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# Implementation of Modified Wave Digital Filters Using Digital Signal Processors

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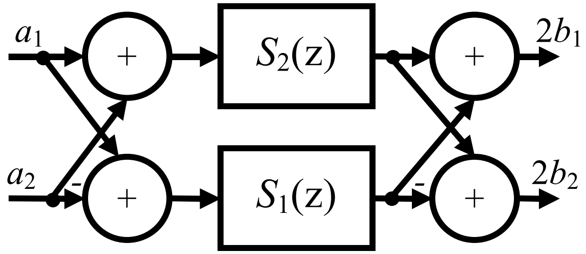
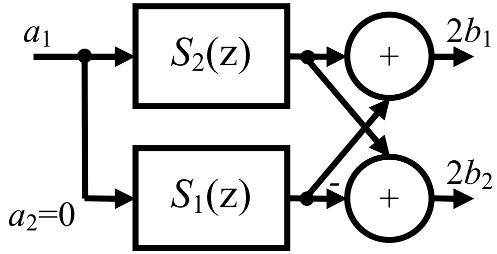
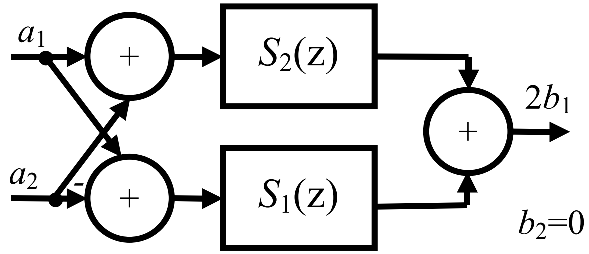
# *Simplified Block Diagrams of Lattice Wave Digital Filter*



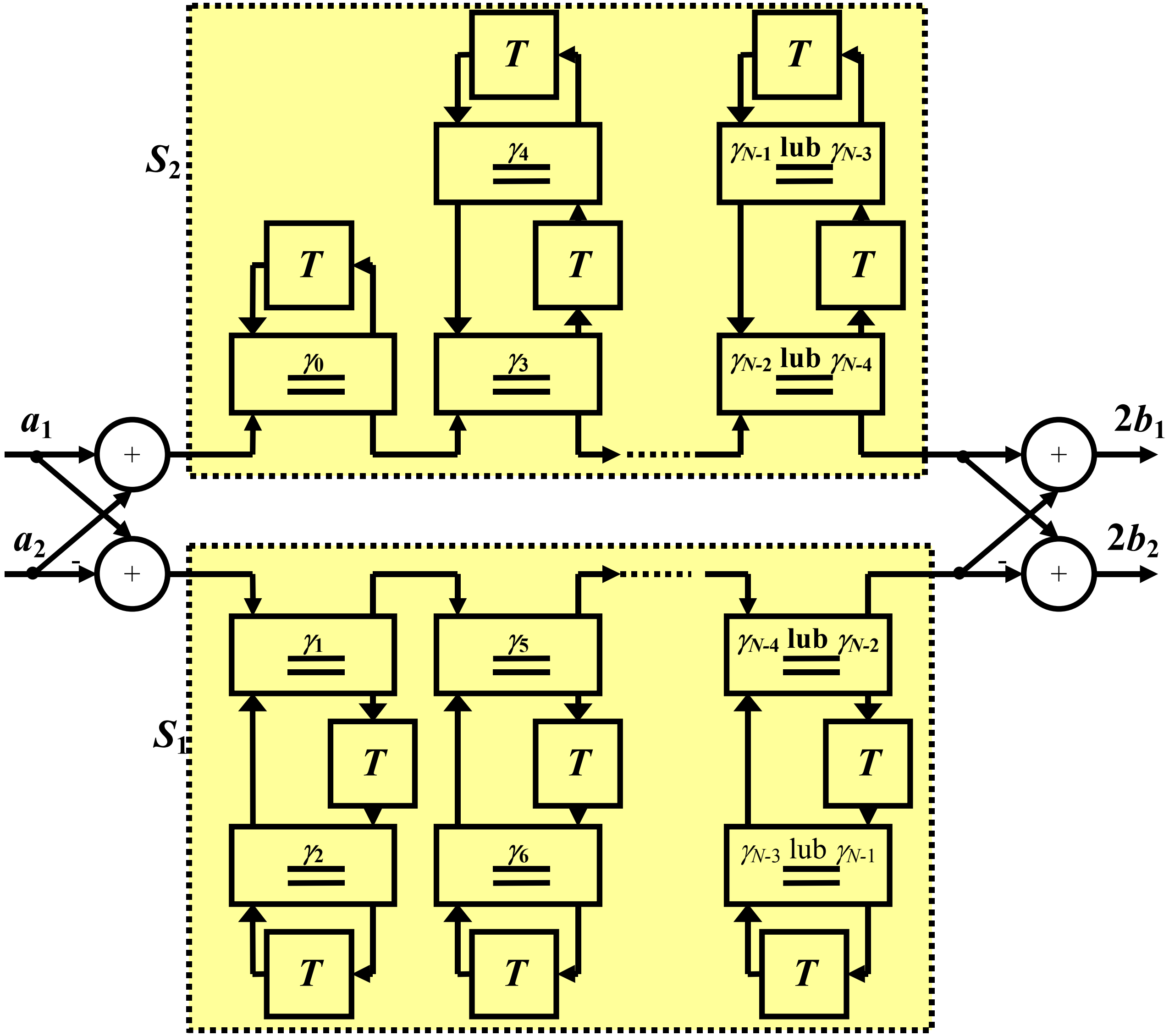

**Analysis Filter Bank**



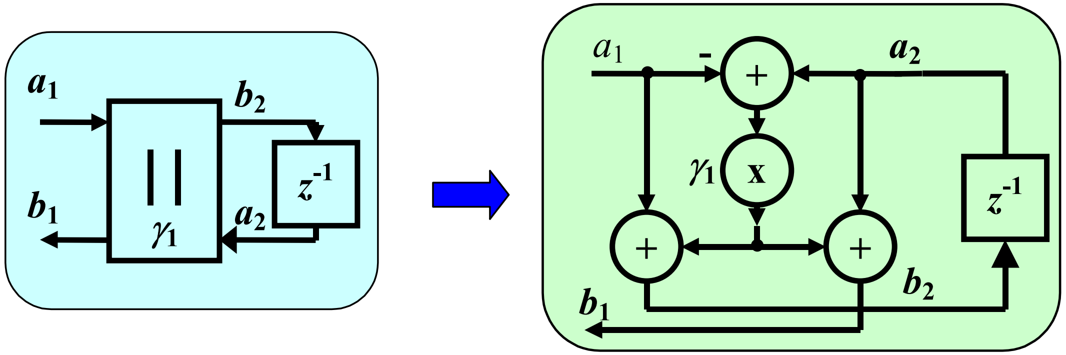

**Synthesis Filter Bank**



# Lattice Wave Digital Filter



# First-Order All-Pass Section



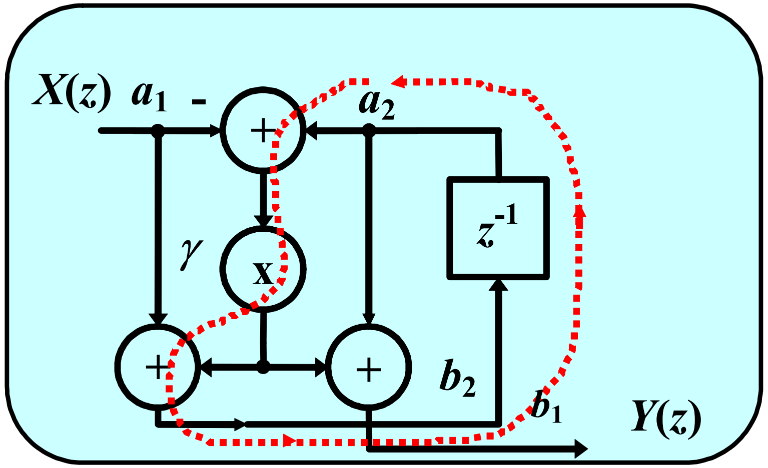

## Reflection signals $b_1$ and $b_2$

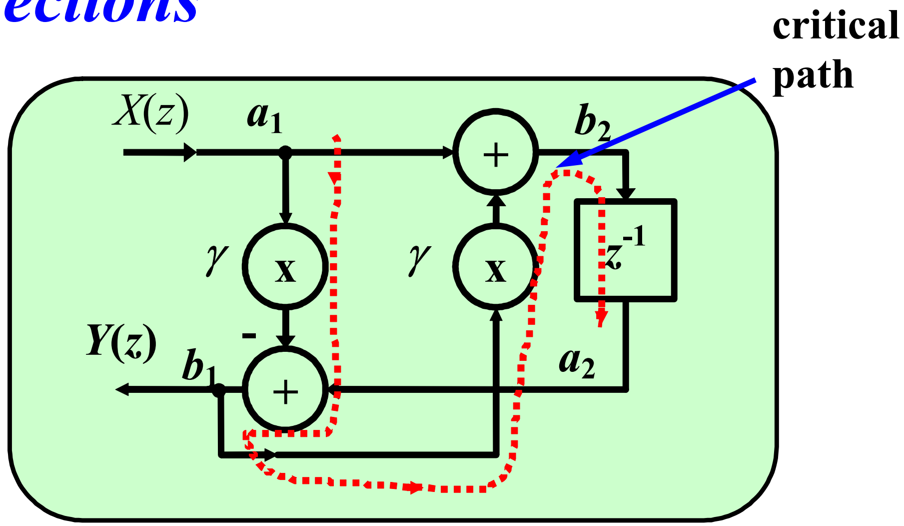
$$\begin{cases} b_1 = -\gamma_1 a_1 + (1+\gamma_1)a_2 \\ b_2 = (1-\gamma_1)a_1 + \gamma_1 a_2 \end{cases}$$

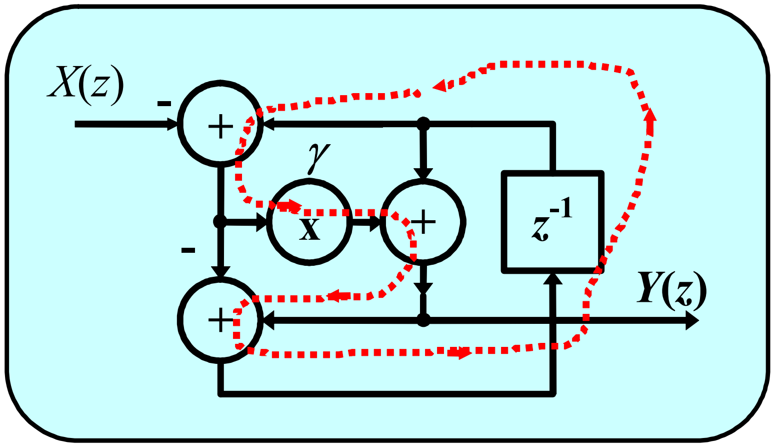
## Transmittance of All-Pass Section

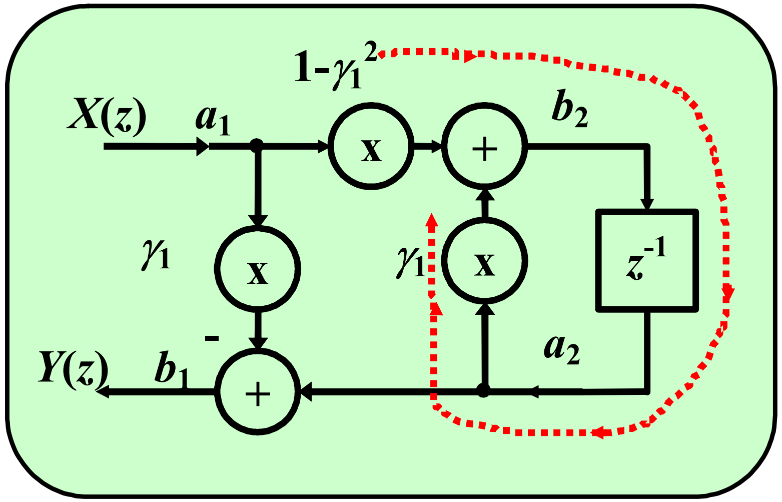
$$H(z) = \frac{-\gamma_1 + z^{-1}}{1-\gamma_1 z^{-1}}$$

# Block Diagram of Classical First-Order All-Pass Sections

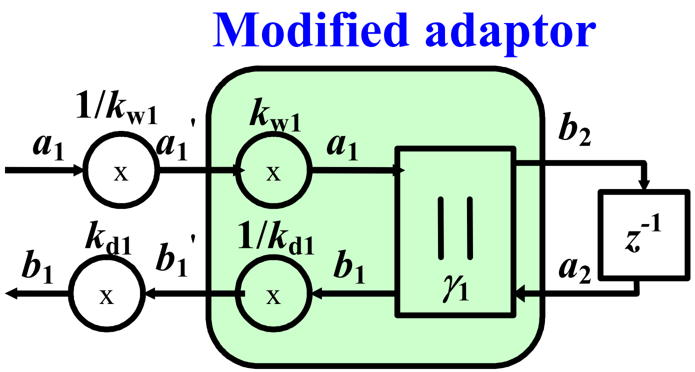


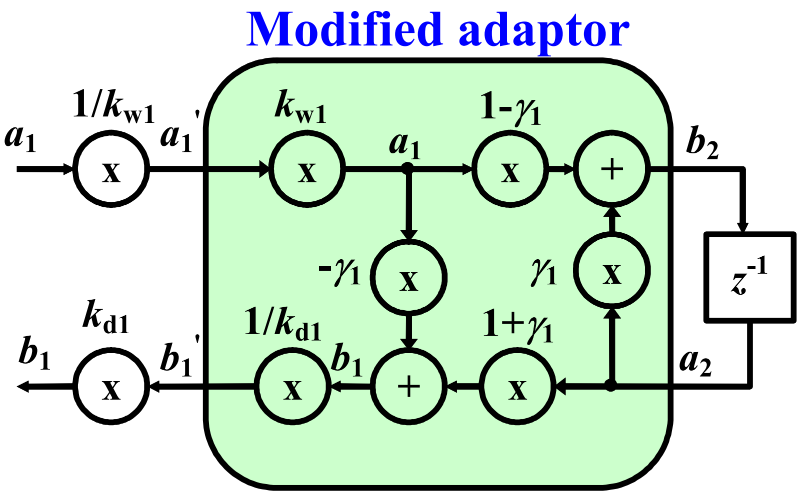



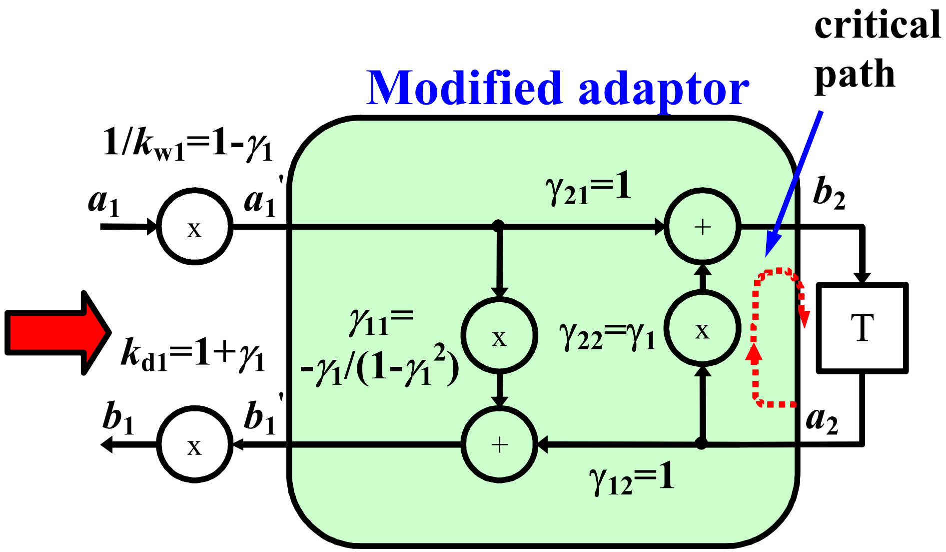



# First-Order Modified All-Pass Section



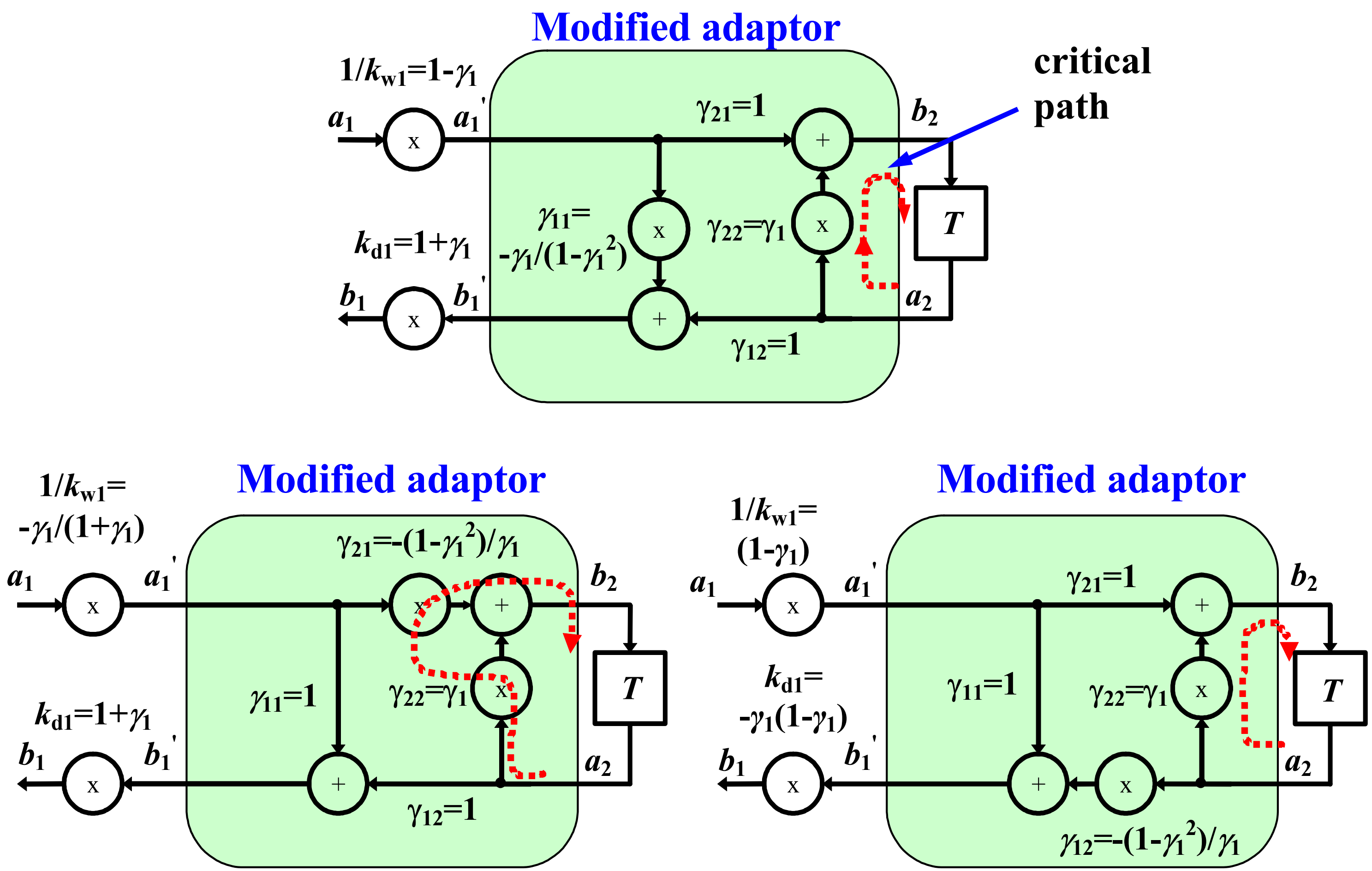
# Equations for the First-Order Modified Two Port Adaptor

$$\begin{cases} b_1^{'} = \gamma_{11} a_1^{'} + \gamma_{12} a_2 \\ b_2 = \gamma_{21} a_1^{'} + \gamma_{22} a_2 \end{cases} ,$$

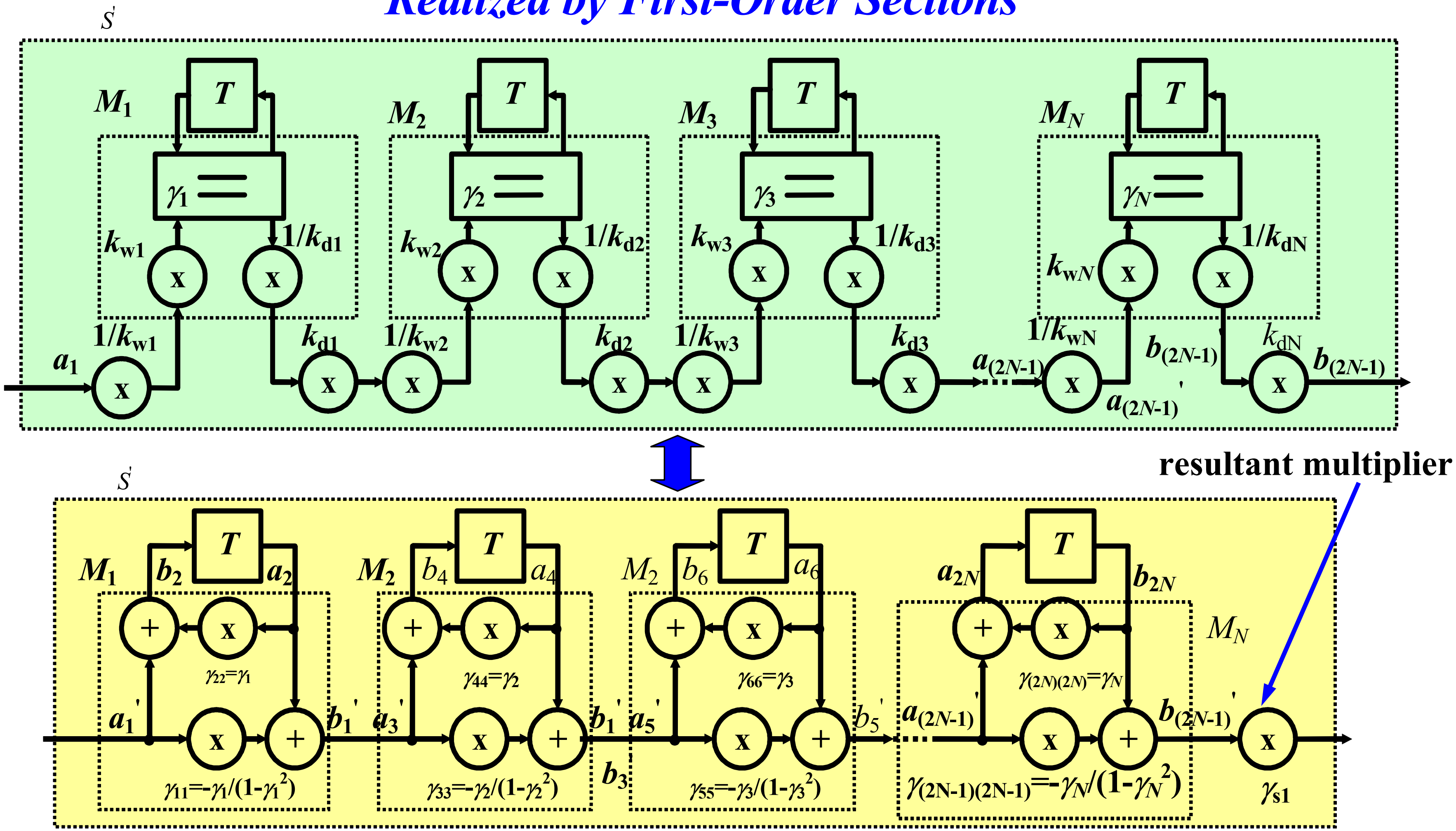
where:

$$\begin{cases} \gamma_{11} = -\gamma_1 \dfrac{k_{\mathrm{w1}}}{k_{\mathrm{d1}}} \\ \gamma_{12} = \left(1 + \gamma_1\right) / k_{\mathrm{d1}} \\ \gamma_{21} = \left(1 - \gamma_1\right) k_{\mathrm{w1}} \\ \gamma_{22} = \gamma_1 \end{cases} .$$

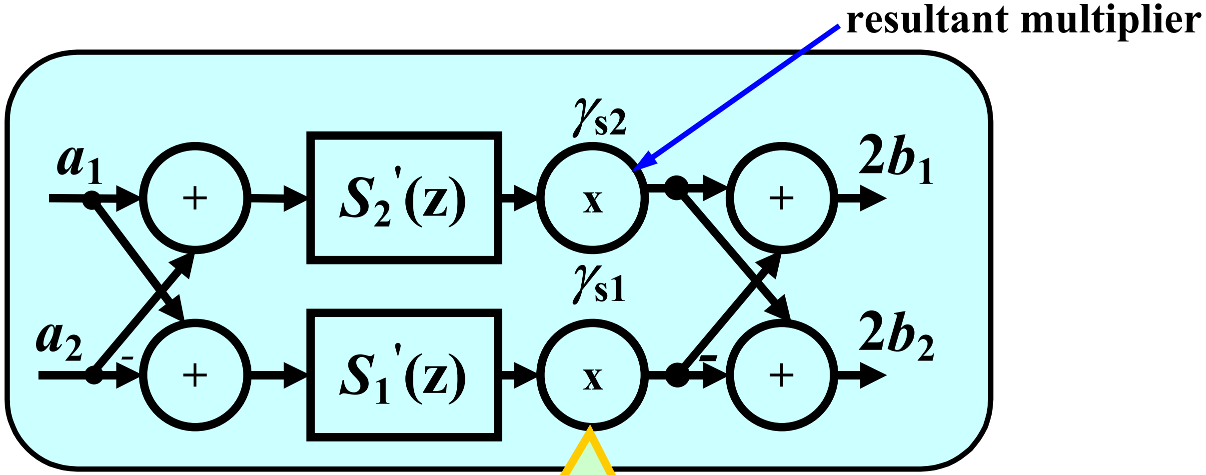
# *Realization Diagrams of First-Order Modified All-Pass Sections*



# N-Order Branch of the Modified Lattice Wave Digital Filter Realized by First-Order Sections

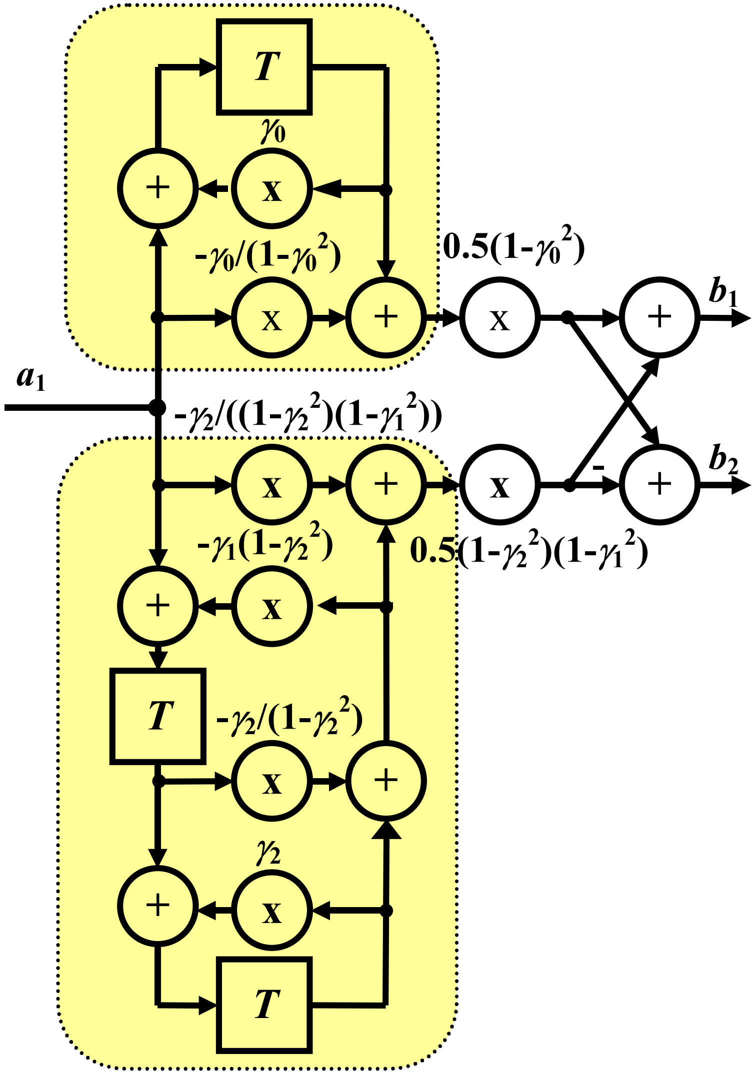


# *Block Diagram of Lattice Modified Wave Digital Filter*

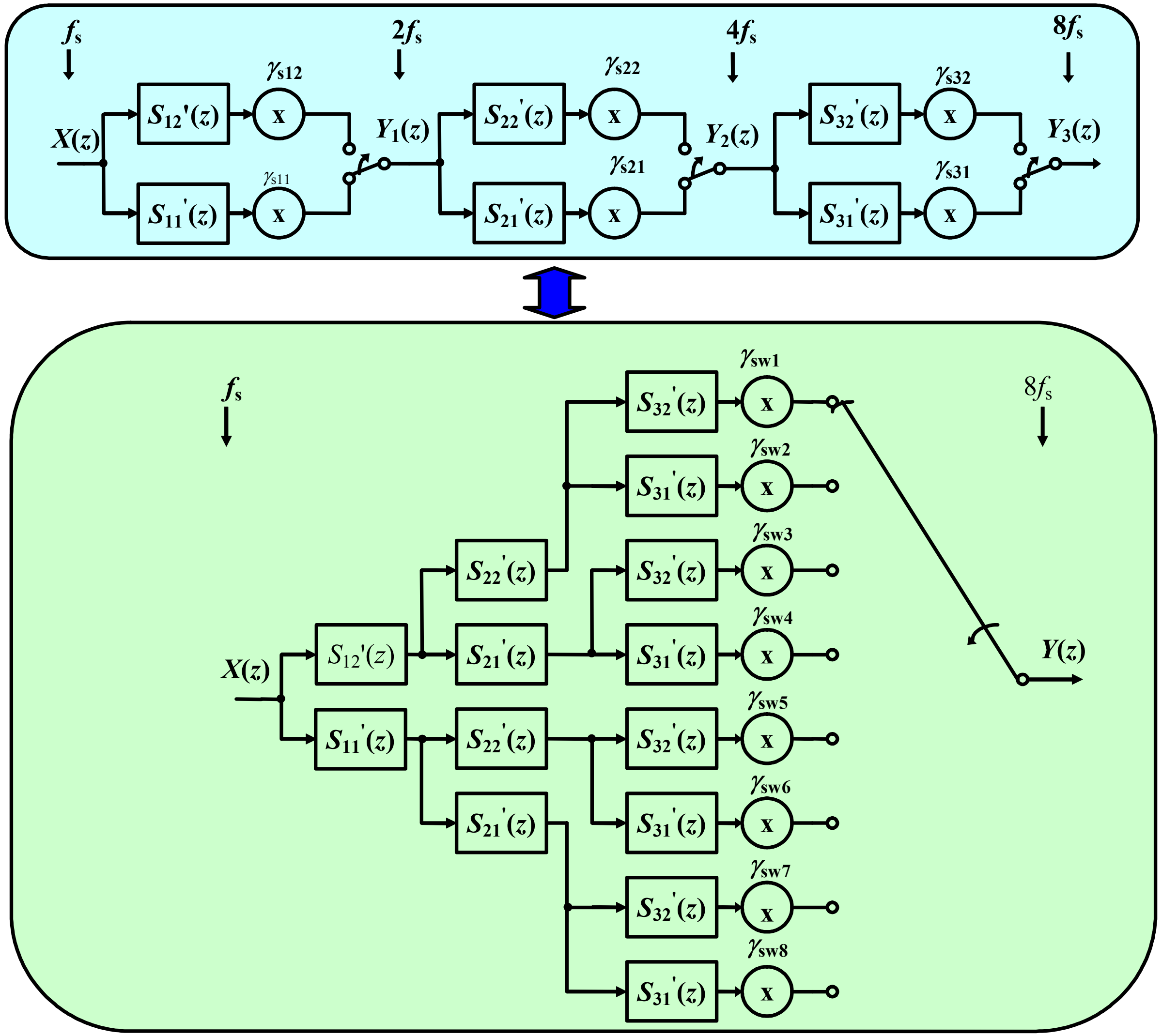



$$\gamma_S = \prod_{i=1}^{N} \frac{k_{di}}{k_{wi}}$$

# Modified Wave Digital Branching Filter Bank

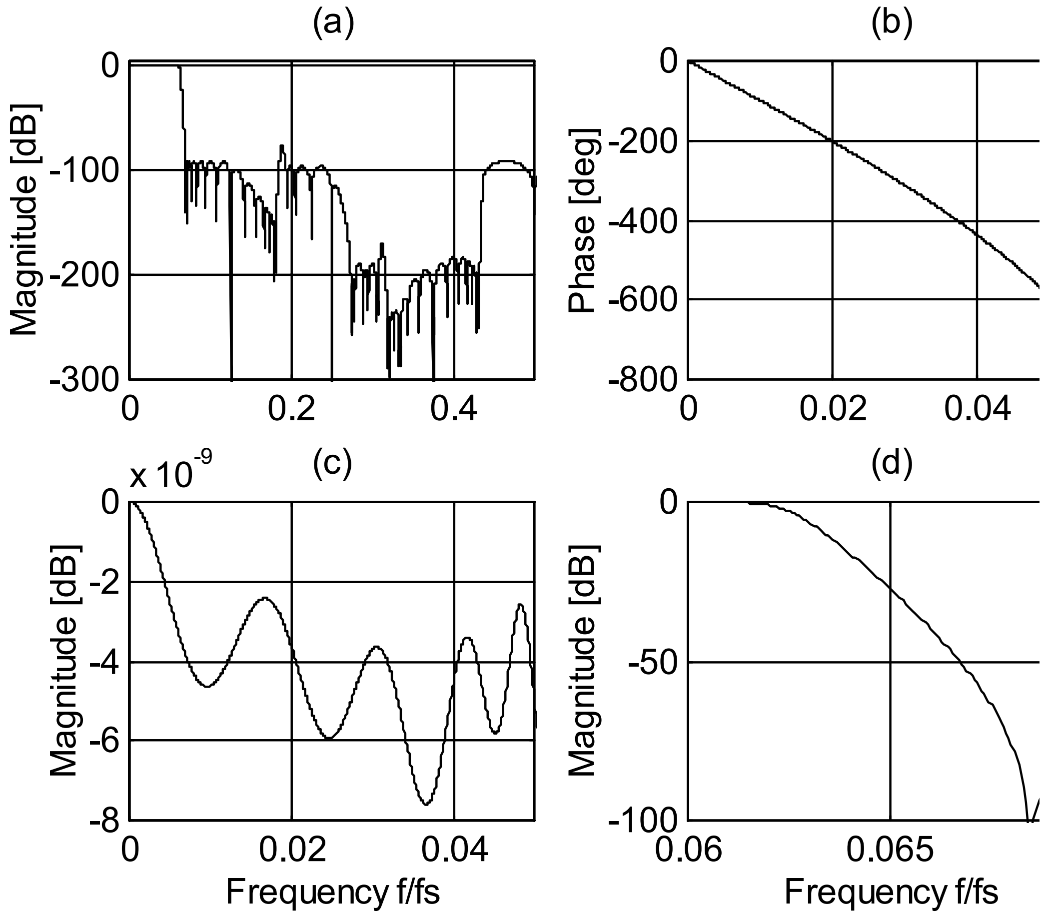


# Cascaded Version of The Interpolator with a Single Switch and Resultant Multipliers



# Frequency Response of Cascaded Interpolator Realized with ADSP-21065L for R=8

**Chosen interpolator prameters: passband ripple $\delta_p$<0.1dB, oversampling ratio $R$=8, passband 0...20kHz, signal-to-noise and distortion ratio $S_{INAD}$<-90dB.**



# *Conclusions*

- the presented modified wave digital filters are very efficient for the implementation in modern floating-point digital signal processors such as the ADSP-21065L, TMS320C40 processor and the VLIW architecture TMS320C6000 processor,
- they are especially suitable for large dynamic range applications,
- similarly modified ladder wave digital filters can be designed.