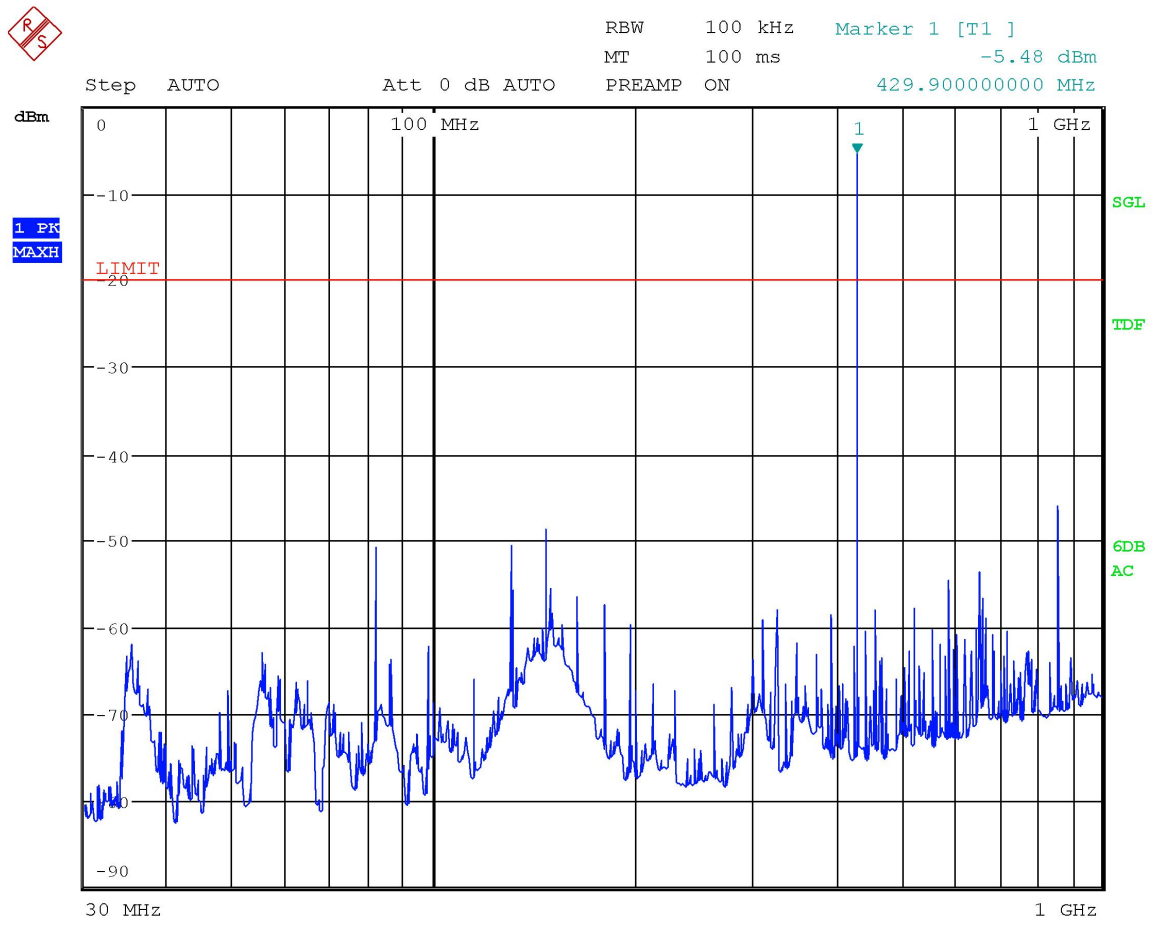
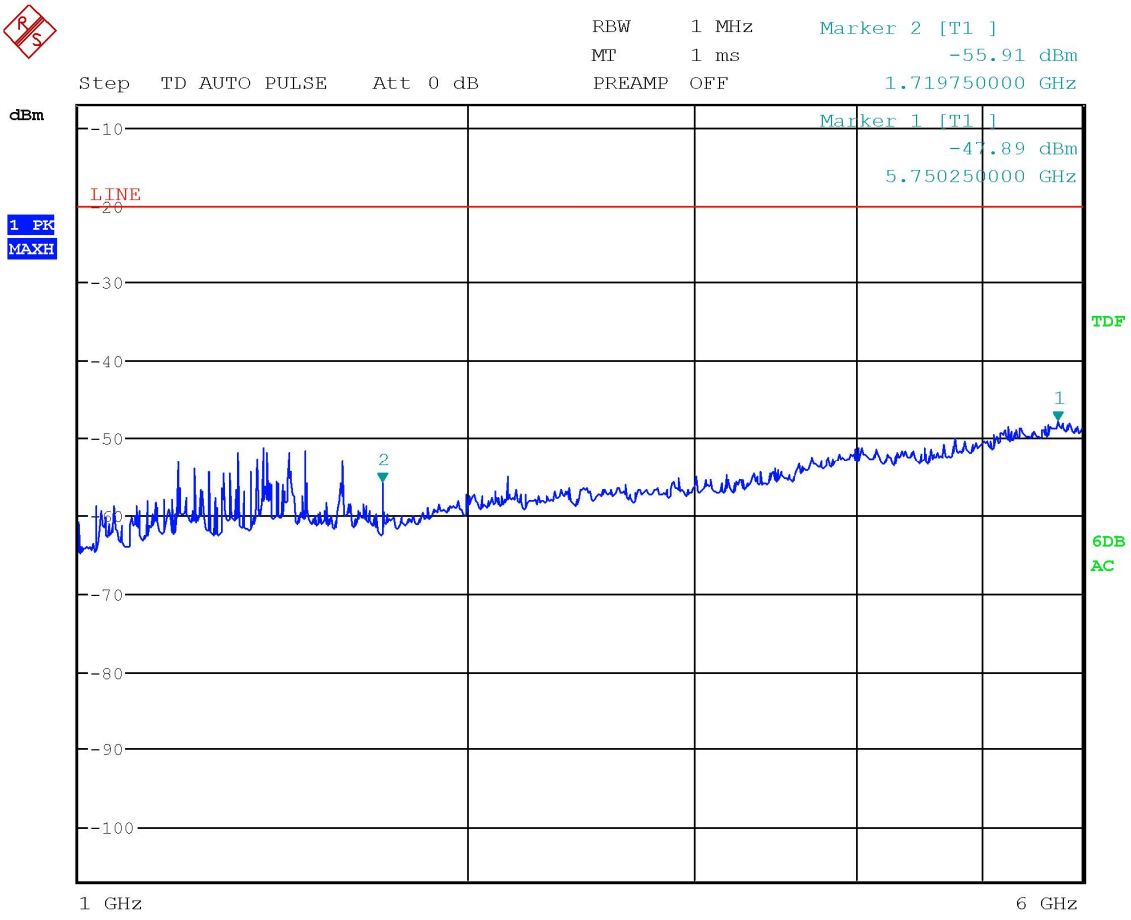
Test data



Channel 429.9 MHz – 25 kHz channel bandwidth FM modulation
Frequency range 30 MHz to 1000 MHz with antenna in vertical polarization

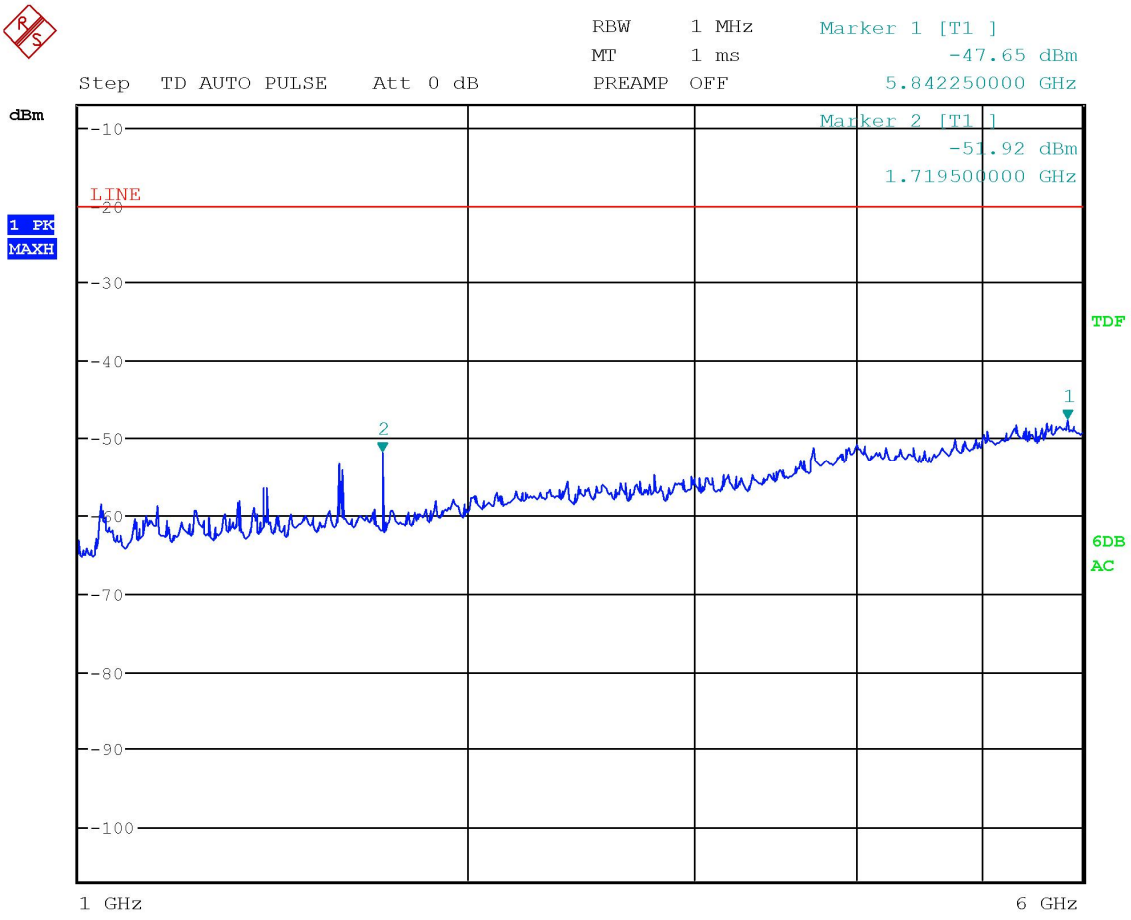
Limit exceeds by the carrier

Test data



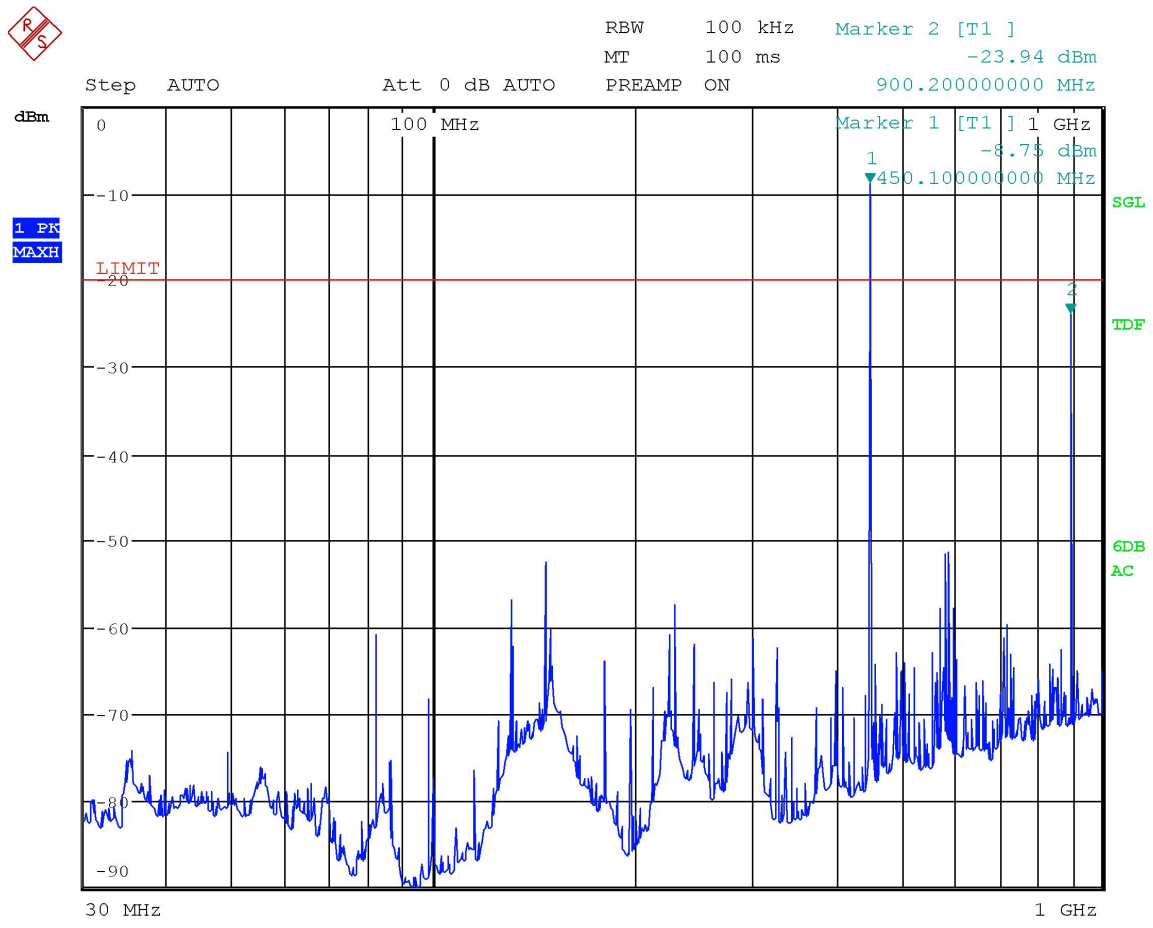
Channel 429.9 MHz – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 6000 MHz with antenna in horizontal polarization

Test data



Channel 429.9 MHz – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 6000 MHz with antenna in vertical polarization

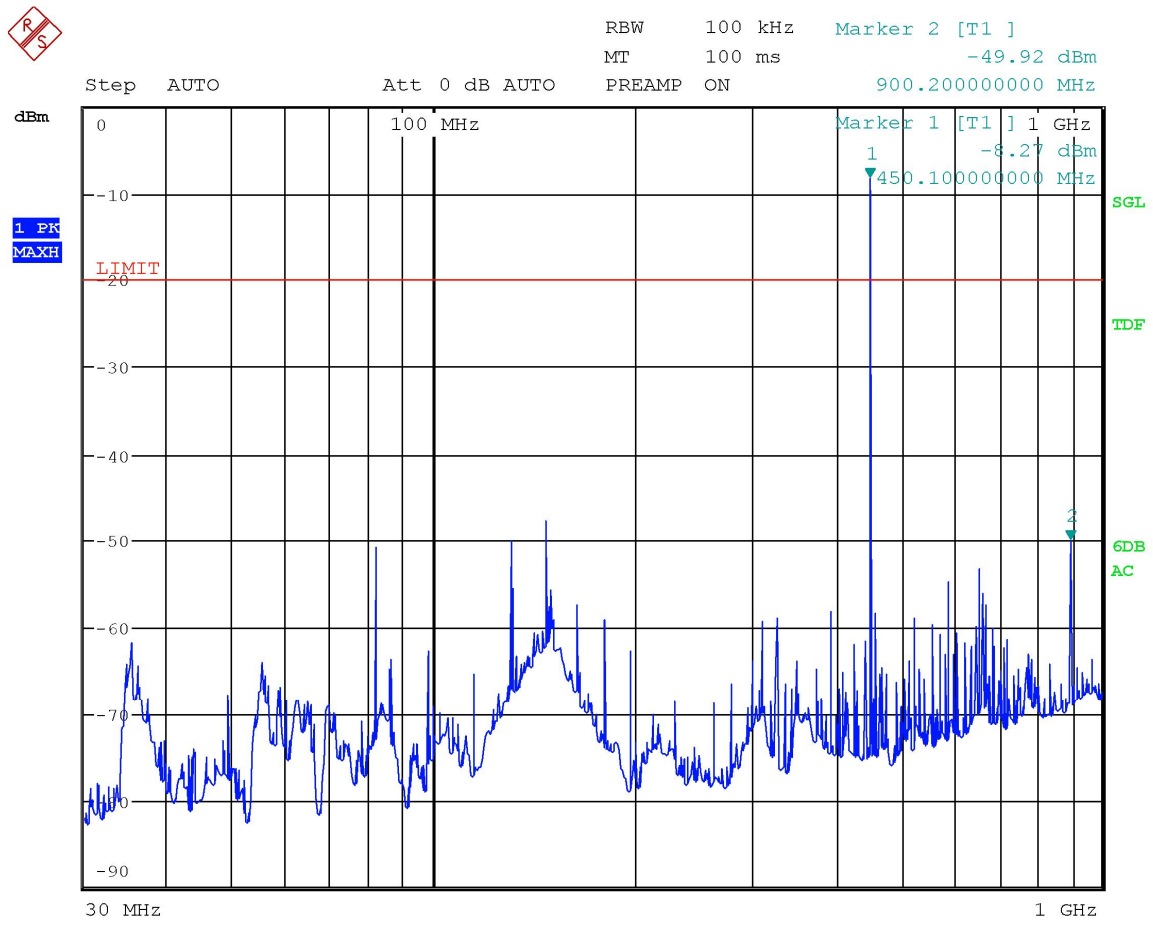
Test data



Channel 450.1 MHz – 25 kHz channel bandwidth FM modulation
Frequency range 30 MHz to 1000 MHz with antenna in horizontal polarization

Limit exceeds by the carrier

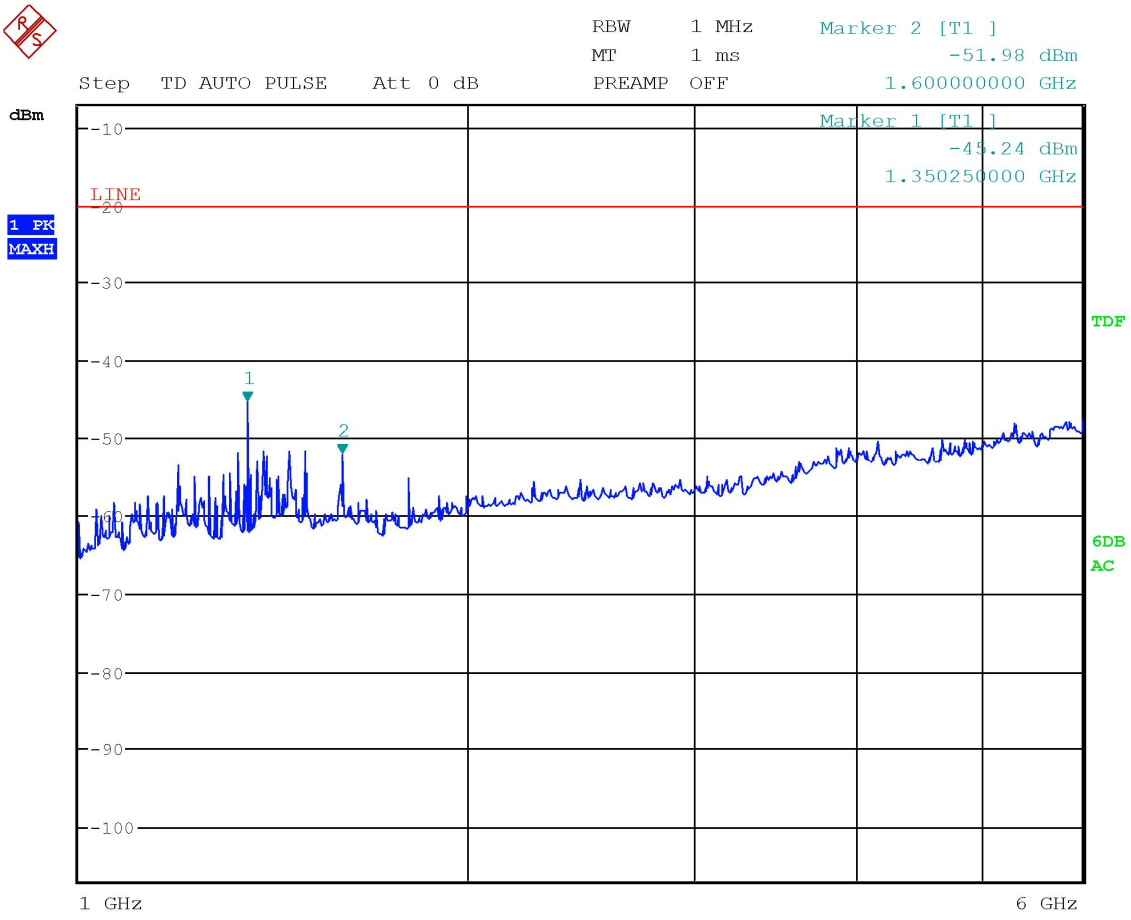
Test data



Channel 450.1 MHz – 25 kHz channel bandwidth FM modulation
Frequency range 30 MHz to 1000 MHz with antenna in vertical polarization

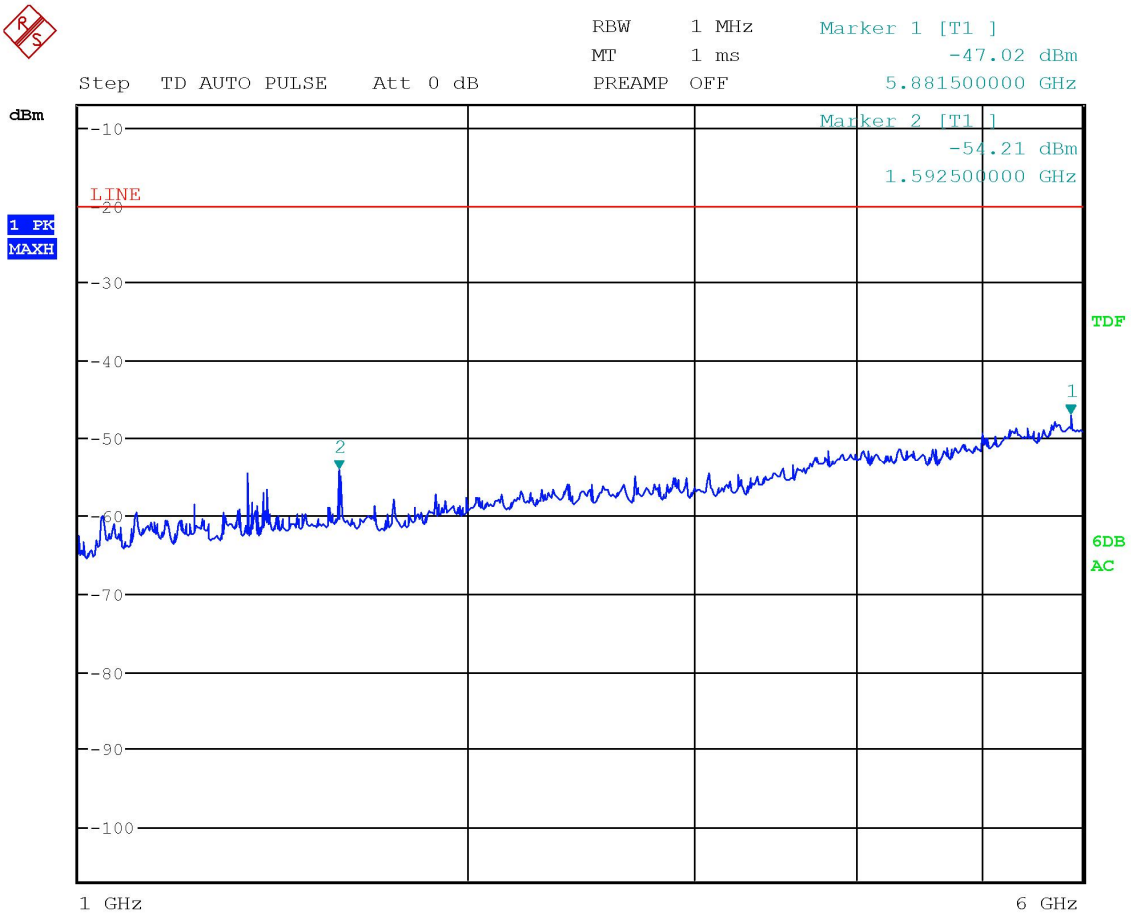
Limit exceeds by the carrier

Test data



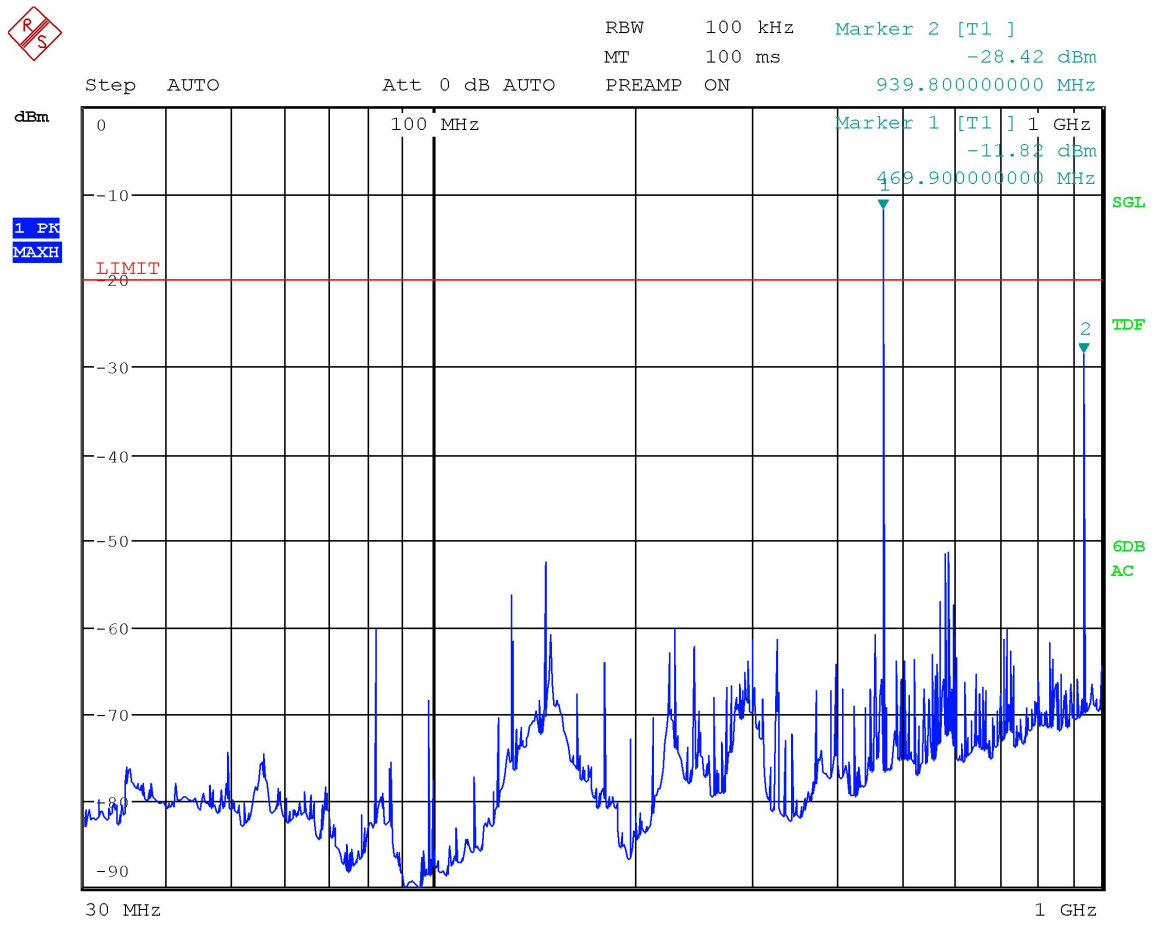
Channel 450.1 MHz – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 6000 MHz with antenna in horizontal polarization

Test data



Channel 450.1 MHz – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 6000 MHz with antenna in vertical polarization

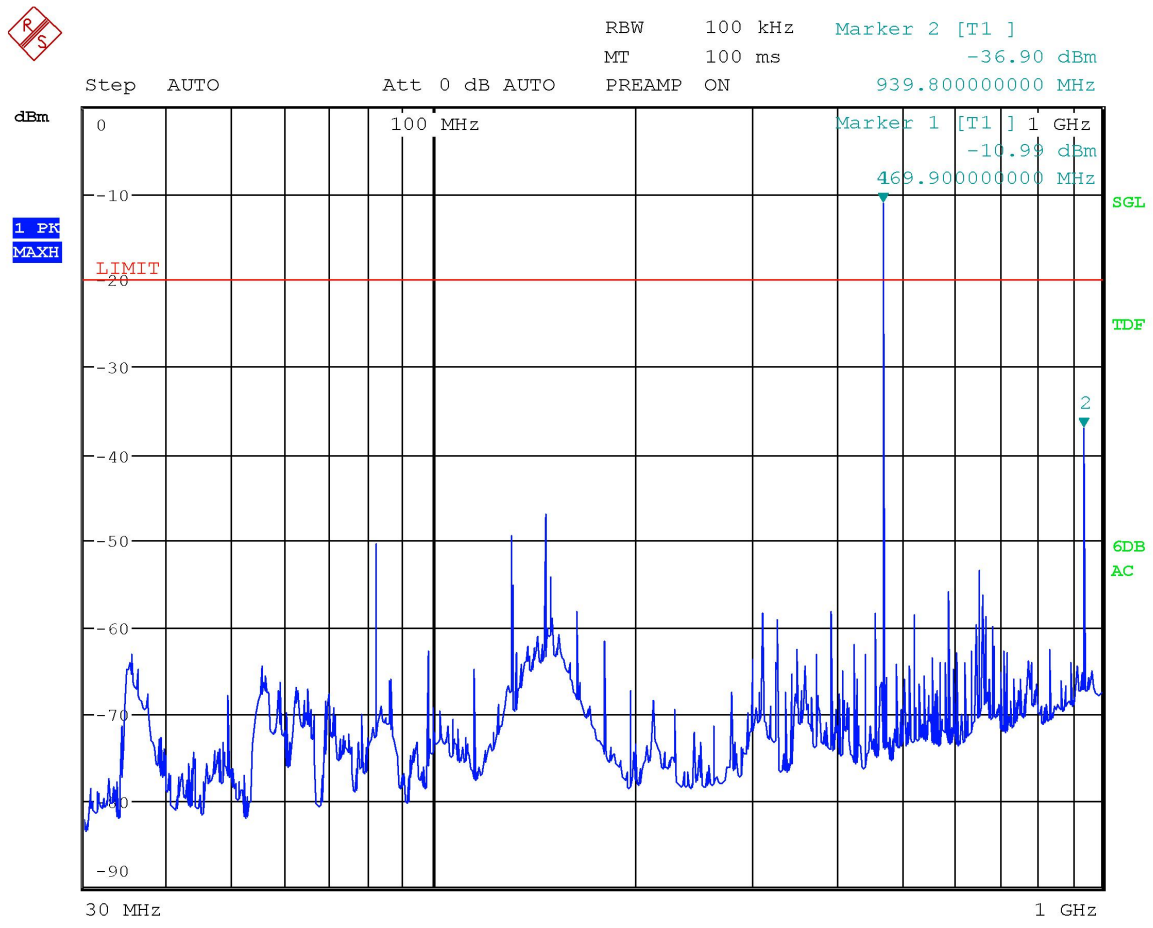
Test data



Channel 469.9 MHz – 25 kHz channel bandwidth FM modulation
Frequency range 30 MHz to 1000 MHz with antenna in horizontal polarization

Limit exceeds by the carrier

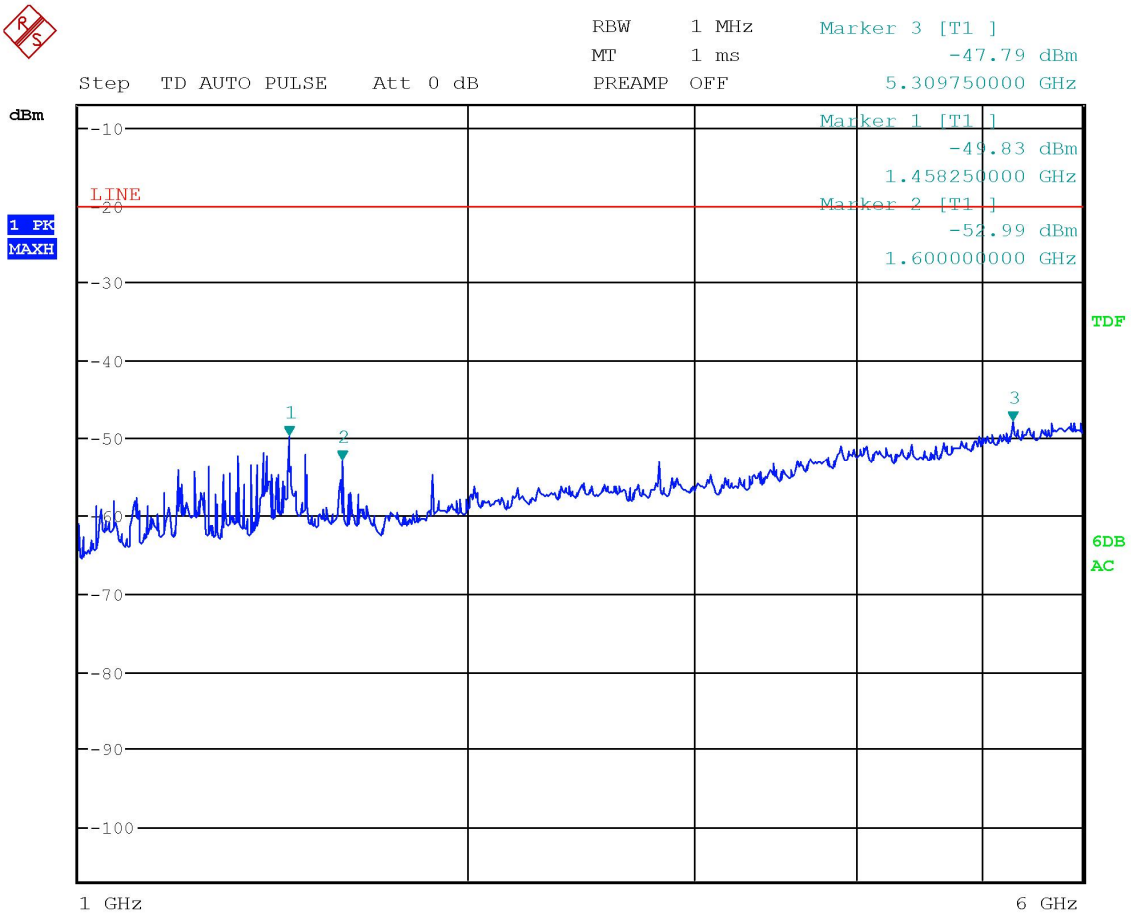
Test data



Channel 469.9 MHz – 25 kHz channel bandwidth FM modulation
Frequency range 30 MHz to 1000 MHz with antenna in vertical polarization

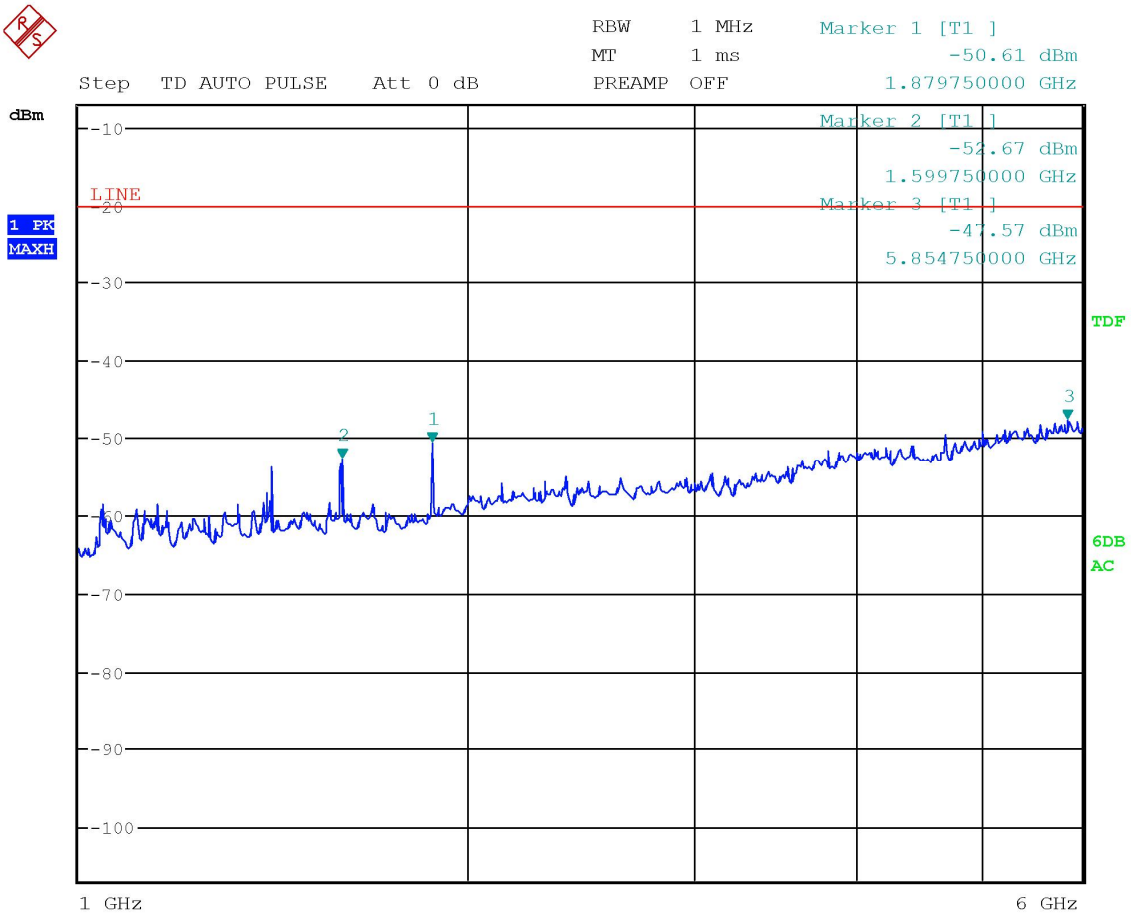
Limit exceeds by the carrier

Test data



Channel 469.9 MHz – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 6000 MHz with antenna in horizontal polarization

Test data



Channel 469.9 MHz – 25 kHz channel bandwidth FM modulation
Frequency range 1000 MHz to 6000 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]			

[7]In the 421-512 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 1.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 0.5 ppm.
[8]In the 421-512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 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.
[14]Control stations may operate with the frequency tolerance specified for associated mobile frequencies.

§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: 2019-07-09

Test results: Pass

Modulation used: CW

Test data		
Test conditions	Frequency (MHz)	ppm
+50 °C, Nominal	450.1000096	0.006
+40 °C, Nominal	450.1000107	0.004
+30 °C, Nominal	450.1000119	0.002
+20 °C, +15 %	450.1000125	0
+20 °C, Nominal	450.1000125	*Reference*
+20 °C, –15 %	450.1000125	0
+10 °C, Nominal	450.1000160	0.008
0 °C, Nominal	450.1000192	0.015
–10 °C, Nominal	450.1000209	0.019
–20 °C, Nominal	450.1000225	0.023
–30 °C, Nominal	450.1000240	0.026
Limit applied: 1.5 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.

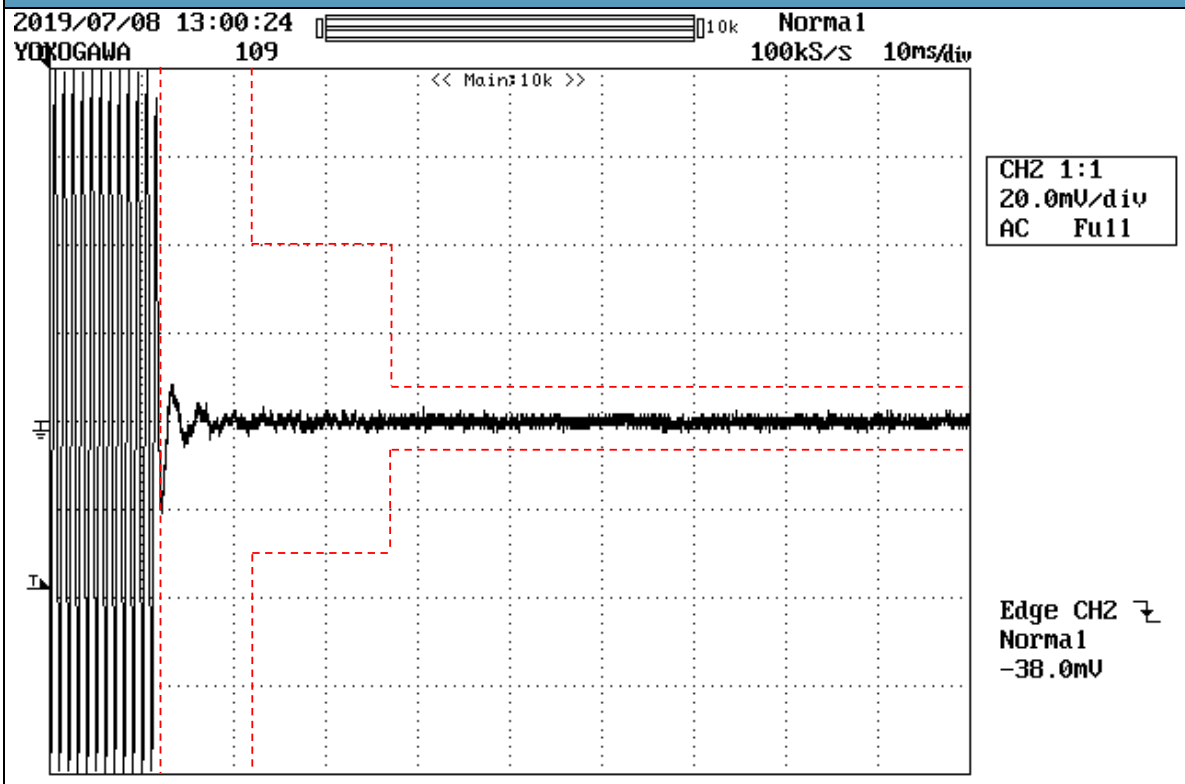
[4] If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

Test date: 2019-07-08

Test results: Pass

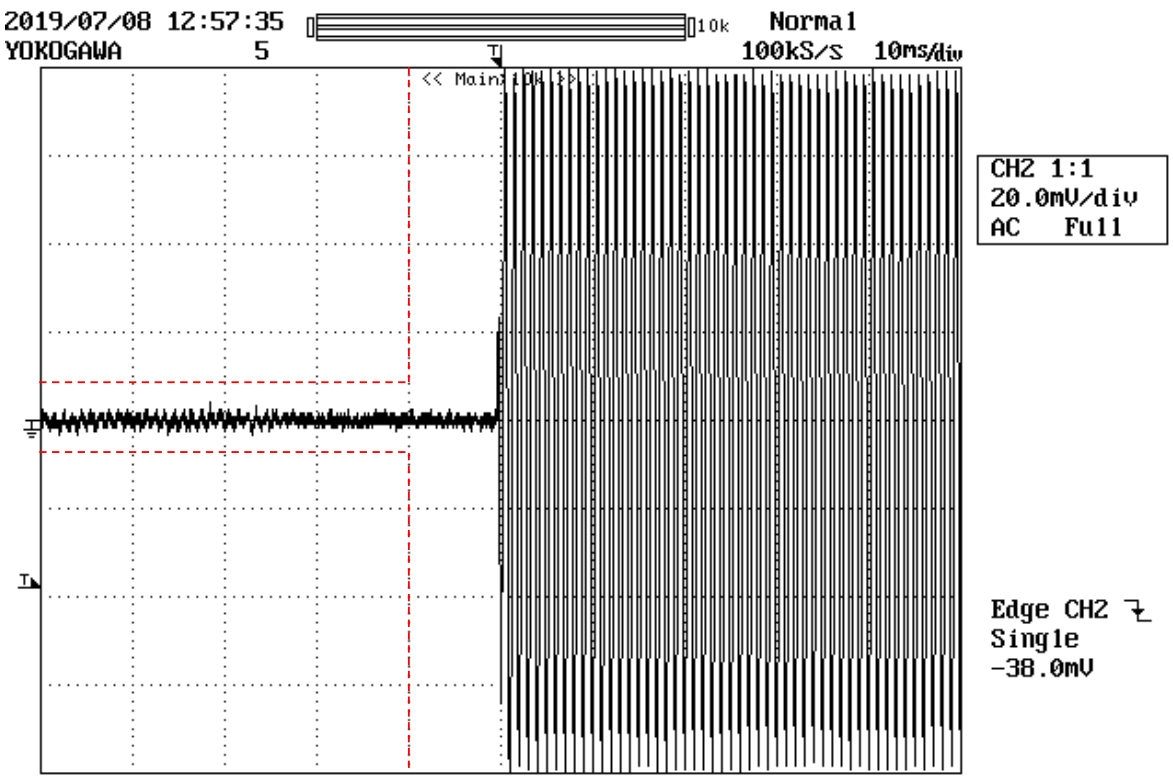
Modulation used: 11K0F3E

Test data



Switch on condition, t_1=10 ms, t_2=25 ms, 450.1 MHz, channel separation ± 12.5 kHz

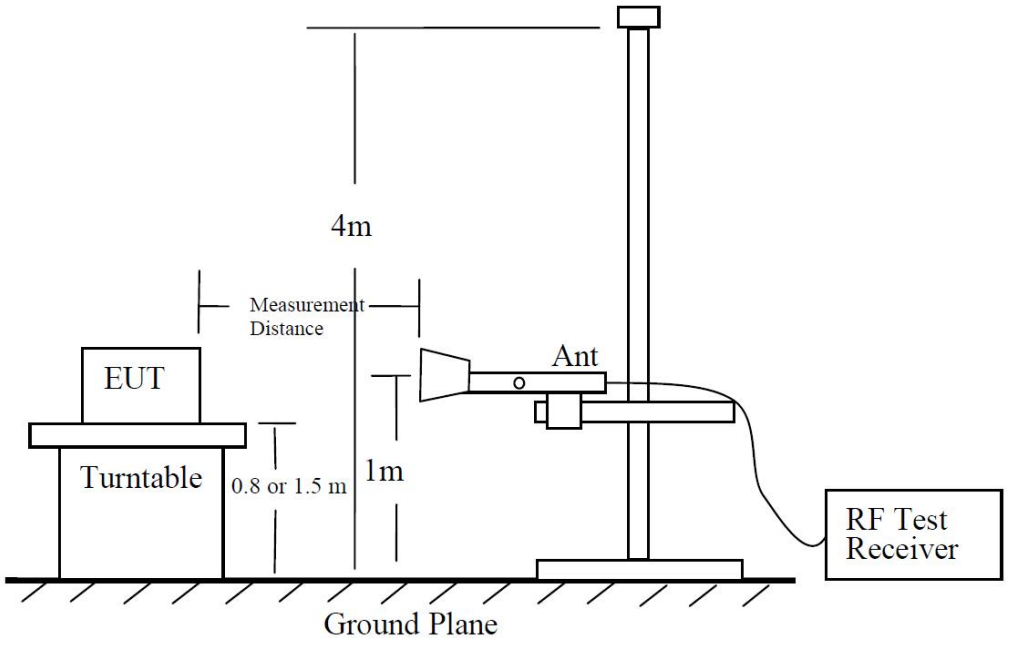
Test data



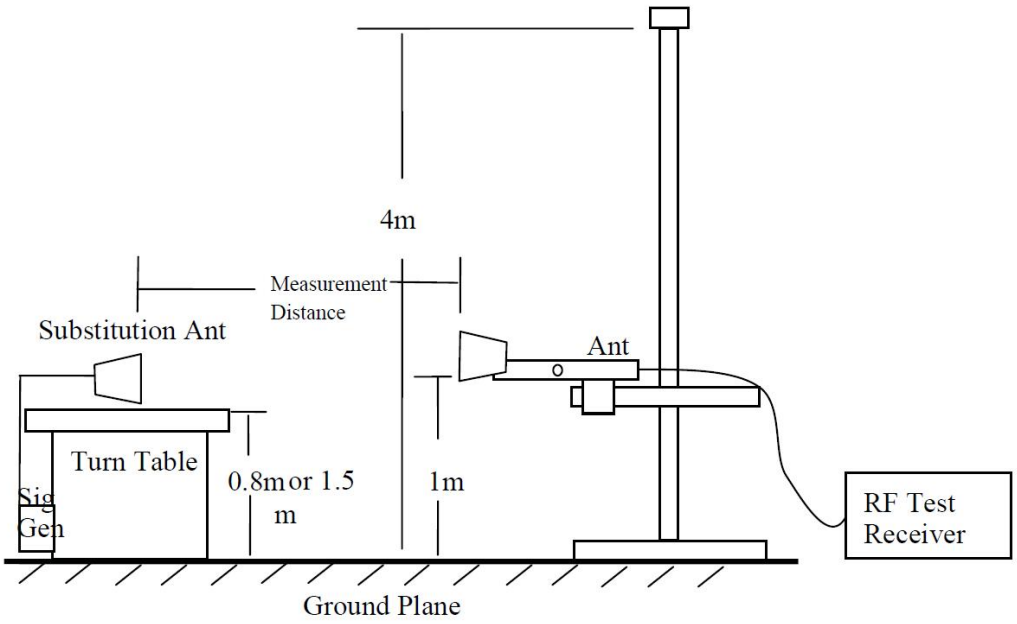
Switch off condition, t_3=10 ms, 450.1 MHz, channel separation ± 12.5 kHz

Appendix B: Block diagrams of test set-ups

Radiated emissions set-up

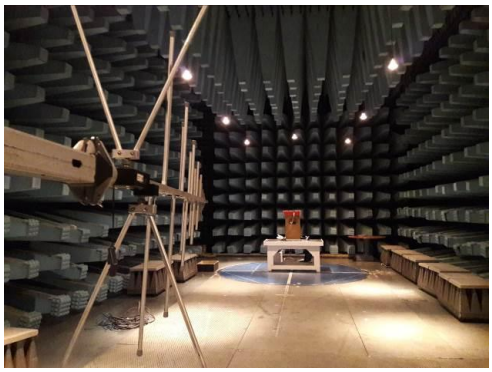


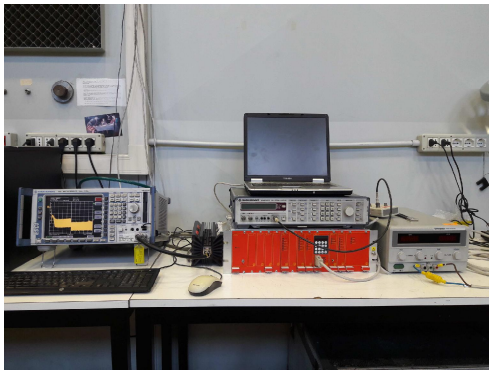
Substitution method set-up for radiated emission



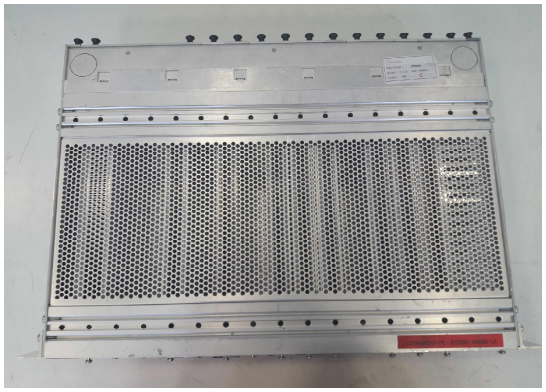
Appendix C: Photos

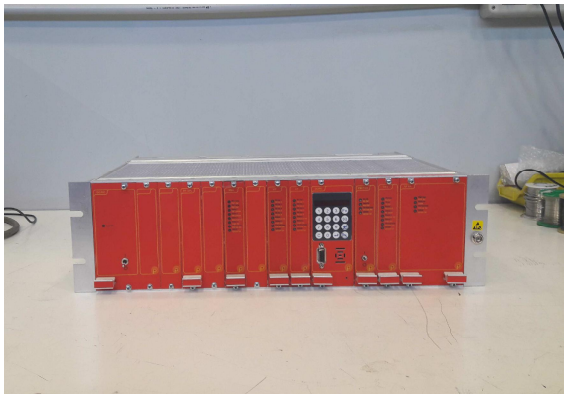
Set-up photos

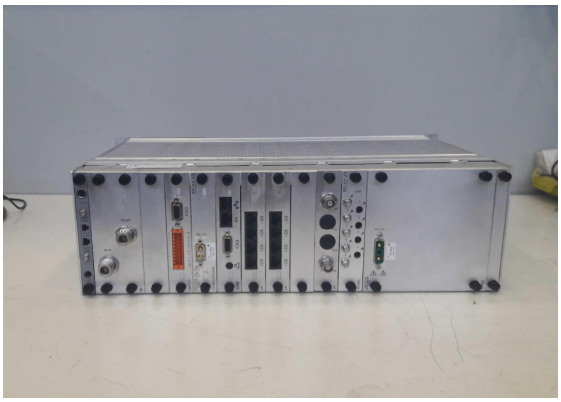




EUT photos







End of report