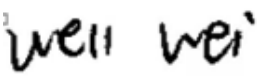
TEST REPORT

Application No.:	SEWM2307000288RG
Applicant:	ALPS Electric Ireland Ltd
Address of Applicant:	Clara Road, Millstreet Town, County Cork P51 XC56, Ireland
Manufacturer:	ALPS Electric Ireland Ltd
Address of Manufacturer:	Clara Road, Millstreet Town, County Cork P51 XC56, Ireland
EUT Description:	Asset Tracker
Model No.:	Lykaner N5
Trade Mark:	Lykaner N5
FCC ID:	2AT4V-LYKANER-N5
Standards:	47 CFR Part 2 47 CFR Part 22 47 CFR Part 24 47 CFR Part 27
Date of Receipt:	2023/07/23
Date of Test:	2023/07/23 to 2023/07/28
Date of Issue:	2023/09/08
Test Result :	**PASS ***

* In the configuration tested, the EUT detailed in this report complied with the standards specified above.

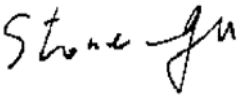
Authorized Signature:



Well Wei
Wireless Laboratory Manager

1 Version

Revision Record				
Version	**Chapter**	**Date**	**Modifier**	**Remark**
01		2023/09/08		Original

Prepared By		 **(Levi Li) / Test Engineer**
Checked By		 **(Stone Gu) / Reviewer**

Contents

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2 Test Summary

2.1 LTE NB1 Band 5

Test Item	FCC Rule No.	Requirements	Test Result	Verdict
Effective (Isotropic) Radiated Power Output Data	§2.1046, §22.913(a)(5)	ERP ≤ 7 W	Section 1 of Appendix B.3	Pass
Peak-Average Ratio	§22.913(d)	Limit≤13 dB	Reference report R1910A0633-R2V1	
Bandwidth	§2.1049	OBW: No limit. EBW: No limit.	Reference report R1910A0633-R2V1	
Band Edges Compliance	§2.1051, §22.917(a)	≤ -13 dBm/1%*EBW, in 1 MHz bands immediately outside and adjacent to the frequency block.	Reference report R1910A0633-R2V1	
Spurious Emission at Antenna Terminals	§2.1051, §22.917(a)	FCC: ≤ -13 dBm/100 kHz, from 9 kHz to 10th harmonics but outside authorized operating frequency ranges.	Reference report R1910A0633-R2V1	
Field Strength of Spurious Radiation	§2.1053, §22.917(a)	FCC: ≤ -13 dBm/100 kHz.	Section 2 of Appendix B.3	Pass
Frequency Stability	§2.1055(a)(1)(b) §2.1055(d)(2) §22.355	≤ ±2.5ppm.	Reference report R1910A0633-R2V1	
Remark for SEWM2307000288RG01 issued on 2023/09/08: The Effective (Isotropic) Radiated Power Output Data and Field Strength of Spurious Radiation were tested in this report, and other items data please refer to the test report R1910A0633-R2V1 issued by TA Technology(Shanghai) Co., Ltd., on 2019/12/09.				

2.2 LTE NB1 Band 2/25

Test Item	FCC Rule No.	Requirements	Test Result	Verdict
Effective (Isotropic) Radiated Power Output Data	§2.1046, §24.232(c)	EIRP ≤ 2 W	Section 1 of Appendix B.1&B.7	Pass
Peak-Average Ratio	§24.232(d)	Limit≤13 dB	Reference report R1910A0633-R2V1	
Bandwidth	§2.1049	OBW: No limit. EBW: No limit.	Reference report R1910A0633-R2V1	
Band Edges Compliance	§2.1051, §24.238(a)	≤ -13 dBm/1%*EBW, in 1 MHz bands immediately outside and adjacent to the frequency block.	Reference report R1910A0633-R2V1	
Spurious Emission at Antenna Terminals	§2.1051, §24.238(a)	≤ -13 dBm/1 MHz, from 9 kHz to 10th harmonics but outside authorized operating frequency ranges.	Reference report R1910A0633-R2V1	
Field Strength of Spurious Radiation	§2.1053, §24.238(a)	≤ -13 dBm/1 MHz.	Section 2 of Appendix B.1&B.7	Pass
Frequency Stability	§2.1055(a)(1)(b) §2.1055(d) (2) §24.235	Within authorized bands of operation/frequency block.	Reference report R1910A0633-R2V1	
Remark for SEWM2307000288RG01 issued on 2023/09/08: The Effective (Isotropic) Radiated Power Output Data and Field Strength of Spurious Radiation were tested in this report, and other items data please refer to the test report R1910A0633-R2V1 issued by TA Technology(Shanghai) Co., Ltd., on 2019/12/09.				

2.3 LTE NB1 Band 4/66

Test Item	FCC Rule No.	Requirements	Test Result	Verdict
Effective (Isotropic) Radiated Power Output Data	§2.1046, §27.50(d)(4)	EIRP ≤ 1 W	Section 1 of Appendix B.2&B.8	Pass
Peak-Average Ratio	§27.50(d)(5)	Limit≤13 dB	Reference report R1910A0633-R2V1	
Bandwidth	§2.1049	OBW: No limit. EBW: No limit.	Reference report R1910A0633-R2V1	
Band Edges Compliance	§2.1051, §27.53(h)	≤ -13 dBm/1%*EBW, in 1 MHz bands immediately outside and adjacent to the frequency block.	Reference report R1910A0633-R2V1	
Spurious Emission at Antenna Terminals	§2.1051, §27.53(h)	≤ -13 dBm/1 MHz, from 9 kHz to 10th harmonics but outside authorized operating frequency ranges.	Reference report R1910A0633-R2V1	
Field Strength of Spurious Radiation	§2.1053, §27.53(h)	≤ -13 dBm/1 MHz.	Section 2 of Appendix B.2&B.8	Pass
Frequency Stability	§2.1055(a)(1)(b) §2.1055(d) (2) §27.54	Within authorized bands of operation/frequency block.	Reference report R1910A0633-R2V1	
Remark for SEWM2307000288RG01 issued on 2023/09/08: The Effective (Isotropic) Radiated Power Output Data and Field Strength of Spurious Radiation were tested in this report, and other items data please refer to the test report R1910A0633-R2V1 issued by TA Technology(Shanghai) Co., Ltd., on 2019/12/09.				

2.4 LTE NB1 Band 12/17/85

Test Item	FCC Rule No.	Requirements	Test Result	Verdict
Effective (Isotropic) Radiated Power Output Data	§2.1046 §27.50(c)(10)	ERP ≤ 3 W.	Section 1 of Appendix B.4&B.6&B.10	Pass
Peak-Average Ratio	---	Limit≤13 dB	Reference report R1910A0633-R2V1	
Bandwidth	§2.1049	OBW: No limit. EBW: No limit.	Reference report R1910A0633-R2V1	
Band Edges Compliance	§2.1051, §27.53(g)	≤ -13 dBm/1%*EBW, in 1 MHz bands immediately outside and adjacent to the frequency block.	Reference report R1910A0633-R2V1	
Spurious Emission at Antenna Terminals	§2.1051, §27.53(g)	FCC: ≤ -13 dBm/100 kHz, from 9 kHz to 10th harmonics but outside authorized operating frequency ranges.	Reference report R1910A0633-R2V1	
Field Strength of Spurious Radiation	§2.1053, §27.53(g)	FCC: ≤ -13 dBm/100 kHz.	Section 2 of Appendix B.4&B.6&B.10	Pass
Frequency Stability	§2.1055(a)(1)(b) §2.1055(d) (2) §27.54	Within authorized bands of operation/frequency block.	Reference report R1910A0633-R2V1	
Remark for SEWM2307000288RG01 issued on 2023/09/08: The Effective (Isotropic) Radiated Power Output Data and Field Strength of Spurious Radiation were tested in this report, and other items data please refer to the test report R1910A0633-R2V1 issued by TA Technology(Shanghai) Co., Ltd., on 2019/12/09.				

2.5 LTE NB1 Band 13

Test Item	FCC Rule No.	Requirements	Test Result	Verdict
Effective (Isotropic) Radiated Power Output Data	§2.1046, §27.50(b)(10)	ERP ≤ 3 W.	Section 1 of Appendix B.5	Pass
Peak-Average Ratio	---	Limit≤13 dB	Reference report R1910A0633-R2V1	
Bandwidth	§2.1049,	OBW: No limit. EBW: No limit.	Reference report R1910A0633-R2V1	
Band Edges Compliance	§2.1051, §27.53(c)	≤ -13 dBm/1%*EBW, in 1 MHz bands immediately outside and adjacent to the frequency block.	Reference report R1910A0633-R2V1	
Spurious Emission at Antenna Terminals	§2.1051, §27.53(c) §27.53(f)	≤ -13 dBm/100 kHz, from 9 kHz to 10th harmonics but outside authorized operating frequency ranges. On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations. For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth.	Reference report R1910A0633-R2V1	
Field Strength of Spurious Radiation	§2.1053, §27.53(c) §27.53(f)	FCC: ≤ -13 dBm/100 kHz. For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth.	Section 2 of Appendix B.5	Pass
Frequency Stability	§2.1055(a)(1)(b) §2.1055(d) (2) §27.54	Within authorized bands of operation/frequency block.	Reference report R1910A0633-R2V1	

Remark for SEWM2307000288RG01 issued on 2023/09/08:
The Effective (Isotropic) Radiated Power Output Data and Field Strength of Spurious Radiation were tested in this report, and other items data please refer to the test report R1910A0633-R2V1 issued by TA Technology(Shanghai) Co., Ltd., on 2019/12/09.

2.6 LTE NB1 Band 71

Test Item	FCC Rule No.	Requirements	Test Result	Verdict
Effective (Isotropic) Radiated Power Output Data	§2.1046 §27.50(c)(10)	ERP ≤ 3 W	Section 1 of Appendix B.9	Pass
Peak-Average Ratio	---	Limit≤13 dB	Reference report R1910A0633-R2V1	
Bandwidth	§2.1049	OBW: No limit. EBW: No limit.	Reference report R1910A0633-R2V1	
Band Edges Compliance	§2.1051, §27.53(g)	≤ -13 dBm/1%*EBW, in 1 MHz bands immediately outside and adjacent to the frequency block.	Reference report R1910A0633-R2V1	
Spurious Emission at Antenna Terminals	§2.1051, §27.53(g)	≤ -13 dBm/1 MHz, from 9 kHz to 10th harmonics but outside authorized operating frequency ranges.	Reference report R1910A0633-R2V1	
Field Strength of Spurious Radiation	§2.1053, §27.53(g)	≤ -13 dBm/1 MHz.	Section 2 of Appendix B.9	Pass
Frequency Stability	§2.1055(a)(1)(b) §2.1055(d) (2) §27.54	within the authorized bands of operation.	Reference report R1910A0633-R2V1	
Remark for SEWM2307000288RG01 issued on 2023/09/08: The Effective (Isotropic) Radiated Power Output Data and Field Strength of Spurious Radiation were tested in this report, and other items data please refer to the test report R1910A0633-R2V1 issued by TA Technology(Shanghai) Co., Ltd., on 2019/12/09.				

3 General Information

3.1 Details of Client

Applicant:	ALPS Electric Ireland Ltd
Address of Applicant:	Clara Road, Millstreet Town, County Cork P51 XC56, Ireland
Manufacturer:	ALPS Electric Ireland Ltd
Address of Manufacturer:	Clara Road, Millstreet Town, County Cork P51 XC56, Ireland

3.2 Test Location

Company:	SGS-CSTC Standards Technical Services (Suzhou) Co., Ltd.
Address:	South of No. 6 Plant, No. 1, Runsheng Road, Suzhou Industrial Park, Suzhou Area, China (Jiangsu) Pilot Free Trade Zone
Post code:	215000
Test engineer:	Levi Li, King-p.Li

3.3 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

• **A2LA (Certificate No. 6336.01)**

SGS-CSTC STANDARDS TECHNICAL SERVICES (SUZHOU) CO., LTD. is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 6336.01.

• **Innovation, Science and Economic Development Canada**

SGS-CSTC STANDARDS TECHNICAL SERVICES (SUZHOU) CO., LTD. has been recognized by ISED as an accredited testing laboratory.

CAB identifier: CN0120.

IC#: 27594.

• **FCC –Designation Number: CN1312**

SGS-CSTC STANDARDS TECHNICAL SERVICES (SUZHOU) CO., LTD. has been recognized as an accredited testing laboratory.

Designation Number: CN1312.

Test Firm Registration Number: 717327

3.4 General Description of EUT

EUT Description:	Asset Tracker			
Model No.:	Lykaner N5			
Trade Mark:	Lykaner N5			
Hardware Version:	1AD-MA00068A			
Software Version:	v22.3.0			
Power Supply:	3.6V			
IMEI:	RF Conducted	863405044387110		
	RSE	863405044387110		
Antenna Type:	☐ External, ☒ Integrated			
Antenna Gain:	LTE NB1 Band 2: 3.1dBi		LTE NB1 Band 4: 3.1dBi	
	LTE NB1 Band 5: 2.5dBi		LTE NB1 Band 12: 2.5dBi	
	LTE NB1 Band 13: 2.5dBi		LTE NB1 Band 17: 2.5dBi	
	LTE NB1 Band 25: 3.1dBi		LTE NB1 Band 66: 3.1dBi	
	LTE NB1 Band 71: 2.5dBi		LTE NB1 Band 85: 2.5dBi	
	Note: The antenna gain are derived from the gain information report provided by the manufacturer.			
RF Cable:	4.2dB(Below 1GHz)	4.5dB(1.0~2.4GHz)	4.8dB(2.4~3.4GHz)	
Remark: As above information is provided and confirmed by the applicant. SGS is not liable to the accuracy, suitability, reliability or/and integrity of the information.				

3.5 Test Mode

Test Mode	Test Modes Description
LTE NB1/TM1	LTE NB1 system, BPSK modulation
LTE NB1/TM2	LTE NB1 system, QPSK modulation
Remark: The test mode(s) are selected according to relevant radio technology specifications.	

3.6 Test Environment

Environment Parameter	101 kPa Selected Values During Tests	
Relative Humidity	44-46 % RH Ambient	
Value	Temperature(℃)	Voltage(V)
NTNV	22~23	3.6
LTLV	-30	2.9
LTHV	-30	3.63
HTLV	50	2.9
HTHV	50	3.63
Remark:		
NV: Normal Voltage	LV: Low Extreme Test Voltage	HV: High Extreme Test Voltage
NT: Normal Temperature	LT: Low Extreme Test Temperature	HT: High Extreme Test Temperature

3.7 Description of Support Units

The EUT has been tested as an independent unit.

3.8 Technical Specification

Characteristics	Description		
Radio System Type	☒ LTE NB1		
Supported Frequency Range	Band	TX	RX
	LTE NB1 Band 2	1850 to 1910 MHz	1930 to 1990 MHz
	LTE NB1 Band 4	1710 to 1755 MHz	2110 to 2155 MHz
	LTE NB1 Band 5	824 to 849 MHz	869 to 894 MHz
	LTE NB1 Band 12	699 to 716 MHz	729 to 746 MHz
	LTE NB1 Band 13	777 to 787 MHz	746 to 756 MHz
	LTE NB1 Band 17	704 to 716 MHz	734 to 746 MHz
	LTE NB1 Band 25	1850 to 1915MHz	1930 to 1995 MHz
	LTE NB1 Band 66	1710 to 1780 MHz	2110 to 2200 MHz
	LTE NB1 Band 71	663 to 698 MHz	617 to 652 MHz
	LTE NB1 Band 85	698 to 716 MHz	728 to 746 MHz
Supported Channel Bandwidth	LTE NB1 Band 2	☒180KHz;	
	LTE NB1 Band 4	☒180KHz;	
	LTE NB1 Band 5	☒180KHz;	
	LTE NB1 Band 12	☒180KHz;	
	LTE NB1 Band 13	☒180KHz;	
	LTE NB1 Band 17	☒180KHz;	
	LTE NB1 Band 25	☒180KHz;	
	LTE NB1 Band 66	☒180KHz;	
	LTE NB1 Band 71	☒180KHz;	
	LTE NB1 Band 85	☒180KHz;	

3.9 Test Frequencies

Test Mode	Bandwidth	TX / RX	RF Channel		
			Low (L)	Middle (M)	High (H)
LTE NB1 Band 2	180KHz	TX	Channel 18601	Channel 18900	Channel 19199
			1850.1 MHz	1880 MHz	1909.9 MHz
		RX	Channel 601	Channel 900	Channel 1199
			1930.1 MHz	1960 MHz	1989.9 MHz
LTE NB1 Band 4	180KHz	TX	Channel 19951	Channel 20175	Channel 20399
			1710.1 MHz	1732.5 MHz	1754.9 MHz
		RX	Channel 1975	Channel 2175	Channel 2375
			2110.1 MHz	2132.5MHz	2154.9 MHz
LTE NB1 Band 5	180KHz	TX	Channel 20401	Channel 20525	Channel 20649
			824.1 MHz	836.5 MHz	848.9 MHz
		RX	Channel 2401	Channel 2525	Channel 2649
			869.1 MHz	881.5 MHz	893.9 MHz
LTE NB1 Band 12	180KHz	TX	Channel 23011	Channel 23095	Channel 23179
			699.1 MHz	707.5 MHz	715.9 MHz
		RX	Channel 5011	Channel 5095	Channel 5179
			729.1 MHz	737.5 MHz	745.9 MHz
LTE NB1 Band 13	180KHz	TX	Channel 23181	Channel 23230	Channel 23279
			777.1 MHz	782 MHz	786.9 MHz
		RX	Channel 5181	Channel 5230	Channel 5279
			746.1 MHz	752 MHz	755.9 MHz
LTE NB1 Band 17	180KHz	TX	Channel 23731	Channel 23790	Channel 23849
			704.1 MHz	710 MHz	715.9 MHz
		RX	Channel 5731	Channel 5790	Channel 5849
			734.1 MHz	740 MHz	745.9 MHz
LTE NB1 Band 25	180KHz	TX	Channel 26041	Channel 26365	Channel 26689
			1850.1 MHz	1882.5 MHz	1914.9 MHz
		RX	Channel 8041	Channel 8365	Channel 8689
			1930.1 MHz	1962.5 MHz	1994.9 MHz
LTE NB1 Band 66	180KHz	TX	Channel 131973	Channel 132322	Channel 132671
			1710.1 MHz	1745 MHz	1779.9 MHz
		RX	Channel 66437	Channel 66786	Channel 67135
			2110.1 MHz	2145 MHz	2179.9 MHz
LTE NB1 Band 71	180KHz	TX	Channel 133123	Channel 133297	Channel 133471
			663.1 MHz	680.5 MHz	697.9 MHz
		RX	Channel 68587	Channel 68761	Channel 68935
			617.1 MHz	634.5 MHz	651.9 MHz
LTE NB1 Band 85	180KHz	TX	Channel 134003	Channel 134092	Channel 134181
			698.1 MHz	707 MHz	715.9 MHz
		RX	Channel 70367	Channel 0456	Channel 70545
			728.1 MHz	737 MHz	745.9 MHz

4 Description of Tests

4.1 Conducted Output Power

Measurement Procedure: FCC KDB 971168 D01 V03r01 Section 5.2.1

The transmitter output was connected to a calibrated coaxial cable, attenuator and power meter, the other end of which was connected to a Base Station Simulator. The Base Station Simulator was set to force the EUT to its maximum power setting. The power output at the transmitter antenna port was determined by adding the value of the cable insertion loss to the power reading. The tests were performed at three frequencies (low channel, middle channel and high channel) and on the highest power levels, which can be setup on the transmitters.

Remark: Reference test setup 1

4.2 Effective (Isotropic) Radiated Power of Transmitter

Measurement Procedure: FCC KDB 971168 D01 V03r01 Section 5.8.4

Calculate power in dBm by the following formula:

ERP (dBm) = Conducted Power (dBm) + antenna gain (dBd)

EIRP(dBm) = Conducted Power (dBm) + antenna gain (dBi)

EIRP=ERP+2.15dB

4.3 Occupied Bandwidth

Measurement Procedure: FCC KDB 971168 D01 V03r01 Section 4.2 & 4.3

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured. The transmitter output was connected to a calibrated coaxial cable, attenuator and Spectrum analyser, the other end of which was connected to a Base Station Simulator. The Base Station Simulator was set to force the EUT to its maximum power setting. The tests were performed at three frequencies (low channel, middle channel and high channel).The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1 percent of the selected span as is possible without being below 1 percent. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used since a peak or, peak hold, may produce a wider bandwidth than actual. The trace data points are recovered and are directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 percent of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth.

Remark: Reference test setup 1

Test Settings

1. The signal analyzer's automatic bandwidth measurement capability was used to perform the 99% occupied bandwidth and the 26dB bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 1 – 5% of the expected OBW
3. VBW ≥ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize
8. If necessary, steps 2 – 7 were repeated after changing the RBW such that it would be within 1 – 5% of the 99% occupied bandwidth observed in Step 7

4.4 Band Edge at Antenna Terminals

Measurement Procedure: FCC KDB 971168 D01 V03r01 Section 6.0

The transmitter output was connected to a calibrated coaxial cable, attenuator and Spectrum analyser, the other end of which was connected to a Base Station Simulator. The Base Station Simulator was set to force the EUT to its maximum power setting. The tests were performed at two frequencies (low channel and high channel).in the 1MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of 100kHz or 1% of the emission bandwidth of the fundamental emission of the transmitter may be employed. The EUT emission bandwidth is measured as the width of the signal between two points, outside of which all emission are attenuated at least 26dB below the transmitter power. The video bandwidth of the spectrum analyzer was set at thrice the resolution bandwidth. Detector Mode was set to rms.

Remark: Reference test setup 1

Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW ≥ 1% of the emission bandwidth
4. VBW ≥ 3 x RBW
5. Detector = RMS
6. Number of sweep points ≥ 2 x Span/RBW
7. Trace mode = trace average for continuous emissions, max hold for pulse emissions
8. Sweep time = auto couple
9. The trace was allowed to stabilize

4.5 Spurious And Harmonic Emissions at Antenna Terminal

Measurement Procedure: FCC KDB 971168 D01 V03r01 Section 6.0

The transmitter output was connected to a calibrated coaxial cable, attenuator and Spectrum analyzer, the other end of which was connected to a Base Station Simulator. The Base Station Simulator was set to force the EUT to its maximum power setting. The tests were performed at three frequencies (low channel and high channel).The level of the carrier and the various conducted spurious and harmonic frequencies is measured by means of a calibrated spectrum analyzer. The spectrum is scanned from the lowest frequency generated in the equipment up to a frequency including its 10th harmonic. On any frequency outside a licensee's frequency block, the power of any emission shall be attenuated below the transmitter power (P) by at least 43 + 10 log(P) dB. Compliance with these provisions is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emission are attenuated at least 26 dB below the transmitter power.

Remark: Reference test setup 1

Test Settings

1. Start frequency was set to 9kHz and stop frequency was set to at least 10* the fundamental frequency(Separated into at least two plots per channel)
2. Detector = RMS
3. Trace mode = trace average for continuous emissinos, max hold for pulse emissions
4. Sweep time = auto couple
5. The trace was allowed to stabilize
6. Please see test notes below for RBW and VBW settings

4.6 Peak-Average Ratio

Measurement Procedure: FCC KDB 971168 D01 V03r01 Section 5.7.2

A peak to average ratio measurement is performed at the conducted port of the EUT. For WCDMA signals, the spectrum analyzers Complementary Cumulative Distribution Function (CCDF) measurement profile is used to determine the largest deviation between the average and the peak power of the EUT in a given bandwidth. The CCDF curve shows how much time the peak waveform spends at or above a given average power level. The percent of time the signal spends at or above the level defines the probability for that particular power level. For GSM signals, an average and a peak trace are used on a spectrum analyzer to determine the largest deviation between the average and the peak power of the EUT in a bandwidth greater than the emission bandwidth. The traces are generated with the spectrum analyzer set to zero span mode.

Remark: Reference test setup 1

Test Settings

1. The signal analyzer's CCDF measurement profile is enabled
2. Frequency = carrier center frequency
3. Measurement BW > Emission bandwidth of signal
4. The signal analyzer was set to collect one million samples to generate the CCDF curve
5. The measurement interval was set depending on the type of signal analyzed. For continuous signals (>98% duty cycle), the measurement interval was set to 1ms. For burst transmissions, the spectrum analyzer is set to use an internal "RF Burst" trigger that is synced with an incoming pulse and the measurement interval is set to less than the duration of the "on time" of one burst to ensure that energy is only captured during a time in which the transmitter is operating at maximum power

4.7 Field Strength of Spurious Radiation

Measurement Procedure: FCC KDB 971168 D01 V03r01 Section 5.8

Below 1GHz test procedure as below:

1). The EUT was powered ON and placed on a 80cm high table in the chamber. The antenna of the transmitter was extended to its maximum length.

2). The disturbance of the transmitter was maximized on the test receiver display by raising and lowering from 1m to 4m (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) the receive antenna and by rotating through 360° the turntable. After the fundamental emission was maximized, a field strength measurement was made.

3). Steps 1) and 2) were performed with the EUT and the receive antenna in both vertical and horizontal polarization.

4). Test the EUT in the lowest channel, the middle channel ,the Highest channel.

5). The radiation measurements are performed in X, Y, Z axis positioning. And found the X axis positioning which it is worse case, Only the test worst case mode is recorded in the report.

6). Repeat above procedures until all frequencies measured was complete.

E (dBμV/m) = Measured amplitude level (dBμV) + (Cable Loss (dB) + Antenna Factor (dB/m) – AMP(dB))

EIRP (dBm) = E (dBμV/m) + 20 log D − 104.8; where D is the measurement distance in meters

Above 1GHz test procedure as below:

1) Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber

2) Calculate power in dBm by the following formula:

E (dBμV/m) = Measured amplitude level (dBμV) + (Cable Loss (dB) + Antenna Factor (dB/m) – AMP(dB))

EIRP (dBm) = E (dBμV/m) + 20 log D − 104.8; where D is the measurement distance in meters

3). Test the EUT in the lowest channel, the middle channel the Highest channel

4). The radiation measurements are performed in X, Y, Z axis positioning. And found the X axis positioning which it is worse case, Only the test worst case mode is recorded in the report.

5). Repeat above procedures until all frequencies measured was complete

Remark1: Reference test setup 2

Remark2: The emission below 18G were measured at a 3m test distance, while emissions above 18GHz were measured at a 1m test distance. At a measurement distance of 1 meter the limit line was increased by 20*LOG(3/1) = 9.54 dB.

Remark: Reference test setup 2

Remark:

1) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier gain. The basic equation with a sample calculation is as follows:

Level = Reading Level + AF(dB/m) + Factor(dB)

AF = Antenna Factor(dB/m)

Factor = Cable Factor(dB) - Preamplifier gain (dB)

Margin = Limit(dBm) - Level(dBm)

2) Scan from 9kHz to 40GHz, The disturbance between 9KHz to 30MHz and 18GHz to 40GHz was very low, and the harmonics were the highest point could be found when testing, so only the harmonics had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

3) All modes have been tested, but only the worst case data (1T0 for 3.75KHz SCS) displayed in this report.

4.8 Frequency Stability / Temperature Variation

Measurement Procedure:

Frequency stability testing is performed in accordance with the guidelines of FCC KDB 971168 D01 V03r01; Section 9

. The frequency stability of the transmitter is measured by:

a.) **Temperature:** The temperature is varied from -30°C to +50°C in 10°C increments using an environmental chamber.

b.) **Primary Supply Voltage:** The primary supply voltage is varied from 85% to 115% of the nominal value for non hand-carried battery and AC powered equipment. For hand-carried, battery-powered equipment, primary supply voltage is reduced to the battery operating end point which shall be specified by the manufacturer.

Specification – The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block. The frequency stability of the transmitter shall be maintained within ±0.00025% (±2.5 ppm) of the center frequency.

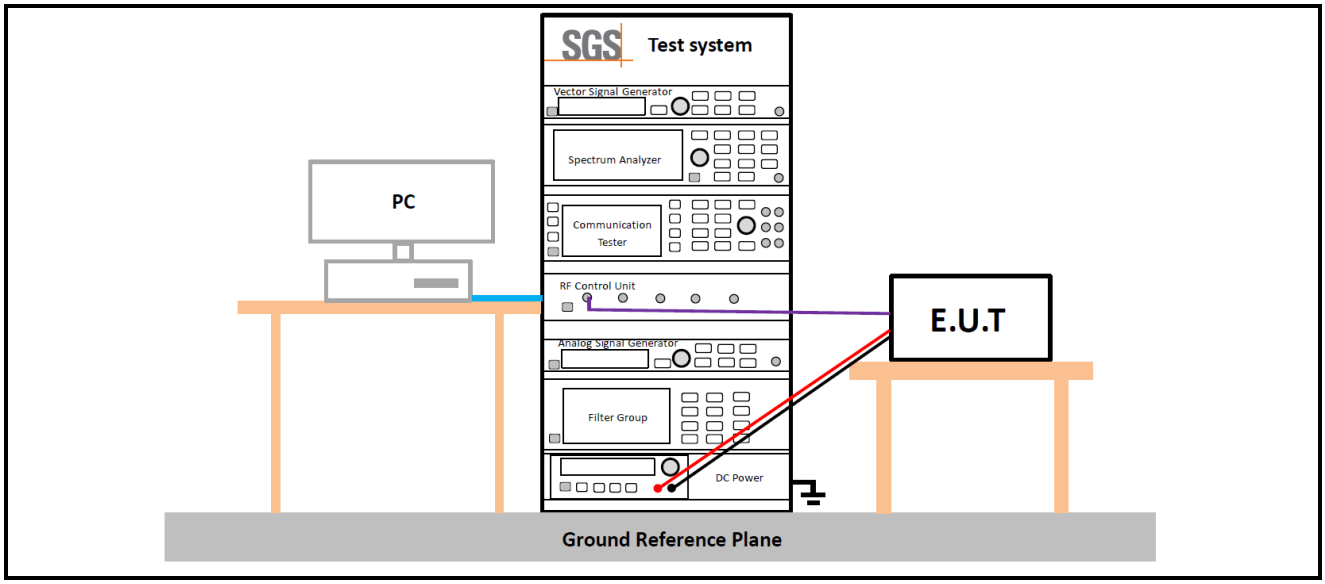
Time Period and Procedure:

1. The carrier frequency of the transmitter is measured at room temperature (20°C to provide a reference).
2. The equipment is turned on in a “standby” condition for fifteen minutes before applying power to the transmitter. Measurement of the carrier frequency of the transmitter is made within one minute after applying power to the transmitter.
3. Frequency measurements are made at 10°C intervals ranging from -30°C to +50°C. A period of at least one half-hour is provided to allow stabilization of the equipment at each temperature level.

Remark: Reference test setup 3

4.9 Test Setups

4.9.1 Test Setup 1



4.9.2 Test Setup 2

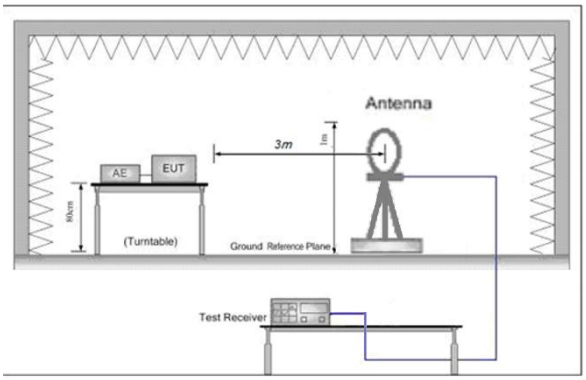


Figure 1. Below 30MHz

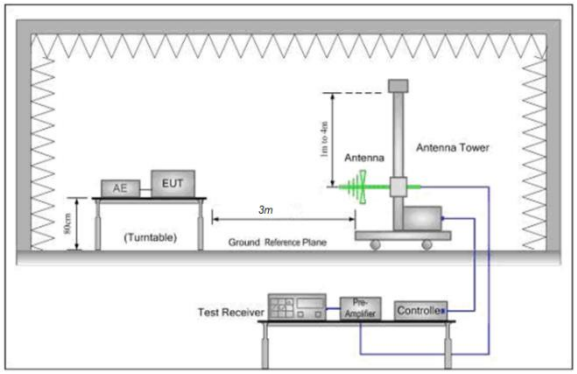


Figure 2. 30MHz to 1GHz

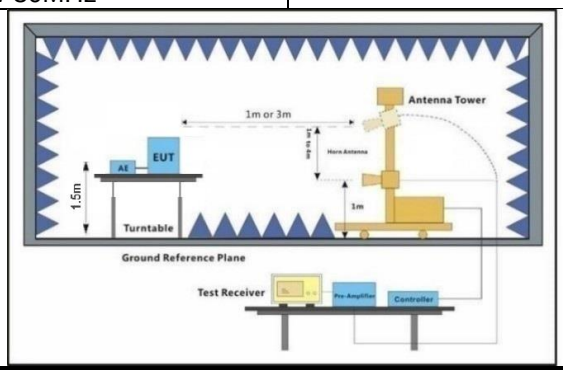
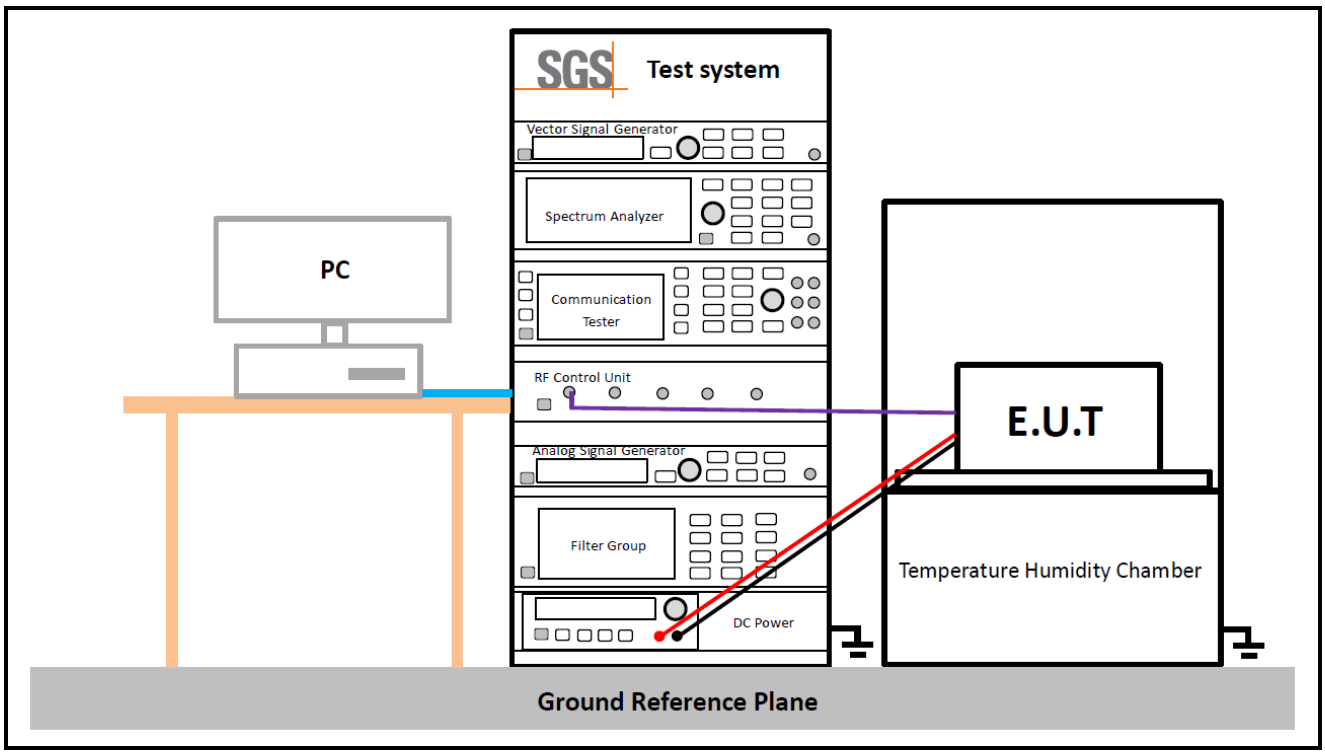


Figure 3. above 1GHz

4.9.3 Test Setup 3



4.10Test Conditions

Transmit Output Power Data - Average Power, Total	
Test Case	**Test Conditions**
Test Environment	Ambient Climate & Rated Voltage
Test Setup	Test Setup 1
RF Channels (TX)	L, M, H (L= low channel, M= middle channel, H= high channel)
Test Mode	LTE NB1/TM1; LTE NB1/TM2

Field Strength of Spurious Radiation	
Test Case	**Test Conditions**
Test Environment	Ambient Climate & Rated Voltage
Test Setup	Test Setup 2
RF Channels (TX)	L, M, H (L= low channel, M= middle channel, H= high channel)
Test Mode	LTE NB1/TM1 Remark: All bandwidth and modulation of LTE NB1 have been pre tested, and only the worst results are reflected in the report.

5 Main Test Instruments

RF Test Equipment					
Test Equipment	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal. date (yyyy/mm/dd)**	**Cal.Due date (yyyy/mm/dd)**
Shielding Room	Brilliant-emc	N/A	SUWI-04-01-06	2021/05/08	2024/05/07
Temperature and humidity meter	MingGao	TH101B	SUWI-01-01-07	2023/02/06	2024/02/05
Signal Analyzer	ROHDE&SCHWARZ	FSV3030	SUWI-01-02-02	2023/05/11	2024/05/10
Measurement Software	Tonscend	JS1120-3 Test System V 2.6.88.0336	SUWI-02-09-09	NCR	NCR
Wideband Radio Communication Tester	Anritsu	MT8821C	SUWI-01-26-03	2022/11/23	2023/11/22
Wideband Radio Communication Tester	ROHDE&SCHWARZ	CMW500	SUWI-01-16-05	2023/02/06	2024/02/05
DC Power Supply	HYELEC	HY3005B	SUWI-01-18-01	2023/02/06	2024/02/05
Temperature Chamber	ESPEC	SU-242	SUWI-01-13-01	2023/02/06	2024/02/05
Signal Analyzer	ROHDE& SCHWARZ	FSW43	SUWI-01-02-04	2023/05/11	2024/05/10
Wideband Radio Communication Test Ststion	Anritsu	MT8000A	SUWI-01-34-02	2022/09/16	2023/09/15

RSE Test System					
Equipment	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal Date (yyyy/mm/dd)**	**Cal Due Date (yyyy/mm/dd)**
Semi-Anechoic Chamber	Brilliant-emc	N/A	SUWI-04-02-01	2021/05/08	2024/05/07
Temperature and humidity meter	MingGao	TH101B	SUWI-01-01-05	2023/02/07	2024/02/06
Signal Analyzer	KEYSIGHT	N9020A	SUWI-01-02-05	2022/11/23	2023/11/22
Test receiver	ROHDE&SCHWARZ	ESR7	SUWI-01-10-01	2023/02/08	2024/02/07
Receiving antenna	SCHWRZBECK MESS-ELEKTRONIK	VULB 9163	SUWI-01-11-01	2023/05/13	2024/05/12
Receiving antenna	SCHWRZBECK MESS-ELEKTRONIK	BBHA 9120D	SUWI-01-11-02	2023/05/13	2024/05/12
Active Loop Antenna	SCHWRZBECK MESS-ELEKTRONIK	FMZB 1519B	SUWI-01-21-01	2023/05/13	2024/05/12
Amplifier	Tonscend	TAP9K3G40	SUWI-01-14-01	2023/02/06	2024/02/05
Amplifier	Tonscend	TAP01018050	SUWI-01-14-02	2023/02/06	2024/02/05
Wideband Radio Communication Tester	Anritsu	MT8821C	SUWI-01-26-03	2022/11/23	2023/11/22
Measurement Software	Tonscend	JS32-RE V4.0.0.0	SUWI-02-09-04	NCR	NCR

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6 Measurement Uncertainty

For a 95% confidence level (k = 2), the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 as following:

No.	Item	Measurement Uncertainty
1	Total RF power, conducted	±0.54dB
2	RF power density, conducted	±1.03dB
3	Spurious emissions, conducted	±0.54dB
4	Radio Frequency	±1.0 %
5	Duty Cycle	±0.37%
6	Occupied Bandwidth	±1.0 %
7	Radiated Emission	± 3.13dB (9k -30MHz)
		± 4.8dB (30M -1GHz)
		± 4.8dB (1GHz to 18 GHz)
Remark: The U_{lab} (lab Uncertainty) is less than $U_{cispr/ETSI}$ (CISPR/ETSI Uncertainty), so the test results – compliance is deemed to occur if no measured disturbance level exceeds the disturbance limit; – non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit.		

7 Appendixes

Appendix A.2	WWAN Setup Photos
Appendix B.1	LTE-NB1 Band 2
Appendix B.2	LTE-NB1 Band 4
Appendix B.3	LTE-NB1 Band 5
Appendix B.4	LTE-NB1 Band 12
Appendix B.5	LTE-NB1 Band 13
Appendix B.6	LTE-NB1 Band 17
Appendix B.7	LTE-NB1 Band 25
Appendix B.8	LTE-NB1 Band 66
Appendix B.9	LTE-NB1 Band 71
Appendix B.10	LTE-NB1 Band 85

---End of Report---

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