Combined transmission of DRM+ and FM

A. Waal, F. Maier
27 November 2008
Introduction

- Combined mode can be helpfully to launch step-by-step the new digital system (DRM+) into the FM band
- Evaluations took place with different frequency distances and protection ratios
Evaluation

- Changing the carrier frequency distance ($\Delta f$) and the power level difference ($\Delta P$, Protection Ratio) of the FM and the DRM+ signal, subjective audio tests of the received FM signal were made.
- $\Delta f$ [100 kHz, 150 kHz, 200 kHz]
- Test equipment:
  - Transradio FM Transmitter T3270
  - DRM+ Modulator (IKT)
  - 10 dB coupler RVRIBJECT12K10A
  - FM receiver Sony STR-GX 415
Exempels of spectrum

\[ \Delta f = 200 \text{kHz}, \Delta P = 20 \text{dB} \quad \Delta f = 150 \text{kHz}, \Delta P = 23 \text{dB} \quad \Delta f = 100 \text{kHz}, \Delta P = 26 \text{dB} \]
Audio signal $\Delta P = 20$ dB

- Only FM
- $\Delta f = 200$ kHz
- $\Delta f = 150$ kHz
- $\Delta f = 100$ kHz

speech | silence | music
Audio signal $\Delta P=17\text{dB}$

- Only FM
- $\Delta f=200\text{kHz}$
- $\Delta f=150\text{kHz}$
- $\Delta f=100\text{kHz}$

speech  silence  musik
Subjective evaluation of audiosignal

- $\Delta f=100\text{kHz}$: Strong disturbance at any $\Delta P$
- $\Delta f=150\text{ kHz}$ and $\Delta P>20\text{dB}$: no audible disturbances (earphone „Beyerdynamics DT770 Pro“)
- $\Delta f=150\text{ kHz}$ and $\Delta P=20\text{dB}$: moderate noise, audible only at low level audio signal
- $\Delta f=150\text{ kHz}$ and $\Delta P=17\text{dB}$: considerable noise at low level audio signal
- $\Delta f=150\text{ kHz}$ and $\Delta P<17\text{dB}$: audible noise at high level audio signal
- Enhancement to $\Delta f=200\text{kHz}$ gives no advantage (which could be caused by the bandpass filter in DRM+ modulator)
Analysis of audio SNR

Unweighted SNR measurement without consideration of the FM receiver input level

<table>
<thead>
<tr>
<th>Audio SNR [dB]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DRM+ switched off</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protection ratio</th>
<th>Distance FM-DRM+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>200 kHz</td>
</tr>
<tr>
<td>26 dB</td>
<td>54.3358</td>
</tr>
<tr>
<td>23 dB</td>
<td>52.7196</td>
</tr>
<tr>
<td>20 dB</td>
<td>50.6859</td>
</tr>
<tr>
<td>17 dB</td>
<td>42.8846</td>
</tr>
<tr>
<td>14 dB</td>
<td>46.1976</td>
</tr>
<tr>
<td>11 dB</td>
<td>45.6885</td>
</tr>
</tbody>
</table>
Conclusion

- The DRM+ signal could be transmitted simultaneous with the FM signal at $\Delta f=150\text{kHz}$ and $\Delta P>20\text{dB}$
- If the combined mode is desired, then there is need for some signaling, corresponding to the FM signal
- Advantages of DRM+ combined mode:
  - No strong coupling between the carrier frequencies. The DRM+ signal can be placed left or right of the FM signal
  - It is not mandatory to transmit the same program analog and digital