



FCC 47CFR part 15C
Test Report
For
MEMS EVOLUTION2 SENSOR
RV1.15

Reference Standard: FCC 47CFR part 15C

Manufacturer:

For type of equipment and serial number, refer to section 3

Report Number: 10-511/4863A/1/11

Supersedes report number: 10-511/4863/1/11

Report Produced by: -

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2. Summary of test results

The MEMS EVOLUTION2 SENSOR RV1.15 was tested to the following standards: -

FCC 47CFR Part 15C (effective date October 1st, 2010); Class DSC Intentional Radiator

Any compliance statements are made reliant on the modes of operation as instructed to us by the Manufacturer based on their specific knowledge of the application and functionality of the equipment tested. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard, particularly under different conditions to those during testing.

Title	Reference	Results
1. Conducted emissions	ANSI C63.4 §7.	Not Applicable ¹
2. Radiated emissions	ANSI C63.4 §8.	PASSED
3. Intentional radiator field strength	ANSI C63.10 §6.5.	PASSED
4. Occupied bandwidth and band edge	ANSI C63.10 §6.9.	PASSED
5. Frequency stability	ANSI C63.10 §6.8.	Not Applicable ²
6. Periodic operation and emissions	ANSI C63.10 §7.4. – 7.6.	PASSED

¹ EUT does not operate from the AC power lines nor contain provisions for operation while connected to AC power lines.

² EUT is not operating in the 40.66 – 40.70 MHz band, therefore no limits are specified.

This report relates to the equipment tested as identified by a unique serial number and at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed.

Date of Test: 11th to 14th October 2011

Test Engineer:

Approved By
Technical Director:

Customer Representative:

3. Equipment Under Test (EUT)

3.1 Equipment Specification

Applicant	Michelin Americas Research & Development Corporation 515 Michelin Road Greenville SC 29615
Manufacturer of EUT	RasterVision Ltd
Brand name of EUT	Michelin
Model Number of EUT	RV1.15
Proposed FCC ID:	FI5-RV1-15E
Serial Number of EUT	20360151
Date when equipment was received by RN Electronics	11th October 2011
Date of test:	11th to 14th October 2011
Customer order number:	7605
Visual description of EUT:	A palm sized unit made up of two plastic moulded parts. A curved top and a flat base, secured together by several hex headed bolts.
Main function of the EUT:	Battery powered air pressure and temperature sensor for operation inside tubeless earthmover tyres.
Height	50 mm
Width	99 mm
Depth	53 mm
Weight	102g g
Voltage	6 V DC from integral battery source
Current required from above voltage source	not stated

3.2 EUT Configurations for testing

Frequency range	433.92MHz
Normal use position	Inside a tyre
Normal test signals	Internally generated
Declared power level	-12dBm
Declared channel bandwidth	50kHz
Highest frequency generated / used	433.92MHz
Lowest frequency generated / used	125kHz

3.3 EUT Modes

Mode	Description of mode	Used for Testing
Fast mode	Transmitting during tyre inflation	YES
Normal	Transmitting once per minute	NO
Conformance test mode	Transmitting every second	YES

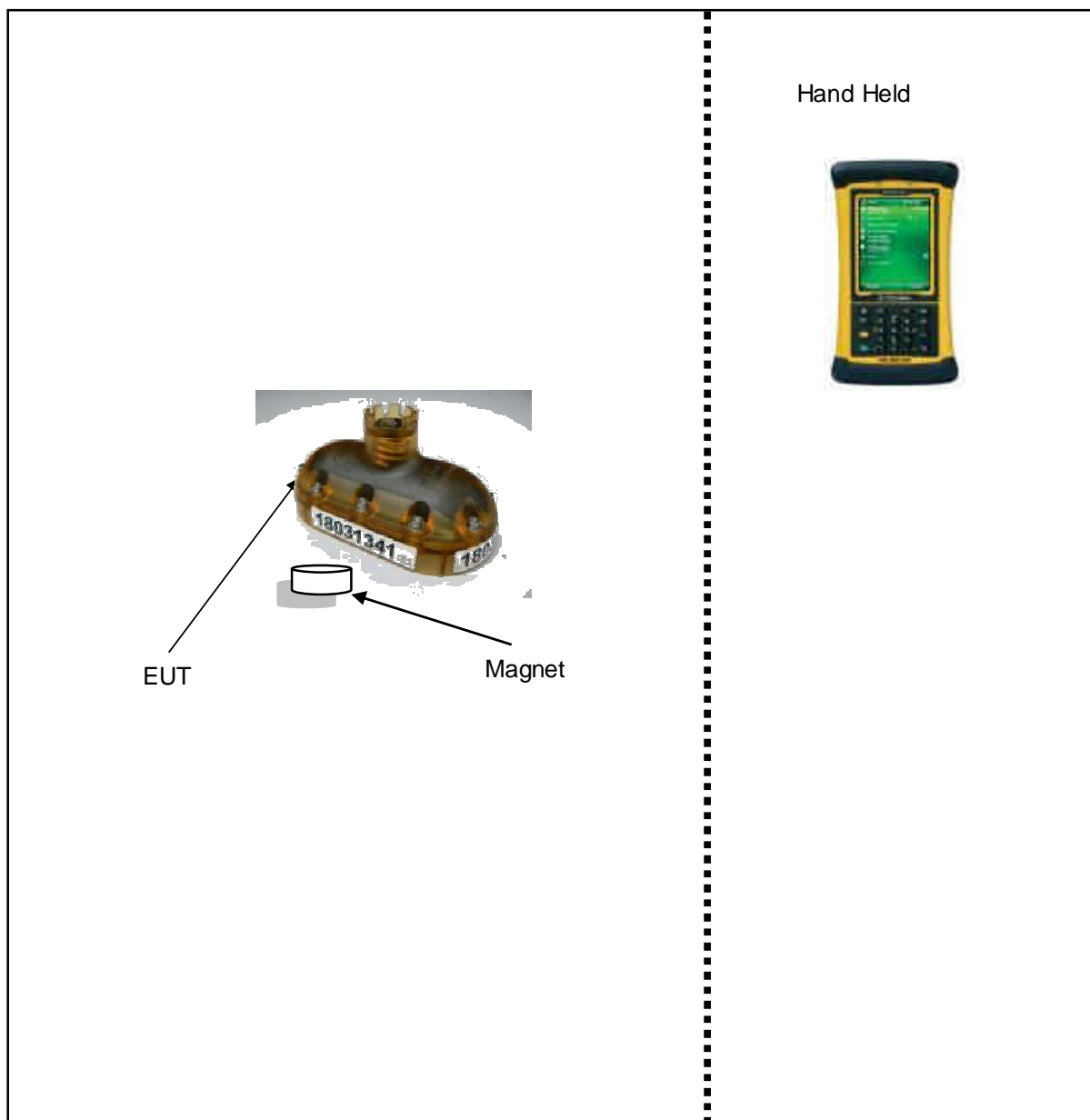
For practicality of testing a conformance test mode was used which allowed transmissions to occur at regular intervals. The normal mode is triggered infrequently and the manufacturer declared that the conformance test mode gives identical transmissions.

Description of ancillary equipment connected to the equipment under test, for the purpose of tests, can be found in Section 10.

Any modifications made to the EUT, whilst under test, can be found in Section 11.

This report was printed on: 10 November 2011

3.4 Emissions Configuration



The EUT was powered by new batteries. A magnet was placed on the bottom of the EUT to trigger the test transmit mode. A remote hand held receiver confirmed correct operation of the transmitter. The hand held could also be used to programme the EUT via a 125kHz signal and software not normally available to the end-user. This was used to set the transmitter to the maximum allowable output power setting.

4. Specifications

The tests were performed by RN Electronics Engineer Peter Finley who set up the tests, the test equipment, and operated it in accordance with the **R.N. Electronics Ltd** procedures manual, FCC Part 15 and those specifications incorporated by reference into 47CFR15 (e.g. ANSI C63.4-2003). In addition reference is made to ANSI C63.10-2009, where no other incorporated standard exists.

R.N. Electronics Ltd sites M and OATS are listed with the FCC. Registration Number 293246

4.1 Deviations

None.

4.2 Tests at Extremes of Temperature & Voltage

No testing at extremes was required for this device.

Tests were performed radiated using the EUT integral antenna.

4.3 Measurement Uncertainties

Parameter	Uncertainty
Transmitter Tests	
Bandwidth	<± 1.9 %
Radiated RF Power	<± 3.5 dB
Radiated Spurious Emissions	<± 3.4 dB

5. Tests, Methods and Results

5.1 Conducted emissions

Not applicable.

The EUT does not operate from the AC power lines nor contain provisions for operation while connected to AC power lines.

5.2 Radiated emissions

5.2.1 Test Methods

Test Requirements

FCC Part 15C, Reference (15.209)

Test Method:

ANSI C63.4, Reference (8)

5.2.1.1 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a new battery. The EUT was operated in Conformance test mode which was a semi-continuous transmit mode for ease of test.

5.2.1.2 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Below 30MHz, measurements were made in a semi-anechoic chamber. The antenna was placed 1m above the ground. The equipment and the antenna were rotated 360° to record the worst case emissions.

30MHz - 1GHz, measurements were made on a site listed with the FCC. The equipment was rotated 360° and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record the worst case emissions.

Above 1GHz, measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. The antenna was placed 1m above the ground in line with the EUT, which was rotated through 360° to record the worst case emissions.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

5.2.2 Test results

Tests were performed using Test Site M and B.

Test Environment:

M	Temperature: 19-20°C	Humidity: 35%
B	Temperature: 19°C	Humidity: 63%

Analyser plots for the Quasi-Peak / Average values as applicable and any table of signals within 20dB of the limit line can be found in Section 6.2 of this report.

Note: Peak emissions observed and duty cycle correction then applied from FCC §15.35. TX on time in 100ms period. See section 5.5 Periodic operation and emissions within this report.

Measuring Polarisation	Frequency (MHz)	Measured result PK (dBuV/m @3m)	Duty cycle adjustment (dB)	Total AV (dBuV/m @3m)	Limit (dBuV/m @3m)
H	867.8	48.1	-14.2	33.9	52.9
H	1301.8	41.2	-14.2	27.0	54
H	1735.7	43.7	-14.2	29.5	52.9
H	2169.6	41.0	-14.2	26.8	52.9
H	2603.5	41.0	-14.2	26.8	52.9
H	3037.4	47.8	-14.2	33.6	52.9
H	3471.4	60.0	-14.2	45.8	52.9
H	3905.3	51.0	-14.2	36.8	54
H	4339.2	52.7	-14.2	38.5	54
V	867.8	49.7	-14.2	35.5	52.9
V	1735.7	46.3	-14.2	32.1	52.9
V	3037.4	48.5	-14.2	34.3	52.9
V	3471.4	54.8	-14.2	40.6	52.9
V	3905.3	48.8	-14.2	34.6	54
V	4339.2	54.8	-14.2	40.6	54
V	3190	47.3	-14.2	33.1	52.9
H	3190	44.2	-14.2	30.0	52.9

LIMITS:

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.231(e) limits are applicable elsewhere, although 15.209 limits may be used where these allow a higher field strength.

These show that the **EUT** has **PASSED** this test.

5.2.2.1 Test Equipment used

E342, E268, E410, E411, E412, TMS81, TMS82, TMS933

See Section 10 for more details

5.3 Intentional radiator field strength

5.3.1 Test Methods

Test Requirements FCC Part 15C, Reference (15.231e)
Test Method: ANSI C63.10, Reference (6.5)

5.3.1.1 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The antenna was scanned 1-4m in height in both Horizontal and Vertical polarisations. The EUT was rotated in all three orthogonal planes. The EUT was operated in Conformance test mode.

5.3.1.2 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber. This site is listed with the FCC.

Both the equipment and the antenna were rotated 360° to record the maximised emission.

5.3.2 Test results

Tests were performed using Test Site **M**.

Test Environment:

Temperature: 20°C Humidity: 35 %

Any Analyser plots can be found in Section 6.3 of this report.

Channel	Measured result	Duty cycle	Total
433.92MHz	PK (dBuV/m @3m)	adjustment (dB)	AV (dBuV/m @3m)
Vertical	86.5	-14.2dB	72.3

Note: EUT tested in a continuous pulsing transmit mode for ease of test. Duty cycle correction then applied from FCC 15.35. TX on time in 100ms period. See section 5.5 Duty cycle within this report.

Limits:

15.231(b) Average = 80.8 dBuV/m @ 3m.

15.231(e) Average = 72.9 dBuV/m @ 3m.

15.35 Peak = 20dB above the maximum permitted average emission limit = 100.8 & 92.9 dBuV/m @ 3m, respectively.

These results show that the EUT has **PASSED** this test.

5.3.2.1 Test Equipment used

E410, E411, E412, TMS933

See Section 10 for more details

5.4 Frequency stability

Not applicable.

EUT is not operating in the 40.66 – 40.70 MHz band, therefore no limits are specified.

5.5 Periodic operation and emissions

5.5.1 Test Methods

Test Requirements

FCC Part 15C, Reference (15.231e)

Test Method:

ANSI C63.10, Reference (7.4 – 7.6)

5.5.1.1 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was operated in **Conformance mode**.

The EUT was then placed in a sealed plastic tube which was pressurised by means of a foot pump. This change in pressure enabled the **Fast mode** which was then also measured.

5.5.1.2 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. The centre frequency of the analyser was set to that of the transmitter, and the span set to zero. The sweep time was adjusted so that either the pulse width or the periodic operation could be observed.

Test site 'M' has been listed with the FCC.

5.5.2 Test results

Tests were performed using Test Site **Q**.

Temperature of test Environment: 20°C

Analyser plots for the dwell time and duty cycle can be found in Section 6.4 of this report.

State	Result	Plot reference
TX on 100ms period	19.5ms	J4863-1 Plot 001
TX period – normal mode	-	Declared approx. 1 minute intervals
TX period – fast mode	14.85s	J4863-1 Plot 003

Limits:

15.231(e) Duration of transmission <= 1s.

Silent period between transmissions >= 10s (or 30x duration where greater).

These results show that the **EUT** has PASSED this test.

The duty cycle correction factor for peak to average emissions is therefore
 $20\log(19.5/100) = -14.2$ dB.

5.5.2.1 Test Equipment used

E226, TMS903

See Section 10 for more details.

5.6 Occupied bandwidth and band edge

5.6.1 Test Methods

Test Requirements	FCC Part 15C, Reference (15.231c)
Test Method:	ANSI C63.10, Reference (6.9)

5.6.1.1 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was operated in Conformance test mode.

5.6.1.2 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. A 3kHz RBW, 3x VBW, auto sweep time and max hold settings were used.

5.6.2 Test results

Tests were performed using Test Site **Q**.

Temperature of test Environment: 20°C

Analyser plots for the 20dB bandwidth can be found in Section 6.5 of this report.

Channel	Result	Plot reference
Bottom	-	-
Middle	83.5 kHz	J4683-1 Plot 004
Top	-	-

n.b. The EUT only had a single channel.

Limits: must be <0.25% of centre frequency, $F_c 433.92\text{MHz} = 1.085\text{MHz}$.

Band edge compliance applies only to 40.66 – 40.70 MHz band.

The restricted band edges closest to the EUT frequency of 433.92MHz are 410 & 608MHz. Further wider span plots have been taken to show the fact that there are no spurious emissions above the restricted limits of 15.209. See section 6.5 of this report.

These results show that the **EUT** has **PASSED** this test.

5.6.2.1 Test Equipment used

E226, TMS903

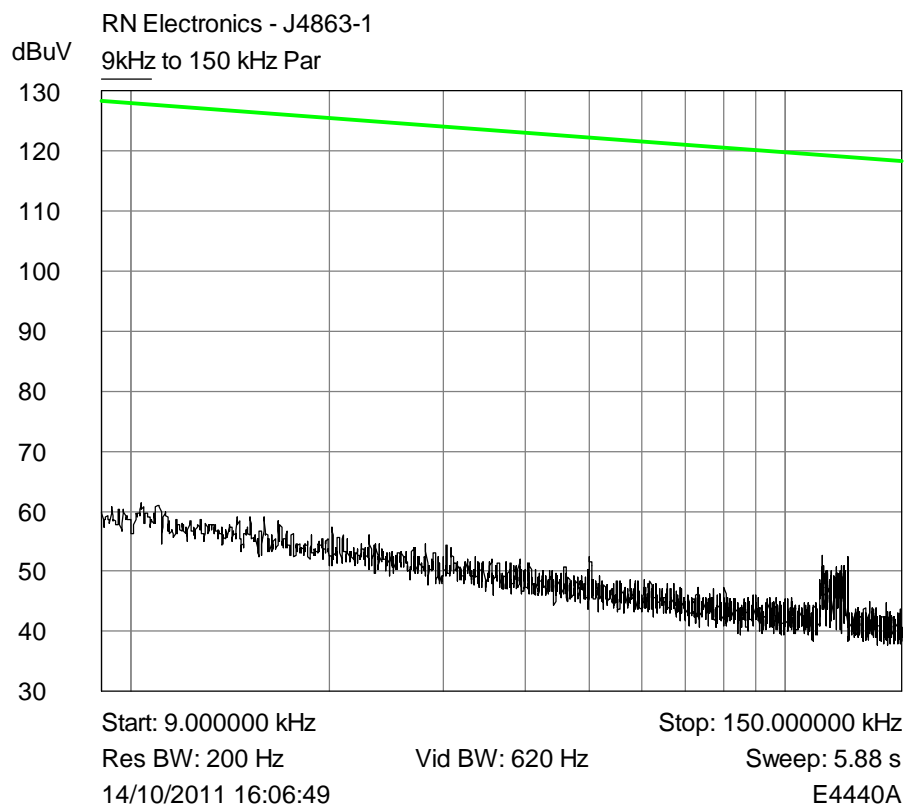
See Section 10 for more details.

6. Plots and Results

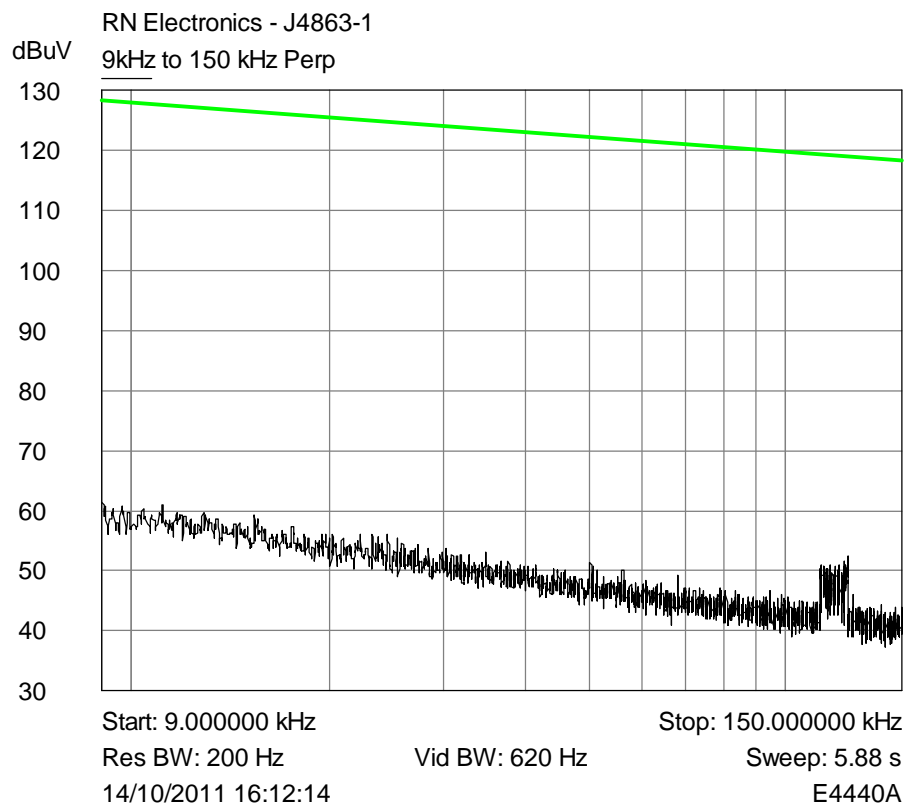
6.1 Conducted Emissions

Not applicable. The EUT is not powered from the mains.

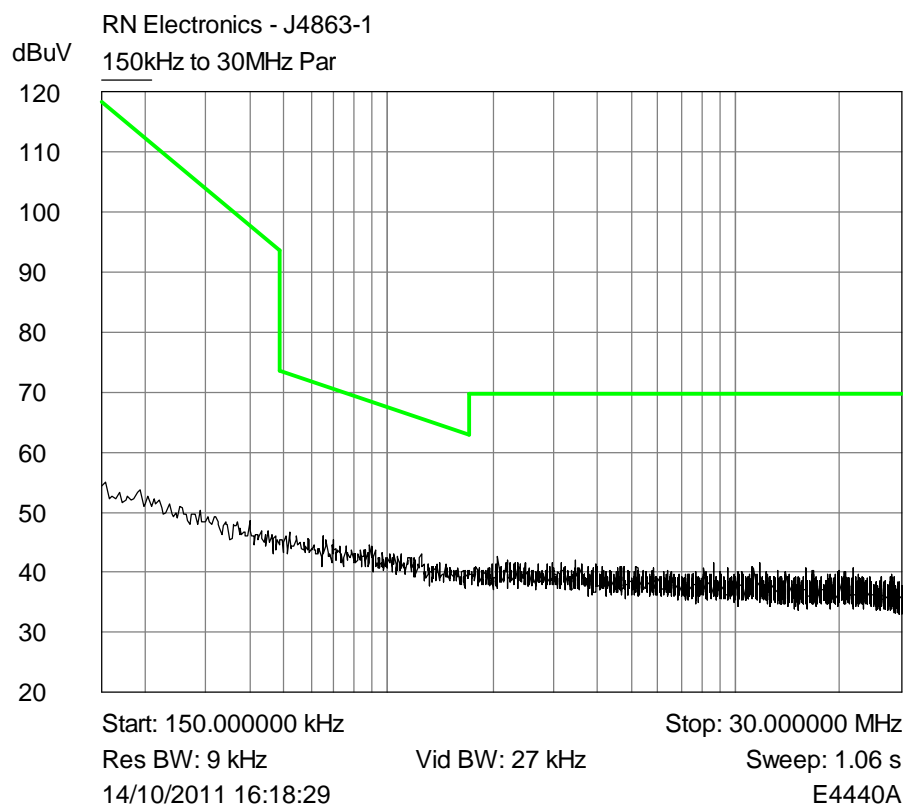
6.2 Radiated Emissions



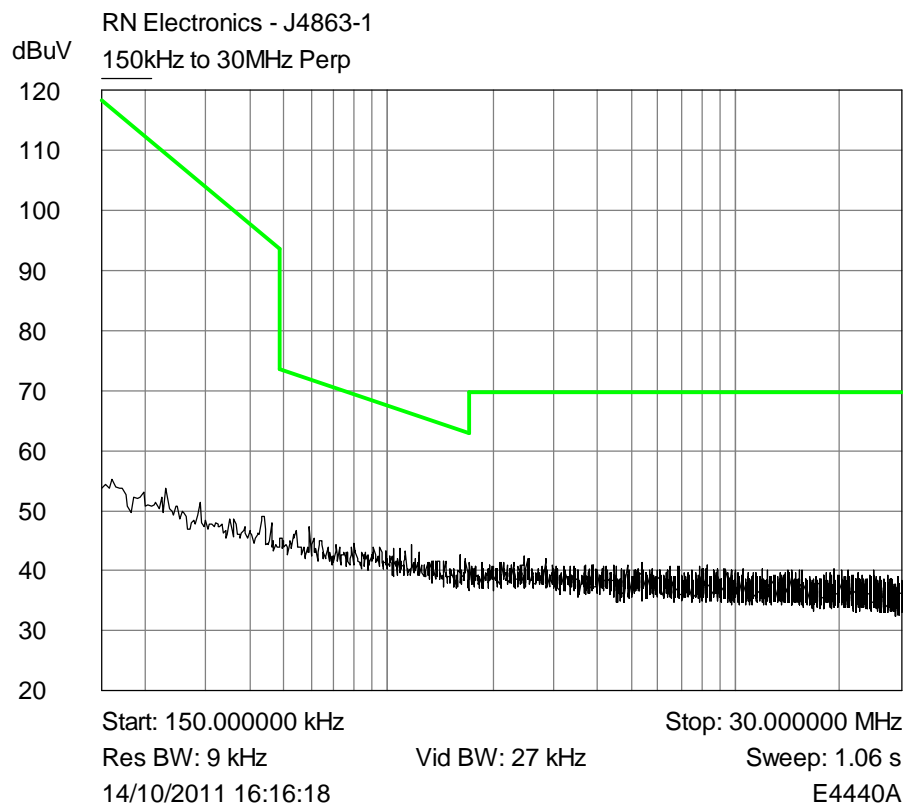
Plot of peak Parallel emissions 9kHz – 150kHz against the quasi-peak limit line.



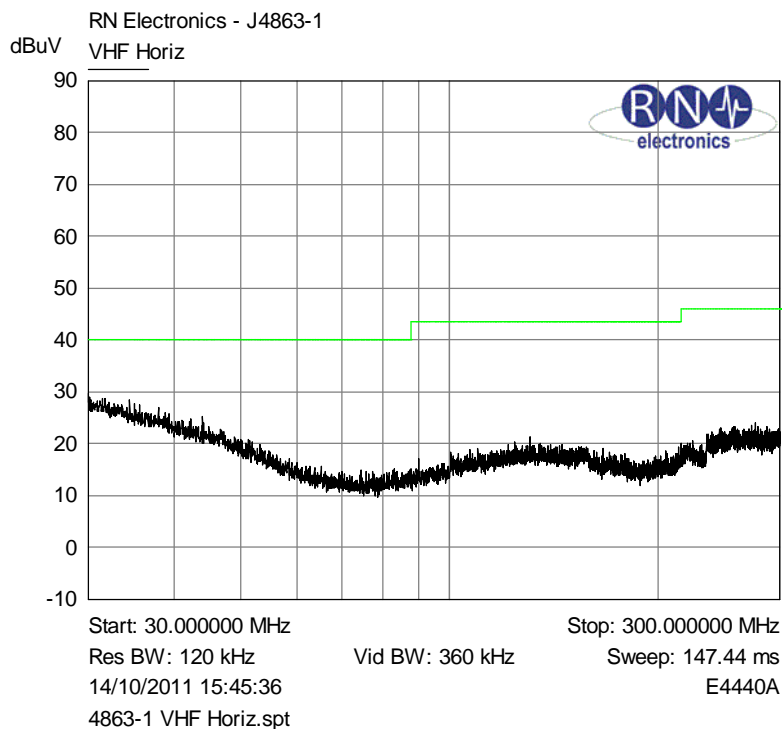
Plot of peak Perpendicular emissions 9kHz – 150kHz against the quasi-peak limit line.



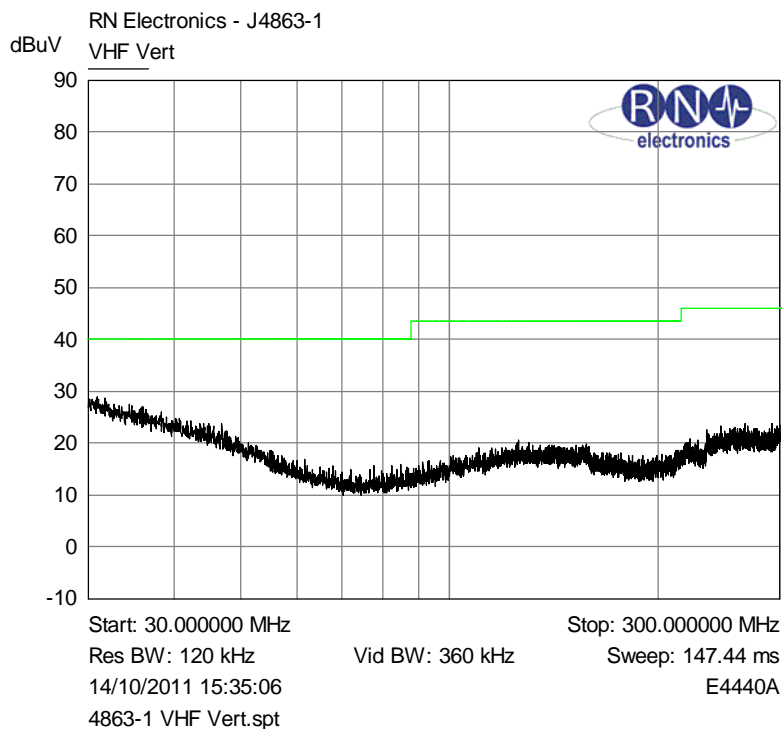
Plot of peak Parallel emissions 150kHz – 30MHz against the quasi-peak limit line



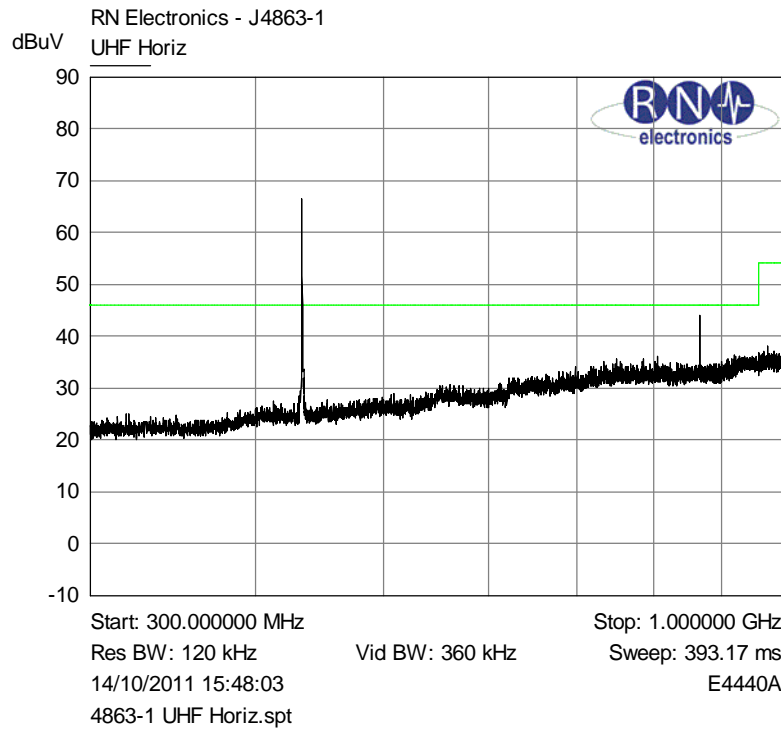
Plot of peak Perpendicular emissions 150kHz – 30MHz against the quasi-peak limit line.



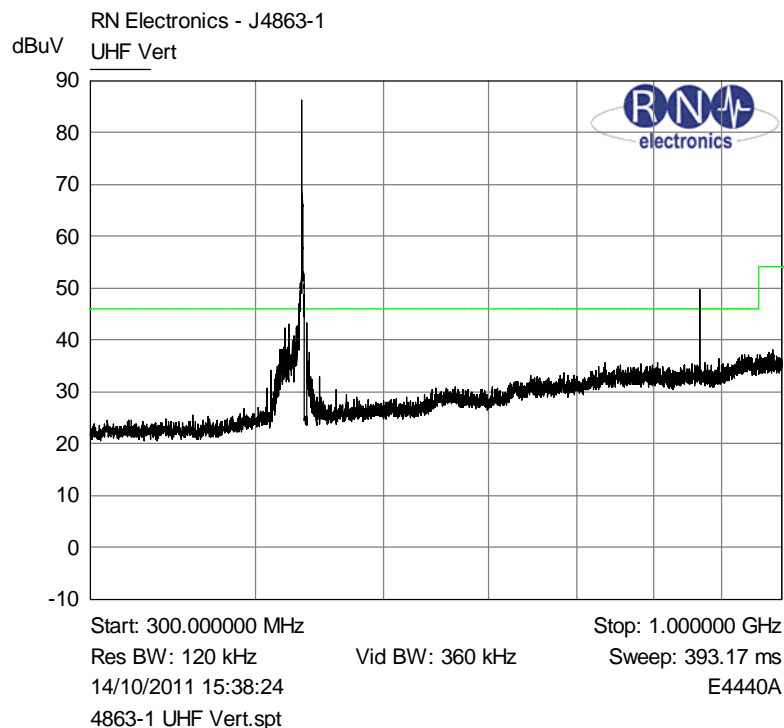
Plot of peak horizontal emissions 30MHz - 300MHz against the quasi-peak limit line.



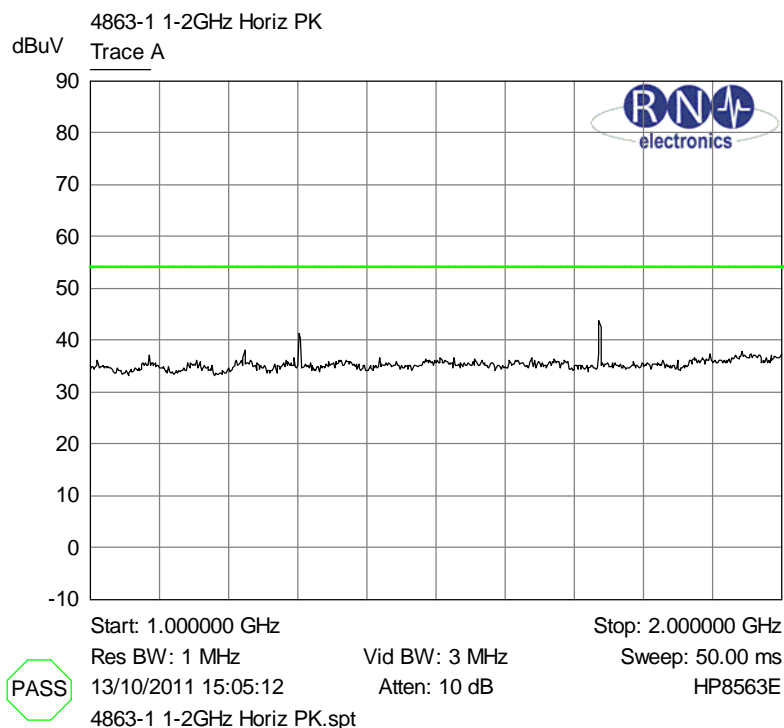
Plot of peak vertical emissions 30MHz - 300MHz against the quasi-peak limit line.



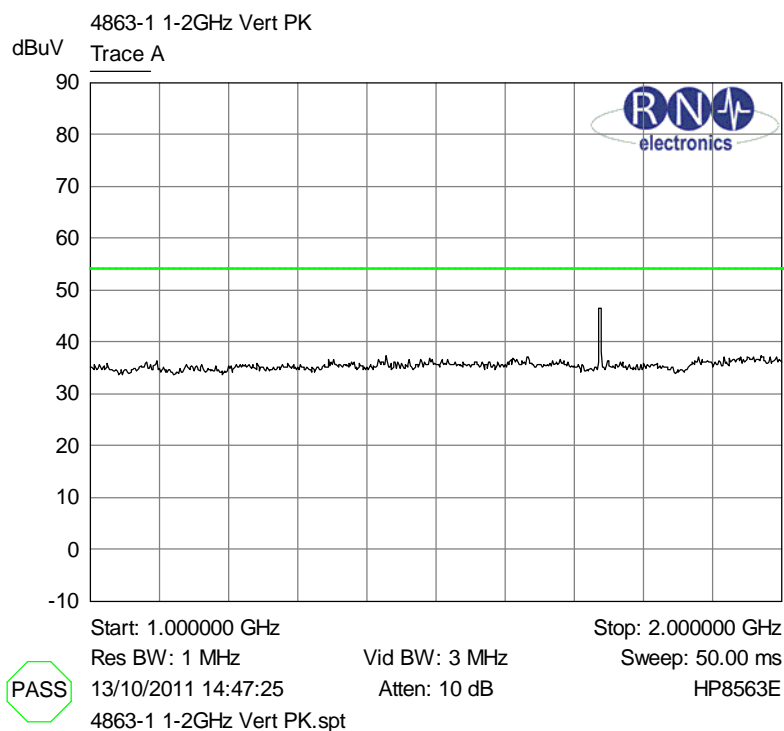
Plot of peak horizontal emissions 300MHz - 1GHz against the quasi-peak limit line.



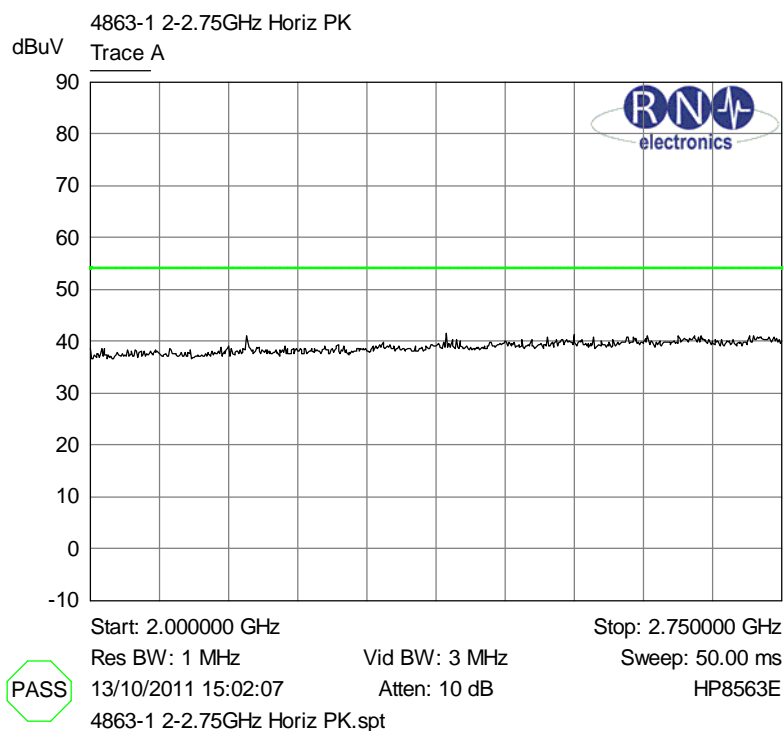
Plot of peak vertical emissions 300MHz - 1GHz against the quasi-peak limit line.



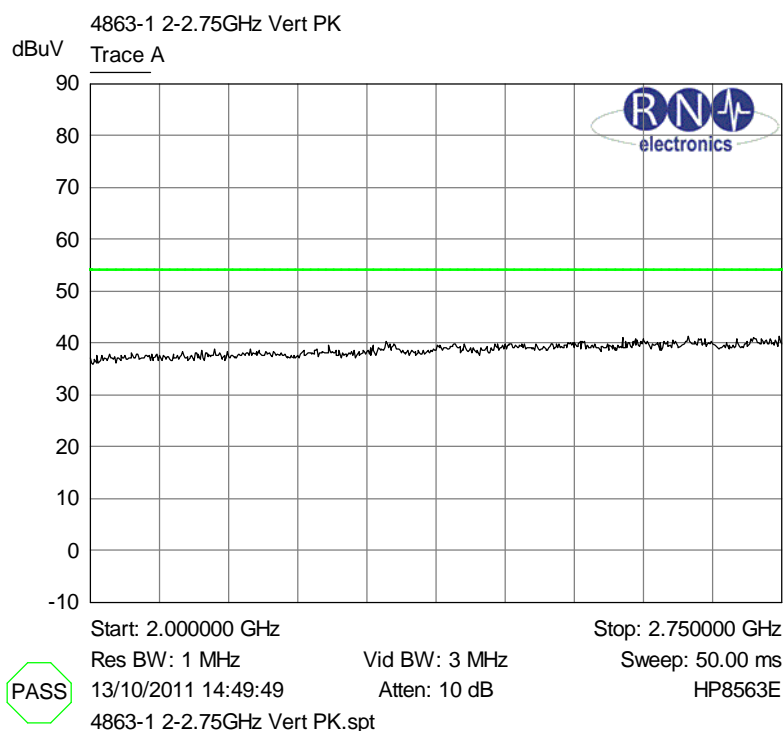
Plots of Peak horizontal emissions 1GHz – 2GHz against the Average limit line.



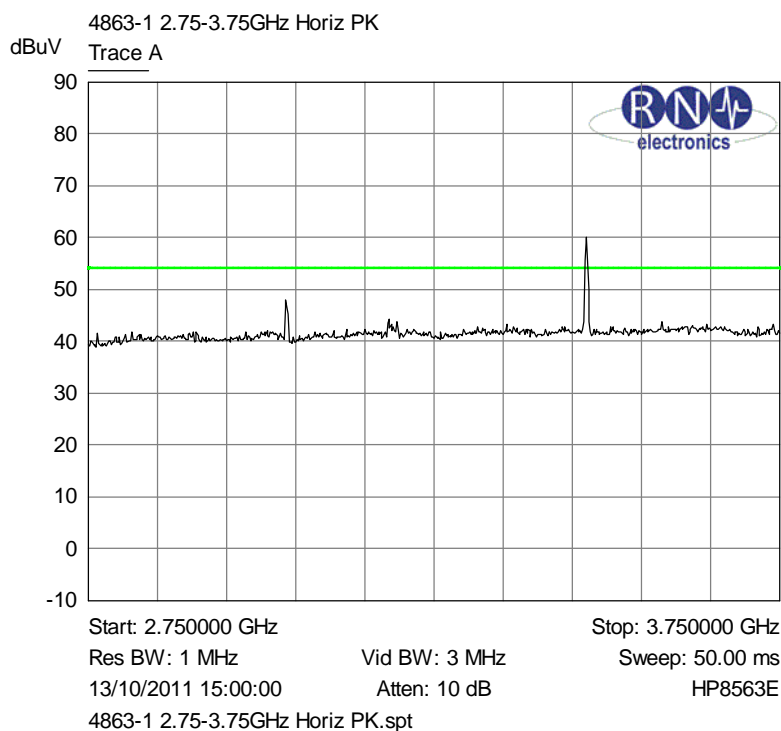
Plot of Peak Vertical emissions 1GHz – 2GHz against the Average limit line.



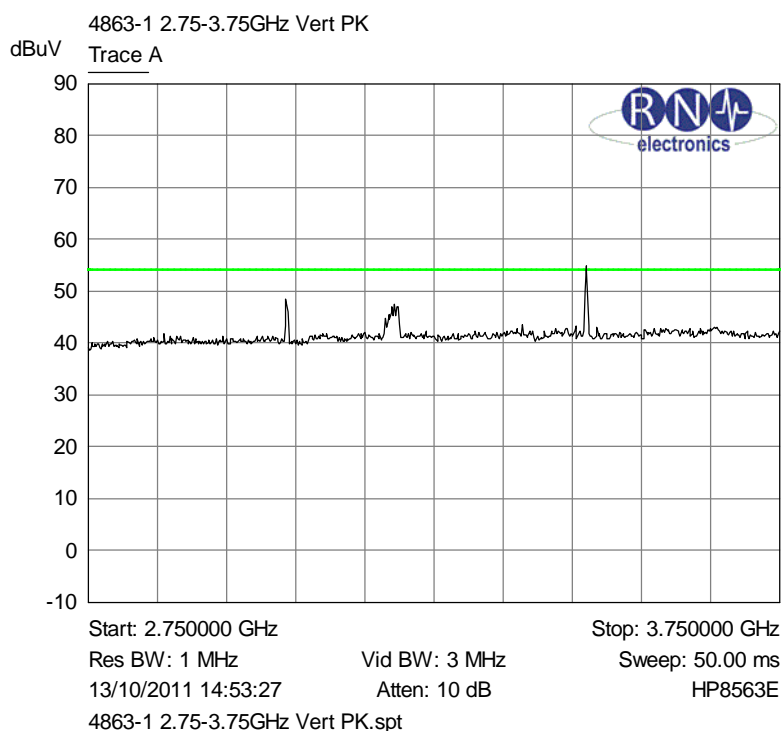
Plot of Peak Horizontal emissions 2GHz – 2.75GHz against the Average limit line.



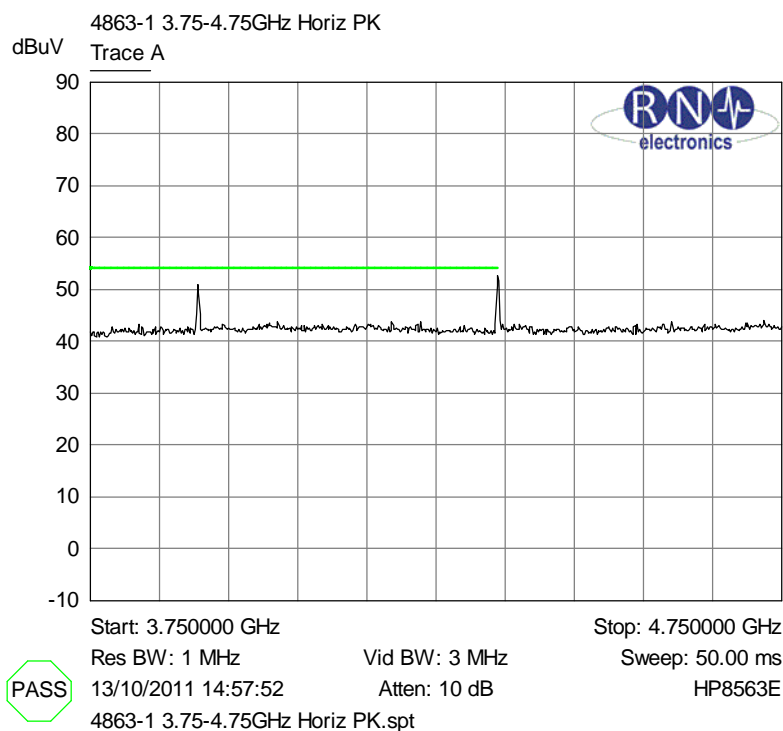
Plot of Peak Vertical emissions 2GHz – 2.75GHz against the Average limit line.



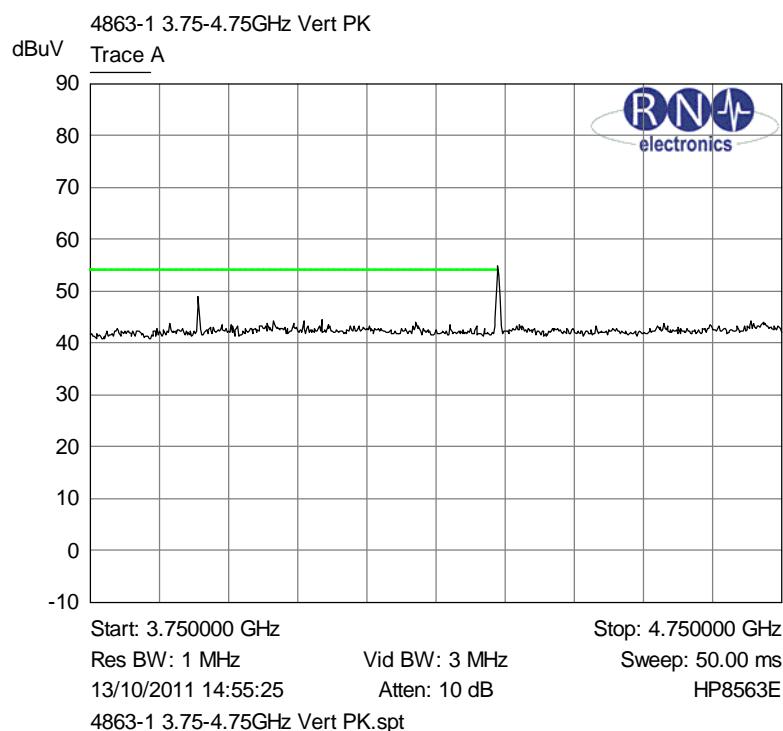
Plot of Peak Horizontal emissions 2.75GHz – 3.75GHz against the Average limit line.



Plot of Peak Vertical emissions 2.75GHz – 3.75GHz against the Average limit line.

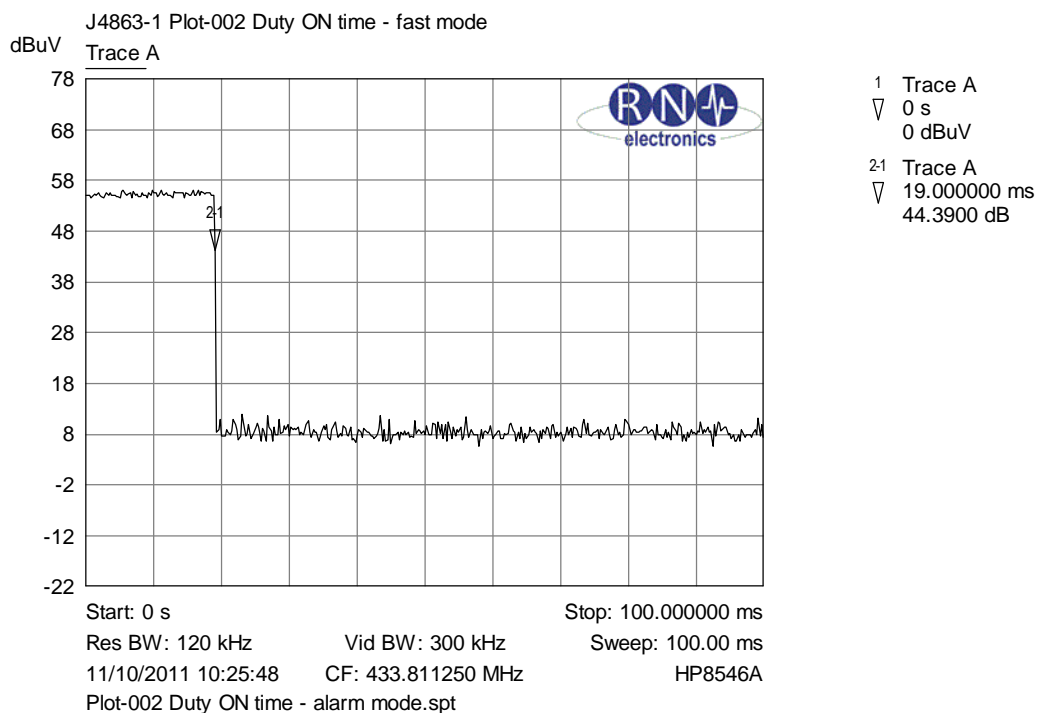
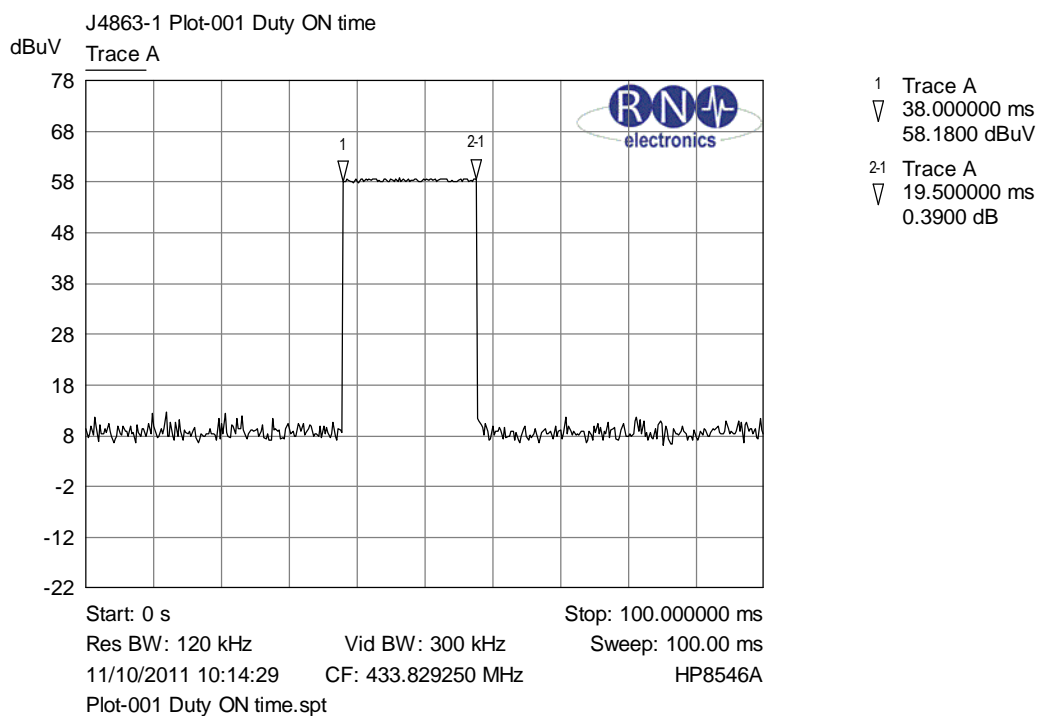


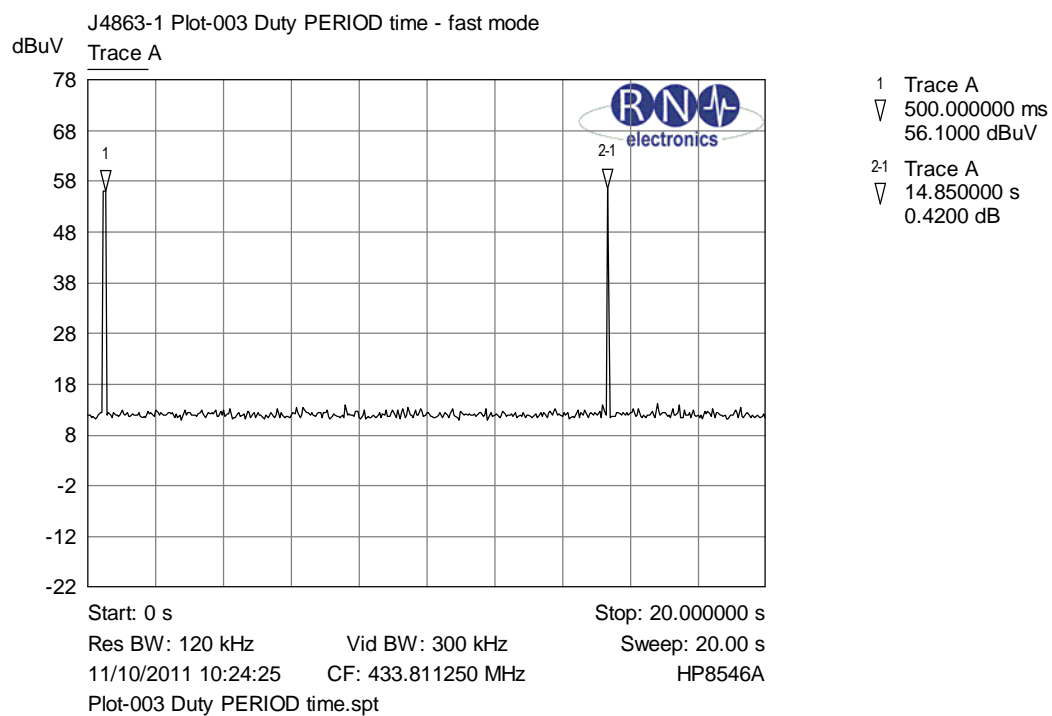
Plot of Peak Horizontal emissions 3.75GHz – 4.75GHz against the Average limit line.



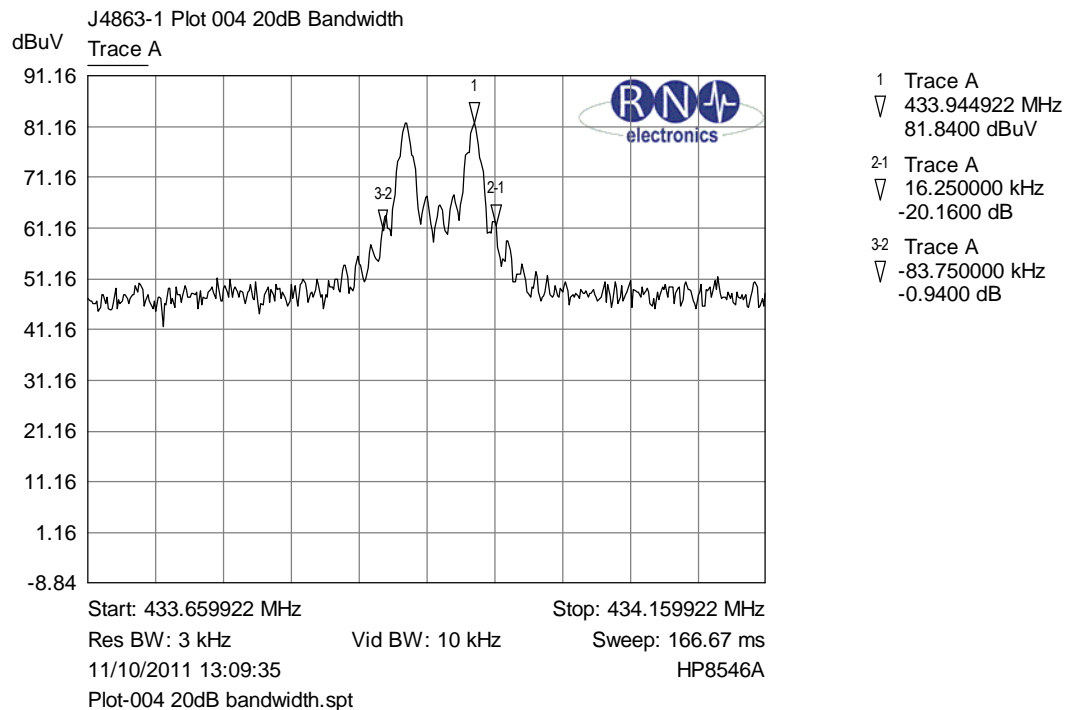
Plot of Peak Vertical emissions 3.75GHz – 4.75GHz against the Average limit line.

6.3 Duty Cycle





6.4 20dB Bandwidth



7 Explanatory Notes

7.1 Explanation of FAIL LIMIT 1 Statement

The **FAIL MARGIN 1** statement(s) may appear on the graphical plots when the receiver used to measure your equipment detects a signal that exceeds the dashed line. This does not mean that the **EUT** has failed the test, only that the 10 dB calculation margin set, has been exceeded on a peak measurement.

Following the indication that the margin has been exceeded, measurements are made at the frequency (ies) of the peaks. These peaks have been calculated to either Quasi Peak or Average Peak dependant on the test. A table of results has been printed on the reverse of the page. This table looks similar to the one illustrated below: -

Signal Number	Frequency (MHz)	Peak (dB μ V)	PK Delta L 1 (dB)	Avg (dB μ V)	Av Delta L 1 (dB)
1	12345.0000	12.9	-2.5	10.2	-5.2

The First column, labelled Signal Number, is a number that the receiver has given to each signal, which has been calculated.

Column Two, labelled Frequency (MHz), is the frequency of the signal received.

Column Three, labelled Peak (dB μ V), (can also be labelled, in the case of Quasi Peak, Peak dB μ V/m) is the Level that was received at peak amount in dB above 1 μ V.

Column Four, labelled PK Delta L1 (dB), is the same level as Column three but is given in a level relative to the limit line required.

Column Five, labelled AVG (dB μ V), (can also be labelled, in the case of Quasi Peak, QP dB μ V/m) when undertaking a Quasi peak test, This is the Average or Quasi peak calculation results given in dB μ V or dB μ V/m above 1 μ V.

Column Six, labelled AV Delta L 1 (dB), (can also be labelled, in the case of Quasi Peak, QP Delta L 1 (dB)) is the Average or Quasi Peak calculation relevant to the limit line. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

7.2 Explanation of limit line calculations for radiated measurements

The limits given in the test standard are normally expressed as absolute values (e.g. in μ V/m at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in dB μ V/m referenced to the measuring instrument inputs. RN Electronics calibrate the test set-up to account for any path losses, antenna gains, etc. so that the value read at the receiver relates directly to the absolute value required, except that it is expressed in dB relative to one microVolt and may need to take account of any alternative measuring distance used. Examples:

- (a) limit of 500 μ V/m equates to $20.\log(500) = 54$ dB μ V/m.
- (b) limit of 300 μ V/m at 10m equates to $20.\log(300 \cdot 10/3) = 60$ dB μ V/m at 3m

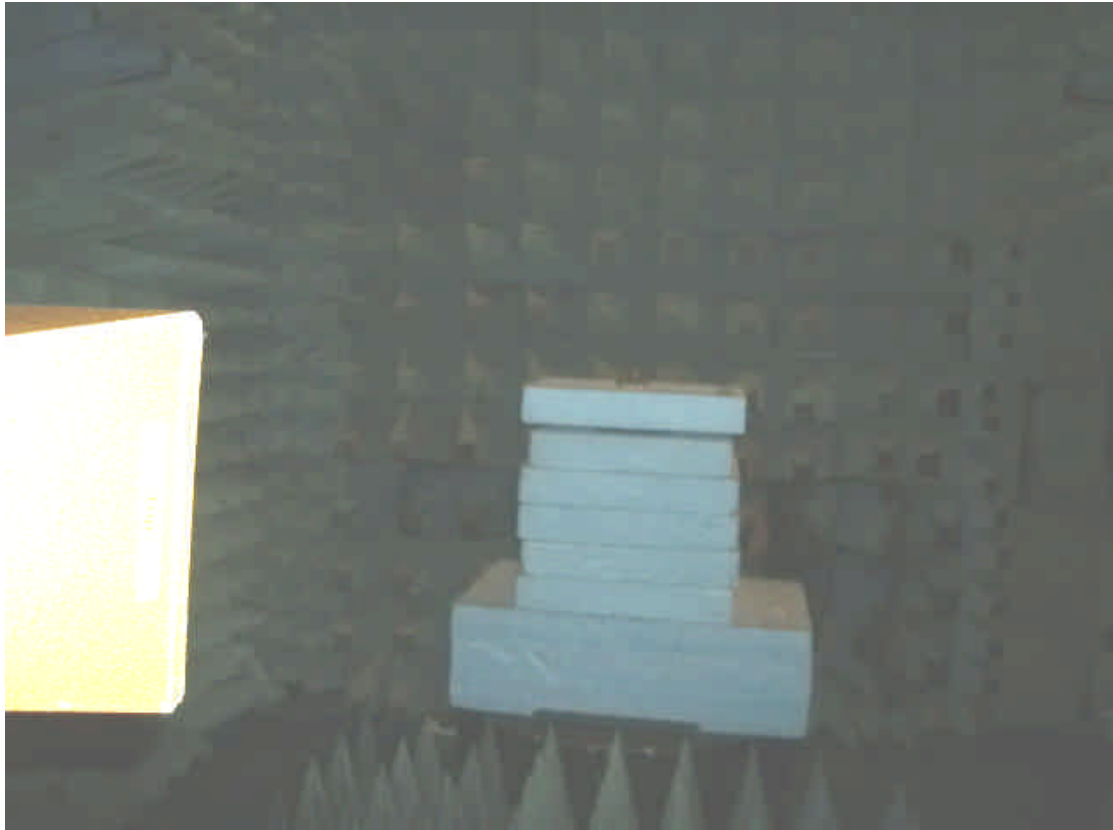
8. Photographs



**Photographs of the EUT as viewed from in front of the antenna,
site M.**



**Photograph of the EUT as viewed from in front of the antenna,
site Q.**



**Photograph of the EUT as viewed from in front of the antenna,
site B.**

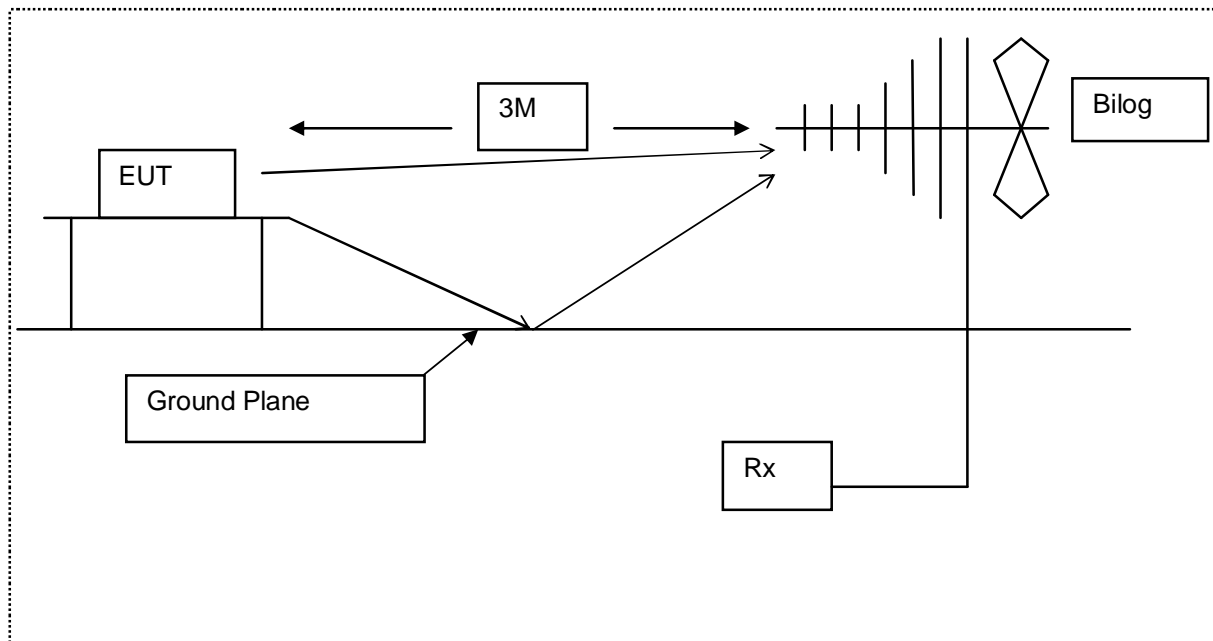


Diagram of the radiated emissions test setup.



Identifying Photograph of the EUT

9. Signal Leads

None.

10. Test Equipment Calibration list

The following table lists the test equipment used, last calibration date and calibration interval. All test equipment used has been maintained within the calibration requirements of **R.N. Electronics Ltd.** test facility quality system. Calibration intervals are regularly reviewed dependent on equipment manufacturer's recommendations and actual usage of the equipment.

RNNNo	Model	Description	Manufacturer	Date Calibrated	Period
E226	8546A	Analyser (calibrated before use)	Hewlett Packard	10-Oct-11	N/A
E268	BHA 9118	1-18 GHz Horn Antenna	Schaffner	14-Apr-11	24
E342	8563E	Spectrum Analyser 26.5 GHz	HP	29-Mar-11	24
E410	N5181A	3 GHz MXG Signal Generator	Agilent Technologies	06-Oct-10	12
E411	N9039A	9 kHz – 1 GHz RF Filter Section	Agilent Technologies	05-Oct-10	12
E412	E4440A	3 Hz – 26.5 GHz PSA	Agilent Technologies	05-Oct-10	12
TMS81	6502	Active Loop Antenna	EMCO	13-Apr-10	24
TMS82	8449B	Pre Amplifier 1 – 26 GHz	Agilent	29-Oct-10	12
TMS903	CBL6111A	Bilog Antenna 30MHz – 1GHz	Chase	12-Apr-10	36
TMS933	CBL6141A	Bilog Antenna 30MHz – 2GHz	York EMC	09-Sep-10	36

11. Auxiliary equipment

11.1 Auxiliary equipment supplied by Raster Vision Ltd

Auxiliary equipment used for the purpose of test supplied by the above has been listed below

Manufacturer	Description	Model Number	Serial Number
-	Magnet	-	-
Trimble	Handheld interrogator/ programming terminal	Nomad	2041
Raster Vision	Pressure chamber and associated foot pump	-	-

11.2 Auxiliary equipment supplied by RN Electronics Limited

Auxiliary equipment used for the purpose of test supplied by the above has been listed below

None.

12. Modifications

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

12.1 Modifications before test

The EUT output power level was set prior to test to level 13 of 15 available settings from the supplied handheld terminal. The manufacturer declares that this software is not normally available to the user.

12.2 Modifications during test

There were no modifications made by R.N. Electronics Ltd during testing.

13. Compliance information

Products subject to the Declaration of Conformity procedure are required to be supplied with a compliance information statement. A copy of this statement may be included here:

The EUT is to be authorised as CERTIFIED equipment, i.e.no DoC is required.

14 Description of Test Sites

Site A	Radio / Calibration Laboratory and anechoic chamber
Site B	Semi-anechoic chamber
Site B1	Control Room for Site B
Site C	Transient Laboratory
Site D	Screened Room (Conducted Immunity)
Site E	Screened Room (Control Room for Site D)
Site F	Screened Room (Conducted Emissions) VCCI Registration No. C-2823
Site K	Screened Room (Control Room for Site M)
Site M	3m Semi-anechoic chamber (indoor OATS) FCC Registration No. 293246
Site Q	Fully-anechoic chamber
Site OATS	3m and 10m Open Area Test Site FCC Registration No. 293246 IC Registration No. 5612A-1 VCCI Registration No. R-2580

15 Abbreviations and Units

%	Percent
μV	microVolts
μW	microWatts
AC	Alternating Current
ALSE	Absorber Lined Screened Enclosure
AM	Amplitude Modulation
Amb	Ambient
ANSI	American National Standards Institute
°C	Degrees Celsius
CFR	Code of Federal Regulations
CS	Channel Spacing
CW	Continuous Wave
dB	decibels
dBμV	decibels relative to 1μV
dBc	decibels relative to Carrier
dBm	decibels relative to 1mW
DC	Direct Current
EIRP	Equivalent Isotropic Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FM	Frequency Modulation
FSK	Frequency Shift Keying
g	Grams
GHz	GigaHertz
Hz	Hertz
IF	Intermediate Frequency
kHz	kiloHertz
LO	Local Oscillator
mA	milliAmps
max	maximum
mbar	milliBars
MHz	MegaHertz
min	minimum
mm	milliMetres
ms	milliSeconds
mW	milliWatts
NA	Not Applicable
nom	Nominal
nW	nanoWatt
OATS	Open Area Test Site
OFDM	Orthogonal Frequency Division Multiplexing
ppm	Parts per million
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
Ref	Reference
RF	Radio Frequency
RTP	Room Temperature and Pressure
s	Seconds
Tx	Transmitter
V	Volts



Certificate of Test

The unit noted below has been tested by **R.N. Electronics Limited** and, where appropriate, conforms to the relevant subpart of FCC 47CFR Part 15.

This certificate relates to the unit, as identified by unique serial number(s) and further detailed in the referenced report, in the condition(s) at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Furthermore, this is a certificate of test only and should not be confused with an equipment authorisation.

Equipment: MEMS EVOLUTION2 SENSOR

Model Number(s): RV1.15
Proposed FCC ID: FI5-RV1-15E

Unique Serial Number(s): 20360151

Manufacturer: Raster Vision Ltd
Unit 1 Crundalls
Gedgges Hill
Matfield
Kent
TN12 7EA

Customer Purchase Order Number: 7605

R.N. Electronics Limited
Report Number: 10-511/4863A/1/11

Test Standards: FCC 47CFR Part 15C:
effective date October 1st 2010,
Class DSC Intentional Radiator

Date: 11th to 14th October 2011

For and on behalf of
R.N. Electronics Limited

Signature
Technical Director:

Notes:

QMF21J – 3: FCC PART 15C: RNE ISSUE 02: - JUN 10