2360

Radio Test Report

Domo Tactical Communications
SOL7TX

47 CFR Part 90I Effective Date 1st October 2020
↳ 47CFR part 2J 2019
TNB: Licensed Non-Broadcast Station Transmitter
Test Date: 3rd June 2021 to 25th August 2021
Report Number: 06-12927-1-21 Issue 02
Supersedes Report Number: 06-12927-1-21 Issue 01

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Certificate of Test 12927-1

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of FCC Part 90I. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	SOL7TX
Model Number:	SOL7TX
Unique Serial Number:	040594 (TX Radiated Spurious Emissions) 040419 (all other tests)
Applicant:	Domo Tactical Communications Fusion 2, 1100 Parkway, Whiteley Hampshire, United Kingdom PO15 7AB
Proposed FCC ID	XRF-SOL7TX
Full measurement results are detailed in Report Number:	06-12927-1-21 Issue 02
Test Standards:	47 CFR Part 90I Effective Date 1st October 2020 ↳ 47CFR part 2J 2019 TNB: Licensed Non-Broadcast Station Transmitter

NOTE:
Certain tests were not performed based upon manufacturer's declarations. Certain other requirements are subject to manufacturer declaration only and have not been tested/verified. For details refer to section 3 of this report.

DEVIATIONS:
No deviations have been applied.

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Federal Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Date Of Test:	3rd June 2021 to 25th August 2021
Test Engineer:	
Approved By: Radio Approvals Manager	Digitally signed by: Daniel Sims DN: CN = Daniel Sims C = GB O = RN Electronics Ltd Date: 2021.08.27 11:54:05 Z
Customer Representative:	

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0 Revision History

Issue Number	Revision History	Page Reference(s)
01	First Issue	-
02	Updated last test date Updated declared power to +22dBm Updated report issued date Updated declared power to +22dBm per channel Updated declared power to +22dBm in all tables and headings Replaced middle channel TX CE plot with corrected middle channel plot	1, 2, 5 5 6 7 10-33 24

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Domo Tactical Communications Fusion 2 1100 Parkway Whiteley Hampshire United Kingdom PO15 7AB	
Manufacturer of EUT	Domo Tactical Communications	
Full Name of EUT	SOL7TX	
Model Number of EUT	SOL7TX	
Serial Number of EUT	040594 (TX Spurious Emissions) 040419 (all other tests)	
Date Received	3rd June 2021	
Date of Test:	3rd June 2021 to 25th August 2021	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	27th August 2021	
Main Function	2.4 GHz mesh radio operating under FCC part 90.	
Information Specification	Height	65 mm
	Width	65 mm
	Depth	15 mm
	Weight	0.2 kg
	Voltage	12 VDC
	Current	2 Amp
EUT Supplied PSU	Manufacturer	Cincon Electronics Co Ltd
	Model number	TRG45A120
	Serial number	45120-0014973
	Input voltage	100 - 240 V AC 47 - 63 Hz
	Input current	1.05 Amp
	Output	12 V DC 3.75 Amp

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Fixed
Choice of model(s) for type tests	Production Sample
Antenna details	External
Antenna port	1 x sma type
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	2481 MHz
Lowest Signal generated in EUT	Not specified
Hardware Version	D1550 V5.0/D1517 3.1
Software Version	V3.4.0
Firmware Version	N/A
Type of Equipment	Licensed non-broadcast transmitter
Technology Type	COFDM
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	2450 – 2483.5 MHz
EUT Declared Modulation Parameters	QPSK, BPSK, 8PSK, 16QAM
EUT Declared Power level	+22 dBm (158.5 mW)
EUT Declared Signal Bandwidths	2.5 MHz
EUT Declared Channel Spacing's	2.5 MHz
EUT Declared Duty Cycle	Up to 100%
Unmodulated carrier available?	No
Declared frequency stability	1 ppm
RX Parameters	
Alignment range – receiver	2450 – 2483.5 MHz
EUT Declared RX Signal Bandwidth	Not declared
Receiver Signal Level (RSL)	Not declared

2.3 Functional description

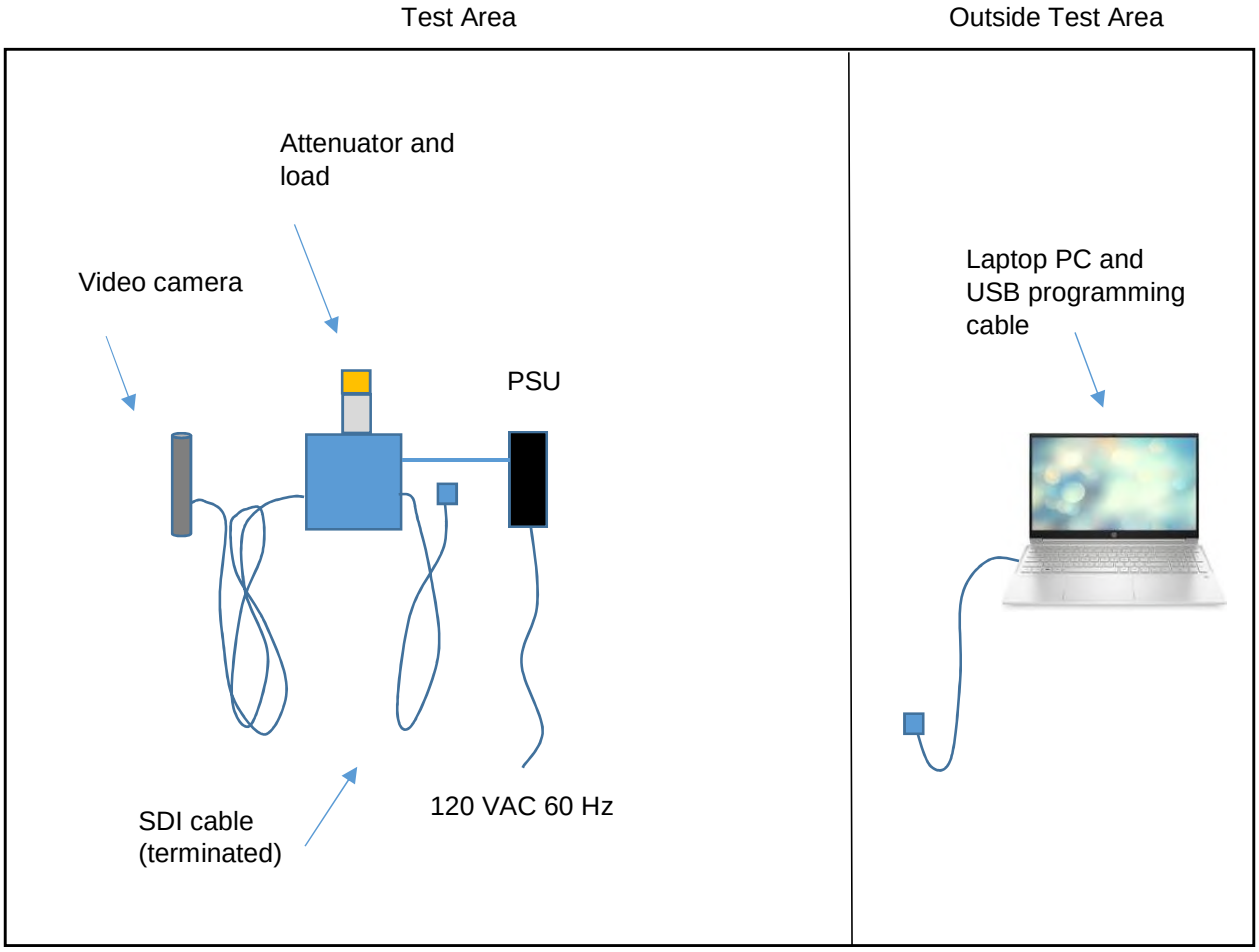
2.4 GHz mesh radio operating under FCC part 90.

2.4 Modes of operation

Mode Reference	Description	Used for testing
mode 1	EUT continuously transmitting at 2452.5 MHz using BPSK modulation	Yes
mode 2	EUT continuously transmitting at 2466.75 MHz using BPSK modulation	Yes
mode 3	EUT continuously transmitting at 2481 MHz using BPSK modulation	Yes
mode 4	EUT continuously transmitting at 2452.5 MHz using QPSK modulation	Yes
mode 5	EUT continuously transmitting at 2466.75 MHz using QPSK modulation	Yes
mode 6	EUT continuously transmitting at 2481 MHz using QPSK modulation	Yes
mode 7	EUT continuously transmitting at 2452.5 MHz using 8PSK modulation	Yes
mode 8	EUT continuously transmitting at 2466.75 MHz using 8PSK modulation	Yes
mode 9	EUT continuously transmitting at 2481 MHz using 8PSK modulation	Yes
mode 10	EUT continuously transmitting at 2452.5 MHz using 16QAM modulation	Yes
mode 11	EUT continuously transmitting at 2466.75 MHz using 16QAM modulation	Yes
mode 12	EUT continuously transmitting at 2481 MHz using 16QAM modulation	Yes

Note: All modes left at default full power setting (+20dBm).

2.5 Emissions configuration



The EUT and ancillary equipment was placed on a turntable inside the test chamber. The unit was powered from the supplied AC/DC power supply. The power supply was connected to a 120 VAC 60 Hz mains source. The EUT's antenna was removed and the antenna port was terminated with an attenuator and an RF load. A cable was connected to the EUT's SDI port and this was terminated with a BNC load. A video camera was connected to the EUT and the excess cables was bundled. The unit was configured with engineering menus in software to allow permanent transmit modes of device on the top, middle and bottom channels as stated within section 2.4 of this report. The unit has a single modulation scheme and bandwidth. For measurements at extremes of voltage and temperature, the AC/DC supply was replaced with a bench power supply, this allowed the supply voltage to be adjusted to the extreme levels as stated in section 4.3. The transmit mode was 100% continuous with modulation and the power settings used for each channel were as stated below:-

Low Channel (2452.5 MHz) = level 22 dBm
Mid Channel (2466.75 MHz) = level 22 dBm
High Channel (2481.0 MHz) = level 22 dBm

2.5.1 Signal leads

Port Name	Cable Type	Connected
Antenna	SMA Connector	Yes
SDI	MCX Connector	Yes
USB	USB Micro	No (See note)
Power / Control	Hirose connector	Yes

Note: USB port only used for initial configuration.

3 Summary of test results

The SOL7TX was tested for compliance to the following standard(s):

47 CFR Part 90I Effective Date 1st October 2020
↳ 47CFR part 2J 2019
TNB: Licensed Non-Broadcast Station Transmitter

Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard or the essential requirements of the directive, particularly under different conditions to those during testing. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Title	References	Results
Transmitter Tests		
1. Radiated emissions	FCC Part 90I Clause 90.210(b), 47CFR part 2J Clause 2.1053	PASSED[5]
2. Conducted emissions	FCC Part 90I Clause 90.210(b), 47CFR part 2J Clause 2.1051	PASSED
3. Conducted power	FCC Part 90I Clause 90.205(o), FCC Part 90I Clause 2.1046	PASSED
4. Frequency stability	FCC Part 90I Clause 90.213(a), 47CFR part 2J Clause 2.1055	PASSED
5. Occupied bandwidth	FCC Part 90I Clause 90.209, 47CFR part 2J Clause 2.1049	PASSED
6. Emission mask	FCC Part 90I Clause 90.210(b)	PASSED
7. Modulation limiting	47CFR part 2J Clause 2.1047(b)	NOT APPLICABLE[3]
8. Modulation frequency response	47CFR part 2J Clause 2.1047(a)	NOT APPLICABLE[3]
9. Transient frequency behaviour	FCC Part 90I Clause 90.214	NOT APPLICABLE[4]
10. Adjacent channel power	FCC Part 90I Clause 90.221	NOT APPLICABLE[1]
11. Duty Cycle / TX on times	-	NOT APPLICABLE[2]

[1] EUT does not operate within the bands 150 - 174 MHz, 809 - 824 MHz nor 854 - 869 MHz

[2] No limit requirement. EUT confirmed as operating at 100% for tests.

[3] EUT employs digital modulation, test only applicable for analogue audio products.

[4] EUT does not operate within the bands 150 - 174 MHz and 421 - 512 MHz

[5] Spectrum investigated up to a frequency of 25 GHz based on 10 times the highest channel/ signal generated in equipment of 2481 MHz.

4 Specifications

The tests were performed and operated in accordance with R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	FCC Part 90I	2020	Part 90 - Private Land Mobile Radio Services - Subpart I - General Technical standards
4.1.2	47CFR part 2J	2019	Part 2 – Frequency Allocations and radio treaty matters; General rules and regulations
4.1.3	ANSI C63.26	2015	American National Standard for Compliance testing of transmitters used in Licensed radio services

4.2 Deviations

No deviations were applied

4.3 Tests at extremes of temperature & voltage

The following test conditions were used to simulate testing at nominal or extremes.

Temperature Test Conditions		Voltage Test Conditions	
T nominal	20 °C	V nominal	12V DC
T minimum	-30 °C	V minimum	10.2V DC
T maximum	50 °C	V maximum	13.8V DC

Extremes of voltage are based upon the nominal supply voltage +/- 15%.
Extremes of temperature are based upon the requirements of the standard.
The ambient test conditions of humidity and pressure in the laboratory were as specified in each specific test section within this report

4.4 Test fixtures

In order to measure RF parameters at temperature extremes, the EUT was tested in a temperature controlled chamber as follows:

The equipment external RF port was used for testing.

5 Tests, methods and results

5.1 Radiated emissions

5.1.1 Test methods

Test Requirements:	FCC Part 90I Clause 90.210(b) [Reference 4.1.1 of this report], 47CFR part 2J Clause 2.1053 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 Clause 5.5 [Reference 4.1.3 of this report]
Limits:	FCC Part 90I Clause 90.210(b)(3) [Reference 4.1.1 of this report]

5.1.2 Configuration of EUT

The EUT was tested in an ALSE and ambient conditions were monitored. The transmit port was terminated with a 50 Ohm load. Three orthogonal planes were examined. All test modes specified in section 2.4 were initially checked; modulation scheme using QPSK was found to be worst case for emissions and, therefore, the EUT was operated in mode 4, mode 5 and mode 6 for this test.

5.1.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section at Site M and B. Peak field strength from the EUT was maximised by rotating it 360 degrees. An RMS detector was used for final measurements.

25MHz - 1GHz.
The measuring antenna was scanned 1 - 4m in both Horizontal and Vertical polarisations. Substitution method was performed using tuned dipoles / a calibrated bi-conical antenna.

1GHz – 25 GHz.
The measuring antenna was used in both Horizontal and Vertical polarisations. Substitution method was performed using standard gain horn antennas.

5.1.4 Test equipment

CAL07, CAL08, E005, E136, E268, E411, E429, E602, E624, E755, TMS78, TMS79, TMS812, TMS82, LPE364

See Section 8 for more details

5.1.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	101kPa

Setup Table

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	QPSK
Low channel	2452.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No emissions within 20 dB of the limit were observed				

Setup Table

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	QPSK
Mid channel	2466.75 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No emissions within 20 dB of the limit were observed				

Setup Table

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	QPSK
High channel	2481.0 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No emissions within 20 dB of the limit were observed				

LIMITS:
Part 90.210(b)(3), -13 dBm

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:

30MHz - 1000MHz ±6.1dB, 1 – 18 GHz ±3.5dB, 18 – 25 GHz ±3.9dB

5.2 Conducted emissions

5.2.1 Test methods

Test Requirements:	FCC Part 90I Clause 90.210(b) [Reference 4.1.1 of this report], 47CFR part 2J Clause 2.1051 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 Clause 5.7 [Reference 4.1.3 of this report]
Limits:	FCC Part 90I Clause 90.210(b)(3) [Reference 4.1.1 of this report]

5.2.2 Configuration of EUT

The EUT was operated on a test bench and measurements were made at the transmit port. The EUT was operated in mode 1 to mode 12 for this test.

5.2.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section at Site N. A complete scan of emissions from the lowest frequency generated used within the equipment up to 10 times the highest frequency generated was made, to identify any signals within 20dB of the limits. Any identified spurious signals were measured in the required bandwidths.

5.2.4 Test equipment

E410, E433, E433, E615, H072

See Section 8 for more details

5.2.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	101kPa

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	QPSK
Mod Scheme	BPSK
Mod Scheme	8PSK
Mod Scheme	16-QAM
Low channel	2452.5 MHz

Mod scheme	Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
16QAM	2450	-16.02	-3.02
QPSK	2450	-16.12	-3.12
BPSK	2450	-14.66	-1.66
8PSK	2450	-15.56	-2.56

Plots
CSE - bottom channel
CSE - bottom channel band edge

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	QPSK
Mod Scheme	BPSK
Mod Scheme	8PSK
Mod Scheme	16-QAM
Mid channel	2466.75 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
No emissions within 20 dB of the limit were observed.		

Plots
CSE - middle channel

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	QPSK
Mod Scheme	BPSK
Mod Scheme	8PSK
Mod Scheme	16-QAM
High channel	2481 MHz

Mod scheme	Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
16QAM	2483.5	-15.80	-2.80
QPSK	2483.5	-16.11	-3.11
BPSK	2483.5	-14.75	-1.75
8PSK	2483.5	-15.30	-2.30

Plots
CSE - top channel
CSE - top channel band edge

Any analyser plots can be found in Section 6 of this report.

LIMITS:
Part 90.210(b)(3), -13 dBm.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: ± 2.8 dB up to 25 GHz.

5.3 Conducted power

5.3.1 Test methods

Test Requirements:	FCC Part 90I Clause 90.205(o) [Reference 4.1.1 of this report], FCC Part 90I Clause 2.1046 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.26 Clause 5.2 [Reference 4.1.3 of this report]
Limits:	FCC Part 90I Clause 90.205(o) [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the external RF port via attenuation. The EUT was operated in TX1 to TX12 modes for this test and highest power levels recorded.

5.3.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section. The channel power function of the analyser was used with an RMS detector. Measurements were made on a test bench in site N.

5.3.4 Test equipment

492A, E410, E433, E615, H072

See Section 8 for more details

5.3.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	BPSK
Low channel	2452.5 MHz
Mid channel	2466.75 MHz
High channel	2481 MHz

Test conditions		Carrier Power (dBm) Low channel	Carrier Power (dBm) Mid channel	Carrier Power (dBm) High channel
Temp Ambient	Volts Nominal	21.9	22.0	22.2
Maximum TX Power observed (Watts)		0.155	0.159	0.166

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	QPSK
Low channel	2452.5 MHz
Mid channel	2466.75 MHz
High channel	2481 MHz

Test conditions		Carrier Power (dBm) Low channel	Carrier Power (dBm) Mid channel	Carrier Power (dBm) High channel
Temp Ambient	Volts Nominal	21.9	22.0	22.0
Maximum TX Power observed (Watts)		0.155	0.159	0.159

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	8PSK
Low channel	2452.5 MHz
Mid channel	2466.75 MHz
High channel	2481 MHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)	Carrier Power (dBm)
		Low channel	Mid channel	High channel
Temp Ambient	Volts Nominal	21.9	22.0	22.1
Maximum TX Power observed (Watts)		0.155	0.159	0.162

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	16QAM
Low channel	2452.5 MHz
Mid channel	2466.75 MHz
High channel	2481 MHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)	Carrier Power (dBm)
		Low channel	Mid channel	High channel
Temp Ambient	Volts Nominal	21.9	22.0	22.1
Maximum TX Power observed (Watts)		0.155	0.159	0.162

LIMITS:
Part 90.205(o), 2450-2483.5 MHz. The maximum transmitter power is 5 watts (37 dBm).

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.0 dB

5.4 Frequency stability

5.4.1 Test methods

Test Requirements: FCC Part 90I Clause 90.213(a) [Reference 4.1.1 of this report], 47CFR part 2J Clause 2.1055 [Reference 4.1.2 of this report]

Test Method: ANSI C63.26 Clause 5.6 [Reference 4.1.3 of this report]

Limits: FCC Part 90I Clause 90.213(a) [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was placed in a temperature controlled chamber and thermal balance was achieved before tests began. Measurements were made at the EUT's transmit port. The EUT was operated in mode 4 for this test.

5.4.3 Test procedure

Tests were made in accordance with the Test Method noted above, using the measuring equipment listed in the 'Test Equipment' Section. Temperature stability was achieved at each test level before taking measurements. No CW carrier was available for measurement since the EUT was digitally modulated, and therefore the mean frequency was calculated by measuring two points (at the same level) on the upper & lower sides of the modulation envelope using the spectrum analyser. EUT supply was varied to 85 & 115% of nominal volts at nominal temperature. Tests were performed using Test Site N.

5.4.4 Test equipment

E410, E433, E615, E812, H072, L264, N607, P168

See Section 8 for more details

5.4.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	QPSK
Low channel	2452.5 MHz

Test conditions		Frequency of Lower -20 dBc point (GHz)	Frequency of Upper -20 dBc point (GHz)	Calculated Average frequency (GHz)
-30°C	Volts Nominal (12)	2.451310	2.453685	2.452498
-20°C	Volts Nominal (12)	2.451310	2.453685	2.452498
-10°C	Volts Nominal (12)	2.451310	2.453685	2.452498
0°C	Volts Nominal (12)	2.451310	2.453685	2.452498
10°C	Volts Nominal (12)	2.451310	2.453685	2.452498
20°C	Volts Minimum (10.2)	2.451315	2.453685	2.452500
	Volts Nominal (12)	2.451315	2.453685	2.452500
	Volts Maximum (13.8)	2.451315	2.453685	2.452500
30°C	Volts Nominal (12)	2.451315	2.453685	2.452500
40°C	Volts Nominal (12)	2.451315	2.453685	2.452500
50°C	Volts Nominal (12)	2.451320	2.453685	2.452503

Max Frequency Error per chan (kHz)	+2.5 / -2.5
Max Frequency Error observed (MHz)	-0.00000250

Note: Refer to operational description provided with certification for justification on testing only a single channel within the EUT operational band.

LIMITS: Part 90.213 Equipment operating above 2450 MHz, no limit is specified

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: <± 0.7 ppm

5.5 Occupied bandwidth

5.5.1 Test methods

Test Requirements:	FCC Part 90I Clause 90.209 [Reference 4.1.1 of this report], 47CFR part 2J Clause 2.1049(h) [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 Clause 5.4 [Reference 4.1.3 of this report]
Limits:	FCC Part 90I Clause 90.209 [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the transmit port. The EUT was operated in mode 1 to mode 12.

5.5.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section. A 47 kHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 99% bandwidth measurement using the Occupied Bandwidth measurement function of the spectrum analyser. Tests were performed using Test Site N.

5.5.4 Test equipment

E410, E433, E615, H072

See Section 8 for more details

5.5.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	BPSK
Low channel	2452.5 MHz
Mid channel	2466.75 MHz
High channel	2481 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz) Nominal Temp & Volts	2.328	2.328	2.332
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts	12927-1 Bottom_OBW_BPSK	12927-1 Middle_OBW_BPSK	12927-1 TOP_OBW_BPSK

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	QPSK
Low channel	2452.5 MHz
Mid channel	2466.75 MHz
High channel	2481 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz) Nominal Temp & Volts	2.327	2.328	2.325
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts	12927-1 Bottom_OBW_QPSK	12927-1 Middle_OBW_QPSK	12927-1 TOP_OBW_QPSK

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	8PSK
Low channel	2452.5 MHz
Mid channel	2466.75 MHz
High channel	2481 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz) Nominal Temp & Volts	2.328	2.328	2.328
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts	12927-1 Bottom_OBW_8PSK	12927-1 Middle_OBW_8PSK	12927-1 TOP_OBW_8PSK

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	16QAM
Low channel	2452.5 MHz
Mid channel	2466.75 MHz
High channel	2481 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz) Nominal Temp & Volts	2.33	2.327	2.324
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts	12927-1 Bottom_OBW_16QAM	12927-1 Middle_OBW_16QAM	12927-1 TOP_OBW_16QAM

Any analyser plots can be found in Section 6 of this report.

LIMITS:
Part 90.209

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

5.6 Emission mask

5.6.1 Test methods

Test Requirements: FCC Part 90I Clause 90.210(b) [Reference 4.1.1 of this report]
Test Method: ANSI C63.26 Clause 5.5 [Reference 4.1.3 of this report]
Limits: FCC Part 90I Clause 90.210(b) [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the transmit port. The EUT was operated in mode 1 to mode 12.

5.6.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test equipment used' Section. The analyser was tuned to the nominal centre frequency with span of 30MHz and RBW of 30kHz and allowed to sweep enough times to capture the entire power envelope. The frequencies at which the spurious emission limits were last exceeded were noted. Plots were taken referenced to the applicable spectrum mask. As the measurement bandwidth is less than the emission bandwidth, the mask is lowered by the ratio of the Occupied Bandwidth to measurement bandwidth. Reference ANSI C63.26:2015 Clause 5.7.2(a).

Highest occupied bandwidth = 2332 kHz

Measurement resolution bandwidth = 30 kHz

Ratio = 10*log(OBW/RBW)

= 18.91 dB.

Lowest transmit power = 21.9 dBm

Reference level for graph = 21.9 – 18.91 = 2.99 dBm.

Tests were performed in test site N.

5.6.4 Test equipment

492A, E410, E433, E615, H072

See Section 8 for more details

5.6.5 Test results

Temperature of test environment 20°C
Humidity of test environment 50%
Pressure of test environment 102kPa

Band	2450-2483.5 MHz
Power Level	+22dBm
Channel Spacing	2.5 MHz
Mod Scheme	BPSK
Mod Scheme	QPSK
Mod Scheme	8PSK
Mod Scheme	16-QAM
Low channel	2452.5 MHz
Mid channel	2466.75 MHz
High channel	2481 MHz

	Low channel	Mid channel	High channel
Nominal plot reference	Bottom Spectrum Mask	Middle Spectrum Mask	Top Spectrum Mask

Analyser plots can be found in Section 6 of this report.

LIMITS:
Part 90.210(b) & (n)
Under Part 90 section 210, the masks for equipment designated to operate in the 2.45 - 2.4835GHz band are not specified in the Applicable Emission Masks Chart.

Therefore, while the EUT has no provision to inject an audio sub carrier into the transmitted RF signal, mask applied is Mask B as noted for “All other bands”. Although Mask B generally pertains to equipment with an audio low pass filter, Mask C is completely inappropriate in that it does not allow for spread spectrum carriers within the designated bandwidth.

(b) Emission Mask B - For transmitters that are equipped with an audio low pass filter pursuant to 90.211(a), the power of any emission must be below the unmodulated carrier power (P) as follows:

1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.
2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: ± 2.8 dB up to 26.5 GHz.

5.7 Modulation limiting

NOT APPLICABLE: EUT employs digital modulation, test only applicable for analogue audio products.

5.8 Modulation frequency response

NOT APPLICABLE: EUT employs digital modulation, test only applicable for analogue audio products.

5.9 Transient frequency behaviour

NOT APPLICABLE: EUT does not operate within the bands 150 - 174 MHz and 421 - 512 MHz

5.10 Adjacent channel power

NOT APPLICABLE: EUT does not operate within the bands 150 - 174 MHz, 809 - 824 MHz or 854 - 869 MHz

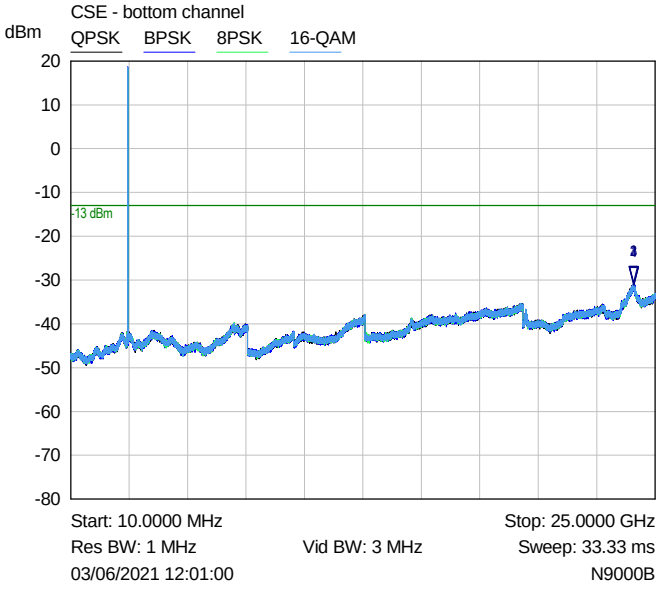
5.11 Duty Cycle / TX on times

NOT APPLICABLE: No requirement

6 Plots/Graphical results

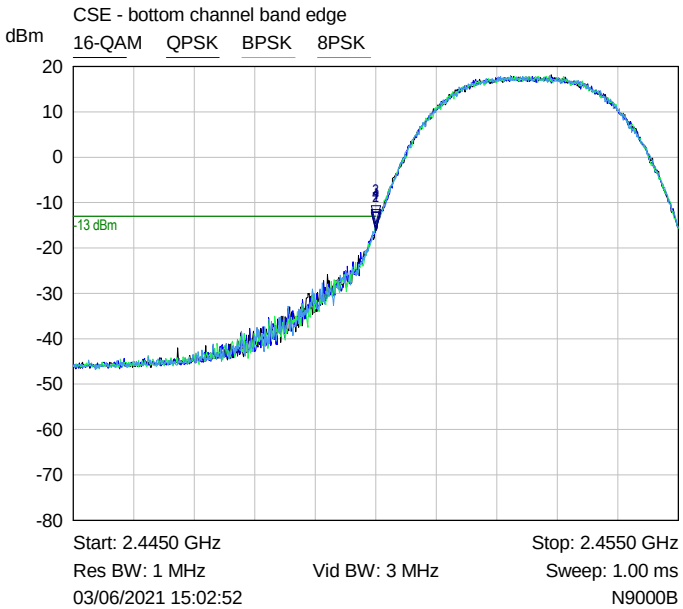
6.1 Conducted emissions

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz



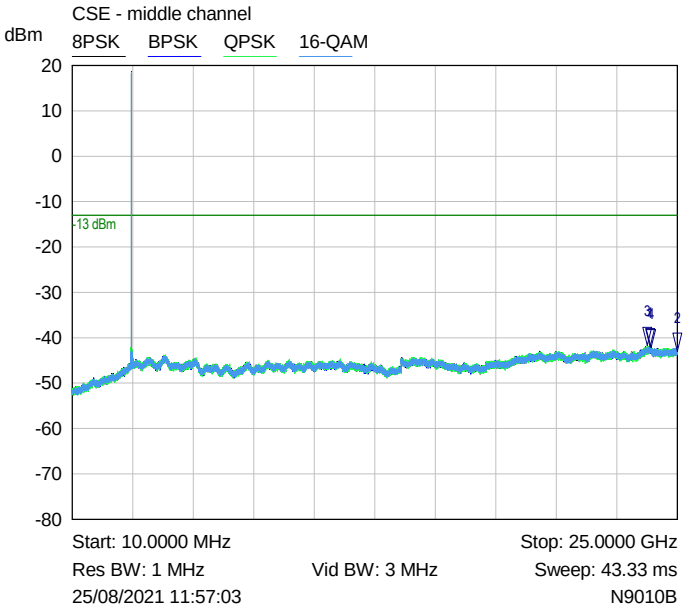
Mkr	Trace	X-Axis	Value	Notes
1 ▽	QPSK	24.0898 GHz	-30.98 dBm	
2 ▽	BPSK	24.0759 GHz	-30.76 dBm	
3 ▽	8PSK	24.0848 GHz	-30.81 dBm	
4 ▽	16-QAM	24.0918 GHz	-31.16 dBm	

The emission that exceeds the limit is the fundamental transmission.



Mkr	Trace	X-Axis	Value	Notes
1 ▽	16-QAM	2.4500 GHz	-16.02 dBm	
2 ▽	QPSK	2.4500 GHz	-16.12 dBm	
3 ▽	BPSK	2.4500 GHz	-14.66 dBm	
4 ▽	8PSK	2.4500 GHz	-15.56 dBm	

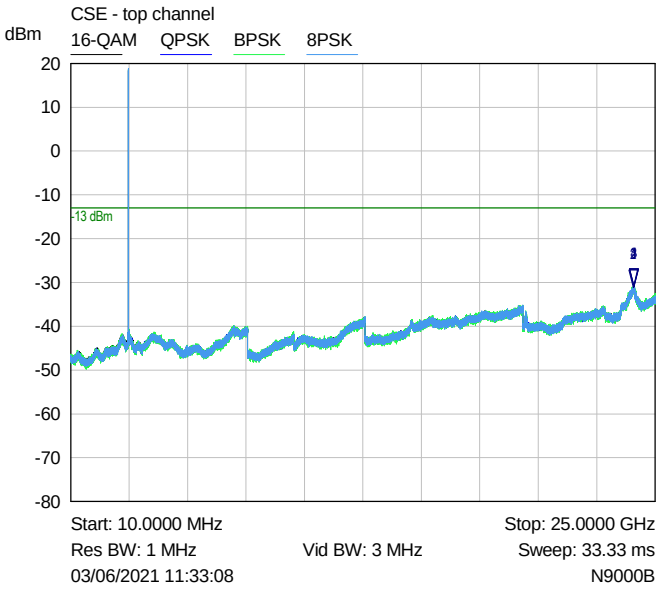
RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	8PSK	23.8829 GHz	-42.08 dBm	
2 ▽	BPSK	25.0000 GHz	-43.03 dBm	
3 ▽	QPSK	23.7375 GHz	-41.73 dBm	
4 ▽	16-QAM	23.8939 GHz	-42.21 dBm	

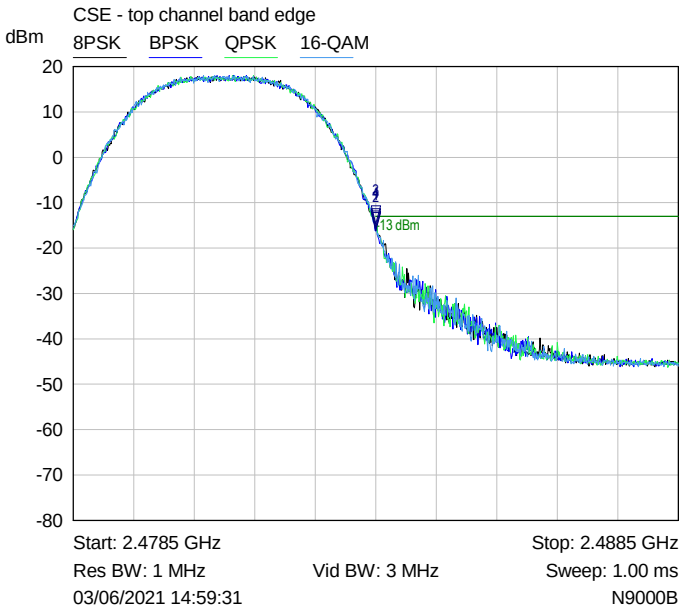
The emission that exceeds the limit is the fundamental transmission.

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	16-QAM	24.0883 GHz	-31.07 dBm	
2 ▽	QPSK	24.0599 GHz	-31.11 dBm	
3 ▽	BPSK	24.1058 GHz	-30.85 dBm	
4 ▽	8PSK	24.0943 GHz	-30.80 dBm	

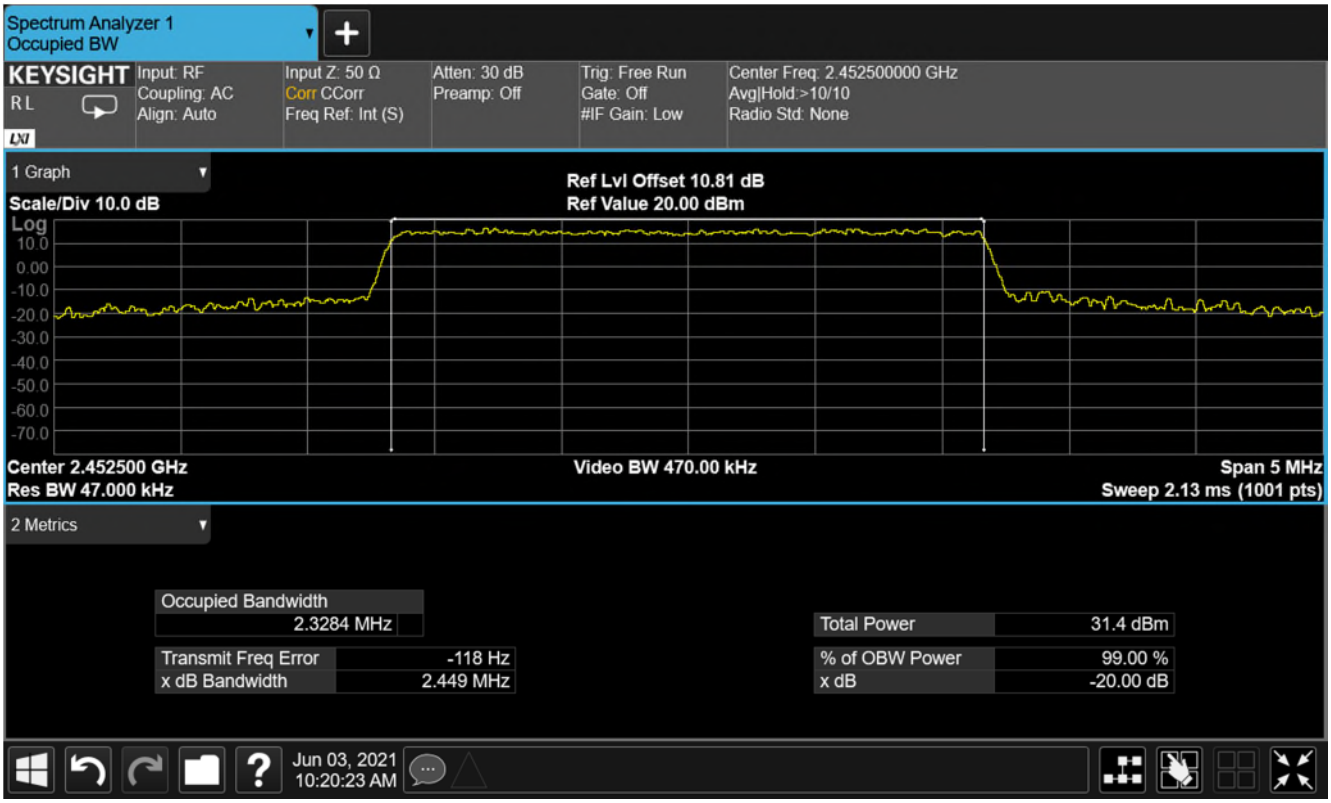
The emission that exceeds the limit is the fundamental transmission.



Mkr	Trace	X-Axis	Value	Notes
1 ▽	16-QAM	2.4835 GHz	-15.80 dBm	
2 ▽	BPSK	2.4835 GHz	-16.11 dBm	
3 ▽	QPSK	2.4835 GHz	-14.75 dBm	
4 ▽	8PSK	2.4835 GHz	-15.30 dBm	

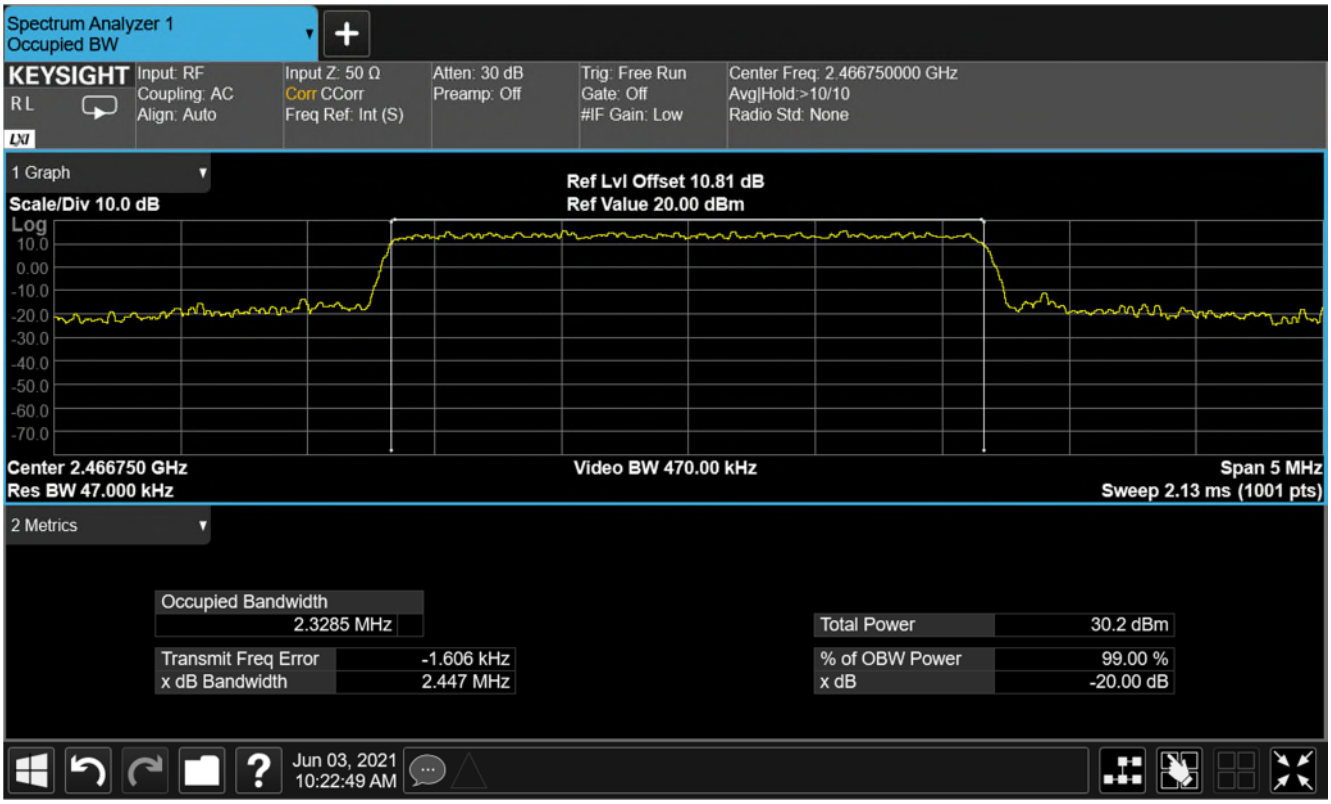
6.2 Occupied bandwidth

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation BPSK, Channel 2452.5 MHz



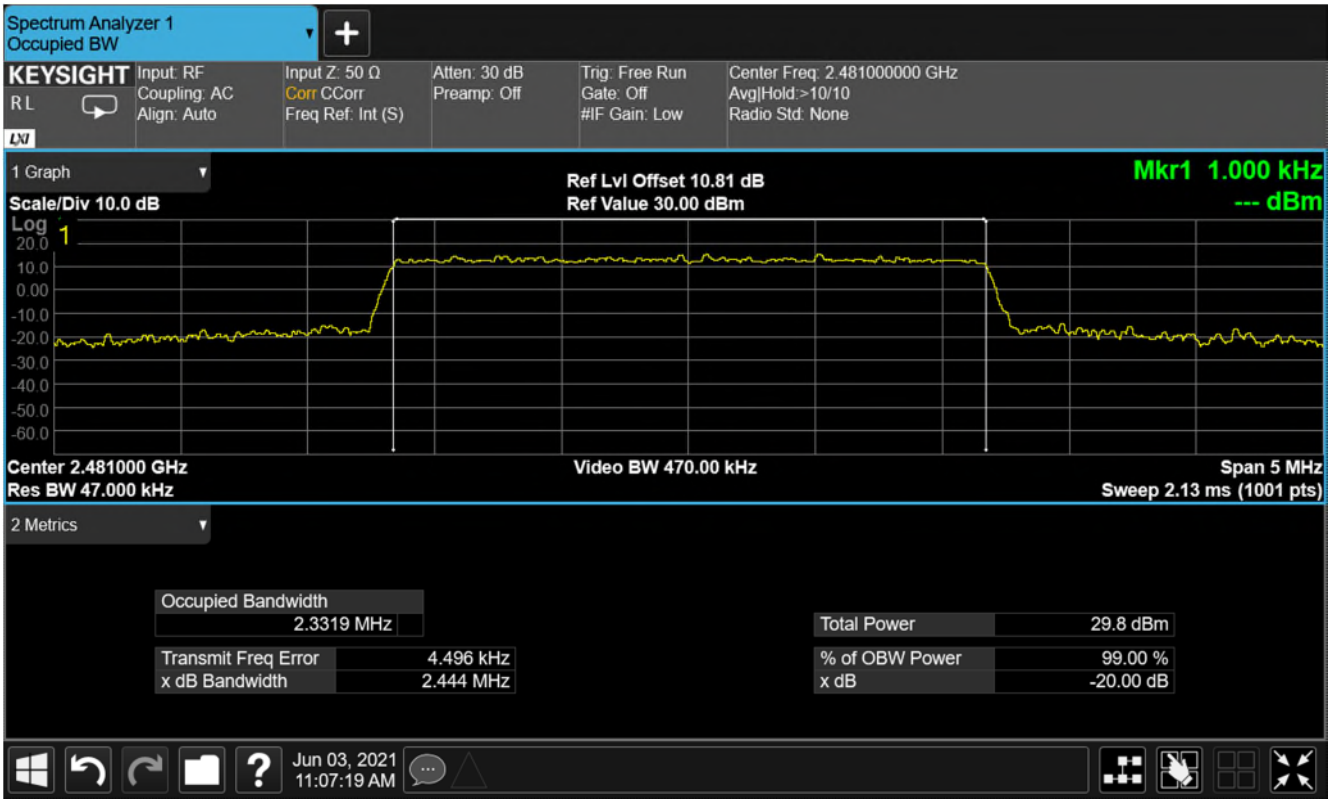
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation BPSK, Channel 2466.75 MHz



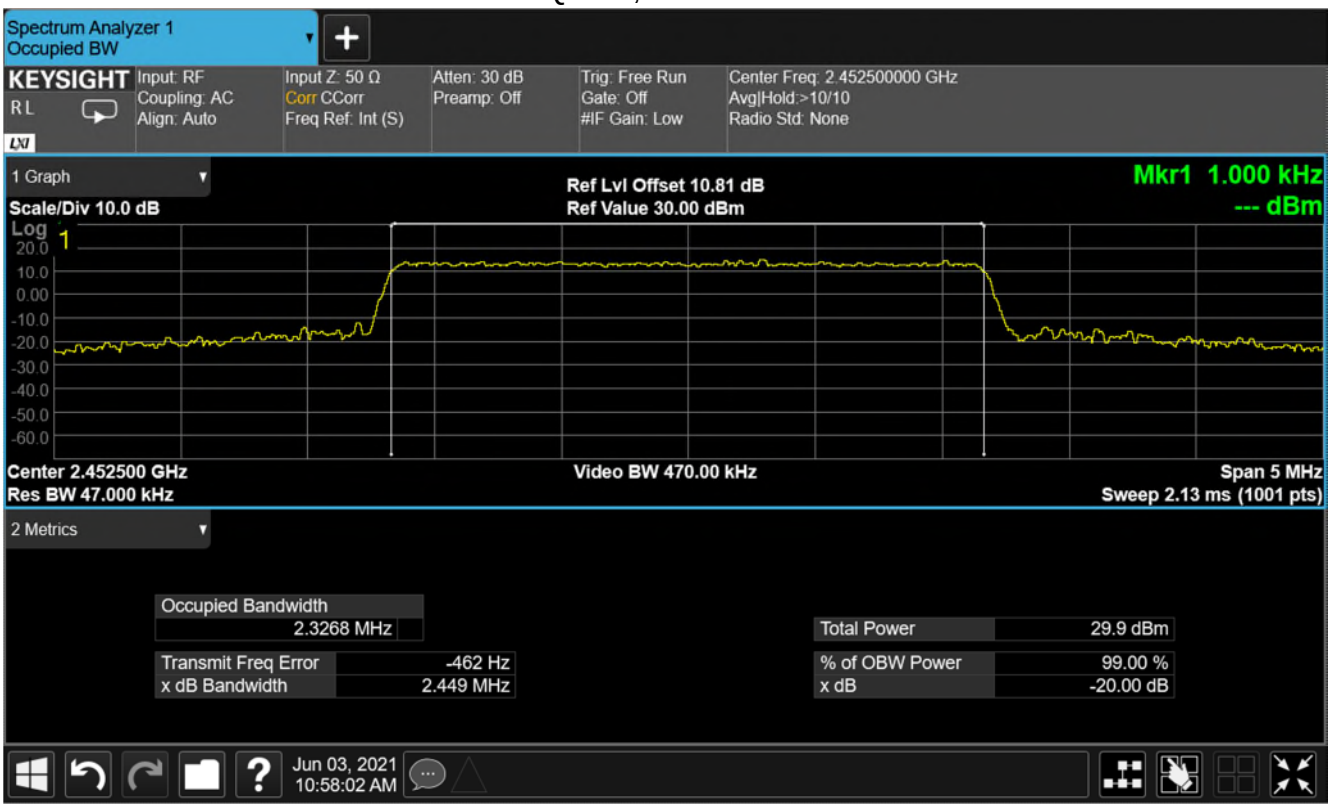
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation BPSK, Channel 2481 MHz



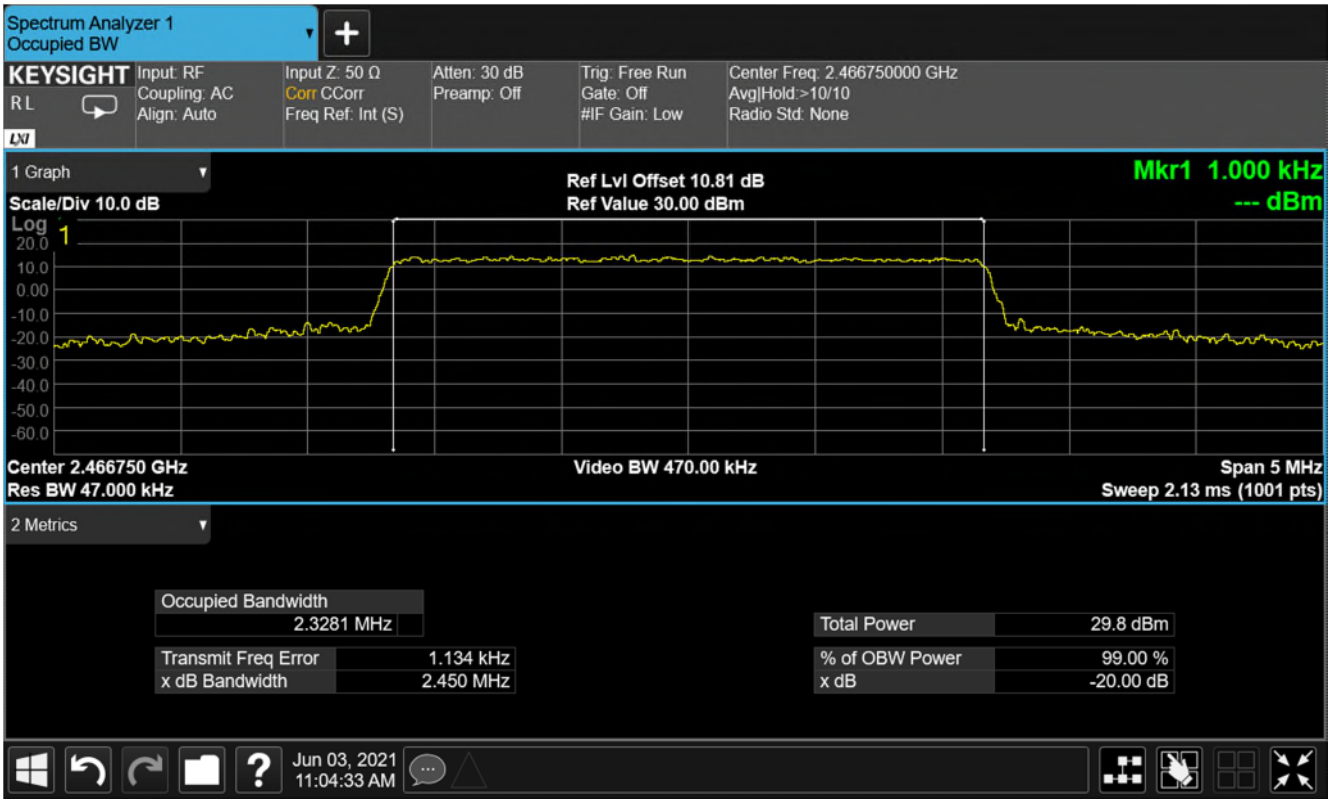
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation QPSK, Channel 2452.5 MHz



Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation QPSK, Channel 2466.75 MHz

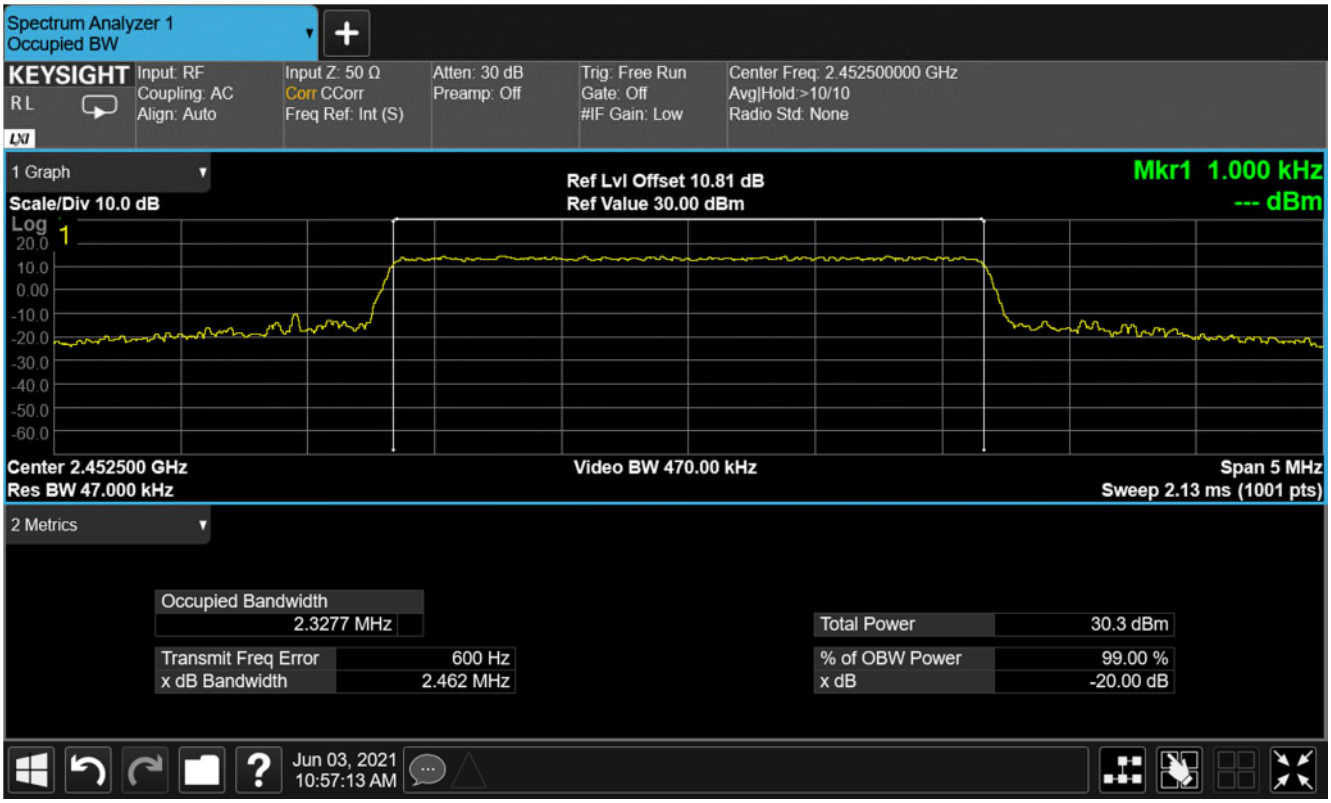


Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation QPSK, Channel 2481 MHz

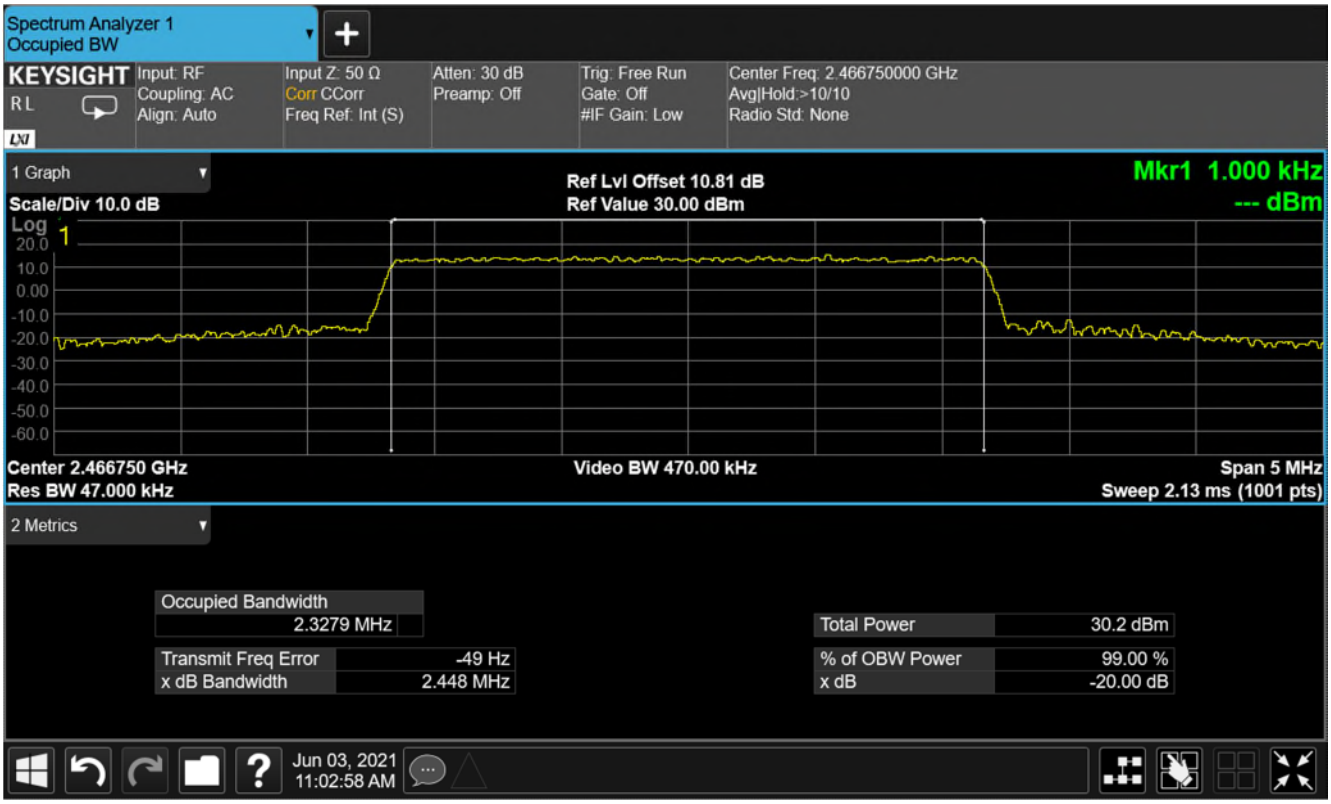
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation 8PSK, Channel 2452.5 MHz



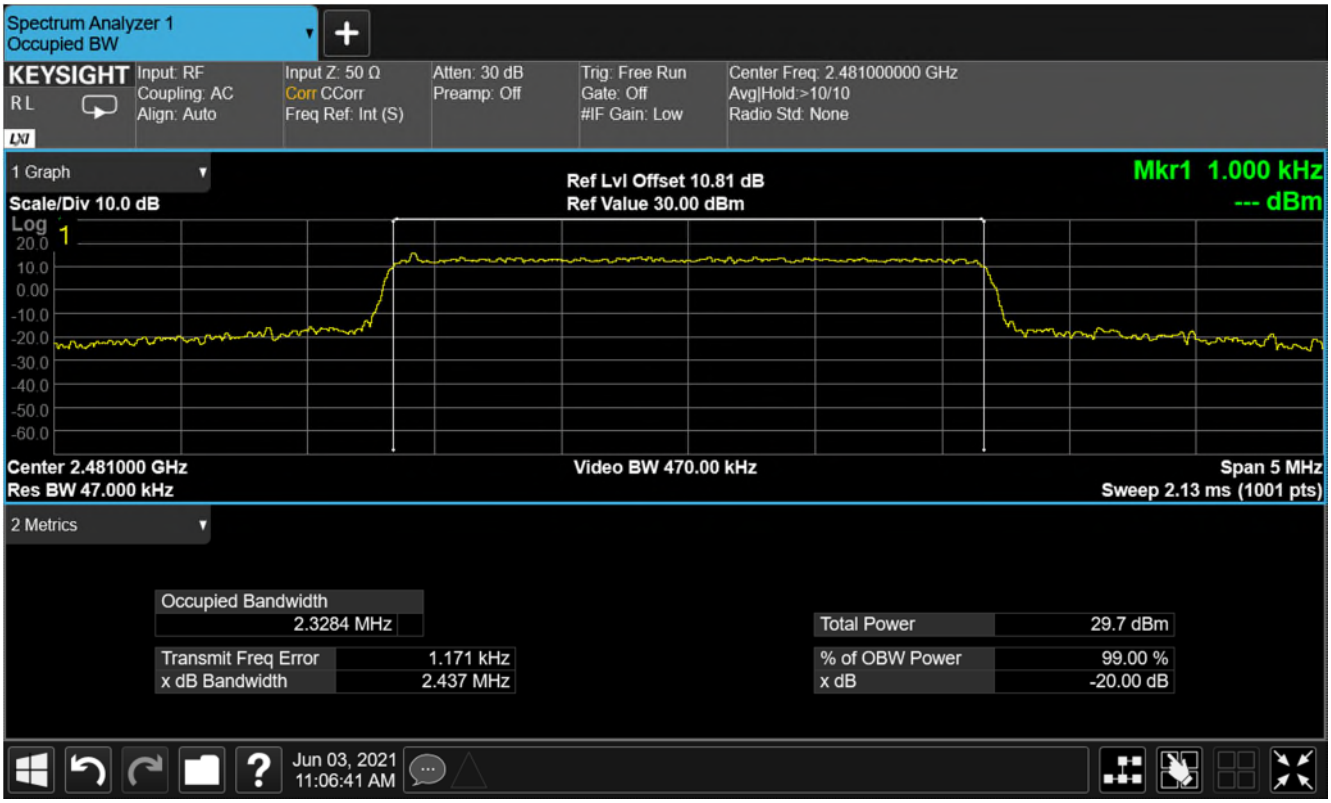
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation 8PSK, Channel 2466.75 MHz



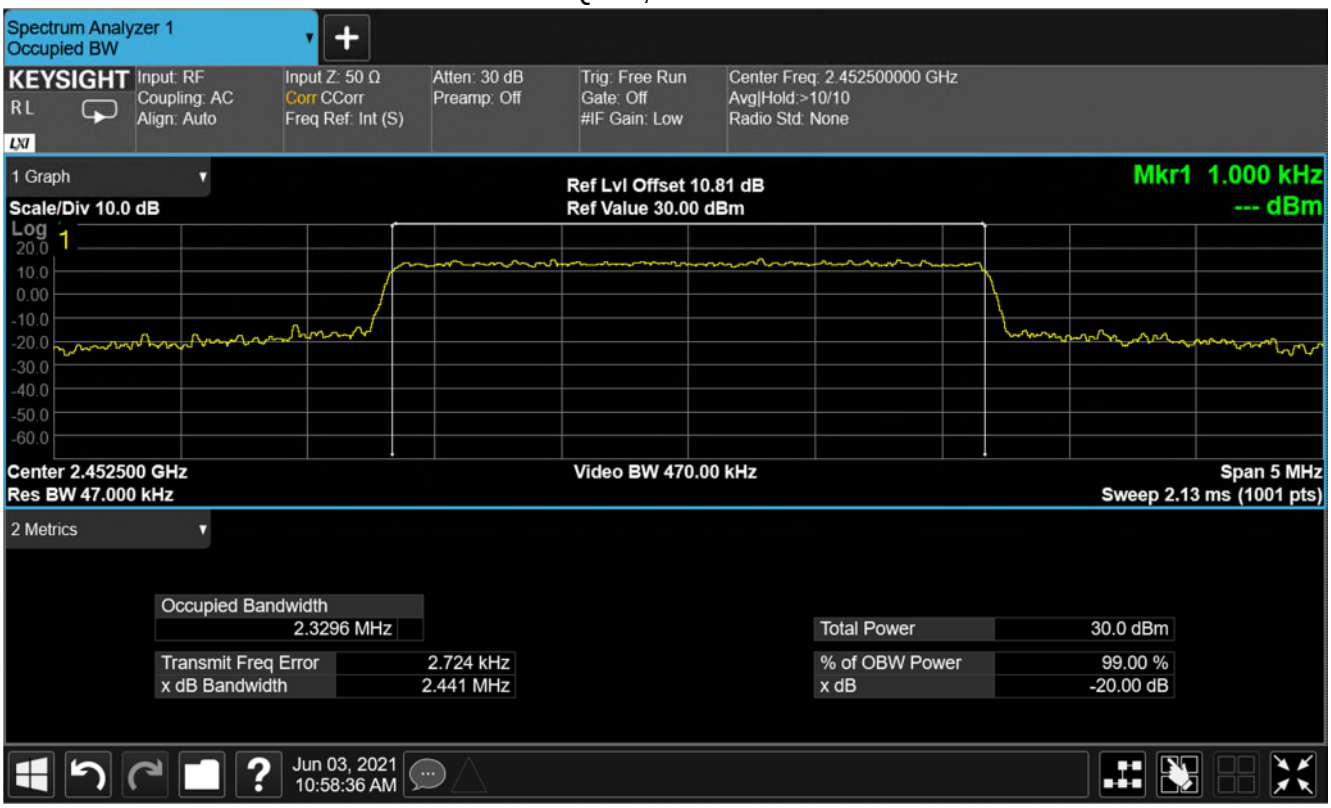
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation 8PSK, Channel 2481 MHz



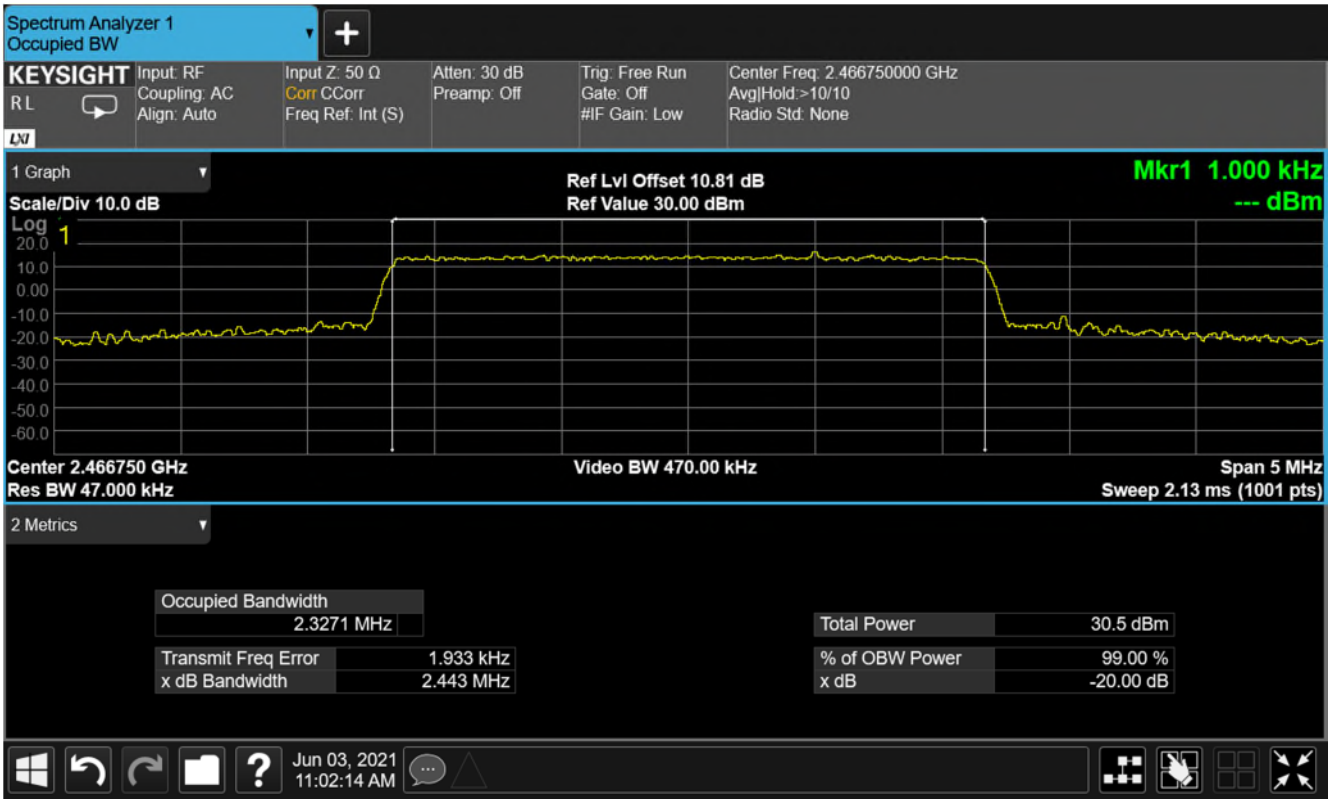
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation 16QAM, Channel 2452.5 MHz



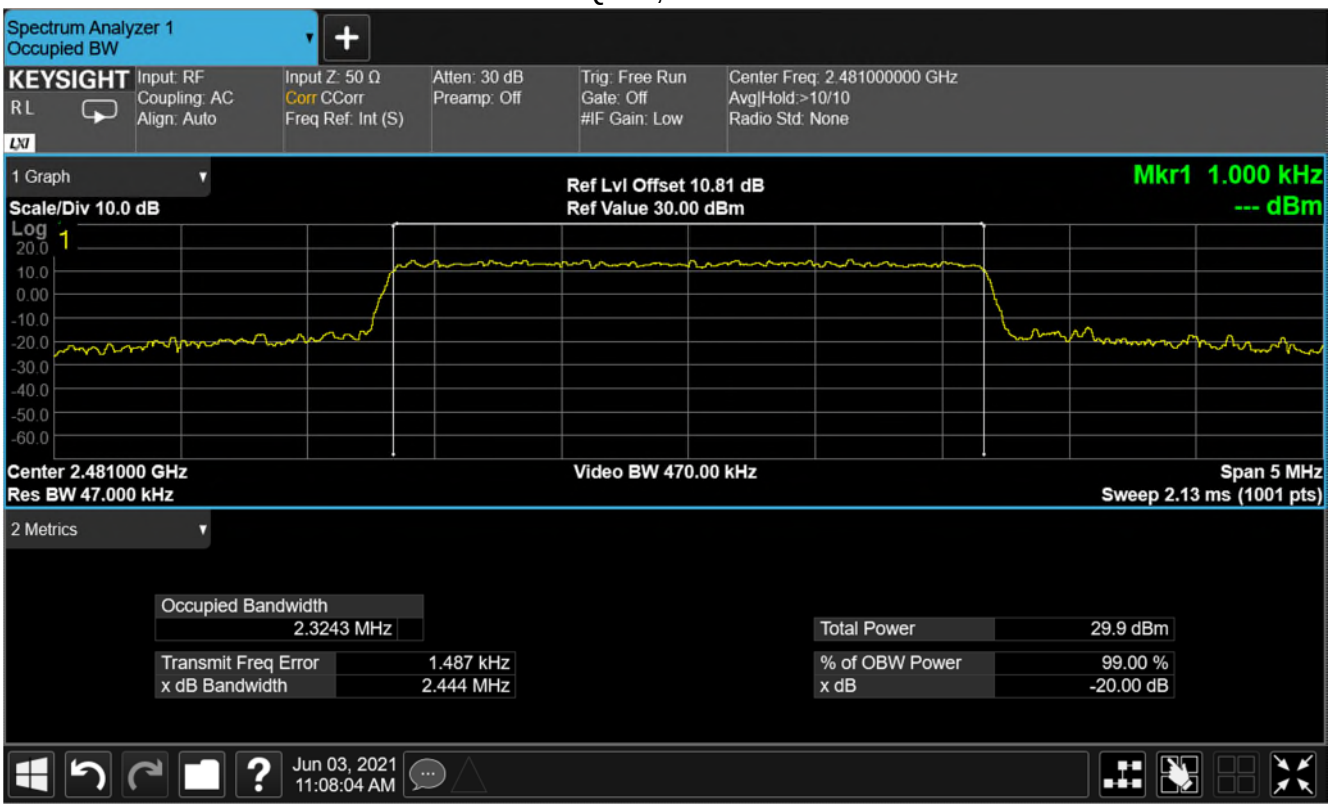
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation 16QAM, Channel 2466.75 MHz



Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

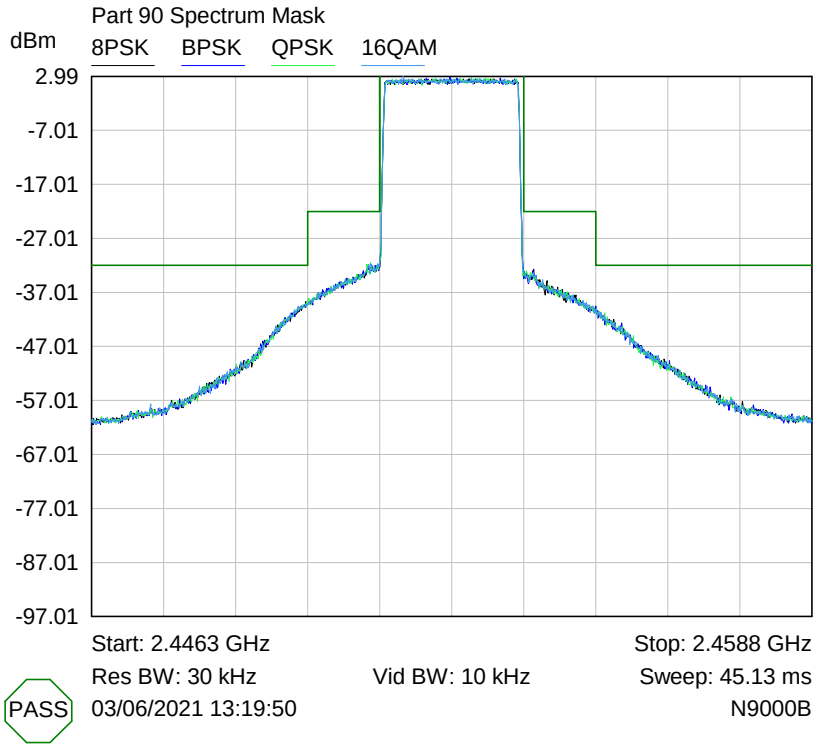
RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation 16QAM, Channel 2481 MHz



Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

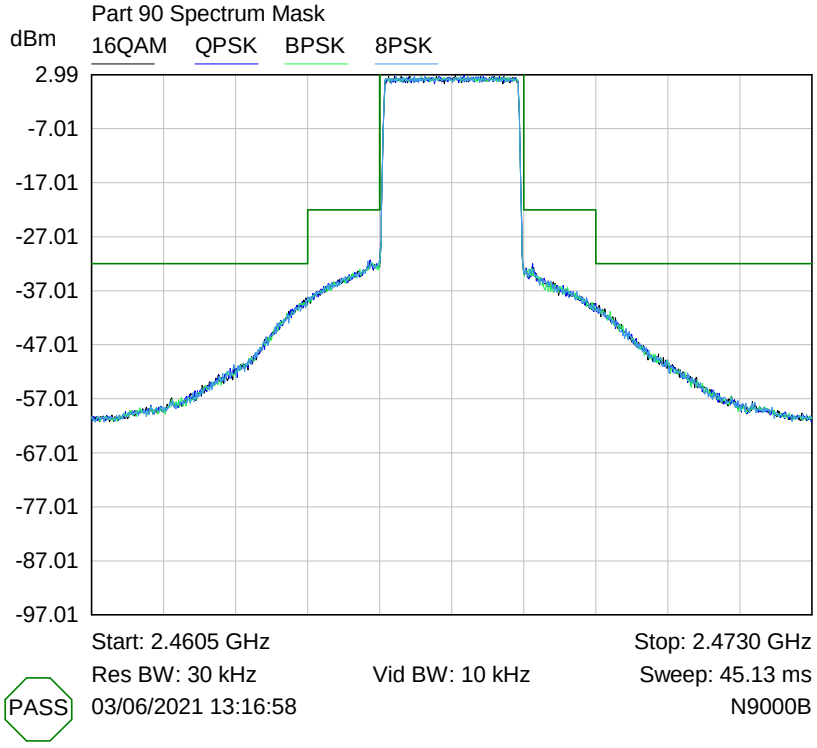
6.3 Emission mask

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation BPSK, Channel 2452.5 MHz



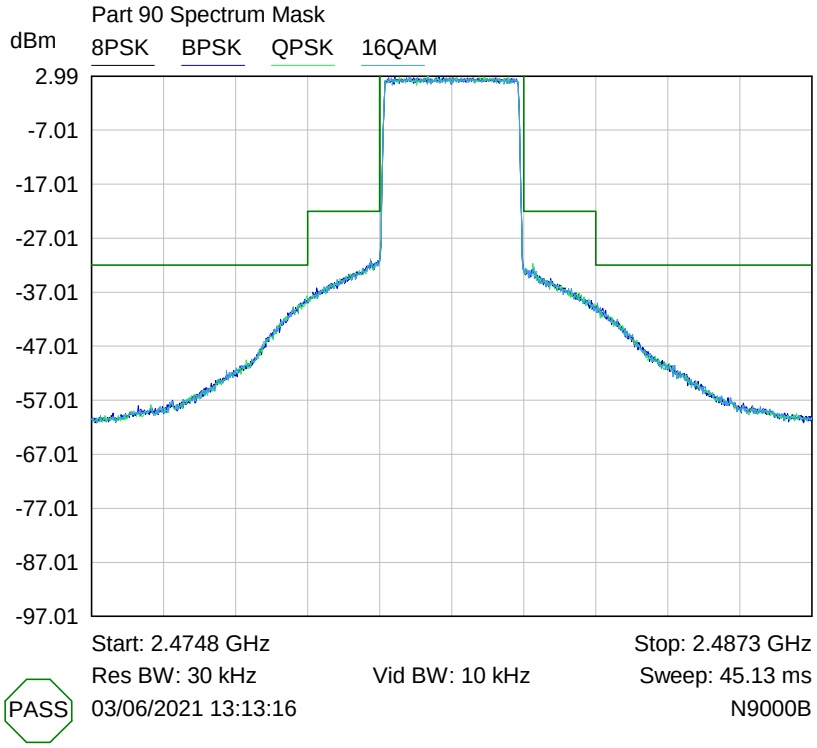
Nominal Temperature, Nominal Voltage

RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation BPSK, Channel 2466.75 MHz



Nominal Temperature, Nominal Voltage

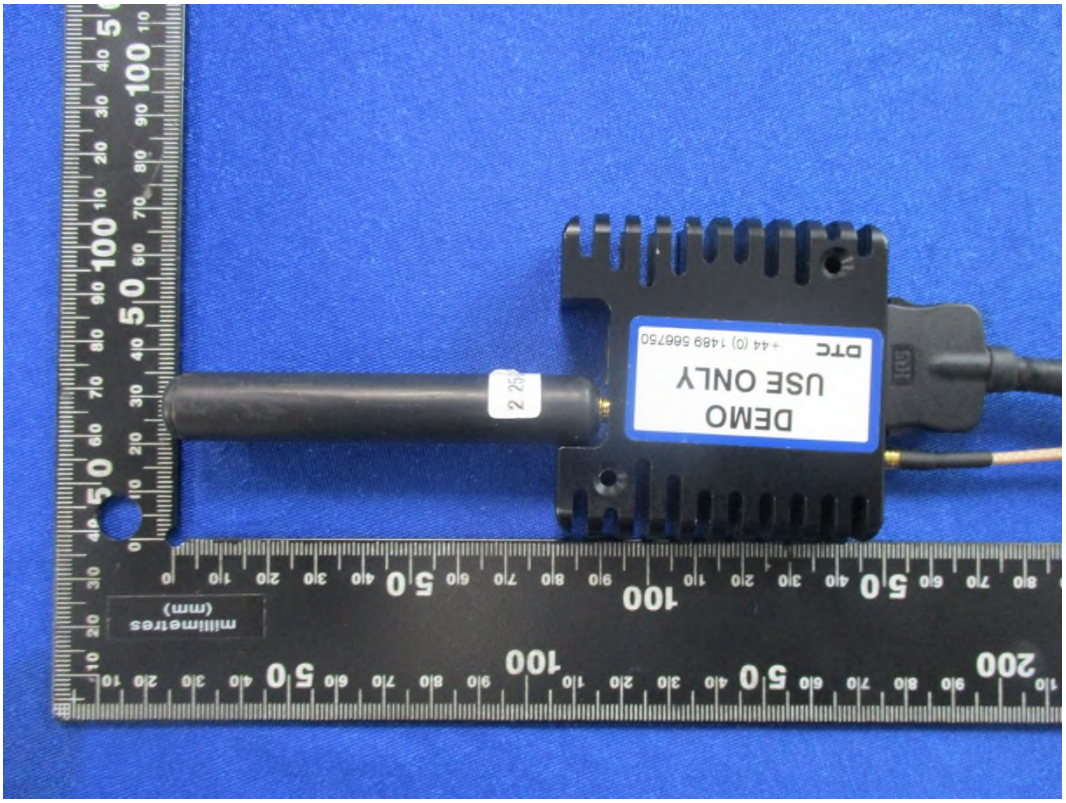
RF Parameters: Band 2450-2483.5 MHz, Power +22dBm, Channel Spacing 2.5 MHz, Modulation BPSK, Channel 2481 MHz

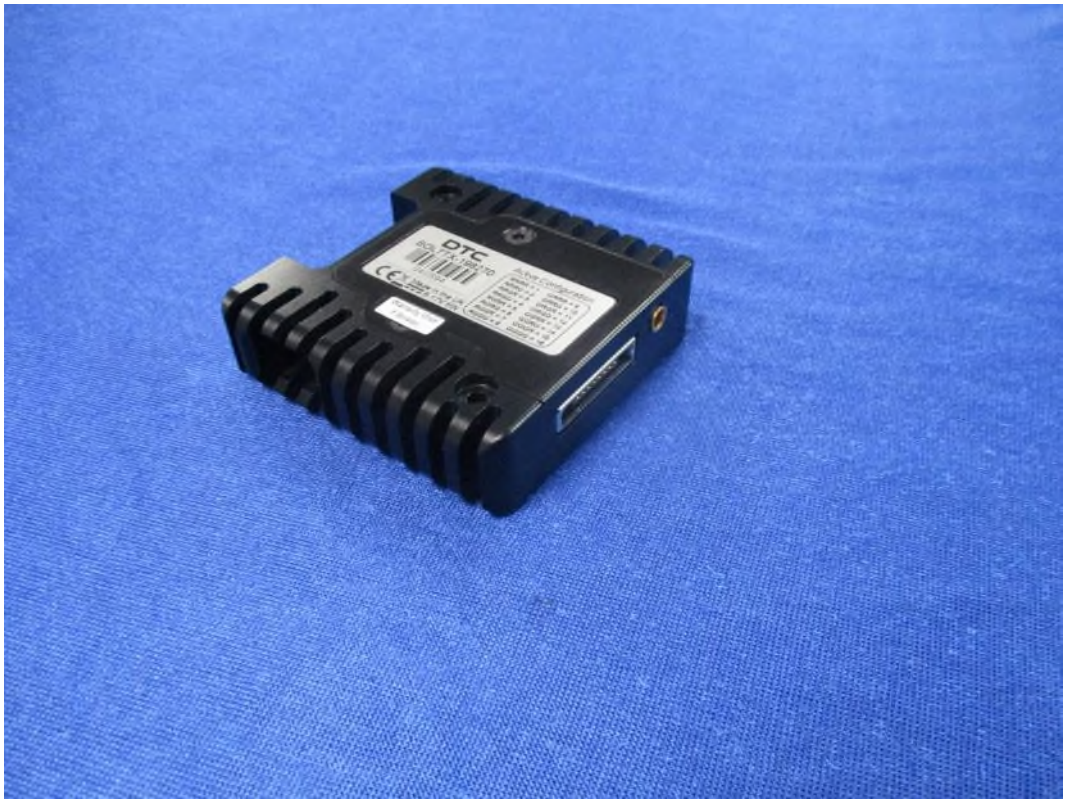


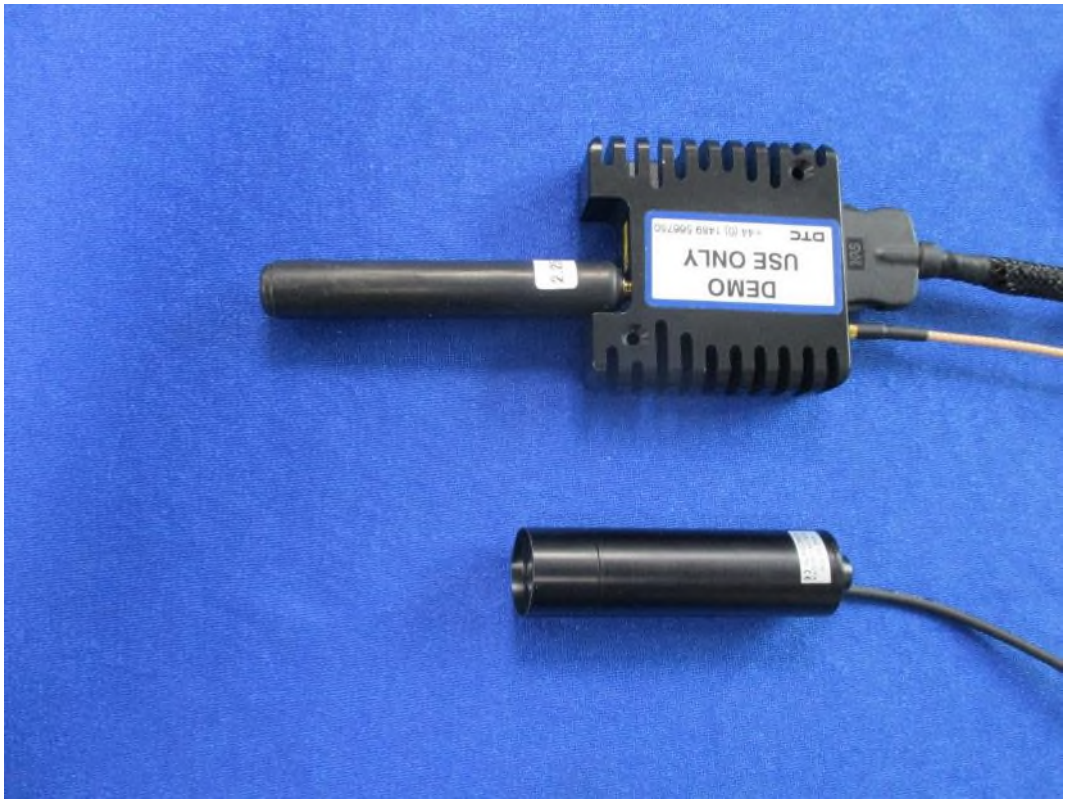
Nominal Temperature, Nominal Voltage

7 Photographs

7.1 EUT Front View







Photograph shows EUT alongside the supplied video camera

Photograph shows the EUT's power supply

7.2 EUT Reverse Angle

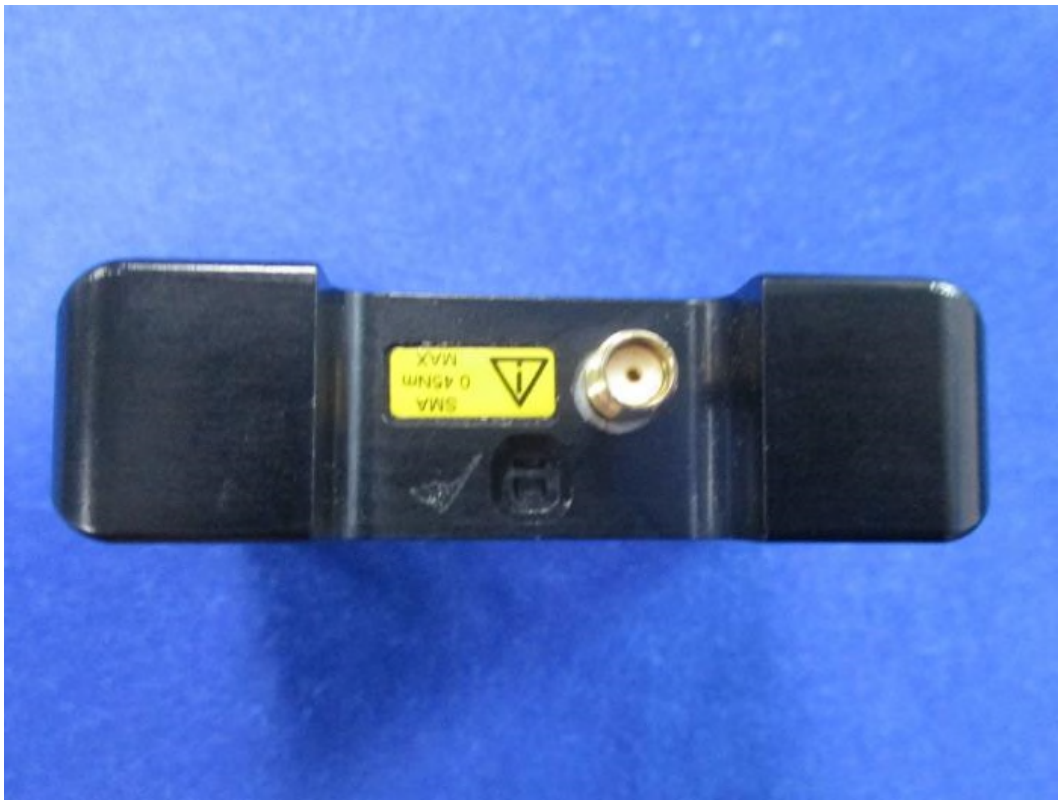
7.3 EUT Left side View

Photograph shows the EUT's USB configuration port

7.4 EUT Right side View

Photograph shows the EUT's power / control port and the SDI port

7.5 EUT Antenna Port



7.6 EUT Display & Controls

The EUT has no display or controls

7.7 EUT Internal photos

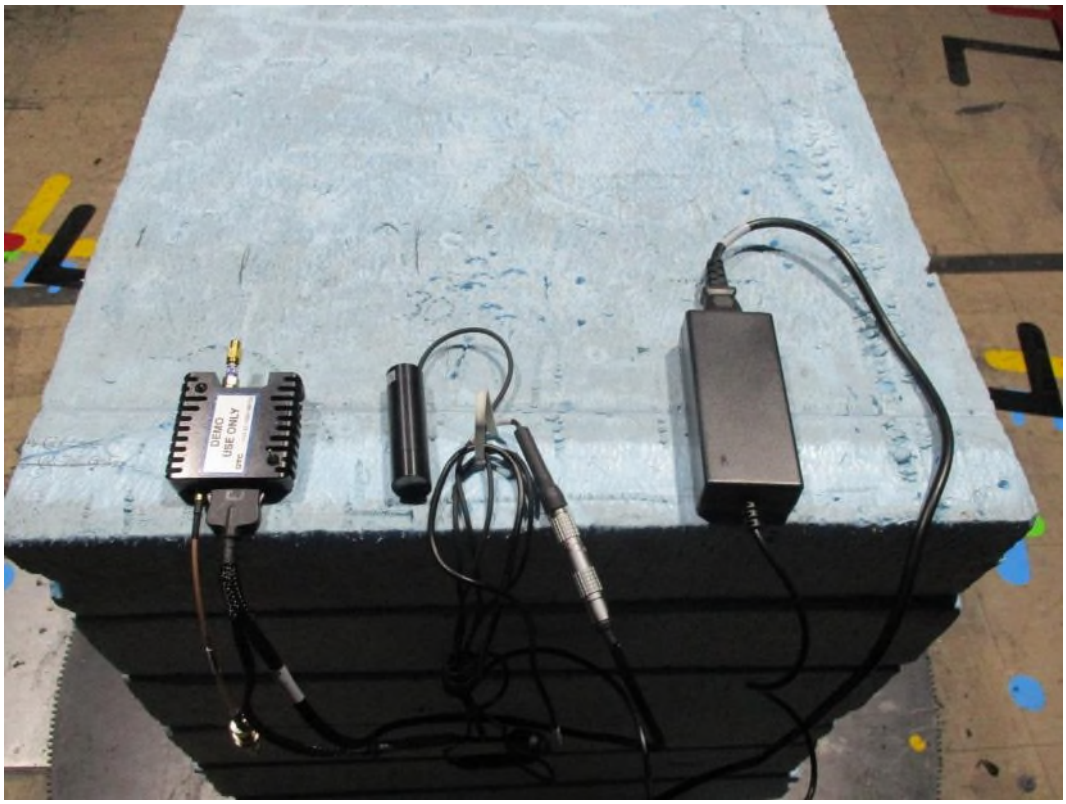
Internal Photos not included for confidentiality reasons.

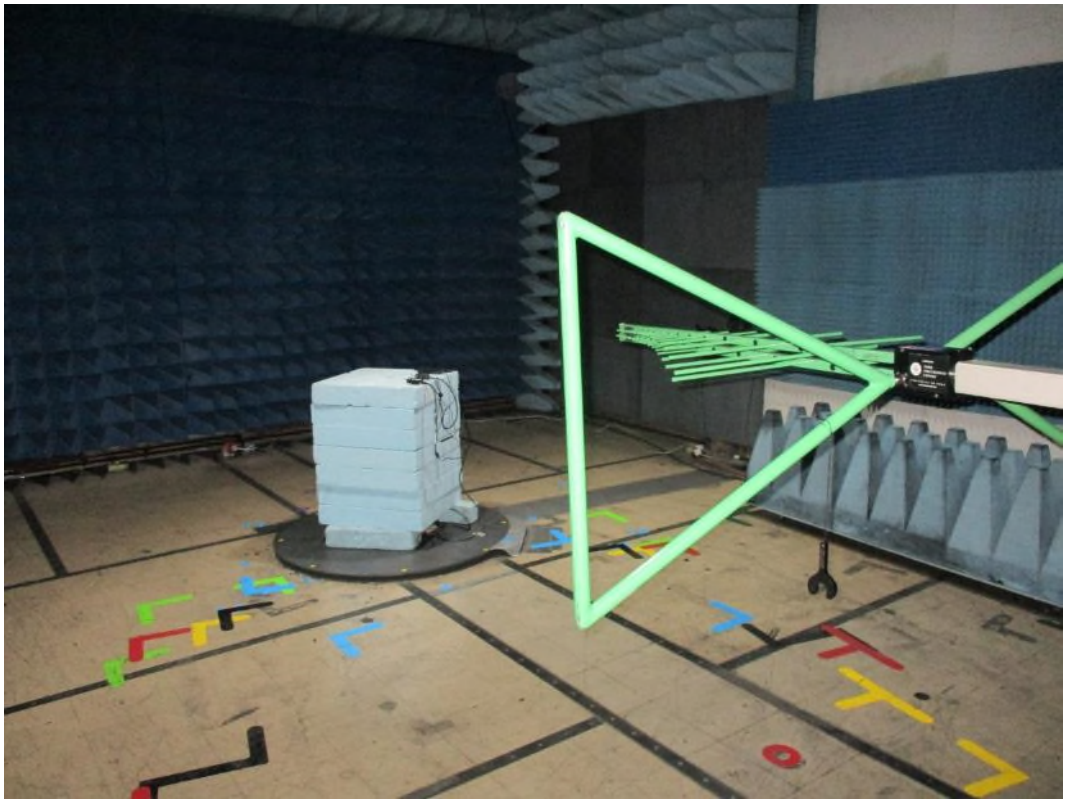
7.8 EUT ID Label

7.9 EUT Chassis

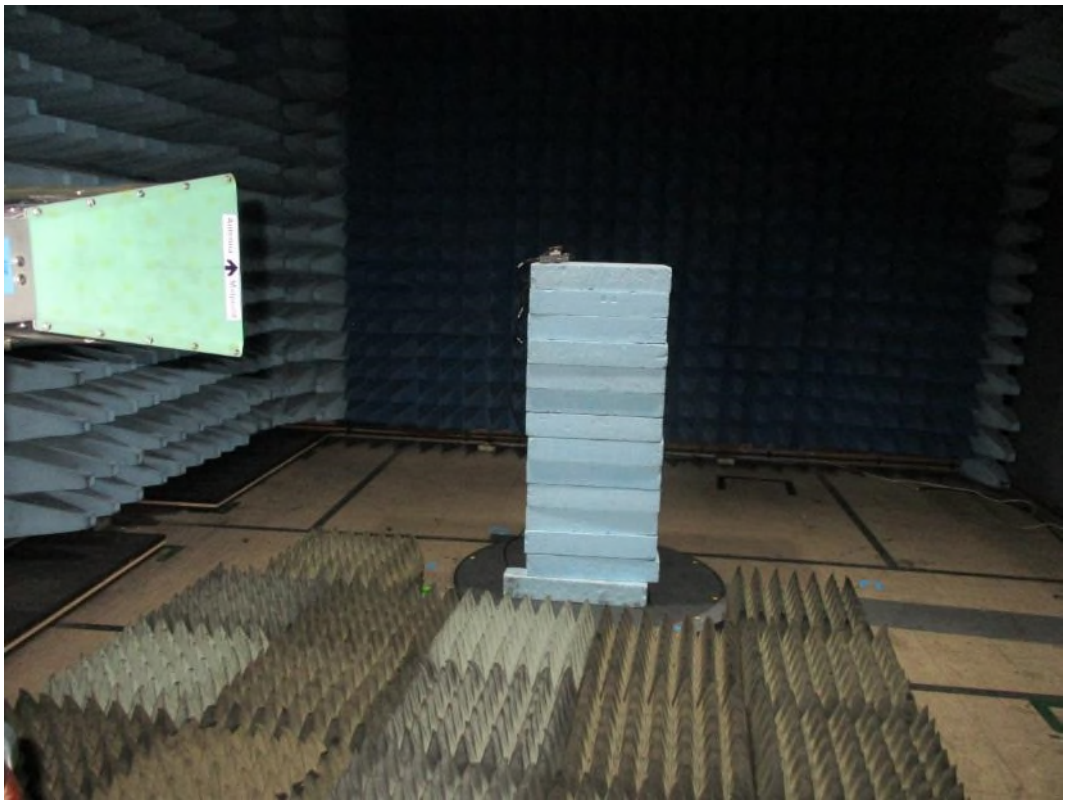
The EUT has no chassis

7.10 30-1000MHz Spurious emissions test set-up

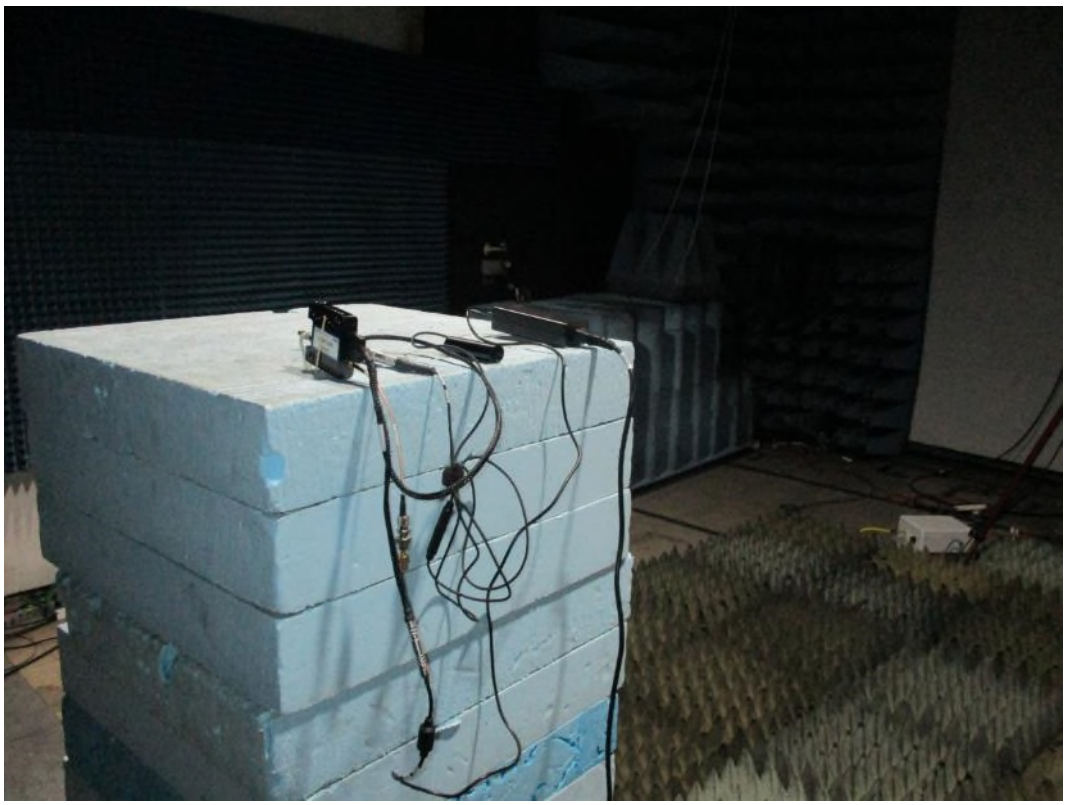




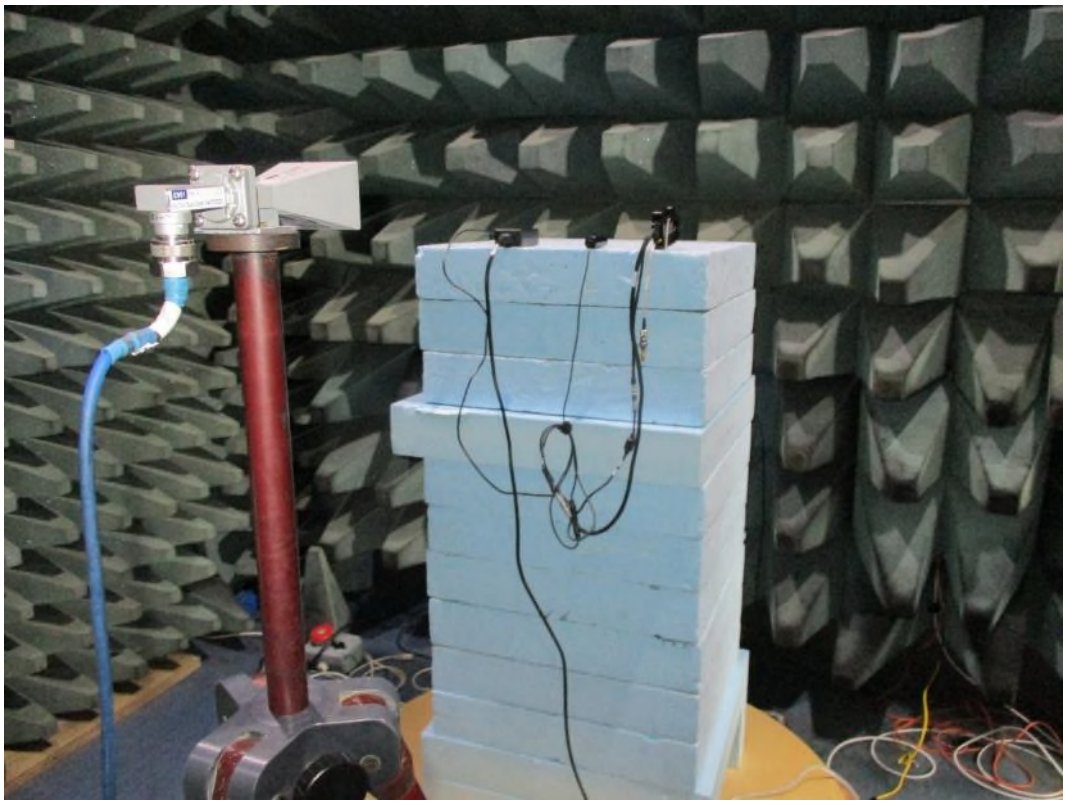
7.11 Above 1GHz Spurious emissions test set-up



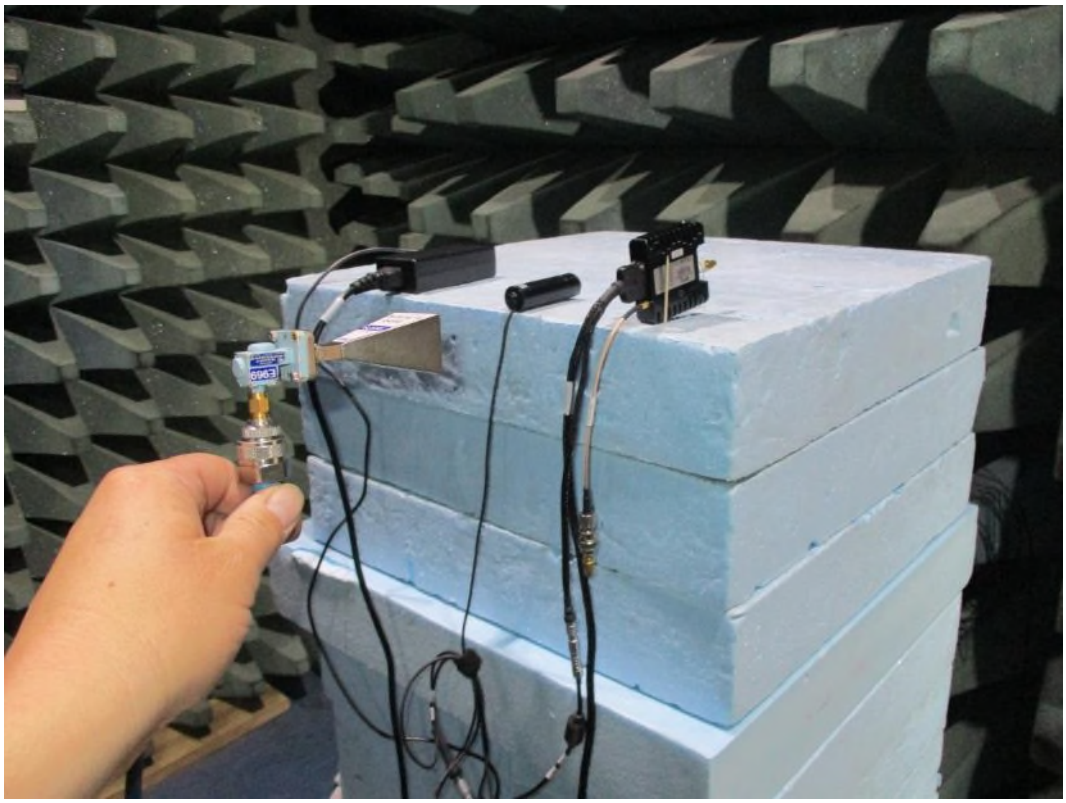
Site M



Site M



Site B



Site B

7.12 Radiated emission diagrams

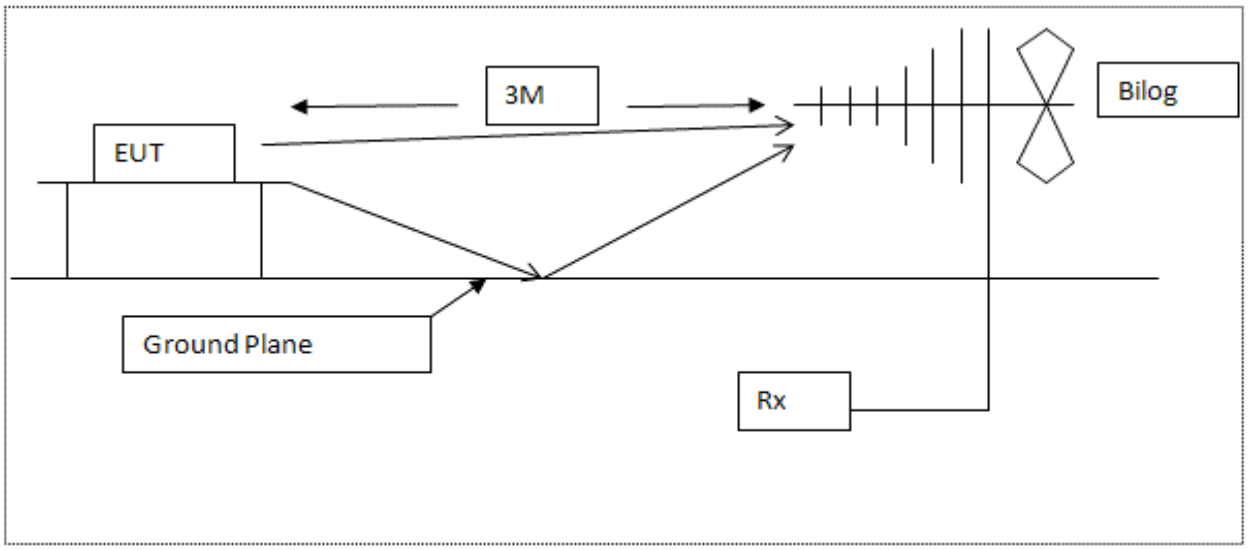


Diagram of the radiated emissions test setup 30 - 1000 MHz

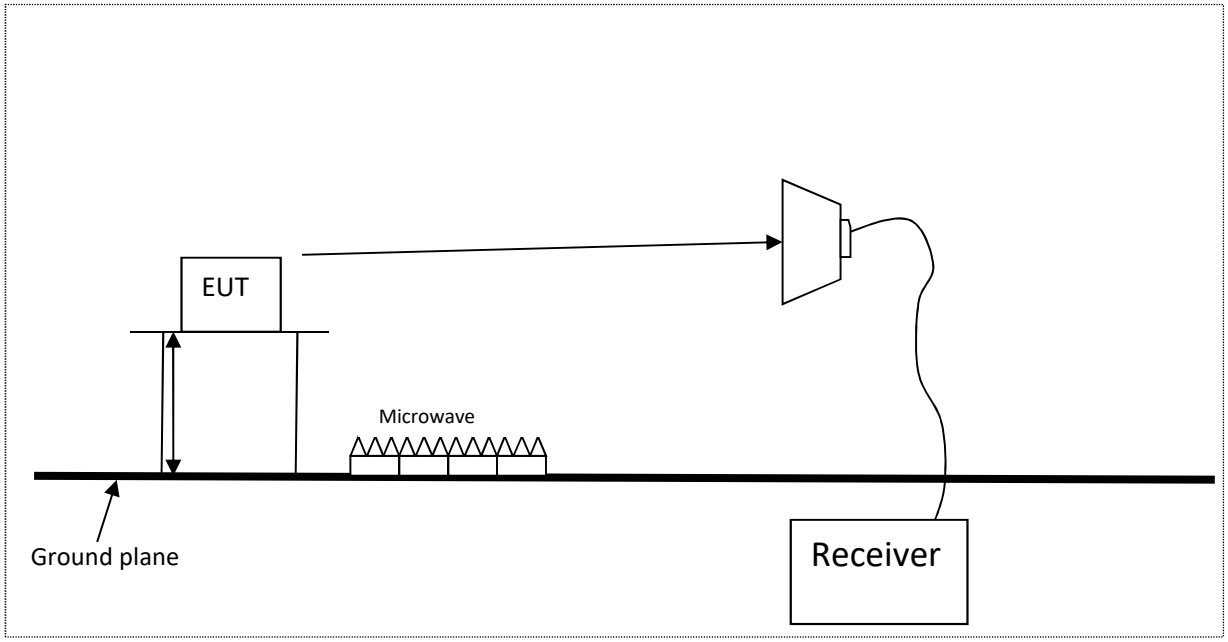


Diagram of the radiated emissions test setup above 1GHz

8 Test equipment calibration list

The following is a list of the test equipment used by R.N. Electronics Ltd to test the unit detailed within this report. In line with our procedures, the equipment was within calibration for the period during which testing was carried out.

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
CAL07	MWX221	Cable N Type to SMA Blue 2m	Junflon	10-Dec-2020	6 months
CAL08	MWX221	Cable N Type to SMA Blue 2m	Junflon	13-Jun-2020	12 months
E005	8447F	Pre-Amplifier 10MHz to 1000MHz	MCL Microwave+Mini-circuits	#11-Jun-2021	12 months
E136	3105	Horn Antenna 1 - 12.5 GHz	EMCO	10-Apr-2021	12 months
E268	BHA 9118	Horn Antenna 1 - 18 GHz	Schaffner	22-Apr-2021	12 months
E410	N5181A	Signal Generator 3 GHz MXG	Agilent Technologies	13-Jul-2018	36 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	11-Jul-2020	12 months
E429	-	Filter Box 5 Switch Filters 0.91 GHz - 16.3 GHz	RN Electronics	27-Aug-2020	12 months
E433	MG3693A	Signal Generator 2 GHz - 30 GHz	Anritsu	17-Sep-2020	12 months
E602	MG3692A	Signal Generator 10 MHz - 20 GHz	Anritsu	22-Feb-2021	12 months
E615	4768-10	Attenuator 10dB 40GHz	Narda	22-Jan-2021	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	11-Jul-2020	24 months
E755	N9030B	PXA 3Hz to 50GHz	Keysight Technologies	04-Aug-2020	12 months
E812	34401A	Digital Multimeter 6.5 digit	Hewlett Packard	04-Feb-2021	12 months
H072	N9000B-CFG013	CXA Signal Analyser 9kHz to 26.5GHz	Keysight Technologies	09-Feb-2021	months
L264	DT75	Digital Thermometer	Instrotech Ltd	16-Dec-2019	24 months
LPE364	CBL6112A	Antenna BiLog 30MHz – 2GHz	Chase Electronics Ltd	07-Mar-2020	24 months
N607	HSGDW-50B	Environmental Oven	Shanghai Hasuc Instrument	Not applicable	
P168	LT30-2	PSU 30V 2A	Farnell	Not applicable	
TMS78	3160-08	Horn Std Gain 12.4-18 GHz	ETS Systems	25-Aug-2020	12 months
TMS79	3160-09	Horn Std Gain 18-26.5 GHz	ETS Systems	11-May-2021	12 months
TMS812	MP534A MP651A	Dipole Set 200 - 1700 MHz	Anritsu	#19-June-2021	12 months
TMS82	8449B	Pre-Amplifier 1GHz - 26.5GHz	Agilent Technologies	21-Dec-2020	12 months

Equipment was within calibration dates for tests and has been re-calibrated since/during date of tests.

9 Auxiliary and peripheral equipment

9.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	HP Folio	Laptop PC	HP	CND151K3TT

9.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
E465	PCR2000LA	AC Power Source 2kVA	Kikusui	HJ000995

10 Condition of the equipment tested

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

10.1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

10.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

11 Description of test sites

Site A Radio Laboratory and Anechoic Chamber

Site B Semi-Anechoic Chamber and Control Room
FCC Registration No. 293246, ISED Registration No. 5612A-4

Site C Transient Laboratory

Site D Screened Room (Conducted Immunity)

Site E Screened Room (Control Room for Site D)

Site F Screened Room (Conducted Emissions)

Site G Screened Room (Control Room for Site H)

Site H 3m Semi-Anechoic Chamber (indoor OATS)
FCC Registration No. 293246, ISED Registration No. 5612A-2, VCCI Registration No. 4065

Site J Transient Laboratory

Site K Screened Room (Control Room for Site M)

Site M 3m Semi-Anechoic Chamber (indoor OATS)
FCC Registration No. 293246, ISED Registration No. 5612A-3

Site N Radio Laboratory

Site Q Fully-Anechoic Chamber

Site OATS 3m and 10m Open Area Test Site
FCC Registration No. 293246, ISED Registration No. 5612A-1

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

RN Electronics CAB identifier as issued by Innovation, Science and Economic Development Canada is UK0002
RN Electronics CAB identifier as issued by FCC is UK0015

12 Abbreviations and units

%	Percent
µA/m	microAmps per metre
µV	microVolts
µW	microWatts
AC	Alternating Current
ALSE	Absorber Lined Screened Enclosure
AM	Amplitude Modulation
Amb	Ambient
ATPC	Automatic Transmit Power Control
BER	Bit Error Rate
ºC	Degrees Celsius
C/I	Carrier / Interferer
CEPT	European Conference of Postal and Telecommunications Administrations
COFDM	Coherent OFDM
CS	Channel Spacing
CW	Continuous Wave
dB	deciBels
dBµA/m	deciBels relative to 1µA/m
dBµV	deciBels relative to 1µV
dBc	deciBels relative to Carrier
dBm	deciBels relative to 1mW
DC	Direct Current
DTA	Digital Transmission Analyser
EIRP	Equivalent Isotropic Radiated Power
ERP	Effective Radiated Power
EU	European Union
EUT	Equipment Under Test
FM	Frequency Modulation
FSK	Frequency Shift Keying
g	Grams
GHz	GigaHertz
Hz	Hertz
IF	Intermediate Frequency
kHz	kiloHertz
LBT	Listen Before Talk
LO	Local Oscillator
mA	milliAmps
max	maximum
kPa	Kilopascal
Mbit/s	MegaBits per second
MHz	MegaHertz
mic	Microphone
min	minimum
mm	milliMetres
ms	milliSeconds
mW	milliWatts
NA	Not Applicable
nom	Nominal
nW	nanoWatt
OATS	Open Area Test Site
OFDM	Orthogonal Frequency Division Multiplexing
ppm	Parts per million
PRBS	Pseudo Random Bit Sequence
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
R&TTE	Radio and Telecommunication Terminal Equipment
Ref	Reference
RF	Radio Frequency
RFC	Remote Frequency Control
RSL	Received Signal Level
RTP	Room Temperature and Pressure
RTPC	Remote Transmit Power Control
Rx	Receiver
s	Seconds
SINAD	Signal to Noise And Distortion
Tx	Transmitter
V	Volts