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RADIO REPORT FOR CERTIFICATION
FCC PART 15 Subpart C (Section 15.225)

Client: FE Technologies Pty. Ltd.
Test Sample: Smart Bin

FCC ID: 2AM6N-FE-SMRTBIN

Report Number: M170210-1R1
(This report supersedes report M170210-1)
Issue Date: 29 March 2018

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RADIO REPORT FOR CERTIFICATION
FCC Part 15 Subpart C (Section 15.225)

CONTENTS

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RADIO REPORT FOR CERTIFICATION

Issued by: EMC Technologies Pty. Ltd.,
Address: 176 Harrick Road, Keilor Park, VIC 3042, Australia.
Phone: +61 3 9365 1000, **E-mail:** sales@emctech.com.au, **Web:** www.emctech.com.au
FCC registration number: 494713, Designation number AU0001 and ISED Canada iOATS number: IC 3569B

Sample:	Smart Bin
Manufacturer:	FE Technologies Pty. Ltd.
FCC ID:	2AM6N-FE-SMRTBIN
Equipment Type:	Intentional Radiator (13.56 MHz Transceiver)
Tested for:	FE Technologies Pty. Ltd.
Address:	129 Fyans Street, Geelong VIC 3220, Australia
Phone:	+61 1300 731 991
Contact:	Clint Agustsson
Email:	clint@fetechgroup.com
Standard:	**CFR FCC Part 15 –** *Radio Frequency Devices* **Subpart C –** *Intentional Radiators* **Section 15.225 –** *Operation within the band 13.110-14.010 MHz*
Result:	The Smart Bin complied with the applicable FCC Part 15C. Refer to Report M170210-1 for full details.
Test Dates:	14th January to 16th February 2016 19th March 2018 (frequency stability test)
Issue Date:	29 March 2018
Test Engineer:	Larry Phuah
Authorised Signatory:	Chris Zombolas Technical Director EMC TECHNOLOGIES PTY LTD
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.*

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FCC PART 15 SUBPART C (SECTION 15.225)

1.0 INTRODUCTION

Test results and procedures were performed in accordance with applicable Federal Communications Commission (FCC) standards/regulations for a transmitter operating in the 13.56 MHz band.

1.1 Test Procedure

The measurement procedure used was in accordance with ANSI C63.10: 2013. The instrumentation conformed to the requirements of ANSI C63.2: 2009.

1.2 Summary of Results

FCC Part 15C	Test Performed	Results
15.203	Antenna Requirement	**Complied**
15.207	Conducted Limits	**Complied**
15.209	Radiated Emissions Limits; General Requirements	**Complied**
15.225(a)	Fundamental Field Strength	**Complied**
15.225(b and c)	Transmission Mask 13.110-14.010 MHz	**Complied**
15.225(d)	Spurious Emissions	**Complied**
15.225(e)	Frequency Tolerance	**Complied**
2.1049	Occupied Bandwidth	**680 Hz**

The sample **complied** with the requirements of 47 CFR, Part 15 Subpart C - Section 15.225.

1.3 Modifications by EMC Technologies

No modifications were performed.

2.0 GENERAL INFORMATION

2.1 EUT (Transmitter) Details

Wireless Radio:	13.56 MHz RFID
Operating band:	13.110 MHz to 14.010 MHz
Modulation type:	ASK
Antenna type:	Loop antenna

2.2 EUT (Host) Details

Test Sample:	Testsample
Manufacturer:	FE Technologies Pty. Ltd.
Supply Rating:	100-240 VAC, 1.2 A, 50/60 Hz

2.3 Test Configuration

The sample was programmed to transmit a modulated RFID signal continuously.

The test sample was a library multiple returns bin. It allowed for multiple items to be returned and automatically read and checked in items whilst changing the security status from off to on.

2.4 Test Facility

2.4.1 General

EMC Technologies Pty Ltd has also been accredited as a Conformity Assessment Body (CAB) by Australian Communications and Media Authority (ACMA) under the APECTEL MRA and is designated to perform compliance testing on equipment subject to Declaration of Conformity (DoC) and Certification under Parts 15 and 18 of the FCC Commission's rules – **Registration Number 494713 & Designation number AU0001.**

EMC Technologies indoor open are test site (iOATS) have been accepted by Industry Canada for the performance of radiated measurements in accordance with RSS-Gen, Issue 8 - **Industry Canada iOATS number - IC 3569B**

Measurements in this report were performed at EMC Technologies' laboratory in Keilor Park, Victoria Australia.

2.4.2 NATA Accreditation

NATA is the Australian National laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO 17025 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).

EMC Technologies is accredited in Australia by the National Association of Testing Authorities (NATA). All testing in this report has been conducted in accordance with EMC Technologies' scope of NATA accreditation.

The current full scope of accreditation can be found on the NATA website: www.nata.asn.au

2.5 Test Equipment Calibration

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) or in-house. All equipment calibration is traceable to Australian national standards at the National Measurements Institute.

Equipment Type	Make/Model/Serial Number	Last Cal. dd/mm/yy	Due Date dd/mm/yy	Cal. Interval
Chamber	Frankonia SAC-10-2 (R-139)	8/01/2016	8/01/2017	1 Year, *1
EMI Receiver	R&S ESU40 20 Hz – 40 GHz Sn: 100392 (R-140)	19/11/2015	19/11/2016	1 Year, *2
	R&S ESCI (*Frequency Stability Test*) 9 kHz - 3 GHz Sn: 100011 (R-028)	13/06/2017	13/06/2018	1 Year, *2
Antennas	EMCO 6502 Active Loop 9kHz – 30MHz Sn. 9311-2801 (A-231)	20/07/2015	20/07/2018	3 Year, *2
	SUNOL JB6 BICONILOG 30 – 6000 MHz Sn. A012312 (A-363)	26/05/2016	26/05/2018	2 Year, *2
Cables	Room 12 inbuilt cable Panel 1 to 10m (C-422)	09/05/2016	09/05/2017	1 Year, *1
	Room 12 Antenna cable (C-437)	09/05/2016	09/05/2017	1 Year, *1

Note *1. Internal NATA calibration.
Note *2. External NATA / A2LA calibration

3.0 TEST RESULTS

3.1 §15.203 Antenna Requirement

An internal, permanently attached antenna was incorporated within the Smart Bin ensuring that it could not be replaced.

3.2 §15.207 Conducted Limits

3.2.1 Test Procedure

The arrangement specified in ANSI C63.10: 2013 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: 2009 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 short duration peaks were captured.

3.2.2 Peak Maximising 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 and the Average detector were then used to measure the actual Quasi-Peak and Average level of the most significant peaks detected.

3.2.3 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 LISN, cables and limiter.

3.2.4 Plotting of Conducted Emission Measurement Data

The measurement data pertaining to each frequency sub-range were 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 graph.

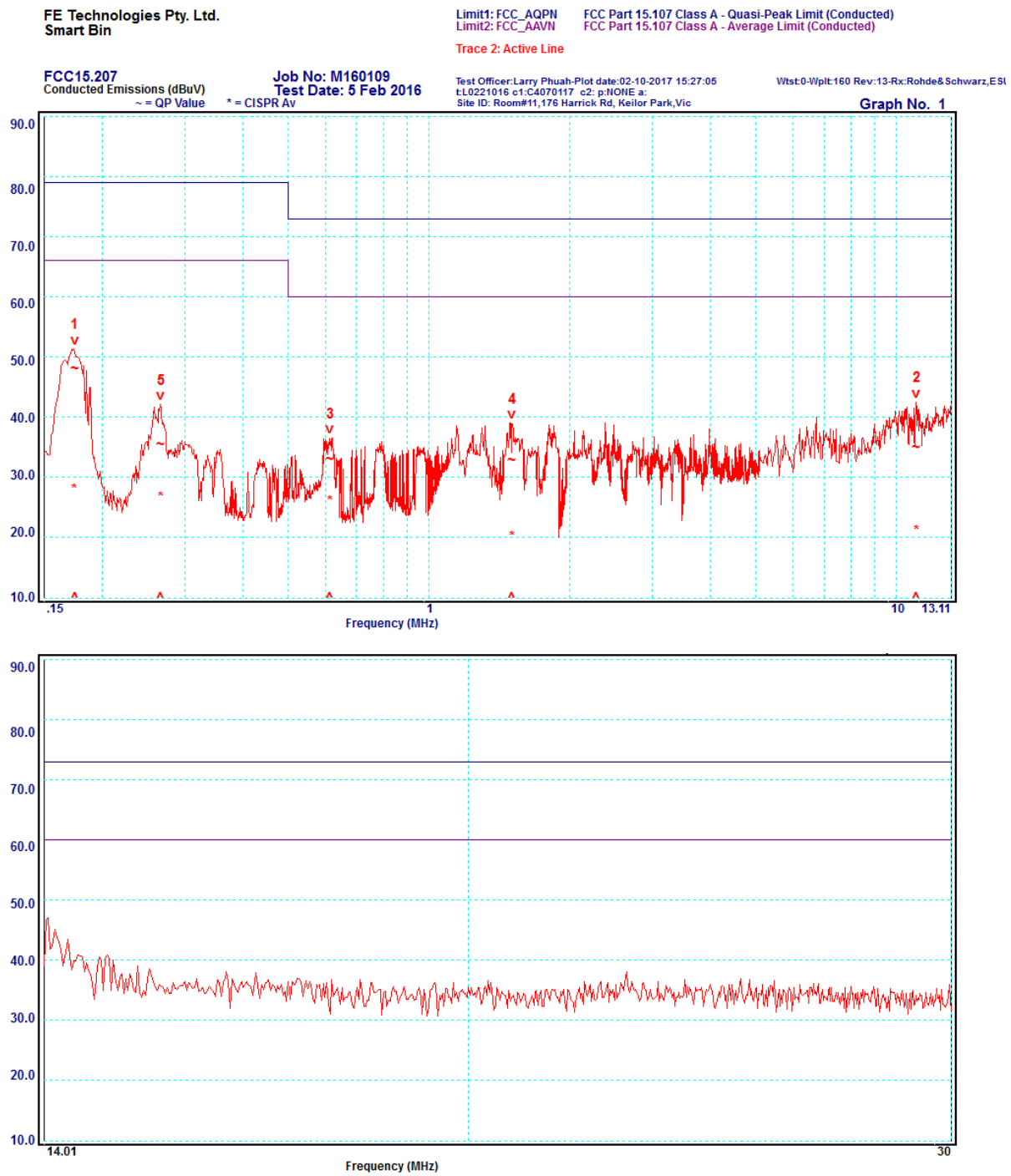
3.2.5 Results of Conducted Emission Measurement

Shielded Room Temperature: 22°C
Relative Humidity: 73%

The host device was deemed a Class A product and therefore in accordance with §15.31(k) the appropriate limits of §15.107 were applied.

The highest conducted emission measured was more than 10 dBµV below the quasi-peak and average limits as outlined in §15.207. All other measured peaks were below this point.

3.2.5.1 Active Line



Peak	Frequency [MHz]	Line	Quasi-Peak			Average		
			Level [dBµV]	Limit [dBµV]	Margin [±dB]	Level [dBµV]	Limit [dBµV]	Margin [±dB]
1	0.175	Active	48.0	79.0	-31.0	27.9	66.0	-38.1
2	11.04	Active	35.0	73.0	-38.0	21.0	60.0	-39.0
3	0.615	Active	33.0	73.0	-40.0	26.0	60.0	-34.0
4	1.509	Active	32.8	73.0	-40.2	20.1	60.0	-39.9
5	0.267	Active	35.5	79.0	-43.5	26.7	66.0	-39.3

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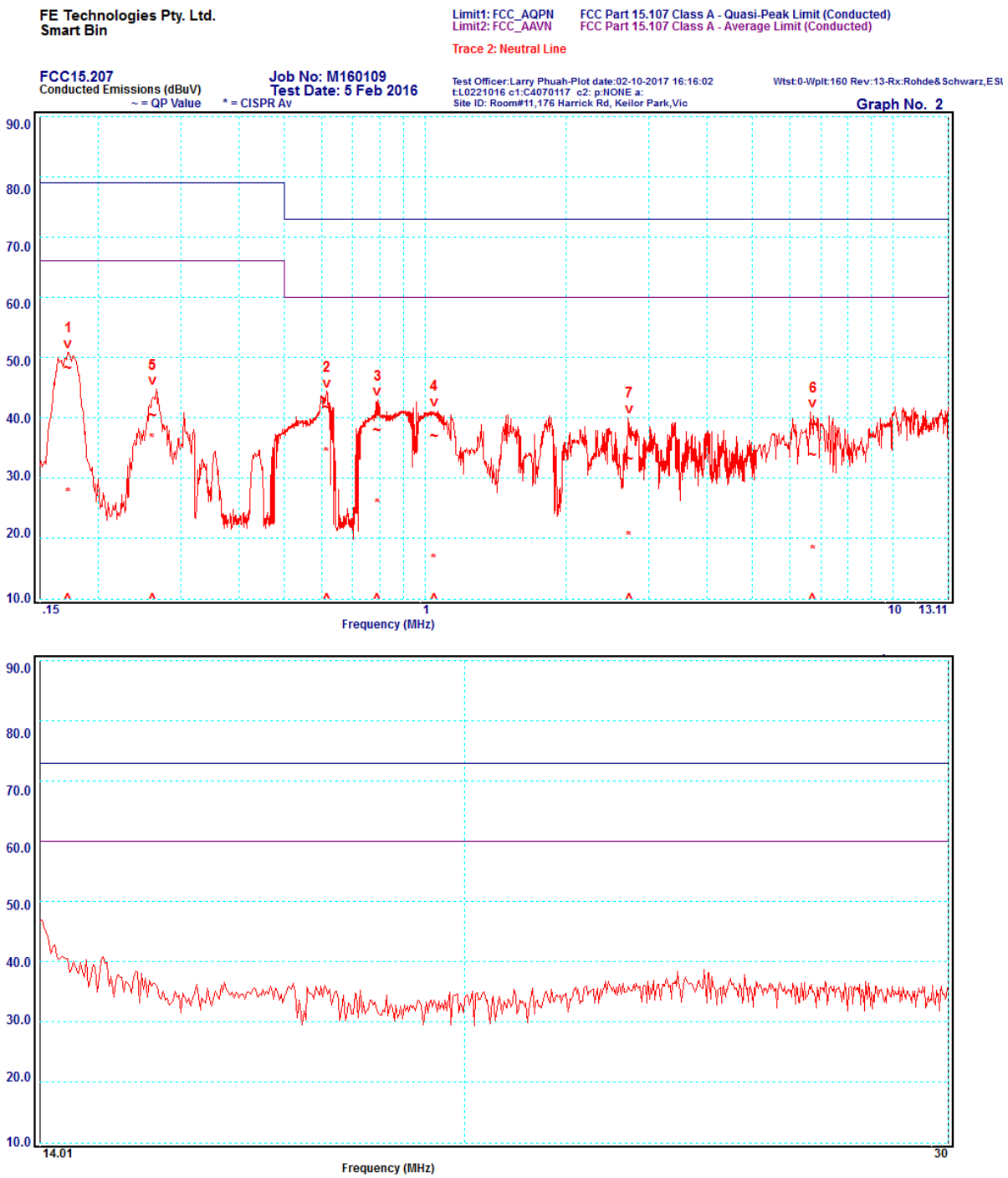
3.2.5.2 Neutral Line



Peak	Frequency [MHz]	Line	Quasi-Peak			Average		
			Level [dBµV]	Limit [dBµV]	Margin [±dB]	Level [dBµV]	Limit [dBµV]	Margin [±dB]
1	0.173	Neutral	48.2	79.0	-30.8	27.5	66.0	-38.5
2	0.616	Neutral	41.6	73.0	-31.4	34.1	60.0	-25.9
3	0.791	Neutral	38.0	73.0	-35.0	25.6	60.0	-34.4
4	1.046	Neutral	36.9	73.0	-36.1	16.5	60.0	-43.5
5	0.262	Neutral	40.3	79.0	-38.7	36.5	66.0	-29.5
6	6.742	Neutral	33.8	73.0	-39.2	18.0	60.0	-42.0
7	2.726	Neutral	33.2	73.0	-39.8	20.2	60.0	-39.8

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3.2.6 Conclusion

The conducted emissions were below the Class A average and quasi-peak limits of §15.107.

3.3 §15.209 Radiated emission limits; general requirements

The general requirement limits were applied to the measurements of §15.225(d).

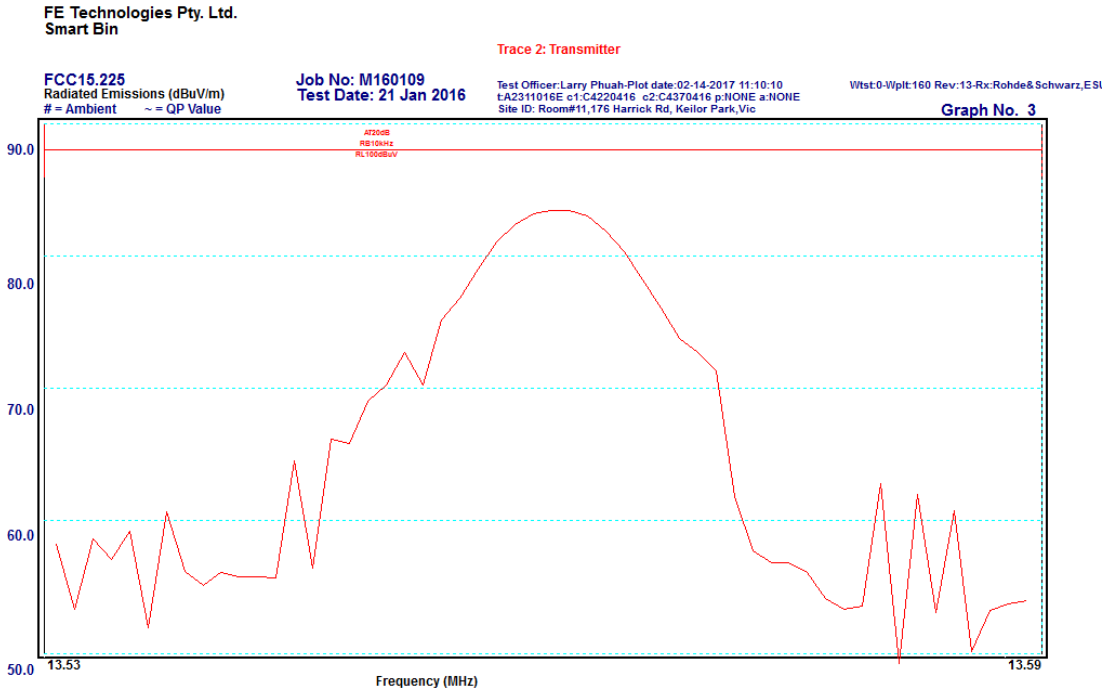
3.4 §15.225(a) Fundamental Field Strength

The field strength of the fundamental transmitted frequency was measured inside a compliant ANSI C63.4: 2014 semi-anechoic chamber. The EUT was positioned on a test turn-table and rotated through 360° to determine the highest emissions. The measurements were made with the loop antenna in three orthogonal orientations.

3.4.1 Result

All measurements were made at a distance of 10 metres, the limit extrapolated by 20 dB/decade calculated according to ANSI C63.10 Clause 6.4.4. The fundamental emissions were measured using a peak detector and as the level did not exceed the limit further measurements were not made.

Measure Antenna	Frequency [MHz]	E(peak) at 10 m		30 m Limit [µV/m]	10 m Limit [µV/m]	Result
		[dBµV/m]	[µV/m]			
Parallel	13.56	79.1	9,016	15,848	47,315	Complied
Perpendicular	13.56	83.3	14,622	15,848	47,315	Complied
Ground-Parallel	13.56	71.7	3,846	15,848	47,315	Complied



3.4.2 Conclusion

The field strength of the fundamental transmitted signal complied with the limit of §15.225(a).

3.5 §15.225(b and c) Transmission Mask 13.110-14-010 MHz

Measurements were made at 10 metres using a 0.6 metre loop antenna, the limit extrapolated by 20 dB/decade calculated according to ANSI C63.10 Clause 6.4.4. Initial investigations were made to find the EUT and measuring antenna orientations that produce the highest reading on the EMI receiver/spectrum analyser. These measurements were made at the transmit frequency, 13.56 MHz.

With the EUT and measuring antenna orientated in the position giving maximum emission measurements with a bandwidth of 10 kHz were made between 13.110 MHz and 14.010 MHz. The following limit mask applied:

Frequency band [MHz]	Field strength limit at 30 m [µV/m]	Equivalent field strength at 10 m [dBµV/m]
13.110 to 13.410	106	50.1
13.410 to 13.553	334	60.0
13.553 to 13.567	15,848	93.5
13.567 to 13.710	334	60.0
13.710 to 14.010	106	50.1

3.5.1 Result

Point	Frequency [MHz]	Quasi-Peak at 10 m [dBµV/m]	Limit at 10 m [dBµV/m]	Result
3	13.11	18.80	50.10	Complied
6	13.41	16.80	60.00	Complied
5	13.55	20.30	60.00	Complied
1	13.56	83.20	93.50	Complied
4	13.57	20.90	60.00	Complied
2	13.73	25.50	50.10	Complied

3.5.2 Conclusion

The transmitted signal complied with the limit mask of §15.225(b and c).

3.6 §15.225(d) Spurious Emissions

Radiated EMI tests were performed in a semi-anechoic chamber compliant with ANSI C63.4: 2014. The chamber allows a 2m x 2m x 2m test volume up to 6 GHz, at a test distance of 3 metres and 10 metres.

The test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks. Measurements between 9 kHz and 30 MHz were made at 10 metres using a 0.6 metre loop antenna and calibrated Biconilog antenna for measurements between 30 MHz and 1000 MHz. Calibrated EMCO 3115, EMCO 3116 and ETS standard gain horn antennas were used for measurements between 1 to 25 GHz.

The EUT was slowly rotated with the spectrum analyser was set to Max-Hold. This was performed for two antenna heights. When an emission was located, it was positively identified and its maximum level found by rotating the automated turntable and by varying the antenna height. The procedure was repeated with the device orientated in three orthogonal axis to further maximise the emission.

Each significant peak was investigated with the Peak/Average Detectors. The measurement data for each frequency range was corrected for cable losses, antenna factors and preamplifier gain. This process was performed for both horizontal and vertical antenna polarisations.

3.6.1 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. (stored as a data array)
G	=	Preamplifier Gain in dB. (stored as a data array)
L	=	Cable loss in dB. (stored as a data array of Insertion Loss versus frequency)

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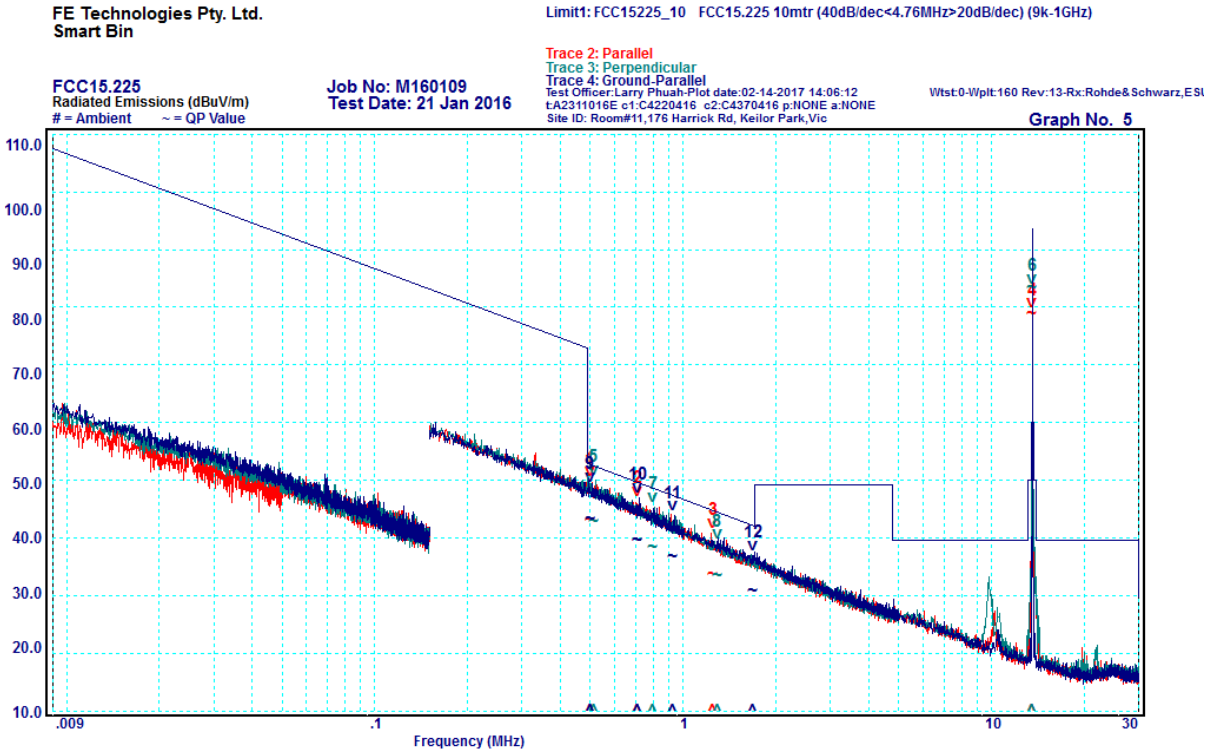
3.6.2 Frequency Band: 9 kHz - 30 MHz

Measurements were made at a distance of 10 metres, the limit was extrapolated by 40 dB/decade below 4.76 MHz and 20 dB/decade above 4.76 MHz calculated according to ANSI C63.10 Clause 6.4.4. The measurement of emissions between 9 kHz – 150 kHz were made with a resolution bandwidth (RBW) of 200 Hz and the video bandwidth (VBW) of 3 kHz, 150 kHz – 30 MHz were measured with the resolution bandwidth (RBW) of 9 kHz and the video bandwidth (VBW) of 30 kHz.

3.6.2.1 Results



Point	Frequency [MHz]	Loop Orientation	Quasi-Peak [dBµV/m]	Limit [dBµV/m]	Margin [dB]
1	0.500	Parallel	43.10	52.73	-9.6
2	0.713	Parallel	39.60	49.65	-10.1
3	1.251	Parallel	33.70	44.78	-11.1
4	13.560	Parallel	-	-	-
5	0.512	Perpendicular	42.80	52.51	-9.7
6	13.560	Perpendicular	-	-	-
7	0.798	Perpendicular	38.30	48.67	-10.4
8	1.288	Perpendicular	33.50	44.53	-11.0
9	0.498	Ground-Parallel	43.20	52.75	-9.6
10	0.714	Ground-Parallel	39.60	49.64	-10.0
11	0.928	Ground-Parallel	36.70	47.37	-10.7
12	1.688	Ground-Parallel	30.80	42.19	-11.4

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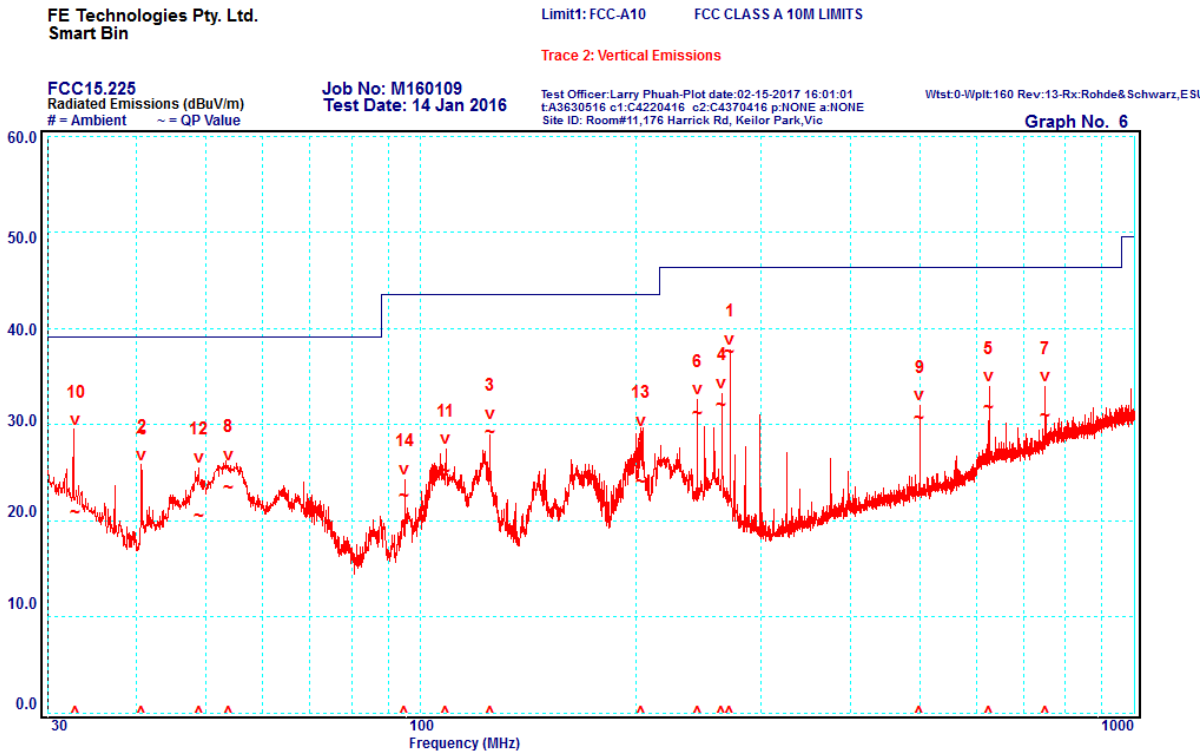
3.6.3 Frequency Band: 30 - 1000 MHz

Measurements were made at a distance of 10 metres. The measurement of emissions between 30 - 1000 MHz were made with a resolution bandwidth (RBW) of 120 kHz and the video bandwidth (VBW) of 300 kHz. The host device was deemed a Class A product and therefore in accordance with §15.31(k) the appropriate limits of §15.109 were applied.

3.6.3.1 Vertical Polarisation



Point	Frequency [MHz]	Quasi-Peak [dBµV/m]	Limit [dBµV/m]	Margin [dB]
1	271.20	37.5	46.4	-8.9
2	40.68	29.0	39.1	-10.1
3	125.01	29.2	43.5	-14.3
4	264.20	32.0	46.4	-14.4
5	625.09	31.8	46.4	-14.6
6	244.09	31.1	46.4	-15.3
7	750.11	30.9	46.4	-15.5
8	53.75	23.4	39.1	-15.7
9	500.07	30.6	46.4	-15.8
10	32.88	20.9	39.1	-18.2
11	108.48	25.1	43.5	-18.4
12	48.93	20.4	39.1	-18.7
13	203.47	24.0	43.5	-19.5
14	94.91	22.5	43.5	-21.0

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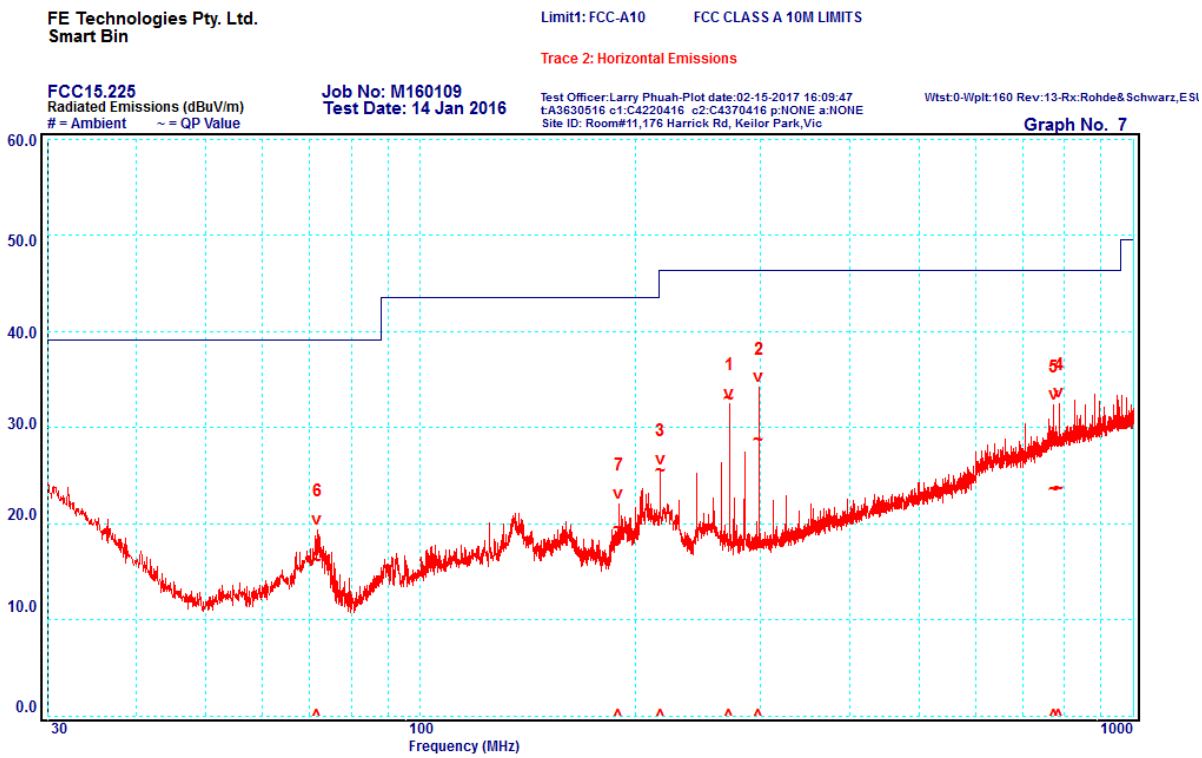
3.6.3.2 Horizontal Polarisation



Point	Frequency [MHz]	Quasi-Peak [dBµV/m]	Limit [dBµV/m]	Margin [dB]
1	271.20	33.0	46.4	-13.4
2	298.27	28.7	46.4	-17.7
3	216.97	25.5	46.4	-20.9
4	786.67	23.6	46.4	-22.8
5	772.75	23.5	46.4	-22.9
6	71.62	16.1	39.1	-23.0
7	189.85	19.5	43.5	-24.0

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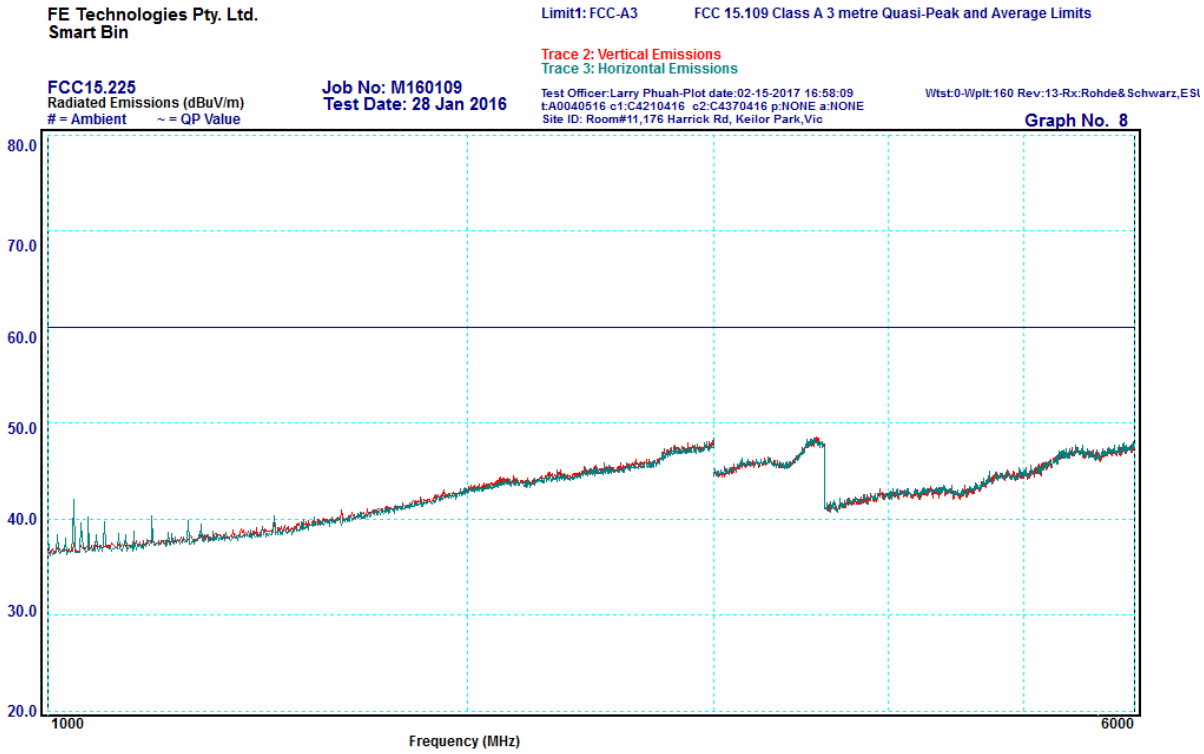
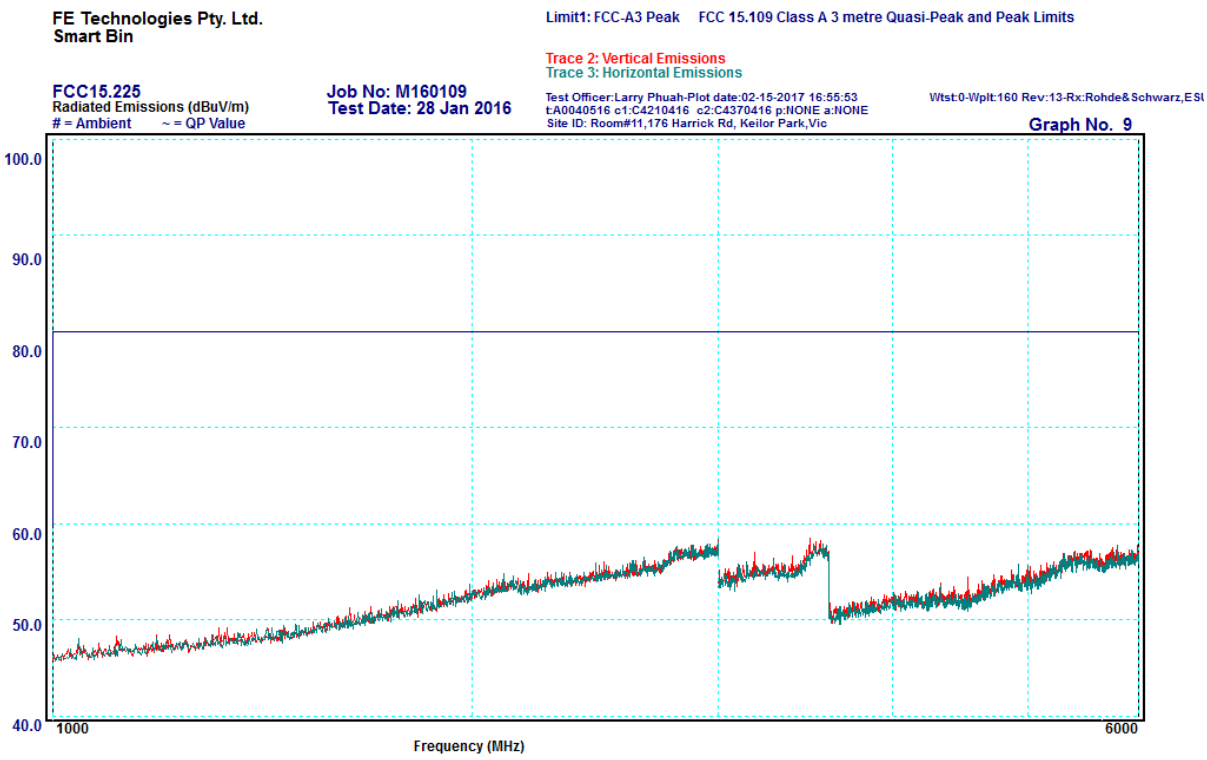
3.6.4 Frequency Band: 1000 - 6000 MHz

Measurements were made at a distance of 3 metres. The measurement of emissions between 1000 - 6000 MHz were made with a resolution bandwidth (RBW) of 1 MHz and a video bandwidth (VBW) of 10 Hz for average measurements and 1 MHz for peak measurements. The host device was deemed a Class A product and therefore in accordance with §15.31(k) the appropriate limits of §15.109 were applied.

3.6.4.1 Average Measurements



3.6.4.2 Peak Measurements



3.6.5 Conclusion

The spurious emissions complied with the Class A limits of §15.109 by a margin of 8.9 dB.

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3.7 §15.225(e) Frequency Tolerance

The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 °C to + 50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 °C. For battery operated equipment, the equipment tests shall be performed using a new battery. After the sample stabilised at each temperature the transmitter was turned on and the fundamental frequency was measured at regular intervals.

ANSI C63.10 Clause 6.8 procedure was applied.

Nominal Supply	24.0 VDC
85%	20.4 VDC
115%	27.6 VDC

Temp [°C]	0 min [MHz]	2 min [MHz]	5 min [MHz]	10 min [MHz]
50	13.55994	13.55993	13.55993	13.55993
40	13.55995	13.55994	13.55994	13.55994
30	13.55998	13.55997	13.55996	13.55996
20	13.56001	13.56000	13.55999	13.55999
10	13.56003	13.56003	13.56002	13.56001
0	13.56004	13.56004	13.56004	13.56003
-10	13.56002	13.56003	13.56004	13.56004
-20	13.56000	13.56001	13.56002	13.56002

Temp. = 20°C

Supply	[MHz]
85%	13.55999
115%	13.55999

Lowest frequency recorded = 13.55993 MHz
Highest frequency recorded = 13.56004 MHz

Result:

Limit (MHz) = 13.558644 < f < 13.561356
Measurement uncertainty = ± 5 Hz

The sample complied with the frequency stability requirements.

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.
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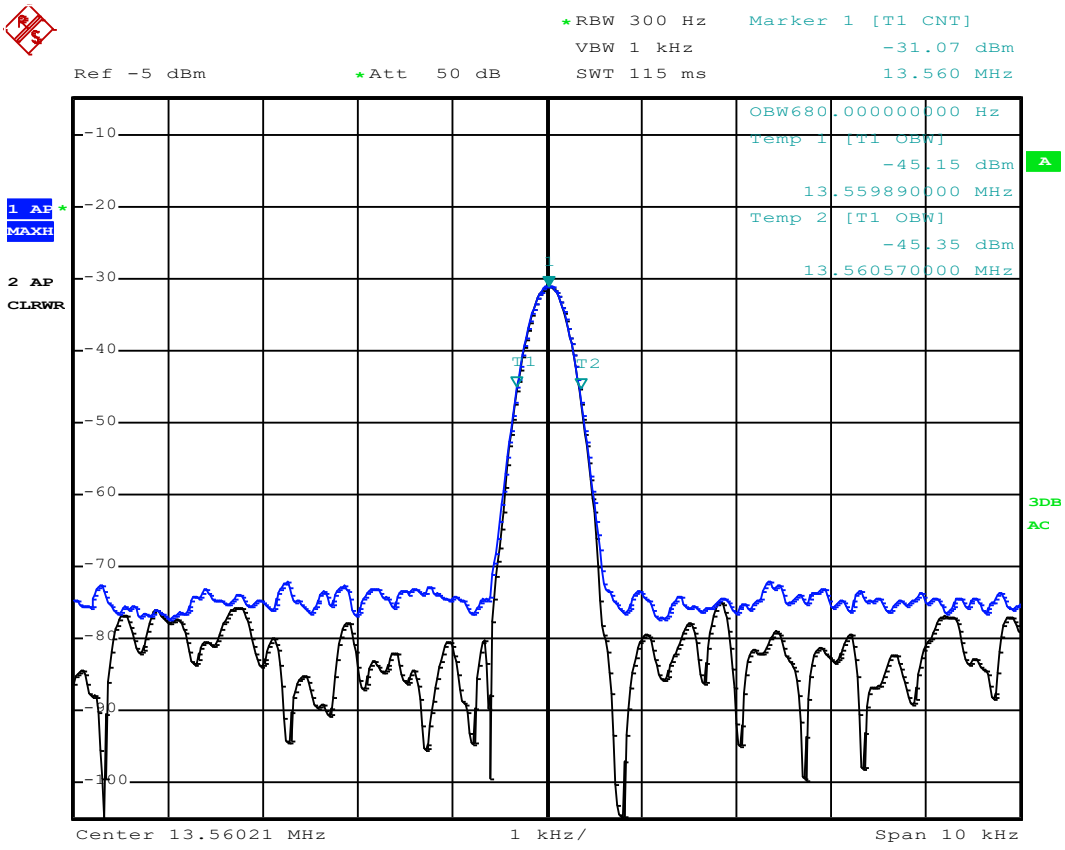
3.8 §2.1049 Occupied bandwidth – 99% power

The bandwidth containing 99% power of the transmitted signal was measured using the procedure from ANSI C63.10 section 6.9.

Result:
The 99% power bandwidth was **680 Hz**.



4.0 COMPLIANCE STATEMENT

The Smart Bin tested on behalf of FE Technologies Pty. Ltd. **complied** with the requirements of 47 CFR, Part 15 Subpart C - Rules for Radio Frequency Devices (intentional radiators), Section 15.225 - Operation within the band 13.110-14.010 MHz.

5.0 MEASUREMENT UNCERTAINTY

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:	9 kHz to 30 MHz	±3.2 dB
Radiated Emissions:	9 kHz to 30 MHz	±4.1 dB
	30 MHz to 300 MHz	±5.1 dB
	300 MHz to 1000 MHz	±4.7 dB
	1 GHz to 18 GHz	±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%.