Subband Coding using FPGA

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Introduction to Subband Coding

The source output can be decomposed into its constituent parts using digital filters.

Each of these constituent parts will be different bands of frequencies which make up the source.

Subband Coding

A compression approach where digital filters are used to separate the source output into different bands of frequencies.

- Each part then can be encoded separately.

Filters used in Subband Coding

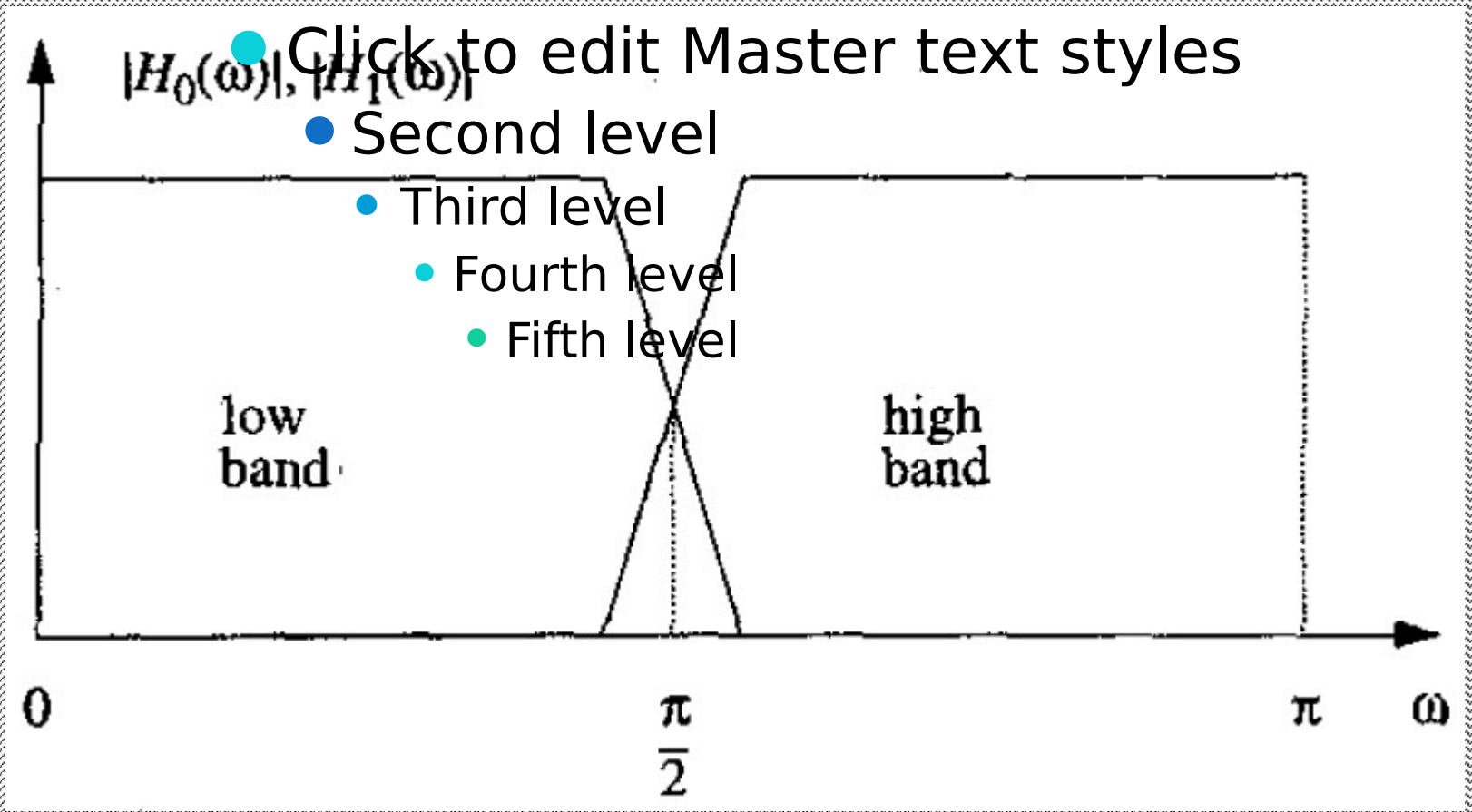
Couple of examples of –*Quadrature Mirror Filters (QMF):*

- *Johnston Filter*
- *Smith-Barnwell Filters*
- *Daubechies Filters*

....and so on

QMF

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  - Second level
    - Third level
      - Fourth level
        - Fifth level

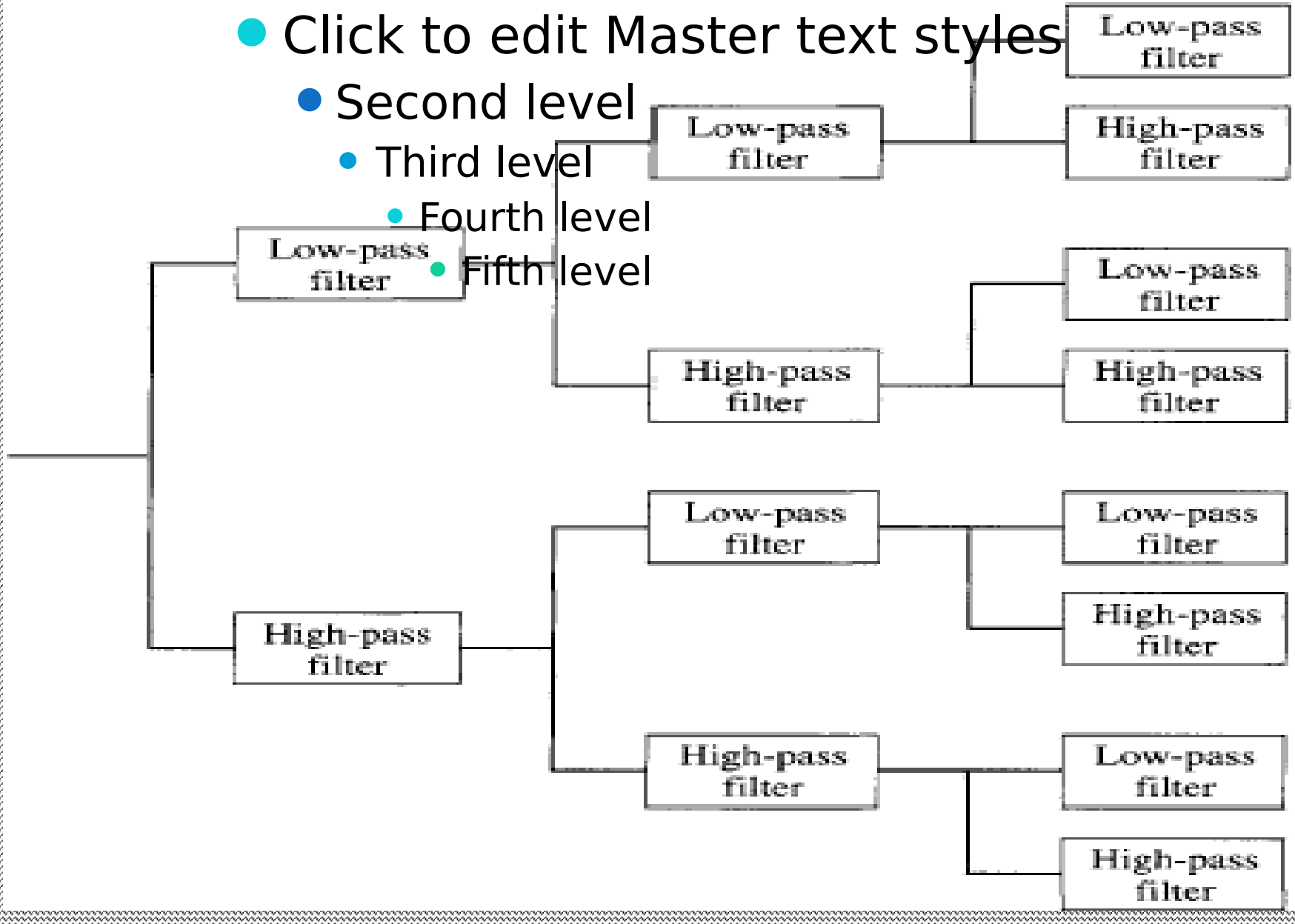


Filter Banks

Subband coding uses *filter banks*.

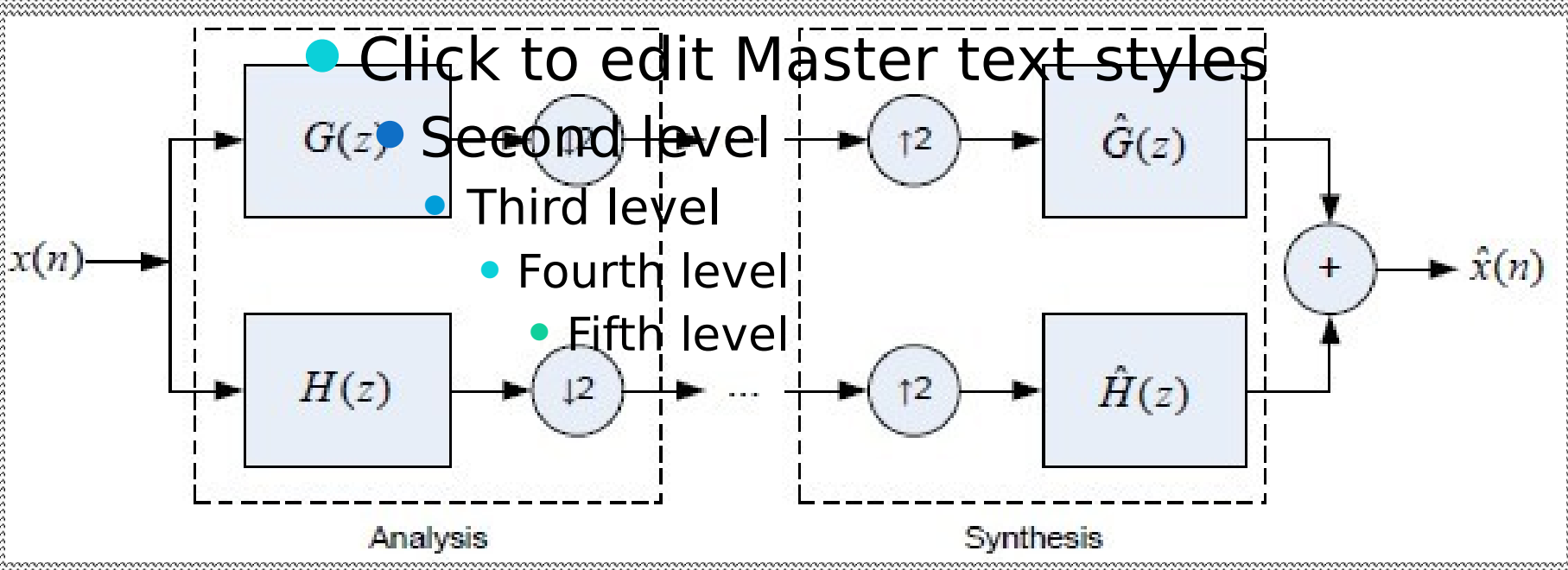
Filter banks are essentially a cascade of stages, where each stage consists of a low-pass filter and a high-pass filter.

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    - Third level
      - Fourth level
        - Fifth level



Subband Coding Algorithm

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      - Fourth level
        - Fifth level



(1) Analysis

Source output analysis filter bank sub-sampled encoded.

Analysis Filter Bank

- The source output is passed through a bank of filters.
- This filter bank covers the range of frequencies that make up the source output.
- The passband of each filter specifies each set of frequencies that can pass through.

(1) Analysis

Source output analysis filter bank sub-sampled encoded.

Analysis Filter Bank

Decimation

- The amount of decimation depends on the ratio of the bandwidth of the filter output to the filter input.

(1) Analysis

Source output analysis filter bank sub-sampled encoded.

Analysis Filter Bank

Decimation

Encoding

- The decimated output is encoded using one of several encoding schemes, including vector quantization.

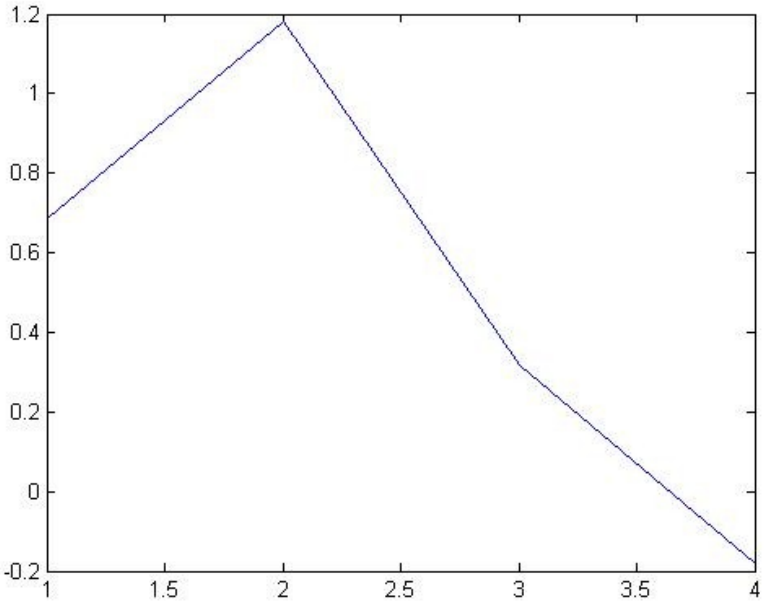
(2) Synthesis

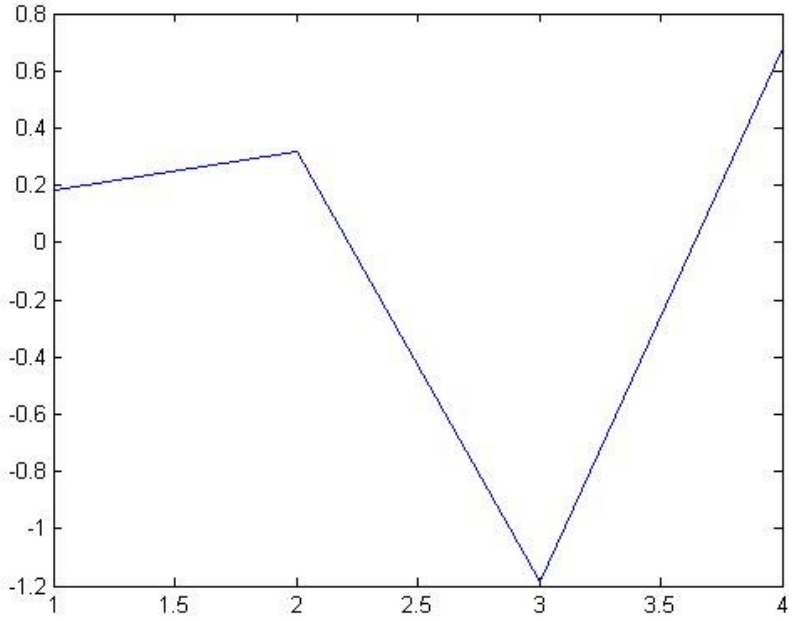
- Processed coefficients are used to reconstruct a representation of the original signal at the decoder.

Encoded samples from each subband decoded upsampled bank of reconstruction filters outputs combined Final reconstructed output

In my project:

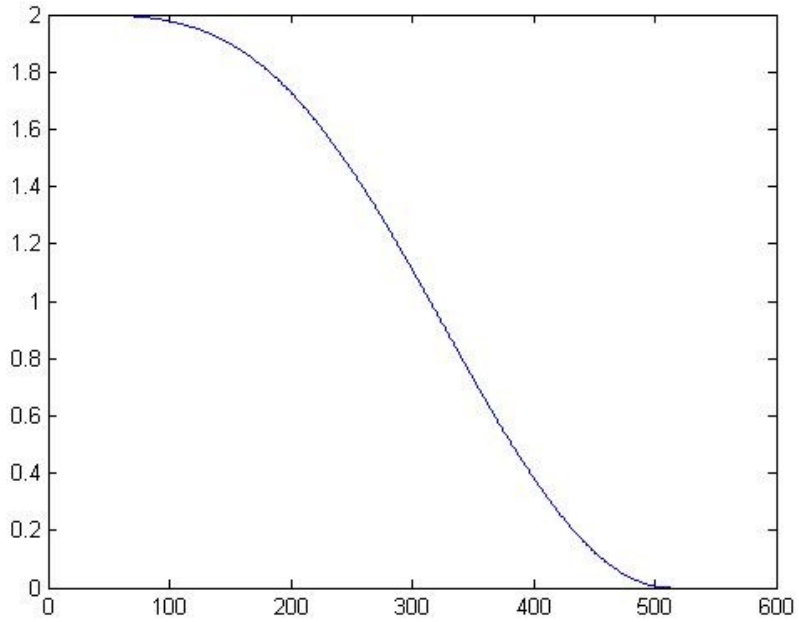
- I use 2-band Daubechies Filter (DB4) Bank in project.



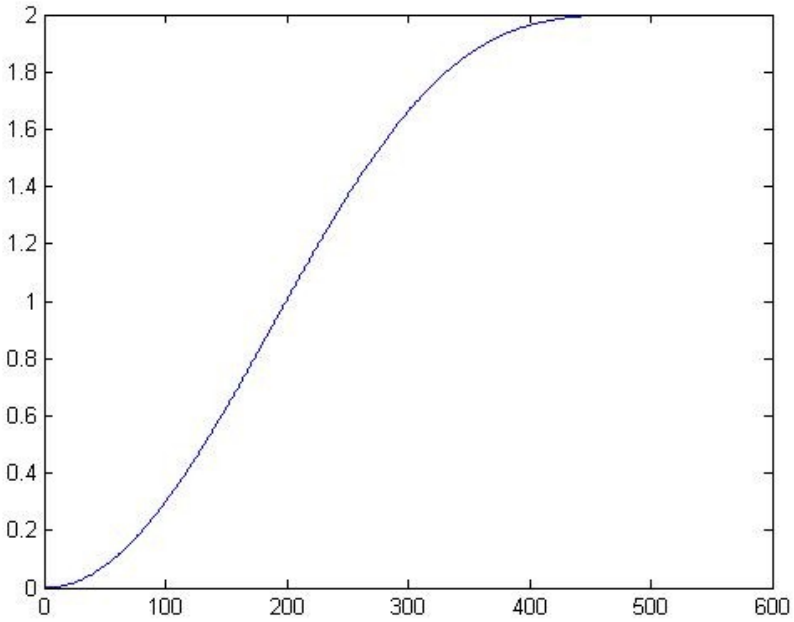


DB4 Magnitude-Frequency Response

- Low pass

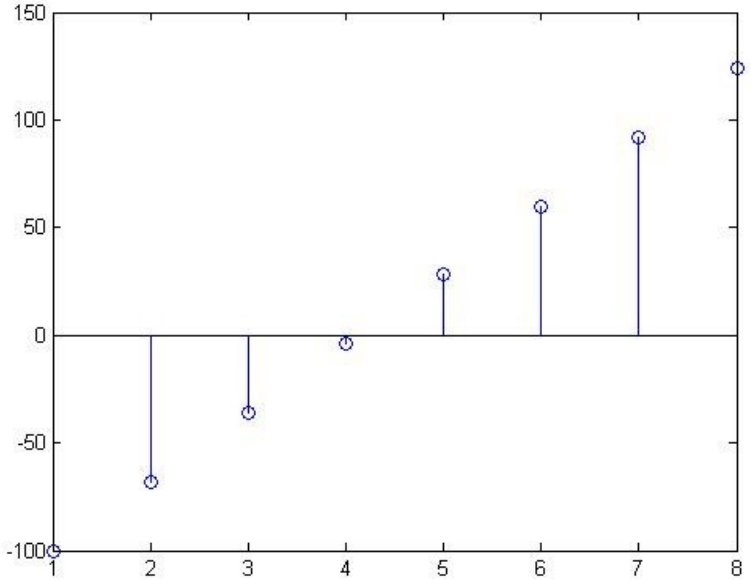


High pass

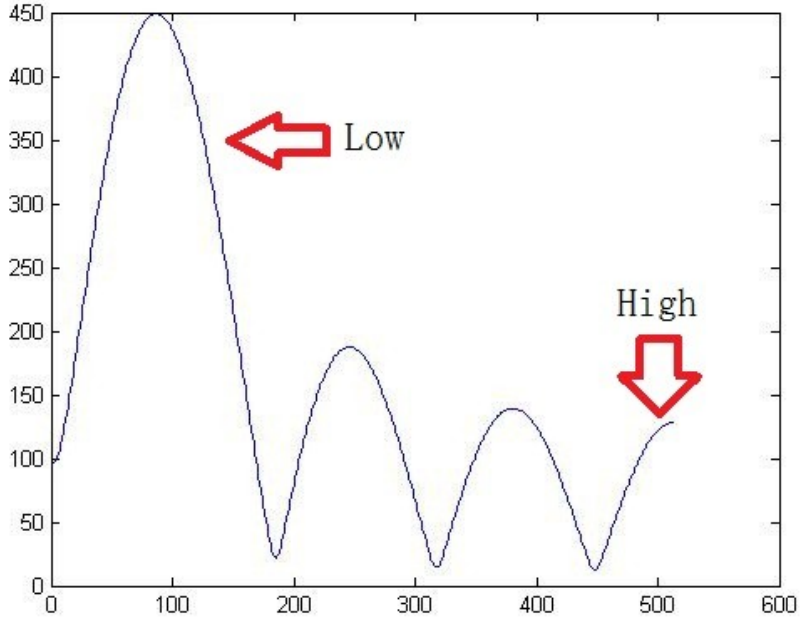


Signal used in my project:

- I use ramp (Zig-Zag) signal because I think the frequency spectrum is richer in Zig-Zag signal than other signal like Sinusoidal signal (Monotone signal).



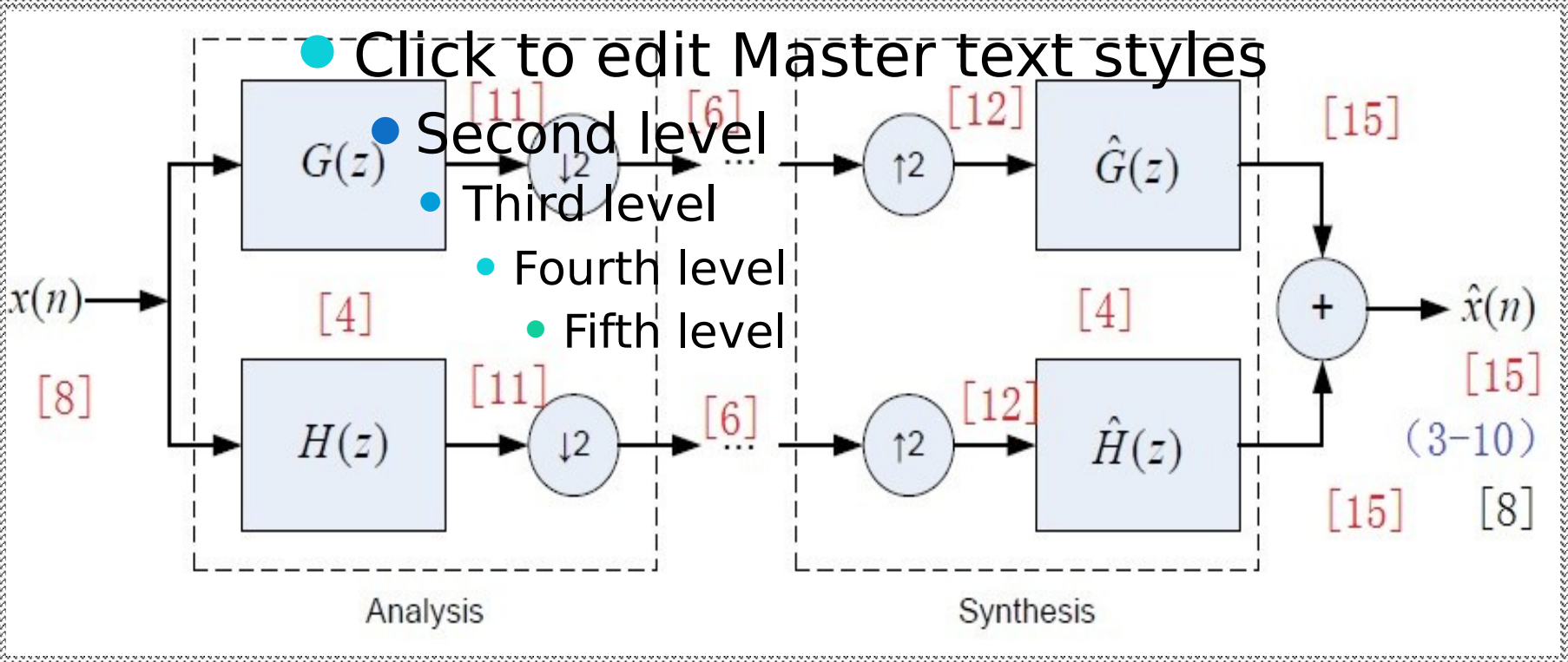
We use 8-points length for easy computation in FPGA in this experiment



Frequency response of Zig-Zag signal

Signal lengths in each state:

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  - Second level
    - Third level
      - Fourth level
        - Fifth level



Reference:

- “DSP_LAB_MANU_version4”----------A. N. Akansu and M. U.Torun,2011
- “Daubechies wavelet”----------Wikipedia

Q&A.

- THANKS!