



FCC RADIO TEST REPORT

FCC ID : 2AY4J-TK23
Equipment : Tack GPS Location Tracker
Brand Name : Tack
Model Name : TK23
Marketing Name : Tackgps Plus
Applicant : Tack One Private Limited
22 SIN MING LANE #06-76, SINGAPORE 573969
Manufacturer : Tack One Private Limited
22 SIN MING LANE #06-76, SINGAPORE 573969
Standard : FCC 47 CFR Part 2, and 90(S)

The product was received on May 05, 2023 and testing was performed from May 18, 2023 to Sep. 06, 2023. We, Sporton International Inc. EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures given in ANSI / TIA-603-E and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval from Sporton International Inc. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

Sporton International Inc. EMC & Wireless Communications Laboratory

No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.)



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History of this test report

Report No.	Version	Description	Issue Date
FG342615B	01	Initial issue of report	Aug. 02, 2023
FG342615B	02	Add data for straddle channel This report is an updated version, replacing the report issued on Aug. 02, 2023.	Sep. 07, 2023

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.2	§2.1046 §90.635	Conducted Output Power and Effective Radiated Power	Pass	-
3.3	-	Peak-to-Average Ratio	Reporting only	-
3.4	§2.1049 §90.209	Occupied Bandwidth and 26dB Bandwidth	Reporting only	-
3.5	§2.1051 §90.691	Emission masks – In-band emissions	Pass	-
3.6	§2.1051 §90.691	Emission masks – Out of band emissions	Pass	-
3.7	§2.1055 §90.213	Frequency Stability for Temperature & Voltage	Pass	-
3.8	§2.1053 §90.691	Field Strength of Spurious Radiation	Pass	37.54 dB under the limit at 1634.00 MHz

Conformity Assessment Condition:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacture who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the section "Measurement Uncertainty".

Disclaimer:

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Alan Liu

Report Producer: Lucy Wu



1 General Description

1.1 Feature of Equipment Under Test

Product Feature	
General Specs LTE, Bluetooth - LE, Wi-Fi 2.4GHz 802.11b/g/n, and GPS.	
Antenna Type WWAN: PIFA Antenna WLAN: PIFA Antenna Bluetooth - LE: PIFA Antenna GPS: PIFA Antenna	
Antenna Gain	-3.66 dBi

Remark: The EUT's information above is declared by manufacturer. Please refer to Disclaimer in report summary.

1.2 Modification of EUT

No modifications made to the EUT during the testing.

1.3 Testing Site

Test Site	Sporton International Inc. EMC & Wireless Communications Laboratory
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	Sporton Site No. TH03-HY
Test Engineer	HaoEn Zhang
Temperature (°C)	21.2~22.6
Relative Humidity (%)	51.8~54.5

Test Site	Sporton International Inc. Wensan Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	Sporton Site No. 03CH13-HY (TAF Code: 3786)
Test Engineer	Rain Lee, Jacky Hong and Mancy Chou
Temperature (°C)	20~26
Relative Humidity (%)	40~65
Remark	The Radiated Spurious Emission test item subcontracted to Sporton International Inc. Wensan Laboratory.

Note: The test site complies with ANSI C63.4 2014 requirement.

FCC Designation No.: TW1190 and TW3786



1.4 Applied Standards

According to the specifications declared by the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC 47 CFR Part 2, 90
- ♦ ANSI / TIA-603-E
- ♦ ANSI C63.26-2015
- ♦ FCC KDB 971168 D01 Power Meas. License Digital Systems v03r01
- ♦ FCC KDB 412172 D01 Determining ERP and EIRP v01r01
- ♦ FCC KDB 414788 D01 Radiated Test Site v01r01
- ♦ Interim Guidance for Equipment Authorization of Devices with Channel Bandwidths Combined Across Two Contiguous Service Rule Allocations OET/Lab/EACB, June 6, 2013

Remark:

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.
3. The TAF code is not including all the FCC KDB listed without accreditation.

2 Test Configuration of Equipment Under Test

2.1 Test Mode

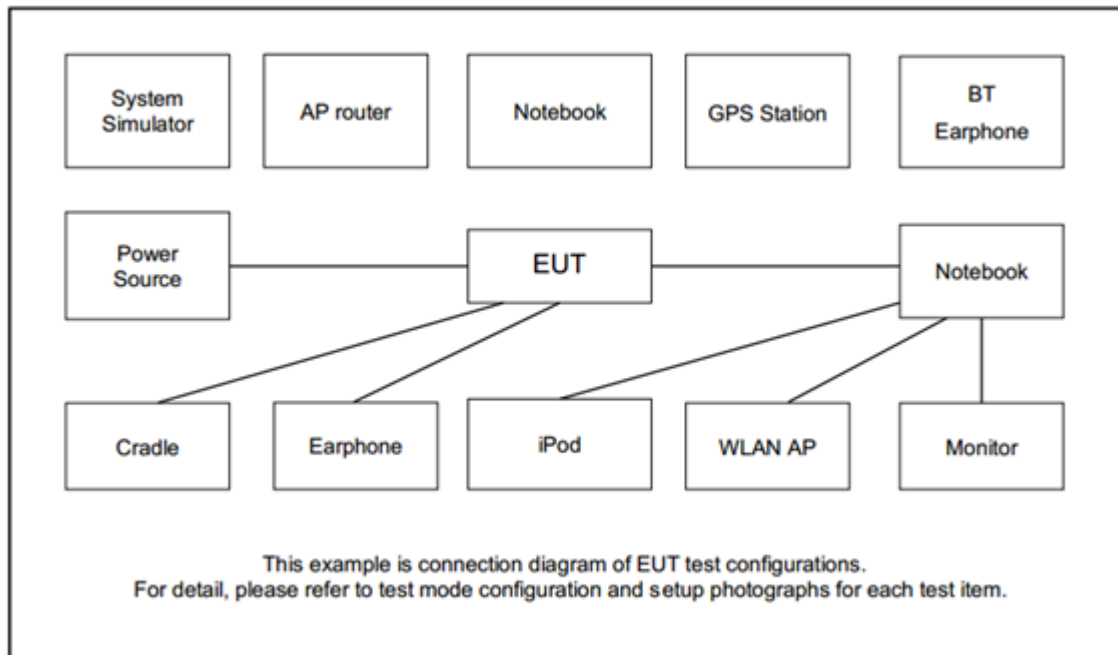
During all testing, EUT is in link mode with base station emulator at maximum power level.

For radiated measurement, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape), and adjusting the measurement antenna orientation, following C63.26 exploratory test procedures and only the worst case emissions were reported in this report.

Frequency range investigated for radiated emission is 30 MHz to 9000 MHz.

Conducted Test Cases	Band	Bandwidth (MHz)						Modulation		RB #			Test Channel		
		1.4	3	5	10	15	20	QPSK	16QAM	1	Half	Full	L	M	H
Max. Output Power	26	v	v	v	v	v	-	v	v	v		v	v	v	v
Peak-to-Average Ratio	26				v	v	-	v	v			v		v	
26dB and 99% Bandwidth	26	v	v	v	v	v	-	v	v			v	v	v	
Emission masks In-band emissions	26	v	v	v	v	v	-	v	v	v		v	v		v
Emission masks – Out of band emissions	26	v	v	v	v	v	-	v		v			v	v	v
Frequency Stability	26				v	v	-	v				v	v	v	
E.R.P.	26	v	v	v	v	v	-	v	v	Max. Power					
Radiated Spurious Emission	26	Worst Case											v	v	v
Remark	<div>1. The mark “v “ means that this configuration is chosen for testing</div> <div>2. The mark “- “ means that this bandwidth is not supported.</div> <div>3. LTE Band26 transmit frequency for part22 rule is 824MHz-849MHz, for part90 rule is 814MHz-824MHz. total ERP of 15MHz bandwidth across Part 22H and Part 90S complies the ERP limit line of part22 rule, therefore ERP of the partial frequency spectrum which falls within part 22 also complies.</div> <div>4. All the radiated test cases were performed with Battery (ZCF).</div> <div>5. One representative bandwidth is selected to perform PAR.</div>														

2.2 Connection Diagram of Test System



2.3 Support Unit used in test configuration and system

Item	Equipment	Brand Name	Model No.	FCC ID	Data Cable	Power Cord
1.	System Simulator	Anritsu	MT8821C	N/A	N/A	Unshielded, 1.8 m
2.	Notebook	Acer	N18Q13	PD9AX201NG	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m

2.4 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between RF conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level will be exactly the RF output level.

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

The following shows an offset computation example with RF cable loss 4.2 dB and a 10dB attenuator.

Example :

$$\begin{aligned} \text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)}. \\ &= 4.2 + 10 = 14.2 \text{ (dB)} \end{aligned}$$

2.5 Frequency List of Low/Middle/High Channels

LTE Band 26 Channel and Frequency List				
BW [MHz]	Channel/Frequency(MHz)	Lowest	Middle	Highest
15	Channel	26765	-	-
	Frequency	821.5	-	-
10	Channel	-	26740	-
	Frequency	-	819	-
5	Channel	26715	26740	26765
	Frequency	816.5	819	821.5
3	Channel	26705	26740	26775
	Frequency	815.5	819	822.5
1.4	Channel	26697	26740	26783
	Frequency	814.7	819	823.3



LTE Band 26 Channel and Frequency List (Part90S)				
BW [MHz]	Channel/Frequency(MHz)	-	cross-rule channels	-
15	Channel	-	26790	-
	Frequency	-	824	-
10	Channel	-	26790	-
	Frequency	-	824	-
5	Channel	-	26790	-
	Frequency	-	824	-
3	Channel	-	26790	-
	Frequency	-	824	-
1.4	Channel	-	26790	-
	Frequency	-	824	-

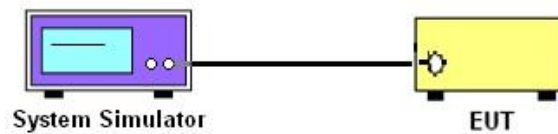
3 Conducted Test Items

3.1 Measuring Instruments

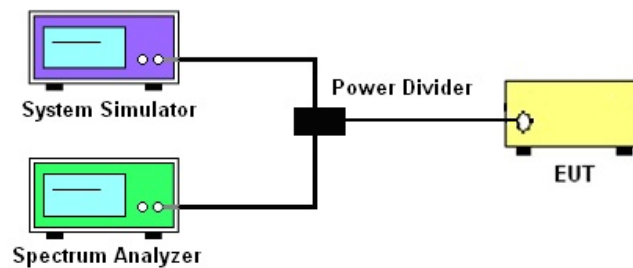
See list of measuring instruments of this test report.

3.1.1 Test Setup

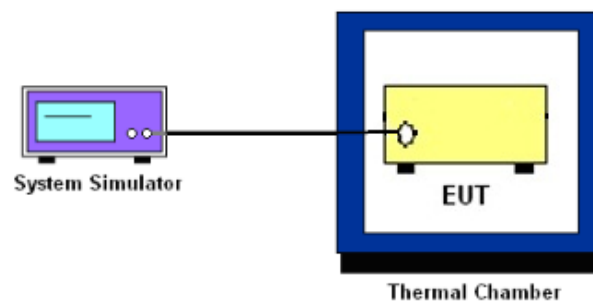
3.1.2 Conducted Output Power



3.1.3 Peak-to-Average Ratio, Occupied Bandwidth, Conducted Band-Edge, Emission Mask, Emissions Mask – Out Of Band Emissions, and Conducted Spurious Emission



3.1.4 Frequency Stability



3.1.5 Test Result of Conducted Test

Please refer to Appendix A.

3.2 Conducted Output Power Measurement and ERP Measurement

3.2.1 Description of the Conducted Output Power Measurement and ERP Measurement

A system simulator was used to establish communication with the EUT. Its parameters were set to enforce EUT transmitting at the maximum power. The measured power in the radio frequency on the transmitter output terminals shall be reported.

The output power of mobile transmitters must not exceed 100 Watts for LTE Band 26.

According to KDB 412172 D01 Power Approach,

$EIRP = P_T + G_T - L_C$, where

P_T = transmitter output power in dBm

G_T = gain of the transmitting antenna in dBi

L_C = signal attenuation in the connecting cable between the transmitter and antenna in dB

3.2.2 Test Procedures

1. The transmitter output port was connected to the system simulator.
2. Set EUT at maximum power through system simulator.
3. Select lowest, middle, and highest channels for each band and different modulation.
4. Measure and record the power level from the system simulator.



3.3 Peak-to-Average Ratio

3.3.1 Description of the PAR Measurement

Reporting only

3.3.2 Test Procedures

1. The EUT was connected to spectrum and system simulator via a power divider.
2. Set the CCDF (Complementary Cumulative Distribution Function) option in spectrum analyzer.
3. The highest RF powers were measured and recorded the maximum PAPR level associated with a probability of 0.1 %.
4. Record the deviation as Peak to Average Ratio.

3.4 99% Occupied Bandwidth and 26dB Bandwidth Measurement

3.4.1 Description of (Occupied) Bandwidth Limitations Measurement

The 99% occupied bandwidth is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5% of the total mean transmitted power.

The emission bandwidth is defined as the width of the signal between two points, located at the 2 sides of the carrier frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

3.4.2 Test Procedures

1. The EUT was connected to spectrum analyzer and system simulator via a power divider.
2. The 26dB and 99% occupied bandwidth (BW) of the middle channel for the highest RF power with full RB sizes were measured.



3.5 Emissions Mask Measurement

3.5.1 Description of Emissions Mask Measurement

Equipment used in this licensed to EA or non-EA systems shall comply with the emission mask provisions of FCC Part 90.691.(a)

(a) Out-of-band emission requirement shall apply only to the "outer" channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:

(1) For any frequency removed from the EA licensee's frequency block by up to and including 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $116 \log_{10}(f/6.1)$ decibels or $50 + 10 \log_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 12.5 kHz.

(2) For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

3.5.2 Test Procedures

1. The EUT was connected to spectrum analyzer and base station via power divider.
2. The emissions mask of low and high channels for the highest RF powers were measured.
3. Set RBW and VBW 3 times of RBW to make the measurement with the spectrum analyzer's, and according to KDB 971168 D02 Misc Rev Approve License Devices v02r01 standards, set RBW = 300 Hz to make offsets less than 37.5 kHz from a channel edge , RBW = 100 kHz to make offsets greater than 37.5 kHz, that is allowed.
4. The test results were shown below plots with a correction offset factor including cable loss, insertion loss of power divider.

3.6 Emissions Mask – Out Of Band Emissions Measurement

3.6.1 Description of Conducted Emissions Out of band emissions measurement

The power of any emission FCC Part 90.691 (a)(2) on any frequency removed from the assigned frequency by out of the authorized bandwidth at least $43 + 10 \log (P)$ dB. It is measured by means of a calibrated spectrum analyzer and scanned from 30 MHz up to a frequency including its 10th harmonic.

3.6.2 Test Procedures

1. The EUT was connected to spectrum analyzer and system simulator via a power divider.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. The middle channel for the highest RF power within the transmitting frequency was measured.
4. The conducted spurious emission for the whole frequency range was taken.
5. For testing below 1GHz, make the measurement with the spectrum analyzer's RBW = 100 kHz, VBW = 3MHz, taking the record of maximum spurious emission.
6. For testing above 1GHz, make the measurement with the spectrum analyzer's RBW = 1MHz, VBW = 3MHz, taking the record of maximum spurious emission.
7. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.
8. The limit line is derived from $43 + 10\log(P)$ dB below the transmitter power P(Watts)

3.7 Frequency Stability Measurement

3.7.1 Description of Frequency Stability Measurement

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

3.7.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.7.3 Test Procedures for Temperature Variation

1. The EUT was set up in the thermal chamber and connected with the base station.
2. With power OFF, the temperature was decreased to -30°C and the EUT was stabilized for three hours. Power was applied and the maximum change in frequency was recorded within one minute.
3. With power OFF, the temperature was raised in 10°C step up to 50°C. The EUT was stabilized at each step for at least half an hour. Power was applied and the maximum frequency change was recorded within one minute.

3.7.4 Test Procedures for Voltage Variation

1. The EUT was placed in a temperature chamber at 20±5° C and connected with the base station.
2. The power supply voltage to the EUT was varied from BEP to 115% of the nominal value measured at the input to the EUT.
3. The variation in frequency was measured for the worst case.

3.8 Field Strength of Spurious Radiation Measurement

3.8.1 Description of Field Strength of Spurious Radiated Measurement

The radiated spurious emission was measured by substitution method according to ANSI / TIA-603-E. The power of any emission FCC Part 90.691 on any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth at least $43 + 10 \log (P)$ dB. The spectrum is scanned from 30 MHz up to a frequency including its 10th harmonic.

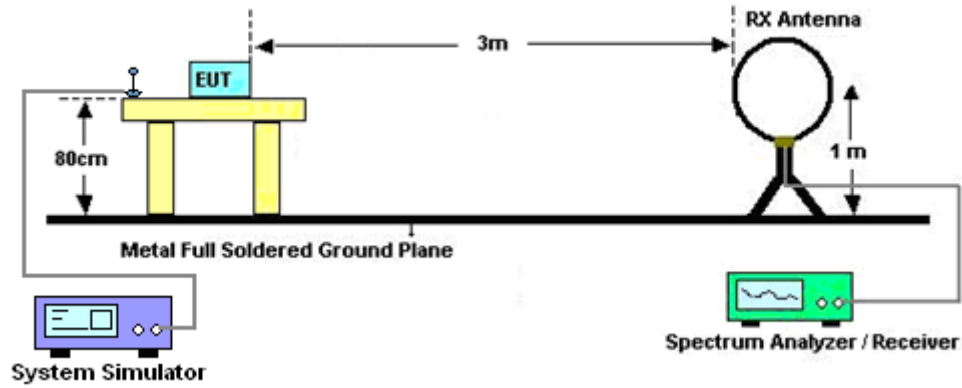
The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitter power (P) by a factor of at least $43 + 10 \log_{10}(P[\text{Watts}])$ dB. The spectrum is scanned from 30 MHz up to a frequency including its 10th harmonic.

3.8.2 Test Procedures

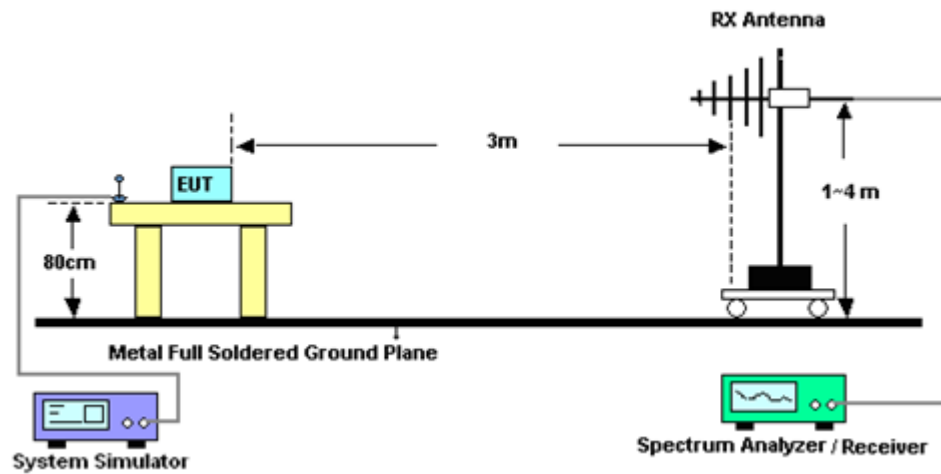
1. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
2. The EUT was set 3 meters from the receiving antenna, which was mounted on the antenna tower.
3. The table was rotated 360 degrees to determine the position of the highest spurious emission.
4. The height of the receiving antenna is varied between one meter and four meters to search the maximum spurious emission for both horizontal and vertical polarizations.
5. For testing below 1GHz, make the measurement with the spectrum analyzer's RBW = 100 kHz, VBW = 3MHz, Sweep = 500ms, Taking the record of maximum spurious emission.
6. For testing above 1GHz, make the measurement with the spectrum analyzer's RBW = 1MHz, VBW = 3MHz, Sweep = 500ms, Taking the record of maximum spurious emission.
7. A horn antenna was substituted in place of the EUT and was driven by a signal generator.
8. Tune the output power of signal generator to the same emission level with EUT maximum spurious emission.
9. Taking the record of output power at antenna port.
10. Repeat step 7 to step 8 for another polarization.
11. $\text{EIRP (dBm)} = \text{S.G. Power} - \text{Tx Cable Loss} + \text{Tx Antenna Gain}$
12. $\text{ERP (dBm)} = \text{EIRP} - 2.15$
13. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.
14. The limit line is derived from $43 + 10 \log(P)$ dB below the transmitter power P(Watts)

3.8.3 Test Setup

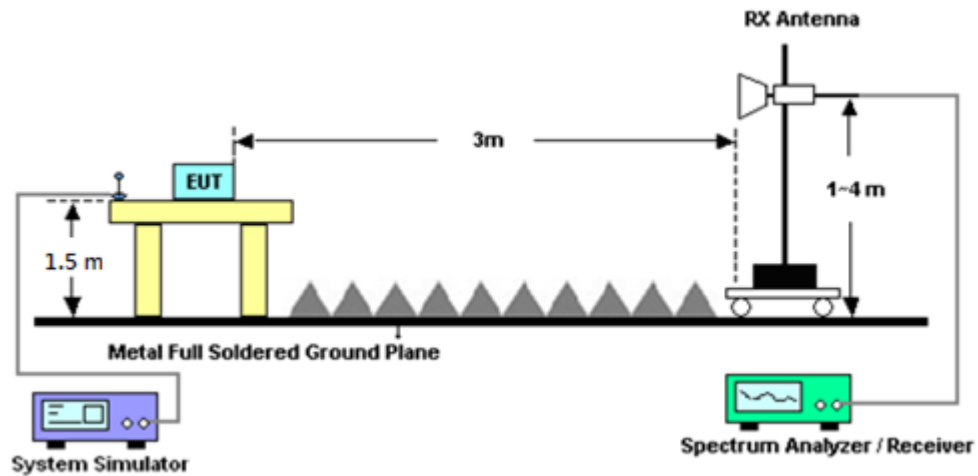
For radiated test below 30MHz



For radiated test from 30MHz to 1GHz



For radiated test above 1GHz



3.8.4 Test Result of Field Strength of Spurious Radiated

Please refer to Appendix B.

Note:

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is adequate comparison measurement of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result came out very similar.



4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Sep. 20, 2022	Jul. 20, 2023~ Jul. 24, 2023	Sep. 19, 2023	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	505134/2	30MHz~40GHz	Dec. 20, 2022	Jul. 20, 2023~ Jul. 24, 2023	Dec. 19, 2023	Radiation (03CH13-HY)
Amplifier	SONOMA	310N	187282	9kHz~1GHz	Dec. 14, 2022	Jul. 20, 2023~ Jul. 24, 2023	Dec. 13, 2023	Radiation (03CH13-HY)
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01N- 06	40103 & 07	30MHz~1GHz	Apr. 23, 2023	Jul. 20, 2023~ Jul. 24, 2023	Apr. 22, 2024	Radiation (03CH13-HY)
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01N- 06	41912 & 05	30MHz~1GHz	Feb. 05, 2023	Jul. 20, 2023~ Jul. 24, 2023	Feb. 04, 2024	Radiation (03CH13-HY)
Hygrometer	TECPEL	DTM-303B	TP140325	N/A	Nov. 07, 2022	Jul. 20, 2023~ Jul. 24, 2023	Nov. 06, 2023	Radiation (03CH13-HY)
Preamplifier	MITEQ	AMF-7D-00101 800-30-10P	1590074	1GHz~18GHz	May 16, 2023	Jul. 20, 2023~ Jul. 24, 2023	May 15, 2024	Radiation (03CH13-HY)
Preamplifier	EM Electronics	EM01G18G	060803	1GHz~18GHz	Jan. 10, 2023	Jul. 20, 2023~ Jul. 24, 2023	Jan. 09, 2024	Radiation (03CH13-HY)
Spectrum Analyzer	Keysight	N9010A	MY55370526	10Hz~44GHz	Mar. 23, 2023	Jul. 20, 2023~ Jul. 24, 2023	Mar. 22, 2024	Radiation (03CH13-HY)
Filter	Wainwright	WLK4-1000-153 0-8000-40SS	SN12	1.53GHz Low Pass Filter	Sep. 13, 2022	Jul. 20, 2023~ Jul. 24, 2023	Sep. 12, 2023	Radiation (03CH13-HY)
Filter	Wainwright	WHKX12-1080- 1200-15000-60 SS	SN3	1.2GHz High Pass Filter	Jun. 29, 2023	Jul. 20, 2023~ Jul. 24, 2023	Jun. 28, 2024	Radiation (03CH13-HY)
Filter	Wainwright	WHKX12-2700- 3000-18000-60 SS	SN2	3GHz High Pass Filter	Jul. 10, 2023	Jul. 20, 2023~ Jul. 24, 2023	Jul. 09, 2024	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 126E	0030/126E	30MHz~18GHz	Feb. 08, 2023	Jul. 20, 2023~ Jul. 24, 2023	Feb. 07, 2024	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	804793/4	30MHz~18GHz	Feb. 08, 2023	Jul. 20, 2023~ Jul. 24, 2023	Feb. 07, 2024	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY15682/4	9 kHz~18GHz	Feb. 22, 2023	Jul. 20, 2023~ Jul. 24, 2023	Feb. 21, 2024	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY24961/4	30MHz~18GHz	Feb. 08, 2023	Jul. 20, 2023~ Jul. 24, 2023	Feb. 07, 2024	Radiation (03CH13-HY)
Controller	EMEC	EM1000	N/A	Control Turn table & Ant Mast	N/A	Jul. 20, 2023~ Jul. 24, 2023	N/A	Radiation (03CH13-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Jul. 20, 2023~ Jul. 24, 2023	N/A	Radiation (03CH13-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Jul. 20, 2023~ Jul. 24, 2023	N/A	Radiation (03CH13-HY)
Horn Antenna	SCHWARZBE CK	BBHA 9120 D	9120D-1326	1GHz~18GHz	Aug. 24, 2022	Jul. 20, 2023~ Jul. 24, 2023	Aug. 23, 2023	Radiation (03CH13-HY)
Horn Antenna	SCHWARZBE CK	BBHA 9120 D	9120D-1212	1GHz~18GHz	Mar. 23, 2023	Jul. 20, 2023~ Jul. 24, 2023	Mar. 22, 2024	Radiation (03CH13-HY)



Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Base Station (Measure)	Anritsu	MT8821C	6201664755	LTE FDD/TDD (with44), LTE-4CC DLCA/2CC ULCA, CatM1/NB1/NB2	Aug. 01, 2022	May 18, 2023~ Jul. 12, 2023	Jul. 31, 2023	Conducted (TH03-HY)
Base Station (Measure)	Anritsu	MT8821C	6201664755	LTE FDD/TDD (with44), LTE-4CC DLCA/2CC ULCA, CatM1/NB1/NB2	Jul. 18, 2023	Sep. 06, 2023	Jul. 17, 2024	Conducted (TH03-HY)
Spectrum Analyzer	Rohde & Schwarz	FSV40	101908	10Hz~40GHz	Sep. 27, 2022	May 18, 2023~ Sep. 06, 2023	Sep. 26, 2023	Conducted (TH03-HY)
Thermal Chamber	ESPEC	SH-641	92013720	-40℃ ~90℃	Sep. 07, 2022	May 18, 2023~ Jul. 12, 2023	Sep. 06, 2023	Conducted (TH03-HY)
Thermal Chamber	ESPEC	SU-241	92003713	-30℃ ~95℃	May 17, 2023	Sep. 06, 2023	May 16, 2024	Conducted (TH03-HY)
DC Power Supply	GW Instek	GPP-2323	GES906037	0V~64V : 0A~6A	Dec. 29, 2022	May 18, 2023~ Sep. 06, 2023	Dec. 28, 2023	Conducted (TH03-HY)
Coupler	Warison	20dB 25W SMA Directional Coupler	#B	1-18GHz	Jan. 06, 2023	May 18, 2023~ Sep. 06, 2023	Jan. 05, 2024	Conducted (TH03-HY)



5 Measurement Uncertainty

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	3.02 dB
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Uncertainty of Radiated Emission Measurement (1 GHz ~ 18 GHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	3.55 dB
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Appendix A. Test Results of Conducted Test

Conducted Output Power(Average power & ERP)

LTE Band 26 Maximum Average Power [dBm] (GT - LC = -3.66 dB)								
BW [MHz]	RB Size	RB Offset	Mod	Lowest	Middle	Highest	ERP (dBm)	ERP (W)
15	1	0	QPSK	19.97	-	-	14.30	0.0269
15	1	5		19.91	-	-		
15	6	0		20.11	-	-		
15	1	0	16-QAM	19.87	-	-		
15	1	5		19.82	-	-		
15	5	0		20.09	-	-		
10	1	0	QPSK	-	19.87	-	14.26	0.0267
10	1	5		-	19.85	-		
10	6	0		-	20.07	-		
10	1	0	16-QAM	-	19.81	-		
10	1	5		-	19.79	-		
10	5	0		-	20.06	-		
5	1	0	QPSK	19.77	19.86	19.68	14.38	0.0274
5	1	5		19.72	19.81	19.66		
5	6	0		20.09	20.16	20.11		
5	1	0	16-QAM	19.61	19.75	19.58		
5	1	5		19.66	19.68	19.56		
5	5	0		20.04	20.08	20.19		
3	1	0	QPSK	19.66	19.71	19.62	14.34	0.0272
3	1	5		19.63	19.75	19.57		
3	6	0		20.07	20.15	20.06		
3	1	0	16-QAM	19.36	19.25	19.48		
3	1	5		19.45	19.58	19.46		
3	5	0		20.07	20.04	20.10		
1.4	1	0	QPSK	19.46	19.61	19.58	14.35	0.0272
1.4	1	5		19.43	19.65	19.55		
1.4	6	0		20.13	20.09	20.07		
1.4	1	0	16-QAM	19.46	19.41	19.37		
1.4	1	5		19.35	19.44	19.41		
1.4	5	0		20.08	20.05	20.16		
Limit	Output Power < 100W			Result			Pass	



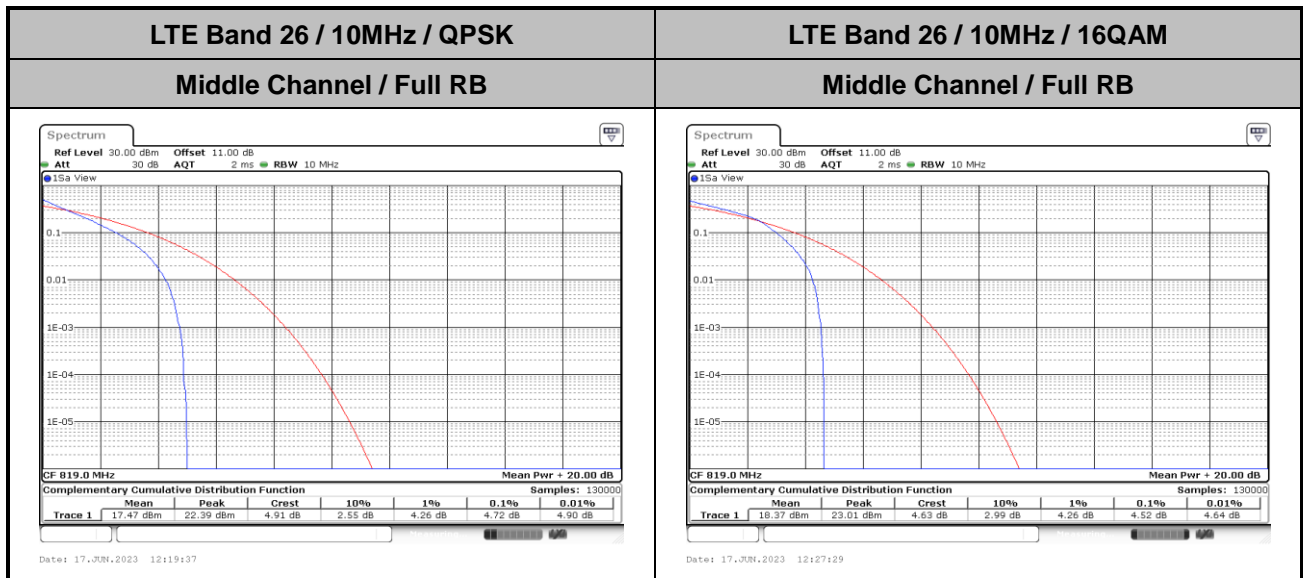
LTE Band 26 Straddle Maximum Average Power [dBm] (GT - LC = -3.66 dB)								
BW [MHz]	RB Size	RB Offset	Mod	Lowest	Middle	Highest	ERP (dBm)	ERP (W)
15	1	0	QPSK	-	19.96	-	14.35	0.0272
15	1	5		-	19.94	-		
15	6	0		-	20.08	-		
15	1	0	16-QAM	-	19.82	-		
15	1	5		-	19.81	-		
15	5	0		-	20.16	-		
10	1	0	QPSK	-	19.87	-	14.30	0.0269
10	1	5		-	19.85	-		
10	6	0		-	20.09	-		
10	1	0	16-QAM	-	19.81	-		
10	1	5		-	19.82	-		
10	5	0		-	20.11	-		
5	1	0	QPSK	-	19.77	-	14.32	0.0270
5	1	5		-	19.76	-		
5	6	0		-	20.13	-		
5	1	0	16-QAM	-	19.88	-		
5	1	5		-	19.85	-		
5	5	0		-	20.12	-		
3	1	0	QPSK	-	19.67	-	14.36	0.0273
3	1	5		-	19.68	-		
3	6	0		-	20.17	-		
3	1	0	16-QAM	-	19.55	-		
3	1	5		-	19.45	-		
3	5	0		-	20.13	-		
1.4	1	0	QPSK	-	19.62	-	14.35	0.0272
1.4	1	5		-	19.58	-		
1.4	6	0		-	20.11	-		
1.4	1	0	16-QAM	-	19.36	-		
1.4	1	5		-	19.37	-		
1.4	5	0		-	20.16	-		
Limit	Reporting only			Result			Pass	



LTE Band 26

Peak-to-Average Ratio

Mode	LTE Band 26 / 10MHz		
Mod.	QPSK	16QAM	Limit: 13dB
RB Size	Full RB	Full RB	Result
Middle CH	4.72	4.52	PASS



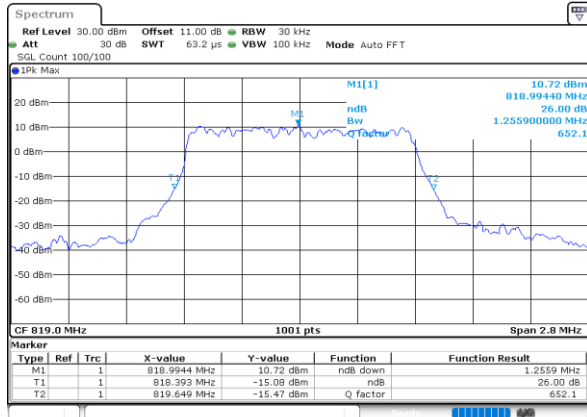
**26dB Bandwidth**

Mode	LTE Band 26 : 26dB BW(MHz)											
BW	1.4MHz		3MHz		5MHz		10MHz		15MHz		20MHz	
Mod.	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Low CH	-	-	-	-	-	-	-	-	1.77	1.59	-	-
Middle CH	1.26	1.11	1.37	1.19	1.37	1.14	1.80	1.62	-	-	-	-

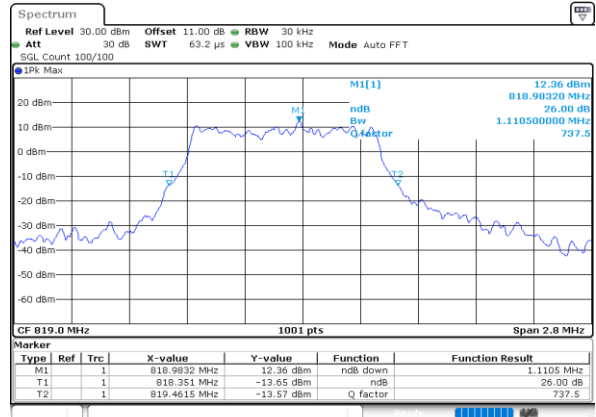


LTE Band 26

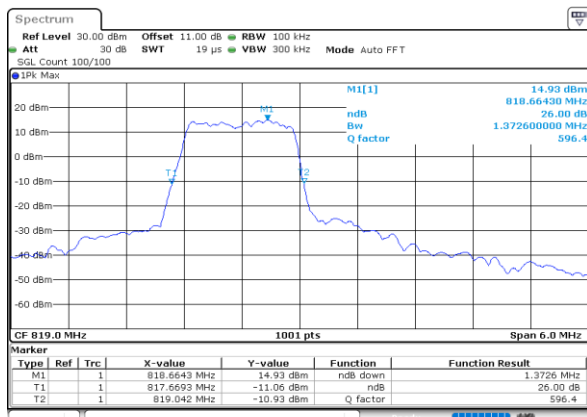
Middle Channel / 1.4MHz / QPSK



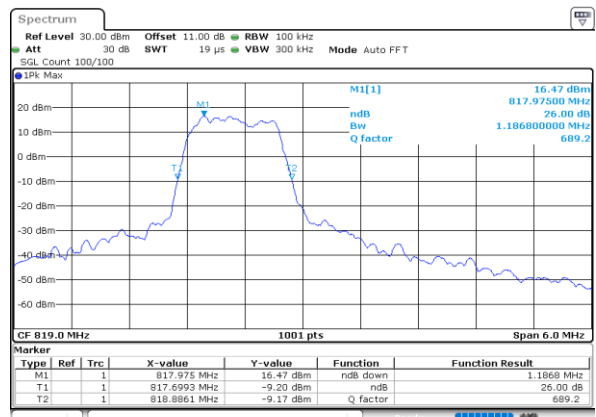
Middle Channel / 1.4MHz / 16QAM



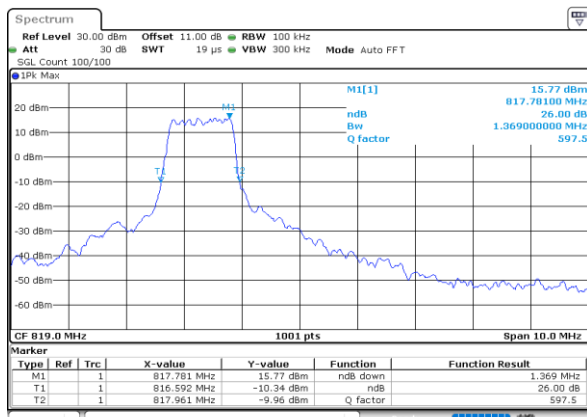
Middle Channel / 3MHz / QPSK



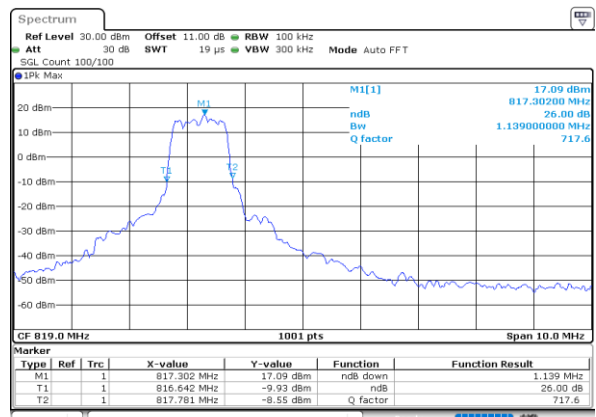
Middle Channel / 3MHz / 16QAM



Middle Channel / 5MHz / QPSK



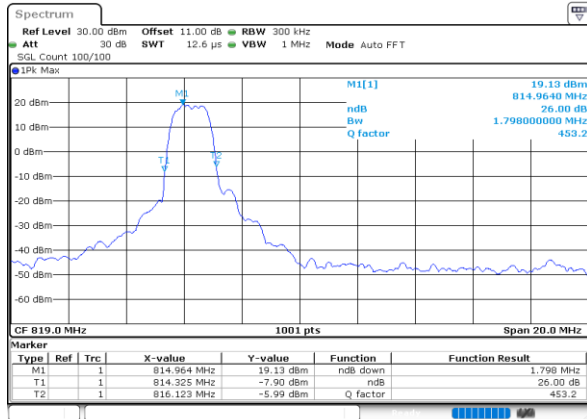
Middle Channel / 5MHz / 16QAM



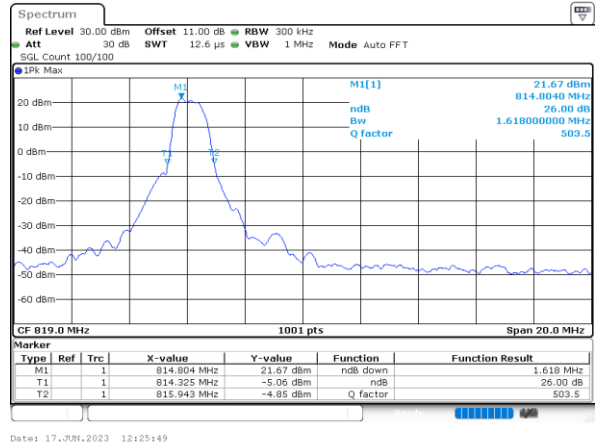


LTE Band 26

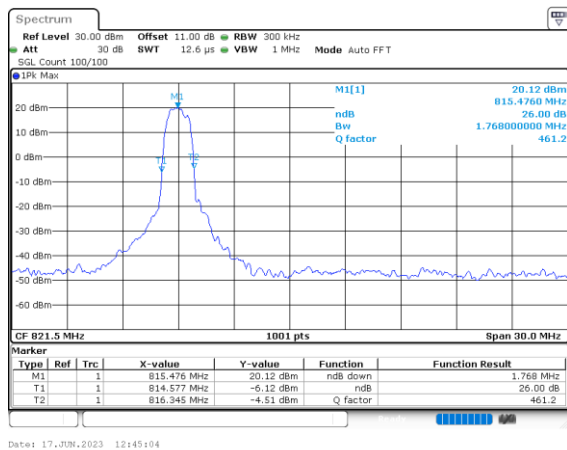
Middle Channel / 10MHz / QPSK



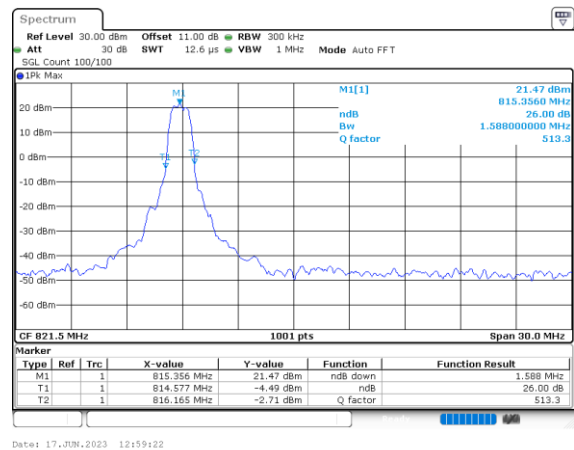
Middle Channel / 10MHz / 16QAM



Low Channel / 15MHz / QPSK



Low Channel / 15MHz / 16QAM

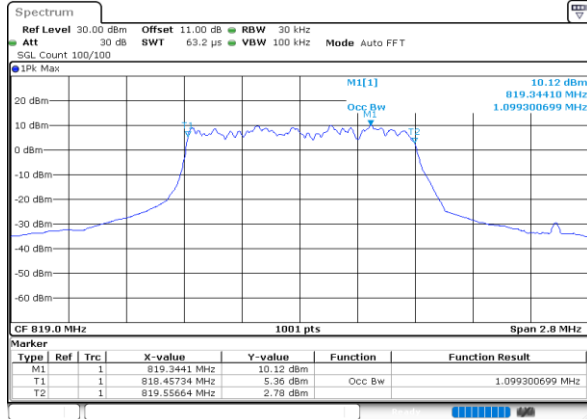


**Occupied Bandwidth**

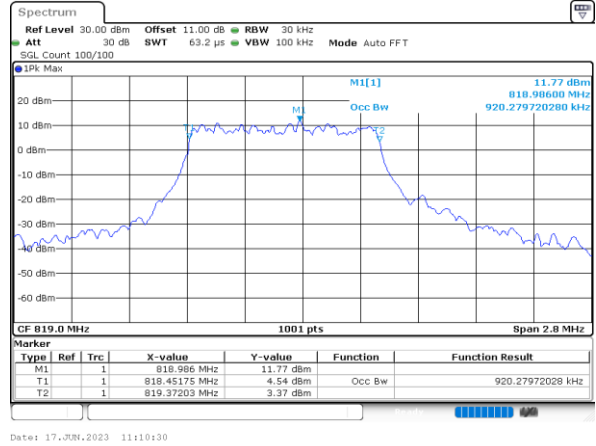
Mode	LTE Band 26 : 99%OBW(MHz)											
BW	1.4MHz		3MHz		5MHz		10MHz		15MHz		20MHz	
Mod.	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Low CH	-	-	-	-	-	-	-	-	1.41	1.29	-	-
Middle CH	1.10	0.92	1.18	0.98	1.16	0.97	1.42	1.30	-	-	-	-

LTE Band 26

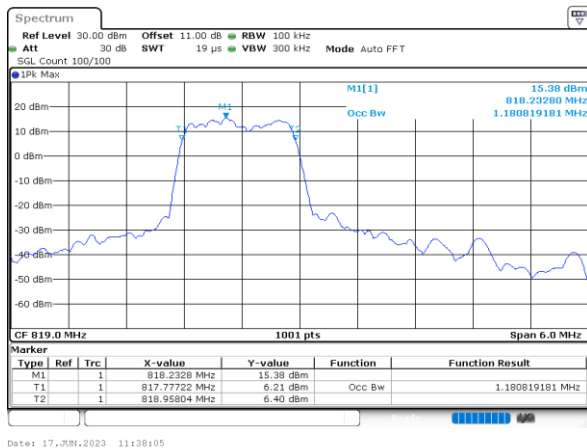
Middle Channel / 1.4MHz / QPSK



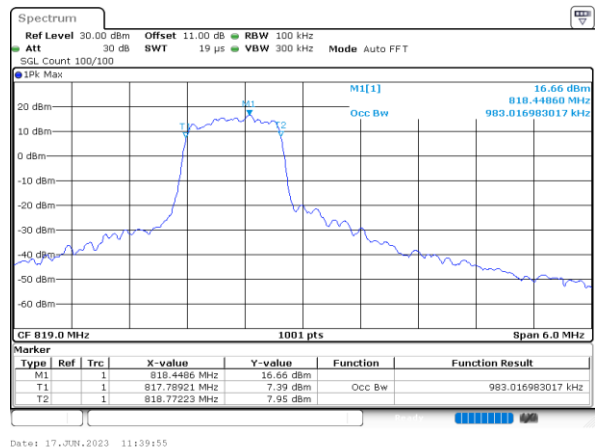
Middle Channel / 1.4MHz / 16QAM



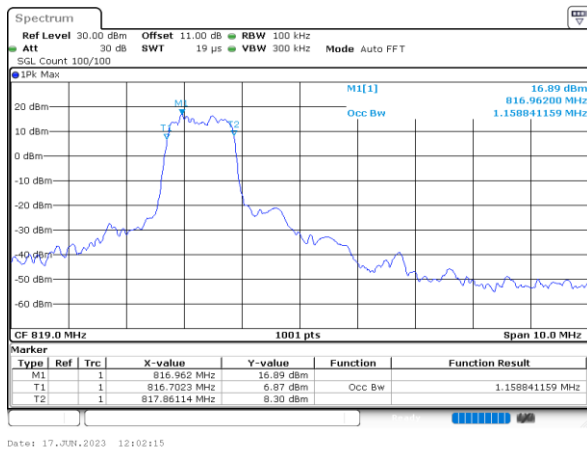
Middle Channel / 3MHz / QPSK



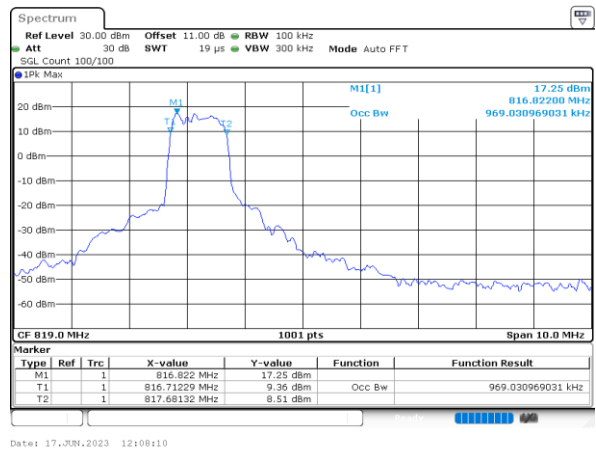
Middle Channel / 3MHz / 16QAM



Middle Channel / 5MHz / QPSK

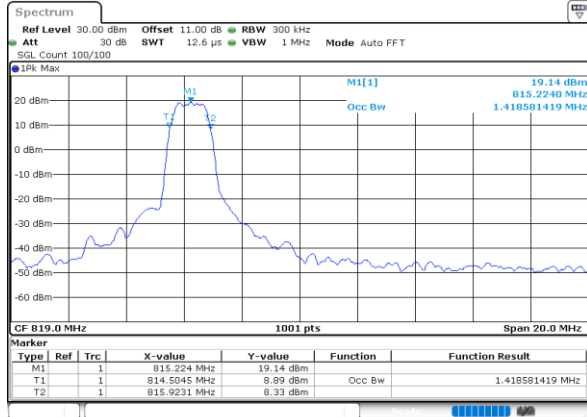


Middle Channel / 5MHz / 16QAM

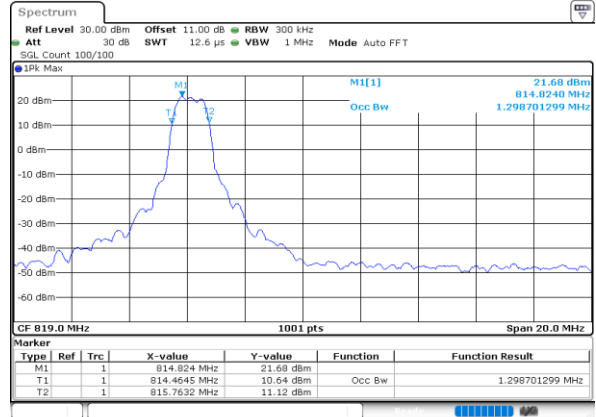


LTE Band 26

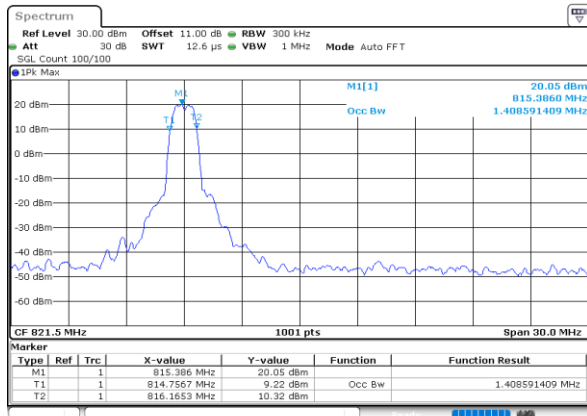
Middle Channel / 10MHz / QPSK



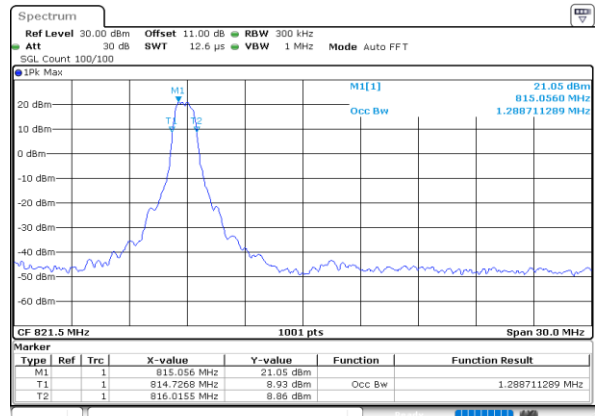
Middle Channel / 10MHz / 16QAM



Low Channel / 15MHz / QPSK



Low Channel / 15MHz / 16QAM

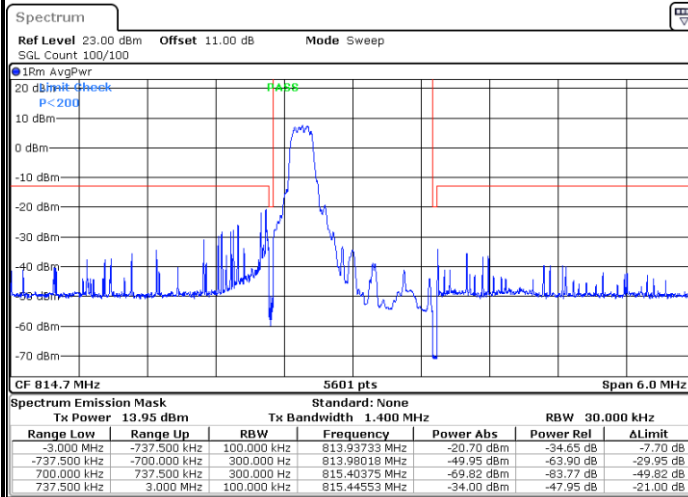




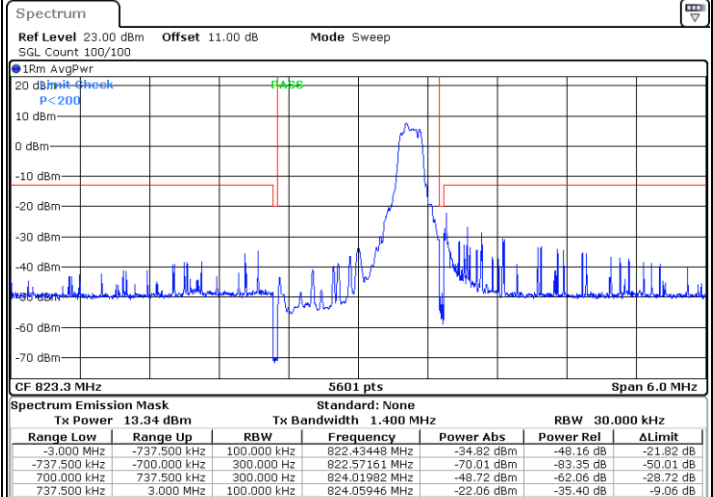
Emission masks – In-band emissions

LTE Band 26 / 1.4MHz / QPSK

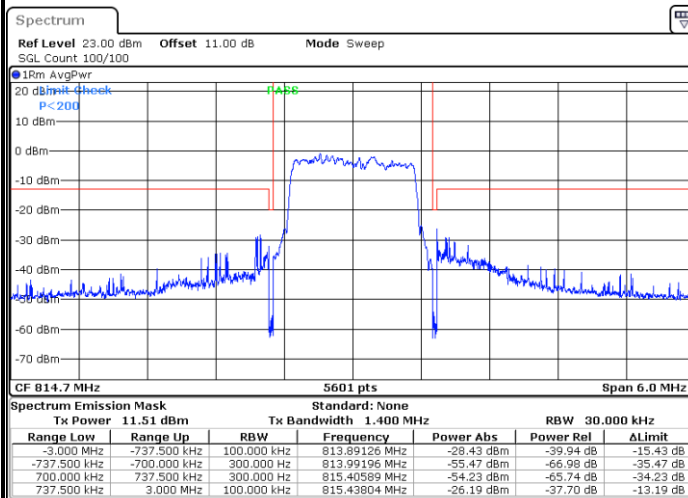
Lowest Band Edge / 1RB



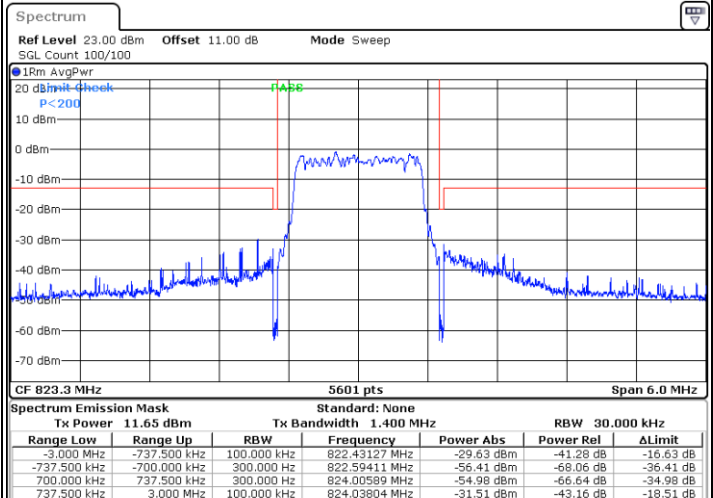
Highest Band Edge / 1RB



Lowest Band Edge / Full RB



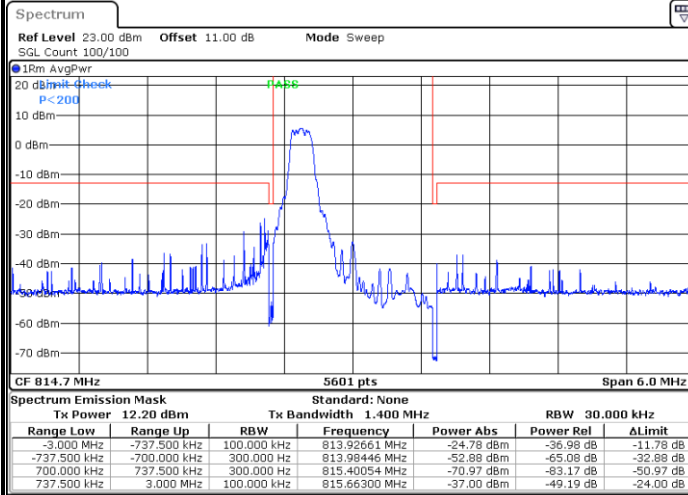
Highest Band Edge / Full RB



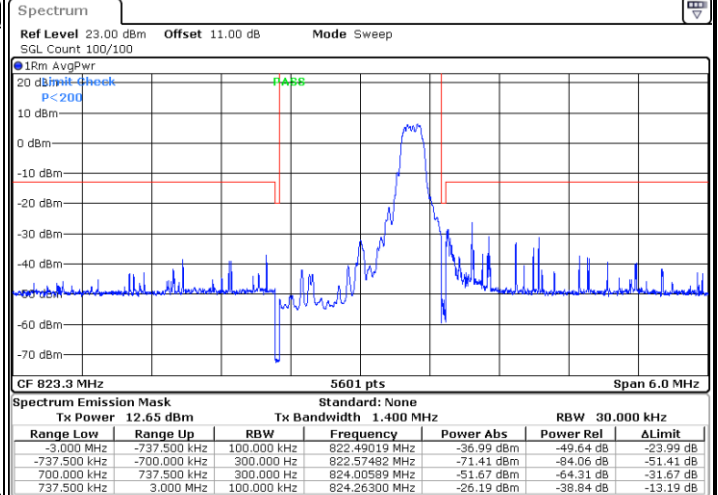


LTE Band 26 / 1.4MHz / 16QAM

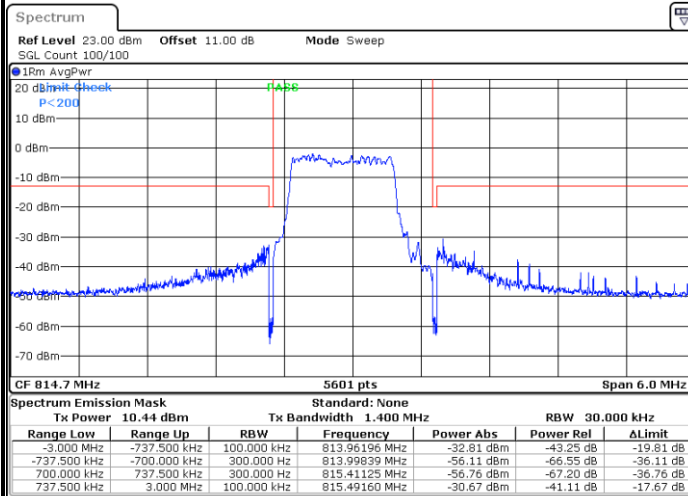
Lowest Band Edge / 1 RB



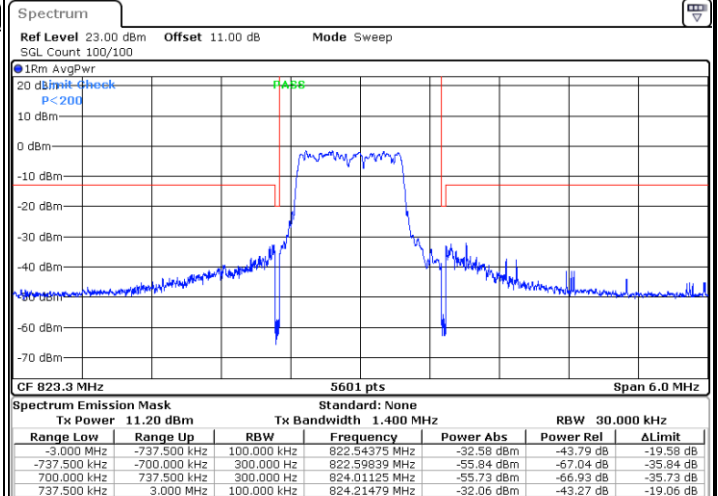
Highest Band Edge / 1 RB



Lowest Band Edge / Full RB



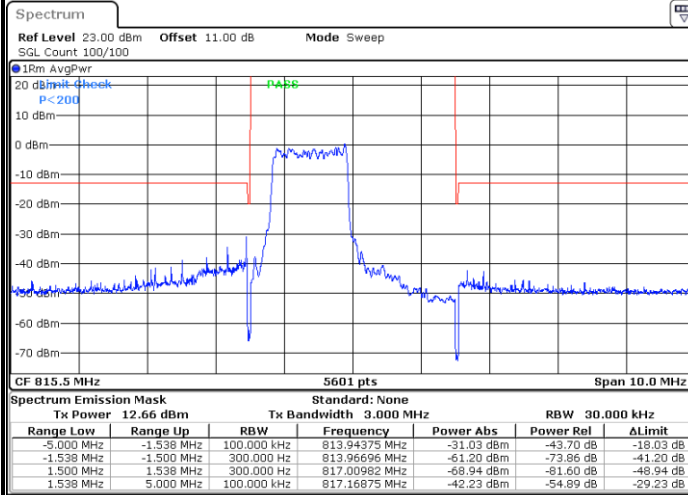
Highest Band Edge / Full RB



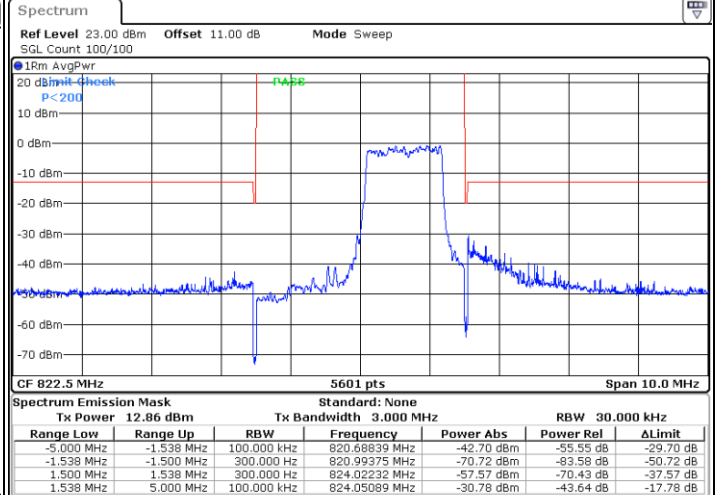


LTE Band 26 / 3MHz / QPSK

Lowest Band Edge / Full RB

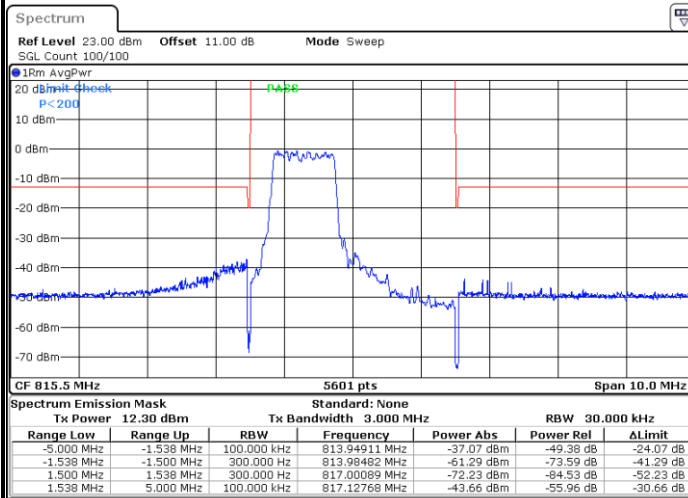


Highest Band Edge / Full RB

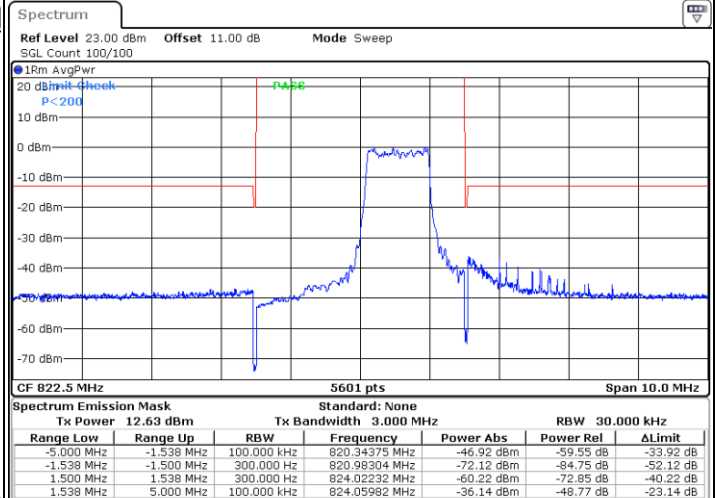


LTE Band 26 / 3MHz / 16QAM

Lowest Band Edge / Full RB



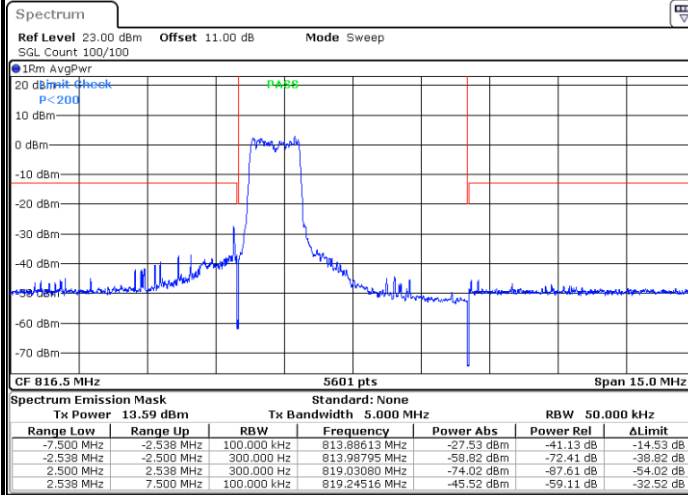
Highest Band Edge / Full RB



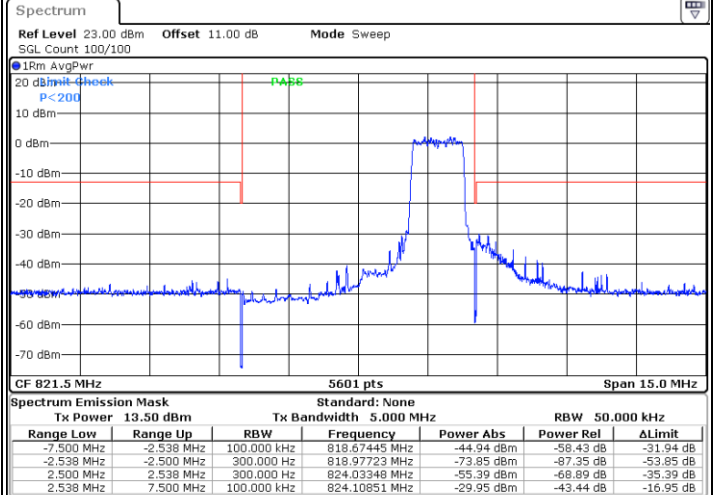


LTE Band 26 / 5MHz / QPSK

Lowest Band Edge / Full RB

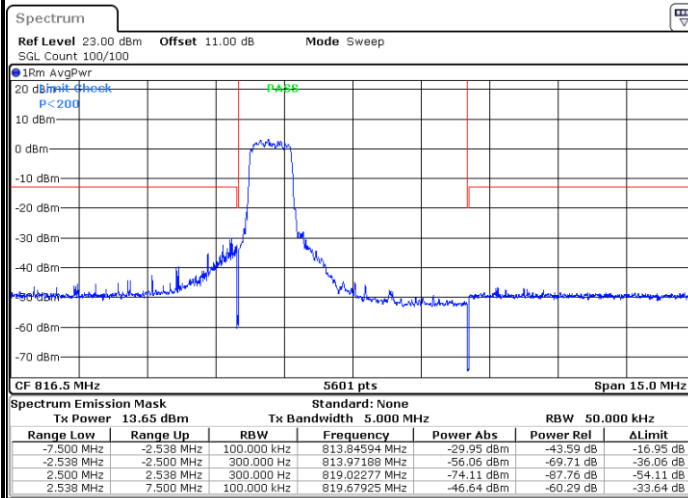


Highest Band Edge / Full RB

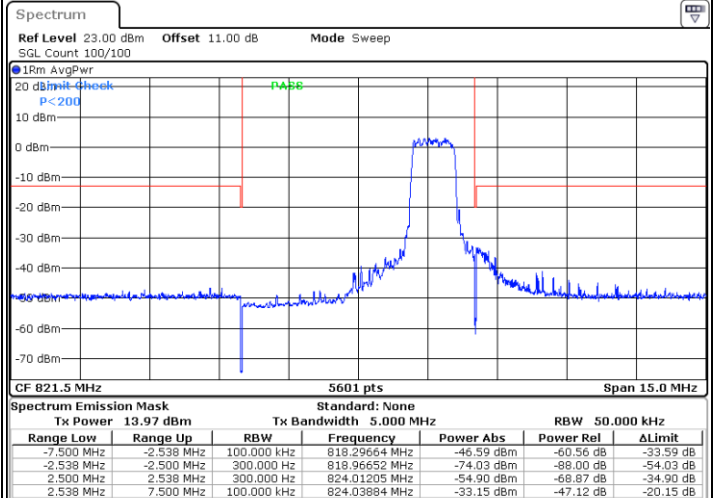


LTE Band 26 / 5MHz / 16QAM

Lowest Band Edge / Full RB



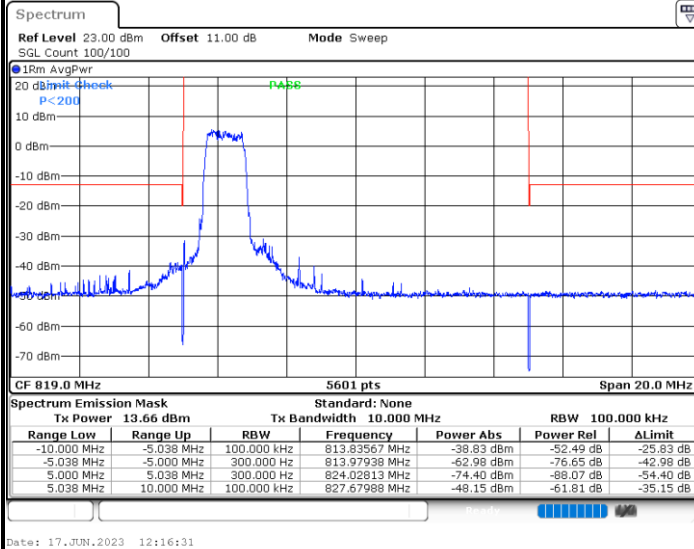
Highest Band Edge / Full RB





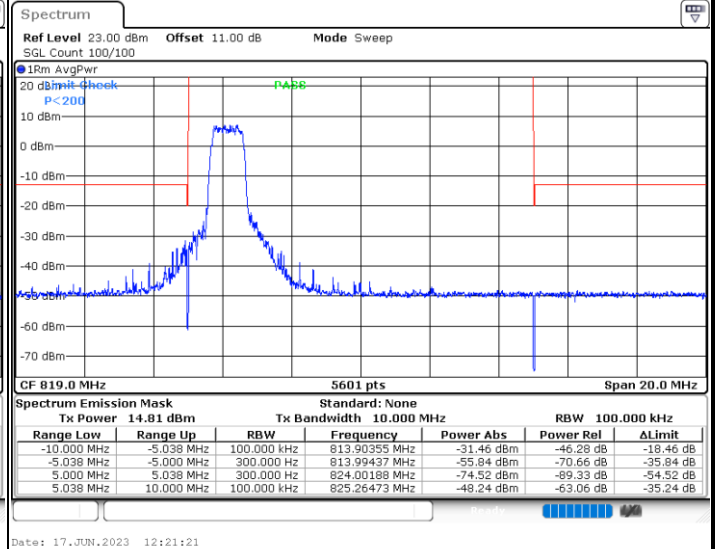
LTE Band 26 / 10MHz / QPSK

Lowest Band Edge / Full RB



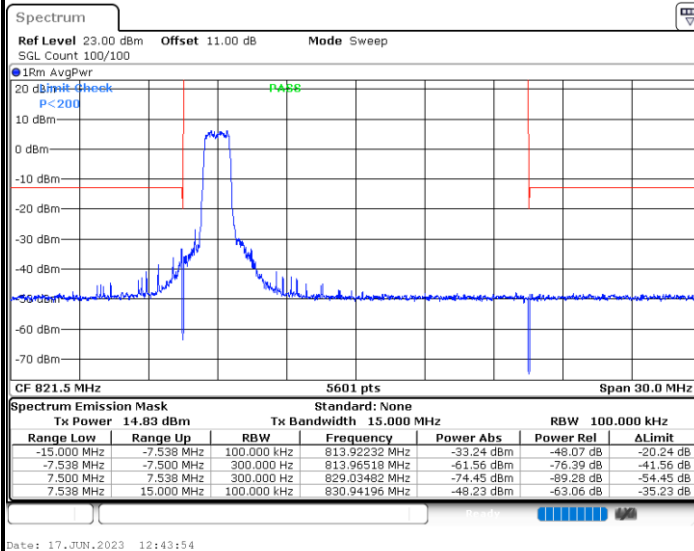
LTE Band 26 / 10MHz / 16QAM

Lowest Band Edge / Full RB



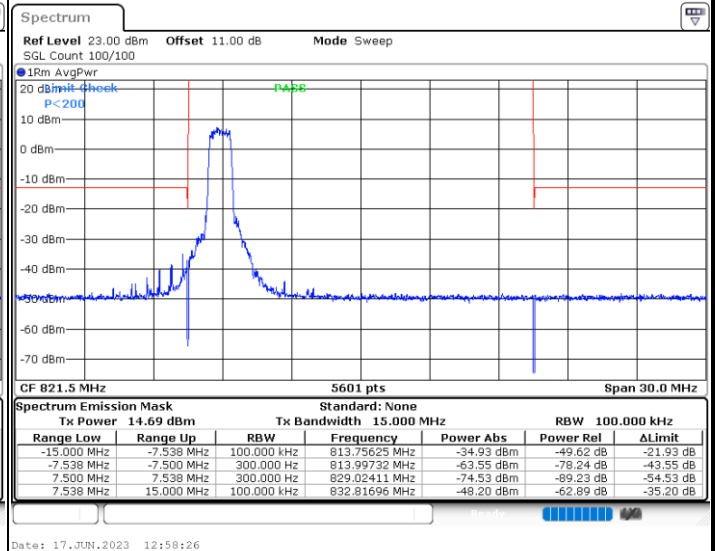
LTE Band 26 / 15MHz / QPSK

Lowest Band Edge / Full RB



LTE Band 26 / 15MHz / 16QAM

Lowest Band Edge / Full RB

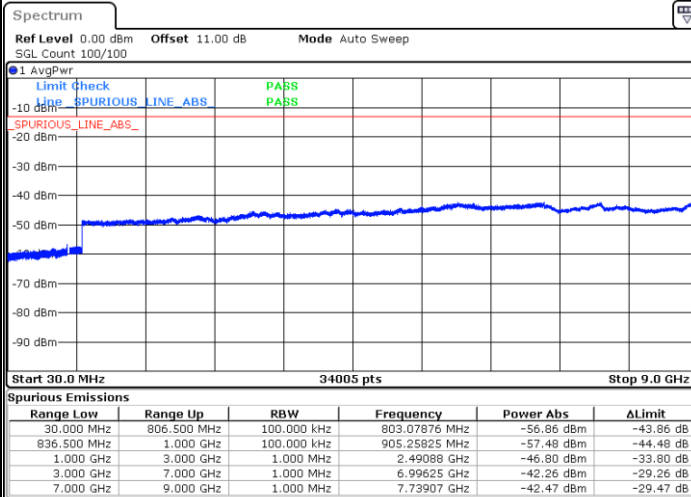




Emission masks – Out of band emissions

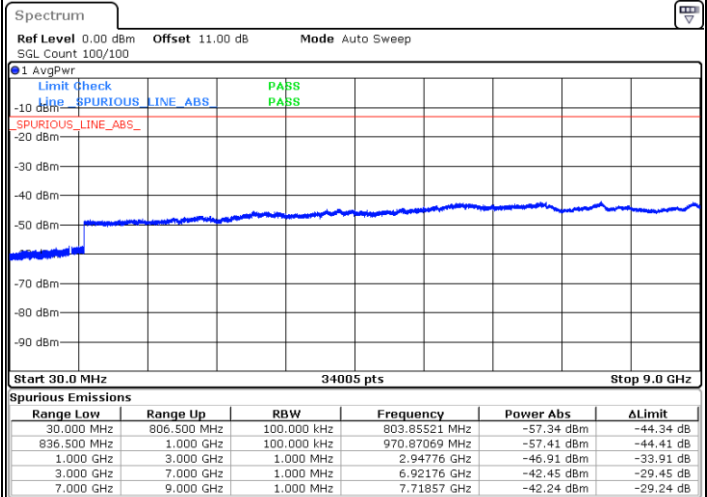
LTE Band 26 / 1.4MHz

Lowest Channel / QPSK



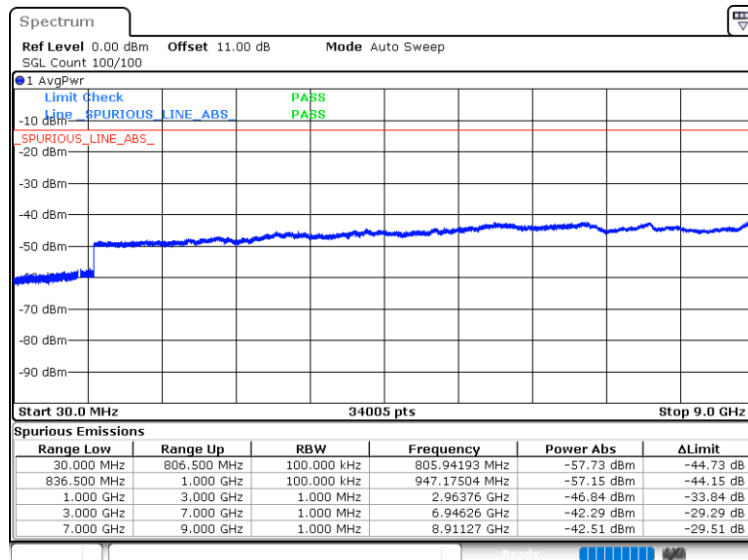
Date: 17.JUN.2023 10:52:31

Middle Channel / QPSK



Date: 17.JUN.2023 11:00:04

Highest Channel / QPSK

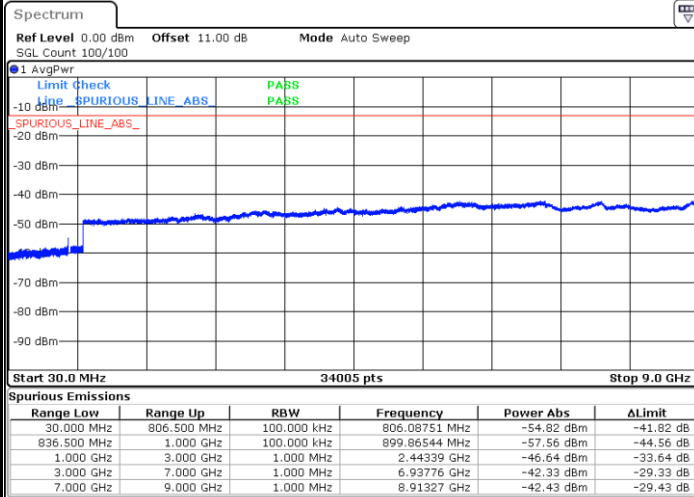


Date: 17.JUN.2023 11:15:49



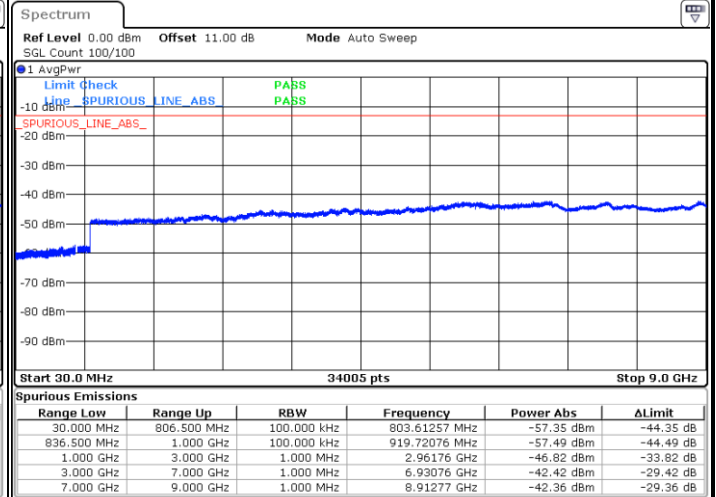
LTE Band 26 / 3MHz

Lowest Channel / QPSK



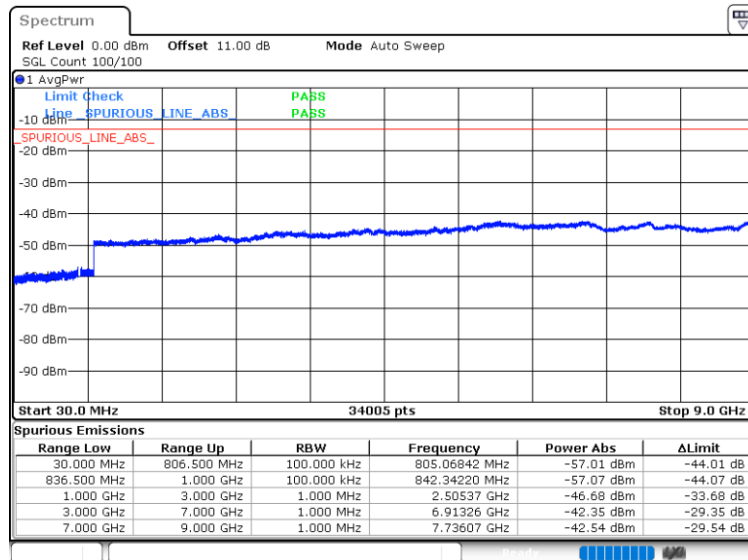
Date: 17.JUN.2023 11:32:59

Middle Channel / QPSK



Date: 17.JUN.2023 11:34:57

Highest Channel / QPSK

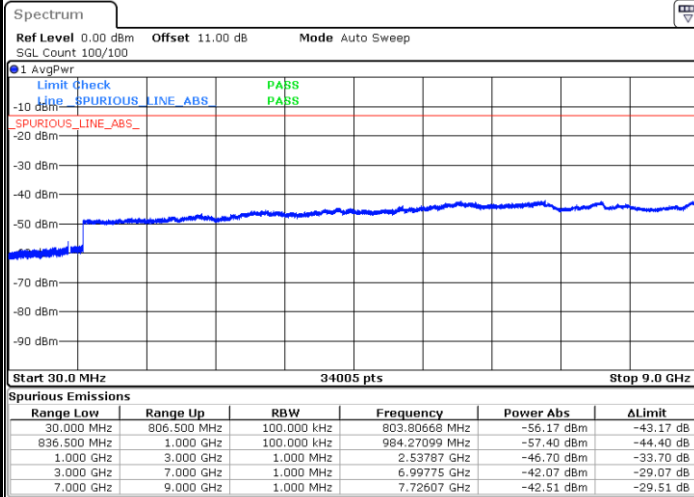


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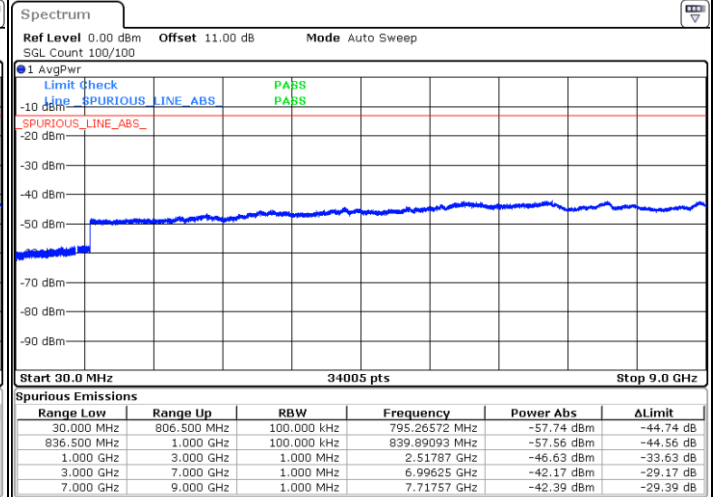
LTE Band 26 / 5MHz

Lowest Channel / QPSK



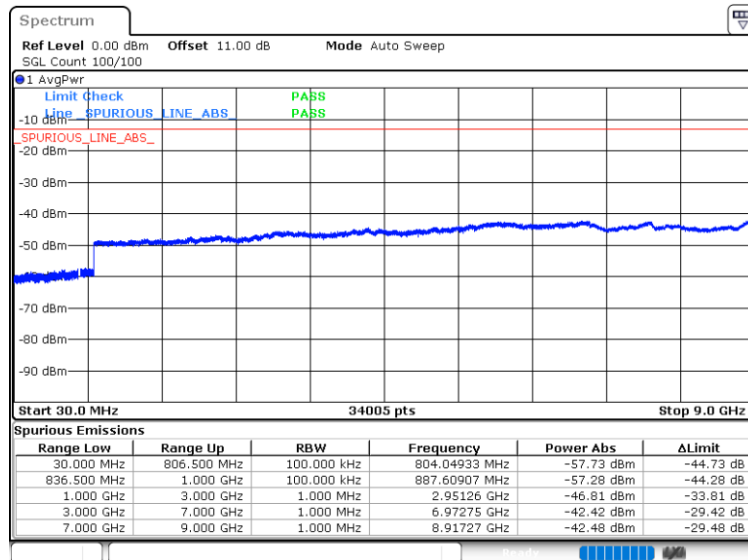
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Middle Channel / QPSK

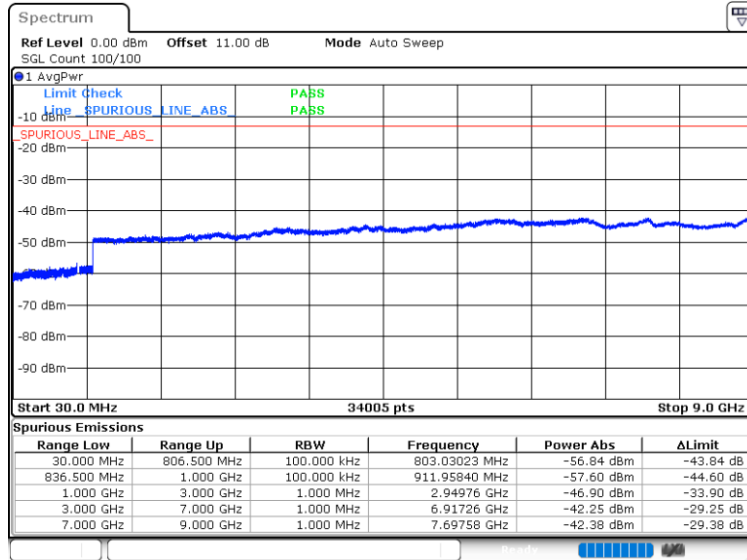
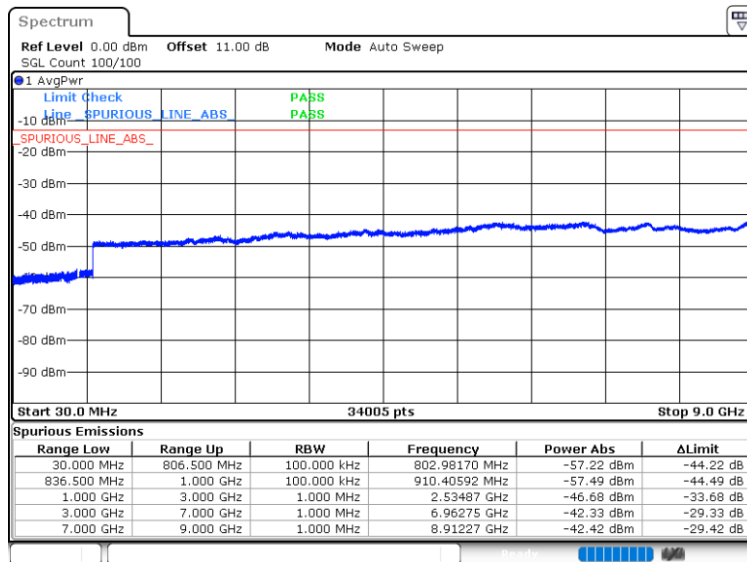


Date: 17.JUN.2023 11:54:08

Highest Channel / QPSK



Date: 17.JUN.2023 12:13:21

**LTE Band 26 / 10MHz****Middle Channel / QPSK****LTE Band 26 / 15MHz****Lowest Channel / QPSK**

Frequency Stability

Test Conditions		LTE Band 26 (QPSK) / Middle Channel	Limit
Temperature (°C)	Voltage (Volt)	BW 10MHz	Note 2.
		Deviation (ppm)	Result
50	Normal Voltage	0.0155	PASS
40	Normal Voltage	0.0187	
30	Normal Voltage	0.0006	
20(Ref.)	Normal Voltage	0.0000	
10	Normal Voltage	0.0107	
0	Normal Voltage	0.0010	
-10	Normal Voltage	0.0136	
-20	Normal Voltage	0.0024	
-30	Normal Voltage	0.0173	
20	Maximum Voltage	0.0061	
20	Normal Voltage	0.0000	
20	Battery End Point	0.0136	

Note:

1. Normal Voltage = 3.7 V. ; Battery End Point (BEP) = 3.4 V. ; Maximum Voltage = 4.2 V.
2. The frequency fundamental emissions stay within the authorized frequency block.

Test Conditions		LTE Band 26 (QPSK) / Low Channel	Limit
Temperature (°C)	Voltage (Volt)	BW 15MHz	Note 2.
		Deviation (ppm)	Result
50	Normal Voltage	0.0096	PASS
40	Normal Voltage	0.0127	
30	Normal Voltage	0.0018	
20(Ref.)	Normal Voltage	0.0000	
10	Normal Voltage	0.0039	
0	Normal Voltage	0.0013	
-10	Normal Voltage	0.0016	
-20	Normal Voltage	0.0037	
-30	Normal Voltage	0.0006	
20	Maximum Voltage	0.0102	
20	Normal Voltage	0.0000	
20	Battery End Point	0.0082	

Note:

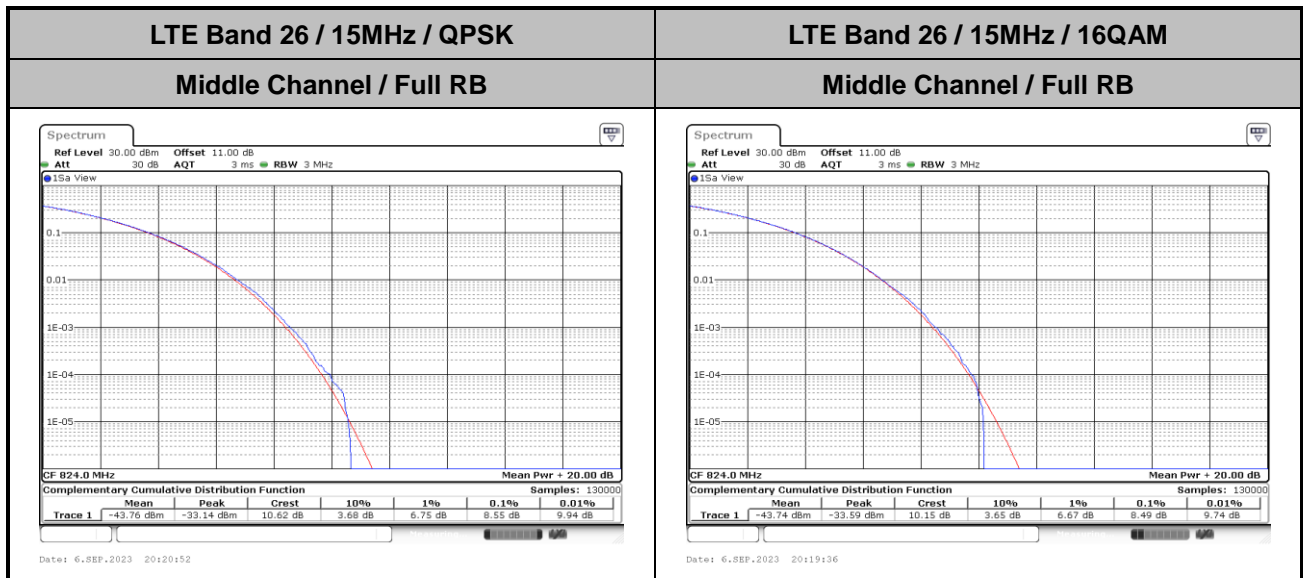
1. Normal Voltage = 3.7 V. ; Battery End Point (BEP) = 3.4 V. ; Maximum Voltage = 4.2 V.
2. The frequency fundamental emissions stay within the authorized frequency block.



LTE Band 26_824MHz

Peak-to-Average Ratio

Mode	LTE Band 26 / 15MHz		
Mod.	QPSK	16QAM	Limit: 13dB
RB Size	Full RB	Full RB	Result
Middle CH	8.55	8.49	PASS



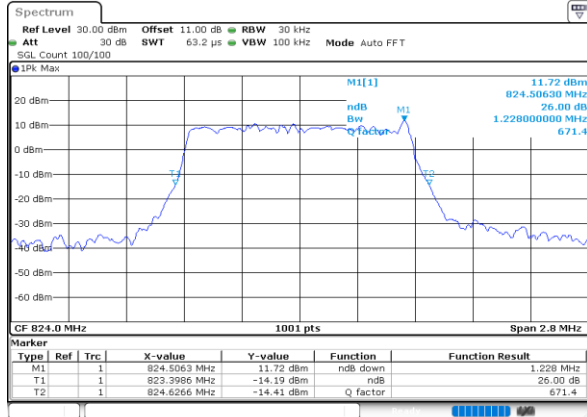
**26dB Bandwidth**

Mode	LTE Band 26 : 26dB BW(MHz)											
BW	1.4MHz		3MHz		5MHz		10MHz		15MHz		20MHz	
Mod.	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Middle CH	1.23	1.09	1.50	1.16	1.34	1.13	1.74	1.62	1.80	1.83	-	-

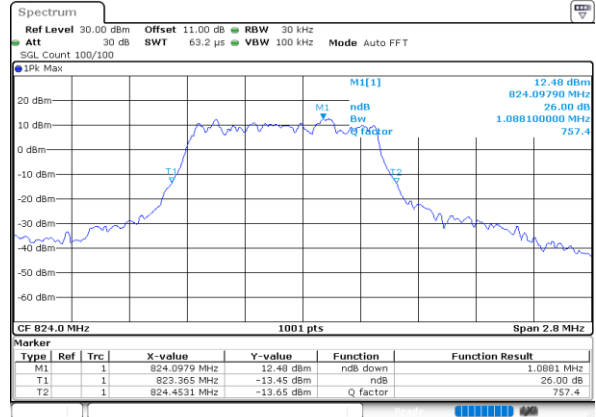


LTE Band 26

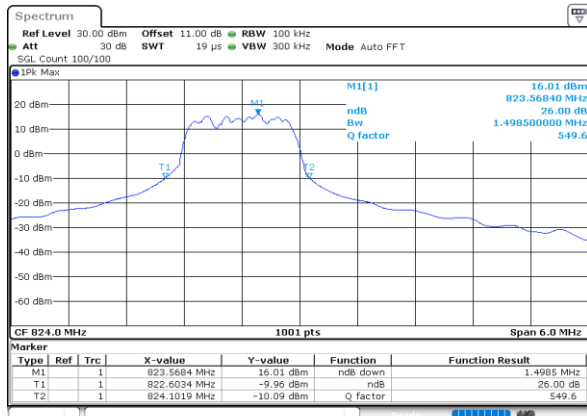
Middle Channel / 1.4MHz / QPSK



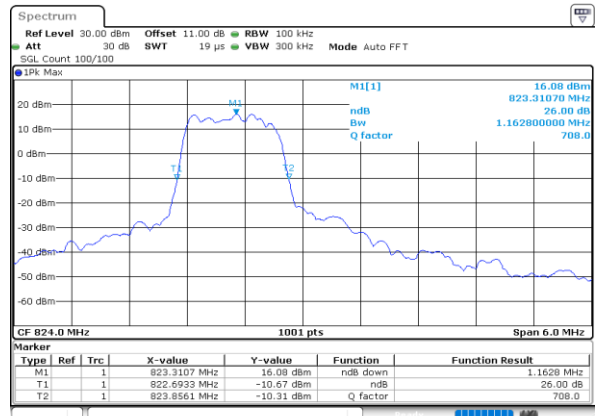
Middle Channel / 1.4MHz / 16QAM



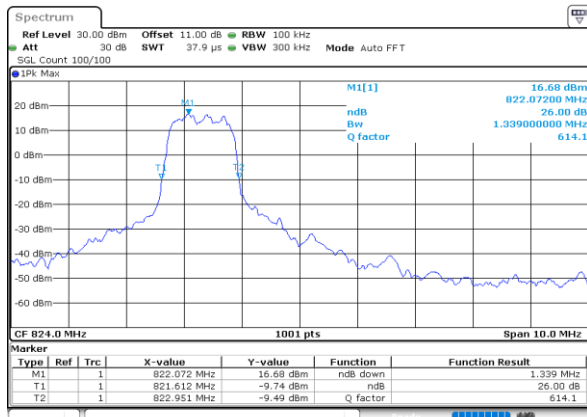
Middle Channel / 3MHz / QPSK



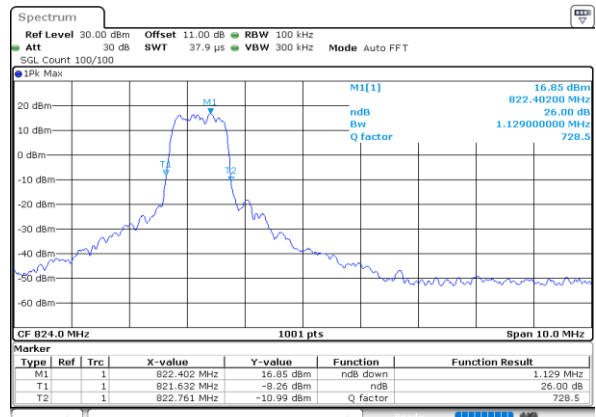
Middle Channel / 3MHz / 16QAM



Middle Channel / 5MHz / QPSK

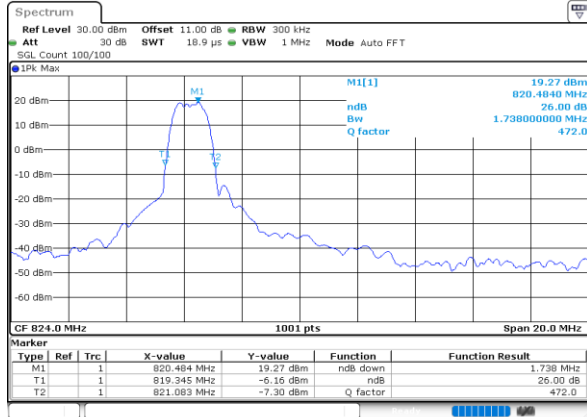


Middle Channel / 5MHz / 16QAM

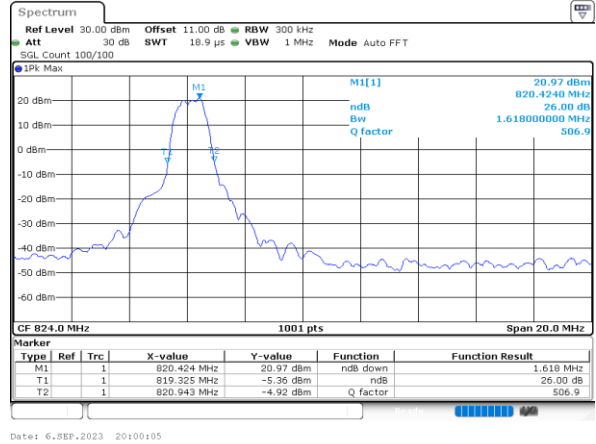


LTE Band 26

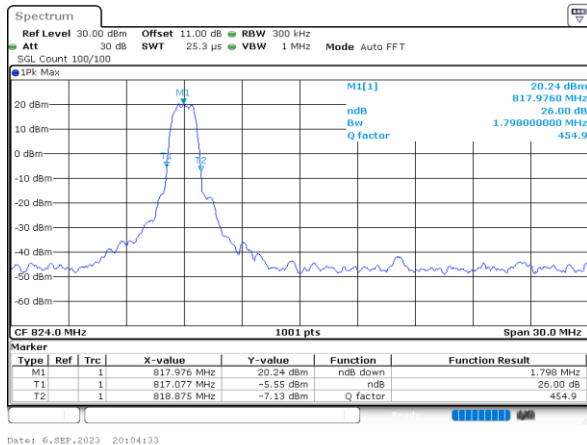
Middle Channel / 10MHz / QPSK



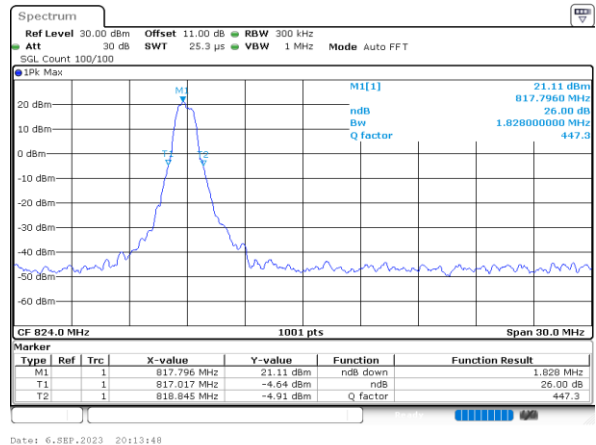
Middle Channel / 10MHz / 16QAM



Middle Channel / 15MHz / QPSK



Middle Channel / 15MHz / 16QAM



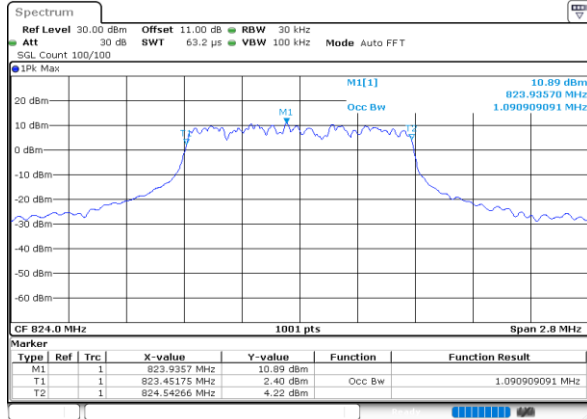
**Occupied Bandwidth**

Mode	LTE Band 26 : 99%OBW(MHz)											
BW	1.4MHz		3MHz		5MHz		10MHz		15MHz		20MHz	
Mod.	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Middle CH	1.09	0.91	1.16	0.95	1.17	1.00	1.42	1.26	1.44	1.26	-	-

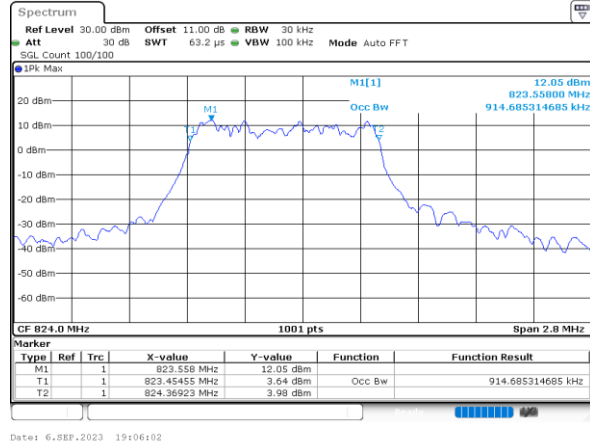


LTE Band 26

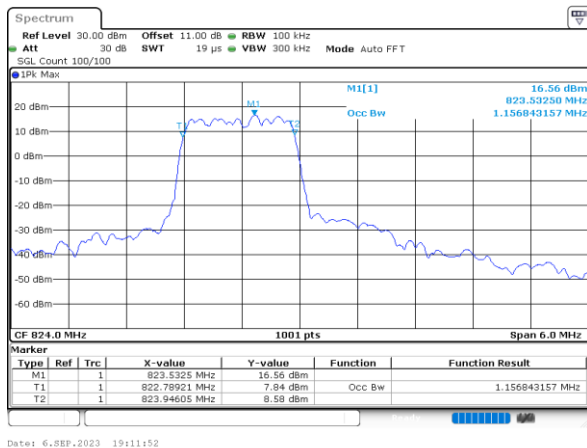
Middle Channel / 1.4MHz / QPSK



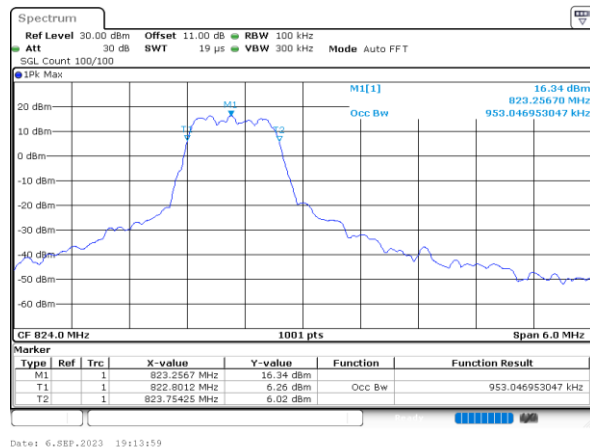
Middle Channel / 1.4MHz / 16QAM



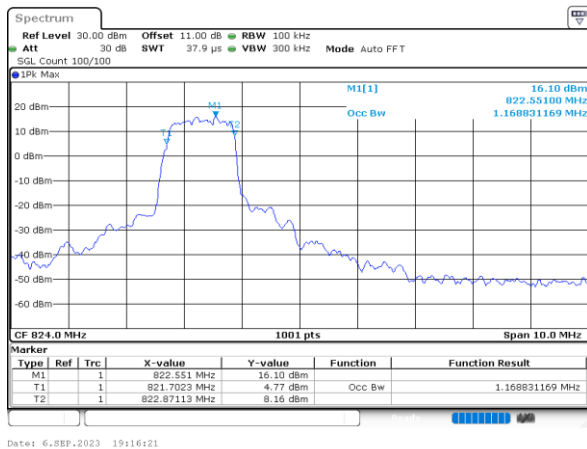
Middle Channel / 3MHz / QPSK



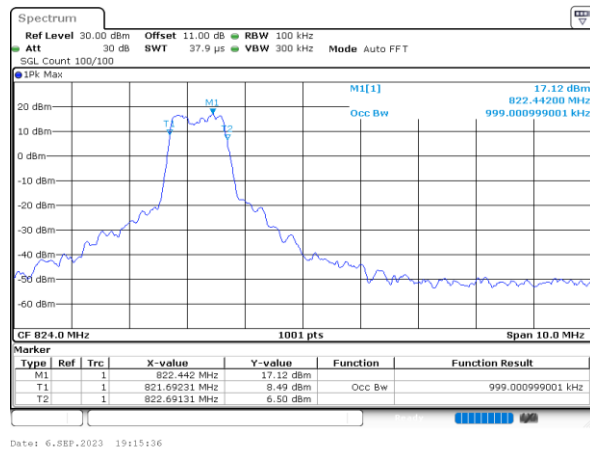
Middle Channel / 3MHz / 16QAM



Middle Channel / 5MHz / QPSK



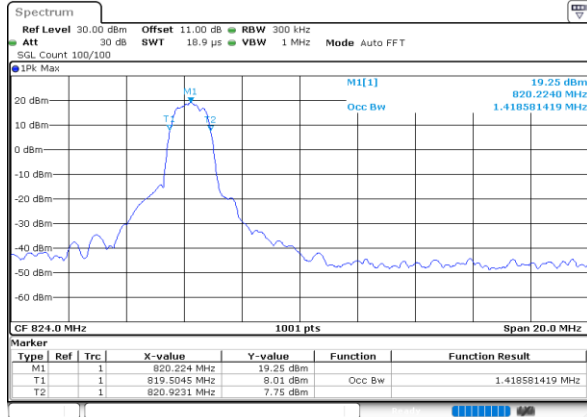
Middle Channel / 5MHz / 16QAM



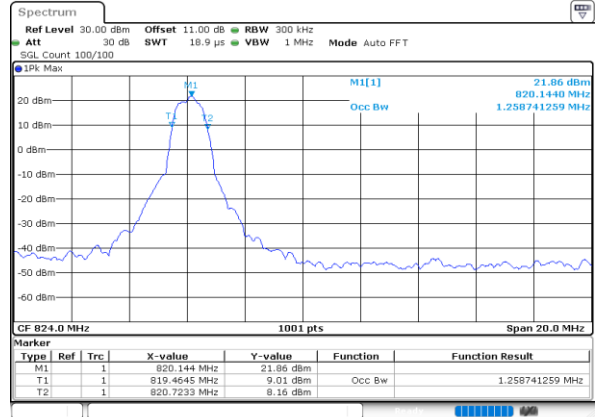


LTE Band 26

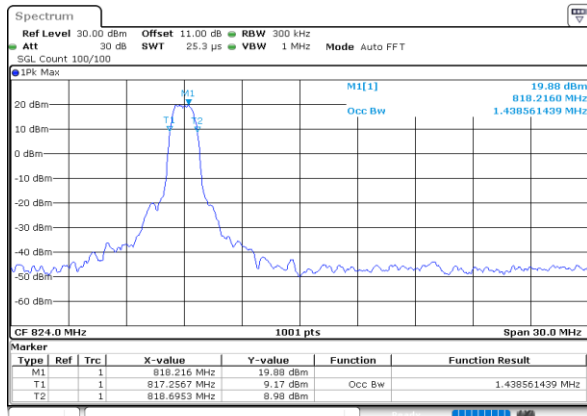
Middle Channel / 10MHz / QPSK



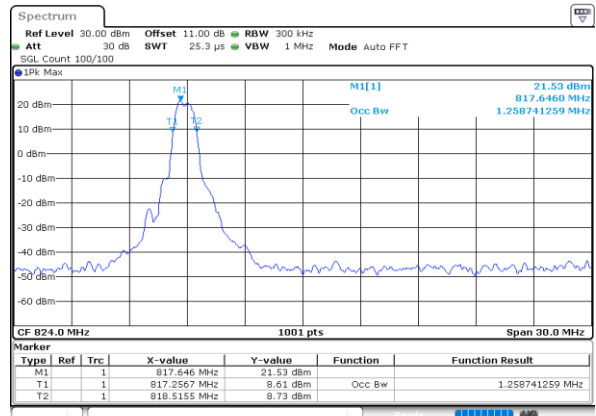
Middle Channel / 10MHz / 16QAM



Middle Channel / 15MHz / QPSK

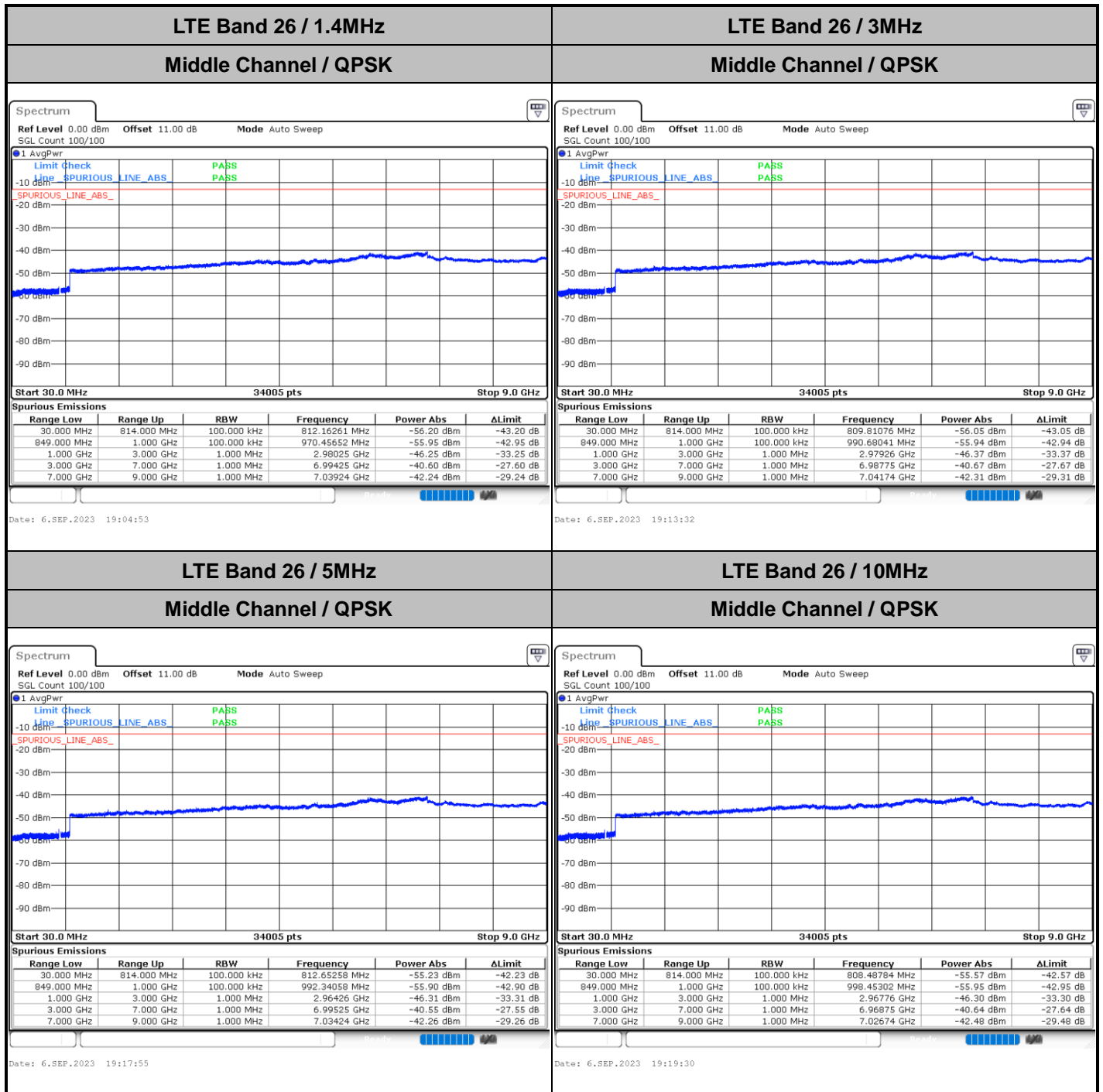


Middle Channel / 15MHz / 16QAM





Conducted Spurious Emission



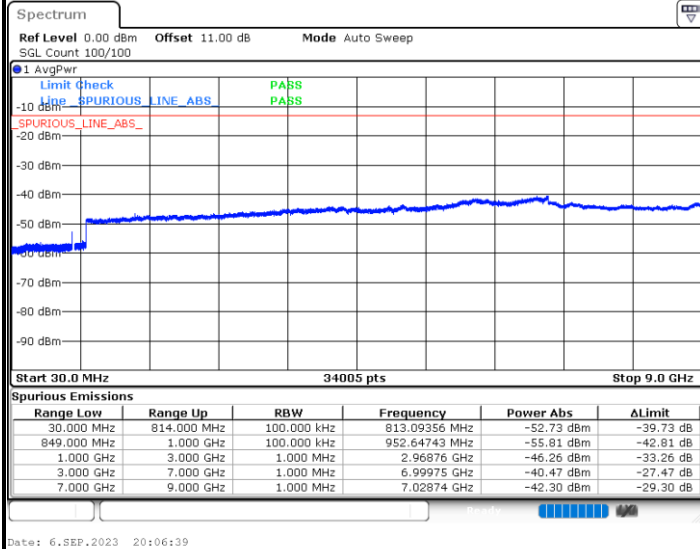


LTE Band 26 / 15MHz

N/A

Middle Channel / QPSK

N/A



Frequency Stability

Test Conditions		LTE Band 26 (QPSK) / Middle Channel	Limit
Temperature (°C)	Voltage (Volt)	BW 10MHz	Note 2.
		Deviation (ppm)	Result
50	Normal Voltage	0.0155	PASS
40	Normal Voltage	0.0187	
30	Normal Voltage	0.0006	
20(Ref.)	Normal Voltage	0.0000	
10	Normal Voltage	0.0107	
0	Normal Voltage	0.0010	
-10	Normal Voltage	0.0136	
-20	Normal Voltage	0.0024	
-30	Normal Voltage	0.0173	
20	Maximum Voltage	0.0061	
20	Normal Voltage	0.0000	
20	Battery End Point	0.0136	

Note:

1. Normal Voltage = 3.7 V. ; Battery End Point (BEP) = 3.4 V. ; Maximum Voltage = 4.2 V.
2. The frequency fundamental emissions stay within the authorized frequency block.

Test Conditions		LTE Band 26 (QPSK) / Middle Channel	Limit
Temperature (°C)	Voltage (Volt)	BW 15MHz	Note 2.
		Deviation (ppm)	Result
50	Normal Voltage	0.0050	PASS
40	Normal Voltage	0.0007	
30	Normal Voltage	0.0011	
20(Ref.)	Normal Voltage	0.0000	
10	Normal Voltage	0.0025	
0	Normal Voltage	0.0045	
-10	Normal Voltage	0.0038	
-20	Normal Voltage	0.0027	
-30	Normal Voltage	0.0034	
20	Maximum Voltage	0.0044	
20	Normal Voltage	0.0000	
20	Battery End Point	0.0032	

Note:

1. Normal Voltage = 3.7 V. ; Battery End Point (BEP) = 3.4 V. ; Maximum Voltage = 4.2 V.
2. The frequency fundamental emissions stay within the authorized frequency block.



Appendix B. Test Results of Radiated Test

LTE Band 26

LTE Band 26 / 5MHz / QPSK									
Channel	Frequency (MHz)	ERP (dBm)	Limit (dBm)	Margin (dB)	SPA Reading (dBm)	S.G. Power (dBm)	TX Cable loss (dB)	TX Antenna Gain (dBi)	Polarization (H/V)
Lowest	1629	-51.24	-13	-38.24	-55.16	-56.93	0.95	8.79	H
	2443	-62.52	-13	-49.52	-68.95	-69.45	1.05	10.13	H
	3257	-62.16	-13	-49.16	-72.13	-69.63	1.12	10.74	H
									H
									H
									H
	1629	-52.28	-13	-39.28	-55.88	-57.97	0.95	8.79	V
	2443	-60.84	-13	-47.84	-67.61	-67.77	1.05	10.13	V
	3257	-62.59	-13	-49.59	-72.35	-70.06	1.12	10.74	V
									V
									V
									V
Middle	1634	-50.54	-13	-37.54	-54.44	-56.28	0.95	8.84	H
	2451	-61.95	-13	-48.95	-68.43	-68.85	1.05	10.10	H
	3267	-61.83	-13	-48.83	-71.79	-69.37	1.12	10.80	H
									H
									H
									H
	1634	-51.77	-13	-38.77	-55.37	-57.51	0.95	8.84	V
	2451	-60.08	-13	-47.08	-66.91	-66.98	1.05	10.10	V
	3267	-61.72	-13	-48.72	-71.48	-69.26	1.12	10.80	V
									V
									V
									V



Highest	1648	-51.06	-13	-38.06	-54.94	-56.94	0.95	8.98	H
	2472	-62.31	-13	-49.31	-68.89	-69.25	1.05	10.14	H
	3296	-62.69	-13	-49.69	-72.6	-70.41	1.11	10.98	H
									H
									H
									H
	1648	-53.41	-13	-40.41	-57.01	-59.29	0.95	8.98	V
	2472	-59.52	-13	-46.52	-66.52	-66.46	1.05	10.14	V
	3296	-62.60	-13	-49.60	-72.35	-70.32	1.11	10.98	V
									V
									V
									V

Remark: Spurious emissions within 30-1000MHz were found more than 20dB below limit line.



LTE Band 26 / 15MHz / QPSK / 824MHz									
Channel	Frequency (MHz)	ERP (dBm)	Limit (dBm)	Margin (dB)	SPA Reading (dBm)	S.G. Power (dBm)	TX Cable loss (dB)	TX Antenna Gain (dBi)	Polarization (H/V)
Middle	1635	-50.99	-13	-37.99	-54.89	-56.74	0.95	8.85	H
	2452	-61.84	-13	-48.84	-68.32	-68.74	1.05	10.10	H
	3269	-61.22	-13	-48.22	-71.17	-68.77	1.12	10.81	H
									H
									H
									H
	1635	-53.09	-13	-40.09	-56.69	-58.84	0.95	8.85	V
	2452	-60.87	-13	-47.87	-67.71	-67.77	1.05	10.10	V
	3269	-61.62	-13	-48.62	-71.38	-69.17	1.12	10.81	V
									V
									V
									V

Remark: Spurious emissions within 30-1000MHz were found more than 20dB below limit line.