GTI NB-IoT Terminal OTA Test Specification

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Contents

Foreword

This specification is a part of China Mobile C-IoT device test and certification scheme, to ensure the NB-IoT terminal compliance with China Mobile requirements. The tests is executed on system simulator.

The objective of this document is to define the test cases for NB-IoT terminal. This document will be used to guide the execution of NB-IoT terminal testing, and also be used to guide the NB-IoT terminal test system development.

1.Scope

The present document specifies the NB-IoT terminal testing, including TRP (Total Radiated Power), TRS (Total Radiated opic Sensitivity) and power consumption tests.

2.References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 36.508: "Common test environments for User Equipment (UE)".

[3] 3GPP TS 36.521-1: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: conformance testing".

[4] 3GPP TS 37.544: " UTRA and E-UTRA UE OTA performance; Conformance testing".

[5] 3GPP TR 37.844: "User Equipment (UE) GSM, UTRA and E-UTRA over the air performance requirements".

[6] T. Laitinen, J. Ollikainen, P. Vainikainen, C. Icheln, "Rapid Spherical 3-D Field Measurement System for Mobile Terminal Antennas", COST273 TD (03)134

[7] 3GPP TS 36 101: "E-UTRA UE radio transmission and reception".

3.Definitions, symbols and abbreviations

For the purposes of the present document, the terms, definitions and abbreviations given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Abbreviation	Definitions
BLER	Block Error Ratio
DUT	Device Under Test
EIRP	Effective Isotropic Radiated Power
EIS	Effective Isotropic Sensitivity
FS	Free Space
OTA	Over The Air
SS	System Simulator
Tx	Transmitter
TRP	Total Radiated Power
TRS	Total Radiated Sensitivity
UE	User Equipment

UL	Uplink

4.Test frequencies

NB-IoT system operates in HD-FDD duplex mode. The test frequencies are based on the E-UTRA frequency bands defined in the core specifications. The reference test frequencies for the tests in this specification of the operating bands are defined in following tables

Table 错误!未找到引用源。-1: NB-IoT standalone Test frequencies for operating band 3

Test Frequency ID	N_{UL}	M_{UL}	Frequency of Uplink [MHz]	N_{DL}	M_{DL}	Frequency of Downlink [MHz]
f1	19201	0	1710.1	1201	-0.5	1805.1
f2	19575	0	1747.5	1575	-0.5	1842.5
f3	19949	0	1784.9	1949	-0.5	1879.9
NOTE 1: Applicable to either 3.75 kHz or 15 kHz NB-IoT UL subcarrier spacing						

Table 错误!未找到引用源。-2: NB-IoT in-band Test frequencies for operating band 3

Test Frequency ID	N_{UL}	M_{UL}	Frequency of Uplink [MHz]	N_{DL}	M_{DL}	Frequency of Downlink [MHz]
f1	19206	-3	1710.5850	1206	-2	1805.5925
f2	19566	-3	1746.5850	1566	-2	1841.5925
f3	19944	3	1784.4150	1944	1	1879.4075
NOTE 1: Related to LTE channel BW 3 MHz NOTE 2: Defined for NB-IoT UL subcarrier spacing 15 kHz. Also applicable for 3.75 kHz UL sub-carrier spacing						

Table 错误!未找到引用源。-3: NB-IoT guard-band Test frequencies for operating band 3

Test Frequency ID	N_{UL}	M_{UL}	Frequency of Uplink [MHz]	N_{DL}	M_{DL}	Frequency of Downlink [MHz]
f1	19201	0	1710.1000	1201	1	1805.1075
f2	19551	0	1745.1000	1551	1	1840.1075
f3	19949	0	1784.9000	1949	-2	1879.8925
NOTE 1: Related to LTE channel BW 5 MHz NOTE 2: Defined for NB-IoT UL subcarrier spacing 15 kHz. Also applicable for 3.75 kHz UL sub-carrier spacing						

Table 错误!未找到引用源。-4: NB-IoT standalone Test frequencies for operating band 8

Test Frequency ID	N_{UL}	M_{UL}	Frequency of Uplink [MHz]	N_{DL}	M_{DL}	Frequency of Downlink [MHz]
f1	21451	0	880.1	3451	-0.5	925.1
f2	21625	0	897.5	3625	-0.5	942.5
f3	21799	0	914.9	3799	-0.5	959.9
NOTE 1: Applicable to either 3.75 kHz or 15 kHz NB-IoT UL subcarrier spacing						

Table 4-5: NB-IoT in-band Test frequencies for operating band 8

Test Frequency ID	N_{UL}	M_{UL}	Frequency of Uplink [MHz]	N_{DL}	M_{DL}	Frequency of Downlink [MHz]
f1	21456	-3	880.5850	3456	-2	925.5925
f2	21616	-3	896.5850	3616	-2	941.5925
f3	21794	3	914.4150	3794	1	959.4075
NOTE 1: Related to LTE channel BW 3 MHz NOTE 2: Applicable to either 3.75 kHz or 15 kHz UL sub-carrier spacing						

Table 4-6: NB-IoT guard-band Test frequencies for operating band 8

Test Frequency ID	N_{UL}	M_{UL}	Frequency of Uplink [MHz]	N_{DL}	M_{DL}	Frequency of Downlink [MHz]
Low Range	21451	0	880.1000	3451	1	925.1075
Mid Range	21601	0	895.1000	3601	1	940.1075
High Range	21799	0	914.9000	3799	-2	959.8925
NOTE 1: Related to LTE channel BW 5 MHz NOTE 2: Applicable to either 3.75 kHz or 15 kHz UL sub-carrier spacing						

5.OTA testing

5.1 General

5.1.1 Test system

Two test systems are considered in this test specification, one is anechoic chamber, the other is Reverberation chamber. The definition and requirements to the test systems refer to Annex A.3 and A.5 in 3GPP TS 37.544.

5.1.2 Test model

According to the UE type and using scenario, proper models should be used to test its OTA performance.

1. Test model 1: Free space.
   For the anechoic chamber, UE is positioned at the rotation table and the 3D rotation center should be the center of UE antennas. For the reverberation chamber, UE is positioned at the rotation table.
2. Test model 2: Human body phantom.
   For the wearable devices, the human body phantom should be used during OTA testing. The phantom requirments refer to Subclause A.2.1 and A.2.2 of 3GPP TS 37.544. The positioning of phantoms refer to clause 4.3 of 3GPP TS 37.544. If no proper phantom is available, then test free space.

5.2 TRP test for free space

5.2.1Test purpose

The purpose of this test is to verify that $TRP_{average}$ and $TRP_{\min}$ of the UE is not below specified values. A lower $TRP_{average}$ and $TRP_{\min}$ decrease the coverage area.

5.2.2 Test environment

A NB-IoT system simulator is used to setup calls to the DUT. The SS may also measure the radiated power samples. Alternatively, a spectrum analyzer may be used for that purpose.

The maximum output power for NB-IoT UE is defined in 3GPP TS 36.521-1 [3] Subclause 6.2.2F.

Test environment: normal; see TS36.508 [10] Subclause 4.1.1.

Frequencies to be tested: f1, f2, f3; see clause 4.

Power on the UE.

Set the initial conditions as per ID3 of Table 6.2.2F.4.1-1 of 3GPP TS 36.521-1 [3] and they are specified in the table below:

Test Parameters				
Configuration ID	**Downlink Configuration**	**Uplink Configuration**		
	N/A	Modulation	N_{tones}	Sub-carrier spacing (kHz)
1		QPSK	1@0	15

5.2.3 Procedure

5.2.3.1 Anechoic chamber

1. Follow Steps 1 and 2 in section 6.2.2F.4.2 of 3GPP TS 36.521-1 [3] and ensure that the DUT transmits with its maximum power.

2. For the anechoic chamber based methodologies, measure the spherical effective isotropic radiated power (EIRP) pattern following the sampling grid specified in Subclause 4.4 of 3GPP TS 37.544. Slots with transient periods are not under test. Calculate the TRP using the EIRP pattern data as per subclause 6.1.6.1 of 3GPP TS 37.544.

3. Repeat the measurement of the DUT for f1, f2 and f3 channels.

4. Calculate the linear average and minimum TRP.

5.2.3.2 Reverberation chamber

1. Follow Steps 1 and 2 in section 6.2.2F.4.2 of 3GPP TS 36.521-1 [3] and ensure that the DUT transmits with its maximum power.

2. Measure a sufficient number of independent samples as per subclause 4.5 of 3GPP TS 37.544. Calculate TRP using equations from Subclause 6.1.6.1 of 3GPP TS 37.544.

3. Repeat the measurement of the DUT for f1, f2 and f3 channels.

4. Calculate the average and minimum TRP.

5.2.4 Test requirements

The average TRP and minimum TRP of f1, f2 and f3 channels shall be higher than the test performance requirements in Table 5.2.4-1.

Table 5.2.4-1: TRP test requirement for free space

Band	Average requirement	Minimum requirement
3	TBD	TBD
8	TBD	TBD

5.3 TRP test for body phantom

5.3.1 Test purpose

The purpose of this test is to verify that $TRP_{average}$ and $TRP_{\min}$ of the UE with body phantom is not below specified values. A lower $TRP_{average}$ and $TRP_{\min}$ decrease the coverage area.

5.3.2 Initial conditions

A NB-IoT system simulator is used to setup calls to the DUT. The SS may also measure the radiated power samples. Alternatively, a spectrum analyzer may be used for that purpose.

Proper body phantom is chosen according to clause 5.1.2.

The maximum output power for NB-IoT UE is defined in 3GPP TS 36.521-1 [3] Subclause 6.2.2F.

Test environment: normal; see TS36.508 [10] Subclause 4.1.1.

Frequencies to be tested: f1, f2, f3; see clause 4.

Power on the UE.

Set the initial conditions as per ID3 of Table 6.2.2F.4.1-1 of 3GPP TS 36.521-1 [3] and they are specified in the table below:

Test Parameters				
Configuration ID	**Downlink Configuration**	**Uplink Configuration**		
	N/A	Modulation	N_{tones}	Sub-carrier spacing (kHz)
1		QPSK	1@0	15

5.3.3 Procedure

5.3.3.1 Anechoic chamber

1. Follow Steps 1 and 2 in section 6.2.2F.4.2 of 3GPP TS 36.521-1 [3] and ensure that the DUT transmits with its maximum power.
2. For the anechoic chamber based methodologies, measure the spherical effective isotropic radiated power (EIRP) pattern following the sampling grid specified in Subclause 4.4 of 3GPP TS 37.544. Slots with transient periods are not under test. Calculate the TRP using the EIRP pattern data as per subclause 6.1.6.1 of 3GPP TS 37.544.
3. Repeat the measurement of the DUT for f1, f2 and f3 channels.
4. Calculate the linear average and minimum TRP.

5.3.3.2 Reverberation chamber

1. Follow Steps 1 and 2 in section 6.2.2F.4.2 of 3GPP TS 36.521-1 [3] and ensure that the DUT transmits with its maximum power.

2. Measure a sufficient number of independent samples as per subclause 4.5 of 3GPP TS 37.544. Calculate TRP using equations from Subclause 6.1.6.1 of 3GPP TS 37.544.

3. Repeat the measurement of the DUT for f1, f2 and f3 channels.

4. Calculate the linear average and minimum TRP.

5.3.4 Test requirements

The average TRP and minimum TRP of f1, f2 and f3 channels shall be higher than the test performance requirements in Table 5.2.4-1.

Table 5.3.4-1: TRP test requirement for body phantom

Band	Average requirement	Minimum requirement
3	TBD	TBD
8	TBD	TBD

5.4 TRS test for free space

5.4.1 Test purpose

The purpose of this test is to ensure that $TRS_{average}$ and $TRS_{\max}$ of the UE is above specified limit.

The lack of the reception sensitivity decreases the coverage area at the far side from base station.

5.4.2 Initial conditions

A NB-IoT system simulator is used to setup calls to the DUT. The SS is also used to send test signals to the UE and measure the BER levels of the radio link and the information on the dedicated channel needed to extract the DUT receiver performances.

Chamber environment constraints and coordinate system shall be the same as described in Subclause A.3 of 3GPP TS 37.544.

Test environment: normal; see TS36.508 [10] Subclause 4.1.1.

Frequencies to be tested: f1, f2 and f3; see clause 4.

Positioning Requirements shall be the same as described in subclause 4.3 of 3GPP TS 37.544.

Power on the UE.

Set the initial conditions as per Table 7.3F.1.4.1-1 in subclause 7.3F.1 of 3GPP TS 36.521-1 [3] and they are specified in the table below:

Configuration ID	Downlink Configuration		Uplink Configuration		
	Modulation	Subcarriers	Modulation	N_{tones}	Subcarrier spacing
1	QPSK	12	BPSK	1@0	15kHz

5.4.3 Procedure

5.4.3.1 Anechoic chamber

1. Follow Steps 1 through 4 in Subclause 7.3F.1.4.2 of 3GPP TS 36.521-1 [3], with the following exception: measure the receiver sensitivity by adjusting the downlink signal level to 95 % throughput of the maximum throughput of the reference channel (maximum throughput is per Annex A of 3GPP TS 36.521-1 [3]).

2. Repeat Step 1) with 3-D sampling grid specified in Subclause 4.4 of 3GPP TS 37.544. The minimum RF power level resulting in a data throughput greater than or equal to 95 % throughput of the maximum throughput for each test shall be recorded for integration pursuant to Subclause 7.1.10.1 of 3GPP TS 37.544 to calculate TRS.

3. Repeat the measurement of the DUT on f1, f2 and f3 channels.

4. Calculate the linear average and minimum TRS.

5.4.3.2 Reverberation chamber

1. Follow Steps 1 through 4 in Subclause 7.3F.1.4.2 of 3GPP TS 36.521-1 [3], with the following exception: measure the receiver sensitivity by adjusting the downlink signal level to 95 % throughput of the maximum throughput of the reference channel (maximum throughput is per Annex A of 3GPP TS 36.521-1 [3]).

2. Repeat Step 1) for a long enough time to get the statistic result. The minimum RF power level resulting in a data throughput greater than or equal to 95 % throughput of the maximum throughput.

3. Repeat the measurement of the DUT on f1, f2 and f3 channels.

4. Calculate the linear average and minimum TRS.

5.4.3.3 Test requirements

The average measured total radiated sensitivity (TRS) of f1, f2 and f3 channels for handheld UE shall be lower than the average TRS requirement specified in Table 5.4.3.3-1. Average TRS requirement is shown in the column “Average” on the requirement tables.

In addition the highest TRS of each measured channel shall be lower than maximum TRS requirement specified in Table 5.4.3.3-1. Maximum TRS requirement is shown in the column “Max” on the requirement tables.

Table 5.4.3.3-1: TRS test requirement for free space

Band	Average requirement	Minimum requirement
3	TBD	TBD
8	TBD	TBD

5.5 TRS test for body phantom

5.5.1 Test purpose

The purpose of this test is to ensure that $TRS_{average}$ and $TRS_{\max}$ of the UE with body phantom is above specified limit. The lack of the reception sensitivity decreases the coverage area at the far side from base station.

5.5.2 Initial conditions

A NB-IoT system simulator is used to setup calls to the DUT. The SS is also used to send test signals to the UE and measure the BER levels of the radio link and the information on the dedicated channel needed to extract the DUT receiver performances.

Proper body phantom is chosen according to clause 5.1.2.

Chamber environment constraints and coordinate system shall be the same as described in Subclause A.3 of 3GPP TS 37.544.

Test environment: normal; see TS36.508 [10] Subclause 4.1.1.

Frequencies to be tested: f1, f2 and f3; see clause 4.

Positioning Requirements shall be the same as described in subclause 4.3 of 3GPP TS 37.544.

Power on the UE.

Set the initial conditions as per Table 7.3F.1.4.1-1 in subclause 7.3F.1 of 3GPP TS 36.521-1 [3] and they are specified in the table below:

Configuration ID	**Downlink Configuration**		**Uplink Configuration**		
	Modulation	Subcarriers	Modulation	N_{tones}	Subcarrier spacing
1	QPSK	12	BPSK	1@0	15kHz

5.5.3 Procedure

5.5.3.1 Anechoic chamber

1. Follow Steps 1 through 4 in Subclause 7.3F.1.4.2 of 3GPP TS 36.521-1 [3], with the following exception: measure the receiver sensitivity by adjusting the downlink signal level to 95 % throughput of the maximum throughput of the reference channel (maximum throughput is per Annex A of 3GPP TS 36.521-1 [3]).

2. Repeat Step 1) with 3-D sampling grid specified in Subclause 4.4 of 3GPP TS 37.544. The minimum RF power level resulting in a data throughput greater than or equal to 95 % throughput of the maximum throughput for each test shall be recorded for integration pursuant to Subclause 7.1.10.1 of 3GPP TS 37.544 to calculate TRS.

3. Repeat the measurement of the DUT on f1, f2 and f3 channels.

4. Calculate the linear average and minimum TRS.

5.5.3.2 Reverberation chamber

1. Follow Steps 1 through 4 in Subclause 7.3F.1.4.2 of 3GPP TS 36.521-1 [3], with the following exception: measure the receiver sensitivity by adjusting the downlink signal level to 95 % throughput of the maximum throughput of the reference channel (maximum throughput is per Annex A of 3GPP TS 36.521-1 [3]).

2. Repeat Step 1) for a long enough time to get the statistic result. The minimum RF power level resulting in a data throughput greater than or equal to 95 % throughput of the maximum throughput.

3. Repeat the measurement of the DUT on f1, f2 and f3 channels.

4. Calculate the linear average and minimum TRS.

5.5.3.3 Test requirements

The average measured total radiated sensitivity (TRS) of f1, f2 and f3 channels for handheld UE shall be lower than the average TRS requirement specified in Table 5.5.3.3-1. Average TRS requirement is shown in the column “Average” on the requirement tables.

In addition the highest TRS of each measured channel shall be lower than maximum TRS requirement specified in Table 5.5.3.3-1. Maximum TRS requirement is shown in the column “Max” on the requirement tables.

Table 5.5.3.3-1: TRS test requirement for body phantom

Band	Average requirement	Minimum requirement
3	TBD	TBD
8	TBD	TBD

6.Document Change Record

Version	Date	Record of changes made to previous released version
1.0.0	2018-10-26	Initial Version