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BSMI Lab ID: SL2-IN-E-3008

FCC Part 15C
Certification Report

for the

IceRobotics Ltd

ICETAG3D Reader
(2.45Hz Transmitter - FCC Part 15.249)

Project Engineer: R. P. St John James

Approval Signatory

Approved signatories: S. M. Connolly ☑ I. P. Kenney ☐ J. A. Jones ☐ I. Kyle ☐

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1.0 DECLARATION

1.1 FCC Part 15C Statement

The Equipment Under Test (EUT), as described and reported within this document, complies with the parts 15.109, 15.209 and 15.249 of the CFR 47:2008 FCC rules in accordance with ANSI C63.4:2003. The EUT operates at frequencies of 127 kHz and 2.45 GHz and complies with part 15C emission requirements.

This report applies to 15.249 of CFR 47. Report 10R100**B** FR applies to part 15.209. As the transmitters are collocated, the same data is common to both reports.

Note: The EUT is a USB powered device and operates in conjunction with a personal computer (PC) or laptop. The EUT is used to read data from battery powered tags collocated with the EUT. The EUT transmits a low power field at 127 kHz. When a tag is brought in close proximity (a few centimetres) to the EUT the 127 kHz field triggers the tag to start transmitting data to the EUT at 2.45 GHz. Both the EUT and the tag transmit and receive to each other at 2.45 GHz.

1.2 Related Submittal(s) Grants

This is a joint application for certification of an ICETAG3D Reader (transmitting at 127 kHz and 2.45 GHz), described in this report, and an ICETAG3D Tag (transmitting at 2.45 GHz), described in the report 08R553**A** FR.

The sections of FCC Part 15 that apply to the EUT are:
15.209 applied to the 127 kHz transmitter (report 10R100**B** FR)
15.249 applied to the 2.45 GHz transmitter (this report)
15.109 applied to the EUT in receive mode and as a PC peripheral.

Note: The ICETAG3D reader in receiver mode and as a PC peripheral complies with part 15B of the FCC rules for unintentional radiators.

1.3 EUT Manufacturer

Trade name:	IceRobotics
Company name:	IceRobotics Ltd
Company address:	Bankhead Steading Bankhead Road South Queensferry Edinburgh EH30 9TF
Manufacturing address:	As above.
Company representative:	Mr Fraser Arnot Tel: +44 (0) 131 541 2010

2.0 EUT DESCRIPTION

2.1 Identity

EUT:	ICETAG3D Reader
Model:	ICETAG3D
Serial numbers:	001 & 30034
Sample build:	Production

2.2 Product Operation

The ICETAG3D is a system for acquiring data on cattle movements and the system consists of the tag (or tags), reader and PC based software application. The ICETAG3D tag is strapped to the leg of an animal for a period of weeks or months and it then gathers data on the physical movement of the animal. Whilst the tag is strapped to the animal the transmitter is turned off. When the tag is removed from the animal it is then placed on the ICETAG3D reader, the 127 kHz field then triggers the tag to start transmitting. The reader and tag then communicate with each other (transmit and receive) at 2.45 GHz, the data is transmitted in a few seconds and the tag transmitter is then turned off. In the 2.45 GHz band the ICETAG3D reader will automatically switch it's transmit frequency to another frequency if it is unable to communicate with the tag, the assigned frequencies are 2.4060, 2.4426 and 2.4737 GHz. The ICETAG3D software does not allow the user to change these frequencies or select any other frequencies.

The ICETAG3D reader is a USB powered device and transmits/receives with its sister device the ICETAG3D tag at 2.45 GHz. The ICETAG3D reader also transmits at 127 kHz, this triggers the tag when it is brought into close proximity to the reader. The ICETAG3D reader and ICETAGE3D tag were therefore tested collocated when in transmit mode. The ICETAG3D reader was tested separately when in receive/standby mode. The ICETAG3D reader is a USB powered by a PC and was therefore tested connected to a Laptop PC.

2.3 Support Equipment

SUPPORTING EQUIPMENT	PART/MODEL NUMBER	SERIAL NUMBER
Lenovo Laptop	0769	L3-MR948 & L3-V6026
Lenovo Power Supply	92P1158	11S92P1158Z1ZD2H83K7GA & 11592P1158Z1ZD2H83K1WV
IceRobotics Tag	ICETAG3D	301-11560 & 301-11436

2.4 Exerciser Program

For the purposes of measurement the ICETAG3D reader and ICETAG3D tag were placed in a mode of continuously transmit and receive. In normal operation they would only transmit for a few seconds every few weeks or months.

3.0 MEASUREMENT PROCEDURE AND INSTRUMENTATION

3.1 EMI Site Address & Test Date

EMI Company Offices	Hursley EMC Services Ltd Unit 16, Brickfield Lane, Chandlers Ford, Hampshire
EMI Measurement Site	Hursley EMC Services Ltd Hursley Park, Winchester; FCC Registered UK Designation number: UK0006
Test Dates	10th to the 12th December 2008 & 15th to the 16th February 2010
HEMCS References:	08R553 & 10R100

3.2 General Operating Conditions

Testing was performed according to the procedures in ANSI C63.4:2003. Final radiated testing was performed at a EUT to antenna distance of three metres (above 30 MHz).

Below 30 MHz the EUT was measured at an antenna distance of three and six metres and the extrapolation factor calculated.

Instrumentation, including receiver and spectrum analyser bandwidth, comply with the requirements of ANSI C63.2:1996.

3.3 Environmental Ambient

Test Type	Temperature	Humidity	Atmospheric Pressure
Radiated	18 to 24 degrees Celsius	32 to 43% relative	1002 to 1010 millibars

3.4 Radiated Emissions

Initial Scan

A radiated profile scan was taken at a three metre distance on eight azimuths of the system under test in both vertical and horizontal polarities of the antenna in a semi-anechoic chamber. Instrumentation used in the chamber as below:

#ID	CP	Manufacturer	Type	Serial No	Description	Calibration due date
006	1	HP	8568B	2841A04350	Spectrum analyser	08/01/2011
009	1	HP	8447D	1937A01808	Pre-amplifier (30-1000MHz)	15/07/2010
011	2.0	Q-par Angus	QSH20S20S	4350	Horn antenna (18-26.5GHz)	23/03/2010
013	0	Schaffner	CBL6140A	1235	Antenna X-wing (20-2000MHz)	*12/12/2009
021	1	Rohde Schwarz	ESIB	100192	Test receiver (40GHz)	22/02/2011
047	1	Rohde Schwarz	HFH2-Z2	879021/22	Loop antenna (9kHz-30MHz)	16/02/2010
053	1	HP+short cable	8449B	3008A01394	Pre-amplifier (1.0-26.5GHz)	*03/02/2010
071	1	Q-par Angus	WBH218HN	2895	Horn antenna (2-18GHz)	03/11/2010
091	2	ATM	E4888/911	CF210K	K' 10.5m cable assy (26.5GHz)	23/03/2010
127	1	Schwarzbeck	BBHA9120B	391	Horn antenna (1-10GHz)	15/12/2010
240	1	Sucoflex	106	52427/6	Cable SMA (18GHz)	01/02/2011

The EUT was measured in two configurations; with the EUT horizontal and with the EUT vertical.

The data obtained from the profile scan was used as a guide for the final Open Area Test Site (OATS) measurements.

Final Measurements

The system under test was transferred to the OATS from the semi-anechoic chamber. The data obtained from the chamber profile-scan was used to guide the test engineer. Above 30 MHz, each emission from the transmitter was maximised by revolving the system on the turntable and moving the antennae in height and azimuth. Below 30 MHz the loop antenna was set at a height of 1m, the EUT was measured with the antenna in the vertical and horizontal polarity and each emission was maximised by revolving the system on the turntable. The worst-case data is presented in this report. Test instrumentation used in the OAT's measurements was as follows:

#ID	CP	Manufacturer	Type	Serial No	Description	Calibration due date
002	1	Rohde Schwarz	ESH-3	872317/037	Test receiver (9kHz-30MHz)	01/05/2010
033	1	HP	8593EM	3726U00203	Spectrum analyser (9kHz-26.5GHz)	23/02/2010
047	1	Rohde Schwarz	HFH2-Z2	879021/22	Loop antenna (9kHz-30MHz)	16/02/2010
053	1	HP	8449B	3008A01394	Pre-amplifier (1.0-26.5GHz)	03/02/2010
073	1+	Schwarzbeck	BBHA9120B	237	Horn antenna (1-10GHz)	*23/01/2010
092	1.5	Schwarzbeck	VULB 9163	232 (grey)	Trilog antenna (30-3000MHz)	03/02/2011
105	1	Tektronix	TDS3032B	B0141694	Oscilloscope (300MHz)	Internal
240	1	Sucoflex	106	52427/6	Cable SMA (18GHz)	01/02/2011
241	1	Rohde Schwarz	ESVP	879962/049	Test receiver (30-1300MHz)	22/02/2011

CP = Interval period [year] prescribed for external calibrations

Note: 'Calibration due date' means that the instrument is certified with a UKAS or traceable calibration certificate.
'Internal' means internally calibrated using HEMCS procedures
'*' denotes that the calibration, as defined by Hursley EMC Services quality system, remains valid whilst within three calendar months of the due date.

3.5 Conducted Emissions

Test Configuration

A filtered 115V/60Hz supply was fed to the system under test, via a 50Ω/50µH Line Impedance Stabilisation Network (LISN). The LISN was directly bonded to a conductive ground plane.

Test Measurement

The worst-case emissions were identified on both the neutral and phase(s) with a spectrum analyser set to scan from 0.15 MHz to 30 MHz.

The worst-case peaks were then identified and measured using an RF receiver using a quasi-peak detector and compared to the frequency range and limits of CISPR 22 as specified by ANSI C63.4-2003. Quasi-peak values that exceeded the average limit were then re-measured using the average signal detector.

The worst-case results are presented in this report.

Test instrumentation used in the conducted test was as follows:

#ID	CP	Manufacturer	Type	Serial No	Description	Calibration due date
002	1	Rohde Schwarz	ESH-3	872317/037	Test receiver (9kHz-30MHz)	14/04/2009
007	1	HP	8568B	1921A00797	Spectrum analyser	13/10/2009
239	1	Rohde Schwarz	ENV216	100016	LISN - single phase	14/04/2009

CP = Interval period [year] prescribed for external calibrations

Note: 'Calibration due date' means that the instrument is certified with a UKAS or traceable calibration certificate.

4.0 TEST DATA

4.1 Power Line Conducted Emissions

4.1.1 Data

A search was made of the frequency spectrum between 0.15 MHz to 30 MHz and the measurements reported here are the highest emissions relative to the CISPR 22 Class B limits. Emissions that meet the average limit on a quasi-peak measurement are deemed to meet both the average and quasi-peak specification.

MAINS – LINE

Frequency (MHz)	Quasi-peak value (dBµV)		Average value (dBµV)		Status
	Measured	Limit	Measured	Limit	
0.191	44.9	64.0	11.1	54.0	Pass
0.254	36.8	61.6	8.4	51.6	Pass
0.339	34.7	59.2	13.4	49.2	Pass

MAINS – NEUTRAL

Frequency (MHz)	Quasi-peak value (dBµV)		Average value (dBµV)		Status
	Measured	Limit	Measured	Limit	
0.188	45.8	64.1	12.8	54.1	Pass
0.252	38.9	61.6	11.6	51.6	Pass
0.341	31.4	59.2	12.3	49.2	Pass

Uncertainty of measurement: ± 3.22dBµV for a 95% confidence level.

Measurements made according to the FCC rules and Hursley EMC Services test procedure CON-02.

TEST ENGINEER: Andy Jones

4.2 FCC – Radiated Emissions (Transmitting)

A search was made of the frequency spectrum from 9 kHz to 26.5 GHz and the measurements reported are the highest emissions relative to the 'FCC CFR 47 Section 15.209 and 15.249 Limits' at a measuring distance of three metres. Below 30 MHz the results have been extrapolated from measurements made at a distance of three and six metres to the limit distance set at 300m.

Below 30 MHz the EUT was connected to the laptop via a 5m USB extension lead so that only the emission from the EUT was measured. Above 30 MHz the EUT was tested together with the laptop. To calculate the extrapolation factor (see FCC Part 15.31) measurements were made at three metres and six metres from the EUT. The extrapolation factor (x) was then calculated as follows:

$$x = \frac{E_1 - E_2}{20\text{Log}\,(d_2 / d_1)}$$

Where (E) is the receiver reading at the distance (d) from the EUT. The extrapolation factor (x) is then used to calculate the extrapolated result at the limit distance.

Between 110 and 490 kHz measurements were made using an average & peak detector with a 200 Hz bandwidth.

AVERAGE RESULTS - 9 kHz to 30 MHz

	Measured amplitude (E_1)	Measured amplitude (E_2)	Extrapolation	Calculated amplitude @ 300m		Specified limit @ 300m	
MHz	**dBµV/m @3m (d_1)**	**dBµV/m @6m (d_2)**	**Factor (x)**	**dBµV/m**	**µV/m**	**dBµV/m**	**µV/m**
0.1277*	44.8	30.6	2.4	-51.2	0.003	25.5	19

*Transmitter frequency

The limit at 127 kHz is calculated from FCC 15.209 as $\frac{2400}{127}$ = 19µV/m.

The average extrapolation factor is calculated as $\frac{44.8 - 30.6}{20 \text{ Log } (6/3)}$ = 2.4

The calculated average amplitude is 44.8 – (20 x 2.4 x Log (300 / 3)) = -51.2 dBµV/m

PEAK RESULTS - 9 kHz to 30 MHz

	Measured amplitude (E_1)	Measured amplitude (E_2)	Extrapolation	Calculated amplitude @ 300m		Specified limit @ 300m	
MHz	**dBµV/m @3m (d_1)**	**dBµV/m @6m (d_2)**	**Factor (x)**	**dBµV/m**	**µV/m**	**dBµV/m**	**µV/m**
0.1277*	51.9	38.5	2.2	-36.1	0.016	45.5	188

*Transmitter frequency

The extrapolation factor and amplitude was calculated as above for the average results.
The peak limit is 20dB higher than the average limit.

Radiated emissions (continued)

RESULTS - 30 MHz to 1000 MHz

Frequency	Receiver amplitude	Antenna factor	Cable loss	Actual quasi-peak value @ 3m		Specified limit @ 3m	
MHz	dBµV	dB	dB	dBµV/m	µV/m	dBµV/m	µV/m
48.00	20.4	8.3	0.6	29.3	29	40.0	100
147.50	15.8	10.1	1.1	27.0	22	43.5	150
156.28	20.2	9.7	1.1	31.0	36	43.5	150
185.35	21.7	11.1	1.6	34.4	53	43.5	150
215.18	24.9	10.5	1.7	37.1	72	43.5	150
294.03	1.4	13.0	1.5	15.9	6	46.0	200
367.74	-2.7	14.9	1.7	13.9	5	46.0	200
444.01	7.8	16.4	1.9	26.1	20	46.0	200
590.02	-6.6	18.7	2.4	14.5	5	46.0	200

RESULTS - 1.0 GHz to 26.5 GHz (middle frequency)

Frequency	Receiver amplitude	Antenna factor	Cable loss	Pre-amp gain	Actual average value @ 3m		Specified average limit @ 3m	
GHz	dBµV	dB	dB	dB	dBµV/m	µV/m	dBµV/m	µV/m
2.4426*	73.3	26.6	2.5	38.4	64.0	1585	94.0	50,000
4.8852	42.4	28.7	3.7	37.0	37.8	78	54.0	500
7.3282	37.7	33.0	4.7	37.4	38.0	79	54.0	500
9.7710	39.7	31.3	5.5	37.8	38.7	86	54.0	500

Frequency	Receiver amplitude	Antenna factor	Cable loss	Pre-amp gain	Actual peak value @ 3m		Specified limit @ 3m	
GHz	dBµV	dB	dB	dB	dBµV/m	µV/m	dBµV/m	µV/m
2.4426*	103.5	26.6	2.5	38.4	94.2	51286	114.0	500,000
4.8852	58.5	28.7	3.7	37.0	53.9	496	74.0	5,000
7.3282	56.7	33.0	4.7	37.4	57.0	708	74.0	5,000
9.7710	54.6	31.3	5.5	37.8	53.6	479	74.0	5,000

Radiated emissions (continued)

RESULTS 1.0 GHz to 26.5 GHz (upper frequency)

Frequency	Receiver amplitude	Antenna factor	Cable loss	Pre-amp gain	Actual average value @ 3m		Specified limit @ 3m	
GHz	dBµV	dB	dB	dB	dBµV/m	µV/m	dBµV/m	µV/m
2.474*	71.1	26.6	2.5	38.4	61.8	1,230	94.0	50,000
4.949	35.4	29.0	3.8	37.0	31.2	36.3	54.0	500
7.424	33.6	32.4	4.7	37.5	33.2	45.7	54.0	500
9.899	35.4	32.7	5.5	37.9	35.7	61.0	54.0	500

Frequency	Receiver amplitude	Antenna factor	Cable loss	Pre-amp gain	Actual peak value @ 3m		Specified limit @ 3m	
GHz	dBµV	dB	dB	dB	dBµV/m	µV/m	dBµV/m	µV/m
2.474*	103.0	26.6	2.5	38.4	93.7	48417	114.0	500,000
4.949	59.3	29.0	3.8	37.0	55.1	568.9	74.0	5,000
7.424	56.2	32.4	4.7	37.5	55.8	616.6	74.0	5,000
9.899	55.1	32.7	5.5	37.9	55.4	588.8	74.0	5,000

RESULTS - 1.0 GHz to 26.5 GHz (lower frequency)

Frequency	Receiver amplitude	Antenna factor	Cable loss	Pre-amp gain	Actual average value @ 3m		Specified limit @ 3m	
GHz	dBµV	dB	dB	dB	dBµV/m	µV/m	dBµV/m	µV/m
2.406*	77.1	26.6	2.5	38.4	67.8	2455	94.0	50,000
4.811	39.0	28.7	3.7	37.0	34.4	52.5	54.0	500
7.218	31.6	33.0	4.6	37.4	31.8	38.9	54.0	500
9.624	35.3	30.8	5.5	37.8	33.8	49.0	54.0	500

Frequency	Receiver amplitude	Antenna factor	Cable loss	Pre-amp gain	Actual peak value @ 3m		Specified limit @ 3m	
GHz	dBµV	dB	dB	dB	dBµV/m	µV/m	dBµV/m	µV/m
2.406*	108.3	26.6	2.5	38.4	99.0	89125	114.0	500,000
4.811	63.1	28.7	3.7	37.0	58.5	841.4	74.0	5,000
7.218	52.9	33.0	4.6	37.4	53.1	451.9	74.0	5,000
9.624	57.2	30.8	5.5	37.8	55.7	609.5	74.0	5,000

*Transmitter frequency

Note: To confirm the average results an oscilloscope was connected to the video out on the spectrum analyzer and the duty cycle was measured according to the method described by ANSI C63.4 H.4.J. The duty cycle was measured as (1.5ms x 2) / 100ms = 0.03 which equates to -30.5dB.

The average results given above are measured. The average results can also be derived from the peak value by deducting the duty cycle factor (calculated as 30.5dB) from the peak results.

Procedure: In accordance with ANSI C63.4:2003.

Measurements below 1.0 GHz performed with a quasi-peak detector (120kHz Bandwidth). Measurements above 1.0 GHz performed with an average and peak detector (1MHz Bandwidth).

TEST ENGINEERS: Rob St John James & Andy Jones

4.3 FCC – Radiated Emissions (Receive Mode)

A search was made of the frequency spectrum from 30 MHz to 26.5 GHz and the measurements reported are the highest emissions relative to the 'FCC CFR 47 Section 15.109 Limits' at a measuring distance of three metres. The limits below 30 MHz have been extrapolated to three metres.

RESULTS 30 MHz to 1000 MHz

Frequency	Receiver amplitude	Antenna factor	Cable loss	Actual quasi-peak value @ 3m		Specified limit @ 3m	
MHz	dBµV	dB	dB	dBµV/m	µV/m	dBµV/m	µV/m
136.25	17.0	11.1	1.1	29.2	29	43.5	150
153.84	18.2	9.8	1.1	29.1	29	43.5	150
276.99	16.7	12.6	1.4	30.7	34	46.0	200
295.04	2.8	13.0	1.5	17.3	7	46.0	200
367.30	-5.2	14.9	1.7	11.4	4	46.0	200
440.41	-2.3	16.5	1.9	16.1	6	46.0	200

RESULTS 1.0 GHz to 26.5 GHz

Frequency	Receiver amplitude	Antenna factor	Cable loss	Actual average value @ 3m		Specified average limit @ 3m	
GHz	dBµV	dB	dB	dBµV/m	µV/m	dBµV/m	µV/m
2.4629	-2.4	26.84	2.40	26.8	22	54.0	500
4.8826	13.3	28.55	3.64	45.5	188	54.0	500

Frequency	Receiver amplitude	Antenna factor	Cable loss	Actual peak value @ 3m		Specified limit @ 3m	
GHz	dBµV	dB	dB	dBµV/m	µV/m	dBµV/m	µV/m
2.4629	13.9	26.84	2.40	43.1	143	74.0	5,000
4.8826	17.6	28.55	3.64	49.8	309	74.0	5,000

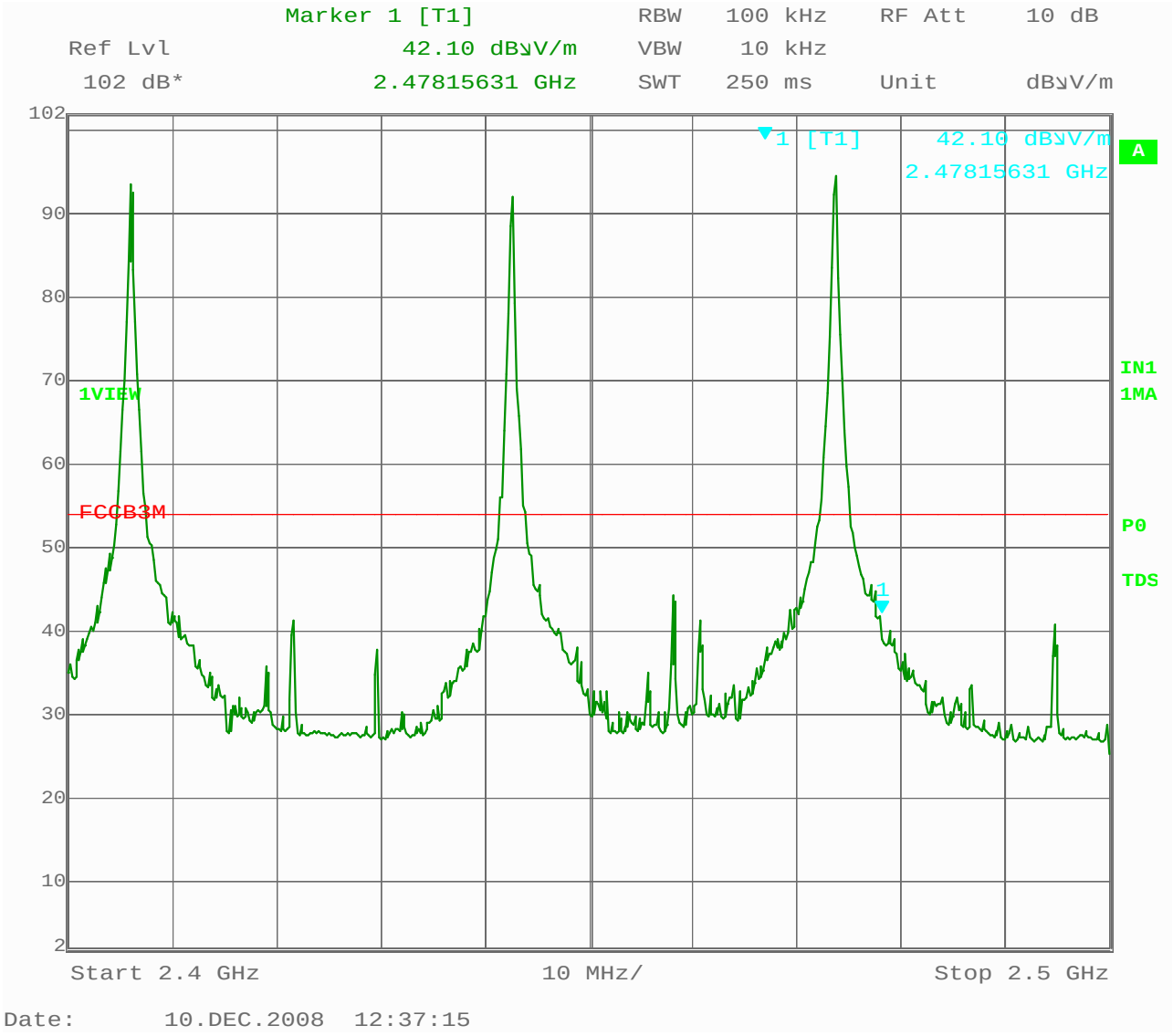
Procedure: In accordance with ANSI C63.4:2003

Measurements below 1000MHz performed with a quasi-peak detector. Measurements above 1000MHz performed with an average and peak detector.

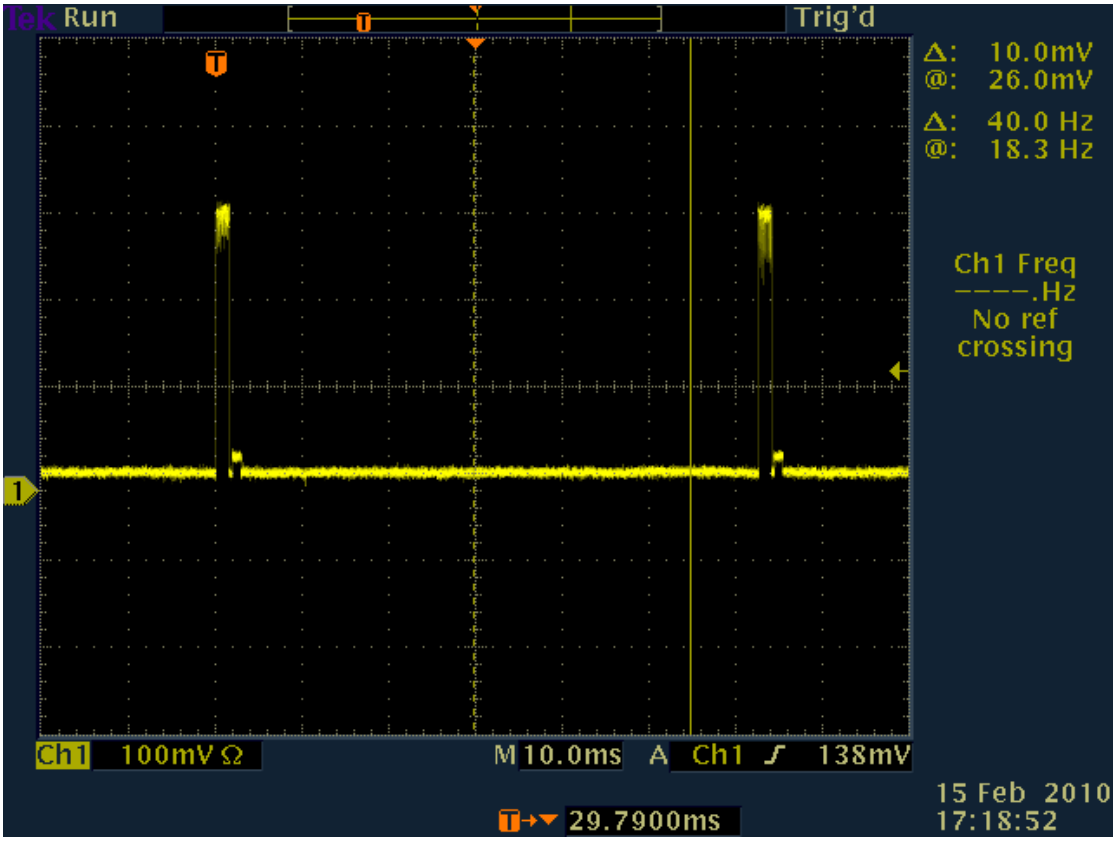
TEST ENGINEERS: Rob St John James & Andy Jones

4.4 FCC –Transmitter Emissions Plot (Occupied Band)

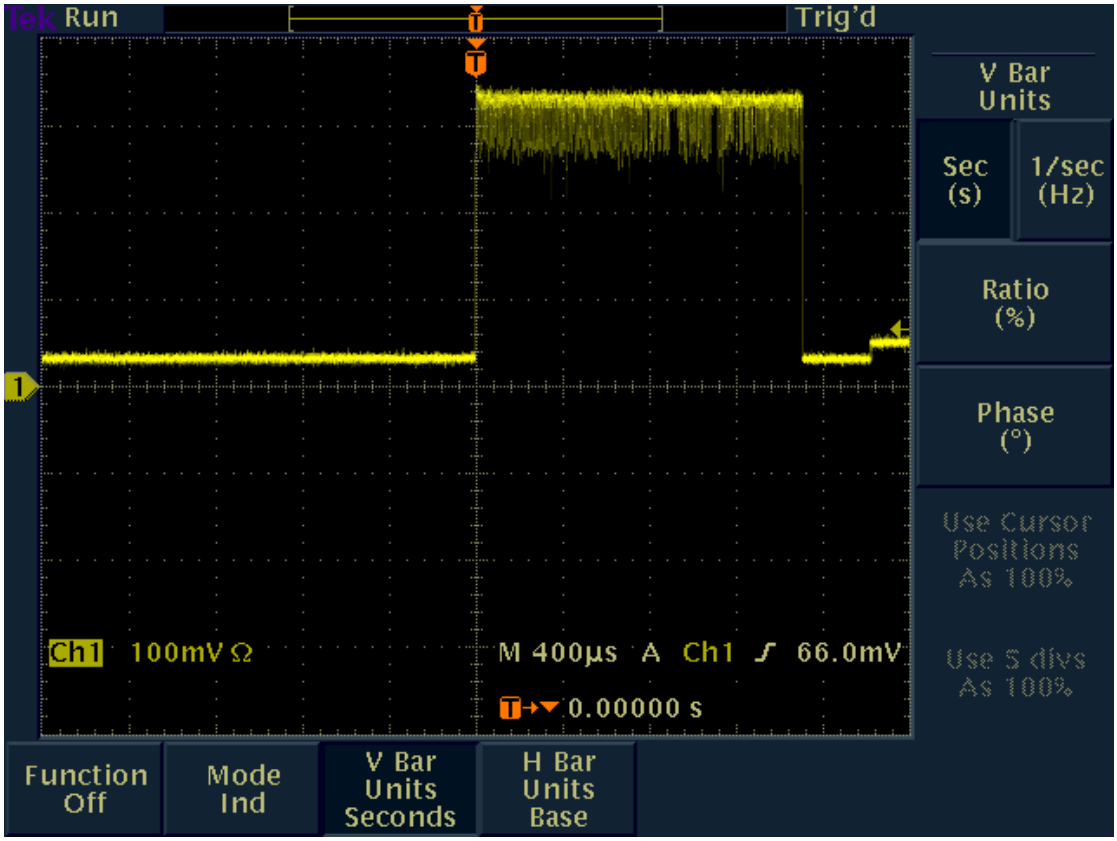
Max Hold Scan showing the three different transmitter frequencies within the 2.4 to 2.4835 GHz Band.



4.5 Duty Cycle Plots (Pulse Train)



4.6 Duty Cycle Plots (ON Time)



5.0 FCC DETAILS

FEDERAL COMMUNICATIONS COMMISSION

Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046

February 13, 2006

Hursley EMC Services Ltd.
Unit 16
Brickfield Lane
Chandlers Ford - Hampshire, SO53 4DB
United Kingdom
Attention: R P St John James

Re: Accreditation of Hursley EMC Services Ltd.
Designation Number: UK0006

Dear Sir or Madam:

We have been notified by Department of Trade and Industry (DTI) that Hursley EMC Services Ltd. has been accredited as a Conformity Assessment Body (CAB).

At this time your organization is hereby designated to perform compliance testing on equipment subject to Declaration Of Conformity (DOC) and Certification under Parts 15 and 18 of the Commission's Rules.

This designation will expire upon expiration of the accreditation or notification of withdrawal of designation.

Sincerely,

Thomas Phillips
Electronics Engineer