

TEST REPORT

 CTK Co., Ltd. The Power Leader of Global Regulatory Certification	CTK Co., Ltd. (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea Tel: +82-31-339-9970 Fax: +82-31-624-9501	Report No.: CTK-2018-00009 Page (1) / (16) Pages	
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1. Client

- Name : SOLUM CO.,LTD.
- Address : 4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea
- Data of Receipt : 2017-12-14

2. Manufacturer

- Name : SOLUM CO.,LTD.
- Address : 4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea

3. Use of Report : For FCC Certification

4. Test Sample / Model: ESL LABEL / ST-GR29****

5. Date of Test : 2017-12-26 to 2017-12-29

6. Test Standard(method) used : FCC 47 CFR part 15 subpart C 15.247

7. Testing Environment: Temp.: (23 ± 1) °C, Humidity: (50 ± 1) % R.H.

8. Test Results : Compliance

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full.

Affirmation	Tested by Bongseok, Kim: (Signature) 	Technical Manager Young-taek, Lee: (Signature) 
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2018-01-02

Republic of KOREA **CTK Co., Ltd.**

REPORT REVISION HISTORY

Date	Revision	Page No
2018-01-02	Issued (CTK-2018-00009)	all

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1. General Product Description

1.1 Client Information

Company	SOLUM CO.,LTD.
Contact Point	4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea
Contact Person	Name : Kim Jun Young E-mail : jy.kim1216@solu-m.com Tel : +81 31-8006-0960

1.2 Product Information

FCC ID	2AFWN-ST-GR29
Product Description	ESL LABEL
Model name	ST-GR29
Variant model	ST-GR29**** (*': It can be alphanumeric (from A to Z, from 0 to9 and blank))
Operating Frequency	2 405 MHz - 2 480 MHz (DSSS)
Antenna Specification	Antenna type : PCB Antenna Peak Gain : 0.7 dBi
Number of channels	16
Channel Spacing	5 MHz
Type of Modulation	OQPSK
Power Source	DC 3.0 V (Coin Battery CR2032)
RF Power setting in Test SW	Initial value

1.3 Peripheral Devices

- For Radiated Measurement

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	HP	HP Probook 650 G1	5CG5114K13
Adapter	HP	PPP012D-S	677777-003

2. Facility and Accreditations

2.1 Test Facility

The measurement facility is located at (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yong-in-si, Gyeonggi-do, Korea.

2.2 Laboratory Accreditations and Listings

Country	Agency	Scope of Accreditation	Registration Number	Logo
USA	FCC	FCC Part 15 & 18 EMI (Electromagnetic Interference / Emission)	805871	
CANADA	IC	IC EMI (3/10m test site)	8737A-2	
JAPAN	VCCI	VCCI V-3 EMI (Electromagnetic Interference / Emission)	C-986 T-1843 R-3627 G-387	
KOREA	MSIP	EMI (Electromagnetic Interference / Emission) EMS (Electromagnetic Susceptibility / Immunity)	KR0025	

2.3 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.

3. Test Specifications

3.1 Standards

Section in RSS	Requirement(s)	Status (Note 1)	Test Condition
15.247(a)	6 dB Bandwidth	NT(Note 6)	Conducted
15.247(e)	Transmitter power spectral density	NT(Note 6)	
15.247(b)	Maximum peak conducted output power	NT(Note 6)	
15.247(d)	Unwanted emission	NT(Note 6)	
15.209	Transmitter emission	C	Radiated
15.207	AC Conducted Emission	NA(Note 3)	Line Conducted
<u>Note 1:</u> C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable			
<u>Note 2:</u> The data in this test report are traceable to the national or international standards.			
<u>Note 3:</u> The equipment is operated on battery power only.			
<u>Note 4:</u> The sample was tested according to the following specification: FCC Part 15.247, ANSI C63.10-2013.			
<u>Note 5:</u> The tests were performed according to the method of measurements prescribed in KDB No.558074.			
<u>Note 6:</u> The test was performed according to the class II permissive change. This change is not related to the conducted-measurement item.			

3.2 Mode of operation during the test

The EUT is operated in a manner representative of the typical of the equipments.
 During at testing, system components were manipulated within the confines of typical usage to maximize each emission. All modulation modes were tests.
 The results are only attached worst cases.

Test Frequency

Lowest channel	Middle channel	Highest channel
2 405 MHz	2 445 MHz	2 480 MHz

Test mode

Modulation	Duty Cycle
OQPSK	100 %

3.3 Maximum Measurement Uncertainty

The value of the measurement uncertainty for the measurement of each parameter.
Coverage factor $k = 2$, Confidence levels of 95 %

Description	Uncertainty
Conducted RF Output Power	1.5 dB
Occupied Bandwidth	0.1 MHz
Unwanted Emission(conducted)	3.0 dB
Radiated Emissions ($f \leq 1$ GHz)	4.0 dB
Radiated Emissions ($f > 1$ GHz)	5.0 dB

4. Technical Characteristic Test

4.1 Radiated Emission

Test Location

- ☒ 10 m SAC (test distance : ☐ 10 m, ☒ 3 m)
☒ 3 m SAC (test distance : 3 m)

Test Procedures

- 1) In the frequency range of 9 kHz to 30 MHz, magnetic field is measured with Loop Antenna. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.
- 2) In the frequency range above 30 MHz, Bi-Log Test Antenna(30 MHz to 1 GHz) and Horn Test Antenna(above 1 GHz) are used. Test Antenna is 3m away from the EUT. Test Antenna height is carried from 1m to 4m above the ground to determine the maximum value of the field strength. The emissions levels at both horizontal and vertical polarizations should be tested.

Instrument Settings

Frequency Range = 9 kHz ~ 25 GHz (2.4 GHz 10th harmonic)

a) RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz, 9 kHz for $f < 30$ MHz

b) VBW $\geq$ RBW

c) Sweep time = auto couple

Limit :

FCC Part 15 § 15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

Table 1. Restricted Frequency Bands

MHz	MHz	MHz	MHz	MHz	GHz
0.09-0.11	8.37626-8.38675	73-74.6	399.9-410	2690-2900	10.6-12.7
¹ 0.495-0.505	8.41425-8.41475	74.8-75.2	608-614	3260-3267	13.25-13.4
2.1735-2.1905	12.29-12.293	108-121.94	960-1240	3332-3339	14.47-14.5
4.125-4.128	12.51975-12.52025	123-138	1300-1427	3345.8-3358	15.35-16.2
4.17725-4.17775	12.57675-12.57725	149.9-150.05	1435-1626.5	3600-4400	17.7-21.4
4.20725-4.20775	13.36-13.41	156.52475-156.52525	1645.5-1646.5	4500-5150	22.01-23.12
6.215-6.218	16.42-16.423	156.7-156.9	1660-1710	5350-5460	23.6-24
6.26775-6.26825	16.69475-16.69525	162.0125-167.17	1718.8-1722.2	7250-7750	31.2-31.8
6.31175-6.31225	16.80425-16.80475	167.72-173.2	2200-2300	8025-8500	36.43-36.5
8.291-8.294	25.5-25.67	240-285	2310-2390	9000-9200	² Above 38.6
8.362-8.366	37.5-38.25	322-335.4	2483.5-2500	9300-9500	

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

² Above 38.6

§ 15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

FCC Part 15 § 15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

Frequency(MHz)	Field Strength uV/m@3m	Field Strength dBuV/m@3m	Measurement Distance (meters)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705-30	30	-	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	3

** Except as provided in 15.209(g).fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72MHz, 76-88MHz, 174-216MHz, 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g.15.231 and 15.241.

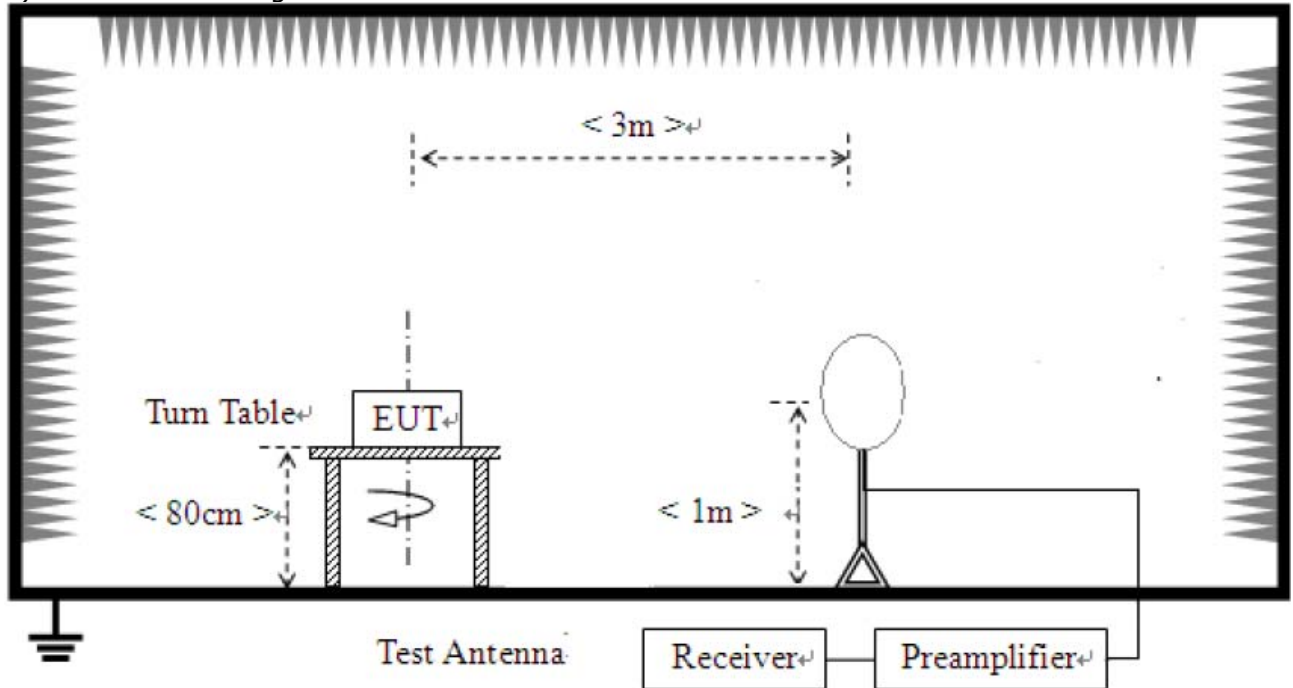
Note :

- 1) For above 1 GHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.
- 2) For above 1 GHz, limit field strength of harmonics : 54 dBuV/m@3m (AV) and 74 dBuV/m@3m (PK)
- 3) For measurement above 1GHz, the resolution bandwidth is set to 1 MHz and video bandwidth is set to 1 MHz for peak measurement and 10 Hz for average measurement.(Duty Cycle is > 98%,)

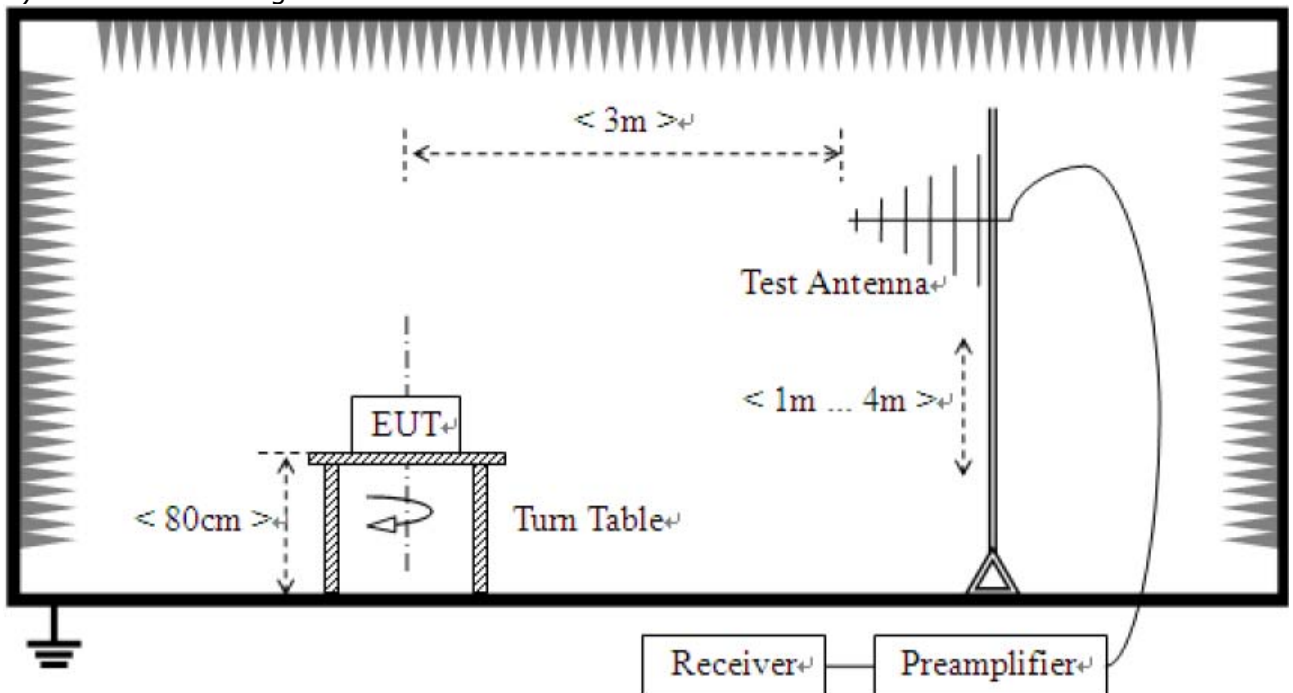
Duty Cycle is < 98%, VBW setting will need to > 1/T.

Test Setup:

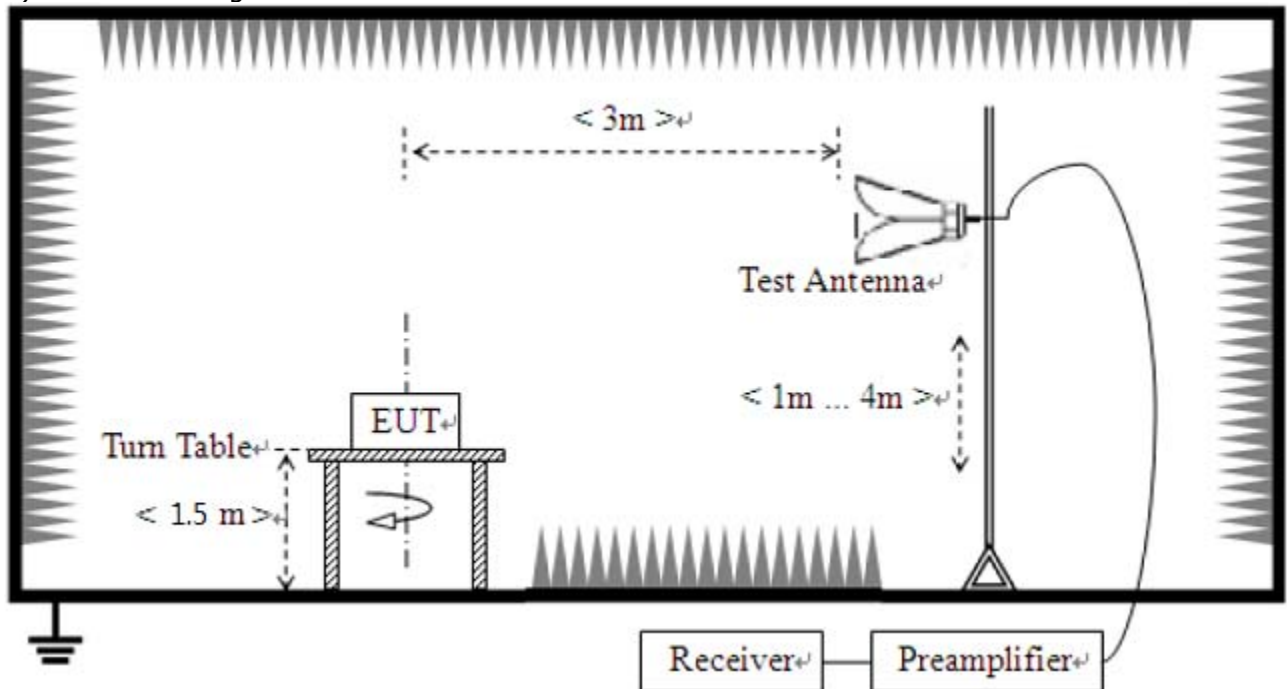
- 1) For field strength of emissions from 9 kHz to 30 MHz



- 2) For field strength of emissions from 30 MHz to 1 GHz



3) For field strength of emissions above 1 GHz



Test results

1) 9 kHz to 30 MHz

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
-	-	-	See note

Note :

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

Distance extrapolation factor = $40 \log (\text{specific distance} / \text{test distance})$ (dB)

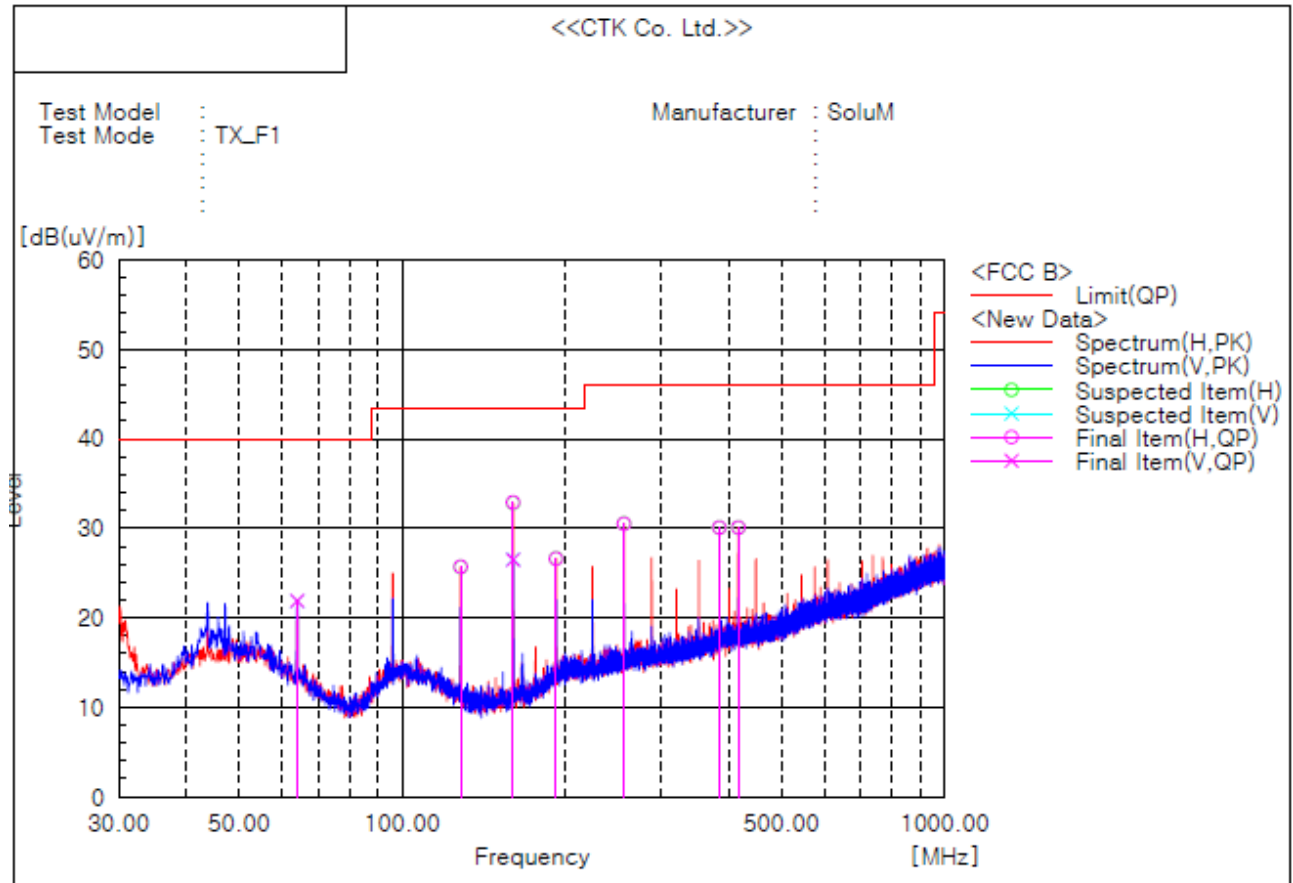
2) 30 MHz to 1 GHz

Test mode : Transmit, Lowest Channel(Worst case)

The requirements are:

☒ Complies

Test Data



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Angle [deg]	Remark
1	63.954	V	36.8	-14.9	21.9	40.0	18.1	174.8	
2	127.982	H	42.6	-16.9	25.7	43.5	17.8	256.6	
3	159.996	H	50.0	-17.1	32.9	43.5	10.6	256.6	
4	159.996	V	43.6	-17.1	26.5	43.5	17.0	162.6	
5	192.010	H	41.3	-14.7	26.6	43.5	16.9	256.6	
6	256.038	H	43.2	-12.7	30.5	46.0	15.5	37.4	
7	383.973	H	40.8	-10.7	30.1	46.0	15.9	269.6	
8	415.987	H	40.5	-10.4	30.1	46.0	15.9	269.6	

Remark :

- The Unwanted emission was measured in the following position: EUT stand-up position(X, Y axis), lie-down position(Z axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
- Result = Reading + c.f(Correction factor)
- Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain
- This data is the Peak(PK) value.

3) above 1 GHz

The requirements are:

☒ Complies

Test Data

Low(2 405 MHz)

Frequency [MHz]	(P)	(m)	Reading AV / PK [dBuV / m]	Correction Factor	Result AV / PK [dBuV / m]	Limit AV / PK [dBuV / m]	Margin [dB]
2373.04	V	2	49.41 / 53.98	-4.07	45.34 / 49.91	54.00 / 74.00	8.66 / 24.09
4809.50	V	2	46.09 / 55.25	2.75	48.84 / 58.00	54.00 / 74.00	5.16 / 16.00

Mid(2 445 MHz)

Frequency [MHz]	(P)	(m)	Reading AV / PK [dBuV / m]	Correction Factor	Result AV / PK [dBuV / m]	Limit AV / PK [dBuV / m]	Margin [dB]
4889.35	V	2	37.81 / 48.40	2.75	40.56 / 51.15	54.00 / 74.00	13.44 / 22.85

High(2 480 MHz)

Frequency [MHz]	(P)	(m)	Reading AV / PK [dBuV / m]	Correction Factor	Result AV / PK [dBuV / m]	Limit AV / PK [dBuV / m]	Margin [dB]
2483.50	V	2	42.32 / 55.10	-3.90	38.42 / 51.20	54.00 / 74.00	15.58 / 22.80
4959.31	V	2	35.73 / 46.14	1.91	37.64 / 48.05	54.00 / 74.00	16.36 / 25.95

Remarks

1. The Unwanted emission was measured in the following position: EUT stand-up position(X,Y axis), lie-down position(Z axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
2. Result = Reading + c.f(Correction factor)
3. Correction factor = Antenna factor + Cable loss - Amp Gain

APPENDIX A – Test Equipment Used For Tests

	Name of Equipment	Manufacturer	Model No.	Serial No.	Date of Calibration	Due Date
1	EMI Test Receiver	Rohde & Schwarz	ESCI7	100814	2017-10-25	2018-10-25
2	Bilog Antenna	Schaffner	CBL6111C	2551	2016-05-13	2018-05-13
3	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-126	2016-05-25	2018-05-25
4	6dB Attenuator	R&S	DNF	272.4110.50-2	2017-10-25	2018-10-25
5	6dB Attenuator	R&S	DNF	272.4110.50-1	2017-02-03	2018-02-03
6	AMPLIFIER	SONOMA	310	291721	2017-02-02	2018-02-02
7	EMI Test Receiver	Rohde & Schwarz	ESU40	100336	2017-05-12	2018-05-12
8	Preamplifier	Agilent	8449B	3008A02011	2018-11-30	2018-11-30
9	Horn Antenna	ETS-Lindgren	3115	00078895	2017-04-25	2019-04-25
10	Horn Antenna	ETS-Lindgren	3116	00062916	2017-04-25	2019-04-25
11	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-125	2017-05-16	2018-05-16

APPENDIX B – EUT Photographs

