



Ingeniería Informática

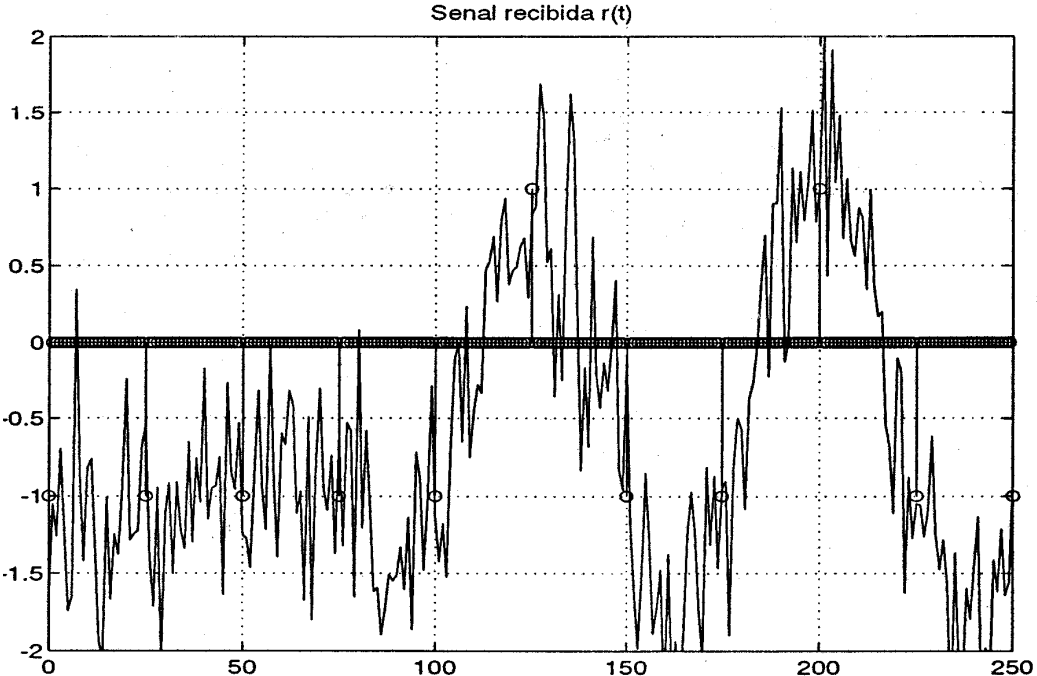
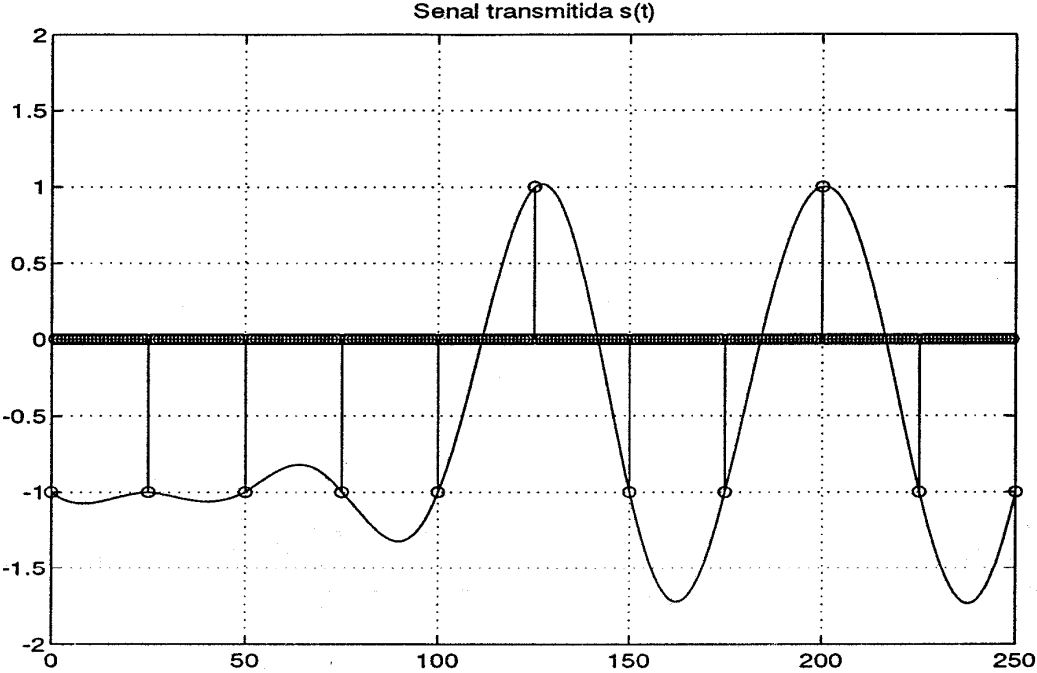
Medios de Transmisión (MT)

Tema 8

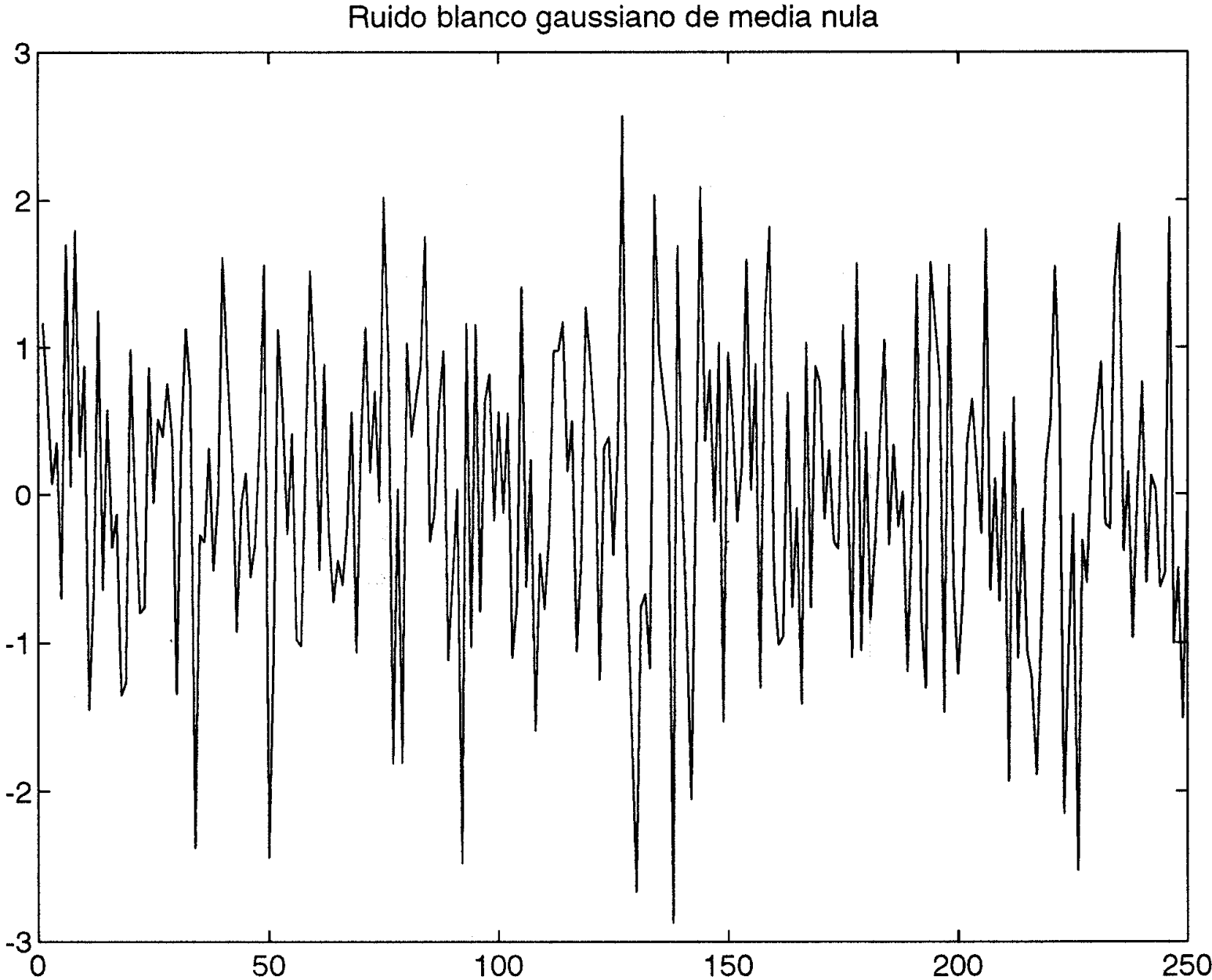
Transmisión digital por canales con ruido

Curso 2006-07

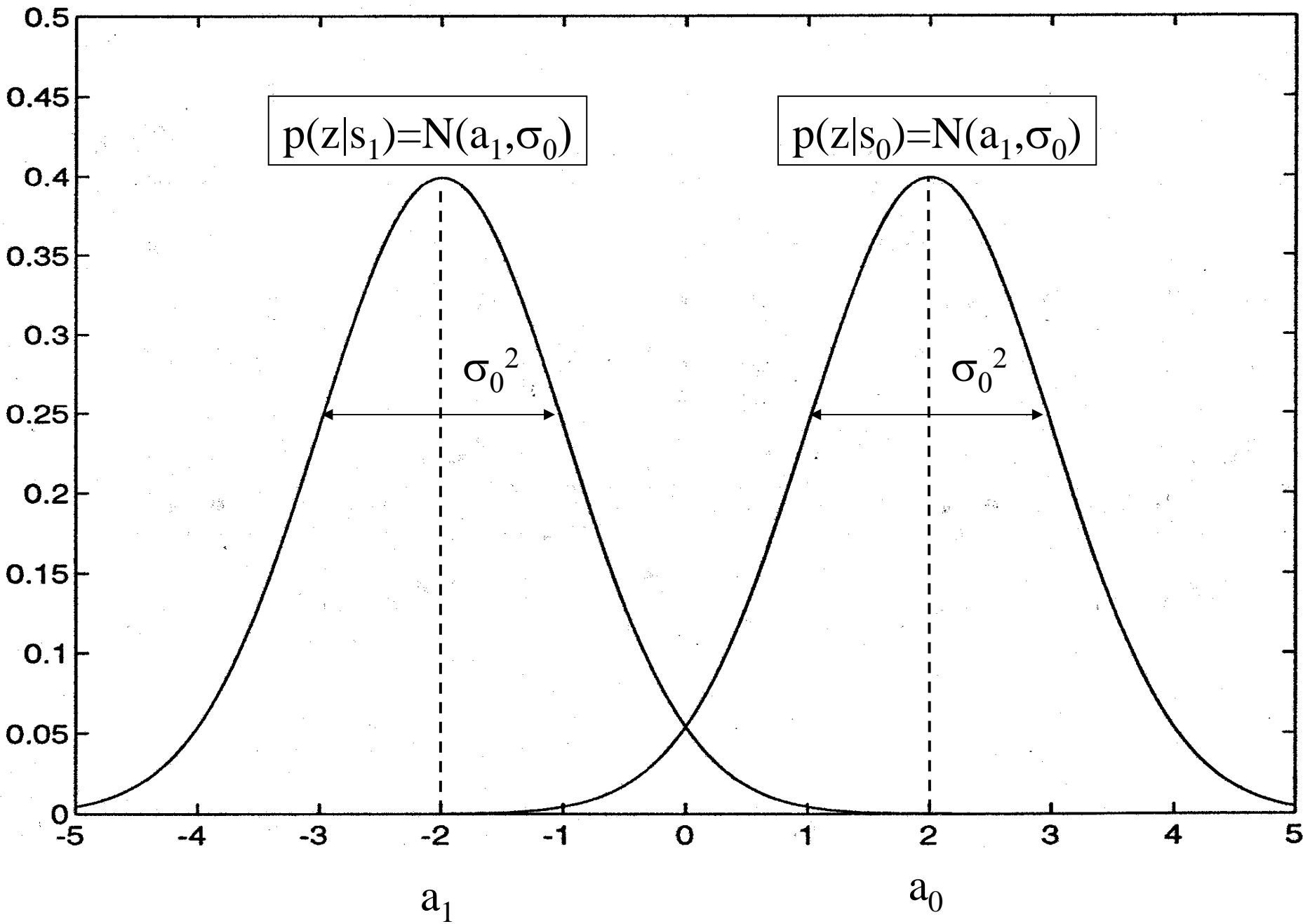
Ejemplo de
distorsión de
una señal PAM
por un canal
con ruido



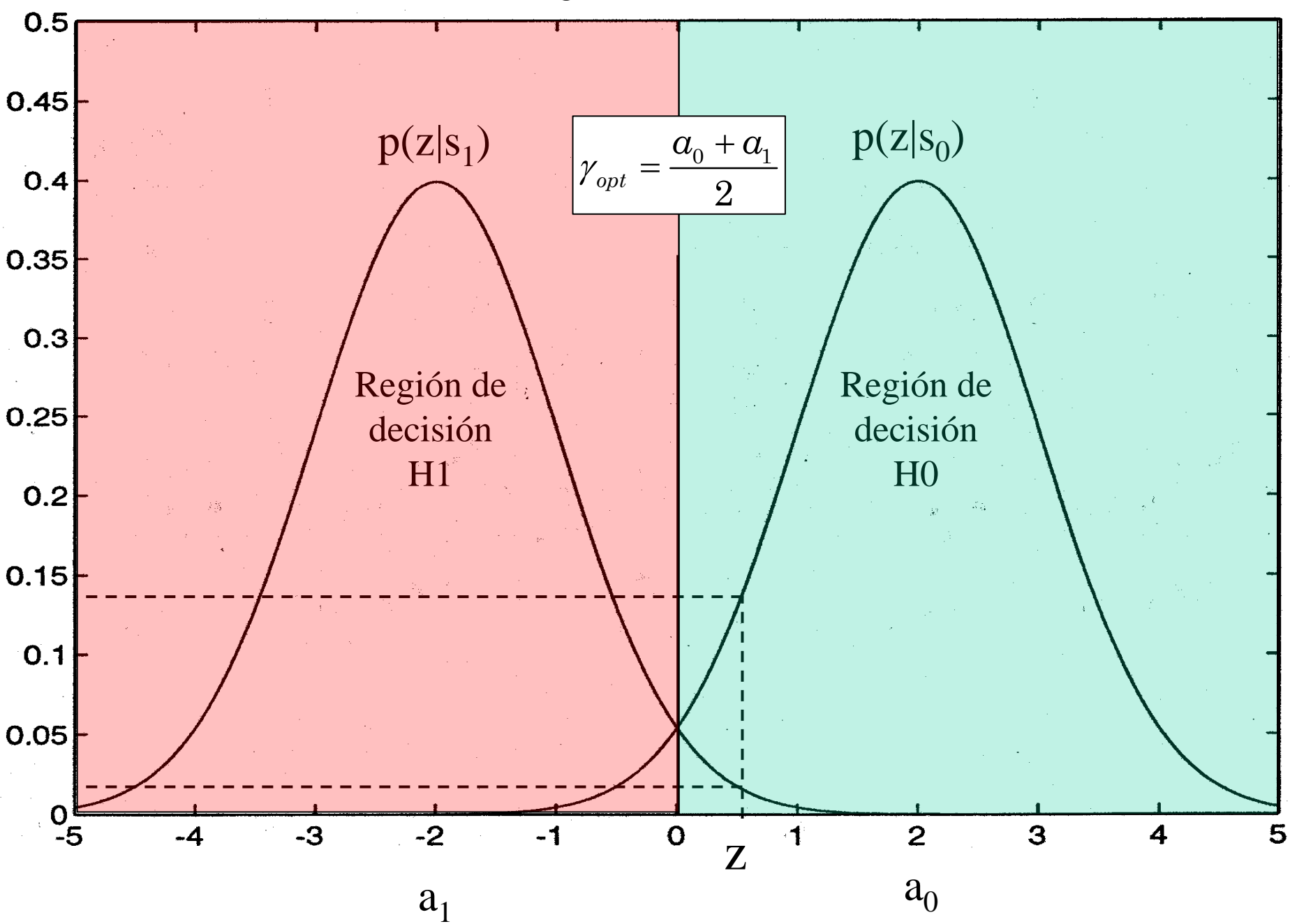
Ruido blanco gaussiano de media cero



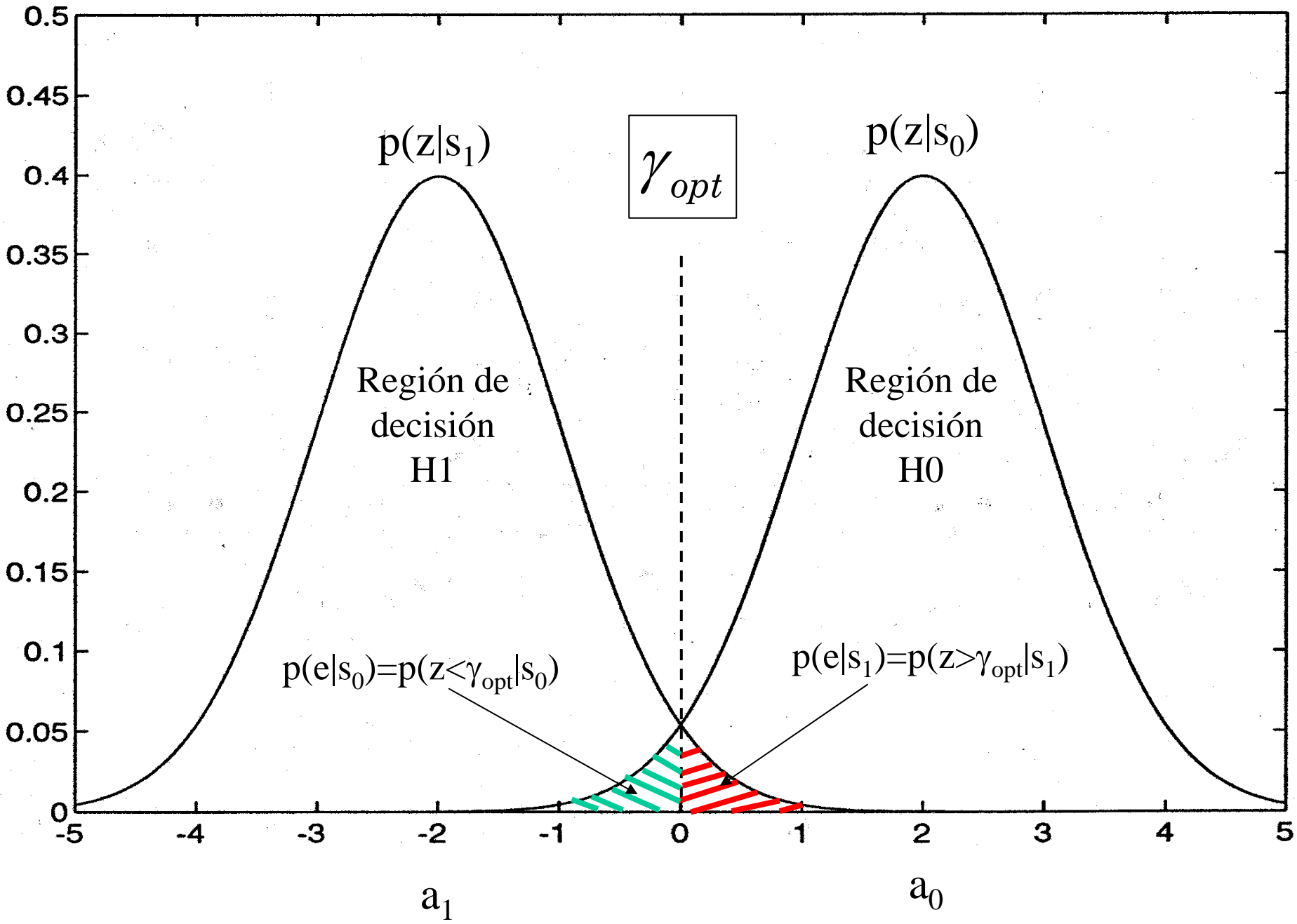
Verosimilitudes: $p(z|s_0)$ y $p(z|s_1)$



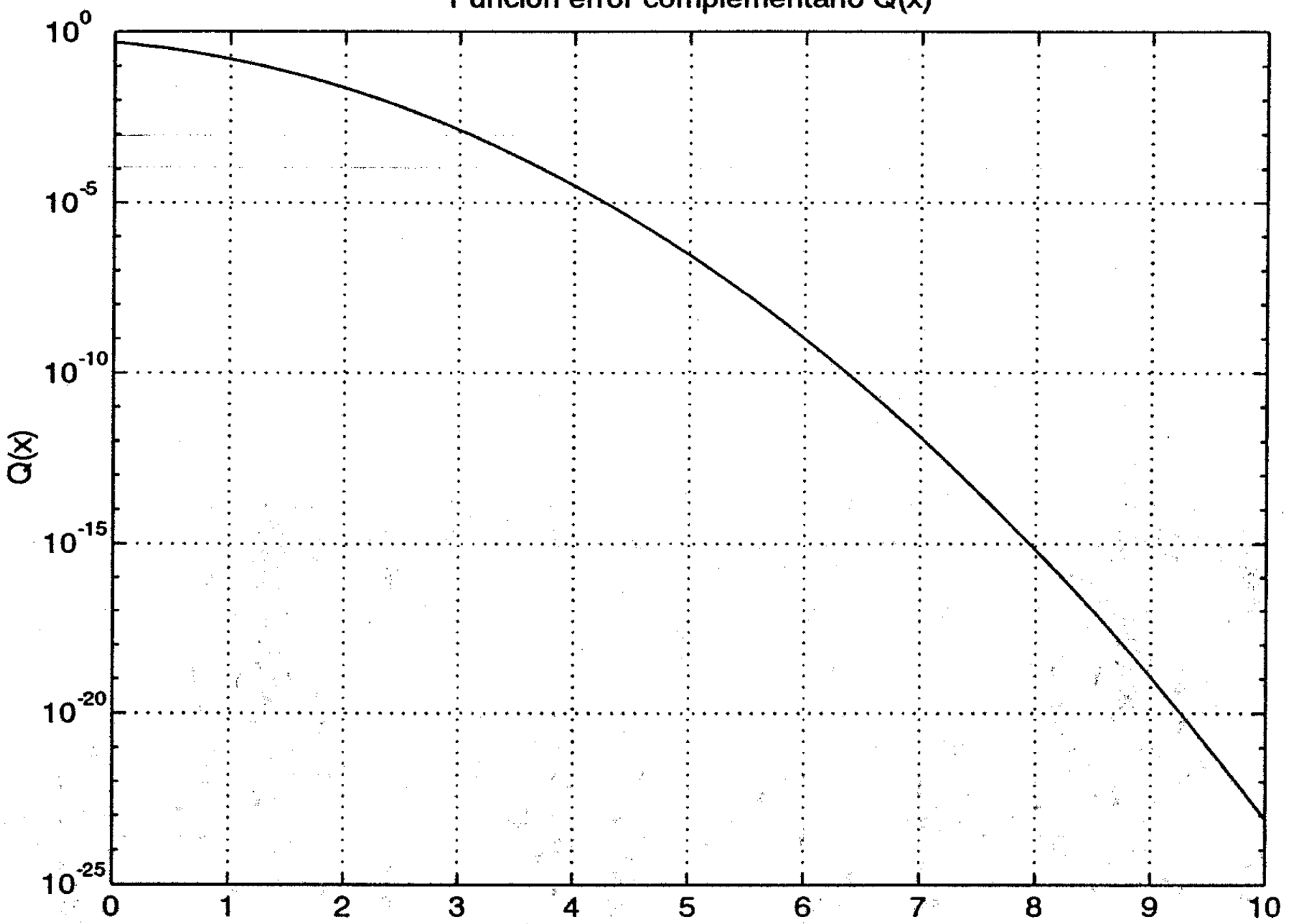
Regla de decisión ML



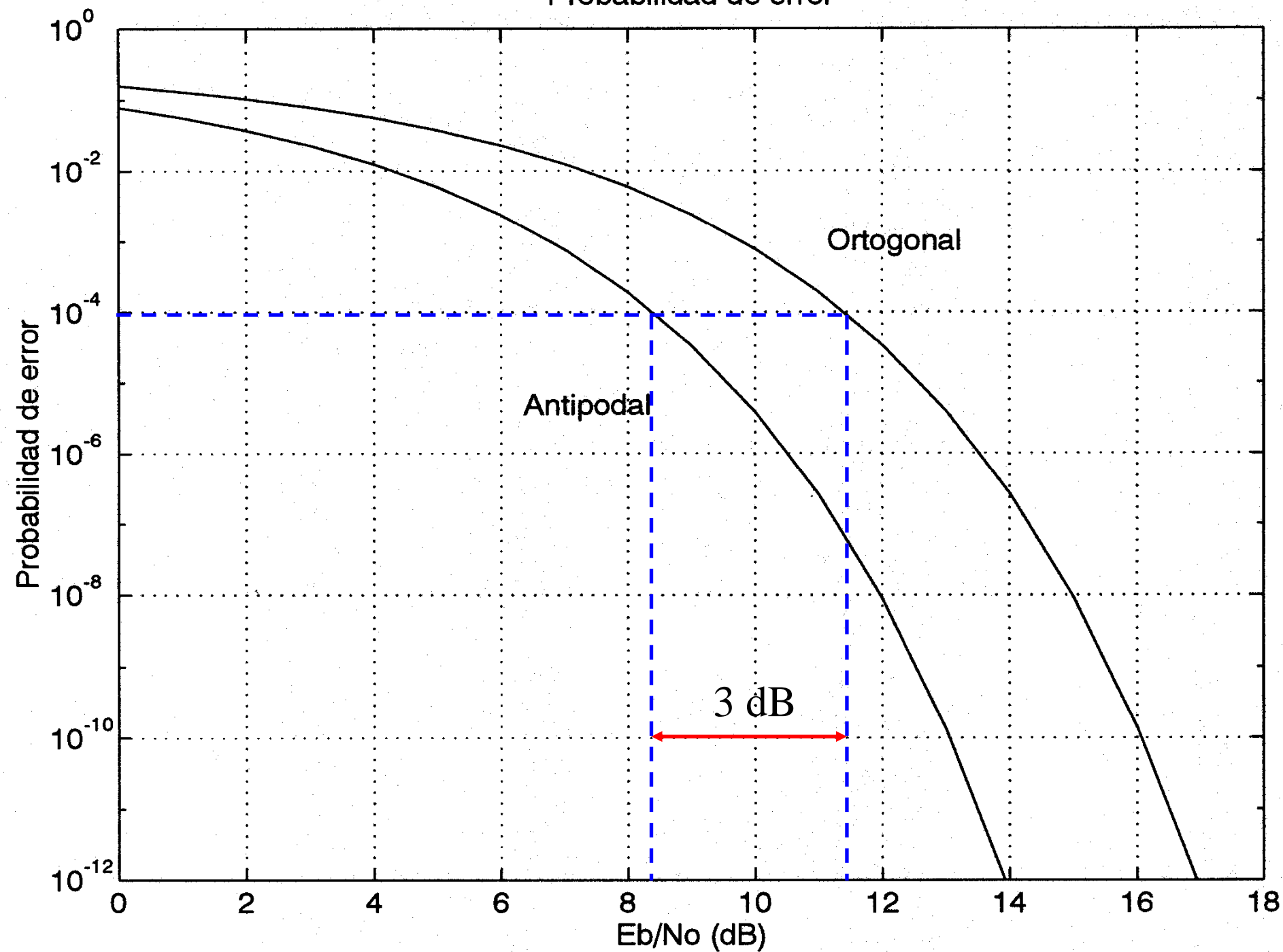
Probabilidad de error



Funcion error complementario Q(x)



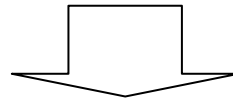
Probabilidad de error



Señalización ortogonal y antipodal

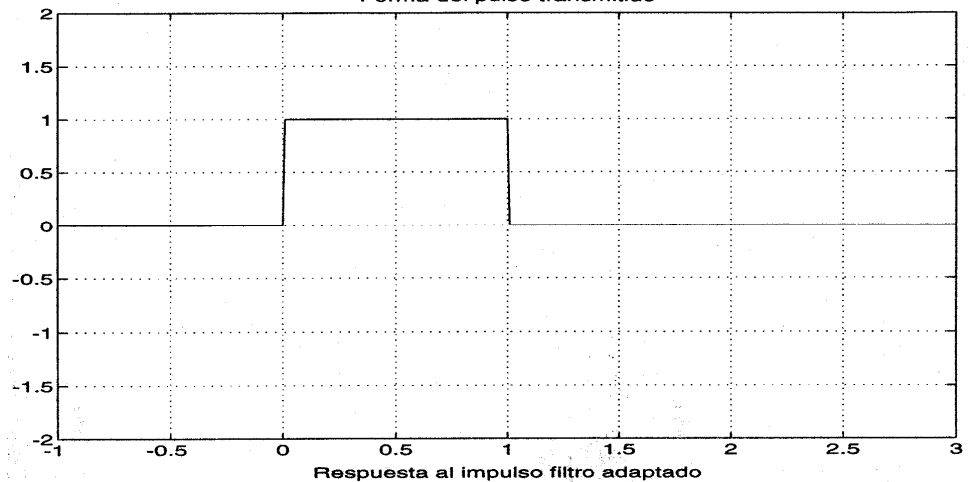
- Señalización ortogonal $\Rightarrow p(e) = Q\left(\sqrt{\frac{E_b}{N_0}}\right)$
- Señalización antipodal $\Rightarrow p(e) = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$
- Para conseguir la misma $p(e)$ se necesita dos veces (i.e., 3 dB) más E_b/N_0 con señalización ortogonal que con antipodal

$$\left.\frac{E_b}{N_0}\right|_{ort} = 2 \left.\frac{E_b}{N_0}\right|_{ant} \Rightarrow 10\log_{10}\left(\left.\frac{E_b}{N_0}\right|_{ort}\right) = 10\log_{10}\left(2 \left.\frac{E_b}{N_0}\right|_{ant}\right) \Rightarrow \left.\frac{E_b}{N_0}\right|_{ort} dB = 10\log_{10}(2) + \left.\frac{E_b}{N_0}\right|_{ant} dB$$

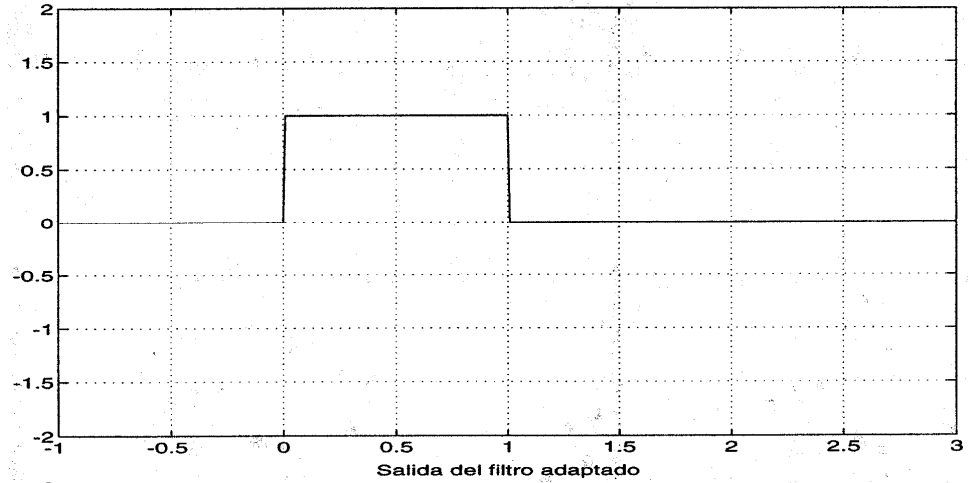


$\left.\frac{E_b}{N_0}\right _{ort} dB = \left.\frac{E_b}{N_0}\right _{ant} dB + 3 dB$
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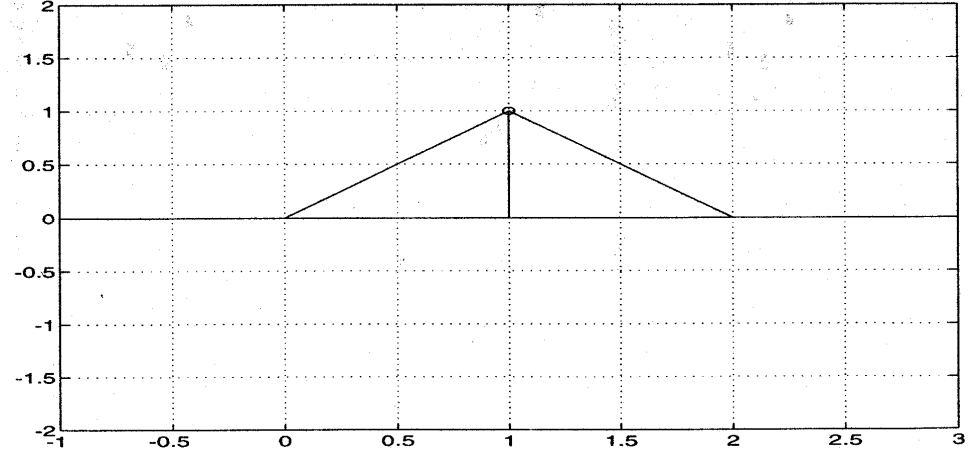
Pulso recibido
sin ruido



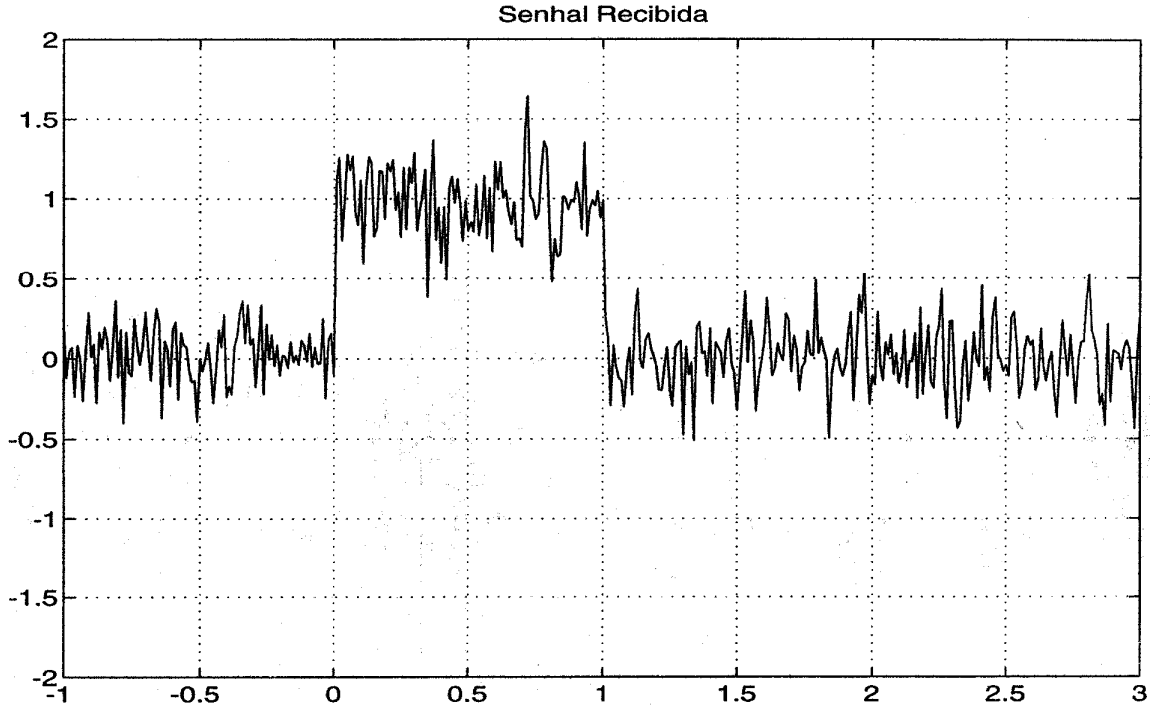
Respuesta al
impulso del filtro
adaptado



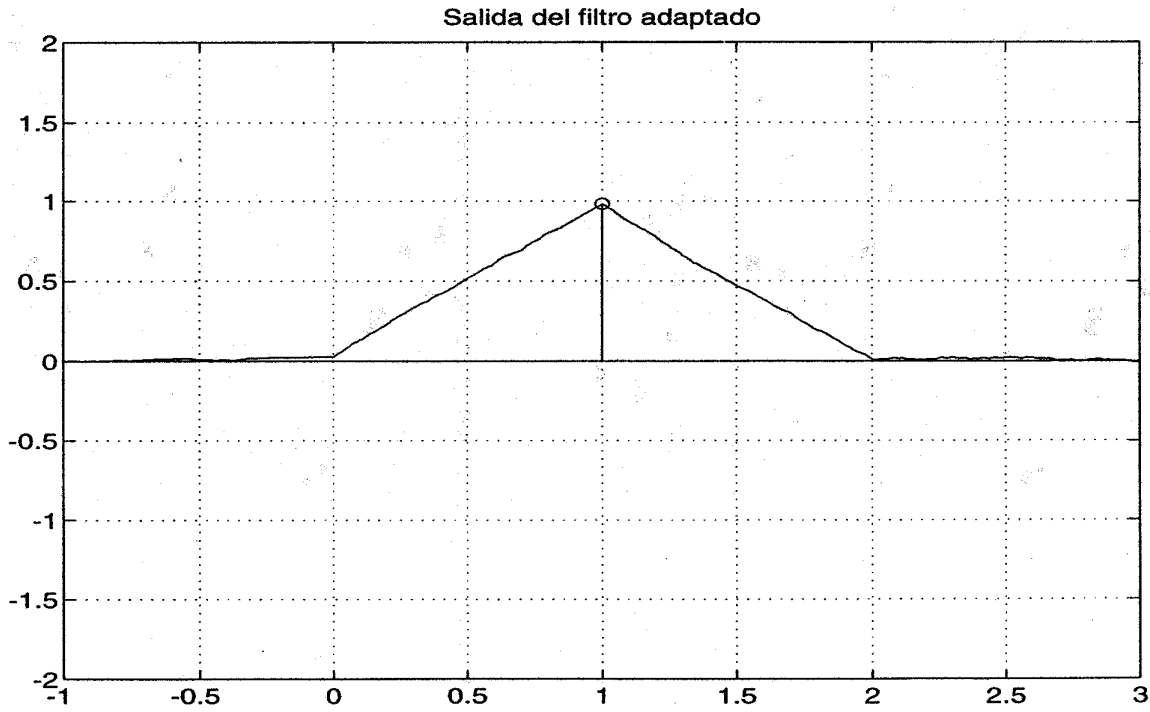
Salida del filtro
adaptado



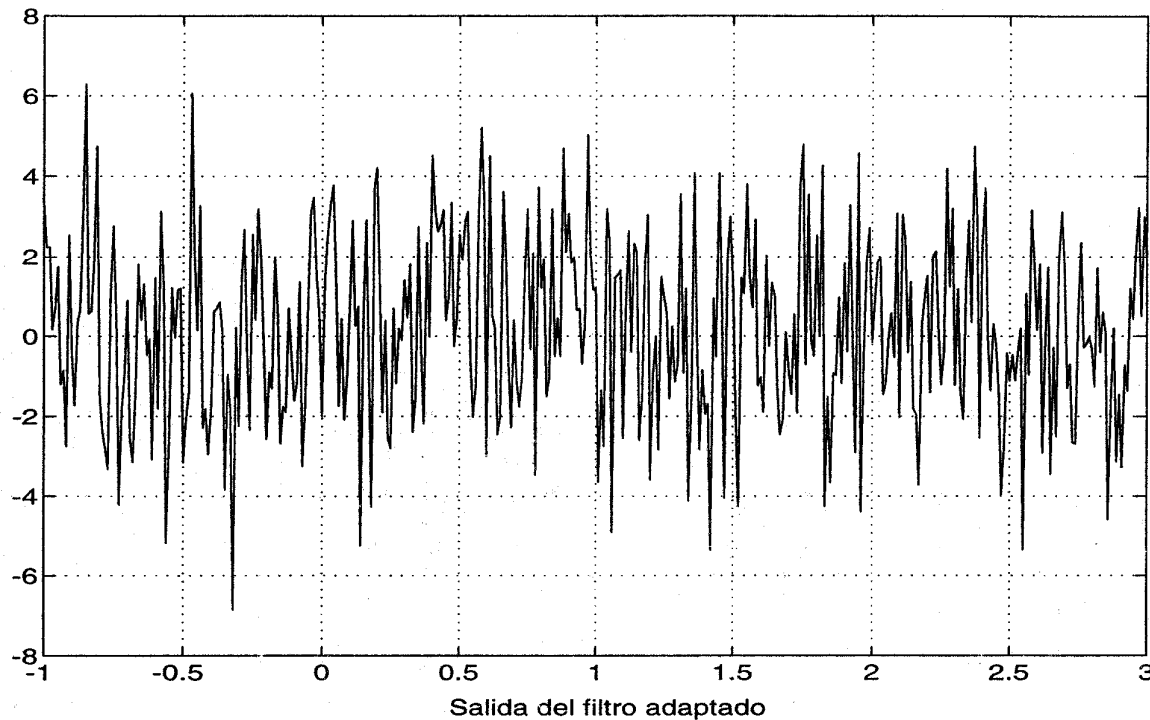
Pulso recibido
 $E_b/N_0 = 30 \text{ dB}$



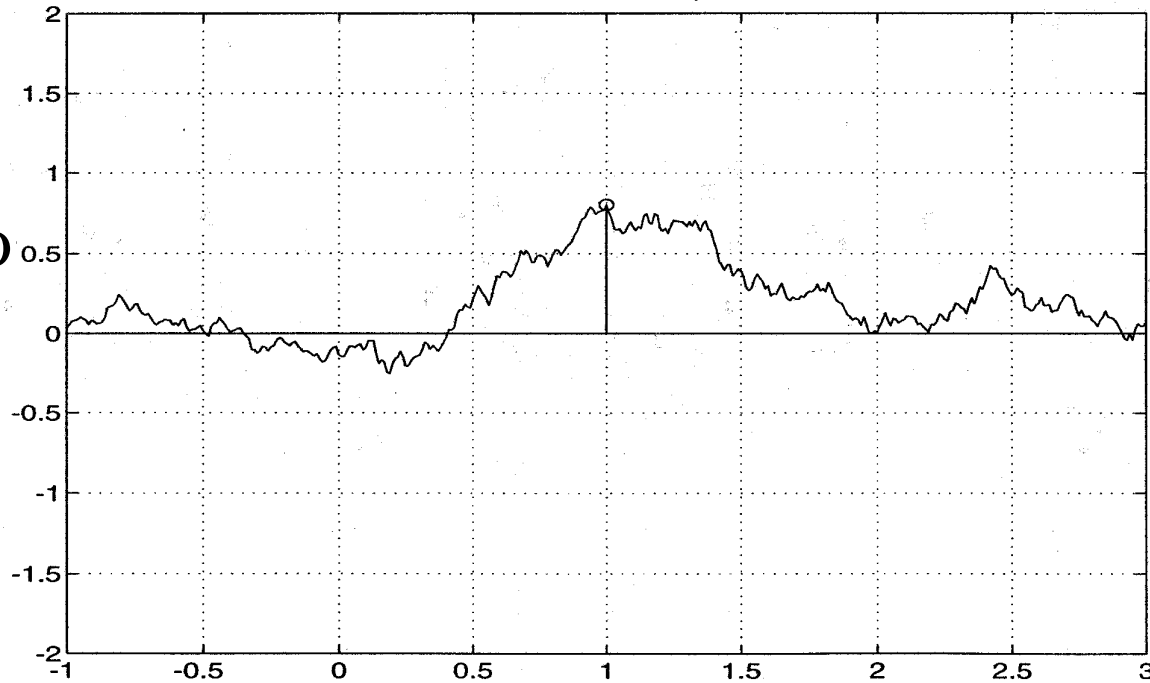
Salida del filtro
adaptado



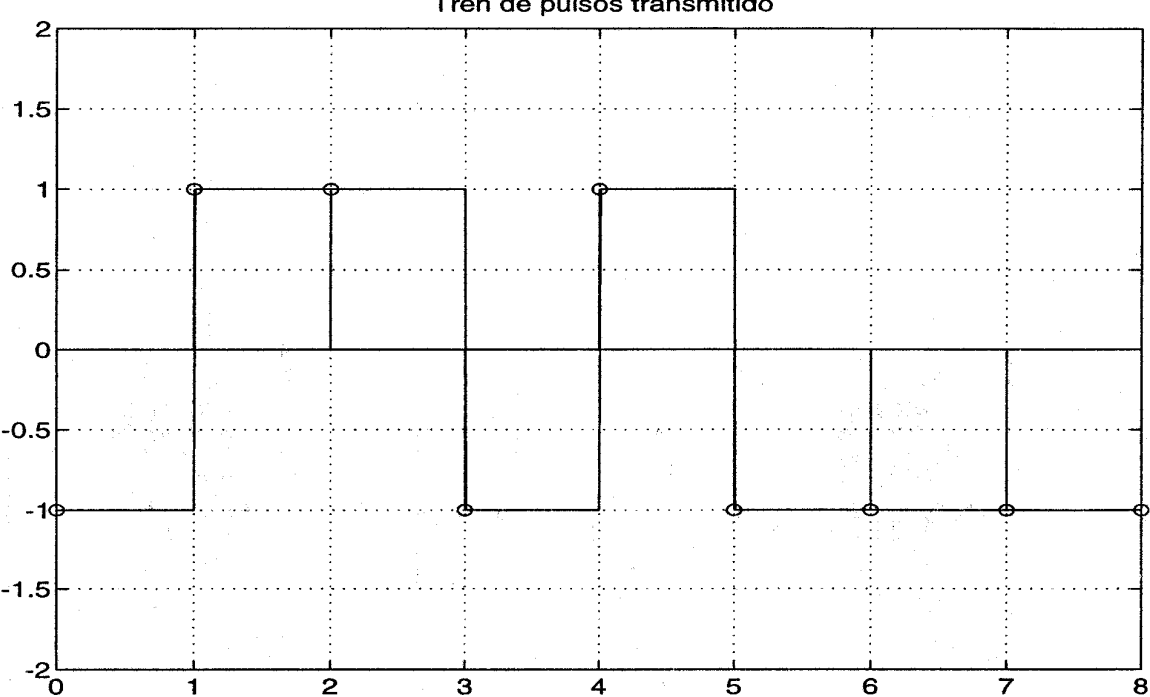
Pulso recibido
 $E_b/N_0 = 10 \text{ dB}$



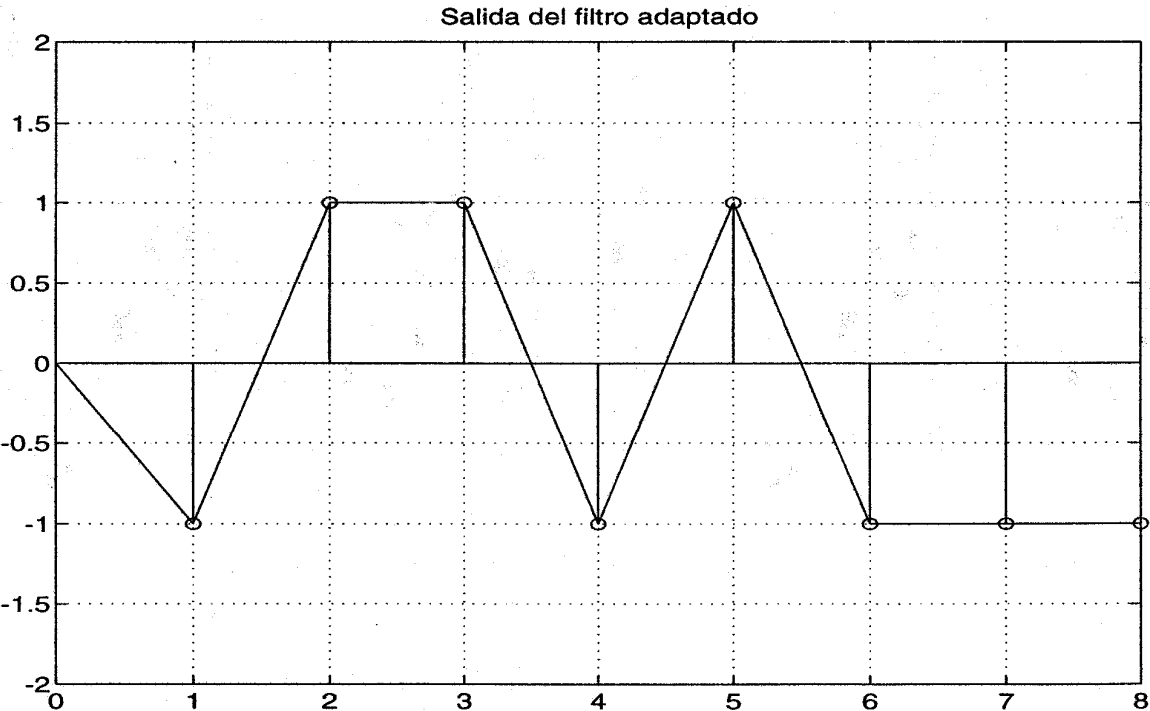
Salida del filtro
adaptado



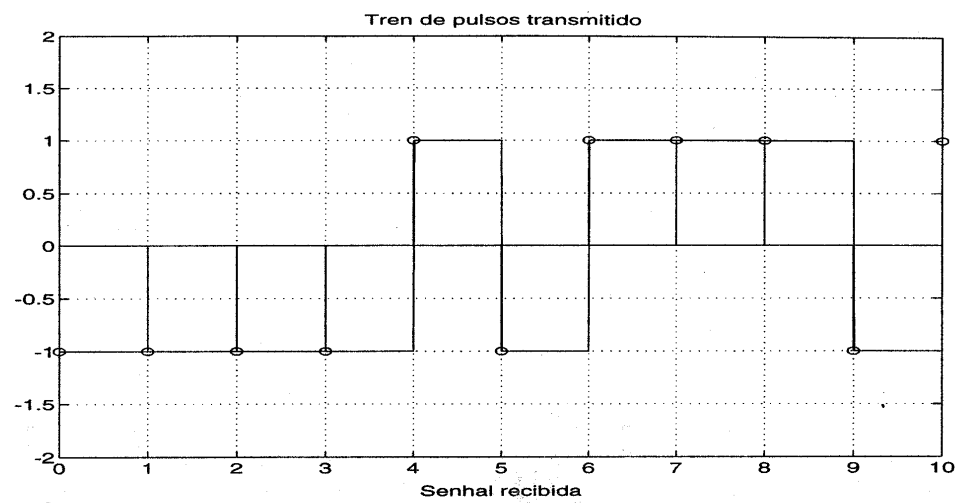
Señal PAM
recibida sin
ruido



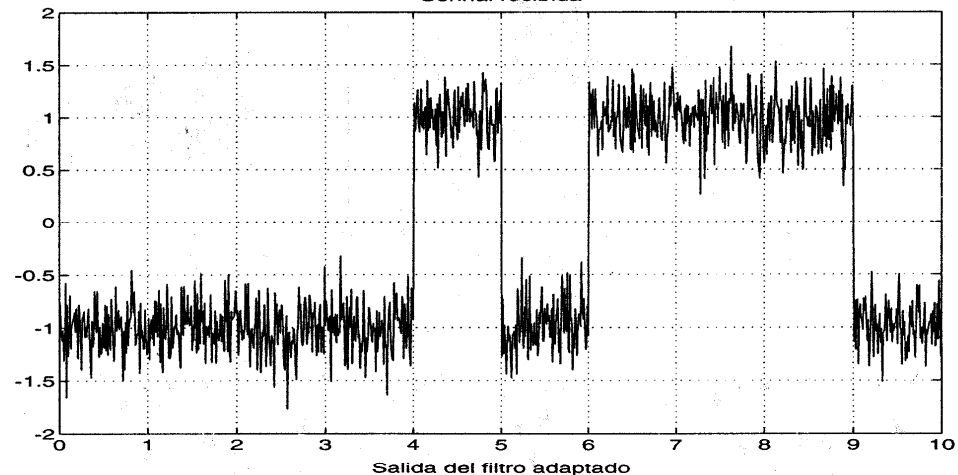
Salida del
filtro
adaptado



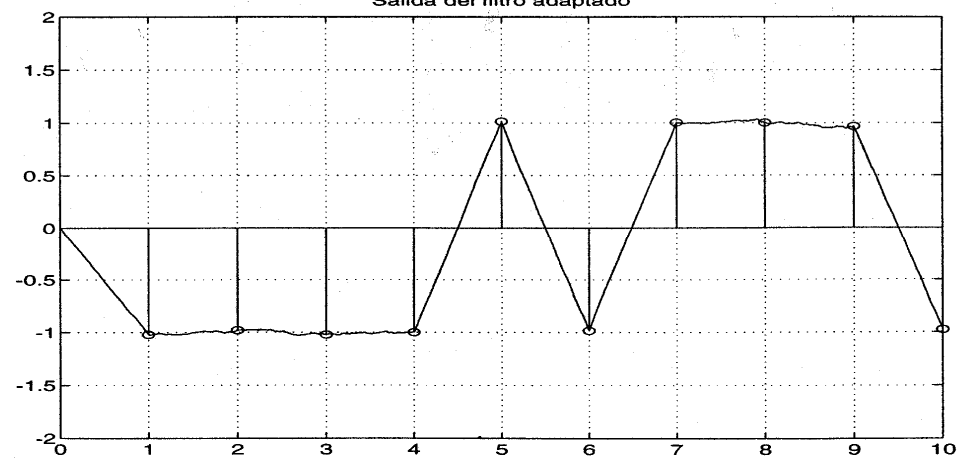
Señal PAM
transmitida



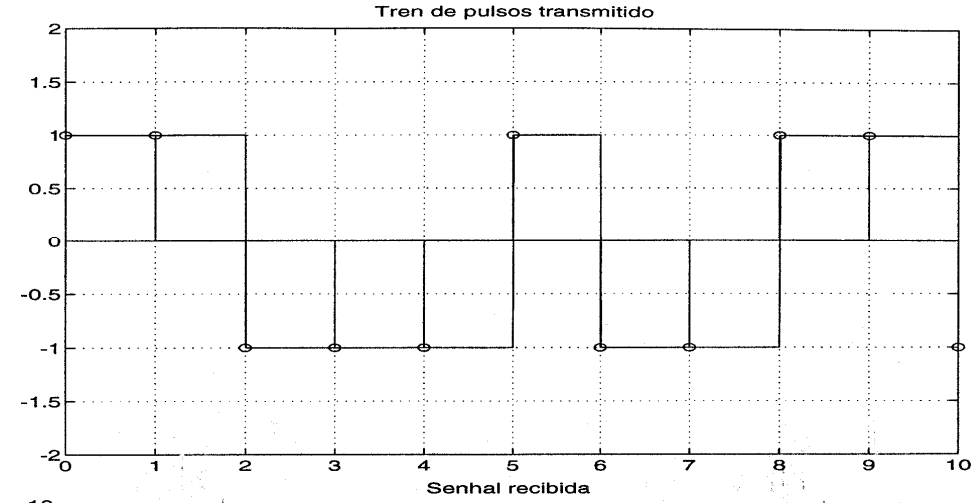
Señal PAM
recibida
 $E_b/N_0 = 30$ dB



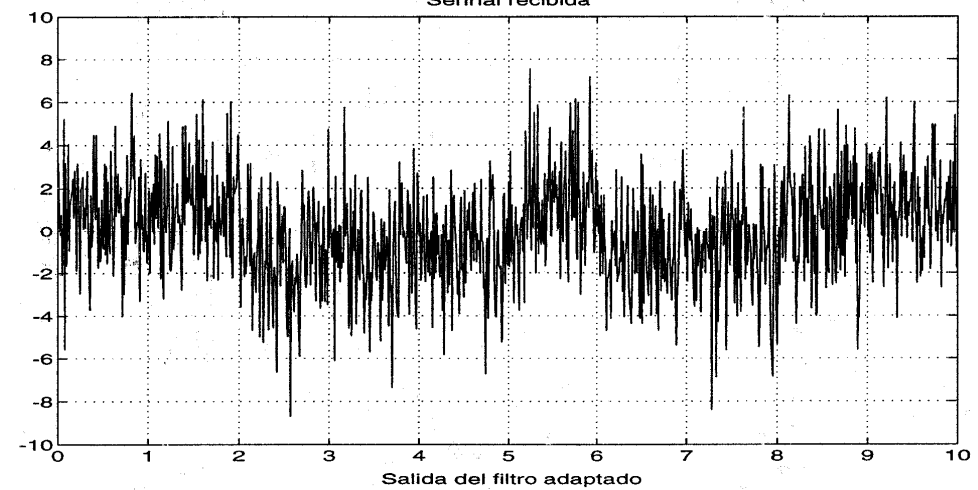
Salida del
filtro adaptado



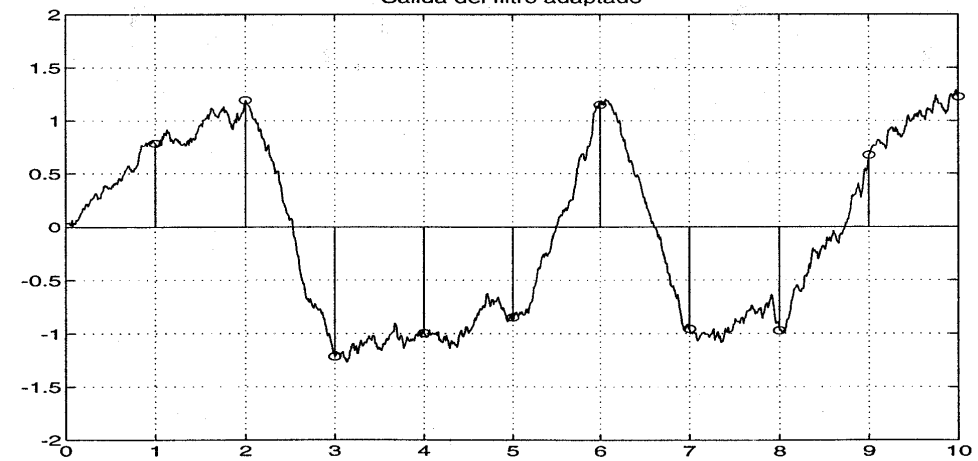
Señal PAM
transmitida



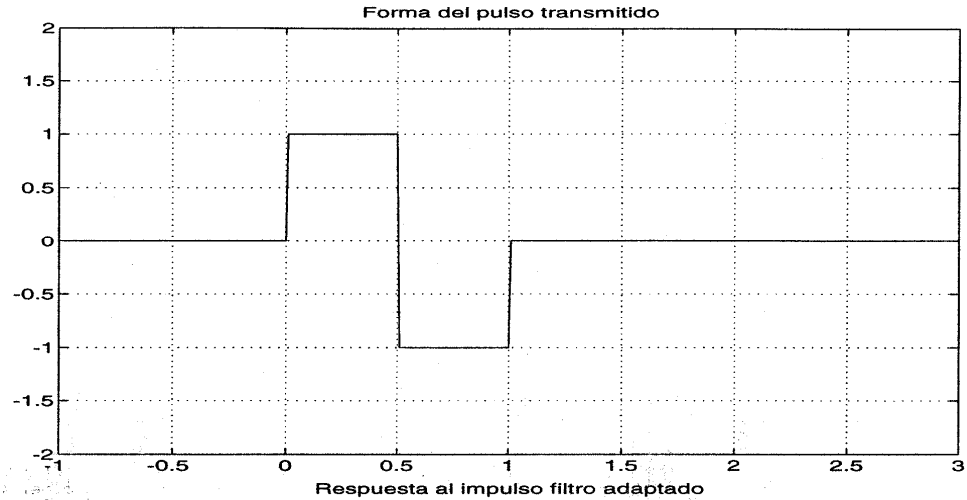
Señal PAM
recibida
 $E_b/N_0 = 10$ dB



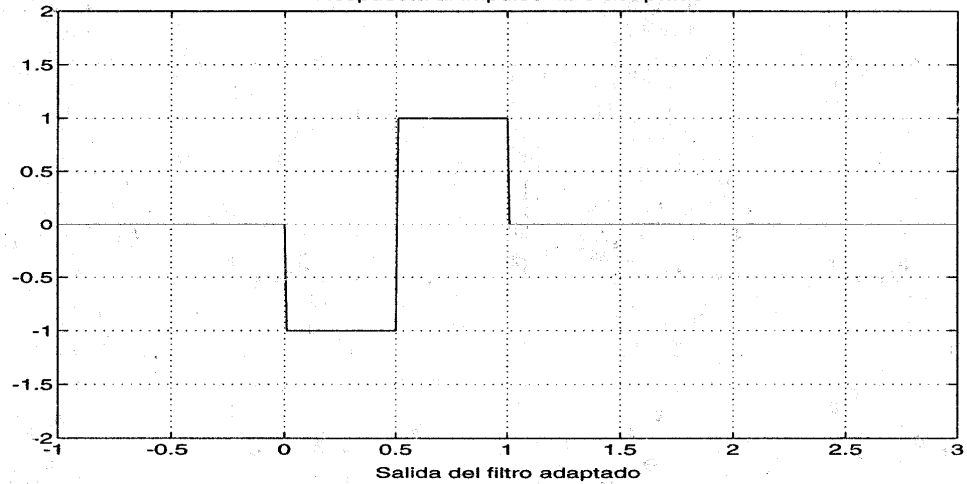
Salida del
filtro adaptado



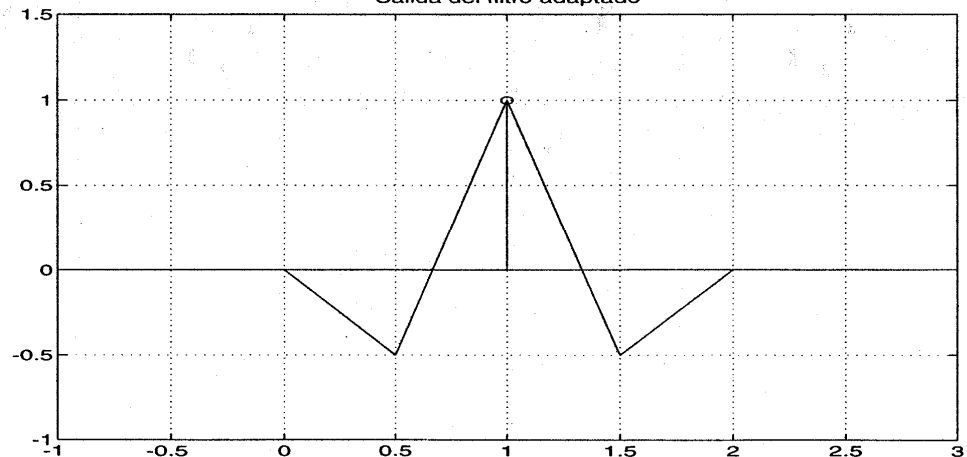
Pulso bifase
recibido
sin ruido



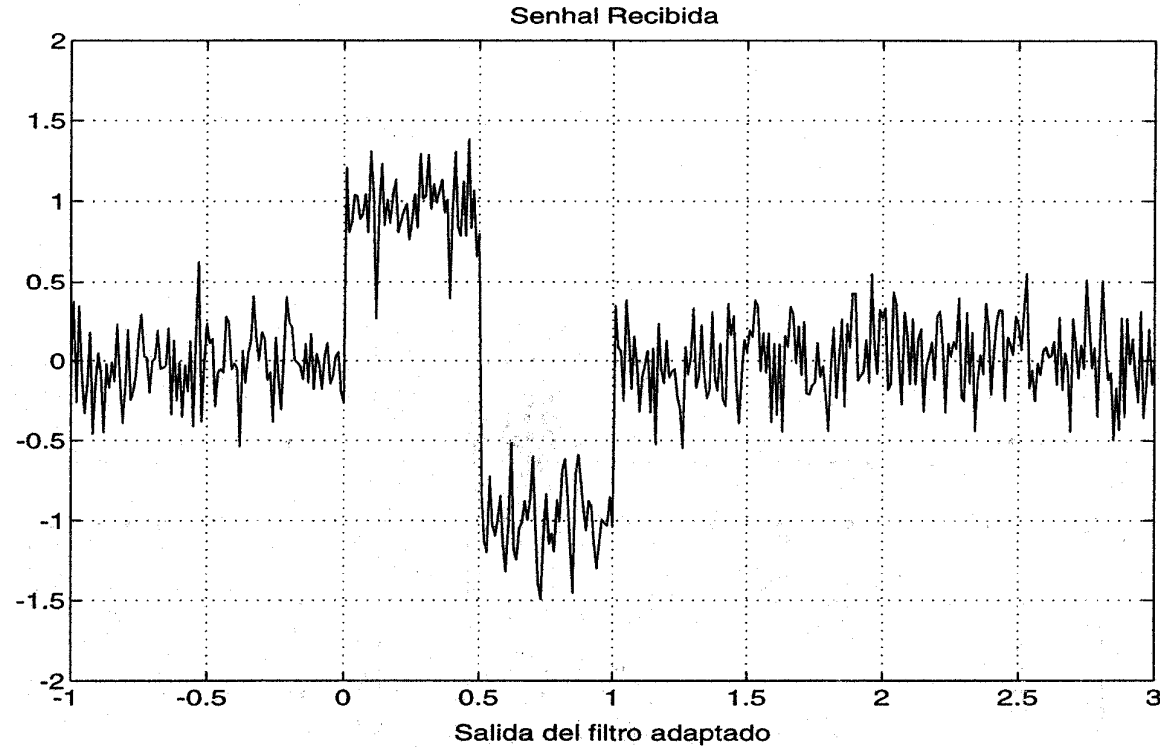
Respuesta al
impulso del filtro
adaptado



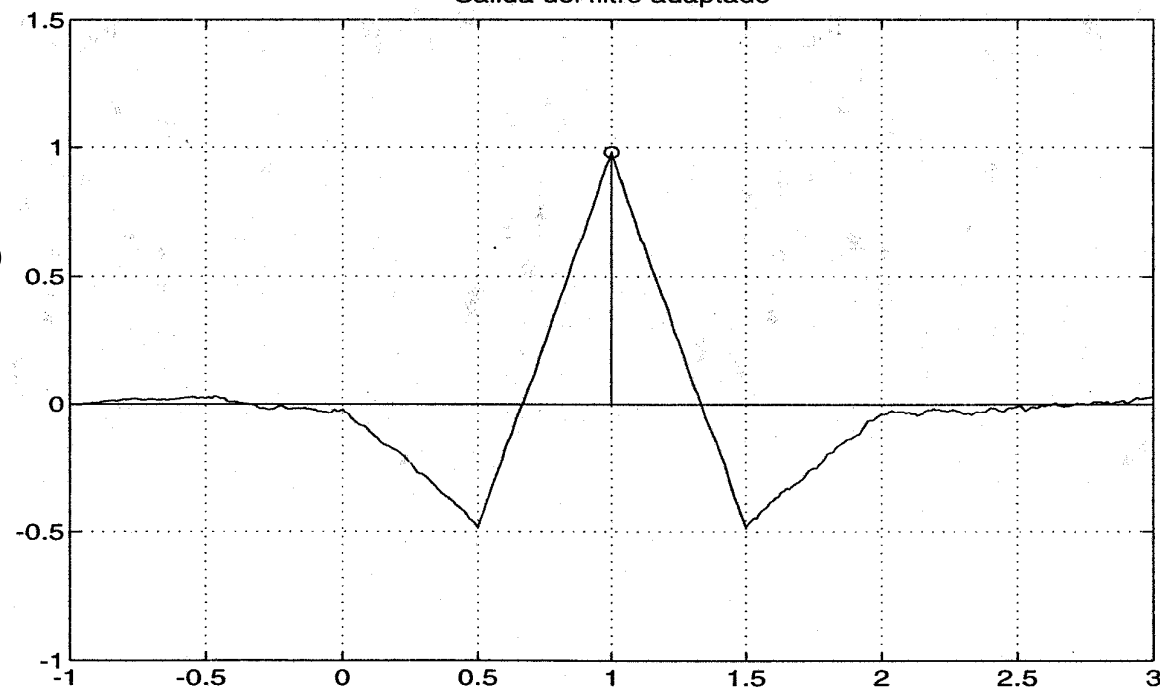
Salida del filtro
adaptado



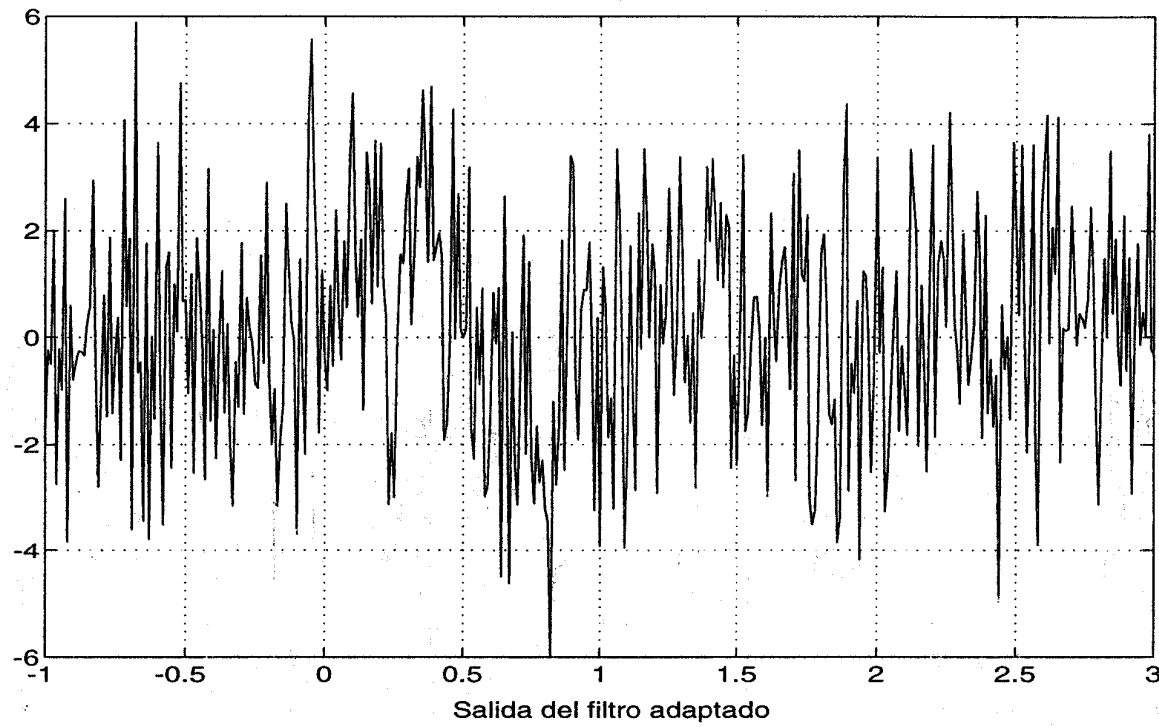
Pulso bifase
recibido
 $E_b/N_0 = 30$ dB



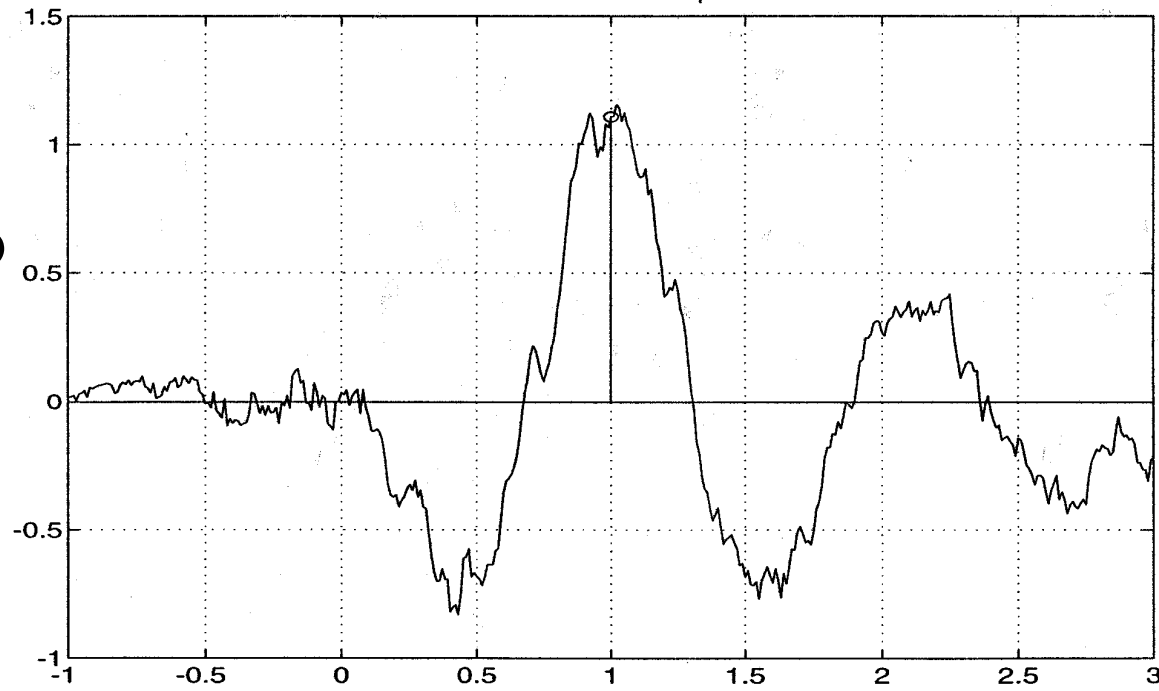
Salida del filtro
adaptado



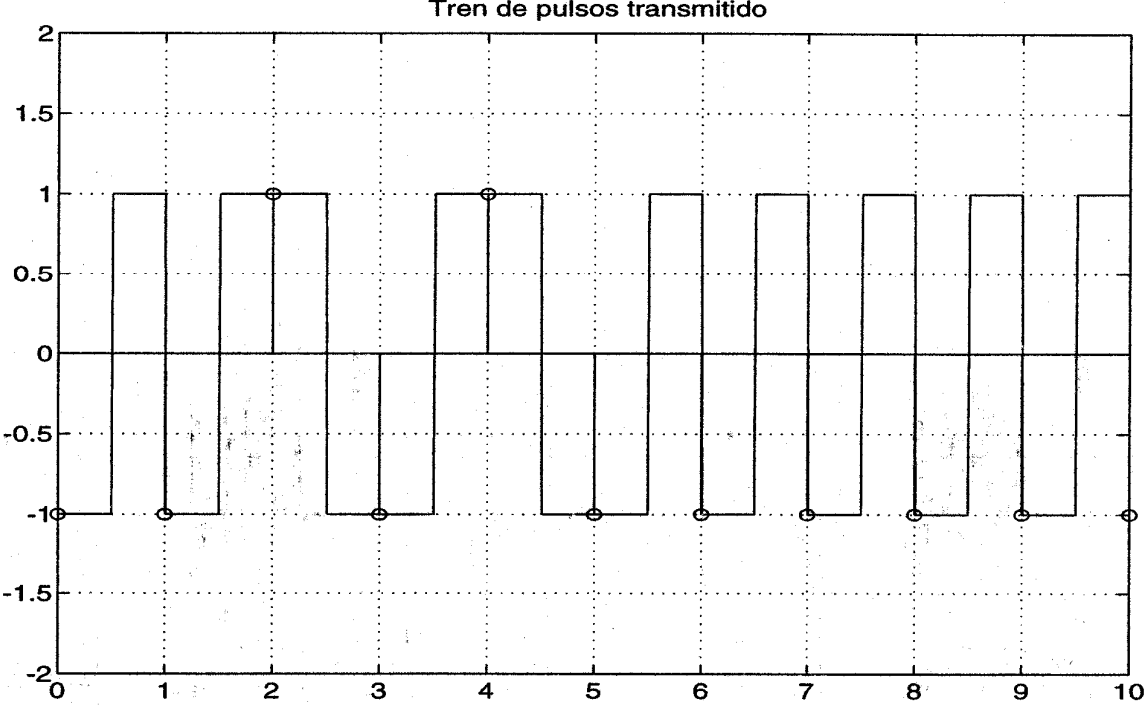
Pulso bifase
recibido
 $E_b/N_0 = 10$ dB



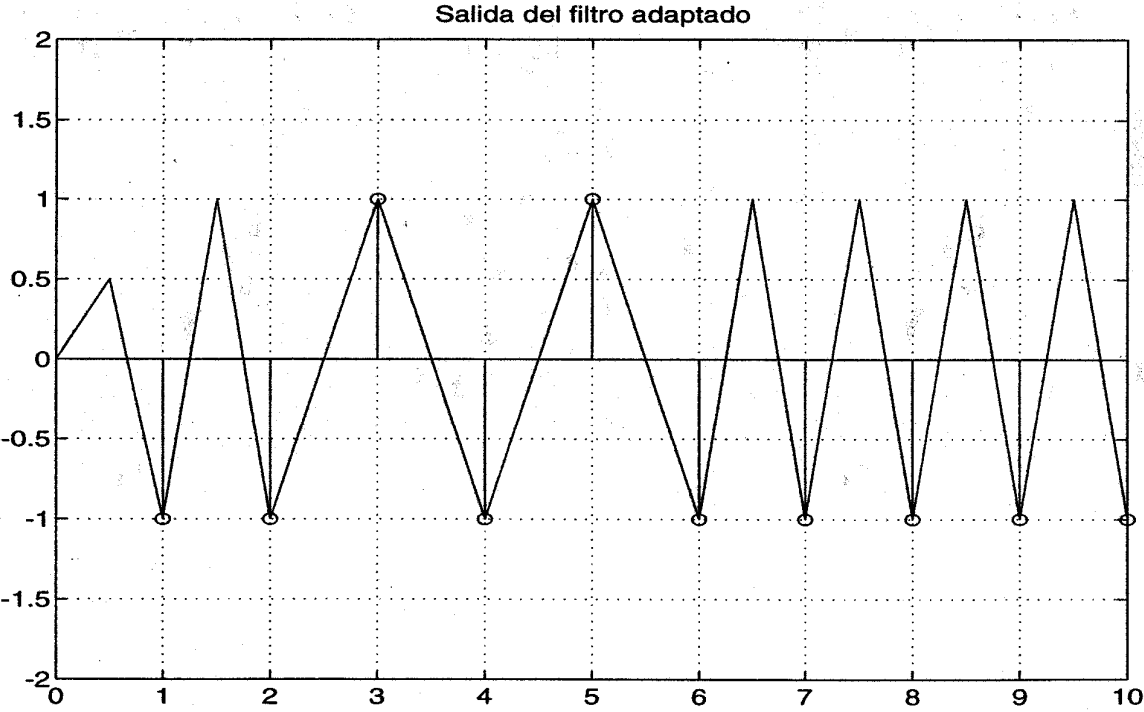
Salida del filtro
adaptado



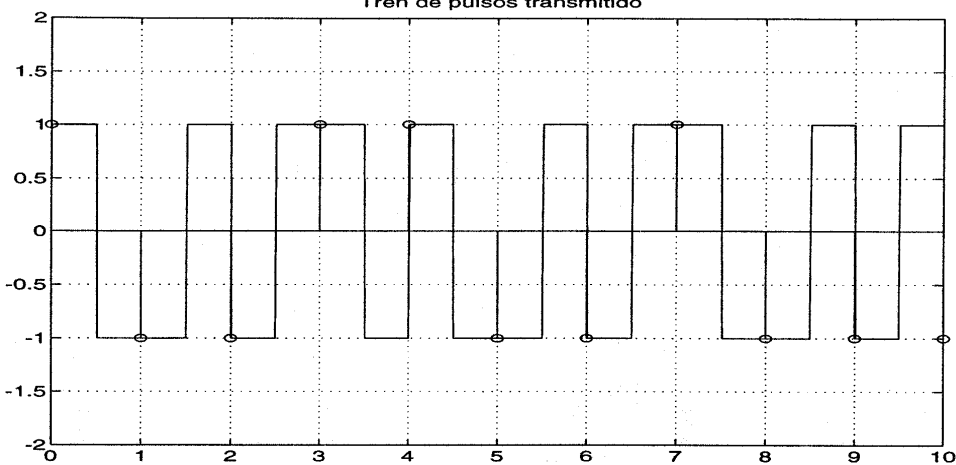
Señal PAM
con pulsos
bifase sin
ruido



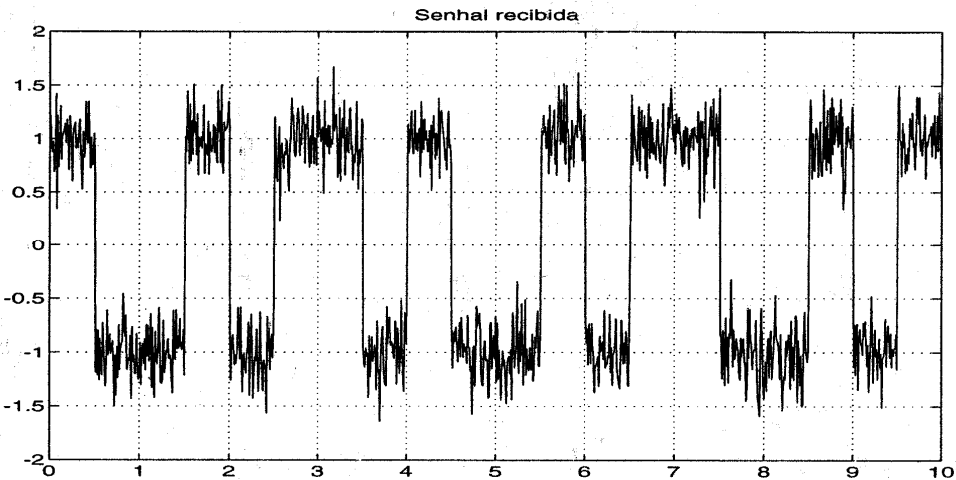
Salida del
filtro
adaptado



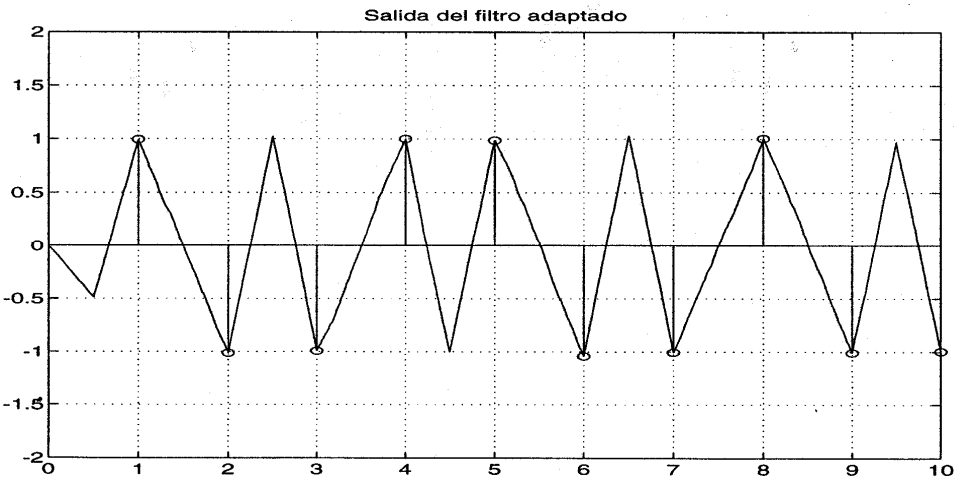
Señal PAM
transmitida



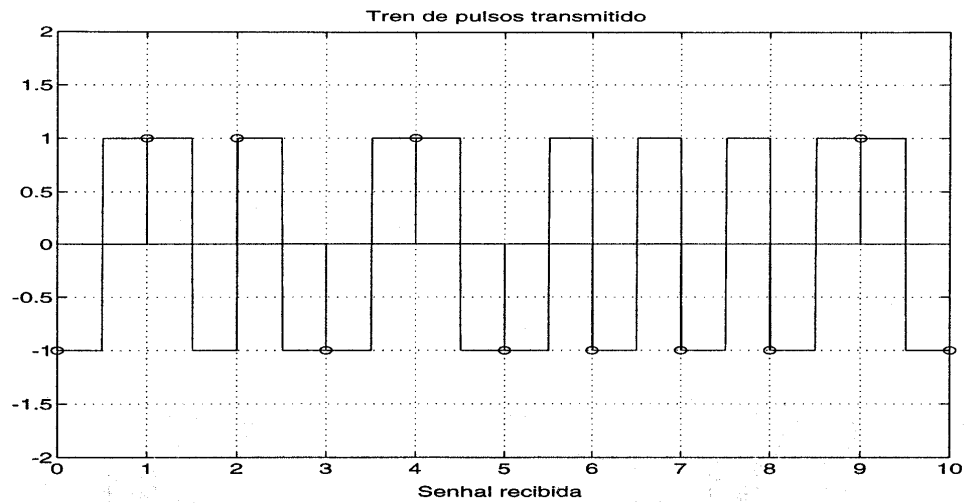
Señal PAM
recibida
 $E_b/N_0 = 30$ dB



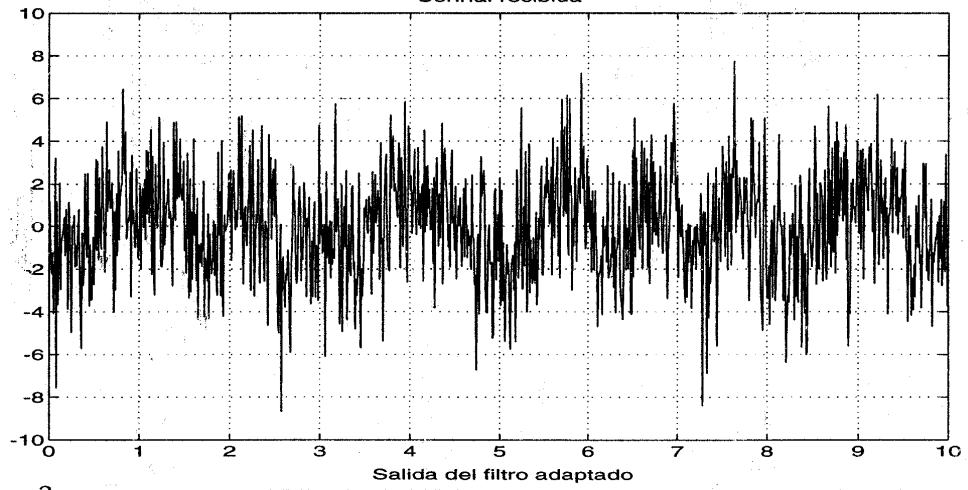
Salida del
filtro adaptado



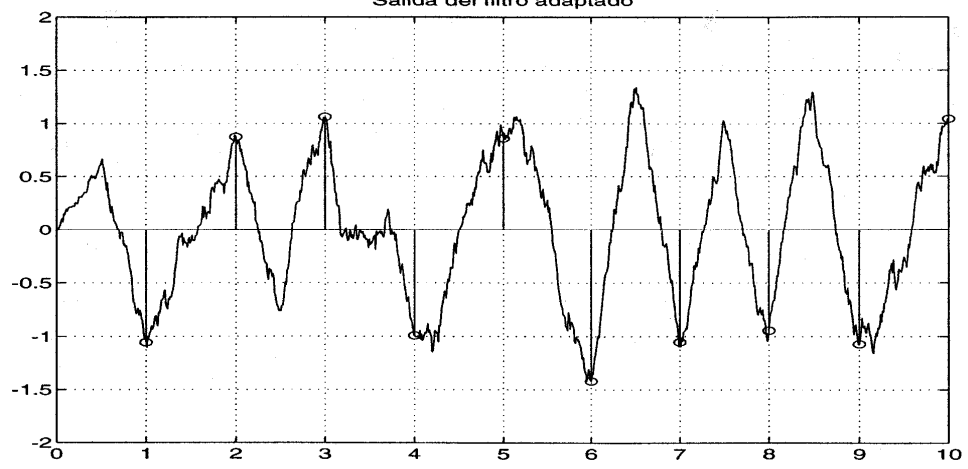
Señal PAM
transmitida



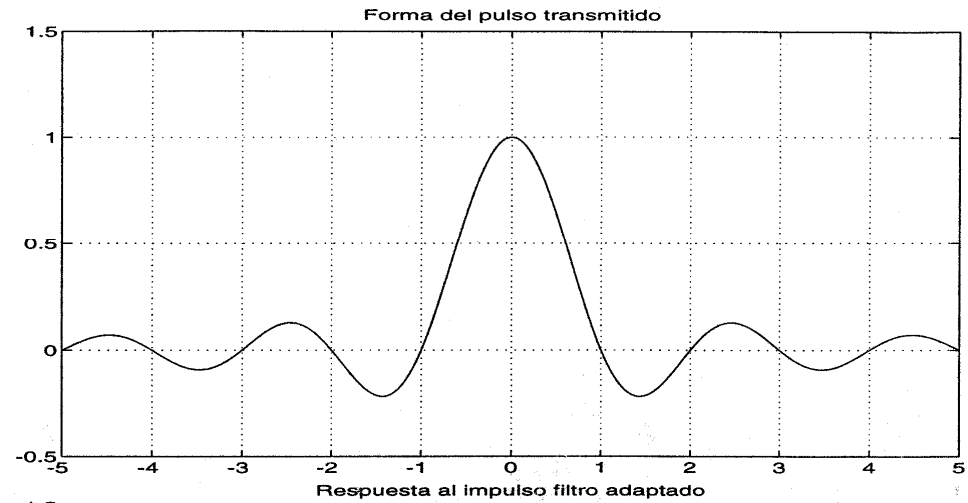
Señal PAM
recibida
 $E_b/N_0 = 10$ dB



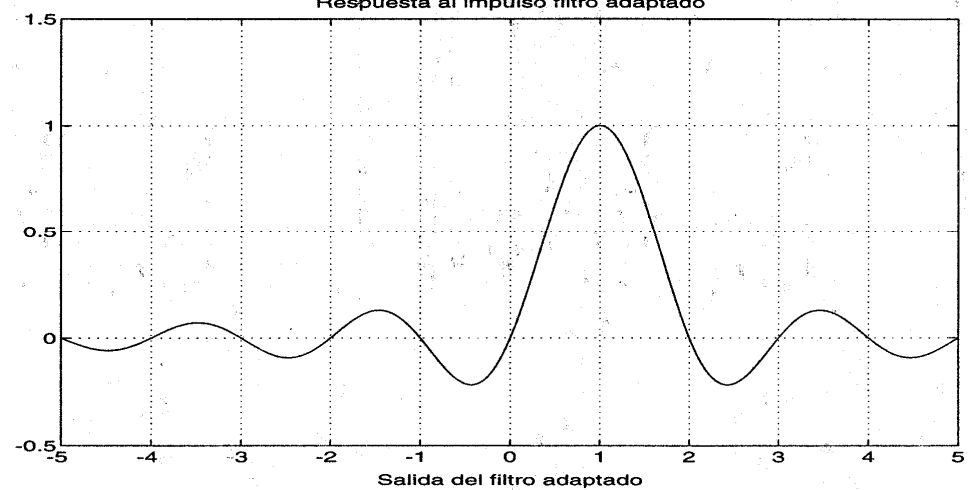
Salida del
filtro adaptado



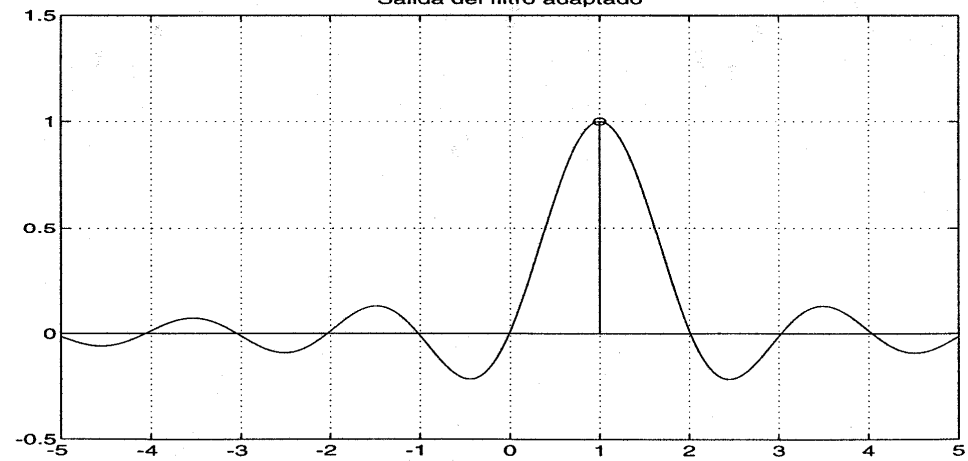
Pulso de Nyquist
recibido
sin ruido



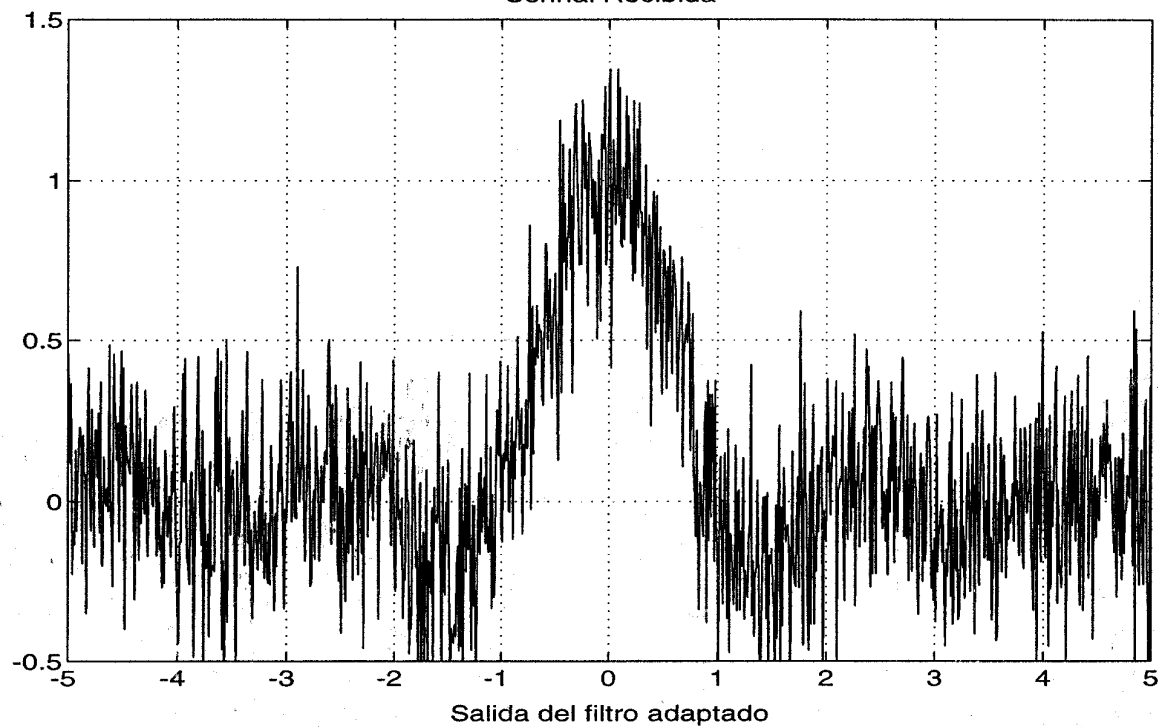
Respuesta al
impulso del filtro
adaptado



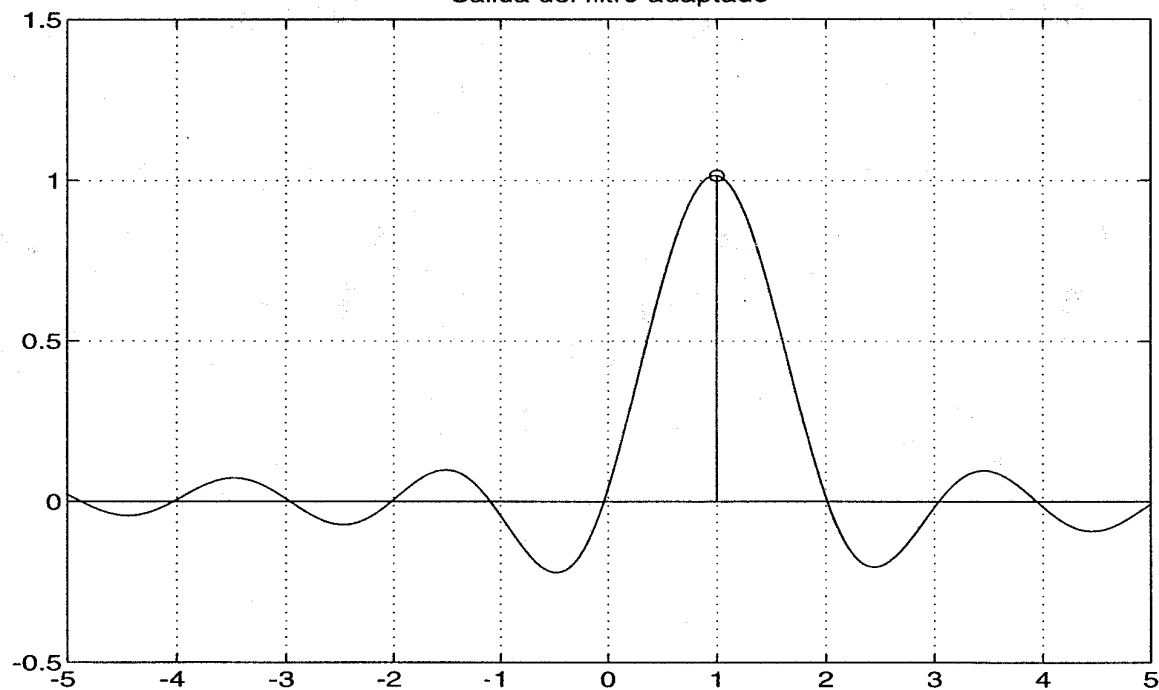
Salida del filtro
adaptado



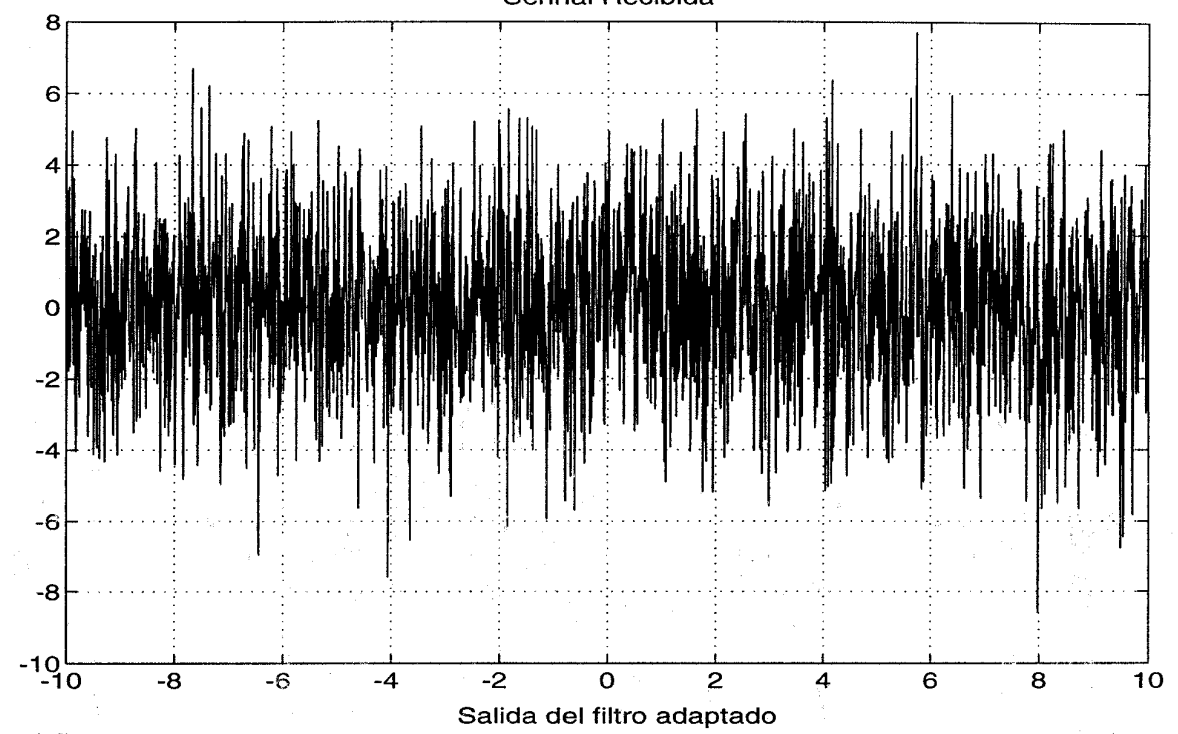
Pulso de Nyquist
recibido
 $E_b/N_0 = 30 \text{ dB}$



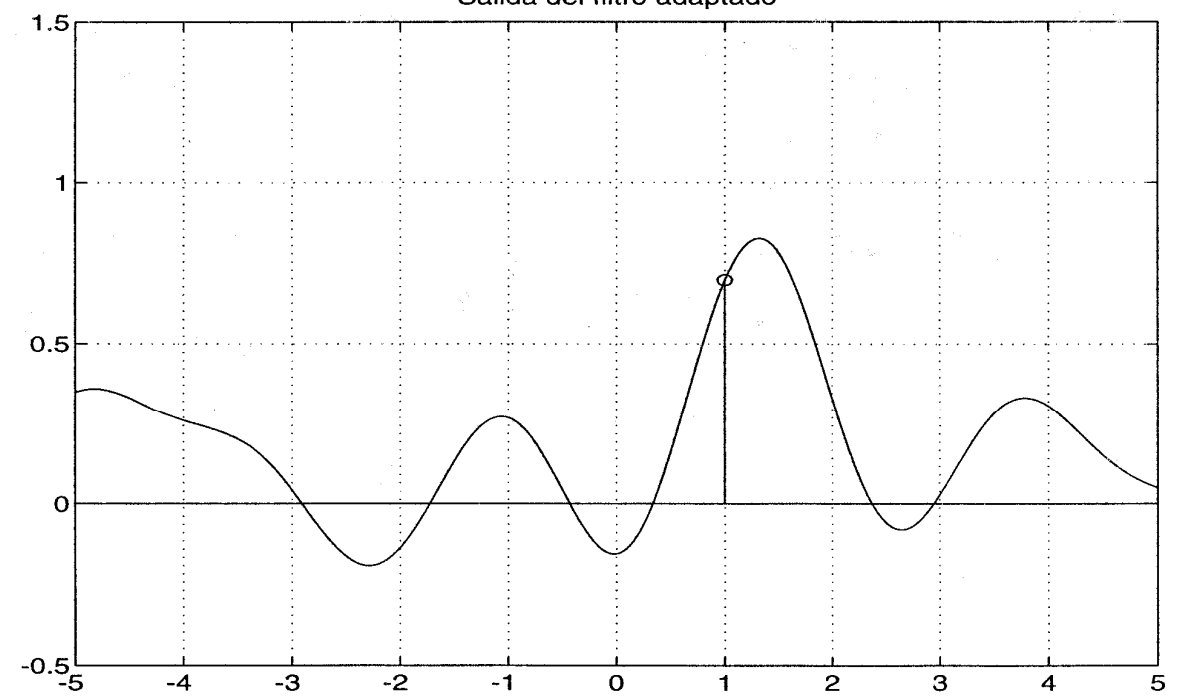
Salida del filtro
adaptado



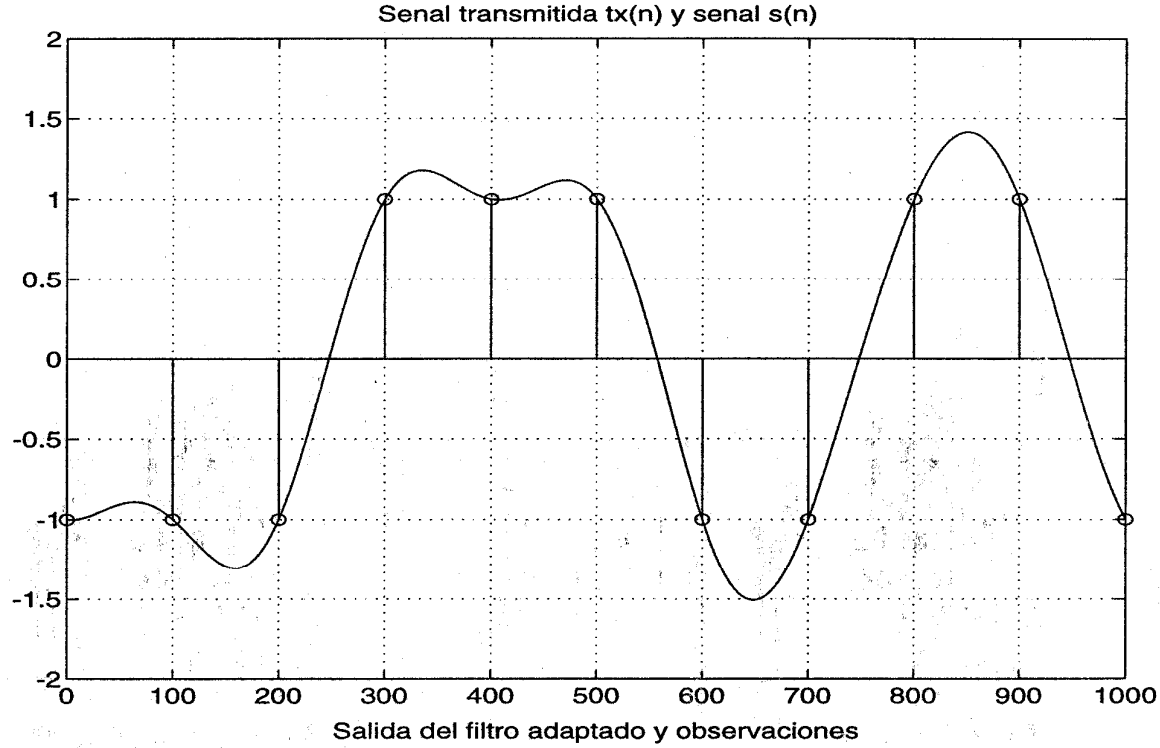
Pulso de Nyquist
recibido
 $E_b/N_0 = 10$ dB



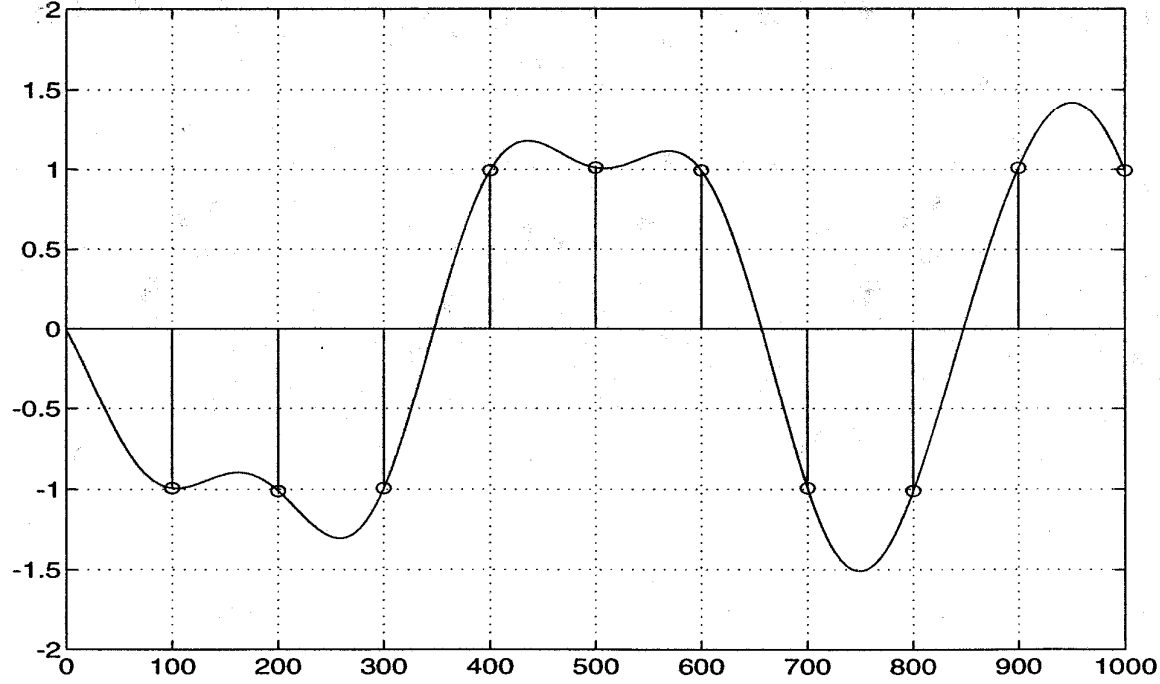
Salida del filtro
adaptado



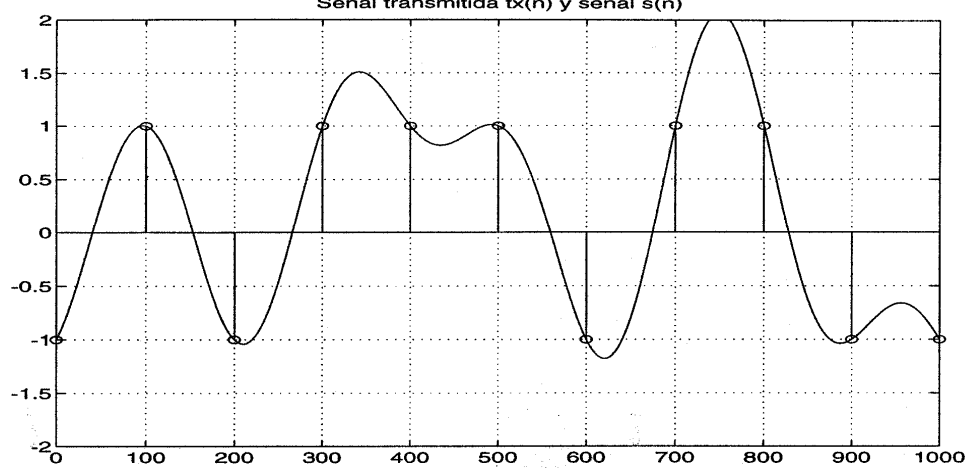
Señal PAM
con pulsos
de Nyquist sin
ruido



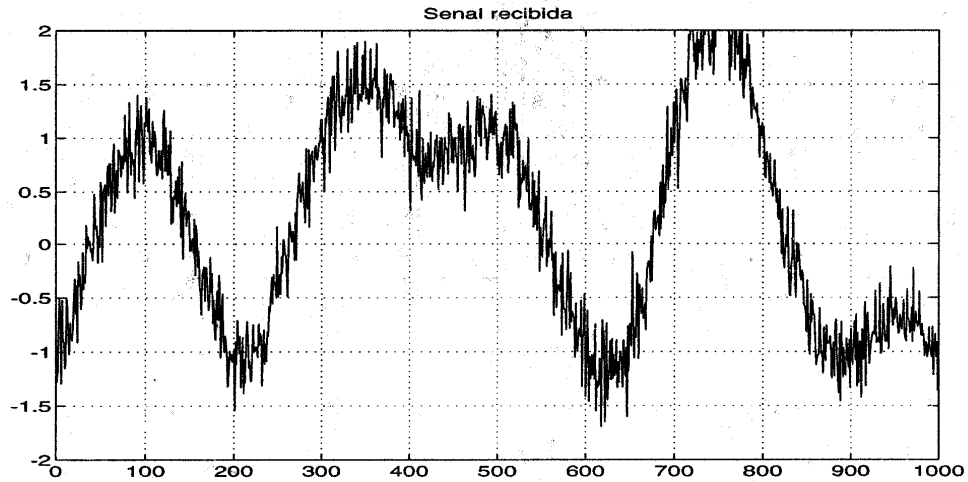
Salida del
filtro
adaptado



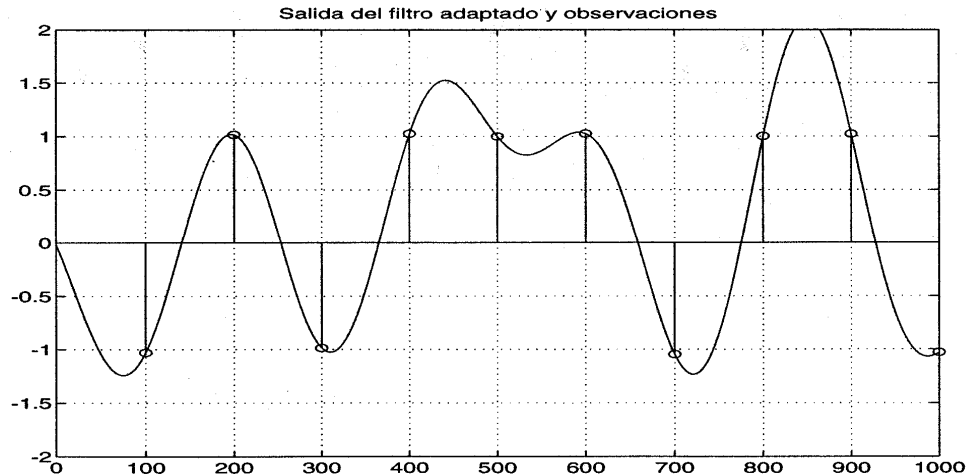
Señal PAM
transmitida



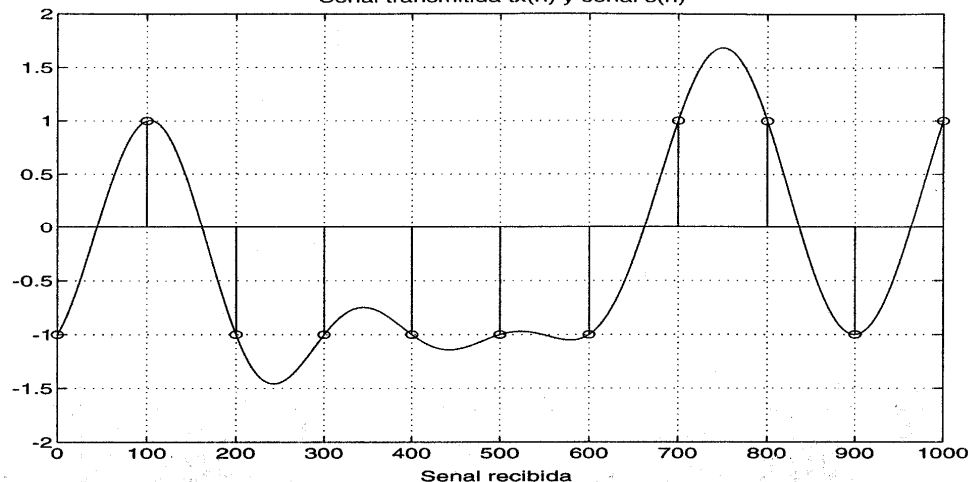
Señal PAM
recibida
 $E_b/N_0 = 30$ dB



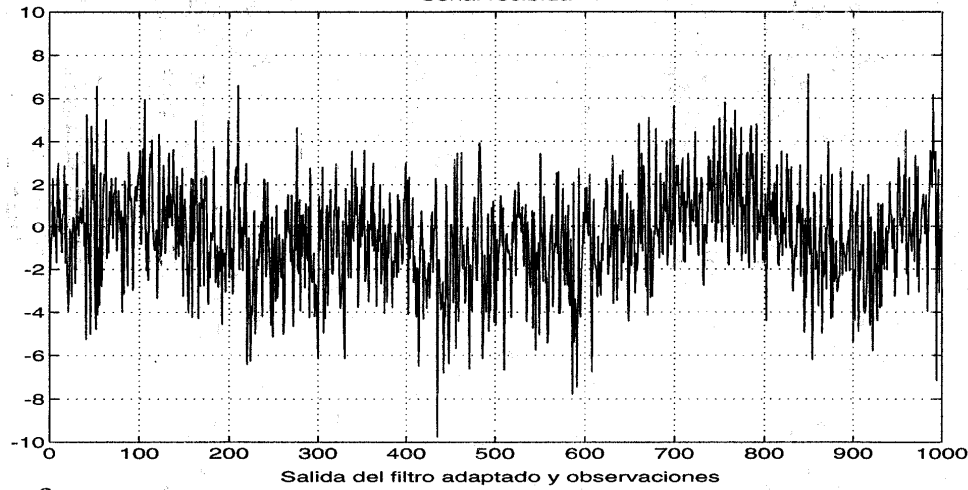
Salida del
filtro adaptado



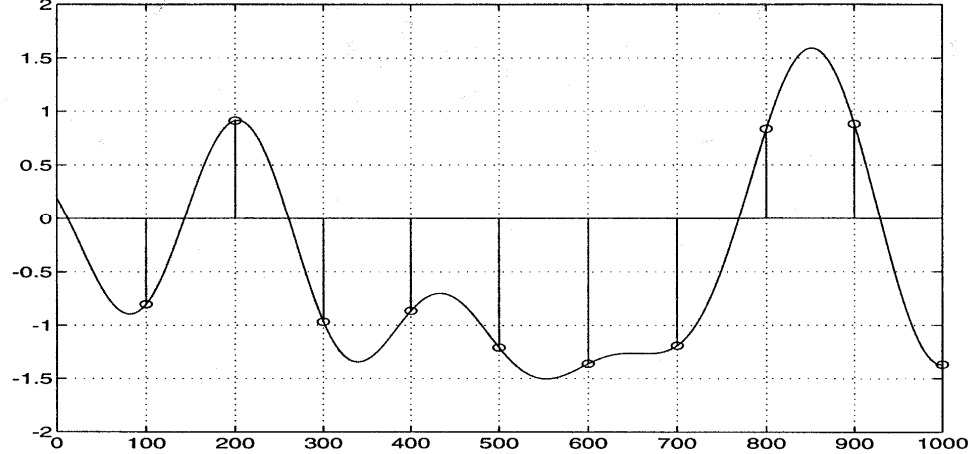
Señal PAM
transmitida



Señal PAM
recibida
 $E_b/N_0 = 10$ dB



Salida del
filtro adaptado



Probabilidad de error de un sistema M-PAM

$$p(e) = \frac{2(M-1)}{M} Q\left(\sqrt{\frac{6 \log_2 M}{M^2-1} \frac{E_b}{N_0}}\right)$$

