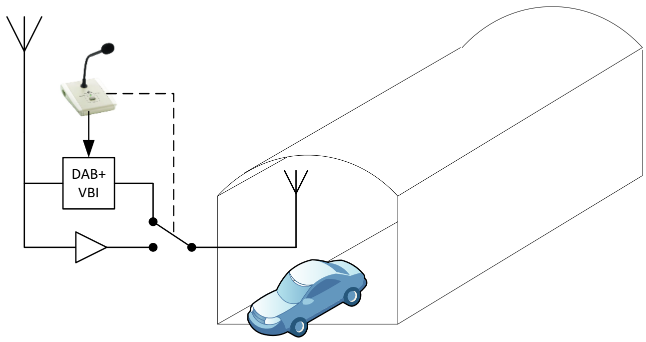
PrecisionWave AG
Swiss RF Solutions

On the Synchronization in DAB+ Voice Break-In

The realization of tunnel transmitters with DAB+ is considerably more complex than traditional VHF systems, irrespective whether break-in is used or not. This is owed to the digital encoding of the DAB+ signal. With DAB+ all transmitters work on the same frequency channel. The receivers, in the tunnel case the DAB+ car radios, must be able to easily synchronize to the transmission signal. Digital data streams of all transmitters within the tunnel must be exactly synchronized to transmitters surrounding the tunnel in order for the receving devices not to loose synchronization. If a receiver loses synchronization only for a short period of time, it usually takes several tens of seconds to recover. During this time no audio signal is available, which provides a very inconvenient listening experience. The transition areas at the entrances of tunnels are especially critical since the client receives a signal from both the external as well as the internal transmitters.

Voice Break-In

Voice break-in (VBI) refers to the process where the regular broadcast signal on all or selected channels is replaced by an announcement message (the voice break-in message). This break-in is usually done over a limited spatial reception area, e.g., a tunnel tube and used to inform listeners of incidents or other urgent messages. Messages delivered can be live-audio or pre-recorded audio files. A tunnel tube break-in operation presents a particular challenge for the sender-receiver synchronization since the DAB+ VBI system must ensure that the synchronization is maintained even during the play-out of an emergency message.



Synchronization

To ensure an uninterrupted switchover of the input signal, PrecisionWave has developed a two level synchronization procedure for their DAB+ Voice Break-In System:

- Automatic frequency synchronization of the tunnel receiver/transmitter system to the transmission frequency of the surrounding, external transmitters
- DAB+ frame synchronization of the digital data stream

One of the difficulties of synchronization is to reliably detect the start of a DAB frame even in a poor signal reception situation. The exact knowledge of the start of a DAB frame is required for a synchronous start of the fast Fourier transform (FFT) operation needed for the orthogonal frequency division multiplex (OFDM) demultiplexing. Otherwise, the audio will also be interrupted in for a short period. To ensure operation even bad reception situations the PrecisionWave receiving electronics are designed with very high dynamic range and resolution.

Correct synchronization can be verified by assessing the probability of error as a function of the signal-to-noise ratio (SNR). PrecisionWave has determined this both by means of simulation and measurement and comparison values from scientific literature (e.g. [2]).

Successful frame synchronization in poor SNR situations can only be achieved with advanced and real-time frequency correction capabilities on a hardware level. Frequency correction ensures that the local receiver oscillator is exactly matched to the transmission frequency of the DAB single-frequency network. For this purpose, PrecisionWave uses the algorithm described in [1] and achieves a maximum frequency error that is always below 5Hz and therefore sufficiently low.

In addition to these synchronization methods, the frame structure of the original digital data stream must also inherited to the break-in message. For this purpose, the incoming audio data streams are replaced by the same coded audio data streams of the break-in signal, including the dynamic label string (DLS), i.e. the text information which appears on the radio display. All remaining data is copied from the original signal.

[1] Yung-Liang Huang, Member, IEEE, Chorng-Ren Sheu, Student Member, IEEE, and Chia-Chi Huang (1999). *Joint Synchronization in Eureka 147 DAB System Based on Abrupt Phase Change Detection*

[2] B.R. Vinod* and S. Srikanth**, * Dept. of Electronics Engineering, MIT Campus, Anna University, Chennai, **AU-KBC Research Center, MIT Campus, Chennai. (2007). *A Null Symbol Detection Algorithm for DAB Receivers*