GM	WORLDWIDE ENGINEERING STANDARDS	General Specification	GMW17680

DSRC Transceiver Performance Requirements

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard specifies static requirements and test procedures for verification of Dedicated Short Range Communications (DSRC) transceiver performance for all General Motors (GM) vehicles marketed and sold around the world.

The requirements stated in this standard supercedes all Component Technical Specifications (CTS), Subsystem Technical Specifications (SSTS), and Vehicle Technical Specifications (VTS) that pertain to DSRC transceiver components.

1.2 Applicability. This standard is applicable to the development and validation of DSRC transceiver components for new vehicle programs as well as design changes for current components.

1.3 Remarks. This standard specifies the static transceiver Radio Frequency (RF) hardware requirements and test procedures for verification. Other documents, such as the Human Machine Interface (HMI) and End of Line (EOL) programming requirements may drive other transceiver hardware behavior requirements not covered in this standard.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

IEEE 802.11

2.2 GM Standards/Specifications.

GMW3059

2.3 Additional References.

- CG4629 DSRC Performance Report.
- DSRC Statement of Requirements (SOR).
- Rhode and Schwarz (R&S) Signal and Spectrum Analyzer, 2 Hz to 26.5 GHz, Model FSW26 and R&S Vector Signal Generator (VSG), Model SMW200A available from Uniform Resource Locator (URL) https://www.rohde-schwarz.com.

3 Test Preparation and Evaluation

3.1 Resources.

3.1.1 Facilities. All tests are to be performed in an RF shielded room or enclosure that provides at least 100 dB of attenuation at 6 GHz.

3.1.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

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3.1.2 Equipment. All equipment is available from Uniform Resource Locator (URL) https://www.rohde-schwarz.com.

3.1.2.1 A Rhode and Schwarz (R&S) Signal and Spectrum Analyzer, 2 Hz to 26.5 GHz, Model FSW26, with the following options, shall be used to create the operating voltage without ripple, unless otherwise specified. **Note:** This instrument is referred in this standard as the Vector Signal Analyzer (VSA).

- FSW-B28 28 MHz analysis bandwidth.
- FSW-K91 IEEE 802.11 a/b/g measurements.
- FSW-K91P IEEE 802.11 p measurements.
- FSW-K6 Pulse measurements.

3.1.2.2 A R&S Vector Signal Generator (VSG), Model SMW200A, with the following options, shall be used to analyze and generate test waveforms. **Note:** This instrument is referred in this standard as the VSG.

- SMW-B106 RF Path A: 100 kHz to 6 GHz.
- SMW-B206 RF Path B: 100 kHz to 6 GHz.
- SMW-B13T Signal routing and baseband main modules, two IQ paths to RF.
- SMW-B10 Baseband generator with realtime coder and Arbitrary Waveform Generator (ARB) (64 Msample), 120 MHz RF bandwidth.
- SMW-K54 IEEE 802.11 a/b/g/n/j/p digital standard.
- SMW-B14 Fading simulator.
- SMW-K72 Enhanced fading models.

Note: Two (2) each of SMW-B10 and SMW-K54 are required.

3.1.3 Test Vehicle/Test Piece. The supplier shall provide any necessary hardware and software required to perform the tests specified in this standard.

3.1.4 Test Time.

Calendar time:	15 days
Test hours:	80 hours
Coordination hours:	6 hours

3.1.5 Test Required Information. See 3.7.1.

3.1.6 Personnel/Skills. The test personnel shall have a working knowledge of RF, VSGs, VSAs, fading and multipath simulators and other RF equipment. A working knowledge of computers, vehicle networking and data spreadsheets is also required.

3.2 Preparation. Not applicable.

3.3 Conditions.

3.3.1 Environmental Conditions. All transceiver measurements shall be taken at -40 °C + 2 °C, +23 °C + 2 °C, and +85 °C + 2 °C, all with a relative humidity of 30% to 70%, unless otherwise specified. **Note:** The upper temperature test point may be +105 ° C + 2 °C. Consult the DSRC Statement of Requirements (SOR).The Device Under Test (DUT) shall be powered and soak at the test temperature at least 1 h prior to commencing any tests.

3.3.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

Note: GM Development/Validation (Dev/Val) personnel must approve any device used for multipath fading tests in advance. Only those fading profiles specified and/or provided by GM shall be used. Units of measure shall be used as specified in this standard.

3.3.2.1 Operating voltage: 13.8 Volts Direct Current (VDC) ± 0.1 VDC.

3.3.2.2 All RF cable losses shall be measured and compensated for in the transceiver measurements.

3.3.2.3 All measurements shall be made at the low: 172/5.86 GHz, mid: 178/5.89 GHz, and high:184/5.92 GHz DSRC channels at the DUT antenna connector(s).

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3.3.2.4 Diversity systems shall test all available transmitters and receivers.

3.3.2.5 Transmitter default shall be maximum output power.

3.3.2.6 The Physical Layer Service Data Unit (PSDU) length for all transmit and receive packets shall be 1000 octets unless otherwise specified.

3.3.2.7 Packet transmission rate shall be at least 200 Packets per Second (PPS) for all tests unless otherwise specified.

3.3.2.8 All transmitter tests shall be evaluated using 1000 packet bursts unless otherwise specified.

3.3.2.9 All receiver performance tests must use an 802.11 p compliant Media Access Control (MAC) frame utilizing a conformant MAC header with fame check sum enabled and at least a PN9 (511-bit pseudo-random test pattern) for data frames.

3.3.2.10 Each modulation and coding rate shown in Table 1 shall be used for all tests.

Table 1: DSRC Supported Modulation and Coding Rates

Modulation	Coding Rate
Binary Phase Shift Keying (BPSK)	½ and ¾
Quadrature Phase Shift Keying (QPSK)	½ and ¾
16 Quadrature Amplitude Modulation (QAM)	½ and ¾
64 QAM	⅔ and ¾

3.4 Instructions. All tests and test methods outlined in Section 4 shall be executed, if not otherwise stated. Design Validation (DV) tests for each region shall be run for each sample/stage delivery.

3.5 Data. See 3.7.1.

3.6 Safety.

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

3.7 Documentation. Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM Department prior to the start of delivery of production level components or materials.

Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release.

If not otherwise agreed to, the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases, a shorter test can be agreed to between the responsible GM department and the supplier.

3.7.1 Test Results. The measurement results shall be documented in the separately available CG4629 DSRC Performance Report, with all plots included. The plots shall conform to the examples in Figure A1, Figure A2, Figure A3, Figure A4 and Figure A5 in Appendix A. CG4629 is provided by the Global Reception Work Group (GRWG) team through the Global Document Management (GDM) system internal to GM and as a supplement to this standard at the time of sale. The supplier shall use CG4629 and not a different format. General guidelines for completing CG4629 are as follows:

- Prior to performing the tests, the tester should become familiar with this standard and CG4629. This test results template does not include any test descriptions.

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- The test results shall be entered using the same word processing tools as GM.
- The supplier shall not change the acceptance criteria.
- All tests shall be performed. If a test is not possible or not applicable, the supplier shall provide the reason why the test was not performed.
- The supplier shall enter the actual result of the test in the "Test Result" cell, e.g., BPSK ½ RF Output = 23.28 dBm, and not simply "OK", "Not OK" (NOK) or left blank.
- Plots/VSA pictures of the transmitter Error Vector Magnitude (EVM), burst power, center frequency and symbol clock errors, IQ offsets, and receiver sensitivity graphs with and without impairment, etc., shall be added to the test report when available from the test equipment/setup. Additions to the test results, e.g., plots, shall be inserted directly after the respective paragraph. Where multiple results are shown the test result of interest shall be clearly identified. The plots shall conform to the examples in Figure A1, Figure A2, Figure A3, Figure A4 and Figure A5 in Appendix A.
- The supplier shall enter all the required information regarding the DUT hardware and software, as well as test equipment used and measured losses for cables used during testing, including, all the test and measurement uncertainties for the equipment used during testing. A copy of the manufacturer's uncertainty statements shall be provided, not simply as text indicating the uncertainty values.

4 Requirements and Procedure

4.1 Integration Requirements.

4.1.1 Transceiver Performance over Temperature. All requirements shall be met over the normal operating temperature range of -40 °C to +85 °C. **Note:** The normal operating range may be extended from +85 °C to +105 °C. Consult the DSRC Statement of Requirements (SOR).

4.1.2 Transceiver Performance over All Supported Frequencies. The transceiver shall be designed to perform similarly across all frequencies (including different regions).

4.1.3 Transceiver Performance over All Regions. The transceiver shall be software configurable to all operating regions specified in this standard.

4.1.4 End of Line (EOL) Programming Requirement. In support of using the same transceiver for multiple geographic regions with different RF and functionality requirements, the transceiver shall support programmable configuration of the features specified in this standard.

4.1.5 General Test Programming Requirements. The transceiver shall be capable of being configured to use a special transmitter/receiver test mode for the sole purpose of validating transceiver physical layer performance as specified in this document. The transceiver shall be configured via the vehicle communications bus/General Motors Local Area Network (GMLAN). Exceptions to communication bus/GMLAN configuration shall be made on a case by case basis.

4.1.5.1 Diagnostics Parameters. The transceiver shall be able to provide engineering diagnostic programming and information. The parameters that need to be available to the diagnostic subsystem are as specified in 4.1.5.1.1 and 4.1.5.1.2.

4.1.5.1.1 Transmit Parameters.

- Transmitter output power.
- Transmitter modulation and coding rate.
- Transmit frequency and/or channel.
- Transmit antenna port.
- Packet transmission rate (PPS).
- Transmitter PSDU length (octets).
- Number of transmission frames.

4.1.5.1.2 Receive Parameters.

- Receive frequency and/or channel.
- Receive antenna port.

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- Receiver Physical (PHY) layer acquisitions.
- Receiver PHY failed Signaling Field (SF).
- Receiver PHY valid frames.
- Receiver MAC Failed Frame Checksum (FCS).
- Receiver MAC valid data frames.
- Receiver MAC broadcast frames.
- Receiver Clear Channel Assessment (CCA) active firings.
- Receiver CCA idle firings.
- Receiver frame firings.
- Reset of link layer counter.
- Received Channel Power Indication (RCPI) report.

4.1.5.2 Diagnostics Communication Interfaces. The transceiver shall provide diagnostic messaging using hardware communication bus(es). At a minimum, these messages which provide access to the parameters of 4.1.5.1, shall be available on the transceiver GMLAN bus.

4.2 Transceiver Transmitter Requirements.

4.2.1 Transmitter Output Power.

4.2.1.1 Requirements. The Transmitter Burst Output Power shall be 24 dBm + 1dB for all modulation and coding rates.

4.2.1.2 Test Method.

a. Place the transceiver in diagnostic test mode.
b. Configure the transmitter for the antenna port under test, and the test channel/frequency.
c. Execute the transmitter test sequence utilizing 1000 packets at 200 PPS with a 1000 byte PSDU length.
d. Record the mean, minimum and maximum average packet output power (dBm) on the VSA in Wireless Local Area Network (WLAN) analysis mode using statistical analysis of at least 100 transmitted packets.

4.2.2 Packet-to-Packet Transmit Power Variation.

4.2.2.1 Requirements. The transmitter packet-to-packet transmit power variation for all modulation and coding rates shall be < 1 dB between the minimum and maximum recorded power for at least 50 consecutive packets.

4.2.2.2 Test Method.

a. Place the transceiver in diagnostic test mode.
b. Configure the transmitter for the antenna port under test, and the test channel/frequency.
c. Execute the transmitter test sequence utilizing at least 51 packets at 200 PPS with a 1000 byte PSDU length.
d. Record the mean, minimum and maximum average packet output power (dB) using the VSA in packet analysis mode, with a statistical analysis of all the transmitted packets.

4.2.3 Transmit Center Frequency Tolerance/Error.

4.2.3.1 Requirements. The transmitter center frequency tolerance/error shall be < ± 5 Parts per Million (PPM) for all modulation and coding rates.

4.2.3.2 Test Method.

a. Place the transceiver in diagnostic test mode.
b. Configure the transmitter for the antenna port under test, and the test channel/frequency.
c. Execute the transmitter test sequence utilizing 1000 packets at 200 PPS with a 1000 byte PSDU length.
d. Record the mean, minimum and maximum transmitter center frequency tolerance (PPM) using the VSA in WLAN analysis mode using statistical analysis of at least 100 transmitted packets.

4.2.4 Symbol Clock Frequency Tolerance/Symbol Clock Error.

4.2.4.1 Requirements. The symbol clock frequency tolerance/symbol clock error shall be < ± 5 PPM for all modulation and coding rates.

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4.2.4.2 Test Method.

a. Place the transceiver in diagnostic test mode.

b. Configure the transmitter for the antenna port under test, and the test channel/frequency.

c. Execute the transmitter test sequence utilizing 1000 packets at 200 PPS with a 1000 byte PSDU length.

d. Record the mean, minimum and maximum symbol clock frequency tolerance/symbol clock error (PPM) using the VSA in WLAN analysis mode using statistical analysis of at least 100 transmitted packets.

4.2.5 Transmit Spectral Mask.

4.2.5.1 Requirements. The transmit spectral mask for all modulation and coding rates shall meet the requirements as shown in Table 2 and Figure 1.

4.2.5.2 Test Method.

a. Place the transceiver in diagnostic test mode.

b. Configure the transmitter for the antenna port under test, and the test channel/frequency.

c. Execute the transmitter test sequence utilizing 1000 packets at 200 PPS with a 1000 byte PSDU length.

d. Record the specified power levels relative to the carrier peak (dB) for each carrier frequency offset and provide a plot of the spectral waveform capture with the spectral mask limit lines clearly shown. The VSA must be set to 100 kHz resolution bandwidth and 30 kHz video bandwidth for this measurement in WLAN analysis mode.

Table 2: Transmitter Spectrum Mask for 10 MHz Channel Bandwidth

Peak Transceiver Output Power	± 4.5 MHz Offset	± 5.0 MHz Offset	± 5.5 MHz Offset	± 10 MHz Offset	± 15 MHz Offset
0 dBr	0 dBr	< -26 dBr	< -32 dBr	< -40 dBr	< -50 dBr

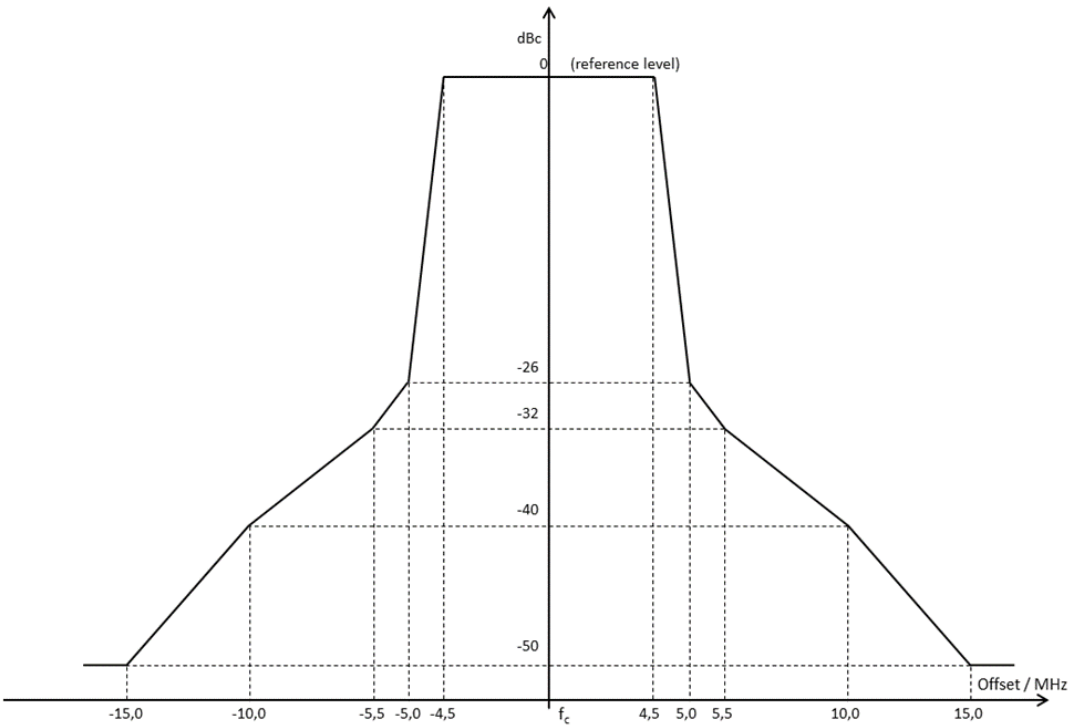

Figure 1: Transmitter Spectrum Mask for 10 MHz Channel Bandwidth

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