Arqiva DAB Car receiver tests in the UK

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Topics:

- Introduction
- Car antenna pattern measurement
- Testing potential interfering sources in cars
- How to test car receiver performance
- Arqiva drive tests
- Interfering transmitter in adjacent band
- Conclusions

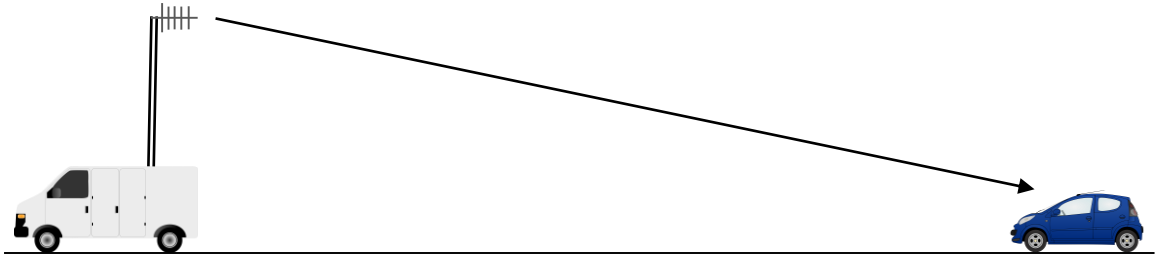
Introduction

- Arqiva is the UK broadcast network operator, transmitting DAB for a range of broadcasters
- We receive some reports of poor DAB reception which suggest that quality of DAB receiver varies between different vehicles and manufacturers
- Our testing of DAB receiver antenna patterns for a number of vehicles, showed that some are very directional and choice antenna location is important

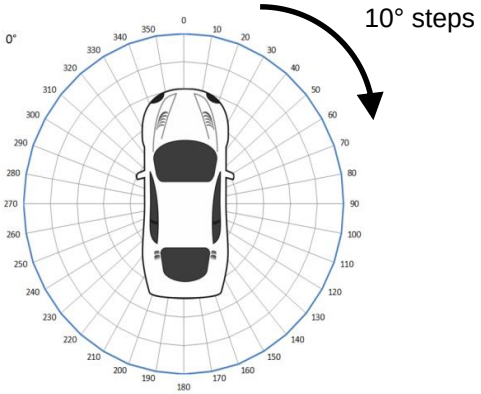
- Subsequent discussions with automotive industry raised the EMC issue due to increasing quantity of electronics in the vehicle

Test method

DAB 11B 218 MHz
5 element Yagi antenna
Vertical polarisation



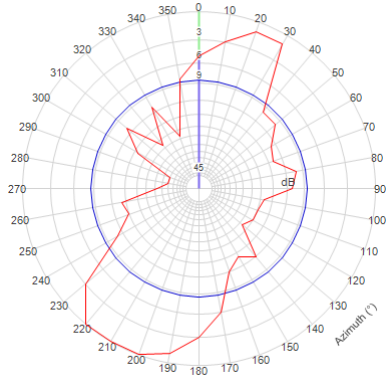
31 metres



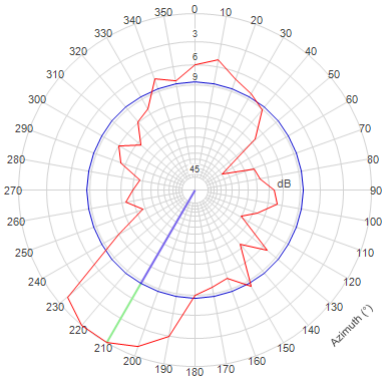
- The aim of these tests was to evaluate the overall sensitivity of the complete receiver systems
- Testing was in controlled conditions on a clear flat car park
- The vehicle being tested was rotated through 360° in 10° steps
- At each orientation the transmitter power was reduced until audio was degraded in the vehicle
- This method tests the complete DAB receiver system in the car from the listeners point of view, we did not break out separate measurements of the antenna and receiver performance

Examples of Horizontal Patterns

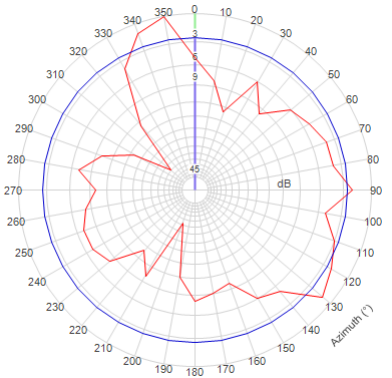
Rear window



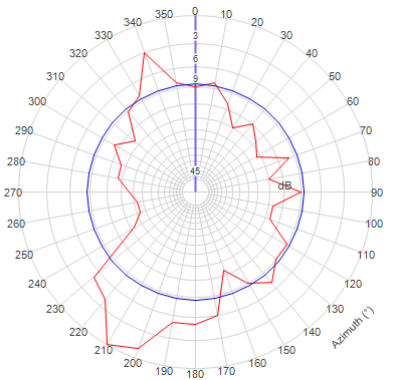
Rear



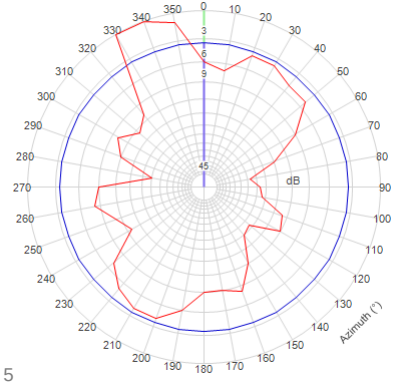
Front window



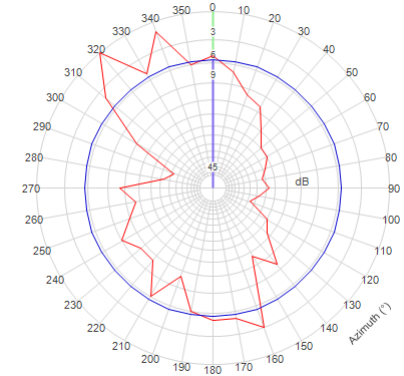
Rear window



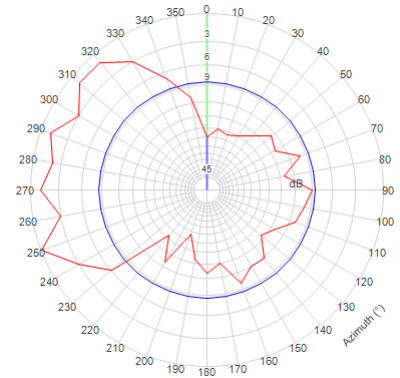
Front window



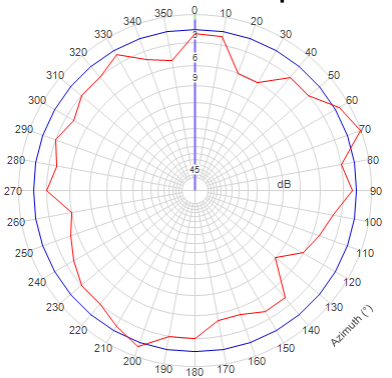
Front windscreen



Driver side rear window



Roof whip



Conclusions from measured patterns

- Some patterns are very directional
- There can be significant nulls in some directions

- Roof mounted whip antennas give best omni-directional patterns
- But vehicle designers prefer antennas to be ‘hidden’ in windows or inside spoilers for aesthetic reasons

Testing potential interfering sources in cars (1)

- Tested the impact of other equipment on DAB reception in four cars at stationary location
- Method is based on the tests used for antenna pattern:
  - Adjust the power of a test transmitter to find receiver threshold of vehicle DAB radio
  - Switch on various devices in vehicle to test if threshold changes significantly

- We did not find significant impact from these items:
  - USB adaptor in cigarette lighter
  - In-car navigation system
- We did find significant impact from these items in two cars:
  - Air Conditioning / Heater – caused complete dropout in one car when turned to front windscreen
  - Dashcam – caused dropout in two cars, when mounted close to rear window antenna
- Conclusions
  - Problem not as bad as we expected, but still significant in some vehicles
  - Position of DAB antenna is important in determining if there is an interference impact

Testing potential interfering sources in cars (2)

- Further testing of an after-market DAB receiver with different USB charger in cigarette lighter
- Found that some chargers caused problems, other did not

- We also have anecdotal reports of problems due to faulty LED lights which were resolved when the LTE was replaced

- Conclusions:
- Impact varies between devices
- After-market devices and faults can mean that reception problems can develop in a vehicle which initially works well when first delivered

How to test receiver performance in vehicles

- Automotive manufacturers need to test car receiver performance
- Two approaches are drive test or measurement in anechoic chamber

Chamber test

- Repeatable and controlled environment
- Allows diagnosis of issues
- But propagation environment is unrealistic due to no multipath
- Important to choose the correct test signal level

Drive test

- Gives a test in realistic propagation environment
- But time consuming and propagation conditions can introduce some variability
- Does not need an expensive test chamber facility

- Manufacturers will likely prefer chamber based testing for control reasons
- But Arqiva prefers drive test because it tests performance of complete system in real conditions

Appropriate level for static noise testing (1)

Setting thresholds

- Important to be careful with thresholds for receiver testing, automotive people will not necessarily understand broadcast spectrum planning assumptions and terminology
- Some of the figures in our standard minimum field strengths are thought to be pessimistic (C/N and antenna gain) so there could be some headroom
- But some of the figures are propagation corrections only for network planning, these should not be included when setting thresholds for receiver testing

Rayleigh channel correction

- The field strength threshold at the vehicle (34.7dBµV/m in UK assumptions) includes a correction factor for mobile reception in a multipath propagation environment (Rayleigh channel margin)
- The Rayleigh channel correction is designed for mobile reception with Rayleigh fading and Doppler spread caused by multiple reflection arriving from scatterers around the receiver
- The propagation environment in the static test will not fit the Rayleigh channel assumption
- So using the 34.7dBµV/m level for static testing could be misleading compared to real reception

Appropriate level for static noise testing (2)

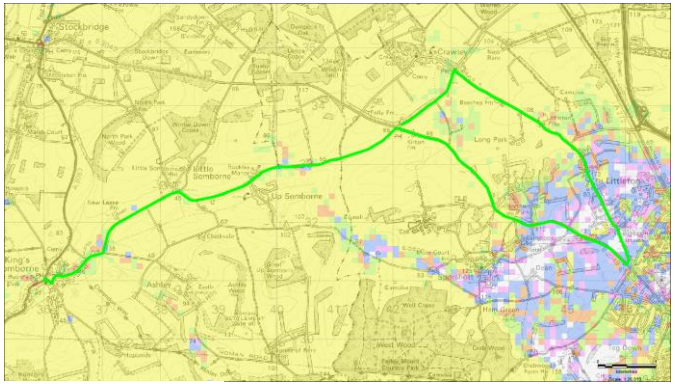
- A possible approach to account for Rayleigh correction in static testing:
  - Transmit the minimum required field strength to the vehicle in the static test
  - Measure the signal strength at the receiver
  - Set the maximum noise threshold at 13dB below the measured signal level
  - Compare measured noise levels with this threshold

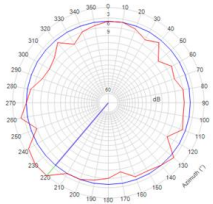
- The 13dB accounts for the C/N requirement in the network planning threshold
- The measured noise would account for LNA noise and other sources

- Measured signal levels will be different for different bearings and frequencies.
- Arqiva suggests 90th percentile of the antenna pattern but this is open for debate

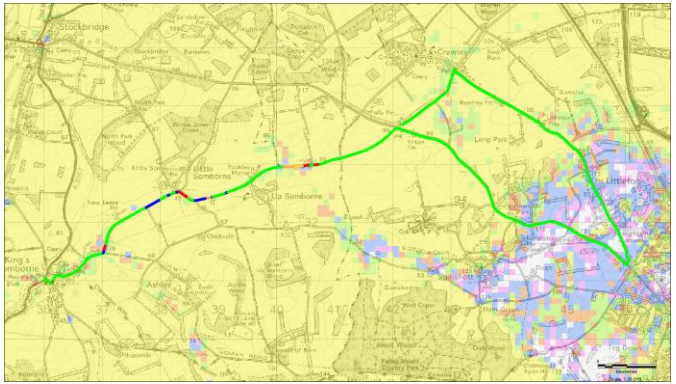
Arqiva drive tests

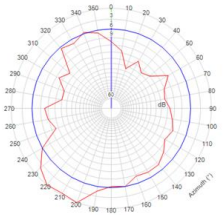
- Arqiva has carried out some drive testing on a defined route near our office
- Aiming to test realistic reception as experienced by real listeners
- Reception performance varies between vehicles, but antenna pattern seems to be main factor
- RF noise generated in the vehicle is included in the test, but not easy to separate out its effect





Car A
No dropouts
Roof-top whip antenna





Car B
Dropouts
More directional pattern
Rear window antenna

Example of interference from adjacent frequency band

- Recently we had complaints about a motorway coverage ‘dead-spot’ affecting DAB reception in many cars
- Investigation found a mobile data system transmitting from a site adjacent to the road on 163MHz
- This frequency is close to the bottom of the DAB band
- Interferer was overloading DAB receivers in the immediate area of the site

- This is a legitimate transmitter, so not an EMC issue
- But effect is similar for listener

Conclusions

- Biggest factor in car DAB reception is the design and positioning of the antenna
- But interference from other devices (eg Dashcam) can cause reception problems, particularly when located near to receiver antenna

- Impact of other devices is dependent on their position relative to the DAB antenna
- Roof-top antenna seems best protected from in-car devices, and also provides best omni-directional pattern

- Test threshold need to account for propagation factors correctly, else headroom designed for network planning reasons could be used up by in-vehicle generated noise

- Services transmitted in adjacent spectrum are not EMC, but can cause similar problems for listeners