# TEST REPORT

**Report Number: 100586460MIN-005**
**Project Number: G100586460**

**Testing performed on the**
**CAT0000435**
**FCC ID: PQMASTOP1**
**Industry Canada ID: 4071-ASTOP1**

**to**
**47 CFR Part 15. 247:2010**
**RSS- 210, Issue 8, 2010**
**AS/NZS 4268:2008**

**For**
**Benchmark Electronics, Inc.**

Test Performed by:
Intertek Testing Services NA, Inc.
7250 Hudson Blvd., Suite 100
Oakdale, MN 55128 USA

Test Authorized by:
Benchmark Electronics, Inc.
3535 Technology Drive
Rochester, MN 55901, USA

Prepared by: _____ Date: February 29, 2012
Richard Blonigen

Reviewed by: _____ Date: February 29, 2012
Norman Shpilsher

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## 1.0 GENERAL DESCRIPTION

| | |
|---|---|
| **Model:** | CAT0000435 |
| **Type of EUT:** | Remote Autonomous Stop |
| **Serial Number:** | 00001 (Continuously transmitting sample)<br>00002 (normal operating mode sample) |
| **FCC ID:** | PQMASTOP1 |
| **Industry Canada ID:** | 4071-ASTOP1 |
| **Related Submittal(s) Grants:** | None |
| **Company:** | Benchmark Electronics, Inc. |
| **Customer:** | Mr. Joeseph Hlavka |
| **Address:** | 3535 Technology Drive<br>Rochester, MN 55901, USA |
| **Phone:** | (507) 535-4265 |
| **Fax:** | (507) 535-4828 |
| **e-mail:** | Joseph.hlavka@bench.com |
| **Test Standards:** | ☒ 47 CFR, Part 15:2010, §15.247<br>☒ RSS–210, Issue 8, 2010<br>☒ RSS-Gen, Issue 3, 2010<br>☒ 47 CFR, Part 15:2010, §15.107 and §15.109, Class B<br>☒ ICES-003, Issue 4:2004<br>☒ AS/NZS 4268:2008 |
| **Type of radio:** | ☒ Stand -alone ☐ Module ☐ Hybrid |
| **Date Sample Submitted:** | January 3, 2012 |
| **Test Work Started:** | January 3, 2012 |
| **Test Work Completed:** | January 4, 2012 |
| **Test Sample Conditions:** | ☐ Damaged ☐Poor (Usable) ☒ Good |

## 1.1 Product Description; Test Facility

| | |
|---|---|
| **Product Description:** | 919MHz Transceiver |
| **Transmitter Type:** | ☐ FHSS ☒ Digital Modulation ☐ WiFi ☐ Blue Tooth |
| **Operating Frequency Range(s):** | 919MHz |
| **Number of Channels:** | 1 |
| **Modulation:** | 2-FSK |
| **Emission Designator:** | 570KFIDBN |
| **Antenna(s) Info:** | External Antenna, Laird MAF94384<br>Antenna Gain: 2.5dBi |
| **Antenna Installation:** | ☐ User ☐ Professional ☒ Factory |
| **Transmitter power configuration:** | ☐ Internal battery ☐ External power source<br>☐ 120VAC ☐ 230VAC ☐ 400VAC ☐ VDC ☐ Other:<br>Amp.<br>☐ 50Hz ☐ 60Hz |
| **Special Test Arrangement:** | None |
| **Test Facility Accreditation:** | A2LA (Certificate No. 1427.01) |
| **Test Methodology:** | Measurements performed according to the procedures in ANSI C63.10-2009 and FCC DTS Measurement Guide |

## 1.2 EUT Configuration

The equipment under test was operated during the measurement under the following conditions:

☐ - Standby
☒ - Continuous transmissions (modulated signal)
☐ - Continuous transmissions (un-modulated signal)
☐ - Continuous receiving
☐ - Test program (customer specific)
☐ -

**Operating modes of the EUT:**

| No. | Description |
|---|---|
| 1 | Test was performed at 919MHz channel |

**Cables:**

| No. | Type | Length | Designation | Note |
|---|---|---|---|---|
| 1 | 7-wire unshielded | 1m | AC power / CAN bus | |

**Support equipment/Services**:

| No. | Item | Description |
|---|---|---|
| 1 | None | |

## 1.3 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

☐ **Normal**

| | |
|---|---|
| **Temperature:** | +15 to +35 ° C |
| **Humidity:** | 20-75 % |
| **Atmospheric pressure:** | 86-106 kPa |

☐ **Extreme**

| | |
|---|---|
| ☐ **Temperature:** | -20 to +50 ° C |
| ☐ **Supply voltage:** | 85% to +115% |

## 1.4 Measurement uncertainty

The expanded uncertainty (k = 2) for radiated measurements has been determined to be:
±4 dB at 10m and ±5.4 dB at 3m
The expanded uncertainty (k = 2) for conducted measurements at antenna terminal has been determined to be:
±1.0 dB
The expanded uncertainty (k = 2) for line conducted measurements has been determined to be:
±2.6 dB

## 1.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured emissions reading on the EMI Receiver.
The basic equation with a sample calculation is as follows:
FS = RA + AF + CF - AG

Where: FS = Field Strength in dB(μV/m)
RA = Receiver Amplitude in dB(μV)
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB($m^{-1}$)
AG = Amplifier Gain in dB

Assume a receiver reading of 48.1 dB(μV) is obtained. The antenna factor of 7.4 dB($m^{-1}$) and cable factor of 1.6 dB is added and amplifier gain of 16.0 dB is subtracted giving field strength of 41.1 dB(μV/m).

RA = 48.1 dB(μV)
AF = 7.4 dB($m^{-1}$)
CF = 1.6 dB
AG = 16.0 dB
FS = RA + AF + CF - AG
FS = 48.1 + 7.4 + 1.6 – 16.0
FS = 41.1 dB(μV/m)

**General notes:**

## 2.0 TEST SUMMARY

Referring to the performance criteria and the operating mode during the tests specified in this report, the equipment complies with the requirements according to the following standards.

| TEST SPECIFICATION | TEST PARAMETERS | RESULT |
|---|---|---|
| 15.247(b), (c) / RSS-210 A8.4 | Maximum peak output power | Pass |
| 15.247(a) / RSS-210 A8.2 | 6dB bandwidth of the digital modulation system | Pass |
| 15.247/(e) / RSS-210 A8.2 | Power spectral density | Pass |
| 15.247(d) / RSS-210 A8.5 | Antenna conducted spurious emissions | Pass |
| 15.247(d) / RSS-210 A8.5 | Radiated spurious emissions | Pass |
| 15.247(i) / RSS- Gen 5.5 | RF Exposure Compliance | Pass |
| 15.207 / RSS-Gen 7.2.2 | Transmitter Power Line conducted emissions | N/A |
| 15.109 / ICES-003 / RSS-Gen | Receiver/digital device radiated emissions | Pass |
| 15.107 / ICES-003 | Digital device conducted emissions | N/A |

## 3.0 TEST CONDITIONS AND RESULTS

### 3.1 Maximum peak output power

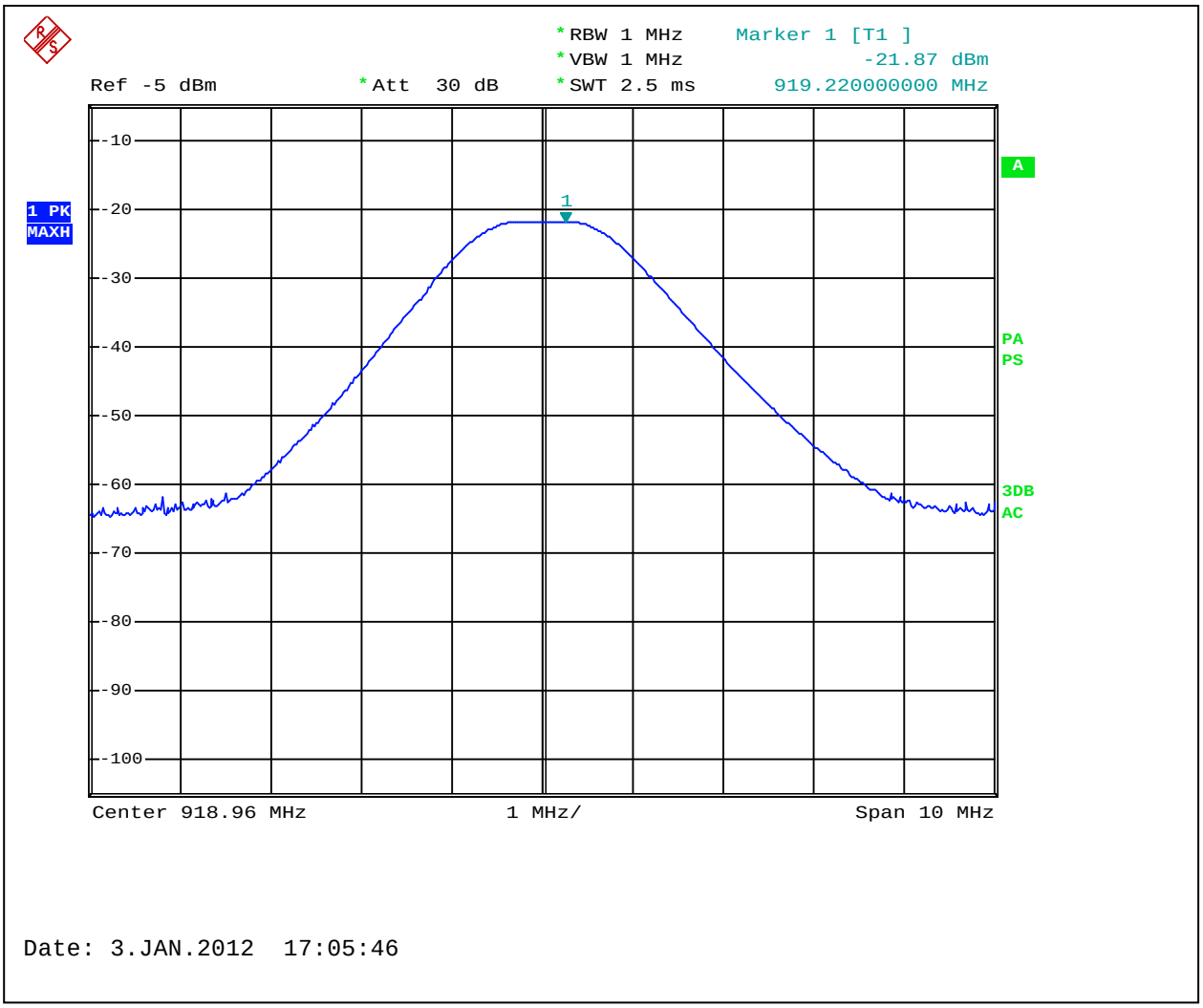
**Test location:** ☐ OATS ☒ Anechoic Chamber ☐ Other

**Test result:** **Pass**

**Max. Margin:** 51.57 dB below the limits

| **Power Output:** | **Conducted** | | | | | |
|---|---|---|---|---|---|---|
| **Frequency Range:** | ☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz | | | | | |
| | **Measured power dBm** | **Attenuaton dB** | **Power at Antenna dBm** | **Limit dBm** | **Limit Reduction dB** | **Margin dB** |
| **919 MHz** | -21.87 | 0.3 | -21.57 | 30.00 | 0 | -51.57 |
| **RBW:** | ☒ 1MHz ☐ 3MHz ☐ 10MHz | | | | | |
| **VBW:** | ☒ 1MHz ☐ 3MHz ☐ 10MHz | | | | | |
| **Antenna Gain:** | ☒ < 6dBi ☐ >6dBi and = dBi, Output power reduction = dB | | | | | |

**Notes:**


*RBW 1 MHz
*VBW 1 MHz
*SWT 2.5 ms
Marker 1 [T1 ]
-21.87 dBm
919.220000000 MHz
Ref -5 dBm
*Att 30 dB
1 PK
MAXH
A
PA
PS
3DB
AC
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
Center 918.96 MHz
1 MHz/
Span 10 MHz
Date: 3.JAN.2012 17:05:46

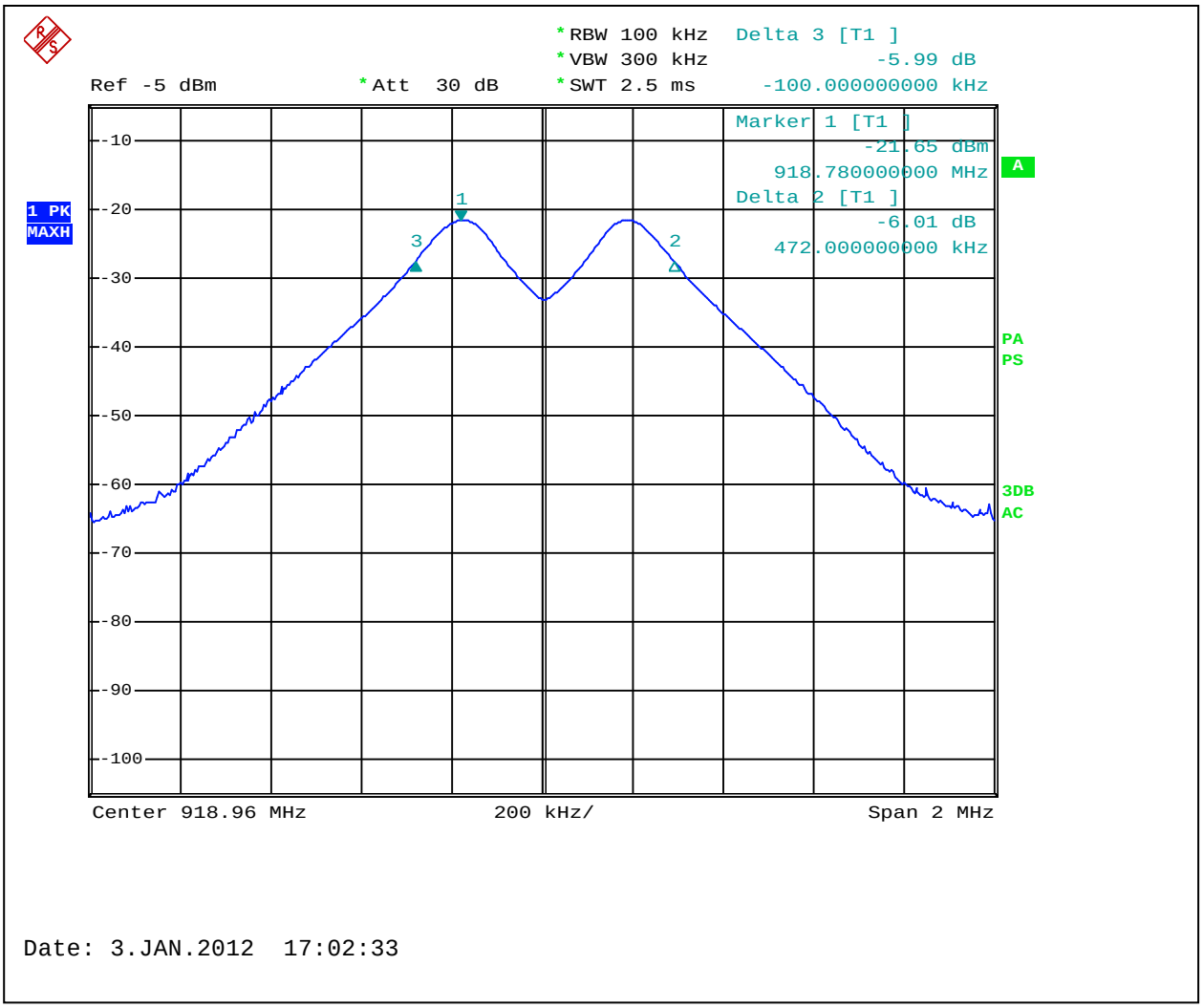
**Graph 3.1.1**

### 3.2 6dB bandwidth of the digital modulation

| 919MHz Channel kHz | Minimum Bandwidth kHz | Result |
|---|---|---|
| 572 | 500 | **Pass** |

| | | | |
|---|---|---|---|
| **RBW:** | ☒ 100kHz | ☐ other | kHz |
| **VBW:** | ☐ 100kHz | ☒ 300kHz | ☐ other kHz |

**Notes:**

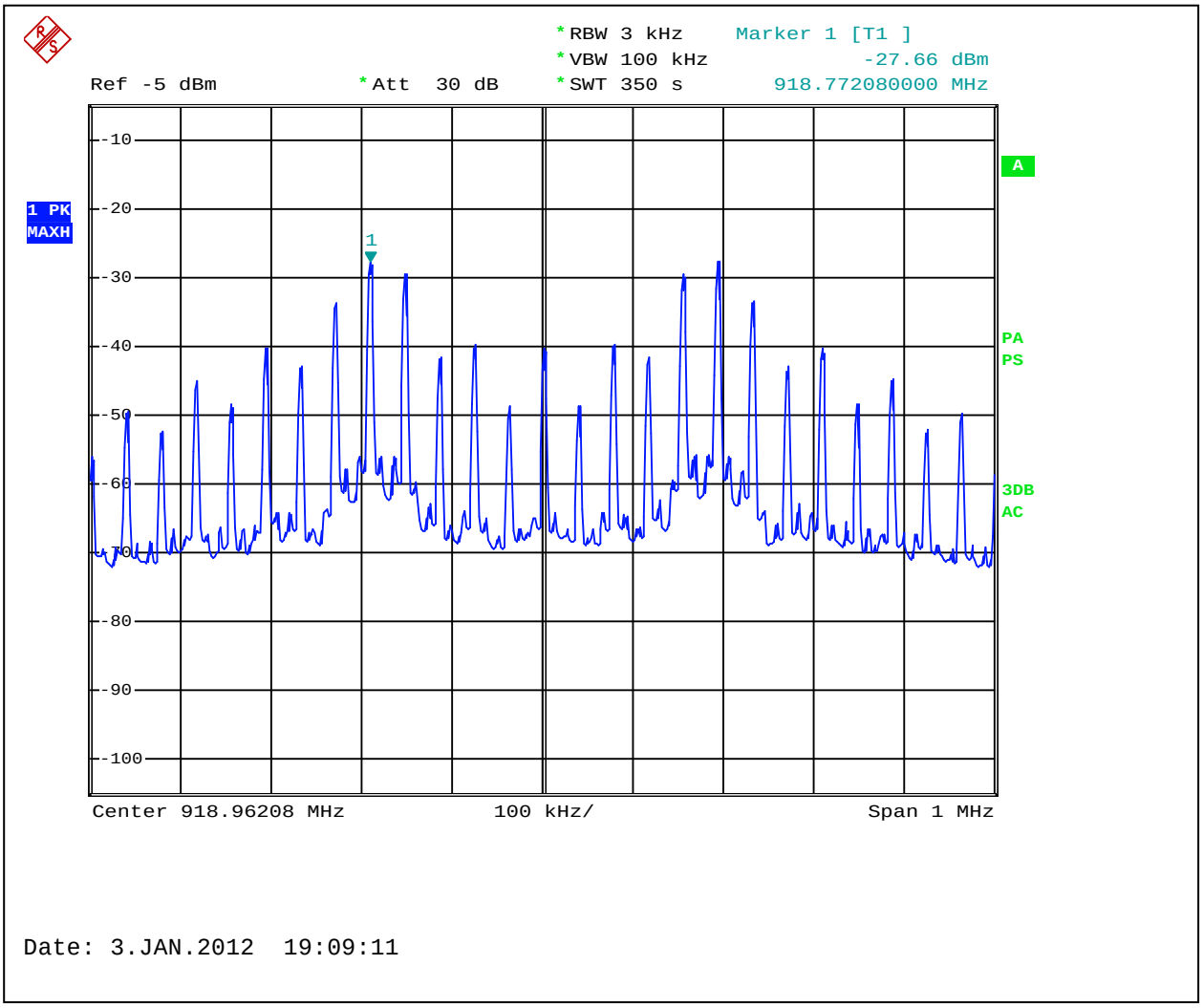

*RBW 100 kHz
*VBW 300 kHz
*SWT 2.5 ms
Delta 3 [T1 ]
-5.99 dB
-100.000000000 kHz
Ref -5 dBm
*Att 30 dB
Marker 1 [T1 ]
-21.65 dBm
918.780000000 MHz
Delta 2 [T1 ]
-6.01 dB
472.000000000 kHz
1 PK
MAXH
A
PA
PS
3DB
AC
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
Center 918.96 MHz
200 kHz/
Span 2 MHz
Date: 3.JAN.2012 17:02:33

**Graph 3.2.1**

### 3.3 Power spectral density

| Power Output: | ☒ Conducted ☐ Radiated | | | |
|---|---|---|---|---|
| | **Measured Density dBm** | **Power Spectral Density dBm** | **Limit dBm** | **Margin dB** |
| **919MHz Channel** | -27.66 | -27.36 | 8 | -35.36 |
| **Analyzer Settings:** | ☒ RBW=3KHz ☒ VBW=100KHz ☒ Span=1MHz ☒ Sweep=350sec | | | |
| **Antenna Gain:** | ☒ < 6dBi and = dBi ☐ >6dBi and = dBi, limit reduction = dB | | | |

**Notes:** The Power Spectral Density was calculated adding the cable/attenuator loss of 0.3 dB from the measured density value.

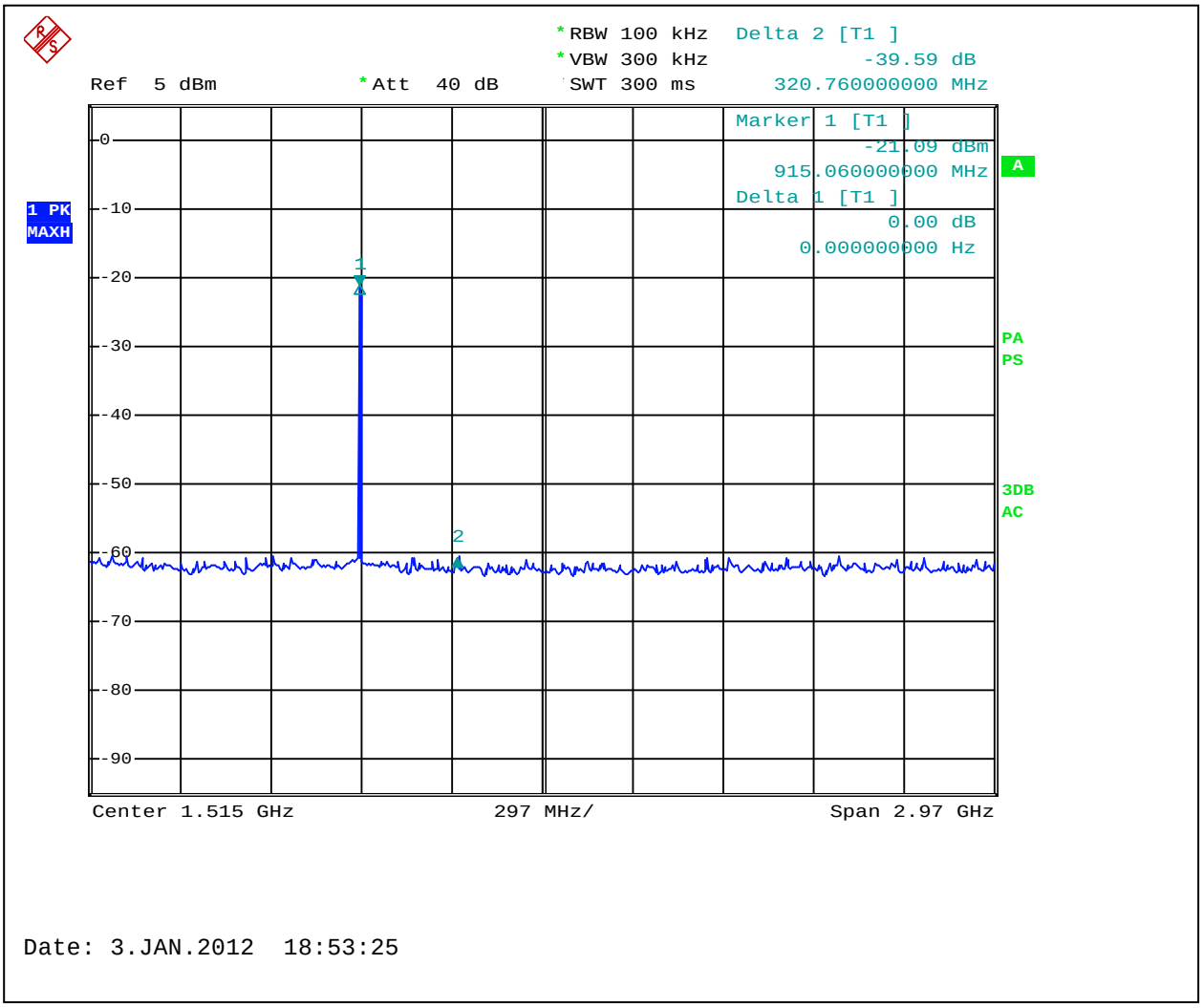

*RBW 3 kHz
*VBW 100 kHz
*SWT 350 s
Marker 1 [T1 ]
-27.66 dBm
918.772080000 MHz
Ref -5 dBm
*Att 30 dB
1 PK
MAXH
A
PA
PS
3DB
AC
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
Center 918.96208 MHz
100 kHz/
Span 1 MHz
Date: 3.JAN.2012 19:09:11

**Graph 3.3.1**

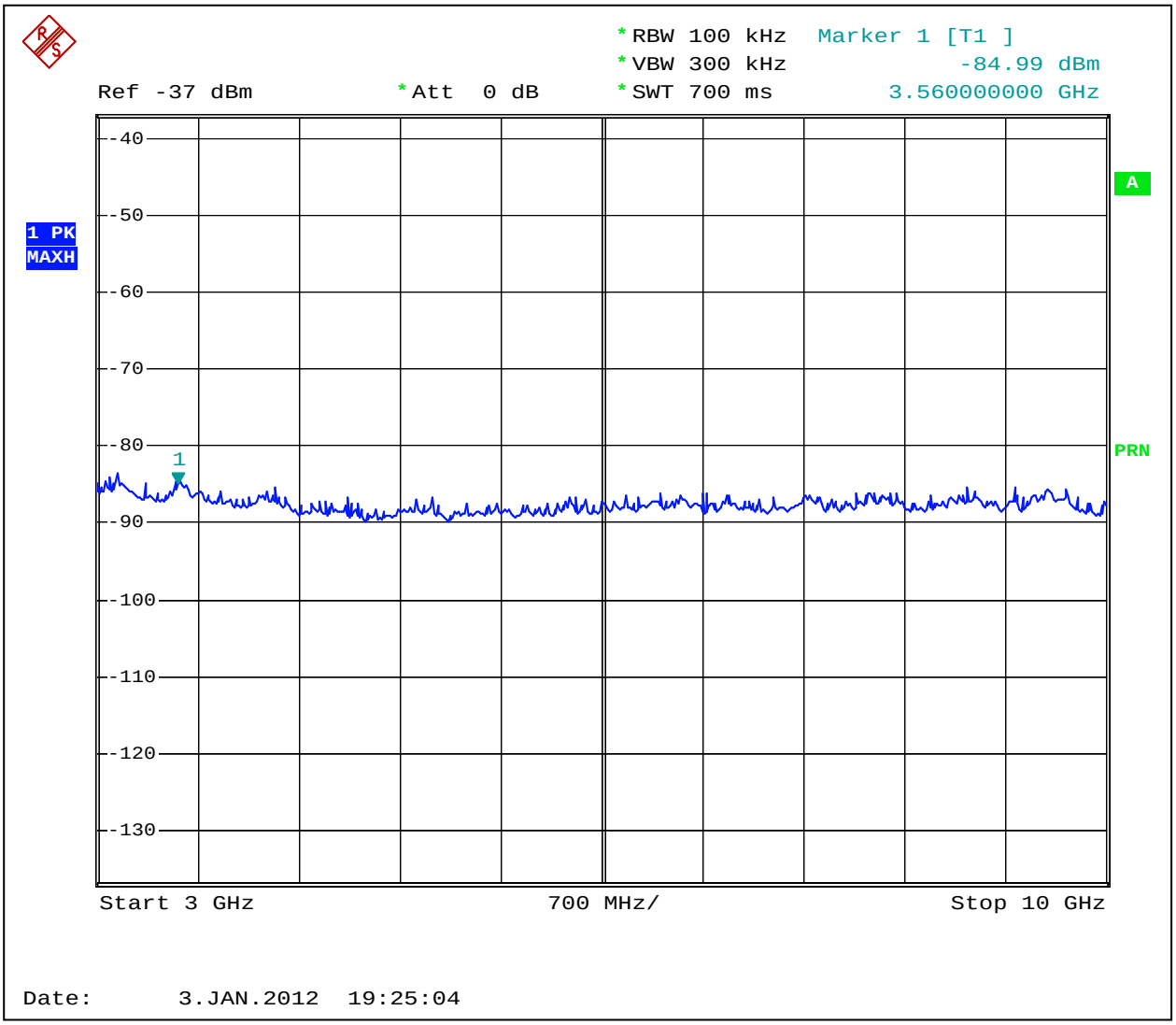
### 3.4 Antenna conducted spurious emissions

| | Minimum Measured Attenuation dB | Minimum Allowed Attenuation dB | Margin dB |
|---|---|---|---|
| **919 MHz Channel** | 39.59 | 20 | -19.59 |
| **Analyzer Settings:** | ☒ RBW=100KHz | | |
| **Minimum Allowed Attenuation:** | ☒ 20dB<br>☐ 30dB (for digital systems with conducted power measured using RMS averaging over a time interval) | | |

**Notes:**


*RBW 100 kHz
*VBW 300 kHz
SWT 300 ms
Delta 2 [T1 ]
-39.59 dB
320.760000000 MHz
Ref 5 dBm
*Att 40 dB
Marker 1 [T1 ]
-21.09 dBm
915.060000000 MHz
Delta 1 [T1 ]
0.00 dB
0.000000000 Hz
1 PK
MAXH
A
PA
PS
3DB
AC
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 1.515 GHz
297 MHz/
Span 2.97 GHz
Date: 3.JAN.2012 18:53:25

**Graph 3.4.1**


*RBW 100 kHz
*VBW 300 kHz
*SWT 700 ms
Marker 1 [T1 ]
-84.99 dBm
3.560000000 GHz
Ref -37 dBm
*Att 0 dB
1 PK
MAXH
A
PRN
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
1
Start 3 GHz
700 MHz/
Stop 10 GHz
Date: 3.JAN.2012 19:25:04

**Graph 3.4.2**

### 3.5 Radiated spurious emissions

**Test location:** ☐ OATS ☒ Anechoic Chamber ☐ Other

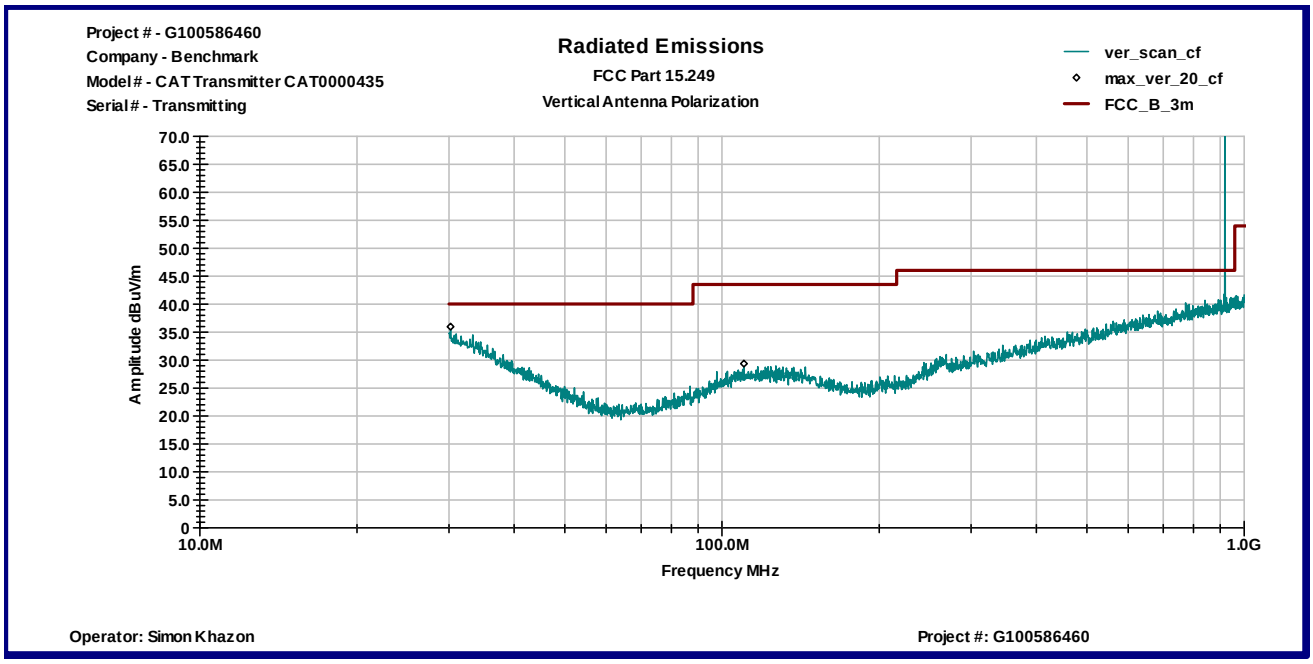
**Test result:** **Pass**

**Max. Margin:** 3.3 dB below the limits

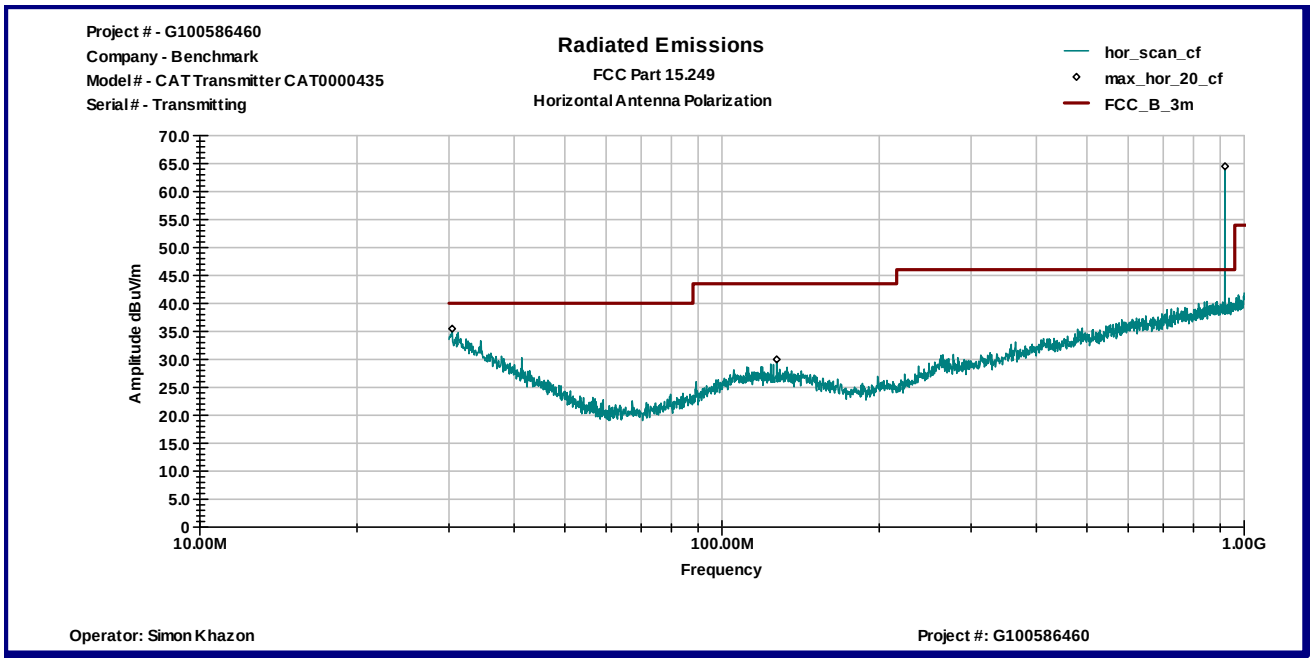
| | | |
|---|---|---|
| **Date:** | January 3, 2012 | **Result:** **Pass** |
| **Standard:** | FCC part 15.247(d) | |
| **Tested by:** | Simon Khazon | |
| **Test Point:** | 919MHz channel | |
| **Operation mode:** | See Page 5 | |
| **Note:** | Frequencies in unrestricted band were removed from table. | |

**Table 3.5.1**

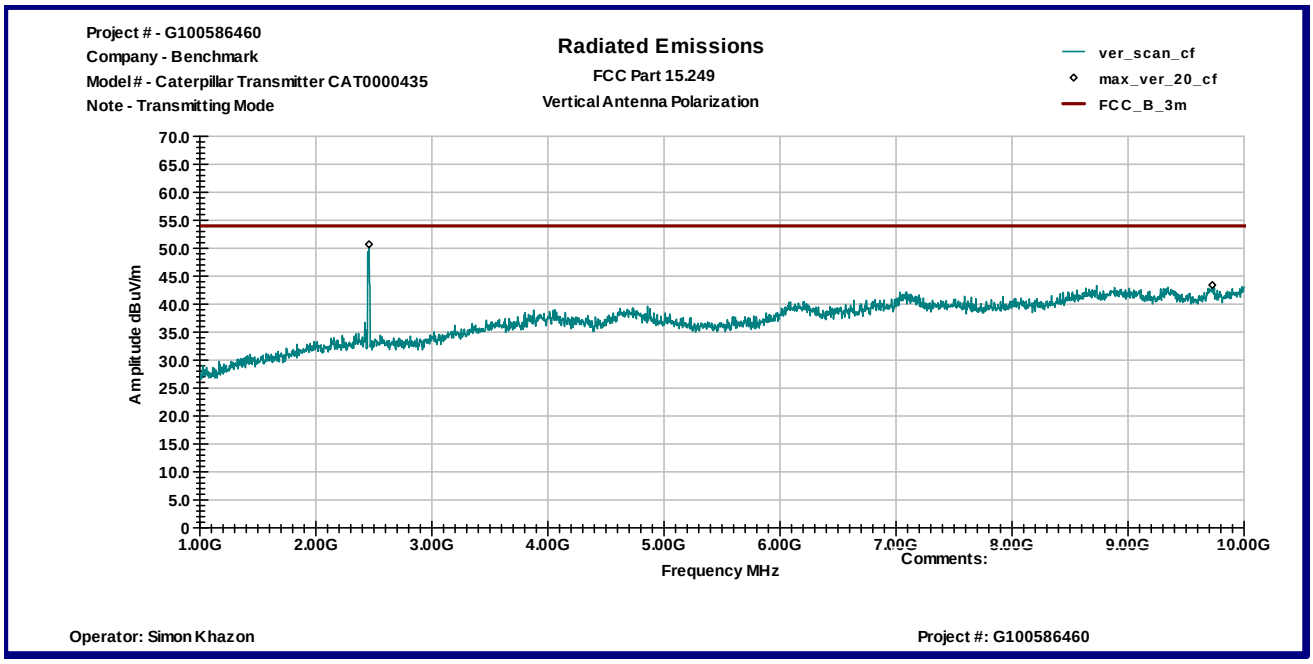
| Frequency MHz | Antenna Polarity | Peak Reading dBµV | Total C.F. dB1/m | Pre-Amp. Gain (dB) | Total at 3m dBµV/m | Limit dBµV/m | Margin dB |
|---|---|---|---|---|---|---|---|
| 30.117 MHz | V | 15.3 | 20.3 | 0.0 | 35.6 | 40.0 | -4.4 |
| 130.12 MHz | V | 15.8 | 13.8 | 0.0 | 29.6 | 43.5 | -13.9 |
| 2.458 GHz | V | 62.6 | 31.6 | 43.5 | 50.7 | 54.0 | -3.3 |
| 9.7264 GHz | V | 40.4 | 44.1 | 41.1 | 43.4 | 54.0 | -10.6 |
| | | | | | | | |
| 30.397 MHz | H | 14.6 | 20.1 | 0.0 | 34.7 | 40.0 | -5.3 |
| 137.96 MHz | H | 16.3 | 13.5 | 0.0 | 29.8 | 43.5 | -13.8 |
| 1.8388 GHz | H | 57.6 | 29.3 | 43.4 | 43.6 | 54.0 | -10.4 |
| 9.7804 GHz | H | 41.1 | 44.2 | 41.1 | 44.2 | 54.0 | -9.8 |
| | | | | | | | |



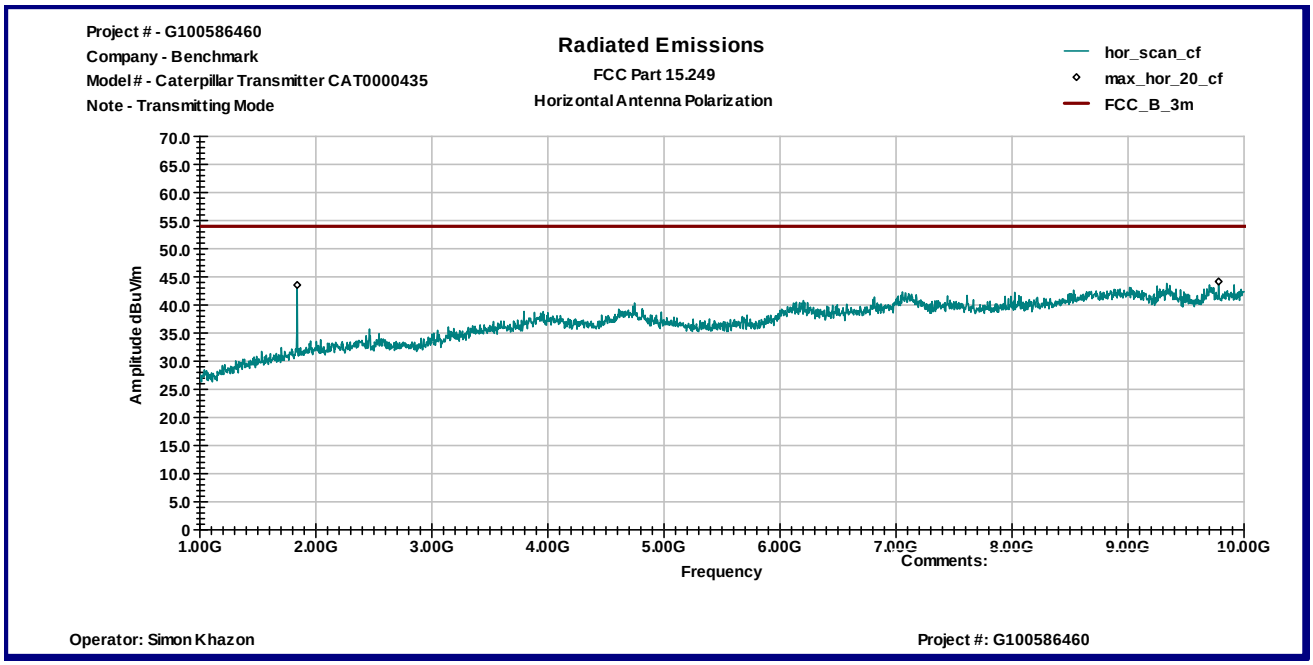

**Graph 3.5.1**




**Graph 3.5.2**




**Graph 3.5.3**




**Graph 3.5.4**

### 3.6 RF Exposure Compliance

The maximum measured antenna conducted power, P is -20dBm

The antenna gain, G is 2.5dBi

The maximum EIRP power = P + G
ERP = -20+ 2.5= -17.5dBm, or 0.00002W

The limits for Maximum Permissible Exposure (MPE) for transmitter operating at 902-928MHz, MPE is 919/1500 = 0.6mW/cm$^2$, or 6W/m$^2$

The Power Density, S is related to EIRP with the equation:
S = EIRP / 4πD$^2$, where D is the safe separation distance and = 0.2m, or 20cm
S = 0.02mW / 4π20$^2$,
S = 0.001mW/cm$^{2,}$, or below the Maximum Permissible Exposure (MPE) of 0.6mW/cm$^2$

### 3.7 Transmitter power line conducted emissions

**Test location:** ☐ OATS ☐ Anechoic Chamber ☐ Other

**Test result:** **N/A**

**Frequency range:** 0.15MHz-30MHz

**Max. Emissions margin:** dB below the limits

Notes: It was determined from consideration of the electrical characteristics and usage of particular apparatus that Conducted Emissions testing is inappropriate and therefore unnecessary (as battery operated equipment).

### 3.8 Receiver/digital device radiated emissions

**Test location:** ☐ OATS ☒ Anechoic Chamber

**Test distance:** ☐ 10 meters ☒ 3 meters

**Test result:** **Pass**

**Frequency range:** 30MHz-5000MHz

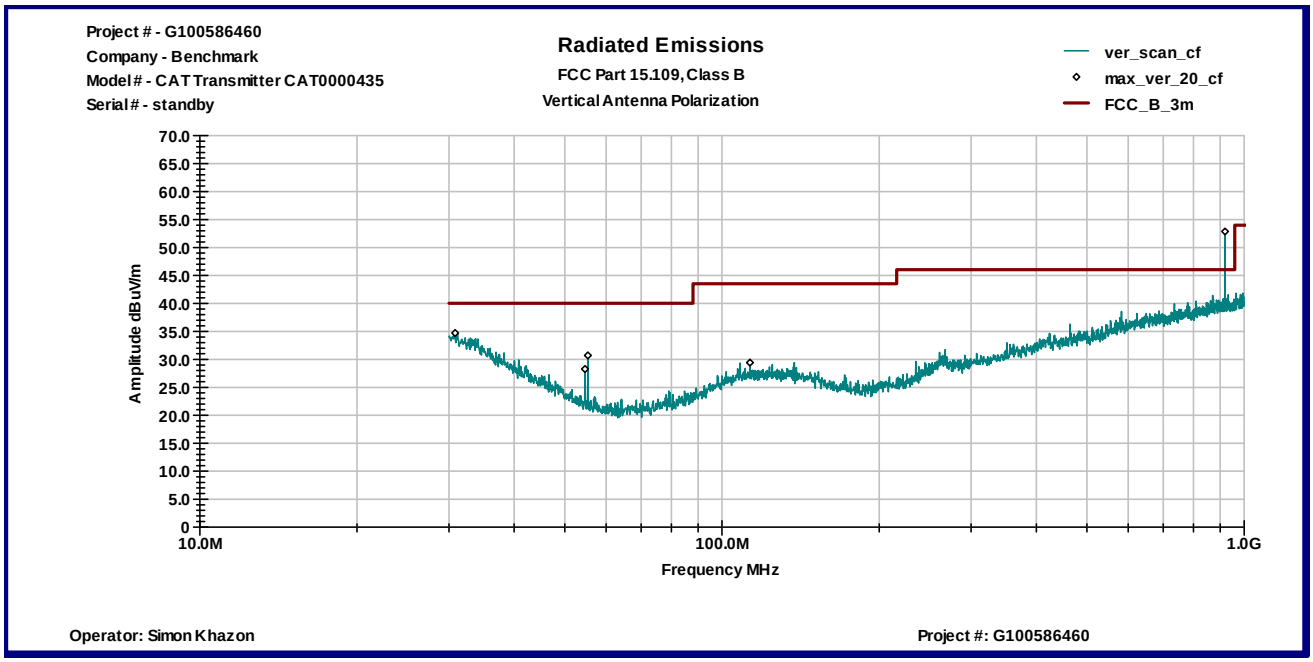
**Max. Emissions margin:** 3.7 dB below the limits

**Notes:** The Radiated Emissions test was performed in the Anechoic chamber at 3m measurement distance (see Table 3.11.1 and Graphs 3.11.1 - 3.11.4)

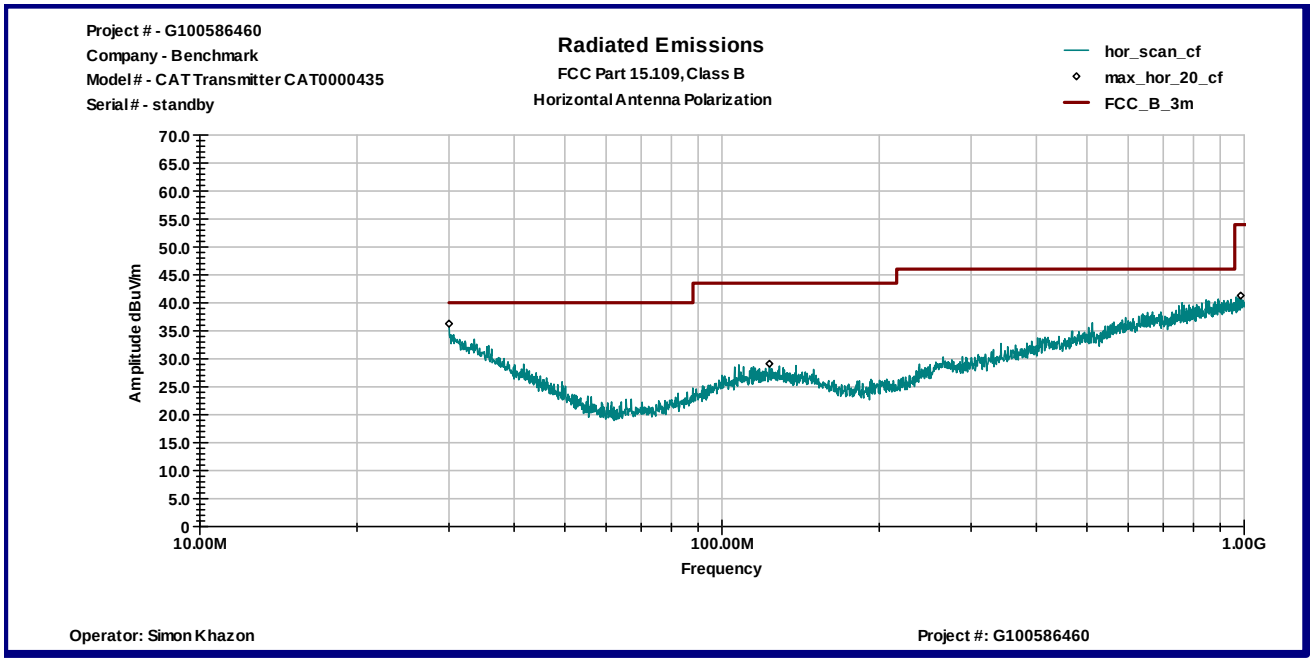
| | | |
|---|---|---|
| **Date:** | January 3, 2012 | **Result:** **Pass** |
| **Standard:** | FCC Part 15.109, Class B | |
| **Tested by:** | Simon Khazon | |
| **Test Point:** | Enclosure | |
| **Operation mode:** | Standby | |
| **Note:** | None | |

**Table 3.8.1**

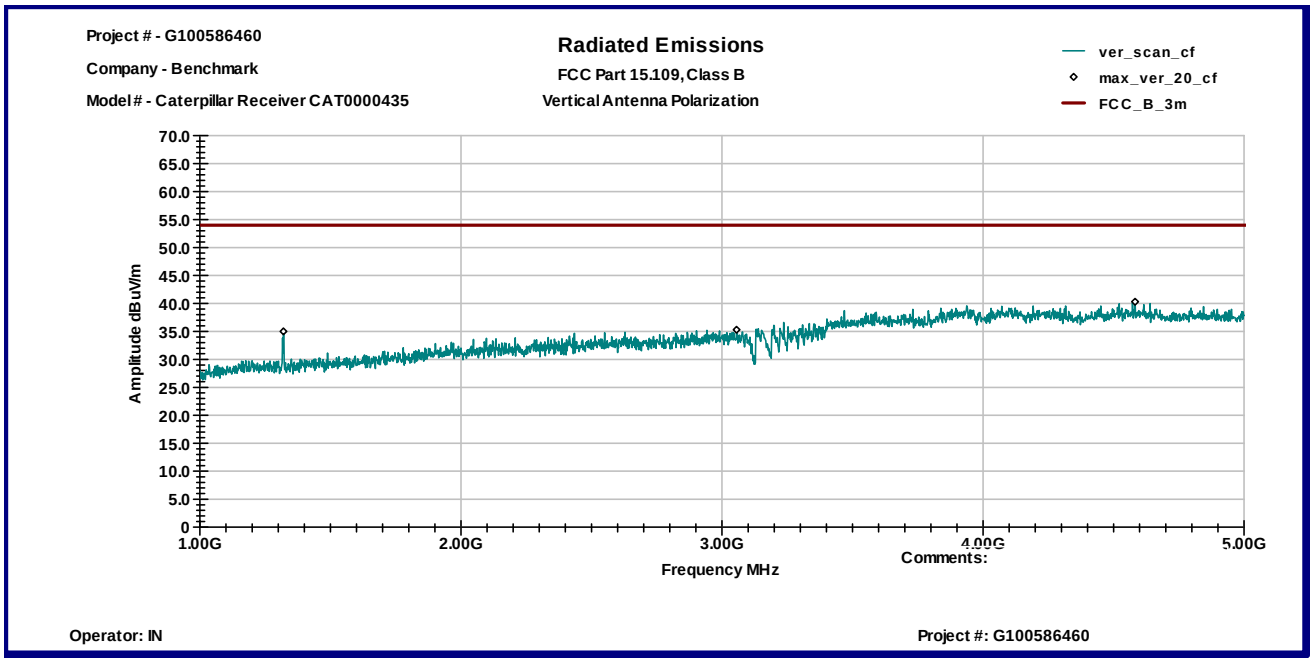
| Frequency MHz | Antenna Polarity | Peak Reading dBµV | Total C.F. dB1/m | Pre-Amp. Gain (dB) | Total at 3m dBµV/m | Limit dBµV/m | Margin dB |
|---|---|---|---|---|---|---|---|
| 30.831 MHz | V | 14.8 | 19.9 | 0.0 | 34.7 | 40.0 | -5.3 |
| 54.659 MHz | V | 19.9 | 8.4 | 0.0 | 28.3 | 40.0 | -11.7 |
| 55.351 MHz | V | 22.5 | 8.2 | 0.0 | 30.7 | 40.0 | -9.3 |
| 113.13 MHz | V | 15.8 | 13.7 | 0.0 | 29.4 | 43.5 | -14.1 |
| 1.32 GHz | V | 50.9 | 27.0 | 42.9 | 35.0 | 54.0 | -19.0 |
| 3.056 GHz | V | 45.3 | 33.7 | 43.8 | 35.3 | 54.0 | -18.7 |
| 4.5824 GHz | V | 45.6 | 36.9 | 42.2 | 40.3 | 54.0 | -13.7 |
| | | | | | | | |
| 30.0 MHz | H | 15.9 | 20.3 | 0.0 | 36.3 | 40.0 | -3.7 |
| 123.28 MHz | H | 15.1 | 14.0 | 0.0 | 29.1 | 43.5 | -14.4 |
| 985.15 MHz | H | 15.1 | 26.2 | 0.0 | 41.3 | 54.0 | -12.7 |
| 4.56 GHz | | 45.9 | 36.9 | 42.2 | 40.6 | 54.0 | -13.4 |
| | | | | | | | |



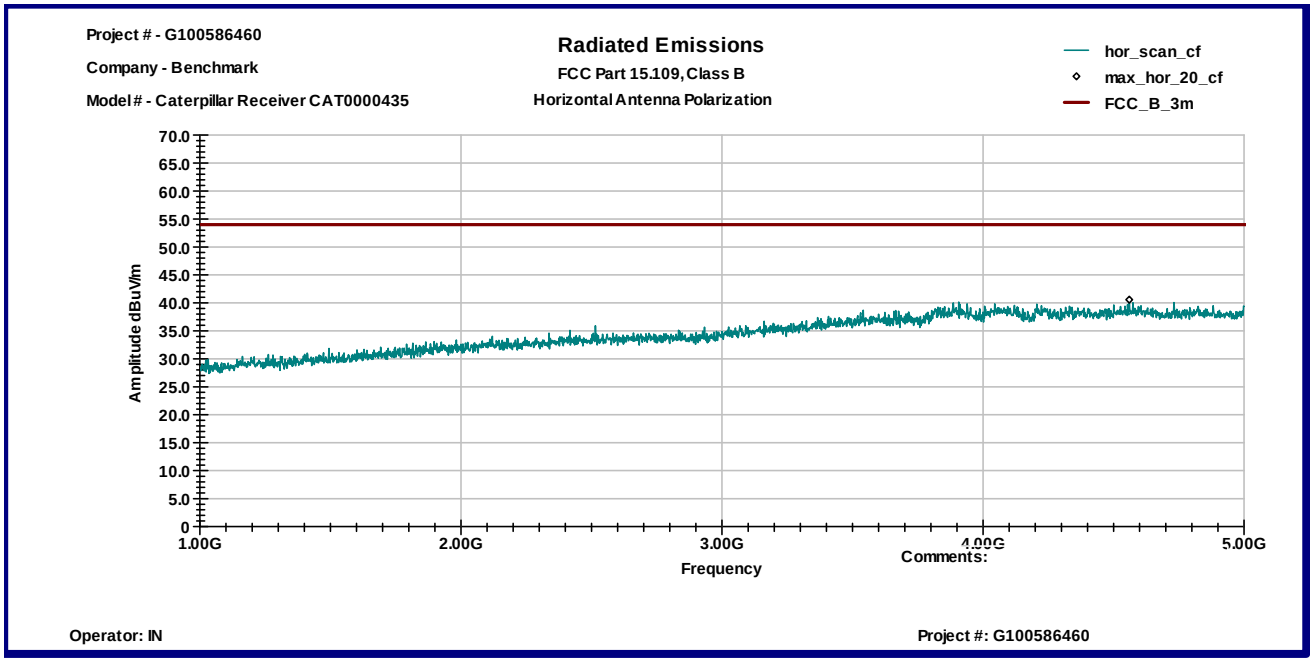

**Graph 3.8.1**




**Graph 3.8.2**




**Graph 3.8.3**




**Graph 3.8.4**

### 3.9 Digital device conducted emissions

**Test location:** ☐ OATS ☐ Anechoic Chamber ☐ Other

**Test result:** **N/A**

**Frequency range:** 0.15MHz-30MHz

**Max. Emissions margin:** dB below the limits

Notes: It was determined from consideration of the electrical characteristics and usage of particular apparatus that Conducted Emissions testing is inappropriate and therefore unnecessary (as battery operated equipment).

## 4.0 TEST EQUIPMENT

| DESCRIPTION | MANUFACTURER | MODEL | SERIAL NO. | INTERTEK ID | CAL DUE | USED |
|---|---|---|---|---|---|---|
| Spectrum Analyzer | R & S | FSP 40 | 100024 | 12559 | 11/17/2012 | ☒ |
| Spectrum Analyzer | R & S | ESCI | 100358 | 12909 | 05/12/2012 | ☒ |
| Bicono-Log Antenna | Schaffner-Chase | CBL 6112 B | 2468 | 9734 | 11/08/2012 | ☒ |
| Horn Antenna | EMCO | 3115 | 9507-4513 | 9936 | 04/29/2012 | ☒ |
| LISN | Fischer Custom Communications | FCC-LISN-2 MOD.SD | 316 | 9945 | 05/26/2012 | ☒ |
| Pre-Amplifier | MITEQ | AMF-5D-00501800-28-13P | 1402232 | 172081 | 10/31/2012 | ☒ |
| System | TILE! Instrument Control | | Ver. 3.4.K.29 | 15259 | VBU | ☒ |