RADIO TEST REPORT

Report No.:STS2103072W07

Issued for

CHEP

2901 Tasman Drive Suite 107 Santa Clara, CA 95054

Product Name:	Pallet Tracker
Brand Name:	CHEP
Model Name:	ULTRA SHORT
Series Model:	N/A
FCC ID:	2APRD-ULTRASHORT
Test Standard:	47 CFR Part 2, 22H, 24(E), 27

Shenzhen STS Test Services Co., Ltd.
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TEST RESULT CERTIFICATION

Applicant's Name.....:	CHEP
Address .....:	2901 Tasman Drive Suite 107 Santa Clara, CA 95054
Manufacturer's Name.....:	Minewing (Shenzhen) Electronics Integrated Co., Ltd
Address .....:	Floor #2, Building H2, Hongfa-Tech Park, No 32 TonG Tau Road, ShiYan Town, Bao'An District, Shenzhen, China, 518108

Product description

Product Name .....:	Pallet Tracker
Brand Name .....:	CHEP
Model Name .....:	ULTRA SHORT
Series Model .....:	N/A
Test Standards.....:	47 CFR Part 2, 22H, 24(E), 27
Test Procedure .....:	KDB 971168 D01 v03r01, ANSI C63.26 2015

This device described above has been tested by STS, the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.
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Date of Test.....:	
Date of receipt of test item.....:	10 Mar. 2021
Date (s) of performance of tests .:	10 Mar. 2021 ~ 29 Apr. 2021
Date of Issue .....:	29 Apr. 2021
Test Result .....:	Pass

Testing Engineer : Chris Chen
(Chris Chen)

Technical Manager : Sean She
(Sean she)

Authorized Signatory : Vita Li
(Vita Li)

Table of Contents Page

1. TEST FACTORY & MEASUREMENT UNCERTAINTY 5
2. GENERAL INFORMATION 6
3. CONDUCTED OUTPUT POWER 14
4. PEAK-TO-AVERAGE RATIO 17
5. RADIATED POWER AND EFFECTIVE ISOTROPIC RADIATED POWER 20
6. OCCUPIED BANDWIDTH 27
7. CONDUCTED BAND EDGE 29
8. CONDUCTED SPURIOUS EMISSION 31
9. RADIATED SPURIOUS EMISSION 32
10. FREQUENCY STABILITY 54
APPENDIX-PHOTOS OF TEST SETUP 60

Revision History

Rev.	Issue Date	Report NO.	Effect Page	Contents
00	29 Apr. 2021	STS2103072W07	ALL	Initial Issue

1. TEST FACTORY & MEASUREMENT UNCERTAINTY

1.1 TEST FACTORY

SHENZHEN STS TEST SERVICES CO., LTD
Add. : A 1/F, Building B, Zhuoke Science Park, No.190 Chongqing Road, HepingShequ, Fuyong Sub-District, Bao'an District, Shenzhen, Guang Dong, China
FCC test Firm Registration Number: 625569
IC test Firm Registration Number: 12108A
A2LA Certificate No.: 4338.01

1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement y ± U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95 %.

No.	Item	Uncertainty
1	RF output power, conducted	±0.68dB
2	Unwanted Emissions, conducted	±2.988dB
3	All emissions, radiated 9K-30MHz	±2.84dB
4	All emissions, radiated 30M-1GHz	±4.39dB
5	All emissions, radiated 1G-6GHz	±5.10dB
6	All emissions, radiated>6G	±5.48dB
7	Conducted Emission (9KHz-150KHz)	±2.79dB
8	Conducted Emission (150KHz-30MHz)	±2.80dB

2. GENERAL INFORMATION

2.1 TECHNICAL SPECIFICATIONS AND REGULATIONS

2.1.1 PRODUCT DESCRIPTION

A major technical description of EUT is described as following:

Product Name	Pallet Tracker
Trade Name	CHEP
Model Name	ULTRA SHORT
Series Model	N/A
Model Difference	N/A
Frequency Bands	U.S. Bands: NB-IoT FDD Band 2 NB-IoT FDD Band 4 NB-IoT FDD Band 5 NB-IoT FDD Band 12 NB-IoT FDD Band 13
SIM Card	Only support Single SIM Card.
Antenna	PIFA
Antenna gain	Band2:3.50dBi, Band4:3.50dBi, Band5:1.60dBi, Band12:0.40dBi, Band13:0.40dBi
Battery	Rated Voltage: Rated Voltage:3V
Extreme Vol. Limits	2.7V to 3.3V (Nominal 3V)
Extreme Temp. Tolerance	-30℃ to +50℃
Hardware version number	48JKB101.SGB
Software version number	v01.02.0015

2.1.2 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Product Specification Subjective To This Standard	
Tx Frequency	NB-IoT Band 2:1850.1~1909.9MHz NB-IoT Band 4:1710.1~1754.9MHz NB-IoT Band 5:824.1~848.9MHz NB-IoT Band 12:699.1~715.9MHz NB-IoT Band 13:777.1~786.9MHz
Rx Frequency	NB-IoT Band 2:1930.1 ~1989.9MHz NB-IoT Band 4:2110.1~2154.9MHz NB-IoT Band 5:869.1~893.9MHz NB-IoT Band 12:729.1~745.9MHz NB-IoT Band 13:746.1~755.9MHz
Deployment	Stand-alone
Ntones	Single, multi-tone
Sub-carrier spacing	3.75KHz, 15KHz
Maximum Output Power Limit	NB-IoT Band 2: 21.03 dBm NB-IoT Band 4: 20.25 dBm NB-IoT Band 5: 21.40 dBm NB-IoT Band 12: 21.45 dBm NB-IoT Band 13: 20.85 dBm
Type of Modulation	BPSK /QPSK

RF Function	Band	UE Category UL	Modulation	Power Class	Ant Gain(dBi)	Ant Type	SIM Card
NB-IoT	FDD:2/4/5/12/13	NB1	BPSK, QPSK	3	Band2:3.50dBi Band4:3.50dBi Band5:1.60dBi Band12:0.40dBi Band13:0.40dBi	PIFA	1 SIM 1 is used to tested.

2.1.3 TEST CONFIGURATION OF EQUIPMENT UNDER TEST

Antenna port conducted and radiated test items listed below are performed according to KDB 971168 D01 v03r01 and ANSI C63.26 2015 Power Meas. License Digital Systems with maximum output power. Radiated measurements are performed by rotating the EUT in three different orthogonal test planes tofind the maximum emission.

Remark:

1. The mark ‘v’means that this configuration is chosen for testing
2. The mark ‘-’means that this bandwidth is not supported.
3. The device is investigated from 30MHz to 10 times of fundamental signal for radiated

ITEMS	Band	Subcarrier Spacing (KHz)		Modulation		Test Channel		
		3.75	15	BPSK	QPSK	L	M	H
Max. Output Power	2	v	v	v	v	v	v	v
	4	v	v	v	v	v	v	v
	5	v	v	v	v	v	v	v
	12	v	v	v	v	v	v	v
	13	v	v	v	v	v	v	v
Peak&Avera Ratio	2	v	v	v	v	v	v	v
	4	v	v	v	v	v	v	v
	5	v	v	v	v	v	v	v
	12	v	v	v	v	v	v	v
	13	v	v	v	v	v	v	v
26dB&99% Bandwidth	2	v	v	v	v	v	v	v
	4	v	v	v	v	v	v	v
	5	v	v	v	v	v	v	v
	12	v	v	v	v	v	v	v
	13	v	v	v	v	v	v	v
Conducted Band Edge	2	v	v	v	v	v		v
	4	v	v	v	v	v		v
	5	v	v	v	v	v		v
	12	v	v	v	v	v		v
	13	v	v	v	v	v		v
Conducted Spurious Emission	2	v	v	v	v	v	v	v
	4	v	v	v	v	v	v	v
	5	v	v	v	v	v	v	v
	12	v	v	v	v	v	v	v
	13	v	v	v	v	v	v	v
Frequency Stability	2	v	v		v		v	
	4	v	v		v		v	
	5	v	v		v		v	
	12	v	v		v		v	
	13	v	v		v		v	

E.R.P.& E.I.R.P.	2	v	v	v	v	v	v	v
	4	v	v	v	v	v	v	v
	5	v	v	v	v	v	v	v
	12	v	v	v	v	v	v	v
	13	v	v	v	v	v	v	v
Radiated Spurious Emission	2	v	v	v	v	v	v	v
	4	v	v	v	v	v	v	v
	5	v	v	v	v	v	v	v
	12	v	v	v	v	v	v	v
	13	v	v	v	v	v	v	v

2.1.4 RELATED SUBMITTAL(S) / GRANT (S)

This submittal(s) (test report) is intended for filing to comply with the 47 CFR Part 2, 22H, 24(E), 27.

2.1.5 SPECIAL ACCESSORIES

The battery and the charger, earphone supplied by the applicant were used as accessories and being tested with eut intended for fcc grant together.

2.1.6 EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commission’s requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.1.7 EUT EXERCISE

The Transmitter was operated in the maximum output power mode through Communication Tester. The TX frequency was fixed which was for the purpose of the measurements.

2.1.8 CONFIGURATION OF EUT SYSTEM

The EUT configuration for testing is installed on RF field strength measurement to meet the Commission's requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

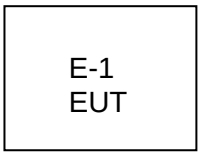


Table 2-1 Equipment Used in EUT System

Item	Equipment	Model No.	Length	Note
N/A	N/A	N/A	N/A	N/A

Note:

(1) For detachable type I/O cable should be specified the length in cm in『Length』column.

2.1.9 MEASUREMENT INSTRUMENTS

The radiated emission testing was performed according to the procedures of ANSI C63.26 2015 and FCC CFR 47 rules of 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057.

Radiation Test equipment

Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
Test Receiver	R&S	ESCI	101427	2020.10.12	2021.10.11
Signal Analyzer	R&S	FSV 40-N	101823	2020.10.10	2021.10.09
Signal Generator	Agilent	83752A	3610A02740	2020.10.10	2021.10.09
Wireless Communications Test Set	R&S	CMW 500	133884	2021.03.04	2022.03.03
Bilog Antenna	TESEQ	CBL6111D	34678	2020.10.12	2022.10.11
Horn Antenna	SCHWARZBECK	BBHA 9120D	02014	2019.10.15	2021.10.14
Bilog Antenna	TESEQ	CBL6111D	45873	2020.10.12	2022.10.11
Horn Antenna	SCHWARZBECK	BBHA 9120D	9120D-1343	2020.10.12	2022.10.11
SHF-EHF Horn Antenna (18G-40GHz)	A-INFO	LB-180400-KF	J211020657	2020.10.12	2022.10.11
Pre-Amplifier (0.1M-3GHz)	EM	EM330	060665	2020.10.12	2021.10.11
Pre-Amplifier (1G-18GHz)	SKET	LNPA-01018G-45	SK2018080901	2020.10.12	2021.10.11
Pre-Amplifier (18G-40GHz)	SKET	LNPA-1840-50	SK2018101801	2020.10.10	2021.10.09
Turn table	EM	SC100_1	60531	N/A	N/A
Antenna mast	EM	SC100	N/A	N/A	N/A
Temperature & Humidity	HH660	Mieo	N/A	2020.10.13	2021.10.12
Test SW	BALUN	BL410-E/18.905			

RF Connected Test

Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
Universal Radio communication tester	R&S	CMU200	119907	2020.10.12	2021.10.11
Wireless Communications Test Set	R&S	CMW 500	133884	2021.03.04	2022.03.03
Signal Analyzer	Agilent	N9020A	MY52440124	2021.03.04	2022.03.03
Temperature& Humidity test chamber	Safety test	AG80L	171200018	2021.03.04	2022.03.03
Programmable power supply	Agilent	E3642A	MY40002025	2020.10.12	2021.10.11
Temperature & Humidity	SW-108	SuWei	N/A	2021.03.04	2022.03.03
Temperature & Humidity	HH660	Mieo	N/A	2019.10.17	2020.10.16
Test SW	FARAD	LZ-RF /LzRf-3A3			

2.1.10 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 factorbetween EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.
The spectrum analyzer offset is derived from RF cable loss and attenuator factor.
Offset = RF Cable Loss + Attenuator Factor.

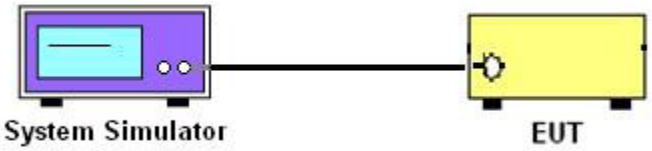
3. CONDUCTED OUTPUT POWER

3.1 DESCRIPTION OF THE CONDUCTED OUTPUT POWER MEASUREMENT

3.1.1 MEASUREMENT METHOD

A system simulator was used to establish communication with the eut. Its parameters were set to force the eut transmitting at maximum output power. The measured power in the radio frequency on the transmitter output terminals shall be reported.
Configuration follows KDB 971168 D01 v03r01.

3.1.2 TEST SETUP



3.1.3 TEST PROCEDURES

1. The transmitter output port was connected to system simulator.

2. Set EUT at maximum power through the system simulator.

3. Select lowest/middle/highest channels for each band and different modulation.

4. Measure and record the power level from the system simulator.

3.1.4 TEST RESULTS

NB-IoT Band 2 Maximum Average Power [dBm]						
Mode	Modulation	Subcarrier Space (KHz)	RB Configure	Lowest	Middle	Highest
Band 2 Standalone	BPSK	3.75	1@0	20.85	21.03	20.92
			1@47	20.57	20.78	20.66
		15	1@0	20.28	20.49	20.46
			1@11	19.99	20.21	20.24
	QPSK	3.75	1@0	19.70	19.98	19.94
			1@47	19.44	19.74	19.69
		15	1@0	19.23	19.51	19.44
			1@11	20.63	20.75	20.67
			12@0	20.41	20.52	20.44

NB-IoT Band 4 Maximum Average Power [dBm]						
Mode	Modulation	Subcarrier Space (KHz)	RB Configure	Lowest	Middle	Highest
Band 4 Standalone	BPSK	3.75	1@0	20.16	20.25	20.08
			1@47	19.92	19.97	19.87
		15	1@0	19.70	19.71	19.64
			1@11	19.44	19.51	19.36
	QPSK	3.75	1@0	19.16	19.23	19.13
			1@47	18.93	18.99	18.89
		15	1@0	18.71	18.77	18.60
			1@11	19.89	19.98	19.88
			12@0	19.61	19.71	19.59

NB-IoT Band 5 Maximum Average Power [dBm]						
Mode	Modulation	Subcarrier Space (KHz)	RB Configure	Lowest	Middle	Highest
Band 5 Standalone	BPSK	3.75	1@0	21.33	21.40	21.28
			1@47	21.12	21.11	21.06
		15	1@0	20.87	20.84	20.83
			1@11	20.66	20.63	20.61
	QPSK	3.75	1@0	20.44	20.34	20.33
			1@47	20.21	20.04	20.05
		15	1@0	20.00	19.81	19.78
			1@11	21.06	21.17	21.07
			12@0	20.82	20.88	20.81

NB-IoT Band 12 Maximum Average Power [dBm]						
Mode	Modulation	Subcarrier Space (KHz)	RB Configure	Lowest	Middle	Highest
Band 12 Standalone	BPSK	3.75	1@0	21.45	21.41	21.39
			1@47	21.16	21.18	21.16
		15	1@0	20.93	20.93	20.96
			1@11	20.69	20.71	20.74
	QPSK	3.75	1@0	20.46	20.47	20.53
			1@47	20.16	20.24	20.30
		15	1@0	19.95	19.96	20.02
			1@11	21.23	21.16	21.19
			12@0	20.98	20.91	20.93

NB-IoT Band 13 Maximum Average Power [dBm]						
Mode	Modulation	Subcarrier Space (KHz)	RB Configure	Lowest	Middle	Highest
Band 13 Standalone	BPSK	3.75	1@0	20.71	20.66	20.85
			1@47	20.46	20.36	20.62
		15	1@0	20.21	20.14	20.34
			1@11	19.91	19.88	20.13
	QPSK	3.75	1@0	19.62	19.67	19.88
			1@47	19.33	19.46	19.64
		15	1@0	19.06	19.22	19.36
			1@11	20.48	20.37	20.62
			12@0	20.25	20.11	20.36

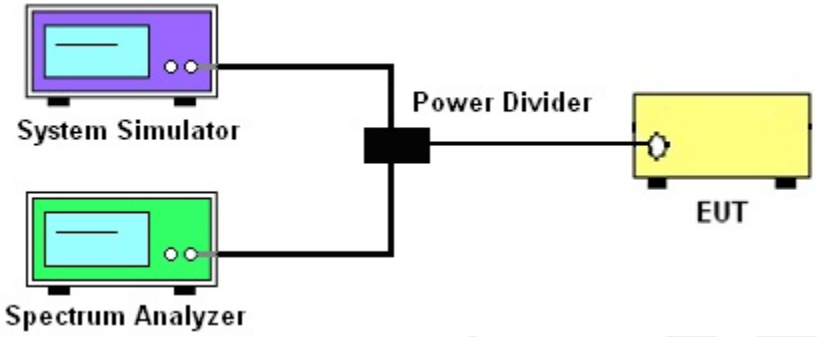
4. PEAK-TO-AVERAGE RATIO

4.1 DESCRIPTION OF THE CONDUCTED OUTPUT POWER MEASUREMENT

4.1.1 MEASUREMENT METHOD

Use one of the procedures presented in 4.1.3 to measure the total peak power and record as PPk. Use one of the applicable procedures presented 4.1.3 to measure the total average power and record as PAvg. Both the peak and average power levels must be expressed in the same logarithmic units (e.g., dBm). Determine the PAPR from:
PAPR (dB) = PPk (dBm) - PAvg (dBm).

4.1.2 TEST SETUP



4.1.3 TEST PROCEDURES

1. The testing follows FCC KDB 971168 D01 v03r01 Section 5.7 and ANSI C63.26 2015 Section 5.2.6.
2. The EUT was connected to spectrum and system simulator via a power divider
3. Select lowest, middle, and highest channels for each band and different modulation.
4. Set the test probe and measure the peak and average power of the spectrum analyzer
5. Record the deviation as Peak to Average Ratio.

	NB-IoT	
NB-IoT BW	3.75K	15K
Span	1MHz	1MHz
RBW	30kHz	30kHz
VBW	100kHz	100kHz
Detector	PK/AVG	PK/AVG
Trace	Max	Max
Sweep Count	Auto	Auto

4.1.4 TEST RESULTS

NB-IoT Band 2 PAR [dBm]						
Mode	Modulation	Subcarrier Space (KHz)	RB Configure	Lowest	Middle	Highest
				P-A	P-A	P-A
Band 2 Standalone	BPSK	3.75	1@0	1.93	1.88	1.38
		15	1@0	1.45	1.46	1.45
	QPSK	3.75	1@0	1.59	1.74	1.76
		15	1@0	1.71	1.56	1.46
		15	3@3	5.83	5.65	5.62
Limit				≤13dB		

NB-IoT Band 4 PAR [dBm]						
Mode	Modulation	Subcarrier Space (KHz)	RB Configure	Lowest	Middle	Highest
				P-A	P-A	P-A
Band 4 Standalone	BPSK	3.75	1@0	1.23	1.35	1.4
		15	1@0	1.34	1.42	1.41
	QPSK	3.75	1@0	1.57	1.28	1.27
		15	1@0	1.39	1.5	1.47
		15	3@3	5.28	5.09	5.44
Limit				≤13dB		

NB-IoT Band 5 PAR [dBm]						
Mode	Modulation	Subcarrier Space (KHz)	RB Configure	Lowest	Middle	Highest
				P-A	P-A	P-A
Band 5 Standalone	BPSK	3.75	1@0	1.58	1.21	1.27
		15	1@0	1.41	1.4	1.35
	QPSK	3.75	1@0	1.31	1.47	1.5
		15	1@0	1.39	1.37	1.33
		15	3@3	5.51	5.5	5.23
Limit				≤13dB		

NB-IoT Band 12 PAR [dBm]						
Mode	Modulation	Subcarrier Space (KHz)	RB Configure	Lowest	Middle	Highest
				P-A	P-A	P-A
Band 12 Standalone	BPSK	3.75	1@0	1.54	1.4	1.2
		15	1@0	1.41	1.43	1.46
	QPSK	3.75	1@0	1.42	1.57	1.53
		15	1@0	1.42	1.4	1.54
		15	3@3	5.39	6.01	5.67
Limit				≤13dB		

NB-IoT Band 13 PAR [dBm]						
Mode	Modulation	Subcarrier Space (KHz)	RB Configure	Lowest	Middle	Highest
				P-A	P-A	P-A
Band 13 Standalone	BPSK	3.75	1@0	1.51	0.9	1.35
		15	1@0	1.47	1.48	1.47
	QPSK	3.75	1@0	1.64	1.48	1.58
		15	1@0	1.46	1.49	1.46
		15	3@3	5.69	5.34	5.72
Limit				≤13dB		

Note: Test chart See Appendix D

5. RADIATED POWER AND EFFECTIVE ISOTROPIC RADIATED POWER

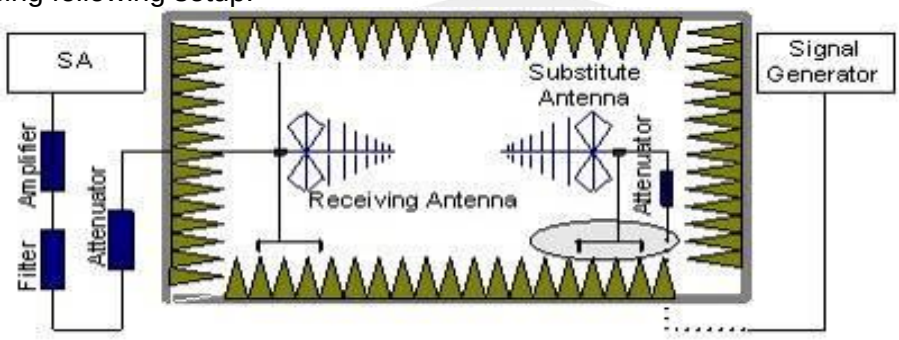
5.1 DESCRIPTION OF THE ERP/EIRP MEASUREMENT

5.1.1 MEASUREMENT METHOD

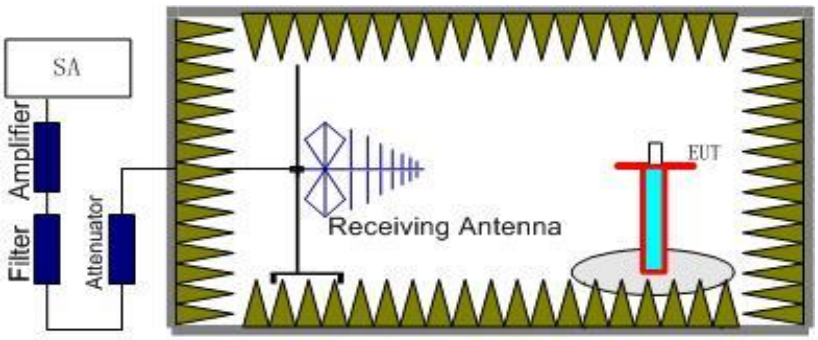
Effective radiated power output measurements by substitution method according to ANSI C63.26 2015, and the spectrum analyzer configuration follows KDB 971168 D01 Power Meas.
License Digital Systems. Mobile and portable (hand-held) stations operating are limited to average ERP, Equivalent isotropic radiated power output measurements by substitution method according to ANSI C63.26 2015, and the spectrum analyzer configuration follows KDB 971168 D01 Power Meas, Mobile and portable (hand-held) stations operating are limited to average EIRP.

5.1.2 TEST SETUP

The procedure of radiated spurious emissions is as follows:
a) Pre-calibration With pre-calibration method, the Radiated Spurious Emissions(RSE) is calculated as, RSE=Rx (dBuV) +CL (dB) +SA (dB) +Gain (dBi) -107 (dBuV to dBm) The SA is calibrated using following setup.



b) EUT was placed on a 1.5m non-conductive stand at a 3 m test distance from the receive antenna. A receiving antenna was placed on the antenna mast 3 m from the test item for emission measurements. The height of receiving antenna is 0.8m. The test setup refers to figure below. Detected emissions were maximized at each frequency by rotating the test item and adjusting the receiving antenna polarization. The radiated emission measurements of all non-harmonic and harmonics of the transmit frequency through the 10th harmonic measured with peak detector and 1MHz bandwidth.



Radiated emissions measurements were made only at the upper, middle, and lower carrier frequencies It was decided that measurements at these three carrier frequencies would be sufficient to demonstrate compliance with emissions limits because it was seen that all the significant spurs occur well outside the band and no radiation was seen from a carrier in one block of any band into any of the other blocks.
The substitution method is used. Substitution values at each frequency are measured before and saved to the test software. A "reference path loss" is established and the ARpl is the attenuation of “reference path loss”, and including the gain of receive antenna, the gain of the preamplifier, the cable loss and the air loss. The measurement results are obtained as described below:
Power=PMea+ARpl

5.1.3 TEST PROCEDURES

1. The testing follows FCC KDB 971168 D01v03r01 Section 5.6 and ANSI C63.26 2015 Section 5.2.

2. The EUT was placed on a non-conductive rotating platform 1.5 meters high in a semi-anechoic chamber. The radiated emission at the fundamental frequency was measured at 3 m with a test antenna and a spectrum analyzer with Peak detector.

3. During the measurement, the system simulator parameters were set to force the EUTtransmitting at maximum output power. The maximum emission was recorded from analyzer power level (LVL) from the 360 degrees rotation of the turntable and the test antenna raised and lowered over a range from 1 to 4 m in both horizontally and vertically polarized orientations.

4. Effective Isotropic Radiated Power (EIRP) was measured by substitution method according to ANSI C63.26 2015. The EUT was replaced by dipole antenna (substitution antenna) at same location and then a known power from S.G. was applied into the dipole antenna through a Tx cable, and then recorded the maximum Analyzer reading through raised and lowered the test antenna. EIRP=S.G Level+ Gain-Cable loss; ERP=S.G Level+ Gain-Cable loss-2.15.

5. RB Set greater than bandwidth, VB Set spectrum analyzer Maximum support.

5.1.4 TEST RESULTS

Note: Test is divided into three directions, X/Y/Z. X pattern for the worst.

Radiated Power (EIRP) for NB-IoT Band 2/Standalone									
Modulation	Subcarrier Space (KHz)	RB Configure	Channel	Result					Conclusion
				S G.Level (dBm)	Cable loss	Gain (dBi)	PMeas E.I.R.P(dBm)	Polarization Of Max. EIRP	
BPSK	3.75	1@0	Lowest	10.19	2.37	10.40	18.22	Horizontal	Pass
			Middle	10.45	2.39	10.42	18.48	Horizontal	Pass
			Highest	10.05	2.40	10.44	18.09	Horizontal	Pass
		1@0	Lowest	11.54	2.37	10.40	19.57	Vertical	Pass
			Middle	11.8	2.39	10.42	19.83	Vertical	Pass
			Highest	11.51	2.40	10.44	19.55	Vertical	Pass
	15	1@0	Lowest	9.44	2.37	10.40	17.47	Horizontal	Pass
			Middle	9.78	2.39	10.42	17.81	Horizontal	Pass
			Highest	9.64	2.40	10.44	17.68	Horizontal	Pass
		1@0	Lowest	10.86	2.37	10.40	18.89	Vertical	Pass
			Middle	11.22	2.39	10.42	19.25	Vertical	Pass
			Highest	11.05	2.40	10.44	19.09	Vertical	Pass
QPSK	3.75	1@0	Lowest	8.93	2.37	10.40	16.96	Horizontal	Pass
			Middle	9.28	2.39	10.42	17.31	Horizontal	Pass
			Highest	9.28	2.40	10.44	17.32	Horizontal	Pass
		1@0	Lowest	10.4	2.37	10.40	18.43	Vertical	Pass
			Middle	10.65	2.39	10.42	18.68	Vertical	Pass
			Highest	10.64	2.40	10.44	18.68	Vertical	Pass
	15	1@0	Lowest	8.39	2.37	10.40	16.42	Horizontal	Pass
			Middle	8.88	2.39	10.42	16.91	Horizontal	Pass
			Highest	8.75	2.40	10.44	16.79	Horizontal	Pass
		1@0	Lowest	9.82	2.37	10.40	17.85	Vertical	Pass
			Middle	10.27	2.39	10.42	18.30	Vertical	Pass
			Highest	10.06	2.40	10.44	18.10	Vertical	Pass
Limit	EIRP<2W=33dBm								

Radiated Power (EIRP) for NB-IoT Band 4/Standalone									
Modulation	Subcarrier Space (KHz)	RB Configure	Channel	Result					Conclusion
				S G.Level (dBm)	Cable loss	Gain (dBi)	PMeas E.R.P(dBm)	Polarization Of Max. ERP	
BPSK	3.75	1@0	Lowest	9.59	2.35	10.13	17.37	Horizontal	Pass
			Middle	9.63	2.36	10.16	17.43	Horizontal	Pass
			Highest	9.67	2.37	10.22	17.52	Horizontal	Pass
		1@0	Lowest	11.09	2.35	10.13	18.87	Vertical	Pass
			Middle	11.12	2.36	10.16	18.92	Vertical	Pass
			Highest	11.01	2.37	10.22	18.86	Vertical	Pass
	15	1@0	Lowest	9.24	2.35	10.13	17.02	Horizontal	Pass
			Middle	9.03	2.36	10.16	16.83	Horizontal	Pass
			Highest	9.03	2.37	10.22	16.88	Horizontal	Pass
		1@0	Lowest	10.66	2.35	10.13	18.44	Vertical	Pass
			Middle	10.53	2.36	10.16	18.33	Vertical	Pass
			Highest	10.39	2.37	10.22	18.24	Vertical	Pass
QPSK	3.75	1@0	Lowest	8.74	2.35	10.13	16.52	Horizontal	Pass
			Middle	8.78	2.36	10.16	16.58	Horizontal	Pass
			Highest	8.47	2.37	10.22	16.32	Horizontal	Pass
		1@0	Lowest	10.14	2.35	10.13	17.92	Vertical	Pass
			Middle	10.18	2.36	10.16	17.98	Vertical	Pass
			Highest	9.93	2.37	10.22	17.78	Vertical	Pass
	15	1@0	Lowest	8.21	2.35	10.13	15.99	Horizontal	Pass
			Middle	8.21	2.36	10.16	16.01	Horizontal	Pass
			Highest	8.24	2.37	10.22	16.09	Horizontal	Pass
		1@0	Lowest	9.6	2.35	10.13	17.38	Vertical	Pass
			Middle	9.61	2.36	10.16	17.41	Vertical	Pass
			Highest	9.54	2.37	10.22	17.39	Vertical	Pass
Limit	EIRP<1W=30dBm								

Radiated Power (ERP) for NB-IoT Band 5/Standalone										
Modulation	Subcarrier Space (KHz)	RB Configure	Channel	Result						Conclusion
				S G.Level (dBm)	Cable loss	Gain (dBi)	correction factor(dB)	PMeas E.R.P(dBm)	Polarization Of Max. ERP	
BPSK	3.75	1@0	Lowest	15.35	1.27	6.70	2.15	18.63	Horizontal	Pass
			Middle	15.34	1.28	6.70	2.15	18.61	Horizontal	Pass
			Highest	15.46	1.29	6.70	2.15	18.72	Horizontal	Pass
		1@0	Lowest	16.81	1.27	6.70	2.15	20.09	Vertical	Pass
			Middle	16.75	1.28	6.70	2.15	20.02	Vertical	Pass
			Highest	16.81	1.29	6.70	2.15	20.07	Vertical	Pass
	15	1@0	Lowest	14.93	1.27	6.70	2.15	18.21	Horizontal	Pass
			Middle	14.91	1.28	6.70	2.15	18.18	Horizontal	Pass
			Highest	14.74	1.29	6.70	2.15	18.00	Horizontal	Pass
		1@0	Lowest	16.26	1.27	6.70	2.15	19.54	Vertical	Pass
			Middle	16.32	1.28	6.70	2.15	19.59	Vertical	Pass
			Highest	16.2	1.29	6.70	2.15	19.46	Vertical	Pass
QPSK	3.75	1@0	Lowest	14.33	1.27	6.70	2.15	17.61	Horizontal	Pass
			Middle	14.42	1.28	6.70	2.15	17.69	Horizontal	Pass
			Highest	14.38	1.29	6.70	2.15	17.64	Horizontal	Pass
		1@0	Lowest	15.76	1.27	6.70	2.15	19.04	Vertical	Pass
			Middle	15.78	1.28	6.70	2.15	19.05	Vertical	Pass
			Highest	15.81	1.29	6.70	2.15	19.07	Vertical	Pass
	15	1@0	Lowest	14.01	1.27	6.70	2.15	17.29	Horizontal	Pass
			Middle	13.89	1.28	6.70	2.15	17.16	Horizontal	Pass
			Highest	13.89	1.29	6.70	2.15	17.15	Horizontal	Pass
		1@0	Lowest	15.43	1.27	6.70	2.15	18.71	Vertical	Pass
			Middle	15.31	1.28	6.70	2.15	18.58	Vertical	Pass
			Highest	15.26	1.29	6.70	2.15	18.52	Vertical	Pass
Limit	ERP<7W=38.45dBm									

Radiated Power (ERP) for NB-IoT Band 12/Standalone										
Modulation	Subcarrier Space (KHz)	RB Configure	Channel	Result						Conclusion
				S G.Level (dBm)	Cable loss	Gain (dBi)	correction factor(dB)	PMeas E.R.P(dBm)	Polarization Of Max. ERP	
BPSK	3.75	1@0	Lowest	15.71	1.21	6.40	2.15	18.75	Horizontal	Pass
			Middle	15.69	1.22	6.40	2.15	18.72	Horizontal	Pass
			Highest	15.74	1.23	6.40	2.15	18.76	Horizontal	Pass
		1@0	Lowest	17.21	1.21	6.40	2.15	20.25	Vertical	Pass
			Middle	17.03	1.22	6.40	2.15	20.06	Vertical	Pass
			Highest	17.14	1.23	6.40	2.15	20.16	Vertical	Pass
	15	1@0	Lowest	15.02	1.21	6.40	2.15	18.06	Horizontal	Pass
			Middle	15.04	1.22	6.40	2.15	18.07	Horizontal	Pass
			Highest	15.24	1.23	6.40	2.15	18.26	Horizontal	Pass
		1@0	Lowest	16.51	1.21	6.40	2.15	19.55	Vertical	Pass
			Middle	16.51	1.22	6.40	2.15	19.54	Vertical	Pass
			Highest	16.71	1.23	6.40	2.15	19.73	Vertical	Pass
QPSK	3.75	1@0	Lowest	14.67	1.21	6.40	2.15	17.71	Horizontal	Pass
			Middle	14.79	1.22	6.40	2.15	17.82	Horizontal	Pass
			Highest	14.89	1.23	6.40	2.15	17.91	Horizontal	Pass
		1@0	Lowest	16.11	1.21	6.40	2.15	19.15	Vertical	Pass
			Middle	16.14	1.22	6.40	2.15	19.17	Vertical	Pass
			Highest	16.21	1.23	6.40	2.15	19.23	Vertical	Pass
	15	1@0	Lowest	14.09	1.21	6.40	2.15	17.13	Horizontal	Pass
			Middle	14.19	1.22	6.40	2.15	17.22	Horizontal	Pass
			Highest	14.31	1.23	6.40	2.15	17.33	Horizontal	Pass
		1@0	Lowest	15.59	1.21	6.40	2.15	18.63	Vertical	Pass
			Middle	15.65	1.22	6.40	2.15	18.68	Vertical	Pass
			Highest	15.63	1.23	6.40	2.15	18.65	Vertical	Pass
Limit	ERP<3W=34.77dBm									

Radiated Power (ERP) for NB-IoT Band 13/Standalone										
Modulation	Subcarrier Space (KHz)	RB Configure	Channel	Result						Conclusion
				S G.Level (dBm)	Cable loss	Gain (dBi)	correction factor(dB)	PMeas E.R.P(dBm)	Polarization Of Max. ERP	
BPSK	3.75	1@0	Lowest	14.91	1.25	6.60	2.15	18.11	Horizontal	Pass
			Middle	14.9	1.25	6.60	2.15	18.10	Horizontal	Pass
			Highest	14.85	1.25	6.60	2.15	18.05	Horizontal	Pass
		1@0	Lowest	16.28	1.25	6.60	2.15	19.48	Vertical	Pass
			Middle	16.24	1.25	6.60	2.15	19.44	Vertical	Pass
			Highest	16.29	1.25	6.60	2.15	19.49	Vertical	Pass
	15	1@0	Lowest	14.34	1.25	6.60	2.15	17.54	Horizontal	Pass
			Middle	14.1	1.25	6.60	2.15	17.30	Horizontal	Pass
			Highest	14.27	1.25	6.60	2.15	17.47	Horizontal	Pass
		1@0	Lowest	15.64	1.25	6.60	2.15	18.84	Vertical	Pass
			Middle	15.59	1.25	6.60	2.15	18.79	Vertical	Pass
			Highest	15.76	1.25	6.60	2.15	18.96	Vertical	Pass
QPSK	3.75	1@0	Lowest	13.73	1.25	6.60	2.15	16.93	Horizontal	Pass
			Middle	13.6	1.25	6.60	2.15	16.80	Horizontal	Pass
			Highest	14.02	1.25	6.60	2.15	17.22	Horizontal	Pass
		1@0	Lowest	15.15	1.25	6.60	2.15	18.35	Vertical	Pass
			Middle	15.08	1.25	6.60	2.15	18.28	Vertical	Pass
			Highest	15.44	1.25	6.60	2.15	18.64	Vertical	Pass
	15	1@0	Lowest	13.13	1.25	6.60	2.15	16.33	Horizontal	Pass
			Middle	13.38	1.25	6.60	2.15	16.58	Horizontal	Pass
			Highest	13.34	1.25	6.60	2.15	16.54	Horizontal	Pass
		1@0	Lowest	14.48	1.25	6.60	2.15	17.68	Vertical	Pass
			Middle	14.78	1.25	6.60	2.15	17.98	Vertical	Pass
			Highest	14.79	1.25	6.60	2.15	17.99	Vertical	Pass
Limit	ERP<3W=34.77dBm									

6. OCCUPIED BANDWIDTH

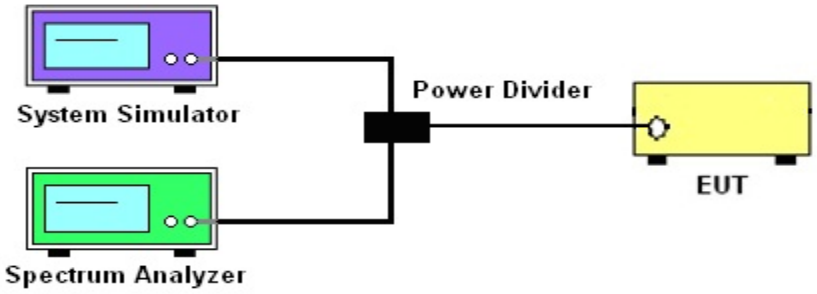
6.1 DESCRIPTION OF OCCUPIED BANDWIDTH MEASUREMENT

6.1.1 MEASUREMENT METHOD

1.The 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.

2.The 26 db emission bandwidth is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 26 db below the maximum in-band spectral density of the modulated signal. spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth equal to approximately 1.0% of the emission bandwidth.

6.1.2 TEST SETUP



6.1.3 TEST PROCEDURES

1. The testing follows FCC KDB 971168 D01 v03r01 Section 4.2 and 4.3.

2. The EUT was connected to spectrum and system simulator via a power divider

3. Select lowest, middle, and highest channels for each band and different modulation.

4. Set the test probe and measure the Occupied Bandwidth of the spectrum analyzer

5. Measure and record the Occupied Bandwidth from the Spectrum Analyzer.

	NB-IoT	
NB-IoT BW	3.75K	15K
Span	1MHz	1MHz
RBW	2kHz	2kHz
VBW	6.2kHz	6.2kHz
Detector	PK	PK
Trace	Max	Max
Sweep Count	Auto	Auto

6.1.4 MEASUREMENT RESULT

NB-IoT Band 2	Bandwidth [kHz]/Standalone							
Modulation	Subcarrier Space (KHz)	RB Configure	Lowest		Middle		Highest	
			99% BW	26dB BW	99% BW	26dB BW	99% BW	26dB BW
BPSK	3.75	1@0	57.75	35.03	60.745	39.27	60.964	39.5
	15	1@0	120.55	102.3	125.98	118.1	128.06	102.4
QPSK	3.75	1@0	67.673	41.96	65.502	38.6	62.777	37.93
	15	1@0	128.12	116.2	119.17	113.7	115.7	116
	15	12@0	189.55	249	191.37	248.8	186.61	244.1

NB-IoT Band 4	Bandwidth [kHz]/Standalone							
Modulation	Subcarrier Space (KHz)	RB Configure	Lowest		Middle		Highest	
			99% BW	26dB BW	99% BW	26dB BW	99% BW	26dB BW
BPSK	3.75	1@0	61.175	39.16	59.238	37.46	58.721	39.57
	15	1@0	123.74	105.4	123.74	105.4	128.45	116.8
QPSK	3.75	1@0	67.142	42.27	65.936	38.45	66.448	39.28
	15	1@0	117.67	115.4	130.07	130.3	116.53	115.1
	15	12@0	187.68	249.4	188.73	249.9	190.61	233.6

NB-IoT Band 5	Bandwidth [kHz]/Standalone							
Modulation	Subcarrier Space (KHz)	RB Configure	Lowest		Middle		Highest	
			99% BW	26dB BW	99% BW	26dB BW	99% BW	26dB BW
BPSK	3.75	1@0	58.655	39.2	56.897	37.94	58.551	38.76
	15	1@0	118.1	104.1	125.23	117.4	122.1	129
QPSK	3.75	1@0	64.268	38.08	64.66	39.93	66.436	39.6
	15	1@0	117.71	116.1	123.67	116.1	114.41	111.1
	15	12@0	185.18	250.2	187.95	235.4	191.53	260

NB-IoT Band 12	Bandwidth [KHz]/Standalone							
Modulation	Subcarrier Space (KHz)	RB Configure	Lowest		Middle		Highest	
			99% BW	26dB BW	99% BW	26dB BW	99% BW	26dB BW
BPSK	3.75	1@0	57.898	37.23	59.235	39.72	57.721	39.25
	15	1@0	125.26	103.6	120.8	115.5	117.51	103.5
QPSK	3.75	1@0	65.379	42.53	63.84	38.18	65.159	42.22
	15	1@0	119.17	116	117.21	103.3	121.1	116.4
	15	12@0	191.44	248.4	191.78	249	188.51	247.6

NB-IoT Band 13	Bandwidth [KHz]/Standalone							
Modulation	Subcarrier Space (KHz)	RB Configure	Lowest		Middle		Highest	
			99% BW	26dB BW	99% BW	26dB BW	99% BW	26dB BW
BPSK	3.75	1@0	58.483	38.16	59.32	38.4	59.859	39.09
	15	1@0	116.14	101.1	124.03	118	121.72	115
QPSK	3.75	1@0	63.894	38.51	65.508	41.86	64.004	39.03
	15	1@0	127.63	130.5	119.1	101.6	127.86	114.1
	15	12@0	186.83	232.8	185.44	236.5	188.63	245.7

Note: Test chart See Appendix A

7. CONDUCTED BAND EDGE

7.1 DESCRIPTION OF CONDUCTED BAND EDGE MEASUREMENT

7.1.1 MEASUREMENT METHOD

1. §22.917(a)
For operations in the 824 – 849 MHz band, the FCC limit is 43 + 10log10(P[Watts]) dB below the transmitter power P(Watts) in a 100kHz bandwidth. However, in the 1MHz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

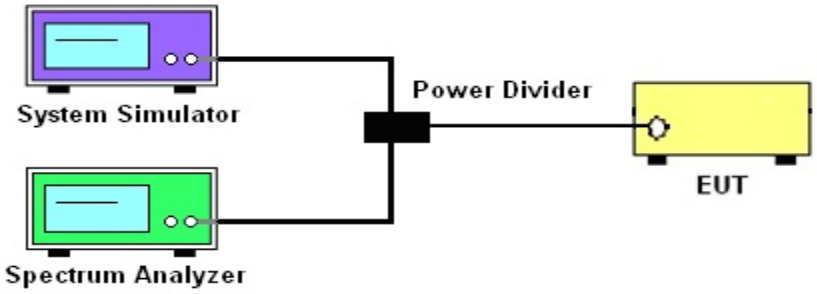
2. §24.238 (a)
For operations in the 1850-1910 and 1930-1990 MHz band, the FCC limit is 43 + 10log10(P[Watts]) dB below the transmitter power P(Watts) in a 1MHz bandwidth. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed

3. §27.53 (h)
For operations in the 1710 – 1755 MHz band, the FCC limit is 43 + 10log10(P[Watts]) dB below the transmitter power P(Watts) in a 1 MHz bandwidth. However, in the 1MHz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

4. §27.53(m)(4)
For operations in the 2500 MHz ~ 2570 MHz band this section, the attenuation factor shall be not less than 40 + 10 log (P) dB on all frequencies between the channel edge and 5 megahertz from the channel edge, 43 + 10 log (P) dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and 55 + 10 log (P) dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less that 43 + 10 log (P) dB on all frequencies between 2490.5 MHzand 2496 MHz and 55 + 10 log (P) dB at or below 2490.5 MHz. Mobile Satellite Service licenseesoperating on frequencies below 2495 MHz may also submit a documented interference complaintagainst BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

5. §27.53 (g)
For operations in the 698 -746 MHz band, the FCC limit is 43 + 10log10(P[Watts]) dB below the transmitter power P(Watts) in a 100 kHz bandwidth. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

7.1.2 TEST SETUP



7.1.3 TEST PROCEDURES

1. The testing FCC KDB 971168 D01 v03r01 Section 6.0 and ANSI C63.26 2015 Section 5.7.

2. The EUT was connected to spectrum analyzer and system simulator via a power divider.

3. The band edges of low and high channels for the highest RF powers were measured. Set RBW >= 1% EBW in the 1MHz band immediately outside and adjacent to the band edge.

4. Set spectrum analyzer with RMS/AVG detector.

5. The RF fundamental frequency should be excluded against the limit line in the operating frquency band.

6.The limit line is derived from 43 + 10log(P)dB below the transmitter power P(Watts)
= P(W)- [43 + 10log(P)] (dB)
= [30 + 10log(P)] (dBm) - [43 + 10log(P)] (dB)
= -13dBm.

Band 7:
= P(W)- [55 + 10log(P)] (dB)
= [30 + 10log(P)] (dBm) - [55 + 10log(P)] (dB)
= -25dBm.

	NB-IoT	
NB-IoT BW	3.75K	15K
Span	1MHz	1MHz
RBW	200Hz	200Hz
VBW	1kHz	1kHz
Detector	AVG	AVG
Trace	Max	Max
Sweep Count	Auto	Auto

7.1.4 MEASUREMENT RESULT

Note: Test chart See Appendix B