

Global EMC Inc. Labs

EMC & RF Test Report

As per

RSS 210 Issue 8:2010

&

FCC Part 15 Subpart C:2015
Unlicensed Intentional Radiators

on the

PPG Sensor



Min Xie
Project Engineer
Global EMC Inc.
11 Gordon Collins Dr.
Gormley, ON
L0H 1G0, Canada
Ph: (905) 883-8189

Testing produced for



See *Appendix A* for full customer & EUT details.



Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

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Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Report Scope

This report addresses the EMC testing and test results of the PPG Sensor, model 13117, from PPG Technologies. This unit is herein referred to as EUT (Equipment Under Test). Testing is performed at Global EMC Labs.

The EUT was tested for compliance against the following standards:

RSS 210 Issue 8:2010
FCC Part 15 Subpart C:2015

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

The results contained in this report relate only to the item(s) tested.

This report does not imply product endorsement by A2LA or any other accreditation agency, any government, or Global EMC Inc.


Opinions/interpretations expressed in this report, if any, are outside the scope of Global EMC Inc accreditation. Any opinions expressed do not necessarily reflect the opinions of Global EMC Inc, unless otherwise stated.

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Summary


The results contained in this report relate only to the item(s) tested.

EUT FCC Certification #, FCC ID:	2AEAC-PPG042
EUT Industry Canada Certification #, IC:	12388A-PPG042
EUT Passed all tests performed.	Yes (see test results summary)
Tests conducted by	Min Xie

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203	Antenna Requirement	Unique	Pass See Justification
FCC 15.205 RSS 210 (Table 1)	Restricted Bands for intentional operation	QuasiPeak Average	Pass
FCC 15.209 RSS-210 (Table 2)	Spurious Radiated emissions	QuasiPeak Average	Pass
FCC 15.247(a)2 RSS-210 A8.2(a)	6 dB Bandwidth	> 500 kHz	Pass
FCC 15.247(b)3 RSS-210 A8.4(4)	Max output power	< 1 Watt	Pass
FCC 15.247(b)(4) RSS-210 A8.4(5)	Antenna Gain	< 6 dBi	Pass See Justifications
FCC 15.247(d) RSS-210 A8.5	Antenna conducted spurious	< 20 dBc	Pass
FCC 15.247(e) RSS-210 A8.2(b)	Spectral Density	< 8 dBm (3 kHz BW)	Pass
FCC 15.247(i) IC Safety code 6	RF Energy Levels	Per requirements	Pass See Justifications
Overall Result			PASS

Client	PPG Technologies	
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All tests were performed by Min Xie.

If the product as tested or otherwise complies with the specification, the EUT is deemed to comply with the requirement and is deemed a 'PASS' grade. If not 'FAIL' grade will be issued. Note that 'PASS' / 'FAIL' grade is independent of any measurement uncertainties. A 'PASS' / 'FAIL' grade within measurement uncertainty is marked with a '*'.

Justifications, Descriptions, or Deviations

The following justifications for tests not performed or deviations from the above listed specifications apply:

For the antenna requirement specified in FCC 15.203 (RSS 210 section 5.5), the antenna used is a ceramic chip antenna soldered onto the PCB, all of which is located inside the unit's enclosure. It is not meant to be replicable by the user.

For the Restricted Bands of operation, the transmitter is designed to operate between 2.402 GHz and 2.480 GHz.

The EUT is not a hybrid system; FCC 15.247 (f) does not apply.

The EUT was tested in the three orthogonal axes. The worst case results are obtained with the EUT upright. Worst case results are presented for all tests.

The antenna gain for the 15.247 transmitter is 0.5 dBi max,

The EUT only operates using an internal battery. It does not have the means to plug into mains.

See separate RF Exposure Exhibit for this unit regarding the permissible RF exposure levels.

Testing of the 15.247 transmitter is performed according to procedures documented in FCC KDB Publication No. 558074 - Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247).

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Applicable Standards, Specifications and Methods

ANSI C63.4:2009	- Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10:2009	- American national standard for testing unlicensed wireless devices
CFR 47 FCC 15	- Code of Federal Regulations – Radio Frequency Devices
CISPR 22:2008	- Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
FCC KDB 558074	- FCC KDB 558074 Digital Transmission Systems, measurements and procedures
ICES-003:2012	- Digital Apparatus - Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard
ISO 17025:2005	- General Requirements for the competence of testing and calibration laboratories
RSS-GEN:2014, Issue 4	General Requirements and Information for the Certification of Radio Apparatus
RSS 210:2010	- Issue 8: Spectrum Management and Telecommunications Policy. Radio Standards Specification Low Power Licence-Exempt Radiocommunication Devices

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Sample calculation(s)

Margin = limit – (received signal + antenna factor + cable loss – pre-amp gain)

Margin = 50.5dBuV/m – (50dBuV + 10dB + 2.5dB – 20dB)

Margin = 8 dB

Document Revision Status

Release 1 - March 16, 2015
Initial release.

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Definitions and Acronyms

The following definitions and acronyms are applicable in this report.
See also ANSI C63.14.

AE – Auxillary Equipment.

BW – Bandwidth. Unless otherwise stated, this refers to the 6 dB bandwidth.

EMC – Electro-Magnetic Compatibility

EMI – Electro-Magnetic Immunity

EUT – Equipment Under Test

ITE – Information Technology Equipment with a primary function(s) of entry, storage, display, retrieval, transmission, processing, switching, or control, of data.

LISN – Line impedance stabilization network

NCR – No Calibration Required

RF – Radio Frequency

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Testing Facility

Testing for EMC on the EUT was carried out at Global EMC labs in Toronto, Ontario, Canada. The testing lab consists of a 3m semi-anechoic chamber calibrated to be able to allow measurements on an EUT with a maximum width or length of up to 2m and height up to 3m. The chamber is equipped with a turn table that is capable of testing devices up to 3300lb in weight. This facility is capable of testing products that are rated for 120 Vac and 240Vac single phase, or 208 Vac 3 phase input. DC capability is also available. The chamber is equipped with an antenna mast that controls polarization and height from the control room adjoining the shielded chamber. Radiated emissions measurements are performed using a Bilog, and Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN.

Calibrations and Accreditations


The measurement site used is registered with Federal Communications Commission (FCC) and Industry Canada (IC). This site is calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 “Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz”. The semi-anechoic chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. All measuring equipment is calibrated on an annual or bi-annual basis as listed for each respective test.

Client	PPG Technologies	
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Testing Environmental Conditions and Dates

Following were the environmental conditions in the facility during time of testing –

Date	Test	Init.	Temperature (°C)	Humidity (%)	Pressure (kPa)
Mar. 2 – 6, 2015	All	MX	20-25°C	30-45%	100 -103kPa

Client	PPG Technologies	
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Detailed Test Results Section

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

6 dB Bandwidth of Digitally Modulated Systems

Purpose

The purpose of this test is to ensure that the bandwidth occupied exceeds a stated minimum. This helps ensure the utilization of the frequency allocation is sufficiently wide. This also helps prevent corruption of data by ensuring adequate data separation to distinguish the reception of the intended information.


Limits

The Limit is as specified in FCC Part 15 and RSS 210.

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.

Results

The EUT passed. The minimum 6 dB BW measured was 750 kHz.

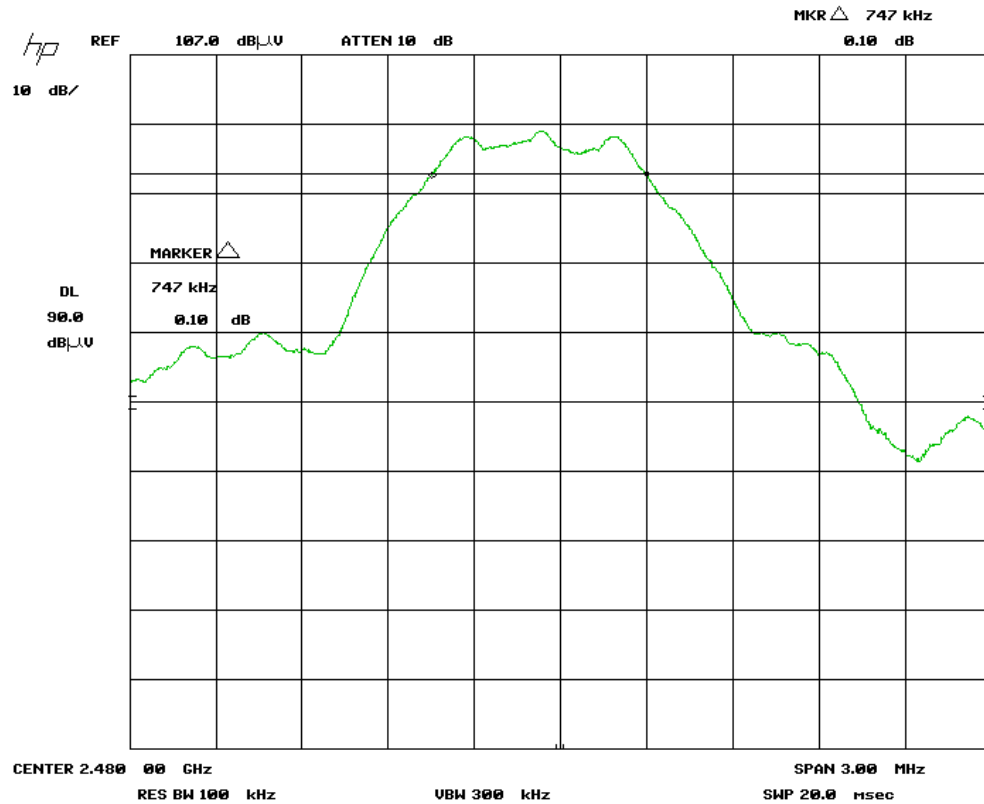
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Graph(s)

The graphs below show the 6dB bandwidth during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the 6 dB bandwidth of a channel during operation of the EUT. This measurement is a peak measurement. Max hold is performed for a duration of not less than 1 minute. Worst case results obtained are shown.

High Channel (2.480 GHz)

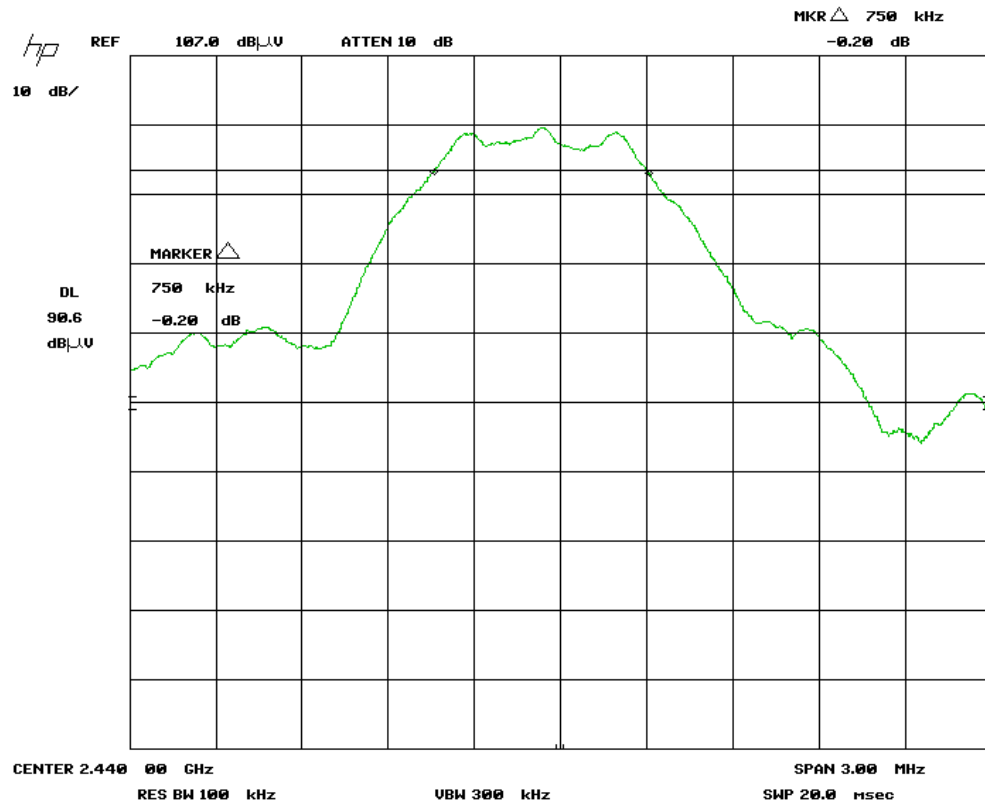
6 dB BW = 747 kHz




Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Mid Channel (2.440 GHz)

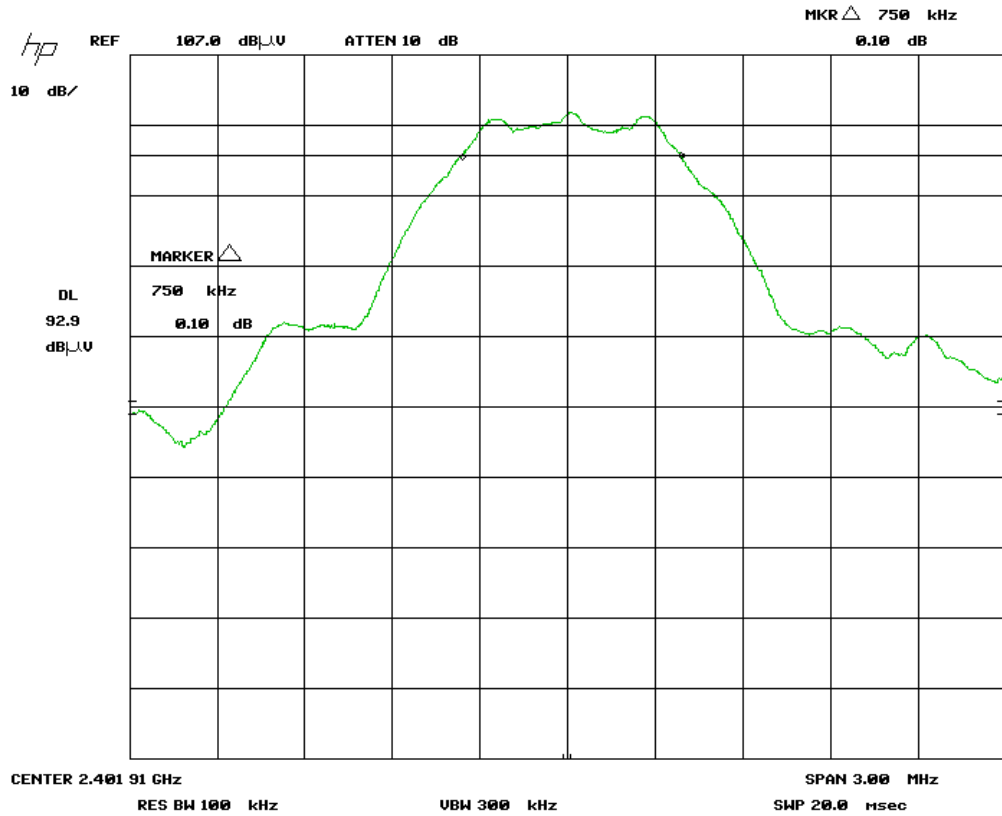
6 dB BW = 750 kHz




Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

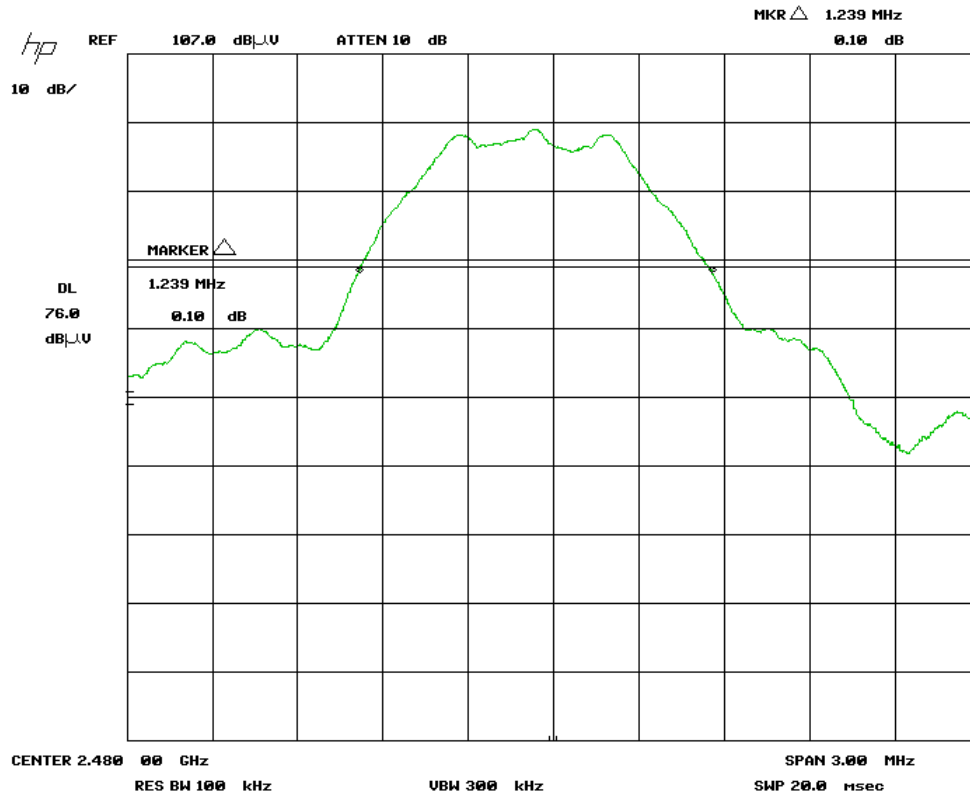
Low Channel (2.402 GHz)

6 dB BW = 750 kHz



Client	PPG Technologies	
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For information purposes, maximum 20 dB bandwidth is 1.239 MHz.



Note: See ‘Appendix B – EUT & Test Setup Photographs’ for photos showing the test set-up.

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	May 21, 2014	May 21, 2016	GEMC 193
Horn Antenna	6878/24	Q-par	Sept 10, 2014	Sept 10, 2016	GEMC 6365
Pre-Amp 1 - 26.5 GHz	HP 8449B	HP	Sept 09, 2014	Sept 09, 2016	GEMC 6351

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Maximum Peak Envelope Conducted Power - DM

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified. This ensures that if the end-user replaces the antenna, that the maximum power does not exceed an amount which may create an excessive power level.


Limits

The limits are defined in FCC Part 15.247(b) and RSS 210.

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands, the peak limit is 1 watt (or 30 dBm = 125.2 dB μ V at 3m distance).

Results

The EUT passed. The peak power output is 3.5 dBm (2.2 mW).


Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Table(s)

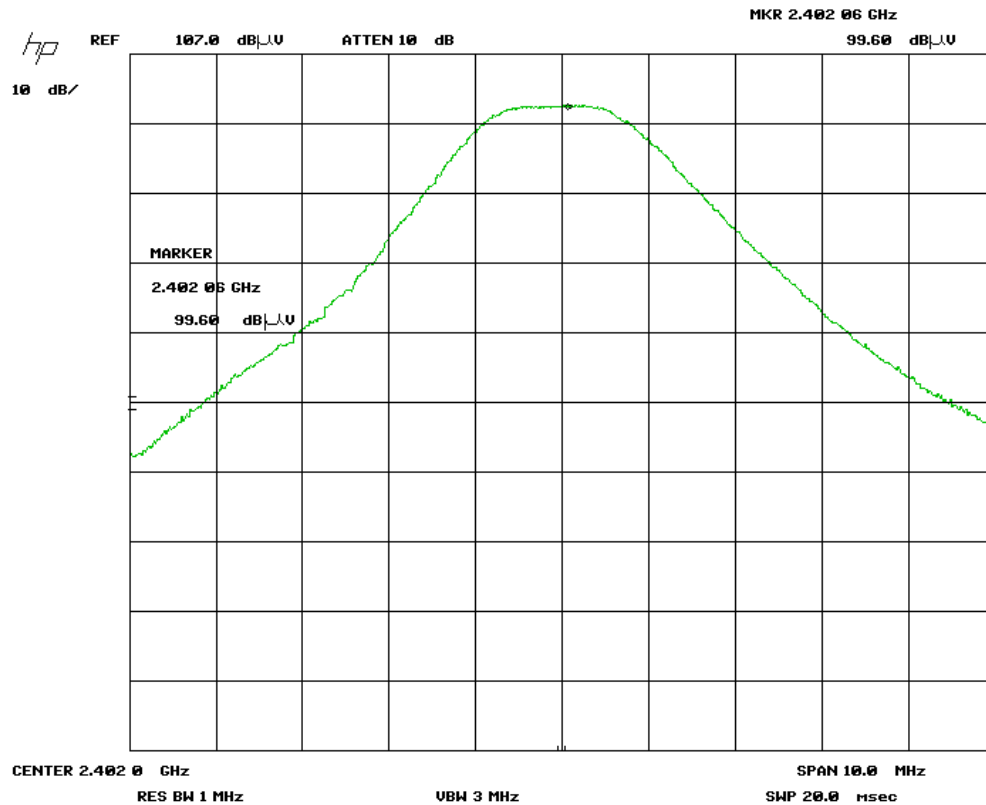
The table below shows the measured peak power output of the device. Peak measurements were made with a 1 MHz resolution bandwidth, during transmit operation of the EUT with continuous modulated data (>98%). Worst case plots are shown.


Maximum Peak Envelope Conducted Power – Table 1

Test Frequency (MHz)	Detection mode	Antenna polarity (Horz/Vert)	Raw signal dB(μV)	Antenna factor dB	Cable loss dB + Preselector	Attenuator dB	Pre-Amp Gain dB	Received signal dB(μV/m) at 3m distance	Output Power (dBm)	Result
Low Channel										
2402	Peak	Horz	99.6	30.8	4.1	0.0	35.8	98.7	3.5	Pass
2402	Peak	Vert	98.1	30.8	4.1	0.0	35.8	97.2	2.0	Pass
Mid Channel										
2440	Peak	Horz	99.3	30.8	4.1	0.0	35.8	98.4	3.2	Pass
2440	Peak	Vert	98.8	30.8	4.1	0.0	35.8	97.9	2.7	Pass
High Channel										
2480	Peak	Horz	97.3	30.8	4.1	0.0	35.8	96.4	1.2	Pass
2480	Peak	Vert	96.3	30.8	4.1	0.0	35.8	95.4	0.2	Pass

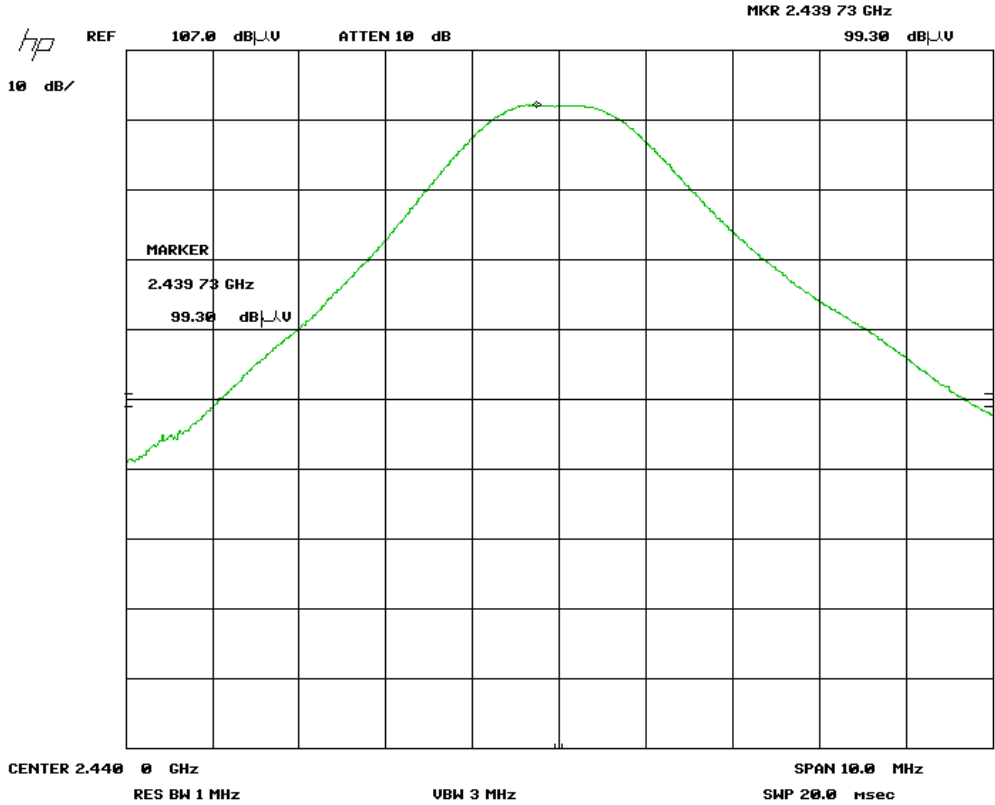
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Low Channel



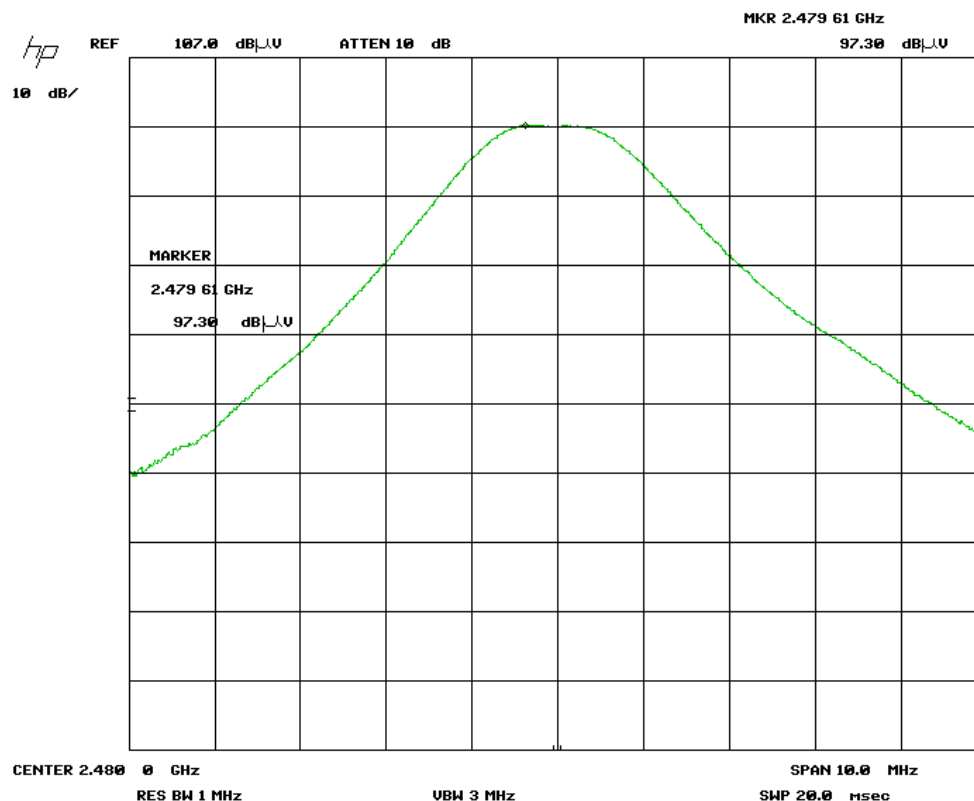
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Mid Channel




Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

High Channel



Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Power Head	PH 2000	AR	Jan. 22, 2015	Jan. 22, 2017	GEMC 15
Power meter	PM 2002	AR	Jan. 21, 2015	Jan. 21, 2017	GEMC 16
Spectrum Analyzer	8566B	HP	May 21, 2014	May 21, 2016	GEMC 193
Horn Antenna	6878/24	Q-par	Sept 10, 2014	Sept 10, 2016	GEMC 6365
Pre-Amp 1 - 26.5 GHz	HP 8449B	HP	Sept 09, 2014	Sept 09, 2016	GEMC 6351

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Antenna Spurious Conducted Emissions (-20 dBc Requirement)

Purpose


The purpose of this test is to ensure that the maximum power conducted to the radiating element at frequencies outside of the authorized spectrum does not exceed the limits specified. This ensures that the only the intended signal is delivered to the radiating element.

Limits

The limits are defined in 15.247(d). In any 100 kHz band, the peak spurious harmonics emissions must be at least 20 dB below the fundamental. Spurious Conducted emissions are to be evaluated up to the 10th harmonic. This -20 dBc requirement also applies at the 'band edge' or 2.4 GHz and 2.4835 GHz.

Results

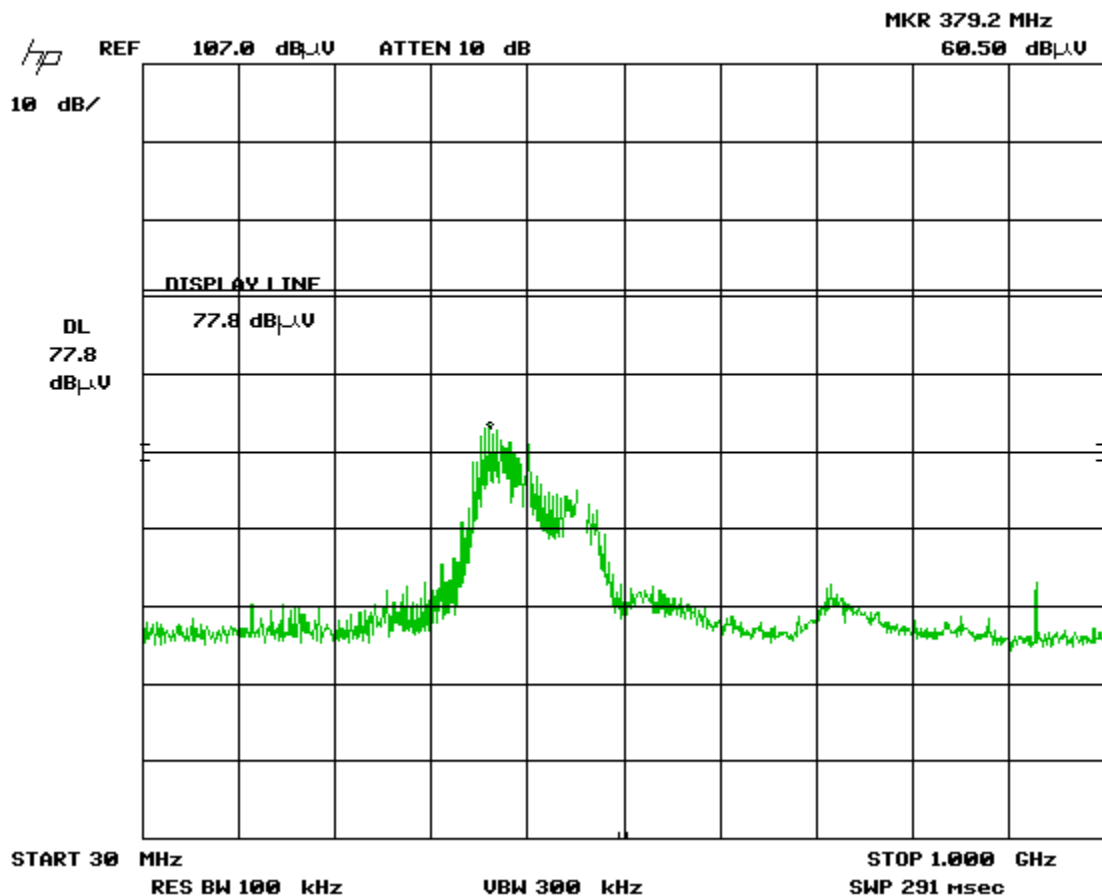
The EUT passes. Low, middle and high band was measured. The worst case is presented as a graph for the spectrum. The -20 dBc requirement is shown for the lower band edge at 2.4 GHz in the low band, and for the high band edge at 2.4835 GHz in the high band.


Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Graph(s)

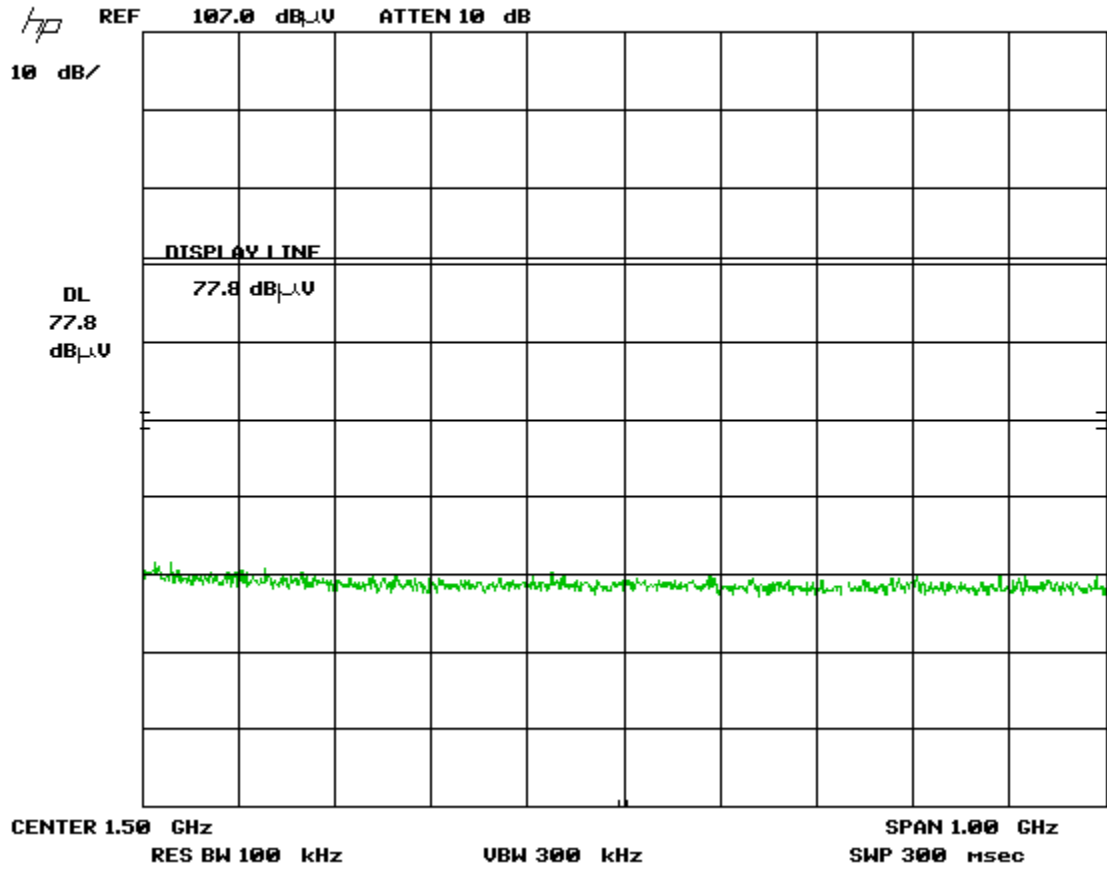
The graphs shown below displays a line 20dB below the peak power output detected from the device during transmit operation of the EUT, and compares the peak emissions other than the fundamental to this limit. Worst cases shown across the frequencies.


30 MHz – 1 GHz



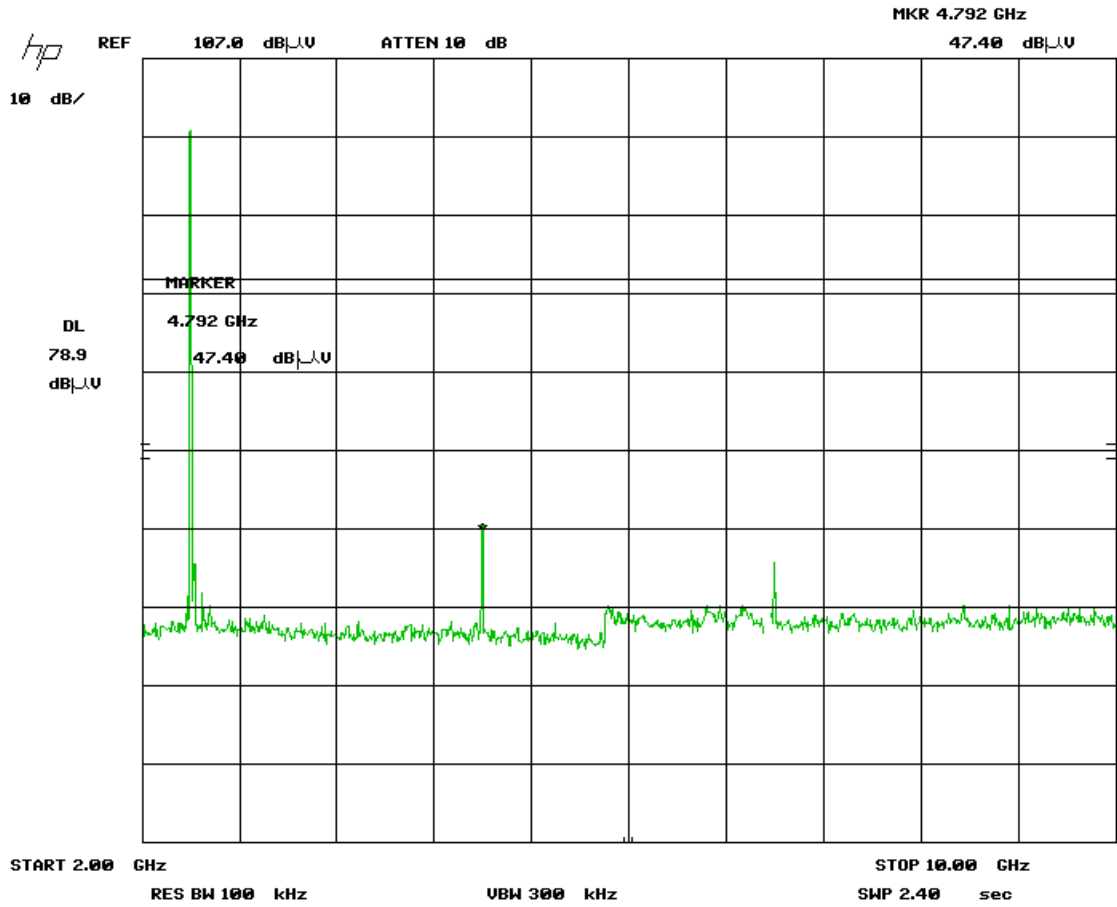
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


1 GHz – 2 GHz



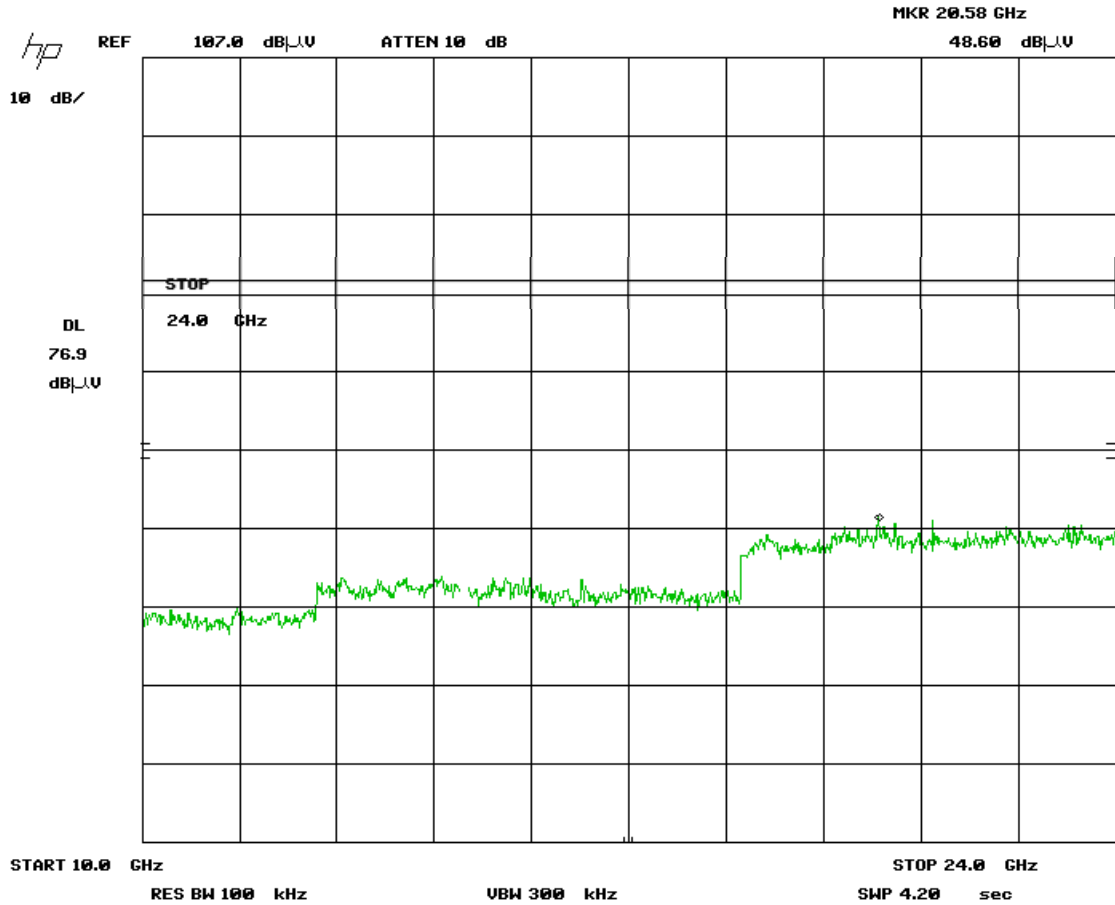
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


2 GHz – 10 GHz
Note: 1st peak is max fundamental



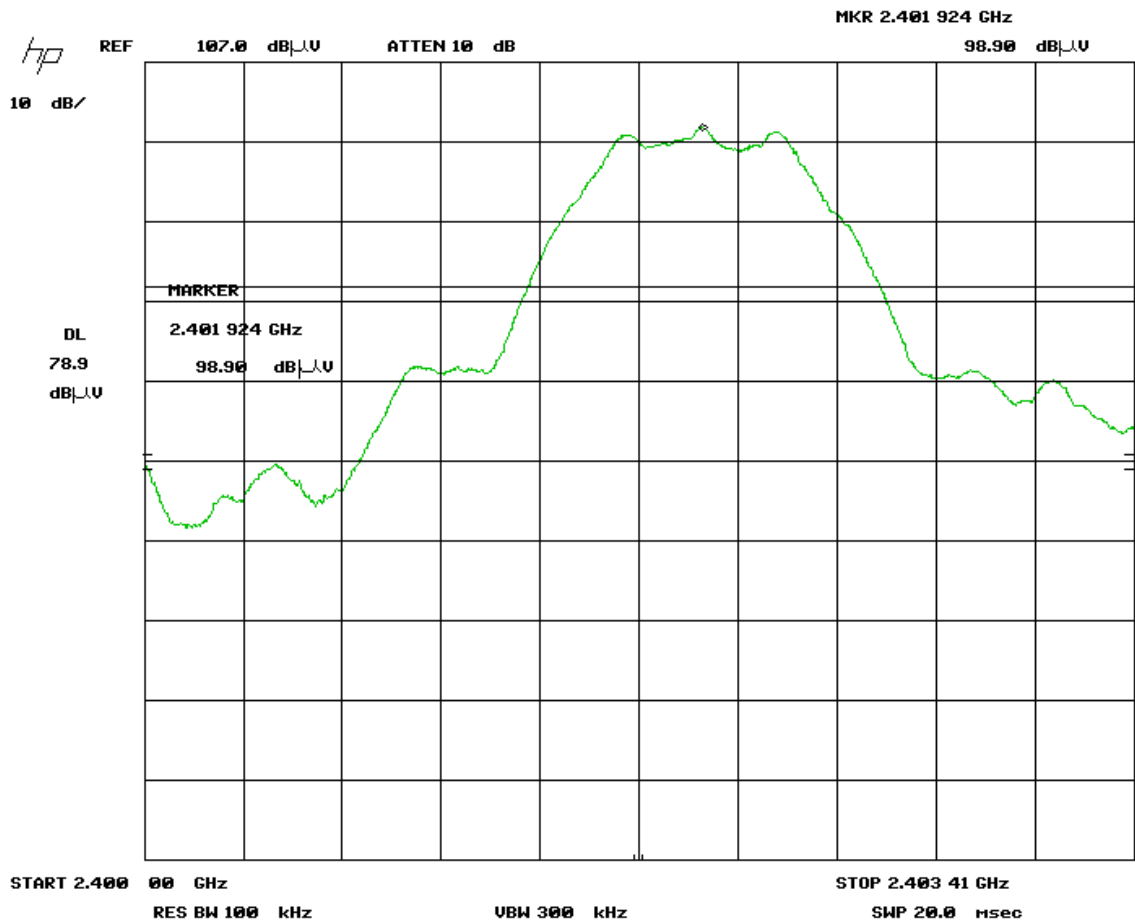
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


10 GHz – 24 GHz



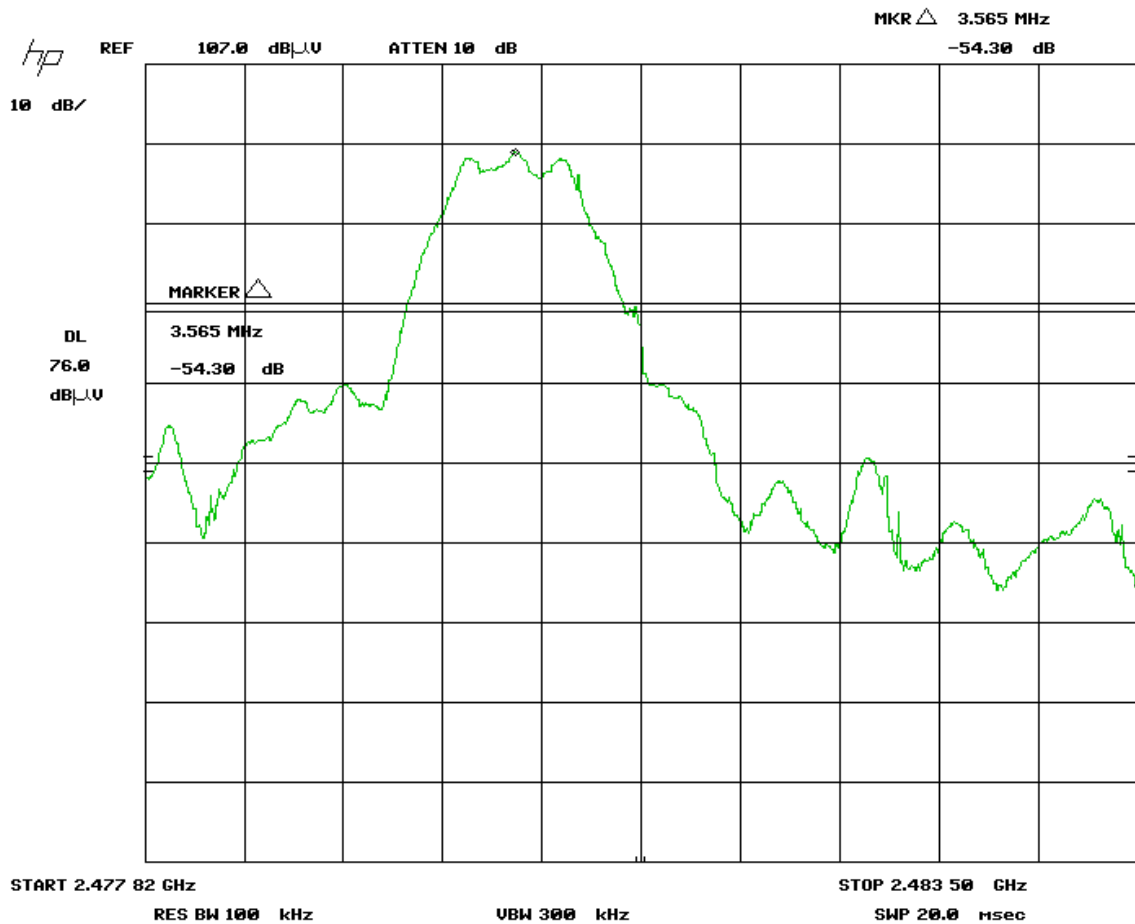
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Low Channel, Lower Band Edge
2.4 GHz – 2.403 GHz



Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

High Channel, Upper Band Edge
2.478 GHz – 2.4835 GHz




Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	May 21, 2014	May 21, 2016	GEMC 193
Horn Antenna	6878/24	Q-par	Sept 10, 2014	Sept 10, 2016	GEMC 6365
Pre-Amp 1 - 26.5 GHz	HP 8449B	HP	Sept 09, 2014	Sept 09, 2016	GEMC 6351

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Power Spectral Density - DM

Purpose

The purpose of this test is to ensure that the maximum power spectral density to the radiating element does not exceed the limits specified. This ensures that the modulation is significantly wide enough, or low enough in power that it will allow for co-operation of other wireless devices operating within this frequency allocation.

Limits

The limits are defined in 15.247(e).


For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

The method is given in Section 10.2 of FCC KDB 558074: June 5, 2014 (peak PSD).

Results

The EUT passed. Low, middle, and high channel was tested. Peak measurements were made for each with a 3 kHz resolution bandwidth, during transmit operation of the EUT with continuous modulated data (>98%). The power spectral density is < 8dBm.

Test Frequency (MHz)	Detection mode	Antenna polarity (Horz/Vert)	Raw signal dB(μV)	Antenna factor dB	Cable loss dB + Preselector	Attenuator dB	Pre-Amp Gain dB	Received signal dB(μV/m) at 3m distance	Output Power (dBm)	Result
Low Channel										
2402	Peak	Horz	83.6	30.8	4.1	0.0	35.8	82.7	-12.5	Pass
2402	Peak	Vert	82.7	30.8	4.1	0.0	35.8	81.8	-13.4	Pass
Mid channel										
2440	Peak	Horz	81.3	30.8	4.1	0.0	35.8	80.4	-14.8	Pass
2440	Peak	Vert	82.9	30.8	4.1	0.0	35.8	82.0	-13.2	Pass
High channel										
2480	Peak	Horz	81.6	30.8	4.1	0.0	35.8	80.7	-14.5	Pass
2480	Peak	Vert	80.7	30.8	4.1	0.0	35.8	79.8	-15.4	Pass

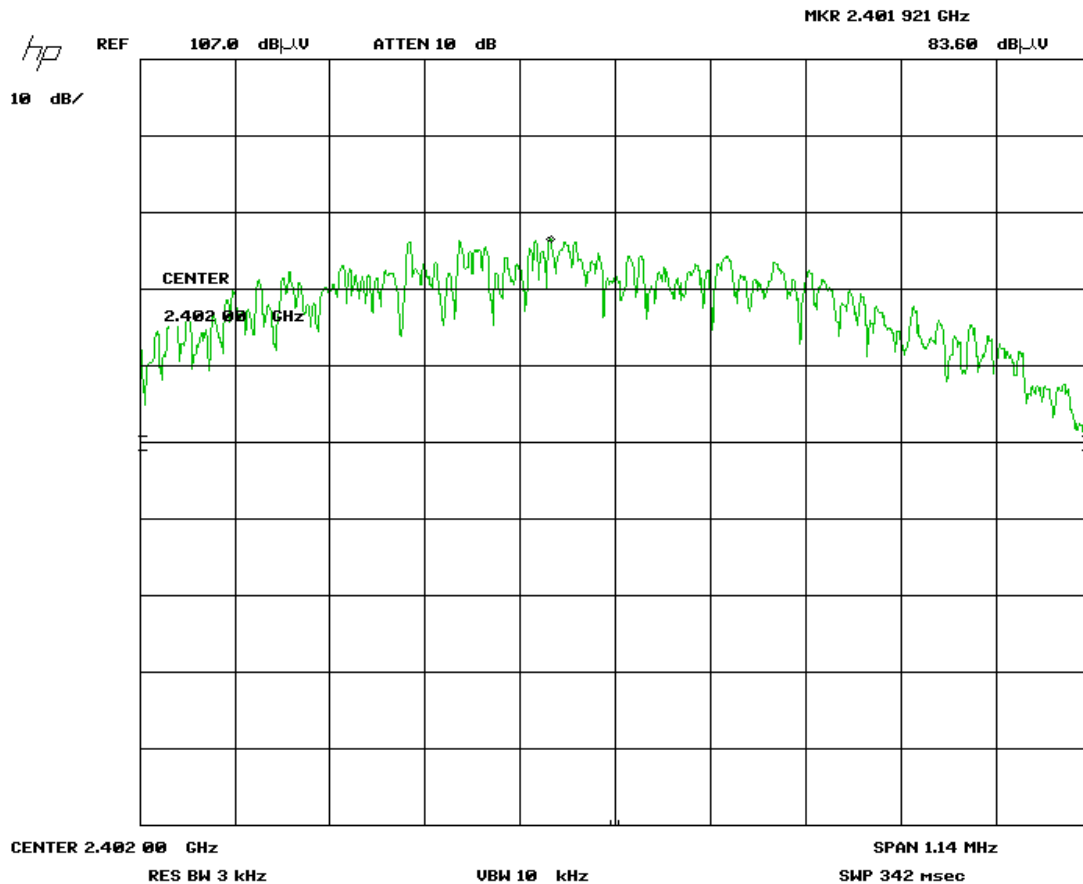
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Graph(s)

The graphs shown below show the power spectral density of the device during the operation of the EUT. Low, middle, and high channel was investigated, and worst cases are presented.

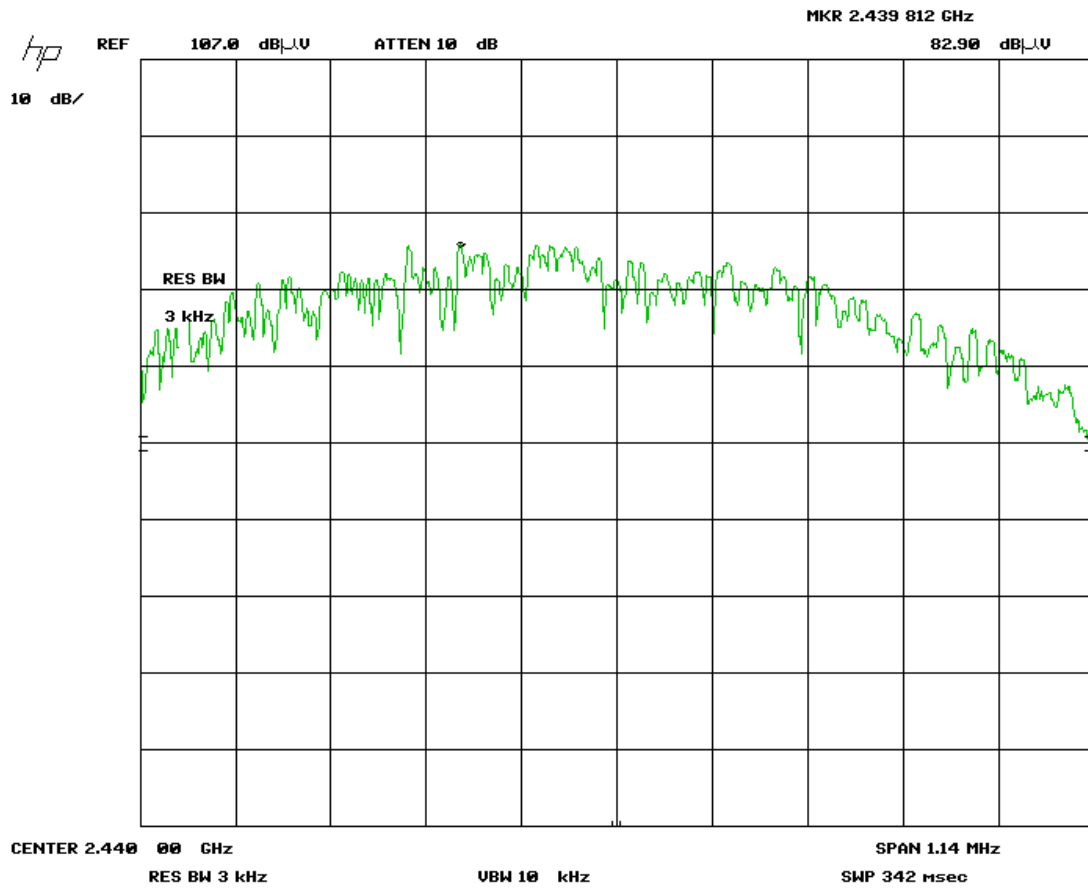
Note: See ‘Appendix B – EUT & Test Setup Photographs’ for photos showing the test set-up.


Low Channel



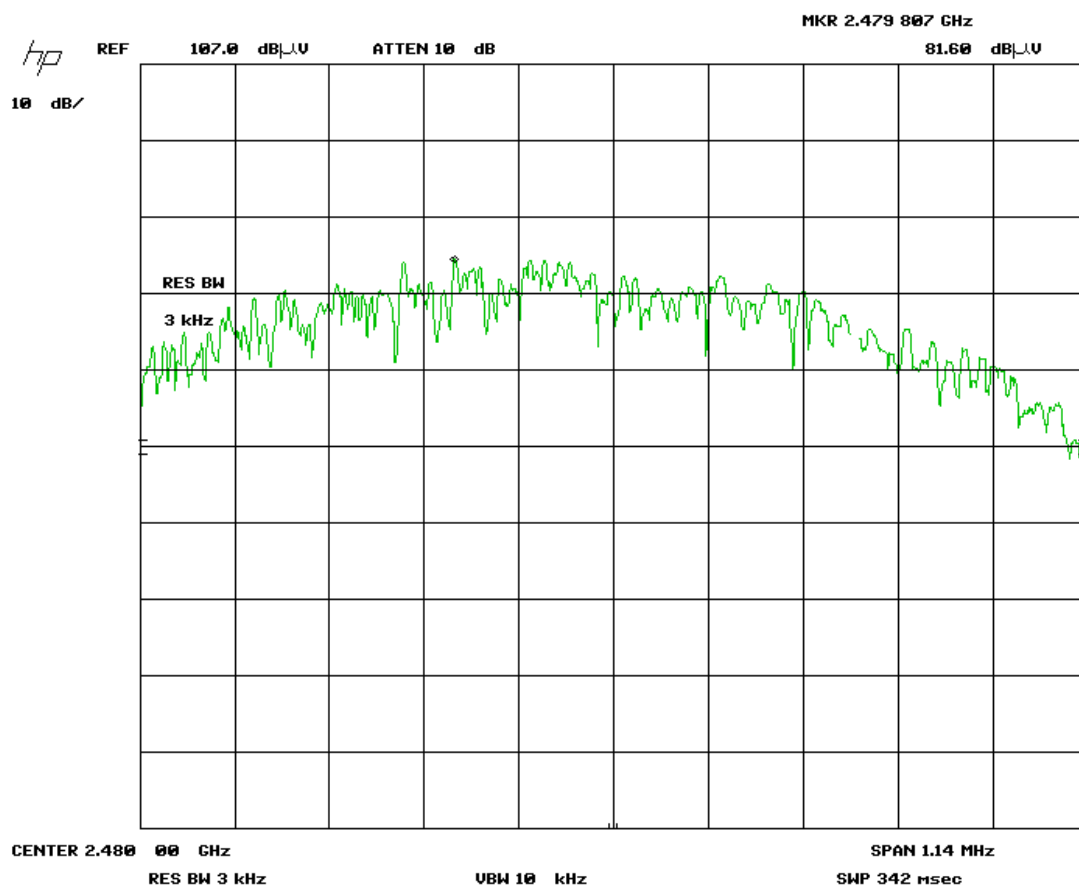
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Mid Channel



Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

High Channel




Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	May 21, 2014	May 21, 2016	GEMC 193
Horn Antenna	6878/24	Q-par	Sept 10, 2014	Sept 10, 2016	GEMC 6365
Pre-Amp 1 - 26.5 GHz	HP 8449B	HP	Sept 09, 2014	Sept 09, 2016	GEMC 6351

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Radiated Emissions – 15.247, 15.209

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

Limit(s) and Method

The method is as defined in ANSI C63.4:2003.

The limits are as defined in FCC Part 15, Section 15.209:

The limits, as defined in 15.247(d) for unintentional radiated emissions apply for those emissions that fall in the restricted bands, as defined in Section 15.205(a). These emissions must comply with the radiated emission limits specified in Section 15.209(a).

0.009 MHz – 0.490 MHz, 2400/F(kHz) uV/m at 300 m¹

0.490 MHz – 1.705 MHz, 24000/F(kHz) uV/m at 30 m¹

1.705 MHz – 30 MHz, 30 uV/m at 30 m¹

30 MHz – 88 MHz, 100 uV/m (40.0 dBuV/m¹) at 3 m

88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m¹) at 3 m

216 MHz – 960 MHz, 200 uV/m (46.0 dBuV/m¹) at 3 m

Above 960 MHz, 500 uV/m (54.0 dBuV/m¹) at 3 m


Above 1000 MHz, 500 uV/m (54 dBuV/m²) at 3m

Above 1000 MHz, 500 uV/m (74 dBuV/m³) at 3m

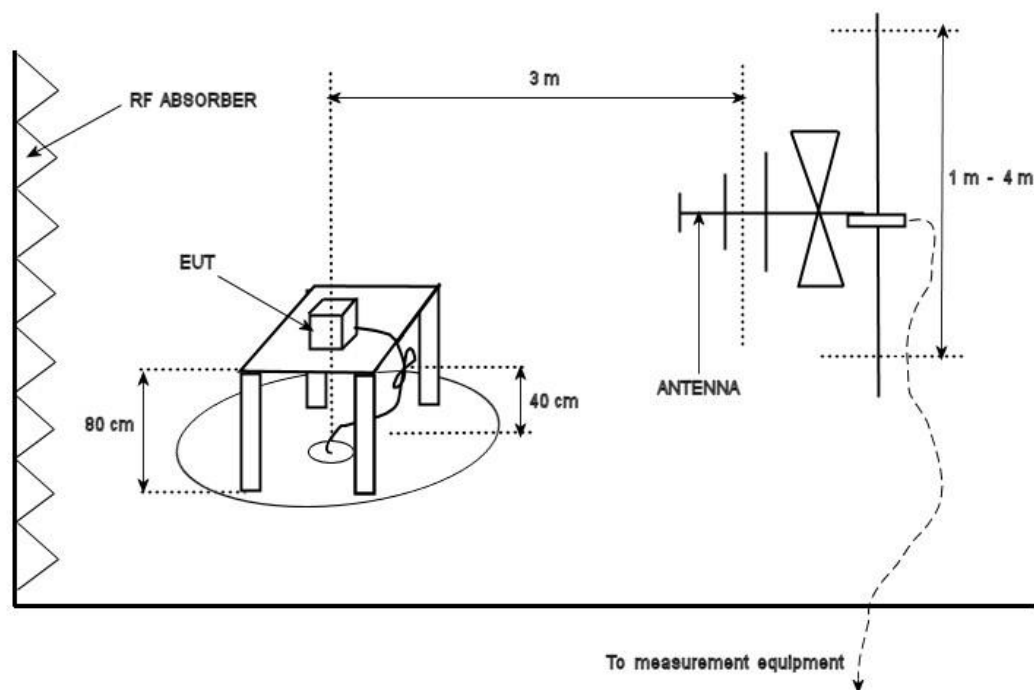
¹Limit is with Quasi Peak detector with bandwidths as defined in CISPR-16-1-1.

²Limit is with 1 MHz measurement bandwidth and using an Average detector.

³Limit is with 1 MHz measurement bandwidth and using a Peak detector.

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Typical Radiated Emissions Setup



Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is ± 4.4 dB with a 'k=2' coverage factor and a 95% confidence level.

Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector, please refer to the final measurement table where applicable. The graphs shown below are maximized peak measurement graphs, measured with a resolution bandwidth greater than or equal to, the final required detector and over a full 0-360° rotation. This peaking process is done as a worst case measurement. This process enables the detection of frequencies of concern for final measurement, and provides considerable time savings.


In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to the 10th harmonic.

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

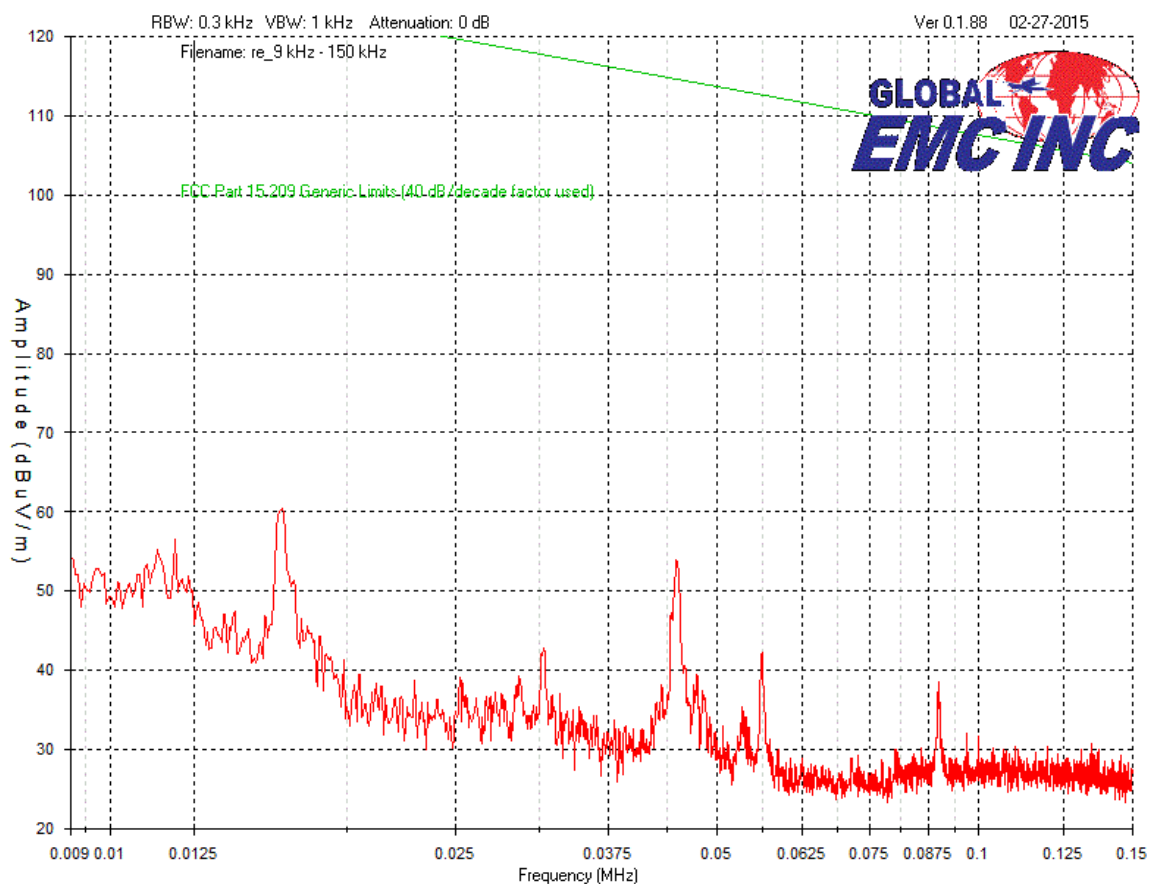
Devices scanned may be scanned at alternate test distances, and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above 30 MHz and 40 dB/decade below 30 MHz. For example for 1 meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m/3m) is applied.


See final measurement section for all measurements.

Low, middle, and high channels were scanned. Worst case is presented.

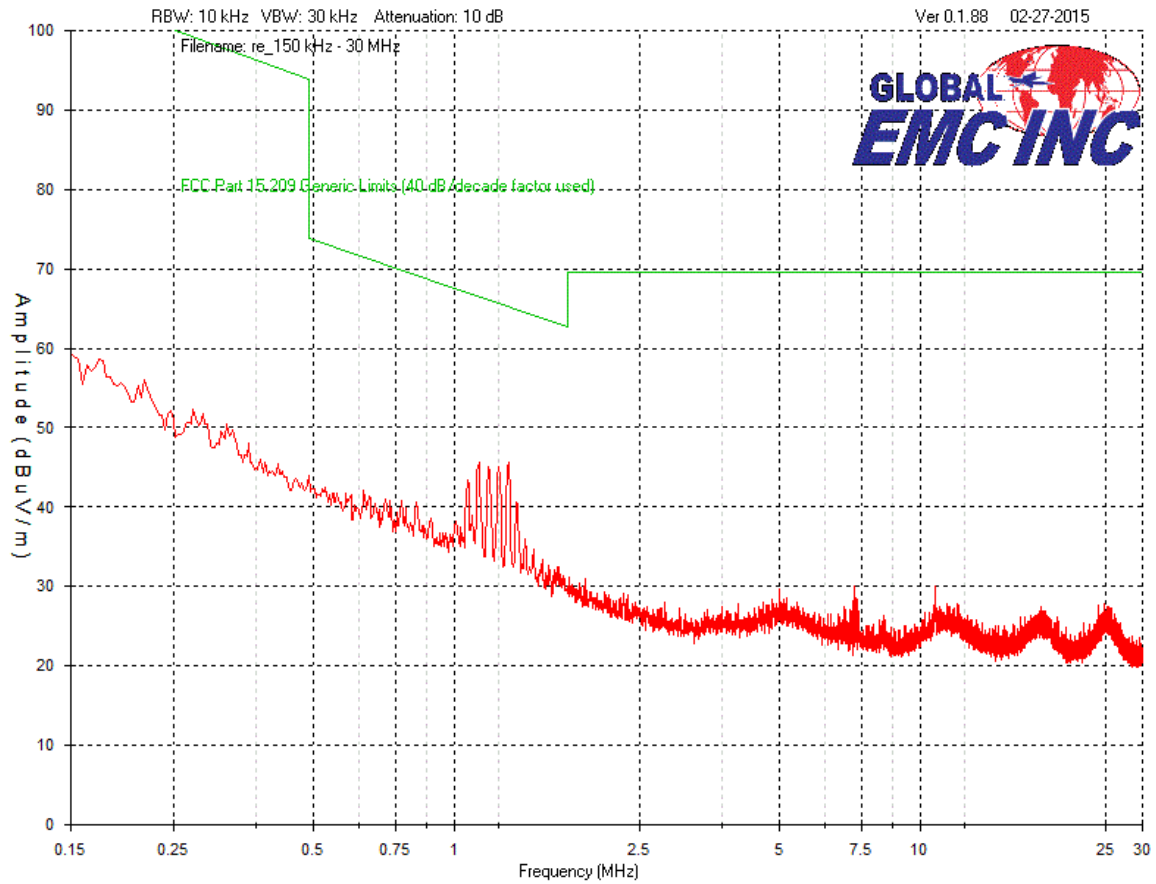
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
9 kHz to 150 kHz



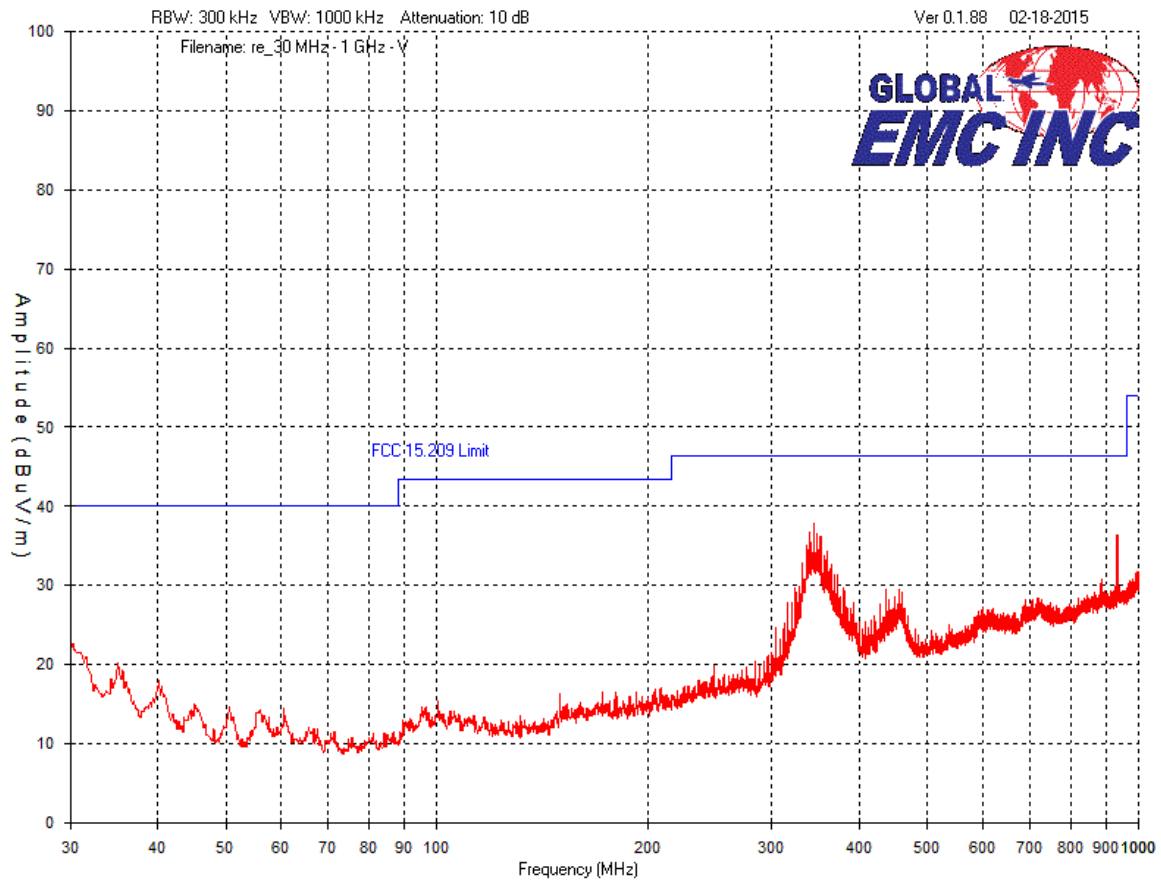
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
150 kHz to 30 MHz



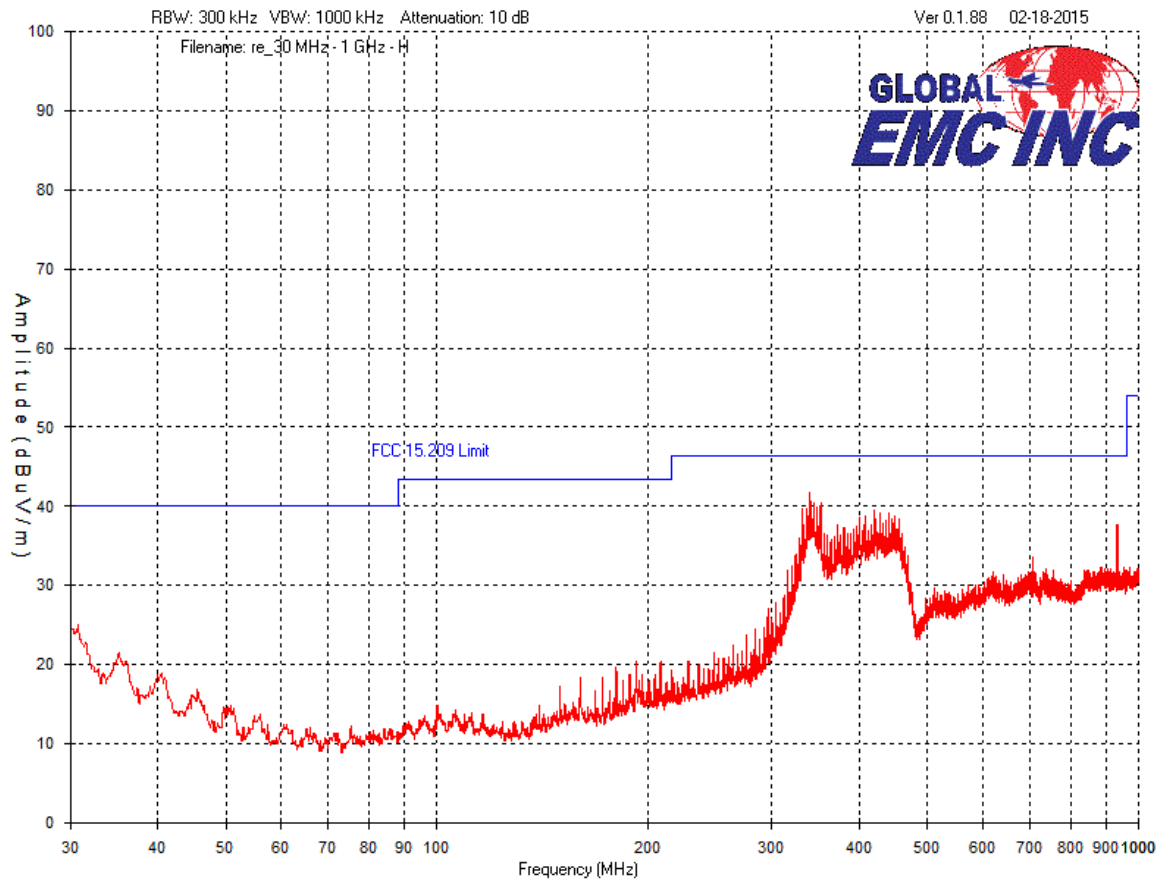
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
Vertical Antenna Polarity
30 MHz to 1 GHz



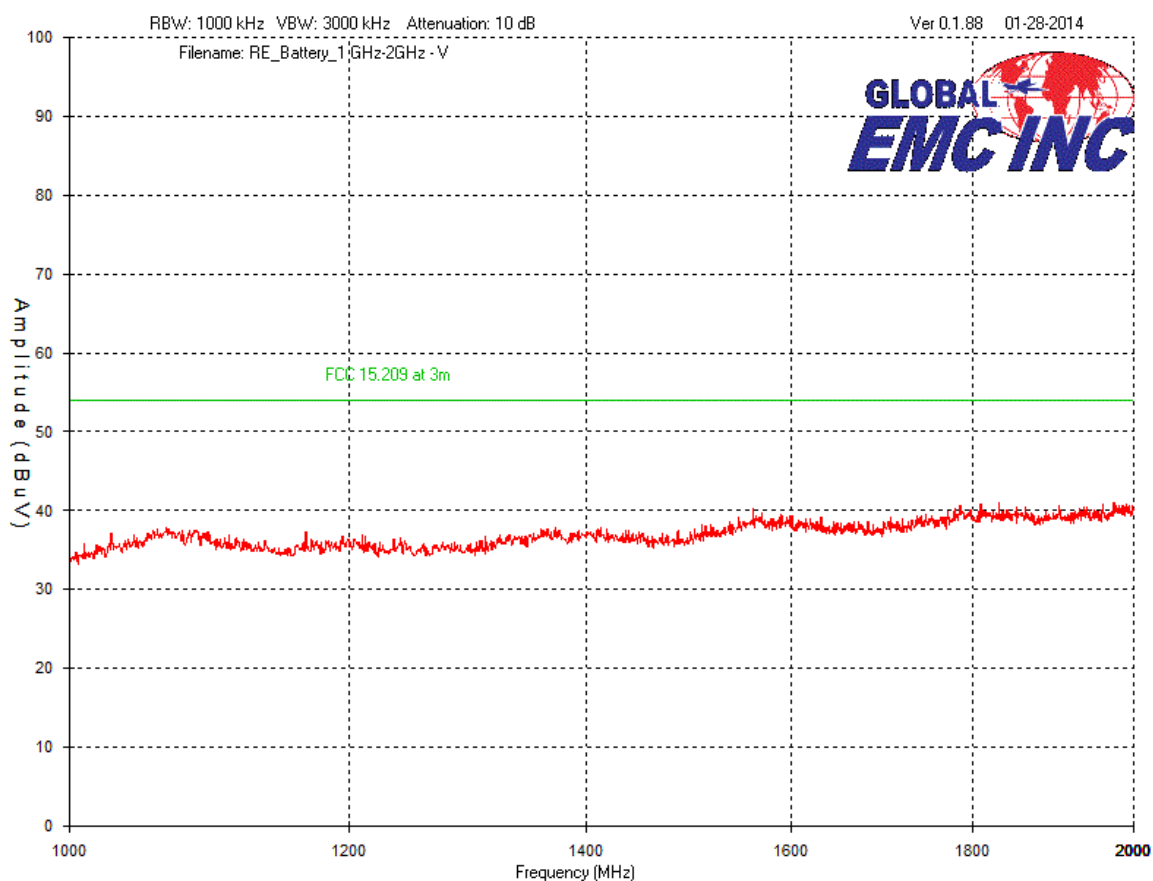
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
Horizontal Antenna Polarity
30 MHz to 1 GHz



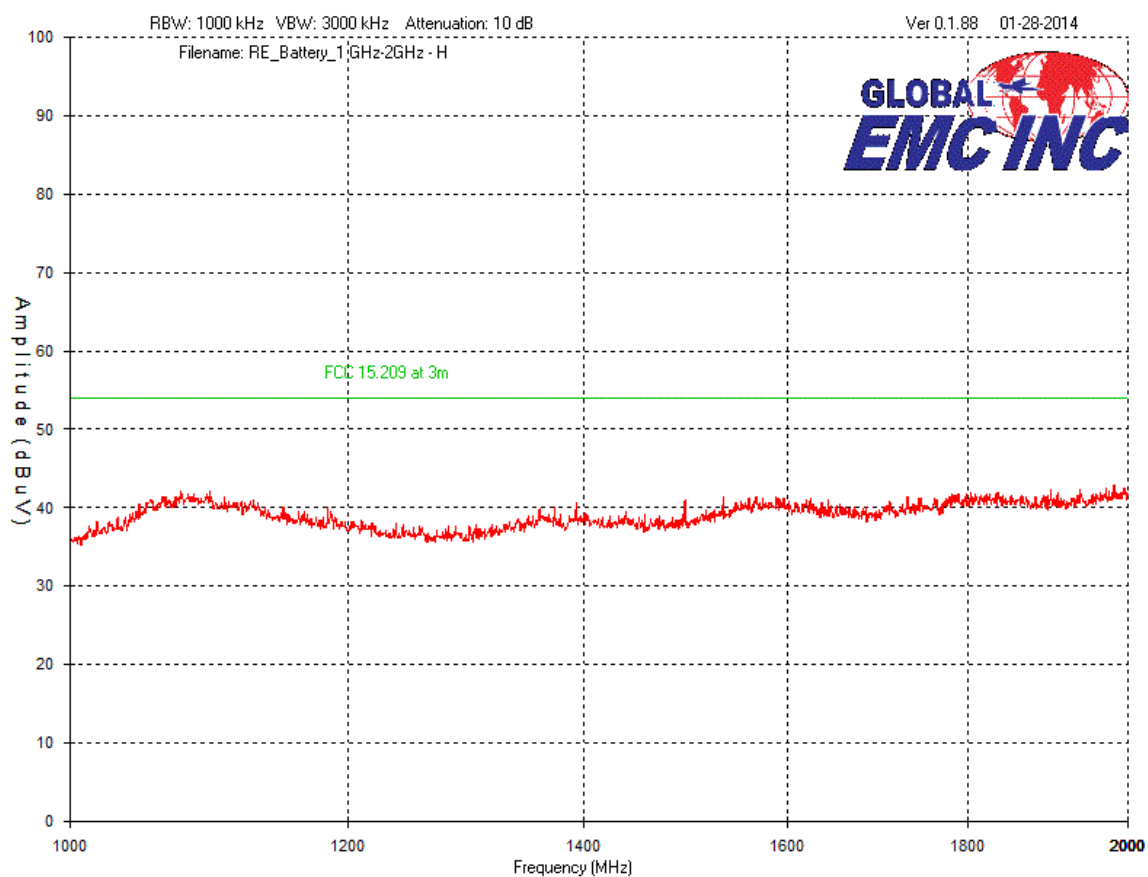
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
Vertical Antenna Polarity
1 GHz to 2 GHz



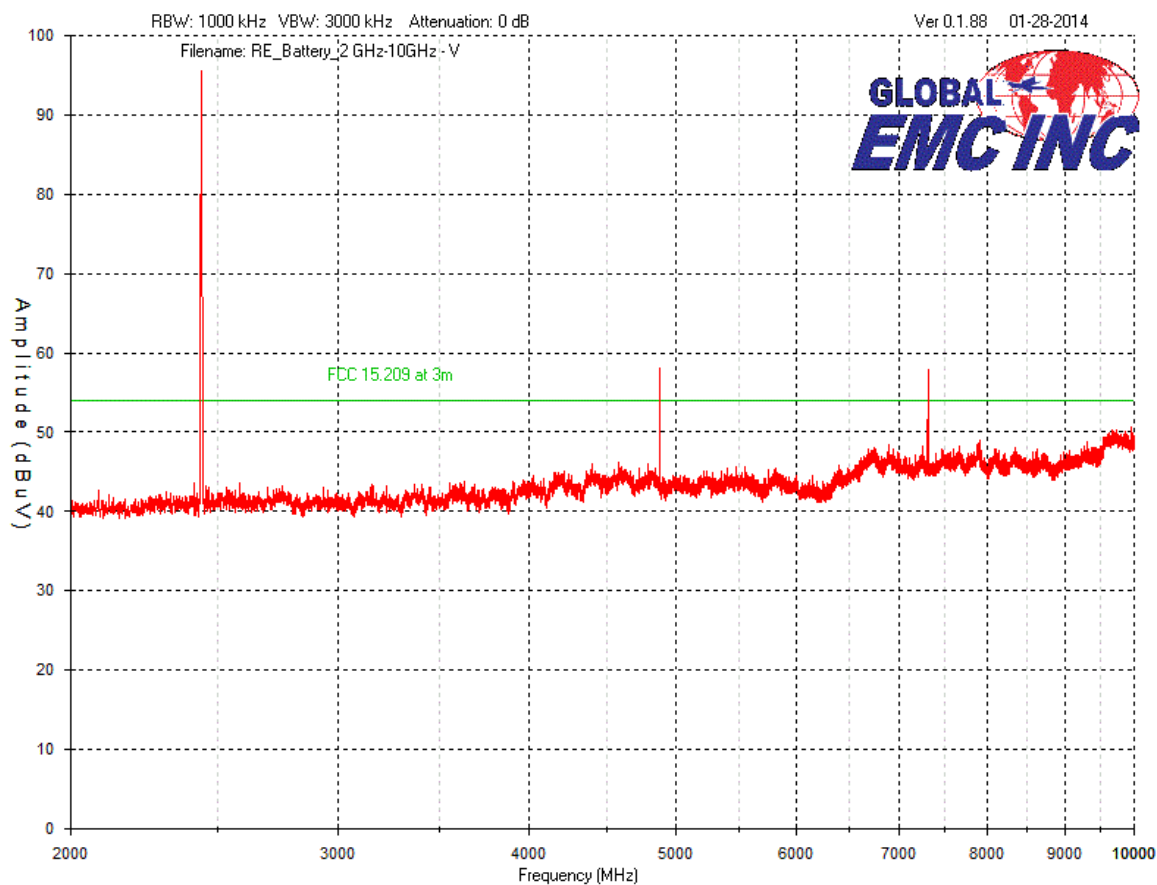
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
Horizontal Antenna Polarity
1 GHz to 2 GHz



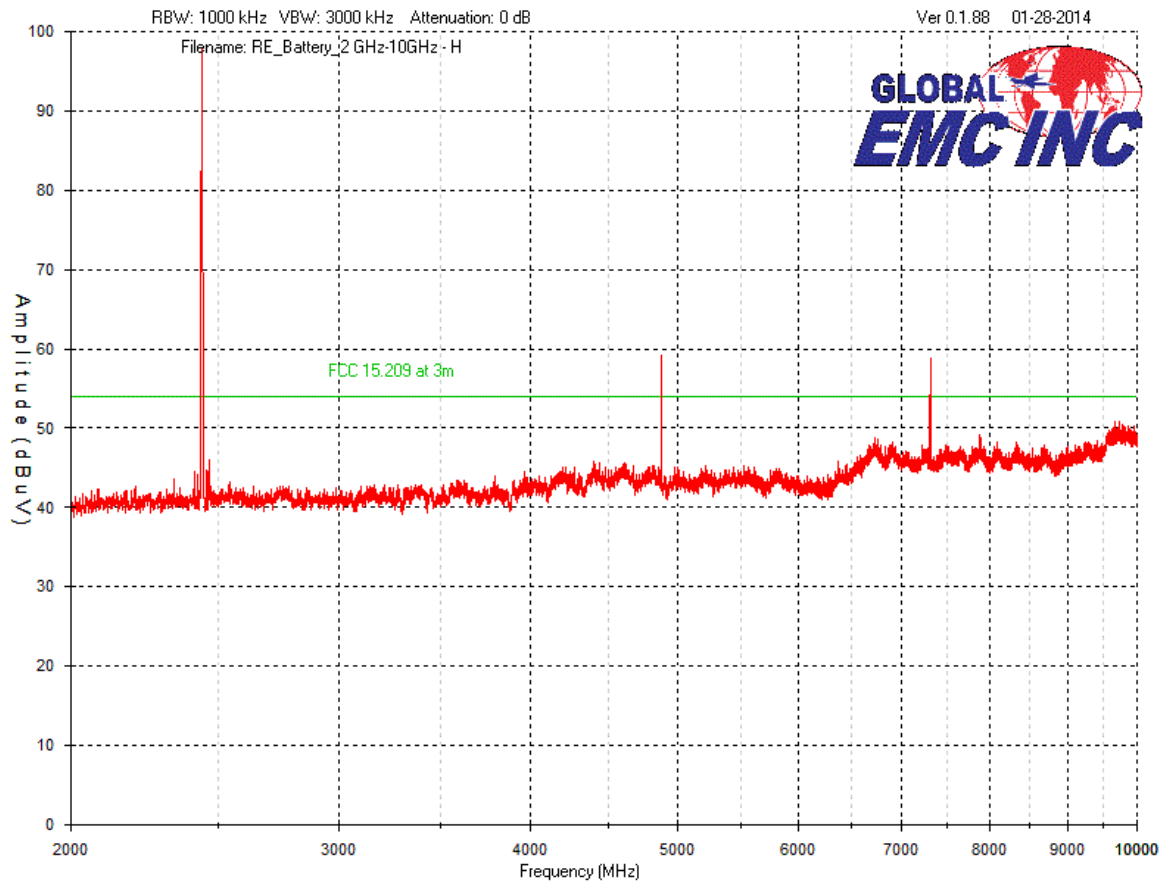
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
Vertical Antenna Polarity
2 GHz to 10 GHz



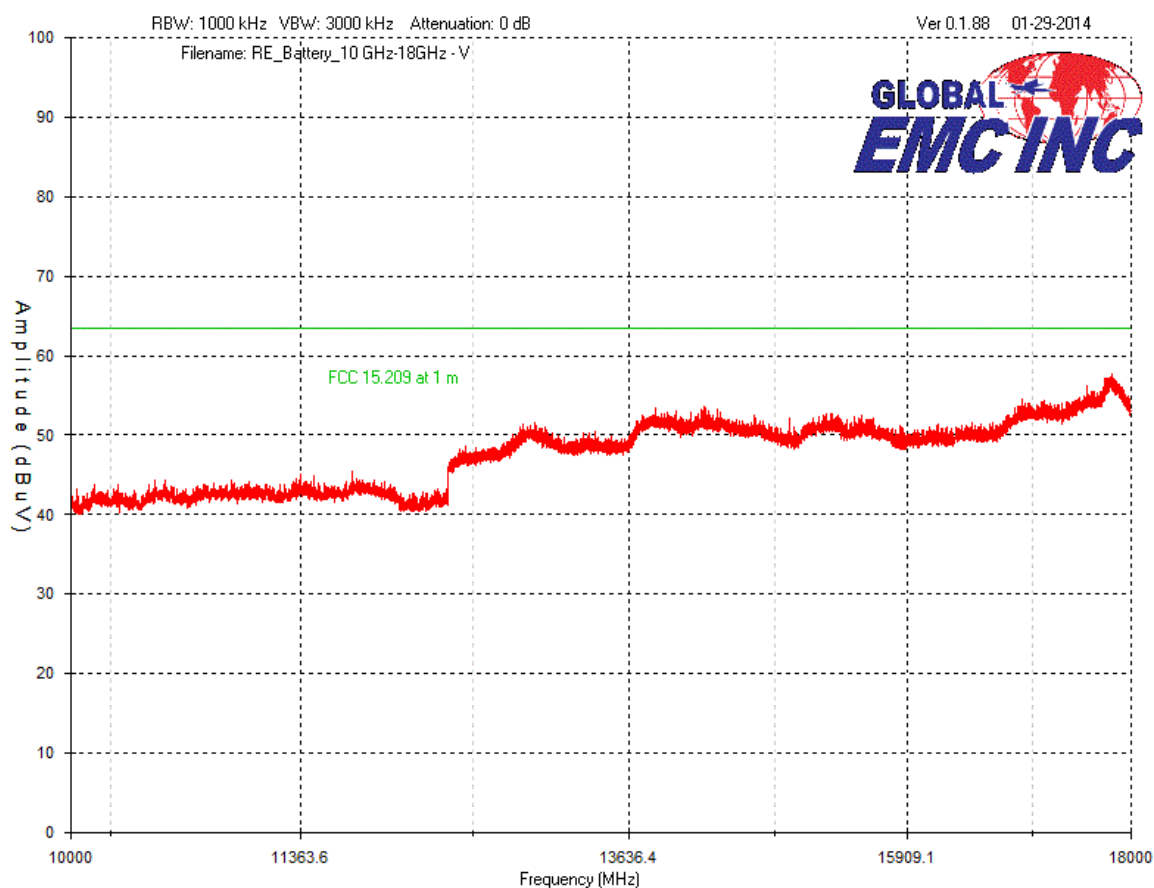
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
Horizontal Antenna Polarity
2 GHz to 10 GHz



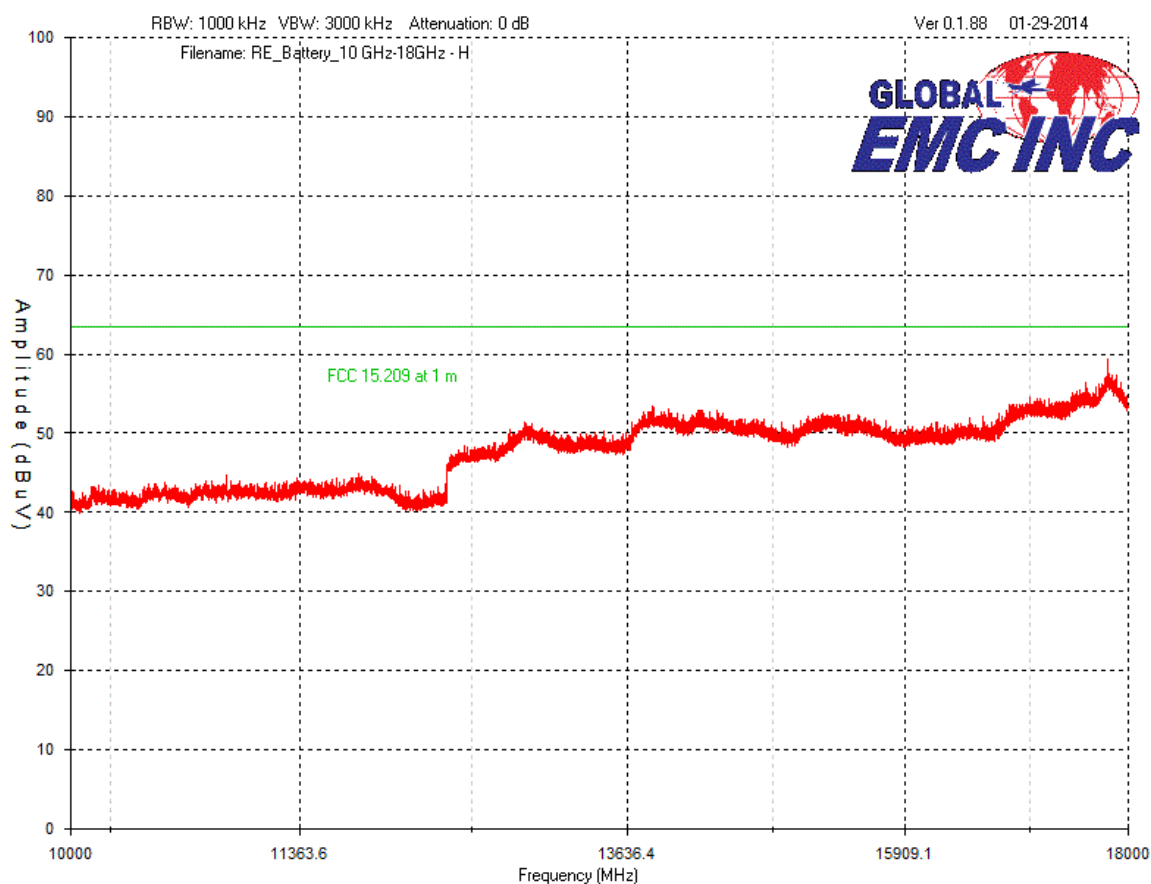
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
Vertical Antenna Polarity
10 GHz to 18 GHz



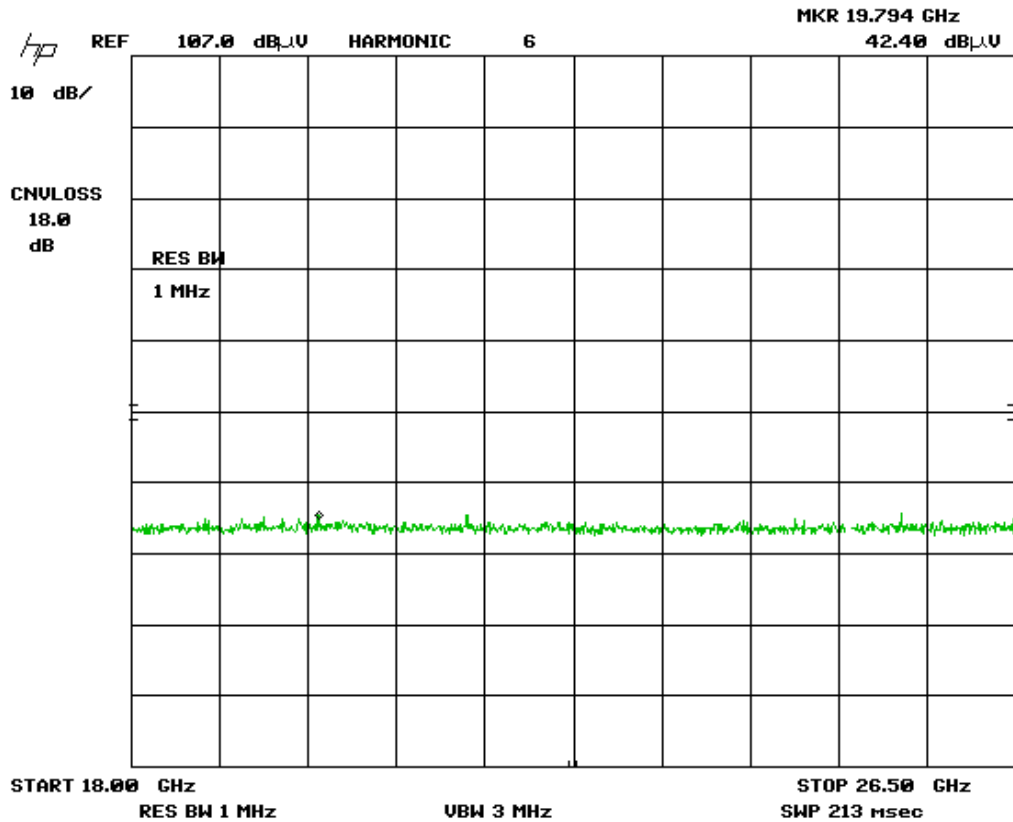
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
Horizontal Antenna Polarity
10 GHz to 18 GHz



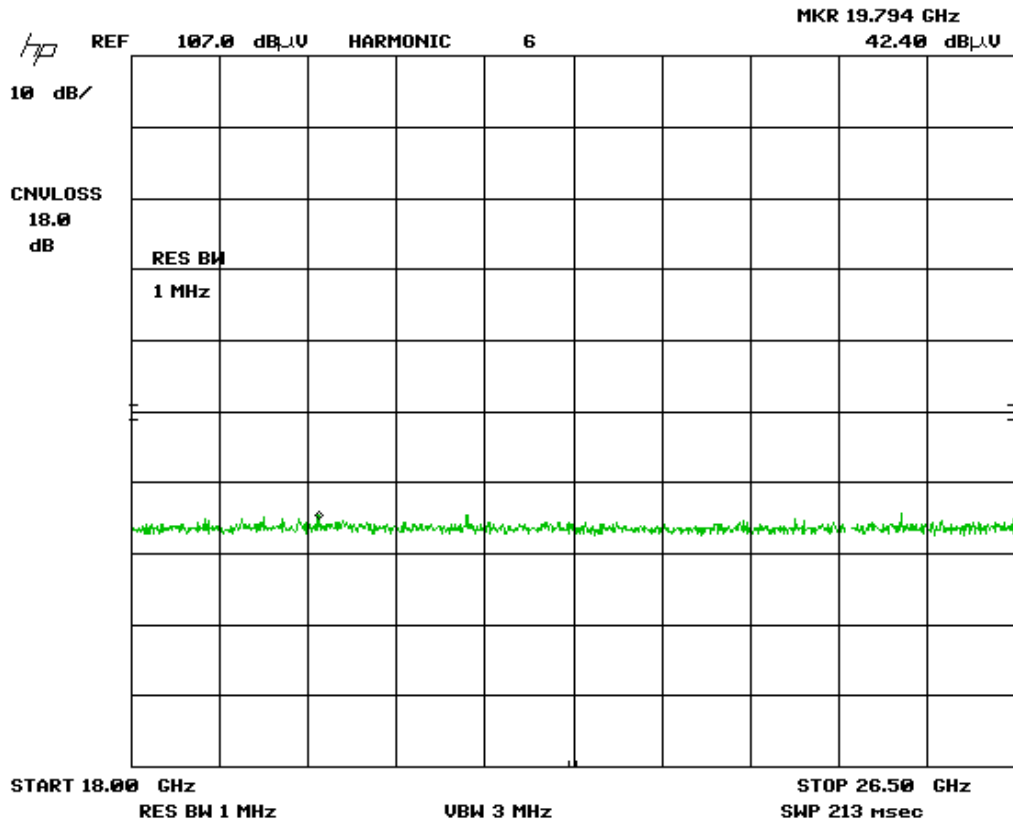
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
Vertical Antenna Polarity
18 GHz to 26.5 GHz



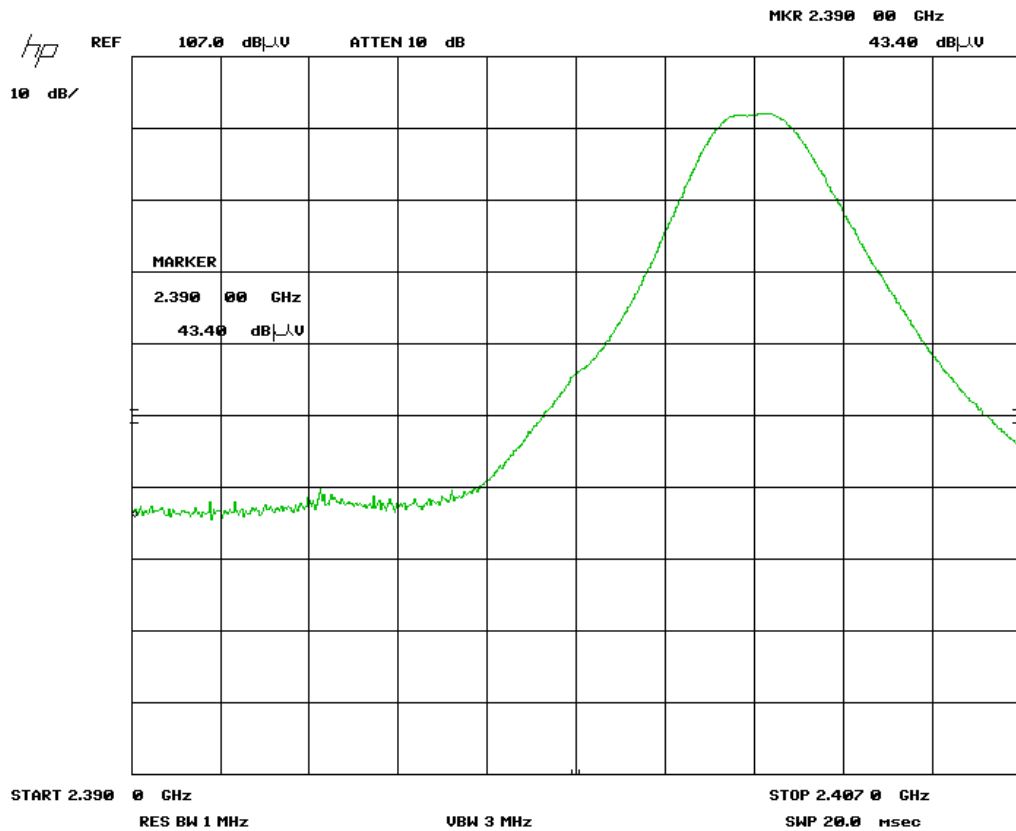
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Peak Emissions Graph
Horizontal Antenna Polarity
18 GHz to 26.5 GHz



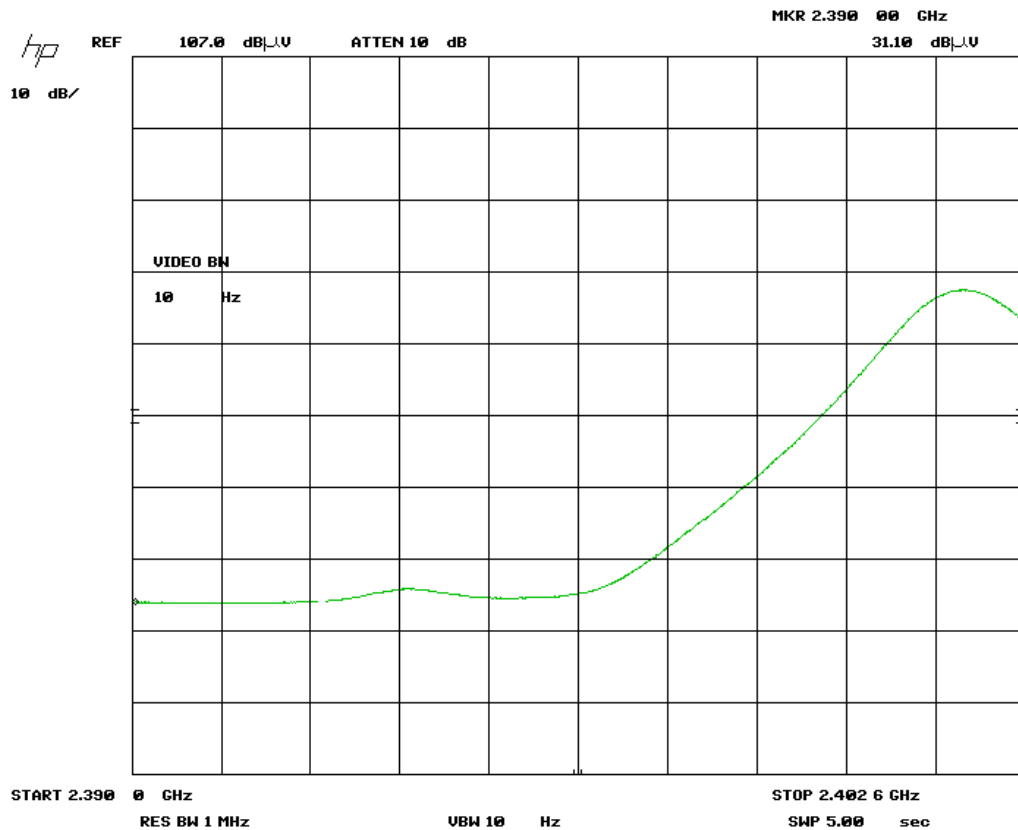
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Restricted Band Edges Emissions Graph (Peak)
At 2.390 GHz, Horizontal Antenna Polarity
Low Channel1 (2402 MHz)



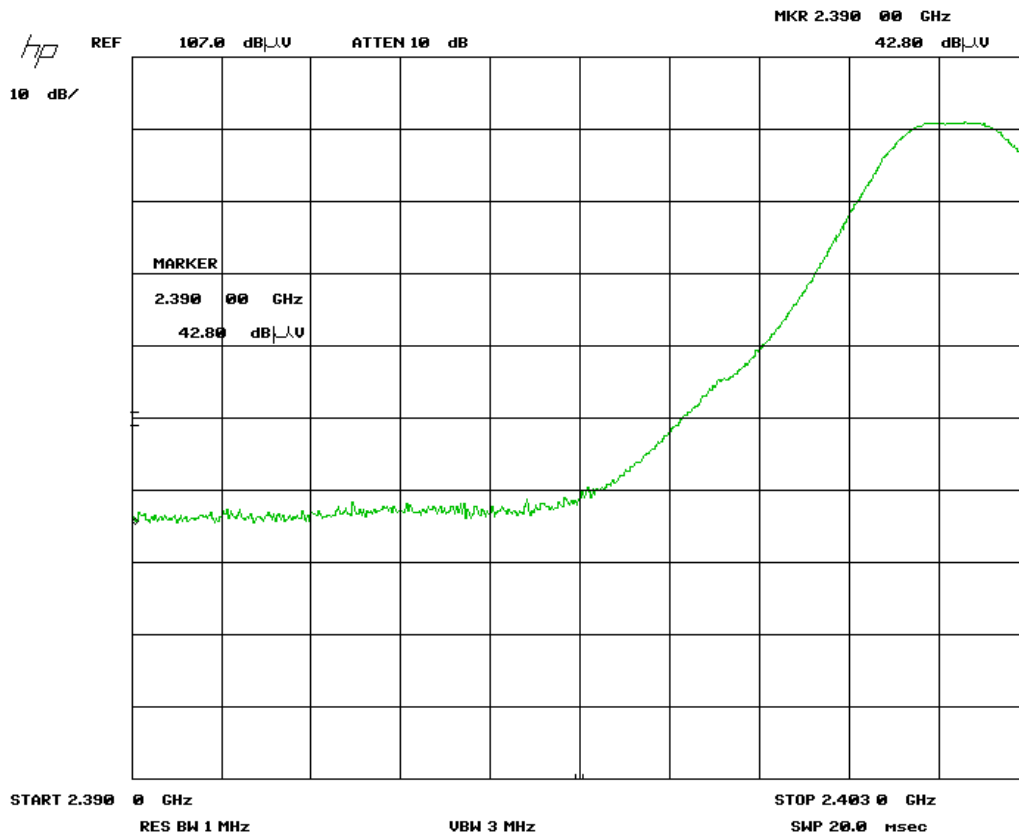
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Restricted Band Edges Emissions Graph (Average)
At 2.390 GHz, Horizontal Antenna Polarity
Low Channel1 (2402 MHz)



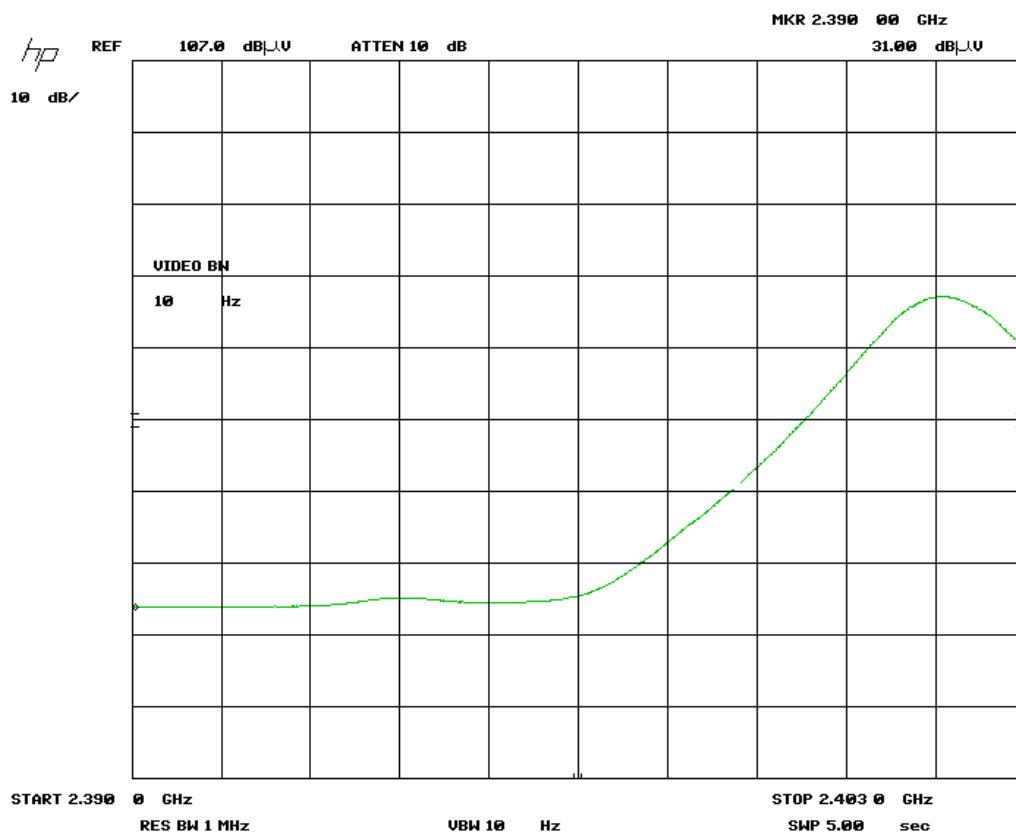
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Restricted Band Edges Emissions Graph (Peak)
At 2.390 GHz, Vertical Antenna Polarity
Low Channel1 (2402 MHz)



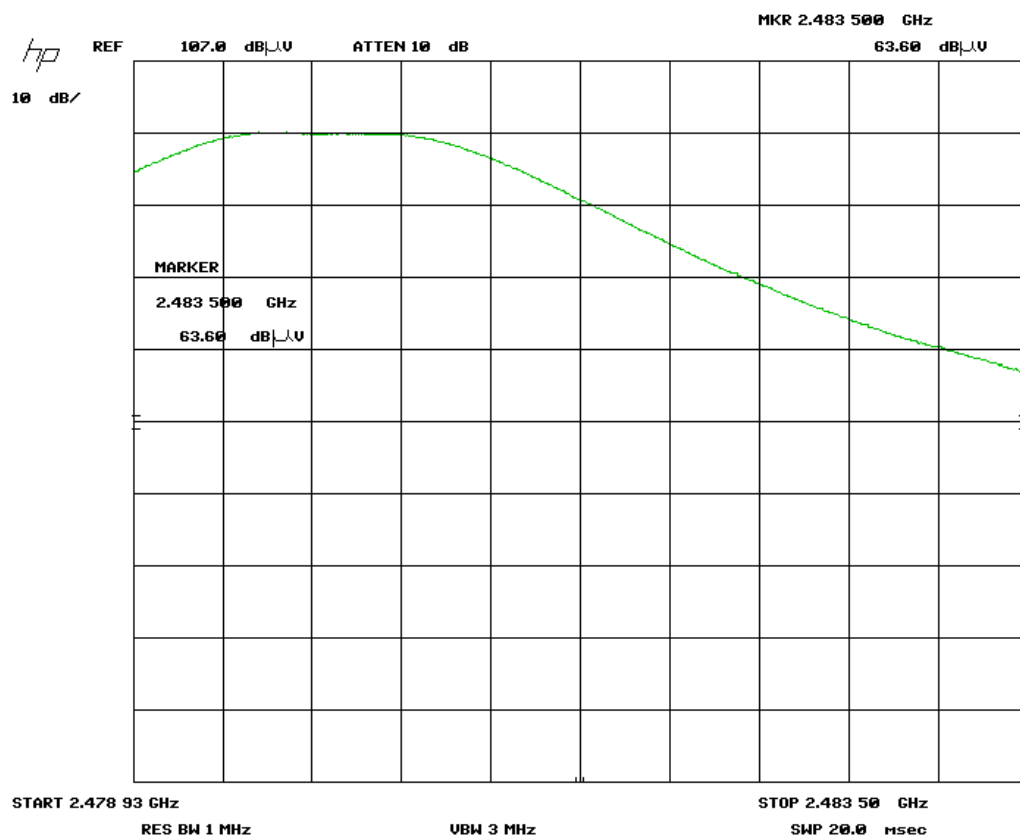
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Restricted Band Edges Emissions Graph (Average)
 At 2.390 GHz, Vertical Antenna Polarity
 Low Channel1 (2402 MHz)



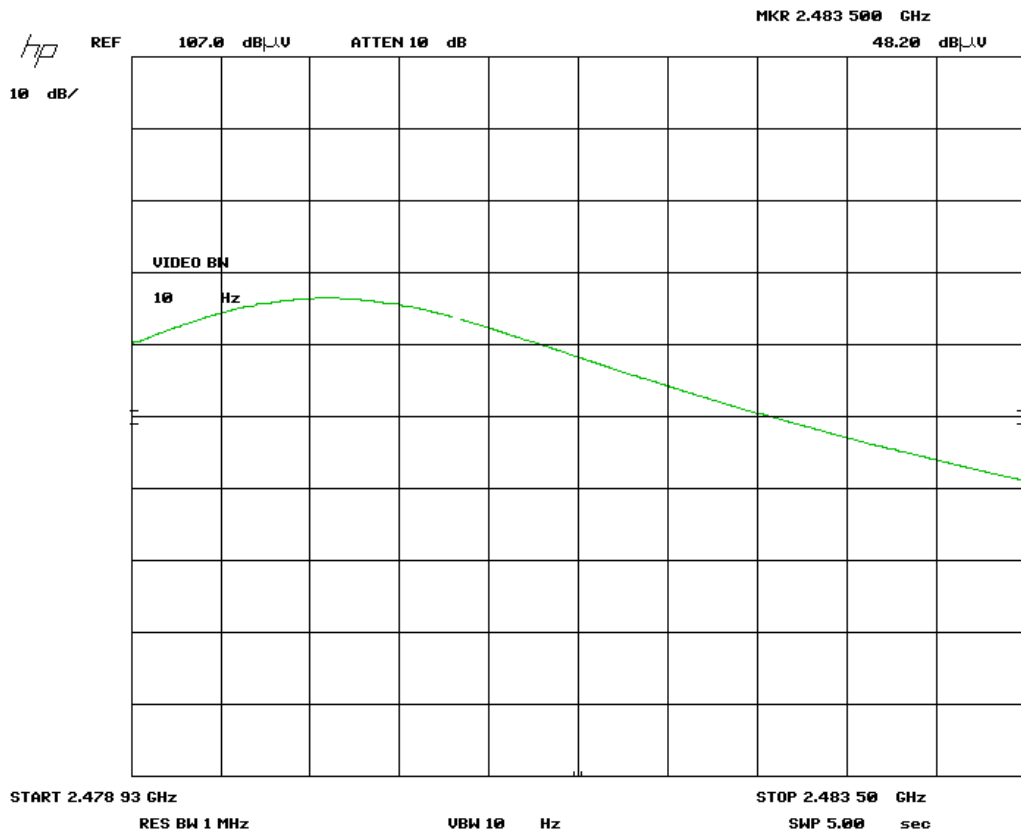
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Restricted Band Edges Emissions Graph (Peak)
At 2.4835 GHz, Horizontal Antenna Polarity
High Channel1 (2480 MHz)



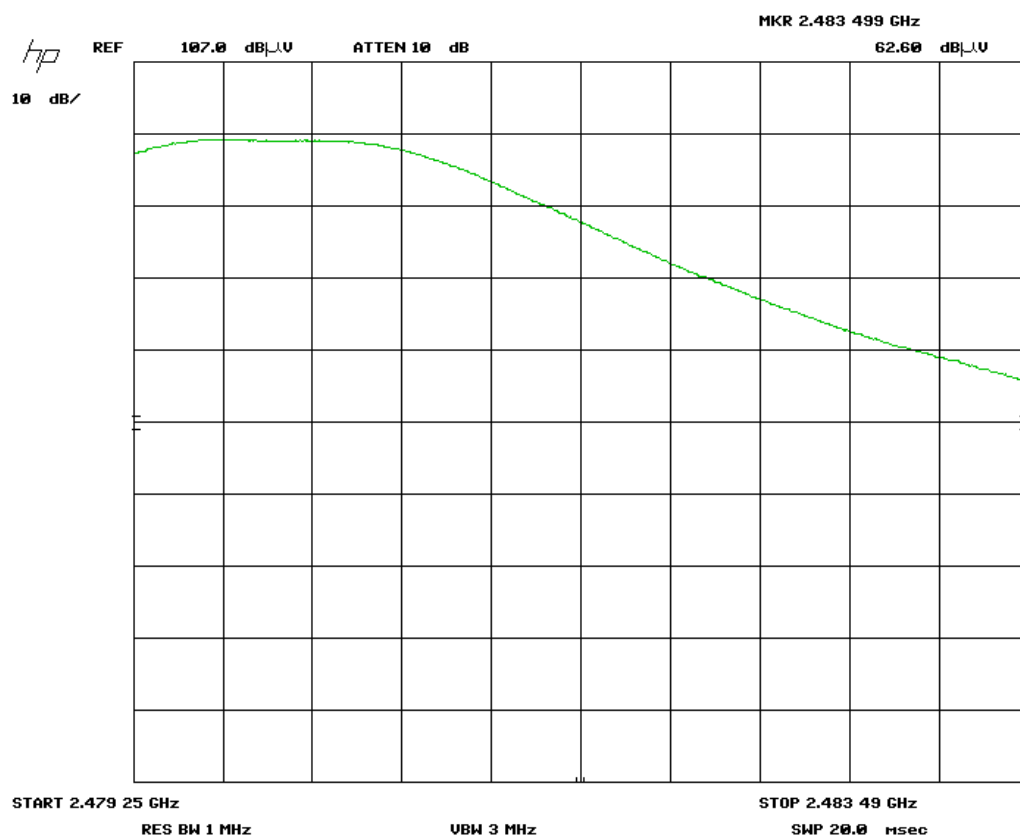
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Restricted Band Edges Emissions Graph (Average)
At 2.4835 GHz, Horizontal Antenna Polarity
High Channel1 (2480 MHz)



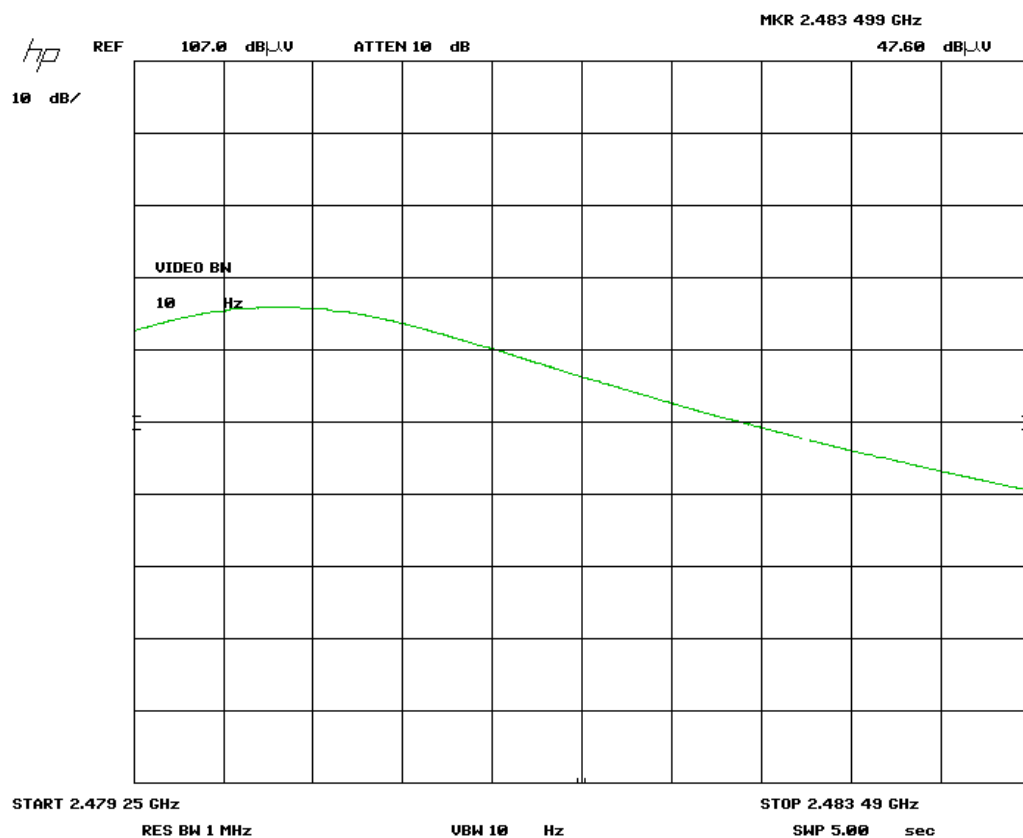
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Restricted Band Edges Emissions Graph (Peak)
At 2.4835 GHz, Vertical Antenna Polarity
High Channel1 (2480 MHz)



Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Restricted Band Edges Emissions Graph (Average)
At 2.4835 GHz, Vertical Antenna Polarity
High Channel1 (2480 MHz)



Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Final Measurements

Table 1: Radiated Emissions
Harmonics/Spurious emissions
3m measurement distance

Test Frequency (MHz)	Detection mode	Antenna polarity (Horz/Vert)	Raw signal dB(μV)	Antenna factor dB	Cable loss dB + Preselector	Pre-Amp Gain dB	Received signal dB(μV/m)	Emission limit dB(μV/m)	Margin dB(μV)	Result
Low Channel										
4804	Peak	Horz	56.8	33.5	5.9	35.2	61.0	74.0	13.0	Pass
4804	Avg	Horz	44.9	33.5	5.9	35.2	49.1	54.0	4.9	Pass
4804	Peak	Vert	57.9	33.5	5.9	35.2	62.1	74.0	11.9	Pass
4804	Avg	Vert	45.6	33.5	5.9	35.2	49.8	54.0	4.2	Pass
7206	Peak	Vert	51.7	38.6	7.4	35.6	62.1	74.0	11.9	Pass
7206	Avg	Vert	39.0	38.6	7.4	35.6	49.4	54.0	4.6	Pass
7206	Peak	Horz	51.7	38.6	7.4	35.6	62.1	74.0	11.9	Pass
7206	Avg	Horz	38.6	38.6	7.4	35.6	49.0	54.0	5.0	Pass
Harmonics above the 3 rd are under the noise floor										
Mid channel										
4880	Peak	Horz	55.7	33.5	5.9	35.2	59.9	74.0	14.1	Pass
4880	Avg	Horz	43.9	33.5	5.9	35.2	48.1	54.0	5.9	Pass
4880	Peak	Vert	53.4	33.5	5.9	35.2	57.6	74.0	16.4	Pass
4880	Avg	Vert	40.9	33.5	5.9	35.2	45.1	54.0	8.9	Pass
7320	Peak	Vert	49.5	37.9	9.6	35.2	61.8	74.0	12.2	Pass
7320	Avg	Vert	36.6	37.9	9.6	35.2	48.9	54.0	5.1	Pass
7320	Peak	Horz	53.6	37.9	9.6	35.2	65.9	74.0	8.1	Pass
7320	Avg	Horz	41.1	37.9	9.6	35.2	53.4	54.0	0.6	Pass
Harmonics above the 3 rd are under the noise floor										
High channel										
4960	Peak	Horz	55.5	33.5	5.9	35.2	59.7	74.0	14.3	Pass
4960	Avg	Horz	43.7	33.5	5.9	35.2	47.9	54.0	6.1	Pass
4960	Peak	Vert	51.4	33.5	5.9	35.2	55.6	74.0	18.4	Pass
4960	Avg	Vert	40.2	33.5	5.9	35.2	44.4	54.0	9.6	Pass
7440	Peak	Vert	51.1	38.6	7.4	35.6	61.5	74.0	12.5	Pass
7440	Avg	Vert	40.1	38.6	7.4	35.6	50.5	54.0	3.5	Pass
7440	Peak	Horz	52.2	38.6	7.4	35.6	62.6	74.0	11.4	Pass
7440	Avg	Horz	39.8	38.6	7.4	35.6	50.2	54.0	3.8	Pass
Harmonics above the 3 rd are under the noise floor										



Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	


Table 2: Radiated Emissions
Band Edge emissions
3m measurement distance

Test Frequency (MHz)	Detection mode	Antenna polarity (Horz/Vert)	Raw signal dB(μV)	Antenna factor dB	Cable loss dB + Pre-selector	Pre-Amp Gain dB	Received signal dB(μV/m)	Emission limit dB(μV/m)	Margin dB	Result
Low Channel Band Edges										
2390	Peak	Horz	43.4	30.8	4.1	35.8	42.5	74.0	31.5	Pass
2390	Avg	Horz	31.1	30.8	4.1	35.8	30.2	54.0	23.8	Pass
2390	Peak	Vert	42.8	30.8	4.1	35.8	41.9	74.0	32.1	Pass
2390	Avg	Vert	31.0	30.8	4.1	35.8	30.1	54.0	23.9	Pass
High channel Band Edges										
2483.5	Peak	Horz	63.6	30.8	4.1	35.8	62.7	74.0	11.3	Pass
2483.5	Avg	Horz	48.2	30.8	4.1	35.8	47.3	54.0	6.7	Pass
2483.5	Peak	Vert	62.6	30.8	4.1	35.8	61.7	74.0	12.3	Pass
2483.5	Avg	Vert	47.6	30.8	4.1	35.8	46.7	54.0	7.3	Pass

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Radiated Emissions - 15.247 - Table 3
Other spurious measurements
3m measurement distance


Test Frequency (MHz)	Detection mode	Raw signal dB(μV)	Antenna factor dB	Cable loss dB + Pre-selector	Pre-Amp Gain dB	Received signal dB(μV/m)	Emission limit dB(μV/m)	Margin dB	Result
Vertical Antenna Polarity									
344.2	Peak	55.1	15.1	1.4	-33.8	37.8	46.4	8.6	Pass
931.6	Peak	43.1	22.7	2.3	-31.7	36.4	46.4	10	Pass
436.1	Peak	45.8	16	1.6	-33.9	29.5	46.4	16.9	Pass
30.2	Peak	39	16.3	0.5	-33.1	22.7	40	17.3	Pass
316.2	Peak	46.1	14	1.4	-33.7	27.8	46.4	18.6	Pass
304.0	Peak	42.8	14.3	1.3	-33.7	24.7	46.4	21.7	Pass
Horizontal Antenna Polarity									
339.9	Peak	59.1	15.1	1.4	-33.8	41.8	46.4	4.6	Pass
352.2	Peak	57.2	15.6	1.4	-33.8	40.4	46.4	6	Pass
332.0	Peak	57.1	14.9	1.4	-33.7	39.7	46.4	6.7	Pass
420.6	Peak	55.3	16.7	1.6	-34	39.6	46.4	6.8	Pass
372.3	Peak	53.8	16.2	1.5	-33.8	37.7	46.4	8.7	Pass
931.6	Peak	43.5	23.5	2.3	-31.7	37.6	46.4	8.8	Pass

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	May 21, 2014	May 21, 2016	GEMC 193
Quasi-Peak Adapter	85650A	HP	May 22, 2014	May 22, 2016	GEMC 194
Loop Antenna 30Hz – 1MHz	EM 6871	Electro-Metrics	Feb. 3, 2015	Feb. 3, 2017	GEMC 70
Loop Antenna 100kHz – 30MHz	EM 6872	Electro-Metrics	Feb. 3, 2015	Feb. 3, 2017	GEMC 71
BiLog Antenna	3142-C	ETS	Feb. 10, 2015	Feb. 10, 2017	GEMC 137
Horn Antenna	6878/24	Q-par	Sept 10, 2014	Sept 10, 2016	GEMC 6365
Horn Antenna 18 GHz - 26.5 GHz	SAS-572	A.H. Systems	Sept. 9, 2014	Sept. 9, 2016	GEMC 6371
18.0-26.5 GHz Harmonic Mixer	11970K	HP	Jan 28, 2014	Jan 28, 2016	GEMC 158
Preamp 9kHz - 2 GHz	CPA9231A	Chase	Sept. 9, 2014	Sept. 9, 2016	GEMC 6403
Pre-amp 1-26GHz	HP 8449B	HP	Sept. 9, 2014	Sept. 9, 2016	GEMC 6351
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31

This report module is based on GEMC template "FCC - 15.209 - Radiated Emissions_Rev1.doc"

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Appendix A – EUT Summary

For further details for filing purposes, refer to filing package.

General EUT Description

Client Details	
Organization / Address	PPG Technologies
Contact	Gord Parke
Phone	601-316-4462
Email	grparke@gmail.com
EUT (Equipment Under Test) Details	
EUT Name	PPG Sensor
EUT Model	13117
EUT is powered using	Li-poly battery
Input voltage range(s) (V)	3.0 - 4.275 VDC
Rated input current (A)	0.05
Nominal power consumption (W)	0.04
Basic EUT functionality description	This product fits inside a baseball pitcher's compression sleeve and measures the motion of the arm during a pitch. It saves this data and transfers it to a smartphone, where it is reconstructed and analyzed, providing analytic feedback to the user.
Modes of operation	On mode only.
Frequency of all clocks present in EUT	26 MHz
I/O cable description (length and type)	None
Available connectors on EUT	None
Dimensions of product	L: 45.1 mm W: 25.3 mm H: 16.1 mm

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated. For a close-up picture of the EUT, see 'Appendix B – EUT & Test Setup Photographs'.

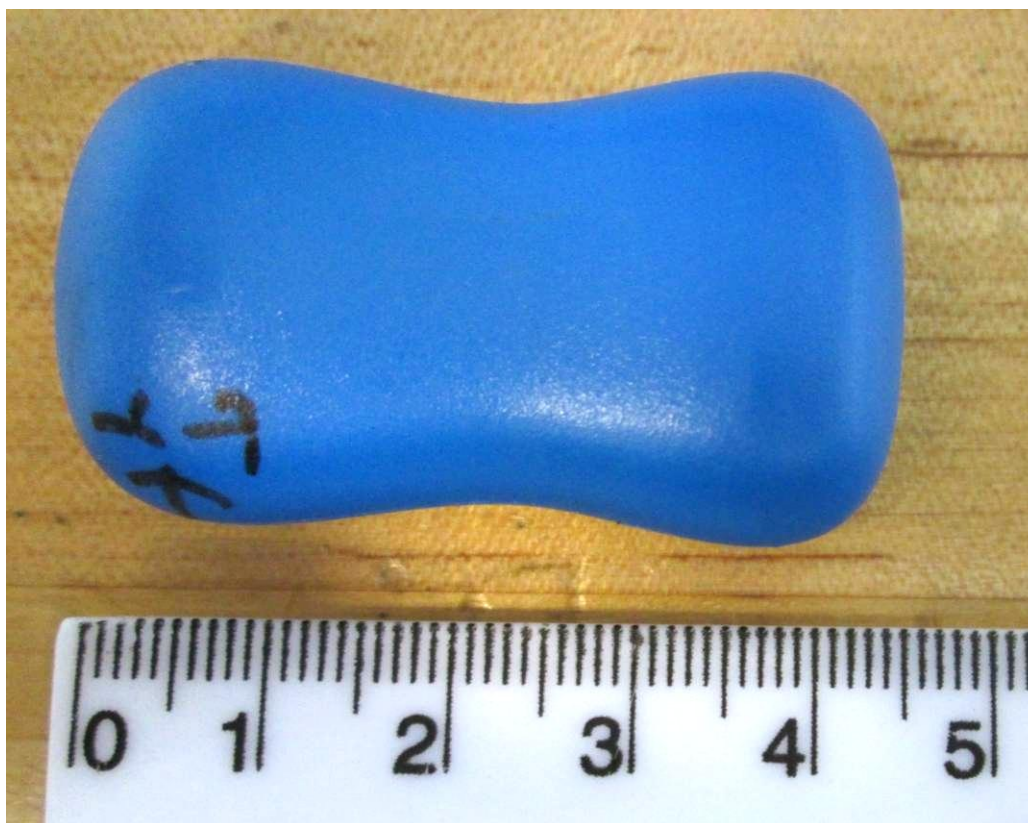
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Appendix B – EUT and Test Setup Photographs

Note: These photos are for information purposes only.
Also refer to .PDF files that are separate from this test report.

Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

EUT – External view 1



Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

EUT – External view 2




Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

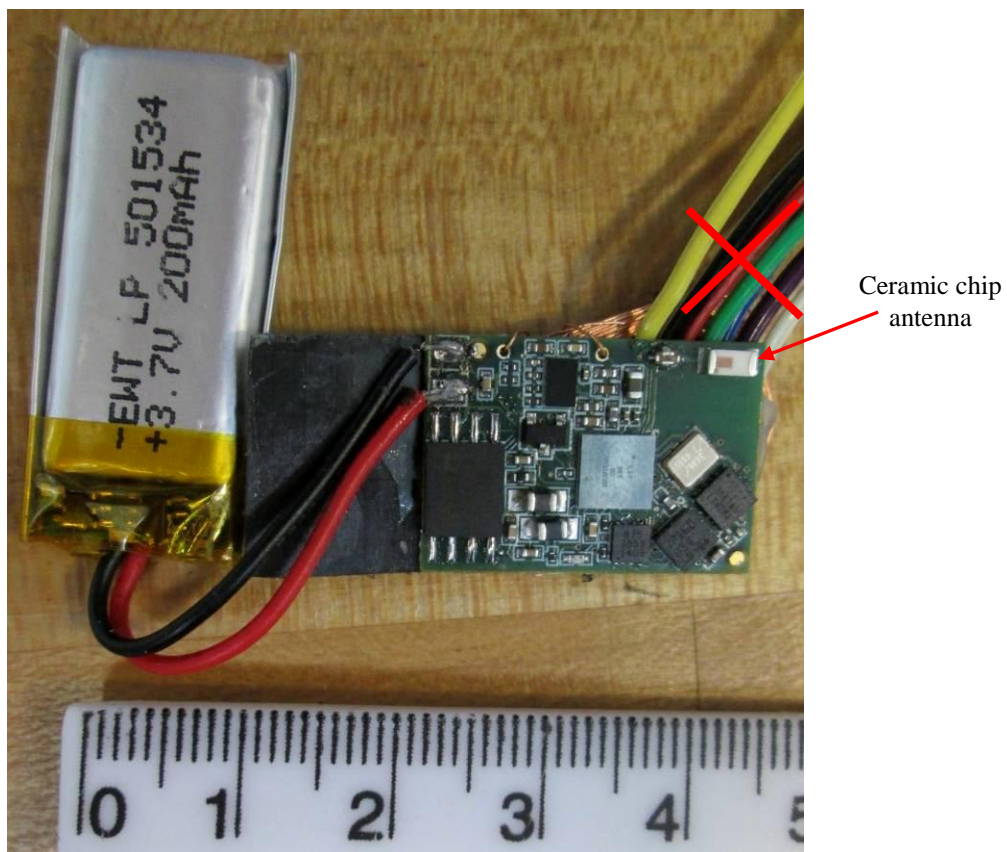
EUT – Internal view 1


Note: Colored wires on the right-hand side are soldered onto the PCB for programming and testing purposes only. They are not part of the EUT



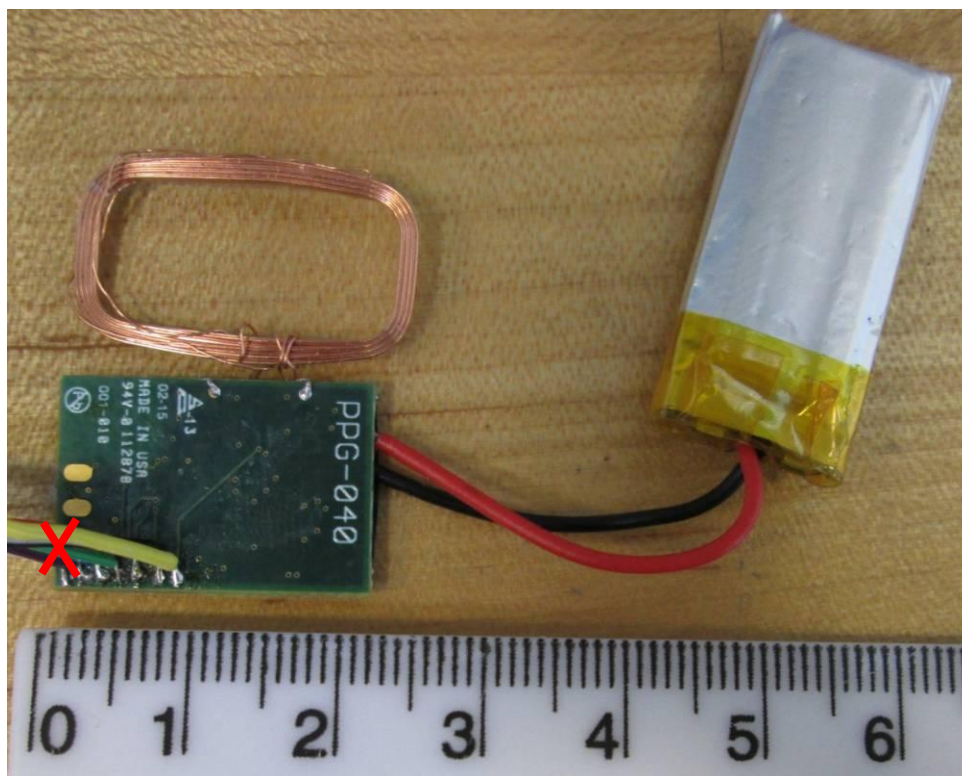
Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

EUT – Internal view 2
PCB, side 1



Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

EUT – Internal view 3
PCB, side 2



Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Radiated Emissions Photo 1



Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Radiated Emissions Photo 2



Client	PPG Technologies	
Product	PPG Sensor	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2015	

Radiated Emissions Photo 3

