Audio processing for digital radio broadcasting

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Omnia Audio, Telos Alliance

THE TELOS ALLIANCE™

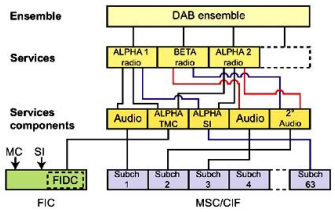
Telos® Omnia® 25 seven™ AXIA® LINEAR ACOUSTIC®

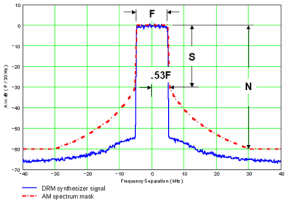
Digital audio broadcasting systems

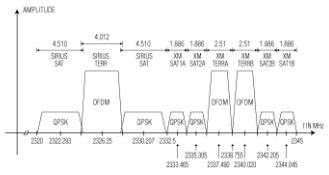
Digital audio broadcasting systems

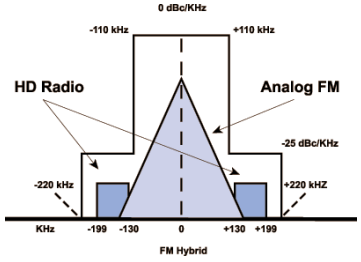
DAB+ | Drm+ | SiriusXM SATELLITE RADIO | HD Radio

TERRESTRIAL OTA MULTIPLEX	REPLACEMENT	SATELLITE OTA MULTIPLEX	OTA IBOC









Codecs used in FM-replacement digital audio broadcasting systems

DAB+	DRM+	SiriusXM Satellite Radio	HD Radio
AAC LC HE-AAC HE-AAC v2	AAC LC HE-AAC HE-AAC v2	AAC LC HE-AAC HE-AAC v2	HDC

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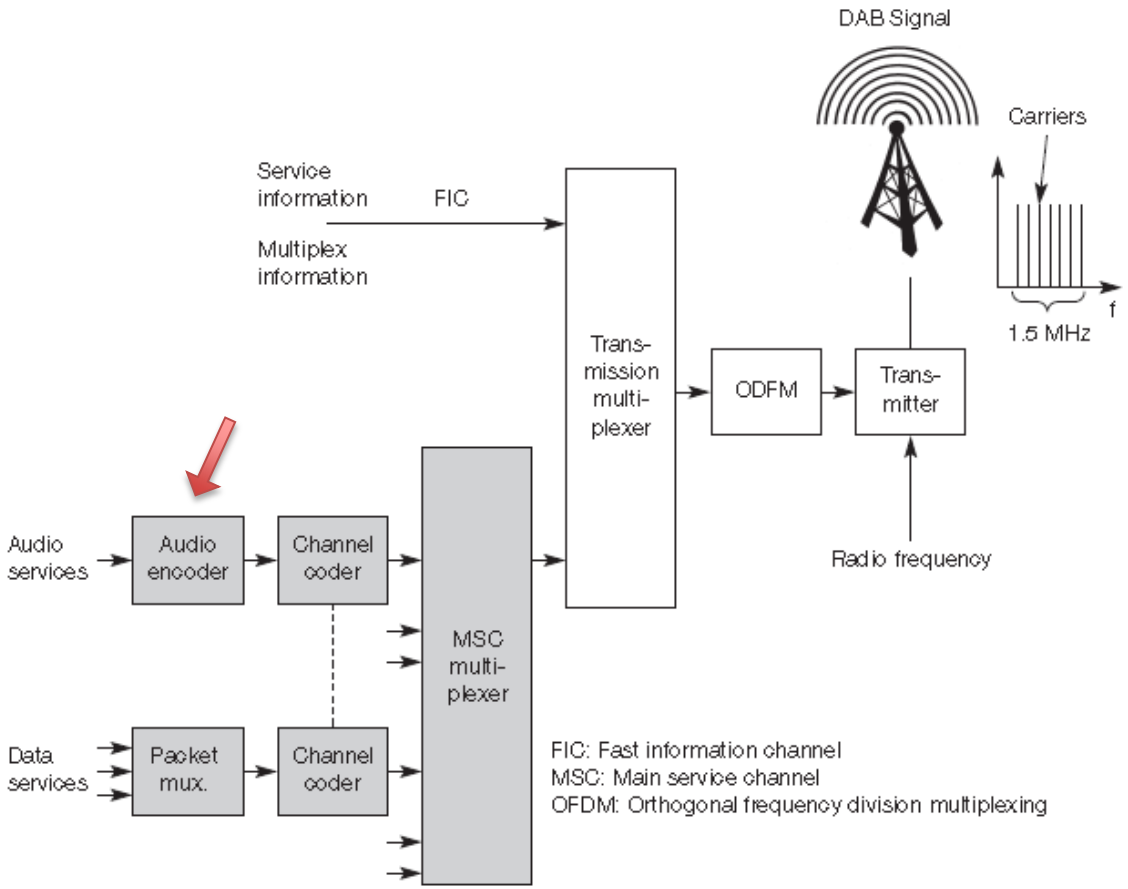
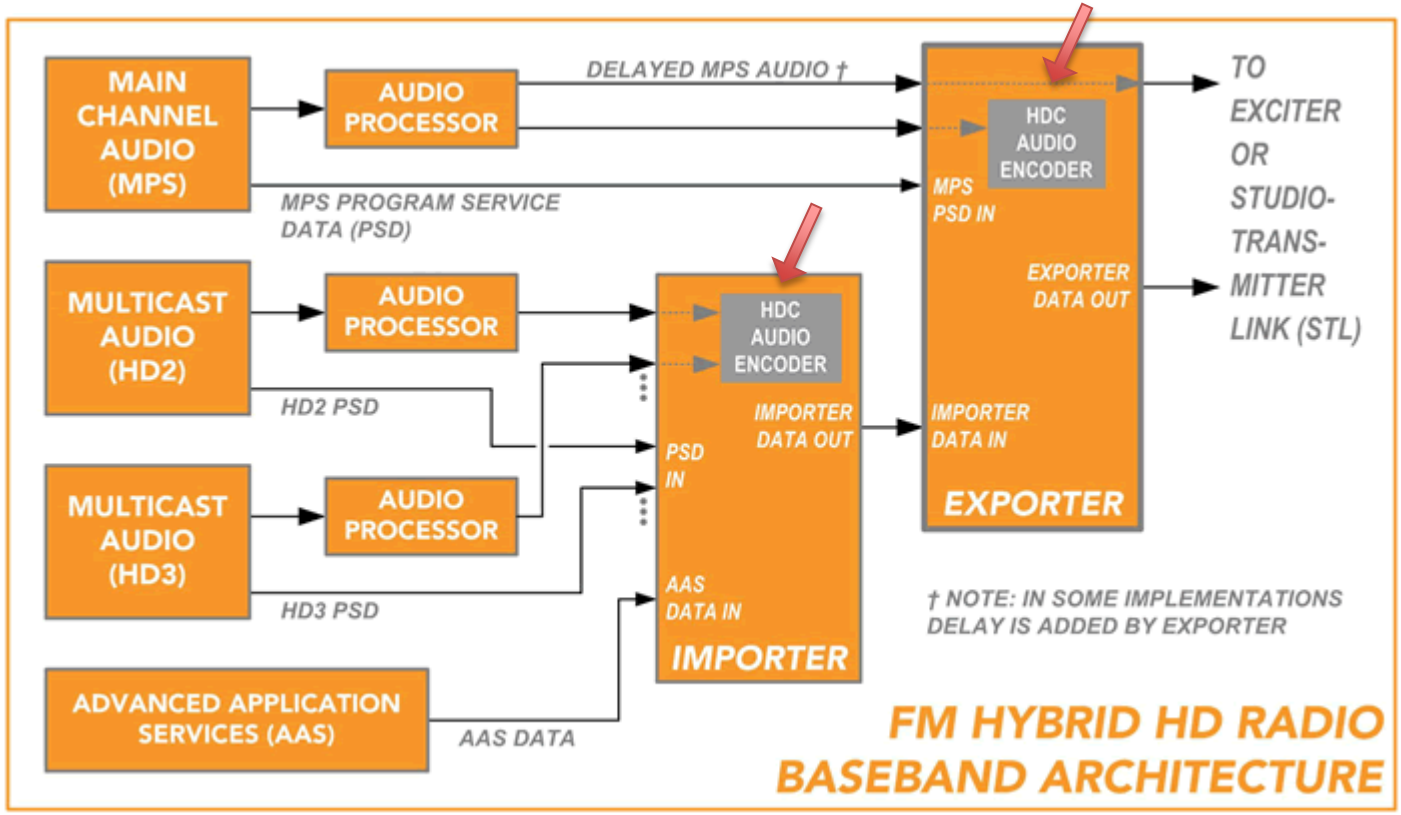
Transmission irrelevant



Transmission irrelevant



Take-away point

Same general target codec → same audio processing and optmization techniques

Perceptual coding principles

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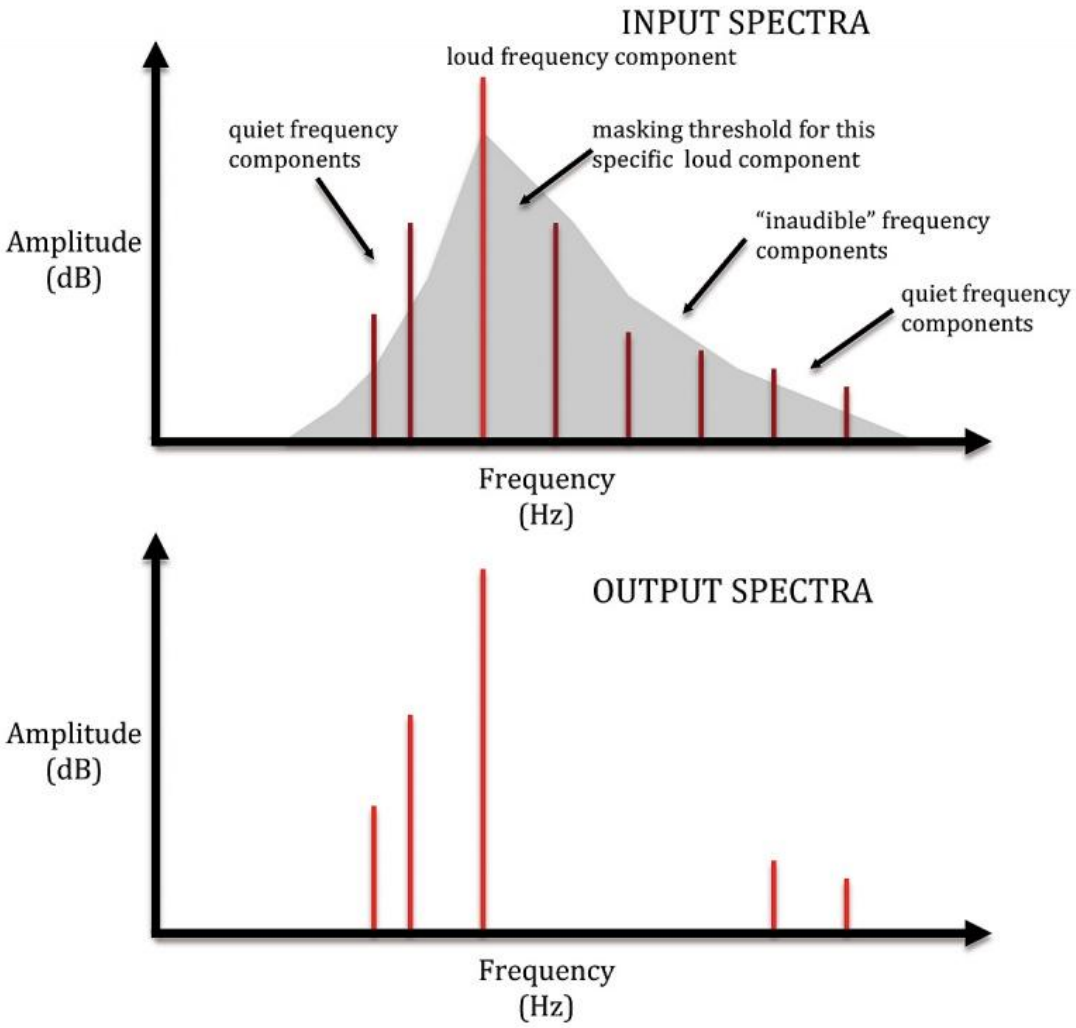
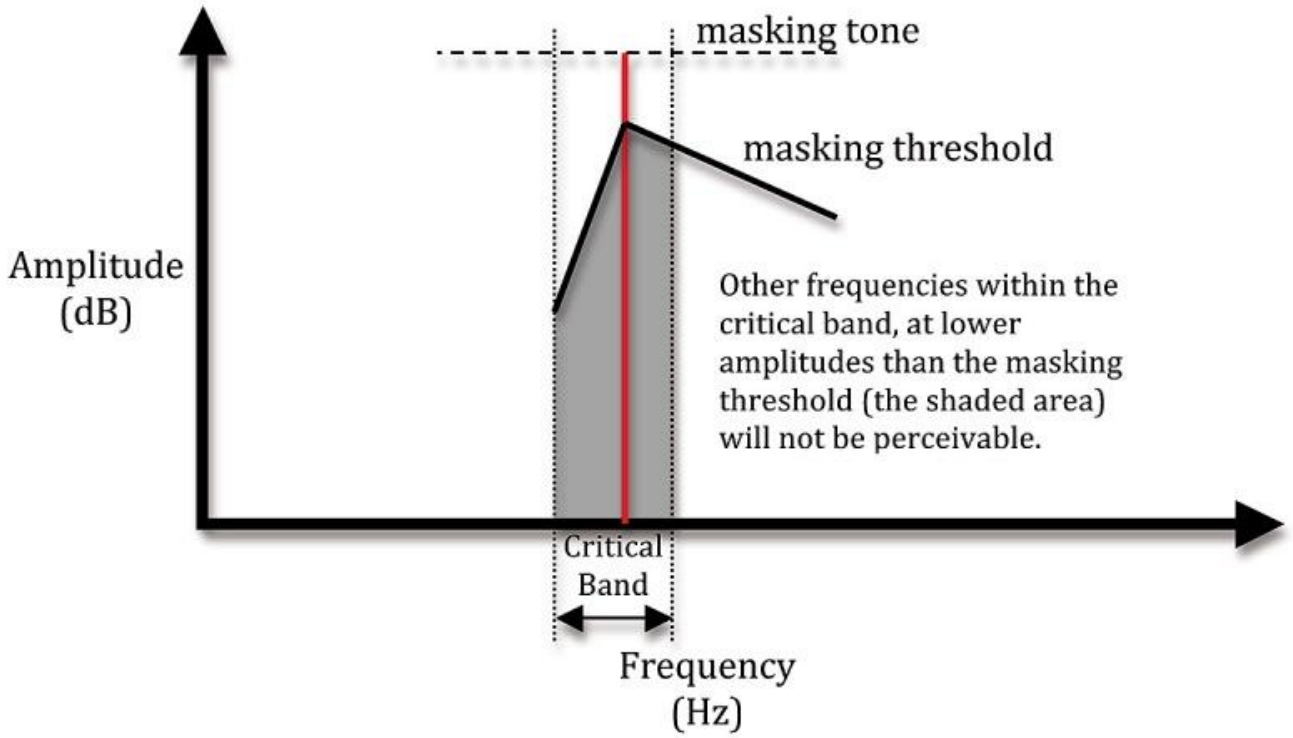
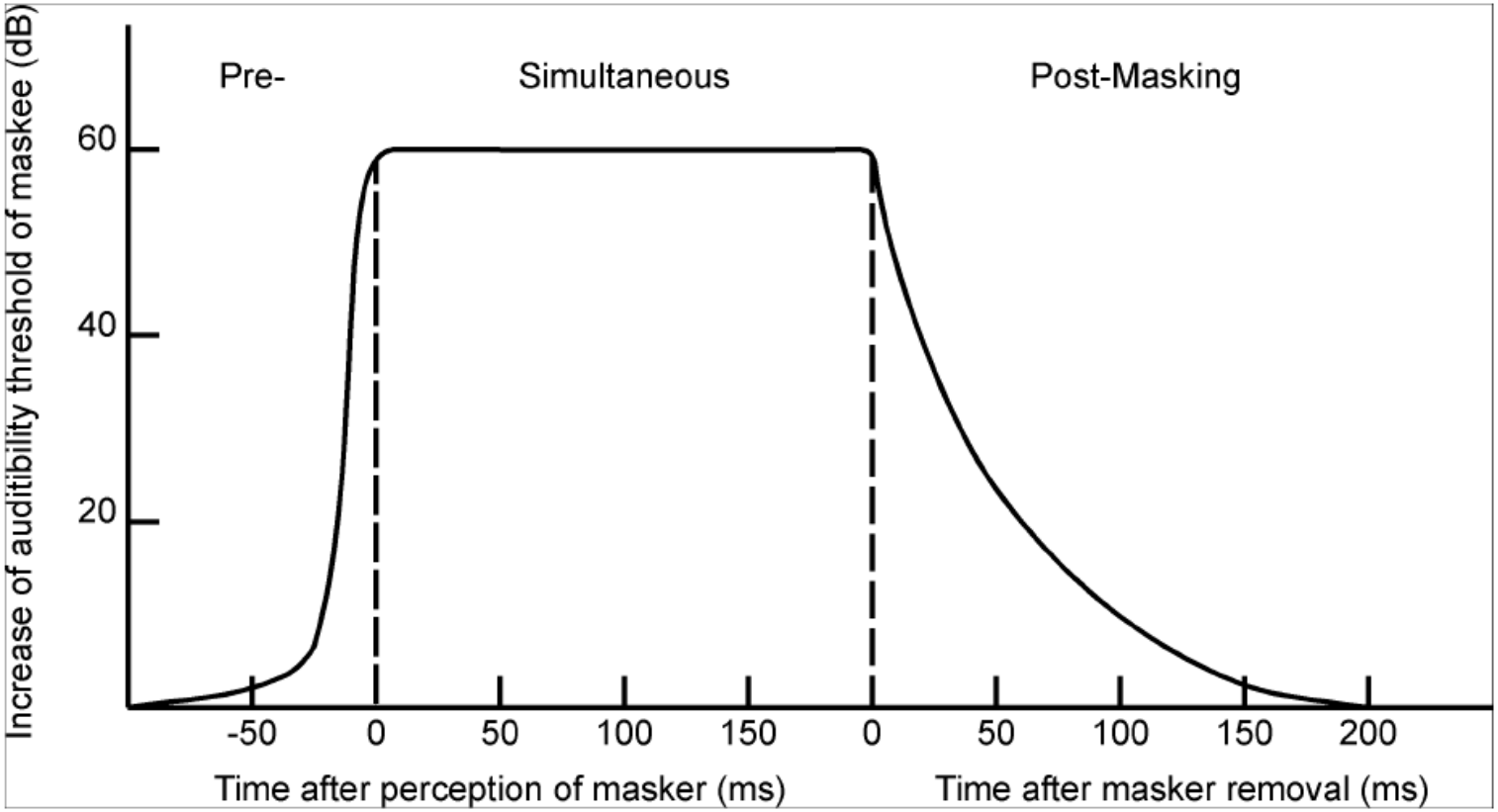
Closer look at the codecs used



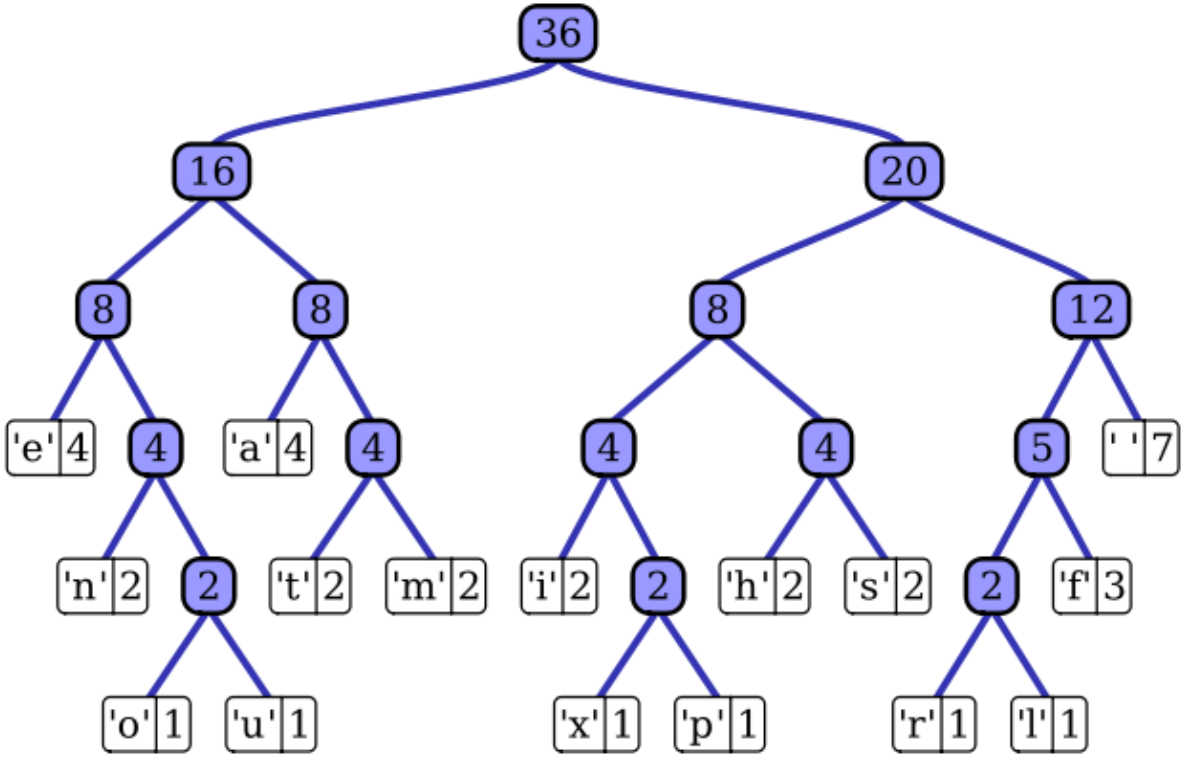
Closer look at the codecs used



Closer look at the codecs used



Closer look at the codecs used



Char	Freq	Code
a	4	010
e	4	000
f	3	1101
h	2	1010
i	2	1000
l	1	11001
m	2	0111
n	2	0010
o	1	00110
p	1	10011
r	1	11000
s	2	1011
t	2	0110
u	1	00111
x	1	10010

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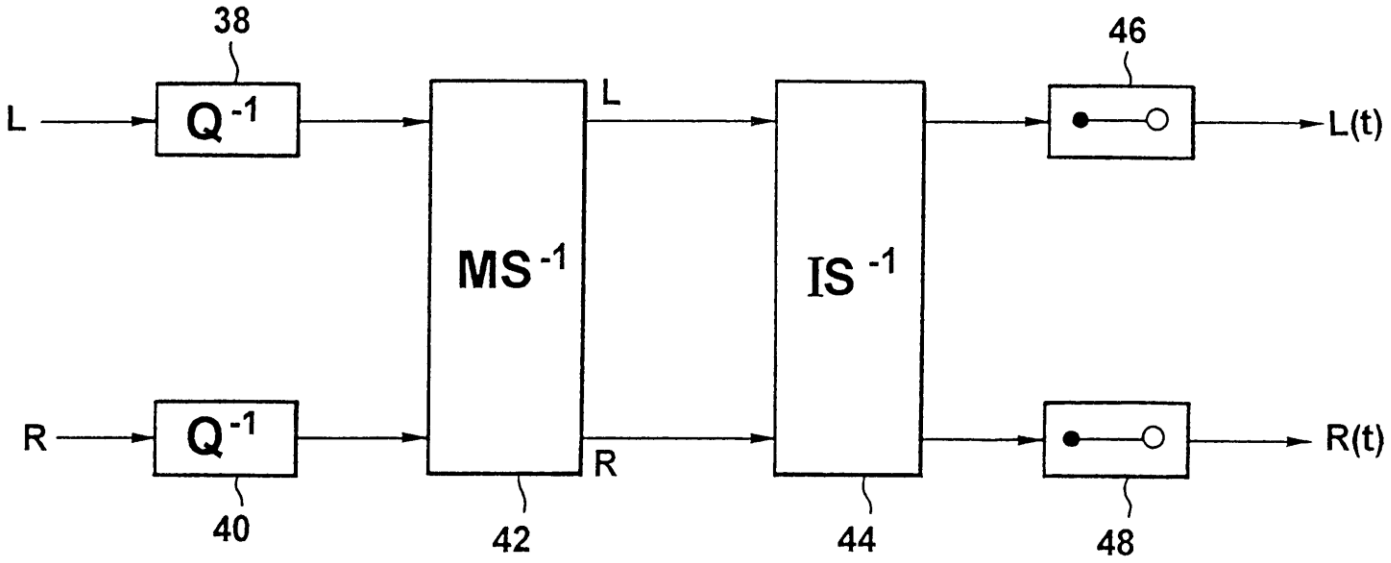
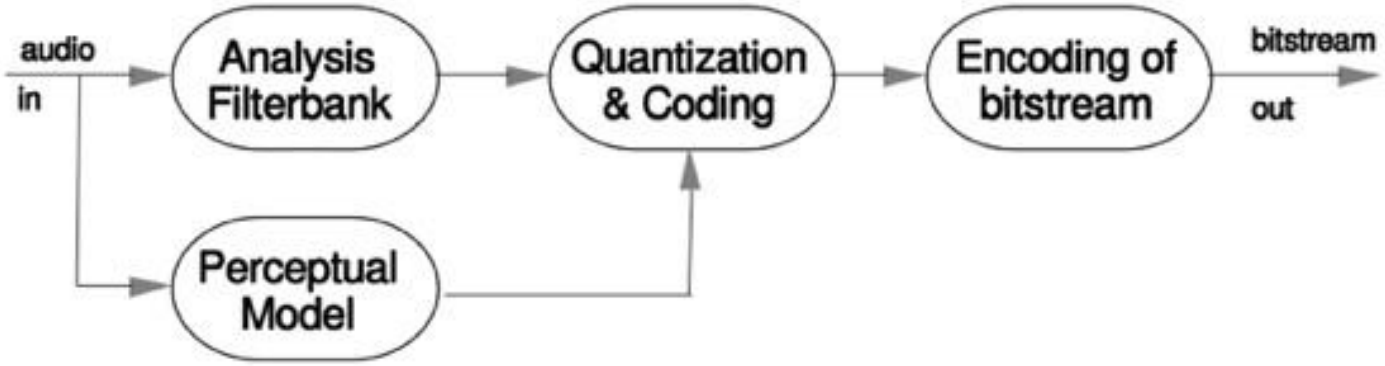
Closer look at the codecs used

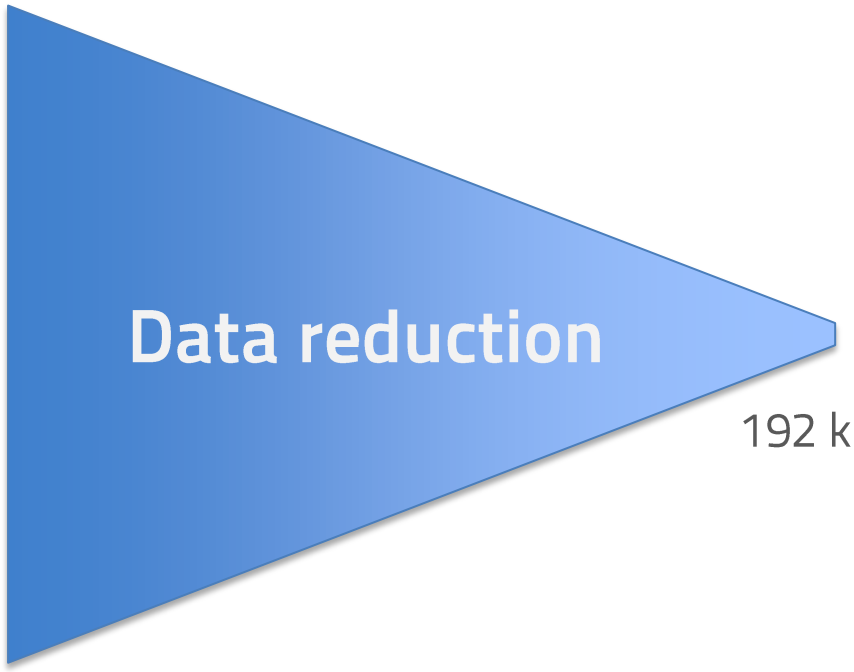


Closer look at the codecs used



Closer look at the codecs used

44.1 kHz, 16 bit, stereo
= 1411 kbps



192 kbps

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AAC family of codecs

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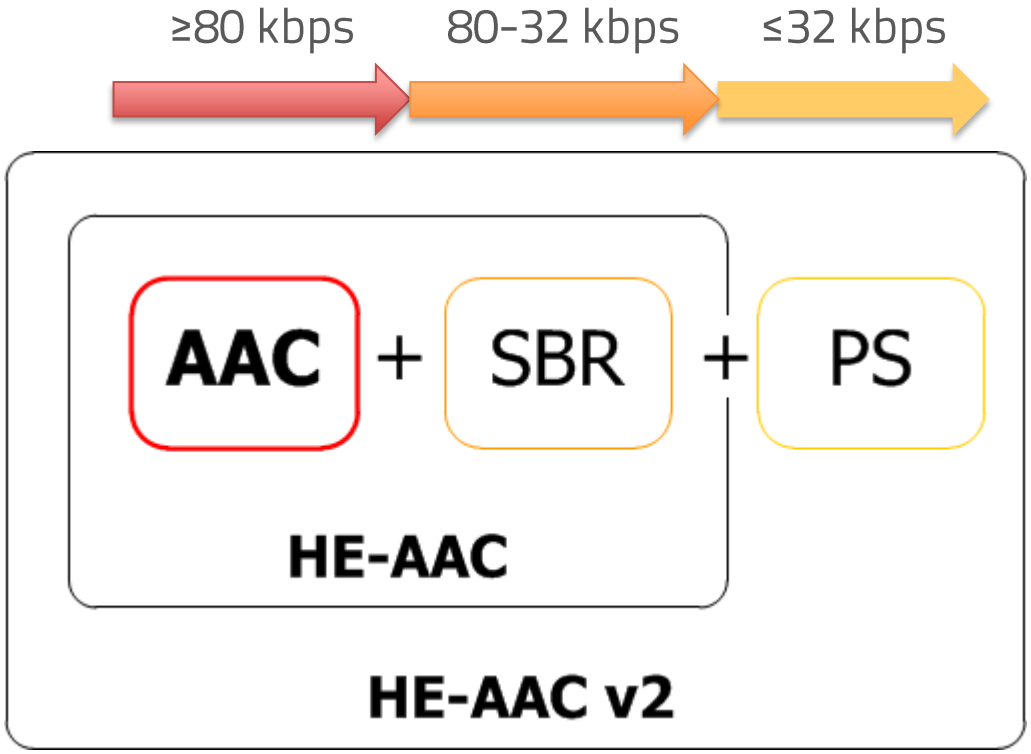
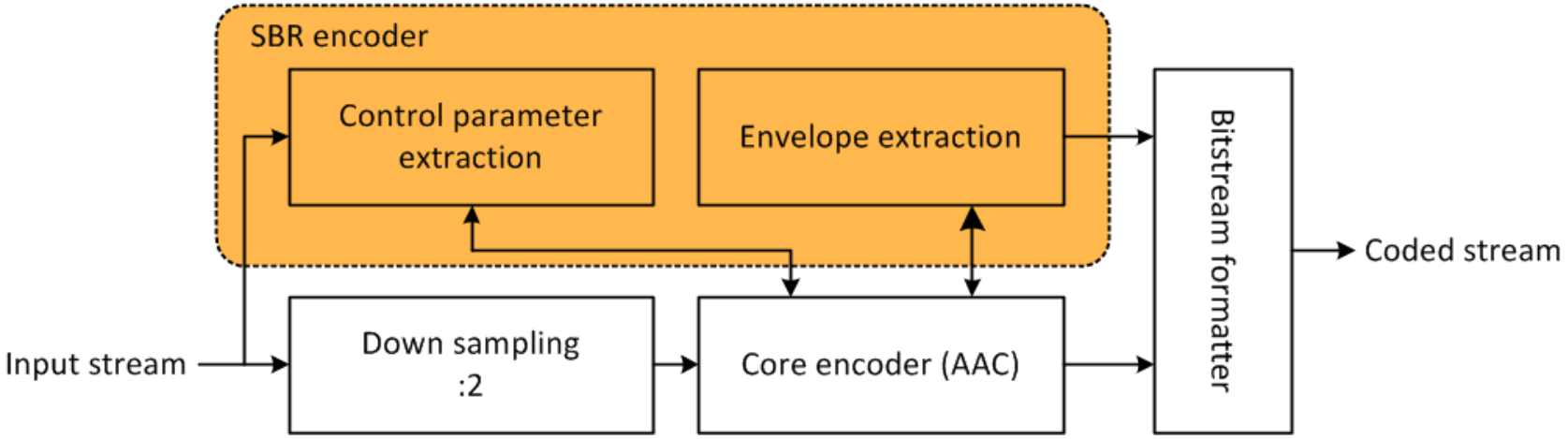
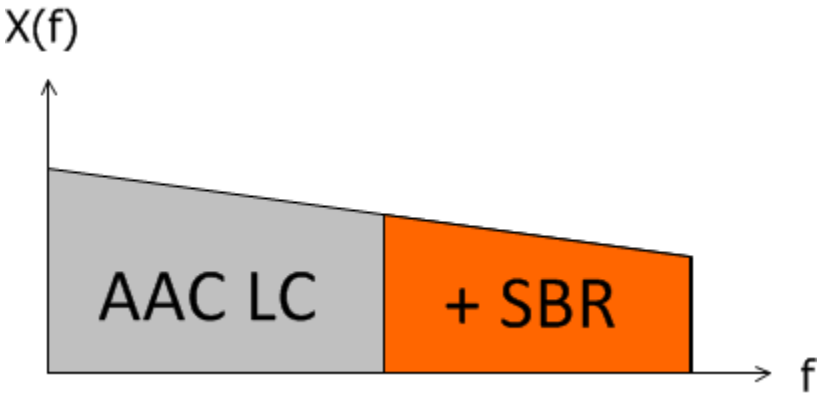
Closer look at the codecs used – AAC family

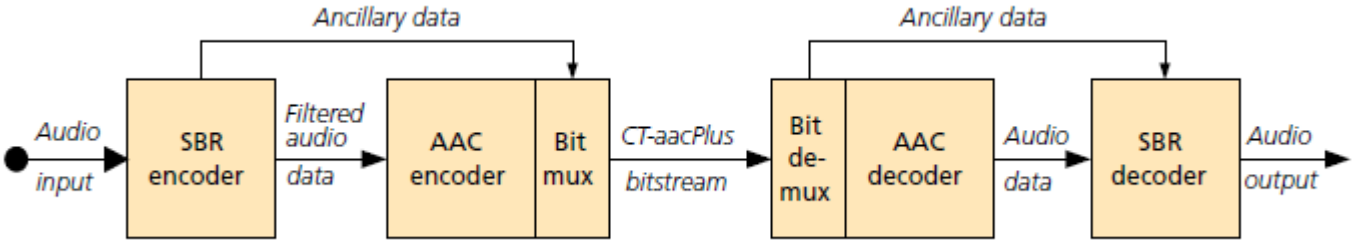


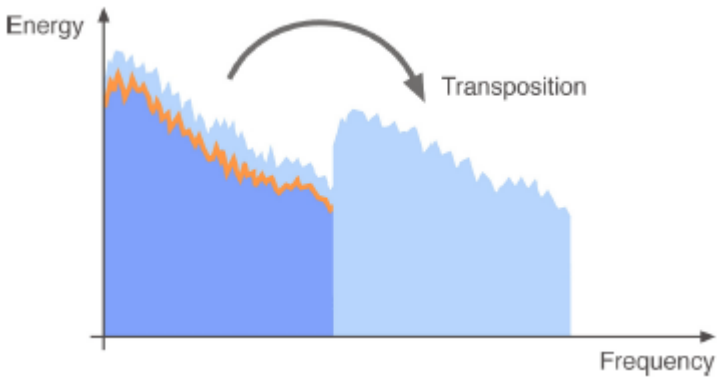
Closer look at the codecs used – HE-AAC

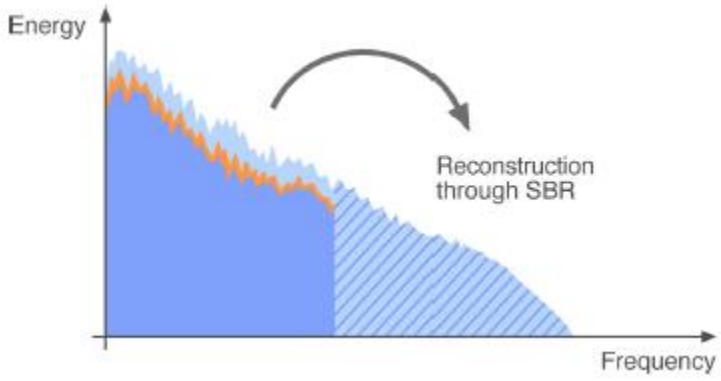




Closer look at the codecs used – HE-AAC







Closer look at perceptual coding

Codec	Transparency at
MPEG Layer II	256 kbps
MPEG Layer III	192-256 kbps
AAC LC	128 kbps
HE-AAC	Never

Closer look at the codecs used

Bitrate	Recommended codec
≥96 kbps	AAC LC
80 kbps	AAC LC, HE-AAC
64 kbps	HE-AAC
48 kbps	HE-AAC
32 kbps	HE-AAC, HE-AAC v2
24 kbps	HE-AAC v2
≤20 kbps	HE-AAC v2, HE-AAC mono

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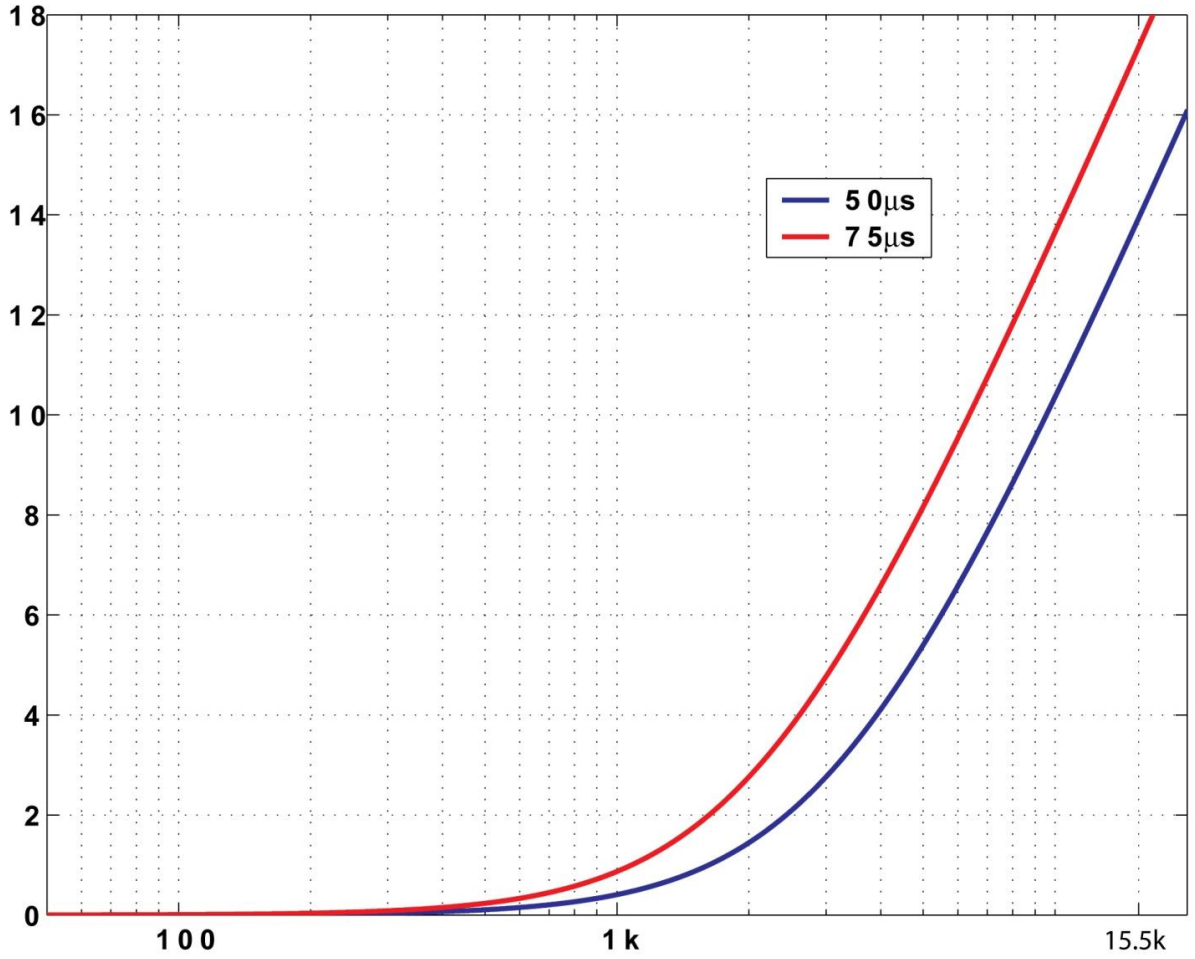
Processing requirements DAB vs FM

Differences between requirements for analog broadcasting (FM) and digital audio broadcasting

1. Preemphasis
2. Audio bandwidth
3. Final peak control

Preemphasis



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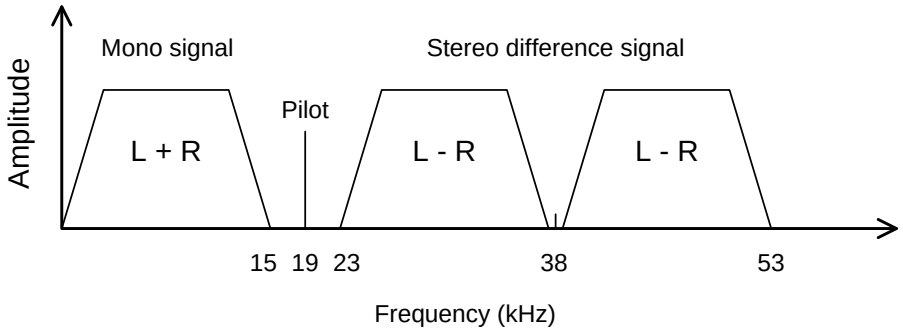
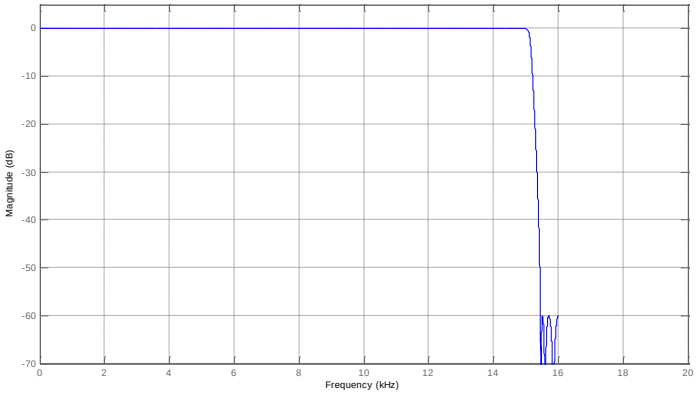
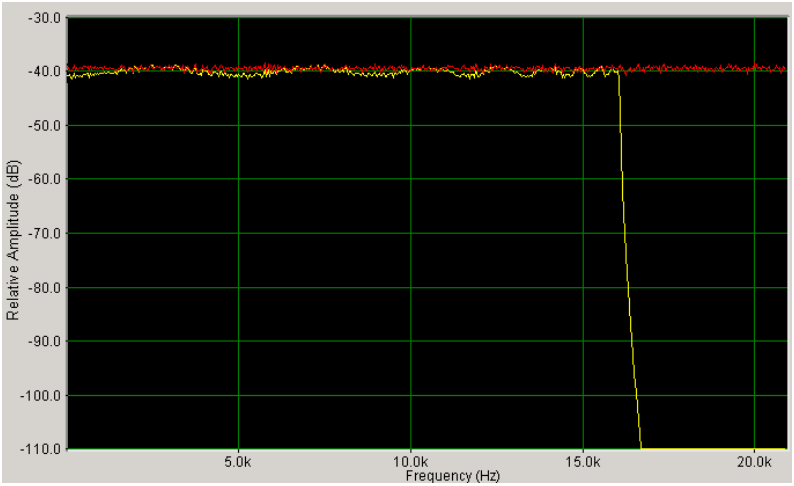
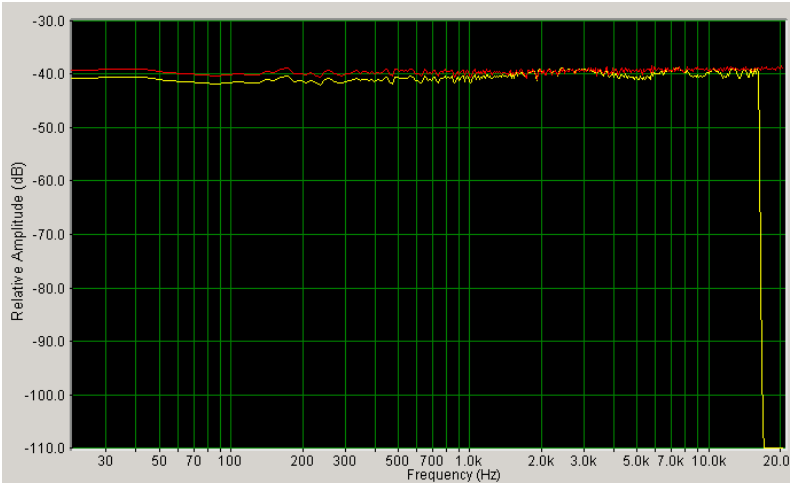
Audio bandwidth



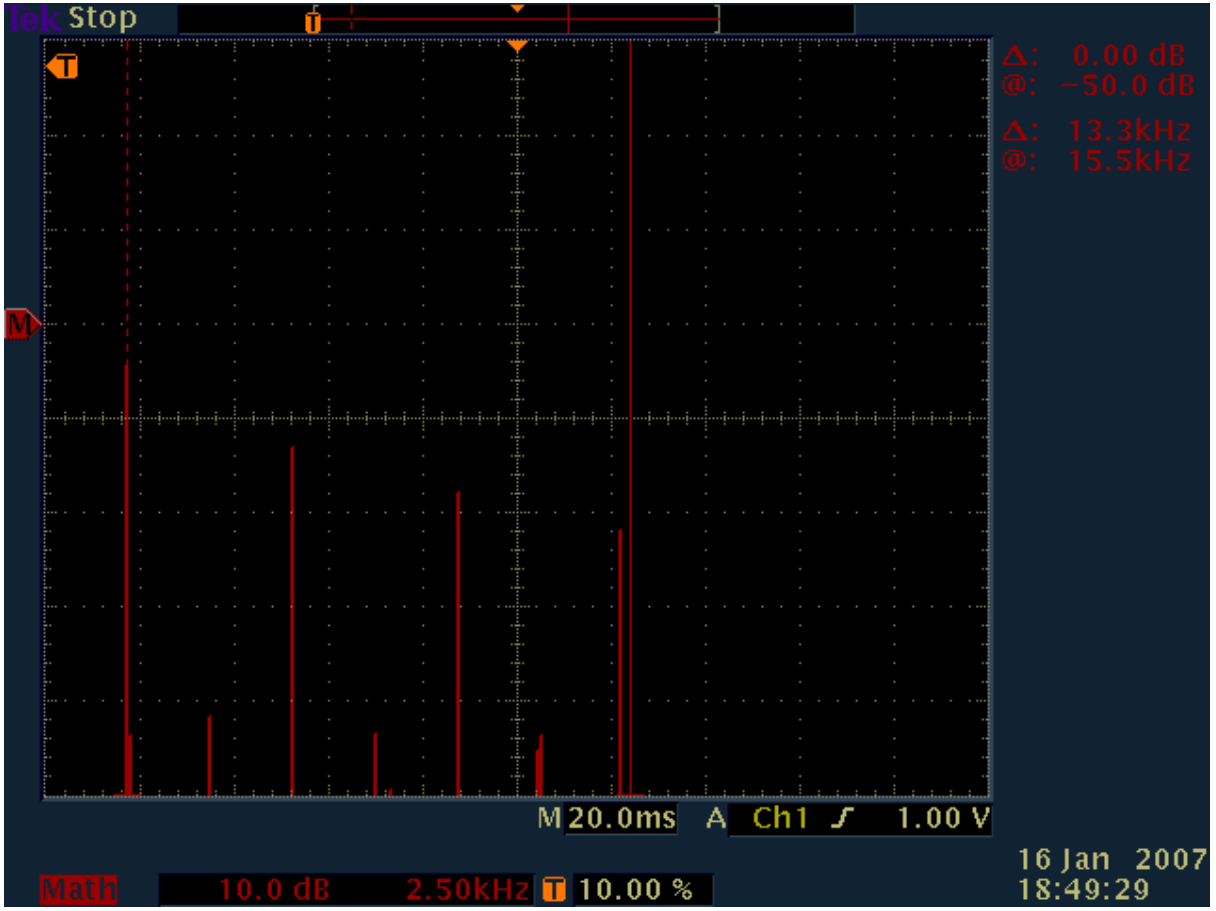


Audio bandwidth



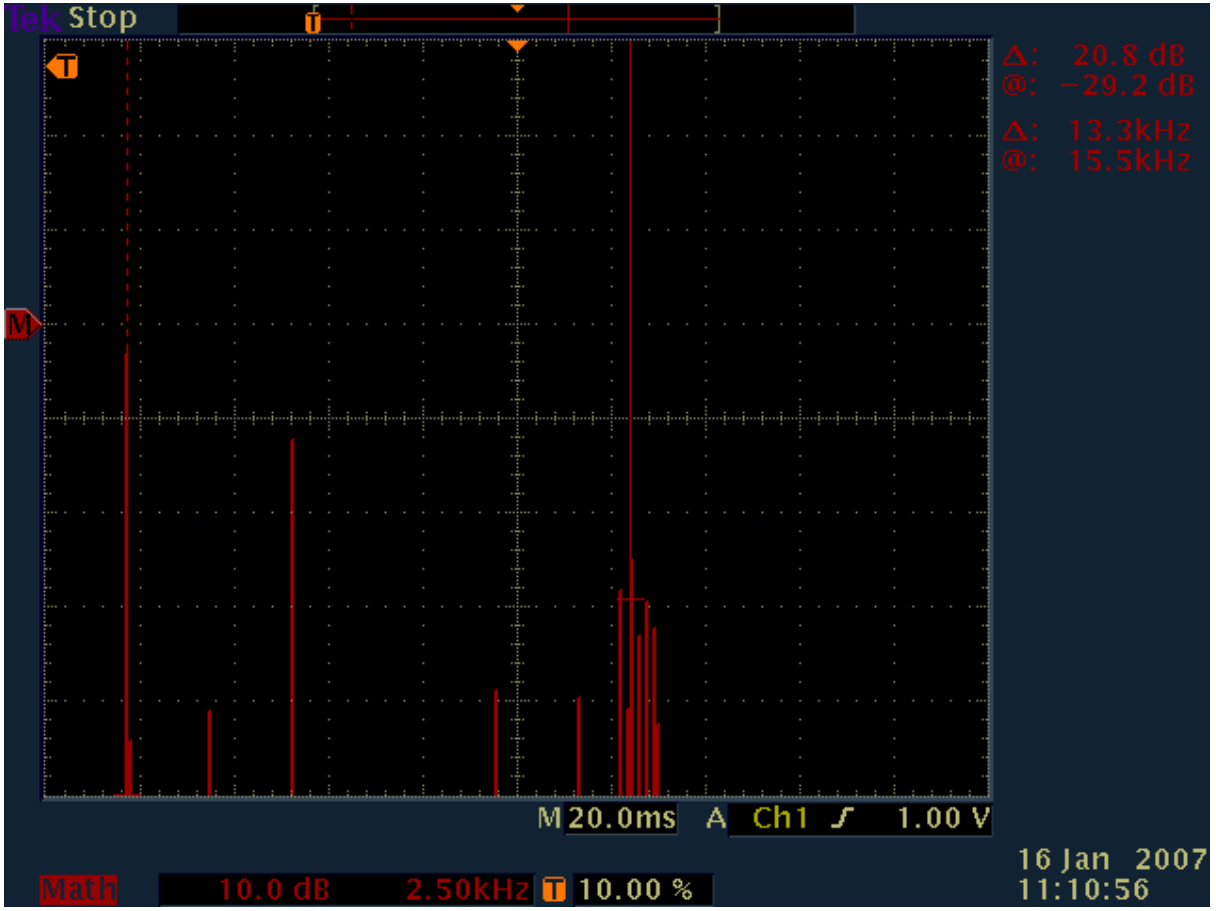


Final limiting



Pre-Codec: 2kHz With Clipping

Final limiting



Post-Codec: 2kHz With Clipping

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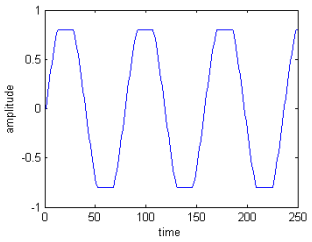
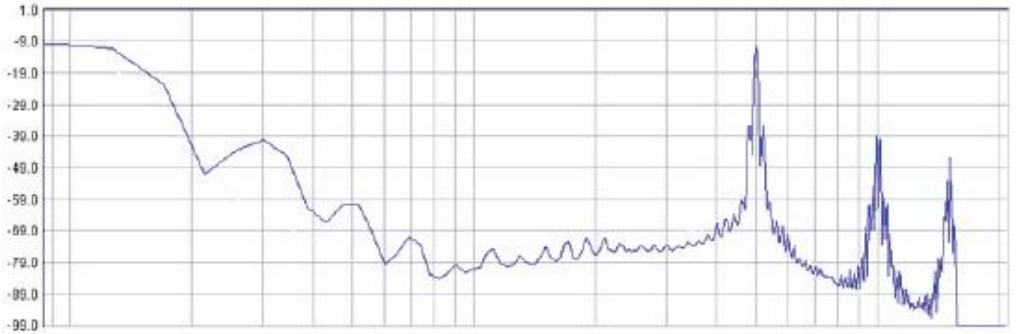
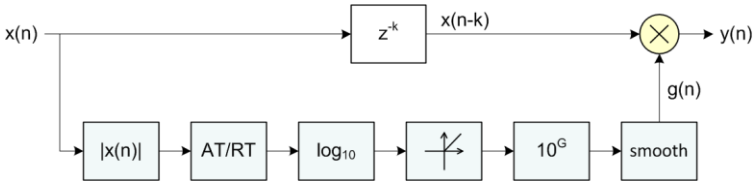
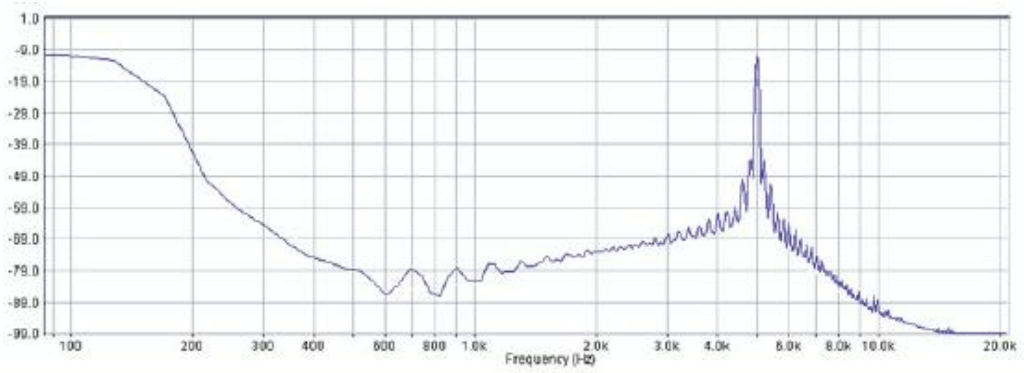
Final limiting









Omnia processors for DAB

Omnia processors for digital radio broadcasting

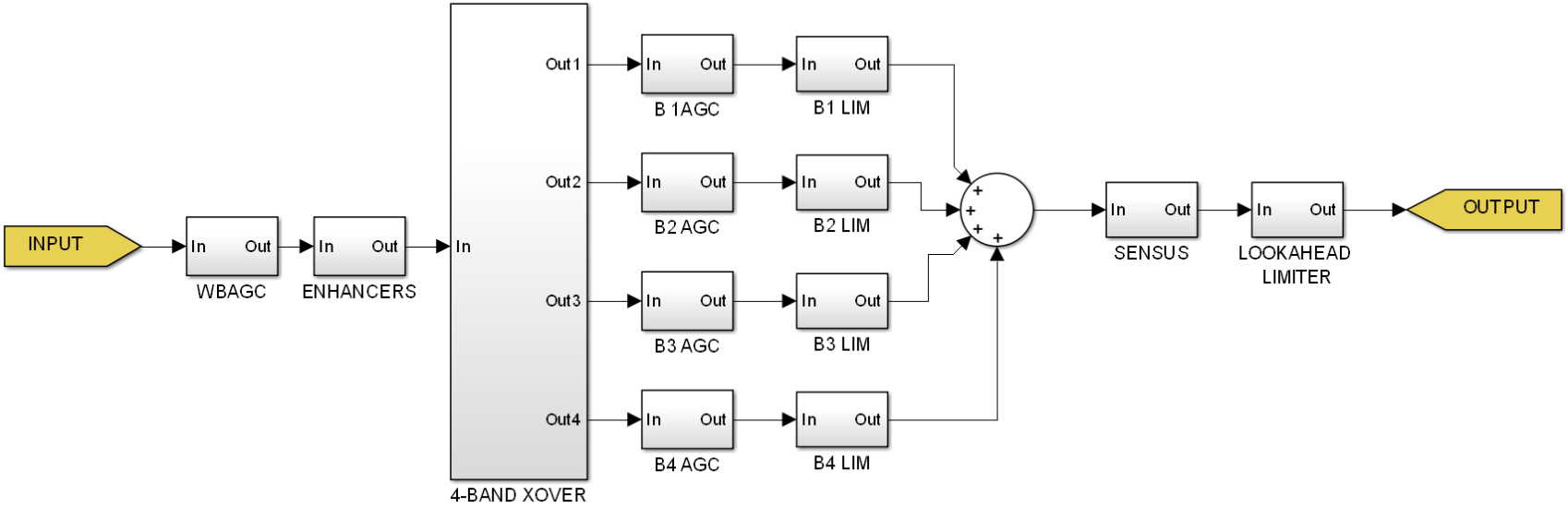
> Omnia 11 FMHD

> Omnia 9 HD1/2/3

> Omnia One Multicast

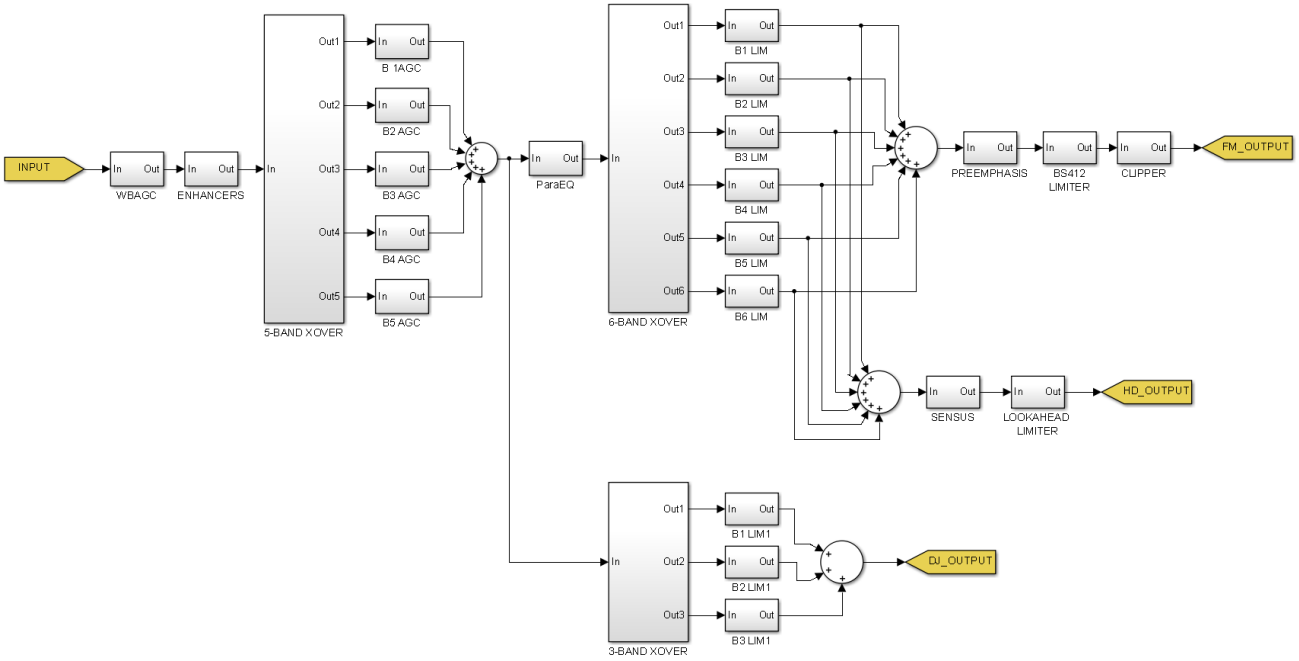
Omnia One Multicast

> **4-band audio processing for coded transmission systems**

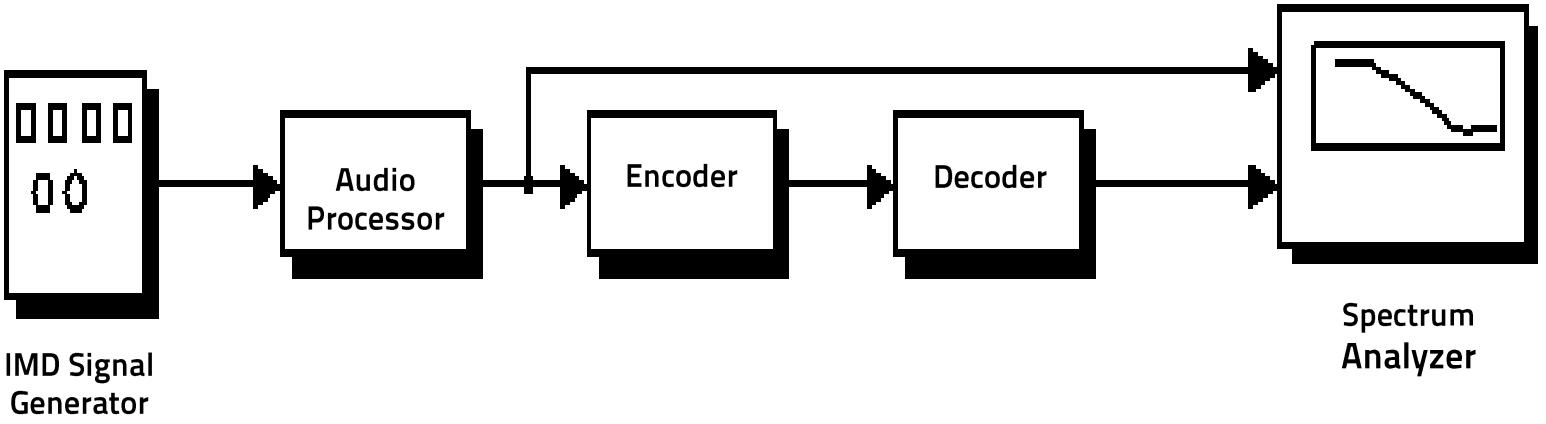


Omnia 11 FMHD

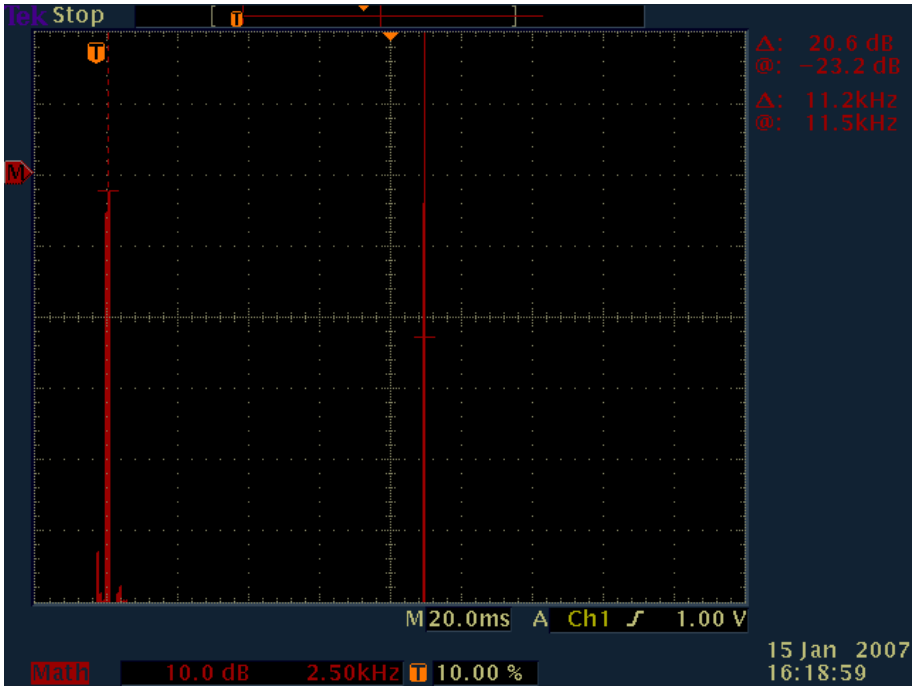
> WB AGC, 5-band AGC and 6-band limiter



LoIMD


Audio Processor
Encoder
Decoder
IMD Signal Generator
Spectrum Analyzer

LoIMD



Processor output: 400 Hz and 11 kHz

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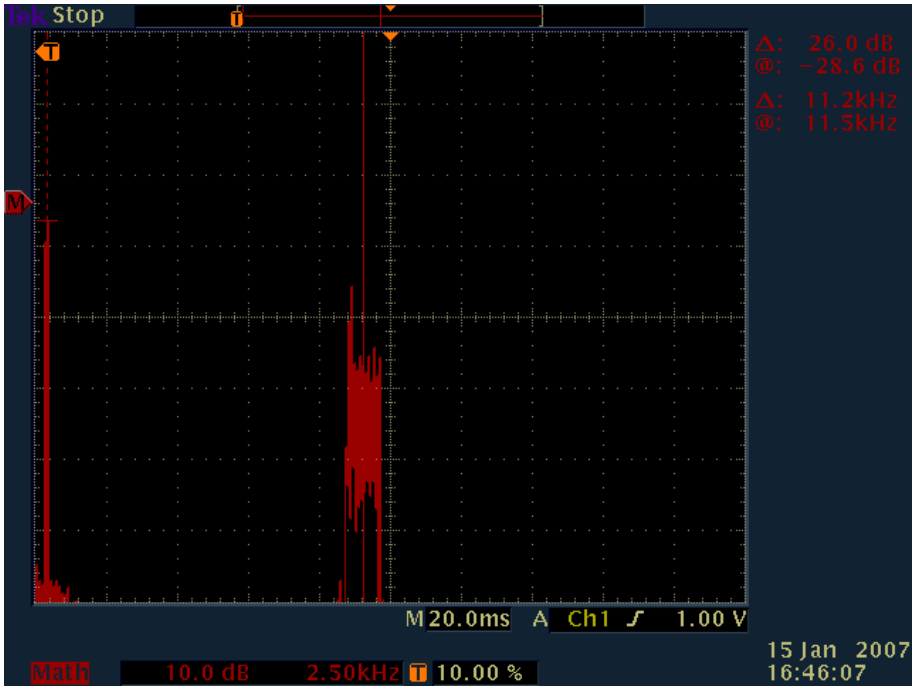
LoIMD



Post-Codec: 400 Hz and 11 kHz

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Sensus

Remove negative colorations with very low bitrate codecs

Codec-induced artifacts reduction

- Static functions:
  - Use of look-ahead in final limiting
  - Static bandwidth control (LPF)

Sensus

- Dynamic algorithm modification
  - Self-modifies topology and functionality upon signal conditions

Filtering:
Dependent upon spectral density

Sound Field Parameters:
Stereo/Mono/Phasing

Peak Control:
IMD reduction (LoIMD) limiting

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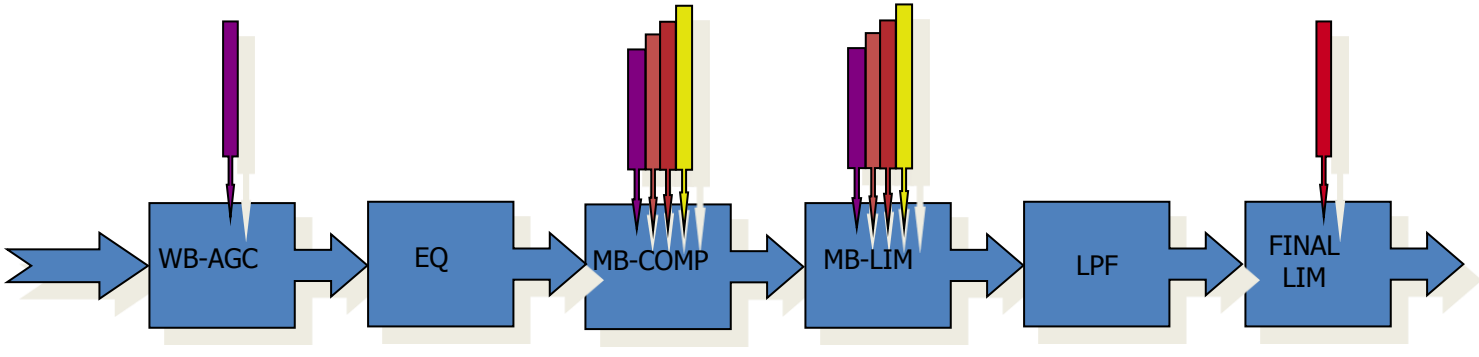
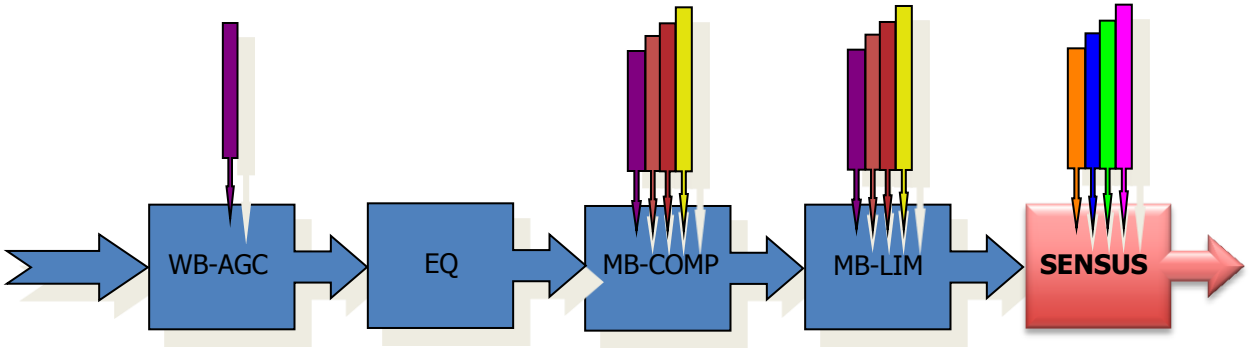
Sensus


WB-AGC
EQ
MB-COMP
MB-LIM
LPF
FINAL LIM


WB-AGC
EQ
MB-COMP
MB-LIM
SENSUS

Omnia 9 HD1/2/3

- Up to 7-bands of dedicated audio processing
- Declipper
- Undo (program-dependent expander)
- Up to 3 individual radio programs

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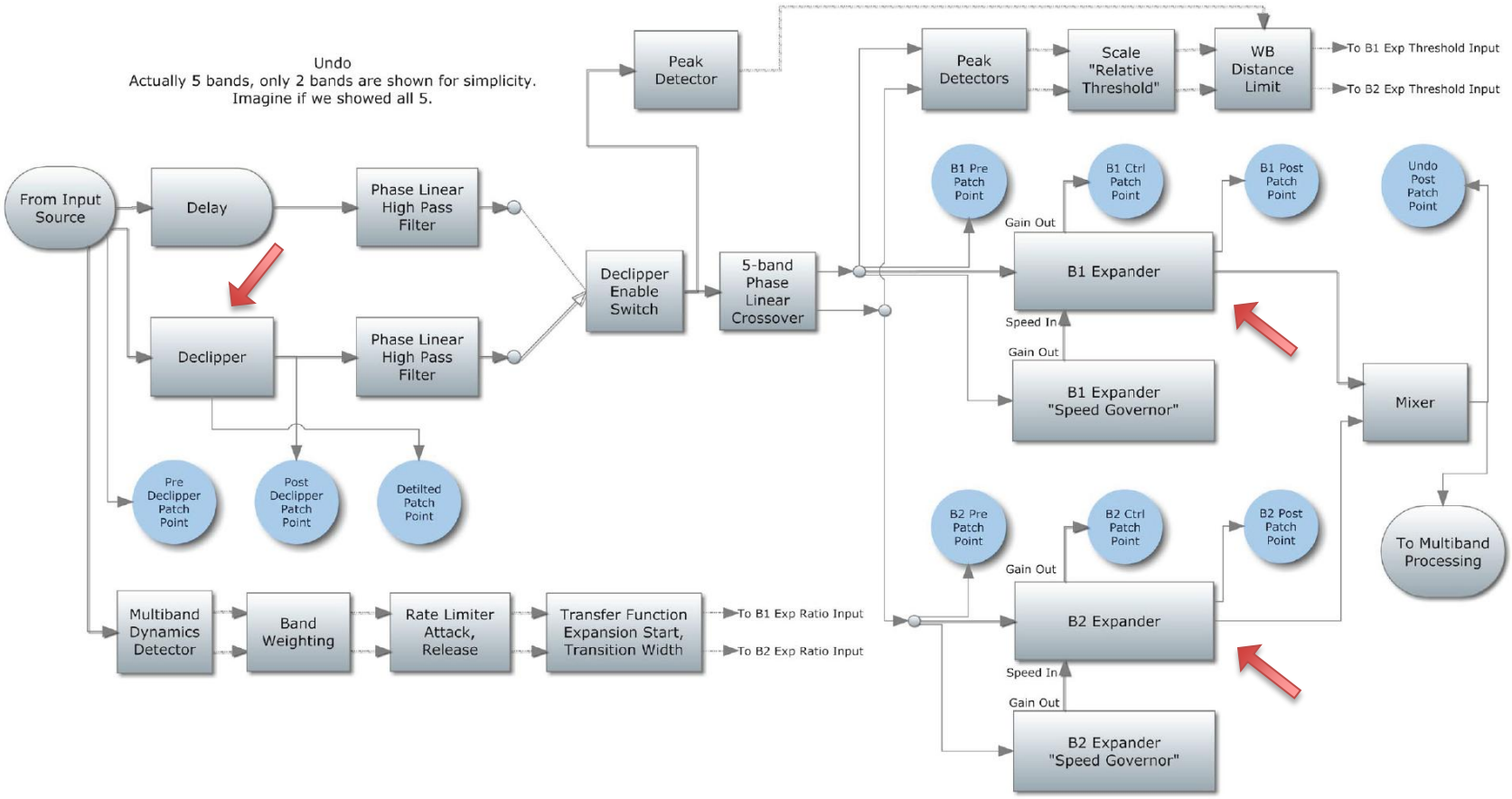
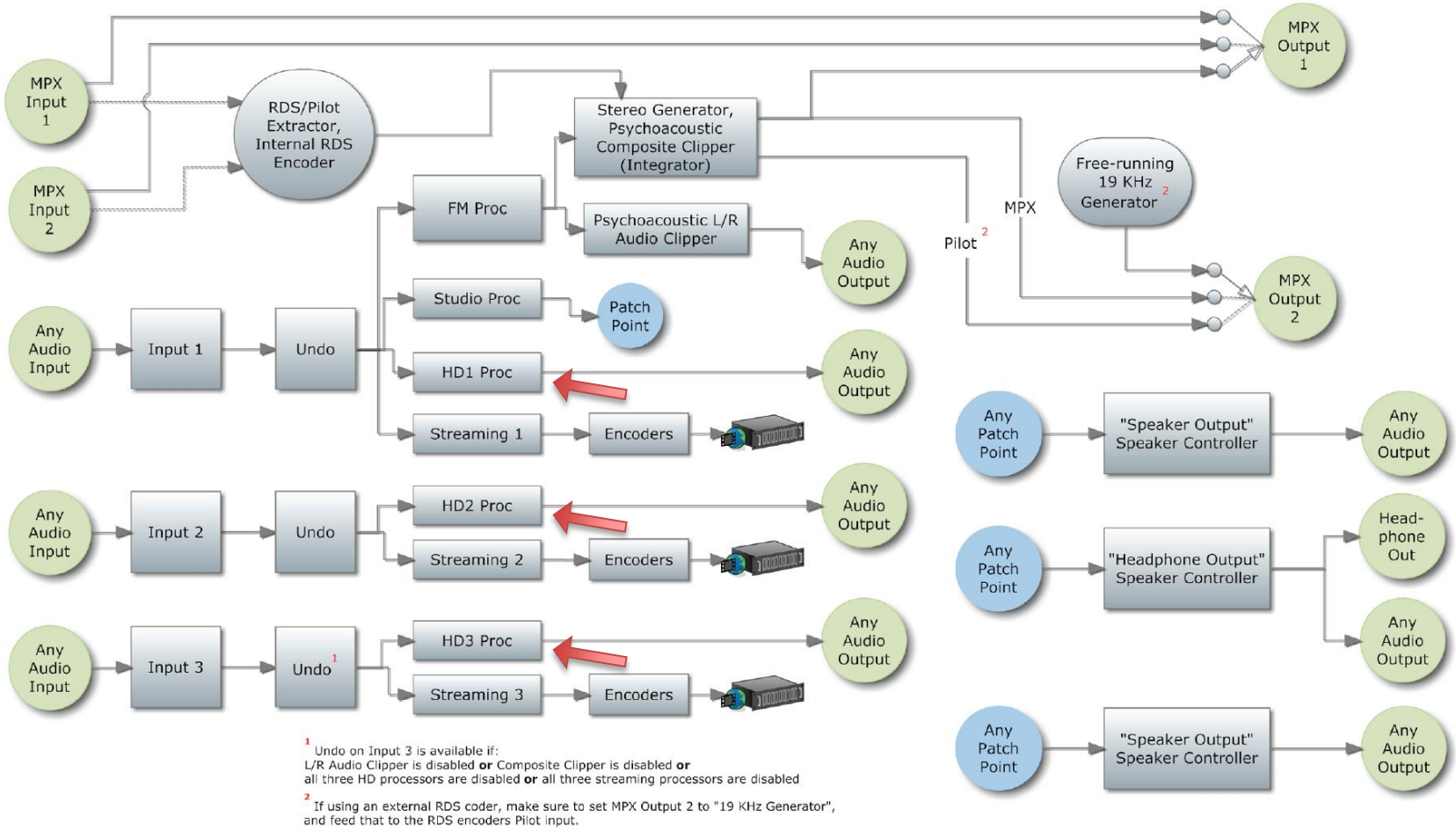
Omnia 9 – pre-procesing



Omnia 9 – up to 3 indepednet audio services



[1] Undo on Input 3 is available if:
L/R Audio Clipper is disabled **or** Composite Clipper is disabled **or**
all three HD processors are disabled **or** all three streaming processors are disabled

[2] If using an external RDS coder, make sure to set MPX Output 2 to "19 KHz Generator", and feed that to the RDS encoders Pilot input.

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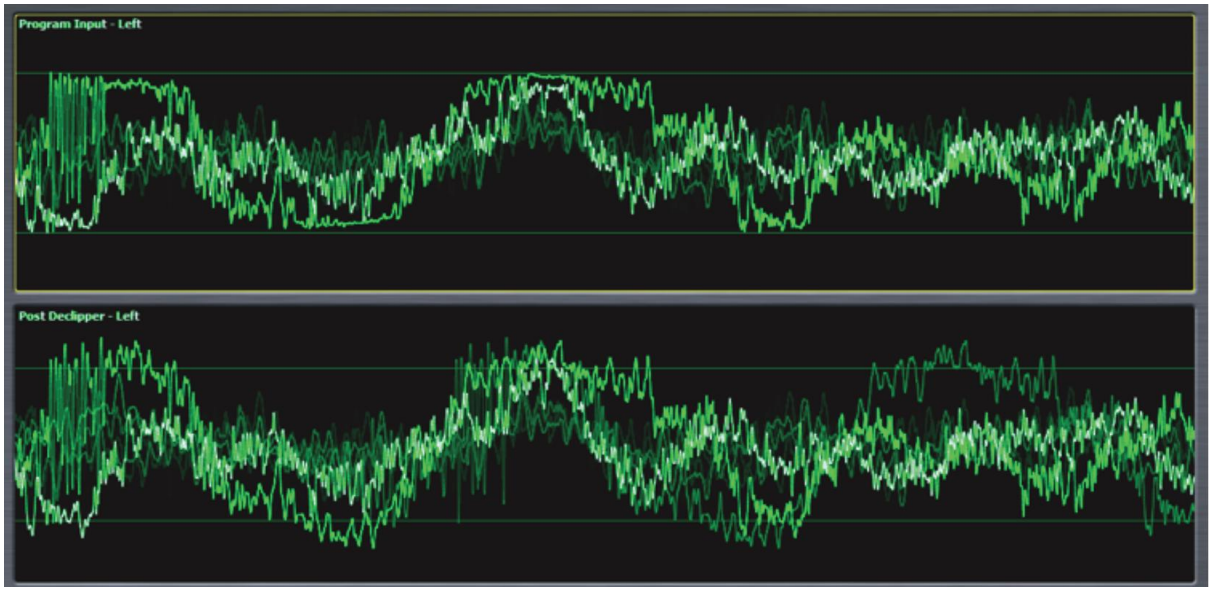
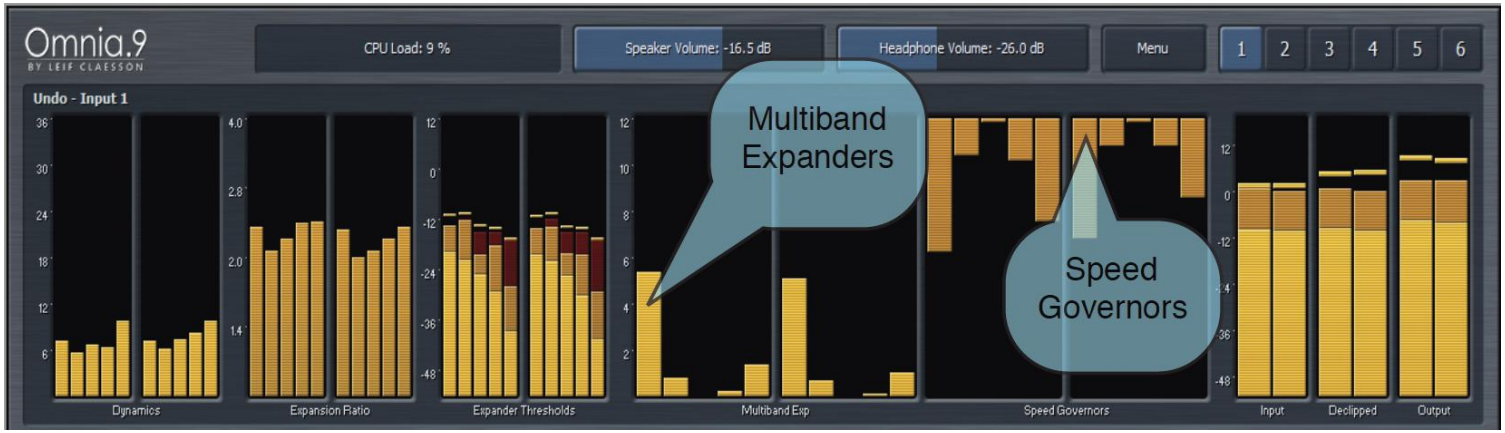
Omnia 9 – declipper



Omnia 9 – Undo


Omnia.9
BY LEIF CLAESSON
CPU Load: 9 %
Speaker Volume: -16.5 dB
Headphone Volume: -26.0 dB
Menu
1
2
3
4
5
6
Undo - Input 1
Multiband Expanders
Speed Governors
Dynamics
Expansion Ratio
Expander Thresholds
Multiband Exp
Speed Governors
Input
Declipped
Output

Optimizing audio for DAB

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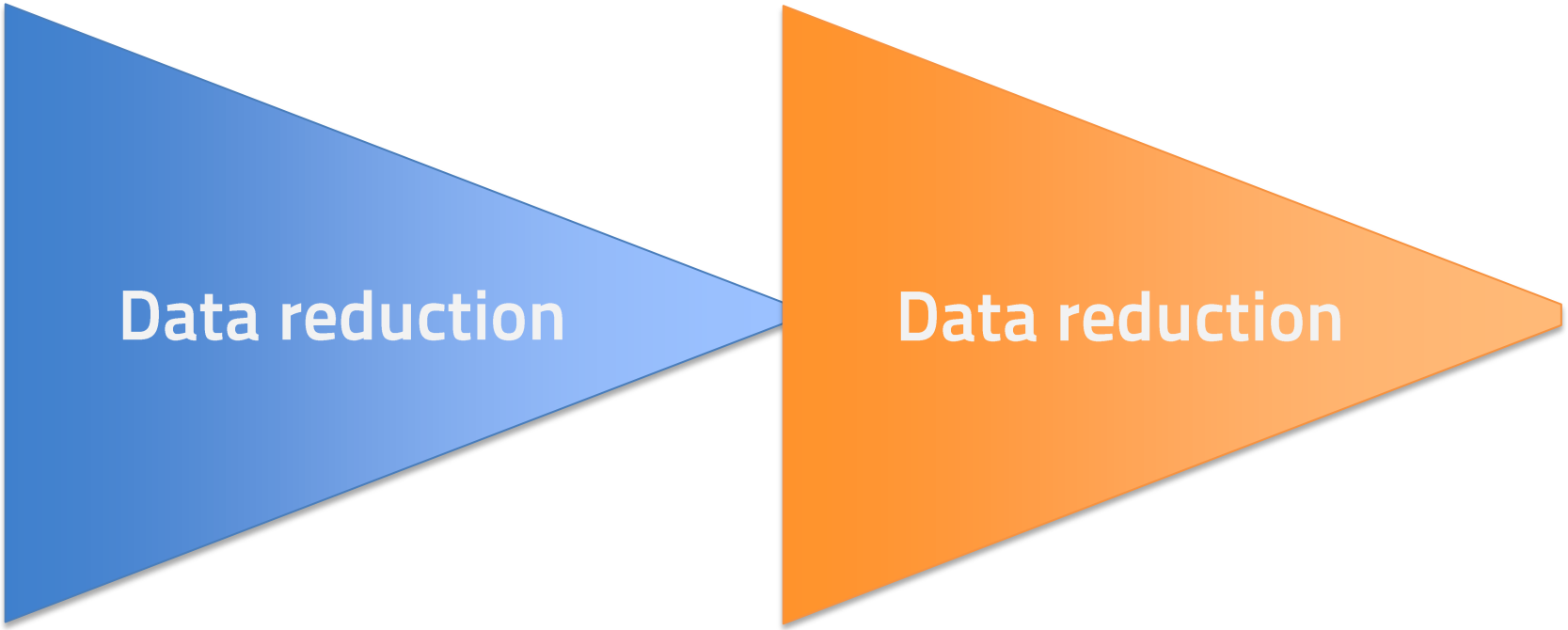
Optimizing audio for digital radio broadcasting

> clean source audio

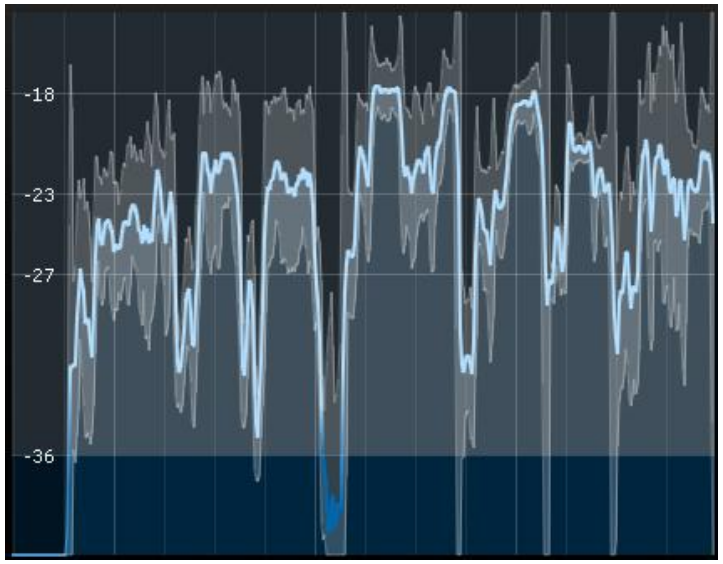
Optimizing audio for digital radio broadcasting

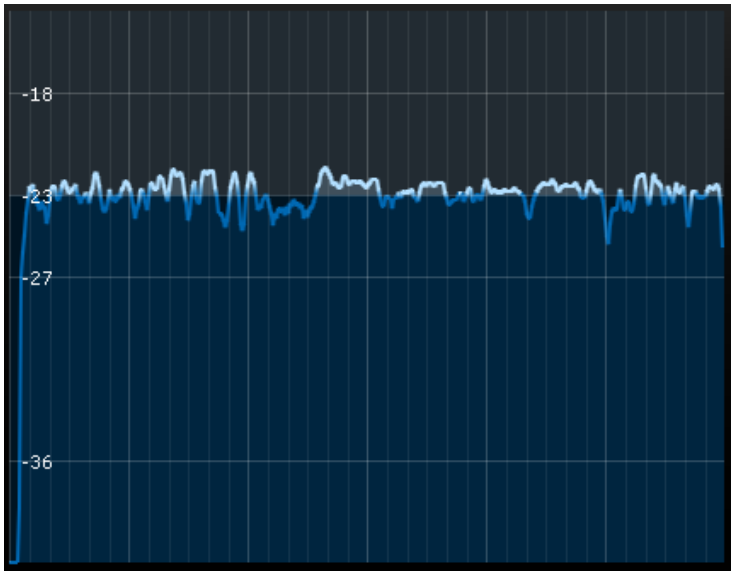
> cascading codecs



Optimizing audio for digital radio broadcasting

> level consistency





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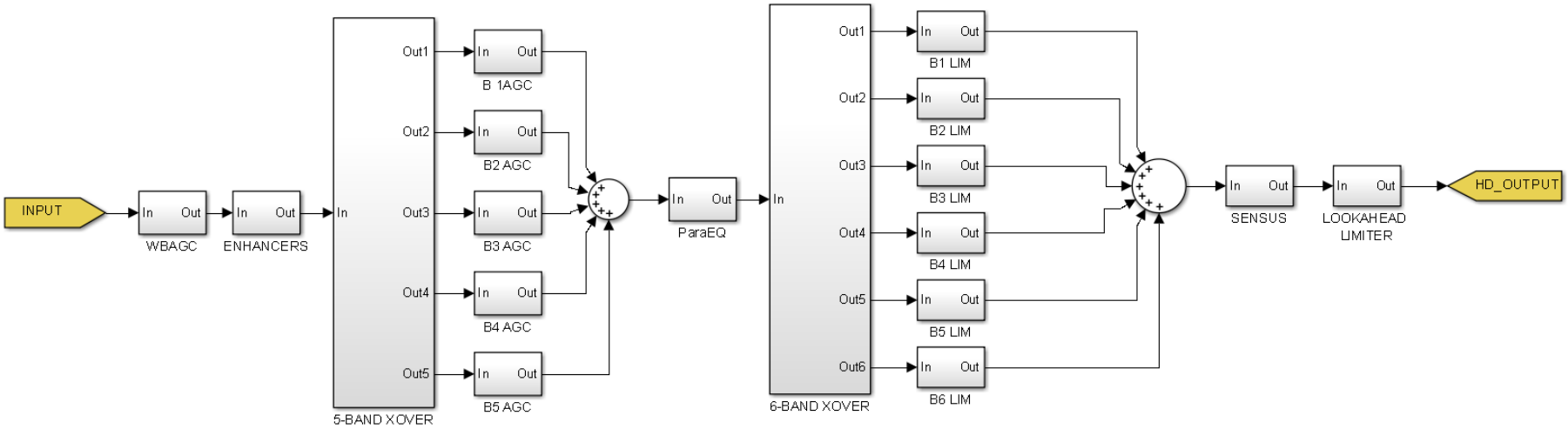
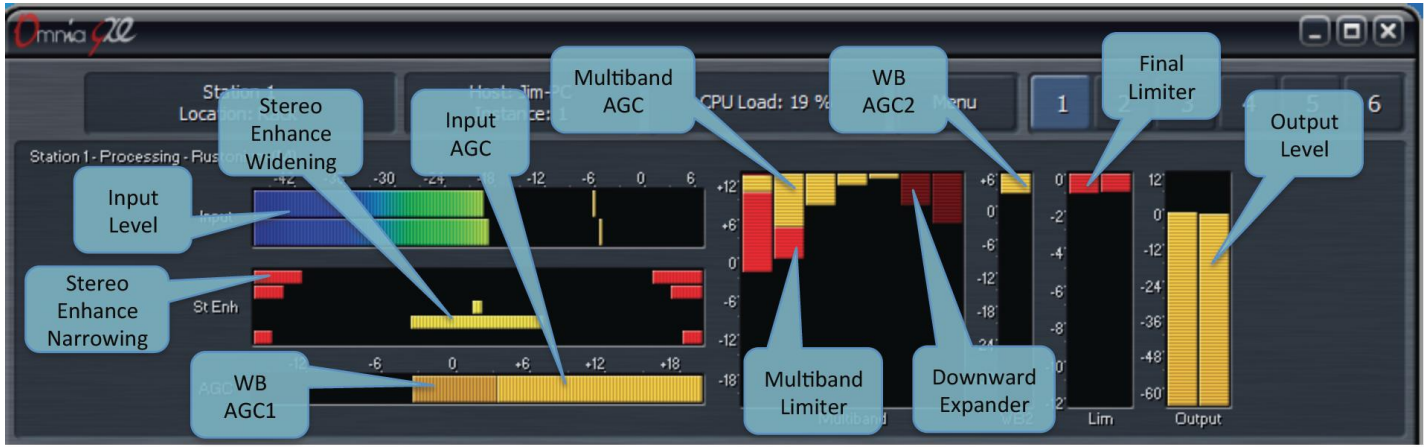
Optimizing audio for digital radio broadcasting

> spectral balance shaping/consistency



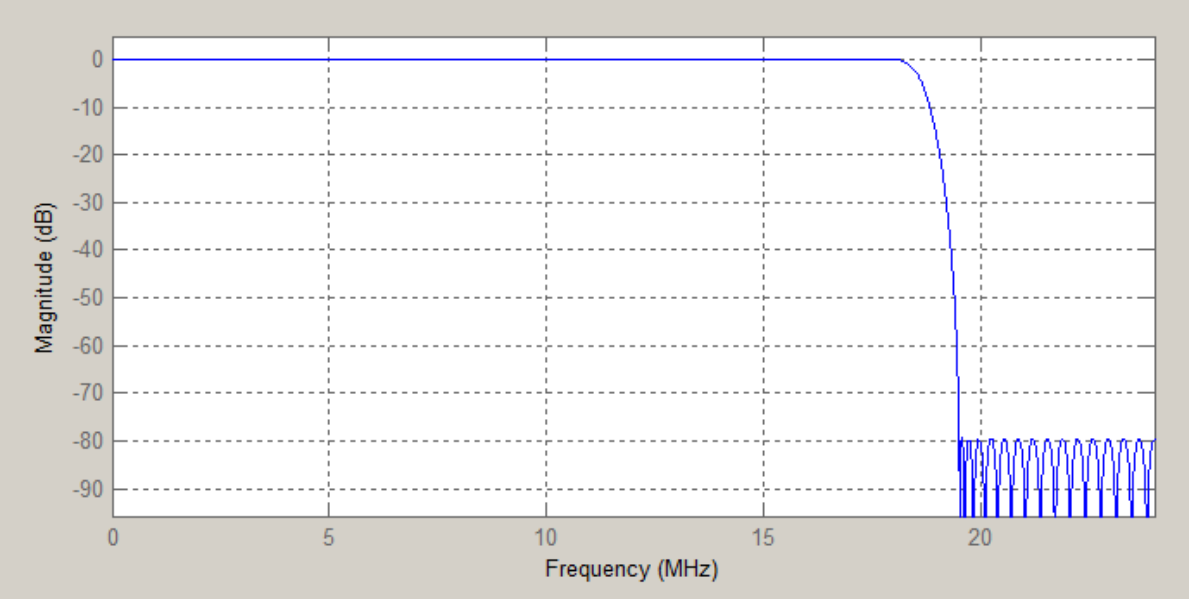
Optimizing audio for digital radio broadcasting

> stereo width control



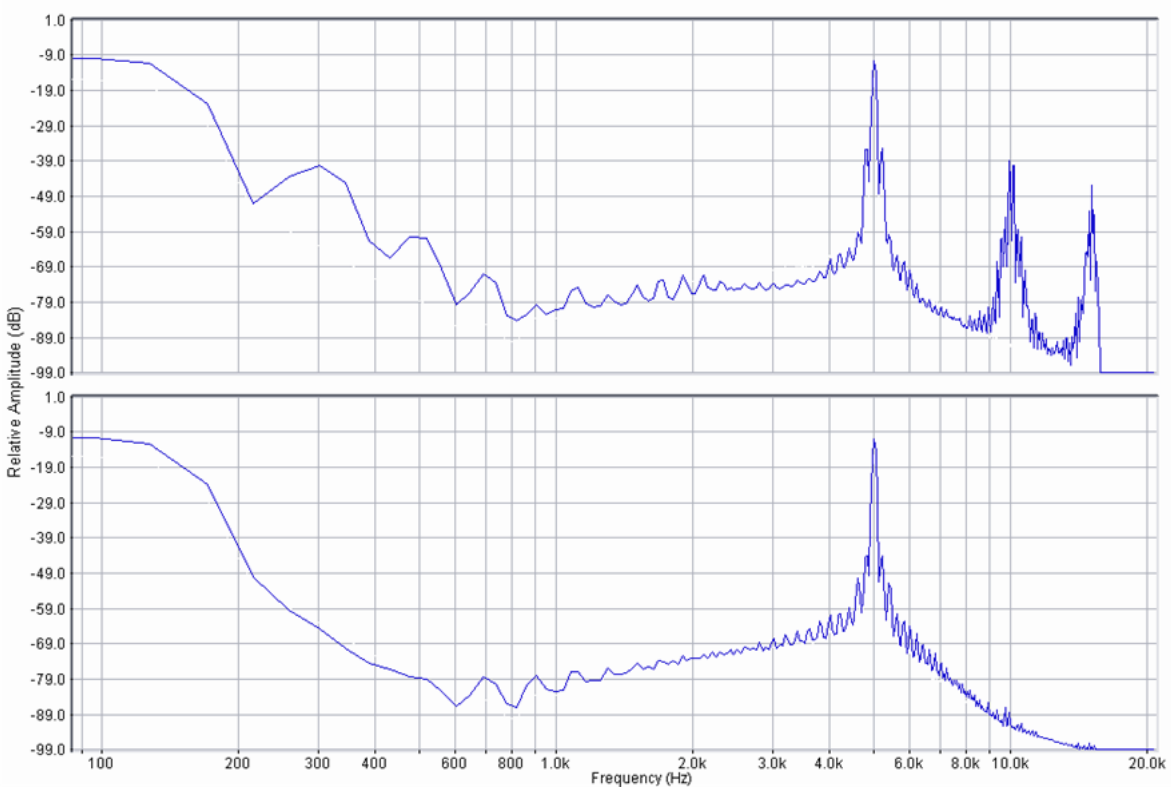
Optimizing audio for digital radio broadcasting

> high frequency filtering



Optimizing audio for digital radio broadcasting

> look-ahead limiting for final peak control



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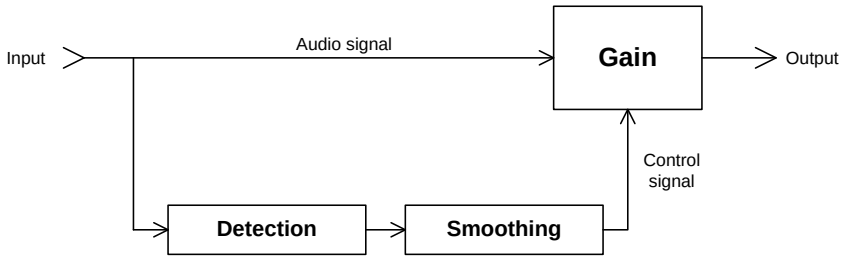
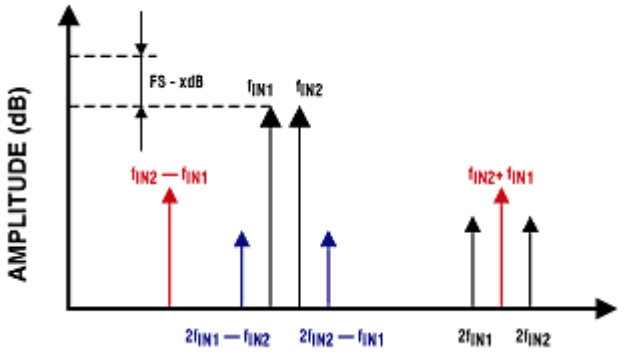
Optimizing audio for digital radio broadcasting

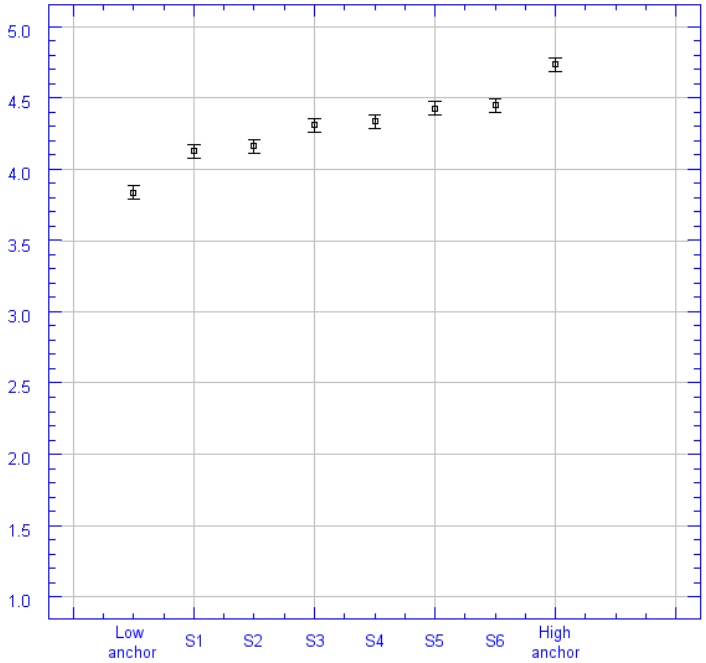
> low IMD dynamic stages (limiters)

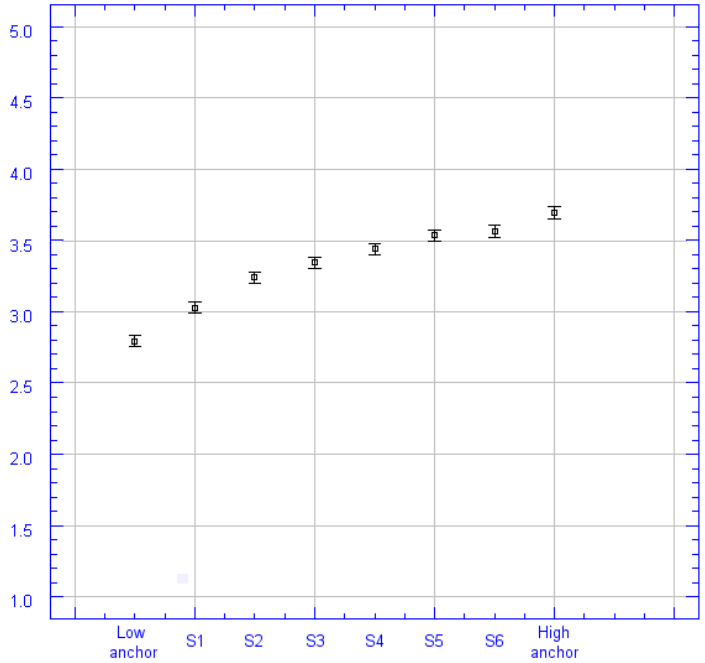




Optimizing audio for digital radio broadcasting

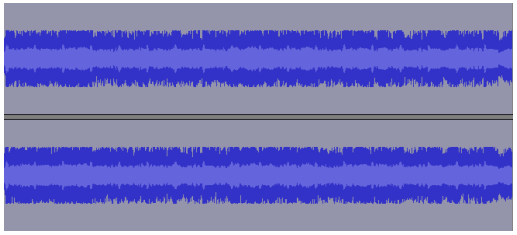
> avoid agressive (dense) audio processing



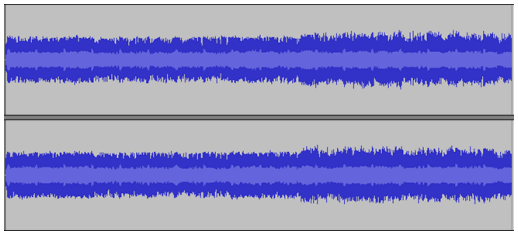


Optimizing audio for digital radio broadcasting

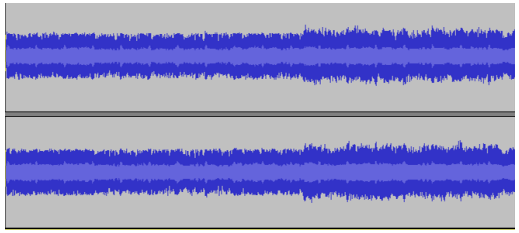
> codec overshoot



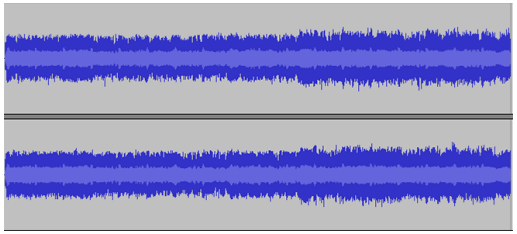
Source PCM (-6.0 dBfs)



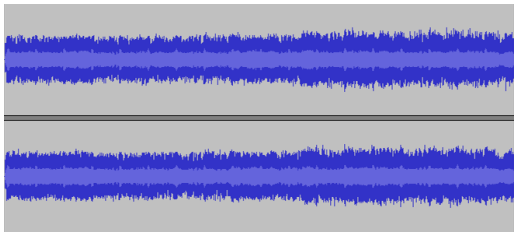
AAC 128 kbps (-5.1 dBfs)



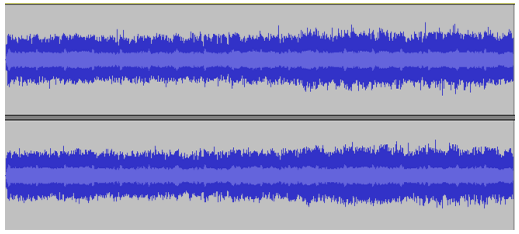
MP3 128 kbps (-4.7 dBfs)



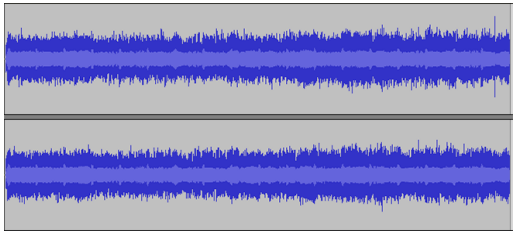
HE-AAC 64 kbps (-4.6 dBfs)



HE-AAC 48 kbps (-4.7 dBfs)



HE-AAC 32 kbps (-3.8 dBfs)



HE-AAC 24 kbps (-3.6 dBfs)

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Thank you! Questions?

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