



A novel IP for Real Time DC Estimation and Removal

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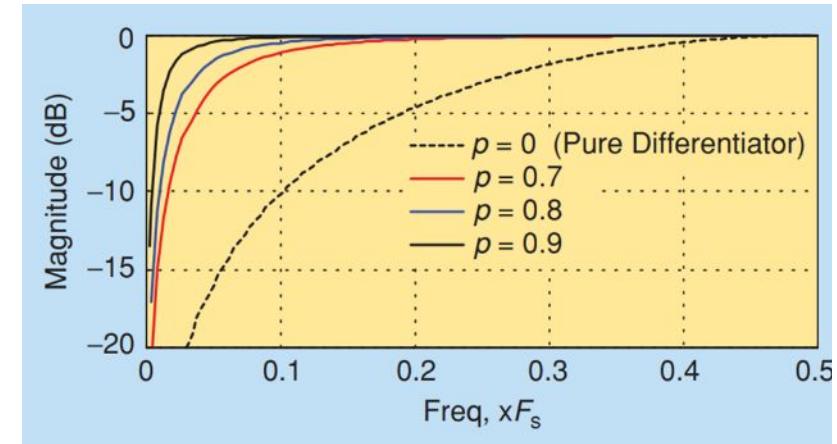
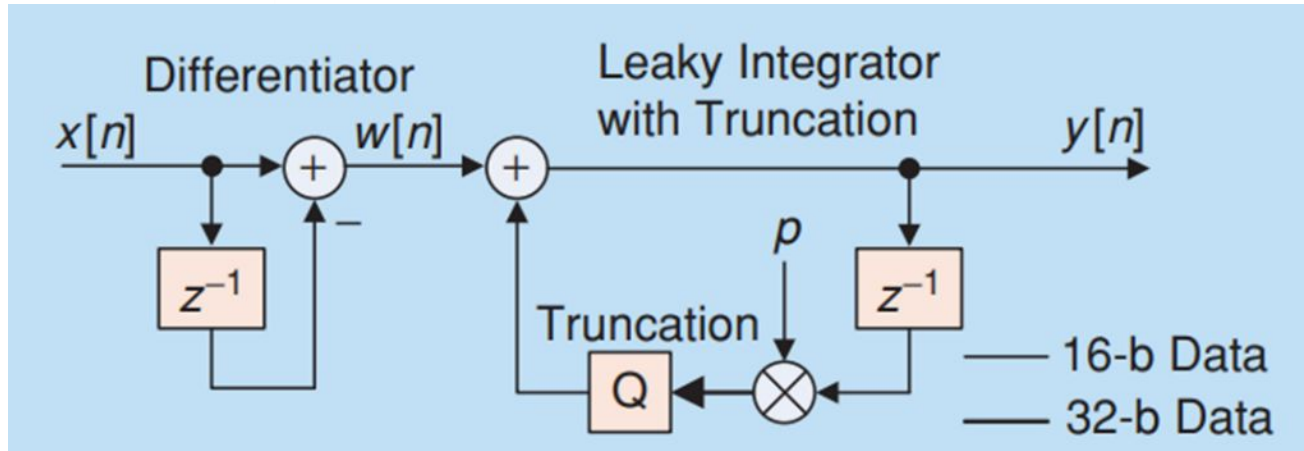


Motivation

- ❑ Analog Front end of design introduces **undesired DC** in signal path known as offset.
- ❑ Usually, DC filter is placed at the **last** of filter chain to remove unwanted parasitic DC.
- ❑ DC filter is placed last in chain, it runs at **lowest rate**.
- ❑ Having null at DC it attenuates DC well, but **energy redistribution** causes loss in **SNR**



DC Filtering

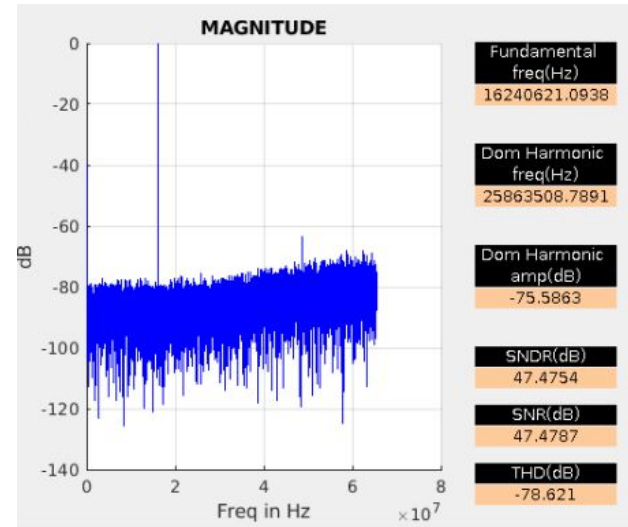
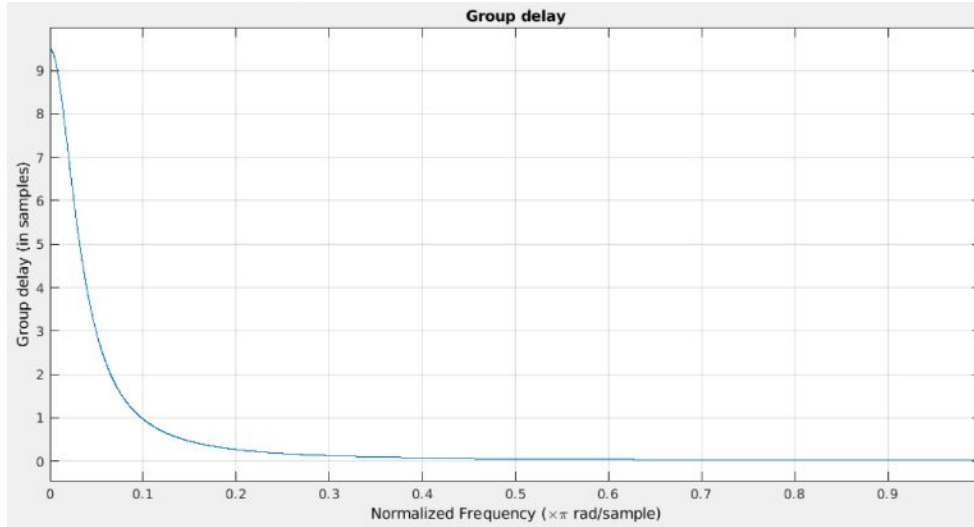


A Contemporary DC filter is:

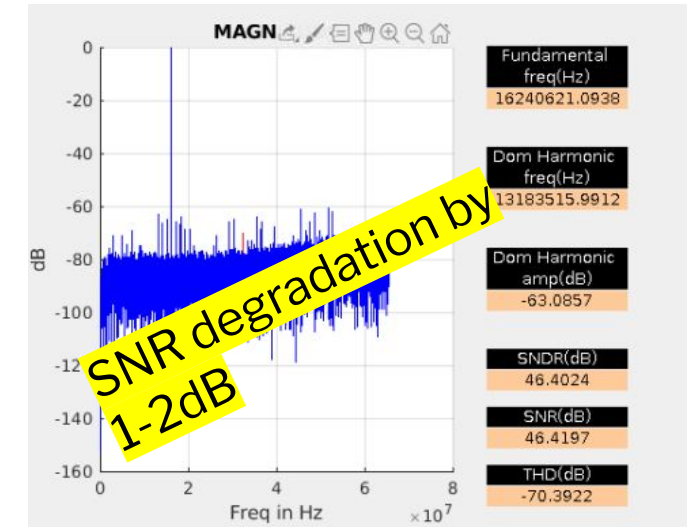
- A single pole, single zero high-pass filter with the **3dB** cut-off decided by the pole position.
- The zero at DC is realized by a differentiator and the pole by a leaky integrator (**Q factor p**).
- It adds **considerable group** delay at low frequencies
- The filtered DC manifests as an increased noise level of non-DC frequencies (**SNR degradation**)



Recognized Problem



DC removal
off



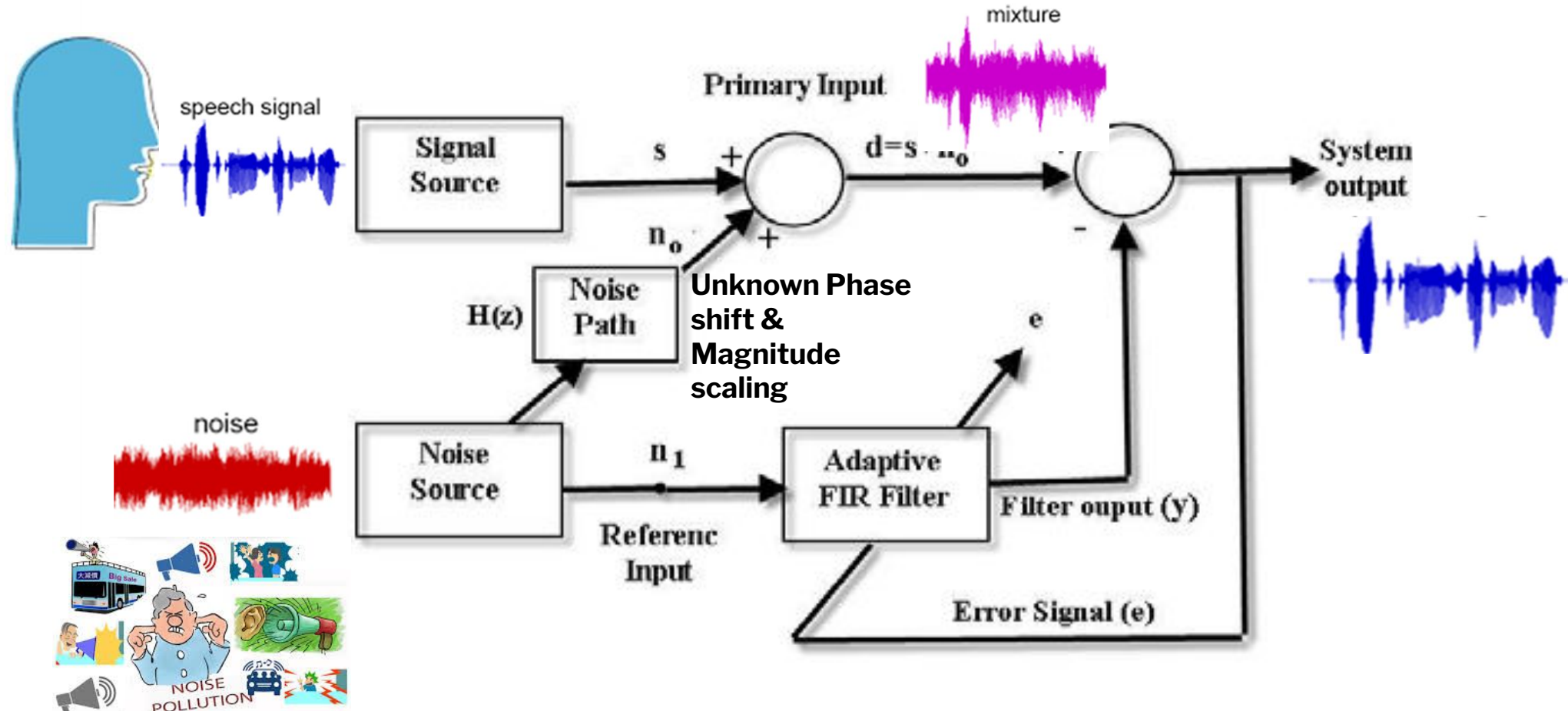
DC removal
on

The DC removal filter lies in the Datapath of the filter with the following signal impairments:

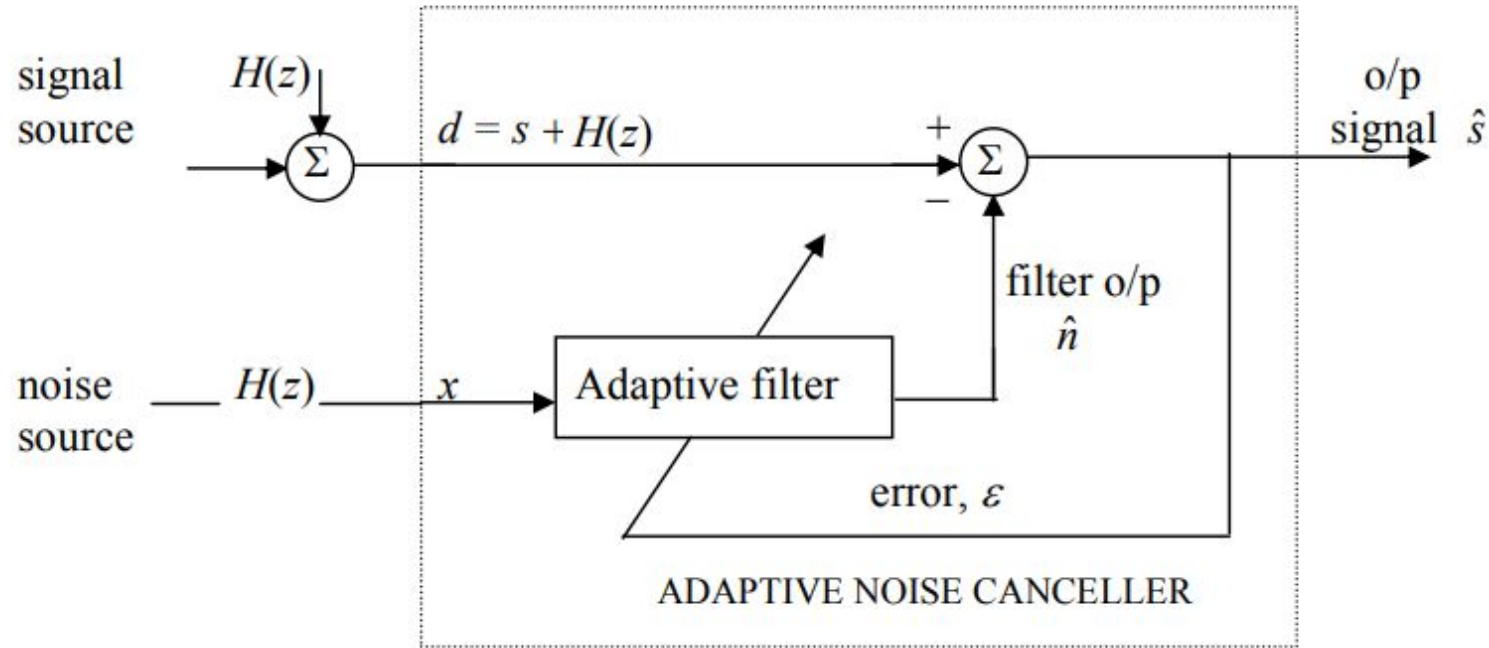
- ❑ It adds **considerable group delay** at low frequencies
- ❑ The filtered DC manifests as an increased noise level of non-DC frequencies (**SNR degradation**)



Active Noise Cancellation ??



Main Idea

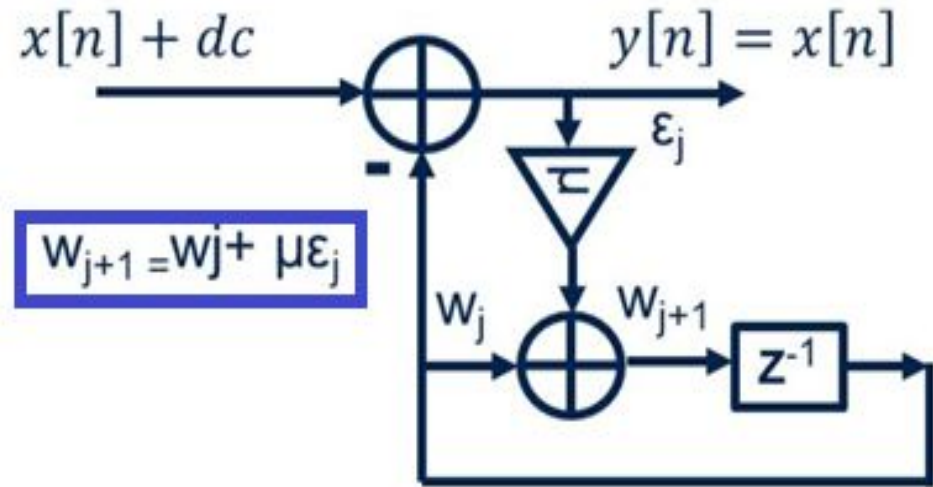


Treat DC like uncorrelated Noise $H(z)$!

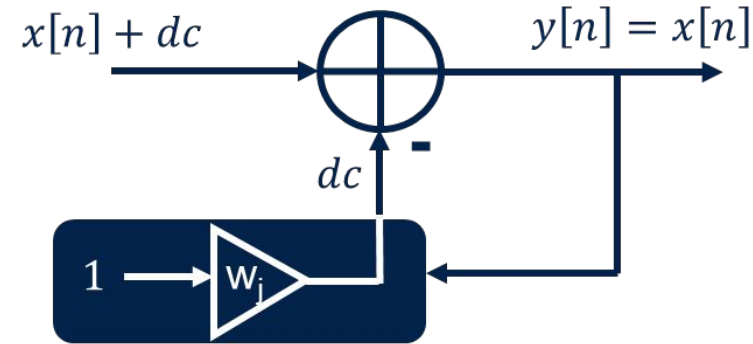
The **LMS** (Least Mean Square) adaptive filter is used to carry out a DC estimation and followed by a DC removal operation



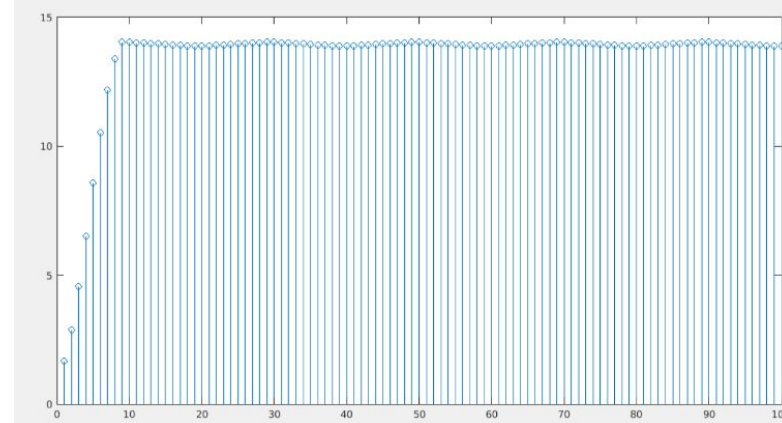
Solution Details



As **no phase information** needed for DC, a single tap filter will suffice



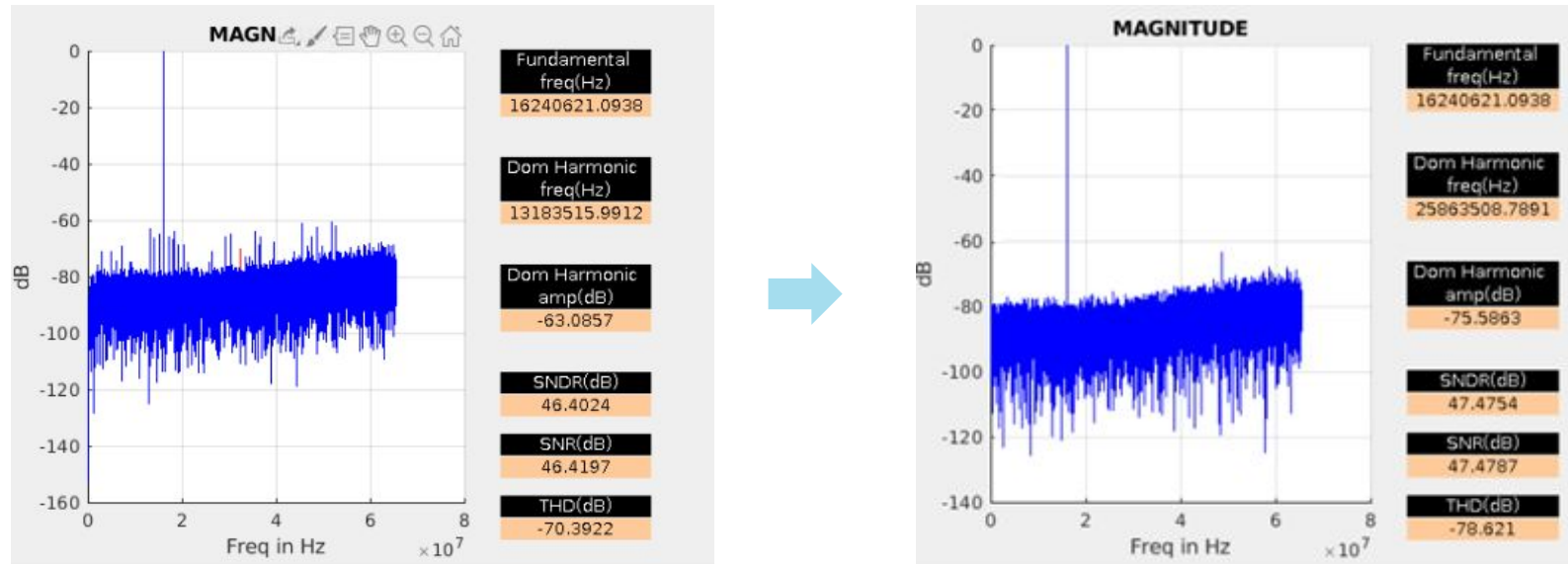
Decouple DC removal TF from signal path



Turn off estimator once converged



Results



- ❑ **No loss** in signal SNR as redistribution of energy is not happening
- ❑ Runs in background and **decorrelates** DC from the output without sitting in the datapath
- ❑ **Group delay** problem solved as no Datapath contribution
- ❑ Much **better** than a moving average filter in terms of **area and power**
- ❑ Can be **shut down** after a while to save dynamic power



Summary

- ❑ A **single tap LMS** filter is proposed to be used as a DC removal filter **without** interfering in the functional Datapath.
- ❑ It removes DC from the signal without performing a filtering operation. It does an **estimation** followed by a **DC removal** operation.
- ❑ The **Group delay** is practically reduced to **zero** as it is now a simple subtraction operation at steady state.
- ❑ The SNR performance is improved by over **1dB** in the **wideband** signal illustration. For **narrowband** systems, the improvement goes up to **3dB**



Question

