TESTING LABORATORY
CERTIFICATE #4820.01

FCC PART 22, 74, 80 and 90

TEST REPORT

For

Hytera Communications Corporation Limited

Hytera Tower, Hi-Tech Industrial Park North, 9108# Beihuan Road, Nanshan District, Shenzhen, 518057 China

FCC ID: YAMHR106XU1

Report Type:	**Product Type:**
Original Report	DIGITAL REPEATER

Report Number:	RDG191225002-00A
Report Date:	2020-03-30
Reviewed By:	Ivan Cao Assistant Manager
Prepared By:	Bay Area Compliance Laboratories Corp. (Dongguan) No.69 Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, Guangdong, China Tel: +86-769-86858888 Fax: +86-769-86858891 www.baclcorp.com.cn

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Name:	DIGITAL REPEATER
EUT Model:	HR1062 U(1)
Mutiple Models:	HR1060 U(1), HR1065 U(1), HR1066 U(1), HR1068 U(1)
Modulation Type:	FM, 4FSK
Channel Spacing:	12.5/25 kHz
Frequency Range:	400-470 MHz
Rated Output Power: (Conducted)	High Power Level: 50W Low Power Level: 5W
Rated Input Voltage:	AC 100-240V or DC 13.6V
Serial Number:	RDG191225002-RF-S1
EUT Received Date:	2019.12.31
EUT Received Status:	Good

Note: The series product, models HR1062 U(1), HR1060 U(1), HR1065 U(1), HR1066 U(1), HR1068 U(1) and HR1062 U(1) are electrically identical, The difference between them please refer to the declaration letter for details. For marketing purpose, we selected HR1062 U(1) for fully test.

Objective

This test report is prepared on behalf of *Hytera Communications Corporation Limited* in accordance with Part 2, and Part 22,74,80 and 90 of the Federal Communication Commissions rules.

Related Submittal(s)/Grant(s)

No Related submittal.

Test Methodology

All tests and measurements indicated in this document were performed in accordance with the Code of federal Regulations Title 47 Part 2, Sub-part J as well as the following individual parts:

Part 22 – Public Mobile Service
Part 74 – Experimental Radio, Auxiliary, Special Broadcast and other Program Distributonal Service
Part 80 –Stations in the Maritime Services
Part 90 – Private Land Mobile Radio Service

Applicable Standards: TIA 603-D.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Dongguan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Parameter	Measurement Uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.61dB
Unwanted Emissions, radiated	30MHz ~ 1GHz:5.85 dB 1G~26.5GHz: 5.23 dB
Unwanted Emissions, conducted	±1.5 dB
Temperature	±1℃
Humidity	±5%
DC and low frequency voltages	±0.4%
Duty Cycle	1%

Note: Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty. The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval.

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Dongguan) to collect test data is located on the No.69 Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, Guangdong, China.

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 897218, the FCC Designation No. : CN1220.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0022.

Declarations

BACL is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with a triangle symbol "△ ". Customer model name, addresses, names, trademarks etc. are not considered data.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

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This report may contain data that are not covered by the accreditation scope and shall be marked with an asterisk "★".

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in a test mode which has been done in the factory.

EUT Exercise Software

No exercise software was used.

Special Accessories

No special accessory was used.

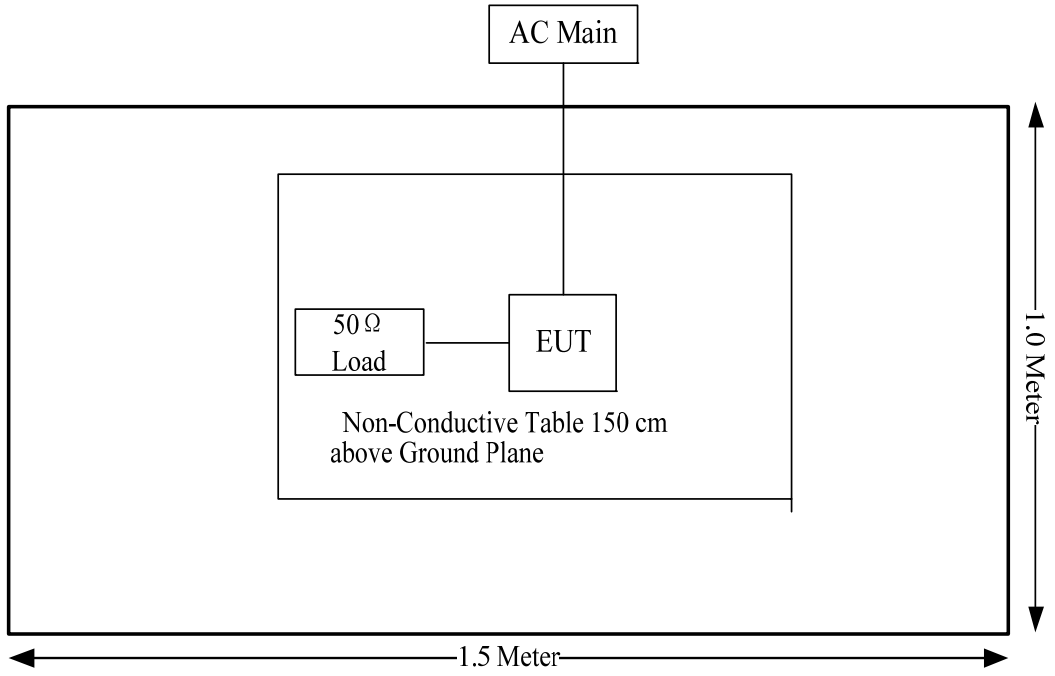
Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
Weinschel	50Ω Load Terminal	MD477	1440-3
HP	RF Communication Tester	8920A	3438A05201

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Results
§1.1310 and §2.1091	Maximum Permissible Exposure (MPE)	Compliance
§2.1046; § 22.727; §80.215; §74.461; §90.205	RF Output Power	Compliance
§2.1047	Modulation Characteristic	Compliance
§2.1049;§22.357;§ 22.731; §74.462;§80.205; §80.207 §90.209; §90.210	Occupied Bandwidth & Emission Mask	Compliance
§2.1051; §22.861; §74.462; §80.211;§90.210	Spurious Emission at Antenna Terminal	Compliance
§2.1053;§22.861; §74.462;§80.211;§90.210	Spurious Radiated Emissions	Compliance
§2.1055; § 22.355; §74.464; §80.209; §90.213	Frequency Stability	Compliance
§90.214	Transient Frequency Behavior	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated emissions below 1GHz					
R&S	EMI Test Receiver	ESCI	100224	2019-09-12	2020-09-12
Sunol Sciences	Antenna	JB3	A060611-3	2017-07-21	2020-07-21
EMCO	Adjustable Dipole Antenna	3121C	9109-753	N/A	N/A
Unknown	Coaxial Cable	C-NJNJ-50	C-1000-01	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-02	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0530-01	2019-09-24	2020-09-24
Unknown	Coaxial Cable	C-NJNJ-50	C-0200-02	2019-09-05	2020-09-05
Sonoma	Amplifier	310N	185914	2019-10-13	2020-10-13
Agilent	Signal Generator	E8247C	MY43321350	2019-12-10	2020-12-10
R&S	EMI Test Receiver	ESCI	100224	2019-09-12	2020-09-12
Radiated emissions above 1GHz					
Agilent	Spectrum Analyzer	E4440A	SG43360054	2019-05-09	2020-05-09
TDK RF	Horn Antenna	HRN-0118	130 084	2018-10-12	2021-10-12
ETS-Lindgren	Horn Antenna	3115	000 527 35	2018-10-12	2021-10-12
Unknown	Coaxial Cable	C-SJSJ-50	C-0800-01	2019-09-05	2020-09-05
Mini-Circuit	Amplifier	ZVA-213-S+	54201245	2019-09-05	2020-09-05
Ouli	Bandpass Filter	136-174M	021	2019-07-23	2020-07-23
Agilent	Signal Generator	E8247C	MY43321350	2019-12-10	2020-12-10
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2019-08-03	2020-08-03
Unknown	Coaxial Cable	C-SJ00-0010	C0010/02	Each time	N/A
Unknown	Coaxial Cable	C-SJ00-0010	C0010/05	Each time	N/A
E-Microwave	Blocking Control	EMDCB-00036	0E01201048	Each time	N/A
E-Microwave	Coaxial Attenuators	EMCA40-200SN-6	OE01201046	Each time	N/A
Ouli	Bandpass Filter	136-174M	021	2019-07-23	2020-07-23
HP	RF Communications Test Set	8920A	3438A05201	2019-05-09	2020-05-09
ESPEC	Constant temperature and humidity Tester	ESX-4CA	018 463	2019-03-26	2020-03-26
UNI-T	Multimeter	UT39A	M130199938	2019-07-23	2020-07-23

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

FCC §1.1310 & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to 1.1310, 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for Maximum Permissible Exposure (MPE)

Limits for Occupational/Controlled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time |E|, |H| or S (minutes)
0.3- 3.0	614	1.63	(100)*	6
3.0 - 30	1842/f	4.89/f	($900/f^2$)*	6
30-300	61.4	0.163	1.0	6
300-1500	/	/	f/300	6
1500-100,000	/	/	5	6

f = frequency in MHz;
* = Plane-wave equivalent power density;

MPE Calculation

Prediction of power density at the distance of the applicable MPE limit

$$S = PG/4\pi R^2$$

Where: S = power density (in appropriate units, e.g. mW/cm^2);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

MPE Results

Frequency (MHz)	Antenna Gain		Maximum Average output power including Tune-up Tolerance (mW)	Evaluation Distance (cm)	Power Density (mW/cm^2)	Power Density Limit (mW/cm^2)
	(dBi)	(numeric)				
400-470	10	10	60000	200	1.19	1.33

Note: the maximum power including Tune-up Tolerance is 60 W.

Result: The device meet FCC MPE of the Occupational/Controlled use at 200 cm distance.

FCC §2.1046 & § 22.727 & §74.461 & §80.215& §90.205 - RF OUTPUT POWER

Applicable Standard

FCC §2.1046, § 22.727, §74.461, §80.215 and §90.205

Test Procedure

Conducted RF Output Power:

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

Spectrum Analyzer Setting:

R B/W	Video B/W
100 kHz	300 kHz

Test Data

Environmental Conditions

Temperature:	22.0℃
Relative Humidity:	61 %
ATM Pressure:	102.1kPa

The testing was performed by Blake Yang on 2020-01-10

Test Mode: Transmitting

Test Result: Compliance. Please refer to following table.

Modulation Mode	Channel Separation	f_c	Reading (W)		Note
		MHz	High Power Level	Low Power Level	
FM	12.5kHz	400.0125	57.612	5.639	**For Federal**
		406.1125	57.412	5.715	**For part 90**
		453.2125	55.590	5.649	
		469.9875	58.210	5.794	
4FSK	12.5kHz	400.0125	57.342	5.539	**For Federal**
		406.1125	56.494	5.346	**For part 90**
		453.2125	54.450	5.559	
		469.9875	55.976	5.649	
FM	25kHz	459.9875	55.719	5.623	**FCC part 80**
FM	12.5kHz	455.0125	55.335	5.623	**FCC part 74**
	25kHz		55.463	5.794	
4FSK	12.5kHz		57.943	5.636	
FM	12.5kHz	454.0125	55.208	5.610	**FCC part 22**
	25kHz		53.456	5.902	
4FSK	12.5kHz		57.280	5.559	

Note: The high rated power level is 50 W(Limit ≤ 60W), and low rated power level is 5 W(Limit ≤ 6W).

FCC §2.1047 - MODULATION CHARACTERISTIC

Applicable Standard

FCC §2.1047

(a) Equipment which utilizes voice modulated communication shall show the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz. for equipment which is required to have a low pass filter, the frequency response of the filter, or all of the circuitry installed between the modulation limited and the modulated stage shall be supplied.
(b) Equipment which employs modulation limiting, a curve showing the percentage of modulation versus the modulation input voltage shall be supplied.

Test Procedure

Test Method: TIA/EIA-603 2.2.3

Test Data

Environmental Conditions

Temperature:	22.0℃
Relative Humidity:	61 %
ATM Pressure:	102.1kPa

The testing was performed by Blake Yang on 2020-01-10

Test Mode: Transmitting

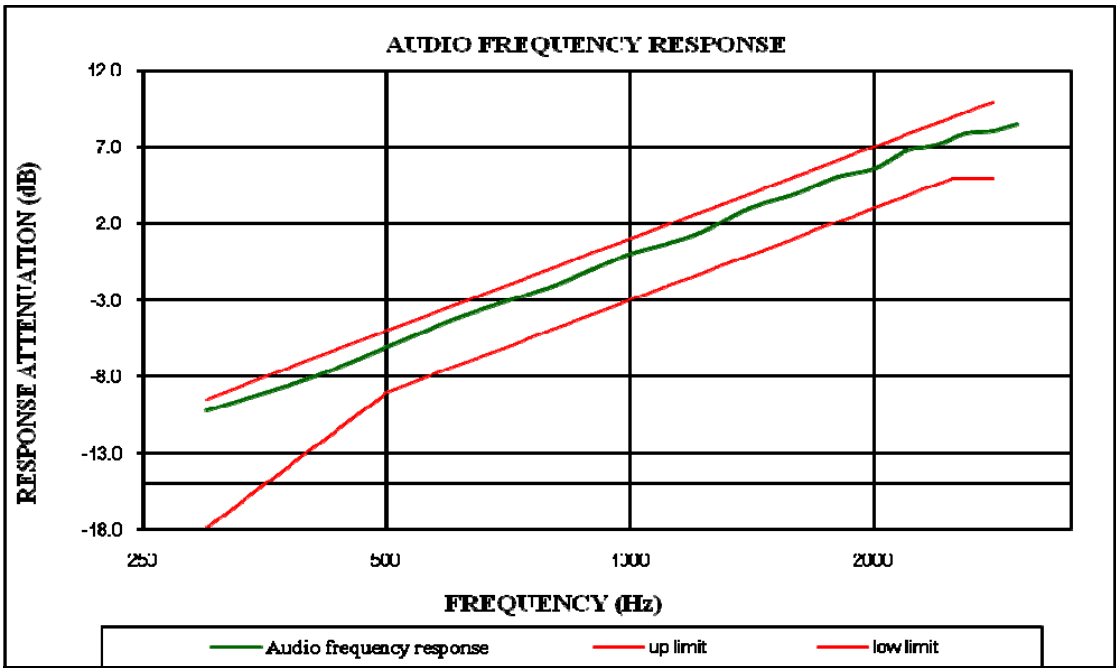
Result: Compliance.

12.5kHz：

Audio Frequency Response – High Power

Carrier Frequency: 453.2125 MHz

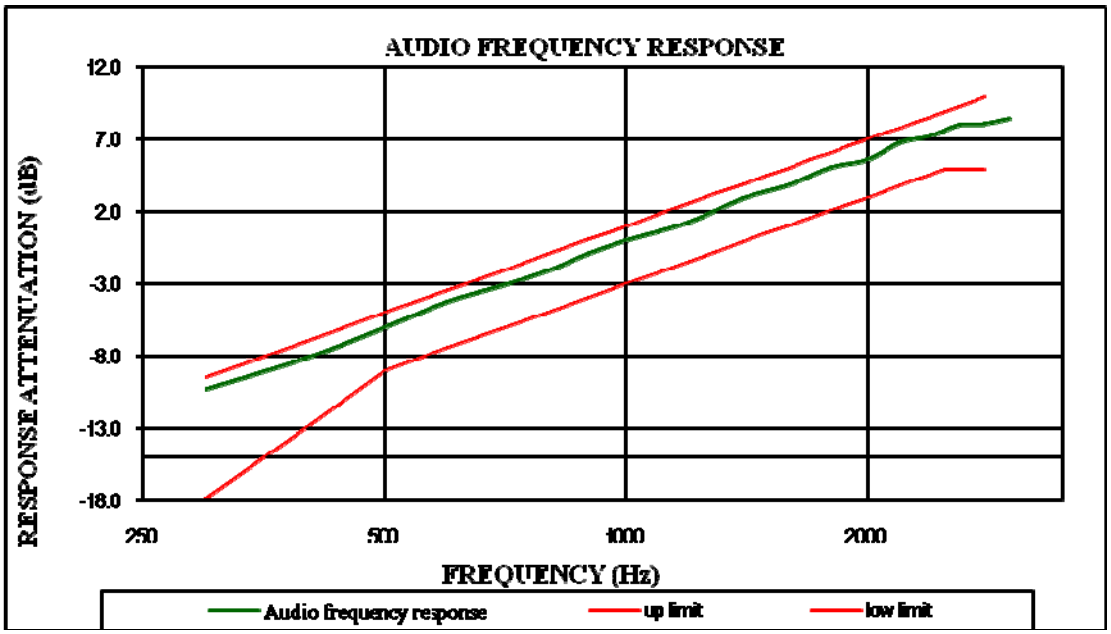
Modulation Frequency (Hz)	Response data (dB)
300	-10.22
400	-8.11
500	-6.05
600	-4.29
700	-3.08
800	-2.09
900	-1.00
1000	0.00
1200	1.23
1400	2.96
1600	3.92
1800	5.04
2000	5.58
2200	6.74
2400	7.20
2600	7.91
2800	8.05
3000	8.49



25 kHz:

Carrier Frequency: 454.0125 MHz

Modulation Frequency (Hz)	Response data (dB)
300	-10.26
400	-8.16
500	-6.04
600	-4.22
700	-3.16
800	-2.11
900	-0.92
1000	0.00
1200	1.25
1400	2.90
1600	3.90
1800	5.04
2000	5.56
2200	6.81
2400	7.26
2600	8.00
2800	8.05
3000	8.44

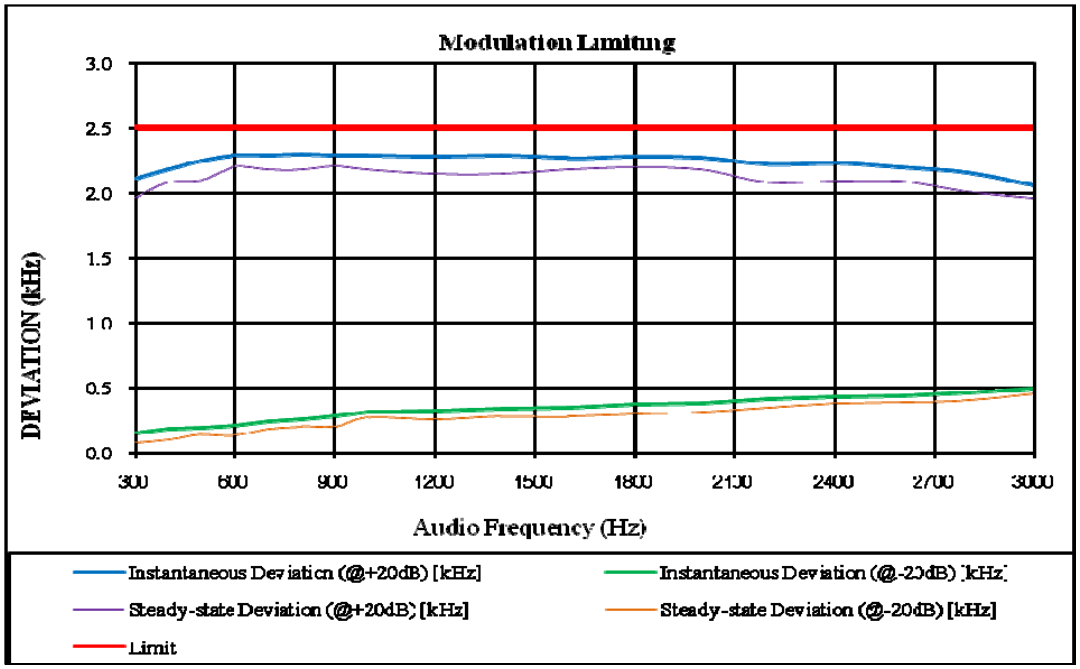


MODULATION LIMITING – High Power

12.5kHz

Carrier Frequency: 453.2125 MHz

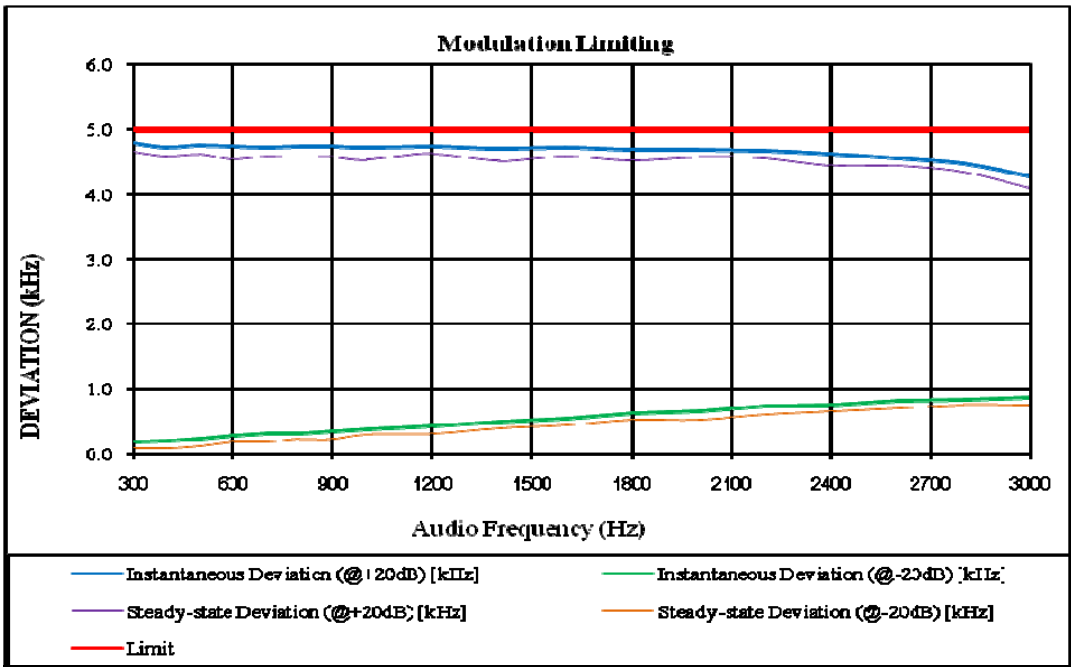
Audio Frequency (Hz)	Instantaneous		Steady-state		Limit [KHz]
	Deviation (@+20dB) [KHz]	Deviation (@-20dB) [KHz]	Deviation (@+20dB) [KHz]	Deviation (@-20dB) [KHz]	
300	2.11	0.15	1.96	0.08	2.5
400	2.18	0.18	2.08	0.10	2.5
500	2.25	0.19	2.10	0.14	2.5
600	2.29	0.21	2.20	0.13	2.5
700	2.29	0.24	2.18	0.18	2.5
800	2.30	0.26	2.18	0.20	2.5
900	2.29	0.28	2.21	0.20	2.5
1000	2.29	0.31	2.18	0.27	2.5
1200	2.28	0.32	2.15	0.26	2.5
1400	2.29	0.34	2.15	0.28	2.5
1600	2.27	0.35	2.18	0.28	2.5
1800	2.28	0.37	2.20	0.30	2.5
2000	2.27	0.38	2.18	0.31	2.5
2200	2.22	0.41	2.08	0.35	2.5
2400	2.23	0.43	2.09	0.38	2.5
2600	2.20	0.44	2.09	0.39	2.5
2800	2.16	0.46	2.01	0.40	2.5
3000	2.06	0.49	1.96	0.45	2.5



25kHz:

Carrier Frequency: 454.0125 MHz

Audio Frequency (Hz)	Instantaneous		Steady-state		Limit [KHz]
	Deviation (@+20dB) [KHz]	Deviation (@-20dB) [KHz]	Deviation (@+20dB) [KHz]	Deviation (@-20dB) [KHz]	
300	4.78	0.18	4.66	0.09	5
400	4.72	0.21	4.59	0.09	5
500	4.75	0.24	4.62	0.13	5
600	4.73	0.28	4.55	0.18	5
700	4.72	0.31	4.59	0.19	5
800	4.74	0.32	4.57	0.23	5
900	4.73	0.35	4.58	0.23	5
1000	4.72	0.38	4.54	0.30	5
1200	4.73	0.43	4.63	0.31	5
1400	4.70	0.50	4.52	0.40	5
1600	4.72	0.55	4.59	0.44	5
1800	4.69	0.62	4.53	0.53	5
2000	4.69	0.65	4.58	0.53	5
2200	4.67	0.73	4.56	0.61	5
2400	4.63	0.76	4.45	0.65	5
2600	4.56	0.82	4.44	0.70	5
2800	4.47	0.84	4.35	0.76	5
3000	4.29	0.87	4.11	0.75	5

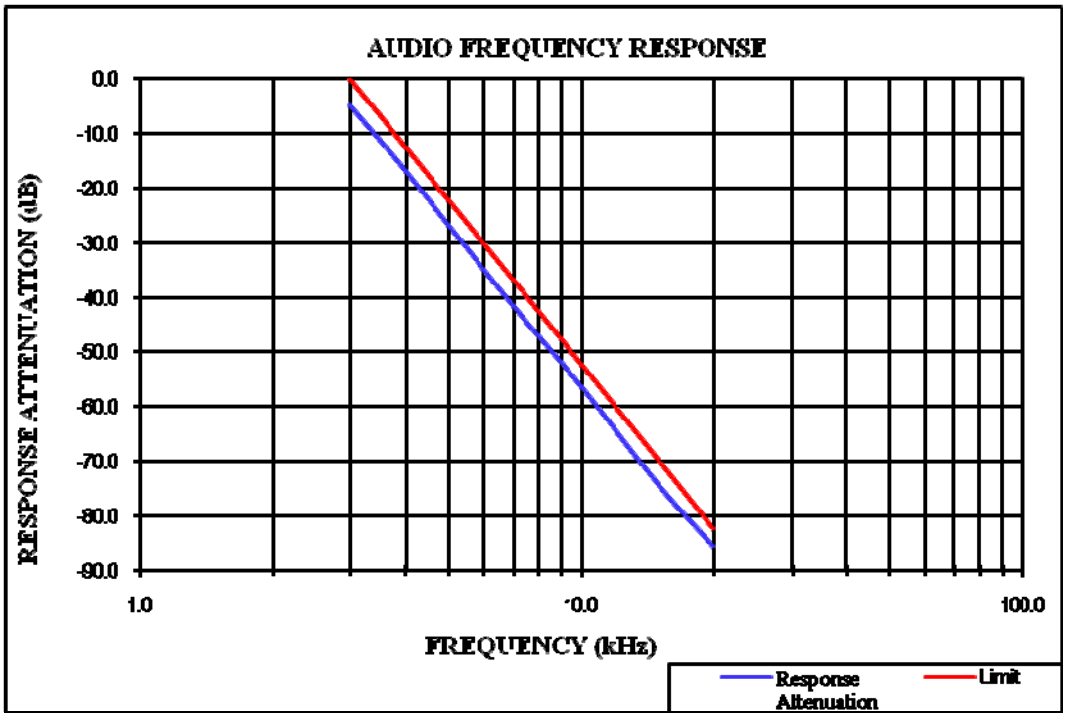


Audio Frequency Low Pass Filter Response – High Power

12.5kHz:

Carrier Frequency: 453.2125 MHz

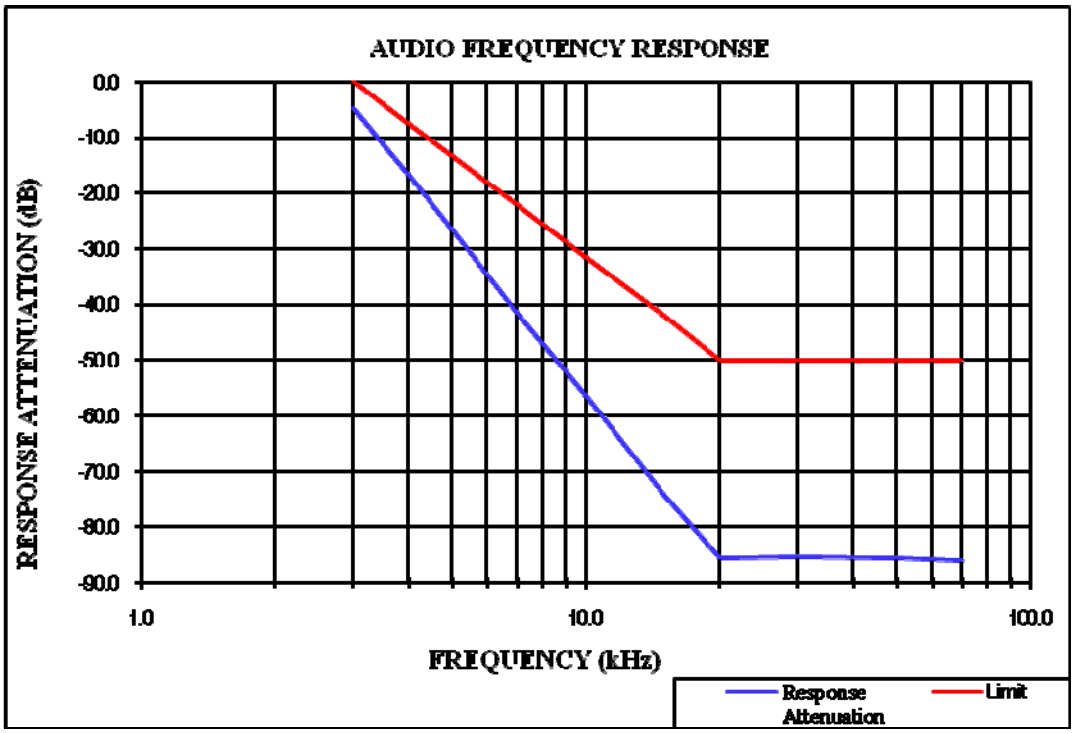
Audio Frequency (kHz)	Response Attenuation (dB)	Limit (dB)
3.0	-4.8	0.0
3.5	-11.2	-6.7
4.0	-16.8	-12.5
5.0	-26.7	-22.2
7.0	-41.5	-36.8
10.0	-56.4	-52.3
15.0	-74.3	-69.9
20.0	-85.6	-82.5



25kHz:

Carrier Frequency: 454.0125 MHz

Audio Frequency (kHz)	Response Attenuation (dB)	Limit (dB)
3.0	-4.8	0.0
3.5	-11.2	-4.0
4.0	-16.8	-7.5
5.0	-26.6	-13.3
7.0	-41.6	-22.1
10.0	-56.4	-31.4
15.0	-74.2	-41.9
20.0	-85.5	-50.0
30.0	-85.4	-50.0
50.0	-85.6	-50.0
70.0	-86.1	-50.0



FCC §2.1049 & §22.357 & § 22.731 & §74.462 & 80.205& §80.207& §90.209 & §90.210 – OCCUPIED BANDWIDTH & EMISSION MASK

Applicable Standard

FCC §2.1049, §22.357, § 22.731, §74.462, §80.205, §80.207,§90.209 and §90.210

Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

The resolution bandwidth of the spectrum analyzer was set at 100 Hz or 300 Hz and the spectrum was recorded in the frequency band ±50 kHz from the carrier frequency.

Test Data

Environmental Conditions

Temperature:	22.0℃
Relative Humidity:	61 %
ATM Pressure:	102.1kPa

The testing was performed by Blake Yang on 2020-01-10

Test mode: transimitting

Modulation Mode	Channel Separation	f_c (MHz)	99% Occupied Bandwidth (kHz)	26 dB Bandwidth (kHz)	Power Level	Note
FM	12.5kHz	453.2125	10.020	10.421	High	FCC part 90
			10.020	10.421	Low	
4FSK	12.5kHz		7.715	9.619	High	
			7.816	9.619	Low	
FM	25kHz	459.9875	15.030	16.032	High	FCC part 80
			15.030	16.032	Low	
FM	12.5kHz	455.0125	9.920	10.421	High	FCC part 74
			9.920	10.321	Low	
	25kHz		15.030	15.982	High	
			15.030	15.982	Low	
4FSK	12.5kHz		7.916	9.419	High	
			7.816	9.118	Low	
FM	12.5kHz	454.0125	9.920	10.321	High	FCC part 22
			9.920	10.321	Low	
	25kHz		15.030	15.832	High	
			15.030	15.832	Low	
4FSK	12.5kHz		7.816	9.619	High	
			7.916	9.419	Low	

Note: Emission bandwidth was based on calculation method instead of measurement.
Emission Designator
Per CFR 47 §2.201& §2.202, BW = 2M + 2D

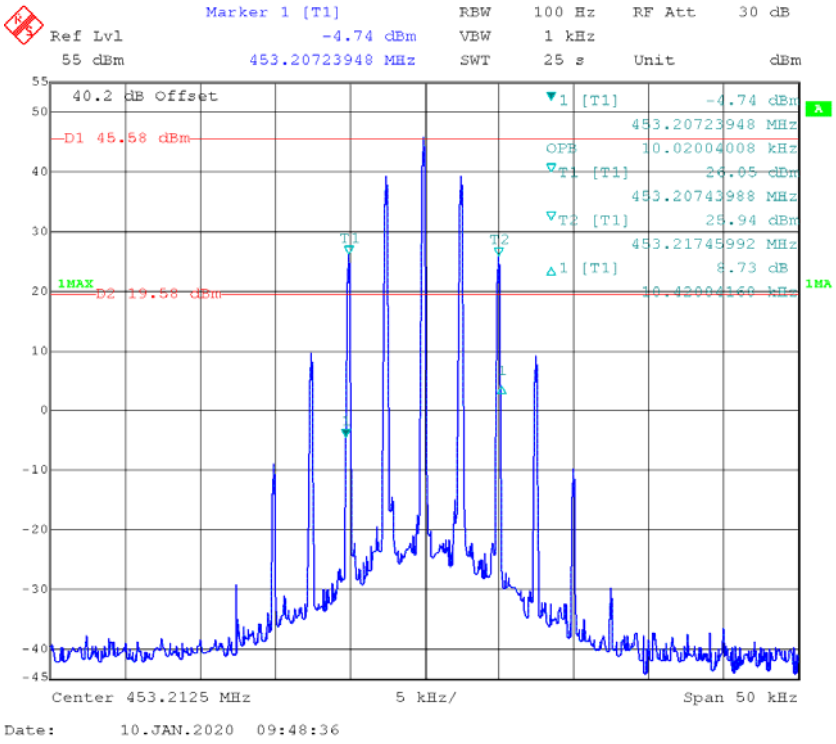
For FM Mode (Channel Spacing: 12.5 kHz)
Emission Designator 11K0F3E
In this case, the maximum modulating frequency is 3.0 kHz with a 2.5 kHz deviation.
BW = 2(M+D) = 2*(3.0 kHz + 2.5 kHz) = 11 kHz = 11K0
F3E portion of the designator represents an FM voice transmission
Therefore, the entire designator for 12.5 kHz channel spacing FM mode is 11K0F3E.

For FM Mode (Channel Spacing: 25 kHz)
Emission Designator 16K0F3E
In this case, the maximum modulating frequency is 3.0 kHz with a 5.0 kHz deviation.
BW = 2(M+D) = 2*(3.0 kHz + 5.0 kHz) = 16 kHz =16K0
F3E portion of the designator represents an FM voice transmission
Therefore, the entire designator for 25 kHz channel spacing FM mode is 16K0F3E.

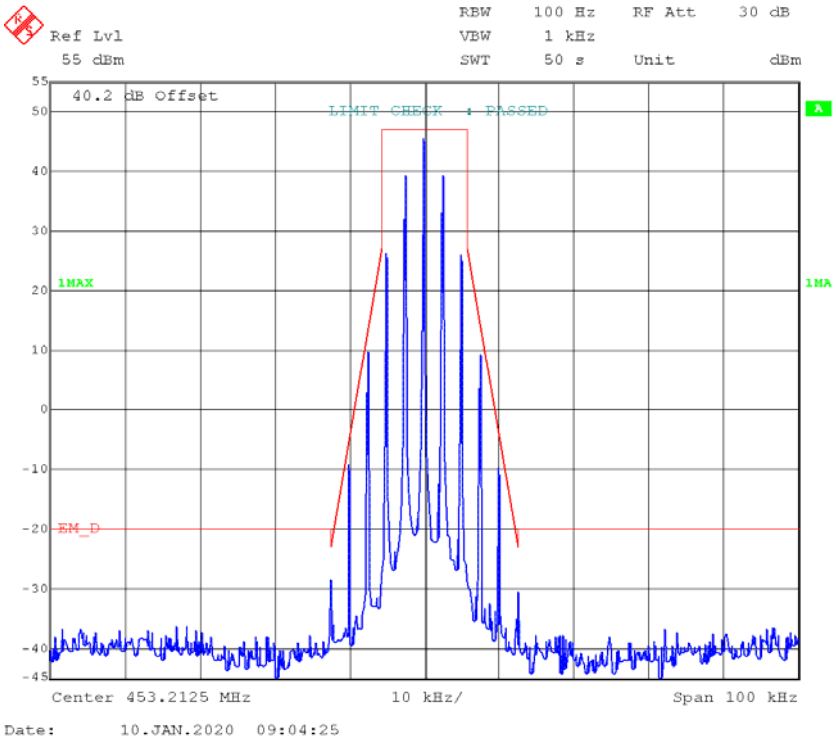
For Digital Mode (Channel Spacing: 12.5 kHz)
Emission Designator 7K60F1D and 7K60F1E
The 99% energy rule (title 47CFR 2.1049) was used for digital mode. It basically states that 99% of the modulation energy falls within X kHz, in this case, 7.60 kHz. The emission mask was obtained from 47CFR 90.210(d).
F1D and F1E portion of the designator indicates digital information.
Therefore, the entire designator for 12.5 kHz channel spacing digital mode is 7K60F1D and 7K60F1E.

Part 90:
FM,12.5kHz,High Power - Frequency 453.2125 MHz:

99% Occupied & 26 dB Bandwidth

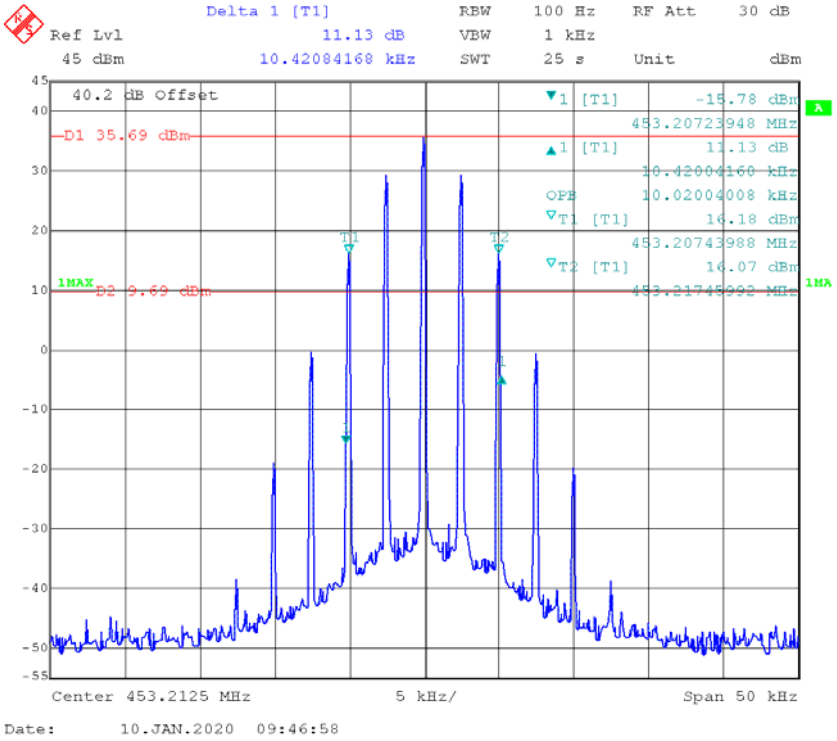


Emission Mask

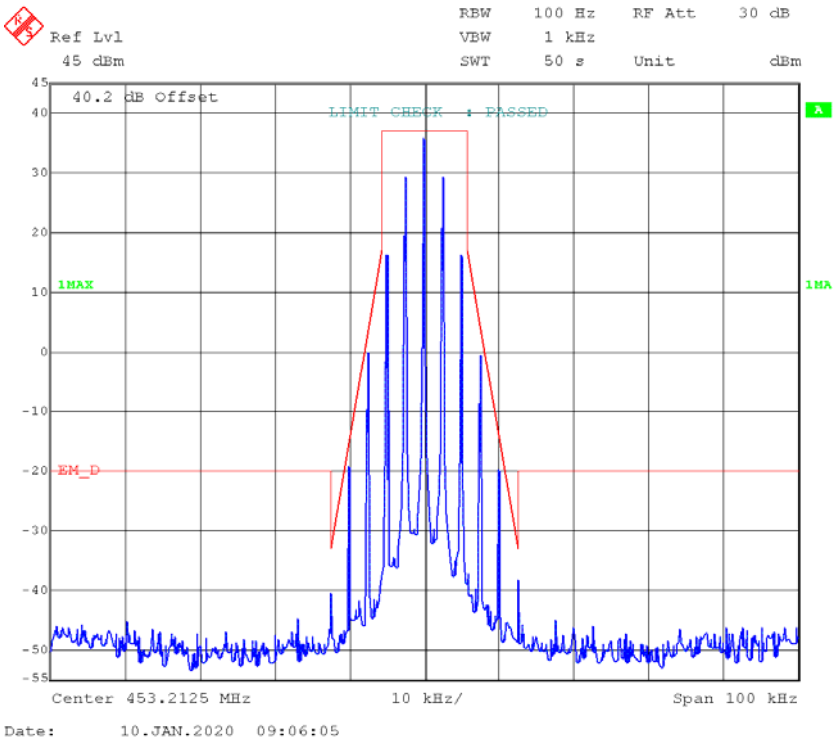


FM,12.5kHz,Low Power - Frequency 453.2125 MHz:

99% Occupied & 26 dB Bandwidth

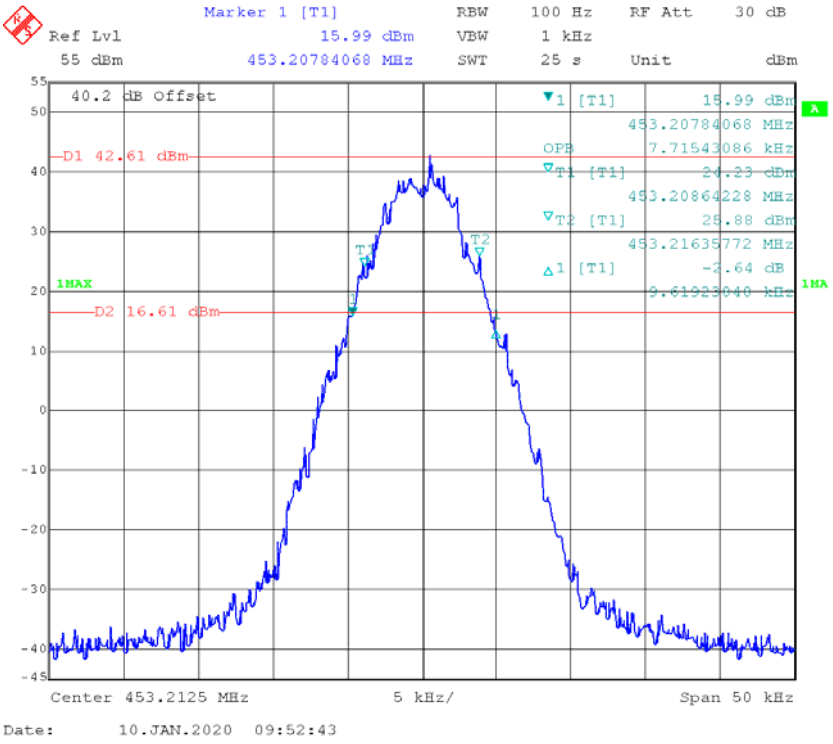


Emission Mask

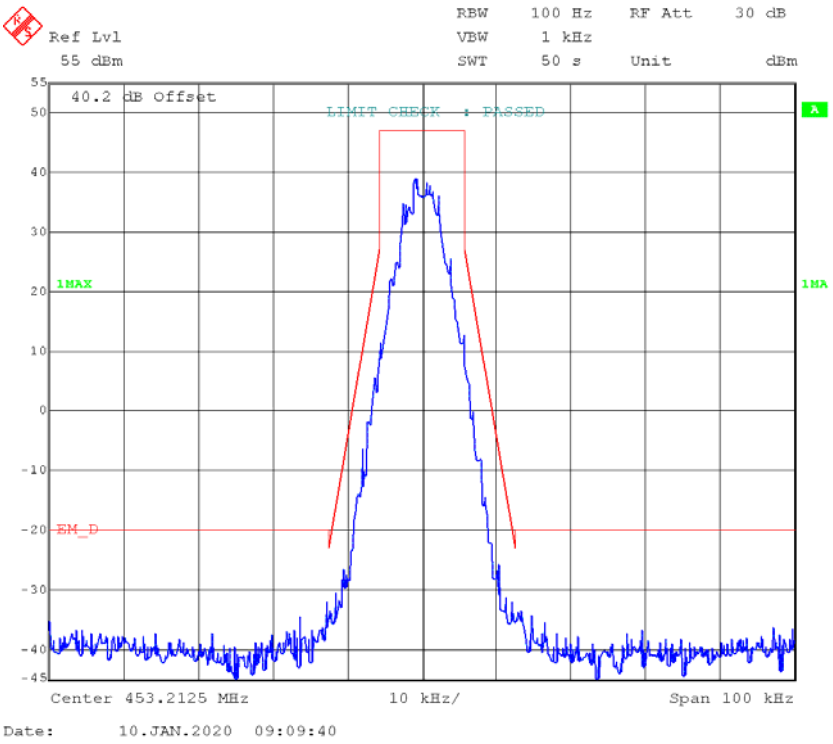


4FSK,12.5kHz,High Power - Frequency 453.2125 MHz:

99% Occupied & 26 dB Bandwidth

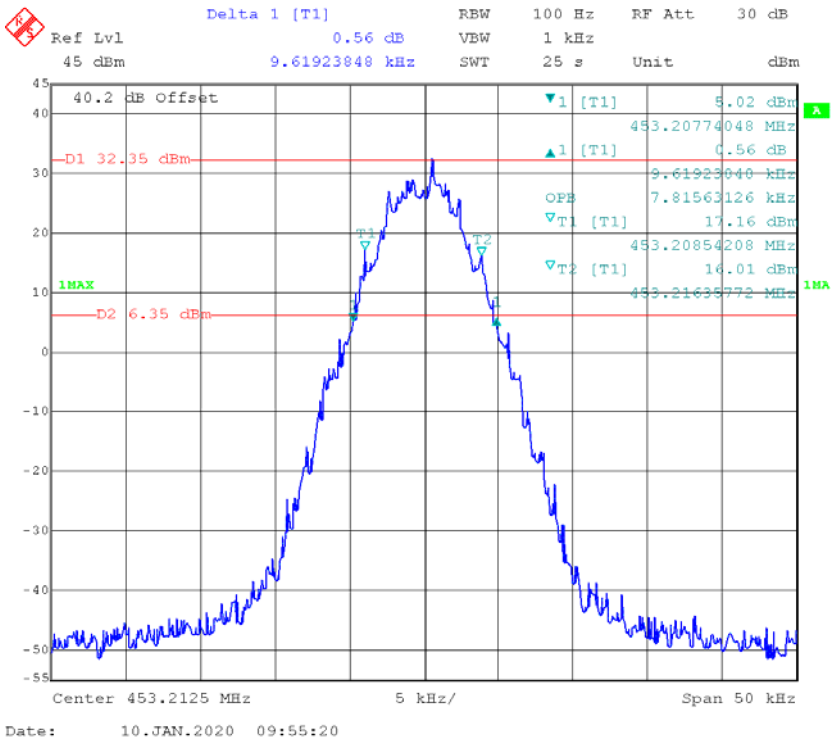


Emission Mask

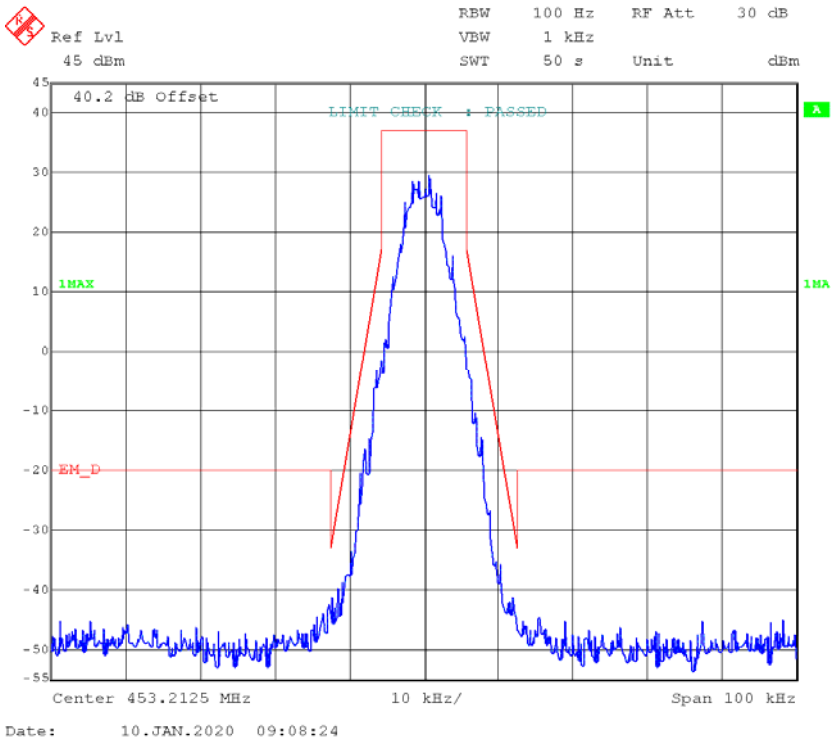


4FSK,12.5kHz,Low Power - Frequency453.2125 MHz:

99% Occupied & 26 dB Bandwidth

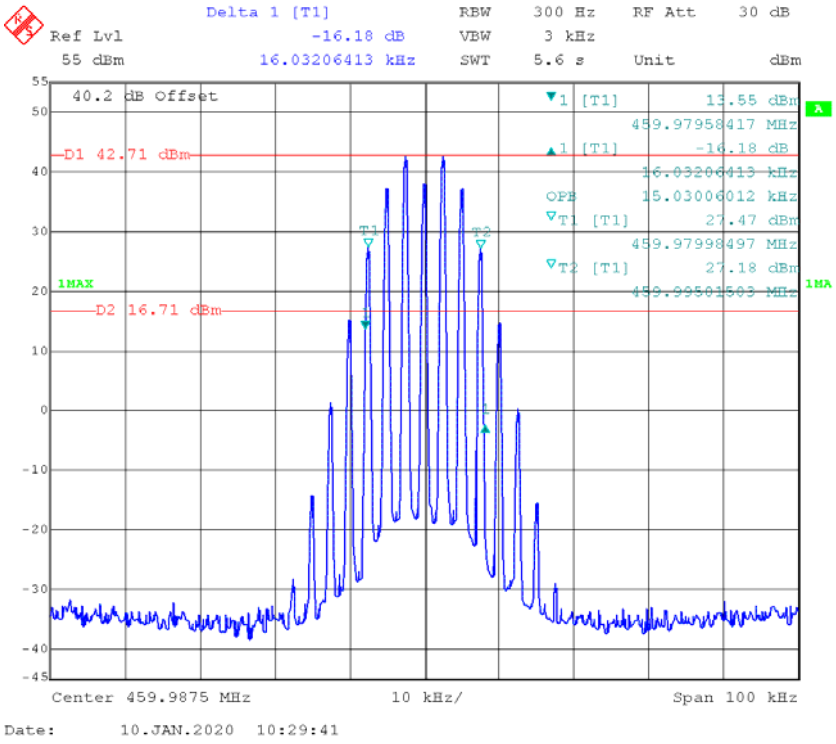


Emission Mask

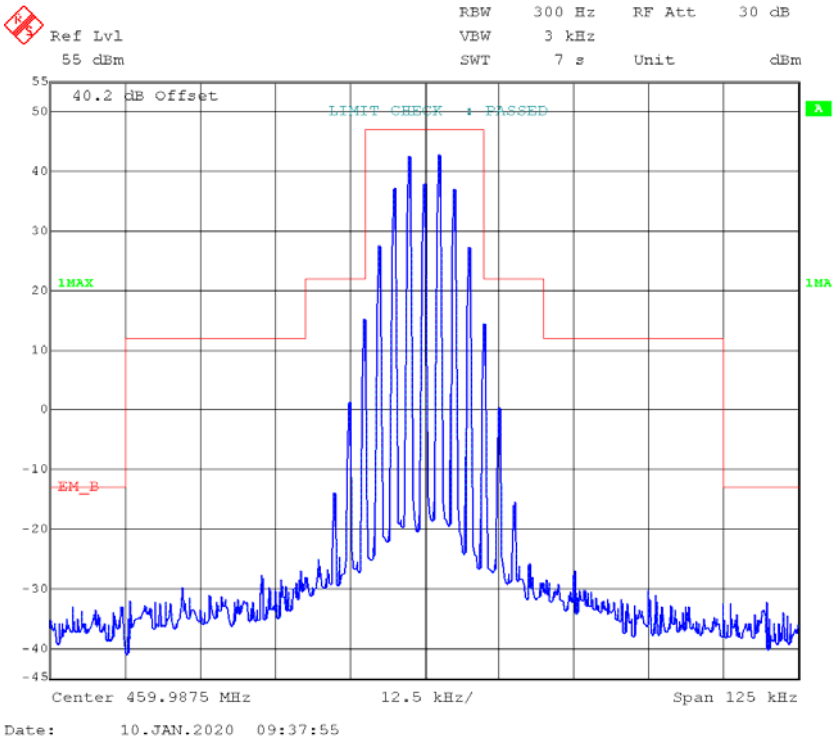


part 80:
FM,25kHz,High Power - Frequency 459.9875MHz:

99% Occupied & 26 dB Bandwidth

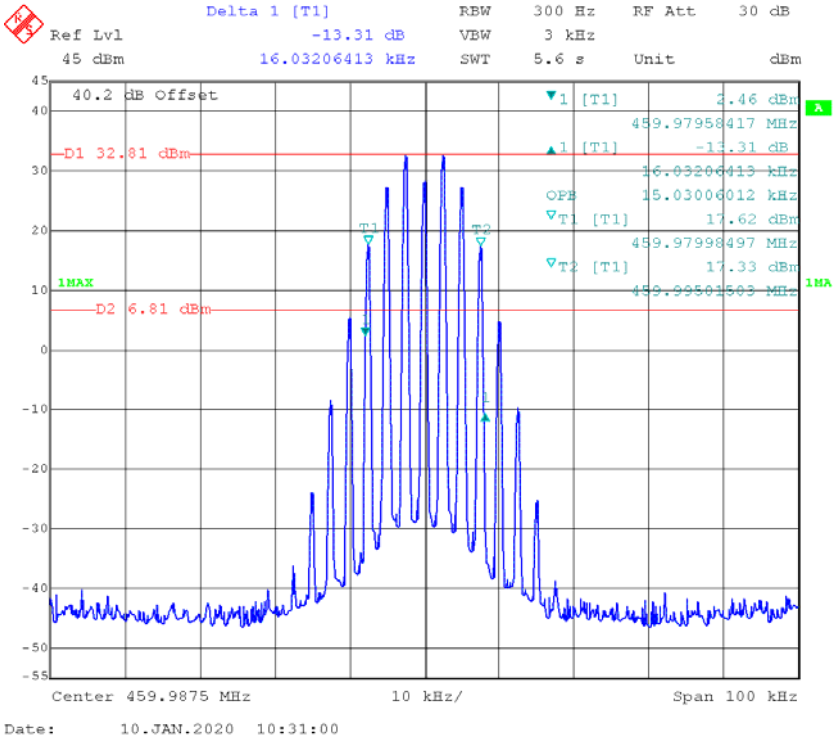


Emission Mask

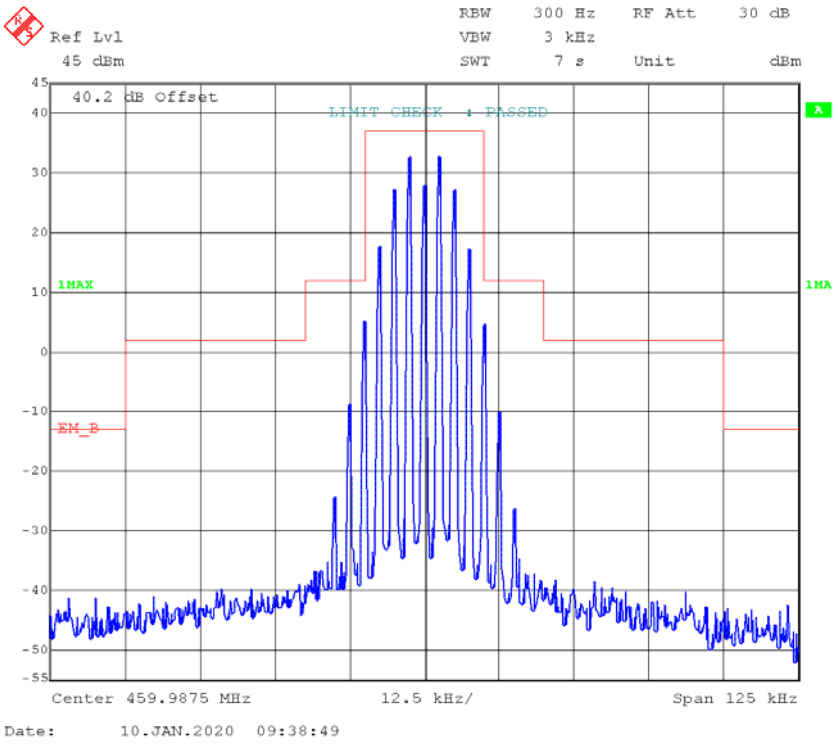


FM,25kHz,Low Power - Frequency 459.9875 MHz:

99% Occupied & 26 dB Bandwidth



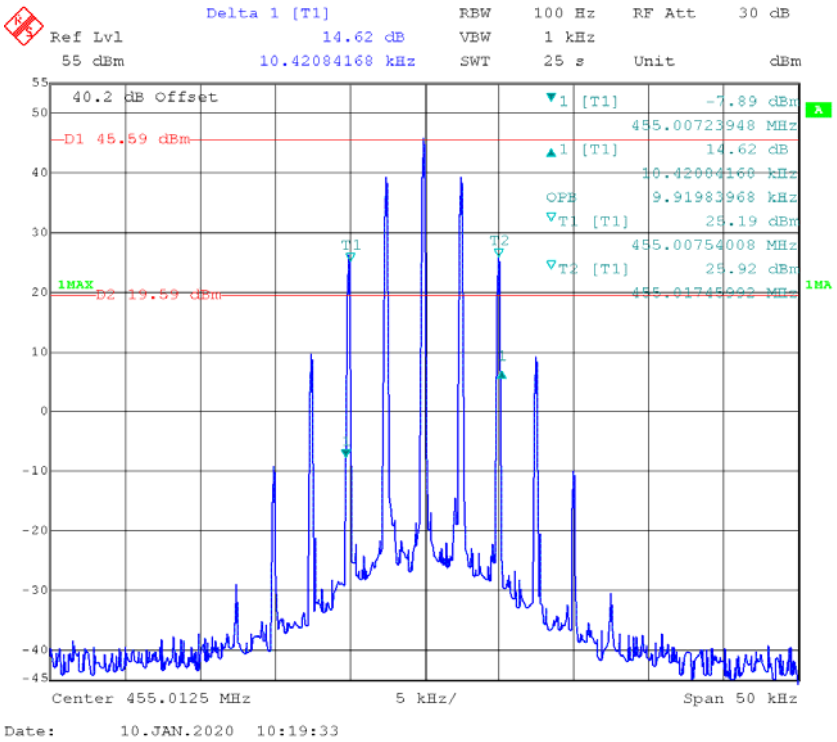
Emission Mask



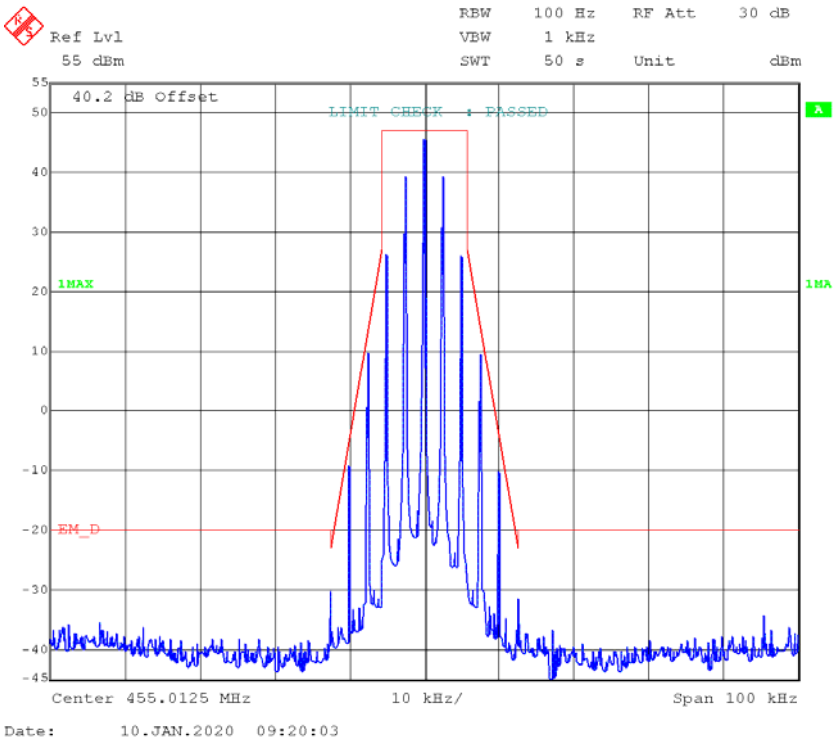
part 74:

FM,12.5kHz,High Power - Frequency 455.0125 MHz:

99% Occupied & 26 dB Bandwidth

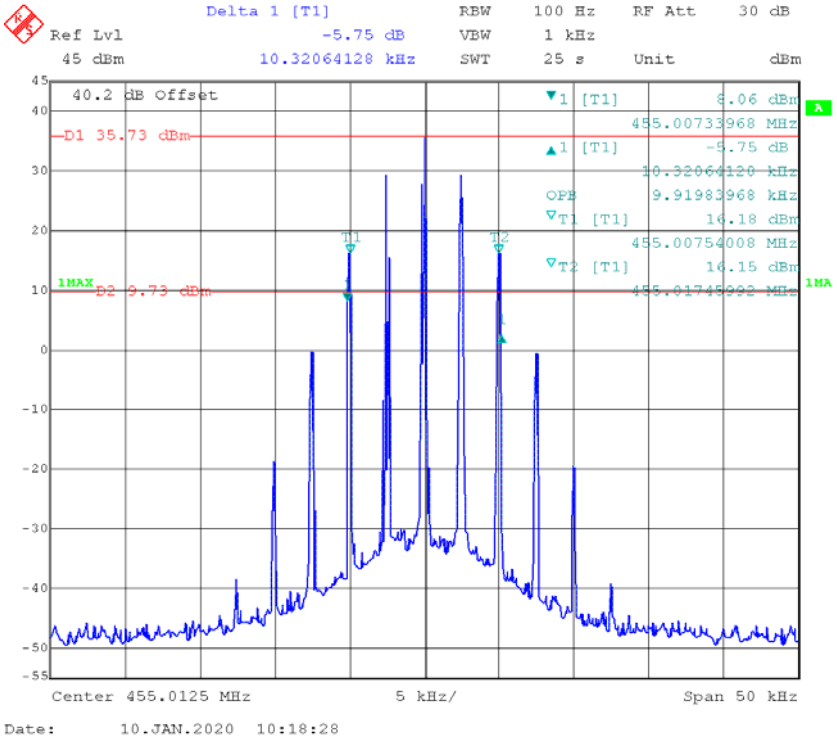


Emission Mask

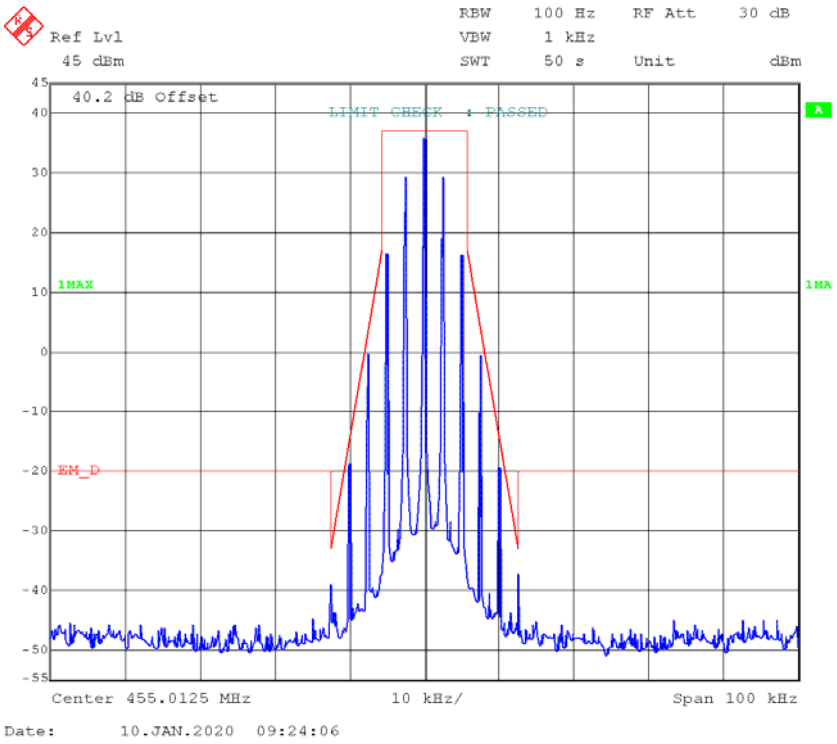


FM,12.5kHz,Low Power – Frequency 455.0125 MHz:

99% Occupied & 26 dB Bandwidth

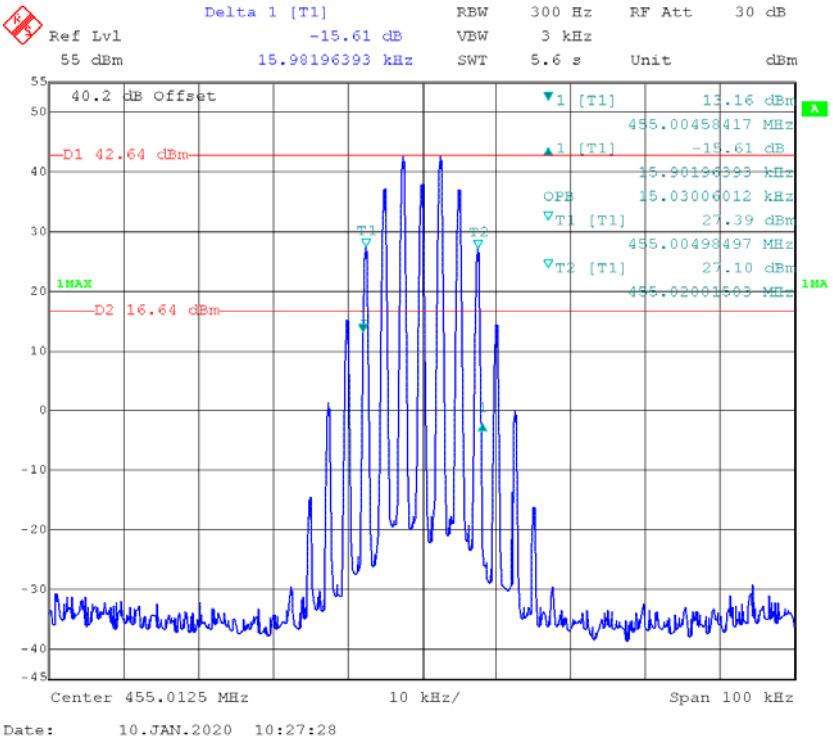


Emission Mask

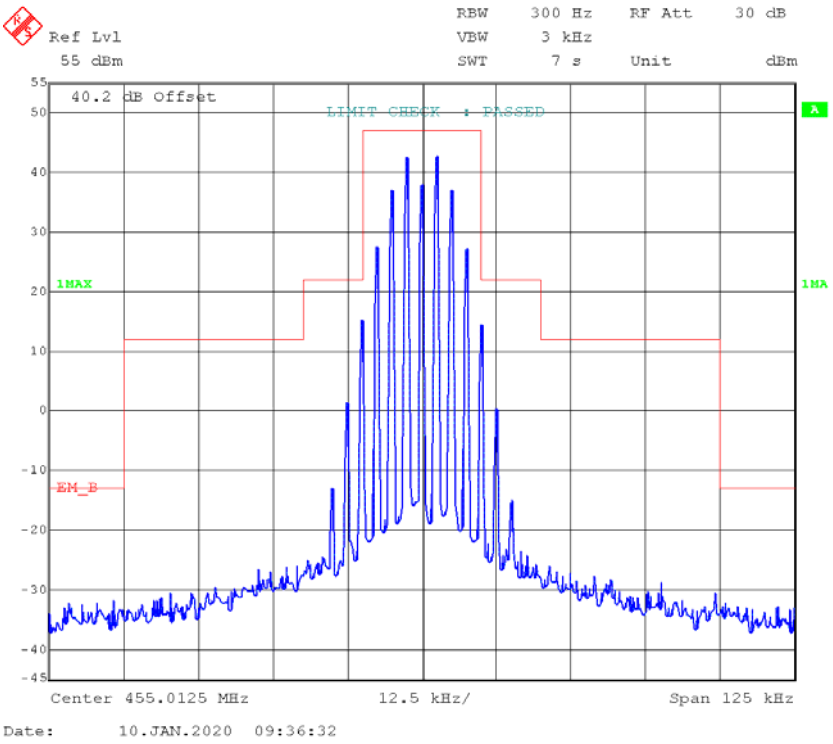


FM,25kHz,High Power - Frequency 455.0125 MHz

99% Occupied & 26 dB Bandwidth

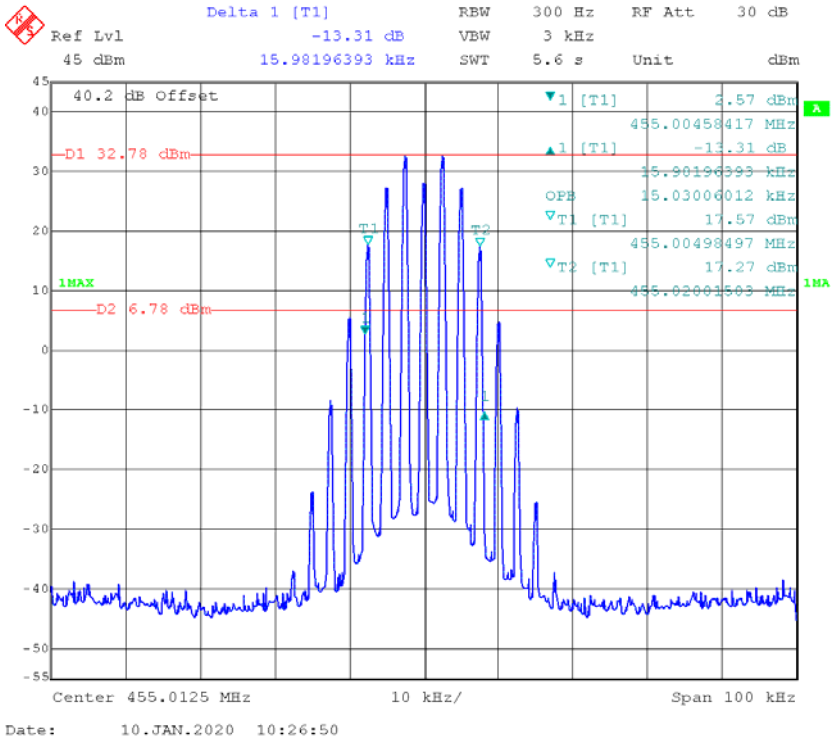


Emission Mask

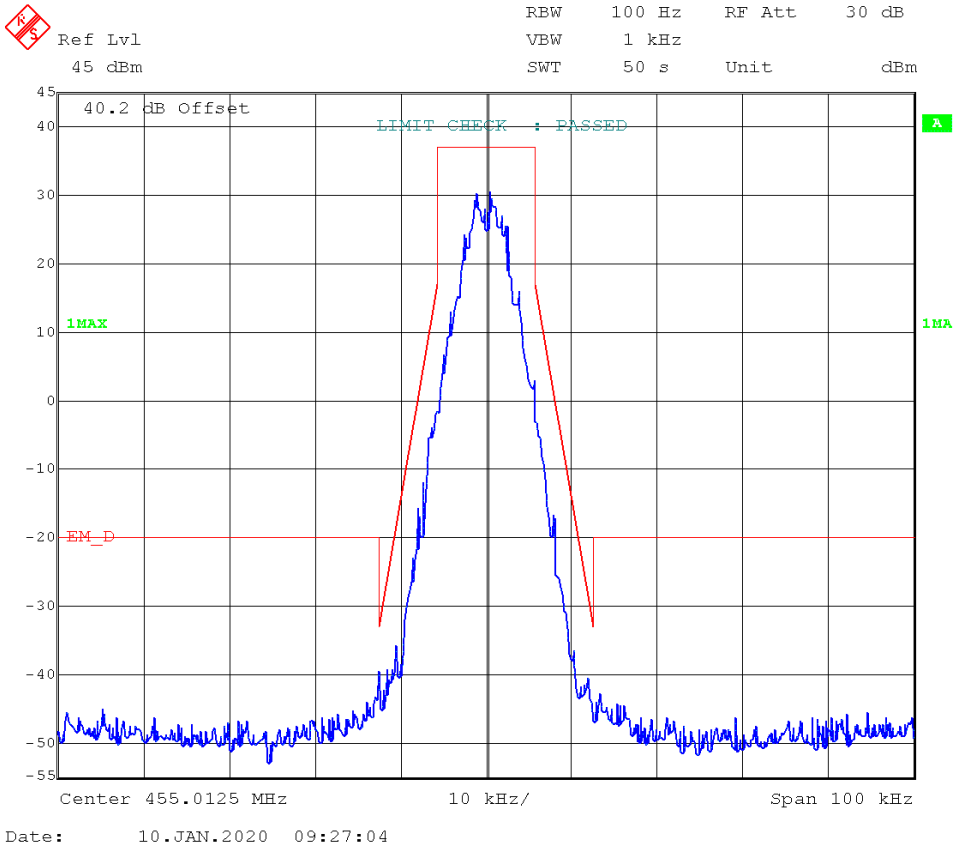


FM,25kHz,Low Power - Frequency 455.0125 MHz:

99% Occupied & 26 dB Bandwidth

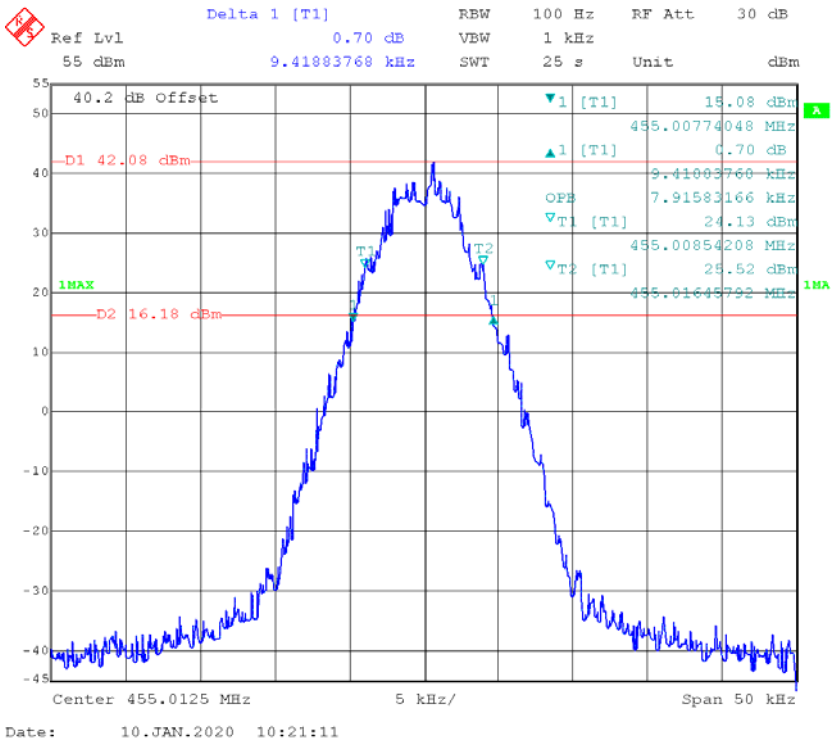


Emission Mask

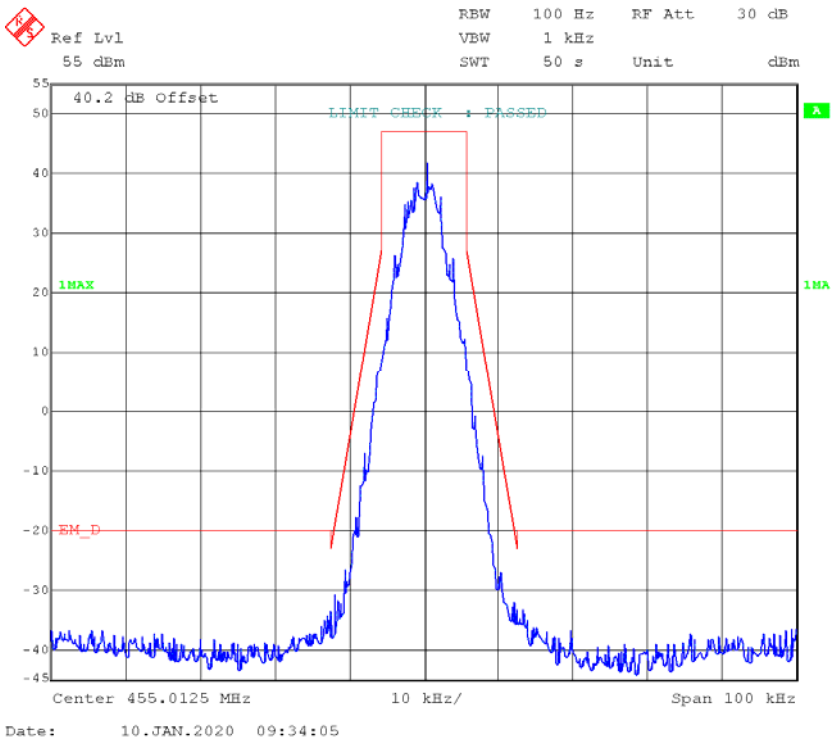


4FSK ,12.5kHz, High Power - Frequency455.0125 MHz:

99% Occupied & 26 dB Bandwidth

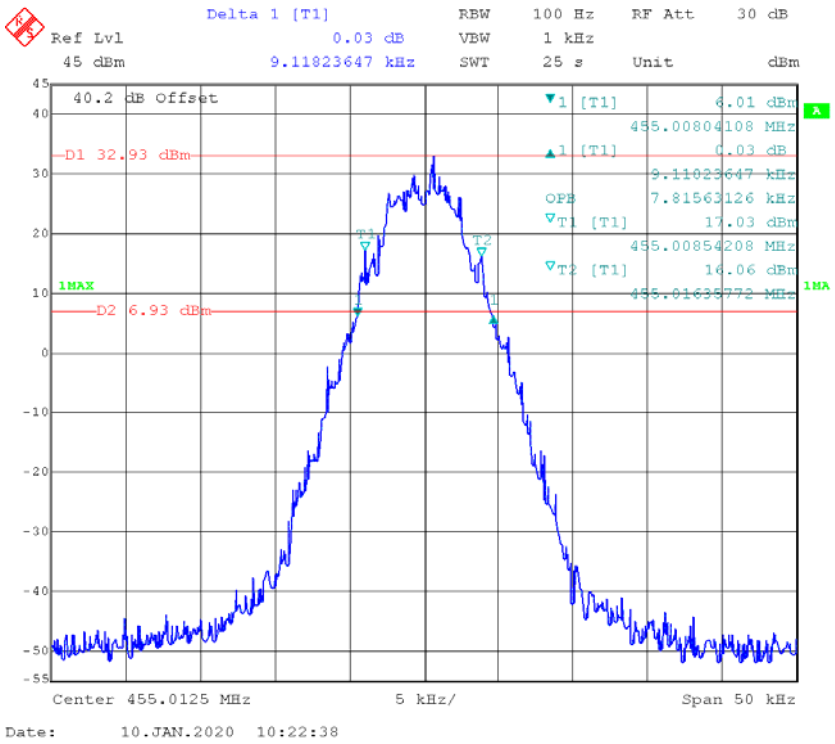


Emission Mask

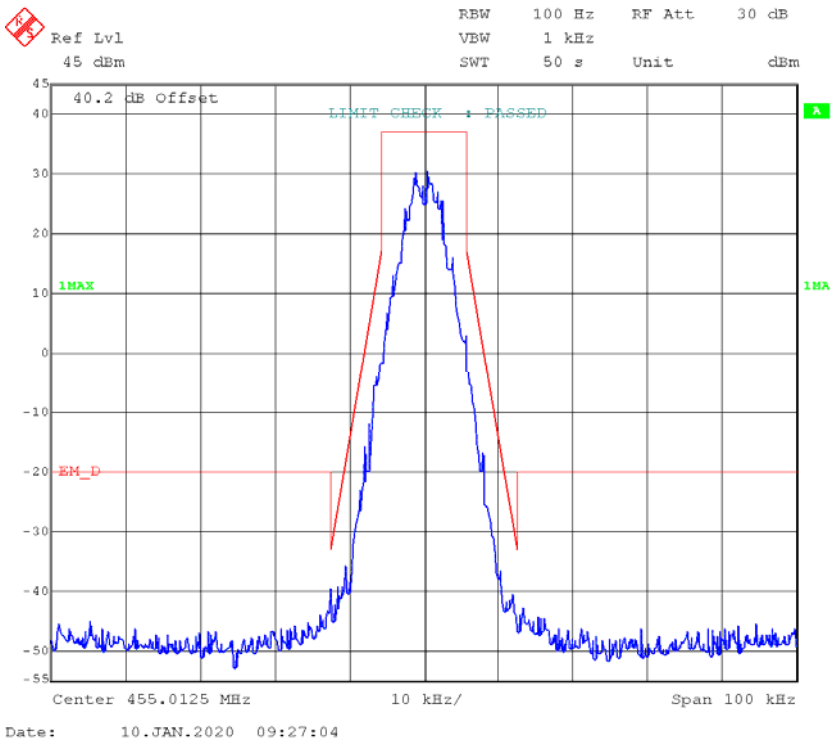


4FSK ,12.5kHz, Low Power - Frequency455.0125 MHz:

99% Occupied & 26 dB Bandwidth



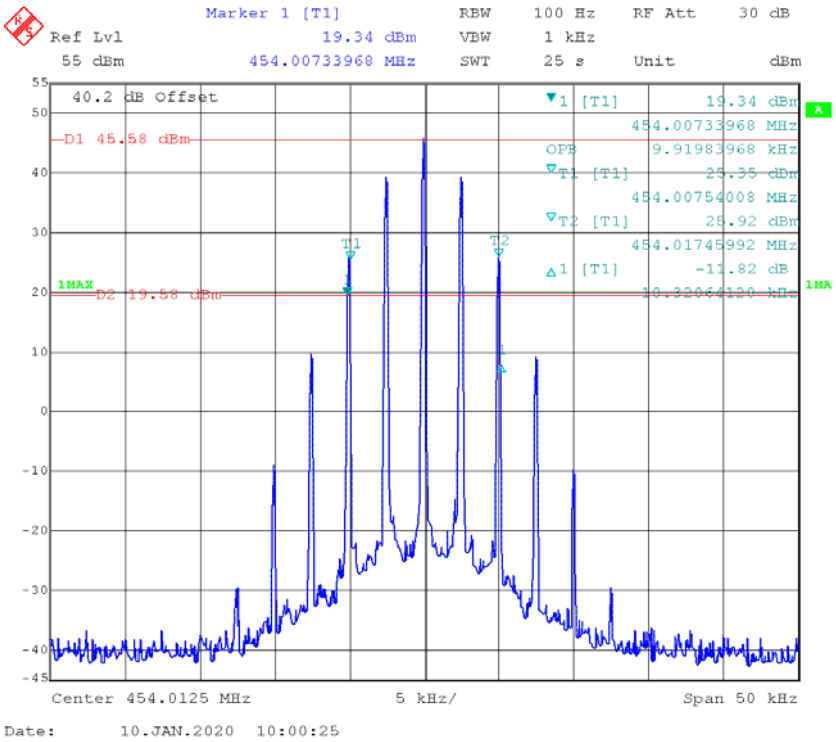
Emission Mask



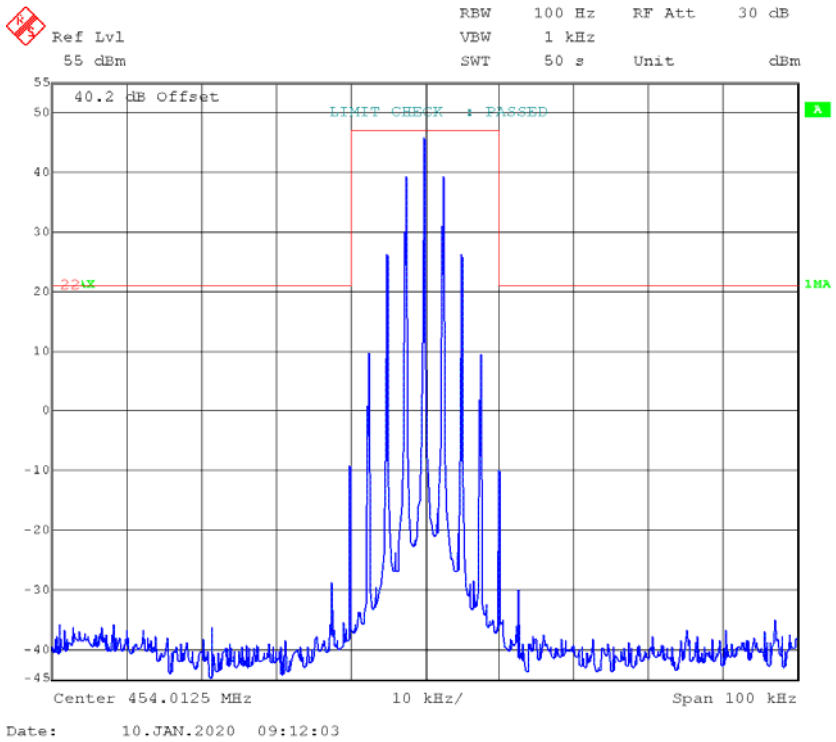
part 22:

FM,12.5kHz,High Power - Frequency 454.0125MHz:

99% Occupied & 26 dB Bandwidth

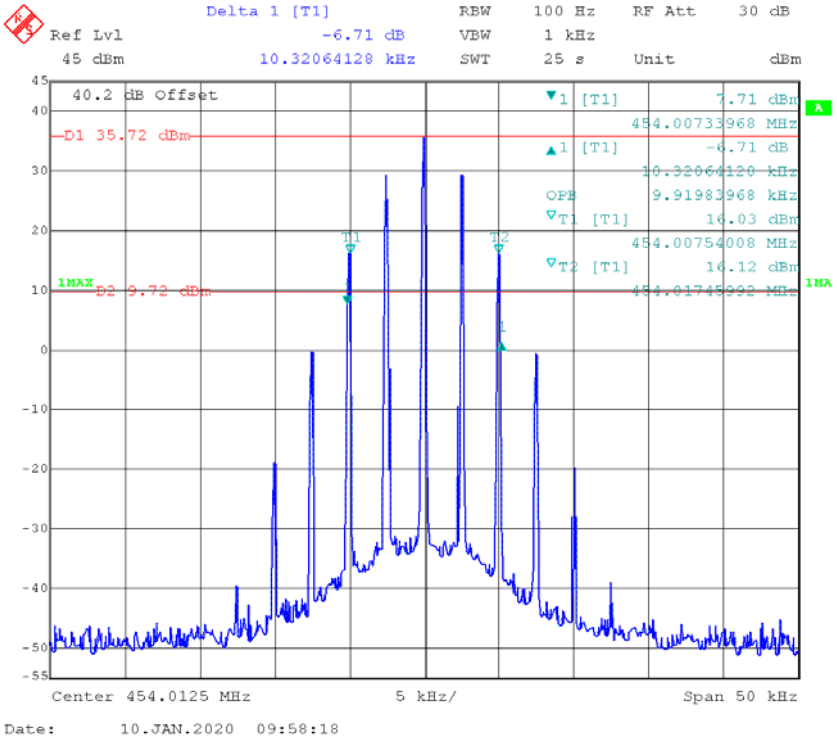


Emission Mask

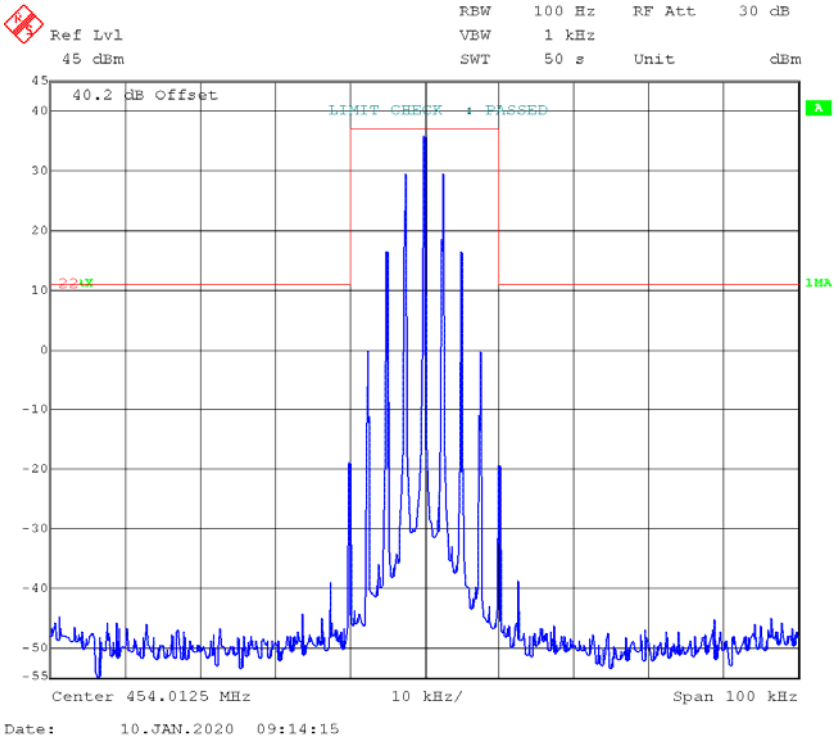


FM,12.5kHz,Low Power - Frequency 454.0125MHz:

99% Occupied & 26 dB Bandwidth

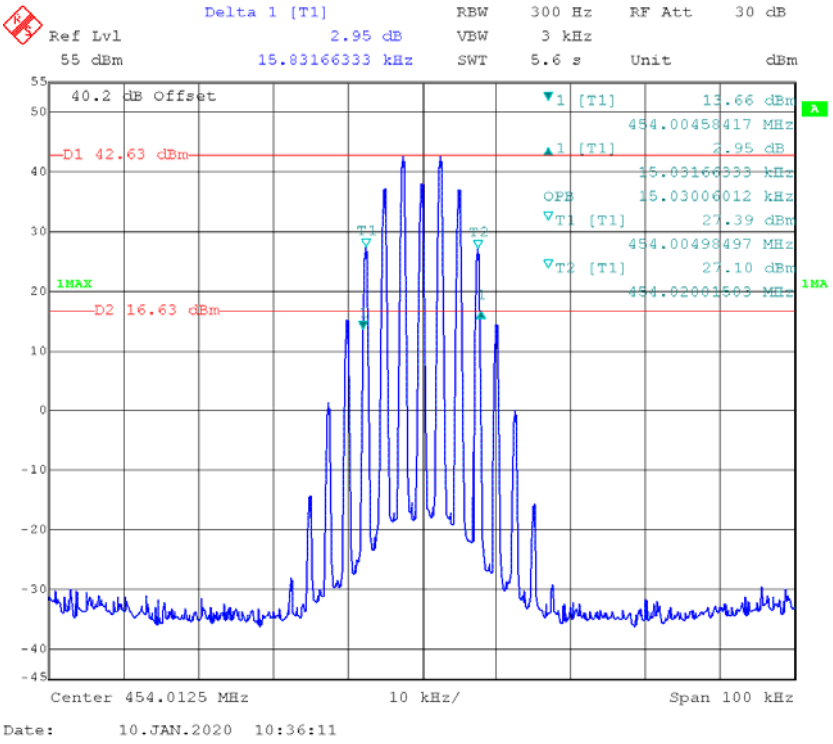


Emission Mask

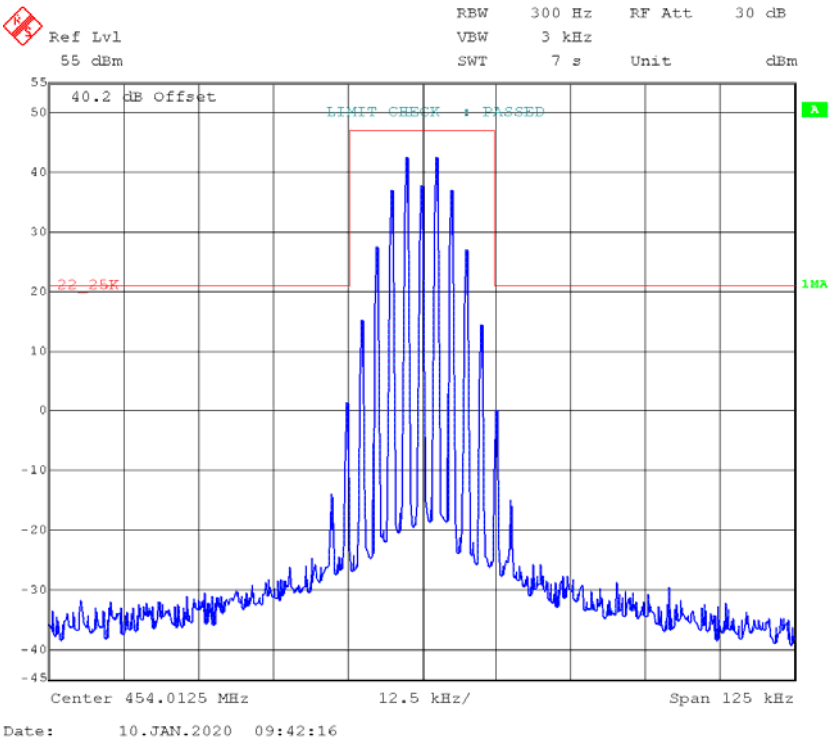


FM,25kHz,High Power - Frequency 454.0125 MHz:

99% Occupied & 26 dB Bandwidth

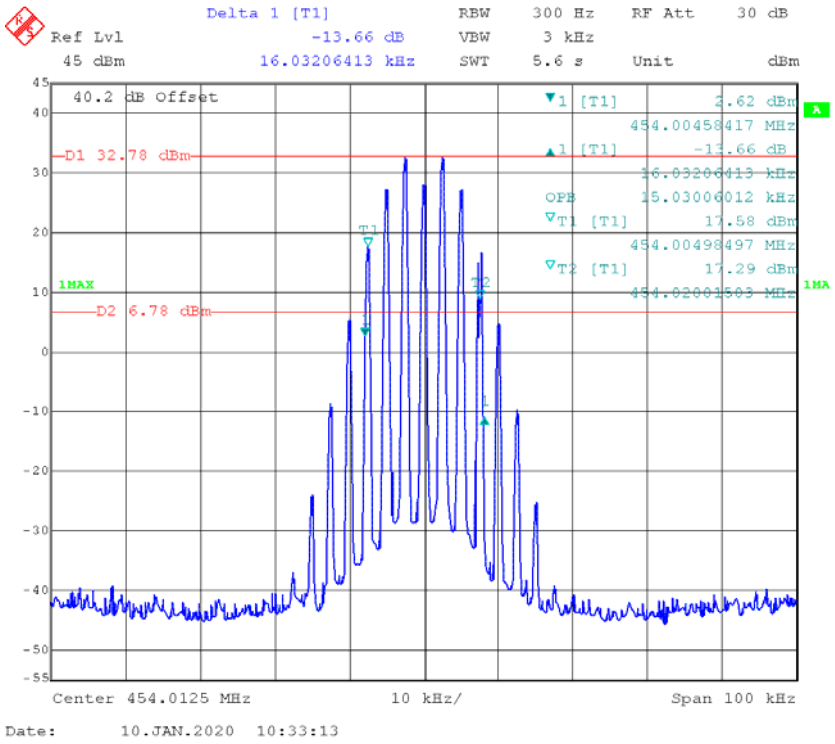


Emission Mask

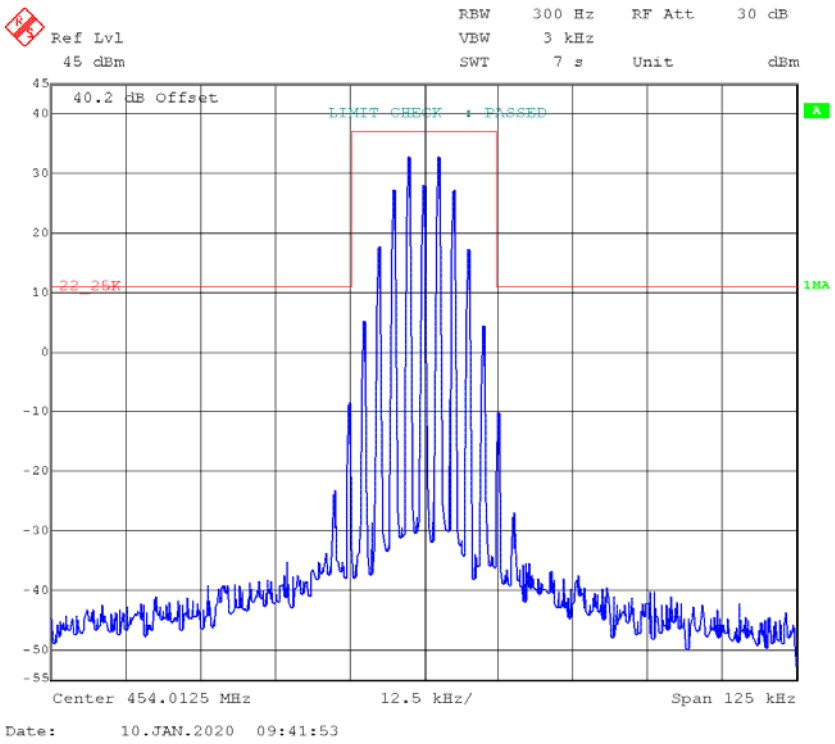


FM,25kHz,Low Power - Frequency 454.0125MHz:

99% Occupied & 26 dB Bandwidth

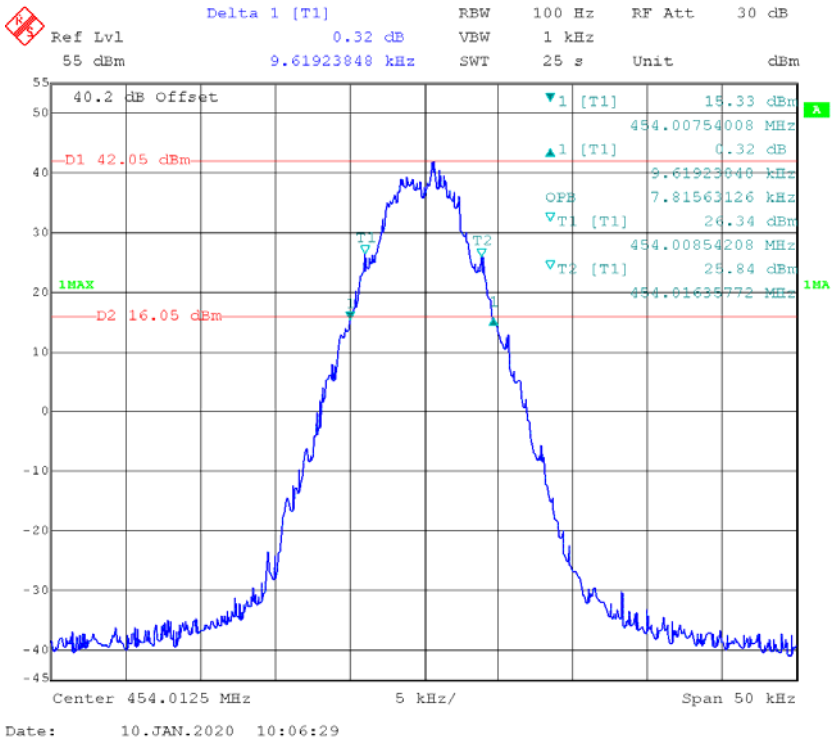


Emission Mask

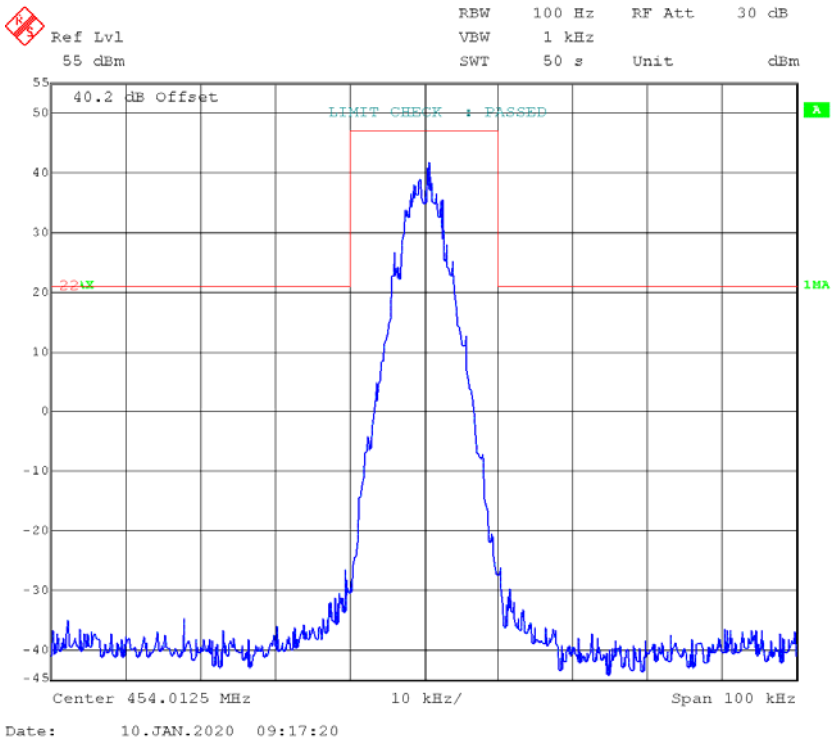


4FSK,12.5kHz,High Power - Frequency 454.0125MHz:

99% Occupied & 26 dB Bandwidth

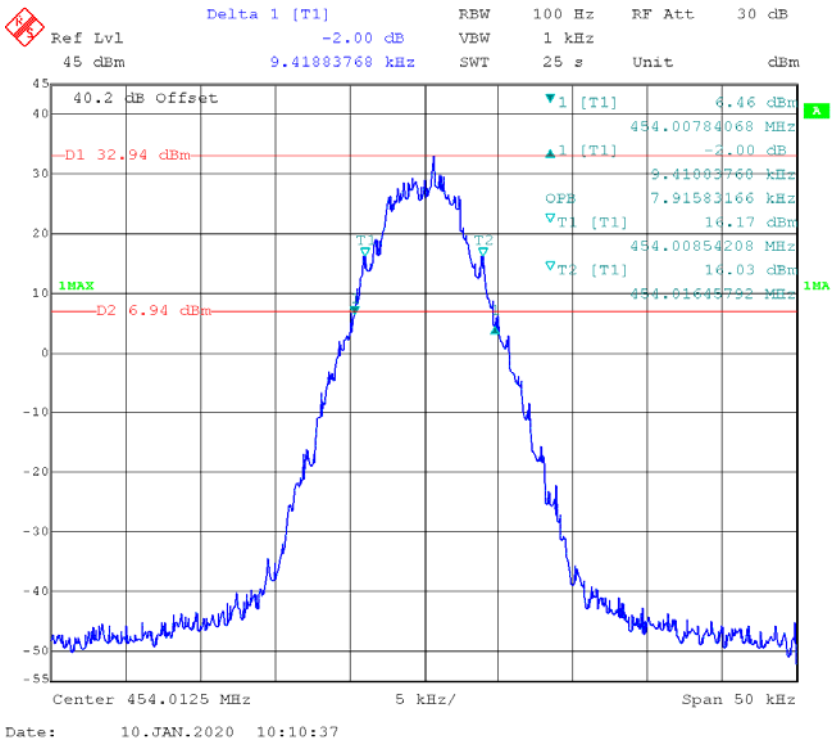


Emission Mask

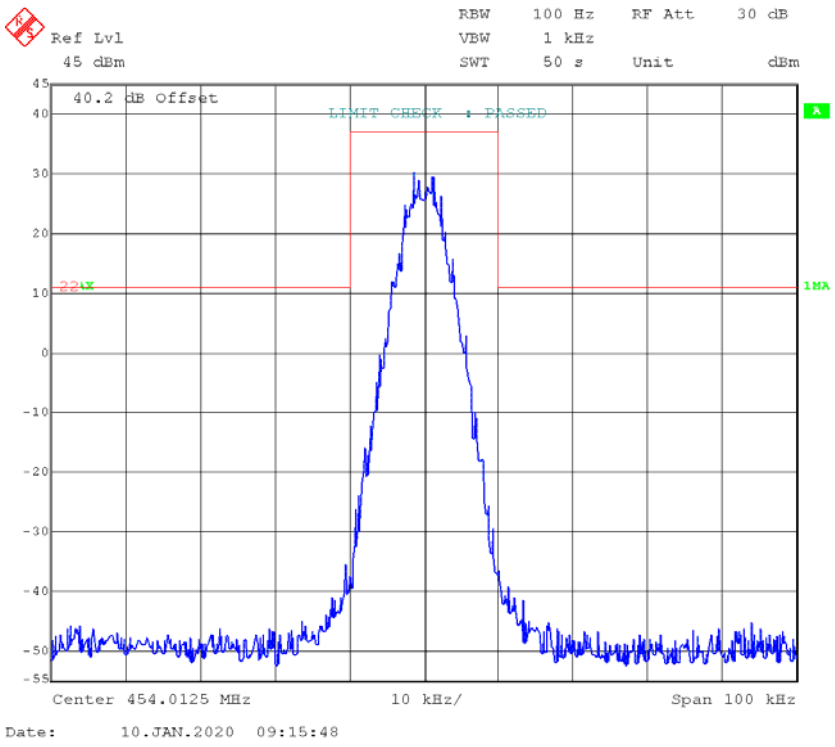


4FSK,12.5kHz,Low Power - Frequency 454.0125MHz:

99% Occupied & 26 dB Bandwidth



Emission Mask



FCC §2.1051 & §22.861 & §74.462 & § 80.211 & §90.210 - SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Applicable Standard

FCC §2.1051, §22.861, §74.462, §80.211, and §90.210

Test Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100kHz for below 1GHz, and 1MHz for above 1GHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

Test Data

Environmental Conditions

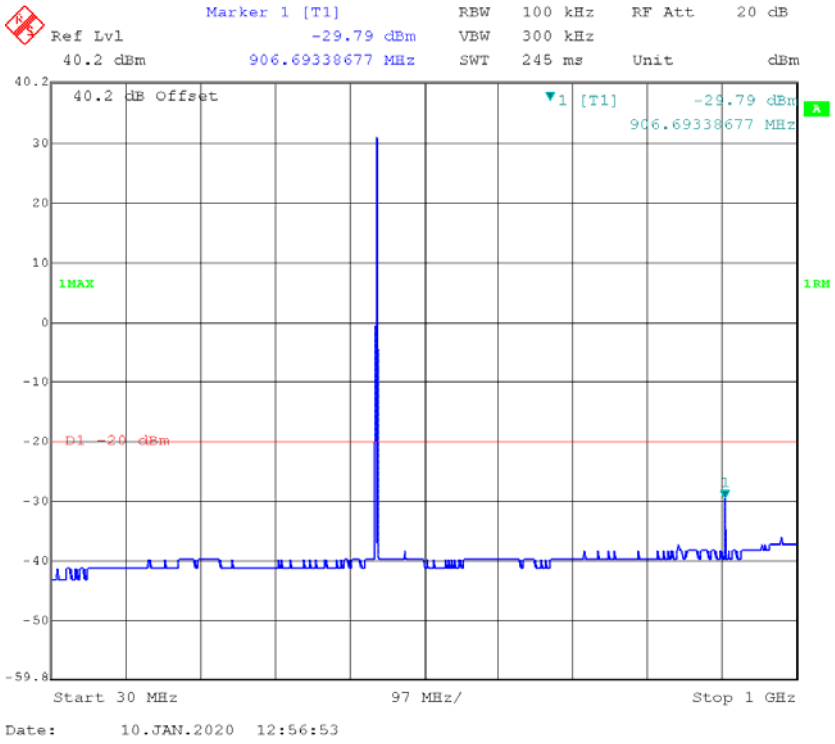
Temperature:	22.0℃
Relative Humidity:	61 %
ATM Pressure:	102.1kPa

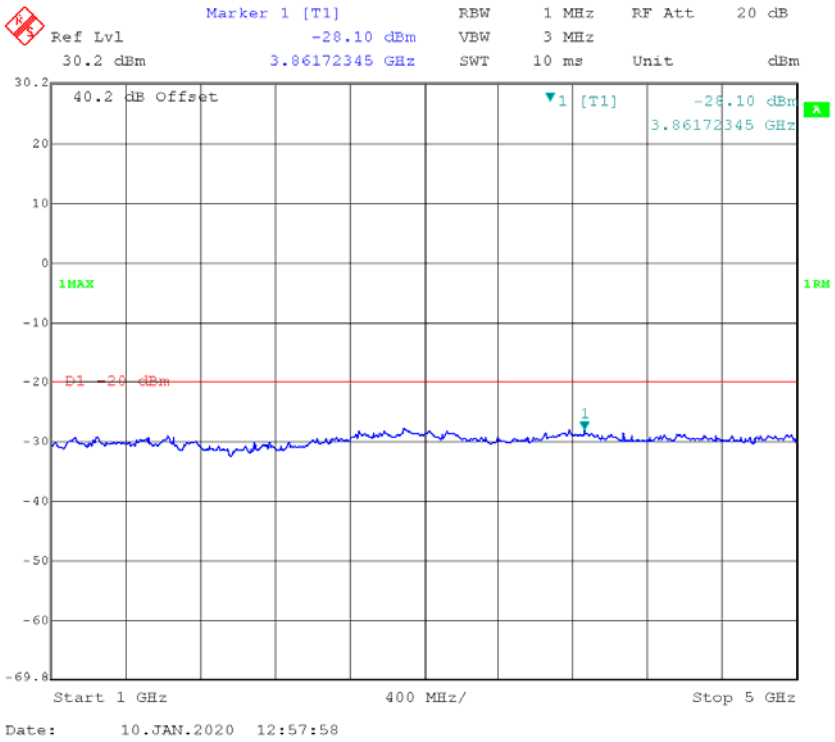
The testing was performed by Blake Yang on 2020-01-10

Test Mode: Transmitting, please refer to the following plots.

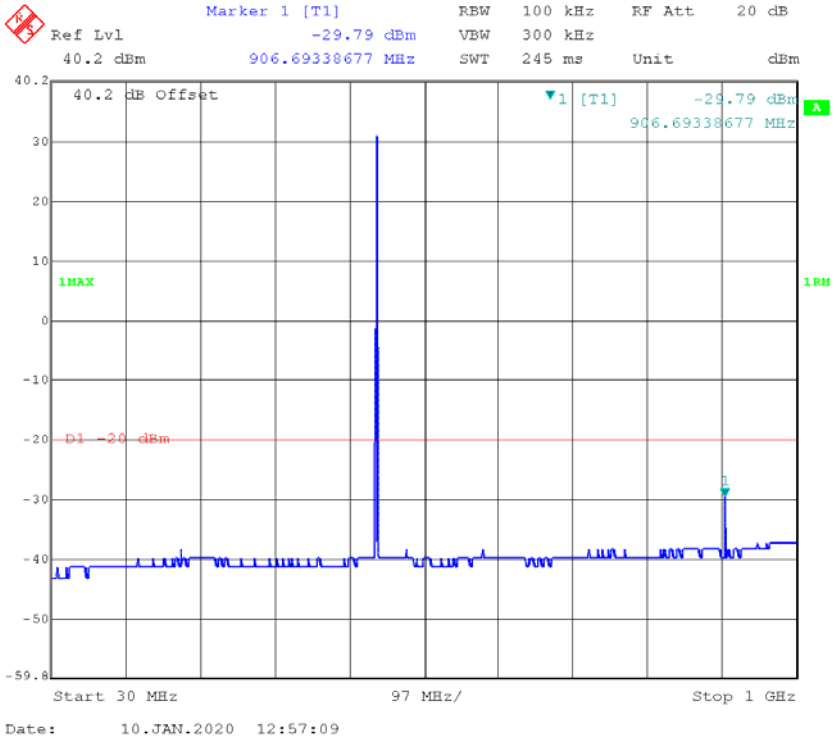
Part 90

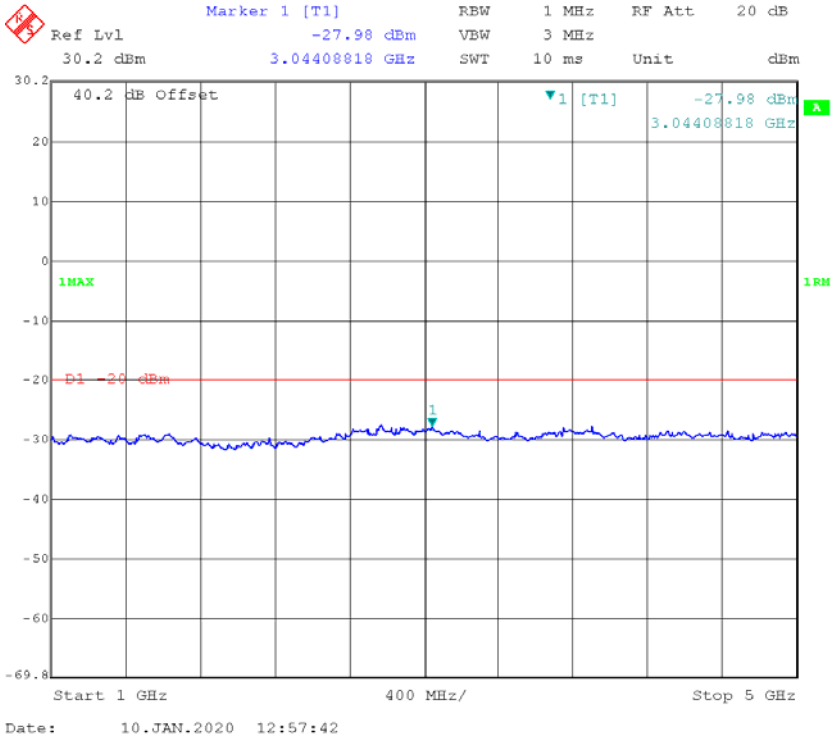
12.5kHz,FM, High power, 453.2125MHz





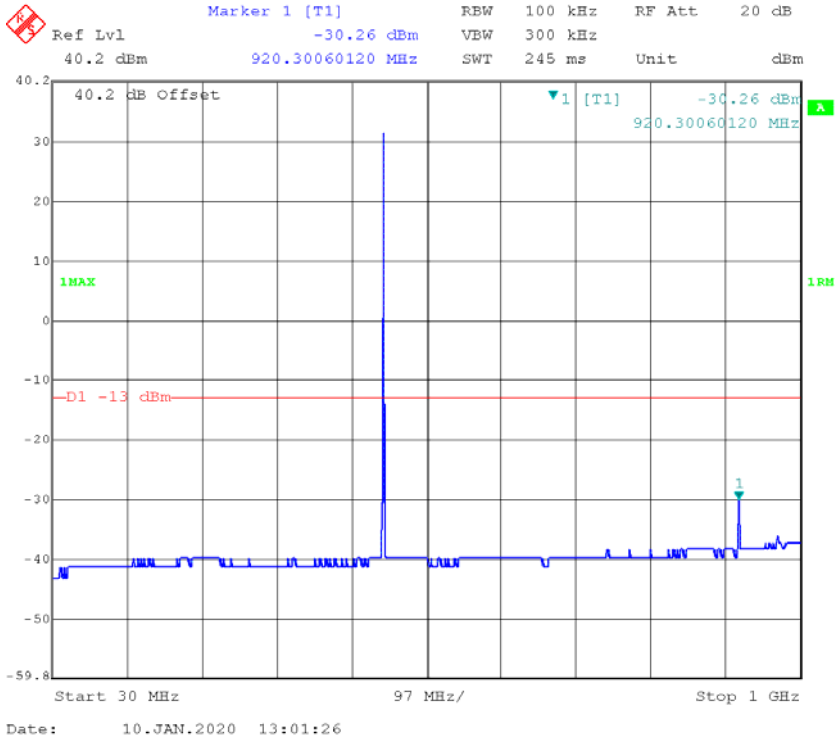
12.5kHz,4FSK, High power, 453.2125 MHz

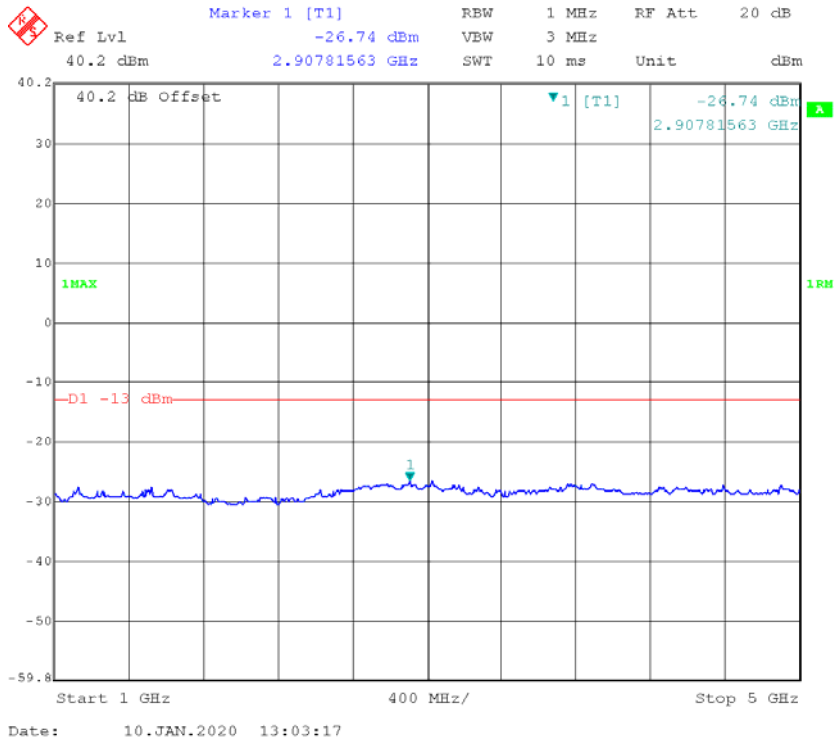




Part 80

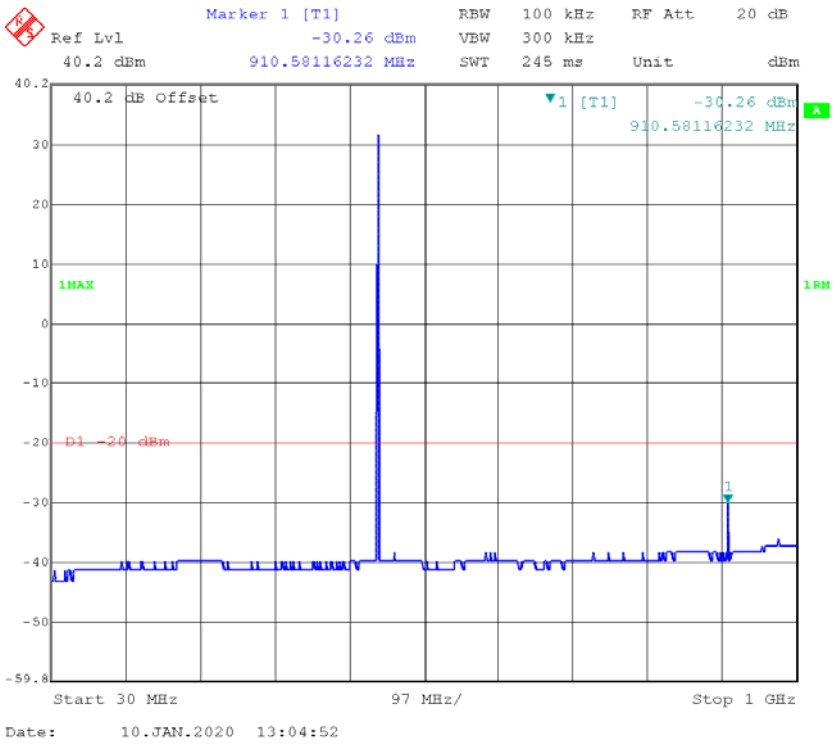
25kHz, FM, High power, 459.9875 MHz

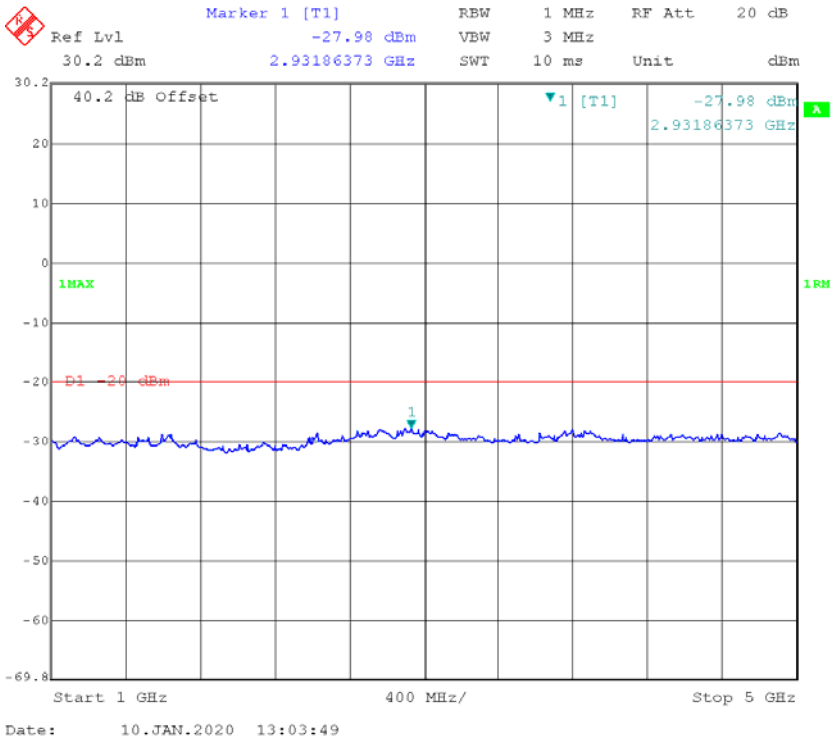




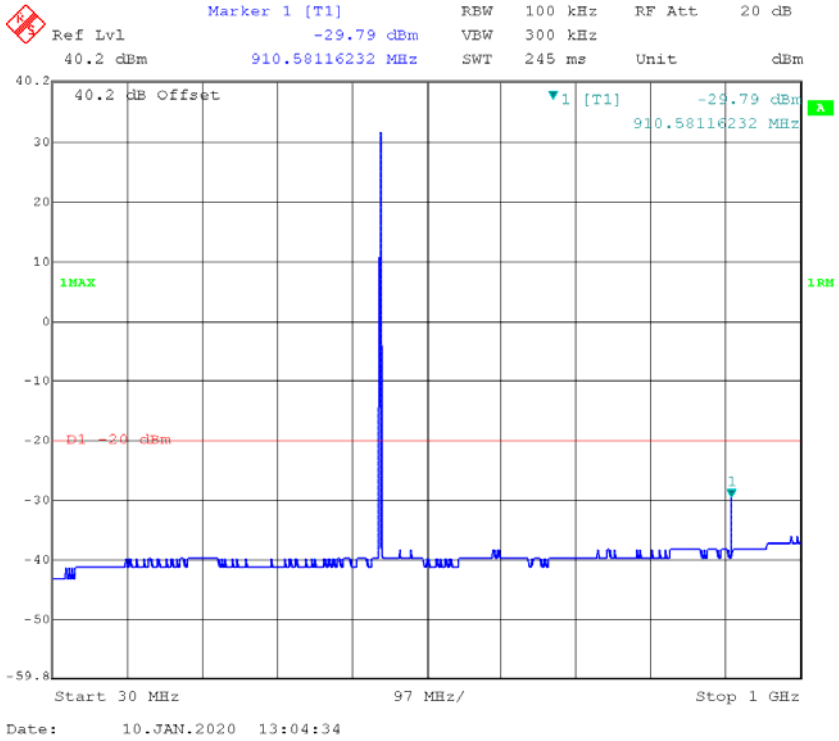
Part 74

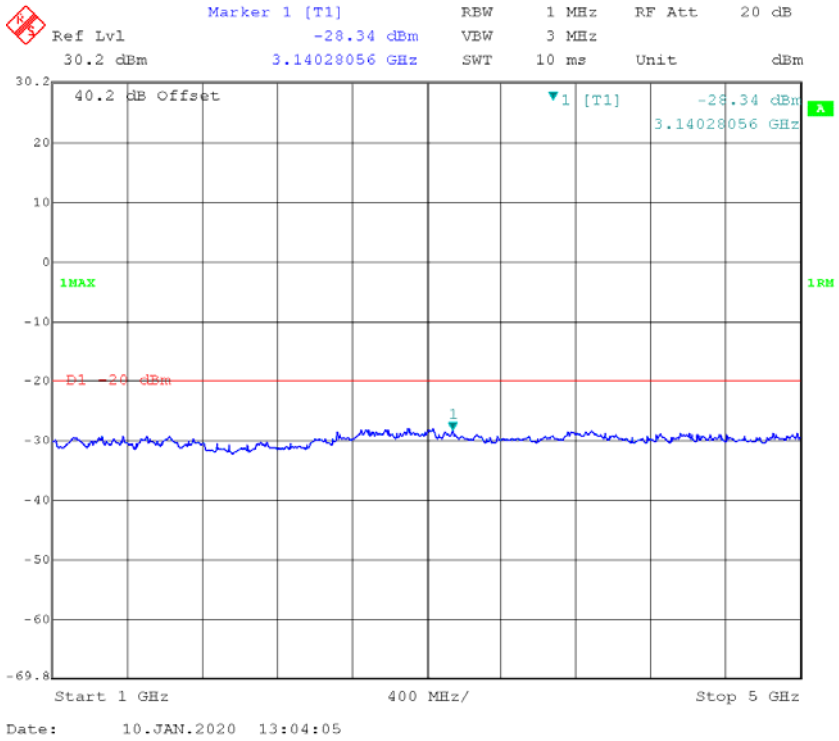
12.5kHz,FM, High power, 455.0125MHz



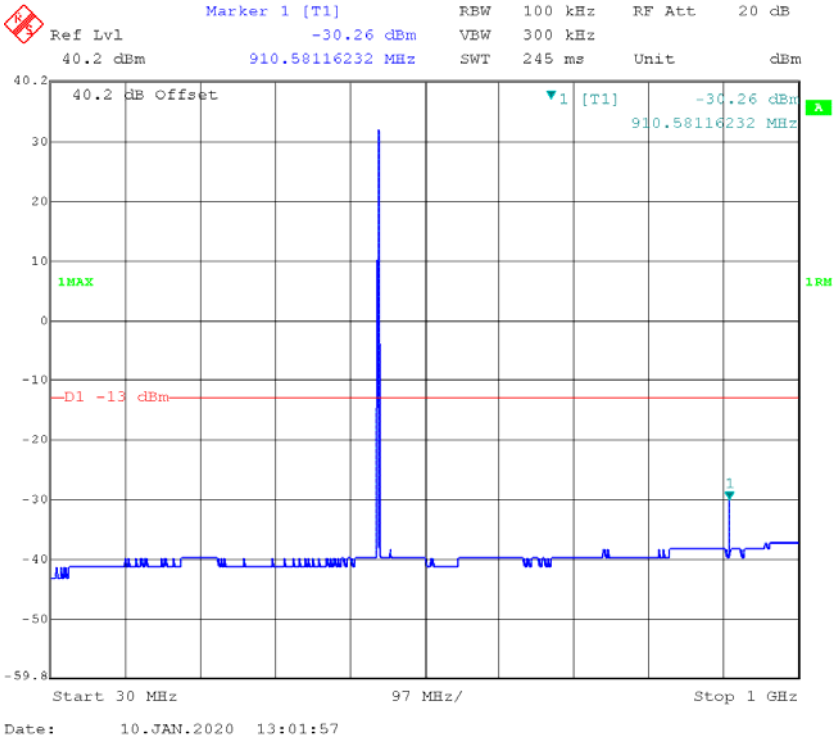


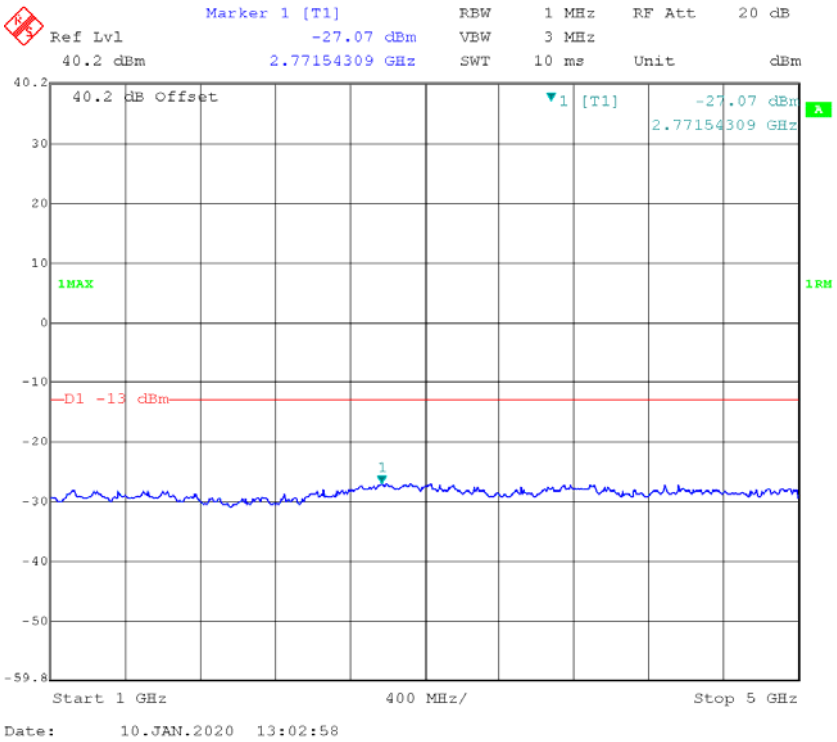
12.5kHz,4FSK, High power, 455.0125 MHz





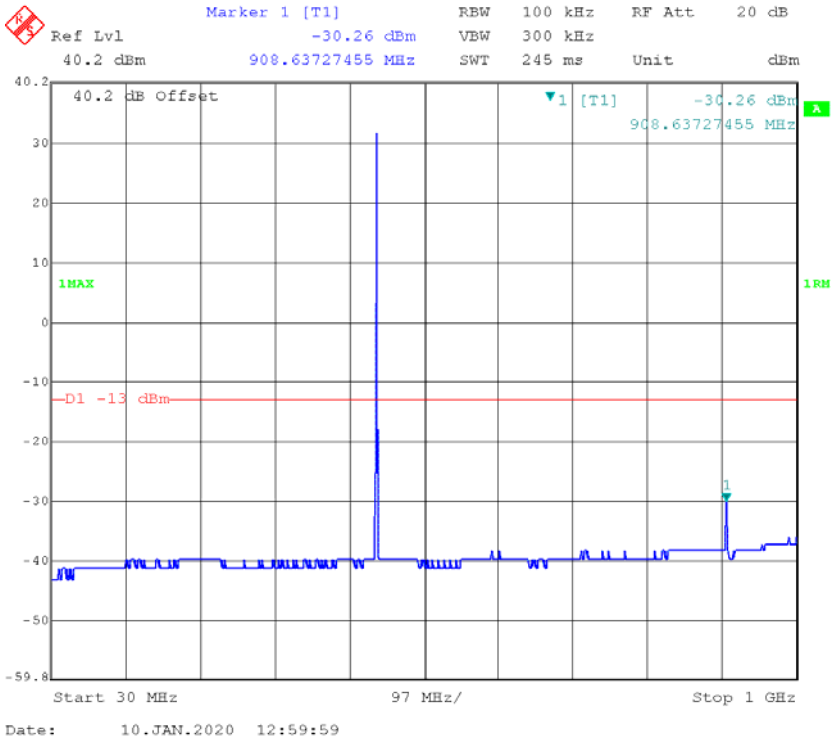
25kHz,FM, High power, 455.0125 MHz

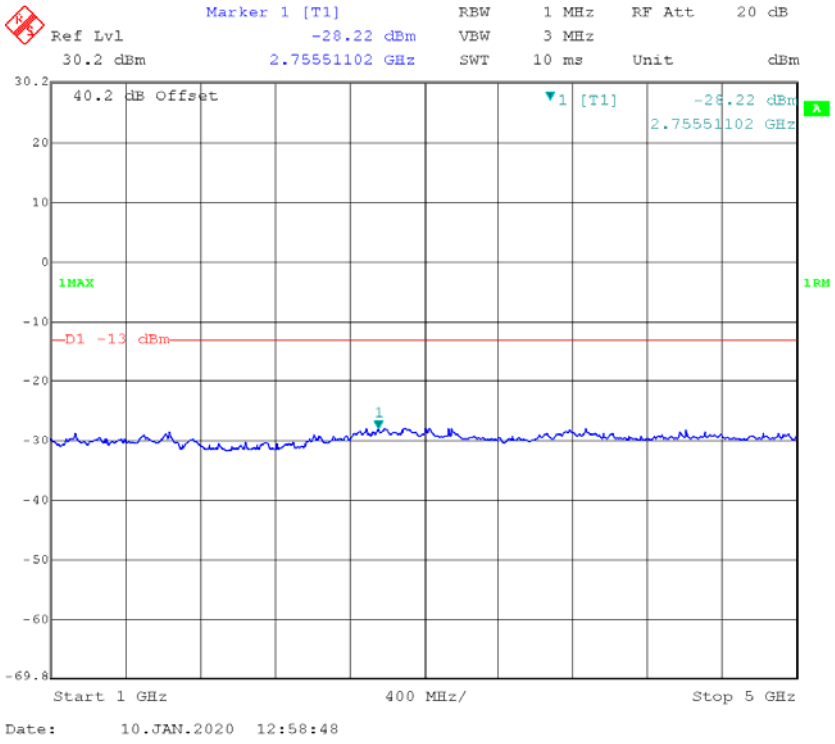




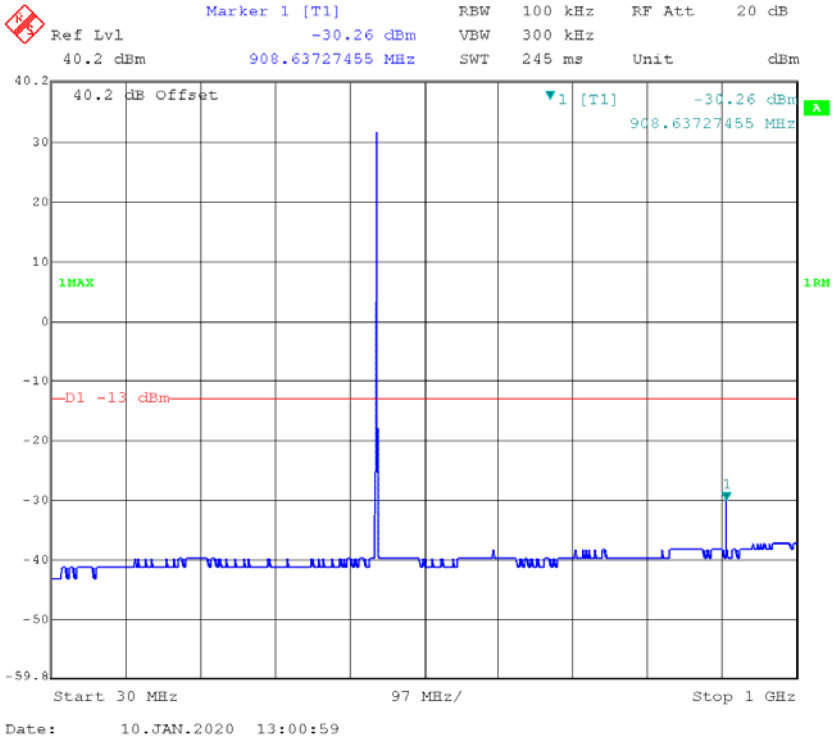
Part 22

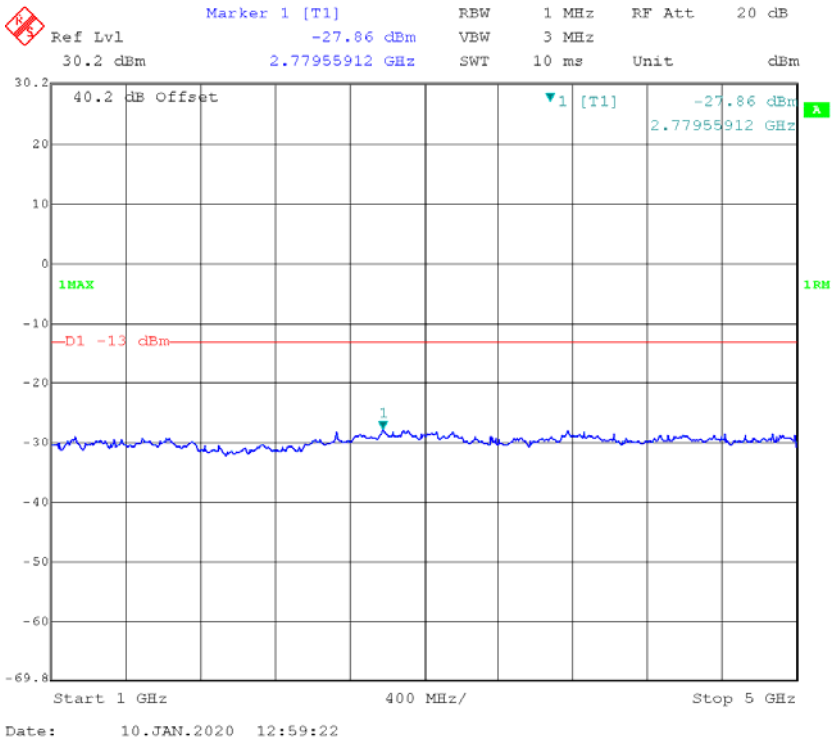
12.5kHz,FM, High power, 454.0125MHz



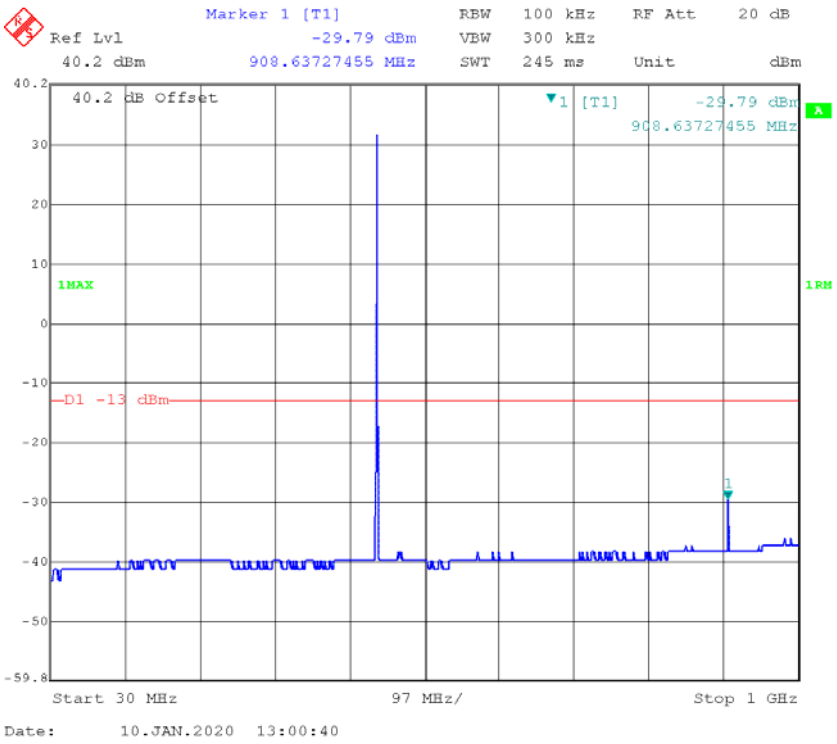


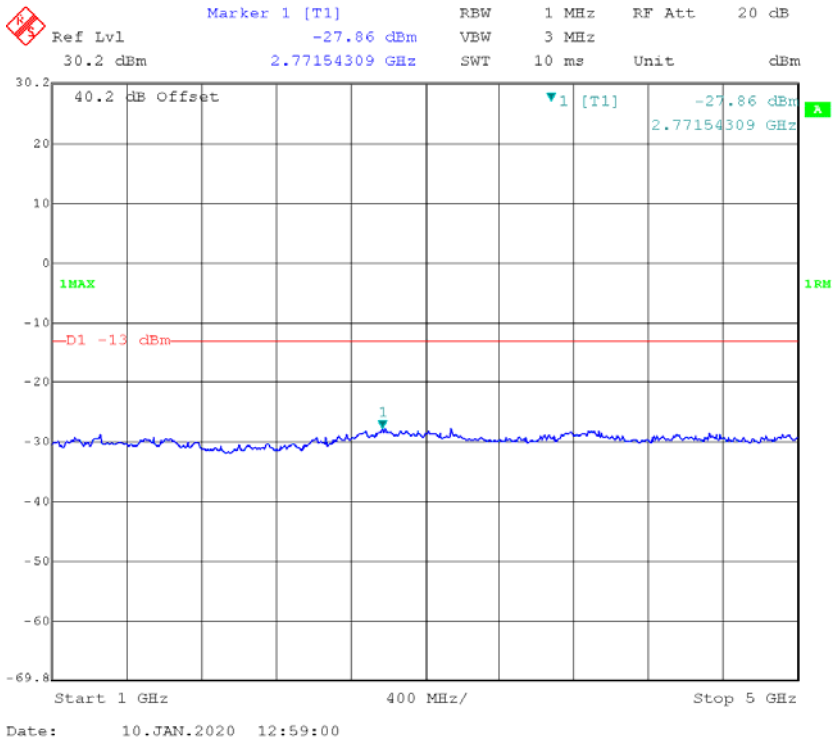
12.5kHz,4FSK, High power, 454.0125MHz





25kHz,FM, High power, 454.0125MHz





FCC §2.1053 & §22.861 & §74.462 &§80.211 & §90.210 - RADIATED SPURIOUS EMISSIONS

Applicable Standard

FCC §2.1053, §22.861, §74.462, §80.211 and §90.210

Test Procedure

The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load, which was also placed on the turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT .The test was performed by placing the EUT on 3-orthogonal axis.

The frequency range up to teeth harmonic of the fundamental frequency was investigated.

Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

Spurious emissions in dB =10 1g (TXpwr in Watts/0.001)-the absolute level

Test Data

Environmental Conditions

Temperature:	21.9℃
Relative Humidity:	41 %
ATM Pressure:	102.2kPa

The testing was performed by Feilx Wang and Davy Wang on 2020-01-17

Test Mode: Transmitting(only high power level was tested)

30MHz - 5GHz:
Part 90

Frequency (MHz)	Polar (H/V)	Receiver Reading (dBµV)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Substituted Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
FM,Frequency: 453.2125MHz-12.5 kHz								
906.43	H	34.51	-62.36	0.00	1.03	-63.39	-20.00	43.39
906.43	V	34.33	-64.51	0.00	1.03	-65.54	-20.00	45.54
1359.64	H	37.90	-65.66	8.72	1.20	-58.14	-20.00	38.14
1359.64	V	37.62	-66.66	8.72	1.20	-59.14	-20.00	39.14
1812.85	H	38.02	-66.08	11.19	0.72	-55.61	-20.00	35.61
1812.85	V	37.55	-67.11	11.19	0.72	-56.64	-20.00	36.64
2266.06	H	37.63	-64.42	11.06	1.20	-54.56	-20.00	34.56
2266.06	V	37.23	-64.72	11.06	1.20	-54.86	-20.00	34.86
2719.28	H	37.25	-64.66	13.10	1.27	-52.83	-20.00	32.83
2719.28	V	37.64	-64.38	13.10	1.27	-52.55	-20.00	32.55
3172.49	H	36.06	-62.96	13.49	1.64	-51.11	-20.00	31.11
3172.49	V	36.12	-62.94	13.49	1.64	-51.09	-20.00	31.09
3625.70	H	36.42	-62.34	14.07	1.58	-49.85	-20.00	29.85
3625.70	V	36.44	-62.32	14.07	1.58	-49.83	-20.00	29.83
4FSK,Frequency: 453.2125MHz-12.5 kHz								
906.43	H	34.32	-62.55	0.00	1.03	-63.58	-20.00	43.58
906.43	V	34.18	-64.66	0.00	1.03	-65.69	-20.00	45.69
1359.64	H	37.63	-65.93	8.72	1.20	-58.41	-20.00	38.41
1359.64	V	37.96	-66.32	8.72	1.20	-58.80	-20.00	38.80
1812.85	H	37.60	-66.50	11.19	0.72	-56.03	-20.00	36.03
1812.85	V	37.65	-67.01	11.19	0.72	-56.54	-20.00	36.54
2266.06	H	37.66	-64.39	11.06	1.20	-54.53	-20.00	34.53
2266.06	V	37.23	-64.72	11.06	1.20	-54.86	-20.00	34.86
2719.28	H	37.87	-64.04	13.10	1.27	-52.21	-20.00	32.21
2719.28	V	37.61	-64.41	13.10	1.27	-52.58	-20.00	32.58
3172.49	H	36.68	-62.34	13.49	1.64	-50.49	-20.00	30.49
3172.49	V	36.54	-62.52	13.49	1.64	-50.67	-20.00	30.67
3625.70	H	36.67	-62.09	14.07	1.58	-49.60	-20.00	29.60
3625.70	V	36.52	-62.24	14.07	1.58	-49.75	-20.00	29.75

Part 80

Frequency (MHz)	Polar (H/V)	Receiver Reading (dBμV)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Substituted Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
FM, Frequency: 459.9875MHz-25 kHz								
919.98	H	34.93	-61.38	0.00	0.99	-62.37	-13.00	49.37
919.98	V	34.46	-63.72	0.00	0.99	-64.71	-13.00	51.71
1379.96	H	38.80	-64.67	8.86	1.20	-57.01	-13.00	44.01
1379.96	V	37.62	-66.51	8.86	1.20	-58.85	-13.00	45.85
1839.95	H	38.81	-64.89	11.38	0.82	-54.33	-13.00	41.33
1839.95	V	38.06	-66.12	11.38	0.82	-55.56	-13.00	42.56
2299.94	H	36.85	-65.30	11.20	1.23	-55.33	-13.00	42.33
2299.94	V	37.96	-64.09	11.20	1.23	-54.12	-13.00	41.12
2759.93	H	37.99	-63.82	13.10	1.32	-52.04	-13.00	39.04
2759.93	V	37.56	-64.41	13.10	1.32	-52.63	-13.00	39.63
3219.91	H	36.82	-62.08	13.60	1.57	-50.05	-13.00	37.05
3219.91	V	36.65	-62.30	13.60	1.57	-50.27	-13.00	37.27
3679.90	H	36.52	-61.68	14.02	1.76	-49.42	-13.00	36.42
3679.90	V	36.30	-61.88	14.02	1.76	-49.62	-13.00	36.62

Part 74

Frequency (MHz)	Polar (H/V)	Receiver Reading (dBμV)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Substituted Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
FM,Frequency: 455.0125MHz-12.5 kHz								
910.03	H	35.08	-61.64	0.00	1.02	-62.66	-20.00	42.66
910.03	V	34.63	-64.03	0.00	1.02	-65.05	-20.00	45.05
1365.04	H	37.83	-65.70	8.76	1.20	-58.14	-20.00	38.14
1365.04	V	37.32	-66.92	8.76	1.20	-59.36	-20.00	39.36
1820.05	H	37.62	-66.38	11.24	0.75	-55.89	-20.00	35.89
1820.05	V	38.05	-66.49	11.24	0.75	-56.00	-20.00	36.00
2275.06	H	37.23	-64.85	11.10	1.21	-54.96	-20.00	34.96
2275.06	V	37.26	-64.72	11.10	1.21	-54.83	-20.00	34.83
2730.08	H	37.15	-64.73	13.10	1.28	-52.91	-20.00	32.91
2730.08	V	37.11	-64.90	13.10	1.28	-53.08	-20.00	33.08
FM,Frequency: 455.0125MHz-25 kHz								
910.03	H	34.64	-62.08	0.00	1.02	-63.10	-13.00	50.10
910.03	V	34.37	-64.29	0.00	1.02	-65.31	-13.00	52.31
1365.04	H	37.98	-65.55	8.76	1.20	-57.99	-13.00	44.99
1365.04	V	37.64	-66.60	8.76	1.20	-59.04	-13.00	46.04
1820.05	H	38.39	-65.61	11.24	0.75	-55.12	-13.00	42.12
1820.05	V	38.32	-66.22	11.24	0.75	-55.73	-13.00	42.73
2275.06	H	37.26	-64.82	11.10	1.21	-54.93	-13.00	41.93
2275.06	V	37.06	-64.92	11.10	1.21	-55.03	-13.00	42.03
2730.08	H	37.21	-64.67	13.10	1.28	-52.85	-13.00	39.85
2730.08	V	37.18	-64.83	13.10	1.28	-53.01	-13.00	40.01
4FSK, Frequency: 455.0125MHz-12.5 kHz								
910.03	H	35.89	-60.83	0.00	1.02	-61.85	-20.00	41.85
910.03	V	36.15	-62.51	0.00	1.02	-63.53	-20.00	43.53
1365.04	H	37.61	-65.92	8.76	1.20	-58.36	-20.00	38.36
1365.04	V	38.66	-65.58	8.76	1.20	-58.02	-20.00	38.02
1820.05	H	37.61	-66.39	11.24	0.75	-55.90	-20.00	35.90
1820.05	V	37.83	-66.71	11.24	0.75	-56.22	-20.00	36.22
2275.06	H	37.20	-64.88	11.10	1.21	-54.99	-20.00	34.99
2275.06	V	37.50	-64.48	11.10	1.21	-54.59	-20.00	34.59
2730.08	H	36.83	-65.05	13.10	1.28	-53.23	-20.00	33.23
2730.08	V	36.94	-65.07	13.10	1.28	-53.25	-20.00	33.25
3185.09	H	36.43	-62.43	13.54	1.61	-50.50	-20.00	30.50
3185.09	V	35.84	-63.07	13.54	1.61	-51.14	-20.00	31.14

Part 22

Frequency (MHz)	Polar (H/V)	Receiver Reading (dBμV)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Substituted Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
FM,Frequency: 454.0125MHz-12.5 kHz								
908.03	H	35.24	-61.57	0.00	1.03	-62.60	-13.00	49.60
908.03	V	34.20	-64.56	0.00	1.03	-65.59	-13.00	52.59
1362.04	H	37.69	-65.86	8.73	1.20	-58.33	-13.00	45.33
1362.04	V	37.52	-66.74	8.73	1.20	-59.21	-13.00	46.21
1816.05	H	37.88	-66.17	11.21	0.73	-55.69	-13.00	42.69
1816.05	V	37.47	-67.14	11.21	0.73	-56.66	-13.00	43.66
2270.06	H	37.54	-64.52	11.08	1.20	-54.64	-13.00	41.64
2270.06	V	37.18	-64.78	11.08	1.20	-54.90	-13.00	41.90
2724.08	H	37.64	-64.25	13.10	1.28	-52.43	-13.00	39.43
2724.08	V	37.89	-64.13	13.10	1.28	-52.31	-13.00	39.31
4FSK,Frequency: 454.0125MHz-12.5 kHz								
908.03	H	35.85	-60.96	0.00	1.03	-61.99	-13.00	48.99
908.03	V	34.90	-63.86	0.00	1.03	-64.89	-13.00	51.89
1362.04	H	37.24	-66.31	8.73	1.20	-58.78	-13.00	45.78
1362.04	V	37.63	-66.63	8.73	1.20	-59.10	-13.00	46.10
1816.05	H	38.36	-65.69	11.21	0.73	-55.21	-13.00	42.21
1816.05	V	37.97	-66.64	11.21	0.73	-56.16	-13.00	43.16
2270.06	H	37.43	-64.63	11.08	1.20	-54.75	-13.00	41.75
2270.06	V	36.82	-65.14	11.08	1.20	-55.26	-13.00	42.26
2724.08	H	37.24	-64.65	13.10	1.28	-52.83	-13.00	39.83
2724.08	V	37.47	-64.55	13.10	1.28	-52.73	-13.00	39.73
FM, Frequency: 454.0125MHz-25 kHz								
908.03	H	38.85	-57.96	0.00	1.03	-58.99	-13.00	45.99
908.03	V	39.77	-58.99	0.00	1.03	-60.02	-13.00	47.02
1362.04	H	37.97	-65.58	8.73	1.20	-58.05	-13.00	45.05
1362.04	V	37.59	-66.67	8.73	1.20	-59.14	-13.00	46.14
1816.05	H	38.34	-65.71	11.21	0.73	-55.23	-13.00	42.23
1816.05	V	38.06	-66.55	11.21	0.73	-56.07	-13.00	43.07
2270.06	H	37.22	-64.84	11.08	1.20	-54.96	-13.00	41.96
2270.06	V	36.86	-65.10	11.08	1.20	-55.22	-13.00	42.22
2724.08	H	36.86	-65.03	13.10	1.28	-53.21	-13.00	40.21
2724.08	V	37.10	-64.92	13.10	1.28	-53.10	-13.00	40.10

Note 1:The unit of antenna gain is dBd for frequency below 1GHz and is dBi for frequency above 1GHz.
Note 2:
Absolute Level = Substituted Level - Cable loss + Antenna Gain
Margin = Limit- Absolute Level

FCC §2.1055 & § 22.355 & §74.464& §80.209 & §90.213 - FREQUENCY STABILITY

Applicable Standard

FCC §2.1055, § 22.355, §74.464, §80.209 and §90.213

Test Procedure

Frequency Stability vs. Temperature: The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feed-through attenuators. The EUT was placed inside the temperature chamber. The DC leads and RF output cable exited the chamber through an opening made for the purpose.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the counter.

Test Data

Environmental Conditions

Temperature:	22.0℃
Relative Humidity:	61 %
ATM Pressure:	102.1kPa

The testing was performed by Blake Yang on 2020-01-10

Test Mode: Transmitting

FCC Part 90:

FM,12.5kHz, Reference Frequency: 453.2125 MHz, Limit: ±1.5 ppm			
Temperature (℃)	**Voltage Supplied (V_{DC})**	**Measured Frequency (MHz)**	**Frequency Error (ppm)**
-30	13.6	453.2121138	-0.85
-20		453.2120988	-0.89
-10		453.2127889	0.64
0		453.2127696	0.59
10		453.2122352	-0.58
20		453.2124699	-0.07
30		453.2127543	0.56
40		453.2124947	-0.01
50		453.2126557	0.34
20	11.0	453.2122413	-0.57
20	15.6	453.2123713	-0.28

4FSK, 12.5kHz, Reference Frequency: 453.2125MHz, Limit: ±1.5 ppm			
Temperature (℃)	**Voltage Supplied (V_{DC})**	**Measured Frequency (MHz)**	**Frequency Error (ppm)**
-30	13.6	453.2126387	0.31
-20		453.2124445	-0.12
-10		453.2125570	0.13
0		453.2128275	0.72
10		453.2125415	0.09
20		453.2120984	-0.89
30		453.2125902	0.20
40		453.2125419	0.09
50		453.2128544	0.78
20	11.0	453.2125211	0.05
20	15.6	453.2124885	-0.03

FCC Part 80:

FM,25kHz, Reference Frequency: 459.9875MHz,Limit: ±5.0 ppm			
Temperature (℃)	**Voltage Supplied (V_{DC})**	**Measured Frequency (MHz)**	**Frequency Error (ppm)**
-30	13.6	459.9876394	0.30
-20		459.9871586	-0.74
-10		459.9872344	-0.58
0		459.9873893	-0.24
10		459.9870105	-1.06
20		459.9874468	-0.12
30		459.9872463	-0.55
40		459.9876128	0.25
50		459.9878459	0.75
20	11.0	459.9873098	-0.41
20	15.6	459.9875014	0.00

FCC Part 74:

FM, 12.5kHz, Reference Frequency: 455.0125 MHz, Limit: ±5.0 ppm			
Temperature (℃)	**Voltage Supplied (V_{DC})**	**Measured Frequency (MHz)**	**Frequency Error (ppm)**
-30	13.6	455.0125946	0.21
-20		455.0125584	0.13
-10		455.0128177	0.70
0		455.0120391	-1.01
10		455.0120102	-1.08
20		455.0126186	0.26
30		455.0123864	-0.25
40		455.0120134	-1.07
50		455.0120657	-0.95
20	11.0	455.0127925	0.64
20	15.6	455.0126253	0.28

4FSK, 12.5kHz, Reference Frequency: 455.0125 MHz, Limit: ±5.0 ppm			
Temperature (℃)	**Voltage Supplied (V_{DC})**	**Measured Frequency (MHz)**	**Frequency Error (ppm)**
-30	13.6	455.0125854	0.19
-20		455.0120483	-0.99
-10		455.0127635	0.58
0		455.0127859	0.63
10		455.0122060	-0.65
20		455.0125774	0.17
30		455.0123308	-0.37
40		455.0127050	0.45
50		455.0123459	-0.34
20	11.0	455.0120872	-0.91
20	15.6	455.0122843	-0.47

FM, 25kHz, Reference Frequency: 455.0125 MHz, Limit: ±5.0 ppm			
Temperature (℃)	**Voltage Supplied (V_{DC})**	**Measured Frequency (MHz)**	**Frequency Error (ppm)**
-30	13.6	455.0122752	-0.49
-20		455.0125359	0.08
-10		455.0122950	-0.45
0		455.0127882	0.63
10		455.0124555	-0.10
20		455.0129694	1.03
30		455.0129060	0.89
40		455.0122364	-0.58
50		455.0120750	-0.93
20	11.0	455.0123640	-0.30
20	15.6	455.0123810	-0.26

FCC Part 22:

FM, 12.5kHz, Reference Frequency: 454.0125MHz, Limit: ±5.0 ppm			
Temperature (℃)	**Voltage Supplied (V_{DC})**	**Measured Frequency (MHz)**	**Frequency Error (ppm)**
-30	13.6	454.0122602	-0.53
-20		454.0126261	0.28
-10		454.0124651	-0.08
0		454.0123378	-0.36
10		454.0125657	0.14
20		454.0128228	0.71
30		454.0128081	0.68
40		454.0120735	-0.94
50		454.0120679	-0.95
20	11.0	454.0128237	0.71
20	15.6	454.0120629	-0.96

4FSK,12.5kHz, Reference Frequency: 454.0125MHz, Limit: ±5.0 ppm			
Temperature (℃)	**Voltage Supplied (V_{DC})**	**Measured Frequency (MHz)**	**Frequency Error (ppm)**
-30	13.6	454.0127237	0.49
-20		454.0128652	0.80
-10		454.0123652	-0.30
0		454.0127246	0.49
10		454.0127227	0.49
20		454.0121829	-0.70
30		454.0123776	-0.27
40		454.0127864	0.63
50		454.0121331	-0.81
20	11.0	454.0127434	0.54
20	15.6	454.0119804	-1.14

FM, 25kHz, Reference Frequency: 454.0125MHz, Limit: ±5.0 ppm			
Temperature (℃)	**Voltage Supplied (V_{DC})**	**Measured Frequency (MHz)**	**Frequency Error (ppm)**
-30	13.6	454.0129057	0.89
-20		454.0123452	-0.34
-10		454.0120297	-1.04
0		454.0126340	0.30
10		454.0125488	0.11
20		454.0124807	-0.04
30		454.0126364	0.30
40		454.0124531	-0.10
50		454.0123171	-0.40
20	11.0	454.0122971	-0.45
20	15.6	454.0124969	-0.01

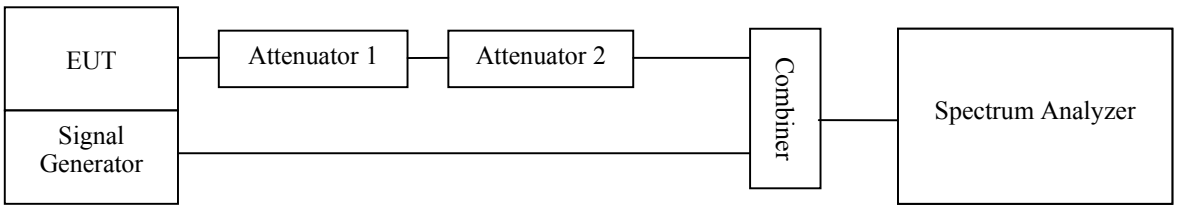
FCC §90.214 - TRANSIENT FREQUENCY BEHAVIOR

Applicable Standard

Regulations: FCC §90.214
Test method: ANSI/TIA-603-D 2010, section 2.2.19.3

Test Procedure

a) Connect the EUT and test equipment as shown on the following block diagram.
b) Set the Spectrum Analyzer to measure FM deviation, and tune the RF frequency to the transmitter assigned frequency.
c) Set the signal generator to the assigned transmitter frequency and modulate it with a 1 kHz tone at ±12.5 kHz deviation and set its output level to -100dBm.
d) Turn on the transmitter.
e) Supply sufficient attenuation via the RF attenuator to provide an input level to the Spectrum Analyzer that is 40 dB below the maximum allowed input power when the transmitter is operating at its rated power level. Note this power level on the Spectrum Analyzer as P_0.
f) Turn off the transmitter.
g) Adjust the RF level of the signal generator to provide RF power equal to P_0. This signal generator RF level shall be maintained throughout the rest of the measurement.
h) Remove the attenuation 1, so the input power to the Spectrum Analyzer is increased by 30 dB when the transmitter is turned on.
i) Adjust the vertical amplitude control of the spectrum analyzer to display the 1000 Hz at ±4 divisions vertically centered on the display. Set trigger mode of the Spectrum Analyzer to "Video", and tune the "trigger level" on suitable level. Then set the "tiger offset" to -10ms for turn on and -15ms for turn off.
j) Turn on the transmitter and the transient wave will be captured on the screen of Spectrum Analyzer. Observe the stored display. The instant when the 1 kHz test signal is completely suppressed is considered to be t_{on}. The trace should be maintained within the allowed divisions during the period t_1 and t_2.
k) Then turn off the transmitter, and another transient wave will be captured on the screen of Spectrum Analyzer. The trace should be maintained within the allowed divisions during the period t_3.



Test Data

Environmental Conditions

Temperature:	22.0℃
Relative Humidity:	61 %
ATM Pressure:	102.1kPa

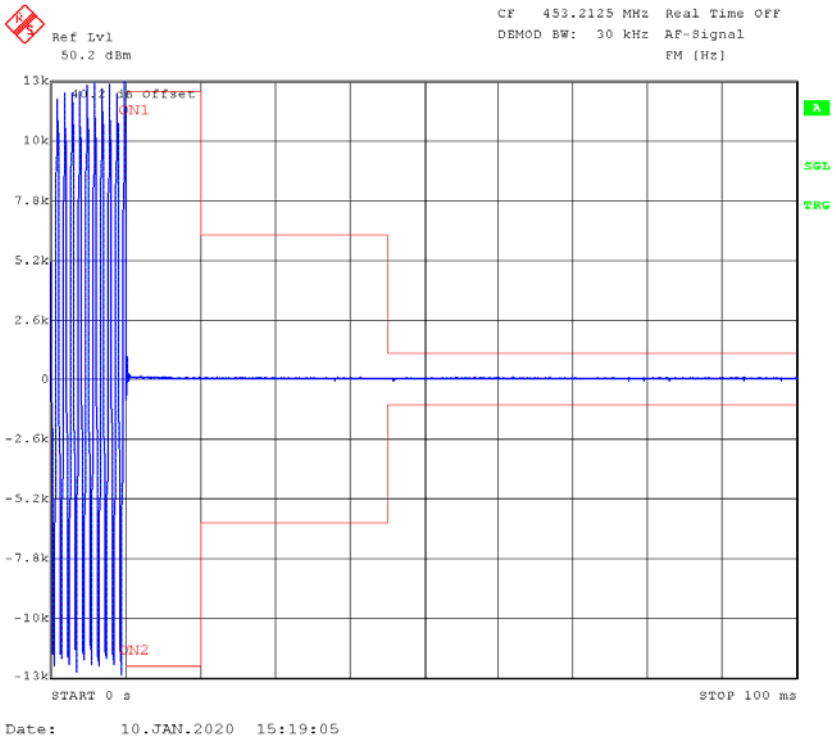
The testing was performed by Blake Yang on 2020-01-10

Channel Spacing (kHz)	Transient Period (ms)	Transient Frequency	Result
12.5	<10(t_1)	±12.5 kHz	Pass
	<25(t_2)	±6.25 kHz	
	<10(t_3)	±12.5 kHz	

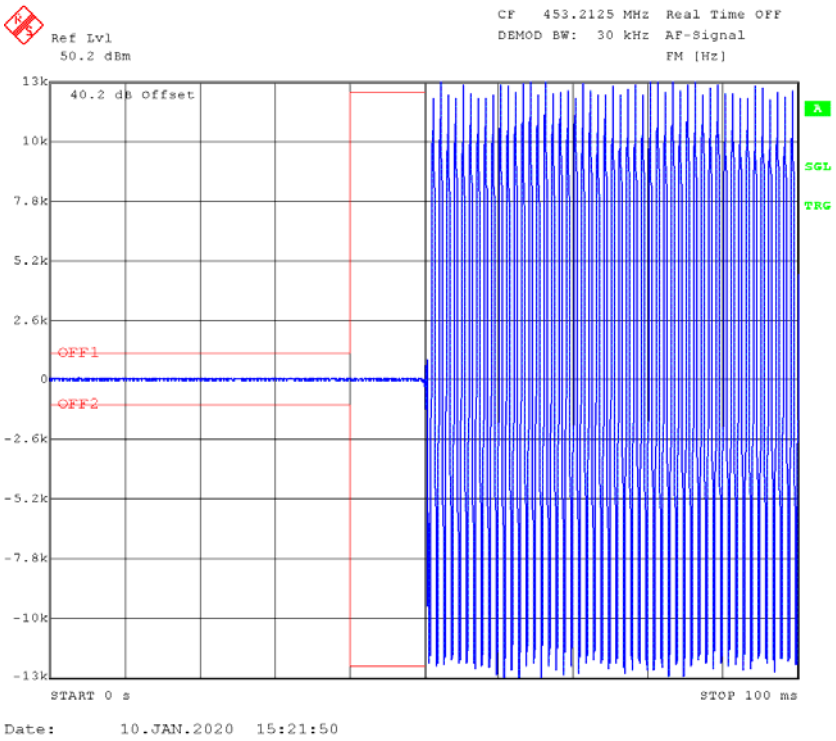
Please refer to the following plots.

High Power Channel: 453.2125 MHz

Turn on



Turn off



******* END OF REPORT *******