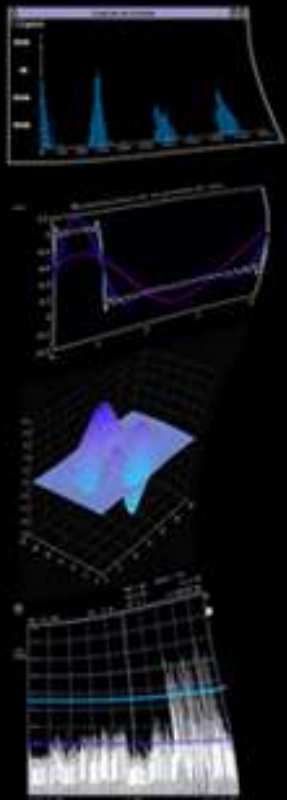


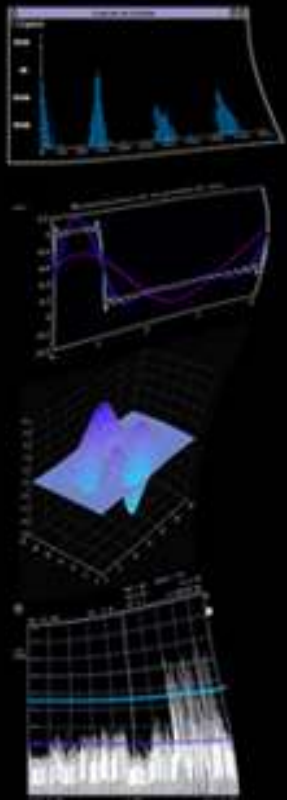
Estructura de filtros



Estructura de Filtros

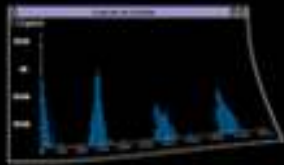
Definición

Es la forma en la que se organiza la implementación

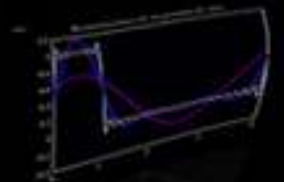


Estructura de Filtros

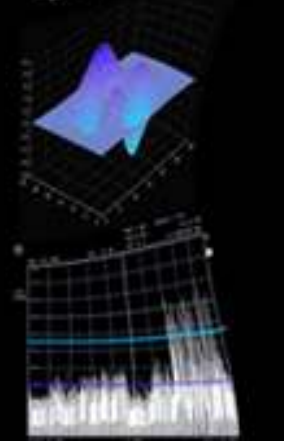
Definición



Es la forma en la que se organiza la implementación



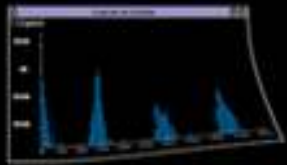
Elementos: Retardos, ganancias y sumadores



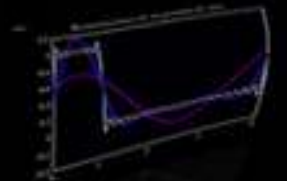
Es definida por los elementos y la forma en que se vinculan

Estructura de Filtros

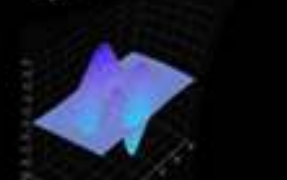
Definición



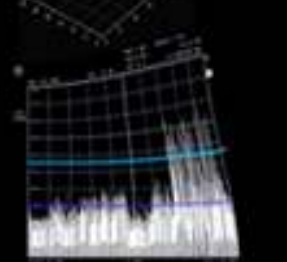
Es la forma en la que se organiza la implementación



Elementos: Retardos, ganancias y sumadores



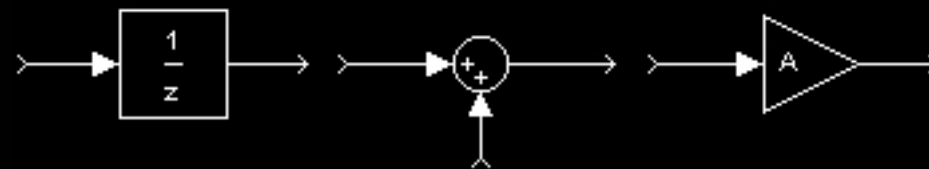
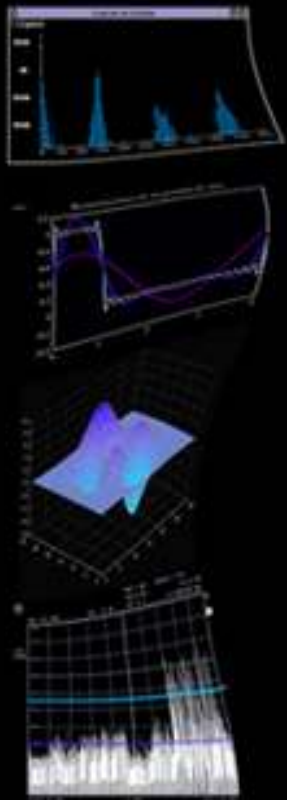
Es definida por los elementos y la forma en que se vinculan



Puede ser hardware o software

Estructura de Filtros

Diagrama de bloques



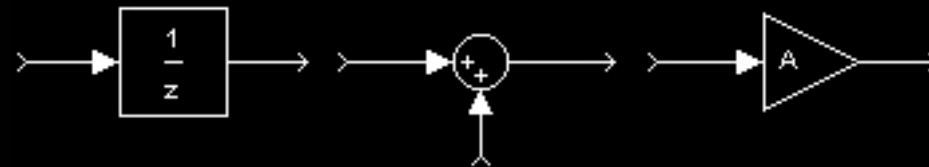
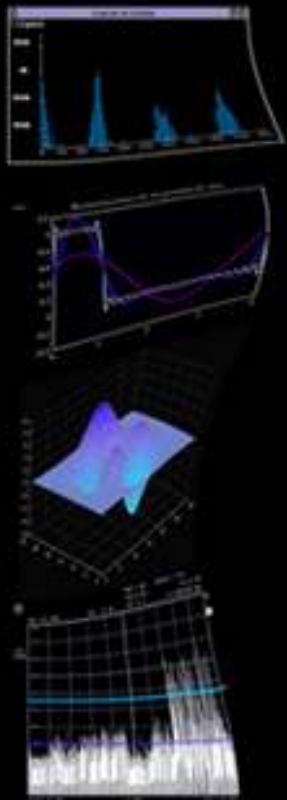
retardo

suma

producto

Estructura de Filtros

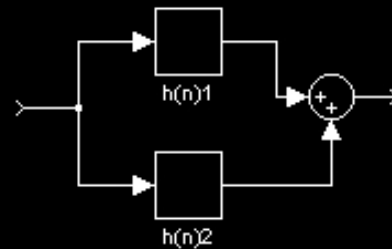
Diagrama de bloques



retardo

producto

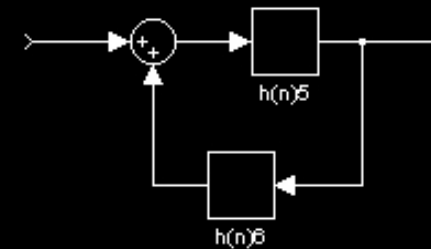
suma



paralelo



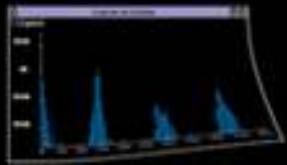
cascada



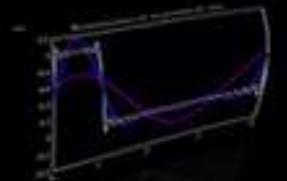
realimentación

Estructura de Filtros

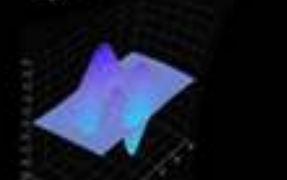
Características



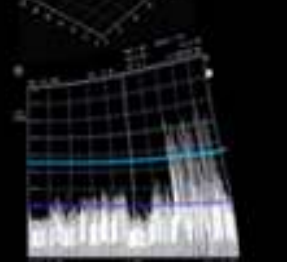
★ Complejidad computacional



★ Requisitos de memoria



★ Efectos de las palabras de longitud finita

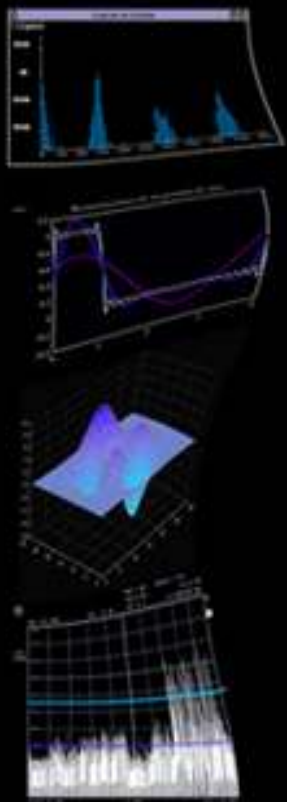


★ Factores adicionales (paralelización, pipeline, etc)

Estructura de Filtros

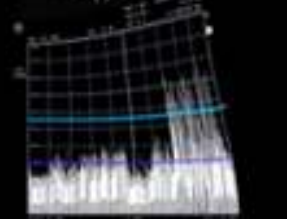
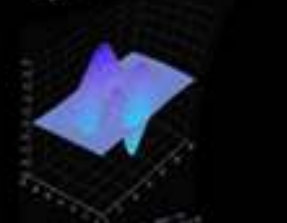
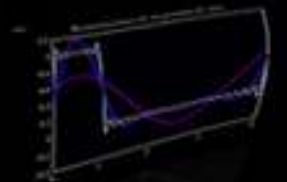
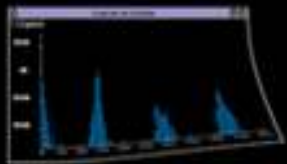
Análisis de sistemas LIT

$$\sum_{k=0}^N a_k y[n-k] = \sum_{k=0}^M b_k x[n-k]$$



Estructura de Filtros

Análisis de sistemas LIT

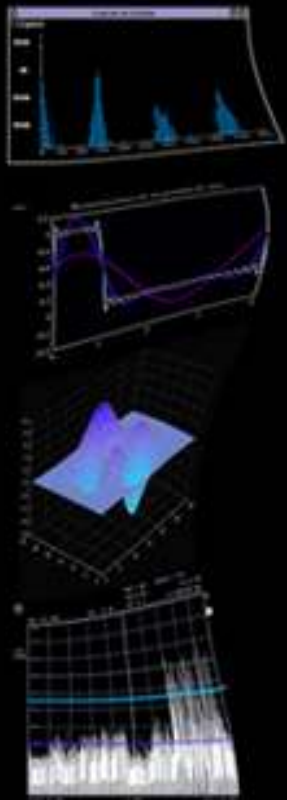


$$\sum_{k=0}^N a_k y[n-k] = \sum_{k=0}^M b_k x[n-k]$$

$$y[n] = \sum_{k=0}^M b_k x[n-k] - \sum_{k=1}^N a_k y[n-k]$$

Estructura de Filtros

Análisis de sistemas LIT



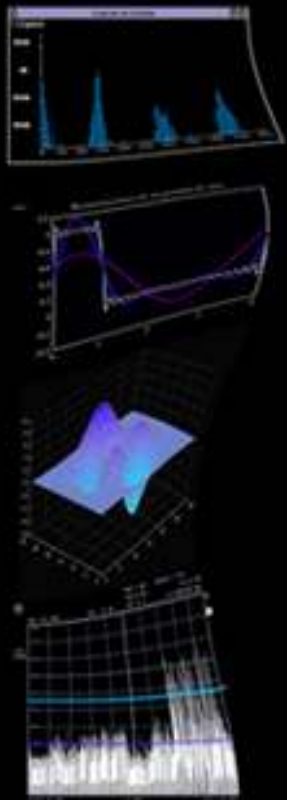
$$\sum_{k=0}^N a_k y[n-k] = \sum_{k=0}^M b_k x[n-k]$$

$$y[n] = \sum_{k=0}^M b_k x[n-k] - \sum_{k=1}^N a_k y[n-k]$$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{\sum_{k=0}^M b_k z^{-k}}{\left(1 + \sum_{k=1}^N a_k z^{-k}\right)}$$

Estructura de Filtros

Análisis de sistemas LIT

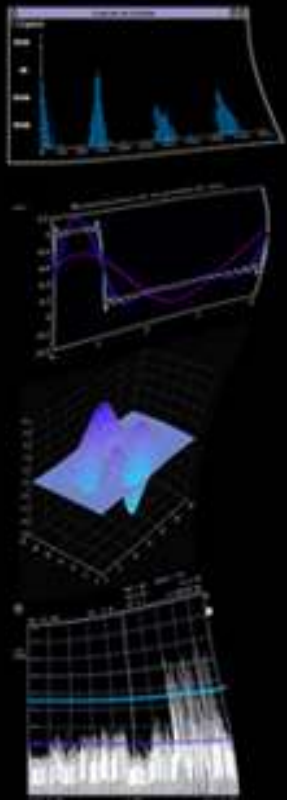
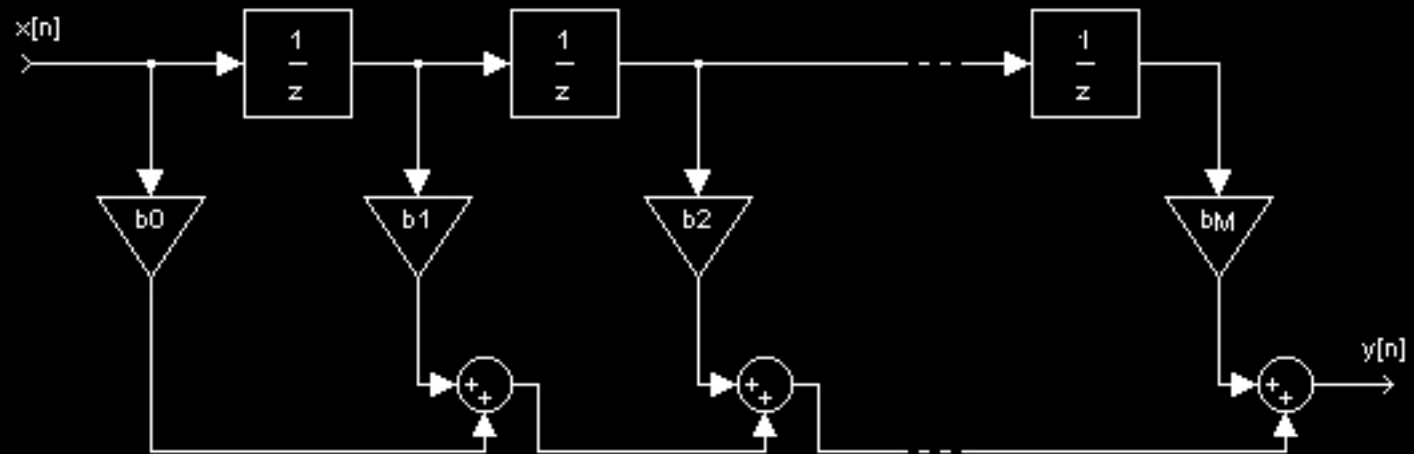


FIR	IIR
<p>MA (Promediador Móvil)</p> $H(z) = \sum_{k=0}^M b_k z^{-k} = \frac{1}{z^M} \sum_{k=0}^M b_k z^{M-k}$ <p>M ceros y 1 polo de orden M</p>	<p>AR (Autoregresivo)</p> $H(z) = \frac{b_0}{\sum_{k=0}^N a_k z^{-k}} = \frac{b_0 z^N}{\sum_{k=0}^N a_k z^{N-k}}$ <p>N polos y 1 cero de orden N</p>
	<p>ARMA (Promediador Móvil Autoregresivo)</p> $H(z) = \frac{\sum_{k=0}^M b_k z^{-k}}{\sum_{k=0}^N a_k z^{-k}}$ <p>M ceros y N polos no triviales</p>

Estructura de Filtros

FIR – Forma Directa

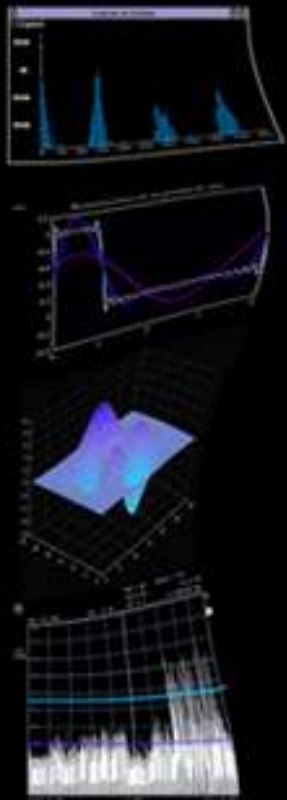
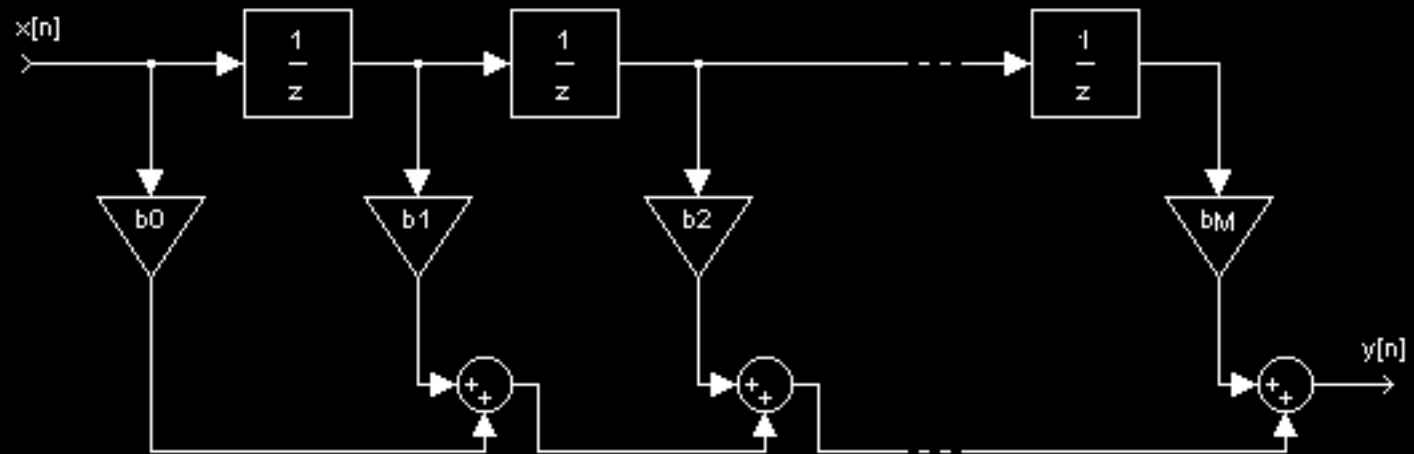
$$y[n] = \sum_{k=0}^M b_k x[n-k]$$



Estructura de Filtros

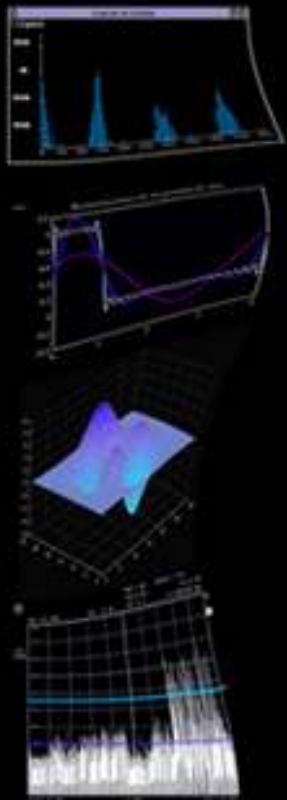
FIR – Forma Directa

M+1 productos, M sumas y M retardos

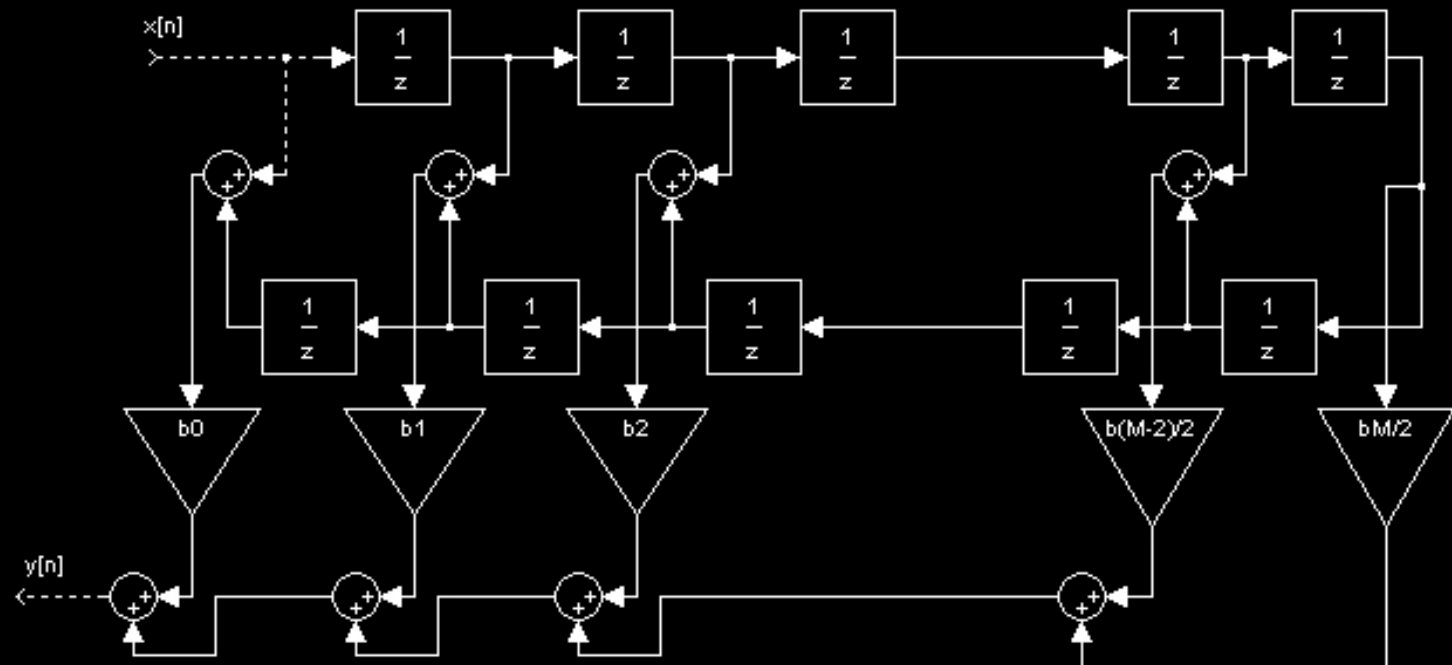


Estructura de Filtros

FIR – Forma Directa con simetría



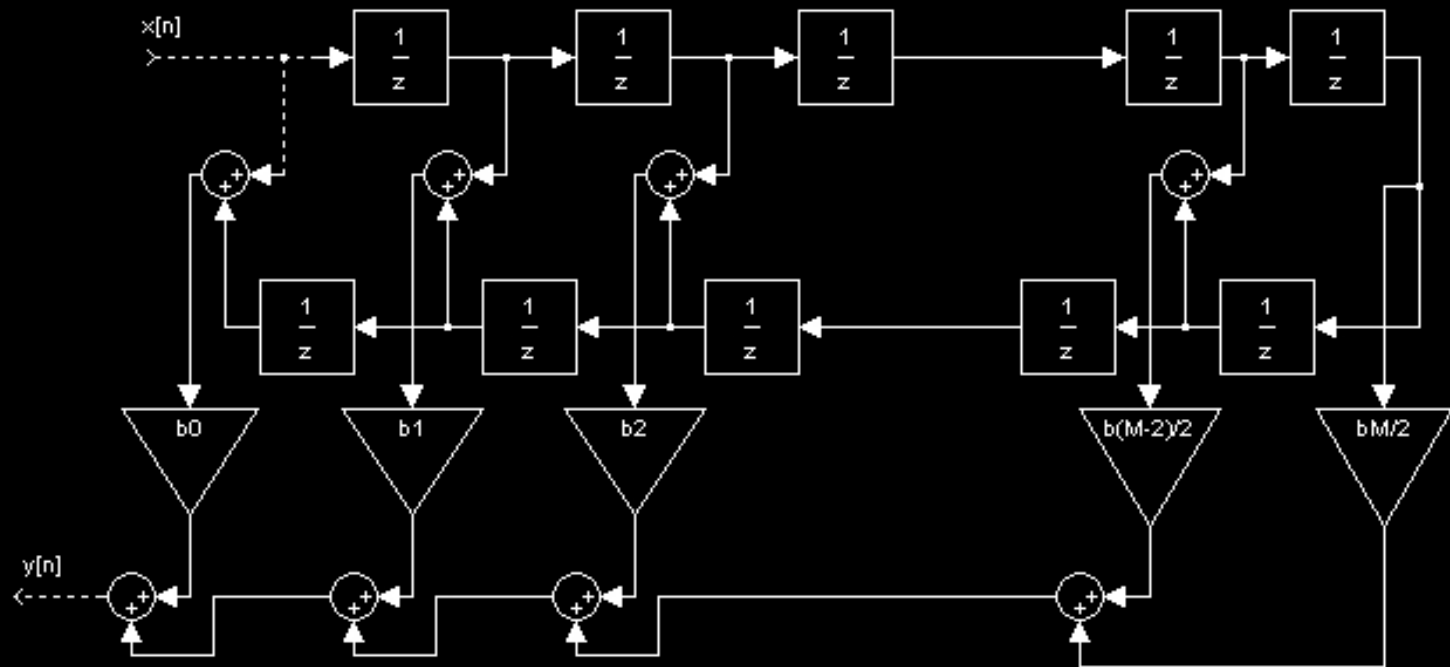
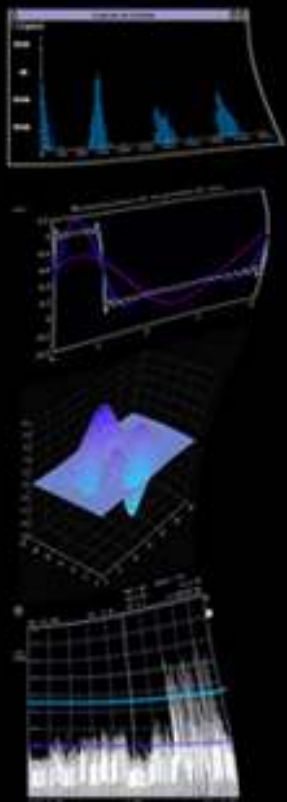
$$h[n] = \pm h[M - n]$$



Estructura de Filtros

FIR – Forma Directa con simetría

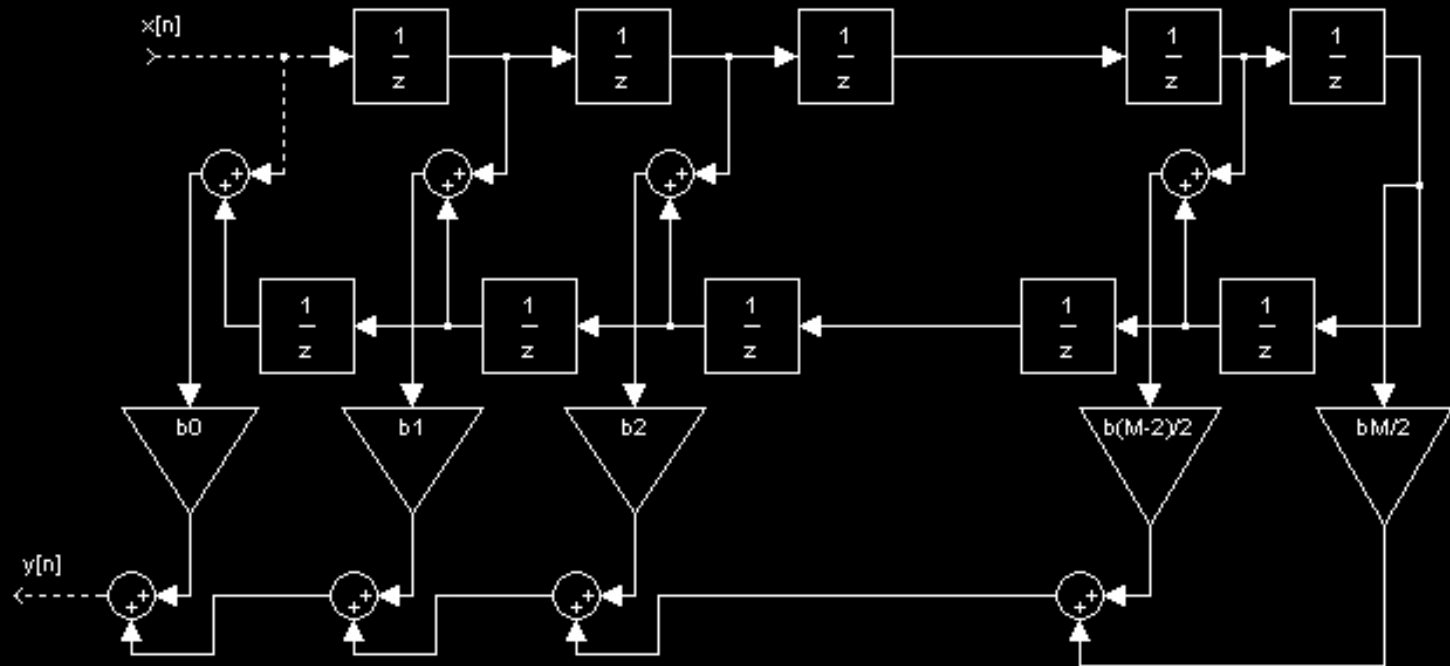
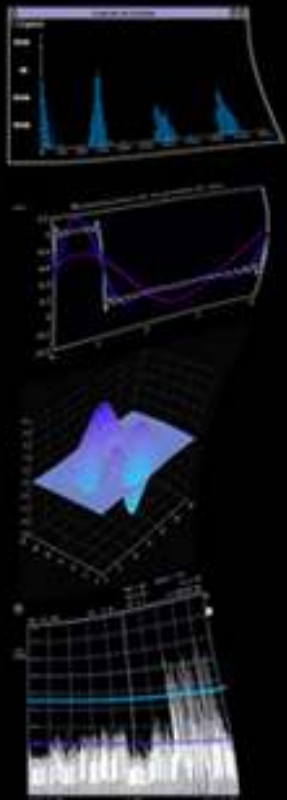
$$y[n] = \sum_{k=0}^K b_k (x[n-k] + x[n-(N-k)])$$



Estructura de Filtros

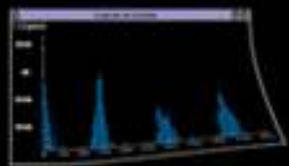
FIR – Forma Directa con simetría

$(M+1)/2$ ó $M/2$ productos, M sumas y M retardos

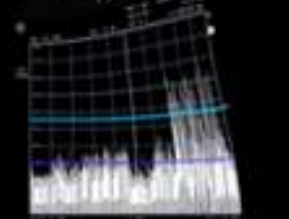
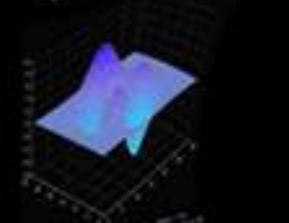
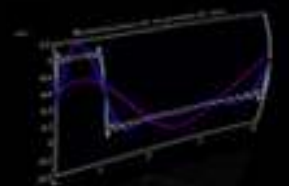


Estructura de Filtros

IIR – Forma Directa I

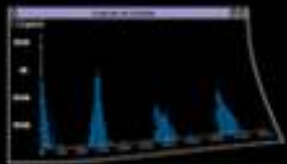


$$\begin{cases} v[n] = \sum_{k=0}^M b_k x[n-k] \\ y[n] = \frac{1}{a_0} \left[v[n] - \sum_{k=1}^N a_k y[n-k] \right] \end{cases}$$

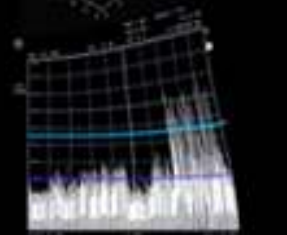
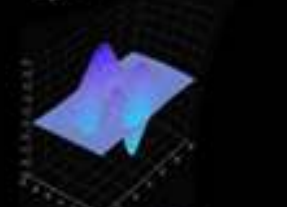
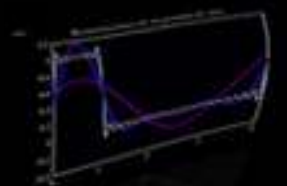


Estructura de Filtros

IIR – Forma Directa I



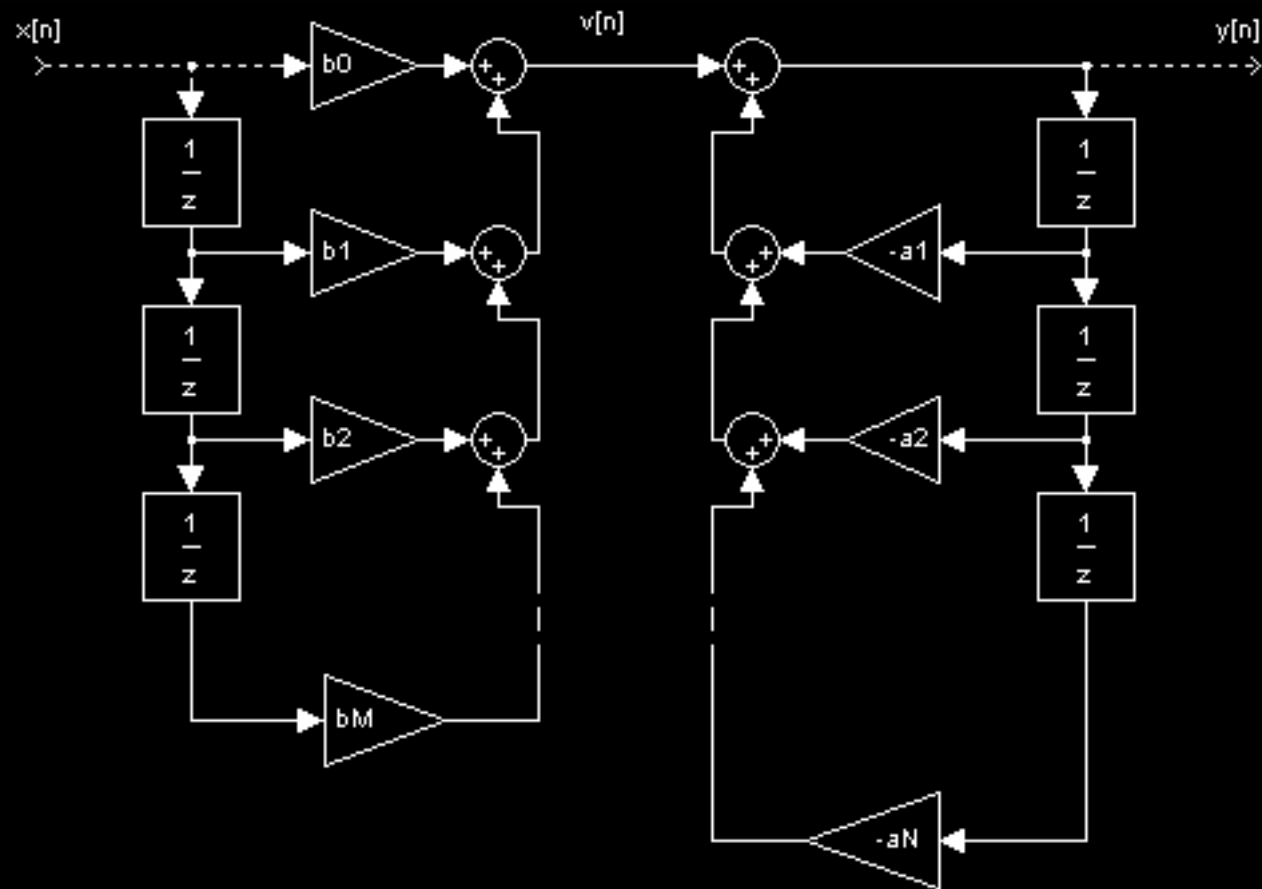
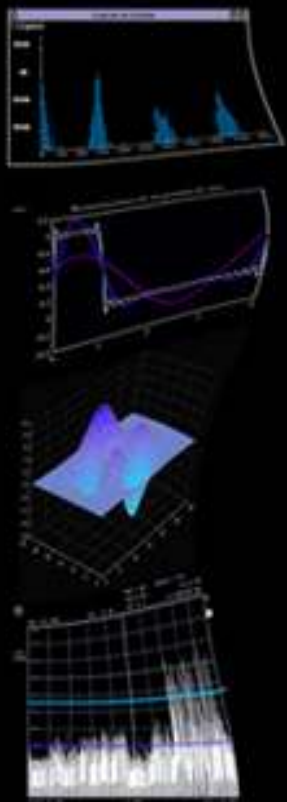
$$\begin{cases} v[n] = \sum_{k=0}^M b_k x[n-k] \\ y[n] = \frac{1}{a_0} \left[v[n] - \sum_{k=1}^N a_k y[n-k] \right] \end{cases}$$



$$\begin{cases} V(z) = X(z)N(z) = X(z) \sum_{k=0}^M b_k z^{-k} \\ Y(z) = V(z) \frac{1}{D(z)} = \frac{W(z)}{\sum_{k=0}^N a_k z^{-k}} \end{cases}$$

Estructura de Filtros

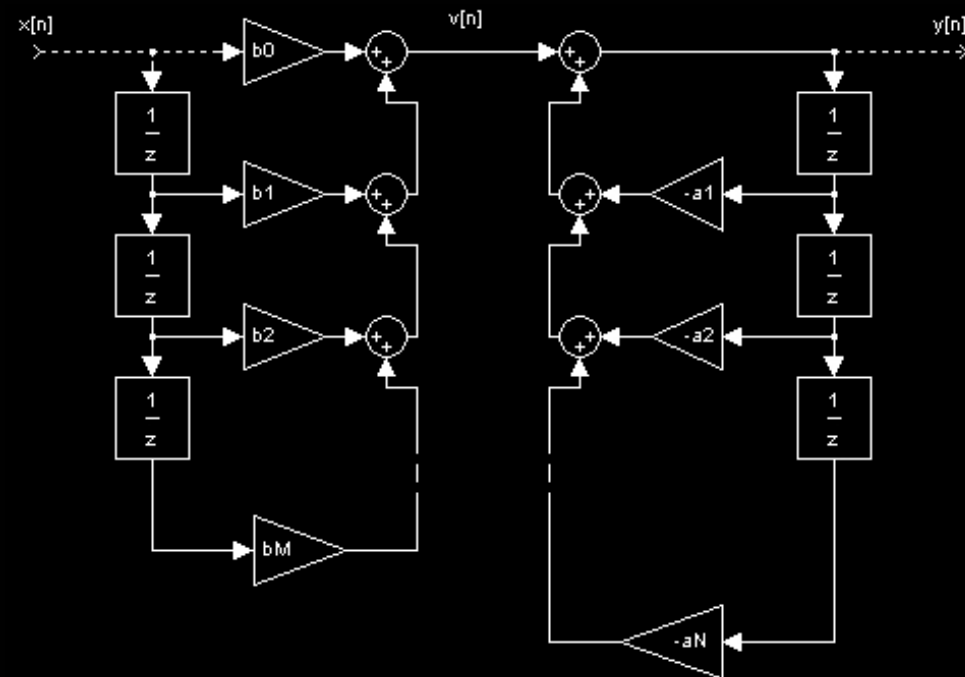
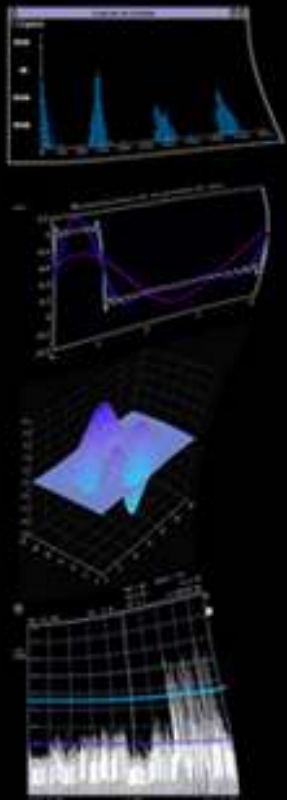
IIR – Forma Directa I



Estructura de Filtros

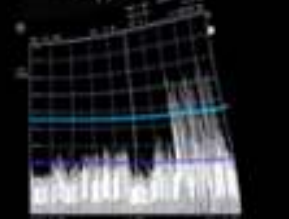
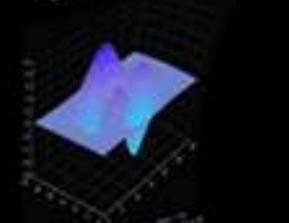
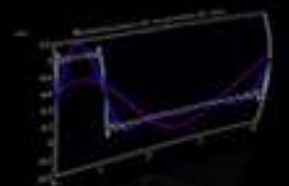
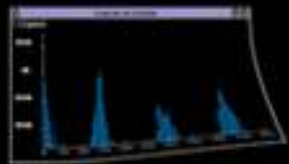
IIR – Forma Directa I

M+N+1 productos, M+N sumas y M+N retardos



Estructura de Filtros

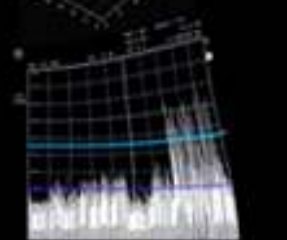
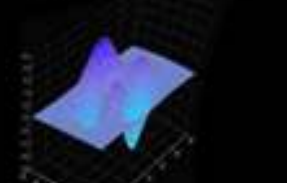
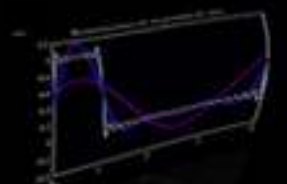
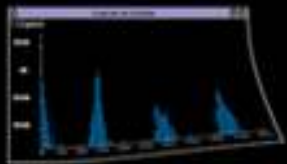
IIR – Forma Directa II



$$\begin{cases} w[n] = \frac{1}{a_0} \left[x[n] - \sum_{k=1}^N a_k w[n-k] \right] \\ y[n] = \sum_{k=0}^M b_k w[n-k] \end{cases}$$

Estructura de Filtros

IIR – Forma Directa II

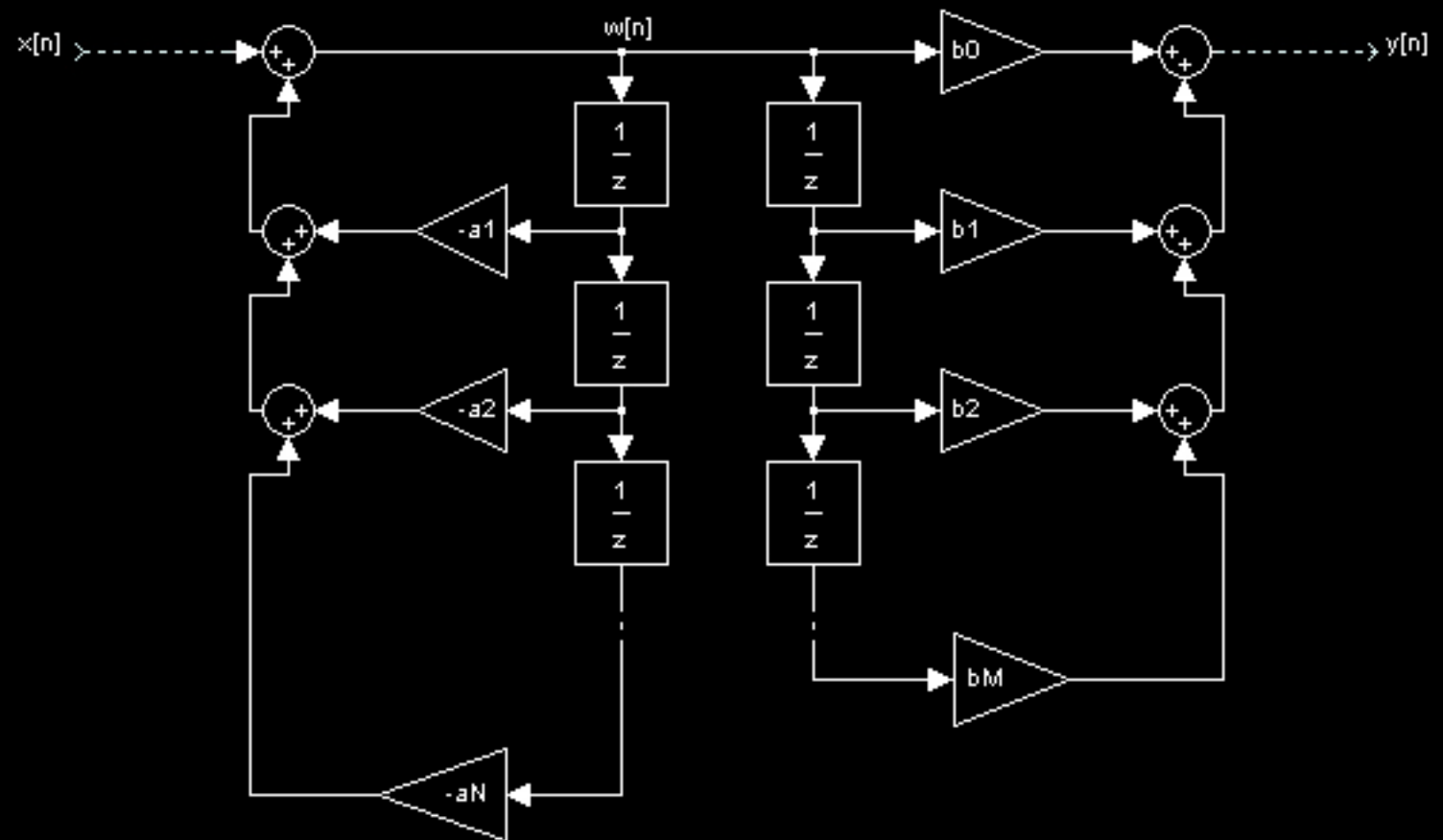
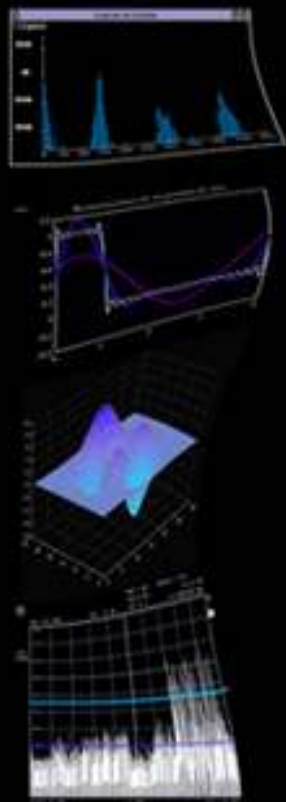


$$\left\{ \begin{array}{l} w[n] = \frac{1}{a_0} \left[x[n] - \sum_{k=1}^N a_k w[n-k] \right] \\ y[n] = \sum_{k=0}^M b_k w[n-k] \end{array} \right.$$

$$\left\{ \begin{array}{l} W(z) = X(z) \frac{1}{D(z)} = \frac{X(z)}{\sum_{k=0}^N a_k z^{-k}} \\ Y(z) = W(z)N(z) = W(z) \sum_{k=0}^M b_k z^{-k} \end{array} \right.$$

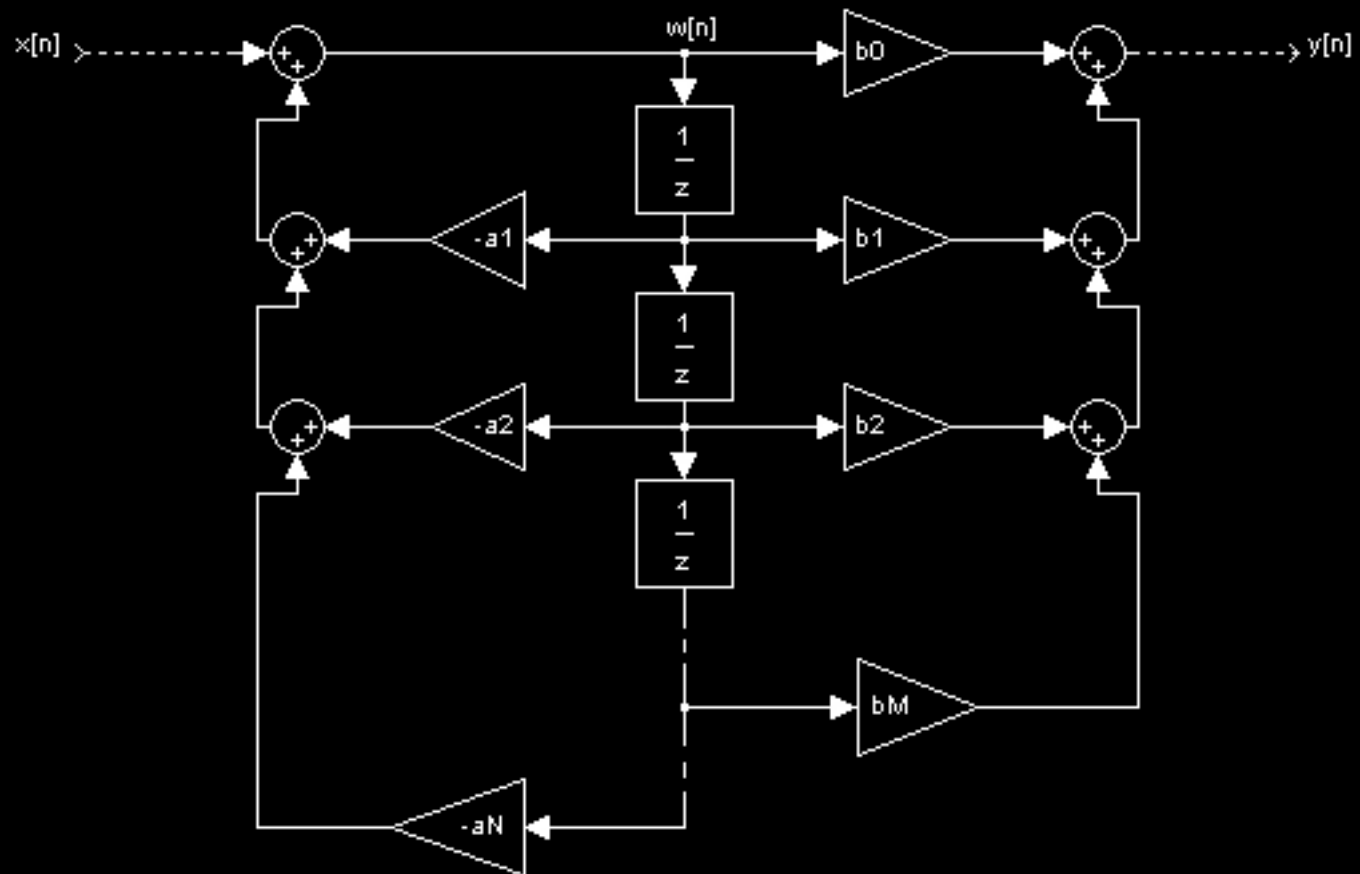
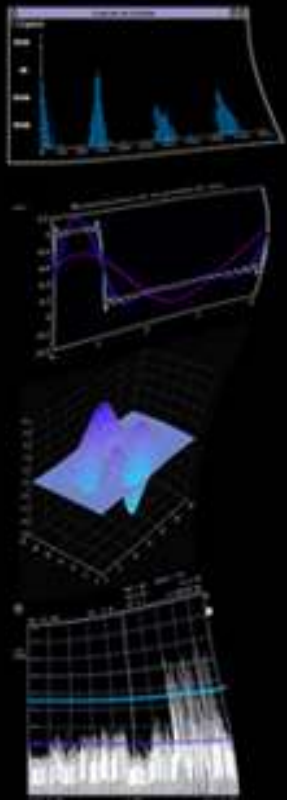
Estructura de Filtros

IIR – Forma Directa II



Estructura de Filtros

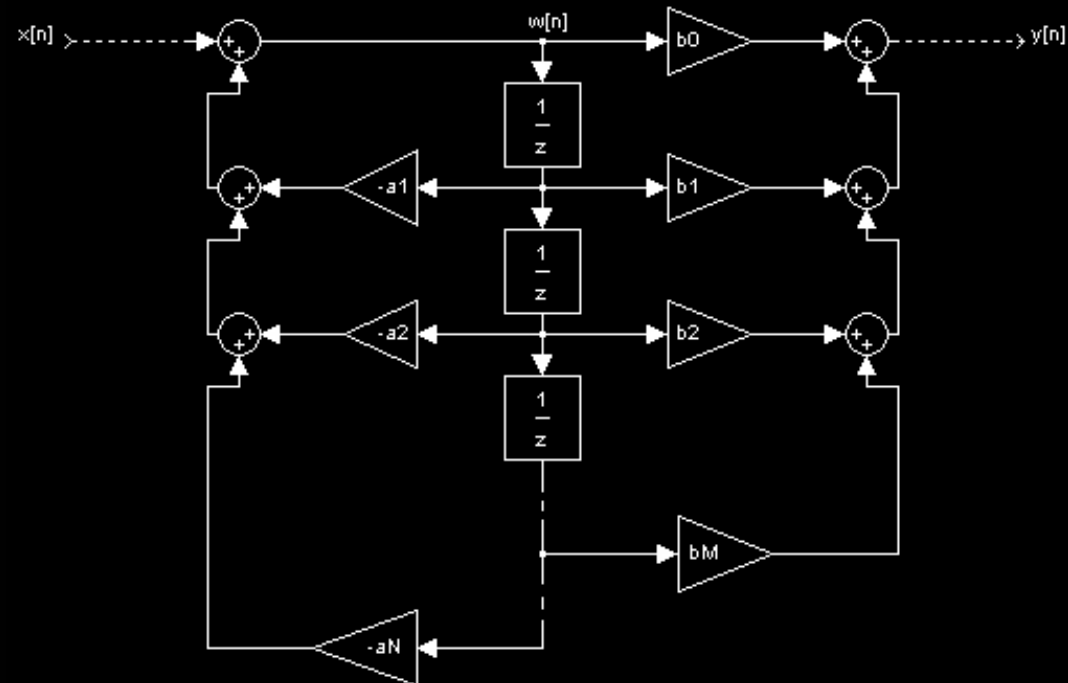
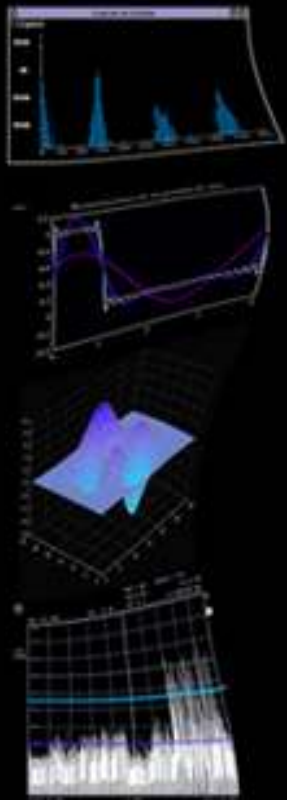
IIR – Forma Directa II



Estructura de Filtros

IIR – Forma Directa II

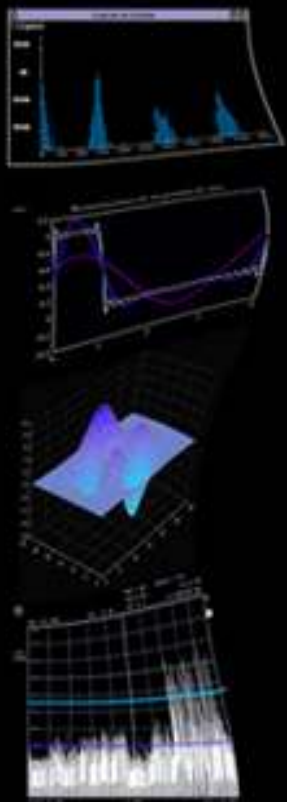
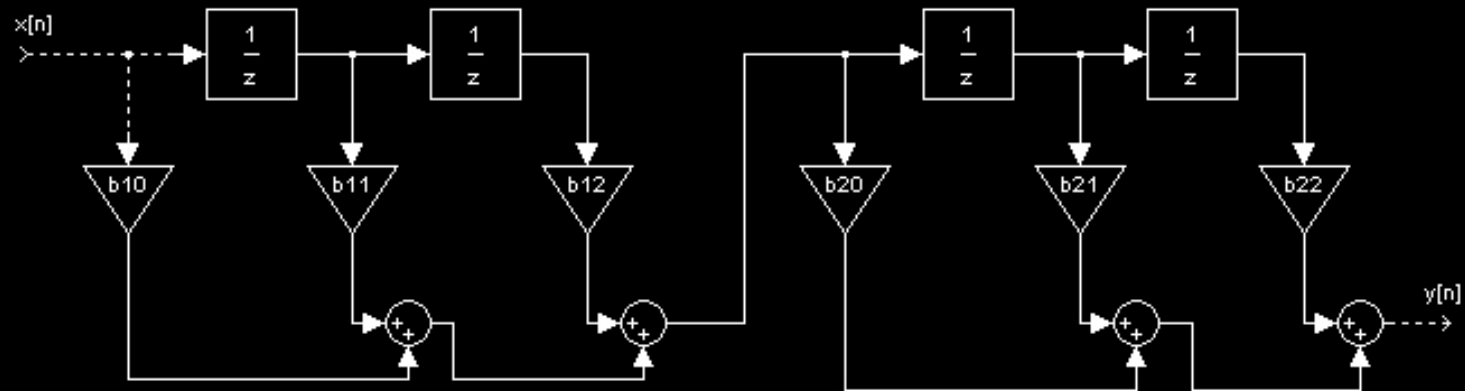
M+N+1 productos, M+N sumas y $\max\{M;N\}$ retardos



Estructura de Filtros

FIR Cascada

$$H(z) = \prod_{k=1}^K H_k(z) = \prod_{k=1}^K (b_{k0} + b_{k1}z^{-1} + b_{k2}z^{-2}) \quad ; \quad K = \text{int} \left\{ \frac{M+1}{2} \right\}$$



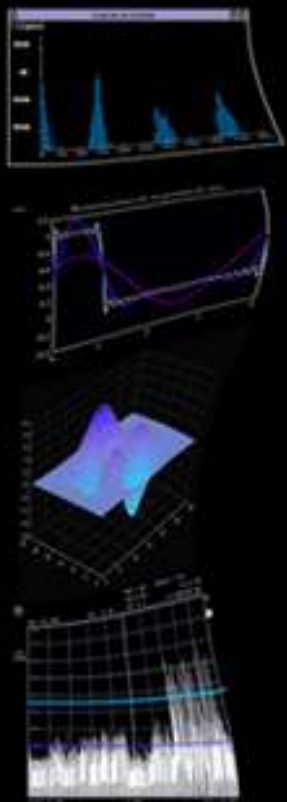
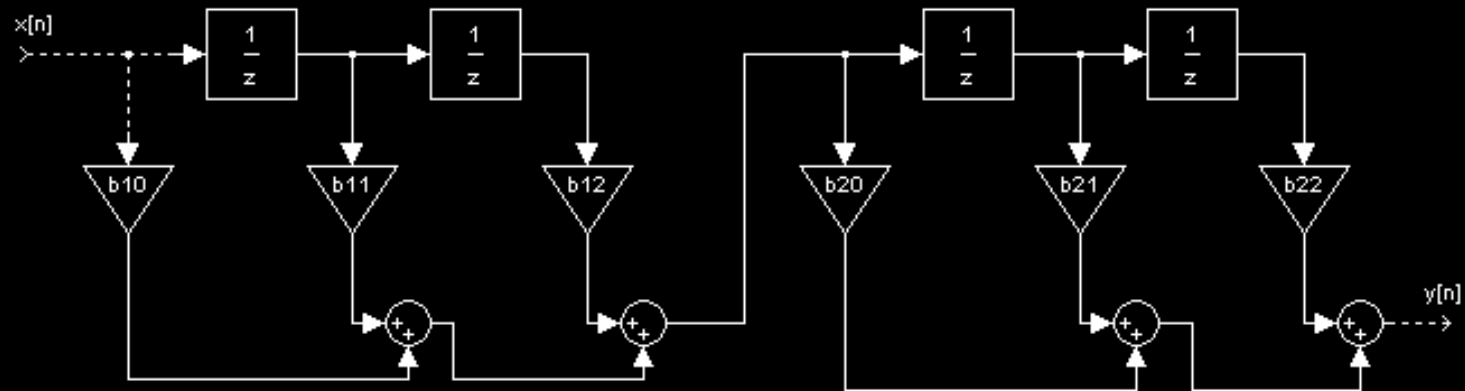
Estructura de Filtros

FIR Cascada

$$y_k[n] = b_{k0}x_k[n] + b_{k1}x_k[n-1] + b_{k2}x_k[n-2]$$

$$x[n] = x_1[n]$$

$$y[n] = y_k[n]$$

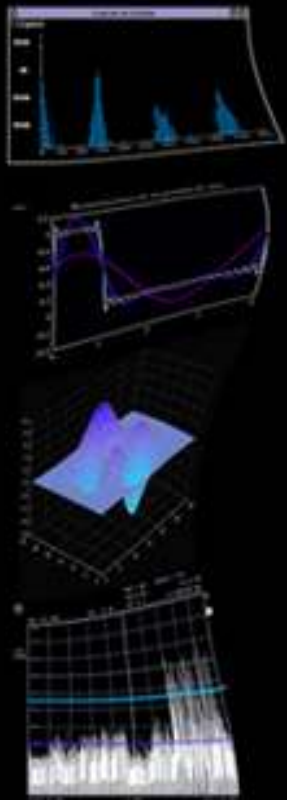
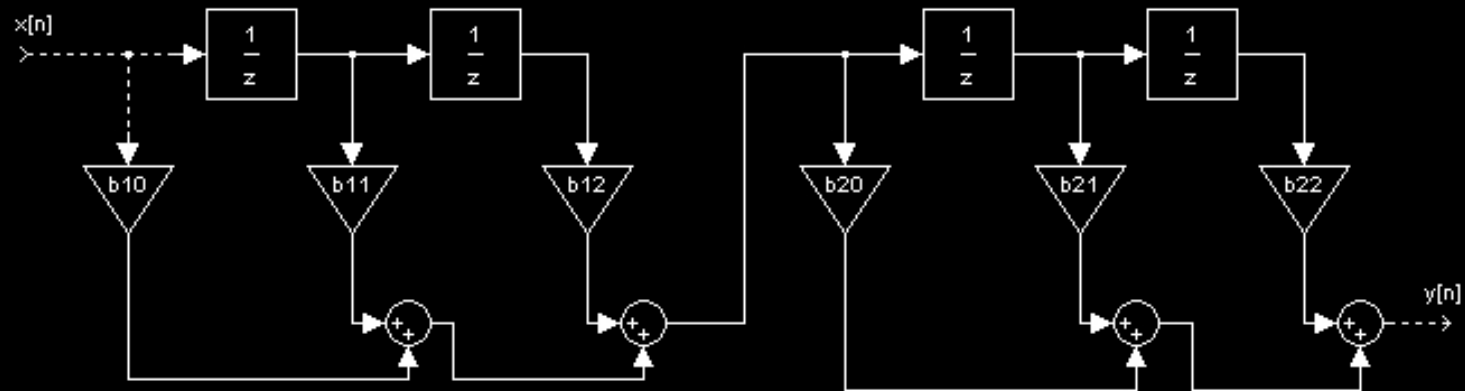


Estructura de Filtros

FIR Cascada

3K productos, 2K sumas y 2K retardos

$$K = \text{int} \left\{ \frac{M+1}{2} \right\}$$

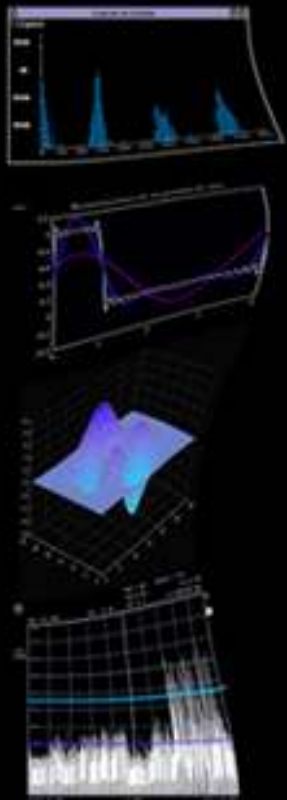
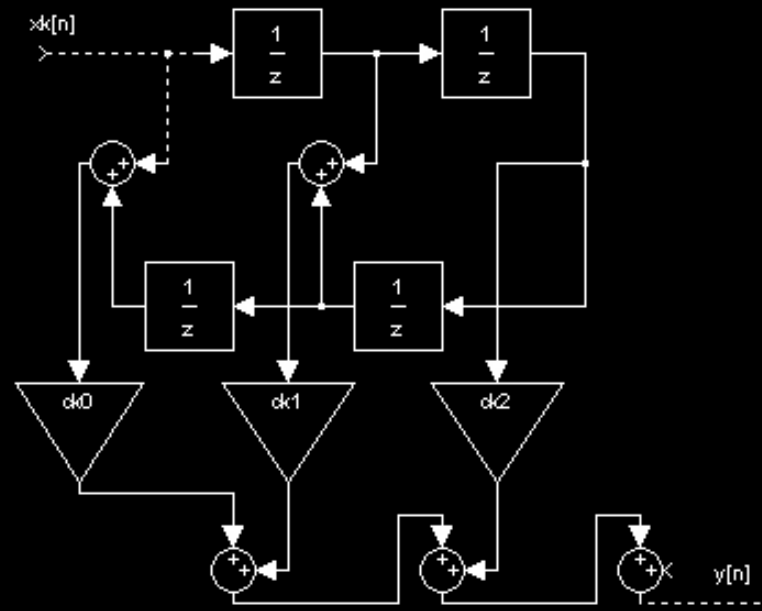


Estructura de Filtros

FIR Cascada con Simetría

$$H(z) = \prod_{k=1}^K H_k(z) = \prod_{k=1}^K \left[c_{k0}(1 + z^{-4}) + c_{k1}(z^{-1} + z^{-3}) + c_{k2}z^{-2} \right]$$

$$K = \text{int} \left\{ \frac{M+1}{2} \right\}$$

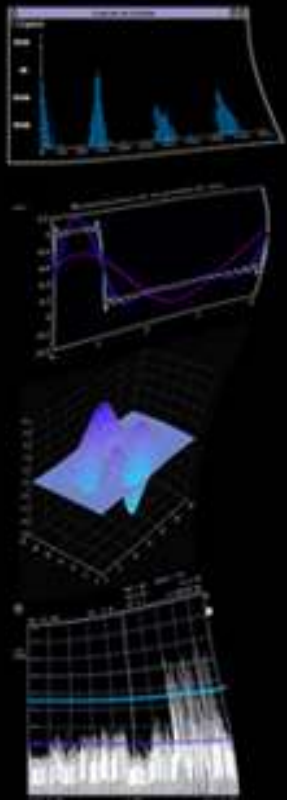
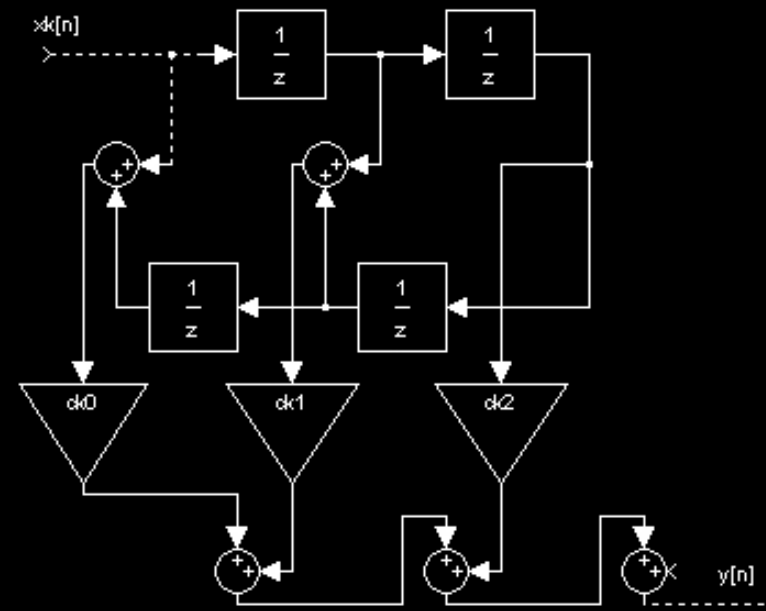


Estructura de Filtros

FIR Cascada con simetría

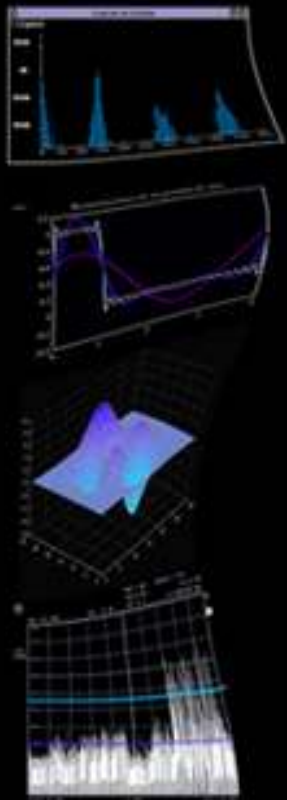
$\text{int}\{3/2K\}$ productos, $2K$ sumas y $2K$ retardos

$$K = \text{int}\left\{\frac{M+1}{2}\right\}$$

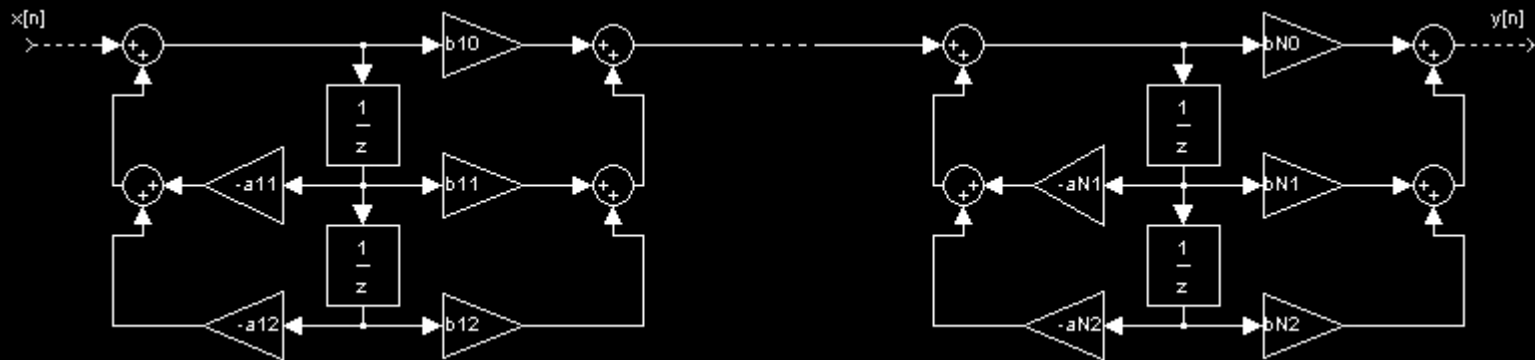


Estructura de Filtros

IIR Cascada

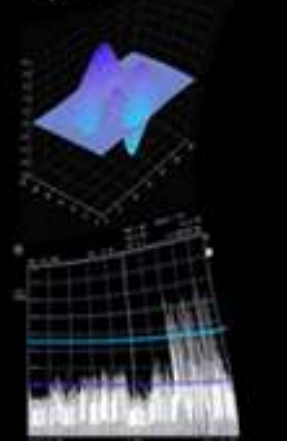
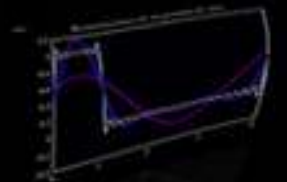
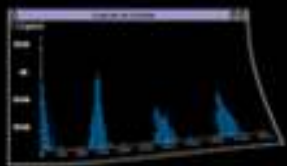


$$H(z) = \prod_{k=1}^K H_k(z) = \prod_{k=1}^K \frac{b_{k0} + b_{k1}z^{-1} + b_{k2}z^{-2}}{1 + a_{k1}z^{-1} + a_{k2}z^{-2}} \quad ; \quad K = \text{int} \left\{ \frac{N+1}{2} \right\}$$



Estructura de Filtros

IIR Cascada

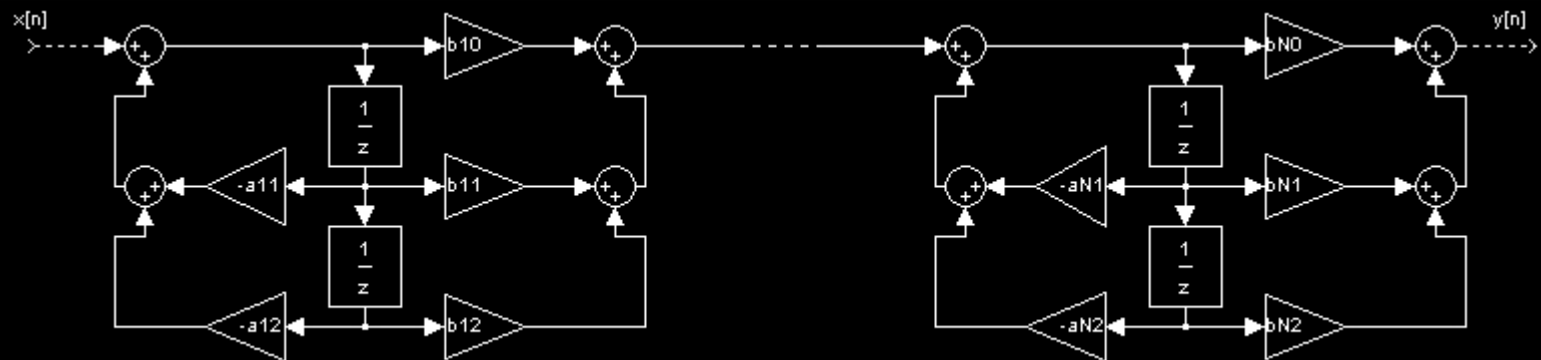


$$w_k[n] = [x_k[n] - a_{k1}w[n-1] - a_{k2}w[n-2]]$$

$$y_k[n] = b_{k0}w_k[n] + b_{k1}w_k[n-1] + b_{k2}w_k[n-2]$$

$$x[n] = x_1[n]$$

$$y[n] = y_k[n]$$

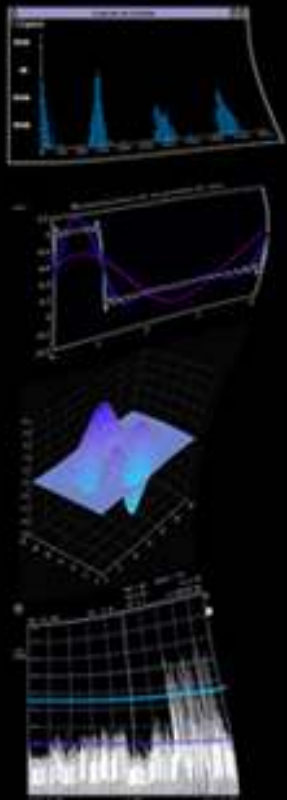
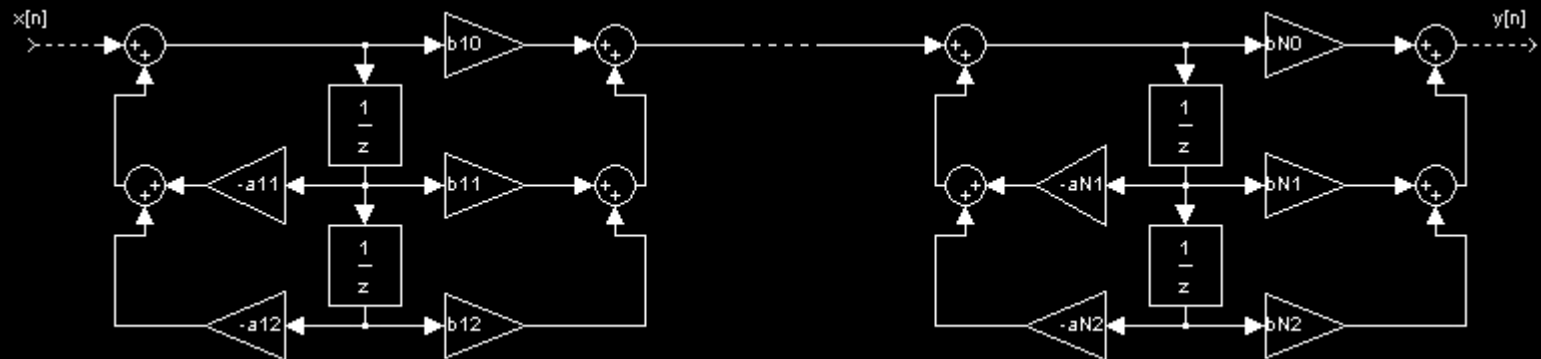


Estructura de Filtros

IIR Cascada

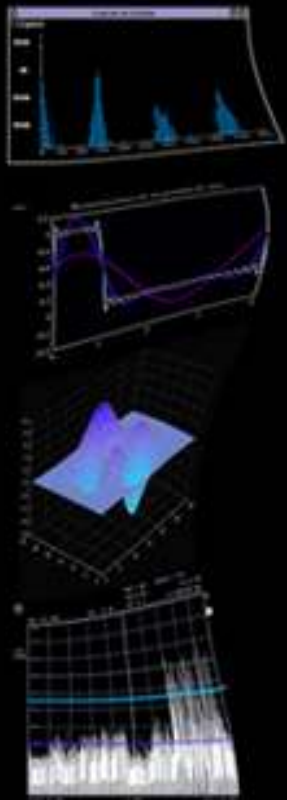
5K productos, 4K sumas y 2K retardos

$$K = \text{int} \left\{ \frac{N+1}{2} \right\}$$



Estructura de Filtros

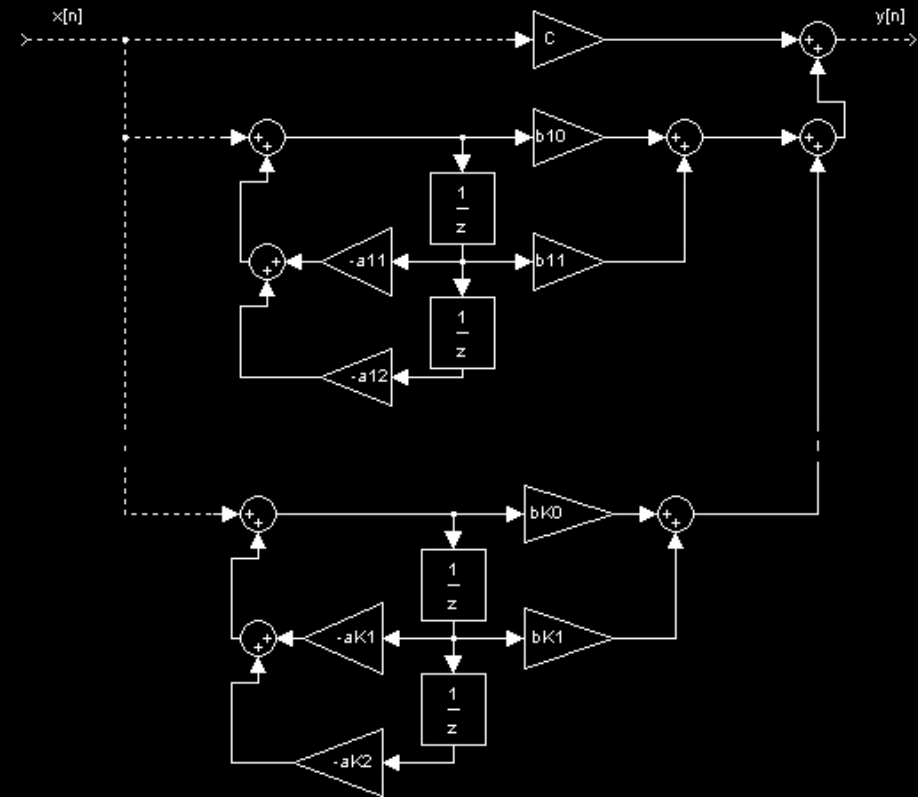
IIR Paralelo



$$d = \frac{b_M}{a_N}$$

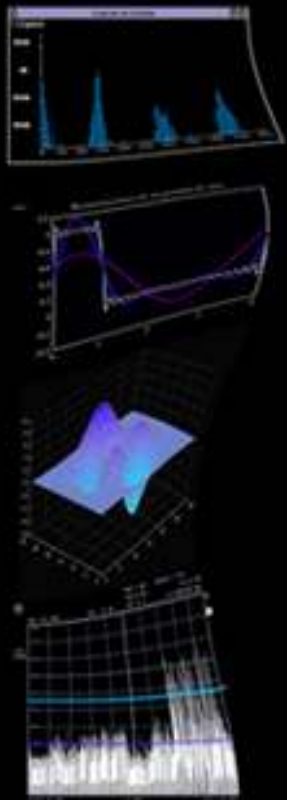
$$K = \text{int} \left\{ \frac{N+1}{2} \right\}$$

$$H(z) = d + \sum_{k=1}^K H_k(z) = d + \sum_{k=1}^K \frac{b_{k0} + b_{k1}z^{-1}}{1 + a_{k1}z^{-1} + a_{k2}z^{-2}}$$



Estructura de Filtros

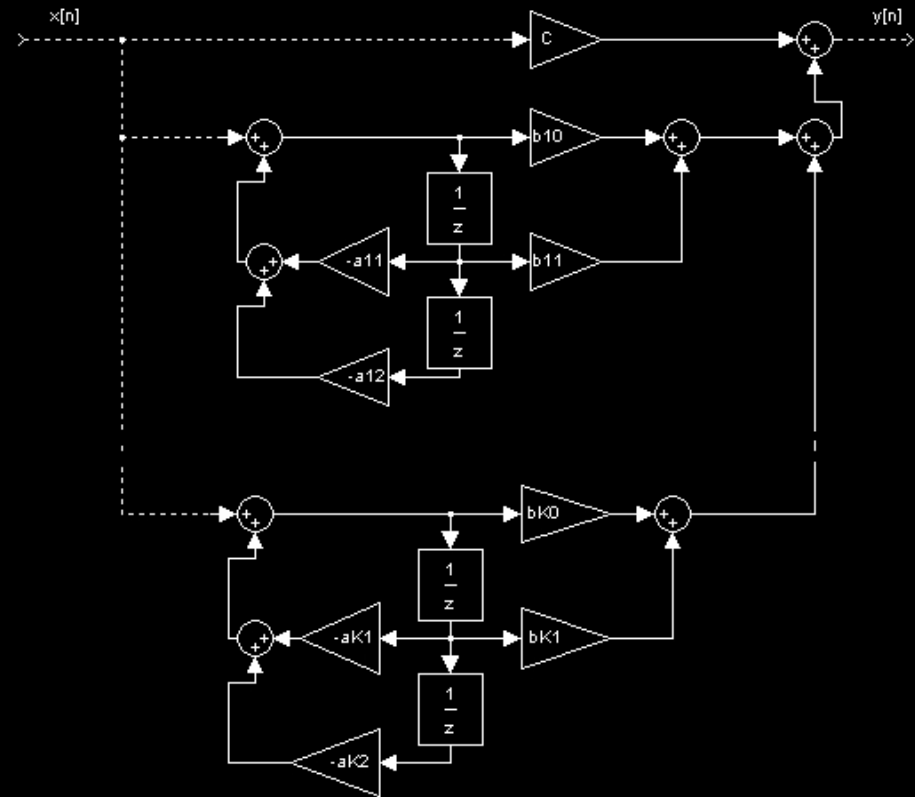
IIR Paralelo



$$y[n] = dx[n] + \sum_{k=1}^K y_k[n]$$

$$y_k[n] = b_{k0}w_k[n] + b_{k1}w_k[n-1]$$

$$w_k[n] = x[n] - a_{k1}w_k[n-1] - a_{k2}w_k[n-2]$$



Estructura de Filtros

Transposición

