Test Report No. 7191130600-EEC16/01
dated 29 Mar 2016

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
47 CFR FCC Parts 15B & C
OF A
RFID READER
[Model : VS-2000]
[FCC ID : ZVUVS-2000]

TEST FACILITY	TÜV SÜD PSB Pte Ltd Electrical & Electronics Centre (EEC), Product Services, No. 1 Science Park Drive, Singapore 118221 TÜV SÜD PSB Pte Ltd Electrical & Electronics Centre (EEC), Product Services, 13 International Business Park #01-01, Singapore 609932
FCC REG. NO.	99142 (3m and 10m Semi-Anechoic Chamber, Science Park) & 160581 (3m and 10m Semi-Anechoic Chamber, International Business Park)
IND. CANADA REG. NO.	2932I-1 (3m and 10m Semi-Anechoic Chamber, Science Park) & 2932N-1 (10m Semi-Anechoic Chamber, International Business Park)
PREPARED FOR	TJS USA INC 434 Massachusetts Avenue Suite 406R Boston MA 02118 USA Tel : 1 202 246 8349 Fax : 617 263 1270
QUOTATION NUMBER	2191032663
JOB NUMBER	7191030600
TEST PERIOD	01 Feb 2016 – 16 Mar 2016

PREPARED BY

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TÜV SÜD PSB

ilac-MRA

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The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council. Inspections/Calibrations/Tests marked "Not SAC-SINGLAS Accredited" in this Report are not included in the SAC-SINGLAS Accreditation Schedule for our inspection body/laboratory.

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TEST SUMMARY

The product was tested in accordance with the customer's specifications.

Test Results Summary

Test Standard	Description	Pass / Fail
47 CFR FCC Part 15		
15.107(a), 15.207	Conducted Emissions	Pass *See Note 3
15.109(a), 15.205, 15.209, 15.225(d)	Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)	Pass
15.225(a)	Radiated Emissions (Fundamental) *(applicable if EUT's carrier is in 13.553 -13.567MHz)*	Pass
15.225(b)	Radiated Emissions (Fundamental) *(applicable if EUT's carrier is in 13.410 -13.553MHz or / and 13.567-13.710MHz)*	Not Applicable *See Note 4
15.225(c)	Radiated Emissions (Fundamental) *(applicable if EUT's carrier is in 13.110 -13.410MHz or / and 13.710-14.010MHz)*	Not Applicable *See Note 4
15.225(e)	Frequency Stability Versus Temperature	Pass
15.225(e)	Frequency Stability Versus Input Voltage	Pass

Notes

1. All test measurement procedures are according to ANSI C63.4: 2014 and ANSI C63.10: 2013.

2. The EUT is a Class B device when in non-transmitting state and meets the 47 CFR FCC Part15B Class B requirements.

3. TJS USA INC declares that in line with the product's actual operational function, the 13.56MHz RFID transmitter will be disabled and scanning is not allowed during charging via 12Vdc input.

4. The Equipment Under Test (EUT) operates in 13.56MHz.

Modifications

No modifications were made.

PRODUCT DESCRIPTION

Description	:	The Equipment Under Test (EUT) is a **RFID READER.**
Applicant	:	TJS USA INC 434 Massachusetts Avenue Suite 406R Boston MA 02118 USA
Manufacturer	:	TJS USA INC 434 Massachusetts Avenue Suite 406R Boston MA 02118 USA
Factory (ies)	:	Kenetics Innovations Pte Ltd 2 Tannery Road #05-01 Cencon Building Singapore 347720
Model Number	:	VS-2000
FCC ID	:	ZVUVS-2000
Serial Number	:	P0410150200011
Microprocessor	:	AT91SAM7
Operating / Transmitting Frequency	:	RFID 13.56MHz, bandwidth is 500kHz Bluetooth 2.402GHz (lower channel) to 2.480GHz (upper channel), total 79 channels WiFi 2.412GHz (lower channel) to 2.484GHz (upper channel), total 14 channels
Clock / Oscillator Frequency	:	27.12MHz (RFID) 18.432MHz (Microprocessor)
Modulation	:	RFID Amplitude Shift Keying (RFID) Bluetooth Gaussian Frequency Shift Keying (GFSK) π/4 Differential-Quadrature Phase Shift Keying (DQPSK) 8 Differential Phase-Shift Keying (DPSK) WiFi 11b - DBPSK, DQPSK,CCK for DSSS, 11g - BPSK, QPSK, 16QAM, 64QAM for OFDM, 11n - MCS0~7,OFDM

Continued..

Antenna Gain	:	-0.54dBi (Bluetooth) 2.00dBi (WiFi) 0.00dBi (RFID)
Port / Connectors	:	Refer to manufacturer's user manual / operating manual
Rated Input Power	:	110V 60Hz
Accessories	:	Power Adapter Model TAP12-120S150U1 Input 100V – 240V 50/60Hz 0.5A Output 12Vdc 1.5A 7.2Vdc 710mAh/5.1Wh Battery

SUPPORTING EQUIPMENT DESCRIPTION

The EUT was tested as a stand-alone unit without any supporting equipment.

EUT OPERATING CONDITIONS

47 CFR FCC Part 15
1. Conducted Emissions **2. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)** **3. Radiated Emissions (Fundamental)** **4. Frequency Stability Versus Temperature** **5. Frequency Stability Versus Input Voltage**
The EUT was exercised by operating in maximum continuous transmission in the following test modes 1. Transmitting RFID at 13.56MHz + Bluetooth continuously + Battery Charging. 2. Transmitting RFID at 13.56MHz + WiFi continuously + Battery Charging.

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (Q-P)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
Schaffner EMI Receiver	SMR4503	040	06 Mar 2017
Agilent EMC Analyzer-SA7	E7403A	US41160167	28 May 2016
Schaffner LISN –LISN10 (EUT)	NNB42	04/10055	30 Oct 2016
EMCO LISN (for supporting) – LISN6	3825/2	9309-2127	30 Oct 2016

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another LISN.

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.
3. High peaks, relative to the limit line, were then selected.
4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 9kHz. Both Quasi-peak and Average measurements were made.
5. Steps 2 to 4 were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz	Q-P limit = 60.0 dBμV
Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB	
Q-P reading obtained directly from EMI Receiver = 40.0 dBμV (Calibrated for system losses)	
Therefore, Q-P margin = 60.0 - 40.0 = 20.0	i.e. 20.0 dB below Q-P limit

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Results

Test Input Power	120V 60Hz	Temperature	23ºC
Line Under Test	AC Mains	Relative Humidity	59%
Mode	Bluetooth + Charging	Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Frequency (MHz)	Q-P Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line
0.4023	49.1	57.8	8.7	36.1	47.8	11.7	Live
0.4539	44.3	56.8	12.5	31.9	46.8	14.9	Neutral
0.7176	46.4	56.0	9.6	29.6	46.0	16.4	Live
1.1014	43.9	56.0	12.1	32.0	46.0	14.0	Neutral
1.9861	40.3	56.0	15.7	28.2	46.0	17.8	Neutral
27.1212	56.2	60.0	3.8	34.2	50.0	15.8	Live

Test Input Power	120V 60Hz	Temperature	23ºC
Line Under Test	AC Mains	Relative Humidity	59%
Mode	WiFi + Charging	Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Frequency (MHz)	Q-P Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line
0.4169	35.5	57.5	22.0	14.7	47.5	32.8	Neutral
0.4169	35.5	57.5	22.0	14.7	47.5	32.8	Neutral
0.5131	32.6	56.0	23.4	11.6	46.0	34.4	Neutral
0.6066	32.1	56.0	23.9	10.7	46.0	35.3	Neutral
0.9688	23.3	56.0	32.7	2.6	46.0	43.4	Live
1.3802	27.7	56.0	28.3	6.6	46.0	39.4	Neutral

Notes

1. All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "positive" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a “negative” margin indicates a FAIL.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   9kHz - 30MHz
   RBW: 9kHz VBW: 30kHz
4. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 9kHz – 30MHz is ±2.2dB.

47 CFR FCC Part 15.205 Restricted Bands

MHz			MHz			MHz			GHz		
0.090	-	0.110	16.42	-	16.423	399.9	-	410	4.5	-	5.15
0.495	-	0.505	16.69475	-	16.69525	608	-	614	5.35	-	5.46
2.1735	-	2.1905	16.80425	-	16.80475	960	-	1240	7.25	-	7.75
4.125	-	4.128	25.5	-	25.67	1300	-	1427	8.025	-	8.5
4.17725	-	4.17775	37.5	-	38.25	1435	-	1626.5	9.0	-	9.2
4.20725	-	4.20775	73	-	74.6	1645.5	-	1646.5	9.3	-	9.5
6.215	-	6.218	74.8	-	75.2	1660	-	1710	10.6	-	12.7
6.26775	-	6.26825	108	-	121.94	1718.8	-	1722.2	13.25	-	13.4
6.31175	-	6.31225	123	-	138	2200	-	2300	14.47	-	14.5
8.291	-	8.294	149.9	-	150.05	2310	-	2390	15.35	-	16.2
8.362	-	8.366	156.52475	-	156.52525	2483.5	-	2500	17.7	-	21.4
8.37625	-	8.38675	156.7	-	156.9	2690	-	2900	22.01	-	23.12
8.41425	-	8.41475	162.0125	-	167.17	3260	-	3267	23.6	-	24.0
12.29	-	12.293	167.72	-	173.2	3332	-	3339	31.2	-	31.8
12.51975	-	12.52025	240	-	285	3345.8	-	3358	36.43	-	36.5
12.57675	-	12.57725	322	-	335.4	3600	-	4400	Above 38.6		
13.36	-	13.41									

47 CFR FCC Parts 15.109(a), 15.209 and 15.225(d) Radiated Emission Limits

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m)
0.009 - 0.490	20 log [2400 / F (kHz)] @ 300m
0.490 - 1.705	20 log [24000 / F (kHz)] @ 30m
1.705 - 30.0	30.0 @ 30m
30 - 88	40.0 @ 3m
88 - 216	43.5 @ 3m
216 - 960	46.0 @ 3m
Above 960	54.0* @ 3m
* For frequency bands 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

47 CFR FCC Parts 15.109(a), 15.209 and 15.225(d) Radiated Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver – ESI1	ESI40	100010	14 Jul 2016
Schaffner Bilog Antenna –(30MHz-2GHz) BL4	CBL6112B	2593	15 Dec 2016
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	20 Apr 2016
ETS Horn Antenna(18GHz-40GHz)(Ref)	3116	0004-2474	14 Oct 2016
Toyo Preamplifier (26.5GHz-40GHz)	HAP26-40W	00000005	14 Oct 2016
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	13 Mar 2017
Agilent Preamplifier(1GHz-26.5GHz) (PA18)	8449D	3008A02305	06 Oct 2016
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441096	09 Oct 2016
EMCO Loop Antenna (9kHz – 30MHz)	6502	134413	01 Oct 2016
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2016

47 CFR FCC Parts 15.109(a), 15.209 and 15.225(d) Radiated Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table for measurement up to 1GHz. For measurement above 1GHz, 1.5m height table was used.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

47 CFR FCC Parts 15.109(a), 15.209 and 5.225(d) Radiated Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.
3. The test was carried out at the selected frequency points obtained from the prescan in step 2. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point in the range of 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, both Peak and Average measurements were carried out.
5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.
6. The frequency range covered was from the lowest radio frequency signal generated from the EUT, without going below 9kHz to 10th harmonics of the EUT fundamental frequency, using the loop antenna for frequency below 30MHz, Bi-log antenna for frequencies from 30MHz up to 1GHz, and the Horn antenna above 1GHz.

Sample Calculation Example

At 300 MHz	Q-P limit = 46.0 dBμV/m
Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB	
Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m (Calibrated level including antenna factors & cable losses)	
Therefore, Q-P margin = 46.0 - 40.0 = 6.0	i.e. 6.0 dB below Q-P limit

47 CFR FCC Parts 15.109(a), 15.205, 15.209 and 15.225(d) Radiated Emission Results

Test Input Power	120V 60Hz	Temperature	23°C
Test Distance	3m (<30MHz) 3m (≥30MHz – 25GHz)	Relative Humidity	59%
Mode	RFID + Bluetooth + Charging	Atmospheric Pressure	1030mbar
		Tested By	Jason Lai Sze Hian

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Note 3

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 5	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)
0.1570	60.0	123.7	63.7	--	103.7	43.7	120	282
0.1910	57.3	122.0	64.7	--	102.0	44.7	120	323
0.2240	56.5	120.6	64.1	--	100.6	44.1	120	356
0.2580	55.1	119.4	64.3	--	99.4	44.3	120	176
0.2910	53.5	118.3	64.8	--	98.3	44.8	120	282

Spurious Emissions ranging from 9kHz – 30MHz *See Note 4

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
17.1912	22.3	69.5	47.2	120	174

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
44.7390	30.5	40.0	9.5	100	237	V
161.6890	31.9	43.5	11.6	100	187	V
215.7040	34.0	43.5	9.5	100	159	V
270.5180	34.9	46.0	11.1	100	81	V
378.9890	44.6	46.0	1.4	100	160	V
798.2400	41.9	46.0	4.1	100	173	V

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
1.6565	29.2	74.0	44.8	15.3	54.0	38.7	101	341	H
3.5643	40.2	74.0	33.8	26.7	54.0	27.3	101	216	V
4.9727	49.0	74.0	25.0	35.6	54.0	18.4	218	162	H
5.6965	48.1	74.0	25.9	34.3	54.0	19.7	399	216	H
15.1708	48.6	74.0	25.4	35.5	54.0	18.5	100	271	H
17.5140	50.0	74.0	24.0	36.7	54.0	17.3	100	151	V

47 CFR FCC Parts 15.109(a), 15.205, 15.209 and 15.225(d) Radiated Emission Results

Test Input Power	120V 60Hz	Temperature	23°C
Test Distance	3m (<30MHz) 3m (≥30MHz – 25GHz)	Relative Humidity	59%
Mode	RFID + 802.11b + Charging	Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Note 3

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 5	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)
0.1570	61.0	123.7	62.7	--	103.7	42.7	120	54
0.1910	59.0	122.0	63.0	--	102.0	43.0	120	41
0.2240	56.5	120.6	64.1	--	100.6	44.1	120	184
0.2580	54.4	119.4	65.0	--	99.4	45.0	120	9
0.4260	51.4	115.0	63.6	--	95.0	43.6	120	63

Spurious Emissions ranging from 9kHz – 30MHz *See Note 4

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
27.1440	25.5	69.5	44.0	120	174.3

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
44.7310	30.6	40.0	9.4	100	204	V
119.9980	37.0	43.5	6.5	100	29	V
162.3670	31.8	43.5	11.7	107	171	V
215.6320	35.3	43.5	8.2	106	148	V
270.6940	37.3	46.0	8.7	100	178	V
311.8790	39.0	46.0	7.0	170	71	V

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
3.2366	38.8	74.0	35.2	39.0	54.0	15.0	200	168	V
3.2872	42.8	74.0	31.2	40.3	54.0	13.7	100	134	H
4.8761	45.3	74.0	28.7	42.2	54.0	11.8	200	172	H
4.9267	42.5	74.0	31.5	41.6	54.0	12.4	200	255	H
4.9469	40.6	74.0	33.4	39.0	54.0	15.0	200	179	V
5.6047	41.9	74.0	32.1	41.1	54.0	12.9	200	168	V

47 CFR FCC Parts 15.109(a), 15.205, 15.209 and 15.225(d) Radiated Emission Results

Test Input Power	120V 60Hz	Temperature	23°C
Test Distance	3m (<30MHz) 3m (≥30MHz – 25GHz)	Relative Humidity	59%
Mode	RFID + 802.11g + Charging	Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Note 3

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 5	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)
0.0150	80.3	144.1	63.8	--	124.1	43.8	120	193

Spurious Emissions ranging from 9kHz – 30MHz *See Note 4

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
2.4430	39.5	69.5	30.0	120	340
26.4760	31.2	69.5	38.3	120	59
26.9620	34.3	69.5	35.2	120	119
27.5690	32.8	69.5	36.7	120	185
27.9330	28.8	69.5	40.7	120	185

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
44.7350	32.4	40.0	7.6	100	201	V
120.0020	36.4	43.5	7.1	100	48	V
167.9880	35.8	43.5	7.7	100	149	V
215.9690	34.1	43.5	9.4	107	173	V
269.4400	33.7	46.0	12.3	100	93	V
311.8870	38.1	46.0	7.9	170	115	V

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
3.2872	43.1	74.0	30.9	40.8	54.0	13.2	200	156	V
4.9267	43.7	74.0	30.3	39.6	54.0	14.4	300	266	H
5.1999	42.2	74.0	31.8	40.6	54.0	13.4	200	186	V
5.2404	44.3	74.0	29.7	41.1	54.0	12.9	200	197	V
5.6857	43.1	74.0	30.9	42.9	54.0	11.1	200	174	V
5.8071	42.0	74.0	32.0	39.8	54.0	14.2	400	266	H

47 CFR FCC Parts 15.109(a), 15.205, 15.209 and 15.225(d) Radiated Emission Results

Test Input Power	120V 60Hz	Temperature	23°C
Test Distance	3m (<30MHz) 3m (≥30MHz – 25GHz)	Relative Humidity	59%
Mode	RFID + 802.11n + Charging	Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Note 3

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 5	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)
0.4400	51.0	114.7	63.7	--	94.7	43.7	120	322

Spurious Emissions ranging from 9kHz – 30MHz *See Note 4

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
1.6540	37.7	63.2	25.5	120	214
3.5350	31.2	69.5	38.3	120	243
9.0580	24.5	69.5	45.0	120	194
17.1910	22.3	69.5	47.2	120	95
27.1440	25.5	69.5	44.0	120	174

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
48.0010	35.7	40.0	4.3	100	244	V
120.0100	34.5	43.5	9.0	100	40	V
162.1700	31.4	43.5	12.1	100	167	V
167.9960	35.7	43.5	7.8	106	173	V
270.2690	35.0	46.0	11.0	100	174	V
324.8420	36.4	46.0	9.6	100	177	V

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
3.2872	43.2	74.0	30.8	40.9	54.0	13.1	200	161	V
4.8356	40.0	74.0	34.0	39.8	54.0	14.2	100	225	V
4.9267	43.5	74.0	30.5	39.3	54.0	14.7	100	103	V
5.2404	43.5	74.0	30.5	41.9	54.0	12.1	300	278	H
5.6452	45.8	74.0	28.2	42.8	54.0	11.2	100	173	V
5.6857	44.5	74.0	29.5	43.0	54.0	11.0	100	160	V

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A closer test distance of 3m was used for the measurement instead of 30m as the fundamental (carrier) electric field strength of the EUT at the 10m distance shows compliance to the limit of 30m test distance.
3. "--" indicates no emissions were found and shows compliance to the limits.
4. The measurement was done at 3m. The specified test limits were extrapolated to the measurement distance as specified in § 15.209 (a) based on 40dB/decade.
5. As the measured peak shows compliance to the average limit, as such no average measurement was required.
6. Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz. The average measurement was done by averaging over a complete cycle of the pulse train, including the blanking interval as the pulse train duration does not exceed 0.1 second.
7. A "positive" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative" margin indicates a FAIL.
8. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   9kHz - 150kHz
   RBW: 100Hz VBW: 300Hz
   150kHz - 30MHz
   RBW: 10kHz VBW: 30kHz
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz
9. The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33(a) for intentional radiators & Section 15.33(b) for unintentional radiators.
10. The channel in the table refers to the transmit channel of the EUT.
11. Radiated Emissions Measurement Uncertainty
    All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 25GHz is ±4.0dB.

47 CFR FCC Parts 15.225(a), 15.225(b) and 15.225(c) Radiated Emission (Fundamental) Limits

Fundamental Frequency (MHz)	Field Strength of Fundamental Limit Values @ 30m (dBµV/m)
13.553 - 13.567	84.0
13.410 -13.553	50.5
13.567 -13.710	50.5
13.110 -13.410	40.5
13.710 -14.010	40.5

47 CFR FCC Parts 15.225(a), 15.225(b) and 15.225(c) Radiated Emission (Fundamental) Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver – ESI1	ESI40	100010	14 Jul 2016
Schaffner Bilog Antenna –(30MHz-2GHz) BL4	CBL6112B	2593	15 Dec 2016
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	20 Apr 2016
ETS Horn Antenna(18GHz-40GHz)(Ref)	3116	0004-2474	14 Oct 2016
Toyo Preamplifier (26.5GHz-40GHz)	HAP26-40W	00000005	14 Oct 2016
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	13 Mar 2017
Agilent Preamplifier(1GHz-26.5GHz) (PA18)	8449D	3008A02305	06 Oct 2016
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441096	09 Oct 2016
EMCO Loop Antenna (9kHz – 30MHz)	6502	134413	01 Oct 2016

47 CFR FCC Parts 15.225(a), 15.225(b) and 15.225(c) Radiated Emission (Fundamental) Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table for measurement up to 1GHz. For measurement above 1GHz, 1.5m height table was used.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

47 CFR FCC Parts 15.225(a), 15.225(b) and 15.225(c) Radiated Emission (Fundamental) Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A prescan was carried out to pick the fundamental frequency from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.
3. The test was carried out at the selected frequency points obtained from the prescan in step 2. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point that above 1GHz, both Peak and Average measurements were carried out.
5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.

Sample Calculation Example

At 300 MHz	Q-P limit = 46.0 dBμV/m
Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB	
Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m (Calibrated level including antenna factors & cable losses)	
Therefore, Q-P margin = 46.0 - 40.0 = 6.0	i.e. 6.0 dB below Q-P limit

47 CFR FCC Part 15.225(a / b / c) Radiated Emission (Fundamental) Results

Test Input Power	120V 60Hz	Temperature	23°C
Test Distance	3m *see Note 2	Relative Humidity	59%
		Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Frequency (MHz)	Peak Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
13.5490	70.3	84.0	13.7	100	197

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the average and peak detectors, are reported. All other emissions were relatively insignificant.
2. A closer test distance of 3m was used for the measurement instead of 30m as the fundamental (carrier) electric field strength of the EUT at the 3m distance shows compliance to the limit of 30m test distance.
3. As the measured peak shows compliance to the Q-P limit, as such no Q-P measurement was required.
4. A "positive" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a “negative” margin indicates a FAIL.
5. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   150kHz - 30MHz
   RBW: 10kHz VBW: 30kHz
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz
6. Radiated Emissions (Fundamental) Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 25GHz is ±4.0dB.

FREQUENCY STABILITY VERSUS TEMPERATURE TEST

47 CFR FCC Part 15.225(e) Frequency Stability Versus Temperature Limits

The EUT shows compliance to the requirements of this section, which states that the frequency tolerance of the carrier frequency shall be ± 0.01% for a temperature variation of -20°C to +50°C at normal supply voltage.

47 CFR FCC Part 15.225(e) Frequency Stability Versus Temperature Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Universal Counter	53132A	3736A06236	05 Apr 2016
Hewlett Packard DC Power Supply	6228B	2833A-0523	Output Monitor
EMCO Near Field Probe Set	7405	9107-2063	Output Monitor

47 CFR FCC Part 15.225(e) Frequency Stability Versus Temperature Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo. The EUT was placed in an environmental temperature chamber with a nominal supply voltage. For the battery operated EUT, a new battery was used.
2. The RF antenna connector of the EUT was connected to the frequency counter via a low-loss coaxial cable.

47 CFR FCC Part 15.225(e) Frequency Stability Versus Temperature Test Method

1. The EUT was switched off and the environmental temperature was set to the highest temperature, i.e, +50°C.
2. Upon reaching the highest set temperature with 30 minutes of stabilisation period, the EUT was switched on and configured to operate in the test mode with transmitting frequency at 13.56MHz.
3. The EUT's transmitting frequency was then measured at start up, and two, five and ten minutes after start up with the frequency counter set to max hold to capture the transmitting frequency. For each measurement, the signal capturing was continuous until no further changes were observed. Four measurements were made in total.
4. Repeat steps 1 to 3 with the temperature set to the lowest temperature, i.e, -20°C.

FREQUENCY STABILITY VERSUS TEMPERATURE TEST

47 CFR FCC Part 15.225(e) Frequency Stability Versus Temperature Results

Test Input Power	7.2Vdc	Temperature	+50°C
		Relative Humidity	59%
		Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Channel Frequency (MHz)	± 0.01% Carrier Tolerance (MHz)	Measured Tolerance (Hz)	Measurement with respects to Start Up Time (Mins)
13.5600	±1356.0000	19.8200	0
13.5600	±1356.0000	113.8100	2
13.5600	±1356.0000	99.8400	5
13.5600	±1356.0000	135.6200	10

Test Input Power	7.2Vdc	Temperature	-20°C
		Relative Humidity	59%
		Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Channel Frequency (MHz)	± 0.01% Carrier Tolerance (MHz)	Measured Tolerance (Hz)	Measurement with respects to Start Up Time (Mins)
13.5600	±1356.0000	-27.4500	0
13.5600	±1356.0000	-50.9100	2
13.5600	±1356.0000	-76.0900	5
13.5600	±1356.0000	-76.0900	10

FREQUENCY STABILITY VERSUS INPUT VOLTAGE TEST

47 CFR FCC Part 15.225(e) Frequency Stability Versus Input Voltage Limits

The EUT shows compliance to the requirements of this section, which states that the frequency tolerance of the carrier frequency shall be ± 0.01% for variation of a primary voltage from 85% to 115% of the rated supply voltage at a temperature of 20ºC. For a battery operated equipment, the equipment tests shall be performed using a new battery.

47 CFR FCC Part 15.225(e) Frequency Stability Versus Input Voltage Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Universal Counter	53132A	3736A06236	05 Apr 2016
Hewlett Packard DC Power Supply	6228B	2833A-0523	Output Monitor
EMCO Near Field Probe Set	7405	9107-2063	Output Monitor

47 CFR FCC Part 15.225(e) Frequency Stability Versus Input Voltage Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo. The EUT was placed in an environmental temperature chamber with a nominal supply voltage. For the battery operated EUT, a new battery was used.
2. The RF antenna connector of the EUT was connected to the frequency counter via a low-loss coaxial cable.

47 CFR FCC Part 15.225(e) Frequency Stability Versus Input Voltage Test Method

1. The EUT was switched off and the environmental temperature was set to 20ºC.
2. Upon reaching the set temperature with 30 minutes of stabilisation period, the EUT was switched on and configured to operate in the test mode with transmitting frequency at 13.56MHz.
3. The EUT's transmitting frequency was then measured at start up, and two, five and ten minutes after start up with the frequency counter set to max hold to capture the transmitting frequency. For each measurement, the signal capturing was continuous until no further changes were observed. Four measurements were made in total.
4. Repeat steps 1 to 3 with the supply voltage set to 85% and 115% of the nominal voltage supply respectively. For the battery operated EUT, this step is not applicable.

47 CFR FCC Part 15.225(e) Frequency Stability Versus Input Voltage Results

Test Input Power	7.2Vdc (Nominal Voltage)	Temperature	20°C
		Relative Humidity	59%
		Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Channel Frequency (MHz)	± 0.01% Carrier Tolerance (MHz)	Measured Tolerance (Hz)	Measurement with respects to Start Up Time (Mins)
13.5600	±1356.0000	137.4607	0
13.5600	±1356.0000	130.8352	2
13.5600	±1356.0000	121.0373	5
13.5600	±1356.0000	105.6177	10

Test Input Power	6.80Vdc (85% of the Nominal voltage)	Temperature	20°C
		Relative Humidity	59%
		Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Channel Frequency (MHz)	± 0.01% Carrier Tolerance (MHz)	Measured Tolerance (Hz)	Measurement with respects to Start Up Time (Mins)
13.5600	±1356.0000	19.1897	0
13.5600	±1356.0000	45.9341	2
13.5600	±1356.0000	49.4828	5
13.5600	±1356.0000	63.4036	10

Test Input Power	8.28Vdc (115% of the Nominal voltage)	Temperature	20°C
		Relative Humidity	59%
		Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Channel Frequency (MHz)	± 0.01% Carrier Tolerance (MHz)	Measured Tolerance (Hz)	Measurement with respects to Start Up Time (Mins)
13.5600	±1356.0000	-0.1630	0
13.5600	±1356.0000	90.5087	2
13.5600	±1356.0000	40.4963	5
13.5600	±1356.0000	79.6613	10

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