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RADIO REPORT FOR CERTIFICATION

REPORT NUMBER: M190435 - 2

TEST STANDARD: FCC PART 15 SUBPART C

CLIENT: FE TECHNOLOGIES PTY LTD

DEVICE: CIRCULATION ASSISTANT

MODEL: 1.0

DATE OF ISSUE: 2 DECEMBER 2019

Equipment Under Test: Circulation Assistant

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GRAPHS

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RADIO REPORT FOR CERTIFICATION TO FCC PART 15 SUBPART C SECTION 15.225

CERTIFICATE OF COMPLIANCE

Device:	Circulation Assistant
Model Number:	1.0
Serial Number:	6564599 (RFID Reader), V1911084B1 (Antenna)
FCC ID:	FCC ID: 2AM6N-FE-LSA4CIRC
Manufacturer:	FE Technologies Pty Ltd
Tested for:	FE Technologies Pty Ltd
Address:	129 Fyans Street, South Geelong, Victoria, Australia
Phone Number:	+61 408 527 596
Contact:	Clint Agustsson
Email:	clint@fetechgroup.com
Standard:	FCC Part 15 – Radio Frequency Devices Subpart C – Intentional Radiators Section 15.225 Operation within the band 13.110-14.010 MHz
Result:	The Test Sample complied with Clause §15.225 Operation within the band 13.110-14.010 MHz of FCC 47 CFR Part 15C. Refer to Report M190435-2 for full details
Test Date(s):	27 May, 13 & 14 June, 5 July, 2019
Issue Date:	2 December 2019
Test Engineer(s):	Wilson Xiao
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 Signatory:	Shabbir Ahmed, PhD Lead RF and Wireless Engineer

Issued by: EMC Technologies Pty. Ltd.,
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RADIO REPORT FOR CERTIFICATION TO FCC PART 15 SUBPART C

1 TEST SUMMARY

Section	Clause	Result(s)
6.1	§15.203 Antenna Requirement	Complied
6.2	§15.207 Conducted Limits	Complied
6.3	§15.225 (a), (b), (c) Field Strength of Emissions within the band 13.110-14.010 MHz	Complied
6.4	§15.225 (d) Radiated Spurious Emissions	Complied
6.5	§15.225 (e) Frequency Tolerance	Complied
6.6	§15.215 Occupied Bandwidth	Complied

2 TEST FACILITY

2.1 General

EMC Technologies Pty Ltd is accredited by the FCC as a test laboratory able to perform compliance testing for the public. EMC Technologies Pty Ltd has also been designated 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 Pty Ltd is also an ISED Canada recognized testing laboratory – **ISED company number: 9626A** and **CAB identifier number: AU0001.**

2.2 NATA Accreditation

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 similar 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).

All testing in this report has been conducted in accordance with EMC Technologies' scope of NATA accreditation to ISO 17025 for both testing and calibration and ISO 17020 for Inspection – **Accreditation Number 5292**.

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

3 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/yyyy	Due Date dd/mm/yyyy	Cal. Interval
Chamber	Frankonia SAC-3-2 (R-144)	17/07/2017	17/07/2020	3 Year*1
Environment Chamber	Weiss C1000/70 Sn:546260057800010 (E-010)	20/05/2019	20/05/2020	1 Year*2
EMI Receiver	R&S ESW26 Sn: 101306 (R-143)	31/05/2019	31/05/2020	1 Year*2
	R&S ESR7 Sn: 101804 (R-142)	24/07/2018	24/07/2019	1 Year*2
	Keysight N9038A Receiver Sn: MY57290154 (R-147)	12/01/2019	12/01/2020	1 Year*2
Antennas	SUNOL JB1 Sn. A061917 (A-425)	21/07/2017	21/07/2019	2 Year*2
	EMCO 6502 Active Loop Antenna Sn. 9311-2801 (A-231)	16/11/2018	16/11/2021	3 Year*1
Cables*3	Huber & Suhner Sucoflex 104A Sn: 503055 (C-457)	21/01/2019	21/01/2020	1 Year*1
	Huber & Suhner Sucoflex 104A Sn: 507099 (C-479)	21/01/2019	21/01/2020	1 Year*1
	Huber & Suhner Sucoflex 104A Sn: 503061 (C-463)	21/01/2019	21/01/2020	1 Year*1
LISN	Teseq Single Phase LISN NNB51 Sn: 47416 (L-072)	30/11/2018	30/11/2019	1 Year*1

Note *1. Internal NATA calibration.
Note *2. External NATA / A2LA calibration.
Note *3. Cables are verified before measurements are taken.

4 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
Peak Output Power:		±1.5 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%.

5 DEVICE DETAILS

(Information supplied by the Client)

The device under test is a high-power RFID reader with a separate antenna pad. The reader is connected to a computer via a USB port and powered by a separate 12 VDC power supply. The RFID transceiver interrogates tags in libraries for automatic material handling.

5.1 EUT (Transmitter) Details

Radio:	RFID Reader (ID ISC.MR102-USB, FEIG Electronic) Sn: 6564599
Highest International Frequency:	25MHz
Operating frequency:	13.56 MHz
No. of Channels:	1
Antenna:	TAGSYS RFID Stack Antenna Model: L-SA4 SHD, Pn: DDP13762B1, Sn: V1911084B1

5.2 EUT (Host) Details

Device under Test:	Circulation Assistant
Model Number:	1.0
Power requirements:	12-24 VDC max 0.5 A via AC Adapter
AC Adapter:	Ktec, Model: KSA-18W-120150VA Input: 100-240V, Output: 12 VDC 1.5 A

5.3 Test Configuration

Testing was performed with the EUT (RFID Reader with separate antenna) set to continuously transmit.

The EUT was configured using ISOStart 2015 Ver. 09.09.00 application on a laptop.

5.4 Modifications

No modification was required to achieve compliance.

6 RESULTS

6.1 §15.203 Antenna Requirement

The Circulation Assistant system by FE Technologies Pty Ltd incorporates the following external antenna only:

Antenna Type: TAGSYS RFID Stack Antenna
Model: L-SA4 SHD
Pn: DDP13762B1
Connector: SMA including 3m coaxial cable

The above antenna will be installed by professional installers who have been trained by FE Technologies Pty Ltd. FE Technologies Pty Ltd shall be responsible for ensuring proper installation of the antenna. The said installation will preclude any unauthorized switching of antennas.

6.2 §15.207 Conducted Limits

The EUT is powered by an AC Adapter as detailed below:

Plug pack:	Ktec
Model:	KAS-18W-120150VA
Input supply:	100-240V AC, 50/60 Hz, 0.5A
Output supply:	12V DC, 1.5A

6.2.1 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 specified 0.15 MHz to 30 MHz frequency range was sub-divided into sub-ranges to ensure that all short duration peaks were captured. 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 invoked to measure the actual Quasi-Peak and Average level of the most significant peaks, which were detected.

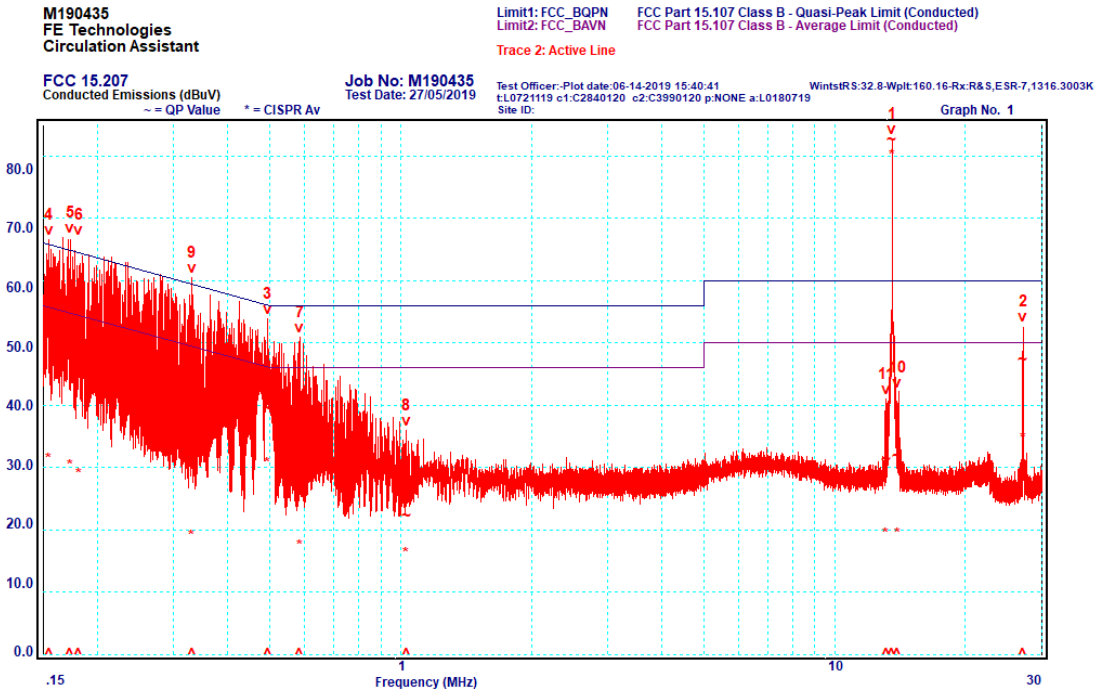
6.2.2 Limits

The limit applied was in accordance to the conducted limits defined in §15.207.

6.2.3 Results

The sample complied with the conducted emission limits of §15.207.

Testing was performed over the frequency range of 150 kHz to 30 MHz at 120V AC, 60 Hz.

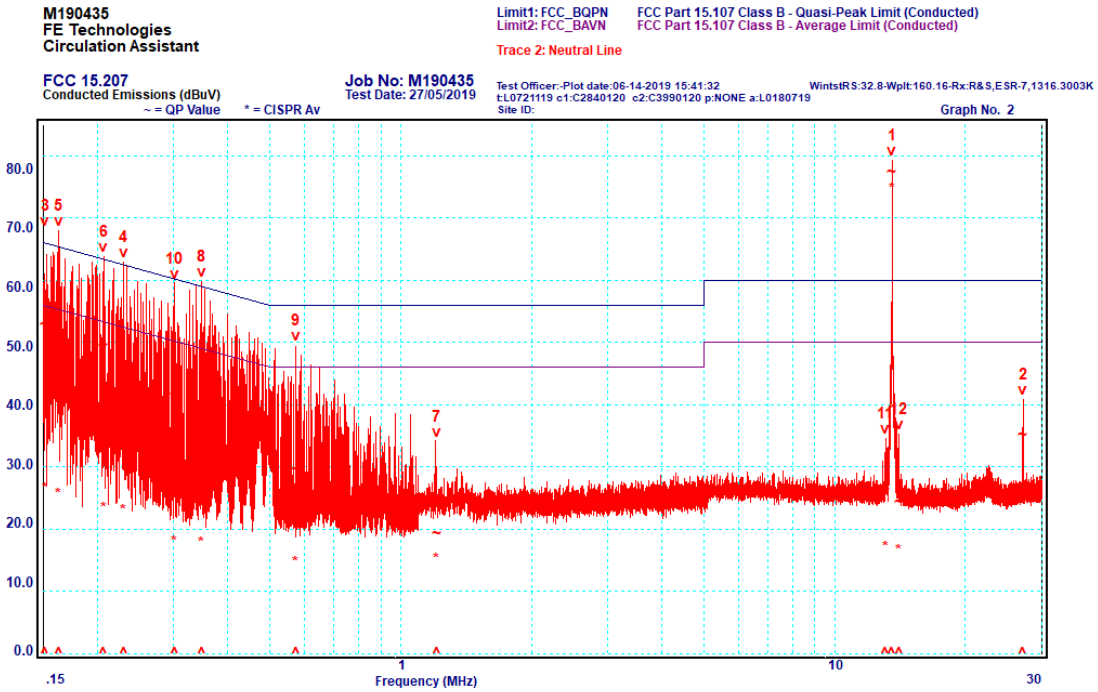


Graph 6-1: Active Line (0.15 MHz to 30 MHz)

Table 6-1: Active Line (0.15 MHz to 30 MHz)

Peak	Frequency [MHz]	Line	Quasi-Peak			Average		
			Level [dBµV]	Limit [dBµV]	Margin [dB]	Level [dBµV]	Limit [dBµV]	Margin [dB]
1*	13.56	Active	N/A	N/A	N/A	N/A	N/A	N/A
2	27.12	Active	47.2	60	-12.8	34.6	50	-15.4
3	0.494	Active	39.4	56.1	-16.7	30.5	46.1	-15.6
4	0.155	Active	53.4	65.7	-12.3	31.2	55.7	-24.5
5	0.173	Active	51.8	64.8	-13	30.2	54.8	-24.6
6	0.182	Active	51.1	64.4	-13.3	28.8	54.4	-25.6
7	0.586	Active	28.6	56	-27.4	17.3	46	-28.7
8	1.031	Active	22.1	56	-33.9	16.1	46	-29.9
9	0.331	Active	40.7	59.4	-18.7	18.9	49.4	-30.5
10	13.96	Active	31.7	60	-28.3	19.3	50	-30.7
11	13.14	Active	31.2	60	-28.8	19.2	50	-30.8

*Note: Peak 1 is the intentional transmission and is not subject to the conducted emission limits of the standard.



Graph 6-2: Neutral Line (0.15 MHz to 30 MHz)

Table 6-2: Neutral Line (0.15 MHz to 30 MHz)

Peak	Frequency [MHz]	Line	Quasi-Peak			Average		
			Level [dBµV]	Limit [dBµV]	Margin [dB]	Level [dBµV]	Limit [dBµV]	Margin [dB]
1*	13.56	Neutral	N/A	N/A	N/A	N/A	N/A	N/A
2	27.12	Neutral	35.1	60	-24.9	25.2	50	-24.8
3	0.152	Neutral	52.7	65.9	-13.2	26.4	55.9	-29.5
4	0.23	Neutral	46.3	62.4	-16.1	22.8	52.4	-29.6
5	0.163	Neutral	51.4	65.3	-13.9	25.5	55.3	-29.8
6	0.207	Neutral	49.6	63.3	-13.7	23.2	53.3	-30.1
7	1.209	Neutral	19.2	56	-36.8	15.1	46	-30.9
8	0.348	Neutral	39.7	59	-19.3	17.6	49	-31.4
9	0.574	Neutral	29.5	56	-26.5	14.5	46	-31.5
10	0.302	Neutral	41.7	60.2	-18.5	17.9	50.2	-32.3
11	13.09	Neutral	26.1	60	-33.9	17	50	-33
12	14.05	Neutral	24.3	60	-35.7	16.5	50	-33.5

*Note: Peak 1 is the intentional transmission and is not subject to the conducted emission limits of the standard.

6.3 §15.225 (a), (b), (c) Field Strength of Emissions within the band

6.3.1 Test Procedure

The field strength of emissions within the band was measured inside a semi-anechoic chamber compliant with ANSI C63.4: 2014.

The EUT was positioned on a test turn-table and slowly rotated through 360° to determine the highest emissions with the spectrum analyser set to Max-hold using a Peak detector and a resolution bandwidth of 9 kHz. The measurement antenna was also varied between 1 and 4 metres height. A calibrated active loop antenna was used for the measurements. Measurements were conducted in all polarisations (Parallel to EUT, Perpendicular to EUT and Ground Parallel).

EUT was investigated on all three axes (x, y, and z) with the loop antenna. Measurements on the worst axis are presented below.

All measurements were made at 3 metres. Final measurements on the fundamental emissions were done using a Quasi-Peak detector.

6.3.2 Limits

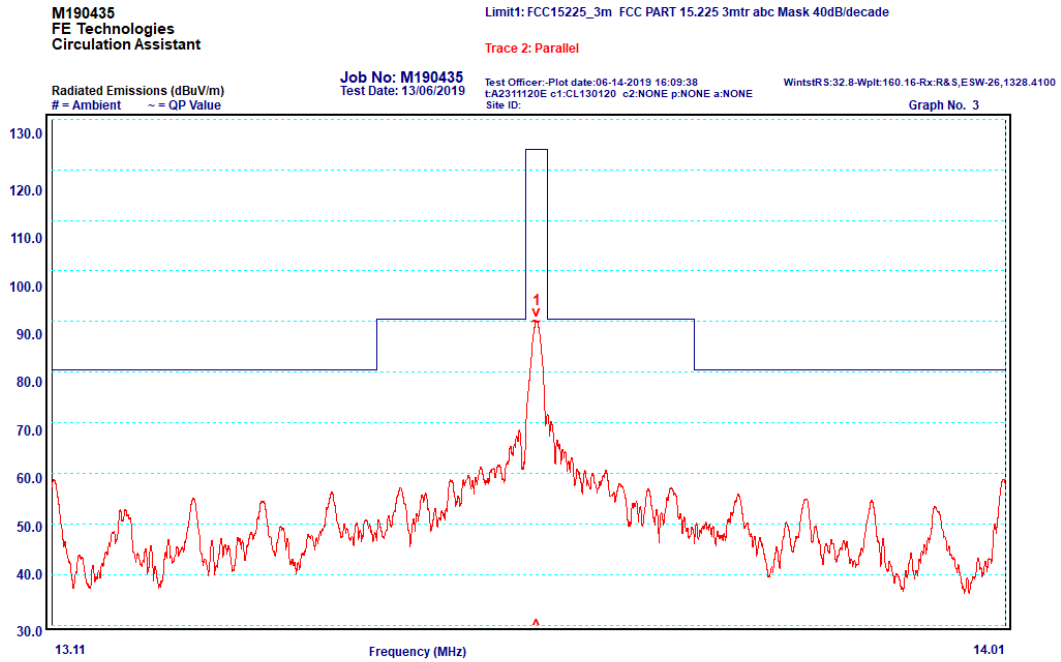
§15.225 defines the following limit mask:

Table 6-3: Field Strength of Emissions within the band 13.110 MHz to 14.010 MHz

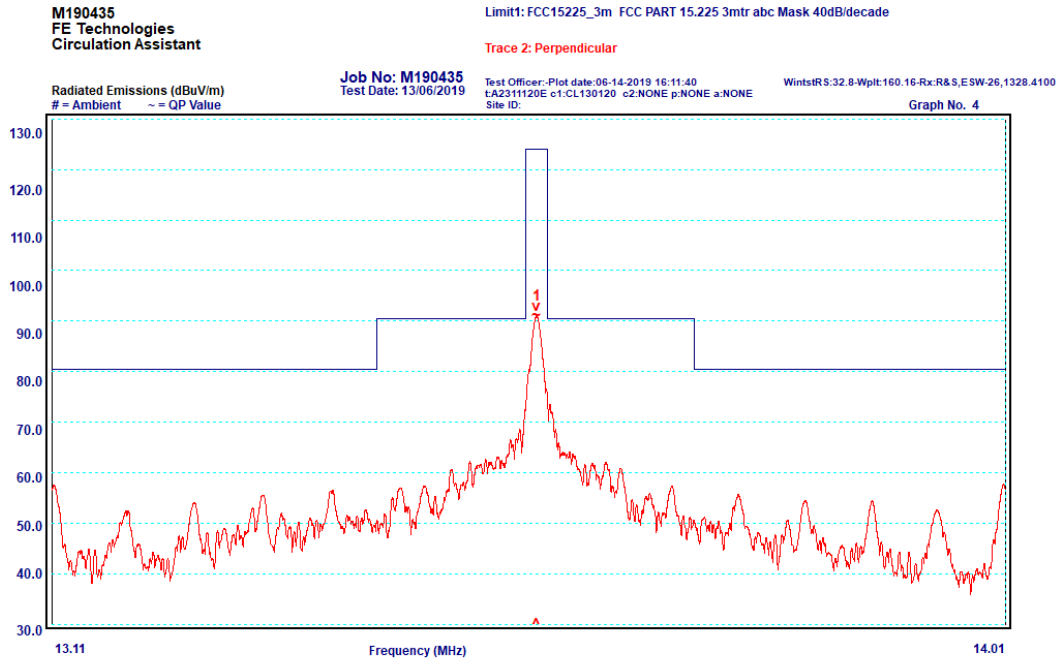
Frequency range (MHz)	Field Strength (µV/m) at 30m	Field Strength (dBµV/m) at 30m	Field Strength (dBµV/m) at 3m
13.110 to 13.410	106	40.5	80.5
13.410 to 13.553	334	50.5	90.5
13.553 to 13.567	15848	84.0	124.0
13.567 to 13.710	334	50.5	90.5
13.710 to 14.010	106	40.5	80.5

6.3.3 Results

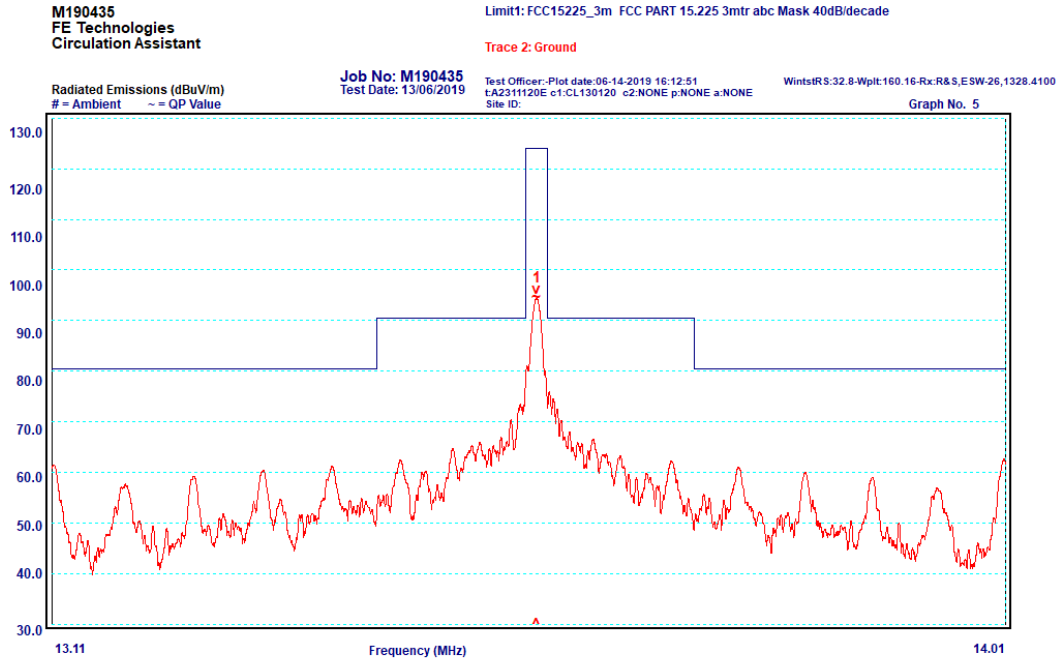
All emissions within the band 13.110 MHz to 14.010 MHz complied with §15.225 limit mask.



Graph 6-3: Field Strength of Emissions within the band 13.110 MHz to 14.010 MHz – Parallel to EUT



Graph 6-4: Field Strength of Emissions within the band 13.110 MHz to 14.010 MHz – Perpendicular to EUT



Graph 6-5: Field Strength of Emissions within the band 13.110 MHz to 14.010 MHz – Ground Parallel

Table 6-4: Field Strength of Fundamental Emissions

Frequency (MHz)	Polarisations	Measured Field Strength (dBµV/m)	Limit (dBµV/m)	Result
13.56	Parallel to EUT	89.9	124.0	Complied
13.56	Perpendicular to EUT	91.1	124.0	Complied
13.56	Ground Parallel	94.6	124.0	Complied

6.4 §15.225 (d) Radiated Spurious Emission limits

6.4.1 Test procedure

Radiated emissions measurements were performed in a semi-anechoic chamber compliant with ANSI C63.4: 2014.

The test frequency range was sub-divided into smaller bands with the defined resolution bandwidths to permit reliable display and identification of emissions.

Frequency range [MHz]	Measurement Bandwidth [kHz]	Measurement Distance [m]	Antenna
0.009 to 0.150	0.2	3	0.6 metre loop antenna
0.150 to 30	9	3	
30 to 1000	120	3	Biconilog hybrid

EUT was set at 0.8 m for measurements below 1000 MHz.

The sample was slowly rotated with the spectrum analyser set to Max-Hold. This was performed for at least 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. For below 1000 MHz the emissions were measured with a Quasi-Peak detector.

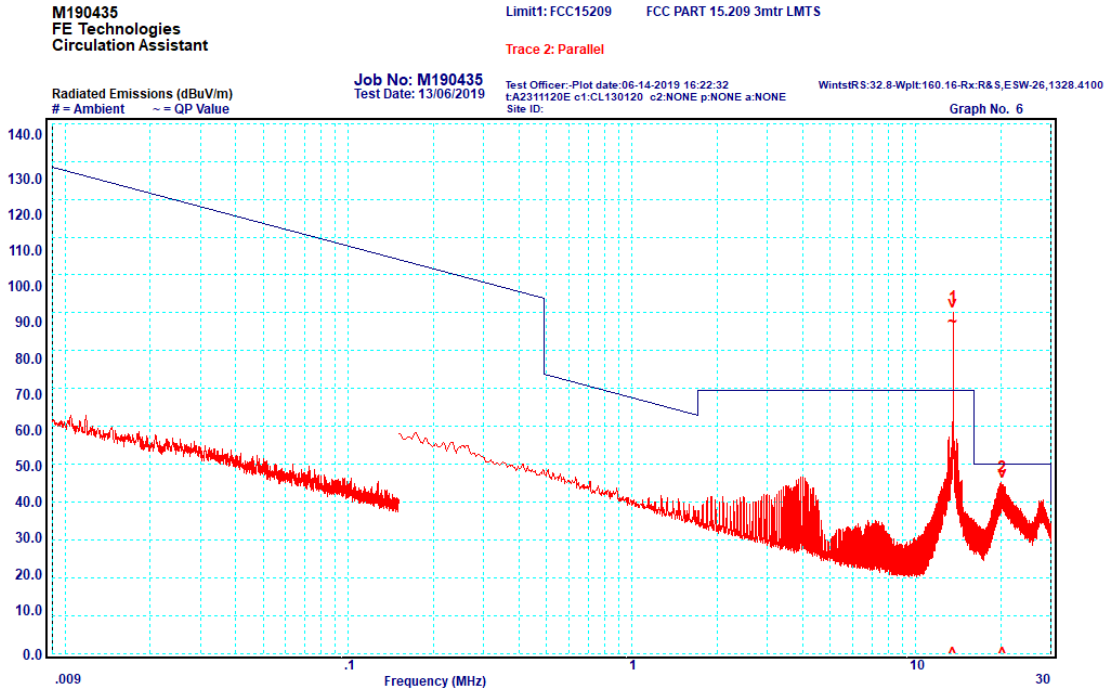
The measurement data for each frequency range was corrected for cable losses, antenna factors and preamplifier gain. This process was performed for both horizontal and vertical polarisations of the measurement antenna.

6.4.2 Limits

The limit applied is in accordance to the radiated emission limits defined in §15.209 Radiated emission limits; general requirements

6.4.3 Results: Frequency Band: 9kHz - 30MHz

All spurious emissions measured in the frequency band 9kHz - 30MHz complied with the requirements of §15.209.

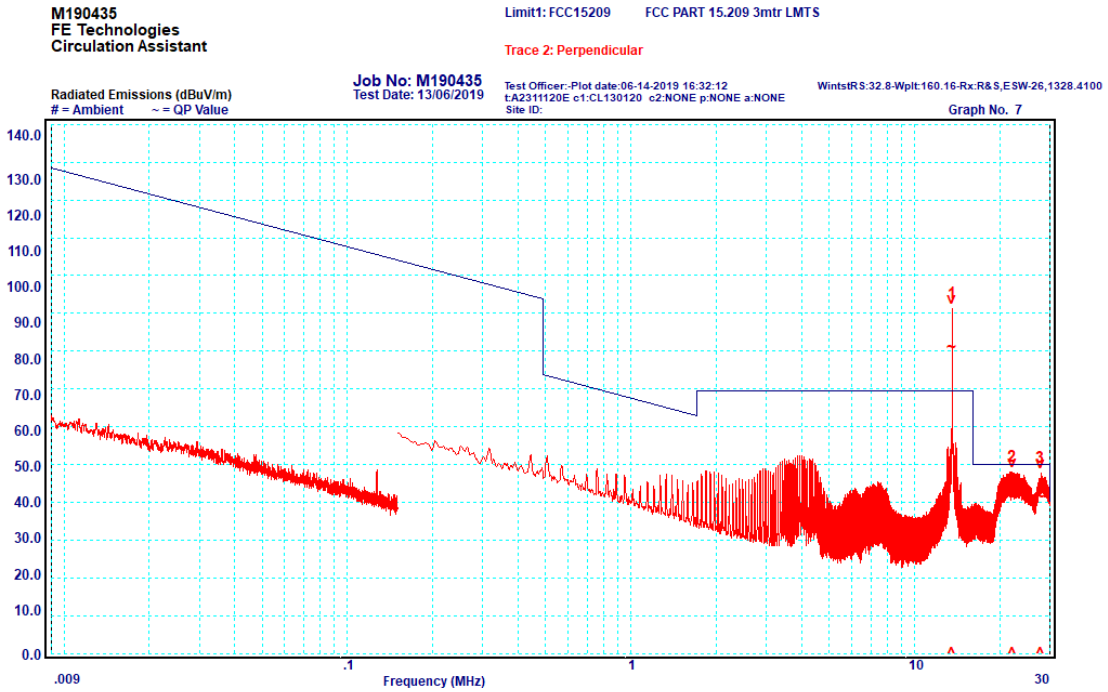


Graph 6-6: Spurious Emissions, 9kHz - 30MHz, Parallel to EUT

Table 6-5: Spurious Emissions, 9kHz - 30MHz, Parallel to EUT

Peak	Frequency (MHz)	Polarisation	Level (dBµV/m)	Limit (dBµV/m)	Delta Limit (dB)
1*	13.56	Parallel to EUT	N/A	N/A	N/A
2	20.20	Parallel to EUT	41.5	50.0	-8.5

*Note: Peak 1 is the intentional transmission and is not subject to the spurious emission limits of the standard.

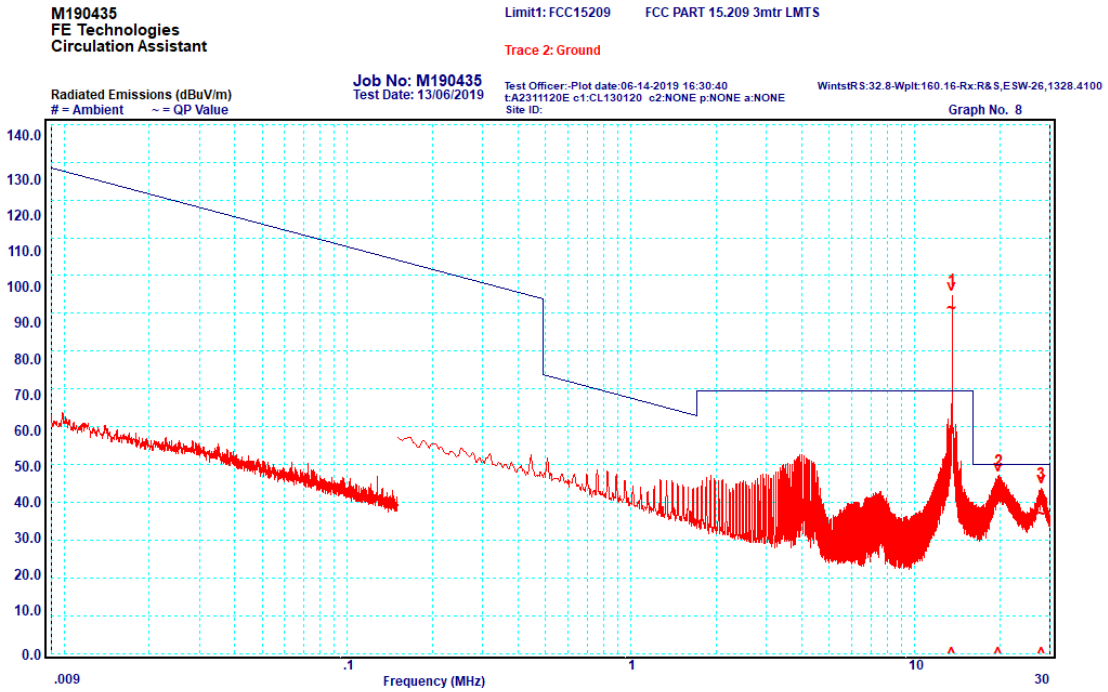


Graph 6-7: Spurious Emissions, 9kHz - 30MHz, Perpendicular to EUT

Table 6-6: Spurious Emissions, 9kHz - 30MHz, Perpendicular to EUT

Peak	Frequency (MHz)	Polarisation	Level (dBµV/m)	Limit (dBµV/m)	Delta Limit (dB)
1*	13.56	Perpendicular to EUT	N/A	N/A	N/A
2	22.08	Perpendicular to EUT	43.3	50.0	-6.7
3	27.72	Perpendicular to EUT	41.5	50.0	-8.5

*Note: Peak 1 is the intentional transmission and is not subject to the spurious emission limits of the standard.



Graph 6-8: Spurious Emissions, 9kHz - 30MHz, Ground Parallel

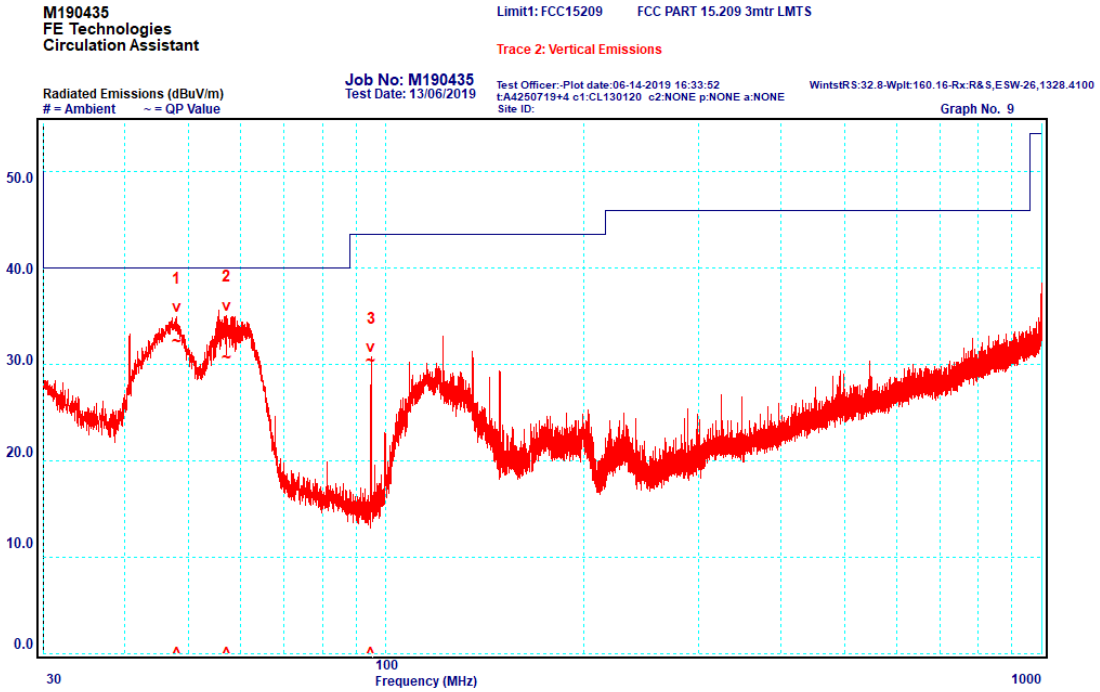
Table 6-7: Spurious Emissions, 9kHz - 30MHz, Ground Parallel

Peak	Frequency (MHz)	Polarisation	Level (dBµV/m)	Limit (dBµV/m)	Delta Limit (dB)
1*	13.56	Ground	N/A	N/A	N/A
2	19.77	Ground	42.8	50.0	-7.2
3	28.01	Ground	39.6	50.0	-13.1

*Note: Peak 1 is the intentional transmission and is not subject to the spurious emission limits of the standard.

6.4.4 Results: Frequency Band: 30 – 1000 MHz

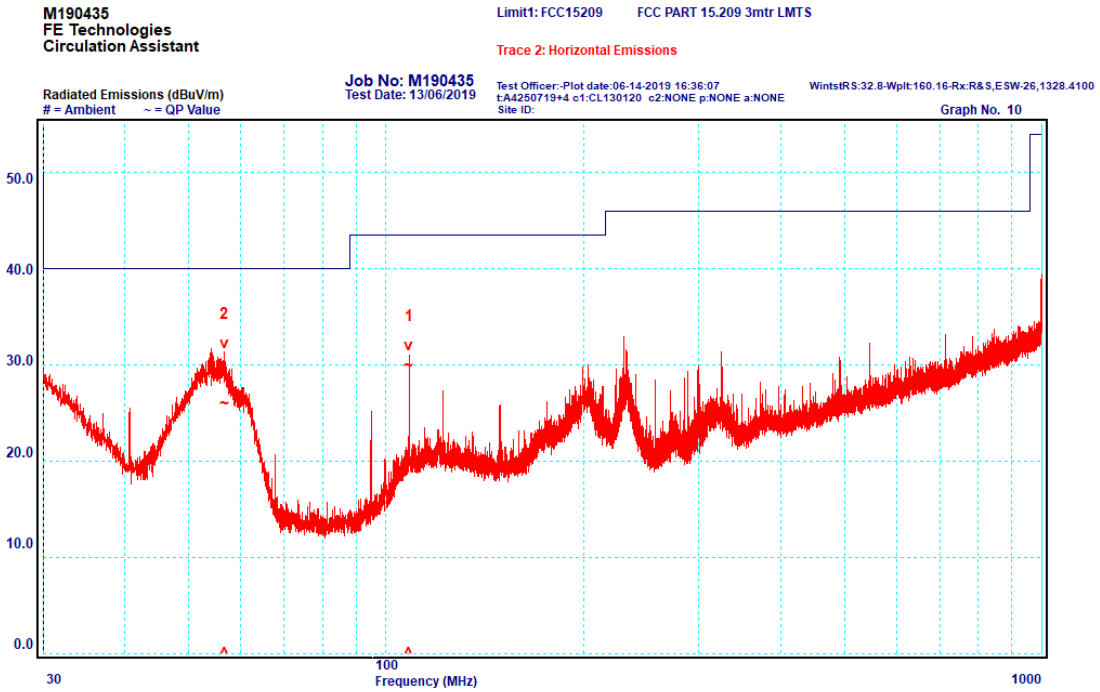
All spurious emissions measured in the frequency band 30 MHz to 1000 MHz complied with the requirements of §15.209.



Graph 6-9: Spurious Emissions, 30 - 1000 MHz, Vertical

Table 6-8: Spurious Emissions, 30 - 1000 MHz, Vertical

Peak	Frequency (MHz)	Polarisation	Level (dBµV/m)	Limit (dBµV/m)	Delta Limit (dB)
1	47.98	Vertical	32.3	40.0	-7.7
2	57.13	Vertical	30.6	40.0	-9.4
3	94.92	Vertical	30.4	43.5	-13.1



Graph 6-10: Spurious Emissions, 30 - 1000 MHz, Horizontal

Table 6-9: Spurious Emissions, 30 - 1000 MHz, Horizontal

Peak	Frequency (MHz)	Polarisation	Level (dBµV/m)	Limit (dBµV/m)	Delta Limit (dB)
1	108.48	Horizontal	29.9	43.5	-13.6
2	56.71	Horizontal	26.0	40.0	-14.0

6.5 §15.225 (e) Frequency Tolerance

6.5.1 Test procedure

The Frequency Tolerance was measured using the procedure from ANSI C63.10 section 6.8.

The frequency tolerance of the carrier signal was measured over

a. a temperature variation of -20ºC to 50ºC at normal supply and
b. a variation in the primary supply voltage from 85% to 115% of the rated voltage at a temperature of 20 ºC

6.5.2 Limits

The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency.

6.5.3 Results

Table 6-10: Frequency Tolerance vs Temperature

Voltage: 120V							
Temperature (ºC)	Measured Frequency (MHz)				Max Frequency Deviation		Result
	Start up	2 min	5 min	10 min	MHz	%	
-20	13.5599	13.5599	13.5599	13.5599	0	0	Complied
-10	13.5599	13.5599	13.5599	13.5599	0	0	Complied
0	13.5599	13.5599	13.5599	13.5599	0	0	Complied
10	13.5599	13.5599	13.5599	13.5599	0	0	Complied
20	13.5599	13.5599	13.5599	13.5599*	0	0	Complied
30	13.5597	13.5597	13.5597	13.5597	-0.0002	-0.0015	Complied
40	13.5597	13.5597	13.5597	13.55965	-0.00025	-0.0018	Complied
50	13.5599	13.5597	13.5597	13.55965	-0.00025	-0.0018	Complied

* Reference operating frequency: 13.5599 MHz at 20 ºC

Table 6-11: Frequency Tolerance vs Voltage

Temperature: 20ºC				
Voltage (V)	Frequency (MHz)	Frequency Deviation (MHz)	Frequency Deviation (%)	Result
102	13.5601	0.0001	0.00074	Complied
120	13.5600*	0	0	Complied
138	13.5599	-0.0001	-0.00074	Complied

* Reference operating frequency: 13.5600 MHz at 120V

6.6 §15.215 Occupied Bandwidth – 99% power

6.6.1 Test procedure

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

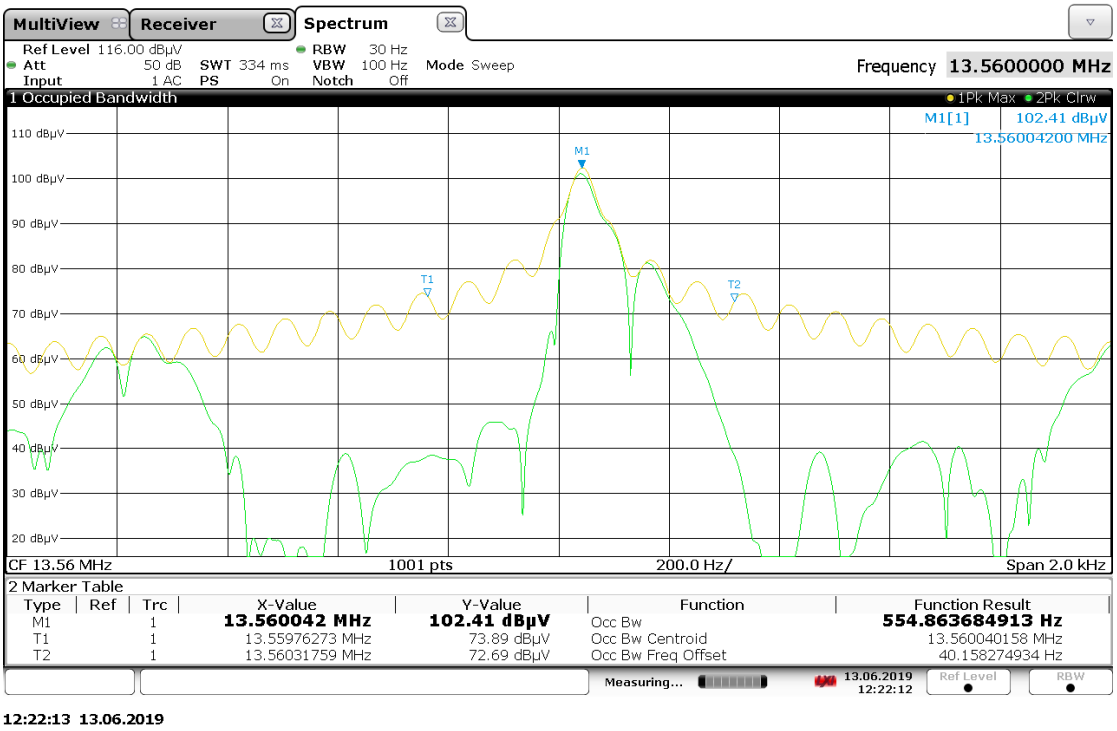
6.6.2 Limits

The 99% power should be contained within the frequency band 13.110 – 14.010 MHz.

6.6.3 Results

Table 6-12: Occupied Bandwidth

Central Frequency [MHz]	99% Bandwidth [Hz]	Low Frequency [MHz]	High Frequency [MHz]	Result
13.56	554.863	13.5597	13.5603	Complied



Graph 6-11: Occupied Bandwidth

END OF REPORT