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EMI TEST REPORT
for
CERTIFICATION of
FCC PART 15.249 & FCC PART 15.207 TRANSMITTER

FCC ID:	2ACNLGPSP-SPI-0001
Manufacturer:	GPSports Systems Pty Ltd
Test Sample:	HPU (High Performance Unit)
Model Number:	SPI HPU
Serial Number:	SPI HPU 1206
Date:	18th August 2014

EMI TEST REPORT FOR CERTIFICATION
FOR
CERTIFICATION OF FCC Part 15.249 & FCC PART 15.207 TRANSMITTER

FCC ID: 2ACNL-GPSP-SPI-0001
EMC Technologies Report No. T130919
Date: 18th August 2014

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EMI TEST REPORT FOR CERTIFICATION OF FCC PART 15.249 & FCC PART 15.207 TRANSMITTER

Report Number:	T130919
Test Sample Name:	HPU (High Performance Unit)
Model Number:	SPI-HPU
Serial Number:	SPI-HPU 1206
FCC ID:	2ACNLGPSP-SPI-0002
Manufacturer:	GPSports Systems Pty Ltd
Tested For:	GPSports Systems Pty Ltd
Address:	Level 2, 18 Barrier Street Fyschwick, ACT,
Phone Number:	(02) 6162 2060
Fax Number:	(02) 6162 2066
Responsible Party:	Michael Reznik
Test Standards:	**FCC Part 15.249 Intentional Radiators** **FCC Part 15.207 Conducted Limits** **ANSI C63.4:2009**
Test Dates:	12th September 2013 to 18th October 2013

Testing Officer:

Kumar Thambiaiah

Attestation: *I hereby certify that the device(s) described herein were tested as described in this report and that the data included is that which was obtained during such testing.*

Authorised Signature:

Christian Kai
Facility Manager
EMC Technologies Pty Ltd

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EMI TEST REPORT FOR CERTIFICATION of FCC PART 15.249 & FCC PART 15.207 TRANSMITTER on the HPU (High Performance Unit)

1.0 SUMMARY of RESULTS

This report details the results of EMI tests and measurements performed on the HPU (High Performance Unit), Model: SPI-HPU, in accordance with the Federal Communications Commission (FCC) regulations as detailed in Title 47 CFR, Part 15 Rules for intentional radiators. All results are detailed in this report.

Part 15.31e	
Amplitude stability with supply variation:	Not applicable
Part 15.207	
Conducted Emissions:	Not applicable
Part 15.249 a &e	
Carrier Signal Field Strength 2400-2483.5MHz:	Complied
Part 15.249 d (15.209)	
Field Strength Outside 2400 – 2483.5MHz:	Complied
Part 15.249 e	
Frequency Tolerance:	Complied

1.1 EUT – Voltage Power Conditions

Testing was performed with a fully charged battery

2.0 GENERAL INFORMATION

2.1 General Description of Test Sample

Manufacturer	:	GPSports Systems Pty Ltd
Test Sample	:	HPU (High Performance Unit)
Model Number	:	SPI HPU
Serial Number	:	SPI HPU 1206
Part Number	:	HPU-Rv1
FCC ID	:	2ACNL-GPSP-SPI-0001
Equipment Type	:	Intentional Radiator

2.2 Test Sample Description

The HPU (High Performance Unit) is worn by athletes during sport to track their movement, loading and heart rate response. Works in conjunction with GPsports receiver and PC with GPSports Team AMS application.

2.3 Technical Specifications and System Overview

Clock Circuit Speed	:	16MHz
Microprocessor	:	AT86RF233, ATxmega256A3U

Refer to Appendix I for User Manual.

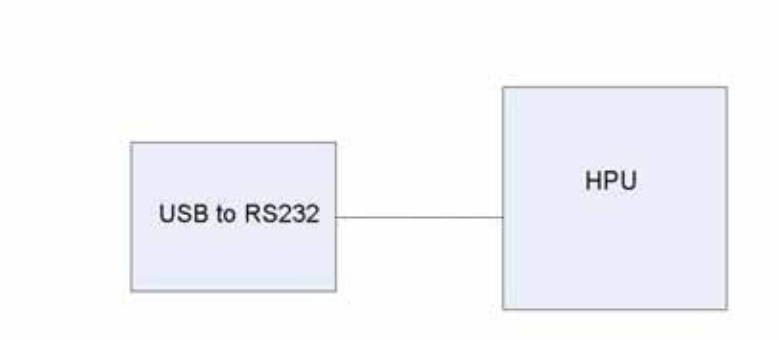
2.4 EUT Configurations

The EUT is to be tested as a table top unit along the guidelines contained in the relevant standards for all testing.
The EUT is supplied prewired and running.

2.5 Test Sample Support Equipment

GPSports charger unit.

2.6 Test Sample Block Diagram



2.7 EUT Operation Conditions

The EUT is operated in accordance with the standard and the customer's requirements.

2.8 Modifications

No modifications were performed on the EUT in order to comply with the standards.

2.9 Test Procedure

Radiated Emissions measurements were performed in accordance with the procedures of ANSI C63.4:2009. The measurement distance for radiated emissions was 3 metres from the EUT for the frequency range 9kHz-25000MHz.

2.10 Test Facility

2.10.1 General

Conducted Emission measurements of fundamental frequency 13.56 MHz were performed at EMC Technologies Laboratory in Seven Hills, New South Wales, Australia. Radiated Emission measurements in the ranges 9kHz-25000MHz were performed at EMC Technologies' indoor open area test site (iOATS) situated at Seven Hills Office, Station Road, Seven Hills, NSW, Australia.

The above sites have been fully described in a report submitted to the FCC office. EMC Technologies Pty Ltd has FCC registration number 411703 and we have been designated by the Australian Communications and Media Authority under the APAC TELMRA and our designation number is AU0002 which will expire on the 7th August 2016.

2.10.2 NATA Accreditation

EMC Technologies is accredited in Australia to test to the following standards by the National Association of Testing Authorities (NATA).

"FCC Part 15 unintentional and intentional emitters in the frequency range 9kHz to 18GHz excluding TV receivers (15.117 and 15.119), TV interface devices (15.115), cable ready consumer electronic equipment (15.118), cable locating equipment (15.213) and unlicensed national information infrastructure devices (Sub part E)."

The current full scope of accreditation can be found on the NATA website:
www.nata.asn.au
It also includes a large number of emission, immunity, SAR, EMR and Safety standards.

NATA is the Australian national laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO17025 requirements. A major requirement for accreditation is the assessment of the company and its personnel as being technically competent in testing to the standards. This requires fully documented test procedures, continued calibration of all equipment to the National Standard at the National Measurements Institute (NMI) and an internal quality system to ISO 9002. NATA has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (A^2LA).

2.11 Units of Measurements

2.11.1 Conducted Emissions

Measurements are reported in units of dB relative to one microvolt (dBμV).

2.11.2 Radiated Emissions

Measurements are reported in units of dB relative to one microvolt per metre (dBμV/m). The measurement distance was 3 metres from the EUT for ranges 30MHz-25 GHz.

2.12 Test Equipment Calibration

All measurement instrumentation and transducers were calibrated in accordance with the applicable standards by an independent NATA registered laboratory such as Agilent Technologies (Australia) Pty Ltd or the National Measurement Institute (NMI). All equipment calibration is traceable to Australia national standards at the National Measurement Institute. The reference antenna calibration was performed by NMI and the working antennas (biconical and log-periodic) calibrated by the NATA approved procedures. The complete list of test equipment used for the measurements, including calibration dates and traceability is contained in Appendix A of this report.

3.0 CONDUCTED EMISSION MEASUREMENTS

3.1 Test Procedure

The arrangement specified in ANSI C63.4:2009 was adhered to for the conducted EMI measurements. The EUT was placed in the RF screened enclosure and a CISPR EMI Receiver as defined in ANSI C63.2-1987 was used to perform the measurements.

The EMI Receiver was operated under program control using the Max-Hold function and automatic frequency scanning, measurement and data logging techniques. The specified 0.15 MHz to 30 MHz frequency range was sub-divided into sub-ranges to ensure that all duration peaks were captured.

3.2 Peak Maximizing Procedure

For each of the sub-ranges, the EMI receiver was set to continuous scan with the Peak detector set to Max-Hold mode. The Quasi-Peak detector was then invoked to measure the actual Quasi-Peak level of the most significant peaks which were detected.

The highest recorded EMI signals are shown on the Peaks List on the bottom right side of the graph. Peaks that were greater than 20dB below the limit were not measured. For each numbered peak the frequency, peak field strength, Quasi-peak field strength, Average field strength and the margin relative to the limit in dB is listed. A negative margin is the level below the limit.

3.3 Calculation of Voltage Levels

The voltage levels were automatically measured in software and compared to the test limit. The method of calculation was as follows:

$V_{EMI} = V_{Rx} + L_{BPF}$

Where:

V_{EMI} = The Measured EMI voltage in dBµV to be compared to the limit.
V_{Rx} = The Voltage in dBµV read directly at the EMI receiver.
L_{BPF} = The insertion loss in dB of the cables and the Limiter and Pass Filter.

3.4 Plotting of Conducted Emission Measurement Data

The measurement data pertaining to each frequency sub-range were then concatenated to form a single graph of (peak) amplitude versus frequency. This was performed for both Active and Neutral lines and the composite graph was subsequently plotted. A list of the highest relevant peaks and the respective Quasi-Peak and Average values were also plotted on the graphs.

3.5 Conducted EMI Results

Conducted emissions testing is not applicable because the EUT does not transmit while charging the internal batteries.

3.6 Results of Conducted Emission Measurement

The EUT complied with the limits of FCC Rule Part 15 Subpart C – Intentional Radiators. Emissions.

4.0 RADIATED EMISSION MEASUREMENTS – 30 MHz to 25GHz

4.1 Frequency Range of Radiated Measurements

The lowest frequency of the EUT is 16 MHz (refer to section 2.3 of this report) and the operating frequency is 2.4 GHz.

Highest frequency generated or used in the device or on which the device operates or tunes [MHz]	Upper frequency of measurement range [MHz]
1.705 - 108	1000
108 – 500	2000
500 – 1000	5000
Above 1000	10^{th} harmonic of the highest frequency or 40 GHz, whichever is lower

Frequencies above 1 GHz: Average trace taken

According to the table in FCC Part 15, Section 15.33 and the highest radio frequency signal generated or used in the EUT is 2.4 GHz, the radiated emissions measurement were performed from 9 kHz to 25000 MHz.

4.2 Test Procedure

Radiated emissions measurements were performed in accordance with the procedures of ANSI C63.4:2003 Radiated emission tests from 30 MHz to 25 GHz were performed at the indoor Open Area Test Site (iOATS) an EUT distance of 3 metres. OET Bulletin 65 was used for reference.

The EUT was placed on a timber table 0.8m above an inground and operated in accordance with section 2 of this report. The EMI Receiver was operated under software control via the PC Controller.

4.2.1 0.009 – 30 MHz Range

The 0.009 MHz to 30 MHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the Peak Detector set to Max-Hold. The receive loop antenna was set to 1m above the ground plane with the Quasi-Peak detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. The orientation of the receive loop antenna was varied to ensure that the emissions were maximised.

4.2.2 30 MHz to 1000 MHz Range

The 30 MHz to 1000 MHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the Peak Detector set to Max-Hold. The EUT was further rotated through three orthogonal directions to ensure worst case emissions are measured. This was performed for two receiver antenna heights. Each significant peak was then investigated and maximised by rotating the turntable and scanning the height of the receiver antenna between 1 to 4 metres with the Quasi-Peak detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. This process was performed for both horizontal and vertical receive antenna polarisation.

4.2.3 1 GHz – 25 GHz

The 1 GHz to 25GHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the average detector set to Max-Hold. The EUT was further rotated through three orthogonal directions to ensure worst case emissions are measured. This was performed for two receiver antenna heights. Each significant peak was then investigated and maximised by rotating the turntable and scanning the height of the receiver antenna between 1 to 4 metres with the Average detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. This process was performed for both horizontal and vertical receive antenna polarisation.

4.3 Plotting of Measurement Data for Radiated Emissions

4.3.1 0.009 – 30 MHz Range

The stored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 0.009 -30 MHz. The fundamental frequency (H-field) was measured at the iOATS and the plot shown is from the Semi-Anechoic Chamber. The worst case radiated EMI *peak* measurements as recorded using the Max-Hold data are presented as the **RED** trace.

4.3.2 30 MHz – 1000 MHz

The stored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 30 – 1000 MHz. The accumulated EMI (EUT ON) was plotted as the Red trace while the Ambient signals (AMBIENT) were plotted as Green trace. The worst case radiated EMI peak measurements (as recorded using the Max-Hold data are presented as the upper or **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the "#" symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with "#" symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right hand side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, Quasi-peak field strength, limit and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit. At times, the quasi-peak level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the QP detector AFTER the MAX-HOLD trace has been stored. This will be apparent when the peaks list at the foot of the graphs shows the quasi peak level higher than the peak level.

4.3.3 1000 MHz to 25000 MHz

The stored measurement data was combined to form graphs which comprised of all the frequency sub-ranges over the range 1 GHz – 25 GHz. The accumulated EMI (EUT ON) was plotted as the Red trace while the Ambient signals (AMBIENT) were plotted as Green trace. The worst case radiated EMI peak measurements (as recorded using the Max-Hold data are presented as the upper or **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the "#" symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with "#" symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right hand side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, Average field strength, limit and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit. At times, the average level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the Average detector AFTER the MAX-HOLD trace has been stored. This will be apparent when the peaks list at the foot of the graphs shows the average level higher than the peak level.

4.4 Calculation of Field Strength

The field strength was calculated automatically by the software using all the pre-stored calibration data. The method of calculation is shown below:

E = V + AF - G + L

Where:
- **E** = Radiated Field Strength in dBμV/m.
- **V** = EMI Receiver Voltage in dBμV. (measured value)
- **AF** = Antenna Factor in dB/m (stored as a data array)
- **G** = Preamplifier Gain in dB. (stored as a data array)
- **L** = Cable insertion loss in dB. (stored as a data array)

Example Field Strength Calculation

Assuming a receiver reading of 34.0 dBμV is obtained at 90 MHz, the Antenna Factor at that frequency is 9.2 dB. The cable loss is 1.9dB while the preamplifier gain is 20dB.

34.0 + 9.2 + 1.9 – 20 = 25.1 dBμV/m

4.5 Radiated Field Strength Measurement Results – Section 15.249

4.5.1 Radiated Field Strength Measurements

All measurements were perforem with a 3m antenna distance to the EUT.

4.5.1.1 0.009 MHz to 30 MHz

All measured frequencies complied with the quasi peak limits by a margin of greater than 10dB.
Refer to Appendix H, Graph 1 and 2.

4.5.1.2 30 MHz to 1000MHz

All measured frequencies complied with the quasi peak limits by a margin of greater than 10dB.
Refer to Appendix H, Graph 3 and 4.

4.5.2 2400MHz Carrier Field Strength Measurement

Tested between 2400 – 2410MHz – Low Channel

Complied with a margin of at greater than 10dB with Section 15.249 Subpart a, b & c.
Refer to Appendix H, Graph 5.

Tested between 2435 – 2445MHz – Mid Channel

Frequency MHz	Peak Level dBµV/m	Limit @ 3m dBµV/m	Result ± dB
2440.03	84.4	94.0	-9.6

Complied with a margin of at least 9.6dB with Section 15.249 Subpart a, b & c.
Refer to Appendix H, Graph 6.

Tested between 2477 – 2483MHz – High Channel

Complied with a margin of at greater than 10dB with Section 15.249 Subpart a, b & c.
Refer to Appendix H, Graph 7.

4.5.3 Band Edges

The lower and higher Band edges complied with a margin of at greater than 10dB.
Refer to Appendix H, Graphs 8 and 9.

4.5.4 Testing between 1000 – 25000MHz – Average

Worst case emissions were found with the mid chanel setting. Full testing was performed on the mid chanel.

Complied with a margin of at greater than 10dB with Section 15.249 Subpart a, b & c.
Refer to Appendix H, Graphs 10 to 15.

4.5.5 Testing between 1000 – 25000MHz – Peak

Harmonics readings found with the average detector were checked with a peak detector. Emissions level with the peak detector are not allowed to be more than 20dB above the average readings.

The peak measurements complied with the 20dB requirement.
Refer to Appendix H, Graphs 16 to 18.

Additional amplitude stability tests according part 15.31e were not applicable because the EUT is powered by internal batteries. Testing was performed with a fully charged battery.

5.0 UNCERTAINTIES

EMC Technologies has evaluated the equipment and the methods used to perform the emissions testing. The estimated measurement uncertainties for emissions tests shown within this report are as follows:

Conducted Emissions

9kHz to 30 MHz	±3.2 dB

Radiated Emissions

9kHz to 30MHz	±4.1 dB
30MHz to 300MHz	±5.1 dB
300MHz to 1000MHz	±4.7 dB
1GHz to 18GHz	±4.6 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

6.0 FREQUENCY TOLERANCE (FCC Part 15 Sections 15.249b)

Supply Voltage Variation
Testing was performed with a fully charged battery.

Temperature Variation
The ambient temperature with a supply fully charged battery was varied between -20°C and +50°C. At each 10°C interval the temperature was maintained until the EUT temperature had stabilised. The frequency of the carrier was observed at each 10°C increments and compared to the nominal frequency.

Low Channel 2.405GHz

Nominal Voltage	Ambient Temperature	Frequency Reading [GHz]	Frequency Variation [%]
Battery	-20°C	2.404757004	0.0003
Battery	-10°C	2.404750893	0.0006
Battery	0°C	2.404781042	0.0007
Battery	10°C	2.404757004	0.0003
Battery	20°C	2.404765026	0.0000
Battery	30°C	2.404781042	0.0007
Battery	40°C	2.404765017	0.0000
Battery	55°C	2.404759016	0.0002

Maximum Frequency Variation to Nominal Frequency:	2.404765026	0.0007

Mid Channel 2.440GHz

Nominal Voltage	Ambient Temperature	Frequency Reading [MHz]	Frequency Variation [%]
Battery	-20°C	2.439741538	0.0003
Battery	-10°C	2.439751603	0.0001
Battery	0°C	2.439733526	0.0007
Battery	10°C	2.43977561	0.0010
Battery	20°C	2.43975	0.0000
Battery	30°C	2.439731731	0.0007
Battery	40°C	2.439735577	0.0006
Battery	55°C	2.439771795	0.0009

Maximum Frequency Variation to Nominal Frequency:	2.43975	0.0010

High Channel 2.480GHz

Nominal Voltage	Ambient Temperature	Frequency Reading [MHz]	Frequency Variation [%]
Battery	-20°C	2.47975755	0.0006
Battery	-10°C	2.47976357	0.0008
Battery	0°C	2.479765641	0.0009
Battery	10°C	2.479765321	0.0009
Battery	20°C	2.47974359	0.0000
Battery	30°C	2.479759615	0.0006
Battery	40°C	2.47974359	0.0000
Battery	55°C	2.479766628	0.0009

Maximum Frequency Variation to Nominal Frequency:	2.47974359	0.0009

The frequency tolerance of the carrier signal was maintained within ± 0.001% of the operating frequency during the temperature variation test.

7.0 CONCLUSION

The HPU (High Performance Unit) with Model Number: SPI HPU,
FCC ID: 2ANCL-GPSP-SPI-0001, complied with the requirements of FCC Part 15 Rules for linternial radiator when tested in accordance with FCC Part 15.31e, 15.207 and 15.249.

Part 15.31e
Amplitude stability with supply variation: Not applicable

Part 15.207
Conducted Emissions: Not applicable

Part 15.249 a &e
Carrier Signal Field Strength 2400-2483.5MHz: Complied

Part 15.249 d (15.209)
Field Strength Outside 2400 – 2483.5MHz: Complied

Part 15.249 e
Frequency Tolerance: Complied