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**Technical requirements and test methods of vehicular
information interactive systems based on LTE-V2X direct
communication**

基于 LTE-V2X 直连通信的车载信息交互系统技术要求及试验方法

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Technical requirements and test methods of vehicular information interactive systems based on LTE-V2X direct communication

1 Scope

This document specifies the system description, vehicle environment requirements, positioning and timing requirements, functional requirements, communication performance requirements, test methods of the vehicular information interaction system based on long-term evolution vehicle wireless communication technology (LTE-V2X) supporting direct communication.

This document is applicable to Class M and Class N vehicles.

Note: In the absence of ambiguity, this document will refer to the vehicular information interaction system based on LTE-V2X direct communication, abbreviated as LTE-V2X system.

2 Normative references

The contents of the following documents constitute essential clauses of this document through normative references in the text. For references with dates, only the versions corresponding to the dates apply to this document; for references without dates, the latest versions (including all amendments) apply to this document.

GB/T 28046.2-2019 Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 2: Electrical loads

GB/T 28046.3-2011 Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 3: Mechanical loads

GB/T 28046.4-2011 Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 4: Climatic loads

GB/T 30038-2013 Road vehicles - Degrees of electrical equipment protection (IP-Code)

GB 34660-2017 Road vehicles - Requirements and test methods of electromagnetic compatibility

YD/T 3340-2018 Technical requirements of air interface of LTE-based vehicular

5.3.5 High temperature operation

Perform the test in accordance with 9.1.3.4; the functional status of the LTE-V2X system shall meet the requirements of 5.1 Level A.

5.3.6 Temperature gradient

Perform the test in accordance with 9.1.3.5; the functional status of the LTE-V2X system shall meet the requirements of 5.1 Level A.

5.3.7 Rapid temperature change with specified switching time

Perform the test in accordance with 9.1.3.6; the functional status of the LTE-V2X system shall meet the requirements of 5.1 Level B.

5.3.8 Temperature cycling with specified change rate

Perform the test in accordance with 9.1.3.7; the functional status of the LTE-V2X system shall meet the requirements of 5.1 Level A.

5.3.9 Damp heat cycling

Perform the test in accordance with 9.1.3.8; the functional status of the LTE-V2X system shall meet the requirements of 5.1 Level A.

5.3.10 Steady-state damp heat

Perform the test in accordance with 9.1.3.9; the functional status of the LTE-V2X system shall meet the requirements of 5.1 Level A.

5.3.11 Salt spray resistance

Perform the test in accordance with 9.1.3.10, to check the appearance of the LTE-V2X system. It shall be sealed intact; the sign and label shall be clearly visible; its functional status shall meet the requirements of 5.1 Level B.

5.4 Shell protection

Perform the test in accordance with 9.1.4 according to the requirements of Table A.1 of GB/T 28046.4-2011. The LTE-V2X system function shall meet the requirements of 5.1 Level B.

5.5 Mechanical properties

5.5.1 Mechanical vibration

Perform the test in accordance with 9.1.5.1. The LTE-V2X system shall not have physical damage; its functional status shall meet the requirements of 5.1 Level A.

5.5.2 Mechanical shock

Perform the test in accordance with 9.1.5.2. The LTE-V2X system shall not have physical damage; its functional status shall meet the requirements of 5.1 Level A.

5.5.3 Free fall

The LTE-V2X system shall not have invisible damage, when tested in accordance with 9.1.5.3. Minor damage to the outer shell is allowed without affecting the performance of the LTE-V2X system. Its functional status shall meet the requirements of 5.1 Level B.

5.6 Durability

The LTE-V2X system shall not have physical damage when tested in accordance with 9.1.6. Its service life shall not be less than 10 years.

5.7 Electromagnetic compatibility

5.7.1 Electromagnetic compatibility of vehicles

5.7.1.1 Broadband radiated emission

The vehicle shall meet the requirements of 4.2 of GB 34660-2017, when tested in accordance with 9.1.7.1.4.1.

5.7.1.2 Narrowband radiated emission

The vehicle shall meet the requirements of 4.3 of GB 34660-2017, when tested in accordance with 9.1.7.1.4.2.

5.7.1.3 Immunity to electromagnetic radiation

Perform the test in accordance with 9.1.7.1.4.3. During and after the test, the number of BSM data packets received by the V2X PC5 message receiving instrument, within the continuous test time t (in seconds) of the vehicle, shall not be less than round ($t \times 10 \times 95\%$).

Note: round means integer.

5.7.2 System electromagnetic compatibility

The electromagnetic compatibility requirements of the LTE-V2X system are shown in Appendix A.

the corresponding UTC time each time it outputs a position.

7 Functional requirements

7.1 Access layer configuration requirements

7.1.1 General requirements for PC5 interface

The system shall set the pre-configured parameters to the corresponding values in Table A.1, Table A.2, Table A.3, Table A.4 of YD/T 3756-2024.

If the LTE-V2X system is pre-configured with synchronization offset indication 1 (syncOffsetIndicator1-r14), synchronization offset indication 2 (syncOffsetIndicator2-r14) or synchronization offset indication 3 (syncOffsetIndicator3-r14) in YD/T 3340-2018, these three parameters shall not take effect.

7.1.2 PC5 interface transmitter requirements

7.1.2.1 The LTE-V2X system shall use broadcast mode to send service data.

7.1.2.2 The LTE-V2X system shall support data transmission using transmission mode 4. When sending service data, it should use a resource selection method of perception plus semi-persistent scheduling.

Note: Transmission mode 4 refers to the autonomous resource selection of the terminal (user equipment); the terminal perceives the occupation of PC5 resources by listening.

7.1.2.3 The 3-bit SDU (service data unit) type of the PDCP header shall be set to 011; a 16-bit PDCP SN shall be used. The PGK (proximity service group key) identifier, PTK (proximity service key) identifier and PDCP SN shall be set to 0.

7.1.2.4 When the LTE-V2X system uses PC5 to send service data, RLC UM (unacknowledged mode) shall be used; a 5-bit RLC SN shall be used.

7.1.2.5 The 4-bit V field of the MAC header shall be set to 0011.

7.2 Network layer configuration requirements

7.2.1 PC5 interface transmitter requirements

The packet transmission behavior shall meet the following requirements.

- a) The adaptation layer randomly generates and maintains the 24 bit Source_Layer-2 ID within the range of [0x010001, 0xFFFFFE]. If the Application layer ID changed parameter appears in ADAPTATION-LAYER.request, the adaptation layer randomly generates and maintains the 24-bit Source_Layer-2 ID in the range [0x010001, 0xFFFFFE] again. The adaptation layer indicates the

condition is first met; the sending of the original BSM shall be canceled. The BSM shall contain all valid critical event flags up to the data encapsulation time. During the validity period of the trigger condition, the critical event trigger BSM shall be generated continuously according to the generation cycle of 100 ms, starting from the generation time of the above first critical event trigger BSM. After a specific trigger condition is invalid, the corresponding critical event flag carried in the BSM shall be canceled.

Note: For an example of sending a critical event trigger BSM, see Appendix B.

The application layer of the LTE-V2X system shall perform congestion control on the regular BSM. The congestion control mechanism is shown in Appendix C.

7.3.1.4 Priority setting

When sending a regular BSM, the LTE-V2X system shall set the priority parameter Priority in the network layer DSM.request primitive to 112.

When sending a critical event-triggered BSM, the LTE-V2X system shall set the priority parameter Priority in the network layer DSM.request primitive to 208.

7.3.1.5 Packet delay budget (PDB) setting

For the transmission of regular BSM, the PDB should be set to 100 ms; for the transmission of critical event-triggered BSM, the PDB should be set to 50 ms.

7.3.1.6 Calling the underlying transmission service

The LTE-V2X system shall call the network layer DSM.request primitive to send BSM and meet the following requirements:

- a) It shall be sent in broadcast mode;
- b) The AID parameter shall be set according to Table 7;
- c) The Network Protocol Type parameter shall be set to 4;
- d) The Priority parameter shall be set according to 7.3.1.4;
- e) The traffic period Traffic Period parameter can be set to the current BSM generation period of the application layer;
- f) When changing the pseudonym certificate according to 7.4.5.2, the Application layer ID changed parameter shall be set.

to Table 7; the generationTime field shall be filled with the generation time of the SPDU; the generationLocation field shall not be filled; the fields expiryTime, p2pcdLearningRequest, missingCrlIdentifier, encryptionKey, inlineP2pcdRequest, requestedCertificate, pduFunctionalType are optional fields and are not filled by default.

7.4.3.5 Signer (signer)

The signer field shall be selected as digest or certificate; it shall not be selected as self or x509 and shall meet the following requirements.

- a) When certificate is selected, the SIZE of SEQUENCE is 1, that is, the certificates of other certificate authorities in the certificate chain are not attached.
- b) Attach a complete pseudonym certificate in the following cases (select certificate); attach a digest of the pseudonym certificate in other cases (select digest):
 - 1) The first BSM sent after the start/restart operation;
 - 2) The first BSM sent after the pseudonym certificate used is changed;
 - 3) The time interval between this BSM and the previous BSM with a complete pseudonym certificate attached is equal to or greater than 450 ms;
 - 4) At least one key event flag in Table 26 is set.

7.4.3.6 Signature value (signature)

The signature field shall be selected as sm2Signature; the input and output of the cryptographic algorithm shall comply with the requirements of D.2 in YD/T 3957-2021.

7.4.4 Security layer message reception requirements

The LTE-V2X system shall verify the received security layer SPDU. The verification content shall meet the relevant requirements of 6.1.9.3 in YD/T 3957-2021.

For the received safety layer SPDU, if its generationTime is 1 s earlier than the current LTE-V2X system time or later than the current LTE-V2X system time, it shall be regarded as invalid data and discarded.

Note: generationTime is the reference time in YD/T 3957-2021.

7.4.5 Privacy protection requirements

7.4.5.1 Identifier randomization

The LTE-V2X system shall randomize the relevant identifiers in the BSM signed with the pseudonym certificate and meet the following requirements:

- a) After the startup/restart operation, the 24-bit Source_Layer-2 ID of the first BSM sent shall be randomly initialized according to 7.2.1;
- b) If the pseudonym certificate used by this BSM is different from that used by the previous BSM, the 24-bit Source_Layer-2 ID of this BSM shall change randomly according to 7.2.1;
- c) If the pseudonym certificate used by this BSM is different from that used by the previous BSM, the DE_MsgCount and id of this BSM shall change randomly according to 7.3.2.1 and 7.3.2.2.

7.4.5.2 Pseudonym certificate replacement

The LTE-V2X system shall not use expired pseudonym certificates.

Each time the LTE-V2X system starts/restarts, when sending the first BSM, a certificate shall be randomly selected from all valid pseudonym certificates for signing the message, meanwhile the continuous use time of the pseudonym certificate shall be reset.

During the validity period of the certificate, the continuous use time of the same pseudonym certificate shall not exceed 300 s except in the following cases:

- a) If the straight-line distance between the current position of the LTE-V2X system and the position at the previous pseudonym certificate change is less than 2100 m (with an allowable error of 100 m), the LTE-V2X system shall continue to use the existing pseudonym certificate (except for the case where the power is turned off and on after the previous pseudonym certificate is changed);
- b) If at least one of the key event flags DE_VehicleEventFlags defined in Table 26 is set, the LTE-V2X system shall continue to use the existing pseudonym certificate, until all key event flags are reset.

If the key event flag is set or the driving distance does not reach 2100 m, the certificate will not be replaced when the timing reaches T ($T = 300$ s), at this time the timing will continue. After the key event flag is reset, if the certificate replacement conditions are not met, the previous timing shall continue; if the certificate replacement conditions are met, the certificate shall be replaced immediately and the timing shall be restarted.

7.4.5.3 Protection requirements for vehicle history track privacy

When the pseudonym certificate is changed, the LTE-V2X system shall clear the corresponding storage area of the history track data and perform privacy protection in accordance with 7.3.2.18.3.

9.1.2.9 Open circuit

The DUT is tested in working mode 2 in Table 1, according to methods 4.9.1.2 and 4.9.2.2 of GB/T 28046.2-2019.

9.1.2.10 Short circuit protection

The DUT is tested in working mode 2 in Table 1, according to methods 4.10.2.1 and 4.10.3.1 of GB/T 28046.2-2019.

9.1.2.11 Insulation resistance

The DUT is tested in working mode 1 in Table 1, according to method 4.12.2 of GB/T 28046.2-2019.

9.1.3 Environmental weathering test

9.1.3.1 Low temperature storage

The DUT is tested with the lower limit of the storage environment temperature in Table 3 and working mode 1 in Table 1, according to the method of 5.1.1.1.2 in GB/T 28046.4-2011. After the test, it is left to stand for at least 1 hour to return to normal temperature; the function is verified in working mode 2 in Table 1.

9.1.3.2 Low temperature operation

The DUT is tested with the lower limit of the working environment temperature T_m in Table 3 and working mode 2 in Table 1, according to the method of 5.1.1.2.2 in GB/T 28046.4-2011. During the test, the DUT is continuously functionally checked in working mode 2 in Table 1. After the test, it is left to stand for at least 1 hour to return to normal temperature; the function is verified in working mode 2 in Table 1.

9.1.3.3 High-temperature storage

The DUT is tested with the upper storage temperature limit in Table 3 and working mode 1 in Table 1, according to the method in 5.1.2.1.2 of GB/T 28046.4-2011. After the test, it is left to stand for at least 1 hour to return to normal temperature; functional verification is performed in working mode 2 in Table 1.

9.1.3.4 High-temperature operation

The DUT is tested with the upper working environment temperature limit T_{max} in Table 3 and working mode 2 in Table 1, according to the method in 5.1.2.2.2 of GB/T 28046.4-2011. During the test, the DUT is continuously functionally checked in working mode 2 in Table 1. After the test, it is left to stand for at least 1 hour to return to normal temperature; functional verification is performed in working mode 2 in Table 1.

9.1.3.5 Temperature gradient

The DUT is tested in the working environment temperature range of $T_{\min} \sim T_{\max}$ in Table 3, in working mode 2 in Table 1, according to the method in 5.2.2 of GB/T 28046.4-2011. During the test, the DUT is continuously functionally verified in working mode 2 in Table 1. After the test, it is left to stand for at least 1 hour to return to normal temperature; functional verification is performed in working mode 2 in Table 1.

9.1.3.6 Rapid temperature change with specified switching time

The DUT is tested in the working environment temperature range of $T_{\min} \sim T_{\max}$ in Table 3, according to the method in 5.3.2.2 of GB/T 28046.4-2011. After the test, it is left to stand for at least 1 hour to return to normal temperature; functional verification is performed in working mode 2 in Table 1.

9.1.3.7 Temperature cycle with specified change rate

DUT is tested in the working environment temperature range of $T_{\min} \sim T_{\max}$ in Table 3 according to the method of 5.3.1.2 in GB/T 28046.4-2011. During the test, the function of DUT is continuously verified in working mode 2 in Table 1. After the test, it is left to stand for at least 1 hour to return to normal temperature; the function is verified in working mode 2 in Table 1.

9.1.3.8 Damp heat cycle

DUT is tested in working mode 2 in Table 1 according to the method of 5.6.2.2 in GB/T 28046.4-2011. During the test, the function of DUT is continuously verified in working mode 2 in Table 1. After the test, it is left to stand for at least 1 hour to return to normal temperature; the function is verified in working mode 2 in Table 1.

9.1.3.9 Steady-state damp heat

The DUT is tested in working mode 1 in Table 1 according to the method in 5.7.2 of GB/T 28046.4-2011. During the last 1 hour of the test, the function is verified in working mode 2 in Table 1. After the test, the device is left to stand for at least 1 hour to return to normal temperature; then the function is verified in working mode 2 in Table 1.

9.1.3.10 Salt spray resistance

The DUT is tested in working mode 1 in Table 1 according to the method of 5.5.1.2 in GB/T 28046.4-2011; the function is verified in working mode 2 in Table 1 after the test.

9.1.4 Shell protection test

Dustproof test: The DUT is tested in working mode 1 in Table 1 according to the method of 8.3.3.2 in GB/T 30038-2013; the function is verified in working mode 2 in Table 1 after the test.

A.1.4.1 Conducted emission

The LTE-V2X system should meet the requirements of Level 3 in Table 5 and Table 6 of GB/T 18655-2018, when testing with reference to A.2.4.1.

A.1.4.2 Radiated emission

The LTE-V2X system should meet the requirements of Level 3 in Table 7 of GB/T 18655-2018, when testing with reference to A.2.4.2.

A.2 Electromagnetic compatibility test

A.2.1 Immunity test for electrical disturbances caused by electrostatic discharge

A.2.1.1 LTE-V2X system is not powered on

The LTE-V2X system is tested in working mode 1 in Table 1, in accordance with the test voltage requirements of Category 1 test severity level not less than L₃ in Table C.1 and Table C.2 in Appendix C of GB/T 19951-2019 and the method specified in Chapter 9. After the test, the test is carried out in working mode 2 in Table 1.

A.2.1.2 LTE-V2X system is powered on

The LTE-V2X system is tested in working mode 2 in Table 1, in accordance with the test voltage requirements of Category 1 test severity level not less than L₃ in Table C.1, Table C.2, Table C.3 in Appendix C of GB/T 19951-2019, as well as the method specified in Chapter 8.

A.2.2 Immunity test for electrical disturbances caused by conduction and coupling

A.2.2.1 Immunity to electrical transient conduction along the power line

The LTE-V2X system is tested in working mode 2 in Table 1, according to the immunity test levels specified in Table A.1 and the methods in GB/T 21437.2-2021, by applying pulses 1, 2a, 2b, 3a, 3b to the power line and other connecting lines that may be connected to the power line.

A.2.2.2 Immunity to electrical transients caused by capacitive and inductive coupling of wires other than power lines

The LTE-V2X system is tested in working mode 2 in Table 1, according to the requirements of Level III in Table B.1 and Table B.2 in GB/T 21437.3-2021 and methods 4.5 and 4.7.

A.2.3 Immunity test for electromagnetic radiation

The LTE-V2X system is tested in working mode 2 in Table 1, according to the anechoic chamber method and the large current injection method in 4.7 and 5.7 of GB 34660-

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