

Multi-band RMS limiter

For Loudspeaker Protection

14. juni 2016

Kasper Kiis Jensen
Poul Hoang
Mikkel Krogh Simonsen
16gr640@es.aau.dk

Department of Electronic Systems
Aalborg University
Denmark



AALBORG UNIVERSITY
DENMARK

Agenda

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse
Problemformulering

Løsning & Design
realization

Blokdiagram

Opbygning

Multi-Rate/stage
Decimation
RMS Limiter
Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings
muligheder
Implementerede
optimeringer

Konklusion

Demonstration

Dept. of Electronic Systems
Aalborg University

Introduktion

Problem

Foranalyse
Problemformulering

Løsning & Design realization

Blokdiagram

Opbygning

Multi-Rate/stage
Decimation
RMS Limiter
Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings muligheder
Implementerede optimeringer

Konklusion

Demonstration



Introduktion

Undertitel

Multi-band RMS
Limiter
Gruppe 640

2

Introduktion

Problem

Foranalyse
Problemformulering

Løsning & Design realization

Blokdiagram

Opbygning

Multi-Rate/stage
Decimation
RMS Limiter
Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings
muligheder
Implementerede
optimeringer

Konklusion

Demonstration

18

Something awesome



Problemet

Ja nemli' Ja

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse
Problemformulering

Løsning & Design
realization

Blokdiagram

Opbygning

Multi-Rate/stage
Decimation
RMS Limiter
Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings
muligheder
Implementerede
optimeringer

Konklusion

Demonstration

Dept. of Electronic Systems
Aalborg University

3

Something awesome

18



Problemet

Foranalyse

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse

Problemformulering

Løsning & Design
realization

Blokdiagram

Opbygning

Multi-Rate/stage

Decimation

RMS Limiter

Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings
muligheder

Implementerede
optimeringer

Konklusion

Demonstration

Dept. of Electronic Systems
Aalborg University

4

Something awesome

18



Problemet

Problemformulering

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse

Problemformulering

5

Løsning & Design
realization

Blokdiagram

Opbygning

Multi-Rate/stage

Decimation

RMS Limiter

Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings
muligheder

Implementerede
optimeringer

Konklusion

Demonstration

Dept. of Electronic Systems
Aalborg University

18

Something awesome



Design Realization

Løsningen

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse

Problemformulering

Løsning & Design
realization

Blokdiagram

Opbygning

Multi-Rate/stage

Decimation

RMS Limiter

Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings
muligheder

Implementerede
optimeringer

Konklusion

Demonstration

Dept. of Electronic Systems
Aalborg University

6

Something awesome

18



Blokdiagram

hold nu kæft et overblik!

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse
Problemformulering

Løsning & Design
realization

Blokdiagram

7

Something awesome

Opbygning

Multi-Rate/stage
Decimation
RMS Limiter
Interpolation

Resultat & Konklusion

Optimering

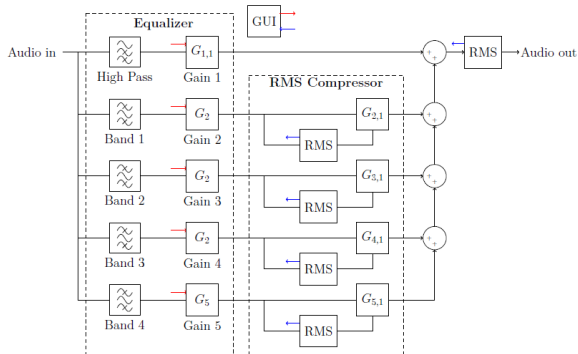
Relevante optimerings
muligheder
Implementerede
optimeringer

Konklusion

Demonstration

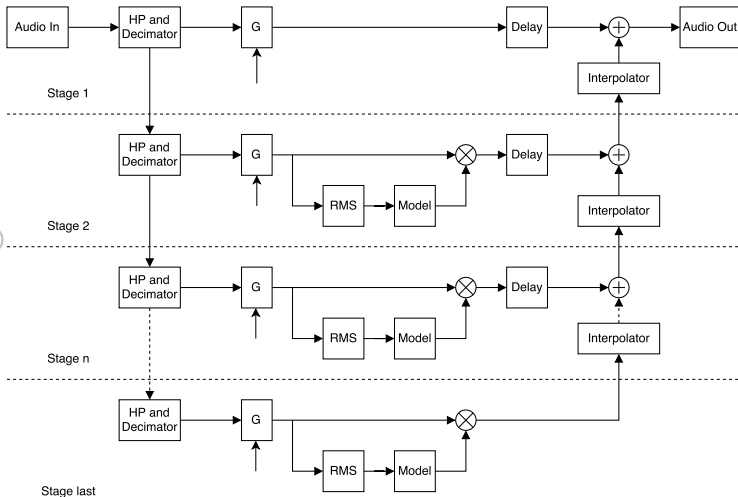
Dept. of Electronic Systems
Aalborg University

18



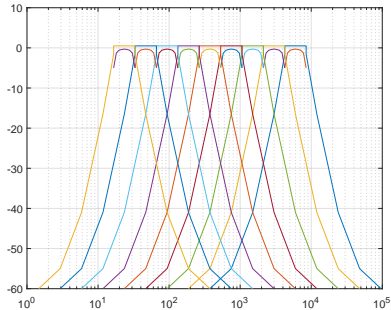
Systemet Overordnet

- Grafisk Equalizer
- 4 Bånd i Bassen
 1. 0 - 66 Hz
 2. 66 - 132 Hz
 3. 132 - 265 Hz
 4. 265 - 530 Hz
- RMS limiter i 4 bånd
- RMS/Peak Limiter
- GUI til løbende justering

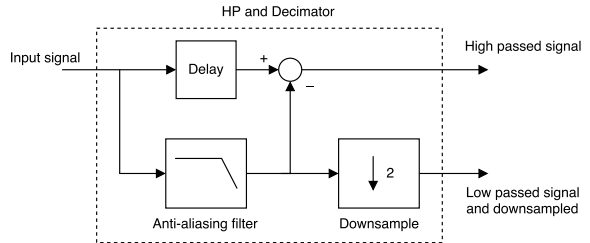


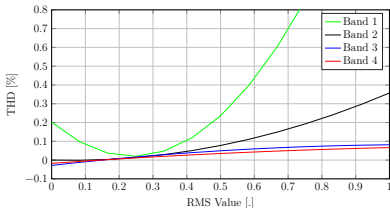
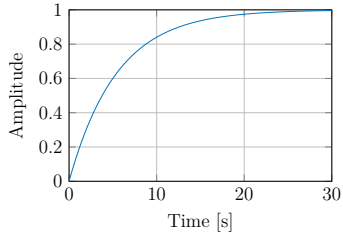
Flow gennem system:

1. Sample
2. Decimate
3. Spektral inversion
4. Påfør gain
5. Mål RMS
6. Påfør dæmpning
7. Interpolate
8. Summation

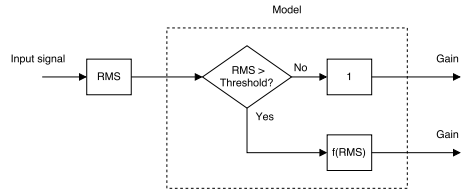


- 1 lavpas filter til båndpas
 - Spektral subtraktion
- 50. orden FIR
- Overholder IEC 6964 - Class 2

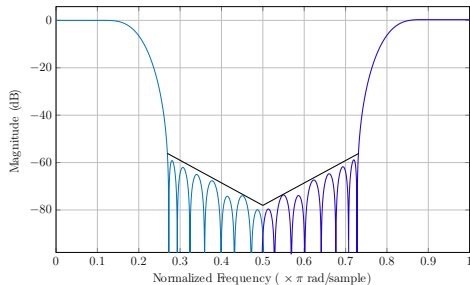
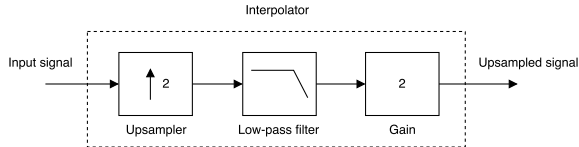




- Dæmpning på op til 60 dB
- Opløsning på 1024 Steps
- Udskiftelig modeller



- Zero-padding
- 48. Orden FIR
- Gain x2





Resultat & Konklusion

...

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse

Problemformulering

Løsning & Design
realization

Blokdiagram

Opbygning

Multi-Rate/stage

Decimation

RMS Limiter

Interpolation

Resultat & Konklusion

13

Optimering

Relevante optimerings
muligheder

Implementerede
optimeringer

Konklusion

Demonstration

Dept. of Electronic Systems
Aalborg University

18

Something new and awesome



Optimering

Undertitel

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse
Problemformulering

Løsning & Design
realization

Blokdiagram

Opbygning

Multi-Rate/stage
Decimation
RMS Limiter
Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings
muligheder
Implementerede
optimeringer

Konklusion

Demonstration

Dept. of Electronic Systems
Aalborg University

Now it goes real crazy

14

18



Optimering

Relevante optimerings muligheder

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse
Problemformulering

Løsning & Design
realization

Blokdiagram

Opbygning

Multi-Rate/stage
Decimation
RMS Limiter
Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings
muligheder
Implementerede
optimeringer

Konklusion

Demonstration

Dept. of Electronic Systems
Aalborg University

Now it goes real crazy

15

18



Optimering

Implementerede optimeringer

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse
Problemformulering

Løsning & Design
realization

Blokdiagram

Opbygning

Multi-Rate/stage
Decimation
RMS Limiter
Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings
muligheder
Implementerede
optimeringer

Konklusion

Demonstration

Dept. of Electronic Systems
Aalborg University

Now it goes real crazy

16

18



Konklusion

Jamen hvad gjorde du så?

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse

Problemformulering

Løsning & Design
realization

Blokdiagram

Opbygning

Multi-Rate/stage

Decimation

RMS Limiter

Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings
muligheder

Implementerede
optimeringer

Konklusion

17

Demonstration

Dept. of Electronic Systems
Aalborg University

18

Now it goes real crazy



Demonstration

Jamen hva' ska' æ kost, Tonni?

Multi-band RMS
Limiter
Gruppe 640

Introduktion

Problem

Foranalyse
Problemformulering

Løsning & Design
realization

Blokdiagram

Opbygning

Multi-Rate/stage
Decimation
RMS Limiter
Interpolation

Resultat & Konklusion

Optimering

Relevante optimerings
muligheder
Implementerede
optimeringer

Konklusion

Demonstration

18

Dept. of Electronic Systems
Aalborg University

18

Now it goes real crazy



AALBORG UNIVERSITY
DENMARK