Test report

25-0007RP10-015-A

Product / EUT:	*Tire pressure monitoring sensor*
Type designation:	*030405 - TireCheck External Sensor*
Tested type:	*PN: 030405*
EUT authorization:	☐ Suppliers Declaration of Conformity ☒ Certification
FCC ID:	*YMY-030405*
S/N:	*n/a*
Production level:	*n/a*
Hardware version:	*030405*
Firmware version:	*1.0.3*
Manufacturer:	*TireCheck GmbH* *In den Stegwiesen 18* *89542 Herbrechtingen / Germany*
Test remit:	47 CFR Part 15 – Subpart C – Intentional radiators in accordance with the procedures given in ANSI C63.10-2020 and ANSI C63.4a-2017
The standards were:	☒ kept ☐ kept, for the limited scope of testing ☐ not kept
Remark:	☒ Validation covered by the accredited scope ☐ Validation not covered by the accredited scope according:_____ ☐ Validation of the EMC-requirements partly proceeded

Applicant:	TireCheck GmbH In den Stegwiesen 18 89542 Herbrechtingen / Germany	
EUT-		
Date of arrival:	01/27/2025	04/08/2025
Test ID:	25-0007PR05-002	25-0007PR15-007
Date(s) of test:	04/08/2025 until 04/16/2025	

Burgrieden, 06/26/2025

Released by:

Principal Engineer - Christian Vogelmann

Test laboratory:

EMCE GmbH
Ingenieurbüro für EMV-Prüfungen und Schaltungsentwicklung
Untere Wiesen 1 / 88483 Burgrieden / Germany

DAkkS-Registration No:	D-PL-12122-01-00
USA / CAB-Registration No.:	BNetzA-CAB-02/21-01

Designated by:
Bundesnetzagentur

Bundesnetzagentur
BNetzA-CAB-02/21-01

Accredited by:
Deutsche Akkreditierungsstelle GmbH

ilac-MRA
DAkkS Deutsche Akkreditierungsstelle D-PL-12122-01-00

Scope:

1 General information

Project manager:	M.Sc. S. Vogelmann
Inspector:	M.Sc. S. Vogelmann
	EMCE GmbH Ingenieurbüro für EMV-Prüfungen und Schaltungsentwicklung
Contact person:	Mr. Markert / TireCheck GmbH
Remarks:	n/a

State of revision:

Source document	New Document	Date / Reviser	Modifications
25-0007RP10-015	25-0007RP10-015-A	06/20/2025 Chr. Vogelmann	The assessment procedure was changed from 15.231(e) to 15.231(a). In addition, editorial corrections were made.

2 EUT information

Sampling: The device was selected and provided by the customer.
Main product: 030405 - TireCheck External Sensor

Description: *The EUT is an external tire pressure monitoring sensor that can be directly attached to a brass truck tire valve (8V1). The sensor measures tire pressure and temperature directly on the wheel and transmits data to an appropriate wireless communication device at 433.92 MHz. In normal operation, the data is transmitted every 40 seconds; in warning mode, e.g. in the event of a sudden drop in pressure, the sensor transmits the data every 5 seconds. For service purposes, an LF receiver at 125 kHz is used in a receive-only mode to activate remote control via 433.92 MHz.*

Voltage supply: *Internal battery, 2.1 – 3.3 VDC*

Frequency list: *125 kHz, 433.92 MHz*

Max. clock frequency: *433.92 MHz*

Temperature range: *-40 °C to +125 °C*

Dimension (mm): *44 x 29 x 27 (LxWxH)*

RF Applications:

Application	Frequency range	Technology	Architecture for application
Unidirectional data transmission to the base station	433.92 MHz	Proprietary RF technology	☐ Receiver ☒ Transmitter ☐ Transceiver
Enabling service mode and configuration of the RF parameters.	125 kHz	Proprietary RF technology	☒ Receiver ☐ Transmitter ☐ Transceiver ☐ Tagging system (RFID)

Used antennas:

Antenna designation	Manufacturer	Connector / cable length	Gain (dBi) @ f / GHz
Integral antenna @125 kHz	*n/a*	*n/a*	*n/a*
Integral antenna @434 MHz	*n/a*	*n/a*	*n/a*

Used band filter:

Filter designation	Filter type	Manufacturer	Connector
n/a			

Supplied / used equipment:

Designation	Type	Manufacturer	S/N
Companion device	*n/a*	*TireCheck GmbH*	*n/a*
Notebook	Thinkpad	Lenovo	EMCE Inv.No. #6033

Configuration:

☒ As-delivered condition
☐ Modified
* _____

Cable designation	Type	Length	Remarks
Interconnection	*USB-B to USB-A*	*2.00 m*	*Power and data connection of the companion device*

Software designation	Type	Manufacturer	Version
RF Sensor Test App	*Control and Monitoring*	*TireCheck GmbH*	*1.0.0.2*

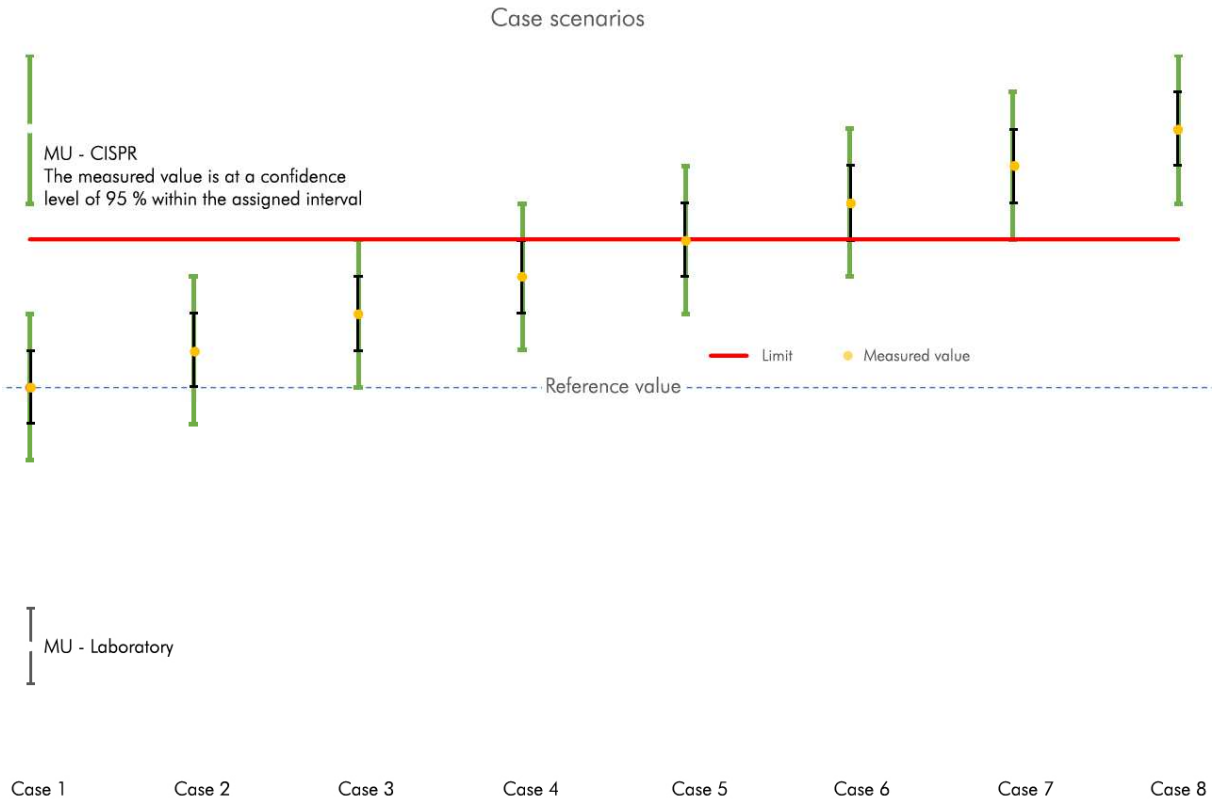
Pictures of the EUT

3 Decision rules for conformity assessment

"Binary" decision rule - pass / fail
Unless otherwise stated in the test module, the following specifications apply:

Interference emission

No measurement uncertainties are taken into account for the statement of conformity. In the case of conducted and radiated interference emission, the measurement is considered passed if the measurement result is below the permitted limit value. The accepted measurement uncertainties for a direct statement of conformity, determined for the U_{Lab} laboratory, must be less than the U_{CISPR} values determined in the CISPR16-4-2 standard. The measurement uncertainties are stated with a confidence level of 95 %. In this case the uncertainty of measurement is not taken into account for the conformity statement.



The test is passed for case 1 - 5. A rejection is made in case 6 - 8.

The test is considered as passed if the evaluation criteria for immunity to interference and the limits of emitted interference of the specified standard are met. Measurement uncertainties are not considered.

4 Test equipment list of EMCE GmbH

Inv.-No.	Designation	Type	Manufacturer	S/N	Calibration: Interval /valid until
002	Passive probe	ESH2-Z3	Rohde & Schwarz		1 Year(s)/ 2026-01-31
003	LISN 1	ESH3-Z5	Rohde & Schwarz	835268/007	1 Year(s)/ 2026-02-28
004	LISN 2	ESH3-Z5	Rohde & Schwarz	835268/003	1 Year(s)/ 2026-02-28
007	Absorbing clamp	MDS 21	Schwarzbeck	942436	1 Year(s)/ 2026-01-31
008	Loop antenna 9kHz-30MHz	HFH2-Z2	Rohde & Schwarz	835776/0002	3 Year(s)/ 2026-02-28
011	Antenna 30-300MHz	VHBA9123 / BBA9106	Schwarzbeck	0403/94	3 Year(s)/ 2028-01-09
012	Antenna 250-1200MHz	UHALP 9108A	Schwarzbeck	166	3 Year(s)/ 2028-01-09
013	Antenna 9 kHz-30 MHz	Ø 1.5 m	EMCE GmbH		1 Year(s)/ 2026-01-31
014	OATS	Test site 3 m referred to ANSI C63.4a-2017	EMCE GmbH		3 Year(s)/ 2027-05-06
015	OATS	Test site 10 m referred to ANSI C63.4a-2017	EMCE GmbH		3 Year(s)/ 2027-05-06
041	Loop antenna shielded	HZ-10 0816.2511.02	Rohde & Schwarz	849788/0020	3 Year(s)/ 2026-01-10
042-2	AC-Source	EMV D 5000/PAS/SyCore	Spitzenberger & Spies	A274700 / 00501	3 Year(s)/ 2026-02-10
042-1	Analyzer Reference System	ARS 16/3	Spitzenberger & Spies	A274707 / 00501	3 Year(s)/ 2028-01-02
043	Receiver	3DH/E Fieldmeter ESM-100	Maschek	971521	3 Year(s)/ 2026-09-11
059	Log.-per. antenna	HL050	Rohde & Schwarz	100006	3 Year(s)/ 2025-10-21
067	LISN	ESH2-Z5	Rohde & Schwarz	872460/043	1 Year(s)/ 2026-02-28
068	LISN	ESH2-Z5	Rohde & Schwarz	872460/042	1 Year(s)/ 2026-02-28
070	Pulse limiter + 10 dB Attenuator	ESH3-Z2	Rohde & Schwarz	n/a	1 Year(s)/ 2025-08-31
116	Vertical rod antenna	VAMP 9243	Schwarzbeck	9243-205	3 Year(s)/ 2026-05-19

Inv.-No.	Designation	Type	Manufacturer	S/N	Calibration: Interval /valid until
117	LISN	ESH3-Z6	Rohde & Schwarz	100521	1 Year(s)/ 2026-02-28
174	LISN	ESH3-Z6	Rohde & Schwarz	101003	1 Year(s)/ 2026-02-28
175	EMI Test receiver	ESR7	Rohde & Schwarz	101108 Firmware: FW V3.46 SP3	1 Year(s)/ 2025-11-26
178	V-LISN 5 µH	NNHV 8123-400	Schwarzbeck	018	1 Year(s)/ 2026-02-28
184	V-LISN 5 µH	NNHV8123-400	Schwarzbeck	019	1 Year(s)/ 2026-02-28
222	Broadband Preamplifier 0.5-18 GHz	BBV 9718	Schwarzbeck	9718-316	1 Year(s)/ 2025-07-31
223	Broadband Preamplifier 12-28 GHz	BBV 9719	Schwarzbeck	9719-024	6 Month(s)/ 2025-07-31
225	Electric and Magnetic Field Probe-Analyzer	EHP-200A	Narda S.T.S. / PMM	170WX70205	3 Year(s)/ 2025-07-22
226	HL050 Log.-Per. Antenna 850 MHz to 26.5 GHz	HL050 4062.4063.02	Rohde & Schwarz	100829	3 Year(s)/ 2026-07-27
229	Test receiver	ESS 5 Hz - 1000 MHz	Rohde & Schwarz	845420/0005	1 Year(s)/ 2026-02-11
230	FSV40 Signal Analyzer 40 GHz	FSV40	Rohde & Schwarz	101717	2 Year(s)/ 2026-02-06
236	Broad-Band Horn Antenna 0.5-6 GHz	BBHA 9120 E	Schwarzbeck	00831	3 Year(s)/ 2027-06-25
237	Exposure Level Tester	ELT-400	Narda Safety Test Solutions	O-0028	3 Year(s)/ 2026-03-03
239	Broadband Horn Antenna 15-40 GHz	BBHA 9170	Schwarzbeck	00932	5 Year(s)/ 2029-05-23
240	Broadband Preamplifier 18-40 GHz	BBV 9721	Schwarzbeck	54	1 Year(s)/ 2025-07-31
253	Broadband Preamplifier 20-1000 MHz	ESV-Z3	Rohde & Schwarz	881 909/030	1 Year(s)/ 2025-08-31
257	Pulse limiter + 10 dB Attenuator	ESH3-Z2	Rohde & Schwarz	102769	1 Year(s)/ 2025-08-31
718	EMC-Software	BAT-EMC Vers. 3.18.0.19	Nexio	n/a	

Inv.-No.	Designation	Type	Manufacturer	S/N	Calibration: Interval /valid until
997	EMC Software	EMC32 Vers. 10.60.20	Rohde & Schwarz	n/a	
1046	Environmental Simulation Chamber	MKF 115 (E3.1)	Binder GmbH	12-02215	3 Year(s)/ 2026-03-24
1212	EMC Software	WMS32 Vers. 10.60.20	Rohde & Schwarz	n/a	
8004	Broadband Preamplifier 18-40 GHz	BLMA 1840-5G	BONN Elektronik GmbH	2113300	1 Year(s)/ 2025-07-31
8007	LPDA Broadband Antenna 180 - 1500 MHz	VULP 9118A	Schwarzbeck	899	3 Year(s)/ 2027-10-30
8008	LPDA Broadband Antenna 180 - 1500 MHz	VULP 9118A	Schwarzbeck	900	3 Year(s)/ 2028-02-10
8009	Field Monitoring Loop	FESP 5134-1	Schwarzbeck	00078	3 Year(s)/ 2028-02-05
8028	EMI Test Receiver	ESW26	Rohde & Schwarz	103119	1 Year(s)/ 2025-05-07
8033	Antenna 30-300 MHz	VHBB9124 / BBA9106	Schwarzbeck	1808	3 Year(s)/ 2027-10-30
8034	Antenna 30-300 MHz	VHBB9124 / BBA9106	Schwarzbeck	1812	3 Year(s)/ 2028-02-10
8044	EMI Test Receiver	ESW44	Rohde & Schwarz	103371	1 Year(s)/ 2026-03-06

5 Testplan provided by customer

☐ Test according to the test plan provided by the customer
☐ Deviation from the test plan authorized by the customer
☒ Test according standard

Source document	Date / Reviser	Modifications

6 Test(s) according 47 CFR Part 15 Subpart C - 04/08/2025

6.1 Requirements and conformance test specifications

Standard

47 CFR Part 15 Subpart C
ANSI C63.10-2020
KDB n/a
-

Requirement		Regulation section
☒	Pulse train	§15.231 (a)(3) §15.231 (a)(4)
☒	Antenna requirement	§ 15.203
☒	Restricted bands of operation	§ 15.205 (a) (b) (c)
☐	Terminal voltage on powerline	§ 15.207 (a)
☒	Radiated emissions H-Field of intentional radiators	§ 15.209 (a) (b) (c) (d) (e) (f)
☒	Radiated emissions E-Field of intentional radiators	§ 15.209 (a) (b) (c) (d) (e) (f) § 15.231 (b)
☒	20 dB Emission bandwidth	§ 15.231 (c)
☐	Frequency stability	§ 15.231 (d)

6.2 Pulse train

☒ No deviation from the standard
☐ Deviation from the standard
☐ Not tested

Note: n/a

Measurement procedure:

Rules and specification	47 CFR Part 15 Section 15.35 (c) 47 CFR Part 15 Section 15.231 (a)(3)
Guide	ANSI C63.10-2020 Section 7.5

When carrying out the radiated emissions for pulsed operation, where the limit values are expressed as an average value of the emission, a detailed analysis of the pulse train is required. For this purpose, a spectrum analyzer is used for a near-field measurement, whereby the pulse train sequence is analyzed in zero-span mode. The sweep time is adjusted so that a time span of at least 100 ms can be monitored in order to determine the maximum number of consecutive pulses.

By determining the maximum number of pulses and their respective duration, the correction factor is calculated from the sum of the individual ON times:

$$DCCF\ (dB) = 20*\log[(t_{P1}(ms) + t_{P2}(ms) + \ldots + t_{Pn}(ms)) / T(ms)]$$

DCCF = Duty cycle correction factor
t_{P1} = Duration of pulse 1 within the pulse train
t_{P2} = Duration of pulse 2 within the pulse train
t_{Pn} = Duration of pulse n within the pulse train
T = Duration of the pulse train period, or 100 ms if the pulse train length is greater than 100 ms

Example:

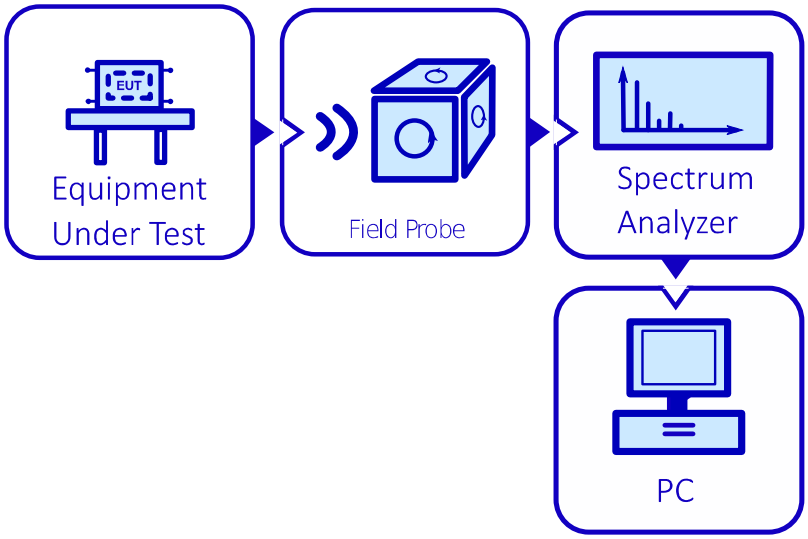
Pulse train period	3 s
Duration of pulse 1	4 ms
Duration of pulse 2	4 ms
Duration of pulse 3	20 ms

Calculated Duty cycle correction factor DCCF:

$DCCF = 20 * \log_{10}[(4\ ms + 4\ ms + 20\ ms) / 100\ ms] = -11.06\ dB$

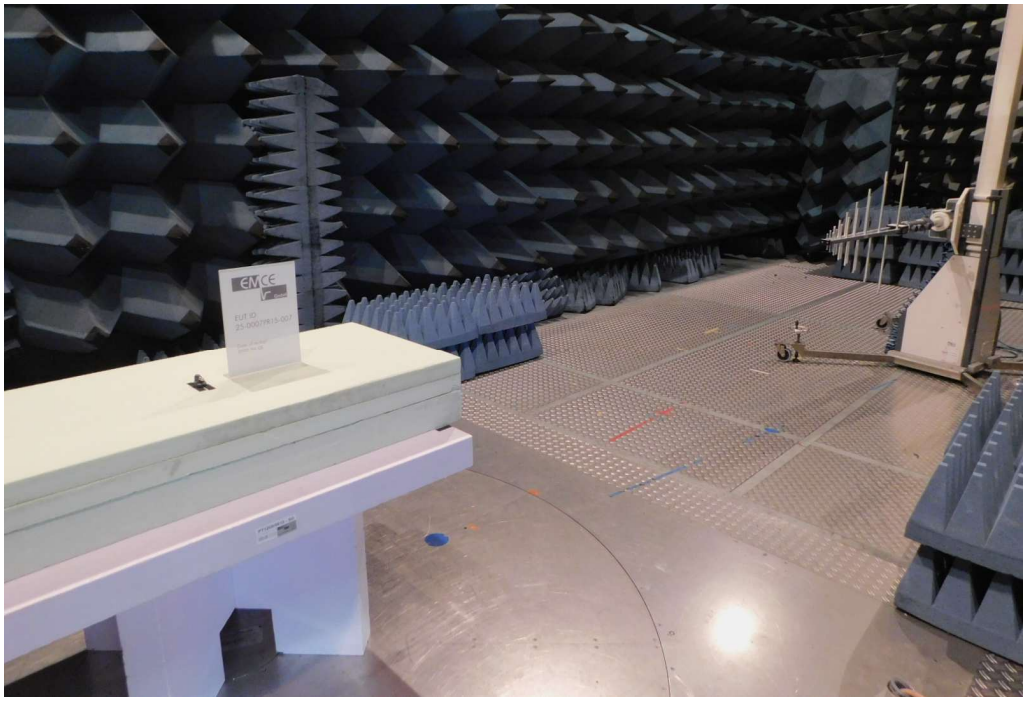
This correction factor is then used to adjust the measured peak emission values to the corresponding average values in order to put these into relation with the given limits.

Basic structure – Setup for radiated test



6.2.1 Test set up

According ANSI C63.10-2020



Test location

Final test					
☒	Inv.-No.	Designation	Type (L x W x H)	Manufacturer	Location
☒	062	Semi anechoic chamber # 2	13.5 x 6.1 x 5.5 m	EMC-Technik & Consulting GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden

Used test equipment

Final test					
☒	Inv.-No.	Designation	Type	Manufacturer	S/N
	042	AC-Source / Analyzer / Norm impedance	EMV D5000/PAS	Spitzenberger + Spies	A274700/ 0 0501
	059	LPDA	HL050	Rohde & Schwarz	100006
	229	Test receiver	ESS	Rohde & Schwarz	845420/0005
	236	Broad-Band Horn Antenna 0.5-6 GHz	BBHA 9120 E	Schwarzbeck	00831
	997	Software	EMC32	Rohde & Schwarz	n/a
☒	8007	LPDA Antenna 180 - 1500 MHz	VULP 9118A	Schwarzbeck	899
	8033	Antenna 30-300 MHz	VHBB9124 / BBA9106	Schwarzbeck	1808
☒	8044	Test receiver	ESW 44	Rohde & Schwarz	103371

All used test equipment are checked resp. calibrated periodically.

☒ Test equipment was checked and complied to the requirements

6.2.2 Test – Normal mode

Test frequencies

☒ Nominal Frequency 1	433.92 MHz
☐ Nominal Frequency 2	___ MHz
☐ Nominal Frequency 3	___ MHz

Test Requirements

Section		Description
☒	15.35 (c)	When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value.
☐	15.231 (a)(1)	A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.
☐	15.231 (a)(2)	A transmitter activated automatically shall cease transmission within 5 seconds after activation.
☒	15.231 (a)(3)	Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system 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 per hour.
☐	15.231 (a)(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.
☐	15.231 (a)(5)	Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of section 15.231, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.
☐	15.231 (e)	Intentional radiators operating at a periodic rate exceeding that specified in 15.231 (a) and may be employed for any type of operation, including operation prohibited in paragraph (a) of section 15.231, shall be provided with a means for automatically limiting operation so that the duration of each transmission is not greater than one second and the silent period between transmissions is at least 30 times the duration of the transmission but in no case less than 10 seconds.

Rationale for selecting the EUT test set up

Equipment units:

EUT as a stand-alone sensor with RF module and an integrated antenna, powered by an internal battery.

Cabling:

☐ Standard cables
☐ Special cables provided by the manufacturer

Port #	Designation	Remarks
n/a		

Operation mode

EUT arrangement:	☒ Tabletop	☐ Floor standing
Power supply:	☐ 120 V/60 Hz	☒ Internal battery
Transmitter operated:	☐ manually	☒ automatically

The sensor operated continuously in normal mode, transmitting data automatically at intervals of approximately 40 seconds.
A manually triggered transmission was initiated by an interrogating LF (Low Frequency) signal. Upon receiving this signal, the sensor transmitted two consecutive RF (Radio Frequency) messages and then automatically returned to normal mode.

The transmission power remained constant across all operating modes.
All RF messages had a consistent duration of approximately 10 milliseconds, regardless of the mode.

Environmental conditions

Temperature:	23.8 °C
Relative humidity:	34 %

Test result

Pulse train / DCCF

Pulse train / ms	Upper limit / ms	DCCF / dB
9.440	n/a	-20.50*
*Worst case DCCF = 20 *$\log_{10}$(9.440 ms / 100 ms) = -20.50 dB		

Silent period

Settings for transmission period / s	Silent period / s	Lower limit / s
40	39.370	n/a

Total transmission time per hour

Pulse train / ms	Silent period / s	Number of individual transmissions / hour	Total transmission time / s	Limit / s
9.440	39.370	92 (normal mode) + 2 (manually triggered)	0.89	2

Limit for pulse train:

☐ kept
☐ not kept
☒ not relevant

Limit for silent period:

☐ kept
☐ not kept
☒ not relevant

Limit for total transmission time
for polling or supervision transmissions:

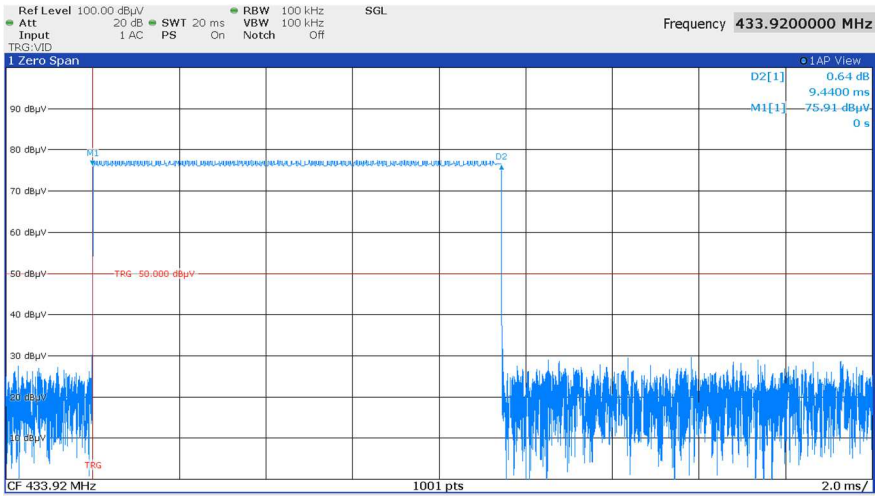
☒ kept
☐ not kept
☐ not relevant

Remarks: n/a

Protocol scope

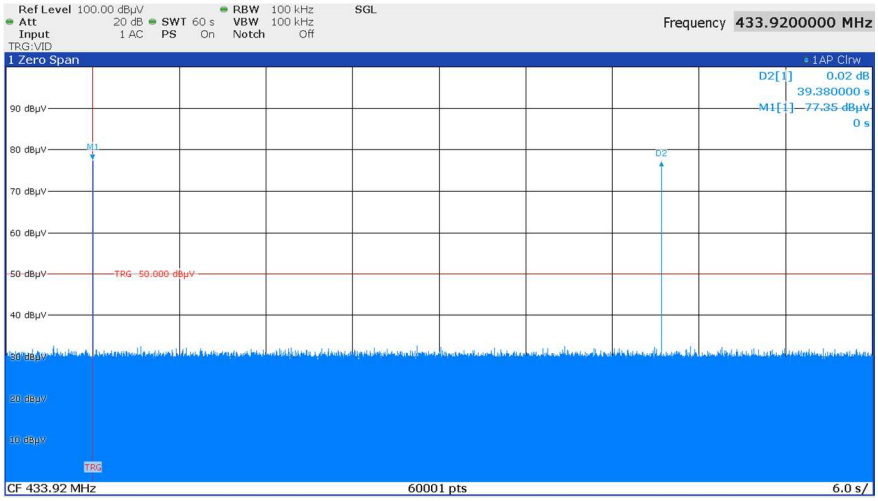
☒ Readings
☒ Diagrams

EUT 25-0007PR15-007 – Single pulse



Pulse train	
Upper limit	n/a
Measured	9.440 ms

EUT 25-0007PR15-007 – Following pulses



Silent period between transmissions	
Lower limit	n/a
Measured	39.370 s

6.2.3 Test – Alarm mode

Test frequencies

☒ Nominal Frequency 1	433.92 MHz
☐ Nominal Frequency 2	___ MHz
☐ Nominal Frequency 3	___ MHz

Test Requirements

Section		Description
☒	15.35 (c)	When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value.
☐	15.231 (a)(1)	A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.
☐	15.231 (a)(2)	A transmitter activated automatically shall cease transmission within 5 seconds after activation.
☐	15.231 (a)(3)	Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system 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 per hour.
☒	15.231 (a)(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.
☐	15.231 (a)(5)	Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of section 15.231, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.
☐	15.231 (e)	Intentional radiators operating at a periodic rate exceeding that specified in 15.231 (a) and may be employed for any type of operation, including operation prohibited in paragraph (a) of section 15.231, shall be provided with a means for automatically limiting operation so that the duration of each transmission is not greater than one second and the silent period between transmissions is at least 30 times the duration of the transmission but in no case less than 10 seconds.

Rationale for selecting the EUT test set up

Equipment units:

EUT as a stand-alone sensor with RF module and an integrated antenna, powered by an internal battery.

Cabling:

☐ Standard cables
☐ Special cables provided by the manufacturer

Port #	Designation	Remarks
n/a		

Operation mode

EUT arrangement:	☒ Tabletop	☐ Floor standing
Power supply:	☐ 120 V/60 Hz	☒ Internal battery
Transmitter operated:	☐ manually	☒ automatically

The sensor operated in "emergency" mode during the presence of an alarm condition, transmitting data approximately every 5 seconds.
In total, the sensor transmitted 26 RF messages per alarm event.
RF transmission sequence:

- Upon entering Alarm Mode, the sensor transmitted a single RF message.
- During the alarm condition, the sensor transmitted 24 additional RF messages at intervals of approximately 5 seconds.
- Upon returning to Normal Mode, the sensor transmitted one final RF message.

After the last transmission, the sensor returned to normal mode. If the alarm condition persisted, the sensor re-enters emergency mode.

The transmission power remained constant across all operating modes.
Each RF message had a uniform duration of approximately 10 milliseconds, regardless of the mode.

Environmental conditions

Temperature: 23.8 °C
Relative humidity: 34 %

Test result

Pulse train / DCCF

Pulse train / ms	Upper limit / ms	DCCF / dB
9.440	n/a	-20.50*
*Worst case DCCF = 20 *$\log_{10}$(9.440 ms / 100 ms) = -20.50 dB		

Silent period

Settings for transmission period / s	Silent period / s	Lower limit / s
5	4.913	n/a

Requirement for security or safety applications:

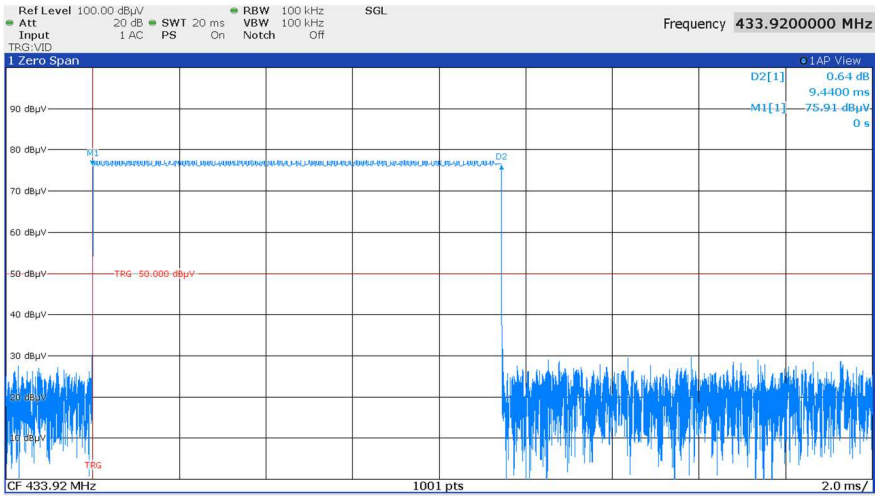
☒ kept
☐ not kept

Remarks: n/a

Protocol scope

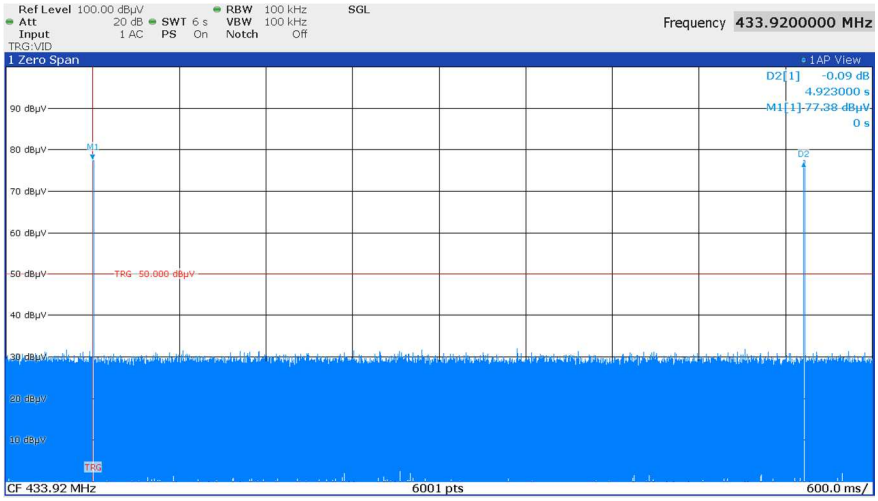
☒ Readings
☒ Diagrams

EUT 25-0007PR15-007 – Single pulse

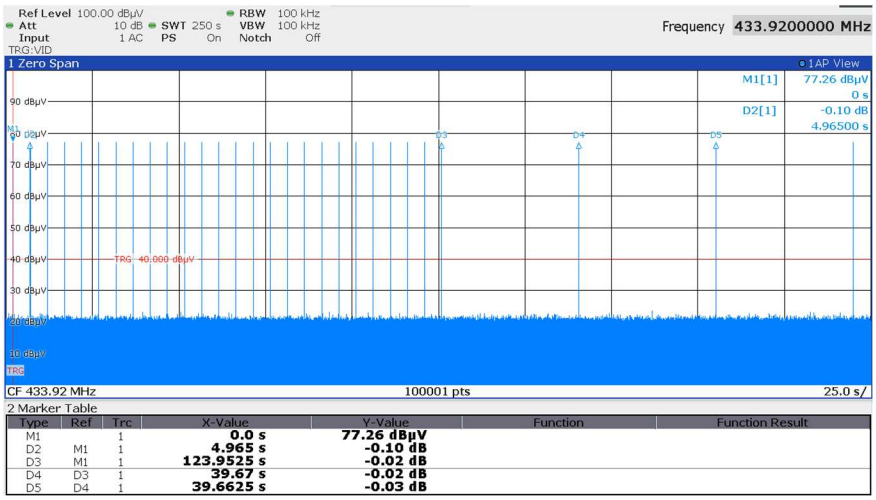


Pulse train	
Upper limit	n/a
Measured	9.440 ms

EUT 25-0007PR15-007 – Following pulses



Silent period between transmissions	
Lower limit	n/a
Measured	4.913 s

EUT 25-0007PR15-007 – Sequence in the event of a single alert

Pendency of the alarm condition

Duration	123.953 s
No. of pulses	1+24+1
Total Transmission Time	245.440 ms (26 pulses, each of 9.440 ms transmission duration)

6.3 Antenna requirements

☒ No deviation from the standard
☐ Deviation from the standard
☐ Not tested

Note: n/a

Measurement procedure:

Rules and specification	47 CFR Part 15 Section 15.203
Guide	n/a
Requirement:	An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficiently to comply with the provisions of this section.
Antenna:	☐ Print antenna ☒ Internal antenna ☐ External antenna
	☒ Single Antenna ☐ Antenna array ☐ MIMO ☐ __-
Antenna connector:	☒ Without connector ☐ Permanent attached ☐ Unique coupling to the intentional radiator
	☐ SMA ☐ UFL ☐ __

Test result

Requirement:	☒ kept ☐ not kept

Remarks: n/a

6.4 Restricted bands of operation

☒ No deviation from the standard
☐ Deviation from the standard
☐ Not tested

Note: n/a

Measurement procedure:

Requirement: 47 CFR Part 15 Section 15.205 (a)(b)(c)
Guide n/a

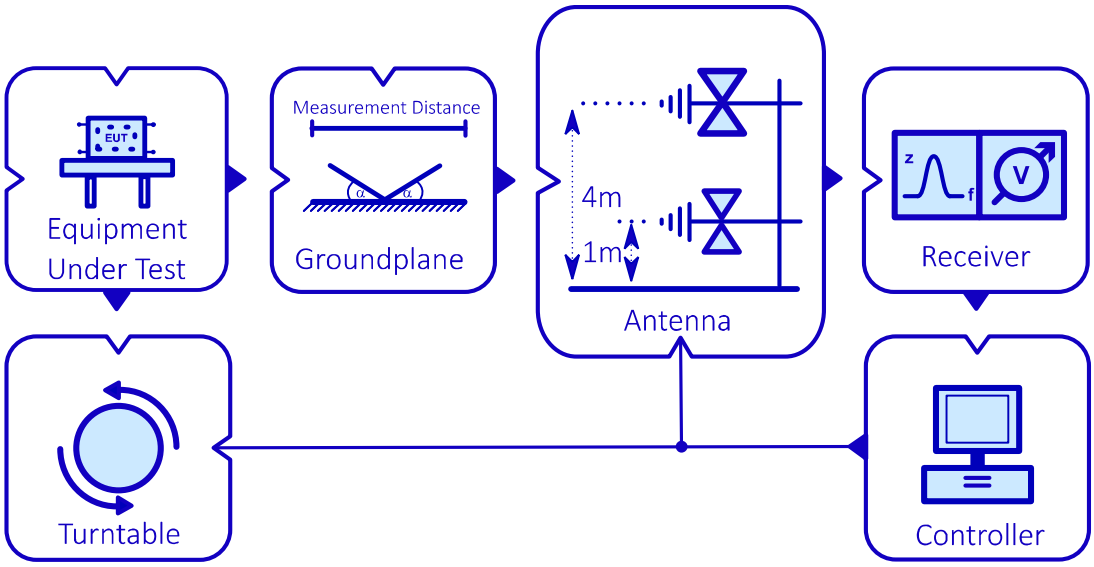
Restricted bands

f / MHz	f / MHz	f / MHz	f / GHz
0.090-0.110	12.57675-12.57725	322-335.4	4.500-5.150
0.495 – 0.505	13.36-13.41	399.9-410	5.350-5.460
2.1735-2.1905	16.42-16.423	608-614	7.250-7.750
4.125-4.128	16.69475-16.69525	960-1427	8.025-8.500
4.17725-4.17775	16.80425-16.80475	1435-1626.5	9.0-9.2
4.20725-4.20775	25.5-25.67	1645.5-1646.5	9.3-9.5
5.677-5.683	37.5-38.25	1660-1710	10.6-12.7
6.215-6.218	73-74.6	1718.8-1722.2	13.25-13.4
6.26775-6.26825	74.8-75.2	2200-2300	14.47-14.5
6.31175-6.31225	108-138	2310-2390	15.35-16.2
8.291-8.294	149.9-150.05	2483.5-2500	17.7-21.4
8.362-8.366	156.52475-156.52525	2655-2900	22.01-23.12
8.37625-8.38675	156.7-156.9	3260-3267	23.6-24.0
8.41425-8.41475	162.0125-167.17	3332-3339	31.2-31.8
12.29-12.293	167.72-173.2	3345.8-3358	36.43-36.5
12.51975-12.52025	240-285	3500-4400	above 38.6

Only spurious emissions are permitted in any of the frequency bands listed before. The field strength of emissions appearing within these frequency bands shall not exceed the radiated emission limits; general requirements. At frequencies equal to or less than 1000 MHz, compliance with the radiated emission limits; general requirements shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions.

Basic structure - Setup

OATS / SAC

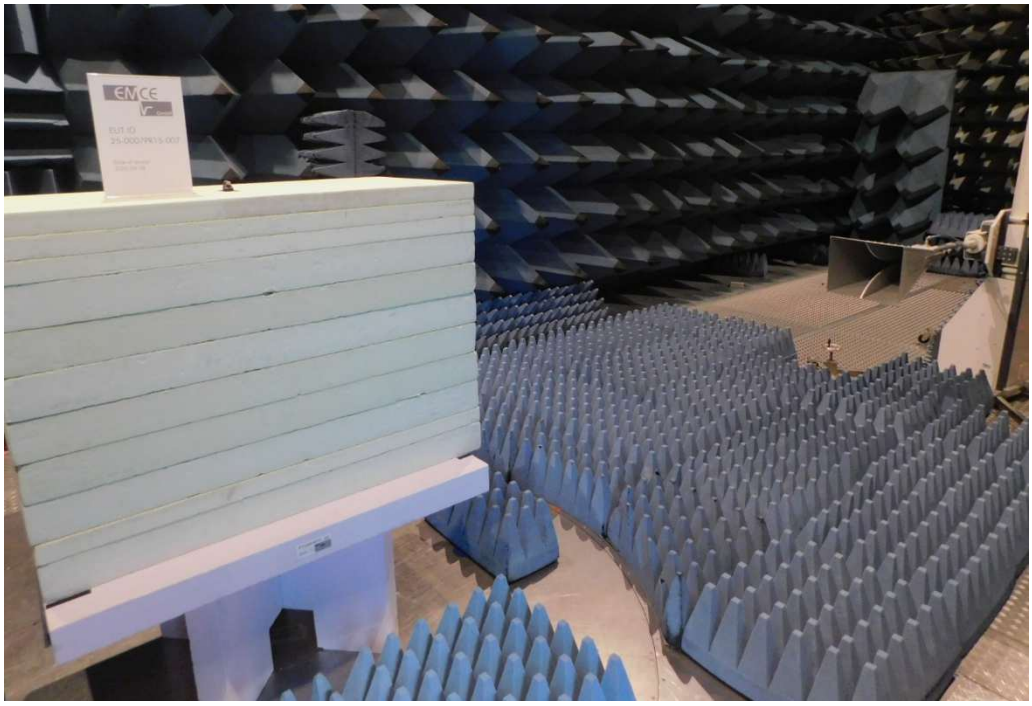


6.4.1 Test set up

According ANSI C63.10-2020

Test setup – SAC [30 – 1000 MHz]

Test setup – SAC [1 – 6 GHz]



Test location

Final test					
☒	Inv.-No.	Designation	Type (L x W x H)	Manufacturer	Location
☒	062	Semi anechoic chamber # 2	13.5 x 6.1 x 5.5 m	EMC-Technik & Consulting GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden
	014	Open area test site	3 m	EMCE GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden
	015	Open area test site	10 m	EMCE GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden

Used test equipment

Final test					
☒	Inv.-No.	Designation	Type	Manufacturer	S/N
	042	AC-Source / Analyzer / Norm impedance	EMV D5000/PAS	Spitzenberger + Spies	A274700/ 0 0501
	059	LPDA	HL050	Rohde & Schwarz	100006
	222	Broadband Preamplifier 0.5-18 GHz	BBV 9718	Schwarzbeck	9718-316
	226	HL050 Log.-Per. Antenna 850 MHz to 26.5 GHz	HL050 4062.4063.02	Rohde & Schwarz	100829
	229	Test receiver	ESS	Rohde & Schwarz	845420/0005
☒	236	Broad-Band Horn Antenna 0.5-6 GHz	BBHA 9120 E	Schwarzbeck	00831
☒	997	Software	EMC32	Rohde & Schwarz	n/a
☒	8007	LPDA Antenna 180 - 1500 MHz	VULP 9118A	Schwarzbeck	899
☒	8033	Antenna 30-300 MHz	VHBB9124 / BBA9106	Schwarzbeck	1808
☒	8044	Test receiver	ESW 44	Rohde & Schwarz	103371

All used test equipment are checked resp. calibrated periodically.

☒ Test equipment was checked and complied to the requirements

Test-/Measurement uncertainty

The measurement uncertainty in the test met the guideline of CISPR16-4-2 or better.

Measurement uncertainty of the radiated emission with an extended coverage factor of k = 2:

Frequency	Measurement uncertainty
30 MHz – 225 MHz	4.8 dB (valid for 10 m-OATS)
225 MHz – 1 GHz	4.9 dB (valid for 10 m-OATS)
30 MHz – 225 MHz	4.8 dB (valid for 3 m-OATS)
225 MHz – 1 GHz	6.2 dB (valid for 3 m-OATS)

6.4.2 Test

Test frequencies

☒ Nominal Frequency 1 433.92 MHz
☐ Nominal Frequency 2 ___ MHz
☐ Nominal Frequency 3 ___ MHz

Test Requirements

Limits for radiated emissions in the restricted bands			
Detector	Frequency / MHz	Limit / µV/m	Measurement distance / m
AV	0.009 – 0.09	2400/F(kHz)	300
QP	0.09 – 0.110	2400/F(kHz)	300
AV	0.110 – 0.49	2400/F(kHz)	300
QP	0.49 – 1.705	24000/F(kHz)	30
QP	1.705 – 30.0	30	30
Detector	Frequency / MHz	Limit / dBµV/m	Measurement distance / m
QP	30.0 – 88.0	40.0	3
QP	88.0 – 216.0	43.5	3
QP	216.0 – 960.0	46.0	3
QP	960.0 – 1000.0	54.0	3
AV	> 1000	54.0	3
PK	> 1000	74.0	3
The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.			

Nearest restricted band(s): ☒ 399.9 – 410.0 MHz
☒ 608.0 – 614.0 MHz

Rationale for selecting the EUT test set up

Equipment units:

EUT as a stand-alone sensor with integrated RF module and powered by an internal battery.

Cabling:

☐ Standard cables
☐ Special cables provided by the manufacturer

Port #	Designation	Remarks
n/a		

EUT Orientation

☒ X-Direction* ☐ Y-Direction ☐ Z-Direction

* Orientation of the EUT for the worst case emission

Operation mode

EUT arrangement:	☒ Tabletop	☐ Floor standing
Power supply:	☐ 120 V/60 Hz	☒ Internal battery

A service tool was used to parameterize the EUT in such a way that it uses an unmodulated carrier with a duty cycle of almost 100 % for transmission.
In this mode, the EUT was operated continuously.

Environmental conditions

Temperature:	23.6 °C
Relative humidity:	35 %

Test result

Used frequency range outside of restricted bands	☒ kept ☐ not kept
General emission limits for restricted frequency bands:	☒ kept ☐ not kept
Limits for next restricted frequency band:	☒ kept ☐ not kept

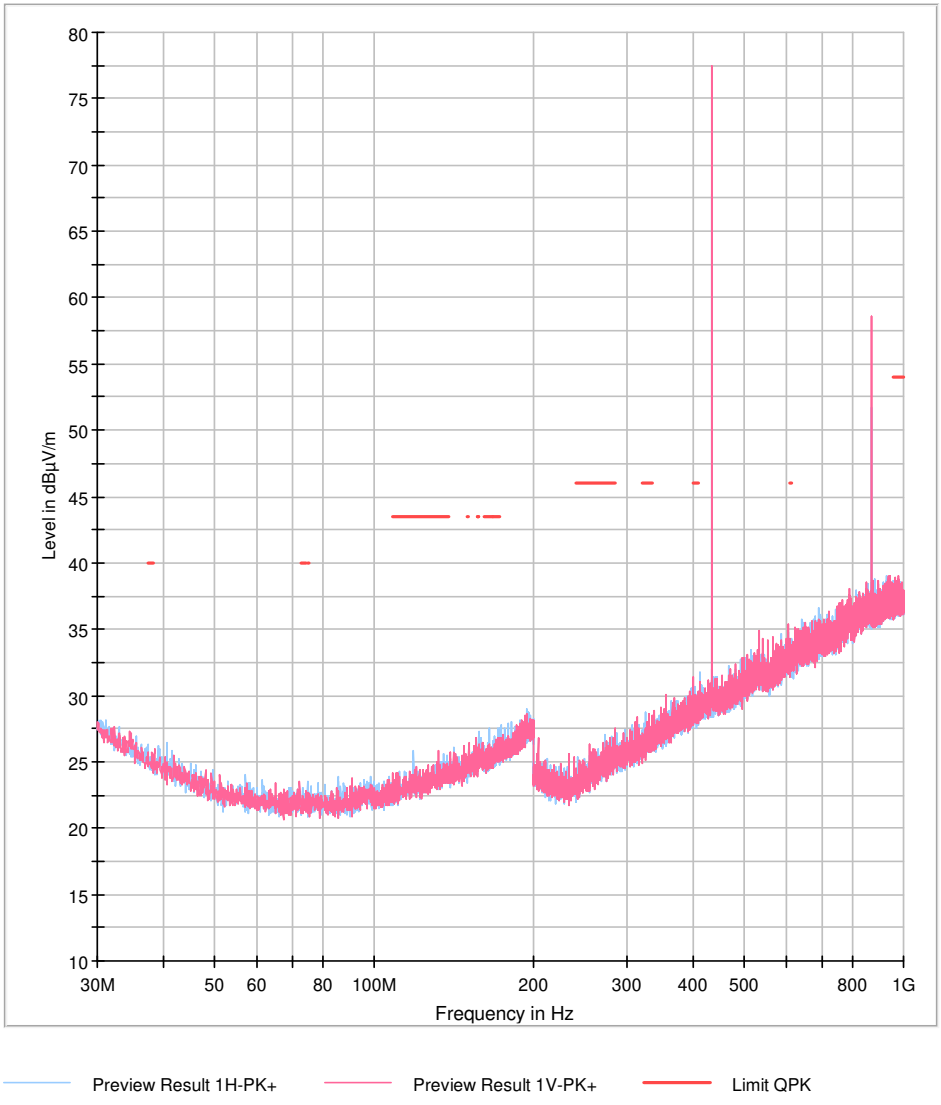
Remarks: n/a

Records

☒ Readings
☒ Diagram

EUT Information

EUT Name:	030405 - TIRECHECK EXTERNAL SENSOR
Test_ID: / SN:	25-0007PR15-007
Customer:	TireCheck GmbH
Operational condition:	Continuous transmission @433.92 MHz, duty cycle of approx. 100%
Test specification:	47 CFR Part 15 Subpart C - Section 15.205 - SAC @3 m
Antenna information:	Distance EUT-Ant.: 3.0 m / Polarization: H/V / Ant.Height: 1.0-4.0 m.
Operator:	S. Vogelmann
File #:	25-0007RC15-007-001
Comment #1:	
Comment #2:	



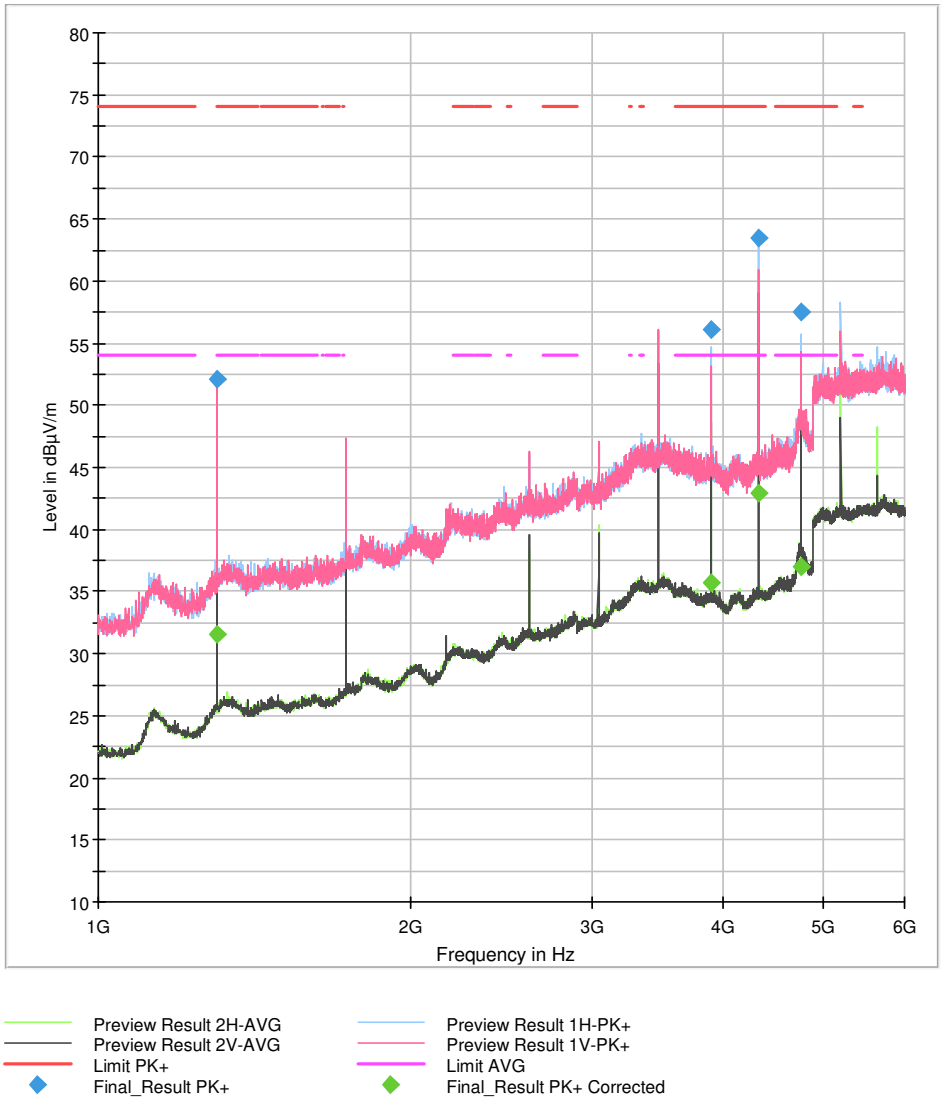
Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---	---	---	---	---	---

No results.

EUT Information

EUT Name:	030405 - TIRECHECK EXTERNAL SENSOR
Test_ID: / SN:	25-0007PR15-007
Customer:	TireCheck GmbH
Operational condition:	Continuous transmission @433.92 MHz, duty cycle of approx. 100%
Test specification:	47 CFR Part 15 Subpart C - Section 15.205 - SAC @3 m
Antenna information:	Distance EUT-Ant.: 3.0 m / Polarization: H/V / Ant.Height: 1.0-4.0 m.
Operator:	S. Vogelmann
File #:	25-0007RC15-007-002
Comment #1:	
Comment #2:	



Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Corrected amplitude MaxPeak (dBµV/m)	Pulse train correction (dB)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	RBW (kHz)	Height (cm)	Pol	Azi-muth (deg)	Corr. (dB/m)
1301.85945	52.10	---	---	74.00	21.90	15000.	1000.0	235.0	V	10.0	24.7
1301.85945	---	31.60	-20.50	54.00	22.40	15000.	1000.0	235.0	V	10.0	24.7
3905.67027	---	35.64	-20.50	54.00	18.36	15000.	1000.0	335.0	H	178.0	32.3
3905.67027	56.14	---	---	74.00	17.86	15000.	1000.0	335.0	H	178.0	32.3
4339.59729	63.46	---	---	74.00	10.54	15000.	1000.0	185.0	H	180.0	32.0
4339.59729	---	42.96	-20.50	54.00	11.04	15000.	1000.0	185.0	H	180.0	32.0
4773.60270	57.50	---	---	74.00	16.50	15000.	1000.0	335.0	H	186.0	35.2
4773.60270	---	37.00	-20.50	54.00	17.00	15000.	1000.0	335.0	H	186.0	35.2

6.5 Terminal voltage on powerline

☐ No deviation from the standard
☐ Deviation from the standard
☒ Not tested

Note: The EUT has no external leads and is not intended for operation on the AC mains.

6.6 Radiated emissions H-Field of intentional radiators

☒ No deviation from the standard
☐ Deviation from the standard
☐ Not tested

Note: n/a

Measurement procedure:

Rules and specification	47 CFR Part 15 Section 15.209 (a)(b)(c)(d)(e)(f)
Guide	ANSI C63.10-2020

The radiated magnetic fields are measured in a frequency range from 9 kHz to 30 MHz. For this purpose, a shielded active loop antenna is used, which is directly connected to a receiver according to CISPR 16 specifications. For the measurement, the loop antenna is successively aligned once parallel to the DUT and once perpendicular to the DUT. The center of the loop antenna is 1 m above the ground. This setup is also used to determine the spectrum of intentional radiators.
The test is performed at a distance of 3 m between the antenna and the EUT in the frequency range up to 30MHz. A Quasi-Peak or Average-Detector is used, depending on the frequency range. The Average-Detector is used in the frequency bands 9-90 kHz and 110-490 kHz, otherwise the quasi-peak is determined. For pulse modulated devices with a pulse repetition frequency of 20 Hz or less, the Peak-Detector is used (§15.35a Note).
To speed up the measurement process, a pre-measurement is performed with the Peak- and Average-Detectors. The spectrum is determined by rotating the EUT by 360° and the antenna orientation changed accordingly. The maxhold function is used. Hand-held or body-worn devices are rotated through three orthogonal axes to determine maximum emanation. Also the placement and layout of the equipment and the cables are arranged to maximize the disturbance level.
For the re-measurement, the 10 frequencies with the highest exceedance or the smallest distance to the limit are selected. The Average and Quasi-Peak-Detectors are used for the final measurement. Depending on the limit lines, 6 final measurements are documented. The highest limit exceeding or, in case of compliance with the limit, the emissions found with the smallest distance to the limit are documented.
If less than six emission frequencies with a distance of 20 dB are below the limit value, the noise level of the measuring device at representative frequencies is indicated.

The final measurement is performed at a test distance of 3 m. In case the regulation requires testing at different distances, the result is extrapolated by an extrapolation factor 40 dB / decade to the required distance.
Frequency, the measured value, antenna information and the limit will be printed out.

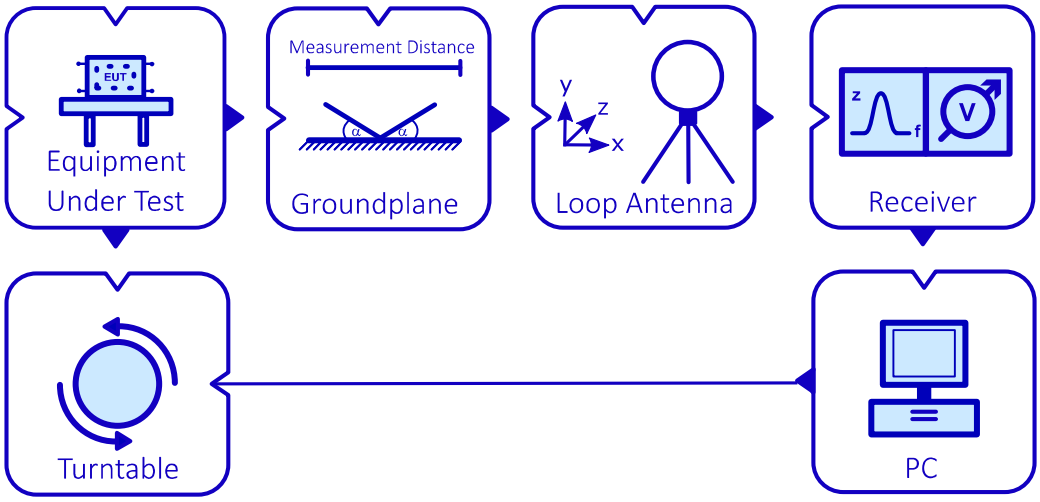
The reported test results are calculated using the following formula to normalize the results for the requested test distance:

Field strength (dBμV/m) = Reading (dBμV) + AF (dB/m) + CF (dB) + 40 *(D_T/D_R) (dB)

AF = Correction factor for the antenna
CF = Correction factor for the cable loss
DT = Test distance
DR = Reference distance for the limit defined in the standard

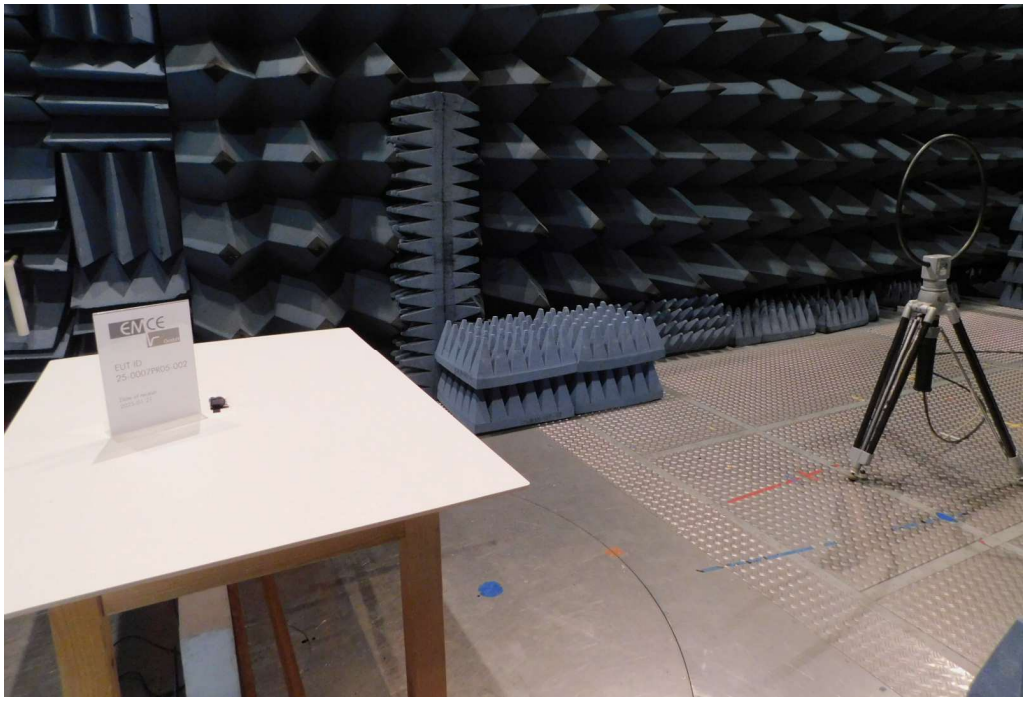
Basic structure - Setup

OATS / SAC



6.6.1 Test set up

According ANSI C63.10-2020



Test location

Final test					
☒	Inv.-No.	Designation	Type (L x W x H)	Manufacturer	Location
☒	062	Semi anechoic chamber # 2	13.5 x 6.1 x 5.5 m	EMC-Technik & Consulting GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden
	014	Open area test site	3 m	EMCE GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden
	015	Open area test site	10 m	EMCE GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden

Used test equipment

Final test					
☒	Inv.-No.	Designation	Type	Manufacturer	S/N
☒	008	Antenna 9 kHz – 30 MHz	HFH2-Z2	Rohde & Schwarz	835776/0002
	042	AC-Source / Analyzer / Norm impedance	EMV D5000/PAS	Spitzenberger + Spies	A274700/ 0 0501
☒	997	Software	EMC32	Rohde & Schwarz	n/a
☒	8044	EMI Test Receiver	ESW44	Rohde & Schwarz	103371

All used test equipment are checked resp. calibrated periodically.

☒ Test equipment was checked and complied to the requirements

Test-/Measurement uncertainty

The measurement uncertainty in the test met the guideline of CISPR16-4-2 or better.

Measurement uncertainty of the radiated emission with an extended coverage factor of k = 2:

Frequency	Measurement uncertainty
9 kHz – 30 MHz	on request

6.6.2 Test

Frequency range: 9 kHz – 30 MHz

Limits for radiated emissions

Technical requirements			
Detector	Frequency / MHz	Limit / µV/m	Measurement distance / m
AV	0.009 – 0.090	2400/F(kHz)	300
QP	0.090 – 0.110	2400/F(kHz)	300
AV	0.110 – 0.490	2400/F(kHz)	300
QP	0.490 – 1.705	24000/F(kHz)	30
QP	1.705 – 30.000	30	30
For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz			

Antenna Orientation

☒ Parallel to EUT ☒ Orthogonal to EUT

Antenna Height

☒ 1 m – Lowest point of the loop above ground

Antenna Distance - EUT

☒ 3 m ☐ 10 m ☐ 30 m

EUT Orientation to Antenna

☐ X-Axis ☒ Y-Axis* ☐ Z-Axis

* Orientation of the EUT for the worst case emission

Rationale for selecting the EUT test set up

Equipment units:

EUT as a stand-alone sensor with integrated RF module and powered by an internal battery.

Cabling:

☐ Standard cables
☐ Special cables provided by the manufacturer

Port #	Designation	Remarks
n/a		

Operation mode

EUT arrangement:	☒ Tabletop	☐ Floor standing
Power supply:	☐ 120 V/60 Hz	☒ Internal battery

Operation in two different operating modes:

1. Continuous operation in normal mode (receiver-only mode) without a request being sent by the companion device.
2. Continuous operation in normal mode (receiver-only mode), with the companion device transmitting a request every second.

Environmental conditions

Temperature:	24 °C
Relative humidity:	38 %

Test result

Limits for unwanted radiated emissions: ☒ kept ☐ not kept

Remarks: n/a

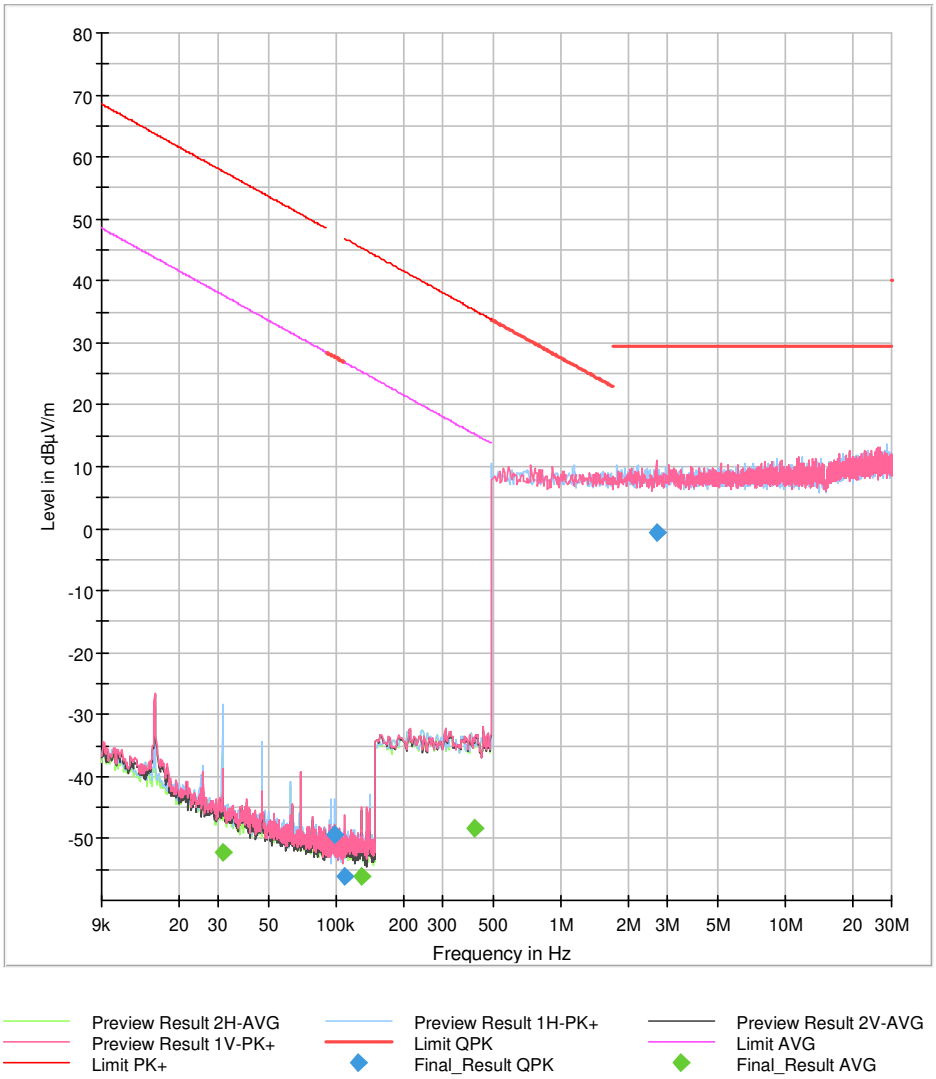
Records

Pre-test measurement
☐ Readings
☐ Diagram

Final measurement
☒ Readings
☒ Diagram

EUT Information

EUT Name:	030405 - TIRECHECK EXTERNAL SENSOR
Test_ID: / SN:	25-0007PR05-002
Customer:	TireCheck GmbH
Operational condition:	Continuous operation
Test specification:	47 CFR Part 15 Subpart C - Section 15.209 - SAC @3 m
Antenna information:	Distance EUT-Ant.: 3.0 m / Polarization: H/V. / Ant.Height: 1.0 m Orientation to the EUT: H = Parallel / V = Orthogonal
Operator:	S. Vogelmann
File #:	25-0007RC07-002-005
Comment #1:	Without a request being sent by the companion device.
Comment #2:	

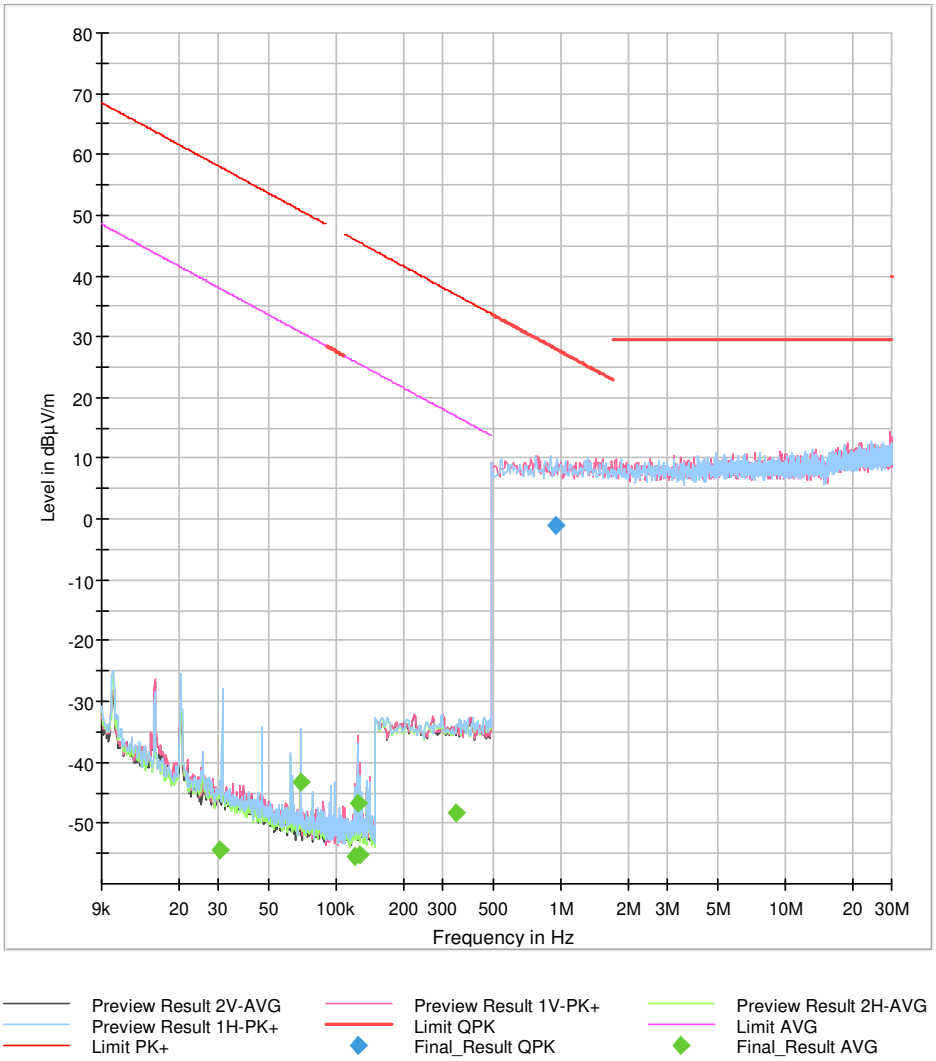


Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azi-muth (deg)	Corr. (dB)
0.031426	---	-52.31	37.66	89.97	15000.0	0.200	H	269.0	-59.8
0.097930	-49.35	---	27.79	77.14	15000.0	0.200	H	175.0	-60.0
0.108566	-56.15	---	26.89	83.04	15000.0	0.200	V	282.0	-60.0
0.129770	---	-56.11	25.34	81.45	15000.0	0.200	V	215.0	-60.0
0.418012	---	-48.45	15.18	63.63	15000.0	9.000	V	218.0	-60.1
2.711915	-0.71	---	29.54	30.25	15000.0	9.000	V	320.0	-20.1

EUT Information

EUT Name:	030405 - TIRECHECK EXTERNAL SENSOR
Test_ID: / SN:	25-0007PR05-002
Customer:	TireCheck GmbH
Operational condition:	Continuous operation
Test specification:	47 CFR Part 15 Subpart C - Section 15.209 - SAC @3 m
Antenna information:	Distance EUT-Ant.: 3.0 m / Polarization: H/V. / Ant.Height: 1.0 m Orientation to the EUT: H = Parallel / V = Orthogonal
Operator:	S. Vogelmann
File #:	25-0007RC07-002-007
Comment #1:	With the companion device sending a request every second at a frequency of 125 kHz.
Comment #2:	



Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azi-muth (deg)	Corr. (dB/m)
0.030324	---	-54.46	37.97	92.43	15000.0	0.200	H	244.0	-59.8
0.069491	---	-43.30	30.77	74.07	15000.0	0.200	H	285.0	-60.0
0.120715	---	-55.55	25.97	81.52	15000.0	0.200	V	262.0	-60.0
0.124510	---	-46.73	25.70	72.44	15000.0	0.200	V	271.0	-60.0
0.128570	---	-55.30	25.43	80.73	15000.0	0.200	V	241.0	-60.0
0.344600	---	-48.26	16.86	65.12	15000.0	9.000	V	330.0	-60.1
0.959868	-1.08	---	27.96	29.04	15000.0	9.000	H	43.0	-20.0

6.7 Radiated emissions E-Field of intentional radiators

☒ No deviation from the standard
☐ Deviation from the standard
☐ Not tested

Note: According to the customer's specifications, the stricter limits according to 15.231 (e) were applied.

Measurement procedure:

Rules and specification	47 CFR Part 15 Section 15.209 (a)(b)(c)(d)(e) 47 CFR Part 15 Section 15.231 (b)
Guide	ANSI C63.10-2020

The radiated interference emission is measured on an alternative open area test site OATS in the frequency range 30 - 1000 MHz. The measurement distance is 3 m or 10 m, depending on the standard. Above 1 GHz, the measurement is performed in a 3 m semi-anechoic chamber with floor absorber to reduce ground reflections. For the measurement of the field strength a biconical antenna up to 200 MHz, a logperiodic antenna from 200 MHz to 1 GHz and horn antennas or double stacked logperiodic antenna above 1 GHz are used. All antennas are linearly polarized. External low-noise preamplifiers are used in the range above 1 GHz to improve measurement sensitivity. Special measures, such as filters or attenuators, are taken to avoid overloading the amplifiers. The antenna height is varied between 1 m and 4 m as required. The elevation angle of the antenna can be corrected via the antenna mast to ensure that the main lobe of the antenna is always directed at the EUT. A turntable allows the alignment of the EUT towards the antenna to maximize the radiated emission. The test sites are located above a metallic ground plane. Table-top devices are placed on a non-conductive wooden table. Hand-held, body-worn, or ceiling-mounted devices are examined in 3 orthogonal axis orientations to determine the maximum emission level. Floor-standing devices are placed directly on the grounded metal turntable/reference insulated from ground plane by an insulating material <12 mm.
During an initial automated pre-test run in a semi-anechoic chamber, the desired frequency range is measured. The receiver is operated as an analyzer and the frequency ranges are run sequentially depending on the antenna. For the measurement, the turntable is continuously rotated from 0° - 360° and back, and the antenna height is changed in 0.5 m increments after each complete turntable cycle. The antenna position is then changed from 1.0 m to 4.0 m in 0.5 m steps for vertical polarization and back for horizontal polarization. During a cycle, the frequency range is continuously swept with peak detector and max hold function.

Depending on the test specification, an average detector is also used if required.
For each discrete antenna polarization over all positions, the maximum peak values are recorded with frequency, level, turntable position, antenna height and antenna polarization. Significant peaks or clock frequencies are marked and re-measured with increased frequency accuracy. The recordings are used to determine the exact frequency and to optimize the interference level. At the predefined position, the turntable position is fine-adjusted in the range of ±20° and then the antenna height is varied by ±0.3 m. At the maximized position, the emission is measured with quasi-peak or average detector and listed. The six highest emissions are selected for final measurement in the OATS.
In a final test run, an open area test site measurement is made at selected frequencies determined by the previous test procedure. For each selected frequency, the frequency setting is optimized again in the OATS and the field strength value is maximized, rotating the EUT 360° at an antenna height of 1.0 m for vertical antenna polarization and 2.0 m for horizontal antenna polarization. At the azimuth position of the EUT for the highest radiation, the antenna height is varied within 1.0 m and 4.0 m until the highest interference level is reached. To maximize the interference level at the determined position, the turntable azimuth is fine-adjusted by ±45° and the antenna height is fine-adjusted by ±0.3 m. The setup of the instrument and the cables are manipulated within the range to produce the highest emission.
Final measurement is made using a receiver conforming to CISPR 16 guidelines with a quasi-peak and average detector.
The identified frequency and amplitude of the six highest radiated emissions relative to the limit lines are listed. If fewer than six emission frequencies are within 20 dB of the limit, the noise level of the instrument at representative frequencies is reported.
For documentation of final testing below 1 GHz on the OATS the plots recorded in den SAC are indicated as pre-test.
In case the regulation requires testing at different distances, the result is extrapolated by an extrapolation factor 20 dB / decade to the required distance.

The reported test results are calculated using the following formula to normalize the results to the requested test distance:

$$\text{Result (dB}\mu\text{V/m)} = \text{Reading (dB}\mu\text{V)} + \text{AF (dB/m)} + \text{CF (dB)} + 20 * (D_T/D_R)\ \text{(dB)}$$

AF = Correction factor for the antenna
CF = Correction factor for the cable loss
D_T = Test distance
D_R = Reference distance for the limit defined in the standard

Example:

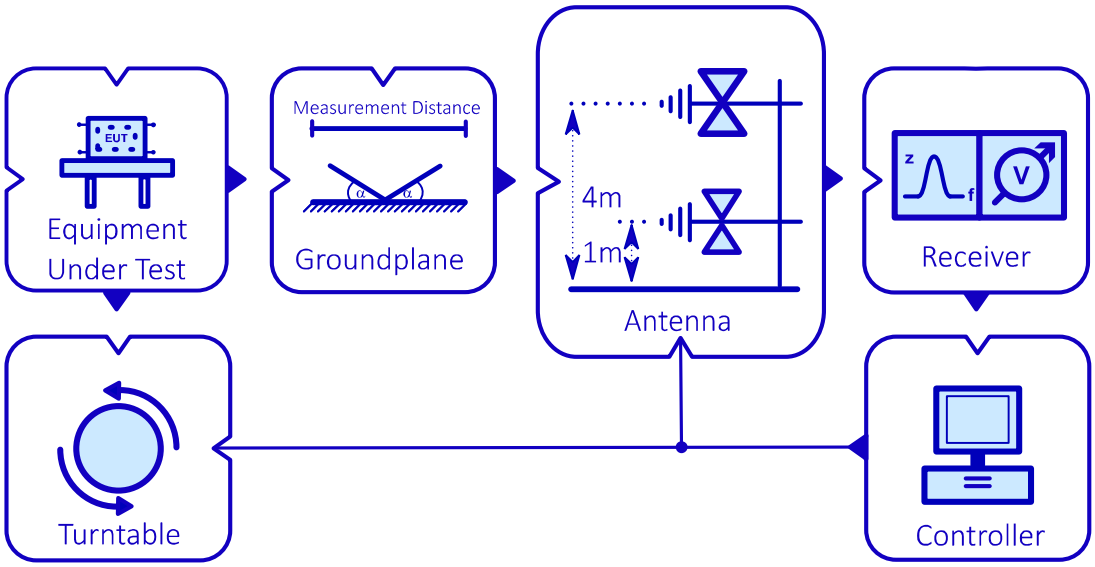
Test frequency	500.00 MHz
Reading	12.3 dBµV
$AF_{(500.00\ MHz)}$	17.1 dB/m
$CF_{(500.00\ MHz)}$	1.4 dB
DT =	3 m
DR =	3 m

Calculated final result for the electrical field strength E(f):

$E_{(500.00\ MHz)} = 12.3\ dB\mu V + 17.1\ dB/m + 1.4\ dB + 0\ dB = 30.8\ dB\mu V/m$

Basic structure - Setup

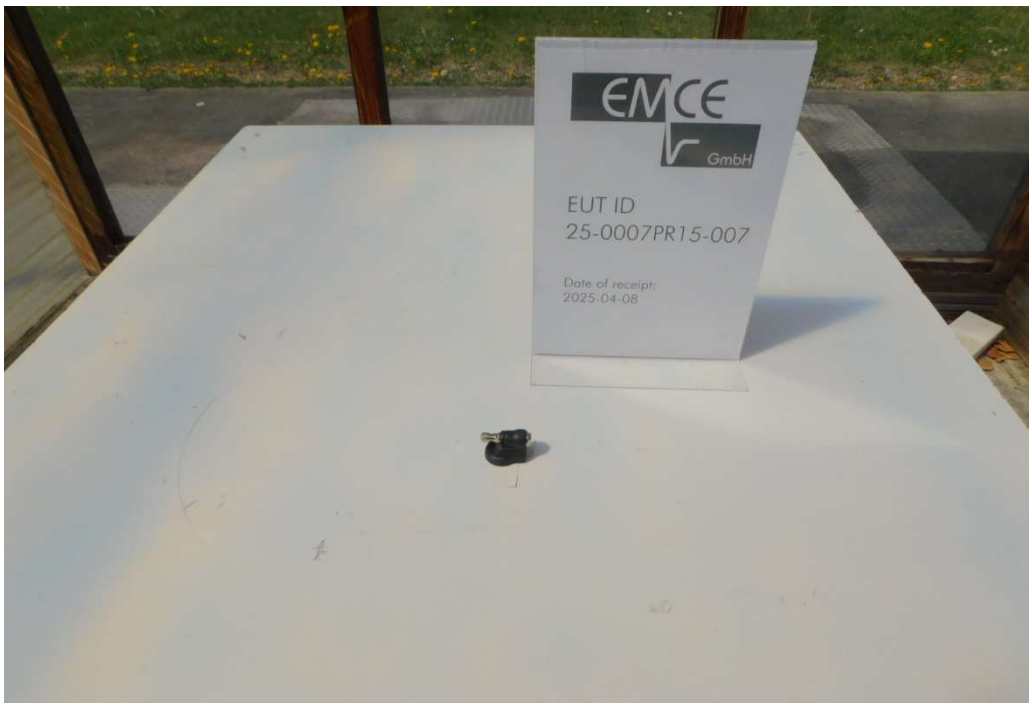
OATS / SAC



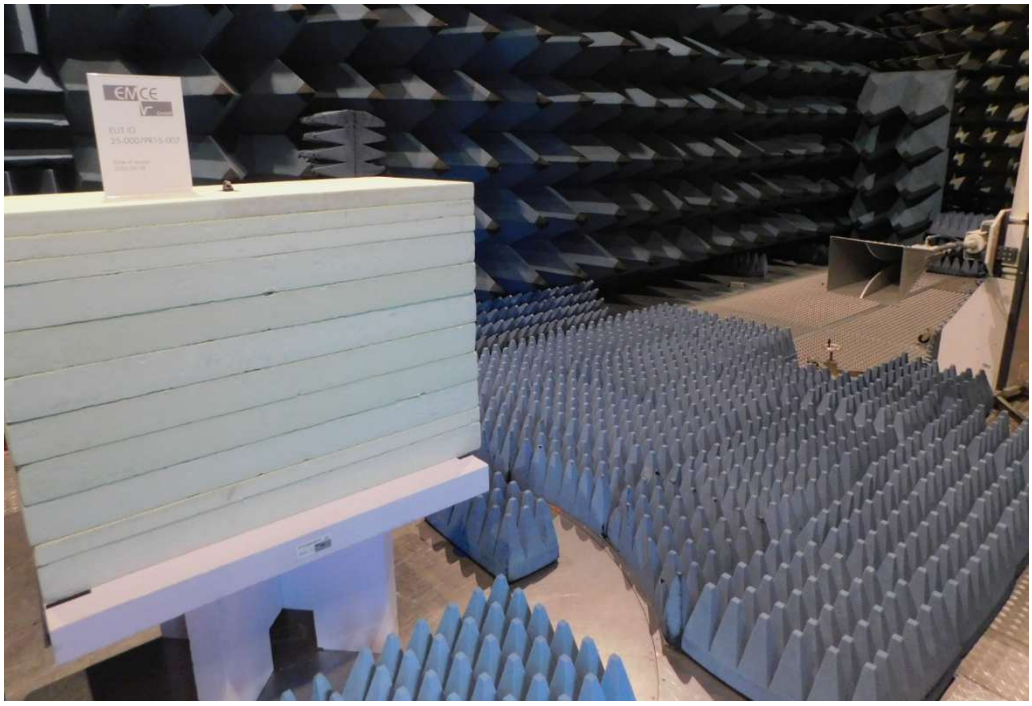
6.7.1 Test set up

According ANSI C63.10-2020

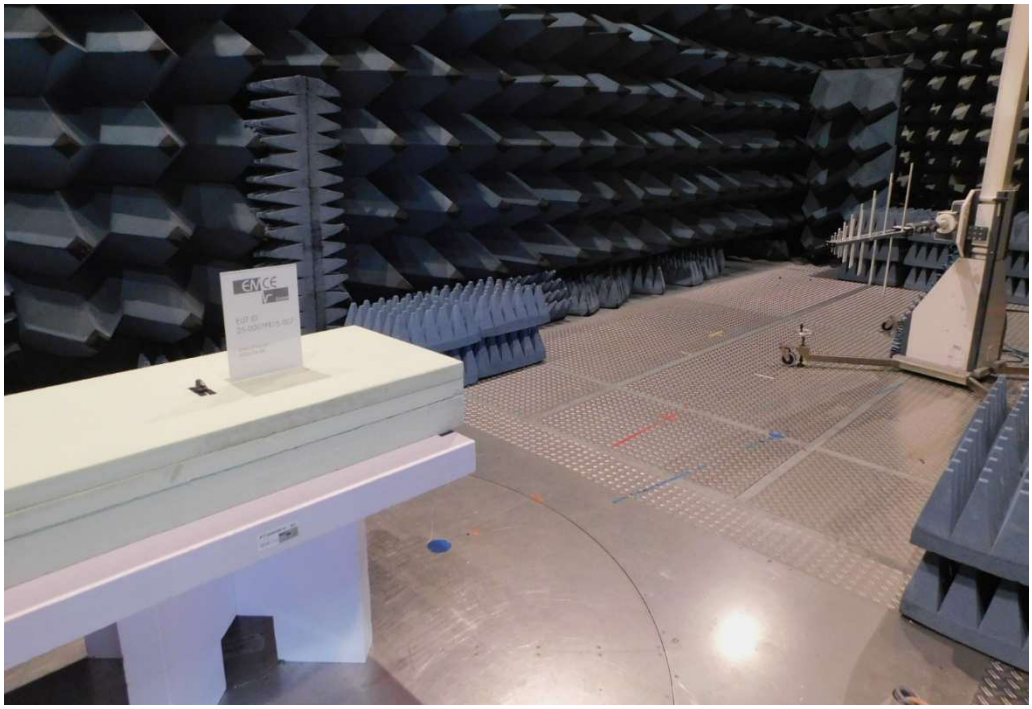
Final test setup – OATS [30 – 1000 MHz]



Final test setup – SAC [1 – 6 GHz]



Pre-test setup – SAC [30 – 1000 MHz]



Test location

Pre-test					
☒	Inv.-No.	Designation	Type (L x W x H)	Manufacturer	Location
☒	062	Semi anechoic chamber # 2	13.5 x 6.1 x 5.5 m	EMC-Technik & Consulting GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden

Final test					
☒	Inv.-No.	Designation	Type (L x W x H)	Manufacturer	Location
☒	062	Semi anechoic chamber # 2	13.5 x 6.1 x 5.5 m	EMC-Technik & Consulting GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden
	014	Open area test site	3 m	EMCE GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden
☒	015	Open area test site	10 m	EMCE GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden

Used test equipment

Pre-test					
☒	Inv.-No.	Designation	Type	Manufacturer	S/N
	042	AC-Source / Analyzer / Norm impedance	EMV D5000/PAS	Spitzenberger + Spies	A274700/ 0 0501
☒	997	Software	EMC32	Rohde & Schwarz	n/a
☒	8008	LPDA Broadband Antenna 180 - 1500 MHz	VULP 9118A	Schwarzbeck	900
☒	8034	Antenna 30-300 MHz	VHBB9124 / BBA9106	Schwarzbeck	1812
☒	8044	Test receiver	ESW 44	Rohde & Schwarz	103371

Final test					
☒	Inv.-No.	Designation	Type	Manufacturer	S/N
	042	AC-Source / Analyzer / Norm impedance	EMV D5000/PAS	Spitzenberger + Spies	A274700/ 0 0501
	059	LPDA	HL050	Rohde & Schwarz	100006
	222	Broadband Preamplifier 0.5-18 GHz	BBV 9718	Schwarzbeck	9718-316
	226	HL050 Log.-Per. Antenna 850 MHz to 26.5 GHz	HL050 4062.4063.02	Rohde & Schwarz	100829
☒	229	Test receiver	ESS	Rohde & Schwarz	845420/0005
☒	236	Broad-Band Horn Antenna 0.5-6 GHz	BBHA 9120 E	Schwarzbeck	00831
☒	997	Software	EMC32	Rohde & Schwarz	n/a
☒	8007	LPDA Antenna 180 - 1500 MHz	VULP 9118A	Schwarzbeck	899
☒	8033	Antenna 30-300 MHz	VHBB9124 / BBA9106	Schwarzbeck	1808
☒	8044	Test receiver	ESW 44	Rohde & Schwarz	103371

All used test equipment are checked resp. calibrated periodically.

☒ Test equipment was checked and complied to the requirements

Test-/Measurement uncertainty

The measurement uncertainty in the test met the guideline of CISPR16-4-2 or better.

Measurement uncertainty of the radiated emission with an extended coverage factor of k = 2:

Frequency	Measurement uncertainty
30 MHz – 225 MHz	4.8 dB (valid for 10 m-OATS)
225 MHz – 1 GHz	4.9 dB (valid for 10 m-OATS)
30 MHz – 225 MHz	4.8 dB (valid for 3 m-OATS)
225 MHz – 1 GHz	6.2 dB (valid for 3 m-OATS)

6.7.2 Test

Highest frequency generated or used in the device or on which the device operates or tunes:

	Upper frequency of measurement:
☒ <10 GHz	☒ 10th harmonic of the highest frequency or 40 GHz, whichever is lower
☐ 10 GHz – 30 GHz	☐ 5th harmonic of the highest frequency or 100 GHz, whichever is lower
☐ 30 GHz – 95 GHz	☐ 5th harmonic of the highest frequency or 200 GHz, whichever is lower
☐ ≥95 GHz	☐ 3rd harmonic of the highest frequency or 750 GHz, whichever is lower

Frequency range:

☐ 9 kHz – 30 MHz	☒ 30 MHz – 1000 MHz
☒ 1 – 6 GHz	☐ 6 – 18 GHz
☐ 18 – 26 GHz	☐ 26 – 40 GHz

General limits for radiated emissions

Technical requirements			
Detector	Frequency / MHz	Limit / dBµV/m	Measurement distance / m
QP	30.0 – 88.0	40.0	3
QP	88.0 – 216.0	43.5	3
QP	216.0 – 960.0	46.0	3
QP	960.0 – 1000.0	54.0	3
AV	> 1000	54.0	3
PK	> 1000	74.0	3
The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.			

☒ Limits according §15.231(b)
According to the customer's specifications, the stricter limits according to 15.231 (e) were applied.

Technical requirements		
Frequency / MHz	Field strength of fundamental / µV/m	Field strength of spurious emission / µV/m
40.66 – 40.70	2,250	225
70 -130	1,250	125
130 – 174	1,250 to 3,750*	125 to 375*
174 – 260	3,750	375
260 – 470	3,750 to 12,500*	375 to 1,250*
Above 470	12,500	1,250
* Linear interpolations		

☒ Limits according §15.231(e)

Technical requirements		
Frequency / MHz	Field strength of fundamental / µV/m	Field strength of spurious emission / µV/m
40.66 – 40.70	1,000	100
70 -130	500	50
130 – 174	500 to 1,500*	50 to 100*
174 – 260	1,500	150
260 – 470	1,500 to 5,000*	150 to 500*
Above 470	5,000	500
* Linear interpolations		

The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in § 15.209, whichever limit permits a higher field strength.

Rationale for selecting the EUT test set up

Equipment units:

EUT as a stand-alone sensor with integrated RF module and powered by an internal battery.

Cabling:

☐ Standard cables
☐ Special cables provided by the manufacturer

Port #	Designation	Remarks
n/a		

EUT Orientation

☒ X-Direction* ☐ Y-Direction ☐ Z-Direction

* Orientation of the EUT for the worst case emission

Operation mode

EUT arrangement:	☒ Tabletop	☐ Floor standing
Power supply:	☐ 120 V/60 Hz	☒ Internal battery

A service tool was used to parameterize the EUT in such a way that it uses an unmodulated carrier with a duty cycle of almost 100 % for transmission.
In this mode, the EUT was operated continuously.

Environmental conditions - SAC

Temperature:	23.6 °C
Relative humidity:	35 %

Environmental conditions - OATS

Temperature: 26 °C
Relative humidity: 34 %

Test result

Limits for radiated emissions of fundamental: ☒ kept ☐ not kept

Limits for radiated emissions of spurious emission based on the fundamental frequency: ☒ kept ☐ not kept

or

Limits for unwanted radiated emissions: ☒ kept ☐ not kept

Remarks: n/a

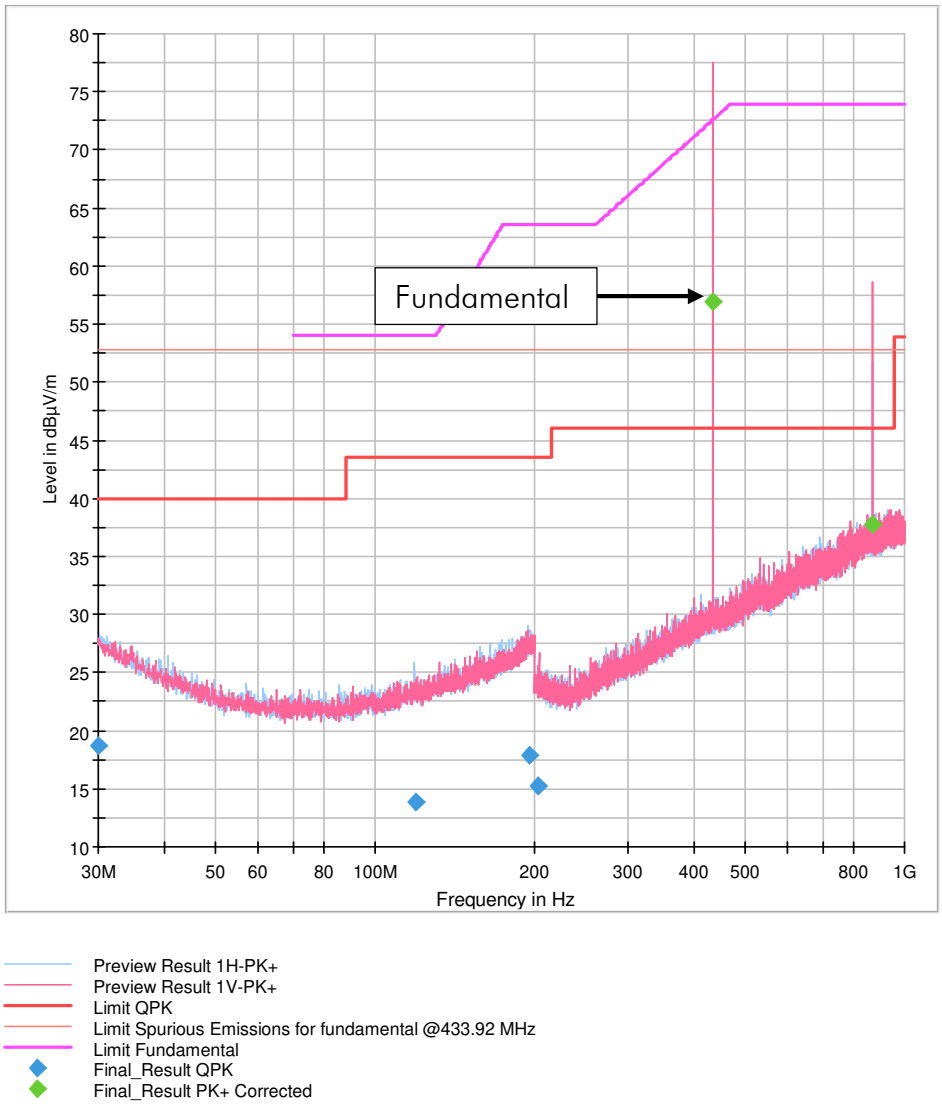
Records

Pre-test measurement
☒ Readings
☒ Diagram

Final measurement
☒ Readings
☒ Diagram

EUT Information

EUT Name:	030405 - TIRECHECK EXTERNAL SENSOR
Test_ID: / SN:	25-0007PR15-007
Customer:	TireCheck GmbH
Operational condition:	Continuous transmission @433.92 MHz, duty cycle of approx. 100%
Test specification:	47 CFR Part 15 Subpart C - Section 15.209 - SAC @3 m 47 CFR Part 15 Subpart C - Section 15.231 (e) - SAC @3 m
Antenna information:	Distance EUT-Ant.: 3.0 m / Polarization: H/V / Ant.Height: 1.0-4.0 m.
Operator:	S. Vogelmann
File #:	25-0007RC15-007-001
Comment #1:	
Comment #2:	

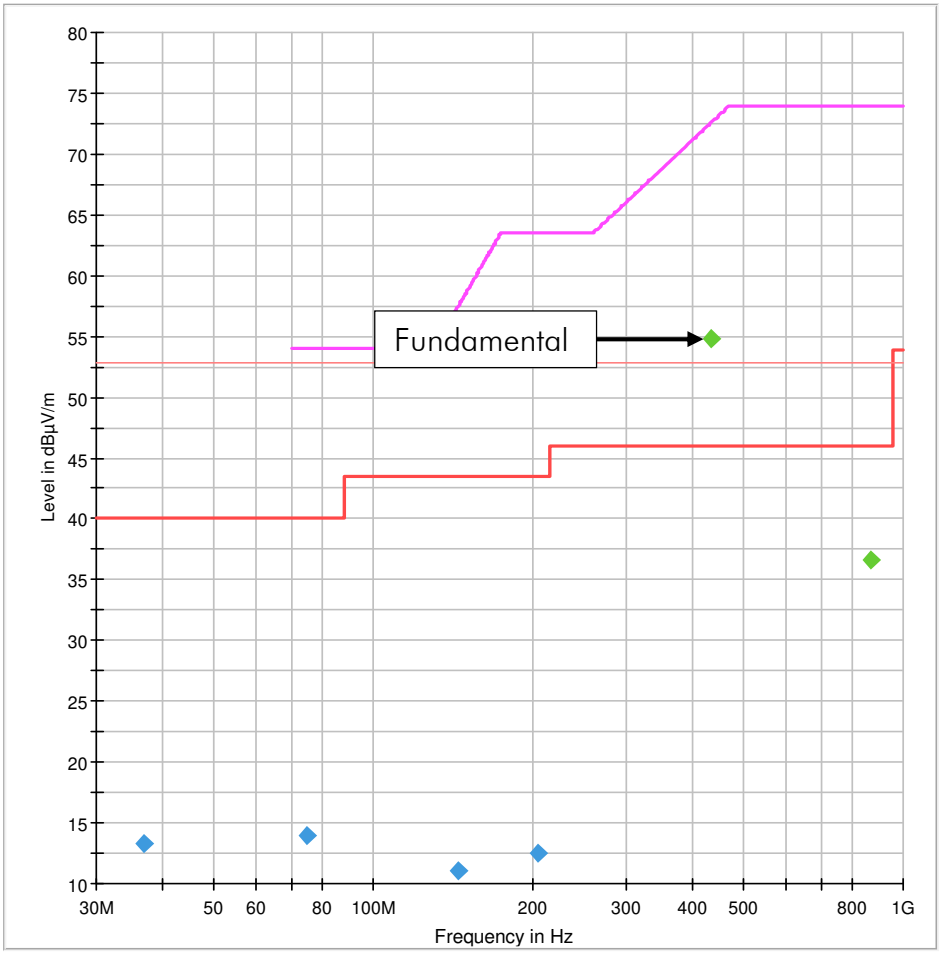


Test Result

Frequency (MHz)	Quasi-Peak (dBµV/m)	Corrected amplitude MaxPeak (dBµV/m)	Pulse train correction (dB)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	RBW (kHz)	Height (cm)	Pol	Azi-muth (deg)	Corr (dB/m)
30.037558	18.76	---	---	40.00	21.24	15000.0	120.00	335.0	H	276.0	13.9
118.870182	13.87	---	---	43.50	29.63	15000.0	120.00	185.0	H	107.0	11.4
195.018182	17.91	---	---	43.50	25.59	15000.0	120.00	128.0	H	12.0	15.2
202.250703	15.23	---	---	43.50	28.27	15000.0	120.00	335.0	H	109.0	12.8
433.962811	---	56.96	-20.50	72.87	15.91	15000.0	120.00	179.0	V	278.0	17.6
867.917946	---	37.81	-20.50	52.87	15.06	15000.0	120.00	178.0	V	295.0	24.5

EUT Information

EUT Name:	030405 - TIRECHECK EXTERNAL SENSOR
Test_ID: / SN:	25-0007PR15-007
Customer:	TireCheck GmbH
Operational condition:	Continuous transmission @433.92 MHz, duty cycle of approx. 100%
Test specification:	47 CFR Part 15 Subpart C - Section 15.209 - OATS @3 m 47 CFR Part 15 Subpart C - Section 15.231 (e) - OATS @3 m
Antenna information:	Distance EUT-Ant.: 3.0 m / Polarization: H/V / Ant.Height: 1.0-4.0 m.
Operator:	S. Vogelmann
File #:	25-0007RC15-007-001
Comment #1:	
Comment #2:	



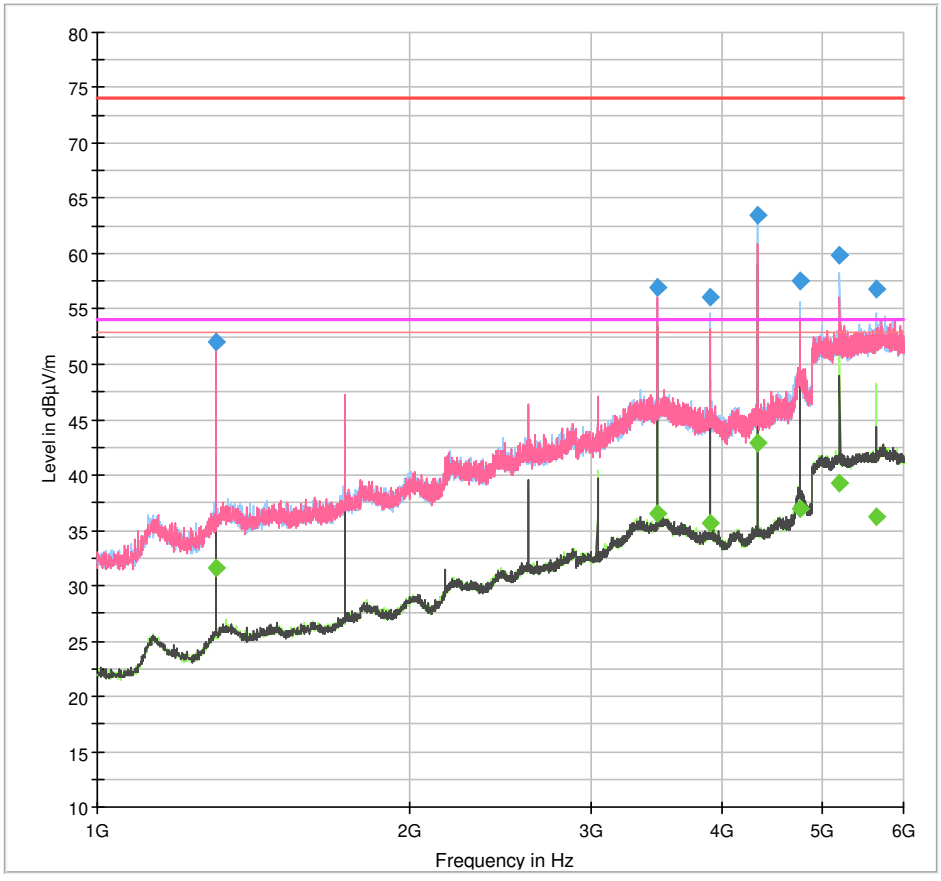
Limit QPK
Limit Spurious Emissions for fundamental @433.92 MHz
Limit Fundamental
Final_Result QPK
Final_Result PK+ Corrected

Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Corrected amplitude MaxPeak (dBµV/m)	Pulse train correction (dB)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	RBW (kHz)	Height (cm)	Pol	Azi-muth (deg)	Corr. (dB/m)
37.000000	13.29	---	---	40.00	26.71	5000.0	120.00	110.0	V	0.0	12.7
75.000000	13.90	---	---	40.00	26.10	5000.0	120.00	160.0	V	180.0	10.0
145.000000	11.06	---	---	43.50	32.44	5000.0	120.00	200.0	H	90.0	13.3
204.000000	12.48	---	---	43.50	31.02	5000.0	120.00	180.0	V	45.0	13.4
433.960000	---	54.82	-20.50	72.87	18.05	5000.0	120.00	150.0	V	270.0	18.6
867.900000	---	36.61	-20.50	52.87	16.62	5000.0	120.00	170.0	V	270.0	26.0

EUT Information

EUT Name:	030405 - TIRECHECK EXTERNAL SENSOR
Test_ID: / SN:	25-0007PR15-007
Customer:	TireCheck GmbH
Operational condition:	Continuous transmission @433.92 MHz, duty cycle of approx. 100%
Test specification:	47 CFR Part 15 Subpart C - Section 15.209 - SAC @3 m 47 CFR Part 15 Subpart C - Section 15.231 (e) - SAC @3 m
Antenna information:	Distance EUT-Ant.: 3.0 m / Polarisation: H/V / Ant.Height: 1.0-4.0 m.
Operator:	S. Vogelmann
File #:	25-0007RC15-007-002
Comment #1:	
Comment #2:	



Preview Result 2H-AVG
Preview Result 1H-PK+
Preview Result 2V-AVG
Preview Result 1V-PK+
Limit PK+
Limit AVG
Limit Spurious Emissions for fundamental @433.92 MHz
Final_Result PK+
Final_Result PK+ Corrected

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Corrected amplitude MaxPeak (dBµV/m)	Pulse train correction (dB)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	RBW (kHz)	Height (cm)	Pol	Azi-muth (deg)	Corr. (dB/m)
1301.85945	---	31.60	-20.50	54.00	22.40	15000.	1000.0	235.0	V	10.0	24.7
1301.85945	52.10	---	---	74.00	21.90	15000.	1000.0	235.0	V	10.0	24.7
3471.67027	---	36.48	-20.50	54.00	17.52	15000.	1000.0	229.0	V	12.0	33.3
3471.67027	56.98	---	---	74.00	17.02	15000.	1000.0	229.0	V	12.0	33.3
3905.67027	56.14	---	---	74.00	17.86	15000.	1000.0	335.0	H	178.0	32.3
3905.67027	---	35.64	-20.50	54.00	18.36	15000.	1000.0	335.0	H	178.0	32.3
4339.59729	---	42.96	-20.50	54.00	11.04	15000.	1000.0	185.0	H	180.0	32.0
4339.59729	63.46	---	---	74.00	10.54	15000.	1000.0	185.0	H	180.0	32.0
4773.60270	---	37.00	-20.50	54.00	17.00	15000.	1000.0	335.0	H	186.0	35.2
4773.60270	57.50	---	---	74.00	16.50	15000.	1000.0	335.0	H	186.0	35.2
5207.66486	59.84	---	---	74.00	14.16	15000.	1000.0	335.0	H	175.0	34.1
5207.66486	---	39.34	-20.50	54.00	14.66	15000.	1000.0	335.0	H	175.0	34.1
5641.53243	---	36.26	-20.50	54.00	17.74	15000.	1000.0	285.0	H	211.0	34.2
5641.53243	56.76	---	---	74.00	17.24	15000.	1000.0	285.0	H	211.0	34.2

6.8 20 dB Emission bandwidth

☒ No deviation from the standard
☐ Deviation from the standard
☐ Not tested

Note: n/a

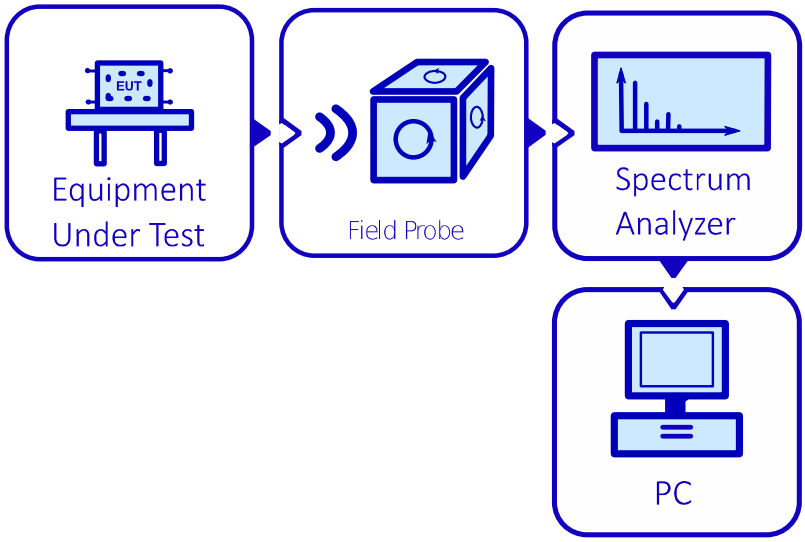
Measurement procedure:

Rules and specification 47 CFR Part 15 Section 15.231 (c)

Guide
☒ ANSI C63.10-2020 Section 6.9.2 – 20 dB Bandwidth
☐ ANSI C63.10-2020 Section 6.9.3 – 99 % Bandwidth

The emission bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by 20 dB. The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. The test is performed in a semi anechoic chamber while the EUT is positioned to a receiving antenna for maximum output power. The modulated signal is recorded with an analyzer.
The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. After the trace of the spectrum analyzer is stabilized the envelope of the signal the amplitude -20 dB below the reference value is determined. The occupied bandwidth is the calculated value between both specific - 20 dB frequency positions.

Basic structure – Setup for radiated test



6.8.1 Test set up

According ANSI C63.10-2020

Test location

Final test					
☒	Inv.-No.	Designation	Type (L x W x H)	Manufacturer	Location
☒	062	Semi anechoic chamber # 2	13.5 x 6.1 x 5.5 m	EMC-Technik & Consulting GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden
	1345	Open area test site	3 - 30 m	EMCE GmbH	EMCE GmbH Untere Wiesen 1 88483 Burgrieden

Used test equipment

Final test					
☒	Inv.-No.	Designation	Type	Manufacturer	S/N
	008	Antenna 9 kHz – 30 MHz	HFH2-Z2	Rohde & Schwarz	835776/0002
	042	AC-Source / Analyzer / Norm impedance	EMV D5000/PAS	Spitzenberger + Spies	A274700/ 0 0501
	230	FSV40 Signal Analyzer 40 GHz	FSV40	Rohde & Schwarz	101717
	997	Software	EMC32	Rohde & Schwarz	n/a
☒	8008	LPDA Broadband Antenna 180 - 1500 MHz	VULP 9118A	Schwarzbeck	900
	8034	Antenna 30-300 MHz	VHBB9124 / BBA9106	Schwarzbeck	1812
☒	8044	EMI Test Receiver	ESW44	Rohde & Schwarz	103371

All used test equipment are checked resp. calibrated periodically.

☒ Test equipment was checked and complied to the requirements

6.8.2 Test

Test frequencies

☒ Nominal Frequency 1	433.92 MHz
☐ Nominal Frequency 2	___ MHz
☐ Nominal Frequency 3	___ MHz

Test Requirements

Frequency range / MHz	Limit / MHz
70 - 900	0.25% of the center frequency
> 900	0.50% of the center frequency

Equipment units:

EUT as a stand-alone sensor with integrated RF module and powered by an internal battery.

Cabling:

☐ Standard cables
☐ Special cables provided by the manufacturer

Port #	Designation	Remarks
n/a		

Operation mode

EUT arrangement:	☒ Tabletop	☐ Floor standing
Power supply:	☐ 120 V/60 Hz	☒ Internal battery

Continuous operation in emergency mode, with periodic data transmission approximately every 5 seconds.

Environmental conditions

Temperature: 23.8 °C
Relative humidity: 34 %

Test result

Nominal Frequency / MHz	Lower edge / MHz	Upper edge / MHz	20 dB BW / MHz	Limit / MHz
433.92	433.8521	433.9939	0.1418	1.0848

Limit for Emissions Bandwidth (20 dB)

- ☒ kept
- ☐ not kept
- ☐ not relevant

Limit for Emissions Bandwidth (99 %):

- ☐ kept
- ☐ not kept
- ☒ not relevant

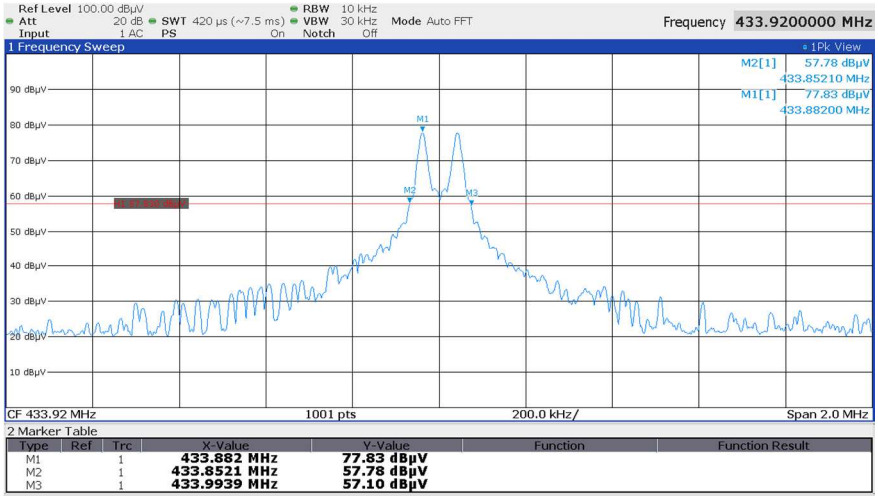
Remarks: n/a

Records

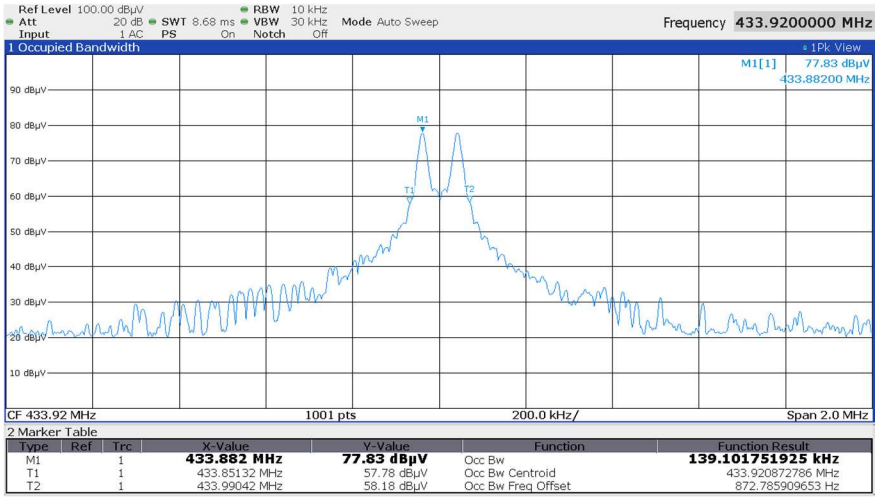
- ☒ Diagrams
- ☒ Readings

Emission Bandwidth

Emission bandwidth 20dB



Emission bandwidth 99 % - informative



Emission bandwidth 20dB	
Lower Edge	
Measured	433.8521 MHz
Upper Edge	
Measured	433.9939 MHz

6.9 Frequency stability

☐ No deviation from the standard
☐ Deviation from the standard
☒ Not tested

Note: Not requested, the carrier frequency of the EUT operates outside the frequency band 40.66 - 40.70 MHz.

7 Summary

47 CFR Part 15 Subpart C

Requirement	Regulation section	Result	Remarks
Pulse train	§15.231 (a)(3) §15.231 (a)(4)	Pass	
Antenna requirement	§ 15.203	Pass	
Restricted bands of operation	§ 15.205 (a) (b) (c)	Pass	
Terminal voltage on powerline	§ 15.207 (a)	n/a	
Radiated emissions H-Field of intentional radiators	§ 15.209 (a) (b) (c) (d) (e) (f)	Pass	
Radiated emissions E-Field of intentional radiators	§ 15.209 (a) (b) (c) (d) (e) (f) § 15.231 (b)	Pass	
20 dB Emission bandwidth	§ 15.231 (c)	Pass	
Frequency stability	§ 15.231 (d)	n/a	

n/a – not applicable

Burgrieden, 06/26/2025

Responsible inspector:

Project manager – Steffen Vogelmann

- End of Test Report -