ELECTRONICS TEST CENTRE
MPB TECHNOLOGIES INC.

ACCREDITED
TESTING CERT#2750.01

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ETC Report #: v19e25a194_DTS Release 1 Report date: July 18, 2025

EMC testing of the Volant Oil Tools, Inc. Torque Monitoring Sub in accordance with
FCC Part 15 Subpart C (15.247(d), 15.209, 15.205)
ANSI C63.10: 2013 /2020
ANSI C63.4: 2014
FCC ID: 2BOMO-VOLANT001

Test Dates: May 14, 2025 to July 4, 2025

Test Personnel: Brendan Van Hee, Joseph Yumol

Prepared for: Volant Oil Tools, Inc.

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REVISION RECORD

ISSUE	DATE	AUTHOR	REVISIONS
DRAFT 1	2025-07-04	I. Akram	Initial draft submitted for review.
Release 1	2025-07-18	I. Akram	Sign Off

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1.0 INTRODUCTION

1.1 Scope

The purpose of this report is to present the results of compliance testing performed in accordance with FCC Part 15.247 and ANSI C63.10:2013/2020 to gain FCC new Authorization for Low-Power License-Exempt transmitters.

The TMS60 was utilized with a specialized mandrel that was thinned to remove weight for testing as the tool can weight > 450 lbs.

All test procedures, limits, criteria, and results described in this report apply only to the Volant Oil Tools, Inc. Torque Monitoring Sub test sample, referred to herein as the EUT (Equipment Under Test).

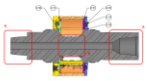
This report does not imply product endorsement by the Electronics Test Centre, A2LA, nor any Canadian Government agency.

1.2 Applicant

This test report has been prepared for Volant Oil Tools, Inc., located in Edmonton, Alberta, Canada.

1.3 Test Sample Description

As provided to ETC (Airdrie) by Volant Oil Tools, Inc.:

Product Name:		Torque Monitoring Sub
Radio		BT
Frequency Band		2400 – 2483.5 MHz
Frequency Range		2402– 2480 MHz
Operating Mode		BLE
Max Transmit Power (Conducted)		5.61 dBm (0.00364W)
BLE	**Associated External Antennas (Max. Gain)**	WiFi / Bluetooth Ceramic Patch Antenna, APAKN2504-S2448-T, Max Antenna Gain: 7 dBi, Number of Antenna = 2
	Detachable/Non Detachable	Detachable (professional Installation)
Model#		TMS60
Serial#		Proto2
Power supply:		VDC (Internal Battery)
Note: The unit uses 1 BLE radio, and its power is split into two antenna ports via a splitter. Antenna port conducted measurements performed on each antenna port. For radiated spurious emission, all three channels (LOW, MID, and HIGH) are analyzed to determine the worst channel. A full emission scan is performed on the worse channel for both data rates.		
Mandrel (Grey area).		

1.4 General Test Conditions

The EUT was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. All inputs and outputs to and from other equipment associated with the EUT were adequately simulated. In order to meet the operational requirements during testing as per KDB 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10-2013 clause 5.11 the device was programmed with a special firmware to transmit at a maximum achievable duty cycle. Special firmware is strictly for testing purpose only and not available to end user. This special test case represents the worst-case duty cycle. The environmental conditions are recorded during each test, and are reported in the relevant sections of this document.

1.5 Reference Standards

Standards	Description
FCC, title 47 CFR § 15.247	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
FCC, title 47 CFR § 15.207	Conducted limits for an intentional radiator that is designed to be connected to the public utility (AC) power line.
FCC, title 47 CFR § 15.107	Conducted limits for equipment that is designed to be connected to the public utility (AC) power line.
FCC, title 47 CFR § 15.209	Radiated emission limits; general requirements
FCC, title 47 CFR § 15.109	Radiated emission limits; from unintentional radiators digital devices.
ANSI C63.10:2013/2020	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
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 9 KHz to 40 GHz
558074 D01 15.247 Meas Guidance v05r02	Guidance For Compliance Measurements On Digital Transmission System, Frequency Hopping Spread Spectrum System, And Hybrid System Devices Operating Under Section 15.247 Of The FCC Rules
662911 D01 Multiple Transmitter Output v02r01	Emissions Testing of Transmitters with Multiple Outputs in the Same Band

1.6 Test Methodology

Test methods are specified in the Basic Standard as referenced and/or modified by the Product Standard in the part of Section 2 of this report associated with each particular test case. EUT is tested in RX mode to cover FCC Part 15 Sub Part B (Digital Circuitry) and the result is included in this test report.

1.6.1 Variations in Test Methodology

Any variance in methodology or deviation from the reference Standard is documented in the part of Section 2 of this report associated with each particular Test Case.

1.6.2 Test Sample Verification, Configuration & Modifications

EUT setup, configuration, protocols for operation and monitoring of EUT functions, and any modifications performed in order to meet the requirements, are detailed in each Test Case of Section 2 of this report.

1.6.3 Uncertainty of Measurement:

The factors contributing to measurement uncertainty are identified and calculated in accordance with CISPR 16-4-2: 2011.
This uncertainty estimate represents an expended uncertainty expressed at approximately 95% confidence using a coverage factor of k = 2.

Test Method	Uncertainty
Radiated Emissions Level (9 KHz – 1 GHz)	±5.8 dB
Radiated Emissions Level (1 GHz – 18 GHz)	±4.9 dB
Radiated Emissions Level (18 GHz – 26.5 GHz)	±5.0 dB
Uncertainty Conducted Power level	±0.5 dB
Uncertainty Conducted Spurious emission level	±0.6 dB
Uncertainty for Bandwidth test	±1.5 %

2.0 TEST CONCLUSION

STATEMENT OF COMPLIANCE

The customer equipment referred to in this report was found to comply with the requirements, as summarized below.

The EUT was subjected to the following tests. Compliance status is reported as **Compliant** or **Non-compliant**. **N/A** indicates the test was Not Applicable to the EUT.

The measurement uncertainty is not accounted for determination of the statement of compliance. The statement of compliance is based only on the measurement value recorded.

> **Note:** Maintenance of compliance is the responsibility of the Manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the EUT with respect to the standards detailed in this test report.

The following table summarizes the tests performed in terms of the specification, class or performance criterion applied, and the EUT modification state.

Test Case	Test Type	Specification	Test Sample	Modifications	Config.	Result
2.1	AC Main Conducted Emissions	15.207 / 15.109	Torque Monitoring Sub	none	see § 2.1	**N/A**
2.2	6dB Bandwidth	15.247(a)	Torque Monitoring Sub	none	see § 2.2	**Compliant**
2.3	Max Output Power	15.247(d)	Torque Monitoring Sub	none	see § 2.3	**Compliant**
2.4	Band Edge	15.247(d)	Torque Monitoring Sub	none	see § 2.4	**Compliant**
2.5	Power Spectral Density	15.247(e)	Torque Monitoring Sub	none	see § 2.5	**Compliant**
2.6	Conducted Spurious Emissions (Non-Restricted Band)	15.247(d)	Torque Monitoring Sub	none	see § 2.6	**Compliant**
2.7	EUT Position	ANSI C63.4	Torque Monitoring Sub	none	see § 2.7	**Fix Position**
2.8	Radiated Spurious Emission (Restricted Band)	15.205, 15.209 15.247(d)	Torque Monitoring Sub	none	see § 2.8	**Compliant**
2.9	Radiated Emission	15.109	Torque Monitoring Sub	none	see § 2.9	**Compliant**
2.10	RF Exposure	15.247(i)	Torque Monitoring Sub	none	see § 2.10	**Exempt**

Refer to the test data for applicable test conditions.

2.1 AC Main Power Line Conducted Emissions: N/A

Test Lab: Electronics Test Centre, Airdrie	**EUT: Torque Monitoring Sub** **Standard: FCC Part 15.207, FCC Part 15.107** **Basic Standard: ANSI C63.10: 2013** **Basic Standard: ANSI C63.4: 2014**
EUT status: N/A	
Comments: EUT is internal rechargeable battery powered. No Direct/indirect connection to AC main.	

2.2 Duty Cycle

Test Lab: Electronics Test Centre, Airdrie	**EUT: Torque Monitoring Sub**
Test Personnel: Brendan Vane Hee, Joseph Yumol	**Standard: FCC Part 15.207, FCC Part 15.107**
Date: July 4, 2025 (19.1°C, 40.7% RH)	**Basic Standard: ANSI C63.10: 2013** **Basic Standard: ANSI C63.4: 2014**
Comments: Duty cycle < 98%.	

2.2.1 Test Guidance: ANSI C63.10-2013, Clause 11.6 / FCC OET KDB 558074

- Set the center frequency of the instrument to the center frequency of the transmission.
- Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.
- Set VBW ≥ RBW. Set detector = peak or average.
- The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring the duty cycle shall not be used if T ≤ 16.7 μs.)

2.2.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.2.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
EMI receiver	Agilent	N9038A (FW A.25.05)	6130	2024-08-15	2025-08-15
Temp/Humidity	Extech	42270	5871	2025-05-01	2026-05-01
Attenuator (DC to 26 GHz)	Mini-Circuits	BW-S10-2W263+	6932	2022-12-10	2025-12-10
Coaxial Cables (RF)	W.L. GORE	PGR01R01036	7024	2025-01-09	2026-01-09
DC Blocker (9 KHz - 27 GHz)	Centric RF	C0927 SMA	6987	2025-01-19	2026-01-19

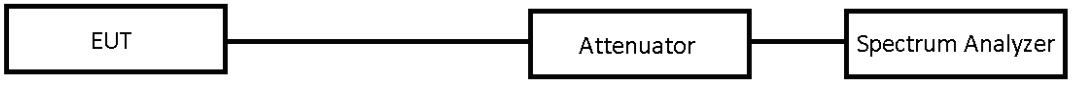
2.2.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT met the requirements without modification.

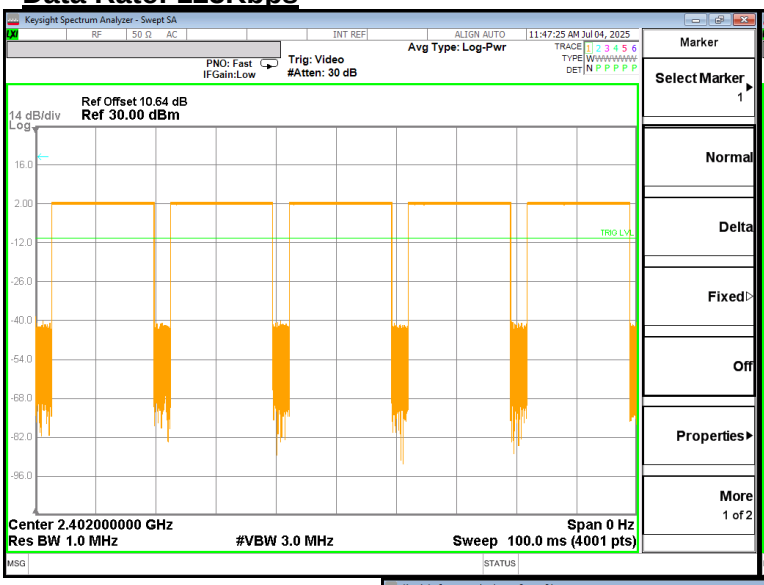
Test setup diagrams for Occupied Bandwidth testing:

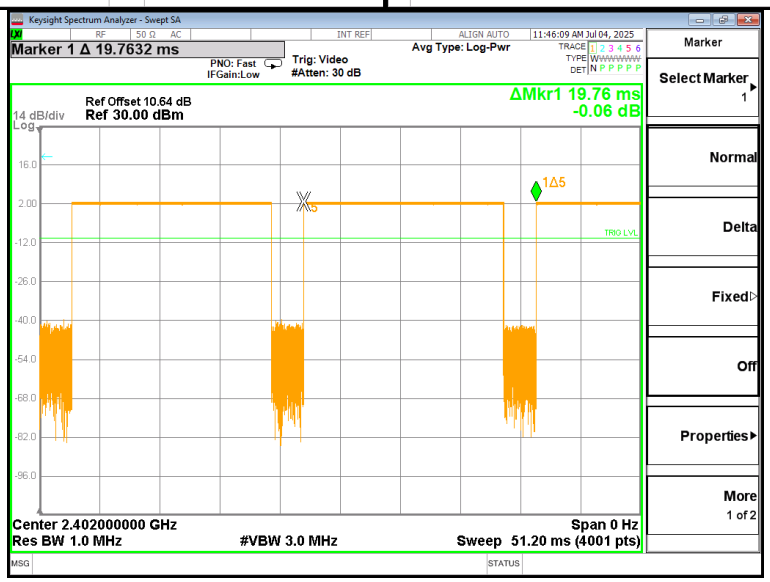
Conducted:



2.2.5 Measurement Result

Data Rate: 125Kbps





On Time = 16.97ms

Time Period = 19.76ms

Duty Cycle = (16.97ms/19.76ms) = 85.8805668%

Duty Cycle (D)= 85.9%

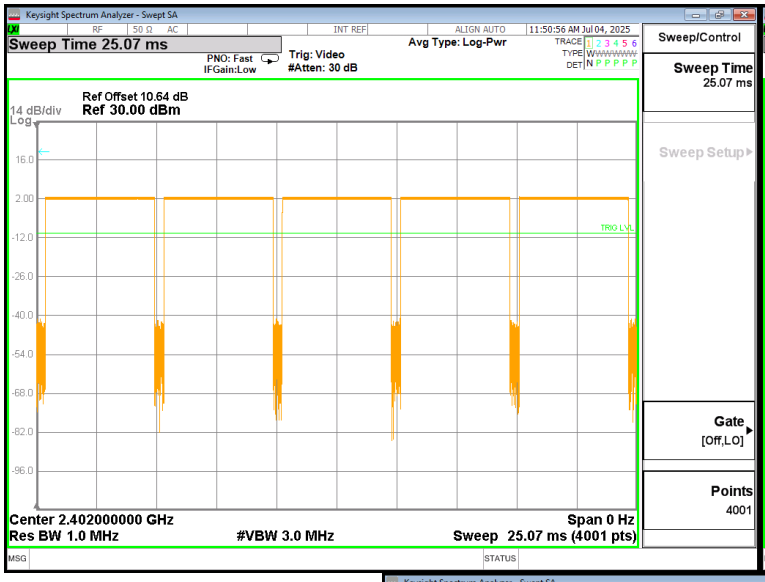
Duty Cycle Correction Factor = 10*log (1/D)

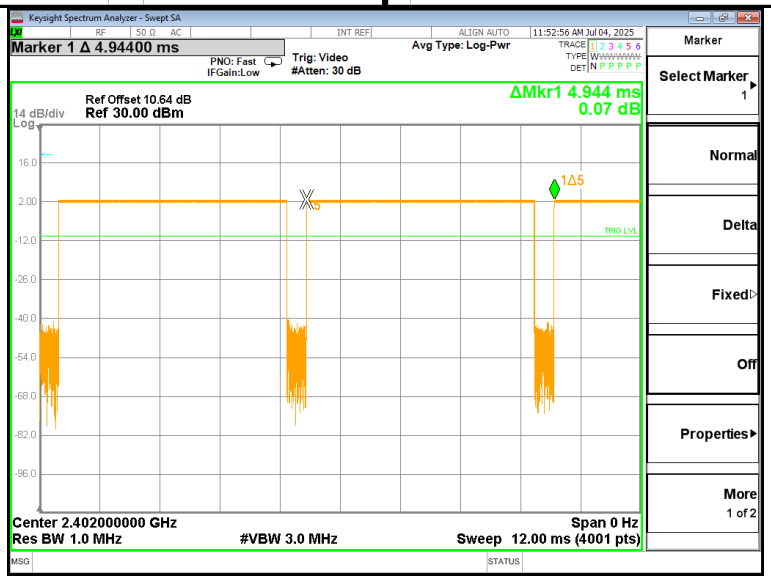
Duty Cycle Correction Factor = 10*log (1/0.859)

Duty Cycle Correction Factor = 0.660068361

Duty Cycle Correction Factor = 0.7 dB

Data Rate: 500Kbps





On Time = 4.542ms

Time Period = 4.944ms

Duty Cycle = (4.542ms/4.944ms) = 91.86893204%

Duty Cycle (D)= 91.9%

Duty Cycle Correction Factor = 10*log (1/D)

Duty Cycle Correction Factor = 10*log (1/0.919)

Duty Cycle Correction Factor = 0.366844886

Duty Cycle Correction Factor = 0.4 dB

2.3 6dB Bandwidth

Test Lab: Electronics Test Centre, Airdrie	**EUT: Torque Monitoring Sub**
Test Personnel: Brendan Van Hee, Joseph Yumol	**Standard: FCC PART 15.247**
	Basic Standard: ANSI C63.10-2013
Date: July 3, 2025 (23.8°C, 33.5% RH)	**FCC OET KDB 558074**
July 4, 2025 (19.1°C, 40.7% RH)	

EUT status: Compliant

Specification: FCC Part 15.247 (a, 2), FCC 15.215 (c)

Criteria: Systems using digital modulation techniques may operate in the 902-928 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

2.3.1 Test Guidance: ANSI C63.10-2013, Clause 11.8 / FCC OET KDB 558074

This measurement is performed at low, mid and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

For DTS the spectrum analyzer is set for a frequency span ≥ (2 * OBW), ≤ (5 * OBW), selected to clearly display the channel. The RBW is set to 100 kHz. The VBW is set to ≥ (3 * RBW). The Peak detector is used, with the trace set to Max Hold.

The automated 99% BW function of the spectrum analyzer is engaged, and the 6 dB OBW and/or 20 dB OBW is measured with the x dB function.

2.3.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.3.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
EMI receiver	Agilent	N9038A (FW A.25.05)	6130	2024-08-15	2025-08-15
Temp/Humidity	Extech	42270	5871	2025-05-01	2026-05-01
Attenuator (DC to 26 GHz)	Mini-Circuits	BW-S10-2W263+	6932	2022-12-10	2025-12-10
Coaxial Cables (RF)	W.L. GORE	PGR01R01036	7024	2025-01-09	2026-01-09
DC Blocker (9 KHz - 27 GHz)	Centric RF	C0927 SMA	6987	2025-01-19	2026-01-19

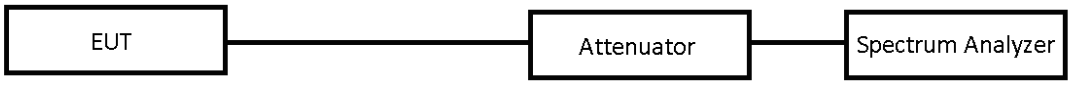
2.3.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT met the requirements without modification.

Test setup diagrams for Occupied Bandwidth testing:

Conducted:

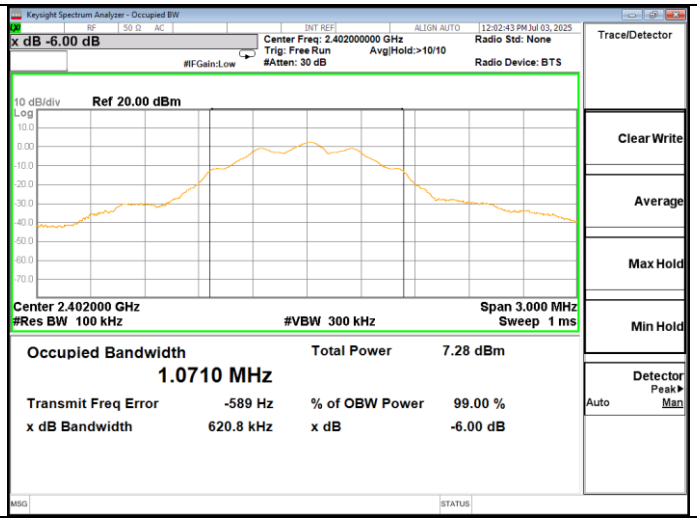


2.3.5 Channel Bandwidth Data Antenna

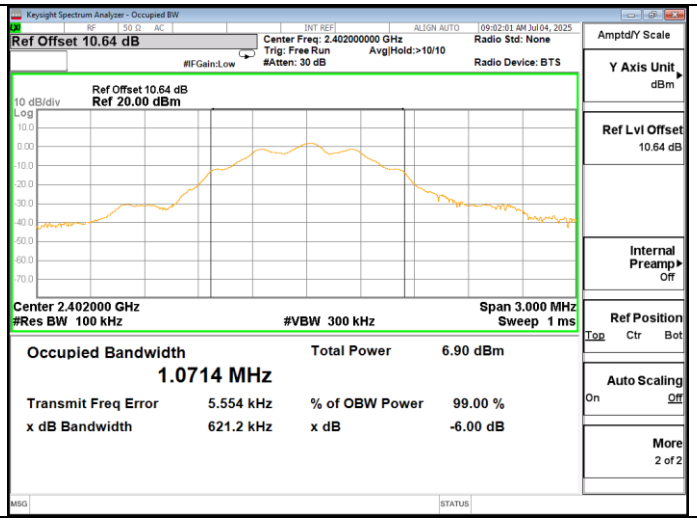
Mode of operation	Data Rate Mode	Channel	Freq. [MHz]	6 dB BW Antenna Port 1 [KHz]	6 dB BW Antenna Port 2 [KHz]	Limit BW [KHz]
BLE	125 Kbps	Low	2402	620.8	621.2	≥ 500
		Mid	2440	620.1	661.4	
		High	2480	662.1	618.5	
	500 Kbps	Low	2402	698.1	697.9	
		Mid	2440	745.6	703.1	
		High	2480	735.2	708.5	

Data Rate 125 Kbps

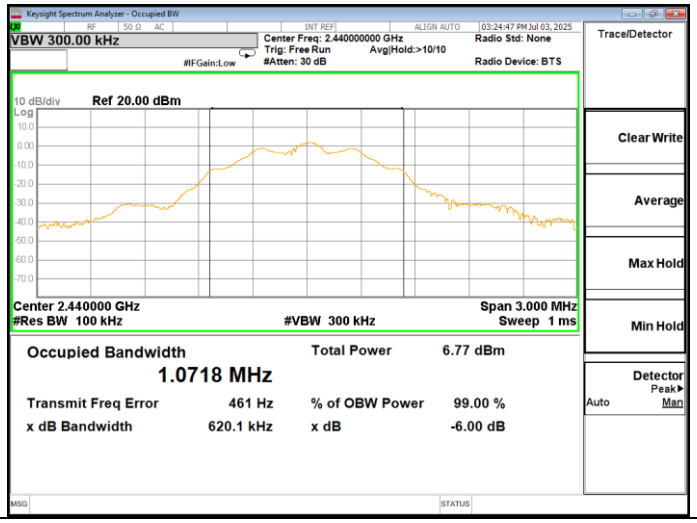
Low Channel Antenna Port 1



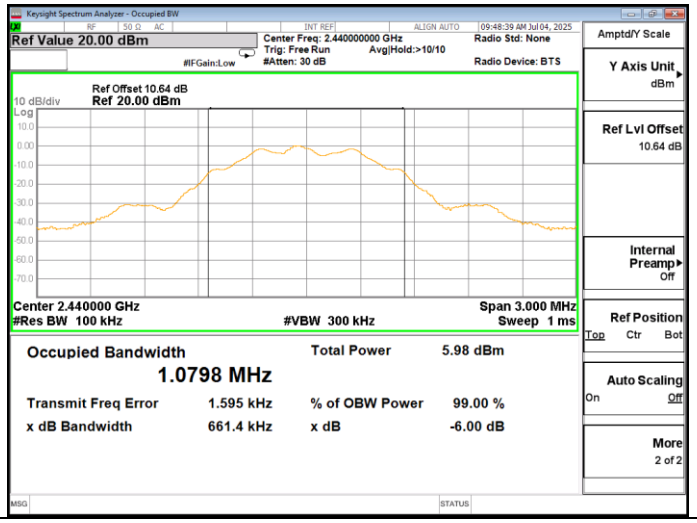
Low Channel Antenna Port 2



MID Channel Antenna Port 1

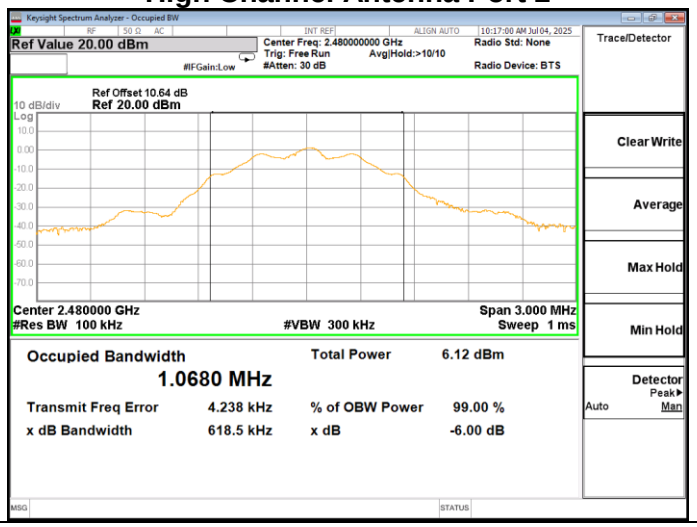


MID Channel Antenna Port 2



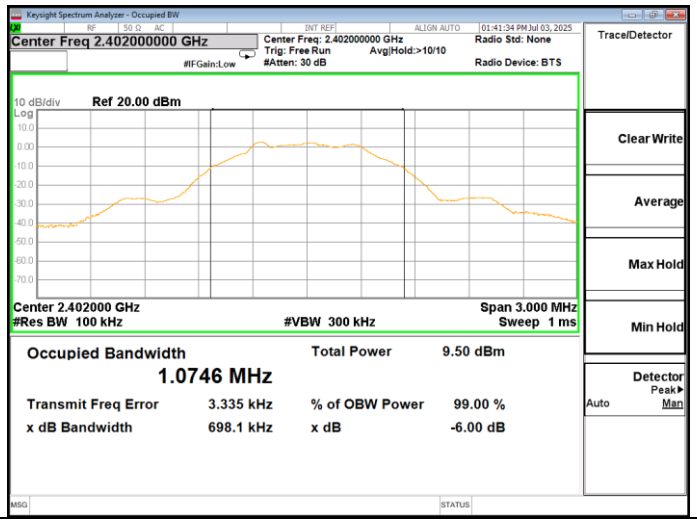
High Channel Antenna Port 1

High Channel Antenna Port 2

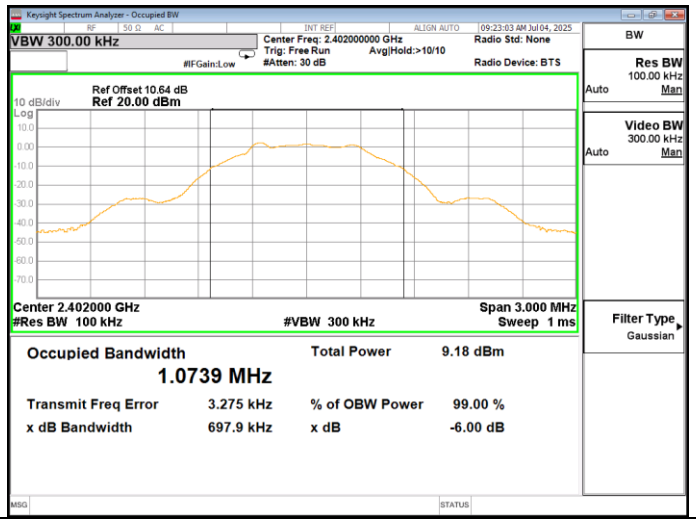


Data Rate 500 Kbps

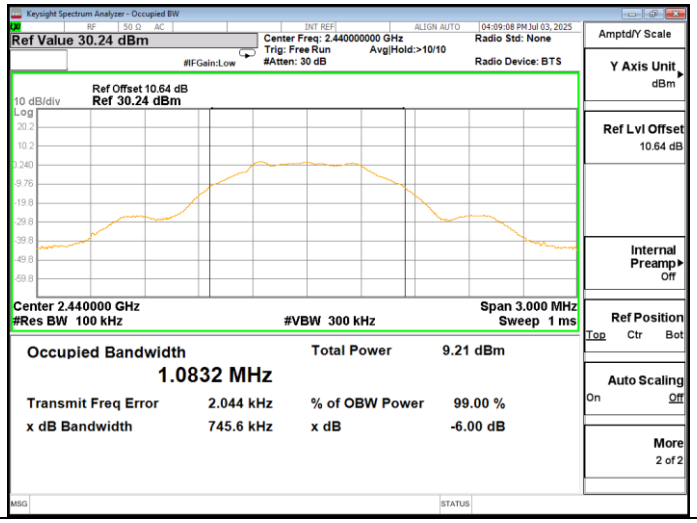
Low Channel Antenna Port 1



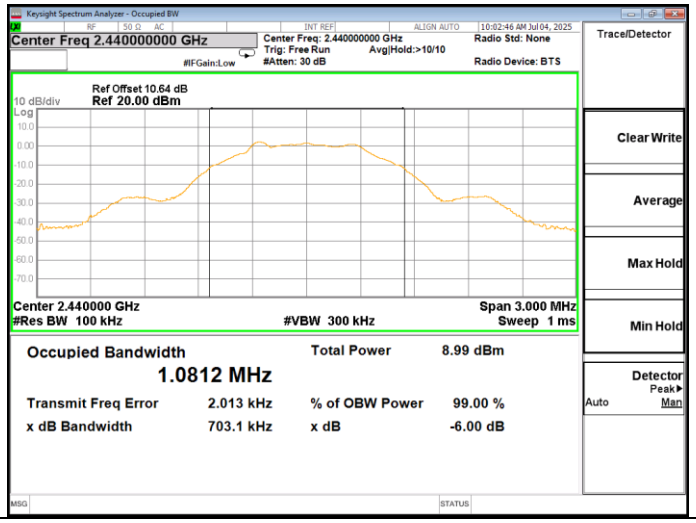
Low Channel Antenna Port 2



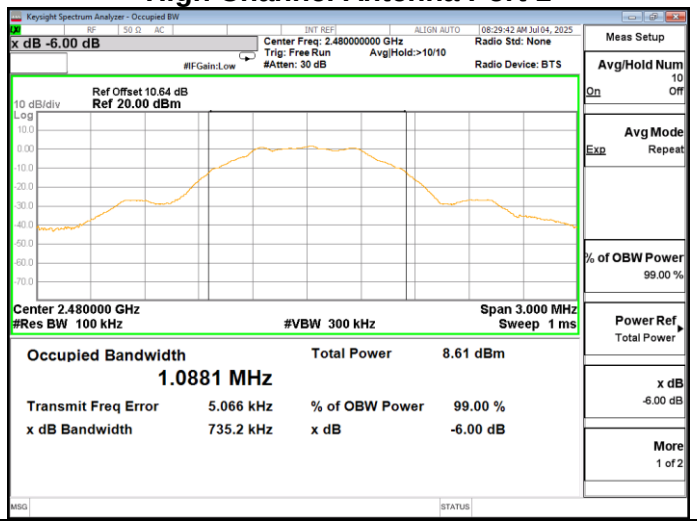
MID Channel Antenna Port 1



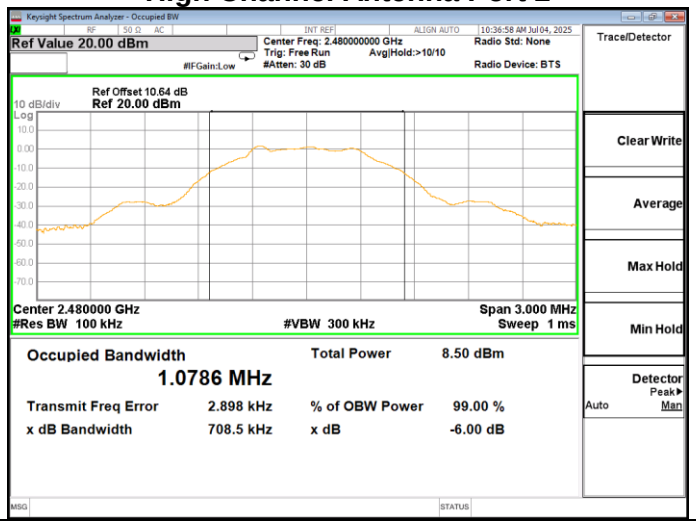
MID Channel Antenna Port 2



High Channel Antenna Port 1



High Channel Antenna Port 2



2.4 Max Average Output Power

Test Lab: Electronics Test Centre, Airdrie	**EUT: Torque Monitoring Sub**
Test Personnel: Brendan Van Hee, Joseph Yumol	**Standard: FCC PART 15.247**
	Basic Standard: ANSI C63.10: 2013 FCC OET KDB 558074
Date: July 3, 2025 (23.8°C, 33.5% RH) July 4, 2025 (19.1°C, 40.7% RH)	

EUT status: Compliant

Specification: FCC Part 15.247(b, 3)

Criteria (3) For systems using digital modulation in the 2400-2483.5 MHz bands: 1 Watt.

2.4.1 Test Guidance: ANSI C63.10-2013, Clause 11.9.2.2.4/ FCC OET KDB 558074

This measurement is performed at low, mid and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

Output Power Method AVGSA-2 For LoRa DTS	
Measure the duty cycle D of the transmitter output signal	
Span	≥ 1.5 times the OBW
RBW	1 – 5 % of the OBW, ≤ 1 MHz
VBW	≥ 3 x RBW
Number of Points in sweep	≥ 2 x Span / RBW
Sweep time	Auto
Detector	RMS (Power Averaging)
Sweep trigger	Free Run (Duty Cycle <98%)
Trace Average	100 traces in power Averaging (RMS)
Compute power by integrating the spectrum across the OBW of the signal using the instrument's band-power measurement function with band limits set equal to the OBW band-edges.	
Add [10 log (1 / D)], where D is the duty cycle, to the measured power to compute the average power during the actual transmission times (because the measurement represents an average over both the ON and OFF times of the transmission).	
Note: Total Average Power (dBm) = 10*log {10(Ant 1 Average Power /10) +10(Ant 2 Average Power /10)} (dBm).	

2.4.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.4.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
EMI receiver	Agilent	N9038A (FW A.25.05)	6130	2024-08-15	2025-08-15
Temp/Humidity	Extech	42270	5871	2025-05-01	2026-05-01
Attenuator (DC to 26 GHz)	Mini-Circuits	BW-S10-2W263+	6932	2022-12-10	2025-12-10
Coaxial Cables (RF)	W.L. GORE	PGR01R01036	7024	2025-01-09	2026-01-09
DC Blocker (9 KHz - 27 GHz)	Centric RF	C0927 SMA	6987	2025-01-19	2026-01-19

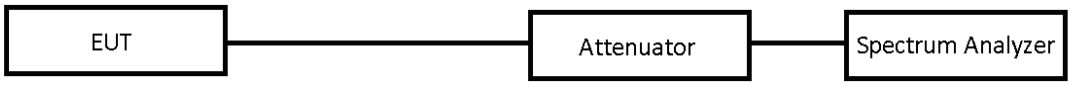
2.4.4 Test Sample Verification, Configuration & Modifications

The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT met the requirements without modification.

Test setup diagrams for Power testing:

Conducted:



2.4.5 Max Average Output Power Data:

Mode of operation	Data Rate	Channel	Freq. [MHz]	Measured Average Power ANT Port 1 [dBm]	Measured Average Power ANT Port 2 [dBm]	Duty Cycle correction Factor [dB]	Total Average Power Sum (dBm)	Limit Power [dBm]
BLE	125KHz	Low	2402	1.75	1.61	0.7	5.39	≤ 26 (0.4Watt)
		Mid	2440	1.57	2.04		5.52	
		High	2480	1.15	0.87		4.72	
	500 KHz	Low	2402	2.13	2.26	0.4	5.61	
		Mid	2440	2.20	2.04		5.53	
		High	2480	1.38	1.20		4.70	

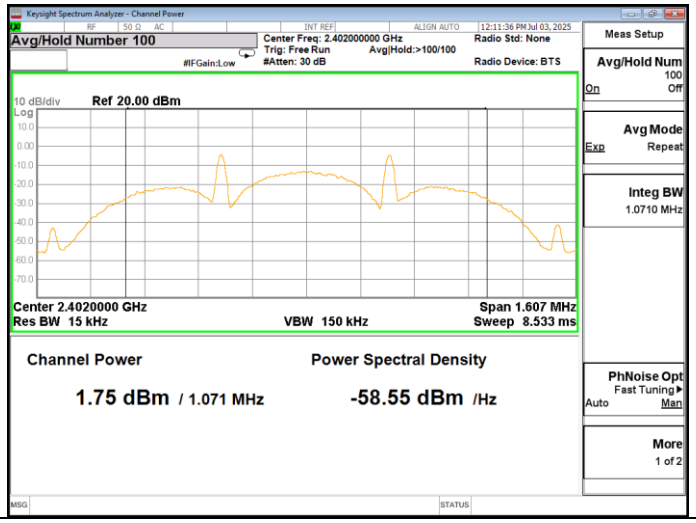
Note:
Total Average Power (dBm) = [10*log {10(Ant 1 Average Power /10) +10(Ant 2 Average Power /10)}] + Duty Cycle correction factors (dBm).

If any transmit signals are correlated with each other,

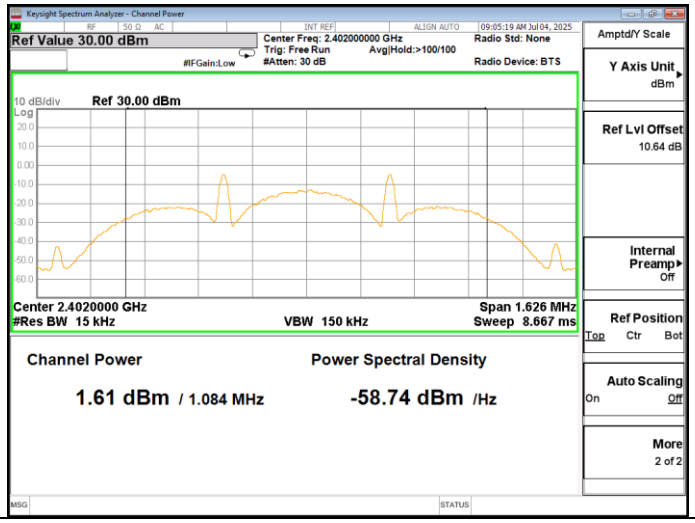
Directional gain = GANT + 10 log(NANT) dBi
= 7 + 1 0 log (2) = 10 dBi

Mode: 125 Kbps

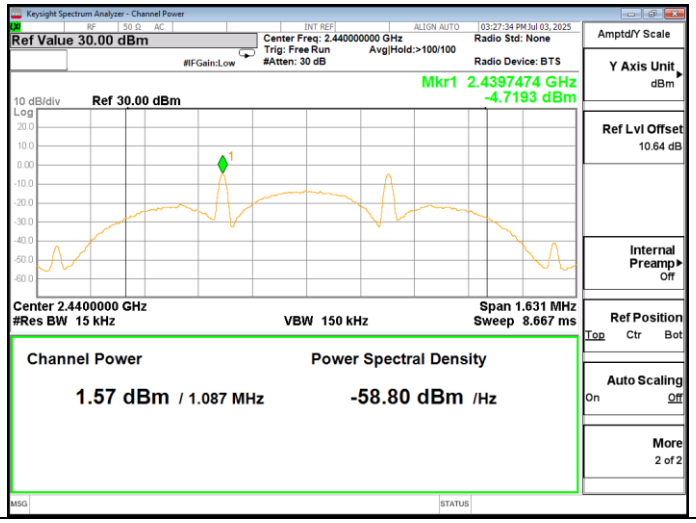
Low Channel Antenna Port 1



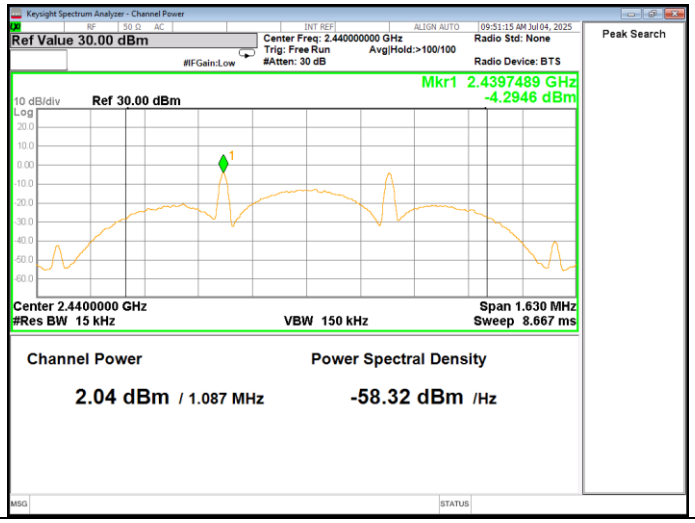
Low Channel Antenna Port 2



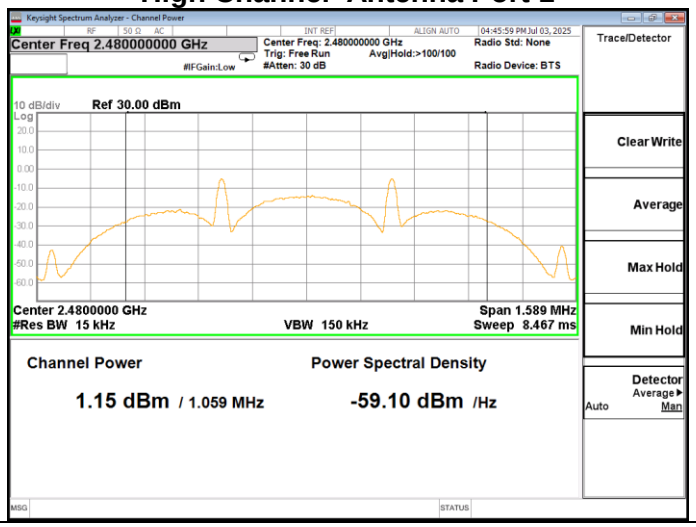
MID Channel Antenna Port 1



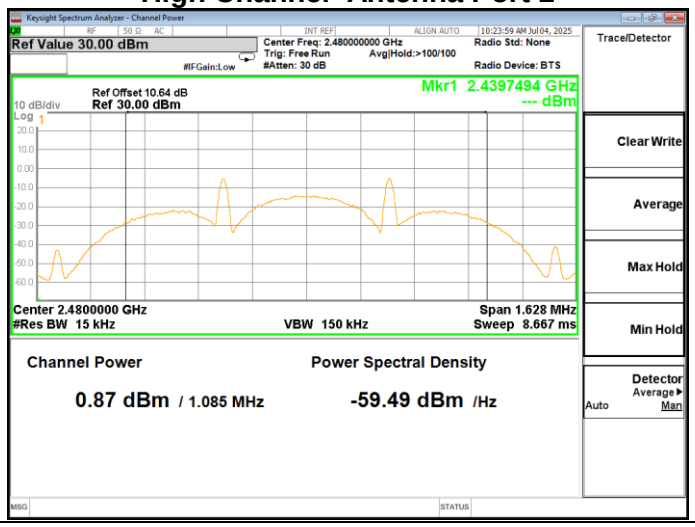
MID Channel Antenna Port 2



High Channel Antenna Port 1

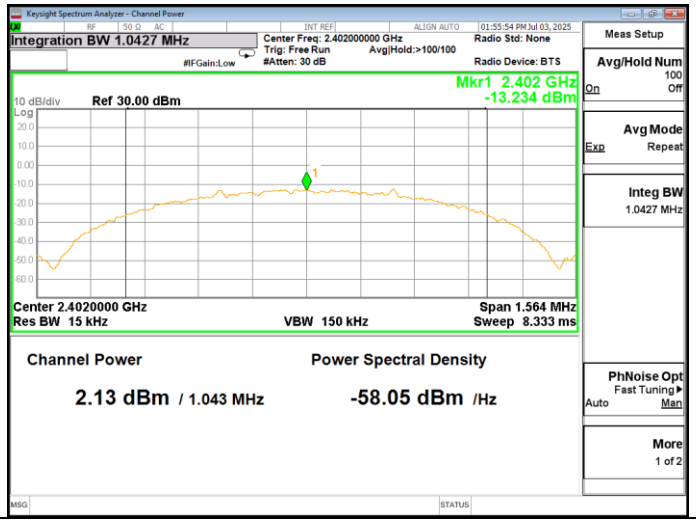


High Channel Antenna Port 2

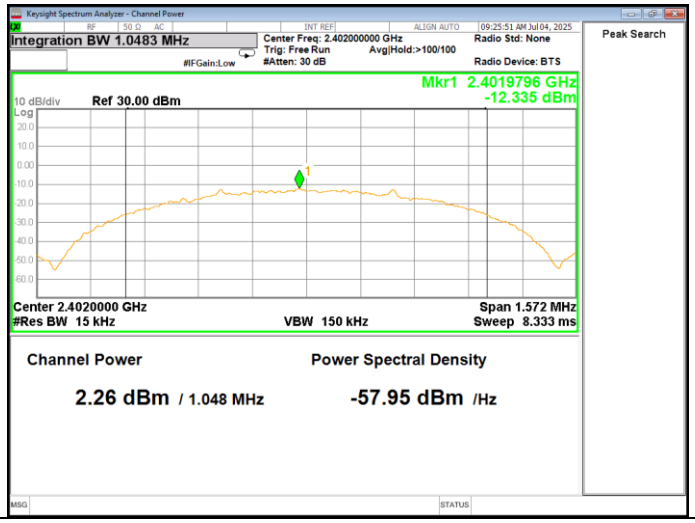


Mode: 500 Kbps

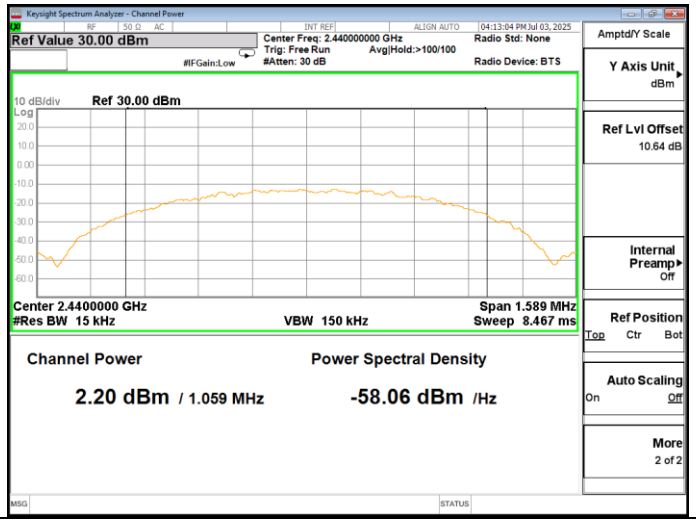
Low Channel Antenna Port 1



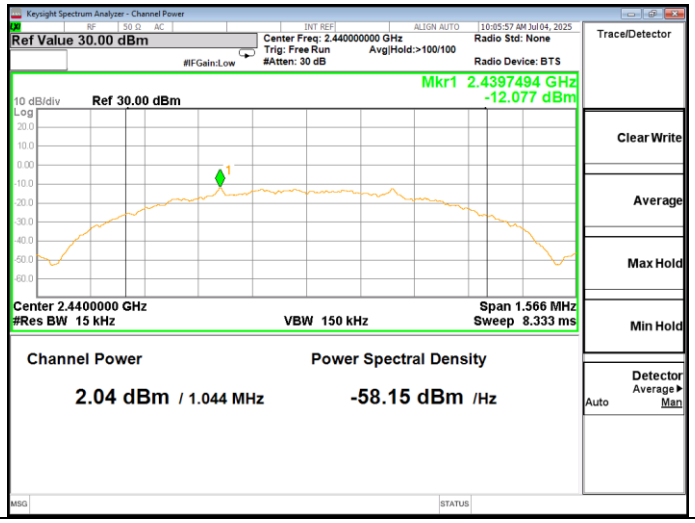
Low Channel Antenna Port 2



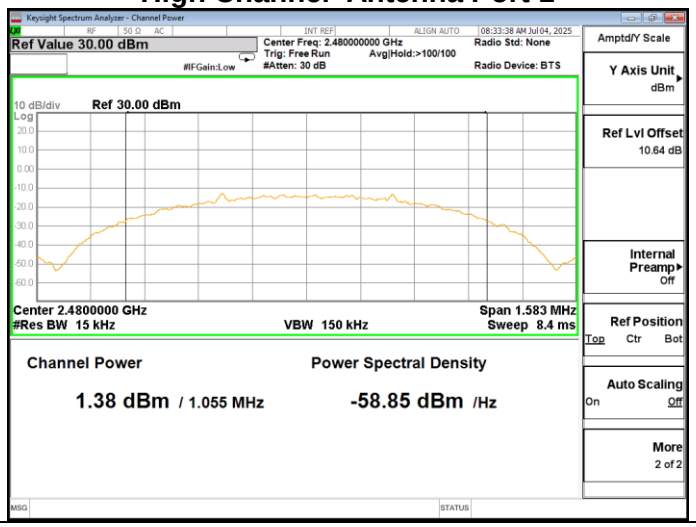
MID Channel Antenna Port 1



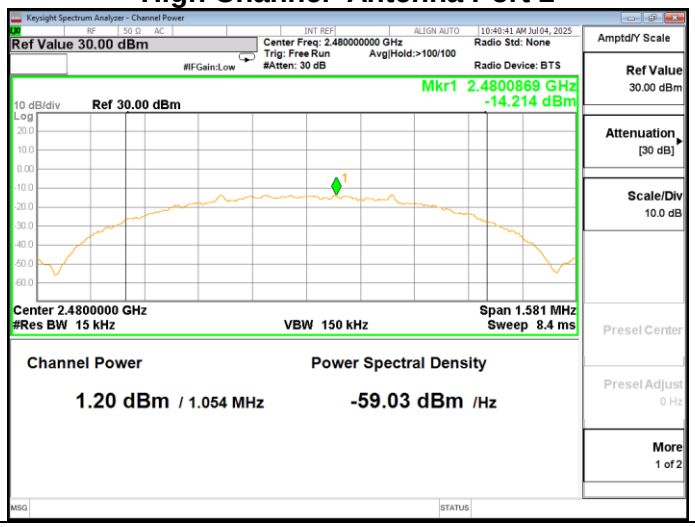
MID Channel Antenna Port 2



High Channel Antenna Port 1



High Channel Antenna Port 2



2.5 Band Edge Attenuation

Test Lab: Electronics Test Centre, Airdrie	**EUT: Torque Monitoring Sub**
Test Personnel: Brendan Van Hee, Joseph Yumol	**Standard: FCC PART 15.247**
	Basic Standard: ANSI C63.10: 2013 **FCC OET KDB 558074**
Date: July 3, 2025 (23.8°C, 33.5% RH) **July 4, 2025 (19.1°C, 40.7% RH)**	

EUT status: Compliant

Specification: FCC Part 15.247(d)

Criteria: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.5.1 Test Guidance: ANSI C63.10-2013 Clause 11.13.2 & 6.10.4, 6.10.6 / FCC OET KDB 558074

This measurement is performed at the low and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

The spectrum analyzer is set for a frequency span to show the band edge and the nearest channel. The RBW is set to ≥ 100 kHz. The VBW is set to ≥ (RBW * 3). The Peak detector is used, with the trace set to Max Hold.

The attenuation is measured with the Marker Delta function.

2.5.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.5.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
EMI receiver	Agilent	N9038A (FW A.25.05)	6130	2024-08-15	2025-08-15
Temp/Humidity	Extech	42270	5871	2025-05-01	2026-05-01
Attenuator (DC to 26 GHz)	Mini-Circuits	BW-S10-2W263+	6932	2022-12-10	2025-12-10
Coaxial Cables (RF)	W.L. GORE	PGR01R01036	7024	2025-01-09	2026-01-09
DC Blocker (9 KHz - 27 GHz)	Centric RF	C0927 SMA	6987	2025-01-19	2026-01-19

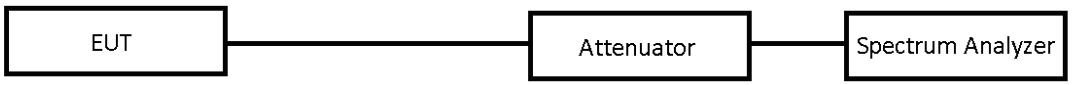
2.5.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT met the requirements without modification.

Test setup diagrams for Band Edge Attenuation testing:

Conducted:



2.5.5 Band Edge Data

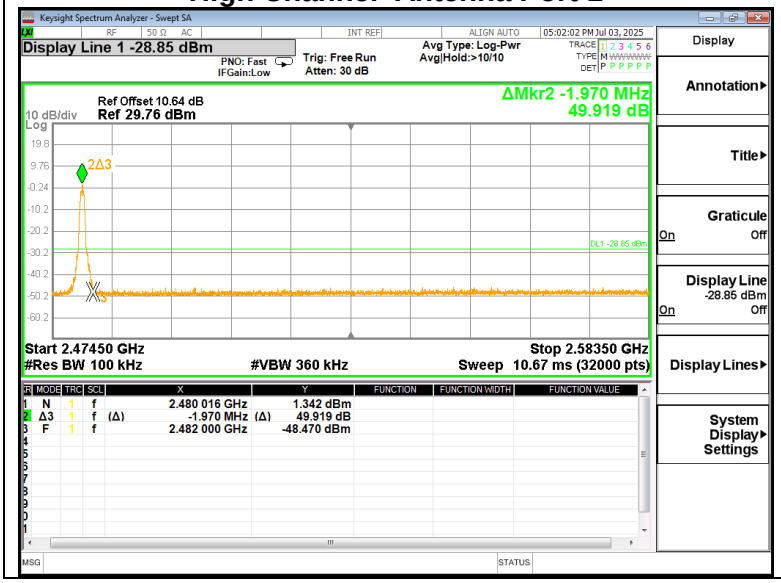
Mode of operation	Data Rate	Channel	Freq. (MHz)	Attenuation at Band Edge Antenna Port 1	Attenuation at Band Edge Antenna Port 2	Attenuation Limit at Band Edge
BLE	125 KHz	Low	2402	52.348dBc	47.300dBc	≥ 30 dBc
		High	2480	49.919dBc	50.619dBc	
	500KHz	Low	2402	53.625dBc	51.516dBc	
		High	2480	49.947dBc	50.117dBc	

Mode: 125 Kbps

Low Channel Antenna Port 1

Low Channel Antenna Port 2

High Channel Antenna Port 1

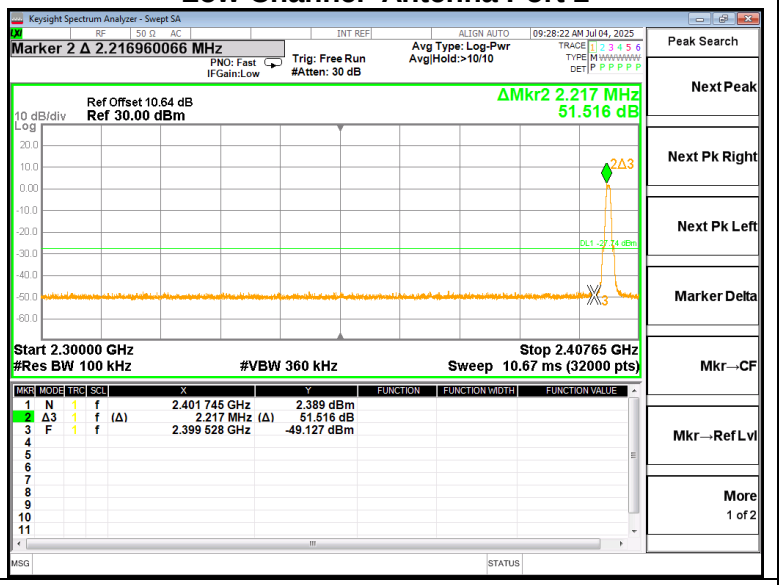


High Channel Antenna Port 2

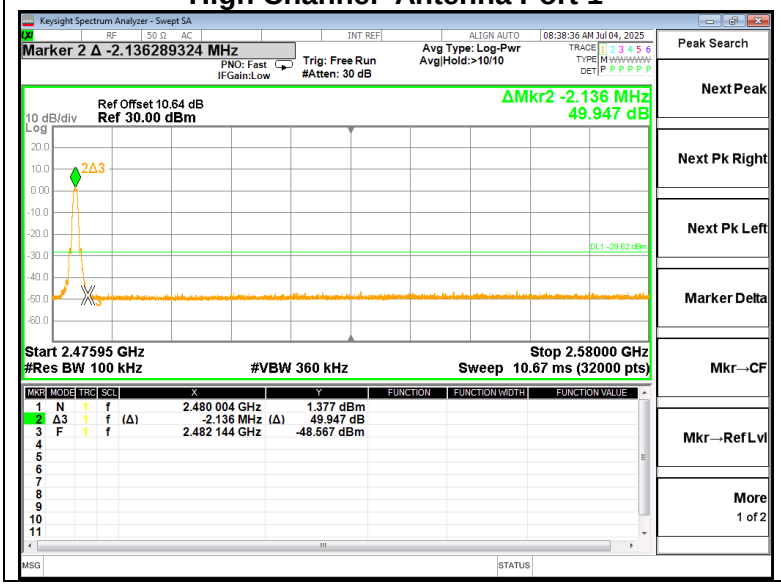
Mode: 500 Kbps

Low Channel Antenna Port 1

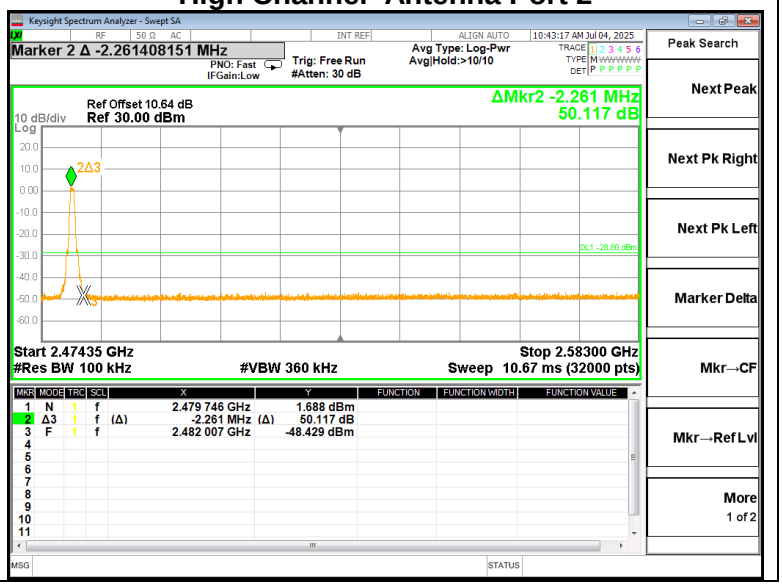
Low Channel Antenna Port 2



High Channel Antenna Port 1



High Channel Antenna Port 2



2.6 Power Spectral Density

Test Lab: Electronics Test Centre, Airdrie	**EUT: Torque Monitoring Sub**
Test Personnel: Brendan Van Hee, Joseph Yumol	**Standard: FCC PART 15.247**
	Basic Standard: ANSI C63.10: 2013
Date: July 3, 2025 (23.8°C, 33.5% RH) **July 4, 2025 (19.1°C, 40.7% RH)**	

EUT status: Compliant

Specification: FCC Part 15.247(e)

Criteria 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.

2.6.1 Test Guidance: ANSI C63.10-2013, Clause 11.10.5 / FCC OET KDB 558074

This measurement is performed at low, mid and high frequencies, in continuous transmission, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

Method AVGPSD-2 For DTS	
Measure the duty cycle (D) of the transmitter output signal	
Span	≥ 1.5 times the OBW
RBW	3 kHz ≤ RBW ≥ 100 kHz.
VBW	≥ 3 x RBW
Number of Points in sweep	≥ 2 x Span / RBW
Sweep time	auto couple
Detector	RMS (Power Averaging)
Sweep trigger	Free Run (Duty Cycle < 98%)
Trace Average	Minimum 100 traces in power Averaging (RMS)
PSD measured	Use the peak marker function to determine the maximum amplitude level.
Add [10 log (1 / D)], where D is the duty cycle measured in step a), to the measured PSD to compute the average PSD during the actual transmission time.	
If the measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced).	
Total Average Power (dBm) = 10*log {10(Ant 1 Average Power /10) +10(Ant 2 Average Power /10)} (dBm).	

2.6.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.6.3 Test Equipment

Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
EMI receiver	Agilent	N9038A (FW A.25.05)	6130	2024-08-15	2025-08-15
Temp/Humidity	Extech	42270	5871	2025-05-01	2026-05-01
Attenuator (DC to 26 GHz)	Mini-Circuits	BW-S10-2W263+	6932	2022-12-10	2025-12-10
Coaxial Cables (RF)	W.L. GORE	PGR01R01036	7024	2025-01-09	2026-01-09
DC Blocker (9 KHz - 27 GHz)	Centric RF	C0927 SMA	6987	2025-01-19	2026-01-19

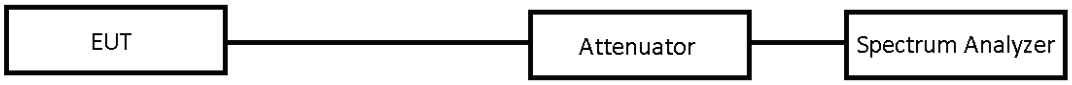
2.6.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT met the requirements without modification.

Test setup diagrams for Power Spectral Density testing:

Conducted:



2.6.5 Average PSD Data

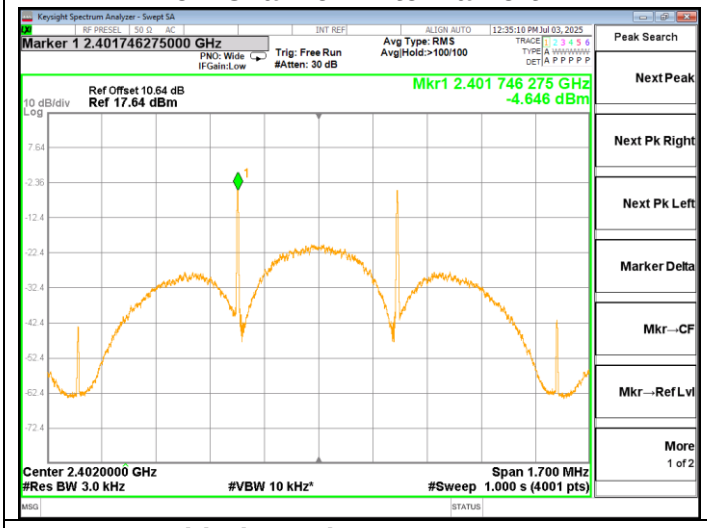
Mode	Data Rate	Channel	Frequency (MHz)	Measured Average PSD Antenna Port 1 (dBm)	Measured Average PSD Antenna Port 2 (dBm)	D.C Correction Factors (dB)	Total Average PSD (Sum) (dBm)	Limit
BLE	125 Kbps	Low	2402	-4.646	-4.495	0.7	-0.86	≤ 8 dBm/ 3KHz
		Mid	2440	-4.698	-4.274		-0.77	
		High	2480	-4.830	-5.445		-1.42	
	500 Kbps	Low	2402	-16.286	-16.675	0.4	-13.1	
		Mid	2440	-17.214	-18.439		-14.4	
		High	2480	-17.315	-17.714		-14.1	

Note:

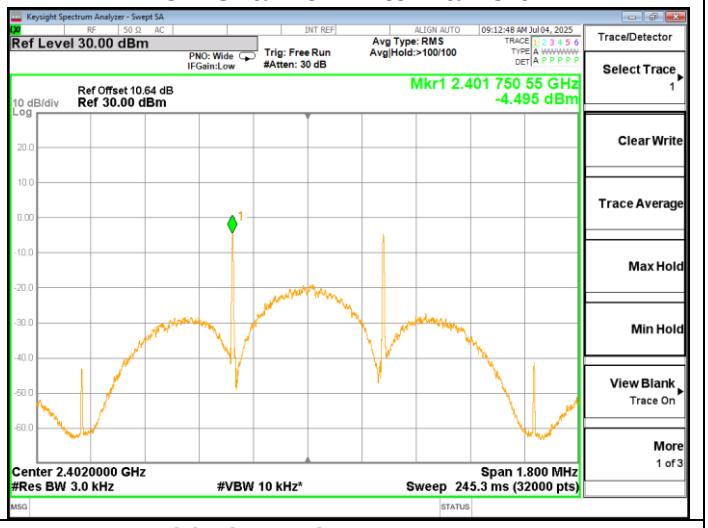
Total Average PSD (dBm) = [10*log {10(Ant 1 Average PSD /10) +10(Ant 2 Average PSD /10)}] + Duty Cycle (dBm).

Mode: 125 Kbps

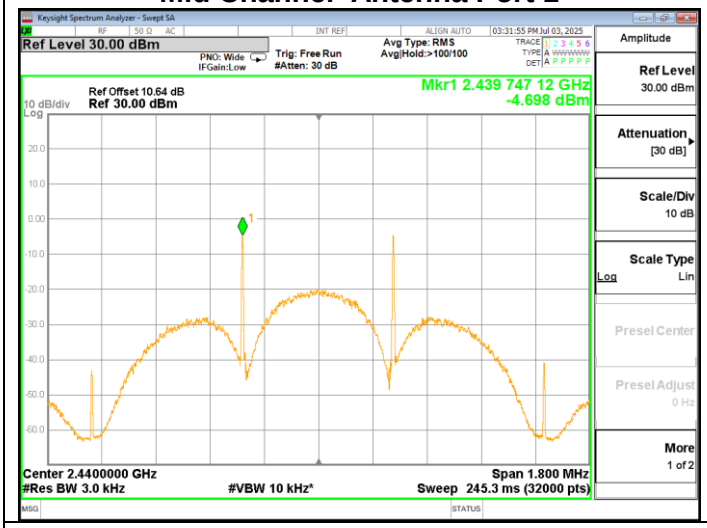
Low Channel Antenna Port 1



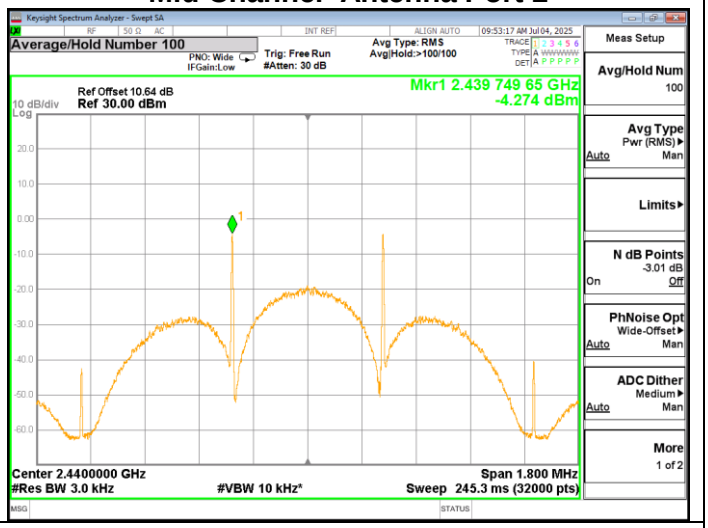
Low Channel Antenna Port 2



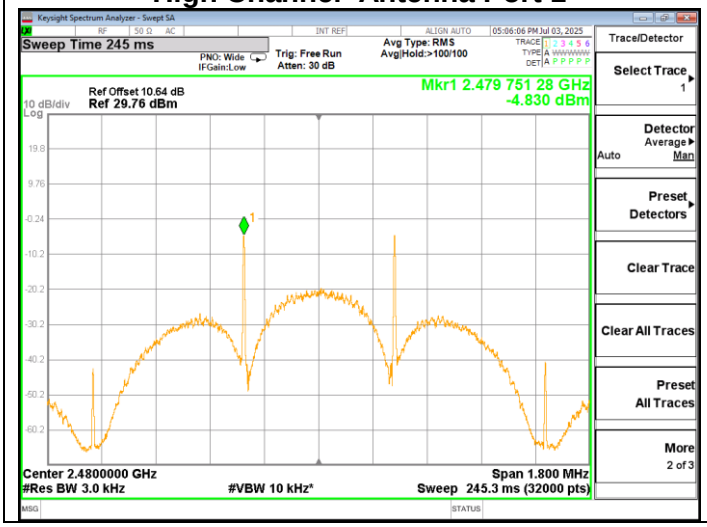
Mid Channel Antenna Port 1



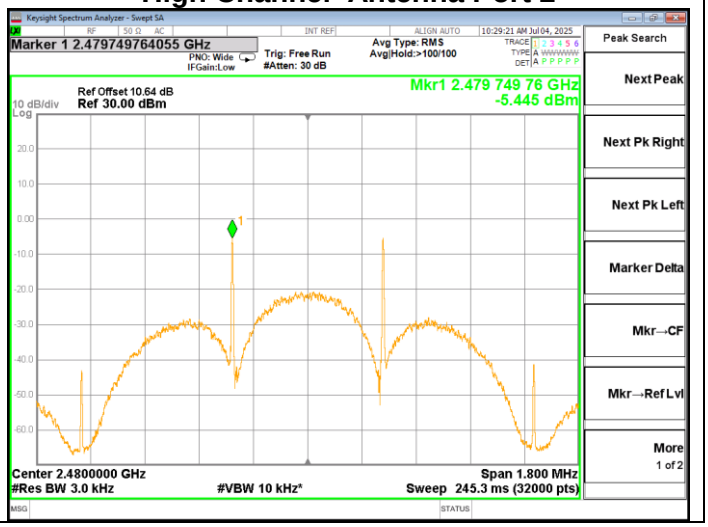
Mid Channel Antenna Port 2



High Channel Antenna Port 1

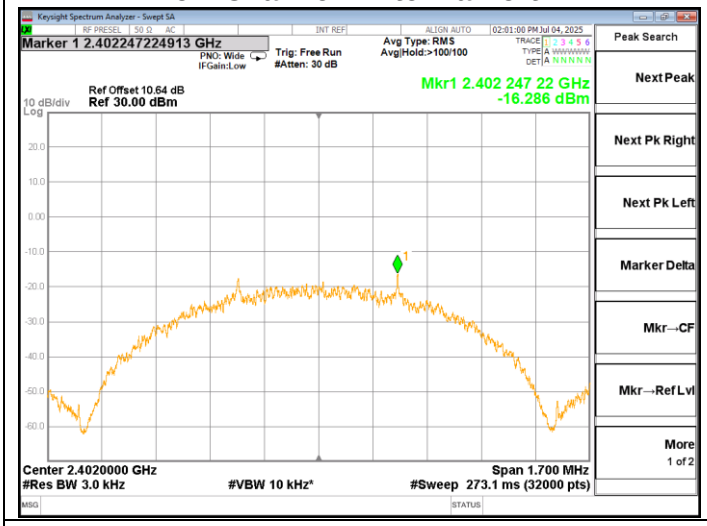


High Channel Antenna Port 2

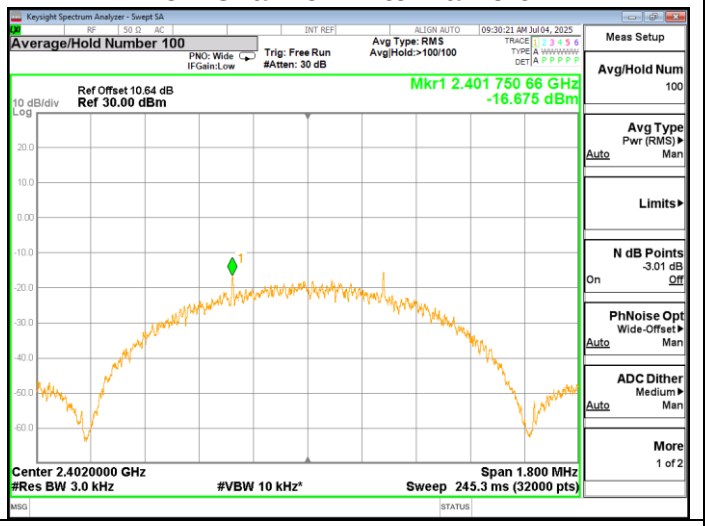


Mode: 500 Kbps

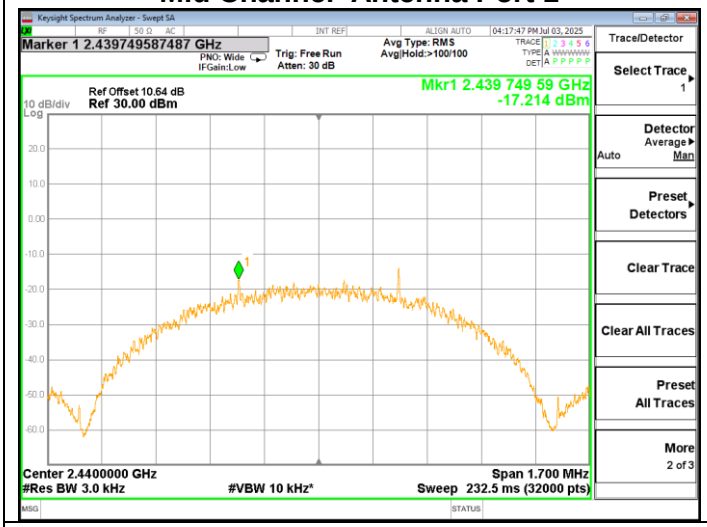
Low Channel Antenna Port 1



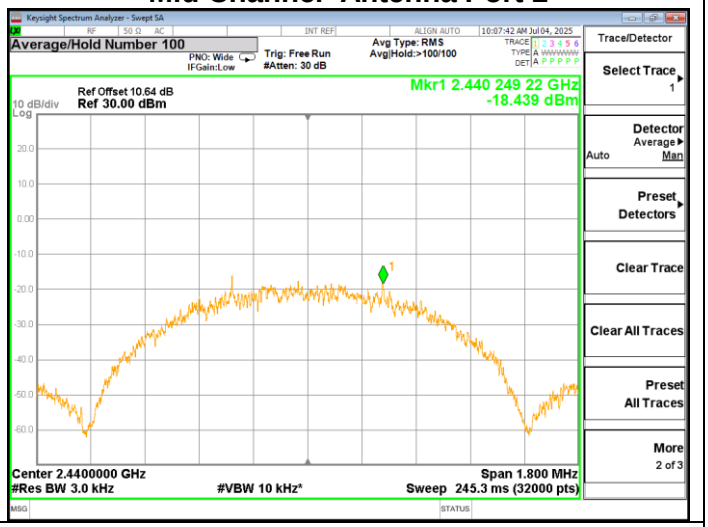
Low Channel Antenna Port 2



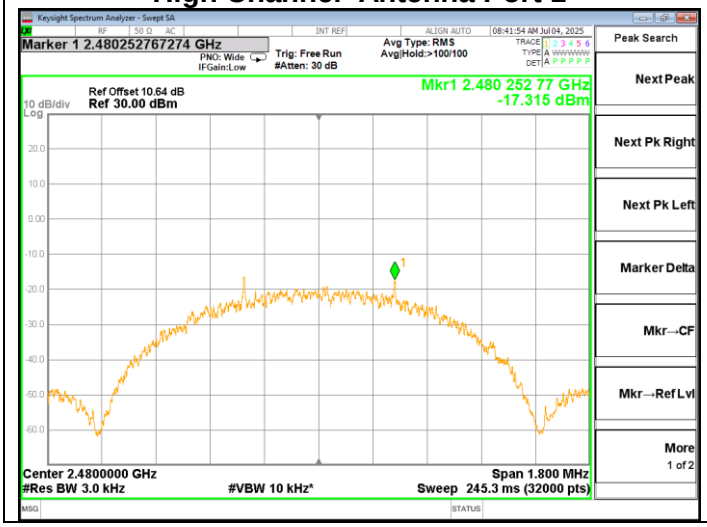
Mid Channel Antenna Port 1



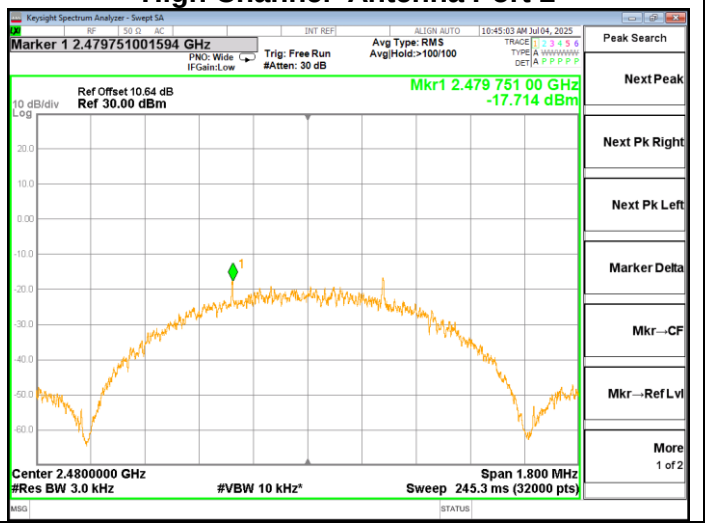
Mid Channel Antenna Port 2



High Channel Antenna Port 1



High Channel Antenna Port 2



2.7 Conducted Spurious Emissions (Non-Restricted Band)

Test Lab: Electronics Test Centre, Airdrie	**EUT: Torque Monitoring Sub**
Test Personnel: Brendan Van Hee, Joseph Yumol	**Standard: FCC PART 15.247**
	Basic Standard: ANSI C63.4-2014 **FCC OET KDB 558470 v04 DTS**
Date: July 3, 2025 (23.8°C, 33.5% RH) **July 4, 2025 (19.1°C, 40.7% RH)**	

EUT status: Compliant

Specification: FCC Part 15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

2.7.1 Test Guidance: ANSI C63.10-2013, Clause 6.7

This measurement is performed at the low, mid and high frequencies, with modulation.
The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.
The spectrum analyzer is stepped through the spectrum in frequency spans selected to ensure acceptable frequency resolution. The RBW is set to 100 kHz. The VBW is set to ≥ 300 kHz. The Peak detector is used, with the trace set to Max Hold.

2.7.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.7.3 Test Equipment

Testing was performed with the following equipment:

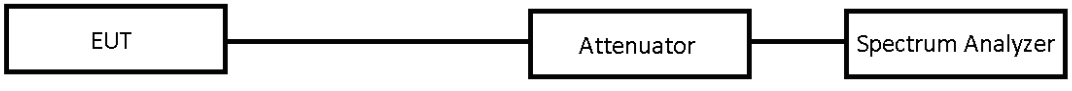
Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
EMI receiver	Agilent	N9038A (FW A.25.05)	6130	2024-08-15	2025-08-15
Temp/Humidity	Extech	42270	5871	2025-05-01	2026-05-01
Attenuator (DC to 26 GHz)	Mini-Circuits	BW-S10-2W263+	6932	2022-12-10	2025-12-10
Coaxial Cables (RF)	W.L. GORE	PGR01R01036	7024	2025-01-09	2026-01-09
DC Blocker (9 KHz - 27 GHz)	Centric RF	C0927 SMA	6987	2025-01-19	2026-01-19

2.7.4 Test Sample Verification, Configuration & Modifications

The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT met the requirements without modification.

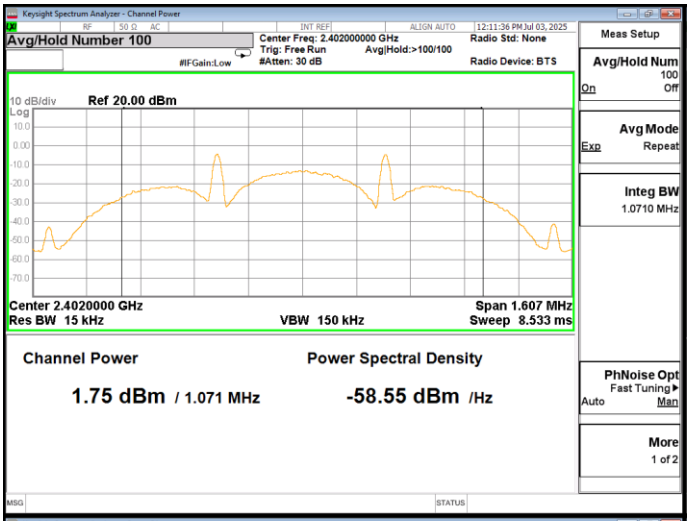
Test setup diagram for Conducted Spurious Emissions testing:

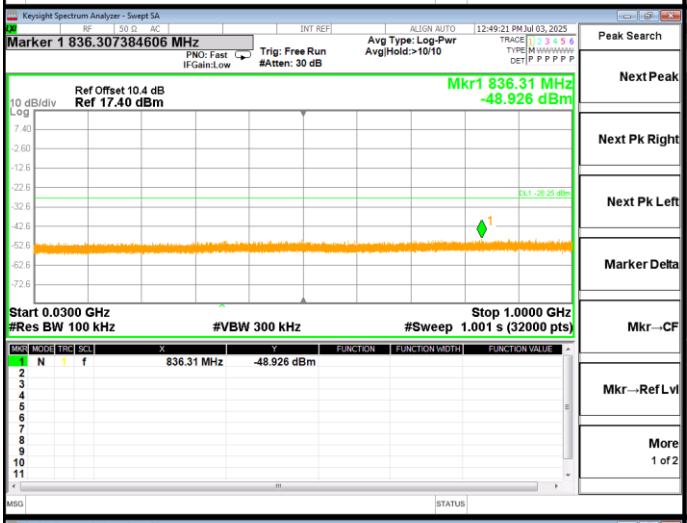


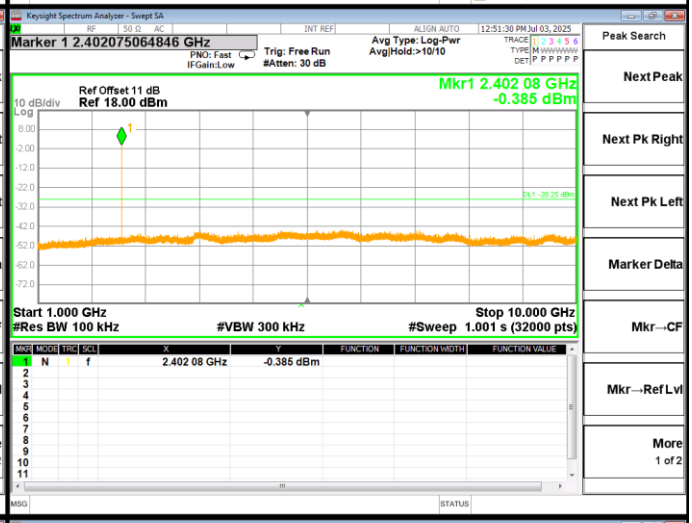
2.7.5 Conducted Emissions Data: Port 1

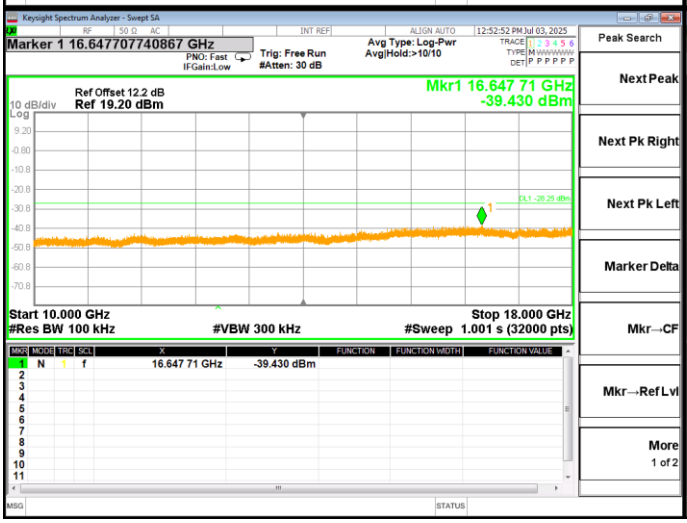
Mode Data Rate: 125 Kbps

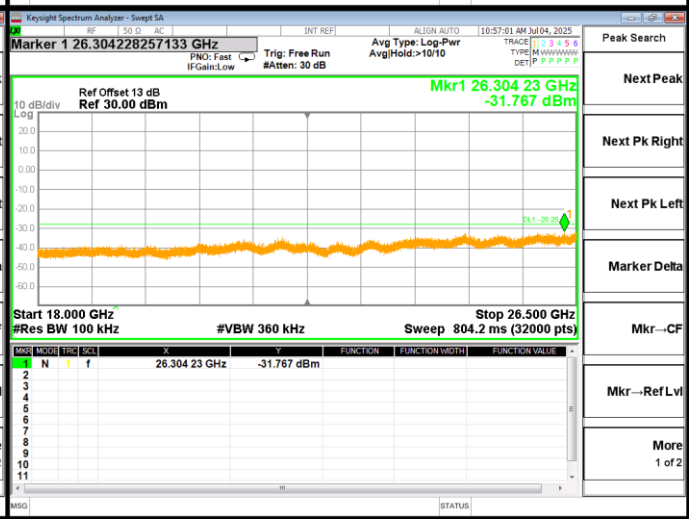
Low Channel











Mid Channel


Ref Value 30.00 dBm
Mkr1 2.4397474 GHz
-4.7193 dBm
Ref 30.00 dBm
Center 2.4400000 GHz
#Res BW 15 kHz
VBW 150 kHz
Span 1.631 MHz
Sweep 8.667 ms
Channel Power
1.57 dBm / 1.087 MHz
Power Spectral Density
-58.80 dBm /Hz
Marker 1 282.053314 kHz
Mkr1 282.1 kHz
-46.956 dBm
Ref Offset 10.4 dB
Ref 30.00 dBm
Start 32 kHz
#Res BW 100 kHz
#VBW 360 kHz
Stop 30.00 MHz
Sweep 4.267 ms (32000 pts)
DC Coupled
Marker 1 886.99468483 MHz
Mkr1 886.99 MHz
-48.449 dBm
Ref Offset 10.4 dB
Ref 30.00 dBm
Start 0.0300 GHz
#Res BW 100 kHz
#VBW 360 kHz
Stop 1.0000 GHz
Sweep 91.73 ms (32000 pts)
Marker 1 2.440045001406 GHz
Mkr1 2.440 05 GHz
-0.593 dBm
Ref Offset 11 dB
Ref 30.60 dBm
Start 1.000 GHz
#Res BW 100 kHz
#VBW 360 kHz
Stop 10.000 GHz
Sweep 851.2 ms (32000 pts)
Marker 1 16.487202725085 GHz
Mkr1 16.487 20 GHz
-38.881 dBm
Ref Offset 12.2 dB
Ref 31.80 dBm
Start 10.000 GHz
#Res BW 100 kHz
#VBW 360 kHz
Stop 18.000 GHz
Sweep 757.3 ms (32000 pts)
Marker 1 25.331479108722 GHz
Mkr1 25.331 48 GHz
-33.012 dBm
Ref Offset 13 dB
Ref 32.60 dBm
Start 18.000 GHz
#Res BW 100 kHz
#VBW 360 kHz
Stop 26.500 GHz
Sweep 804.2 ms (32000 pts)

High Channel