



Boss Snowplow A Division of the Toro Company

Sprayer Controls, Model: 143-7443

FCC 15:247:2023

RSS-247 Issue 2:2017

Bluetooth Low Energy (DTS) Radio

Report: BONY0007.0 Rev. 1, Issue Date: July 25, 2023



CERTIFICATE OF TEST



Last Date of Test: March 8, 2023
Boss Snowplow A Division of the Toro Company
EUT: Sprayer Controls, Model: 143-7443

Radio Equipment Testing

Standards

Specification	Method
FCC 15.247:2023	ANSI C63.10:2013, FCC KDB 558074 v05r02:2019
RSS-247 Issue 2:2017	
RSS-Gen Issue 5:2018+A1:2019+A2:2021	

Results

Test Description	Result	FCC Section(s)	RSS Section(s)	ANSI C63.10 Section(s)	Comments
Powerline Conducted Emissions	N/A	15.207	RSS-Gen 8.8	6.2	Not required for battery powered device
Duty Cycle	Evaluated	KDB 558074 -6.0	RSS-Gen 3.2	11.6	
DTS Bandwidth (6 dB)	Pass	15.247(a)(2), KDB 558074 -8.2	RSS-247 5.2(a)	11.8.2	
Occupied Bandwidth (99%)	Evaluated	KDB 558074 -2.1	RSS-Gen 6.7	6.9.3	
Output Power	Pass	15.247(b)(3), KDB 558074 -8.3.1	RSS-247 5.4(d, f), RSS-Gen 6.12	11.9.1.1	
Equivalent Isotropic Radiated Power	Pass	15.247(b)(3), KDB 558074 -8.3.1	RSS-247 5.4(d, f), RSS-Gen 6.12	11.9.1.1	
Power Spectral Density	Pass	15.247(e), KDB 558074 -8.4	RSS-247 5.2(b)	11.10.2	
Band Edge Compliance	Pass	15.247(d), KDB 558074 -8.5	RSS-247 5.5	11.11	
Spurious Conducted Emissions	Pass	15.247(d), KDB 558074 -8.5	RSS-247 5.5	11.11	
Spurious Radiated Emissions	Pass	15.247(d), KDB 558074 - 8.6, 8.7	RSS-247 5.5, RSS-Gen 6.13, 8.10	11.12.1, 11.13.2, 6.5, 6.6	

Deviations From Test Standards

None

Approved By:

James Morris, Operations Manager

Product compliance is the responsibility of the client; therefore, the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test. This report reflects only those tests from the referenced standards shown in the certificate of test. It does not include inspection or verification of labels, identification, marking or user information. As indicated in the Statement of Work sent with the quotation, Element's standard process is to always use the latest published version of the test methods even when earlier versions are cited in the test specification. Issuance of a purchase order was de facto acceptance of this approach. Otherwise, the client would have advised Element in writing of the specific version of the test methods they wanted applied to the subject testing.

REVISION HISTORY



Revision Number		Description	Date (yyyy-mm-dd)	Page Number
00		None		
01		Clarify EUT name, Radio type, description, included retesting data due to EUT configuration problem	2023-07-25	All

ACCREDITATIONS AND AUTHORIZATIONS



United States

FCC - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

A2LA - Each laboratory is accredited by A2LA to ISO / IEC 17025, and as a product certifier to ISO / IEC 17065 which allows Element to certify transmitters to FCC and IC specifications.

Canada

ISED - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB) and as a CAB for the acceptance of test data.

European Union

European Commission – Recognized as an EU Notified Body validated for the EMCD and RED Directives.

United Kingdom

BEIS – Recognized by the UK as an Approved Body under the UK Radio Equipment and UK EMC Regulations.

Australia/New Zealand

ACMA - Recognized by ACMA as a CAB for the acceptance of test data.

Korea

MSIT / RRA - Recognized by KCC's RRA as a CAB for the acceptance of test data.

Japan

VCCI - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

Taiwan

BSMI – Recognized by BSMI as a CAB for the acceptance of test data.

NCC - Recognized by NCC as a CAB for the acceptance of test data.

Singapore

IDA – Recognized by IDA as a CAB for the acceptance of test data.

Israel

MOC – Recognized by MOC as a CAB for the acceptance of test data.

Hong Kong

OFCA – Recognized by OFCA as a CAB for the acceptance of test data.

Vietnam

MIC – Recognized by MIC as a CAB for the acceptance of test data.

SCOPE

For details on the Scopes of our Accreditations, please visit:

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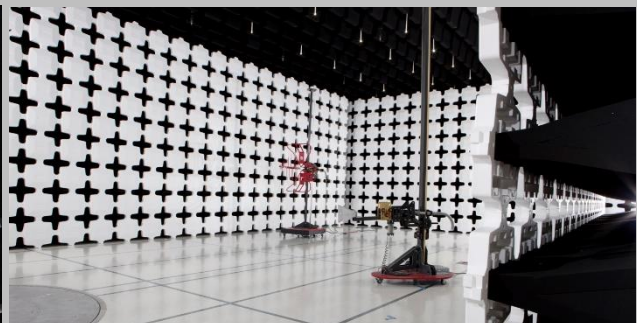
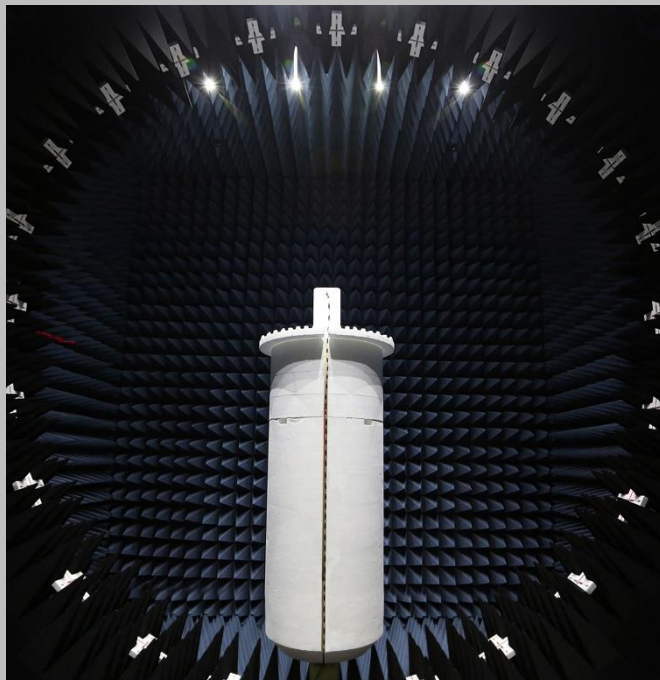
[Texas](#)

[Washington](#)

FACILITIES



California Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Minnesota Labs MN01-11 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	Oregon Labs EV01-12 6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	Texas Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Washington Labs NC01-05 19201 120 th Ave NE Bothell, WA 98011 (425)984-6600
A2LA				
Lab Code: 3310.04	Lab Code: 3310.05	Lab Code: 3310.02	Lab Code: 3310.03	Lab Code: 3310.06
Innovation, Science and Economic Development Canada				
2834B-1, 2834B-3	2834E-1, 2834E-3	2834D-1	2834G-1	2834F-1
BSMI				
SL2-IN-E-1154R	SL2-IN-E-1152R	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI				
A-0029	A-0109	A-0108	A-0201	A-0110
Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA				
US0158	US0175	US0017	US0191	US0157



MEASUREMENT UNCERTAINTY



Measurement Uncertainty

When a measurement is made, the result will be different from the true or theoretically correct value. The difference is the result of tolerances in the measurement system that cannot be completely eliminated. To the extent that technology allows us, it has been our aim to minimize this error. Measurement uncertainty is a statistical expression of measurement error qualified by a probability distribution.

A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found in the table below. A lab specific value may also be found in the applicable test description section. Our measurement data meets or exceeds the measurement uncertainty requirements of the applicable specification; therefore, the test data can be compared directly to the specification limit to determine compliance. The calculations for estimating measurement uncertainty are based upon ETSI TR 100 028 (or CISPR 16-4-2 as applicable), and are available upon request.

The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

Test	+ MU	- MU
Frequency Accuracy	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	1.2 dB	-1.2 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.2 dB	-5.2 dB
AC Powerline Conducted Emissions (dB)	3.2 dB	-3.2 dB

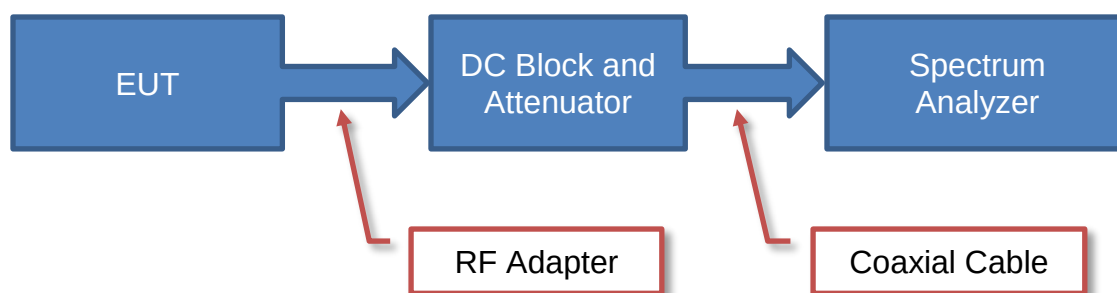
TEST SETUP BLOCK DIAGRAMS

Measurement Bandwidths

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01 - 0.15	1.0	0.2	0.2
0.15 - 30.0	10.0	9.0	9.0
30.0 - 1000	100.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

Unless otherwise stated, measurements were made using the bandwidths and detectors specified. No video filter was used.

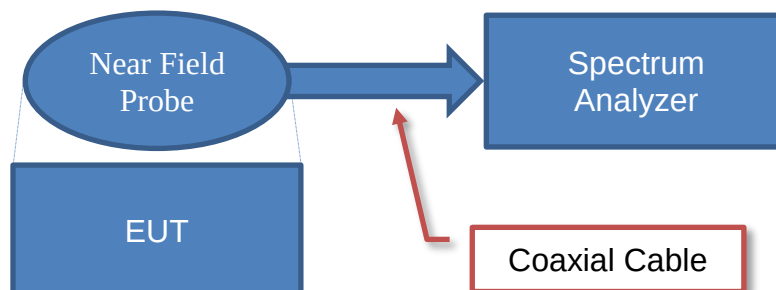
Antenna Port Conducted Measurements



Sample Calculation (logarithmic units)

Measured Value		Measured Level		Reference Level Offset
71.2	=	42.6	+	28.6

Near Field Test Fixture Measurements

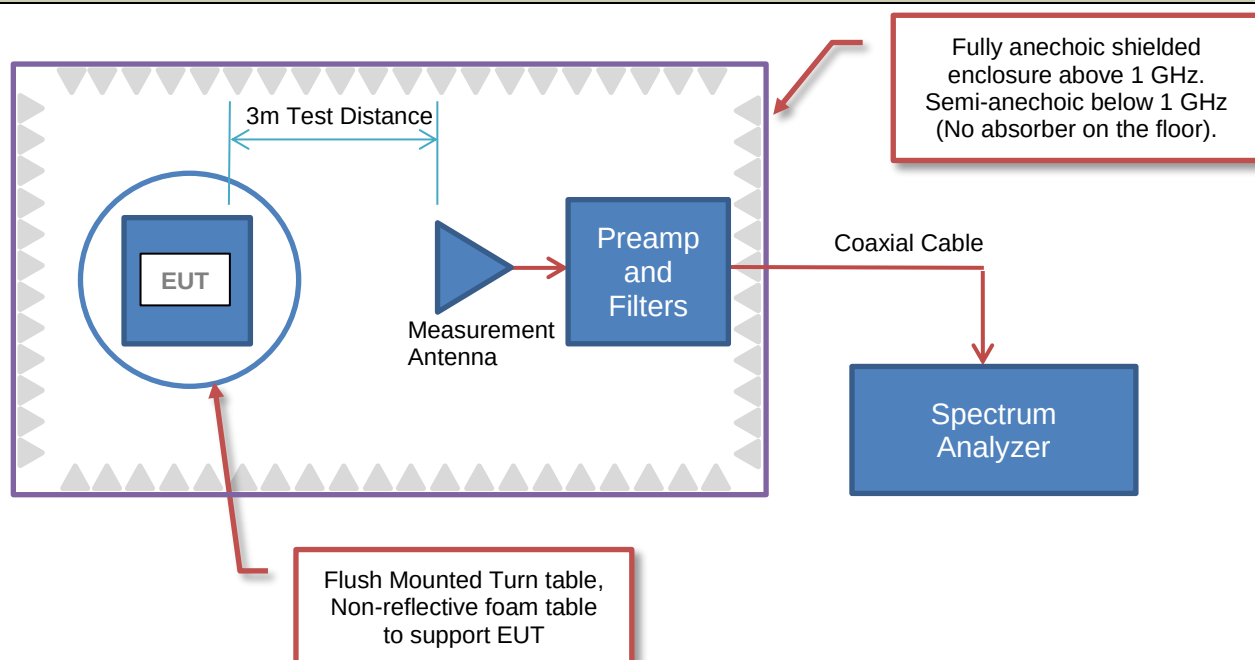


Sample Calculation (logarithmic units)

Measured Value		Measured Level		Reference Level Offset
71.2	=	42.6	+	28.6

TEST SETUP BLOCK DIAGRAMS

Emissions Measurements



Sample Calculation (logarithmic units)

Radiated Emissions:

Measured Level (Amplitude)	Factor			Distance Adjustment Factor	External Attenuation	Field Strength
	Antenna Factor	Cable Factor	Amplifier Gain			
42.6	28.6	3.1	40.8	0.0	0.0	33.5

Conducted Emissions:

Measured Level (Amplitude)	Factor		External Attenuation	Adjusted Level
	Transducer Factor	Cable Factor		
26.7	0.3	0.1	20.0	47.1

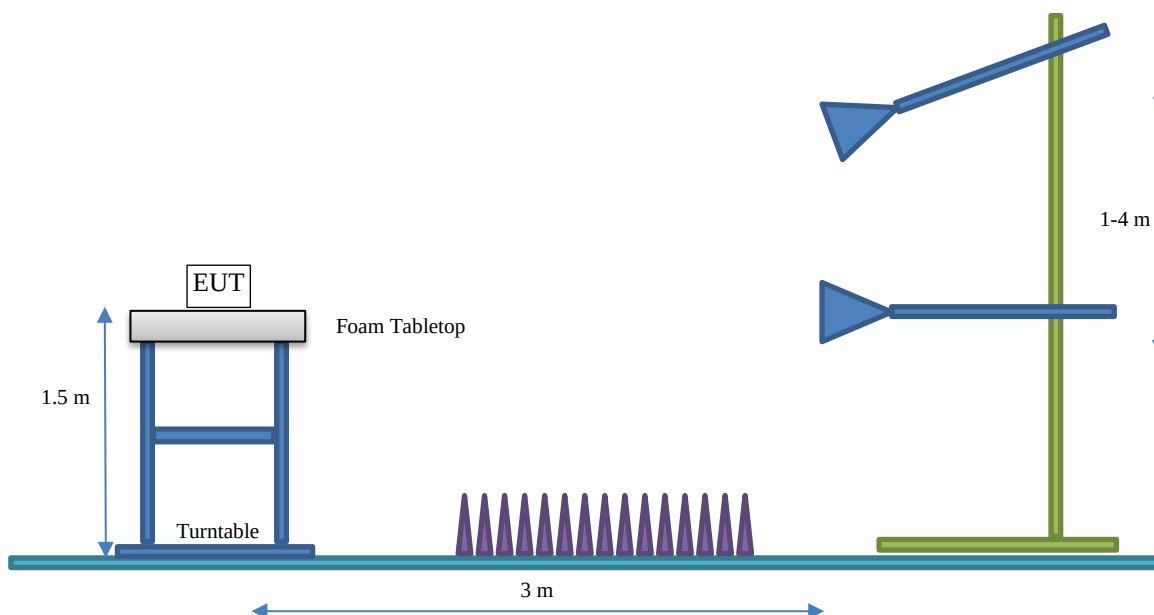
Radiated Power (ERP/EIRP) – Substitution Method:

Measured Level into Substitution Antenna (Amplitude dBm)	Substitution Antenna Factor (dBi)	EIRP to ERP (if applicable)	Measured power (dBm ERP/EIRP)
10.0	6.0	2.15	13.9/16.0

TEST SETUP BLOCK DIAGRAMS

Bore Sighting (>1GHz)

The diameter of the illumination area is the dimension of the line tangent to the EUT formed by 3 dB beamwidth of the measurement antenna at the measurement distance. At a 3 meter test distance, the diameter of the illumination area was 3.8 meters at 1 GHz and greater than 2.1 meters up to 6 GHz. Above 1 GHz, when required by the measurement standard, the antenna is pointed for both azimuth and elevation to maintain the receive antenna within the cone of radiation from the EUT. The specified measurement detectors were used for comparison of the emissions to the peak and average specification limits.



PRODUCT DESCRIPTION

Client and Equipment under Test (EUT) Information

Company Name:	Boss Snowplow A Division of the Toro Company
Address:	2010 The Boss Way
City, State, Zip:	Iron Mountain, MI 49801
Test Requested By:	Derek Meyer
EUT:	Sprayer Controls, Model: 143-7443
First Date of Test:	September 28, 2022
Last Date of Test:	March 8, 2023
Receipt Date of Samples:	September 28, 2022
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
Battery powered device containing pre-approved radios: Wi-Fi (802.11b/g/n) (FCC ID: 2AEMI-ARGN; IC: 20127-ARGN), Bluetooth Low Energy (DTS) Radio, LoRa module (915MHz) and a GPS Module (Sierra Wireless XM1110; GPS L1 1575.42MHz, GLONASS L1 (1598.0625MHz – 1605.375MHz))

Testing Objective:
To demonstrate compliance of the Bluetooth Low Energy (DTS) Radio to FCC 15.247/RSS-247 requirements.

POWER SETTINGS AND ANTENNAS



The power settings, antenna gain value(s) and cable loss (if applicable) used for the testing contained in this report were provided by the customer and will affect the validity of the results. Element assumes no responsibility for the accuracy of this information. The power settings below reflect the maximum power that the EUT is allowed to transmit at during normal operation.

ANTENNA GAIN (dBi)

Type	Provided by:	Frequency Range (MHz)	Gain (dBi)
Omni Directional (Dipole)	L-COM	2400-2500 MHz	4.0

The EUT was tested using the power settings provided by the manufacturer which were based upon:

- ☒ Test software settings Test software/firmware installed on EUT: ESP 32_RFTTest_184_20210927
☐ Rated power settings

SETTINGS FOR ALL TESTS IN THIS REPORT

Modulation Types / Data Rates	Type	Channel	Frequency (MHz)	Power Setting
BLE 1 Mbps, 2 Mbps	DTS	0 or 37	2402	8
		20 or 18	2442	8
		39	2480	8

CONFIGURATIONS



Configuration BONY0001-3

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Sprayer Controls, Model: 143-7443	Boss Snowplow A Division of the Toro Company	143-7443	22100008
WiFi/BT Antenna (Omni)	L-Com	HGV-2404U	None

Remote Equipment Outside of Test Setup Boundary			
Description	Manufacturer	Model/Part Number	Serial Number
12V Lead Acid Battery	Interstate	HD-24DP	None

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
Antenna Cable (WiFi/BT)	Yes	7.6 m	No	Sprayer Controller	WiFi/BT Antenna
Battery Cable	No	1.8 m	No	Battery	Sprayer Controller
Wiring Harness (3x bundles)	No	1 m	No	Sprayer Controller	Unterminated

Configuration BONY0010-1

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Sprayer Controls, Model: 143-7443	Boss Snowplow A Division of the Toro Company	143-7443	22100009

Remote Equipment Outside of Test Setup Boundary			
Description	Manufacturer	Model/Part Number	Serial Number
12V Lead Acid Battery	Interstate	HD-24DP	None
Laptop	Dell	Precision 5760	7YVCPL3
Programming Adapter	Particle	Particle Debugger V1.0	None

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
Battery Cable	No	1.8 m	No	Battery	Sprayer Controller
Wiring Harness (3x bundles)	No	1 m	No	Sprayer Controller	Unterminated
Programming leads (3x)	No	0.5 m	No	Laptop (programming adapter)	Sprayer Assembly

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2022-09-28	Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	2023-03-08	Band Edge Compliance	Tested as delivered to test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
3	2023-03-08	Duty Cycle	Tested as delivered to test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
4	2023-03-08	DTS Bandwidth (6 dB)	Tested as delivered to test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
5	2023-03-08	Equivalent Isotropic Radiated Power	Tested as delivered to test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
6	2023-03-08	Occupied Bandwidth (99%)	Tested as delivered to test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
7	2023-03-08	Output Power	Tested as delivered to test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
8	2023-03-08	Power Spectral Density	Tested as delivered to test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
9	2023-03-08	Spurious Conducted Emissions	Tested as delivered to test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

DUTY CYCLE



XMH 2023.02.14.0

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Attenuator	S.M. Electronics	SA26B-20	TZP	2022-11-06	2023-11-06
Block - DC	Fairview Microwave	SD3379	AMZ	2022-11-06	2023-11-06
Cable	Micro-Coax	D150A-1-0720-200	MNL	2022-09-10	2023-09-10
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	2023-02-02	2024-02-02
Generator - Signal	Keysight	N5182B	TEV	2021-04-27	2024-04-27

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The Duty Cycle (x) of the single channel operation of the radio as controlled by the provided test software was measured for each of the EUT operating modes.

There is no compliance requirement to be met by this test, so therefore no Pass / Fail criteria.

The measurements were made using a zero span on the spectrum analyzer to see the pulses in the time domain. The transmit power was set to its default maximum.

The duty cycle was calculated by dividing the transmission pulse duration (T) by the total period of a single on and total off time.

If the transmit duty cycle < 98 percent, burst gating may have been used during some of the other tests in this report to only take the measurement during the burst duration.

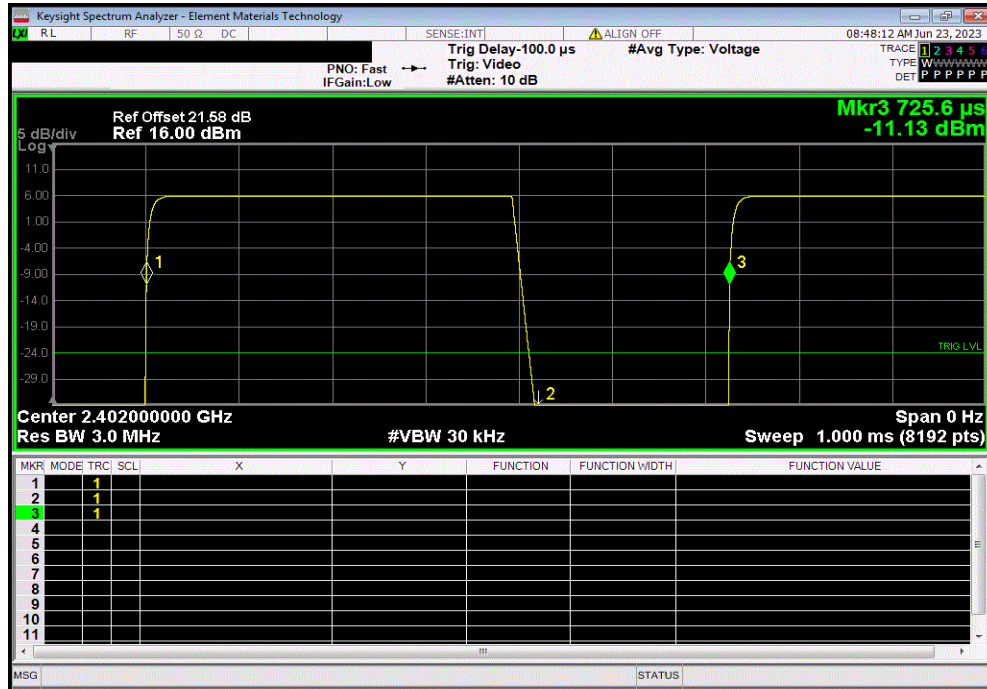
TbtTx 2022.06.03.0 XMit 2023.02.14.0

DUTY CYCLE

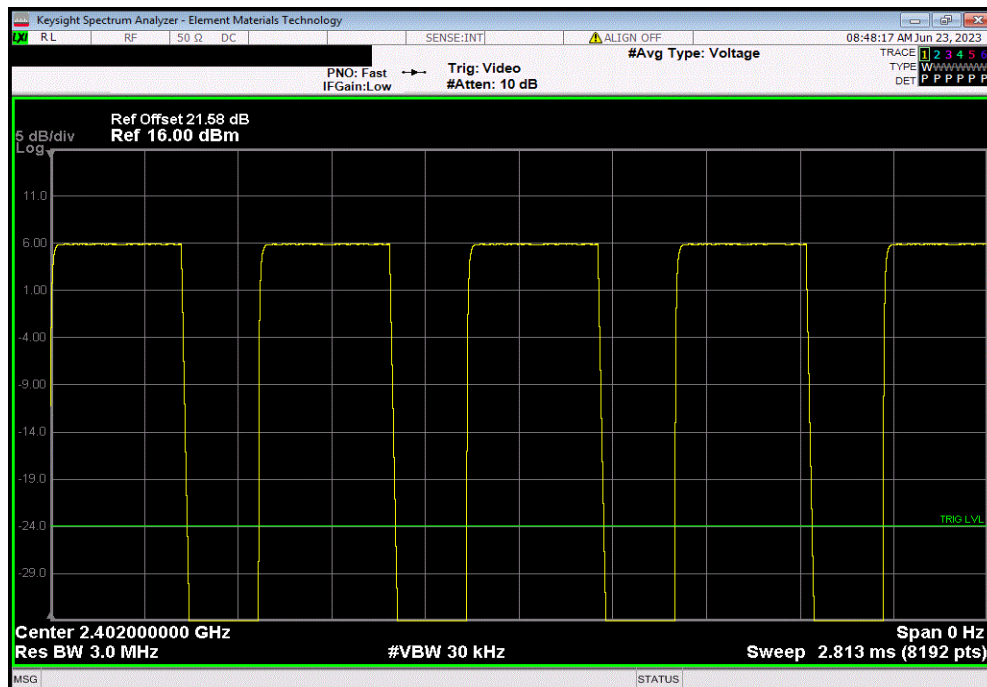


TbTtx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results	
419.7 us	625.1 us	1	67.1	N/A	N/A	



BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results	
N/A	N/A	5	N/A	N/A	N/A	

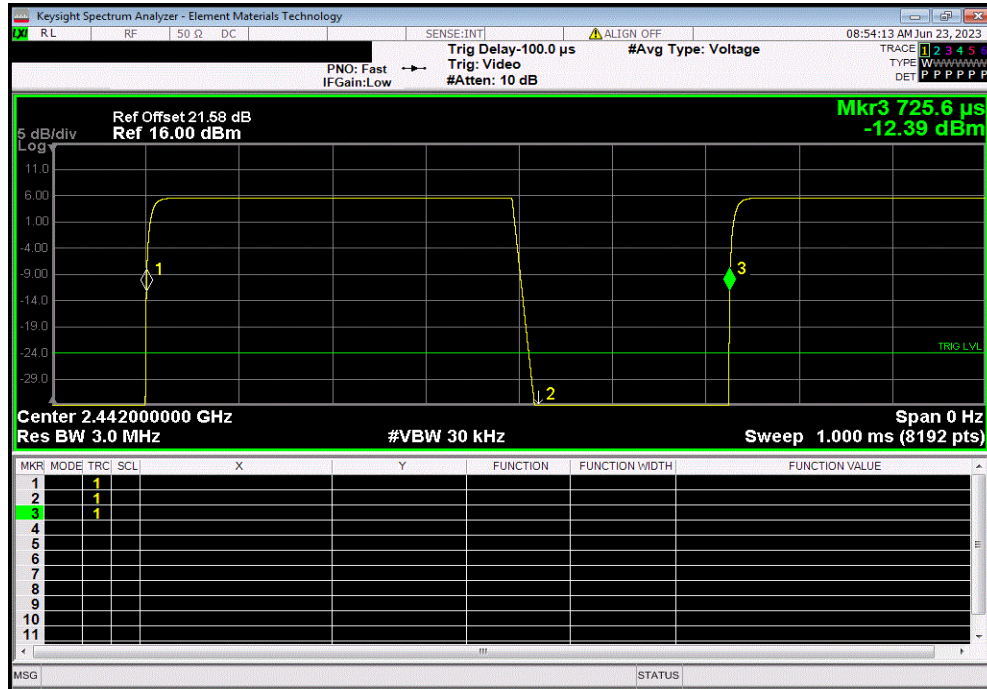


DUTY CYCLE

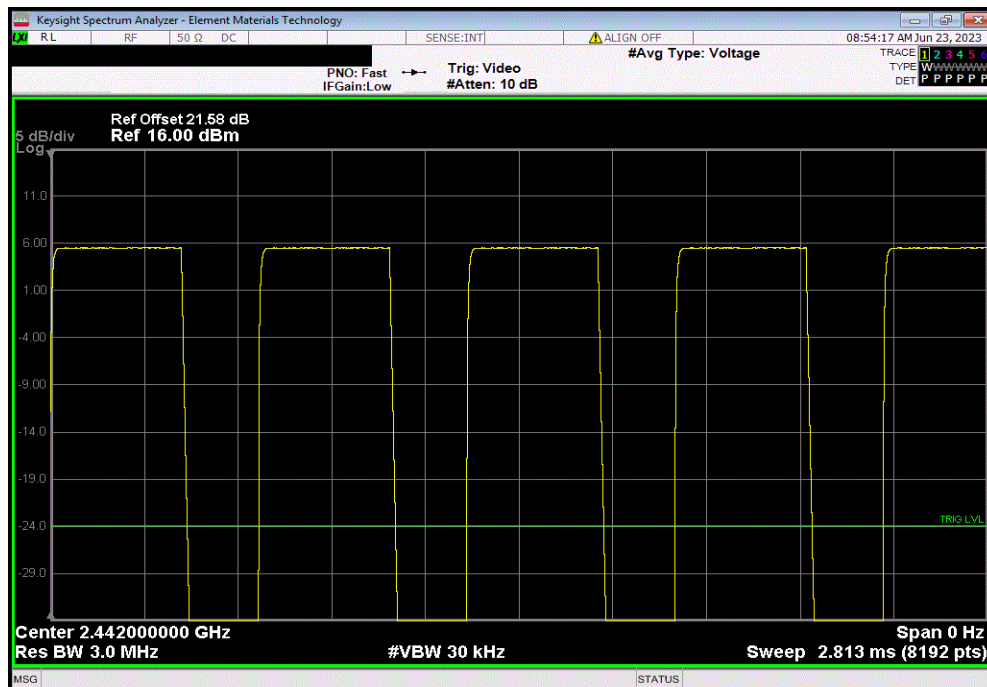


TbTtx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results	
419.8 us	625.1 us	1	67.2	N/A	N/A	



BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results	
N/A	N/A	5	N/A	N/A	N/A	

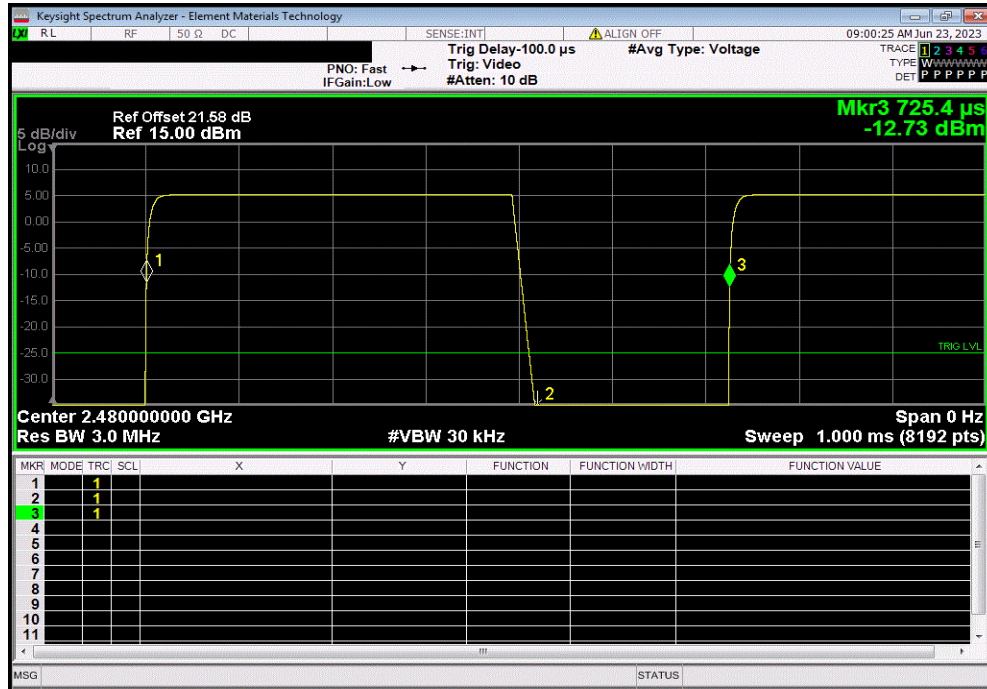


DUTY CYCLE

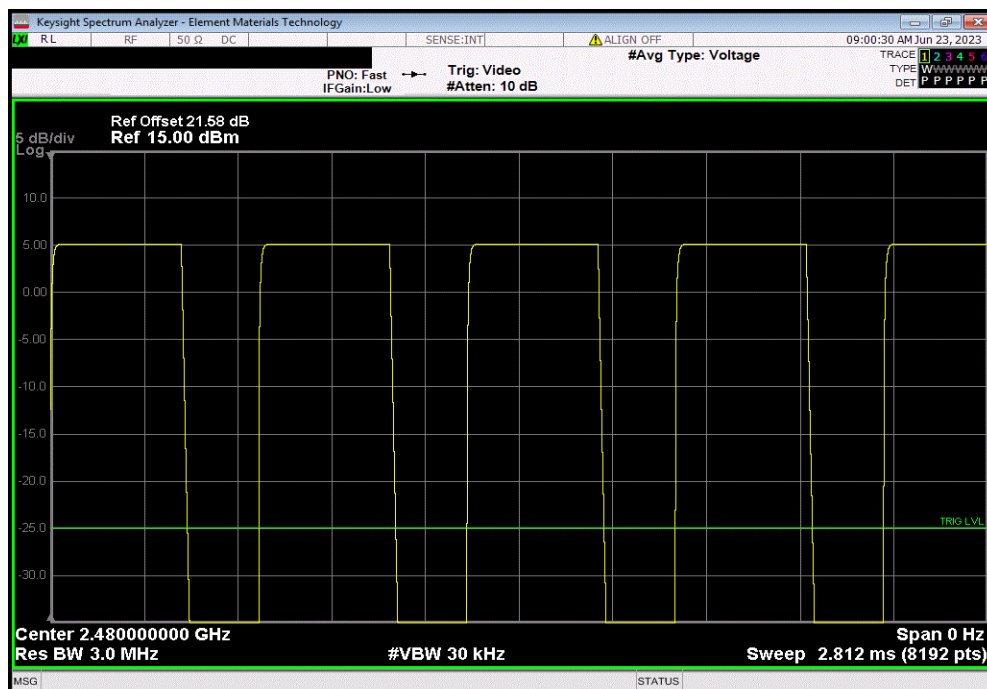


TbTtx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results	
419.1 us	624.9 us	1	67.1	N/A	N/A	



BLE/GFSK 1 Mbps High Channel, 2480 MHz						
Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results	
N/A	N/A	5	N/A	N/A	N/A	



DTS BANDWIDTH (6 dB)

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Attenuator	S.M. Electronics	SA26B-20	TZP	2022-11-06	2023-11-06
Block - DC	Fairview Microwave	SD3379	AMZ	2022-11-06	2023-11-06
Cable	Micro-Coax	D150A-1-0720-200	MNL	2022-09-10	2023-09-10
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	2023-02-02	2024-02-02
Generator - Signal	Keysight	N5182B	TEV	2021-04-27	2024-04-27

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The EUT was set to the channels and modes listed in the datasheet.

The 6dB DTS bandwidth was measured using 100 kHz resolution bandwidth and 300 kHz video bandwidth. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.

DTS BANDWIDTH (6 dB)



TSTx 2022.06.03.0 XMR 2023.02.14.0

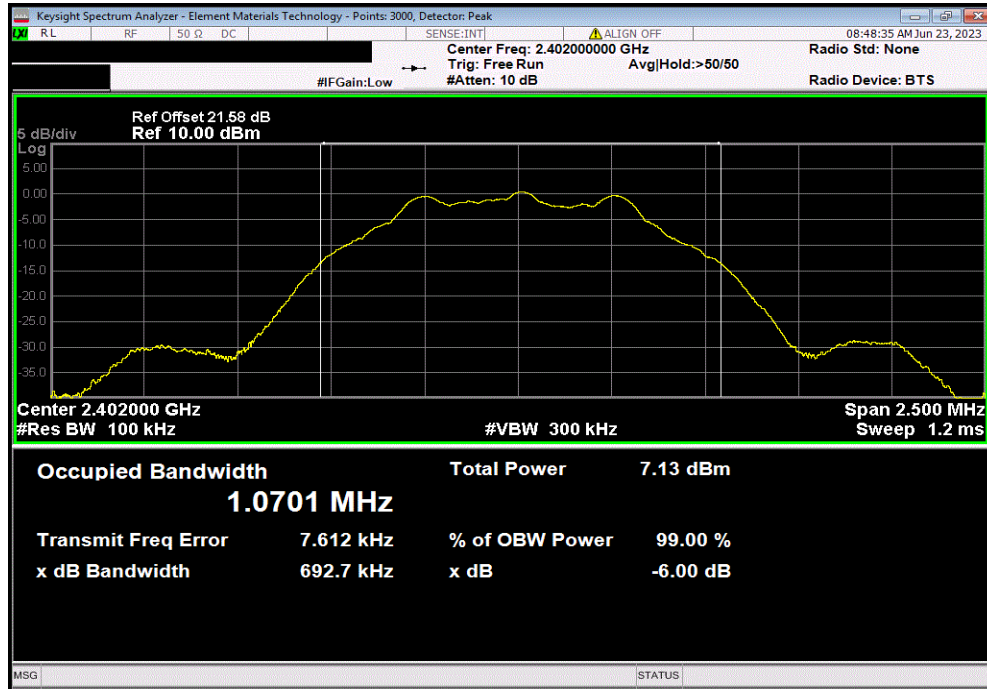
EUT: Sprayer Controls, Model: 143-7443		Work Order: BONY0010	
Serial Number: 22100009		Date: 06/22/2023	
Customer: Boss Snowplow A Division of the Toro Company		Temperature: 22.6°C	
Attendees: Derek Meyer		Humidity: 50.3%	
Project: None		Barometric Pres.: 1017 mbar	
Tested by: Christopher Heintzelman	Power: Battery (12VDC)	Job Site: MN11	
TEST SPECIFICATIONS			
FCC 15.247:2023		ANSI C63.10:2013	
RSS-247 Issue 2:2017		ANSI C63.10:2013	
RSS-Gen Issue 5:2018+A1:2019+A2:2021		ANSI C63.10:2013	
COMMENTS			
Reference level offset includes measurement cable, attenuator, and DC block.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	BONY0010-1	Signature <i>Christopher Heintzelman</i>	
		Value	Limit (±) Result
BLE/GFSK 1 Mbps Low Channel, 2402 MHz		692.679 kHz	500 kHz Pass
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz		700.051 kHz	500 kHz Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz		696.273 kHz	500 kHz Pass

DTS BANDWIDTH (6 dB)

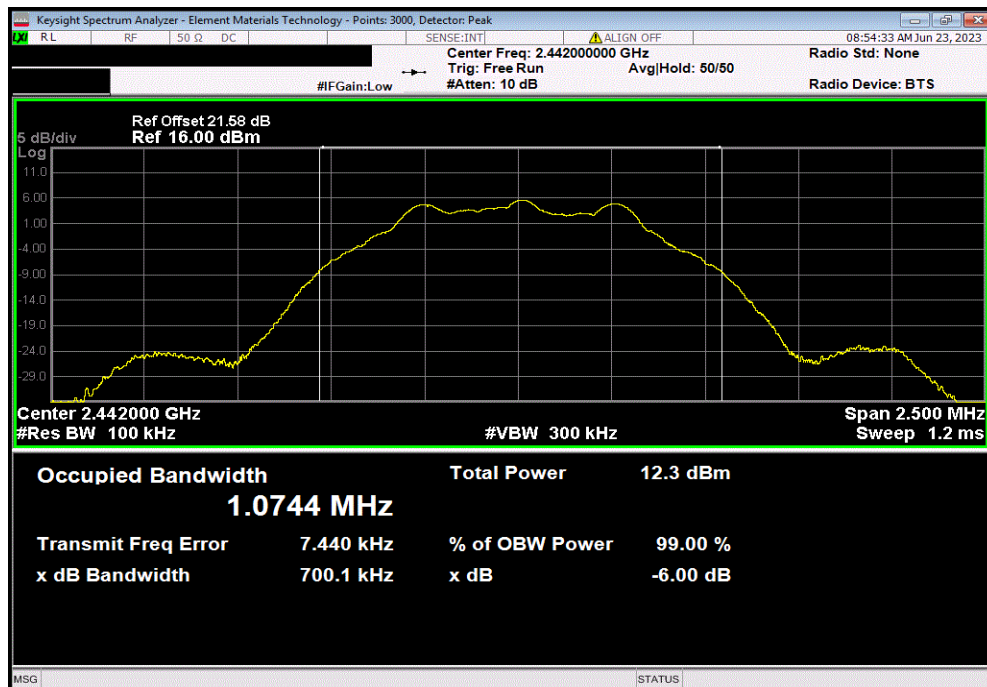


TbTx 2022.06.03.0 XbM 2023.02.14.0

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
				Value	Limit (≥)	Result
				692.679 kHz	500 kHz	Pass



BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
				Value	Limit (≥)	Result
				700.051 kHz	500 kHz	Pass

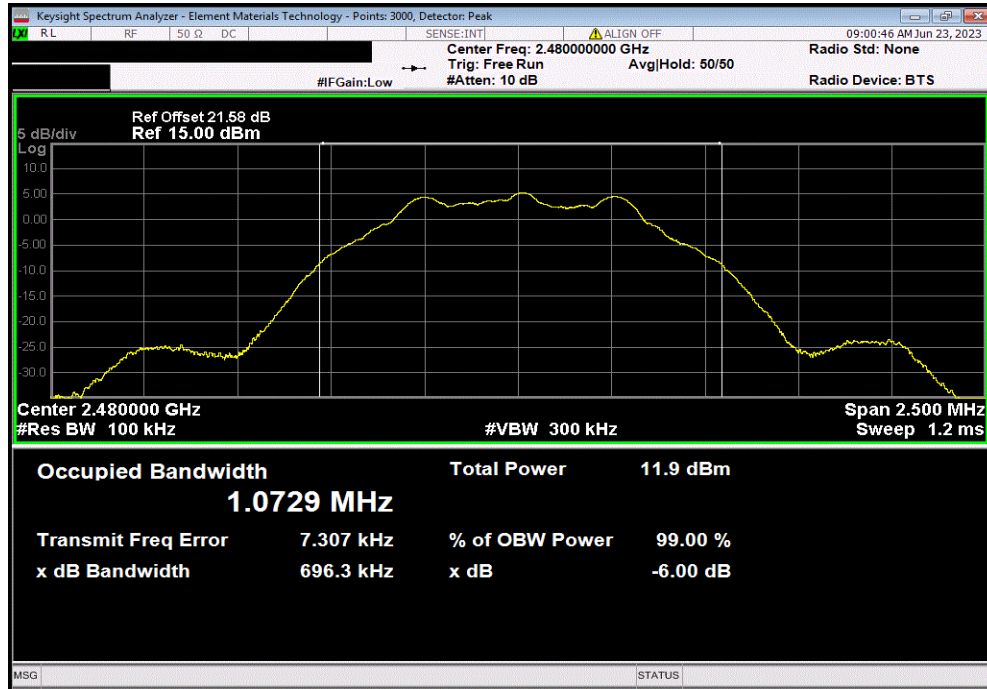


DTS BANDWIDTH (6 dB)



TbTx 2022.06.03.0 XbM 2023.02.14.0

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
Value				Limit	Result	
				(≥)		
696.273 kHz				500 kHz	Pass	



OCCUPIED BANDWIDTH (99%)

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Attenuator	S.M. Electronics	SA26B-20	TZP	2022-11-06	2023-11-06
Block - DC	Fairview Microwave	SD3379	AMZ	2022-11-06	2023-11-06
Cable	Micro-Coax	D150A-1-0720-200	MNL	2022-09-10	2023-09-10
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	2023-02-02	2024-02-02
Generator - Signal	Keysight	N5182B	TEV	2021-04-27	2024-04-27

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The 99% occupied bandwidth was measured with the EUT configured for continuous modulated operation.

Per ANSI C63.10:2013, 6.9.3, the spectrum analyzer was configured as follows:

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.

The resolution bandwidth (RBW) of the spectrum analyzer was set to the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) bandwidth was set to at least 3 times the resolution bandwidth. The analyzer sweep time was set to auto to prevent video filtering or averaging. A sample detector was used unless the device was not able to be operated in a continuous transmit mode, in which case a peak detector was used.

The spectrum analyzer occupied bandwidth measurement function was used to sum the power of the transmission in linear terms to obtain the 99% bandwidth.

OCCUPIED BANDWIDTH (99%)



TSTx 2022.06.03.0 XMR 2023.02.14.0

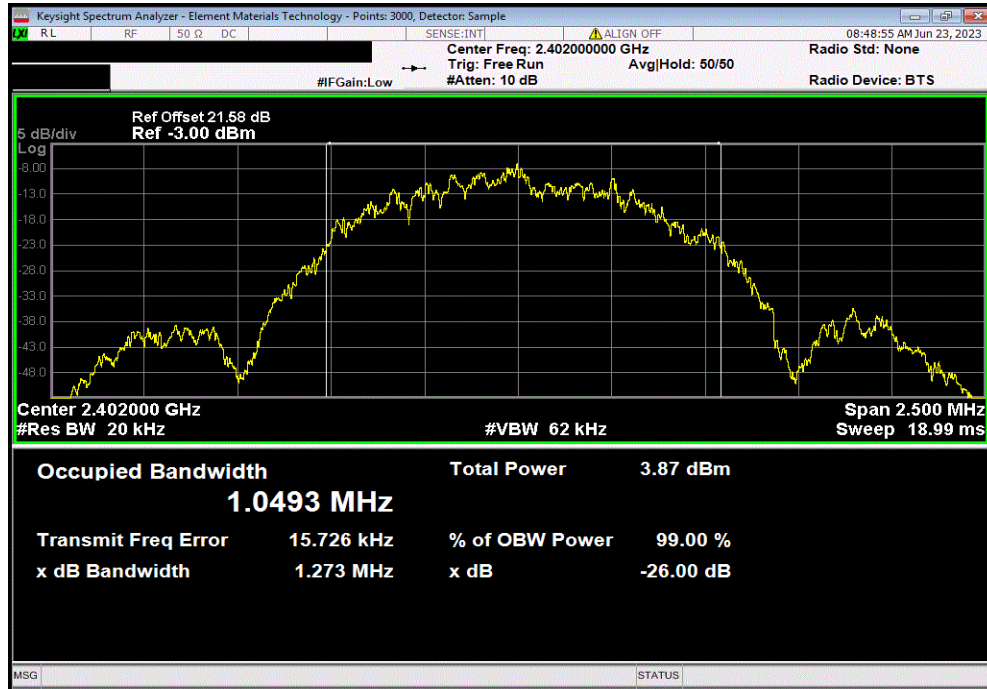
EUT: Sprayer Controls, Model: 143-7443		Work Order: BONY0010	
Serial Number: 22100009		Date: 06/22/2023	
Customer: Boss Snowplow A Division of the Toro Company		Temperature: 22.6°C	
Attendees: Derek Meyer		Humidity: 50%	
Project: None		Barometric Pres.: 1017 mbar	
Tested by: Christopher Heintzelman	Power: Battery (12VDC)	Job Site: MN11	
TEST SPECIFICATIONS			
FCC 15.247:2023		Test Method	
RSS-247 Issue 2:2017		ANSI C63.10:2013	
RSS-Gen Issue 5:2018+A1:2019+A2:2021		ANSI C63.10:2013	
COMMENTS			
Reference level offset includes measurement cable, attenuator, and DC block.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	BONY0010-1	Signature <i>Christopher Heintzelman</i>	
		Value	Limit
BLE/GFSK 1 Mbps Low Channel, 2402 MHz		1.049 MHz	N/A
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz		1.053 MHz	N/A
BLE/GFSK 1 Mbps High Channel, 2480 MHz		1.048 MHz	N/A

OCCUPIED BANDWIDTH (99%)

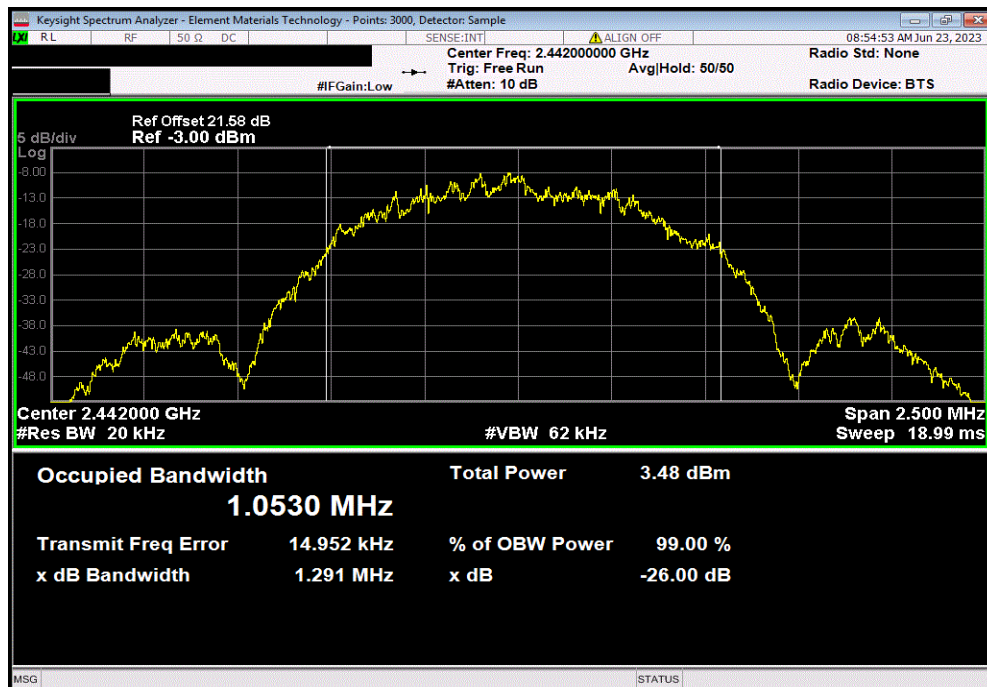


TbTx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
				Value	Limit	Result
				1.049 MHz	N/A	N/A



BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
				Value	Limit	Result
				1.053 MHz	N/A	N/A

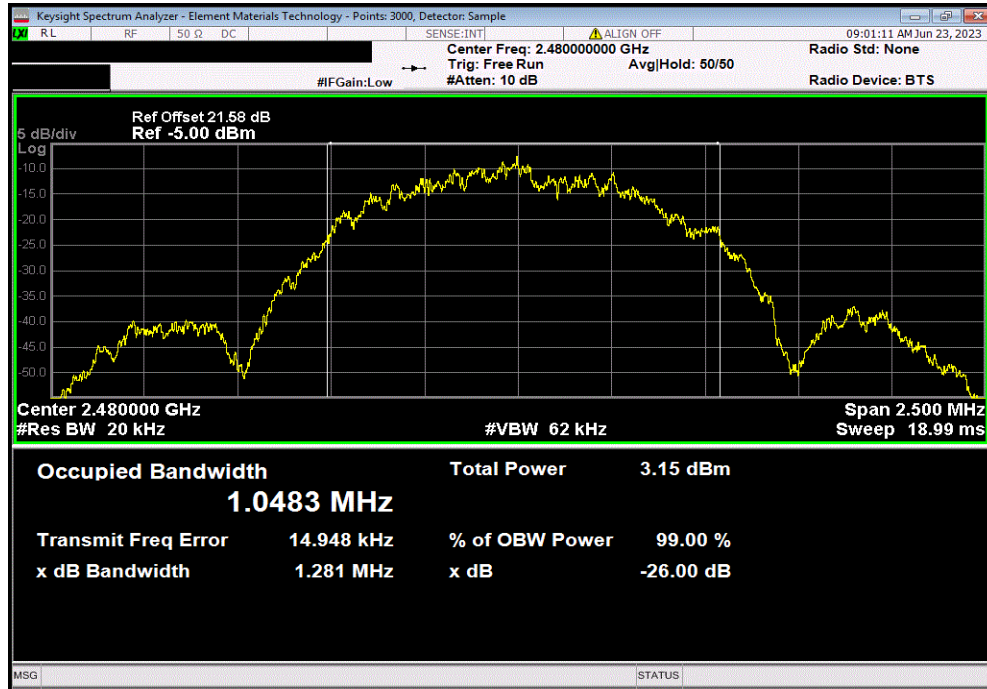


OCCUPIED BANDWIDTH (99%)



TbTx 2022.06.03.0 XbTx 2023.02.14.0

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
				Value	Limit	Result
				1.048 MHz	N/A	N/A



OUTPUT POWER



XMH 2023.02.14.0

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Attenuator	S.M. Electronics	SA26B-20	TZP	2022-11-06	2023-11-06
Block - DC	Fairview Microwave	SD3379	AMZ	2022-11-06	2023-11-06
Cable	Micro-Coax	D150A-1-0720-200	MNL	2022-09-10	2023-09-10
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	2023-02-02	2024-02-02
Generator - Signal	Keysight	N5182B	TEV	2021-04-27	2024-04-27

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The transmit frequency was set to the required channels in each band. The transmit power was set to its default maximum.

Prior to measuring peak transmit power the DTS bandwidth (B) was measured.

The method found in ANSI C63.10:2013 Section 11.9.1.1 was used because the RBW on the analyzer was greater than the DTS Bandwidth of the radio.

OUTPUT POWER



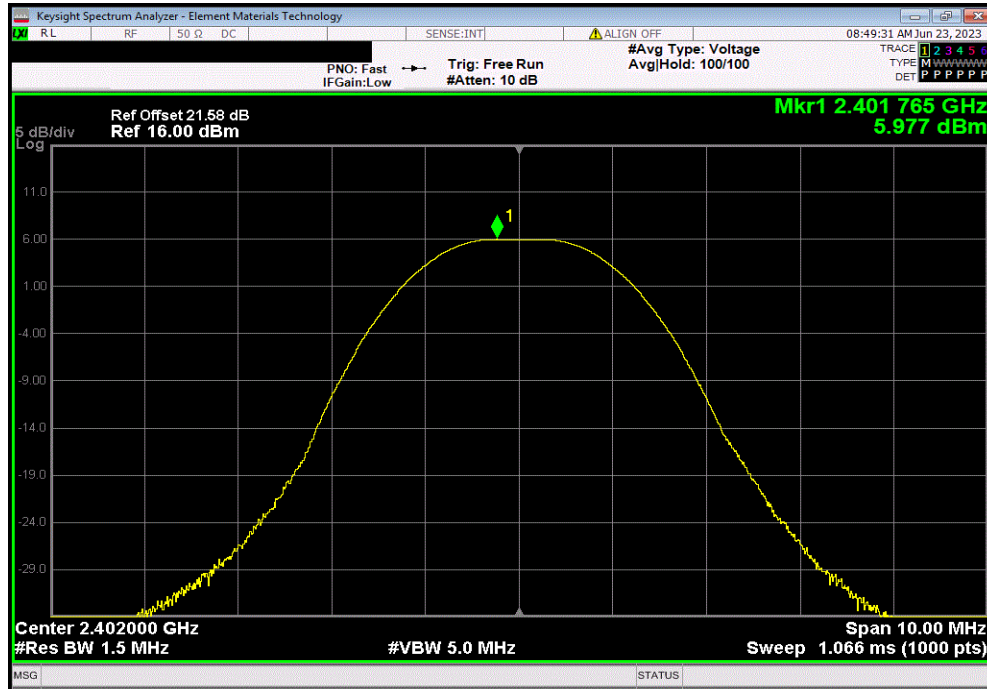
EUT: Sprayer Controls, Model: 143-7443		Work Order: BONY0010	
Serial Number: 22100009		Date: 06/22/2023	
Customer: Boss Snowplow A Division of the Toro Company		Temperature: 22.7°C	
Attendees: Derek Meyer		Humidity: 50.1%	
Project: None		Barometric Pres.: 1017 mbar	
Tested by: Christopher Heintzelman	Power: Battery (12VDC)	Job Site: MN11	
TEST SPECIFICATIONS			
FCC 15.247:2023		ANSI C63.10:2013	
RSS-247 Issue 2:2017		ANSI C63.10:2013	
RSS-Gen Issue 5:2018+A1:2019+A2:2021		ANSI C63.10:2013	
COMMENTS			
Reference level offset includes measurement cable, attenuator, and DC block.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	BONY0010-1	Signature <i>Christopher Heintzelman</i>	
		Out Pwr (dBm)	Limit (dBm) Result
BLE/GFSK 1 Mbps Low Channel, 2402 MHz		5.977	30 Pass
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz		5.589	30 Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz		5.235	30 Pass

OUTPUT POWER

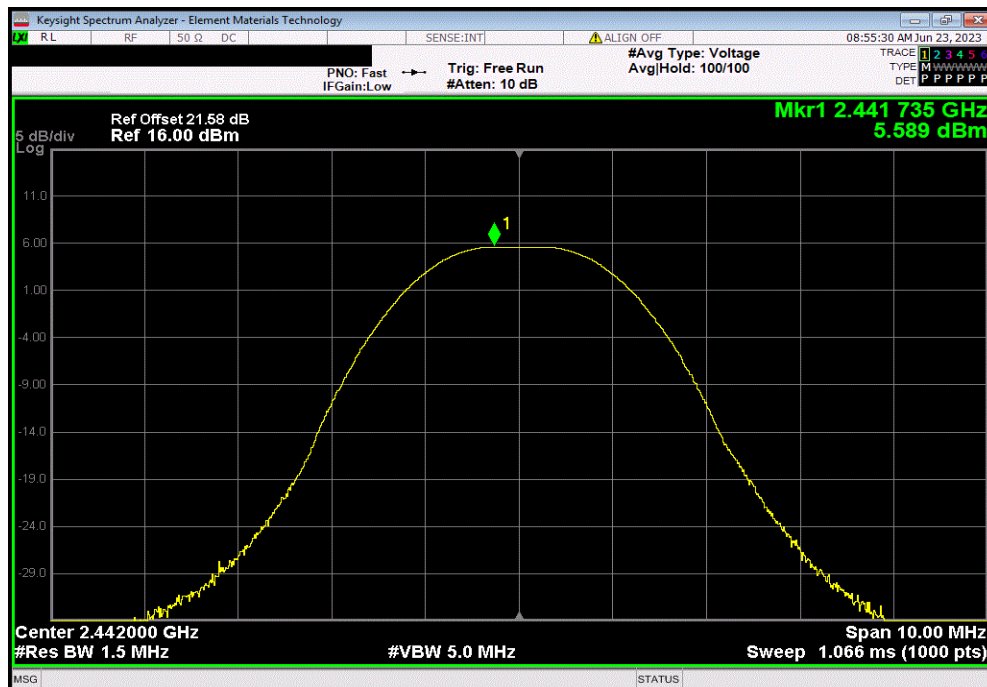


TbTx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				5.977	30	Pass



BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				5.589	30	Pass

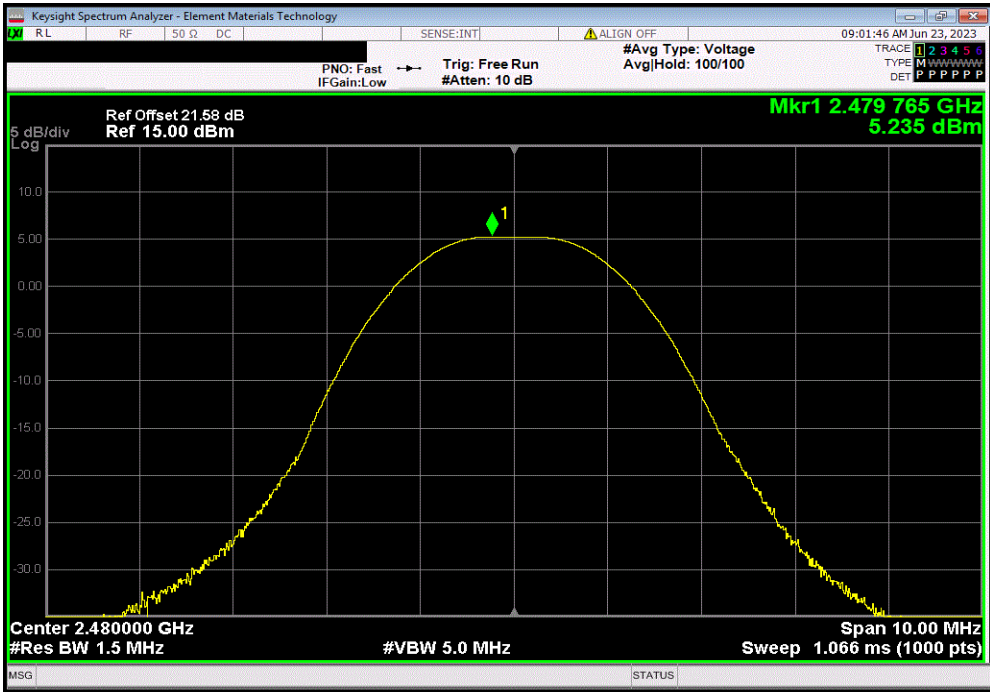


OUTPUT POWER



TbTx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				5.235	30	Pass



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)



XMH 2023.02.14.0

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Attenuator	S.M. Electronics	SA26B-20	TZP	2022-11-06	2023-11-06
Block - DC	Fairview Microwave	SD3379	AMZ	2022-11-06	2023-11-06
Cable	Micro-Coax	D150A-1-0720-200	MNL	2022-09-10	2023-09-10
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	2023-02-02	2024-02-02
Generator - Signal	Keysight	N5182B	TEV	2021-04-27	2024-04-27

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The transmit frequency was set to the required channels in each band. The transmit power was set to its default maximum.

Prior to measuring peak transmit power the DTS bandwidth (B) was measured.

The method found in ANSI C63.10:2013 Section 11.9.1.1 was used because the RBW on the analyzer was greater than the DTS Bandwidth of the radio.

Equivalent Isotropic Radiated Power (EIRP) = Max Measured Power + Antenna gain (dBi)

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)



TSTx 2022.06.03.0 XMR 2023.02.14.0

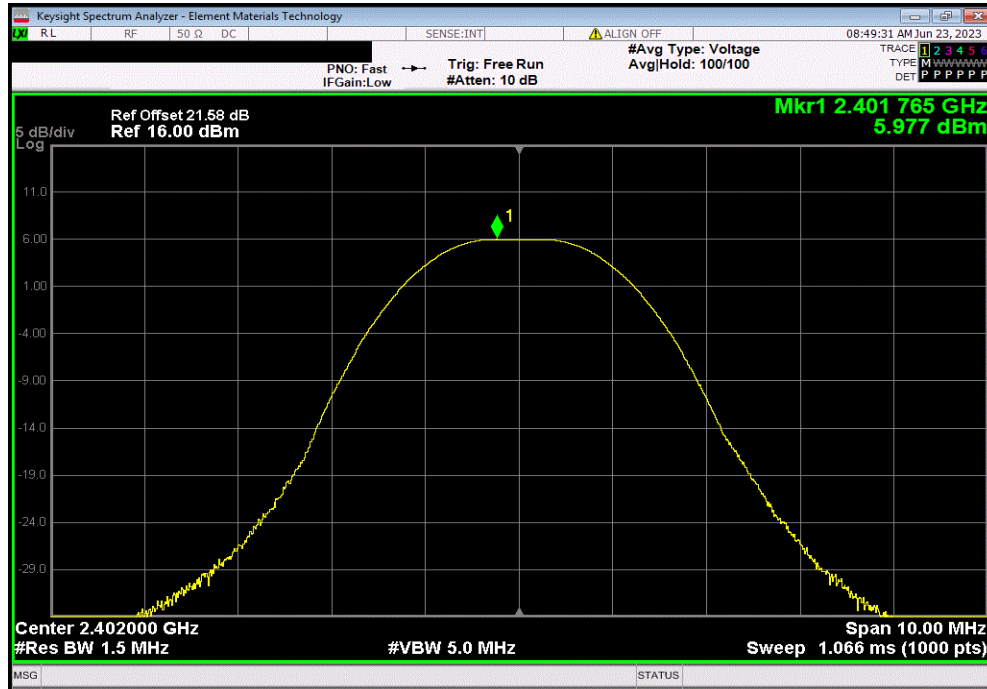
EUT: Sprayer Controls, Model: 143-7443		Work Order: BONY0010	
Serial Number: 22100009		Date: 06/22/2023	
Customer: Boss Snowplow A Division of the Toro Company		Temperature: 22.6°C	
Attendees: Derek Meyer		Humidity: 50.1%	
Project: None		Barometric Pres.: 1017 mbar	
Tested by: Christopher Heintzelman	Power: Battery (12VDC)	Job Site: MN11	
TEST SPECIFICATIONS			
FCC 15.247:2023		Test Method	
FCC 15.247:2023		ANSI C63.10:2013	
RSS-Gen Issue 5:2018+A1:2019+A2:2021		ANSI C63.10:2013	
COMMENTS			
Reference level offset includes measurement cable, attenuator, and DC block.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	BONY0010-1	Signature <i>Christopher Heintzelman</i>	
		Out Pwr (dBm)	Antenna Gain (dBi)
BLE/GFSK 1 Mbps Low Channel, 2402 MHz		5.977	4
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz		5.589	4
BLE/GFSK 1 Mbps High Channel, 2480 MHz		5.235	4
		EIRP (dBm)	EIRP Limit (dBm)
		9.977	36
		9.589	36
		9.235	36
			Result
			Pass
			Pass
			Pass

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

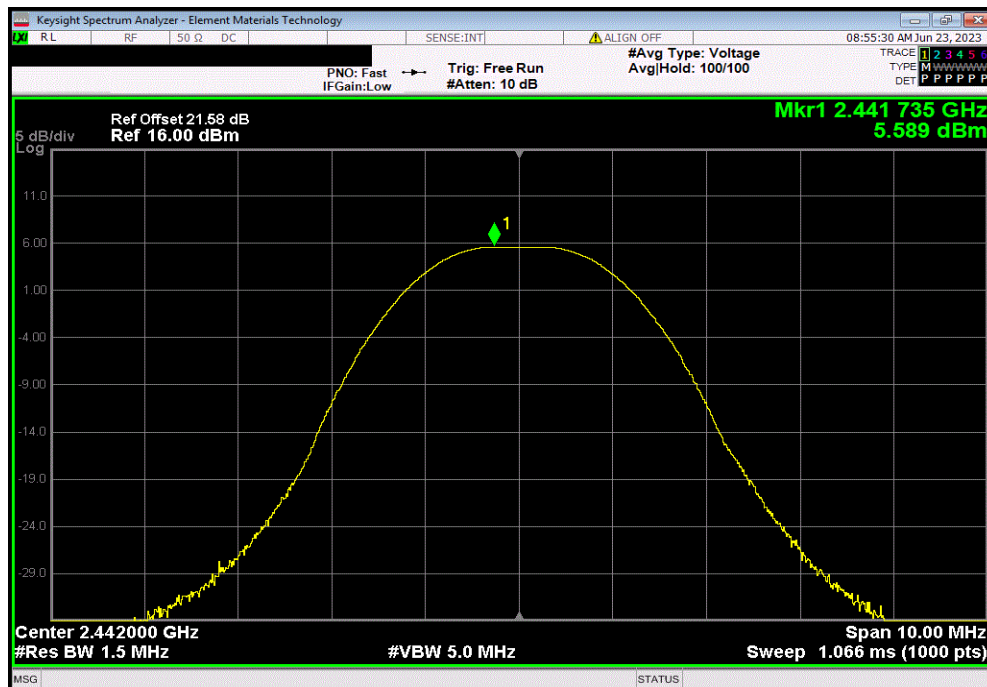


TbTx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result	
	5.977	4	9.977	36	Pass	



BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result	
	5.589	4	9.589	36	Pass	

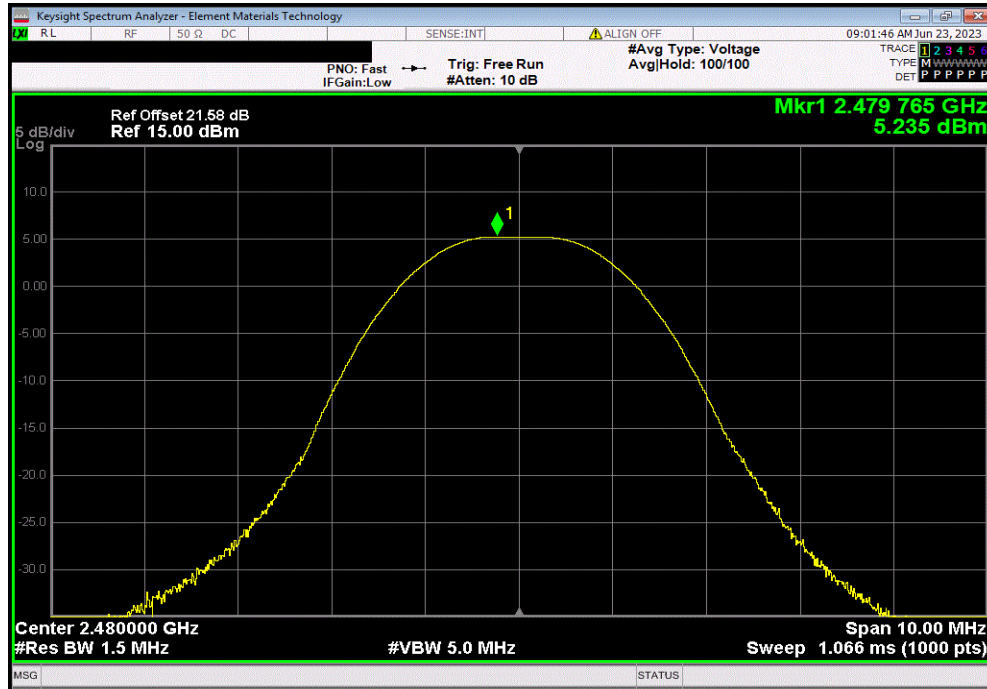


EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)



TbTx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps High Channel, 2480 MHz					
Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result	
5.235	4	9.235	36	Pass	



POWER SPECTRAL DENSITY

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Attenuator	S.M. Electronics	SA26B-20	TZP	2022-11-06	2023-11-06
Block - DC	Fairview Microwave	SD3379	AMZ	2022-11-06	2023-11-06
Cable	Micro-Coax	D150A-1-0720-200	MNL	2022-09-10	2023-09-10
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	2023-02-02	2024-02-02
Generator - Signal	Keysight	N5182B	TEV	2021-04-27	2024-04-27

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The maximum power spectral density measurements was measured using the channels and modes as called out on the following data sheets.

Per the procedure outlined in ANSI C63.10 the peak power spectral density was measured in a 3 kHz RBW.

POWER SPECTRAL DENSITY



TSTx 2022.06.03.0 XMR 2023.02.14.0

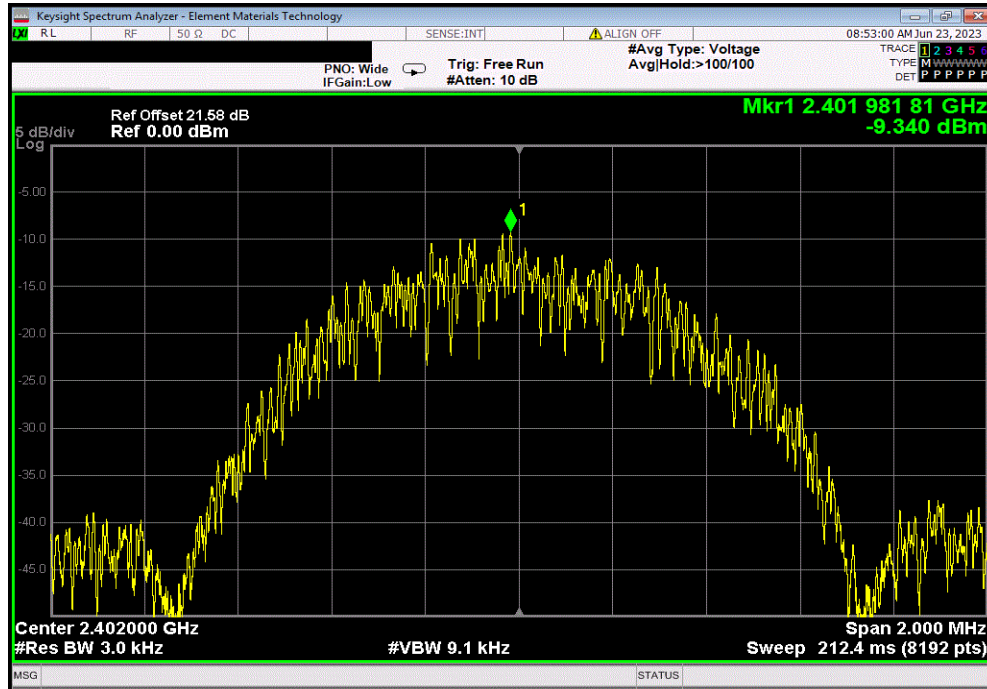
EUT: Sprayer Controls, Model: 143-7443		Work Order: BONY0010	
Serial Number: 22100009		Date: 06/22/2023	
Customer: Boss Snowplow A Division of the Toro Company		Temperature: 22.7°C	
Attendees: Derek Meyer		Humidity: 49.8%	
Project: None		Barometric Pres.: 1017 mbar	
Tested by: Christopher Heintzelman	Power: Battery (12VDC)	Job Site: MN11	
TEST SPECIFICATIONS			
FCC 15.247:2023		Test Method	
RSS-247 Issue 2:2017		ANSI C63.10:2013	
RSS-Gen Issue 5:2018+A1:2019+A2:2021		ANSI C63.10:2013	
COMMENTS			
Reference level offset includes measurement cable, attenuator, and DC block.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	BONY0010-1	Signature <i>Christopher Heintzelman</i>	
		Value dBm/3kHz	Limit < dBm/3kHz
BLE/GFSK 1 Mbps Low Channel, 2402 MHz		-9.34	8
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz		-9.864	8
BLE/GFSK 1 Mbps High Channel, 2480 MHz		-10.145	8
			Results
			Pass
			Pass
			Pass

POWER SPECTRAL DENSITY

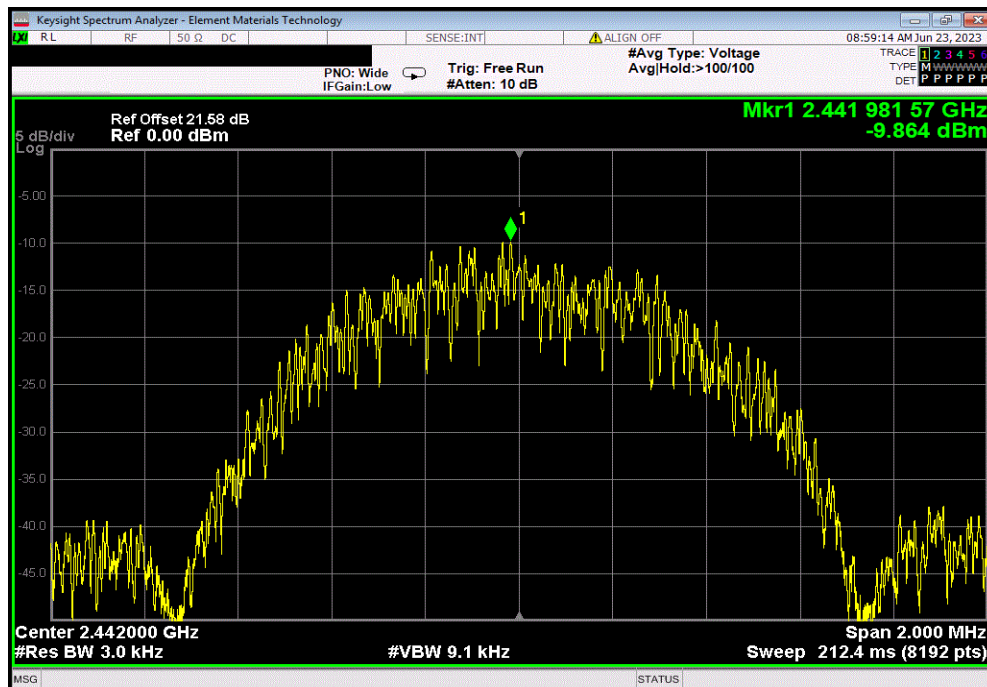


TbTx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
	Value	Limit	Results			
	dBm/3kHz	< dBm/3kHz				
	-9.34	8	Pass			



BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
	Value	Limit	Results			
	dBm/3kHz	< dBm/3kHz				
	-9.864	8	Pass			



BLE/GFSK 1 Mbps High Channel, 2480 MHz							
					Value	Limit	
					dBm/3kHz	< dBm/3kHz	Results
					-10.145	8	Pass



BAND EDGE COMPLIANCE

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Attenuator	S.M. Electronics	SA26B-20	TZP	2022-11-06	2023-11-06
Block - DC	Fairview Microwave	SD3379	AMZ	2022-11-06	2023-11-06
Cable	Micro-Coax	D150A-1-0720-200	MNL	2022-09-10	2023-09-10
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	2023-02-02	2024-02-02
Generator - Signal	Keysight	N5182B	TEV	2021-04-27	2024-04-27

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The spurious RF conducted emissions at the edges of the authorized bands were measured with the EUT set to low and high transmit frequencies in each available band. The channels closest to the band edges were selected. The EUT was transmitting at the data rate(s) listed in the datasheet.

The spectrum was scanned below the lower band edge and above the higher band edge.

BAND EDGE COMPLIANCE



TSTx 2022.06.03.0 XMR 2023.02.14.0

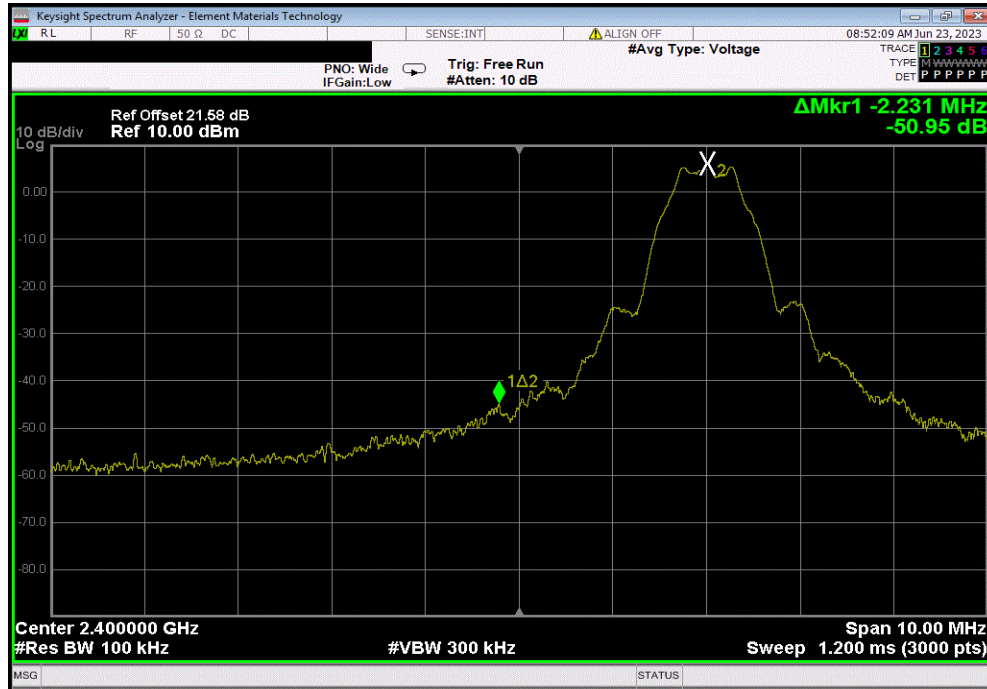
EUT: Sprayer Controls, Model: 143-7443		Work Order: BONY0010		
Serial Number: 22100009		Date: 06/22/2023		
Customer: Boss Snowplow A Division of the Toro Company		Temperature: 22.3°C		
Attendees: Derek Meyer		Humidity: 50.9%		
Project: None		Barometric Pres.: 1017 mbar		
Tested by: Christopher Heintzelman	Power: Battery (12VDC)	Job Site: MN11		
TEST SPECIFICATIONS				
FCC 15.247:2023		ANSI C63.10:2013		
RSS-247 Issue 2:2017		ANSI C63.10:2013		
RSS-Gen Issue 5:2018+A1:2019+A2:2021		ANSI C63.10:2013		
COMMENTS				
Reference level offset includes measurement cable, attenuator, and DC block.				
DEVIATIONS FROM TEST STANDARD				
None				
Configuration #	BONY0010-1	Signature <i>Christopher Heintzelman</i>		
		Value (dBc)	Limit ≤ (dBc) Result	
BLE/GFSK 1 Mbps Low Channel, 2402 MHz		-50.96	-20	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz		-58.56	-20	Pass

BAND EDGE COMPLIANCE

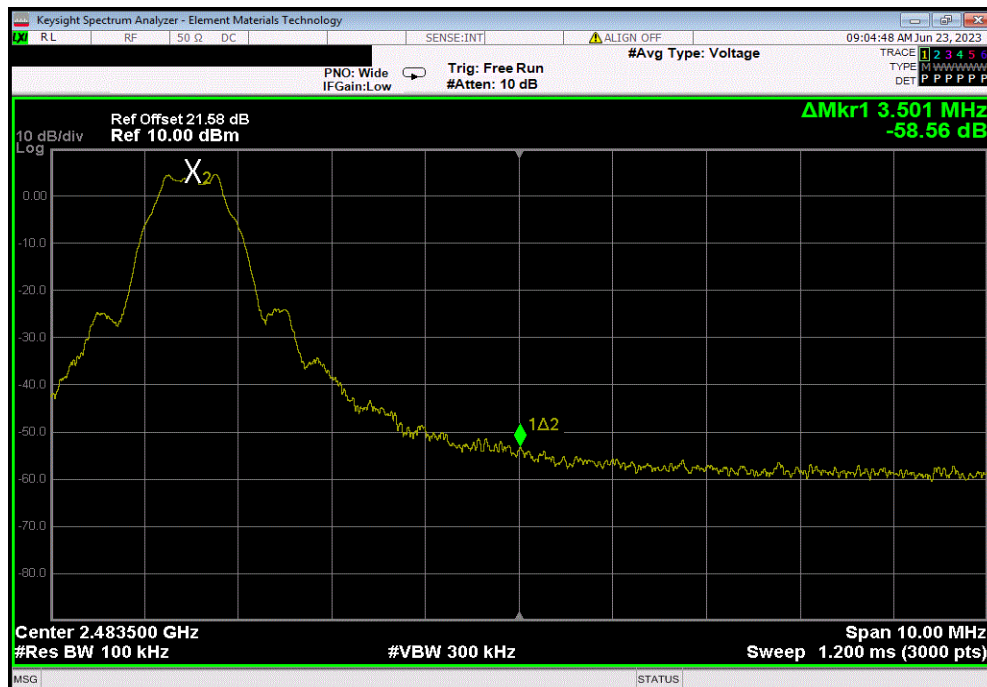


TbTtx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-50.96	-20	Pass



BLE/GFSK 1 Mbps High Channel, 2480 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-58.56	-20	Pass



SPURIOUS RADIATED EMISSIONS

TEST DESCRIPTION

The highest gain antenna of each type to be used with the EUT was tested. The EUT was configured for the required transmit frequencies and the modes as showed in the data sheets.

For each configuration, the spectrum was scanned throughout the specified range as part of the exploratory investigation of the emissions. These “pre-scans” are not included in the report. Final measurements on individual emissions were then made and included in this test report.

The individual emissions from the EUT were maximized by rotating the EUT on a turntable, adjusting the position of the EUT and EUT antenna in three orthogonal axis if required, and adjusting the measurement antenna height and polarization (per ANSI C63.10). A preamp and high pass filter (and notch filter) were used for this test in order to provide sufficient measurement sensitivity.

Measurements were made with the required detectors and annotated on the data for each individual point using the following annotation:

QP = Quasi-Peak Detector
PK = Peak Detector
AV = RMS Detector

Measurements were made to satisfy the specific requirements of the test specification for out of band emissions as well as the restricted band requirements.

If there are no detectable emissions above the noise floor, the data included may show noise floor measurements for reference only.

Measurements within 2 MHz of the allowable band may have been taken using the integration method from ANSI C63.10 clause 11.13.3. This procedure uses the channel power feature of the spectrum analyzer to integrate the power of the emission within a 1 MHz bandwidth.

Where the radio test software does not provide for a duty cycle at continuous transmit conditions (> 98%) and the RMS (power average) measurements were made across the on and off times of the EUT transmissions, a duty cycle correction is added to the measurements using the formula of $10 \cdot \log(1/dc)$.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Antenna - Double Ridge	ETS Lindgren	3115	AJQ	2023-02-02	2025-02-02
Cable	ESM Cable Corp.	Double Ridge Guide Horn Cables	MNI	2023-01-14	2024-01-14
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVT	2023-01-14	2024-01-14
Filter - High Pass	Micro-Tronics	HPM50108	LFM	2022-08-27	2023-08-27
Antenna - Standard Gain	ETS Lindgren	3160-07	AXP	NCR	NCR
Cable	ESM Cable Corp.	Standard Gain Horn Cables	MNJ	2023-01-14	2024-01-14
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVV	2023-01-14	2024-01-14
Antenna - Biconilog	ETS Lindgren	3142D	AXO	2021-09-14	2023-09-14
Cable	ESM Cable Corp.	Bilog Cables	MNH	2022-10-08	2023-10-08
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AVO	2022-10-08	2023-10-08
Filter - Low Pass	Micro-Tronics	LPM50004	LFK	2022-08-27	2023-08-27
Filter - Low Pass	Micro-Tronics	LPM50003	LFJ	2022-08-27	2023-08-27
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	2023-02-06	2024-02-06
Filter - Band Pass/Notch	K&L Microwave	3TNF-500/1000-N/N	HGS	2022-06-22	2023-06-22
Attenuator	Fairview Microwave	SA18E-20	TWZ	2022-08-27	2023-08-27
Filter - High Pass	Micro-Tronics	HPM50111	LFN	2022-08-27	2023-08-27
Antenna - Double Ridge	ETS Lindgren	3115	AIB	2022-09-01	2024-09-01
Cable	Element	Double Ridge Guide Horn Cables	MNV	2023-01-31	2024-01-31
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVX	2023-01-31	2024-01-31
Filter - High Pass	Micro-Tronics	HPM50111	HFM	2022-09-10	2023-09-10

SPURIOUS RADIATED EMISSIONS

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFG	2022-05-18	2023-05-18
Attenuator	Coaxicom	3910-20	AXY	2022-09-10	2023-09-10
Antenna - Biconilog	Ametek	CBL 6141B	AYS	2021-03-09	2023-03-09
Cable	Element	Biconilog Cable	MNX	2023-01-31	2024-01-31
Amplifier - Pre-Amplifier	Miteq	AM-1064-9079 and SA18E-10	AOO	2023-01-31	2024-01-31
Filter - Low Pass	Micro-Tronics	LPM50004	HGG	2022-09-10	2023-09-10
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFL	2022-03-22	2023-03-22
Antenna - Standard Gain	ETS Lindgren	3160-09	AHG	NCR	NCR
Cable	ESM Cable Corp.	TTBJ141 KMKM-72	MNP	2022-09-10	2023-09-10
Amplifier - Pre-Amplifier	Miteq	JSD4-18002600-26-8P	APU	2022-09-10	2023-09-10

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	5.2 dB	-5.2 dB

FREQUENCY RANGE INVESTIGATED

80 MHz TO 26 GHz

POWER INVESTIGATED

Battery (12VDC)

CONFIGURATIONS INVESTIGATED

BONY0001-3

MODES INVESTIGATED

Transmitting BLE Low and High Chs, (2402 and 2480 MHz), 1 Mbps
Transmitting BLE Low, Mid, and High Chs (2404, 2442, and 2480 MHz), 1 Mbps

SPURIOUS RADIATED EMISSIONS

EUT:	Sprayer Assembly (two variants)	Work Order:	BONY0001
Serial Number:	22100008	Date:	2023-02-28
Customer:	Boss Snowplow A Division of the Toro Company	Temperature:	24.9°C
Attendees:	Derek Meyer	Relative Humidity:	21.5%
Customer Project:	None	Bar. Pressure (PMSL):	1009 mb
Tested By:	Marcelo Aguayo	Job Site:	MN05
Power:	Battery (12VDC)	Configuration:	BONY0001-3

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2023	ANSI C63.10:2013

TEST PARAMETERS

Run #:	34	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)
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COMMENTS

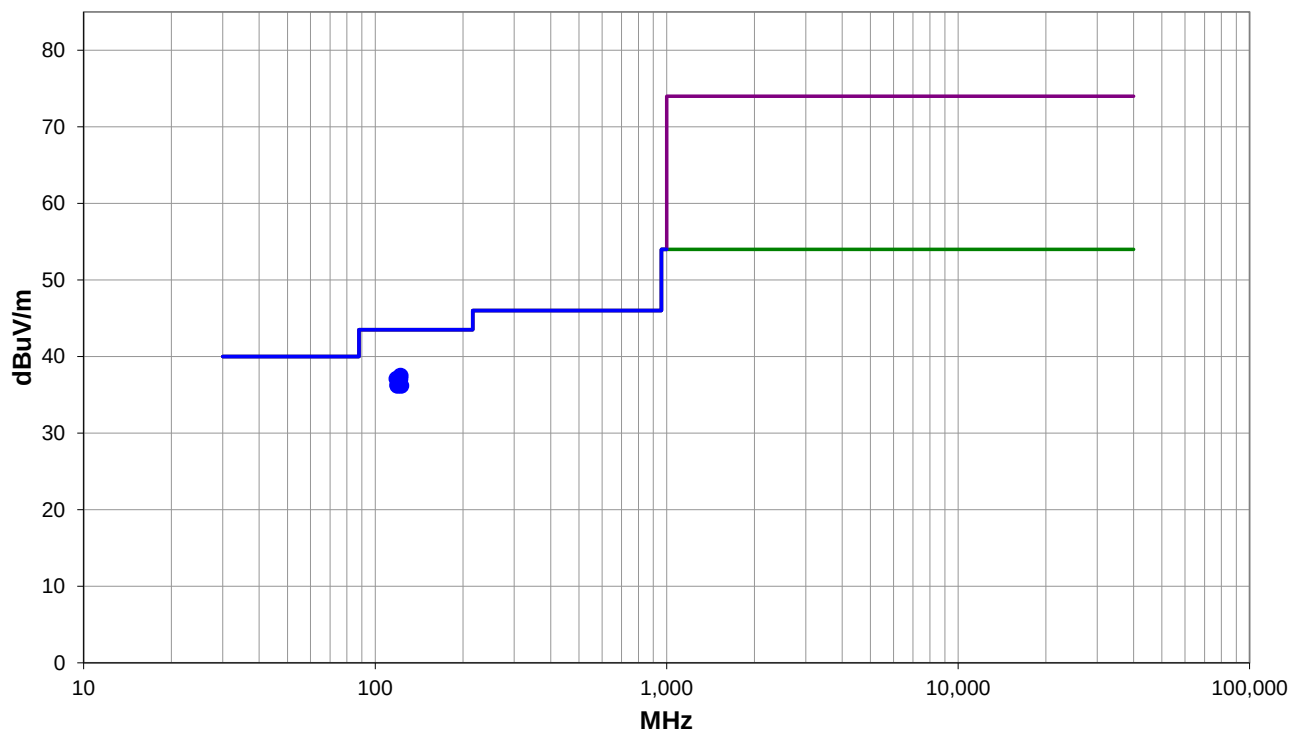
None

EUT OPERATING MODES

Transmitting BLE Low, Mid and High Chs (2402, 2442, 2480 MHz) 1 Mbps
--

DEVIATIONS FROM TEST STANDARD

None



Run #: 34

■ PK ◆ AV ● QP

SPURIOUS RADIATED EMISSIONS

RESULTS - Run #34

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
122.081	47.3	-9.8	2.8	65.0	3.0	0.0	Horz	QP	0.0	37.5	43.5	-6.0
118.281	46.8	-9.7	2.7	247.9	3.0	0.0	Horz	QP	0.0	37.1	43.5	-6.4
122.003	46.9	-9.8	2.8	51.0	3.0	0.0	Horz	QP	0.0	37.1	43.5	-6.4
119.222	46.0	-9.7	1.0	181.0	3.0	0.0	Vert	QP	0.0	36.3	43.5	-7.2
119.178	45.9	-9.7	1.0	164.9	3.0	0.0	Vert	QP	0.0	36.2	43.5	-7.3
122.804	46.1	-9.9	2.8	37.9	3.0	0.0	Horz	QP	0.0	36.2	43.5	-7.3

CONCLUSION

Pass



Tested By

SPURIOUS RADIATED EMISSIONS

EUT:	Sprayer Assembly	Work Order:	BONY0001
Serial Number:	22100008	Date:	2022-09-28
Customer:	Boss Snowplow A Division of the Toro Company	Temperature:	22.4°C
Attendees:	Derek Meyer	Relative Humidity:	29.6%
Customer Project:	None	Bar. Pressure (PMSL):	1035 mb
Tested By:	Christopher Heintzelman	Job Site:	MN05
Power:	Battery (12VDC)	Configuration:	BONY0001-3

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2022	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

TEST PARAMETERS

Run #:	29	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)
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COMMENTS

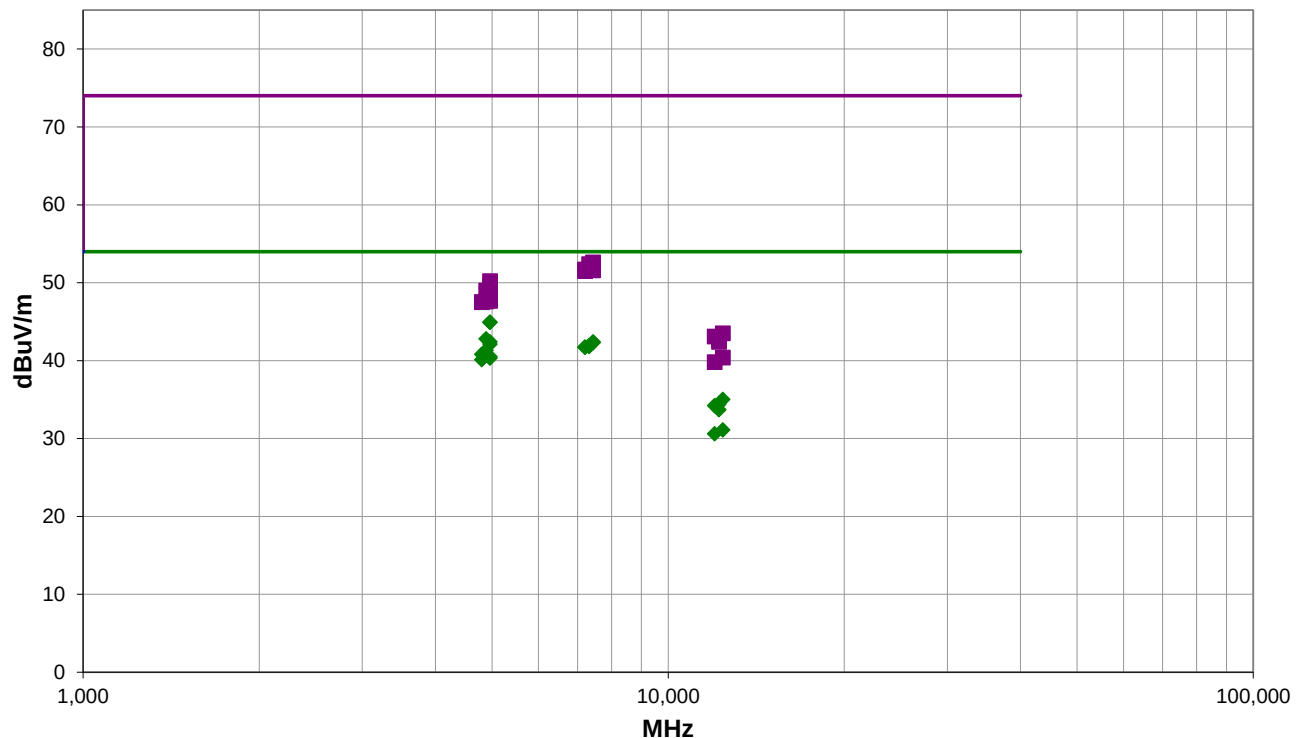
BT antenna cable is bulky, will not make a standard cable bundle. Test mode duty cycle is 84%, 0.8 dB duty cycle correction factor (DCCF) added from DCCF = $10 * \log(1/\text{duty cycle})$.

EUT OPERATING MODES

Transmitting BLE Low, Mid, and High Chs (2404, 2442, and 2480 MHz), 1 Mbps only.

DEVIATIONS FROM TEST STANDARD

None



Run #: 29

■ PK ◆ AV ● QP

SPURIOUS RADIATED EMISSIONS

RESULTS - Run #29

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor	External Attenuation (dB)	Polarity/Transducer	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
4959.975	39.6	4.5	2.5	178.0	0.8	0.0	Horz	AV	0.0	44.9	54.0	-9.1	EUT Horz, High Ch, 1 Mbps
4960.050	39.6	4.5	1.4	312.9	0.8	0.0	Horz	AV	0.0	44.9	54.0	-9.1	EUT Vert, High Ch, 1 Mbps
4884.117	37.9	4.1	1.5	200.9	0.8	0.0	Vert	AV	0.0	42.8	54.0	-11.2	EUT On Side, Mid Ch, 1 Mbps
4960.150	37.1	4.5	1.3	19.9	0.8	0.0	Horz	AV	0.0	42.4	54.0	-11.6	EUT On Side, High Ch, 1 Mbps
7442.450	29.8	11.8	1.5	311.9	0.8	0.0	Horz	AV	0.0	42.4	54.0	-11.6	EUT Horz, High Ch, 1 Mbps
7440.958	29.7	11.8	1.5	307.9	0.8	0.0	Vert	AV	0.0	42.3	54.0	-11.7	EUT On Side, High Ch, 1 Mbps
4960.017	36.8	4.5	1.8	196.9	0.8	0.0	Vert	AV	0.0	42.1	54.0	-11.9	EUT On Side, High Ch, 1 Mbps
7325.242	29.8	11.3	1.5	47.0	0.8	0.0	Horz	AV	0.0	41.9	54.0	-12.1	EUT Horz, Mid Ch, 1 Mbps
7326.567	29.7	11.3	1.5	286.0	0.8	0.0	Vert	AV	0.0	41.8	54.0	-12.2	EUT On Side, Mid Ch, 1 Mbps
7208.283	30.1	10.8	1.5	351.0	0.8	0.0	Horz	AV	0.0	41.7	54.0	-12.3	EUT Horz, Low Ch, 1 Mbps
7207.133	30.1	10.8	1.5	58.0	0.8	0.0	Vert	AV	0.0	41.7	54.0	-12.3	EUT On Side, Low Ch, 1 Mbps
4884.025	36.4	4.1	1.5	181.0	0.8	0.0	Horz	AV	0.0	41.3	54.0	-12.7	EUT Horz, Mid Ch, 1 Mbps
4803.992	36.3	3.7	2.1	311.9	0.8	0.0	Vert	AV	0.0	40.8	54.0	-13.2	EUT On Side, Low Ch, 1 Mbps
4960.133	35.2	4.5	1.5	109.0	0.8	0.0	Vert	AV	0.0	40.5	54.0	-13.5	EUT Horz, High Ch, 1 Mbps
4959.975	35.0	4.5	1.5	203.0	0.8	0.0	Vert	AV	0.0	40.3	54.0	-13.7	EUT Vert, High Ch, 1 Mbps
4804.008	35.6	3.7	3.0	99.0	0.8	0.0	Horz	AV	0.0	40.1	54.0	-13.9	EUT Horz, Low Ch, 1 Mbps
12399.110	33.3	0.9	1.5	16.0	0.8	0.0	Vert	AV	0.0	35.0	54.0	-19.0	EUT On Side, High Ch, 1 Mbps
12211.020	32.3	1.3	1.5	19.0	0.8	0.0	Vert	AV	0.0	34.4	54.0	-19.6	EUT On Side, Mid Ch, 1 Mbps
12011.150	32.9	0.5	1.4	360.0	0.8	0.0	Vert	AV	0.0	34.2	54.0	-19.8	EUT On Side, Low Ch, 1 Mbps
12209.100	31.6	1.3	3.6	66.9	0.8	0.0	Horz	AV	0.0	33.7	54.0	-20.3	EUT Horz, Mid Ch, 1 Mbps
7437.783	40.8	11.8	1.5	311.9	0.0	0.0	Horz	PK	0.0	52.6	74.0	-21.4	EUT Horz, High Ch, 1 Mbps
7327.250	41.1	11.3	1.5	286.0	0.0	0.0	Vert	PK	0.0	52.4	74.0	-21.6	EUT On Side, Mid Ch, 1 Mbps
7324.025	40.4	11.3	1.5	47.0	0.0	0.0	Horz	PK	0.0	51.7	74.0	-22.3	EUT Horz, Mid Ch, 1 Mbps
7206.542	40.9	10.8	1.5	351.0	0.0	0.0	Horz	PK	0.0	51.7	74.0	-22.3	EUT Horz, Low Ch, 1 Mbps
7437.733	39.8	11.8	1.5	307.9	0.0	0.0	Vert	PK	0.0	51.6	74.0	-22.4	EUT On Side, High Ch, 1 Mbps
7208.083	40.7	10.8	1.5	58.0	0.0	0.0	Vert	PK	0.0	51.5	74.0	-22.5	EUT On Side, Low Ch, 1 Mbps
12399.000	29.4	0.9	3.7	72.0	0.8	0.0	Horz	AV	0.0	31.1	54.0	-22.9	EUT Horz, High Ch, 1 Mbps
12011.230	29.3	0.5	1.5	-0.1	0.8	0.0	Horz	AV	0.0	30.6	54.0	-23.4	EUT Horz, Low Ch, 1 Mbps
4960.092	45.7	4.5	2.5	178.0	0.0	0.0	Horz	PK	0.0	50.2	74.0	-23.8	EUT Horz, High Ch, 1 Mbps
4959.592	45.1	4.5	1.4	312.9	0.0	0.0	Horz	PK	0.0	49.6	74.0	-24.4	EUT Vert, High Ch, 1 Mbps
4883.517	44.9	4.1	1.5	200.9	0.0	0.0	Vert	PK	0.0	49.0	74.0	-25.0	EUT On Side, Mid Ch, 1 Mbps
4959.867	44.1	4.5	1.3	19.9	0.0	0.0	Horz	PK	0.0	48.6	74.0	-25.4	EUT On Side, High Ch, 1 Mbps
4960.733	43.7	4.5	1.8	196.9	0.0	0.0	Vert	PK	0.0	48.2	74.0	-25.8	EUT On Side, High Ch, 1 Mbps
4959.742	43.2	4.5	1.5	109.0	0.0	0.0	Vert	PK	0.0	47.7	74.0	-26.3	EUT Horz, High Ch, 1 Mbps
4959.750	43.2	4.5	1.5	203.0	0.0	0.0	Vert	PK	0.0	47.7	74.0	-26.3	EUT Vert, High Ch, 1 Mbps
4884.525	43.5	4.1	1.5	181.0	0.0	0.0	Horz	PK	0.0	47.6	74.0	-26.4	EUT Horz, Mid Ch, 1 Mbps
4803.208	43.8	3.7	3.0	99.0	0.0	0.0	Horz	PK	0.0	47.5	74.0	-26.5	EUT Horz, Low Ch, 1 Mbps
4803.700	43.8	3.7	2.1	311.9	0.0	0.0	Vert	PK	0.0	47.5	74.0	-26.5	EUT On Side, Low Ch, 1 Mbps
12399.230	42.6	0.9	1.5	16.0	0.0	0.0	Vert	PK	0.0	43.5	74.0	-30.5	EUT On Side, High Ch, 1 Mbps
12011.340	42.6	0.5	1.4	360.0	0.0	0.0	Vert	PK	0.0	43.1	74.0	-30.9	EUT On Side, Low Ch, 1 Mbps

SPURIOUS RADIATED EMISSIONS

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor	External Attenuation (dB)	Polarity/Transducer	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
12209.240	41.4	1.3	1.5	19.0	0.0	0.0	Vert	PK	0.0	42.7	74.0	-31.3	EUT On Side, Mid Ch, 1 Mbps
12211.370	41.1	1.3	3.6	66.9	0.0	0.0	Horz	PK	0.0	42.4	74.0	-31.6	EUT Horz, Mid Ch, 1 Mbps
12398.920	39.5	0.9	3.7	72.0	0.0	0.0	Horz	PK	0.0	40.4	74.0	-33.6	EUT Horz, High Ch, 1 Mbps
12010.820	39.3	0.5	1.5	-0.1	0.0	0.0	Horz	PK	0.0	39.8	74.0	-34.2	EUT Horz, Low Ch, 1 Mbps

CONCLUSION

Pass



Tested By

SPURIOUS RADIATED EMISSIONS

EUT:	Sprayer Assembly	Work Order:	BONY0001
Serial Number:	22100008	Date:	2022-09-28
Customer:	Boss Snowplow A Division of the Toro Company	Temperature:	21.9°C
Attendees:	Derek Meyer	Relative Humidity:	32.6%
Customer Project:	None	Bar. Pressure (PMSL):	1031 mb
Tested By:	Chris Patterson	Job Site:	MN05
Power:	Battery (12VDC)	Configuration:	BONY0001-3

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2022	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

TEST PARAMETERS

Run #:	33	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)
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COMMENTS

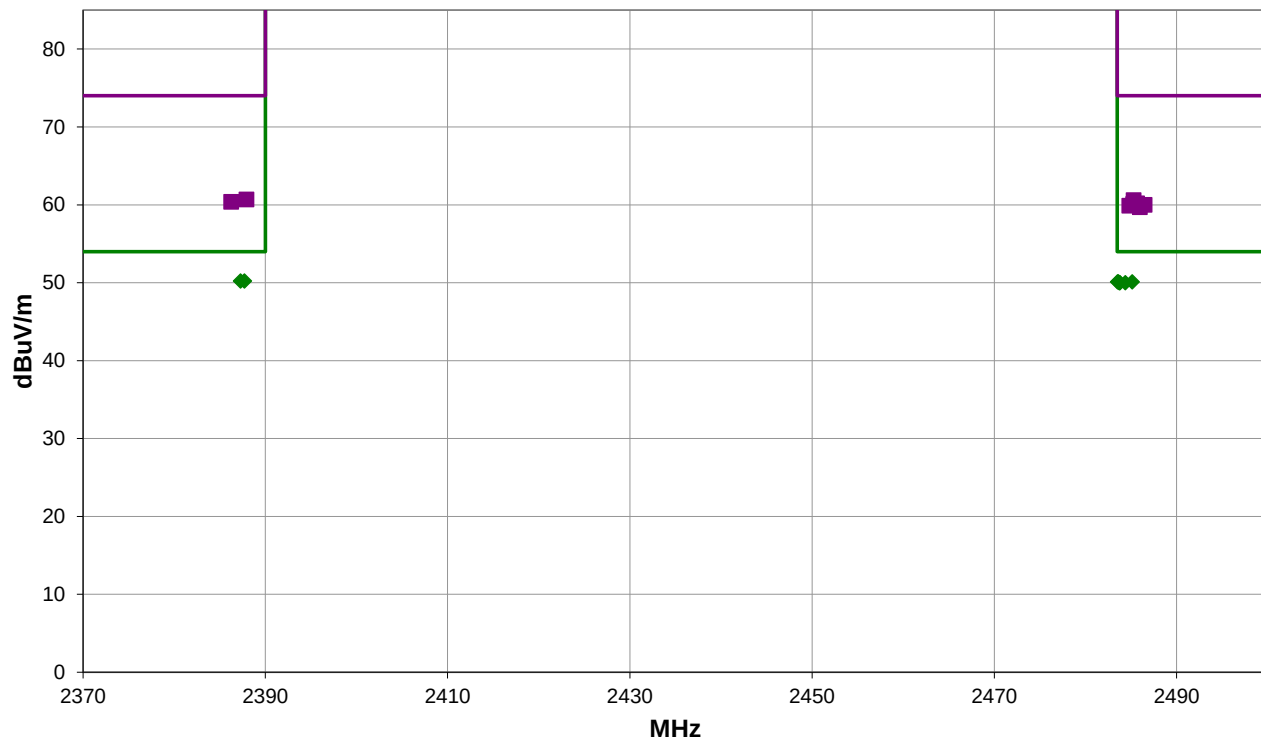
BT antenna cable is bulky, will not make a standard cable bundle. Test mode duty cycle is 84%, 0.8 dB duty cycle correction factor (DCCF) added from DCCF = $10 * \log(1/\text{duty cycle})$.

EUT OPERATING MODES

Transmitting BLE Low and High Chs, (2402 and 2480 MHz), 1 Mbps

DEVIATIONS FROM TEST STANDARD

None



Run #: 33

■ PK ◆ AV ● QP

SPURIOUS RADIATED EMISSIONS

RESULTS - Run #33

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor	External Attenuation (dB)	Polarity/ Transducer	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2387.700	30.8	-1.4	2.4	138.0	0.8	20.0	Horz	AV	0.0	50.2	54.0	-3.8	EUT On Side, Low Ch, 1 Mbps
2387.275	30.8	-1.4	1.5	297.9	0.8	20.0	Vert	AV	0.0	50.2	54.0	-3.8	EUT On Side, Low Ch, 1 Mbps
2483.550	31.5	-2.2	1.5	243.0	0.8	20.0	Horz	AV	0.0	50.1	54.0	-3.9	EUT Horz, High Ch, 1 Mbps
2485.150	31.5	-2.2	1.3	293.0	0.8	20.0	Horz	AV	0.0	50.1	54.0	-3.9	EUT On Side, High Ch, 1 Mbps
2483.633	31.5	-2.2	1.6	9.9	0.8	20.0	Vert	AV	0.0	50.1	54.0	-3.9	EUT On Side, High Ch, 1 Mbps
2484.383	31.4	-2.2	1.5	26.0	0.8	20.0	Vert	AV	0.0	50.0	54.0	-4.0	EUT Horz, High Ch, 1 Mbps
2483.792	31.4	-2.2	2.9	228.9	0.8	20.0	Vert	AV	0.0	50.0	54.0	-4.0	EUT Vert, High Ch, 1 Mbps
2483.742	31.4	-2.2	1.5	271.0	0.8	20.0	Horz	AV	0.0	50.0	54.0	-4.0	EUT Vert, High Ch, 1 Mbps
2387.917	42.1	-1.4	1.5	297.9	0.0	20.0	Vert	PK	0.0	60.7	74.0	-13.3	EUT On Side, Low Ch, 1 Mbps
2485.300	42.8	-2.2	1.5	243.0	0.0	20.0	Horz	PK	0.0	60.6	74.0	-13.4	EUT Horz, High Ch, 1 Mbps
2386.250	41.8	-1.4	2.4	138.0	0.0	20.0	Horz	PK	0.0	60.4	74.0	-13.6	EUT On Side, Low Ch, 1 Mbps
2485.667	42.4	-2.2	1.3	293.0	0.0	20.0	Horz	PK	0.0	60.2	74.0	-13.8	EUT On Side, High Ch, 1 Mbps
2485.233	42.3	-2.2	2.9	228.9	0.0	20.0	Vert	PK	0.0	60.1	74.0	-13.9	EUT Vert, High Ch, 1 Mbps
2486.500	42.2	-2.2	1.5	271.0	0.0	20.0	Horz	PK	0.0	60.0	74.0	-14.0	EUT Vert, High Ch, 1 Mbps
2484.808	42.1	-2.2	1.6	9.9	0.0	20.0	Vert	PK	0.0	59.9	74.0	-14.1	EUT On Side, High Ch, 1 Mbps
2485.967	41.9	-2.2	1.5	26.0	0.0	20.0	Vert	PK	0.0	59.7	74.0	-14.3	EUT Horz, High Ch, 1 Mbps

CONCLUSION

Pass



Tested By

SPURIOUS CONDUCTED EMISSIONS

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Attenuator	S.M. Electronics	SA26B-20	TZP	2022-11-06	2023-11-06
Block - DC	Fairview Microwave	SD3379	AMZ	2022-11-06	2023-11-06
Cable	Micro-Coax	D150A-1-0720-200	MNL	2022-09-10	2023-09-10
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	2023-02-02	2024-02-02
Generator - Signal	Keysight	N5182B	TEV	2021-04-27	2024-04-27

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The spurious RF conducted emissions were measured with the EUT set to low, medium and high transmit frequencies. The EUT was transmitting at the data rate(s) listed in the datasheet. For each transmit frequency, the fundamental was measured with a 100 kHz resolution bandwidth and the highest value was recorded. The rest of the spectrum was then measured with a 100 kHz resolution bandwidth and the highest value was found. The difference between the value found on the fundamental and the rest of the spectrum was compared against the limit to determine compliance.

The reference level offset for the fundamental screen capture was based on a measured value of the loss between the spectrum analyzer and the EUT which was verified at the time of test. The remaining screen capture(s) use an internal transducer factor on the analyzer to correct the displayed trace based on the cable loss over frequency. The reference level offset for the additional screen capture(s) is then based on the expected attenuator value and any other losses.

Fundamental Offset = Ref Lvl Offset showing measured composite factor of all losses

Remaining Screen capture(s) Offset = "Internal" cable loss factor not shown on screen capture + Ref Lvl Offset showing expected attenuator value and any other losses

SPURIOUS CONDUCTED EMISSIONS



TMTx 2022.06.03.0 XMR 2023.02.14.0

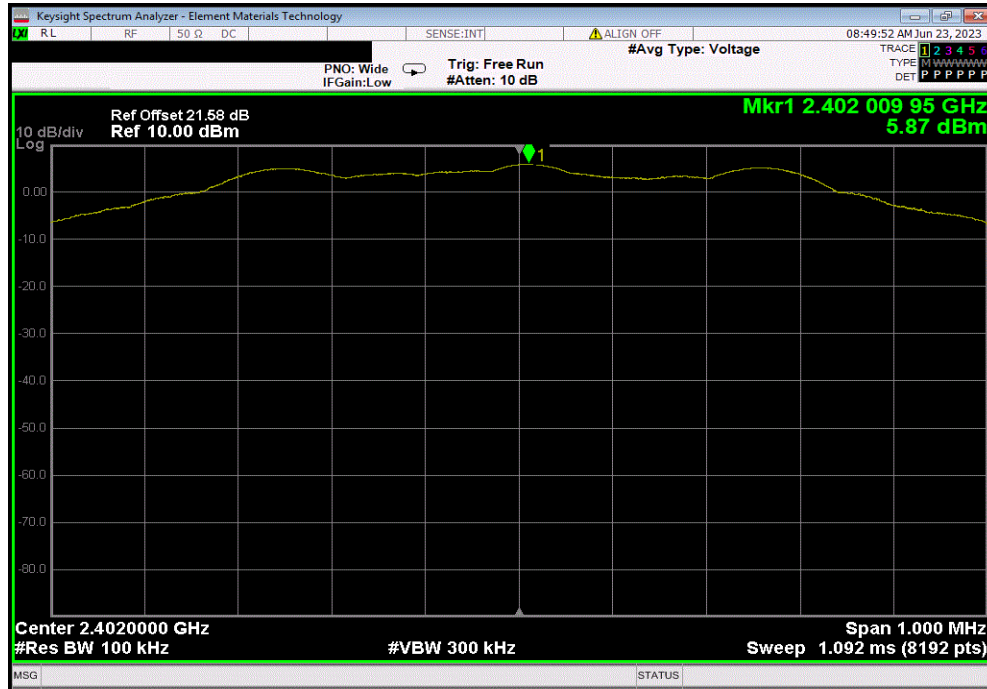
EUT: Sprayer Controls, Model: 143-7443		Work Order: BONY0010				
Serial Number: 22100009		Date: 06/22/2023				
Customer: Boss Snowplow A Division of the Toro Company		Temperature: 22.7°C				
Attendees: Derek Meyer		Humidity: 49.7%				
Project: None		Barometric Pres.: 1017 mbar				
Tested by: Christopher Heintzelman	Power: Battery (12VDC)	Job Site: MN11				
TEST SPECIFICATIONS						
FCC 15.247:2023		Test Method				
RSS-247 Issue 2:2017		ANSI C63.10:2013				
RSS-Gen Issue 5:2018+A1:2019+A2:2021		ANSI C63.10:2013				
COMMENTS						
None						
DEVIATIONS FROM TEST STANDARD						
None						
Configuration #	BONY0010-1	Signature <i>Christopher Heintzelman</i>				
		Frequency Range	Measured Freq (MHz)			
			Max Value (dBc)			
			Limit ≤ (dBc)			
			Result			
BLE/GFSK 1 Mbps Low Channel, 2402 MHz		Fundamental	2402.01	N/A	N/A	
BLE/GFSK 1 Mbps Low Channel, 2402 MHz		30 MHz - 12.5 GHz	8106.35	-59.8	-20	Pass
BLE/GFSK 1 Mbps Low Channel, 2402 MHz		12.5 GHz - 25 GHz	23881.39	-54.67	-20	Pass
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz		Fundamental	2442.01	N/A	N/A	N/A
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz		30 MHz - 12.5 GHz	9771.85	-59.31	-20	Pass
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz		12.5 GHz - 25 GHz	24096.57	-54.6	-20	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz		Fundamental	2480.01	N/A	N/A	N/A
BLE/GFSK 1 Mbps High Channel, 2480 MHz		30 MHz - 12.5 GHz	1729	-55.92	-20	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz		12.5 GHz - 25 GHz	24174.4	-54.67	-20	Pass

SPURIOUS CONDUCTED EMISSIONS

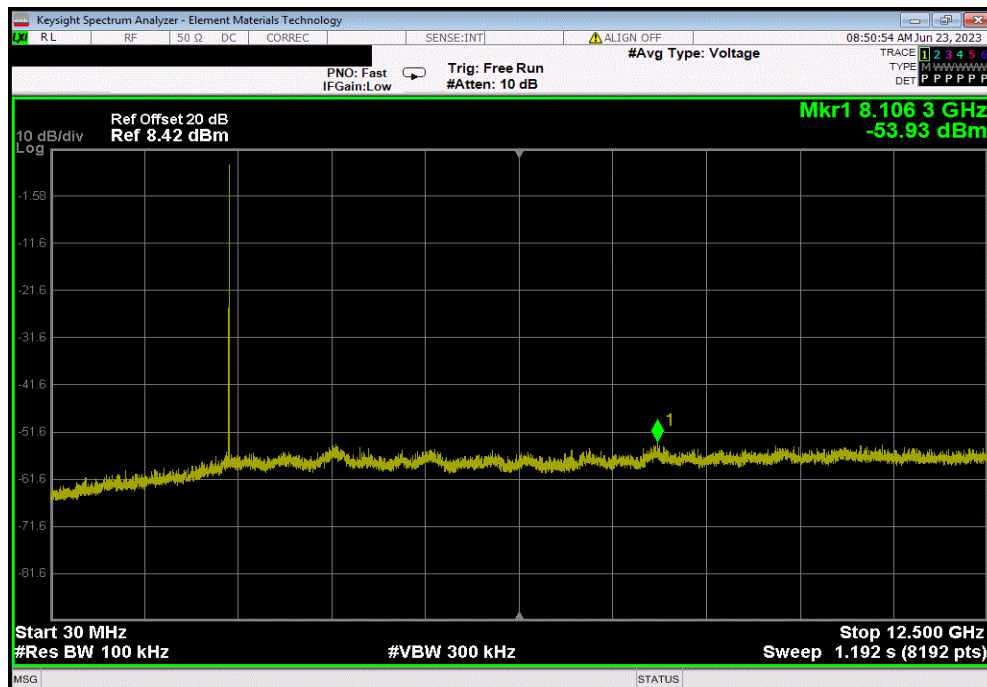


TbTtx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps Low Channel, 2402 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
Fundamental	2402.01	N/A	N/A	N/A	



BLE/GFSK 1 Mbps Low Channel, 2402 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
30 MHz - 12.5 GHz	8106.35	-59.8	-20	Pass	

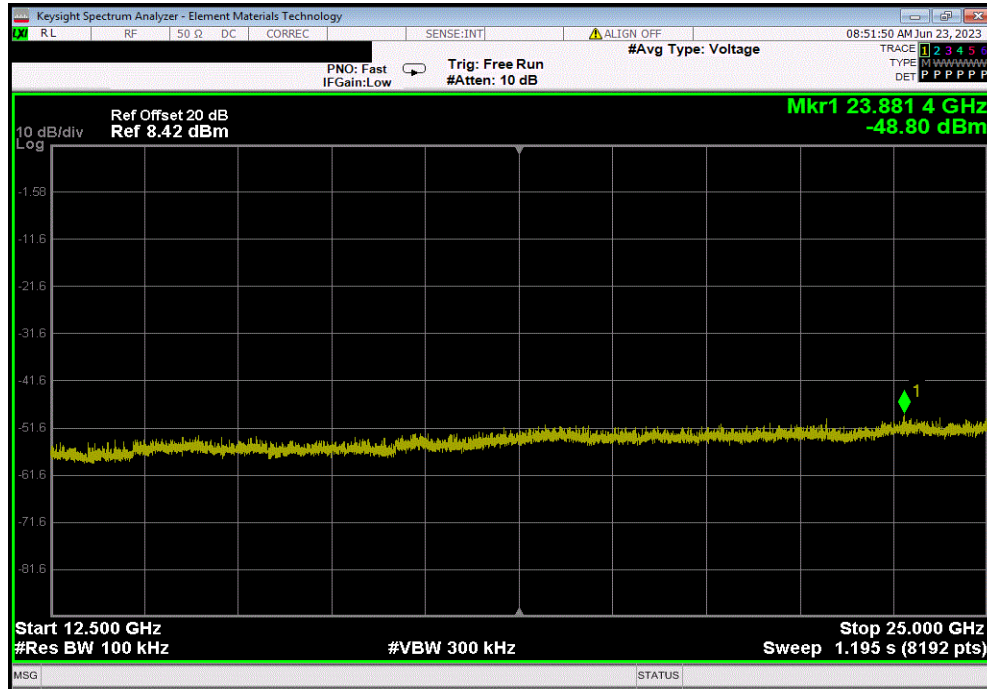


SPURIOUS CONDUCTED EMISSIONS

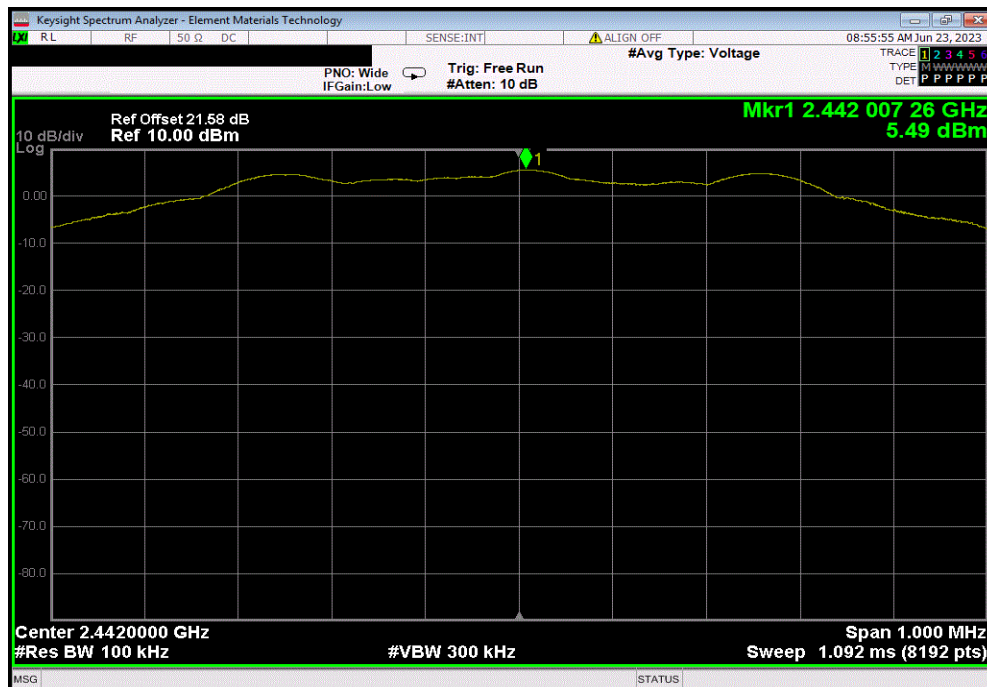


TbTtx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps Low Channel, 2402 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
12.5 GHz - 25 GHz	23881.39	-54.67	-20	Pass	



BLE/GFSK 1 Mbps Mid Channel, 2442 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
Fundamental	2442.01	N/A	N/A	N/A	

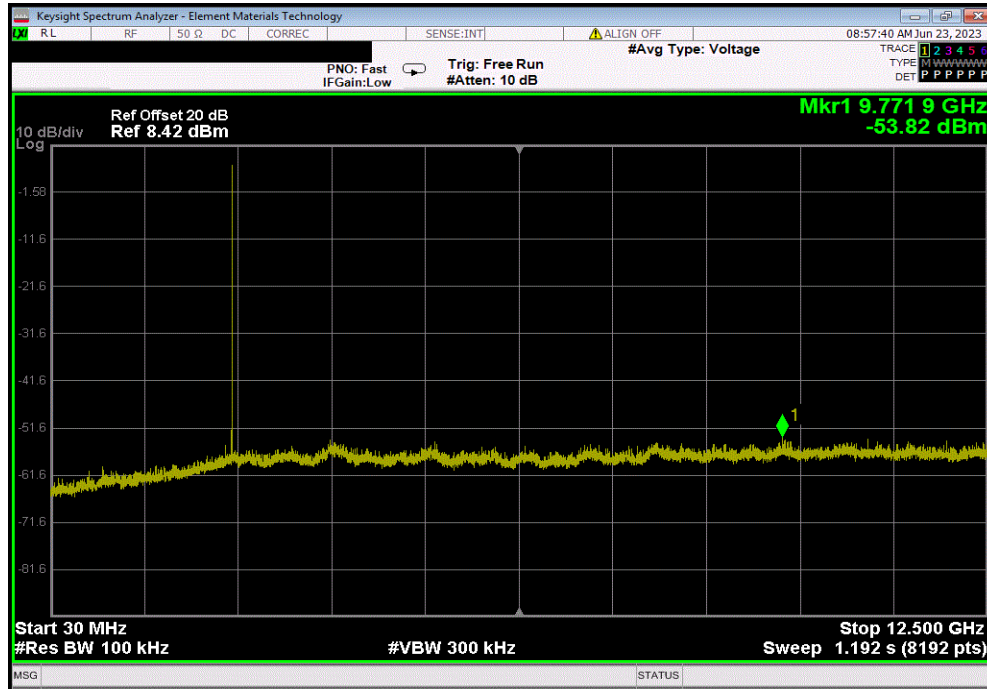


SPURIOUS CONDUCTED EMISSIONS

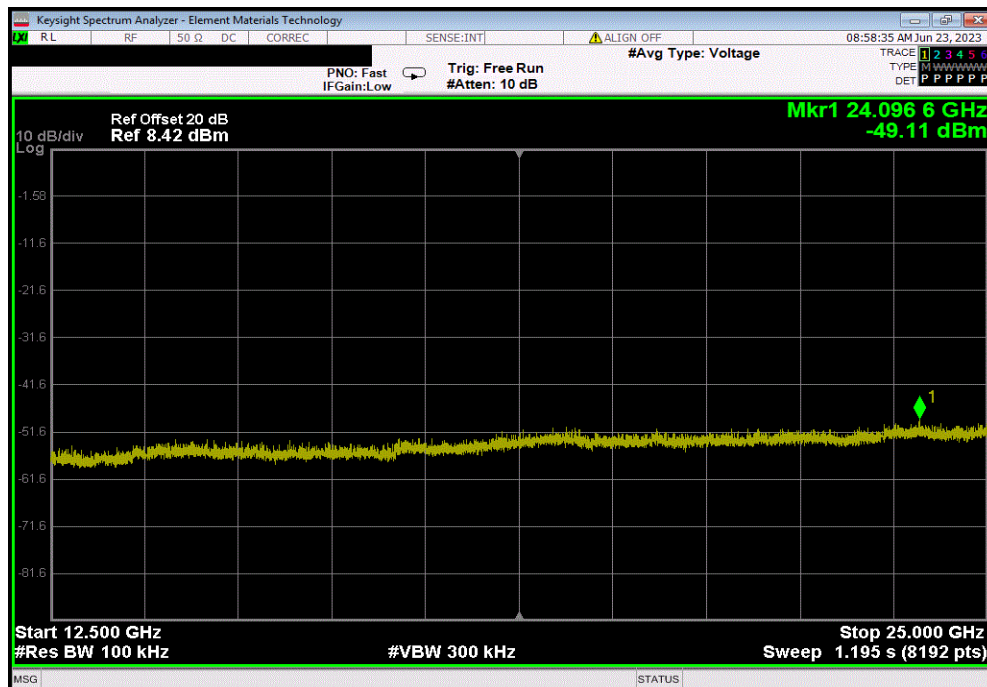


TbTtx 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps Mid Channel, 2442 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
30 MHz - 12.5 GHz	9771.85	-59.31	-20	Pass	



BLE/GFSK 1 Mbps Mid Channel, 2442 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
12.5 GHz - 25 GHz	24096.57	-54.6	-20	Pass	

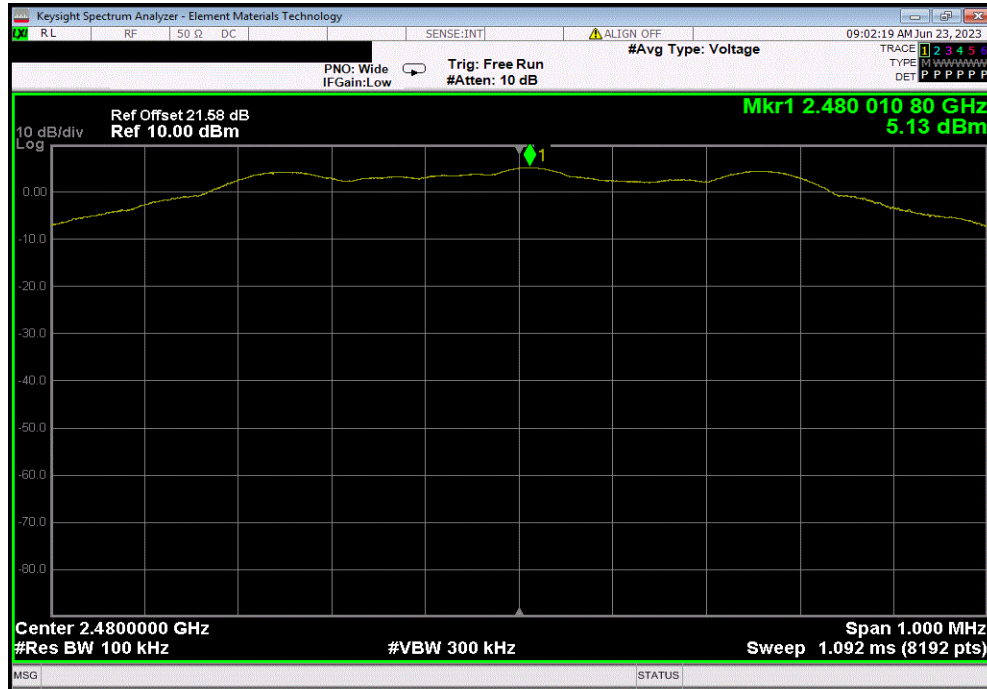


SPURIOUS CONDUCTED EMISSIONS

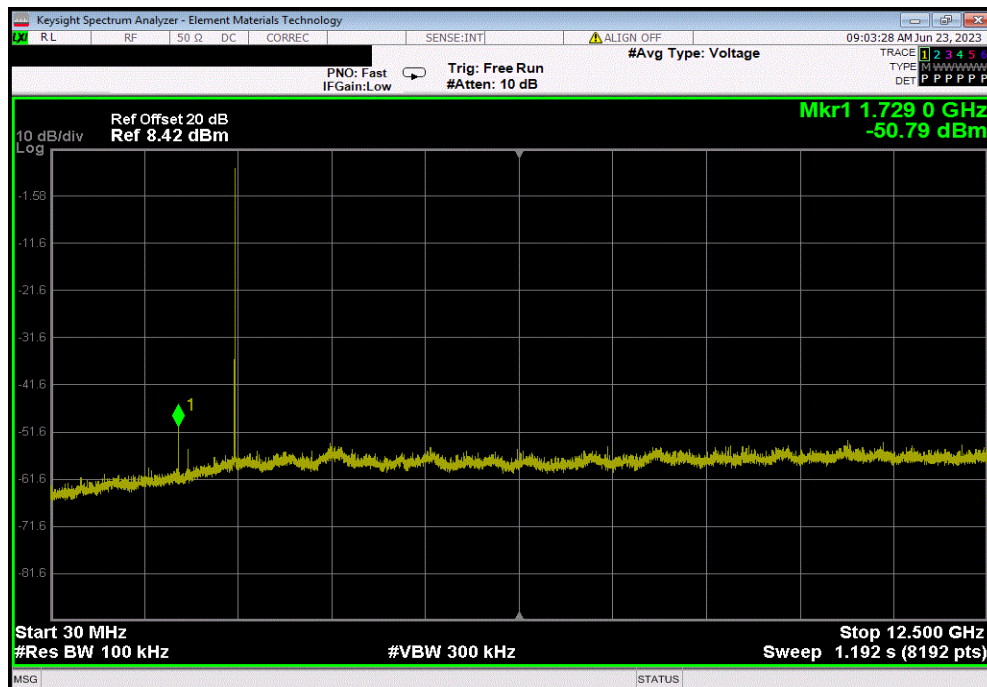


TbTtX 2022.06.03.0 XMt 2023.02.14.0

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result		
Fundamental	2480.01	N/A	N/A	N/A		



BLE/GFSK 1 Mbps High Channel, 2480 MHz						
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result		
30 MHz - 12.5 GHz	1729	-55.92	-20	Pass		

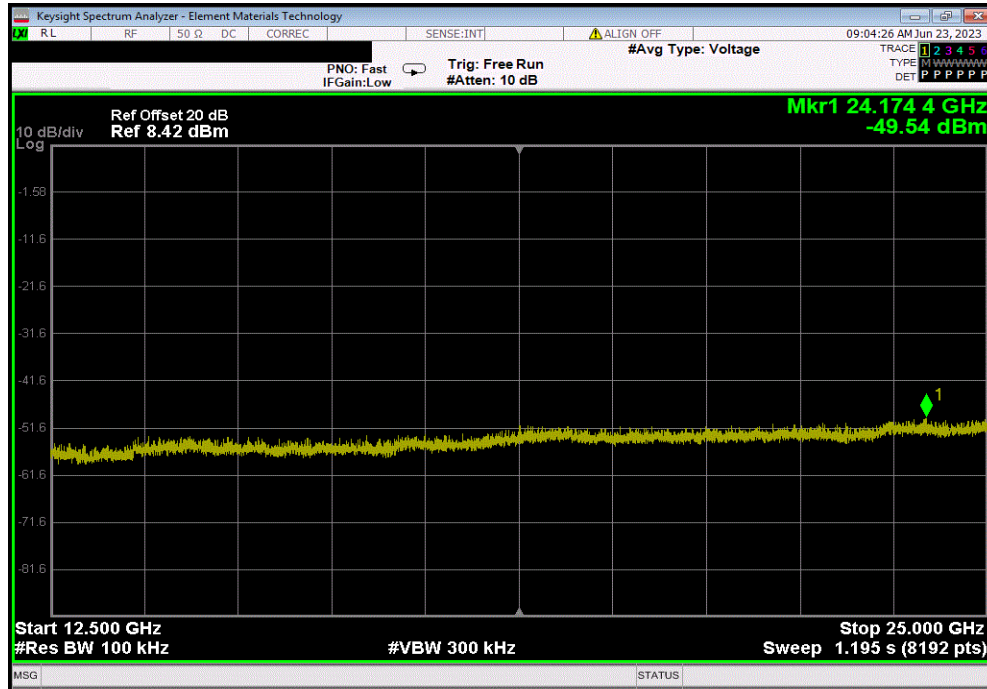


SPURIOUS CONDUCTED EMISSIONS



TbTx 2022.06.03.0 XMR 2023.02.14.0

BLE/GFSK 1 Mbps High Channel, 2480 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
12.5 GHz - 25 GHz	24174.4	-54.67	-20	Pass	



End of Test Report