

Test Report



INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 90 AND ISED CANADA REQUIREMENTS

Equipment Under Test: Radio module

Model: TR400900

Type: UHF Radio Module

Manufacturer: Trimble Inc.
4450 Gibson Drive
Tipp City, Ohio 45371
United States

Customer: Trimble Inc.
4450 Gibson Drive
Tipp City, Ohio 45371
United States

FCC Rule Part: 90: October 2019
IC Rule Part: RSS-119, Issue 12, May 2015
KDB: 971168 D01 Power Meas License Digital Systems
v03r01
Measurement Guidance for Certification of
Licensed Digital Transmitters
(April 9, 2018)

Date: 6 April 2022

Issued by:



Henri Mäki
Testing Engineer

Date: 6 April 2022

Checked by:



Pekka Kälviäinen
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GENERAL REMARKS

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Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.

RELEASE HISTORY

Version	Changes	Issued
1.0	Initial release	6 April 2022

PRODUCT DESCRIPTION

Equipment Under Test

Trade mark: Trimble
 Model: TR400900
 Type: UHF Radio Module
 Serial no: 2024000279
 FCC ID: S9E123130
 IC: 5817A-123130

General Description

The equipment under test is a dual-band radio module using 410-475 MHz / 902-928 MHz bands. Only one of the bands can be operated at a time. This test report contains the results for 400 MHz radio. The results for 900 MHz radio are presented in Test Report HELEM2103000053-8.

Classification

Fixed device
 Mobile Device (Human body distance > 20cm)
 Portable Device (Human body distance < 20cm)

Modifications Incorporated in the EUT

Modifications on September 4, 2020:

The EUT firmware was updated to narrow the filtering on the TX side of the transceiver.

Modifications on November 3, 2020:

The EUT firmware was updated to implement the following additional data rates with GMSK modulation:

- 12.5 kHz channel width: 8 000, 9 600 bps
- 25.0 kHz channel width: 4 800, 16 000, 19 200 bps.

Ports and cables

Cable / Port	Description
Serial port RS232	Device configuration and data communication. Unshielded
DC input port	9-16 VDC (12 V used during testing)
Antenna port	50Ω TNC (female)

Specifications

Frequency: 410-430 MHz and 450-470 MHz
 Channel width: 12.5 kHz, 25 kHz
 Channel spacing: 12.5 kHz, 25 kHz
 Modulation: GMSK, 4FSK
 Carrier power: 0.1, 0.2, 0.5, 1 W
 Power supply: 3.8-4.4 VDC

Mechanical Size of the EUT

Height: 6.7 mm

Width: 36 mm

Length: 57 mm

Weight: 0.02 kg

Peripherals

Peripheral	Description / Usage
Test PC	Device configuration and monitoring with programs supplied by customer.

SUMMARY OF TESTING

Test Specification	Description of Test	Result
§90.205 / RSS-119 5.4	Transmitter output power	PASS
§90.210 / RSS-119 5.5	Occupied bandwidth	PASS
§90.210 / RSS-119 5.5	Spectrum emission mask	PASS
§90.210 / RSS-119 5.8	Spurious emissions (conducted)	PASS
§90.210 / RSS-119 5.8	Spurious emissions (radiated)	PASS
§90.213 / RSS-119 5.3	Frequency stability	PASS
§90.214 / RSS-119 5.9	Transient frequency behaviour	PASS

The decision rule applied for the tests results stated in this test report is according to the requirements of section 1.3 of ANSI C63.26-2015.

EUT Test Conditions

The EUT was in continuous transmit mode during all the tests. The EUT was configured into the wanted channel using software provided by the manufacturer. During the tests the EUT was mounted on an evaluation kit provided by the manufacturer (model M3-TR3 Evaluation kit).

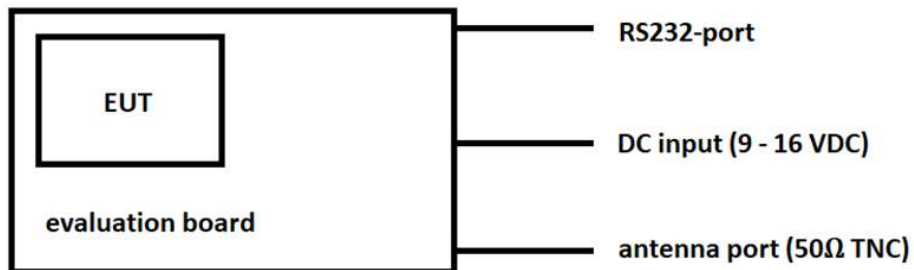


Figure 1: Test setup block diagram

Table 1: Transmission mode of the EUT

Channel width (kHz)	Modulation	On-air data rate [bps]
12.5	GMSK	4 800, 8 000, 9 600
	4FSK	9 600
25	GMSK	4 800, 9 600, 16 000, 19 200
	4FSK	19 200

Table 2: Test frequencies used in the tests

Channel	Frequency (MHz)
LOW	410.0
MID 1	429.5
MID 2	450.5
HIGH	469.5

Test Facility

Testing Laboratory / address: FCC designation number: FI0002 ISED CAB identifier: T004	SGS Fimko Ltd Takomotie 8 FI-00380, HELSINKI FINLAND
Test Site:	<input type="checkbox"/> K10LAB, ISED Canada registration number: 8708A-1 <input checked="" type="checkbox"/> K5LAB, ISED Canada registration number: 8708A-2 <input type="checkbox"/> T10LAB

TEST RESULTS

Transmitter output power

Standard:	ANSI C63.26 (2015)	
Tested by:	HEM	JAT
Date:	21-22 July 2020	3 November 2020
Temperature:	22 °C	23 °C
Humidity:	61 %RH	32 %RH
Measurement uncertainty:	± 0.470 dB	Level of confidence 95.45 % (k = 2)
Test result:	PASS	

FCC Rule: 90.205

RSS-119 5.4

The output power shall be within ±1 dB of the manufacturer's rated power listed in the equipment specifications.

The test was performed with a spectrum analyser with following settings:

Span:	200 kHz
RBW:	30 kHz
VBW:	100 kHz
Sweep points:	32001
Sweep time:	Auto
Detector:	Positive Peak

The worst-case test result figures are presented with 1000 mW rated output power.

Transmitter output power
Test results
Table 3. Rated output power 100 mW (20.00 dBm)

Frequency (MHz)	Ch. Spacing (kHz)	Modulation	Data Rate [bps]	Measured Output Power (dBm)	Result
410.0	12.5	GMSK	4 800	19.64	PASS
410.0	12.5	4FSK	9 600	19.62	PASS
410.0	25	GMSK	9 600	19.64	PASS
410.0	25	4FSK	19 200	19.61	PASS
429.5	12.5	GMSK	4 800	19.46	PASS
429.5	12.5	4FSK	9 600	19.68	PASS
429.5	25	GMSK	9 600	19.45	PASS
429.5	25	4FSK	19 200	19.63	PASS
450.5	12.5	GMSK	4 800	19.42	PASS
450.5	12.5	4FSK	9 600	19.40	PASS
450.5	25	GMSK	9 600	19.42	PASS
450.5	25	4FSK	19 200	19.40	PASS
469.5	12.5	GMSK	4 800	19.75	PASS
469.5	12.5	4FSK	9 600	19.74	PASS
469.5	25	GMSK	9 600	19.75	PASS
469.5	25	4FSK	19 200	19.74	PASS

Table 4. Rated output power 200 mW (23.01 dBm)

Frequency (MHz)	Ch. Spacing (kHz)	Modulation	Data Rate [bps]	Measured Output Power (dBm)	Result
410.0	12.5	GMSK	4 800	22.91	PASS
410.0	12.5	4FSK	9 600	22.88	PASS
410.0	25	GMSK	9 600	22.91	PASS
410.0	25	4FSK	19 200	22.89	PASS
429.5	12.5	GMSK	4 800	22.48	PASS
429.5	12.5	4FSK	9 600	22.60	PASS
429.5	25	GMSK	9 600	22.48	PASS
429.5	25	4FSK	19 200	22.64	PASS
450.5	12.5	GMSK	4 800	22.29	PASS
450.5	12.5	4FSK	9 600	22.26	PASS
450.5	25	GMSK	9 600	22.28	PASS
450.5	25	4FSK	19 200	22.27	PASS
469.5	12.5	GMSK	4 800	22.52	PASS
469.5	12.5	4FSK	9 600	22.50	PASS
469.5	25	GMSK	9 600	22.52	PASS
469.5	25	4FSK	19 200	22.51	PASS

Table 5. Rated output power 500 mW (26.99 dBm)

Frequency (MHz)	Ch. Spacing (kHz)	Modulation	Data Rate [bps]	Measured Output Power (dBm)	Result
410.0	12.5	GMSK	4 800	26.56	PASS
410.0	12.5	4FSK	9 600	26.52	PASS
410.0	25	GMSK	9 600	26.56	PASS
410.0	25	4FSK	19 200	26.52	PASS
429.5	12.5	GMSK	4 800	26.34	PASS
429.5	12.5	4FSK	9 600	26.45	PASS
429.5	25	GMSK	9 600	26.33	PASS
429.5	25	4FSK	19 200	26.44	PASS
450.5	12.5	GMSK	4 800	26.36	PASS
450.5	12.5	4FSK	9 600	26.34	PASS
450.5	25	GMSK	9 600	26.36	PASS
450.5	25	4FSK	19 200	26.34	PASS
469.5	12.5	GMSK	4 800	26.74	PASS
469.5	12.5	4FSK	9 600	26.72	PASS
469.5	25	GMSK	9 600	26.73	PASS
469.5	25	4FSK	19 200	26.72	PASS

Transmitter output power
Table 6. Rated output power 1000 mW (30.00 dBm)

Frequency (MHz)	Ch. Spacing (kHz)	Modulation	Data Rate [bps]	Measured Output Power (dBm)	Result
410.0	12.5	GMSK	4 800	29.38	PASS
410.0	12.5	GMSK	8 000	29.18	PASS
410.0	12.5	GMSK	9 600	29.19	PASS
410.0	12.5	4FSK	9 600	29.33	PASS
410.0	25	GMSK	4 800	29.19	PASS
410.0	25	GMSK	9 600	29.37	PASS
410.0	25	GMSK	16 000	29.22	PASS
410.0	25	GMSK	19 200	29.22	PASS
410.0	25	4FSK	19 200	29.33	PASS
429.5	12.5	GMSK	4 800	29.41	PASS
429.5	12.5	GMSK	8 000	29.33	PASS
429.5	12.5	GMSK	9 600	29.34	PASS
429.5	12.5	4FSK	9 600	29.46	PASS
429.5	25	GMSK	4 800	29.34	PASS
429.5	25	GMSK	9 600	29.41	PASS
429.5	25	GMSK	16 000	29.34	PASS
429.5	25	GMSK	19 200	29.35	PASS
429.5	25	4FSK	19 200	29.47	PASS
450.5	12.5	GMSK	4 800	29.29	PASS
450.5	12.5	GMSK	8 000	29.23	PASS
450.5	12.5	GMSK	9 600	29.24	PASS
450.5	12.5	4FSK	9 600	29.27	PASS
450.5	25	GMSK	4 800	29.24	PASS
450.5	25	GMSK	9 600	29.29	PASS
450.5	25	GMSK	16 000	29.25	PASS
450.5	25	GMSK	19 200	29.24	PASS
450.5	25	4FSK	19 200	29.27	PASS
469.5	12.5	GMSK	4 800	29.38	PASS
469.5	12.5	GMSK	8 000	29.29	PASS
469.5	12.5	GMSK	9 600	29.28	PASS
469.5	12.5	4FSK	9 600	29.36	PASS
469.5	25	GMSK	4 800	29.30	PASS
469.5	25	GMSK	9 600	29.38	PASS
469.5	25	GMSK	16 000	29.28	PASS
469.5	25	GMSK	19 200	29.28	PASS
469.5	25	4FSK	19 200	29.36	PASS

Transmitter output power

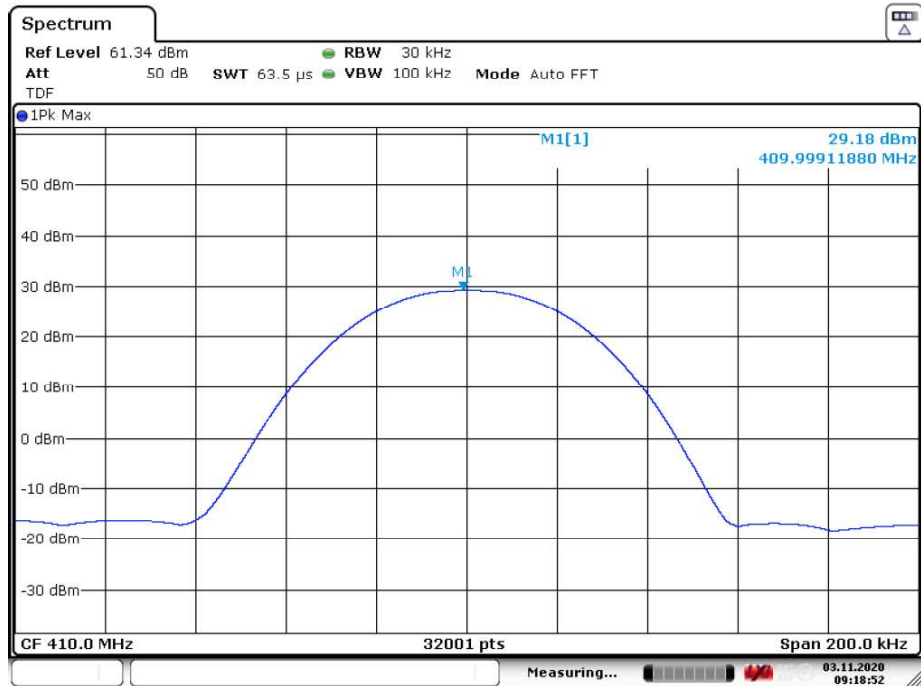


Figure 2: Transmitter output power (410.0 MHz, 12.5 kHz channel width, GMSK, 8000 bps)

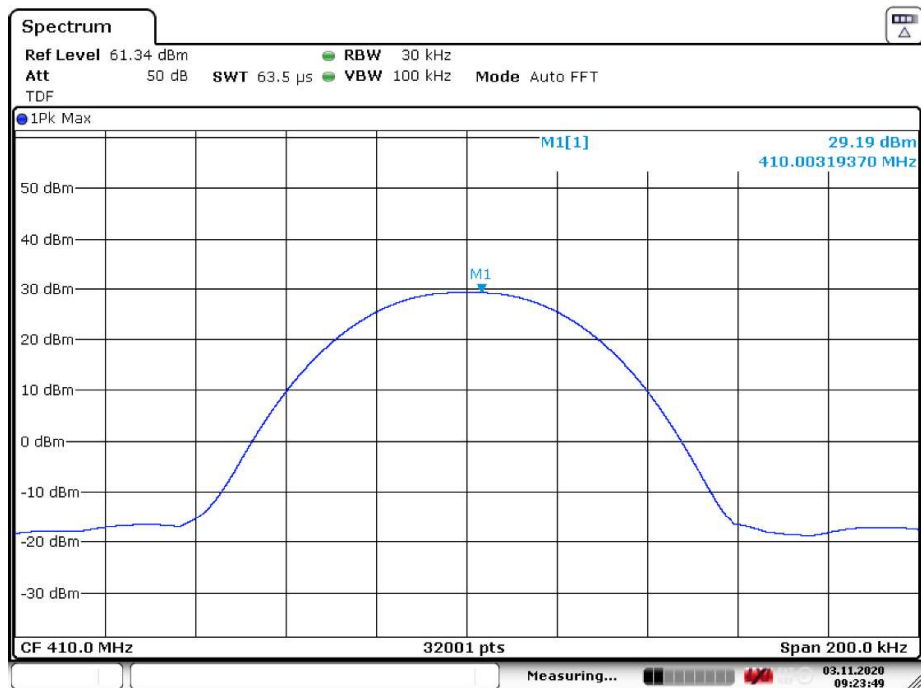


Figure 3: Transmitter output power (410.0 MHz, 25 kHz channel width, GMSK, 4800 bps)

Occupied bandwidth

Standard:	ANSI C63.26 (2015)	
Tested by:	HEM	JAT
Date:	21 July 2020	3 November 2020
Temperature:	22 °C	23 °C
Humidity:	61 %RH	32 %RH
Measurement uncertainty:	± 0.0005 %	Level of confidence 95.45 % (k = 2)
Test result:	PASS	

FCC Rule: 90.210 RSS-119 5.5

The occupied bandwidth is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained.

The maximum permissible occupied bandwidth shall not exceed the authorized bandwidth specified 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 licenses.

Frequency Band (MHz)	Channel Bandwidth (kHz)	Authorized Bandwidth (kHz)
406.1-430 and 450-470	12.5	11.25
	25	20

The test was performed with a spectrum analyser with following settings:

Channel Bandwidth:	12.5 kHz	25 kHz
Span:	20 kHz	50 kHz
RBW:	200 Hz	500 Hz
VBW:	1 kHz	2 kHz
Sweep points:	32001	32001
Sweep time:	Auto	Auto
Detector:	Positive Peak	Positive Peak

Test results
Table 7: Occupied bandwidth test results

Frequency (MHz)	Ch. Spacing (kHz)	Modulation	Data Rate [bps]	Occupied Bandwidth (kHz)	Result
410.0	12.5	GMSK	4 800	8.528	PASS
410.0	12.5	GMSK	8 000	7.760	PASS
410.0	12.5	GMSK	9 600	8.063	PASS
410.0	12.5	4FSK	9 600	7.761	PASS
410.0	25	GMSK	4 800	9.525	PASS
410.0	25	GMSK	9 600	10.392	PASS
410.0	25	GMSK	16 000	12.882	PASS
410.0	25	GMSK	19 200	15.335	PASS
410.0	25	4FSK	19 200	14.646	PASS
429.5	12.5	GMSK	4 800	8.513	PASS
429.5	12.5	GMSK	8 000	7.749	PASS
429.5	12.5	GMSK	9 600	8.065	PASS
429.5	12.5	4FSK	9 600	7.725	PASS
429.5	25	GMSK	4 800	9.523	PASS
429.5	25	GMSK	9 600	10.398	PASS
429.5	25	GMSK	16 000	15.876	PASS
429.5	25	GMSK	19 200	15.860	PASS
429.5	25	4FSK	19 200	14.667	PASS
450.5	12.5	GMSK	4 800	8.504	PASS
450.5	12.5	GMSK	8 000	7.747	PASS
450.5	12.5	GMSK	9 600	8.063	PASS
450.5	12.5	4FSK	9 600	7.707	PASS
450.5	25	GMSK	4 800	9.533	PASS
450.5	25	GMSK	9 600	10.414	PASS
450.5	25	GMSK	16 000	15.925	PASS
450.5	25	GMSK	19 200	15.901	PASS
450.5	25	4FSK	19 200	14.532	PASS
469.5	12.5	GMSK	4 800	8.528	PASS
469.5	12.5	GMSK	8 000	7.747	PASS
469.5	12.5	GMSK	9 600	8.061	PASS
469.5	12.5	4FSK	9 600	7.702	PASS
469.5	25	GMSK	4 800	9.537	PASS
469.5	25	GMSK	9 600	10.384	PASS
469.5	25	GMSK	16 000	15.493	PASS
469.5	25	GMSK	19 200	15.606	PASS
469.5	25	4FSK	19 200	14.632	PASS

EUT frequency 410.0 MHz

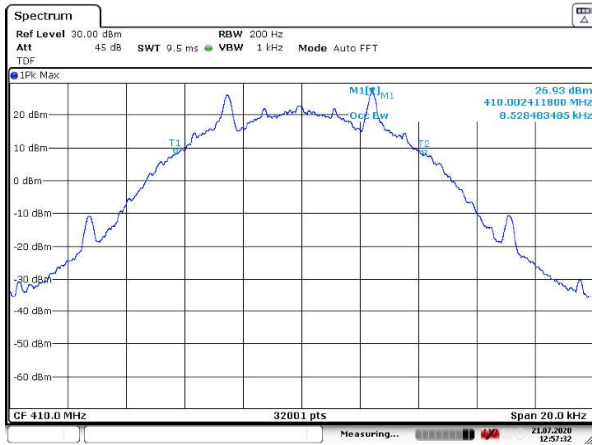


Figure 4: OBW (GMSK, 12.5 kHz, 4800bps)

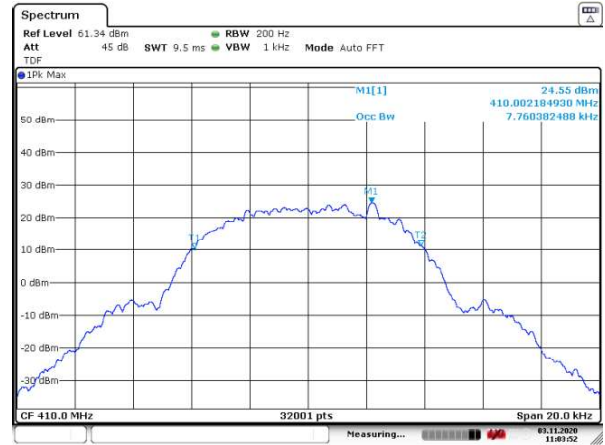


Figure 5: OBW (GMSK, 12.5 kHz, 8000bps)

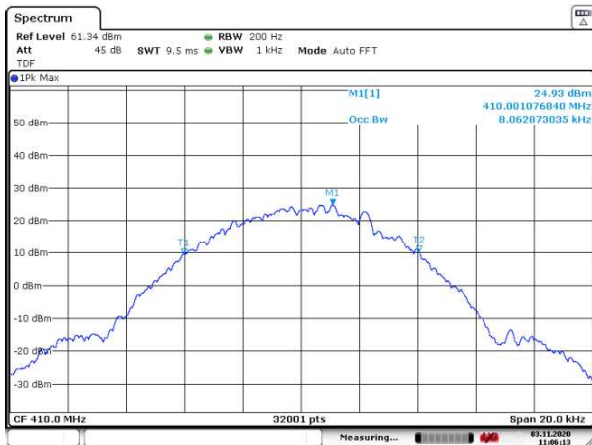


Figure 6: OBW (GMSK, 12.5 kHz, 9600bps)

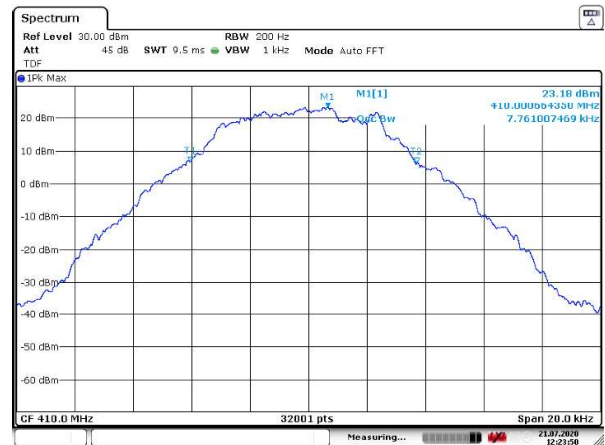


Figure 7: OBW (4FSK, 12.5 kHz, 9600bps)

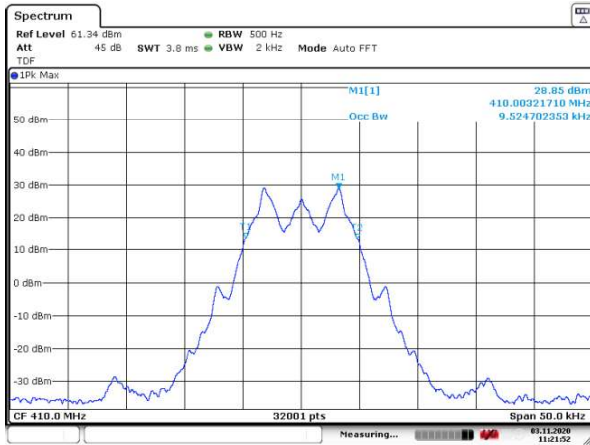


Figure 8: OBW (GMSK, 25 kHz, 4800bps)

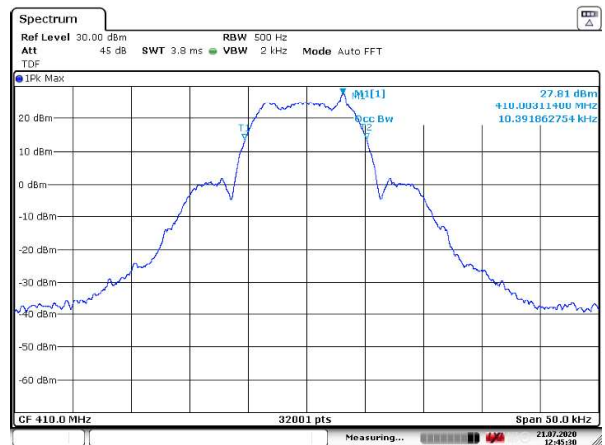


Figure 9: OBW (GMSK, 25 kHz, 9600bps)

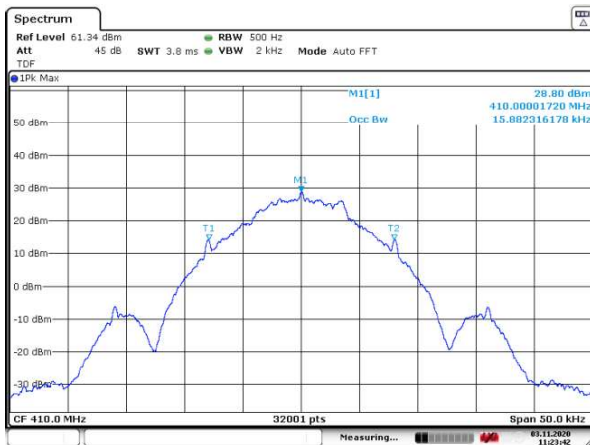


Figure 10: OBW (GMSK, 25 kHz, 16000bps)

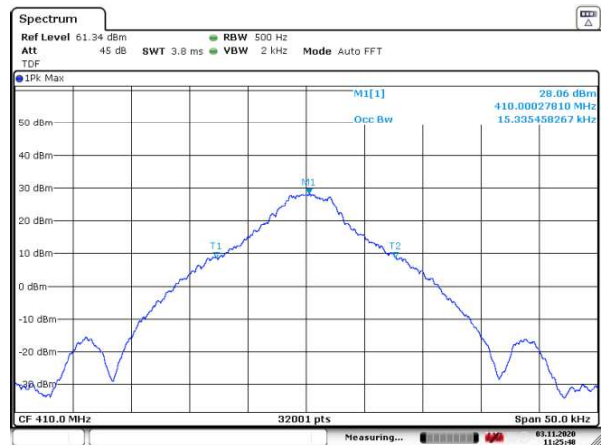


Figure 11: OBW (GMSK, 25 kHz, 19200bps)



Figure 12: OBW (4FSK, 25 kHz, 19200bps)

EUT frequency 429.5 MHz

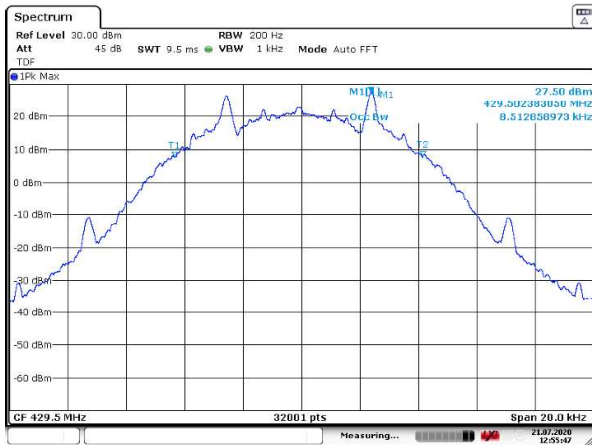


Figure 13: OBW (GMSK, 12.5 kHz, 4800bps)

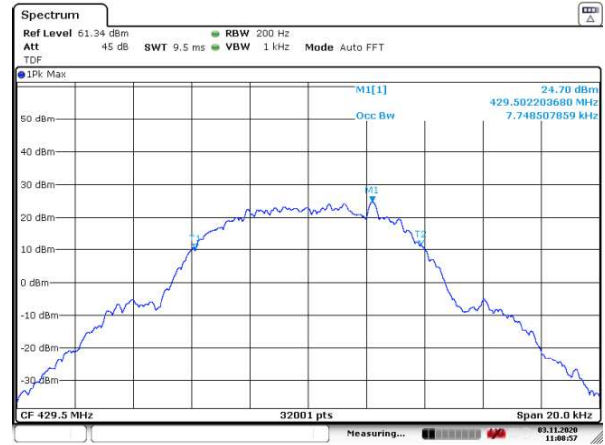


Figure 14: OBW (GMSK, 12.5 kHz, 8000bps)

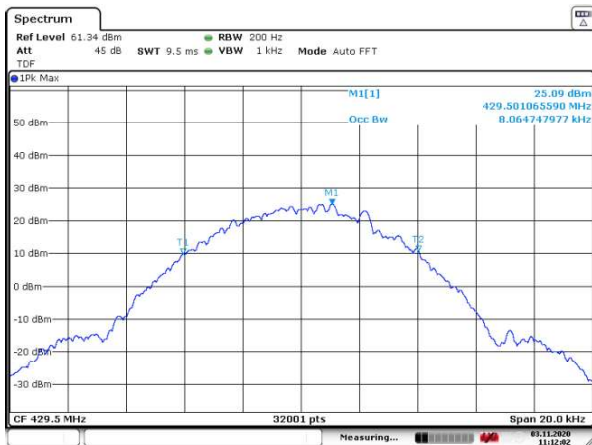


Figure 15: OBW (GMSK, 12.5 kHz, 9600bps)

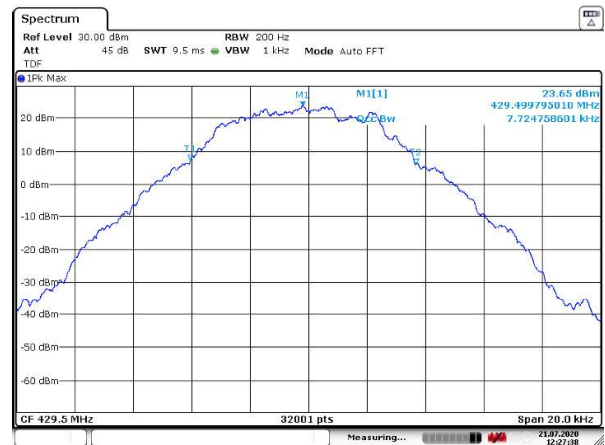


Figure 16: OBW (4FSK, 12.5 kHz, 9600bps)

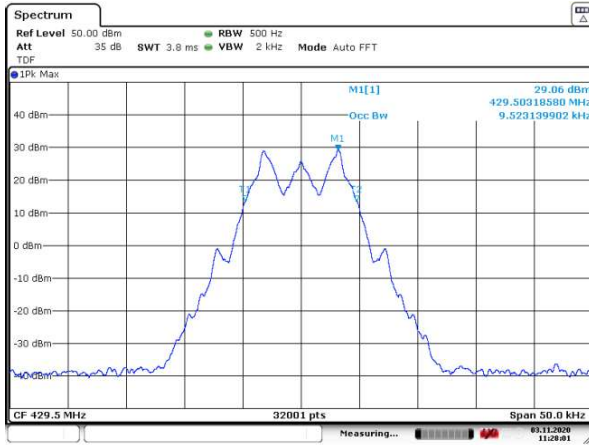


Figure 17: OBW (GMSK, 25 kHz, 4800bps)

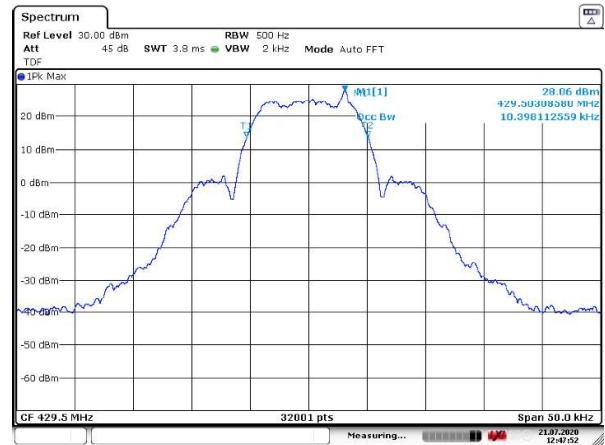


Figure 18: OBW (GMSK, 25 kHz, 9600bps)

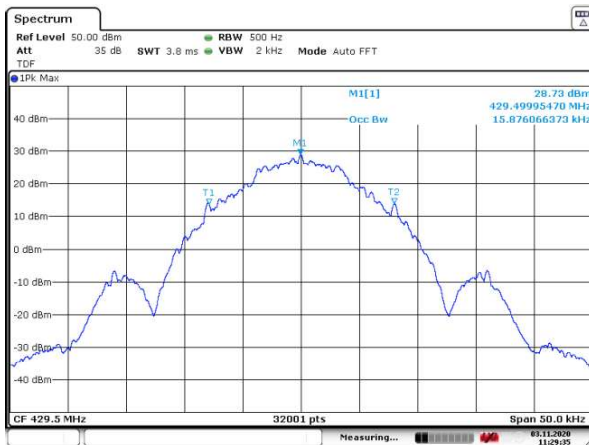


Figure 19: OBW (GMSK, 25 kHz, 16000bps)

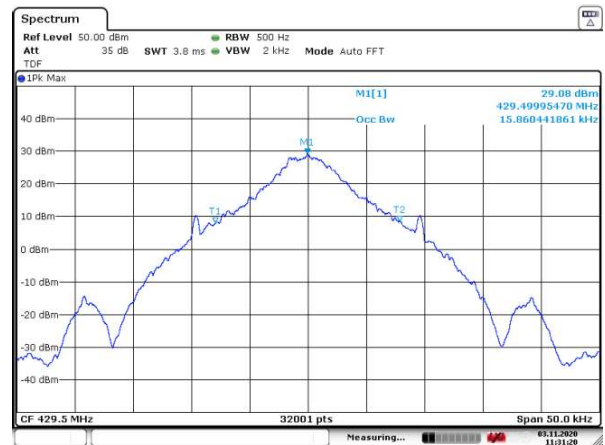


Figure 20: OBW (GMSK, 25 kHz, 19200bps)

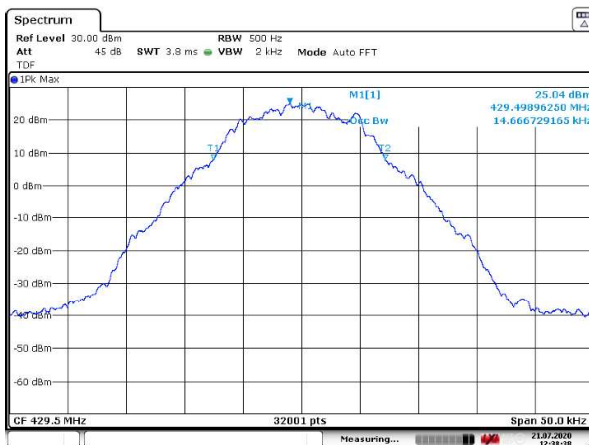


Figure 21: OBW (4FSK, 25 kHz, 19200bps)

EUT frequency 450.5 MHz

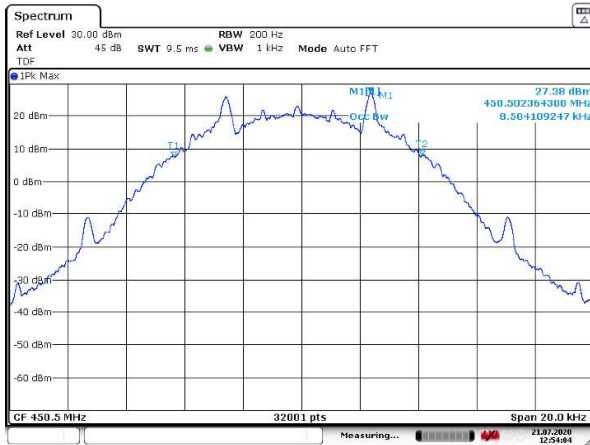


Figure 22: OBW (GMSK, 12.5 kHz, 4800bps)

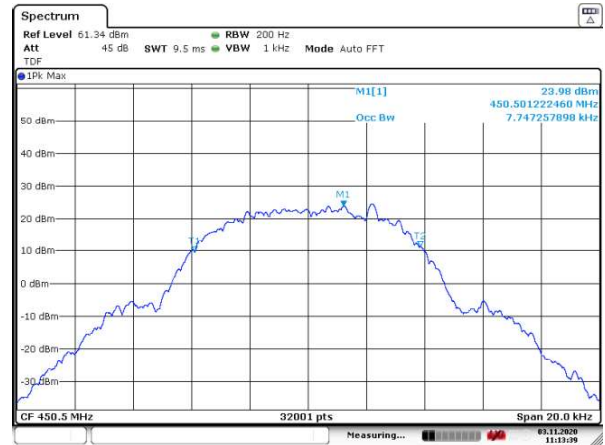


Figure 23: OBW (GMSK, 12.5 kHz, 8000bps)

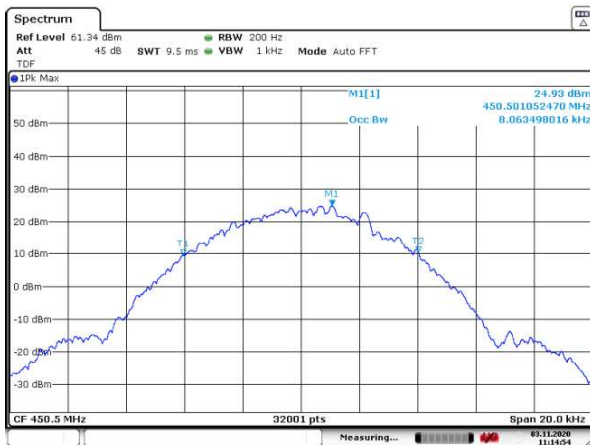


Figure 24: OBW (GMSK, 12.5 kHz, 9600bps)



Figure 25: OBW (4FSK, 12.5 kHz, 9600bps)

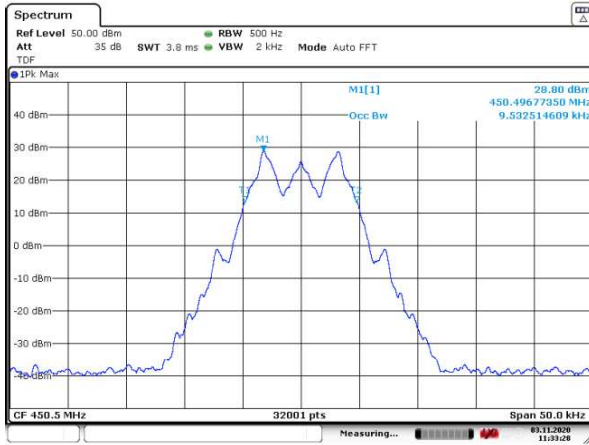


Figure 26: OBW (GMSK, 25 kHz, 4800bps)

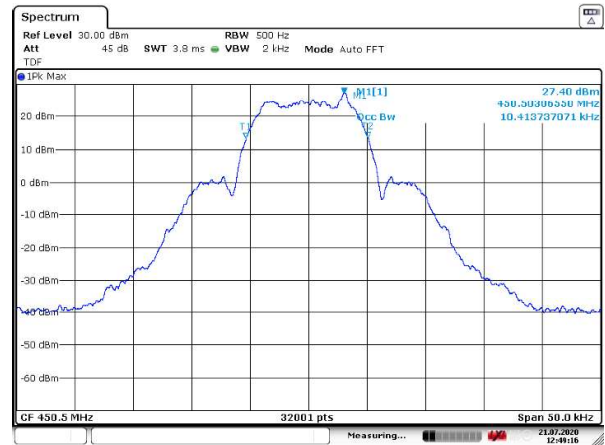


Figure 27: OBW (GMSK, 25 kHz, 9600bps)

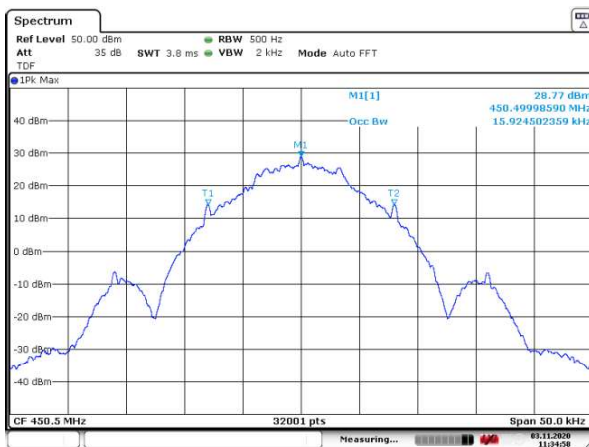


Figure 28: OBW (GMSK, 25 kHz, 16000bps)

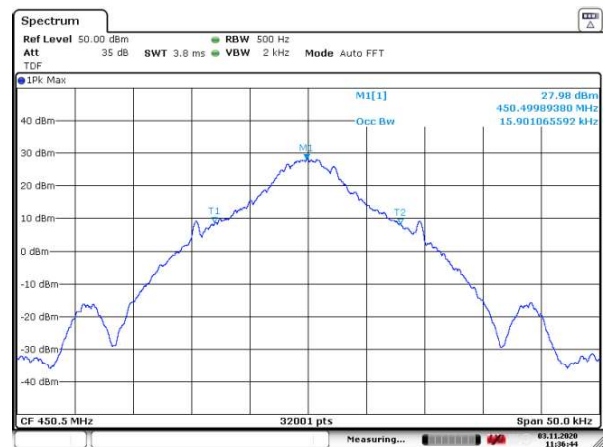


Figure 29: OBW (GMSK, 25 kHz, 19200bps)

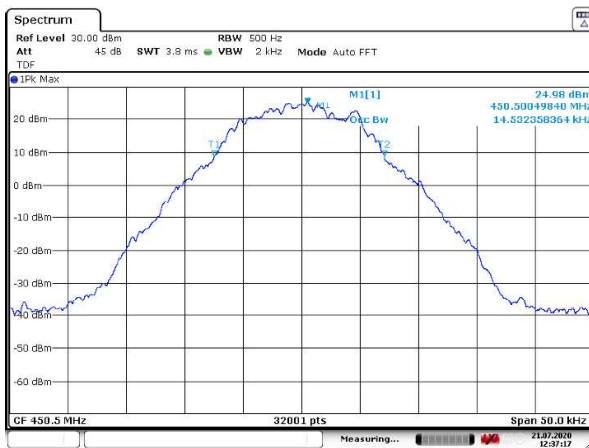


Figure 30: OBW (4FSK, 25 kHz, 19200bps)

EUT frequency 469.5 MHz

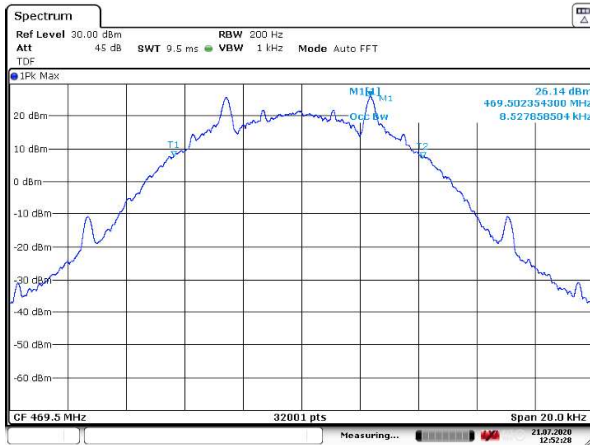


Figure 31: OBW (GMSK, 12.5 kHz, 4800bps)

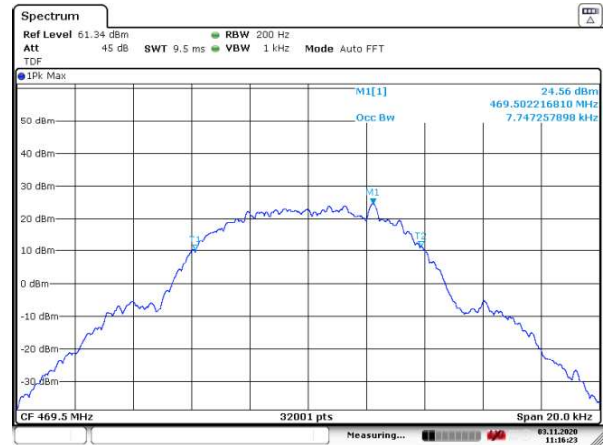


Figure 32: OBW (GMSK, 12.5 kHz, 8000bps)

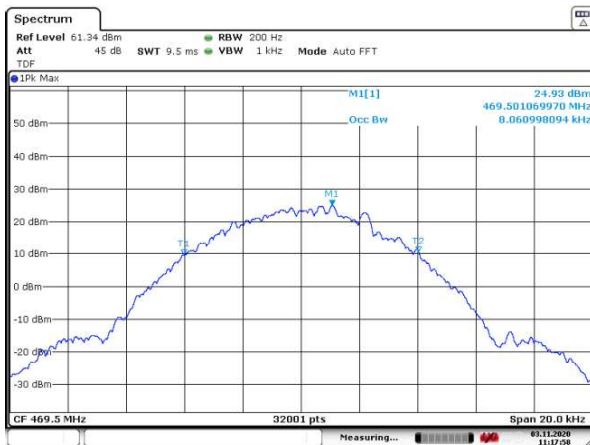


Figure 33: OBW (GMSK, 12.5 kHz, 9600bps)

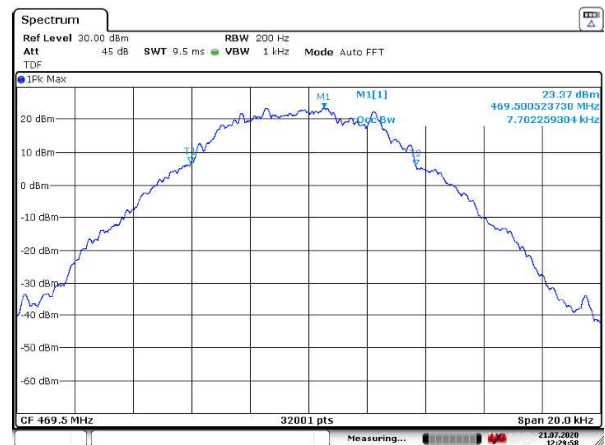


Figure 34: OBW (4FSK, 12.5 kHz, 9600bps)

Occupied bandwidth

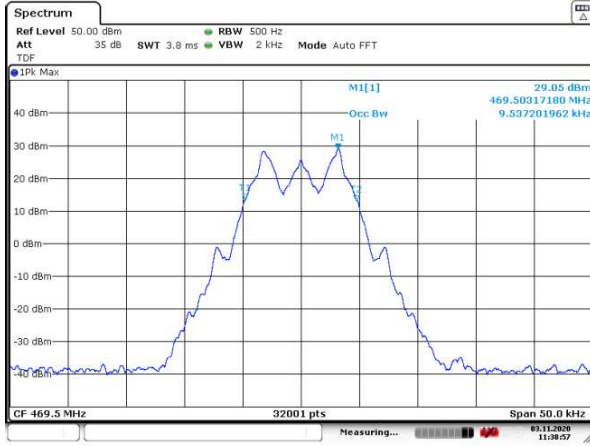


Figure 35: OBW (GMSK, 25 kHz, 4800bps)

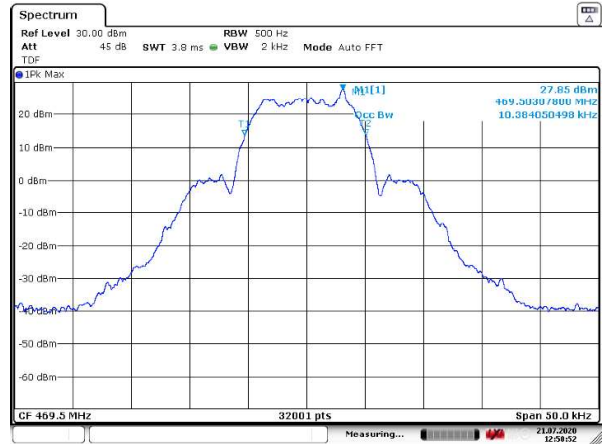


Figure 36: OBW (GMSK, 25 kHz, 9600bps)

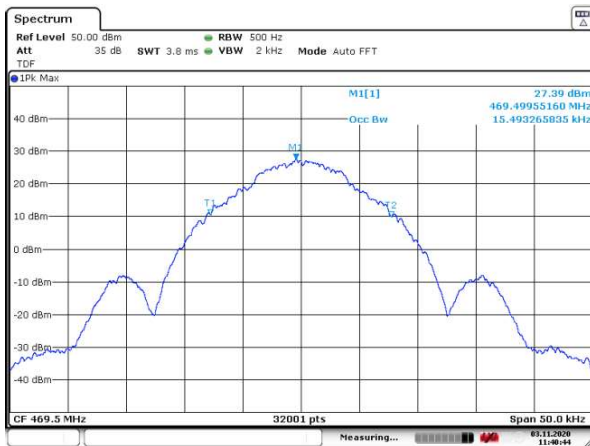


Figure 37: OBW (GMSK, 25 kHz, 16000bps)

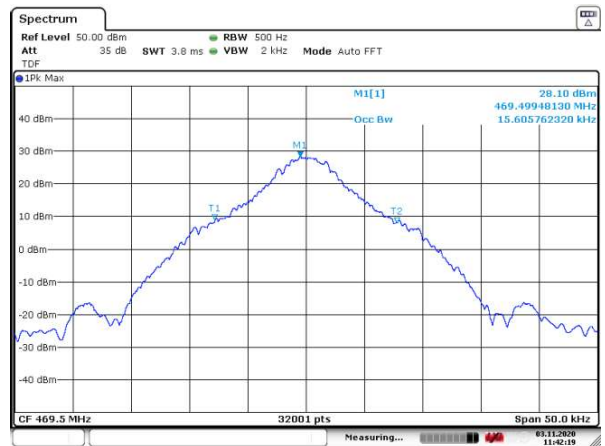


Figure 38: OBW (GMSK, 25 kHz, 19200bps)

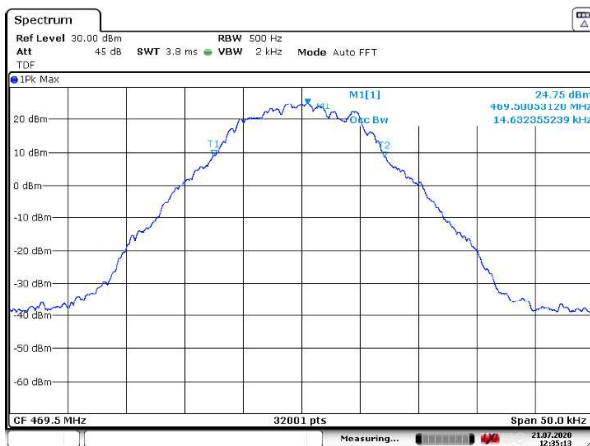


Figure 39: OBW (4FSK, 25 kHz, 19200bps)

Spurious emission mask

Standard:	ANSI C63.26 (2015)		
Tested by:	HEM	JAT	HEM
Date:	4 September 2020	3 November 2020	18 November 2020
Temperature:	22 °C	23 °C	22 °C
Humidity:	60 %RH	32 %RH	41 %RH
Measurement uncertainty:	± 2.90 dB	Level of confidence 95.45 % (k = 2)	
Test result:	PASS		

**FCC Rule: 90.210
RSS-119 5.5**

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

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 $7.27(f_d - 2.88 \text{ kHz})$ 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 $50 + 10 \log(P)$ or 70 dB, whichever is the lesser attenuation

The test was performed with a spectrum analyser with following settings:

	25 kHz (Mask C)	12.5 kHz (Mask D)
Channel Bandwidth:	25 kHz (Mask C)	12.5 kHz (Mask D)
Span:	100 kHz	50 kHz
RBW:	300 Hz	100 Hz
VBW:	1 kHz	300 Hz
Sweep points:	32001	32001
Sweep time:	Auto	Auto
Detector:	Positive Peak	Positive Peak

Spurious emission mask
Test Results

Frequency (MHz)	Ch. Spacing (kHz)	Modulation	Data Rate [bps]	Mask	Result
410.0	12.5	GMSK	4 800	D	PASS
410.0	12.5	GMSK	8 000	D	PASS
410.0	12.5	GMSK	9 600	D	PASS
410.0	12.5	4FSK	9 600	D	PASS
410.0	25	GMSK	4 800	C	PASS
410.0	25	GMSK	9 600	C	PASS
410.0	25	GMSK	16 000	C	PASS
410.0	25	GMSK	19 200	C	PASS
410.0	25	4FSK	19 200	C	PASS
429.5	12.5	GMSK	4 800	D	PASS
429.5	12.5	GMSK	8 000	D	PASS
429.5	12.5	GMSK	9 600	D	PASS
429.5	12.5	4FSK	9 600	D	PASS
429.5	25	GMSK	4 800	C	PASS
429.5	25	GMSK	9 600	C	PASS
429.5	25	GMSK	16 000	C	PASS
429.5	25	GMSK	19 200	C	PASS
429.5	25	4FSK	19 200	C	PASS
450.5	12.5	GMSK	4 800	D	PASS
450.5	12.5	GMSK	8 000	D	PASS
450.5	12.5	GMSK	9 600	D	PASS
450.5	12.5	4FSK	9 600	D	PASS
450.5	25	GMSK	4 800	C	PASS
450.5	25	GMSK	9 600	C	PASS
450.5	25	GMSK	16 000	C	PASS
450.5	25	GMSK	19 200	C	PASS
450.5	25	4FSK	19 200	C	PASS
469.5	12.5	GMSK	4 800	D	PASS
469.5	12.5	GMSK	8 000	D	PASS
469.5	12.5	GMSK	9 600	D	PASS
469.5	12.5	4FSK	9 600	D	PASS
469.5	25	GMSK	4 800	C	PASS
469.5	25	GMSK	9 600	C	PASS
469.5	25	GMSK	16 000	C	PASS
469.5	25	GMSK	19 200	C	PASS
469.5	25	4FSK	19 200	C	PASS

Emission Mask C (25 kHz, GMSK, 4800bps)

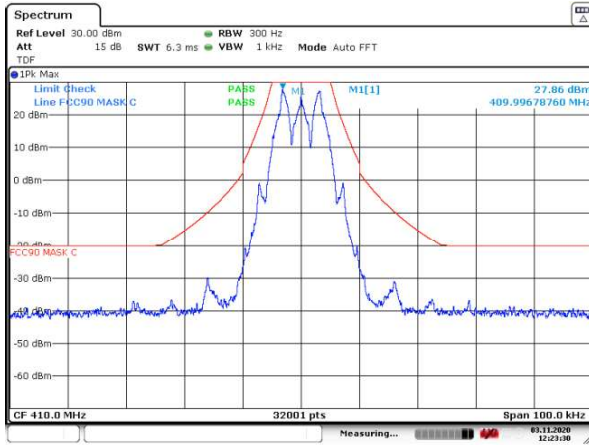


Figure 40: 410.0 MHz, 25 kHz, GMSK, 4800bps

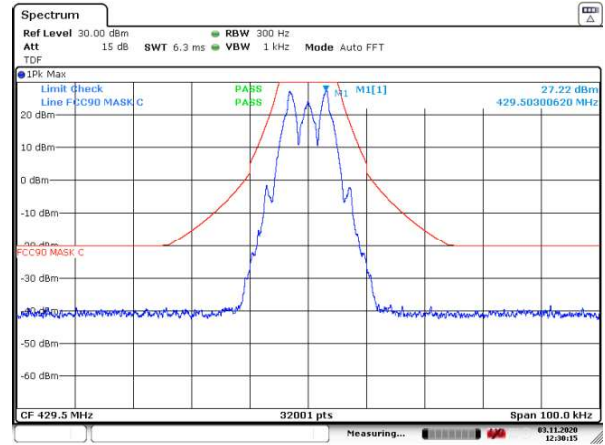


Figure 41: 429.5 MHz, 25 kHz, GMSK, 4800bps

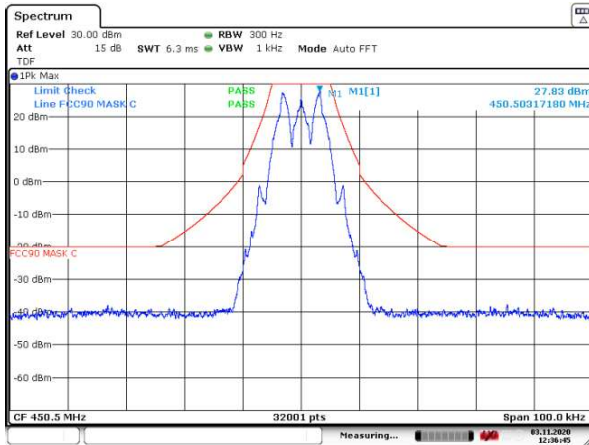


Figure 42: 450.5 MHz, 25 kHz, GMSK, 4800bps

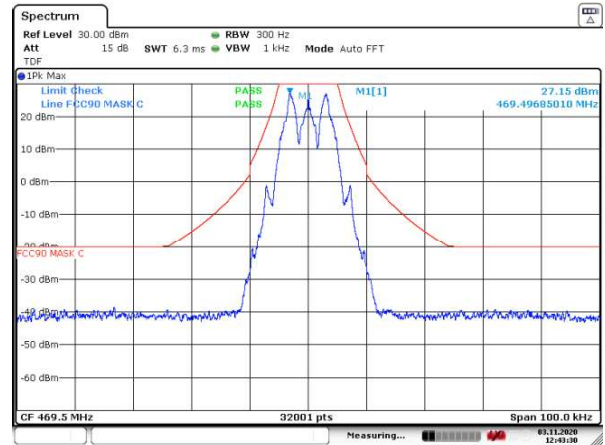


Figure 43: 469.5 MHz, 25 kHz, GMSK, 4800bps

Emission Mask C (25 kHz, GMSK, 9600bps)

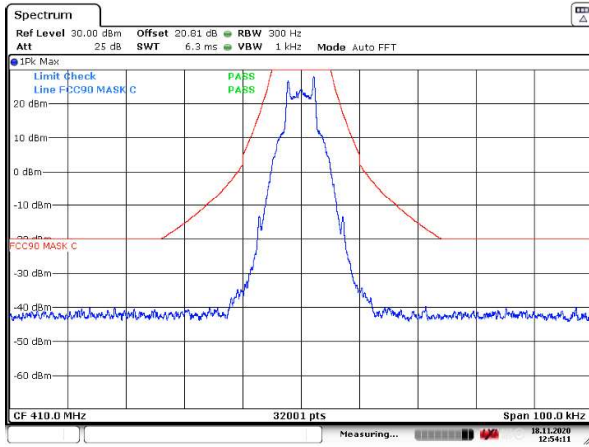


Figure 44: 410.0 MHz, 25 kHz, GMSK, 9600bps

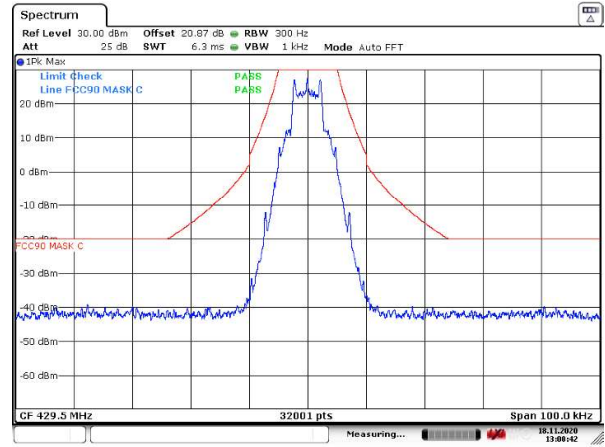


Figure 45: 429.5 MHz, 25 kHz, GMSK, 9600bps

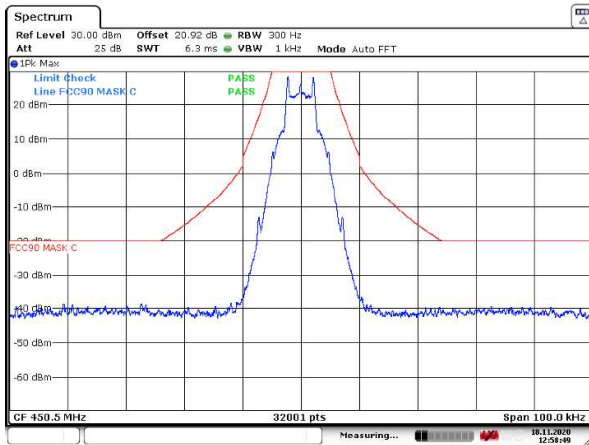


Figure 46: 450.5 MHz, 25 kHz, GMSK, 9600bps

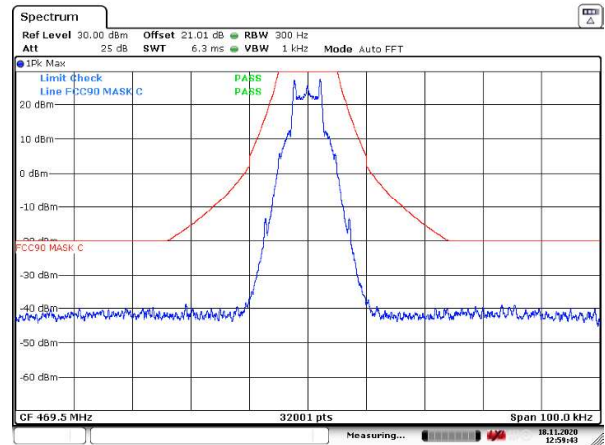


Figure 47: 469.5 MHz, 25 kHz, GMSK, 9600bps

Emission Mask C (25 kHz, GMSK, 16000bps)

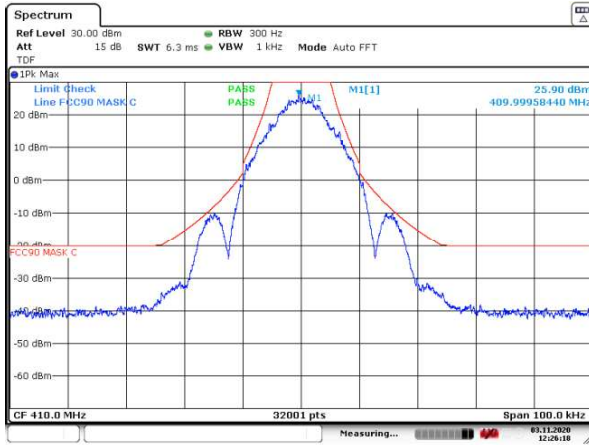


Figure 48: 410.0 MHz, 25 kHz, GMSK, 16000bps

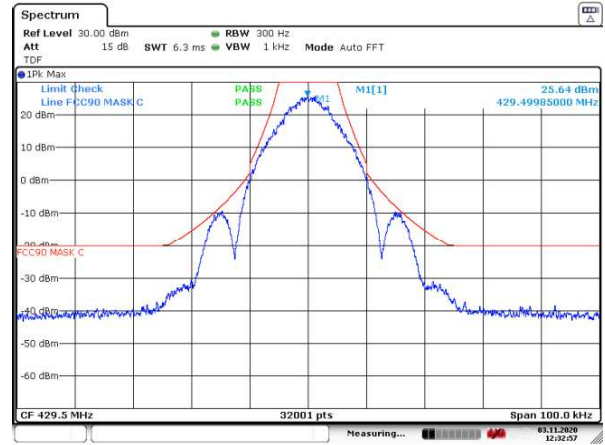


Figure 49: 429.5 MHz, 25 kHz, GMSK, 16000bps

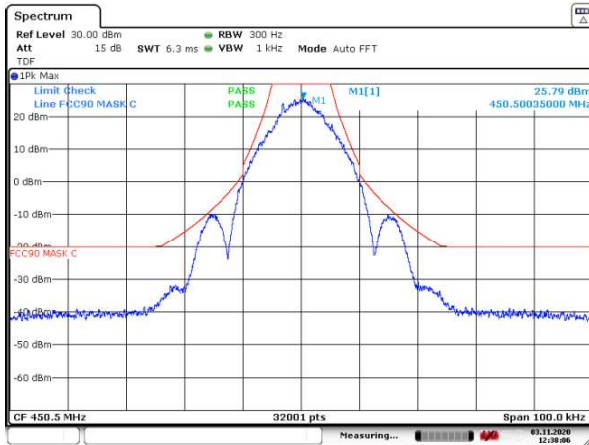


Figure 50: 450.5 MHz, 25 kHz, GMSK, 16000bps

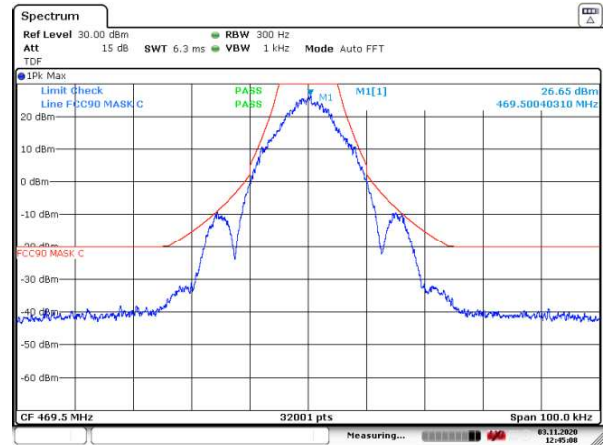


Figure 51: 469.5 MHz, 25 kHz, GMSK, 16000bps

Emission Mask C (25 kHz, GMSK, 19200bps)

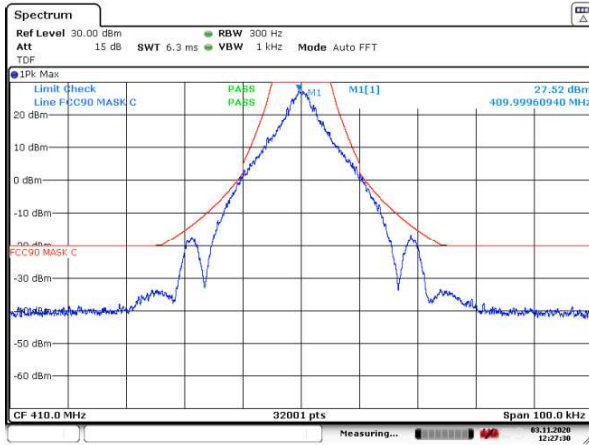


Figure 52: 410.0 MHz, 25 kHz, GMSK, 19200bps

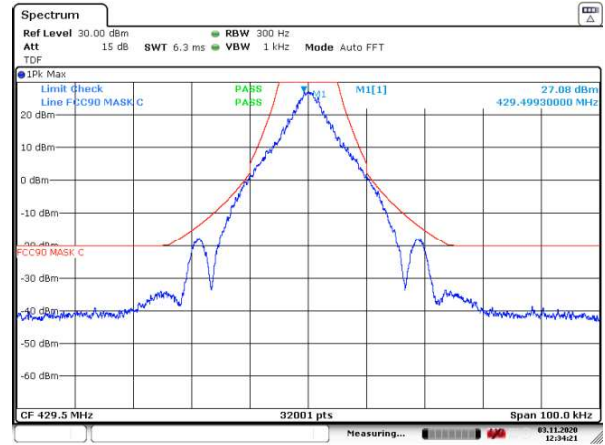


Figure 53: 429.5 MHz, 25 kHz, GMSK, 19200bps

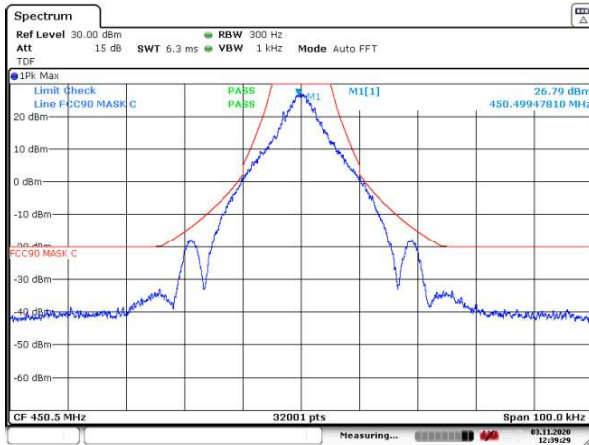


Figure 54: 450.5 MHz, 25 kHz, GMSK, 19200bps

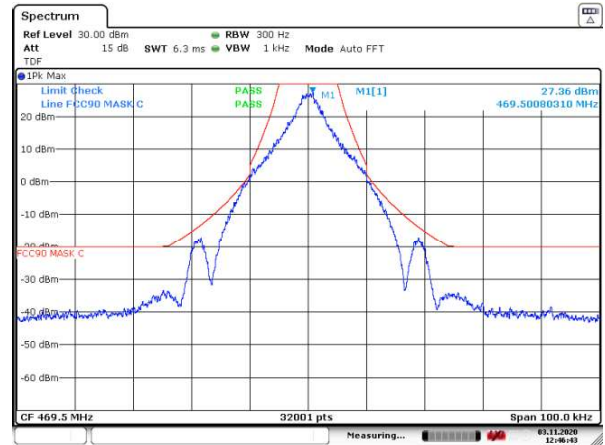


Figure 55: 469.5 MHz, 25 kHz, GMSK, 19200bps

Emission Mask C (25 kHz, 4FSK, 19200bps)

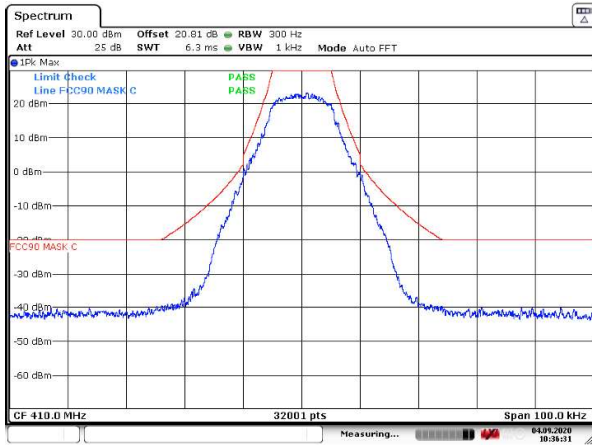


Figure 56: 410.0 MHz, 25 kHz, 4FSK, 19200bps

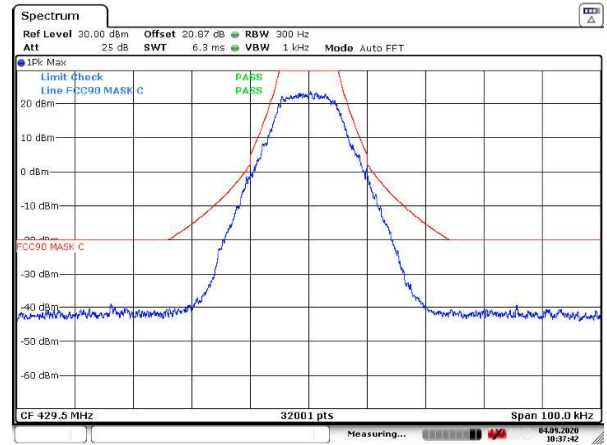


Figure 57: 429.5 MHz, 25 kHz, 4FSK, 19200bps

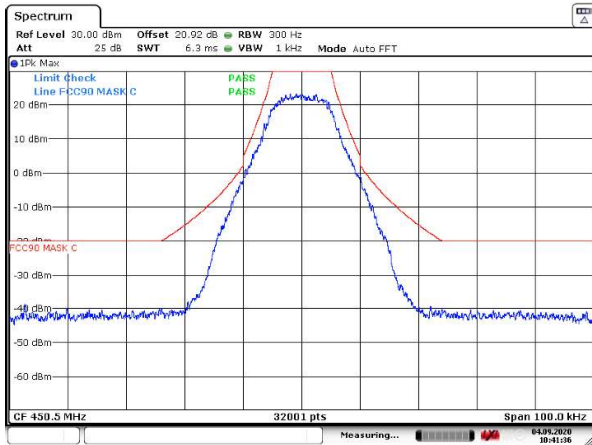


Figure 58: 450.5 MHz, 25 kHz, 4FSK, 19200bps

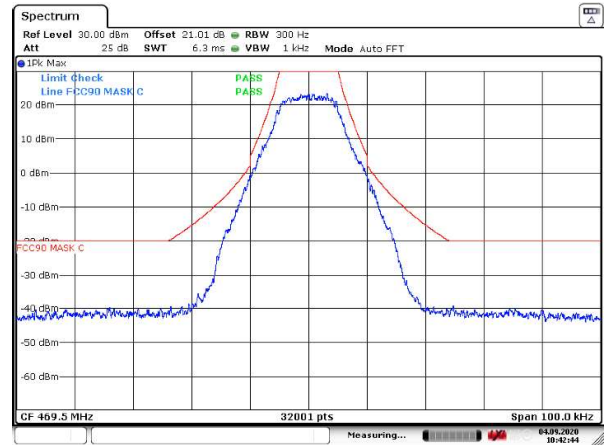


Figure 59: 469.5 MHz, 25 kHz, 4FSK, 19200bps

Emission Mask D (12.5 kHz, GMSK, 4800bps)

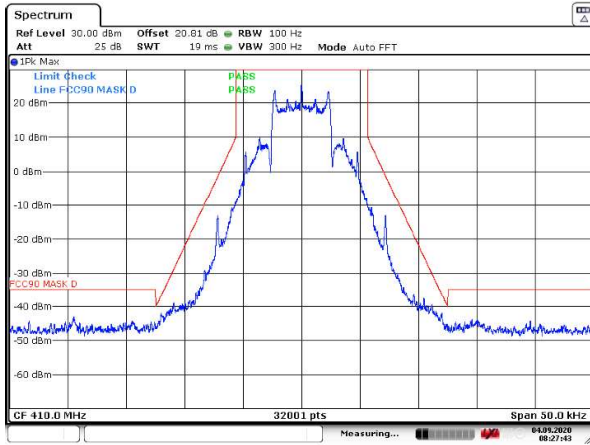


Figure 60: 410.0 MHz, 12.5 kHz, GMSK, 4800bps

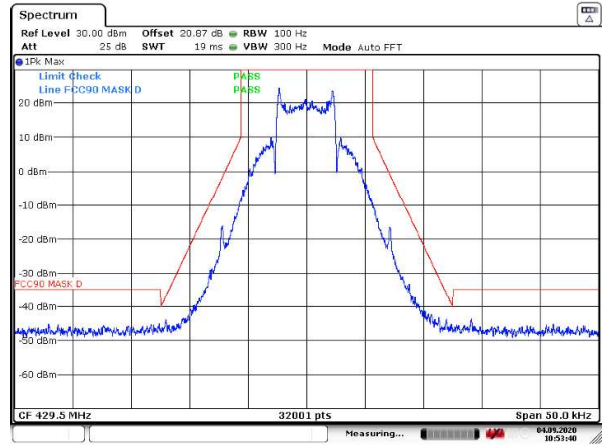


Figure 61: 429.5 MHz, 12.5 kHz, GMSK, 4800bps

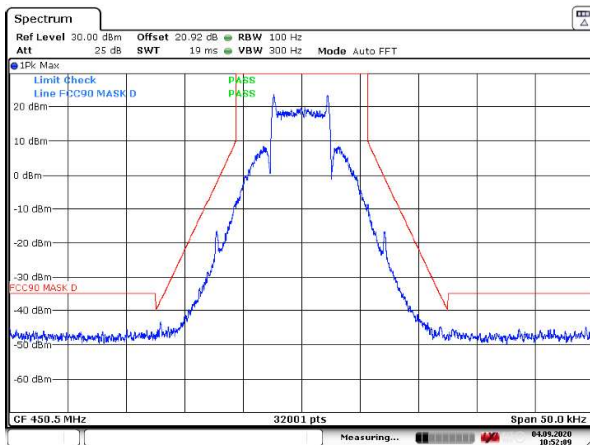


Figure 62: 450.5 MHz, 12.5 kHz, GMSK, 4800bps

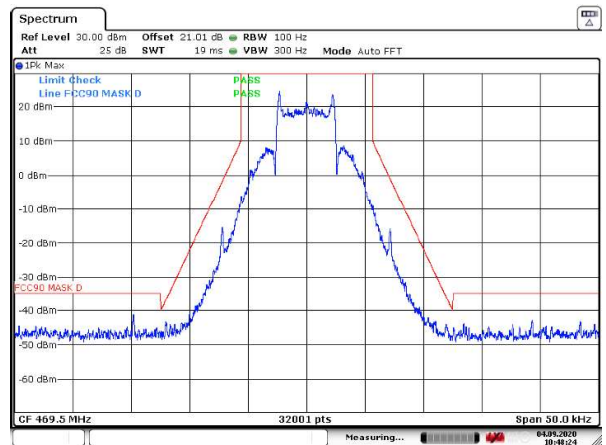


Figure 63: 469.5 MHz, 12.5 kHz, GMSK, 4800bps

Emission Mask D (12.5 kHz, GMSK, 8000bps)

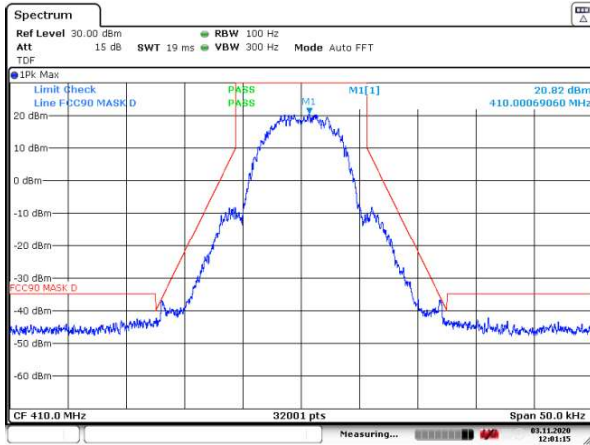


Figure 64: 410.0 MHz, 12.5 kHz, GMSK, 8000bps

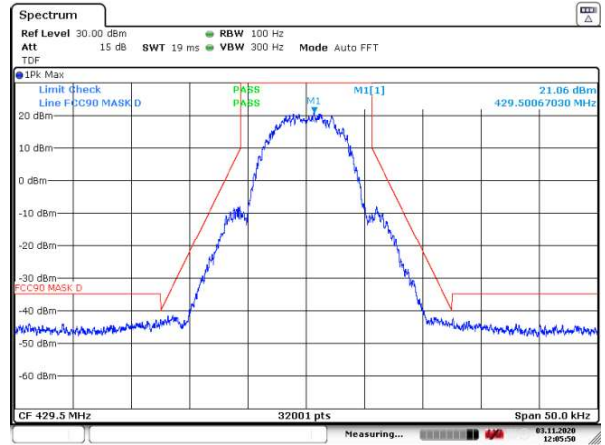


Figure 65: 429.5 MHz, 12.5 kHz, GMSK, 8000bps

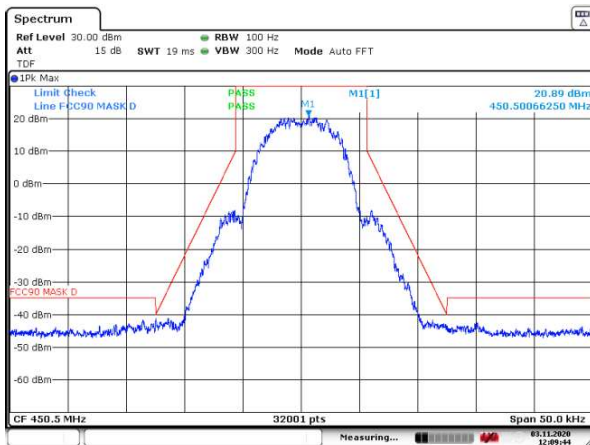


Figure 66: 450.5 MHz, 12.5 kHz, GMSK, 8000bps

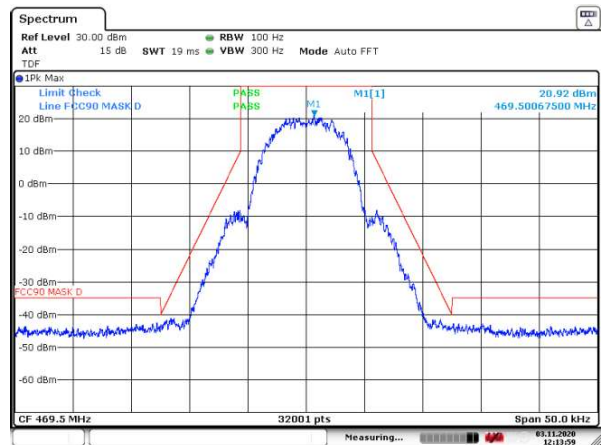


Figure 67: 469.5 MHz, 12.5 kHz, GMSK, 8000bps

Emission Mask D (12.5 kHz, GMSK, 9600bps)

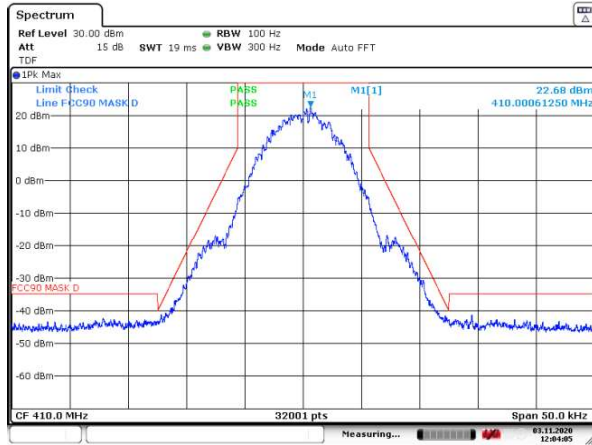


Figure 68: 410.0 MHz, 12.5 kHz, GMSK, 9600bps

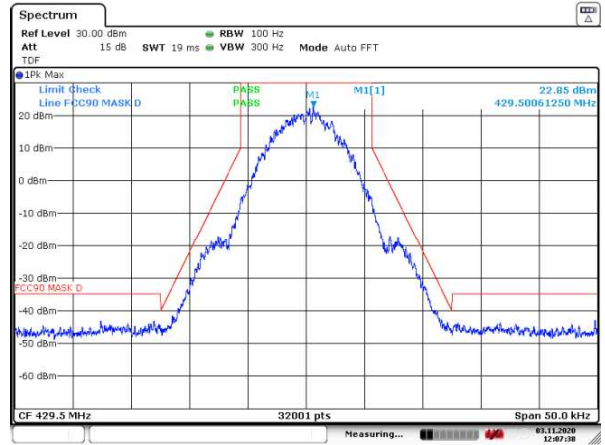


Figure 69: 429.5 MHz, 12.5 kHz, GMSK, 9600bps

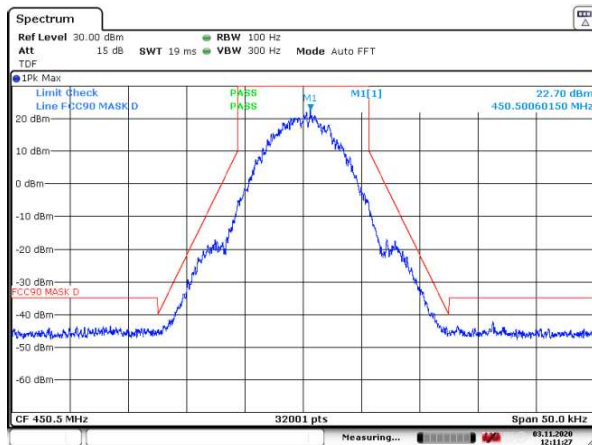


Figure 70: 450.5 MHz, 12.5 kHz, GMSK, 9600bps

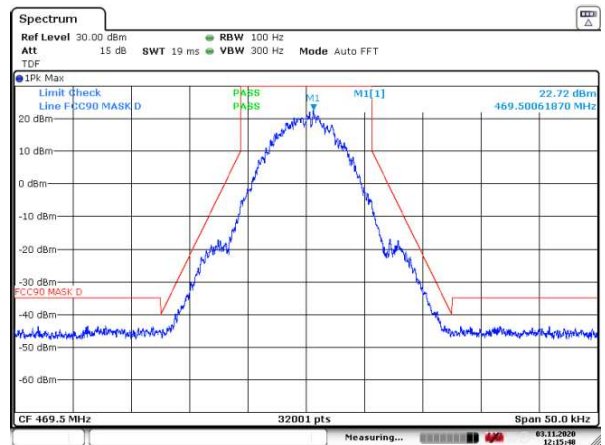


Figure 71: 469.5 MHz, 12.5 kHz, GMSK, 9600bps

Emission Mask D (12.5 kHz, 4FSK, 9600bps)

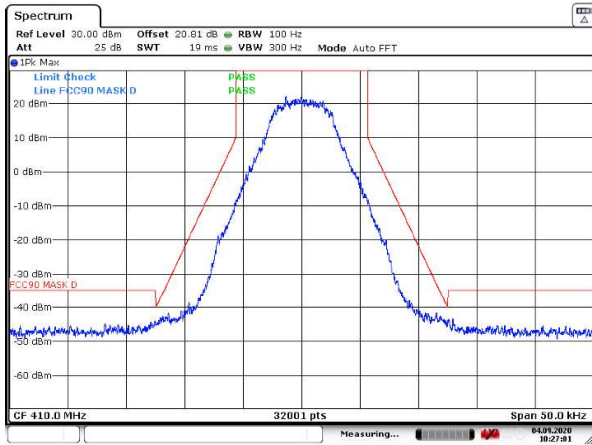


Figure 72: 410.0 MHz, 12.5 kHz, 4FSK, 9600bps

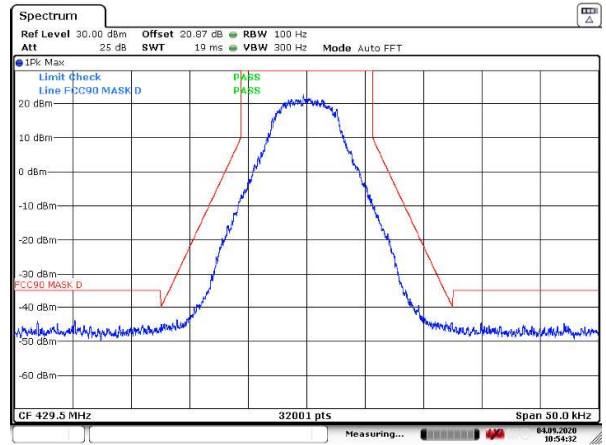


Figure 73: 429.5 MHz, 12.5 kHz, 4FSK, 9600bps

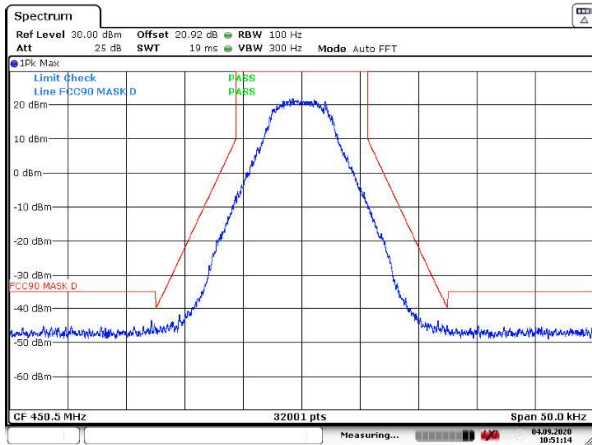


Figure 74: 450.5 MHz, 12.5 kHz, 4FSK, 9600bps

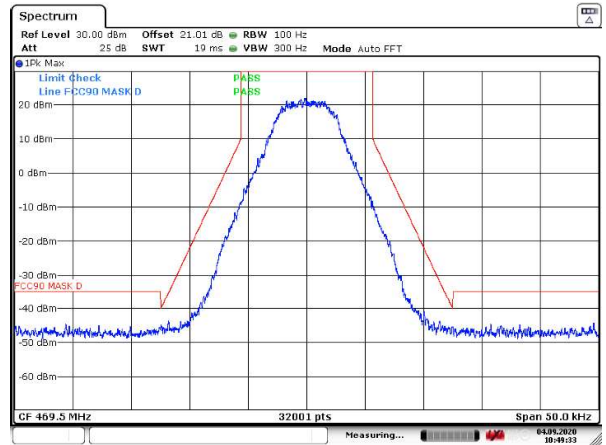


Figure 75: 469.5MHz, 12.5 kHz, 4FSK, 9600bps

Spurious emissions (conducted) 9 kHz – 5 GHz
Spurious emissions (conducted) 9 kHz – 5 GHz

Standard:	ANSI C63.26 (2015)	
Tested by:	PKA	JAT
Date:	4 August 2020	4 November 2020
Temperature:	23 °C	22 °C
Humidity:	59 %RH	38 %RH
Measurement uncertainty:	± 2.90 dB	Level of confidence 95.45 % (k = 2)
Test result:	PASS	

FCC Rule: 90.210
RSS-119 5.8

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: 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.

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: 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) or 70 dB, whichever is the lesser attenuation.

Frequency Band (MHz)	Channel Bandwidth (kHz)	Authorized Bandwidth (kHz)	Limit (dBm)
406.1-430 and 450-470	12.5	11.25	-20
	25	20	-13

The test was performed at maximum power level, and with a spectrum analyser with following settings:

Frequency range:	9 kHz – 150 kHz	150 kHz – 30 MHz	30 MHz – 1 GHz	1 GHz – 5 GHz
RBW:	1 kHz	10 kHz	100 kHz	1 MHz
VBW:	3 kHz	30 kHz	300 kHz	3 MHz
Sweep points:	10001	10001	10001	10001
Sweep time:	Auto	Auto	Auto	Auto
Detector:	Positive Peak	Positive Peak	Positive Peak	Positive Peak

Spurious emissions (conducted) 9 kHz – 5 GHz
Test results
Table 8: Spurious emissions (conducted) test results (EUT frequency 410.0 MHz)

EUT Frequency (MHz)	Ch. Bandwidth (kHz)	Modulation	Data Rate [bps]	Spurious Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
410.0	12.5	GMSK	4 800	0.0090630	-50.94	-20.00	30.94
410.0	12.5	GMSK	4 800	0.17540	-49.58	-20.00	29.58
410.0	12.5	GMSK	4 800	820.0340	-38.48	-20.00	18.48
410.0	12.5	GMSK	4 800	4801.420	-24.34	-20.00	4.34
410.0	12.5	GMSK	8 000	0.009007	-49.43	-20.00	29.43
410.0	12.5	GMSK	8 000	0.18130	-47.84	-20.00	27.84
410.0	12.5	GMSK	8 000	820.034	-37.28	-20.00	17.28
410.0	12.5	GMSK	8 000	4891.010	-24.52	-20.00	4.52
410.0	12.5	4FSK	9 600	0.0092040	-50.89	-20.00	30.89
410.0	12.5	4FSK	9 600	0.16640	-47.74	-20.00	27.74
410.0	12.5	4FSK	9 600	820.0340	-38.46	-20.00	18.46
410.0	12.5	4FSK	9 600	4900.610	-24.65	-20.00	4.65
410.0	25.0	GMSK	9 600	0.0104450	-51.21	-13.00	38.21
410.0	25.0	GMSK	9 600	0.17540	-49.89	-13.00	36.89
410.0	25.0	GMSK	9 600	820.0340	-38.59	-13.00	25.59
410.0	25.0	GMSK	9 600	4892.210	-24.78	-13.00	11.78
410.0	25.0	GMSK	16 000	0.0101070	-50.40	-13.00	37.40
410.0	25.0	GMSK	16 000	0.20820	-47.77	-13.00	34.77
410.0	25.0	GMSK	16 000	820.0340	-37.51	-13.00	24.51
410.0	25.0	GMSK	16 000	4914.610	-24.00	-13.00	11.00
410.0	25.0	4FSK	19 200	0.0090070	-52.07	-13.00	39.07
410.0	25.0	4FSK	19 200	20.80560	-50.07	-13.00	37.07
410.0	25.0	4FSK	19 200	984.1420	-39.10	-13.00	26.10
410.0	25.0	4FSK	19 200	4875.810	-24.11	-13.00	11.11

Spurious emissions (conducted) 9 kHz – 5 GHz
Table 9: Spurious emissions (conducted) test results (EUT frequency 429.5 MHz)

EUT Frequency (MHz)	Ch. Bandwidth (kHz)	Modulation	Data Rate [bps]	Spurious Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
429.5	12.5	GMSK	4 800	0.0090070	-51.32	-20.00	31.32
429.5	12.5	GMSK	4 800	0.41120	-49.81	-20.00	29.81
429.5	12.5	GMSK	4 800	859.0250	-37.92	-20.00	17.92
429.5	12.5	GMSK	4 800	4682.630	-24.63	-20.00	4.63
429.5	12.5	GMSK	8 000	0.0091340	-48.75	-20.00	28.75
429.5	12.5	GMSK	8 000	0.20220	-48.19	-20.00	28.19
429.5	12.5	GMSK	8 000	859.0250	-36.22	-20.00	16.22
429.5	12.5	GMSK	8 000	4912.610	-24.66	-20.00	4.66
429.5	12.5	4FSK	9 600	0.0092890	-51.89	-20.00	31.89
429.5	12.5	4FSK	9 600	0.27090	-49.31	-20.00	29.31
429.5	12.5	4FSK	9 600	859.0250	-37.71	-20.00	17.71
429.5	12.5	4FSK	9 600	4801.820	-24.88	-20.00	4.88
429.5	25.0	GMSK	9 600	0.0102050	-51.58	-13.00	38.58
429.5	25.0	GMSK	9 600	21.06230	-49.29	-13.00	36.29
429.5	25.0	GMSK	9 600	859.0250	-37.57	-13.00	24.57
429.5	25.0	GMSK	9 600	4874.210	-24.60	-13.00	11.60
429.5	25.0	GMSK	16 000	0.0098670	-49.91	-13.00	36.91
429.5	25.0	GMSK	16 000	0.32760	-48.38	-13.00	35.38
429.5	25.0	GMSK	16 000	859.0250	-35.94	-13.00	22.94
429.5	25.0	GMSK	16 000	4484.250	-24.15	-13.00	11.15
429.5	25.0	4FSK	19 200	0.0121790	-52.12	-13.00	39.12
429.5	25.0	4FSK	19 200	0.19330	-49.84	-13.00	36.84
429.5	25.0	4FSK	19 200	859.0250	-38.29	-13.00	25.29
429.5	25.0	4FSK	19 200	4977.000	-24.95	-13.00	11.95

Spurious emissions (conducted) 9 kHz – 5 GHz
Table 10: Spurious emissions (conducted) test results (EUT frequency 450.5 MHz)

EUT Frequency (MHz)	Ch. Bandwidth (kHz)	Modulation	Data Rate [bps]	Spurious Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
450.5	12.5	GMSK	4 800	0.0090070	-52.31	-20.00	32.31
450.5	12.5	GMSK	4 800	0.22610	-48.97	-20.00	28.97
450.5	12.5	GMSK	4 800	901.0210	-36.68	-20.00	16.68
450.5	12.5	GMSK	4 800	4896.210	-24.40	-20.00	4.40
450.5	12.5	GMSK	8 000	0.0097400	-49.42	-20.00	29.42
450.5	12.5	GMSK	8 000	0.20520	-46.80	-20.00	26.80
450.5	12.5	GMSK	8 000	901.0210	-34.53	-20.00	14.53
450.5	12.5	GMSK	8 000	4492.650	-23.91	-20.00	3.91
450.5	12.5	4FSK	9 600	0.0096700	-51.36	-20.00	31.36
450.5	12.5	4FSK	9 600	0.19330	-49.90	-20.00	29.90
450.5	12.5	4FSK	9 600	901.0210	-36.38	-20.00	16.38
450.5	12.5	4FSK	9 600	4151.480	-24.03	-20.00	4.03
450.5	25.0	GMSK	9 600	0.0090070	-51.51	-13.00	38.51
450.5	25.0	GMSK	9 600	0.01902970	-49.34	-13.00	36.34
450.5	25.0	GMSK	9 600	901.0210	-36.49	-13.00	23.49
450.5	25.0	GMSK	9 600	4900.210	-24.93	-13.00	11.93
450.5	25.0	GMSK	16 000	0.0090070	-50.47	-13.00	37.47
450.5	25.0	GMSK	16 000	0.18130	-47.72	-13.00	34.72
450.5	25.0	GMSK	16 000	901.0210	-34.69	-13.00	21.69
450.5	25.0	GMSK	16 000	3885.910	-23.47	-13.00	10.47
450.5	25.0	4FSK	19 200	0.0090070	-51.44	-13.00	38.44
450.5	25.0	4FSK	19 200	0.37530	-50.40	-13.00	37.40
450.5	25.0	4FSK	19 200	901.0210	-36.03	-13.00	23.03
450.5	25.0	4FSK	19 200	4789.420	-24.61	-13.00	11.61

Spurious emissions (conducted) 9 kHz – 5 GHz
Table 11: Spurious emissions (conducted) test results (EUT frequency 469.5 MHz)

EUT Frequency (MHz)	Ch. Bandwidth (kHz)	Modulation	Data Rate [bps]	Spurious Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
469.5	12.5	GMSK	4 800	0.0090070	-51.99	-20.00	31.99
469.5	12.5	GMSK	4 800	0.24700	-48.63	-20.00	28.63
469.5	12.5	GMSK	4 800	939.0420	-35.49	-20.00	15.49
469.5	12.5	GMSK	4 800	4972.200	-25.18	-20.00	5.18
469.5	12.5	GMSK	8 000	0.0091060	-49.34	-20.00	29.34
469.5	12.5	GMSK	8 000	0.16640	-47.22	-20.00	27.22
469.5	12.5	GMSK	8 000	939.0420	-33.48	-20.00	13.48
469.5	12.5	GMSK	8 000	4492.650	-23.91	-20.00	3.91
469.5	12.5	4FSK	9 600	0.0090210	-51.09	-20.00	31.09
469.5	12.5	4FSK	9 600	0.37830	-49.57	-20.00	29.57
469.5	12.5	4FSK	9 600	939.1390	-36.22	-20.00	16.22
469.5	12.5	4FSK	9 600	4624.240	-24.42	-20.00	4.42
469.5	25.0	GMSK	9 600	0.0103890	-51.76	-13.00	38.76
469.5	25.0	GMSK	9 600	0.21420	-49.07	-13.00	36.07
469.5	25.0	GMSK	9 600	939.1390	-35.29	-13.00	22.29
469.5	25.0	GMSK	9 600	4899.810	-24.46	-13.00	11.46
469.5	25.0	GMSK	16 000	0.0090070	-49.93	-13.00	36.93
469.5	25.0	GMSK	16 000	0.17240	-47.49	-13.00	34.49
469.5	25.0	GMSK	16 000	939.1390	-34.08	-13.00	21.08
469.5	25.0	GMSK	16 000	4163.080	-24.31	-13.00	11.31
469.5	25.0	4FSK	19 200	0.0093880	-51.13	-13.00	38.13
469.5	25.0	4FSK	19 200	0.15150	-48.79	-13.00	35.79
469.5	25.0	4FSK	19 200	939.0420	-35.97	-13.00	22.97
469.5	25.0	4FSK	19 200	4895.410	-24.58	-13.00	11.58

Spurious emissions TX 410.0 MHz, 12.5 kHz, GMSK, 4800bps

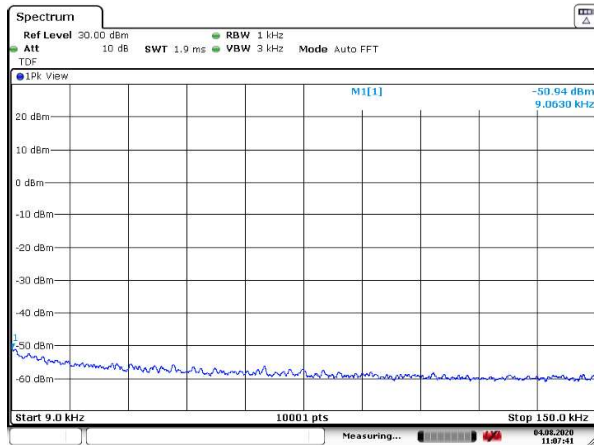


Figure 76: 9 – 150 kHz

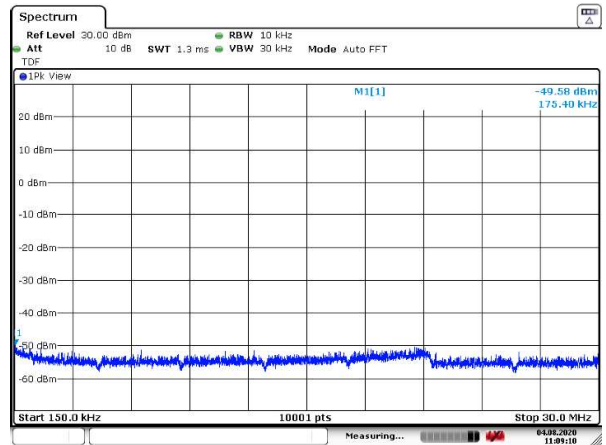


Figure 77: 150 kHz – 30 MHz

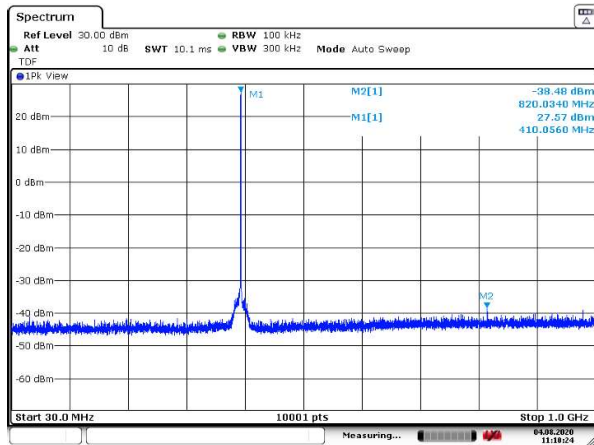


Figure 78: 30 – 1000 MHz

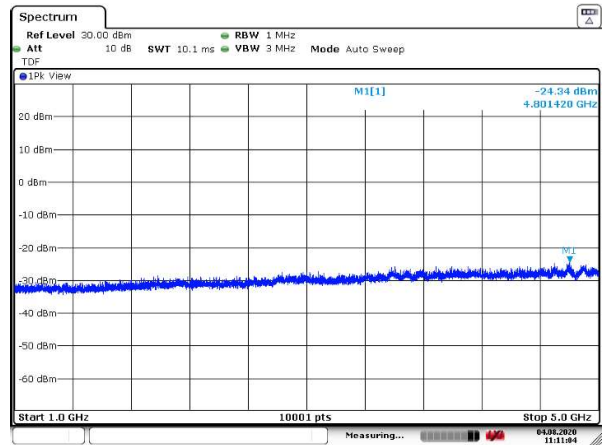


Figure 79: 1 – 5 GHz

Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 12.5 kHz, GMSK, 8000bps

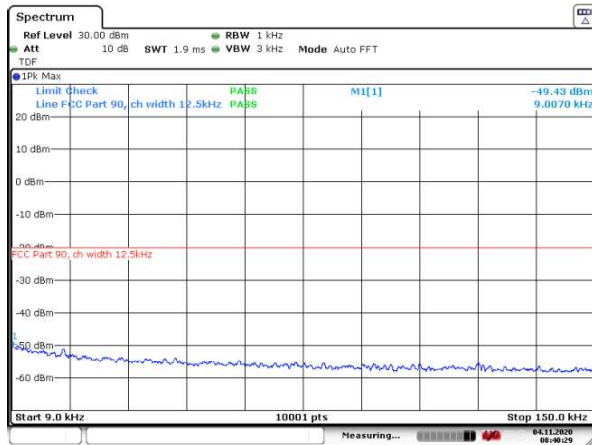


Figure 80: 9 – 150 kHz

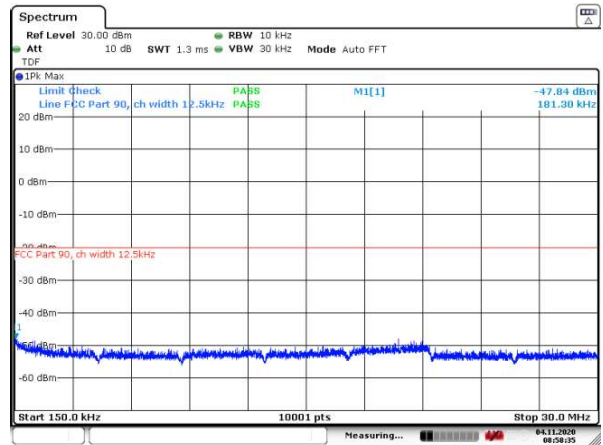


Figure 81: 150 kHz – 30 MHz

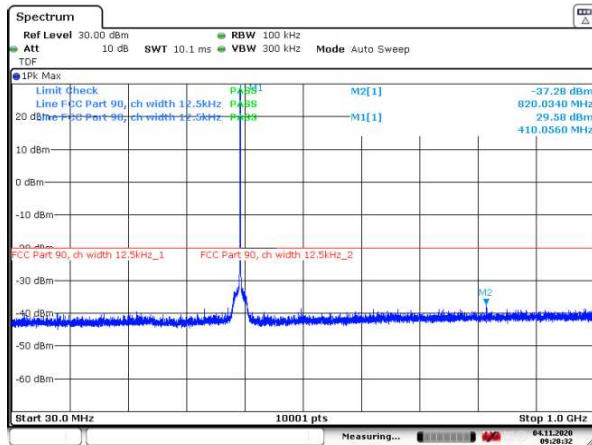


Figure 82: 30 – 1000 MHz

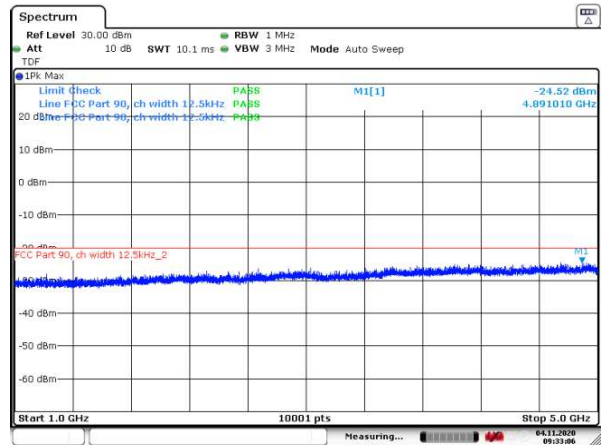


Figure 83: 1 – 5 GHz

Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 12.5 kHz, 4FSK, 9600bps

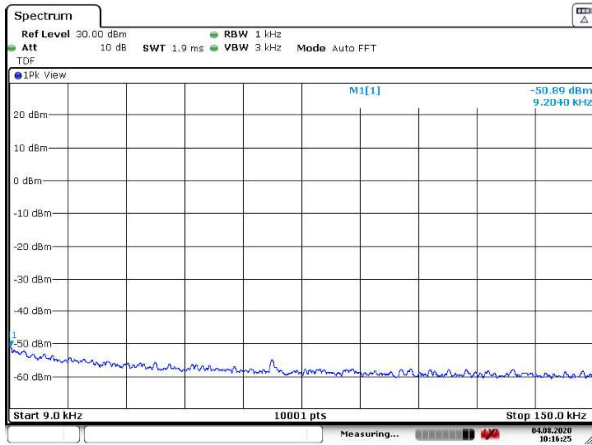


Figure 84: 9 – 150 kHz

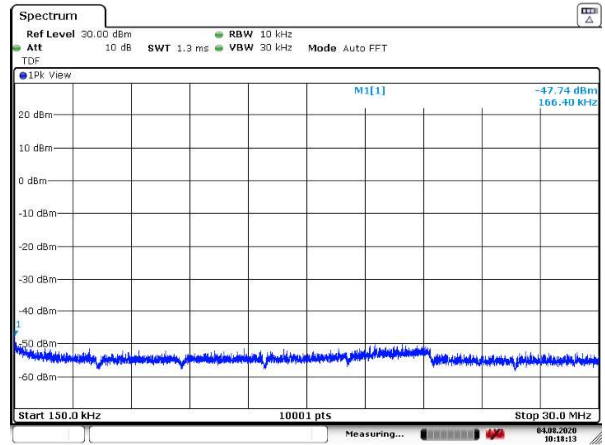


Figure 85: 150 kHz – 30 MHz

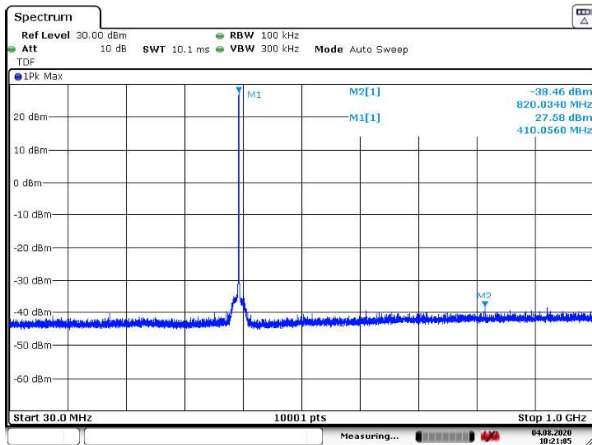


Figure 86: 30 – 1000 MHz

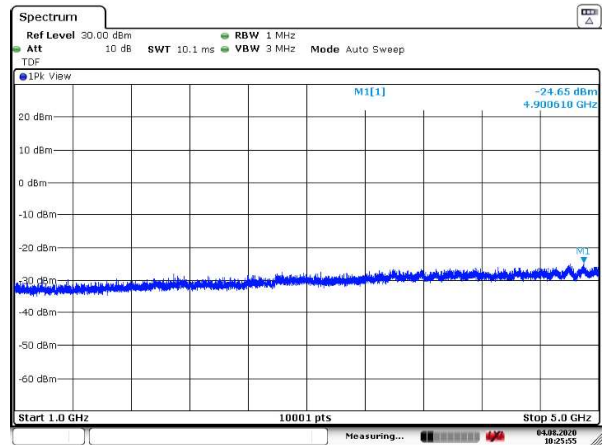


Figure 87: 1 – 5 GHz

Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 25 kHz, GMSK, 9600bps

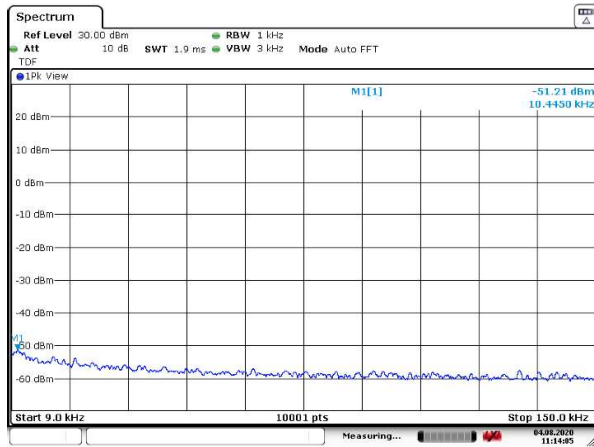


Figure 88: 9 – 150 kHz

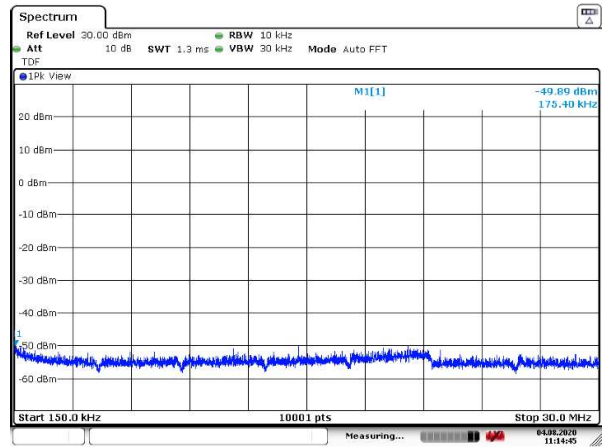


Figure 89: 150 kHz – 30 MHz

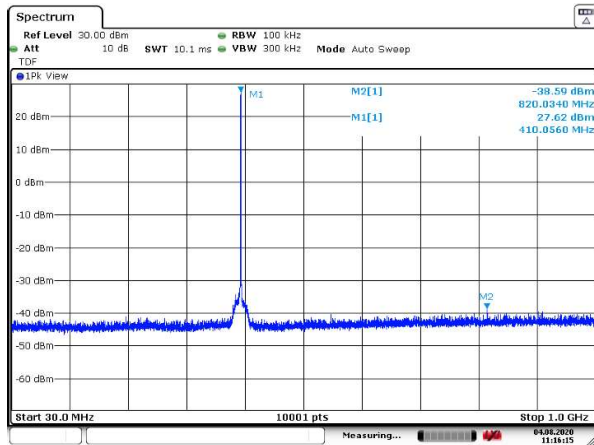


Figure 90: 30 – 1000 MHz

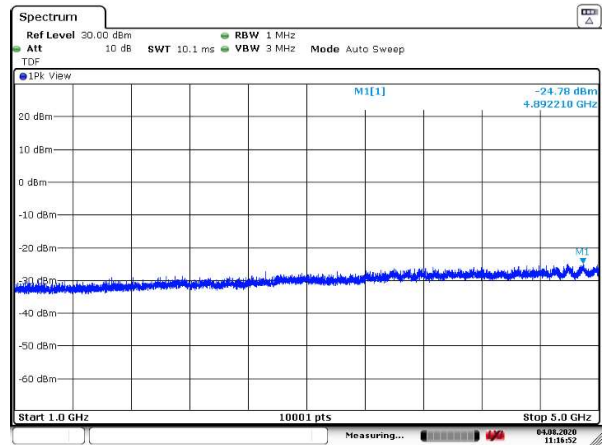


Figure 91: 1 – 5 GHz

Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 25 kHz, GMSK, 16000bps

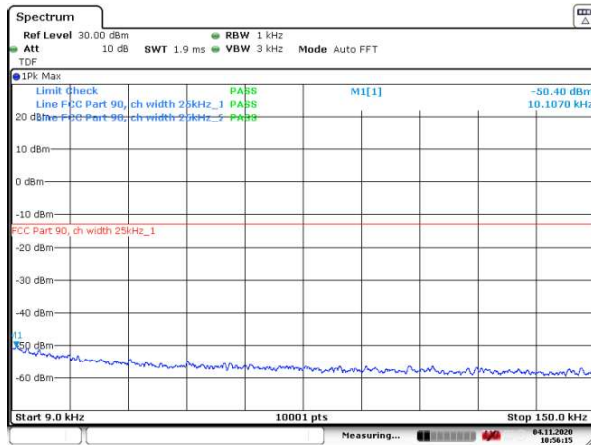


Figure 92: 9 – 150 kHz

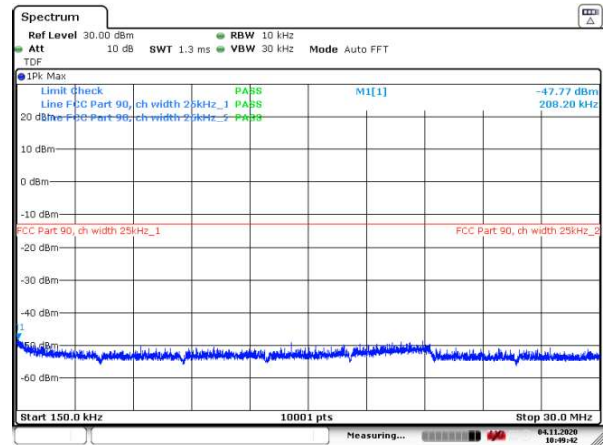


Figure 93: 150 kHz – 30 MHz

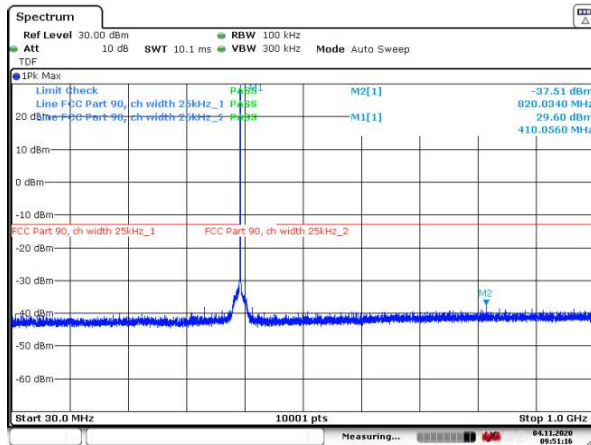


Figure 94: 30 – 1000 MHz

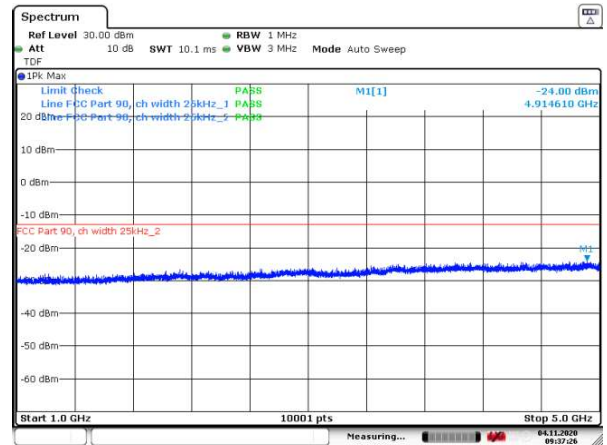


Figure 95: 1 – 5 GHz