Testing Cert # 2778.01



# *Segway PT-SE*

# Report of FCC and Industry Canada Intentional Radiator Testing

| | |
|---|---|
| **Prepared For:** | ***Stephen Phillips*** |
| **Company** | ***Segway Inc.<br>14 Technology Drive<br>Bedford, NH 03110*** |
| **Applicable Models** | ***PT-SE*** |
| **Test Laboratory** | ***Core Compliance Testing Services, LLC<br>79 River Road<br>Hudson, NH 03051*** |
| **Test Dates** | ***August 11 – 21, 2014*** |
| **Tested & Reviewed By** | ***Ken MacGrath, Manager<br>George Correia, Test Engineer*** |
| **Signature** | Kenneth McGrath |

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# 1.0 GENERAL INFORMATION

## 1.1 Product Description

Equipment Under Test (EUT): PT-SE Personal Transporter
Manufacturer: Segway Inc.
Applicable Models: PT-SE
Serial Number: 132361085597

<u>EUT Technical Specifications:</u>

A) Operation Frequency: 2405 – 2480 MHz, 16 channels

1. Low Channel #11, 2.405 GHz
2. Mid Channel #18, 2.440 GHz
3. High Channel #26, 2.480 GHz

B) Rated output power: 0.06mW (-12.2dBm) (based on test results, ref: 4.3)

C) Modulation type: IEEE 802.15.4 Modulation Format

D) Antenna Designation: PCB trace antenna, non-user replaceable (fixed), 1.0dBi (1.259 numerical gain). Three test points were removed from the antenna balun.

E) This report documents the results for the Model PT-SE which is a personal transporter.

F) FCC ID: T2Z-23444
IC: 6395A-23444

## 1.2 Applicable Documents and Standards

This test report is based on the following standards.

Intentional Radiators:

- FCC CFR 47, Part 15, Subpart C, Section 15.247
- Industry Canada RSS-210, Annex A8.2, Digital Modulation Systems
- ANSI C63.10: 2013
- FCC KDB 558074

Unintentional Radiators:

- EN55022: 2006, Information Technology Equipment, Class B
- FCC CFR47, Part 15, Subpart B, Digital Devices, Class B
- ICES-003, Issue 5, August 2012, Information Technology Equipment, Class B
- AS/NZS CISPR 22: 2006, Information Technology Equipment, Class B

## 1.3 Test Dates

August 11 - 21, 2014

## 1.4 Test Methodology

Testing was done according to the standards listed in section 1.2. Radiated testing was performed at an antenna-to-EUT distance of 3-meters.

This testing was done to support a Class II Permissive Change. The change made to the EUT was three test points were removed from the antenna balun. Please refer to Appendix A for drawings showing the test point removal.

## 1.5 Test Facility

The Open Area Test Site (OATS) and ferrite lined shielded chamber used to collect the radiated data is located at Core Compliance Testing Services, 79 River Road, Hudson, NH. The OATS is constructed and calibrated to meet the FCC requirements of ANSI C63.4: 2003, MP5, and OST-55. The test facility is listed with the FCC (registration number 792478) and ISO 17025 accredited by A2LA (2778.01).

## 1.6 Test Equipment List

All equipment used in the testing process has up to date calibrations traceable to the National Institute of Standards and Technology (NIST). Refer to the Table 1 on the following page for a complete list of equipment used during the test.

**Table 1: Test Equipment**

| Asset # | Description | Manufacturer | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| 3 | Preamplifier 8447F OPT H64 | Agilent/HP | 8447F-H64 | 3113A07400 | 12/26/13 | 12/26/15 |
| 4 | LISN | Rohde & Schwarz | ESH3-Z5 | 826789/014 | 12/26/13 | 12/26/14 |
| 6 | EMI Receiver | HP | 8546A/85460A | 3906A00498 | 01/24/14 | 01/24/15 |
| 15 | Horn Antenna | EMCO | 3115 | 9906-5841 | 2/06/13 | 2/06/15 |
| 19 | Pre amplifier | HP/Agilent | 08449B | 3008A01322 | 12/26/13 | 12/26/14 |
| 20 | 8-meter Low Loss Cable | Andrew | ETS1-50T | 0081108339 | 03/05/14 | 03/05/15 |
| 21 | 25-meter Low Loss Cable | Andrew | ETS1-50T | 00A1108341 | 02/06/13 | 02/06/15 |
| 30 | Semi-Anechoic chamber | Keene Ray Proof | N/A | 8298 | 03/30/14 | 03/30/15 |
| 46 | Antenna | Chase | CBL6111 | 2602 | 12/20/13 | 12/20/14 |
| 51,52 | Receiver | Rohde & Schwarz | ESMI | 845364/009 | 12/08/13 | 12/08/14 |
| 61 | 8-meter Low Loss Cable | Andrew | ETS1-50T | 00A1108347 | 6/19/14 | 6/19/15 |
| 103 | Magnetic Loop Antenna | A.H.Systems | SAS-200/562B | 216 | 3/18/14 | 3/18/15 |
| 109 | Alternative Open Area Test Site | Strongwell | 10 Meter | None | 12/15/12 | 12/15/15 |
| 123 | Spectrum Analyzer | HP | E4405B | US39440317 | 12/26/13 | 12/26/14 |
| 126 | Horn Antenna | A.H.Systems | SAS-571 | 782 | 5/11/13 | 5/11/15 |

*All equipment used for testing has been calibrated according to methods and procedures defined by the National Institute of Standards and Technology (NIST).*

## 1.7 Measurement Uncertainty

The measurement uncertainty of radiated emissions data is 4.06 dB based on the test equipment used and the OATS site attenuation data.

## 1.8 Equipment Modifications

Not applicable.

## 2.0 SYSTEM TEST CONFIGURATION

### 2.1 EUT Configuration

The EUT configuration for testing was based on the requirements as given in the applicable standards and was operated in a manner which intends to maximize its emissions characteristics in a continuous transmit application. Constant transmit is not an intended mode of operation but was used to produce maximum emissions. Preliminary testing was done at voltage variations between 7.2VDC (which is the manufacturer specified low voltage of 8.0, –10%) and 9.9VDC (which is the manufacturer specified high voltage of 9.0, +10%). There was 0.2dBµV or less difference in the EUT transmitter output between 7.2 and 9.9 VDC; therefore, all testing was done at 9.0 VDC.

The EUT was placed on a short plastic stand for all testing.

### 2.2 EUT Exercise

The EUT has been tested under operating conditions and was programmed to allow it to remain in continuous transmitting mode.

The EUT was operated as follows:

| Transmit Channel | Transmit Freq. (MHz) | Transmit Power Level (dBm) | Test Mode | Modulation |
|---|---|---|---|---|
| Chan. 11 | 2405 | 0 (max) | continuous transmit | ON |
| Chan. 18 | 2440 | 0 (max) | continuous transmit | ON |
| Chan. 26 | 2480 | 0 (max) | continuous transmit | ON |

## 3.0 SUMMARY OF TEST RESULTS

**Table 2, Test Summary**

| Rules | Description Of Test | Test Report Section | Result |
|---|---|---|---|
| FCC 15.247(b)(3) | Peak Output Power (1 W) | 4.0 | *Pass* |
| FCC 15.247(a)(2), IC RSS-210, A8.2 | 6dB Bandwidth (≥500kHz) | 5.0 | *Pass* |
| FCC 15.247(d) | 100 KHz Bandwidth Of Frequency Band Edges | 6.0 | *Pass* |
| FCC 15.209(a) through (f) FCC Part 15, Subpart B, Class B, EN55022/CISPR22 Class B, ICES-003 Class B | Unintentional/Spurious Emissions | 7.0 | *Pass* |
| FCC 15.247(e), IC RSS-210, A8.2 | Peak Power Density (8dBm/3kHz) | 8.0 | *Pass* |
| FCC 15.203 | Antenna Requirement | 9.0 | *Pass* |
| FCC 15.207(a) | Conducted Emissions | N/A | **N/A* |

*Conducted Emissions was not done because the transmitter is not active when the unit is plugged in.  The EUT is only plugged in when the batteries need to be charged.

## 4.0 PEAK OUTPUT POWER MEASUREMENT

### 4.1 Applicable Standard

CFR 47, Part 15.247 (b) (3). For systems using digital modulation techniques in the 2400 – 2483.5 MHz band, the maximum peak conducted output power is 1.0 Watt.

### 4.2 Measurement Procedure

Place the EUT on the plastic stand and set it into transmitting mode. Measurements were made with and without modulation applied. It was found that with modulation produced equal or just slightly higher results so only these results are shown. It was also found that a higher peak output power was measured with the PT-SE laying down (handle bars down); therefore, these measurements were made with the EUT in this orientation.

Utilizing the radiated emissions method, the EUT was set up on a three meter OATS. The field strength was maximized by rotating the turntable and adjusting the antenna height. Measurements were further optimized for vertical and horizontal polarization of the receive antenna.

The peak field strength for each transmit frequency was recorded.

To convert field strength at 3 meters to power in Watts, the following formula was

Used: $P = (E \times d)^2 / (30 \times G)$

Where:
P = Power in Watts
E = Field strength in V/m
d = Measurement distance in meters
G = Numerical Gain of Antenna

Repeat the above procedures for each of the low, mid, and high frequency channels.

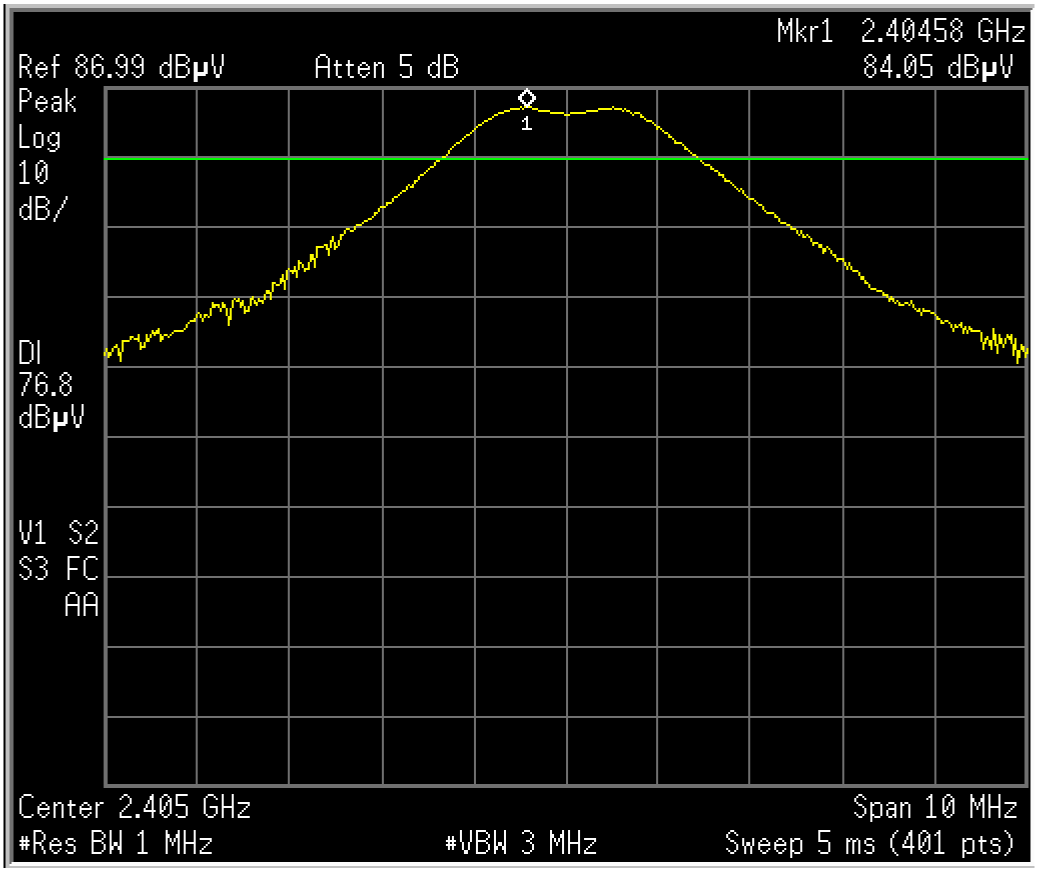
### 4.3 Measurement Results

| Maximum Conducted Output Power | | | | | | | |
|---|---|---|---|---|---|---|---|
| Channel | Frequency (MHz) | Field Strength (dBµV/m) | Field Strength (µV/m) | Antenna Numerical Gain | Power Calculation (mW) | Limit (mW) | Result |
| 11 | 2405 | 84.0 | 15849 | 1.259 | 0.06 | 1000.0 | Pass |
| 18 | 2440 | 82.1 | 12735 | 1.259 | 0.04 | 1000.0 | Pass |
| 26 | 2480 | 80.7 | 10839 | 1.259 | 0.03 | 1000.0 | Pass |

*Field strength includes cable loss, preamplifier gain, and antenna factor as shown below each of the following plots.

**Data plots for low, mid, and high channels**

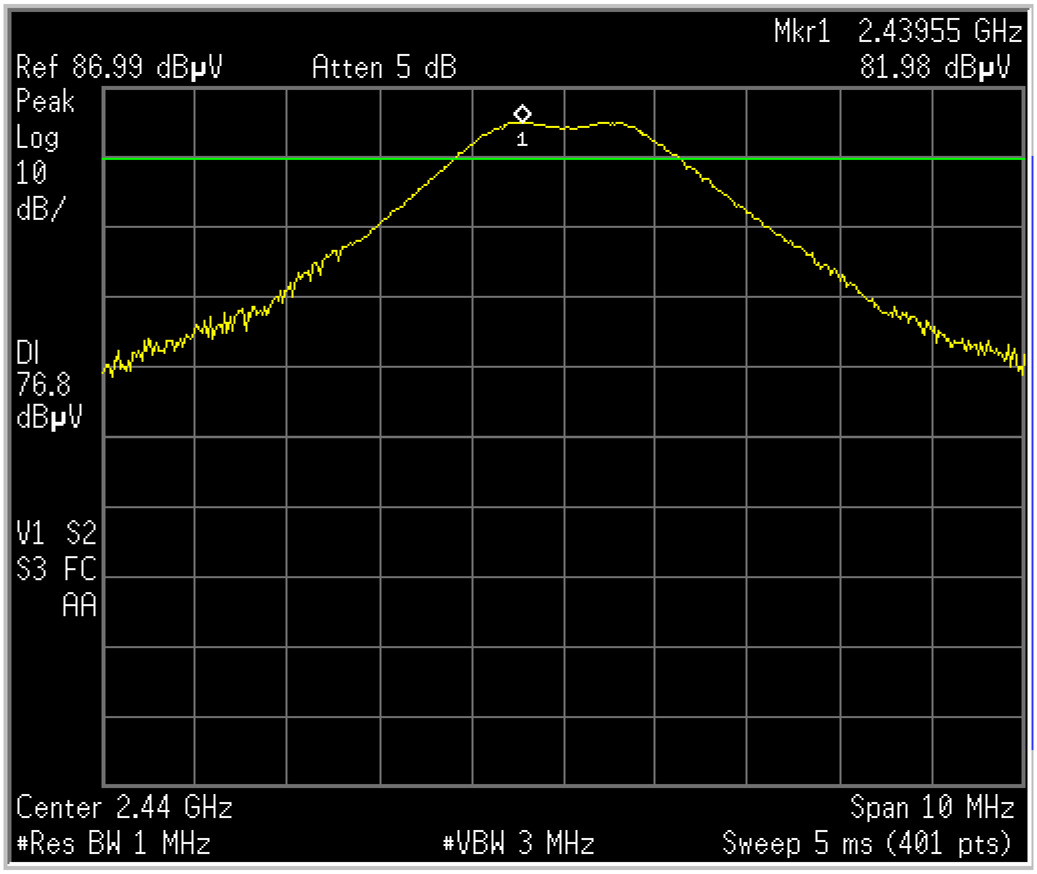
**Peak Power Output Data Plot (CH 11, Low)**




| Channel | Frequency (MHz) | Reading (dBµV) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Field Strength (dBµV/m) | Field Strength (µV/m) | Power Calculation (mW) | *EIRP (dBm) |
|---|---|---|---|---|---|---|---|---|---|
| 11 | 2405 | 84.1 | 8.3 | -37.2 | 28.8 | 84.0 | 15849 | 0.08 | -11.2 |

*EIRP calculation Ref: 4.2

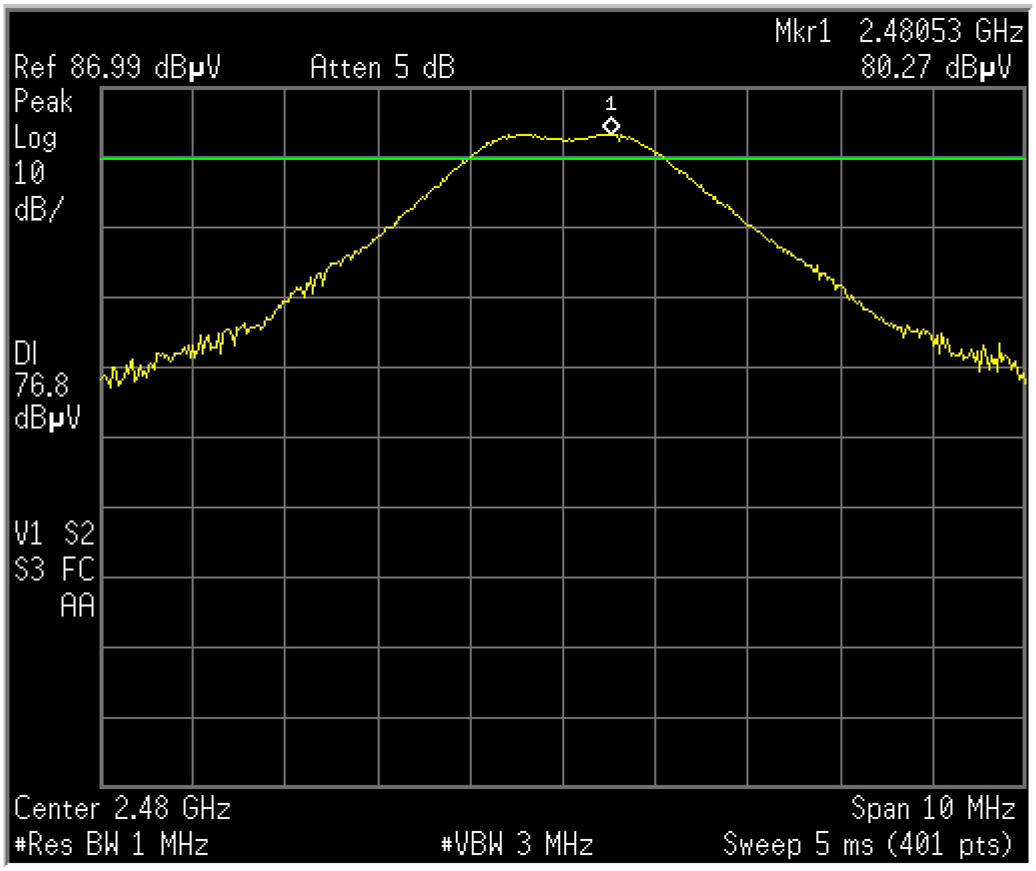
**Peak Power Output Data Plot (CH 18, Mid)**




| Channel | Frequency (MHz) | Reading (dBμV) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Field Strength (dBμV/m) | Field Strength (μV/m) | Power Calculation (mW) | *EIRP (dBm) |
|---|---|---|---|---|---|---|---|---|---|
| 18 | 2440 | 82.0 | 8.3 | -37.2 | 29.0 | 82.1 | 12735 | 0.05 | -13.1 |

*EIRP calculation Ref: 4.2

## Peak Power Output Data Plot (CH 26, High)




| Channel | Frequency (MHz) | Reading (dBµV) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Field Strength (dBµV/m) | Field Strength (µV/m) | Power Calculation (mW) | *EIRP (dBm) |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 2480 | 80.3 | 8.4 | -37.2 | 29.2 | 80.7 | 10839 | 0.04 | -14.5 |

*EIRP calculation Ref: 4.2

## 5.0 6dB BANDWIDTH

### 5.1 Applicable Standard

In accordance with FCC CFR 47, Part 15.247 (a)(2) and Industry Canada RSS-210, A8 and A8.2, systems using digital modulation techniques may operate in the 2400-2483.5 MHz band. The minimum 6 dB bandwidth shall be at least 500 kHz.

### 5.2 Measurement Procedure

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points that are attenuated by 6 dB, relative to the peak of the fundamental frequency.

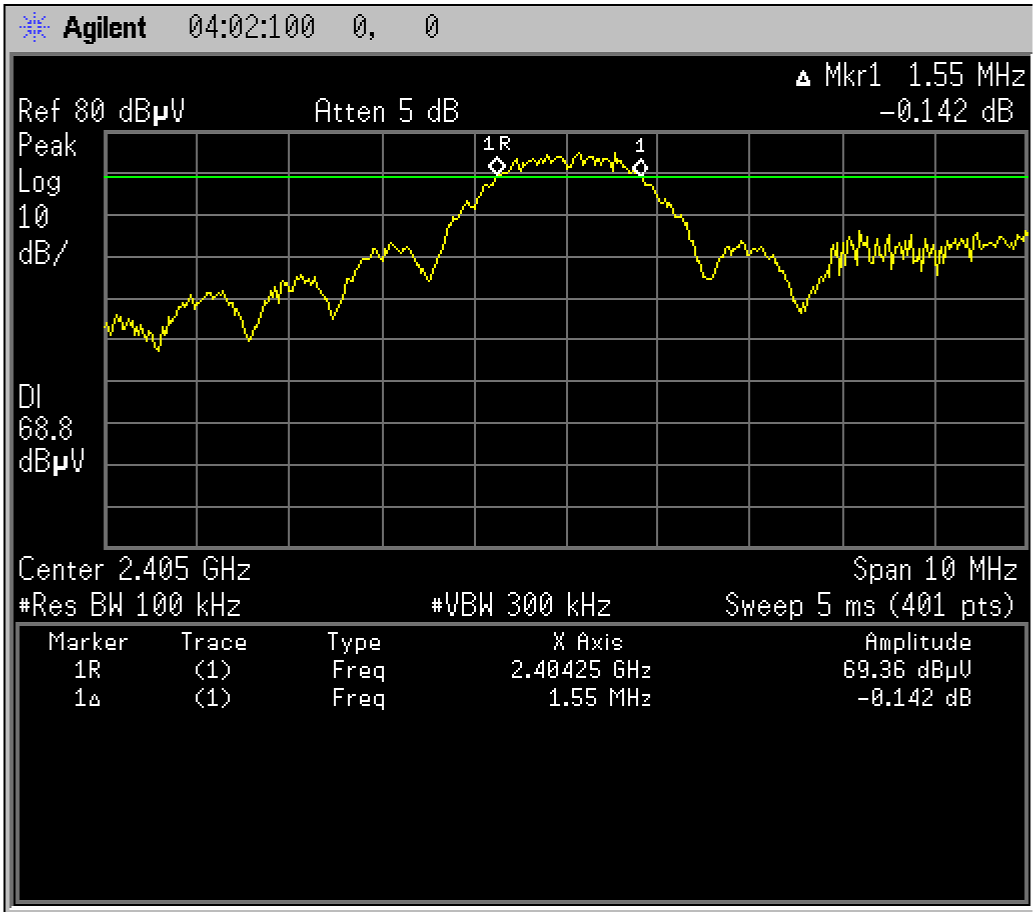
These measurements were performed at the low, mid, and high channel frequencies.

### 5.3 Measurement Result

| Channel | Bandwidth (MHz) |
|---|---|
| 11, Low | 1.55 |
| 18, Mid | 1.55 |
| 26, High | 1.55 |

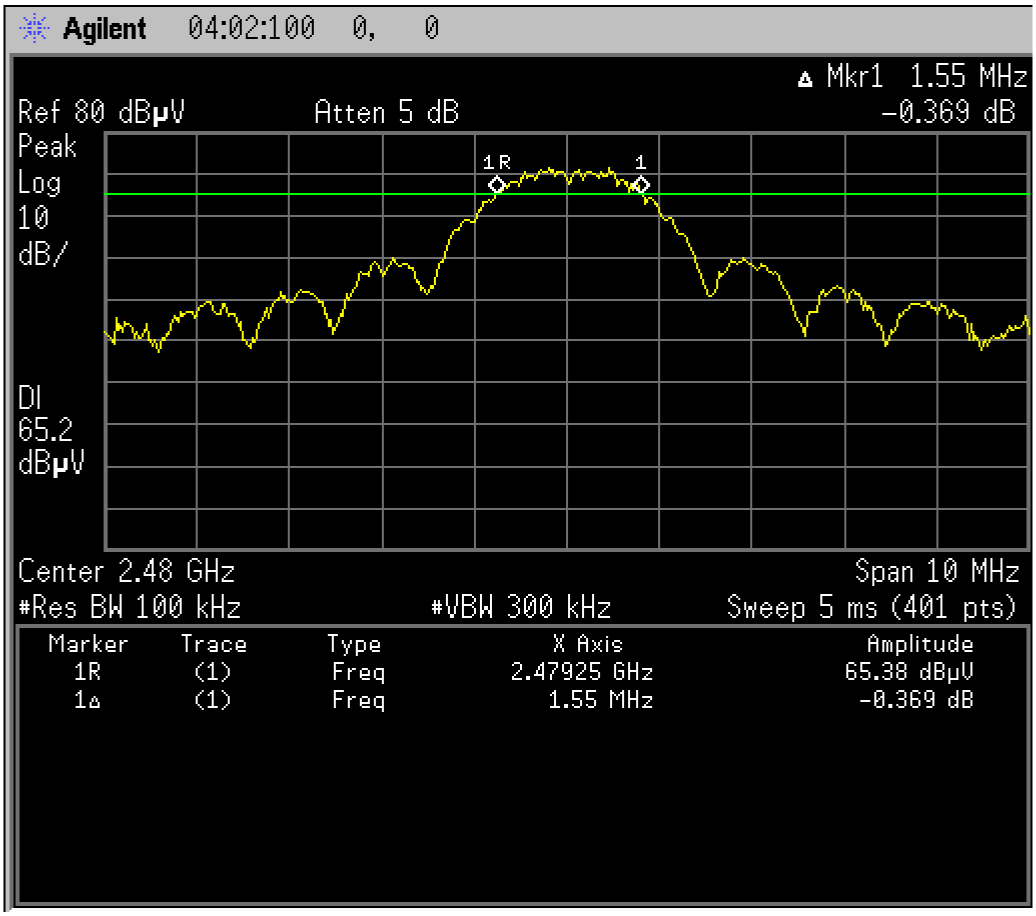
**Data plots for low, mid, and high channels**

**6dB Bandwidth Data Plot (CH 11, Low)**



**6dB Bandwidth Data Plot (CH 18, Mid)**

**6dB Bandwidth Data Plot (CH 26, High)**



## 6.0 100kHz BANDWIDTH OF BAND EDGES MEASUREMENT

### 6.1 Applicable Standard

According to 15.247(d), in any 100 KHz bandwidth outside the frequency bands in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power. In addition, radiated emissions, which fall in the restricted bands, as defined in 15.205(a), must also comply with the radiated emission limits specified in 15.209(a).

### 6.2 Measurement Procedure

- Place the EUT on the plastic stand and set it in transmitting mode with modulation.
- Set the center frequency of the spectrum analyzer to the operating frequency.
- Set the spectrum analyzer RBW= 100kHz, VBW=300KHz, Span=50MHz, Sweep Auto
- Mark the peak, 2.405 GHz, Lo Channel # 11 and record the maximum level.
- Set the delta marker to next lower frequency of spurious emission and record peak.
- Repeat the above procedures at 2.480 GHz, Hi Channel # 26 and measure the next highest spurious emission and record the level.

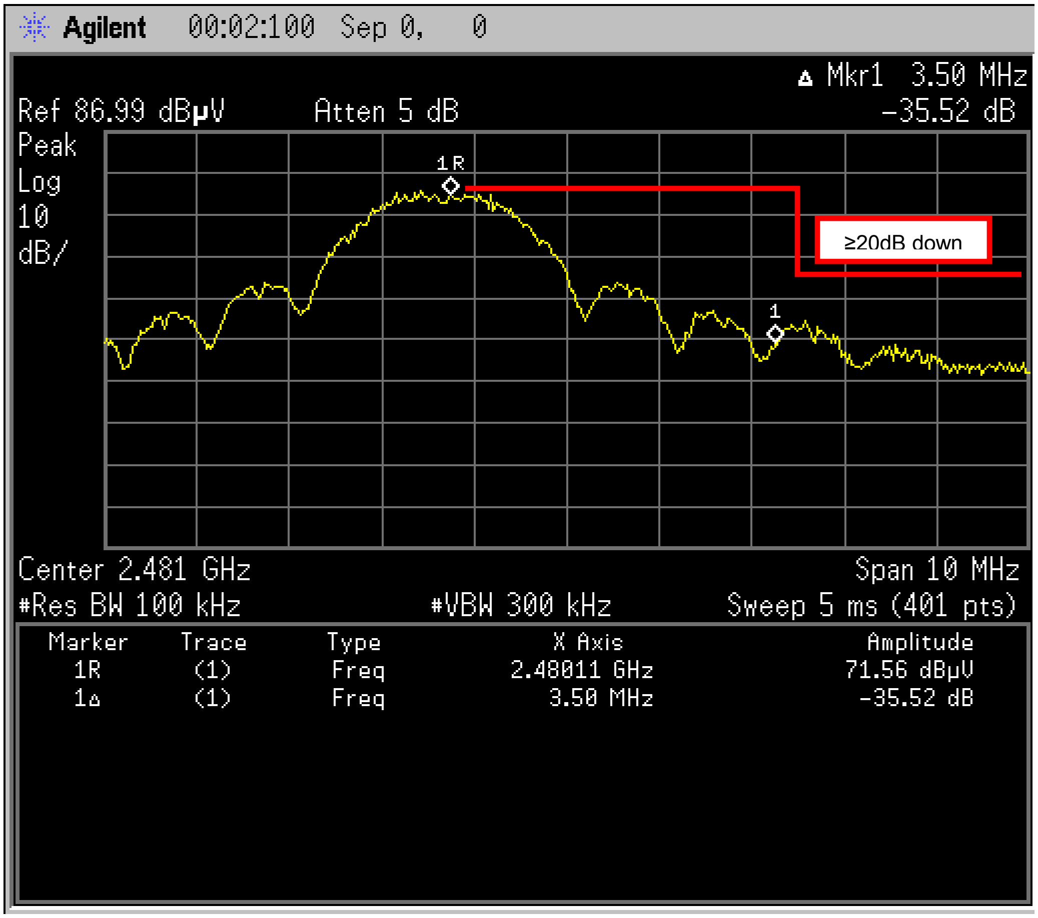
### 6.3 Measurement Result

Refer to attached spectrum analyzer data charts.

## Data plots for low and high channels

### 100kHz Band Edge Measurement Data (CH-11, Low)

**100kHz Band Edge Measurement Data (CH 26, High)**



## 7.0 UNINTENTIONAL/SPURIOUS RADIATED EMISSION TEST

### 7.1 Radiated Emissions

Preliminary testing was done in a ferrite lined shielded enclosure for frequency identification from the EUT. All final measurements were done on the OATS.

The EUT was placed on a short plastic stand, which is on a turntable per ANSI C63.10, clause 6.3.1. The turntable was rotated 360 degrees to determine the position of maximum emission level. The EUT is set 3m away from the receiving antenna which was varied from 1m to 4m in height during the final OATS measurements, to find the highest emissions level. Each frequency of emission was maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, the relative positions of the transmitter (EUT) was rotated through three orthogonal axes according to the requirements in ANSI C63.10, clause 5.10.1.

### 7.2 Prescan Radiated Emissions

The radiated emissions prescan testing was performed in the 3 meter ferrite lined shielded chamber.

The EUT was placed on a short plastic stand for all measurements.

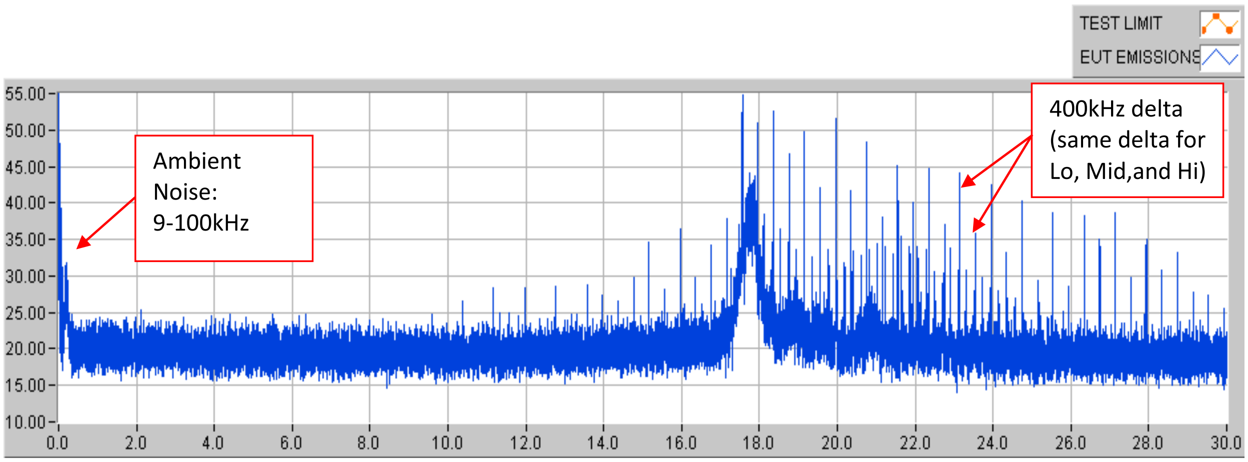
### 7.3 Prescan Measurement Procedure

- Prescans from 9kHz to 26GHz were done in the ferrite-lined shielded chamber for EUT frequency identification. These scans are exploratory emission tests only that are voluntarily submitted.
- The turntable was rotated 360 degrees to determine the position of maximum emission level at the transmit frequency. Scans from 1-26GHz were done at this azimuth angle at both horizontal and vertical receive antenna polarization.
- In the 30-1000MHz range, the EUT prescans were done at 0°, 90°, 180°, and 270° turntable angles.
- Emissions were measured with the EUT transmitting at the low, mid, and high frequencies.

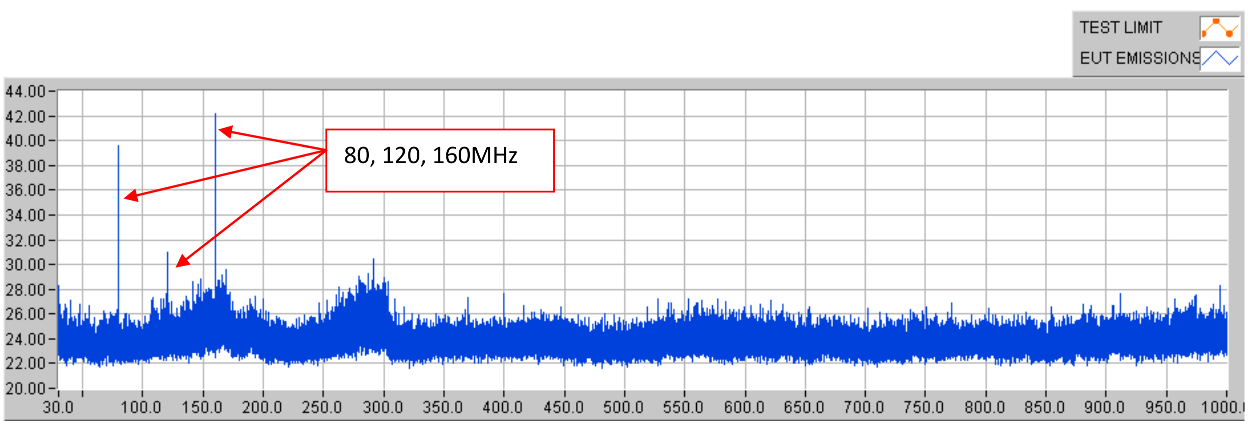
### 7.4 Prescan Measurement Results

The following plots show a summary of the prescan data that was collected.

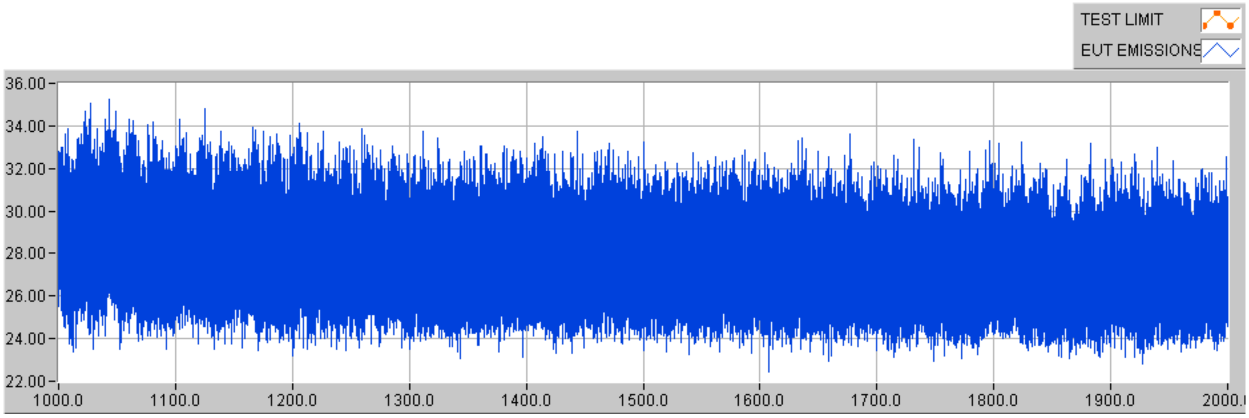
## Summary of Prescan Data



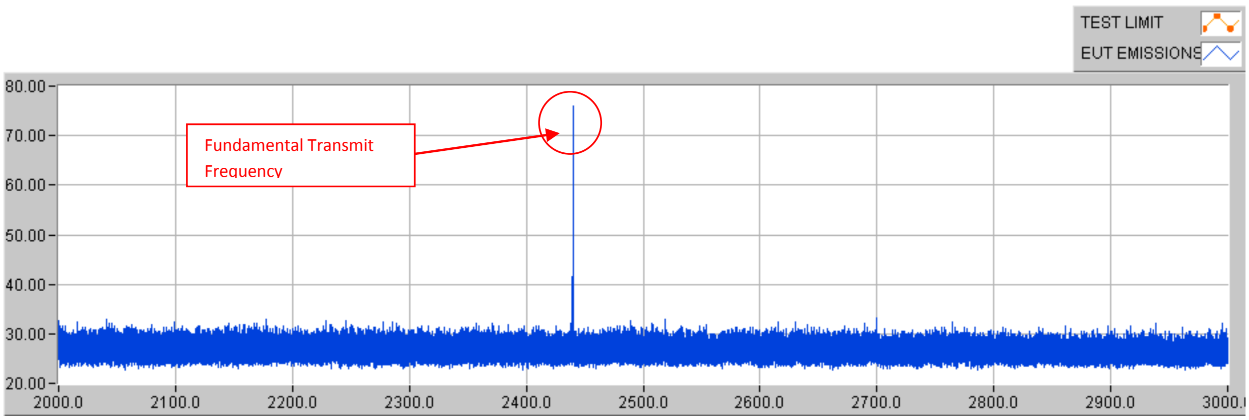

9kHz – 30MHz Antenna: Magnetic Loop



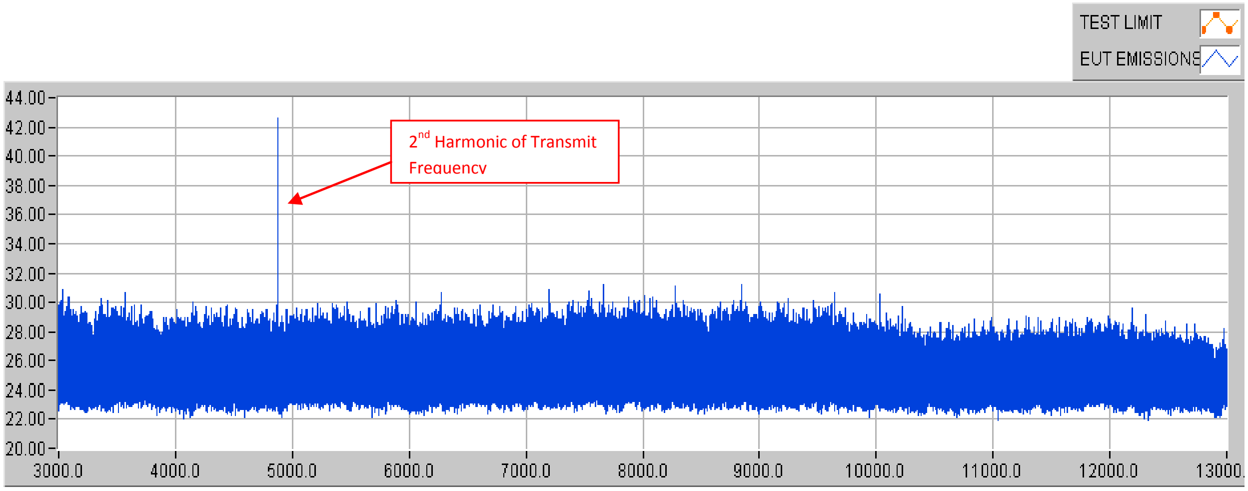

30 - 1000MHz Antenna: BiLog



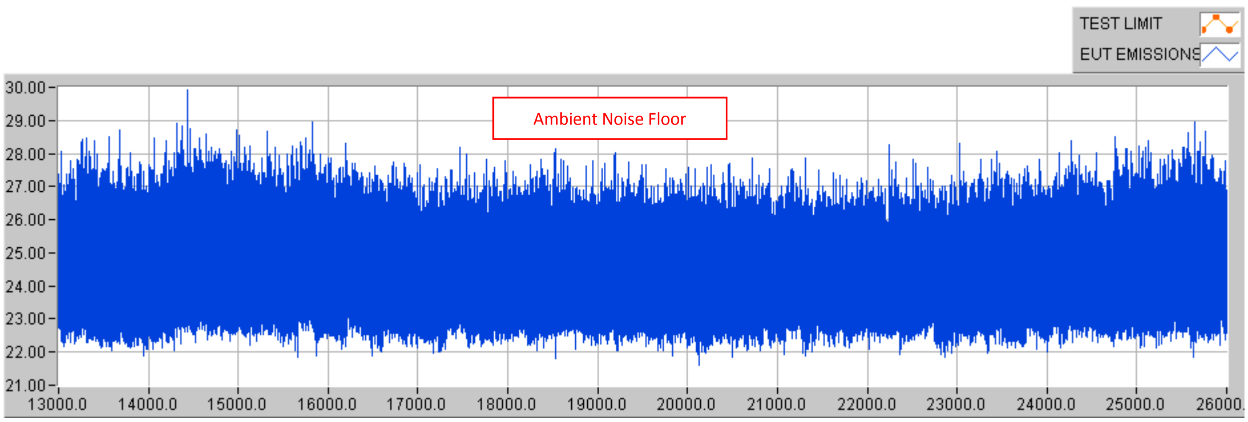

1-2GHz Antenna: Horn




2-3GHz Antenna: Horn




3-13GHz Antenna: Horn




13-26GHz Antenna: Horn

### 7.5 Radiated Emissions Applicable Standard

Emissions outside the authorized bands shall not exceed the general radiated emission limits specified in 15.209(a), and according to 15.33(a)(1), for an intentional radiator operating below 10GHz, the frequency range of measurements shall encompass the tenth harmonic of the highest fundamental frequency or 40GHz, whichever is lower.

### 7.6 Radiated Emissions EUT Setup

The radiated emission tests were performed on the 3 meter open area test site, in accordance with ANSI C63.4-2003.

The EUT was placed on a short plastic stand for all measurements.

### 7.7 Radiated Emissions Measurement Procedure

- The EUT/stand was placed on a turntable, which is flush with the ground plane.
- The turntable was rotated 360 degrees to determine the position of maximum emission level.
- The EUT was 3m away from the receiving antenna which was varied from 1m to 4m to obtain the maximum emissions level.
- The data was recorded at the six highest emissions to ensure EUT compliance.
- Each emission was maximized by changing the polarization of receiving antenna both horizontal and vertical.
- Emissions were measured with the EUT transmitting at the low, mid, and high frequencies.

## 7.8 Radiated Emissions Test Setup Photos

Refer to photos in the Tsup document.

## 7.9 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation is as follows:

$$FS = RA + AF + CL - AG$$

*Where:*
FS = Field Strength
RA = Reading Amplitude
AF = Antenna Factor
CL = Cable Attenuation Factor (Cable Loss)
AG = Amplifier Gain

## 7.10 Limit Extrapolation Method for Frequencies Below 30MHz

For radiated emissions results below 30MHz, the limit was adjusted based on a 40dB/decade extrapolation factor for distance (Reference: FCC Part 15.31 f 2). The field strength limit is calculated and converted to dBµV/m and then the 3m Limit Adjustment was added to this to get the 3 meter limit shown in the 9kHz - 30MHz results tables.

| Frequency (MHz) | Field strength limit (microvolts/meter) | Measurement distance (meters) | 3m Limit Adjustment (dB) | 3m Limit (dBµV/m) |
|---|---|---|---|---|
| 0.009-0.490 | 2400/F(kHz) | 300 | 80 | 128.5 - 93.8 |
| 0.490-1.705 | 24000/F(kHz) | 30 | 40 | 73.8 – 62.9 |
| 1.705-30.0 | 30 | 30 | 40 | 69.5 – 69.5 |
| 30.0 | 100 | 3 | N/A | 40.0 |

For example: At 32 kHz, the field strength limit is 2400/32 = 75 µV/m. This converts to 37.5 dBµV/m. To this is added the 3m Limit Adjustment of 80dB. Therefore the 3m limit at 32 kHz is 117.5 dBµV/m.

## 7.11 Duty Cycle Correction Factor

A duty cycle correction factor has been calculated and used to determine the average field strength from the peak field strength as given on the following pages.

<u>Duty Cycle Calculation:</u>
Manufacturer statement and calculations provided:

*UIC Worst Case Transmit Time per 100 mSec:*
*This assumes that the FOB is not transferring messages to the UIC and the UIC is repeatedly sending one 96-bit message back to the FOB. The following is the Transmission Time Calculations for Heartbeat/Message Transfer.*
*Description for UIC:*
*1 FOB->UIC start transfer (Off Time) 768 uS*
*2 Shortest UIC setup response delay (Off Time) 2900 uS*
*3 UIC->FOB transfer (On Time) 1216 uS*
*4 Shortest FOB setup response delay (Off Time) 1750 uS*
*5 Repeat 1-4*
*Total pulse train 6634 uS*
*% UIC transmit time =1216/6634*
*% UIC transmit time 18.33 %*
*Transmit time per 100ms 18.33 mS*

*Duty Cycle Correction Factor (ref: ANSI C63.10, 7.5)*
$\delta(dB) = 20\log(\square) = 20 \log (0.18) = -14.8\ dB$

## 7.12 Measurement Result – Radiated Emissions Data Tables

The data tables on the following page show the Radiated Emissions test results.

## Table A1: FCC 15.209 Radiated Emissions 9kHz – 30MHz

**Company:** Segway
**Test Engineers:** GC
**Model:** PT-SE
**Serial No.:** 132361085597
**Test Date:** August 19, 2014
**Test Configuration:** On battery
Transmitting on Channel 11 (2.405 GHz) with modulation applied

| Azimuth/ Height | Pol. (V or H) | Freq. (MHz) | Detector QP or AVG | 3 m Reading (dBuV) | Cable Loss (dB) | AF includes E Factor (dB) | Net (dBuV/m) | FCC 15.209 Limit at 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 270/1 | V | 17.53 | QP | 40.1 | 0.4 | 0.5 | 41.0 | 69.5 | -28.5 |
| 270/1 | V | 17.93 | QP | 34.9 | 0.4 | -2.0 | 33.3 | 69.5 | -36.2 |
| 270/1 | V | 18.33 | QP | 35.8 | 0.4 | -0.5 | 35.7 | 69.5 | -33.8 |
| 270/1 | V | 20.72 | QP | 29.5 | 0.4 | 13.5 | 43.4 | 69.5 | -26.1 |
| 270/1 | V | 24.70 | QP | 18.8 | 0.5 | 20.5 | 39.8 | 69.5 | -29.7 |
| 270/1 | V | 29.48 | QP | 13.1 | 0.6 | 26.0 | 39.7 | 69.5 | -29.8 |

Used Prescan data for EUT signal identification. Measured on 3 Meter OATS.
RBW=200Hz from 9kHz to 150kHz (Ref: CISPR 16-1-1, 5.2.1)
RBW=9kHz from 150kHz to 30MHz (Ref: CISPR 16-1-1, 5.2.1)

Detectors used
Quasi-peak (QP) for all except as follows:
Average (AVG) 9-90kHz
Average (AVG) 110-490kHz

Antenna: Magnetic Loop (Asset #103)

Mag Loop measurements: V=plane of loop perpendicular to EUT; H=plane of loop parallel to EUT

**Table 1: FCC Part 15 Class B Radiated Emissions**

**Company:** Segway
**Test Engineers:** GC
**Model:** PT-SE
**Serial No.:** 132361085597
**Test Date:** August 20, 2014
**Temperature/Humidity:** 29ºC / 48%
**Test Configuration:** On battery
Transmitter board - normal operating mode (30-1000MHz)
Transmitting on Channel 11 (2.405 GHz) with modulation applied (>1GHz)

**30-1000MHz Spurious Radiated Emissions Results**

| Turntable/ Height | Polarity (V or H) | Frequency (MHz) | Reading (dBuV) | Cable Loss (dB) | A.F. (dB) | Net (dBuV/m) | FCC Part 15 Limit @ 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 90/1.4 | V | 80.0 | 21.9 | 1.1 | 7.9 | 30.9 | 40.0 | -9.1 |
| 90.0 | V | 120.0 | 19.0 | 1.2 | 12.5 | 32.7 | 43.5 | -10.8 |
| 90.0 | V | 160.0 | 21.4 | 1.4 | 11.4 | 34.2 | 43.5 | -9.3 |
| 247/1.9 | H | 240.0 | 10.6 | 1.6 | 12.0 | 24.2 | 46.0 | -21.8 |
| 292.5/2.4 | H | 264.9 | 11.0 | 1.7 | 13.1 | 25.8 | 46.0 | -20.2 |
| 315/1.4 | H | 400.0 | 10.3 | 1.7 | 16.3 | 28.3 | 46.0 | -17.7 |

**1-26 GHz Spurious Radiated Emissions Results, Peak**

| Turntable/ Height | Polarity (V or H) | Frequency (MHz) | Reading (dBuV) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Net (dBuV/m) | FCC Part 15 Limit @ 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 0/1.6 | Hpk | 4809.9 | 42.5 | 12.6 | -36.3 | 33.0 | 51.8 | 73.9 | -22.1 |

**1-26 GHz Spurious Radiated Emissions Results, Average (using Duty Cycle correction factor)**

| Turntable/ Height | Polarity (V or H) | Frequency (MHz) | Reading (dBuV) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Duty Cycle Correction Factor (dB) | Net (dBuV/m) | FCC Part 15 Limit @ 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0/1.6 | Hpk | 4809.9 | 42.5 | 12.6 | -36.3 | 33.0 | -14.8 | 37.0 | 53.9 | -16.9 |

Notes: Did complete scans in the ferrite-lined shielded chamber.
Checked transmitter harmonics to the $10^{th}$ harmonic (26 GHz).
Cable Loss: 30-1000MHz: 25-meter cable; Above 1GHz: Sum of 8-meter plus 25-meter cables
Measurements below 30-1000MHz: RBW=120kHz, QP
Measurements above 1GHz: RBW=1MHz, VBW=3MHz, Peak

**Duty Cycle Calculation:**
Manufacturer statement:
UIC Worst Case Transmit Time per 100 mSec:
This assumes that the FOB is not transferring messages to the UIC and the UIC is repeatedly sending one 96-bit message back to the FOB. The following is the Transmission Time Calculations for Heartbeat/Message Transfer.
Description for UIC:
1 FOB->UIC start transfer (Off Time) 768 uS
2 Shortest UIC setup response delay (Off Time) 2900 uS
3 UIC->FOB transfer (On Time) 1216 uS
4 Shortest FOB setup response delay (Off Time) 1750 uS
5 Repeat 1-4
Total pulse train 6634 uS
% UIC transmit time =1216/6634
% UIC transmit time 18.33 %
Transmit time per 100ms 18.33 mS
Duty Cycle Correction Factor (ref: ANSI C63.10, 7.5)
$\delta(dB) = 20\log(\Delta) = 20 \log (0.18) = -14.8$ dB

### Table A1: FCC 15.209 Radiated Emissions 9kHz – 30MHz

**Company:** Segway
**Test Engineers:** GC
**Model:** PT-SE
**Serial No.:** 132361085597
**Test Date:** August 19, 2014
**Test Configuration:** On battery
Transmitting on Channel 18 (2.440 GHz) with modulation applied

| Azimuth/ Height | Pol. (V or H) | Freq. (MHz) | Detector QP or AVG | 3 m Reading (dBuV) | Cable Loss (dB) | AF includes E Factor (dB) | Net (dBuV/m) | FCC 15.209 Limit at 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 270/1 | V | 17.53 | QP | 39.6 | 0.4 | 0.5 | 40.5 | 69.5 | -29.0 |
| 270/1 | V | 17.93 | QP | 35.2 | 0.4 | -2.0 | 33.6 | 69.5 | -35.9 |
| 270/1 | V | 18.33 | QP | 36.0 | 0.4 | -0.5 | 35.9 | 69.5 | -33.6 |
| 270/1 | V | 20.72 | QP | 29.4 | 0.4 | 13.5 | 43.3 | 69.5 | -26.2 |
| 270/1 | V | 24.70 | QP | 18.8 | 0.5 | 20.5 | 39.8 | 69.5 | -29.7 |
| 270/1 | V | 29.90 | QP | 10.4 | 0.6 | 26.0 | 37.0 | 69.5 | -32.5 |

Used Prescan data for EUT signal identification. Measured on 3 Meter OATS.
RBW=200Hz from 9kHz to 150kHz (Ref: CISPR 16-1-1, 5.2.1)
RBW=9kHz from 150kHz to 30MHz (Ref: CISPR 16-1-1, 5.2.1)

Detectors used
Quasi-peak (QP) for all except as follows:
Average (AVG) 9-90kHz
Average (AVG) 110-490kHz

Antenna: Magnetic Loop (Asset #103)

Mag Loop measurements: V=plane of loop perpendicular to EUT; H=plane of loop parallel to EUT

**Table 1: FCC Part 15 Class B Radiated Emissions**

**Company:** Segway
**Test Engineers:** GC
**Model:** PT-SE
**Serial No.:** 132361085597
**Test Date:** August 20, 2014
**Temperature/Humidity:** 29ºC / 48%
**Test Configuration:** On battery
Transmitter board - normal operating mode (30-1000MHz)
Transmitting on Channel 18 (2.440 GHz) with modulation applied (>1GHz)

**30-1000MHz Spurious Radiated Emissions Results**

| Turntable/ Height | Polarity (V or H) | Frequency (MHz) | Reading (dBuV) | Cable Loss (dB) | A.F. (dB) | Net (dBuV/m) | FCC Part 15 Limit @ 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 90/1.4 | V | 80.0 | 21.9 | 1.1 | 7.9 | 30.9 | 40.0 | -9.1 |
| 90.0 | V | 120.0 | 19.0 | 1.2 | 12.5 | 32.7 | 43.5 | -10.8 |
| 90.0 | V | 160.0 | 21.4 | 1.4 | 11.4 | 34.2 | 43.5 | -9.3 |
| 247/1.9 | H | 240.0 | 10.6 | 1.6 | 12.0 | 24.2 | 46.0 | -21.8 |
| 292.5/2.4 | H | 264.9 | 11.0 | 1.7 | 13.1 | 25.8 | 46.0 | -20.2 |
| 315/1.4 | H | 400.0 | 10.3 | 1.7 | 16.3 | 28.3 | 46.0 | -17.7 |

**1-26 GHz Spurious Radiated Emissions Results, Peak**

| Turntable/ Height | Polarity (V or H) | Frequency (MHz) | Reading (dBuV) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Net (dBuV/m) | FCC Part 15 Limit @ 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 0/1.5 | Hpk | 4880.0 | 43.7 | 12.8 | -36.3 | 33.2 | 53.4 | 73.9 | -20.5 |

**1-26 GHz Spurious Radiated Emissions Results, Average (using Duty Cycle correction factor)**

| Turntable/ Height | Polarity (V or H) | Frequency (MHz) | Reading (dBuV) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Duty Cycle Correction Factor (dB) | Net (dBuV/m) | FCC Part 15 Limit @ 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0/1.5 | Hpk | 4880.0 | 43.7 | 12.8 | -36.3 | 33.2 | -14.8 | 38.6 | 53.9 | -15.3 |

Notes: Did complete scans in the ferrite-lined shielded chamber.
Checked transmitter harmonics to the $10^{th}$ harmonic (26 GHz).
Cable Loss: 30-1000MHz: 25-meter cable; Above 1GHz: Sum of 8-meter plus 25-meter cables
Measurements below 30-1000MHz: RBW=120kHz, QP
Measurements above 1GHz: RBW=1MHz, VBW=3MHz, Peak

**Duty Cycle Calculation:**
Manufacturer statement:
UIC Worst Case Transmit Time per 100 mSec:
This assumes that the FOB is not transferring messages to the UIC and the UIC is repeatedly sending one 96-bit message back to the FOB. The following is the Transmission Time Calculations for Heartbeat/Message Transfer.
Description for UIC:
1 FOB->UIC start transfer (Off Time) 768 uS
2 Shortest UIC setup response delay (Off Time) 2900 uS
3 UIC->FOB transfer (On Time) 1216 uS
4 Shortest FOB setup response delay (Off Time) 1750 uS
5 Repeat 1-4
Total pulse train 6634 uS
% UIC transmit time =1216/6634
% UIC transmit time 18.33 %
Transmit time per 100ms 18.33 mS
Duty Cycle Correction Factor (ref: ANSI C63.10, 7.5)
$\delta(dB) = 20\log(\Delta) = 20 \log (0.18) = -14.8$ dB

## Table A1: FCC 15.209 Radiated Emissions 9kHz – 30MHz

**Company:** Segway
**Test Engineers:** GC
**Model:** PT-SE
**Serial No.:** 132361085597
**Test Date:** August 19, 2014
**Test Configuration:** On battery
Transmitting on Channel 26 (2.480 GHz) with modulation applied

| Azimuth/ Height | Pol. (V or H) | Freq. (MHz) | Detector QP or AVG | 3 m Reading (dBuV) | Cable Loss (dB) | AF includes E Factor (dB) | Net (dBuV/m) | FCC 15.209 Limit at 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 270/1 | V | 17.54 | QP | 38.4 | 0.4 | 0.5 | 39.3 | 69.5 | -30.2 |
| 270/1 | V | 17.94 | QP | 34.6 | 0.4 | -2.0 | 33.0 | 69.5 | -36.5 |
| 270/1 | V | 18.34 | QP | 36.0 | 0.4 | -0.5 | 35.9 | 69.5 | -33.6 |
| 270/1 | V | 20.72 | QP | 29.7 | 0.4 | 13.5 | 43.6 | 69.5 | -25.9 |
| 270/1 | V | 24.70 | QP | 18.9 | 0.5 | 20.5 | 39.9 | 69.5 | -29.6 |
| 270/1 | V | 29.40 | QP | 13.3 | 0.6 | 26.0 | 39.9 | 69.5 | -29.6 |

Used Prescan data for EUT signal identification. Measured on 3 Meter OATS.
RBW=200Hz from 9kHz to 150kHz (Ref: CISPR 16-1-1, 5.2.1)
RBW=9kHz from 150kHz to 30MHz (Ref: CISPR 16-1-1, 5.2.1)

Detectors used
Quasi-peak (QP) for all except as follows:
Average (AVG) 9-90kHz
Average (AVG) 110-490kHz

Antenna: Magnetic Loop (Asset #103)

Mag Loop measurements: V=plane of loop perpendicular to EUT; H=plane of loop parallel to EUT

**Table 1: FCC Part 15 Class B Radiated Emissions**

**Company:** Segway
**Test Engineers:** KM
**Model:** PT-SE
**Serial No.:** 132361085597
**Test Date:** August 20, 2014
**Temperature/Humidity:** 29ºC / 48%
**Test Configuration:** On battery
Transmitter board - normal operating mode (30-1000MHz)
Transmitting on Channel 26 (2.480 GHz) with modulation applied (>1GHz)

**30-1000MHz Spurious Radiated Emissions Results**

| Turntable/ Height | Polarity (V or H) | Frequency (MHz) | Reading (dBuV) | Cable Loss (dB) | A.F. (dB) | Net (dBuV/m) | FCC Part 15 Limit @ 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 90/1.4 | V | 80.0 | 21.9 | 1.1 | 7.9 | 30.9 | 40.0 | -9.1 |
| 90.0 | V | 120.0 | 19.0 | 1.2 | 12.5 | 32.7 | 43.5 | -10.8 |
| 90.0 | V | 160.0 | 21.4 | 1.4 | 11.4 | 34.2 | 43.5 | -9.3 |
| 247/1.9 | H | 240.0 | 10.6 | 1.6 | 12.0 | 24.2 | 46.0 | -21.8 |
| 292.5/2.4 | H | 264.9 | 11.0 | 1.7 | 13.1 | 25.8 | 46.0 | -20.2 |
| 315/1.4 | H | 400.0 | 10.3 | 1.7 | 16.3 | 28.3 | 46.0 | -17.7 |

**1-26 GHz Spurious Radiated Emissions Results, Peak**

| Turntable/ Height | Polarity (V or H) | Frequency (MHz) | Reading (dBuV) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Net (dBuV/m) | FCC Part 15 Limit @ 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 0/1.4 | Hpk | 4960.0 | 42.8 | 12.9 | -36.3 | 33.4 | 52.8 | 73.9 | -21.1 |

**1-26 GHz Spurious Radiated Emissions Results, Average (using Duty Cycle correction factor)**

| Turntable/ Height | Polarity (V or H) | Frequency (MHz) | Reading (dBuV) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Duty Cycle Correction Factor (dB) | Net (dBuV/m) | FCC Part 15 Limit @ 3m (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0/1.4 | Hpk | 4960.0 | 42.8 | 12.9 | -36.3 | 33.4 | -14.8 | 38.0 | 53.9 | -15.9 |

Notes: Did complete scans in the ferrite-lined shielded chamber.
Checked transmitter harmonics to the $10^{th}$ harmonic (26 GHz).
Cable Loss: 30-1000MHz: 25-meter cable; Above 1GHz: Sum of 8-meter plus 25-meter cables
Measurements below 30-1000MHz: RBW=120kHz, QP
Measurements above 1GHz: RBW=1MHz, VBW=3MHz, Peak

**Duty Cycle Calculation:**
Manufacturer statement:
UIC Worst Case Transmit Time per 100 mSec:
This assumes that the FOB is not transferring messages to the UIC and the UIC is repeatedly sending one 96-bit message back to the FOB. The following is the Transmission Time Calculations for Heartbeat/Message Transfer.
Description for UIC:
1 FOB->UIC start transfer (Off Time) 768 uS
2 Shortest UIC setup response delay (Off Time) 2900 uS
3 UIC->FOB transfer (On Time) 1216 uS
4 Shortest FOB setup response delay (Off Time) 1750 uS
5 Repeat 1-4
Total pulse train 6634 uS
% UIC transmit time =1216/6634
% UIC transmit time 18.33 %
Transmit time per 100ms 18.33 mS
Duty Cycle Correction Factor (ref: ANSI C63.10, 7.5)
$\delta(dB) = 20\log(\Delta) = 20 \log (0.18) = -14.8$ dB

## 8.0 PEAK POWER SPECTRAL DENSITY

### 8.1 Applicable Standard

According to 15.247(e), for digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3kHz band during any time of continuous transmission.

### 8.2 Measurement Procedure

- Place the EUT on a short plastic stand and set it for continuous transmit mode without modulation.
- Set the spectrum analyzer RBW = 3kHz, VBW = 10kHz, Span = 1MHz, Sweep = Auto.
- Record the maximum reading.
- Repeat above procedures for low, mid, and high frequency channels.

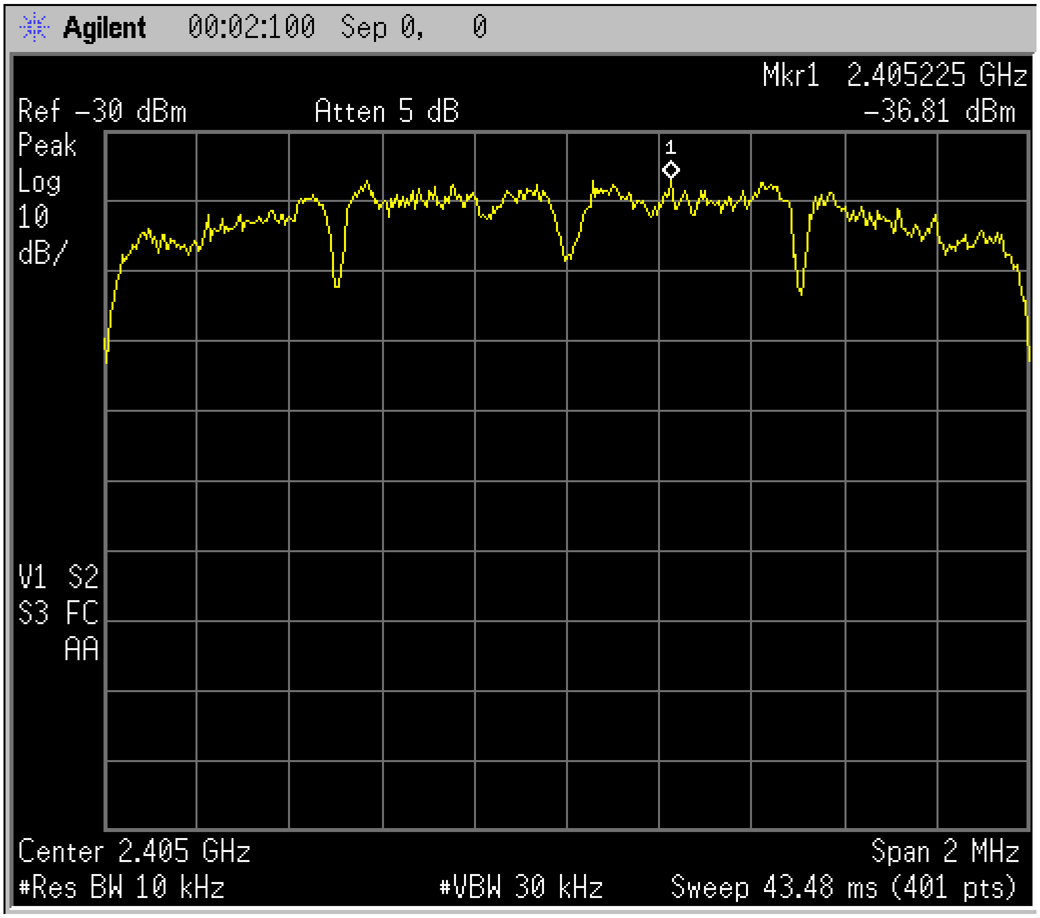
### 8.3 Measurement Result

This data table and the plots on the following pages show the Peak Power Spectral Density test results.

| CH | Channel Frequency (GHz) | Maximum Limit (dBm) | Peak Power Spectral Density (dBm) |
|---|---|---|---|
| Low | 2.405 | 8 | -36.9 |
| Mid | 2.440 | 8 | -38.2 |
| High | 2.480 | 8 | -41.5 |

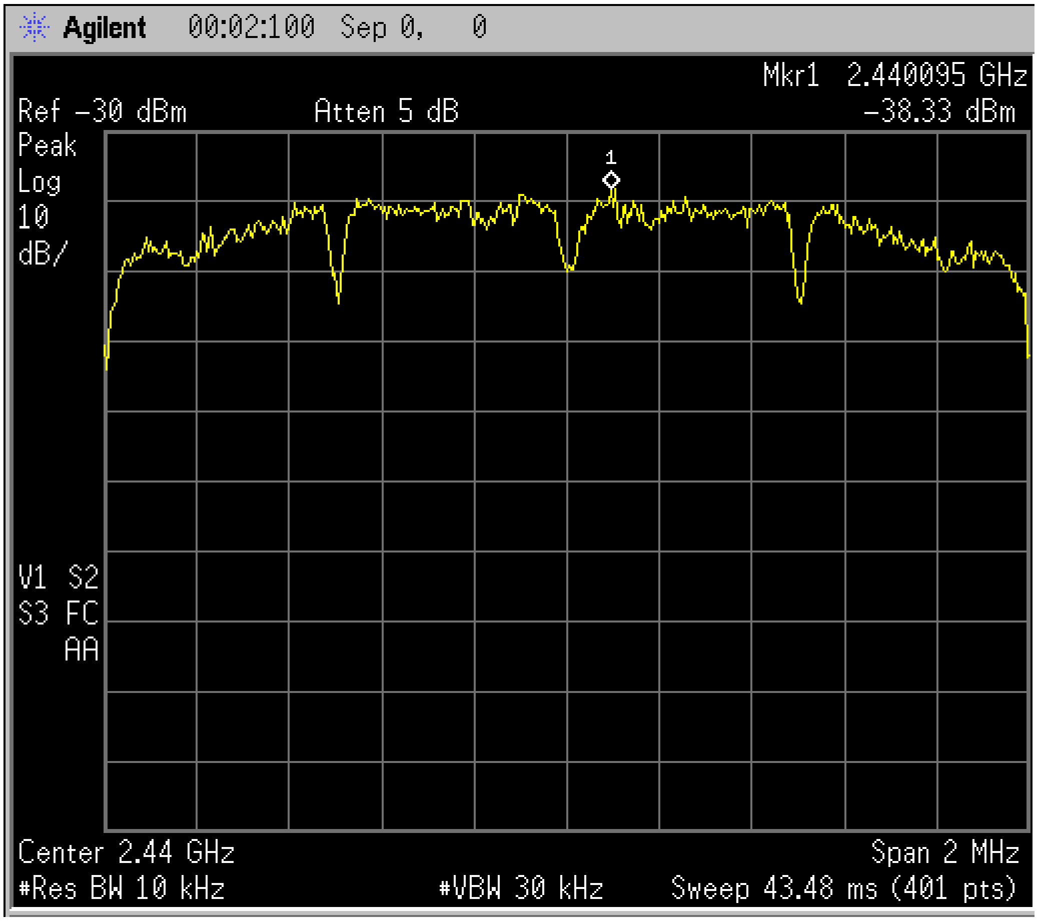
**Data plots for low, mid, and high channels**

**Power Spectral Density Test Plot (CH 11, Low)**



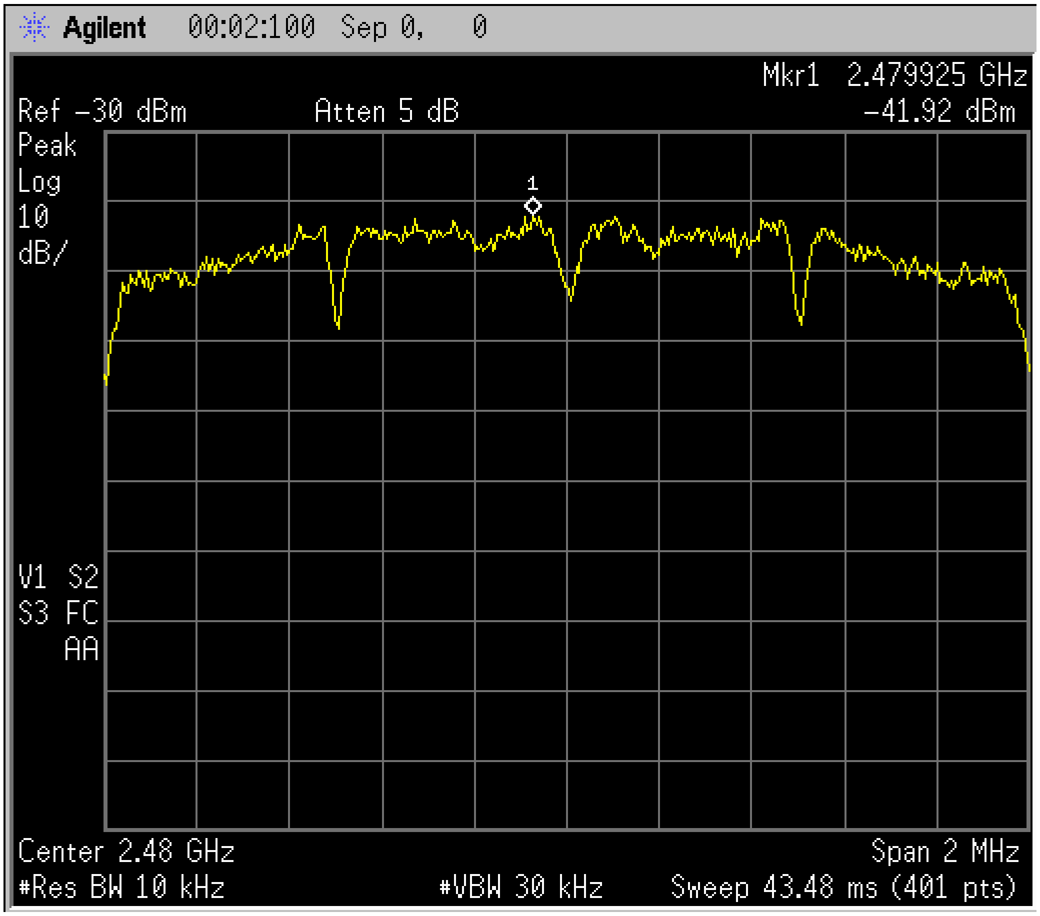

| Channel | Frequency (MHz) | Reading (dBm) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Field Strength (dBm/m) |
|---|---|---|---|---|---|---|
| 11 | 2405.0 | -36.8 | 8.3 | -37.2 | 28.8 | -36.9 |

## Power Spectral Density Test Plot (CH-18, Mid)




| Channel | Frequency (MHz) | Reading (dBm) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Field Strength (dBm/m) |
|---|---|---|---|---|---|---|
| 18 | 2440.0 | -38.3 | 8.3 | -37.2 | 29.0 | -38.2 |

**Power Spectral Density Test Plot (CH-26, High)**




| Channel | Frequency (MHz) | Reading (dBm) | Cable Loss (dB) | Preamp Gain (dB) | A.F. (dB) | Field Strength (dBm/m) |
|---|---|---|---|---|---|---|
| 26 | 2480 | -41.9 | 8.4 | -37.2 | 29.2 | -41.5 |

## 9.0 ANTENNA REQUIREMENT

### 9.1 Applicable Standard

For an intentional radiator device, according to 15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

And according to 15.247(4)(1), system operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi 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.

### 9.2 Antenna Connected Construction

The directional gain of the antenna used for transmitting is 1 dBi, and the antenna is permanently mounted to the EUT (circuit board trace type antenna) with no consideration of replacement.

## 10.0 PHOTOGRAPHS

PT-SE

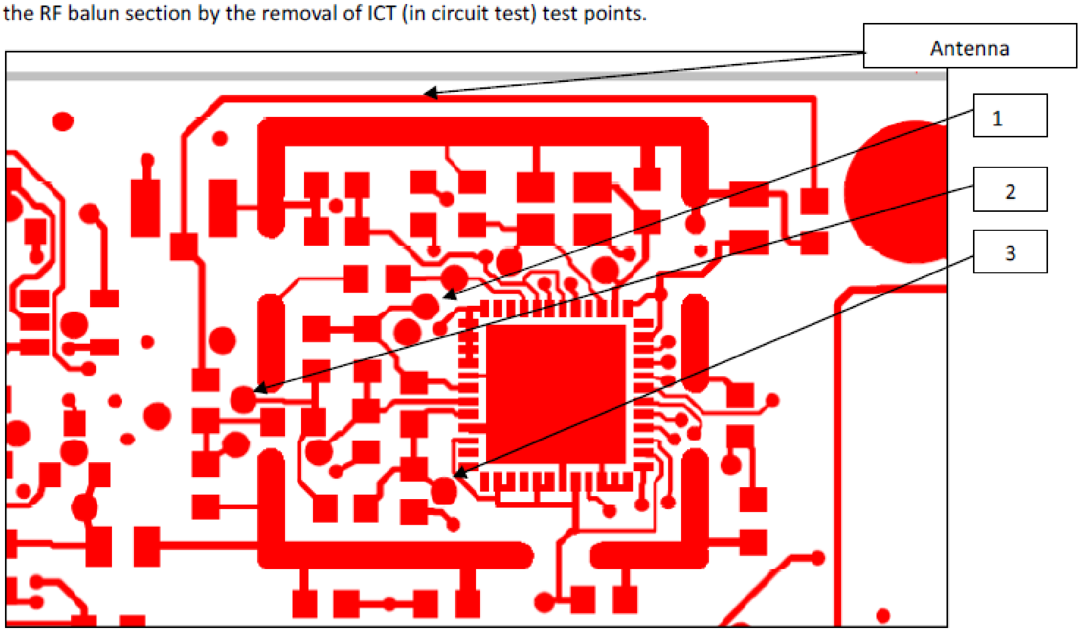
*Additional Photographs can be found in separate documents:*

*PT-SE Tsup.pdf*
*PT-SE Intpho.pdf*
*PT-SE Extpho.pdf.*

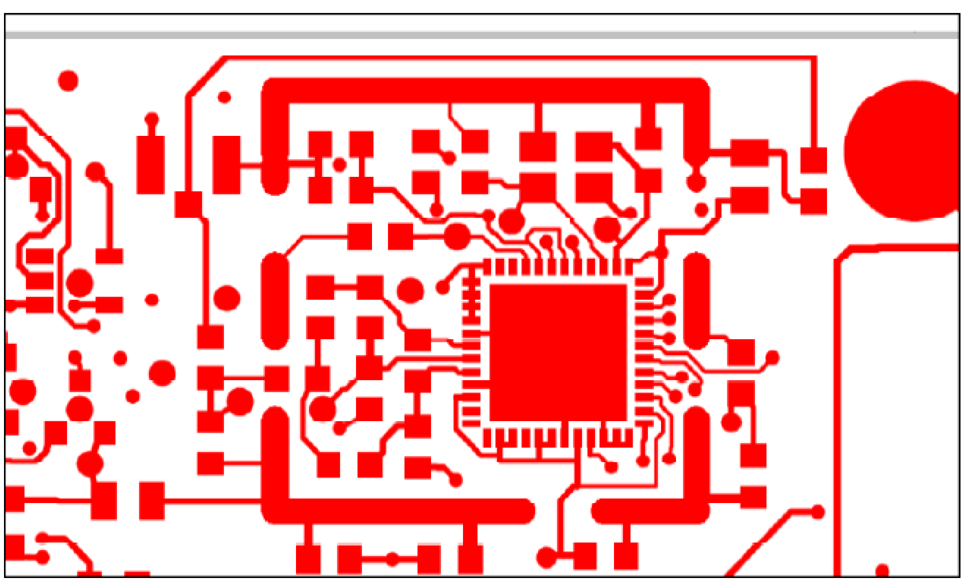
## ***Appendix A** – Class II Permissive Change Detail*

### 23451-00001 User Interface Change Description

The PCB artwork is being adjusted on the revision ad assembly. This document shows the changes being made to the RF balun section by the removal of ICT (in circuit test) test points.




Graphic above shows the three test points being removed from the RF balun section. The graphic below shows the particular section of the corrected PCB artwork with the test points removed.



# END OF TEST REPORT