

Report on the EMC Testing of:

REAL-TIME PCR INSTRUMENT

Model(s): QuantStudio™ 7 Pro Real-Time PCR System & QuantStudio™ 6 Pro Real-Time PCR System

In accordance with
FCC 47 CFR Part 15C
LP0002: 2018, January 10

Prepared for:
Life Technologies Holdings Pte Ltd
33 Marsiling Industrial Estate Road 3
#07-06 Singapore 739256

COMMERCIAL-IN-CONFIDENCE

Document Number: 7191209644-EEC19/01 | Issue: 1
Contains FCC ID: PJMMR102

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Song Zhi Qun	11 May 2019	
Authorised Signatory	Quek Keng Huat	10 May 2019	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD PSB document control rules.

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with the mentioned standard(s).



LA-2007-0380-A
LA-2007-0381-F
LA-2007-0382-B
LA-2007-0383-G

LA-2007-0384-G
LA-2007-0385-E
LA-2007-0386-C
LA-2010-0464-D

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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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	11 May 2019





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1.2 Introduction

Applicant	:	Life Technologies Holdings Pte Ltd 33 Marsiling Industrial Estate Road 3 #07-06 Singapore 739256
Manufacturer	:	Same as Applicant
Factory	:	Life Technologies Holdings Pte Ltd 33 Marsiling Industrial Estate Road 3 #07-06 Singapore 739256
Model Number(s)	:	QuantStudio™ 7 Pro Real-Time PCR System (tested) QuantStudio™ 6 Pro Real-Time PCR System (declared)
Serial Number(s)	:	277871902001
Number of Samples Tested	:	1
Test Sample(s) Condition	:	Good
Quotation Reference	:	5150264
Test Specification/Issue/Date	:	FCC 47 CFR 15B LP0002: 2018
Test Sample(s) Received Date	:	19 Feb 2019
Start of Test	:	19 Feb 2019
Finish of Test	:	26 Mar 2019

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with the specifications as shown below.

Specification Clause	Test Description	Result	Comments/Base Standard
FCC 47 CFR 15/ LP0002			
15.107(a), 15.207/ Clause 2.3	Conducted Emissions	Pass	ANSI C63.4: 2014 ANSI C63.10: 2013
15.109(a), 15.205, 15.209, 15.225(d) Clauses 2.7, 2.8	Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)	Pass	ANSI C63.4: 2014 ANSI C63.10: 2013
15.225(a)/ Clauses 2.7	Radiated Emissions (Fundamental)	Pass	ANSI C63.10: 2013
15.225(e)/ Appendix Part VI	Frequency Stability Versus Temperature	Pass	ANSI C63.10: 2013
15.225(e)/ Appendix Part VII	Frequency Stability Versus Input Voltage	Pass	ANSI C63.10: 2013
2.1091/ Clause 5.20.2	Maximum Permissible Exposure	See Note 2	

Notes

- The Equipment Under Test (EUT) incorporates the FCC certified RFID module bearing FCC ID: JMMR012 without modifications. The complies to requirements based on the following justifications:
 - the RFID module was evaluated at -20°C to 60°C. The temperature range of the EUT 15°C to 30°C.
 - there is a voltage regulator after the DC input of the RFID module.
- The EUT is employing a 13.56MHz RFID. The highest level detected was 54.5dBµV/m at 10m distance which was extrapolated to 35.5dBµV/m at 30m. The level is below the general population/uncontrolled exposure level of 60.7dBµV/m at 13.56MHz .
- Life Technologies Holdings Pte Ltd declare QuantStudio™ 7 Pro Real-Time PCR System is similar to QuantStudio™ 6 Pro Real-Time PCR System. The differences between both models are tabulated in Table 1 below.

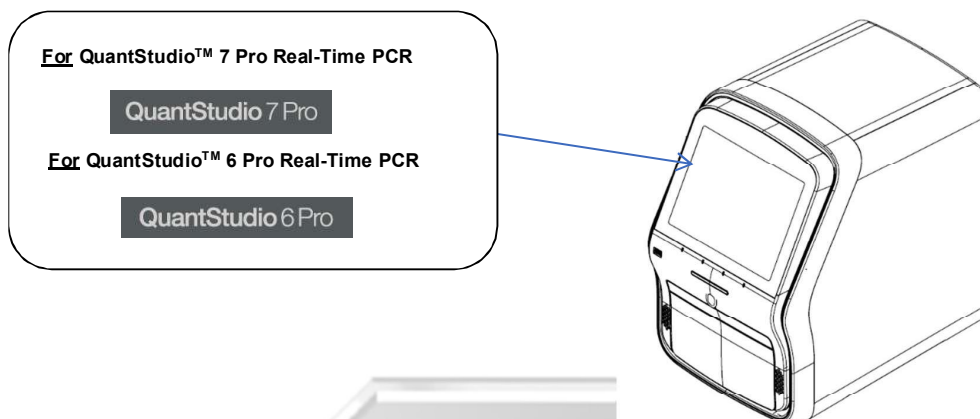
Part / Assembly Type	Differences
Finish Goods SKU Number, Silkscreen and Product Label	The differences are related to silkscreen at drawer cover, product label and SKU number.
Emission Filter and Excitation Filter	QuantStudio™ 6 Pro Real-Time PCR System shall disable 1x emission filter and 1x excitation filter. QuantStudio™ 7 Pro Real-Time PCR System uses all the emission filters and excitation filters
Drawer Cover	Different in silkscreen.

Table 1



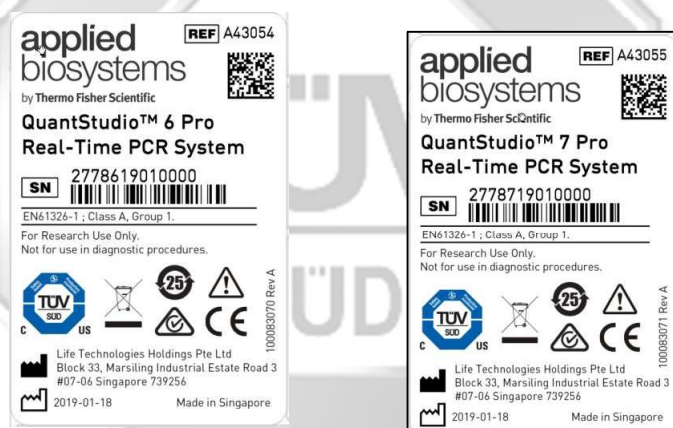
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All the enclosures for QuantStudio™ 7 Pro Real-Time PCR System and QuantStudio™ 6 Pro Real-Time PCR System have same color and material type except silkscreen.



Picture 1

Difference for QuantStudio™ 7 Pro Real-Time PCR System and QuantStudio™ 6 Pro Real-Time PCR System labels are shown in Picture 2.



Picture 2

Rating labels at the rear of both QuantStudio™ 7 Pro Real-Time PCR System and QuantStudio™ 6 Pro Real-Time PCR System are the same. The electrical parts, mechanical parts, cables and the connections in both QuantStudio™ 7 Pro Real-Time PCR System and QuantStudio™ 6 Pro Real-Time PCR System are the same.

QuantStudio™ Pro 96-Well Block and QuantStudio™ Pro 96-Well Heated Cover are used together in both QuantStudio™ 7 Pro Real-Time PCR System and QuantStudio™ 6 Pro Real-Time PCR System.



1.4 Product Information

1.4.1 Technical Description

Description	:	The Equipment Under Test(s) (EUT(s)) is a Real-Time PCR System. The equipment uses fluorescent-based polymerase chain reaction (PCR) reagents to perform - Quantitative detection of target nucleic acid sequences (targets) - Qualitative detection of targets (endpoint analysis) - Qualitative analysis of the PCR product (post-PCR melt curve analysis) The equipment can be run directly from the touchscreen to create & start experiments; and has the following features. - Facial authentication - An Interchangeable block - Microphone for voice activation - Speakers - Proximity detection - RFID for tracking plates
Microprocessor	:	Freescale MC56F84789, Freescale MC56F8367, Freescale MCIMX6Q5EYM10AC, Intel Core i5-4300U
Operating Frequency	:	100 MHz (MC56F84789), 60MHz (MC56F8367), 1GHz (MCIMX6Q5EYM10AC), 2.9GHz (Intel Core i5-4300U)
Clock / Oscillator Frequency	:	8MHz (MC56F84789 & MC56F8367)
Modulation	:	ASK
Antenna Gain	:	0dBi
Port / Connectors	:	AC Inlet, USB, LAN
Rated Power	:	Input 100V -240V, 50/ 60Hz, Max Power 960W

(continued)

Accessories	:	Nil

1.4.2 Test Configuration and Modes of Operation

Mode(s)	Description
a. Protocol Run with RFID	The EUT was exercised in the mode(s) throughout the test(s).

1.4.3 Performance Criteria and Monitoring Methods

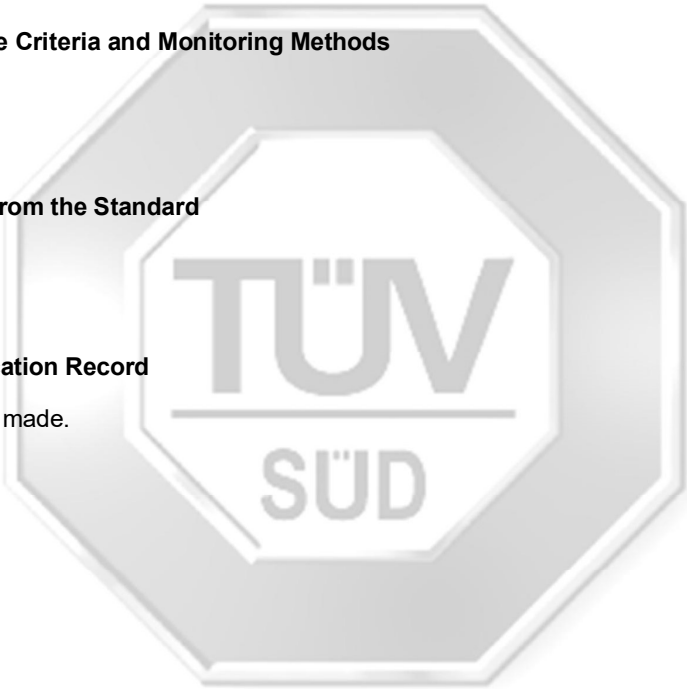
Not Applicable.

1.5 Deviations from the Standard

Nil.

1.6 EUT Modification Record

No modifications were made.



1.7 Test Location(s)

TÜV SÜD PSB Pte Ltd
 Electrical & Electronics Centre (EEC), Product Services,
 1 Science Park Drive, Singapore 118221

TÜV SÜD PSB Pte Ltd
 Electrical & Electronics Centre (EEC), Product Services,
 15 International Business Park #01-01, Singapore 609937

1.8 Test Facilities Registrations

Requirements	Registration Numbers
FCC	994109 (Test Firm Registration Number) SG0002 (Designation Number)
ISED	SGAP01 (CAB Identifier) <u>Science Park</u> 2932I-1 (3m and 10m Semi-Anechoic Chamber) <u>International Business Park</u> 2932N-1 (10m Semi-Anechoic Chamber)
VCCI	<u>Science Park</u> R-1335 (10m ANC) C-2306 (C.E @ Lab 3) T-1471 (Telecom Ports @ Lab 3) <u>International Business Park</u> R-3324 (10m ANC), G-203 (10mANC) C-4933 (C.E @ CEIBP) T-2403 (Telecom Ports @ CEIBP)
BSMI	SL2-IS-E-6001R [CNS-13803 (ISM Equipment)] SL2-IN-E-6001R [CNS-13438 (IT Equipment)] SL2-R1/R2-E-6001R [CNS-13439 (Broadcast Receivers)] SL2-A1-E-6001R [CNS-13783-1 (Household Appliances)] SL2-L1-E-6001R [CNS-14115 (Lighting Equipment)]
SABS	SABS/A-LAB/0029/2018

1.9 Supporting Equipment

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
SYMBOL RFID Module	P/N: LS2208-SR20007R-UR S/N: Y79VG1 FCC ID: PJMMR102	Nil
Dell USB Mouse	M/N: N889 S/N: CN-093H7Y-71581-219-0MWE FCC ID: DoC	1.80m USB cable
Sandisk Cruzer Blade 16GB	M/N: SDCZ50C-016G S/N: BL190125882B FCC ID: DoC	Nil
ThermoFisher 802.11bgn USB Dongle	M/N: 100027791 S/N: 17A35W2200477 FCC ID: 2ADEZ-WUBR508GN	Nil
D-Link Airplus G+ Wireless Router	P/N: DI624 + EEU.B2 S/N: BN67547012180 FCC ID: KA2T1130	1.80m unshielded power cable
DELL Latitude Laptop	M/N: E6530 DPN: TJGG3 A00 FCC ID: DoC	1.80m unshielded power cable
DELL AC Adapter	M/N: LA130PM121 DPN: 0VJCH5 FCC ID: Nil	1.80m unshielded power cable

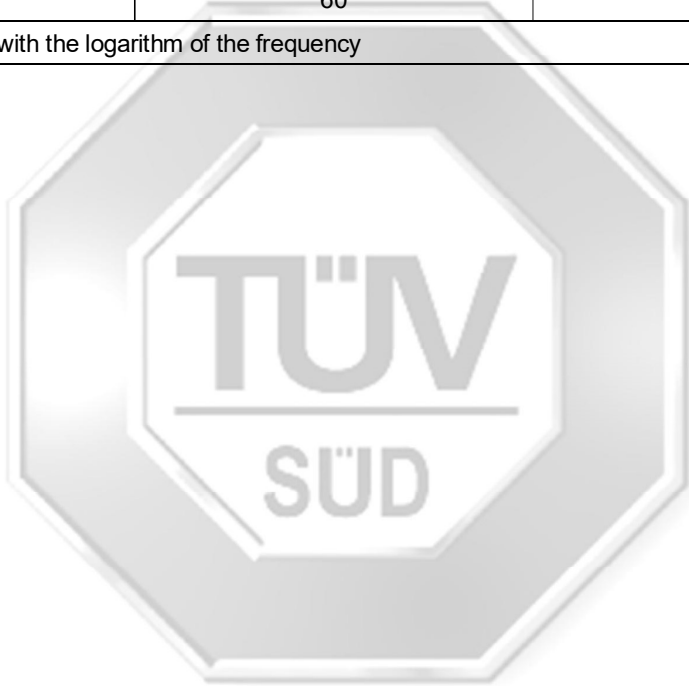
2 Test Details

2.1 Conducted Emissions at Mains Terminals

2.1.1 Test Limits

AC Mains Port (Class B)

Frequency Range (MHz)	Limits (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		





2.1.2 Test Setup

- 2.1.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.
- 2.1.2.2 The power supply for the EUT was fed through a $50\Omega/50\mu\text{H}$ EUT LISN, connected to filtered mains.
- 2.1.2.3 The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
- 2.1.2.4 All other supporting equipment were powered separately from another LISN.

2.1.3 Test Method

- 2.1.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.
- 2.1.3.2 A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.
- 2.1.3.3 High peaks, relative to the limit line, were then selected.
- 2.1.3.4 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.
- 2.1.3.5 The measurements were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz

Q-P limit (Class B) = 60.0 dB μV

Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dB μV
(Calibrated for system losses)

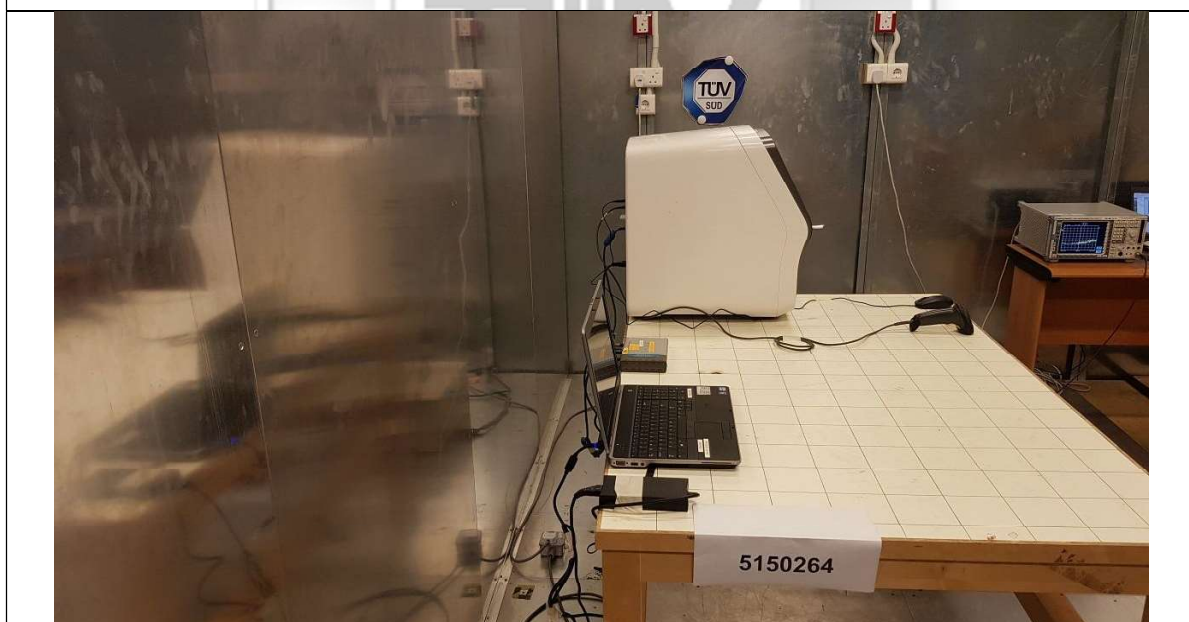
Therefore, Q-P margin = 60.0 - 40.0 = 20.0

i.e. 20.0 dB below Q-P limit

2.1.4 Test Setup Photographs



Conducted Emissions at Mains Test Setup (Front View)



Conducted Emissions at Mains Test Setup (Rear View)



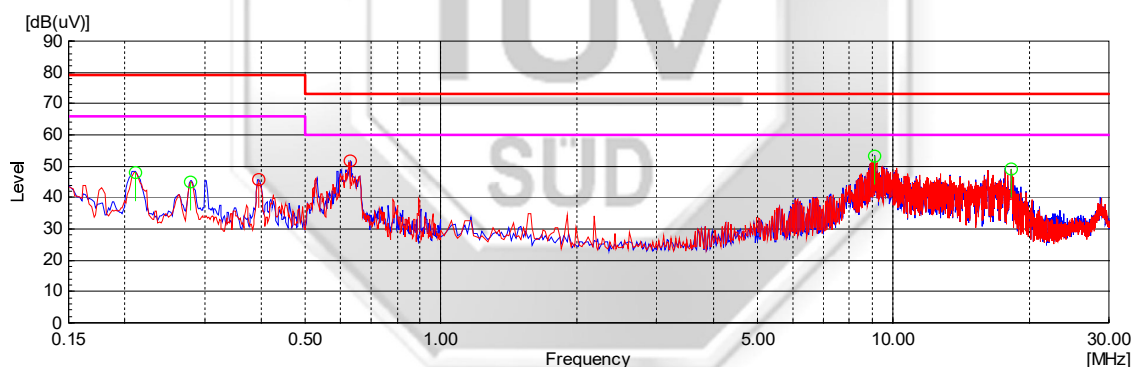
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2.1.5 Test Results

The detailed of the test results are shown below.

Operating Mode	Protocol Run with RFID	Temperature	20°C
Test Input Power	120V 60Hz	Relative Humidity	52%
Line Under Test	AC Mains	Atmospheric Pressure	1017mbar
Class	B	Tested By	Derrick Ng
		Test Date	19 Feb 2019

Frequency(MHz)	Q-P Value (dBμV)	Q-P Limit (dBμV)	Q-P Margin (dB)	AV Value (dBμV)	AV Limit (dBμV)	AV Margin (dB)	Line
0.2089	43.2	63.2	20.0	40.4	53.2	12.8	Live
0.2792	42.4	60.8	18.4	39.4	50.8	11.4	Live
0.3963	37.3	57.9	20.6	36.9	47.9	11.0	Neutral
0.6284	41.6	56.0	14.4	31.3	46.0	14.7	Neutral
9.1072	52.6	60.0	7.4	47.6	50.0	2.4	Live
18.2444	46.8	60.0	13.2	43.2	50.0	6.8	Live



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: <u>150kHz - 30MHz</u> RBW: 9kHz VBW: 30kHz

2.2 Radiated Emissions

2.2.1 Test 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.

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			



2.2.2 Test Setup

- 2.2.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.
- 2.2.2.2 The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
- 2.2.2.3 The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

2.2.3 Test Method

- 2.2.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.
- 2.2.3.2 A pre-scan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the pre-scan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.
- 2.2.3.3 The test was carried out at the selected frequency points obtained from the pre-scan. 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.
- 2.2.3.4 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.
- 2.2.3.5 The measurements were repeated for the next frequency point, until all selected frequency points were measured.

Sample Calculation Example

At 300 MHz

Q-P limit (Class B) = 37.0 dB μ V/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB

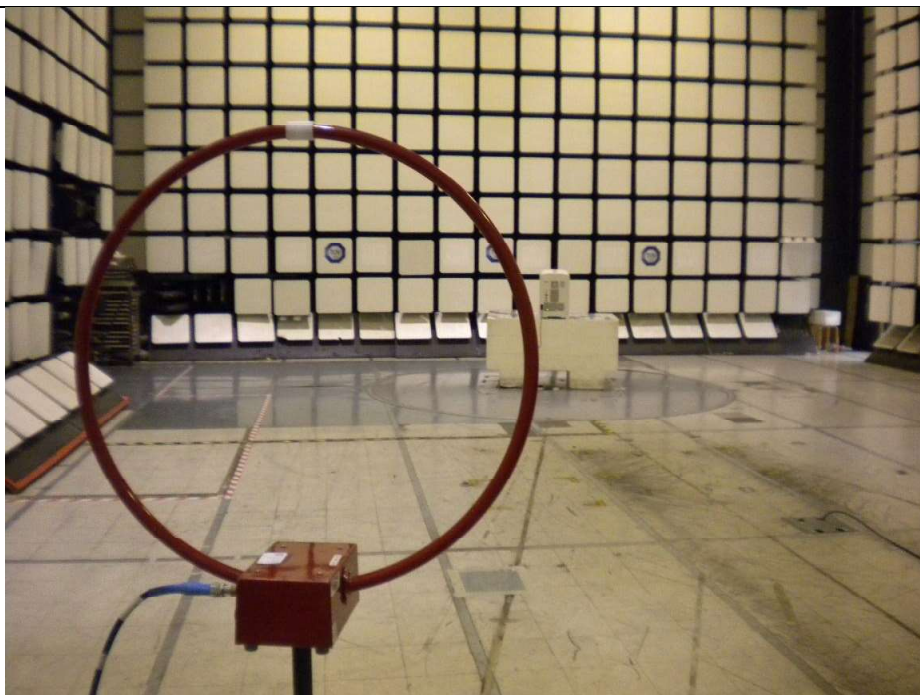
Q-P reading obtained directly from EMI Receiver = 31.0 dB μ V/m
(Calibrated level including antenna factors & cable losses)

Therefore, Q-P margin = 37.0 - 31.0 = 6.0

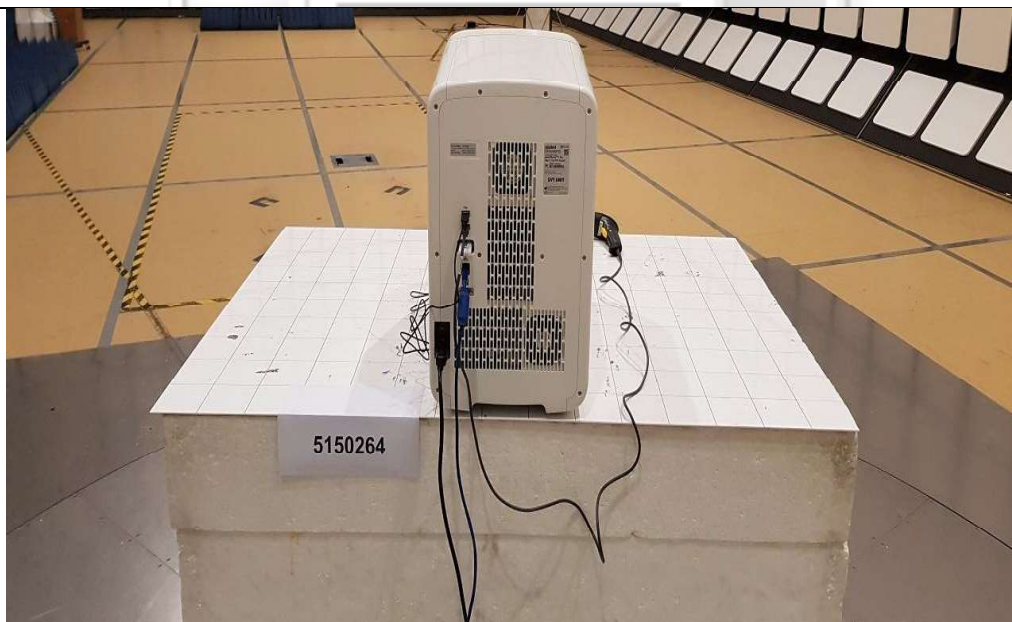
i.e. 6.0 dB below Q-P limit

2.2.4 Test Setup Photographs

9kHz – 30MHz Test Setup



Radiated Emissions Test Setup (Front View)

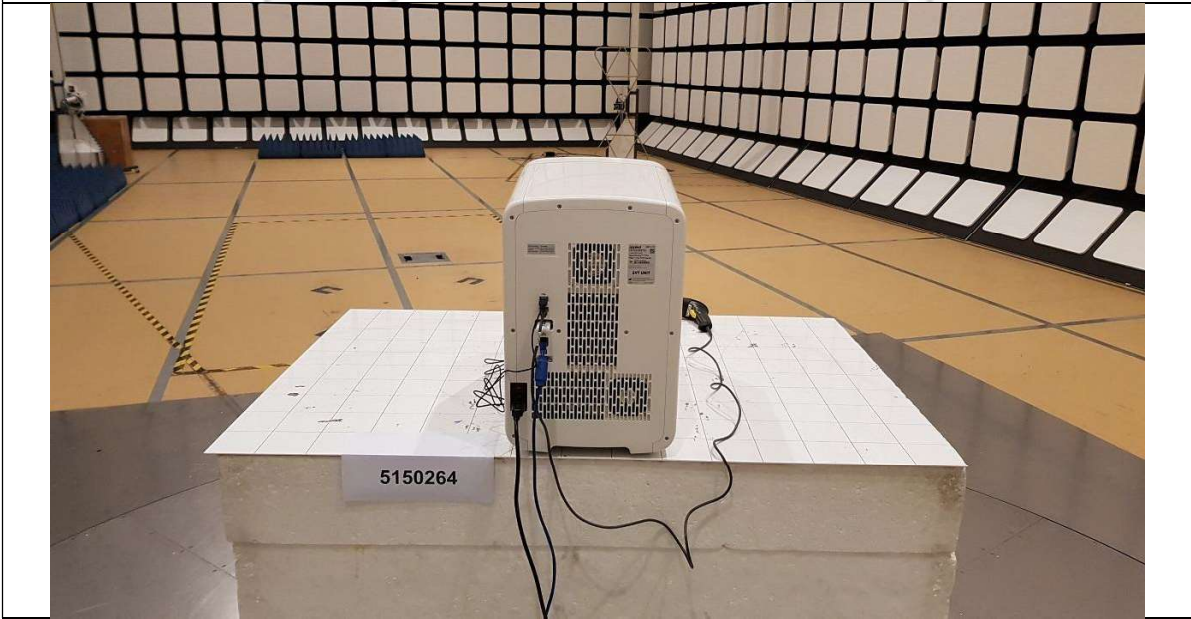


Radiated Emissions Test Setup (Rear View)

30MHz – 1GHz Test Setup



Radiated Emissions Test Setup (Front View)

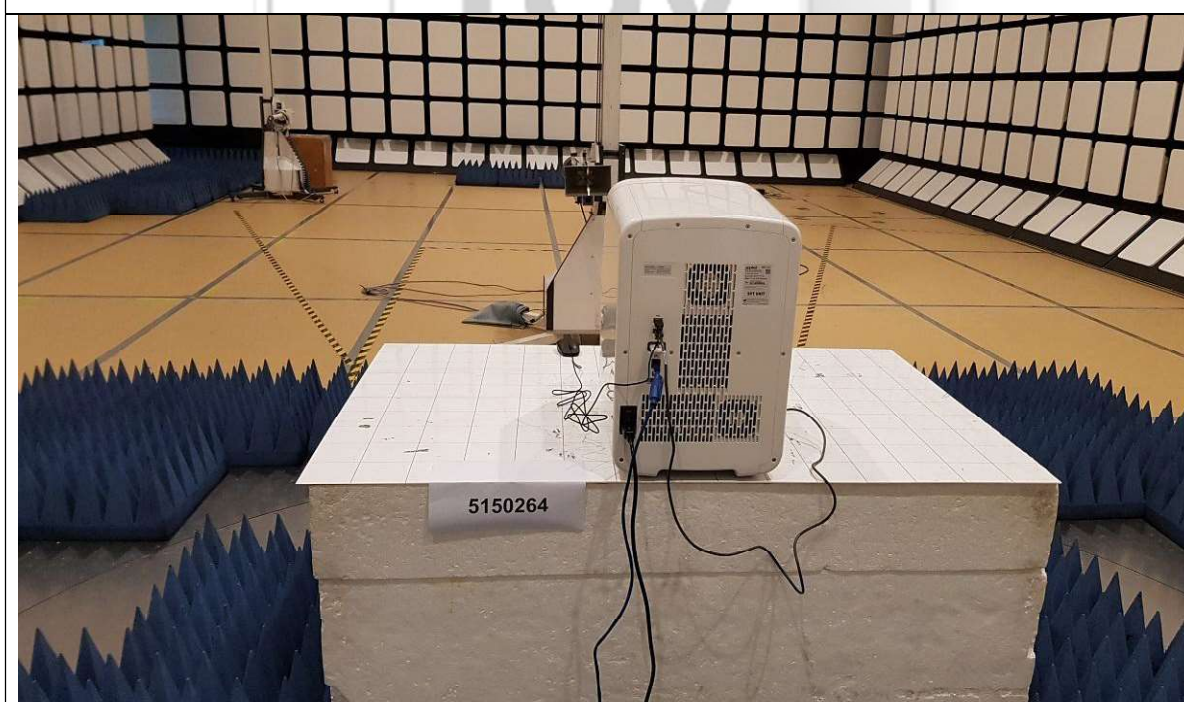


Radiated Emissions Test Setup (Rear View)

1GHz – 18GHz Test Setup



Radiated Emissions Test Setup (Front View)



Radiated Emissions Test Setup (Rear View)

2.2.5 Test Results

The detailed of the test results are shown below.

Operating Mode	Protocol Run with RFID	Temperature	22°C
Test Input Power	120V 60Hz	Relative Humidity	55%
Test Distance	10m (9kHz – 1GHz) 3m (>1GHz – 6GHz)	Atmospheric Pressure	1017mbar
Class	B	Tested By	Derrick Ng
		Test Date	19 Feb 2019

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)	AV Limit (dBμV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
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Spurious Emissions ranging from 9kHz – 30MHz *See Note 3

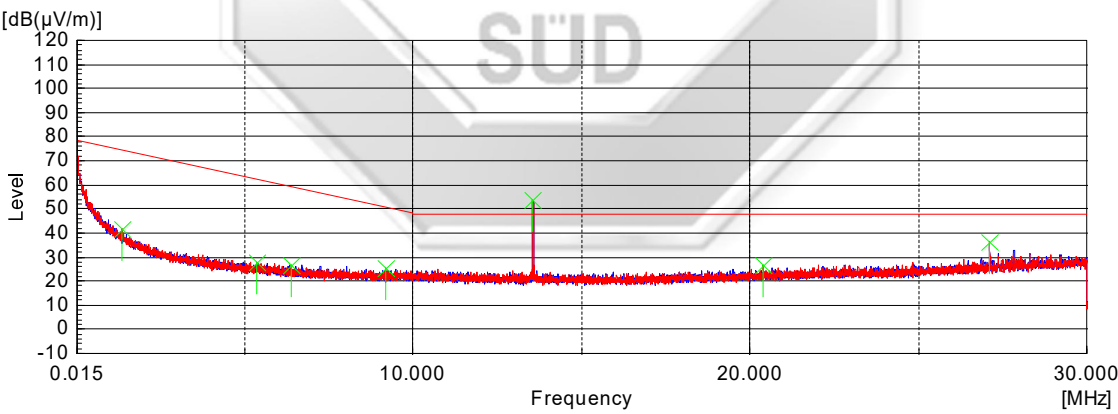
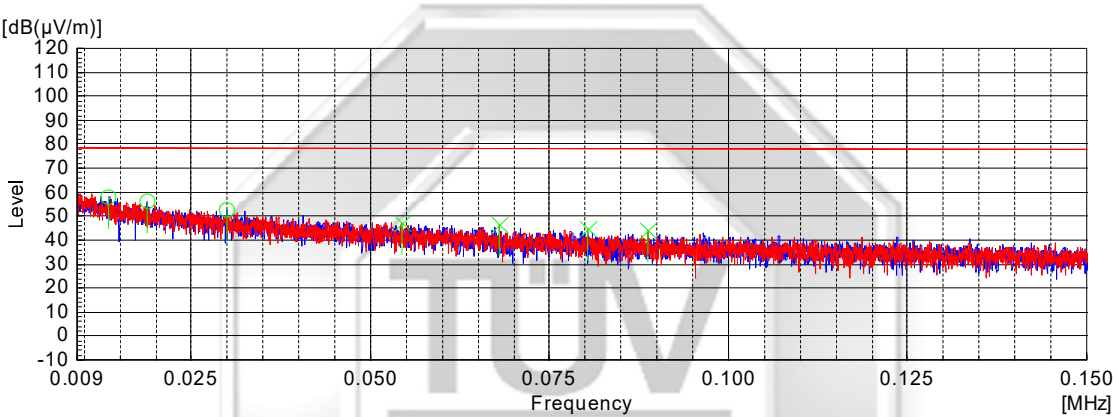
Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Limit (dBμV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
0.0130	-0.9	45.3	46.2	100	191	H
0.0190	-2.9	42.0	44.9	100	29	H
0.0300	-6.7	38.0	44.7	100	191	H
9.1790	6.6	30.0	23.4	100	41	V
20.4090	7.4	30.0	22.6	100	285	V
27.1230	17.4	30.0	12.6	100	11	V

Emissions from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBμV/m) *See Note 4	Q-P Limit (dBμV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Polarisation (H/V)
67.5560	38.0	40.0	2.0	301	231	V
75.6560	38.2	40.0	1.8	299	274	H
246.4880	45.3	46.0	0.7	399	7	H
431.9840	44.9	46.0	1.1	301	50	V
532.0480	45.3	46.0	0.7	301	255	V
784.2960	45.7	46.0	0.3	100	282	H

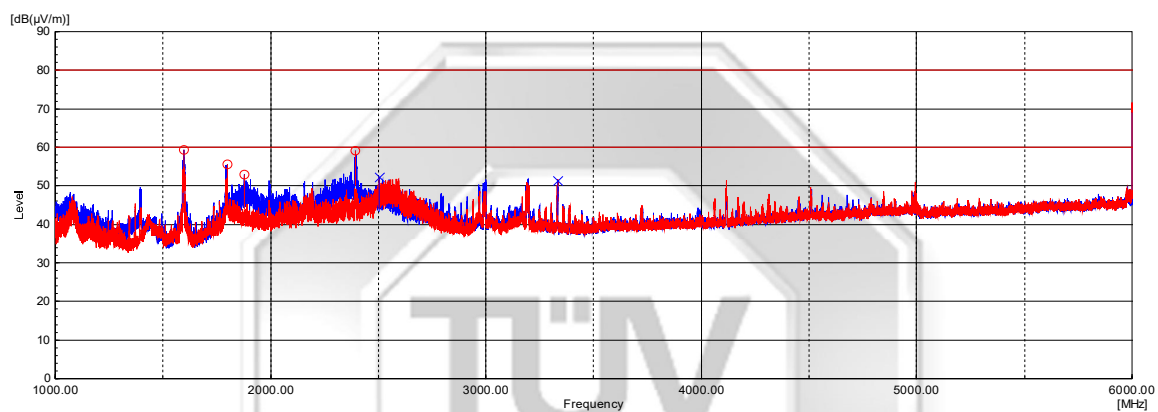
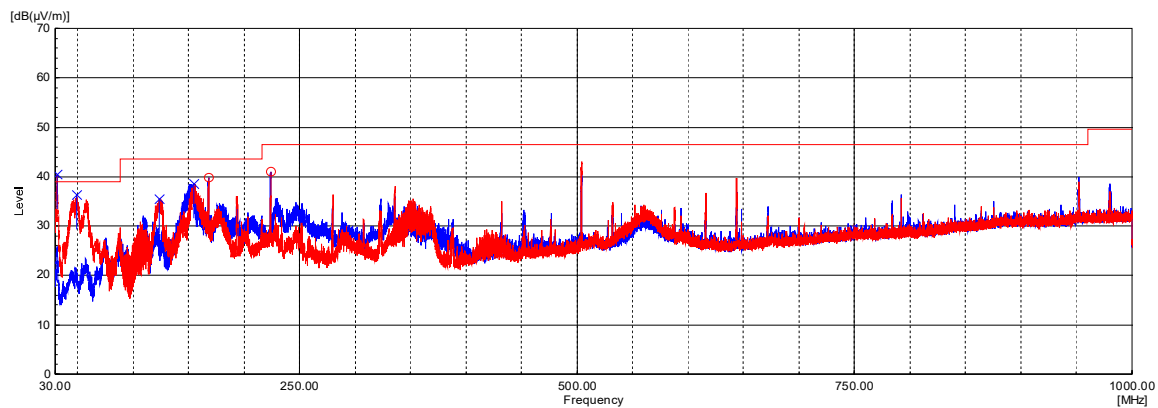
Emissions above 1GHz - 6GHz

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)
1.5928	60.8	74.0	13.2	28.8	54.0	25.2	100	318	H
1.7997	59.7	74.0	14.3	34.1	54.0	19.9	198	293	H
1.8760	52.6	74.0	21.4	28.8	54.0	26.2	102	337	H
2.3997	61.3	74.0	12.7	34.2	54.0	19.8	198	318	H
2.5059	53.1	74.0	20.9	31.0	54.0	23.0	100	304	V
3.3326	55.2	74.0	20.8	40.5	54.0	13.5	100	241	V





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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 "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.	The measurement was done at 10m. The measured results were extrapolated to the specified test limits as specified in § 15.209 (a) based on 40dB/decade.
4.	The measurement was done at 10m. The measured results were extrapolated to the specified test limits at 3m as specified in § 15.209 (a) based on 20dB/decade.
5.	EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings: <u>9kHz - 150kHz</u> RBW: 100Hz VBW: 300Hz <u>150kHz - 30MHz</u> RBW: 10kHz VBW: 30kHz <u>30MHz - 1GHz</u> RBW: 120kHz VBW: 1MHz <u>1GHz – 18GHz</u> RBW: 1MHz VBW: 3MHz
6.	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.
7.	"--" indicates no emissions were found and shows compliance to the limits.

2.3 Radiated Emissions (Fundamental) Limits

2.3.1 Test 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





2.3.2 Test Setup

- 2.3.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.
- 2.3.2.2 The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
- 2.3.2.3 The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

2.3.3 Test Method

- 2.3.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.
- 2.3.3.2 A pre-scan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the pre-scan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.
- 2.3.3.3 The test was carried out at the selected frequency points obtained from the pre-scan. 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.
- 2.3.3.4 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.
- 2.3.3.5 The measurements were repeated for the next frequency point, until all selected frequency points were measured.

Sample Calculation Example

At 300 MHz

Q-P limit (Class B) = 37.0 dB μ V/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB

Q-P reading obtained directly from EMI Receiver = 31.0 dB μ V/m

(Calibrated level including antenna factors & cable losses)

Therefore, Q-P margin = 37.0 - 31.0 = 6.0

i.e. 6.0 dB below Q-P limit

2.3.4 Test Setup Photographs

Test Setup



Radiated Emissions Test Setup (Front View)



Radiated Emissions Test Setup (Rear View)



2.3.5 Test Results

The detailed of the test results are shown below.

Operating Mode	Protocol Run with RFID	Temperature	22°C
Test Input Power	120V 60Hz	Relative Humidity	55%
Test Distance	10m	Atmospheric Pressure	1017mbar
		Tested By	Derrick Ng
		Test Date	19 Feb 2019

Frequency (MHz)	Q-P Value (dB μ V/m)	Q-P Limit (dB μ V/m) *See Note 2	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
13.5600	54.5	84.0	29.5	100	307

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 10m 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.	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.
4.	EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings: <u>150kHz - 30MHz</u> RBW: 10kHz VBW: 30kHz <u>30MHz - 1GHz</u> RBW: 120kHz VBW: 1MHz <u>>1GHz</u> RBW: 1MHz VBW: 3MHz



2.4 Frequency Stability Versus Temperature/Input Voltage

2.4.1 Test Limits

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

2.4.2 Test Setup

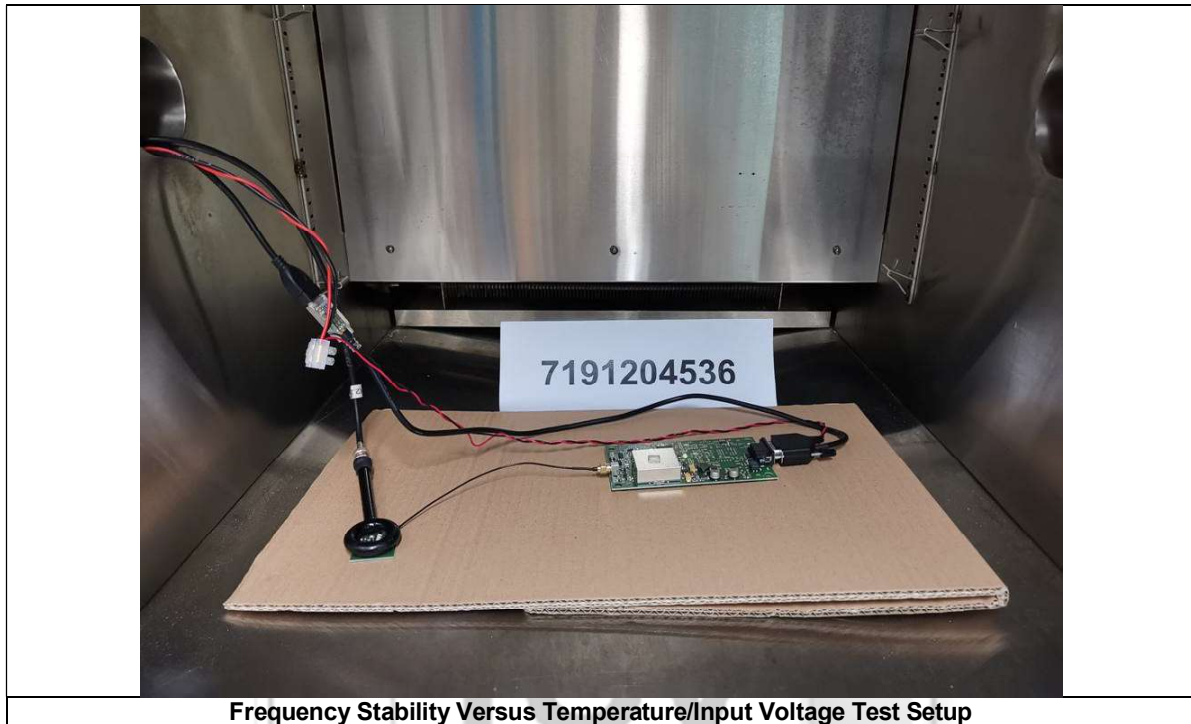
1. The EUT and supporting equipment were set up as shown in the setup photo. The EUT was placed in an environmental temperature chamber with a nominal supply voltage. For the battery operated EUT, a new battery was used.
2. The RF antenna connector of the EUT was connected to the spectrum analyser via a low-loss coaxial cable.
3. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 10kHz and 30kHz.

2.4.3 Test Method

1. The EUT was switched off and the environmental temperature was set to the highest temperature, i.e., $+30^{\circ}\text{C}$.
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 spectrum analyser was 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. The EUT was switched off. The environmental chamber temperature was lowered by 10°C and was allowed the temperature inside the chamber to stabilize.
5. The EUT was turned on and the step 3 was repeated.
6. The steps 3 and 4 were repeated until the lowest temperature was reached, i.e., $+15^{\circ}\text{C}$.
7. Repeat steps 1 to 3 with the supply voltage set to 85% and 115% of the nominal voltage supply respectively.

2.4.4 Test Setup Photographs

Test Setup



2.4.5 Test Results

Operating Mode	Protocol Run with RFID	Temperature	22°C
Test Input Power	12V DC	Relative Humidity	55%
		Atmospheric Pressure	1017mbar
		Tested By	Chelmin Li
		Test Date	26 Mar 2019

Frequency Stability Versus Temperature

Voltage (%)	Power (V _{dc})	Temperature (°C)	± 0.01% Carrier Tolerance (MHz)	Measured Tolerance (MHz)	Measurement with respects to Start Up Time (Mins)
100	12	50.0	13.5601	+ 0.0001	0
			13.5601	+ 0.0001	2
			13.5600	0.0000	5
			13.5601	+ 0.0001	10
		40.0	13.5601	+ 0.0001	0
			13.5600	0.0000	2
			13.5601	+ 0.0001	5
			13.5601	+ 0.0001	10
		30.0	13.5601	+ 0.0001	0
			13.5601	+ 0.0001	2
			13.5600	0.0000	5
			13.5600	0.0000	10
		20.0	13.5600	0.0000	0
			13.5600	0.0000	2
			13.5600	0.0000	5
			13.5600	0.0000	10
		10.0	13.5601	+ 0.0001	0
			13.5600	0.0000	2
			13.5601	+ 0.0001	5
			13.5600	0.0000	10
		0.0	13.5600	0.0000	0
			13.5600	0.0000	2
			13.5601	+ 0.0001	5
			13.5601	+ 0.0001	10
		-10.0	13.5600	0.0000	0
			13.5601	+ 0.0001	2
			13.5601	+ 0.0001	5
			13.5600	0.0000	10
		-20.0	13.5601	+ 0.0001	0
			13.5600	0.0000	2
			13.5600	0.0000	5
			13.5600	0.0000	10

Frequency Stability Versus Input Voltage

Voltage (%)	Power (V _{dc})	Temperature (°C)	± 0.01% Carrier Tolerance (MHz)	Measured Tolerance (MHz)	Measurement with respects to Start Up Time (Mins)
100	12	20	13.5600	0.0000	0
			13.5600	0.0000	2
			13.5600	0.0000	5
			13.5600	0.0000	10
85	12	20	13.5600	0.0000	0
			13.5601	+ 0.0001	2
			13.5600	0.0000	5
			13.5601	+ 0.0001	10
115	12	20	13.5601	+ 0.0001	0
			13.5601	+ 0.0001	2
			13.5600	0.0000	5
			13.5600	0.0000	10

