RF Test Report

Report No.: AGC10232210502EE11

PRODUCT DESIGNATION	:	Open-Source Sensor Beacon
BRAND NAME	:	Ruuvi
MODEL NAME	:	RuuviTag
APPLICANT	:	Ruuvi Innovations Ltd (Oy)
DATE OF ISSUE	:	Jun. 07, 2021
STANDARD(S)	:	ETSI EN 300 328 V2.2.2(2019-07)
REPORT VERSION	:	V1.0

Attestation of Global Compliance (Shenzhen) Co., Ltd

REPORT REVISE RECORD

Report Version	Revise Time	Issued Date	Valid Version	Notes
V1.0	/	Jun. 07, 2021	Valid	Initial release

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1. TEST REPORT CERTIFICATION

Applicant	Ruuvi Innovations Ltd (Oy)
Address	Hämeenkatu 10 B 132, 11100 RIIHIMÄKI, FINLAND
Manufacturer	Ruuvi Innovations Ltd (Oy)
Address	Hämeenkatu 10 B 132, 11100 RIIHIMÄKI, FINLAND
Factory	Ruuvi Innovations Ltd (Oy)
Address	Hämeenkatu 10 B 132, 11100 RIIHIMÄKI, FINLAND
Product Designation	Open-Source Sensor Beacon
Brand Name	Ruuvi
Test Model	RuuviTag
Date of test	May 31, 2021 to Jun. 05, 2021
Deviation	None
Condition of Test Sample	Normal
Test Result	Pass
Report Template	AGCRT-EC-BLE/RF

We, Attestation of Global Compliance (Shenzhen) Co., Ltd., for compliance with the requirements set forth in the European Standard ETSI EN 300 328 V2.2.2. The results of test in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Prepared By	Cool Cheng Project Engineer	Jun. 05, 2021
Reviewed By	Max Zhang Reviewer	Jun. 07, 2021
Approved By	Forrest Lei Authorized Officer	Jun. 07, 2021

2. GENERAL INFORMATION

2.1. DESCRIPTION OF EUT

Operating Frequency	2402MHz-2480MHz
Support Channels	40 Channels
Modulation	GFSK
Bluetooth Version	V5.0
Hardware Version	B8
Software Version	B8
The type of the equipment	non-FHSS adaptive equipment with only one antenna
The maximum RF Output Power	5.87dBm
Nominal Channel Bandwidth	☒1MHz☐2MHz
Antenna designation	☒PCB Antenna(Temporary RF connector provided by manufacturer) ☐Dedicated Antenna
Antenna Gain	4.99dBi
Power Supply	DC 3V by battery
The extreme operating conditions	Operating temperature range: -10°C~40°C
Geo-location capability	☐Yes ☒No

Note:

1. The above information was declaredby the manufacturer.
2. The equipment submitted are representative production models.
3. The EUT can not operated unmodulated.
4. The EUT provides Bluetooth wireless interface operating at 2.4G ISM band (2402MHZ-2480MHZ).
5. Only the Bluetooth was tested according the standard requirement.
6. The EUT is a stand-alone and portable equipment according to ETSI EN 300 328 V2.2.2.
7. For more details, please refer to the User's manual of the EUT.

2.2. SUPPORT EQUIPMENT

Item	Equipment	Mfr/Brand	Model/Type No.	Remark
1	--	--	--	--

2.3. DESCRIPTION OF TEST MODES

NO.	TEST MODE DESCRIPTION
1	Low channel TX
2	Middle channel TX
3	High channel TX
4	Low channel (Receiver Mode)
5	Middle channel (Receiver Mode)
6	High channel (Receiver Mode)

Note:

1. All modes have been tested and the worst mode test data recording in the test report, if no any other data.

2.4. OBJECTIVE

Perform Radio Spectrum tests for CE Marking according to the provisions of article 3.2 of the Radio Equipment Directive (2014/53/EU) for the BT function of the EUT.

2.5. TEST ITEMS AND THE RESULTS

The EUT has been tested according to ETSI EN 300 328 V2.2.2 (2019-07).

ETSI EN 300 328 V2.2.2 (2019-07)	Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz band; Harmonised Standard for access to radio spectrum

Test items and the results are as bellow:

No.	Basic Standard	Test Type	Result
1	ETSI EN 300 328 4.3.2.2	RF Output Power	Pass
2	ETSI EN 300 328 4.3.2.3	Power Spectral Density	Pass
3	ETSI EN 300 328 4.3.2.4	Duty Cycle, Tx-sequence, Tx-gap	N/A
4	ETSI EN 300 328 4.3.2.5	Medium Utilisation (MU) factor	N/A
5	ETSI EN 300 328 4.3.2.6	Adaptivity	N/A
6	ETSI EN 300 328 4.3.2.7	Occupied Channel Bandwidth	Pass
7	ETSI EN 300 328 4.3.2.8	Transmitter unwanted emissions in the out-of-band domain	Pass
8	ETSI EN 300 328 4.3.2.9	Transmitter unwanted emissions in the spurious domain	Pass
9	ETSI EN 300 328 4.3.2.10	Receiver spurious emissions	Pass
10	ETSI EN 300 328 4.3.2.11	Receiver Blocking	Pass

Note:

1. N/A- Not Applicable.
2. The latest versions of basic standards are applied.

2.6. ENVIRONMENTAL CONDITIONS

- Temperature: 15-35ºC
- Relative humidity: 30-60 %
- Atmospheric pressure: 86-106 kPa

3. MEASUREMENT UNCERTAINTY

The uncertainty is calculated using the methods suggested in the “Guide to the Expression of Uncertainty in Measurement” (GUM) published by ISO.

-Uncertainty of Radio Frequency, Uc=±1 x 10-7

- Uncertainty of total RF power, conducted, Uc = ±0.8dB
- Uncertainty of RF power density, conducted, Uc = ±2.6dB
- Uncertainty of spurious emissions, conducted, Uc = ±2.7dB
- Uncertainty of spurious emissions, radiated, Uc = ±5.4dB
- Uncertainty of Temperature: ±0.5°C
- Uncertainty of Humidity: ±1 %
- Uncertainty of DC and low frequency voltages: ±2%

4. IDENTIFICATION OF THE RESPONSIBLE TESTING LOCATION

Site	Attestation of Global Compliance(Shenzhen) Co., Ltd.
Location	1-2/F, Building 19, Junfeng Industrial Park, Chongqing Road, Heping Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China

LIST OF EQUIPMENTS USED

Description	Manufacturer	Model No.	S/N	Calibration Due.	Calibration Due.
MXG X-Series Vector Signal Generator	Agilent	N5182B	MY50140530	Aug. 21,2020	Aug. 20,2021
Signal Generator	Agilent	N5171B	MY45141029	Aug. 21,2020	Aug. 20,2021
EXA Signal Analyzer	Agilent	N9020A	MY52090123	Aug. 21,2020	Aug. 20,2021
USB Wideband Power Sensor	Agilent	U2021XA	MY54110007	Jun. 08,2020	Jun. 07,2021
USB Wideband Power Sensor	Agilent	U2021XA	MY54110009	Jun. 08,2020	Jun. 07,2021
RF Communication Tester	R&S	CMW270	1201.0002K75 -100528-Tu WIRELESSCON NN.TESTER	Aug. 21,2020	Aug. 20,2021
Attenuator	Wariors	W13	11324	N/A	N/A
Power spliter	Mini-Circuits	ZFRSC-183-s	3122	N/A	N/A
2.4G Band Fliter	EM Electronics	2400-2500	N/A	Mar. 23, 2020	Mar. 22, 2022
Small environment tester	ESPEC	SH-242	N/A	Oct. 08, 2019	Oct. 07, 2021
AMPLIFIER	ETS-LINDGREN	3117PA	00225134	Oct. 15, 2019	Oct. 14, 2021
ANTENNA	SCHWARZBECK	VULB9168	494	Sep. 20, 2019	Sep. 19, 2021
ANTENNA	ETS-LINDGREN	3142C	00060447	N/A	N/A
HORN ANTENNA	ETS-LINDGREN	3117	00154520	Oct. 26, 2019	Oct. 25, 2021
HORN ANTENNA	ETS-LINDGREN	3117	00034609	Apr. 23, 2021	Apr. 22, 2023
RF Cable	Harbour	RE004	N/A	May 15, 2020	May 14, 2022

5. ETSI EN 300 328 REQUIREMENTS

5.1. RF OUTPUT POWER

5.1.1 LIMIT

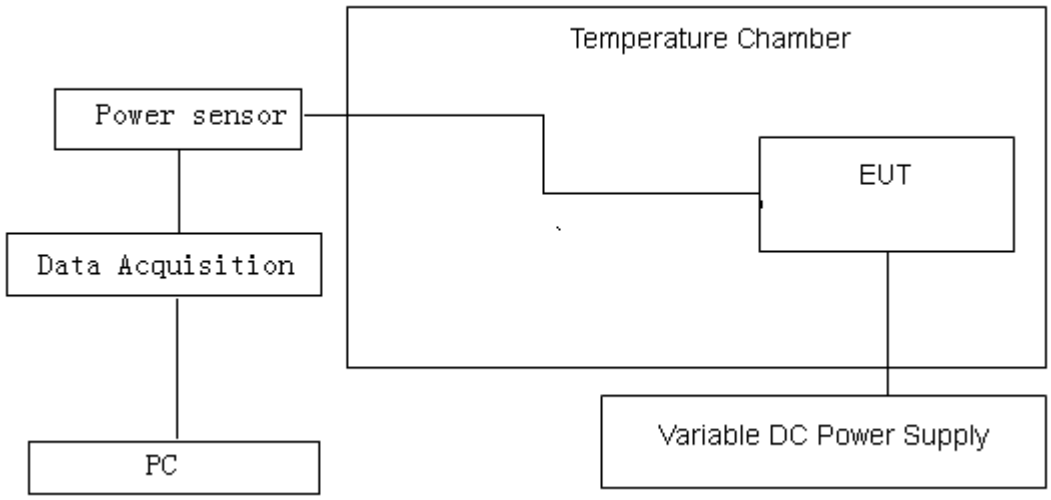
RF Output Power <= 100mW (20dBm) over Normal and Extreme conditions.

5.1.2 MEASUREMENT PROCEDURE

1) Use a fast power sensor and set the samples speed 1MS/s or faster.
2) Con nect one power sensor to each transmit port, Trigger the power sensors so that they start sampling at the same time. For each instant in time, sum the power of the individual samples of all ports and store them. Use these stored samples in all following steps.
3) Find the start and stop times of each burst in the stored measurement samples.
4) Between the start and stop times of each individual burst calculate the RMS power over the burst. Save these Pburst values, as well as the start and stop times for each burst.
5) The highest of all Pburst values (Value “A” in dBm) will be used for maximum e.i.r.p calculations.
6) The cable loss and attenuator factor shall be considered to the value “A”.
6) Add the (stated) antenna assembly gain “G” in dBi of the individual antenna. If applicable, add the additional beamforminggain“Y” in dB.
7) The RF output power (P) shall be calculated using the formula: P=A+G+Y

5.1.3 TEST CONFIGURATION

Temperature and Voltage Measurement (under normal and extreme test conditions)

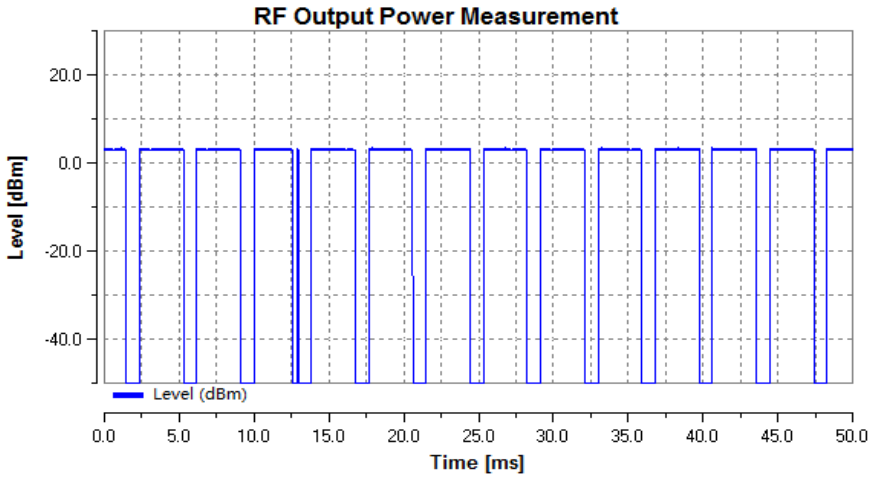
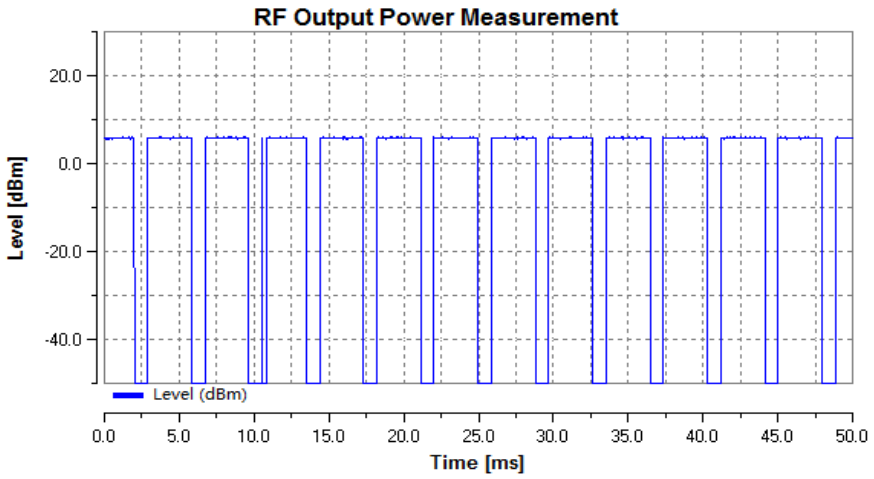
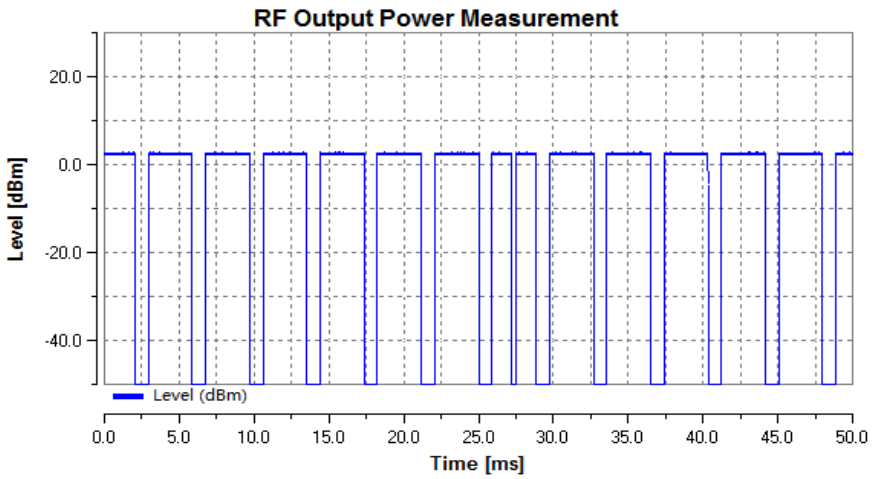


5.1.4 MEASUREMENT RESULTS

Operation Mode	Single TX	**Test Date**	Jun. 02, 2021
Temperature	25°C	**Tested by**	Cool
Humidity	55 % RH	**Polarity**	--
Antenna assembly Gain		=4.99dBi	
Cable Loss		=0.1dB	
Beamforming gain		=0dB	
EIRP		=P+ Gain+Y	

TEST CONDITIONS	RF OUTPUT POWER (dBm)		
	Temp (25)°C	Temp (-10)°C	Temp (40)°C
Low Channel TX	3.19	3.14	3.10
Middle Channel TX	5.87	5.82	5.66
High Channel TX	2.59	2.54	2.50
Limit	20dBm		

Note: Only the worst case data is reported as below.

BLE/LCH	
BLE/MCH	
BLE/HCH	

Conclusion: PASS

5.2. POWER SPECTRAL DENSITY

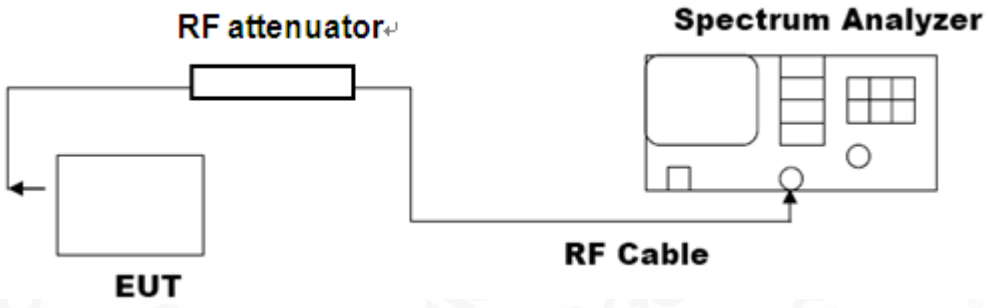
5.2.1 LIMIT

For non-adaptive equipment using wide band modulations other than FHSS, The maximum Power spectral density is limited to 10mW Per MHz

5.2.2 TEST PROCEDURE

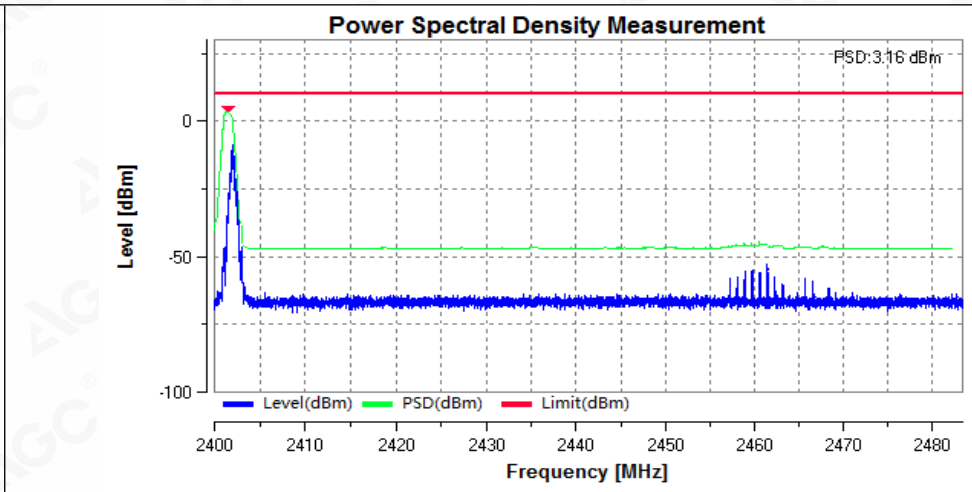
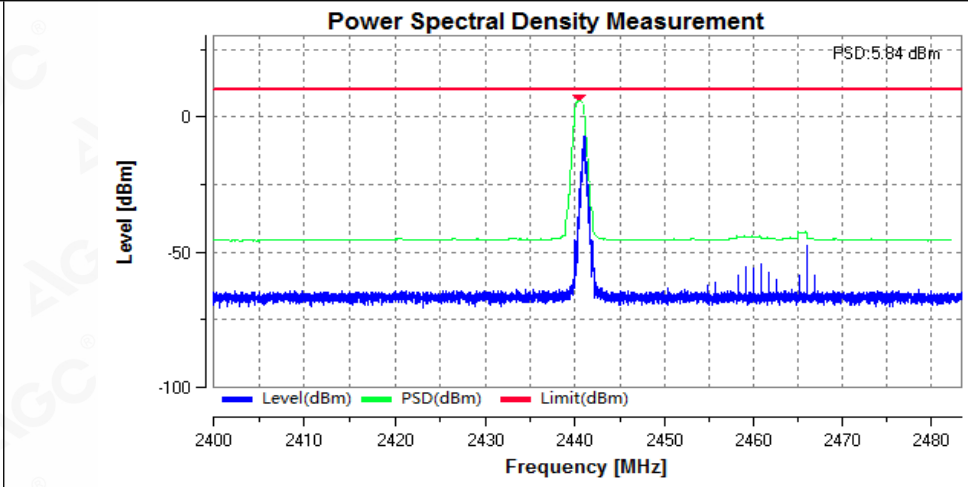
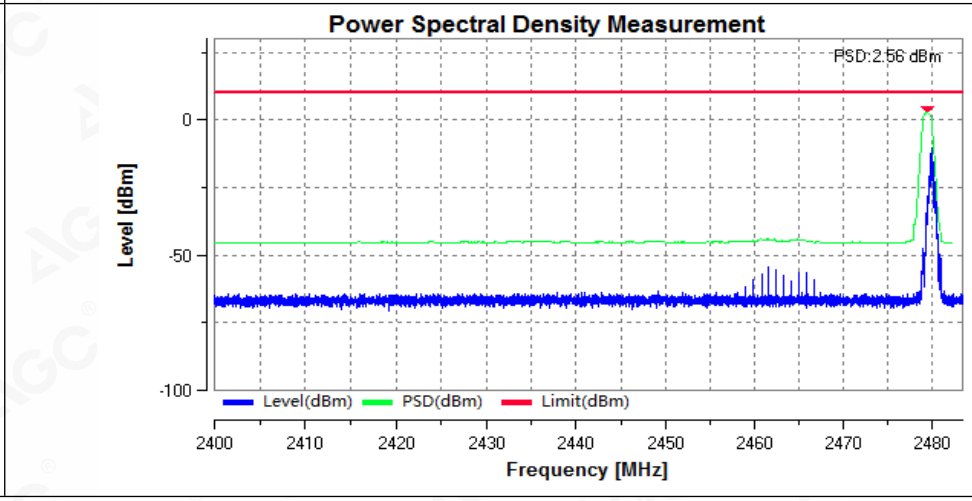
1) Set the frequency from 2400MHz to 2483.5MHz, use 10kHz RBW and 30kHz VBW for pre-scan. The number of sweep points shall be more than 8350.Wait for the trace to be completed and save the (trace) data set to a file.
2) Add up the values for amplitude (power) for all the samples in the file.
3) Normalize the individual values for amplitude so that the sum is equal to the RF Output Power (e.i.r.p) measured in 5.1.
4)Starting from the first sample in the file (lowest frequency), add up the power of the following samples representing a 1MHz segment and record the results for power and position (i.e. sample #1 to #100). This is the Power Spectral Density (e.i.r.p) for the first 1MHz segment which shall be recorded.
5) Shift the start point of the samples added up in step 5 by 1 sample and repeat the procedure in step 4(i.e. sample #2 to #101).
6) Repeat step 5 until the end of the data set and record the radiated power spectral Density values for each of the 1MHz segments.
7) The cable loss and attenuator factor shall be considered to the test result.
8) The highest value shall be recorded in the test report.

5.2.3 TEST CONFIGURATION



5.2.4 TEST RESULTS

BLE Power Spectral Density			
Channel Tested	**Power Density (dBm/MHz)**	**Test Limit (dBm/MHz)**	**Pass / Fail**
Low Channel TX	3.16	10	Pass
Middle Channel TX	5.84	10	Pass
High Channel TX	2.56	10	Pass

BLE/LCH	
BLE/MCH	
BLE/HCH	

Conclusion: PASS

5.3. ADAPTIVITY

The method of adaptivity is using LBT based on LBE.

5.3.1 LIMIT

The Channel Occupancy Time shall be less than 13ms.

If implemented, Short Control Signalling Transmissions of adaptive equipment using wide band modulations other than FHSS shall have a maximum duty cycle of 10 % within an observation period of 50 ms.

For power levels less than 20 dBm e.i.r.p., the CCA threshold level (TL) may be relaxed to:
TL = -70 dBm/MHz + 10 × log10 (100 mW / Pout) (Pout in mW e.i.r.p.)

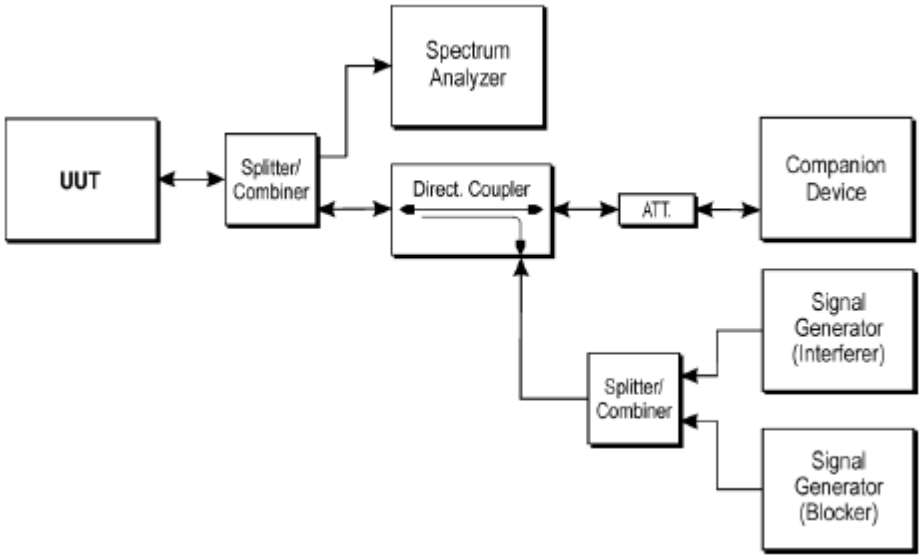
An unwanted CW signal as defined in the below table.

Wanted signal mean power from companion device	Unwanted signal frequency (MHz)	Unwanted signal power (dBm)
sufficient to maintain the link (see note 2)	2 395 or 2 488,5 (see note 1)	-35 (see note 3)
NOTE 1: The highest frequency shall be used for testing operating channels within the range 2 400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483,5 MHz. See clause 5.4.6.1.		
NOTE 2: A typical conducted value which can be used in most cases is -50 dBm/MHz.		
NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna.		

5.3.2 TEST PROCEDURE

1) The EUT connect to a companion device during the test. Adjust the received signal level at the EUT to the value of -50dBm/MHz.
2) the analyzer shall be set as below: RBW>=Occupied Channel Bandwidth (if the analyser does not support this setting, the highest available setting shall be used) and VBW>=3×RBW.
3) Configure the EUT for normal transmission with a sufficiently high payload to allow demonstration of compliance of the adaptive mechanism on the channel being tested.
4) Adding the interference signal and verification of reaction to the interference signal.
5) Adding the unwanted signal and verification of reaction to the unwanted signal.
6) Removing the interference and unwanted signal.

5.3.3 TEST CONFIGURATION



5.3.4TEST RESULTS

The EIRP of the EUT is less than 10dBm/MHz, So the adaptivity test is not applicable for the EUT.

5.4. OCCUPIED CHANNEL BANDWIDTH

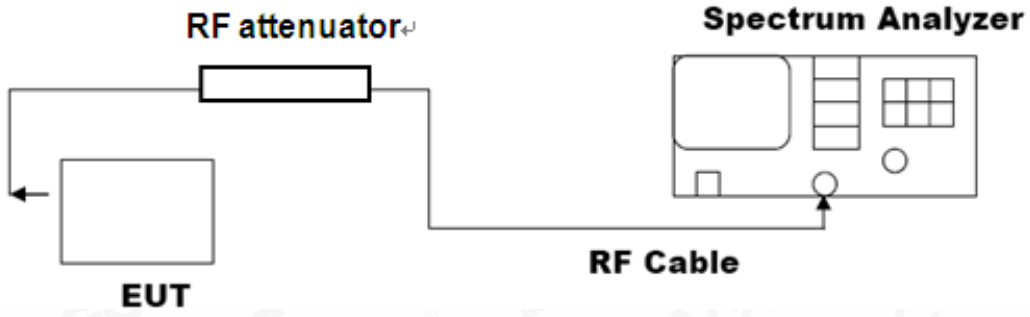
5.4.1 LIMIT

The Occupied Channel Bandwidth shall fall completely within the band 2400MHz to 2483.5MHz.

5.4.2 TEST PROCEDURE

1) The spectrum analyser shall be used the following settings:
   Centre Frequency: The centre frequency of the channel under test
   Resolution BW: ~1% of the span without going below 1%
   Video BW: 3×RBW
   Span: 2×OBW
   Detector: RMS
   Trace mode: Max Hold
2) Wait until the trace is completed, find the peak value of the trace and place the analyser marker on this peak.
3) Use the 99 % bandwidth function of the spectrum analyser to measure the Occupied Channel Bandwidth of the UUT. This value shall be recorded.

5.4.3 TEST CONFIGURATION



5.4.4 TEST RESULTS

Modulation	Channel	OBW [MHz]	FL@OBW	FH@OBW	Verdict
GFSK	LCH	1.0365	2401.49	2402.52	PASS
GFSK	HCH	1.0404	2479.49	2480.53	PASS

5.5. TRANSMITTER UNWANTED EMISSIONS IN THE OUT-OF-BAND DOMAIN

5.5.1 LIMIT

The transmitter unwanted emissions in the out-of-band domain but outside the allocated band, shall not exceed the values provided by the mask.

5.5.2 TEST PROCEDURE

1) The spectrum analyser shall be used the following settings:
   Centre Frequency: 2484MHz
   Resolution BW: 1MHz; Video BW: 3MHz; Span: 0Hz; Detector: RMS
   Trace mode: Max Hold; Sweep Points: 5000
2) (segment 2 483.5 MHz to 2 483.5 MHz + BW)
   Adjust the trigger level to select the transmissions with the highest power level.

Increase the centre frequency in steps of 1 MHz and repeat this measurement for every 1 MHz segment within the range 2 483.5 MHz to 2 483.5 MHz + BW.

3) Segment 2 483.5 MHz + BW to 2 483.5 MHz + 2BW
   Change the centre frequency of the analyser to 2 484 MHz + BW and perform the measurement for the first 1 MHz segment within range 2 483.5 MHz + BW to 2 483.5 MHz + 2BW. Increase the centre frequency in 1 MHz steps and repeat the measurements to cover this whole range. The centre frequency of the last 1 MHz segment shall be set to 2 483,5 MHz + 2 BW – 0.5 MHz.
4) Segment 2 400 MHz - BW to 2 400 MHz

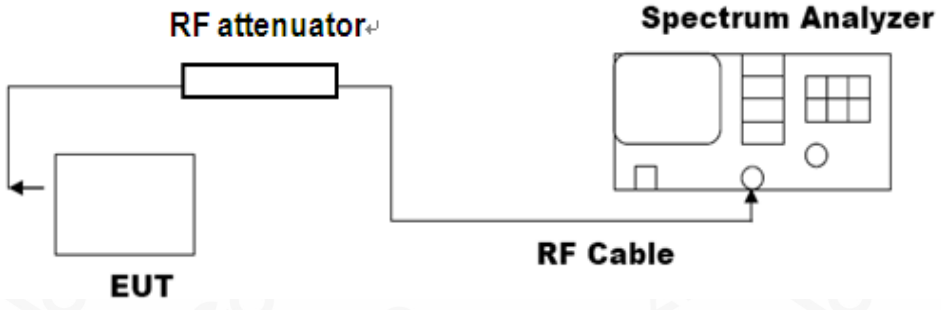
Change the centre frequency of the analyser to 2 399.5 MHz and perform the measurement for the first 1 MHz segment within range 2 400 MHz - BW to 2 400 MHz Reduce the centre frequency in 1 MHz steps and repeat the measurements to cover this whole range. The centre frequency of the last 1 MHz segment shall be set to 2 400 MHz - 2BW + 0.5 MHz.

5) Segment 2 400 MHz - 2BW to 2 400 MHz - BW

Change the centre frequency of the analyser to 2 399,5 MHz - BW and perform the measurement for the first 1 MHz segment within range 2 400 MHz - 2BW to 2 400 MHz - BW. Reduce the centre frequency in 1 MHz steps and repeat the measurements to cover this whole range. The centre frequency of the last 1 MHz segment shall be set to 2 400 MHz - 2BW + 0.5 MHz.

6) The cable loss and attenuator factor shall be considered to the test result.

5.5.3 TEST CONFIGURATION

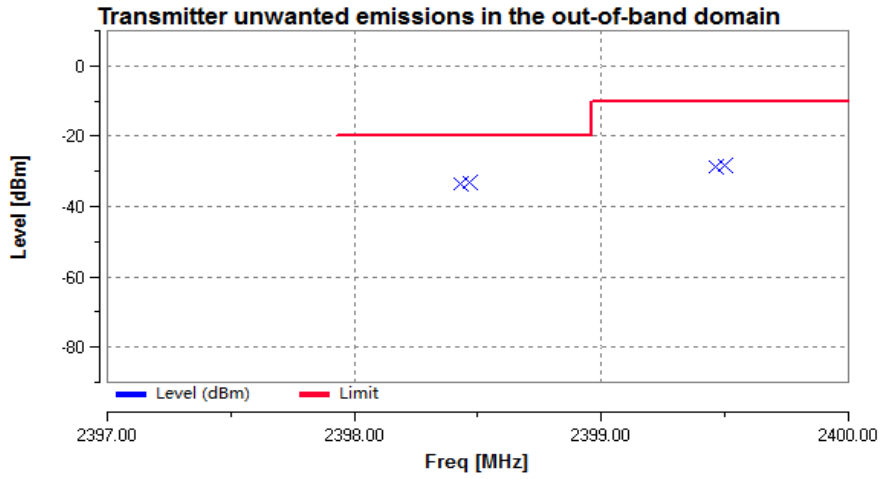


5.5.4TEST RESULT

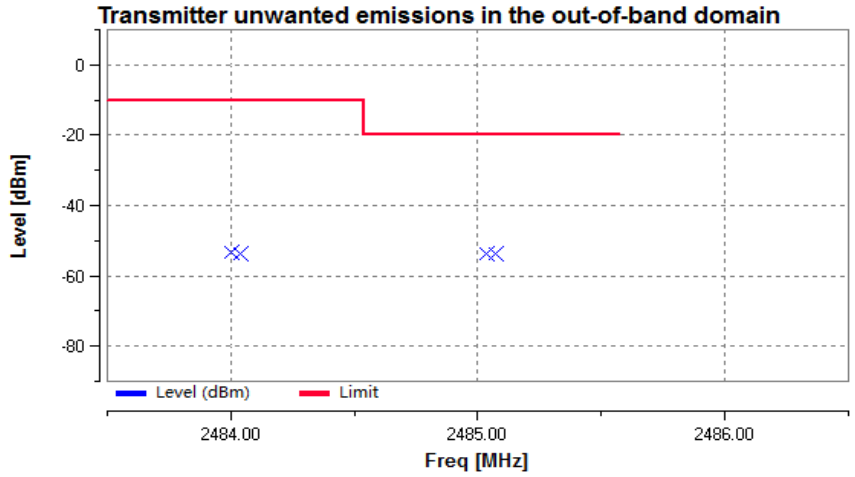
TEST ITEM	TRANSMITTER UNWANTED EMISSIONS IN THE OUT-OF-BAND DOMAIN
TEST MODE	GFSK MODULATION

MEASUREMENT RESULT	
Test Data (MHz)	Criteria
Low Channel	PASS
High Channel	PASS

CH Low-2402（BLE）



CH High-2480（BLE）



Note: All the modes had been tested, but only the worst data recorded in the report.

5.6. TRANSMITTER UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN

5.6.1 LIMIT

Spurious emissions are emissions outside the frequency range(s) of the equipment as defined in Clause 4.3.2.9.

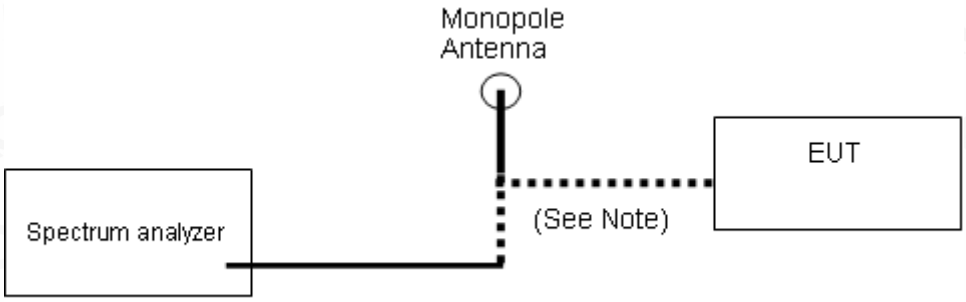
The spurious emissions of the transmitter shall not exceed the values in tables in the indicated bands:

Frequency Range	Maximum Power e.r.p(<=1GHz)/e.i.r.p(>1GHz)	Bandwidth
30MHz to 47MHz	-36dBm	100kHz
47MHz to 74MHz	-54dBm	100kHz
74MHz to 87.5MHz	-36dBm	100kHz
87.5MHz to 118MHz	-54dBm	100kHz
118MHz to 174MHz	-36dBm	100kHz
174 MHz to 230MHz	-54dBm	100kHz
230 MHz to 470MHz	-36dBm	100kHz
470 MHz to 694MHz	-54dBm	100kHz
694 MHz to 1GHZ	-36dBm	100kHz
1 GHZ to 12.75GHZ	-30dBm	1MHz

5.6.2 TEST PROCEDURE

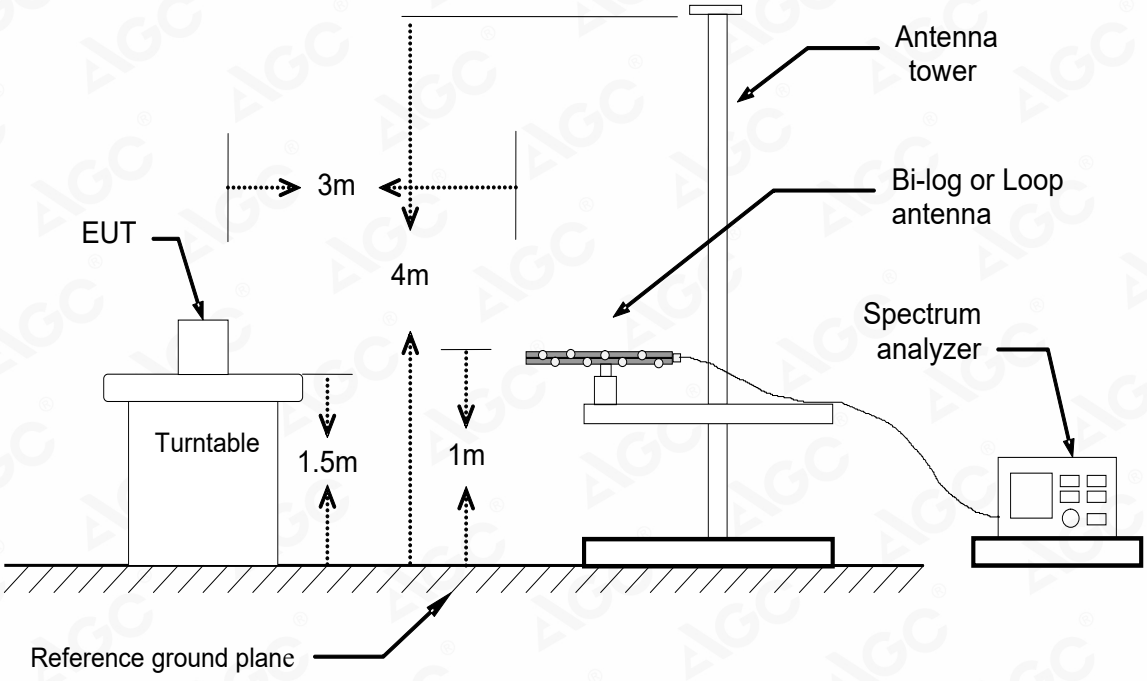
1) The emissions over the range 30 MHz to 1 000 MHz shall be identified.
2) Spectrum analyzer settings:
Resolution bandwidth: 100 kHz
Video bandwidth: 300 kHz
Detector mode: Peak
Sweep Points: ⩾19 400
Trace Mode: Max Hold
3) Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within the 6 dB range below the applicable limit or above, shall be individually measured using RMS detector and compared to the limits.
4) The emissions over the range 1 GHz to 12,75 GHz shall be identified.
5) Resolution bandwidth: 1 MHz
Video bandwidth: 3 MHz
Detector mode: Peak
Trace Mode: Max Hold
Sweep Points: ⩾23 500
6) Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within the 6 dB range below the applicable limit or above, shall be individually measured using RMS detector and compared to the limits.
7) For radiated method, the applicable measurement procedures as described in the EN 300 328 V2.2.2 annex C.2 and C.4 are used.

5.6.3 TEST CONFIGURATION

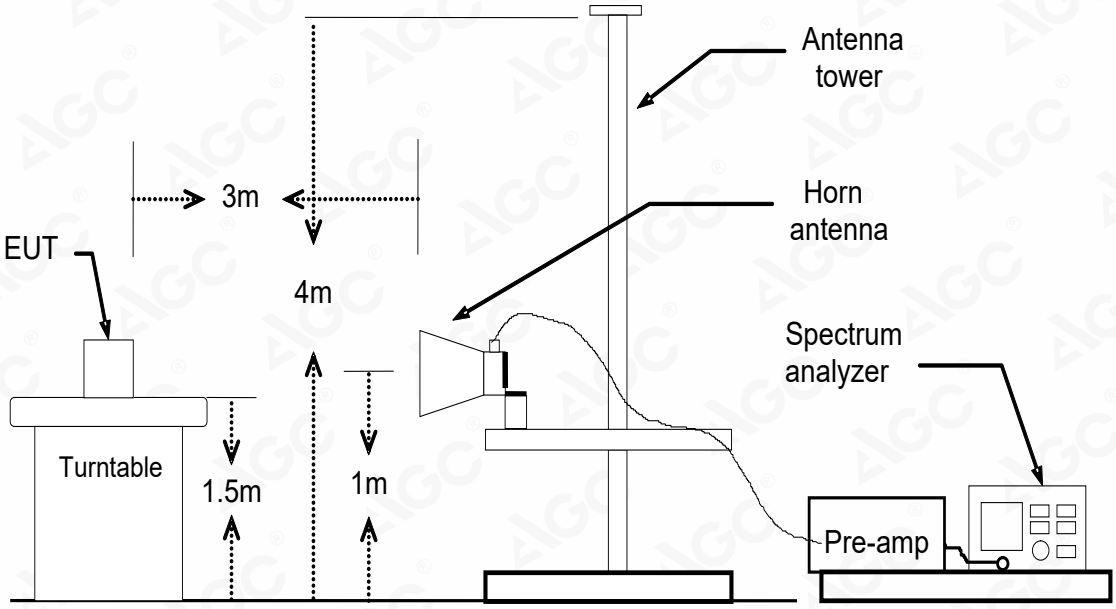


Conducted Method

Below 1GHz



Above 1GHz

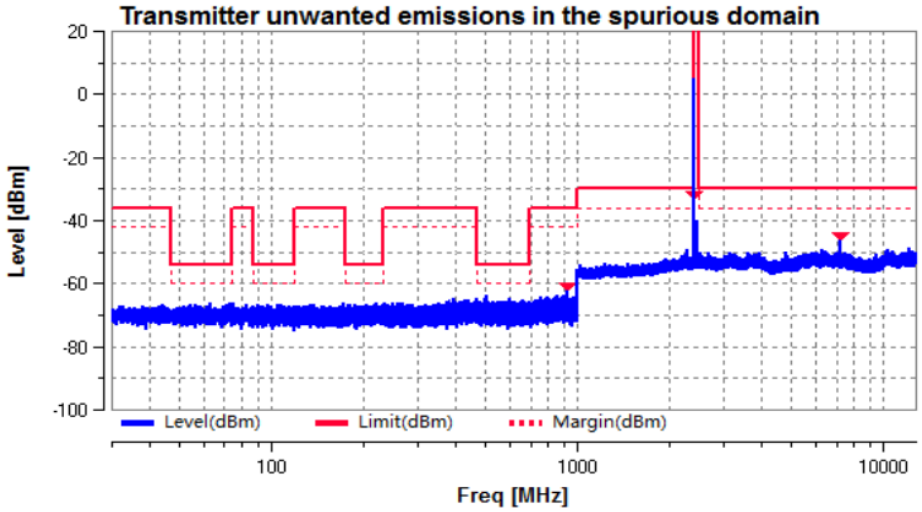


Radiated Method

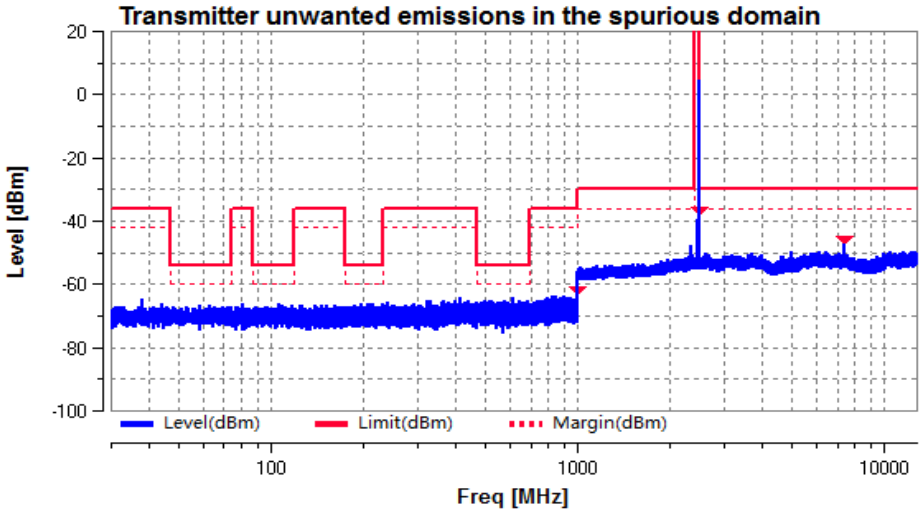
5.6.4TEST RESULT

Test Mode	Channel	Freq. [MHz]	Level[dBm]	Limit[dBm]	Verdict
BLE	2402	901.96	-68.67	-36	PASS
		2397.71	-33.77	-30	PASS
		7205.37	-47.66	-30	PASS
	2480	995.96	-63.12	-36	PASS
		2485.88	-37.95	-30	PASS
		7439.37	-47.07	-30	PASS

(Low channel, BLE)



(High channel, BLE)



Note: 1. All the modes had been test but only the worst data record in the report.

2. The 2.4G fundamental frequency is not considered to compare with the limit.

Radiated Method:

(Worst Case: Low channel)

Transmitter Spurious Emission below 1GHz (30MHz-1GHz)

Frequency	Reading Level	Antenna	S.G.	Cable Loss	Ant.Gain	Emission Level	Limit	Margin
(MHz)	(dBuV/m)	Polarization	(dBm)	(dB)	(dBi)	(dBm)	(dBm)	(dB)
90.53	31.16	V	-62.78	0.04	1.40	-61.42	-54.00	7.42
156.14	27.65	V	-66.98	0.06	0.80	-66.24	-36.00	30.24
354.03	31.48	V	-67.90	0.25	6.02	-62.13	-36.00	26.13
425.78	27.00	V	-73.10	0.33	7.00	-66.44	-36.00	30.44
627.22	28.37	V	-71.96	0.51	7.18	-65.29	-54.00	11.29
759.34	28.10	V	-70.13	0.61	6.55	-64.19	-36.00	28.19
Other(30-1000)	--	V	--	--	--	--	-36.00/-54.00	--
105.46	31.32	H	-62.35	0.04	0.80	-61.59	-54.00	7.59
154.17	26.02	H	-67.00	0.06	0.70	-66.36	-36.00	30.36
350.62	28.61	H	-69.50	0.25	5.50	-64.24	-36.00	28.24
431.16	26.47	H	-73.54	0.34	6.83	-67.05	-36.00	31.05
632.46	29.24	H	-69.83	0.52	7.26	-63.09	-54.00	9.09
731.51	28.96	H	-70.64	0.59	6.76	-64.47	-36.00	28.47
Other(30-1000)	--	H	--	--	--	--	-36.00/-54.00	--

Transmitter Spurious Emission above 1GHz (1GHz-12.75GHz)

Frequency	Reading Level	Antenna	S.G.	Cable Loss	Ant.Gain	Emission Level	Limit	Margin
(MHz)	(dBuV/m)	Polarization	(dBm)	(dB)	(dBi)	(dBm)	(dBm)	(dB)
4804	52.16	V	-47.85	2.65	9.34	-41.16	-30.00	11.16
7206	46.66	V	-54.85	3.13	11.32	-46.66	-30.00	16.66
--	--	V	--	--	--	--	--	--
--	--	V	--	--	--	--	--	--
--	--	V	--	--	--	--	--	--
Other(1000-12750)	--	V	--	--	--	--	-30.00	--
4804	51.62	H	-48.09	2.65	9.34	-41.40	-30.00	11.40
7206	43.74	H	-58.31	3.13	11.32	-50.12	-30.00	20.12
--	--	H	--	--	--	--	--	--
--	--	H	--	--	--	--	--	--
--	--	H	--	--	--	--	--	--
Other(1000-12750)	--	H	--	--	--	--	-30.00	--

Note: 1.The margins of the other spectrum are not exceeding the minimum value of margin, and this part of the results without recording in the test report.

2. Measurements above show only up to 6 maximum emissions noted, or would be lesser, with “--” remark, if no specific emission from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that’s already beyond the background noise floor.

(Worst Case: High channel)

Transmitter Spurious Emission below 1GHz (30MHz-1GHz)

Frequency	Reading Level	Antenna	S.G.	Cable Loss	Ant.Gain	Emission Level	Limit	Margin
(MHz)	(dBuV/m)	Polarization	(dBm)	(dB)	(dBi)	(dBm)	(dBm)	(dB)
94.36	31.78	V	-62.18	0.04	1.72	-60.50	-54.00	6.50
161.36	28.61	V	-64.88	0.06	1.28	-63.66	-36.00	27.66
357.50	31.79	V	-67.62	0.25	6.41	-61.46	-36.00	25.46
425.44	26.51	V	-72.49	0.33	7.00	-65.82	-36.00	29.82
629.45	28.12	V	-70.99	0.51	7.26	-64.25	-54.00	10.25
760.07	27.20	V	-71.69	0.61	6.60	-65.70	-36.00	29.70
Other(30-1000)	--	V	--	--	--	--	-36.00/-54.00	--
109.42	31.84	H	-62.11	0.04	1.28	-60.87	-54.00	6.87
154.01	26.45	H	-68.01	0.06	0.70	-67.37	-36.00	31.37
351.06	28.12	H	-70.03	0.25	5.63	-64.65	-36.00	28.65
429.87	26.65	H	-73.91	0.34	6.92	-67.32	-36.00	31.32
628.14	29.18	H	-71.24	0.51	7.22	-64.53	-54.00	10.53
730.66	29.00	H	-69.55	0.59	6.80	-63.34	-36.00	27.34
Other(30-1000)	--	H	--	--	--	--	-36.00/-54.00	--

Transmitter Spurious Emission above 1GHz (1GHz-12.75GHz)

Frequency	Reading Level	Antenna	S.G.	Cable Loss	Ant.Gain	Emission Level	Limit	Margin
(MHz)	(dBuV/m)	Polarization	(dBm)	(dB)	(dBi)	(dBm)	(dBm)	(dB)
4960	52.17	V	-46.76	2.65	9.34	-40.07	-30.00	10.07
7440	46.50	V	-54.56	3.13	11.32	-46.37	-30.00	16.37
--	--	V	--	--	--	--	--	--
--	--	V	--	--	--	--	--	--
--	--	V	--	--	--	--	--	--
Other(1000-12750)	--	V	--	--	--	--	-30.00	--
4960	51.46	H	-48.56	2.65	9.34	-41.87	-30.00	11.87
7440	44.00	H	-56.66	3.13	11.32	-48.47	-30.00	18.47
--	--	H	--	--	--	--	--	--
--	--	H	--	--	--	--	--	--
--	--	H	--	--	--	--	--	--
Other(1000-12750)	--	H	--	--	--	--	-30.00	--

Note: 1.The margins of the other spectrum are not exceeding the minimum value of margin, and this part of the results without recording in the test report.

2. Measurements above show only up to 6 maximum emissions noted, or would be lesser, with "--" remark, if no specific emission from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.

Conclusion: PASS

5.7. RECEIVER UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN

5.7.1 LIMIT

ETSI EN300328 SUBCLAUSE 4.3.2.10

Receiver spurious emissions are emissions at any frequency when the equipment is in receive mode.

The spurious emissions of the receiver shall not exceed the values given in table.

Frequency Range	Maximum Power e.r.p(<=1GHz)/e.i.r.p(>1GHz)	Measurement Bandwidth
30MHz to 1000MHz	-57dBm	100kHz
1GHz to 12.75GHz	-47dBm	1MHz

5.7.2 TEST PROCEDURE

1) The emissions over the range 30 MHz to 1 000 MHz shall be identified.
2) Spectrum analyzer settings:
Resolution bandwidth: 100 kHz
Video bandwidth: 300 kHz
Detector mode: Peak
Sweep Points: ≥19 400
Trace Mode: Max Hold
3) Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within the 6 dB range below the applicable limit or above, shall be individually measured using RMS detector and compared to the limits given in 5.7.1.
4) The emissions over the range 1 GHz to 12.75 GHz shall be identified.
5) Resolution bandwidth: 1 MHz
Video bandwidth: 3 MHz
Detector mode: Peak
Trace Mode: Max Hold
Sweep Points: ≥23200
6) Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within the 6 dB range below the applicable limit or above, shall be individually measured using RMS detector and compared to the limits given in 5.7.1.
7) For radiated method, the applicable measurement procedures as described in the EN 300 328 V2.2.2 annex C.2 and C.4 are used.

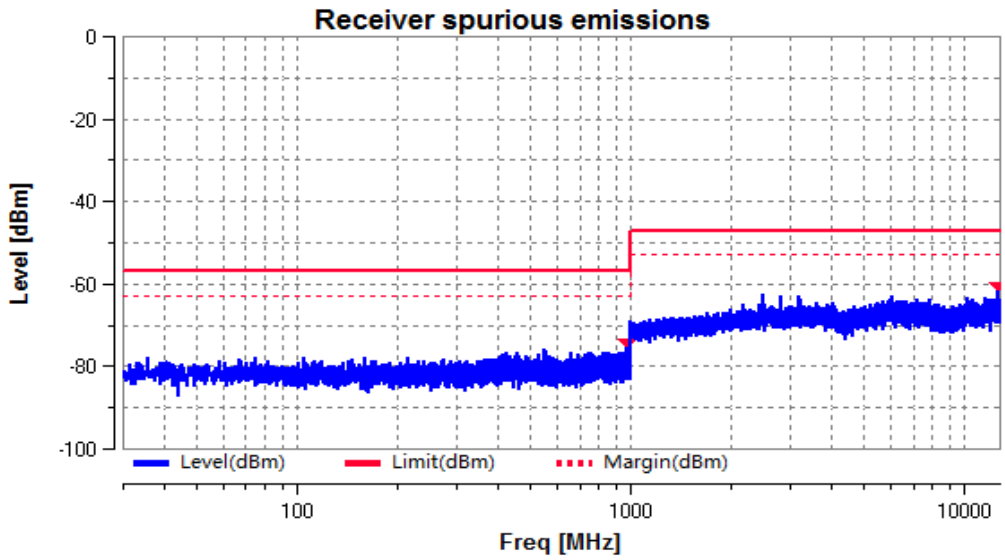
5.7.3 TEST CONFIGURATION

Refer to 5.6.3

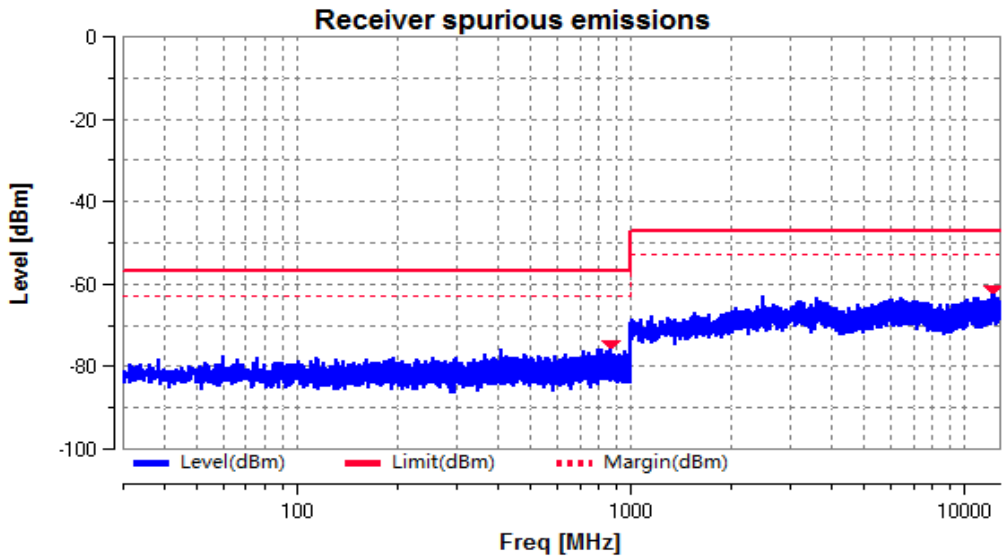
5.7.4TEST RESULT

Test Mode	Channel	Freq. [MHz]	Level[dBm]	Limit[dBm]	Verdict
BLE_BT4.0	2402	973.33	-75.41	-57.00	PASS
		12617.81	-61.83	-47.00	PASS
	2480	871.72	-75.68	-57.00	PASS
		12158.09	-62.66	-47.00	PASS

(Low channel, BLE)



(High channel, BLE)



Note: 1. All the modes had been test but only the worst data record in the report.

Radiated Method:

(Worst Case: Low channel)

Receiver Spurious Emission below 1GHz (30MHz-1GHz)

Frequency	Reading Level	Antenna	S.G.	Cable Loss	Ant.Gain	Emission Level	Limit	Margin
(MHz)	(dBuV/m)	Polarization	(dBm)	(dB)	(dBi)	(dBm)	(dBm)	(dB)
121.36	26.66	V	-67.38	0.04	0.70	-66.72	-57.00	9.72
160.96	28.32	V	-66.09	0.06	1.20	-64.95	-57.00	7.95
359.62	28.96	V	-71.19	0.26	6.67	-64.77	-57.00	7.77
533.64	26.68	V	-73.23	0.44	6.78	-66.89	-57.00	9.89
676.79	30.60	V	-69.58	0.55	6.56	-63.57	-57.00	6.57
830.84	30.60	V	-67.79	0.66	6.30	-62.14	-57.00	5.14
Other(30-1000)	--	V	--	--	--	--	-57.00	--
135.72	27.34	H	-65.53	0.05	0.00	-65.58	-57.00	8.58
163.20	29.68	H	-64.21	0.06	1.44	-62.83	-57.00	5.83
340.94	30.17	H	-68.43	0.23	5.70	-62.96	-57.00	5.96
536.40	27.31	H	-72.52	0.45	6.96	-66.00	-57.00	9.00
679.00	29.85	H	-69.83	0.55	6.44	-63.94	-57.00	6.94
829.52	27.51	H	-72.31	0.66	6.35	-66.62	-57.00	9.62
Other(30-1000)	--	H	--	--	--	--	-57.00	--

Receiver Spurious Emission above 1GHz (1GHz-12.75GHz)

Frequency	Reading Level	Antenna	S.G.	Cable Loss	Ant.Gain	Emission Level	Limit	Margin
(MHz)	(dBuV/m)	Polarization	(dBm)	(dB)	(dBi)	(dBm)	(dBm)	(dB)
4947.72	31.64	V	-68.50	1.22	6.84	-62.88	-47.00	15.88
--	--	V	--	--	--	--	--	--
--	--	V	--	--	--	--	--	--
--	--	V	--	--	--	--	--	--
--	--	V	--	--	--	--	--	--
Other(1000-12750)	--	V	--	--	--	--	-47.00	--
4953.10	33.61	H	-65.27	1.19	6.67	-59.79	-47.00	12.79
--	--	H	--	--	--	--	--	--
--	--	H	--	--	--	--	--	--
--	--	H	--	--	--	--	--	--
--	--	H	--	--	--	--	--	--
Other(1000-12750)	--	H	--	--	--	--	-47.00	--

Note: 1.The margins of the other spectrum are not exceeding the minimum value of margin, and this part of the results without recording in the test report.

2. Measurements above show only up to 6 maximum emissions noted, or would be lesser, with “--” remark, if no specific emission from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that’s already beyond the background noise floor.

(Worst Case: High channel)

Receiver Spurious Emission below 1GHz (30MHz-1GHz)

Frequency	Reading Level	Antenna	S.G.	Cable Loss	Ant.Gain	Emission Level	Limit	Margin
(MHz)	(dBuV/m)	Polarization	(dBm)	(dB)	(dBi)	(dBm)	(dBm)	(dB)
125.49	27.68	V	-65.48	0.05	0.30	-65.23	-57.00	8.23
156.29	28.63	V	-65.28	0.06	0.80	-64.54	-57.00	7.54
360.70	28.34	V	-71.24	0.26	6.80	-64.70	-57.00	7.70
536.75	27.32	V	-72.84	0.45	6.96	-66.33	-57.00	9.33
672.77	30.98	V	-67.86	0.55	6.72	-61.68	-57.00	4.68
834.75	29.31	V	-70.50	0.66	6.58	-64.58	-57.00	7.58
Other(30-1000)	--	V	--	--	--	--	-57.00	--
139.81	27.53	H	-64.64	0.05	0.00	-64.69	-57.00	7.69
163.95	28.23	H	-65.62	0.06	1.44	-64.24	-57.00	7.24
340.54	30.64	H	-67.94	0.23	5.70	-62.48	-57.00	5.48
538.69	28.95	H	-71.13	0.45	7.08	-64.50	-57.00	7.50
675.61	28.55	H	-71.52	0.55	6.60	-65.47	-57.00	8.47
827.92	27.59	H	-71.07	0.66	6.45	-65.28	-57.00	8.28
Other(30-1000)	--	H	--	--	--	--	-57.00	--

Receiver Spurious Emission above 1GHz (1GHz-12.75GHz)

Frequency	Reading Level	Antenna	S.G.	Cable Loss	Ant.Gain	Emission Level	Limit	Margin
(MHz)	(dBuV/m)	Polarization	(dBm)	(dB)	(dBi)	(dBm)	(dBm)	(dB)
4979.91	32.79	V	-67.47	1.22	6.84	-61.85	-47.00	14.85
--	--	V	--	--	--	--	--	--
--	--	V	--	--	--	--	--	--
--	--	V	--	--	--	--	--	--
--	--	V	--	--	--	--	--	--
Other(1000-12750)	--	V	--	--	--	--	-47.00	--
4914.08	33.79	H	-65.63	1.19	6.67	-60.15	-47.00	13.15
--	--	H	--	--	--	--	--	--
--	--	H	--	--	--	--	--	--
--	--	H	--	--	--	--	--	--
--	--	H	--	--	--	--	--	--
Other(1000-12750)	--	H	--	--	--	--	-47.00	--

Note: 1.The margins of the other spectrum are not exceeding the minimum value of margin, and this part of the results without recording in the test report.

2. Measurements above show only up to 6 maximum emissions noted, or would be lesser, with "--" remark, if no specific emission from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.

Conclusion: PASS

5.8. RECEIVER BLOCKING

5.8.1 LIMIT

☐Receiver Blocking parameters for Receiver Category 1 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 4)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 4)	Type of blocking signal
(-133 dBm + 10 × log10(OCBW)) or -68 dBm whichever is less(see note 2)	2 380 2 504	-34	CW
(-139 dBm + 10 × log10(OCBW)) or -74 dBm whichever is less(see note 3)	2 300 2 330 2 360 2 524 2 584 2 674		

NOTE 1: OCBW is in Hz.

NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 26 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.2.11.3 in the absence of any blocking signal.

NOTE 3: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 20 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.2.11.3 in the absence of any blocking signal.

NOTE 4: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the(in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being con figured/ positioned as recorded in clause 5.4.3.2.2.

☒Receiver Blocking parameters for Receiver Category 2 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
(-139 dBm + 10 × log10(OCBW) + 10 dB) or (-74 dBm + 10 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW

NOTE 1: OCBW is in Hz.

NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 26 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.2.11.3 in the absence of any blocking signal.

NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the(in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being con figured/ positioned as recorded in clause 5.4.3.2.2.

☐Receiver Blocking parameters for Receiver Category 3 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
(-139 dBm + 10 × log10(OCBW) + 20 dB) or (-74 dBm + 20 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW

NOTE 1: OCBW is in Hz.

NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 30 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.2.11.3 in the absence of any blocking signal.

NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the(in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being con figured/ positioned as recorded in clause 5.4.3.2.2.

5.8.2 TEST PROCEDURE

For non-FHSS equipment, having more than one operating channel, the operating channels on which the testing has to be performed shall be selected as follows:

- For testing blocking frequencies less than 2 400 MHz, the equipment shall operate on the lowest operating channel.
- For testing blocking frequencies greater than 2 500 MHz, the equipment shall operate on the highest operating channel.

The simplified conducted measure procedures are as follows:

1) For non-FHSS equipment, the UUT shall be set to the lowest operating channel on which the blocking test has to be performed.

2) The blocking signal generator is set to the first frequency as defined in the appropriate table corresponding to the receiver category and type of equipment.

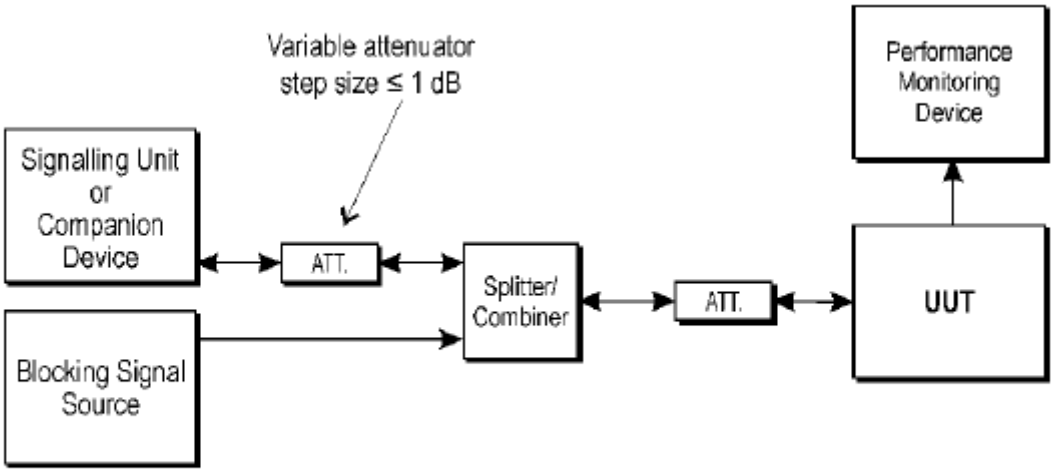
3) With the blocking signal generator switched off, a communication link is established between the UUT and the associated companion device using the test setup. The level of the wanted signal shall be set to the value provided in the table corresponding to the receiver category and type of equipment.This level may be measured directly at the output of the companion device and a correction is made for the coupling loss into the UUT. The actual level for the wanted signal shall be recorded in the test report.

4) The blocking signal at the UUT is set to the level provided in the table corresponding to the receiver category and type of equipment. It shall be verified and recorded in the test report that the performance cri teria is met.

5) Repeat step 4 for each remaining combination of frequency and level for the blocking signal as provided in the table corresponding to the receiver category and type of equipment.

6) Repeat step 2 to step 5 with the UUT operating at the highest operating channel.

5.8.3 TEST CONFIGURATION



Test Set-up for receiver blocking

5.8.4TEST RESULT

Test channel	Blocking Signal Frequency(MHz)	Blocking Signal Power(dBm)	Wanted signal mean power from companion device(dBm)	Performance PER	Limit PER	Result
Low	2300	-29.01	-63.85	1.49%	10%	Pass
	2380	-29.01	-63.85	1.10%	10%	
High	2504	-29.01	-63.84	2.57%	10%	
	2584	-29.01	-63.84	1.81%	10%	

Note: The levels of the blocking signal and wanted signal have to be corrected for the (in-band) antenna assembly gain.

APPENDIX A: PHOTOGRAPHS OF TEST SETUP

Refer to Attached file (Appendix I)

APPENDIX B: PHOTOGRAPHS OF THE EUT

Refer to Attached file (Appendix I)

----END OF REPORT----

Conditions of Issuance of Test Reports

1. All samples and goods are accepted by the Attestation of Global Compliance (Shenzhen) Co., Ltd (the "Company") solely for testing and reporting in accordance with the following terms and conditions. The company provides its services on the basis that such terms and conditions constitute express agreement between the company and any person, firm or company requesting its services (the "Clients").

2. Any report issued by Company as a result of this application for testing services (the "Report") shall be issued in confidence to the Clients and the Report will be strictly treated as such by the Company. It may not be reproduced either in its entirety or in part and it may not be used for advertising or other unauthorized purposes without the written consent of the Company. The Clients to whom the Report is issued may, however, show or send it, or a certified copy thereof prepared by the Company to its customer, supplier or other persons directly concerned. The Company will not, without the consent of the Clients, enter into any discussion or correspondence with any third party concerning the contents of the Report, unless required by the relevant governmental authorities, laws or court orders.

3.The Company shall not be called or be liable to be called to give evidence or testimony on the Report in a court of law without its prior written consent, unless required by the relevant governmental authorities, laws or court orders.

4. The non-CMA report issued by AGC is only permitted to be used by the client as internal reference use and shall not be used for public demonstration purpose.

5. In the event of the improper use of the report as determined by the Company, the Company reserves the right to withdraw it, and to adopt any other additional remedies which may be appropriate.

6. Samples submitted for testing are accepted on the understanding that the Report issued cannot form the basis of, or be the instrument for, any legal action against the Company.

7. The Company will not be liable for or accept responsibility for any loss or damage however arising from the use of information contained in any of its Reports or in any communication whatsoever about its said tests or investigations.

8.Clients wishing to use the Report in court proceedings or arbitration shall inform the Company to that effect prior to submitting the sample for testing.

9. The Company is not responsible for recalling the electronic version of the original report when any revision is made to them. The Client assumes the responsibility to providing the revised version to any interested party who uses them.

10. Subject to the variable length of retention time for test data and report stored hereinto as otherwise specifically required by individual accreditation authorities, the Company will only keep the supporting test data and information of the test report for a period of six years. The data and information will be disposed of after the aforementioned retention period has elapsed. Under no circumstances shall we provide any data and information which has been disposed of after retention period. Under no circumstances shall we be liable for damage of any kind, including (but not limited to) compensatory damages, lost profits, lost data, or any form of special, incidental, indirect, consequential or punitive damages of any kind, whether based on breach of contract of warranty, tort (including negligence), product liability or otherwise, even if we are informed in advance of the possibility of such damages.