



AM/FM Reception Drive Test

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.

Note: In the event of a conflict between the text of this specification and the documents cited herein, the text of this specification takes precedence.

1.1 Purpose. The purpose of this test is to determine the Amplitude Modulation (AM) (530 kHz to 1710 kHz) and Frequency Modulation (FM) (87.9 MHz to 107.9 MHz) reception performance for all General Motors vehicles marketed and sold around the world. This document applies to passenger vehicles and light duty trucks.

1.1.1 This test subjectively determines the overall vehicle level reception performance in both the AM and FM frequency bands utilizing an unweighted average jury listening methodology. The AM and FM seek sensitivity test uses a simple percentage method. The systems are validated under the following test conditions:

- AM and FM Overload
- FM Multipath
- AM and FM Fringe
- AM and FM Seek Sensitivity
- Radio Data System (RDS) Testing in Europe (GM Europe (GME) only)
- AM and FM Mile/Kilometer Marker Evaluations (GM North America (GMNA) only)

1.1.2 In addition, the following optional developmental tests are performed to gain additional insight into the overall system performance:

- AM and FM Mile/Kilometer Marker Evaluations (GME/GM Holden (GMH) only)
- Power Line Intrusion
- AM and FM In-Band-On-Channel (IBOC) Seek Sensitivity (GMNA only)
- AM Reception Range

1.2 Applicability. This test procedure shall apply to passive and active antennas along with all receiver tuner implementations. This procedure is applicable to the development and validation of antenna systems for new vehicle programs as well as design changes for current vehicles.

1.3 Remarks. The results of this test will be used to determine if the AM and FM reception system meet(s) the requirements of:

- The Vehicle Technical Specification (VTS) of the particular vehicle program being evaluated
- Any particular vehicle level requirements detailed in Component Technical Specifications (CTS) or Subsystem Technical Specifications (SSTS) or Global Infotainment Standard (GIS)
- If no other requirements exist within the aforementioned documents, the default values called out in the methodology section of this document shall be used

Note: This document is one out of a series of four global antenna and reception documents, which specify antenna, radio, and reception test and validation requirements. The complete series consists of the following documents: GMW15650, GMW15649, GMW15648, and GMW16273. Additional antenna information can be found in the Infotainment Global Subsystem Leadership Team Global Infotainment Standard (GSSLT GIS) documents: GIS 24, GIS 46, GIS 65 and GIS 90.

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2 References

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

2.1 External Standards/Specifications.

IEEE 185-1975 ISO 17025

2.2 GM Standards/Specifications.

GMW3091	GMW14264	GMW15650
GMW3097	GMW15649	GMW16273

2.3 Additional References.

- Component Technical Specification (CTS)
- GIS 24 - Silverbox/AM-FM Antenna Interface Specification
- GIS 46 - AM/FM Antenna System Design
- GIS 65 - On-Display Diagnostics Requirements
- GIS 90 - AM/FM Antenna Component Performance Specification
- Impedance and Range Study Workbook (IRSW) Work Instruction
- Subsystem Technical Specification (SSTS)
- Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities.

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

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.

3.1.3 General Motors Brazil (GMB). Located at the Cruz Alta Proving Ground (CAPG) in the Indaiatuba, São Paulo, Brazil, the Proving Ground shall be used to conduct the reception drive pre-tests (Voltage Standing Wave Ratio (VSWR), antenna impedance, and resistance measurements). Refer to GMW15650.

3.1.4 General Motors Korea (GMK). The Korean Manufacturers' Range located in South Korea shall be used if antenna polar pattern measurements are necessary.

GMW15650 shall be used to conduct the reception drive pre-tests:

- Voltage Standing Wave Ratio (VSWR)
- Antenna impedance
- Resistance measurements

Refer to Institute of Electrical and Electronics Engineers (IEEE) IEEE 185-1975 for:

- Amplitude Modulation/Frequency Modulation (AM/FM) Tuner Blend Curve
- FM Multipath Reduction Strategy
- AM/FM Frequency Response measurements

Refer to GMW16273, GIS 24, and GIS 46 for:

- Automatic Gain Control (AGC) Threshold Level of Active Antenna
- AGC Threshold Level of AM/FM Tuner

3.1.5 General Motors Europe (GME). The European Antenna Ranges, located at the Pferdsfeld Proving Ground in Germany or the Millbrook Proving Ground in Great Britain (development site), shall be used if antenna polar pattern measurements are necessary. The Building P30 antenna Electromagnetic Compatibility (EMC) test lab, located at the International Technical Development Center in Rüsselsheim, Germany, shall be used to conduct the reception drive pre-tests (VSWR, antenna impedance, and resistance measurements). Refer to GMW15650.

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3.1.6 General Motors Holden (GMH). The Holden Proving Ground located at Lang Lang, Victoria, Australia is an outdoor secure site that can be used for AM/FM testing along with the Holden Electrical Lab at Port Melbourne, Victoria, Australia. Reception drive pre-tests are under development along with AM gain capability.

3.1.7 General Motors North America (GMNA). Located at the Milford Proving Ground (MPG) in the United States, the MPG Range shall be used if antenna polar pattern measurements are necessary. The Building 40 antenna test personnel, located at the Milford Proving Ground, shall be used to conduct the reception drive pre-tests (antenna impedance/resistance and radio tuner measurements). Refer to GMW15650 (including Impedance and Range Study Workbook (IRSW) Work Instruction) and GMW16273.

3.1.8 General Motors Thailand (GMTH). The Rayong Assembly Plant in Rayong, Thailand can be used for pre-test vehicle checks.

3.2 Equipment. External calibration laboratories that are accredited to ISO 17025 shall be used to calibrate applicable equipment that is used for the testing outlined in this procedure.

Emission measurements of the test laptops and inverters shall be made on a yearly basis per the International Special Committee on Radio Interference (CISPR) 25 test method using the non-spark radiated emissions AM and FM requirements in GMW3097.

See GMW15650 for a complete listing of equipment needed to perform the pre-tests (VSWR, impedance, and resistance measurements). Suggested test equipment for the reception drive test is listed as follows:

3.2.1 Two, 2-way radios per vehicle.

3.2.2 Test laptop and Alternating Current/Direct Current (AC/DC) inverter per vehicle.

3.2.3 First aid kit.

3.2.4 Booster pack for jump starting vehicles.

3.2.5 Duct tape.

3.2.6 Radio capable of displaying field strength information.

3.2.7 European RDS capable radio with engineering interface with test modes enabled.

3.2.8 Audio switch box.

3.2.9 Antenna switch box.

3.2.10 Audio recording device.

3.2.11 Test route maps and instructions.

3.2.12 AM/FM magnetic mount antenna and associated coaxial cable (for troubleshooting Overload reception issues).

3.2.13 GMB. The GMB reference vehicle is a 2006 Chevrolet S10 Blazer with a Delphi radio and front 76 cm front fender mount antenna.

3.2.14 GMK. The reference vehicle is a Chevrolet Orlando with a Laird rod antenna on the rear roof, and it may include an additional radio.

3.2.15 GME. The reference vehicle is an Opel Vectra hatchback with a diversity system and rod antenna, and it may include an additional test radio.

3.2.16 GMH. The reference vehicle is a previous generation or a best in class competitive vehicle. It may also include an additional test radio and/or antenna.

3.2.17 GMNA. The reference vehicle is a 2012 GMC Sierra Crew Cab Pickup or an equivalent vehicle, as specified by the Infotainment test group, with a passive rod antenna.

3.2.18 GMTH. The reference vehicle is a previous generation or a best in class competitive vehicle. It may also include an additional test radio and/or antenna.

3.3 Test Vehicle/Test Piece. The specified reference vehicle, as listed for each region, and test vehicles shall be in good working order.

The number of test vehicles required is determined by the number of antenna/receiver combinations for the vehicle program; however, the maximum number of test vehicles for a given reception drive test is limited to six (6) including the reference and/or benchmark vehicle. A second reception drive test may be necessary to accommodate additional test vehicles. The ride trip captain should verify the latest level hardware and software version parts are on the test vehicles.

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3.3.1 Antenna Under Test. The Antenna Under Test (AUT) shall be in a production-ready state and have passed all applicable component-level tests for validation verification. For development evaluations, this requirement may not be applicable. The AUT is comprised of any of the following: Receiver coax, passive matching network (passive module), active matching network (active module), coax interconnects, and the antenna element(s).

3.3.2 Receiver Under Test. The receiver shall be in a production ready state and have passed all applicable component level tests and shall be programmed for the test vehicle.

3.4 Test Time.

Calendar time:	GMB:	4 days to 5 days
	GMK:	6 days
	GME:	15 days
	GMH:	4 days to 5 days
	GMNA:	4 days to 5 days
	GMTH:	10 working days (including time for troubleshooting)
Test hours:	GMB:	16 h
	GMK:	24 h
	GME:	105 h to 120 h
	GMH:	24 h
	GMNA:	18 h to 20 h
	GMTH:	60 h
Coordination hours:	GMB:	5 h to 6 h
	GMK:	24 h
	GME:	20 h to 35
	GMH:	16 h
	GMNA:	5 h to 6
	GMTH:	20 h

3.5 Test Required Information. The following information shall be recorded for each of the test vehicles prior to testing:

- Vehicle number
- Antenna elements part number and serial number
- Antenna module(s) part number and serial number
- Receiver part number, serial number, and software level
- Coaxial cable part number

Record the following test conditions:

- Start of Test (SOT) weather conditions and time
- End of Test (EOT) weather conditions and time

Occasionally, due to station transmitter issues or environmental changes (e.g., AM or FM ducting, solar flares, thunderstorms, etc.), actual test frequencies will differ from those stated in this document and shall be recorded.

3.6 Personnel/Skills. Test personnel shall be familiar and qualified in the application of the Subjective Rating Scale method, GMW14264, as it applies to audio performance parameters particular to AM and FM reception systems. A working knowledge of computers and data spreadsheets is also required. Participants, who drive during the test, must possess a valid driver license and have the ability to drive vehicles equipped with manual or automatic transmissions. All evaluators shall have average (or better) hearing capability.

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4 Procedure

4.1 Preparation.

4.1.1 Vehicle Preparation. The following parameters shall be measured and verified on each test vehicle prior to conducting a reception drive test per GMW15650 antenna impedance, coax shield ground resistance, and receiver case ground resistance.

The following parameters may be measured and verified on each test vehicle, prior to conducting a reception drive test per GMW15650, GMW15649, and GMW3091, at the discretion of the test engineer:

- Antenna gain, directionality, and noise figure.
- Vehicle radiated emissions to identify and/or fix potential emitters prior to the reception drive test.

The reference vehicle, as described in 3.2, shall be tested quarterly for antenna impedance, coax shield ground resistance, receiver case ground resistance, gain, and directionality to ensure that the antenna system has not changed and is within specified limits. It should not be used as a reference vehicle if it does not meet the requirements listed in GMW15650.

Prior to leaving the responsible region's home base, each vehicle shall be fueled and cleaned. All required equipment listed in 3.2 shall be installed in each vehicle. For vehicles that have camouflage security restrictions, one roll of duct tape shall be placed in the vehicle in case the soft camouflage panels loosen or become partially detached during the trip.

4.1.2 Drive Test Preparation. Proper safety protocol shall be followed and the mandatory ride trip documentation shall be filed with the Security and Traffic Safety groups as necessary for each region.

4.2 Conditions.

4.2.1 Environmental Conditions. The AM/FM reception drive test may be run during most types of weather conditions; however, it may be cancelled at the discretion of the trip captain for safety reasons, or if it is deemed that the overall reception performance will be compromised due to weather extremes such as violent electrical storms, solar flares, etc.

For all AM testing, the test shall run during daylight hours no earlier than 1 h after sunrise and no later than 1 h before sunset.

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 unweighted 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 A, Section A7 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.

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.

AVG SR_{ref} is the final average score for the reference vehicle.

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

- AM Overload
- FM Overload
- FM Multipath
- AM Fringe
- FM Fringe
- AM noise suppression (audio reduction under bridges, tunnels - GME only)
- FM noise suppression (audio reduction under bridges, tunnels, Mono/Stereo blend - GME only)

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4.2.2.2 The acceptable Vehicle Delta Value shall be specified in the VTS, SSTS or 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 non-diversity reception systems, the Vehicle Delta Value shall not be < 1.0 SR point below that of the reference vehicle, for any of the validation test conditions listed in 4.2.2.1. **In the case where the vehicle under test is the next generation of the reference vehicle, the Vehicle Delta Value shall not be less than 0 SR.**

For diversity reception systems, the Vehicle Delta Value shall not be less than the reference vehicle, for the FM Multipath test condition, and not < 1.0 SR point for all the other validation test conditions listed in 4.2.2.1.

Table 1: Default Performance Requirements

AM/FM Antenna Type	Required Vehicle Delta Point	Validation Test Condition	Region
Passive Fixed Mast, Active Non-diversity	≥ -1.0 SR	AM/FM Overload, AM/FM Fringe, FM Multipath	All
Passive Fixed Mast, Active Non-diversity	≥ -1.0 SR	FM European RDS	GME
Active Diversity	≥ 1.0 SR	FM Multipath, FM European RDS	GMK, GME
Active Diversity	> 0 SR	FM Multipath	GMB, GMNA
Active Diversity	≥ -1.0 SR	AM/FM Overload, AM/FM Fringe	All
All	$\geq 90\%$ of number of stations reference vehicle seeks to	AM/FM Seek Sensitivity	All
All	≥ -2.0 SR	AM/FM Mile Markers	GMNA
All	SR ≥ 5.0 (overall average, not a delta to the reference vehicle)	FM Overload	GMNA

For all antenna types, performance shall be equal or better than the previous generation reference vehicle and/or best in class in all test conditions. **Note:** The evaluation scores are averaged and then rounded to one decimal point.

4.2.3 Validation Test Methodology. The following (4.2.3.1 thru 4.2.3.6) describes each of the individual route segments and their associated reception related impacts.

All extraneous electronic equipment shall be unplugged or turned off (e.g., cell phones, cell phone chargers, inverters, test equipment). It is recommended that computer laptops are powered down during Fringe testing. Two-way radios may be left on, but not used during testing. There shall not be rear seat passengers in backglass antenna vehicles.

All AM testing shall be done 1 h after sunrise and completed prior to 1 h before sunset.

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4.2.3.1 FM Overload. The purpose of this route is to validate the fidelity of the antenna system (active AUTs) and receiver in a mixed strong and weak FM station environment. Potential FM overload issues are:

- 2nd and 3rd order intermodulation (IM)
- FM desensitization
- FM intrusion into AM (i.e., FM IM2) and
- AGC threshold dynamic behavior issues

Intermodulation causes stations at other frequencies to mix and break in on the desired station as a result of either 2nd or 3rd order difference products defined by the following formulas:

$A + B = 2^{\text{nd}}$ Order Intermod frequency (e.g., AM IM2)

$A - B = 2^{\text{nd}}$ Order Intermod frequency (e.g., FM IM2 or AM IM2)

$2A - B = 3^{\text{rd}}$ Order Intermod frequency (e.g., FM IM3 or AM IM3)

$A + B - C = 3^{\text{rd}}$ Order Intermod frequency (e.g., FM IM3 or AM IM3)

Where:

A is the first broadcast station frequency

B is the second broadcast station frequency

C is the third broadcast station frequency

Desensitization describes loss of receiver sensitivity when reception of a weaker signal is degraded by a nearby strong signal, but no break-in occurs.

FM intrusion into the AM band occurs when the frequency difference between two nearby FM stations equals the frequency of a nearby AM station. Little or no modulation from the FM station is normally heard. This is also called FM IM2.

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.

GMNA test frequencies example:

The calculations for the actual frequencies in the GMNA test route area are:

- FM IM3

$$2 \times (94.7 \text{ MHz}) - 95.5 \text{ MHz} = 93.9 \text{ MHz}$$

- FM IM3

$$2 \times (105.9 \text{ MHz}) - 105.1 \text{ MHz} = 106.7 \text{ MHz}$$

- FM IM3

$$105.9 \text{ MHz} + 93.1 \text{ MHz} - 105.1 \text{ MHz} = 93.9 \text{ MHz}$$

- FM IM3

$$105.1 \text{ MHz} + 93.1 \text{ MHz} - 95.5 \text{ MHz} = 102.7 \text{ MHz}$$

- FM IM2

$$95.5 \text{ MHz} - 93.9 \text{ MHz} = 1.6 \text{ MHz}$$

- Desensitization of 93.9 MHz by 93.1 MHz

4.2.3.1.1 GMB. The test location is the Paulista Avenue area in São Paulo, Brazil. There are fourteen FM transmitters in the immediate area, with some stations over 90 dBμV. The signal strengths of the test frequencies range is between 55 dBμV to 65 dBμV. Several high power FM and television (TV) transmitters are located nearby. The test frequencies are: 93.7 MHz, 100.1 MHz, 107.3 MHz and 1600 kHz.

4.2.3.1.2 GMK. The test location is the Nam-san Library parking lot area near the Seoul tower in Seoul, South Korea. There are nine (89.1 MHz, 89.7 MHz, 90.7 MHz, 91.9 MHz, 93.9 MHz, 95.1 MHz, 99.1 MHz, 101.9 MHz, 105.3 MHz, and 106.1 MHz) FM transmitters in the immediate area, with four (89.1 MHz, 91.9 MHz, 93.9 MHz,

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and 95.1 MHz) of the stations over 90 dB μ V. The signal strengths of the test frequencies (91.1 MHz and 95.9 MHz) range between 18 dB μ V to 74 dB μ V.

4.2.3.1.3 GME. The test location is the Feldberg area in Hessen, Germany. There are five FM transmitters in the immediate area, with five of the stations over 100 dB μ V. The signal strengths of the test frequencies range between 60 dB μ V to 70 dB μ V.

4.2.3.1.4 GMH. The test location is Mount Dandenong, Victoria, Australia (Location 12 - in area of transmitters and Location 13 - under towers). The test frequencies are 91.5 MHz, 100.3 MHz, 101.1 MHz, 101.9 MHz, 104.3 MHz, 105.1 MHz, 105.9 MHz, and 107.5 MHz.

Record both the average and worst case rating for each test frequency.

The test location is Eyre Road/Burkes Lookout, Mount Dandenong, Victoria, Australia. The test frequencies are 100.3 MHz, 101.9 MHz and 104.3 MHz. The same route is used for FM intrusion into AM, and the test frequencies are 693 kHz and 774 kHz.

4.2.3.1.5 GMNA. AM and FM Overload transmit stations' maximums vary from 88 dB μ V to 117 dB μ V using peak detector and maximum hold.

4.2.3.1.6 GMTH. The test location is Vipavadee Rangsit Road in Bangkok. The test frequencies are 91.00 MHz, 93.00 MHz, 95.50 MHz, 105.50 MHz. The signal strengths range between 40 dB μ V to 60 dB μ V.

4.2.3.1.7 Pan Asia Technical Automotive Center (PATAC). The test location is the Lujiazui area near Oriental Pearl Tower in Pudong District, Shanghai, China. There are eleven (89.9 MHz/90.9 MHz/93.4 MHz/97.2 MHz/97.7 MHz/98.1 MHz/99.0 MHz/101.7 MHz/103.7 MHz/105.7 MHz/107.7 MHz) FM transmitters in the immediate area. The test frequencies are 89.9 MHz, 93.4 MHz, 97.7 MHz, 99.0 MHz, 101.7 MHz, 103.7 MHz, and 107.7 MHz.

4.2.3.2 FM Multipath. The purpose of this route is to ensure the fidelity of the antenna system and receiver in a multipath environment. Multipath effects are the result of secondary time distorted signal reflections out of phase with the first. A common cause of this is signal reflection off of tall buildings and structures, as well as naturally occurring features on the landscape. When the non-line-of-sight reflected signals arrive at the antenna, they may add to or subtract from the original line-of-sight signal from the transmitting tower. When they subtract, the total received signal strength is lower and an audio dropout may be heard. The distance between these signal nulls is half a wavelength which is 1.5 m for the FM band, so care must be taken to drive slowly enough that the effect can be observed.

Multipath effects can be characterized by picket fencing or fluttering artifacts in the audio information. Another identifiable multipath effect is the presence of sibilants of the "s" and "z" sounds. This makes "s" sound more like "shhh", for example. A time averaged score is recorded for the entire loop, for each test frequency.

4.2.3.2.1 GMB. The test is performed driving a loop for each frequency at Itapecuru Alameda in Alphaville, São Paulo, Brazil. This location has tall buildings and some natural obstacles. The test frequencies are 92.1 MHz (Sulamerica) and 103.3 MHz (Cultura). The typical signal strength in this area is 50 dB μ V to 70 dB μ V, with swings around 20 dB.

4.2.3.2.2 GMK. Station 93.1 MHz (KBS-1 Classic Music FM) on the Gwanaksan tower, provides a consistent multipath environment on Yeoi-do, Seoul, South Korea. A loop is driven around the west end of Yeoi-do. A time averaged score is recorded for the entire loop, for each frequency.

Short Route: The evaluation is done around the National Assembly Building.

Long Route: The evaluation is done on the North Riverside Road (Seo-kang Bridge to Won-Hyo Bridge).

The typical signal strength in this area is 32 dB μ V to 92 dB μ V with maximum to minimum swings > 60 dB.

4.2.3.2.3 GME. The multipath testing is done in three different test routes. The typical signal strengths in these areas are 10 dB μ V to 60 dB μ V with maximum to minimum swings > 50 dB.

4.2.3.2.3.1 South European Test Route. See Appendix B for test frequencies and route details.

4.2.3.2.3.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.2.3.3 Rüsselsheim Area Route (Geinsheim, Bacherach, Mörfelden). See Appendix B for test frequencies and route details.

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4.2.3.2.4 GMH. The test location is Stanley Street, West Melbourne, Victoria, Australia (Global Positioning System (GPS) coordinates 37° 48' 28" S, 144° 56' 58" E). The test frequencies are 100.3 MHz, 101.9 MHz, 103.5 MHz and 105.1 MHz.

4.2.3.2.5 GMNA. FM Multipath stations maximums vary from 67 dBμV to 70 dBμV using peak detector and maximum hold. The maximum to minimum signal ratio is > 30 dB.

4.2.3.2.6 GMTH. The test location is a loop between Silom Road and Suwarong Road in Bangkok. The test frequencies are 91.00 MHz, 93.00 MHz, 95.50 MHz, 105.50 MHz. The signal strengths vary from 40 dBμV to 70 dBμV.

4.2.3.2.7 PATAAC. Stations 103.7 MHz and 105.7 MHz in Luhang Town provide a consistent multipath environment. A loop starts from Gutang Road across Shangfeng Road, goes along with Gutang Road and turns right at Kayuan No.1 Road, then turns right at Kayuan No.2 Road, and then turns right at Shangfeng Road, goes straight to the starting point.

4.2.3.3 AM Overload. The purpose of this route is to ensure the fidelity of both the antenna performance (active AUTs) and the receiver in a strong AM signal environment. Potential AM overload issues are:

- Receiver desensitization
- Adjacent-channel rejection
- Receiver second harmonic distortion
- Tuner overload
- AGC threshold dynamic behavior issues, and
- Out-of-band signal rejection capability

4.2.3.3.1 GMB. The test location is in **Centro de Tradições Nordestinas (CTN)**, located on Jacofer Street, 615, (which is in the intersection between Júlio de Mesquita Neto Bridge and Marginal Tiete), São Paulo, Brazil. The test frequencies are 660 kHz and 1230 kHz. The transmitter located there uses 50 kW. The AM signal strength there is 120 dBμV.

4.2.3.3.2 GMK. The test location is the shopping district near the KBS-1 Radio transmitter (tower located in Yeoncheon) which transmits at 918 kHz using 50 kW both day and night. AM signal strength is typically > 90 dBμV.

Test time is between 10:00 AM and 3:00 PM. The test frequency for the static test is 918 kHz. The test is done with an attenuator as a root-cause tool with the attenuator added to the input of the radio. The test frequencies for the driving test are 792 kHz and 837 kHz. Initialize the trip meter of the vehicle to zero. While moving the vehicle slowly along the test route at a speed of 20 to 30 km/h, record the trip data when the noise and interference signal is received.

4.2.3.3.3 GME. The AM Overload testing is done in two different test routes. The typical signal strengths in these areas are 60 dBμV to 100 dBμV.

4.2.3.3.3.1 United Kingdom Test Route (Rugby). See Appendix B for test frequencies and route details.

4.2.3.3.3.2 Rüsselsheim Area Route (Mainflingen, Saarbrücken, Berus). See Appendix B for test frequencies and route details.

4.2.3.3.4 GMH. The preferred test location is Sydenham Road, Delahey, Victoria, Australia (GPS coordinates 37° 43' 11" S, 144° 47' 19" E). Broadcast frequency 774 kHz, power 50 kW.

Other test locations are Stawell Road, Lower Plenty, Victoria, Australia (Broadcast frequencies 927 kHz, 1026 kHz, 1116 kHz, 1179 kHz, 1278 kHz, and 1503 kHz), and George Knox Drive, Rowville, Victoria, Australia (Broadcast frequency 1377 kHz).

4.2.3.3.5 GMNA. AM Overload transmit stations maximums vary from 106 dBμV to 116 dBμV using peak detector and maximum hold. AM Overload "victim" stations maximums vary from 64 dBμV to 70 dBμV using peak detector and maximum hold.

4.2.3.3.6 GMTH. The test location is Vipavadee Rangsit Road in Bangkok. The test frequencies are 819 kHz, 837 kHz, 891 kHz, and 918 kHz. The signal strengths range between 40 dBμV to 60 dBμV.

4.2.3.4 FM Fringe. The purpose of this route is to ensure the fidelity of the antenna system and receiver in a weak signal area, where the number of radio stations are limited. This results in a low FM noise floor and minimizes adjacent-channel and co-channel interference issues. This test should be conducted in area free from

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obstructions to minimize multipath. This test, along with GMW15650 is used to verify antenna gain, antenna directionality, receiver sensitivity, and antenna receiver integration performance. The test is performed by tuning to each of the test frequencies and driving a set route to exercise the system.

4.2.3.4.1 GMB. The FM fringe is done at kilometer 55 from Sao Paulo (SP) SP 157 - Aristides de Costa Barros Road. This road is located at exit kilometer 162 of Castelo Branco Highway, Guarei, São Paulo, Brazil. The test frequencies are 91.7 MHz, 103.1 MHz and 104.3 MHz. Typical signal strength in this area is approximately 20 dBμV to 35 dBμV.

4.2.3.4.2 GMK. The test location is Yeoncheon, South Korea. The test frequencies are: 91.9 MHz, 93.1 MHz, 95.9 MHz, and 107.7 MHz. See 4.3 for route details. Typical FM signal strength in this area is approximately 13 dBμV to 30 dBμV.

Note: FM Subjective radio frequency interference (RFI) Test is performed at this location based upon EMC Test Results.

4.2.3.4.3 GME. The FM Fringe testing is done in three different test routes. The typical signal strengths in these areas are 5 dBμV to 25 dBμV.

4.2.3.4.3.1 South European Test Route. See Appendix B for test frequencies and route details.

4.2.3.4.3.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.4.3.3 Rüsselsheim Area (Geinsheim, Allertshofen, Mörfelden) Test Route. See Appendix B for test frequencies and route details.

4.2.3.4.4 GMH. The preferred test location is Tarago Reservoir, Neerim South, Victoria, Australia. (GPS coordinates 38° 01' 14" S, 145° 56' 26" E). Test frequencies are 88.6 MHz, 91.5 MHz, 94.7 MHz, 101.5 MHz and 103.1 MHz. Other test location is Buxton, Victoria, Australia. (GPS coordinates 37° 25' 34" S, 145° 42' 22" E). The test frequencies are 100.3 MHz, 101.1 MHz, 105.1 MHz, 105.9 MHz.

4.2.3.4.5 GMNA. FM Fringe stations maximums vary from 45 dBμV to 52 dBμV using peak detector and maximum hold.

4.2.3.4.6 GMTH. The test location is Nong Yai, Chonburi. The test frequencies are 105.50 MHz and 107.75 MHz. The signal strengths vary from 20 dBμV to 40 dBμV.

4.2.3.4.7 PATAC. The test location is Shangfeng Road parking lot, Pudong District, Shanghai, China. The test frequencies are 88.7 MHz, 90.6 MHz, 96.2 MHz, 100.1 MHz, 100.3 MHz, and 102.7 MHz.

4.2.3.5 AM Fringe. The purpose of this route is to ensure the fidelity of the antenna system and receiver in a weak signal area where the number of radio stations in the area is limited. This results in a low AM noise floor and minimizes adjacent-channel and co-channel interference issues. This test should be conducted in an area free from obstructions and overhead power lines to minimize reflections and interference. This test, along with GMW15650, is used to verify antenna gain, receiver sensitivity, and antenna receiver integration performance.

AM directionality is not tested due to its long wavelength. Testing is done with the test vehicles parked for GMNA and GMK only. Testing of electric hybrid vehicles is done dynamically. For this special case, the vehicles are driven and evaluated both with the hybrid mode active and also with it inactive to evaluate the degradation contributed by the additional EMC noise generated by the hybrid system and controllers.

Each test frequency is evaluated with engine on and engine off. The result of the "engine on" score minus the "engine off" score is the EMC degradation of reception quality. Antenna gain and vehicle noise floor effects are the primary system characteristics for this test.

4.2.3.5.1 GMB. The test location is parked at Rodoserv Sorriso, Castello Branco Highway - kilometer 198 west, Pardinho, São Paulo, Brazil. The test frequencies are 620 kHz (Jovem Pan), 1000 kHz (Record) and 1100 kHz (Globo). The typical AM signal strength in this area is approximately between 20 dBμV and 35 dBμV.

4.2.3.5.2 GMK. The test location is playground Yeoncheon. The test frequencies are 639 kHz, 792 kHz, 837 kHz, and 900 kHz.

Typical AM signal strength is 30 dBμV to 40 dBμV.

An AM Subjective RFI Test is performed at this location based upon EMC Test Results.

4.2.3.5.3 GME. The test location is the Pferdsfeld Proving Ground in Germany or the Hassloch B 486 parking lot in Germany.

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The test frequencies for the Pferdsfeld location are 531 kHz, 711 kHz, 1180 kHz, 1278 kHz, 1320 kHz, and 1539 kHz.

The test frequencies for the Hassloch location are 531 kHz, 594 kHz, 756 kHz, 1422 kHz, and 1539 kHz.

4.2.3.5.4 GMH. The preferred test location is Tarago Reservoir, Neerim South, Victoria, Australia (GPS coordinates 38° 01' 14" S, 145° 56' 26" E). Test frequencies are 558 kHz, 900 kHz, 1134 kHz, and 1278 kHz.

Other test location is Buxton, Victoria, Australia (GPS coordinates 37° 25' 34" S, 145° 42' 22" E). The test frequencies are 558 kHz, 594 kHz, 882 kHz, 1071 kHz and 1566 kHz.

4.2.3.5.5 GMNA. AM Fringe stations maximums vary from 20 dBμV to 28 dBμV using peak detector and maximum hold.

4.2.3.5.6 GMTH. The test location is Nongyai, Chonburi. The test frequencies are 837 kHz, 774 kHz, and 891 kHz. The signal strengths vary from 20 dBμV to 40 dBμV.

4.2.3.5.7 PATAC. The test location is Shangfeng Road parking lot, Pudong District, Shanghai, China. The test frequencies are 684 kHz, 702 kHz, 738 kHz, 756 kHz, 1080 kHz, and 1323 kHz.

4.2.3.6 European FM RDS Reception. Currently, the only region with a fully functional RDS network is Europe. The purpose of this test is to evaluate FM RDS system performance. Testing is required for vehicles sold in Europe and testing can only be performed in Europe.

4.2.3.6.1 GMB. GME marketed vehicles only.

4.2.3.6.2 GMK. GME marketed vehicles only.

4.2.3.6.3 GME. The FM RDS testing is done in three routes.

4.2.3.6.3.1 South European Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.3 Rüsselsheim Area (Bacharach, Koblenz-Trier, Saarbrücken-Luxenburg) Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.4 Alternative Frequency (AF) Switching Behavior. The purpose of the testing is to quantify AF switching. Tune to the best alternative frequency. If the field strength of an alternative frequency is > 6 dB or the quality indicator is one step higher than the tuned frequency, the radio shall be switched to the stronger alternative frequency.

No wrong modulation (i.e., no program content change) is allowed during alternative switching or checking of the alternative frequencies. Testing is done in three routes.

4.2.3.6.3.4.1 Alps Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.4.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.4.3 Rüsselsheim Area Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.4.4 Performance Requirements.

4.2.3.6.3.4.4.1 Single Tuner. Equal to or less than mutes from the reference radio.

Only one wrong modulation of an approved alternative frequency, after 50 km, is allowed according to the reference single tuner.

4.2.3.6.3.4.4.2 Double Tuner. No mutes for checking alternative frequencies and no wrong modulation.

4.2.3.6.3.5 Tunnel Switching Behavior. The purpose of the test is to evaluate the tuner's ability to properly switch in a tunnel environment. After entering the tunnel, the tuner has to switch without any disturbances and audio interruptions to the tunnel AF. After leaving the tunnel, the tuner has to switch to the best available alternative frequency outside the tunnel without any disturbances and audio interruption.

The test is passed if all AF changes happen without disturbances, audio interruption, and tuning to a wrong station. The testing is done during the Alps Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.5.1 Performance Requirements.

4.2.3.6.3.5.1.1 Single Tuner. Equal or less mutes than the reference radio.

Better or equal behavior as the reference unit according to the test template.

4.2.3.6.3.5.1.2 Double Tuner. No mutes for checking the alternative frequencies.

Better or equal behavior as the reference unit according test template.

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4.2.3.6.3.6 Enhanced Other Network-Traffic Announcement (EON-TA) Switching Behavior. The purpose of this test is to evaluate EON-TA switching behavior. Every time the EON-TA threshold is passed, the EON-TA station shall be tuned.

If the RDS-synchronization is lost during the EON-TA message, the radio shall automatically switch to the tuned station after the timer requirements are fulfilled.

EON-TA program service name (PSN) shall be shown out of the FM-Memory immediately after switching to the EON-TA station. Testing is done in three routes.

4.2.3.6.3.6.1 Alps Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.6.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.6.3 Rüsselsheim Area Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.6.4 Performance Requirements.

4.2.3.6.3.6.4.1 Single Tuner. When checking the EON-TA message, there shall be equal or less mutes as the reference radio.

Better or equal EON-TA behavior as the reference unit according to the test template.

4.2.3.6.3.6.4.2 Double Tuner. No mutes for during checking of the EON-TA message the alternative frequencies.

Better or equal EON-TA behavior as the reference unit according test template.

4.2.3.6.3.7 Traffic Message Channel (TMC) Station Switching Behavior for Double Tuners Only. The purpose of the testing is to evaluate the TMC switching. If the tuned TMC-station is below the TMC-threshold, the best available TMC-station shall be tuned in the background with the second tuner.

Also if a TMC-station is manually selected, the TMC-station shall be changed if the TMC-station quality is below the TMC-threshold. If the manually selected TMC-station is again receivable, the radio shall tune to the selected TMC-station. Testing is done in three routes.

4.2.3.6.3.7.1 Alps Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.7.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.7.3 Rüsselsheim Area Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.7.4 Performance Requirements. Better or equal TMC switching behavior as the reference unit according to test template.

4.2.3.6.3.8 TMC-station List and TMC Message List for Double Tuners Only. The purpose of the testing is to evaluate the TMC-station list and TMC message list behavior. Testing is done in three routes.

4.2.3.6.3.8.1 Alps Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.8.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.8.3 Rüsselsheim Area Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.8.4 Performance Requirements. The TMC-stations list shall contain equal or more TMC-stations as the reference radio.

The TMC message list shall contain equal or less TMC messages as the reference radio.

Better or equal TMC-stations list and TMC message list behavior as the reference unit according to test template.

4.2.3.6.3.9 FM-Memory Stepping. The purpose of this test is to evaluate the FM-Memory stepping behavior. The FM-Memory list shall contain all receivable stations according to the FM-Memory thresholds (RDS station and non-RDS stations). Tune to the FM-Memory stations by depressing the Memory buttons. The station shall be sorted according to the Program Identification (PI) code and shall also contain non-RDS stations. The FM-Memory shall be updated in the background during stepping in the FM-Memory. Testing is done in three routes.

4.2.3.6.3.9.1 Alps Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.9.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.9.3 Rüsselsheim Area Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.9.4 Performance Requirements. Equal or more stations in the FM-Memory than the reference radio. Better or equal behavior as the reference unit according test template.

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4.2.3.6.3.10 FM-Memory Station List. The purpose of this test is to evaluate the FM-Memory station list and thresholds. The FM-Memory station list shall contain all receivable station according to the FM-Memory thresholds (RDS-station, non-RDS-stations).

Background update of the stations list after power down, in non-tuner mode, FM-Memory stepping. Testing is done in three routes.

4.2.3.6.3.10.1 Alps Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.10.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.10.3 Rüsselsheim Area Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.10.4 Performance Requirements.

4.2.3.6.3.10.4.1 Single Tuner. Equal or more stations in the FM-station list as the reference radio.

Better or equal FM-station list update behavior as the reference unit according to test template.

4.2.3.6.3.10.4.2 Double Tuner. Equal or more stations in the FM-station list as the reference radio.

Non-receivable station shall not be inside the station list.

Fast dynamic station list update after changing the reception area especially after tunnel exit (e.g., Gotthard Tunnel).

Better or equal dynamic FM-station list update behavior as the reference unit according to test template.

4.2.3.6.3.11 Enhanced Other Network (EON) Memory Update. The purpose of this test is to evaluate the EON-memory update performance. Testing is done in three routes.

4.2.3.6.3.11.1 Alps Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.11.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.11.3 Rüsselsheim Area Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.11.4 Performance Requirements. The FM-Memory list shall be updated with transmit RDS-Information of other stations (PSN, PI), if an EON-station is tuned.

The FM-Memory shall be updated in the background when the EON-station is tuned.

By stepping with the Memory buttons, only the receivable EON stations from the FM-Memory shall be tuned.

Equal or less stations in FM-Memory than the reference radio.

Better or equal behavior as the reference unit according to the test template.

4.2.3.6.3.12 Memory Update After Power Down. The purpose of this test is to verify the FM-Memory update after a power down. The FM-Memory shall be updated after power down with the receivable stations. Testing is done in three routes.

4.2.3.6.3.12.1 Alps Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.12.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.12.3 Rüsselsheim Area Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.12.4 Performance Requirements. Equal or more stations in the FM-Memory than the reference radio.

Better or equal behavior as the reference unit according test template.

4.2.3.6.3.13 Recall Preset of FM Station. The purpose of this test is to evaluate the FM-station recall preset performance. The FM preset recall has to be performed after:

Leaving the reception area of the stored station.

Re-entry into the transmission area of the stored station.

The Recall preset test has to be performed with activated and inactivated Traffic Program functionality. Testing is done in three routes.

4.2.3.6.3.13.1 Alps Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.13.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.13.3 Rüsselsheim Area Test Route. See Appendix B for test frequencies and route details.

4.2.3.6.3.13.4 Performance Requirements. If the stored station is receivable it shall be tuned.

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If the stored station is not receivable, the Human Machine Interface (HMI) recall behavior according to specification shall be used.

No wrong audio modulation allowed during recall behavior.

After recall, the right Program Service Name of the tuned station shall be shown.

4.2.3.6.3.13.4.1 Single Tuner. Same recall preset behavior as the reference radio.

4.2.3.6.3.13.4.2 Double Tuner. Same recall preset behavior as the reference radio.

4.2.3.6.4 GMH. GME marketed vehicles only.

4.2.3.6.5 GMNA. GME marketed vehicles only.

4.2.4. Development Test Methodology. The following optional development tests are done to provide additional insight into the performance of the reception system but may not have specific requirements:

AM and FM Mile/Kilometer Marker Evaluations

Power Line Intrusion

AM and FM IBOC Seek Sensitivity (GMNA only)

AM Reception Range

The following (4.2.4.1 thru 4.2.4.5) provide a detailed description of each of these tests:

4.2.4.1 AM and FM Mile/Kilometer Marker Evaluations. The purpose of this test is to provide additional performance information across the band. The radios are tuned to weak AM and FM stations across the entire bandwidth and evaluations are performed for 0.5 km (1 mi) durations at each frequency.

4.2.4.1.1 GMB. The test location is at Castelo Branco Highway West, from kilometer 179 to 197, Pardinho, São Paulo, Brazil. This test is done on Castelo Branco Highway on the way to the AM Fringe test area and again returning trip on the way to FM Fringe area.

4.2.4.1.2 GMK. Not applicable.

4.2.4.1.3 GME. The complete AM and FM kilometer/mile marker test execution takes place over two weeks on the Alps and United Kingdom (UK) test ride and additional one week around Rüsselsheim. Each vehicle is tested by tuning the radio to the requested radio station. See Appendix B. Subjective Rating scores are done by each test engineer every 0.5 km or on special routes at the end of the test section. The scores are recorded by each test engineer.

4.2.4.1.4 GMH. Test performed on the way to the AM/FM fringe area in Buxton.

4.2.4.1.5 GMNA. AM Mile Marker stations maximums vary from 16 dB μ V to 29 dB μ V using peak detector and maximum hold. FM Mile Marker stations maximums vary from 38 dB μ V to 48 dB μ V using peak detector and maximum hold. The scores for both northbound and southbound tests are averaged together for each band. This is now considered a validation test (see Table 1).

4.2.4.1.6 GMTH. Not applicable.

4.2.4.2 Power Line Intrusion. The purpose of this test is to ensure the antenna/receiver system has low frequency (50 kHz to 500 kHz) rejection. Power line intrusion manifests itself when the audio system has poor out-of-band noise rejection capability. This can be heard in the audio system as a buzz sound with an accompanying increase in volume.

4.2.4.2.1 GMB. The test location is in SP 75 - Santos Dumont, kilometer 45 south, Salto, São Paulo, Brazil. The test frequency is 1100 kHz. Two score are taken, before and under the power line with evaluator rotation.

4.2.4.2.2 GMK. Testing is performed on the 37 National Road (Munsan to Jungok) and finishes where this road crosses the 3 National Road.

While moving there, power lines cross the road many times, which are generating radio frequency (RF) noise. Evaluate this noise.

The frequency tested is 900 kHz.

Adjust the volume level to 1 W and evaluate the strength of noise and for how long it lasts.

The foremost vehicle should control the speed of all the other vehicles and the speed should be as slow as possible. Make the speed of all the vehicles the same.

When noise is heard, evaluate the strength of noise by hearing, and record the status of sound on the sheet.

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When both the noise and the broadcasting signal can be heard at one time, distinguish whether this signal comes from the noise or broadcasting signal and record which signal is strongest.

Record the overall rating on the sheet per the SR 10 rating scale on the basis of the overall reception quality.

4.2.4.2.3 GME. The first test location is along the Darmstadt route where the cable car power lines cross the road. The second test location is along the Mörfelden to Groß-Gerau route beside the railway. Test frequencies are 576 kHz and 1539 kHz.

4.2.4.2.4 GMH. The test location for Power Line Intrusion is Welington/Stud Road, Rowville, Victoria, Australia (GPS coordinates 37° 55' 35" S, 145° 13' 25" E). The test frequency is 1278 kHz.

The test location for Tramline Intrusion is Waverley Road, East Malvern, Melbourne, Victoria, Australia, between Dandenong Road and Darling Road. The test frequency is 774 kHz.

4.2.4.2.5 GMNA. A score is taken prior to the power line and a worse case score is taken while underneath the power line.

4.2.4.2.6 GMTH. Not applicable.

4.2.4.2.7 PATAC. The test location is along West Gaoke Road, from Gutang Road to Zhangdong Road, Pudong District, Shanghai, China. There are many power lines across this trip. The test frequencies are 540 kHz and 603 kHz.

4.2.4.3 AM and FM Seek Sensitivity. The purpose of this test is to verify that the reception system is seeking to an acceptable number of radio stations. This test provides insight into the calibratable seek threshold performance of the radio and the ability of the system to receive stations with low signal strength.

This test is to be performed in a medium to low signal strength environment away from industrial noise. Selected test locations must allow the reference reception system to seek to a minimum of 10 stations. An optional strong signal seek sensitivity test can be performed at the discretion of the test engineer.

4.2.4.3.1 GMB. The AM and FM Seek Sensitivity testing is done in two places. For low signal strength, the location is in the old gas station located in kilometer 55 from SP 157 - Aristides de Costa Barros Road. This road is located in Castelo Branco Highway, exit kilometer 162, Guareí, São Paulo, Brazil. For high signal strength stations, the location is in the Alameda Jaú Street, São Paulo, Brazil. There, the evaluators must find a permitted location to safely park all the vehicles near Tenente Siqueira Campos Public Square and perform the test.

4.2.4.3.2 GMK. The AM Seek Sensitivity testing is done at the AM Overload location and the fringe location. The FM Seek Sensitivity testing is done at the FM Multipath location, fringe location and FM Overload location.

4.2.4.3.3 GME. The AM and FM seek sensitivity testing is done in three routes.

4.2.4.3.3.1 South European Test Route. See Appendix B for test frequencies and route details.

4.2.4.3.3.2 United Kingdom Test Route. See Appendix B for test frequencies and route details.

4.2.4.3.3.3 Rüsselsheim Area (Mainflingen, Geinsheim, Mörfelden) Test Route. See Appendix B for test frequencies and route details.

4.2.4.3.4 GMH. The test locations for AM/FM seek are Tarago Reservoir, Neerim South, Victoria, Australia (GPS coordinates 38° 01' 14" S, 145° 56' 26" E) (fringe area) and Holden parking area, Port Melbourne, Victoria, Australia (strong signal area). Alternative AM/FM seek test location (fringe area) is Buxton, Victoria, Australia (GPS coordinates 37° 25' 34" S, 145° 42' 22" E).

4.2.4.3.5 GMNA. Test route stored locally.

4.2.4.3.6 GMTH. The AM Seek Sensitivity testing is done at the AM Overload location and the AM fringe location. The FM Seek Sensitivity testing is done at the FM Overload location and FM Fringe location.

4.2.4.3.7 Performance Requirement. The requirement for the vehicle under test is to seek to at least 90% of the number of stations the reference vehicle system seeks to. The criterion for an acceptable station is that it must be at least a SR 7 or better in listening quality.

4.2.4.4 AM and FM IBOC Seek Sensitivity. Currently, AM and FM transmitters are broadcasting both analog and digital signals, in the U.S. The digital signals are referred to as In-Band-On-Channel (IBOC) digital broadcast system. Currently, both analog and digital are allowed resulting in a hybrid signal, where the analog signal is in the center of the broadcast signal and the digital sidebands are placed on either side of the analog signal.

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The purpose of this test is to determine if the radio can properly discriminate between the digital sideband signals and the center analog carrier signal. Testing is required for vehicles sold in North America and testing can only be performed in North America.

4.2.4.4.1 GMB. GMNA marketed vehicles only.

4.2.4.4.2 GMK. GMNA marketed vehicles only.

4.2.4.4.3 GME. GMNA marketed vehicles only.

4.2.4.4.4 GMH. GMNA marketed vehicles only.

4.2.4.4.5 GMNA. For AM, reference 4.2.3.3.5 for spectral levels. For FM, reference 4.2.3.2.5 for spectral levels.

4.2.4.4.6 GMTH. GMNA marketed vehicles only.

4.2.4.5 AM Reception Range. The purpose of this test is to quantify the AM reception performance as a function of distance from the broadcast tower.

4.2.4.5.1 GMB. The test location begins in Castelo Branco Highway West, from kilometer 80 (Itu) to 170 (Bofete), São Paulo, Brazil. Subjective Rating scores are taken every 5 km to observe the degradation in AM reception performance as the distance from the broadcast tower increases. The radio is tuned to 1160 kHz. This station broadcasts radiated power of 10 kW.

4.2.4.5.2 GMK. Not applicable.

4.2.4.5.3 GME. The test location is Proving Ground Pferdsfeld and Hassloch parking lot. Each vehicle is tested by tuning the radio to test frequency. Subjective Rating scores are done by each test engineer every 0.5 km beginning at Hassloch parking lot to Mörfelden parking lot. The scores are recorded by each test engineer.

4.2.4.5.4 GMH. Not applicable.

4.2.4.5.5 GMNA. Subjective Rating scores are taken every 8 km (5 mi) to observe the degradation in AM reception performance as the distance from the broadcast tower increases. The test station should broadcast with a radiated power of 1 kW.

4.2.4.5.6 GMTH. Not applicable.

4.3 Instructions. For the ride test, evaluator shall rotate one vehicle to the rear of the current test vehicle. The evaluator in the last vehicle shall rotate forward into the lead vehicle. Repeat the test until all participants have evaluated each test vehicle.

4.3.1 GMB. The complete AM/FM reception drive test takes two work days. One day is spent performing AM Power Line, AM Reception Range, AM/FM Mile Marker, AM/FM Fringe and AM/FM Seek Sensitivity. The second day is spent performing AM/FM Overload and FM Multipath. The ride trip captain decides the test order for the two-day event.

4.3.2 GMK. The complete AM/FM reception drive test takes place over three work days. One day is spent performing AM overload, AM and FM fringe testing, and a second day is spent doing FM multipath testing, and a third day is spent doing FM overload. The ride trip captain decides the test order for the three-day event.

4.3.3 GME. The complete AM/FM reception drive test takes over two weeks for the Alps and United Kingdom test routes and an additional week for the Rüsselsheim Area route. The detailed test instructions are listed in Appendix B.

4.3.4 GMH. The complete AM/FM reception drive test takes three work days. One day is spent performing AM overload and FM multipath testing, second day is spent performing FM overload, Power Line Intrusion and Tramline Intrusion testing, and a third day is spent performing AM/FM fringe and AM/FM seek testing. The ride trip captain decides the test order for the three-day event. The ride trip captain shall create the individual vehicle ride trip files using the AM/FM Reception Ride Trip Planner.mdb database file. The vehicle data files are provided to the ride trip participants for installation on the laptop computers in each of the test vehicles prior to the start of the ride trip.

4.3.5 GMNA. The complete AM/FM reception drive test takes two work days. One day is spent performing AM overload, FM overload, and FM multipath testing, and a second day is spent doing AM and FM fringe testing. The ride trip captain decides the test order for the two-day event.

4.3.6 GMTH. The complete AM/FM reception drive test takes place over four work days. One day is spent performing AM and FM fringe testing, and a second day is spent doing FM multipath testing, and a third day is spent doing AM and FM overload. The fourth day is used to evaluate calibration changes as necessary.

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4.3.7 Data Gathering Equipment Setup.

4.3.7.1 GMB. The data gathering equipment for the test vehicles should be set up as follows:

- Plug the 12 V to 120 V inverter into an auxiliary 12 V outlet and connect the laptop power supply to it.
- Turn on the test laptop and install the data spreadsheet file provided by the trip captain in the C:/Data directory of the laptop. Open the file. The "Main Menu" screen will appear with Graphical User Interface (GUI) buttons for each of the tests that pertain to this procedure. At this point the laptop is ready for data gathering.
- The data file for reference vehicle Blazer 2.4 has an additional feature available with a drop down menu to record date, time and weather for each test event. The reference vehicle data file contains a setup macro to record the vehicle numbers and the initials of the participants in each vehicle. This data is automatically populated in the master data file on the sheet labeled "Other Tests".

4.3.7.2 GMK. Currently, the data is recorded on paper. A macro is being written to record the data electronically.

4.3.7.3 GME. The reference vehicle with the reference radio shall be used for the test. Additional test equipment shall be installed in the reference vehicle and in the test vehicles.

4.3.7.4 GMH. Data is recorded electronically in an Access Database.

- Plug the 12 V to 120 V inverter into an auxiliary 12 V outlet and connect the laptop power supply to it.
- Turn on the test laptop and install the data spreadsheet file provided by the trip captain in the C:/Data directory of the laptop. Open the file. The "Main Menu" screen will appear with Graphical User Interface (GUI) buttons for each of the tests that pertain to this procedure. At this point the laptop is ready for data gathering.

The data file for reference vehicle has an additional feature available with a drop down menu to record date, time and weather for each test event. The test data for the Tramline Intrusion test and the Power Line Intrusion test will be recorded on an excel spreadsheet instead of in the database.

4.3.7.5 GMNA. The data is recorded on paper. The trip book in the reference vehicle has additional data sheets to record date, time and weather conditions for each test event. Data sheets for the Sibley Road overload, AM power line, AM fade to distance, and AM and FM mile marker tests are included in the trip book as well.

4.3.7.6 GMTH. The data is recorded on paper and stored in an official evaluation report by the GMTH validation engineer.

4.3.8 Test Vehicle Setup.

4.3.8.1 Set the AM and FM radio presets to the frequencies called out by the trip captain.

4.3.8.2 Verify that the equalizer settings are flat (detent).

4.3.8.3 Disable automatic volume control (speed and noise) if applicable.

4.3.8.4 During AM band testing, all extraneous electronic equipment shall be unplugged or turned off (e.g., cell phones, cell phone chargers, inverters, test equipment). Two-way radios may be left on, but not used during testing.

4.3.9 Overload and Multipath Tests. Any tests in 4.3.9 as follows and listed as optional are performed at the discretion of the test engineer.

4.3.9.1 FM Overload Test Execution.

4.3.9.1.1 GMB. Proceed from the Cruz Alta Proving Ground to Paulista Avenue area at São Paulo City. The ride trip captain shall decide the appropriate route to reach this region according to traffic and weather conditions and inform all the participants. On Paulista Avenue, proceed east and turn right on Pamplona Street. Proceed down the street and turn right on Alameda Jaú Street. Find a permitted location to safely park all the vehicles near Parque Tenente Siqueira Campos Public Square. This is the start and end point of the loop.

- Set the FM radio presets to 93.7 MHz, 100.1 MHz and 107.3 MHz and an AM preset to 1600 kHz.
- Open the test spreadsheet on the laptop and click the "FM Overload Test" button on the "Main Menu" page. Then at the middle of the page add the names of the evaluators from the pick list and click the "Begin Test" button. A score sheet will then appear on the page. The laptop spreadsheet will now be ready for data entry. Two scores will be recorded for each vehicle. The average score for this route, as well as the worst score, shall be entered into the laptop spreadsheet.

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The test route is as follows:

- a. Start the loop on Alameda Jaú Street.
- b. Turn right on Alameda Ministro Rocha Azevedo Street.
- c. Turn right on Paulista Avenue.
- d. Turn right on Pamplona Street.
- e. Turn right on Alameda Jaú Street and return to the starting point.

Once data for all four frequencies is entered, click the "Done" button to save the scores and reset the spreadsheet for the next evaluator(s). Participants shall rotate one vehicle to the rear of the current test vehicle. The participant(s) in the last vehicle shall rotate forward into the lead vehicle. Repeat the test until all participants have evaluated each test vehicle. This concludes the FM overload portion of the test sequence. See Appendix A, Section A5.2 for an example of the FM Overload data entry screen.

4.3.9.1.2 GMK. There are two test modes in this test. One is a static test and the other is a ride test. The evaluating criteria for this test are a received voltage of 91.9 MHz (approximately 90 dBμV to 100 dBμV).

4.3.9.1.2.1 Static 1 (Antenna Test).

- a. Move to Nam-san Library parking lot.
- b. Orient test vehicle to get maximum antenna gain toward transmitting tower.
- c. Put the monopole reference antenna on the roof of the test vehicle and then connect it to the input port of the spectrum analyzer (SA) via 20 dB internal attenuator.
- d. Measure the received voltage with the spectrum analyzer from 85 MHz to 110 MHz.
- e. After finishing the measurement, remove the monopole reference antenna from the roof and connect the vehicle antenna to the spectrum analyzer and measure the received voltage again.
- f. Repeat the same measurement with an external 3 dB, 10 dB, and 20 dB attenuator instead of the internal attenuator.

4.3.9.1.2.2 Static 2 (Receiver Test).

- a. Activate the scan function of the radio and perform SR evaluation for the each reception frequency.
- b. While performing the SR evaluation, audible distortion caused by IM interference should be recorded.
- c. Repeat the same measurement with an external 3 dB, 10 dB, and 20 dB attenuator instead of the internal attenuator.

4.3.9.1.2.3 Ride.

- a. Set the radio frequency to 95.9 MHz, the test route is as follows:
 1. Turn West (right turn) on to So-pa Road.
 2. Turn North (left turn) at the Seoul Hilton Hotel.
 3. Turn East (left turn) at the Nam-san Library and return to the starting point.
- b. Change the radio frequency to 91.1 MHz. The test route is as follows.
 1. Turn West (right turn) on to So-pa Road.
 2. Turn North (left turn) at the Seoul Hilton Hotel.
 3. Turn East (left turn) at the Nam-san Library and return to the starting point.

Move to the long route after finishing the test in this area.

4.3.9.1.3 GME. The complete FM Overload Test reception drive test takes place in the Rüsselsheim area. The detailed test instructions are listed in Appendix B.

4.3.9.1.4 GMH. Drive to Eyre Road/Burkes Lookout, Mount Dandenong and park the vehicles on the lookout car park.

- a. Make sure that the radio equalizer settings are flat. Loudness, speed dependent etc., must be off.
- b. Verify that the radio volume in each vehicle is set to a level that gives roughly the same sound level in each vehicle.
- c. Set the FM radio presets to 100.3 MHz, 101.9 MHz and 104.3 MHz., and set the AM presets to 693 kHz and 774 kHz.

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- d. Open the AM/FM Reception Ride main menu on the laptop and click the "FM Overload Test" button on the "Main Menu" page. Select the Current Test Evaluators and click the "Begin Test" button. The scores are now ready to be recorded in the spreadsheet. The average score for this route, as well as the worst score, shall be entered into the laptop spreadsheet.
- e. Start the test from the lookout car park. Drive down and up the length of Eyre Road and record the average score for the frequency being evaluated, and also record the worst case score.
- f. Once data for all test frequencies are entered, click the "Done" button to save the scores and reset the spreadsheet for the next evaluator(s). Participants shall rotate one vehicle to the rear of the current test vehicle. The participant(s) in the last vehicle shall rotate forward into the lead vehicle.
- g. Repeat until all participants have evaluated each test vehicle.

4.3.9.1.5 GMNA. Routes stored internally.

4.3.9.1.6 GMTH. Drive to the Petroleum Authority of Thailand (PTT) gas station near the Thai Army stadium on Vipavadee Road in Bangkok.

- a. Make sure that the radio equalizer settings are flat. Loudness, speed dependent, etc., must be off.
- b. Verify that the radio volume in each vehicle is set to a level that gives roughly the same sound level in each vehicle.
- c. The test route runs on Vipavadee Road from the Sutisarn intersection to the DinDaeng intersection. The drive should start at the PTT gas station and make this loop.
- d. The test engineer shall choose 10 points along the route to evaluate the reception.
- e. The test engineer shall record the evaluation of the radio reception for 91.00 MHz and the test vehicle for each of the 10 points in the trip logbook.
- f. The test engineer shall repeat the evaluation for 91.00 MHz for the reference vehicle for each of the 10 points in the trip logbook.
- g. Repeat for the additional test frequencies of 93.00 MHz, 95.50 MHz, and 105.50 MHz.

4.3.9.2 Multipath Test Execution.

4.3.9.2.1 GMB. Proceed from Cruz Alta Proving Ground to at Itapecuru Alameda in Alphaville, São Paulo, Brazil.

- a. Select the FM Multipath test on the laptop spreadsheet "Main Menu". Add the names of the evaluators from the pick list and click the "Begin Test" button.
- b. Set the FM station presets to 92.1 MHz and 103.3 MHz.
- c. Allow radio to achieve best reception quality (i.e., full recovery from Treble/Stereo reduction).
- d. Move forward into poor quality signal area to initiate treble/stereo reaction.
- e. Repeat as required.
- f. Drive up and down Itapecuru Alameda between Mamoré Avenue and Oiapoque Avenue. Check the time taken for full recovery. Determine if full recovery is possible while driving.
- g. The average score for this route is entered into the laptop spreadsheet.

4.3.9.2.2 GMK. Move the vehicle to the Yeoui-do KT building and park the vehicle facing the Federation of the Korean Industries Hall. Put the reference car in the middle of test vehicles. Change the radio display to test mode. Each evaluator of the vehicles records the broadcasting frequencies and the received voltage. After recording, tune to 93.1 MHz. Evaluate the reception quality along the short route. At this moment, keep the vehicle at a speed of 30 km/h to 40 km/h. Perform the SR evaluation when returning to the starting point.

Short and repeating multipath is generated in this area. Variation in volume and high-cut effect, sound quality are evaluated in this area. Evaluator shall rotate one vehicle to the rear of the current test vehicle. The evaluator in the last vehicle shall rotate forward into the lead vehicle. Repeat the test until all participants have evaluated each test vehicle. Move to the long route after finishing the test in this area.

- a. Starting point for evaluation is the stop line on the right side of Yeoui-do KT building.
- b. From starting point to KBS Annex is an area where short and repetitive multipath is generated.
- c. Some popping noises are intermittently generated near the Nation Assembly area.

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- d. Evaluation is done from the south to north of Seo-Kang Bridge. In this area, noise from multipath can hardly be heard.
- e. This area is Mapo Bridge area. Start from north riverside road. In this area, multipath occurs deeply and continuously and strong distortion of the broadcasting station occurs. This area is used for evaluating the clearness of sound.
- f. This area is from Mapo Bridge to the north part of Wonhyo Bridge. The direction of the vehicle is changed to the north part of Wonhyo Bridge. In this area also strong distortion of broadcasting station occurs.
- g. This area is from the north part of Wonhyo Bridge to the south part of Wonhyo Bridge. In this area, noise from multipath can hardly be heard.
- h. This area is from the south of Wonhyo Bridge to the starting point. Due to the many skyscrapers in this area, the short and repeated noise from multipath can be heard.

Each preceding step is separated by a selected building and each has a starting point. The evaluations are performed in each area separately. The evaluations in the short route are performed several times as determined by the number of evaluators and vehicles. The number of evaluators and vehicles is the same. The evaluators test all vehicles from starting point to end point. After finishing all evaluations, the final evaluation report is made by putting together all the results.

4.3.9.2.3 GME. The complete multipath test takes place over two weeks on the Alps and United Kingdom (UK) test ride and an additional one week around Rüsselsheim. The detailed test instructions are listed in Appendix B.

4.3.9.2.4 GMH. Drive to Stanley Street, West Melbourne (GPS coordinates 37° 48' 28" S, 144° 56' 58" E) and park the vehicles.

- a. Make sure that the radio equalizer settings are flat. Loudness, speed dependent, etc., must be off.
- b. Verify that the radio volume in each vehicle is set to a level that gives roughly the same sound level in each vehicle.
- c. Set the FM radio presets to 100.3 MHz, 101.9 MHz, 103.5 MHz and 105.1 MHz.
- d. Open the AM/FM Reception Ride main menu on the laptop and click the "FM Multipath Test" button on the "Main Menu" page. Select the Current Test Evaluators and click the "Begin Test" button. The scores are now ready to be recorded in the spreadsheet.
- e. Start the test. Drive up and down Stanley Street between Spencer Street and King Street. Record the average score for the frequency being evaluated. See Figure 1 for further detail.
- f. Once data for all test frequencies are entered, click the "Done" button to save the scores and reset the spreadsheet for the next evaluator(s). Participants shall rotate one vehicle to the rear of the current test vehicle. The participant(s) in the last vehicle shall rotate forward into the lead vehicle.
- g. Repeat until all participants have evaluated each test vehicle.

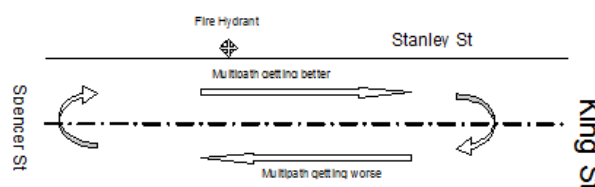


Figure 1: Stanley Street

4.3.9.2.4.1 Location 3 Stanley Street - FM Multipath. Stanley Street, Melbourne, Victoria, Australia, 1 km from Melbourne central business district (CBD).

- a. Set the FM station presets to 100.3 MHz, 101.9 MHz, 104.3 MHz.
- b. Stop near fire hydrant; find a place which has good signal quality by moving forward/backward slowly.
- c. Allow radio to achieve best reception quality (i.e., full recovery from Treble/Stereo reduction).
- d. Move forward into poor quality signal area to initiate treble/stereo reaction.

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- e. Repeat as required.
- f. Seek Performance Test (FM Loc/Dx).
- g. Drive up and down Stanley Street between Spencer Street and King Street. Check the time taken for full recovery. Determine if full recovery is possible while driving.

See Figure 1 for further detail.

Record both the average and worst case rating for each test frequency.

Move vehicle slowly in and out of a "hot spot" (noise peak) to record worst case rating.

4.3.9.2.4.2 Location 5 Noone Street - FM Multipath. Noone Street and Alexander Street, Fitzroy, Victoria, Australia, 3.5 km from Melbourne CBD.

- a. Set the FM station presets to 100.3 MHz, 101.9 MHz, 104.3 MHz.
- b. There are patches of high multipath on Noone Street and Alexander Street. These can be used for measuring reaction and recovery times by driving back and forth.
- c. Use these roads to measure Multipath reaction/recovery performance.

4.3.9.2.4.3 Location 6 Yarra Boulevard - FM Multipath. Yarra Boulevard, Kew, Victoria, Australia approximately 5 km from Melbourne CBD.

- a. Set the FM station pre-sets to 100.3 MHz, 101.1 MHz, 101.9 MHz, 104.3 MHz.
- b. This road has varying degrees of Multipath interference.
- c. Use to measure Multipath reaction and recovery performance.
- d. At Studley Park boat house, stop in car park to perform Seek performance test on FM Loc/Dx.
- e. Generally use 101.1 MHz for testing in this area, but also confirm FM reception on the other preset stations.

4.3.9.2.4.4 Location 7 City Loop 2 - FM Multipath. Walmer Street, Young Street, Rochester Street, Raven Street, Kew, Victoria, Australia, 4 km from Melbourne CBD.

- a. Loop this block listening for Multipath reaction and recovery. Dynamically check FM stations 100.3 MHz, 101.9 MHz, 104.3 MHz.

4.3.9.2.4.5 Location 16 Burwood Highway - FM Multipath. Burwood Highway section between Springvale Road and Cathies Lane, Wantirna, Victoria, Australia, 22 km East of Melbourne.

- a. Loop up and down this section of Burwood Highway to check for Multipath interference on 100.3 MHz, 101.9 MHz, 104.3 MHz.

4.3.9.2.5 GMNA. Routes stored internally.

4.3.9.2.6 GMTH. Drive to the corner of Silom Road and Naradhiwas Rajanagarindra Road.

- a. Make sure that the radio equalizer settings are flat. Loudness, speed dependent etc., must be off.
- b. Verify that the radio volume in each vehicle is set to a level that gives roughly the same sound level in each vehicle.
- c. The test route runs in a loop on Silom Road, Naradhiwas Rajanagarindra Road, Thaiya Road, and Surawong Road.
- d. The test engineer shall choose 8 points along the route to evaluate the reception.
- e. The test engineer shall record the evaluation of the radio reception for 91.00 MHz and the test vehicle for each of the 10 points in the trip logbook.
- f. The test engineer shall repeat the evaluation for 91.00 MHz for the reference vehicle for each of the 8 points in the trip logbook.
- g. Repeat for the additional test frequencies of 93.00 MHz, 95.50 MHz, 105.50 MHz.

4.3.9.3 FM IBOC Seek Sensitivity Test Execution (Optional). There is no environment available for IBOC testing in other regions other than GMNA. This test is performed by GMNA for GMNA marketed vehicles only.

4.3.9.3.1 GMB. GMNA marketed vehicles only.

4.3.9.3.2 GMK. GMNA marketed vehicles only.

4.3.9.3.3 GME. GMNA marketed vehicles only.

4.3.9.3.4 GMH. GMNA marketed vehicles only.

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4.3.9.3.5 GMNA. Routes stored internally.

4.3.9.3.6 GMTH. GMNA marketed vehicles only.

4.3.9.4 AM Overload Test Execution.

4.3.9.4.1 GMB. Proceed from the CAPG to São Paulo. The test location is at the Parking lot of CTN (Centro de Tradições Nordestinas), which is in the intersection between Júlio de Mesquita Neto Bridge and Marginal Tiete. The evaluation zone for 1230 kHz is from beginning of the bridge up to gate of CTN. The overload test must be done for the best and worst score. Park the vehicle inside parking lot, close to the antenna, and evaluate 660 kHz and 1230 kHz frequencies. Rotate the other test vehicles into this same position to evaluate to maintain consistency with respect to signal level. All extraneous electronic equipment shall be unplugged or turned off (e.g., cell phones, cell phone chargers, inverters, test equipment). Open the test spreadsheet on the laptop and click the "AM Overload Test" button. Enter the names of the participant(s) and click "Begin Test". Perform SR evaluations on both frequencies with the vehicles parked, engine running and inverters unplugged each time entering the data into the laptop spreadsheets in each test vehicle. Click "Done" to save the data once all evaluators have finished.

4.3.9.4.2 GMK. Test location is on the way to the AM/FM test site. The overload test site is located on the way to the AM/FM Fringe Test Route. The evaluation must check the oscillation of 918 kHz by Overload near the 918 kHz transmitting tower. Check the AGC performance of the station. The lowering in reception performance is evaluated from the point off the transmitting tower. The position of the vehicle does not need to be taken into consideration.

Received voltage is measured with the EZ12 antenna impedance converter and spectrum analyzer. The measurement procedure is the same as that of the GMK FM overload Test described in 4.3.9.1.2.

4.3.9.4.3 GME. The complete AM Overload Test reception drive test takes place on one day around Rüsselsheim and one day in UK test trip. The detailed test instructions are listed in Appendix B.

4.3.9.4.4 GMH. Three different test locations can be used for the AM overload test but the preferred test site is Sydenham Road, Delahey due to the secluded road and the high signal strength.

4.3.9.4.4.1 Sydenham Road, Delahey. (GPS coordinates 37° 48' 28" S, 144° 56' 58" E). Park the vehicles on Sydenham Road opposite the AM transmission tower entrance.

- Make sure that the radio equalizer settings are flat. Loudness, speed dependent etc., must be off.
- Verify that the radio volume in each vehicle is set to a level that gives roughly the same sound level in each vehicle.
- Set the AM radio presets to 927 kHz, 774 kHz and 1377 kHz.
- Open the AM/FM Reception Ride main menu on the laptop and click the "AM Overload Test" button on the "Main Menu" page. Select the Current Test Evaluators and click the "Begin Test" button. The scores are now ready to be recorded in the spreadsheet.
- Tune in the correct frequency and start the evaluation. Drive slowly down Sydenham Road, 30 km/h, turn around at the end of the road and continue up to the first round about, turn around and drive back to the start position record the average score for the frequency evaluated.
- Once data for all test frequencies are entered, click the "Done" button to save the scores and reset the spreadsheet for the next evaluator(s). Participants shall rotate one vehicle to the rear of the current test vehicle. The participant(s) in the last vehicle shall rotate forward into the lead vehicle.
- Repeat until all participants have evaluated each test vehicle.

4.3.9.4.4.2 Stawell Road (Lower Plenty). Use the same basic procedure as described in 4.3.9.4.4.1.

AM radio presets to 693 kHz, 774 kHz and 1278 kHz.

4.3.9.4.4.3 George Knox Drive, Rowville. Use the same basic procedure as described in 4.3.9.4.4.1.

AM radio preset 1278 kHz.

4.3.9.4.5 GMNA. Routes stored internally.

4.3.9.4.6 GMTH. Drive to the PTT gas station near the Thai Army stadium on Vipavadee Road in Bangkok.

- Make sure that the radio equalizer settings are flat. Loudness, speed dependent, etc., must be off.

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- b. Verify that the radio volume in each vehicle is set to a level that gives roughly the same sound level in each vehicle.
- c. The test route runs on Vipavadee Road from the Sutisarn intersection to the DinDaeng intersection. The drive should start at the PTT gas station and make this loop.
- d. The test engineer shall choose 10 points along the route to evaluate the reception.
- e. The test engineer shall record the evaluation of the radio reception for 837 kHz and the test vehicle for each of the 10 points in the trip logbook.
- f. The test engineer shall repeat the evaluation for 837 kHz for the reference vehicle for each of the 10 points in the trip logbook.
- g. Repeat for the additional test frequencies of 774 kHz and 891 kHz.

4.3.9.5 AM IBOC Seek Sensitivity Test Execution (Optional). There is no environment available for IBOC testing in other regions other than GMNA. This test is performed by GMNA for GMNA marketed vehicles only.

4.3.9.5.1 GMB. GMNA marketed vehicles only.

4.3.9.5.2 GMK. GMNA marketed vehicles only.

4.3.9.5.3 GME. GMNA marketed vehicles only.

4.3.9.5.4 GMH. GMNA marketed vehicles only.

4.3.9.5.5 GMNA. Routes stored internally.

4.3.9.5.6 GMTH. GMNA marketed vehicles only.

4.3.10 Fringe Tests.

4.3.10.1 AM Reception Range Test Execution (Optional).

4.3.10.1.1 GMB. Proceed from the Cruz Alta Proving Ground to SP 75 - Santos Dumont Road southbound. Follow SP 75 and take exit 15 to Castello Branco Highway westbound. Prior to testing, create an Excel spreadsheet with the participant initials and vehicle numbers as column headings. Select an appropriate file name and save the file in the C:\data directory on the laptop computer in the reference vehicle. Each vehicle is tested by tuning the radio to 1160 kHz. Subjective Rating scores are requested by the trip captain every 5 km beginning at kilometer marker 80. The scores are recorded by the trip captain in the free cell space on the spreadsheet page as a simple list of SR scores vs. kilometer marker for each of the vehicles. The test ends at kilometer marker 170. No personnel rotation is done for this test. This concludes the AM Reception Range portion of the test sequence.

4.3.10.1.2 GMK. Not applicable.

4.3.10.1.3 GME. The test location is Proving Ground Pferdsfeld and Hassloch parking lot. Each vehicle is tested by tuning the radio to test frequency. Subjective Rating scores are done by each test engineer every 0.5 km beginning at Hassloch parking lot to Mörfelden parking lot. The scores are recorded by each test engineer.

4.3.10.1.4 GMH. Not applicable.

4.3.10.1.5 GMNA. Routes stored internally.

4.3.10.1.6 GMTH. Not applicable.

4.3.10.2 AM and FM Mile/Kilometer Marker Test Execution (Required for GMNA, Optional for all other regions).

4.3.10.2.1 GMB. The test location is at Castelo Branco Highway, Pardinho, São Paulo, Brazil. Evaluations are done between kilometer markers from kilometer 179 to 197 west and Kilometer markers from kilometer 197 to 179 east. Open the laptop data entry file in the reference vehicle and click the "North" button. Add the participant names and click the "Begin Test" button. Using the drop down vehicle number menus, match the participants to the appropriate vehicles on the data entry screen and then click the "AM" button. The laptop file is now ready for data entry in the AM band. The trip captain will check each test frequency prior to starting the evaluations to ensure there no adjacent-channel or co-channel interference issues exist. The following stations may be used for this evaluation:

- AM: 580 kHz, 650 kHz, 900 kHz, 1080 kHz and 1540 kHz.
- FM: 89.5 MHz, 94.7 MHz, 99.5 MHz, 102.3 MHz and 106.7 MHz.

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Typically, the AM stations are done first. The trip captain instructs the participants which station to listen to and provides a kilometer marker to begin the scoring. The station is evaluated for one kilometer (i.e., until the next kilometer marker is passed) and another 1 km for interval to include grade, change station. The trip captain then calls for scores and records them on the "North" page. Once the AM frequencies are finished, click the "FM" button and repeat the process for the FM frequencies and click the "Done" button. This concludes the AM and FM kilometer Marker portion of the test sequence. See Appendix A, Section A5.9 for an example of the mile marker data entry screen.

4.3.10.2.2 GMK. Not applicable.

4.3.10.2.3 GME. The complete AM and FM kilometer/mile marker test execution takes place over two weeks on the Alps and UK test ride and additional one week around Rüsselsheim. Each vehicle is tested by tuning the radio to the requested radio station. See Appendix B. Subjective Rating scores are done by each test engineer every 0.5 km or on special routes at the end of the test section. The scores are recorded by each test engineer.

4.3.10.2.4 GMH. The kilometer/mile marker test starts at intersection of Warburton Highway and Maroondah Highway, Lilydale, Victoria, Australia.

- a. Make sure that the radio equalizer settings are flat. Loudness, speed dependent etc., must be off.
- b. Verify that the radio volume in each vehicle is set to a level that gives roughly the same sound level in each vehicle.
- c. Set the FM radio presets to 100.3 MHz and 104.3 MHz, and AM radio presets to 693 kHz and 774 kHz.
- d. The trip meter shall be set at the intersection and the evaluation starts as per instructions as follows:
 - After 10 km - FM 104.3 MHz. Evaluate for 1 km.
 - After 15 km - FM 100.3 MHz. Evaluate from guard rail to bridge.
 - After 21 km - AM 693 kHz. Evaluate from intersection in middle of Healseville (Maroondah Highway and Badger Creek Road) for 1 km.
 - After 36 km - AM 774 kHz. Evaluate for 1 km.
 - After 43.5 km - FM 105.1 MHz. Evaluate from outdoor center for 1 km.
- e. Record the average and worst case score for the frequencies evaluated.

4.3.10.2.5 GMNA. Typically, the FM stations are tested first traveling northbound while the AM stations are typically tested first traveling southbound. This is done to ensure AM testing is performed 1 h after sunrise and 1 h before sunset year round. The trip captain instructs the participants which station to listen to and provides a mile marker to begin the scoring. The station is evaluated for one mile (i.e., until the next mile marker is passed). The trip captain then calls for scores and records them on the mile marker score sheet. Once the FM (northbound) or AM (southbound) frequencies are finished, repeat the process for the AM (northbound) or FM (southbound) frequencies.

4.3.10.2.6 GMTH. Not applicable.

4.3.10.3 Power Line Intrusion Test Execution (Optional).

4.3.10.3.1 GMB. The test location is in SP 75 - Santos Dumont, kilometer 45 south, Salto, São Paulo, Brazil, where a high voltage power line crosses the freeway. On the laptop computer in the reference vehicle, click the "Power Line Eval" button and select the participant names. Click "Begin Test" and match the participants to vehicle numbers using the vehicle drop down menus. The vehicle radios are tuned to 1100 kHz. The trip captain will request a score before the power line and a second score under the power line. The evaluations are recorded in the data entry fields on the "Power Line Evaluation – Score Entry" page. Once all the scores are entered, click the "Done" button to save the data and return to the "Power Line Evaluation" page. Click "Done" on this page to return to the "Main Menu". This concludes the Power Line Intrusion portion of the test sequence.

4.3.10.3.2 GMK. The power line intrusion test is conducted with the frequency of 900 kHz on the way to AM fringe test site (Yeoncheon).

4.3.10.3.3 GME. The first test location is along the Darmstadt route where the cable car power lines cross the road. The second test location is along the Mörfelden to Groß-Gerau route beside the railway. Test frequencies are 576 kHz and 1539 kHz.

4.3.10.3.4 GMH. Power Line and Tramline Intrusion Test.

- Make sure that the radio equalizer settings are flat. Loudness, speed dependent etc., must be off.

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