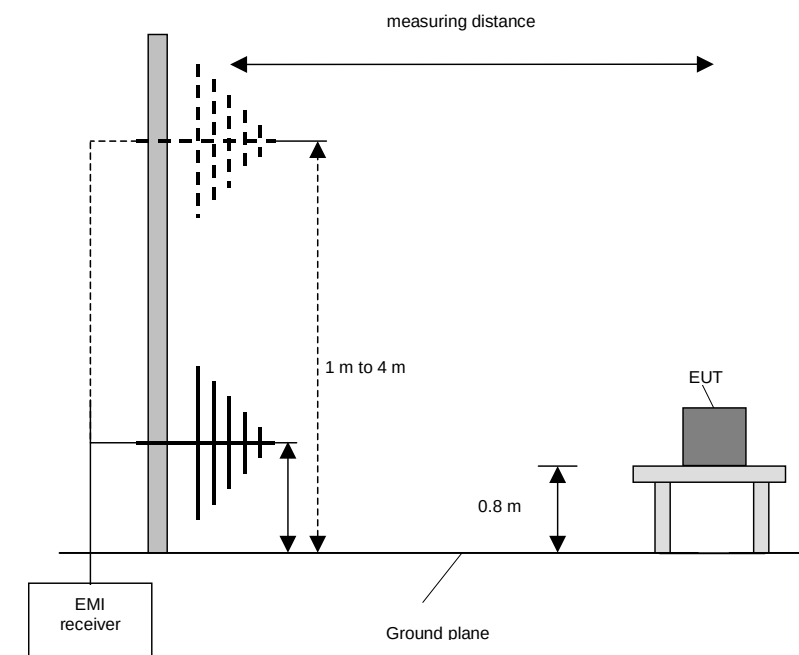
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the 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:

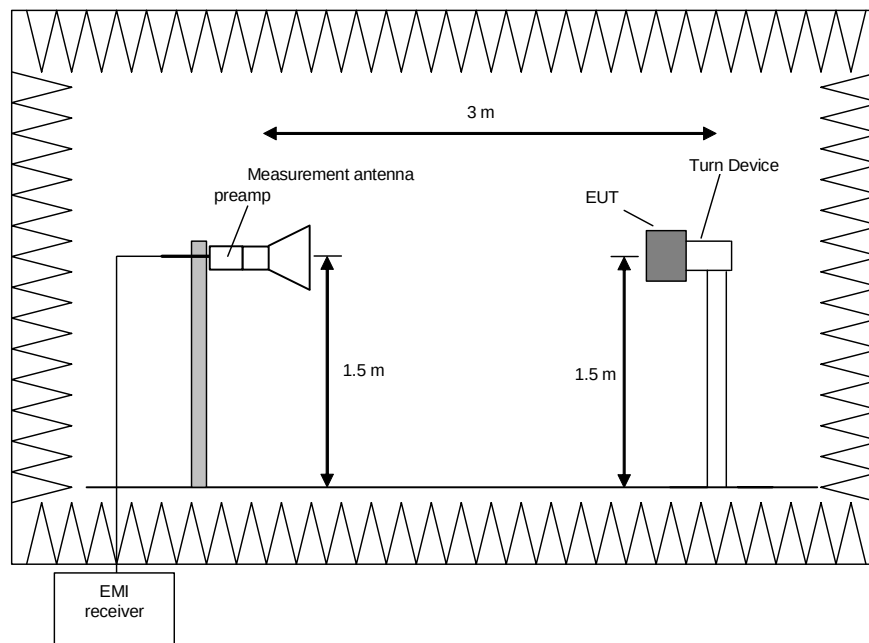
- 1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
- 2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
- 3) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
- 4) Repeat 1) to 3) for the other orthogonal 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:

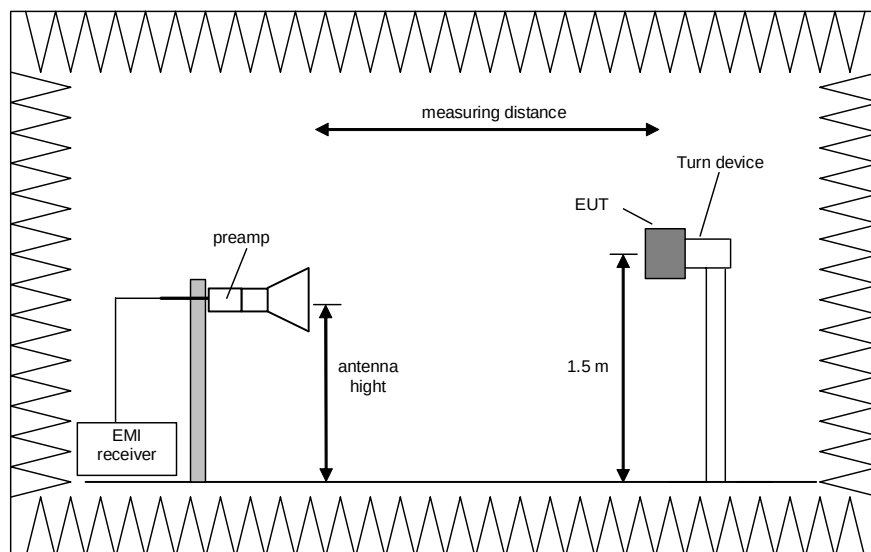
Prescans were performed in the frequency range 1 to 40 GHz.

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	72 %
---------------------	------	-------------------	------

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.

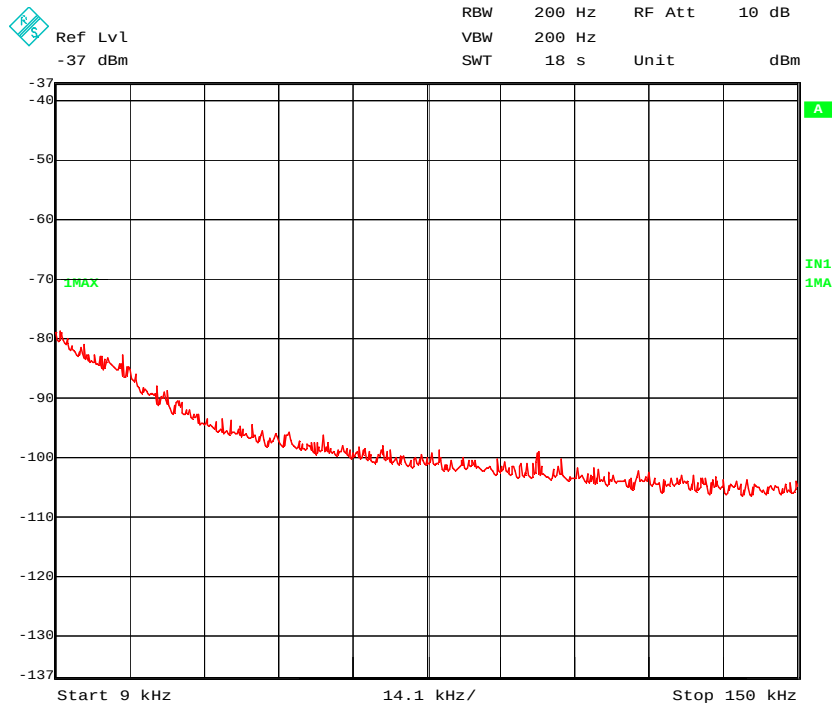
Remark: The antenna terminal was terminated with 50 ohms.

Only the plots of the worst case emissions are submitted for every frequency range above 1 GHz in the preliminary results.

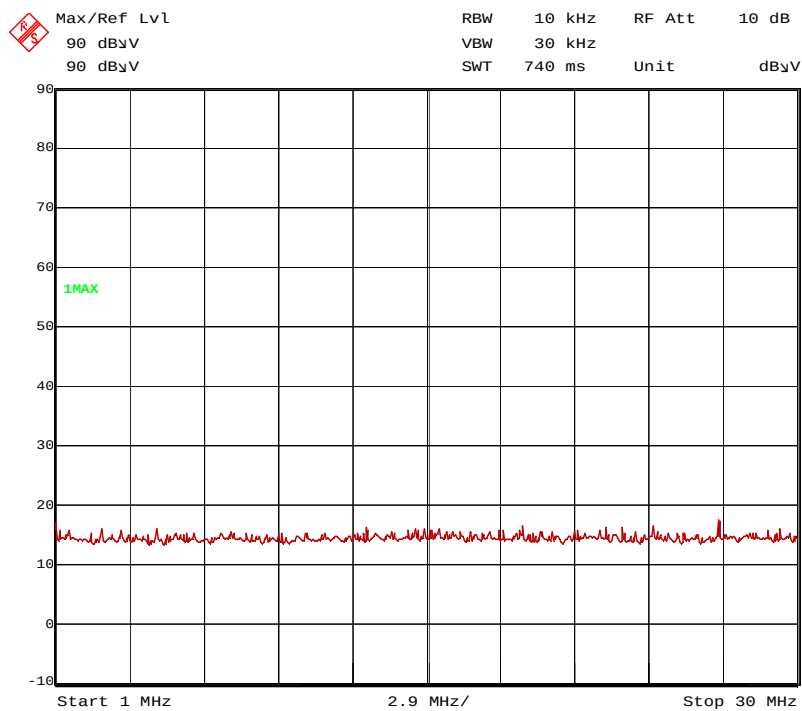
The Emissions below 1 GHz were similar for all transmit frequencies, modulation schemes and data rates. Therefore only the results of an exemplary test case are submitted in the following.

Modulation was set to 16FSK.

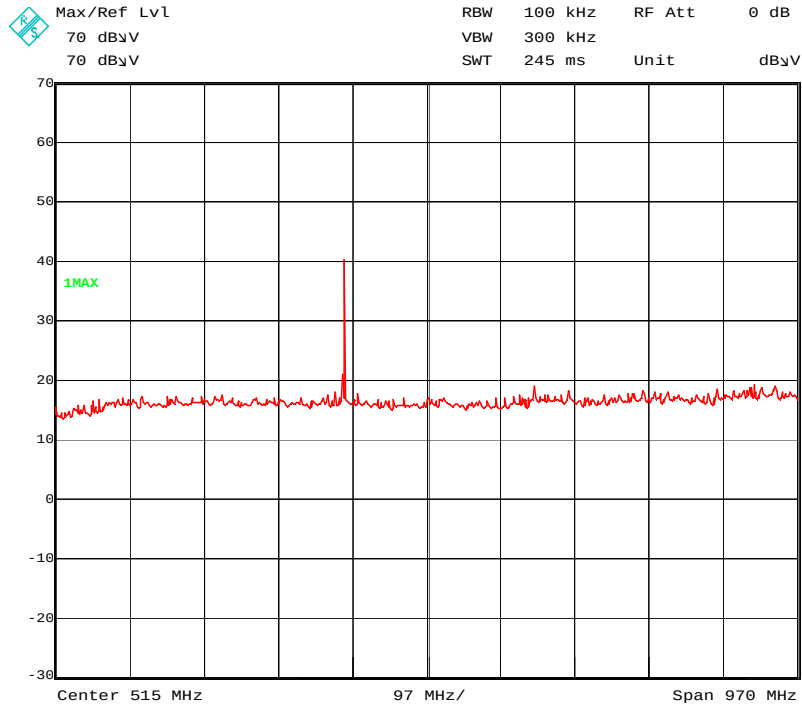
160575_9k-150k



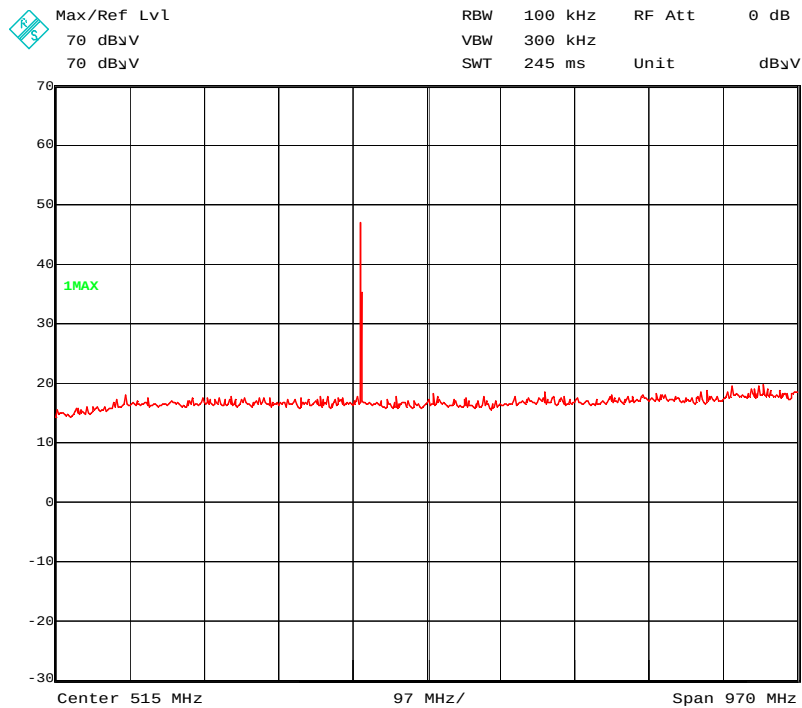
160575_1M-30M



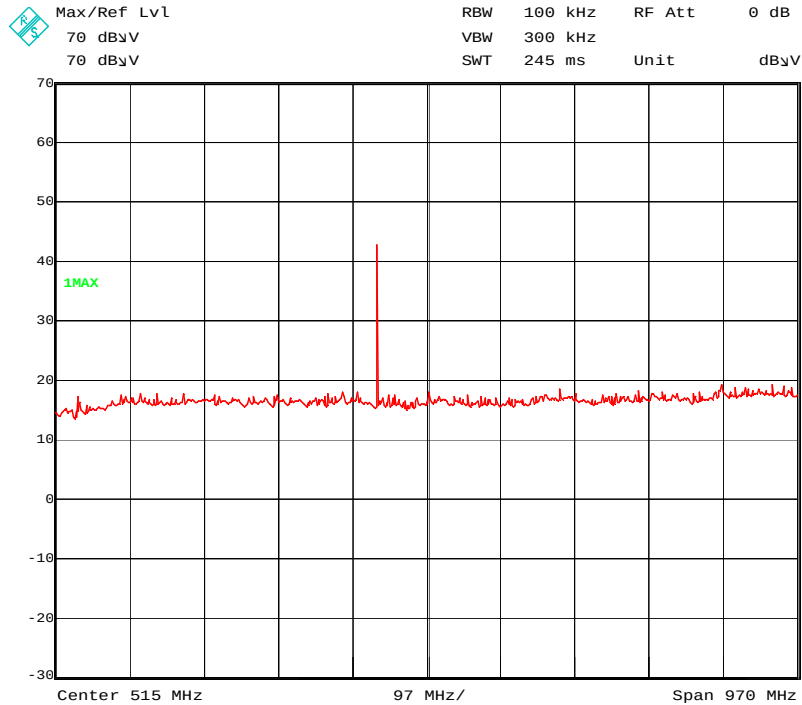
160575_406.5M_30M-1G



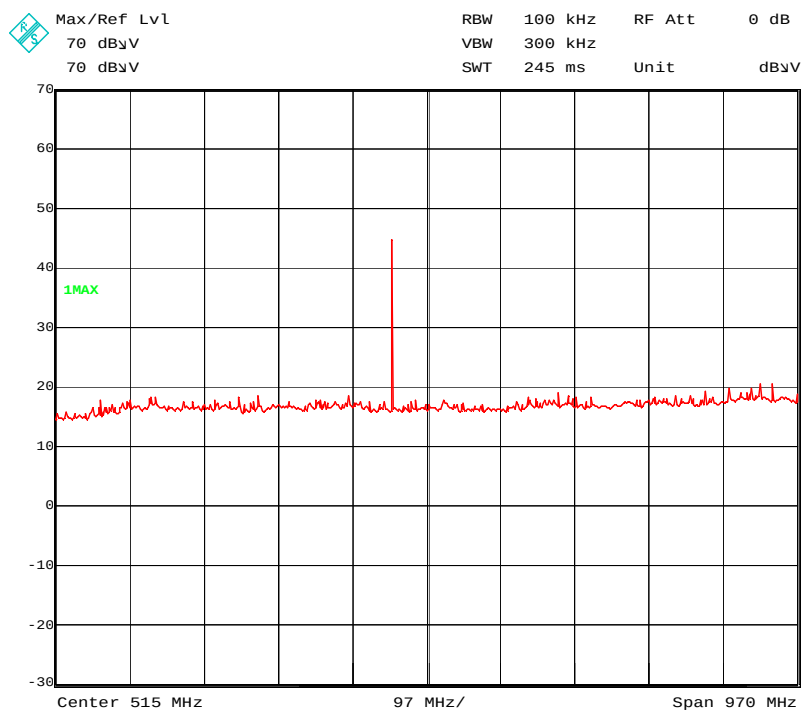
160575_429.5M_30M-1G



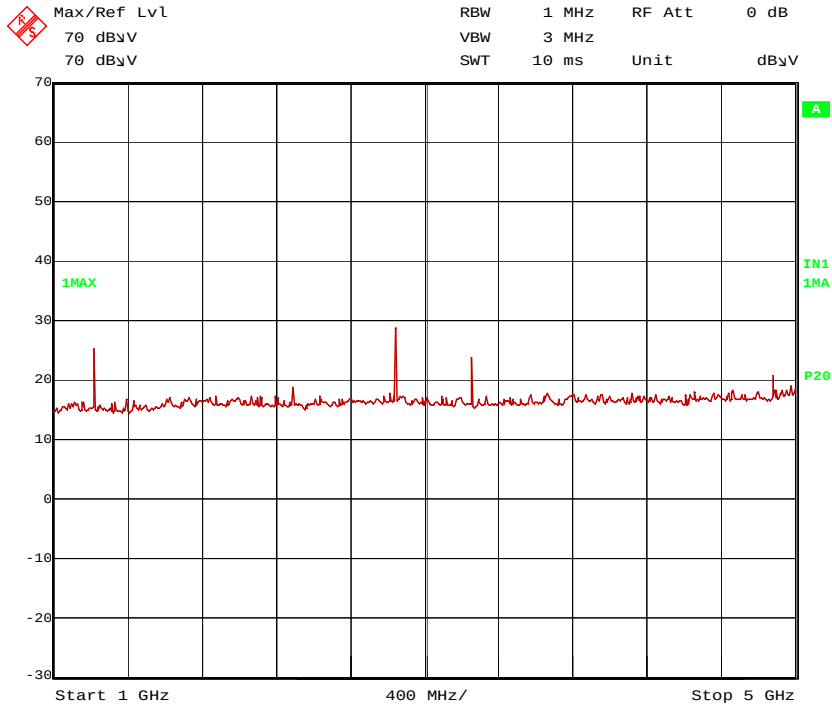
160575_450.5M_1M-30M



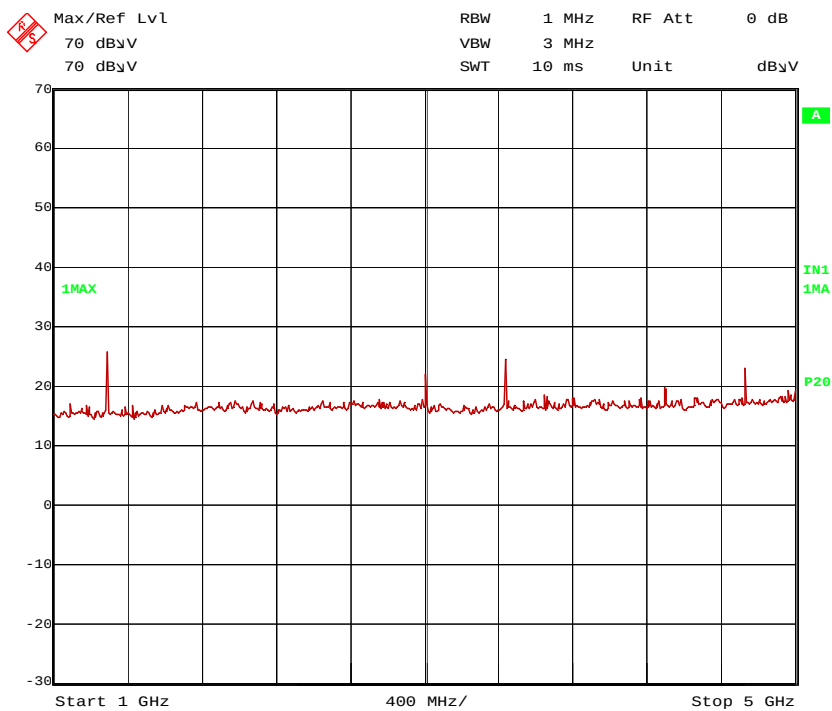
160575_469.5M_30M-1G



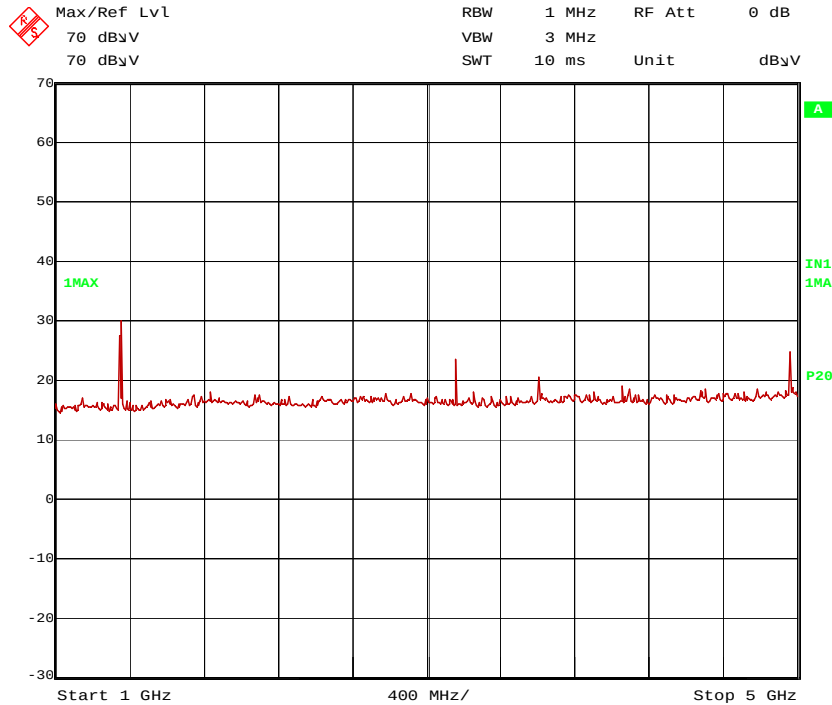
160575_406.5M_1G-5G_120°



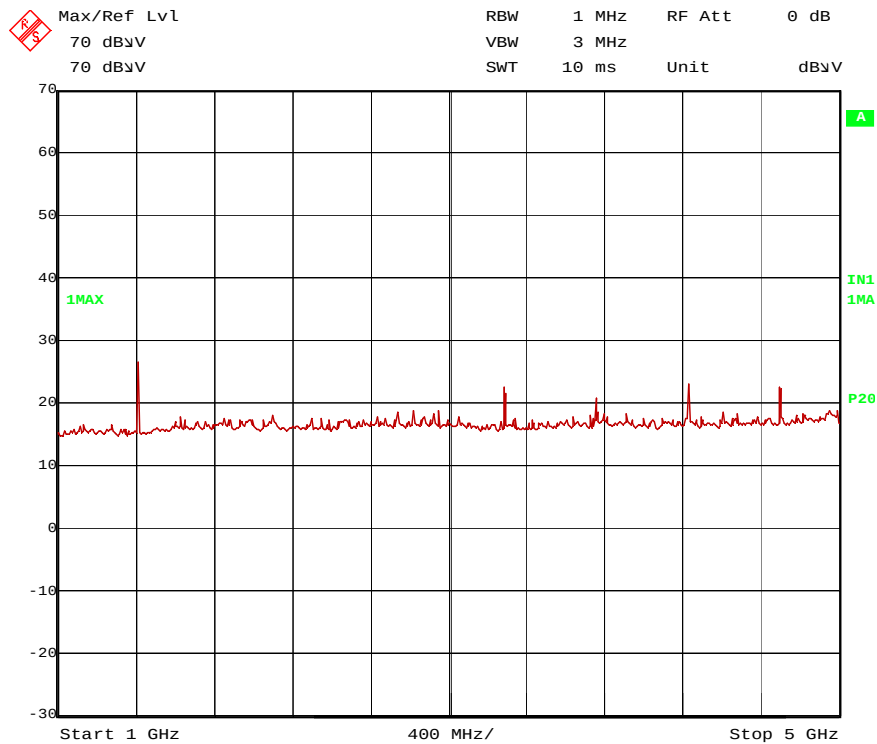
160575_429.5M_1G-5G_0°



160575_450.5M_1G-5G_120°



160575_469.5M_1G-5G_60°



The following frequencies were found during the preliminary radiated emission test:

1219.5 MHz, 1288.5 MHz, 1351.5 MHz, 1408.5 MHz, 2845.5 MHz, 3006.5 MHz, 3153.5 MHz,
3252.0 MHz, 3286.5 MHz, 3436.0 MHz, 3604.0 MHz, 3756.0 MHz, 4225.5 MHz, 4295.0 MHz,
4695.0 MHz, 4878.0 MHz, 4955.5 MHz

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

5.5.3 Final Results

5.5.3.1 Final radiated emission measurement (9 kHz to 1 GHz)

No emissions could be found in the preliminary measurement. Therefore no final measurement was performed.

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

Ambient temperature	22 °C	Relative humidity	72 %
---------------------	-------	-------------------	------

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.
Remark:	The antenna terminal was terminated with 50 ohms. Modulation was set to 16FSK.

5.5.3.3 Channel Spacing 12.5 kHz

Tx frequency: 406.5MHz										
Frequency [MHz]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Reading / dBuV	Antenna Factor [1/m]	Preamp [dB]	Cable Loss [dB]	Antenna Polarisation	Positioner Angle [°]	Turntable Angle [°]
1219.5	65.23	77.46	12.23	37.72	24.91	0.00	2.60	Hor.	0	114
2845.5	58.96	77.46	18.50	25.72	29.24	0.00	4.00	Vert.	120	10
3252.0	59.92	77.46	17.54	24.78	30.84	0.00	4.30	Vert.	60	328
4878.0	59.92	77.46	17.54	21.80	32.82	0.00	5.30	Vert.	120	360
Tx frequency: 429.5MHz										
Frequency [MHz]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Reading / dBuV	Antenna Factor [1/m]	Preamp [dB]	Cable Loss [dB]	Antenna Polarisation	Positioner Angle [°]	Turntable Angle [°]
1288.5	54.52	77.46	22.94	26.77	25.05	0.00	2.70	Hor.	60	315
3006.5	57.52	77.46	19.94	23.20	30.12	0.00	4.20	Hor.	0	349
3436.0	59.05	77.46	18.41	23.59	31.06	0.00	4.40	Vert.	0	336
4295.0	60.20	77.46	17.26	23.20	32.00	0.00	5.00	Vert.	60	15
Tx frequency: 450.5MHz										
Frequency [MHz]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Reading / dBuV	Antenna Factor [1/m]	Preamp [dB]	Cable Loss [dB]	Antenna Polarisation	Positioner Angle [°]	Turntable Angle [°]
1351.5	54.17	77.46	23.29	26.38	24.99	0.00	2.80	Hor.	120	269
3153.5	60.33	77.46	17.13	25.32	30.71	0.00	4.30	Vert.	30	360
3604.0	57.56	77.46	19.90	21.68	31.28	0.00	4.60	Vert..	60	22
4955.5	64.44	77.46	13.02	26.25	32.89	0.00	5.30	Vert.	120	8
Tx frequency: 469.5MHz										
Frequency [MHz]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Reading / dBuV	Antenna Factor [1/m]	Preamp [dB]	Cable Loss [dB]	Antenna Polarisation	Positioner Angle [°]	Turntable Angle [°]
1408.5	59.33	77.46	18.13	31.36	25.07	0.00	2.90	Hor.	120	308
3286.5	60.25	77.46	17.21	25.05	30.90	0.00	4.30	Hor.	150	323
3756.0	58.87	77.46	18.59	22.16	32.11	0.00	4.60	Hor.	120	321
4225.5	61.48	77.46	15.98	24.51	32.07	0.00	4.90	Vert.	60	15
4695.0	67.88	77.46	9.58	30.15	32.53	0.00	5.20	Hor.	0	227
Measurement uncertainty: +2.2 dB / -3.6 dB										

Limit:

The power of any emission on any frequency removed from the center 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 35 W carrier power: $50 + 10 \log (P)$ dB = $50 + 10 \log (35)$ dB = 65.44 dB

ERP limit for any emission: 45.44 dBm - 65.44 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 = 77.46 dBμV/m

Test: Passed

Test equipment used (refer clause 6):

8, 11 – 22, 24, 25, 27 - 36

5.5.3.4 Channel Spacing 25 kHz

Tx frequency: 406.5MHz										
Frequency [MHz]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Reading / dBuV	Antenna Factor [1/m]	Preamp [dB]	Cable Loss [dB]	Antenna Polarisation	Positioner Angle [°]	Turntable Angle [°]
1219.5	54.93	84.46	29.53	53.92	24.91	26.50	2.60	Vert.	0	358.00
2845.5	55.58	84.46	28.88	48.74	29.24	26.40	4.00	Vert.	120	192.00
3252.0	55.65	84.46	28.81	46.91	30.84	26.40	4.30	Vert.	60	29.00
4878.0	61.26	84.46	23.20	48.74	32.82	25.60	5.30	Vert.	120	360.00
Tx frequency: 429.5MHz										
Frequency [MHz]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Reading / dBuV	Antenna Factor [1/m]	Preamp [dB]	Cable Loss [dB]	Antenna Polarisation	Positioner Angle [°]	Turntable Angle [°]
1288.5	53.84	84.46	30.62	52.59	25.05	26.50	2.70	Hor.	60	269
3006.5	24.88	84.46	59.58	16.96	30.12	26.40	4.20	Vert.	0	0
3436.0	55.24	84.46	29.22	46.18	31.06	26.40	4.40	Hor.	0	223
4295.0	56.62	84.46	27.84	45.72	32.00	26.10	5.00	Vert.	60	15
Tx frequency: 450.5MHz										
Frequency [MHz]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Reading / dBuV	Antenna Factor [1/m]	Preamp [dB]	Cable Loss [dB]	Antenna Polarisation	Positioner Angle [°]	Turntable Angle [°]
1351.5	56.96	84.46	27.50	55.67	24.99	26.50	2.80	Hor.	120	265
3153.5	57.09	84.46	27.37	48.48	30.71	26.40	4.30	Vert.	30	351
3604.0	55.76	84.46	28.70	45.98	31.28	26.10	4.60	Vert.	60	311
4955.5	63.14	84.46	21.32	50.55	32.89	25.60	5.30	Vert.	120	354
Tx frequency: 469.5MHz										
Frequency [MHz]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Reading / dBuV	Antenna Factor [1/m]	Preamp [dB]	Cable Loss [dB]	Antenna Polarisation	Positioner Angle [°]	Turntable Angle [°]
1408.5	54.46	84.46	30.00	52.99	25.07	26.50	2.90	Hor.	120	300
3286.5	58.70	84.46	25.76	49.90	30.90	26.40	4.30	Vert.	150	320
3756.0	55.93	84.46	28.53	45.32	32.11	26.10	4.60	Hor.	120	320
4225.5	59.61	84.46	24.85	48.74	32.07	26.10	4.90	Hor.	60	360
4695.0	65.92	84.46	18.54	53.79	32.53	25.60	5.20	Hor.	0	227
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 35 W carrier power: $43 + 10 \log (P)$ dB = $43 + 10 \log (35)$ dB = 58.44 dB

ERP limit for any emission: 58.44 dBm - 65.44 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 = 84.46 dBμV/m

Test: Passed

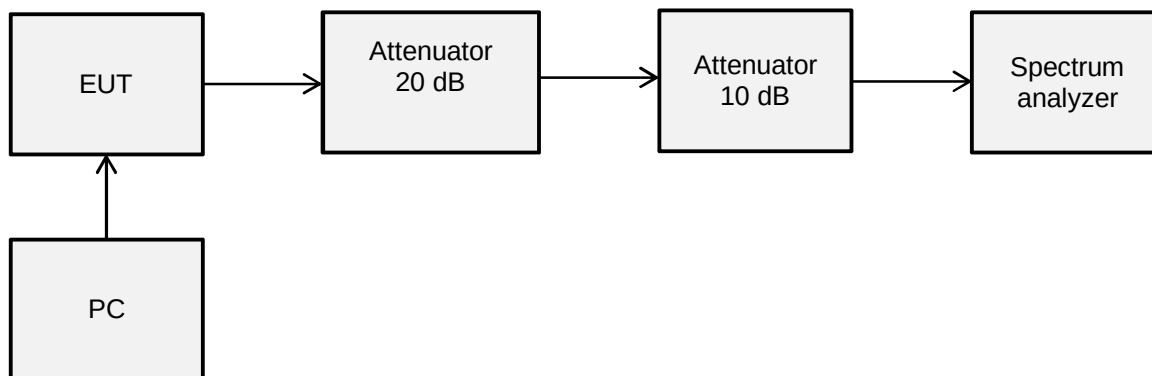
Test equipment used (refer clause 6):

8, 11 – 22, 24, 25, 27 - 36

5.6 Frequency Stability

5.6.1 Method of measurement

Test setup:



Test was performed at 406.5 MHz and 469.5 MHz at 35W unmodulated.

5.6.1.1 Test results

Ambient temperature	22 °C	Relative humidity	38 %
---------------------	-------	-------------------	------

Frequency stability versus voltage variations

Voltage	Frequency (MHz)		Frequency error		
	measured	nominal	(Hz)	(ppm)	Limit (ppm)
Nominal voltage (12 V)	406.499943	406.5	-57	-0.140	±1.5
85% of nominal voltage	406.499943	406.5	-57	-0.140	
115% of nominal voltage	406.499943	406.5	-57	-0.140	
Minimal voltage (9V)	406.499943	406.5	-57	-0.140	
Maximal voltage (16V)	406.499943	406.5	-57	-0.140	
Measurement uncertainty: $<10^{-7}$ (frequency), +0.66 dB / -0.72 dB (level)					

Voltage	Frequency (MHz)		Frequency error		
	measured	nominal	(Hz)	(ppm)	Limit (ppm)
Nominal voltage (12 V)	469.499936	469.5	-64	-0.136	±1.5
85% of nominal voltage	469.499936	469.5	-64	-0.136	
115% of nominal voltage	469.499936	469.5	-64	-0.136	
Minimal voltage (9V)	469.499936	469.5	-64	-0.136	
Maximal voltage (16V)	469.499936	469.5	-64	-0.136	
Measurement uncertainty: $<10^{-7}$ (frequency)					

Frequency stability versus voltage variations

Temperature (°C)	Frequency (MHz)		Frequency error		
	measured	nominal	(Hz)	(ppm)	Limit (ppm)
60	406.499938	406.5	-62	-0.153	±1.5
50	406.499937	406.5	-63	-0.155	
40	406.499938	406.5	-62	-0.153	
30	406.499938	406.5	-62	-0.153	
20	406.499943	406.5	-57	-0.140	
10	406.499896	406.5	-104	-0.256	
0	406.499848	406.5	-152	-0.374	
-10	406.499830	406.5	-170	-0.418	
-20	406.499765	406.5	-235	-0.578	
-30	406.499783	406.5	-217	-0.534	
Measurement uncertainty: <10 ⁻⁷ (frequency)					

Temperature (°C)	Frequency (MHz)		Frequency error		
	measured	nominal	(Hz)	(ppm)	Limit (ppm)
60	469.499933	469.5	-67	-0.143	±1.5
50	469.499932	469.5	-68	-0.145	
40	469.499928	469.5	-72	-0.153	
30	469.499928	469.5	-72	-0.153	
20	469.499936	469.5	-64	-0.136	
10	469.499896	469.5	-104	-0.222	
0	469.499873	469.5	-127	-0.271	
-10	469.499815	469.5	-185	-0.394	
-20	469.499718	469.5	-282	-0.601	
-30	469.499746	469.5	-254	-0.541	
Measurement uncertainty: <10 ⁻⁷ (frequency)					

Limit:

The equipment tested shall not deviate more than 1.5 ppm from the nominal frequency.

Test: Passed

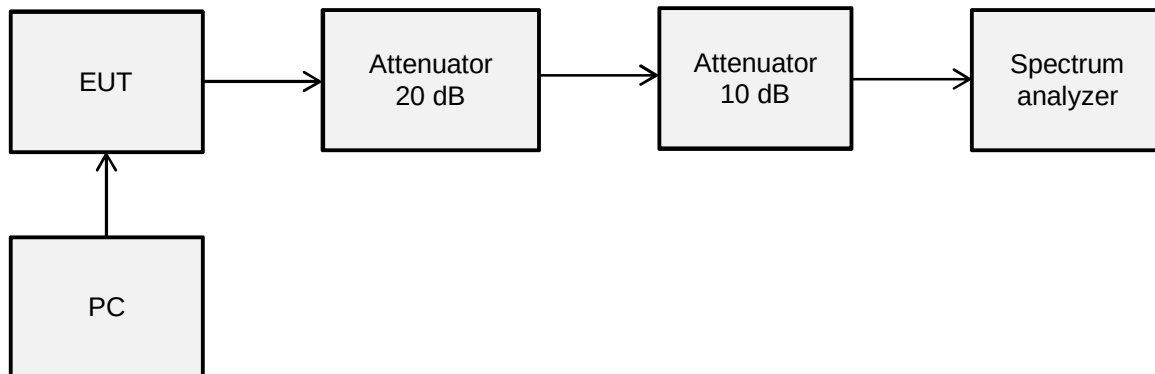
Test equipment used (refer clause 6):

23, 24, 29, 30, 35, 36

5.7 Transient frequency behaviour

5.7.1 Method of measurement

Test setup:



The following spectrum analyser settings were used:

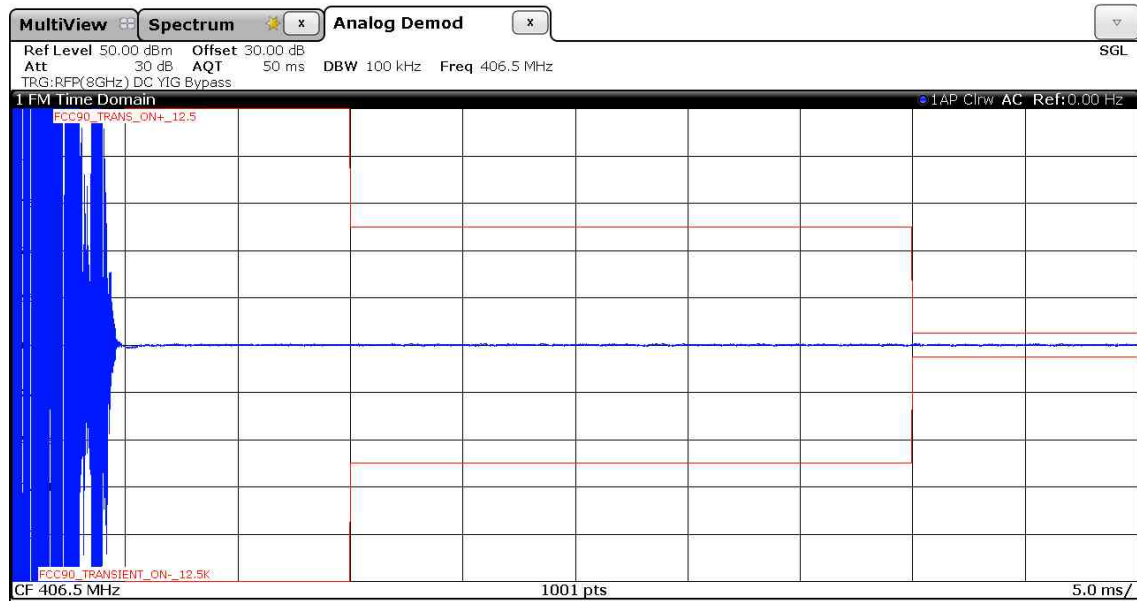
- Mode: Analog Demodulation
- Demodulation bandwidth: 100 kHz
- Video bandwidth: 500 kHz
- Sweep Mode: Single sweep
- Acquisition time: 50 ms
- Detector function: RMS
- Trace mode: Max hold

By the PC the EUT was set to transmit at 406.5 MHz and 469.5 MHz unmodulated. The output power was set to 35W and the channel spacing to 12.5 kHz and 25 kHz.

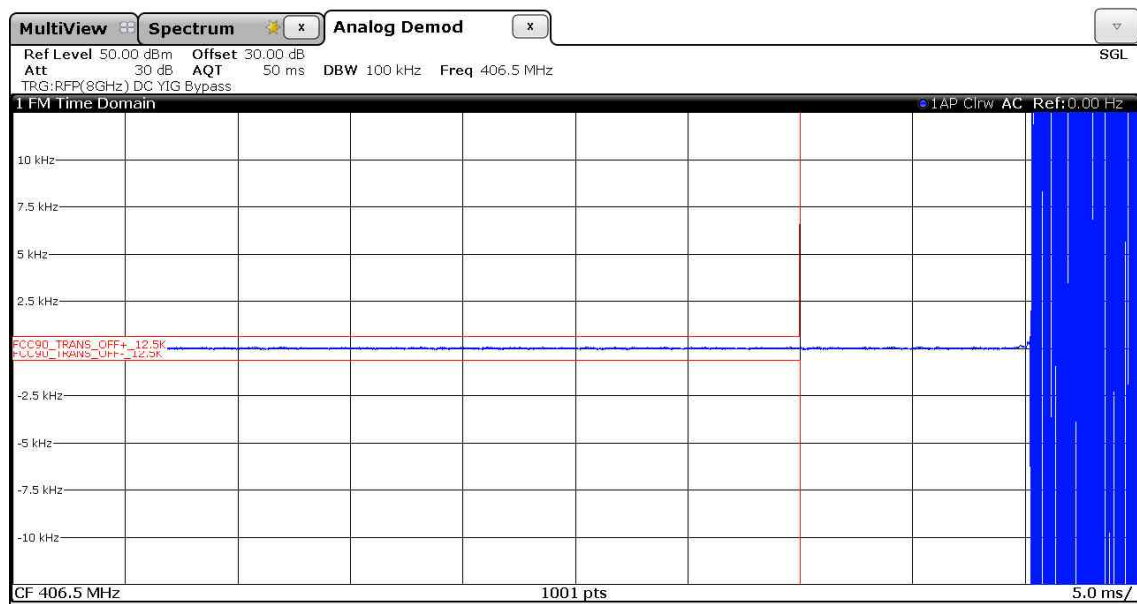
5.7.2 Test Results

Ambient temperature	22 °C	Relative humidity	38 %
---------------------	-------	-------------------	------

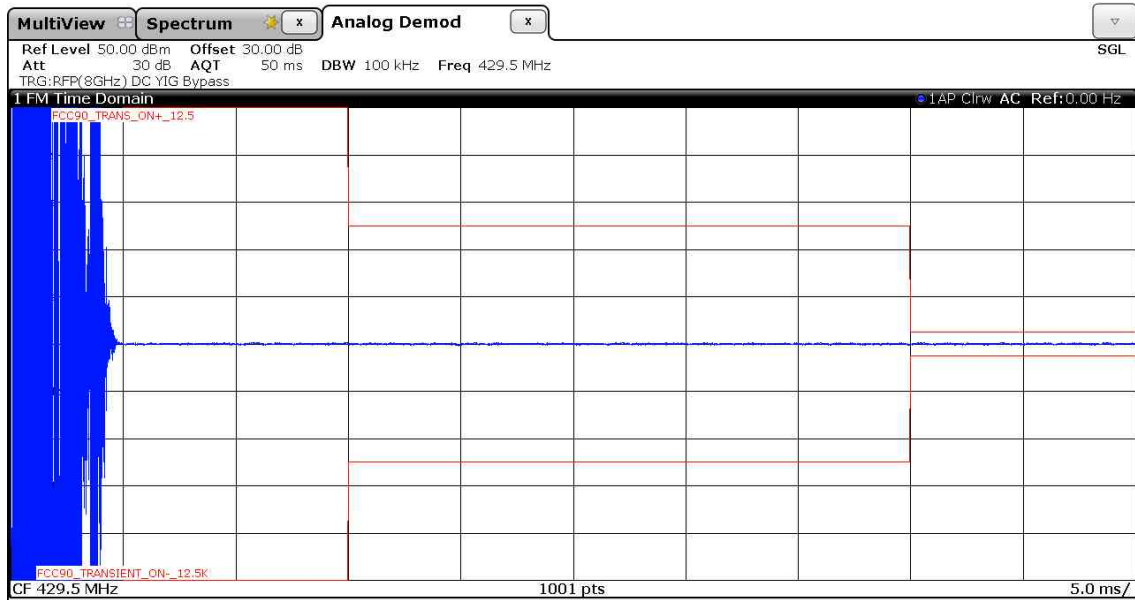
160575_transient_on_406.5M_12.5k_35W



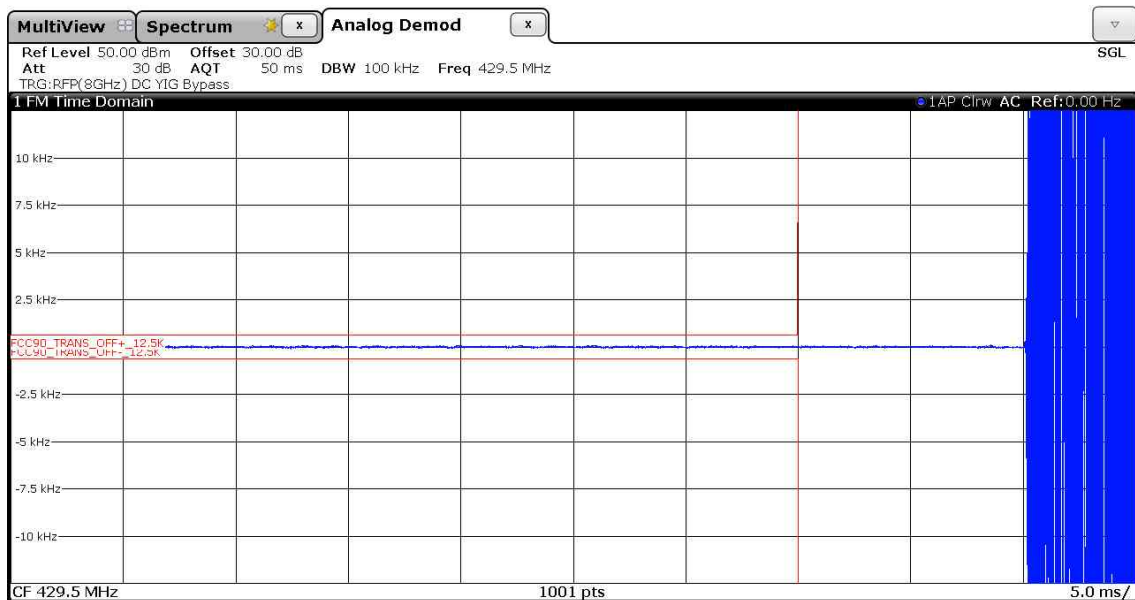
160575_transient_off_406.5M_12.5k_35W



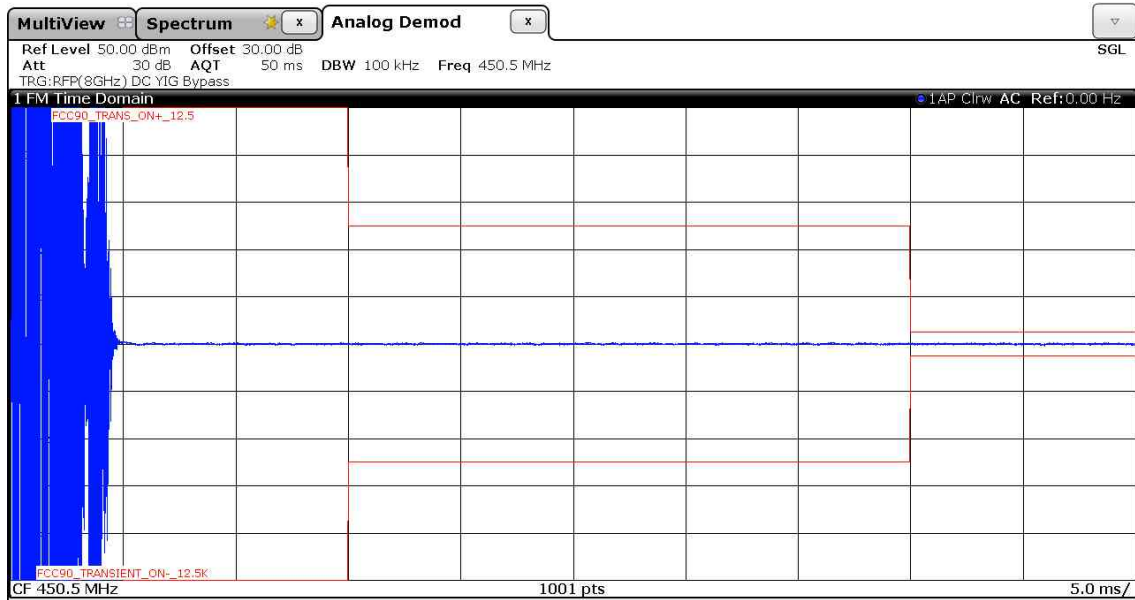
160575_transient_on_429.5M_12.5k_35W



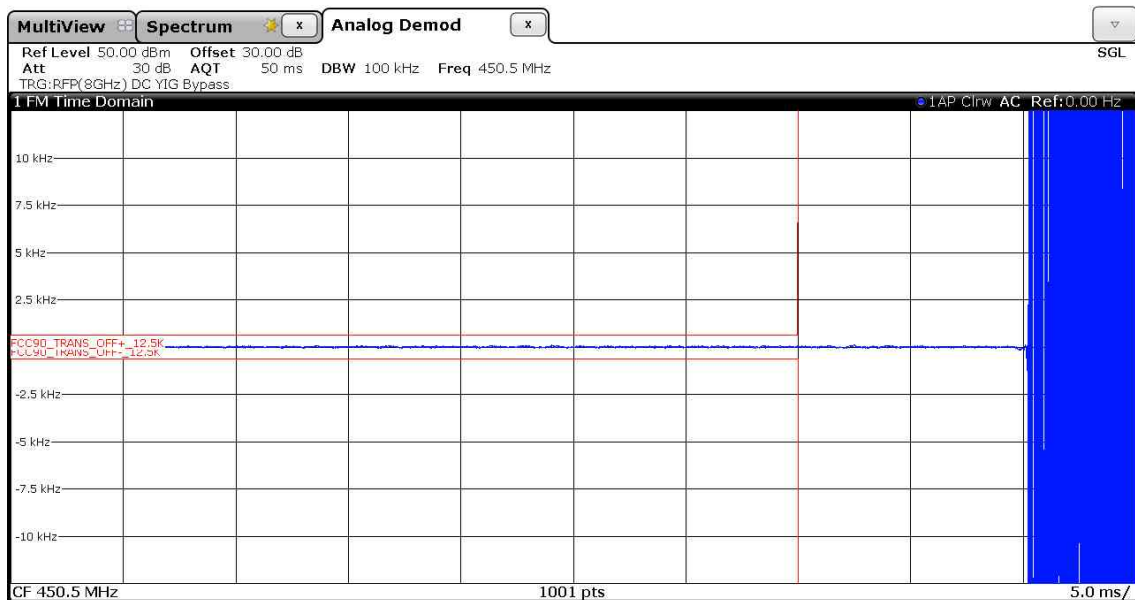
160575_transient_off_429.5M_12.5k_35W



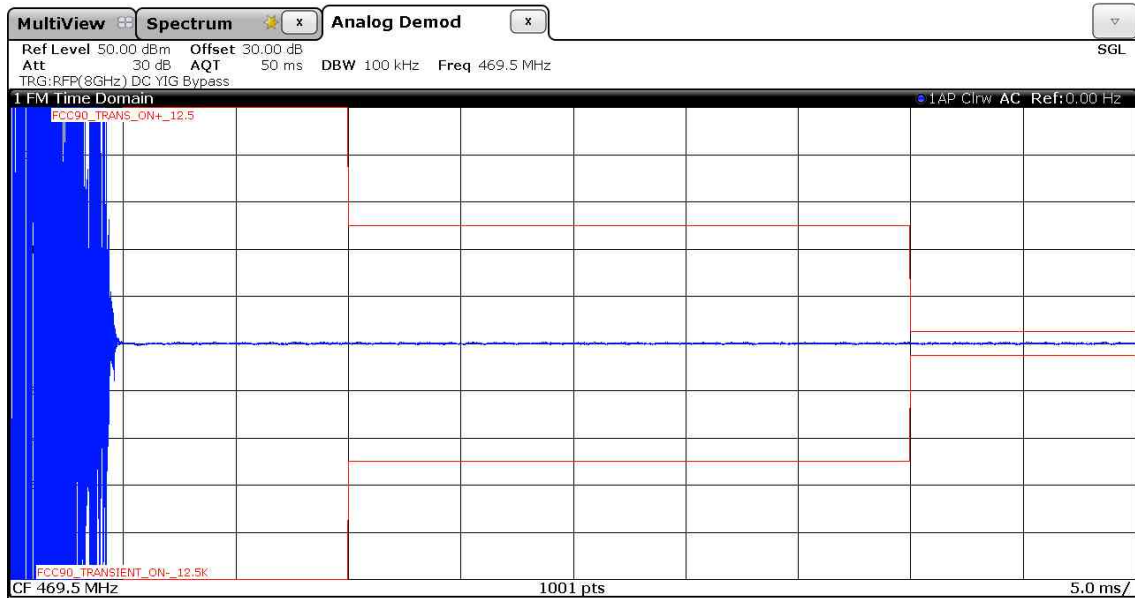
160575_transient_on_450.5M_12.5k_35W



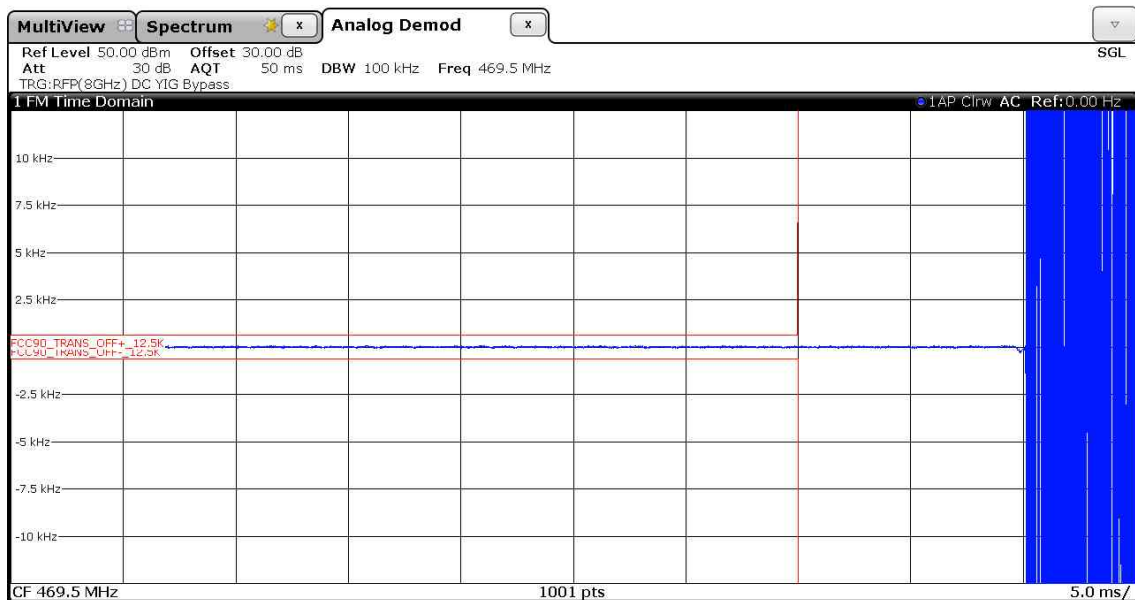
160575_transient_off_450.5M_12.5k_35W



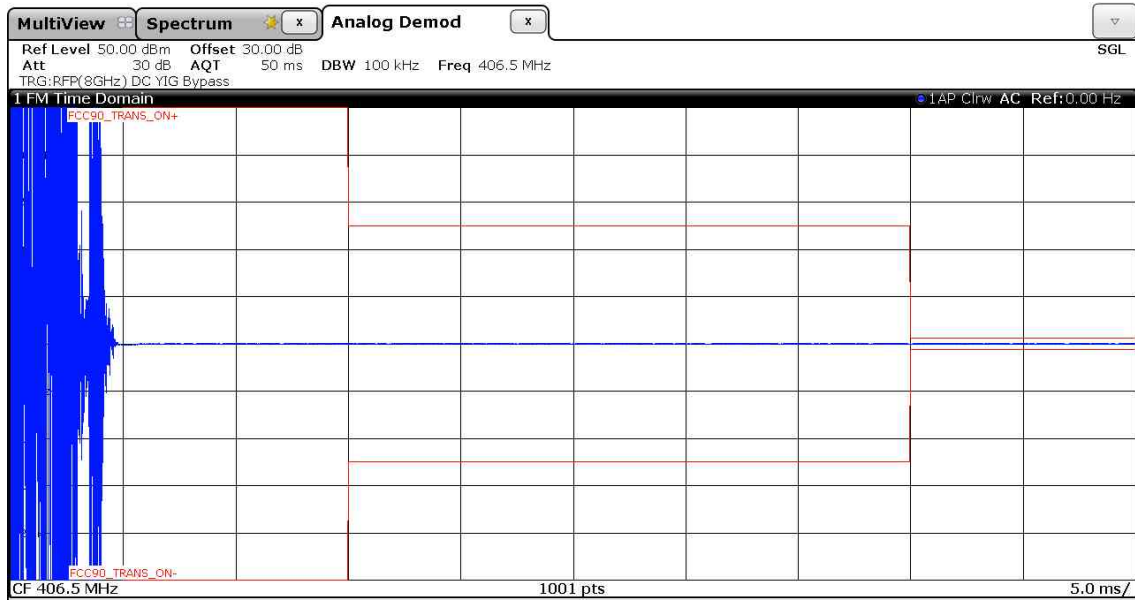
160575_transient_on_469.5M_12.5k_35W



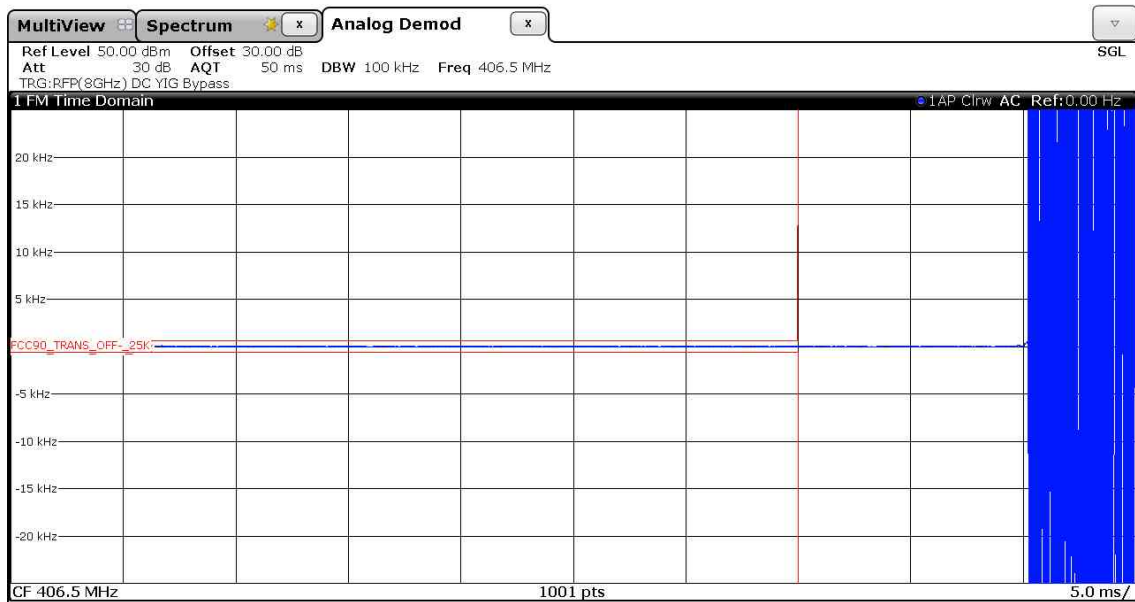
160575_transient_off_469.5M_12.5k_35W



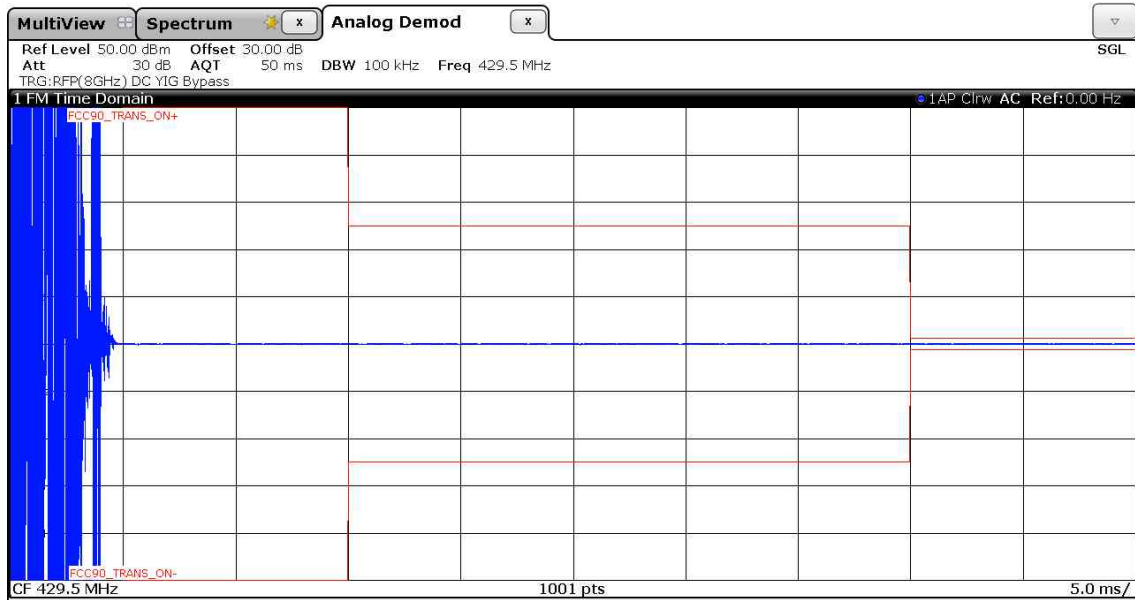
160575_transient_on_406.5M_25k_35W



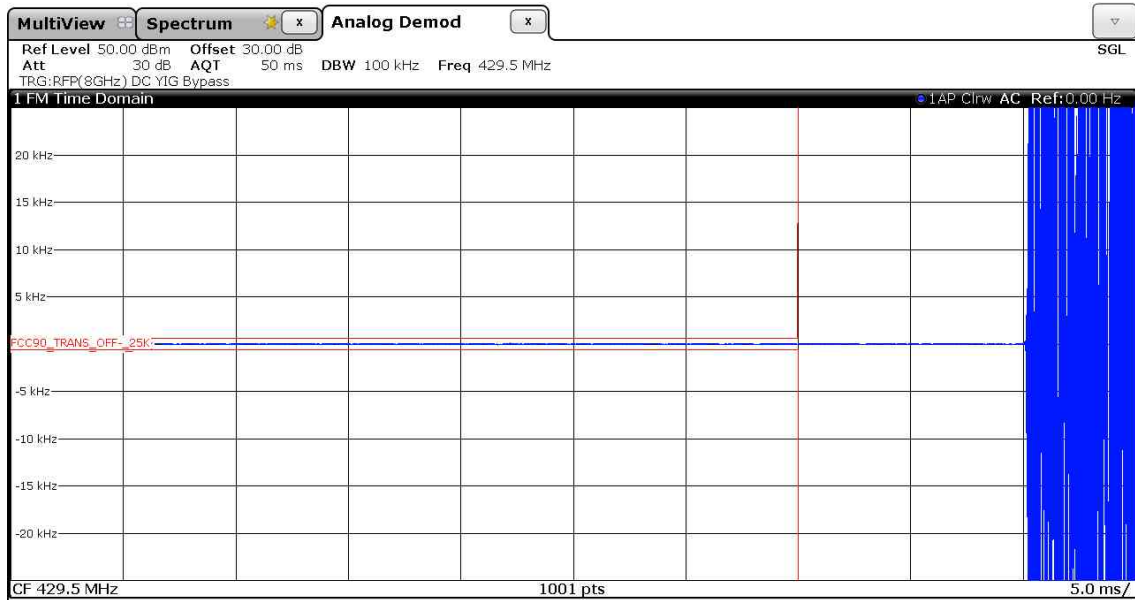
160575_transient_off_406.5M_25k_35W



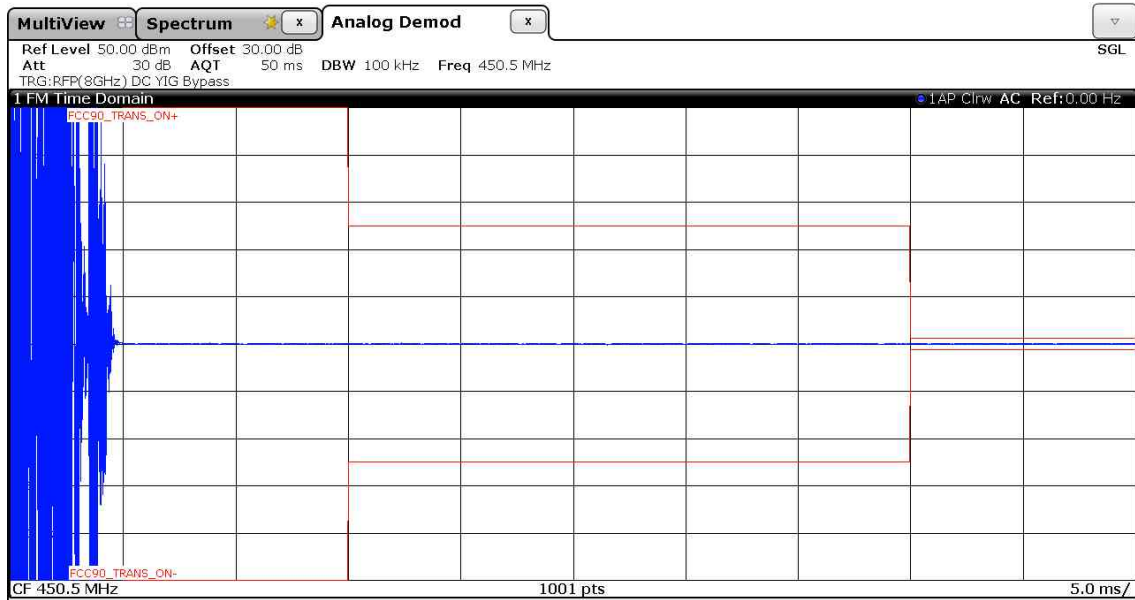
160575_transient_on_429.5M_25k_35W



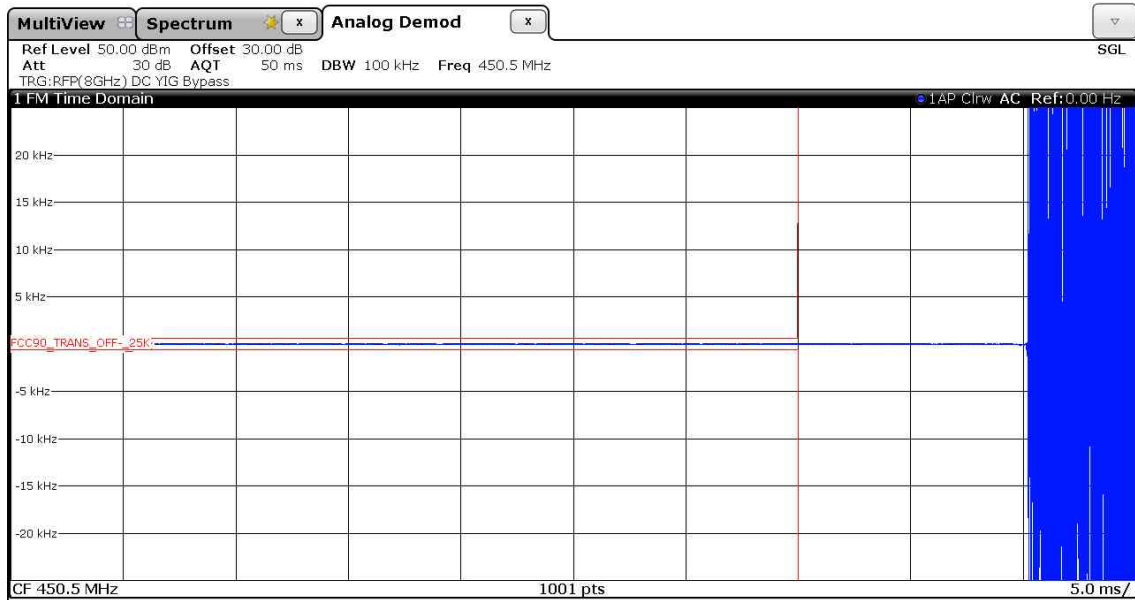
160575_transient_off_429.5M_25k_35W



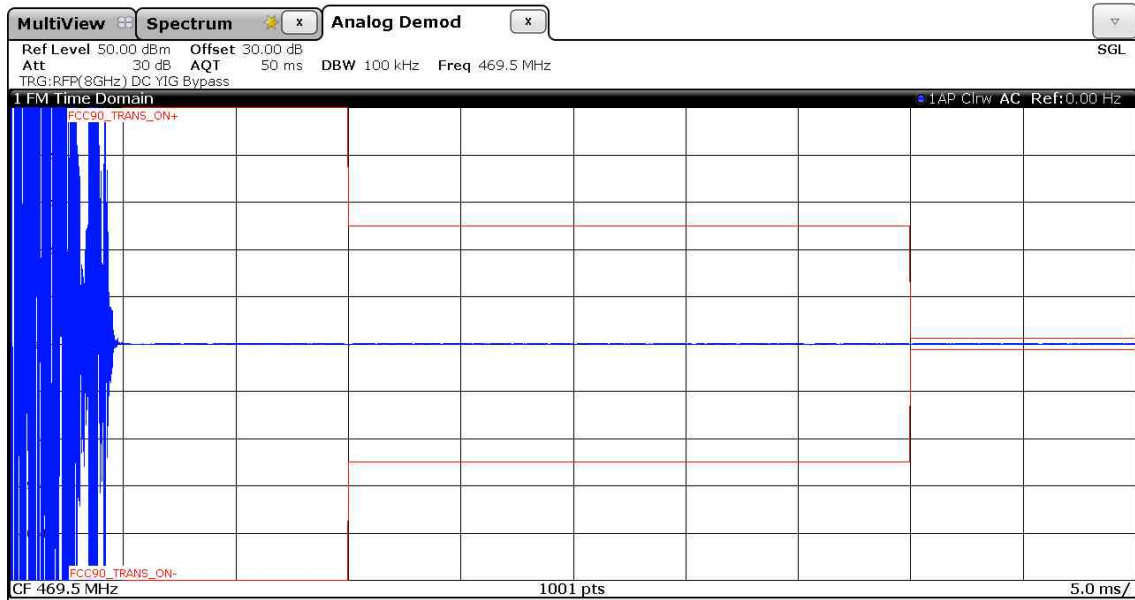
160575_transient_on_450.5M_25k_35W



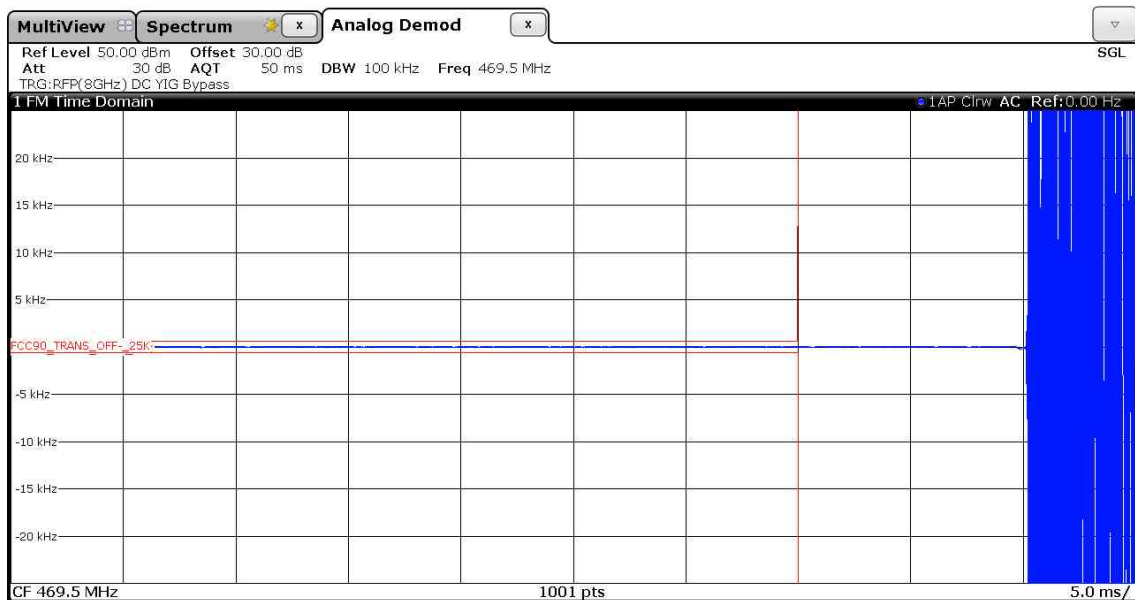
160575_transient_off_450.5M_25k_35W



160575_transient_on_469.5M_25k_35W



160575_transient_off_469.5M_25k_35W



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):

23, 24, 29, 30, 35, 36

6 Test equipment used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Open area test site	-	Phoenix Testlab	-	480085	Weekly verification (system cal.)	
2	Measuring receiver	ESIB7	Rohde & Schwarz	100304	480521	02.03.2015	03/2017
3	Controller	HD100	Deisel	100/670	480139	-	-
4	Turntable	DS420HE	Deisel	420/620/80	480087	-	-
5	Antenna support	AS615P	Deisel	615/310	480086	-	-
6	Antenna	CBL6111 D	Chase	25761	480894	-	-
7	EMI Software	EMC32	Rohde & Schwarz	100061	481022	-	-
8	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
11	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02.03.2015	03/2017
12	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
13	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
14	Antenna support	AS615P	Deisel	615/310	480187	-	-
15	Positioner	TDF 1.5	Maturo	15920215	482034	-	-
16	Antenna	CBL6112 B	Chase	2688	480328	14.04.2014	04/2017
17	Horn Antenna	3115 A	EMCO	9609-4918	480183	10.11.2014	11/2017
18	High Pass Filter	WHJS1000C11/6 OEF	Wainwright Instruments GmbH	1	480413	Monthly verification (system cal.)	
19	RF-cable No. 36	Sucoflex 106B	Huber + Suhner	-	480865	Weekly verification (system cal.)	
20	RF-cable No. 3	Sucoflex 106B	Suhner	0563/6B	480670	Weekly verification (system cal.)	
21	RF-cable No. 40	Sucoflex 106B	Suhner	0708/6B	481330	Weekly verification (system cal.)	
22	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	29.02.2016	02/2018
23	Spectrum analyser	FSW43	Rohde & Schwarz	100586	481720	24.02.2016	02/2018
24	Notebook	Lifebook E780	Fujitsu	YL4A022034	201167	-	-
25	Low Pass Filter	TP-250	Dirk Fischer Elektronik	-	480582	Check prior to use	
26	High Pass Filter	WHF800-6HH/1000	Wainwright Instruments GmbH	3	480954	Check prior to use	
27	Notch Filter	TTR 375-3EE	Telonic	375-3EE	480330	Check prior to use	
28	High Pass Filter	WHJS1000C11/6 OEF	Wainwright Instruments GmbH	1	480413	Monthly verification (system cal.)	
29	Coaxial-Attenuator	WA47-20-34	Weinschel	A1169	481452	25.08.2015	08/2016
30	Coaxial-Attenuator	WA8/18-10-34	Weinschel	-	481449	25.08.2015	08/2016
31	Precision dipole	HZ-12	Rohde & Schwarz	831781/02	480061	-	
32	Precision dipole	HZ-13	Rohde & Schwarz	831782/02	480062	-	
33	Horn Antenna	3115 B	EMCO	9609-4922	480184	18.09.2014	09/2017
34	Swept CW generator	83650L	Agilent	3844A00554	480333	25.02.2015	02/2017
35	Power Supply	TOE8871	Toellner Electronic	61008	480835	11.01.2016	01/2018
36	Multimeter	971A	Hewlett Packard	JP40010640	480724	19.01.2016	01/2018

7 Report history

Report Number	Date	Comment
F154676E1	21.06.2016	Document created
-	-	-
-	-	-

8 List of annexes

ANNEX A	TEST SETUP PHOTOS	4 pages
	160575_01.JPG: Test setup - Radiated emission (fully anechoic chamber)	
	160575_02.JPG: Test setup - Radiated emission (fully anechoic chamber)	
	160575_03.JPG: Test setup - Radiated emission (fully anechoic chamber)	
	160575_04.JPG: Temperature chamber	
ANNEX B	EXTERNAL PHOTOS	4 pages
	160575_05.jpg: Front view of the EUT	
	160575_06.jpg: Side view 1 of the EUT	
	160575_07.jpg: Side view 2 of the EUT	
	160575_08.jpg: Backside view of the EUT	
	160575_09.jpg: Top view of the EUT	
	160575_10.jpg: Bottom view of the EUT	
ANNEX C	INTERNAL PHOTOS	17 pages
	160575_11.jpg: EUT - cabinet opened	
	160575_12.jpg: EUT - DC power supply board, display board and DC / RS 232 board removed	
	160575_13.jpg: EUT - DC / RS232 connection board, top view	
	160575_14.jpg: EUT - DC / RS232 connection board, top view	
	160575_15.jpg: EUT - DC power supply board, top view	
	160575_16.jpg: EUT - DC power supply board, bottom view	
	160575_17.jpg: EUT - Connector board, top view	
	160575_18.jpg: EUT - Connector board, bottom view	
	160575_19.jpg: EUT - Display board, top view	
	160575_20.jpg: EUT - Display board, top view, display removed *	
	160575_21.jpg: EUT - Display board, bottom view	
	160575_22.jpg: EUT - PA board, top view	
	160575_23.jpg: EUT - PA board, bottom view	
	160575_24.jpg: EUT - Modem board, top view	
	160575_25.jpg: EUT - Modem board, bottom view	
	160575_26.jpg: EUT - Modem board, top view, shielding removed *	
	160575_27.jpg: EUT - Modem board, bottom view, shielding removed *	
	160575_28.jpg: EUT - DC power cable	
	160575_29.jpg: EUT - RS 232 cable	

* Photo supplied by the applicant