

Efficient Pre-Distortion Digital Shaping Filter For Very Wideband QAM Modems

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11-14 Mar, 2014



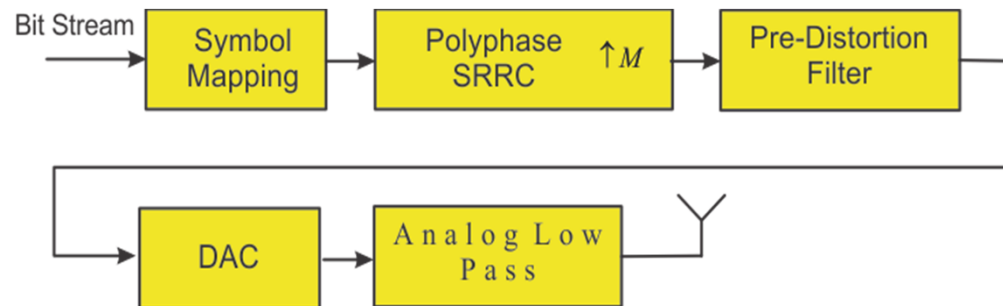
Outline:

- **Motivations**
- **Review of Conventional Approach**
- **Polyphase Channelizer Based Digital Filtering**
- **Proposed Architecture**
- **Simulation Results**

Motivations and Project Goal:

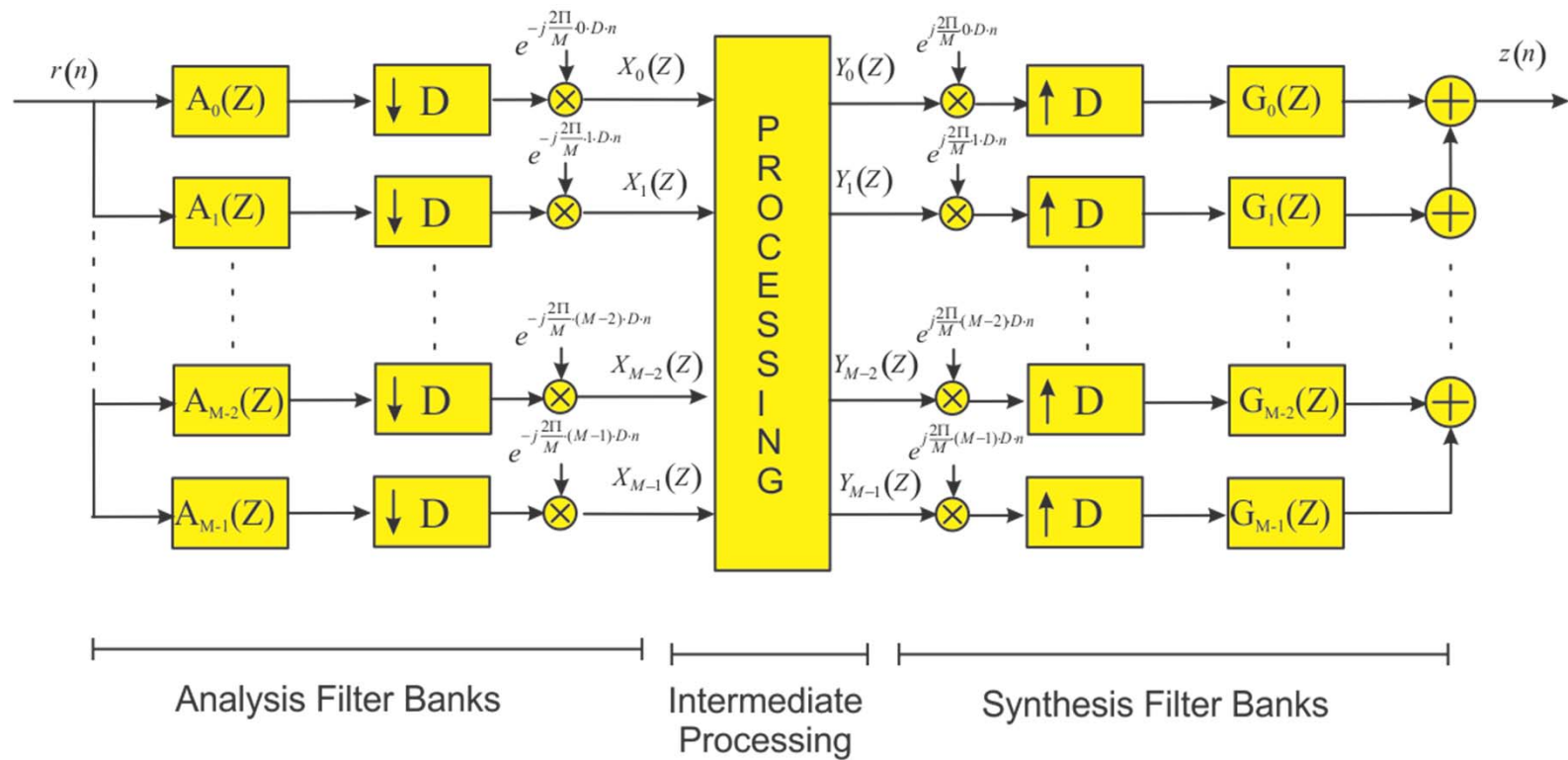
- To build cost-effective wideband ($> \text{GHz}$ Bandwidth) QAM transmitter.
- FIR based filtering approach easily saturates available hardware resources.

Review of Current State of Art

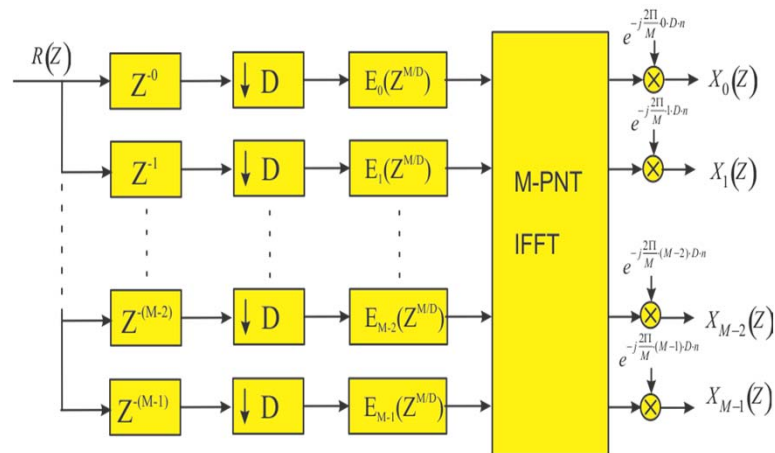


Conventional Pre-distorted Digital Shaping

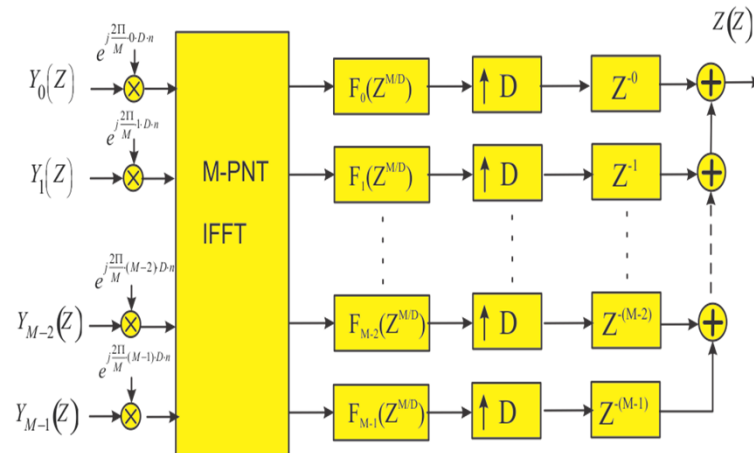
Polyphase Channelizer Based Digital Filtering



Polyphase Channelizer Based Digital Filtering: Polyphase Implementation



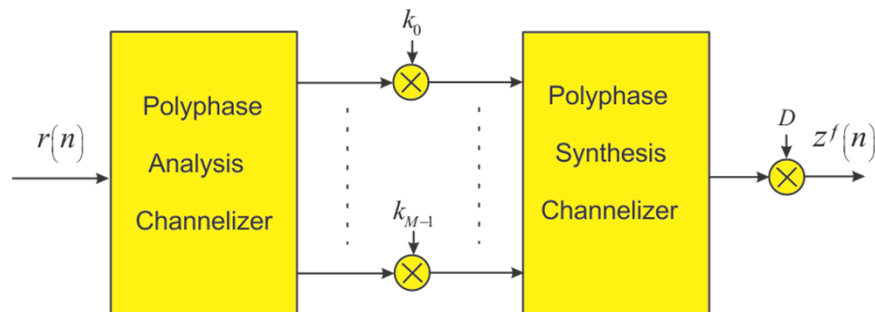
Polyphase Analysis Channelizer
(PAC)



Polyphase Synthesis Channelizer
(PSC)

ONE low pass filter plus ONE IFFT implements PAC or PSC

Polyphase Channelizer Based Digital Filtering: Channelizer Domain V.S. Time Domain



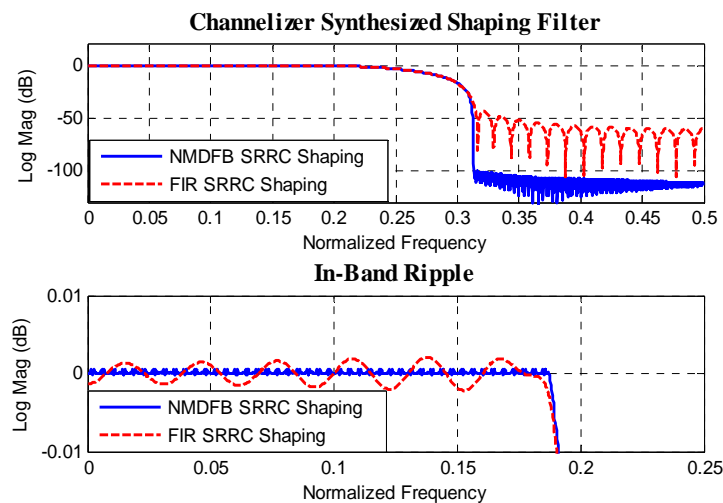
Channelized Domain Filtering



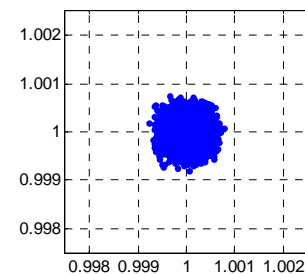
Time Domain Filtering

The error of the two can be reduced by increasing the number of channels at the cost of **FFT**

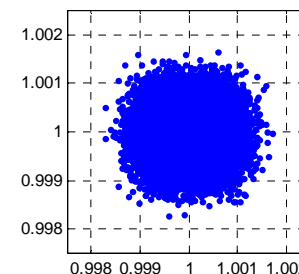
Polyphase Channelizer Based Digital Filtering: SRRC Shaping Filter



NMDFB MF Constellation

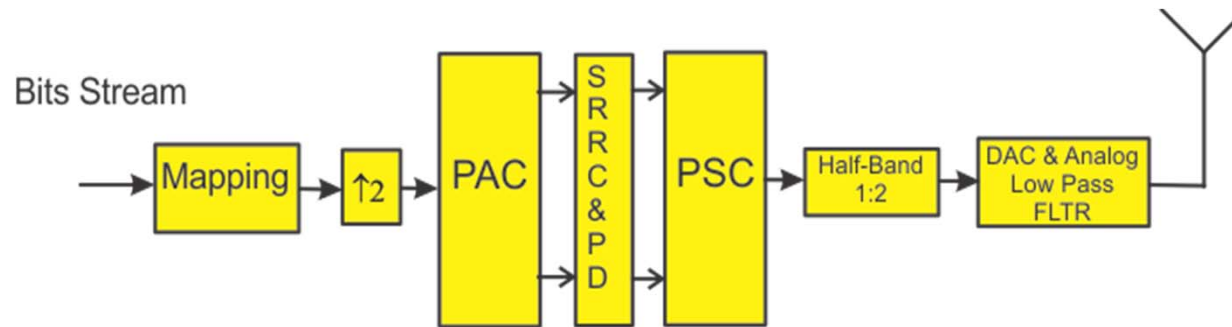


FIR MF Constellation



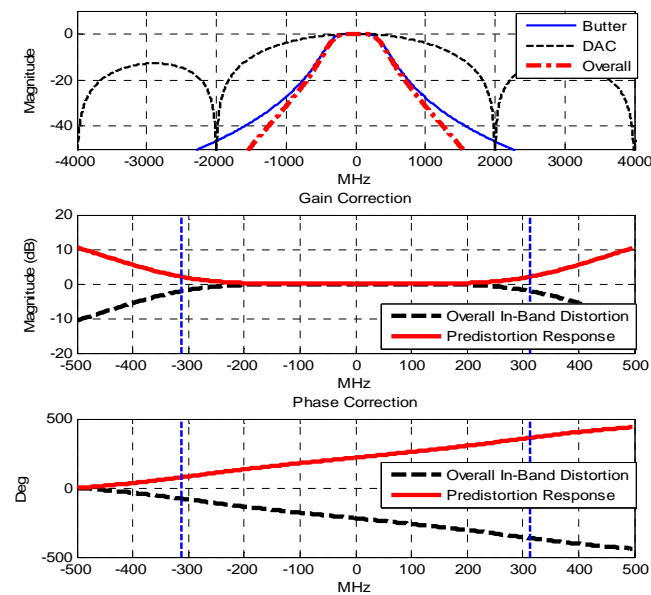
- ❑ Two designs both have 137 multiplies and additions per input sample.
- ❑ NMDFB approach offers much better system response: **over 50 dB** increase in stop-band performance, and the in-band ripple is **4 times smaller**.

Proposed Architecture



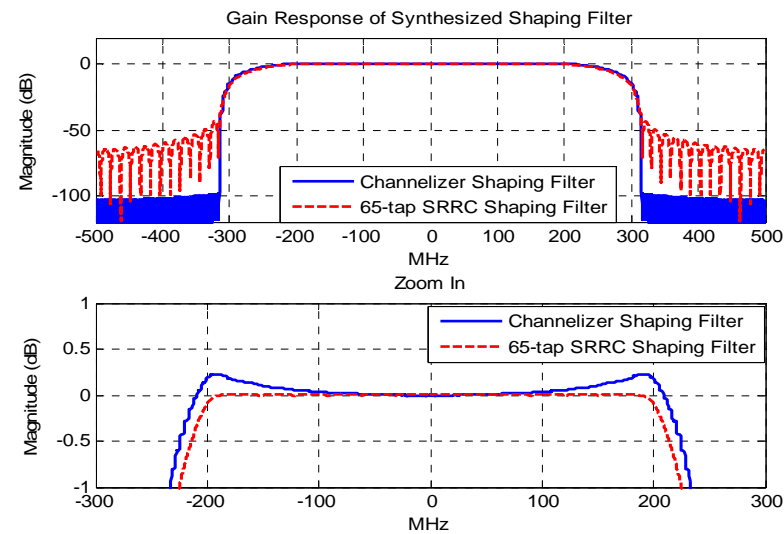
- ❑ Embed SRRC Shaping Filter & Pre-Distortion Filter in Between Channelizers
- ❑ Building **two** filters at the cost of **one**!
- ❑ Entire Architecture Runs on Deeply Decimated Clock Rates

Simulation Results



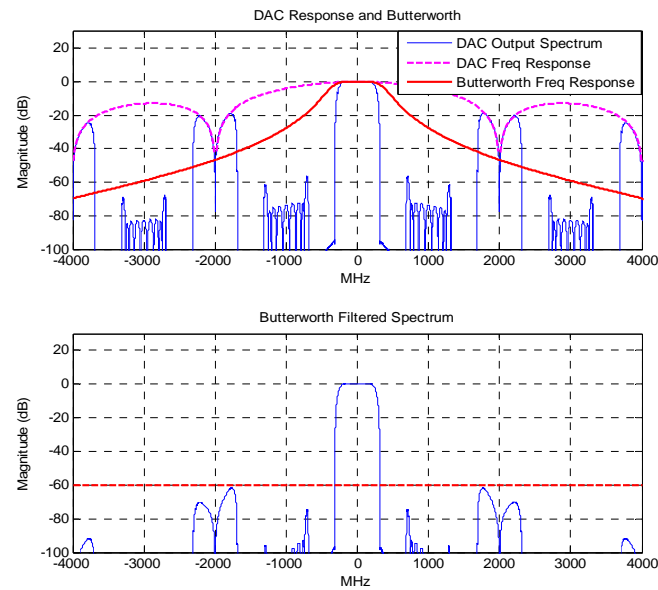
Predistortion Response w.r.t Overall DAC & Analog Filter Response

Simulation Results (Cont'd)



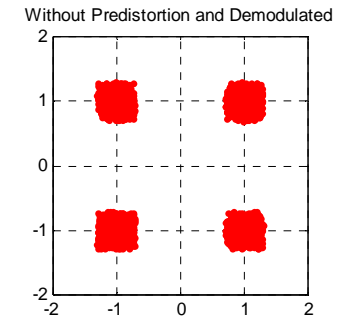
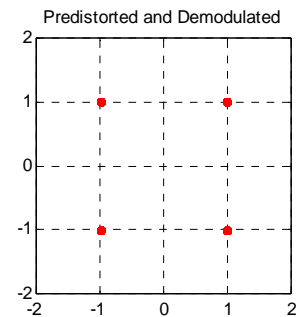
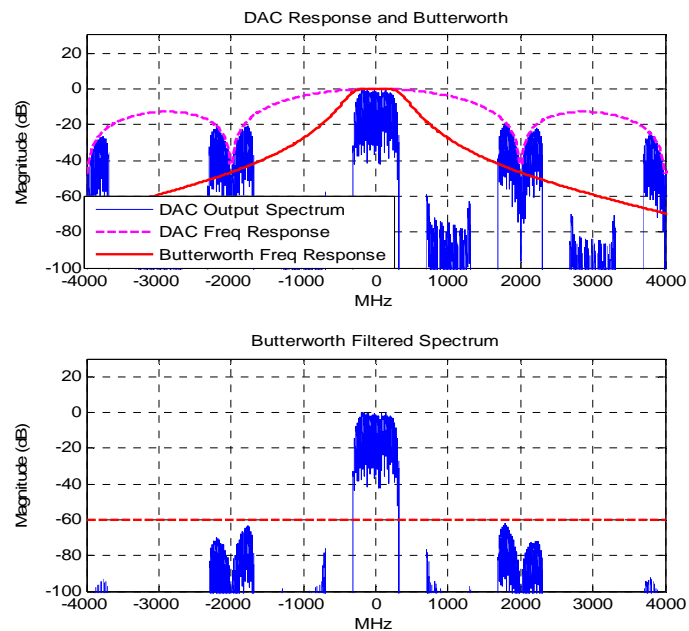
Frequency Response of Pre-Distorted Shaping Filter

Simulation Results (Cont'd)



DAC and Analog Filter Output Spectra

Simulation Results (Cont'd)



DAC and Analog Filter Output Spectra

Workload Analysis

In our simulation example:

$M = 256$ path

$D = 128$ (Decimation Factor)

Analysis / Synthesis Low Pass Prototype Filter Length = 10 taps / arm

which roughly corresponds to an FIR filter of **76 taps** processing complex data.

Let the input signal's symbol rate be 500 MHz, our system runs on 500 MHz * 2 / 128 = **7.815 MHz**; while the FIR solution runs on 500 MHz * 76 / 2 = **19 GHz**.

Conclusion

- ❑ The polyphase channelizer based filter effectively solves the wideband digital filtering problem.
- ❑ The polyphase channelizer offers power efficient and cost effective wideband communication architecture.

Thanks ! And, Open for Questions 😊