

EMC

TEST REPORT

Report No. : 150100371TWN-001
Model No. : BT Dongle
Issued Date : Jul. 16, 2015

Applicant: Strength Master Fitness Tech Co. Ltd
No. 398, Sec. 1, Yaofeng Rd., Puxin Township, Changhua
County, Taiwan

Test Method/ Standard: 47 CFR FCC Part 15.247 & ANSI C63.4 2009
KDB 558074 D01 v03r03

Test By: Intertek Testing Services Taiwan Ltd.
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FCC Laboratory
Registration Number: 93910

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1. Summary of Test Data

Test Requirement	Applicable Rule (Section 15.247)	Result
Minimum 6 dB Bandwidth	15.247(a)(2) KDB 558074 D01 v03r03	Pass
Maximum Peak Conducted Output Power	15.247(b)(3)	Pass
Power Spectral Density	15.247(e)	Pass
Emissions In Non-Restricted Frequency Bands	15.247(d)	Pass
Emissions In Restricted Frequency Bands (Radiated emission measurements)	15.247(d), 15.205, 15.209	Pass
Emission On The Band Edge	15.247(d), 15.205	Pass
AC Power Line Conducted Emission	15.207	Pass
Antenna Requirement	15.203	Pass

2. General Information

2.1 Identification of the EUT

Product:	BT Dongle
Model No:	BT Dongle
FCC ID:	2AB9OBTDONGLE
Operating Frequency:	2402MHz ~ 2480MHz
Channel Number:	40 Channels
Access scheme:	See section 2.3
Modulation:	GFSK
Rated Power:	DC 3.3V
Power Cord:	N/A
Sample Received:	Jul. 14, 2014
Sample condition:	Workable
Test Date(s):	Jan. 14, 2015 ~ Jul. 16, 2015

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Note 2: When determining the test conclusion, the Measurement Uncertainty of test has been considered.

2.2 Description of EUT

Modulation mode	Transmit path
	Chain 0/Main
BT 4.0	V

2.3 Channel Number of EUT

Channel No.	Frequency	Channel No.	Frequency	Channel No.	Frequency	Channel No.	Frequency
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

2.4 Antenna description

The EUT uses a permanently connected antenna.

Antenna Gain : 0 dBi
Antenna Type : PCB Antenna
Connector Type : Fixed

2.5 Peripherals equipment

Peripherals	Brand	Model No.	Serial No.	Data cable
Notebook PC	DELL	Latitude D610	1YWZK1S	RS232 1 meter × 1

2.6 Operation mode

The EUT was supplied with DC 3.3V.

2.7 Applied test modes and channels

Test items	Mode	Channel	Antenna
Minimum 6 dB Bandwidth	BT 4.0	0, 20, 39	Chain0
Maximum peak conducted output power	BT 4.0	0, 20, 39	Chain0
Power Spectral Density	BT 4.0	0, 20, 39	Chain0
RF Antenna Conducted Spurious	BT 4.0	0, 20, 39	Chain0
Radiated spurious Emission 30MHz~1GHz	BT 4.0	20	Chain0
Radiated Spurious Emission 10GHz~10th Harmonic	BT 4.0	0, 20, 39	Chain0
Emission on the Band Edge	BT 4.0	0, 39	Chain0
AC Power Line Conducted Emission	BT 4.0	0, 20, 39	Chain0

2.8 Power setting of test software

Channels & power setting software provided by the client was used to change the operating channels as well as the output power level and is going to be installed in the final end product.

Mode	Software Version: ISRT.exe V 2.1.25.4149		
	Channel	Frequency	Power setting
BT 4.0	0	2402	20
	20	2442	20
	39	2480	20

Note: The EUT was programmed to be in continuously transmitting mode and the transmit duty cycle is not less than 98%.

3. Minimum 6 dB Bandwidth

3.1 Operating environment

Temperature:	25	°C
Relative Humidity:	50	%
Atmospheric Pressure	1008	hPa
Requirement & Test method	15.247(a)(2) KDB 558074 D01 v03r03	
Channel number	0, 20, 39	

3.2 Limit for minimum 6dB bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz.

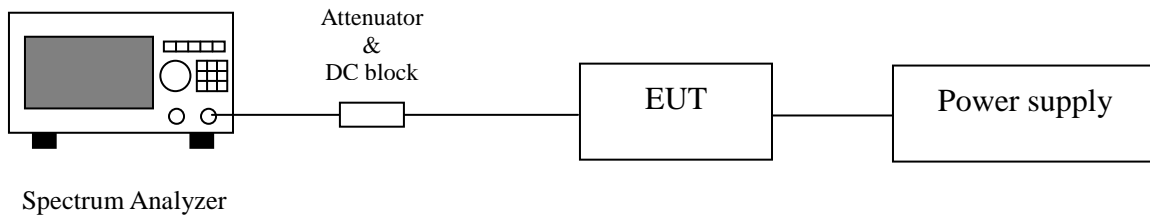
3.3 Measuring instrument setting

Spectrum analyzer settings	
Spectrum Analyzer function	Setting
Detector	Peak
RBW	100kHz
VBW	$\geq 3 \times \text{RBW}$
Sweep	Auto couple
Trace	Allow the trace to stabilize.
Span	Between two times and five times the occupied bandwidth
Attenuation	Auto

3.4 Test procedure

1. The transmitter output was connected to the spectrum analyzer.
2. Test was performed in accordance with clause 8.1 option1 of KDB 558074 D01
3. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

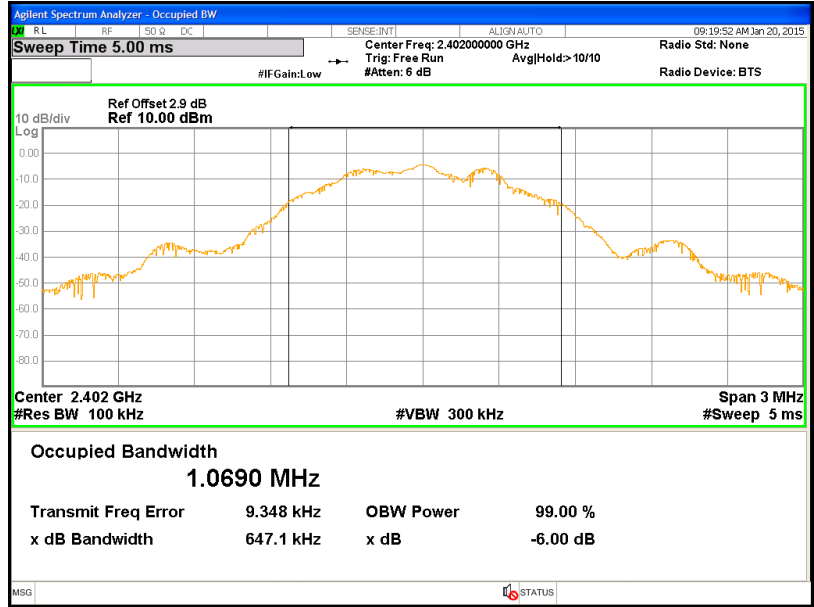
3.5 Test diagram



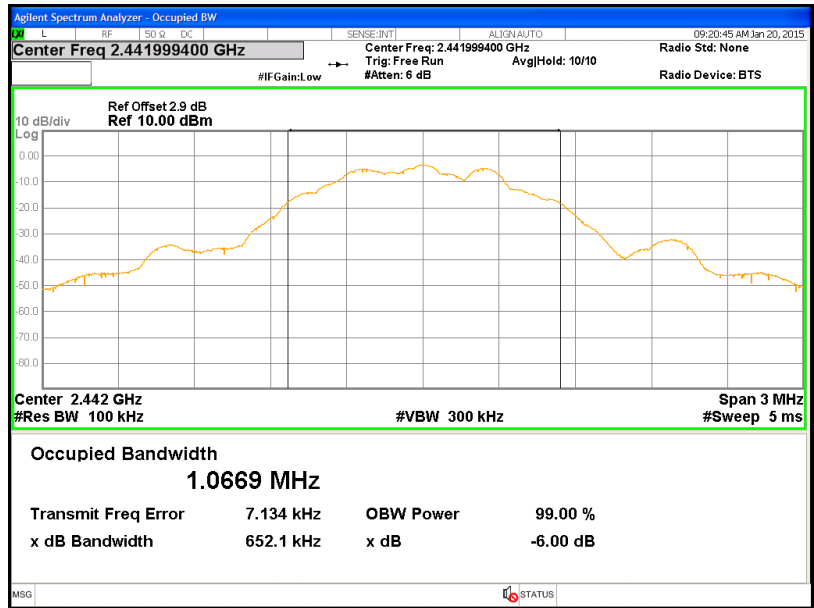
3.6 Test results

Mode	Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Limit (MHz)	Pass/Fail
BT 4.0	0	2402	0.6471	0.5	Pass
	20	2442	0.6521	0.5	Pass
	39	2480	0.6552	0.5	Pass

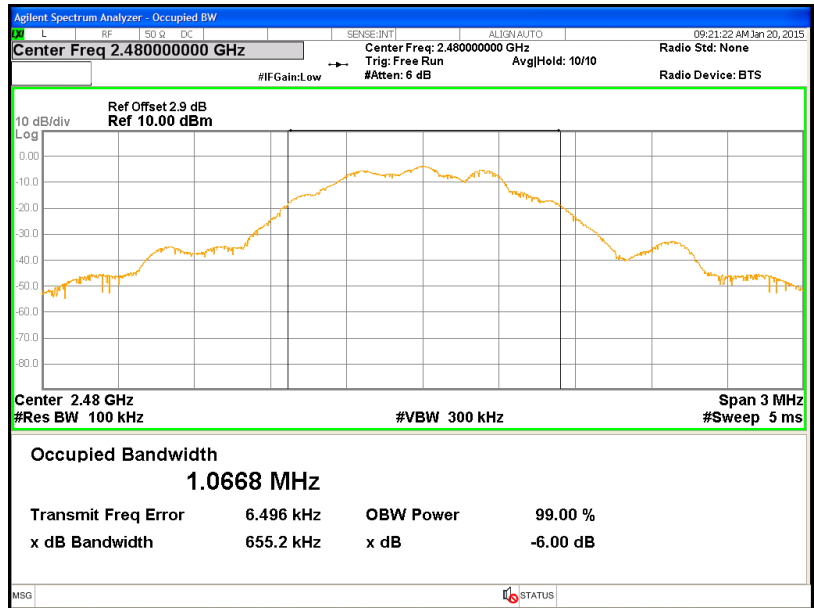
6dB Occupied Bandwidth @ BT4.0 mode Ch 0



6dB Occupied Bandwidth @ BT4.0 mode Ch 20



6dB Occupied Bandwidth @ BT4.0 mode Ch 39



4. Maximum Peak Conducted Output Power

4.1 Operating environment

Temperature:	25	°C
Relative Humidity:	50	%
Atmospheric Pressure	1008	hPa
Requirement & Test method	15.247(b)(3) KDB 558074 D01 v03r03	
Channel number	0, 20, 39	

4.2 Limit for maximum peak conducted output power

For systems using digital modulation in the 2400-2483.5 MHz: 1 Watt (30dBm)

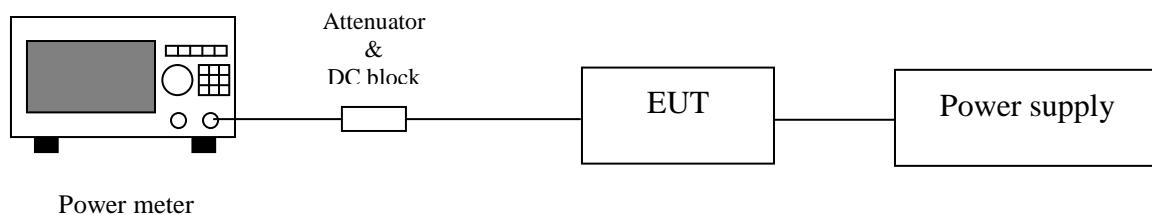
4.3 Measuring instrument setting

Power meter	
Power meter	Setting
Bandwidth	65MHz bandwidth is greater than the EUT emission bandwidth
Detector	Peak & Average

4.4 Test procedure

Test procedures refer to clause 9.1.3 peak power meter method and clause 9.2.3.2 measurement using a gated RF average power meter of KDB 558074 D01.

4.5 Test diagram



4.6 Test result

Mode	Channel	Frequency (MHz)	Output Power (AV) (dBm)	Total Power (AV) (mW)	Maximum power (PK) (dBm)	Maximum power (PK) (mW)	Limit (dBm)	Margin (dB)
BT 4.0	0	2402	-3.83	0.41	-3.34	0.46345	30	-33.34
	20	2442	-4.43	0.36	-4.01	0.39719	30	-34.01
	39	2480	-3.52	0.44	-3.14	0.48529	30	-33.14

Note: The relevant measured result has the offset with cable loss already.

5. Power Spectral Density

5.1 Operating environment

Temperature:	25	°C
Relative Humidity:	50	%
Atmospheric Pressure	1008	hPa
Requirement & Test method	15.247(e) KDB 558074 D01 v03r03	
Channel number	0, 20, 39	

5.2 Limit for power spectrum density

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission

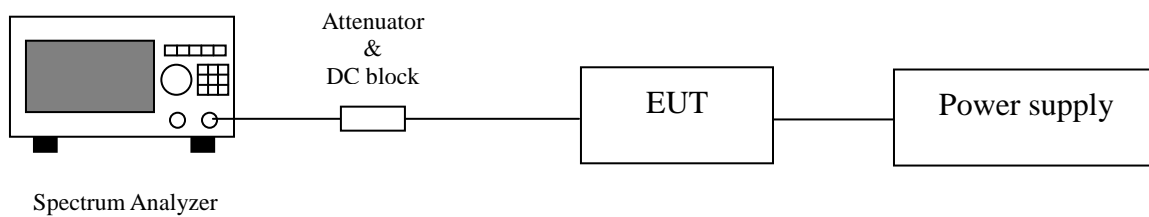
5.3 Measuring instrument setting

Spectrum analyzer settings	
Spectrum Analyzer function	Setting
Detector	Peak
RBW	≥ 3 kHz
VBW	$\geq 3 \times$ RBW
Sweep	Auto couple
Trace	Max hold
Span	1.5 times x 6dB bandwidth
Attenuation	Auto

5.4 Test procedure

1. Test procedure refers to clause 10.2 method PKPSD (peak PSD) of KDB 558074 D01.
2. Using the maximum conducted output power in the fundamental emission demonstrates compliance. The EUT must be configured to transmit continuously at full power over the measurement duration.
3. Use the peak marker function to determine the maximum amplitude level within the RBW.

5.5 Test diagram

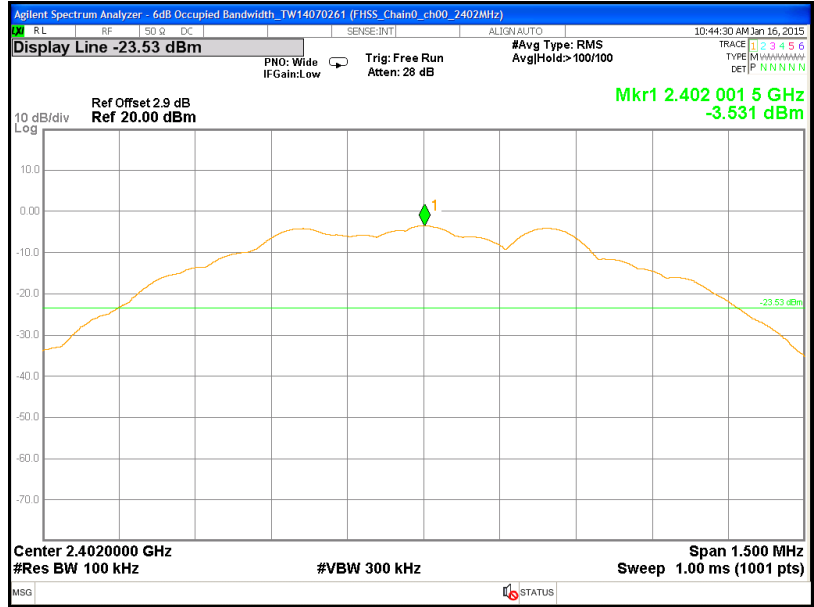


5.6 Test results

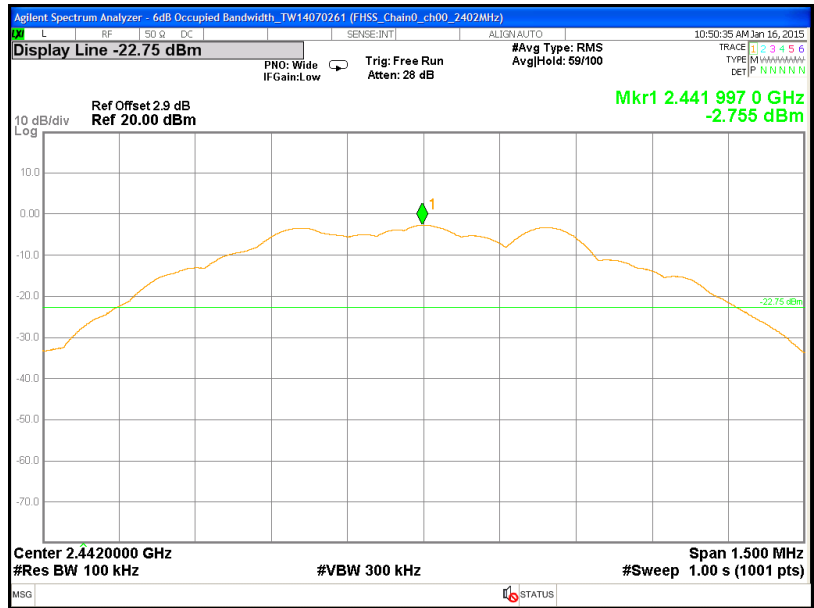
Mode	Channel	Frequency (MHz)	PSD	Limit	Margin
			(dBm/ 100kHz)	(dBm/ 3kHz)	(dB)
BT 4.0	0	2402	-3.53	8	-11.53
	20	2442	-2.76	8	-10.76
	39	2480	-2.70	8	-10.70

Note: The relevant measured result has the offset with cable loss already.

Power Spectral Density @ BT4.0 mode channel 0

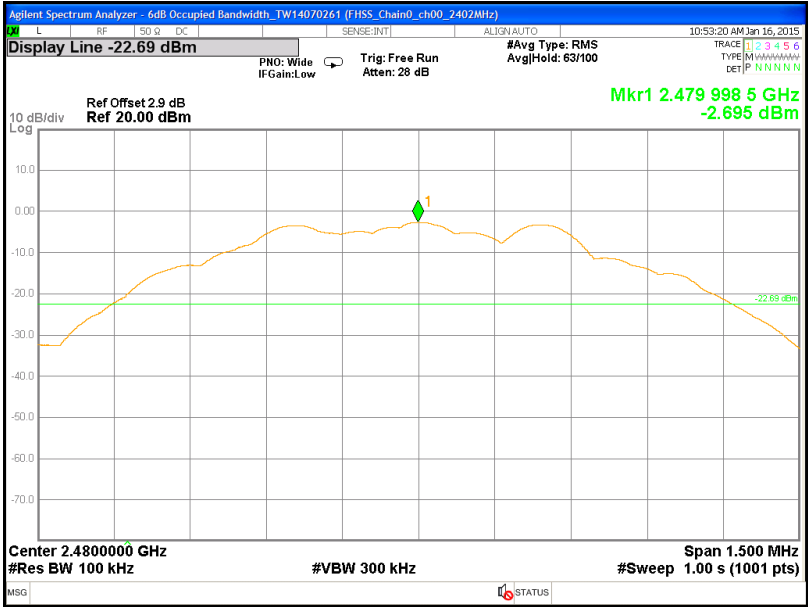


Power Spectral Density @ BT4.0 mode channel 20





Power Spectral Density @ BT4.0 mode channel 39



6. Emissions In Non-Restricted Frequency Bands

6.1 Operating environment

Temperature:	25	°C
Relative Humidity:	50	%
Atmospheric Pressure	1008	hPa
Requirement	15.247(d)	
Channel number	0, 20, 39	

6.2 Limit for emissions in non-restricted frequency bands

The peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz

6.3 Measuring instruments setting

Reference level measurement

Spectrum analyzer settings	
Spectrum Analyzer function	Setting
Detector	Peak
RBW	≥ 100 kHz
VBW	$\geq 3 \times$ RBW
Sweep	Auto couple
Trace	Max hold
Span	≥ 1.5 time 6dB bandwidth
Attenuation	Auto

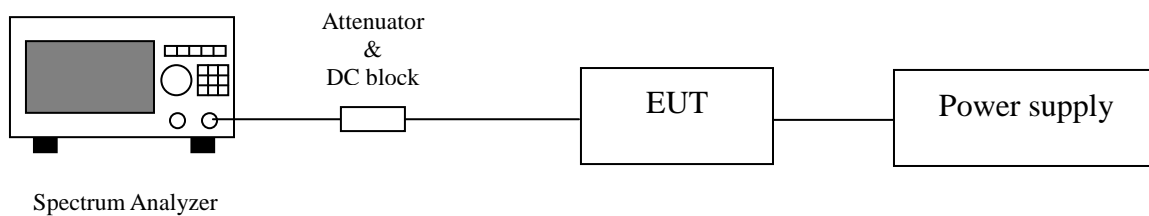
Emission level measurement

Spectrum analyzer settings	
Spectrum Analyzer function	Setting
Detector	Peak
RBW	≥ 100 kHz
VBW	$\geq 3 \times$ RBW
Sweep	Auto couple
Trace	Max hold
Attenuation	Auto

6.4 Test procedure

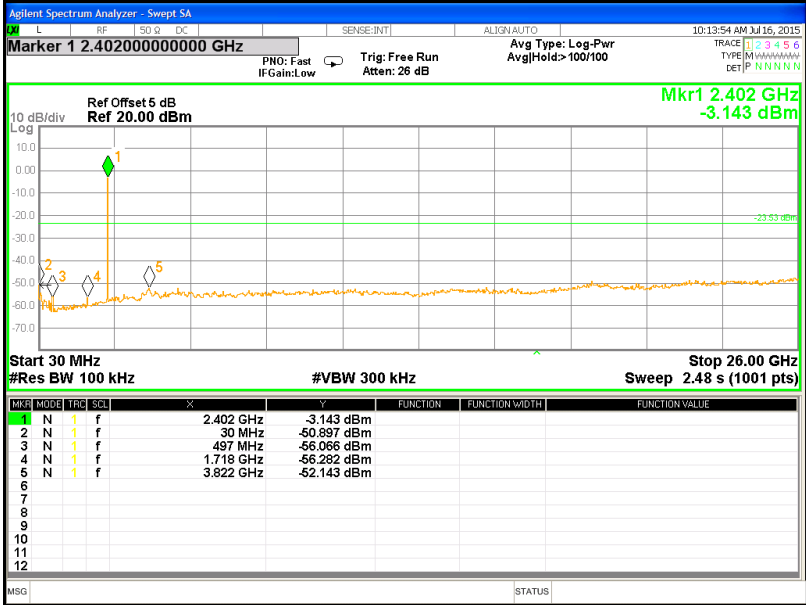
1. The procedure was used in antenna-port conducted and connected to the spectrum analyzer.
2. Set instrument center frequency to center frequency
3. Use the parameter configured in clause 6.3 to measure
4. Use the peak marker function to determine the maximum amplitude level.

6.5 Test diagram

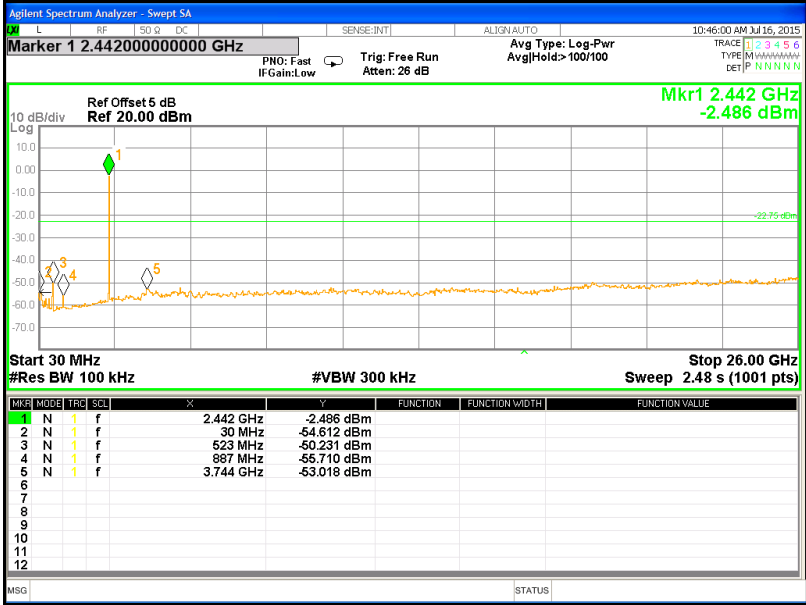


6.6 Test results

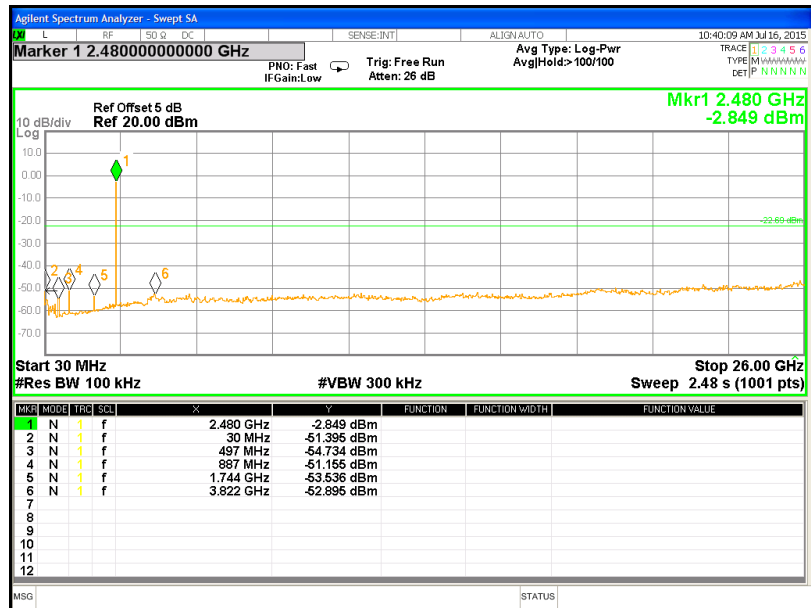
Conducted Spurious @ BT4.0_Chain0_2402MHz



Conducted Spurious @ BT4.0_Chain0_2442MHz



Conducted Spurious @ BT4.0_Chain0_2480MHz



7. Emissions In Restricted Frequency Bands (Radiated emission measurements)

7.1 Operating environment

Temperature:	25	°C
Relative Humidity:	50	%
Atmospheric Pressure	1008	hPa
Requirement	15.247(d), 15.205, 15.209	
Channel number	0, 20, 39	

7.2 Limit for emission in restricted frequency bands (Radiated emission measurement)

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement distance (meters)
0.009~0.490	2400/F(kHz)	300
0.490~1.705	2400/F(kHz)	30
1.705~30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remark:

1. In the above table, the tighter limit applies at the band edges.
2. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system

7.3 Measuring instrument setting

Below 1GHz measurement

Receiver settings	
Receiver function	Setting
Detector	QP
RBW	9-150 kHz ; 200-300 Hz 0.15-30 MHz; 9-10 kHz 30-1000 MHz; 100-120 kHz
VBW	$\geq 3 \times$ RBW
Sweep	Auto couple
Attenuation	Auto

Above 1GHz measurement

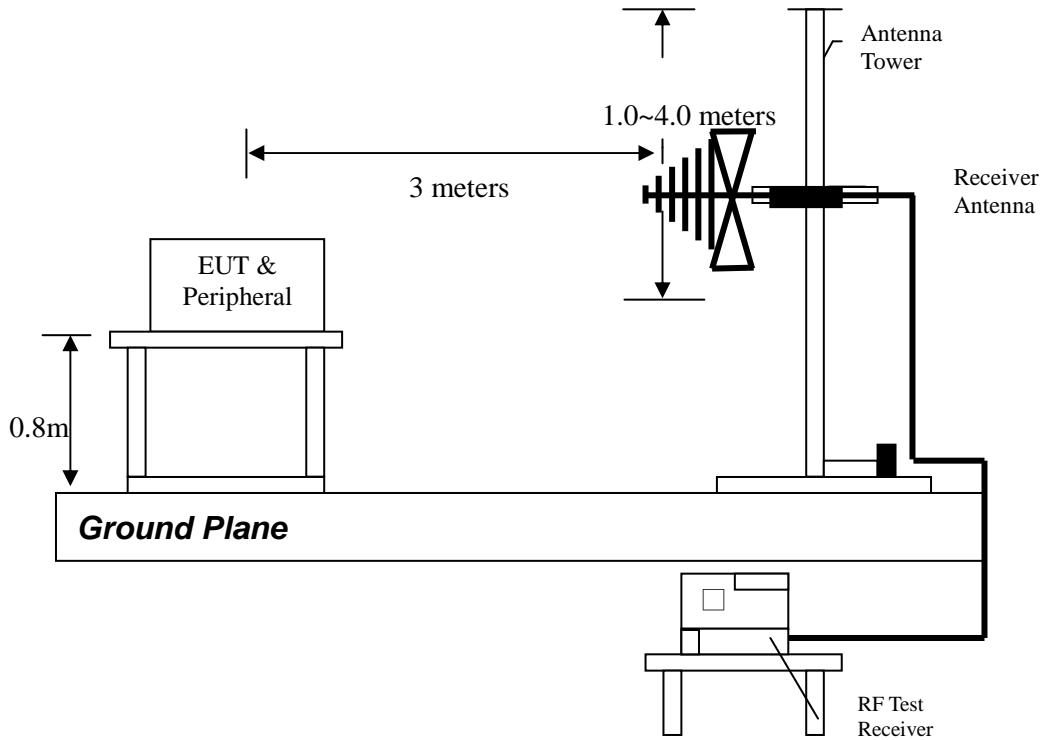
Spectrum analyzer settings	
Spectrum Analyzer function	Setting
Detector	Peak
RBW	1MHz
VBW	3MHz for Peak; 10Hz for Average
Sweep	Auto couple
Start Frequency	1GHz
Stop Frequency	Tenth harmonic
Attenuation	Auto

7.4 Test procedure

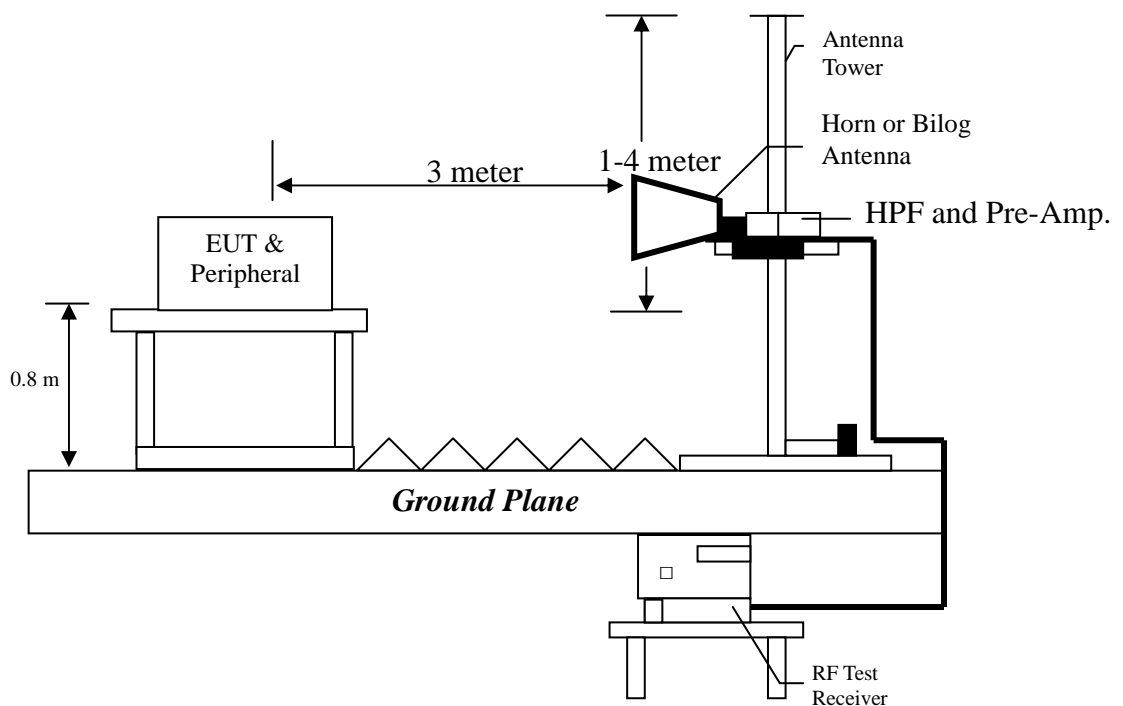
1. The center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable.
2. Power on the EUT and all the companion devices. The turntable was rotated by 360 degree to find the position of the maximum emission level.
3. The height of the receiving antenna was varied between one meter and four meters above ground to find the maximum emission field strength of the both horizontal and vertical polarization
4. If find the frequencies above the limit or below within 3dB, the antenna tower was scan (from 1m to 4m) and then the turntable was rotated to find the maximum reading.
5. Set the test-receiver system to peak or CISPR quasi-peak detector with specified bandwidth under maximum hold mode.
6. For emissions above 1GHz, use 1MHz VBW and 3MHz RBW for peak reading. Then 1MHz RBW and 10Hz VBW for average reading in spectrum analyzer.
Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response.
7. If the emissions level of the EUT in peak mode was 3dB lower than the average limit specified then testing will be stopped and peak values of the EUT will be reported. Otherwise, the emissions which do not have 3dB margin will be measured using the quasi-peak method for below 1GHz.
8. For testing above 1GHz, The emissions level of the EUT in peak mode was lower than average limit, then testing will be stopped and peak values of the EUT will be reported, otherwise, the emission will be measured in average mode again and reported.

7.5 Test configuration

7.5.1 Radiated emission below 1GHz using Bilog Antenna



7.5.2 Radiated emission above 1GHz using Horn Antenna



7.6 Test result

7.6.1 Measurement results: frequencies below 1 GHz

The test was performed on EUT continuously transmitting mode. The worst case occurred at chain 0: BT4.0 Tx channel 20.

EUT : BT Dongle
Worst Case : BT4.0 Tx channel 20

Antenna Polariz. (V/H)	Freq. (MHz)	Receiver Detector	Corr. Factor (dB/m)	Reading (dBμV)	Corrected Level (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
V	191.02	QP	13.98	20.92	34.90	43.50	-8.60
V	224.00	QP	14.75	17.92	32.67	46.00	-13.33
V	270.56	QP	16.50	15.30	31.79	46.00	-14.21
V	288.02	QP	17.06	15.17	32.23	46.00	-13.77
V	352.04	QP	18.79	15.55	34.34	46.00	-11.66
V	400.54	QP	19.92	14.81	34.73	46.00	-11.27
H	191.02	QP	13.98	20.03	34.01	43.50	-9.49
H	270.56	QP	16.49	16.65	33.14	46.00	-12.86
H	288.02	QP	17.06	18.17	35.23	46.00	-10.77
H	319.06	QP	17.92	16.39	34.31	46.00	-11.69
H	336.52	QP	18.38	20.20	38.58	46.00	-7.42
H	352.04	QP	18.79	15.11	33.89	46.00	-12.11

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor

Note: The amplitude of spurious emissions that are attenuated by more than 20dB below the permissible value has no need to be reported.

7.6.2 Measurement results: frequency above 1GHz

EUT : BT Dongle
 Test Condition : BT4.0 Tx channel 0, 20, 39

Mode	Freq. (MHz)	Spectrum Analyzer Detector	Ant. Pol. (H/V)	Preamp. Gain (dB)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Channel 37	3990	PK	V	40.38	-1.57	44.55	42.98	74.00	-31.02
	4804	PK	V	40.13	-0.10	47.31	47.21	74.00	-26.79
	4804	PK	H	40.13	-0.10	50.18	50.08	74.00	-23.92
Channel 18	3990	PK	V	40.38	-1.57	44.08	42.51	74.00	-31.49
	4884	PK	V	39.99	0.16	44.17	44.33	74.00	-29.67
	4884	PK	H	39.99	0.16	52.08	52.24	74.00	-21.76
Channel 39	3990	PK	V	40.38	-1.57	43.69	42.12	74.00	-31.88
	4960	PK	V	39.84	0.41	46.39	46.80	74.00	-27.20
	4960	PK	H	39.84	0.41	55.71	56.12	74.00	-17.88
	4960	AV	H	39.84	0.41	32.87	33.28	54.00	-20.72

Remark: Correction Factor = Antenna Factor + Cable Loss + High Pass Filter Loss - Pre_Amplifier Gain

8. Emission On Band Edge

8.1 Operating environment

Temperature:	25	°C
Relative Humidity:	50	%
Atmospheric Pressure	1008	hPa
Requirement	15.247(d), 15.205,	
Channel	0, 29	

8.2 Measuring instrument setting

Spectrum analyzer settings	
Spectrum Analyzer function	Setting
Detector	Peak
RBW	1MHz
VBW	3MHz for Peak; 10Hz for Average
Sweep	Auto couple
Restrict bands	2310~2390MHz
	2483.5 ~2500MHz
Attenuation	Auto

8.3 Test procedure

The test procedure is the same as clause 7.4

8.4 Test results

EUT : BT Dongle
 Test Condition : BT4.0

Mode	Freq. (MHz)	Spectrum Analyzer Detector	Ant. Pol. (H/V)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)	Restricted band (MHz)
BT4.0	2318.20	PK	V	32.25	29.27	61.52	74	-12.48	2310~2390
	2390.00	AV	V	32.51	15.20	47.71	54	-6.29	
	2497.90	PK	V	32.89	29.33	62.22	74	-11.78	2483.5~2500
	2483.50	AV	V	32.84	16.34	49.18	54	-4.82	

9. AC Power Line Conducted Emission

9.1 Operating environment

Temperature:	25	°C
Relative Humidity:	50	%
Atmospheric Pressure	1008	hPa
Requirement	15.207	

9.2 Limit for AC power line conducted emission

Freq. (MHz)	Conducted Limit (dBuV)	
	Q.P.	Ave.
0.15~0.50	66 – 56*	56 – 46*
0.50~5.00	56	46
5.00~30.0	60	50

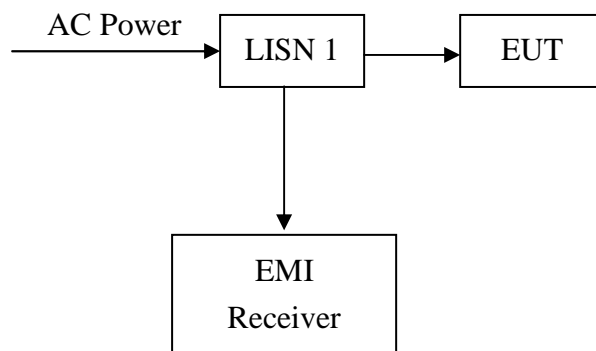
9.3 Measuring instrument setting

Receiver settings	
Receiver function	Setting
Detector	QP
Start frequency	0.15MHz
Stop frequency	30MHz
IF bandwidth	9 kHz
Attenuation	10dB

9.4 Test procedure

1. The EUT or host of EHT has to be placed 0.4 meter far from the conducting wall of the shielding room and at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT or host of EUT to the power mains through a line impedance stabilization network.
3. All the companion devices are connected to the other LISN. The LISN should provide 50uH/50ohms coupling impedance.
4. The frequency range from 150 kHz to 30MHz was searched
5. Set the test-receiver system to peak detector and specified bandwidth with maximum hold mode.
6. The measurement has to be done between each power line and ground at the power terminal.

9.5 Test diagram



Note: The EUT was tested while in normal communication mode.

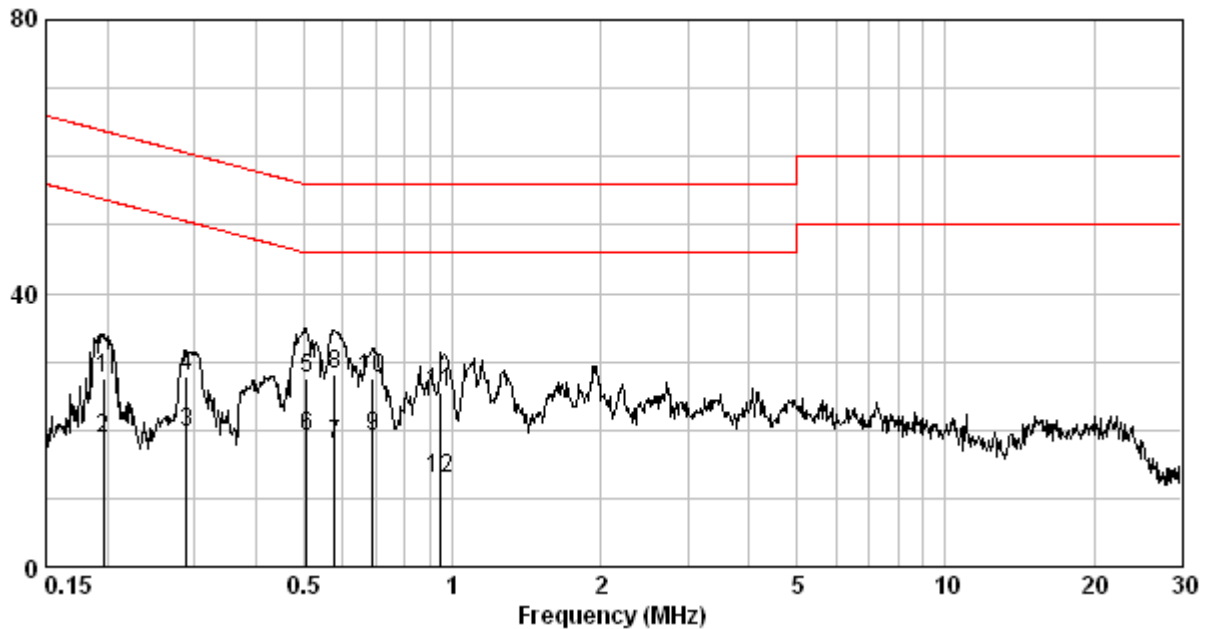
9.6 Test results

Phase : Line
 EUT : BT Dongle
 Test Condition : Tx mode
 Test Voltage : 120 Vac, 60 Hz

Frequency (MHz)	Corr. Factor (dB)	Level Qp (dBuV)	Limit Qp (dBuV)	Level Av (dBuV)	Limit Av (dBuV)	Over Limit (dB)	
						Qp	Av
0.197	0.39	27.59	63.76	18.67	53.76	-36.17	-35.09
0.289	0.39	27.94	60.54	19.62	50.54	-32.60	-30.92
0.507	0.40	27.46	56.00	19.15	46.00	-28.54	-26.85
0.576	0.40	28.17	56.00	17.96	46.00	-27.83	-28.04
0.690	0.40	27.56	56.00	18.99	46.00	-28.44	-27.01
0.948	0.41	25.47	56.00	12.81	46.00	-30.53	-33.19

Remark:

1. Correction Factor (dB) = LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Level (dBuV) – Limit (dBuV)

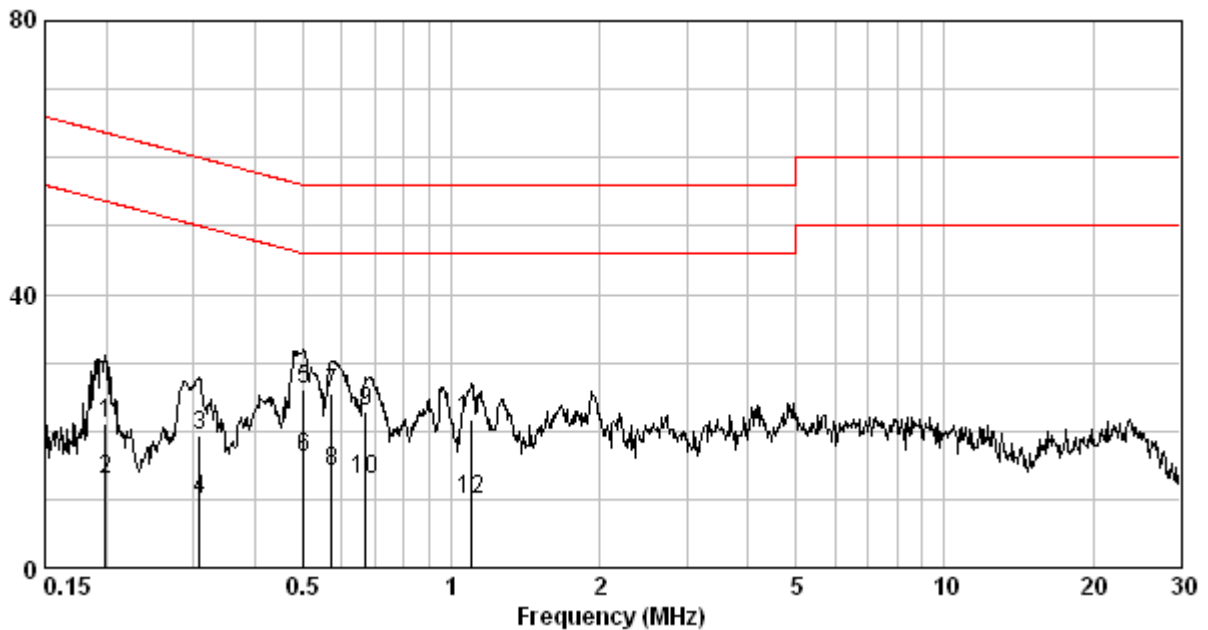


Phase : Neutral
 EUT : BT Dongle
 Test Condition : TX mode
 Test Voltage : 120 Vac, 60 Hz

Frequency (MHz)	Corr. Factor (dB)	Level Qp (dBuV)	Limit Qp (dBuV)	Level Av (dBuV)	Limit Av (dBuV)	Over Limit (dB)	
						Qp	Av
0.199	0.37	21.07	63.67	12.97	53.67	-42.60	-40.70
0.308	0.38	19.42	60.02	9.96	50.02	-40.60	-40.06
0.502	0.38	26.21	56.00	16.02	46.00	-29.79	-29.98
0.573	0.39	25.42	56.00	14.02	46.00	-30.58	-31.98
0.672	0.39	22.97	56.00	12.85	46.00	-33.03	-33.15
1.100	0.40	21.82	56.00	10.07	46.00	-34.18	-35.93

Remark:

1. Correction Factor (dB) = LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Level (dBuV) – Limit (dBuV)



Appendix A: Test equipment list

Equipment	Brand	Model No.	Serial No.	Calibration Date	Next Calibration Date
ESCI EMI Test Receiver	Rohde & Schwarz	ESCI	100018	2014/12/02	2015/12/01
Spectrum Analyzer	Rohde & Schwarz	FSP30	100137	2014/06/16	2015/06/15
Horn Antenna (1-18G)	Schwarzbeck	BBHA 9120 D	9120D-456	2014/08/29	2017/08/27
Horn Antenna (14-42G)	SHWARZBECK	BBHA 9170	BBHA9170159	2014/09/16	2017/09/14
Broadband Antenna	Schwarzbeck	VULB 9168	9168-172	2013/08/08	2015/08/07
Pre-Amplifier	AML	AML0120L3401	0419-114	2015/05/25	2016/05/23
Pre-Amplifier	MITEQ	JS4-26004000--2 7-8A	828825	2014/09/15	2015/09/14
Power Meter	Anritsu	ML2495A	0844001	2014/11/12	2015/11/11
Power Sensor	Anritsu	MA2411B	0738452	2014/11/12	2015/11/11
Two-Line V-Network	Rohde & Schwarz	ESH3-Z5	838979/014	2014/10/05	2015/10/04
Singal Analyzer	Agilent	N9030A	MY51380492	2014/09/19	2015/09/18
Loop Antenna	RolfHeine	LA-285	02/10033	2014/03/18	2017/03/16
966-2(A) Cable	SUHNER	SMA / EX 100	N/A	2015/05/06	2016/05/04
966-2(B) Cable	SUHNER	SUCOFLEX 104P	CB0005	2015/05/06	2016/05/04
RF Cable	SUHNER	SUCOFLEX 102	CB0006	2015/05/06	2016/05/04
Bore Sight Antenna mast	Max-Full Antenna Corp.	MFA-520BS	N/A	N/A	N/A

Appendix B: Measurement Uncertainty

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level using a coverage factor of $k=2$.

Item	Uncertainty
Vertically polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.15 dB
Horizontally polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.23 dB
Vertically polarized Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m	4.19 dB
Horizontally polarized Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m	4.3 dB
Vertically polarized Radiated disturbances from 18GHz~40GHz in a semi-anechoic chamber at a distance of 3m	4.19 dB
Horizontally polarized Radiated disturbances from 18GHz~40GHz in a semi-anechoic chamber at a distance of 3m	4.3 dB
Conducted Output power	0.86 dB
Radiated electromagnetic disturbances in the frequency range from 9kHz to 30MHz	2.92 dB
Conducted disturbance measurements at a mains port from 9 kHz to 30 MHz using a 50 Ω /50 μ H +5 Ω artificial mains network (AMN)	2.5dB