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RADIO TEST REPORT – REP016466

Type of assessment:

Final product testing

Applicant:

Leonardo Spa

Piazza Monte Grappa, 4

00195 Roma RM – Italy

Product:

Radio Base Station for fixed installation

Model:

ECOS-E DTA7000 V3LPW121

P/N 774-1147/02

FCC ID:

2ATWB-DTA7KV3L1202

Specifications:

- FCC 47 CFR Part 90, Subpart I
- FCC 47 CFR Part 22, Subpart C
- FCC 47 CFR Part 22, Subpart E

Date of issue: September 15, 2023

P. Barbieri	
Tested by	Signature
D. Guarnone	
Reviewed by	Signature

Nemko

Lab locations

Company name	Nemko Spa	
Facilities	Via del Carroccio, 4 20853 Biassono (MB) Italy +39 039 220 12 01	
Test site registration	**Organization**	**Recognition numbers**
	FCC	682159
Website	www.nemko.com	

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. All results contained in this report are within Nemko Spa ISO/IEC 17025 accreditation.

Copyright notification

Table of Contents

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 90, Subpart I	Private land mobile radio services. General technical standards
FCC 47 CFR Part 22, Subpart C	Public Mobile Services. Operational and Technical Requirements
FCC 47 CFR Part 22, Subpart E	Public Mobile Services. Paging and Radiotelephone Service

1.2 Test methods

ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
FCC 47 CFR Part 2, Subpart J	Equipment authorization procedures

1.3 Exclusions

None

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.3 above. Results obtained indicate that the product under test complies In full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Test report revision history

Table 1.5-1: ***Test report revision history***

Revision #	Date of issue	Details of changes made to test report
REP016466	September 15, 2023	Original report issued

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

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

2.2 Technical judgment

None

2.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Atmospheric conditions

In the laboratory, the following ambient conditions are respected for each test reported below:

Ambient temperature:	18 ÷ 33 °C (1)
Relative Humidity:	25 ÷ 70 % (2)
Atmospheric pressure:	860 ÷ 1060 hPa

The following instruments are used to monitor the environmental conditions:

Equipment	Manufacturer	Model	Serial N°
Thermo-hygrometer data loggers	Testo	175-H2	20012380/305
Thermo-hygrometer data loggers	Testo	175-H2	38203337/703
Barometer	Castle	GPB 3300	072015

3.2 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.

Section 4 Measurement uncertainty

4.1 Uncertainty of measurement

The measurement uncertainty was calculated for each test and quantity listed in this test report, according to CISPR 16-4-2 and other specific test standard and is documented in Nemko Spa working manual WML1002. The assessment of conformity for each test performed on the equipment is performed not taking into account the measurement uncertainty. The two following possible verdicts are stated in the report:

P (Pass) - The measured values of the equipment respect the specification limit at the points tested. The specific risk of false accept is up to 50% when the measured result is close to the limit.

F (Fail) - One or more measured values of the equipment do not respect the specification limit at the points tested. The specific risk of false reject is up to 50% when the measured result is close to the limit.

Hereafter Nemko's measurement uncertainties are reported:

EUT	Type	Test	Range	Measurement Uncertainty	Notes
Transmitter	Conducted	Frequency error	0.001 MHz ÷ 40 GHz	0.08 ppm	(1)
		Carrier power RF Output Power	0.009 MHz ÷ 30 MHz	1.1 dB	(1)
			30 MHz ÷ 18 GHz	1.5 dB	(1)
			18 MHz ÷ 40 GHz	3.0 dB	(1)
			40 MHz ÷ 140 GHz	5.0 dB	(1)
		Adjacent channel power	1 MHz ÷ 18 GHz	1.4 dB	(1)
		Conducted spurious emissions	0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 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	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Effective radiated power transmitter	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)

NOTES:
(1) The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %

Section 5 Information provided by the applicant

5.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

5.2 Applicant/Manufacture

Applicant name	Leonardo Spa
Applicant address	Piazza Monte Grappa, 4 – 00195 Roma (RM) – Italy
Manufacture name	Leonardo Spa
Manufacture address	Piazza Monte Grappa, 4 – 00195 Roma (RM) – Italy

5.3 EUT information

Product name	Radio Base Station for fixed installation
Model	ECOS-E DTA7000 V3LPW121
Model variant(s)	General Code: ECOS-E DTA7000 **aayP**z12**o** **aa = 2 digits** (Frequency Band) V3 = 136 - 174 MHz 00 = no radio part **y = 1 digit** (RF Power level Configuration) L = 50 Watt N = no transmitter **z = 1 digit** (RF Configuration (Antenna Commutation and RX Diversity)) W =configuration with 2 receivers 0 = configuration without receiver **o = 1 digit** (Options) 0 = no option board 1 = with DMR option board
Serial number	145307
Part number	774-1147/02
Power supply requirements	13.2 V DC
Product description and theory of operation	The EUT is a radio base station for fixed installation
Software version	1.14.3.0

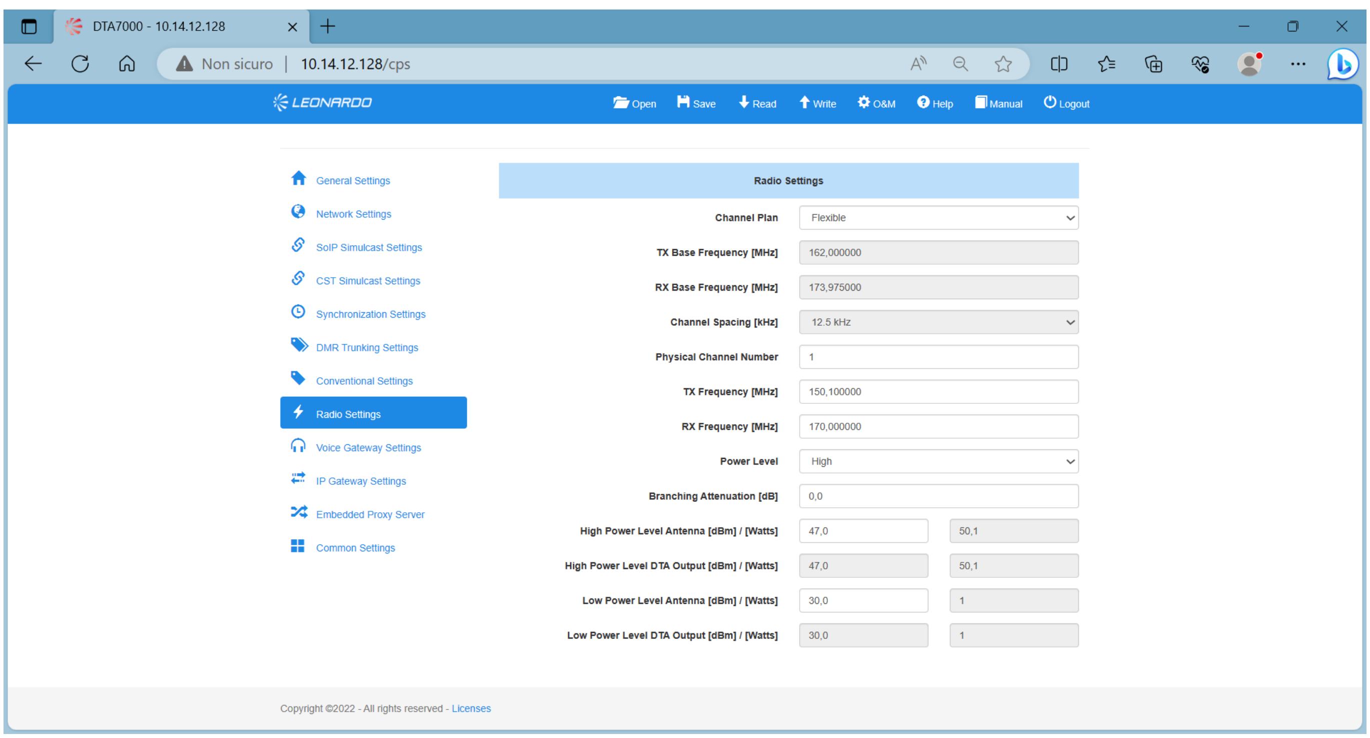
5.4 Technical information

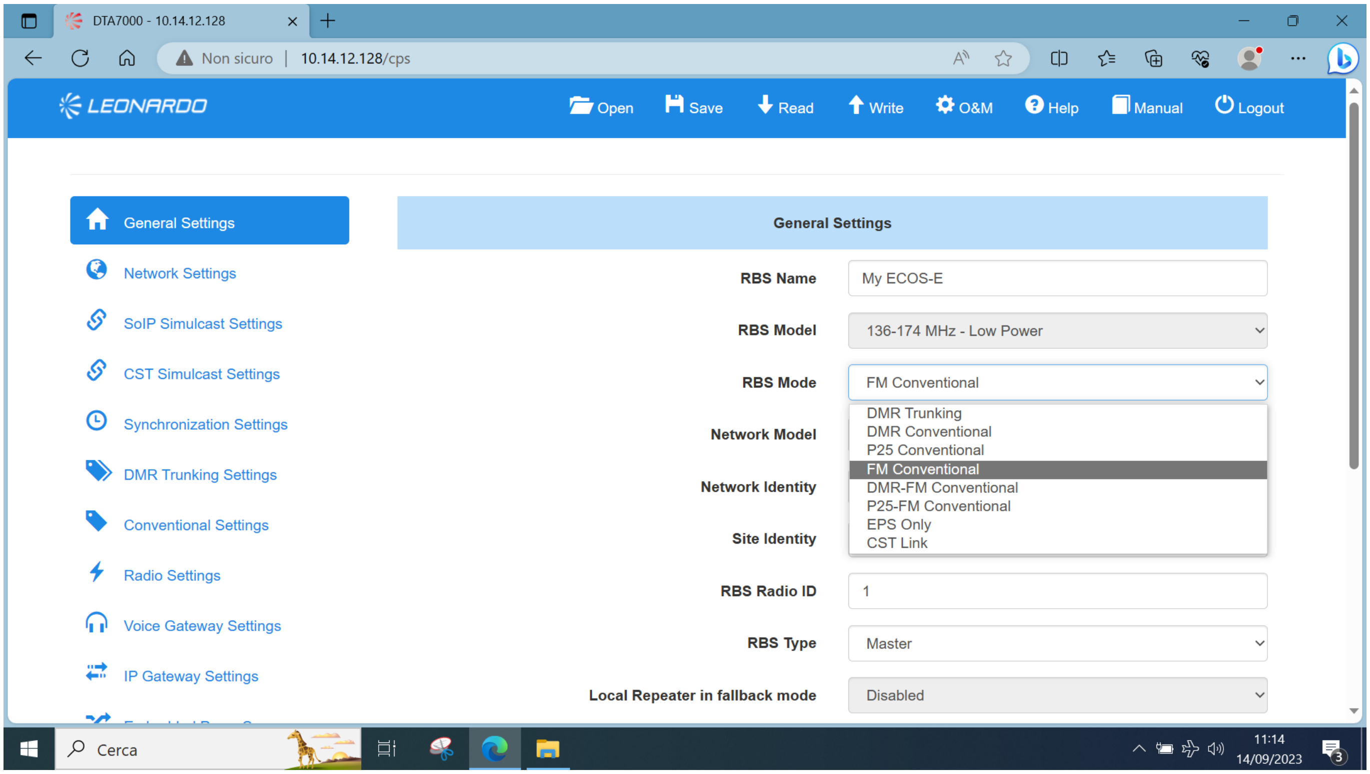
System type	☐ Mobile system	
	☒ Base/Fixed point-to-point system	
Frequency band	138 MHz – 174 MHz	
Frequency Min (MHz)	138 MHz	
Frequency Max (MHz)	174 MHz	
RF power Max (W), Conducted	50 W (47 dBm)	
Field strength, dBμV/m @ 3 m	N/A	
Measured BW (kHz), 99% OBW	10.3 kHz	
Emission designators	Analog	FM 11K0F3E / 16K0F3E (12.5 / 25 kHz)
	DMR 4FSK Voice	7K60FXE (12.5 kHz)
	DMR 4FSK Data	7K60FXD (12.5 kHz)
	CST link 4FSK	6K05FXD / 6K05FXE (12.5 kHz)
	P25 C4FM Voice	8K10F1E (12.5 kHz)
	P25 C4FM Data	8K10F1D (12.5 kHz)
Transmitter spurious, dBm @ 3 m	-45.68 dBm (@ 1.89 GHz)	
Antenna information	Antenna not provided	

5.5 EUT setup details

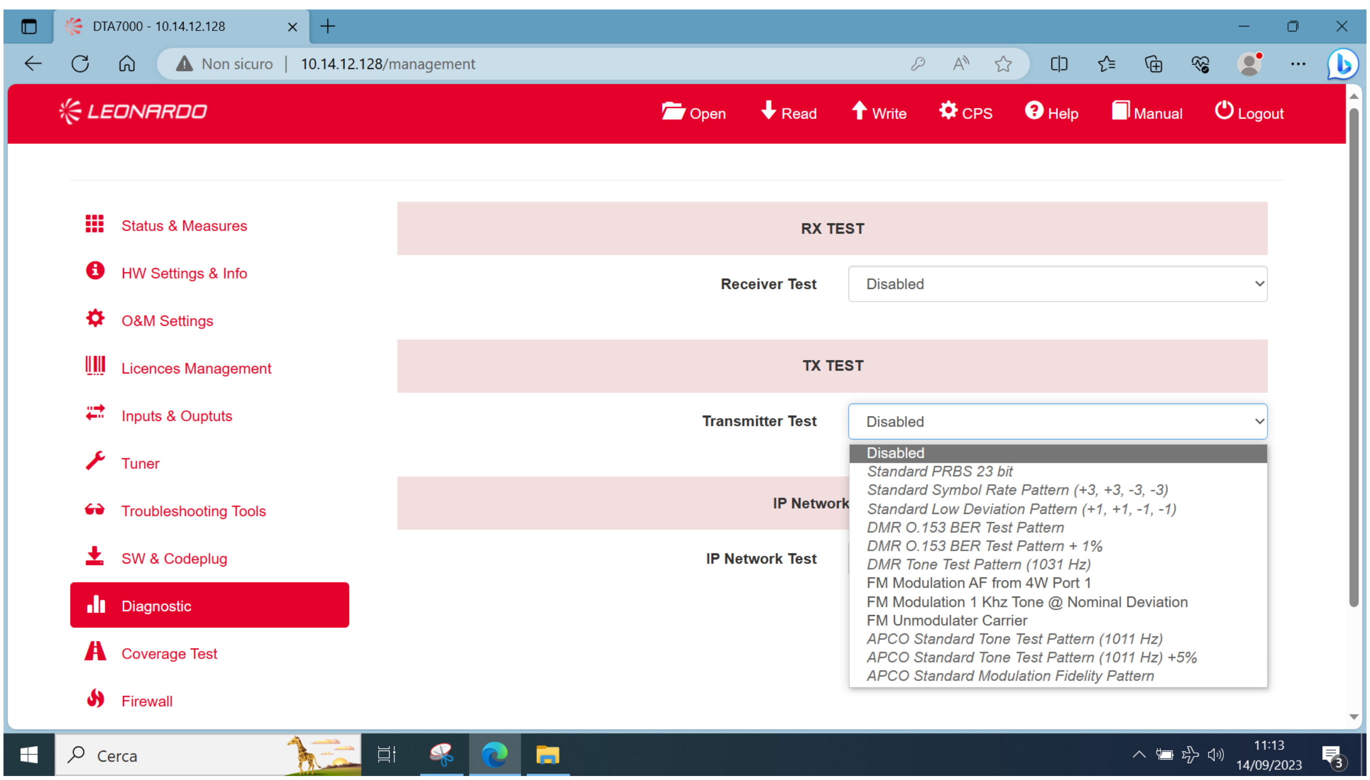
5.5.1 Radio exercise details

The following software has been used to set the EUT.





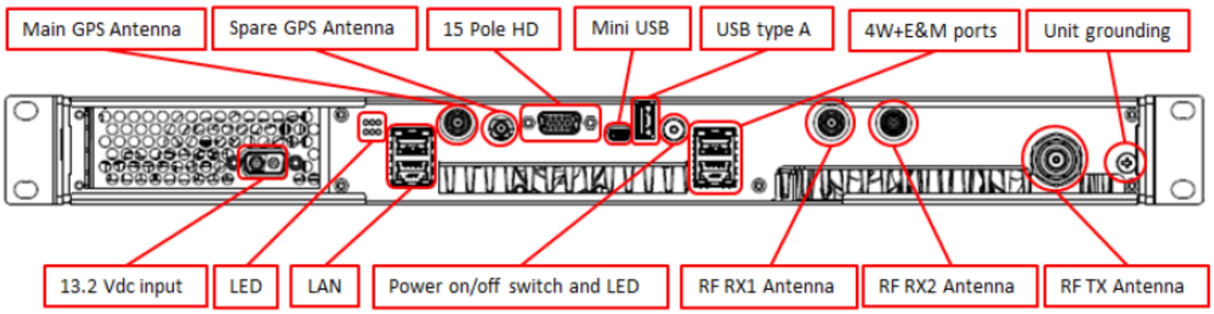
DTA7000 - 10.14.12.128
Non sicuro | 10.14.12.128/cps
LEONARDO
Open
Save
Read
Write
O&M
Help
Manual
Logout
General Settings
Network Settings
SoIP Simulcast Settings
CST Simulcast Settings
Synchronization Settings
DMR Trunking Settings
Conventional Settings
Radio Settings
Voice Gateway Settings
IP Gateway Settings
General Settings
RBS Name
My ECOS-E
RBS Model
136-174 MHz - Low Power
RBS Mode
FM Conventional
DMR Trunking
DMR Conventional
P25 Conventional
FM Conventional
DMR-FM Conventional
P25-FM Conventional
EPS Only
CST Link
Network Model
Network Identity
Site Identity
RBS Radio ID
1
RBS Type
Master
Local Repeater in fallback mode
Disabled
Cerca
11:14
14/09/2023



DTA7000 - 10.14.12.128
Non sicuro | 10.14.12.128/management
LEONARDO
Open
Read
Write
CPS
Help
Manual
Logout
Status & Measures
HW Settings & Info
O&M Settings
Licences Management
Inputs & Ouptuts
Tuner
Troubleshooting Tools
SW & Codeplug
Diagnostic
Coverage Test
Firewall
RX TEST
Receiver Test
Disabled
TX TEST
Transmitter Test
Disabled
Disabled
Standard PRBS 23 bit
Standard Symbol Rate Pattern (+3, +3, -3, -3)
Standard Low Deviation Pattern (+1, +1, -1, -1)
DMR O.153 BER Test Pattern
DMR O.153 BER Test Pattern + 1%
DMR Tone Test Pattern (1031 Hz)
FM Modulation AF from 4W Port 1
FM Modulation 1 Khz Tone @ Nominal Deviation
FM Unmodulater Carrier
APCO Standard Tone Test Pattern (1011 Hz)
APCO Standard Tone Test Pattern (1011 Hz) +5%
APCO Standard Modulation Fidelity Pattern
IP Network
IP Network Test
Cerca
11:13
14/09/2023

5.5.2 EUT sub assemblies

In the following picture the architecture of the EUT is shown.



5.5.3 EUT interface ports

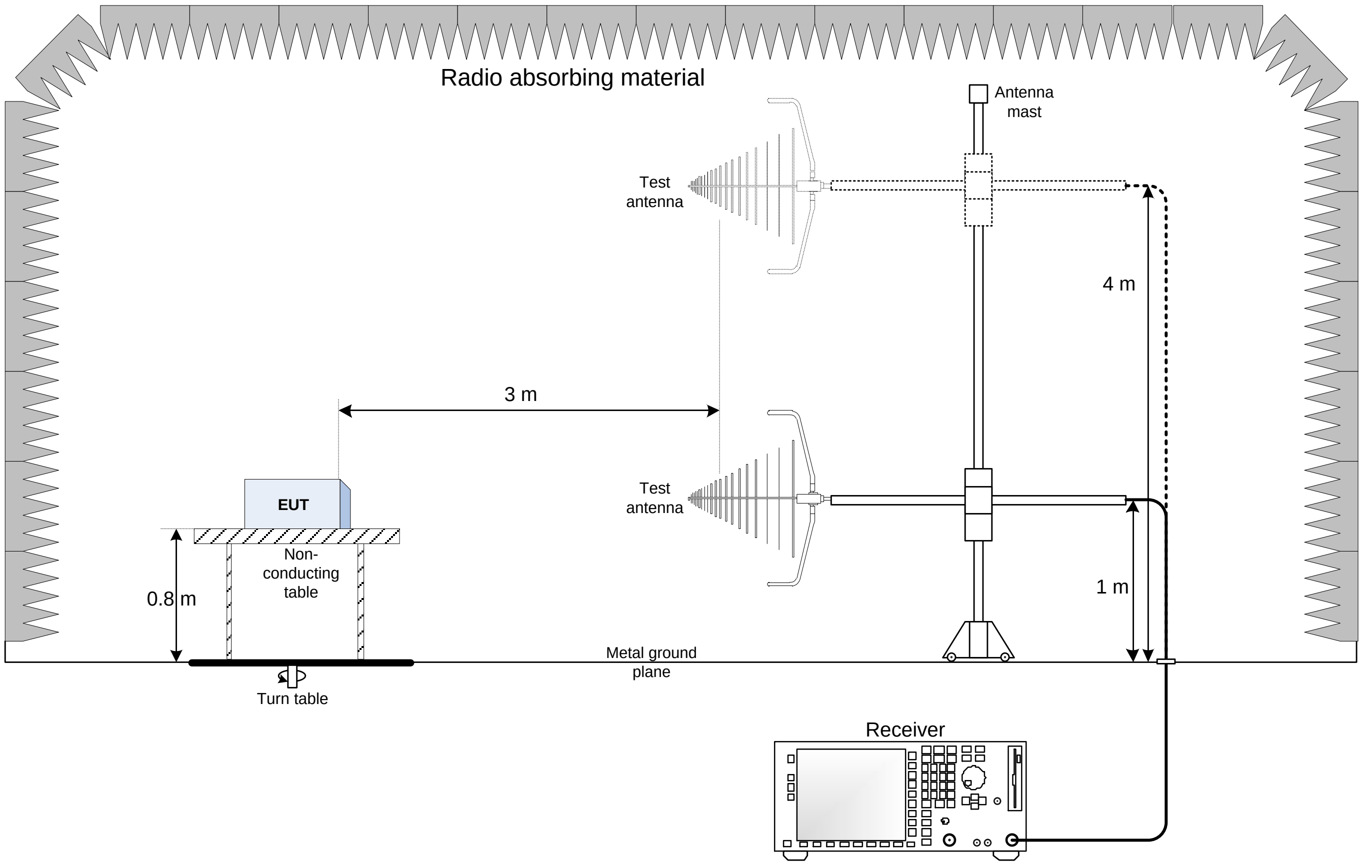
Port	Name	Type [1]	Cable Max. >3m	Cable Shielded	Description
0	Enclosure	N/E	—	—	—
1	13.2 V dc input	DC	☒	☐	Two wires cable
2	LAN	TP	☒	☒	Standard cable with RJ45 connector
3	RF RX1 antenna	ANT	☒	☒	Coaxial cable with sma connector
4	RF RX2 antenna	ANT	☒	☒	Coaxial cable with sma connector
5	Main GPS antenna	ANT	☒	☒	Coaxial cable with sma connector
6	Spare GPS antenna	ANT	☒	☒	Coaxial cable with sma connector
7	Mini USB	I/O	—	—	Normally not used
8	USB type A	I/O	—	—	Normally not used
9	RF TX antenna	ANT	☒	☒	Coaxial cable with N connector
10	15 pole HD	I/O	☒	☐	Multi wires cable
11	4W+E&M	TP	☒	☐	Multi wires cable

Notes:
[1] Port type:
AC = AC Power Port DC = DC Power Port N/E = Non-Electrical ANT = Antenna Port
I/O = Signal/Control Input or Output Port TP = Wired network or telecommunication Port

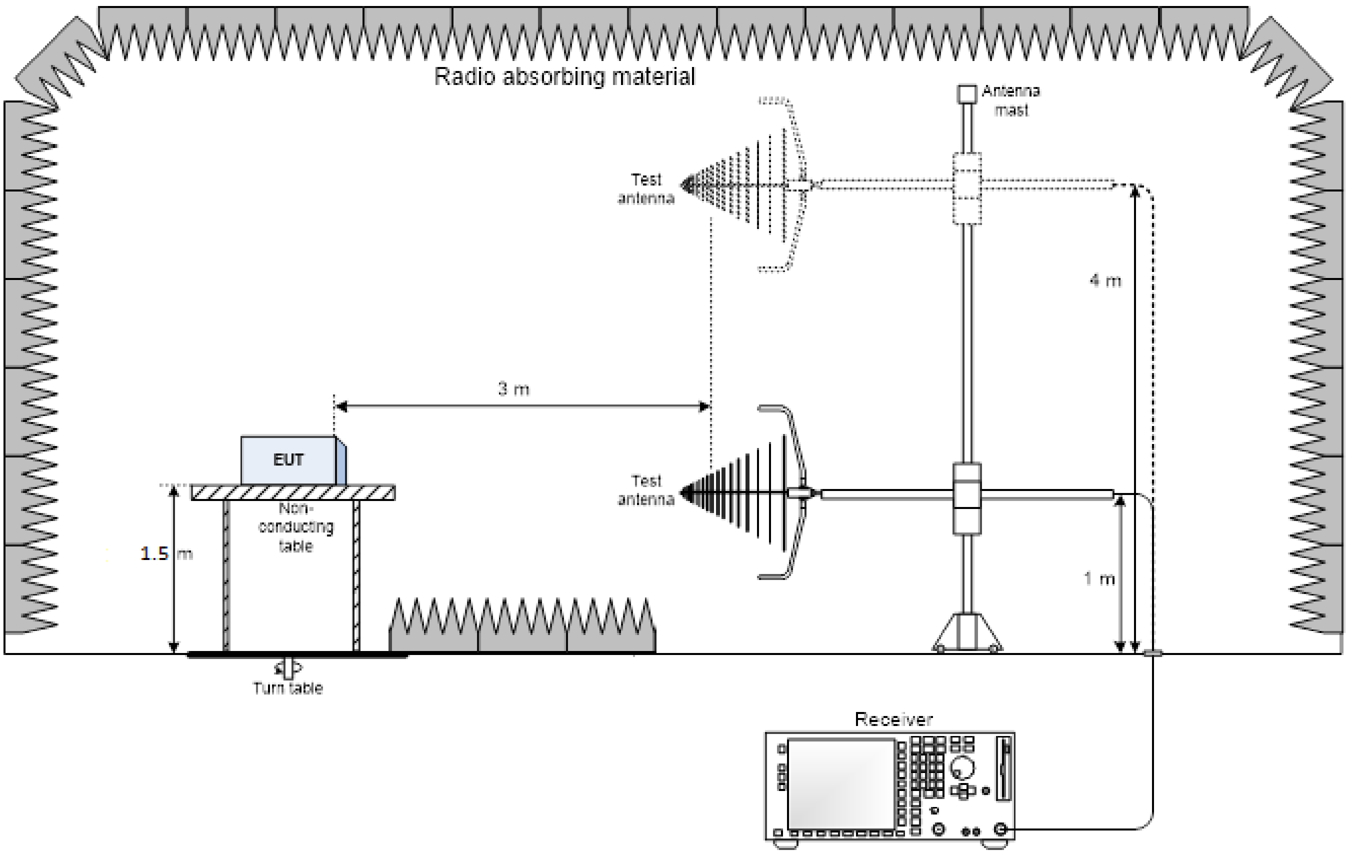
5.5.4 Support equipment

Product Type	Manufacturer	Model	Comments
Notebook	DELL	Latitude	—

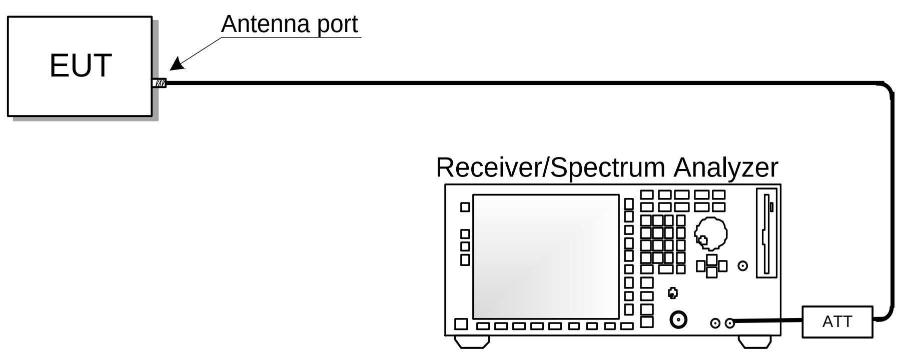
5.5.5 Radiated testing block diagram (below 1 GHz)



5.5.6 Radiated testing block diagram (above 1 GHz)



5.5.7 Antenna port testing block diagram



Section 6 Summary of test results

6.1 Testing location

Test location (s)	Nemko Spa

6.2 Testing period

Test start date	September 11, 2023	Test end date	September 15, 2023

6.3 Sample information

Receipt date	August 02, 2023	Nemko sample ID number(s)	PRJ00367500001

6.4 FCC Part 2, 22 and 90 test requirements results

Table 6.4-1: FCC requirements results

Part	Test description	Verdict
§2.1047	Modulation characteristics	Pass

Part	Test description	Verdict
§90.205(h)	Transmitter output power	Pass
§90.209(b)	Bandwidth limitations	Pass
§90.210	Spectrum mask and spurious emissions	Pass
§90.214	Transient frequency behavior	Pass
§90.213(a)	Transmitter frequency stability	Pass

Notes: --

Part	Test description	Verdict
§22.565	Transmitter output power	Pass
§22.359	Emission limitations	Pass
§22.355	Frequency tolerance	Pass

Notes: --

Section 7 Testing data

7.1 Number of frequencies

7.1.1 References, definitions and limits

ANSI C63.26, Clause 5.1.2:

Measurements of transmitters shall be performed and, if required, reported for each frequency band in which the EUT can be operated with the device transmitting at the number of frequencies in each band specified in table below.

Table 7.1-1: ***Frequency Range of Operation***

Frequency range over which the device operates (in each band)	Number of test frequencies required	Location of measurement frequency inside the operating frequency range
1 MHz or less	1	Center (middle of the band)
1–10 MHz	2	1 near high end, 1 near low end
Greater than 10 MHz	3	1 near high end, 1 near center and 1 near low end

Notes: "near" means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

7.1.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	September 11, 2023

7.1.3 Observations, settings and special notes

None

7.1.4 Test data

Table 7.1-2: ***Test channels selection***

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
138	174	36	138.1	156.0	173.9

7.2 Modulation characteristic

7.2.1 References, definitions and limits

FCC §2.1047:

(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

7.2.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	September 14, 2023

7.2.3 Observations, settings and special notes

Per ANSI C63.26 Subclause 5.3.1: The audio frequency response is the degree of closeness to which the frequency deviation of the transmitter follows a prescribed characteristic.
Spectrum analyser settings:

Receiver mode	RMS deviation
Audio frequency generator tone	100 Hz and 5000 Hz

Reference voltage measurement: Apply a 1000 Hz tone and adjust the audio frequency generator to produce 20% of the rated system deviation. Record the DMM reading as V_{REF}.
Calculation of the audio frequency response at the present frequency: $20 \times \text{Log}_{10} (V_{FREQ} / V_{REF})$

Per ANSI C63.26 Subclause 5.3.2: Modulation limiting is the ability of a transmitter circuit to limit the transmitter from producing deviations in excess of a rated system deviation.
Spectrum analyser settings:

Receiver mode	Peak positive and negative deviation
Audio frequency generator tone	300 Hz, 2500 Hz and 3000 Hz

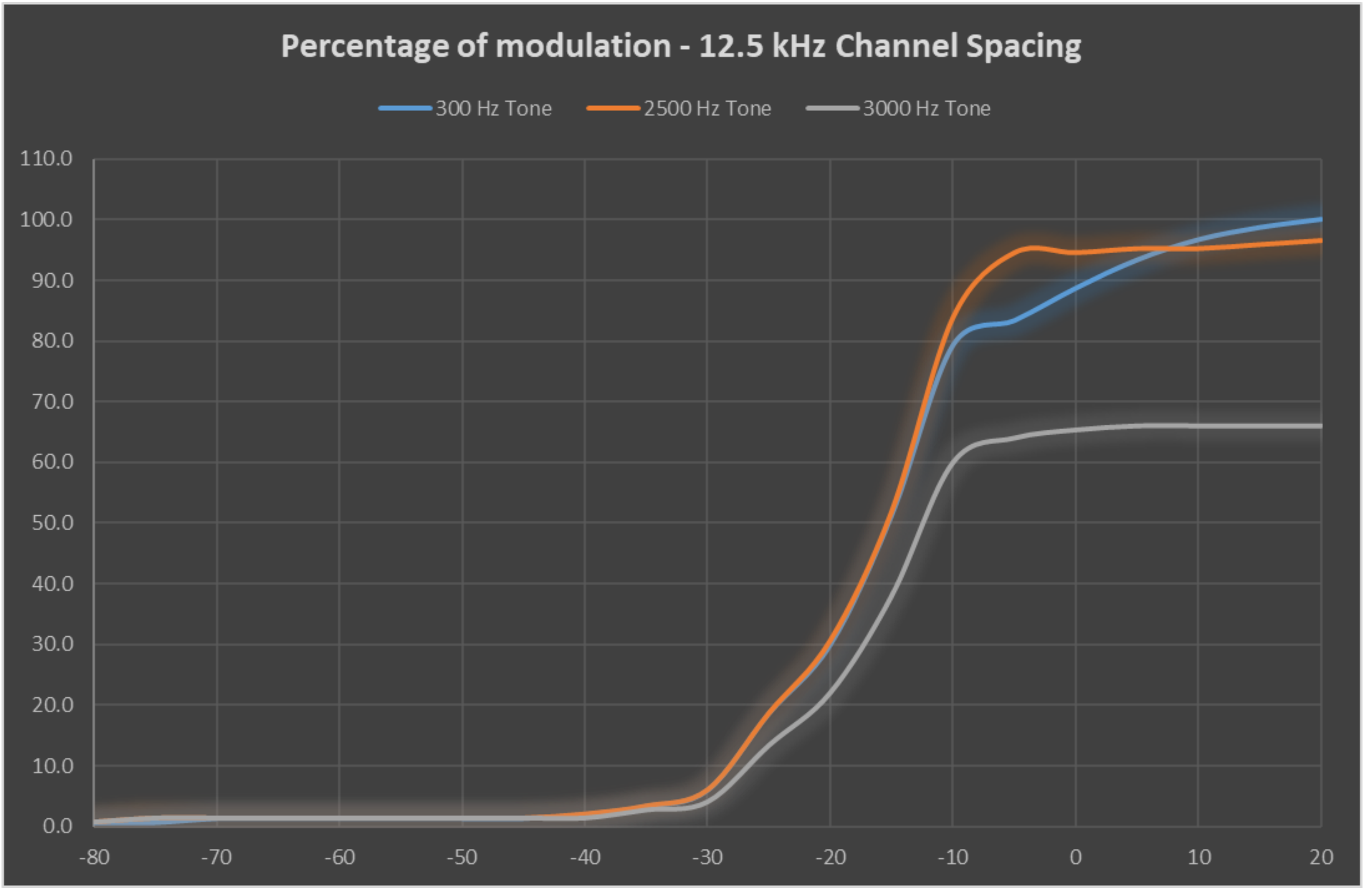
Reference voltage measurement: Apply a 1000 Hz tone and adjust the audio frequency generator to produce 60% of the rated system deviation. This is the 0 dB reference level. Plot the data set as a percentage of deviation relative to the 0 dB reference point versus input voltage.

7.2.4 Test equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767	2023-01	2024-01
Shielded room	Siemens	10m control room	1947	NCR	NCR
Radiocommunication Tester	R&S	CMT	883152/001	2021/01	2024-01
Audio Generator	Rohde & Schwarz	APN04	860 093/017	2021-12	2023-12

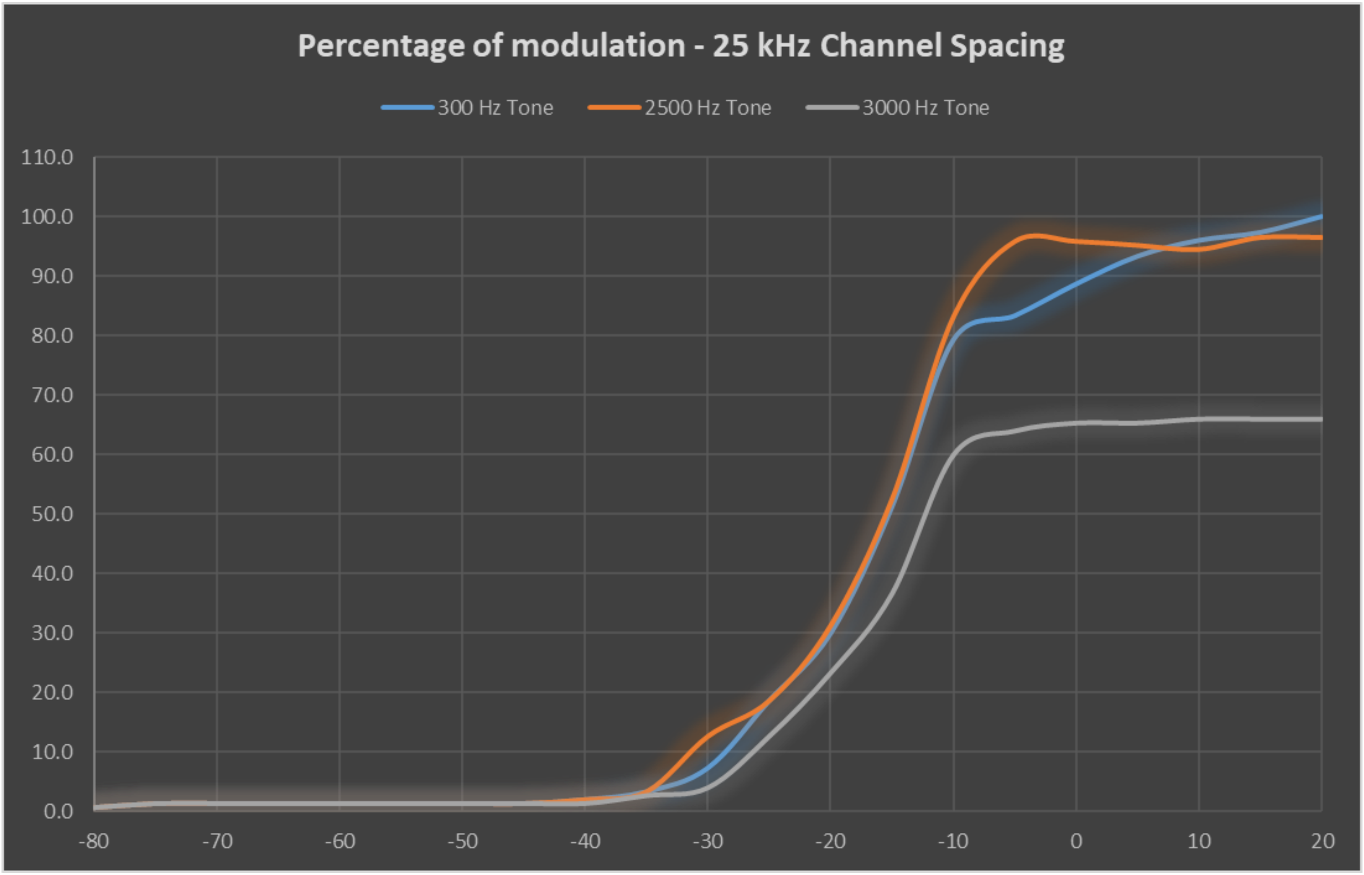
Note: NCR - no calibration required, VOU - verify on use

7.2.5 Test data



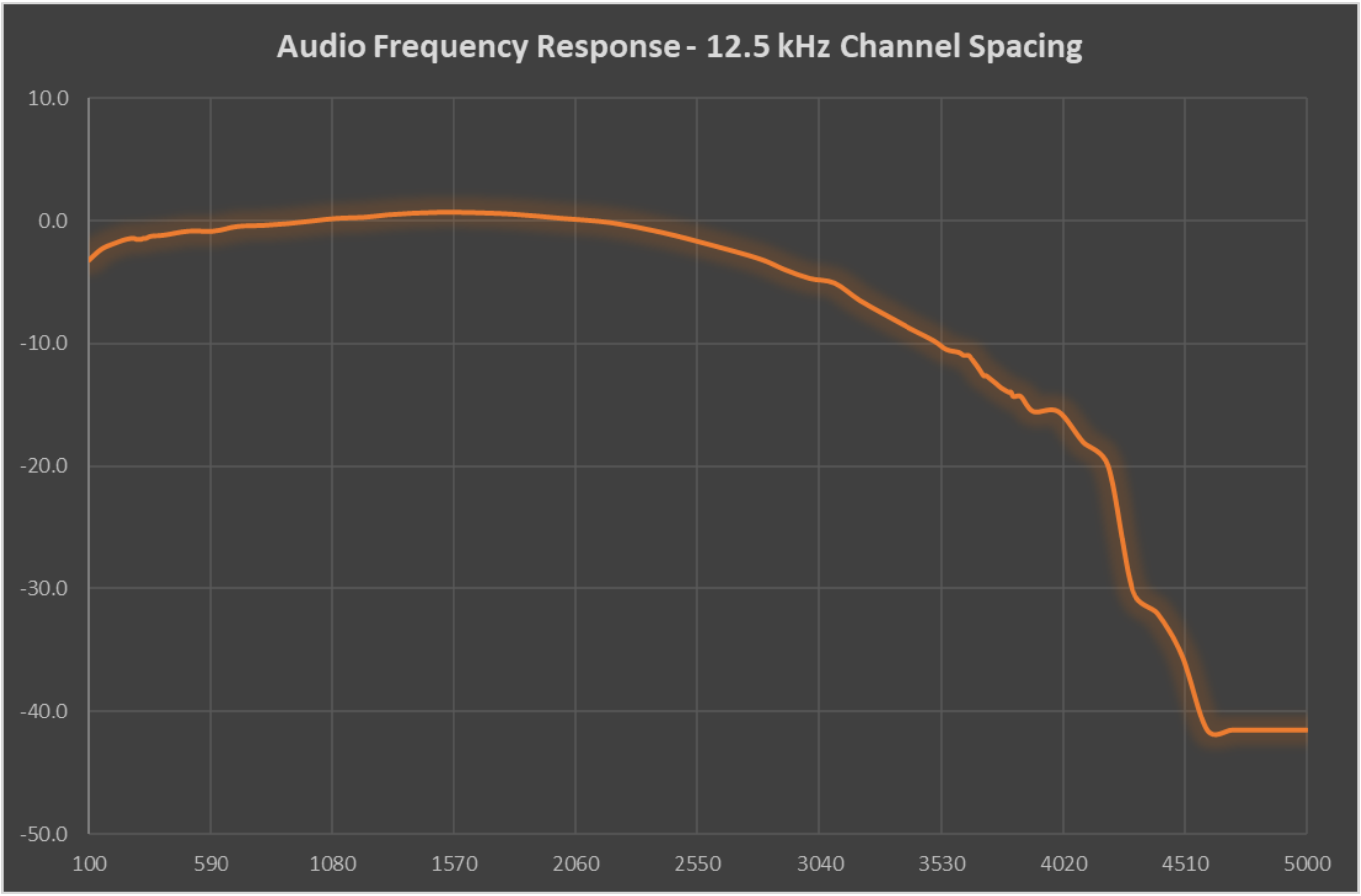
Modulation Limiting

Test data, continued



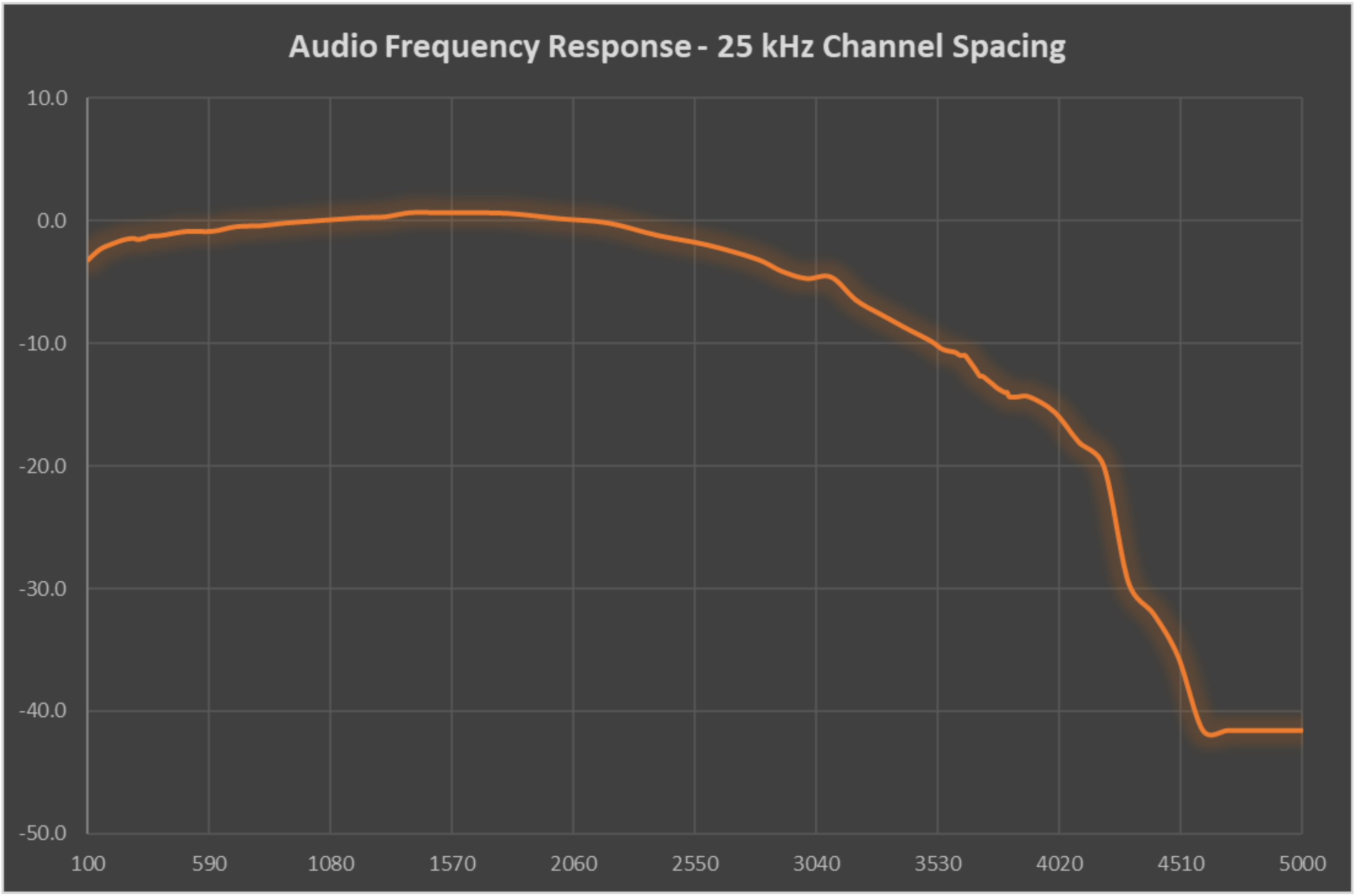
Modulation Limiting

Test data, continued



Audio frequency response

Test data, continued



Audio frequency response

7.3 Transmitter Output Power

7.3.1 References, definitions and limits

FCC §90.205:

(d) Power and antenna height limits within 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 7.3-1: Maximum ERP/Reference HAAT for a Specific Service Area Radius

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

Notes: [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: $ERP_{allow} = ERP_{max} \times (HAAT_{ref} / HAAT_{actual})^2$.

[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.

FCC §22.565:

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.

References, definitions and limits, continued

(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.

7.3.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	September 12, 2023

7.3.3 Observations, settings and special notes

Manufacturer's rated output power is 50 W or 47 dBm. 20% of the rated power = 47.78 dBm

Measurement of peak power was performed per ANSI C63.26 subclause 5.2.3.3. Spectrum analyser settings:

Resolution bandwidth	≥ OBW
Video bandwidth	≥ 3 × RBW
Frequency span	≥ 2 × OBW
Detector mode	Peak
Trace mode	Max Hold
Sweep time	≥ 10 × (number of points in sweep) × (transmission symbol period)

7.3.4 Test equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767	2023-01	2024-01
Shielded room	Siemens	10m control room	1947	NCR	NCR

Note: NCR - no calibration required, VOU - verify on use

7.3.5 Test data

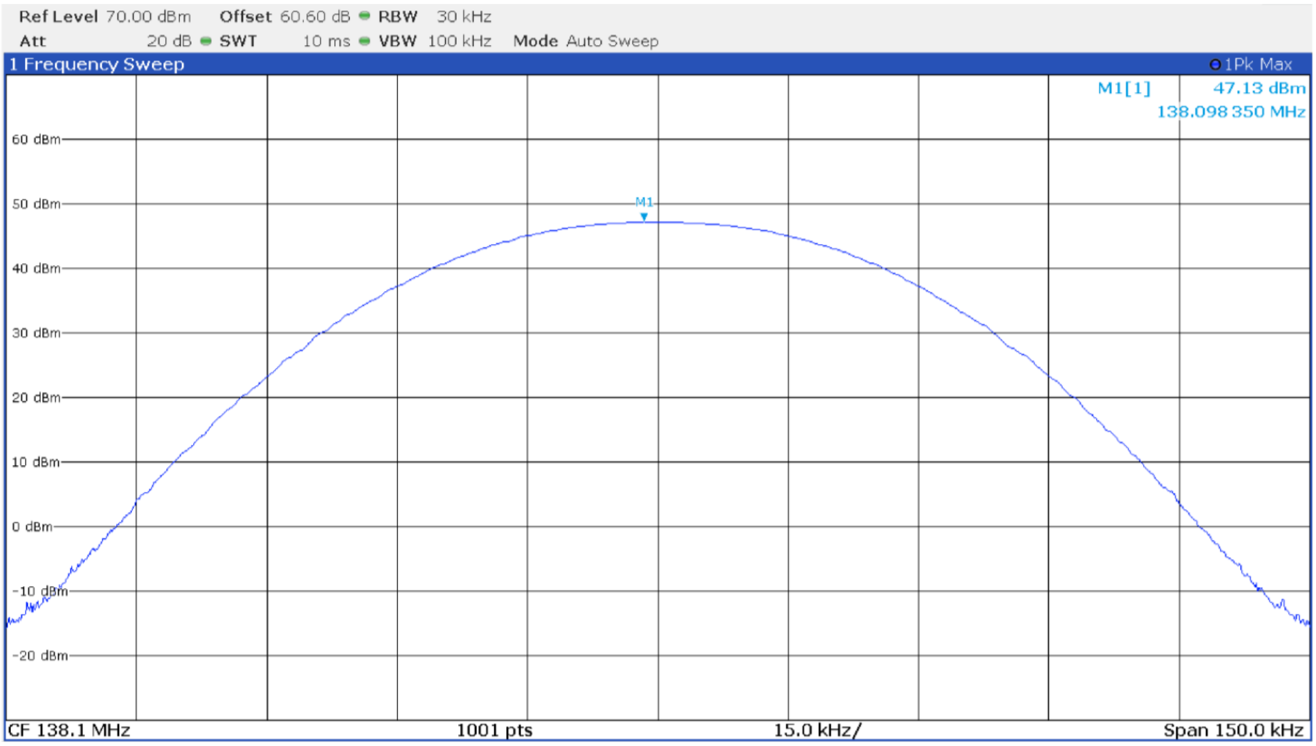
*Table 7.3-2: **Transmitter power results***

Modulation	Frequency, MHz	Output power, dBm	Max Antenna gain, dBd	ERP limit, dBm
FM 12.5 kHz	138.1	47.1	4.7	51.8
FM 25.0 kHz	138.1	47.1	4.7	51.8
DMR 4FSK	138.1	47.1	4.7	51.8
CST 4FSK	138.1	47.2	4.6	51.8
P25 C4FM	138.1	47.2	4.6	51.8
FM 12.5 kHz	156.0	47.4	4.4	51.8
FM 25.0 kHz	156.0	47.4	4.4	51.8
DMR 4FSK	156.0	47.4	4.4	51.8
CST 4FSK	156.0	47.4	4.4	51.8
P25 C4FM	156.0	47.4	4.4	51.8
FM 12.5 kHz	173.9	47.2	4.6	51.8
FM 25.0 kHz	173.9	47.2	4.6	51.8
DMR 4FSK	173.9	47.2	4.6	51.8
CST 4FSK	173.9	47.3	4.5	51.8
P25 C4FM	173.9	47.2	4.6	51.8

*Table 7.3-3: **Rated vs measured power***

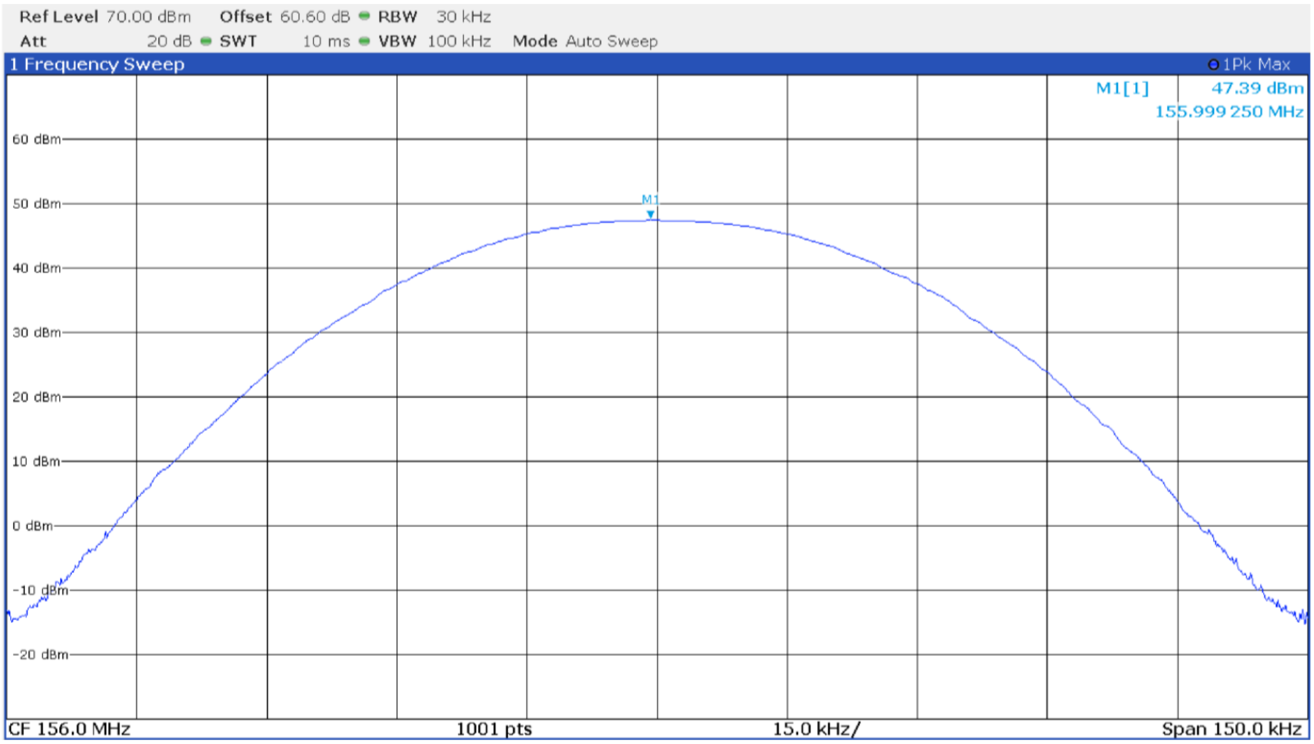
Modulation	Frequency, MHz	Rated output power, dBm	Measured output power, dBm	Difference, dB	Difference limit, dB	Margin, dB
FM 12.5 kHz	138.1	47.0	47.1	+0.1	+0.8	-0.7
FM 25.0 kHz	138.1	47.0	47.1	+0.1	+0.8	-0.7
DMR 4FSK	138.1	47.0	47.1	+0.1	+0.8	-0.7
P25 C4FM	138.1	47.0	47.2	+0.2	+0.8	-0.6
CST 4FSK	138.1	47.0	47.2	+0.2	+0.8	-0.6
FM 12.5 kHz	156.0	47.0	47.4	+0.4	+0.8	-0.4
FM 25.0 kHz	156.0	47.0	47.4	+0.4	+0.8	-0.4
DMR 4FSK	156.0	47.0	47.4	+0.4	+0.8	-0.4
P25 C4FM	156.0	47.0	47.4	+0.4	+0.8	-0.4
CST 4FSK	156.0	47.0	47.4	+0.4	+0.8	-0.4
FM 12.5 kHz	173.9	47.0	47.2	+0.2	+0.8	-0.6
FM 25.0 kHz	173.9	47.0	47.2	+0.2	+0.8	-0.6
DMR 4FSK	173.9	47.0	47.2	+0.2	+0.8	-0.6
P25 C4FM	173.9	47.0	47.3	+0.3	+0.8	-0.5
CST 4FSK	173.9	47.0	47.2	+0.2	+0.8	-0.6

Test data, continued



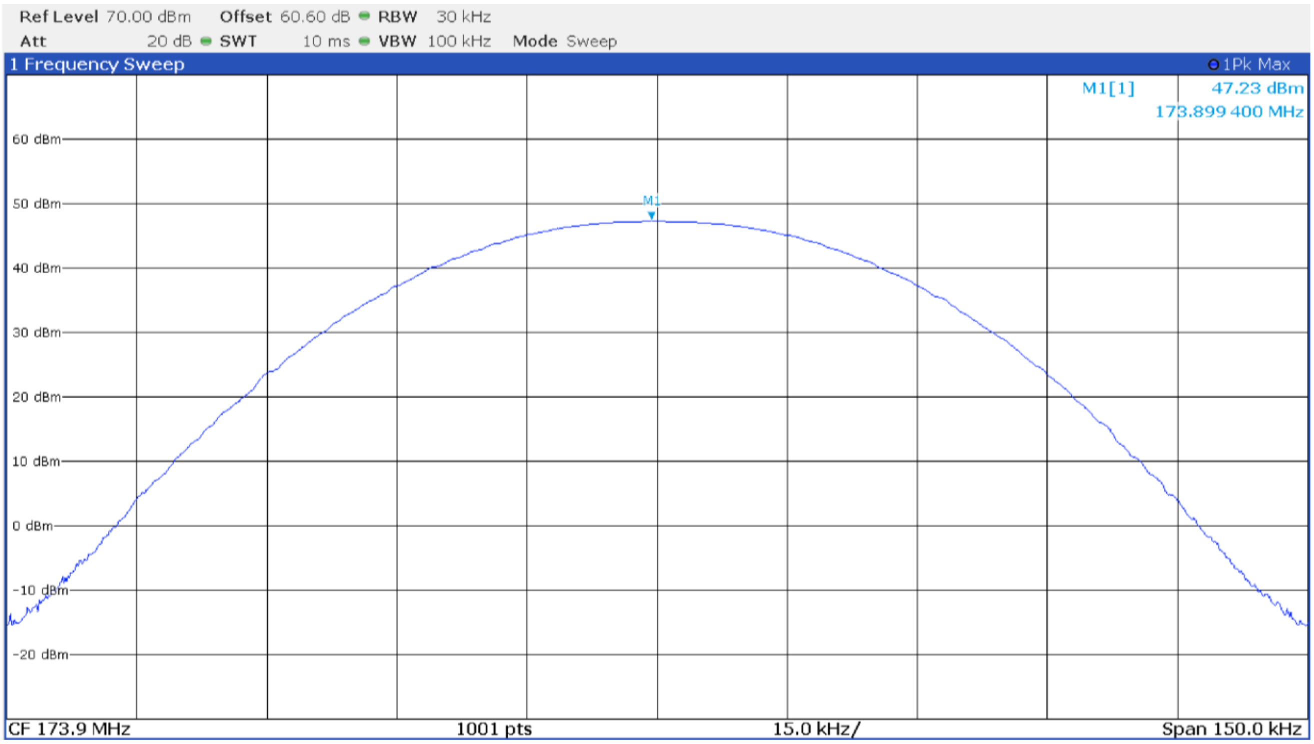
Output power with modulation DMR 4FSK at 138.1 MHz

Test data, continued



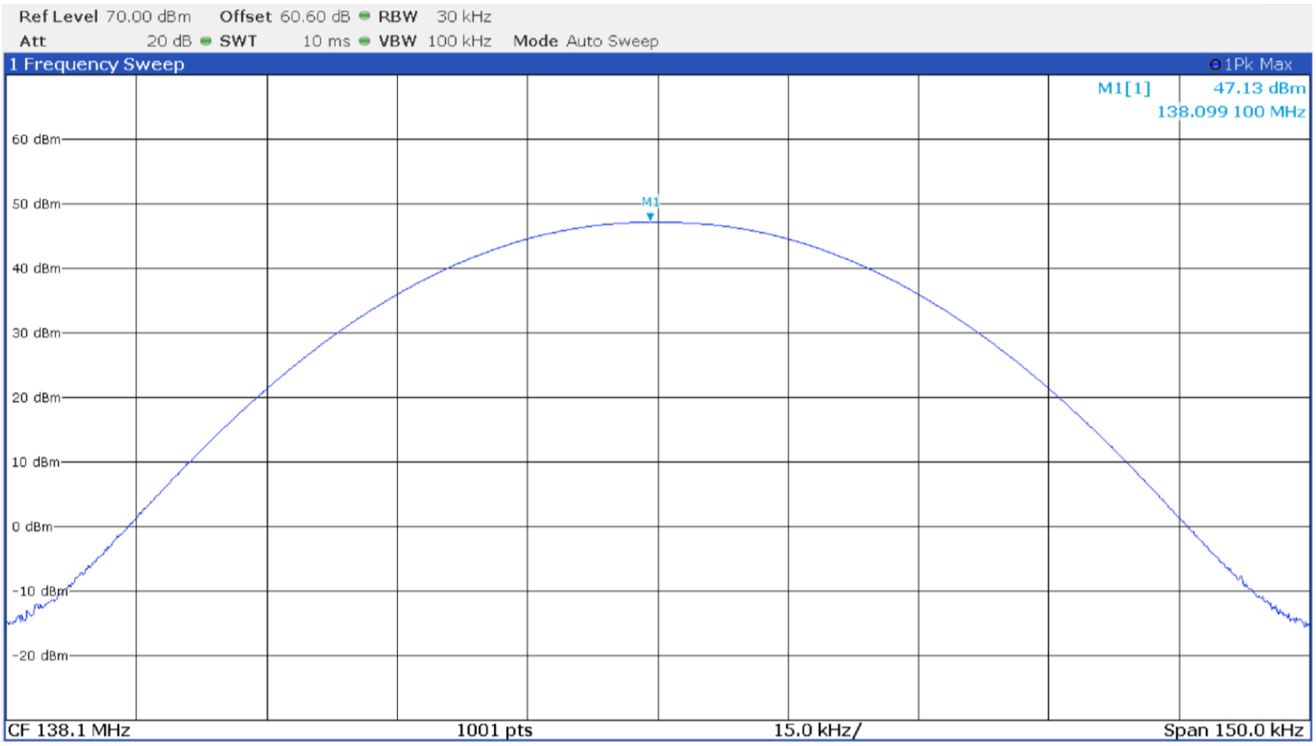
Output power with modulation DMR 4FSK at 156.0 MHz

Test data, continued



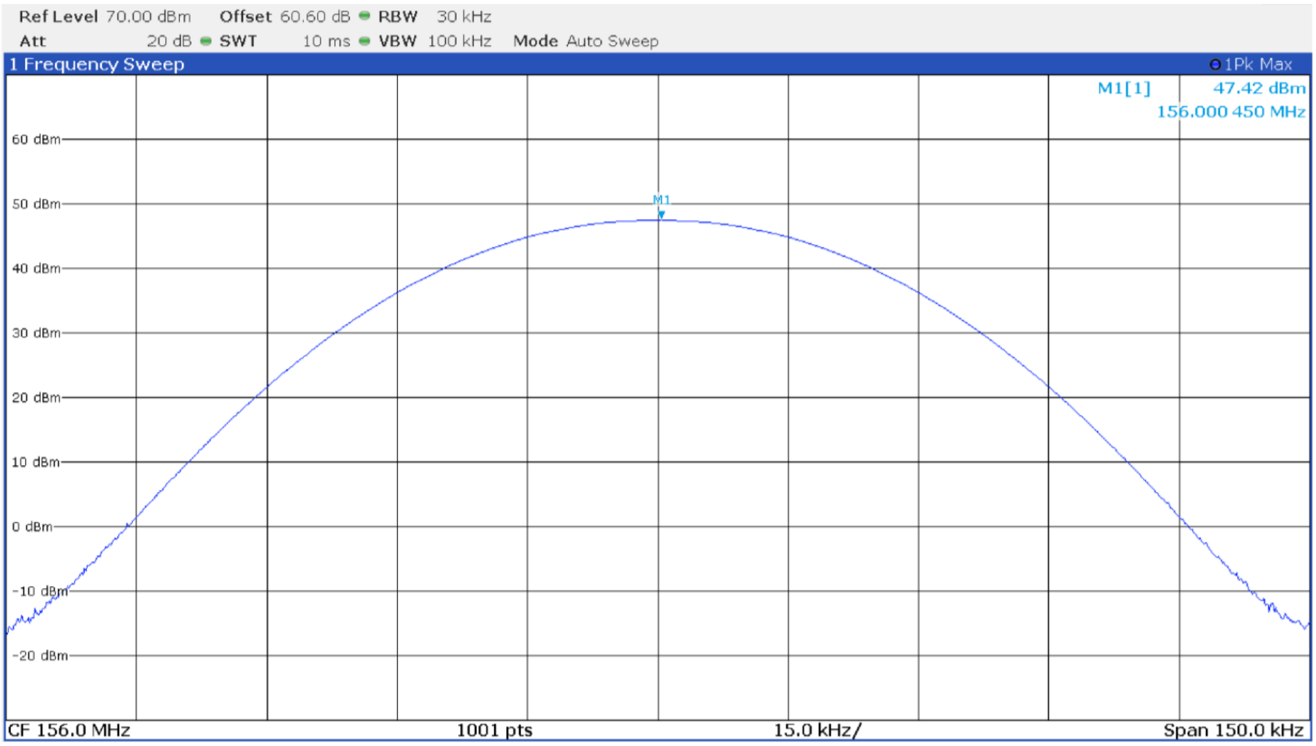
Output power with modulation DMR 4FSK at 173.9 MHz

Test data, continued



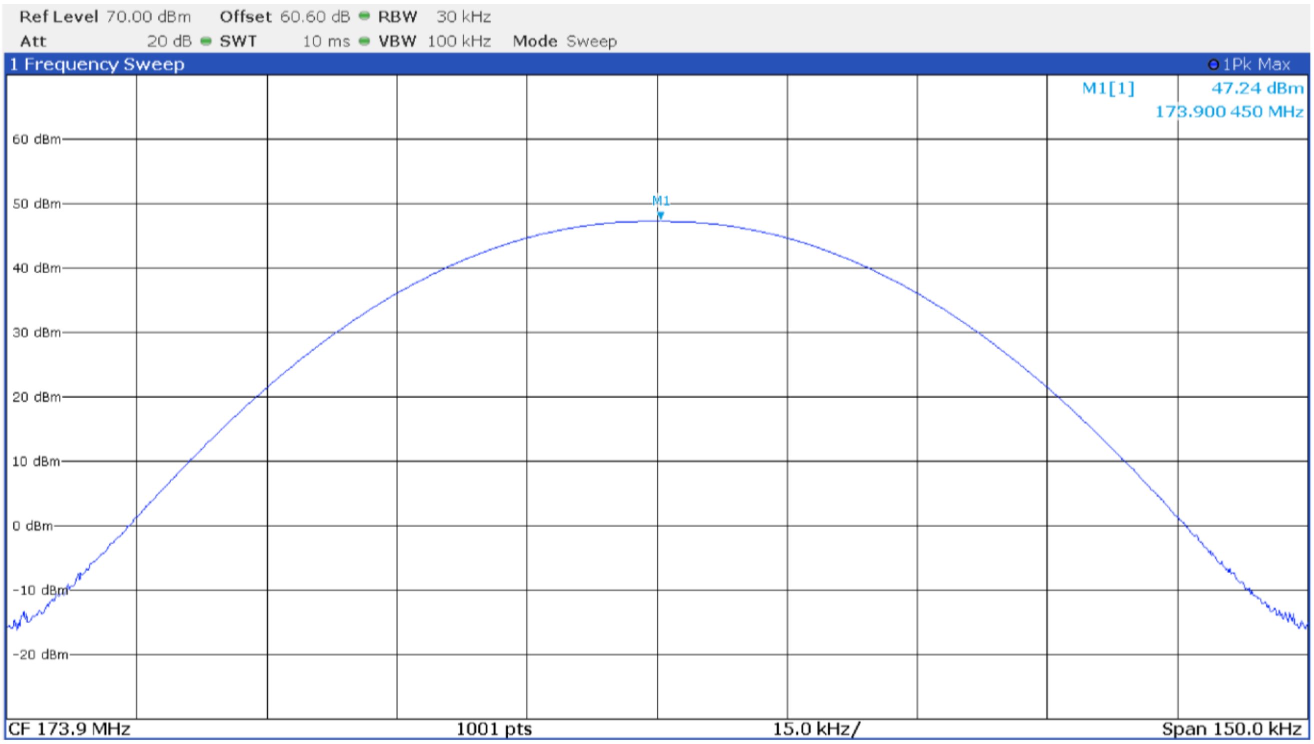
Output power with modulation *FM 12.5 kHz* at 138.1 MHz

Test data, continued



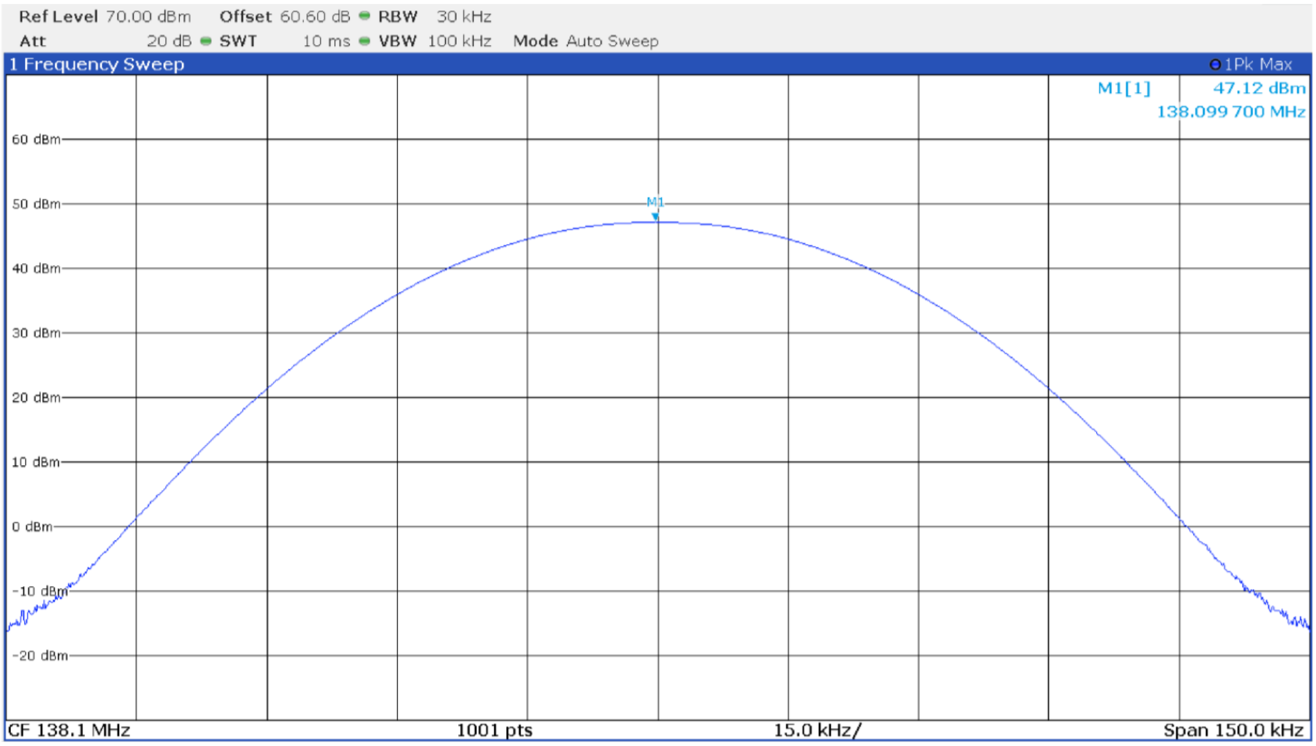
Output power with modulation *FM 12.5 kHz* at 156.0 MHz

Test data, continued



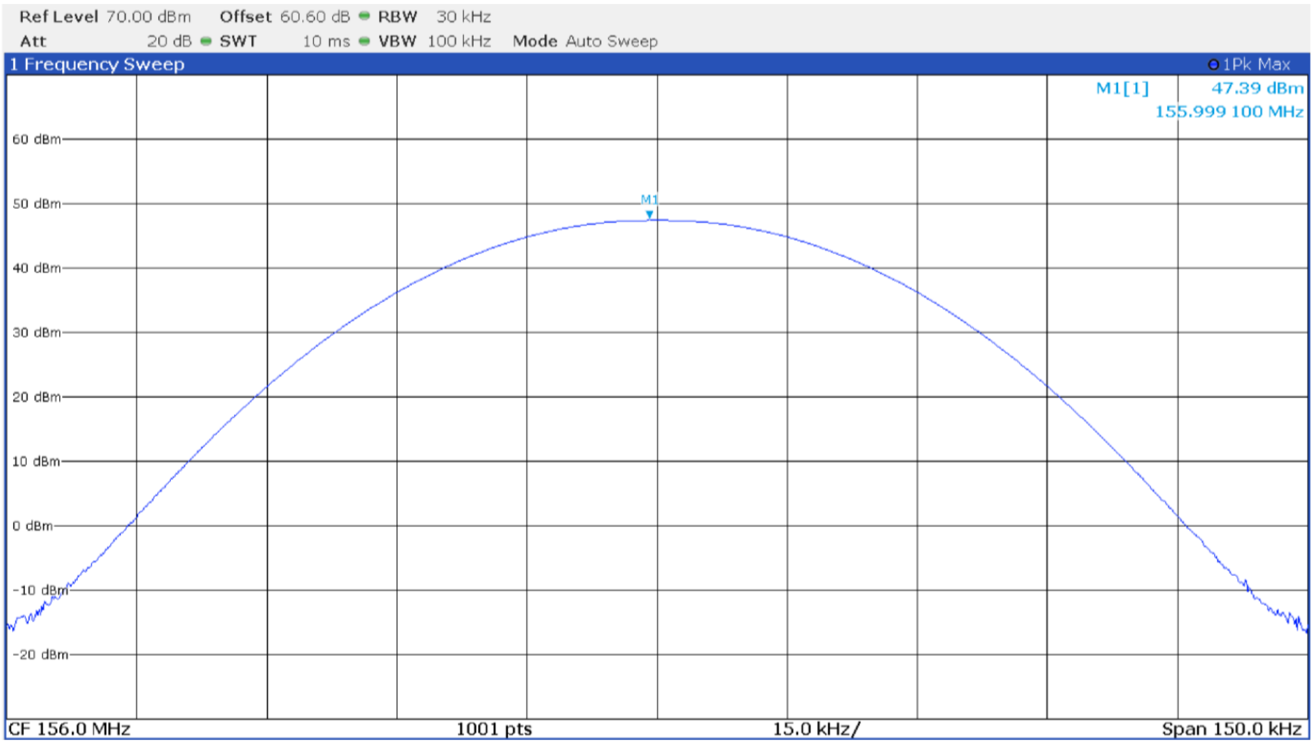
Output power with modulation *FM 12.5 kHz* at 173.9 MHz

Test data, continued



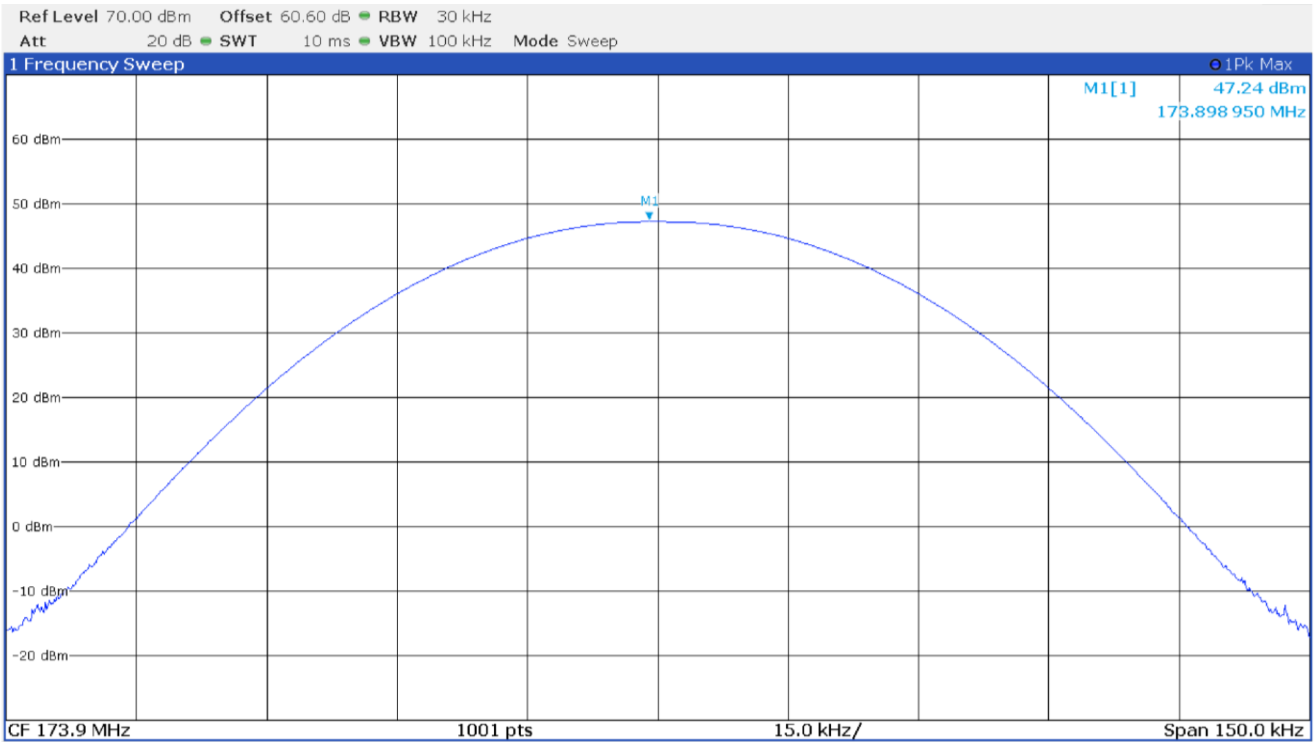
Output power with modulation *FM 25 kHz* at 138.1 MHz

Test data, continued



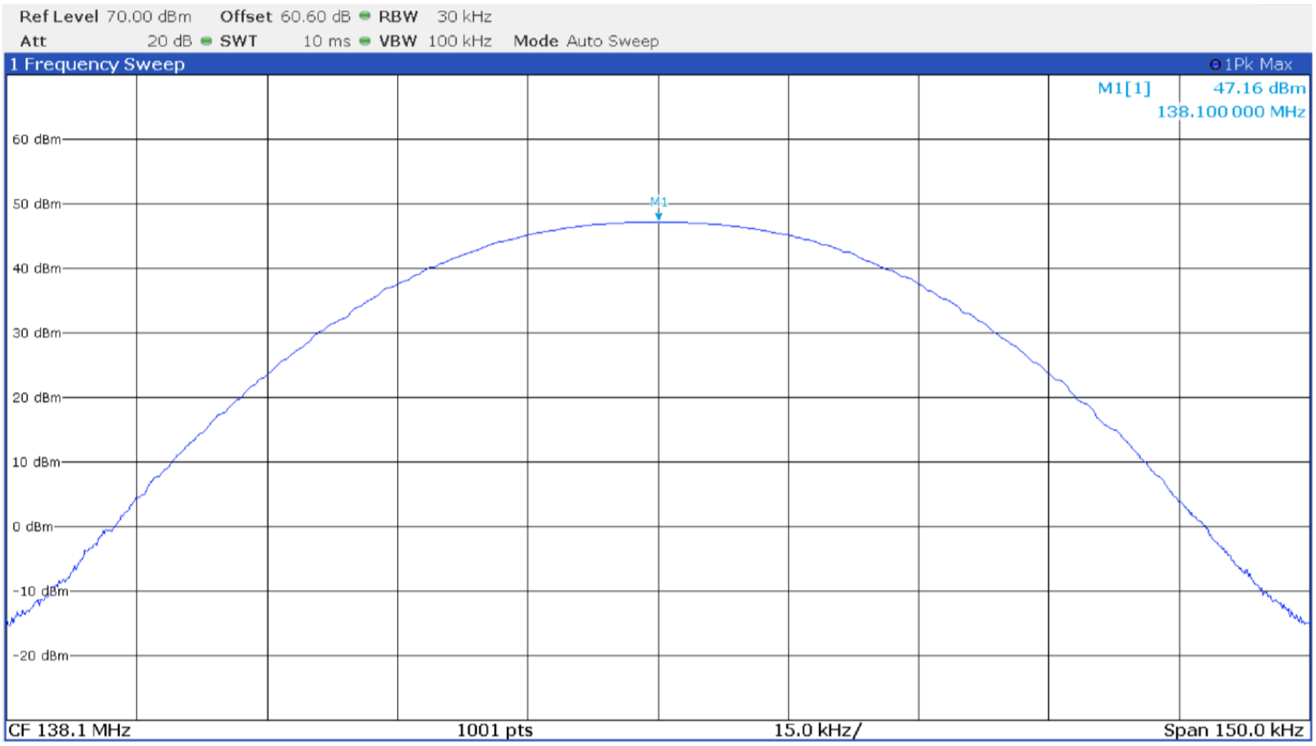
Output power with modulation *FM 25 kHz* at 156.0 MHz

Test data, continued



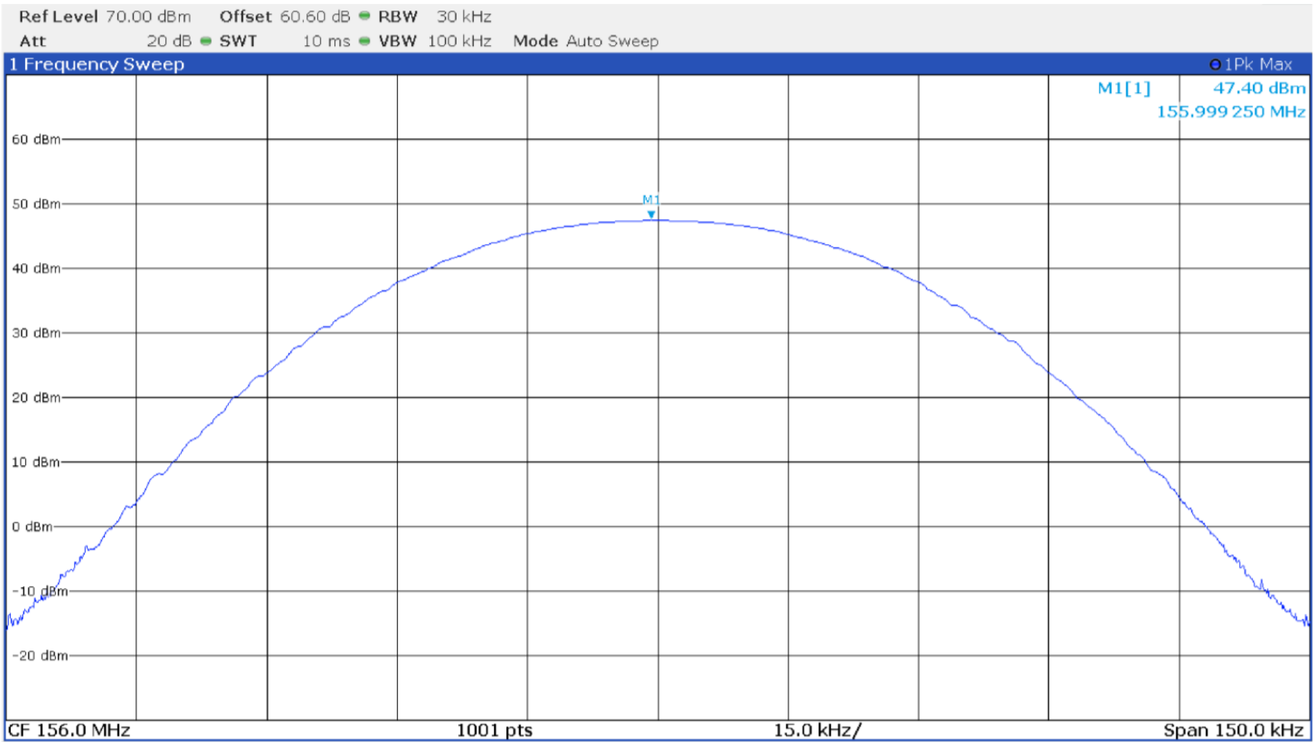
Output power with modulation *FM 25 kHz* at 173.9 MHz

Test data, continued



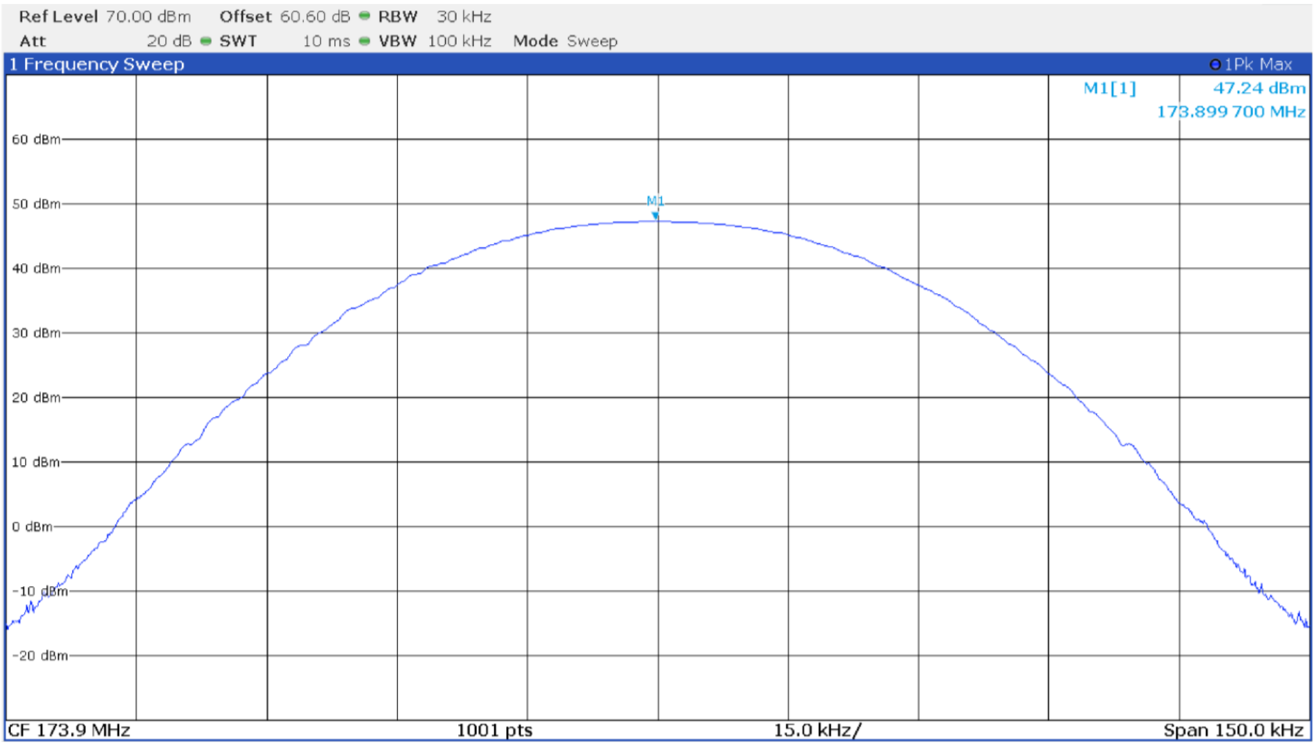
Output power with modulation P25 C4FM at 138.1 MHz

Test data, continued



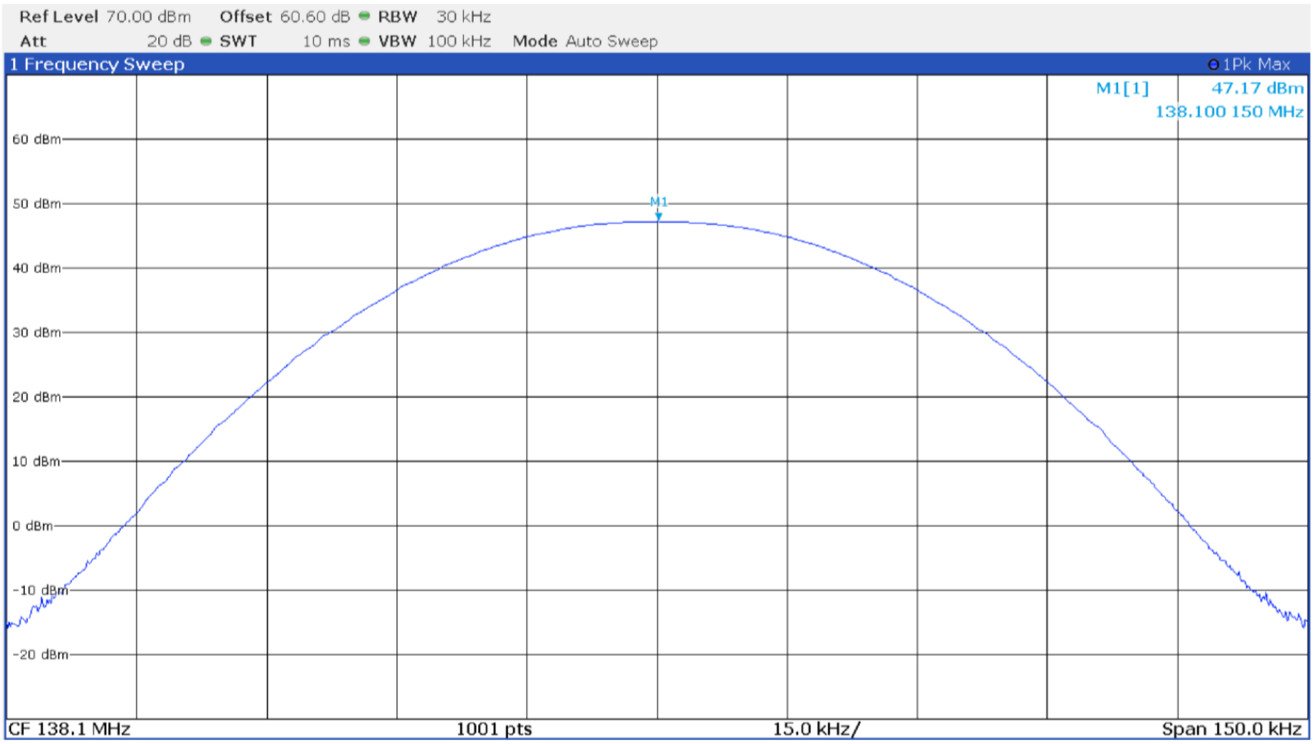
Output power with modulation P25 C4FM at 156.0 MHz

Test data, continued



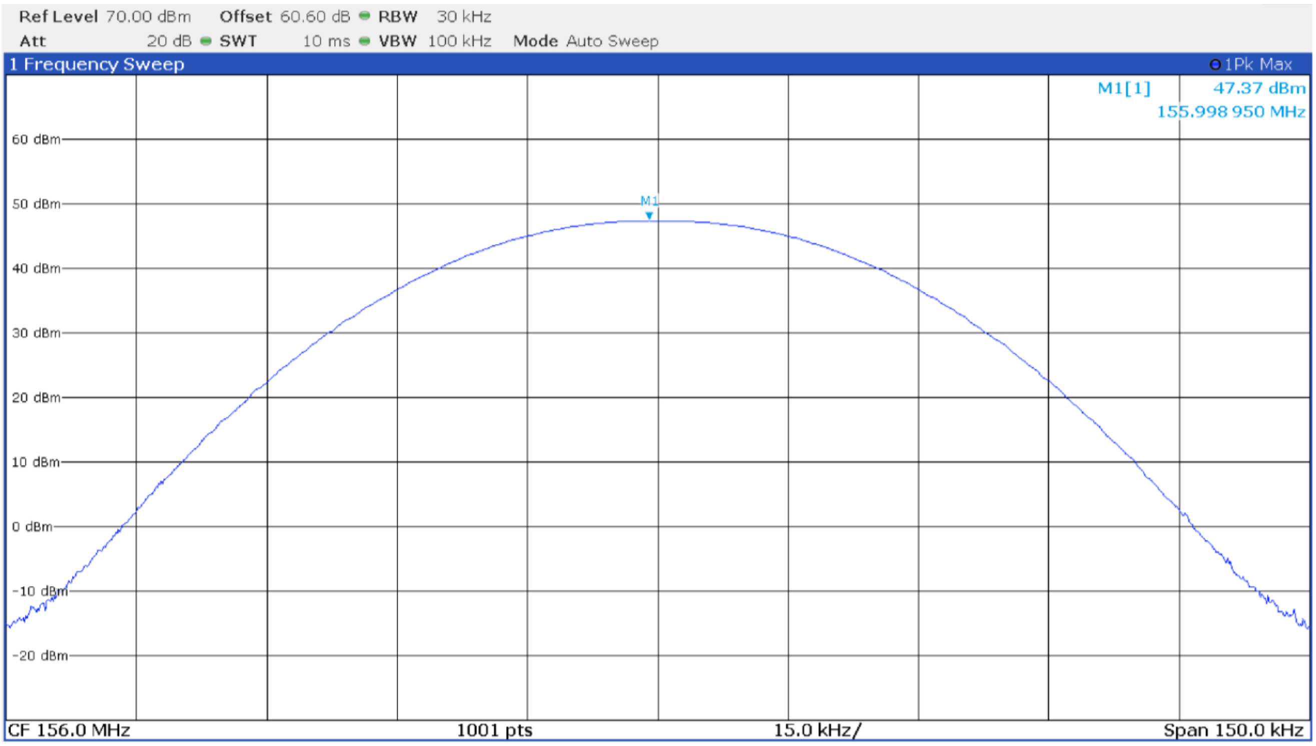
Output power with modulation P25 C4FM at 173.9 MHz

Test data, continued



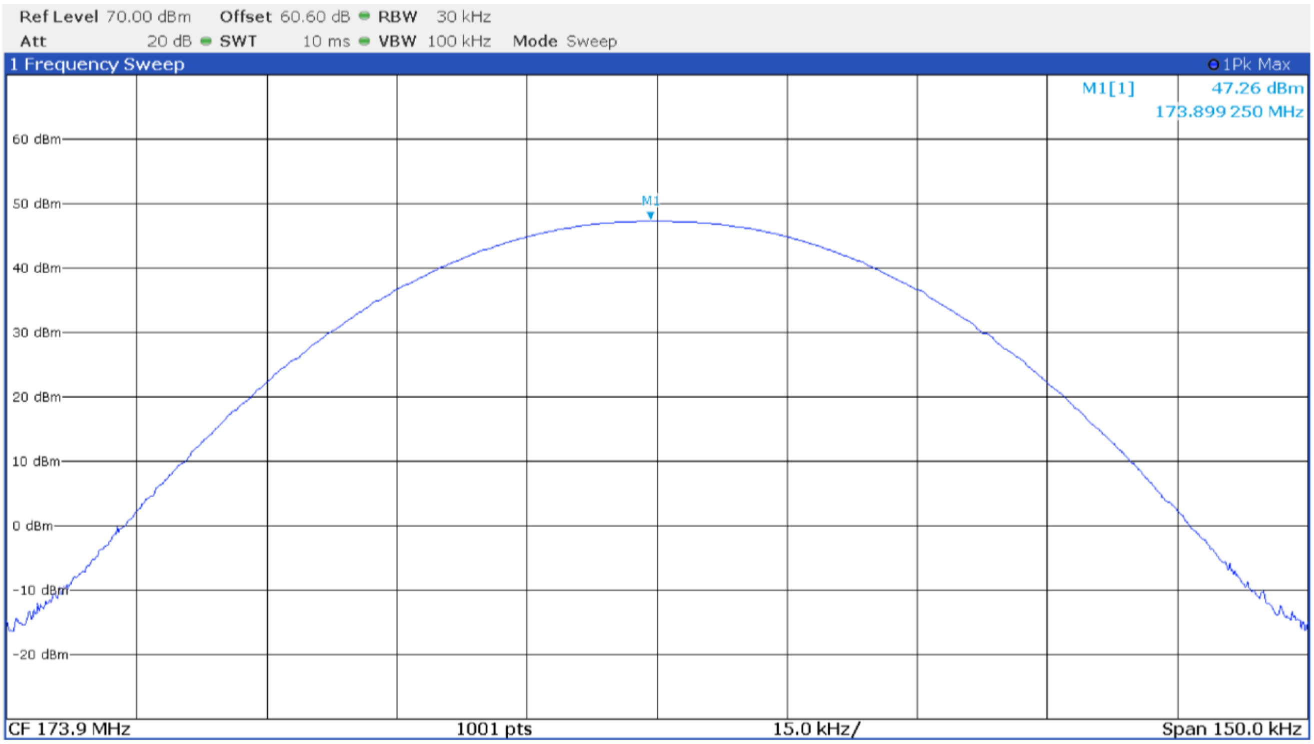
Output power with modulation CST 4FSK at 138.1 MHz

Test data, continued



Output power with modulation CST 4FSK at 156.0 MHz

Test data, continued



Output power with modulation CST 4FSK at 173.9 MHz

7.4 Bandwidth limitations

7.4.1 References, definitions and limits

FCC §90.209:

(b) The maximum authorized single channel bandwidth of emission corresponding to the type of emission specified in §90.207 is as follows:

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

Table 7.4-1: Standard Channel Spacing/Bandwidth

Frequency band, MHz	Channel spacing, kHz	Authorized bandwidth[1], kHz
138 – 174	7.5	20 / 11.25 / 6

Note: [1]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

(6)(i) Beginning January 1, 2011, no new applications for the 421–512 MHz bands will be acceptable for filing if the applicant utilizes channels with an authorized bandwidth exceeding 11.25 kHz, unless specified elsewhere or the operations meet the efficiency standards of §90.203(j)(3).

7.4.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	September 13, 2023

7.4.3 Observations, settings and special notes

The test was performed as per ANSI C63.26, subclause 5.4.4.
Spectrum analyser settings:

Resolution bandwidth	1–5% of OBW
Video bandwidth	≥3 × RBW
Frequency span	1.5 × OBW
Detector mode	Peak
Trace mode	Max Hold

7.4.4 Test equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767	2023-01	2024-01
Shielded room	Siemens	10m control room	1947	NCR	NCR

Note: NCR - no calibration required, VOU - verify on use

7.4.5 Test data

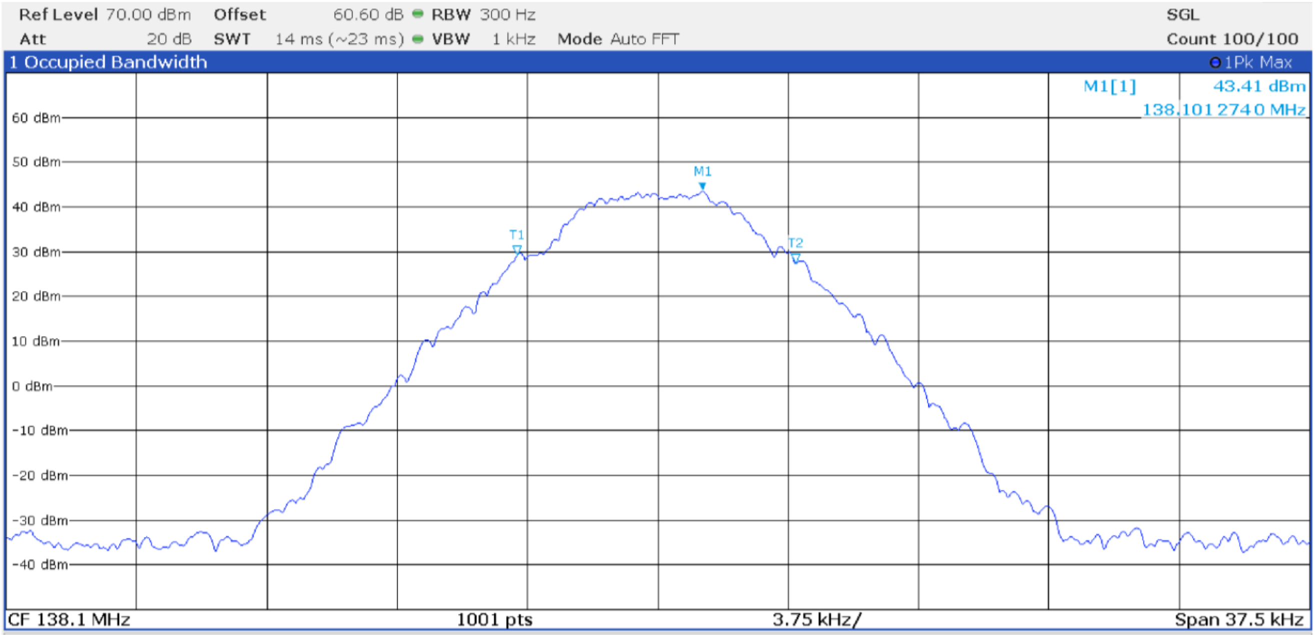
Table 7.4-2: ***99% occupied bandwidth results***

Modulation	Frequency, MHz	99% occupied bandwidth, kHz	Limit, kHz	Margin, kHz
FM 12.5 kHz	138.1	5.38	11.25	-5.87
FM 25.0 kHz	138.1	10.27	20.00	-9.73
DMR 4FSK	138.1	8.01	11.25	-3.24
P25 C4FM	138.1	8.61	11.25	-2.64
CST 4FSK	138.1	6.21	11.25	-5.04

Modulation	Frequency, MHz	99% occupied bandwidth, kHz	Limit, kHz	Margin, kHz
FM 12.5 kHz	156.0	5.38	11.25	-5.87
FM 25.0 kHz	156.0	10.27	20.00	-9.73
DMR 4FSK	156.0	7.77	11.25	-3.48
P25 C4FM	156.0	8.20	11.25	-3.05
CST 4FSK	156.0	6.25	11.25	-5.00

Modulation	Frequency, MHz	99% occupied bandwidth, kHz	Limit, kHz	Margin, kHz
FM 12.5 kHz	173.9	5.39	11.25	-5.86
FM 25.0 kHz	173.9	10.25	20.00	-9.75
DMR 4FSK	173.9	7.96	11.25	-3.29
P25 C4FM	173.9	8.21	11.25	-3.04
CST 4FSK	173.9	6.05	11.25	-5.2

Test data, continued

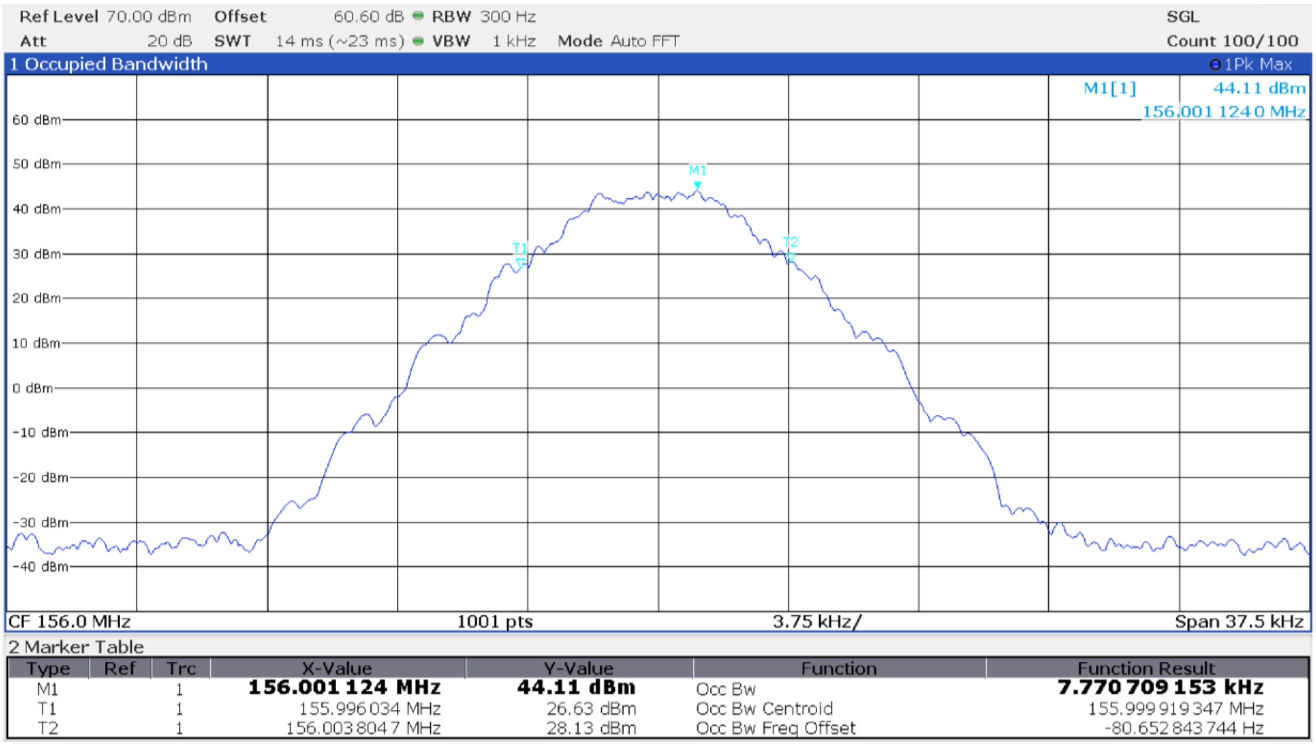


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**138.101 274 MHz**	**43.41 dBm**	Occ Bw	**8.014 200 33 kHz**
T1		1	138.095 956 2 MHz	29.29 dBm	Occ Bw Centroid	138.099 963 327 MHz
T2		1	138.103 970 4 MHz	27.42 dBm	Occ Bw Freq Offset	-36.672 943 83 Hz

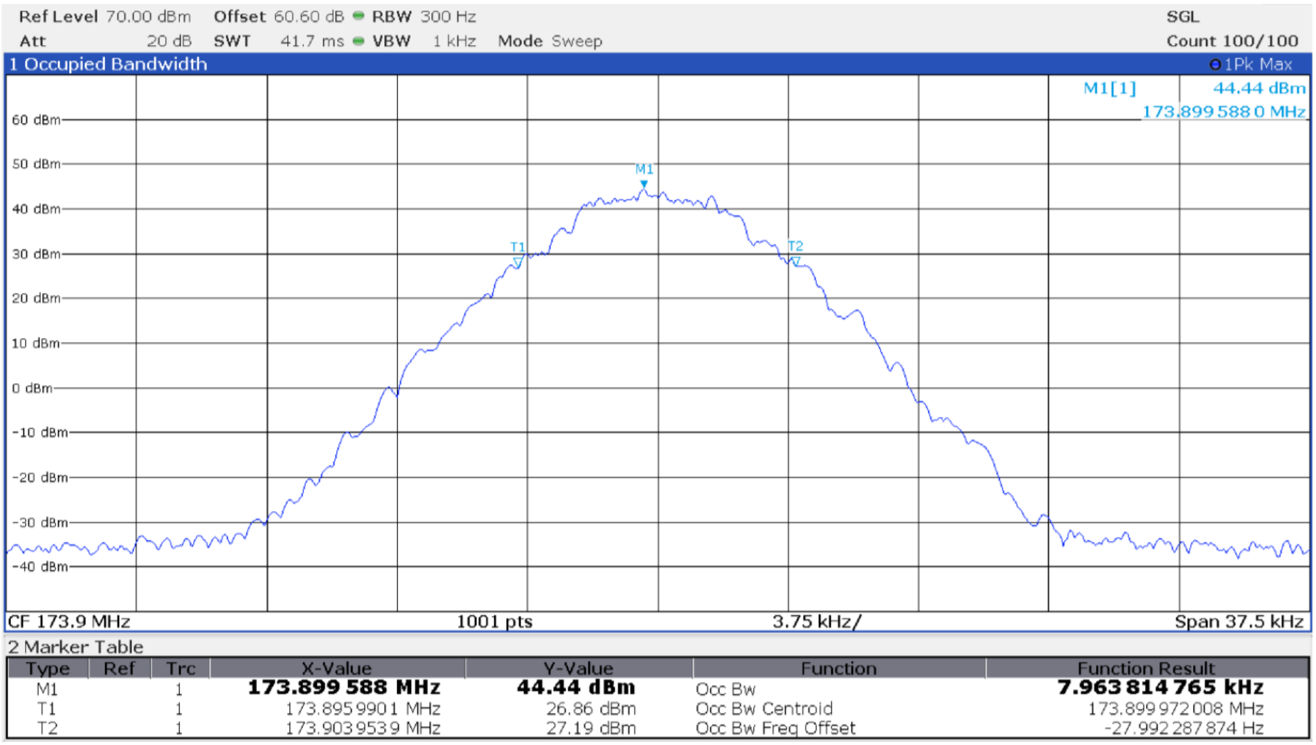
99% occupied bandwidth with modulation DMR 4FSK at 138.1 MHz

Test data, continued



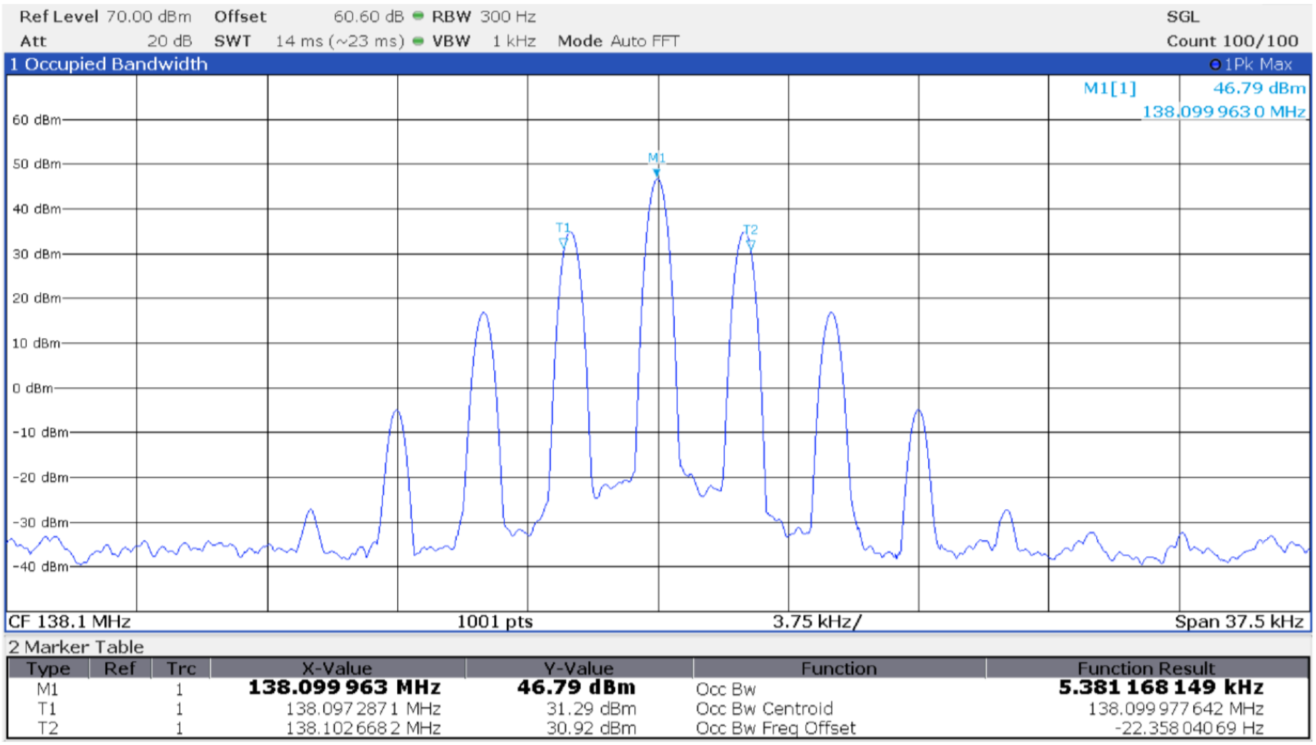
99% occupied bandwidth with modulation DMR 4FSK at 156.0 MHz

Test data, continued



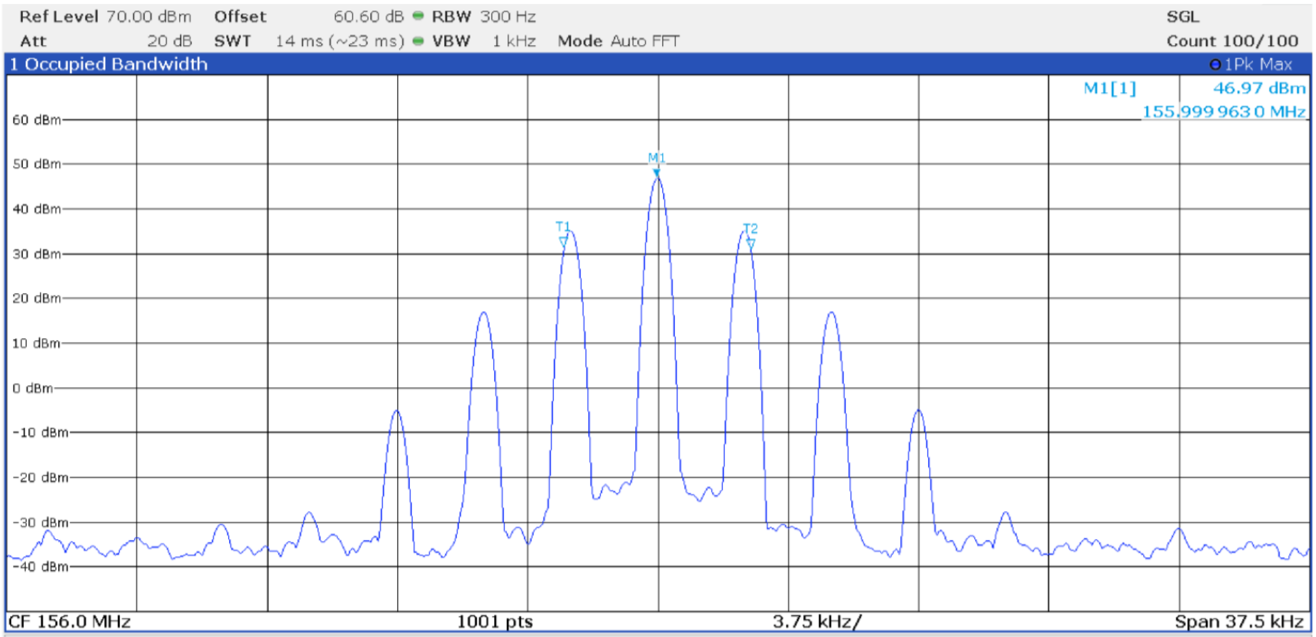
99% occupied bandwidth with modulation DMR 4FSK at 173.9 MHz

Test data, continued



99% occupied bandwidth with modulation FM 12.5 kHz at 138.1 MHz

Test data, continued

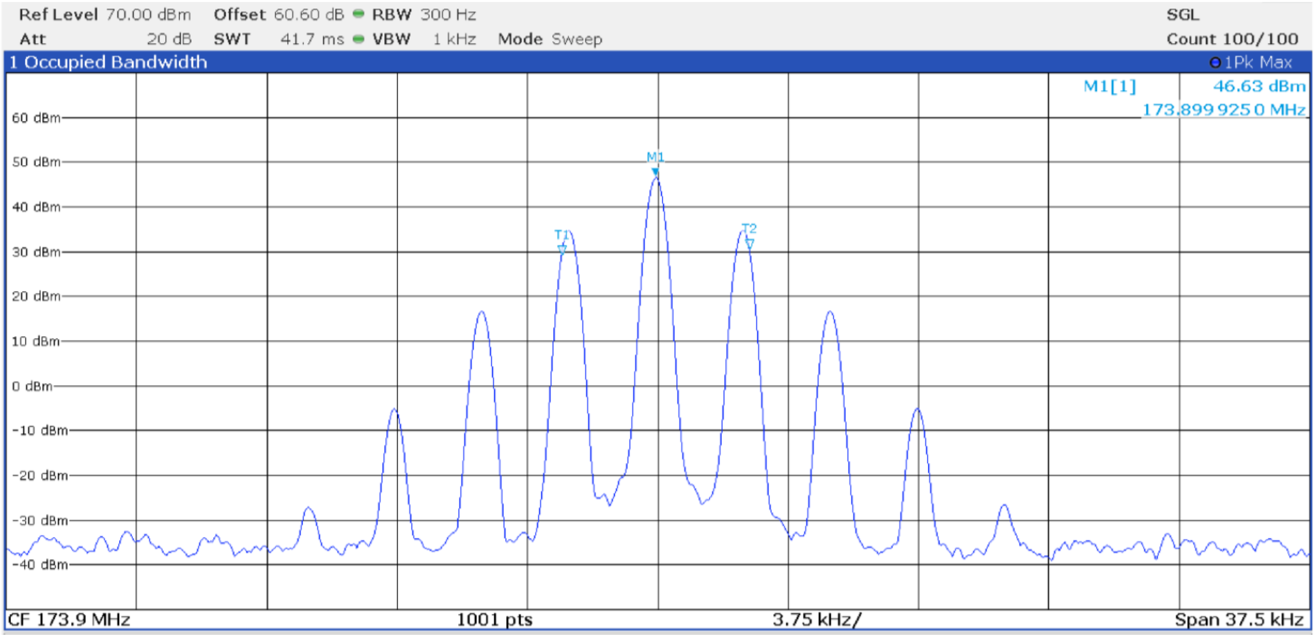


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**155.999 963 MHz**	**46.97 dBm**	Occ Bw	**5.380 751 838 kHz**
T1		1	155.997 287 7 MHz	31.45 dBm	Occ Bw Centroid	155.999 978 116 MHz
T2		1	156.002 668 5 MHz	31.13 dBm	Occ Bw Freq Offset	-21.884 151 638 Hz

99% occupied bandwidth with modulation FM 12.5 kHz at 156.0 MHz

Test data, continued

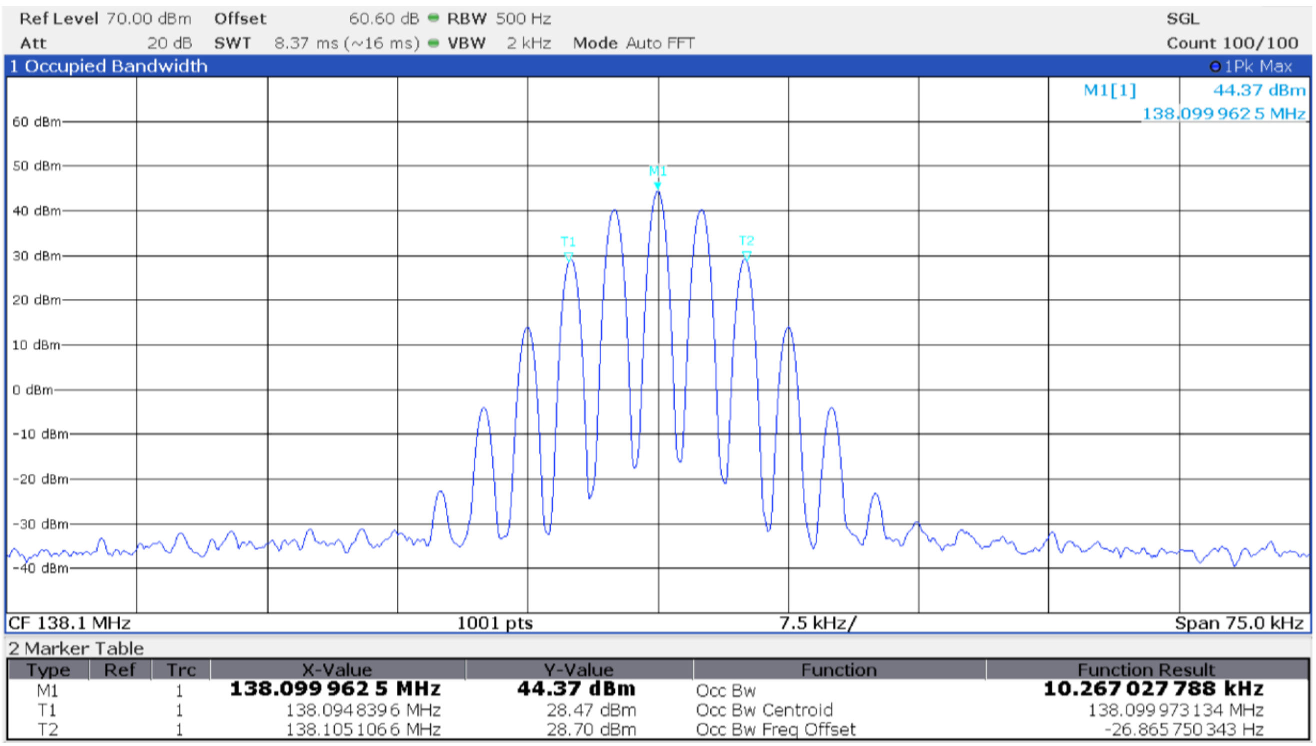


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**173.899 925 MHz**	**46.63 dBm**	Occ Bw	**5.388 810 603 kHz**
T1		1	173.897 244 3 MHz	29.26 dBm	Occ Bw Centroid	173.899 938 702 MHz
T2		1	173.902 633 1 MHz	30.61 dBm	Occ Bw Freq Offset	-61.297 551 572 Hz

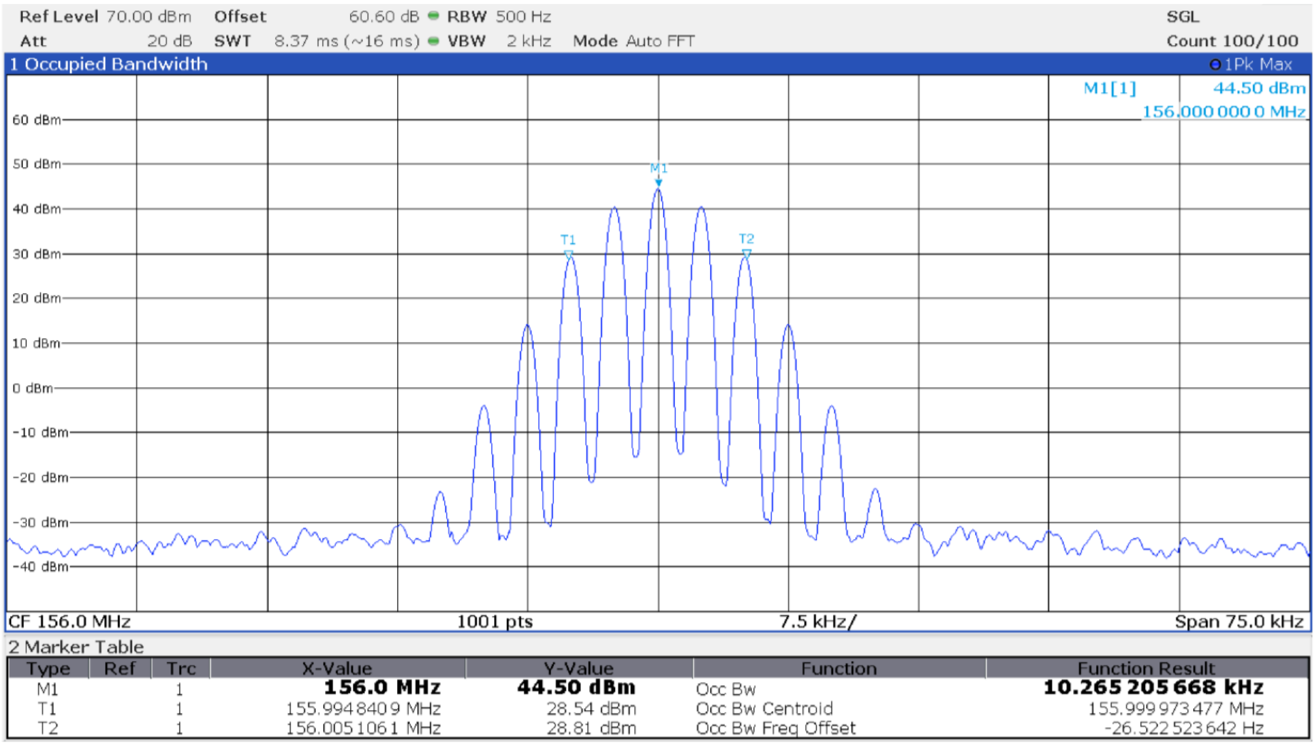
99% occupied bandwidth with modulation FM 12.5 kHz at 173.9 MHz

Test data, continued



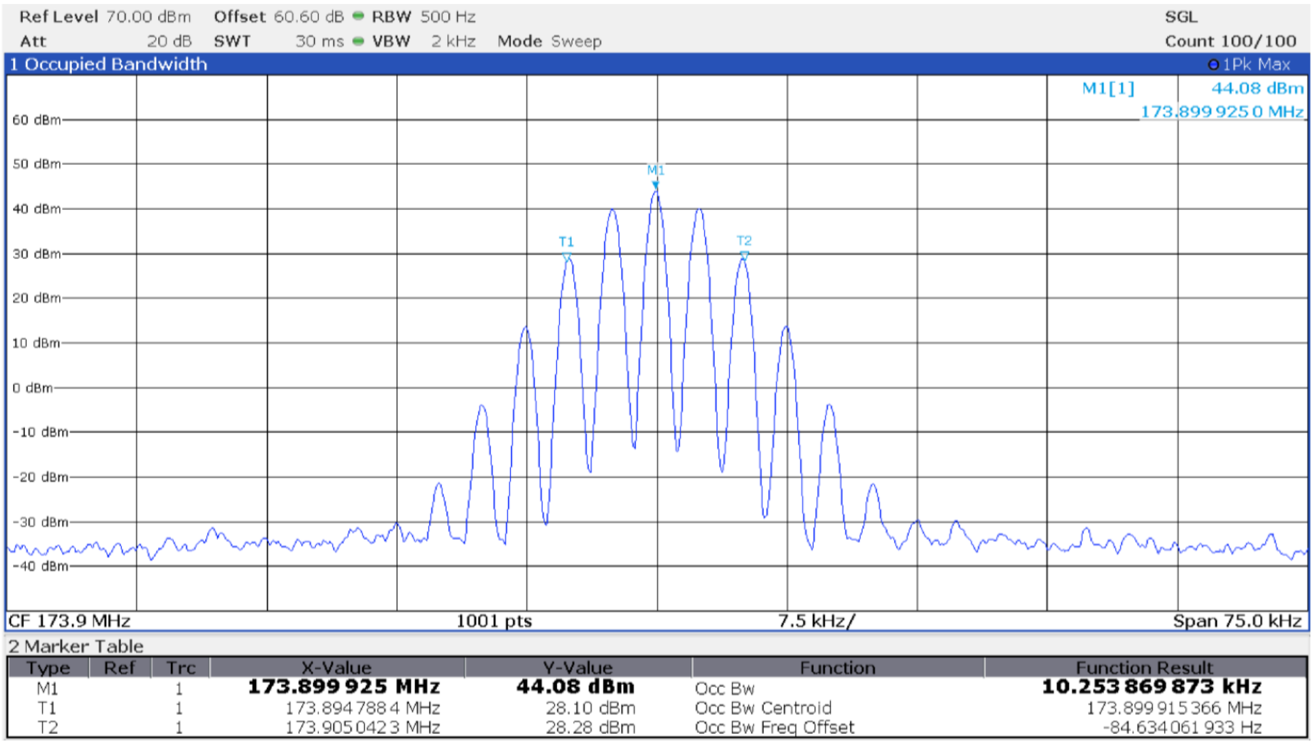
99% occupied bandwidth with modulation FM 25.0 kHz at 138.1 MHz

Test data, continued



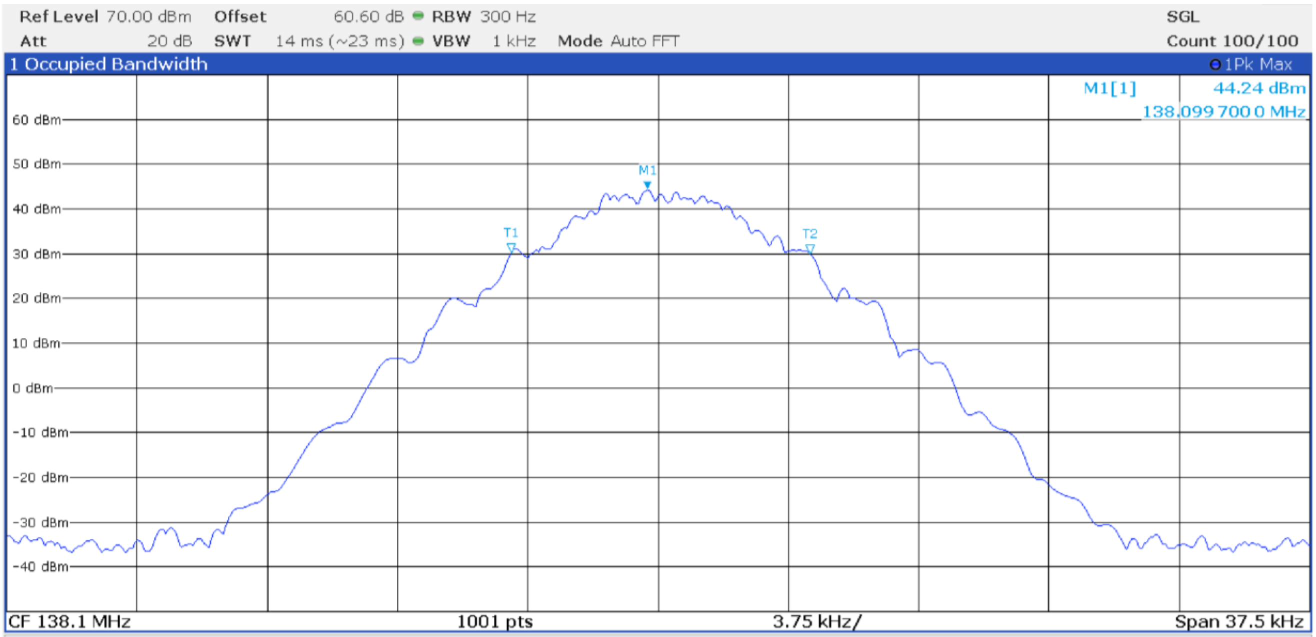
99% occupied bandwidth with modulation FM 25.0 kHz at 156.0 MHz

Test data, continued



99% occupied bandwidth with modulation FM 25.0 kHz at 173.9 MHz

Test data, continued

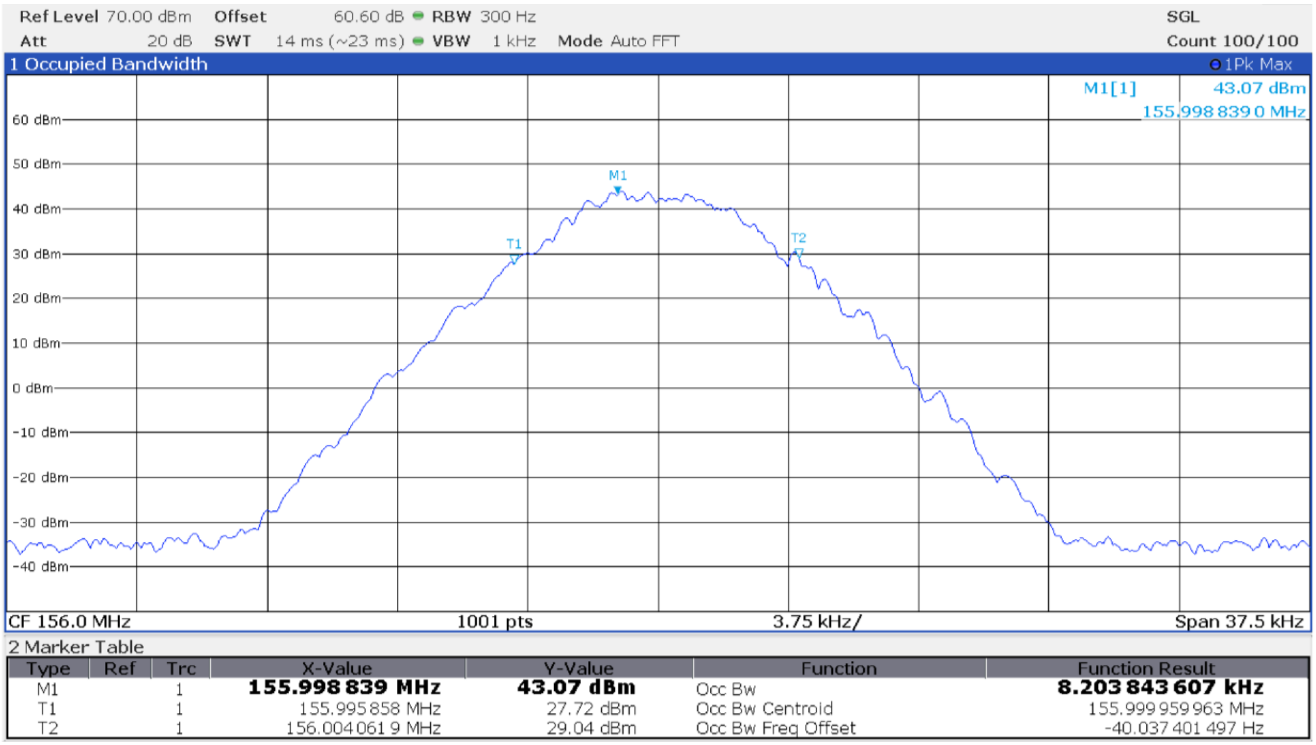


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**138.099 7 MHz**	**44.24 dBm**	Occ Bw	**8.613 878 897 kHz**
T1		1	138.095 771 7 MHz	30.22 dBm	Occ Bw Centroid	138.100 078 651 MHz
T2		1	138.104 385 6 MHz	29.94 dBm	Occ Bw Freq Offset	78.650 556 684 Hz

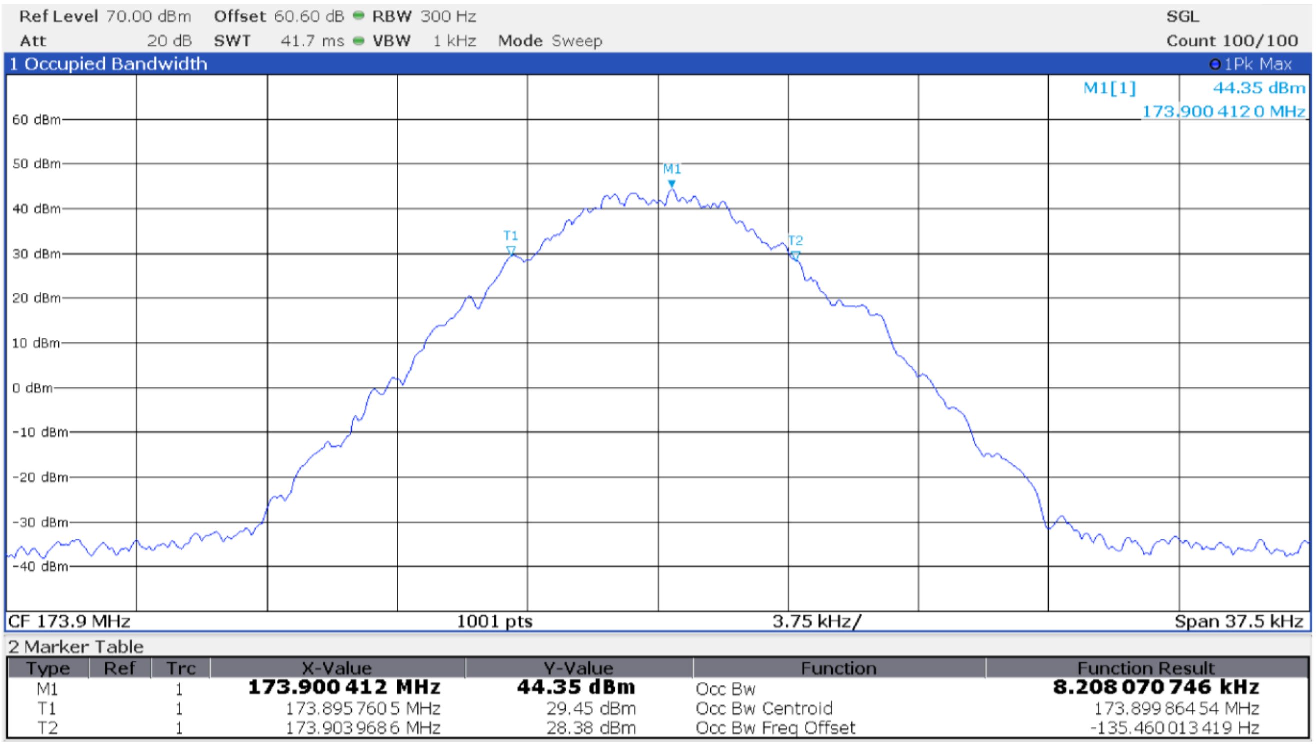
99% occupied bandwidth with modulation P25 C4FM at 138.1 MHz

Test data, continued



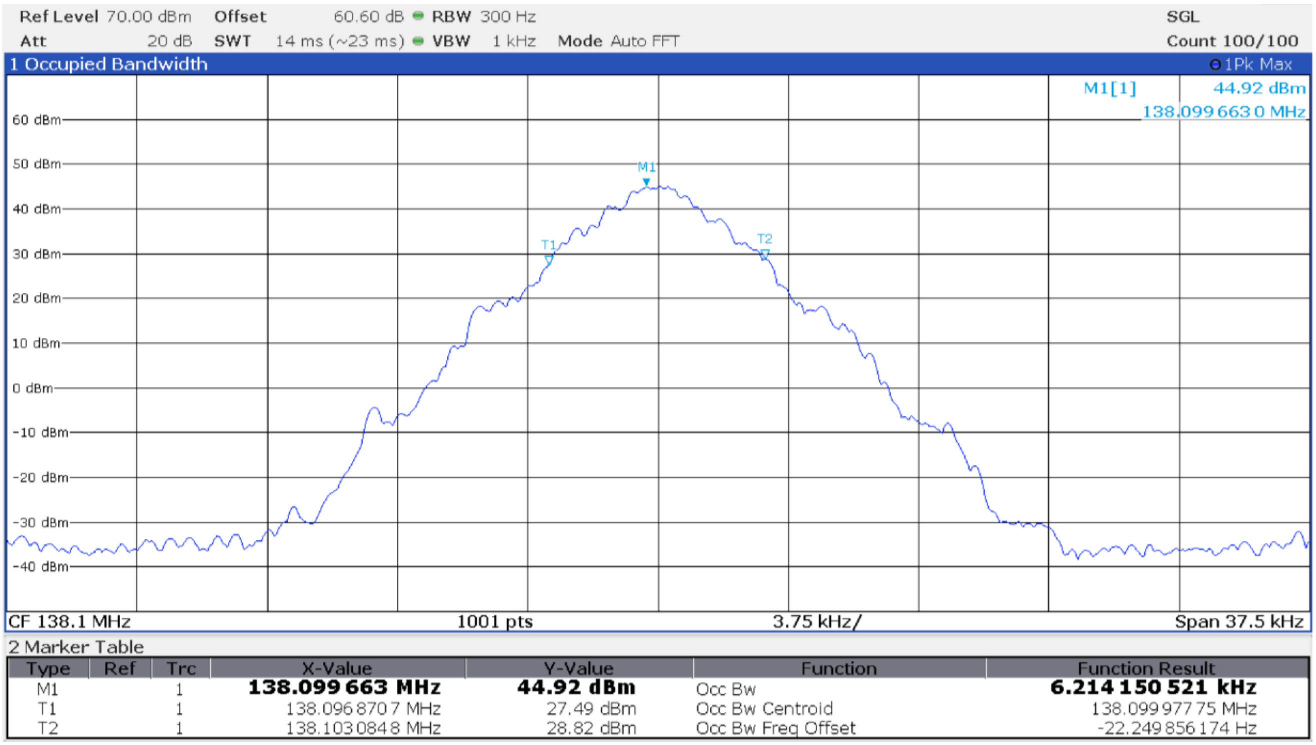
99% occupied bandwidth with modulation P25 C4FM at 156.0 MHz

Test data, continued



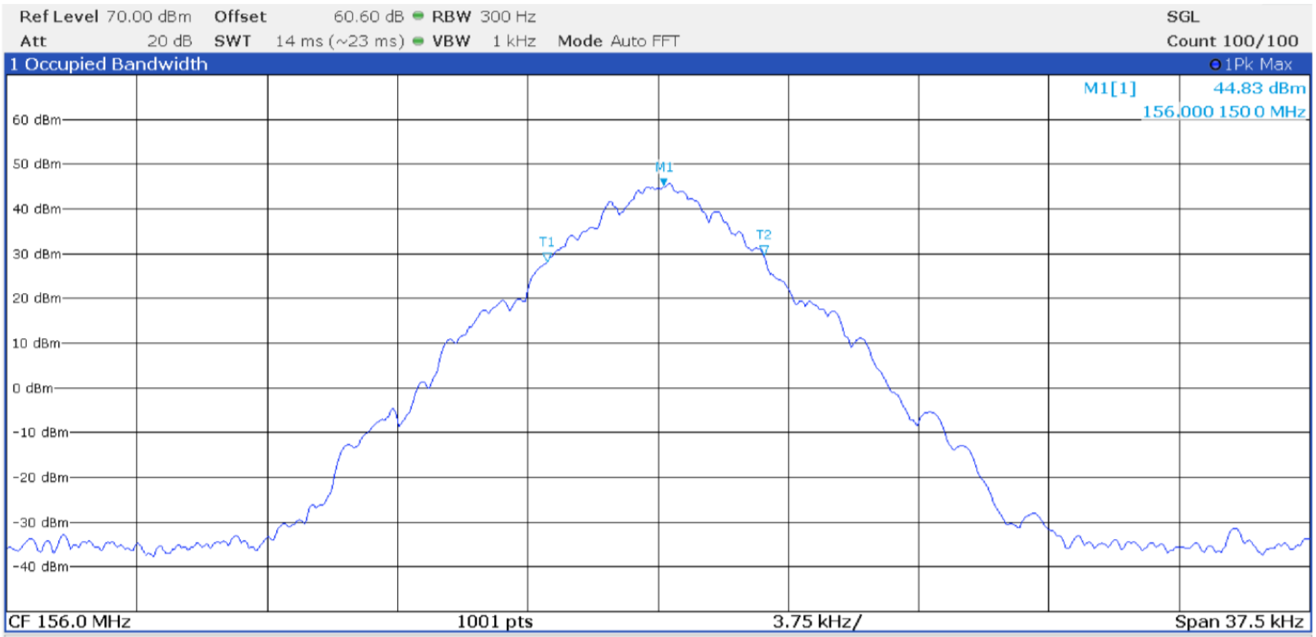
99% occupied bandwidth with modulation P25 C4FM at 173.9 MHz

Test data, continued



99% occupied bandwidth with modulation CST 4FSK at 138.1 MHz

Test data, continued

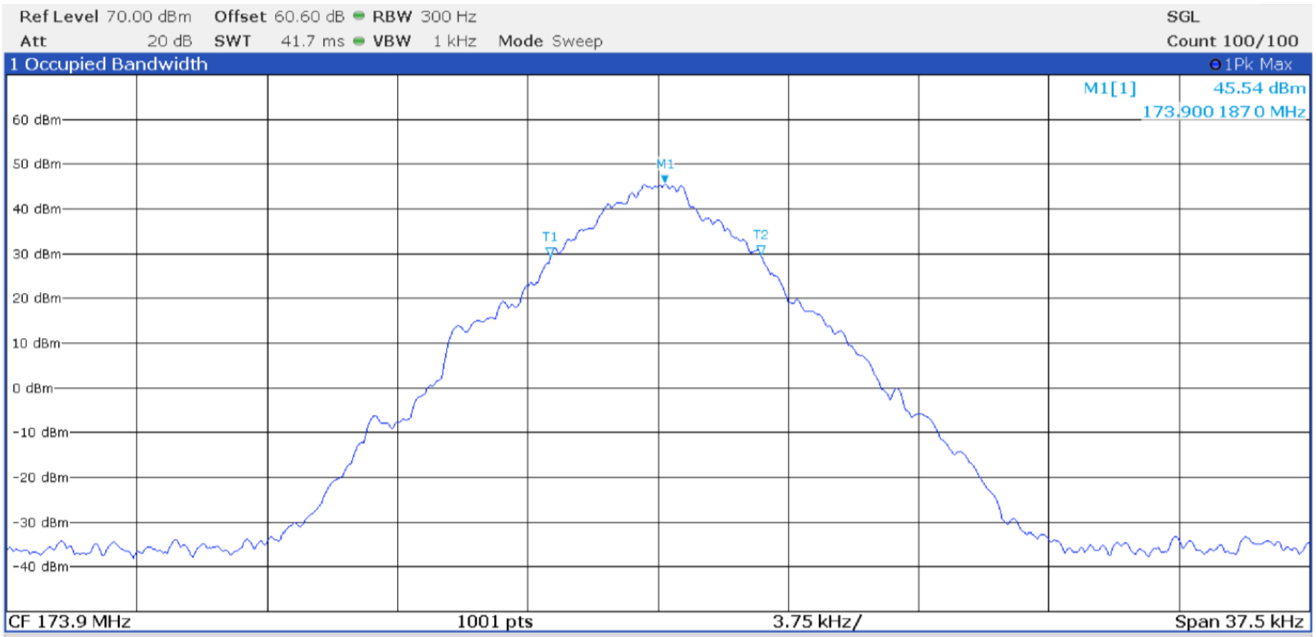


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**156.000 15 MHz**	**44.83 dBm**	Occ Bw	**6.245 494 313 kHz**
T1		1	155.996 796 5 MHz	28.00 dBm	Occ Bw Centroid	155.999 919 22 MHz
T2		1	156.003 042 MHz	29.63 dBm	Occ Bw Freq Offset	-80.779 521 614 Hz

99% occupied bandwidth with modulation CST 4FSK at 156.0 MHz

Test data, continued



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**173.900 187 MHz**	**45.54 dBm**	Occ Bw	**6.048 261 146 kHz**
T1		1	173.896 904 2 MHz	29.16 dBm	Occ Bw Centroid	173.899 928 291 MHz
T2		1	173.902 952 4 MHz	29.72 dBm	Occ Bw Freq Offset	-71.708 907 366 Hz

99% occupied bandwidth with modulation CST 4FSK at 173.9 MHz

7.5 Spectrum mask and spurious emissions

7.5.1 References, definitions and limits

FCC §90.210:

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.

Table 7.5-1: Applicable Emission Masks

Frequency band, MHz	Mask for equipment with audio low pass filter	Mask for equipment with audio low pass filter
150–174[,2]	B, D, or E	C, D, or E

Notes: [1]Equipment designed to operate with a 25 kHz channel bandwidth must meet the requirements of Emission Mask B or C, as applicable. Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D, and equipment designed to operate with a 6.25 kHz channel bandwidth must meet the requirements of Emission Mask E.

[2]Equipment designed to operate on 25 kilohertz bandwidth channels must meet the requirements of either Emission Mask B or G, whichever is applicable, while equipment designed to operate on 12.5 kilohertz bandwidth channels must meet the requirements of Emission Mask D. Equipment designed to operate on 25 kilohertz bandwidth channels may alternatively meet the Adjacent Channel Power limits of §90.221.

(b) **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.

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

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (f_d/5) dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least 29 log (f_d^2/11) dB or 50 dB, whichever is the lesser attenuation;

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

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

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

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(f_d−2.88 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.

References, definitions and limits, continued

FCC §90.210:

(e) **Emission Mask E**—6.25 kHz or less channel bandwidth equipment. For transmitters designed to operate with a 6.25 kHz or less 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 3.0 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 3.0 kHz but no more than 4.6 kHz: At least 30 + 16.67(f_d−3 kHz) or 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.

(3) On any frequency removed from the center of the authorized bandwidth by more than 4.6 kHz: At least 55 + 10 log (P) or 65 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.

FCC §22.359:

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.

7.5.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	September 13 to 15, 2023

7.5.3 Observations, settings and special notes

Spectrum analyser settings for spectrum mask:

Resolution bandwidth:	100 Hz / 300 Hz
Video bandwidth:	> RBW
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for spurious emissions:

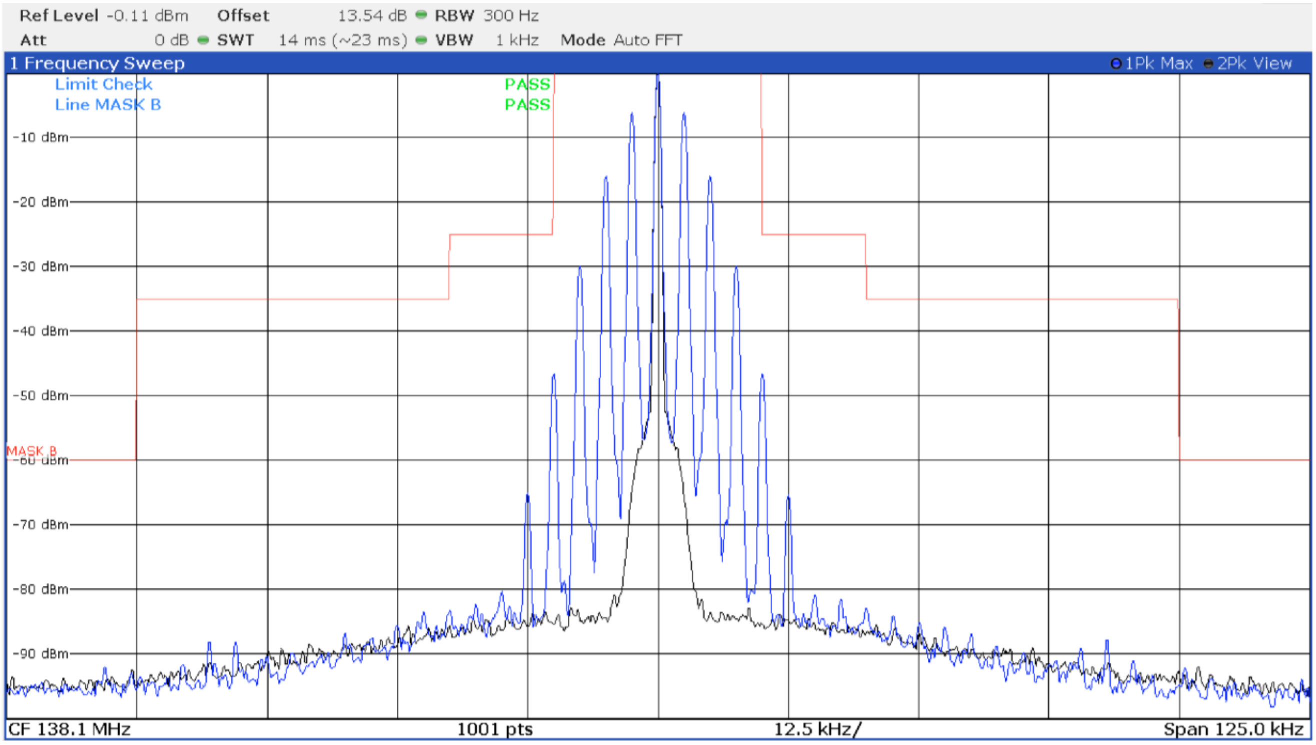
Resolution bandwidth:	100k Hz (below 1 GHz); 1 MHz (above 1 GHz)
Video bandwidth:	> RBW
Detector mode:	Peak
Trace mode:	Max Hold

7.5.4 Test equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Receiver	Rohde & Schwarz	ESU8	100202	2022-09	2023-09
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767	2023-01	2024-01
Trilog Broadband Antenna	Schwarzbeck	VULB 9162	9162-025	2021-07	2024-07
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STLP 9148-152	2021-09	2024-09
Broadband Amplifier	Schwarzbeck Mess-Elektronik	BBV9718C	00121	2023-03	2024-03
Controller	Maturo	FCU3.0	10041	NCR	NCR
Tilt antenna mast	Maturo	TAM4.0-E	10042	NCR	NCR
Turntable	Maturo	TT4.0-5T	2.527	NCR	NCR
Semi-anechoic chamber	Nemko	10m semi-anechoic chamber	530	2021-09	2023-09
Shielded room	Siemens	10m control room	1947	NCR	NCR

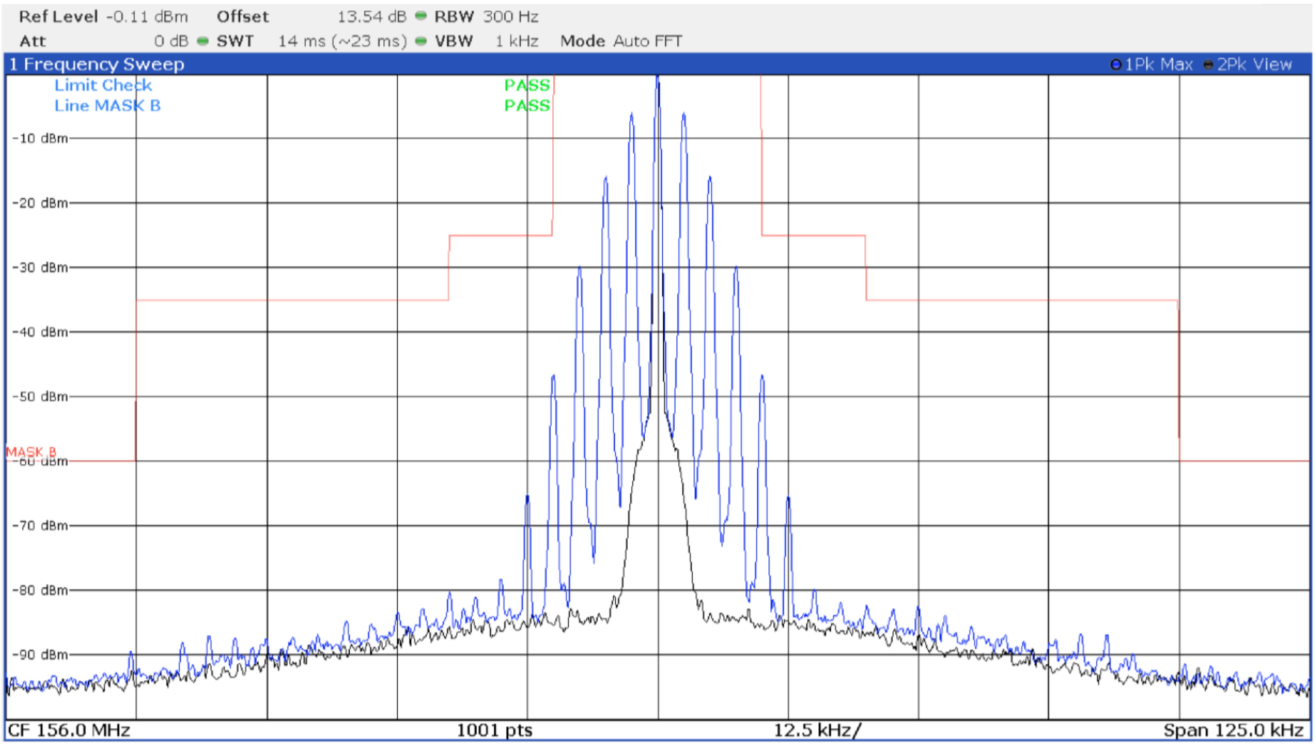
Note: NCR - no calibration required, VOU - verify on use

7.5.5 Test data



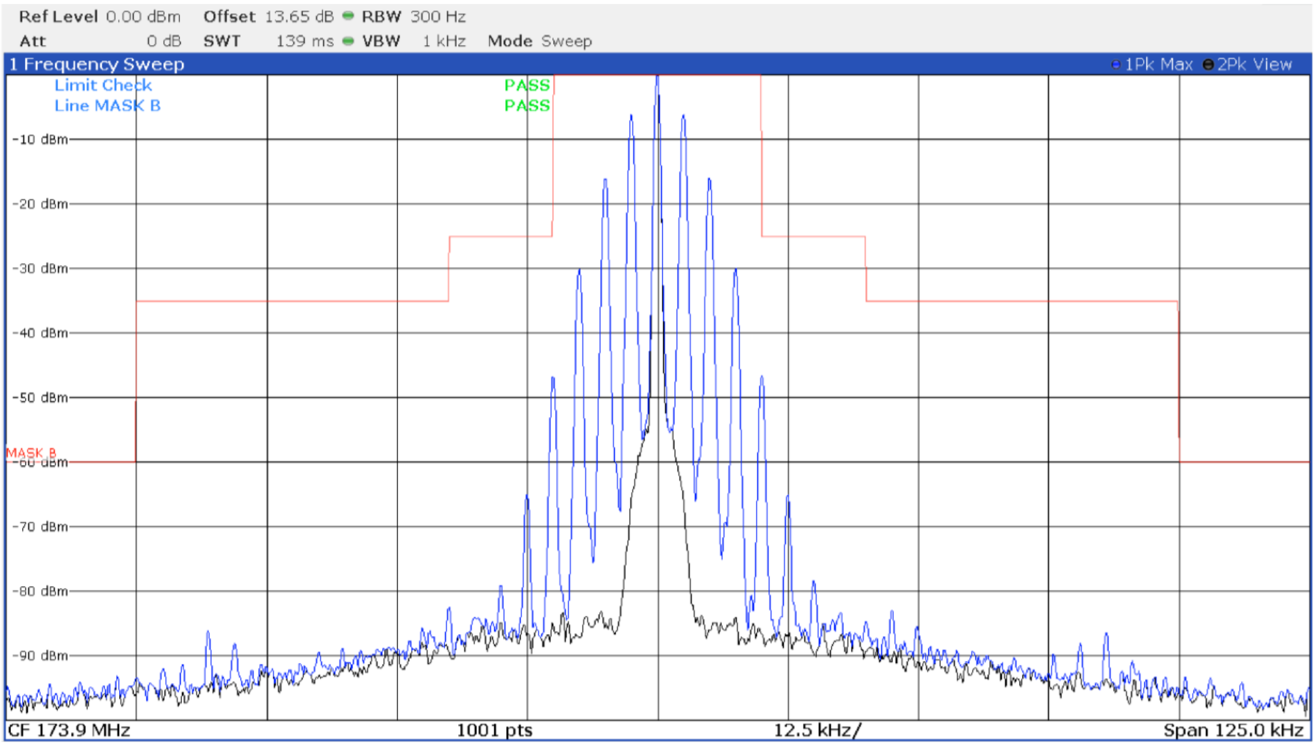
Emission mask B with modulation FM 25.0 kHz at 138.1 MHz

Test data, continued



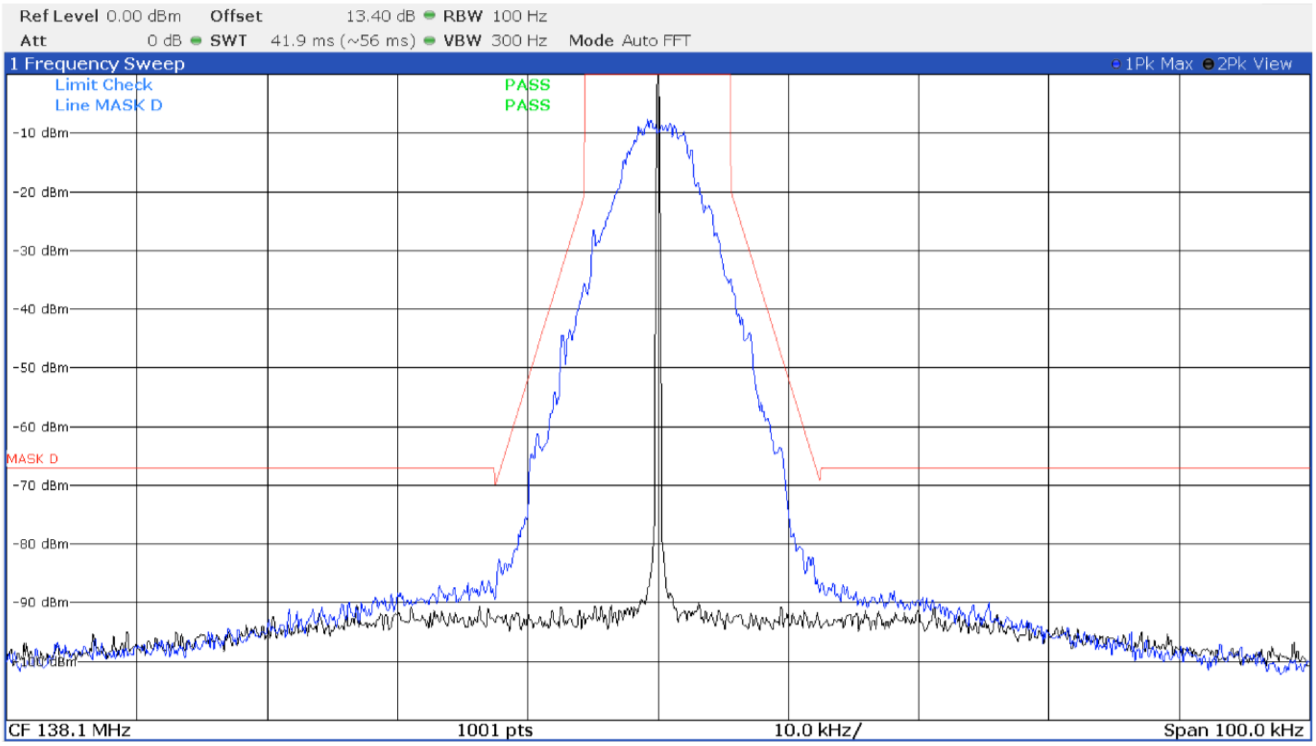
Emission mask B with modulation FM 25.0 kHz at 156.0 MHz

Test data, continued



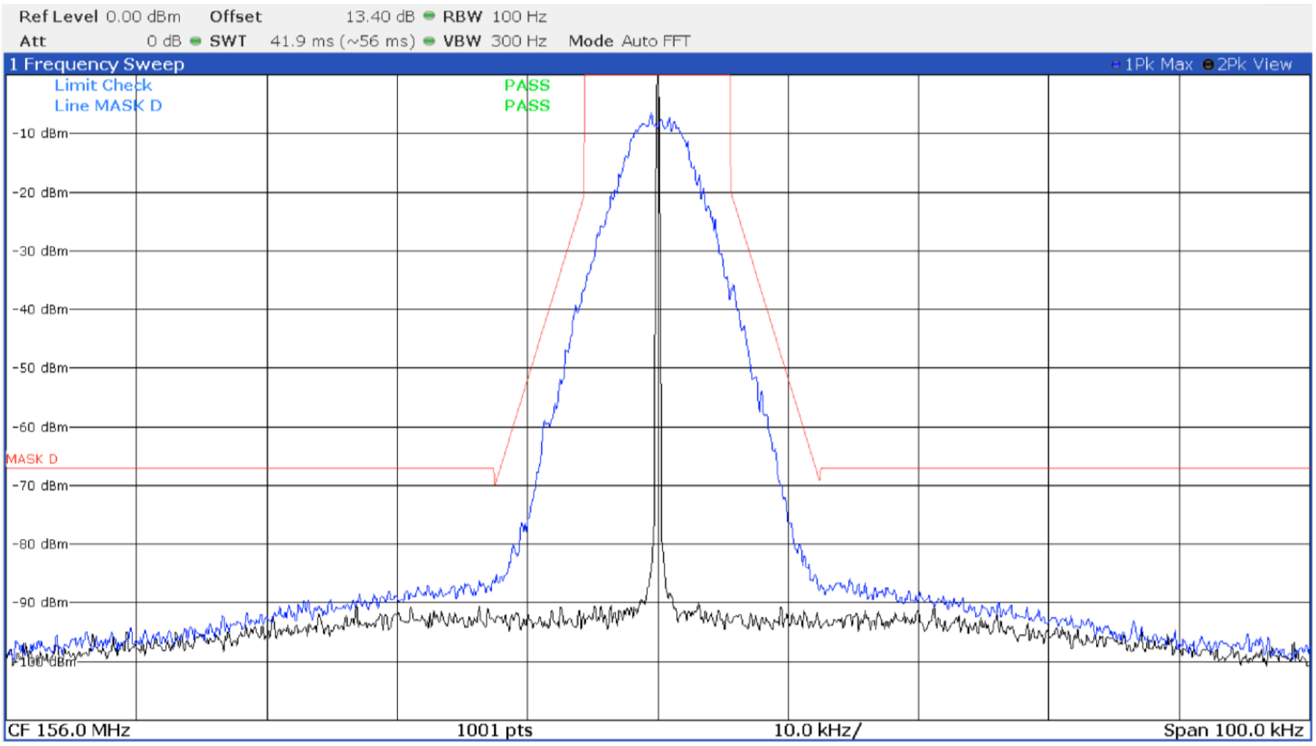
Emission mask B with modulation FM 25.0 kHz at 173.9 MHz

Test data, continued



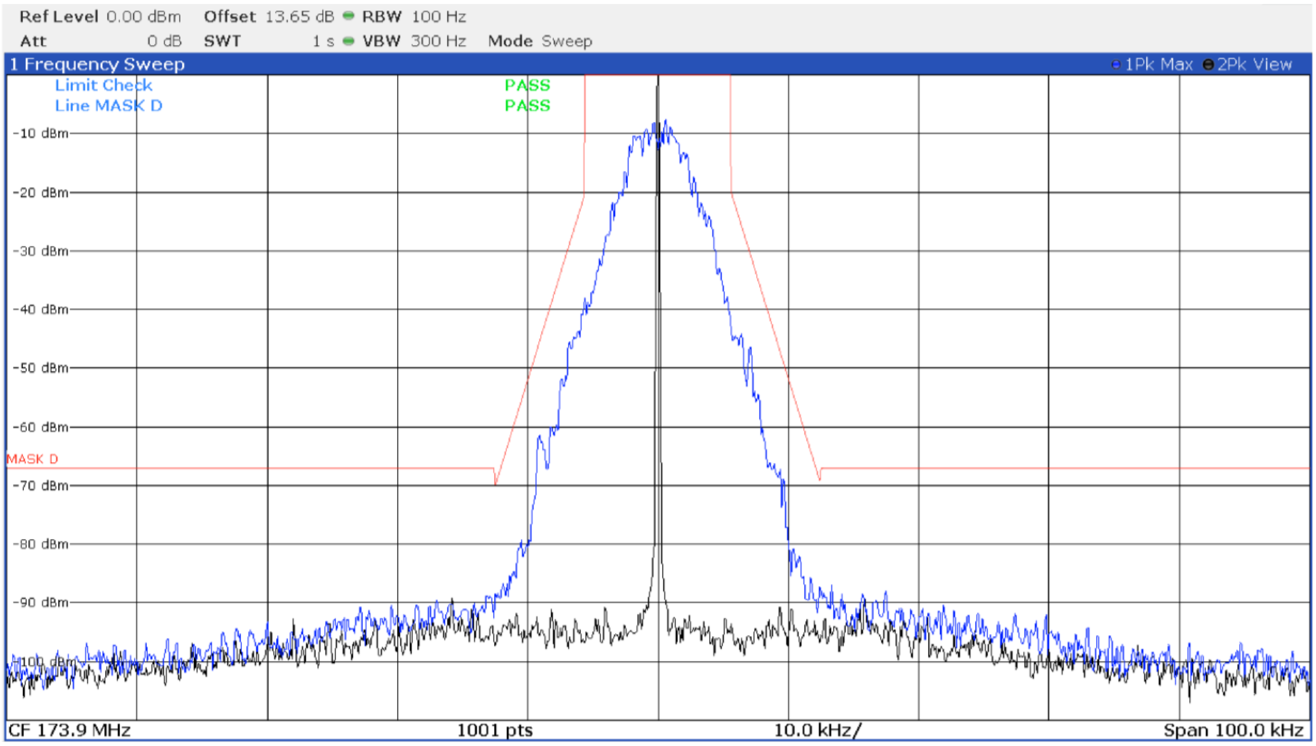
Emission mask D with modulation DMR 4FSK at 138.1 MHz

Test data, continued



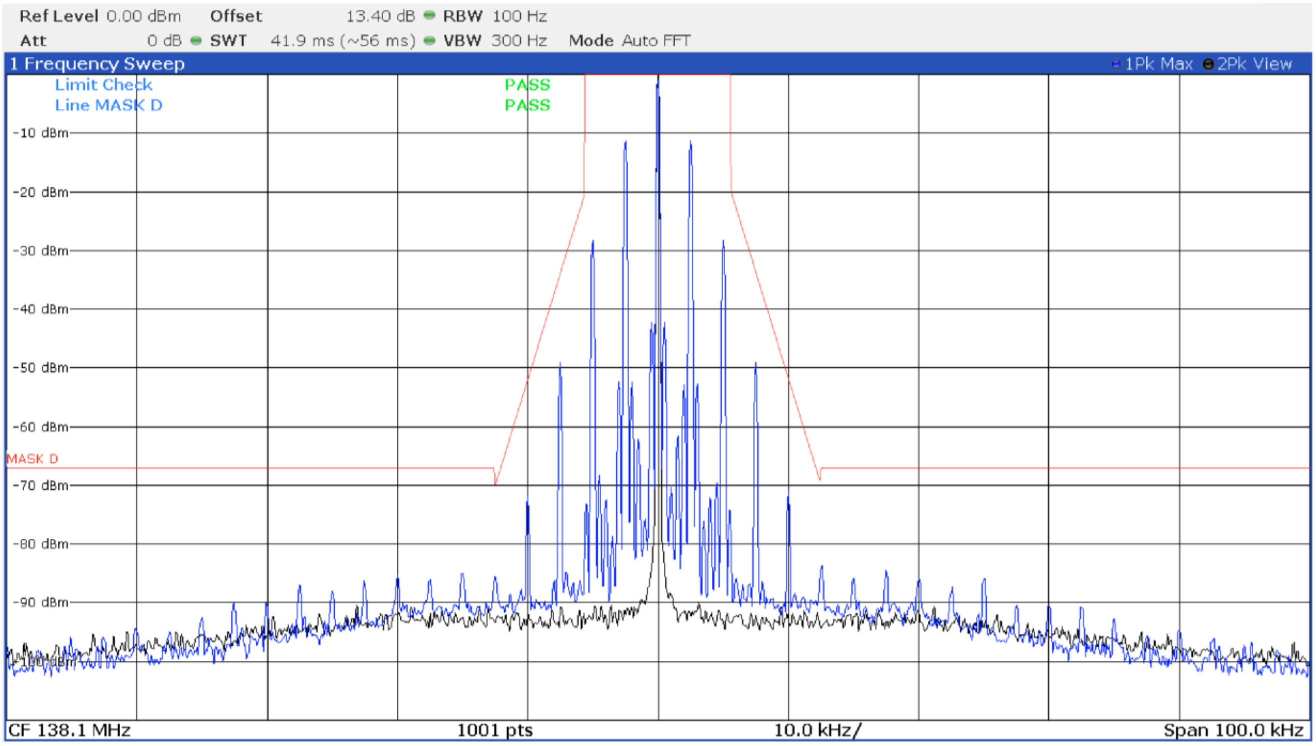
Emission mask D with modulation DMR 4FSK at 156.0 MHz

Test data, continued



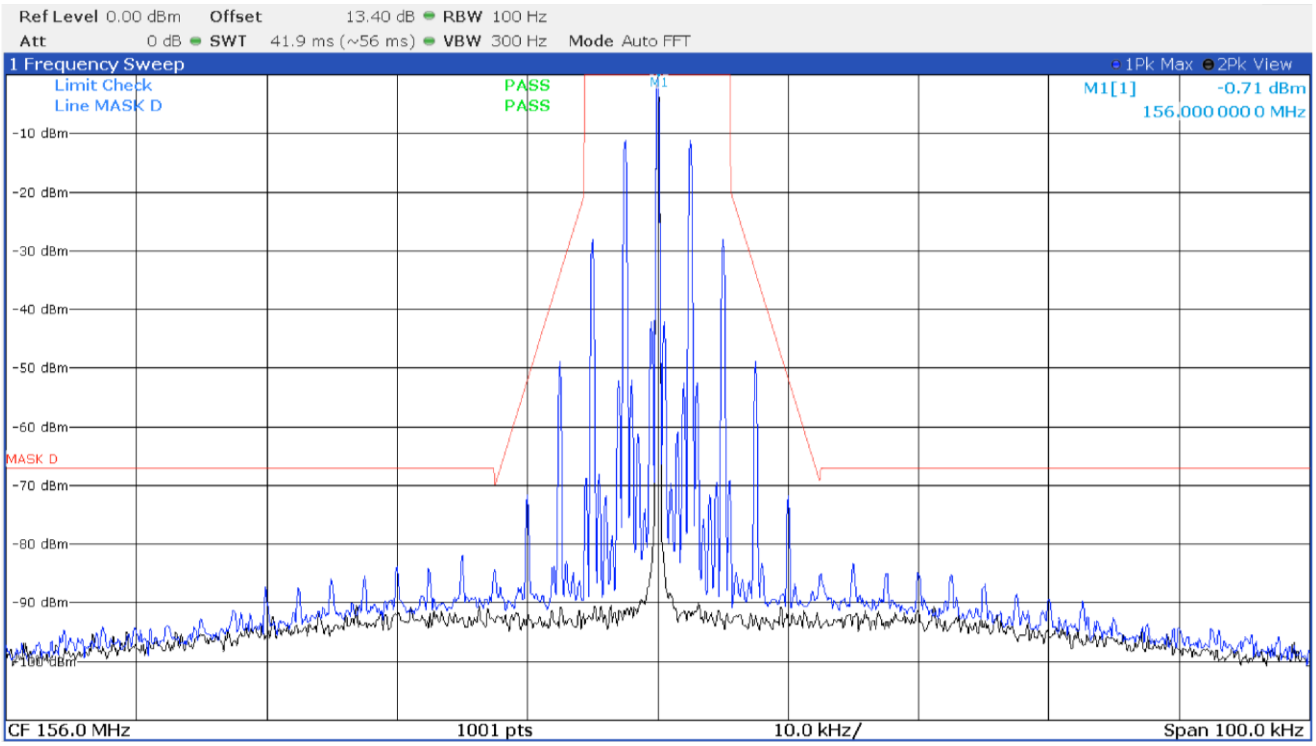
Emission mask D with modulation DMR 4FSK at 173.9 MHz

Test data, continued



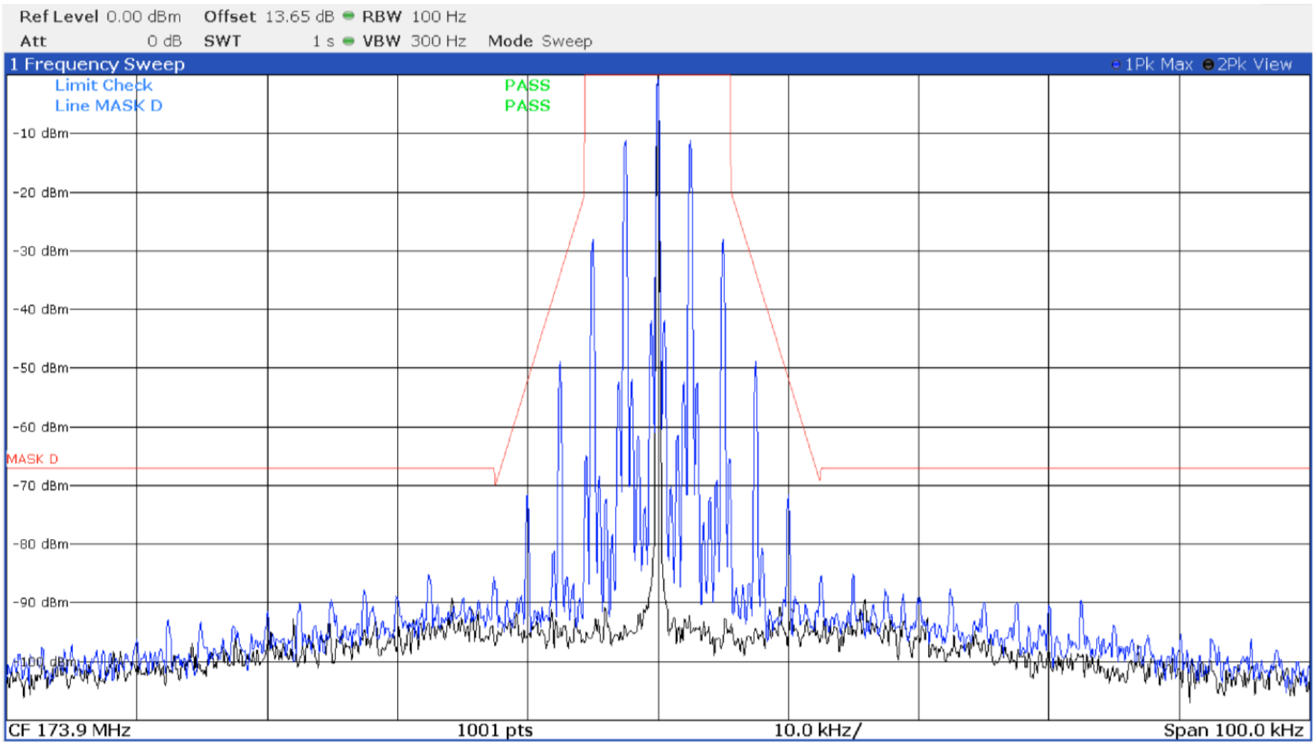
Emission mask D with modulation FM 12.5 kHz at 138.1 MHz

Test data, continued



Emission mask D with modulation FM 12.5 kHz at 156.0 MHz

Test data, continued



Emission mask D with modulation FM 12.5 kHz at 173.9 MHz