



Digital Audio Reception Performance 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.

1.1 Purpose. The purpose of this standard is to determine the Digital Audio Reception Performance for all General Motors vehicles equipped with Digital Audio Broadcast (DAB) option.

1.2 Applicability. This Test Procedure shall apply to all global vehicles equipped with DAB system capable of reception of DAB Services.

Note: This document is one out of a series of three global antenna and reception documents, which specify antenna and reception test and validation requirements. The complete series consists of GMW15650, GMW15649 and GMW15648. Additional antenna information can be found in the Infotainment Global Subsystem Leadership Team Global Infotainment Standard (GSSLT GIS) documents, e.g. GIS 92.

This test procedure shall apply to passive and active antennas (rod antenna, screen antenna) 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 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.

IEEE 185-1975 ISO 17025

2.2 GM Standards/Specifications.

GMW3091 GMW3097 GMW14264 GMW15649
GMW15650

2.3 Additional References.

CG4427

All DAB reception related GIS specifications:

GIS 46 GIS 65 GIS 90 GIS 92
GIS-316

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.

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3.1.3 General Motors Europe (GME). The European Antenna Ranges, located at the Dudenhofen 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.

3.1.4 General Motors Holden (GMH) (Proposal). Digital audio reception performance drive test is under development.

3.1.5 General Motors North America (GMNA), Korea (GMK), Brazil (GMB). GMNA MPG Range and GMK CPG Range are also able to perform GMW15650 but do not have any digital audio reception performance drive test capability.

3.2 Equipment.

3.2.1 Spectrum Analyzer (Vector Analyzer) or two DAB measurement receiver: For measuring electric field strength of each test location.

3.2.2 DAB Reference Antenna shall be connected with DAB measurement receiver.

3.2.3 BER Measuring System. USB Interface and Laptop computer with BER test software.

3.2.4 AC/DC converter.

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

3.2.6 IRT tool DAB-Scout.2 to check the original DAB data from air.

3.3 Test Vehicle/Test Piece. The vehicle under test shall be verified to have the intended Digital DAB antenna and receiver system meeting the design requirement. Testing should be performed with any movable obstructions to the antenna (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: 10 days

Test hours: 10 h

Coordination hours: 16 h

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

- Vehicle number
- Antenna part number and serial number
- DAB tuner part number, serial number, software version and calibration file
- Test device RPO and manufacturer

3.6 Personnel/Skills. The test personnel shall have a valid driver's license and be familiar with the performance subjective rating scale required to evaluate DAB reception while driving according to Appendix A1, Table A1 and GMW14264.

The test personnel shall be familiar operating the DAB measurement receiver and BER system required to collect the electric field strength data.

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.

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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 insure 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.

4.1.3 Preparation. The DAB services status should be checked to ensure DAB in the test area is operating normally.

IRT tool DAB-Scout.2 is used to check the original DAB data from air.

4.1.4 BER System. BER system should be equipped to measure Bit Error Ratio. It consists of a PC and USB Interface which is connected to DAB tuner/receiver module with multimedia serial port. BER test software tool and program should be installed in the PC.

4.2 Conditions.

4.2.1 Environmental Conditions. The DAB 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.

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.

4.3 Instructions. This procedure utilizes an un-weighted average jury listening method in conjunction with the DAB Reception Subjective Rating Scale (SR) to subjectively quantify the performance characteristics of the reception-system-under-test relative to a reference-reception-system (see Appendix A, A1, Table A1 for a copy of the SR).

The reception-system-under-test (DABut) and the reference-reception-system (DABref) are built in one vehicle supplied by one rod antenna using a splitter device. For a direct comparison the audio of both systems is distributed to the vehicle's speaker system in that way that one system uses the left audio channel(s) and the other one the right audio channel(s).

Comparing the reception-system-under-test against the reference-reception-system 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 DAB tuner under test and the DAB reference tuner is the DAB Tuner Delta Value and is defined by the following relationship:

$$\text{DAB Tuner Delta Value} = \text{AVG SR DABut} - \text{AVG SR DABref}$$

where:

AVG SR DABut is the final average score for the DAB tuner under test, and

AVG SR DABref is the final average score for the reference DAB tuner.

4.3.1 Individual DAB Tuner Delta Values are calculated for each of the following validation test conditions:

- DAB HMI Requirements
- DAB Tuning Operations
- DAB Recall Preset Station
- DAB Announcements
- DAB Reception Performance
- DAB2DAB Linking Performance
- DAB2FM Linking Performance
- DAB Audio Performance

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· DAB Data Services (e.g. TPEG)

4.3.2 The acceptable DAB Tuner Delta Value shall be specified in the VTS, SSTs or CTS documents for the vehicle program under test. The following default performance requirements shall apply where the acceptable DAB Tuner Delta Value is not specified:

Today's DAB reference tuner is a single DAB tuner system. The DAB tuner under test can be a single DAB tuner system or a dual DAB tuner system.

For single DAB tuner systems the final average score for the DAB tuner under test shall not be less than that one of the DAB reference tuner for each of the validation test conditions listed in 4.3.1 according to Table 1.

For dual DAB tuner systems the final average score for the DAB tuner under test shall not be less than that one of the DAB reference tuner or at least 1 SR point above that one of the DAB reference tuner for each of the validation test conditions listed in 4.3.1 according to Table 1.

Table 1: Default Performance Requirements

Tuner Type	Required DAB Tuner Delta Value	DAB Validation Test Conditions (according to 4.3.1)
single DAB tuner	≥ 0 SR	DAB HMI Requirements DAB Announcements DAB Reception Performance DAB2FM Linking Performance
dual DAB tuner	≥ 0 SR	
single DAB tuner	≥ 0 SR	DAB Tuning Operations DAB Recall Preset Station DAB2DAB Linking Performance DAB Audio Performance DAB Data Services (e.g. TPEG)
dual DAB tuner	≥ 1 SR	

Note: The evaluation scores are averaged and then rounded to one decimal point.

4.3.3 Validation Test Methodology.

4.3.3.1 DAB HMI Requirements. The performance of DAB related HMI screens and popups is evaluated under different specified reception conditions.

Ensemble and service information, program associated data (PAD) and announcements pop ups need to correspond to the actual DAB audio output.

HMI changes are synchronous to the corresponding DAB audio output changes.

The representation of ensemble name, service name and PTY label shall be considered as 16 bit format instead of 8 bit format wherever possible.

See Appendix A, A2.1 as reference for the evaluation.

4.3.3.1.1 Radio Test Alps Countries Route. See Appendix B, B1.1.1 for test frequencies and route details.

4.3.3.1.2 Radio Test UK London Route. See Appendix B, B1.1.2 for test frequencies and route details.

4.3.3.1.3 Radio Test Germany Rüsselsheim Area Route. See Appendix B, B1.1.3 for test frequencies and route details.

4.3.3.1.4 Performance Requirements. There is no latency allowed from DAB audio output change to HMI reaction. There is also no latency allowed between user interaction and HMI reaction.

HMI screens and popups always match correctly to the actual audio output state.

The 16 bit format e.g. for ensemble name and service name is used wherever space is available. Using the 8 bit format is limited to exceptions with minor space available, only (e.g. favorite keys).

4.3.3.1.4.1 Single DAB Tuner. Performance of DAB HMI Requirements is equal or better than the DAB reference tuner.

4.3.3.1.4.2 Dual DAB Tuner. Performance of DAB HMI Requirements is equal or better than the DAB reference tuner.

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4.3.3.2 DAB Tuning Operations. The performance of DAB manual tuning, DAB autostore, DAB service list update and DAB PTY category list is evaluated under different specified reception conditions.

DAB channels are tunable independent of being receivable. DAB channels are entered and indicated by their channel number. This takes precedence over using channel frequencies that are used for additional information, only.

If ensemble and service names are decoded from the fast information channel (FIC) they are represented by their names in the DAB service list. From this list ensembles and services can be tuned directly.

See Appendix A, A2.1 as reference for the evaluation.

4.3.3.2.1 Radio Test Alps Countries Route. See Appendix B, B1.1.1 for test frequencies and route details.

4.3.3.2.2 Radio Test UK London Route. See Appendix B, B1.1.2 for test frequencies and route details.

4.3.3.2.3 Radio Test Germany Rüsselsheim Area Route. See Appendix B1.1.3 for test frequencies and route details.

4.3.3.2.4 Performance Requirements. All DAB channels including not receivable are tunable. DAB channels are entered and indicated by their channel number.

The DAB service list is complete and contains all available services and at least all those services that the DAB reference tuner's list contains.

Sorting ensembles and services within the DAB service list is in the correct and specified order.

The DAB service list shows a clear mapping of services to ensembles.

Adding new ensembles and services to the DAB service list is performed as specified and at least as fast as the DAB reference tuner performs.

Removing no longer receivable ensembles and services from the DAB service list is performed as specified and performs equal or better as the DAB reference tuner.

In areas that are not DAB covered (e.g. complete countries like Austria) no ensemble and no service is allowed to be removed from the DAB service list.

In parking garages no ensemble and no service is allowed to be removed from the DAB service list.

The DAB service list is updated during service and ensemble stepping, after power down and manually initiated by HMI.

4.3.3.2.4.1 Single DAB Tuner. The DAB service list is updated in the background while any other audio than the DAB tuner itself is active.

Performance of DAB Tuning Operations is equal or better than the DAB reference tuner.

4.3.3.2.4.2 Dual DAB Tuner. The DAB service list is updated continuously even if the DAB tuner is active audio.

Performance of DAB Tuning Operations is better than the DAB reference tuner.

4.3.3.3 DAB Recall Preset Station. DAB services can be stored to favorite keys as preset stations. Recalling these preset stations distinguishes four different reception conditions.

- (1) DAB service is available within the identical ensemble and channel as stored.
- (2) DAB service is available within any different ensemble and channel as stored (requires DAB2DAB linking).
- (3) DAB service is not available within any ensemble and channel but available as FM alternative (requires DAB2FM linking).
- (4) DAB service is not available at all.

See Appendix A, A2.1 as reference for the evaluation.

4.3.3.3.1 Radio Test Alps Countries Route. See Appendix B, B1.1.1 for test frequencies and route details.

4.3.3.3.2 Radio Test UK London Route. See Appendix B, B1.1.2 for test frequencies and route details.

4.3.3.3.3 Radio Test Germany Rüsselsheim Area Route. See Appendix B, B1.1.3 for test frequencies and route details.

4.3.3.3.4 Performance Requirements. Switching to the new DAB service mutes the audio with the old service (ramp down) and unmutes the audio with the new recalled station (ramp up).

If upon recall the

- (1) DAB service is available within the identical ensemble and channel as stored this is played immediately.

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- (2) DAB service is available within any different ensemble and channel as stored a DAB2DAB linking to the different ensemble is performed
- (3) DAB service is not available within any ensemble and channel but available as FM alternative a DAB2FM linking to the FM alternative is performed.
- (4) DAB service is not available at all this shall be indicated by HMI. If there is any other ensemble available at the channel once being stored the first service of this ensemble is played. Otherwise the audio remains muted.

4.3.3.3.4.1 Single DAB Tuner. For cases (2), (3) and (4) a DAB band scan is likely to search for the DAB service. During this band scan the audio remains muted.

Performance of DAB Recall Preset Stations is equal or better than the DAB reference tuner.

4.3.3.3.4.2 Dual DAB Tuner. For cases (2), (3) and (4) the tuner has the actual reception landscape available without any band scan. In case (2) the DAB service is played immediately. In case (3) the FM alternative is played immediately.

Performance of DAB Recall Preset Stations is better than the DAB reference tuner.

4.3.3.4 DAB Announcements. Different DAB announcements types are available, e.g. Road Traffic Flash and News. By HMI all announcement types need to be activated prior to the test. The DAB announcements supported from air can be looked up inside the fast information channel (FIC), Announcement Support (FIG0/18).

DAB Announcements are switched from the actually audible DAB service.

In addition further DAB announcements of other services inside the same ensemble can be switched if these announcements of those other services are connected to the actual audible service via the announcement support information inside the fast information channel (FIC), Announcement Support (FIG0/18).

IRT tool DAB-Scout.2 is used to check the real FIC announcement support information from air.

See Appendix A, A2.1 as reference for the evaluation.

4.3.3.4.1 Radio Test Alps Countries Route. See Appendix B, B1.1.1 for test frequencies and route details.

4.3.3.4.2 Radio Test UK London Route. See Appendix B, B1.1.2 for test frequencies and route details.

4.3.3.4.3 Radio Test Germany Rüsselsheim Area Route. See Appendix B, B1.1.3 for test frequencies and route details.

4.3.3.4.4 Performance Requirements. All HMI selected types of DAB announcements shall be switched if transmitted.

All DAB Announcements of other services within the same ensemble shall be switched if connected to the actual service via the announcement support information of the FIC.

All DAB announcements shall be switched and at least that number of announcements that the DAB reference tuner switches.

4.3.3.4.4.1 Single DAB Tuner. Performance of DAB Announcements is equal or better than the DAB reference tuner.

4.3.3.4.4.2 Dual DAB Tuner. Performance of DAB Announcements is equal or better than the DAB reference tuner.

4.3.3.5 DAB Reception Performance. For DAB reception performance the reception-system-under-test and the reference-reception-system are compared at the same time being built in one vehicle supplied by one rod antenna using a splitter device. Both systems are listened to at the same time using the left audio channel(s) for one system and the right audio channel(s) for the other one.

This test is based on the un-weighted average jury listening method in conjunction with the Subjective Rating Scale (SR) and does not measure the bit error rates (BER). Measuring and comparing BERs in detail is in focus of another specific test and described in a separate section.

See Appendix A, A2.1 as reference for the evaluation.

4.3.3.5.1 Radio Test Alps Countries Route. See Appendix B, B1.1.1 for test frequencies and route details.

4.3.3.5.2 Radio Test UK London Route. See Appendix B1.1.2 for test frequencies and route details.

4.3.3.5.3 Radio Test Germany Rüsselsheim Area Route. See Appendix B1.1.3 for test frequencies and route details.

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4.3.3.5.4 Performance Requirements. The reception-system-under-test shall provide proper DAB reception at least whenever the reference-reception-system offers DAB reception.

Clipping as a result of too high bit error rate (BER) shall not start earlier at the reception-system-under-test than at the reference-reception-system.

4.3.3.5.4.1 Single DAB Tuner. Performance of DAB Reception is equal or better than the DAB reference tuner.

4.3.3.5.4.2 Dual DAB Tuner. Performance of DAB Reception is equal or better than the DAB reference tuner.

4.3.3.6 DAB2DAB Linking Performance. In case of the DAB reception of the actual service becomes too weak a DAB2DAB linking is performed if the identical service is available within any other better receivable DAB ensemble.

If there is no DAB alternative ensemble available but a FM alternative this is to be linked instead. This DAB2FM linking is described in a separate section below.

See Appendix A, A2.1 as reference for the evaluation.

4.3.3.6.1 Radio Test Alps Countries Route. See Appendix B, B1.1.1 for test frequencies and route details.

4.3.3.6.2 Radio Test UK London Route. See Appendix B, B1.1.2 for test frequencies and route details.

4.3.3.6.3 Radio Test Germany Rüsselsheim Area Route. See Appendix B, B1.1.3 for test frequencies and route details.

4.3.3.6.4 Performance Requirements. If there are more than one DAB alternative ensembles available for DAB2DAB linking available the linking shall be performed to that DAB ensemble with the best quality or lowest bit error rate (BER).

DAB2DAB linking to any available DAB alternative ensemble shall be performed without any audible mute.

4.3.3.6.4.1 Single DAB Tuner. If no DAB alternative ensemble is known a DAB search is required. During this search the audio shall be muted. If any FM alternative is available this shall be played instead of muting the audio. The requirements for this DAB2FM linking are described in a separate section below.

Nevertheless the amount of such DAB searches shall be minimized by proper timing criteria and hold times.

Performance of DAB2DAB Linking is equal or better than the DAB reference tuner.

4.3.3.6.4.2 Dual DAB Tuner. There is no DAB search for a DAB alternative ensemble allowed as a dual tuner shall collect this information in the background.

Performance of DAB2DAB Linking is better than the DAB reference tuner.

4.3.3.7 DAB2FM Linking Performance. In case of the DAB reception of the actual service becomes too weak a DAB2DAB linking is performed if the identical service is available within any other better receivable DAB ensemble. This DAB2DAB linking is described in a separate section above.

If there is no DAB alternative ensemble available a DAB2FM linking to a FM alternative shall be performed instead if there is any FM alternative available.

As soon as the quality or bit error rate (BER) of the actual service raises again on any DAB ensemble the audio shall switch back to this ensemble.

All possible FM RDS PI codes for this DAB2FM linking are provided via the service linking information inside the fast information channel (FIC), Service Linking Information (FIG0/06).

IRT tool DAB-Scout.2 is used to check the real FIC service linking information data from air.

See Appendix A2.1 as reference for the evaluation.

4.3.3.7.1 Radio Test Alps Countries Route. See Appendix B, B1.1.1 for test frequencies and route details.

4.3.3.7.2 Radio Test UK London Route. See Appendix B, B1.1.2 for test frequencies and route details.

4.3.3.7.3 Radio Test Germany Rüsselsheim Area Route. See Appendix B, B1.1.3 for test frequencies and route details.

4.3.3.7.4 Performance Requirements. No audible mutes are allowed neither at switching to the FM audio nor at switching back to the DAB audio.

Although there is a timeshift of several seconds between the DAB audio signal from air and the FM audio signal from air (DAB audio signal is delayed) the DAB2FM linking shall be performed seamless. No audible timeshift is allowed neither at switching to the FM audio nor at switching back to the DAB audio.

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Furthermore there are no audible volume jumps allowed neither at switching to the FM audio nor at switching back to the DAB audio.

Nevertheless the switching between the DAB audio and the FM audio always remains audible for experienced customers as the DAB audio provides digital and therefore always best quality and in contrast FM audio is overlayed with noise due to weak reception, multipath and adjacent channels. Toggling between the FM and the DAB audio source too fast results in an annoying and poor audio impression due to these different audio qualities. Switching too fast shall be prevented by a proper time and quality based switching hysteresis between the FM audio and the DAB audio.

4.3.3.7.4.1 Single DAB Tuner. Performance of DAB2FM Linking is equal or better than the DAB reference tuner.

4.3.3.7.4.2 Dual DAB Tuner. Performance of DAB2FM Linking is equal or better than the DAB reference tuner.

4.3.3.8 DAB Audio Performance. For DAB audio performance the reception-system-under-test and the reference-reception-system are compared at the same time being built in one vehicle supplied by one rod antenna using a splitter device. Both systems are listened to at the same time using the left audio channel(s) for one system and the right audio channel(s) for the other one.

This test is based on the un-weighted average jury listening method in conjunction with the Subjective Rating Scale (SR) and does not measure the bit error rates (BER). Measuring and comparing BERs in detail is in focus of another specific test and described in a separate section.

DAB audio performance shall be evaluated under strong, normal and weak reception conditions.

As DAB audio is provided with digital and therefore best quality the most differences between the reception-system-under-test and the reference-reception-system occur when leaving, entering or changing coverage areas of different DAB ensembles and the need for DAB2DAB linking and when listening in weak reception areas and the need for DAB2FM linking.

Focus of this evaluation is the overall DAB audio performance in contrast to the pure performance of DAB2DAB and DAB2FM linking that is evaluated in separate sections above.

See Appendix A, A2.1 as reference for the evaluation.

4.3.3.8.1 Radio Test Alps Countries Route. See Appendix B, B1.1.1 for test frequencies and route details.

4.3.3.8.2 Radio Test UK London Route. See Appendix B, B1.1.2 for test frequencies and route details.

4.3.3.8.3 Radio Test Germany Rüsselsheim Area Route. See Appendix B, B1.1.3 for test frequencies and route details.

4.3.3.8.4 Performance Requirements. For the overall DAB audio performance no timeshift and no volume jumps are allowed especially not in those events when switching between DAB ensembles or tuner modes due to any linking operations. Ideally a seamless overall audio is played with only less perceptible differences in the audio quality independent whether the audio source is DAB or FM.

FM traffic announcements (TA) and FM enhanced other network traffic announcements (EON-TA) shall perform similar to the DAB2FM linking. If FM TAs and EON-TAs are activated by HMI and interrupt the actual DAB audio no mutes and no timeshift are allowed neither at switching to the announcement nor at switching back to the original DAB audio. The only allowed volume jump while switching to a FM TA or EON-TA is that raise that is specified to achieve the customer's attention for the announcement.

4.3.3.8.4.1 Single DAB Tuner. Due to DAB searches are likely for single DAB tuner systems some mutes may occur if during this searches there is no FM alternative available.

Performance of DAB Audio is equal or better than the DAB reference tuner.

4.3.3.8.4.2 Dual DAB Tuner. As dual tuner systems collect all the DAB search information in background no mutes are allowed except for that use case that there is no more reception at all for the desired service on any DAB ensemble or any FM alternative.

Performance of DAB2DAB Audio is better than the DAB reference tuner.

4.3.3.9 DAB Data Services (e.g. TPEG). Beside the DAB audio DAB services provide additional program associated data (PAD) within their fast information channel (FIC). Some of these data is needed to control the DAB service, e.g. DAB announcements and DAB2FM linking (see separate sections above). Some more data within PAD and FIC are for additional DAB service information purpose like dynamic label (DL), artist, title, station

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