FCC ID: OYGTMSS5A2

EMI – TEST REPORT

- FCC Part 15.231 -

Type / Model Name : TMSS5A2

Product Description : TPMS Sensor S5.xG Dual Band

Applicant : Huf Baolong Electronics Bretten GmbH

Address : Gewerbestr. 40

75015 Bretten, Germany

Manufacturer : Huf Baolong Electronics Bretten GmbH

Address : Gewerbestr. 40

75015 Bretten, Germany

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

Test Report No. :	**T46523-00-00HU**	22. July 2020 Date of issue

Deutsche Akkreditierungsstelle
D-PL-12030-01-01
D-PL-12030-01-02

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15 Subpart C - Intentional Radiators (July 16, 2020)

Part 15, Subpart C, Section 15.231	Periodic operation in the band 40.66-40.70 MHz and above 70 MHz §15.231(a) Signal deactivation §15.231(b) Radiated emissions, Fundamental & Harmonics §15.231(c) Emission Bandwidth
Part 15, Subpart C, Section 15.35(c)	Correction for Pulse Operation (Duty Cycle)
Part 15, Subpart C, Section 15.207(a)	AC Line conducted emissions
Part 15, Subpart C, Section 15.209(a)	Radiated emissions, general requirements
ANSI C63.10: 2013	Testing Unlicensed Wireless Devices
ANSI C95.1:2005	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
CISPR 16-4-2: 2003	Uncertainty in EMC measurement

2 SUMMARY

2.1 General remarks

All radiated tests have been performed on samples which are in original state.

The EuT has an incorporated antenna and is powered by a primary battery.

All radiated measurements were made with the device positioned in three orientations.
Such as orientations X, Y and Z (Lying flat, lying on its end and lying on its side).
The values in the test report shows only the maximum measured value.

Declaration of the manufacturer:
The EuT is a part of a tire monitoring system. The TPM electronic module and battery can be mounted in three different housings to provide the mounting option for four different types of valves.
=> The PCBA (Tx part) and the battery are always the same.

This test report covers complete testing on version S5.0G of the TMSS5A2 – family, which is as representative model defined by customer.
To active the different test modes from the wheel sensor the TPMS tool TransRaLF with test software GUI (TransRaLF.exe) was used. Both was supplied from the customer.

For testing the manufacturer declares following transmitting intervals:

The TPMS sensor includes already all possible application cases in its program memory and is configured once by a professional installer.
Upon manually activated LF request (through special configuration tool at a vehicle dealership), the EUT respond with a single RF transmission (sensor type information). In the second step the tool will send the configuration data on LF and the EUT will respond with a single confirmation transmission. Now the TPMS sensor is configured for the target vehicle application.
When the EUT is mounted in the vehicle tire in the worst case, periodically RF transmission where the duration of each transmission is always less than 1 second and the silent period is at least 30 times the duration of the transmission, and never less than 10 seconds.
In the case of an emergency condition (rapid pressure loss), the devise will transmit tire pressure and temperature information throughout the duration of the condition.

The CW lower and CW upper test mode represents the upper and lower frequency of FSK modulation.

#	EUT test mode	repetition rate (sec)	number of frames	overall transmission time (sec)	max. frame length (msec)	min. frame period (msec)	frame encoding
1	CW lower	Single event exit after 4min or LF CMD					
2	CW upper	Single event exit after 4min or LF CMD					
3	ASK*	single	9	< 1	9.7	52.5	manchester encoded frames / ASK modulated / 9k6BPS / 8 bytes frame length
4	FSK*	15	4	< 1	9.7	100	manchester encoded frames / FSK modulated / 9k6BPS / 10 bytes frame length each FSK frame is 9.7msec in duration with no less than 100msec period
* Note: Device modes are bounded by these two worst case modulations. Devices are professional installed and configured by the vehicle dealership at the time of installation.							

FCC ID: OYGTMSS5A2

FINAL ASSESSMENT:

The equipment under test **fulfills** the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample	:	acc. to storage records
Testing commenced on	:	15. June 2020
Testing concluded on	:	23. June 2020

Checked by:

Klaus Gegenfurtner
I confirm the correctness and integrity of this document
2020.07.22 13:03:41 +02'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:

Markus Huber
I am the author of this document
2020.07.22 13:01:18 +02'00'

Markus Huber

3 EQUIPMENT UNDER TEST

3.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

3.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

3.3 Photo documentation of the EuT – See Attachment A

3.4 Power supply system utilised

Power supply voltage: 3.0 V / DC (Lithium battery, CR 2032)

3.5 Short description of the Equipment under Test (EUT)

The wheel unit sensor is a part of a TPMS system embedded on a vehicle. The device takes places in the tire, fix on rim of a vehicles wheel.
The wheel unit sensor can send either in the 433 MHz range or in the 315 MHz range but not in both ranges at the same time. The setting is controlled via software from authorized personal only.

Number of tested samples: 1
Variant: Housing S5.0G
Serial number: Prototype

3.6 EUT operation mode:

The equipment under test was operated during the measurement under the following conditions:

- Unmodulated Tx mode at 315 MHz, 433.92 MHz (CW Lower / CW Upper mode)

- Modulated Tx mode at 315 MHz, 433.92 MHz (ASK / FSK)

- Standby

3.7 EUT configuration:

The following peripheral devices and interface cables were connected during the measurements:

-	LapTop (supplied from CSA)	Model :	
-	Software (supplied from manufacturer)	Model :	GUI (TransRALF.exe)
-	TPMS tool (supplied from manufacturer)	Model :	TransRaLF
-		Model :	
-		Model :	
-		Model :	

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Statement regarding the usage of logos in test reports

The accreditation and notification body logos displayed in this test report are only valid for standards listed in the accreditation or notification scope of CSA Group Bayern GmbH.

4.3 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 ° C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

4.4 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 % The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
20 dB Bandwidth	Center frequency of EuT	95%	± 2.5 x 10^{-7}
99% Occupied Bandwidth	Center frequency of EuT	95%	± 2.5 x 10^{-7}
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	± 3.53 dB
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	± 3.71 dB
Radiated Spurious Emissions	1000 MHz to 10000 MHz	95%	± 2.34 dB
Radiated power of the fundamental wave	Center frequency of EuT	95%	± 3.71 dB
Peak conducted output power	902 MHz to 928 MHz	95%	± 0.35 dB
Conducted Spurious Emissions	9 kHz to 10000 MHz	95%	± 2.15 dB

4.5 Measurement Protocol for FCC, VCCI and AUSTEL

4.5.1 GENERAL INFORMATION

4.5.1.1 Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.5.1.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

FCC: DE 0011

4.6 Deviations or Exclusions from the Requirements and Standards

None

5 TEST CONDITIONS AND RESULTS

5.1 Conducted emissions

For test instruments and accessories used see section 6 Part **A 4**.

5.1.1 Description of the test location

Test location: NONE

5.1.2 Photo documentation of the test set-up

5.1.3 Applicable standard

According to FCC Part 15C, Section 15.207(a):
Except as shown in paragraphs (b) and (c) of this Section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

5.1.4 Description of Measurement

The measurements are performed on the power interface 120 V / 60 Hz using a receiver, which has CISPR characteristic bandwidth, quasi-peak detection and line impedance stabilization network with 50Ω/50 µH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 cm above the floor and is positioned 40 cm from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are remeasured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

To convert between dBµV and µV, the following conversions apply:

dBµV = 20 log µV

µV = 10^(dBµV/20)

5.1.5 Test result

Remarks: The measurement is not applicable.

The EuT has no AC mains connections.

The EuT is separated powered by a 3.0 V battery.

5.2 Field strength of the fundamental wave

For test instruments and accessories used see section 6 Part **CPR 2**.

5.2.1 Description of the test location

Test location: OATS1

Test distance: 3 metres

5.2.2 Photo documentation of the test set-up – See Attachment B

5.2.3 Applicable standard

According to FCC Part 15C, Section 15.231(b):
The field strength of emissions from intentional radiators shall not exceed the effective field strength limits.

5.2.4 Description of Measurement

The radiated power of the fundamental wave from the EUT is measured in the frequency range of 30 to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 metres non-conducting table 80 centimeters above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the EUT will be in accordance to ANSI C63.10. The Interface cables that are closer than 40 centimeters to the ground plane are bundled in the center in a serpentine fashion, so they are at least 40 centimeters from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna was positioned 3, 10 or 30 metres horizontally from the EUT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres, measurement scans are made in horizontal and vertical antenna polarization's and the EUT is rotated 360 degrees.

The resolution bandwidth during the measurement is as follows:
30 MHz – 1000 MHz: RBW: 120 kHz

Example:

Frequency (MHz)	Level (dBµV)	+	Factor (dB)	=	Level dB(µV/m)	-	Limit dB(µV/m)	=	Delta (dB)
170.5	5	+	20	=	25	-	30	=	-5

5.2.5 Test result

f: 433.92 MHz
Lower Mode:

Frequency (MHz)	Level Pk (dBµV)	Level QP (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Duty Cycle Correct. factor (dB)	Level Pk dB(µV/m)	Calculated Level Av dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
433.92	54.1	--	120	20.3	-17.08	74.4	57.32	72.87	-15.6

Upper Mode:

Frequency (MHz)	Level Pk (dBµV)	Level QP (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Duty Cycle Correct. factor (dB)	Level Pk dB(µV/m)	Calculated Level Av dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
433.92	53.8	--	120	20.3	-17.08	74.1	57.02	72.87	-15.9

For calculating the AV Level, the Duty Cycle Correction Factor from the ASK mode was used, because this correction factor is stronger as the ASK mode.

f: 315.0 MHz
Lower Mode:

Frequency (MHz)	Level Pk (dBµV)	Level QP (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Duty Cycle Correct. factor (dB)	Level Pk dB(µV/m)	Calculated Level Av dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
315.0	51.4	--	120	17.2	-16.36	68.6	52.24	67.66	-15.4

Upper Mode:

Frequency (MHz)	Level Pk (dBµV)	Level QP (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Duty Cycle Correct. factor (dB)	Level Pk dB(µV/m)	Calculated Level Av dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
315.0	51.0	--	120	17.2	-16.36	68.2	51.84	67.66	-15.8

For calculating the AV Level the Duty Cycle Correction Factor from the ASK mode was used, because this correction factor is stronger as the ASK mode.

Limit according to FCC Section 15.231(e):

Frequency (MHz)	Field strength of fundamental @ 3m		**Effective limit for 433.92 MHz**	
	(µV/m)	dB(µV/m)	(µV/m)	dB(µV/m)
40.66 – 40.70	1000	60		
70 - 130	500	54		
130 - 174	500 to 1500*	54 to 63.5*		
174 - 260	1500	63.5		
260 - 470	**1500 to 5000***	**63.5 to 74***	**4398.67**	**72.87**
Above 470	5000	81.9		

*Linear interpolation

Frequency (MHz)	Field strength of fundamental @ 3m		**Effective limit for 315 MHz**	
	(µV/m)	dB(µV/m)	(µV/m)	dB(µV/m)
40.66 – 40.70	1000	60		
70 - 130	500	54		
130 - 174	500 to 1500*	54 to 63.5*		
174 - 260	1500	63.5		
260 - 470	**1500 to 5000***	**63.5 to 74***	**2416.67**	**67.66**
Above 470	5000	81.9		

*Linear interpolation

The requirements are **FULFILLED.**

Remarks: The test was performed in “Lower Mode” of the EuT.

The test was performed in “Upper Mode” of the EuT.

5.3 Spurious emissions (magnetic field) 9 kHz – 30 MHz

For test instruments and accessories used see section 6 Part **SER 1**.

5.3.1 Description of the test location

Test location: OATS1

Test distance: 3 metres

5.3.2 Photo documentation of the test set-up – See Attachment B

5.3.3 Applicable standard

According to FCC Part 15C, Section 15.209:
The emissions from intentional radiators shall not exceed the effective field strength limits.

5.3.4 Description of Measurement

The magnetic field strength from the EUT will be measured on an open area test site in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna. The setup of the Equipment under test will be in accordance to ANSI C63.10. The antenna was positioned 3, 10 or 30 meters horizontally from the EUT. Measurements have been made in all three orthogonal axes and the shielded loop antenna was rotated to locate the maximum of the emissions. In the case where larger measuring distances are required the results will extrapolated based on the values measured on the closer distances according to Section 15.31(f)(2)(2). The final measurement will be performed with an EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 to 490 kHz where an average detector will be used according to Section 15.209(d)(2).

The resolution bandwidth during the measurement is as follows:
9 kHz – 150 kHz: RBW: 200 Hz
150 kHz – 30 MHz: RBW: 9 kHz

Example:

Frequency (MHz)	Level (dBµV)	+	Factor (dB)	=	Level dB(µV/m)	-	Limit dB(µV/m)	=	Delta (dB)
1.705	5	+	20	=	25	-	30	=	-5

5.3.5 Test result

Measurement distance: 3 m

Frequency [kHz]	L: QP [dBµV]	L: AV [dBµV]	Bandwidth [kHz]	Correct. [dB]	L: QP [dBµV/m]	L: AV [dBµV/m]	Limit [dBµV/m]	Delta [dB]
536.8	24.1	19.7	9.0	20	44.1	39.7	73.0	-33.3
1073.6	23.4	18.0	9.0	20	43.4	38.0	67.0	-29.0
1342.0	21.6	15.9	9.0	20	41.6	35.9	65.0	-29.1

⇨ **No unwanted emissions from the EuT could be measured in the relevant frequency ranges.**
⇨ **Only ambient noises could be detected.**

Limit according to FCC Part 15C Section 15.209(a):

Frequency	Field strength of spurious emissions		Measurement distance
(MHz)	(µV/m)	dB(µV/m)	(metres)
0.009-0.490	2400/F(kHz)	--	300
0.490-1.705	24000/F (kHz)	--	30
1.705-30.0	30	29.5	30

The requirements are **FULFILLED.**

Remarks: All unwanted emissions in the frequency range from 9 kHz to 30 MHz are below 10 dBµV/m at a test distance of 3 metres.

The level of Field Strength is identically in all Tx operation modes (433.92 MHz and 315.0 MHz).

5.4 Spurious emissions radiated (electric field)

For test instruments and accessories used see section 6 Part **SER 2, SER 3**.

5.4.1 Description of the test location

Test location: OATS1
Anechoic Chamber A1

Test distance: 3 metres

5.4.2 Photo documentation of the test set-up – See Attachment B

5.4.3 Applicable standard

According to FCC Part 15C, Section 15.231(b), Section 15.209(a) and Section 15.205(a):
The emissions from intentional radiators shall not exceed the effective field strength limits.

5.4.4 Description of Measurement

The radiated power of the spurious emission from the EUT is measured in the frequency range of 30 to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 cm above the ground plane. Floor standing equipment is placed directly on the turntable ground plane. The setup of the EUT will be in accordance to ANSI C63.10. The interface cables closer than 40 cm to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 cm away from the ground plane. Cables to simulators/testers are routed through the center of the table to a screen room located outside the test area. To locate maximum emission from the test sample the antenna is varied in height from 1 to 4 m, measurement scans are made in horizontal and vertical antenna polarization and the EUT is turned 360 degrees.
The radiated power of the spurious emission from the EUT is measured in the frequency range above 1 GHz using a spectrum analyser and appropriate linear polarized antennas. Measurements are made in the horizontal and vertical polarization of the antenna. The setup of the EUT will be in accordance to ANSI C63.10. The interface cables closer than 40 cm to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 cm away from the ground plane. Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration results in the highest emission and therefore shall be used for final testing. During the tests the EUT is turned 360 degrees to find the maximum level of emission. For testing above 1 GHz, if the emission level of the EUT in peak mode complies with the average limit is 20 dB lower, then testing will be stopped and peak values of the EUT will be reported, otherwise the emission will be measured in average mode again and reported.

The resolution bandwidth during the measurement is as follows:
30 MHz – 1000 MHz: RBW: 120 kHz
1000 MHz – 18000 MHz RBW: 1 MHz
Example:

Frequency (MHz)	Level (dBµV)	+	Factor (dB)	=	Level dB(µV/m)	-	Limit dB(µV/m)	=	Delta (dB)
170.5	5	+	20	=	25	-	30	=	-5

5.4.5 Test result f < 1 GHz

f: 433.92 MHz
Lower Mode

Frequency (MHz)	Level Pk (dBµV)	Level QP (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Duty Cycle Correct. factor (dB)	Level Pk dB(µV/m)	Calculated Level Av dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
867.84	18.8	--	120	28.1	-17.08	46.90	29.82	52.87	-23.1

Upper Mode

Frequency (MHz)	Level Pk (dBµV)	Level QP (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Duty Cycle Correct. factor (dB)	Level Pk dB(µV/m)	Calculated Level Av dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
867.84	18.1	--	120	28.1	-17.08	46.20	29.12	52.87	-23.8

f: 315.0 MHz
Lower Mode

Frequency (MHz)	Level Pk (dBµV)	Level QP (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Duty Cycle Correct. factor (dB)	Level Pk dB(µV/m)	Calculated Level Av dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
630.0	9.3	--	120	24.6	-16.36	33.90	17.54	47.7	-30.2

Lower Mode

Frequency (MHz)	Level Pk (dBµV)	Level QP (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Duty Cycle Correct. factor (dB)	Level Pk dB(µV/m)	Calculated Level Av dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
630.0	8.6	--	120	24.6	-16.36	33.20	16.84	47.7	-30.9

5.4.6 Test result f > 1 GHz

f: 433.92 MHz
Lower mode:

Frequency (MHz)	L: PK (dBµV)	L: AV (dBµV)	Bandwidth (kHz)	Correct. (dB)	Duty Cycle Correct. factor (dB)	PK level dB(µV/m)	Calculated AV level dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
1301.76	64.82	--	1000	-18.4	-17.08	46.42	29.34	54.0	-24.7
1735.68	63.82	--	1000	-18.4	-17.08	45.46	28.38	54.0	-25.6
2169.60	58.62	--	1000	-15.6	-17.08	43.07	25.99	54.0	-28.0
2603.52	59.72	--	1000	-12.9	-17.08	46.85	29.77	54.0	-24.2
3037.44	58.02	--	1000	-12.3	-17.08	45.73	28.65	54.0	-25.3
3471.36	53.92	--	1000	-12.2	-17.08	41.68	24.60	54.0	-29.4
3905.28	52.72	--	1000	-11.3	-17.08	41.40	24.32	54.0	-29.7

Upper mode:

Frequency (MHz)	L: PK (dBµV)	L: AV (dBµV)	Bandwidth (kHz)	Correct. (dB)	Duty Cycle Correct. factor (dB)	PK level dB(µV/m)	Calculated AV level dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
1301.76	59.52	--	1000	-18.4	-17.08	41.12	24.04	54.0	-30.0
1735.68	57.32	--	1000	-18.4	-17.08	38.97	21.89	54.0	-32.1
2169.60	51.52	--	1000	-15.6	-17.08	35.97	18.89	54.0	-35.1
2603.52	49.42	--	1000	-12.9	-17.08	36.55	19.47	54.0	-34.5
3037.44	57.82	--	1000	-12.3	-17.08	45.54	28.46	54.0	-25.5
3471.36	59.12	--	1000	-12.2	-17.08	46.88	29.80	54.0	-24.2
3905.28	55.62	--	1000	-11.3	-17.08	44.30	27.22	54.0	-26.8

For calculating the AV Level, the Duty Cycle Correction Factor from the ASK mode was used, because this correction factor is stronger as the ASK mode.

f: 315.0 MHz:
Lower mode:

Frequency (MHz)	L: PK (dBµV)	L: AV (dBµV)	Bandwidth (kHz)	Correct. (dB)	Duty Cycle Correct. factor (dB)	PK level dB(µV/m)	Calculated AV level dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
1260.0	52.94	--	1000	-18.0	-16.36	34.91	18.55	54.0	-35.4
1575.0	61.44	--	1000	-19.9	-16.36	41.50	25.14	54.0	-28.9
1890.0	56.24	--	1000	-15.8	-16.36	40.43	24.07	54.0	-29.9
2205.0	62.44	--	1000	-15.4	-16.36	47.06	30.70	54.0	-23.3
2520.0	64.54	--	1000	-13.2	-16.36	51.35	34.99	54.0	-19.0
2835.0	65.84	--	1000	-13.0	-16.36	52.80	36.44	54.0	-17.6
3150.0	66.64	--	1000	-12.5	-16.36	54.18	37.82	54.0	-16.2

Upper mode:

Frequency (MHz)	L: PK (dBµV)	L: AV (dBµV)	Bandwidth (kHz)	Correct. (dB)	Duty Cycle Correct. factor (dB)	PK level dB(µV/m)	Calculated AV level dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
1260.0	51.06	--	1000	-18.0	-16.36	33.03	16.67	54.0	-37.3
1575.0	60.16	--	1000	-19.9	-16.36	40.22	23.86	54.0	-30.1
1890.0	57.66	--	1000	-15.8	-16.36	41.84	25.48	54.0	-28.5
2205.0	63.66	--	1000	-15.4	-16.36	48.28	31.92	54.0	-22.1
2520.0	64.76	--	1000	-13.2	-16.36	51.57	35.21	54.0	-18.8
2835.0	66.06	--	1000	-13.0	-16.36	53.02	36.66	54.0	-17.3
3150.0	64.96	--	1000	-12.5	-16.36	52.49	36.13	54.0	-17.9

For calculating the AV Level the Duty Cycle Correction Factor from the ASK mode was used, because this correction factor is stronger as the ASK mode.

FCC ID: OYGTMSS5A2

Limit according to FCC Section 15.231(e), Section 15.209(a) and Section 15.205(a):

Frequency (MHz)	Field strength of spurious emissions @ 3m		**Effective limit for 433.92 MHz**	
	(µV/m)	dB(µV/m)	(µV/m)	dB(µV/m)
40.66 – 40.70	100	40		
70 - 130	50	34		
130 - 174	50 to 150*	34 to 43.5*		
174 - 260	150	43.5		
260 - 470	**150 to 500***	**43.5 to 54**	**439.87**	**52.87**
Above 470	500	54		

*Linear interpolation

Limit according to FCC Section 15.231(e), Section 15.209(a) and Section 15.205(a):

Frequency (MHz)	Field strength of spurious emissions @ 3m		**Effective limit for 315 MHz**	
	(µV/m)	dB(µV/m)	(µV/m)	dB(µV/m)
40.66 – 40.70	100	40		
70 - 130	50	34		
130 - 174	50 to 150*	34 to 43.5*		
174 - 260	150	43.5		
260 - 470	**150 to 500***	**43.5 to 54**	**241.67**	**47.66**
Above 470	500	54		

*Linear interpolation

Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in the table above or to the general limits shown in the table below according to § 15.209, whichever limit permits a higher field strength.

Frequency (MHz)	15.209 Limits (µV/m)	15.209 Limits dB(µV/m)
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

Additionally, there is a limit according to §15.35(b) on the radio frequency emissions, as measured with a peak detector, corresponding to 20 dB above the maximum permitted average limits.

FCC ID: OYGTMSS5A2

Restricted bands of operation according to FCC Part 15C, Section 15.205(a):

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

The requirements are **FULFILLED.**

Remarks: The level of Field Strength is identically in all Tx operation modes.

The test was performed in “Lower Mode” of the EuT.

The test was performed in “Upper Mode” of the EuT.

5.5 Correction for pulse operation (duty cycle)

For test instruments and accessories used see section 6 Part **DC**.

5.5.1 Description of the test location

Test location: Shielded room S4

5.5.2 Photo documentation of the test set-up – See Attachment B

5.5.3 Applicable standard

According to FCC Part 15C, Section 15.35(c):
The emissions from intentional radiators shall not exceed the effective field strength limits.

5.5.4 Test result

The Duty cycle factor (dB) is calculated applying the following formula:

$$K_E = 20 \log ((t_{iB})/100)$$

K_E:	pulse operation correction factor	(dB)
t_{iB}	pulse duration for one pulse	(ms)

f: 433.92 MHz
ASK: Maximum transmitting duration in every 100ms period:
$K_E = 20 \log ((14.0)/100) = -17.08$ dB

FSK: Maximum transmitting duration in every 100ms period:
$K_E = 20 \log ((10.0)/100) = -20.00$ dB
f: 315.0 MHz
ASK: Maximum transmitting duration in every 100ms period:
$K_E = 20 \log ((15.2)/100) = -16.36$ dB

FSK: Maximum transmitting duration in every 100ms period:
$K_E = 20 \log ((10.0)/100) = -20.00$ dB

Remarks: The pulse train (*Tw*) exceeds 100 ms, therefore the duty cycle has been calculated by averaging the sum of the pulse widths over the 100 ms width with the highest average value.

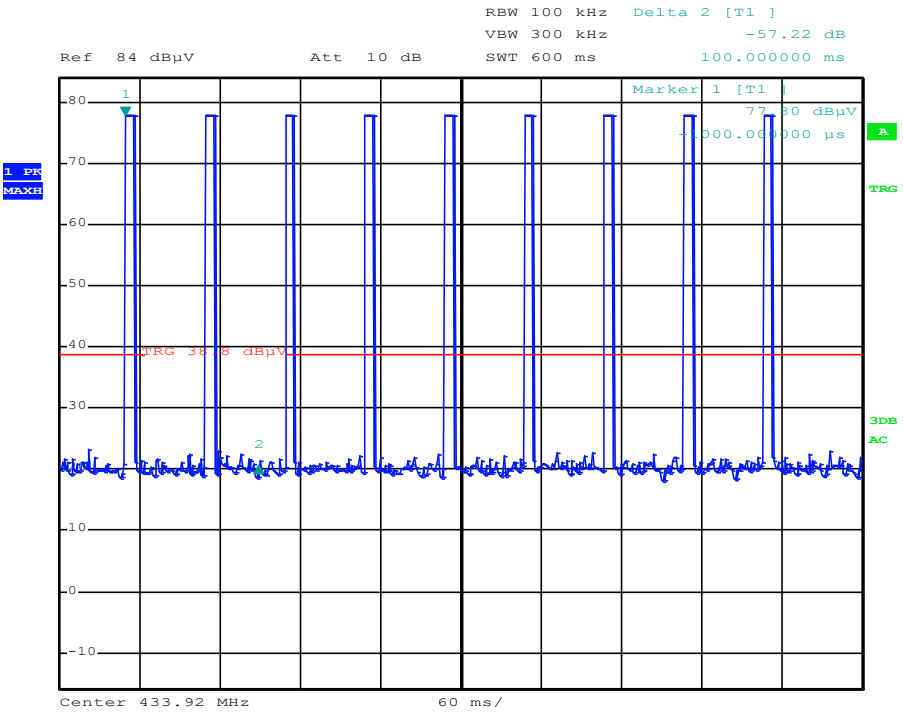
For detailed results, please see the test protocol below.

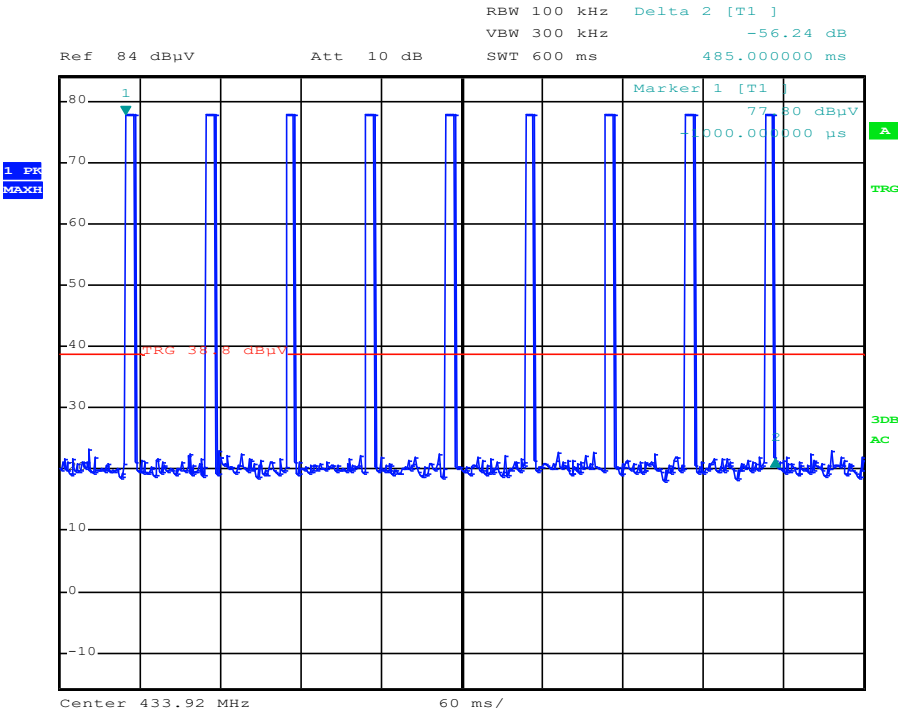
5.5.5 Test protocol

Correction for pulse operation (duty cycle)
FCC Part 15C, Section 15.35(c)

Pulse duration for one pulse

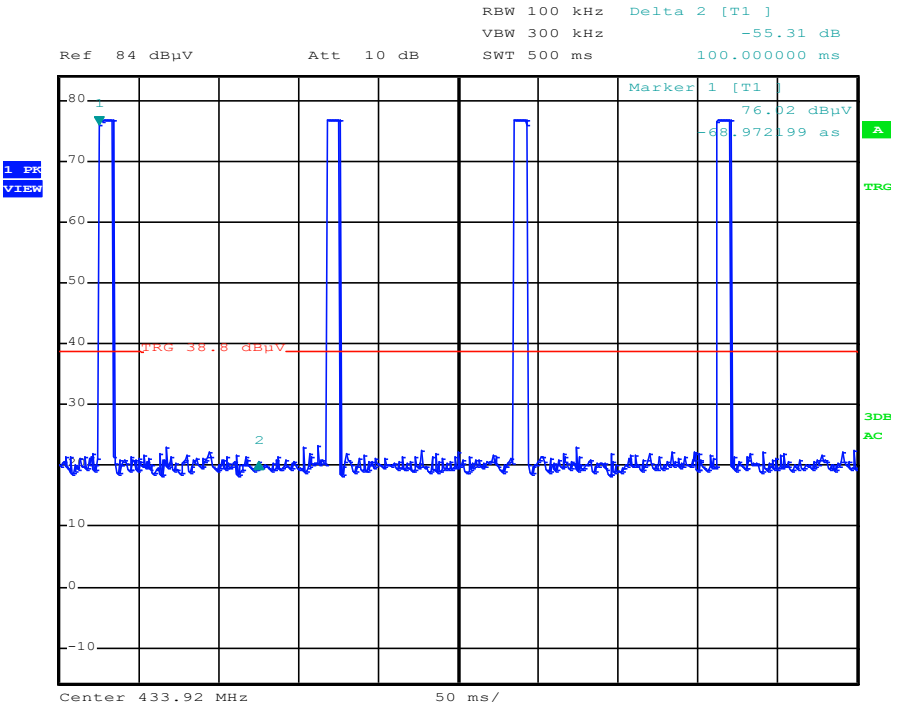
f: 433.92 MHz
Worst Tx on time – ASK mode: 2 times a 7.0 ms within 100ms

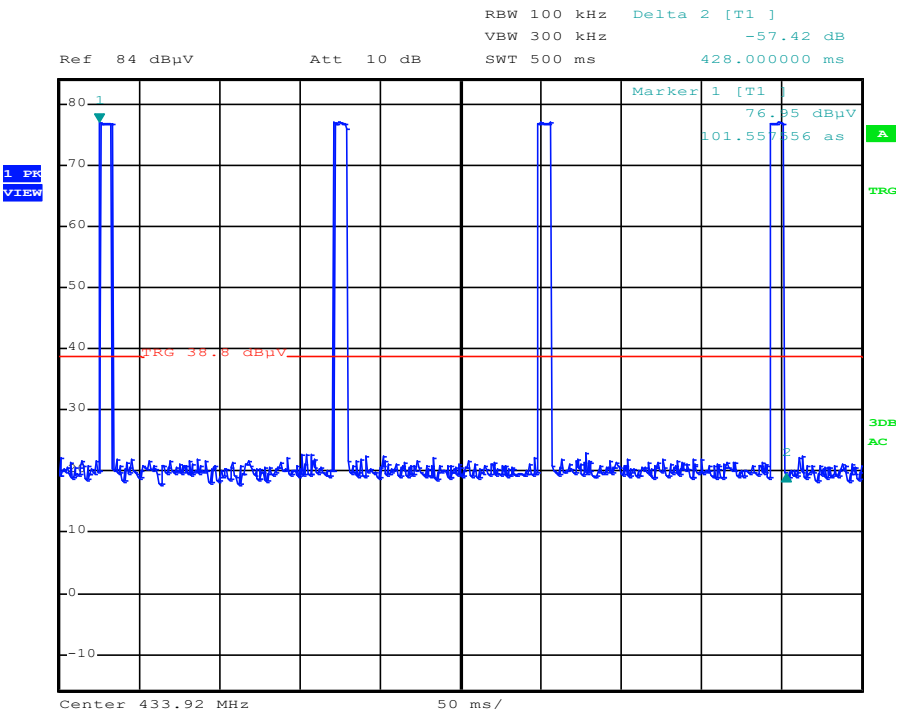




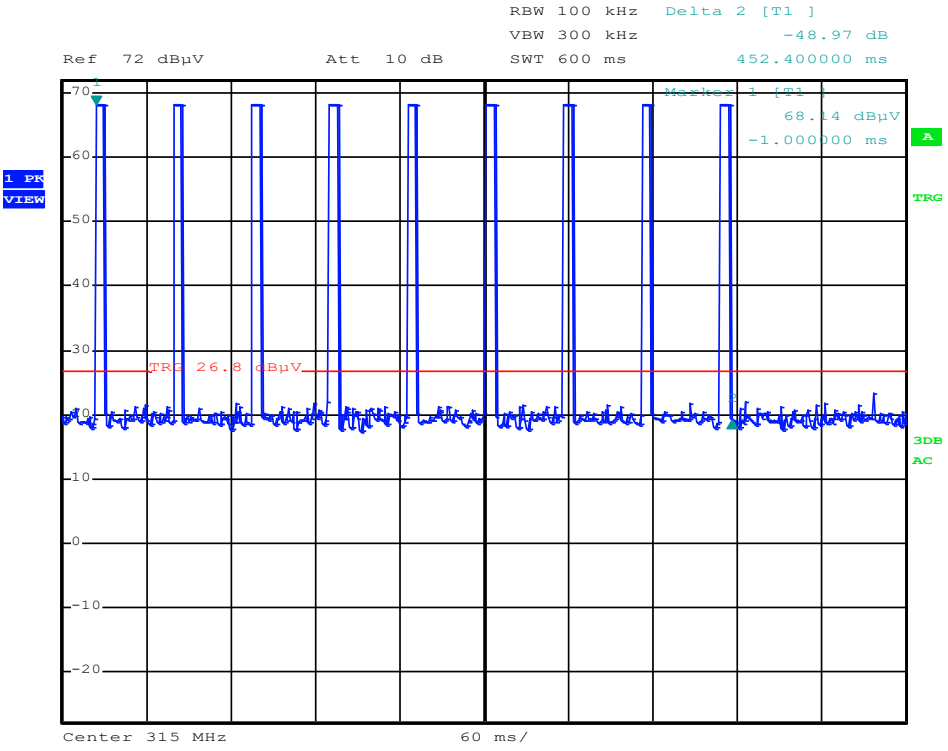
FCC ID: OYGTMSS5A2

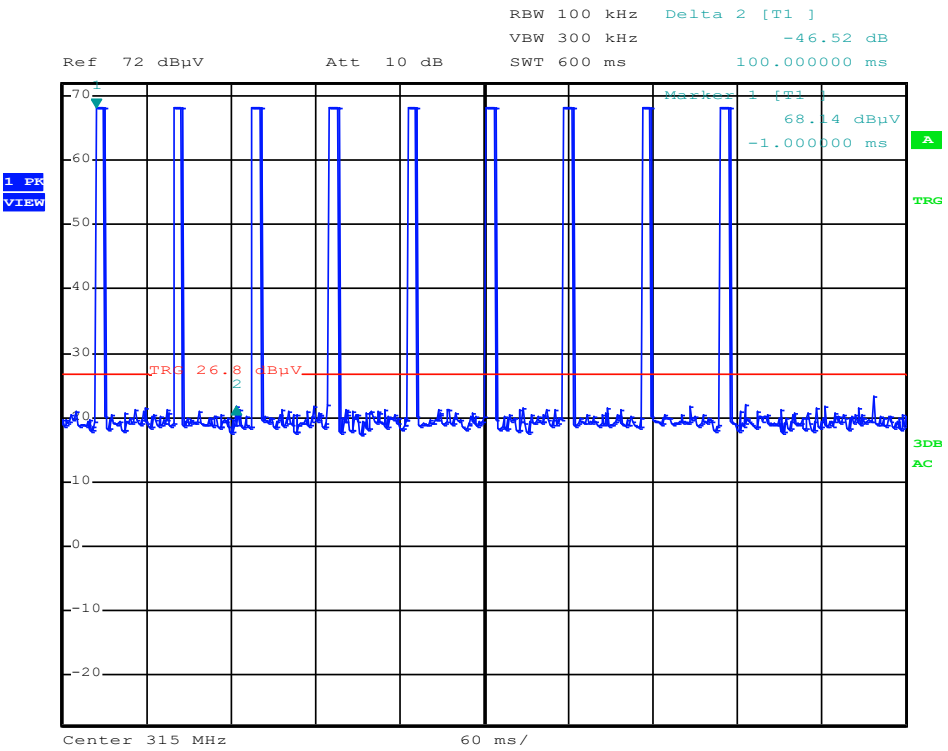
f: 433.92 MHz
Worst Tx on time – FSK mode: 10.0 ms within 100ms



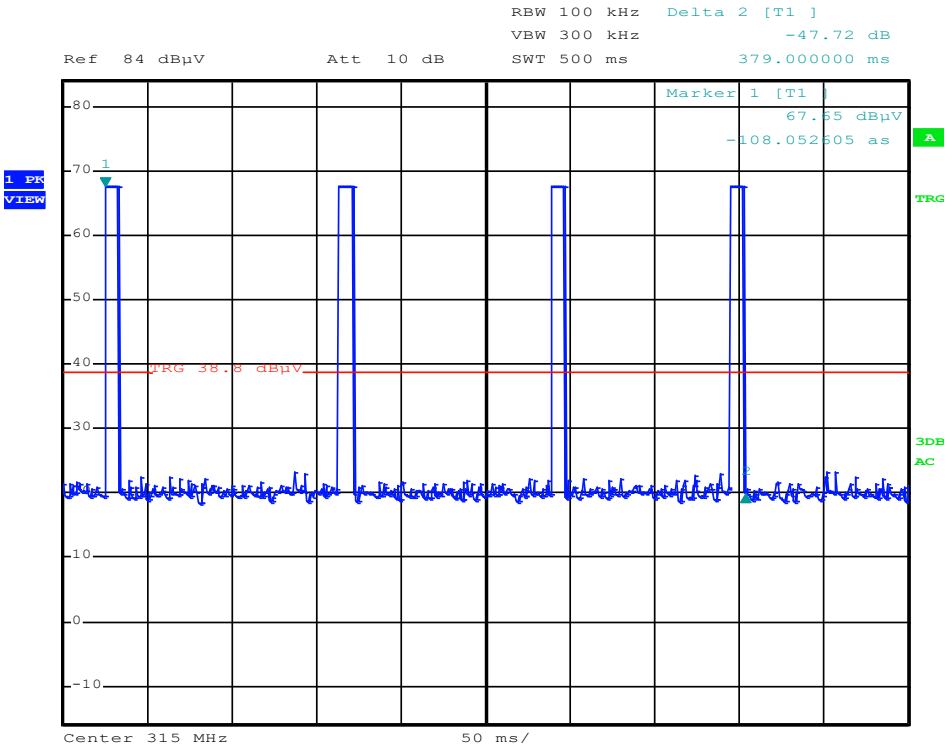


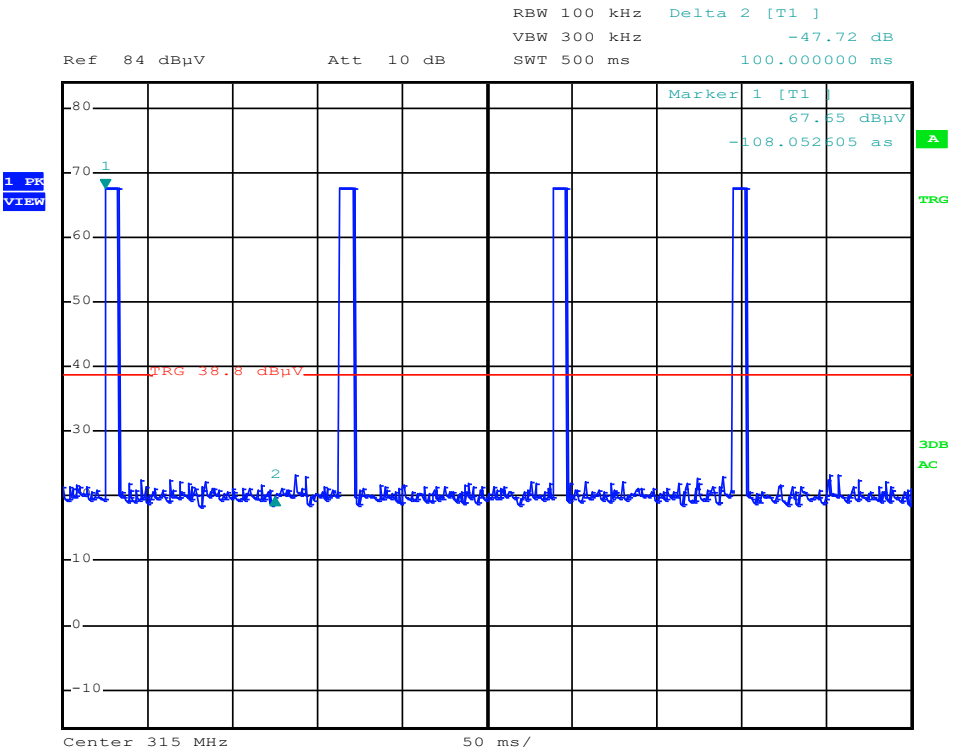
f: 315.0 MHz
Worst Tx on time – ASK mode: 2 times a 7.6 ms within 100ms





f: 315.0 MHz
Worst Tx on time – FSK mode: 10.0 ms within 100ms





Remarks:

5.6 Emission bandwidth

For test instruments and accessories used see section 6 Part **MB**.

5.6.1 Description of the test location

Test location: AREA4

5.6.2 Photo documentation of the test set-up - See Attachment B

5.6.3 Applicable standard

According to FCC Part 15C, Section 15.231(c):
The bandwidth of the emission shall not exceed the effective limits.

5.6.4 Description of Measurement

The measurement was performed conducted with intentional modulation using a spectrum analyser. The analyser span was set wide enough to capture most of the power envelope of the signal. The function “20-dB-down” is used to determine the BW. For an overview on the adjacent restricted bands the span was set as wide as needed to show that the restricted bands are not affected.

5.6.5 Test result

f: 433.92 MHz:
ASK – Mode:

Fundamental [MHz]	20dB Bandwidth F1 [MHz]	20dB Bandwidth F2 [MHz]	Measured Bandwidth [kHz]	LIMIT Fundamental f*0,0025 [MHz]
433.92	433.8930	433.9480	55.0	1.0848

FSK – Mode:

Fundamental [MHz]	20dB Bandwidth F1 [MHz]	20dB Bandwidth F2 [MHz]	Measured Bandwidth [kHz]	LIMIT Fundamental f*0,0025 [MHz]
433.92	433.8650	433.9830	118.0	1.0848

f: 315.0 MHz
ASK – Mode:

Fundamental [MHz]	20dB Bandwidth F1 [MHz]	20dB Bandwidth F2 [MHz]	Measured Bandwidth [kHz]	LIMIT Fundamental f*0,0025 [MHz]
315.0	314.9720	315.0370	65.0	0.7875

FSK – Mode:

Fundamental [MHz]	20dB Bandwidth F1 [MHz]	20dB Bandwidth F2 [MHz]	Measured Bandwidth [kHz]	LIMIT Fundamental f*0,0025 [MHz]
315.0	314.9460	315.0630	117.0	0.7875

Limit according to FCC Part 15C Section 15.231(c):

Frequency (MHz)	20 dB BW limit dependent of the carrier (%)
70 – 900	0.25
above 900	0.50

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

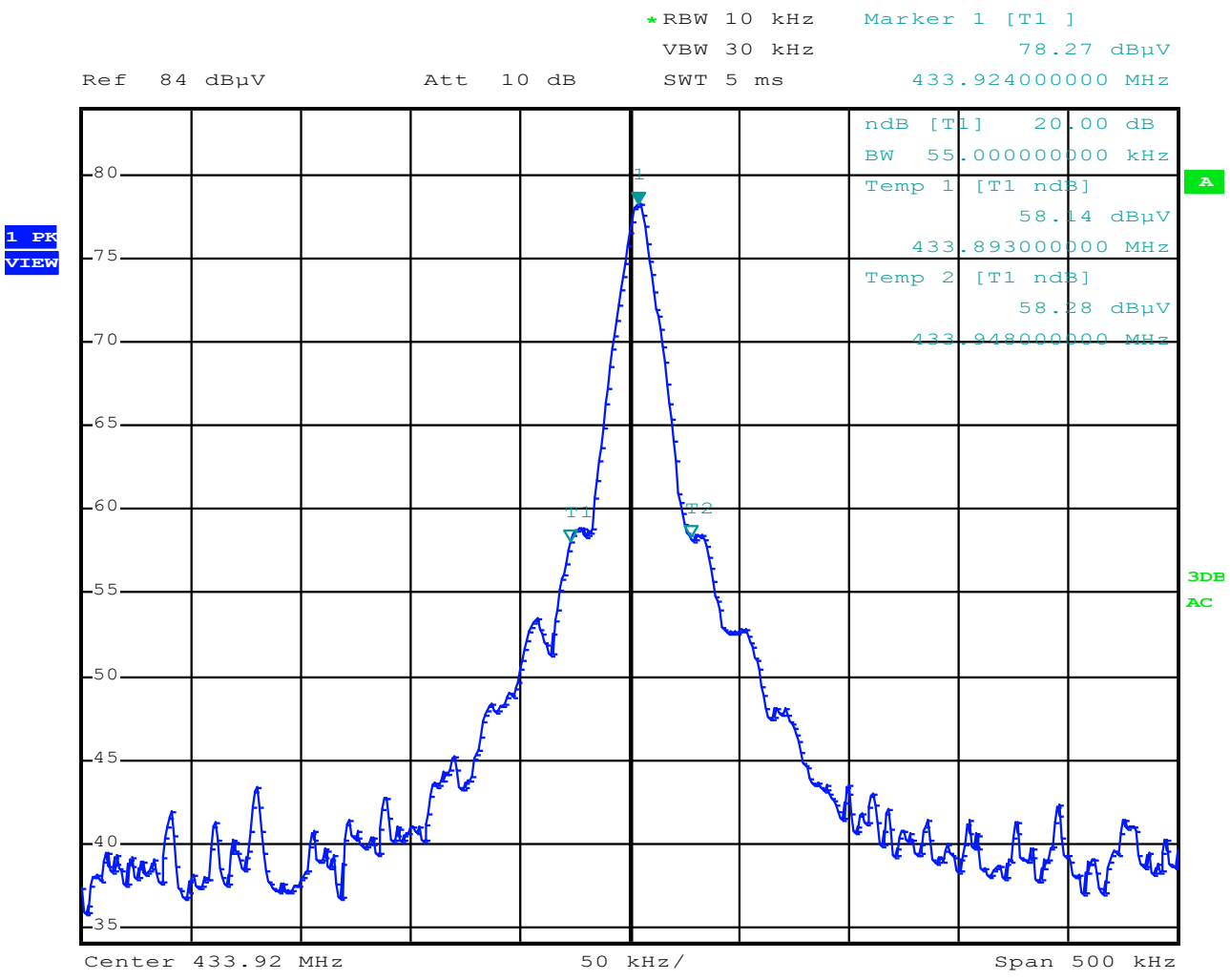
The requirements are **FULFILLED.**

Remarks: For detailed results, please see the test protocol below.

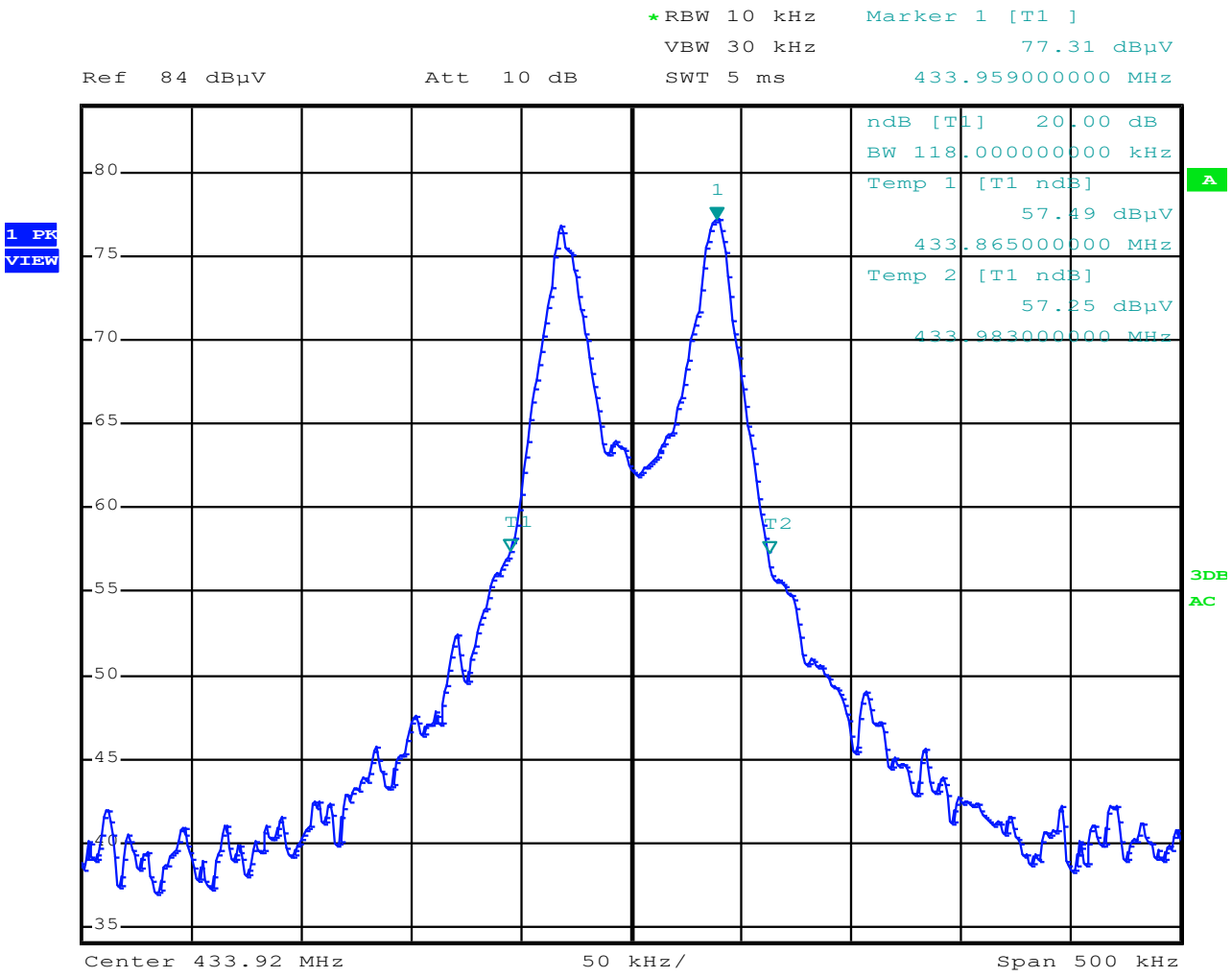
5.6.6 Test protocol

Emission bandwidth – f: 433.92 MHz
FCC Part 15C, Section 15.231(c)

ASK Mode:

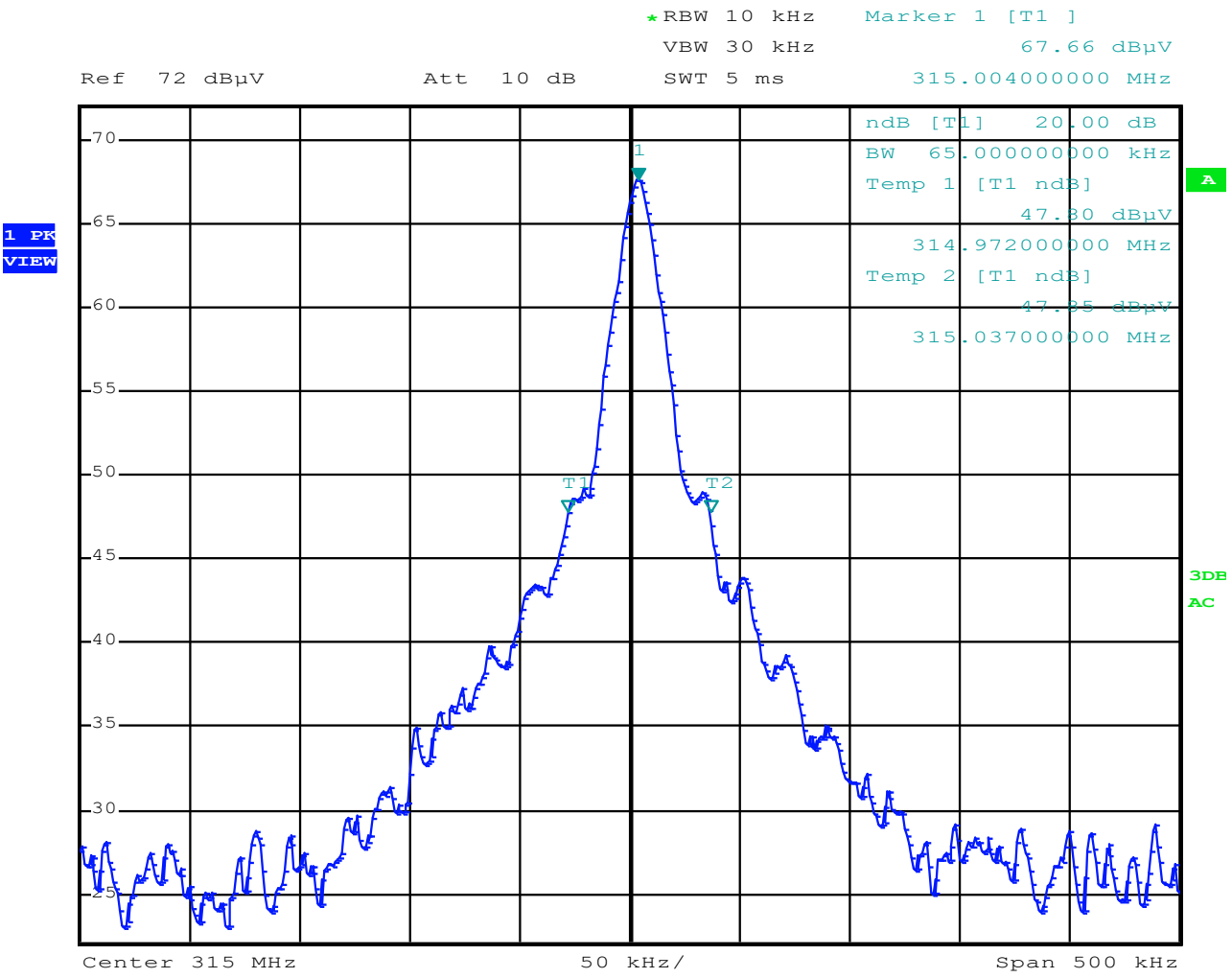


FSK Mode:

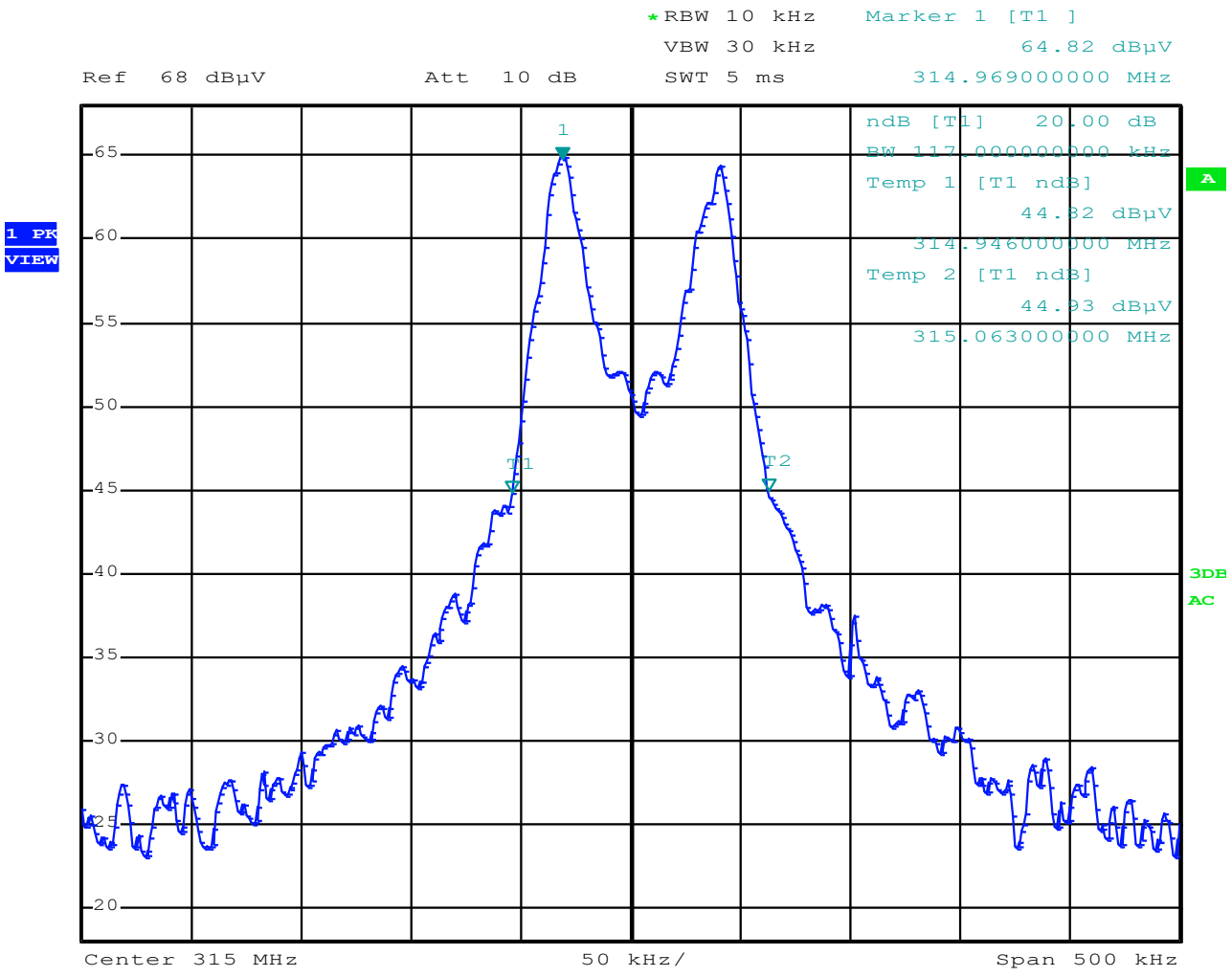


Emission bandwidth – f: 315.0 MHz
FCC Part 15C, Section 15.231(c)

ASK Mode:



FSK Mode:



5.7 On / Off Period

For test instruments and accessories used see section 6 Part **MB**.

5.7.1 Description of the test location

Test location: Shielded room S4

5.7.2 Photo documentation of the test set-up – See Attachment B

5.7.3 Applicable standard

According to FCC Part 15C, Section 15.231(e):

5.7.4 Description of Measurement

The duration of transmission is measured with the spectrum analyzer. The sweep points were set to maximum for higher the time resolution. The signal is modulated; the marker of the analyzer is set to maximum amplitude at normal temperature and zero span. The analyser was set to single sweep and triggered on the button, the marker was set to the edges in order to measure the duration time and then recorded.

5.7.5 Test result

The manufacturer declares following transmitting intervals:
When the EUT is mounted in the vehicle tire in the worst case, periodically RF transmission where the duration of each transmission is always less than 1 second and the silent period is at least 30 times the duration of the transmission, and never less than 10 seconds.
In the case of an emergency condition (rapid pressure loss), the devise will transmit tire pressure and temperature information throughout the duration of the condition.

f: 433.92 MHz:
-ASK mode:

Duration of transmission (ms)	Limit (s)
485.0	1.0

Silent period (s)	Limit (s)
13.6	> 10.0

-FSK mode:

Duration of transmission (ms)	Limit (s)
428.0	1.0

Silent period (s)	Limit (s)
14.22	> 10.0

f: 315 MHz:
-ASK mode:

Duration of transmission (ms)	Limit (s)
452.4	1.0

Silent period (s)	Limit (s)
11.07	> 10.0

-FSK mode:

Duration of transmission (ms)	Limit (s)
379.0	1.0

Silent period (s)	Limit (s)
13.76	> 10.0

Limit according to FCC Part 15C, Section 15.231(e):

In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

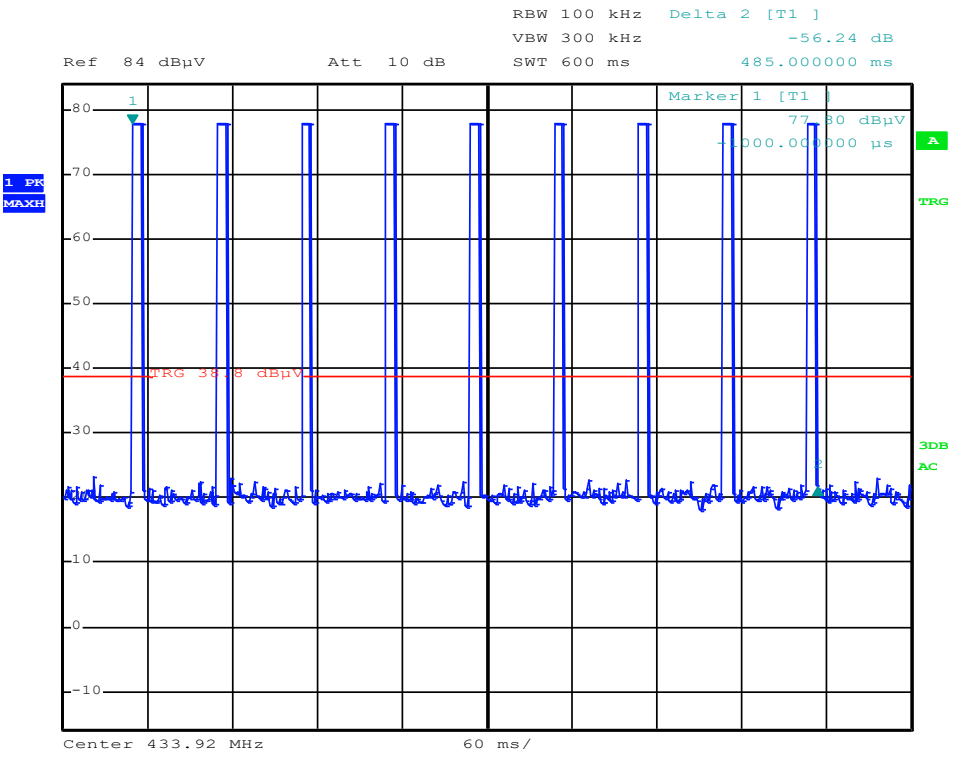
The requirements are **FULFILLED.**

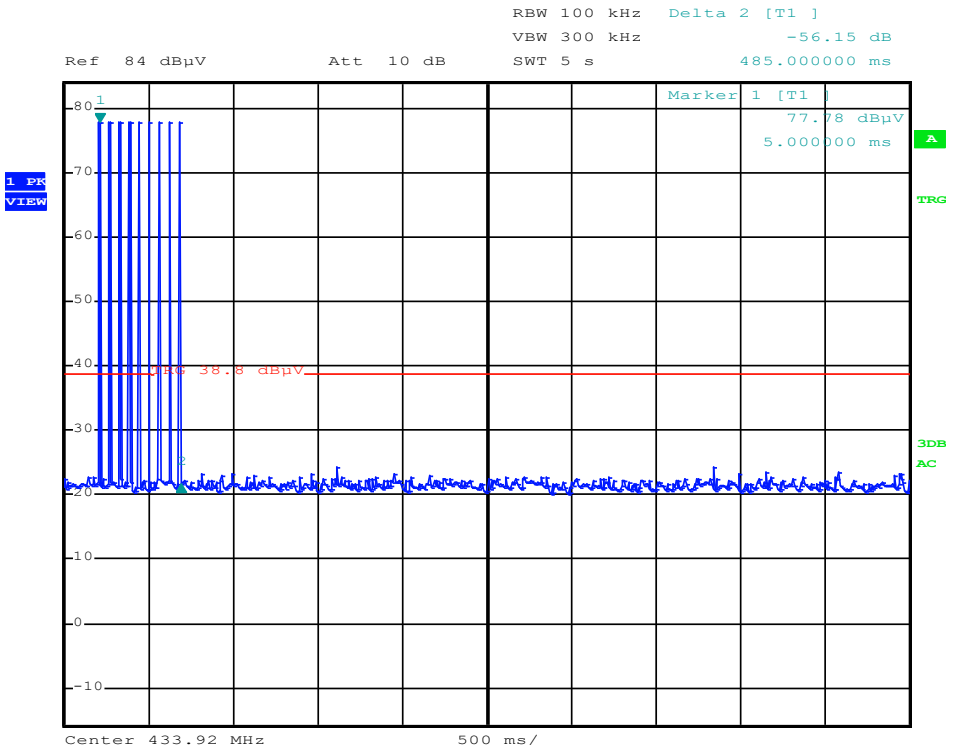
Remarks: For detailed test results, please see the test protocol below.

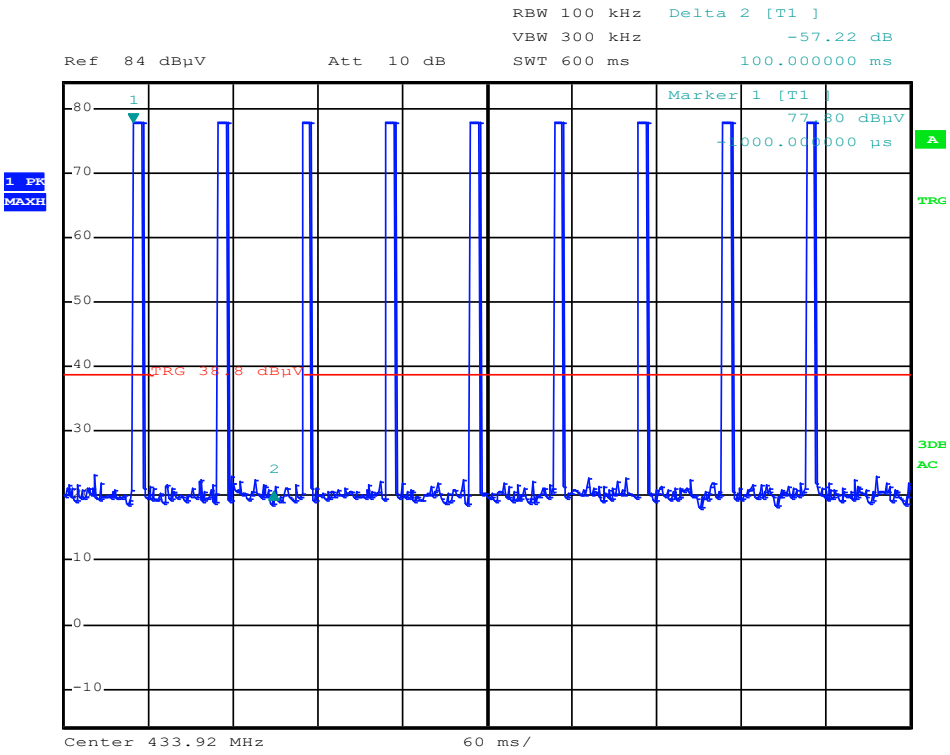
5.7.6 Test protocol

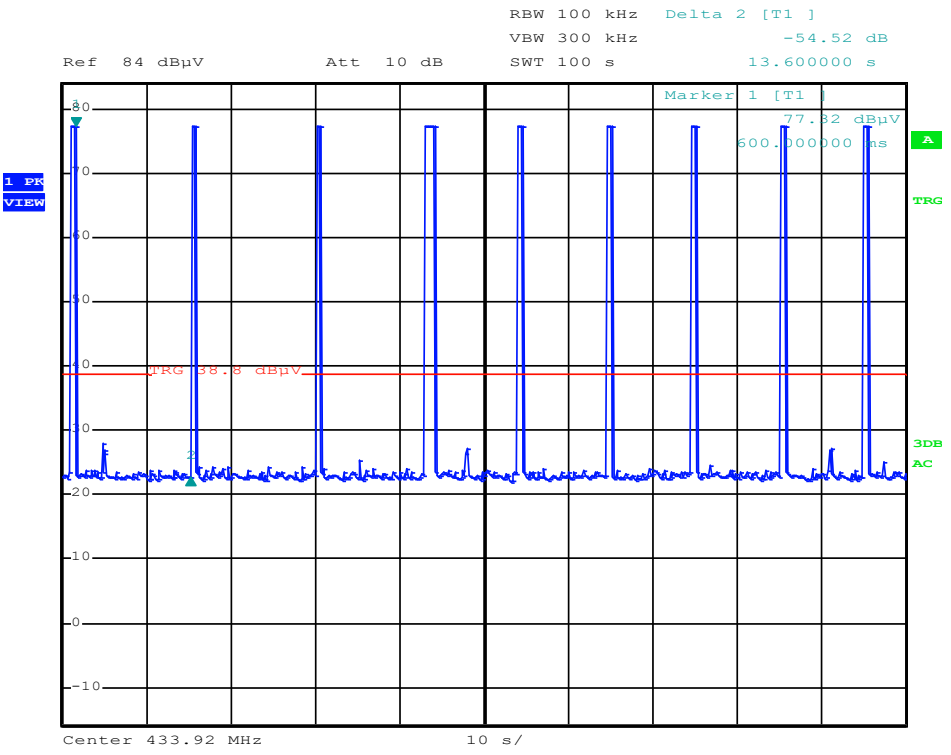
Signal deactivation – f: 433.92 MHz
FCC Part 15C, Section 15.231(e)

Worst Tx on time – ASK mode: 14.0 ms within 100ms

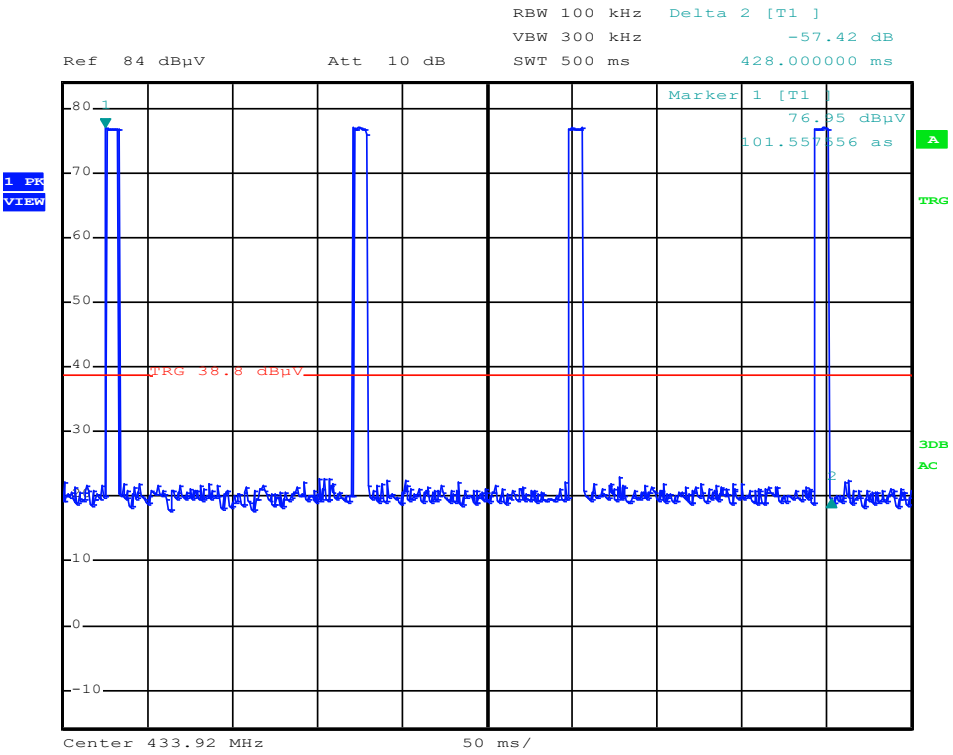


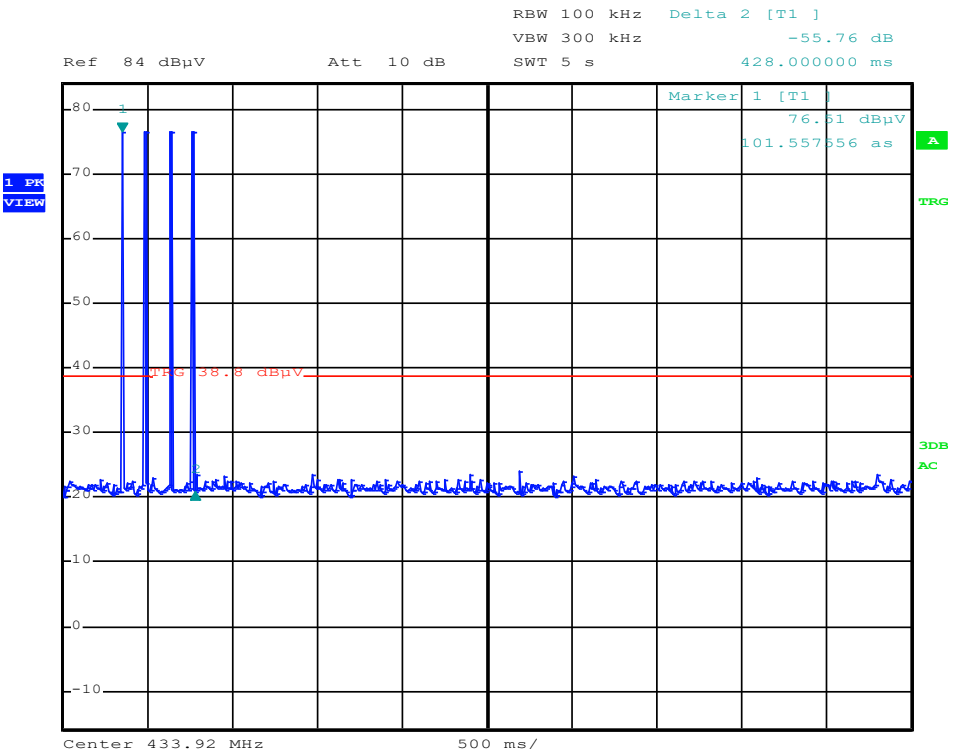


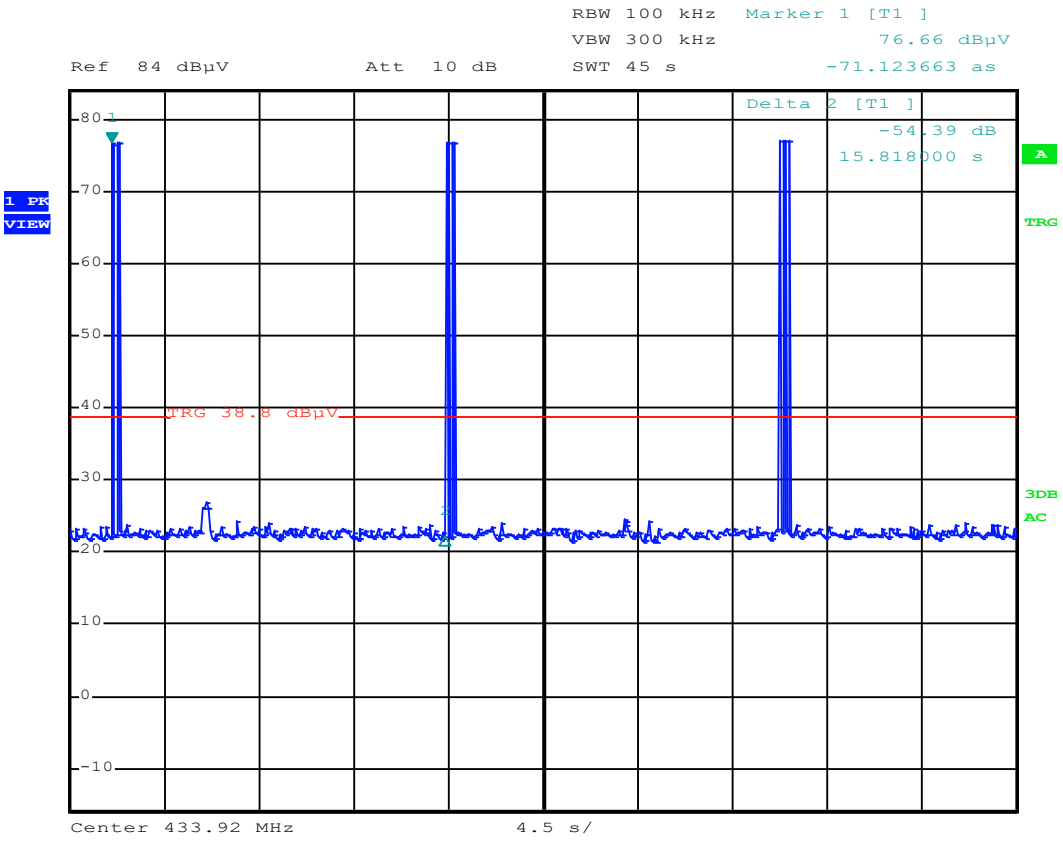




Worst Tx on time – FSK mode: 10.0 ms within 100ms



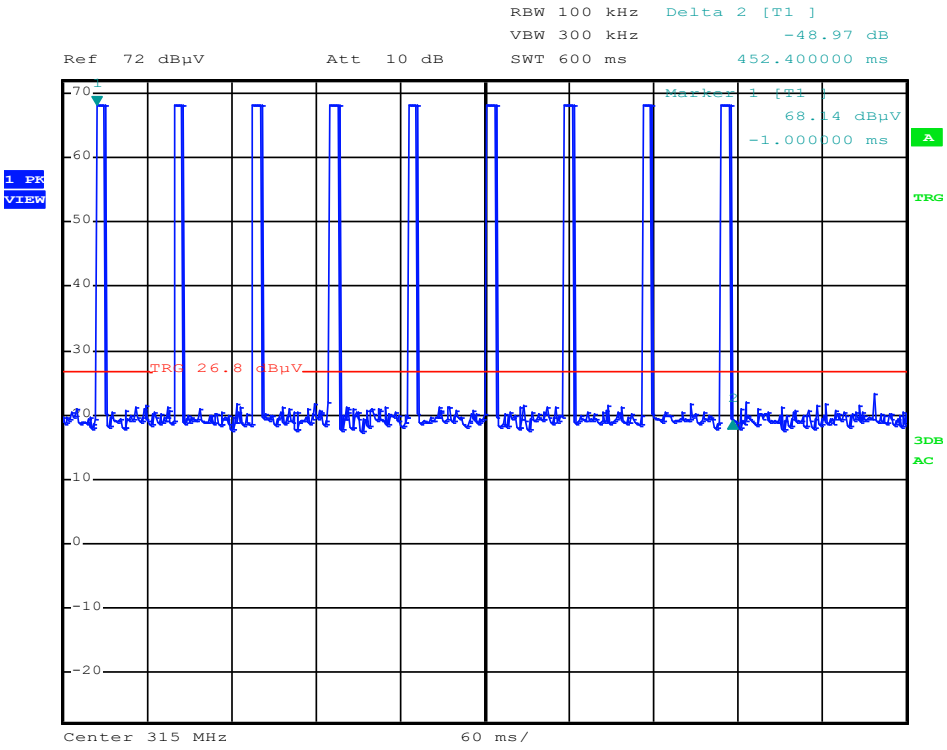


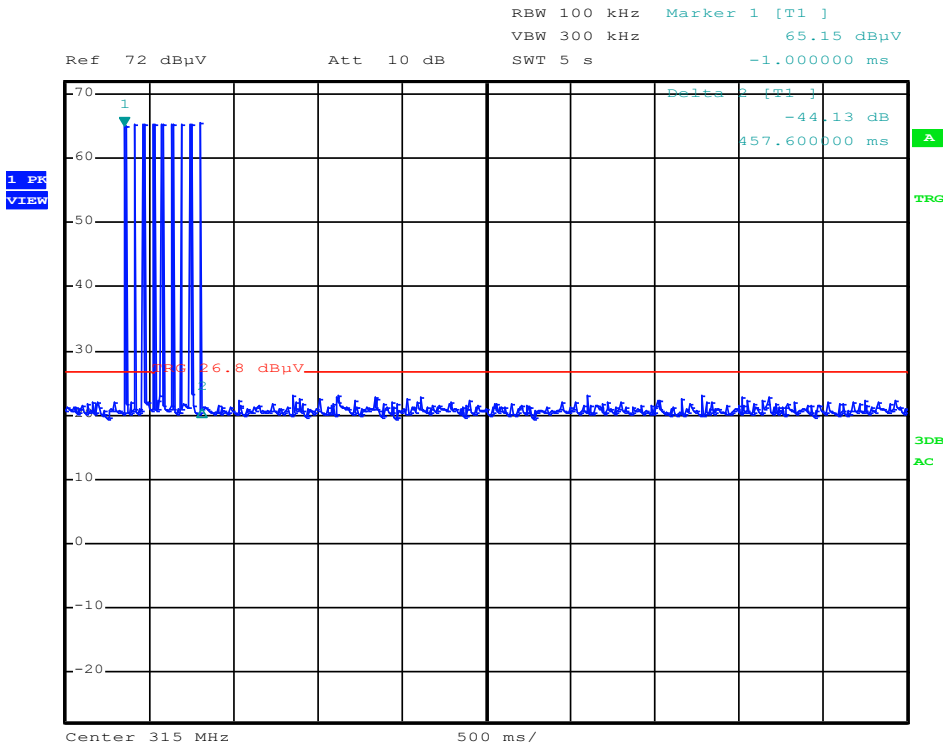


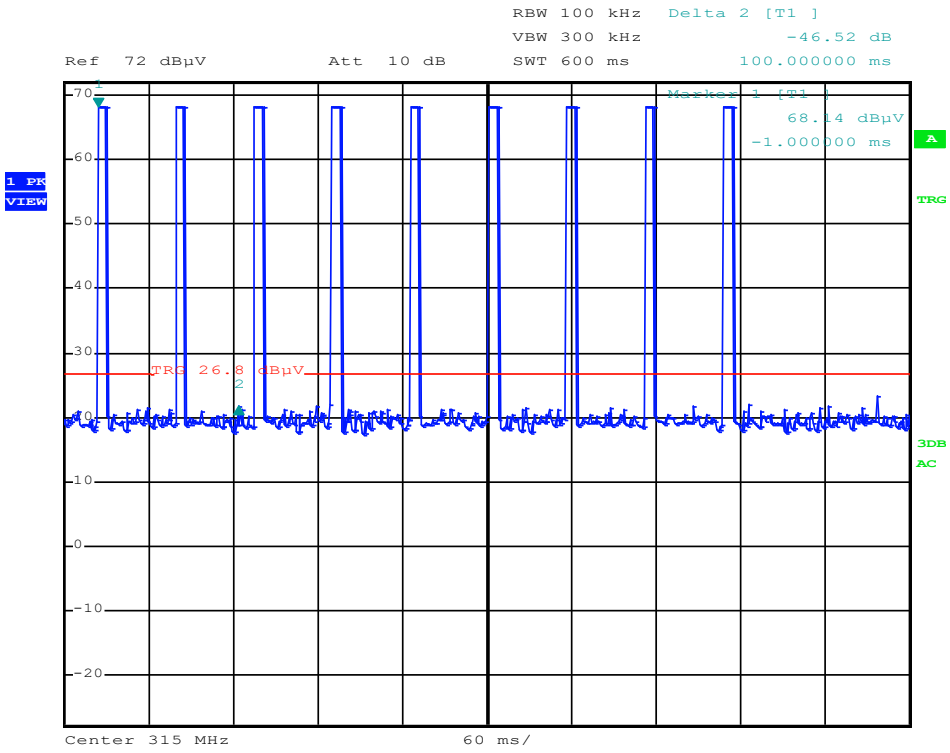
FCC ID: OYGTMSS5A2

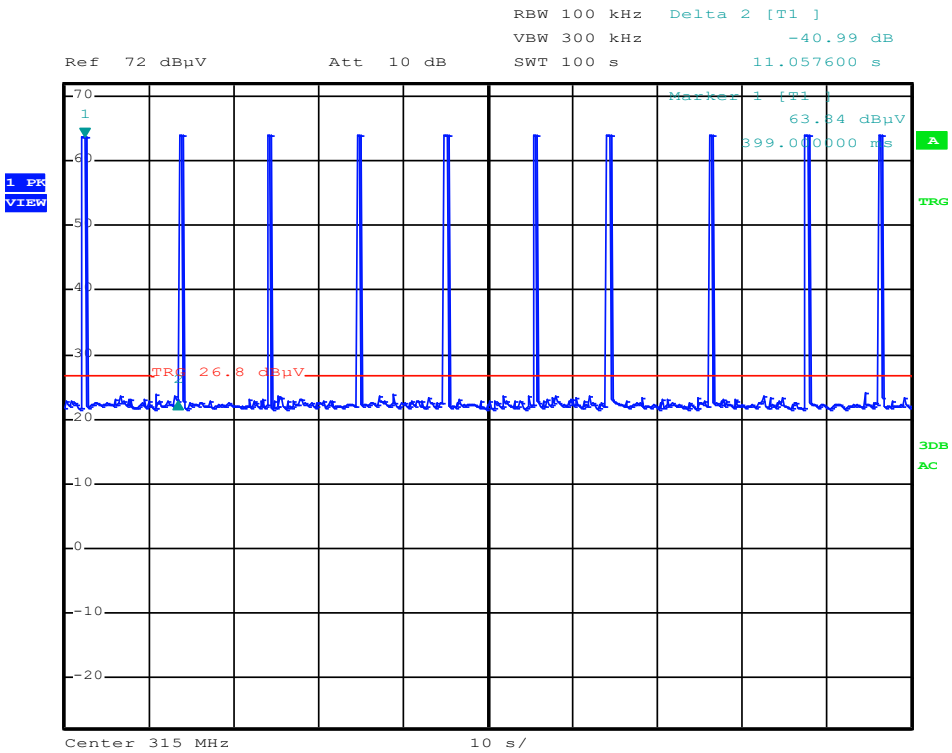
Signal deactivation – f: 315.0 MHz
FCC Part 15C, Section 15.231(e)

Worst Tx on time – ASK mode: 14.0 ms within 100ms

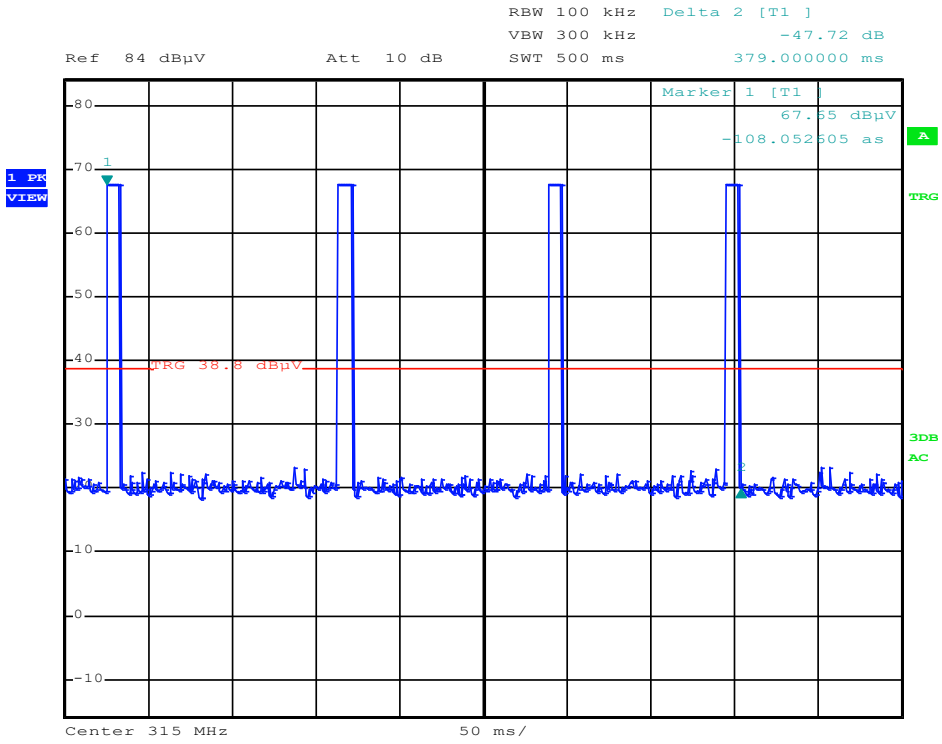


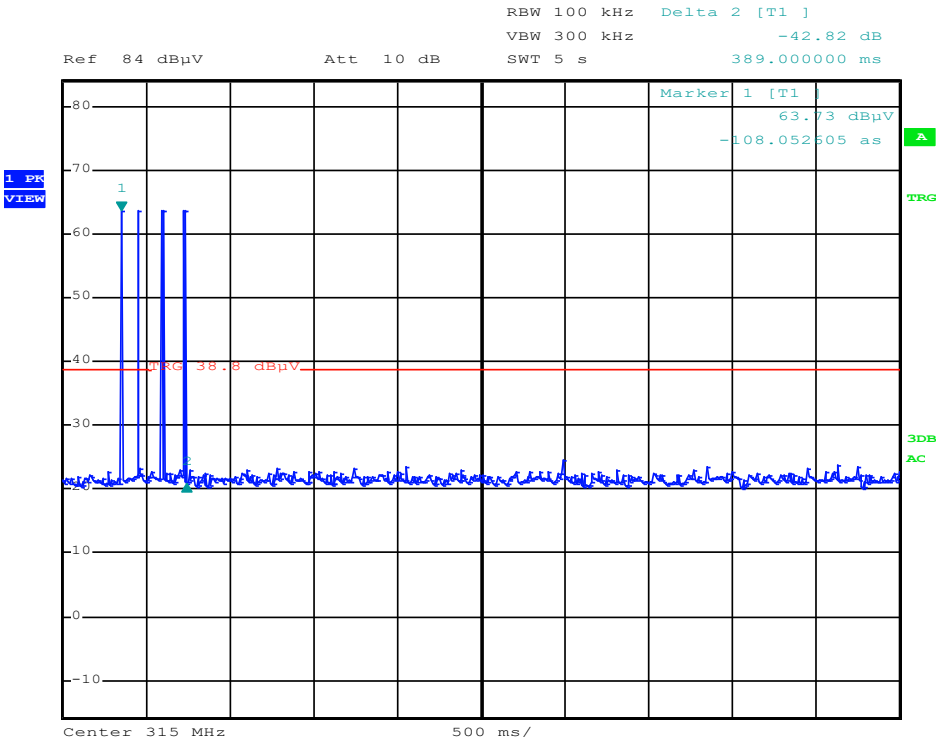


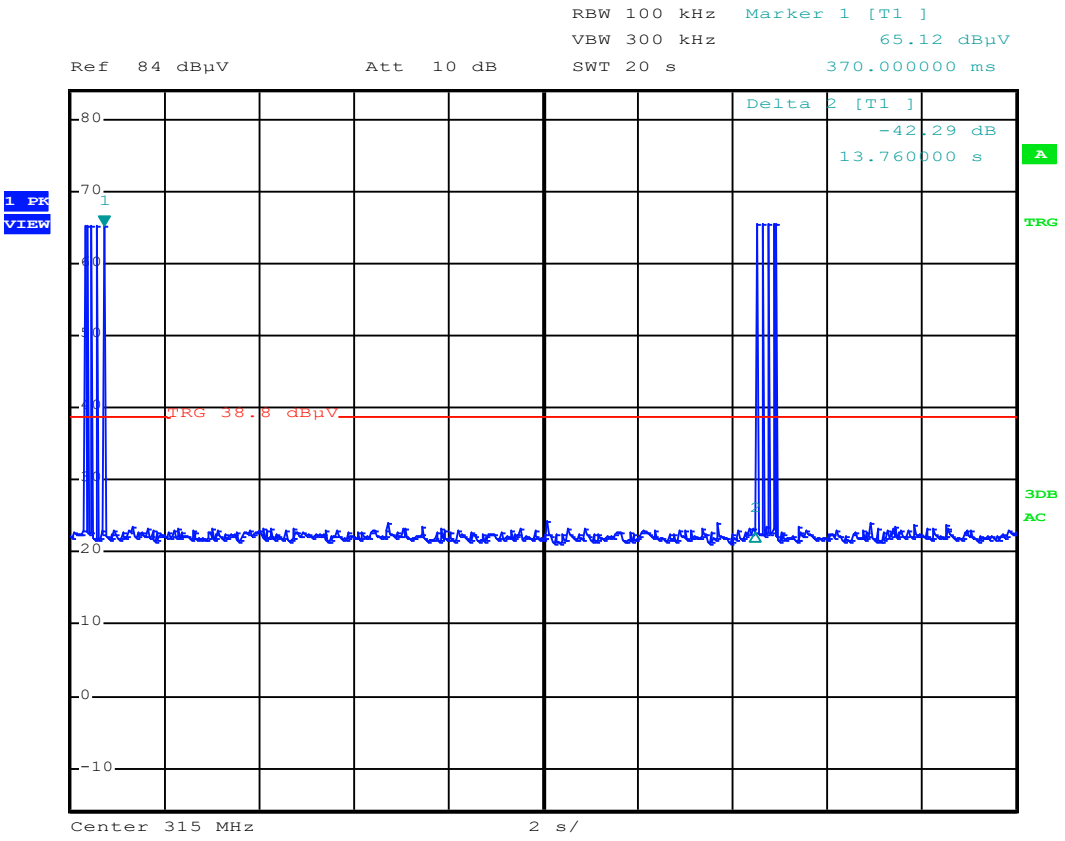




Worst Tx on time – FSK mode: 10.0 ms within 100ms







5.8 Signal deactivation

For test instruments and accessories used see section 6 Part **MB**.

5.8.1 Description of the test location

Test location: AREA4

5.8.2 Photo documentation of the test set-up – See Attachment B

5.8.3 Applicable standard

According to FCC Part 15C, Section 15.231(a):

5.8.4 Description of Measurement

The duration of transmission is measured with the spectrum analyzer. The sweep points were set to maximum for higher the time resolution. The signal is modulated; the marker of the analyzer is set to maximum amplitude at normal temperature and zero span. The analyser was set to single sweep and triggered on the button, the marker was set to the edges in order to measure the duration time and then recorded.

5.8.5 Test result

The manufacturer declares following transmitting intervals:

f: 433.92 MHz:
ASK mode:

Duration of transmission (ms)
14.0

FSK mode:

Duration of transmission (ms)
10.0

f: 315.0 MHz:
ASK mode:

Duration of transmission (ms)
11.06

FSK mode:

Duration of transmission (ms)
13.76

Limit according to FCC Part 15C, Section 15.231(a)(4):

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released and a transmitter activated automatically shall cease transmission within 5 seconds after activation.

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine systems integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds.
(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

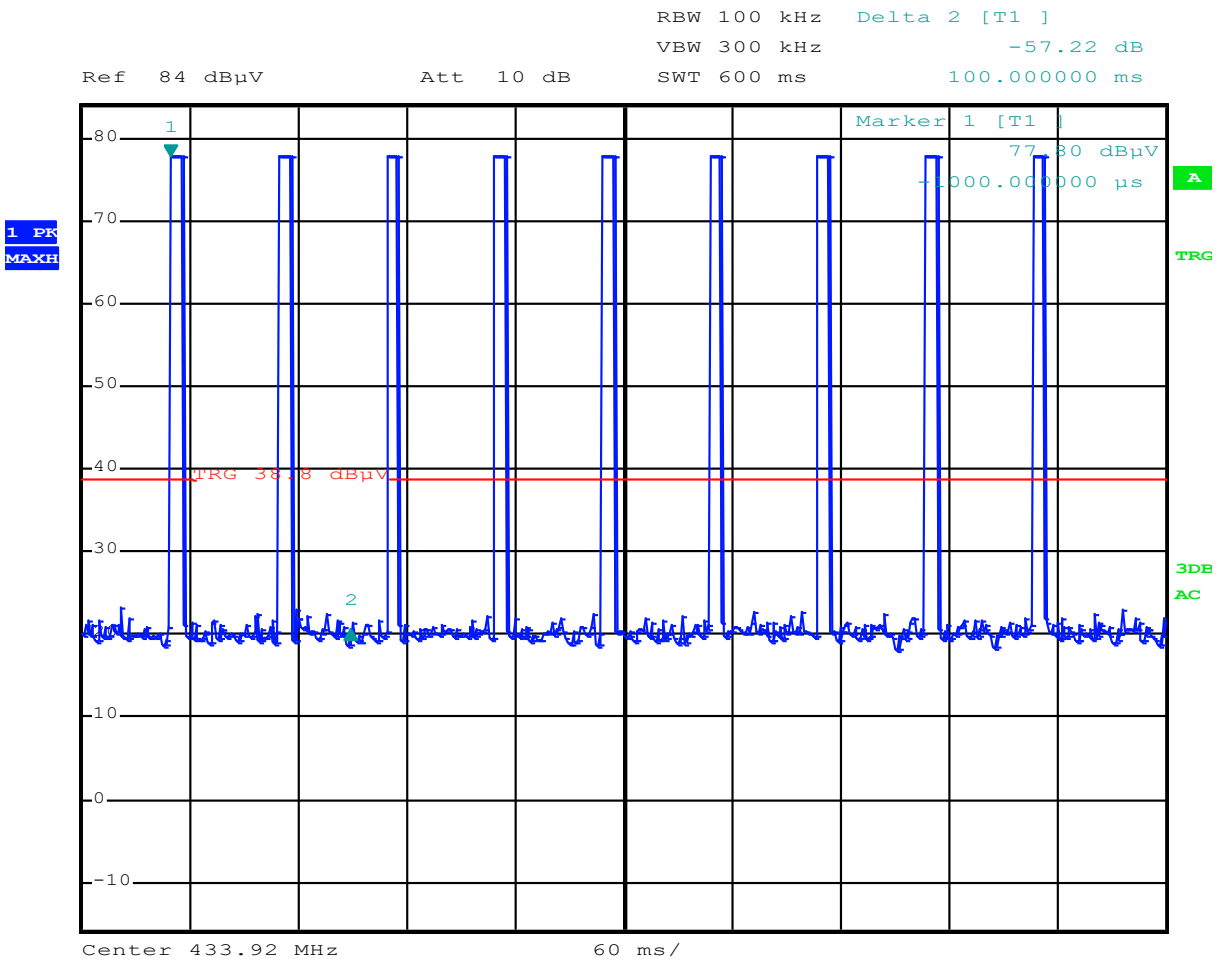
The requirements are **FULFILLED.**

Remarks: For detailed test results, please see the test protocol below.

5.8.6 Test protocol

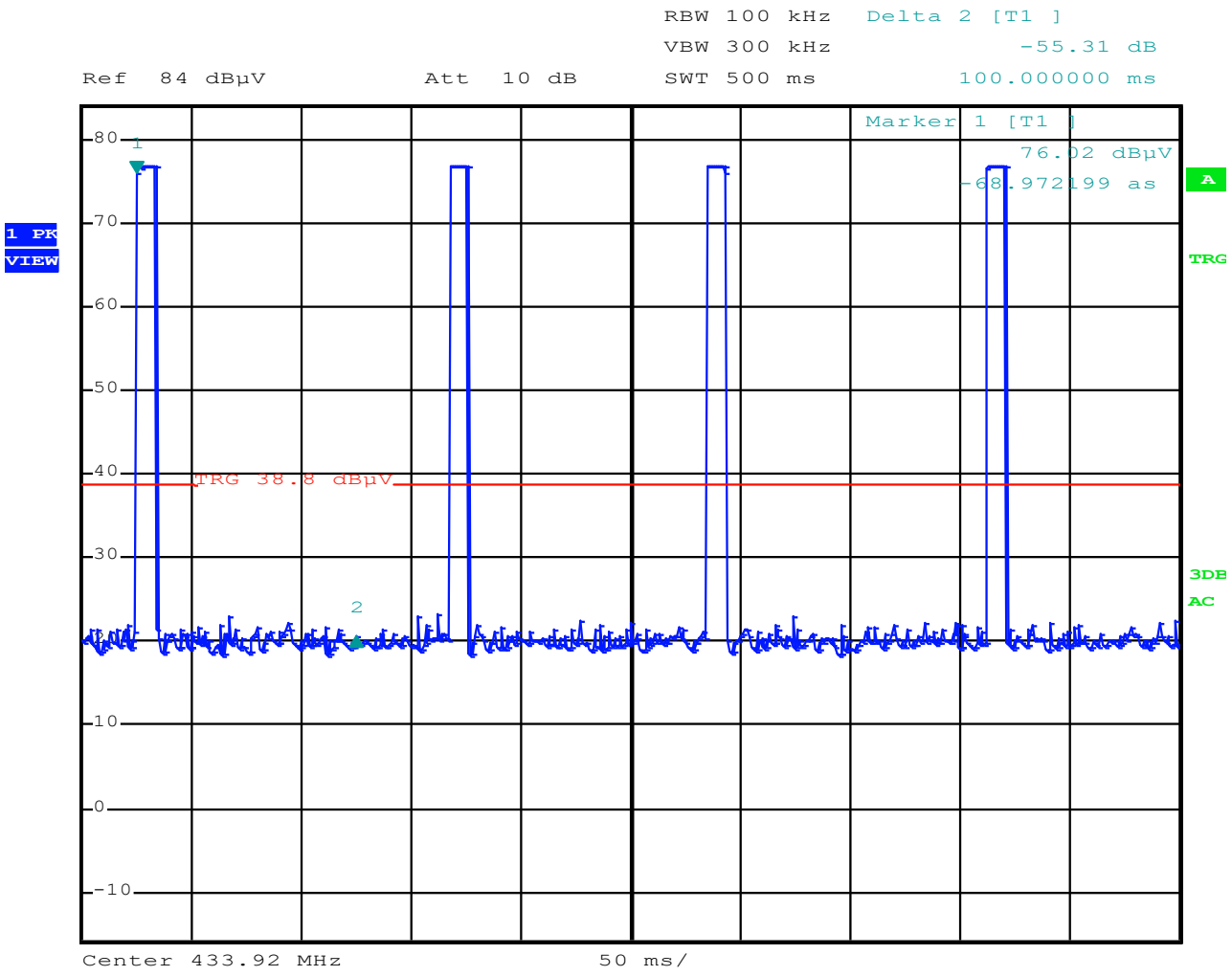
Signal deactivation – f: 433.92 MHz
FCC Part 15C, Section 15.231(a)

Worst Tx on time – ASK mode: 14.0 ms within 100ms



FCC ID: OYGTMSS5A2

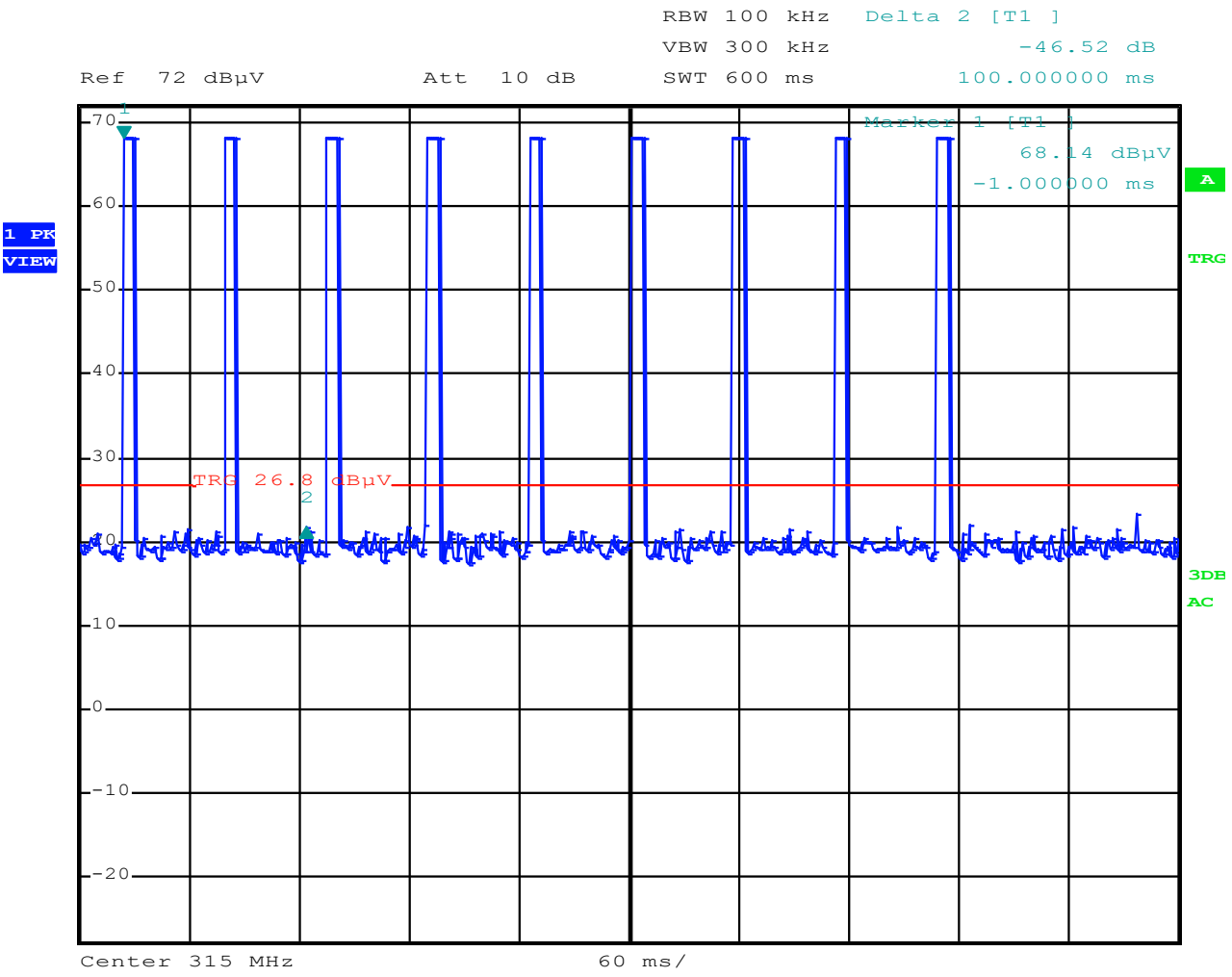
Worst Tx on time – FSK mode: 10.0 ms within 100ms



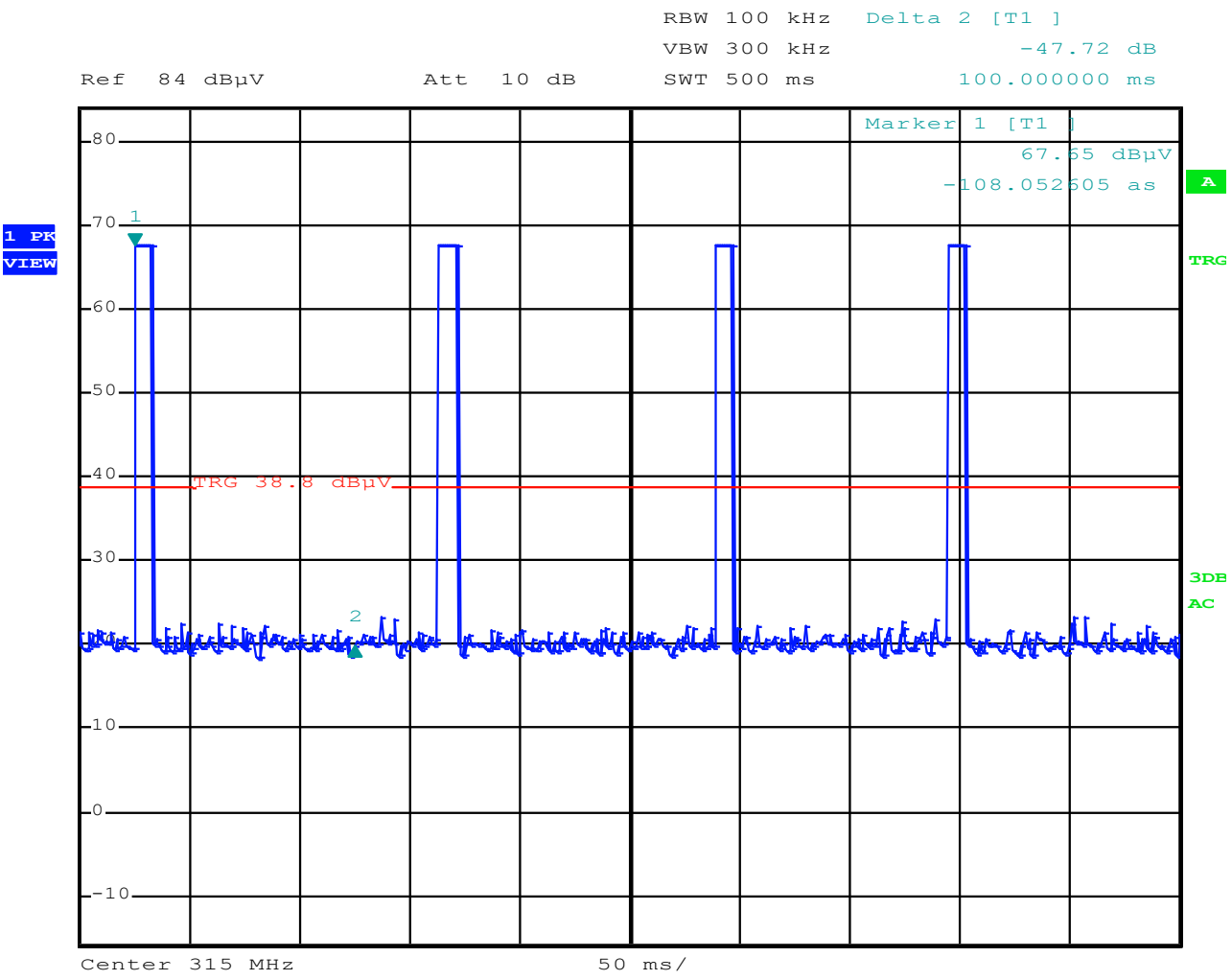
FCC ID: OYGTMSS5A2

Signal deactivation – f: 315.0 MHz
FCC Part 15C, Section 15.231(a)

Worst Tx on time – ASK mode: 15.2 ms within 100ms



Worst Tx on time – FSK mode: 10.0 ms within 100ms



6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
CPR 2	ESVS 30	02-02/03-05-006	15/07/2021	15/07/2020		
	VULB 9168	02-02/24-05-005	19/09/2020	19/07/2019		
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
DC	ESCI	02-02/03-05-005	04/12/2020	04/12/2019		
	RF Antenna	02-02/24-05-032				
	METRAHIT WORLD	02-02/32-15-001	16/12/2020	16/12/2019		
MB	ESCI	02-02/03-05-005	04/12/2020	04/12/2019		
	RF Antenna	02-02/24-05-032				
	METRAHIT WORLD	02-02/32-15-001	16/12/2020	16/12/2019		
SER 1	ESCI	02-02/03-05-005	04/12/2020	04/12/2019		
	HFH 2 - Z 2	02-02/24-05-020	09/08/2020	09/08/2017	20/01/2021	20/01/2020
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
SER 2	ESVS 30	02-02/03-05-006	19/08/2020	19/08/2019		
	VULB 9168	02-02/24-05-005	19/07/2020	19/07/2019		
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
SER 3	FSP 40	02-02/11-11-001	07/10/2020	07/10/2019		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	18/06/2021	18/06/2020		
	18N-20	02-02/50-17-003				
	NMS111-GL200SC01-NMS11	02-02/50-17-012				
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				