



Test Report No.: RFA210305W001-4



FCC TEST REPORT (PART 90S)

Applicant:	ThingsMatrix Inc.
Address:	9442 North Capital of Texas Hwy, Plaza One, Suite 500, Austin, TX 78759

Manufacturer or Supplier:	ThingsMatrix Inc.
Address:	9442 North Capital of Texas Hwy, Plaza One, Suite 500, Austin, TX 78759
Product:	IoT Wireless Device
Brand Name:	ThingsMatrix
Model Name:	TMX08-EX
FCC ID:	2ATV9TMX08-EX
Date of tests:	Mar. 17, 2021 ~ Mar. 26, 2021

The tests have been carried out according to the requirements of the following standard:

- FCC Part 90, Subpart S ANSI/TIA/EIA-603- D
- FCC Part 2 ANSI/TIA/EIA-603-E ANSI C63.26-2015

CONCLUSION: The submitted sample was found to COMPLY with the test requirement

Prepared by Simon Wang Supervisor / Mobile Department	Approved by Luke Lu Manager / Mobile Department
Date: Mar. 26, 2021	Date: Mar. 26, 2021

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RELEASE CONTROL RECORD

ISSUE NO.	REASON FOR CHANGE	DATE ISSUED
RF190701W004-4	Original release	Jul. 24, 2019
RFA210305W001-4	Base on the original release changes the non-RF components include DC-DC power chip model , add RS232 debug external interface and digital temperature sensor , an NTC thermistor, use lidar sensor instead of ultrasonic sensor ,update LTE band 26 radiated spurious and verify conducted power , other refer to the original release report	Mar. 26, 2021

1 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part 90S & Part 2			
STANDARD SECTION	TEST TYPE AND LIMIT	RESULT	REMARK
2.1046 90.635(b)	Maximum Peak Output Power	N/A	See Note 2
2.1055 90.213	Frequency Stability	N/A	See Note 1
2.1049 90.209	Occupied Bandwidth	N/A	See Note 1
2.1051 90.691	Emission Masks	N/A	See Note 1
2.1051 90.691	Conducted Spurious Emissions	N/A	See Note 1
2.1053 90.691	Radiated Spurious Emissions	PASS	Meet the requirement of limit. Minimum passing margin is -15.11 dB at 205.570MHz.

Note:

- These items please refer to the LTE module report RXA1706-0199RF01R1 which The FCC ID is XMR201707BG96, and the LTE module has been certified by TA Technology(shanghai)Co.,Ltd on 09/12/2017.
- Per the product equivalent declaration provided by the manufacturer, the change not affect any RF parameters, Verify the original report (FCC ID: 2ATV9TMX08; Report No.: RF190701W004-4) worst mode of radiative spurious emission.

1.1 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

MEASUREMENT	UNCERTAINTY
Maximum Peak Output Power	±1dB
Frequency Stability	± 39.27Hz
Radiated emissions	±4.48dB
Conducted emissions	±2 dB
Occupied Channel Bandwidth	±21.7KHz
Emission Mask Measurements	±4.48dB

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

1.2 TEST SITE AND INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
MXE EMI Receiver	KEYSIGHT	N9038A-544	MY54450026	May. 19,20	May. 18,23
EXA Signal Analyzer	KEYSIGHT	N9010A-526	MY54510322	Mar. 27,20	Mar. 26,21
Bilog Antenna 1	ETS-LINDGREN	3143B	00161964	Mar. 27,20	Mar. 26,21
Bilog Antenna 2	ETS-LINDGREN	3143B	00161965	Feb. 24,21	Feb. 25,22
Horn Antenna 1	ETS-LINDGREN	3117	00168728	Nov. 24, 20	Nov. 23, 21
Horn Antenna 2	ETS-LINDGREN	3117	00168692	Nov. 23, 20	Nov. 22, 21
Loop antenna	Daze	ZN30900A	0708	Mar. 27,20	Mar. 26,21
Horn Antenna (18GHz-40GHz)	N/A	QWH-SL-18-40 -K-SG/QMS-00 361	15433	Feb. 24,21	Feb. 23,22
Radio Communication Analyzer	ANRITSU	MT8820C	6201465426	Jun. 02,20	Jun. 01,21
Signal Pre-Amplifier	EMSI	EMC 9135	980249	Jun. 02,20	Jun. 01,21
Signal Pre-Amplifier	EMSI	EMC 012645B	980257	Jun. 02,20	Jun. 01,21
Signal Pre-Amplifier	EMSI	EMC 184045B	980259	Feb. 24,21	Feb. 23,22
3m Semi-anechoic Chamber	ETS-LINDGREN	9m*6m*6m	Euroshieldpn- CT0001143-1216	Feb. 24,21	Feb. 23,22
Test Software	E3	V 9.160323	N/A	Feb. 24,21	Feb. 23,22
Test Software	ADT	ADT_Radiated _V7.6.15.9.2	N/A	Feb. 24,21	Feb. 23,22
10dB Attenuator	JFW/USA	50HF-010-SM A	1505	Aug. 25,20	Aug. 24,21
Power Meter	Anritsu	ML2495A	1506002	NA	NA
Power Sensor	Anritsu	MA2411B	1339352	Jun. 23,20	Jun. 21,21
Humid & Temp Programmable Tester	Juyi	ITH-120-45-CP -AR	IAA1504-001	Nov. 21, 20	Nov. 20, 21
MXG Analog Microvave Signal Generator	KEYSIGHT	N5183A	MY50143024	May. 19,20	May. 18,23

- NOTE:**
1. The calibration interval of the above test instruments is 12 months or 24 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.
 2. The test was performed in 3m Semi-anechoic Chamber and RF Oven Room.
 3. The horn antenna is used only for the measurement of emission frequency above 1GHz if tested.
 4. The FCC Site Registration No. is 525120; The Designation No. is CN1171.

2 GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

EUT	IoT Wireless Device	
BRAND NAME	TMX08-EX	
MODEL NAME	12Vdc (adapter or host equipment) 3.7Vdc (Li-ion, battery)	
POWER SUPPLY	IoT Wireless Device	
MODULATION TECHNOLOGY	LTE CAT M1	QPSK, 16QAM
FREQUENCY RANGE	LTE Band 26 (Channel Bandwidth: 1.4MHz)	814.7MHz ~ 823.3MHz
	LTE Band 26 (Channel Bandwidth: 3MHz)	815.5MHz ~ 822.5MHz
	LTE Band 26 (Channel Bandwidth: 5MHz)	816.5MHz ~ 821.5MHz
	LTE Band 26 (Channel Bandwidth: 10MHz)	819MHz
MAX. ERP POWER	LTE Band 26 (Channel Bandwidth: 1.4MHz)	111mW
	LTE Band 26 (Channel Bandwidth: 3MHz)	113mW
	LTE Band 26 (Channel Bandwidth: 5MHz)	124mW
	LTE Band 26 (Channel Bandwidth: 10MHz)	101mW
ANTENNA TYPE	External Antenna with 1.4dBi gain	
HW VERSION	V2.0	
SW VERSION	TMX08-EXV02	
I/O PORTS	Refer to user's manual	
DATA CABLE	N/A	



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NOTE:

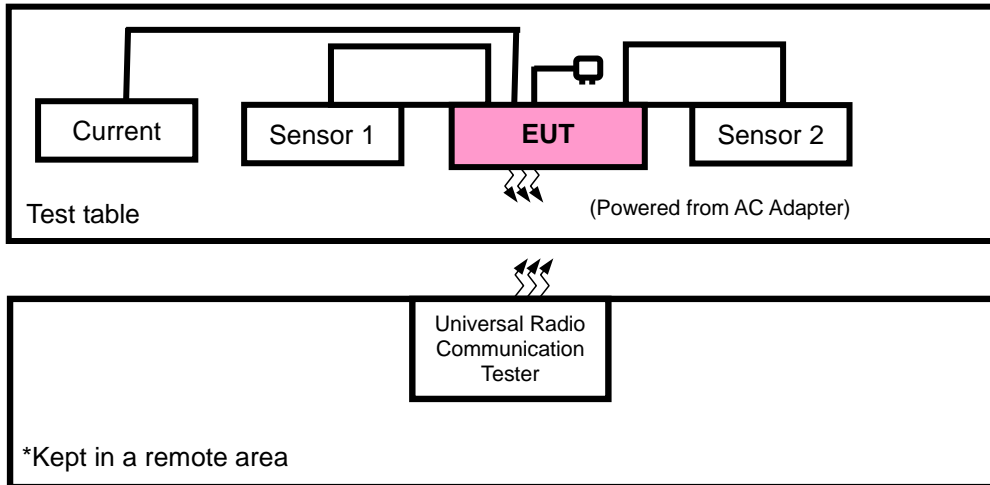
1. For a more detailed features description, please refer to the manufacturer's specifications or the user's manual.
2. For the test results, the EUT had been tested with all conditions. But only the worst case was shown in test report.

List of Accessories:

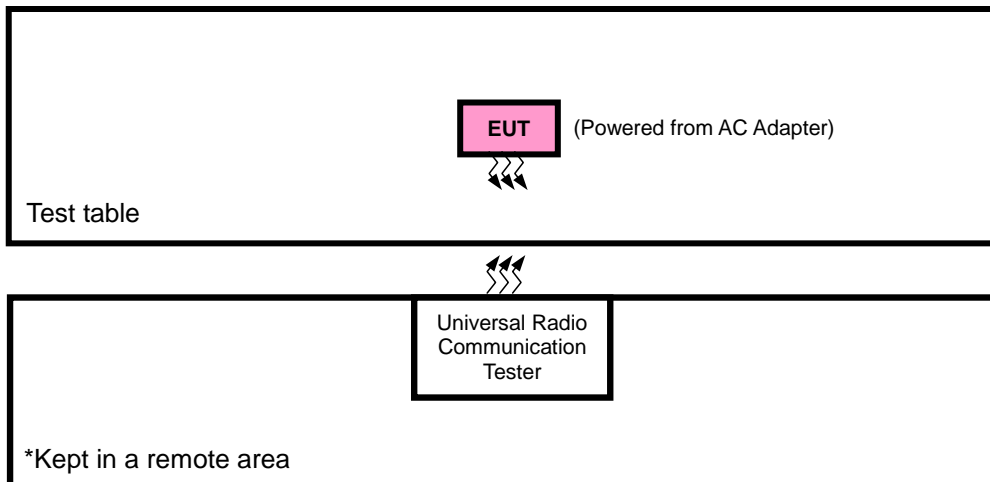
ACCESSORIES	MODEL	SPECIFICATION
Power supply adapter	TDX-1201000	I/P:100~240VAC O/P:12VDC/1A
Battery	Li-ion Polymer Battery	DC 3.7V, 3000mAh, 11.1Wh
Sensor 1	Ultrasonic&Temperature sensor	-
Sensor 2	Lidar sensor	-
Current draw sensor	Current draw sensor	-
Cellular Antenna	Cellular Antenna	-
GPS Antenna	GPS Antenna	-

2.2 CONFIGURATION OF SYSTEM UNDER TEST

FOR RADIATION EMISSION TEST



FOR CONDUCTED & E.R.P./E.I.R.P TEST





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2.3 DESCRIPTION OF TEST MODES

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports. The worst case in ERP/EIRP and radiated emission was found when positioned on X-plane for LTE. Following channel(s) was (were) selected for the final test as listed below:

EUT CONFIGURE MODE	DESCRIPTION
-	EUT + Adapter with LTE link

LTE BAND 26

TEST ITEM	AVAILABLE CHANNEL	TESTED CHANNEL	CHANNEL BANDWIDTH	MODULATION	MODE
ERP	26697 to 26783	26697, 26740, 26783	1.4MHz	QPSK, 16QAM	1 RB / 0 RB Offset
	26705 to 26775	26705, 26740, 26775	3MHz	QPSK, 16QAM	1 RB / 0 RB Offset
	26715 to 26765	26715, 26740, 26765	5MHz	QPSK, 16QAM	1 RB / 0 RB Offset
	26740	26740	10MHz	QPSK, 16QAM	1 RB / 0 RB Offset
RADIATED EMISSION	26697 to 26783	26697, 26740, 26783	1.4MHz	QPSK	1 RB / 0 RB Offset
	26705 to 26775	26740	3MHz	QPSK	1 RB / 0 RB Offset
	26715 to 26765	26740	5MHz	QPSK	1 RB / 0 RB Offset
	26740	26740	10MHz	QPSK	1 RB / 0 RB Offset

Note: This device was tested under all bandwidths, RB configurations and modulations. The worst case was found in QPSK modulation.

TEST CONDITION:

TEST ITEM	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RADIATED EMISSION	23deg. C, 70%RH	12Vdc from adapter	Star Le



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2.4 GENERAL DESCRIPTION OF APPLIED STANDARDS

The EUT is a RF product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC 47 CFR Part 2

FCC 47 CFR Part 90

ANSI/TIA/EIA-603-D

ANSI/TIA/EIA-603-E

ANSI C63.26-2015

NOTE: All test items have been performed and recorded as per the above standards.

3 TEST TYPES AND RESULTS

3.1 OUTPUT POWER MEASUREMENT

3.1.1 LIMITS OF OUTPUT POWER MEASUREMENT

Per FCC Part 90.635(a)(b)

Mobile stations are limited to 100 watts e.r.p. Portable stations are limited to 3 watts e.r.p.

3.1.2 TEST PROCEDURES

EIRP / ERP MEASUREMENT:

Per KDB 971168 D01 Power Meas License Digital Systems v03r01 or subclause 5.2.5.5 of ANSI C63.26-2015, the relevant equation for determining the ERP or EIRP from the conducted RF output power measured using the guidance provided above is:

$$\text{ERP or EIRP} = P_{\text{Meas}} + G_{\text{T}} - L_{\text{C}}$$

Where:

ERP or EIRP = effective radiated power or equivalent isotropically radiated power, respectively (expressed in the same units as P_{Meas} , typically dBW or dBm);

P_{Meas} = measured transmitter output power or PSD, in dBm or dBW;

G_{T} = gain of the transmitting antenna, in dBd (ERP) or dBi (EIRP);

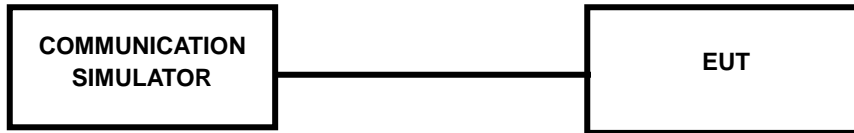
L_{C} = signal attenuation in the connecting cable between the transmitter and antenna, in dB.

CONDUCTED POWER MEASUREMENT:

- a. The EUT was set up for the maximum power with LTE link data modulation and link up with simulator.
- b. Set the EUT to transmit under low, middle and high channel and record the power level shown on simulator.

3.1.3 TEST SETUP

CONDUCTED POWER MEASUREMENT:



For the actual test configuration, please refer to the attached file (Test Setup Photo).

3.1.4 TEST RESULTS

AVERAGE CONDUCTED OUTPUT POWER (dBm)

Pre-scan conducted Power as below, the Conducted Power is the same Power level with module test report (RXA1706-0199RF04R1), verify that the change does not affect the RF parameters.

LTE BAND 26

LTE Band 26							
BW	Modulation	RB Size	RB Offset	Low CH 26697	Mid CH 26740	High CH 26783	MPR
				Frequency 814.7 MHz	Frequency 819 MHz	Frequency 823.3 MHz	
1.4	QPSK	1	0	23.46	23.50	23.50	0
		1	3	23.53	23.43	23.53	0
		1	5	23.56	23.48	23.62	0
		3	0	23.63	23.57	23.47	0
		3	2	23.71	23.57	23.67	0
		3	3	23.50	23.42	23.48	0
		6	0	23.43	23.27	23.41	0
	16QAM	1	0	23.58	23.52	23.54	0
		1	3	23.47	23.57	23.51	0
		1	5	23.58	23.62	23.58	0
		3	0	23.46	23.50	23.50	0
		3	2	23.53	23.43	23.53	0
		3	3	23.56	23.48	23.62	0
		6	0	23.63	23.57	23.47	0

3.2 FREQUENCY STABILITY MEASUREMENT

3.2.1 LIMITS OF FREQUENCY STABILITY MEASUREMENT

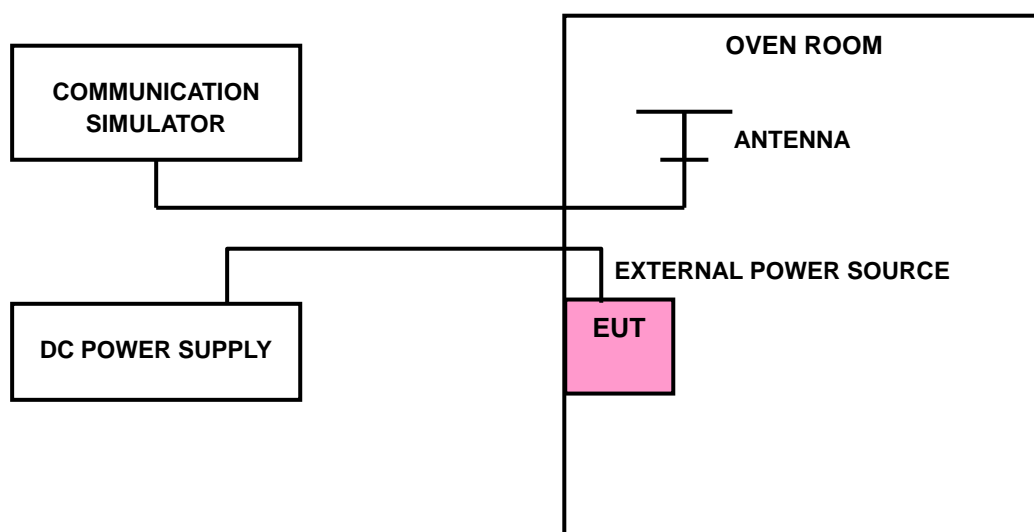
The frequency stability of mobile, portable and control transmitters operating in the wideband segment must be 1.25 parts per million or better when AFC is locked to a base station, and 5 parts per million or better when AFC is not locked

3.2.2 TEST PROCEDURE

- a. Device is placed at the oven room. The oven room could control the temperatures and humidity. Power warm up is at least 15 min and power applied should perform before recording frequency error.
- b. EUT is connected the external power supply to control the DC input power. The test voltage range is from minimum to maximum working voltage. Each step shall be record the frequency error rate.
- c. The temperature range step is 10 degrees in this test items. All temperature levels shall be hold the $\pm 0.5^{\circ}\text{C}$ during the measurement testing. The each temperature step shall be at least 0.5 hours, consider the EUT could be test under the stability condition.

NOTE: The frequency error was recorded frequency error from the communication simulator.

3.2.3 TEST SETUP





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3.2.4 TEST RESULTS

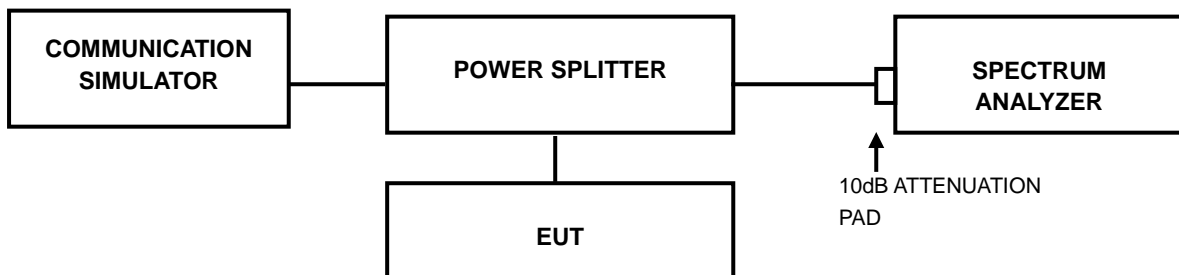
The test results was recorded in Report No.: RXA1706-0199RF04R1.

3.3 OCCUPIED BANDWIDTH MEASUREMENT

3.3.1 LIMITS OF OCCUPIED BANDWIDTH MEASUREMENT

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 power of a given emission.

3.3.2 TEST SETUP



3.3.3 TEST PROCEDURES

- The conducted occupied bandwidth used the power splitter via EUT RF power connector between simulation base station and spectrum analyzer.
- Use OBW measurement function of Spectrum analyzer to measure 99 % occupied bandwidth.

3.3.4 TEST RESULTS

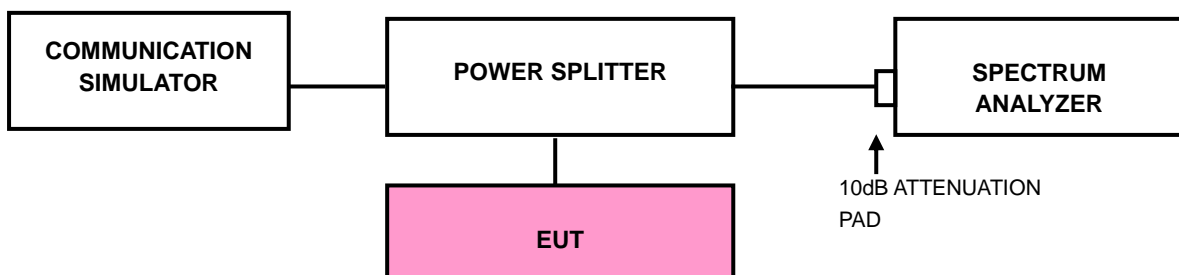
The test results was recorded in Report No.: RXA1706-0199RF04R1.

3.4 EMISSION MASK MEASUREMENT

3.4.1 LIMITS OF EMISSION MASK MEASUREMENT

According to FCC part 90.691 shall be tested the emission mask. 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.

3.4.2 TEST SETUP





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3.4.3 TEST PROCEDURES

- a. The EUT was set up for the maximum peak power with LTE link data modulation. The power was measured with R&S Spectrum Analyzer. All measurements were done at 2 channels (low and high operational frequency range.).
- b. The band edge measurement used the power splitter via EUT RF power connector between simulation base station and spectrum analyzer.
- c. The center frequency of spectrum is the band edge frequency and span is 1~5 MHz. RBW of the spectrum is 50kHz and VBW of the spectrum is 200kHz. (LTE bandwidth 5MHz)
- d. The center frequency of spectrum is the band edge frequency and span is 1~5 MHz. RBW of the spectrum is 100kHz and VBW of the spectrum is 300kHz. (LTE bandwidth 10MHz)
- e. Record the max trace plot into the test report.

3.4.4 TEST RESULTS

The test results was recorded in Report No.: RXA1706-0199RF04R1.

3.5 CONDUCTED SPURIOUS EMISSIONS

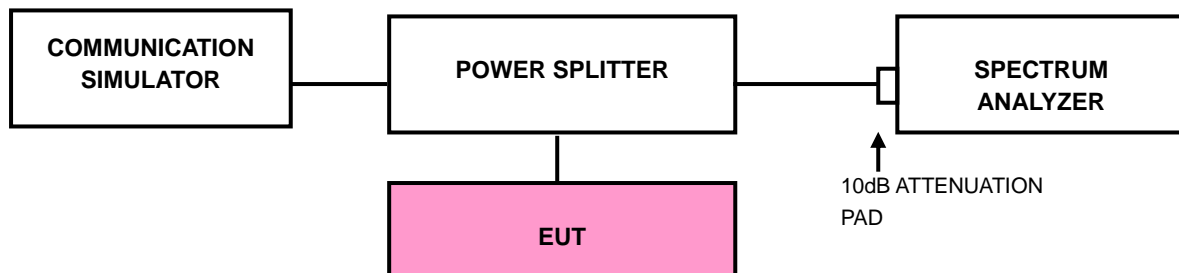
3.5.1 LIMITS OF CONDUCTED SPURIOUS EMISSIONS MEASUREMENT

The power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) by at least $43 + 10 \log_{10}(P)$ dB. The limit of emission equal to -13dBm

3.5.2 TEST PROCEDURE

- a. The EUT makes a phone call to the communication simulator. All measurements were done at middle operational frequency range.
- b. Measuring frequency range is from 30 MHz to 9GHz. 10dB attenuation pad is connected with spectrum. RBW=1MHz and VBW=3MHz are used for conducted emission measurement.

3.5.3 TEST SETUP



3.5.4 TEST RESULTS

The test results was recorded in Report No.: RXA1706-0199RF04R1.



3.6 RADIATED EMISSION MEASUREMENT

3.6.1 LIMITS OF RADIATED EMISSION MEASUREMENT

(1) The power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) by at least $43 + 10 \log_{10}(P)$ dB. The limit of emission equal to -13dBm

(2) For operations in the 763–775 MHz and 793–805 MHz bands, all emissions including harmonics 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. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

3.6.2 TEST PROCEDURES

- a. Substitution method is used for E.I.R.P measurement. In the semi-anechoic chamber, EUT placed on the 0.8m height of Turn Table, rotated the table around 360 degrees to search the maximum radiation power and receiver antenna shall be rotated vertical and horizontal polarization and moved height from 1m to 4m to find the maximum polar radiated power. The “Read Value” is the spectrum reading the maximum power value.
- b. The substitution horn antenna is substituted for EUT at the same position and signals generator export the CW signal to the substitution antenna via a TX cable. Rotated the Turn Table and moved receiving antenna to find the maximum radiation power. Adjust output power level of S.G to get a Value of spectrum reading equal to “Read Value” of step a. Record the power level of S.G
- c. $\text{EIRP} = \text{Output power level of S.G} - \text{TX cable loss} + \text{Antenna gain of substitution horn.}$
- d. E.R.P power can be calculated form E.I.R.P power by subtracting the gain of dipole, $\text{E.R.P power} = \text{E.I.P.R power} - 2.15\text{dBi.}$

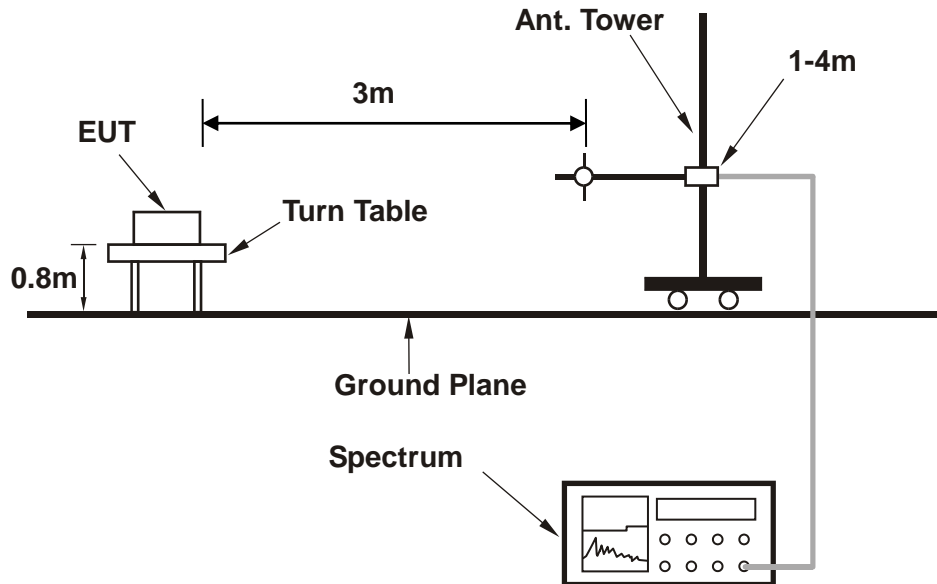
NOTE: The resolution bandwidth of spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz.

3.6.3 DEVIATION FROM TEST STANDARD

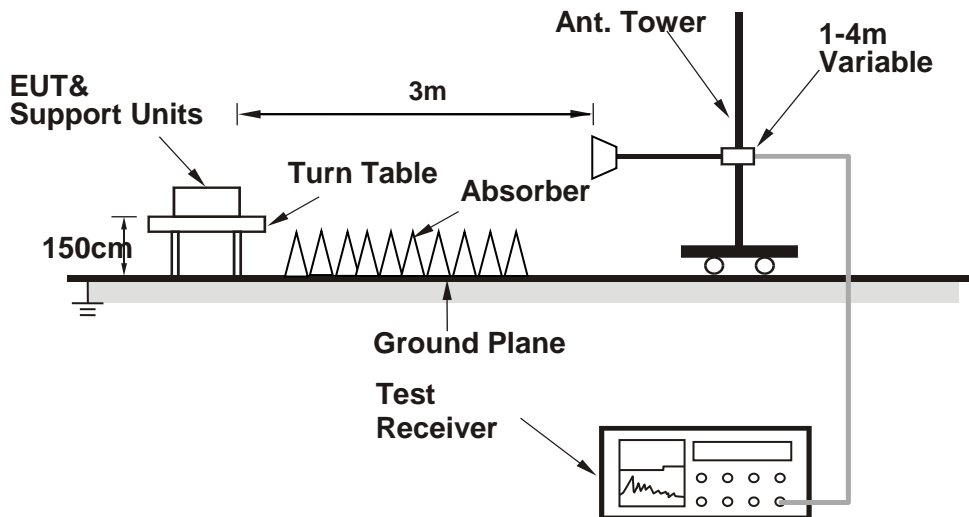
No deviation

3.6.4 TEST SETUP

< Frequency Range 30MHz~1GHz >



< Frequency Range above 1GHz >



For the actual test configuration, please refer to the attached file (Test Setup Photo).



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3.6.5 TEST RESULTS

BELOW 1GHz WORST-CASE DATA

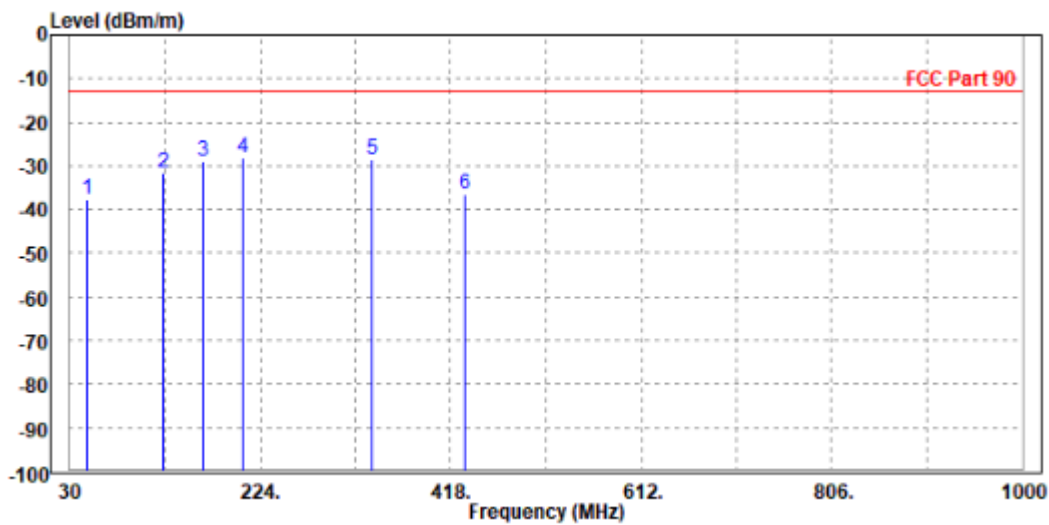
30 MHz – 1GHz data:

LTE BAND 26

CHANNEL BANDWIDTH: 1.4MHz / QPSK

MODE	TX channel 26697	FREQUENCY RANGE	Below 1000MHz
ENVIRONMENTAL CONDITIONS	23deg. C, 70%RH	INPUT POWER	DC 12V from adapter
TESTED BY	Jace Hu		
ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M			

	Freq	Level	Read Level	Limit Line	Over Limit	Factor	Remark	Pol/Phase
	MHz	dBm/m	dBm	dBm/m	dB	dB/m		
1	47.460	-37.59	-47.21	-13.00	-24.59	9.62	Peak	Horizontal
2	126.030	-31.63	-38.99	-13.00	-18.63	7.36	Peak	Horizontal
3	165.800	-28.91	-39.38	-13.00	-15.91	10.47	Peak	Horizontal
4 PP	205.570	-28.11	-38.50	-13.00	-15.11	10.39	Peak	Horizontal
5	337.490	-28.48	-43.28	-13.00	-15.48	14.80	Peak	Horizontal
6	431.580	-36.57	-54.13	-13.00	-23.57	17.56	Peak	Horizontal

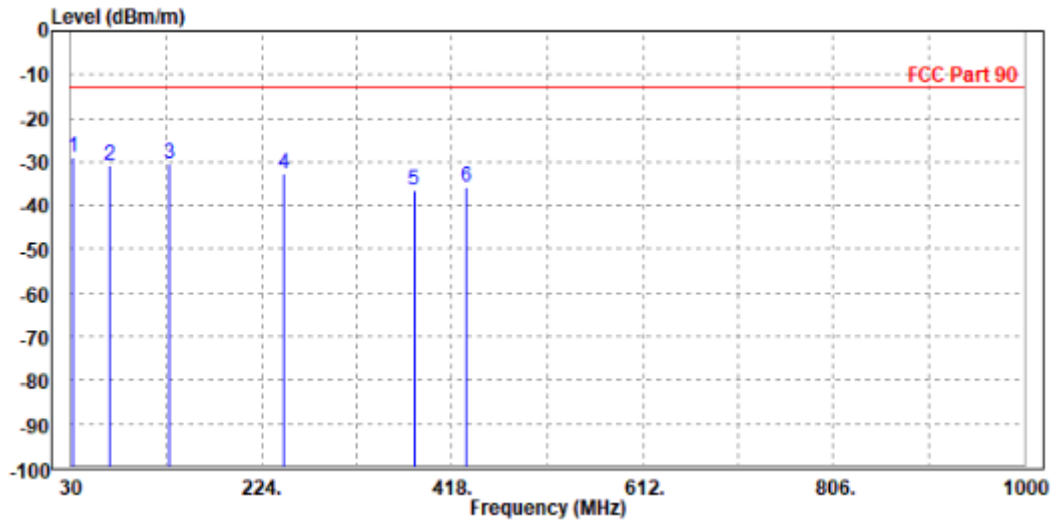




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MODE	TX channel 26697	FREQUENCY RANGE	Below 1000MHz
ENVIRONMENTAL CONDITIONS	23deg. C, 70%RH	INPUT POWER	DC 12V from adapter
TESTED BY	Jace Hu		
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M			

		Freq	Level	Read Level	Limit Line	Over Limit	Factor	Remark	Pol/Phase
		MHz	dBm/m	dBm	dBm/m	dB	dB/m		
1	PP	31.940	-28.76	-48.69	-13.00	-15.76	19.93	Peak	Vertical
2		69.770	-30.76	-37.87	-13.00	-17.76	7.11	Peak	Vertical
3		129.910	-30.58	-37.78	-13.00	-17.58	7.20	Peak	Vertical
4		246.310	-32.87	-46.11	-13.00	-19.87	13.24	Peak	Vertical
5		379.200	-36.39	-52.52	-13.00	-23.39	16.13	Peak	Vertical
6		431.580	-35.90	-53.46	-13.00	-22.90	17.56	Peak	Vertical





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ABOVE 1GHz

Note: For higher frequency, the emission is too low to be detected.

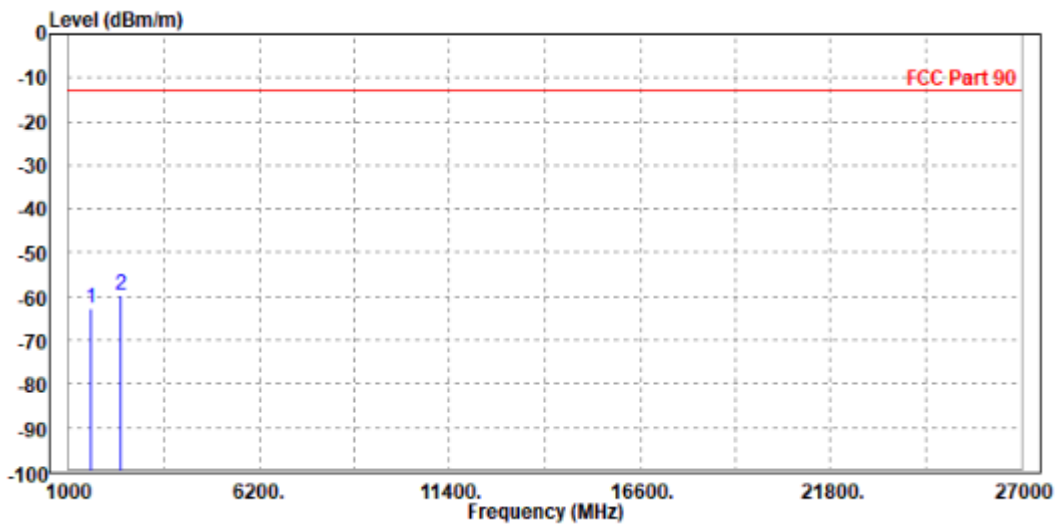
LTE BAND 26

CHANNEL BANDWIDTH: 1.4MHz / QPSK

CH 26697

MODE	TX channel 26697	FREQUENCY RANGE	Above 1000MHz
ENVIRONMENTAL CONDITIONS	23deg. C, 70%RH	INPUT POWER	DC 12V from adapter
TESTED BY	Jace Hu		
ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M			

	Freq	Level	Read Level	Limit Line	Over Limit	Factor	Remark	Pol/Phase
	MHz	dBm/m	dBm	dBm/m	dB	dB/m		
1	1629.400	-62.83	-57.71	-13.00	-49.83	-5.12	Peak	Horizontal
2 PP	2444.100	-59.77	-58.09	-13.00	-46.77	-1.68	Peak	Horizontal

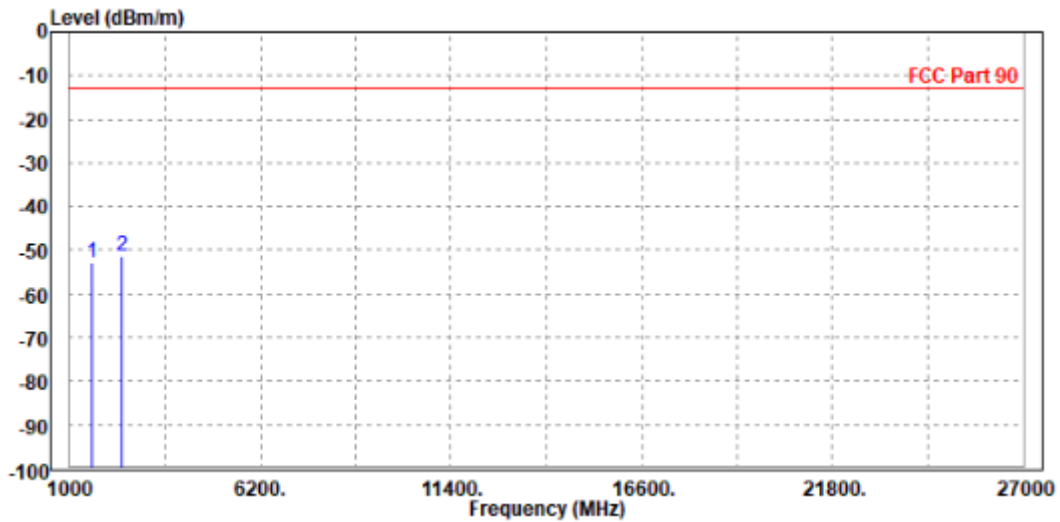




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MODE	TX channel 26697	FREQUENCY RANGE	Above 1000MHz
ENVIRONMENTAL CONDITIONS	23deg. C, 70%RH	INPUT POWER	DC 12V from adapter
TESTED BY	Jace Hu		
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M			

	Freq	Level	Read Level	Limit Line	Over Limit	Factor	Remark	Pol/Phase
	MHz	dBm/m	dBm	dBm/m	dB	dB/m		
1	1629.000	-52.87	-56.08	-13.00	-39.87	3.21	Peak	Vertical
2 PP	2444.000	-51.15	-58.16	-13.00	-38.15	7.01	Peak	Vertical





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4 INFORMATION ON THE TESTING LABORATORIES

We, BV 7LAYERS COMMUNICATIONS TECHNOLOGY (SHENZHEN) CO. LTD., were founded in 2015 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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Email: customerservice.dg@cn.bureauveritas.com

Web Site: www.adt.com.tw

The address and road map of all our labs can be found in our web site also.



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5 APPENDIX A – MODIFICATIONS RECORDERS FOR ENGINEERING CHANGES TO THE EUT BY THE LAB

No modifications were made to the EUT by the lab during the test.

---END---