



Digital Television (DTV) Reception Drive Test (Including Korean Terrestrial Digital Multimedia Broadcasting (T-DMB))

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. The purpose of this standard is to determine the Digital Television (DTV) reception performance for all General Motors vehicles equipped with DTV option.

1.2 Applicability. This test procedure shall apply to all global vehicles equipped with audio visual system capable of reception of DTV Service. DTV includes Korea's Terrestrial Digital Multimedia Broadcasting (T-DMB), China Mobile Multimedia Broadcasting (CMMB) and Digital Terrestrial Multimedia Broadcast (DTMB) in China, Digital Video Broadcasting Terrestrial (Digital Video Broadcasting (DVB-T)) in Europe, Advanced Television Systems Committee (ATSC) in North America and Terrestrial Integrated Services Digital Broadcasting (ISDB-T) in Japan.

1.3 Remarks. The results of this test will be a reception quality subjectively measured by rating over each of the specified routes and a collection of Bit Error Ratio (BER) and a number of data measured by specified tool.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- CG4679, Korean T-DMB Reception Drive Test External Supplement to GMW17722
- Component Technical Specification (CTS)
- Subsystem Technical Specification (SSTS)
- Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities. Testing for DTV Service shall take place in the specific places which satisfy test conditions.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label. Test facilities and equipment shall be in good working order and shall have a valid calibration label if applicable, that is traceable to a national standards organization.

3.1.2 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.

3.2 Equipment. The test equipment shall be in good working order and shall have a valid calibration label. This test requires the following.

3.2.1 Spectrum analyzer (Vector Analyzer): For measuring electric field strength of each test location.

3.2.2 DTV reference antenna shall be connected with spectrum analyzer.

3.2.3 BER Measuring System: USB interface and laptop computer with BER test software.

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3.2.4 Alternating Current (AC)/Direct Current (DC) inverter.

3.2.5 Data sheets to record the subjective scores, electric field strengths and BER for each specific test location.

3.2.6 The reference vehicle is a vehicle designated, as specified by the Infotainment Test Group, and the antenna and receiver use the proven performance. (GM Korea uses a Malibu vehicle equipped with Kathrein back antenna and DAESUNG ELTEC's LVM receiver, or an equivalent vehicle with $\frac{1}{4}$ wave reference monopole antenna and DTV Receiver)

3.3 Test Vehicle/Test Piece. The vehicle under test shall be verified to have the intended DTV antenna and receiver system meeting the design requirement. Testing should be performed with any movable obstructions to the antenna (e.g., sunroofs, roof racks, etc.) moved to the least obstructive positions. Testing should be performed using the poorest performing antenna based on antenna component testing.

3.4 Test Time.

Calendar time: 4 days

Test time: 24 h

Coordination time: 8 h

3.5 Test Required Information. Record the following information for each of the test vehicles prior to testing:

- Antenna part number and serial number.
- Receiver part number, serial number, and software version.
- Test device RPO and manufacturer.
- Vehicle number.

3.6 Personnel/Skills. The test personnel shall have a valid driver's license and be familiar with the subjective scoring system required to evaluate the DTV receiver while driving and the operation of spectrum analyzer and BER system required to collect the electric field strength data.

4 Procedure

4.1 Preparation. The DTV network status should be checked to ensure DTV in the test area is operating normally.

4.1.1 Hardware and Software. The test vehicle shall have the correct version of hardware and software installed. The part number and software version shall be recorded on a data sheet. The test vehicle shall have the correct antenna hardware installed. Antenna and receiver type shall be recorded on a data sheet.

4.1.2 Field Strength. Spectrum analyzer (Vector Analyzer) or field captured system should be equipped in the vehicle to measure electric field strength with a DTV reference antenna located on the roof center of vehicle. AC/DC inverter should be connected between battery and spectrum analyzer to provide electric power.

4.1.3 BER System. BER system should be equipped to measure Bit Error Ratio. It consists of a PC and USB interface which is connected to DTV module with multimedia serial port. BER test software tool, NX3300EB1 Commander Driver and program, should be installed in the PC.

4.2 Conditions.

4.2.1 Environmental Conditions. Record weather conditions at the start and end of test.

4.2.2 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.

This procedure utilizes an un-weighted average jury listening method in conjunction with the Subjective Rating Scale (SR) to subjectively quantify the performance characteristics of the reception system under test relative to a reference vehicle (see Appendix A3 for a copy of the SR). Comparing the test vehicle's performance against a reference vehicle mitigates the effects of weather and variations in signal strength, from test to test.

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All of the scores from all of the jury members are averaged together to generate a final SR score for each vehicle for each test condition. The difference between the final averaged score of the vehicle under test and the reference vehicle is the Vehicle Delta Value and is defined by the following relationship:

$$\text{Vehicle Delta Value} = \text{Avg. SR}_{\text{VUT}} - \text{Avg. SR}_{\text{REF}}$$

Where:

Avg. SR_{VUT} is the final average score for the vehicle under test, and

Avg. SR_{REF} is the final average score for the reference vehicle.

Avg. = Average

4.2.2.1 Individual Vehicle Delta Values are calculated for each of the following validation test conditions:

- Overload: IM2, IM3, Others Channel Interference, AGC Threshold
- Multipath: Ghost by Typical Urban Area, Ghost by Typical Rural Area, Ghost by Doppler Frequency Shift
- Fringe: Threshold of Visibility (TOV) for input RF signal levels

4.2.2.2 The acceptable Vehicle Delta Value shall be specified in the Vehicle Technical Specification (VTS), Subsystem Technical Specification (SSTS) or Component Technical Specification (CTS) documents for the vehicle program under test. The following default criteria shall apply where the acceptable Vehicle Delta Value is not specified:

- For passive and active single antenna reception systems, the Vehicle Delta Value shall not be less than 1 SR point below that of the reference vehicle, for any of the validation test conditions listed in 4.2.2.1.
- For diversity reception systems, the Vehicle Delta Value shall not be less than the reference vehicle, for the DTV Multipath test condition, and not less than 1 SR point for all the other validation test conditions listed in 4.2.2.1.

4.2.3 Validation Test Methodology.

Evaluate the reception performance compared to $\frac{1}{4}$ wave reference monopole antenna (Isotropic gain is (0 ± 3) dBi for VHF Band III, UHF Band IV and V) as the reception quality is determined by combination result of antenna directionality and receiver performance. Use monopole antenna as reference which is not influenced by IM, AGC effect (passive and omni-directionality characteristic).

4.2.3.1 Overload. The purpose of this route is to validate the fidelity of the antenna system (active AUTs) and receiver in a mixed strong signal level (more than ATV or DTV Station power of -28 dBm for VHF and UHF band) and weak DTV station environment. Potential DTV overload issues are:

- 3rd order intermodulation (IM3).
- VHF band III and UHF band IV intrusion into UHF band V (IM2).
- AGC threshold dynamic behavior issues.
- Others (Co-, Adjacent, Alternative) Channel Interference.

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4.2.3.1.1 Third Order Intermodulation.

Intermodulation causes stations at other frequencies to mix and break in on the desired station as a result of 3rd order difference products defined by the following formula:

$$2(N+2) - (N+4) = N$$

Where:

(N+2) is the first station frequency,

(N+4) is the second station frequency, and

N is the 3rd order difference frequency. This is a problem when it is at the same frequency as the desired station.

4.2.3.1.2 Second Order Intermodulation.

The following 2nd order mixing formula applies when three transmitted signals are involved:

$$\text{VHF band III} + \text{UHF band IV} = \text{UHF band V}$$

Where:

VHF band III and UHF band IV are the transmitted frequencies UHF band V is the 2nd order IM2 frequency produced.

4.2.3.1.3 Others Channel Interference.

The DTV receiver and active antenna should not exceed the following thresholds for rejection of co-channel, Adjacent Channel Selectivity (ACS) and alternative-channel interference at the desired signal levels.

$$P_{U/D} \text{ dB} = 10 \log_{10} (P_U/P_D)$$

Where:

Ratios of signal levels, such as Undesired to Desired (U/D) signal level ratios, are expressed in dB:

P_U = Undesired signal level, are expressed in dBm

P_D = Desired signal level, are expressed in dBm

4.2.3.1.4 AGC Threshold.

Dynamic behavior issues are where intermittent intermodulation effects may be heard, such as audio distortion, alternate frequencies, and volume fluctuation. This phenomenon does not always occur at the highest signal amplitude.

- Choose appropriate AGC threshold level of tuner and active antenna to prevent the reception issue by IM and low AGC threshold in near to the transmitting tower.
- ACS evaluation shall be performed at the place where both the Analog and DTV signal is caught and can be substituted for Lab simulation.

4.2.3.2 Multipath. The purpose of this route is to validate the fidelity of the antenna system (active AUTs) and receiver in a fading signal DTV station environment. The potential DTV multipath issue defines two test routes as follows:

- a. Signal paths have different levels, loss of paths, levels, delay and phase of desired signal can be occurred from reflection by hill terrain and buildings between transmitter and receiver. Therefore, test route shall be chosen referred to the conditions of the spectrum data in each region, test vehicle speed shall be 80 km/h or less.
- b. Signals are Doppler shifted for moving receiver issues, purpose of this test is to evaluate the tuner performance of the receiver against Doppler shift when the vehicle is moving fast. Reception evaluation is performed at a speed of 120 km/h.

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