



Combined transmission of DRM+ and FM

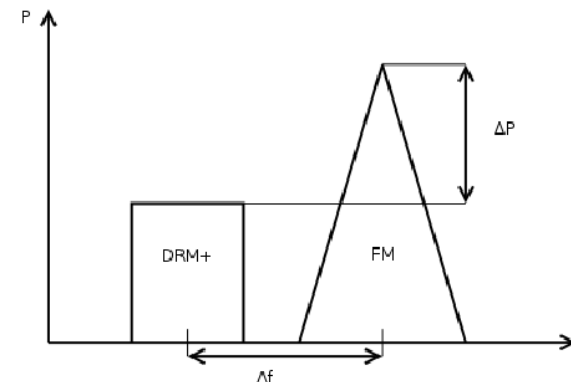
A. Waal, F. Maier
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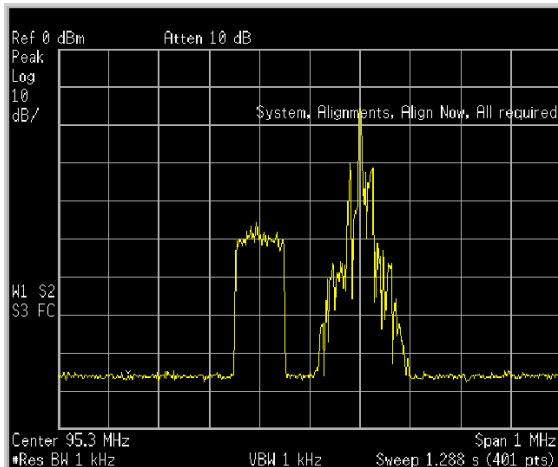
- Combined mode can be helpfully to launch step-by-step the new digital system (DRM+) into the FM band
- Evaluations took place with different frequency distances and protection ratios



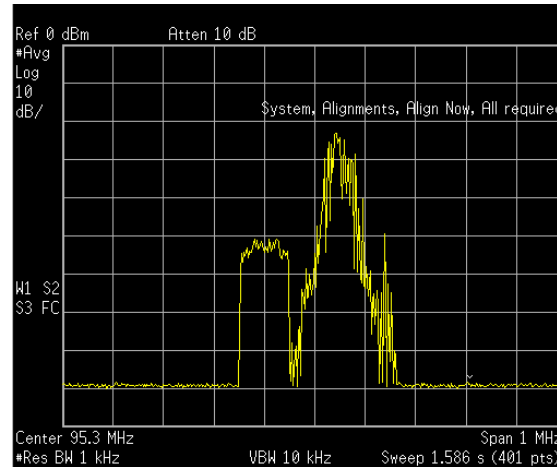
- Changing the carrier frequency distance (Δf) and the power level difference (ΔP , Protection Ratio) of the FM and the DRM+ signal, subjective audio tests of the received FM signal were made
- Δf [100 kHz, 150 kHz, 200 kHz]
- ΔP [11dB, 14dB, 17dB, 20dB, 23dB, 26dB]
- Test equipment:
 - Transradio FM Transmitter T3270
 - DRM+ Modulator (IKT)
 - 10 dB coupler RVRIBJECT12K10A
 - FM receiver Sony STR-GX 415



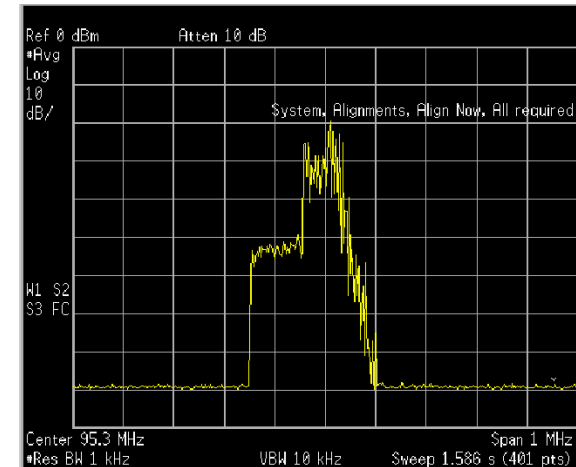
Exempels of spectrum



$\Delta f=200\text{kHz}$, $\Delta P=20\text{dB}$

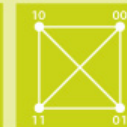


$\Delta f=150\text{kHz}$, $\Delta P=23\text{dB}$



$\Delta f=100\text{kHz}$, $\Delta P=26\text{dB}$

Audio signal $\Delta P=20\text{dB}$



Only FM

$\Delta f=200\text{kHz}$

$\Delta f=150\text{kHz}$

$\Delta f=100\text{kHz}$



speech

silence

music

Audio signal $\Delta P=17\text{dB}$

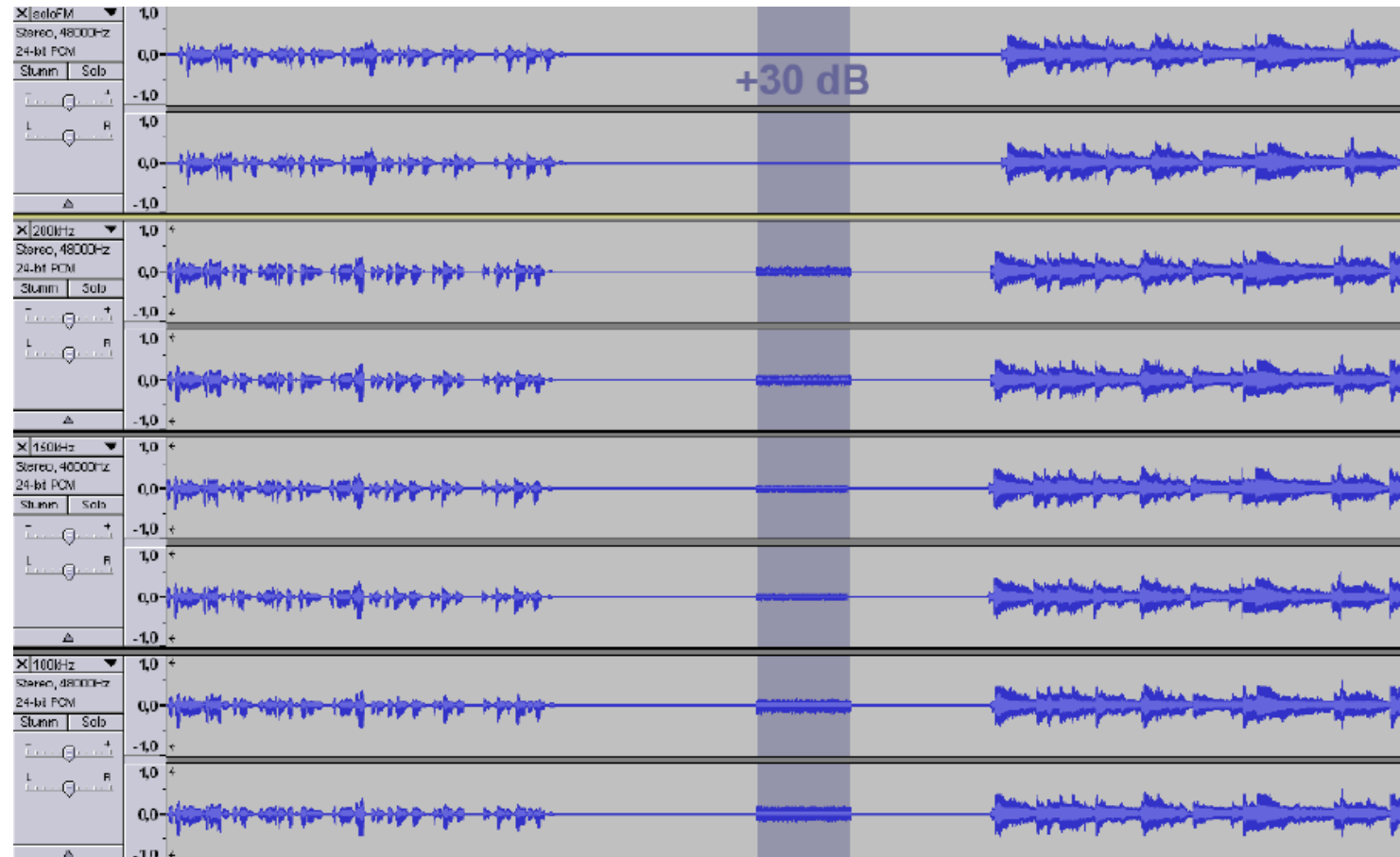


Only FM

$\Delta f=200\text{kHz}$

$\Delta f=150\text{kHz}$

$\Delta f=100\text{kHz}$



speech

silence

musik

Subjectiv evaluation of audiosignal



- $\Delta f=100\text{kHz}$: Strong disturbance at any ΔP
- $\Delta f=150\text{ kHz}$ and $\Delta P>20\text{dB}$: no audible disturbances (ear phone „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

Audio SNR [dB]			
DRM+ switched off	57.1886		
	Distance FM-DRM+		
Protection ratio	200 kHz	150 kHz	100 kHz
26 dB	54.3358	54.9064	46.0478
23 dB	52.7196	53.5398	43.2225
20 dB	50.6859	51.3290	41.5168
17 dB	42.8846	45.6501	38.0204
14 dB	46.1976	47.0369	36.3422
11 dB	45.6885	46.6148	36.1325



- 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