COMPLIANCE WORLDWIDE INC.
TEST REPORT 272-18

In Accordance with the Requirements of

FCC PART 15.247, SUBPART C
Innovation, Science and Economic Development Canada
RSS-247, ISSUE 2

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Issued to

ShotTracker
7220 W, Frontage Road
Merriam, KS 66203
(240) 305-9193

for the

Ball Sensor Model: S8R1
2.4 GHz Bluetooth Low Energy Radio

FCC ID: 2AC4B-S8R1
IC: 12327A-S8R1

Report Issued on June 29, 2018

Tested by

Brian F. Breault

Reviewed by

Larry K. Stillings

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1. Scope

This test report certifies that the ShotTracker Ball Sensor 2.4 GHz Bluetooth Low Energy Radio, as tested, meets the FCC Part 15, Subpart C and ISED Canada RSS-247, Issue 2 requirements. The scope of this test report is limited to the test sample provided by the client, only in as much as that sample represents other production units. If any significant changes are made to the unit, the changes shall be evaluated and a retest may be required.

2. Product Details

2.1. Manufacturer:	ShotTracker
2.2. Model Number:	S8R1
2.3. Serial Number:	Pre-production
2.4. Description:	Basketball Location Sensor
2.5. Power Source:	DC 3.7 Volts, 110 mAh Lithium Ion battery
2.6. Hardware Revision:	Rev C
2.7. Software Version:	2.1.320
2.8. Modulation Type:	GFSK
2.9. Operating Frequency:	2.4 GHz to 2.4835 GHz Nominal
2.10. EMC Modifications:	None

3. Product Configuration

3.1. Operational Characteristics & Software

Hardware Setup:

Two samples were supplied for test:

- The first was an unmodified sample suitable for radiated emissions measurements.
- The second utilized a short pigtail with an SMA adapter in place of the integrated antenna. This configuration provided a means of directly connecting the device under test to the measurement equipment.

The two samples were otherwise identical.

Software Setup:

The device used the conventional Nordic command set for setting the required channels, modulation, etc. as required for testing. The command set was embedded in a C program which was compiled and uploaded to the device under test. Commands were sent over a Bluetooth link to the device as necessary to change the operating characteristics of the device.

The device under test was rotated through three orthogonal axes in accordance with ANSI C63.10, section 5.10.1, as required for a hand held or body worn device.

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3. Product Configuration (continued)

3.2. EUT Hardware

Manufacturer	Model/Part # / Options	Serial Number	Input Voltage	Freq (Hz)	Description/Function
ShotTracker	S8R1	Pre production	3.7	VDC	Basketball Location Sensor [1]

[1] Two separate units were used for radiated and conducted test measurements.

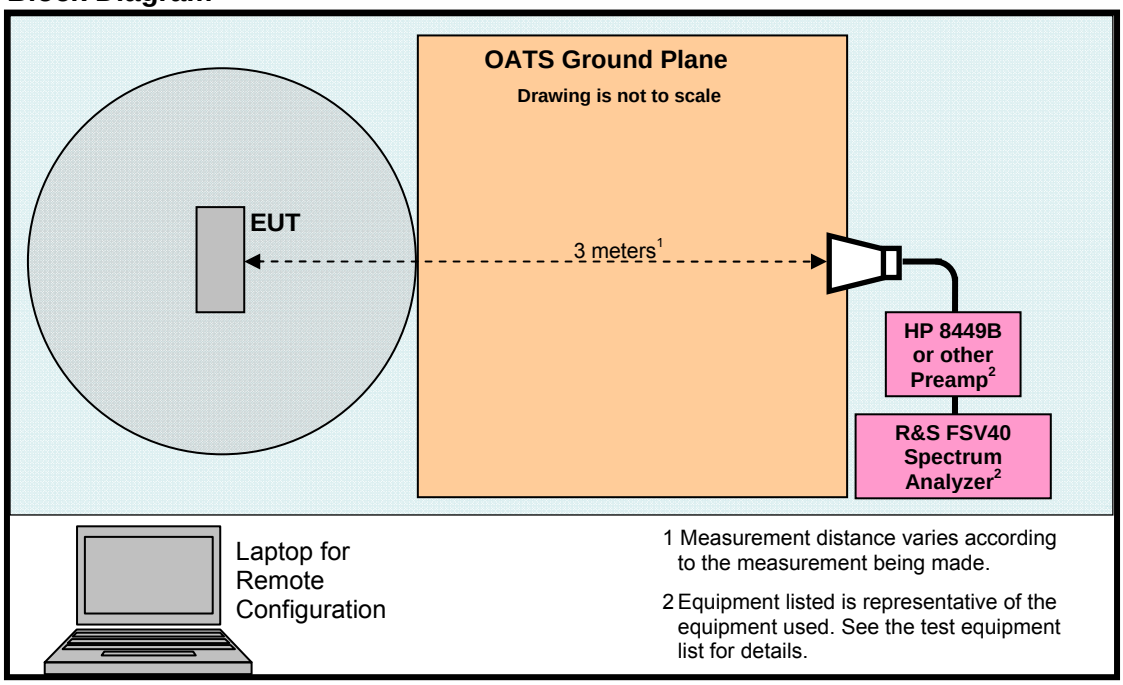
3.3. EUT Cables/Transducers

Cable Type	Length	Shield	From	To
None				

3.4. Support Equipment

Manufacturer	Model/Part # / Options	Serial Number	Input Voltage	Freq (Hz)	Description/Function
Apple	MacBook Pro (Retina, 15-inch, Late 2013)	C02MJ1S1FD59	120	60	Laptop used for configuration

3.5. Block Diagram



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4. Measurements Parameters

4.1. Measurement Equipment Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due	Interval
EMI Test Receiver, 9kHz - 7GHz [1]	Rohde & Schwarz	ESR7	101156	7/23/2018	3 Years
Spectrum Analyzer 20 Hz – 40 GHz [2]	Rohde & Schwarz	FSV40	100899	7/23/2018	3 Years
Spectrum Analyzer, 9 kHz - 40 GHz [3]	Rohde & Schwarz	FSVR40	100909	5/3/2019	2 Years
Spectrum Analyzer, 2 Hz - 26 GHz [4]	Rohde & Schwarz	FSW26	102057	12/7/2018	2 Years
EMI Receiver	Hewlett Packard	8546A	3650A00360	12/6/2018	3 Years
Passive Loop Antenna, 9 kHz to 30 MHz	EMCO	6512	9309-1139	10/26/2018	2 Years
Biconilog Antenna, 30 MHz to 2 GHz	Sunol Sciences	JB1	A050913	6/3/2019	2 Years
Horn Antenna 1 to 18 GHz	ETS-Lindgren	3117	00143292	2/22/2019	3 Years
Horn Antenna, 18 GHz to 40 GHz	Com-Power	AH-840	3075	10/11/2018	2 Years
Preamplifier, 1 GHz to 26.5 GHz	Hewlett Packard	8449B	3008A00329	7/22/2018	3 Years
LISN 50 ohm 50 µH, 9 kHz to 30 MHz	EMCO	3825/2	9109-1860	11/17/2018	1 Year
2.4 GHz Band Reject Filter	Micro-Tronics	BRM50702	150	1/23/2019	1 Year
EMI Receiver, 9 kHz to 6.5 GHz	Hewlett Packard	8546A	3330A00115	12/4/2018	2 Years
Digital Barometer	Control Company	4195	ID236	10/8/2017	2 Years

[1] ESR7 Firmware revision: V3.36, SP2 Date installed: 11/02/2017 Previous V3.36, installed 05/16/2017.
[2] FSV40 Firmware revision: V2.30 SP4, Date installed: 05/04/2016 Previous V2.30 SP1, installed 10/22/2014.
[3] FSVR40 Firmware revision: V2.23 SP1, Date installed: 08/19/2016 Previous V2.23, installed 10/20/2014.
[4] FSW26 Firmware revision: V2.80, Date installed: 10/28/2017 Previous V2.61, installed 04/04/2017.

4.2. Measurement Software

Manufacturer	Software Description	Title or Model #	Rev.	Report Sections
Compliance Worldwide	Test Report Generation Software	Test Report Generator	1.0	Not required for this device

4.3. Measurement & Equipment Setup

Test Dates:	6/19/2018 – 6/22/2018
Test Engineer:	Brian Breault
Normal Site Temperature (15 - 35°C):	19.0
Relative Humidity (20 -75%RH):	31
Frequency Range:	30 kHz to 40 GHz
Measurement Distance:	3, 1.5, 1 and 0.3 Meters
EMI Receiver IF Bandwidth:	200 Hz - 10 kHz to 150 kHz 9 kHz - 150 kHz to 30 MHz 120 kHz - 30 MHz to 1 GHz 1 MHz - Above 1 GHz
EMI Receiver Average Bandwidth:	1 kHz - 10 kHz to 150 kHz 30 kHz - 150 kHz to 30 MHz 300 kHz - 30 MHz to 1 GHz 3 MHz - Above 1 GHz
Detector Function:	Peak, QP - 10 kHz to 1 GHz Peak, Avg - Above 1 GHz Unless otherwise specified.

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4. Measurements Parameters (continued)

4.4. Measurement Procedures

Test measurements were made in accordance FCC Part 15.247: Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, 5725 - 5850 MHz, and 24.0 - 24.25 GHz.

The measurement procedures in this report are in accordance with ANSI C63.10-2013: *American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices*. FCC OET Publication Number KDB 558074 D01 v04, *Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247*, dated April 5, 2017, was also referenced for the test procedures used to generate the data in this report. All references to FCC OET publication number 558074 refer to this version of the publication.

All radiated emissions measurements include correction factors for antenna, cables, preamp and attenuators, if used.

4.5. Measurement Uncertainty

The following uncertainties are expressed for an expansion/coverage factor of K=2.

RF Frequency	$\pm$ 1x10^{-8}
Radiated Emission of Transmitter	$\pm$ 4.55 dB
Radiated Emission of Receiver	$\pm$ 4.55 dB
Temperature	$\pm$ 0.91^{o} C
Humidity	$\pm$ 5%

5. Choice of Equipment for Test Suits

5.1 Choice of Model

This test report is based on the one test sample supplied by the manufacturer. These units are reported by the manufacturer to be equivalent to the production units.

5.2 Presentation

The test samples were tested complete with all required ancillary equipment. Refer to Section 3 of this report for product equipment configuration.

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5. Choice of Equipment for Test Suits (continued)

5.3 Choice of Operating Frequencies

The device under test, as tested, operates on 40 channels, from channels 0 to 39 in the 2.4 GHz band.

In accordance with ANSI C63.10-2013, section 5.6, and FCC Part 15.31 (m), the choice of operating frequencies selected for the testing detailed in this report are as follows:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
37	2402	9	2422	18	2442	28	2462
0	2404	10	2424	19	2444	29	2464
1	2406	38	2426	20	2446	30	2466
2	2408	11	2428	21	2448	31	2468
3	2410	12	2430	22	2450	32	2470
4	2412	13	2432	23	2452	33	2472
5	2414	14	2434	24	2454	34	2474
6	2416	15	2436	25	2456	35	2476
7	2418	16	2438	26	2458	36	2478
8	2420	17	2440	27	2460	39	2480

5.4 Mode of Operation

Modulation type : GFSK
Payload pattern : PRB9
Frame Length : 37 bytes (0x25)
Power Setting : Max (+4 dBm) (Maximum)

For band edge measurements (section 7.6), the DTS bandwidth measurements were taken into consideration for the worst case examples.

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6. Measurement Summary

Test Requirement	FCC Rule Reference	ISED RSS-247 Issue 2 Section	Test Report Section	Result
Antenna Requirement	15.203	RSS-GEN Issue 4 §6.8	7.1	Compliant
Minimum DTS Bandwidth	15.247 (a) (2)	5.2 a	7.2	Compliant
Maximum Peak Conducted Output Power	15.247 (b) (1)	5.4 d	7.3	Compliant
Operation with directional antenna gains greater than 6 dBi	15.247 (b) (4)	5.4 f	7.4	Compliant
Spurious Radiated Emissions	15.247 (d)	RSS-GEN Issue 4	7.5	Compliant
Spurious Radiated Emissions (> GHz) - Harmonic Measurements	15.247 (d)	RSS-GEN Issue 4		Compliant
Lower and Upper Band Edges	15.247 (d)	RSS-GEN Issue 4	7.6	Compliant
Emissions in Non-restricted Frequency Bands	15.247(e)	5.5	7.7	Compliant
Peak Power Spectral Density	15.247(e)	5.2 b	7.8	Compliant
AC Power Line Conducted Emissions	15.207	RSS-GEN Issue 4 §8.8	----	Not Required
Duty Cycle	15.207	RSS-GEN Issue 4 §9	7.9	Compliant
Public Exposure to Radio Frequency Energy Levels	1.1307 (b) (1)	RSS-GEN Issue 4 §5.5 RSS 102	7.10	Compliant

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7. Measurement Data

7.1. Antenna Requirement (15.203)

Requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section.

Results: The device under test utilizes a wire antenna soldered to the PC board. It is not user accessible.

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7. Measurement Data

7.2. Minimum DTS Bandwidth

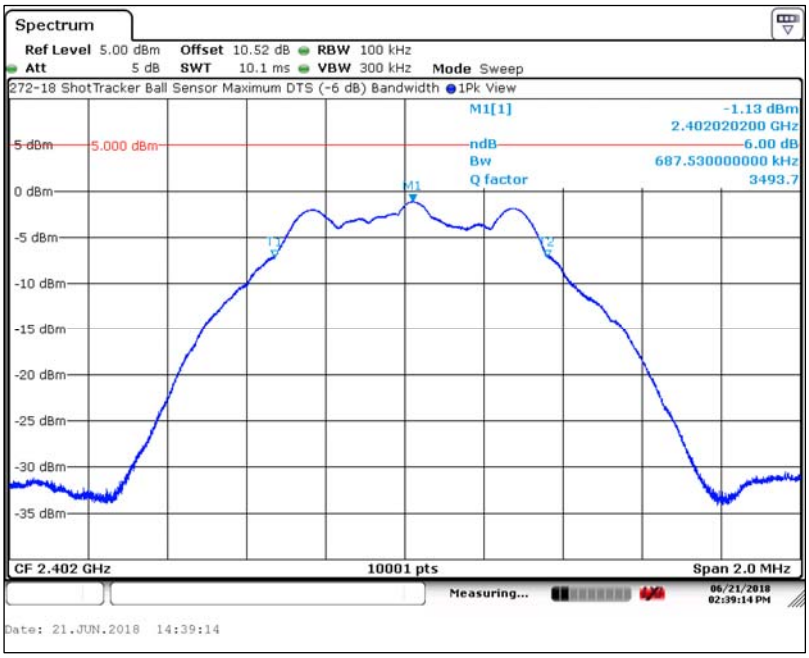
Requirement: (15.247 (a) (2)
Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Procedure: This test was performed in accordance with the procedure detailed in FCC OET publication number 558074, Section 8.1 Option 1, DTS (6 dB) Channel Bandwidth.

Results: The device under test meets the minimum 500 kHz DTS (6 dB) bandwidth requirement.

Channel	Frequency (MHz)	-6 dB Bandwidth 1 Mbps (kHz)	-6 dB Bandwidth 2 Mbps (kHz)	Result
0	2402	687.53	>500	Compliant
19	2440	686.53	>500	Compliant
39	2480	689.73	>500	Compliant

7.2.1. Low Channel – 37, 2402 MHz



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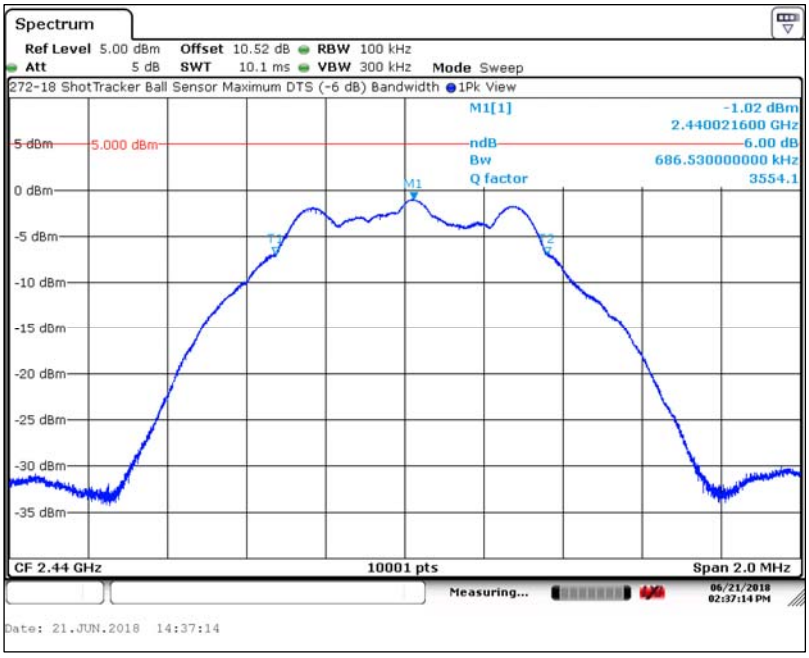
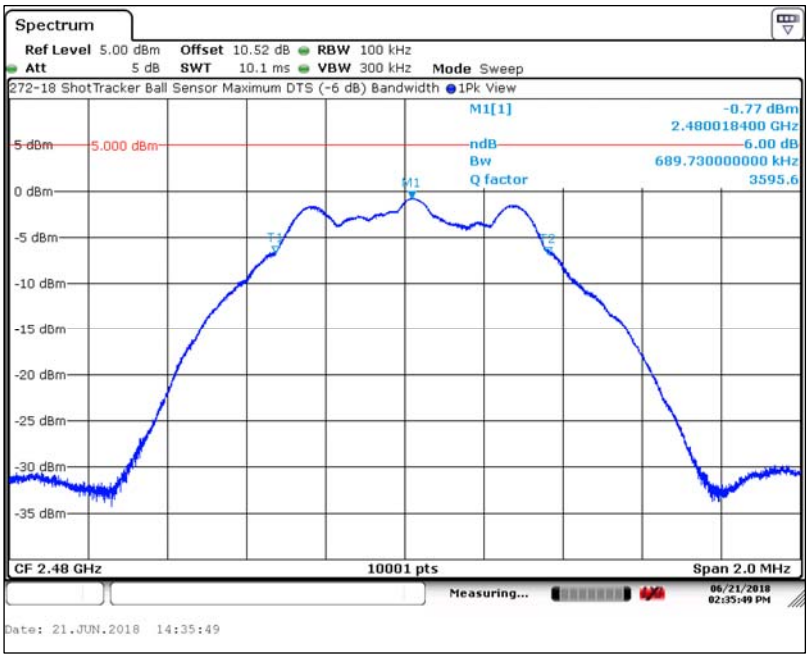
7. Measurement Data

7.2. Minimum DTS Bandwidth (15.247 (a) (2)) (continued)

7.2.2. Middle Channel – 17, 2440 MHz



7.2.3. High Channel – 39, 2480 MHz



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7. Measurement Data (continued)

7.3. Maximum Peak Conducted Output Power

Requirement: (15.247 (b) (3))
The maximum peak conducted output power of the intentional radiator shall not exceed the following: For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt (+30 dBm).

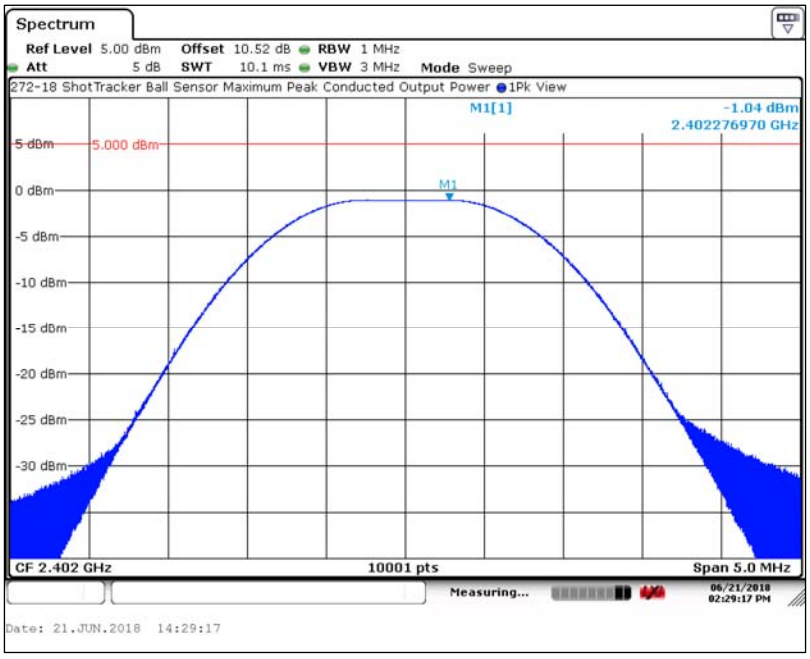
Procedure: This test was performed in accordance with the procedure detailed in FCC OET publication number KDB 558074, Section 9.1.1.

Test Note: A spectrum analyzer resolution bandwidth of 1 MHz and a video bandwidth of 3 MHz were used to meet the requirements of FCC OET publication number 558074, Section 9.1.1 and the measured product DTS bandwidth.

Results: The device under test meets the required maximum peak conducted output power level of 1 Watt.

BLE Channel	Frequency	Maximum Peak Conducted Output Power	Peak Limit	Margin	Result
	(MHz)	(dBm)	(dBm)	(dB)	
0	2402	-1.04	30.00	-31.04	Compliant
19	2440	-0.93	30.00	-30.93	Compliant
39	2480	-0.68	30.00	-30.68	Compliant

7.3.1. Low Channel – 37, 2402 MHz



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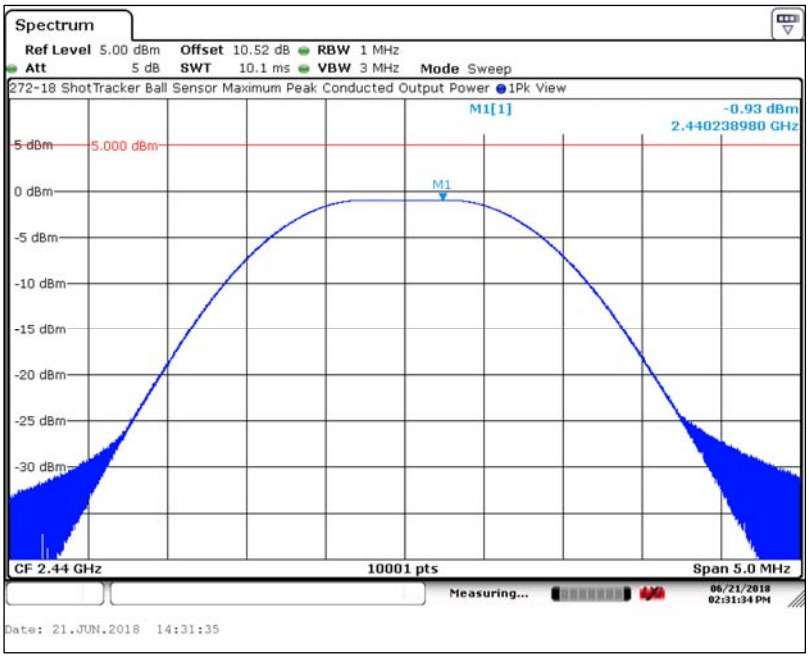
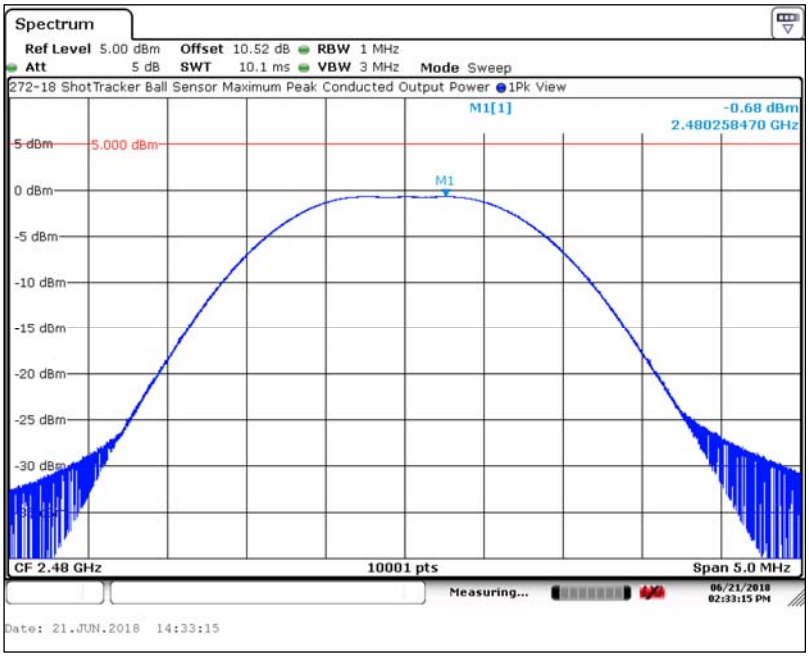
7. Measurement Data

7.3. Maximum Peak Conducted Output Power (continued)

7.3.2. Middle Channel – 17, 2440 MHz



7.3.3. High Channel – 39, 2480 MHz



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7. Measurement Data

7.4. Operation with directional antenna gains greater than 6 dBi (15.247 (b)(4))

Requirement: If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of FCC Part 15.247, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Procedure: Not applicable for the device under test.

DUT Status: The DUT utilizes an antenna with an approximate gain of -5.89 dBi peak gain and therefore is exempt from this requirement.

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7. Measurement Data (continued)

7.5. Transmitter Spurious Radiated Emissions (30 kHz to 40 GHz)

7.5.1 Transmitter Spurious Radiated Emissions

Requirement: (15.209) The Emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency Range (MHz)	Distance (Meters)	Limit (dBµV/m)[1]
0.009 to 0.490	3	128.5 to 93.8
0.490 to 1.705	3	73.8 to 63.0
1.705 to 30	3	69.5
30 to 88	3	40.0
88 to 216	3	43.5
216 to 960	3	46.0
>960	3	54.0

[1] Measurements in the 9 to 90 kHz, 110 to 490 kHz and above 1000 MHz ranges employ an average detector. Otherwise a quasi-peak detector is used.

Procedure: This test was performed in accordance with the procedure detailed in FCC OET publication number 558074, Section 12.0: Emissions in restricted frequency bands and FCC 47CFRPart 15.209: Radiated Emission Limits; General Requirements.

The test methods used to generate the data in this test report is in accordance with ANSI C63.10:2013, American National Standard for Testing Unlicensed Wireless Devices.

Test Notes: Measurements were made from the lowest oscillator frequency as stated by the manufacturer (32.768 kHz) to the 10th harmonic of the highest transmitter frequency or 40 GHz, whichever is lower.

Reference FCC Part 15.33(a) and FCC Part 15.33(a)(1).

Each of the test modes documented within the test report were evaluated and the worst case of each of the test modes is detailed in this section. A full set of measurement scans are presented in Appendix A of this test report.

Results: The Emissions from the DUT did not exceed the field strength levels specified in the above table.

Frequency Range	Worst-Case Measured Frequency	Field Strength	FCC Part 15.209 Limit	Margin	Reference	Receive Antenna Polarity
	(MHz)	(dBµV/m)	(dBµV/m)	(dB)	Appendix A	(H/V)
30 kHz - 150 kHz	31.41170	101.20	117.65	-16.45	A1.1.2	Perpendicular
150 kHz - 30 MHz	150.00000	61.41	104.08	-42.67	A2.3.1	Parallel
30 MHz - 1000 MHz	998.73550	30.75	54.00	-23.25	A3.2.3	H
1000 MHz - 10000 MHz	7205.800	44.4	54.00	-9.60	A4.1.4	V
10000 MHz - 18000 MHz	17916.500	52.48	54.00	-1.52	A5.1.1	H
18000 MHz - 40000 MHz	39992.500	43.74	54.00	-10.26	A6.1.1	H

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7. Measurement Data (continued)

7.5. Transmitter Spurious Radiated Emissions (30 kHz to 40 GHz)

7.5.2. Transmitter Spurious Radiated Emissions (Harmonic Meas.) Test Results

Worst case measurements of harmonics that fall into the restricted bands.

7.5.2.1. 2.4 GHz, BLE

Freq. (MHz)	Field Strength (dBµV/m)[1]		Limit (dBµV/m)		Margin (dBµV/m)		Antenna Polarity (H/V)	Result
	Peak	Average	Peak	Average	Peak	Average		
4804	49.16	35.46	74.00	54.00	-24.84	-18.54	V	Compliant
4880	48.70	35.19	74.00	54.00	-25.30	-18.81	V	Compliant
4960	50.29	36.29	74.00	54.00	-23.71	-17.71	V	Compliant
7320	53.74	40.51	74.00	54.00	-20.26	-13.49	H	Compliant
7440	54.25	41.00	74.00	54.00	-19.75	-13.00	H	Compliant
12010	58.99	45.52	74.00	54.00	-15.01	-8.48	H	Compliant
12200	60.08	46.96	74.00	54.00	-13.92	-7.04	H	Compliant
12400	61.08	46.69	74.00	54.00	-12.92	-7.31	H	Compliant
19216	62.00	48.17	74.00	54.00	-12.00	-5.83	V	Compliant
19520	62.50	48.29	74.00	54.00	-11.50	-5.71	H	Compliant
19840	61.44	47.80	74.00	54.00	-12.56	-6.20	V	Compliant
22320	64.81	50.78	74.00	54.00	-9.19	-3.22	V	Compliant

[1] All correction factors are stored in the spectrum analyzer and applied to these column entries.

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7. Measurement Data (continued)

7.6. Band Edge and Out of Band Measurements

Requirement: 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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

Procedure: For the lower band edge, this measurement was performed in accordance with the procedure detailed in FCC OET publication number 558074, Section 11: Emissions in non-restricted frequency bands.

For the upper band edge, this measurement was performed as a typical restricted band radiated emissions measurement above 1 GHz. Peak and CISPR average detectors and a 1 MHz resolution and 3 MHz video bandwidth were utilized.

Results: The DUT met the 20 dB requirement at the lower band edge and the Part 15.209 requirements at the upper band edge.

7.6.1. Lower Band Edge

Band Edge Frequency	Lowest Transmitter Frequency	Maximum PSD (100 kHz) (Measured)	Max PSD (100 kHz) at Band Edge (Calculated)	Max PSD (100 kHz) to Band Edge Delta (Measured)	Minimum Required Max PSD to Band Edge Delta	Result
(MHz)	(MHz)	(dBm)	(dB)	(dB)	(dB)	
2400	2402	-1.10	-50.98	-49.88	-20	Compliant

Note: Reference the plot on the following page.

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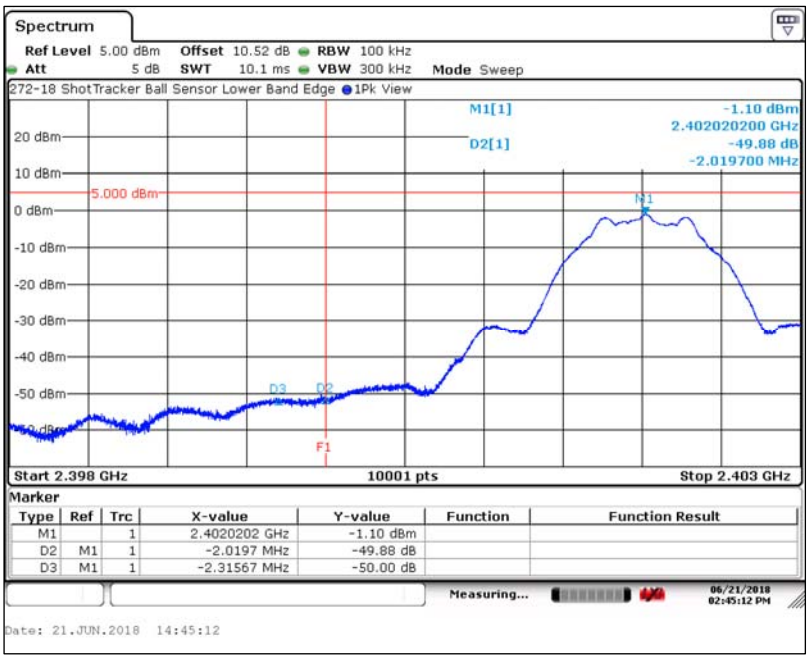
7. Measurement Data (continued)

7.6. Band Edge and Out of Band Measurements (continued)

Lower Band Edge



7.6.2. Upper Band Edge and Worst Case Out of Band

Upper Band Edge

Band Edge Frequency	Field Strength (dBµV/m)		Limit (dBµV/m)		Margin (dB)		Result
(MHz)	Peak	Average	Peak	Average	Peak	Average	
2483.5	54.07	42.68	74	54	-19.93	-11.32	Compliant

Worst Case Out of Band

Band Edge Frequency	Out of Band Frequency	Field Strength (dBµV/m)		Limit (dBµV/m)		Margin (dBµV/m)		Result
(MHz)	(MHz)	Peak	Average	Peak	Average	Peak	Average	
2483.5	2483.9212	56.00	42.65	74	54	-18.00	-11.35	Compliant

Note: Reference the plots on the following page.

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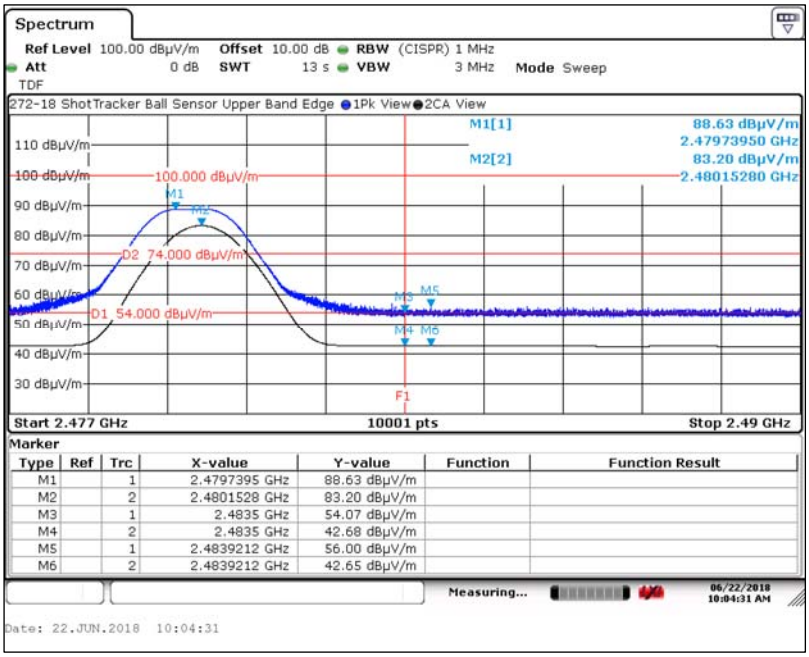
7. Measurement Data (continued)

7.6. Band Edge and Out of Band Measurements (continued)



Band edge measurements were taken in real-time.

7.6.3. Lower Restricted Band, 2.310 MHz to 2390 MHz

Frequency (MHz)	Field Strength (dBµV/m)		Limit (dBµV/m)		Margin (dB)		Result
	Peak	Average	Peak	Average	Peak	Average	
2322.3388	46.78	36.99	74	54	-27.22	-17.01	Compliant

7.6.4. Upper Restricted Band, 2483.5 MHz, to 2500 MHz

Frequency (MHz)	Field Strength (dBµV/m)		Limit (dBµV/m)		Margin (dB)		Result
2485.5961	56.59	42.57	74	54	-17.41	-11.43	Compliant

Note: Reference the plots on the following page.

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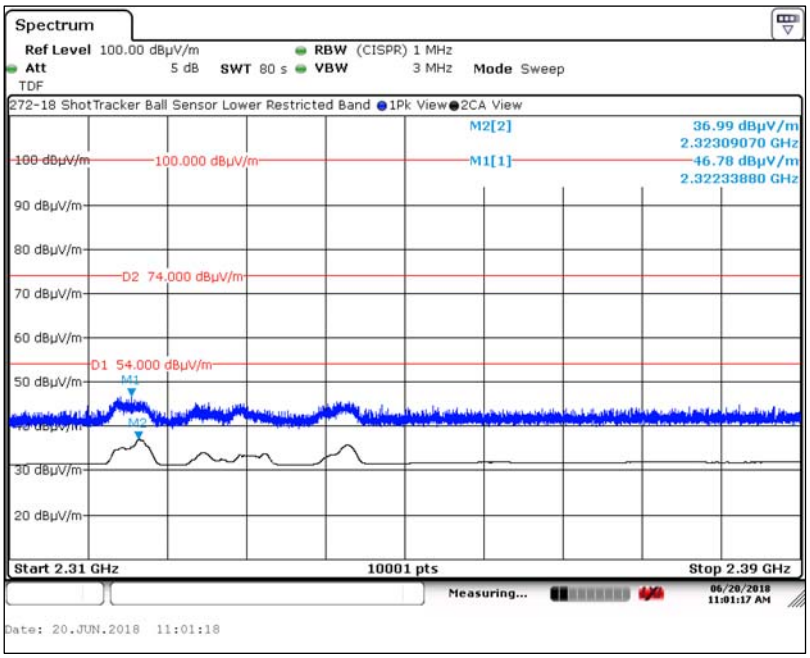
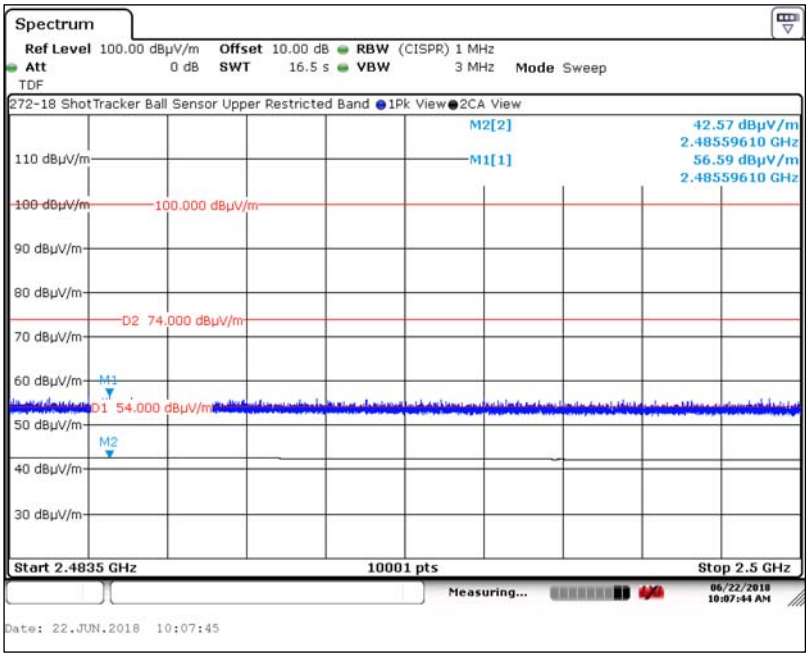
7. Measurement Data (continued)

7.6. Band Edge and Out of Band Measurements (continued)

Lower Restricted Band, 2310 MHz, to 2390 MHz



Upper Restricted Band, 2483.5 MHz, to 2500 MHz



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7. Measurement Data (continued)

7.7. Emissions in Non-restricted Frequency Bands

Requirement: 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.

Test Notes: Peak in-band measurements were taken at the time the DTS (-6 dB) bandwidth measurements were made. These values were used as the reference levels for the following measurements. Refer to section 7.2 of this report for these values.

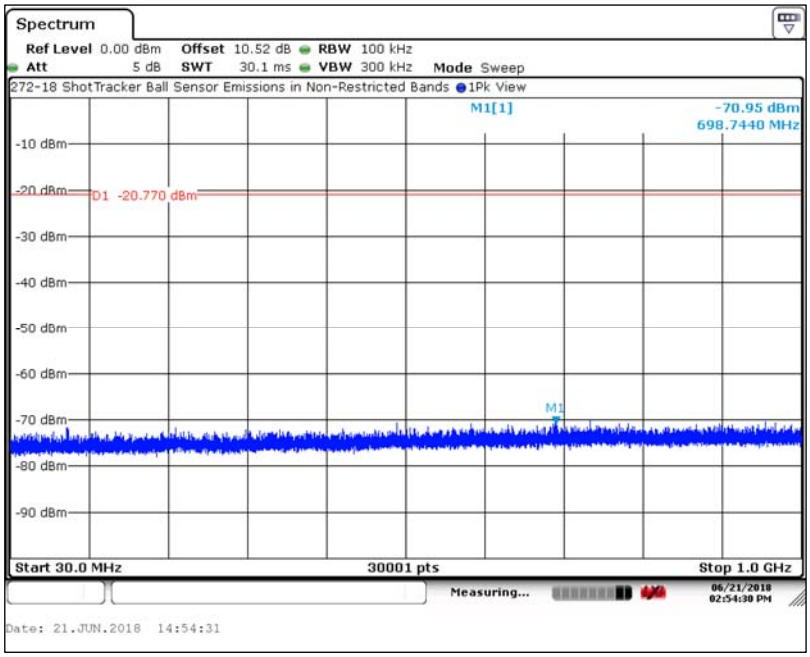
Results: The DUT met the 20 dB requirement emission level delta requirement in the non restricted frequency bands.

Emissions in Non-restricted Frequency Bands

Maximum PSD (100 kHz) In-Band[1] (dB/m)	Worst Case Out-of-Band Frequency (MHz)	Maximum PSD (100 kHz) Out-of-Band (dBm)	Delta to Maximum PSD (dB)	Minimum Required Delta	Result
-0.77	38709.5	-59.24	-58.47	-20 dB	Compliant

[1]Taken from Section 7.2 - DTS Bandwidth

7.7.1. Emissions in Non-restricted Frequency Bands, Plot 1 of 3



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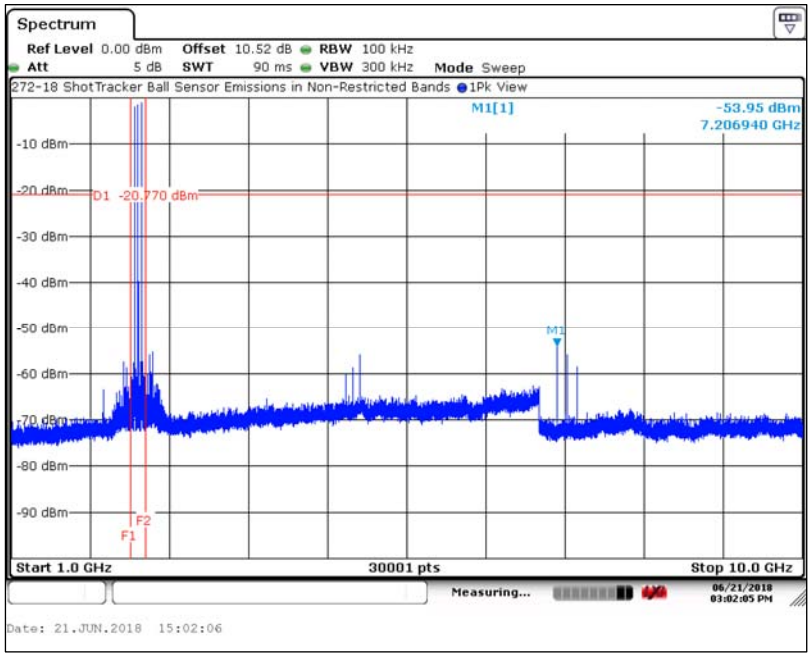
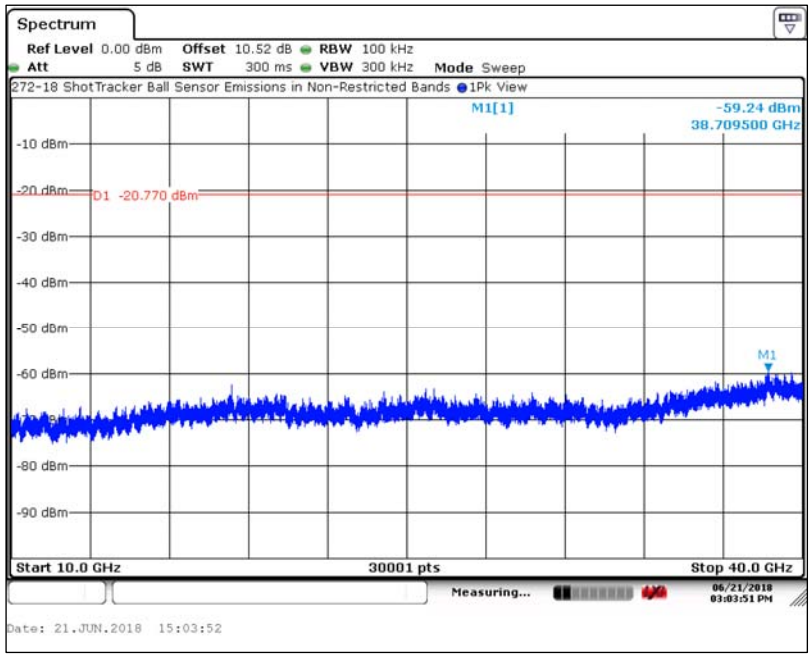
7. Measurement Data (continued)

7.7. Emissions in Non-restricted Frequency Bands (continued)

7.7.2. Emissions in Non-restricted Frequency Bands, Plot 2 of 3



7.7.3. Emissions in Non-restricted Frequency Bands, Plot 3 of 3



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7. Measurement Data (continued)

7.8. Peak Power Spectral Density (15.247(e))

Requirement: For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of FCC Part 15.247. The same method of determining the conducted output power shall be used to determine the power spectral density.

Procedure: FCC OET publication number 558074, Section 10.2: Method PKPSD (peak PSD). FCC OET 662911 was referenced to determine the procedure for measuring in-band power spectral density of transmitters with multiple outputs in the same band.

Results: The DUT met the required power spectral density limit at the tested frequencies.

Measurement Results in 2400 MHz to 2483.5 MHz Band

Channel	Frequency	Maximum PSD Frequency	Maximum Power Spectral Density	Limit	Margin	Result
	(MHz)	(MHz)	(dBm/3 kHz)	(dBm/3 kHz)	(dB)	
37	2402	2401.9967	-16.37	8.0	-24.37	Compliant
17	2440	2439.9967	-16.34	8.0	-24.34	Compliant
39	2480	2479.7592	-16.05	8.0	-24.05	Compliant

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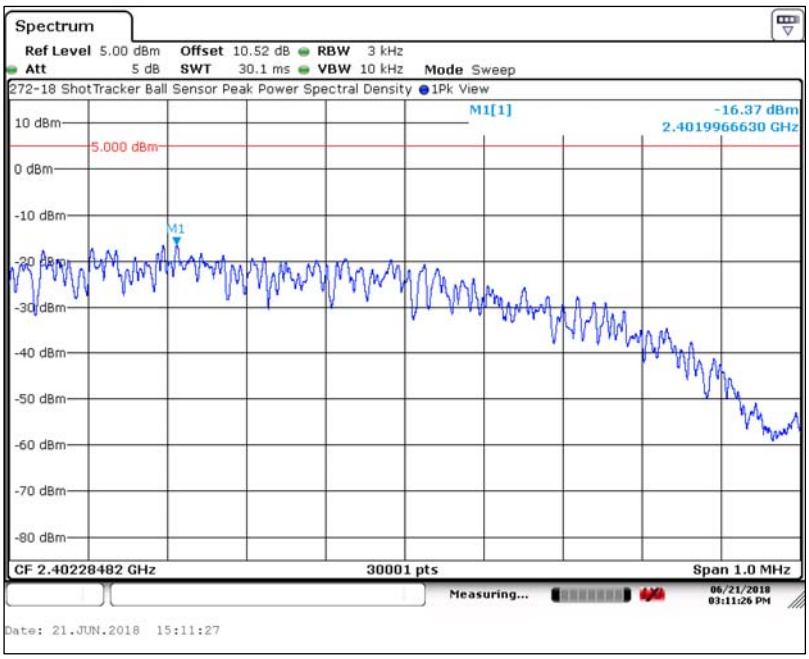
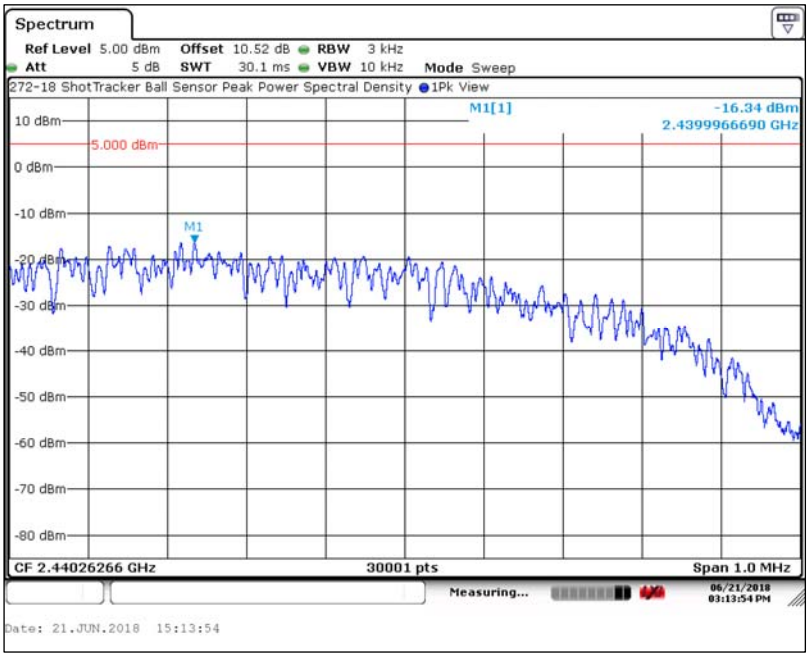
7. Measurement Data (continued)

7.8. Peak Power Spectral Density (15.247(e)) (continued)

7.8.1. Low Channel – 37, 2402 MHz



7.8.2. Middle Channel – 17, 2440 MHz



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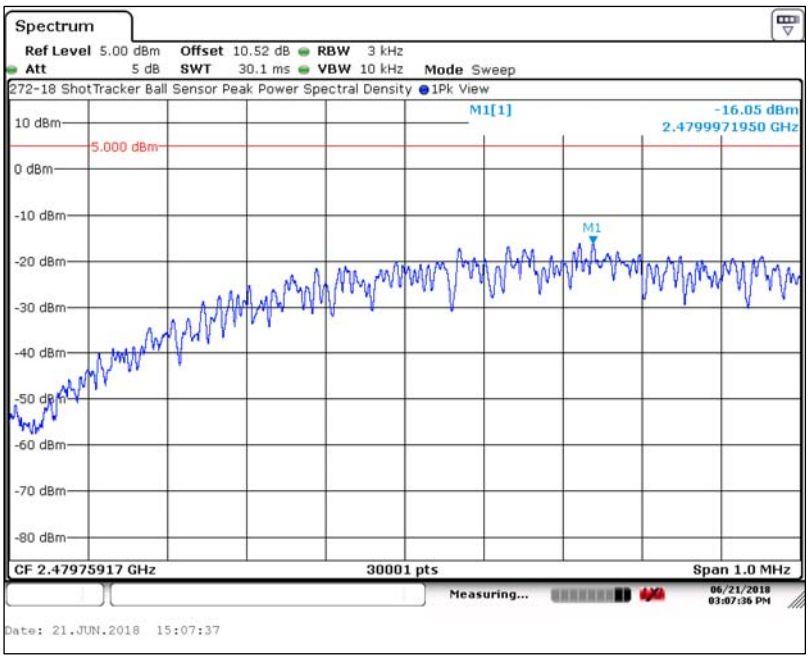
7. Measurement Data

7.8. Peak Power Spectral Density (15.247(e)) (continued)

7.8.3. High Channel – 39, 2480 MHz



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7. Measurement Data (continued)

7.9. Duty Cycle

Requirement: (FCC OET publication number 558074)
Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%).

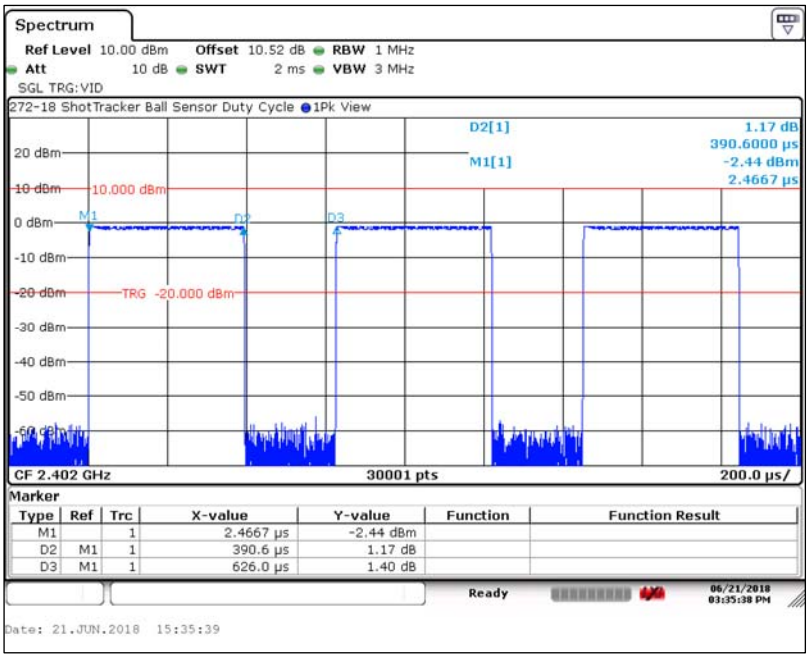
Procedure: Duty cycle measurements were made according to the procedure detailed ANSI C63.10-2013, Section 11.6(b)

Results: Duty cycle measurements are listed in the following table.

All power and power spectral density measurements for this report are peak mode measurements. Ample peak hold time was provided to ensure maximum peak measurements.

Channel	Frequency	Time High	Time per Period	Duty Cycle	
	(MHz)	(µS)	(µS)	(Numeric)	(%)
37	2402	390.6	626.0	0.62396	62.40
17	2440	390.6	626.0	0.62396	62.40
39	2480	390.6	626.0	0.62396	62.40

7.9.1. Low Channel – 37, 2402 MHz



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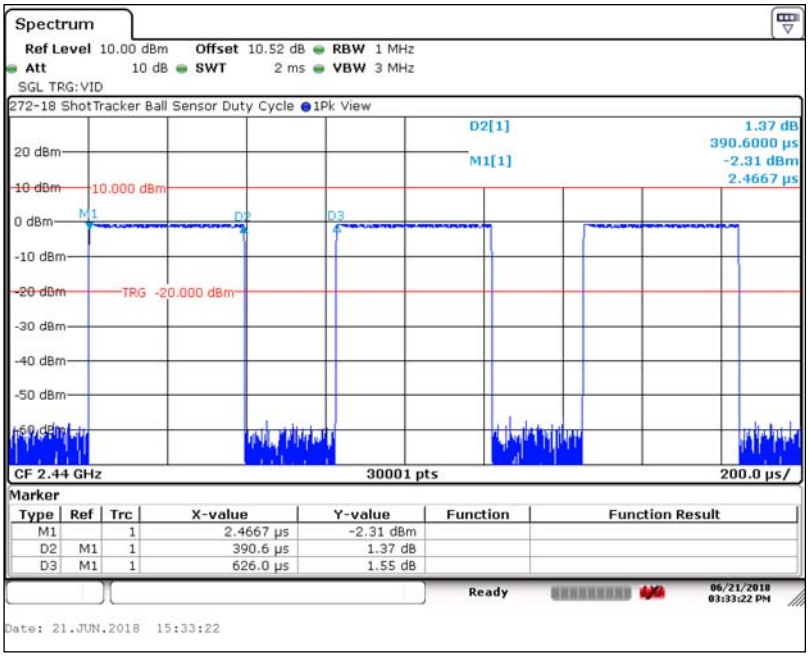
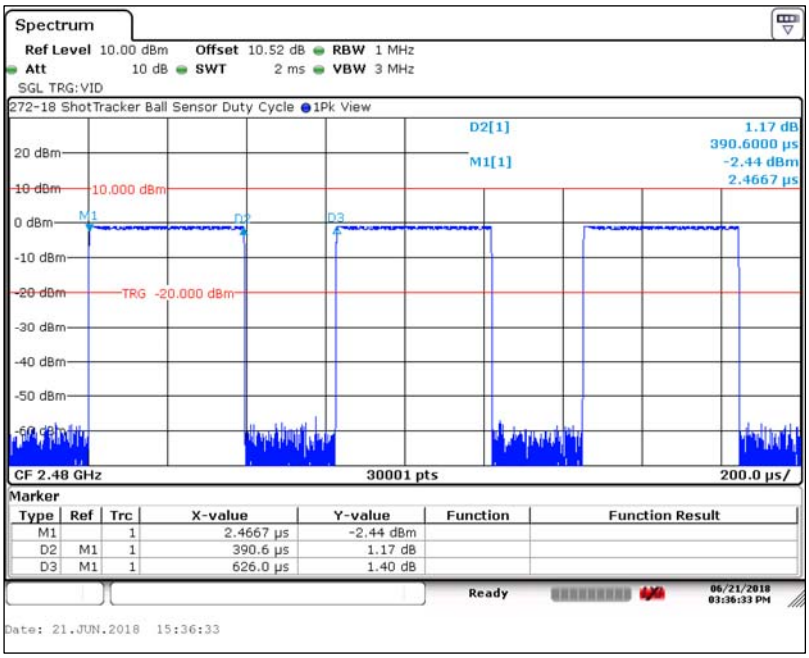
7. Measurement Data (continued)

7.9. Duty Cycle (continued)

7.9.2. Middle Channel – 17, 2440 MHz



7.9.3. High Channel – 39, 2480 MHz



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7. Measurement Data (continued)

7.10. Public Exposure to Radio Frequency Energy Levels (15.247(i) (1.1307 (b)(1)) RSS-GEN, ISSUE 4 5.5, RSS 102)

7.10.1. 15.247(i) (1.1307 (b)(1) Requirements

Requirement: Portable devices are subject to radio frequency radiation exposure requirements.

For a 1-g head or body SAR, the test exclusion result must be ≤ 3.0.
For a 10-g extremity SAR, the test exclusion result must be ≤ 7.5.

Test Notes: The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by the following formula:

$$\text{SAR Test Exclusion} = \frac{P_{MAX}}{d_{MIN}} \times \sqrt{f_{(GHz)}} \quad (1)$$

P_{MAX}	mW	Maximum power of channel, including tune-up tolerance
d_{MIN}	mm	Minimum test separation distance, mm (≤ 50 mm)
$f_{(GHz)}$	GHz	$f_{(GHz)}$ is the RF channel transmit frequency in GHz (>100 MHz and <6 GHz)

(1) FCC OET 447498 - Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

Results: Passed - The device under test meets the exclusion requirement detailed in FCC OET 447498.

Channel:		**37**	**17**	**39**	
Input[1]:	P_{MAX}	0.787	0.807	0.855	**mW**
	d_{MIN}[2]	5.00	5.00	5.00	**mm**
	$f_{(GHz)}$	2.402	2.440	2.480	**GHz**
Test Exclusion:		**0.24**	**0.25**	**0.27**	
Limit Exemption:		**3.0**	**3.0**	**3.0**	
Measurement Result:		**Compliant**	**Compliant**	**Compliant**	

[1] Taken from column 3 of the table in Section 7.3 of this test report.

[2] When the minimum test separation distance is < 5 mm, a distance of 5 mm according to KDB 447498, 4.1 f) is applied to determine SAR test exclusion.

Note: The UWB and BLE Radios do not operate simultaneously.

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7. Measurement Data (continued)

7.10. Public Exposure to Radio Frequency Energy Levels (15.247(i) (1.1307 (b)(1)) RSS-GEN, ISSUE 4 5.5, RSS 102) (continued)

7.10.2. RSS-102 Issue 5 Requirements

Requirement: SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1. Portable devices are subject to radio frequency radiation exposure requirements.

Test Notes: The limit was taken from Table 1 of RSS-102 Issue 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5.

Results: Compliant

Bluetooth Radio

Frequency	Separation Distance	Maximum Power	RSS-102 Limit	Result
MHz	mm	mW	mW	
2402	≤5	0.79	10.65	Compliant
2440	≤5	0.81	10.14	Compliant
2480	≤5	0.86	9.86	Compliant

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8. Test Site Description

Compliance Worldwide is located at 357 Main Street in Sandown, New Hampshire. The test sites at Compliance Worldwide are used for conducted and radiated emissions testing in accordance with the Federal Communications Commission (FCC) and Industry Canada standards. Through our American Association for Laboratory Accreditation (A2LA) ISO Guide 17025:2005 Accreditation our test sites are designated with the FCC (designation number **US1091**), Industry Canada (file number **IC 3023A-1)** and VCCI (Member number 3168) under registration number A-0274.

Compliance Worldwide is also designated as a Phase 1 CAB under APEC-MRA (US0132) for Australia/New Zealand AS/NZS CISPR 22, Chinese-Taipei (Taiwan) BSMI CNS 13438 and Korea (RRA) KN 11, KN 13, KN 14-1, KN 22, KN 32, KN 61000-6-3, KN 61000-6-4.

The radiated emissions test site is a 3 and 10 meter enclosed open area test site (OATS). Personnel, support equipment and test equipment are located in the basement beneath the OATS ground plane.

The conducted emissions site is part of a 16' x 20' x 12' ferrite tile chamber and uses one of the walls for the vertical ground plane required by EN 55022. A second conducted emissions site is also located in the basement of the OATS site with a 2.3 x 2.5 meter ground plane and a 2.4 x 2.4 meter vertical wall.

Both sites are designed to test products or systems 1.5 meters W x 1.5 meters L x 2.0 meters H, floor standing or table top.

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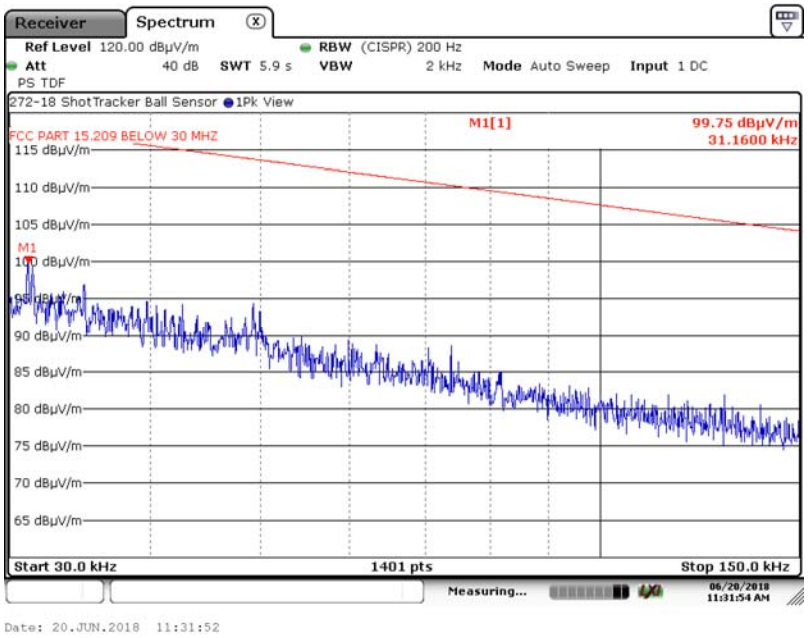
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

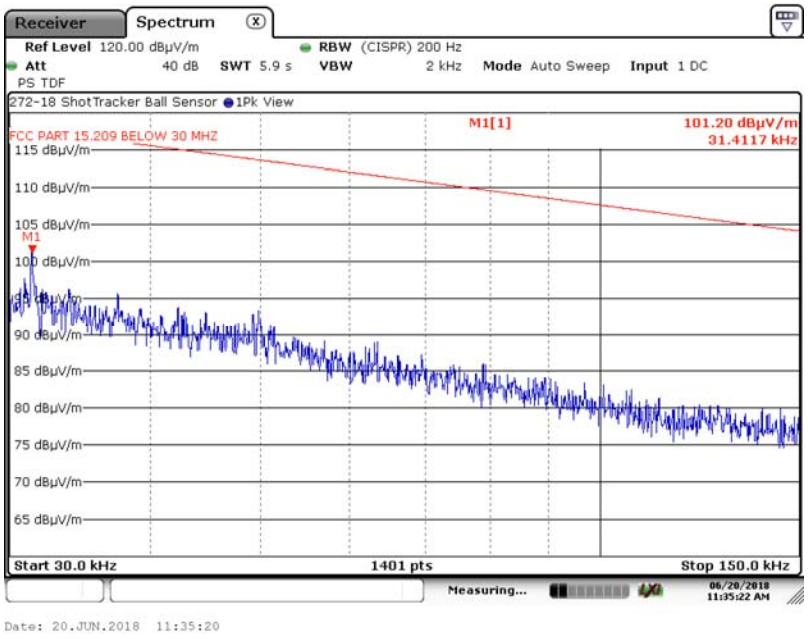
A1. Spurious Radiated Emissions (30 kHz – 150 kHz) Test Results

A1.1. Orthogonal Position: X-Axis

A1.1.1. Measurement Results: Parallel Antenna



A1.1.2. Measurement Results: Perpendicular Antenna



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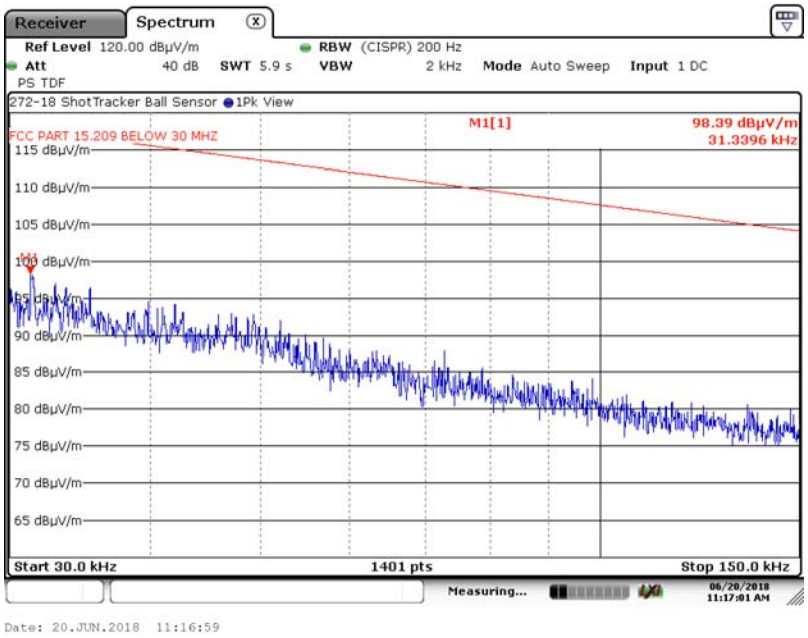
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

A1. Spurious Radiated Emissions (30 kHz – 150 kHz) Test Results

A1.1. Orthogonal Position: X-Axis

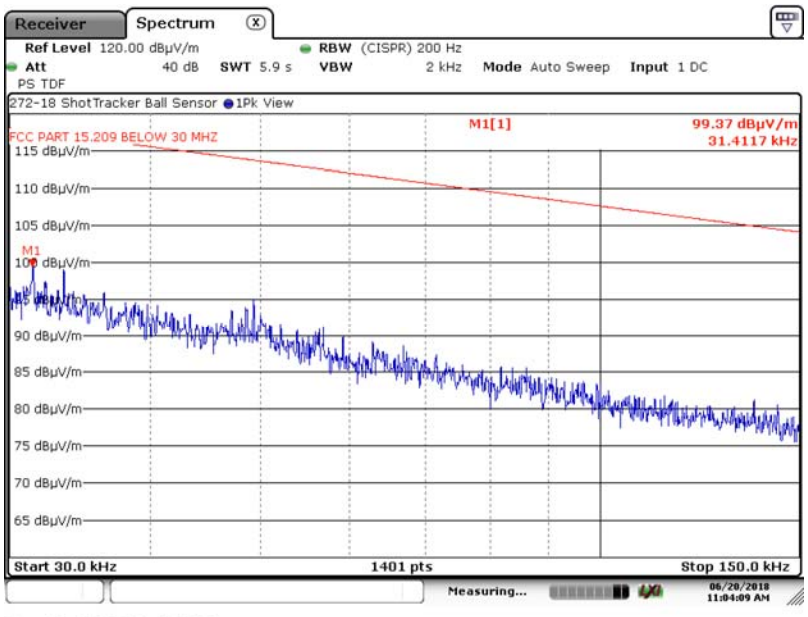
A1.1.3. Measurement Results: Ground Parallel Antenna



Date: 20.JUN.2018 11:16:59

A1.1.2. Orthogonal Position: Y-Axis

A1.2.1. Measurement Results: Parallel Antenna



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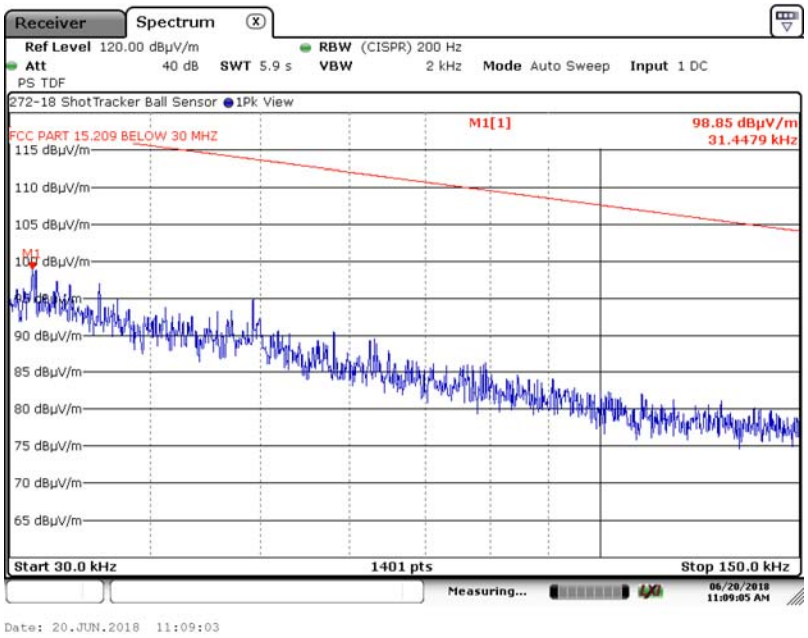
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

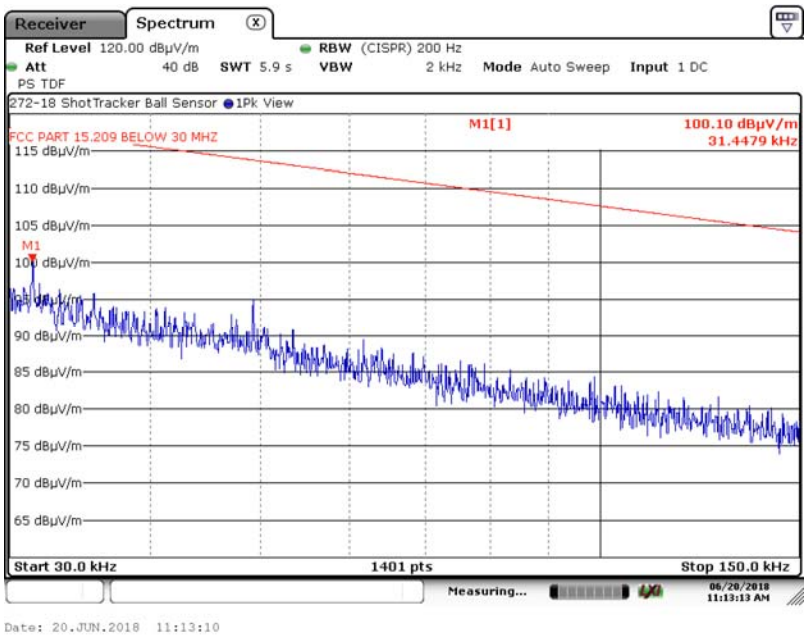
A1. Spurious Radiated Emissions (30 kHz – 150 kHz) Test Results

A1.2. Orthogonal Position: Y-Axis

A1.2.2. Measurement Results: Perpendicular Antenna



A1.2.3. Measurement Results: Ground Parallel Antenna



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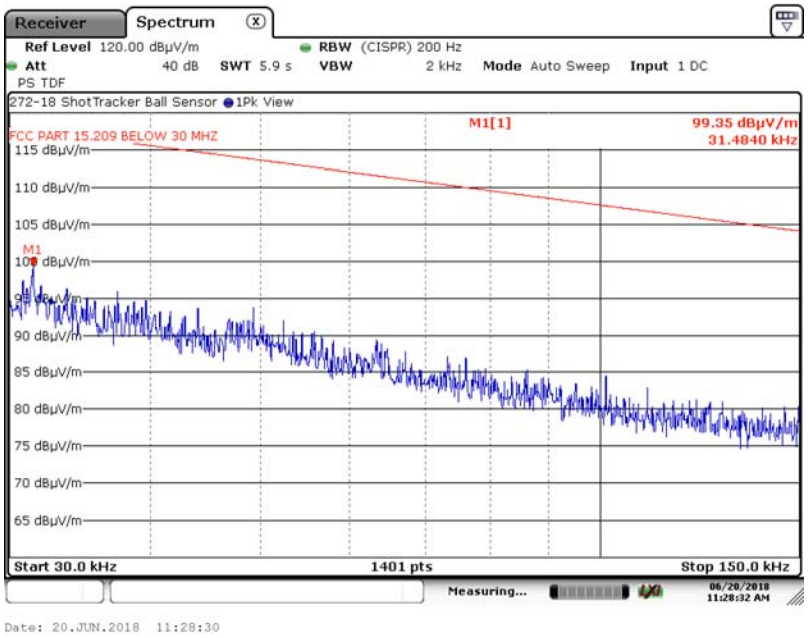
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

A1. Spurious Radiated Emissions (30 kHz – 150 kHz) Test Results

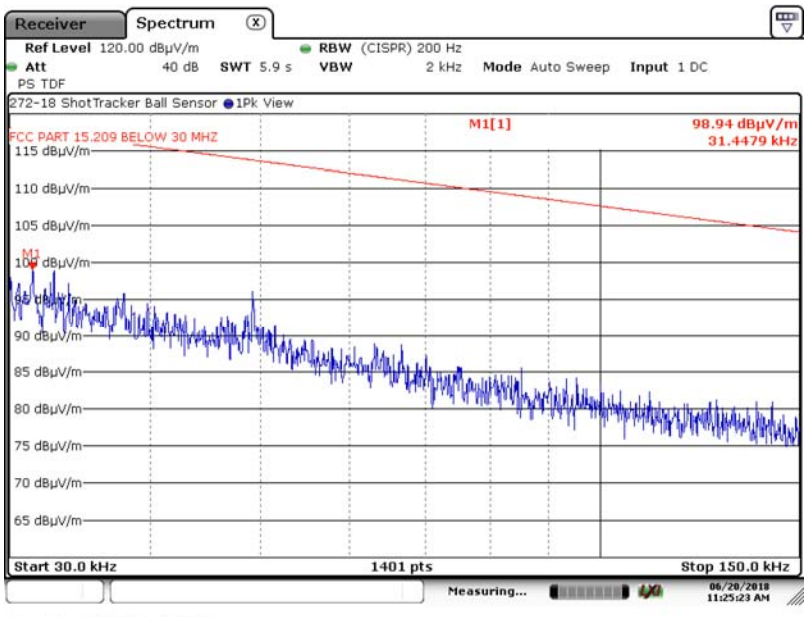
A1.3. Orthogonal Position: Z-Axis

A1.3.1. Measurement Results: Parallel Antenna



Date: 20.JUN.2018 11:28:30

A1.3.2. Measurement Results: Perpendicular Antenna



Date: 20.JUN.2018 11:25:21

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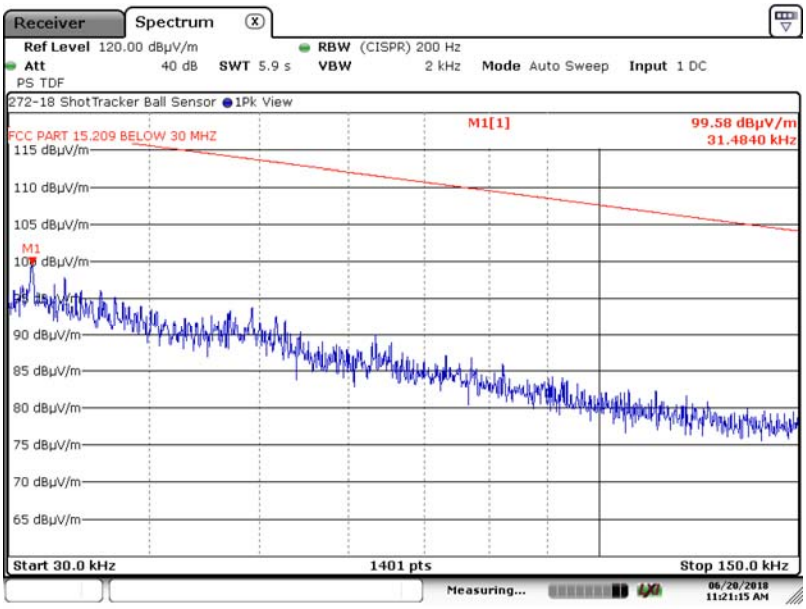
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

A1. Spurious Radiated Emissions (30 kHz – 150 kHz) Test Results

A1.3. Orthogonal Position: Z-Axis

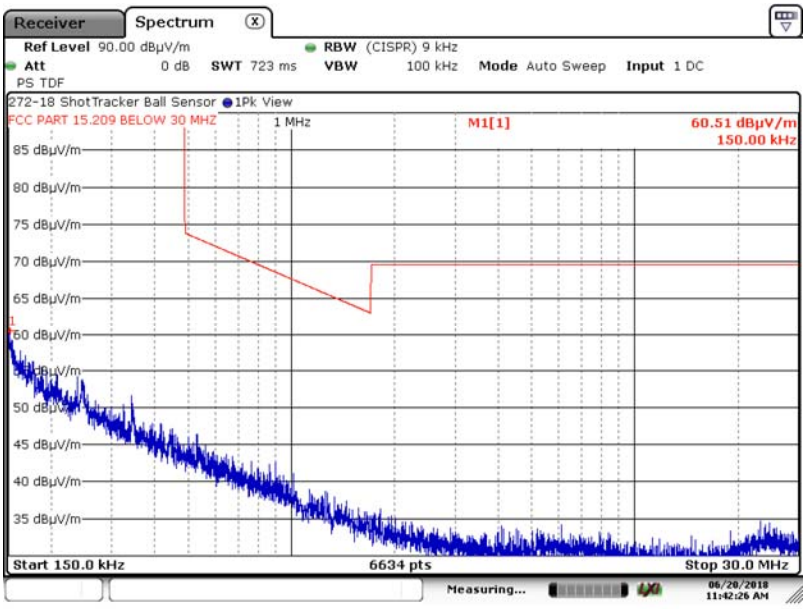
A1.3.3. Measurement Results: Ground Parallel Antenna



A2. Spurious Radiated Emissions (150 kHz – 30 MHz) Test Results

A2.1. Orthogonal Position: X-Axis

A2.1.1. Measurement Results: Parallel Antenna



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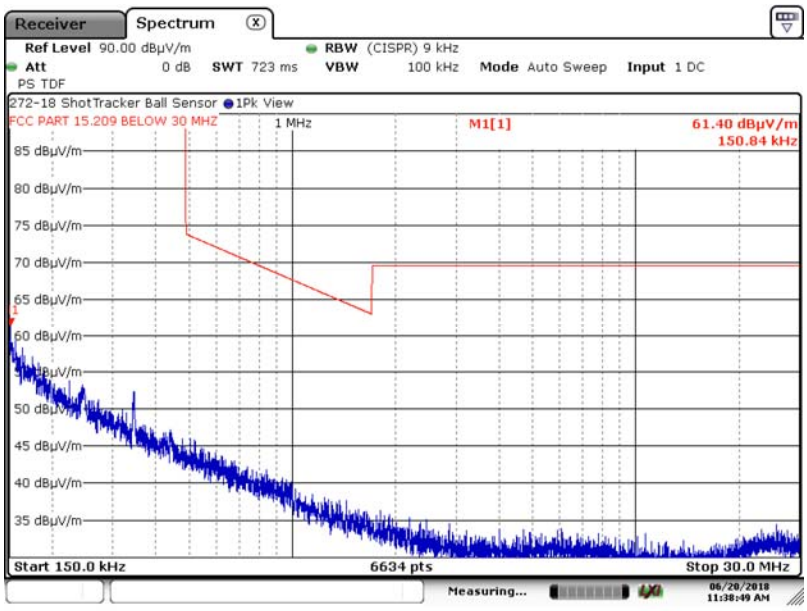
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

A2. Spurious Radiated Emissions (150 kHz – 30 MHz) Test Results

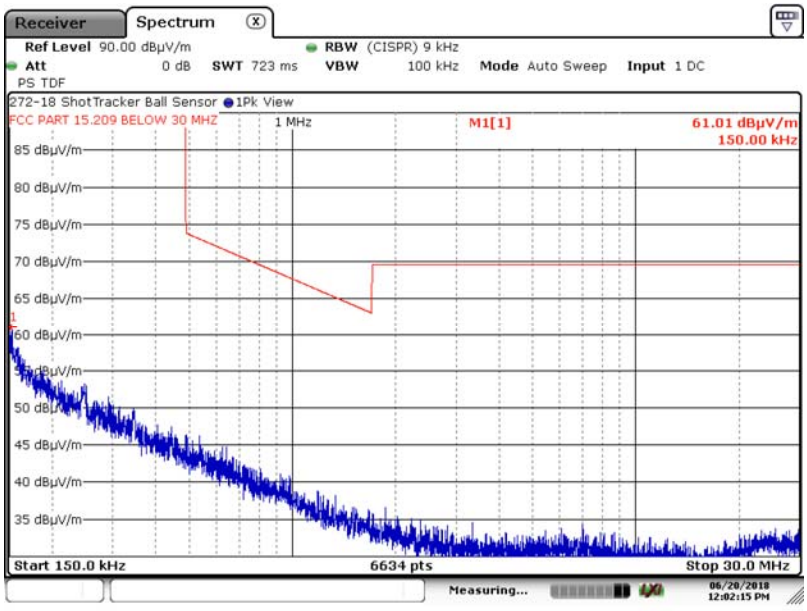
A2.1. Orthogonal Position: X-Axis

A2.1.2. Measurement Results: Perpendicular Antenna



Date: 20.JUN.2018 11:38:47

A2.1.3. Measurement Results: Ground Parallel Antenna



Date: 20.JUN.2018 12:02:12

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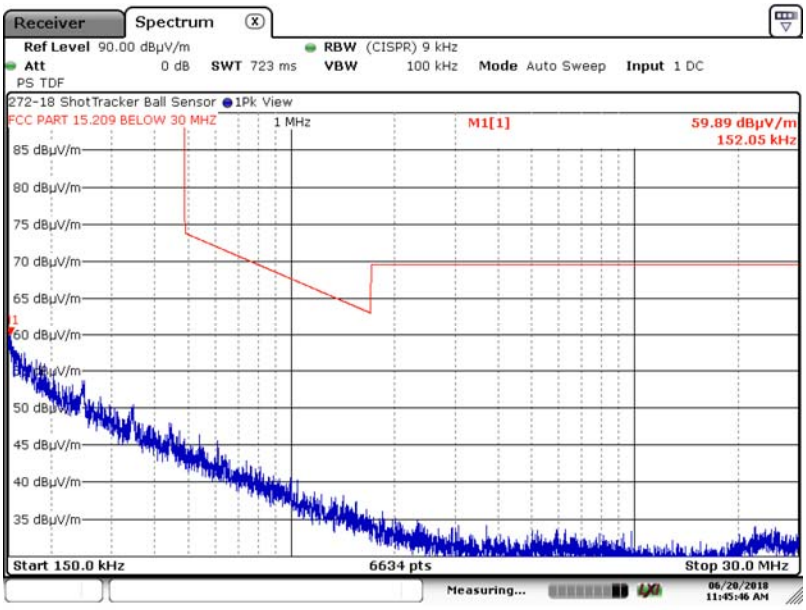
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

A2. Spurious Radiated Emissions (150 kHz – 30 MHz) Test Results

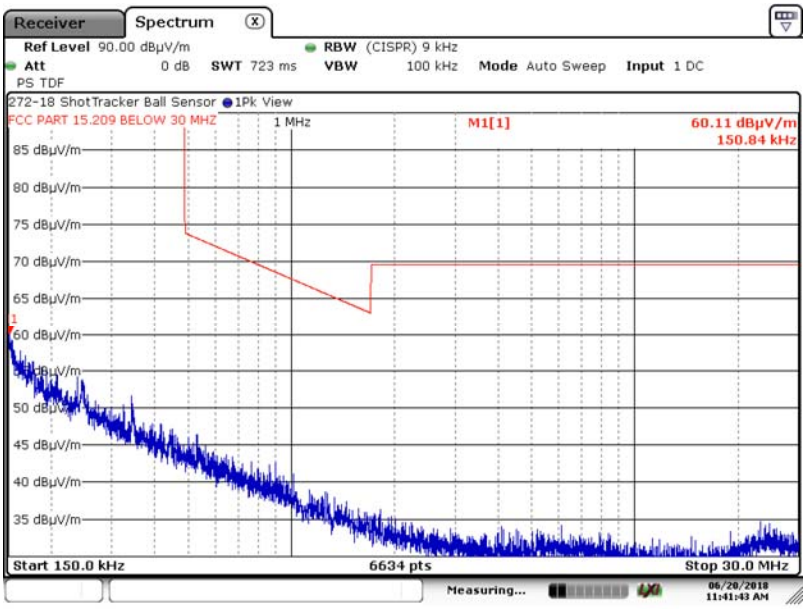
A2.2. Orthogonal Position: Y-Axis

A2.2.1. Measurement Results: Parallel Antenna



Date: 20.JUN.2018 11:45:44

A2.2.2. Measurement Results: Perpendicular Antenna



Date: 20.JUN.2018 11:41:41

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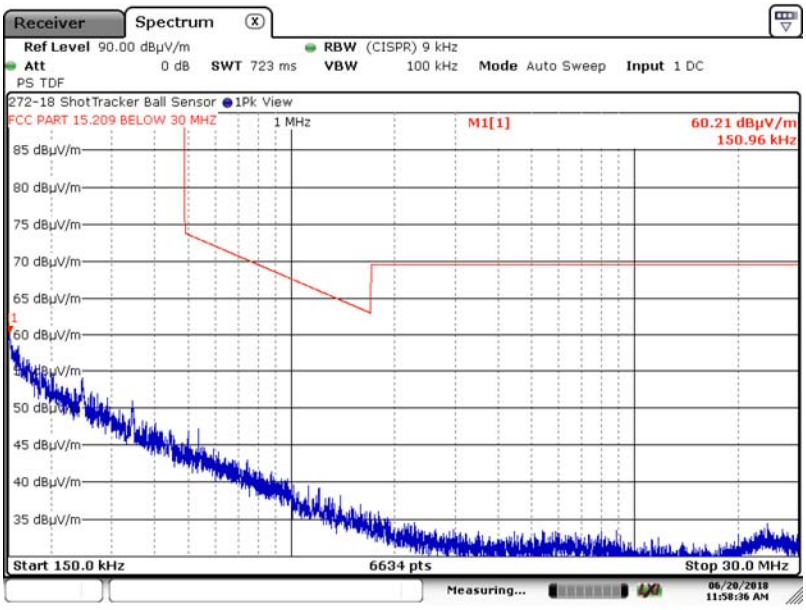
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

A2. Spurious Radiated Emissions (150 kHz – 30 MHz) Test Results

A2.2. Orthogonal Position: Y-Axis

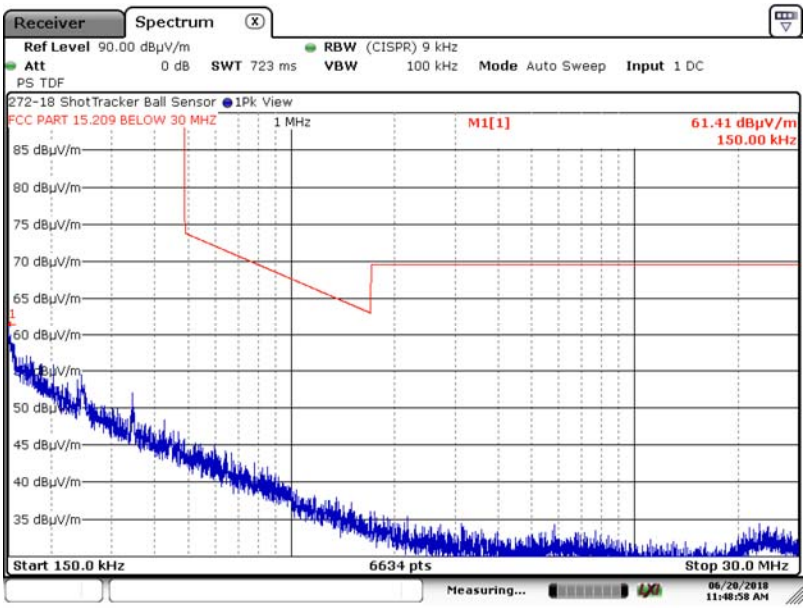
A2.2.3. Measurement Results: Ground Parallel Antenna



Date: 20.JUN.2018 11:58:34

A2.3. Orthogonal Position: Z-Axis

A2.3.1. Measurement Results: Parallel Antenna



Date: 20.JUN.2018 11:48:56

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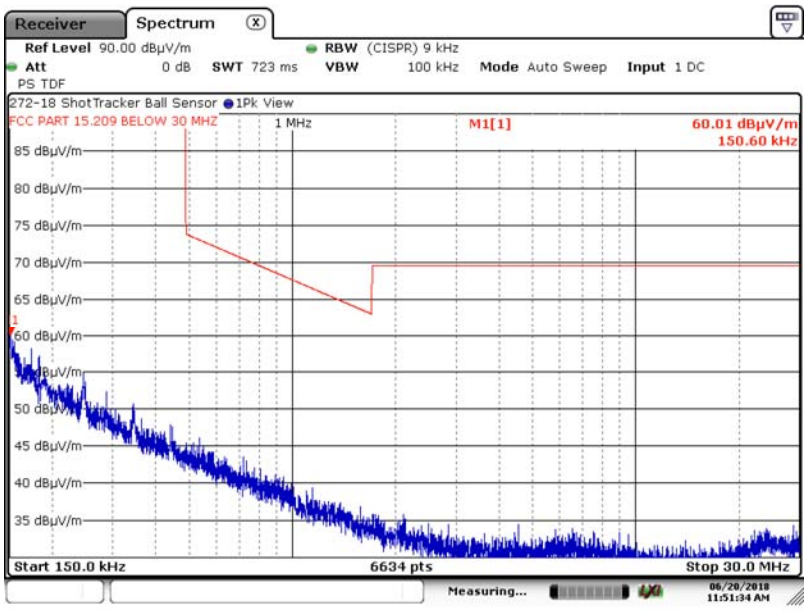
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

A2. Spurious Radiated Emissions (150 kHz – 30 MHz) Test Results

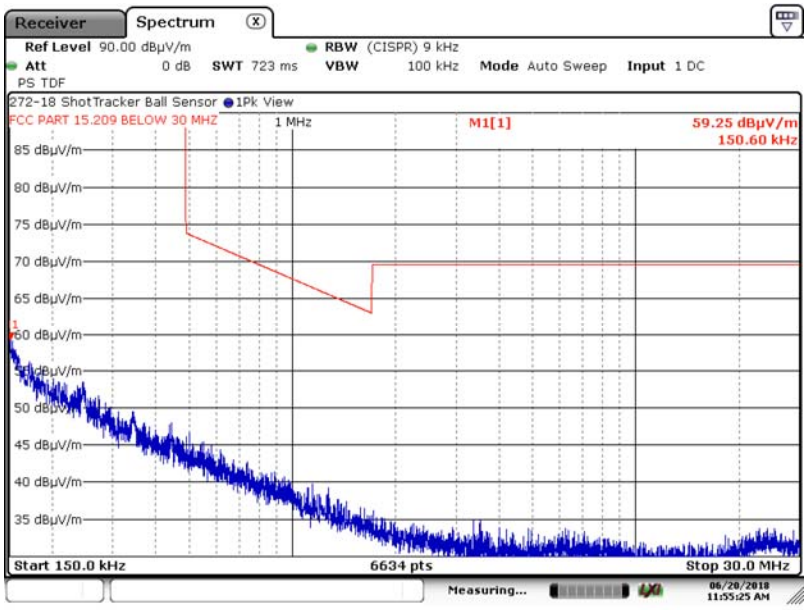
A2.3. Orthogonal Position: Z-Axis

A2.3.2. Measurement Results: Perpendicular Antenna



Date: 20.JUN.2018 11:51:31

A2.3.3. Measurement Results: Ground Parallel Antenna



Date: 20.JUN.2018 11:55:23

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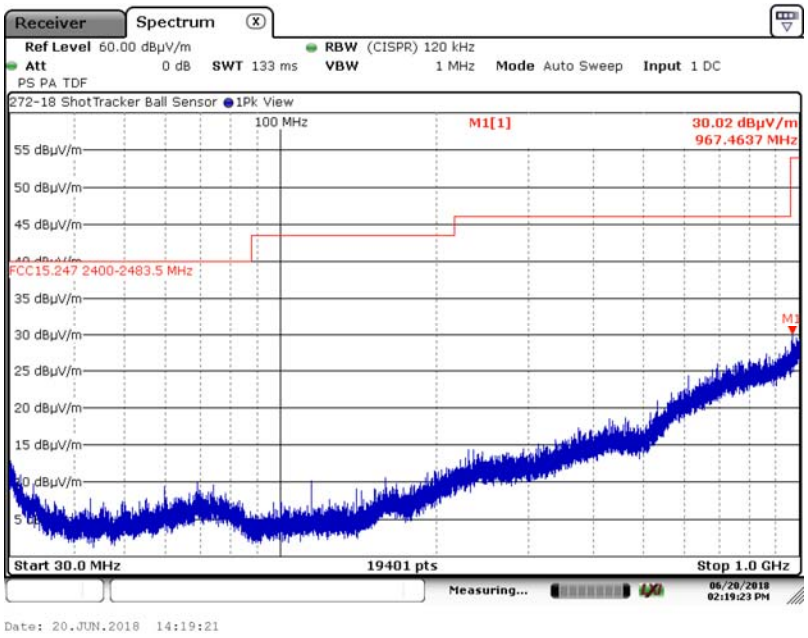
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

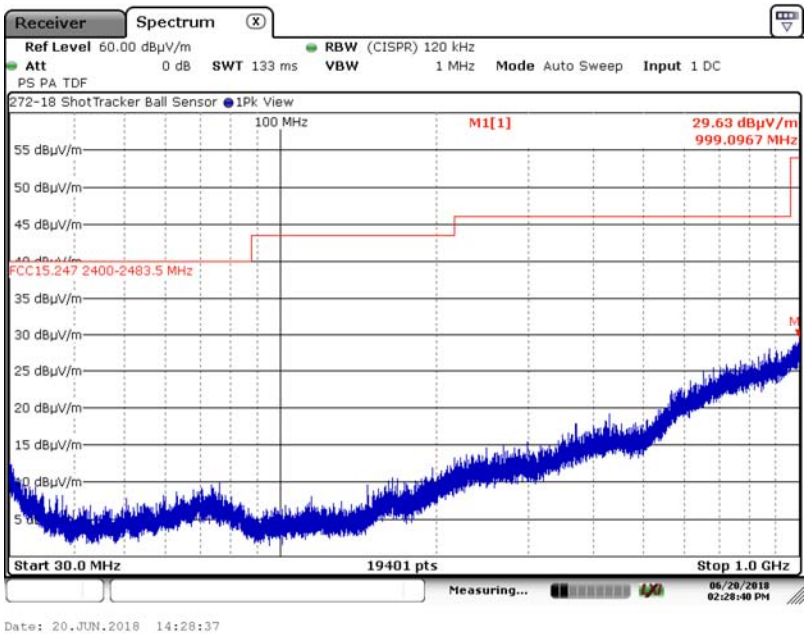
A3. Spurious Radiated Emissions (30 MHz – 1 GHz) Test Results

A3.1. Low Frequency: Channel 37, 2402 MHz

A3.1.1. Measurement Results: X-Axis, Horizontal Antenna



A3.1.2. Measurement Results: X-Axis, Vertical Antenna



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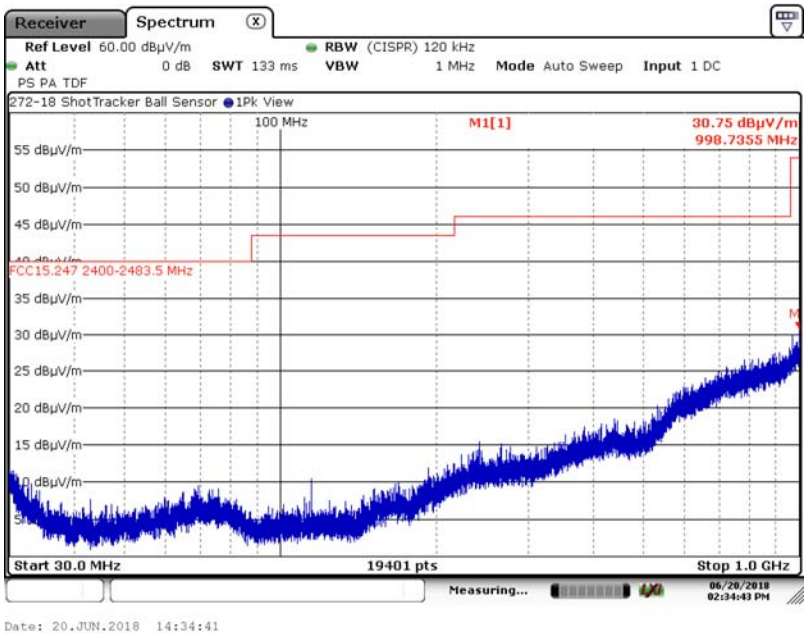
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

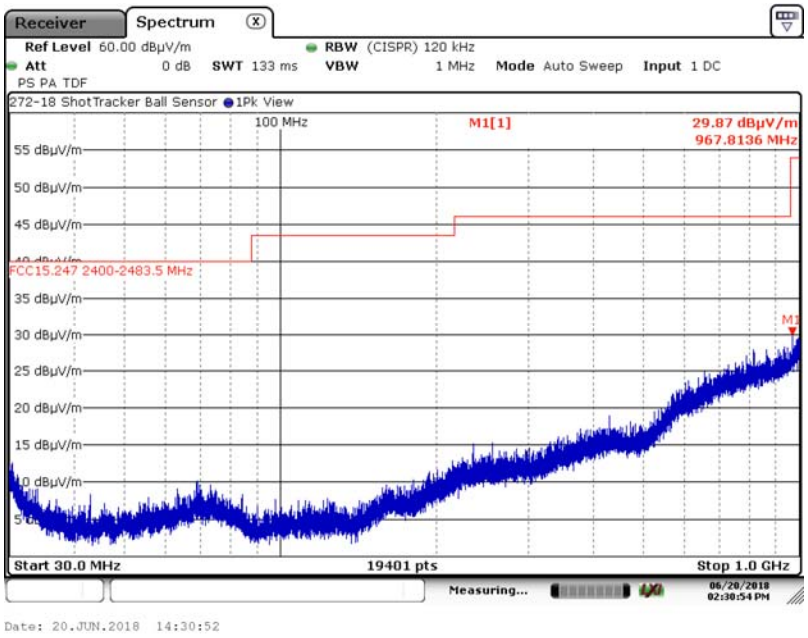
A3. Spurious Radiated Emissions (30 MHz – 1 GHz) Test Results

A3.2. Low Frequency: Channel 37, 2402 MHz

A3.2.3. Measurement Results: Y-Axis, Horizontal Antenna



A3.1.4. Measurement Results: Y-Axis, Vertical Antenna



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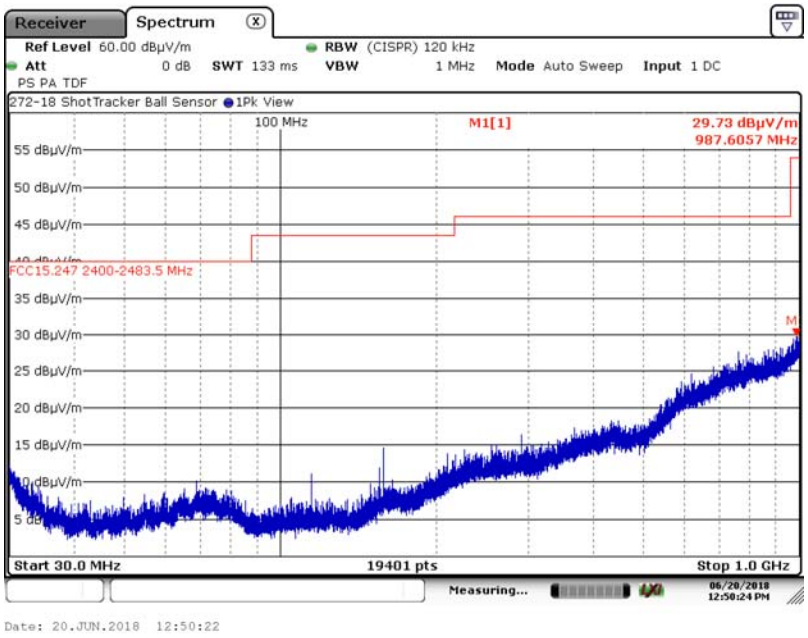
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

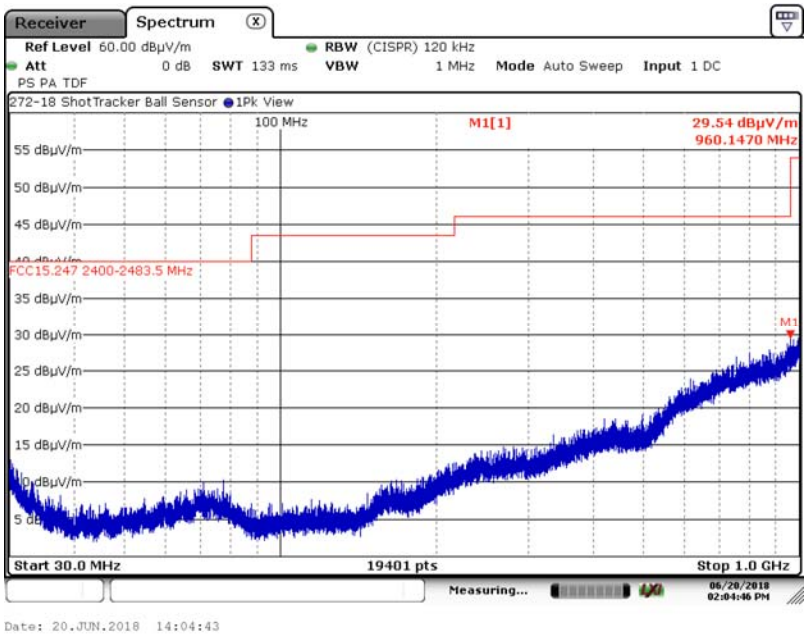
A3. Spurious Radiated Emissions (30 MHz – 1 GHz) Test Results

A3.1 Low Frequency: Channel 37, 2402 MHz

A3.1.5. Measurement Results: Z-Axis, Horizontal Antenna



A3.1.6. Measurement Results: Z-Axis, Vertical Antenna



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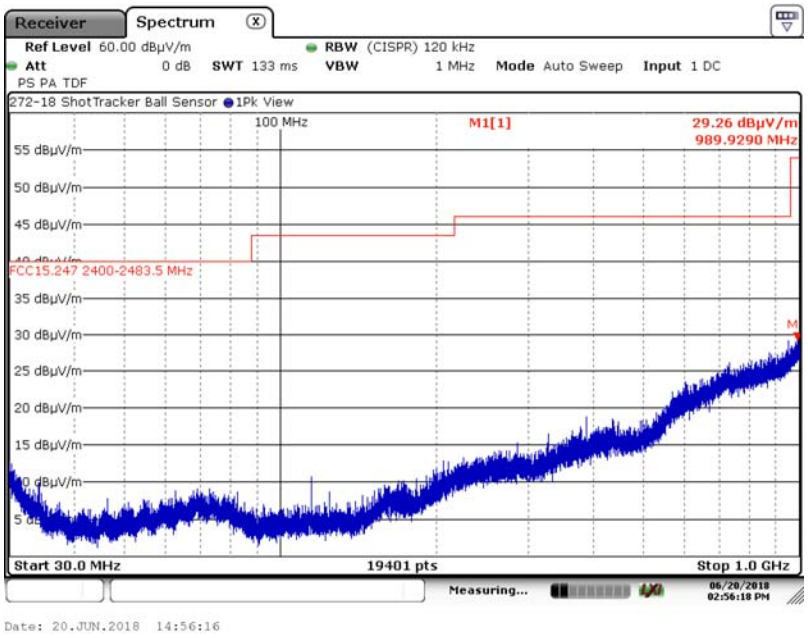
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

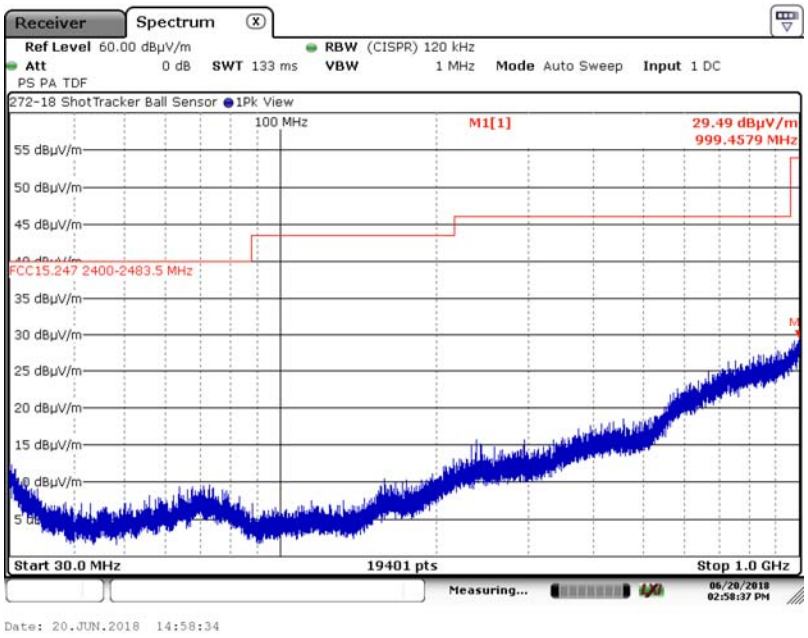
A3. Spurious Radiated Emissions (30 MHz – 1 GHz) Test Results

A3.2. Middle Frequency: Channel 17, 2440 MHz

A3.2.1. Measurement Results: X-Axis, Horizontal Antenna



A3.2.2. Measurement Results: X-Axis, Vertical Antenna



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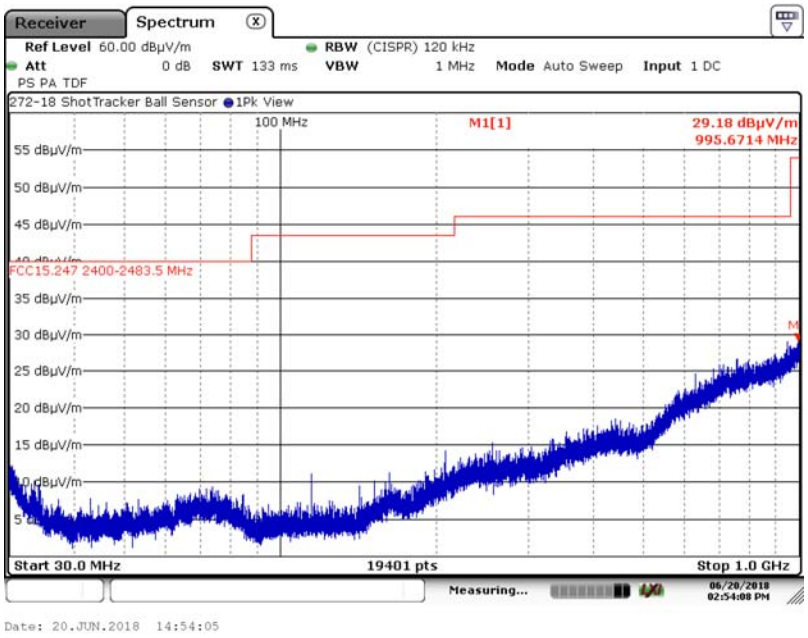
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

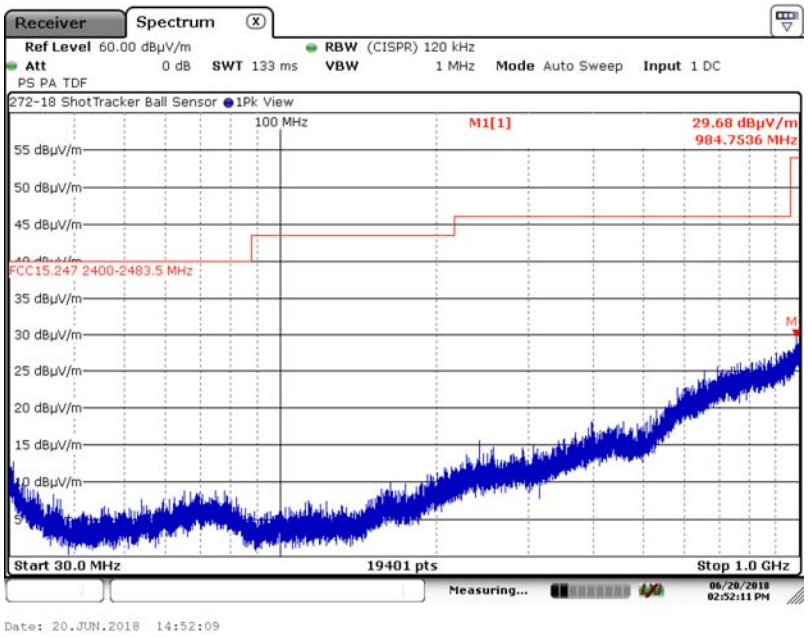
A3. Spurious Radiated Emissions (30 MHz – 1 GHz) Test Results

A3.2. Middle Frequency: Channel 17, 2440 MHz

A3.2.3. Measurement Results: Y-Axis, Horizontal Antenna



A3.2.4. Measurement Results: Y-Axis, Vertical Antenna



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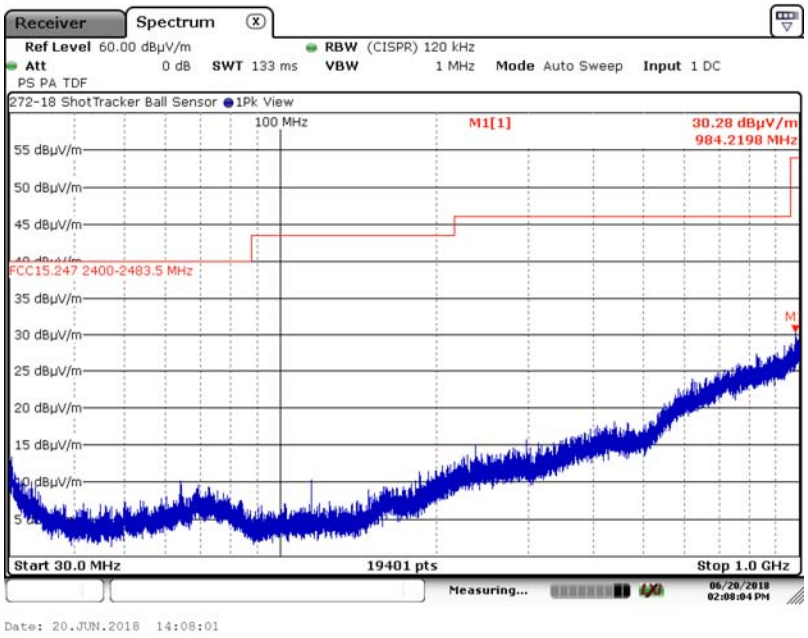
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

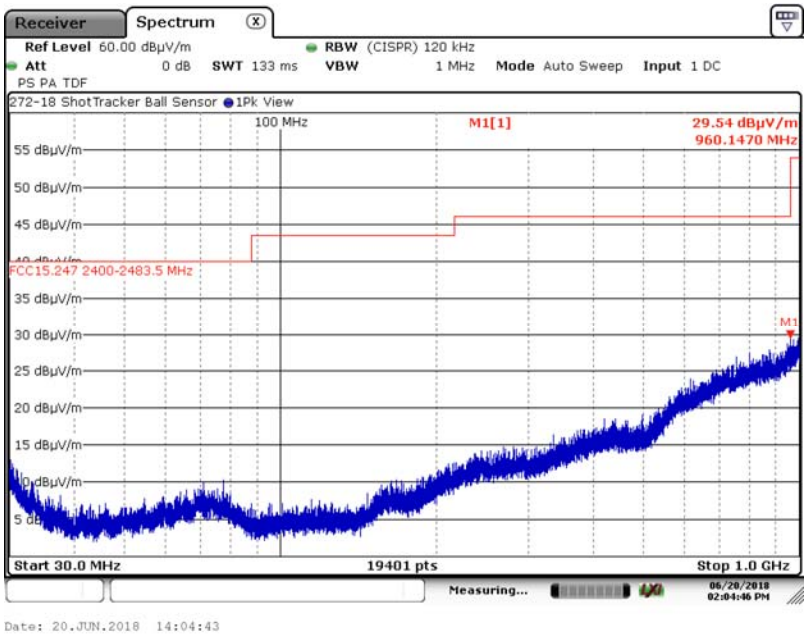
A3. Spurious Radiated Emissions (30 MHz – 1 GHz) Test Results

A3.2. Middle Frequency: Channel 17, 2440 MHz

A3.2.5. Measurement Results: Z-Axis, Horizontal Antenna



A3.2.6. Measurement Results: Z-Axis, Vertical Antenna



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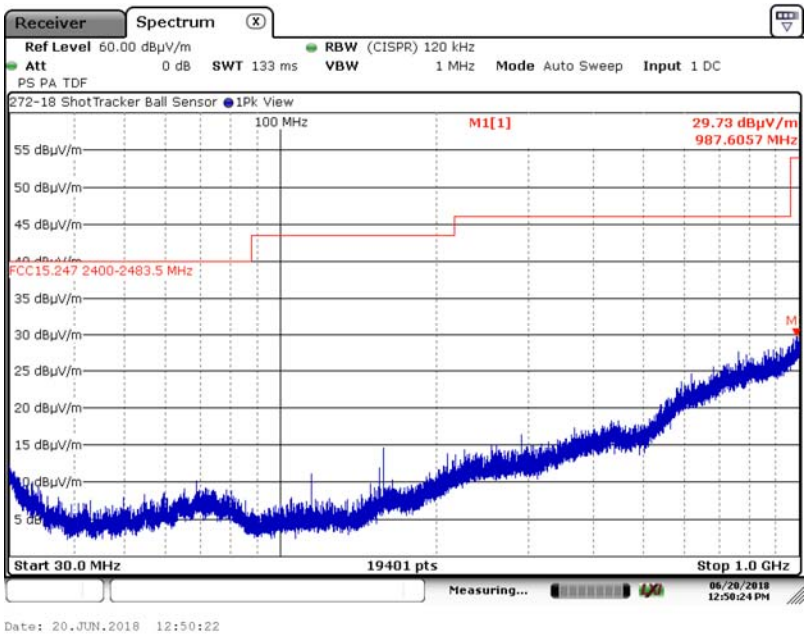
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

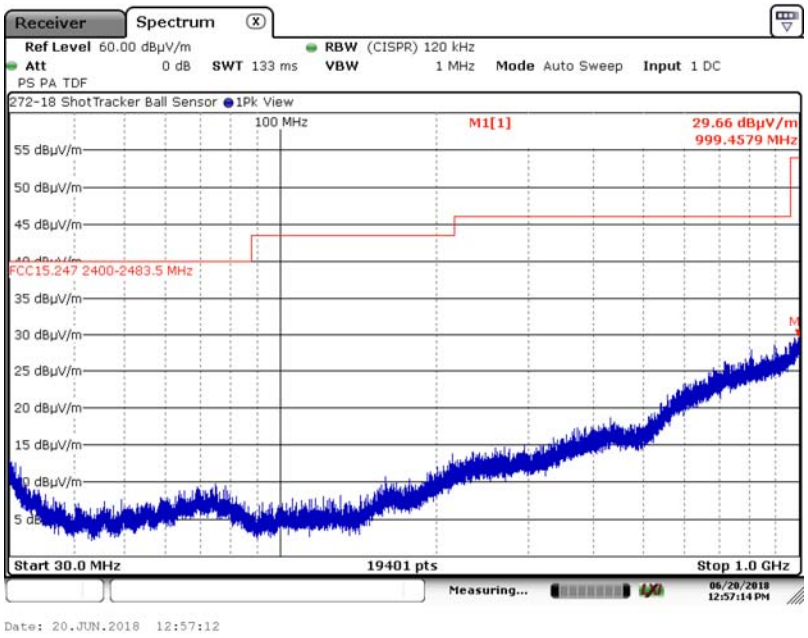
A3. Spurious Radiated Emissions (30 MHz – 1 GHz) Test Results

A3.3. High Frequency: Channel 39, 2480 MHz

A3.3.1. Measurement Results: X-Axis, Horizontal Antenna



A3.3.2. Measurement Results: X-Axis, Vertical Antenna



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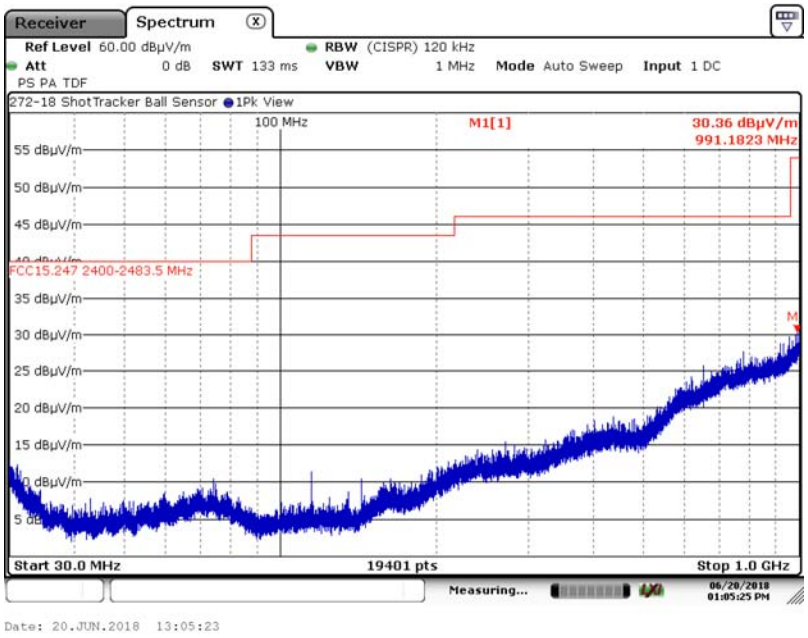
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

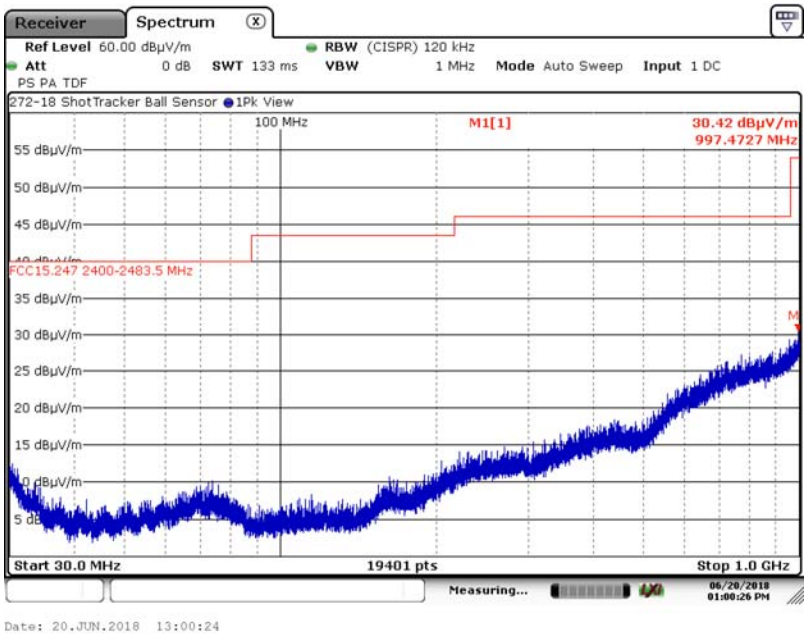
A3. Spurious Radiated Emissions (30 MHz – 1 GHz) Test Results

A3.3. High Frequency: Channel 39, 2480 MHz

A3.3.3. Measurement Results: Y-Axis, Horizontal Antenna



A3.3.4. Measurement Results: Y-Axis, Vertical Antenna



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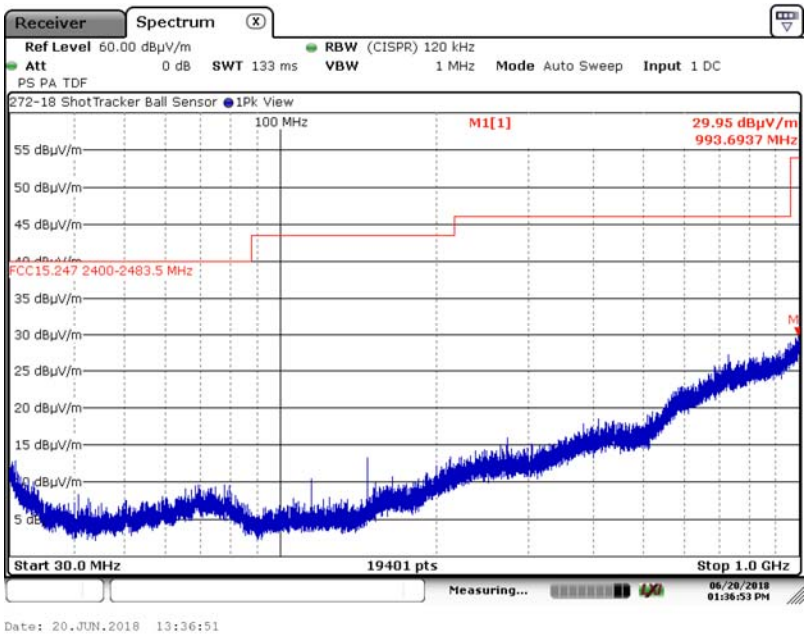
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

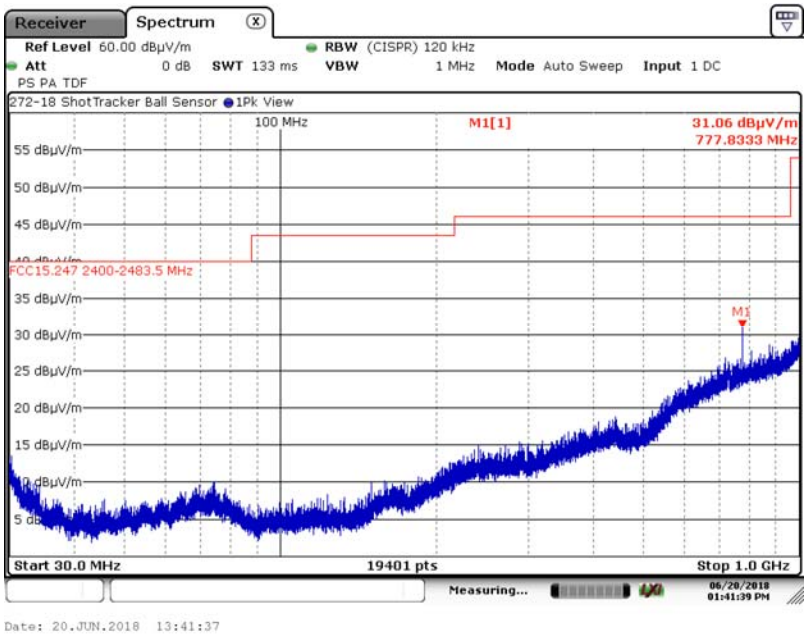
A3. Spurious Radiated Emissions (30 MHz – 1 GHz) Test Results

A3.3. High Frequency: Channel 39, 2480 MHz

A3.3.5. Measurement Results: Z-Axis, Horizontal Antenna



A3.3.6. Measurement Results: Z-Axis, Vertical Antenna



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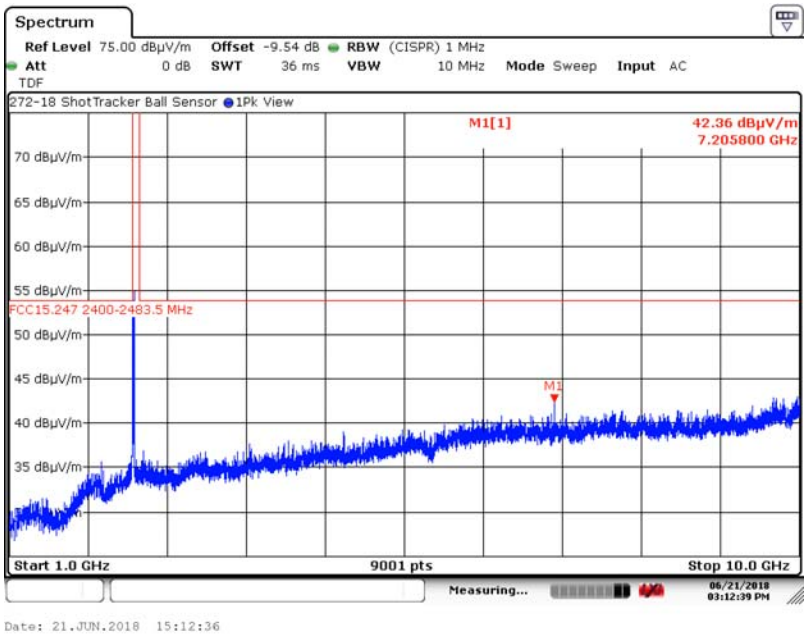
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

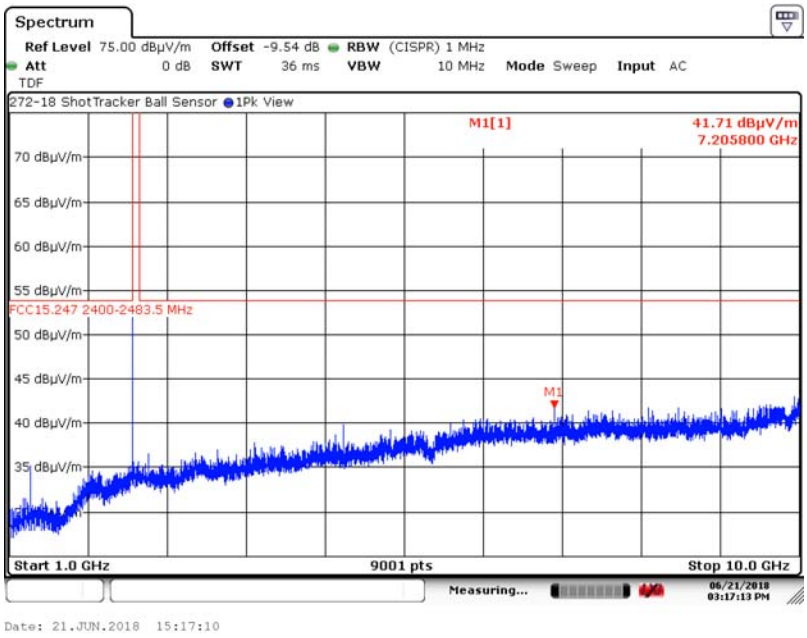
A4. Spurious Radiated Emissions (1 GHz – 10 GHz) Test Results

A4.1. Channel 37, 2402 MHz

A4.1.1. Measurement Results: X-Axis, Horizontal Antenna



A4.1.2. Measurement Results: X-Axis, Vertical Antenna



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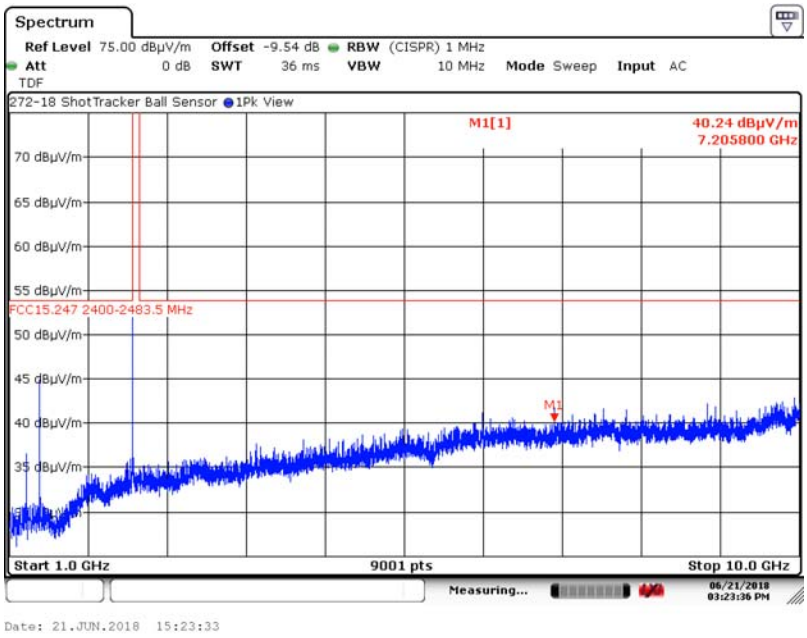
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

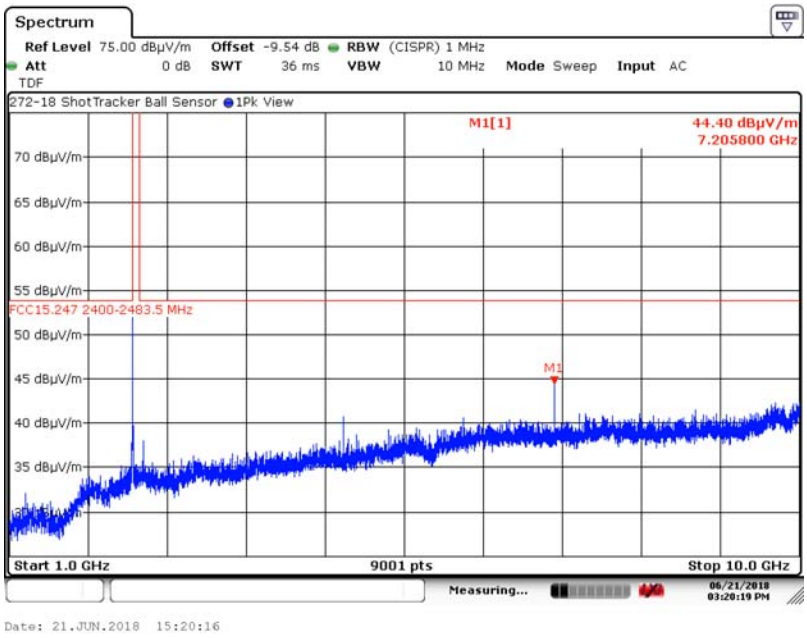
A4. Spurious Radiated Emissions (1 GHz – 10 GHz) Test Results

A4.1. Channel 37, 2402 MHz

A4.1.3. Measurement Results: Y-Axis, Horizontal Antenna



A4.1.4. Measurement Results: Y-Axis, Vertical Antenna



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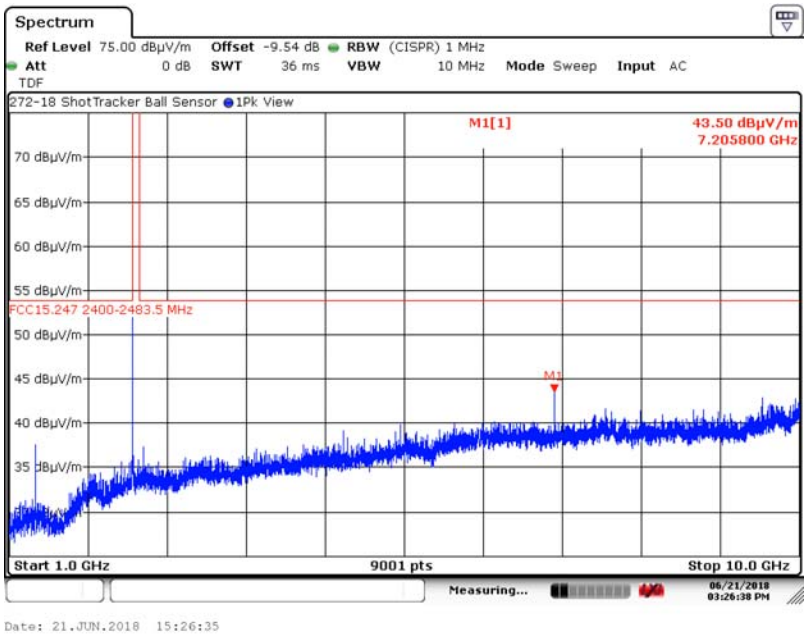
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

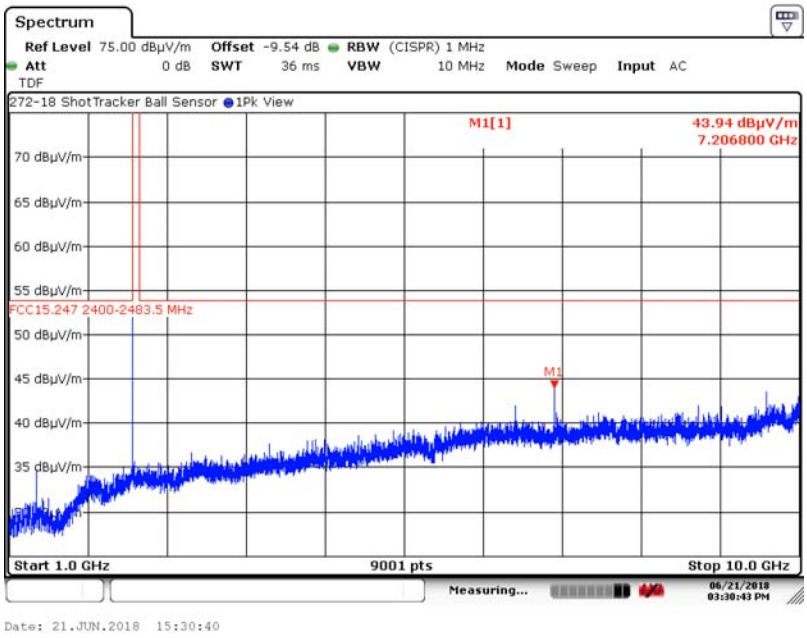
A1. Spurious Radiated Emissions (1 GHz – 10 GHz) Test Results

A4.1. Channel 37, 2402 MHz

A4.1.5. Measurement Results: Z-Axis, Horizontal Antenna



A4.1.6. Measurement Results: Z-Axis, Vertical Antenna



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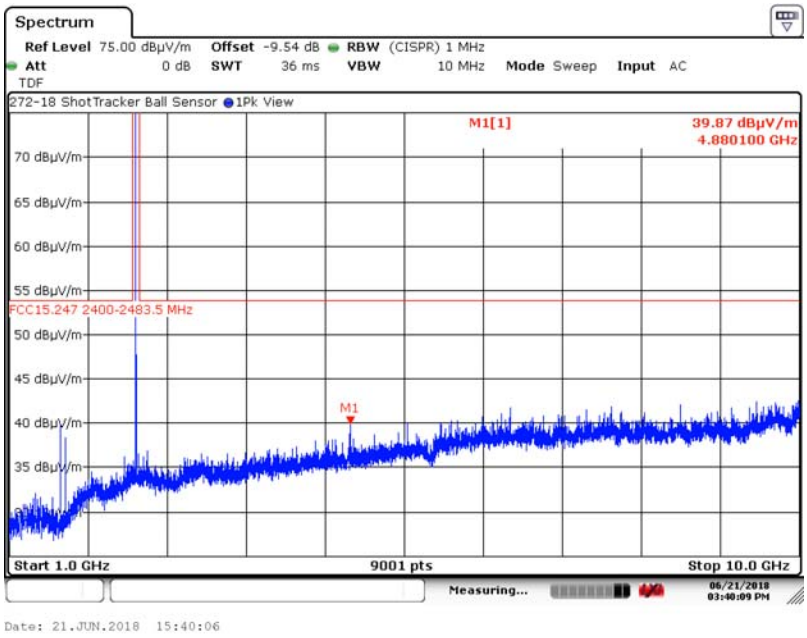
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

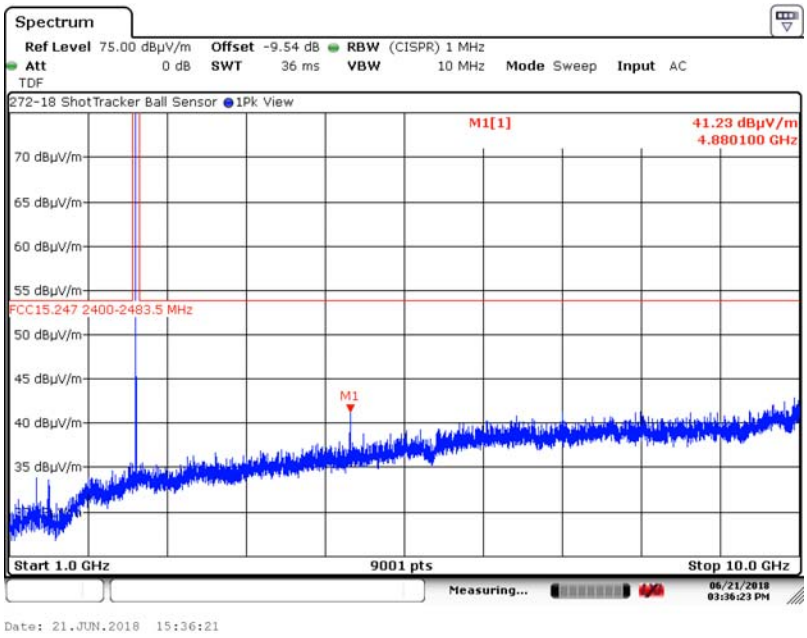
A4. Spurious Radiated Emissions (1 GHz – 10 GHz) Test Results

A4.2. Channel 17, 2440 MHz

A4.2.1. Measurement Results: X-Axis, Horizontal Antenna



A4.2.2. Measurement Results: X-Axis, Vertical Antenna



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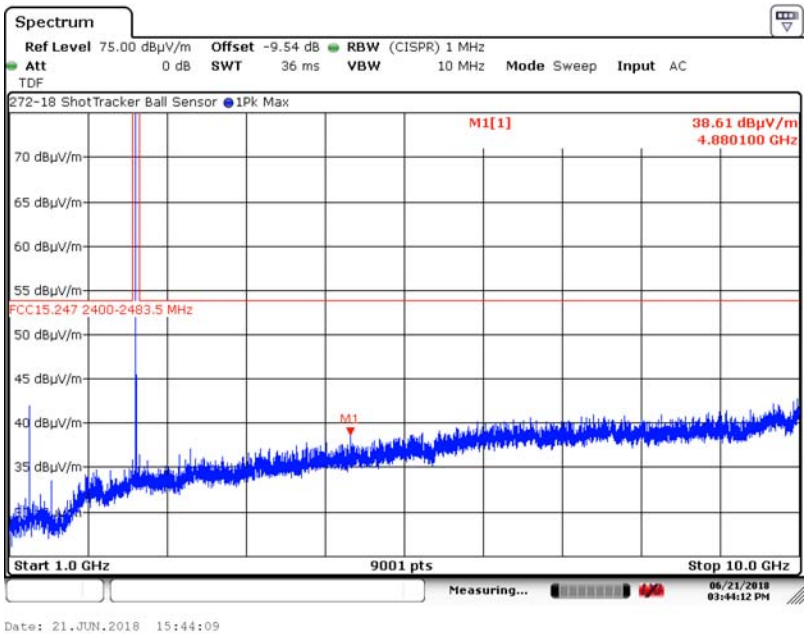
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

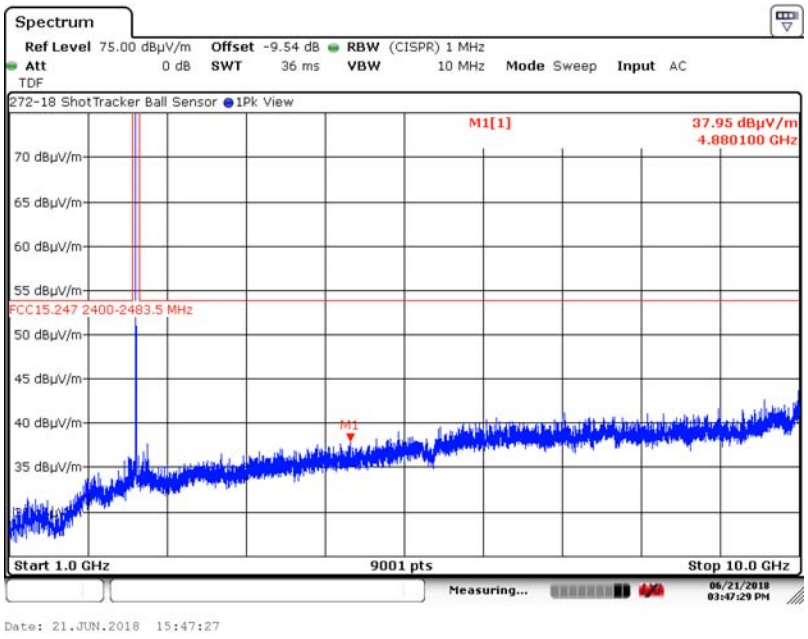
A4. Spurious Radiated Emissions (1 GHz – 10 GHz) Test Results

A4.2. Channel 17, 2440 MHz

A4.2.3. Measurement Results: Y-Axis, Horizontal Antenna



A4.2.4. Measurement Results: Y-Axis, Vertical Antenna



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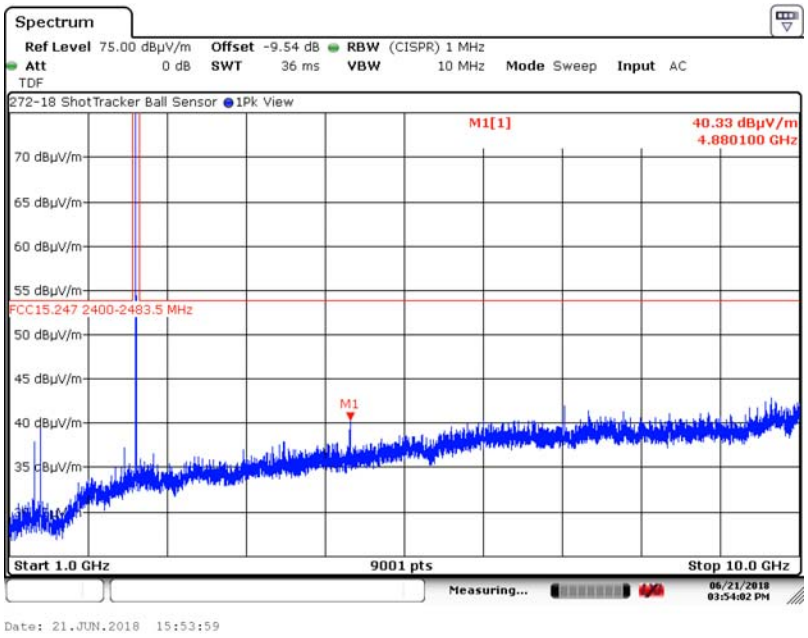
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

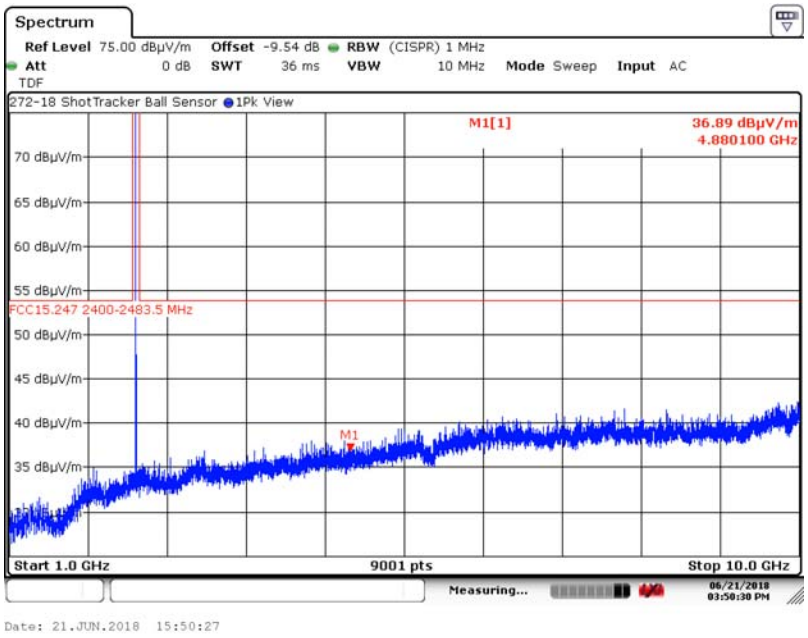
A4. Spurious Radiated Emissions (1 GHz – 10 GHz) Test Results

A4.2. Channel 17, 2440 MHz

A4.2.5. Measurement Results: Z-Axis, Horizontal Antenna



A4.2.6. Measurement Results: Z-Axis, Vertical Antenna



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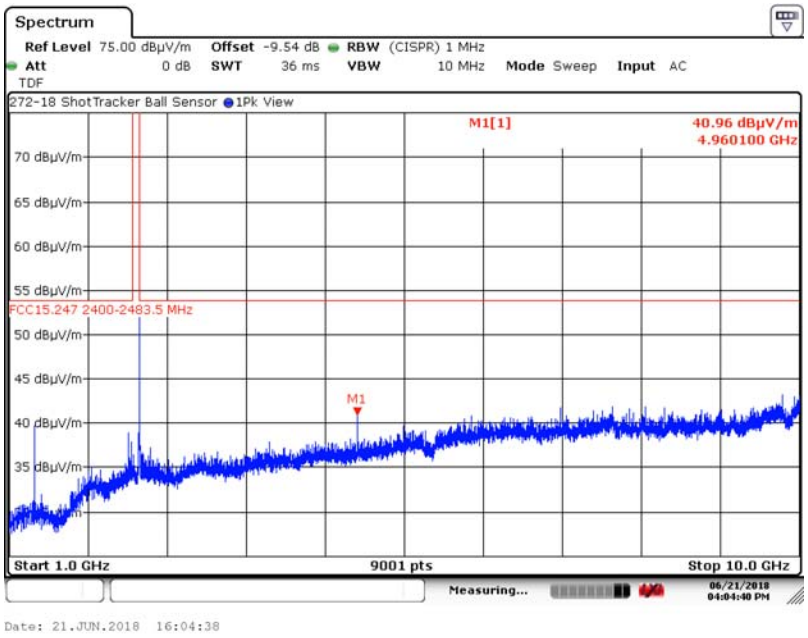
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

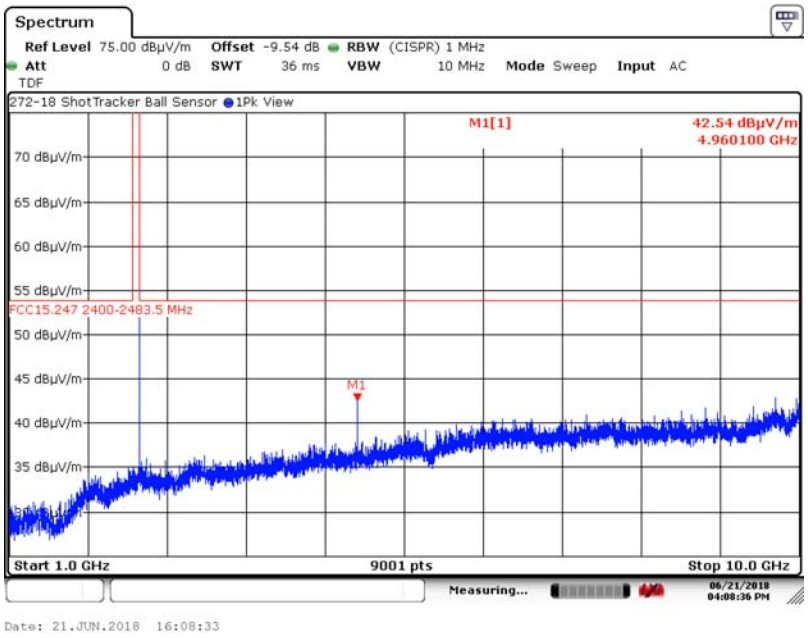
A4. Spurious Radiated Emissions (1 GHz – 10 GHz) Test Results

A4.3. Channel 39, 2480 MHz

A4.3.1. Measurement Results: X-Axis, Horizontal Antenna



A4.3.2. Measurement Results: X-Axis, Vertical Antenna



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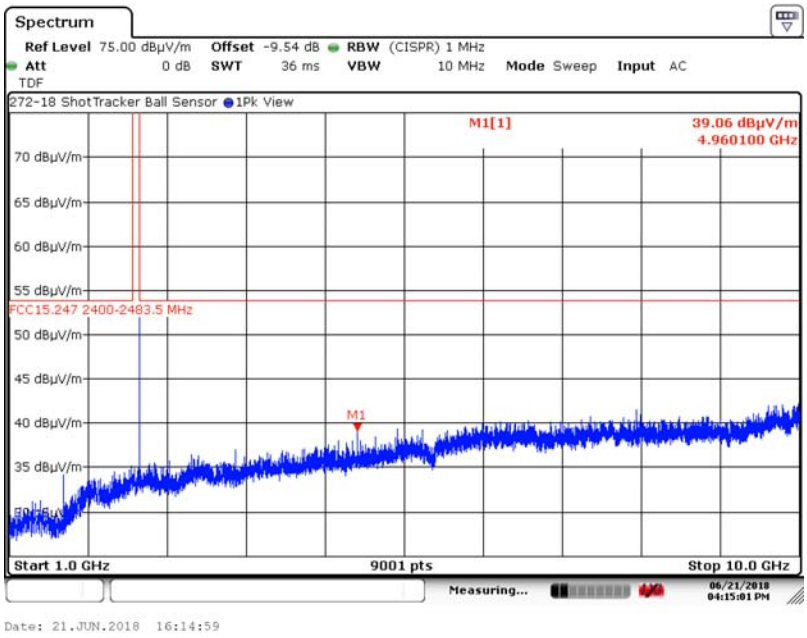
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

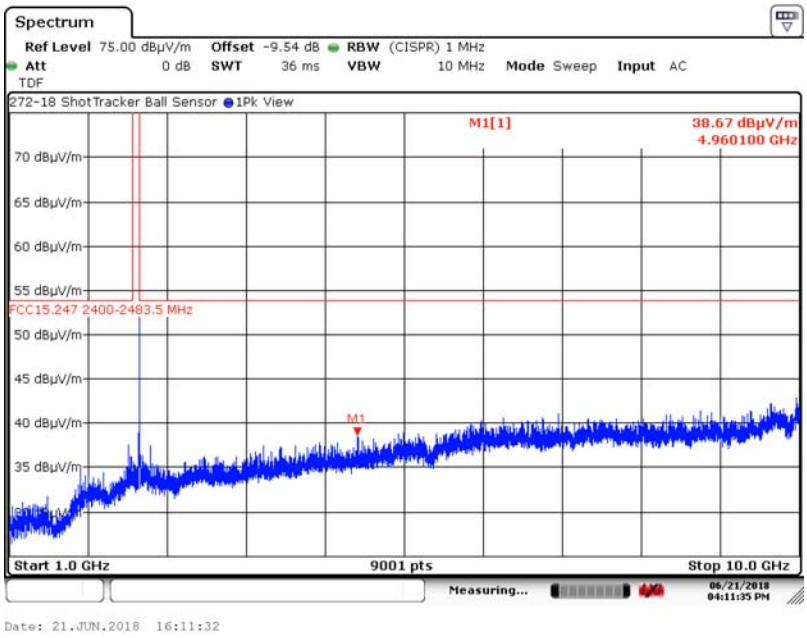
A4. Spurious Radiated Emissions (1 GHz – 10 GHz) Test Results

A4.3. Channel 39, 2480 MHz

A4.3.3. Measurement Results: Y-Axis, Horizontal Antenna



A4.3.4. Measurement Results: Y-Axis, Vertical Antenna



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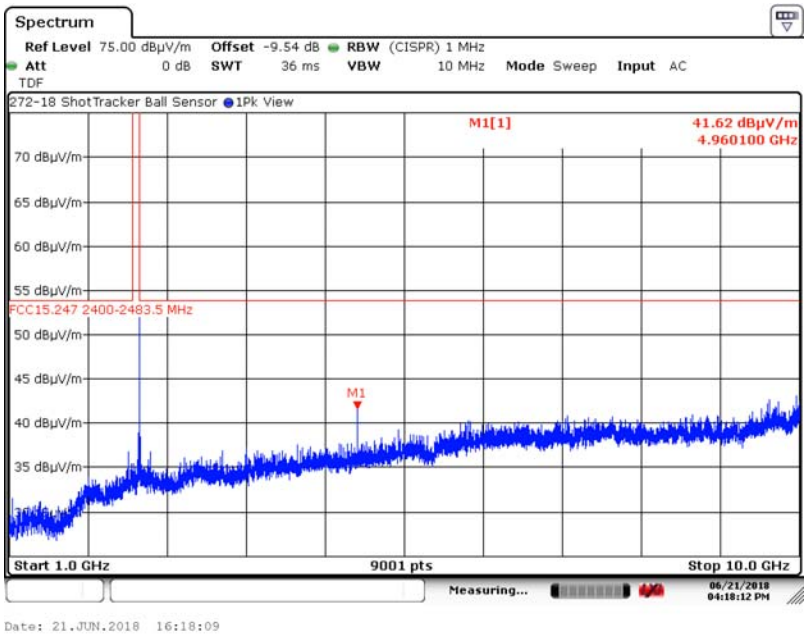
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

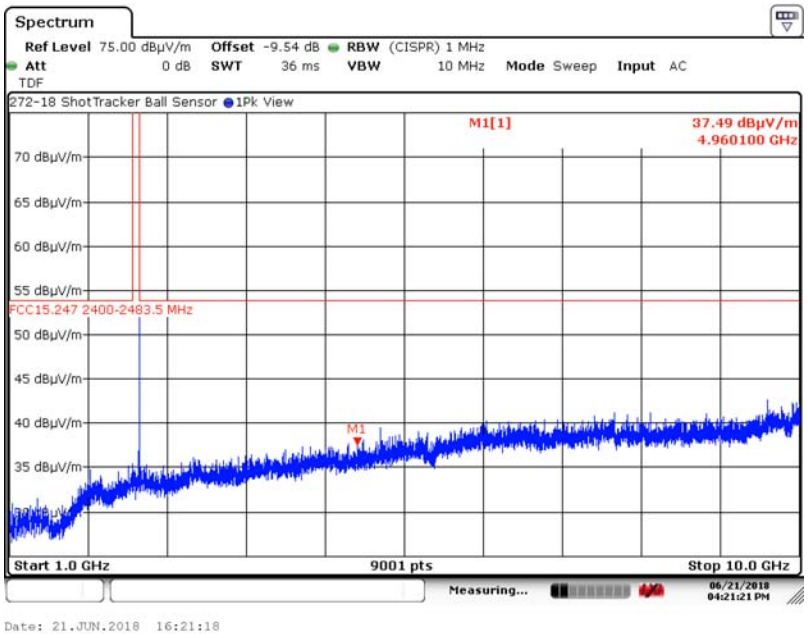
A4. Spurious Radiated Emissions (1 GHz – 10 GHz) Test Results

A4.3. Channel 39, 2480 MHz

A4.3.5. Measurement Results: Z-Axis, Horizontal Antenna



A4.3.6. Measurement Results: Z-Axis, Vertical Antenna



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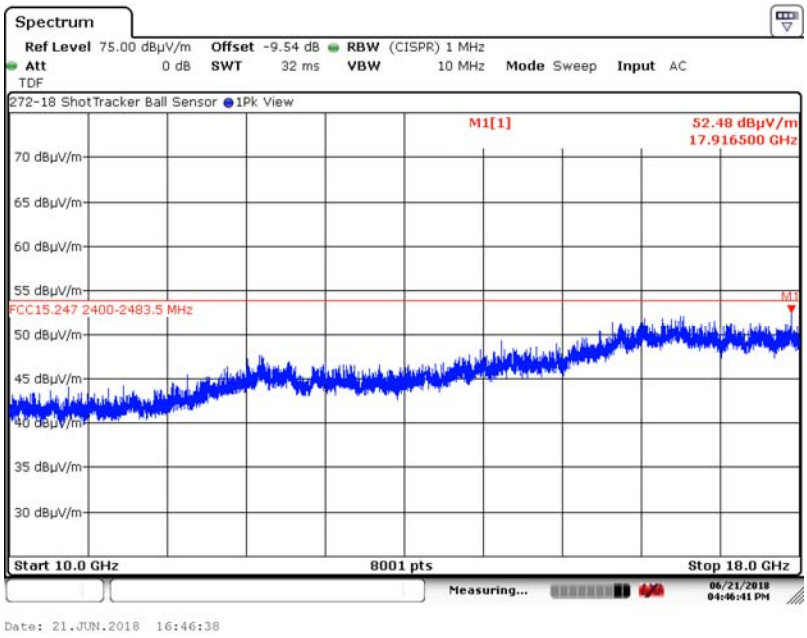
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

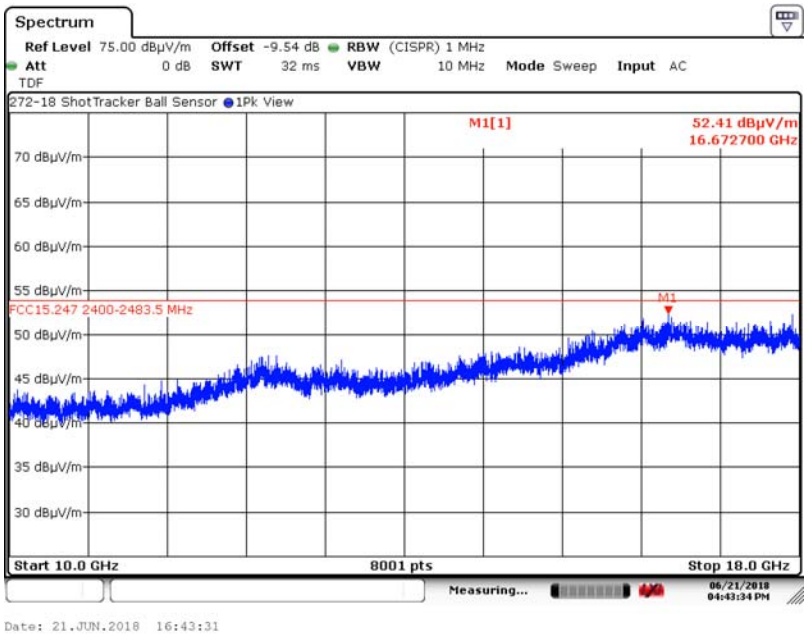
A5. Spurious Radiated Emissions (10 GHz – 18 GHz) Test Results

A5.1. Channel 39, 2480 MHz

A5.1.1. Measurement Results: X-Axis, Horizontal Antenna



A5.1.2. Measurement Results: X-Axis, Vertical Antenna



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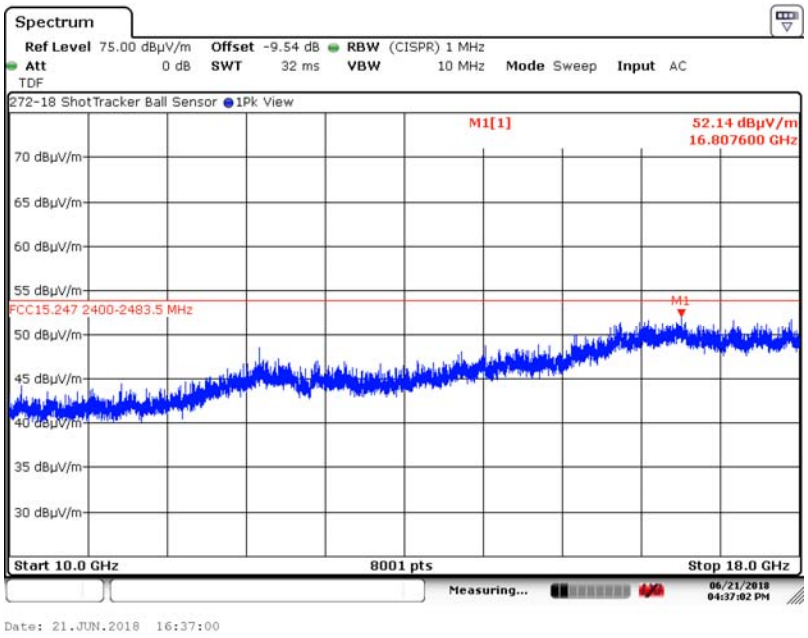
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

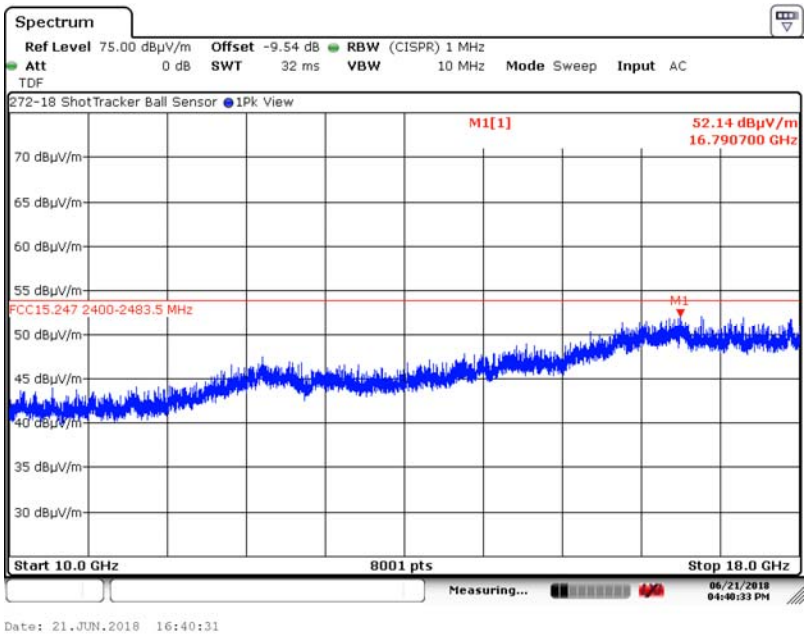
A5. Spurious Radiated Emissions (10 GHz – 18 GHz) Test Results

A5.1. Channel 39, 2480 MHz

A5.1.3. Measurement Results: Y-Axis, Horizontal Antenna



A5.1.4. Measurement Results: Y-Axis, Vertical Antenna



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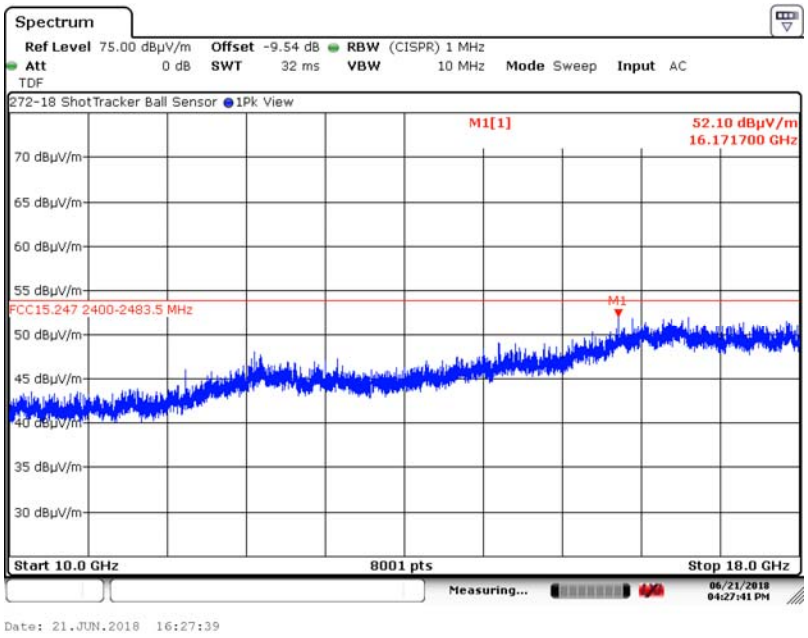
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

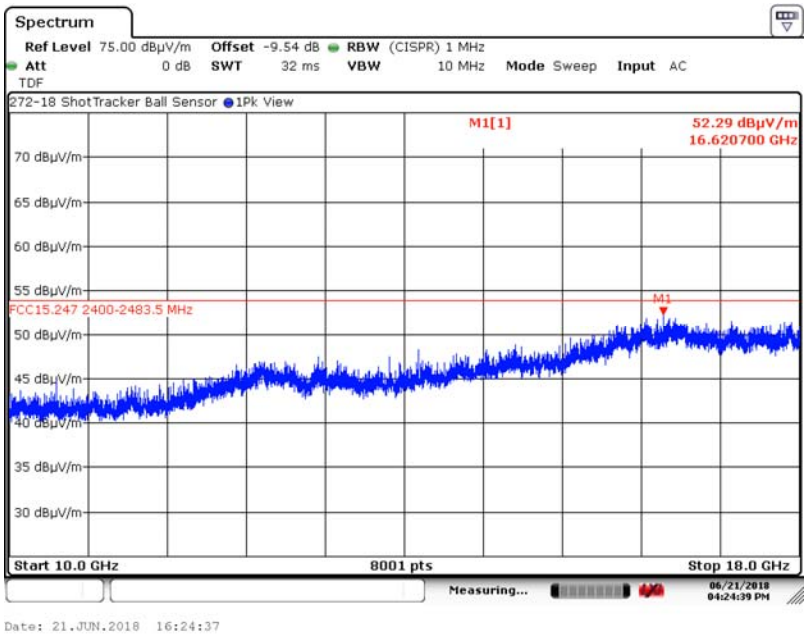
A5. Spurious Radiated Emissions (10 GHz – 18 GHz) Test Results

A5.1. Channel 39, 2480 MHz

A5.1.5. Measurement Results: Z-Axis, Horizontal Antenna



A5.1.6. Measurement Results: Z-Axis, Vertical Antenna



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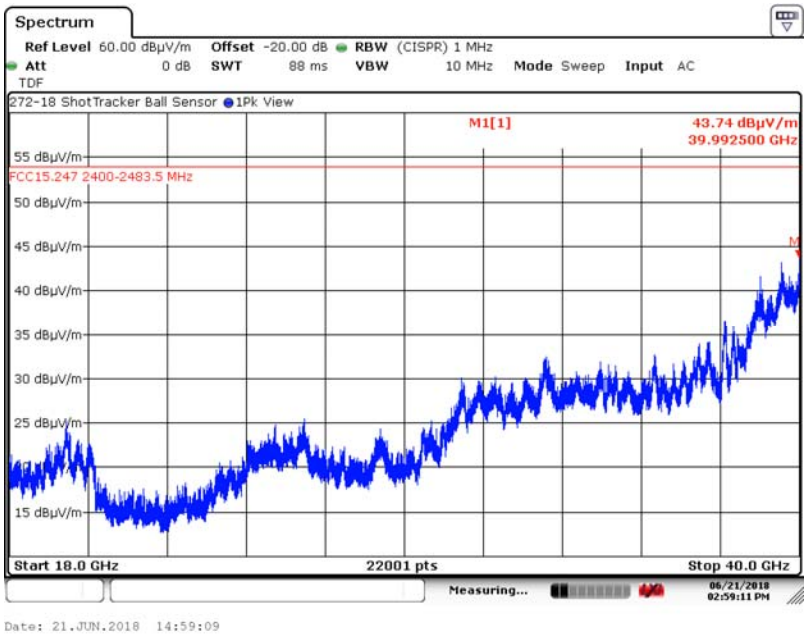
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

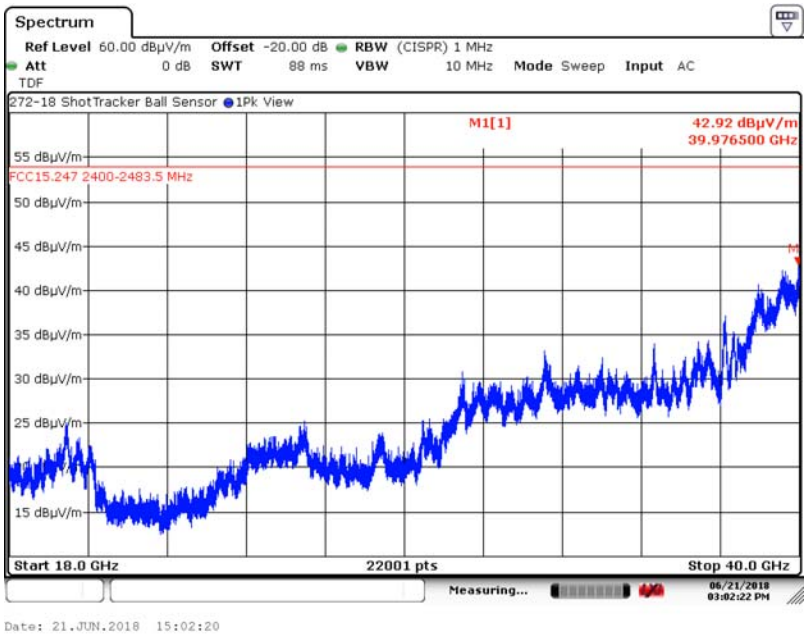
A6. Spurious Radiated Emissions (18 GHz – 40 GHz) Test Results

A6.1. Channel 37, 2402 MHz

A6.1.1. Measurement Results: X-Axis, Horizontal Antenna



A6.1.2. Measurement Results: X-Axis, Vertical Antenna



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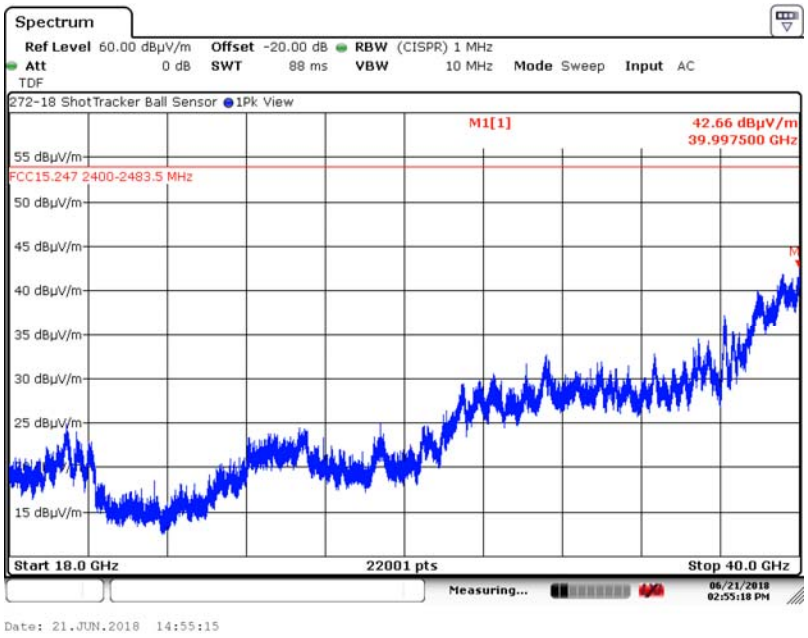
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

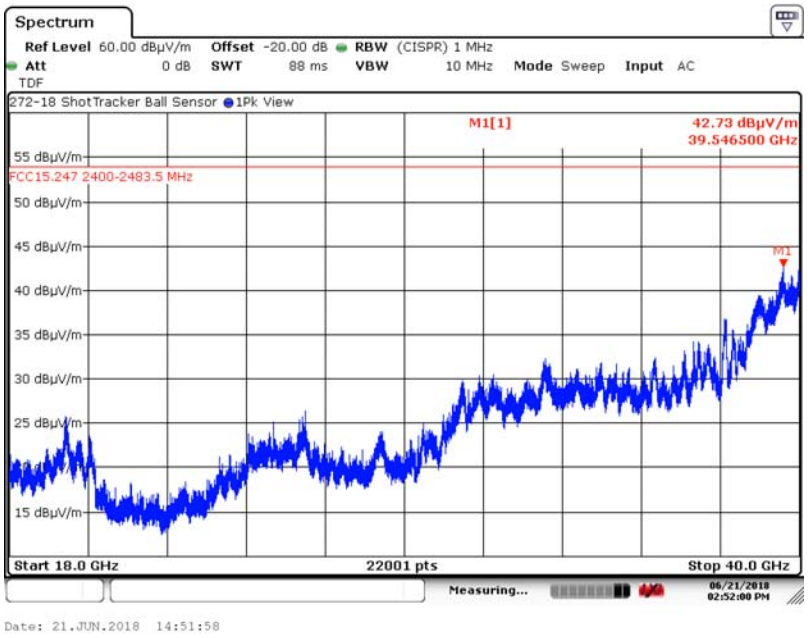
A6. Spurious Radiated Emissions (18 GHz – 40 GHz) Test Results

A6.2. Channel 17, 2440 MHz

A6.2.1. Measurement Results: X-Axis, Horizontal Antenna



A6.2.2. Measurement Results: X-Axis, Vertical Antenna



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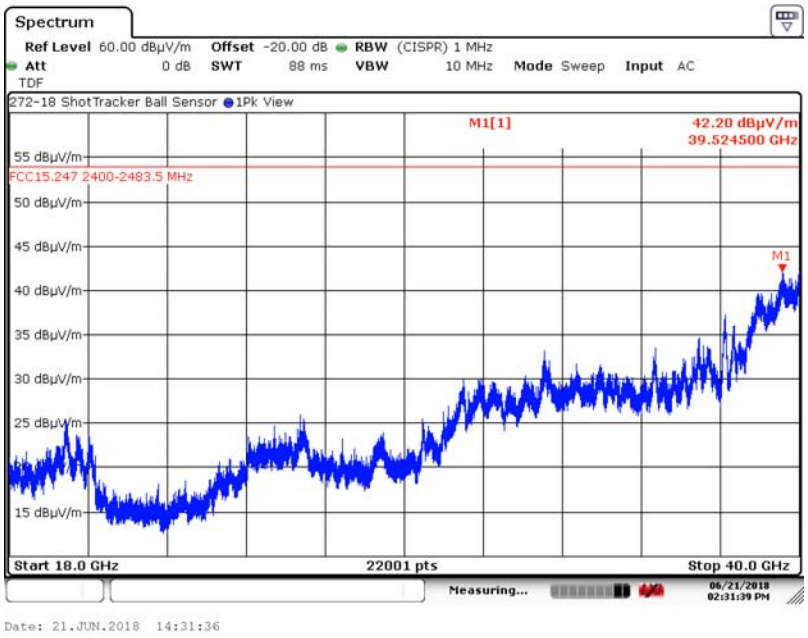
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

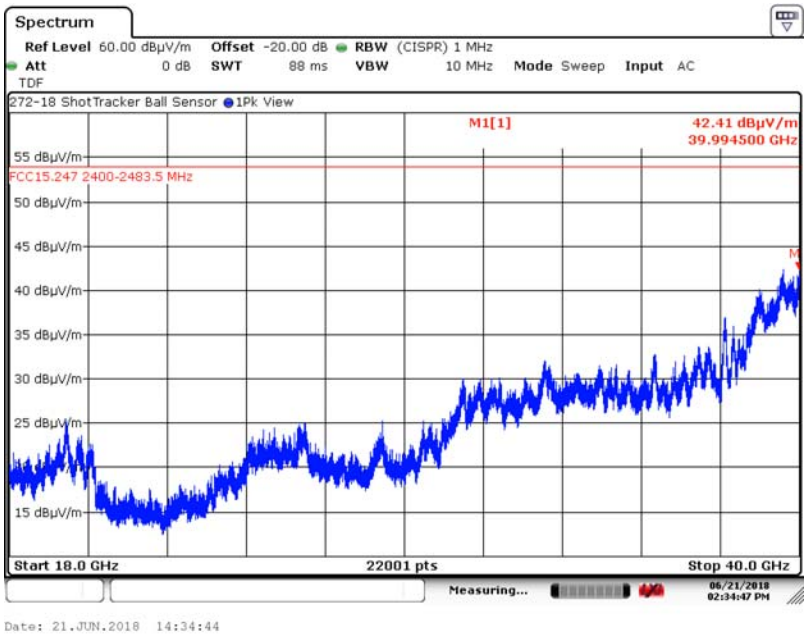
A6. Spurious Radiated Emissions (18 GHz – 40 GHz) Test Results

A6.3. Channel 39, 2480 MHz

A6.3.1. Measurement Results: X-Axis, Horizontal Antenna



A6.3.2. Measurement Results: X-Axis, Vertical Antenna



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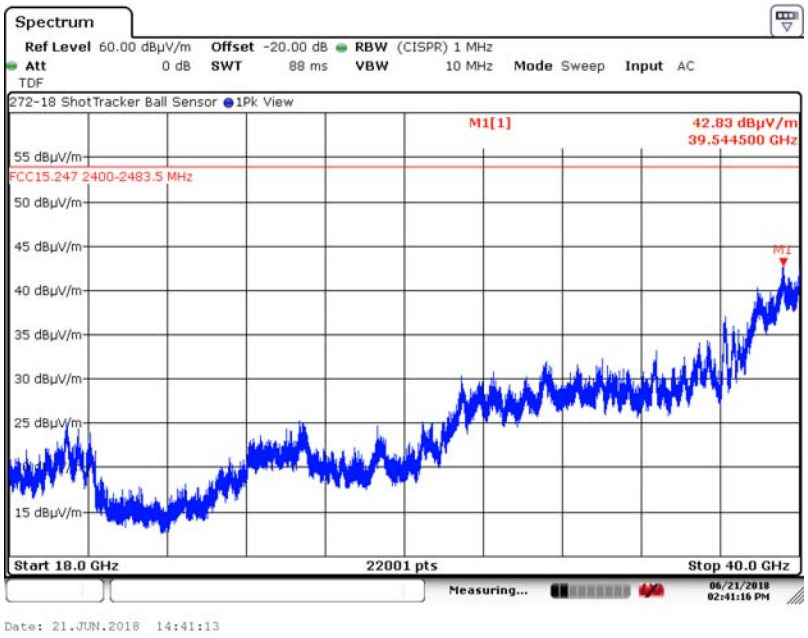
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

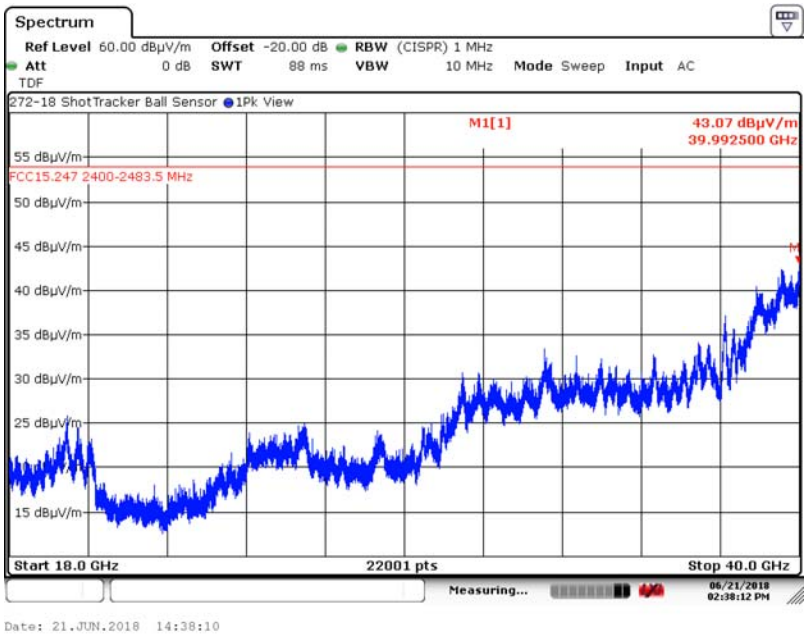
A6. Spurious Radiated Emissions (18 GHz – 40 GHz) Test Results

A6.3. Channel 39, 2480 MHz

A6.3.3. Measurement Results: Y-Axis, Horizontal Antenna



A6.3.4. Measurement Results: Y-Axis, Vertical Antenna



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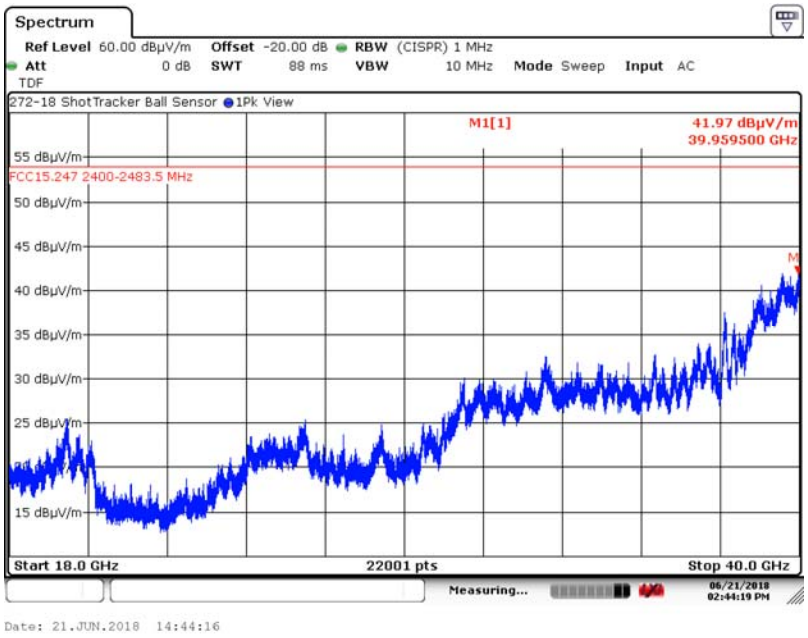
Appendix A - Transmitter Spurious Radiated Emissions (10 kHz to 40 GHz)

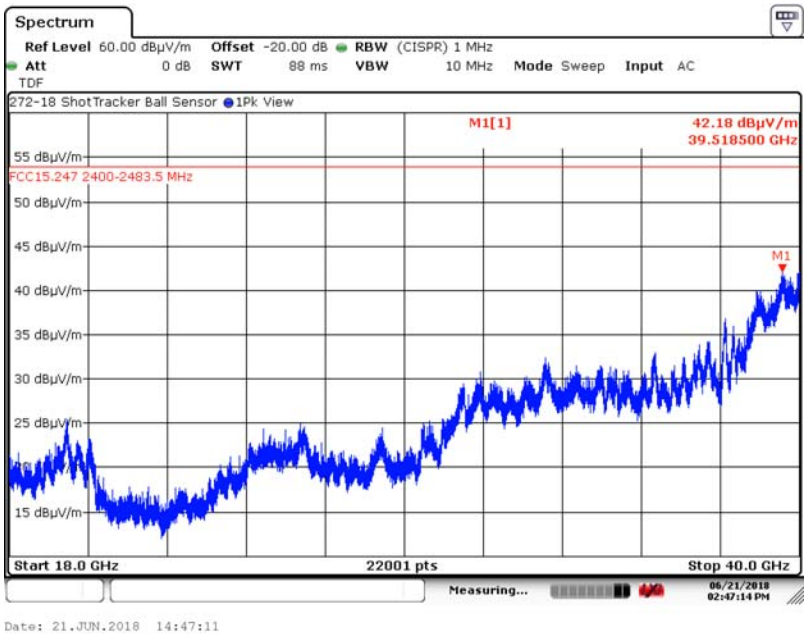
A6. Spurious Radiated Emissions (18 GHz – 40 GHz) Test Results

A6.3. Channel 39, 2480 MHz

A6.3.5. Measurement Results: Z-Axis, Horizontal Antenna



A6.3.6. Measurement Results: Z-Axis, Vertical Antenna



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