

Test Report

Report Number:

F210861E3

Equipment under Test (EUT):

Marker Mini

Applicant:

TRUMPF Tracking Technologies

Manufacturer:

WEPTech elektronik GmbH



Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

- [1] **ANSI C63.10-2013**, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- [2] **FCC CFR 47 Part 15**, Radio Frequency Devices
- [3] **558074 D01 15.247 Meas Guidance v05r02 (April 2019)**, GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES

Test Result

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test. The complete test results are presented in the following.

Tested and written
by:

Signature

Reviewed and
approved by:

Signature

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The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

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1 Identification

1.1 Applicant

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Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	WEPTech elektronik GmbH
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Country:	Germany
Name for contact purposes:	Mr. Jochen RIGA
Phone:	+49 63 41 92 55 - 331 / +49 160 97 72 58 61
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Applicant represented during the test by the following person:	-

1.3 Test Laboratory

The tests were carried out by: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

Accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-05 and D-PL-17186-01-06, FCC Test Firm Accreditation designation number DE0004, FCC Test Firm Registration Number 469623.

1.4 EUT (Equipment under Test)

EUT	
Test object: *	Tag for indoor localization
PMN / Model name: *	Marker Mini
FCC ID: *	2A2TP-2677368

* Declared by the applicant

	EUT number		
	1	2	3
Serial number: *	1910154B00301EAA	-	-
PCB identifier: *	E001-3233-02	-	-
Hardware version: *	V1.0.0	-	-
Software version: *	3.3.2	-	-

Note: PHOENIX Testlab GmbH does not take samples. The samples used for the tests are provided exclusively by the applicant.

1.5 Technical Data of Equipment

General EUT data			
Power supply EUT: *	Lithium battery 3.7 V / 2400 mAh		
Supply voltage EUT: *	U _{Nom} = 3.7 V _{DC}	U _{Min} = 3.1 V _{DC}	U _{Max} = 4.2 V _{DC}
Temperature range: *	-10 °C to +55 °		
Lowest / highest internal clock frequency: *	32 kHz / 4500 MHz		

Ports / Connectors				
Identification	Connector		Length during test	Shielding (Yes / No)
	EUT	Ancillary		
	No ports / connectors are available.			

Bluetooth® Low Energy radio mode			
Fulfills radio specification: *	Bluetooth® Low Energy 4.2 (1 Mbit/s only)		
Radio chip: *	Nordic nRF52840		
Antenna type: *	Internal PCB antenna		
Antenna name: *	ANT		
Antenna gain: *	2 dBi		
Antenna connector: *	none		
Type of modulation: *	BLE 1 Mbit/s	GFSK (1 Mbit/s)	
Operating frequency range: *	BLE 1 Mbit/s	2402 – 2480 MHz	
Number of channels: *	BLE 1 Mbit/s	40 (2 MHz channel spacing)	

Bluetooth® Low Energy frequencies				
Channel 0	RX	2402 MHz	TX	2402 MHz
Channel 1	RX	2404 MHz	TX	2404 MHz
...
Channel 19	RX	2440 MHz	TX	2440 MHz
...
Channel 38	RX	2478 MHz	TX	2478 MHz
Channel 39	RX	2480 MHz	TX	2480 MHz

UWB radio part	
Rated rf-output power: *	-41.3 dBm (e.i.r.p.)
Antenna type: *	Internal PCB antenna
Antenna gain: *	2dBi
Antenna connector: *	None

Channel 1	$f_c = 3.575$ GHz, 500 MHz bandwidth
Channel 2	$f_c = 4.000$ GHz, 500 MHz bandwidth
Channel 3	$f_c = 4.500$ GHz, 500 MHz bandwidth

1.5.1 Ancillary Equipment / Equipment used for testing

Equipment used for testing	
-	-

Ancillary equipment	
-	-

1.6 Dates

Date of receipt of test sample:	17.05.2021
Start of test:	05.11.2021
End of test:	05.11.2021

2 Operational States

2.1 Description of function of the EUT

The EUT is intended to be used as transceiver for locating of machine tools inside a factory building. It will be mounted onto machines.

2.2 The following states were defined as the operating conditions

All radiated tests were carried out with an unmodified test sample powered by an internal battery. The EUT was setup with a special firmware, where the applicable radio modes were active.

Operation mode #	Radio technology	Frequency [MHz]	Channel / Band	Modulation / Mode	Data rate	TX / RX	EUT #	Power setting
1	Bluetooth® LE	2402	0	GFSK	1 Mbit/s	TX	1	Not settable
1	UWB	4000	Ch2	-	-	TX	1	Not settable

3 Additional Information

This test report contains only the results of the Simultaneous transmission of the EUT.

F210861E1 contains: UWB relevant results
 F210861E2 contains: BLE relevant results
 F210861E3 contains: Simultaneous transmission of BLE and UWB relevant results

The tested sample was not labeled as required by the FCC.

The tests were done with an unmodified sample.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	Status	EUT
Maximum unwanted emissions	1,000 – 40,000	15.247 (d) 15.205 (a) 15.209 (a)	Passed	1

5 Results

5.1 Test setup

5.1.1 Test Setup (radiated)

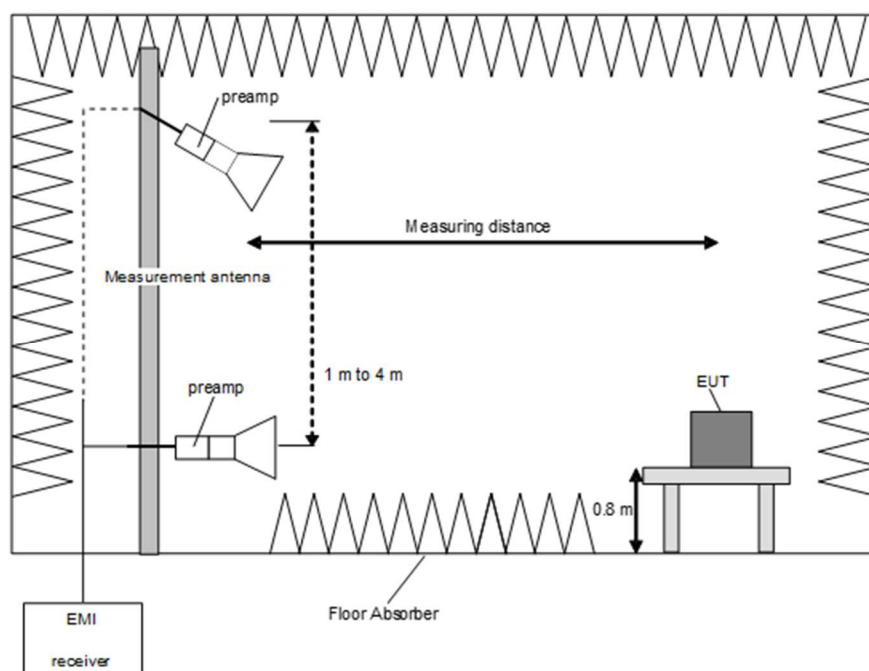
5.1.2 Radiated: 1 GHz to 40 GHz

The preliminary and final measurements are performed in a semi-anechoic chamber at a measuring distance of 3 meters, with floor absorbers between EUT and measuring antenna. Table-top devices are set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices are placed directly on the turntable / ground plane. The setup of the equipment under test is in accordance with [1].

During the tests the EUT is rotated in the range of 0 ° to 360 °, the measuring antenna is set to horizontal and vertical polarization and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions. While changing the height, the measuring antenna gets tilted so that it is always aiming at the EUT.

The resolution bandwidth of the EMI receiver is set to the following values:

Test	Frequency range	Step-size	Resolution bandwidth	Measuring time	Detector
Preliminary measurement	1 - 40 GHz	250 kHz	1 MHz	-	Peak Average
Frequency peak search	+ / - 1 MHz	50 kHz	1 MHz	100 ms	Peak
Final measurement	1 - 40 GHz	-	1 MHz	100 ms	Peak Average



Procedure preliminary measurement:

The following procedure is used:

- 1) Set the measuring antenna to 1 m height.
- 2) Monitor the frequency range at horizontal polarization of the measuring antenna and an EUT / turntable azimuth of 0 °.
- 3) Rotate the EUT by 360° to maximize the detected signals.
- 4) Repeat steps 2 to 3 with the vertical polarization of the measuring antenna.
- 5) Increase the height of the measuring antenna for 0.5 m and repeat steps 2 to 4 until the final height of 4 m is reached.
- 6) The highest values for each frequency are saved by the software, including the measuring antenna height and polarization and the turntable azimuth for that value.

Procedure final measurement:

The following procedure is used:

- 1) Select the highest frequency peaks (lowest margin to the limit) for the final measurement.
- 2) The software determines the exact peak frequencies by doing a partial scan with reduced step size of the pre-scan of the selected peaks.
- 3) If the EUT is portable or ceiling mounted, find the worst-case EUT orientation (x,y,z) for the final test.
- 4) The worst-case measuring antenna height is found via varying the height by +/- 0.5 m from the value obtained in the preliminary measurement while monitoring the emission level.
- 5) The worst-case turntable position is found via varying the turntable azimuth by +/- 30° from the value obtained in the preliminary measurement while monitoring the emission level.
- 6) The final measurement is performed at the worst-case measuring antenna height and the worst-case turntable azimuth.
- 7) Steps 2 to 6 are repeated for each frequency peak selected in step 1.

5.2 Maximum unwanted emissions

5.2.1 Test setup (Maximum unwanted emissions)

Test setup (Maximum unwanted emissions)			
Used	Setup	See sub-clause	Comment
<input checked="" type="checkbox"/>	Test setup (radiated)	5.1.1	

5.2.2 Test method (Maximum unwanted emissions)

☒ Test method (radiated) see sub-clause 5.1.1 as described herein

5.2.3 Test results (Maximum unwanted emissions)

5.2.3.1 Test results (above 1 GHz)

Ambient temperature:	22 °C
Relative humidity:	32 %

Date	05.11.2021
Tested by	B. ROHDE

Position of EUT: For tests for f between 1 GHz and the 10th harmonic, the EUT was set-up on a positioner device with a height of 150 cm. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in the annex A in the test report.

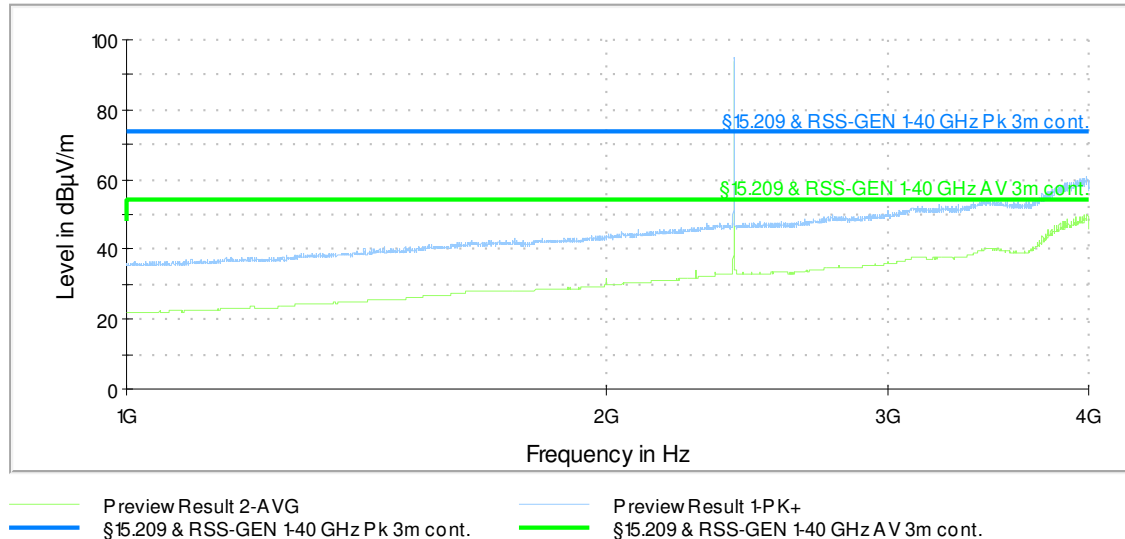
Test record: Plots for each frequency range are submitted below.

Remark:

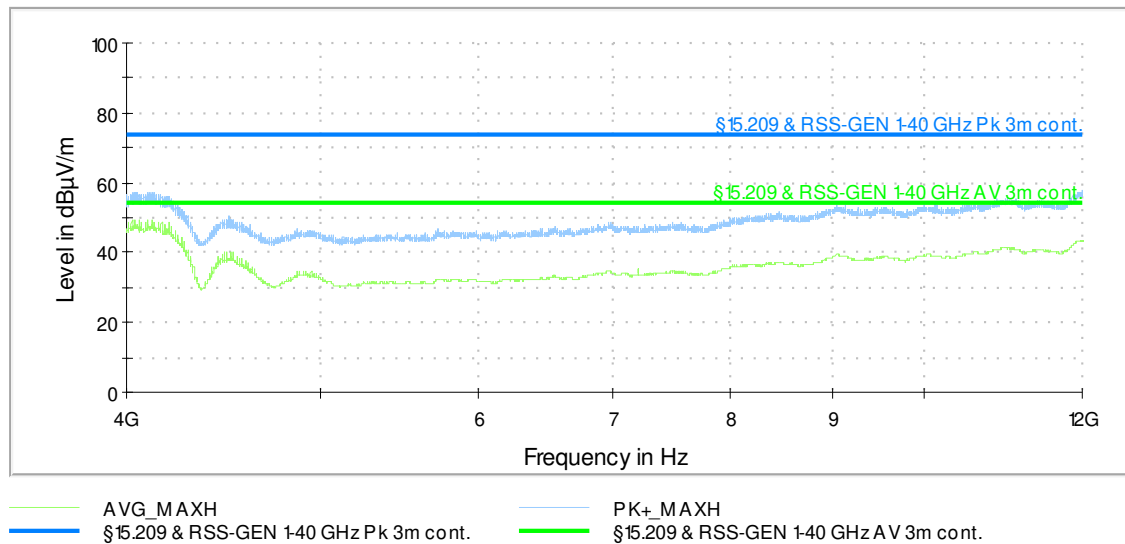
$$\begin{aligned} \text{Max Peak [dB}\mu\text{V/m]} &= \text{Reading [dB}\mu\text{V]} + \text{Correction [dB}\mu\text{V/m]} \\ \text{Average [dB}\mu\text{V/m]} &= \text{Reading [dB}\mu\text{V]} + \text{Correction [dB}\mu\text{V/m]} \\ \text{Correction [dB}\mu\text{V/m]} &= \text{AF [dB/m]} + \text{Cable attenuation [dB]} + \\ &\quad \text{optional preamp gain [dB]} + \text{DCCF [dB]} \text{ (if applicable)} \\ \text{Margin [dB]} &= \text{Limit [dB}\mu\text{V/m]} - \text{Max Peak // Average [dB}\mu\text{V/m]} \end{aligned}$$

5.2.3.1.1 Worst case plot:

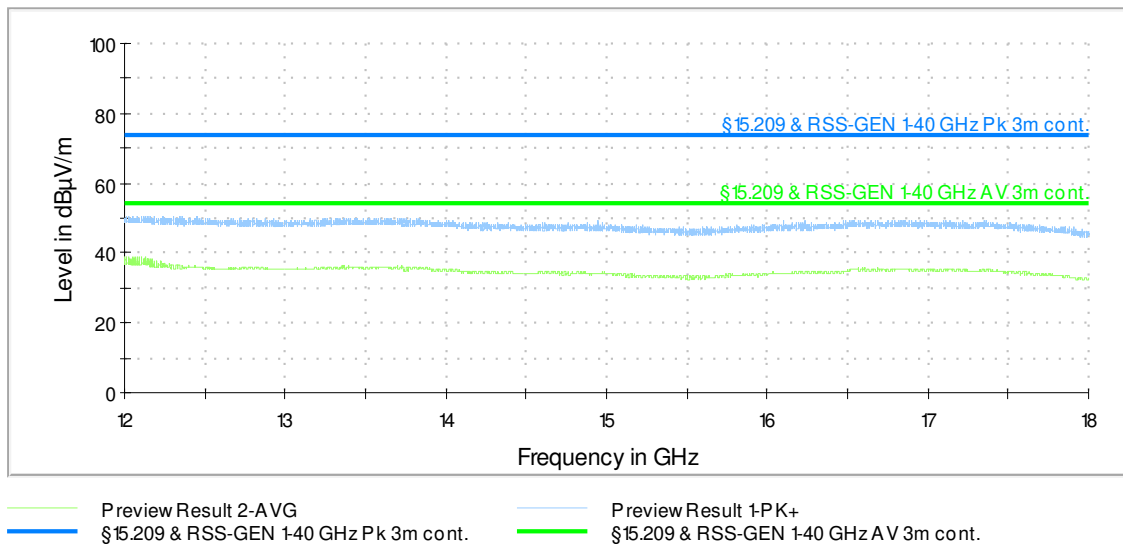
Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



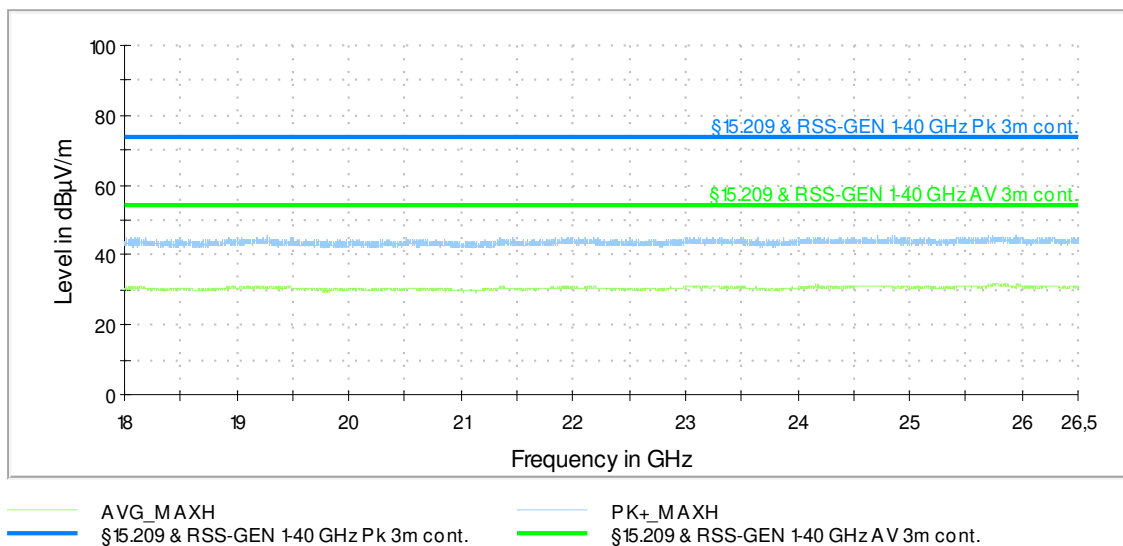
Spurious emissions from 4 GHz to 12 GHz (operation mode 1):



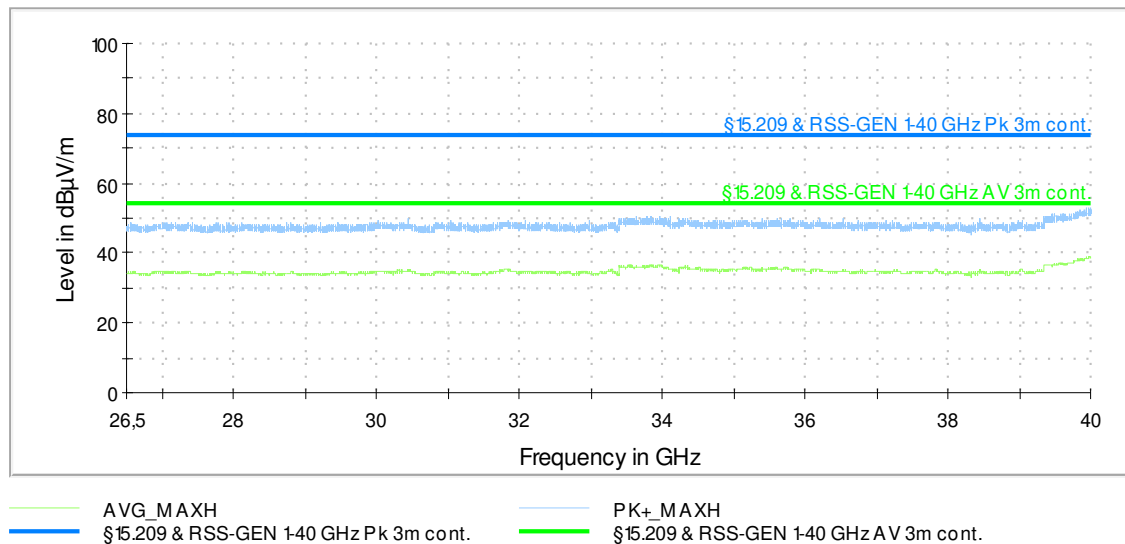
Spurious emissions from 12 GHz to 18 GHz (operation mode 1):



Spurious emissions from 18 GHz to 26.5 GHz (operation mode 1):



Spurious emissions from 26.5 GHz to 40 GHz (operation mode 1):



5.2.3.1.2 Result tables

5.2.3.1.2.1 (operation mode 1):

Frequency [MHz]	MaxPeak [dBμV/m]	Average [dBμV/m]	Limit [dBμV/m]	Margin (dB)	Reading [dBμV]	Corr. [dB/m]	Elevation [deg]	Azimuth [deg]	Pol	Comment
No significant emissions related to the simultaneous transmission found										
Measurement uncertainty					+/- 5.9 dB					

Test equipment (please refer to chapter 6 for details)

1 - 17

6 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Log.-Per. antenna	HL050	Rohde & Schwarz	100908	482977	13.08.2019	08.2022
2	RF Switch Matrix	OSP220	Rohde & Schwarz		482976	Calibration not necessary	
3	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
4	Antennasupport	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
5	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
6	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
7	Measuring software EMC32 M276	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
8	EMI Test receiver	ESW44	Rohde & Schwarz	101828	482979	14.11.2019	11.2021
9	Low Noise Amplifier 100 MHz - 18 GHz	LNA-30-00101800-25-10P	Narda-Miteq	2110917	482967	18.02.2020	02.2022
10	Low Noise Amplifier 12 GHz - 18 GHz	LNA-30-12001800-13-10P	Narda-Miteq	2089798	482968	Calibration not necessary	
11	Standard Gain Horn 20 dB, 12 GHz-18 GHz	18240-20	Flann	267220	483025	Calibration not necessary	
16	Low Noise Amplifier 18 GHz - 26.5 GHz	LNA-30-18002650-20-10P	Narda-Miteq	2110911	482969	17.02.2020	02.2022
17	Standard Gain Horn 20 dB, 18 GHz -26 GHz	20240-20	Flann	266399	483026	Calibration not necessary	

7 Test site Validation

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
Semi anechoic chamber M276	483227	1 -18 GHz	SVSWR	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	25.02.2021	24.02.2023

8 Report History

Report Number	Date	Comment
F210861E3	01.03.2022	Initial Test Report
-	-	-
-	-	-

9 List of Annexes

Annex A Test Setup Photos

5 pages