Report Reference ID:	374942TRFWL

Test specification:	Title 47 – Telecommunication Chapter I – Federal Communications Commission Part 22 – Public mobile services Part 90 – Private land mobile radio services

Applicant:	**Leonardo Spa** P.zza Monte Grappa, 4 – 00195 Roma (RM) – Italy
Apparatus:	RadioBase Station for fixed installation
Model:	ECOS-D RBS4000C V3025WA1C14W2E100S1V2G2-111
FCC ID:	2ATWB-F567C-LP

Testing laboratory:	**Nemko Spa** Via del Carroccio, 4 – 20853 Biassono (MB) – Italy

	Name, function and signature	**Date**
Tested by:	P. Barbieri (project handler)	2019-07-03
Reviewed by:	R. Giampaglia (verifier)	2019-07-03

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Section 1: Report summary

1.1 Test specification

Specifications	FCC Part 22 – Public mobile services FCC Part 90 – Private land mobile radio services

1.2 Statement of compliance

Compliance	In the configuration tested the EUT was found compliant Yes ☒ No ☐ This report contains an assessment of apparatus against specifications based upon tests carried out on samples submitted at Nemko Spa. These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 22 and 90. The tests were conducted in accordance with ANSI C63.26-2015.

1.3 Exclusions

Exclusions	None

1.4 Registration number

Test site:	FCC ID number 682159 (10 m Semi anechoic chamber)

1.5 Test report revision history

Revision #	Details of changes made to test report
374942TRFWL	Original report issued

1.6 Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report. This test report has been completed in accordance with the requirements of ISO/IEC 17025. Nemko Spa authorizes the applicant to reproduce this report provided it is reproduced in its entirety and for use by the company's employees only. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Nemko Spa accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Section 2: Summary of test results

2.1 FCC Part 90: Test results

Part	Test method	Test description	Result
§90.205	§2.1046	Output power	Pass
§90.207	§2.1047	Modulation characteristics	Pass
§90.209	§2.1049	Occupied bandwidth	Pass
§90.210	§2.1051	Emission masks	Pass
§90.210	§2.1051	Spurious emissions at antenna terminals	Pass
§90.210	§2.1053	Field strength of spurious radiation	Pass
§90.213	§2.1055	Frequency stability	Pass
§90.214	---	Transient Behaviour	Pass
Notes: None			

2.2 FCC Part 22: Test results

Part	Test method	Test description	Result
§22.565	§2.1046	Output power	Pass
§22.359	§2.1051	Emission masks	Pass
§22.359	§2.1051	Spurious emissions at antenna terminals	Pass
§22.359	§2.1053	Field strength of spurious radiation	Pass
§22.355	§2.1055	Frequency stability	Pass
Notes: None			

2.3 FCC general requirements results

Part	Test method	Test description	Result
§15.31	--	Number of tested frequencies	Pass

Section 3: Equipment under test

3.1 Applicant details

Name:	Leonardo Spa
Address:	P.zza Monte Grappa, 4
City:	Roma
Province/State:	RM
Post code:	00195
Country:	Italy
FRN:	0028621795

3.2 Manufacturer details

Name:	Leonardo Spa
Address:	P.zza Monte Grappa, 4
City:	Roma
Province/State:	RM
Post code:	00195
Country:	Italy
FRN:	0028621795

3.3 Identification of equipment under test (EUT)

Type of equipment:	RadioBase Station for fixed installation
Product marketing name:	ECOS-D RBS4000C V3025WA1C14W2E100S1V2G2-111
Part number:	145-0539/01
Serial number:	00306068
FCC ID:	2ATWB-F567C-LP
Date of receipt:	2019-06-18

3.4 Accessories and support equipment

The following information identifies accessories used to exercise the EUT during testing:

Item # 1	
Type of equipment:	DC power supply
Brand name:	Elind
Model name or number:	60HL
Serial number:	3.542
Connection port:	DC
Cable length and type:	2 m two wires cable
Item # 2	
Type of equipment:	Receiver (Radiocommunication Tester)
Brand name:	R&S
Model name or number:	CMT
Serial number:	883152/001
Connection port:	TX OUT and BF TX
Cable length and type:	1 m coaxial cables

3.5 EUT description

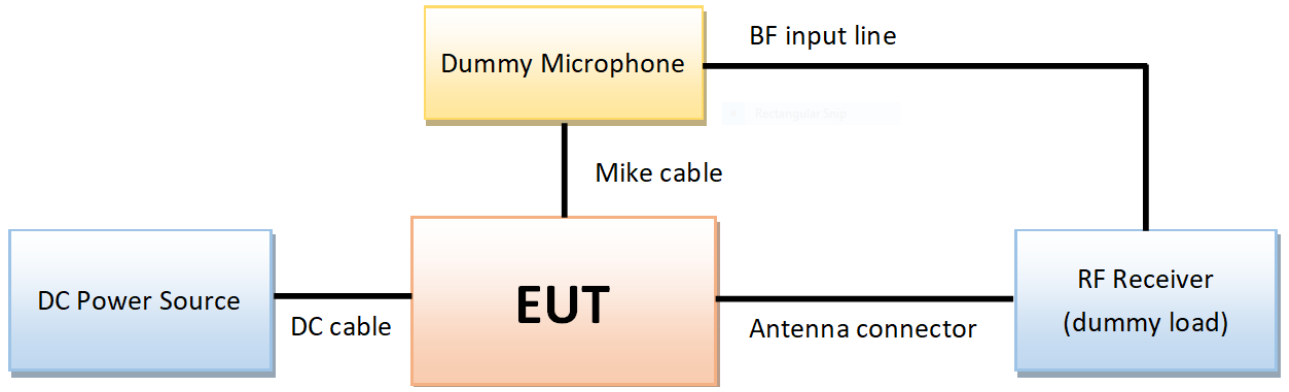
The EUT is a radio base station for fixed installation. The RBS is composed by the following modules:

- "Power Amplifier" (PA) module representing the final amplification stage.
- "Voltage converter" (DC/DC) module is a DC power voltage converter from an external power source (48Vdc) to the necessary voltages for the operation of the RBS modules.
- "Vectorial transceiver" (RTX) module, in VHF range equipped with an I&Q modulator and demodulator.
- "Power Supply" (SWITCH) module that generates and distributes the power supply (both the 7 Vdc and the 13.2 Vdc) to the whole RBS.
- "RBS Simulcast Controller" (CORE) module which is able to performs the voting process, manages the incoming signal, allows the local listening/monitoring of the incoming signals, allows the RBS remote control, provides an Ethernet 10/100 Base-T interface, supplies the 4W+E&M interface towards external analogical dispatcher when serving analog modulation, generates the reference synchronization signal and manages a piggy-back board

3.6 Technical specifications of the EUT

Operating frequency:	150 ÷ 174 MHz for US market
Modulation type:	FM with channel bandwidth 12.5 kHz / 25 kHz (voice) 4FSK 9600 bps with channel bandwidth 12.5 kHz (voice and data) C4FM with channel bandwidth 12.5 kHz (voice and data)
Occupied bandwidth:	12.5 kHz / 25 kHz
Channel step:	5 kHz – 6.25 kHz
Emission designator:	16K0F3E, 11K0F3E, 7K60FXE and 8K0F1E
RF output power:	25 W
Antenna type:	External Antenna (not provided)
Power source	External 48 V DC or 13.2 V DC

3.7 EUT setup diagram



3.8 Operation of the EUT during testing

The EUT has been tested in TX mode at maximum power, with the antenna connector closed on a 50 Ω dummy load.

3.9 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

Section 4: Test conditions

4.1 Deviations from laboratory tests procedures

No deviations were made from laboratory test procedures.

4.2 Test conditions, power source and ambient temperatures

Normal temperature, humidity and air pressure test conditions	Unless different values are declared in the test case, following ambient conditions apply for the tests: Temperature: 18 ÷ 33 °C Relative humidity: 30 ÷ 60 % Air pressure: 980 ÷ 1060 hPa When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.
Power supply range:	The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

4.3 Equipment used for the monitoring of the environmental conditions

Equipment	Manufacturer	Model	Serial N°
Thermohygrometer data loggers	Testo	175-H2	20012380/305
Thermohygrometer data loggers	Testo	175-H2	38203337/703
Barometer	MSR	MSR145B	330080

4.4 Measurement uncertainty

EUT	Type	Test	Range and Setup features	Measurement Uncertainty	Notes
Transmitter	Conducted	Frequency error	0.001 MHz ÷ 40 GHz	0.08 ppm	(1)
		Carrier power RF Output Power	10 kHz ÷ 30 MHz	1.0 dB	(1)
			30 MHz ÷ 18 GHz	1.5 dB	(1)
			18 MHz ÷ 40 GHz	3.0 dB	(1)
		Adjacent channel power	1 MHz ÷ 18 GHz	1.6 dB	(1)
		Conducted spurious emissions	10 kHz ÷ 26 GHz	3.0 dB	(1)
			26 GHz ÷ 40 GHz	4.5 dB	(1)
		Intermodulation attenuation	1 MHz ÷ 18 GHz	2.2 dB	(1)
		Attack time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Attack time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Release time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Release time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Transient behaviour of the transmitter– Transient frequency behaviour	1 MHz ÷ 18 GHz	0.2 kHz	(1)
		Transient behaviour of the transmitter – Power level slope	1 MHz ÷ 18 GHz	9%	(1)
		Frequency deviation - Maximum permissible frequency deviation	0.001 MHz ÷ 18 GHz	1.3%	(1)
		Frequency deviation - Response of the transmitter to modulation frequencies above 3 kHz	0.001 MHz ÷ 18 GHz	0.5 dB	(1)
		Dwell time	-	3%	(1)
		Hopping Frequency Separation	0.01 MHz ÷ 18 GHz	1%	(1)
		Occupied Channel Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
		Modulation Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
	Radiated	Radiated spurious emissions	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 40 GHz	8.0 dB	(1)
		Effective radiated power transmitter	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26,5 GHz ÷ 40 GHz	8.0 dB	(1)
Receiver	Radiated	Radiated spurious emissions	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 40 GHz	8.0 dB	(1)
		Sensitivity measurement	1 MHz ÷ 18 GHz	6.0 dB	(1)
	Conducted	Conducted spurious emissions	10 kHz ÷ 26 GHz	3.0 dB	(1)
			26 GHz ÷ 40 GHz	4.5 dB	(1)

(1) The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2 which has been derived from the assumed normal probability distribution with infinite degrees of freedom and for a coverage probability of 95 %

4.5 Test equipment

Equipment	Manufacturer	Model	Serial N°	Cal Date	Due Date
Trilog Broadband Antenna	Schwarzbeck	VULB 9162	9162-025	2018-07	2021-07
Bilog antenna (1 ÷ 18 GHz)	Schwarzbeck	STLP 9148	9148-123	2018-07	2021-07
Broadband preamplifier	Schwarzbeck	BBV 9718	9718-137	2018-08	2019-08
EMI receiver (20 Hz ÷ 8 GHz)	Rohde & Schwarz	ESU8	100202	2019-01	2020-01
Spectrum analyzer (20 Hz ÷ 8 GHz)	Rohde & Schwarz	FSEK	848255/005	2018-02	2020-02
EMI receiver (9 kHz ÷ 3 GHz)	Rohde & Schwarz	ESCI	100888	2018-09	2019-09
Signal generator	Rohde & Schwarz	SMBV100A	263397	2018-09	2019-09
Signal generator	Rohde & Schwarz	SMBV100A	263254	2019-03	2020-03
Semi-anechoic chamber	Nemko	10 m semi-anechoic chamber	530	NSC	--
Shielded room	Siemens	10 m control room	1947	NSC	--
Radiocommunication Tester	R&S	CMT	883152/001	2018-01	2021-01
Climatic chamber	Espec	ARS-1100	4100000067	2018-11	2019-11
Oscilloscope	Yokogawa	DL1740£	27D904989	2019-03	2020-03
Note: N/A = Not Applicable, NCR = No Cal Required, COU = CAL On Use					

Appendix A: Test results

Clause 15.31 Number of frequencies

(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz or less	1	Middle.
1 to 10 MHz	2	1 near top and 1 near bottom.
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom.

Test date: 2019-06-28

Test results: Pass

Test data

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz
150	174	24

Test data

Low channel, MHz	Mid channel, MHz	High channel, MHz
150.9	162.0	173.3

Clause 90.205 and 22.565 Output power

§90.205 Power and antenna height limits.
Applicants for licenses must request and use no more power than the actual power necessary for satisfactory operation. Except where otherwise specifically provided for, the maximum power that will be authorized to applicants whose license applications for new stations are filed after August 18, 1995 is as follows: (d) 150-174 MHz.

(1) The maximum allowable station ERP is dependent upon the station's antenna HAAT and required service area and will be authorized in accordance with table 1. Applicants requesting an ERP in excess of that listed in table 1 must submit an engineering analysis based upon generally accepted engineering practices and standards that includes coverage contours to demonstrate that the requested station parameters will not produce coverage in excess of that which the applicant requires.

(2) Applications for stations where special circumstances exist that make it necessary to deviate from the ERP and antenna heights in Table 1 will be submitted to the frequency coordinator accompanied by a technical analysis, based upon generally accepted engineering practices and standards, that demonstrates that the requested station parameters will not produce a signal strength in excess of 37 dBu at any point along the edge of the requested service area. The coordinator may then recommend any ERP appropriate to meet this condition.

(3) An applicant for a station with a service area radius greater than 40 km (25 mi) must justify the requested service area radius, which will be authorized only in accordance with table 1, note 4. For base stations with service areas greater than 80 km, all operations 80 km or less from the base station will be on a primary basis and all operations outside of 80 km from the base station will be on a secondary basis and will be entitled to no protection from primary operations.

TABLE 1—150-174MHZ—MAXIMUM ERP/REFERENCE HAAT FOR A SPECIFIC SERVICE AREA RADIUS

	Service area radius (km)									
	3	**8**	**13**	**16**	**24**	**32**	**40**	**48[4]**	**64[4]**	**80[4]**
Maximum ERP (w)[1]	1	28	178	[2]500	[2]500	[2]500	500	[2]500	[2]500	[2]500
Up to reference HAAT (m)[3]	15	15	15	15	33	65	110	160	380	670

[1]Maximum ERP indicated provides for a 37 dBu signal strength at the edge of the service area per FCC Report R-6602, Fig. 19 (See §73.699, Fig. 10).
[2]Maximum ERP of 500 watts allowed. Signal strength at the service area contour may be less than 37 dBu.
[3]When the actual antenna HAAT is greater than the reference HAAT, the allowable ERP will be reduced in accordance with the following equation: ERPallow = ERPmax × (HAATref / HAATactual)2.
[4]Applications for this service area radius may be granted upon specific request with justification and must include a technical demonstration that the signal strength at the edge of the service area does not exceed 37 dBu.

(s) The output power shall not exceed by more than 20 percent either the output power shown in the Radio Equipment List [available in accordance with §90.203(a)(1)] for transmitters included in this list or when not so listed, the manufacturer's rated output power for the particular transmitter specifically listed on the authorization.

§22.565 Transmitting power limits.

The transmitting power of base, mobile and fixed transmitters operating on the channels listed in §22.561 must not exceed the limits in this section.

(a) Maximum ERP. The effective radiated power (ERP) of base and fixed transmitters must not exceed the applicable limits in this paragraph under any circumstances.

Frequency range (MHz)	Maximum ERP (watts)
152-153	1400
157-159	150
454-455	3500
459-460	150

(b) Basic power limit. Except as provided in paragraph (d) of this section, the ERP of base transmitters must not exceed 500 Watts.

(c) Height-power limits. Except as provided in paragraph (d) of this section, the ERP of base transmitters must not exceed the amount that would result in an average distance to the service contour of 41.6 kilometers (26 miles) for VHF channels or 30.7 kilometers (19 miles) for UHF channels. The average distance to the service contour is calculated by taking the arithmetic mean of the distances determined using the procedures specified in §22.567 for the eight cardinal radial directions, excluding cardinal radial directions for which 90% or more of the distance so calculated is over water.

(d) Encompassed interfering contour areas. Base transmitters are exempt from the basic power and height-power limits of this section if the area within their interfering contours is totally encompassed by the interfering contours of operating co-channel based transmitters controlled by the same licensee. For the purpose of this paragraph, operating transmitters are authorized transmitters that are providing service to subscribers.

(e) Adjacent channel protection. The ERP of base and fixed transmitters must not exceed 500 Watts if they transmit on channel 454.025 MHz and are located less than 7 kilometers (4.3 miles) from any Private Radio Services station receiving on adjacent channel 454.0000 MHz.

(f) Mobile transmitters. The transmitter output power of mobile transmitters must not exceed 60 watts.

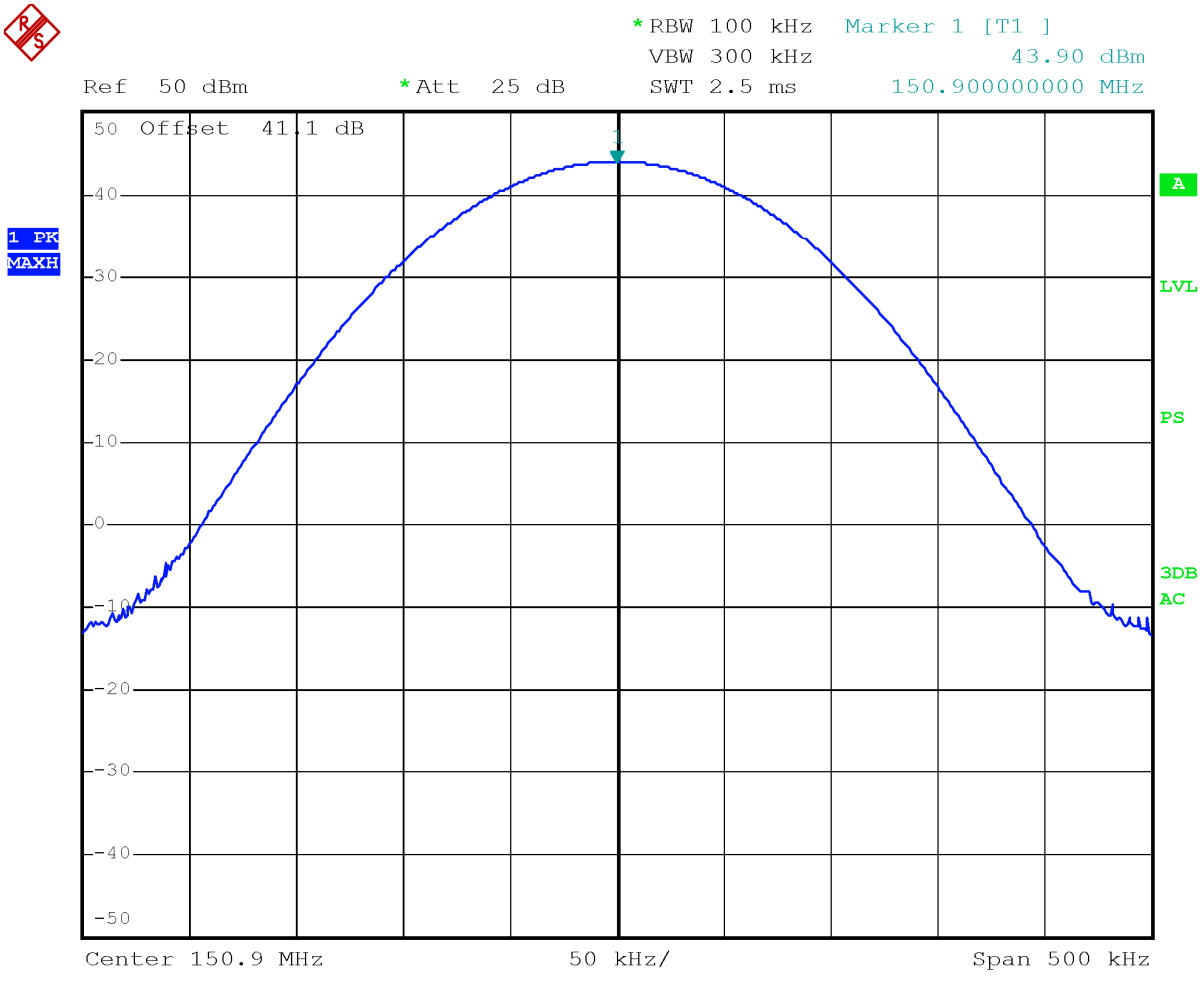
§2.1046 Measurements required: RF power output.

For measurements conducted pursuant to paragraphs (a) and (b) of § 2.1046, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

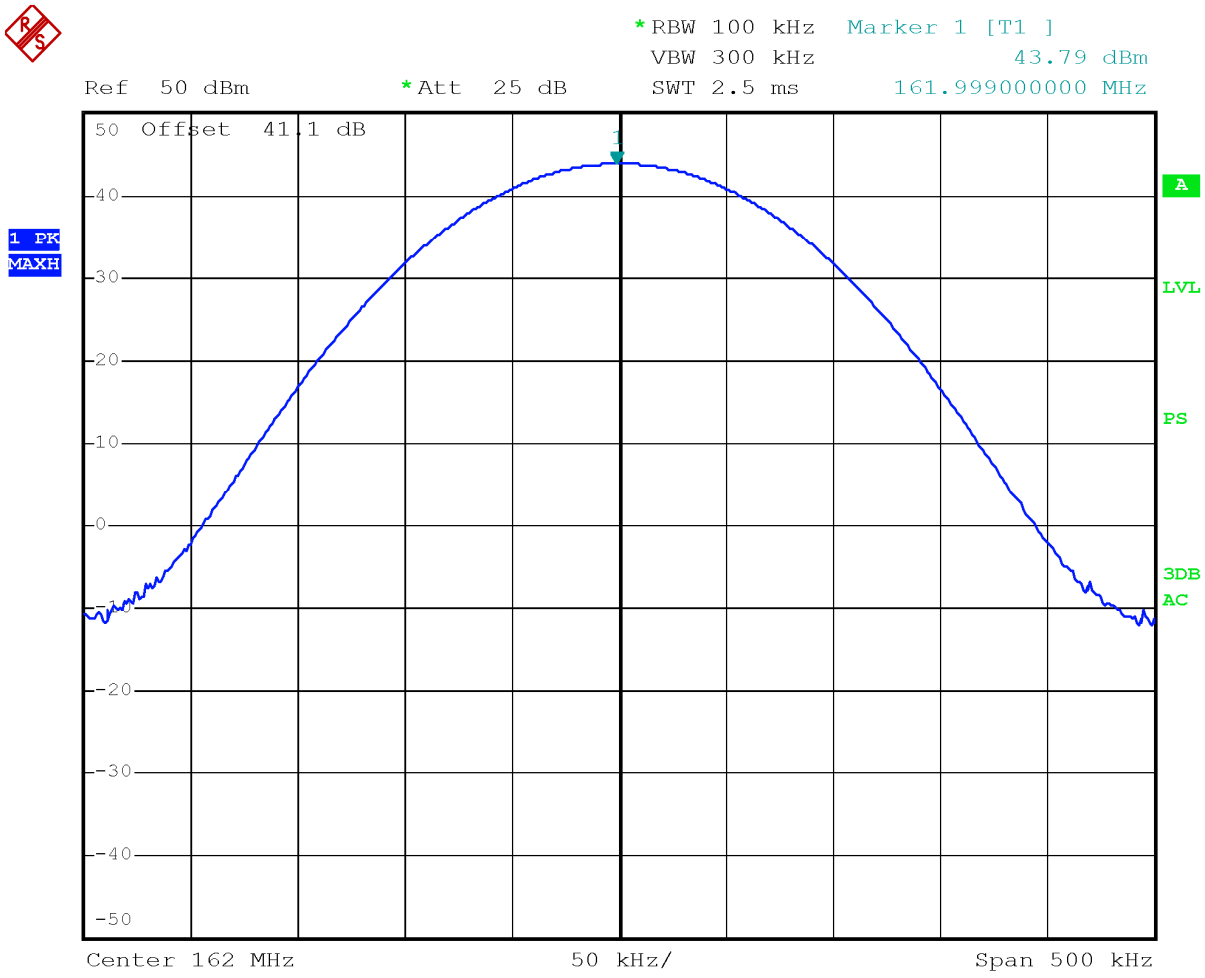
Test date: 2019-07-02
Test results: Pass
Modulation used: 16K0F3E, 11K0F3E, 7K60FXE, 8K0F1E

Channel	Measured Output power	Measured Output power
LOW	43.90 dBm	24.55 W
MID	43.79 dBm	23.93 W
HIGH	43.87 dBm	24.38 W
Maximum antenna gain for 150 W limit (51.76 dB ERP) = 10.0 dBi Manufacturer's rated Power + 20% = 30 W The RF Power maintains unchanged from 10.8 to 15.6 V DC and 18 to 60 V DC at 20° C Same result for all the modulations.		

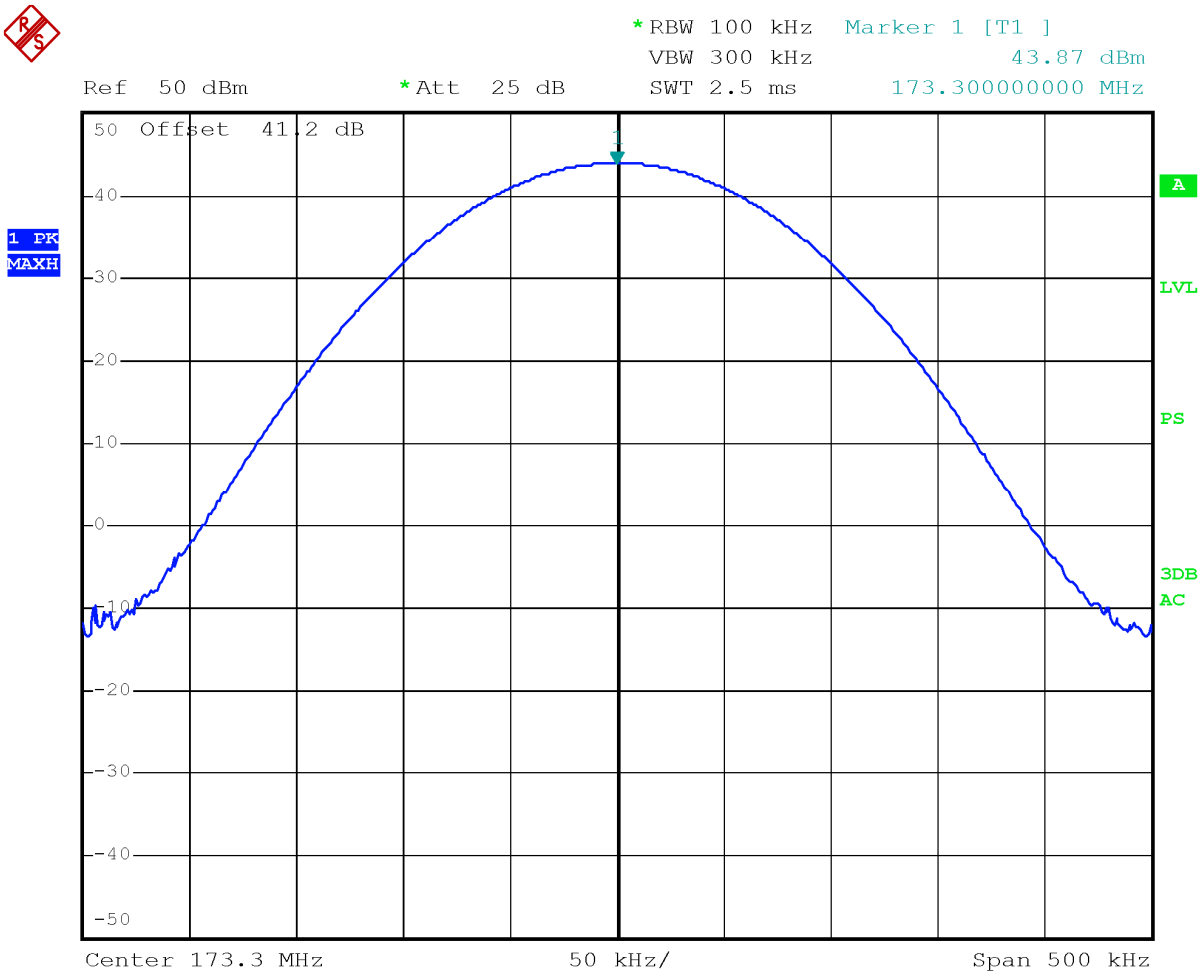
Test data



Test data


*RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
43.79 dBm
161.999000000 MHz
Ref 50 dBm
*Att 25 dB
50 Offset 41.1 dB
1 PK
MAXH
A
LVL
PS
3DB
AC
40
30
20
10
0
-10
-20
-30
-40
-50
Center 162 MHz
50 kHz/
Span 500 kHz

Test data


*RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
43.87 dBm
173.300000000 MHz
Ref 50 dBm
*Att 25 dB
50 Offset 41.2 dB
1 PK
MAXH
A
LVL
PS
3DB
AC
40
30
20
10
0
-10
-20
-30
-40
-50
Center 173.3 MHz
50 kHz/
Span 500 kHz

Clause 90.207 Modulation characteristics

Unless specified elsewhere in this part, stations will be authorized emissions as provided for in paragraphs (b) through (n) of section 90.207.

§2.1047 Measurements required: Modulation characteristics.

(a) Voice modulated communication equipment. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.

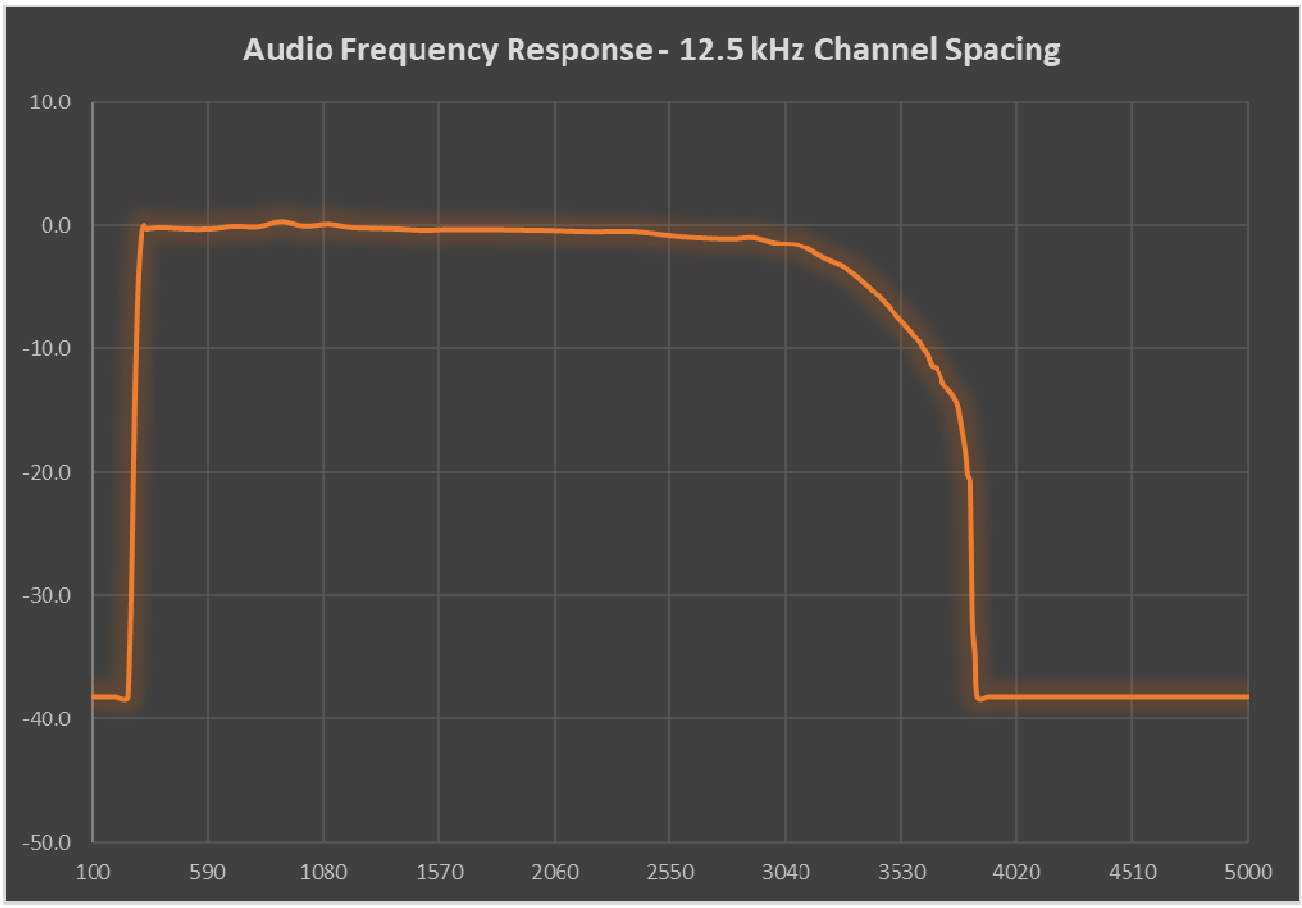
(b) Equipment which employs modulation limiting. A curve or family of curves showing the percentage of modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

(c) Single sideband and independent sideband radiotelephone transmitters which employ a device or circuit to limit peak envelope power. A curve showing the peak envelope power output versus the modulation input voltage shall be supplied. The modulating signals shall be the same in frequency as specified in paragraph (c) of §2.1049 for the occupied bandwidth tests.

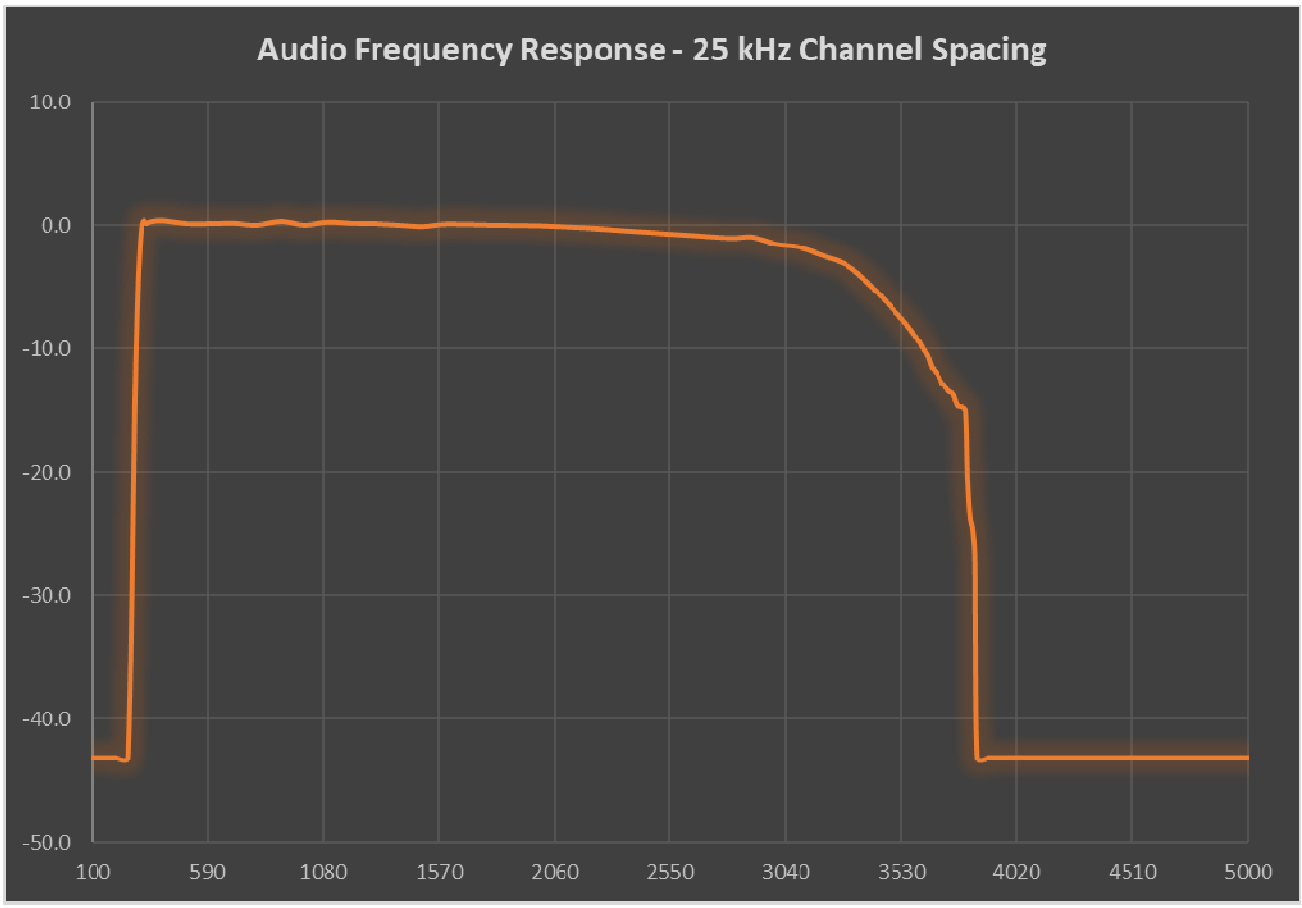
(d) Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

Test date: 2019-07-02
Test results: Pass
Modulation used: 16K0F3E, 11K0F3E

Test data


Audio Frequency Response - 12.5 kHz Channel Spacing
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
100
590
1080
1570
2060
2550
3040
3530
4020
4510
5000
Tone frequency (Hz)

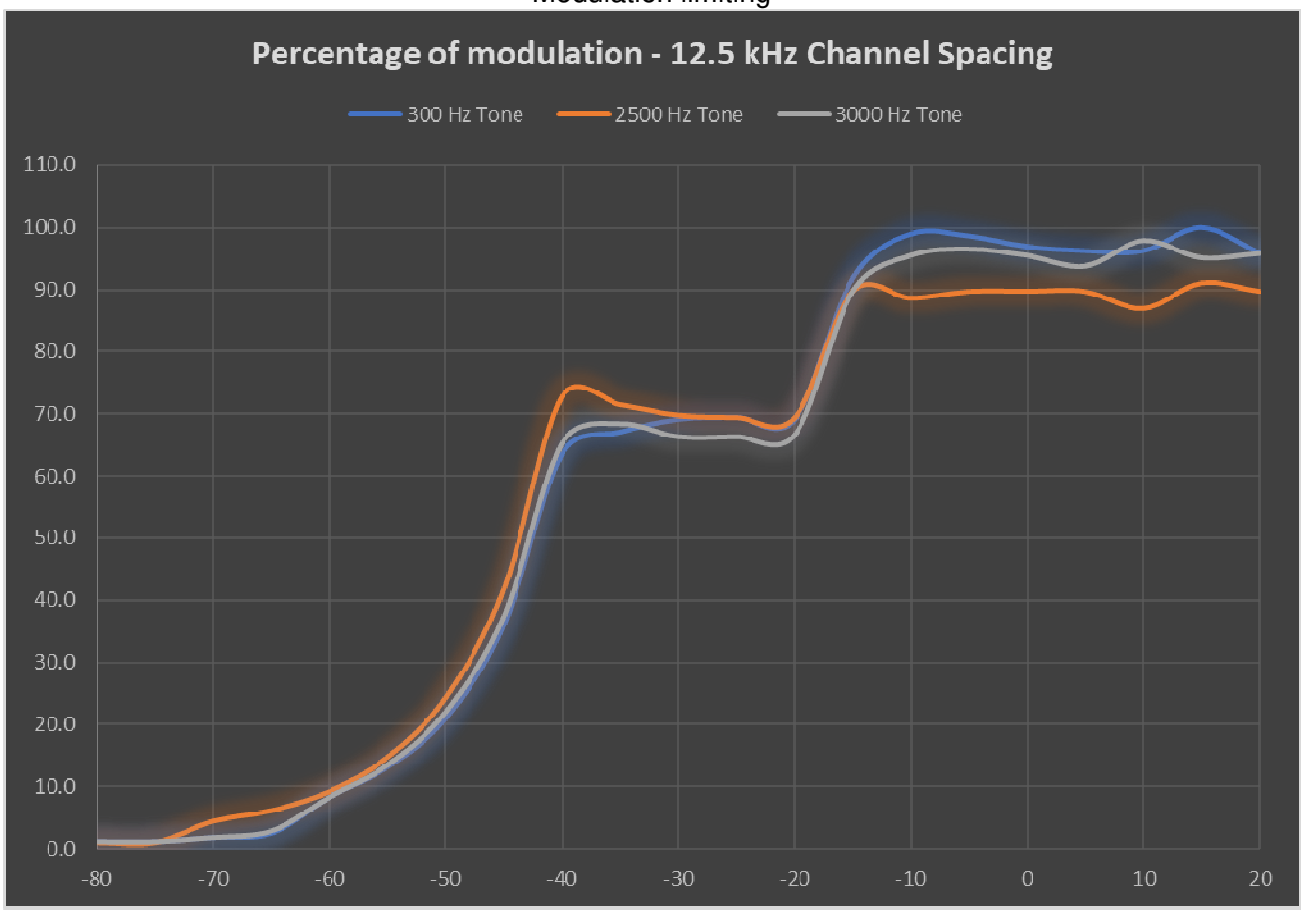
Test data



Tone frequency (Hz)

Test data

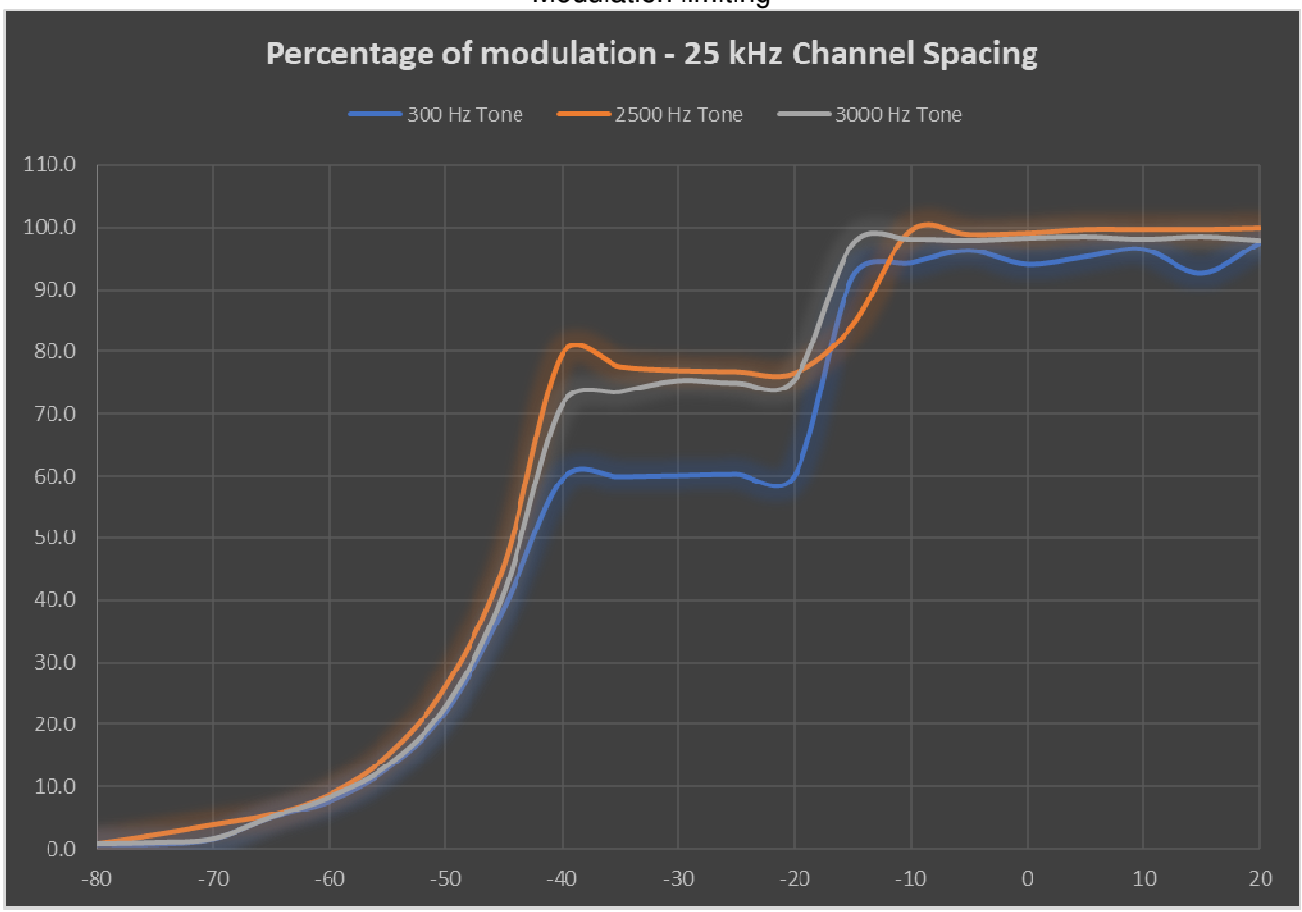
Modulation limiting



Modulation input voltage (dBm)

Test data

Modulation limiting



Modulation input voltage (dBm)

Clause 90.209 Occupied bandwidth

Unless specified elsewhere, channel spacings and bandwidths that will be authorized in the following frequency bands are given in the following table:

STANDARD CHANNEL SPACING/BANDWIDTH

Frequency band (MHz)	Channel spacing (kHz)	Authorized bandwidth (kHz)
Below 25[2]		
25-50	20	20
72-76	20	20
150-174	[1]7.5	[1 3]20/11.25/6
216-220[5]	6.25	20/11.25/6
220-222	5	4
406-512[2]	[1]6.25	[1 3 6]20/11.25/6
806-809/851-854	12.5	20
809-817/854-862	12.5	[6]20/11.25
817-824/862-869	25	[6]20
896-901/935-940	12.5	13.6
902-928[4]		
929-930	25	20
1427-1432[5]	12.5	12.5
[3]2450-2483.5[2]		
Above 2500[2]		

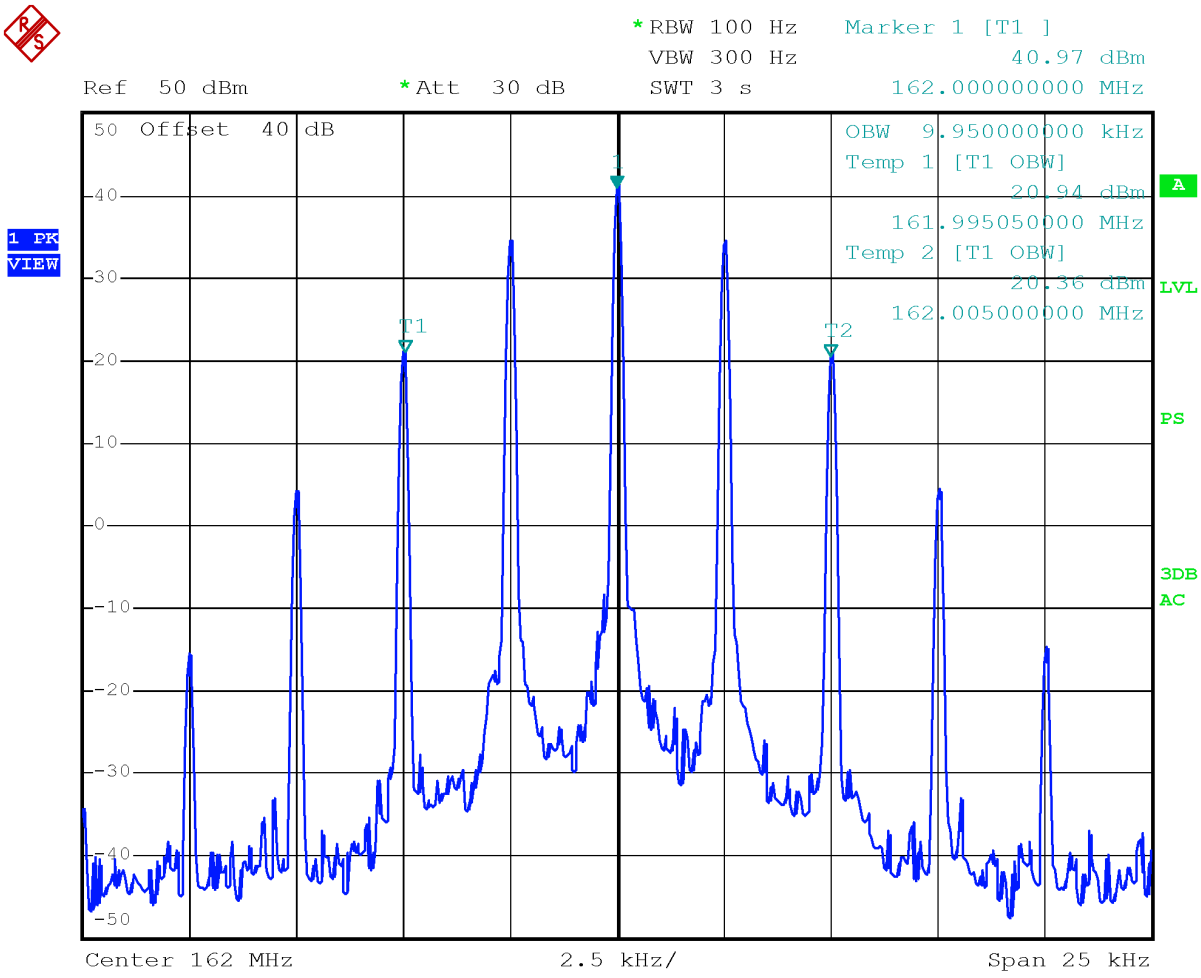
Operations using equipment designed to operate with a 25 kHz channel bandwidth will be authorized a 20 kHz bandwidth. Operations using equipment designed to operate with a 12.5 kHz channel bandwidth will be authorized a 11.25 kHz bandwidth. Operations using equipment designed to operate with a 6.25 kHz channel bandwidth will be authorized a 6 kHz bandwidth. All stations must operate on channels with a bandwidth of 12.5 kHz or less beginning January 1, 2013, unless the operations meet the efficiency standard of §90.203(j)(3).

§2.1049 Measurements required: Occupied bandwidth.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the conditions stated in §2.1049 as applicable.

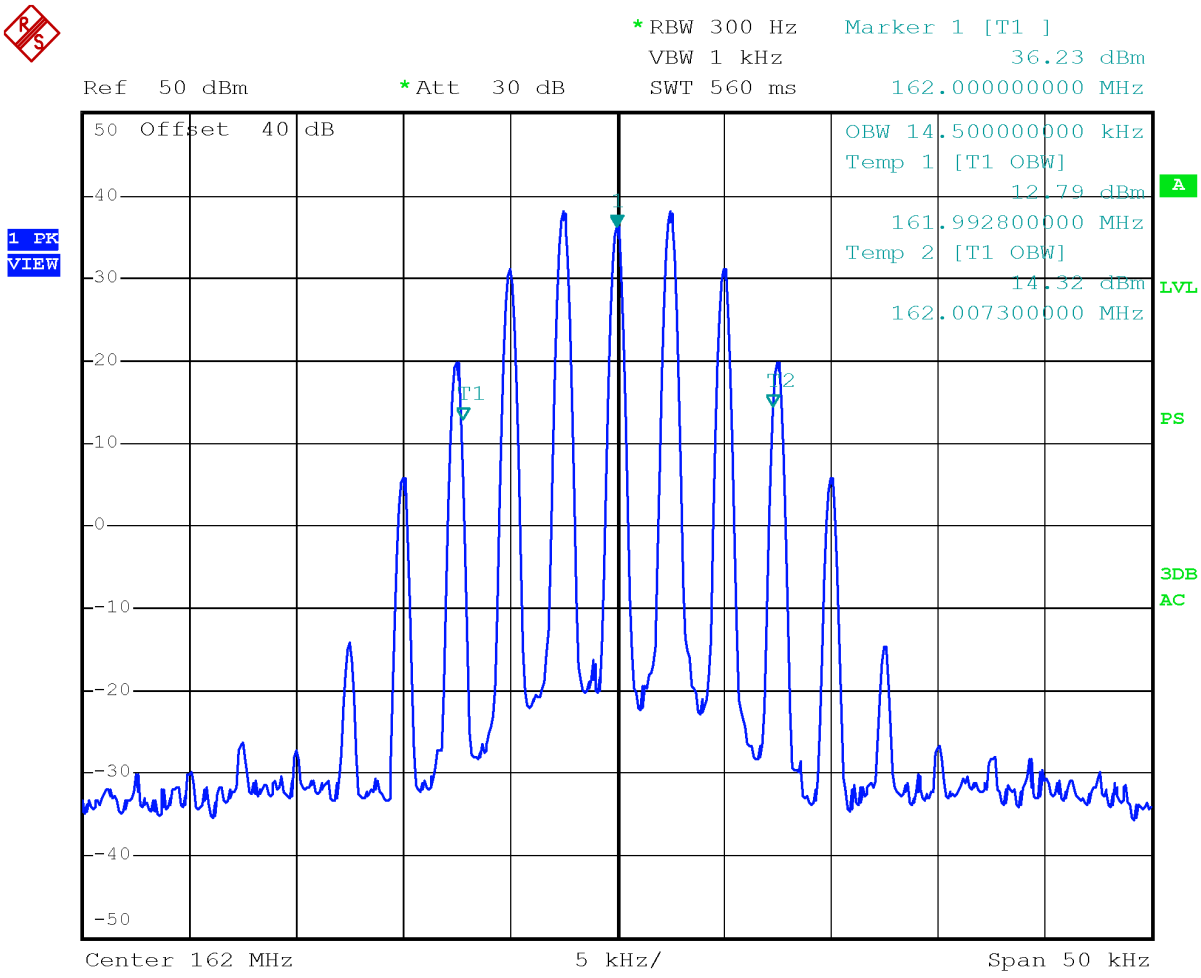
Test date: 2019-07-02
Test results: Pass
Modulation used: 16K0F3E, 11K0F3E, 7K60FXE, 8K0F1E

Test data



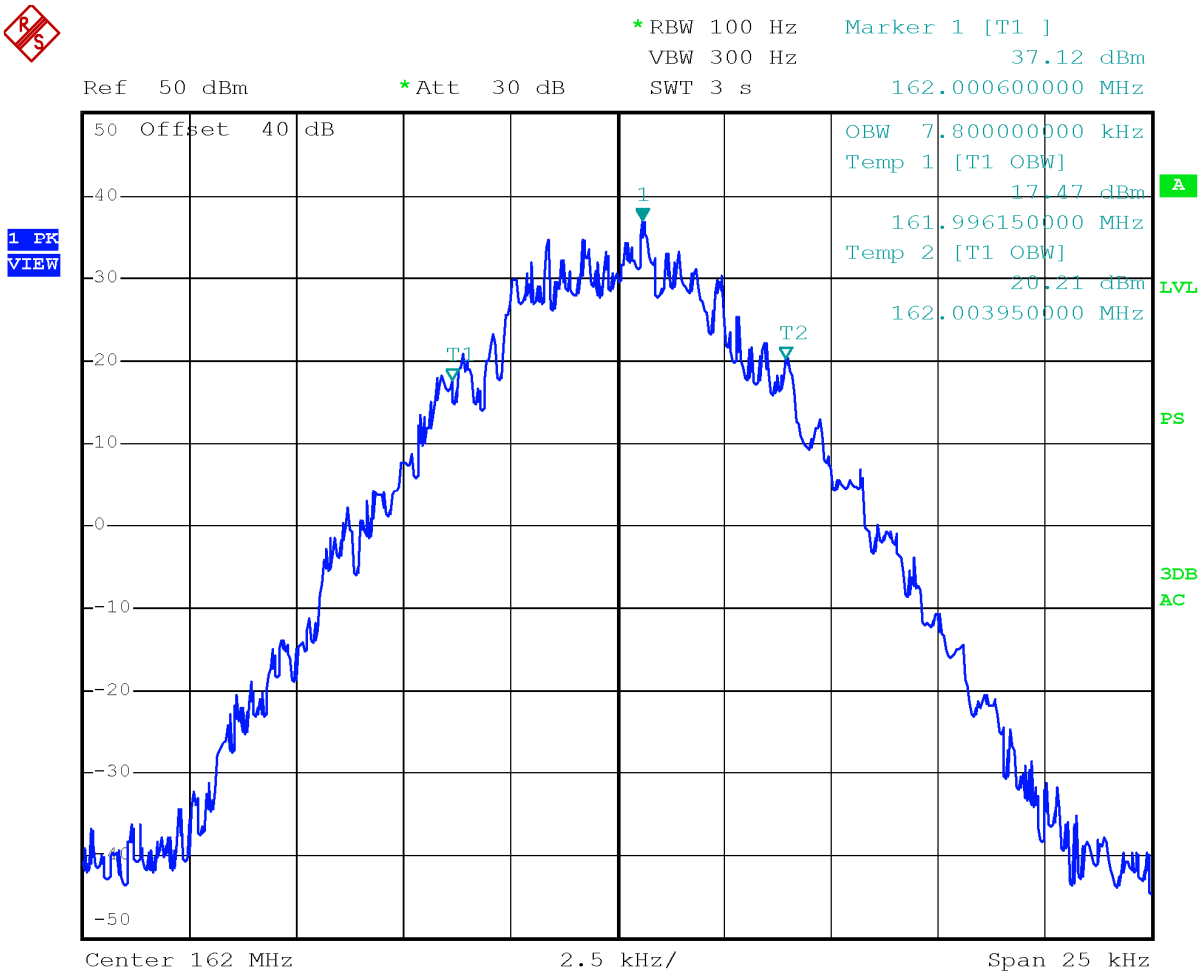
Channel MID – FM modulation with 12.5 kHz channel bandwidth

Test data



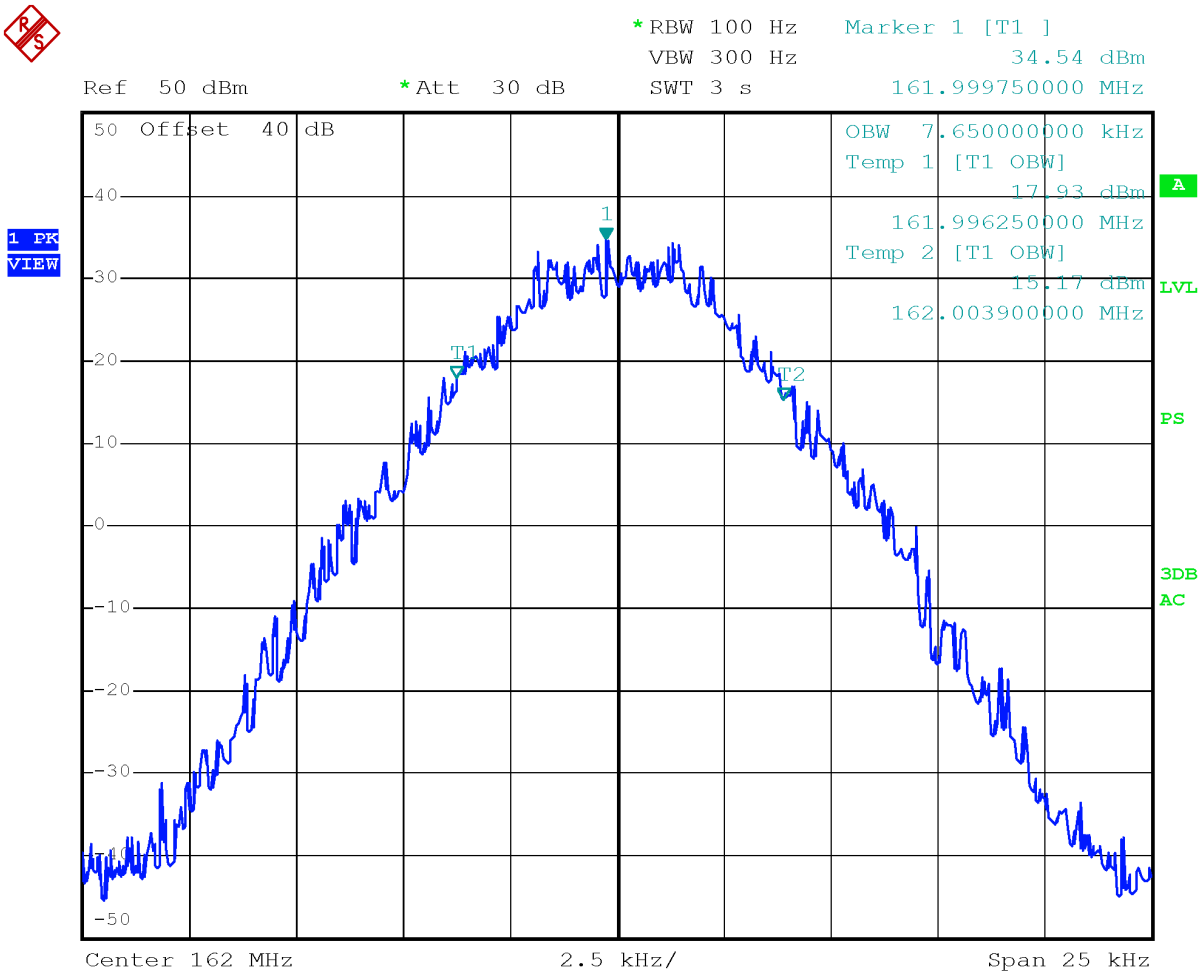
Channel MID – FM modulation with 25 kHz channel bandwidth

Test data



Channel MID – 4FSK modulation with 12.5 kHz channel bandwidth

Test data



Channel MID – C4FM modulation with 12.5 kHz channel bandwidth

Clause 90.210 and 22.359 Emission masks

§90.210 Emission masks.

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (o) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth. Unless indicated elsewhere in this part, the table in this section specifies the emission masks for equipment operating under this part.

APPLICABLE EMISSION MASKS

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
Below 25[1]	A or B	A or C
25-50	B	C
72-76	B	C
150-174[2]	B, D, or E	C, D or E
150 paging only	B	C
220-222	F	F
421-512[2 5]	B, D, or E	C, D, or E
450 paging only	B	G
806-809/851-854[6]	B	H
809-824/854-869[35]	B, D	D, G.
896-901/935-940	I	J
902-928	K	K
929-930	B	G
4940-4990 MHz	L or M	L or M
5850-5925[4]		
All other bands	B	C

Emission Mask B. For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

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

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(fd–2.88 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.

§22.359 Emission limitations.

The rules in this section govern the spectral characteristics of emissions in the Public Mobile Services, except for the Air-Ground Radiotelephone Service (see §22.861, instead) and the Cellular Radiotelephone Service (see §22.917, instead).

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

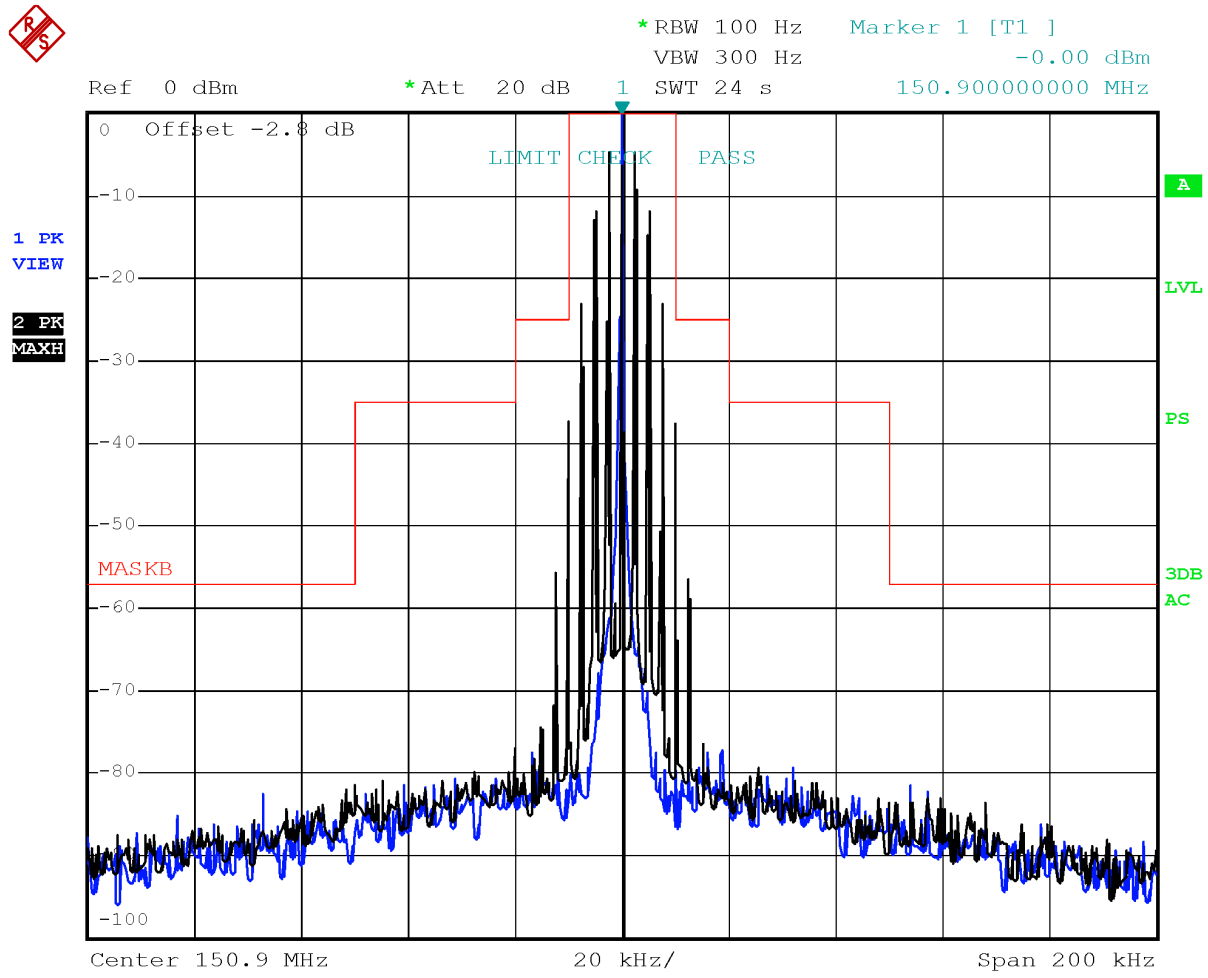
(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 30 kHz or more. In the 60 kHz bands immediately outside and adjacent to the authorized frequency range or channel, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e., 30 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(c) Alternative out of band emission limit. Licensees in the Public Mobile Services may establish an alternative out of band emission limit to be used at specified frequencies (band edges) in specified geographical areas, in lieu of that set forth in this section, pursuant to a private contractual arrangement of all affected licensees and applicants. In this event, each party to such contract shall maintain a copy of the contract in their station files and disclose it to prospective assignees or transferees and, upon request, to the FCC.

(d) Interference caused by out of band emissions. If any emission from a transmitter operating in any of the Public Mobile Services results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

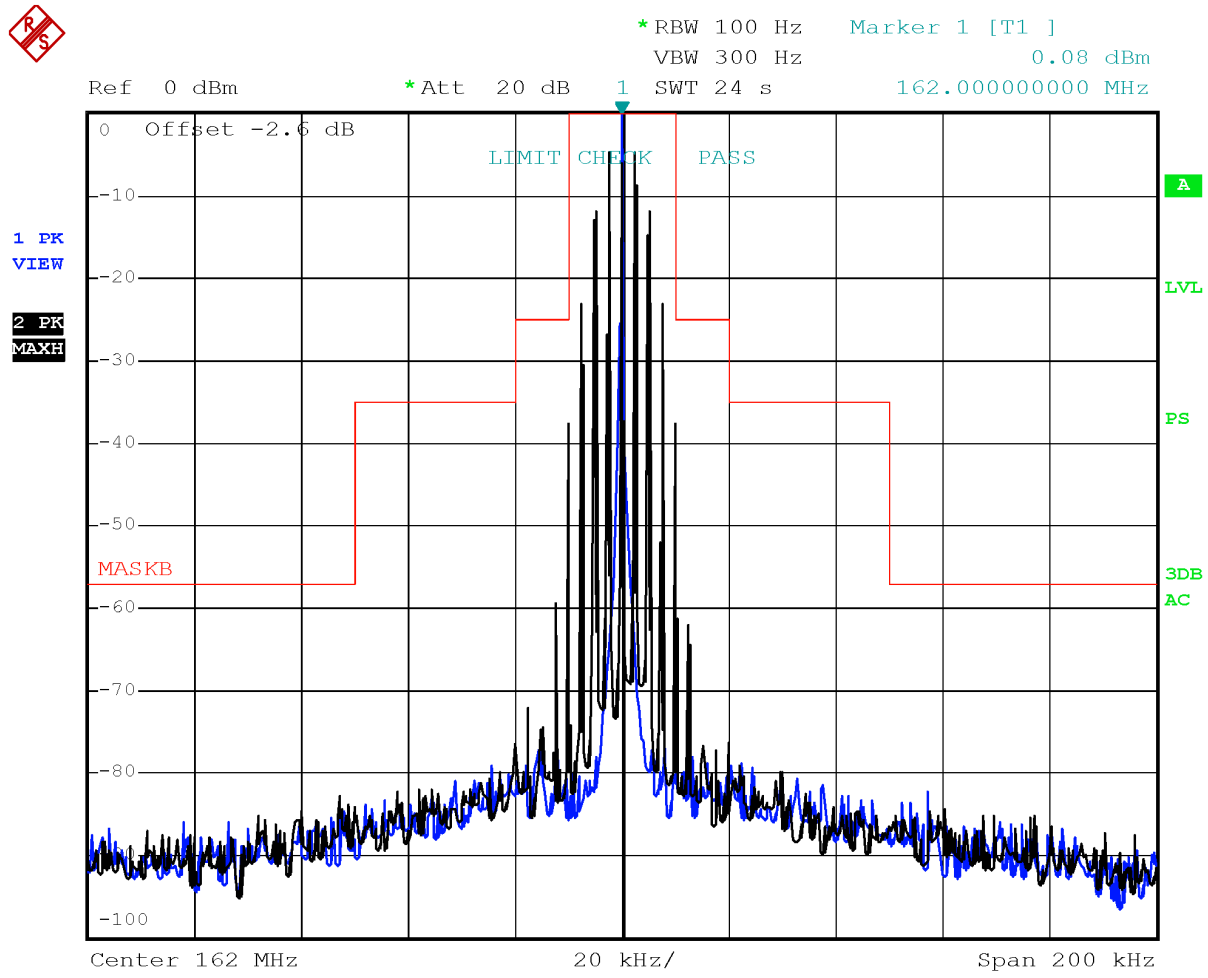
Test date: 2019-07-02
Test results: Pass
Modulation used: 16K0F3E, 11K0F3E, 7K60FXE, 8K0F1E

Test data



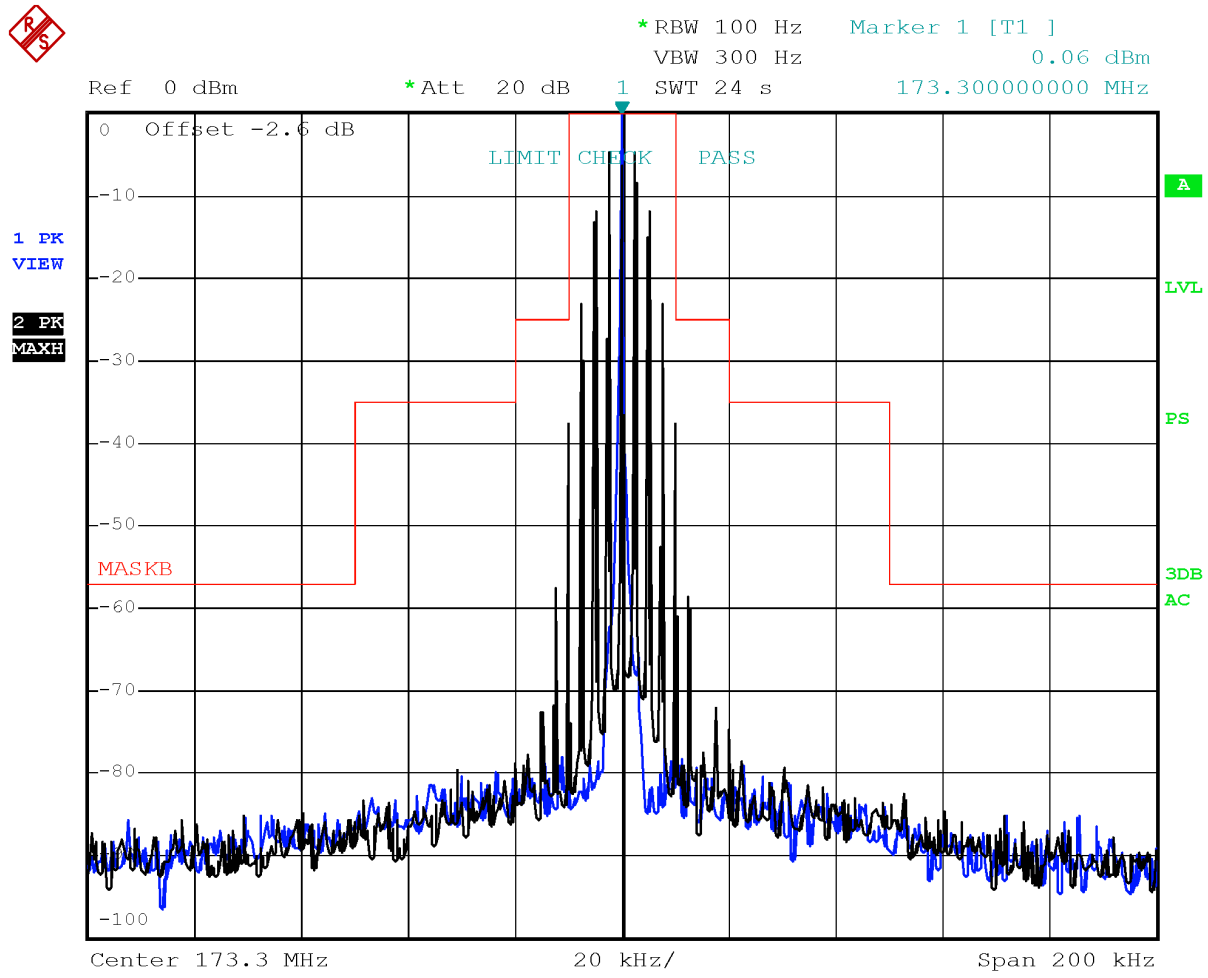
Channel LOW – FM modulation with 25 kHz channel bandwidth

Test data



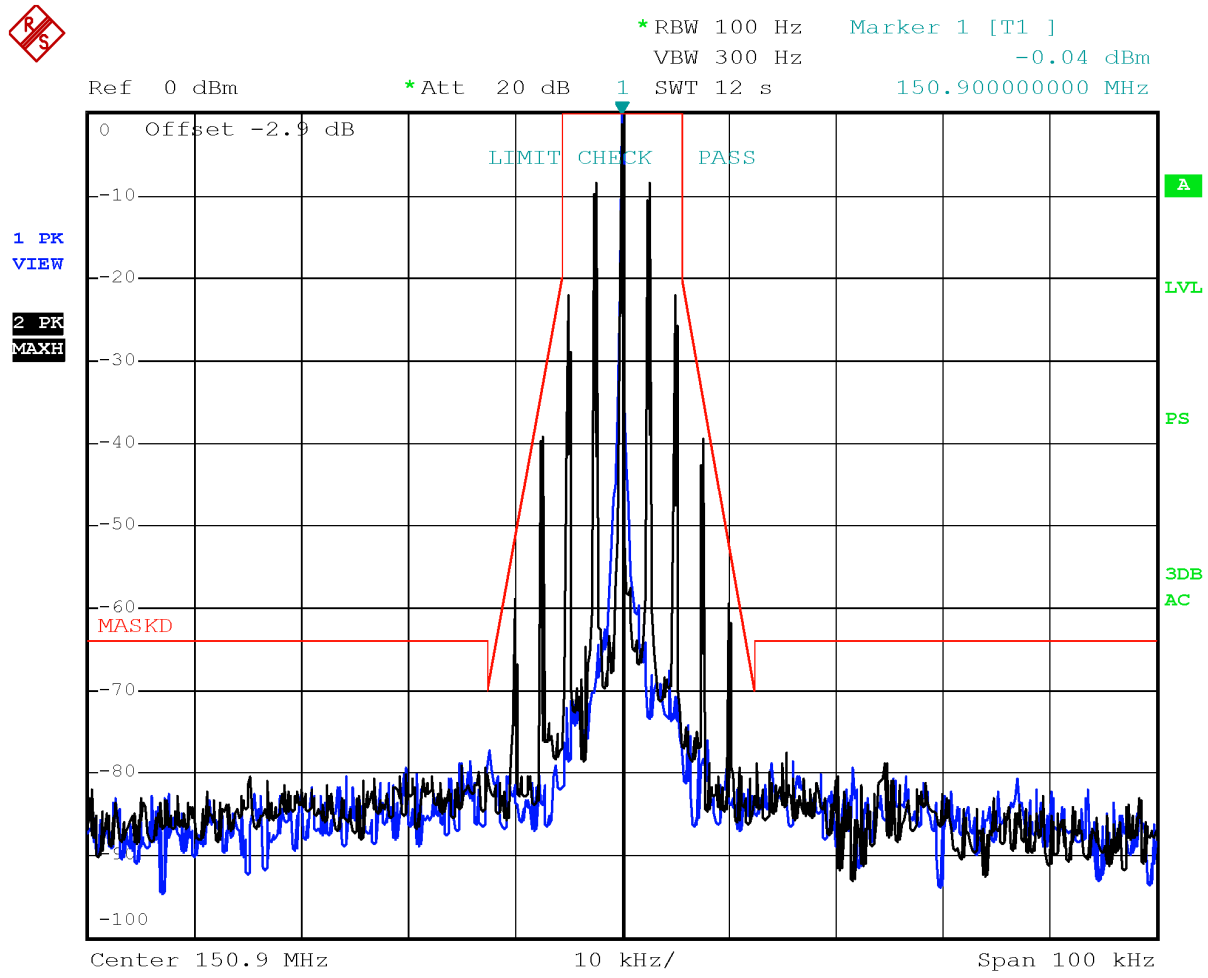
Channel MID – FM modulation with 25 kHz channel bandwidth

Test data



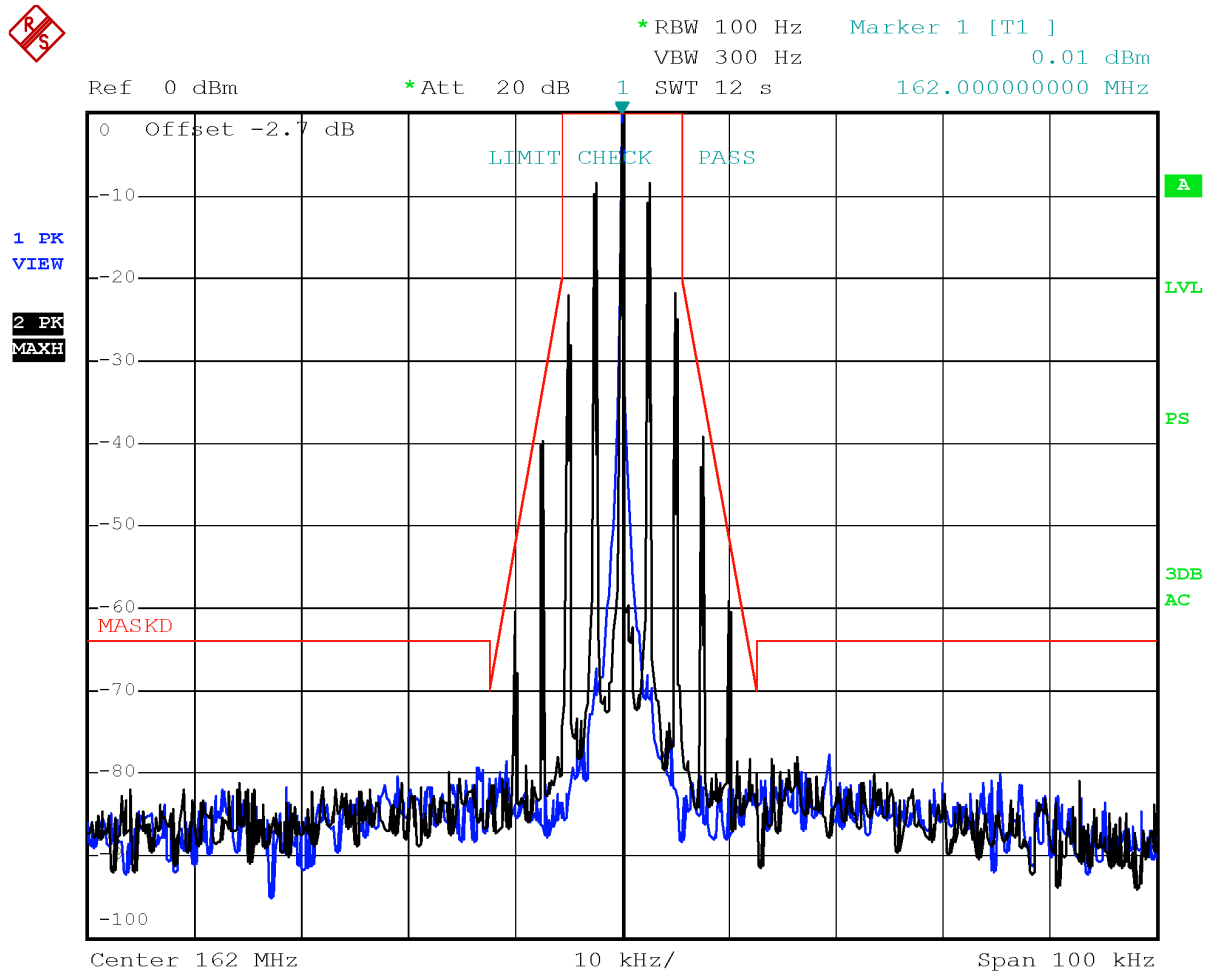
Channel HIGH – FM modulation with 25 kHz channel bandwidth

Test data



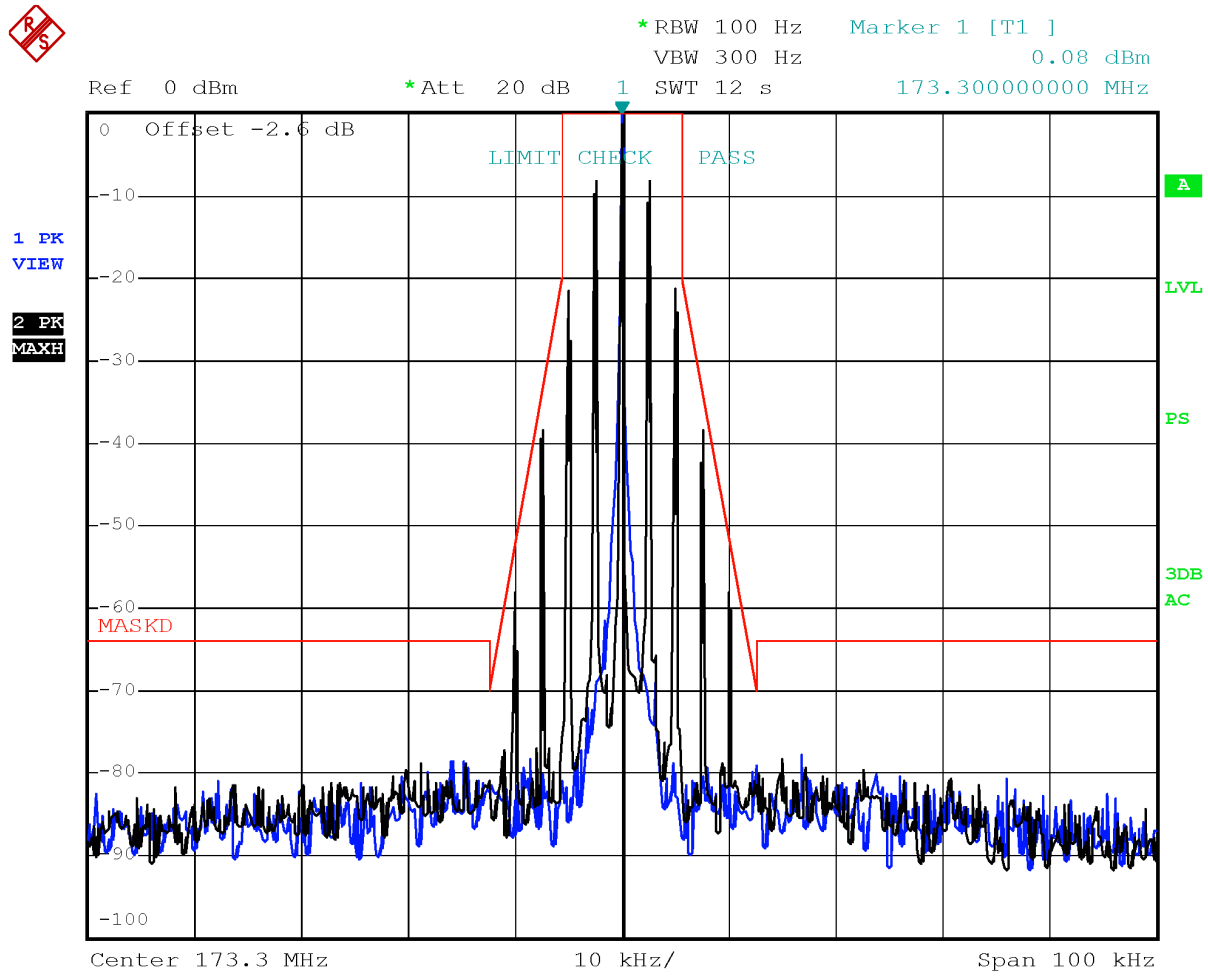
Channel LOW – FM modulation with 12.5 kHz channel bandwidth

Test data



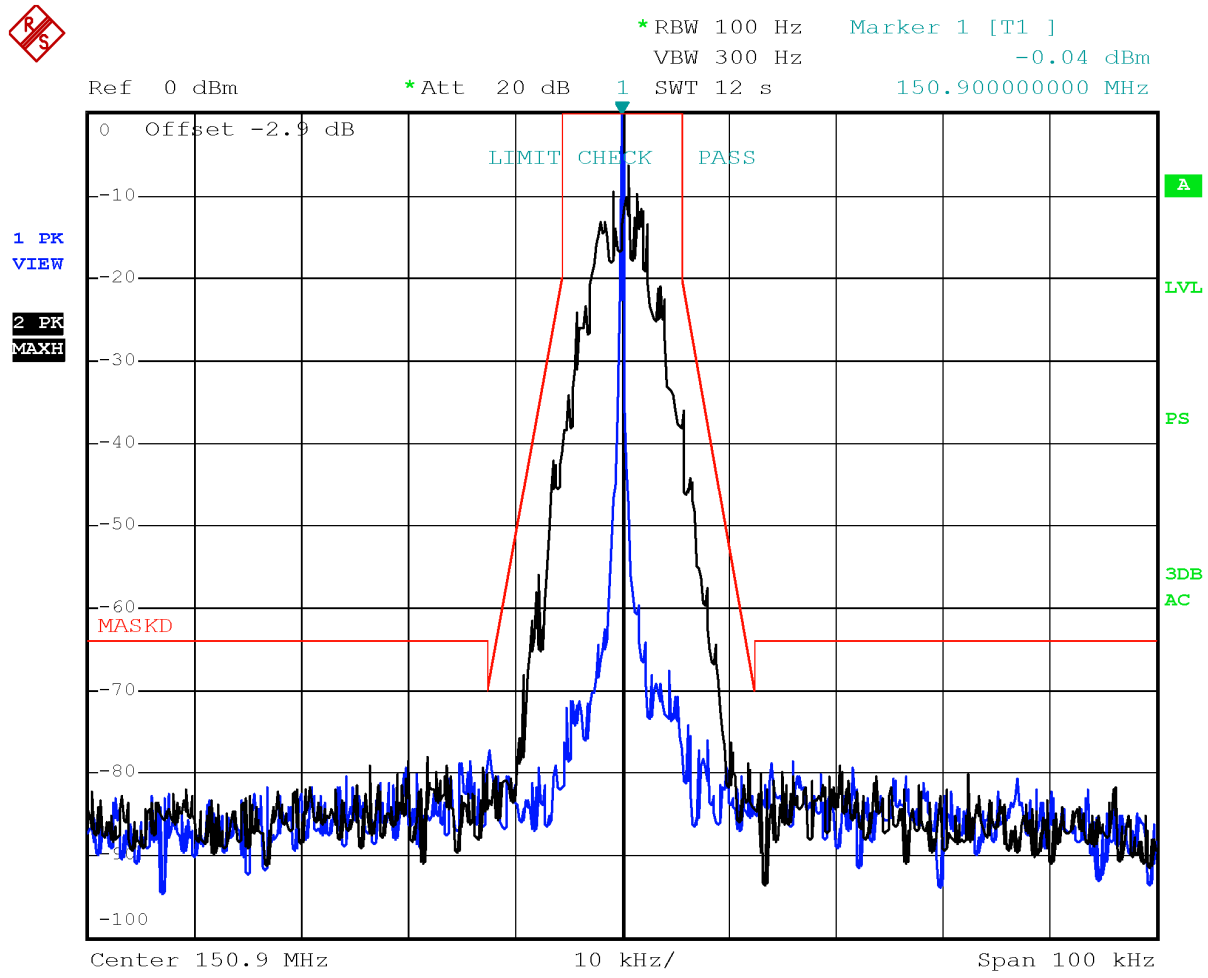
Channel MID – FM modulation with 12.5 kHz channel bandwidth

Test data



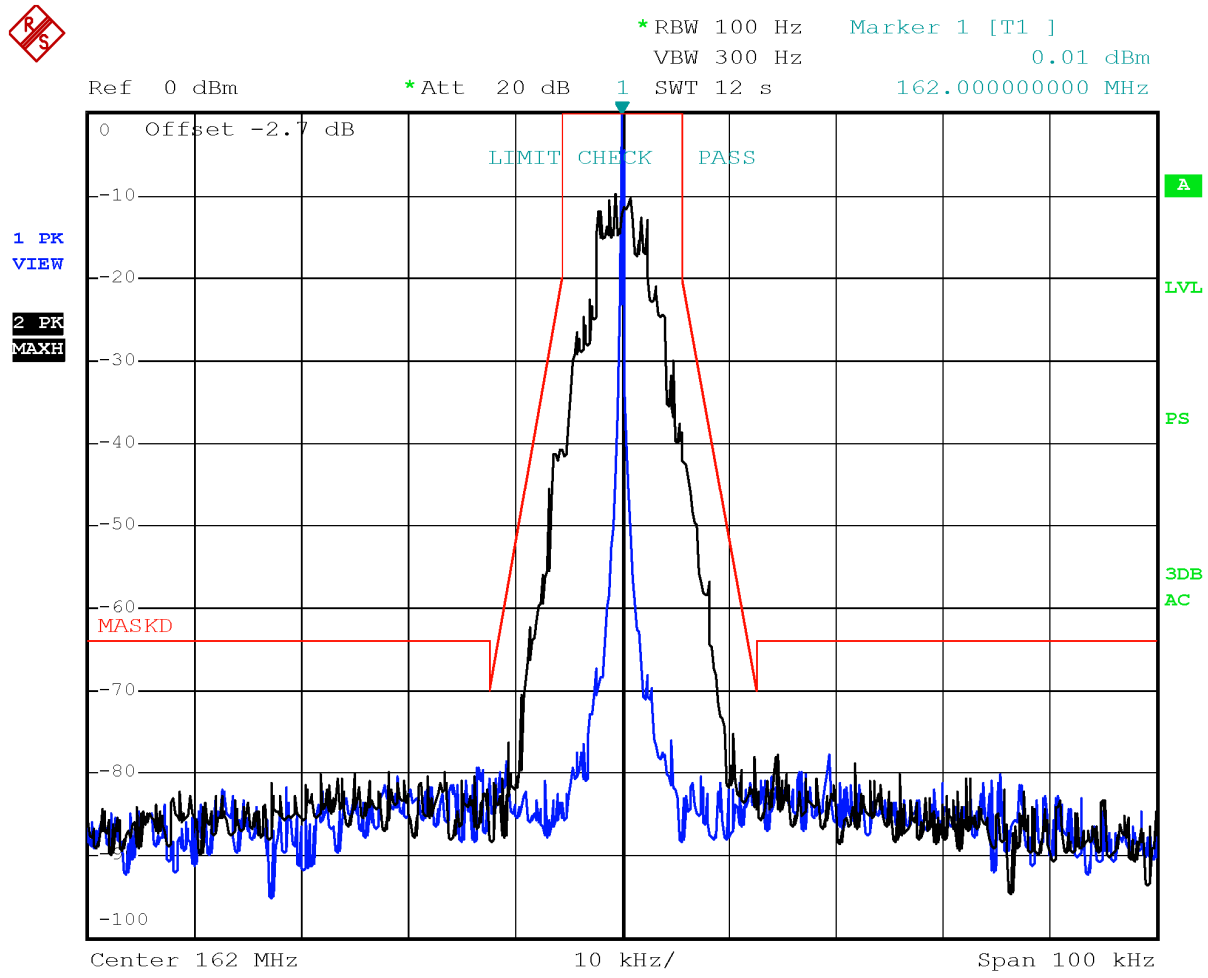
Channel HIGH – FM modulation with 12.5 kHz channel bandwidth

Test data



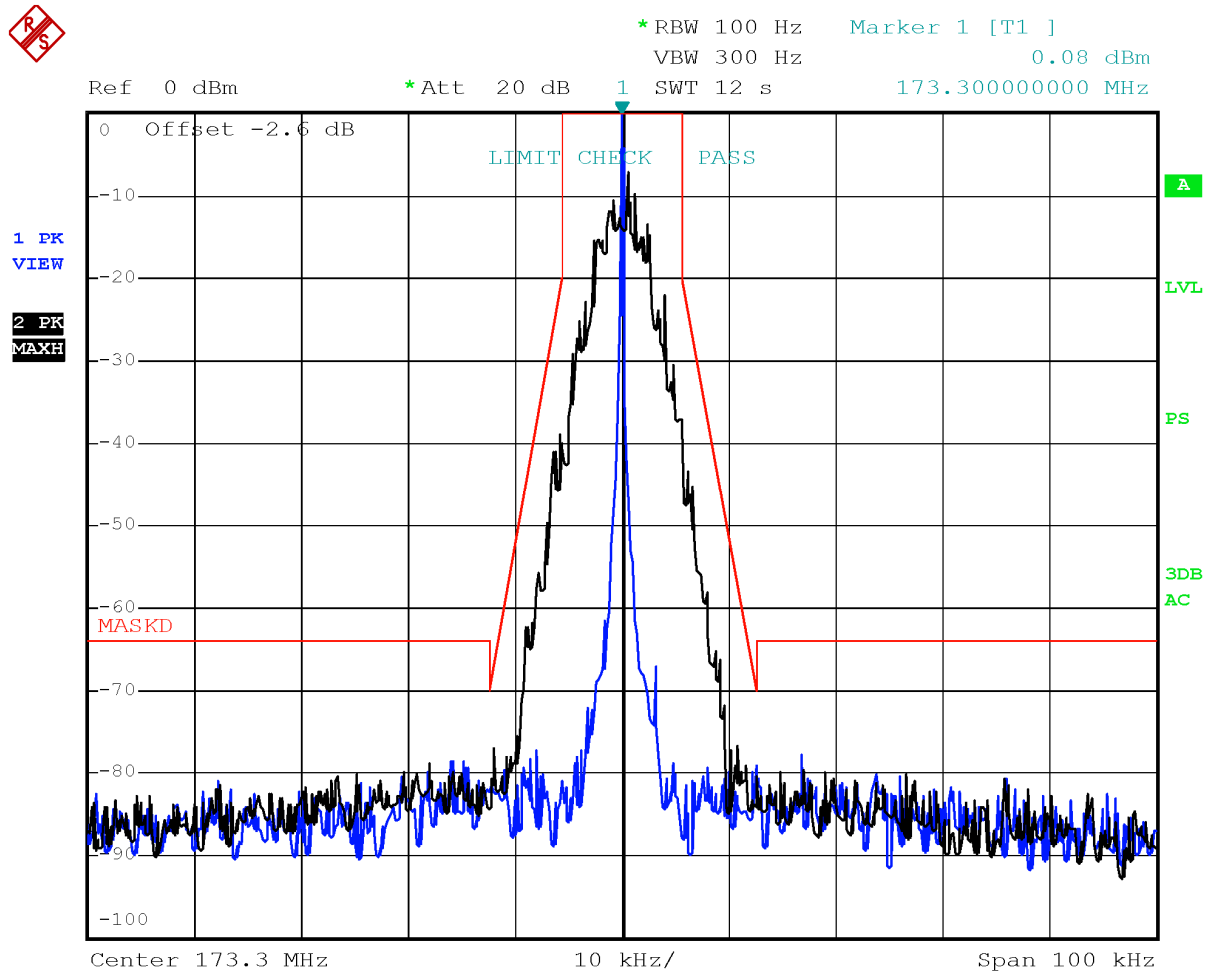
Channel LOW – 4FSK modulation with 12.5 kHz channel bandwidth

Test data



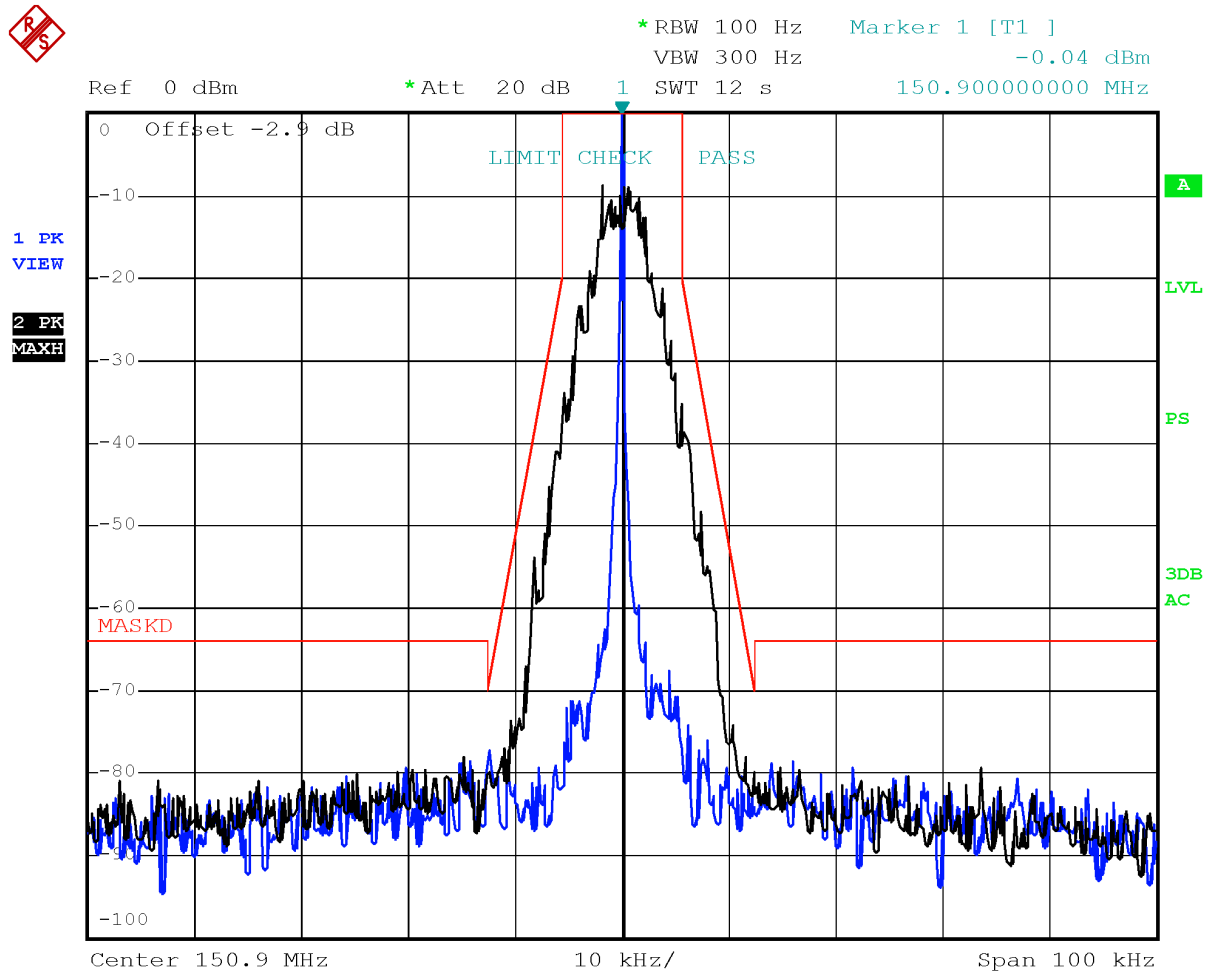
Channel MID – 4FSK modulation with 12.5 kHz channel bandwidth

Test data



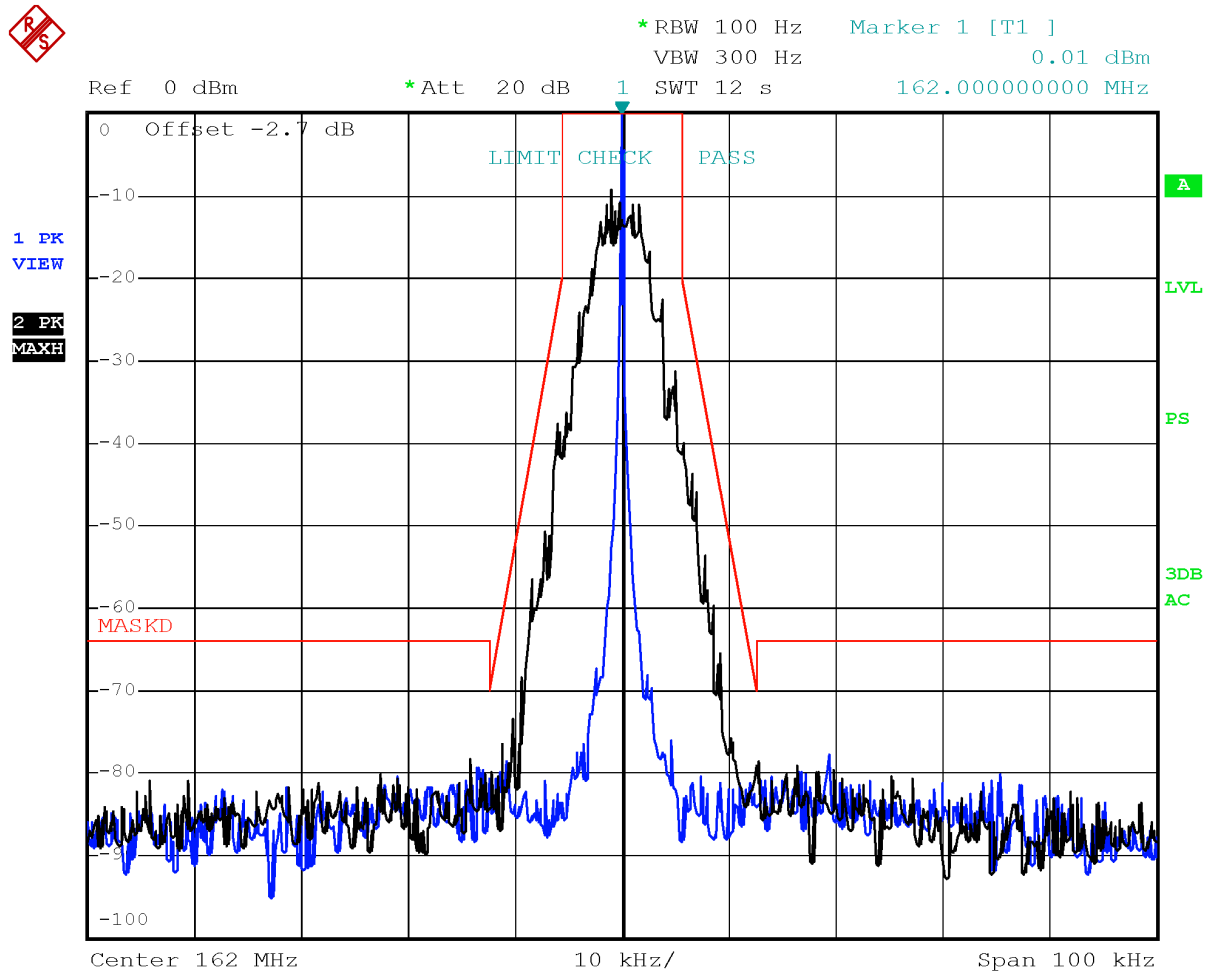
Channel HIGH – 4FSK modulation with 12.5 kHz channel bandwidth

Test data



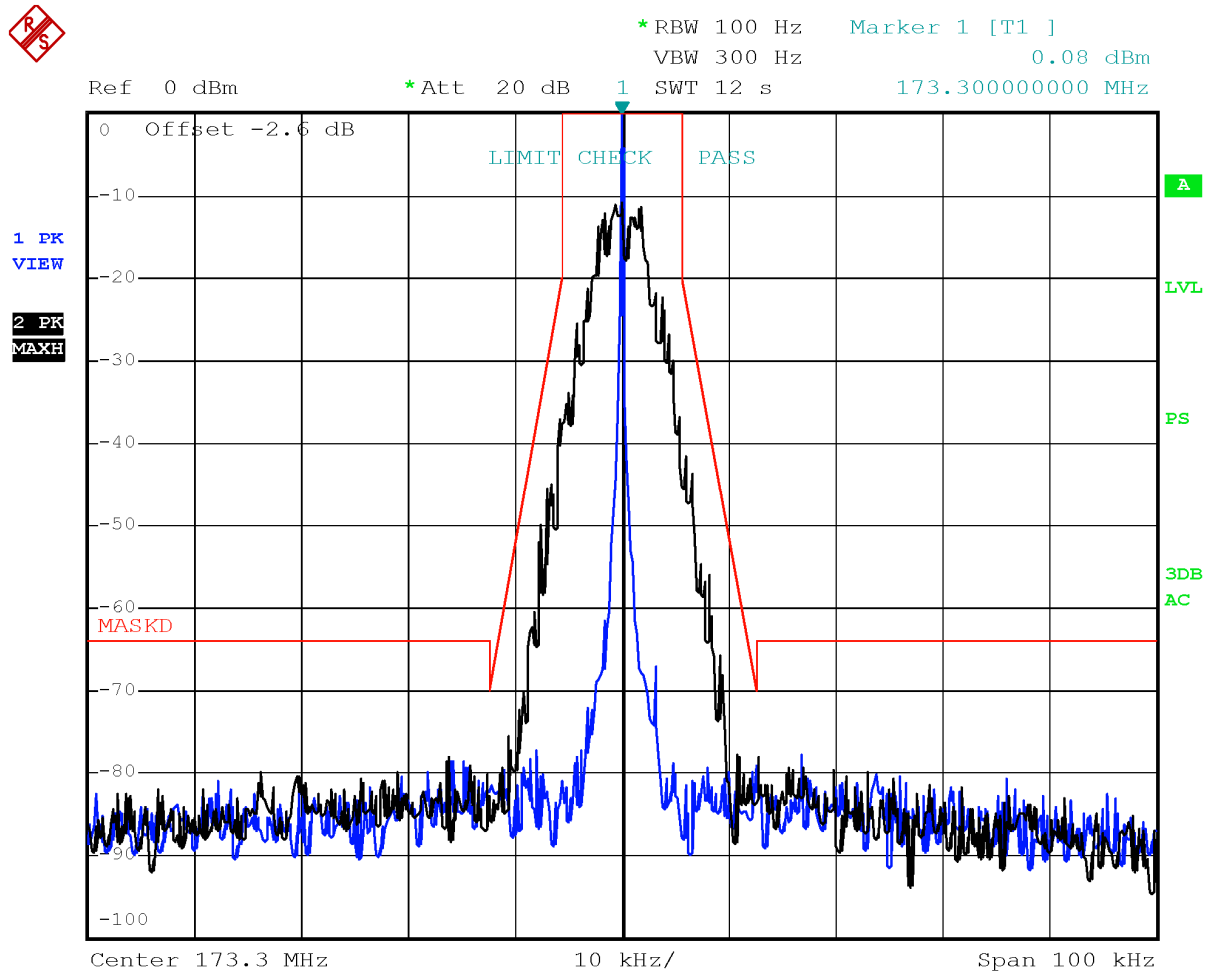
Channel LOW – C4FM modulation with 12.5 kHz channel bandwidth

Test data



Channel MID – C4FM modulation with 12.5 kHz channel bandwidth

Test data



Channel HIGH – C4FM modulation with 12.5 kHz channel bandwidth

Clause 90.210 and 22.359 Spurious emissions at antenna terminals

§90.210 Emission masks.

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (o) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth. Unless indicated elsewhere in this part, the table in this section specifies the emission masks for equipment operating under this part.

APPLICABLE EMISSION MASKS

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
Below 25[1]	A or B	A or C
25-50	B	C
72-76	B	C
150-174[2]	B, D, or E	C, D or E
150 paging only	B	C
220-222	F	F
421-512[2 5]	B, D, or E	C, D, or E
450 paging only	B	G
806-809/851-854[6]	B	H
809-824/854-869[35]	B, D	D, G.
896-901/935-940	I	J
902-928	K	K
929-930	B	G
4940-4990 MHz	L or M	L or M
5850-5925[4]		
All other bands	B	C

Emission Mask B. For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.
(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.
(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

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:

(5) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0: Zero dB.

(6) 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(fd–2.88 kHz) dB.

(7) 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.

(8) 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.

§22.359 Emission limitations.

The rules in this section govern the spectral characteristics of emissions in the Public Mobile Services, except for the Air-Ground Radiotelephone Service (see §22.861, instead) and the Cellular Radiotelephone Service (see §22.917, instead).

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 30 kHz or more. In the 60 kHz bands immediately outside and adjacent to the authorized frequency range or channel, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e., 30 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(c) Alternative out of band emission limit. Licensees in the Public Mobile Services may establish an alternative out of band emission limit to be used at specified frequencies (band edges) in specified geographical areas, in lieu of that set forth in this section, pursuant to a private contractual arrangement of all affected licensees and applicants. In this event, each party to such contract shall maintain a copy of the contract in their station files and disclose it to prospective assignees or transferees and, upon request, to the FCC.

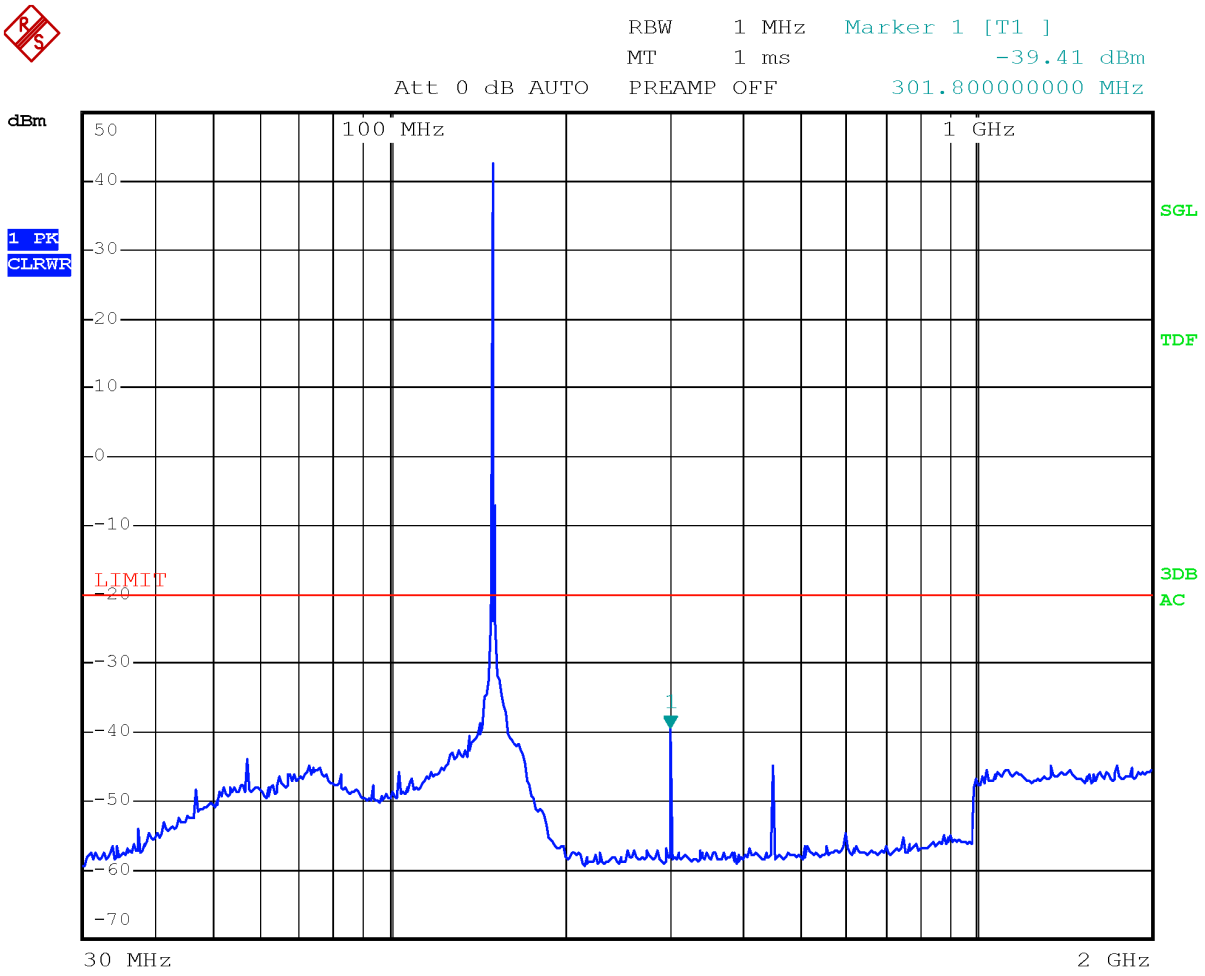
(d) Interference caused by out of band emissions. If any emission from a transmitter operating in any of the Public Mobile Services results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

§2.1051 Measurements required: Spurious emissions at antenna terminals.

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

Test date: 2019-06-30
Test results: Pass
Modulation used: 16K0F3E, 11K0F3E, 7K60FXE, 8K0F1E

Test data

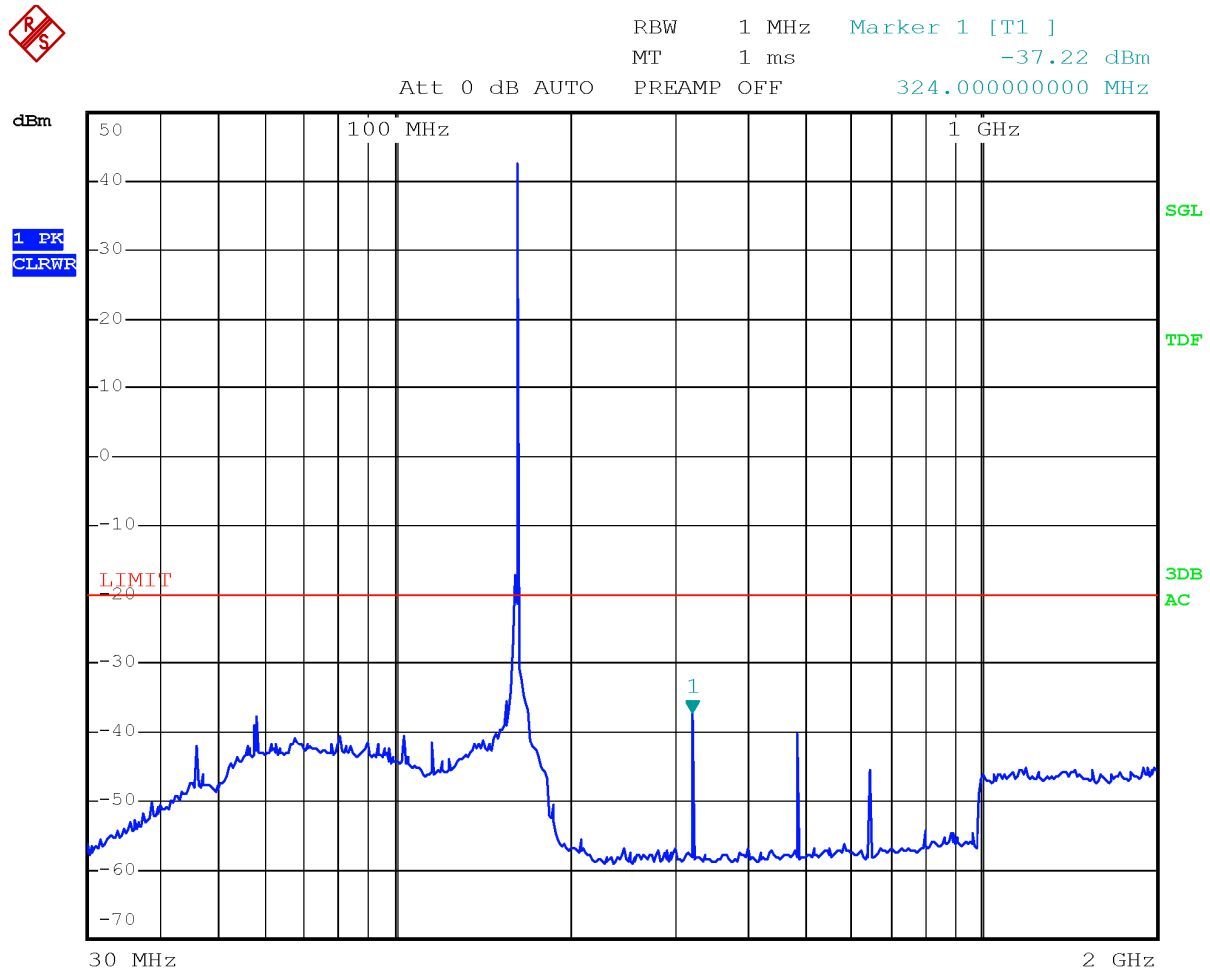


Channel LOW – FM modulation with 25 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
301.8000	-39.5	-20.0	-19.4

Limit exceeds by the carrier

Test data

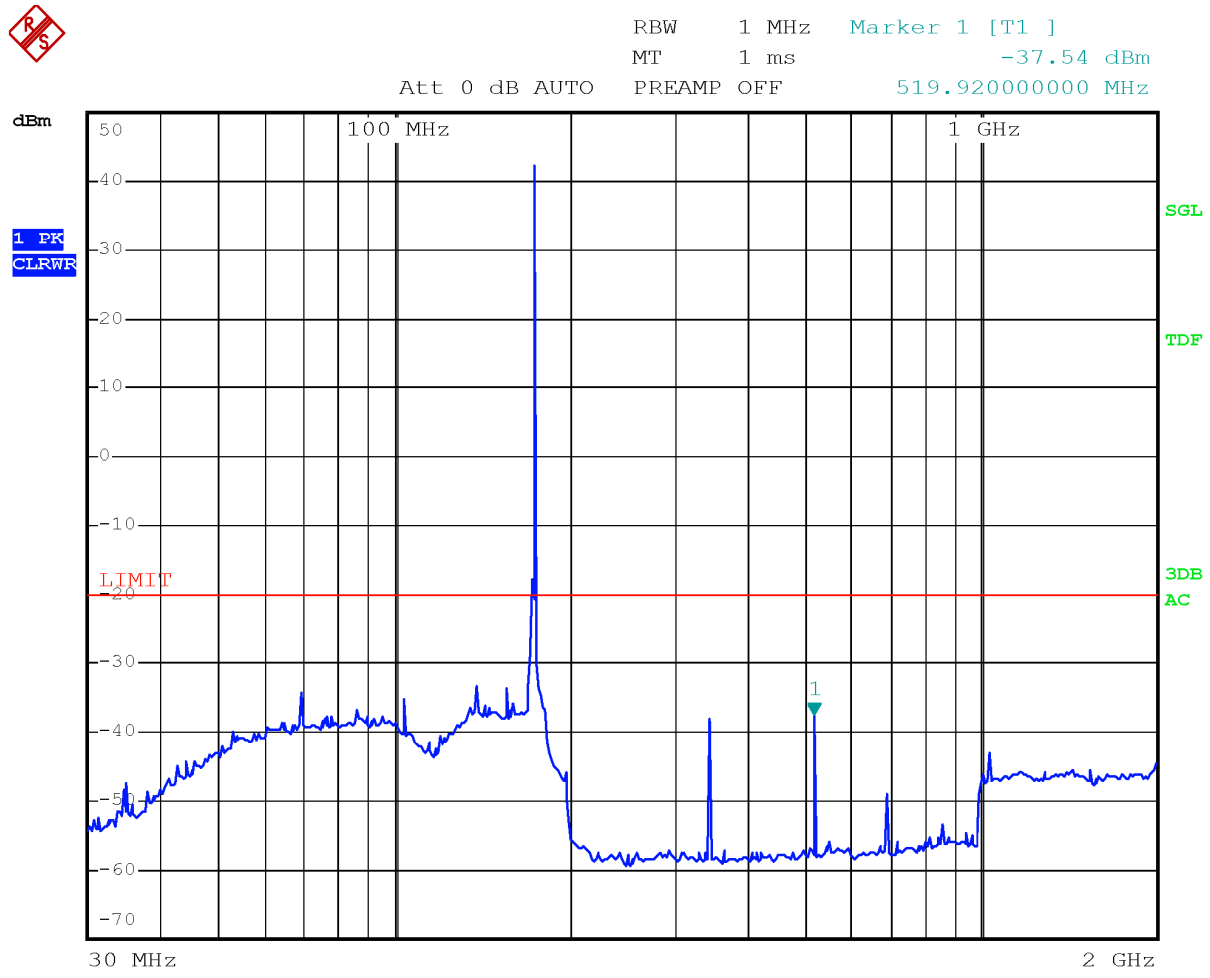


Channel MID – FM modulation with 25 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
58.0000	-37.7	-20.0	-17.6
324.0000	-37.3	-20.0	-17.2
486.0000	-40.2	-20.0	-20.1

Limit exceeds by the carrier

Test data

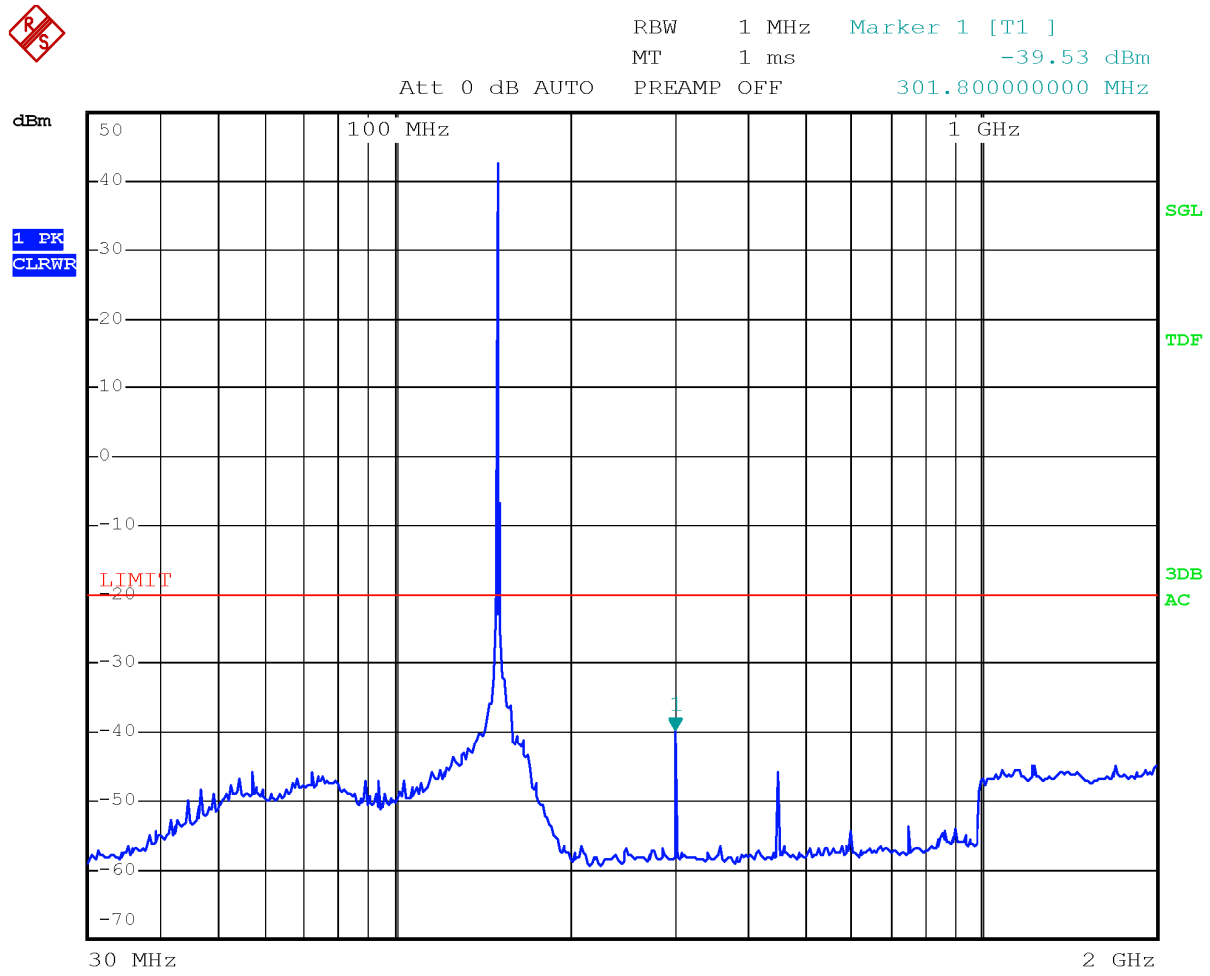


Channel HIGH – FM modulation with 25 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
69.3200	-34.4	-20.0	-14.3
104.0000	-35.2	-20.0	-15.1
138.6000	-33.4	-20.0	-13.3
156.0000	-33.5	-20.0	-13.4
346.6000	-38.0	-20.0	-17.9
519.9200	-37.6	-20.0	-17.5
693.2000	-49.2	-20.0	-29.1
1039.6000	-43.1	-20.0	-23.0

Limit exceeds by the carrier

Test data

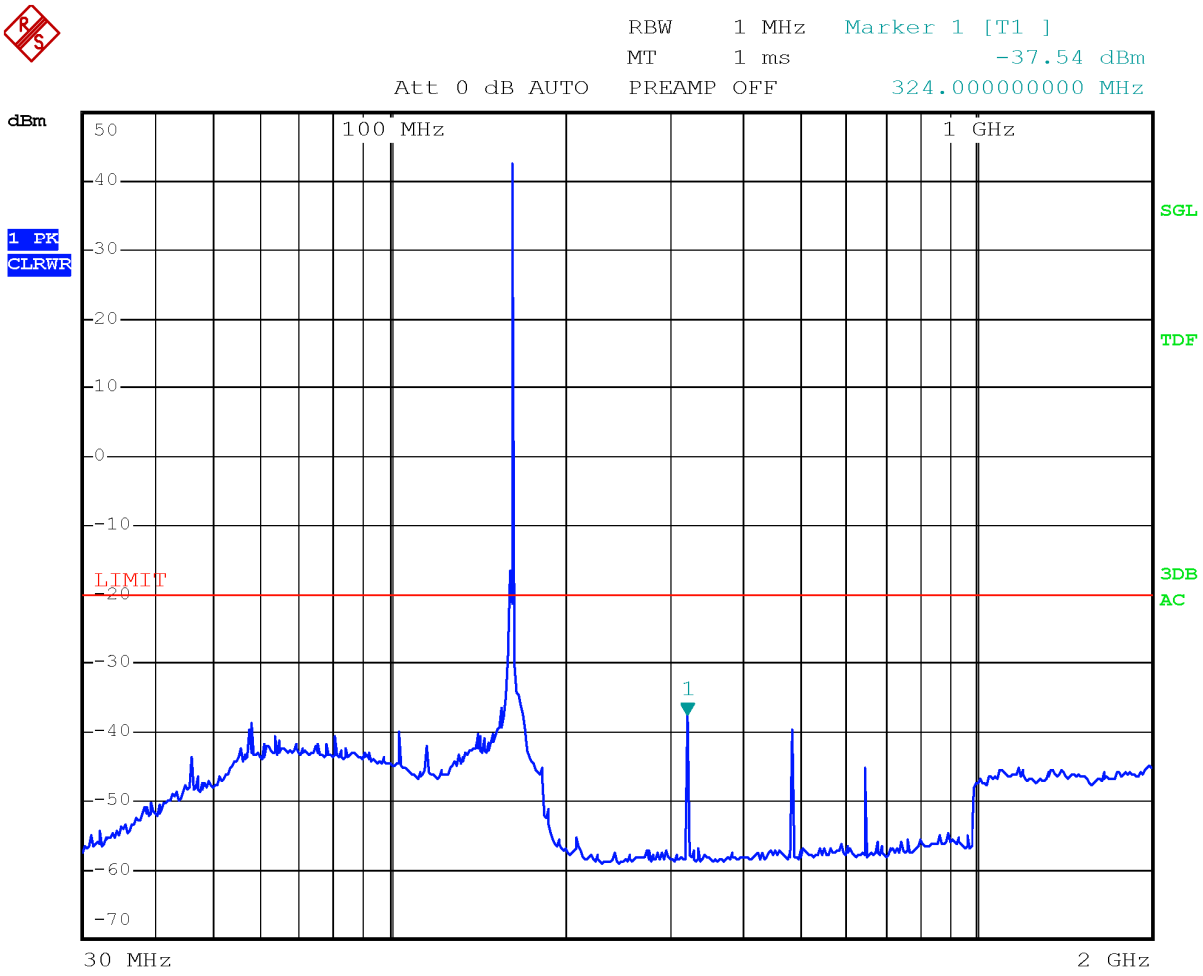


Channel LOW – FM modulation with 12.5 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
301.8000	-39.6	-20.0	-19.5

Limit exceeds by the carrier

Test data

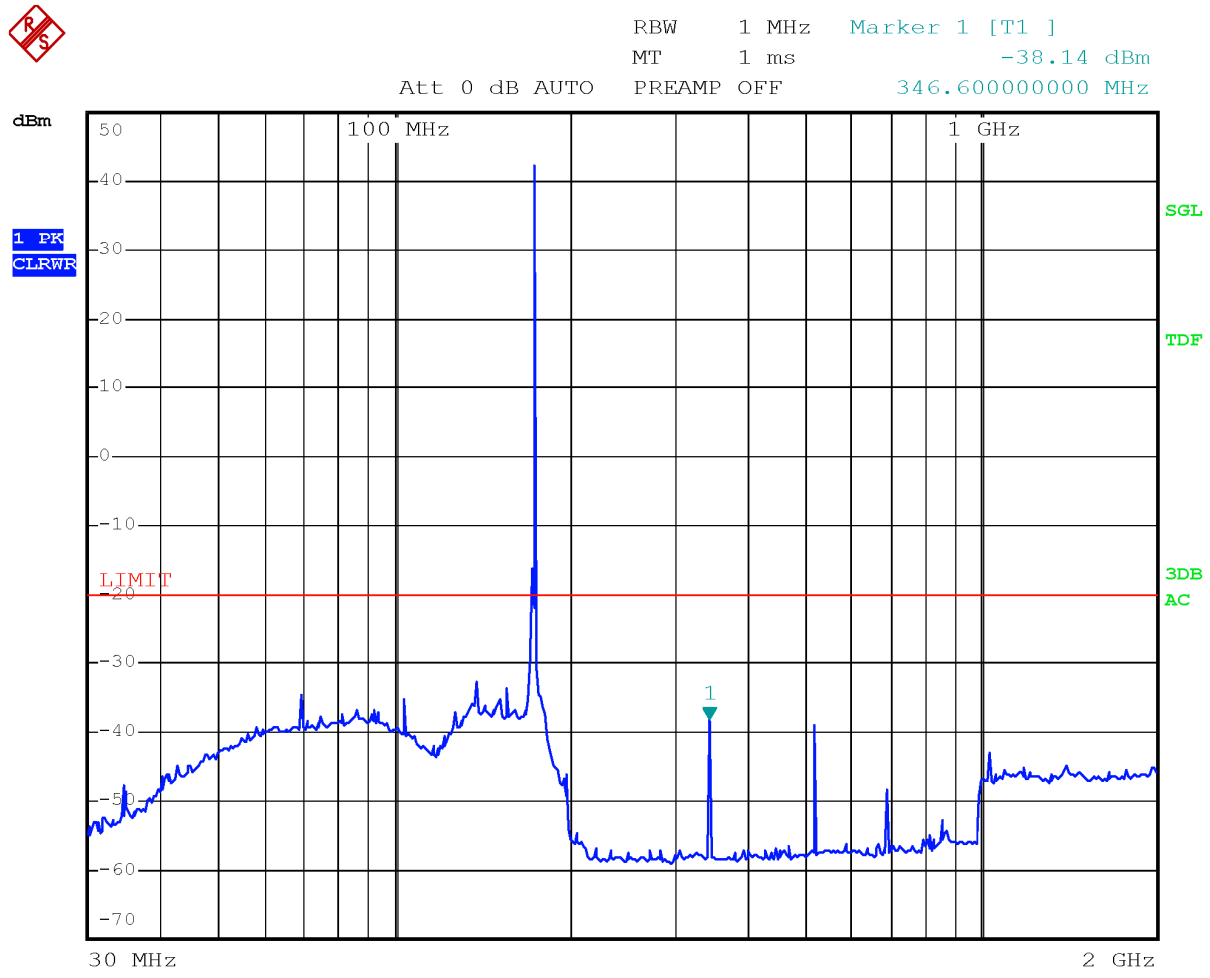


Channel MID – FM modulation with 12.5 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
58.0400	-38.8	-20.0	-18.7
104.0000	-39.9	-20.0	-19.8
324.0000	-37.6	-20.0	-17.5
486.0000	-39.8	-20.0	-19.7

Limit exceeds by the carrier

Test data

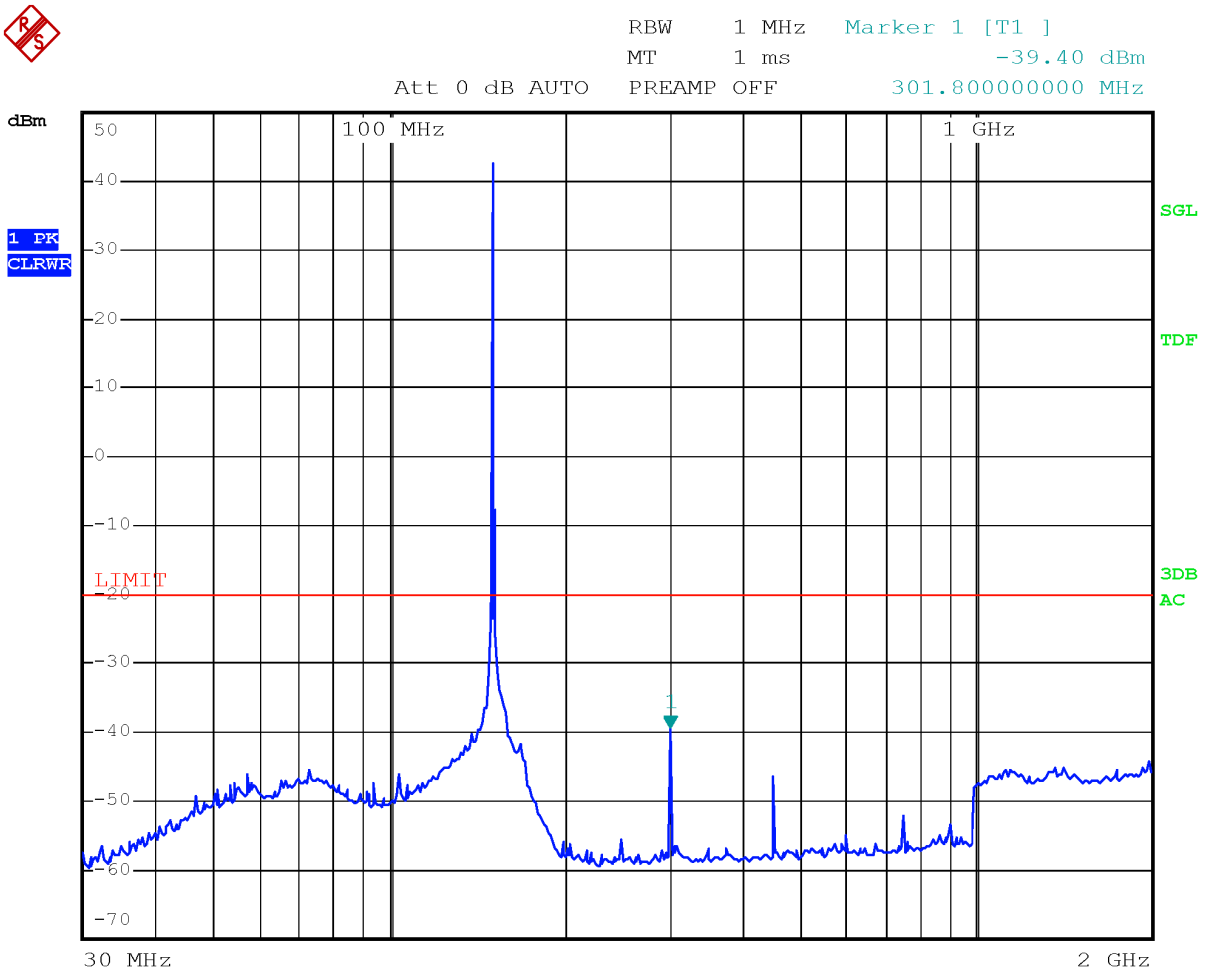


Channel HIGH – FM modulation with 12.5 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
69.2800	-34.5	-20.0	-14.4
104.0000	-35.2	-20.0	-15.1
138.6400	-32.8	-20.0	-12.7
156.0000	-33.8	-20.0	-13.7
346.6000	-38.2	-20.0	-18.1
519.9200	-39.0	-20.0	-18.9
693.2000	-48.5	-20.0	-28.4
1039.6000	-43.1	-20.0	-23.0

Limit exceeds by the carrier

Test data

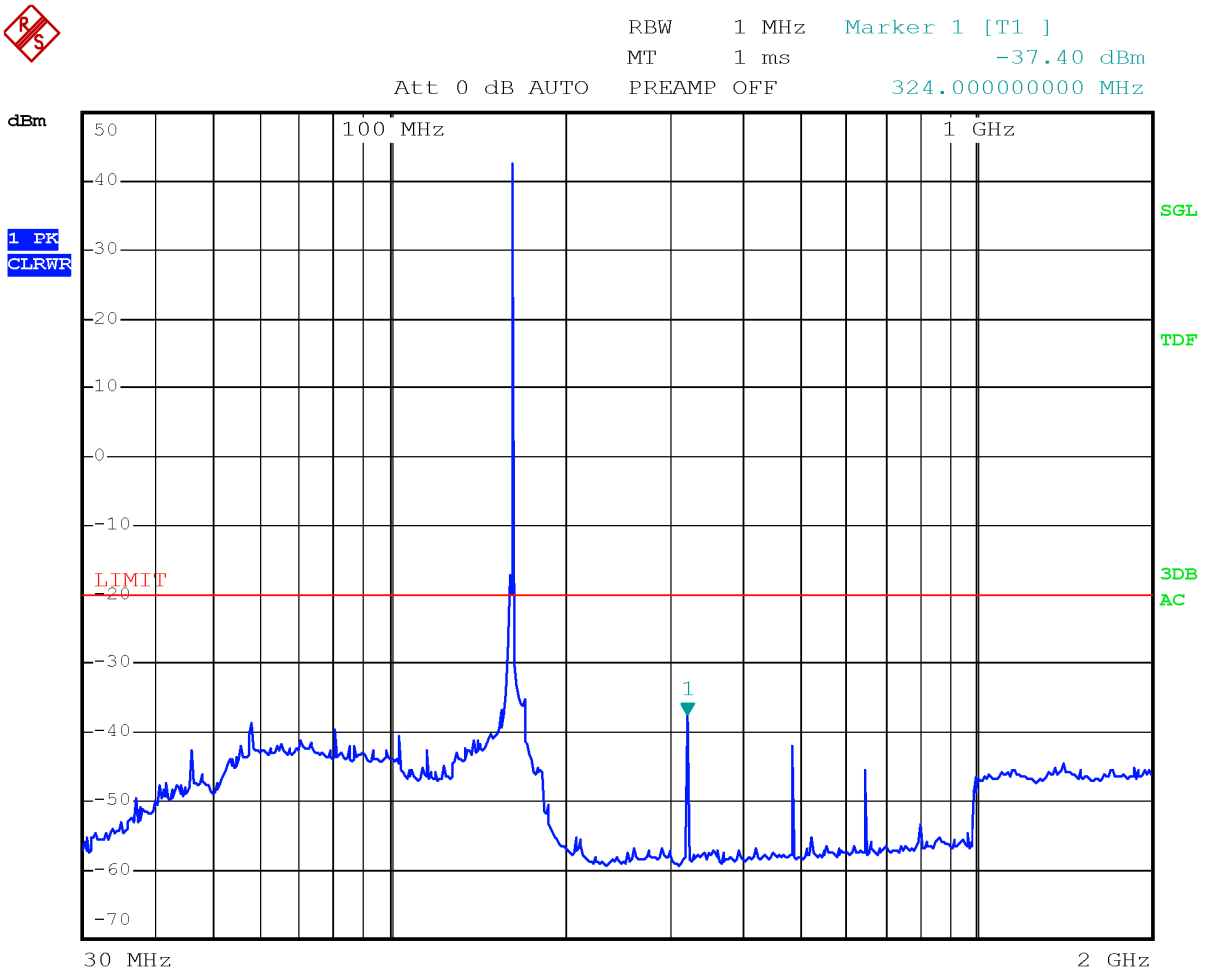


Channel LOW – 4FSK modulation with 12.5 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
301.8000	-39.4	-20.0	-19.3

Limit exceeds by the carrier

Test data

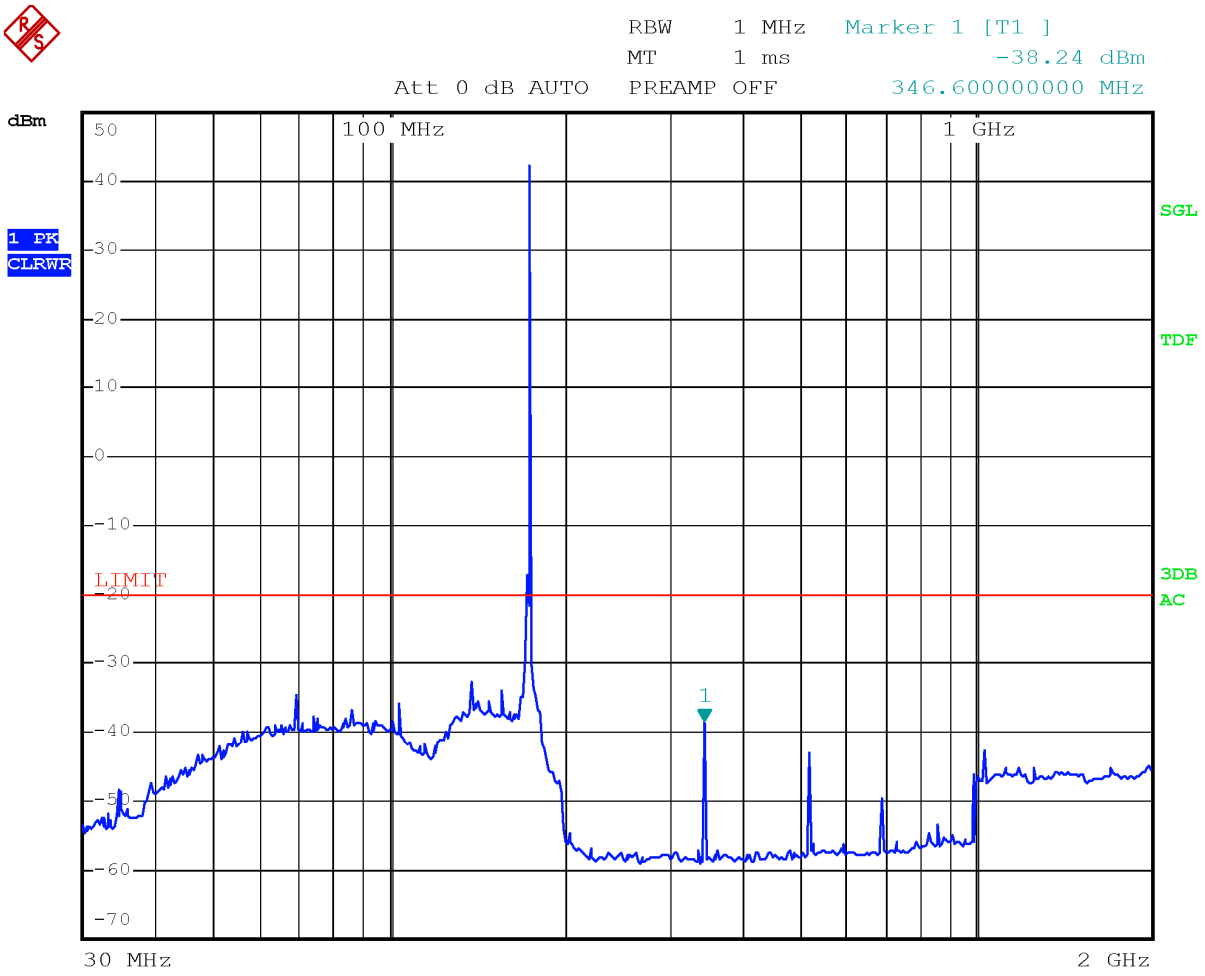


Channel MID – 4FSK modulation with 12.5 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
58.0000	-38.8	-20.0	-18.7
81.0000	-39.8	-20.0	-19.7
324.0000	-37.5	-20.0	-17.4

Limit exceeds by the carrier

Test data

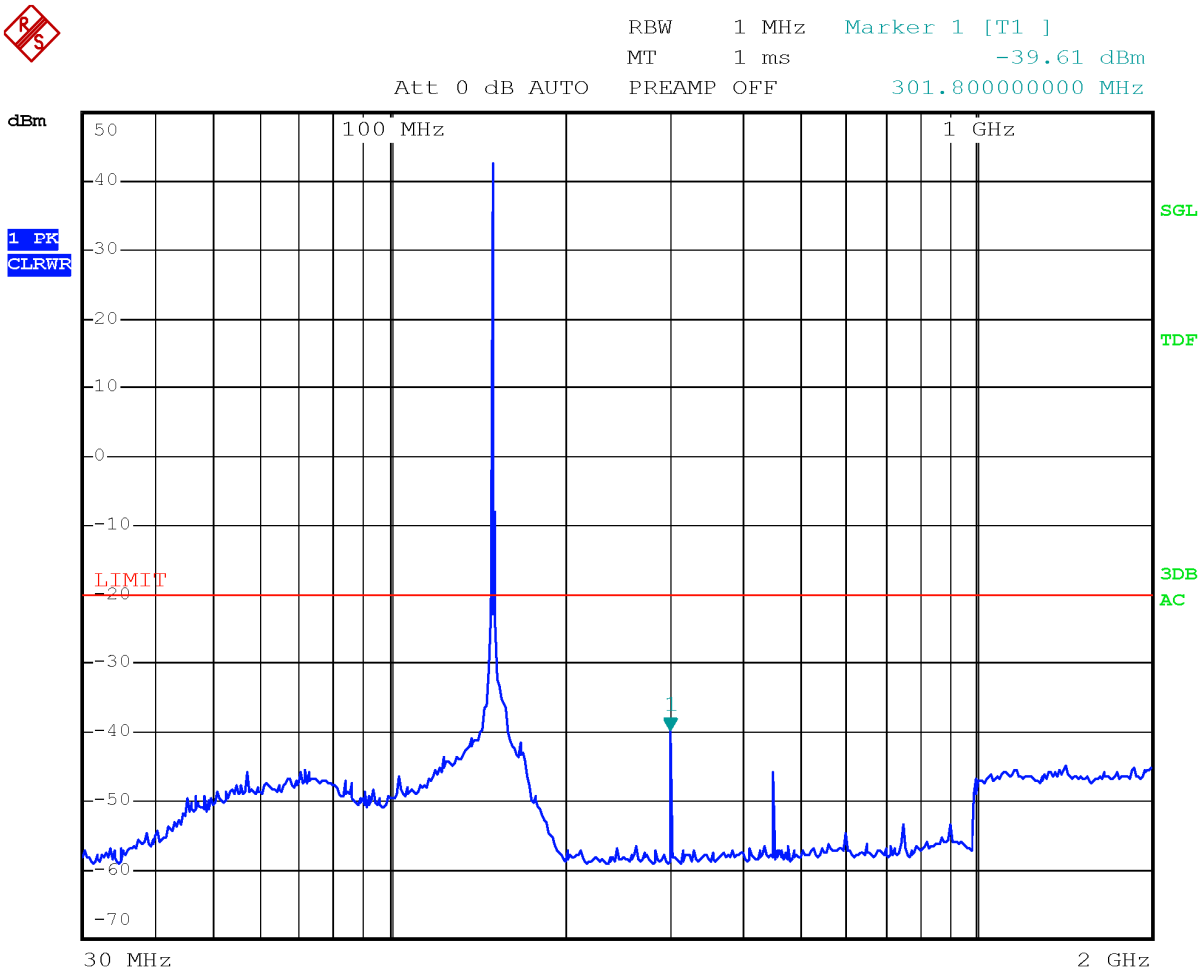


Channel HIGH – 4FSK modulation with 12.5 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
69.3200	-34.5	-20.0	-14.4
86.6000	-37.0	-20.0	-16.9
104.0000	-35.9	-20.0	-15.8
138.6000	-32.9	-20.0	-12.8
156.0000	-33.9	-20.0	-13.8
346.6000	-38.3	-20.0	-18.2

Limit exceeds by the carrier

Test data

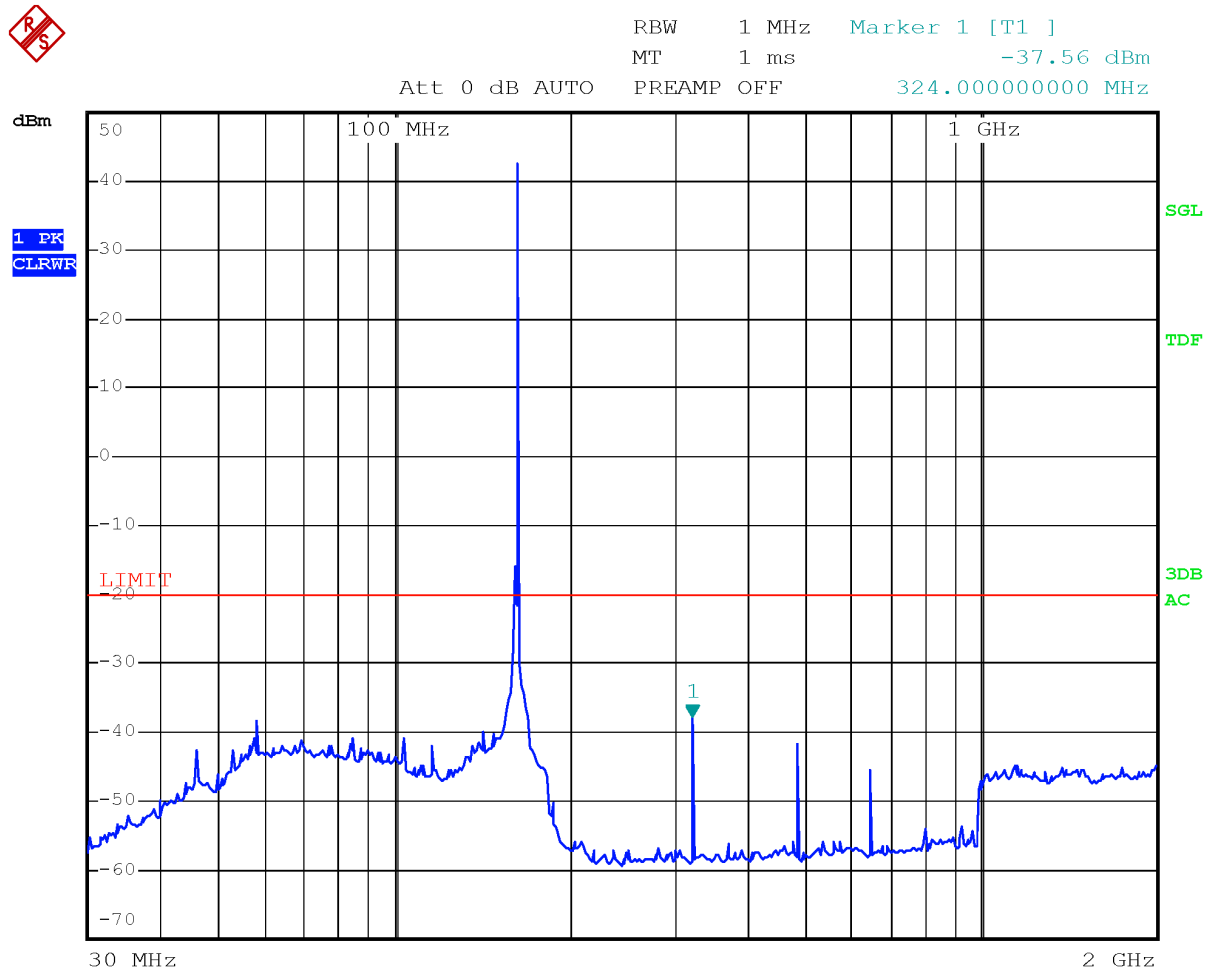


Channel LOW – C4FM modulation with 12.5 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
301.8000	-39.7	-20.0	-19.6

Limit exceeds by the carrier

Test data

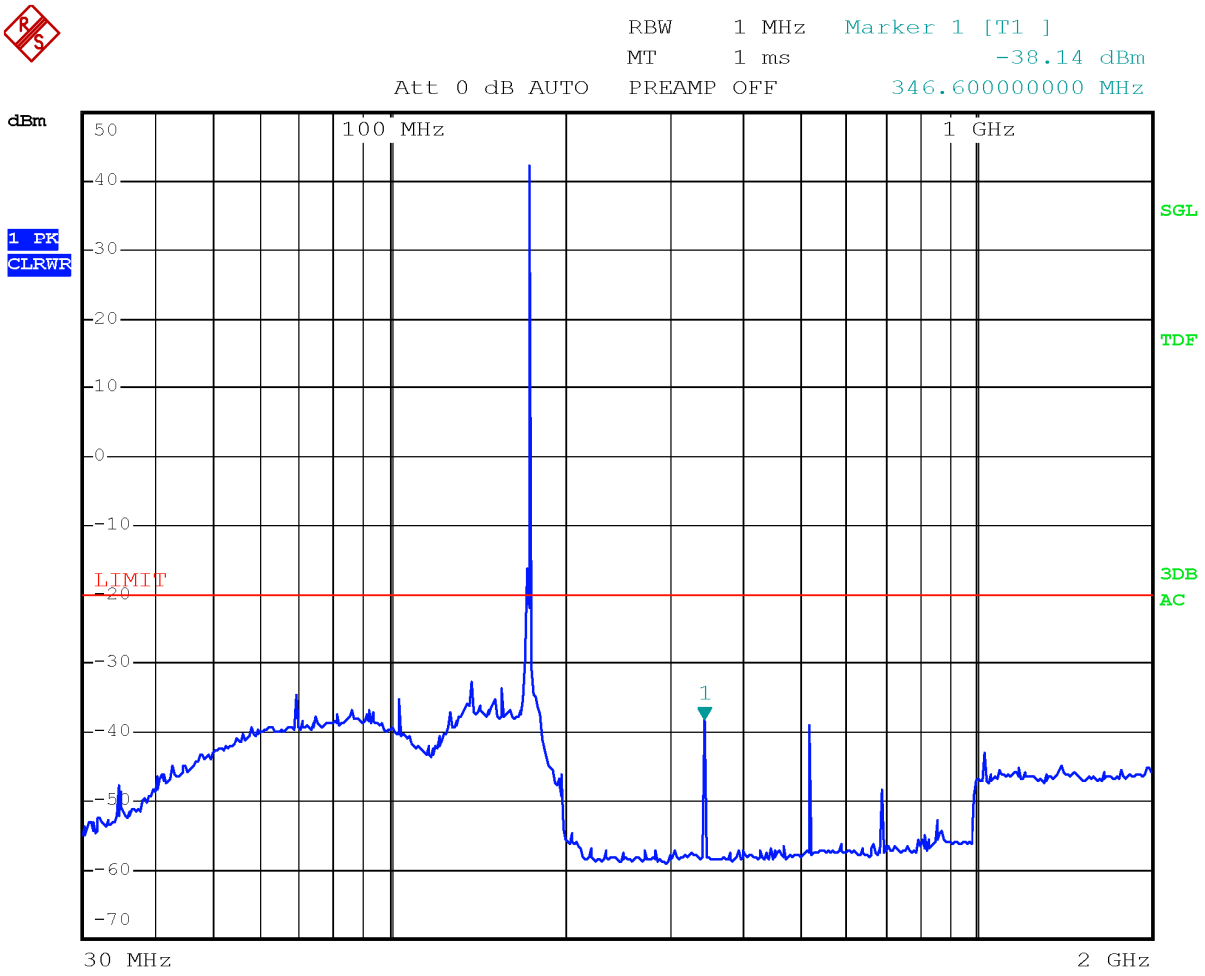


Channel MID – C4FM modulation with 12.5 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
58.0400	-38.5	-20.0	-18.4
324.0000	-37.6	-20.0	-17.5

Limit exceeds by the carrier

Test data



Channel HIGH – C4FM modulation with 12.5 kHz channel bandwidth

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
69.3200	-35.2	-20.0	-15.1
104.0000	-35.9	-20.0	-15.8
138.6000	-32.2	-20.0	-12.1
156.0000	-34.1	-20.0	-14.0
346.6000	-38.2	-20.0	-18.1

Limit exceeds by the carrier

Clause 90.210 and 22.359 Field strength of spurious radiation

§90.210 Emission masks.

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (o) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth. Unless indicated elsewhere in this part, the table in this section specifies the emission masks for equipment operating under this part.

APPLICABLE EMISSION MASKS

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
Below 25[1]	A or B	A or C
25-50	B	C
72-76	B	C
150-174[2]	B, D, or E	C, D or E
150 paging only	B	C
220-222	F	F
421-512[2 5]	B, D, or E	C, D, or E
450 paging only	B	G
806-809/851-854[6]	B	H
809-824/854-869[35]	B, D	D, G.
896-901/935-940	I	J
902-928	K	K
929-930	B	G
4940-4990 MHz	L or M	L or M
5850-5925[4]		
All other bands	B	C

Emission Mask B. For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(4) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(5) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

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

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:

(9) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0: Zero dB.

(10) 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(fd–2.88 kHz) dB.

(11) 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.

(12) 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.

§22.359 Emission limitations.

The rules in this section govern the spectral characteristics of emissions in the Public Mobile Services, except for the Air-Ground Radiotelephone Service (see §22.861, instead) and the Cellular Radiotelephone Service (see §22.917, instead).

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 30 kHz or more. In the 60 kHz bands immediately outside and adjacent to the authorized frequency range or channel, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e., 30 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(c) Alternative out of band emission limit. Licensees in the Public Mobile Services may establish an alternative out of band emission limit to be used at specified frequencies (band edges) in specified geographical areas, in lieu of that set forth in this section, pursuant to a private contractual arrangement of all affected licensees and applicants. In this event, each party to such contract shall maintain a copy of the contract in their station files and disclose it to prospective assignees or transferees and, upon request, to the FCC.

(d) Interference caused by out of band emissions. If any emission from a transmitter operating in any of the Public Mobile Services results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

§2.1053 Measurements required: Field strength of spurious radiation.

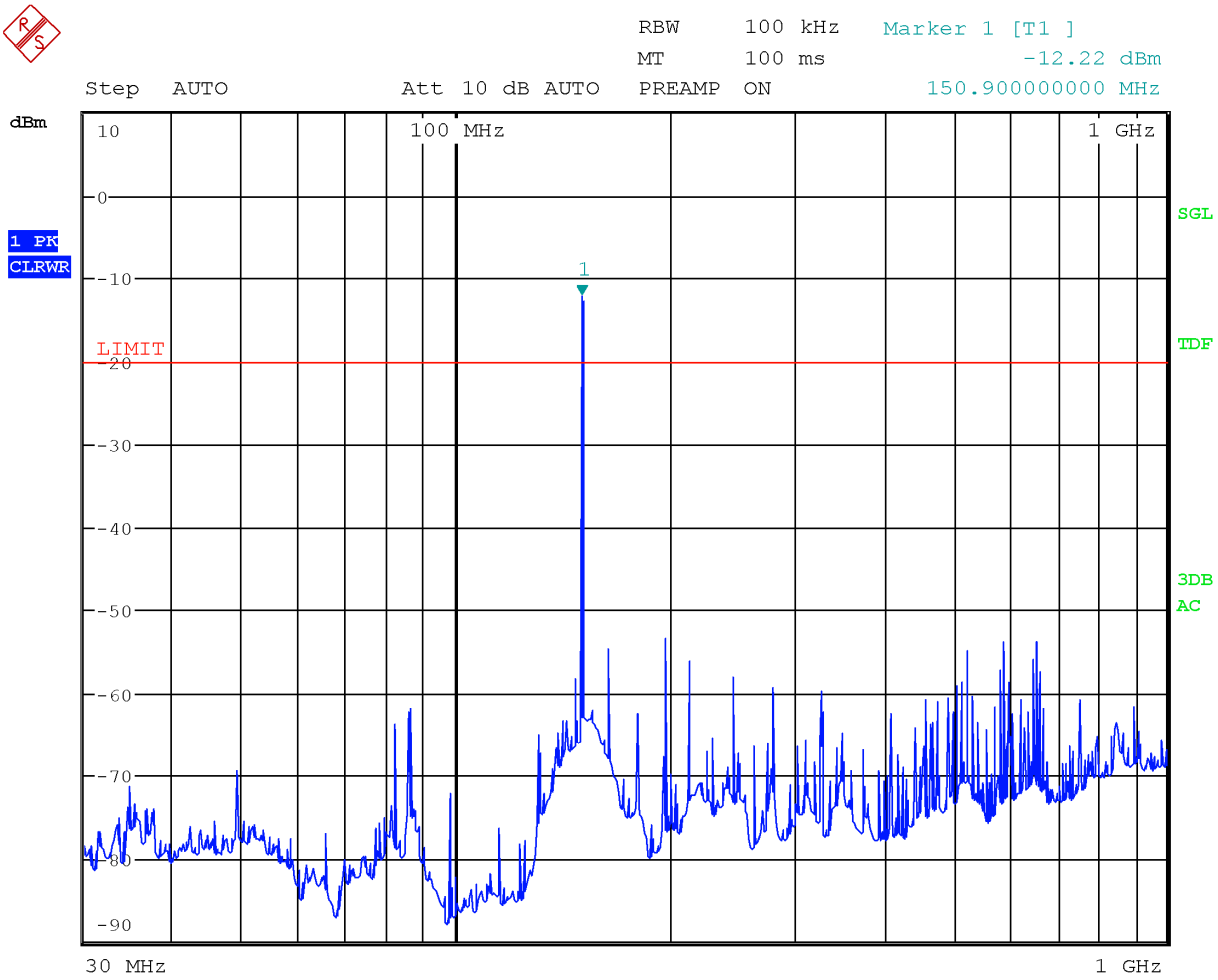
(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.
(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
(2) All equipment operating on frequencies higher than 25 MHz.
(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.

Other types of equipment as required, when deemed necessary by the Commission.

Test date: 2019-06-30
Test results: Pass
Modulation used: 16K0F3E, 11K0F3E, 7K60FXE, 8K0F1E

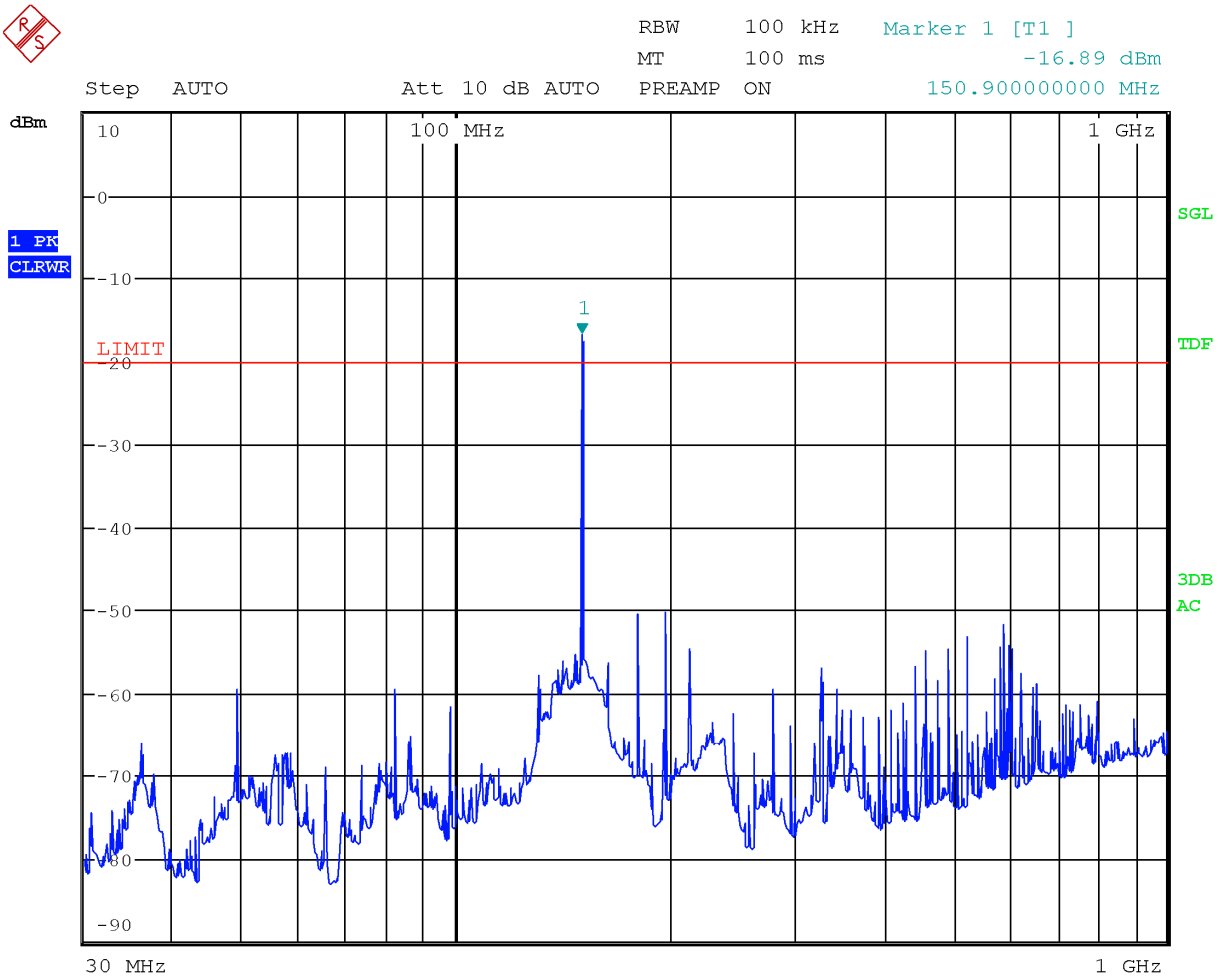
Test data



Channel LOW – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 30 MHz to 1000 MHz with antenna in horizontal polarization

Limit exceeds by the carrier

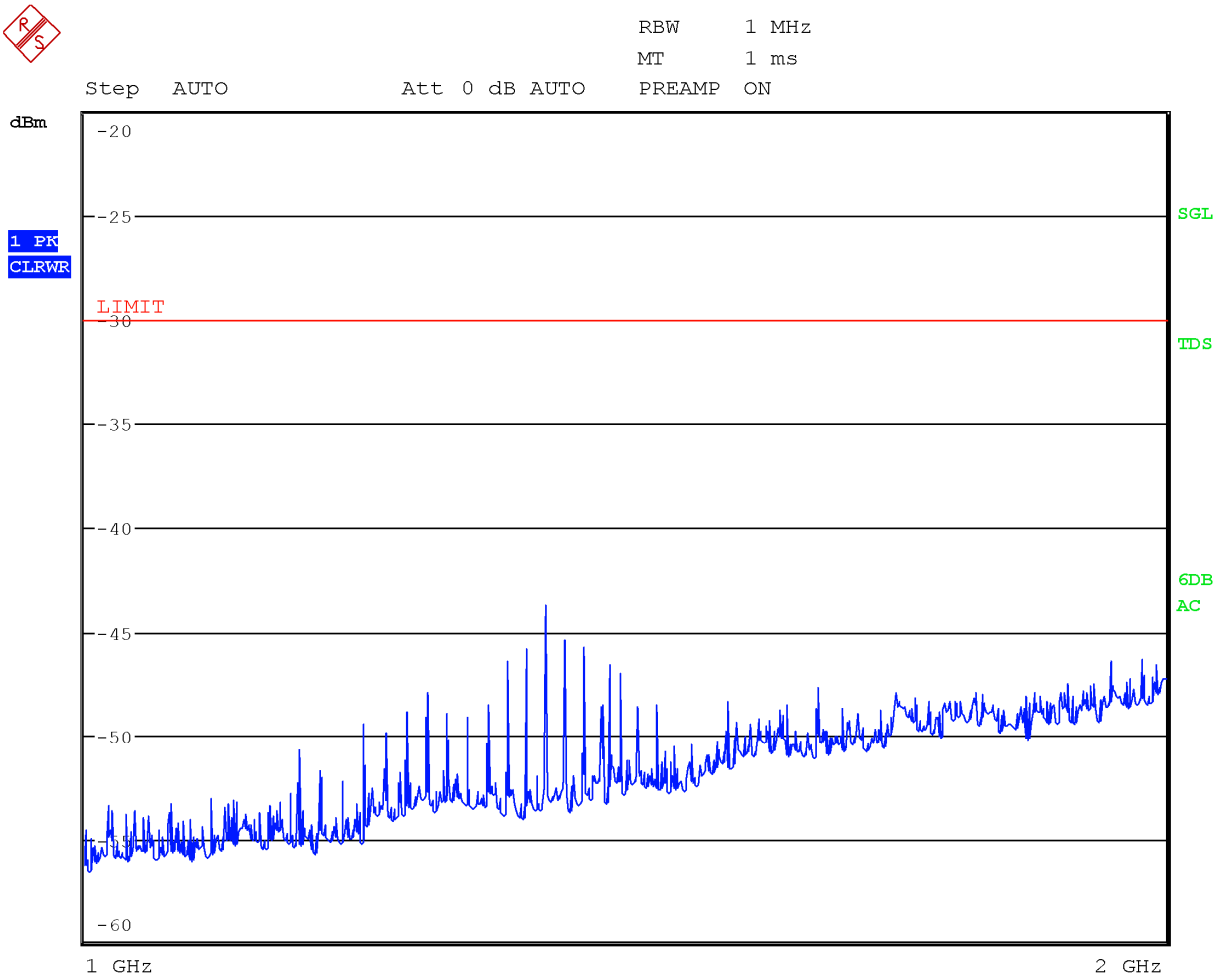
Test data



Channel LOW – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 30 MHz to 1000 MHz with antenna in vertical polarization

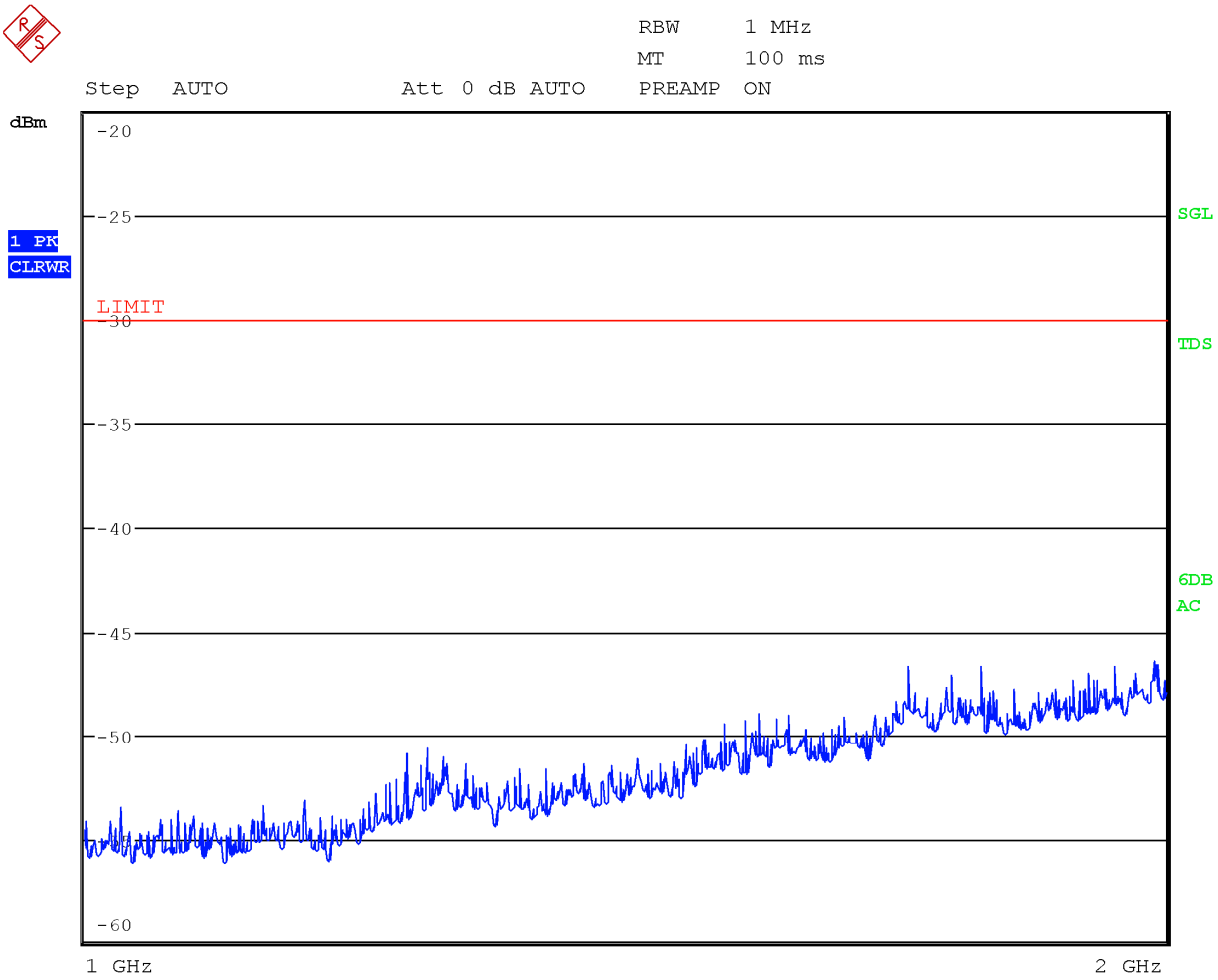
Limit exceeds by the carrier

Test data



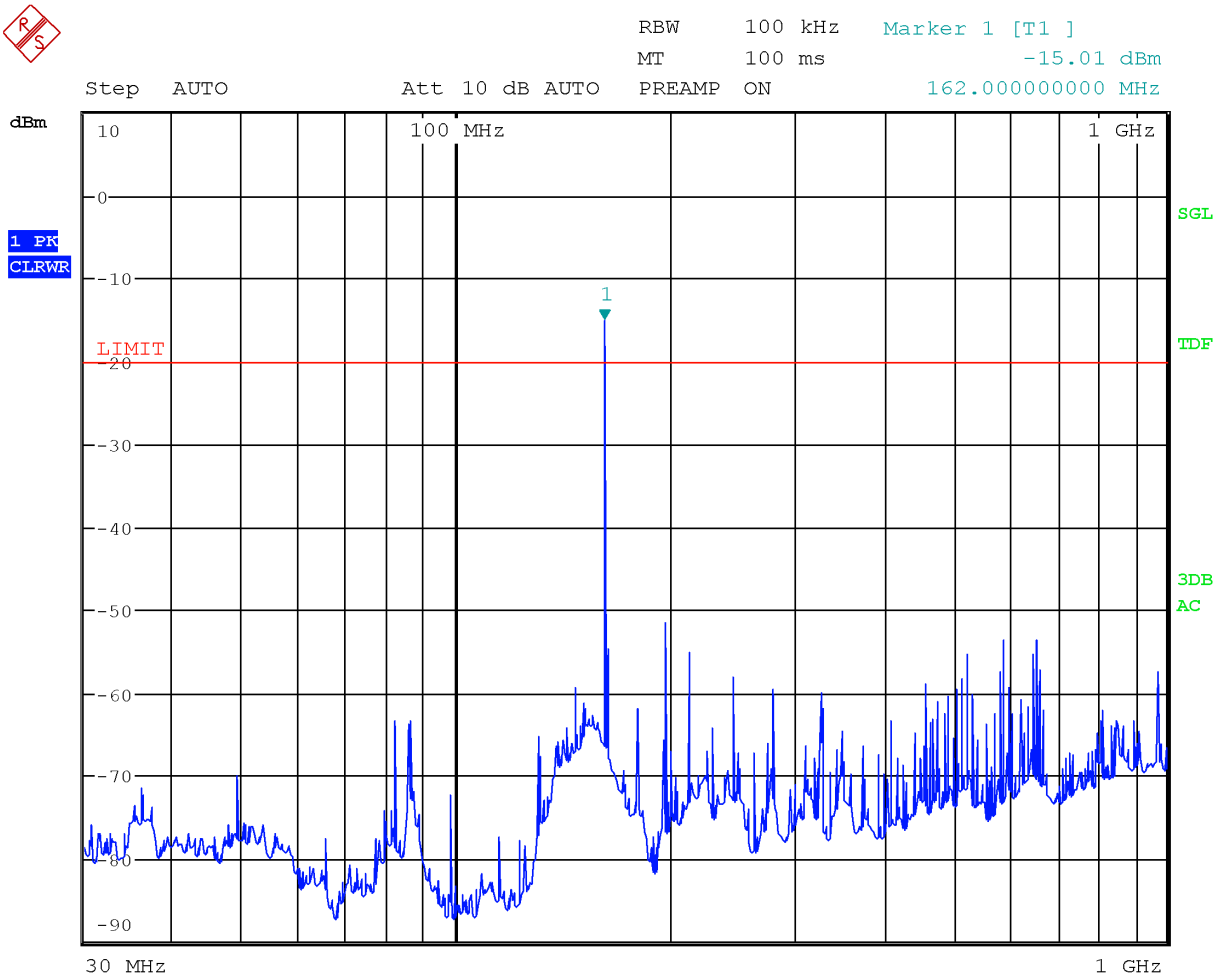
Channel LOW – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 1000 MHz to 2000 MHz with antenna in horizontal polarization

Test data



Channel LOW – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 1000 MHz to 2000 MHz with antenna in vertical polarization

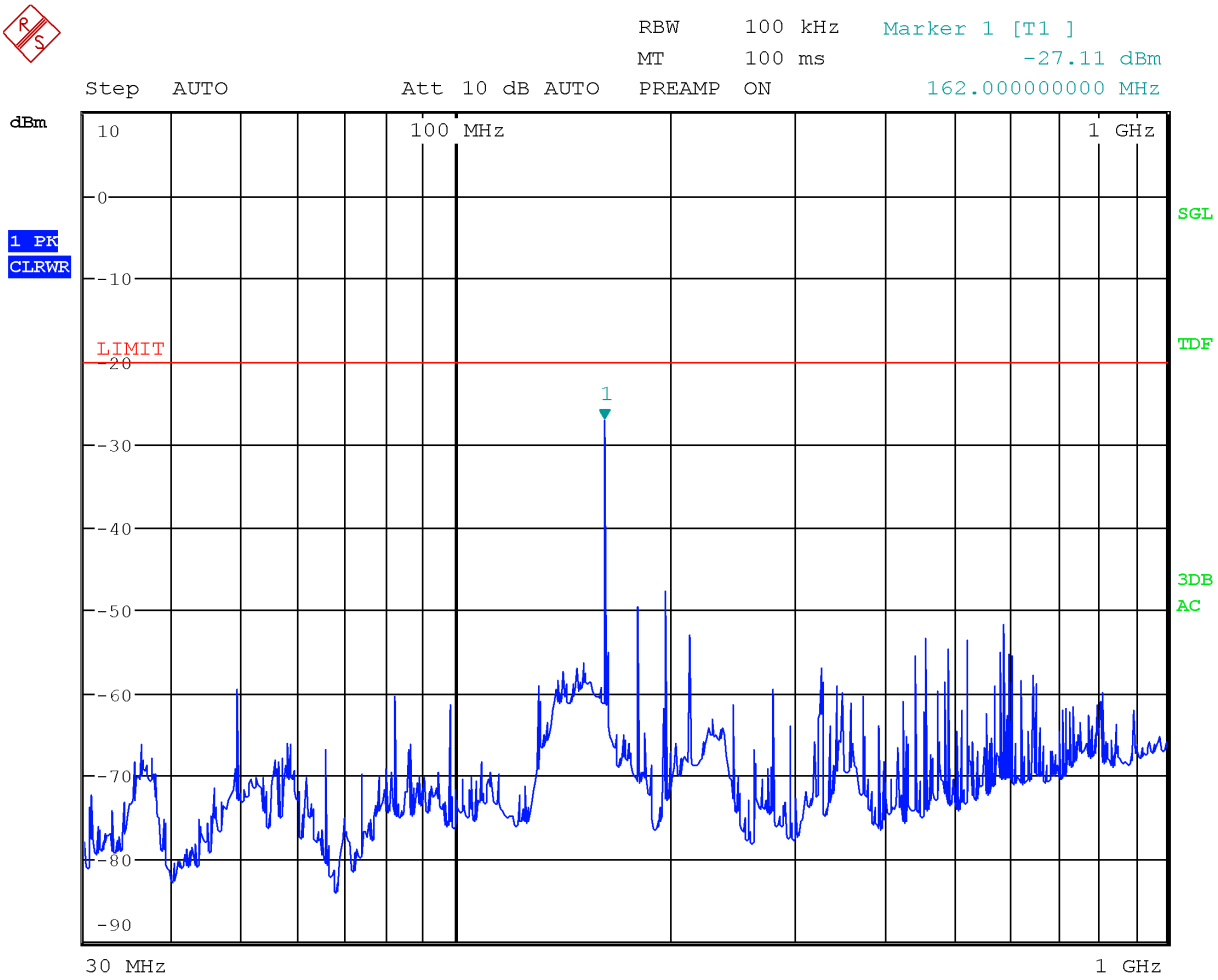
Test data



Channel MID – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 30 MHz to 1000 MHz with antenna in horizontal polarization

Limit exceeds by the carrier

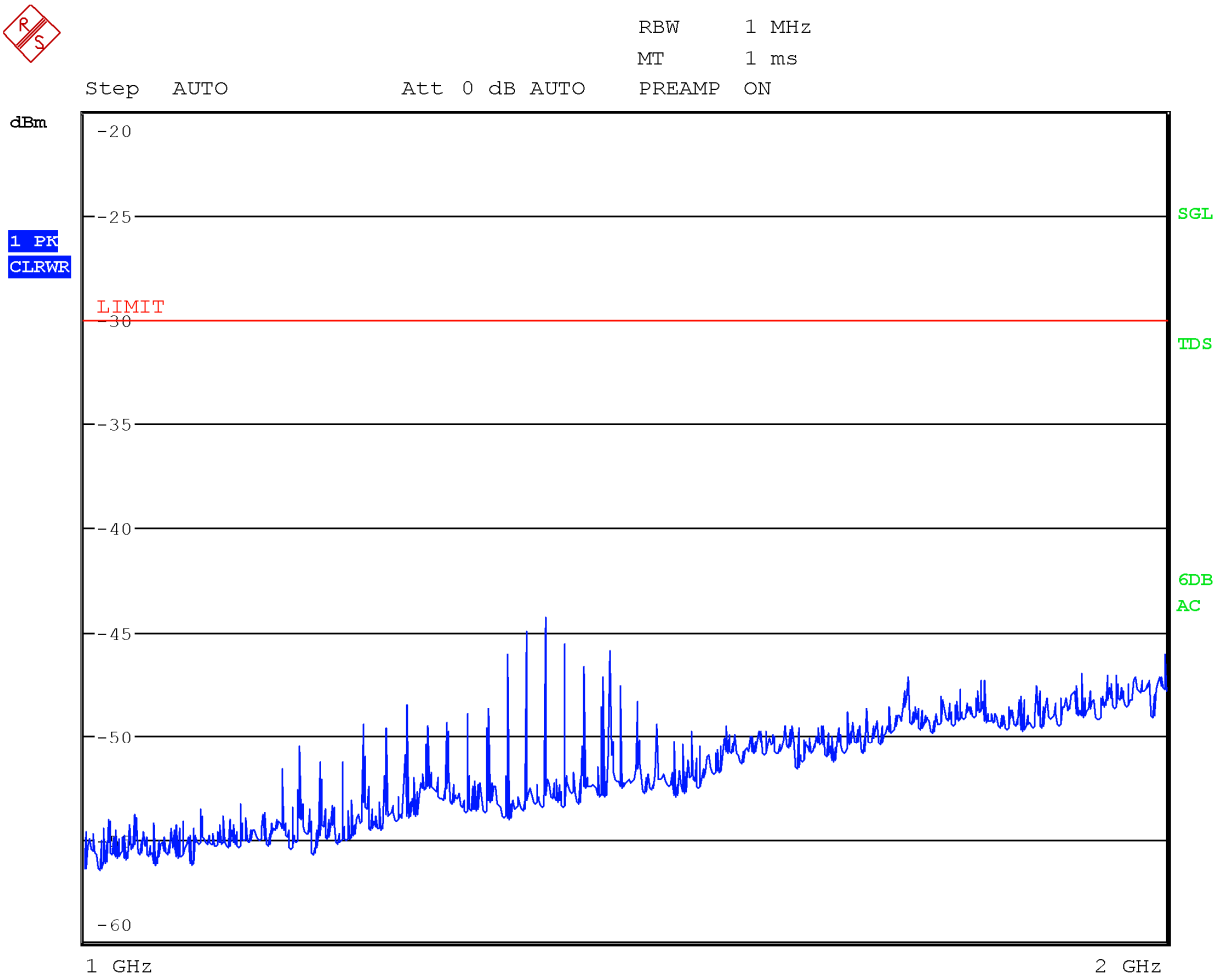
Test data



Channel MID – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 30 MHz to 1000 MHz with antenna in vertical polarization

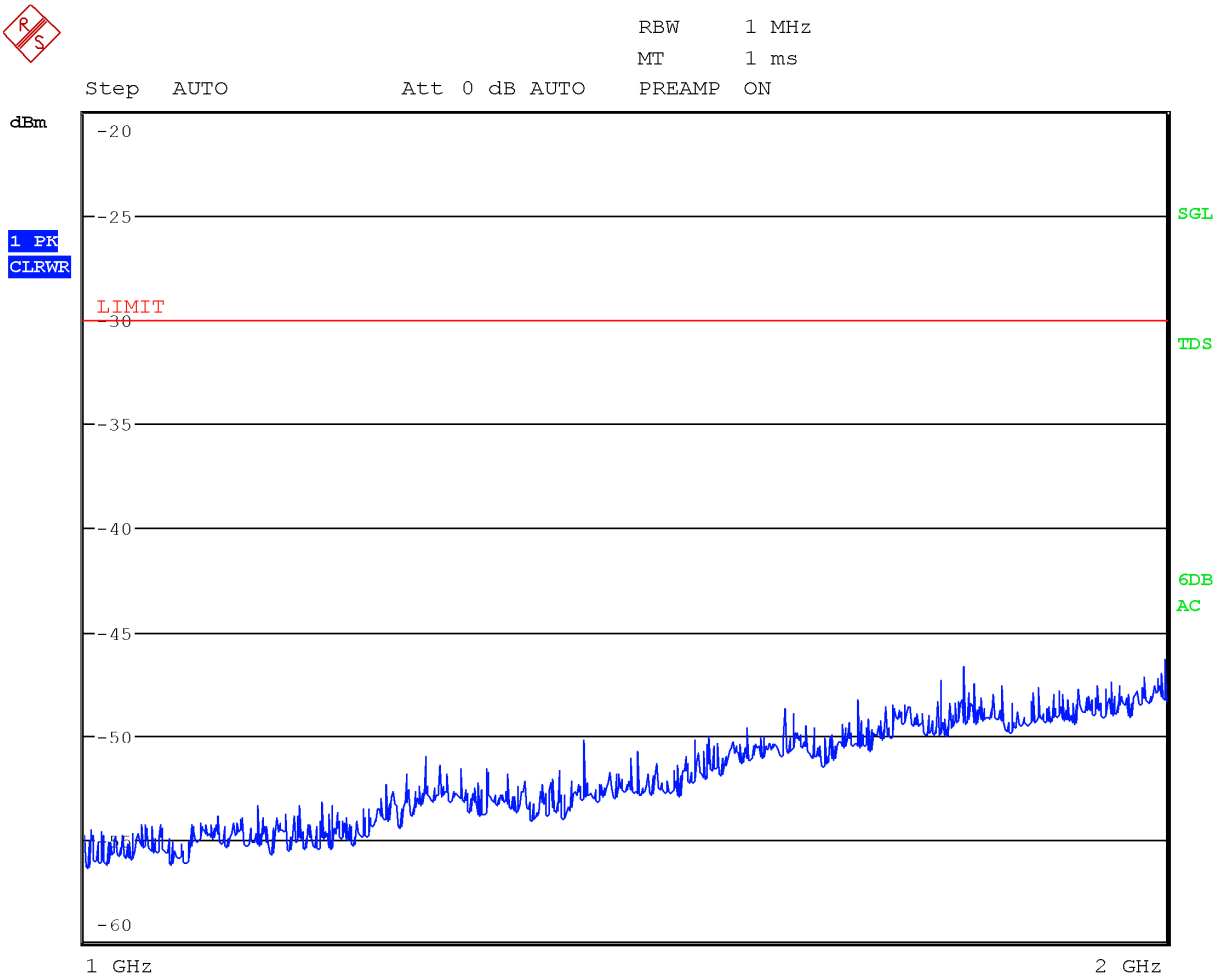
Limit exceeds by the carrier

Test data



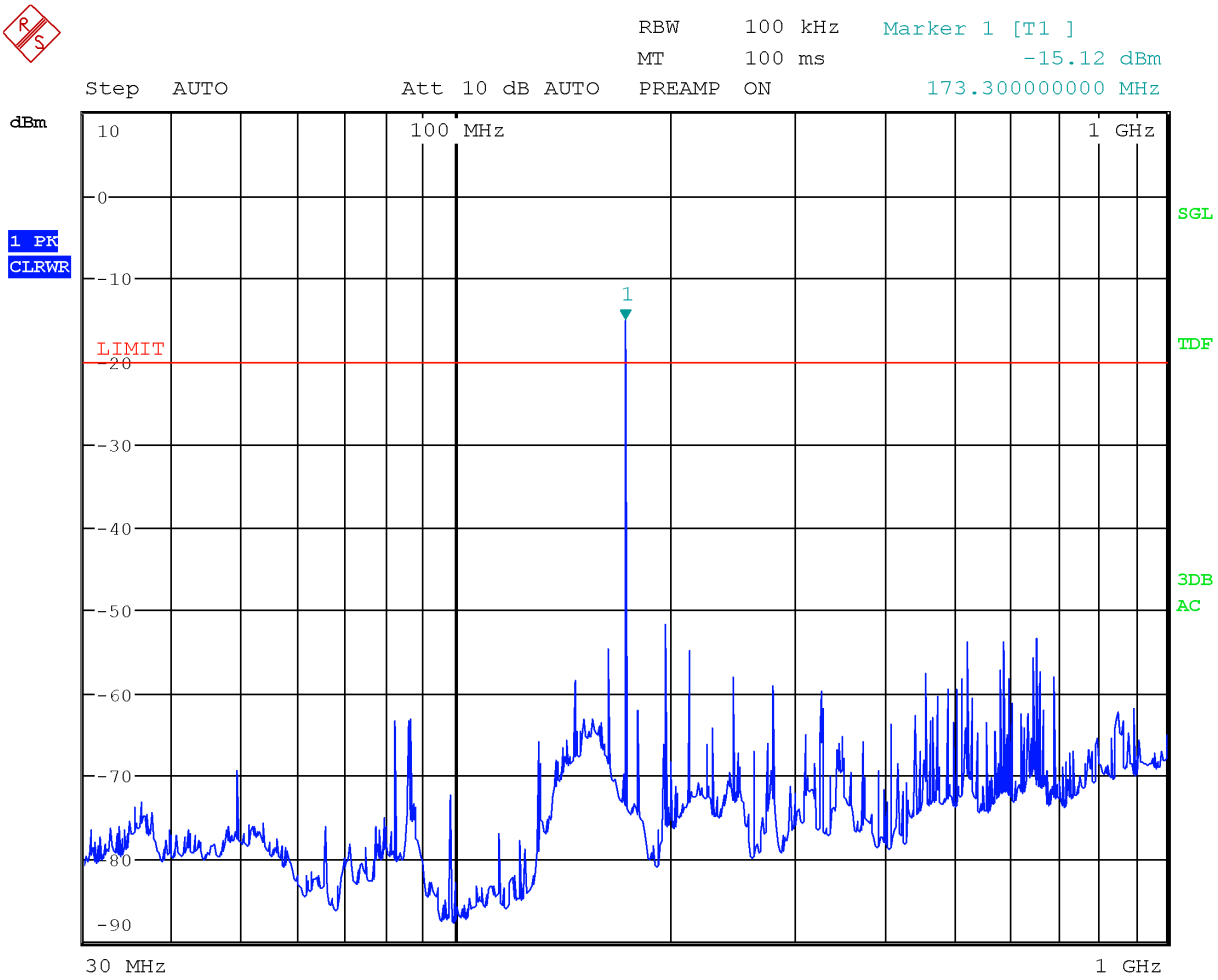
Channel MID – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 1000 MHz to 2000 MHz with antenna in horizontal polarization

Test data



Channel MID – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 1000 MHz to 2000 MHz with antenna in vertical polarization

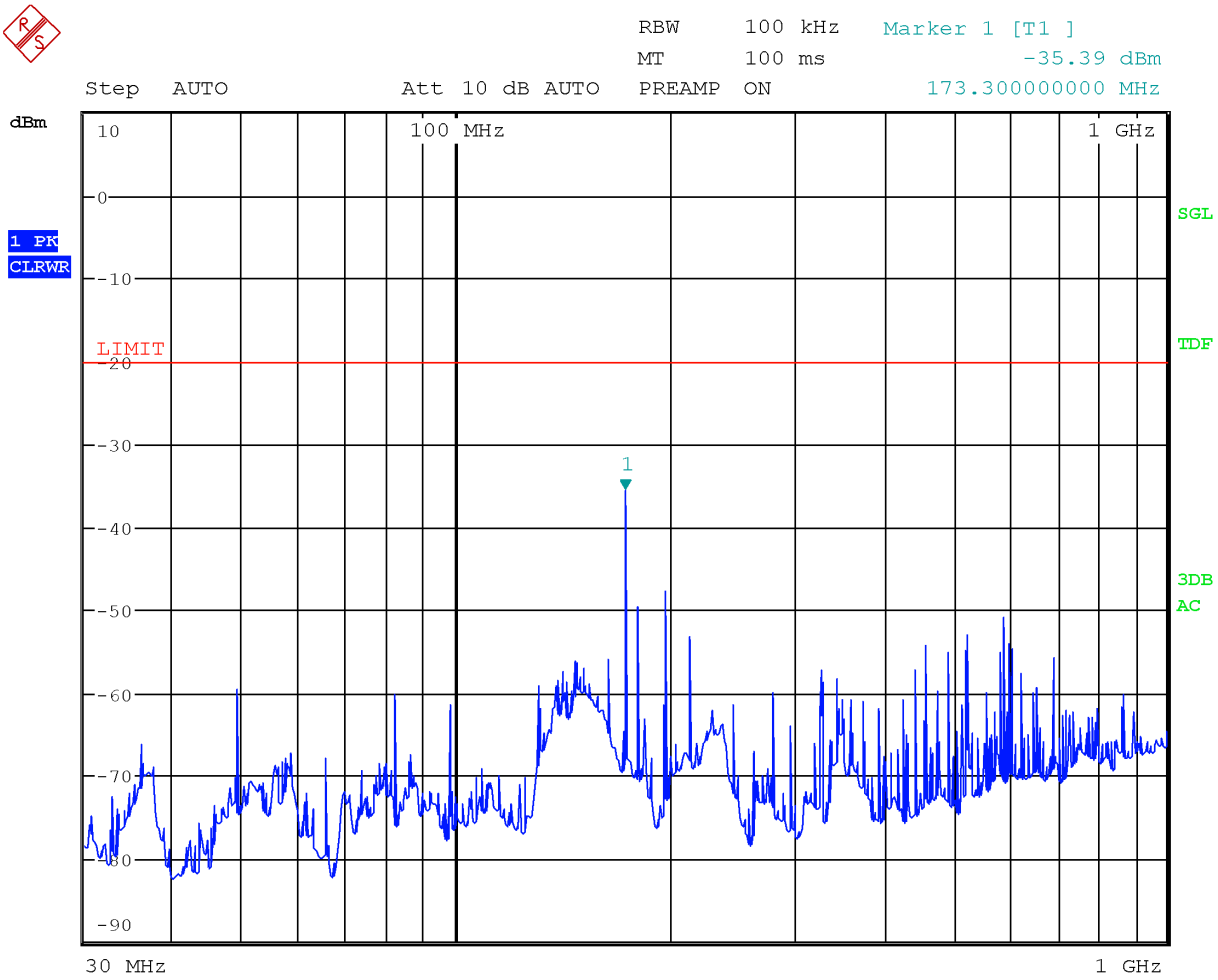
Test data



Channel HIGH – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 30 MHz to 1000 MHz with antenna in horizontal polarization

Limit exceeds by the carrier

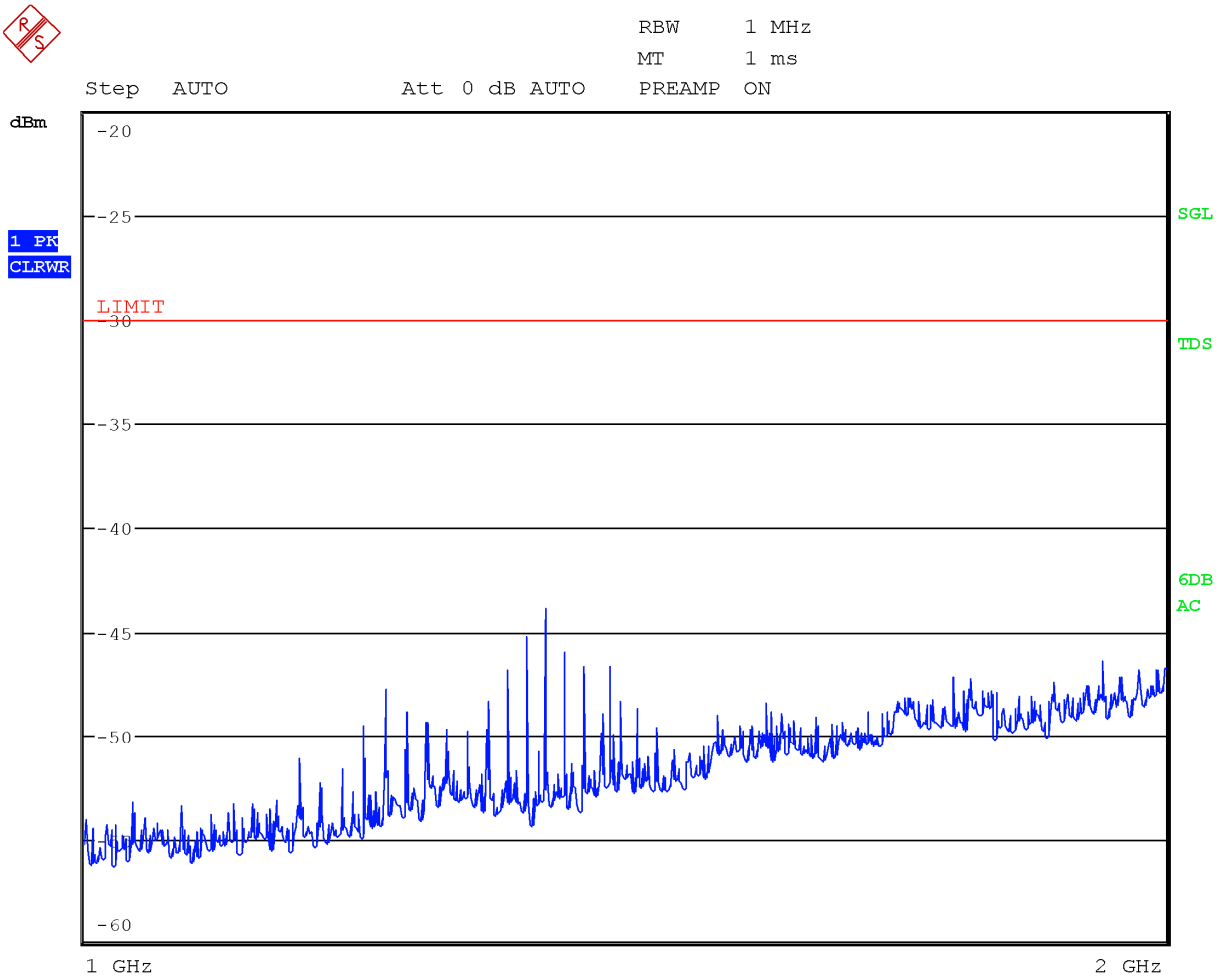
Test data



Channel HIGH – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 30 MHz to 1000 MHz with antenna in vertical polarization

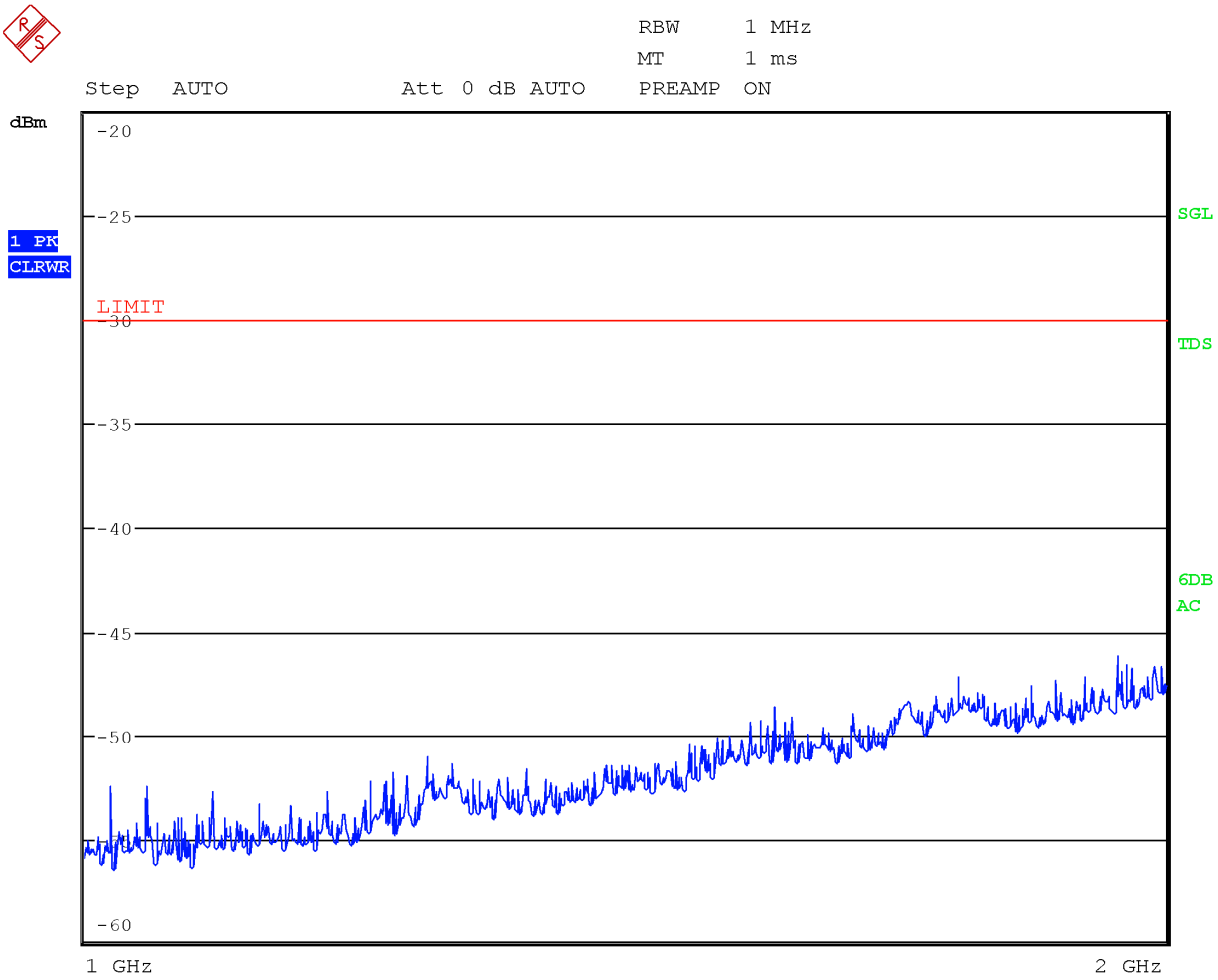
Limit exceeds by the carrier

Test data



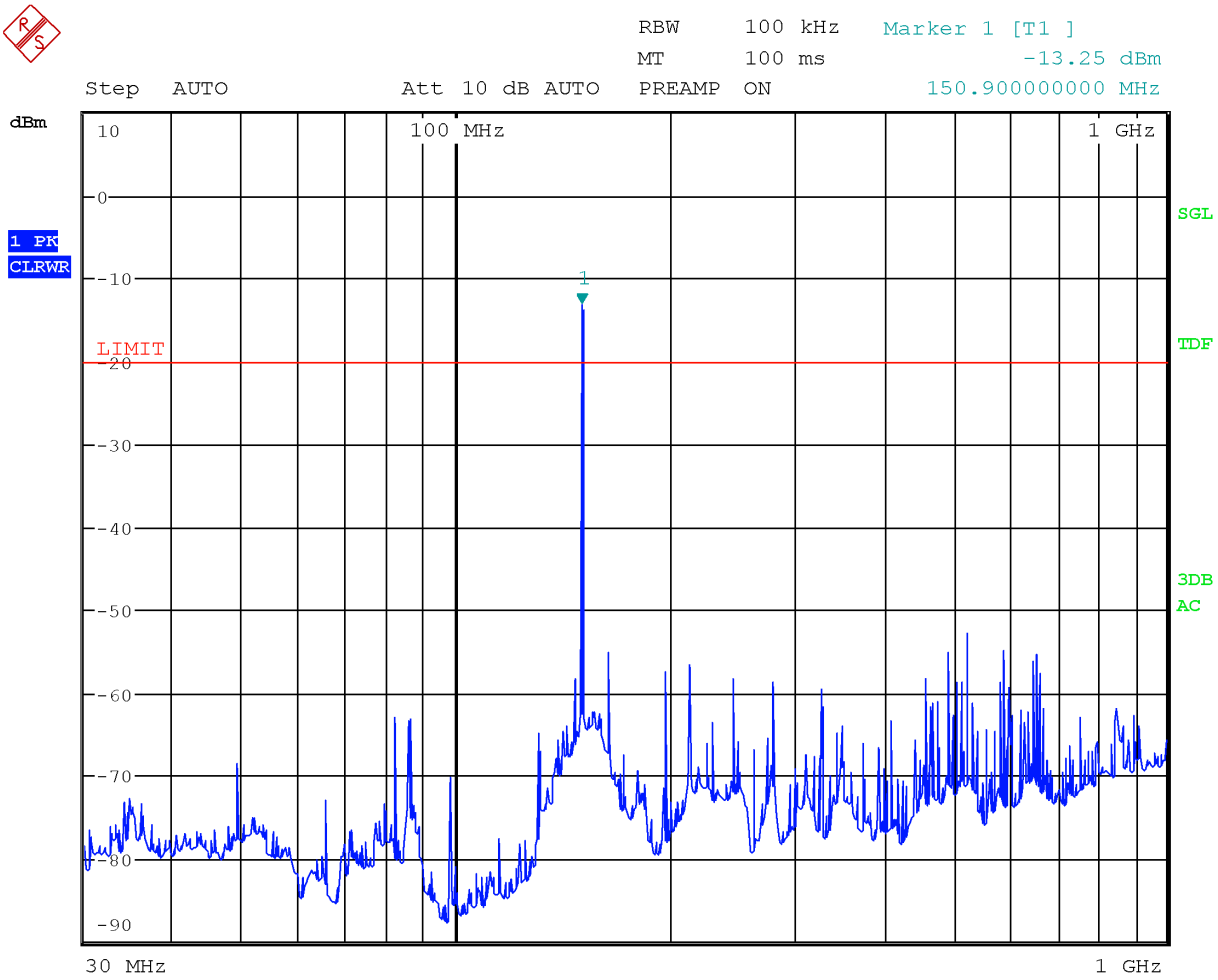
Channel HIGH – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 1000 MHz to 2000 MHz with antenna in horizontal polarization

Test data



Channel HIGH – 12.5 kHz channel bandwidth modulation (same result for all modulations)
Frequency range 1000 MHz to 2000 MHz with antenna in vertical polarization

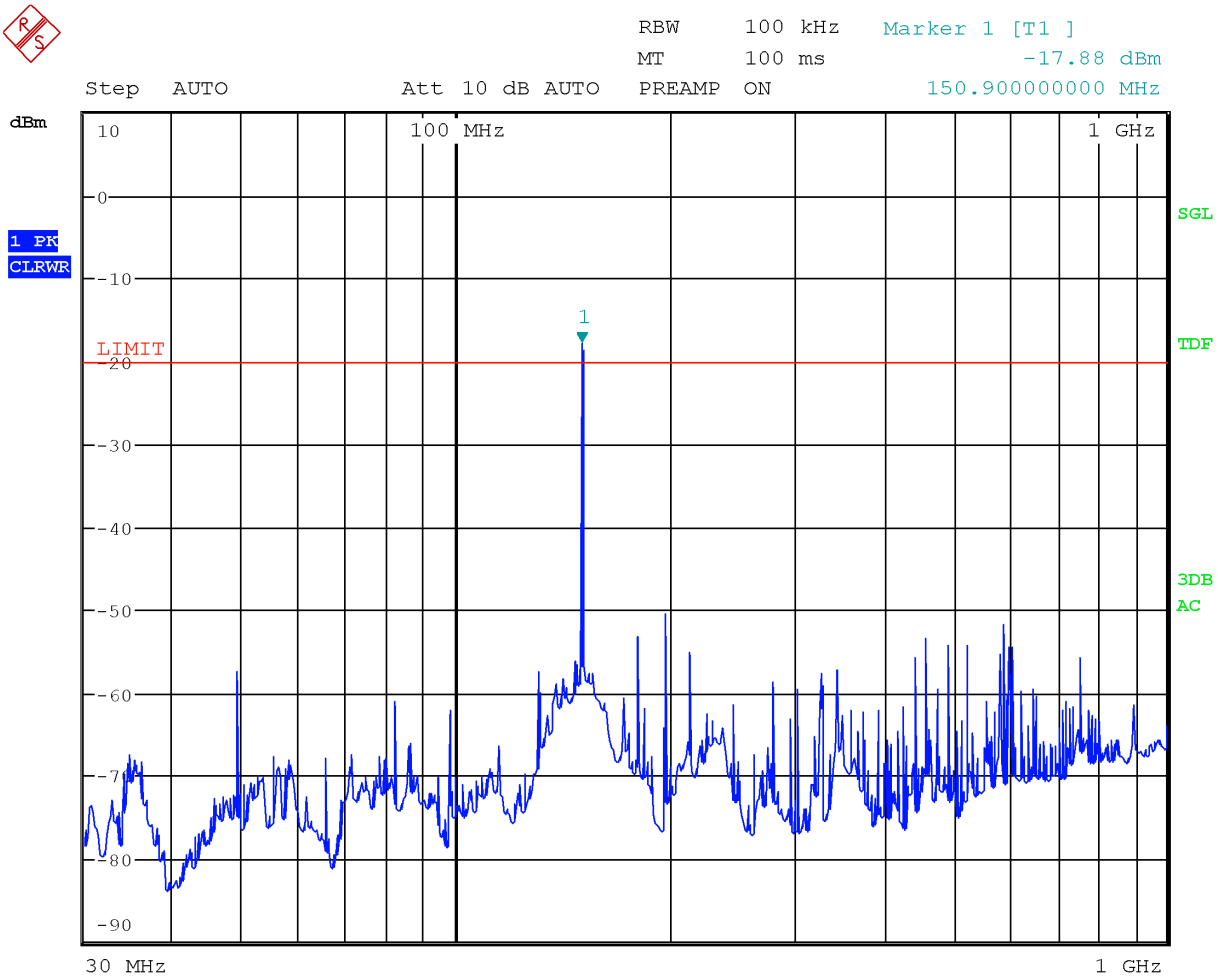
Test data



Channel LOW – 25 kHz channel bandwidth FM modulation
Frequency range 30 MHz to 1000 MHz with antenna in horizontal polarization

Limit exceeds by the carrier

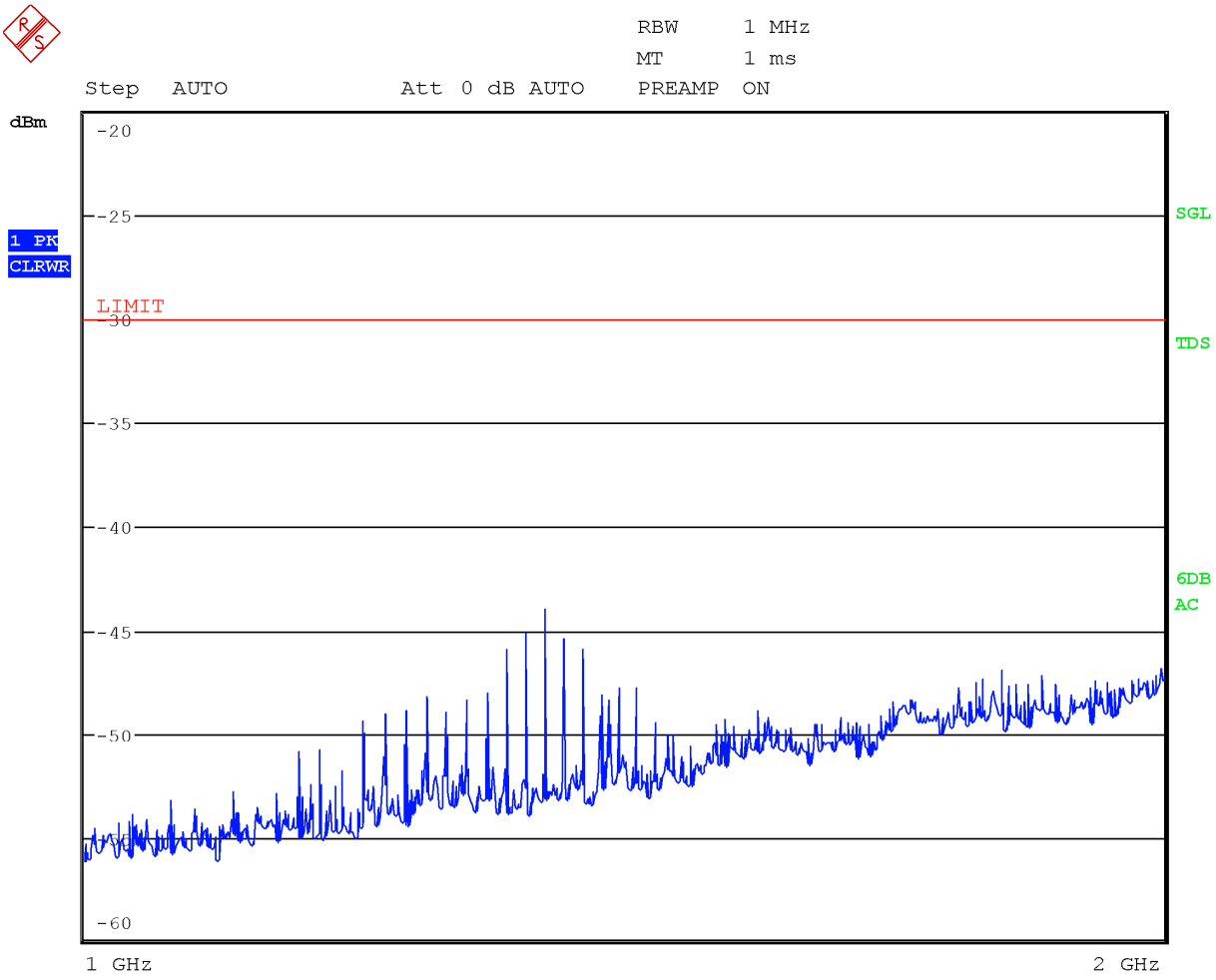
Test data



Channel LOW – 25 kHz channel bandwidth FM modulation
Frequency range 30 MHz to 1000 MHz with antenna in vertical polarization

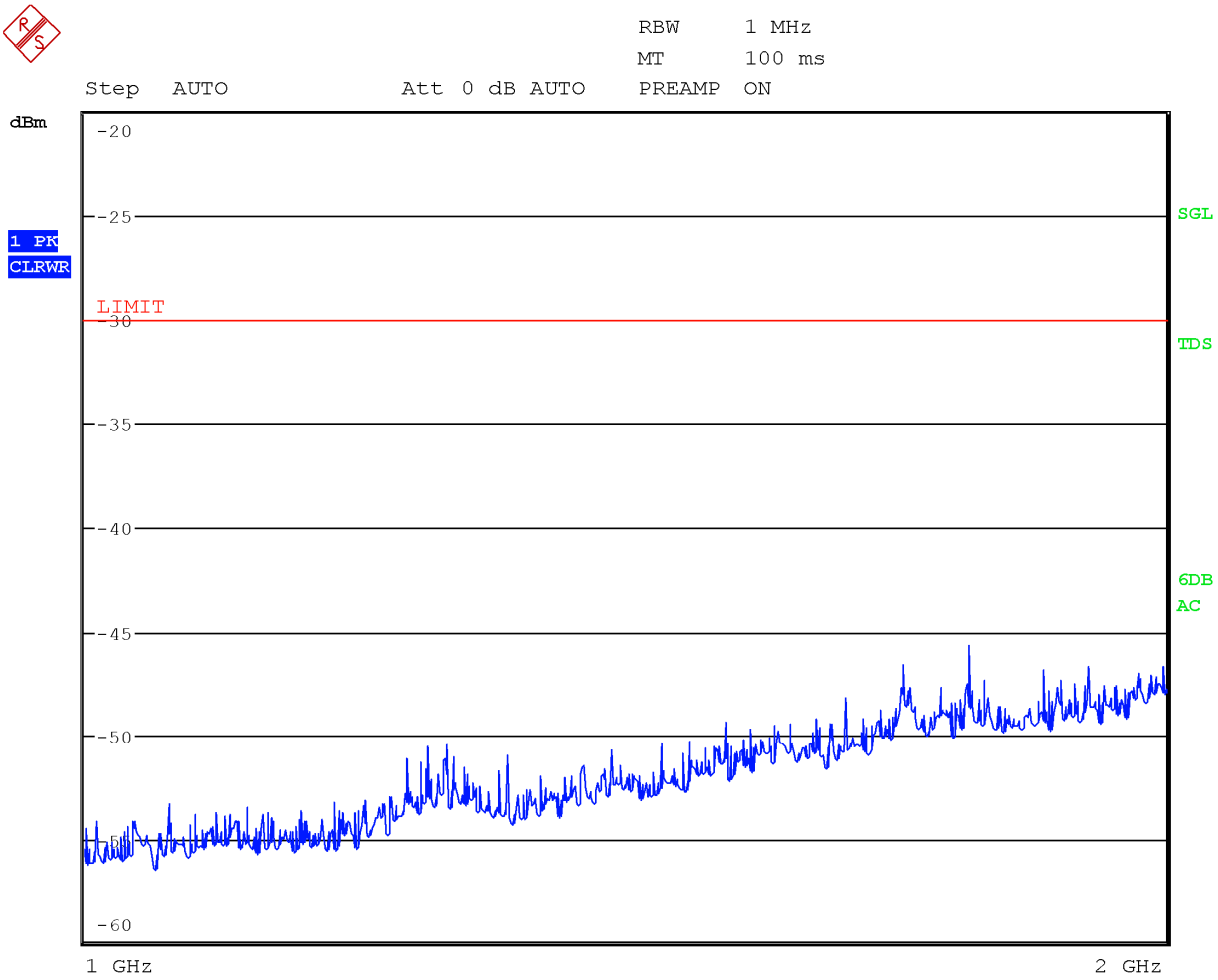
Limit exceeds by the carrier

Test data



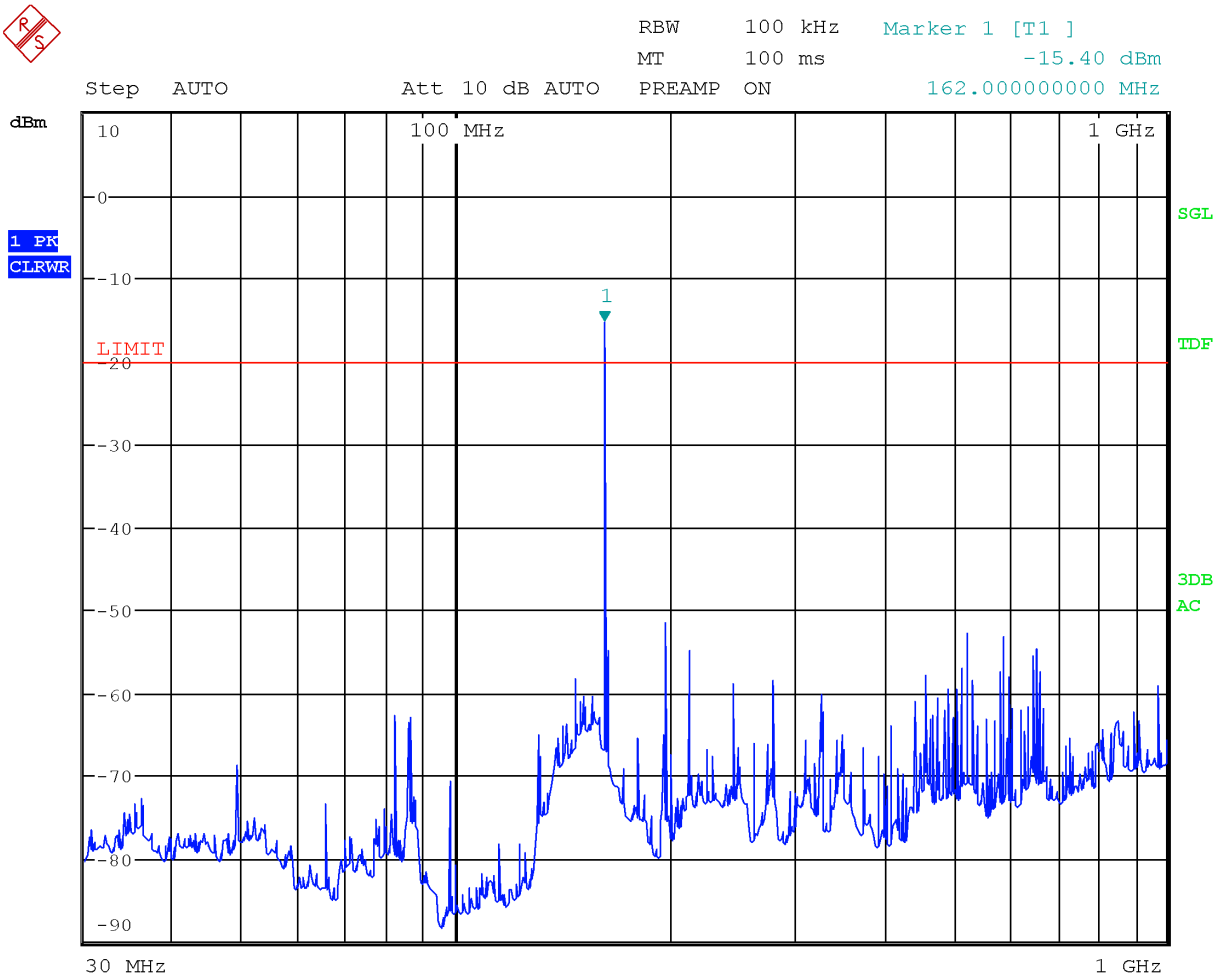
Channel LOW – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 2000 MHz with antenna in horizontal polarization

Test data



Channel LOW – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 2000 MHz with antenna in vertical polarization

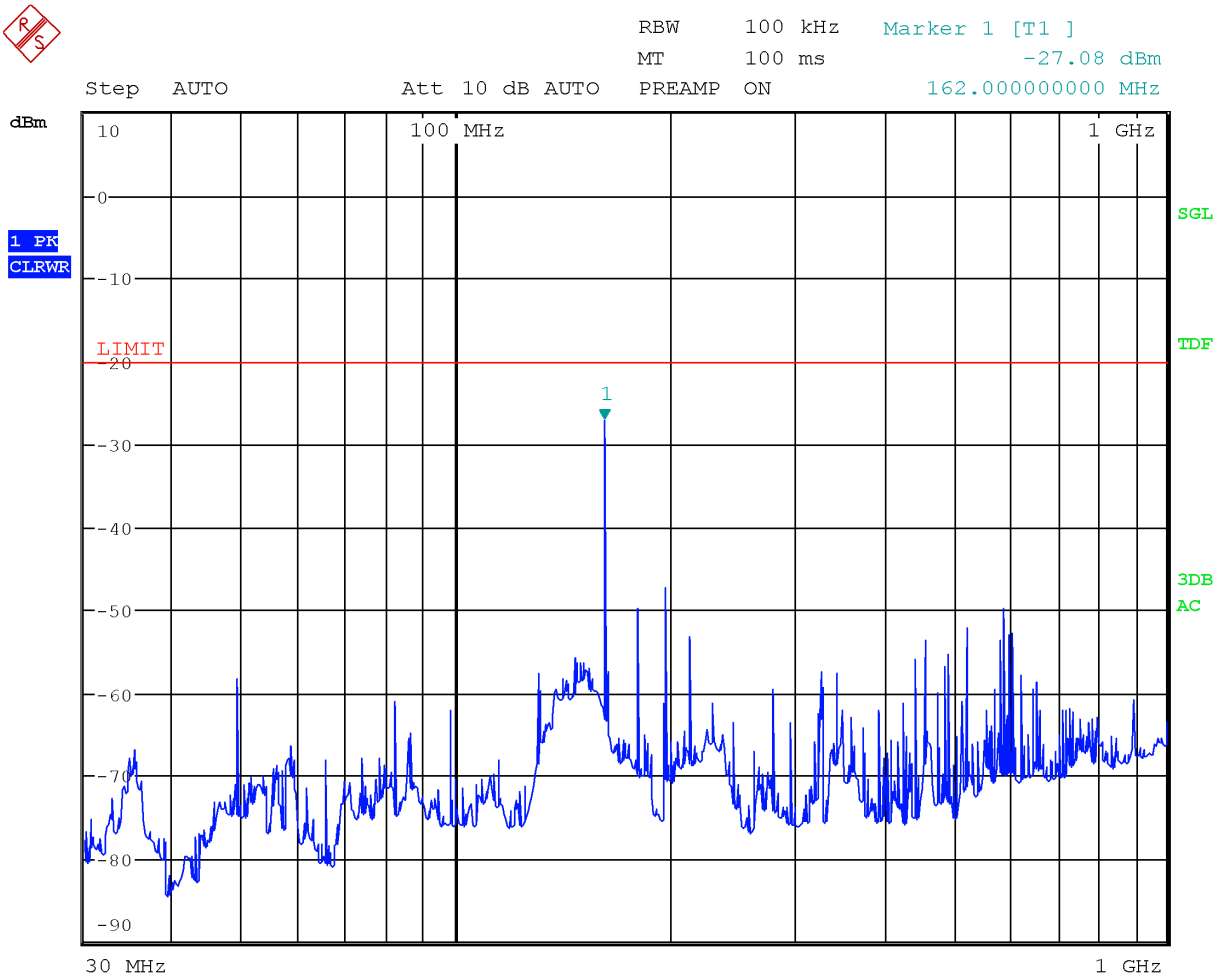
Test data



Channel MID – 25 kHz channel bandwidth FM modulation
Frequency range 30 MHz to 1000 MHz with antenna in horizontal polarization

Limit exceeds by the carrier

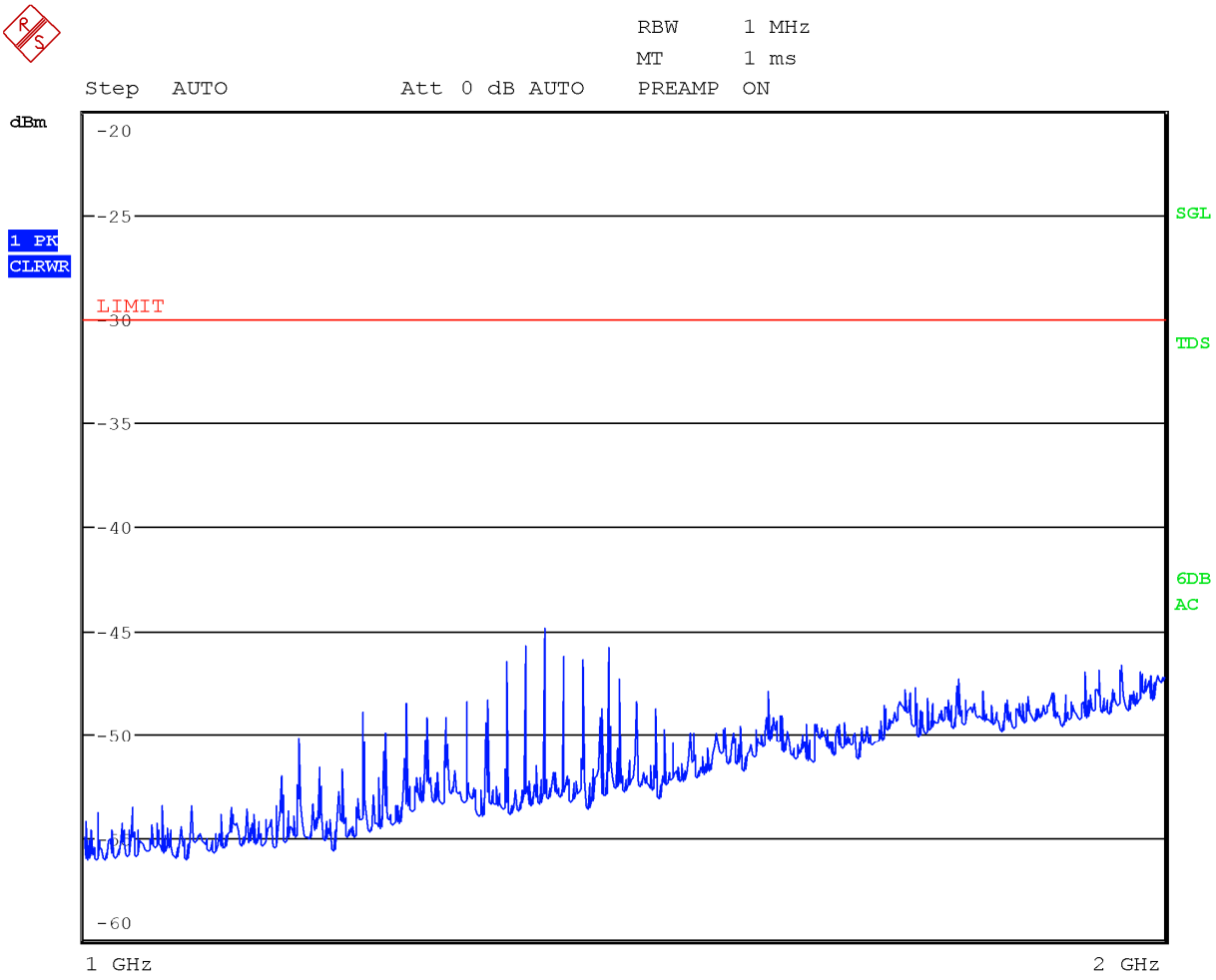
Test data



Channel MID – 25 kHz channel bandwidth FM modulation
Frequency range 30 MHz to 1000 MHz with antenna in vertical polarization

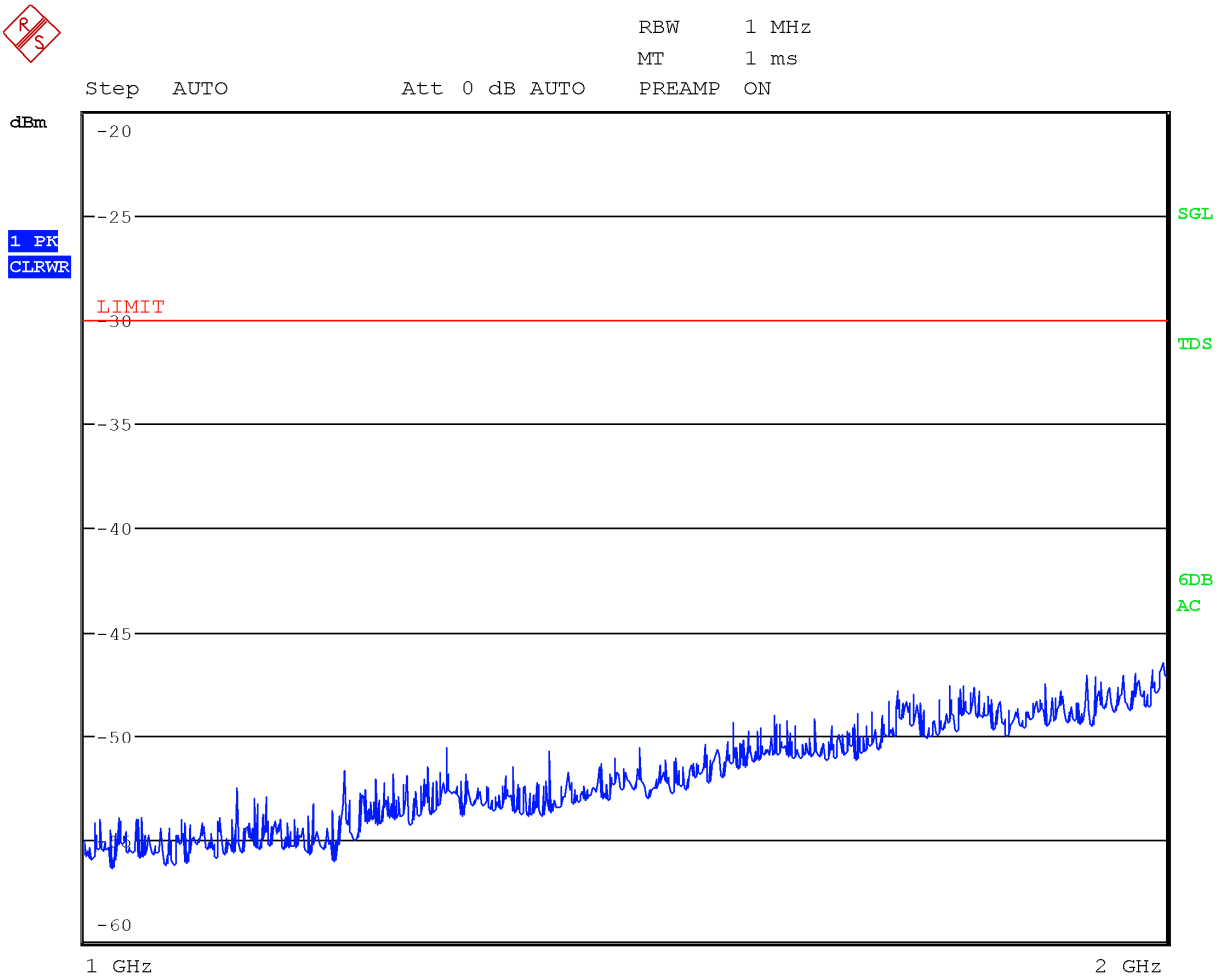
Limit exceeds by the carrier

Test data



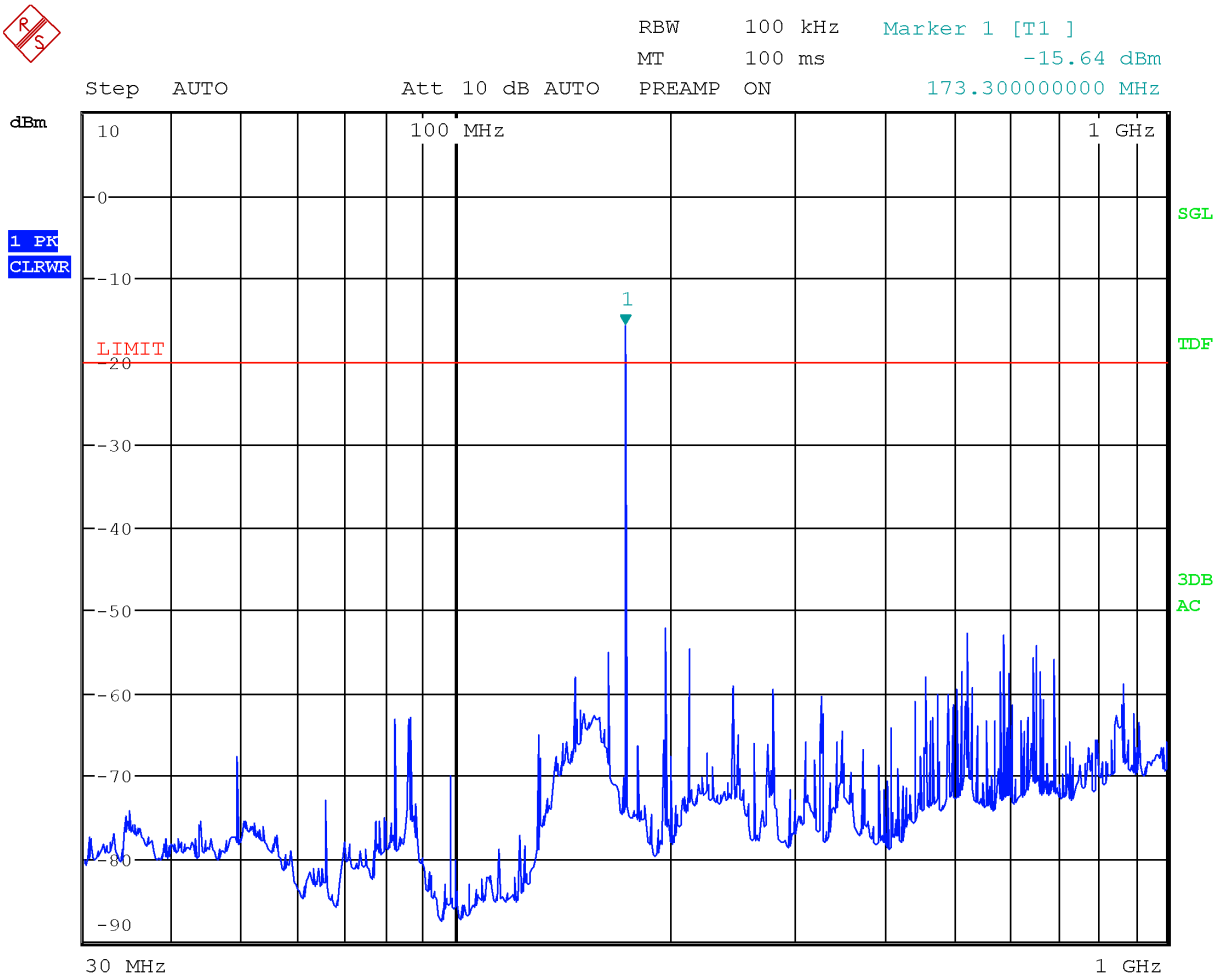
Channel MID – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 2000 MHz with antenna in horizontal polarization

Test data



Channel MID – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 2000 MHz with antenna in vertical polarization

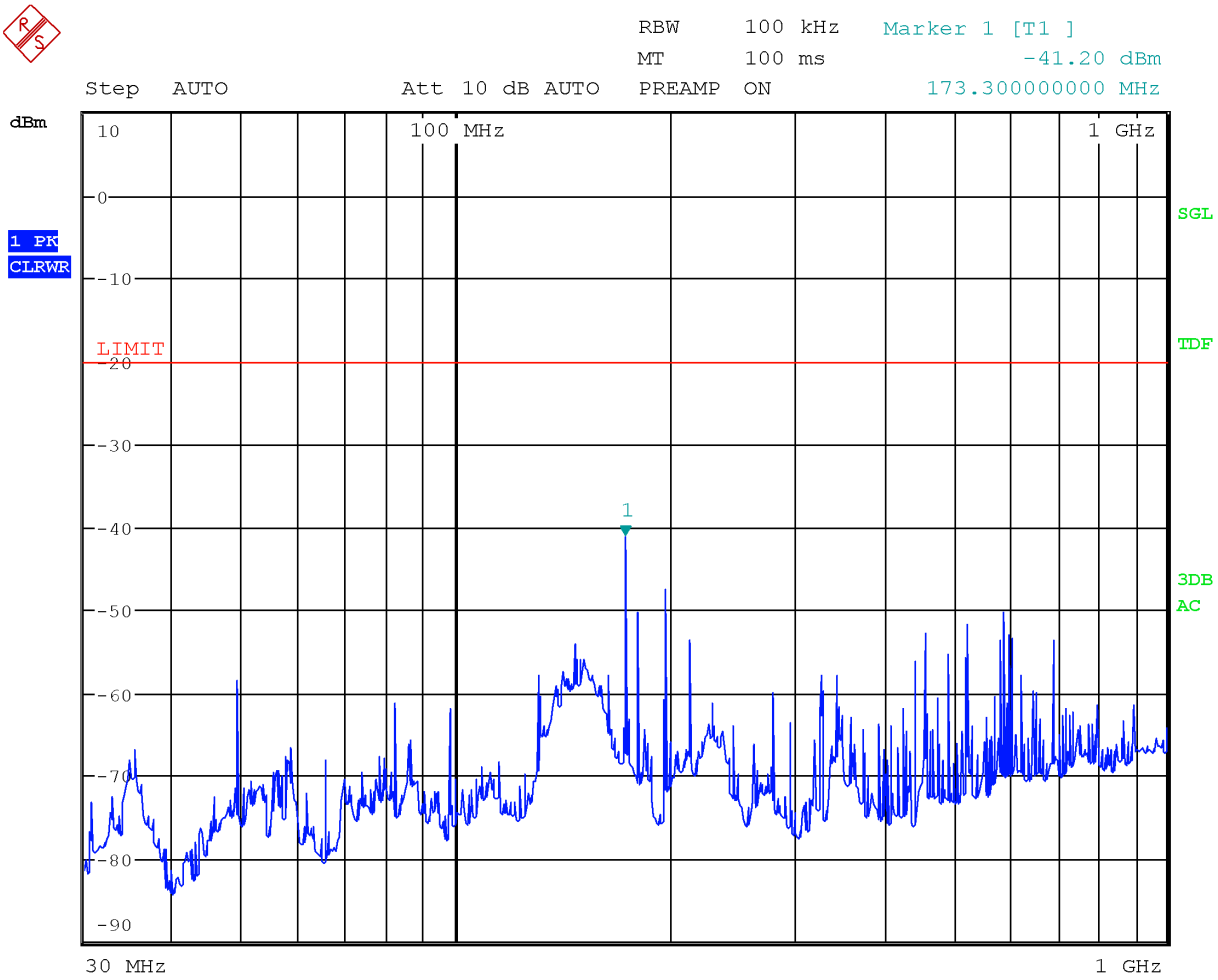
Test data



Channel HIGH – 25 kHz channel bandwidth FM modulation
Frequency range 30 MHz to 1000 MHz with antenna in horizontal polarization

Limit exceeds by the carrier

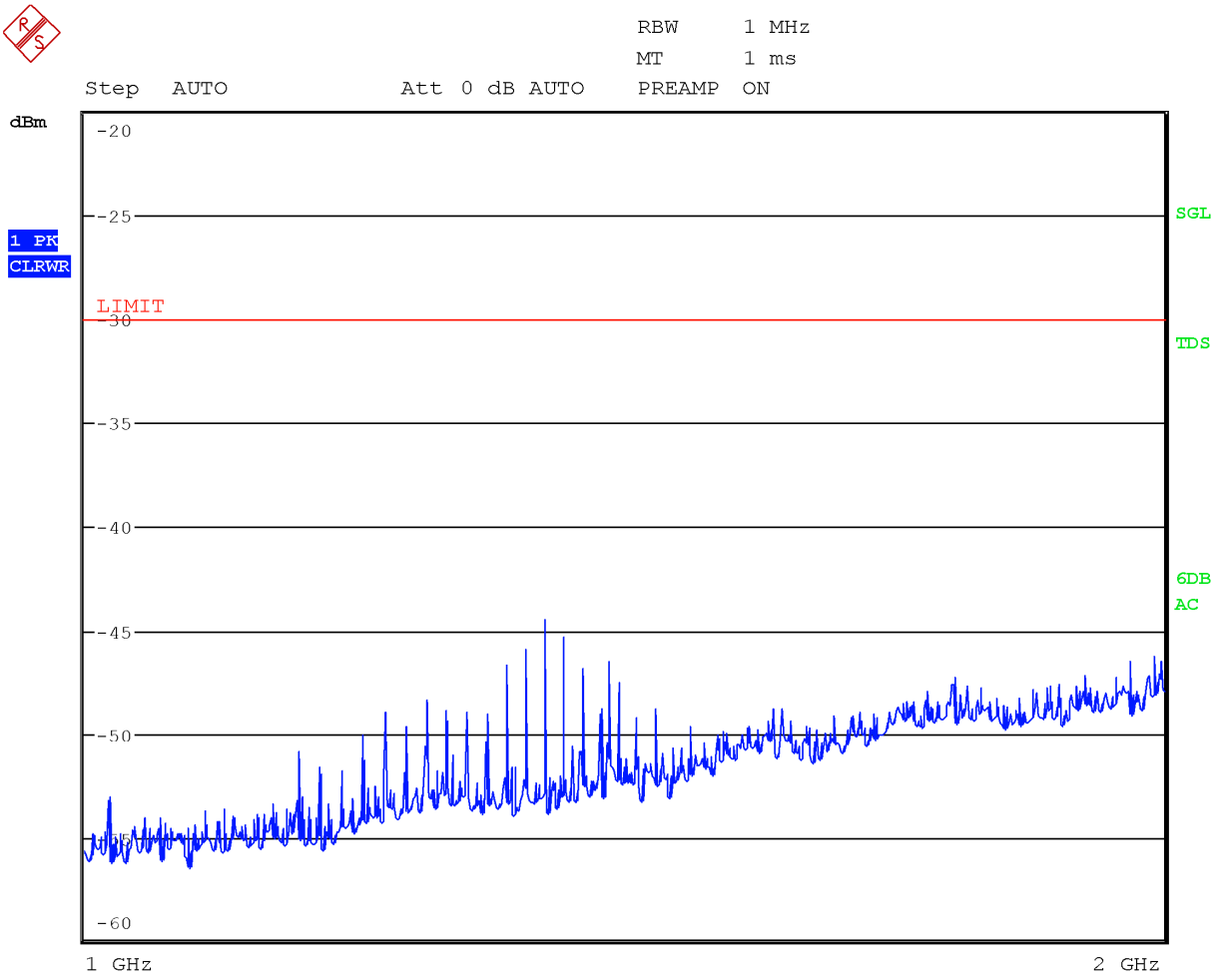
Test data



Channel HIGH – 25 kHz channel bandwidth FM modulation
Frequency range 30 MHz to 1000 MHz with antenna in vertical polarization

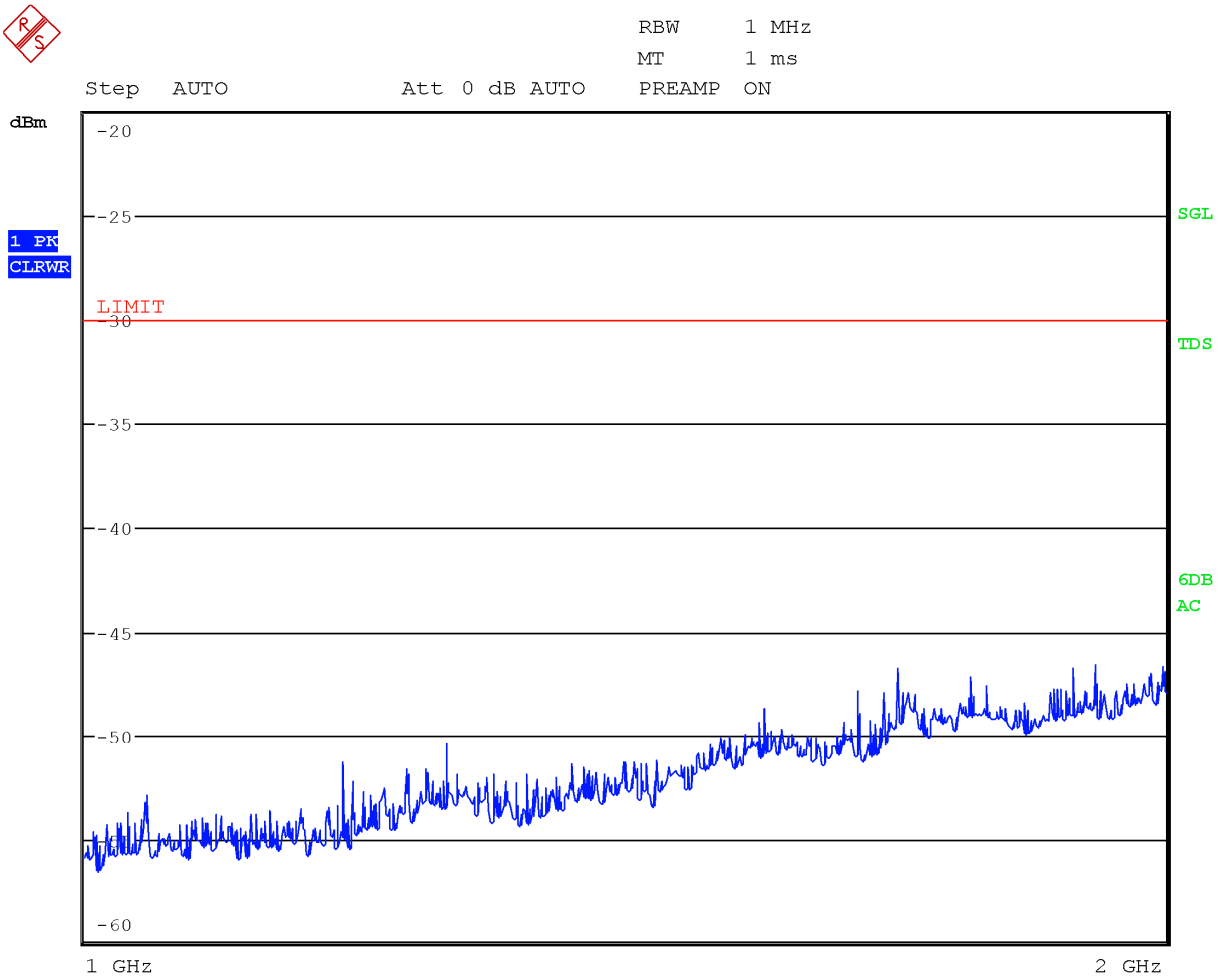
Limit exceeds by the carrier

Test data



Channel HIGH – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 2000 MHz with antenna in horizontal polarization

Test data



Channel HIGH – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 2000 MHz with antenna in vertical polarization

Clause 90.213 and 22.355 Frequency stability

§90.213 Frequency stability.

Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

[Parts per million (ppm)]

Frequency range (MHz)	Fixed and base stations	Mobile stations	
		Over 2 watts output power	2 watts or less output power
Below 25	[1][2][3]100	100	200
25-50	20	20	50
72-76	5		50
150-174	[5][11]5	[6]5	[4][6]50
216-220	1.0		1.0
220-222[12]	0.1	1.5	1.5
421-512	[7][11][14]2.5	[8]5	[8]5
806-809	[14]1.0	1.5	1.5
809-824	[14]1.5	2.5	2.5
851-854	1.0	1.5	1.5
854-869	1.5	2.5	2.5
896-901	[14]0.1	1.5	1.5
902-928	2.5	2.5	2.5
902-928[13]	2.5	2.5	2.5
929-930	1.5		
935-940	0.1	1.5	1.5
1427-1435	[9]300	300	300
Above 2450[10]			

[4]Stations operating in the 154.45 to 154.49 MHz or the 173.2 to 173.4 MHz bands must have a frequency stability of 5 ppm.
[5]In the 150-174 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.
[6]In the 150-174 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth or designed to operate on a frequency specifically designated for itinerant use or designed for low-power operation of two watts or less, must have a frequency stability of 5.0 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 2.0 ppm.
[11]Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150-174 MHz band and 2.5 ppm in the 421-512 MHz band.

§22.355 Frequency tolerance.

Except as otherwise provided in this part, the carrier frequency of each transmitter in the Public Mobile Services must be maintained within the tolerances given in Table C-1 of this section.

Frequency range (MHz)	Base, fixed (ppm)	Mobile >3 watts (ppm)	Mobile ≤3 watts (ppm)
25 to 50	20.0	20.0	50.0
50 to 450	5.0	5.0	50.0
450 to 512	2.5	5.0	5.0
821 to 896	1.5	2.5	2.5
928 to 929	5.0	n/a	n/a
929 to 960	1.5	n/a	n/a
2110 to 2220	10.0	n/a	n/a

§2.1055 Measurements required: Frequency stability.

(a) The frequency stability shall be measured with variation of ambient temperature as follows:
- (1) From –30° to + 50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
- (2) From –20° to + 50° centigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radiobeacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to-Point Microwave Radio Service under part 21 of this chapter, equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter, and equipment authorized for use in the Family Radio Service under part 95 of this chapter.
- (3) From 0° to + 50° centigrade for equipment to be licensed for use in the Radio Broadcast Services under part 73 of this chapter.

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(c) In addition to all other requirements of this section, the following information is required for equipment incorporating heater type crystal oscillators to be used in mobile stations, for which type acceptance is first requested after March 25, 1974, except for battery powered, hand carried, portable equipment having less than 3 watts mean output power.

(1) Measurement data showing variation in transmitter output frequency from a cold start and the elapsed time necessary for the frequency to stabilize within the applicable tolerance. Tests shall be made after temperature stabilization at each of the ambient temperature levels; the lower temperature limit, 0° centigrade and + 30° centigrade with no primary power applied.

(2) Beginning at each temperature level specified in paragraph (c)(1) of this section, the frequency shall be measured within one minute after application of primary power to the transmitter and at intervals of no more than one minute thereafter until ten minutes have elapsed or until sufficient measurements are obtained to indicate clearly that the frequency has stabilized within the applicable tolerance, whichever time period is greater. During each test, the ambient temperature shall not be allowed to rise more than 10° centigrade above the respective beginning ambient temperature level.

(3) The elapsed time necessary for the frequency to stabilize within the applicable tolerance from each beginning ambient temperature level as determined from the tests specified in this paragraph shall be specified in the instruction book for the transmitter furnished to the user.

When it is impracticable to subject the complete transmitter to this test because of its physical dimensions or power rating, only its frequency determining and stabilizing portions need be tested.

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

(e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c), and (d) of this section. (For example measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment.)

Test date: 2019-07-03

Test results: Pass

Modulation used: CW

Test data		
Test conditions	Frequency (MHz)	ppm
+50 °C, Nominal	162.0000161	0.05
+40 °C, Nominal	162.0000197	0.03
+30 °C, Nominal	162.0000226	0.01
+20 °C, +15 %	162.0000234	0
+20 °C, Nominal	162.0000234	*Reference*
+20 °C, –15 %	162.0000234	0
+10 °C, Nominal	162.0000272	0.02
0 °C, Nominal	162.0000308	0.05
–10 °C, Nominal	162.0000311	0.05
–20 °C, Nominal	162.0000315	0.05
–30 °C, Nominal	162.0000321	0.06
Limit applied: 2.5 ppm		

Clause 90.214 Transient frequency behaviour

Transmitters designed to operate in the 150-174 MHz and 421-512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals[1 2]	Maximum frequency difference[3]	All equipment	
		150 to 174 MHz	421 to 512 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels			
t_1[4]	±25.0 kHz	5.0 ms	10.0 ms
t_2	±12.5 kHz	20.0 ms	25.0 ms
t_3[4]	±25.0 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels			
t_1[4]	±12.5 kHz	5.0 ms	10.0 ms
t_2	±6.25 kHz	20.0 ms	25.0 ms
t_3[4]	±12.5 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels			
t_1[4]	±6.25 kHz	5.0 ms	10.0 ms
t_2	±3.125 kHz	20.0 ms	25.0 ms
t_3[4]	±6.25 kHz	5.0 ms	10.0 ms

[1] on is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.
t1 is the time period immediately following ton.
t2 is the time period immediately following t1.
t3 is the time period from the instant when the transmitter is turned off until toff.
toff is the instant when the 1 kHz test signal starts to rise.

[2] During the time from the end of t2 to the beginning of t3, the frequency difference must not exceed the limits specified in §90.213.

[3] Difference between the actual transmitter frequency and the assigned transmitter frequency.

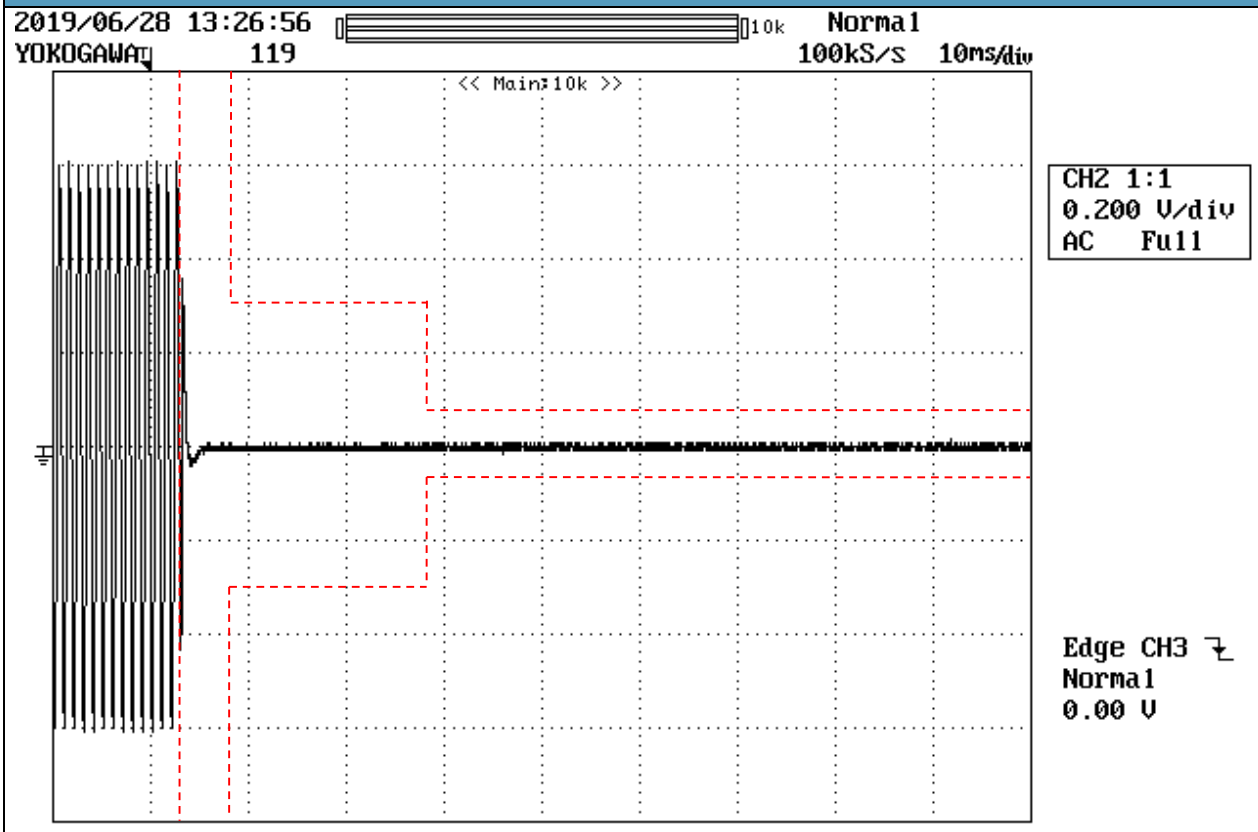
[4] If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

Test date: 2019-06-28

Test results: Pass

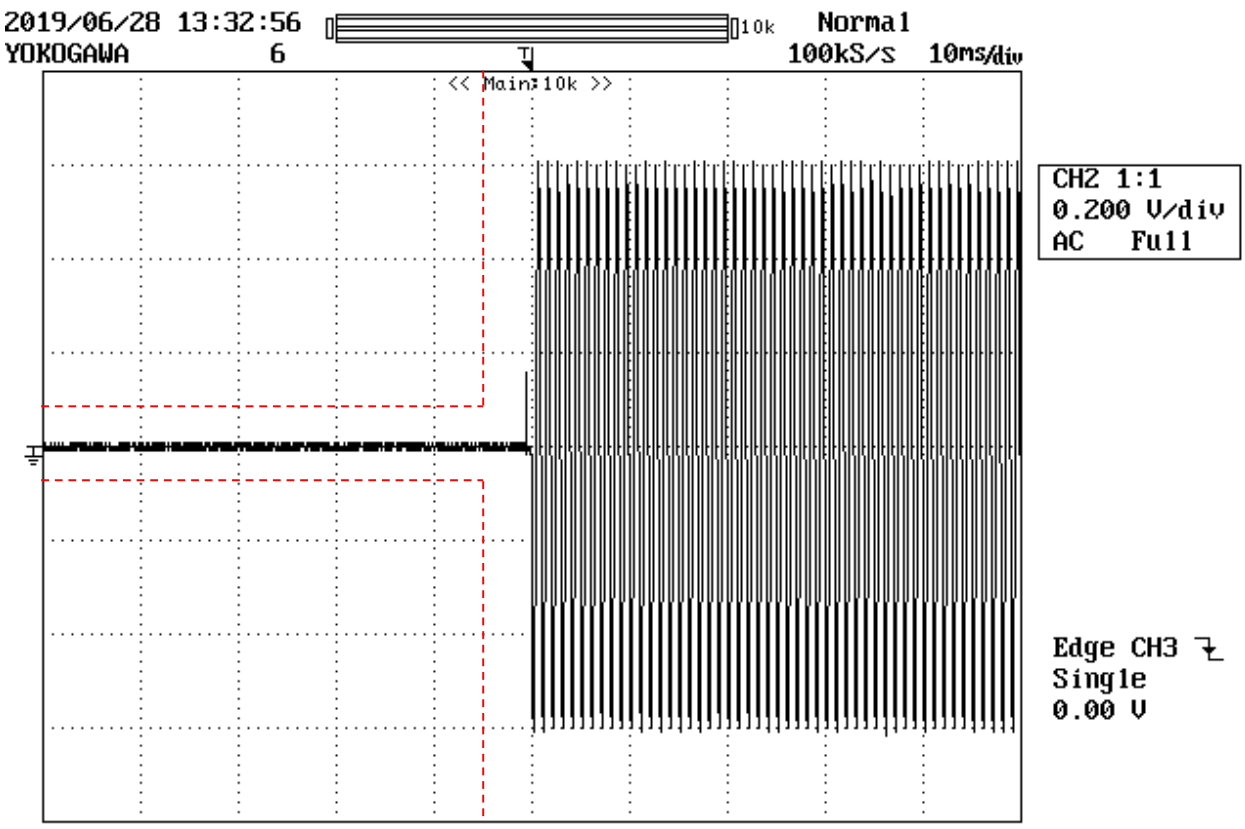
Modulation used: 11K0F3E

Test data



Switch on condition, t_1=5 ms, t_2=20 ms, 162 MHz, channel separation ± 12.5 kHz

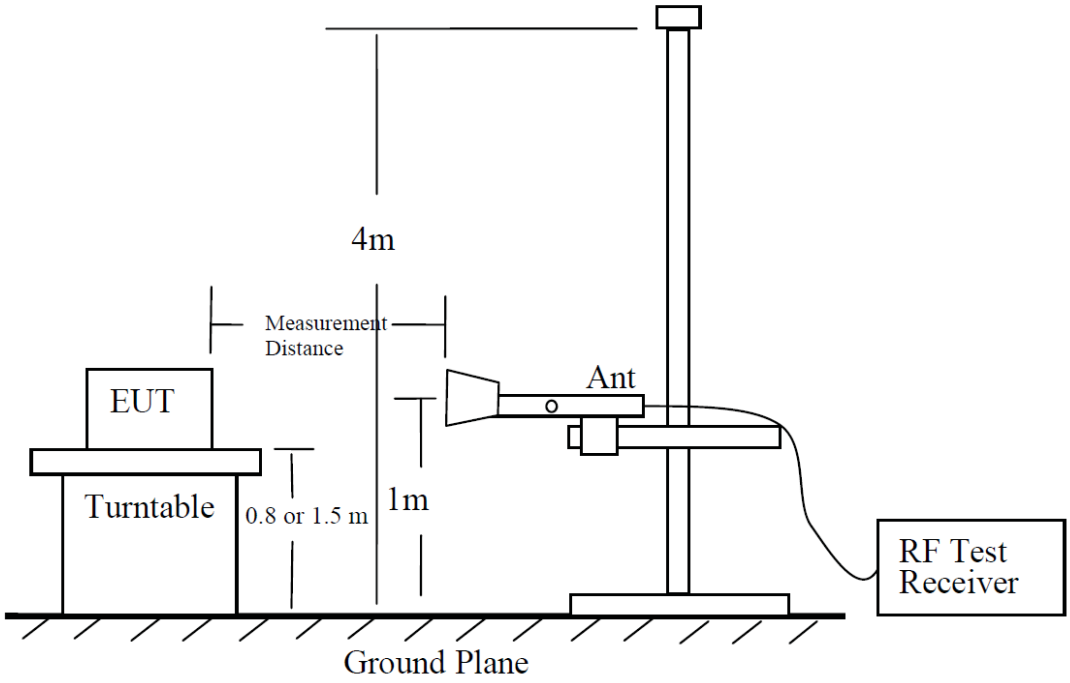
Test data



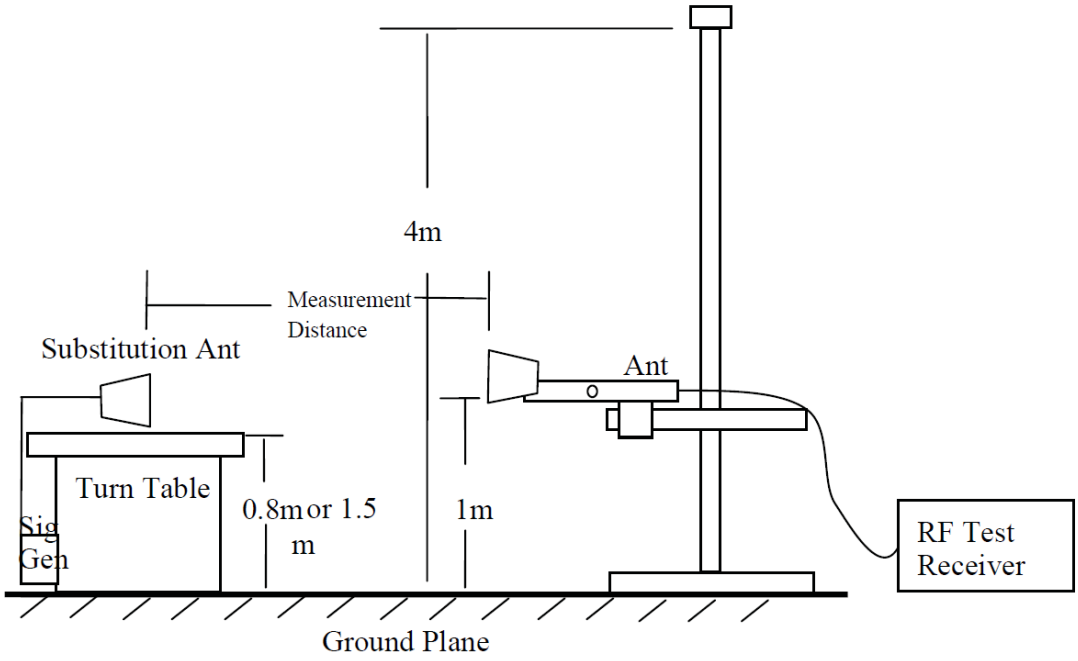
Switch off condition, t_3=5 ms, 162 MHz, channel separation ± 12.5 kHz

Appendix B: Block diagrams of test set-ups

Radiated emissions set-up

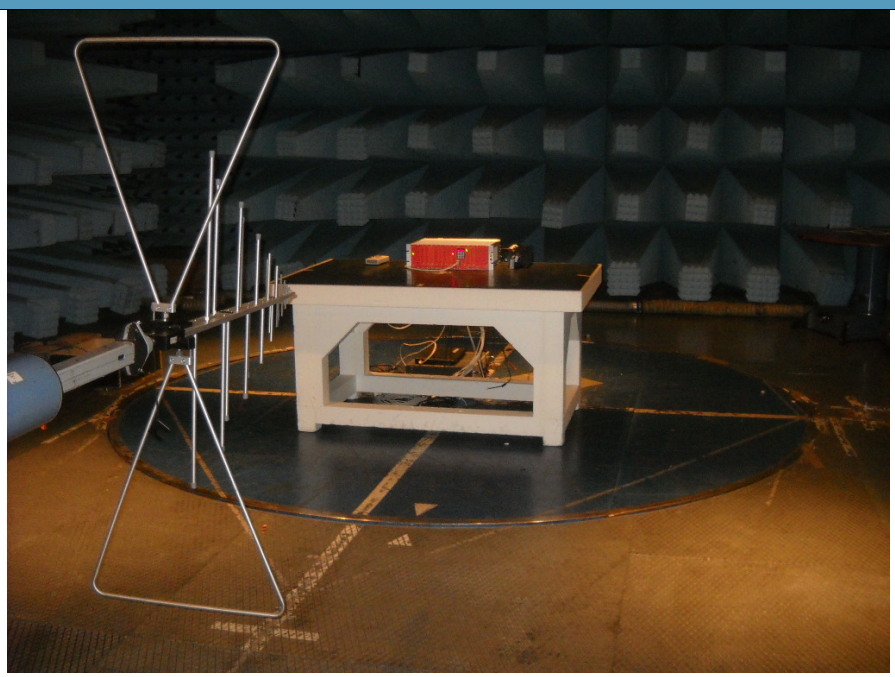


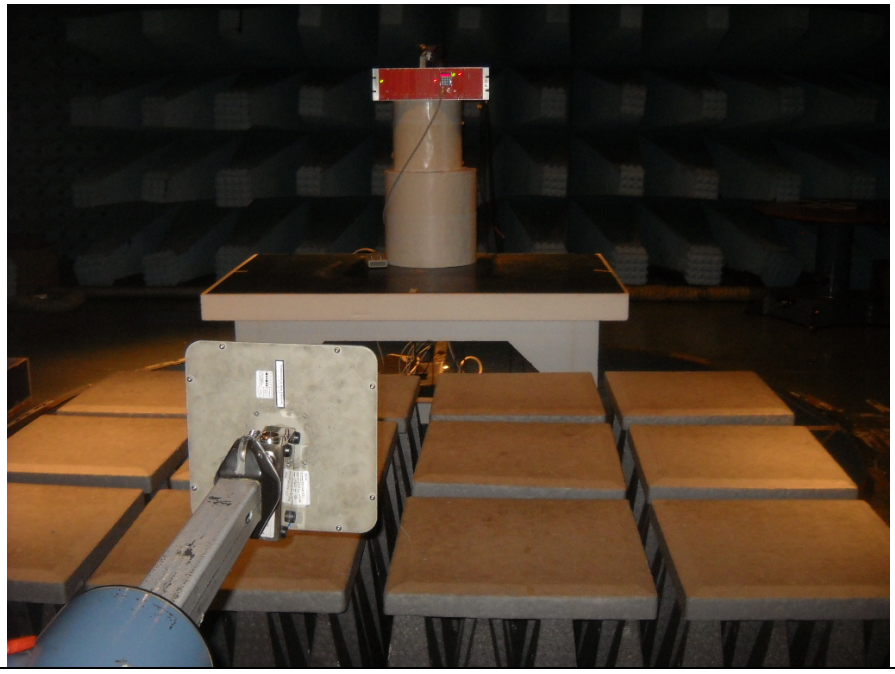
Substitution method set-up for radiated emission



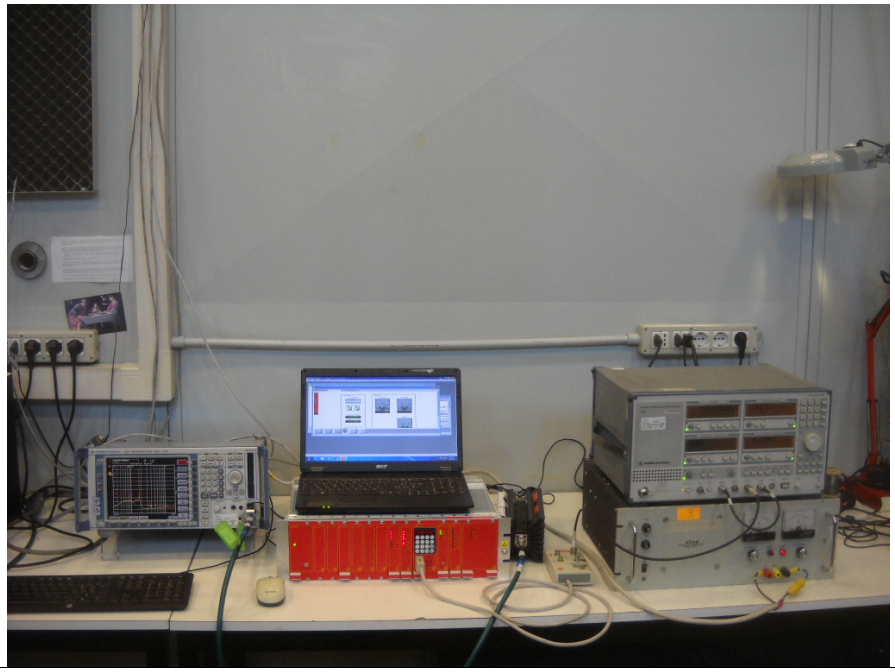
Appendix C: Photos

Set-up photos





Set-up photos



EUT photos

End of report