Engineering Test Report No. 2104195-01 Rev. A		
Report Date	December 21, 2021	
Manufacturer Name	Otto Engineering	
Manufacturer Address	10 West Main Street Carpentersville, IL 60110	
Model No.	OTTOVL01	
Date Received	November 15, 2021	
Test Dates	November 15 – 19, 2021	
Specifications	FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 Innovation, Science, and Economic Development Canada, RSS-247 Innovation, Science, and Economic Development Canada, RSS-GEN	
Test Facility	Elite Electronic Engineering, Inc. 1516 Centre Circle, Downers Grove, IL 60515	FCC Reg. Number: 269750 IC Reg. Number: 2987A CAB Identifier: US0107
Signature		
Tested by	Tylar Jozefczyk	
Signature		
Approved by	Raymond J. Klouda, Registered Professional Engineer of Illinois – 44894	
PO Number	P000070028	

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1. Report Revision History

Revision	Date	Description
–	28 DEC 2021	Initial Release of Engineering Test Report No. 2104195-01
A	7 JAN 2022 by TMJ	- Engineering Test Report number updated from 2104195-01 to 2104195-01 Rev. A throughout report. - Model No. has been changed from “OTTO VL10000 Series” to “OTTOVL01” throughout report.

2. Introduction

2.1. Scope of Tests

This document presents the results of a series of RF emissions tests that were performed on the Lynq-PRO Handheld GPS/LoRa/BT device (hereinafter referred to as the Equipment Under Test (EUT)). The EUT was manufactured and submitted for testing by Otto Engineering located in Carpentersville, IL.

2.2. Purpose

The test series was performed to determine if the EUT meets the RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.247 for a Frequency Hopping Spread Spectrum intentional radiator operating within the 902-928MHz band.

The test series was also performed to determine if the EUT meets the RF emission requirements of the Innovation, Science, and Economic Development Canada Radio Standards Specification RSS-Gen and Innovation, Science, and Economic Development Canada Radio Standards Specification RSS-247 for a Frequency Hopping Spread Spectrum intentional radiator operating within the 902-928MHz band.

Testing was performed in accordance with ANSI C63.10-2013.

2.3. Identification of the EUT

The EUT was identified as follows:

EUT Identification	
Product Description	Lynq-PRO Handheld GPS/LoRa/BT device
Model/Part No.	OTTOVL01
Serial No.	N/A
Size of EUT	2.30" x 4.25" x 1.11"
Device Type	Frequency Hopping Transmission Device
Band of Operation	902 – 928MHz
Modulation Type	LoRa
Software/Firmware Version	Host: v1.0.0.7 LoRA Module: V1.0.0.Q
Antenna Type	Omni-directional trace antenna
Antenna Gain (dBi) (Manufacturer Supplied*)	+0.9dB
Conducted Output Power	0.54W (27.36dBm)
Rated Output Power	1.425W (31.54dBm)
20dB Bandwidth	141.36kHz
Occupied Bandwidth (99% CBW)	193.5kHz

*- Antenna gain is supplied by the manufacturer and Elite is not responsible for the accuracy of the antenna gain.

The EUT listed above was used throughout the test series.

3. Power Input

The EUT was powered by internal batteries.

4. Grounding

The EUT was not connected to ground.

5. Support Equipment

The EUT was submitted for testing along with the following support equipment:

Equipment	Description
Laptop	Used to program the EUT into the needed test modes.

6. Interconnect Leads

The following interconnect cables were submitted with the test item:

Lead	Description
Micro-USB to USB cable	Connects laptop to EUT

7. Modifications Made to the EUT

No modifications were made to the EUT during the testing.

8. Modes of Operation

The EUT and all peripheral equipment were energized. The unit was programmed to transmit in one of the following modes:

Mode	Description
Tx	The EUT is programmed to transmit at one of the following frequencies: - 902.475MHz - 915.075MHz - 927.525MHz
Hopping	The EUT was programmed to hop in the 902 – 928MHz range.

9. Test Specifications

The tests were performed to selected portions of, and in accordance with the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 test specifications.

- Federal Communications Commission “Code of Federal Regulations”, Title 47, Part 15, Subpart C
- ANSI C63.4-2014, “American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz”
- ANSI C63.10-2013, “American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices”
- Federal Communications Commission Office of Engineering and Technology Laboratory Division, Guidance For Compliance Measurements On Digital Transmission Systems, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 April 2, 2019 KDB 558074 D01v05r02
- RSS-247 Issue 2, February 2017, “Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices”
- RSS-Gen Issue 5, March 2019, Amendment 1, Innovation, Science, and Economic Development Canada, “Spectrum Management and Telecommunications, Radio Standards Specification, General Requirements for Compliance of Radio Apparatus”

10. Test Plan

No test plan was provided. Instructions were provided by personnel from Otto Engineering and used in conjunction with the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247, Innovation, Science, and Economic Development Canada, RSS-247, and ANSI C63.4-2014 specifications.

11. Deviation, Additions to, or Exclusions from Test Specifications

There were no deviations, additions to, or exclusions from the test specifications during this test series.

12. Laboratory Conditions

The ambient parameters of the laboratory during testing were as follows:

Ambient Parameters	Value
Temperature	21.4°C
Relative Humidity	20%
Atmospheric Pressure	1010.58mb

13. Summary

The following EMC tests were performed, and the results are shown below:

Test Description	Requirements	Test Methods	Results
20dB Bandwidth	FCC 15C 15.247 ISED RSS-247	ANSI C63.10:2013	Conforms
Occupied Bandwidth (99%)	FCC 15C 15.247 ISED RSS-247	ANSI C63.10:2013	Conforms
Carrier Frequency Separation	FCC 15C 15.247 ISED RSS-247	ANSI C63.10:2013	Conforms
Number of Carrier Channels	FCC 15C 15.247 ISED RSS-247	ANSI C63.10:2013	Conforms
Average Time of Occupancy	FCC 15C 15.247 ISED RSS-247	ANSI C63.10:2013	Conforms
Maximum Peak Conducted Output Power	FCC 15C 15.247 ISED RSS-247	ANSI C63.10:2013	Conforms
Effective Isotropic Radiated Power (EIRP)	FCC 15C 15.247 ISED RSS-247	ANSI C63.10:2013	Conforms
Case Spurious Radiated Emissions	FCC 15C 15.247 ISED RSS-247	ANSI C63.10:2013	Conforms
Band-Edge Compliance	FCC 15C 15.247 ISED RSS-247	ANSI C63.10:2013	Conforms

14. Sample Calculations

For Radiated Emissions:

The resultant field strength (FS) is a summation in decibels (dB) of the receiver meter reading (MTR), the antenna correction factor (AF), and the cable loss factor (CF). If an external preamplifier is used, the total is reduced by its gain (-PA). If a distance correction (DC) is required, it is added to the total.

Formula 1: FS (dBμV/m) = MTR (dBμV) + AF (dB/m) + CF (dB) + (- PA (dB)) + DC (dB)

To convert the Field Strength dBμV/m term to μV/m, the dBμV/m is first divided by 20. The Base 10 AntiLog is taken of this quotient. The result is the Field Strength value in μV/m terms.

Formula 2: FS (μV/m) = AntiLog [(FS (dBμV/m))/20]

15. Statement of Conformity

The Otto Engineering Lynq-PRO Handheld GPS/LoRa/BT device (Model No. OTTOVL01) did fully conform to the selected requirements of FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 and Innovation, Science, and Economic Development Canada, RSS-247.

16. Certification

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 and Innovation, Science, and Economic Development Canada, RSS-247 test specifications. The data presented in this test report pertains to the EUT on the test date specified. Any electrical or mechanical modifications made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification.

17. Photograph of EUT

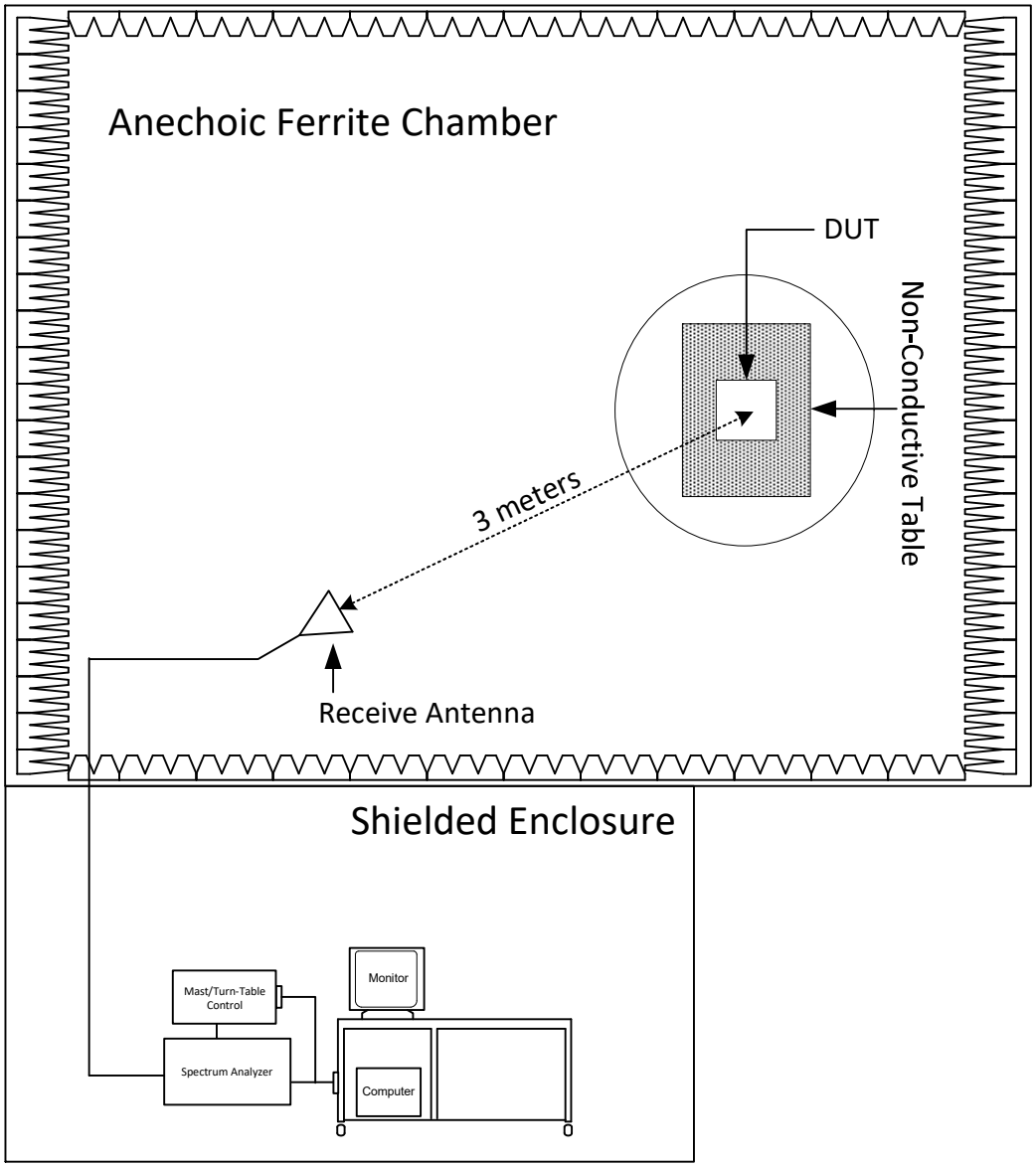
18. Equipment List

Eq ID	Equipment Description	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW14	PREAMPLIFIER	PE2-35-120-5R0-10-12-SFF	PL22671	1-20GHz	9/21/2021	9/21/2022
CDZ3	LAB WORKSTATION	LWS-10		WINDOWS 10	CNR	
CDZ4	LAB WORKSTATION	LWS-10		WINDOWS 10	CNR	
GRE2	SIGNAL GENERATOR	E4438C	MY42081749	250KHZ-6GHZ	3/5/2021	3/5/2022
GSD2	SIGNAL GENERATOR	SMB 100A	100396	9KHZ-6GHZ	3/10/2021	3/10/2022
NTA3	BILOG ANTENNA	6112D	32853	25-1000MHz	10/20/2020	10/20/2022
NWQ2	DOUBLE RIDGED WAVEGUIDE ANTENNA	3117	66659	1GHZ-18GHZ	4/7/2020	4/7/2022
R29F	3M ANECHOIC CHAMBER NSA	3M ANECHOIC		30MHZ-18GHZ	3/13/2021	3/13/2022
RBG0	EMI ANALYZER	ESW44	101533	10HZ-44GHZ	3/2/2021	11/15/2022
RBG3	EMI ANALYZER	ESW44	101592	2HZ-44GHZ	7/12/2021	7/12/2022
SES0	24VDC POWER SUPPLY	FS-32024-1M	001	18-27VDC	NOTE 1	
T2D1	20DB, 25W ATTENUATOR	46-20-43	AV5814	DC-18GHZ	3/19/2020	3/19/2022
T2D2	20DB, 25W ATTENUATOR	46-20-43	AV5815	DC-18GHZ	3/10/2020	3/10/2022
XPQ3	HIGH PASS FILTER	4IH30-1804/T10000-0	4	1.8GHZ-10GHZ	9/7/2021	9/7/2023

N/A: Not Applicable I/O: Initial Only CNR: Calibration Not Required

NOTE 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

19. Block Diagram of Test Setup



Radiated Measurements Test Setup

20. 20dB Bandwidth

EUT Information	
Manufacturer	Otto Engineering
Product	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx

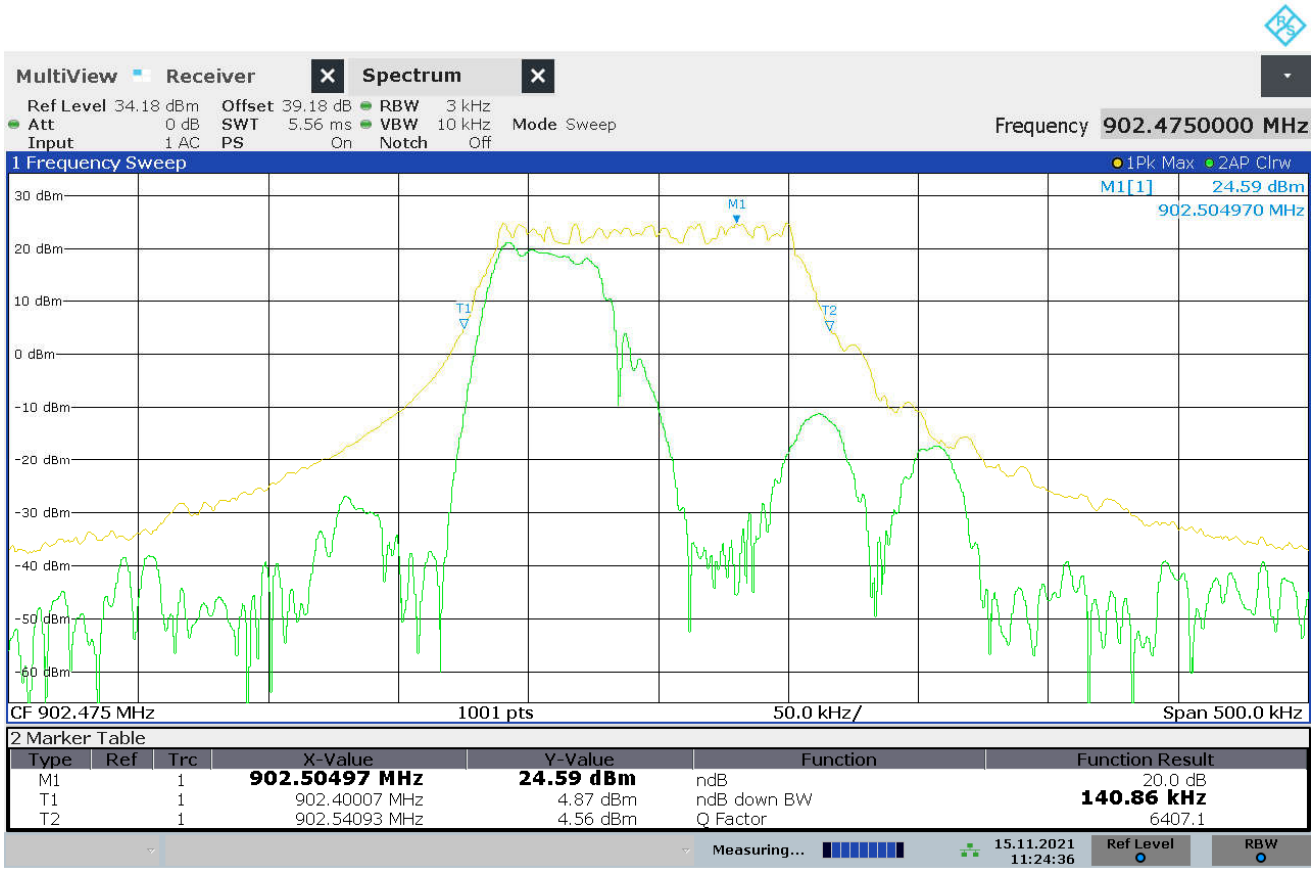
Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop
Type of Antennas Used	N/A
Notes	

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3

Requirements
Systems using frequency hopping techniques operating in the 902-928MHz band are allowed a maximum 20dB bandwidth of 500kHz.

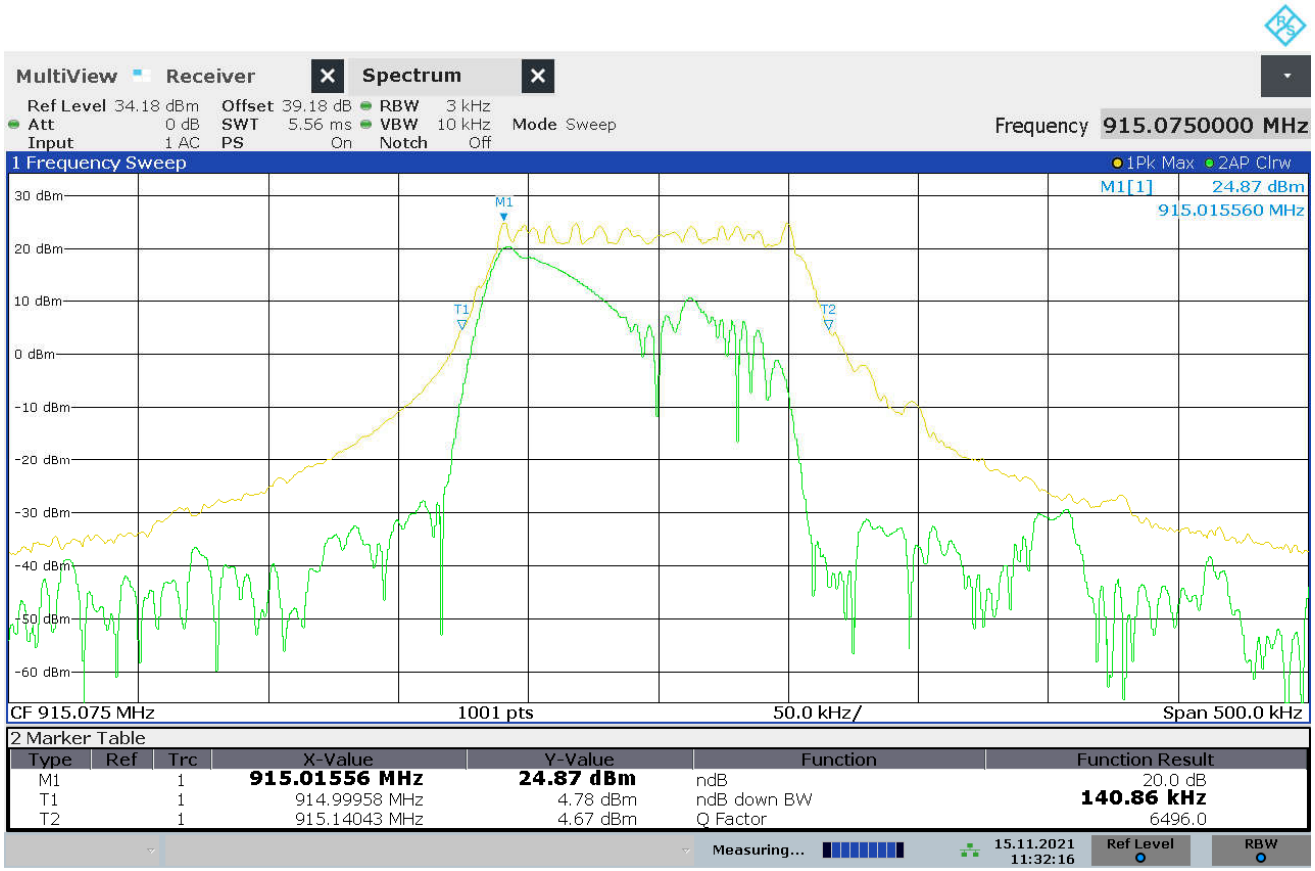
Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function disabled, the EUT was allowed to transmit continuously. The frequency hopping channel was set separately to low, middle, and high hopping channels. The resolution bandwidth (RBW) was set to ≥ 1% of the 20dB BW. The span was set to approximately 2 to 3 times the 20dB bandwidth. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. The analyzer's display was then screenshot and saved.

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	902.475MHz
Result	20dB BW = 140.86kHz
Notes	



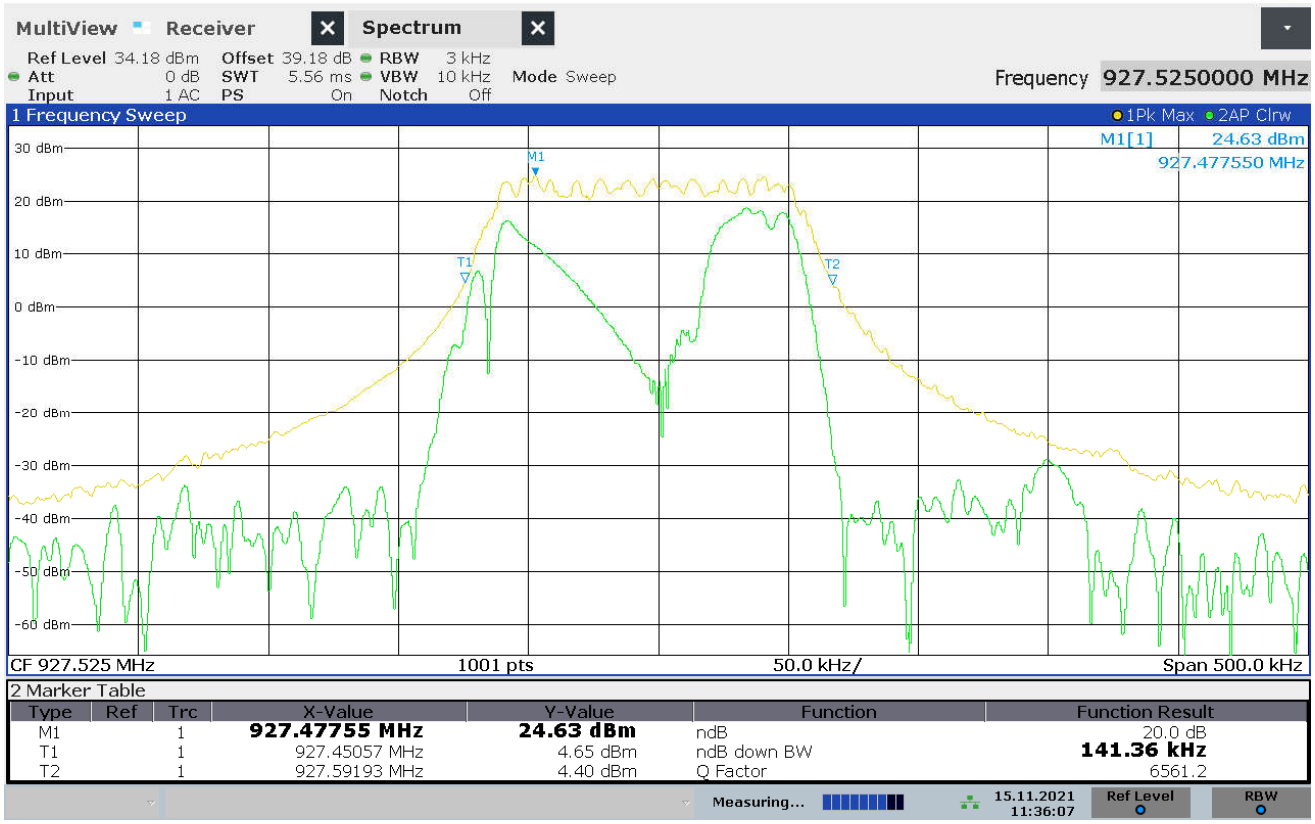
11:24:37 15.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	915.075MHz
Result	20dB BW = 140.86kHz
Notes	



11:32:16 15.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	915.075MHz
Result	20dB BW = 141.36kHz
Notes	



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21. Occupied Bandwidth (99%)

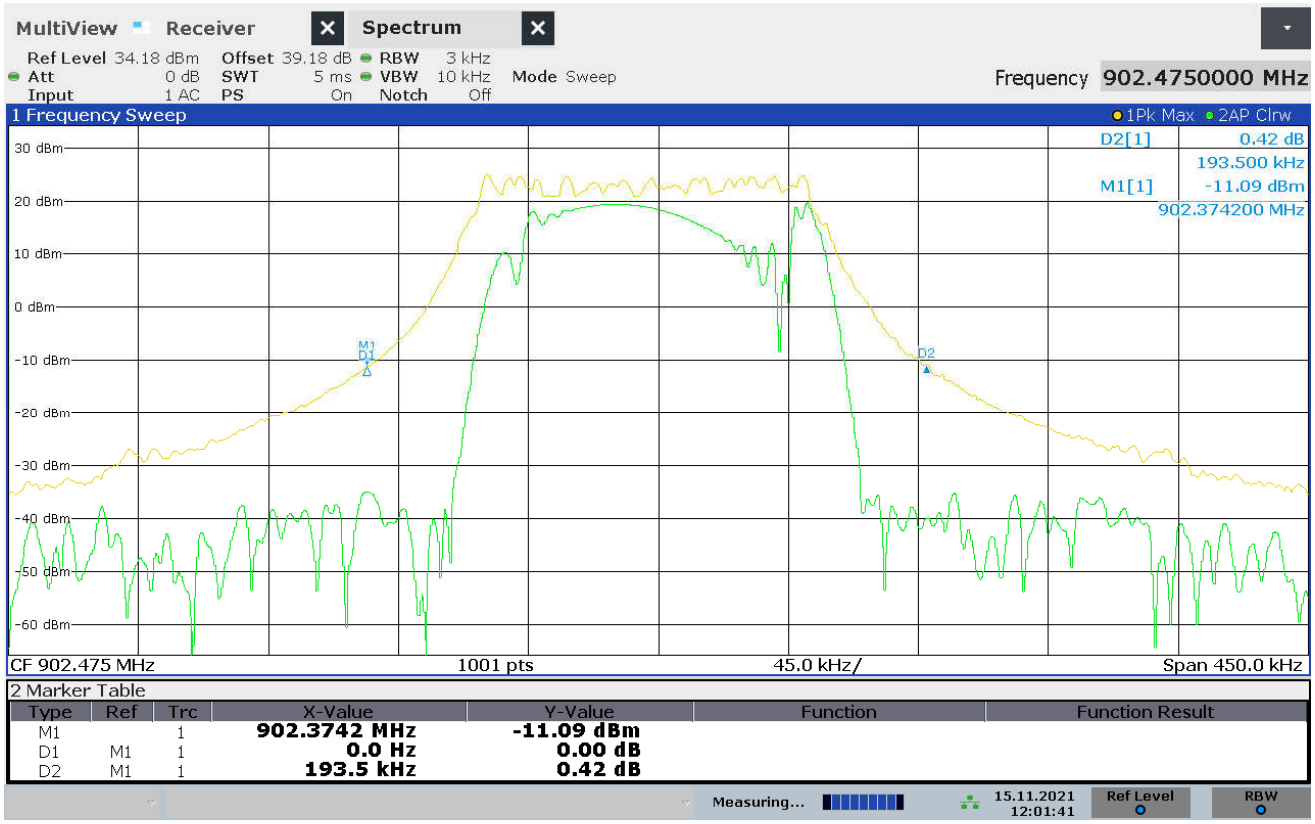
EUT Information	
Manufacturer	Otto Engineering
Product	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx

Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Antenna Conducted
Type of Test Site	N/A
Type of Antennas Used	N/A
Notes	None

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3

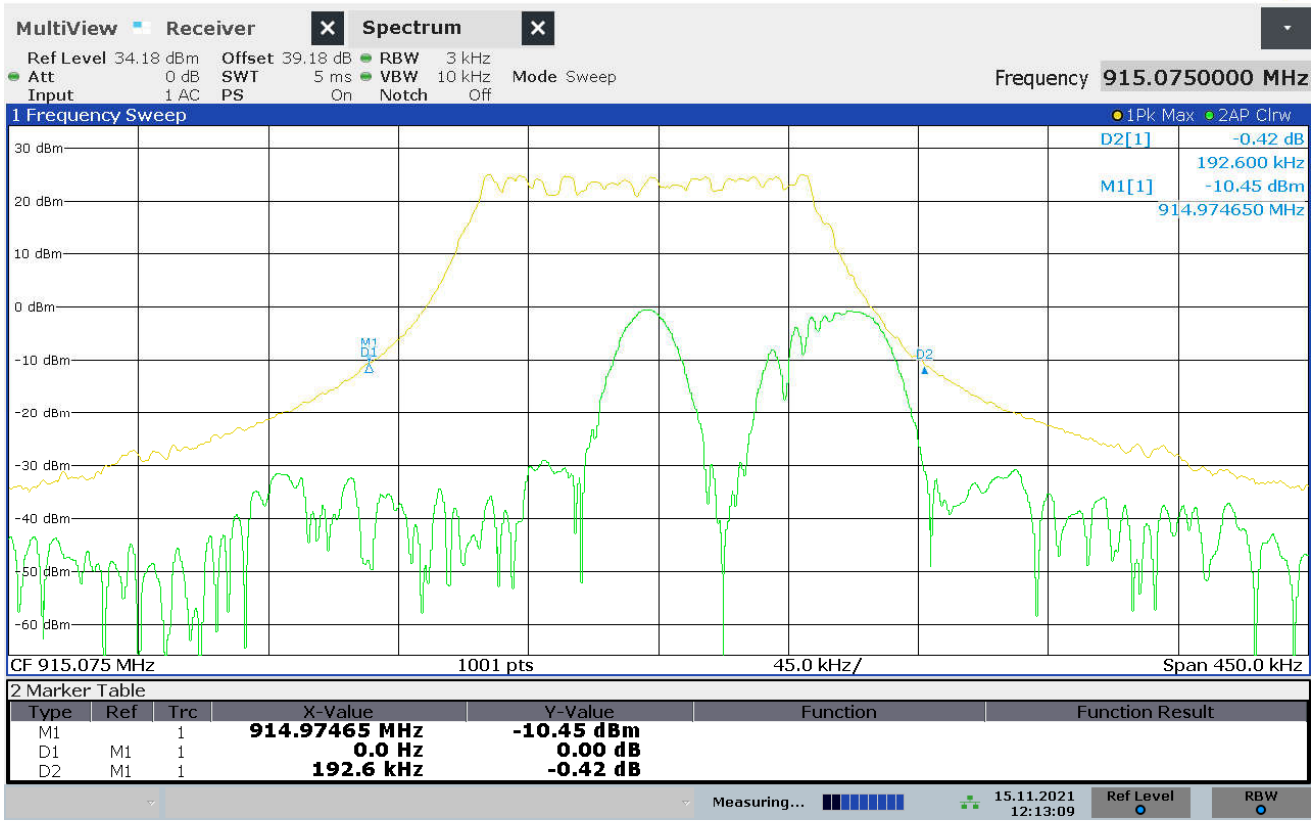
Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation. The EUT was allowed to transmit continuously. The transmit channel was set separately to low, middle, and high channels. The resolution bandwidth (RBW) was set to 1% to 5% of the actual occupied / x dB bandwidth, the video bandwidth (VBW) was set 3 times greater than the RBW, and the span was set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. The analyzer's display was plotted using a 'screen dump' utility.

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	902.475MHz
Result	OBW = 193.5kHz
Notes	



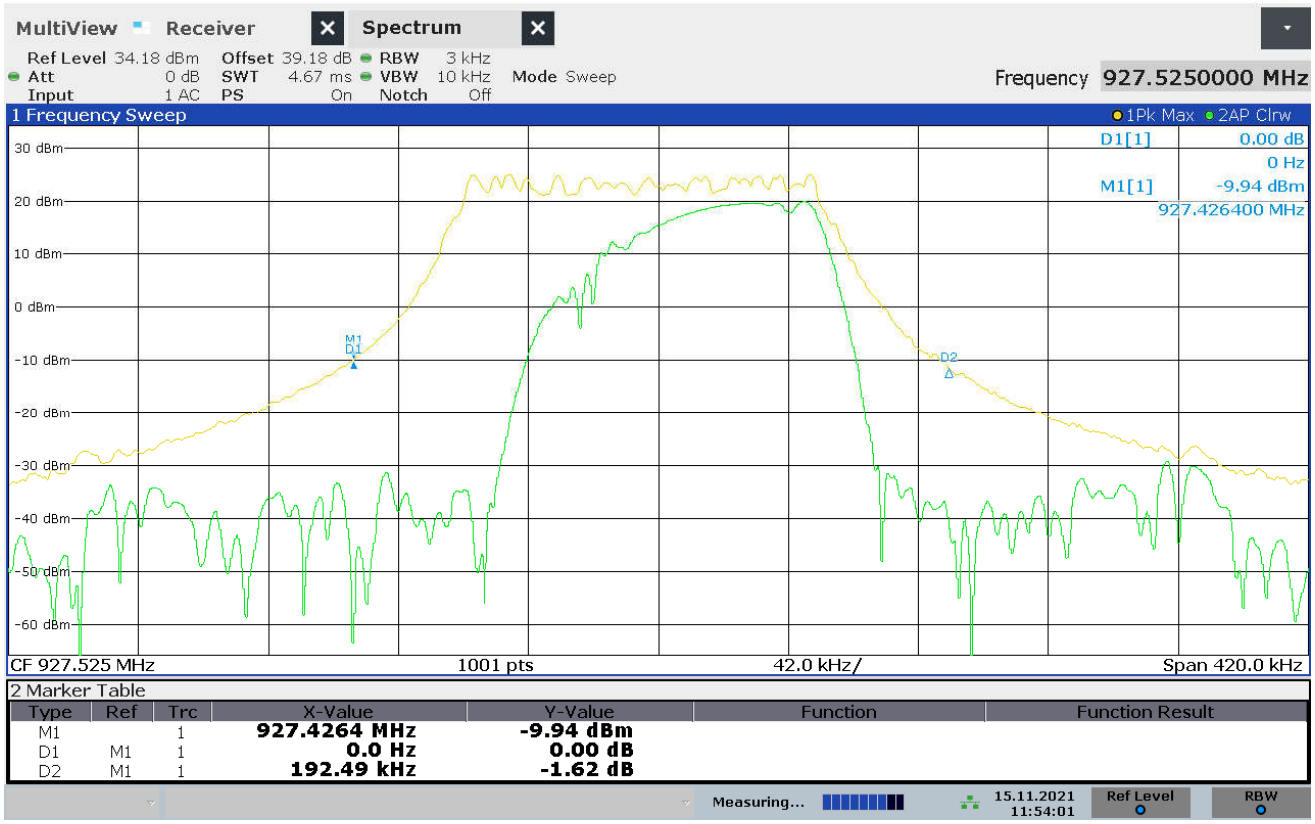
12:01:42 15.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	915.075MHz
Result	OBW = 192.6kHz
Notes	



12:13:09 15.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	927.525MHz
Result	OBW = 192.49kHz
Notes	



11:54:01 15.11.2021

22. Carrier Frequency Separation

EUT Information	
Manufacturer	Otto Engineering
Product	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx

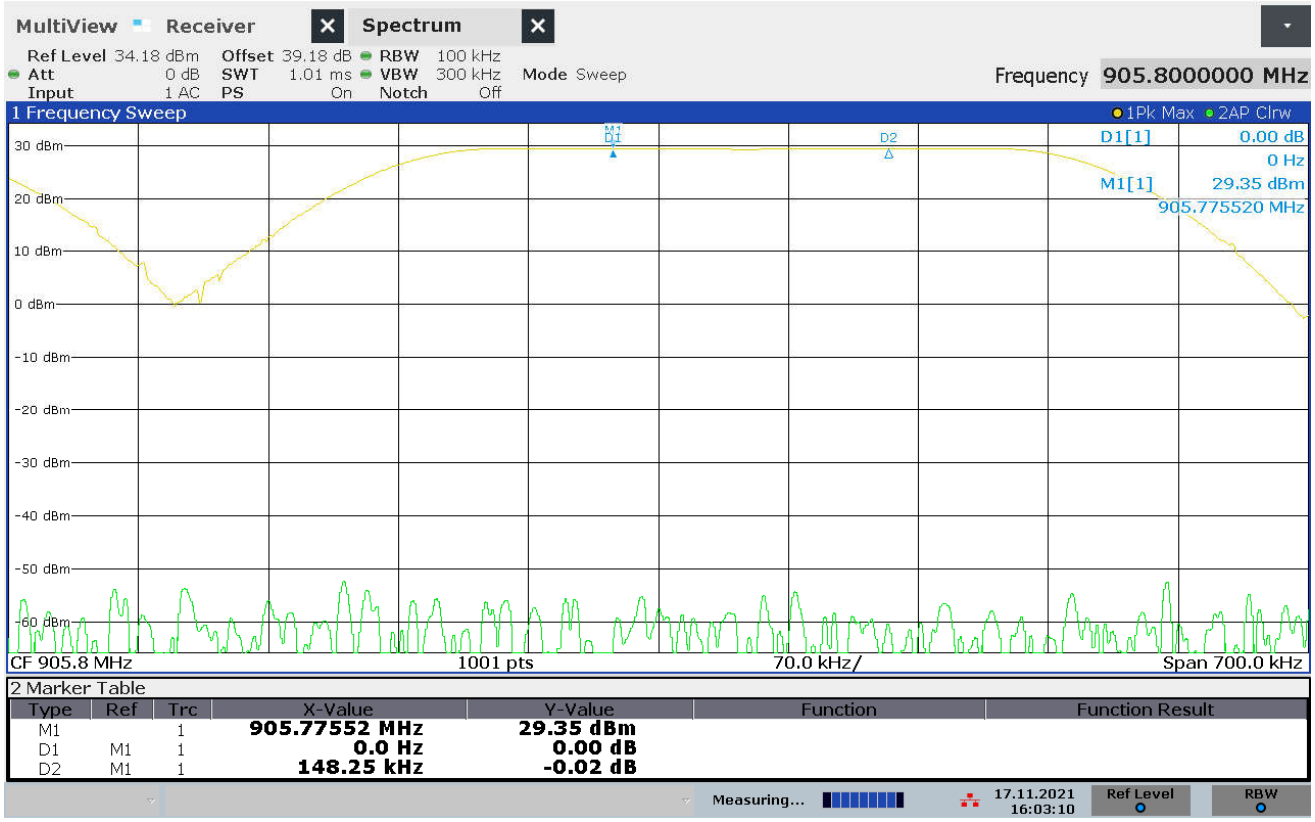
Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Antenna Conducted
Type of Test Site	N/A
Type of Antennas Used	N/A
Notes	None

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3

Requirement
Channel carrier frequencies shall be separated by a minimum of 25kHz or the 20dB bandwidth, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5MHz band may have hopping channel carrier frequencies that are separated by 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.

Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously. Span was set wide enough to capture the peaks of two adjacent channels. The resolution bandwidth was set to approximately 30% of the channel spacing. The peak detector and 'Max-Hold' function were engaged. The span was set wide enough to capture the peaks of at least two adjacent channels. When the trace had stabilized after multiple scans, the marker-delta function was used to determine the separation between the peaks of the adjacent channels. The analyzer's display was plotted using a 'screen dump' utility.

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Hopping
Result	Separation = 148.25kHz
Notes	



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23. Number of Carrier Channels

EUT Information	
Manufacturer	Otto Engineering
Product	Lynq-PRO Handheld GPS/LoRa/BT device
Model	OTTOVL01
Serial No	N/A
Mode	Tx

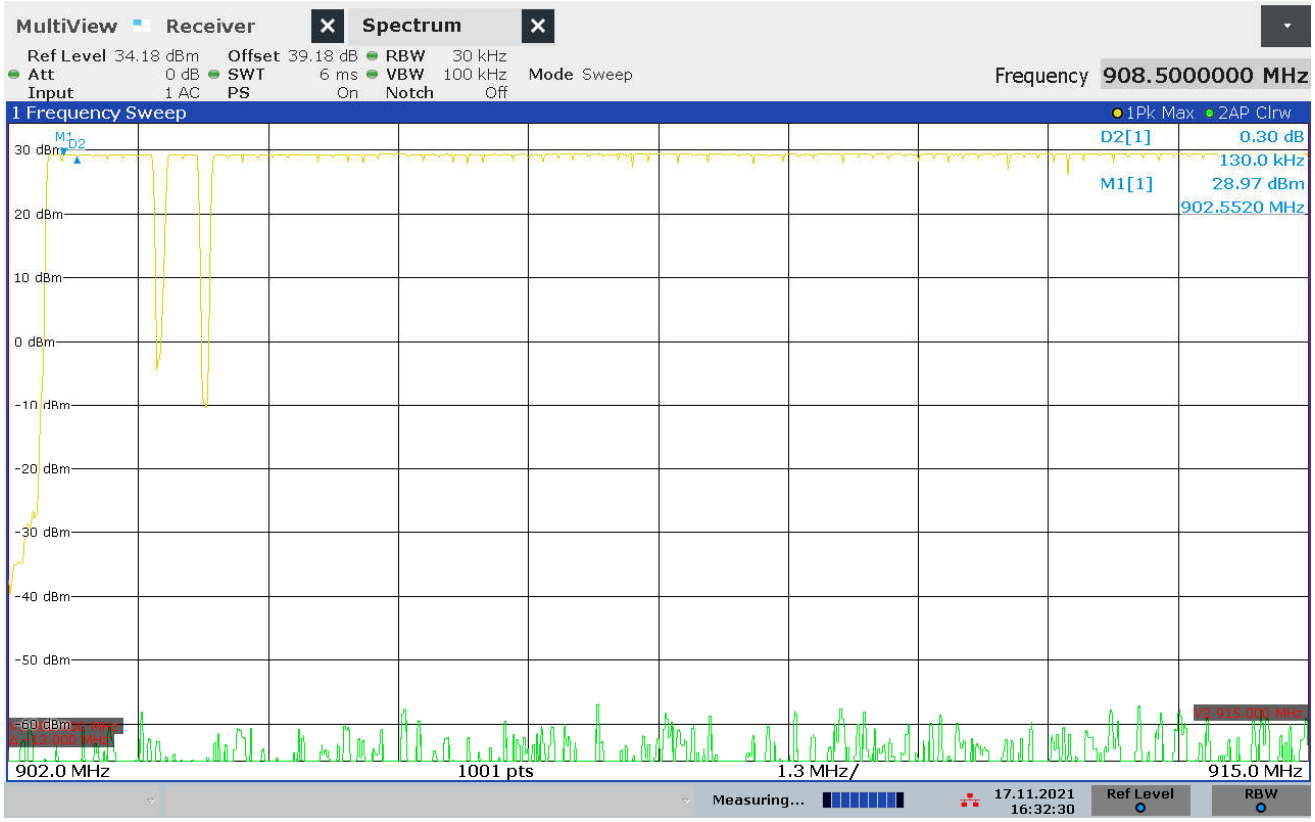
Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Antenna Conducted
Type of Test Site	N/A
Type of Antennas Used	N/A
Notes	None

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3

Requirements
The system shall use at least 50 hopping frequencies.

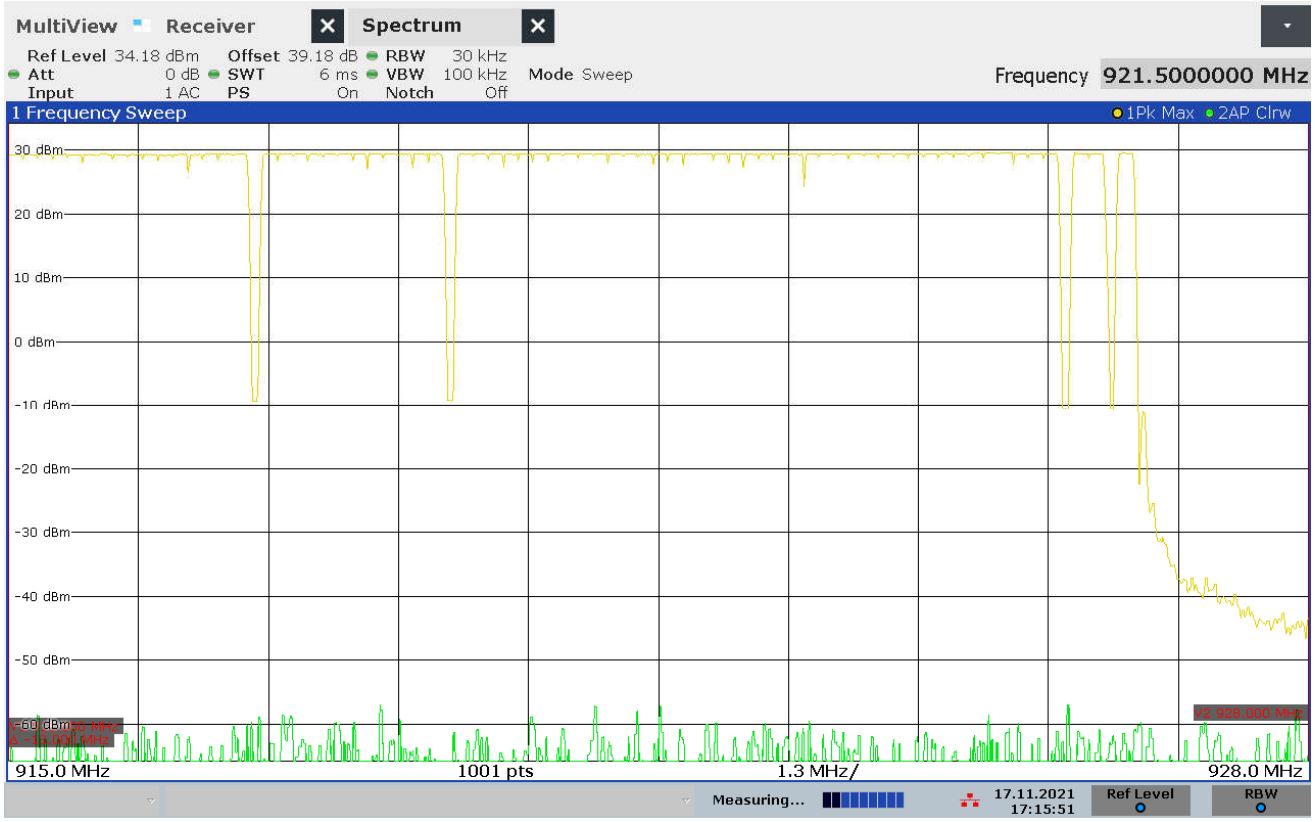
Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously. The resolution bandwidth (RBW) was set to less than 30% of the channel spacing or the 20dB bandwidth, whichever is smaller. The peak detector and 'Max-Hold' function were engaged. The span was set wide enough to capture the entire frequency band of operation. The EUT's signal was allowed to stabilize after multiple scans. The number of hopping frequencies was counted. The analyzer's display was plotted using a 'screen dump' utility.

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Hopping
Result	902 – 915MHz = 82 hopping frequencies
Notes	



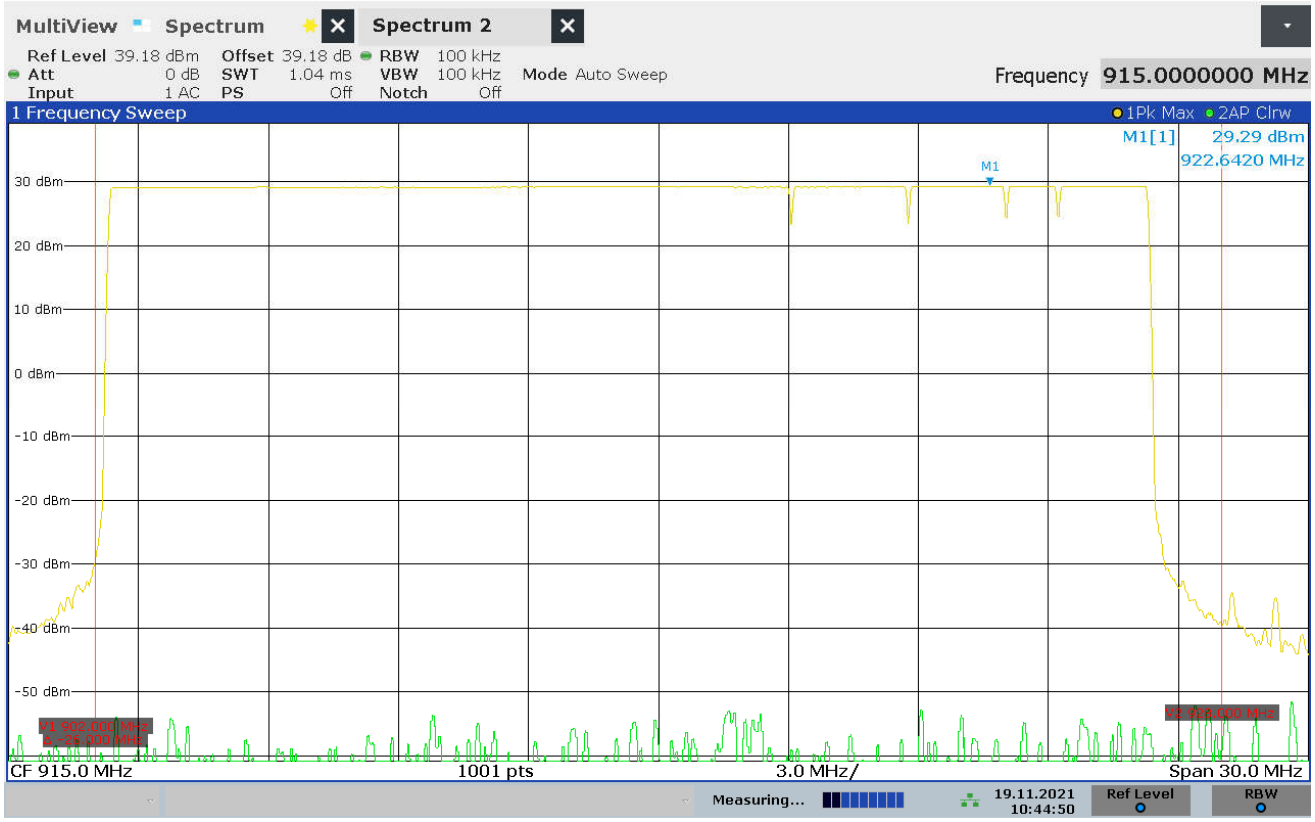
16:32:31 17.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Hopping
Result	915 – 928MHz = 81 hopping frequencies
Notes	



17:15:51 17.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Hopping
Result	163 hopping frequencies
Notes	



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24. Average Time of Occupancy

EUT Information	
Manufacturer	Otto Engineering
Product	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx

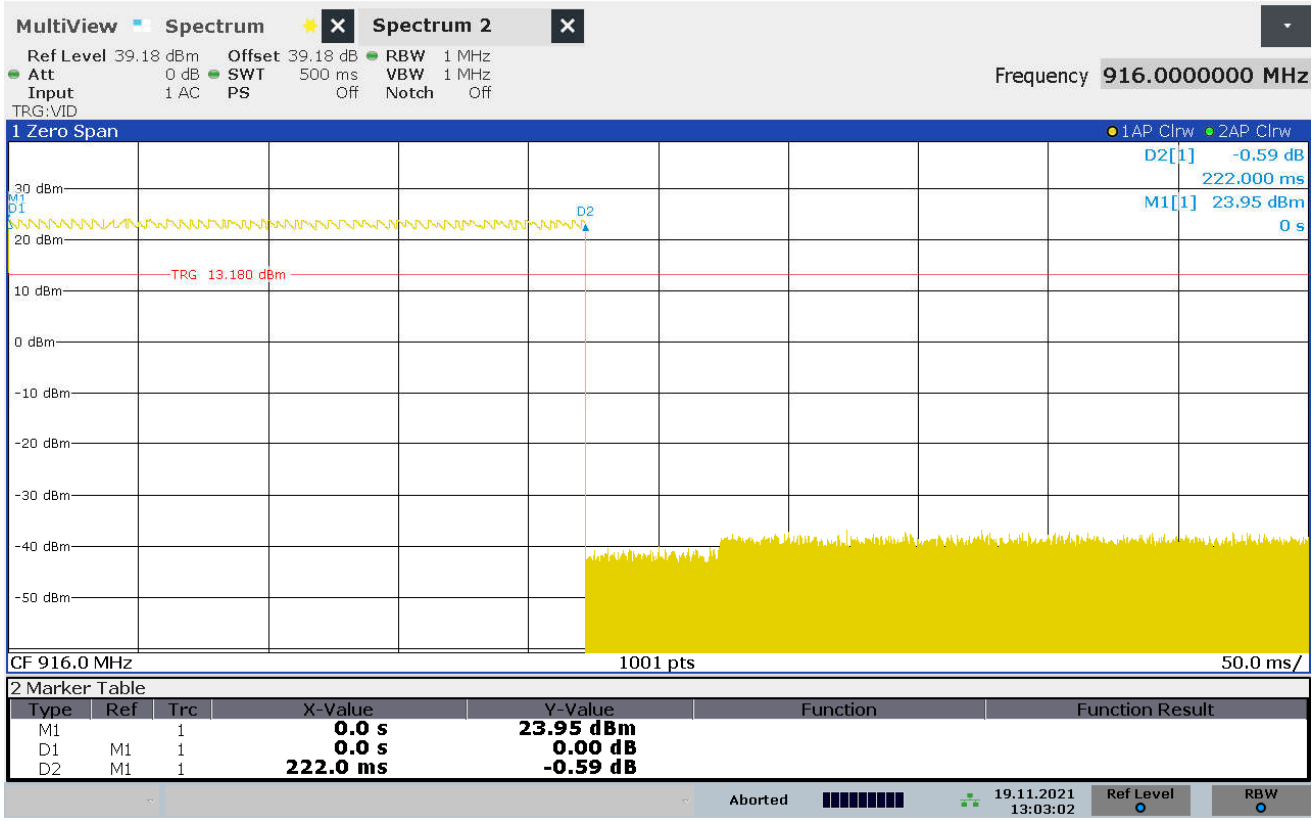
Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Antenna Conducted
Type of Test Site	N/A
Type of Antennas Used	N/A
Notes	None

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3

Requirements
The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period

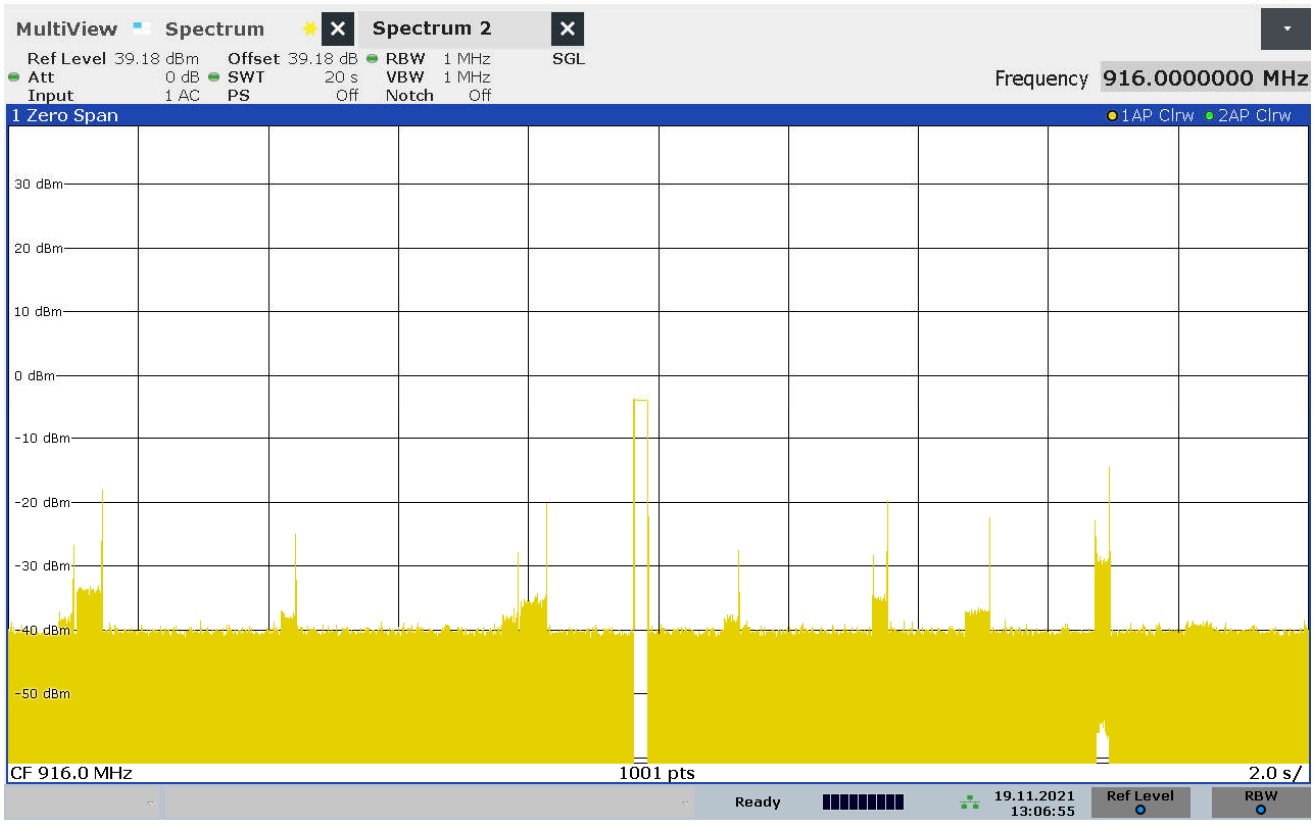
Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously. The spectrum analyzer was set to zero span centered on a hopping channel. The resolution bandwidth (RBW) was set ≥ to the channel spacing. The sweep was set to capture the entire dwell time per hopping channel. The peak detector and 'Max-Hold' function were engaged. The analyzer's display was plotted using a 'screen dump' utility.

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Hopping
Result	Pulse = 222ms
Notes	



13:03:02 19.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Hopping
Result	Ave. Time of Occupancy = 0.222s
Notes	Time of Occupancy = # of bursts × burst duration = (222ms) = 0.222s



13:06:56 19.11.2021

25. Maximum Peak Conducted Output Power

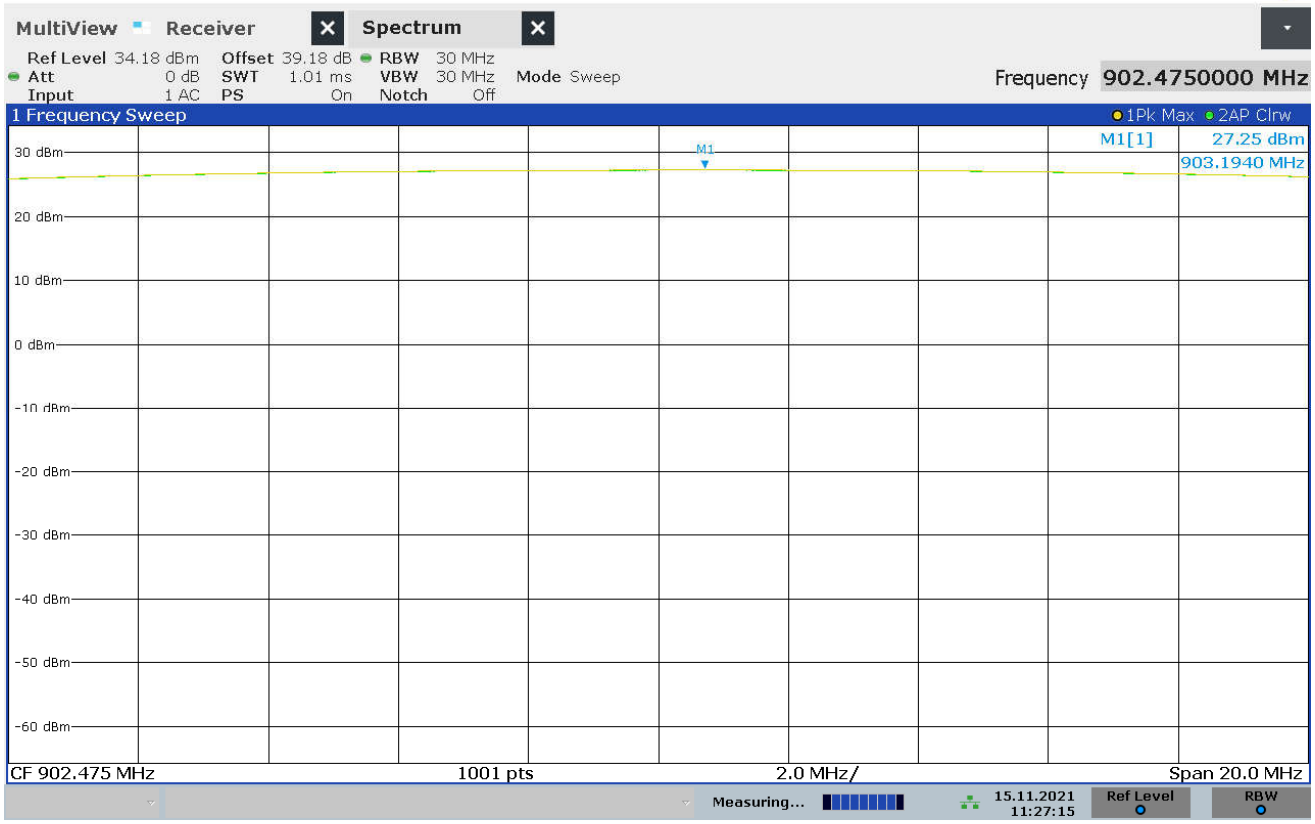
EUT Information	
Manufacturer	Otto Engineering
Product	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No	N/A
Mode	Tx

Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Antenna Conducted
Type of Test Site	N/A
Type of Antennas Used	N/A
Notes	None

Requirements
The output power shall not exceed 1W (30dBm).

Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function disabled, the EUT was allowed to transmit continuously. The frequency hopping channel was set separately to low, middle, and high hopping channels. The resolution bandwidth (RBW) was set to greater than the 20dB bandwidth. The span was set to approximately 5 times the 20dB bandwidth. The 'Max-Hold' function was engaged. The maximum meter reading was recorded. The peak power output was calculated for the low, middle, and high hopping frequencies.

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	902.475MHz
Result	Output Power = 0.53W (27.25dBm)
Notes	



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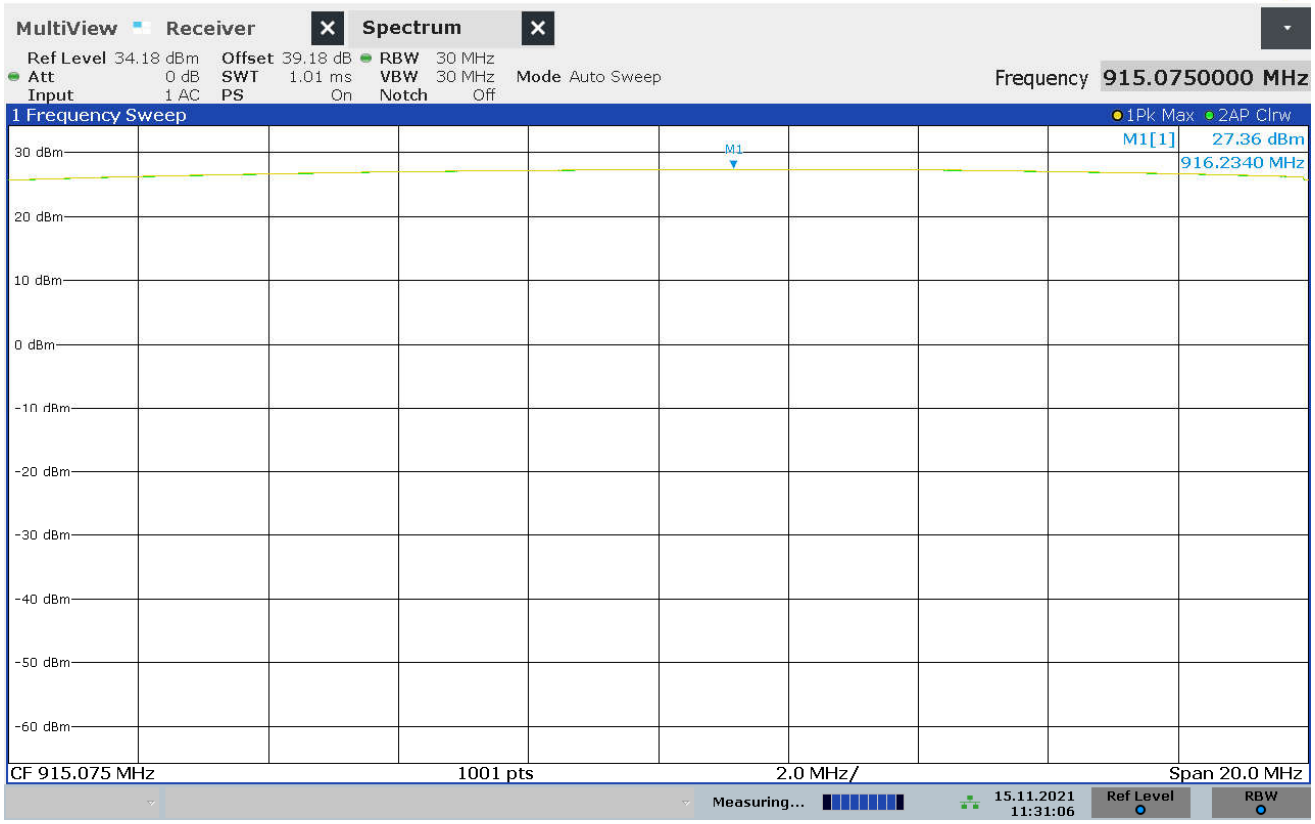
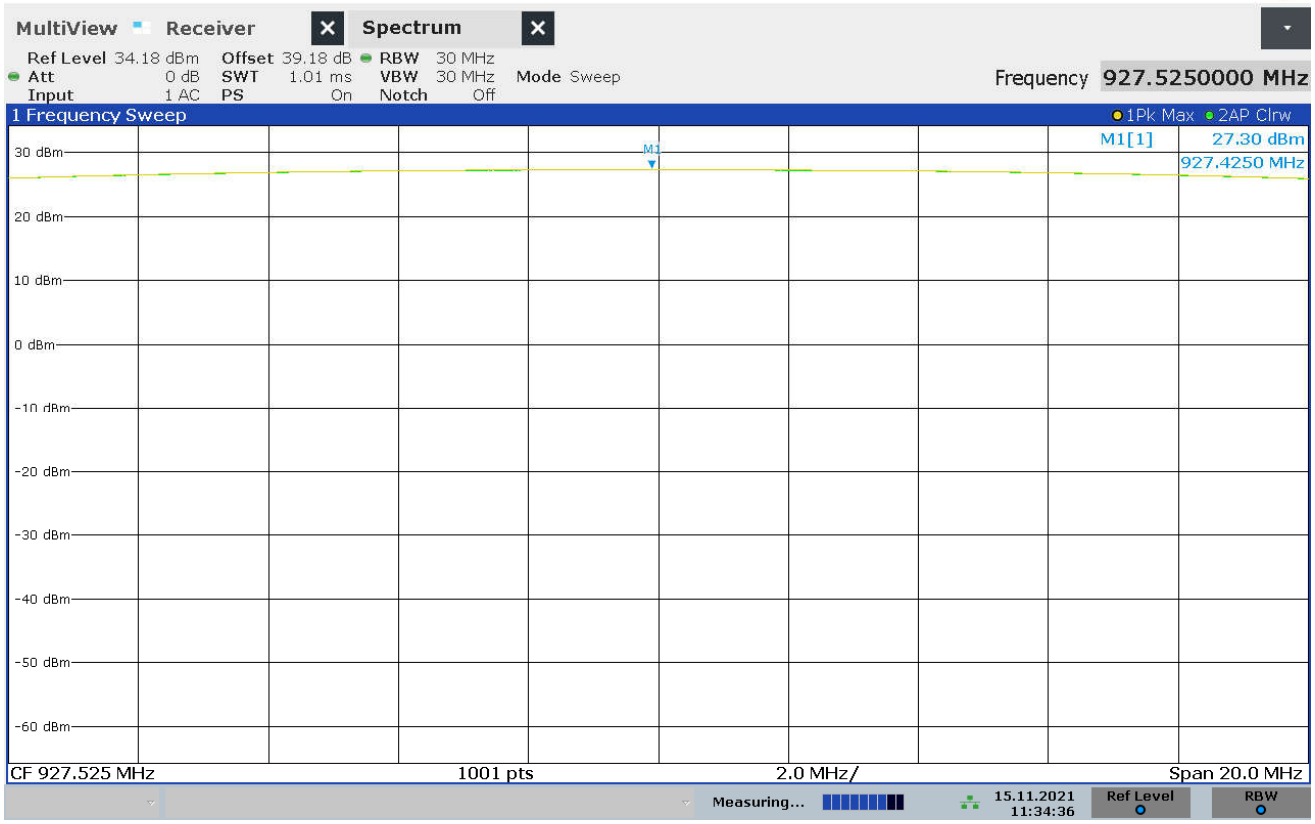
Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	915.075MHz
Result	Output Power = 0.54W (27.36dBm)
Notes	



11:31:06 15.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	927.525MHz
Result	Output Power = 0.537W (27.30dBm)
Notes	



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26. Effective Isotropic Radiated Power (EIRP)

EUT Information	
Manufacturer	Otto Engineering
Product	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx

Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Radiated
Type of Test Site	Semi-Anechoic Chamber
Test Site Used	Room 29
Type of Antennas Used	Below 1GHz: Bilog (or equivalent)
Notes	None

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3

Requirements
The output power shall not exceed 4W (36dBm).

Procedure
The EUT was placed on the non-conductive stand and set to transmit. A bilog antenna was placed at a test distance of 3 meters from the EUT. The resolution bandwidth (RBW) of the spectrum analyzer was set to greater than the 20dB bandwidth. The span was set to approximately 5 times the 20 dB bandwidth. The EUT was maximized for worst case emissions (or maximum output power) at the measuring antenna. The maximum meter reading was recorded. The peak power output was measured for the low, middle, and high hopping frequencies. The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power, a dipole antenna (double ridged waveguide antenna for all measurements above 1GHz) was then set in place of the EUT and connected to a calibrated signal generator. The output of the signal generator was adjusted to match the received level at the spectrum analyzer. The signal level was recorded. The reading was then corrected to compensate for cable loss (and antenna gain for all measurements above 1GHz), as required. The peak power output was calculated for low, middle, and high hopping frequencies.

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Result	EIRP = 1.425W (31.54dBm)
Notes	

Freq (MHz)	Ant Pol	Wide BW Meter Reading (dBµV)	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total (dBµV/m)	EIRP (dBm)	Limit (dBm)	Margin (dB)
902.475	H	95.20	2.88	26.47	0.00	124.55	29.55	36.00	-6.45
902.475	V	93.86	2.88	26.47	0.00	123.21	28.21	36.00	-7.79
915.075	H	97.33	2.89	26.31	0.00	126.54	31.54	36.00	-4.46
915.075	V	93.90	2.89	26.31	0.00	123.11	28.11	36.00	-7.89
927.525	H	96.67	2.90	26.66	0.00	126.23	31.23	36.00	-4.77
927.525	V	92.67	2.90	26.66	0.00	122.23	27.23	36.00	-8.77

27. Case Spurious Radiated Emissions

EUT Information	
Manufacturer	Otto Engineering
Product	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx

Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Type of Test Site	Semi-Anechoic Chamber
Test Site Used	Room 29
Type of Antennas Used	Below 1GHz: Bilog (or equivalent) Above 1GHz: Double-Ridged Waveguide (or equivalent)
Notes	None

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz)	3.1
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2

Procedure

Radiated measurements were performed in a 32ft. x 20ft. x 14ft. high shielded enclosure. The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

Preliminary radiated emissions tests were performed to determine the emission characteristics of the EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the EUT. The entire frequency range from 30MHz to 10GHz was investigated using a peak detector function.

The final open field emission tests were then manually performed over the frequency range of 30MHz to 10GHz.

For all harmonics not in the restricted bands, the following procedure was used:

a) The field strength of the fundamental was measured using a bilog antenna. The bilog antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on an 80cm high non-conductive stand. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.

b) The field strengths of all of the harmonics not in the restricted band were then measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on a 1.5 meter high non-conductive stand. A peak detector with a resolution bandwidth of 100kHz was used on the spectrum analyzer.

c) To ensure that maximum or worst case emission levels at the fundamental and harmonics were measured, the following steps were taken when measuring the fundamental emissions and the spurious emissions:

i) The EUT was rotated so that all sides were exposed to the receiving antenna.

ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

iv) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer. The measuring antenna was not raised or lowered to ensure maximized readings, instead the EUT was rotated through all axis to ensure the maximum readings were recorded for the EUT.

d) All harmonics not in the restricted bands must be at least 20dB below levels measured at the fundamental. However, attenuation below the general limits specified in §15.209(a) is not required.

For all emissions in the restricted bands, the following procedure was used:

a) The field strengths of all emissions below 1GHz were measured using a bi-log antenna. The bi-log antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on an 80cm high non-conductive stand. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.

b) The field strengths of all emissions above 1GHz were measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on a 1.5 meter high non-conductive stand. A peak detector with a resolution bandwidth of 1MHz was used on the spectrum analyzer.

c) To ensure that maximum or worst case emission levels were measured, the following steps were taken when taking all measurements:

i) The EUT was rotated so that all sides were exposed to the receiving antenna.

ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

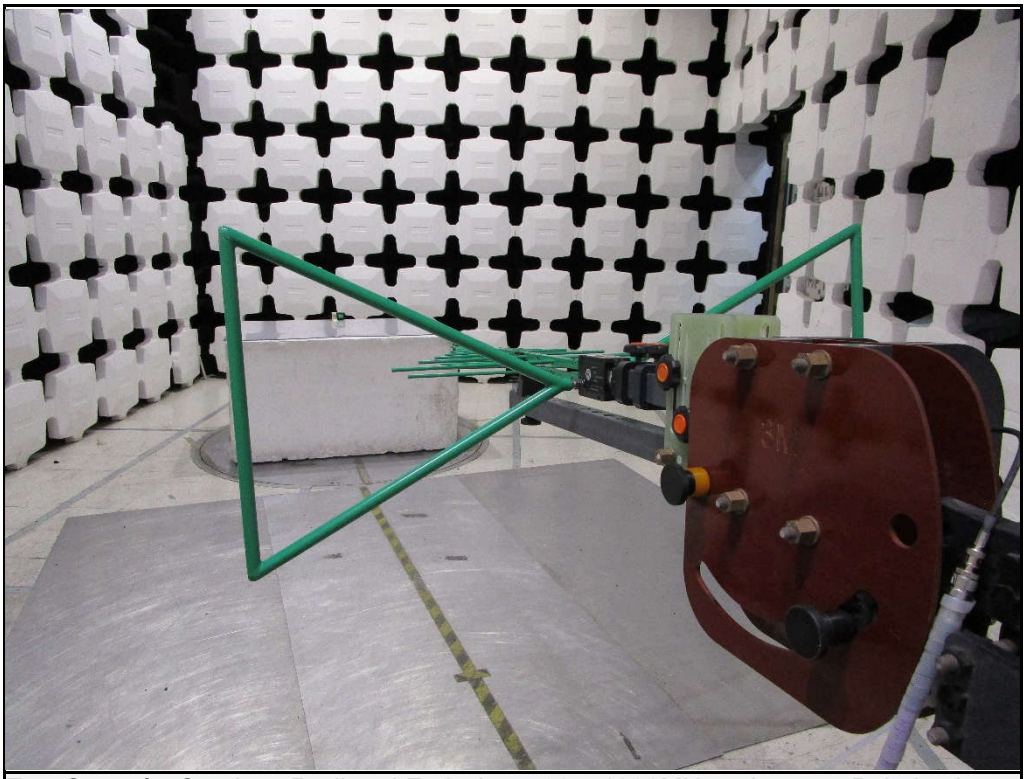
iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

d) For all radiated emissions measurements below 1GHz, if the peak reading is below the limits listed in §15.209(a), no further measurements are required. If, however, the peak readings exceed the limits listed in §15.209(a), then the emissions are remeasured using a quasi-peak detector.

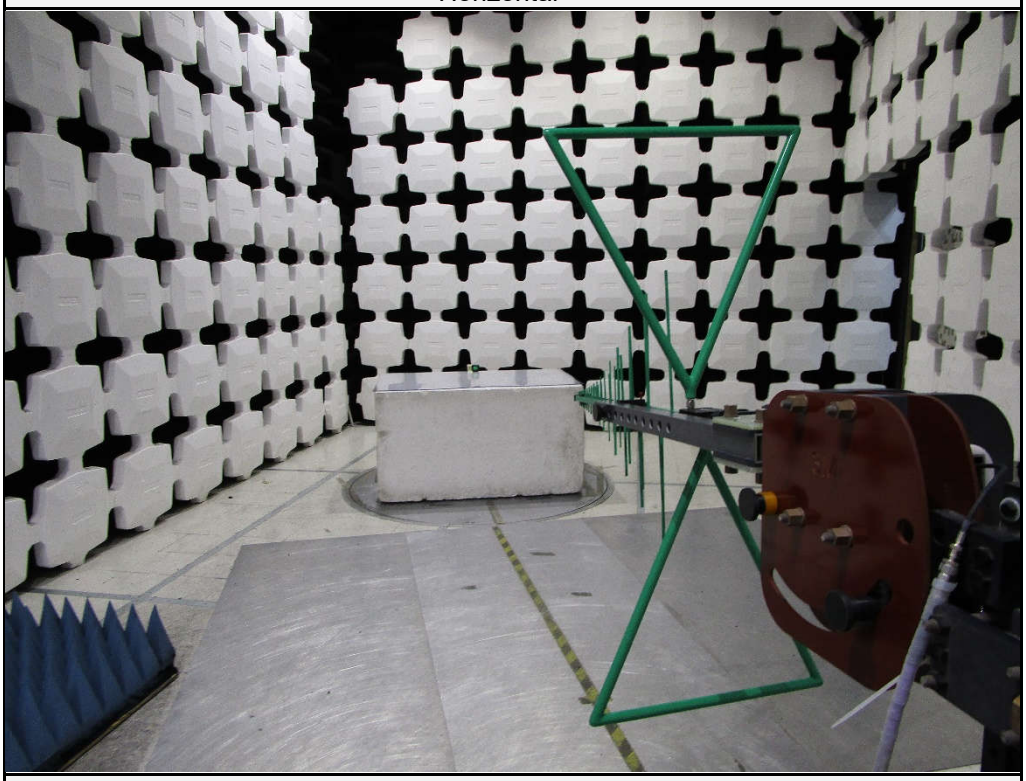
e) For all radiated emissions measurements above 1GHz, the peak readings must comply with the §15.35(b) limits. §15.35(b) states that when average radiated emissions measurements are specified, there also is a limit on the peak level of the radiated emissions. The limit on the peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. Therefore, all peak readings above 1GHz must be no greater than 20dB above the limits specified in §15.209(a).

f) Next, for all radiated emissions measurements above 1GHz, the resolution bandwidth was set to 1MHz. The analyzer was set to linear mode with a 10Hz video bandwidth in order to simulate an average detector. An average reading was taken.

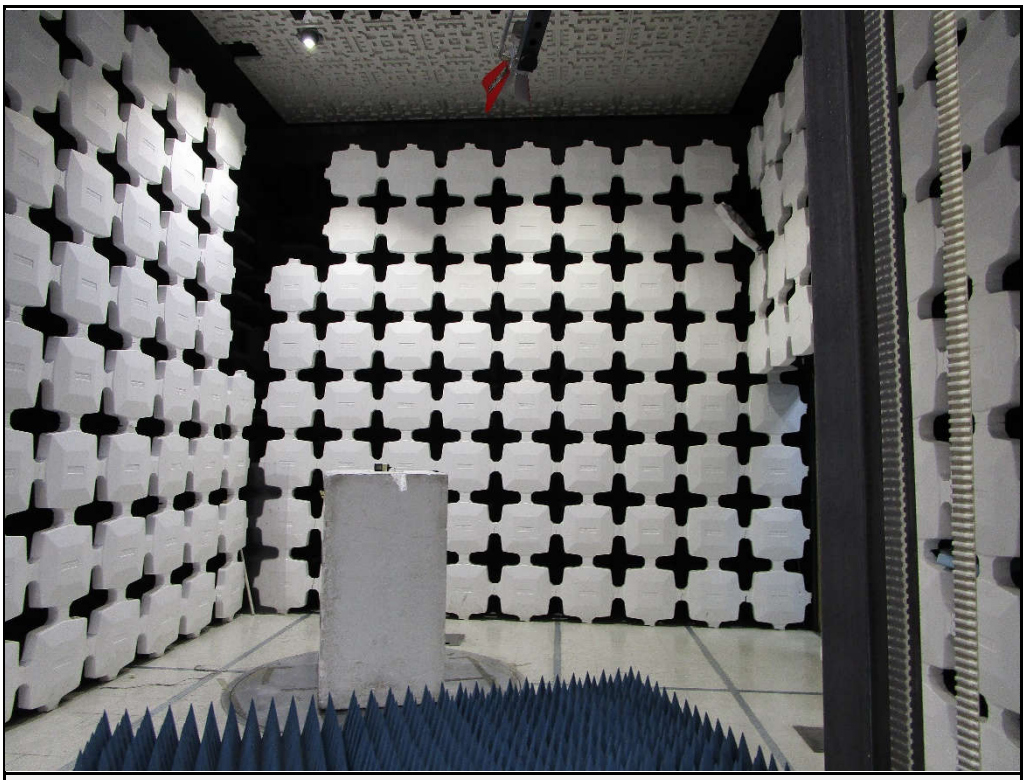
g) If the dwell time per channel of the hopping signal is less than 100msec, then the reading obtained with the 10Hz video bandwidth may be further adjusted by a duty cycle correction factor derived from 20*log(dwell time/100msec). These readings must be no greater than the limits specified in §15.209(a).



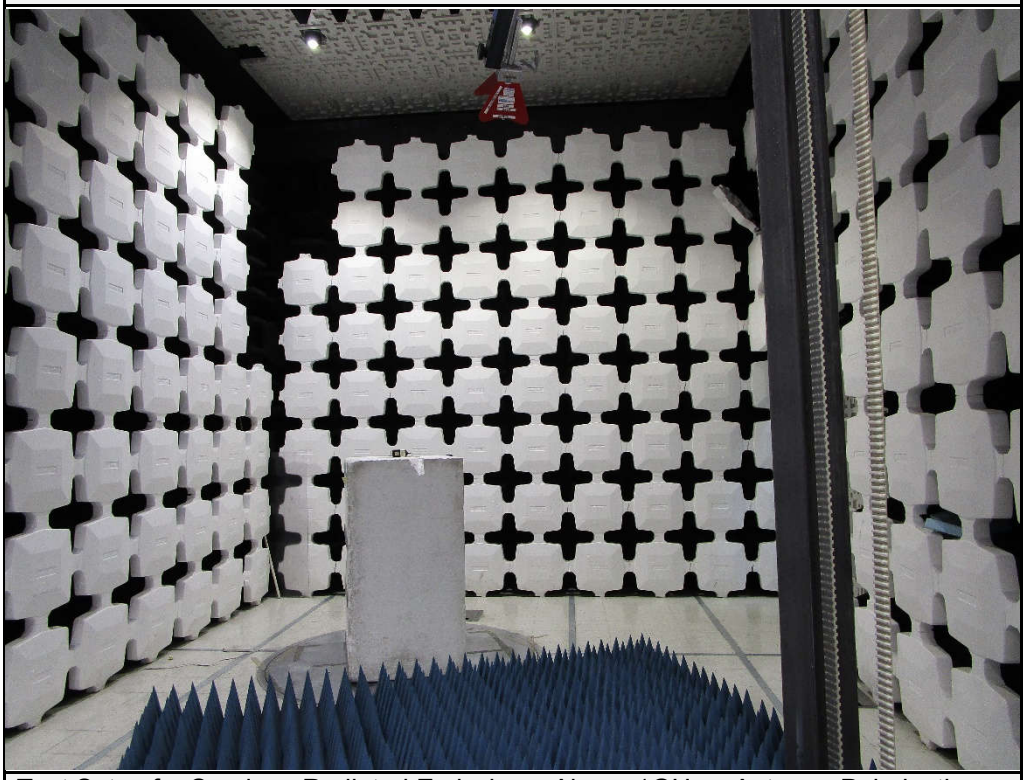
Test Setup for Spurious Radiated Emissions, 30 – 1000MHz – Antenna Polarization Horizontal



Test Setup for Spurious Radiated Emissions, 30 – 1000MHz – Antenna Polarization Vertical



Test Setup for Spurious Radiated Emissions, Above 1GHz – Antenna Polarization Horizontal



Test Setup for Spurious Radiated Emissions, Above 1GHz – Antenna Polarization Vertical

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	902.475MHz
Notes	Peak Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
2707.43	H	56.5		3.7	33.4	-40.2	53.4	466.9	5000.0	-20.6
	V	54.3		3.7	33.4	-40.2	51.2	362.4	5000.0	-22.8
3609.90	H	50.3	Ambient	4.8	34.6	-39.5	50.2	322.1	5000.0	-23.8
	V	50.0	Ambient	4.8	34.6	-39.5	49.8	309.3	5000.0	-24.2
4512.38	H	49.8	Ambient	4.8	35.9	-39.6	50.9	351.5	5000.0	-23.1
	V	49.9	Ambient	4.8	35.9	-39.6	51.0	356.4	5000.0	-22.9
5414.85	H	49.7	Ambient	5.1	36.6	-39.5	51.9	392.0	5000.0	-22.1
	V	49.0	Ambient	5.1	36.6	-39.5	51.2	364.6	5000.0	-22.7
8122.28	H	48.9	Ambient	6.1	38.3	-39.6	53.7	483.7	5000.0	-20.3
	V	48.4	Ambient	6.1	38.3	-39.6	53.1	453.0	5000.0	-20.9
9024.75	H	50.2		6.3	38.6	-39.4	55.7	613.0	5000.0	-18.2
	V	50.0		6.3	38.6	-39.4	55.5	594.2	5000.0	-18.5

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	902.475MHz
Notes	Average Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle Factor (dB)	Average Total at 3m (dBµV/m)	Average Total at 3m (µV/m)	Average Limit at 3m (µV/m)	Margin (dB)
2707.43	H	52.17		3.7	33.4	-40.2	0.0	49.1	284.3	500.0	-4.9
	V	47.85		3.7	33.4	-40.2	0.0	44.8	172.9	500.0	-9.2
3609.90	H	39.13	Ambient	4.8	34.6	-39.5	0.0	39.0	88.9	500.0	-15.0
	V	35.16	Ambient	4.8	34.6	-39.5	0.0	35.0	56.3	500.0	-19.0
4512.38	H	34.26	Ambient	4.8	35.9	-39.6	0.0	35.4	58.9	500.0	-18.6
	V	34.25	Ambient	4.8	35.9	-39.6	0.0	35.4	58.8	500.0	-18.6
5414.85	H	33.79	Ambient	5.1	36.6	-39.5	0.0	36.0	63.1	500.0	-18.0
	V	35.20	Ambient	5.1	36.6	-39.5	0.0	37.4	74.3	500.0	-16.6
8122.28	H	33.64	Ambient	6.1	38.3	-39.6	0.0	38.4	83.2	500.0	-15.6
	V	33.08	Ambient	6.1	38.3	-39.6	0.0	37.8	78.0	500.0	-16.1
9024.75	H	42.10		6.3	38.6	-39.4	0.0	47.6	240.1	500.0	-6.4
	V	41.16		6.3	38.6	-39.4	0.0	46.7	215.5	500.0	-7.3

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	902.475MHz
Notes	Peak Measurements in Non-Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
902.48	H	94.90		2.9	26.5	0.0	124.3	1631474.2		
	V	93.72		2.9	26.5	0.0	123.1	1424230.2		
1804.95	H	63.50		3.2	31.5	-40.1	58.1	806.1	163147.4	-46.1
	V	66.04		3.2	31.5	-40.1	60.7	1079.9	163147.4	-43.6
6317.33	H	42.31		5.5	38.1	-39.6	46.4	208.3	163147.4	-57.9
	V	44.31		5.5	38.1	-39.6	48.4	262.2	163147.4	-55.9
7219.80	H	45.09		5.9	38.4	-39.7	49.7	305.4	163147.4	-54.6
	V	48.60		5.9	38.4	-39.7	53.2	457.5	163147.4	-51.0

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	915.075MHz
Notes	Peak Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
2745.23	H	54.7		3.7	33.2	-40.2	51.4	372.0	5000.0	-22.6
	V	54.5		3.7	33.2	-40.2	51.2	364.4	5000.0	-22.7
3660.30	H	50.4		4.8	34.8	-39.5	50.4	330.3	5000.0	-23.6
	V	49.9	Ambient	4.8	34.8	-39.5	49.9	313.3	5000.0	-24.1
4575.38	H	49.6	Ambient	4.8	36.4	-39.7	51.1	357.9	5000.0	-22.9
	V	49.9	Ambient	4.8	36.4	-39.7	51.4	369.7	5000.0	-22.6
7320.60	H	50.3		5.8	38.2	-39.6	54.7	541.5	5000.0	-19.3
	V	52.0		5.8	38.2	-39.6	56.4	662.4	5000.0	-17.6
8235.68	H	48.8	Ambient	6.2	38.4	-39.5	53.9	495.4	5000.0	-20.1
	V	49.2	Ambient	6.2	38.4	-39.5	54.3	517.6	5000.0	-19.7
9150.75	H	50.3		6.3	38.7	-39.4	55.9	625.3	5000.0	-18.1
	V	49.1		6.3	38.7	-39.4	54.7	545.8	5000.0	-19.2

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	915.075MHz
Notes	Average Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle Factor (dB)	Average Total at 3m (dBµV/m)	Average Total at 3m (µV/m)	Average Limit at 3m (µV/m)	Margin (dB)
2745.23	H	46.92		3.7	33.2	-40.2	0.0	43.7	152.8	500.0	-10.3
	V	49.04		3.7	33.2	-40.2	0.0	45.8	195.0	500.0	-8.2
3660.30	H	36.68		4.8	34.8	-39.5	0.0	36.7	68.3	500.0	-17.3
	V	36.94	Ambient	4.8	34.8	-39.5	0.0	36.9	70.4	500.0	-17.0
4575.38	H	34.37	Ambient	4.8	36.4	-39.7	0.0	35.8	61.9	500.0	-18.1
	V	34.86	Ambient	4.8	36.4	-39.7	0.0	36.3	65.5	500.0	-17.7
7320.60	H	35.04		5.8	38.2	-39.6	0.0	39.4	93.8	500.0	-14.5
	V	44.52		5.8	38.2	-39.6	0.0	48.9	279.3	500.0	-5.1
8235.68	H	33.56	Ambient	6.2	38.4	-39.5	0.0	38.6	85.6	500.0	-15.3
	V	32.44	Ambient	6.2	38.4	-39.5	0.0	37.5	75.2	500.0	-16.4
9150.75	H	34.17		6.3	38.7	-39.4	0.0	39.8	98.0	500.0	-14.2
	V	34.43		6.3	38.7	-39.4	0.0	40.1	100.9	500.0	-13.9

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	915.075MHz
Notes	Peak Measurements in Non-Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
915.08	H	97.11		2.9	26.3	0.0	126.3	2069000.9		
	V	93.82		2.9	26.3	0.0	123.0	1416643.8		
1830.15	H	65.61		3.3	31.7	-40.1	60.4	1052.2	206900.1	-45.9
	V	65.40		3.3	31.7	-40.1	60.2	1027.0	206900.1	-46.1
5490.45	H	40.02		5.1	36.7	-39.4	42.4	131.8	206900.1	-63.9
	V	43.04		5.1	36.7	-39.4	45.4	186.5	206900.1	-60.9
6405.53	H	43.36		5.6	38.0	-39.5	47.4	233.2	206900.1	-59.0
	V	44.78		5.6	38.0	-39.5	48.8	274.6	206900.1	-57.5

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	927.525MHz
Notes	Peak Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
2782.58	H	58.7		3.8	32.9	-40.1	55.3	580.4	5000.0	-18.7
	V	58.4		3.8	32.9	-40.1	55.0	560.7	5000.0	-19.0
3710.10	H	49.5	Ambient	4.8	34.4	-39.5	49.2	287.9	5000.0	-24.8
	V	50.3	Ambient	4.8	34.4	-39.5	50.0	317.9	5000.0	-23.9
4637.63	H	49.9	Ambient	4.8	36.7	-39.6	51.8	389.7	5000.0	-22.2
	V	50.0	Ambient	4.8	36.7	-39.6	51.9	394.6	5000.0	-22.1
7420.20	H	49.4		5.9	38.0	-39.6	53.7	482.4	5000.0	-20.3
	V	51.7		5.9	38.0	-39.6	56.0	633.7	5000.0	-17.9
8347.73	H	51.0		6.2	38.3	-39.5	56.0	631.0	5000.0	-18.0
	V	50.9		6.2	38.3	-39.5	56.0	629.5	5000.0	-18.0

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	927.525MHz
Notes	Average Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle Factor (dB)	Average Total at 3m (dBµV/m)	Average Total at 3m (µV/m)	Average Limit at 3m (µV/m)	Margin (dB)
2782.58	H	55.44		3.8	32.9	-40.1	0.0	52.0	399.3	500.0	-2.0
	V	54.60		3.8	32.9	-40.1	0.0	51.2	362.5	500.0	-2.8
3710.10	H	34.00	Ambient	4.8	34.4	-39.5	0.0	33.7	48.6	500.0	-20.3
	V	33.98	Ambient	4.8	34.4	-39.5	0.0	33.7	48.4	500.0	-20.3
4637.63	H	34.64	Ambient	4.8	36.7	-39.6	0.0	36.6	67.3	500.0	-17.4
	V	34.67	Ambient	4.8	36.7	-39.6	0.0	36.6	67.5	500.0	-17.4
7420.20	H	35.91		5.9	38.0	-39.6	0.0	40.2	102.7	500.0	-13.8
	V	41.45		5.9	38.0	-39.6	0.0	45.8	194.3	500.0	-8.2
8347.73	H	43.18		6.2	38.3	-39.5	0.0	48.2	257.9	500.0	-5.7
	V	40.79		6.2	38.3	-39.5	0.0	45.8	195.9	500.0	-8.1

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	927.525MHz
Notes	Peak Measurements in Non-Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
927.53	H	96.45		2.9	26.7	0.0	126.0	1997677.9		
	V	92.31		2.9	26.7	0.0	121.9	1240296.3		
1855.05	H	65.29		3.3	31.9	-40.1	60.4	1043.8	199767.8	-45.6
	V	66.95		3.3	31.9	-40.1	62.0	1263.6	199767.8	-44.0
5565.15	H	40.84		5.1	37.2	-39.4	43.7	152.5	199767.8	-62.3
	V	44.61		5.1	37.2	-39.4	47.4	235.4	199767.8	-58.6
6492.68	H	40.44		5.6	38.2	-39.5	44.7	171.4	199767.8	-61.3
	V	43.14		5.6	38.2	-39.5	47.4	233.9	199767.8	-58.6
9275.25	H	40.33		6.4	38.8	-39.4	46.2	204.9	199767.8	-59.8
	V	39.52		6.4	38.8	-39.4	45.4	186.6	199767.8	-60.6

28. Band-Edge Compliance

EUT Information	
Manufacturer	Otto Engineering
Product	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx

Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Antenna Conducted
Type of Test Site	N/A
Type of Antennas Used	N/A
Notes	N/A

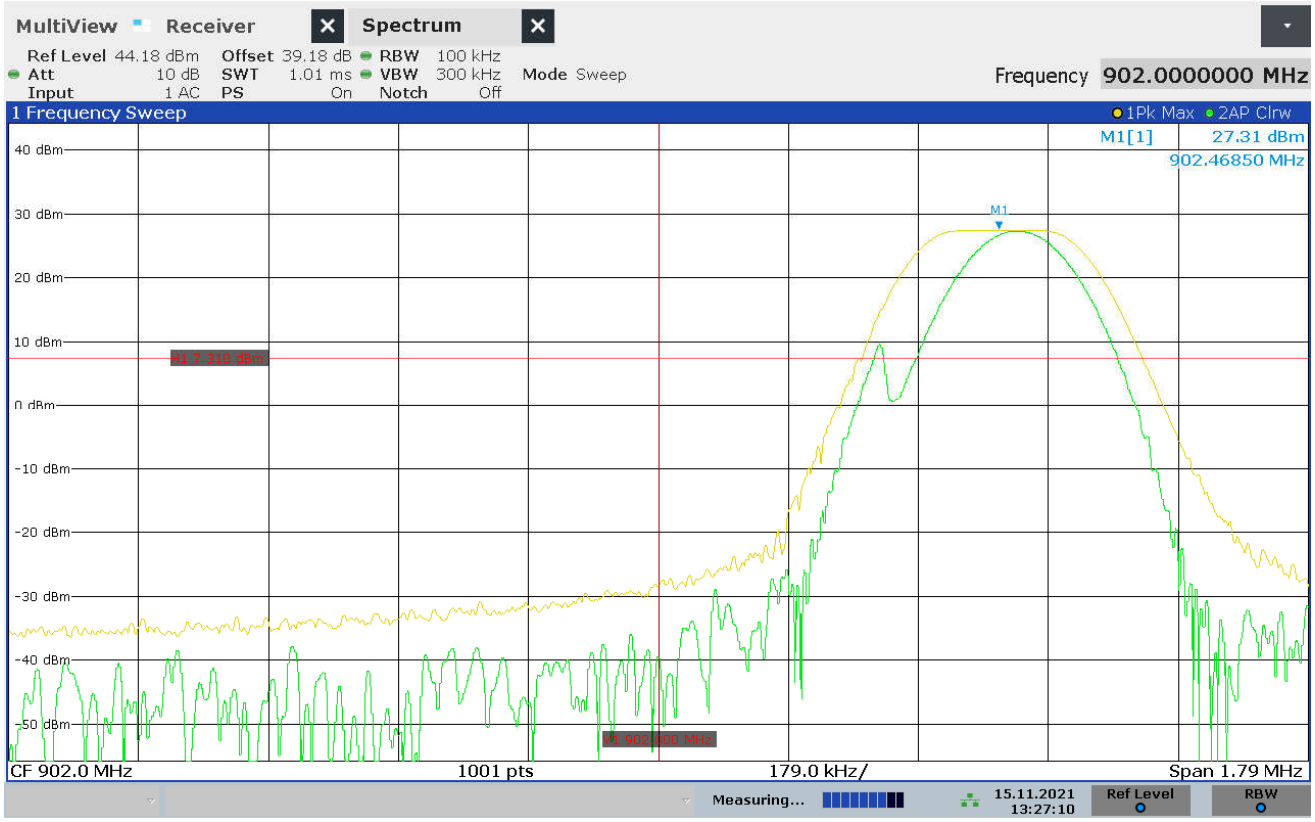
Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3

Procedure

1) Low Band Edge:
   a) The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation.
   b) The EUT was set to transmit continuously at the channel closest to the low band-edge with the hopping function disabled.
   c) To determine the band edge compliance, the following spectrum analyzer settings were used:
      - Center Frequency = 902MHz (low band-edge frequency).
      - Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
      - Resolution Bandwidth (RBW) = ≥ 1% of the span.
      - 'Max-Hold' function was engaged.
   d) The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.
   e) The marker was set on the peak of the in-band emissions. A display line was placed 20dB down from the peak of the in-band emissions. All emissions which fall outside of the authorized band of operation must be below the 20dB down display line. (All emissions to the left of the center frequency (band-edge) must be below the display line.)
   f) The analyzer's display was then screenshot and saved.
   g) Steps (d) through (f) were repeated with the frequency hopping function enabled.

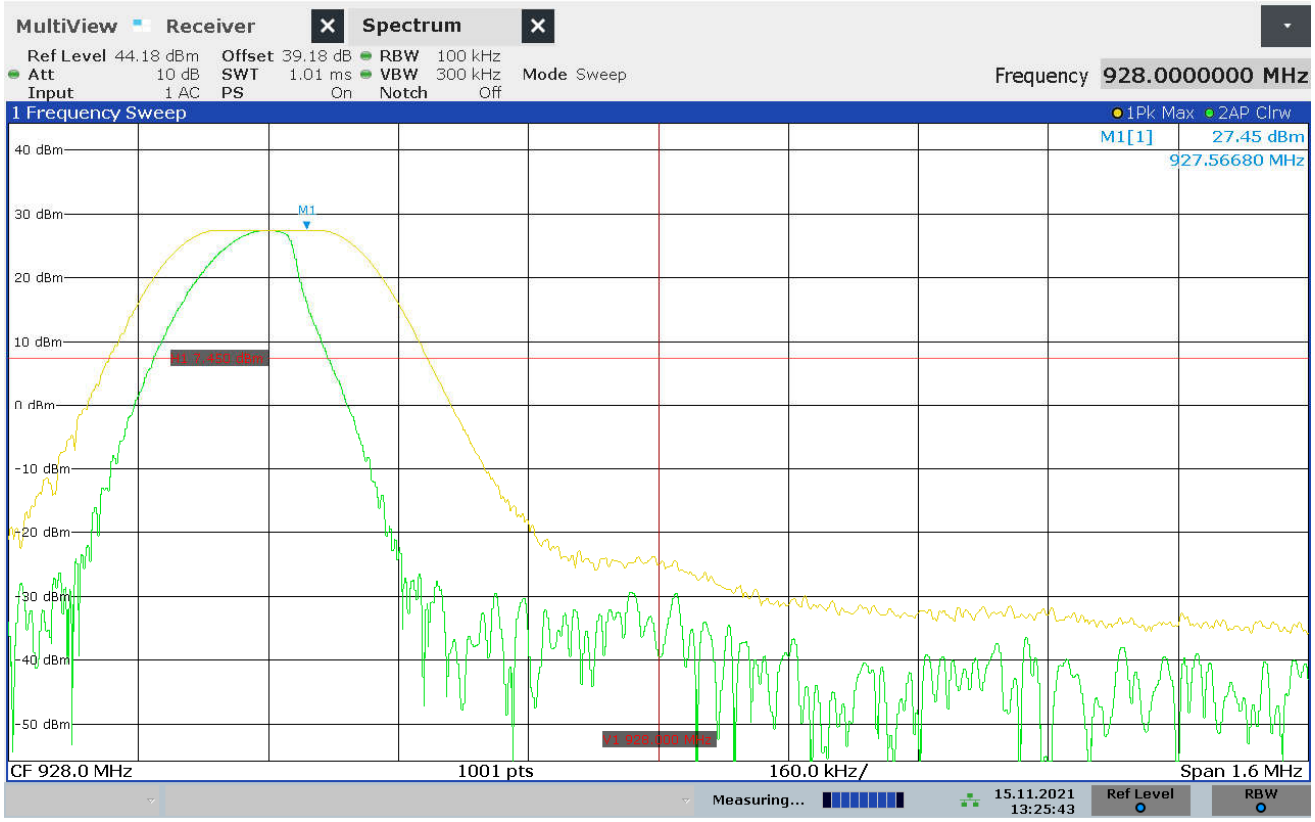
2) High Band Edge
   a) The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation.
   b) The EUT was set to transmit continuously at the channel closest to the high band-edge with the hopping function disabled.
   c) To determine the band edge compliance, the following spectrum analyzer settings were used:
      - Center Frequency = 928MHz (high band-edge frequency).
      - Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
      - Resolution Bandwidth (RBW) = ≥ 1% of the span.
      - 'Max-Hold' function was engaged.
   d) The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.
   e) The marker was set on the peak of the in-band emissions. A display line was placed 20dB down from the peak of the in-band emissions. All emissions which fall outside of the authorized band of operation must be below the 20dB down display line. (All emissions to the left of the center frequency (band-edge) must be below the display line.)
   f) The analyzer's display was then screenshot and saved.
   g) Steps (d) through (f) were repeated with the frequency hopping function enabled.

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	902.475MHz
Notes	Low Band Edge



13:27:11 15.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Tx
Frequency Tested	927.525MHz
Notes	High Band Edge

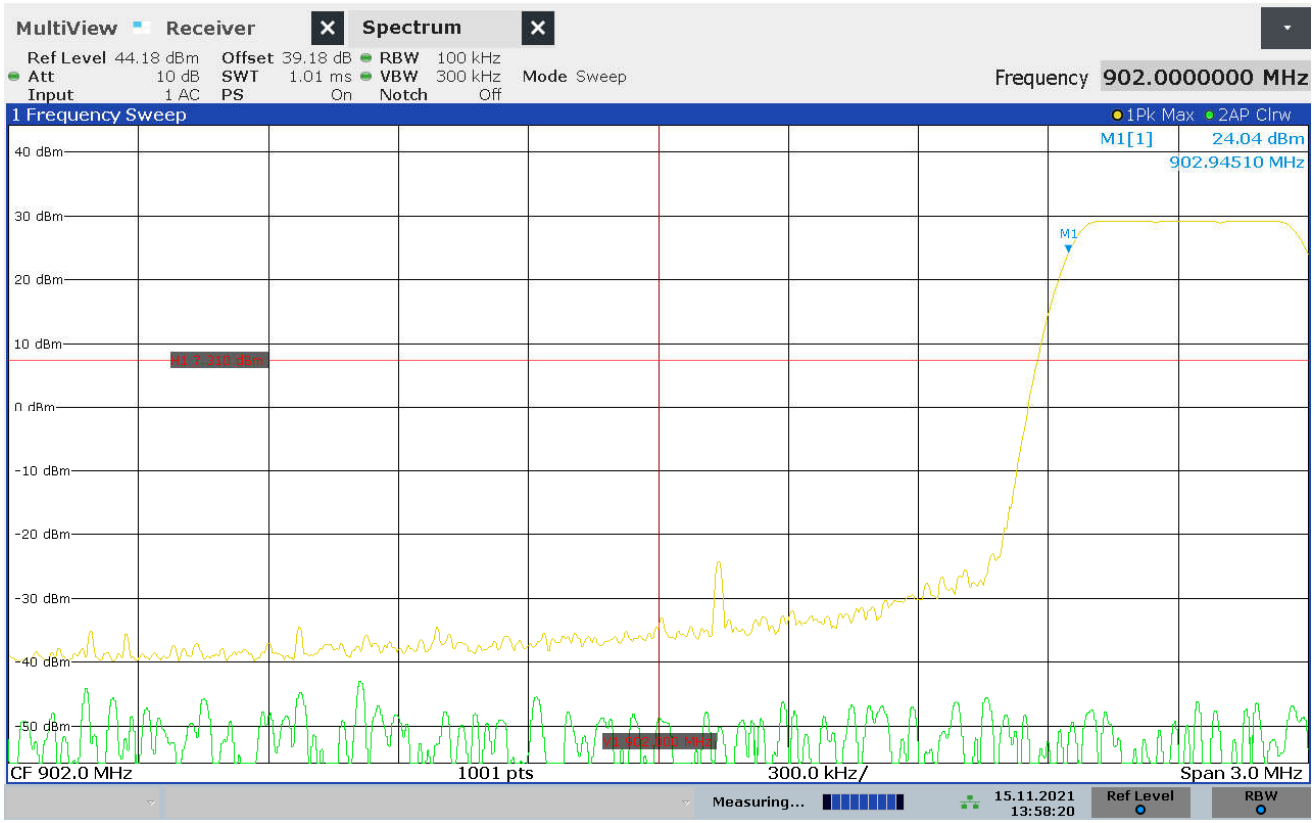


13:25:44 15.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Hopping
Notes	Low and High Band Edge

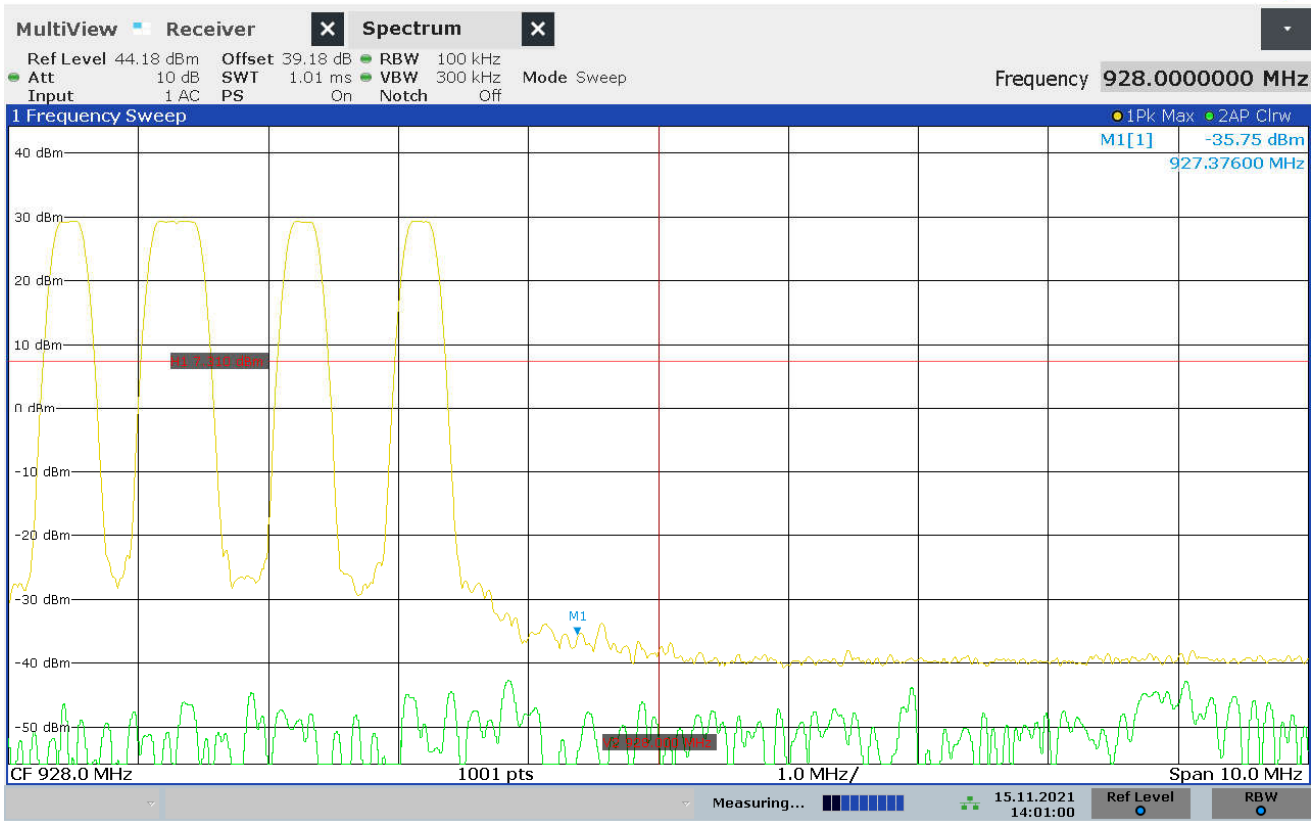
13:48:55 15.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Hopping
Notes	Low Band Edge



13:58:20 15.11.2021

Test Details	
Manufacturer	Otto Engineering
EUT	Lynq-PRO Handheld GPS/LoRa/BT device
Model No.	OTTOVL01
Serial No.	N/A
Mode	Hopping
Notes	High Band Edge



14:01:01 15.11.2021

30. Scope of Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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ELECTRICAL

Valid To: June 30, 2023 Certificate Number: 1786.01

In recognition of the successful completion of the A2LA Accreditation Program evaluation process, accreditation is granted to this laboratory to perform the following automotive electromagnetic compatibility and other electrical tests:

Test Technology:	Test Method(s) [1]:
Transient Immunity	ISO 7637-2 (including emissions); ISO 7637-3; ISO 16750-2:2012, Sections 4.6.3 and 4.6.4; CS-11979, Section 6.4; CS.00054, Section 5.9; EMC-CS-2009.1 (CI220); FMC1278 (CI220, CI221, CI222); GMW 3097, Section 3.5; SAE J1113-11; SAE J1113-12; ECE Regulation 10.06 Annex 10
Electrostatic Discharge (ESD)	ISO 10605 (2001, 2008); CS-11979 Section 7.0; CS.00054, Section 5.10; EMC-CS-2009.1 (CI 280); FMC1278 (CI280); SAE J1113-13; GMW 3097 Section 3.6
Conducted Emissions	CISPR 25 (2002, 2008), Sections 6.2 and 6.3; CISPR 25 (2016), Sections 6.3 and 6.4; CS-11979, Section 5.1; CS.00054, Sections 5.6.1 and 5.6.2; GMW 3097, Section 3.3.2; EMC-CS-2009.1 (CE 420); FMC1278 (CE420, CE421)
Radiated Emissions Anechoic	CISPR 25 (2002, 2008), Section 6.4; CISPR 25 (2016), Section 6.5; CS-11979, Section 5.3; CS.00054, Section 5.6.3; GMW 3097, Section 3.3.1; EMC-CS-2009.1 (RE 310); FMC1278 (RE310); ECE Regulation 10.06 Annex 7 (Broadband) ECE Regulation 10.06 Annex 8 (Narrowband)

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Test Technology:	Test Method(s) [1]:
Vehicle Radiated Emissions	CISPR 12; CISPR 36; ICES-002; ECE Regulation 10.06 Annex 5
Bulk Current Injection (BCI)	ISO 11452-4; CS-11979, Section 6.1; CS.00054, Section 5.8.1; GMW 3097, Section 3.4.1; SAE J1113-4; EMC-CS-2009.1 (RI112); FMC1278 (RI112); ECE Regulation 10.06 Annex 9
Radiated Immunity Anechoic *(Including Radar Pulse)*	ISO 11452-2; ISO 11452-5; CS-11979, Section 6.2; CS.00054, Section 5.8.2; GMW 3097, Section 3.4.2; EMC-CS-2009.1 (RI114); FMC1278 (RI114); SAE J1113-21; ECE Regulation 10.06 Annex 9
Radiated Immunity Magnetic Field	ISO 11452-8
Radiated Immunity Reverb	ISO/IEC 61000-4-21; GMW 3097, Section 3.4.3; EMC-CS-2009.1 (RI114); FMC1278 (RI114); ISO 11452-11
Radiated Immunity *(Portable Transmitters)*	ISO 11452-9; EMC-CS-2009.1 (RI115); FMC1278 (RI115)
Vehicle Radiated Immunity (ALSE)	ISO 11451-2; ECE Regulation 10.06 Annex 6
Vehicle Product Specific EMC Standards	EN 14982; EN ISO 13309, ISO 13766; EN 50498; EC Regulation No. 2015/208; EN 55012
Electrical Loads	ISO 16750-2
Emissions Radiated and Conducted (3m Semi-anechoic chamber, up to 40 GHz)	47 CFR, FCC Part 15 B (using ANSI C63.4:2014); 47 CFR, FCC Part 18 (using FCC MP-5:1986); ICES-001; ICES-003; ICES-005; IEC/CISPR 11, Ed. 4.1 (2004-06); AS/NZS CISPR 11 (2004); IEC/CISPR 11 Ed 5 (2009-05) + A1 (2010); KN 11 (2008-5) with RRL Notice No. 2008-3 (May 20, 2008); CISPR 11; EN 55011; KS C 9811; CNS 13803 (1997, 2003); CISPR 14-1; EN 55014-1; AS/NZS CISPR 14.1; KS C 9814-1; KN 14-1; IEC/CISPR 22 (1997); EN 55022 (1998) + A1(2000); EN 55022 (1998) + A1(2000) + A2(2003); EN 55022 (2006); IEC/CISPR 22 (2008-09); AS/NZS CISPR 22 (2004); AS/NZS CISPR 22, 3rd Edition (2006); KN 22 (up to 6 GHz); CNS 13438 (up to 6 GHz); VCCI V-3 (up to 6 GHz); CISPR 32; EN 55032; KS C 9832; KN 32; ECE Regulation 10.06 Annex 14
Cellular Radiated Spurious Emissions	ETSI TS 151 010-1 GSM; 3GPP TS 51.010-1, Sec 12; ETSI TS 134 124 UMTS; 3GPP TS 34.124; ETSI TS 136 124 LTE; E-UTRA; 3GPP TS 36.124

Test Technology:	Test Method(s) [1]:
Emissions (cont'd)	
Current Harmonics	IEC 61000-3-2; EN 61000-3-2; KN 61000-3-2; KS C 9610-3-2; ECE Regulation 10.06 Annex 11
Flicker and Fluctuations	IEC 61000-3-3; EN 61000-3-3; KN 61000-3-3; KS C 9610-3-3; ECE Regulation 10.06 Annex 12
Immunity	
Electrostatic Discharge	IEC 61000-4-2, Ed. 1.2 (2001); IEC 61000-4-2 (1995) + A1(1998) + A2(2000); EN 61000-4-2 (1995); EN 61000-4-2 (2009-05); KN 61000-4-2 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-2; EN 61000-4-2; KN 61000-4-2; KS C 9610-4-2; IEEE C37.90.3 2001
Radiated Immunity	IEC 61000-4-3 (1995) + A1(1998) + A2(2000); IEC 61000-4-3, Ed. 3.0 (2006-02); IEC 61000-4-3, Ed. 3.2 (2010); KN 61000-4-3 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-3; EN 61000-4-3; KN 61000-4-3; KS C 9610-4-3; IEEE C37.90.2 2004
Electrical Fast Transient/Burst	IEC 61000-4-4, Ed. 2.0 (2004-07); IEC 61000-4-4, Ed. 2.1 (2011); IEC 61000-4-4 (1995) + A1(2000) + A2(2001); KN 61000-4-4 (2008-5); RRL Notice No. 2008-5 (May 20, 2008); IEC 61000-4-4; EN 61000-4-4; KN 61000-4-4; KS C 9610-4-4; ECE Regulation 10.06 Annex 15
Surge	IEC 61000-4-5 (1995) + A1(2000); IEC 61000-4-5, Ed 1.1 (2005-11); EN 61000-4-5 (1995) + A1(2001); KN 61000-4-5 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-5; EN 61000-4-5; KN 61000-4-5; KS C 9610-4-5; IEEE C37.90.1 2012; IEEE STD C62.41.2 2002; ECE Regulation 10.06 Annex 16
Conducted Immunity	IEC 61000-4-6 (1996) + A1(2000); IEC 61000-4-6, Ed 2.0 (2006-05); IEC 61000-4-6 Ed. 3.0 (2008); KN 61000-4-6 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); EN 61000-4-6 (1996) + A1(2001); IEC 61000-4-6; EN 61000-4-6; KN 61000-4-6; KS C 9610-4-6

Test Technology:	Test Method(s) [1]:
Immunity (cont'd)	
Power Frequency Magnetic Field Immunity (*Down to 3 A/m*)	IEC 61000-4-8 (1993) + A1(2000); IEC 61000-4-8 (2009); EN 61000-4-8 (1994) + A1(2000); KN 61000-4-8 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-8; EN 61000-4-8; KN 61000-4-8; KS C 9610-4-8
Voltage Dips, Short Interrupts, and Line Voltage Variations	IEC 61000-4-11, Ed. 2 (2004-03); KN 61000-4-11 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-11; EN 61000-4-11; KN 61000-4-11; KS C 9610-4-11
Ring Wave	IEC 61000-4-12, Ed. 2 (2006-09); EN 61000-4-12:2006; IEC 61000-4-12; EN 61000-4-12; KN 61000-4-12; IEEE STD C62.41.2 2002
Generic and Product Specific EMC Standards	IEC/EN 61000-6-1; AS/NZS 61000-6-1; KN 61000-6-1; KS C 9610-6-1; IEC/EN 61000-6-2; AS/NZS 61000-6-2; KN 61000-6-2; KS C 9610-6-2; IEC/EN 61000-6-3; AS/NZS 61000-6-3; KN 61000-6-3; KS C 9610-6-3; IEC/EN 61000-6-4; AS/NZS 61000-6-4; KN 61000-6-4; KS C 9610-6-4; EN 50130-4; EN 61326-1; EN 50121-3-2; EN 12895; EN 50270; EN 50491-1; EN 50491-2; EN 50491-3; EN 55015; EN 60730-1; EN 60945; IEC 60533; EN 61326-2-6; EN 61800-3; IEC/CISPR 14-2; EN 55014-2; AS/NZS CISPR 14.2; KN 14-2; KS C 9814-2; IEC/CISPR 24; AS/NZS CISPR 24; EN 55024; KN 24; IEC/CISPR 35; AS/NZS CISPR 35; EN 55035; KN 35; KS C 9835; IEC 60601-1-2; JIS T0601-1-2
TxRx EMC Requirements	EN 301 489-1; EN 301 489-3; EN 301 489-9; EN 301 489-17; EN 301 489-19; EN 301 489-20
European Radio Test Standards	ETSI EN 300 086-1; ETSI EN 300 086-2; ETSI EN 300 113-1; ETSI EN 300 113-2; ETSI EN 300 220-1; ETSI EN 300 220-2; ETSI EN 300 220-3-1; ETSI EN 300 220-3-2; ETSI EN 300 330-1; ETSI EN 300 330-2; ETSI EN 300 440-1; ETSI EN 300 440-2; ETSI EN 300 422-1; ETSI EN 300 422-2; ETSI EN 300 328; ETSI EN 301 893; ETSI EN 301 511; ETSI EN 301 908-1; ETSI EN 908-2; ETSI EN 908-13; ETSI EN 303 413; ETSI EN 302 502; EN 303 340; EN 303 345-2; EN 303 345-3; EN 303 345-4

Test Technology:	Test Method(s) [1]:
Canadian Radio Tests	RSS-102 (RF Exposure Evaluation only); RSS-111; RSS-112; RSS-117; RSS-119; RSS-123; RSS-125; RSS-127; RSS-130; RSS-131; RSS-132; RSS-133; RSS-134; RSS-135; RSS-137; RSS-139; RSS-140; RSS-141; RSS-142; RSS-170; RSS-181; RSS-182; RSS-191; RSS-192; RSS-194; RSS-195; RSS-196; RSS-197; RSS-199; RSS-210; RSS-211; RSS-213; RSS-215; RSS-216; RSS-220; RSS-222; RSS-236; RSS-238; RSS-243; RSS-244; RSS-247; RSS-251; RSS-252; RSS-287; RSS-288; RSS-310; RSS-GEN
Mexico Radio Tests	IFT-008-2015; NOM-208-SCFI-2016
Japan Radio Tests	Radio Law No. 131, Ordinance of MPT No. 37, 1981, MIC Notification No. 88:2004, Table No. 22-11; ARIB STD-T66, Regulation 18
Taiwan Radio Tests	LP-0002 (July 15, 2020)
Australia/New Zealand Radio Tests	AS/NZS 4268; Radiocommunications (Short Range Devices) Standard (2014)
Hong Kong Radio Tests	HKCA 1039 Issue 6; HKCA 1042; HKCA 1033 Issue 7; HKCA 1061; HKCA 1008; HKCA 1043; HKCA 1057; HKCA 1073
Korean Radio Test Standards	KN 301 489-1; KN 301 489-3; KN 301 489-9; KN 301 489-17; KN 301 489-52; KS X 3124; KS X 3125; KS X 3130; KS X 3126; KS X 3129
Vietnam Radio Test Standards	QCVN 47:2015/BTTTT; QCVN 54:2020/BTTTT; QCVN 55:2011/BTTTT; QCVN 65:2013/BTTTT; QCVN 73:2013/BTTTT; QCVN 74:2020/BTTTT; QCVN 112:2017/BTTTT; QCVN 117:2020//BTTTT
Vietnam EMC Test Standards	QCVN 18:2014/BTTTT; QCVN 86:2019/BTTTT; QCVN 96:2015/BTTTT; QCVN 118:2018/BTTTT
Unlicensed Radio Frequency Devices *(3 Meter Semi-Anechoic Room)*	47 CFR FCC Part 15C, 15D, 15E, 15F, 15G, 15H (using ANSI C63.10:2013, ANSI C63.17:2013 and FCC KDB 905462 D02 (v02))
Licensed Radio Service Equipment	47 CFR FCC Parts 20, 22, 24, 25, 27, 30, 73, 74, 80, 87, 90, 95, 96, 97, 101 (using ANSI/TIA-603-E, TIA-102.CAAA-E, ANSI C63.26:2015)

Test Technology:	Test Method(s) [1]:
OTA (Over the Air) Performance GSM, GPRS, EGPRS UMTS (W-CDMA) LTE including CAT M1 A-GPS for UMTS/GSM LTS A-GPS, A-GLONASS, SIB8/SIB16 Large Device/Laptop/Tablet Testing Integrated Device Testing WiFi 802.11 a/b/g/n/a	CTIA Test Plan for Wireless Device Over-the-Air Performance (Method for Measurement for Radiated Power and Receiver Performance) V3.8.2; CTIA Test Plan for RF Performance Evaluation of WiFi Mobile Converged Devices V2.1.0
Electrical Measurements and Simulation AC Voltage / Current (1mV to 5kV) 60 Hz (0.1V to 250V) up to 500 MHz (1µA to 150A) 60 Hz DC Voltage / Current (1mV to 15-kV) / (1µA to 10A) Power Factor / Efficiency / Crest Factor (Power to 30kW) Resistance (1mΩ to 4000MΩ) Surge (Up to 10 kV / 5 kA) (Combination Wave and Ring Wave)	 FAA AC 150/5345-10H FAA AC 150/5345-43J FAA AC 150/5345-44K FAA AC 150/5345-46E FAA AC 150/5345-47C FAA EB 67D

On the following products and materials:
Telecommunications Terminal Equipment (TTE), Radio Equipment, Network Equipment, Information Technology Equipment (ITE), Automotive Electronic Equipment, Automotive Hybrid Electronic Devices, Maritime Navigation and Radio Communication Equipment and Systems, Vehicles, Boats and Internal Combustion Engine Driven Devices, Automotive, Aviation, and General Lighting Products, Medical Electrical Equipment, Motors, Industrial, Scientific and Medical (ISM) Radio-Frequency Equipment, Household Appliances, Electric Tools, Low-voltage Switchgear and Control gear, Programmable Controllers, Electrical Equipment for Measurement, Control and Laboratory Use, Base Materials, Power and Data Transmission Cables and Connectors

[1] When the date, edition, version, etc. is not identified in the scope of accreditation, laboratories may use the version that immediately precedes the current version for a period of one year from the date of publication of the standard measurement method, per part C., Section 1 of A2LA *R101 - General Requirements - Accreditation of ISO-IEC 17025 Laboratories*.

Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1[2]

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Unintentional Radiators Part 15B	ANSI C63.4:2014	40000

Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1[2]

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Industrial, Scientific, and Medical Equipment Part 18	FCC MP-5 (February 1986)	40000
Intentional Radiators Part 15C	ANSI C63.10:2013	40000
Unlicensed Personal Communication Systems Devices Part 15D	ANSI C63.17:2013	40000
U-NII without DFS Intentional Radiators Part 15E	ANSI C63.10:2013	40000
U-NII with DFS Intentional Radiators Part 15E	FCC KDB 905462 D02 (v02)	40000
UWB Intentional Radiators Part 15F	ANSI C63.10:2013	40000
BPL Intentional Radiators Part 15G	ANSI C63.10:2013	40000
White Space Device Intentional Radiators Part 15H	ANSI C63.10:2013	40000
Commercial Mobile Services (FCC Licensed Radio Service Equipment) Parts 22 (cellular), 24, 25 (below 3 GHz), and 27	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
General Mobile Radio Services (FCC Licensed Radio Service Equipment) Parts 22 (non-cellular), 90 (below 3 GHz), 95, 97, and 101 (below 3 GHz)	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
Citizens Broadband Radio Services (FCC Licensed Radio Service Equipment) Part 96	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000

Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1[2]

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Maritime and Aviation Radio Services		
Parts 80 and 87	ANSI/TIA-603-E; ANSI C63.26:2015	40000
Microwave and Millimeter Bands Radio Services		
Parts 25, 30, 74, 90 (above 3 GHz), 97 (above 3 GHz), and 101	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
Broadcast Radio Services		
Parts 73 and 74 (below 3 GHz)	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
Signal Boosters		
Part 20 (Wideband Consumer Signal Boosters, Provider-specific signal boosters, and Industrial Signal Boosters) Section 90.219	ANSI C63.26:2015	40000

[2] Accreditation does not imply acceptance to the FCC equipment authorization program. Please see the FCC website (https://apps.fcc.gov/oetcf/eas/) for a listing of FCC approved laboratories.

Accredited Laboratory

A2LA has accredited

ELITE ELECTRONIC ENGINEERING INC.

Downers Grove, IL

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories.* This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 19th day of May 2021.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 1786.01
Valid to June 30, 2023

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.