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RADIO TEST REPORT – 462197-1TRFWL

Type of assessment:
Final product testing

Applicant:
DAMM Cellular System A/S

Model (HVIN):
10522143, 10522243, 10522145

Product description:
450 MHz band cellular base station

PMN:
BS422 Multi-Tech outdoor Base station

Part numbers (types):
BS422-S, BS422-SP

FCC ID:
Z5W-10522X43

ISED certification number:
IC: 10159A-10522X43

Specifications:

- FCC 47 CFR Part 90, Subpart I
- FCC 47 CFR Part 22, Subpart E
- FCC 47 CFR Part 74, Subpart D
- RSS-119 Issue 12, May 2015.

Date of issue: December 21, 2022

Abdoulaye Ndiaye, EMC/RF Specialist
Tested by

Signature

Kevin Rose, EMC/RF Specialist
Reviewed by

Signature

Lab locations

Company name	Nemko Canada Inc.			
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Test site registration	**Organization**	**Recognition numbers and location**		
	FCC/ISED	FCC: CA2040; IC: 2040A-4 (Ottawa/Almonte); FCC: CA2041; IC: 2040G-5 (Montreal); CA0101 (Cambridge)		
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 Canada's 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 E	Public Mobile Services. Paging and Radiotelephone Service
FCC 47 CFR Part 74, Subpart D	Experimental Radio, Auxiliary, Special Broadcast and Other Program Distributional Services. Remote Pickup Broadcast Stations
RSS-119 Issue 12, May 2015	Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41–960 MHz

1.2 Test methods

ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
RSS-102, Issue 5, March 19, 2015	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
SRSP-501, Issue 5, October 2004	Technical Requirements for Land Mobile and Fixed Radio Services Operating in the Bands 406.1–430 MHz and 450–470 MHz
FCC 47 CFR Part 2, Subpart J	Equipment authorization procedures
RSS-Gen Issue 5, March 2019	General Requirements for Compliance of Radio Apparatus

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
TRF	December 21, 2022	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 Model variant declaration

As declared by the applicant, the EUT model BS422-S has been chosen to be representative for all other models in the model family. The model family, and the description of the variations, are as follows:
The difference between the BS422-S and the BS422-SP is a power supply module on the back of the unit. (P is Power module - for 115 or 230 Vac - which is not related to FCC/ISED)

2.4 Deviations from laboratory tests procedures

The following deviations were made:
As per customer, EUT can be supplied by battery, the switch on voltage is between 45–47 V, and the switch off voltage is between 40–42 V. The maximum supply voltage is 59.9 V. Hence frequency stability was tested for input voltage −48 Vdc (STV), range from −55.2 Vdc (this is 115%STV) to −42 Vdc (this is 87.5%STV rather than 85%).

Section 3 Test conditions

3.1 Atmospheric conditions

Temperature	15 °C – 35 °C
Relative humidity	20 % – 75 %
Air pressure	86 kPa (860 mbar) – 106 kPa (1060 mbar)

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

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

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Table 4.1-1: *Measurement uncertainty calculations for Radio*

Test name	Measurement uncertainty, ±dB
All antenna port measurements	0.55
Occupied bandwidth	4.45
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

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/Manufacturer

Applicant name	DAMM Cellular Systems A/S
Applicant address	Møllegade 68, 6400 Sønderborg, Denmark
Manufacturer name	Same as applicant
Manufacturer address	Same as applicant

5.3 EUT information

Product name	450 MHz band cellular base station
PMN	BS422 Multi-Tech outdoor Base station
Model (HVIN)	10522143, 10522243, 10522145
Part numbers	BS422-S, BS422-SP
Serial number	20000001
Power supply requirements	DC: -48 V
Product description and theory of operation	Outdoor base station featuring multiple technologies in one single core-connected system: TETRA, DMR Tier III, TEDS and Analog. During test EUT was set to continues transmit mode with test software OM, controlled with command provided by client. Each BS422 can operate up to four different carriers simultaneously, independent of the selected radio technology, inside a defined band. The different carriers may operate in different bandwidths depending of the selected technology.

5.4 Technical information

System type	☐ Mobile system
	☒ Base/Fixed point-to-point system
Frequency band	450–460 MHz
Tested Frequencies (MHz)	450.1, 459.9
RF power Max, Conducted	47.7 dBm
Measured BW, 99% OBW	DMR 2 Slot TDMA: 7K60FXW = 7.84 kHz Analog Voice: 16K0FX3E: 8.19 kHz Analog Voice: 11K0FX3E: 4.34 kHz Analog Voice: 6K00F3E: 2.24 kHz 0.20 TETRA 4 Slot TDMA: 19.38 kHz
Type of modulation	FM
Emission classification	DMR 2 Slot TDMA data, 7K60FXW Analog voice, 2.5 kHz deviation, 16K0F3E, 11K0F3E, 6K00F3E 0.20TETRA 4 Slot TDMA, ETS 300 392, 20K0D1W
Transmitter spurious, dBµV/m @ 3 m	Peak = 55.5 @919.78 MHz, Average = 40.03 @ 5.35 GHz
Antenna information	External Antenna with N connector. Antenna type preferred is Omnidirectional with 5.2 dBi max, gain and an electrical down tilt of 6 degrees. Various types can be used.

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	SW. ver.8.10, Dongle settings to enable carrier setup by OM commands, specified max rated power 50 W. External Antenna with N connector. Antenna type preferred is Omnidirectional with 5.2 dBi max, gain and an electrical down tilt of 6 degrees. Various types can be used.
Transmitter state	Continuous transmission

5.5.2 EUT setup configuration

Table 5.5-1: *EUT sub assemblies*

Description	Brand name	Model, Part number, Serial number, Revision level
450 MHz band cellular base station	DAMM Cellular Systems A/S	MN: 10522X43, SN: 20000001, Rev. 01

Table 5.5-2: *EUT interface ports*

Description	Qty.
TX/ RX Antenna port	1
RX Antenna port	1
GNSS antenna port	1
A-Antenna port	1

Table 5.5-3: *Support equipment*

Description	Brand name	Model, Part number, Serial number, Revision level
Hub USB Soundcard	CREATIVE THX	MN: S8 1290
Switch	NETGEAR	MN: GS108, SN: 3TX14C7C84F2E, Rev. 4
Dongle Key 0.20	Matrix	MN: 105180, SN: 20029146
Laptop	DELL	MN: PP39L, PN: U082M A00, SN: 71QGXK1, Rev. XX

Table 5.5-4: *Inter-connection cables*

Cable description	From	To	Length (m)
LAN cable	BS422	Hub	5
LAN cable	Hub	Switch	0.2
LAN cable	Switch	Laptop	2

EUT setup configuration, continued

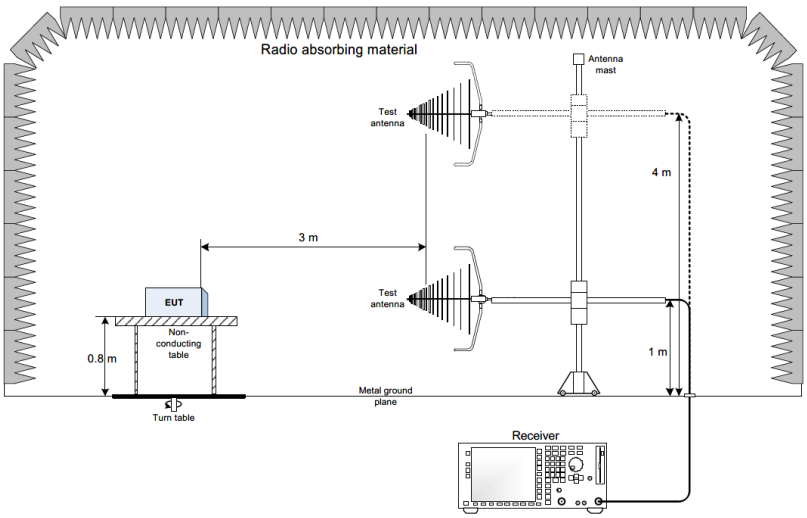


Figure 5.5-1: *Radiated testing block diagram*

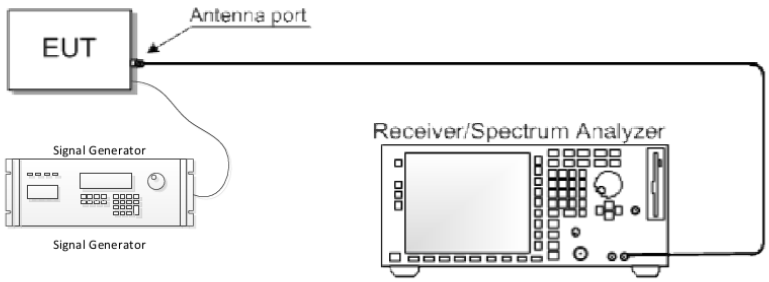


Figure 5.5-2: *Antenna port testing block diagram*

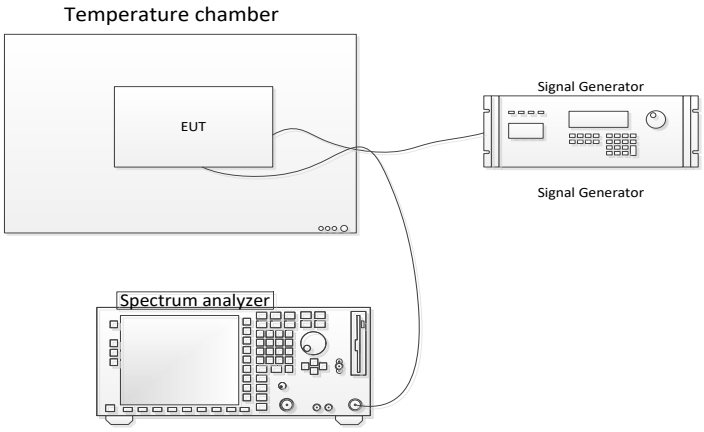


Figure 5.5-3: *Frequency stability block diagram*

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Montreal

6.2 Testing period

Test start date	May 16, 2022	Test end date	October 7, 2022

6.3 Sample information

Receipt date	May 5, 2022	Nemko sample ID number(s)	4621970001

6.4 FCC Part 2, 22, 74 and 90 Subpart I test requirements results

Table 6.4-1: *FCC requirements results*

Part	Test description	Verdict
§2.1047(a), §2.1047(b),	Modulation characteristics	Pass
§90.205(h), §2.1046, §74.461, §22.565	Transmitter output power	Pass
§90.209(b), §2.1049, §74.462	Bandwidth limitations	Pass
§90.210, §2.1051, §74.462, §22.359, §2.1053	Spectrum mask and spurious emissions	Pass
§90.214	Transient frequency behavior	Pass
§90.213(a), §2.1055, §74.464, §22.355	Transmitter frequency stability	Pass

Notes: None

6.5 ISED RSS-119, Issue 12 and RSS-Gen, Issue 5 test requirements results

Table 6.5-1: *ISED requirements results*

Section	Test description	Verdict
RSS-119, 5.4	Transmitter output power	Pass
RSS-119, 5.5	Bandwidth limitations	Pass
RSS-119, 5.5 + 5.8	Spectrum mask and spurious emissions	Pass
RSS-119, 5.9	Transient frequency behavior	Pass
RSS-119, 5.3	Transmitter frequency stability	Pass
RSS-Gen, 6.9	Number of frequencies	Pass

Notes: None

Section 7 Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber (Emissions)	TDK	SAC-3	FA002532e	1 year	April 1, 2023
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
DC Power Supply	Sorensen	SGA80X125C-AAA	FA002738	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	March 3, 2023
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	March 24, 2023
Horn antenna (1–18 GHz)	EMCO	3115	FA001451	1 year	March 10, 2023
Pre-amplifier (0.5–18 GHz)	Com-Power	PAM-118A	FA002561	1 year	August 10, 2023
Spectrum analyzer	Rohde & Schwarz	FSV 40	FA002731	1 year	March 3, 2023
Attenuator	Narda	776B-20	FA001153	None	—
Directional coupler (80–1000 MHz)	AR	DC6180	FA001659	1 year	January 28, 2023
50 ohms termination, 300 watts	PHILCO	160B-300	FA002588	—	NCR

Notes: NCR - no calibration required

Section 8 Testing data

8.1 Number of frequencies

8.1.1 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.

RSS-Gen, Clause 6.9:

Except where otherwise specified, measurements shall be performed for each frequency band of operation for which the radio apparatus is to be certified, with the device operating at the frequencies in each band of operation shown in table below. The frequencies selected for measurements shall be reported in the test report.

Table 8.1-1: *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.

8.1.2 Test summary

Verdict	Pass		
Tested by	Abdoulaye Ndiaye	Test date	May 16, 2022

8.1.3 Observations, settings and special notes

None

8.1.4 Test data

Table 8.1-2: *Test channels selection*

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low Channel, MHz	High Channel, MHz
450	460	10	450.1	459.9

8.2 Modulation characteristic

8.2.1 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

8.2.2 Test summary

Verdict	Pass		
Tested by	Abdoulaye Ndiaye	Test date	September 23, 2022

8.2.3 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 to 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.

8.2.4 Test data

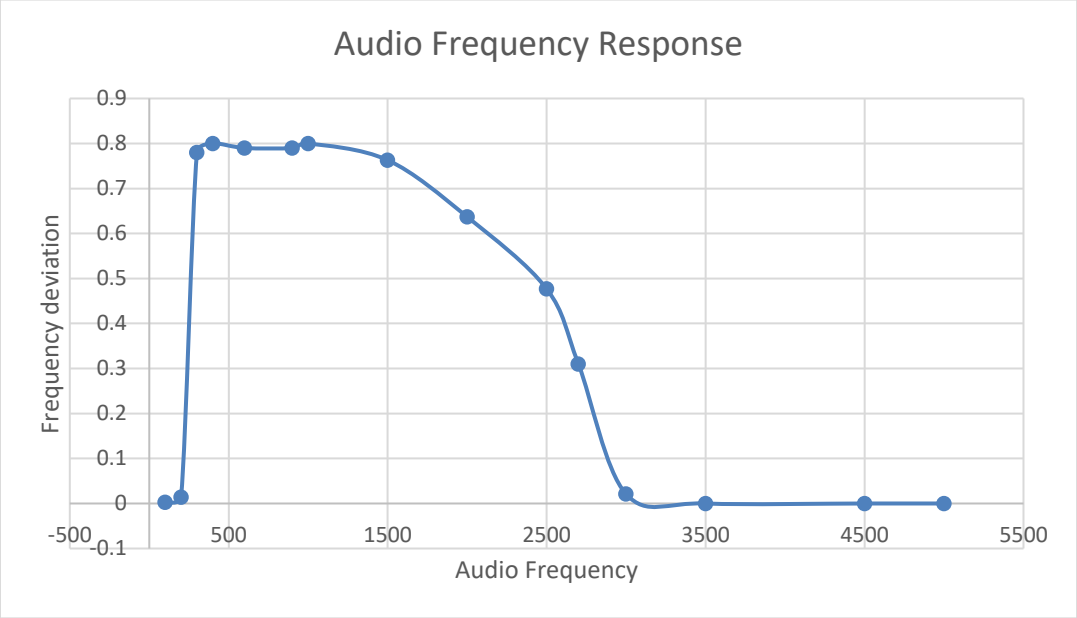


Figure 8.2-1: *Audio frequency response*

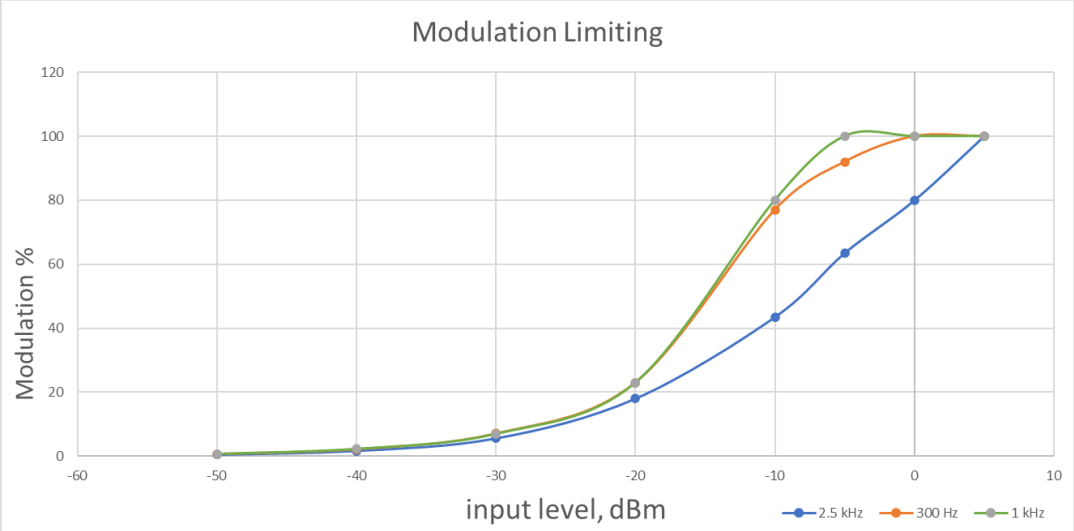


Figure 8.2-2: *Modulation limiting for 300 Hz, 1 kHz and 2.5 kHz*

8.3 Transmitter Output Power

8.3.1 References, definitions and limits

FCC §90.205:

(h) Power and antenna height limits within 450–470 MHz.

(1) The maximum allowable station effective radiated power (ERP) is dependent upon the station's antenna HAAT and required service area and will be authorized in accordance with table below. Applicants requesting an ERP in excess of that listed in table below 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 below 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 39 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 32 km (20 mi) must justify the requested service area radius, which may be authorized only in accordance with table below, 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 8.3-1: *Maximum ERP/Reference HAAT for a Specific Service Area Radius (FCC)*

Service area radius (km):	**3**	**8**	**13**	**16**	**24**	**32**	**40[4]**	**48[4]**	**64[4]**	**80[4]**
Maximum ERP (w)[1]:	2	100	[2]500	[2]500	[2]500	[2]500	[2]500	[2]500	[2]500	[2]500
Up to reference HAAT (m)[3]:	15	15	15	27	63	125	250	410	950	2700

Notes:
[1]Maximum ERP indicated provides for a 39 dBu signal strength at the edge of the service area per FCC Report R-6602, Fig. 29 (See §73.699, Fig. 10 b).
[2]Maximum ERP of 500 watts allowed. Signal strength at the service area contour may be less than 39 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 39 dBu.

FCC §74.461:

(a) Transmitter power is the power at the transmitter output terminals and delivered to the antenna, antenna transmission line, or any other impedance-matched, radio frequency load. For the purpose of this Subpart, the transmitter power is the carrier power

(b) The authorized transmitter power for a remote pickup broadcast station shall be limited to that necessary for satisfactory service and, in any event, shall not be greater than 100 watts, except that a station to be operated aboard an aircraft shall normally be limited to a maximum authorized power of 15 watts. Specific authorization to operate stations on board aircraft with an output power exceeding 15 watts will be issued only upon an adequate engineering showing of need, and of the procedures that will be taken to avoid harmful interference to other licensees.

References, definitions and limits, continued

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

Table 8.3-2: *Maximum ERP*

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

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

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

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

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

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

RSS-119, Clause 5.4:

The output power shall be within ±1 dB of the manufacturer's rated power listed in the equipment specifications.
The transmitter output power limits set forth in Table below will come into force upon the publication of Issue 12 of this standard and will apply to newly certified equipment.

Table 8.3-3: *Transmitter Output Power (ISED)*

Frequency Band, MHz	Transmitter Output Power for Base/Fixed Equipment, W	Transmitter Output Power for Mobile Equipment, W
450–470	110	60

8.3.2 Test summary

Verdict	Pass		
Tested by	Abdoulaye Ndiaye	Test date	May 16, 2022 & September 22, 2022

8.3.3 Observations, settings and special notes

Only these 4 modulations had been considered for this test: 7K60FXW, 16K0F3E, 0.2TETRA, 0.35TETRA
Tests were performed with RMS power meter, as per test method described in ANSI C63.26, clause 5.2.4.2

8.3.4 Test data

Table 8.3-4: *Transmitter power results for FCC*

Modulation	Frequency, MHz	Conducted Output power, dBm	Antenna gain, dBd	ERP, dBm
7K60FXW	450.1	47.7	3.05	50.75
16K0F3E	450.1	47.2	3.05	50.25
0.2TETRA (20K0D1W)	450.1	44.8	3.05	47.85
7K60FXW	459.9	47.7	3.05	50.75
16K0F3E	459.9	47.2	3.05	50.25
0.2TETRA (20K0D1W)	459.9	44.7	3.05	47.75

Notes:

ERP = P + GT - LC

P = conducted output power, in dBm

GT = gain of Tx antenna, in dBd (ERP)

LC = signal loss in the cable connecting EUT and Tx antenna, in dB

dBd = dBi - 2.15, ERP = EIRP - 2.15, EIRP = ERP + 2.15

Table 8.3-5: *Transmitter power results for ISED*

Modulation	Frequency, MHz	Output power, dBm	Output power limit, dBm	Margin, dB
7K60FXW	450.1	47.7	50.4	2.7
16K0F3E	450.1	47.2	50.4	3.2
0.2TETRA (20K0D1W)	450.1	44.8	50.4	5.6
7K60FXW	459.9	47.7	50.4	2.7
16K0F3E	459.9	47.2	50.4	3.2
0.2TETRA (20K0D1W)	459.9	44.7	50.4	5.7

Test data, continued

Table 8.3-6: *Rated vs measured power*

Modulation	Frequency, MHz	Rated output power, dBm	Measured output power, dBm	Difference, dB	Difference limit, ±dB	Margin, dB
7K60FXW	450.1	47.0 (50 W)	47.7	0.7	1.00	0.3
16K0F3E	450.1	47.0 (50 W)	47.2	0.2	1.00	0.8
0.2TETRA (20K0D1W)	450.1	44.0 (25 W)	44.8	0.8	1.00	0.2
7K60FXW	459.9	47.0 (50 W)	47.7	0.7	1.00	0.3
16K0F3E	459.9	47.0 (50 W)	47.2	0.2	1.00	0.8
0.2TETRA (20K0D1W)	459.9	44.0 (25 W)	44.7	0.7	1.00	0.3

Notes: As per client's the command to have 50 W is: 01/1/PWR/47.0. But instead, we are having 47.7 dBm while transmitting.
With this command instead: 01/1/PWR/46.0, we are having a transmission at 47.4 dBm which is closer to 50W.
As well as to have a rated power close to 25 W, the command should be: 01/1/PWR/43.0 to measure 44.8 dBm while it is transmitting.

8.4 Bandwidth limitations

8.4.1 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 8.4-1: *Standard Channel Spacing/Bandwidth*

Frequency band, MHz	Channel spacing, kHz	Authorized bandwidth[1], kHz
406–512	6.25	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).

FCC §74.762

(a) The licensee of a low power TV station, a TV translator, or a TV booster station must measure the carrier frequencies of its output channel as often as necessary to ensure operation within the specified tolerances, and at least once each calendar year at intervals not exceeding 14 months.

(b) In the event that a low power TV, TV translator, or TV booster station is found to be operating beyond the frequency tolerance prescribed in § 74.761, the licensee promptly shall suspend operation of the transmitter and shall not resume operation until transmitter has been restored to its assigned frequencies. Adjustment of the frequency determining circuits of the transmitter shall be made only by a qualified person in accordance with § 74.750(g).

RSS-119, Clause 5.5:

For the purpose of this document, channel bandwidth is the channel width in which the equipment is designed to operate.

The maximum permissible occupied bandwidth shall not exceed the authorized bandwidth specified in Table below for the equipment's frequency band. The authorized bandwidth is defined as the maximum width of the band of frequencies used to derive spectrum masks and is not necessarily equivalent to the bandwidth found on radio and spectrum licences.

The channel bandwidths and authorized bandwidths are given in Table below for equipment having an output power greater than 120 mW. For equipment with an output power that does not exceed 120 mW, Section 5.10 applies.

Table 8.4-2: *Channel Bandwidths, Authorized Bandwidths for 450–470 MHz frequency band*

Channel bandwidth, kHz	Authorized bandwidth, kHz
25.00	20.00
12.50	11.25
6.25	6.00

8.4.2 Test summary

Verdict	Pass		
Tested by	Abdoulaye Ndiaye	Test date	May 2, 2022 to September 22, 2022

8.4.3 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

8.4.4 Test data

Table 8.4-3: *99% occupied bandwidth results*

Modulation	Frequency, MHz	99% occupied bandwidth, kHz	Limit, kHz	Margin, kHz
7K60FXW	450.10	7.83	11.25	3.42
16K0F3E	450.10	8.19	20.00	11.81
11K0F3E	450.10	4.34	11.25	6.91
6K00F3E	450.10	2.19	6.00	3.81
0.2TETRA (20K0D1W)	450.10	19.32	20.00	0.68
7K60FXW	459.90	7.84	11.25	3.41
16K0F3E	459.90	8.19	20.00	11.81
11K0F3E	459.90	4.34	11.25	6.91
6K00F3E	459.90	2.24	6.00	3.76
0.2TETRA (20K0D1W)	459.90	19.38	20.00	0.62

Test data, continued

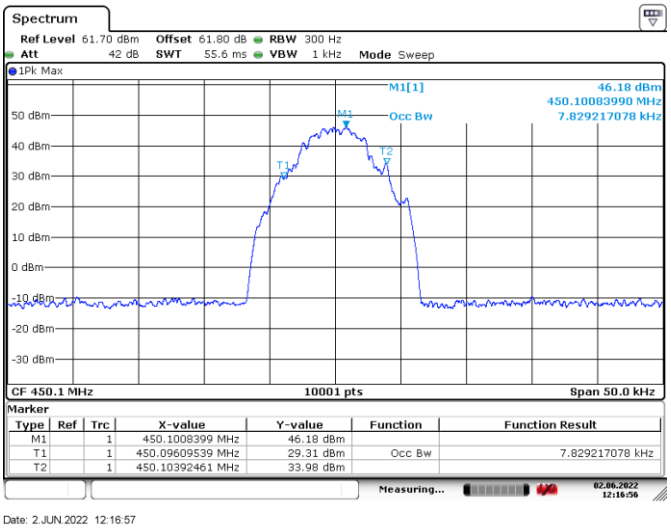


Figure 8.4-1: *99% occupied bandwidth, 7K60FXW modulation @50W and 450.1 MHz*

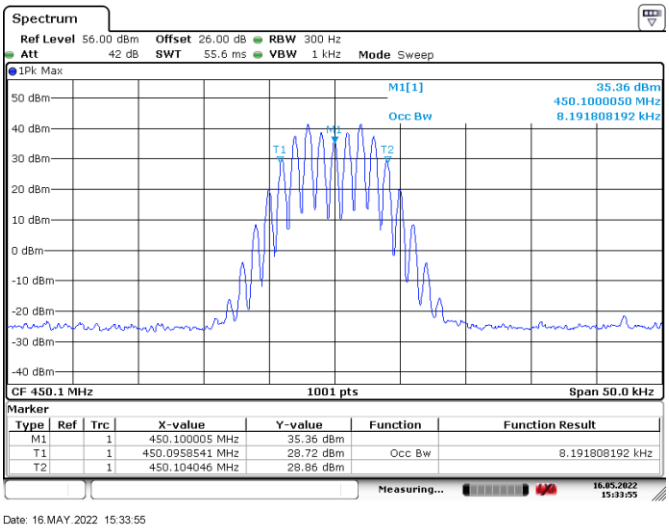


Figure 8.4-2: *99% occupied bandwidth, 16K0F3E modulation @50W and 450.1 MHz*

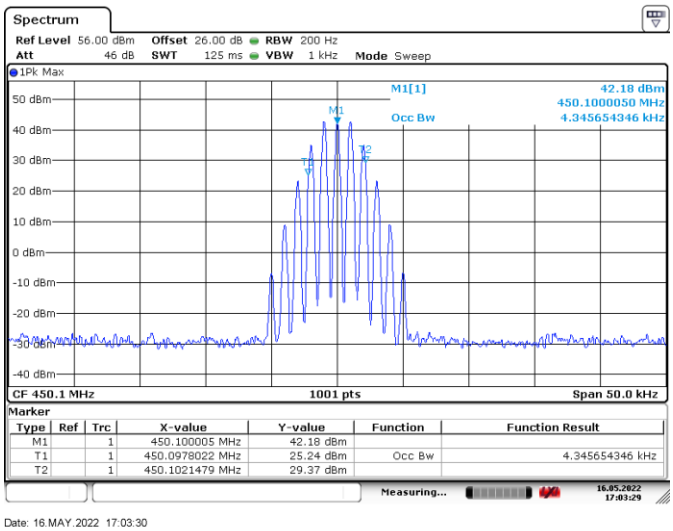


Figure 8.4-3: *99% occupied bandwidth, 11K0F3E modulation @50W and 450.1 MHz*

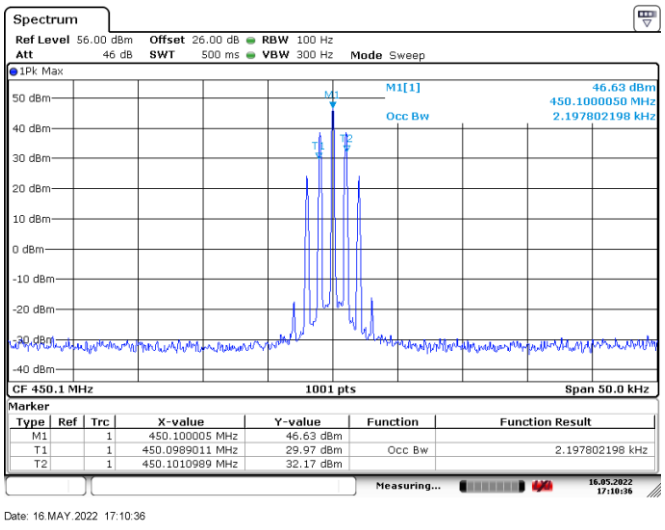


Figure 8.4-4: *99% occupied bandwidth, 6K00F3E modulation @50W and 450.1 MHz*

Test data, continued

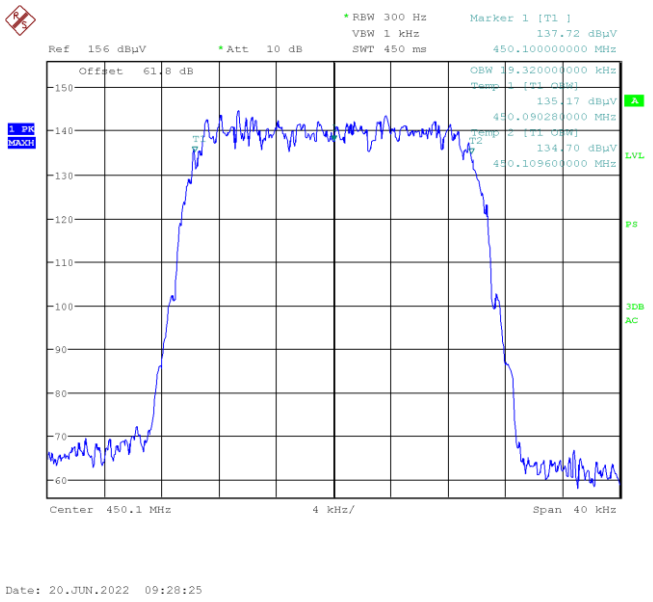


Figure 8.4-5: *99% occupied bandwidth, 0.2TETRA modulation @25W and 450.1 MHz*

Test data, continued

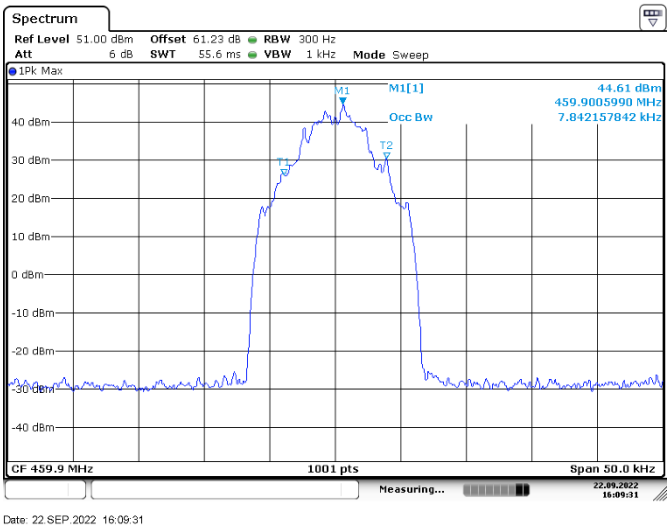


Figure 8.4-6: *99% occupied bandwidth, 7K60FXW modulation @50W and 459.9 MHz*

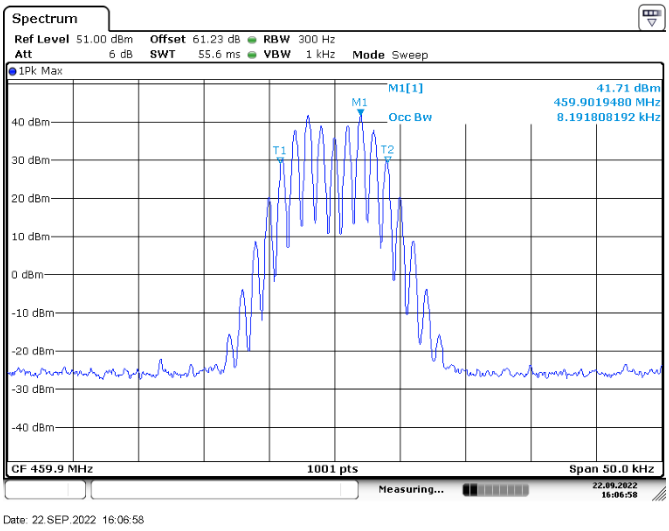


Figure 8.4-7: *99% occupied bandwidth, 16K0F3E modulation @50W and 459.9 MHz*

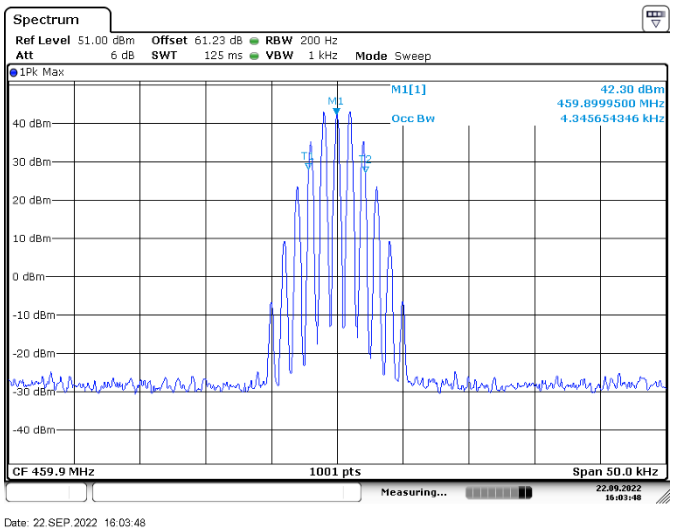


Figure 8.4-8: *99% occupied bandwidth, 11K0F3E modulation @50W and 459.9 MHz*

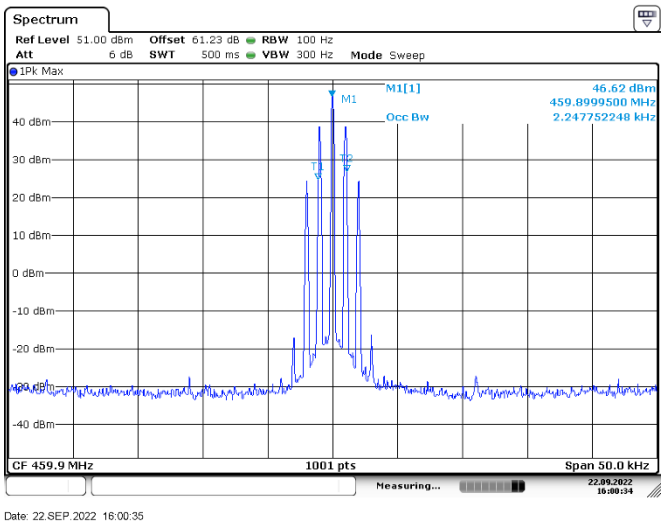


Figure 8.4-9: *99% occupied bandwidth, 6K00F3E modulation @50W and 459.9 MHz*

Test data, continued

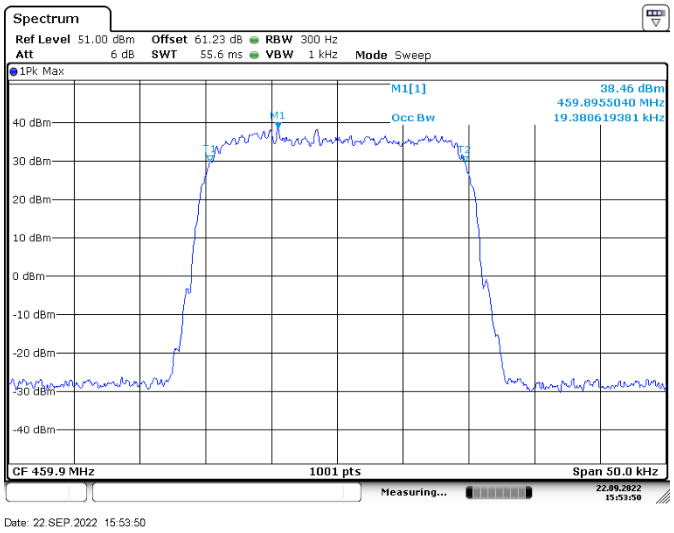


Figure 8.4-10: *99% occupied bandwidth, 0.2TETRA modulation @25W and 459.9 MHz*

8.5 Spectrum mask and spurious emissions

8.5.1 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 8.5-1: *Applicable Emission Masks*

Frequency band, MHz	Mask for equipment with audio low pass filter	Mask for equipment with audio low pass filter
421–512[1,2]	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

References, definitions and limits, continued

FCC §74.462:

(a) Each authorization for a new remote pickup broadcast station or system shall require the use of certificated equipment and such equipment shall be operated in accordance with emission specifications included in the grant of certification and as prescribed in paragraphs (b), (c), and (d) of this section.

(b) The maximum authorized bandwidth of emissions corresponding to the types of emissions specified below, and the maximum authorized frequency deviation in the case of frequency or phase modulated emission, shall be as follows:

Table 8.5-2: *Authorized bandwidth and emissions*

Frequency band, MHz	Authorized Bandwidth (kHz)	Maximum frequency deviation[1] (kHz)	Type of emission[2]
25.87 to 26.03	40	10	Frequencies 25.87 to 153.3575 MHz: A3E, F1E, F3E, F9E
26.07 to 26.47	20	5	
152.8625 to 153.3575[3]	30/60	5/10	
160.860 to 161.400	60	10	
161.625 to 161.775	30	5	
166.25 and 170.15[4]	12.5/25	5	166.25 and 170.154
450.00625 to 450.025 450.98125 to 450.99375 455.00625 to 455.025 455.98125 to 455.99375 Up to 12.5 1.5	Frequencies 160.860 to 455.950 MHz: A1A, A1B, A1D, A1E, A2A, A2B, A2D, A2E, A3E, F1A, F1B, F1D, F1E, F2A, F2B, F2D, F2E, F3E, F9E		
450.03125 to 450.61875			
455.03125 to 455.61875	Up to 25	5	
450.6375 to 450.8625			
455.6375 to 455.8625	25-50	10	
450.900, 450.950			
455.900, 455.950	50-100	35	

Notes: [1] Applies where F1A, F1B, F1D, F1E, F2A, F2B, F2D, F2E, F3E, or F9E emissions are used.
[2] Stations operating above 450 MHz shall show a need for employing A1A, A1B, A1D, A1E, A2A, A2B, A2D, A2E, F1A, F1B, F1D, F1E, F2A, F2B, F2D, or F2E emission.
[3] New or modified licenses for use of the frequencies will not be granted to utilize transmitters on board aircraft, or to use a bandwidth in excess of 30 kHz and maximum deviation exceeding 5 kHz
[4] For stations licensed or applied for before April 16, 2003, the sum of the bandwidth of emission and tolerance on frequencies 166.25 MHz or 170.15 MHz shall not exceed 25 kHz, and such operation may continue until January 1, 2005. For new stations licensed or applied for on or after April 16, 2003, the sum of the bandwidth of emission and tolerance on these frequencies shall not exceed 12.5 kHz. For all remote pickup broadcast stations, the sum of the bandwidth of emission and tolerance on these frequencies shall not exceed 12.5 kHz on or after January 1, 2005.

(c) For emissions on frequencies above 25 MHz with authorized bandwidths up to 30 kHz, the emissions shall comply with the emission mask and transient frequency behavior requirements of §§ 90.210 and 90.214 of this chapter. For all other emissions, the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:

1- On any frequency removed from the assignment frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: at least 25 dB:
2- On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: at least 35 dB;
3- On any frequency removed from the assigned frequency by more than 250 percent on the authorized bandwidth; at least 43 plus 10 log10 (mean output power, in watts) dB.

(d) In the event a station's emissions outside its authorized channel cause harmful interference, the Commission may, at its discretion, require the licensee to take such further steps as may be necessary to eliminate the interference.

RSS-119, Clause 5.5:

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

Table 8.5-3: *Spectrum Masks*

Frequency band, MHz	Channel Bandwidth (kHz)	Authorized Bandwidth (kHz)	Mask for equipment with audio low pass filter	Mask for equipment with audio low pass filter
450–470	25.00	20.00	B	C
	12.50	11.25	D	D
	6.25	6.00	E	E

Notes: The spectrum masks are given in the table for equipment having an output power greater than 120 mW. For equipment with an output power that does not exceed 120 mW, Section 5.10 applies.

RSS-119, Clause 5.8:

The spectrum plots of the unwanted emissions shall comply with the masks specified in tables below.

The term *displacement frequency, f_d*, used in these sections refers to the difference between the channel frequency and the emission component frequency expressed in kilohertz, and *p* is the transmitter output power in Watts.

5.8.1 **Emission Mask B** for Transmitters Equipped With an Audio Low-Pass Filter

The power of any emission shall be attenuated below the transmitter output power P (dBW) as specified in Table below:

Table 8.5-4: *Emission Mask B*

Displacement Frequency, f_d (kHz)	Minimum Attenuation (dB)	Resolution Bandwidth (Hz)
$10 < f_d \leq 20$	25	300
$20 < f_d \leq 50$	35	300
$f_d > 50$	$43 + 10 \times \text{Log}_{10}$ (p)	Specified in Section 4.2.1

5.8.2 **Emission Mask C** for Transmitters not Equipped With an Audio Low-Pass Filter

The power of any emission shall be attenuated below the transmitter output power P (dBW) as specified in Table below:

Table 8.5-5: *Emission Mask C*

Displacement Frequency, f_d (kHz)	Minimum Attenuation (dB)	Resolution Bandwidth (Hz)
$5 < f_d \leq 10$	$83 \times \text{Log}_{10} (f_d / 5)$	300
$10 < f_d \leq 50$	Whichever is the lesser: 50 *or* $29 \times \text{Log}_{10} (f_d^2 / 11)$	300
$f_d > 50$	$43 + 10 \times \text{Log}_{10}$ (p)	Specified in Section 4.2.1

References, definitions and limits, continued

RSS-119, Clause 5.8:

5.8.3 **Emission Mask D** for Transmitters Equipped With or Without an Audio Low-Pass Filter

The power of any emission shall be attenuated below the transmitter output power P (dBW) as specified in Table below:

Table 8.5-6: *Emission Mask D*

Displacement Frequency, f_d (kHz)	Minimum Attenuation (dB)	Resolution Bandwidth (Hz)
$5.625 < f_d \leq 12.5$	7.27 (f_d - 2.88)	Specified in Section 4.2.2
$f_d > 12.5$	Whichever is the lesser: 70 *or* 50 × Log_{10} (p)	Specified in Section 4.2.2

5.8.4 **Emission Mask E** for Transmitters Equipped With or Without an Audio Low-Pass Filter

The power of any emission shall be attenuated below the transmitter output power P (dBW) as specified in Table below:

Table 8.5-7: *Emission Mask E*

Displacement Frequency, f_d (kHz)	Minimum Attenuation (dB)	Resolution Bandwidth (Hz)
$3 < f_d \leq 4.6$	Whichever is the lesser: 30 + 16.67 (f_d – 3) *or* 55 + 10 × Log_{10} (p)	Specified in Section 4.2.2
$f_d > 4.6$	Whichever is the lesser: 57 *or* 55 × Log_{10} (p)	Specified in Section 4.2.2

5.8.10 **Emission Mask Y** for Equipment With a 25 kHz Channel Bandwidth and an Occupied Bandwidth Greater Than 20 kHz

The power of any emission shall be attenuated below the transmitter output power P (dBW) as specified in Table below:

Table 8.5-8: *Emission Mask Y*

Displacement Frequency, f_d (kHz)	Minimum Attenuation (dB)	Resolution Bandwidth (Hz)
12.375 < fd ≤ 13.975	Whichever is the lesser: 30 + 16.67(fd−12.375) or 55 + 10 log10(p)	Specified in Section 4.2.2
fd > 13.975	Whichever is the lesser: 57 or 55 + 10 log10(p)	Specified in Section 4.2.2

RSS-119, Clause 4.2:

When the transmitter unwanted emissions are being measured, a sufficient number of sweeps must be measured to ensure that the emission profile is developed. The video bandwidth shall be at least three times the width of the instrument resolution bandwidth.

For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated carrier power refers to the total output power contained in the occupied bandwidth when the transmitter is modulated with signals representative of those encountered in a real system operation.

4.2.1 Emission Masks B, C, G, I and J

Unwanted emission measurements can be in peak or averaging mode, provided that the same parameter, peak power or average power, used for the transmitter's output power measurement is also used for the unwanted emission measurements.
Except where otherwise stated, on any frequency removed from the carrier frequency by more than 250% of the authorized bandwidth, a resolution bandwidth of at least 100 kHz must be used for frequencies to be measured at or below 1 GHz, and a resolution bandwidth of at least 1 MHz must be used for frequencies to be measured above 1 GHz. If a narrower resolution bandwidth is used, power integration shall be applied.

4.2.2 Emission Masks D, E, F and Y

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 mode. For emissions beyond 50 kHz from the edge of the authorized bandwidth, the resolution bandwidth shall be 100 kHz for frequencies at or below 1 GHz, and 1 MHz for frequencies above 1 GHz. However, for emission mask F, at a displacement frequency of less than 3.75 kHz, the resolution bandwidth shall be 30 Hz.

8.5.2 Test summary

Verdict	Pass		
Tested by	Abdoulaye Ndiaye	Test date	May 18, 2022 to December 7, 2022

8.5.3 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

8.5.4 Test data

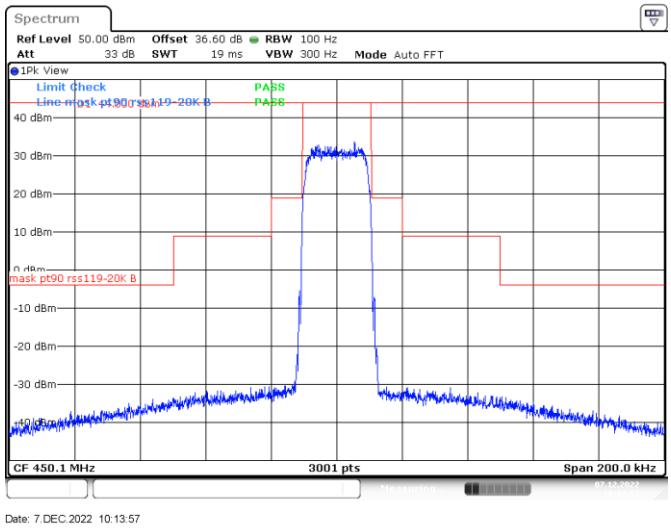


Figure 8.5-1: *Emission mask B for 0.2TETRA modulation @25W and 450.1 MHz*

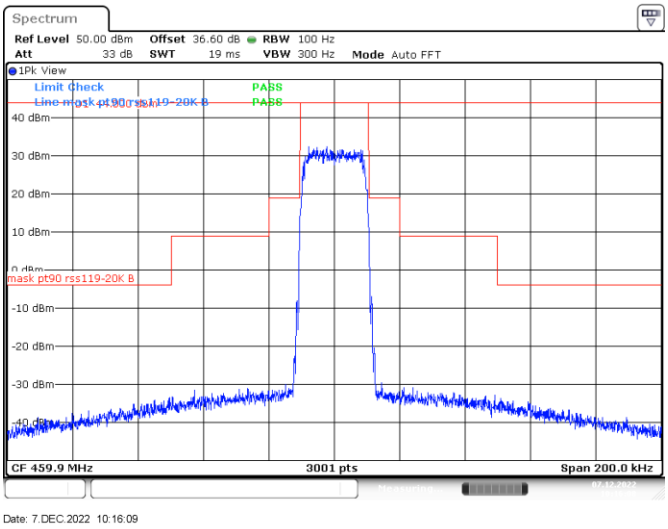


Figure 8.5-2: *Emission mask B for 0.2TETRA modulation @25W and 459.9 MHz*

Test data, continue

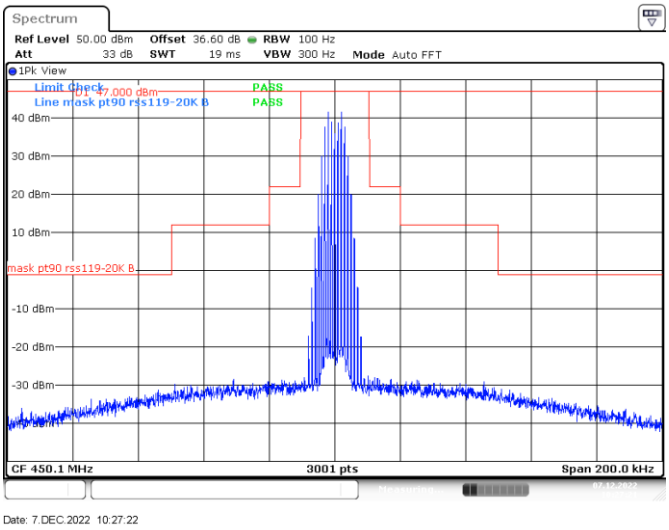


Figure 8.5-3: *Emission mask B for 16K0F3E modulation @50W and 450.1 MHz*

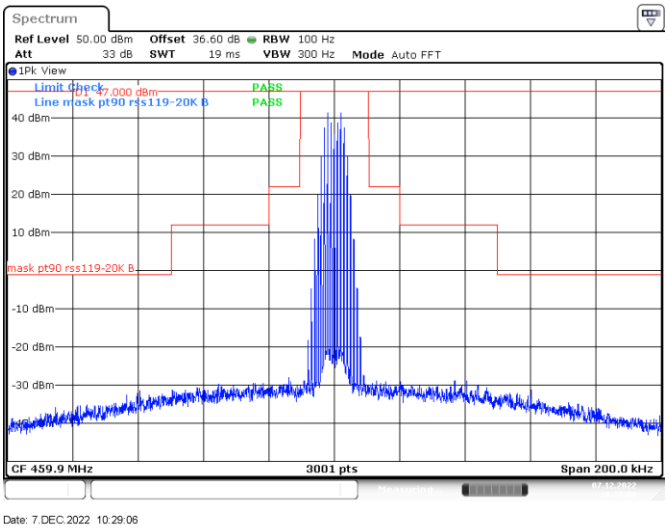


Figure 8.5-4: *Emission mask B for 16K0F3E modulation @50W and 459.9 MHz*

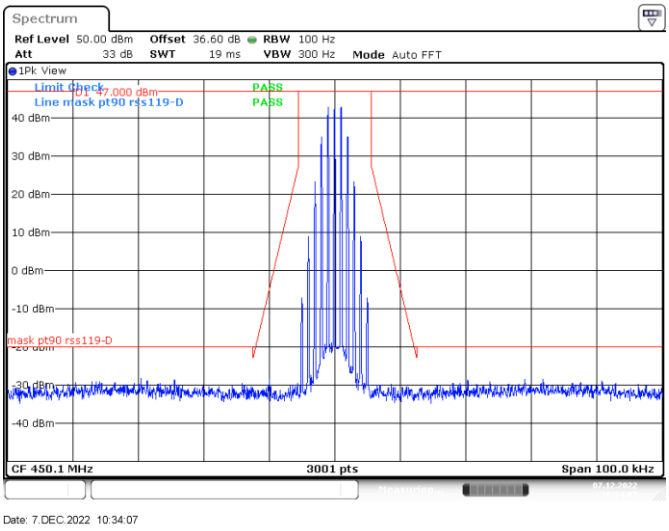


Figure 8.5-5: *Emission mask D for 11K0F3E modulation @50W and 450.1 MHz*

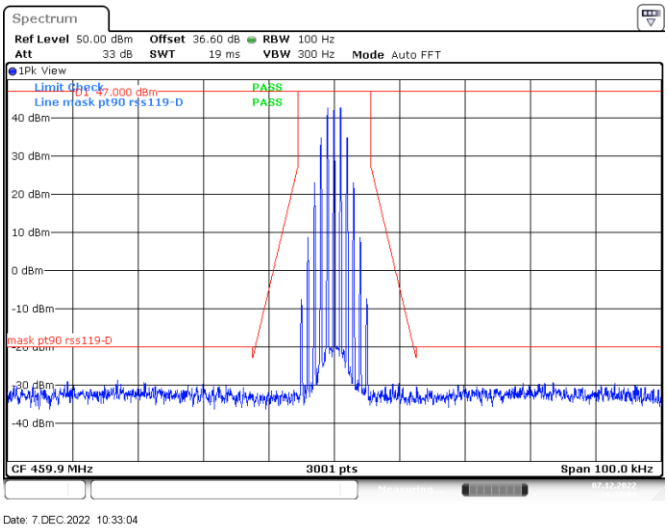


Figure 8.5-6: *Emission mask D for 11K0F3E modulation @50W and 459.9 MHz*

Test data, continued

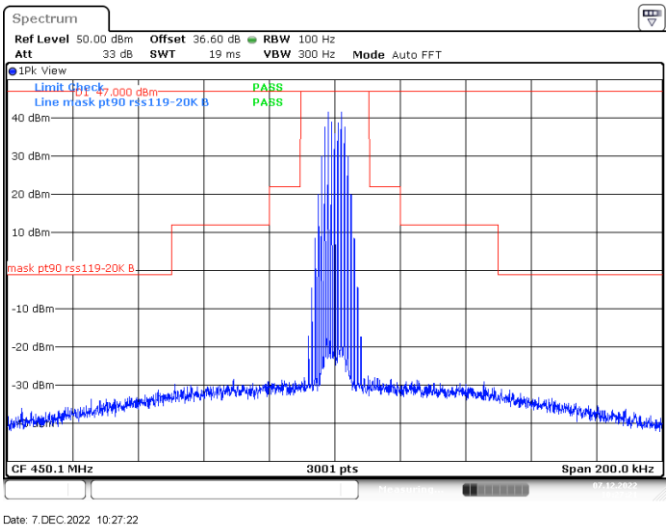


Figure 8.5-7: *Emission mask B for 16K0F3E modulation @50W and 450.1 MHz*

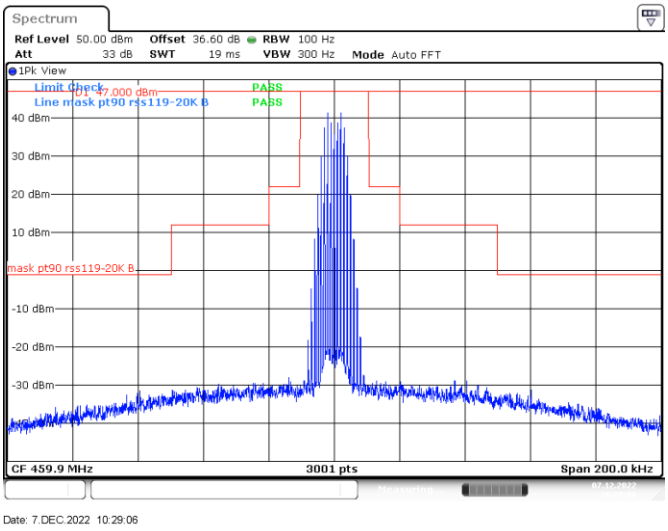


Figure 8.5-8: *Emission mask B for 16K0F3E modulation @50W and 459.9 MHz*

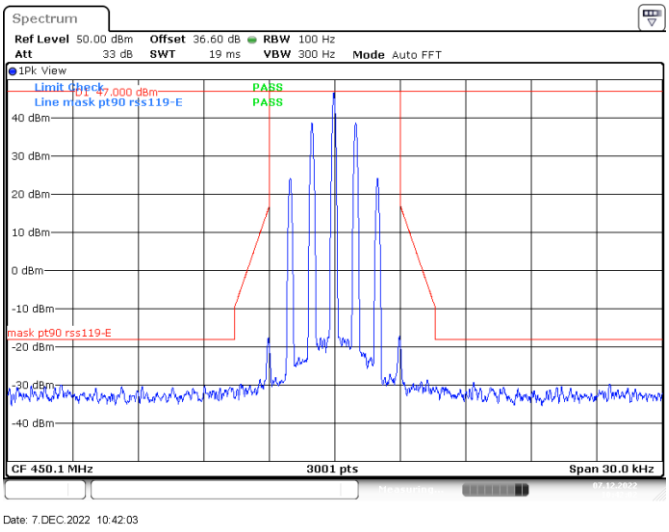


Figure 8.5-9: *Emission mask E for 6K00F3E modulation @50W and 450.1 MHz*

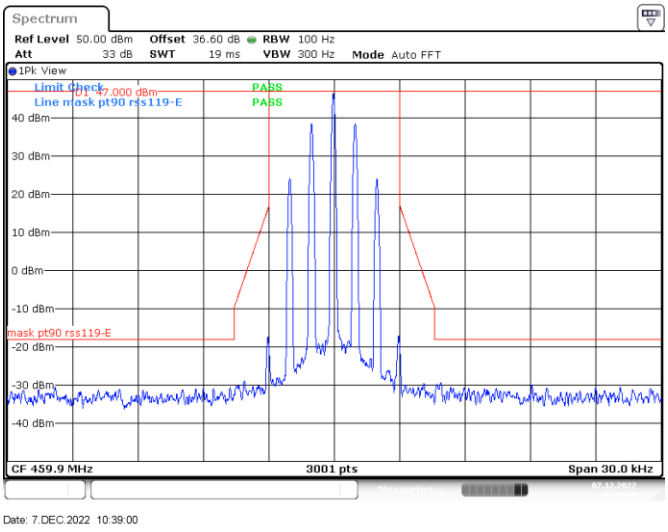


Figure 8.5-10: *Emission mask E for 6K00F3E modulation @50W and 459.9 MHz*

Test data, continued

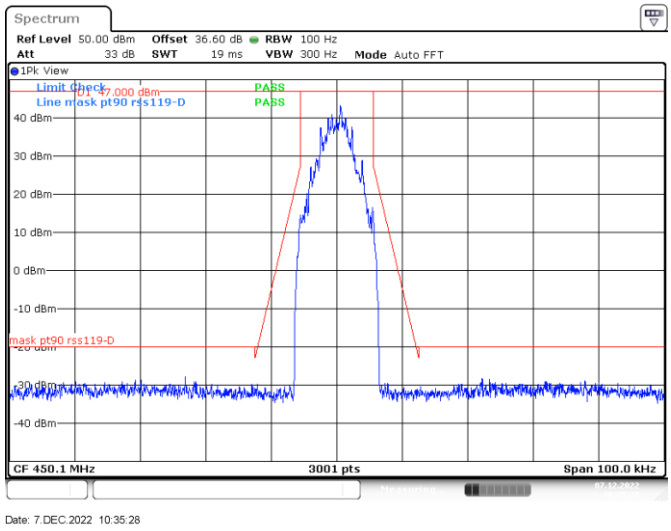


Figure 8.5-11: *Emission mask D for 7K60FXW modulation @50W and 450.1 MHz*

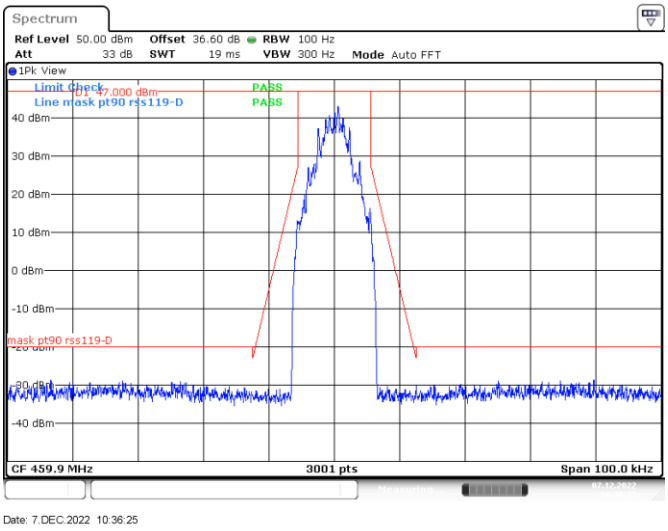


Figure 8.5-12: *Emission mask D for 7K60FXW modulation @50W and 459.9 MHz*

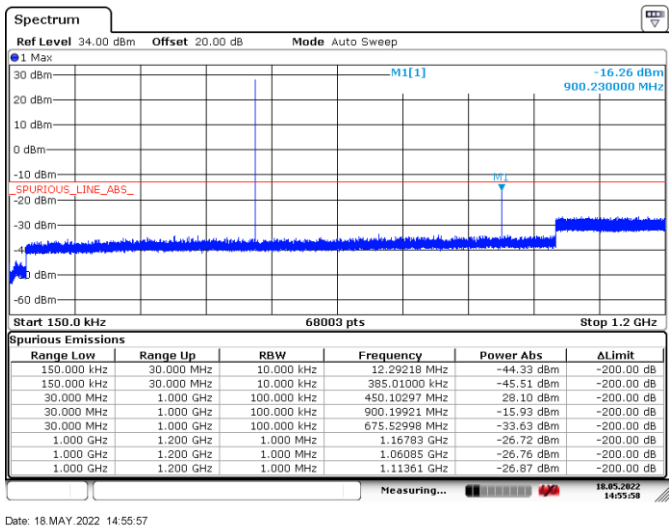


Figure 8.5-13: *Conducted spurious emissions for 16K0F3E modulation @ 50W – 150kHz-1.2 GHz at 450.1 MHz*

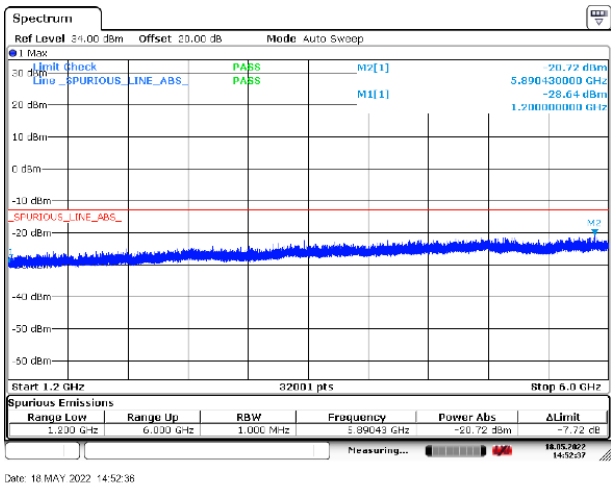


Figure 8.5-14: *Conducted spurious emissions for 0.35 TETRA modulation @25W – 1.2 GHz – 6 GHz at 450.1 MHz*

Test data, continued

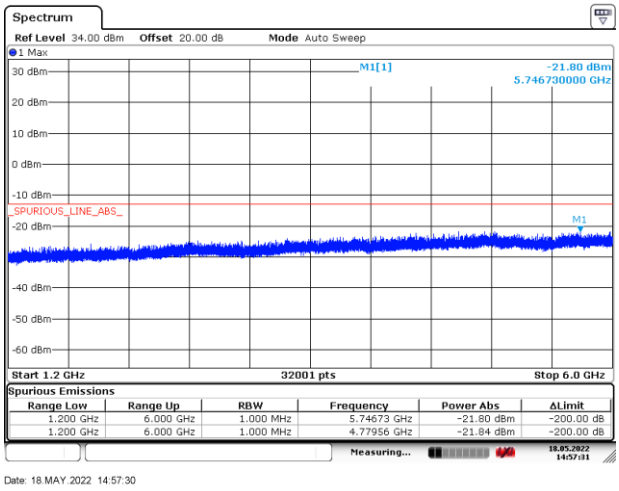


Figure 8.5-15: *Conducted spurious emissions for 16K0F3E modulation @50W – 1.2 GHz – 6 GHz at 450.1 MHz*

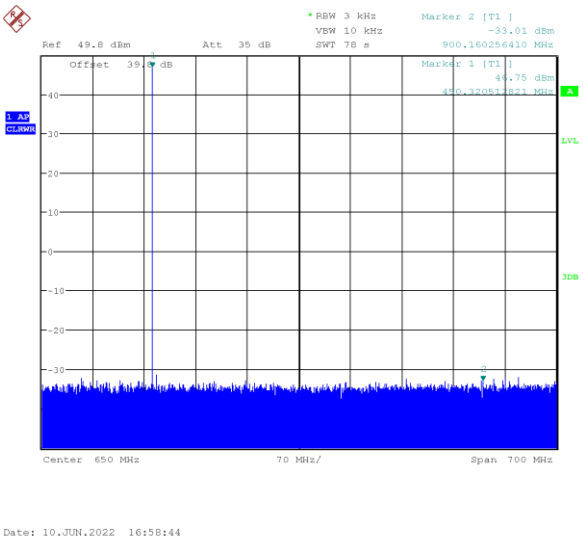


Figure 8.5-16: *Conducted spurious emissions for 7K60FXW modulation @50W with notch filter at 450.1 MHz*

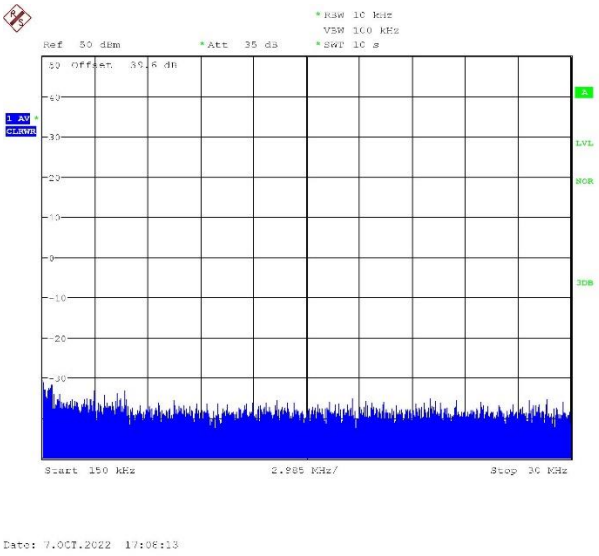


Figure 8.5-17: *Conducted spurious emissions for 16K0F3E modulation @ 50W – 150kHz-30 MHz at 459.9 MHz*

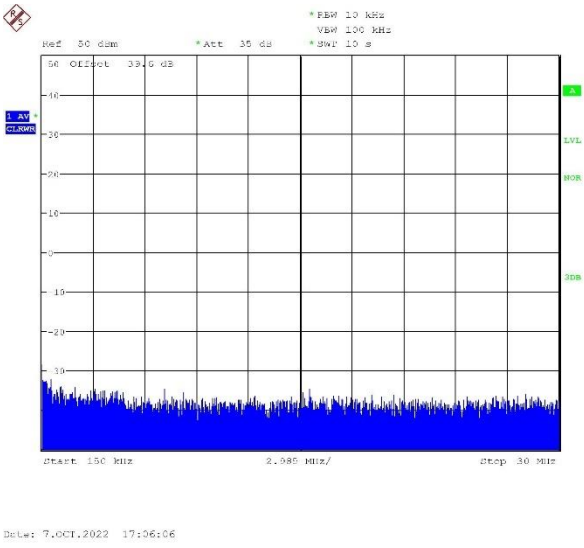


Figure 8.5-18: *Conducted spurious emissions for 7K60FXW modulation @50W – 150kHz-30 MHz at 459.9 MHz*

Test data, continued

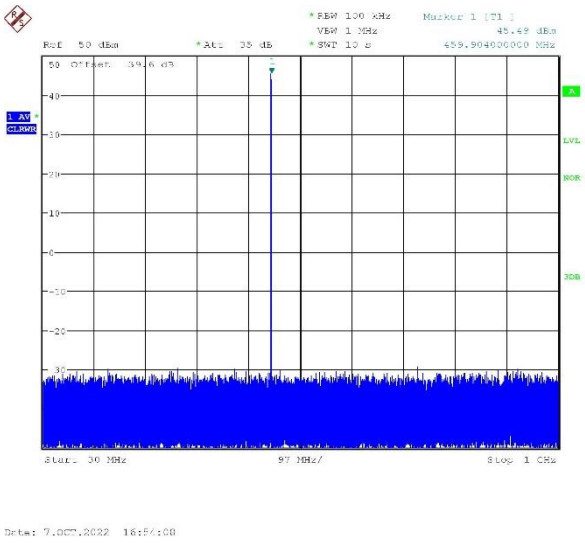


Figure 8.5-19: *Conducted spurious emissions for 16K0F3E modulation @ 50W – 30 MHz-1 GHz at 459.9 MHz*

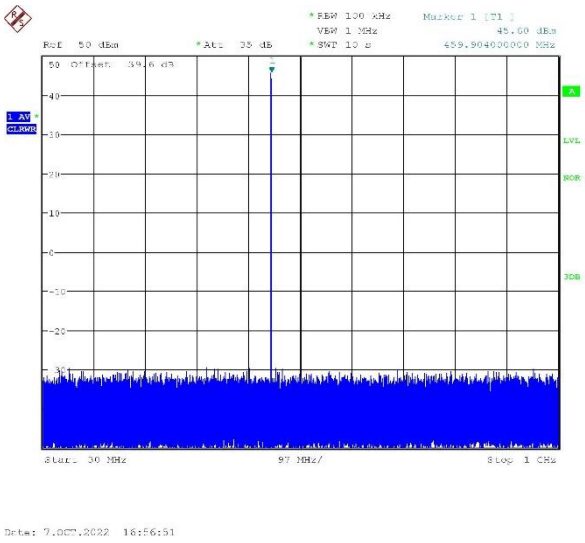


Figure 8.5-20: *Conducted spurious emissions for 7K60FXW modulation @50W – 30 MHz-1 GHz at 459.9 MHz*

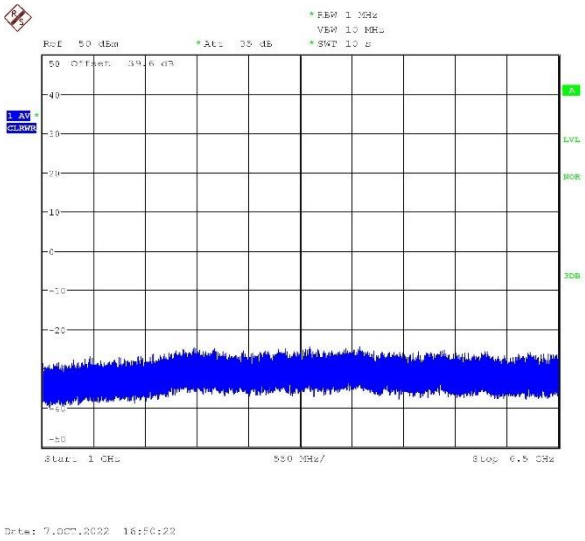


Figure 8.5-21: *Conducted spurious emissions for 16K0F3E modulation @ 50W – 1 GHz-6 GHz at 459.9 MHz*

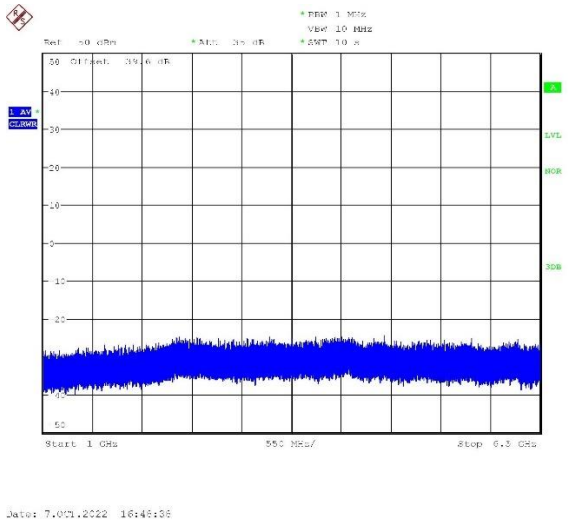
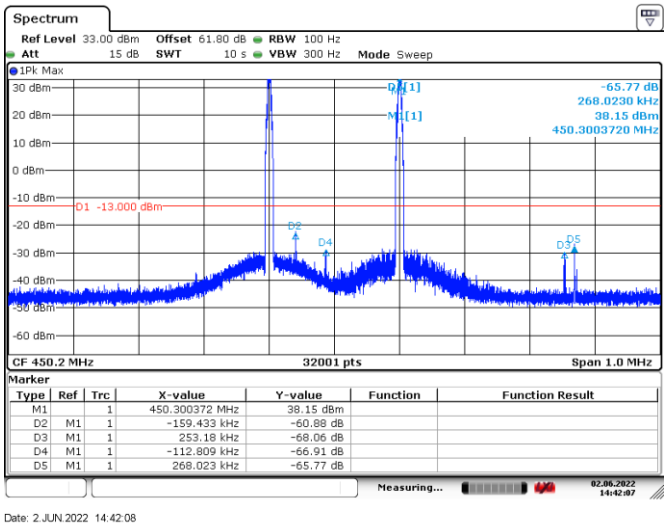


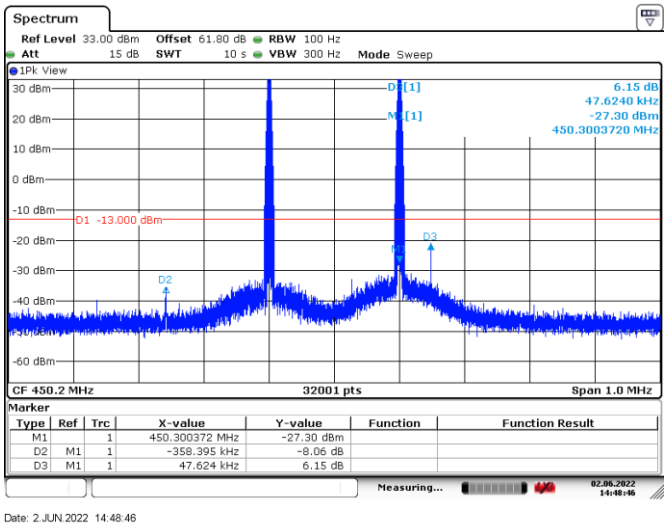
Figure 8.5-22: *Conducted spurious emissions for 7K60FXW modulation @50W – 1 GHz-6 GHz at 459.9 MHz*

Test data, continued



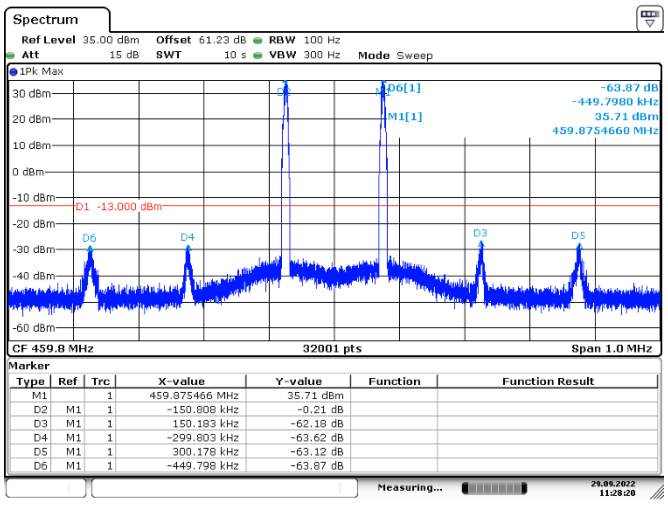
Date: 2.JUN.2022 14:42:08

Figure 8.5-23: *Conducted spurious emissions from inter-modulation for 7K60FXW modulation @ 2x15W –within 449.7 MHz-450.7 MHz*



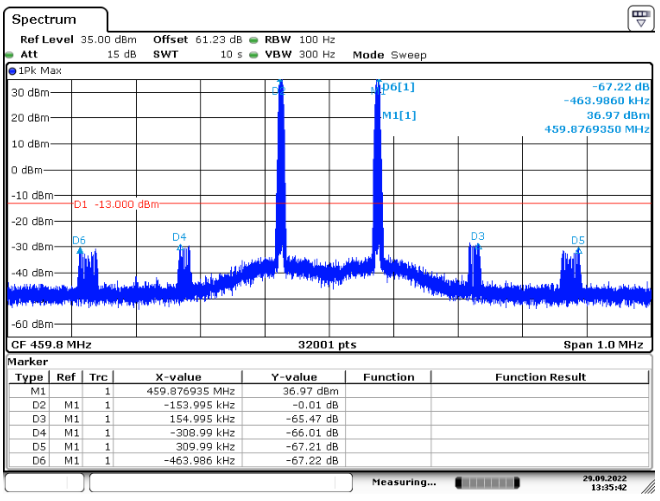
Date: 2.JUN.2022 14:48:46

Figure 8.5-24: *Conducted spurious emissions from inter-modulation for 16K0F3E modulation @ 2x15W –within 449.7 MHz-450.7 MHz*



Date: 29.SEP.2022 11:28:20

Figure 8.5-25: *Conducted spurious emissions from inter-modulation for 7K60FXW modulation @ 2x15W –within 459.3MHz-460.3MHz*



Date: 29.SEP.2022 13:35:43

Figure 8.5-26: *Conducted spurious emissions from inter-modulation for 16K0F3E modulation @ 2x15W – within 459.3MHz-460.3MHz*

Test data, continued

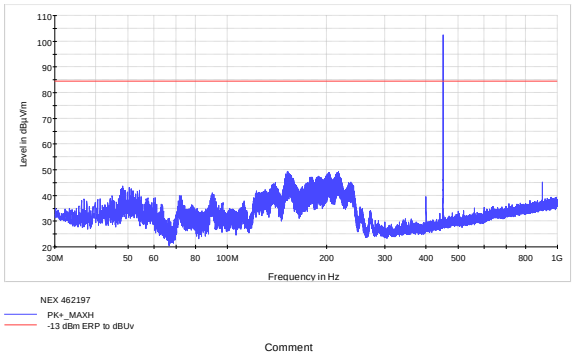


Figure 8.5-27: *Cabinet Radiated spurious emissions from 30MHz-1GHz for 7K60FXW modulation @50W for 450.1 MHz*

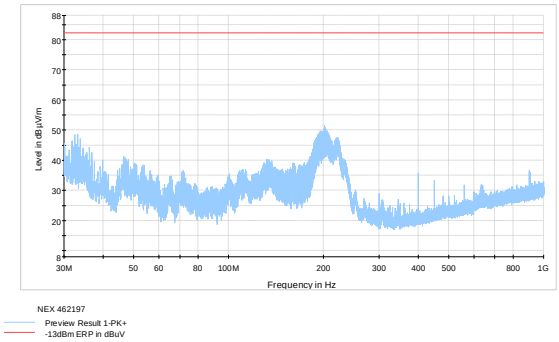


Figure 8.5-28: *Cabinet Radiated spurious emissions from 30MHz-1GHz for 16K0F3E modulation @50W for 450.1 MHz*

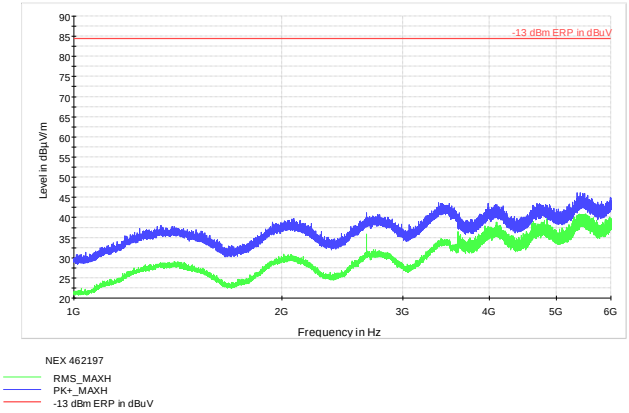


Figure 8.5-29: *Cabinet Radiated spurious emissions from 1GHz-6GHz for 7K60FXW modulation @50W for 450.1 MHz*

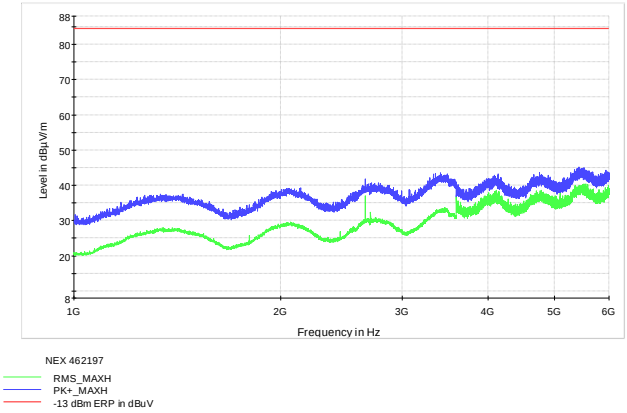


Figure 8.5-30: *Cabinet Radiated spurious emissions from 1GHz-6GHz for 16K0F3E modulation @50W for 450.1 MHz*

Test data, continued

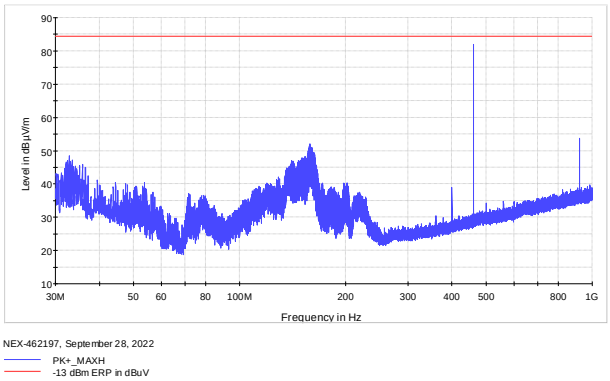


Figure 8.5-31: *Cabinet Radiated spurious emissions from 30MHz-1GHz for 7K60FXW modulation @50W for 459.9 MHz*

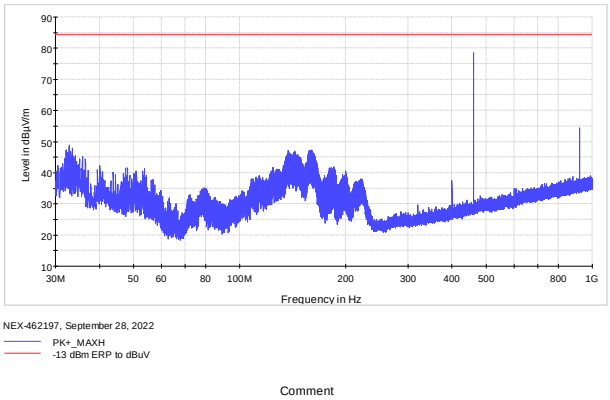


Figure 8.5-32: *Cabinet Radiated spurious emissions from 30MHz-1GHz for 16K0F3E modulation @50W for 459.9 MHz*

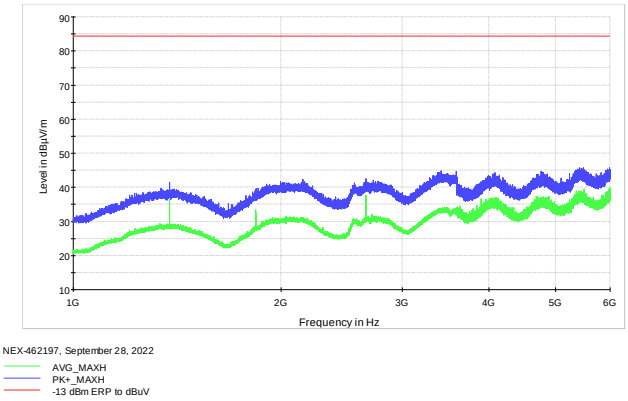


Figure 8.5-33: *Cabinet Radiated spurious emissions from 1GHz-6GHz for 7K60FXW modulation @50W for 459.9 MHz*

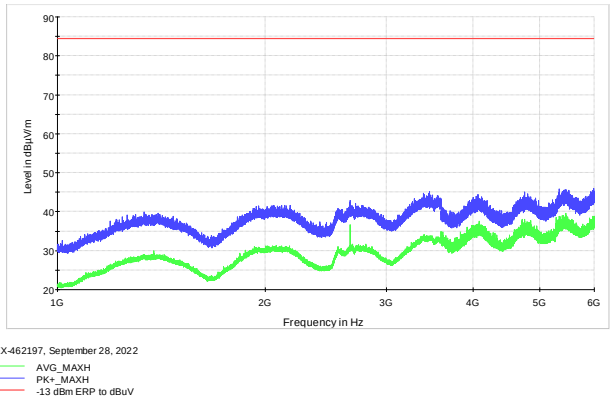


Figure 8.5-34: *Cabinet Radiated spurious emissions from 1GHz-6GHz for 16K0F3E modulation @50W for 459.9 MHz*

8.6 Transient frequency behavior

8.6.1 References, definitions and limits

FCC §15.214:

Transmitters designed to operate in the 421–512 MHz frequency band must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Table 8.6-1: *Transient frequency behavior*

Time intervals[1,2]	Maximum frequency difference[3]	Transient duration limit
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels		
t_1[4]	±25.0 kHz	10.0 ms
t_2	±12.5 kHz	25.0 ms
t_3[4]	±25.0 kHz	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels		
t_1[4]	±12.5 kHz	10.0 ms
t_2	±6.25 kHz	25.0 ms
t_3[4]	±12.5 kHz	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels		
t_1[4]	±6.25 kHz	10.0 ms
t_2	±3.125 kHz	25.0 ms
t_3[4]	±6.25 kHz	10.0 ms

Notes: [1]t_{on} is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.
t_1 is the time period immediately following t_{on}.
t_2 is the time period immediately following t_1.
t_3 is the time period from the instant when the transmitter is turned off until t_{off}.
t_{off} is the instant when the 1 kHz test signal starts to rise.
[2]During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in §90.213.
[3]Difference between the actual transmitter frequency and the assigned transmitter frequency.
[4]If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

References, definitions and limits, continued

RSS-119, Clause 5.9:

When a transmitter is turned on, the radio frequency may take some time to stabilize. During this initial period, the frequency error or frequency difference (i.e., between the instantaneous and the steady state frequencies) shall not exceed the limits specified in Table below.
Any suitable method of measurement can be used provided that it is fully described in the test report. A suitable and recommended method is given in TIA Standard 603.

Table 8.6-2: *Transient frequency behavior*

Channel Bandwidth, kHz	Time intervals[1,2]	Maximum frequency difference	Transient duration limit
25	t_1	±25.0 kHz	10.0 ms
	t_2	±12.5 kHz	25.0 ms
	t_3	±25.0 kHz	10.0 ms
12.5	t_1	±12.5 kHz	10.0 ms
	t_2	±6.25 kHz	25.0 ms
	t_3	±12.5 kHz	10.0 ms
6.25	t_1	±6.25 kHz	10.0 ms
	t_2	±3.125 kHz	25.0 ms
	t_3	±6.25 kHz	10.0 ms

Notes: [1]t_{on}: the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.
t_1: the time period immediately following t_{on}.
t_2: the time period immediately following t_1.
t_3: the time period from the instant when the transmitter is turned off until t_{off}.
t_{off}: the instant when the 1 kHz test signal starts to rise.
[2]If the transmitter carrier output power rating is 6 W or less, the frequency difference during the time periods t_1 and t_3 may exceed the maximum frequency difference for these time periods. The corresponding plot of frequency versus time during t_1 and t_3 shall be recorded in the test report.

8.6.2 Test summary

Verdict	Pass		
Tested by	Yong Huang & Kevin Rose	Test date	June 10, 2019

8.6.3 Observations, settings and special notes

Tests were performed as per test method described in ANSI C63.26, clause 6.5.2.2

8.6.4 Test data

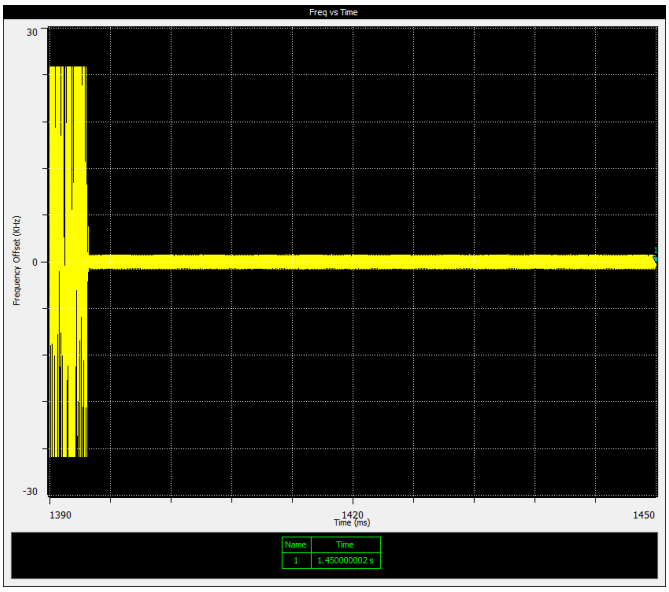


Figure 8.6-1: *Transient Frequency behavior, Tx @mid channel 25kHz channel, switch ON*

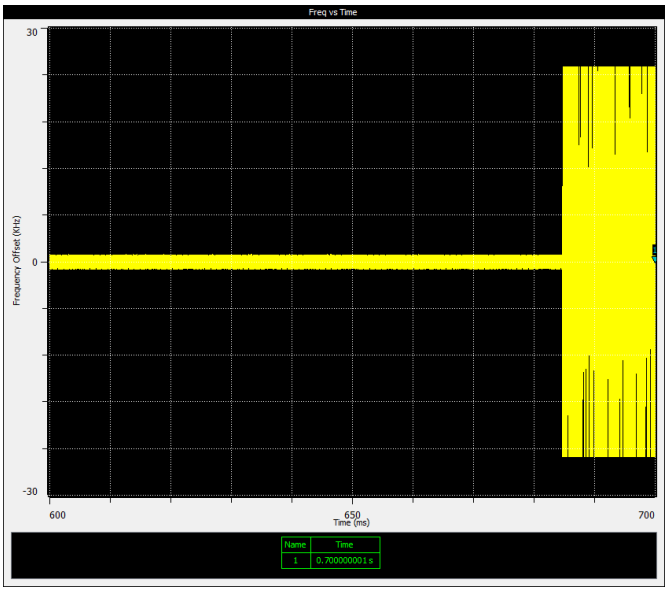


Figure 8.6-2: *Transient Frequency behavior, Tx @mid channel 25kHz channel, switch OFF*

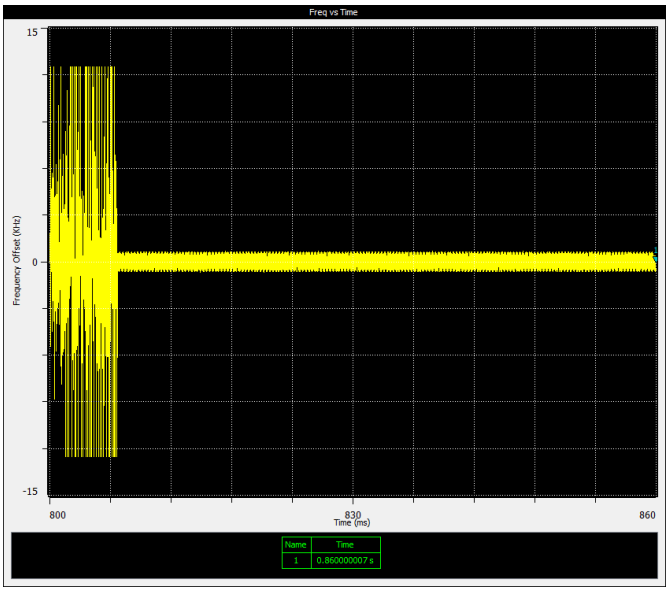


Figure 8.6-3: *Transient Frequency behavior, Tx @ mid channel 12.5 kHz channel, switch ON*

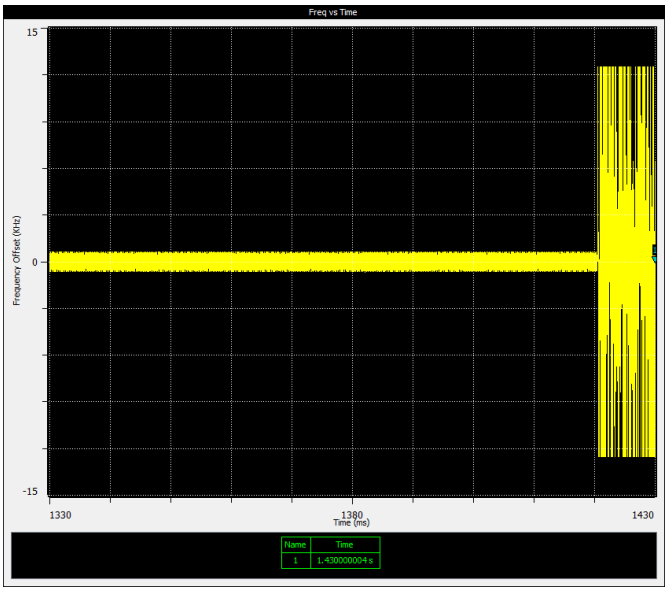


Figure 8.6-4: *Transient Frequency behavior, Tx @ mid channel 12.5 kHz channel, switch OFF*

Test data, continued

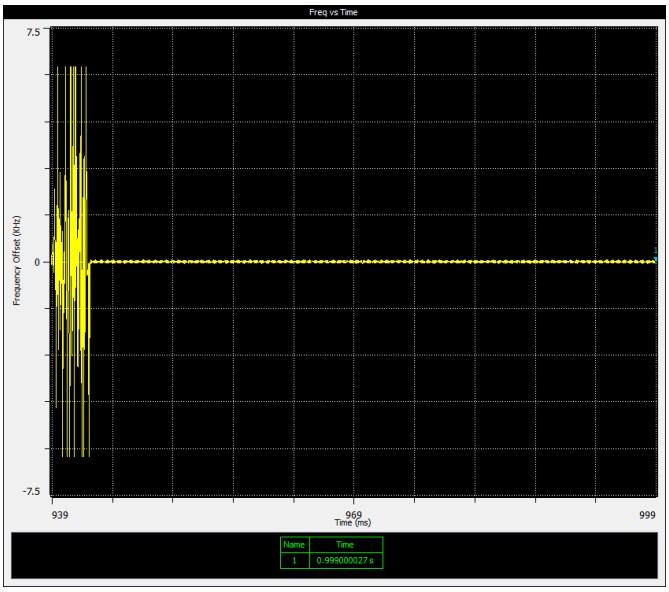


Figure 8.6-5: *Transient Frequency behavior, Tx @ mid channel 6.25 kHz channel, switch ON*

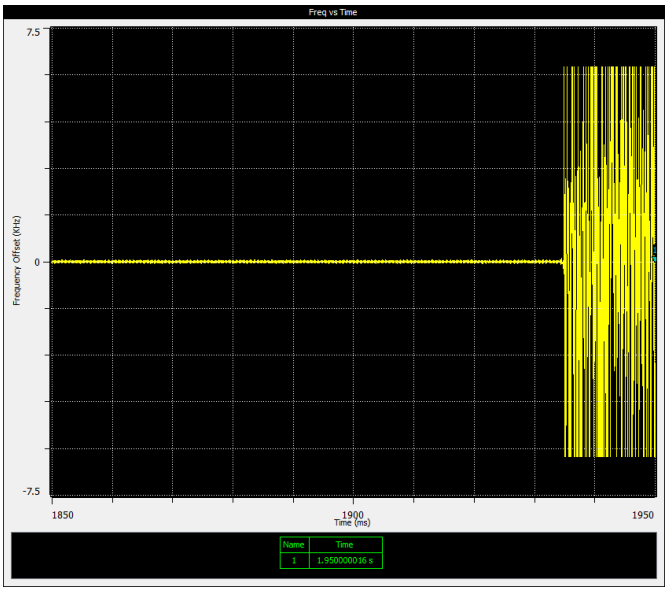


Figure 8.6-6: *Transient Frequency behavior, Tx @ mid channel 6.25 kHz channel, switch OFF*

8.7 Transmitter frequency stability

8.7.1 References, definitions and limits

FCC §90.213:

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

Table 8.7-1: *Minimum frequency stability*

Frequency range (MHz)	Fixed and base stations	Mobile stations over 2 watts output power	Mobile stations 2 watts or less output power
421–512	±2.5 ppm[1]	±5 ppm[2]	±5 ppm[2]

Notes: [1]In the 421–512 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 1.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 0.5 ppm.
[2]In the 421–512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

FCC §22.355:

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

Table 8.7-2: *Frequency Tolerance for Transmitters in the Public Mobile Services*

Frequency range (MHz)	Fixed and base stations (ppm)	Mobile stations >3 Watts (ppm)	Mobile stations ≤ 3 Watts (ppm)
25 to 50	20.0	20.0	50.0
50 to 450	5.0	5.0	
450 to 512	2.5	5.0	
821 to 896	1.5	2.5	
928 to 929	5.0	N/A	N/A
929 to 960	1.5	N/A	N/A
2110 to 2220	10.0	N/A	N/A

FCC §74.464:

For operations on frequencies above 25 MHz using authorized bandwidths up to 30 kHz, the licensee of a remote pickup broadcast station or system shall maintain the operating frequency of each station in compliance with the frequency tolerance requirements of § 90.213 of this chapter. For all other operations, the licensee of a remote pickup broadcast station or system shall maintain the operating frequency of each station in accordance with the following:

Table 8.7-3: *Frequency Tolerance in Base station and Mobile station*

Frequency range (MHz)	Tolerance (percent)	
	Base station	Mobile station
25 to 30 MHz:	-	-
3 W or less	.002	.005
Over 3 W	.002	.002
30 to 300 MHz:	-	-
3 W or less	.0005	.005
Over 3 W	.0005	.0005
300 to 500 MHz, all powers	.00025	.0005

References, definitions and limits, continued

RSS-119, Clause 5.3:

The carrier frequency shall not depart from the reference frequency in excess of the values given in Table below. For transmitters that have an output power of less than 120 mW, the frequency stability shall comply with the limits listed in Table below or, alternatively, with the conditions in Section 5.10.

For fixed and base station equipment, in lieu of meeting the frequency stability limit specified in Table below, the test report can show that the frequency stability is met by demonstrating that the unwanted emission limits, related to the equipment's nominal carrier frequency measured under normal operation, are met when the equipment is tested at the temperature and supply voltage variations specified for the frequency stability measurement in RSS-Gen.

Table 8.7-4: *Transmitter frequency stability*

Frequency range (MHz)	Channel bandwidth (kHz)	Frequency stability for Base/Fixed stations (±ppm)	Frequency stability for mobile stations with output power >2 W (±ppm)	Frequency stability for mobile stations with output power ≤2 W (±ppm)
450–470	25	2.5	5	5
	12.5	1.5	2.5	2.5
	6.25	0.5	1	1

8.7.2 Test summary

Verdict	Pass		
Tested by	Abdoulaye Ndiaye	Test date	September 29, 2022

8.7.3 Observations, settings and special notes

The tightest limit of 0.5 ppm was used to demonstrate compliance.

8.7.4 Test data

Table 8.7-5: *Transmitter frequency stability results*

Test conditions	Frequency, Hz	Drift, Hz	Drift, ppm	Limit ±ppm	Margin, ±ppm
+50 °C, Nominal	450099996.03	51.84	0.11	0.50	0.39
+40 °C, Nominal	450100012.34	68.16	0.15	0.50	0.35
+30 °C, Nominal	450100018.62	74.44	0.16	0.50	0.34
+20 °C, Max voltage	450099949.47	5.29	0.01	0.50	0.49
+20 °C, Nominal	450099944.18	Reference	Reference	Reference	Reference
+20 °C, Min voltage	450099950.56	6.38	0.01	0.50	0.49
+10 °C, Nominal	450099948.93	4.75	0.01	0.50	0.49
0 °C, Nominal	450099944.87	0.68	0.00	0.50	0.50
−10 °C, Nominal	450099951.40	7.22	0.01	0.50	0.49
−20 °C, Nominal	450099983.50	39.32	0.08	0.50	0.42
−30 °C, Nominal	450099989.90	45.72	0.10	0.50	0.40

End of the test report