

Test report

408216-16R1TRFWL

Date of issue: March 24, 2021

Applicant:

Garmin International, Inc.

Product:

Battery Cradle + Battery (BLE)

Model:

A04118

Specifications:

◆ **LP0002-2020-07-15**

Low-power Radio-frequency Devices

Clause 4.10.1 Intentional radiators employing frequency hopping spread spectrum and digital modulation techniques

Lab and test locations

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FCC Site Number	Test Firm Registration Number: 392943 Designation Number: US5058
ISED Test Site	2040B-3

Tested by	Martha Espinoza, Wireless Test Engineer
Reviewed by	James Cunningham, EMC/MIL/WL Supervisor
Review date	March 24, 2021
Reviewer signature	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko USA's ISO/IEC 17025 accreditation.

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Section 1 Report summary

1.1 Applicant

Company name	Garmin International, Inc.
Address	1200 E. 151 st street
City	Olathe
Province/State	KS
Postal/Zip code	66062
Country	USA

1.2 Manufacturer

Company name	Garmin International, Inc.
Address	1200 E. 151 st street
City	Olathe
Province/State	KS
Postal/Zip code	66062
Country	USA

1.3 Test specifications

LP0002 – July 15, 2020	Intentional radiators employing frequency hopping spread spectrum and digital modulation techniques
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1.4 Test methods

ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
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1.5 Exclusions

None

1.6 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

1.7 Test report revision history

Table 1.7-1: Test report revision history

Revision #	Details of changes made to test report
408216-16TRFWL	Original report issued
408216-16R1TRFWL	Updated version of LP002, added conducted power to Section 3.3

Notes:

Section 2 Summary of test results

2.1 LP0002, Intentional Radiators Test Results

Part	Test description	Verdict
2.3	Conducted limits	Not applicable ¹
4.10.1 (2.1)	Maximum peak output power for frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	Not applicable
4.10.1 (2.2)	Maximum peak output power for other frequency hopping systems in the 2400–2483.5 MHz band	Not applicable
4.10.1 (2.3)	Maximum peak output power of systems using digital modulation in the 2400–2483.5 MHz and 5725–5850 MHz bands	Pass
4.10.1 (3)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Pass
4.10.1 (5)	Spurious emissions	Pass
4.10.1 (6.1.2)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
4.10.1 (6.1.3)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
4.10.1 (6.2.1)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Pass
4.10.1 (6.2.2)	Power spectral density for digitally modulated devices	Pass
4.10.1 (6.3)	Hybrid systems requirements	Not applicable

Notes: ¹EUT is battery power only

Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	November 9, 2020
Nemko sample ID number	NEx: 408216

3.2 EUT information

Product name	Battery Cradle + Battery
Model	A04118
Serial number	Conducted sample (50212): 3345709192 Radiated sample (30926): 3345709262
Part number	N/A

3.3 Technical information

Frequency band	2400 – 2483.5 MHz
Minimum frequency (MHz)	2402
Maximum frequency (MHz)	2480
Minimum output power (dBm)	8.31 dBm EIRP (4.51 dBm conducted power)
Maximum output power (dBm)	8.79 dBm EIRP (4.99 dBm conducted power)
Measured 6 dB bandwidth	2402 MHz: 689.603 kHz 2441 MHz: 690.822 kHz 2480 MHz: 693.072 kHz
Type of modulation	GFSK
Emission classification	N/A
Power requirements	Battery package
Antenna information	3.8 dBi maximum antenna gain

3.4 EUT exercise and monitoring details

Conducted and radiated sample were configured through a tool named “RF State Setter” where different parameters can be configured such as, channel frequency, continuous wave signal, modulated signal, ANT, BLE, etc., depending on the test requirement.

3.5 EUT setup details

Table 3.5-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number	Rev.
Battery cradle	Garmin	A04118	3345709192	---
Battery	Garmin	A04119	3345708884	---

Table 3.5-2: EUT interface ports

Description	Qty.
Field disturbance sensor port	1
Field disturbance sensor display port	1
Battery port	1

EUT setup details

Table 3.5-3: Support equipment

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop	Dell	Latitude	N/A	---
ANT USB	Dynastream	ANTUSB-m	203-JN6016	---

Table 3.5-4: Inter-connection cables

Cable description	From	To	Length (ft)
N/A	N/A	N/A	N/A

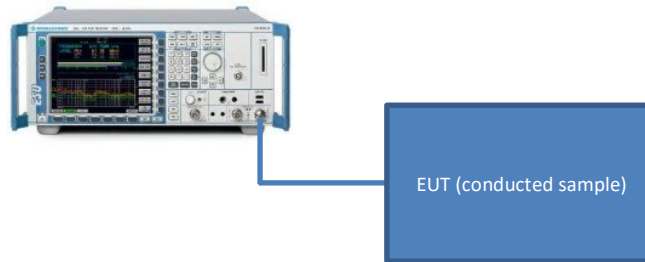


Figure 3.5-1: Test conducted setup.

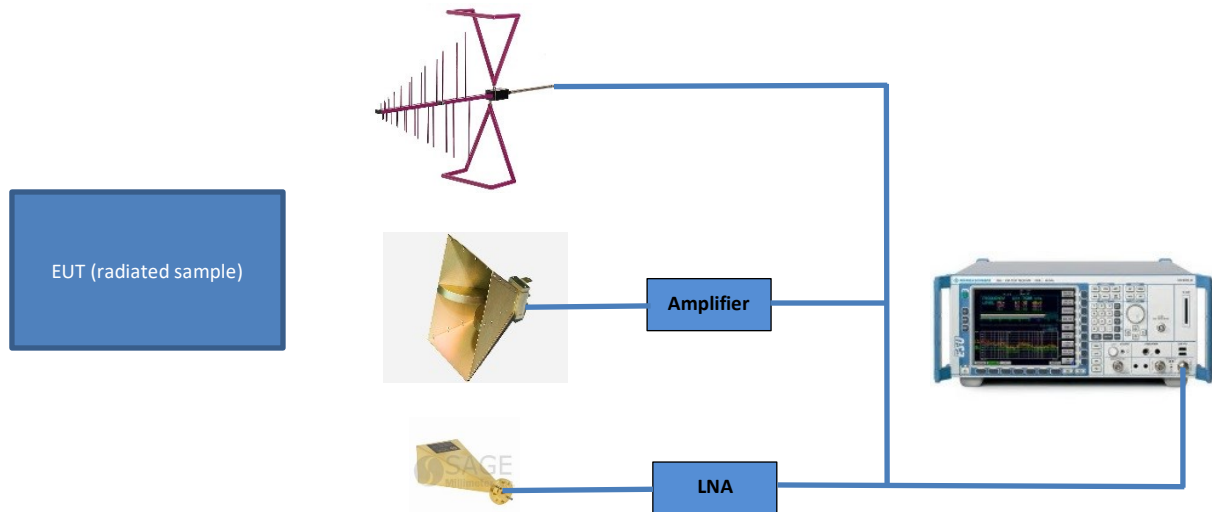


Figure 3.5-2: Test radiated setup

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature	15-30 °C
Relative humidity	20-75 %
Air pressure	86–106 kPa

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages $\pm 5\%$, for which the equipment was designed.

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of $K = 2$ with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements/ including OBW	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	1.38
Supply Voltages	0.05%
Time	2.09%

Table 6.1-1: Measurement uncertainty.

Important note: All testing in this document were done using the maximum radiation pattern from transmitter antenna for covering the worst case in all the measurements.

Section 7 Test Equipment

7.1 Test equipment list

Table 7.1-1: Test Equipment List

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Test Receiver	Rohde & Schwarz	ESU40	E1131	1 year	03 Dec 2021
EMI Test Receiver	Rohde & Schwarz	ESU40	E1121	1 year	01 Dec 2021
Spectrum analyzer	Rohde & Schwarz	FSW	E1302	1 year	18 Sep 2021
Spectrum analyzer	Rohde & Schwarz	FSV	E1120	1 year	19 Dec 2021
System controller	Sunol sciences	SC104V	E1191	NCR	NCR
Power sensor	ETS Lindgren	7002-006	E1062	1 year	29 Oct 2021
DRG Horn	ETS-Lindgren	3117-PA	E1139	2 years	21 March 2021
Bilog Antenna	Schaffner	CBL6111C	1763	2 years	18 Feb 2022
Antenna Horn	Sage	SAR-2309-42-S2	E1143	2 years	13 Nov 2022
Low Noise Amplifier	Sage	SBL-1834034030-KFKF	E1228	NCR	NCR

Table 7.1-2: Test Software

Manufacturer of Software	Details
Rohde & Schwarz	EMC 32 V10.60.15

Section 8 Testing data

8.1 Minimum 6 dB bandwidth for systems using digital modulation techniques

8.1.1 Definition and limits

LP0002 → 4.10.1

- (a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
- (2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.1.2 Test summary

Verdict	Pass		
Test date	November 10, 2020	Temperature	22 °C
Test engineer	Martha Espinoza	Air pressure	1001 mbar
Test location	Wireless bench	Relative humidity	49 %

8.1.3 Notes

Testing was performed in BLE mode and the EUT transmitting on a fixed channel at full power. Calibrated cable losses were included using an offset of 1.5 dB.

8.1.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench

Receiver/spectrum analyzer settings:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.1.5 Test data

Table 8.1-1: 6 dB occupied bandwidth test data

Test Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Margin (kHz)
2402	689.603	> 500	189.603
2440	690.822	> 500	190.822
2480	693.072	> 500	193.072

Minimum 6 dB bandwidth for systems using digital modulation techniques

8.1.5 Test data, continued

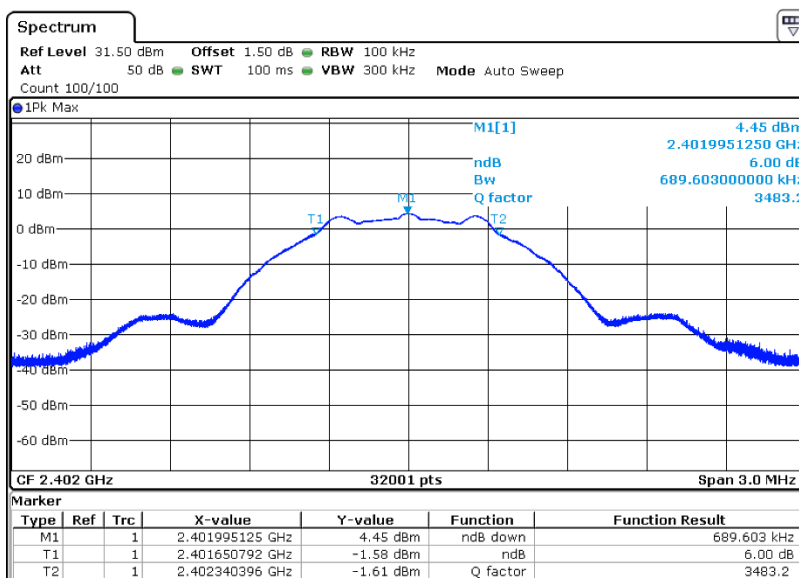


Figure 8.1-1: 6 dB occupied bandwidth, 2402 MHz

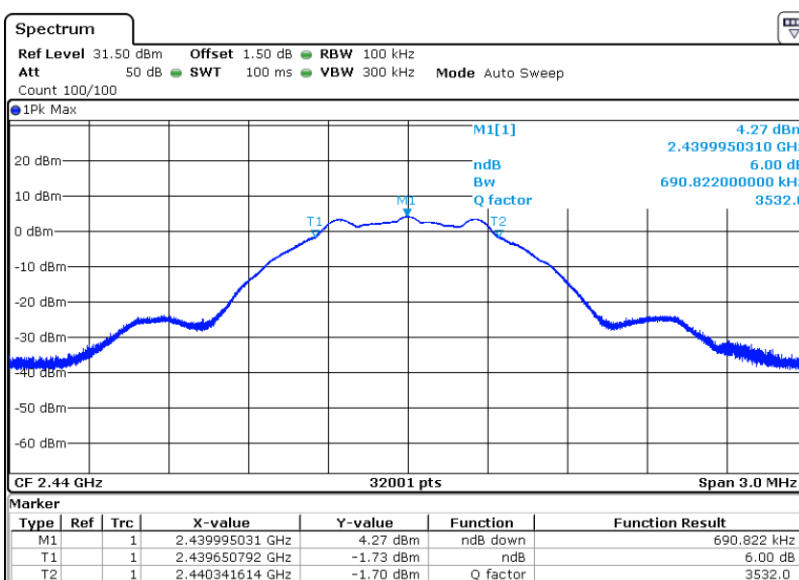


Figure 8.1-2: 6 dB occupied bandwidth, 2440 MHz

Minimum 6 dB bandwidth for systems using digital modulation techniques

8.1.5 Test data, continued

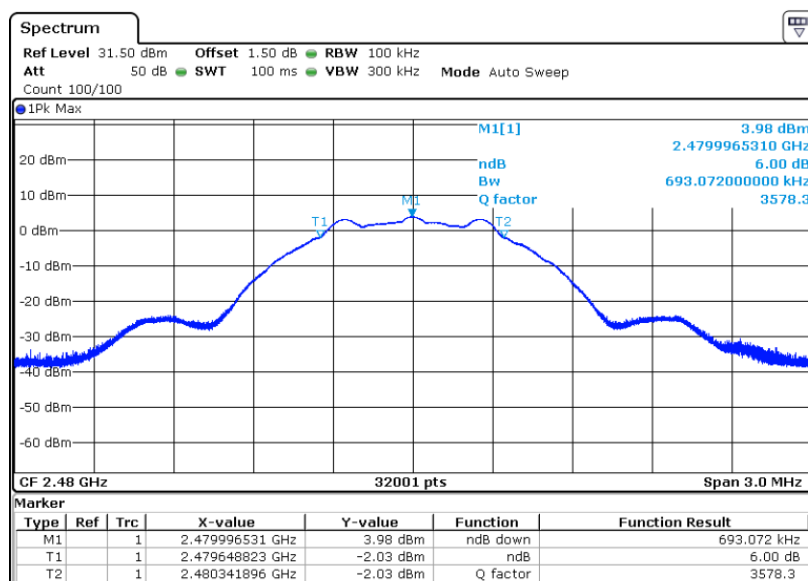


Figure 8.1-3: 6 dB occupied bandwidth, 2480 MHz

8.2 Transmitter output power and E.I.R.P. requirements

8.2.1 Definition and limits

LP0002 → 4.10.1 (2.3) & (3)

The maximum peak output power for systems using digital modulation in the 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt (30 dBm). If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below by the amount in dB. For fixed, point-to-point operations, shall follow the following conditions:

(3.1) Systems operating in the 2400–2483.5 MHz band, the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(3.2) Systems operating in the 5725–5850 MHz band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

8.2.2 Test summary

Verdict	Pass		
Test date	November 10, 2020	Temperature	22 °C
Test engineer	Martha Espinoza	Air pressure	1001 mbar
Test location	Wireless bench	Relative humidity	49 %

8.2.3 Notes

Testing was performed in BLE mode and the EUT transmitting on a fixed channel at full power.

The attenuation of the interconnecting cable was included in the power meter software as a correction factor. Calibrated cable losses were included using an offset of 1.5 dB.

The antenna gain is 3.8 dBi per client declaration.

8.2.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench

8.2.5 Test data

Table 8.2-1: Output power

Test Frequency (MHz)	Peak Conducted Power (dBm)	Cable losses (dB)	Total conducted power (dBm)	Conducted Limit (dBm)	Antenna Gain (dBi)	Peak EIRP (dBm)	EIRP Limit (dBm)
2402	3.49	1.5	4.99	30.0	3.8 ¹	8.79	36.0
2441	3.29	1.5	4.79	30.0	3.8 ¹	8.59	36.0
2480	3.01	1.5	4.51	30.0	3.8 ¹	8.31	36.0

Note ¹: Maximum antenna gain declared by manufacturer (worst case).

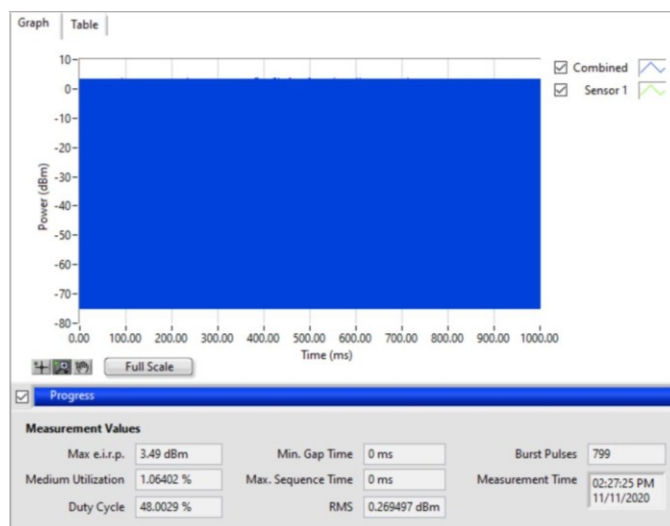


Figure 8.2-1: Output power, 2402 MHz

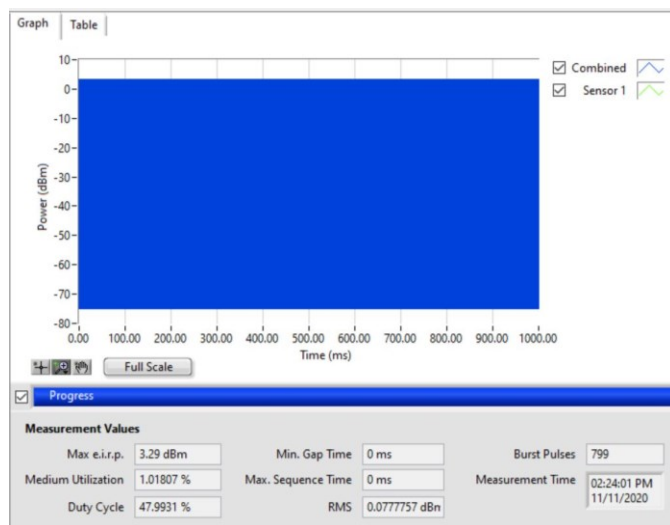


Figure 8.2-2: Output power, 2440 MHz

8.2.5 Test data, continued

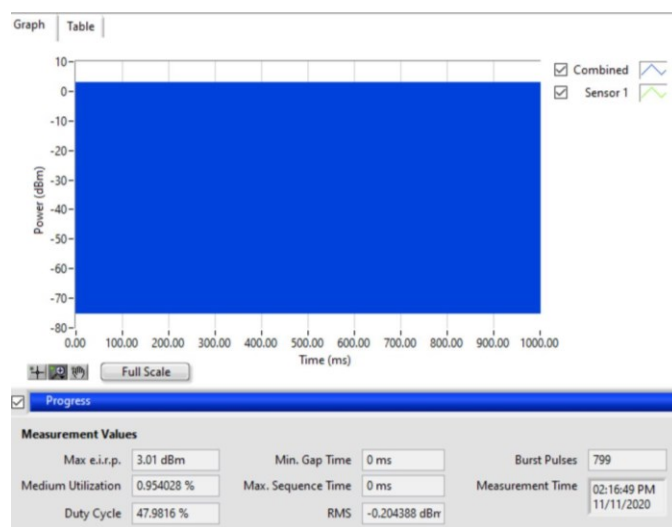


Figure 8.2-3: Output power, 2480 MHz

Spurious (out-of-band) emissions

8.3 Spurious (out-of-band) emissions

8.3.1 Definition and limits

LP0002 → 4.10.1 (5)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the modulation products of the spreading sequence, the information sequence and the carrier frequency shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in Section 2.8, whichever results in the lesser attenuation. In addition, radiated emissions which fall in section 2.7 the restricted bands, must also comply with the radiated emission limit specified in section 2.8

Table 8.3-1: Section 2.8 Radiated emission limits

Frequency, MHz	Field strength of emissions		Measurement distance, m
	$\mu\text{V/m}$	$\text{dB}\mu\text{V/m}$	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges. F is in kHz units

For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

Table 8.3-2: Section 2.7 Restricted frequency bands

MHz	MHz	MHz
0.090–0.110	156.70–156.90	3332.0–3339.0
0.490–0.510	162.01–167.17	3345.8–3358.0
2.172–2.198	240.00–285.00	3500.0–4400.0
3.013–3.033	322.00–335.40	4500.0–5250.0
4.115–4.198	399.90–410.00	7250.0–7750.0
5.670–5.690	608.00–614.00	8025.0–8500.0
6.200–6.300	825.00–915.00	9000.0–9200.0
8.230–8.400	938.00–1240.0	9300.0–9500.0
12.265–12.600	1300.0–1427.0	10600–12700
13.340–13.430	1435.0–1626.5	13250–13400
14.965–15.020	1660.0–1710.0	14470–14500
16.700–16.755	1718.8–1722.2	15350–16200
19.965–20.020	2200.0–2300.0	17700–21400
25.500–25.700	2310.0–2390.0	22010–23120
37.475–38.275	2483.5–2500.0	23600–24000
73.500–75.400	2655.0–2900.0	31200–31800
108.00–138.00	3260.0–3267.0	36430–36500
149.90–150.05		Above 38600

Spurious (out-of-band) emissions

8.3.2 Test summary

Verdict	Pass		
Test date	November 12, 2020 (conducted) November 16,17,19 2020 (radiated)	Temperature	21°C 21°C; 20°C; 23°C
Test engineer	Martha Espinoza	Air pressure	1005; 1001; 1000 mbar
Test location	Wireless bench 3m semi-anechoic chamber	Relative humidity	48; 50; 51 %

8.3.3 Notes

The EUT was configured to transmit continuously on the lowest, middle, and highest channels.
 The spectrum was search from 30 MHz to 26 GHz (above the 10th harmonic of the highest transmit frequency).
 Radiated measurements were performed at a 3 m measurement distance.
 For conducted measurements, the loss of the connected cable was input into the spectrum analyzer as 1.5 dB offset.

For conducted measurements, the limit was established at a level 20 dB down from the peak fundamental power as measured in 100 kHz RBW.

8.3.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench 3 m semi anechoic chamber

Spectrum analyzer settings for conducted spurious emissions:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

Receiver settings for radiated measurements within restricted bands below 1 GHz:

Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	Peak (preview measurements) Quasi-Peak (final measurements)
Trace mode	Max Hold
Measurement time	5 s (final measurements)

Receiver settings for radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Average and peak (final measurements)
Trace mode	Max Hold
Measurement time	5 s (final measurements)

8.3.5 Test data

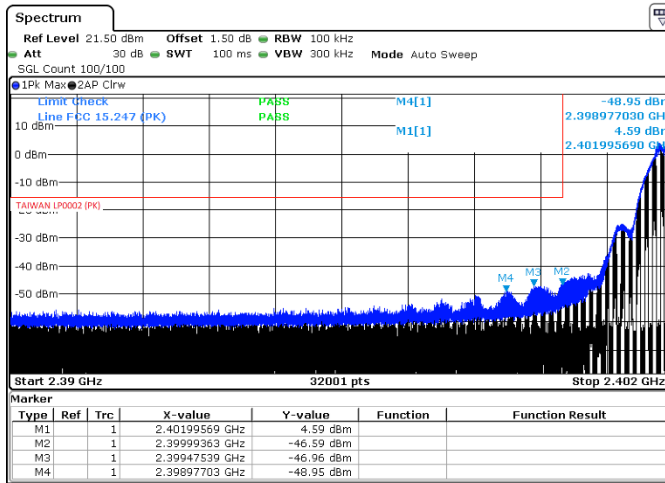


Figure 8.3-1: Band edge measurement, low channel

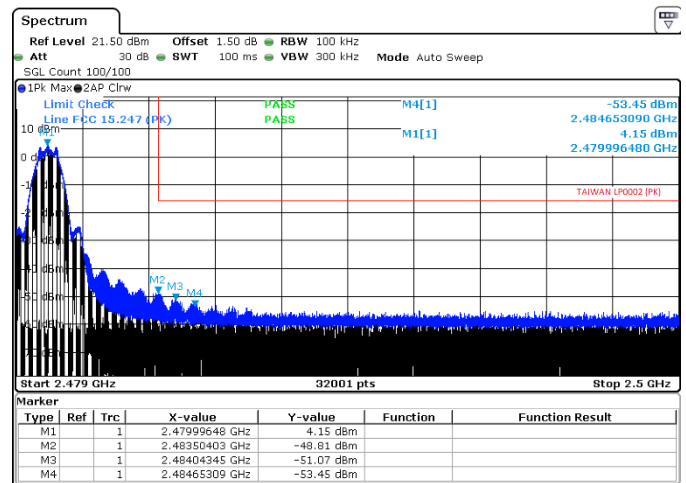


Figure 8.3-2: Band edge measurement, high channel

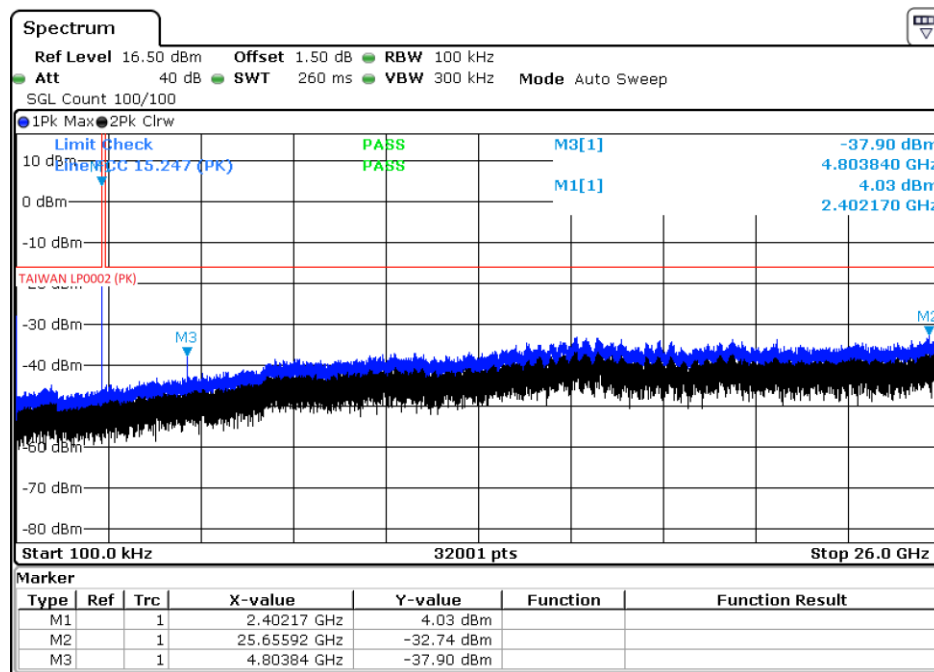


Figure 8.3-3: Conducted spurious emissions, low channel

Spurious (out-of-band) emissions

8.3.5 Test data, continued

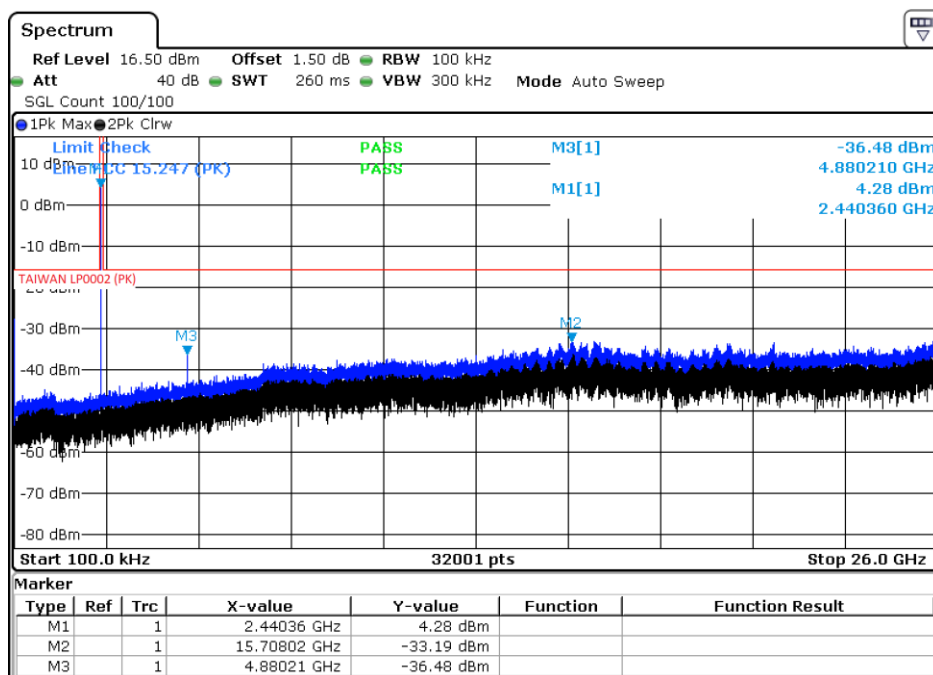


Figure 8.3-4: Conducted spurious emissions, middle channel

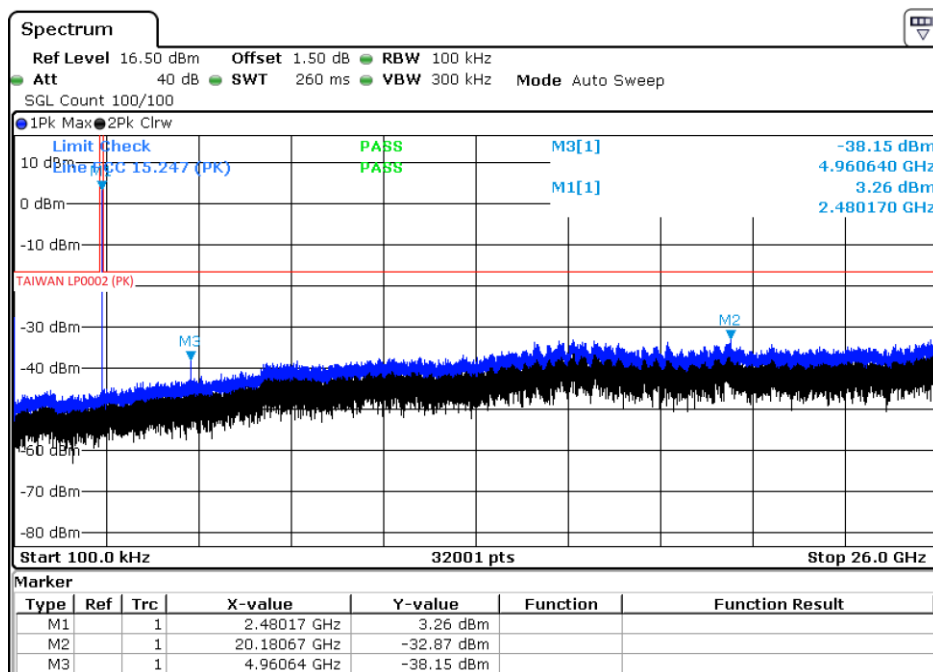


Figure 8.3-5: Conducted spurious emissions, high channel

Note: Peaks within 2400-2483.5MHz are transmitter fundamentals.

Spurious (out-of-band) emissions

8.3.5 Test data, continued

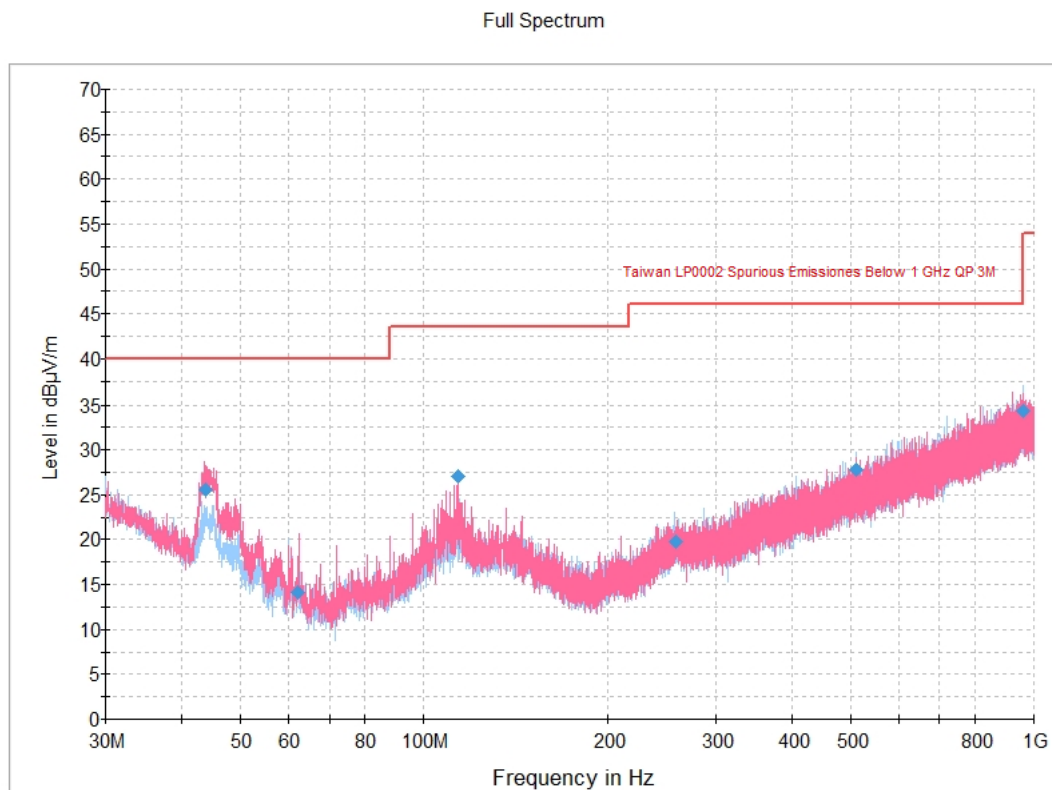


Figure 8.3-3: Radiated emissions, low channel, 30 – 1000 MHz

Table 8.3-3: Radiated emissions, low channel, 30 – 1000 MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
43.932333	25.60	40.00	14.40	5000.0	120.000	98.0	V	10.0	19.0
62.205667	14.15	40.00	25.85	5000.0	120.000	98.0	V	40.0	12.7
113.654000	27.12	43.50	16.38	5000.0	120.000	379.0	V	333.0	19.1
258.277000	19.70	46.00	26.30	5000.0	120.000	410.0	H	71.0	21.9
510.028333	27.78	46.00	18.22	5000.0	120.000	98.0	H	285.0	27.3
960.774333	34.29	53.90	19.61	5000.0	120.000	201.0	H	11.0	34.7

Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

Correction factors = antenna factor ACF (dB) + cable loss (dB)

Notes:

Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

Spurious (out-of-band) emissions

8.3.5 Test data, continued

Full Spectrum

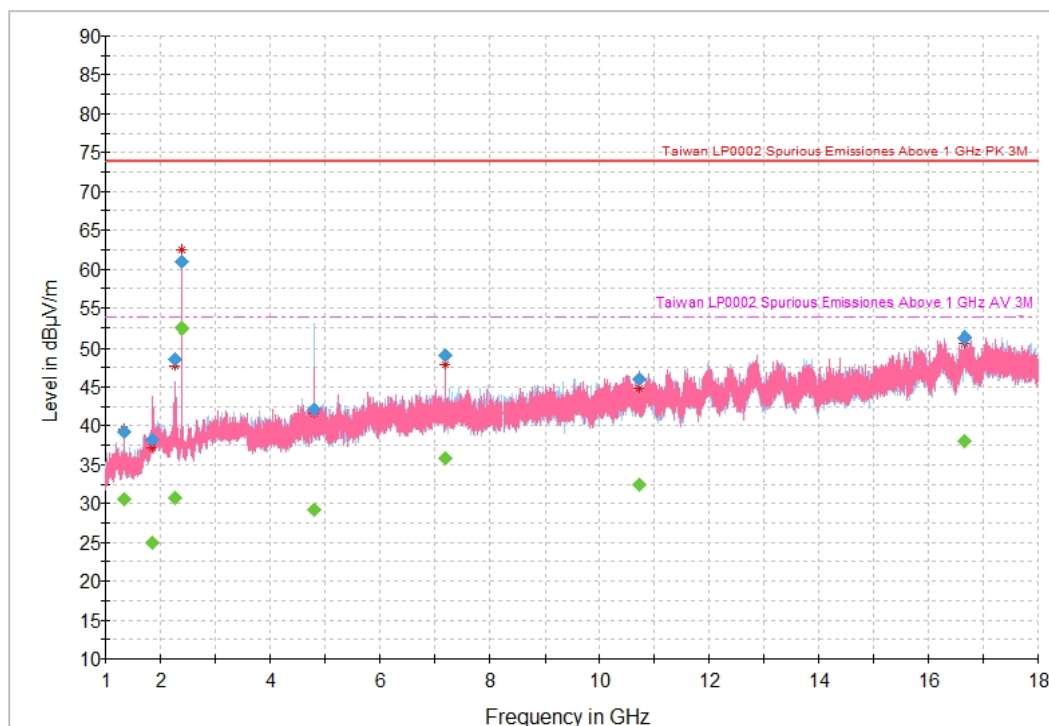


Figure 8.3-4: Radiated emissions, low channel, 1 – 18 GHz

Table 8.3-4: Radiated emissions, low channel, 1 - 18 GHz

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1350.033333	39.22	---	73.90	34.68	5000.0	1000.000	193.0	V	0.0	-14.4
1350.033333	---	30.56	53.90	23.34	5000.0	1000.000	193.0	V	0.0	-14.4
1865.633333	---	25.00	53.90	28.90	5000.0	1000.000	191.0	V	356.0	-11.2
1865.633333	38.18	---	73.90	35.72	5000.0	1000.000	191.0	V	356.0	-11.2
2273.700000	---	30.72	53.90	23.18	5000.0	1000.000	100.0	V	0.0	-10.4
2273.700000	48.50	---	73.90	25.40	5000.0	1000.000	100.0	V	0.0	-10.4
2401.766667	Low channel fundamental									
2401.766667	Low channel fundamental									
4806.833333	---	29.16	53.90	24.74	5000.0	1000.000	287.0	H	154.0	-1.7
4806.833333	42.15	---	73.90	31.75	5000.0	1000.000	287.0	H	154.0	-1.7
7206.700000	49.11	---	73.90	24.79	5000.0	1000.000	202.0	H	213.0	0.7
7206.700000	---	35.79	53.90	18.11	5000.0	1000.000	202.0	H	213.0	0.7
10717.266667	---	32.35	53.90	21.55	5000.0	1000.000	342.0	V	242.0	4.1
10717.266667	45.95	---	73.90	27.95	5000.0	1000.000	342.0	V	242.0	4.1
16654.200000	51.27	---	73.90	22.63	5000.0	1000.000	162.0	V	206.0	13.9
16654.200000	---	38.08	53.90	15.82	5000.0	1000.000	162.0	V	206.0	13.9

Notes:

The marked row as low channel fundamental is the wanted frequency of the transmitter and is not evaluated against the limits.

Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

Correction factors = antenna factor ACF (dB) + cable loss (dB)

Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

A 2.4 GHz filter was used to protect the receiver system.

Spurious (out-of-band) emissions

8.3.5 Test data, continued

Full Spectrum

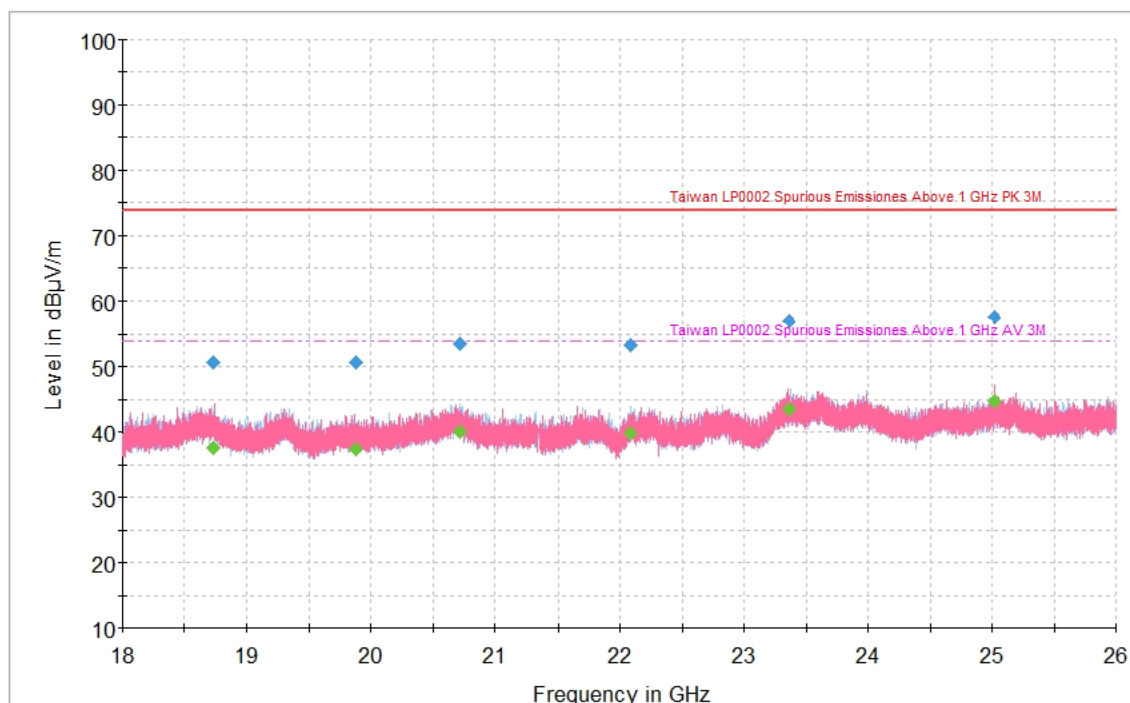


Figure 8.3-5: Radiated emissions, low channel, 18 - 26 GHz

Table 8.3-5: Radiated emissions, low channel, 18 - 26 GHz

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18731.666667	50.61	---	73.90	23.29	3000.0	1000.000	297.0	V	11.0	18.0
18731.666667	---	37.70	53.90	16.20	3000.0	1000.000	297.0	V	11.0	18.0
19878.600000	---	37.44	53.90	16.46	3000.0	1000.000	179.0	V	190.0	17.8
19878.600000	50.60	---	73.90	23.30	3000.0	1000.000	179.0	V	190.0	17.8
20721.666667	53.53	---	73.90	20.37	3000.0	1000.000	149.0	H	0.0	20.6
20721.666667	---	40.09	53.90	13.81	3000.0	1000.000	149.0	H	0.0	20.6
22082.333333	53.40	---	73.90	20.50	3000.0	1000.000	368.0	H	57.0	19.2
22082.333333	---	39.89	53.90	14.01	3000.0	1000.000	368.0	H	57.0	19.2
23369.533333	56.91	---	73.90	16.99	3000.0	1000.000	327.0	H	173.0	23.0
23369.533333	---	43.45	53.90	10.45	3000.0	1000.000	327.0	H	173.0	23.0
25025.533333	---	44.74	53.90	9.16	3000.0	1000.000	402.0	V	57.0	23.2
25025.533333	57.59	---	73.90	16.31	3000.0	1000.000	402.0	V	57.0	23.2

Field strength (dBμV/m) = receiver/spectrum analyzer value (dBμV) + correction factor (dB)

Correction factors = antenna factor ACF (dB) + cable loss (dB)

Notes:

Limits converted to dBμV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

Spurious (out-of-band) emissions

8.3.5 Test data, continued

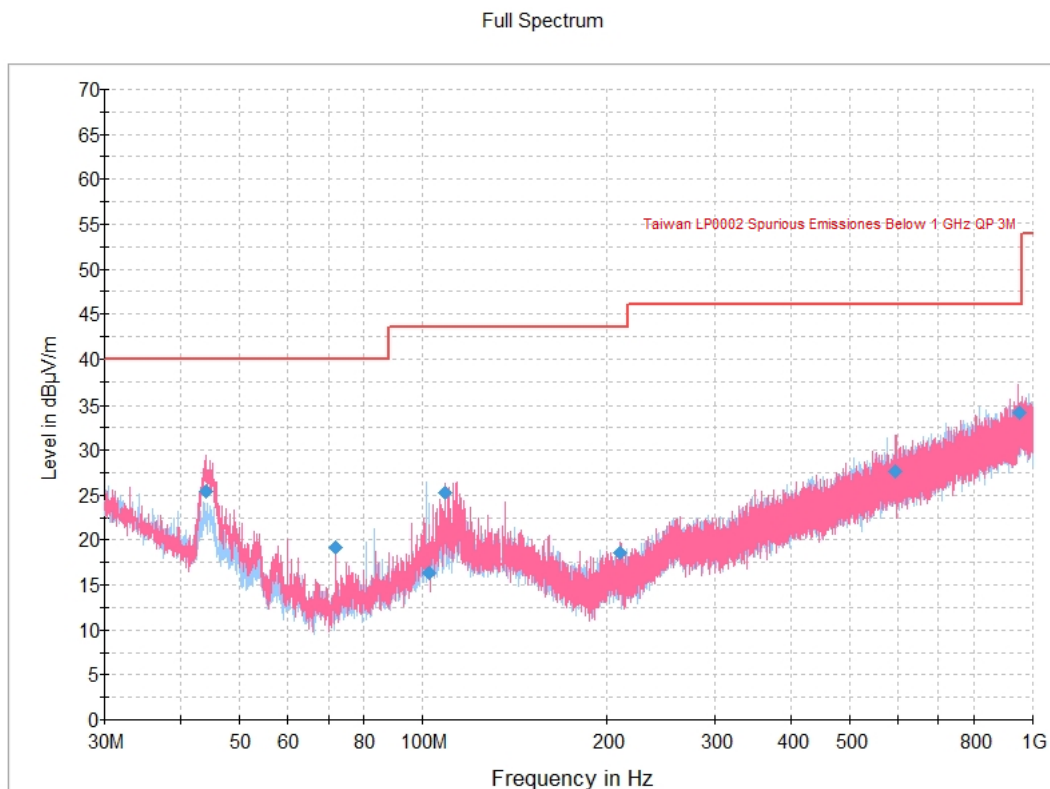


Figure 8.3-6: Radiated emissions, middle channel, 30 – 1000 MHz

Table 8.3-6: Radiated emissions, middle channel, 30 – 1000 MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
44.008000	25.34	40.00	14.66	5000.0	120.000	98.0	V	286.0	18.9
72.001000	19.21	40.00	20.79	5000.0	120.000	378.0	V	11.0	13.9
102.506000	16.31	43.50	27.19	5000.0	120.000	262.0	H	182.0	18.1
108.804000	25.23	43.50	18.27	5000.0	120.000	402.0	V	76.0	18.7
209.959667	18.61	43.50	24.89	5000.0	120.000	188.0	V	292.0	18.2
595.181667	27.62	46.00	18.38	5000.0	120.000	210.0	V	0.0	29.0
948.700000	34.21	46.00	11.79	5000.0	120.000	113.0	V	0.0	34.5

Notes:

Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

Correction factors = antenna factor ACF (dB) + cable loss (dB)

Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

Spurious (out-of-band) emissions

8.3.5 Test data, continued

Full Spectrum

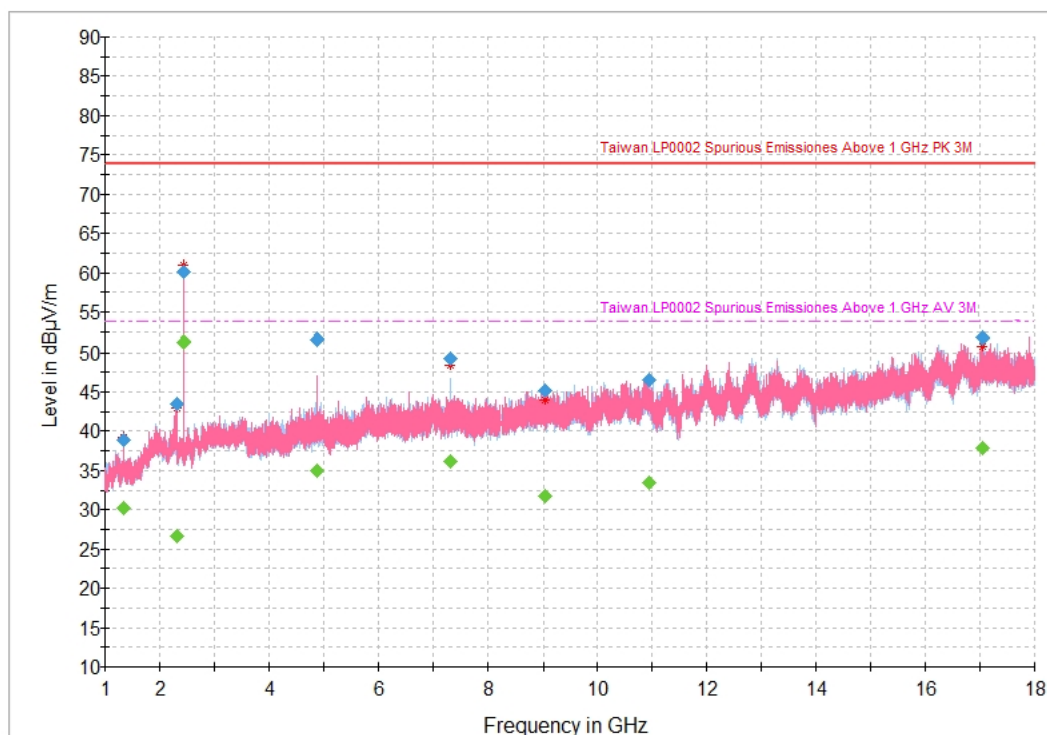


Figure 8.3-7: Radiated emissions, middle channel, 1 - 18 GHz

Table 8.3-7: Radiated emissions, middle channel, 1 - 18 GHz

Frequency (MHz)	QuasiPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1350.033333	---	30.28	53.90	23.62	5000.0	1000.000	195.0	V	212.0	-14.4
1350.033333	38.93	---	73.90	34.97	5000.0	1000.000	195.0	V	212.0	-14.4
2311.433333	---	26.68	53.90	27.22	5000.0	1000.000	128.0	V	0.0	-10.5
2311.433333	43.55	---	73.90	30.35	5000.0	1000.000	128.0	V	0.0	-10.5
2439.733333	Middle channel fundamental									
2439.733333	Middle channel fundamental									
4879.966667	51.58	---	73.90	22.32	5000.0	1000.000	108.0	V	76.0	-2.0
4879.966667	---	35.04	53.90	18.86	5000.0	1000.000	108.0	V	76.0	-2.0
7319.400000	---	36.19	53.90	17.71	5000.0	1000.000	215.0	H	222.0	0.8
7319.400000	49.32	---	73.90	24.58	5000.0	1000.000	215.0	H	222.0	0.8
9026.000000	---	31.82	53.90	22.08	5000.0	1000.000	397.0	H	0.0	2.9
9026.000000	45.13	---	73.90	28.77	5000.0	1000.000	397.0	H	0.0	2.9
10952.100000	---	33.43	53.90	20.47	5000.0	1000.000	227.0	H	344.0	4.6
10952.100000	46.55	---	73.90	27.35	5000.0	1000.000	227.0	H	344.0	4.6
17048.500000	51.72	---	73.90	22.18	5000.0	1000.000	402.0	V	174.0	12.9
17048.500000	---	37.93	53.90	15.97	5000.0	1000.000	402.0	V	174.0	12.9

Notes:

The marked row as middle channel fundamental is the wanted frequency of the transmitter and is not evaluated against the limits.

Field strength (dBμV/m) = receiver/spectrum analyzer value (dBμV) + correction factor (dB)

Correction factors = antenna factor ACF (dB) + cable loss (dB)

Limits converted to dBμV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

A 2.4 GHz filter was used to protect the receiver system.

Spurious (out-of-band) emissions

8.3.5 Test data, continued

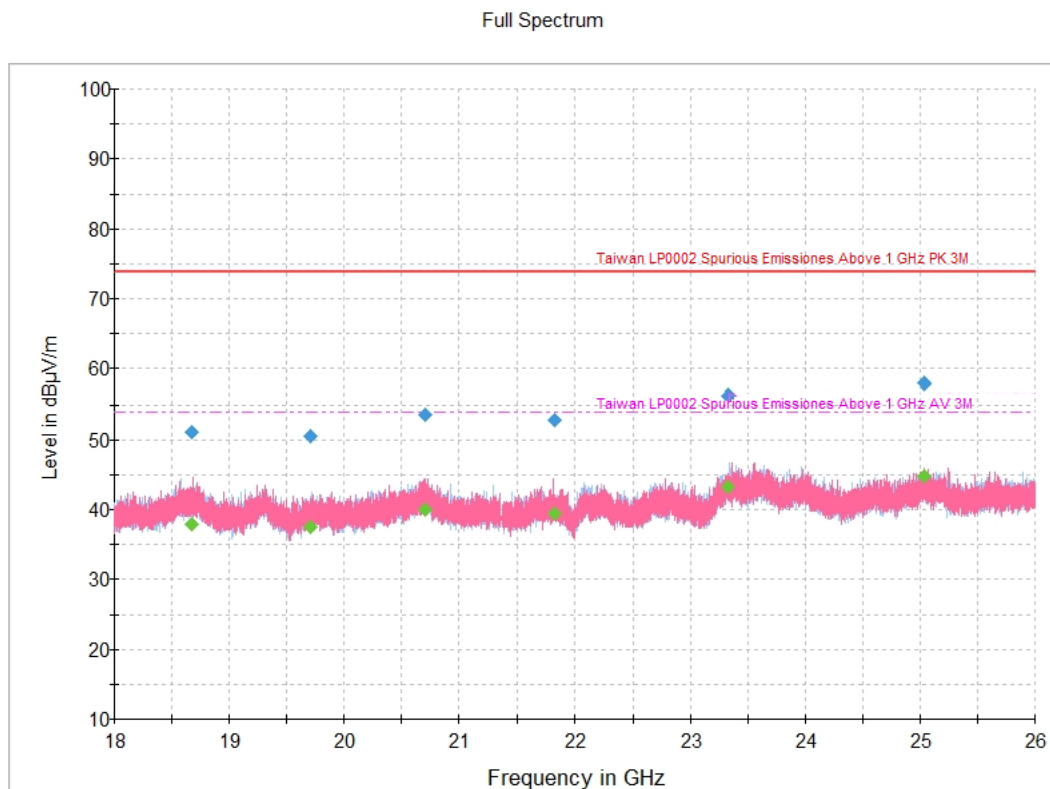


Figure 8.3-8: Radiated emissions, middle channel, 18 - 26 GHz

Table 8.3-8: Radiated emissions, middle channel, 18 - 26 GHz

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18678.066667	51.14	---	73.90	22.76	3000.0	1000.000	200.0	V	11.0	18.1
18678.066667	---	37.95	53.90	15.95	3000.0	1000.000	200.0	V	11.0	18.1
19707.000000	---	37.54	53.90	16.36	3000.0	1000.000	410.0	H	58.0	17.8
19707.000000	50.55	---	73.90	23.35	3000.0	1000.000	410.0	H	58.0	17.8
20701.933333	---	40.02	53.90	13.88	3000.0	1000.000	297.0	H	56.0	20.6
20701.933333	53.50	---	73.90	20.40	3000.0	1000.000	297.0	H	56.0	20.6
21814.333333	---	39.37	53.90	14.53	3000.0	1000.000	226.0	V	72.0	19.5
21814.333333	52.87	---	73.90	21.03	3000.0	1000.000	226.0	V	72.0	19.5
23326.200000	56.21	---	73.90	17.69	3000.0	1000.000	410.0	H	72.0	22.7
23326.200000	---	43.33	53.90	10.57	3000.0	1000.000	410.0	H	72.0	22.7
25033.400000	---	44.77	53.90	9.13	3000.0	1000.000	284.0	V	0.0	23.1
25033.400000	57.93	---	73.90	15.97	3000.0	1000.000	284.0	V	0.0	23.1

Field strength (dBμV/m) = receiver/spectrum analyzer value (dBμV) + correction factor (dB)

Correction factors = antenna factor ACF (dB) + cable loss (dB)

Notes:

Limits converted to dBμV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

Spurious (out-of-band) emissions

8.3.5 Test data, continued

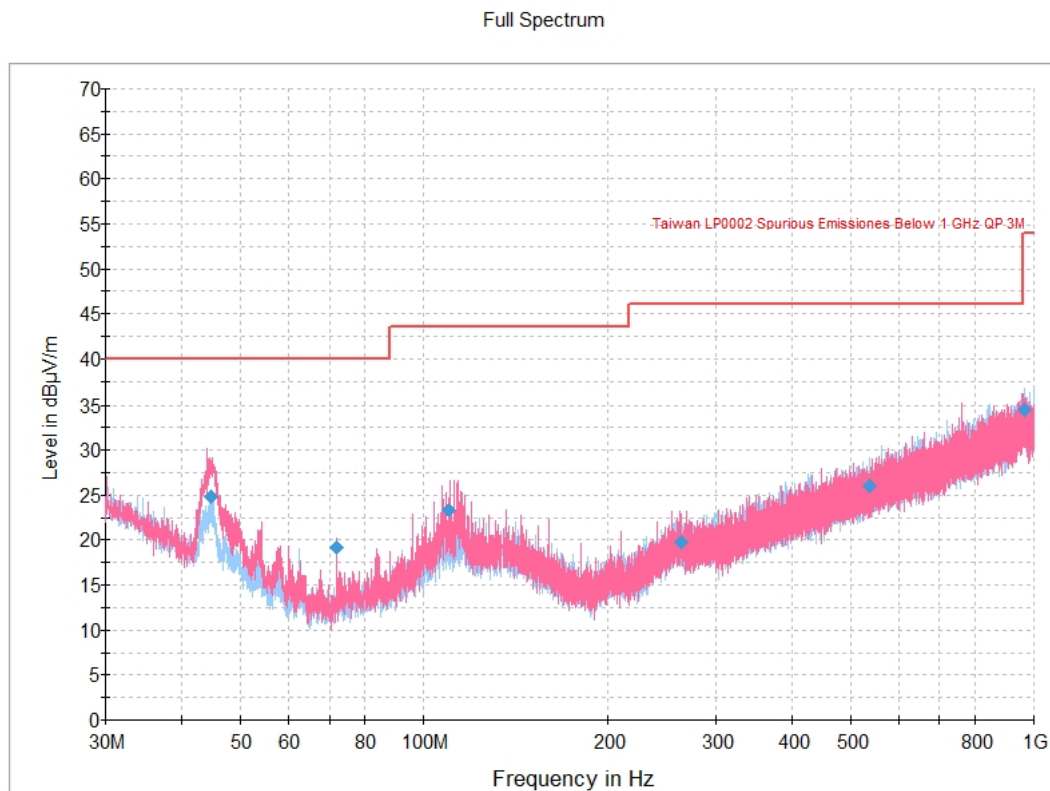


Figure 8.3-9: Radiated emissions, high channel, 30 – 1000 MHz

Table 8.3-9: Radiated emissions, high channel, 30 – 1000 MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
44.800333	24.84	40.00	15.16	5000.0	120.000	111.0	V	237.0	18.5
72.001000	19.10	40.00	20.90	5000.0	120.000	392.0	V	171.0	13.9
109.853000	23.33	43.50	20.17	5000.0	120.000	386.0	V	256.0	18.8
262.787333	19.72	46.00	26.28	5000.0	120.000	410.0	H	273.0	21.9
536.876667	25.98	46.00	20.02	5000.0	120.000	250.0	H	0.0	27.7
963.983333	34.41	53.90	19.49	5000.0	120.000	249.0	H	0.0	34.7

Notes:

Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

Correction factors = antenna factor ACF (dB) + cable loss (dB)

Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

Spurious (out-of-band) emissions

8.3.5 Test data, continued

Full Spectrum

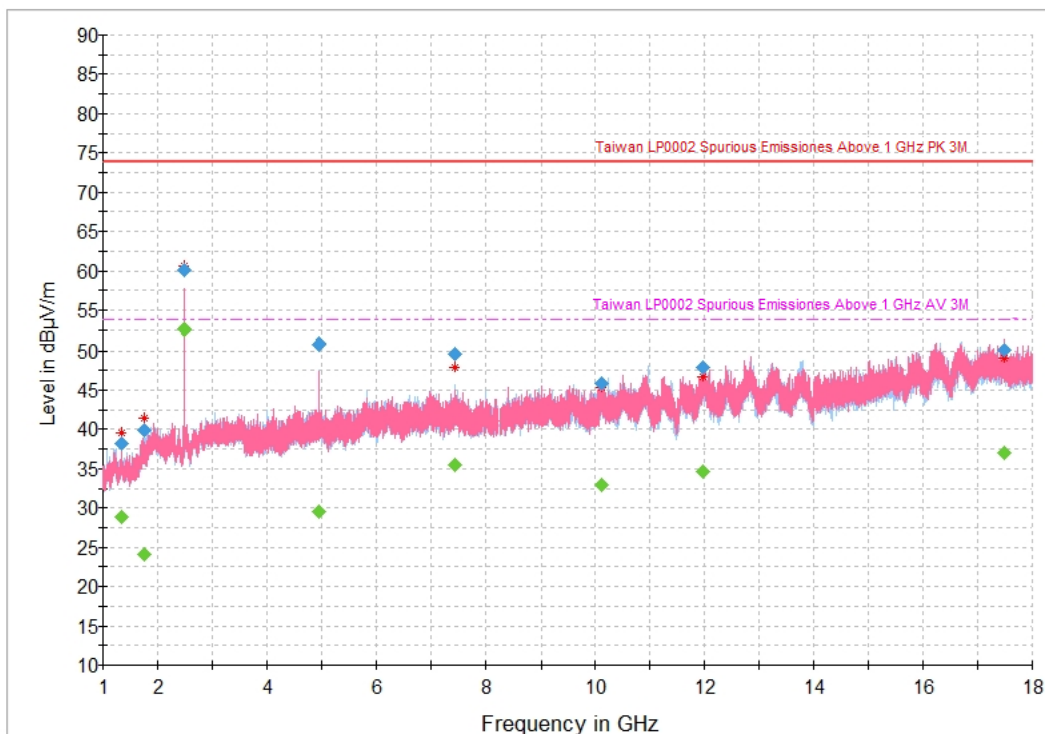


Figure 8.3-10: Radiated emissions, high channel, 1 - 18 GHz

Table 8.3-10: Radiated emissions, high channel, 1 - 18 GHz

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1350.033333	38.24	---	73.90	35.66	5000.0	1000.000	234.0	V	10.0	-14.4
1350.033333	---	28.84	53.90	25.06	5000.0	1000.000	234.0	V	10.0	-14.4
1754.066667	39.93	---	73.90	33.97	5000.0	1000.000	223.0	H	10.0	-12.2
1754.066667	---	24.02	53.90	29.88	5000.0	1000.000	223.0	H	10.0	-12.2
2479.966667	High channel fundamental									
2479.966667	High channel fundamental									
4960.033333	50.81	---	73.90	23.09	5000.0	1000.000	254.0	H	257.0	-2.1
4960.033333	---	29.61	53.90	24.29	5000.0	1000.000	254.0	H	257.0	-2.1
7439.933333	49.54	---	73.90	24.36	5000.0	1000.000	214.0	H	241.0	1.3
7439.933333	---	35.56	53.90	18.34	5000.0	1000.000	214.0	H	241.0	1.3
10108.500000	---	32.90	53.90	21.00	5000.0	1000.000	402.0	V	310.0	4.4
10108.500000	45.91	---	73.90	27.99	5000.0	1000.000	402.0	V	310.0	4.4
11964.633333	---	34.66	53.90	19.24	5000.0	1000.000	410.0	H	165.0	6.0
11964.633333	47.84	---	73.90	26.06	5000.0	1000.000	410.0	H	165.0	6.0
17491.600000	50.06	---	73.90	23.84	5000.0	1000.000	267.0	V	156.0	13.0
17491.600000	---	37.08	53.90	16.82	5000.0	1000.000	267.0	V	156.0	13.0

Notes:

The marked row as high channel fundamental is the wanted frequency of the transmitter and is not evaluated against the limits.

Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

Correction factors = antenna factor ACF (dB) + cable loss (dB)

Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

A 2.4 GHz filter was used to protect the receiver system.

Spurious (out-of-band) emissions

8.3.5 Test data, continued

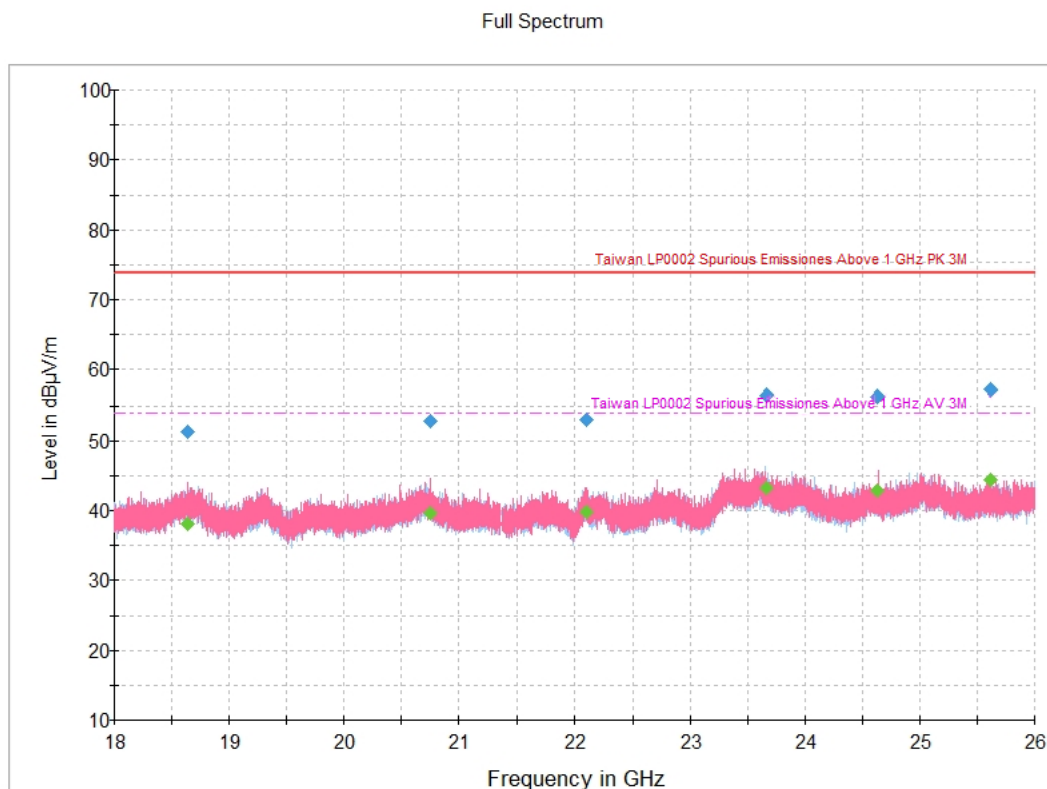


Figure 8.3-11: Radiated emissions, high channel, 18 - 26 GHz

Table 8.3-11: Radiated emissions, high channel, 18 - 26 GHz

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18643.266667	---	38.12	53.90	15.78	3000.0	1000.000	402.0	V	291.0	18.1
18643.266667	51.23	---	73.90	22.67	3000.0	1000.000	402.0	V	291.0	18.1
20750.333333	52.81	---	73.90	21.09	3000.0	1000.000	300.0	V	76.0	20.3
20750.333333	---	39.70	53.90	14.20	3000.0	1000.000	300.0	V	76.0	20.3
22099.933333	53.01	---	73.90	20.89	3000.0	1000.000	377.0	H	172.0	19.2
22099.933333	---	39.88	53.90	14.02	3000.0	1000.000	377.0	H	172.0	19.2
23663.800000	56.34	---	73.90	17.56	3000.0	1000.000	233.0	H	175.0	23.4
23663.800000	---	43.30	53.90	10.60	3000.0	1000.000	233.0	H	175.0	23.4
24631.533333	---	42.93	53.90	10.97	3000.0	1000.000	140.0	V	0.0	22.1
24631.533333	56.34	---	73.90	17.56	3000.0	1000.000	140.0	V	0.0	22.1
25613.133333	57.22	---	73.90	16.68	3000.0	1000.000	402.0	V	214.0	22.7
25613.133333	---	44.42	53.90	9.48	3000.0	1000.000	402.0	V	214.0	22.7

Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

Correction factors = antenna factor ACF (dB) + cable loss (dB)

Notes:

Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

Spurious (out-of-band) emissions

8.3.5 Test data, continued

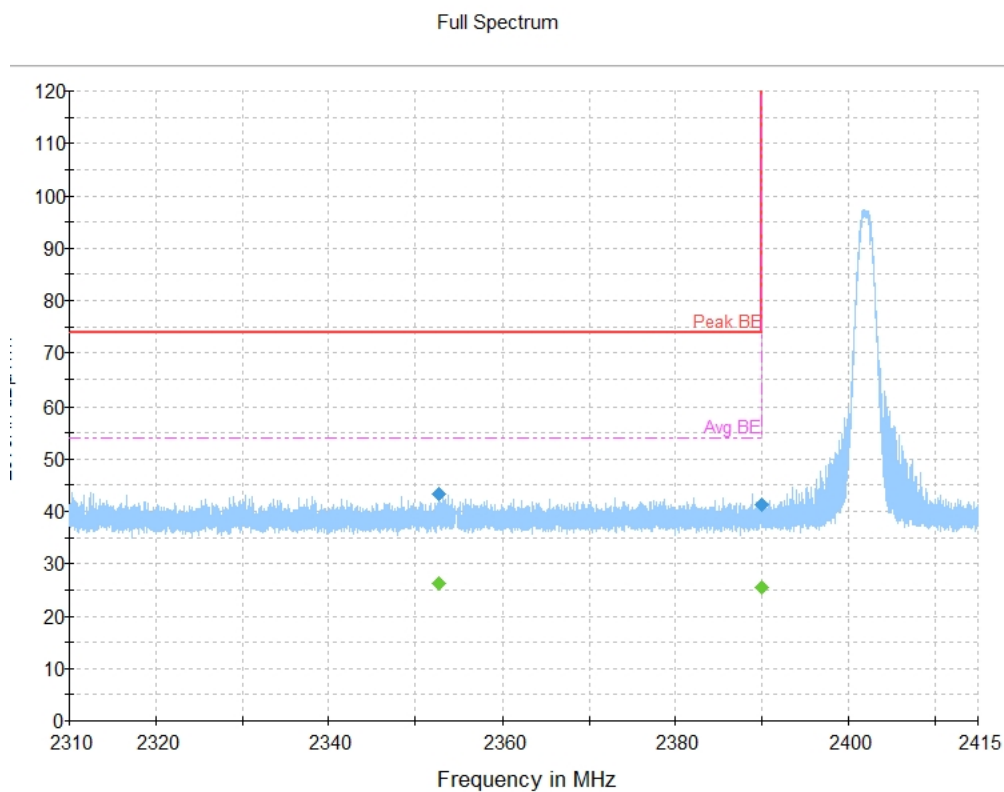


Figure 8.3-12: Radiated emissions, restricted band edge, low

Table 8.3-11: Radiated emissions, restricted band edge, low

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2352.833000	43.40	---	73.90	30.50	5000.0	1000.000	98.0	V	148.0	-10.3
2352.833000	---	26.13	53.90	27.77	5000.0	1000.000	98.0	V	148.0	-10.3
2390.000000	41.29	---	73.90	32.61	5000.0	1000.000	175.0	H	310.0	-10.1
2390.000000	---	25.56	53.90	28.34	5000.0	1000.000	175.0	H	310.0	-10.1

Field strength (dBμV/m) = receiver/spectrum analyzer value (dBμV) + correction factor (dB)

Correction factors = antenna factor ACF (dB) + cable loss (dB)

Notes:

Limits converted to dBμV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

Spurious (out-of-band) emissions

8.3.5 Test data, continued

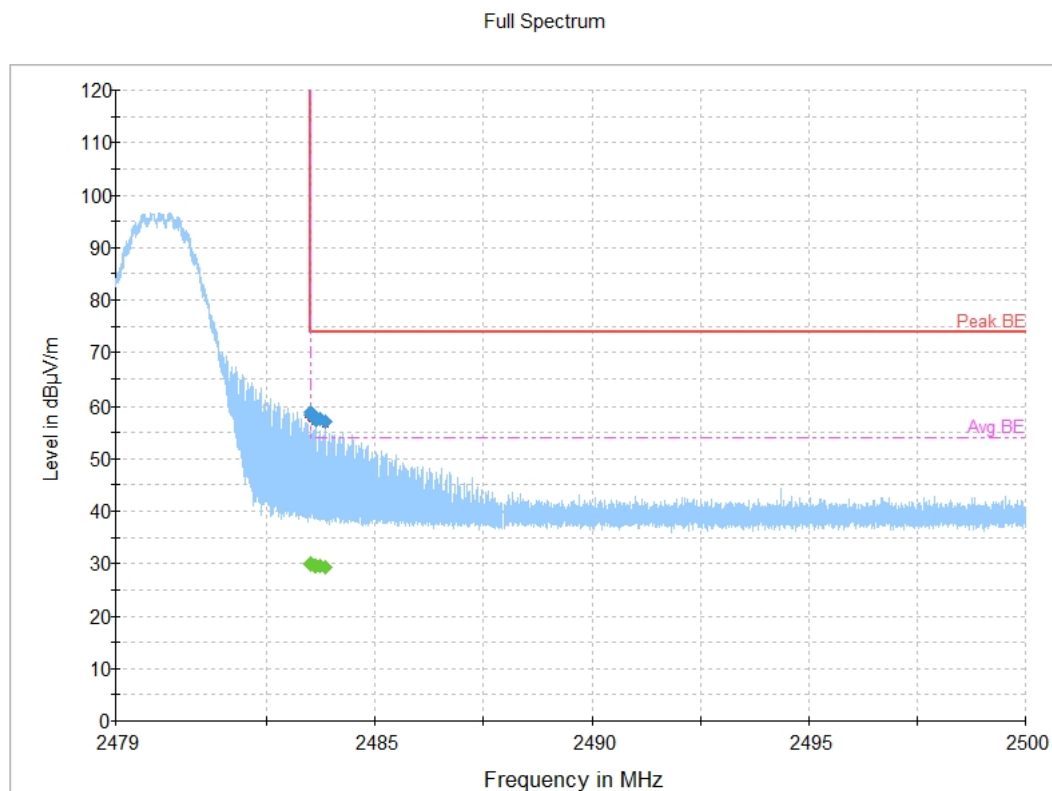


Figure 8.3-13: Radiated emissions, restricted band edge, high

Table 8.3-11: Radiated emissions, restricted band edge, high

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2483.500000	---	30.17	53.90	23.73	5000.0	1000.000	146.0	H	21.0	-9.5
2483.500000	58.74	---	73.90	15.16	5000.0	1000.000	146.0	H	21.0	-9.5
2483.517800	---	29.91	53.90	23.99	5000.0	1000.000	102.0	H	10.0	-9.5
2483.517800	58.23	---	73.90	15.67	5000.0	1000.000	102.0	H	10.0	-9.5
2483.611600	---	29.49	53.90	24.41	5000.0	1000.000	116.0	H	10.0	-9.5
2483.611600	57.51	---	73.90	16.39	5000.0	1000.000	116.0	H	10.0	-9.5
2483.622100	---	29.68	53.90	24.22	5000.0	1000.000	117.0	H	20.0	-9.5
2483.622100	57.65	---	73.90	16.25	5000.0	1000.000	117.0	H	20.0	-9.5
2483.645200	---	29.48	53.90	24.42	5000.0	1000.000	117.0	H	10.0	-9.5
2483.645200	57.32	---	73.90	16.58	5000.0	1000.000	117.0	H	10.0	-9.5
2483.729200	---	29.66	53.90	24.24	5000.0	1000.000	102.0	H	10.0	-9.5
2483.729200	57.52	---	73.90	16.38	5000.0	1000.000	102.0	H	10.0	-9.5
2483.834200	---	29.37	53.90	24.53	5000.0	1000.000	101.0	H	10.0	-9.5
2483.834200	57.03	---	73.90	16.87	5000.0	1000.000	101.0	H	10.0	-9.5

Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

Correction factors = antenna factor ACF (dB) + cable loss (dB)

Notes:

Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

8.4 Power spectral density of digital transmission system

8.4.1 References

LP0002 → 4.10.1 (6.2.2)

- (e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this Section. The same method of determining the conducted output power shall be used to determine the power spectral density.

8.4.2 Test summary

Verdict	Pass		
Test date	November 12, 2020	Temperature	221°C
Test engineer	Martha Espinoza	Air pressure	1005 mbar
Test location	Wireless bench	Relative humidity	48 %

8.4.3 Notes

Testing was performed in BLE mode and the EUT transmitting on a fixed channel at full power.

The EUT antenna port was connected to the spectrum analyzer via low loss cable. The cable loss was corrected for 1.5 dB offset in the spectrum analyzer.

8.4.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench
Measurement details	Measurement performed as per C63.10 §11.10.3 (Method AVGPS-1)

Receiver/spectrum analyzer settings:

Resolution bandwidth	3 kHz ($3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$)
Video bandwidth	300 kHz ($\geq 3 \times \text{RBW}$)
Frequency span	1.5 x DTS bandwidth
Detector mode	Peak
Trace mode	Max hold
Averaging sweeps	100

8.4.5 Test data

Table 8.4-1: Power spectral density of DTS

Transmitter Frequency (MHz)	Measured Level (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)
2402	-10.66	8.00	18.66
2440	-10.76	8.00	18.76
2480	-11.11	8.00	19.11

Notes:

None

8.4.5 Test data, continued

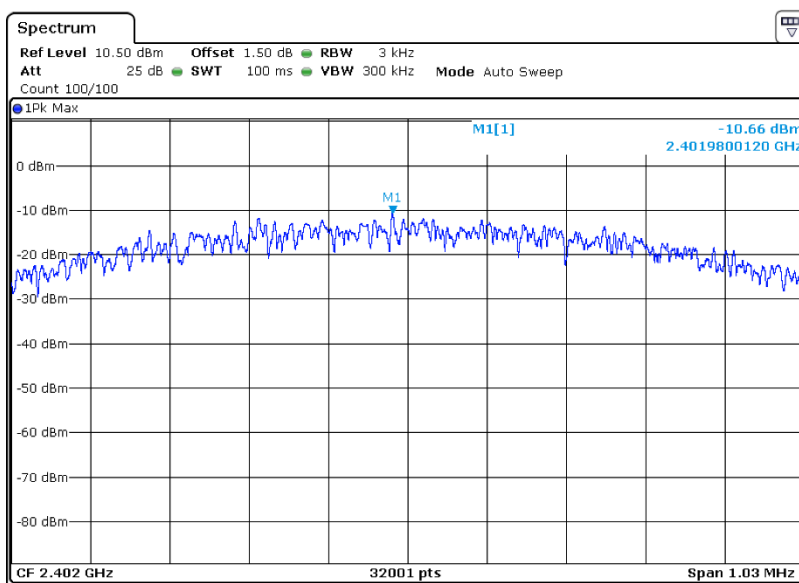


Figure 8.4-1: Power spectral density of digital transmission system, 2402 MHz

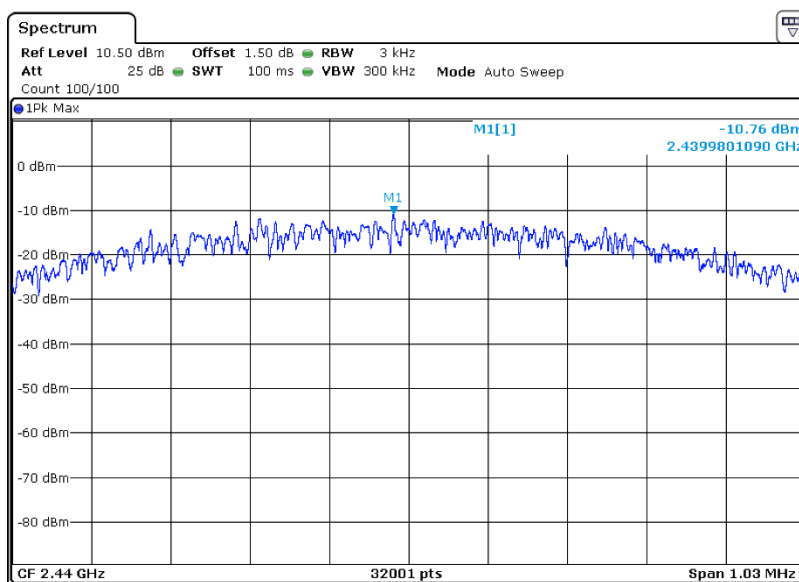


Figure 8.4-2: Power spectral density of digital transmission system, 2440 MHz

Power spectral density of digital transmission system

8.4.5 Test data, continued

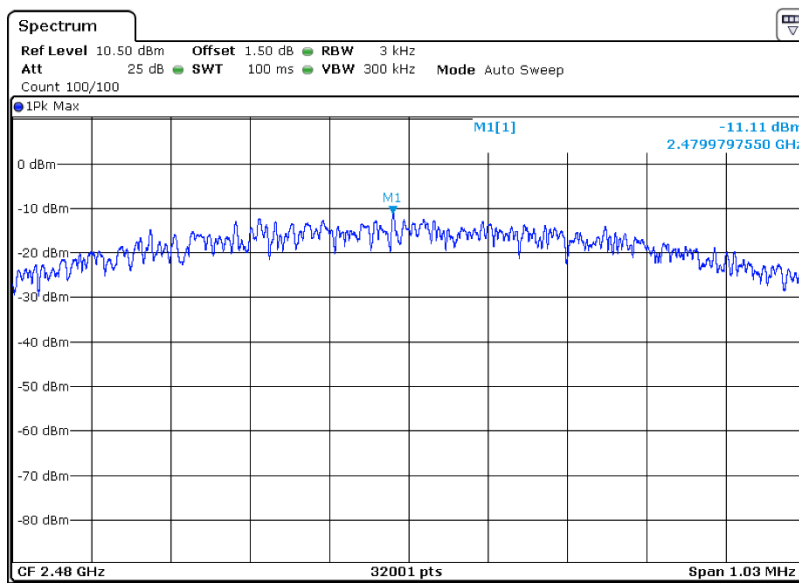


Figure 8.4-3: Power spectral density of digital transmission system, 2480 MHz

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up

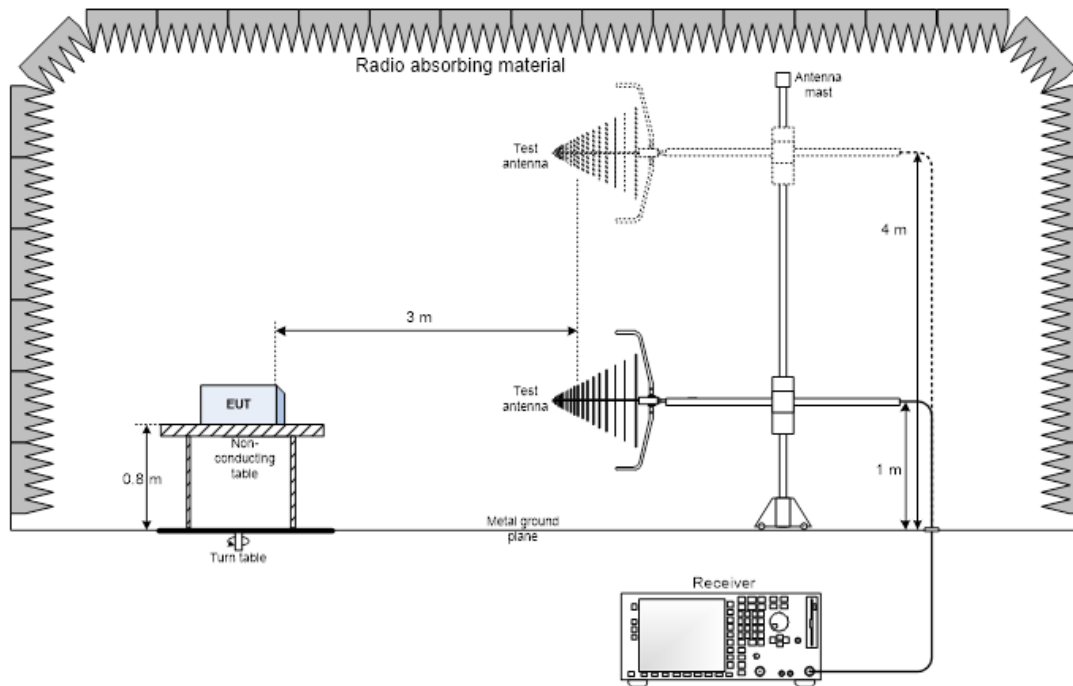


Figure 9.1-1: 30 MHz - 1000 MHz Setup

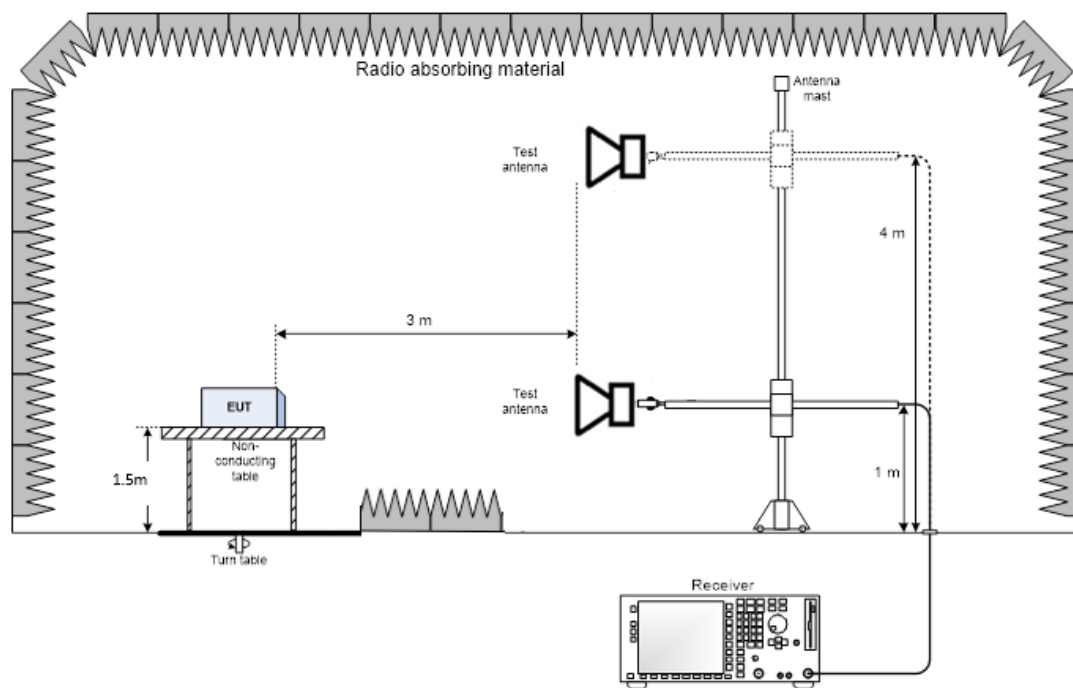


Figure 9.1-2: 1 GHz - 26 GHz Setup

Thank you for choosing

