

Report on the FCC and IC Testing of the LDL Technology S.A.S.

WUS Belt

Model: 18137

In accordance with FCC 47 CFR Part
15 C and ISED RSS-210 and ISED
RSS-GEN



Product Service

Add value.
Inspire trust.

Prepared for: LDL Technology S.A.S.
Parc Technologique du canal 3,
rue Giotto
31520 Ramonville Saint-Agne;
France

FCC ID: T4514127
IC: 6450A-14127

COMMERCIAL-IN-CONFIDENCE

Date: 2021-02-26

Document Number: TR-55559-07085-01 | Edition 1

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	M. Steindl	2021-02-26	 SIGN-ID 477340
Authorised Signatory	M. Stumpe	2021-02-26	 SIGN-ID 478362

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

Engineering Statement:

This measurement shown in this report were made in accordance with the procedures described on test pages.

All reported testing was carried out on a sample equipment to demonstrate limited compliance with with FCC 47 CFR Part 15 C and ISED RSS-210 and RSS-GEN.

The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	M. Steindl	2021-02-26	 SIGN-ID 477342

Laboratory Accreditation

DAkS Reg. No. D-PL-11321-11-02

DAkS Reg. No. D-PL-11321-11-03

Laboratory recognition

Registration No. BNetzA-CAB-16/21-15

Industry Canada test site registration

3050A-2

Executive Statement:

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15 C:2020 and ISED RSS-210:2020 and RSS-GEN:2021



DISCLAIMER AND COPYRIGHT

This non-binding report has been prepared by TÜV SÜD Product Service with all reasonable skill and care. The document is confidential to the potential Client and TÜV SÜD Product Service. No part of this document may be reproduced without the prior written approval of TÜV SÜD Product Service. © 2021 TÜV SÜD Product Service.

ACCREDITATION

Our BNetzA Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our BNetzA Accreditation. Results of tests not covered by our BNetzA Accreditation Schedule are marked NBA (Not BNetzA Accredited).

Trade Register Munich
HRB 85742
VAT ID No. DE129484267
Information pursuant to Section 2(1)
DL-InfoV (Germany) at
www.tuev-sued.com/imprint

Managing Directors:
Walter Reithmaier (CEO)
Dr. Jens Butenandt
Patrick van Welij

Phone: +49 (0) 9421 55 22-0
Fax: +49 (0) 9421 55 22-99
www.tuev-sued.de

TÜV SÜD Product Service GmbH
Äußere Frühlingstraße 45
94315 Straubing
Germany



Content

1	Report Summary.....	2
1.1	Modification Report.....	2
1.2	Introduction	2
1.3	Brief Summary of Results.....	3
1.4	Product Information	1
1.5	Test Configuration	1
1.6	Modes of Operation	1
1.7	Deviations from Standard	1
1.8	EUT Modifications Record	1
1.9	Test Location	2
2	Test Details.....	3
2.1	Antenna requirement	3
2.2	Bandwidth of Momentary Signals	4
2.3	Periodic Operation Requirement	6
2.4	Temperature Stability	10
2.5	Radiated emissions	13
2.6	RF Exposure.....	19
3	Measurement Uncertainty	22
Annex A	Photographs of Test Setup.....	2 pages
Annex B	Plots taken during testing	9 pages
Annex C	External photographs of EUT	3 pages



1 Report Summary

1.1 Modification Report

Alternations and additions of this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of changes	Date of Issue
1	First Issue	2021-02-26

Table 1: Report of Modifications

1.2 Introduction

Applicant	LDL Technology S.A.S.
Manufacturer	LDL Technology S.A.S.
Model Number(s)	18137
Serial Number(s)	94E60983
Hardware Version(s)	N/A
Software Version(s)	N/A
Number of Samples Tested	1
Test Specification(s) /	FCC 47 CFR Part 15 C : 2020
Issue / Date	ISED RSS-210, Issue 10, Amendment 1 : 2020 ISED RSS-GEN, Issue 5, Amendment 1 : 2019 + Amendment 2 : 2021
Test Plan/Issue/Date	N/A
Order Number	N/A
Date	
Date of Receipt of EUT	2021-02-15
Start of Test	2021-02-17
Finish of Test	2021-02-18
Name of Engineer(s)	M. Steindl
Related Document(s)	ANSI C63.4: 2014 ANSI C63.10: 2013 FCC 47 CFR Part 2 J : 2019 KDB 558074 D01 V05R02 ISED RSS-102, Issue 5, 2015



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15 C, ISSED RSS-210 and ISSED RSS-GEN is shown below.

Section	Specification Clause	Test Description	Result
2.1	15.203	Antenna requirement	Pass
2.2	15.231(c)	Bandwidth of momentary signals	Pass
2.3	15.231(a)	Periodic operation requirement	Pass
2.5	15.231(a) 15.205, 15.209	Radiated Emissions	Pass
Fehler! V erweis- quelle konnte nicht ge- funden werden.	15.207	Conducted Emissions on Mains Terminals	Not applicable
2.6	15.247(i)	RF Exposure	Pass

Table 2: Results according to FCC 47 CFR Part 15 C

Section	Specification Clause	Test Description	Result
2.2	A1.3	Bandwidth of momentary signals	Pass
2.3	A.1.1	Periodic operation requirement	Pass
2.5	A1.1	Radiated Emissions	Pass

Table 3: Results according to ISSED RSS-247

Section	Specification Clause	Test Description	Result
2.2	6.7	Bandwidth of momentary signals	Pass
2.5	8.9, 8.10	Spurious Emissions	Pass
2.4	6.11	Temperature Stability	Pass
Fehler! V erweis- quelle konnte nicht ge- funden werden.	8.8	Conducted Emissions on Mains Terminals	Not applicable
2.6	3.4	RF Exposure	Pass

Table 4: Results according to RSS-Gen



1.4 Product Information

1.4.1 Technical Description

The 18137 is a Wheel Unit Sensor, intended to operate on a wheel of an automotive.

<i>Frequency Band</i>	433.92 MHz
<i>Number of frequency channels:</i>	1
<i>Emission designator:</i>	53K2F1D
<i>Supply Voltage:</i>	3 V
<i>Supply Frequency:</i>	0 Hz - Battery supply

1.4.2 EUT Ports / Cables identification

No ports

1.5 Test Configuration

The EUT was set to transmitting continuously

1.6 Modes of Operation

Transmitting continuously with and without modulation

1.7 Deviations from Standard

N/A

1.8 EUT Modifications Record

The table below details modifications made to the EUT during the test program.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
0	As supplied by the customer	Not Applicable	Not Applicable

Table 5



Product Service

1.9 Test Location

TÜV SÜD Product Service conducted the following tests at our Straubing test laboratory:

Test Name	Name of Engineer(s)
Antenna requirement	M. Steindl
Bandwidth of Momentary Signal	M. Steindl
Periodic Operation Requirement	M. Steindl
Temperature Stability	M. Steindl
Radiated Emissions	M. Steindl
RF Exposure	M. Steindl

Office Address:

Äußere Frühlingstraße 45
94315 Straubing
Germany



2 Test Details

2.1 Antenna requirement

2.1.1 Specification Reference

FCC 47 CFR Part 15 C, Clauses 15.203

2.1.2 Equipment under Test and Modification State

18137; S/N 94E60983; Modification State 0

2.1.3 Date of Test

2021-02-18

2.1.4 Specification Limits

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 an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some fields disturbance sensors, or to other intentional radiators which must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits are not exceeded.

2.1.5 Test Results

The EUT is equipped with an internal antenna. See external photos for details.



2.2 Bandwidth of Momentary Signals

2.2.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.231(c)
ISED RSS-210, Clause A.1.3
ISED RSS-Gen, Clause 6.7

2.2.2 Equipment under Test and Modification State

18137; S/N 94E60983; Modification State 0

2.2.3 Date of Test

2021-02-17

2.2.4 Environmental Conditions

Ambient Temperature	23 °C
Relative Humidity	27 %

2.2.5 Specification Limits

FCC 47 CFR, clause 15.231(c)

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. For devices operating above 900 MHz, the emission shall no wider than 0.5 % of the center frequency. Bandwidth is determined at the points 20 dB down from the modulation carrier.

ISED RSS-210 Issue 10, Amd. 1; clause A1.3

The occupied bandwidth of the momentary devices shall be less than or equal to 0.25 % of the centre frequency for devices operating between 70 MHz and 900 MHz. For devices operating above 900 MHz, the occupied bandwidth shall be less than or equal to 0.5 % of the centre frequency.

2.2.6 Test Method

The test was performed according to ANSI C63.10, clauses 6.9
See section 2.5.6 of this test report for details.



2.2.7 Test Results

Center frequency	20 dB Bandwidth (MHz)	Limit
433.92 MHz	54.94 kHz	1.0848 MHz

Table 6: 20 dB bandwidth

Centre Frequency	99% Bandwidth	Limit
433.92 MHz	53.284 kHz	1.0848 MHz

Table 7: 99% bandwidth

2.2.8 Test Location and Test Equipment

The test was carried out in Semi anechoic room No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	2021-03	2022-03
ULTRALOG antenna	Rohde & Schwarz	HL562E	39969	2022-03	2021-03
Fixed attenuator	Aeroflex / Weinschel	Model 1: 6 dB	39632	2019-11	2022-11

Table 8



2.3 Periodic Operation Requirement

2.3.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.231(a)
ISED RSS-210, Clause A.1.1

2.3.2 Equipment under Test and Modification State

18137; S/N 94E60983; Modification State 0

2.3.3 Date of Test

2021-02-18

2.3.4 Environmental Conditions

Ambient Temperature	22 °C
Relative Humidity	30 %

2.3.5 Test Method

The test was performed using a spectrum analyser in zero-span-mode with the frequency set to the center frequency of the transmitter and the resolution bandwidth set to a value greater of the emission bandwidth to cover the full output power of the transmitter. Sweep time and sweep points were set to values given a reasonable resolution of test results.

Center frequency:	433.92 MHz
RBW:	1 MHz
Sweep time:	100 ms / 10 s / 140 s
Sweep points:	691 / 10001



2.3.6 Specification Limits

FCC 47 CFR 15.231(a) and ISED RSS-210 A1.1

1. A manually operated transmitter shall employ a push-to-operate switch that will automatically deactivate the transmitter within not more than 5 s of being released.
2. A transmitter activated automatically shall cease transmission within 5 s after activation.
3. Periodic transmissions at regular predetermined intervals are not permitted (except as defined in FCC 47 CFR 15.231(e) and ISED RSS-210 A1.1.4). 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 (2 s/h) for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed 2 s/h.
4. Intentional radiators which are employed for radio control purposes during emergencies involving fire, security of goods (e.g. burglar alarms), and safety-of-life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

FCC 47 CFR 15.231(e) and ISED RSS-210 A1.1.4

In additions, devices operated under these section shall be capable of automatically limiting their operation so that the duration of each transmission is not greater than 1 s and the silent period between transmission is at least 30 times the duration of the transmission, but not less than 10 s und all circumstances.



2.3.7 Test Results

General information on transmitter:

The transmitter is used for

- ☒ Security or safety applications
- ☐ other applications

- ☒ Declared by applicant
- ☐ Declared by applicant

The transmitter is operated

- ☐ manually
- ☒ automatically

- ☐ Declared by applicant ¹
- ☒ Declared by applicant

Periodic operation according to

CFR 47 Part 15, clause 15.231(a)
ISED RSS-210, Issue 10, Amd. 1, section A1.1

- ☒ Only control signals are sent and there is no continuous transmission.
- ☐ A manually operated transmitter employs a switch that will automatically deactivate the transmitter within not more than 5 s of being released.
- ☐ A transmitter activated automatically ceased transmission within 5 s after activation
- ☒ Periodic transmissions at regular predetermined intervals are:
 - ☐ not performed
 - ☒ performed with total time of two seconds per hour or less (for polling or supervision transmissions to determine system integrity of transmitters used in security or safety applications)

- ☒ Declared by applicant
- ☐ Test performed
- ☐ Passed
- ☐ Test performed
- ☐ Passed
- ☐ Declared by applicant
- ☐ Declared by applicant
- ☒ Test performed
- ☒ Passed

Periodic operation according to

CFR 47 Part 15, clause 15.231(e)
ISED RSS-210, Issue 10, Amd. 1, section A1.4

The device is 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 s.

- ☐ Test performed
- ☐ Passed

¹ Please refer to external photos in annex for details.



Test results:

The EUT provides to (test) modes: During “Drive Mode”, which represents normal operation, the EUT transmits 3 frames of 8.45 ms each 128 seconds. During “Alarm Mode” it transmits 3 frames of 8.45 ms each 8 seconds.

Measured time per frame: 8.841 ms

Drive mode

Transmitting time: 26.523 ms within 129.414 s:

Total transmitting time within an hour: 0.738 ms; Requirement passed.

Alarm mode

Transmitting time: 26.523 ms within 8.214203 s:

Total transmitting time within an hour: 11.624 s; Alarm mode is exempt from limitation to 2 seconds within an hour: Value noted.

2.3.8 Test Location and Test Equipment

The test was carried out in radio test lab

Instrument	Manufacturer	Type No	TE No	Calibra- tion Pe- riod (months)	Calibration Due
Signal and spectrum analysator	Rohde & Schwarz	FSV40	20219	24	2022-01

Table 9



2.4 Temperature Stability

2.4.1 Specification Reference

ISED RSS-Gen, Clause 6.11, 8.11

2.4.2 Equipment under Test and Modification State

18137; S/N 94E60983; Modification State 0

2.4.3 Date of Test

2021-02-18

2.4.4 Environmental Conditions

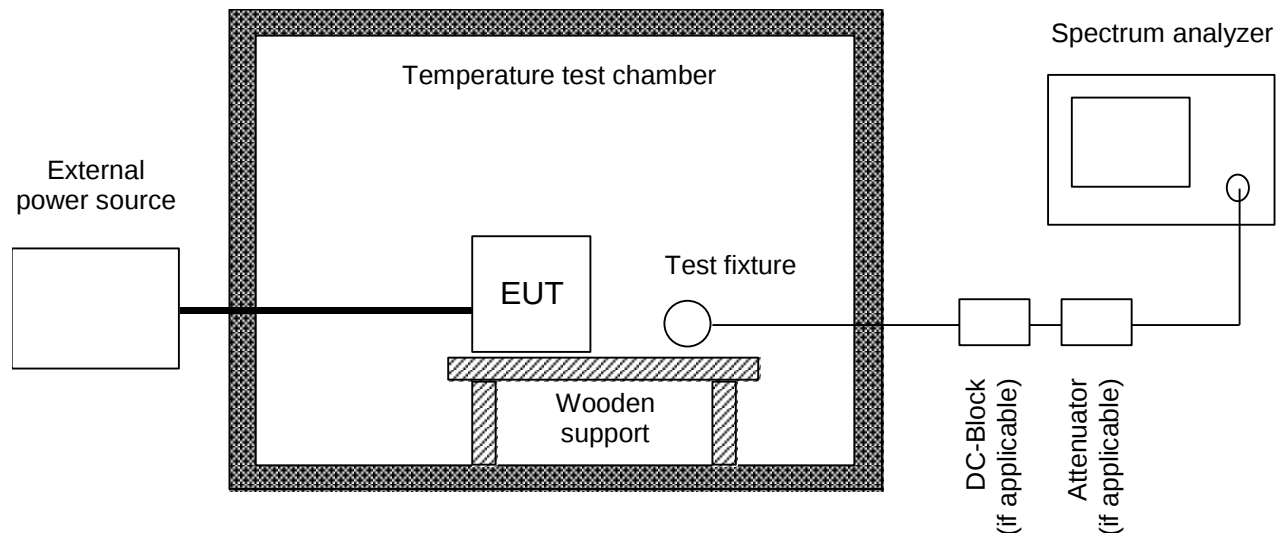
Ambient Temperature	22 °C
Relative Humidity	30 %

2.4.5 Specification Limits

If the stability of the license-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80 % of its permitted operating frequency band in order to minimize the possibility of out-of-band operation. In addition, its occupied bandwidth shall be entirely outside the restricted bands and the prohibited TV bands of 85 MHz – 72 MHz, 76 MHz – 88 MHz, 174 MHz – 216 MHz, and 470 MHz – 602 MHz, unless otherwise indicated.

2.4.6 Test Method

The test was performed according to ANSI C63.10, section 6.8.



The frequency tolerance of the carrier signal is measured over a temperature variation of -20 °C to +50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20 °C. Temperature and voltage range may vary if the manufacturer states another temperature or voltage range.

If the EUT provides an antenna connector the spectrum analyzer is connected to this port. If required, a resistive matching network equal to the impedance specified or employed for the antenna is used as well as a DC block and appropriate (50 Ω) attenuators. In case where the EUT does not provide an antenna connector or a test fixture is used.

For battery operated equipment, the test is performed using a new battery. Alternatively, an external supply voltage can be used and is at least set to:

- The maximum battery voltage as delivered by a new battery or 115 % of the battery nominal voltage;
- The battery nominal voltage
- 85 % of the battery nominal voltage
- The battery operating end point voltage which shall be specified by the equipment manufacturer.

The EUT is operating providing an unmodulated carrier for frequency error tests. The peak detector of the spectrum analyzer is selected and resolution as well as video bandwidth are set to values appropriate to shape of the spectrum of the EUT. The frequency counter mode of the spectrum analyzer is used to maximize the accuracy of the measured frequency tolerance.

If an unmodulated carrier is not available a significant and stable point of the spectrum is selected and the span is reduced to a value that delivers an accuracy which shall be better than 1 % of the maximum frequency tolerance allowed for the carrier signal. This method may be performed as long as the margin to the frequency tolerance is larger than the uncertainty of the measured frequency tolerance.



2.4.7 Test Results

The test was performed with a new battery

<i>Temperature</i>	<i>Frequency</i>	<i>Frequency drift</i>
-20 °C	433.9175900 MHz	15.459 ppm
20 °C	433.9108822 MHz	0.000 ppm
50 °C	433.9035291 MHz	-16.946 ppm

Table 10

2.4.8 Test Location and Test Equipment

The test was carried out in radio test lab

Instrument	Manufacturer	Type No	TE No	Calibra- tion Pe- riod (months)	Calibration Due
Signal and spectrum analysator	Rohde & Schwarz	FSV40	20219	24	2022-01
Climatic test chamber	Feutron	KPK200-2	19868	36	2023-02

Table 11



2.5 Radiated emissions

2.5.1 Specification Reference

FCC 47 CFR Part 15 C, Clauses 15.205, 15.209 and 15.231(a)
ISED RSS-231, Clause A.1.1
ISED RSS-Gen, Clauses 8.9 and 8.10

2.5.2 Equipment under Test and Modification State

18137; S/N 94E60983; Modification State 0

2.5.3 Date of Test

2021-02-17

2.5.4 Environmental Conditions

Ambient Temperature 23 °C
Relative Humidity 27 %

2.5.5 Specification Limits

General radiated emission limits:					
Frequency Range (MHz)	Test distance (m)	Field strength		Field strength	
		($\mu\text{A}/\text{m}$)	(dB $\mu\text{A}/\text{m}$)	($\mu\text{V}/\text{m}$)	(dB $\mu\text{V}/\text{m}$)
0.009 – 0.49	300	6.37 / f	20*lg(6.37 / f)	2400 / f	20*lg(2400 / f)
0.49 – 1.705	30	63.7 / f	20*lg(63.7 / f)	24000 / f	20*lg(24000 / f)
1.705 - 30	30	0.08	20*lg(0.08 / f)	30	20*lg(30 / f)
30 – 88	3	---	---	100	40
88 – 216	3	--	---	150	43.5
126 – 960	3	--	---	200	46
above 960	3	--	---	500	54
Note 1: f in kHz					

Table 12 General radiated emission limits



FCC 47 CFR Part 15 C, Clause 15.231(a); ISED RSS-231, Clause A.1.1

Frequency Range (MHz)	Field strength of fundamental		Field strength of spurious emissions	
	($\mu\text{V/m}$)	(dB $\mu\text{V/m}$)	($\mu\text{V/m}$)	(dB $\mu\text{V/m}$)
40.66 – 40.70	2500	67.96	225	47.96
70 – 130	1250	61.94	125	41.94
130 – 174	1250 – 3750 *	61.94 – 71.48 *	125 – 375 *	41.94 – 51.48 *
174 – 260	3750	71.48	375	51.48
260 – 470	3750 – 12500 *	71.48 – 81.94 *	375 – 1250 *	51.48 – 61.94 *
Above 470	12500	81.94	1250	61.94

* linear interpolation

The above field strength limits are specified at a distance of 3 m. The tighter limits apply at the band edges.

Intentional radiators shall demonstrate compliance with the limits above based on the (linear) average value of the measured emissions. As an alternative, compliance with these limits may be based on the use of measurement instrumentations with a CISPR quasi-peak detector. If average emission measurements are employed, the provisions for averaging pulsed emissions and for limiting peak emissions apply.

The limits on the field strength of the spurious emissions in the 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 spurious emission limits, whichever limit permits a higher field strength.

FCC 47 CFR Part 15 C, Clause 15.231(e); ISED RSS-231, Clause A.1.4

Frequency Range (MHz)	Field strength of fundamental		Field strength of spurious emissions	
	($\mu\text{V/m}$)	(dB $\mu\text{V/m}$)	($\mu\text{V/m}$)	(dB $\mu\text{V/m}$)
40.66 – 40.70	1000	60	100	40
70 – 130	500	53.98	50	33.98
130 – 174	500 – 1500 *	53.98 – 63.52 *	50 – 150 *	33.98 – 43.52
174 – 260	1500	63.52	150	43.52
260 – 470	1500 – 5000 *	63.52 – 73.98 *	150 – 500 *	43.52 – 53.98
Above 470	5000	73.98	500	53.98

* linear interpolation

The above field strength limits are specified at a distance of 3 m. The tighter limits apply at the band edges.

Intentional radiators shall demonstrate compliance with the limits above based on the (linear) average value of the measured emissions. As an alternative, compliance with these limits may be based on the use of measurement instrumentations with a CISPR quasi-peak detector. If average emission measurements are employed, the provisions for averaging pulsed emissions and for limiting peak emissions apply.

The limits on the field strength of the spurious emissions in the 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 spurious emission limits, whichever limit permits a higher field strength.

2.5.6 Test Method

The test was performed according to ANSI C63.10, sections 11.11 and 11.12

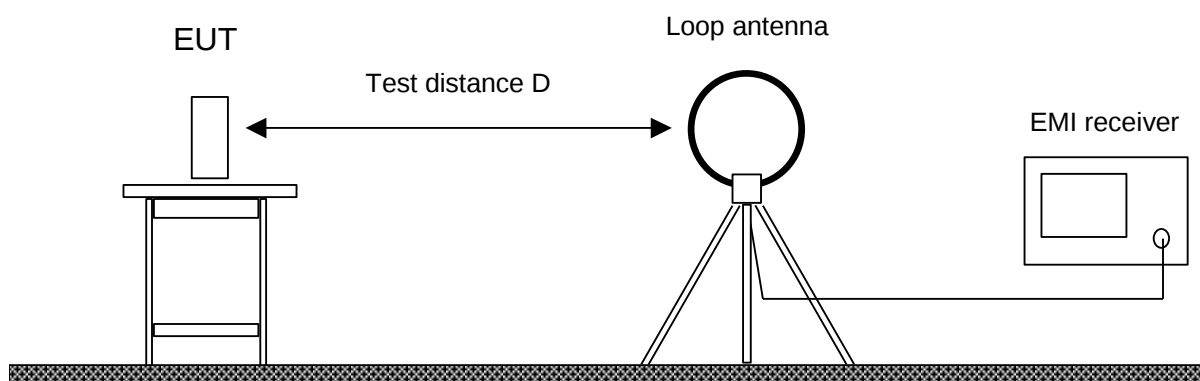
Prescans are performed in six positions of the EUT to get the full spectrum of emission caused by the EUT with the measuring antenna raised and lowered from 1 m to 4 m with vertical and horizontal polarisation to find the combination of table position, antenna height and antenna polarisation for the maximum emission levels.

Data reduction is applied to these results to select those levels having less margin than 10 dB or exceeding the limit using subranges and limited number of maximums.

Further maximisation for adjusting the maximum position is following.

Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

2.5.6.1 Frequency range 9 kHz – 30 MHz

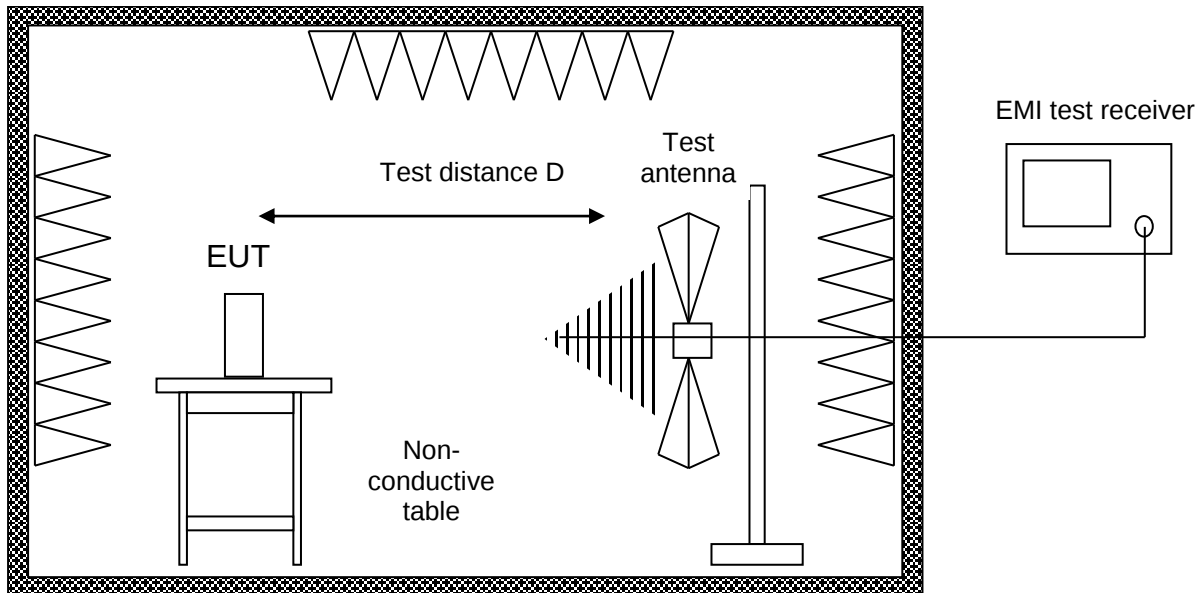


The EUT was placed on a non-conductive table, 0.8 m above the ground.

Radiated emissions in the frequency 9 kHz – 30 MHz is measured within a semi-anechoic room with an active loop antenna with the measurement detector set to peak. In addition in the frequency range 9 kHz to 490 kHz also an average detector was used. The measurement bandwidth of the receiver was set to 300 Hz in the frequency range 9 kHz to 150 kHz and 10 kHz in the frequency range 150 kHz to 30 MHz. Prescans were performed in six positions of the EUT.

For final measurements the detector was set to CISPR quasi-peak and in addition to CISPR average in the frequency range 9 kHz to 490 kHz with a resolution bandwidth 200 Hz in the frequency range 9 kHz to 150 kHz and 9 kHz in the frequency range 150 kHz to 30 MHz. Final tests were performed immediately after a final frequency and zoom (for drifting disturbances) and maximum adjustment.

2.5.6.2 Frequency range 30 MHz – 1 GHz



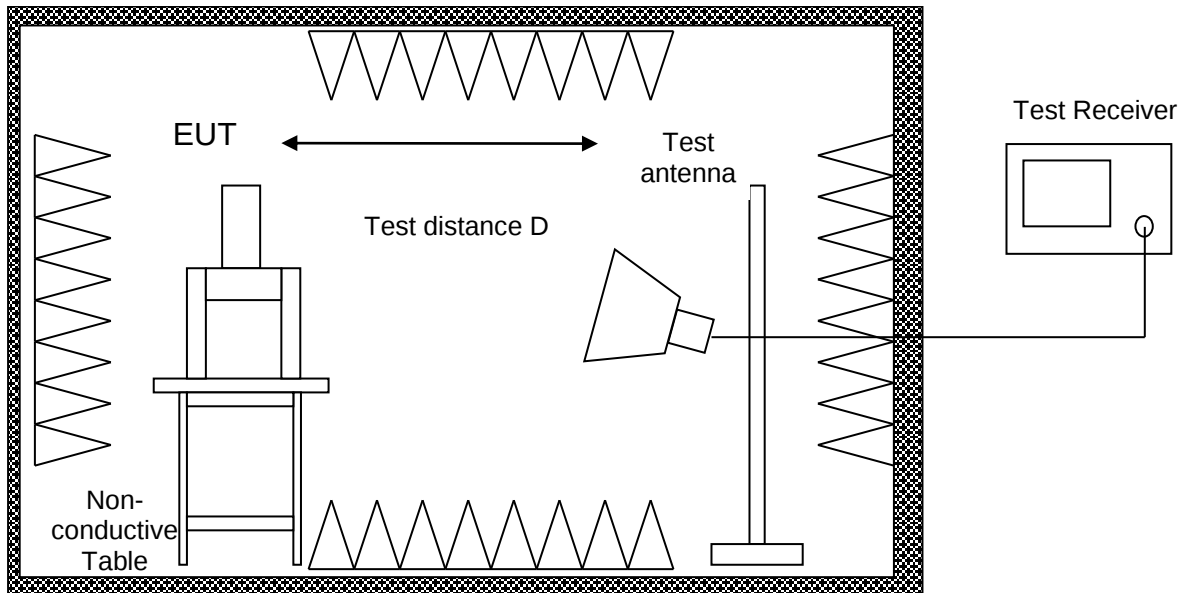
Alternate test site (semi anechoic room)

The EUT was placed on a non-conductive table, 0.8 m above the ground plane. Radiated emissions in the frequency range 30 MHz – 1 GHz are measured within a semi-anechoic room with a groundplane complying with the NSA requirements of ANSI C63.4. for alternative test sites. A linear polarised logarithmic periodic antenna combined with a 4:1 broadband dipole ("Trilog broadband antenna") is used.

For prescan tests the test receiver is set to peak-detector with a bandwidth of 120 kHz.

With the measurement bandwidth of the test receiver set to 120 kHz CISPR quasi-peak detector is selected for final measurements following immediately after a final frequency zoom (for drifting disturbances) and maximum adjustment.

2.5.6.3 Frequency range above 1 GHz



Fully anechoic room

The EUT was placed on a non-conductive table, 1.5 m above the ground plane

Radiated emission tests above 1 GHz are performed in a fully anechoic room with the S_{VSWR} requirements of ANSI C63.4. Measurements are performed both in the horizontal and vertical planes of polarisation using a test receiver with the detector function set to peak and average and the resolution bandwidth set to 1 MHz. Testing above 1 GHz is performed with horn antennas with the EUT in boresight of the antenna.

For prescan tests the test receiver is set to peak- and average-detector with a bandwidth of 1 MHz.

With the measurement bandwidth of the test receiver set to 1 MHz and peak- and CISPR average-detector is selected for final measurements following immediately after a final frequency zoom (for drifting disturbances) and maximum adjustment.



2.5.7 Test Results

Frequency range	Limit applied	Test distance
9 kHz – 5 GHz	FCC 47 CFR Part 15 C, Clause 15.231(a); ISED RSS-231, Clause A.1.1	3 m

Table 13

Sample calculation:

$$\text{Final Value (dB}\mu\text{V/m)} = \text{Reading Value (dB}\mu\text{V)} + (\text{Cable attenuation (dB)} + \text{Antenna Transducer (dB(1/m)))}$$

Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBμV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBμV/m)	Limit (dBμV/m)	Margin (dB)
30.240	vertical	Quasi-Peak	10.2	24.5		34.7	60.8	26.2
59.880	vertical	Quasi-Peak	5.3	11.5		16.8	60.8	44.1
433.920	horizontal	Quasi-Peak	57.8	22.8		80.6	80.8	0.2
869.010	horizontal	Quasi-Peak	4.0	29.4		33.4	60.8	27.5
3037.530	vertical	Average	18.5	35.2		53.7	60.8	7.2
3037.530	vertical	Peak	24.3	35.2	0.0	59.5	74.0	14.5
3471.430	vertical	Average	12.0	36.4	0.0	48.4	60.8	12.4
3471.430	vertical	Peak	20.9	36.4	0.0	57.3	74.0	16.7
3905.400	vertical	Average	13.6	37.9	0.0	51.5	55.0	3.5
3905.400	vertical	Peak	21.1	37.9	0.0	59.0	74.0	15.0

2.5.8 Test Location and Test Equipment

The test was carried out in semi-anechoic room No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	2021-03	2022-03
Loop antenna	Schwarzbeck	FMZB 1519 B	44334	2023-01	2020-01
ULTRALOG antenna	Rohde & Schwarz	HL562E	39969	2022-03	2021-03
Fixed attenuator	Aeroflex / Weinschel	Model 1: 6 dB	39632	2019-11	2022-11
Double ridged waveguide horn antenna	EMCO	3115	19383	2020-03	2023-03
EMC measurement software	Rohde & Schwarz	EMC32 V10.50.10	42986		

Table 14



2.6 RF Exposure

2.6.1 Specification Reference

FCC 47 CFR Part 2 J, Clause 2.1093
KDB 447498 D01 V06, section 4.3.1
ISED RSS-Gen, Clause 3.4
ISED RSS-102, Clause

2.6.2 Equipment under Test and Modification State

18137; S/N 94E60983; Modification State 0

2.6.3 Date of Test

2021-02-17

2.6.4 Environmental Conditions

Ambient Temperature	23 °C
Relative Humidity	27 %

2.6.5 Test Method

Estimation is based on output power test.
For details please refer to section 2.3.5 of this test report.

2.6.6 Specification Limits

FCC 47 CFR Part 15 C

Systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy levels in excess of the Comission's guideline.
Acc. to KDB 477498:

The 1 g and 10 g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separations distances ≤ 50 mm are determined by:

$$\frac{\text{max. power of channel, incl. tune - up tol., mW}}{\text{min. test separation distance, mm}} \cdot \sqrt{f, \text{GHz}} \leq \begin{cases} 3.0 & \text{for 1 g} \\ 7.5 & \text{for 10 g} \end{cases} \text{ extremity SAR}$$

1. f (GHz) is the RF channel frequency in GHz;
2. Power and distance are rounded to the nearest mW and mm before calculation;
3. The result is rounded to one decimal place for comparison;
4. 3.0 and 7.5 are referred to as the numeric thresholds



The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm, and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied.

ISED RSS-102, Clause 2.5.1

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in the table.

For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in the table, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

For medical implants devices, the exemption limit for routine evaluation is set at 1 mW. The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.:

Frequency (MHz)	Exemption limits (mW) ² at separation distance of									
	≤ 5 mm	10 mm	15 mm	20 mm	25 mm	30 mm	35 mm	40 mm	45 mm	≥ 50 mm
≤ 300 ³	71	101	132	162	193	223	254	284	315	345
450	52	70	88	106	123	141	159	177	195	213
835	17	30	42	55	67	80	92	105	117	130
1900	7	10	18	34	60	99	153	225	316	431
2450	4	7	15	30	52	83	123	173	235	309
3500	2	6	16	32	55	86	124	170	225	290
5800	1	6	15	27	41	56	71	85	97	106

² The exemption limit in the table are based on measurements and simulations on half-wave dipole antennas at separation distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.

³ Transmitters operating between 3 kHz and 10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in IC RSS-102, issue 5, section 4.



2.6.7 Test Results

$$EIRP = P_{tx} \cdot G_{tx} = \frac{4 \pi d^2 E^2}{Z_0}$$

E = 80.6 dBμV/m = 10.715 mV/m

d = 3 m

EIRP = 34.44 μW = -14.63 dBm

FCC 47 CFR Part 15 C, Clause 15.247(i)

<i>Maximum output power:</i>	0.03 mW
<i>Minimum test separation distance:</i>	50 mm
<i>Frequency:</i>	0.433 GHz
<i>SAR test exclusion threshold (calculated):</i>	0.0004
<i>Limit (1 g SAR):</i>	3.0
<i>Limit (10 g SAR):</i>	7.5
<i>Test Result:</i>	Pass

ISED RSS-Gen, Clause 3.4

<i>Frequency:</i>	433.92 MHz
<i>Test distance:</i>	3 m
<i>Carrier Power (e.i.r.p.):</i>	34.44 μW
<i>Exemption limit:</i>	345 mW
<i>Test Result:</i>	Pass



3 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

The measurement uncertainty in the laboratory is less than or equal to the maximum measurement uncertainty according to CISPR16-4-2: 2011 + A1 + A2 + Cor1 (U_{CISPR}). This normative regulation means that the measured value is also the value to be assessed in relation to the limit value.

<i>Radio Interference Emission Testing</i>		
<i>Test Name</i>	<i>kp</i>	<i>Expanded Uncertainty</i>
Conducted Voltage Emission		
9 kHz to 150 kHz (50Ω/50μH AMN)	2	± 3.8 dB
150 kHz to 30 MHz (50Ω/50μH AMN)	2	± 3.4 dB
100 kHz to 200 MHz (50Ω/5μH AMN)	2	± 3.6 dB
Discontinuous Conducted Emission		
9 kHz to 150 kHz (50Ω/50μH AMN)	2	± 3.8 dB
150 kHz to 30 MHz (50Ω/50μH AMN)	2	± 3.4 dB
Conducted Current Emission		
9 kHz to 200 MHz	2	± 3.5 dB
Magnetic Fieldstrength		
9 kHz to 30 MHz (with loop antenna)	2	± 3.9 dB
9 kHz to 30 MHz (large-loop antenna 2 m)	2	± 3.5 dB
Radiated Emission		
30 MHz to 300 MHz	2	± 4.9 dB
300 MHz to 1 GHz	2	± 5.0 dB
1 GHz to 6 GHz	2	± 4.6 dB
Test distance 10 m		
30 MHz to 300 MHz	2	± 4.9 dB
300 MHz to 1 GHz	2	± 4.9 dB
The expanded uncertainty reported according to CISPR16-4-2: 2011 + A1 + A2 + Cor1 is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2$, providing a level of confidence of $p = 95.45\%$		

Table 15 Measurement uncertainty based on CISPR 16-4-2



<i>Radio Interference Emission Testing</i>		
<i>Test Name</i>	<i>kp</i>	<i>Expanded Uncertainty</i>
Occupied Bandwidth	2	± 5 %
Conducted Power		
9 kHz ≤ f < 30 MHz	2	± 1.0 dB
30 MHz ≤ f < 1 GHz	2	± 1.5 dB
1 GHz ≤ f ≤ 40 GHz	2	± 2.5 dB
1 MS/s power sensor (TS8997)	2	± 1.5 dB
Occupied Bandwidth	2	± 5 %
Power Spectral Density	2	± 3.0 dB
Radiated Power		
9 kHz ≤ f < 26.5 GHz	2	± 6.5 dB
26.5 GHz ≤ f < 60 GHz	2	± 8.0 dB
60 GHz ≤ f < 325 GHz	2	± 10 dB
Conducted Spurious Emissions	2	± 3.0 dB
Radiated Spurious Emissions	2	± 6.0 dB
Voltage		
DC	2	± 1.0 %
AC	2	± 2.0 %
Time (automatic)	2	± 5 %
Frequency	2	± 10 ⁻⁷
The expanded uncertainty reported according to to ETSI TR 100 028:2001 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%		

Table 16 Measurement uncertainty based on ETSI TR 100 028