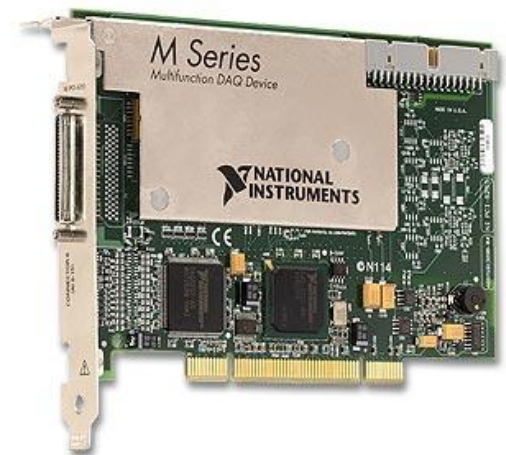
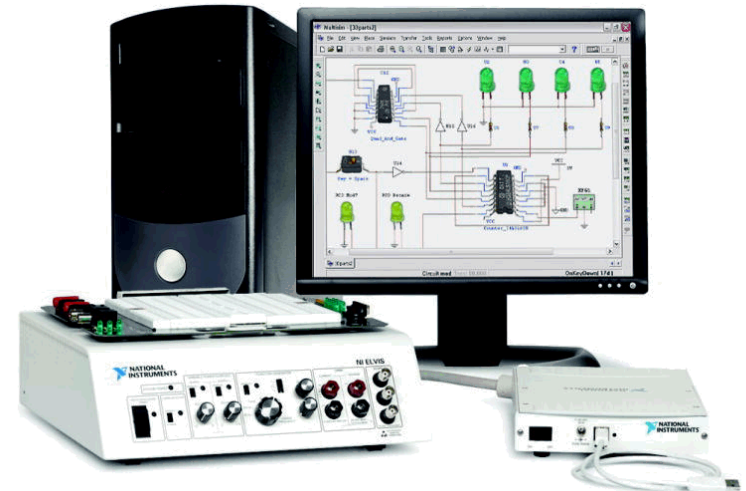
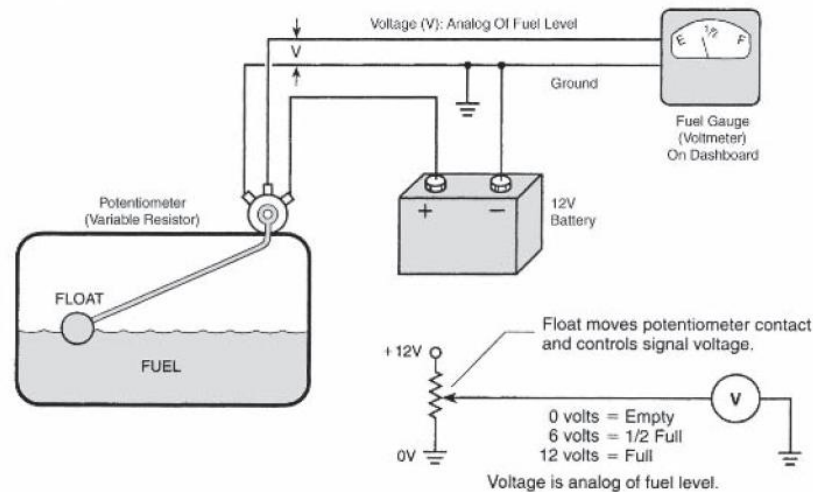
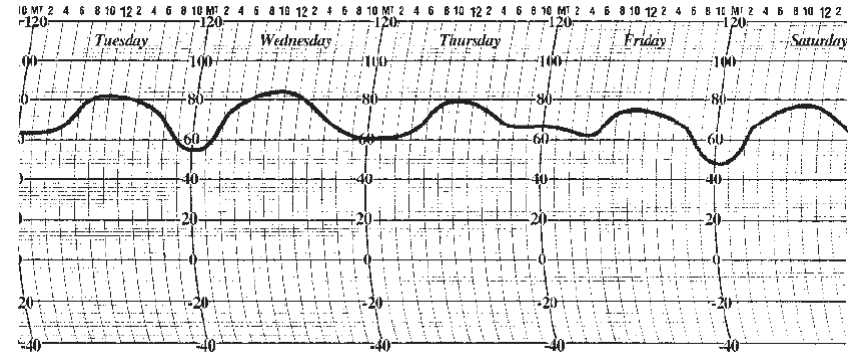
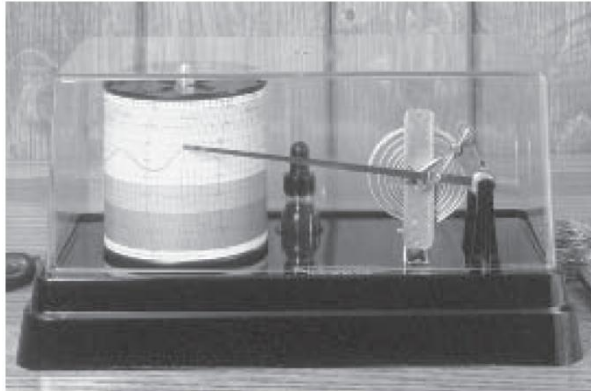
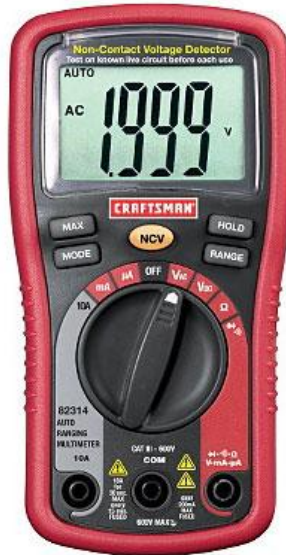


- Aquisição dados
- Conversão DA
- Conversão AD
- Outros tipos de conversores AD
- Características de conversores AD e DA

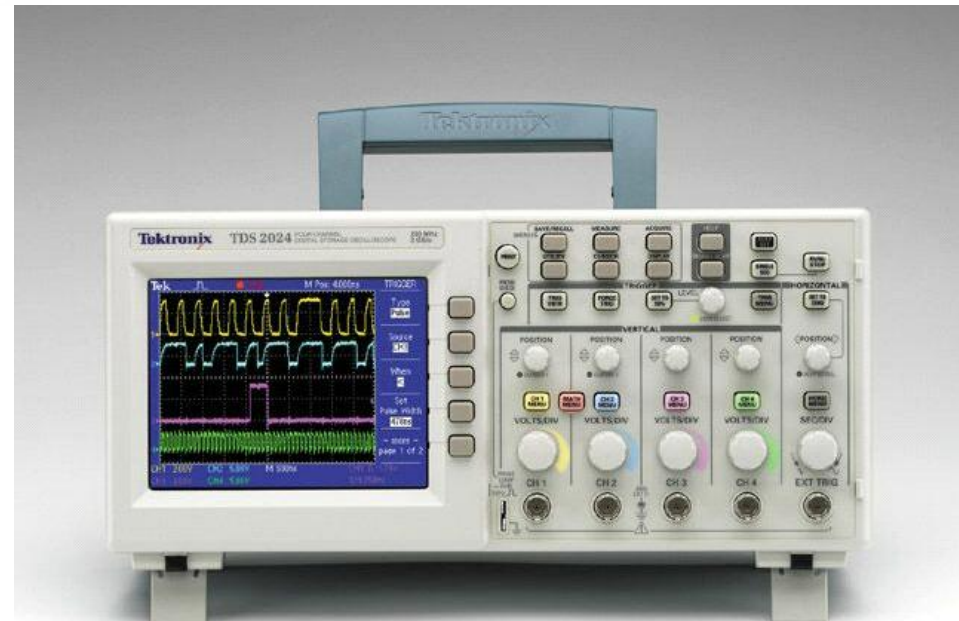


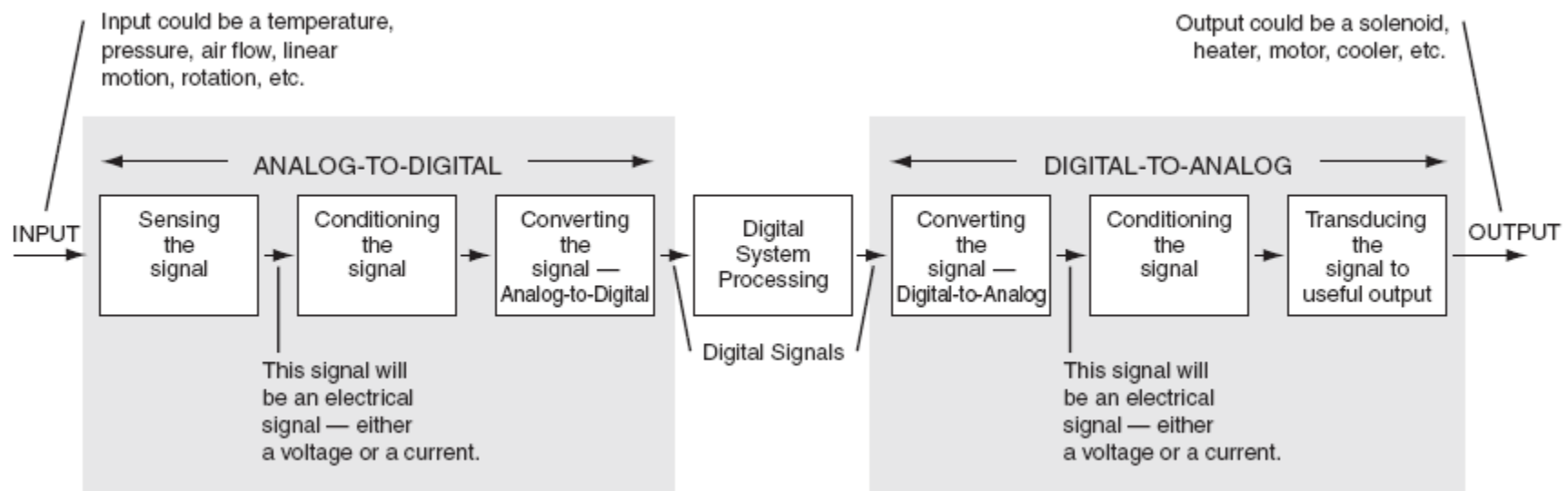


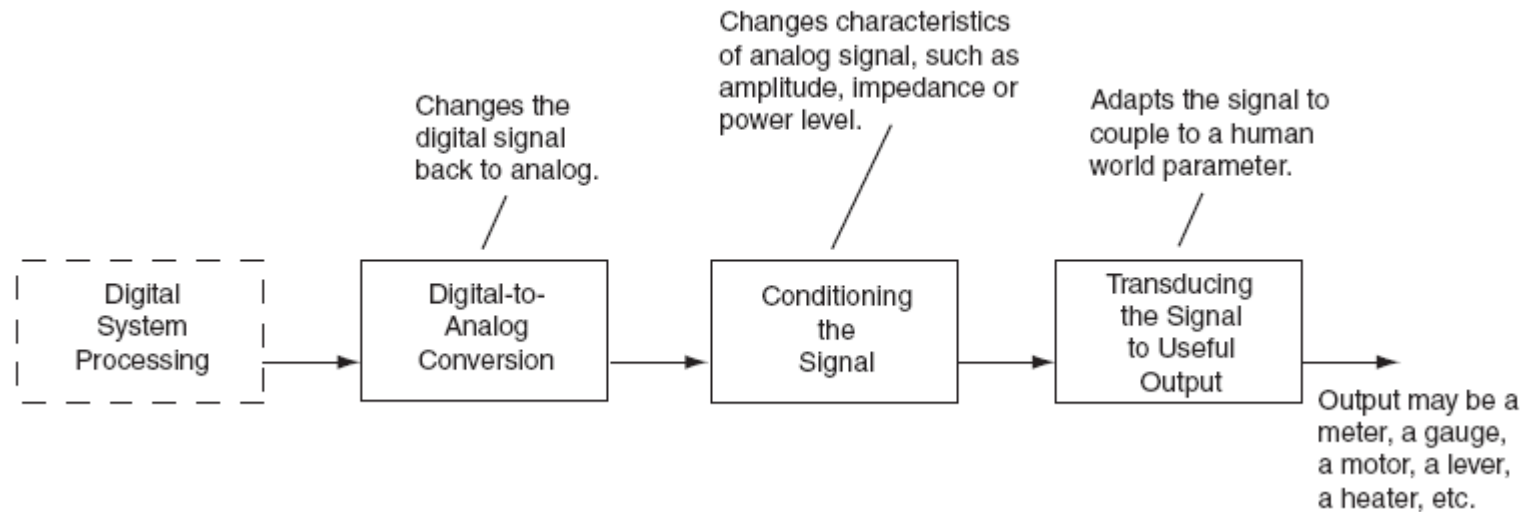


Multímetro

Osciloscópio

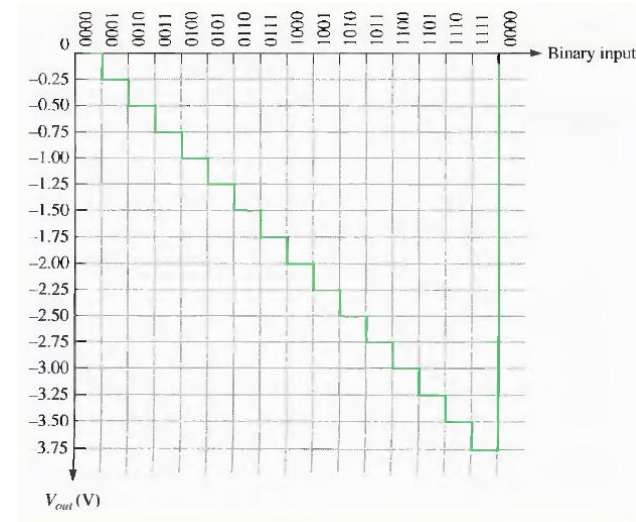
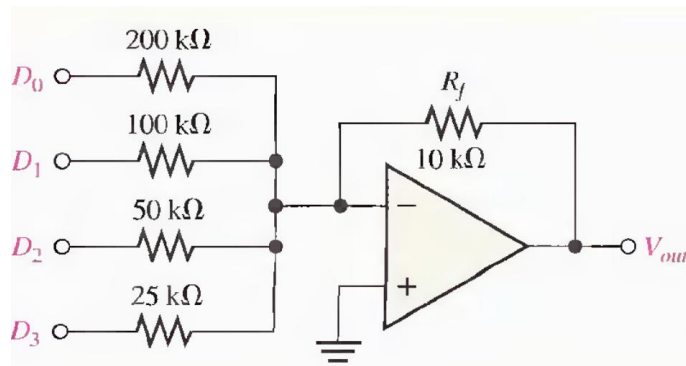




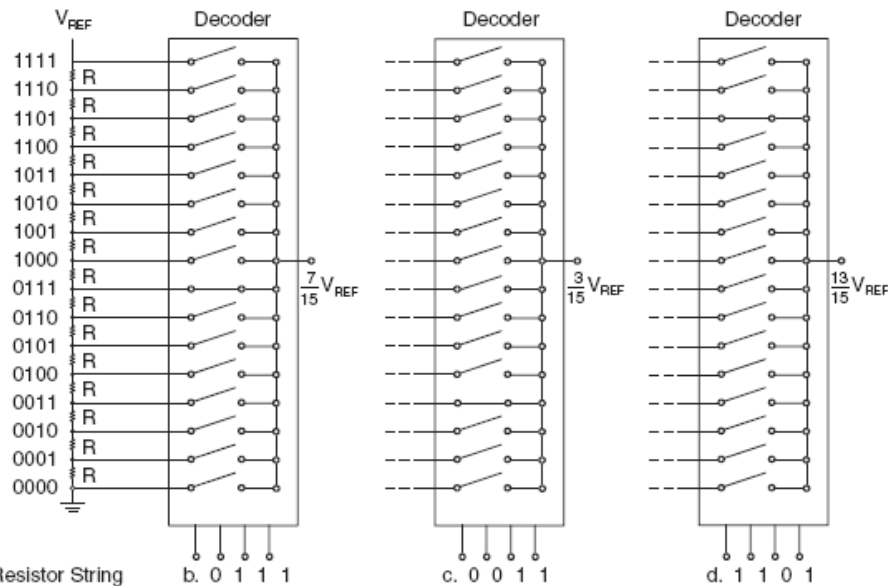


0's e 1's para níveis de tensão analógicos

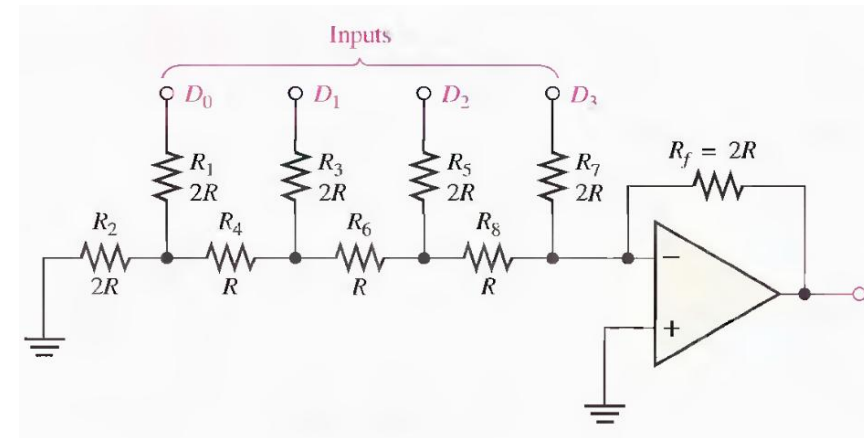
DA com entrada digital binária ponderada

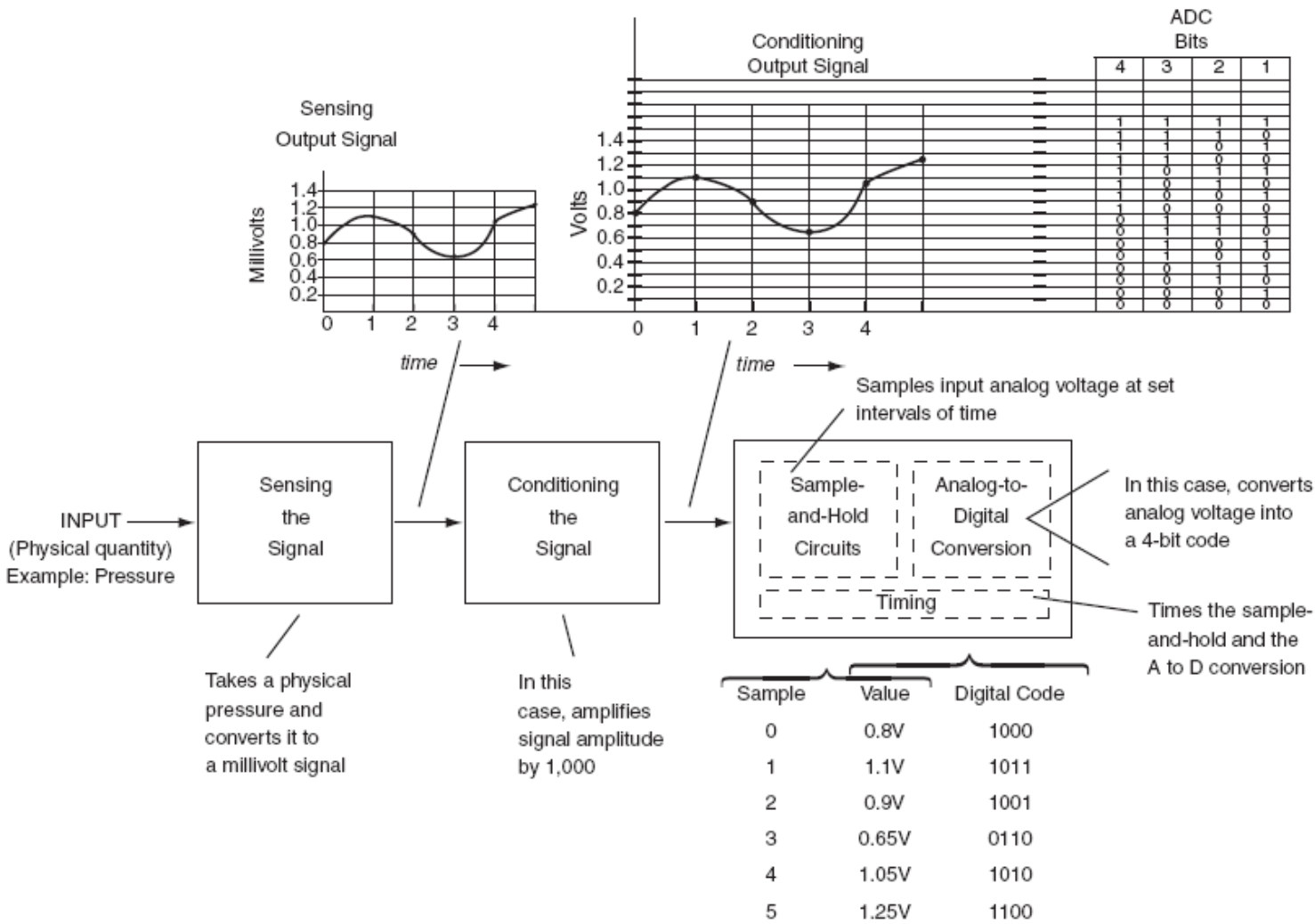


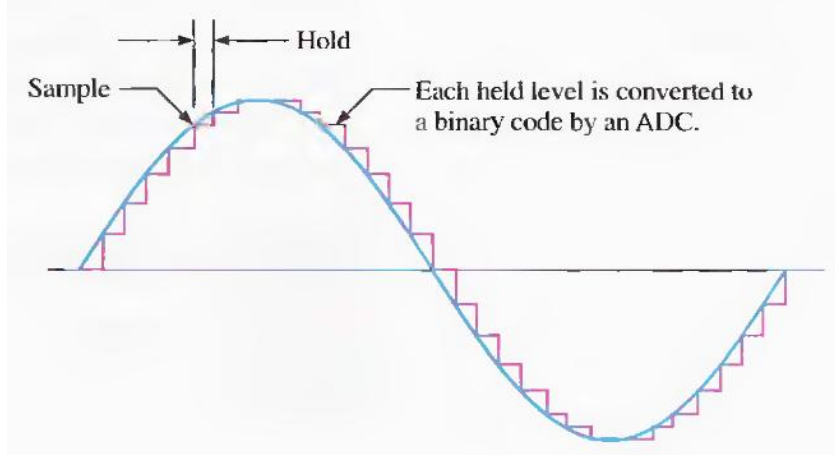
DA com cadeia de resistores



DA com escada R/2R

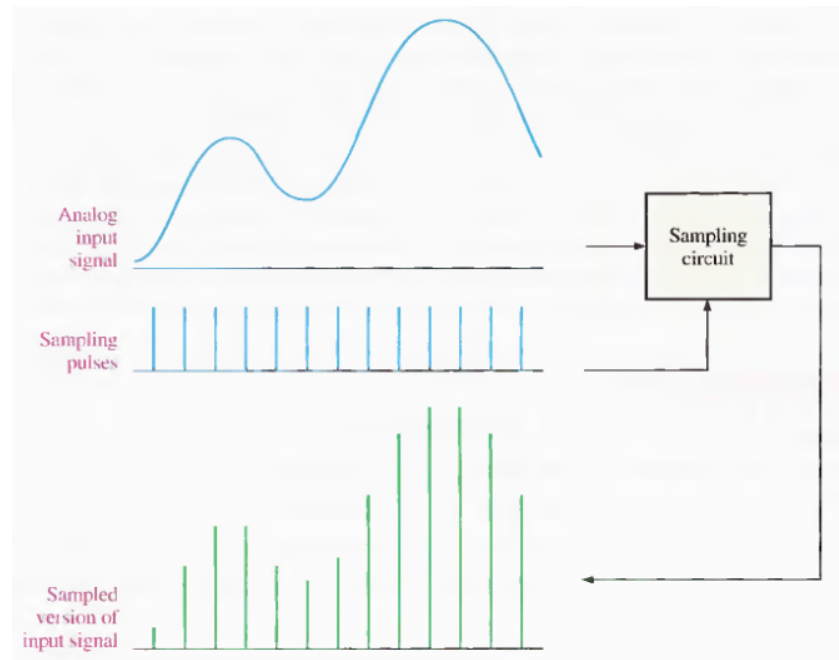
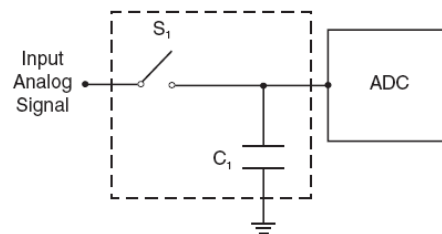




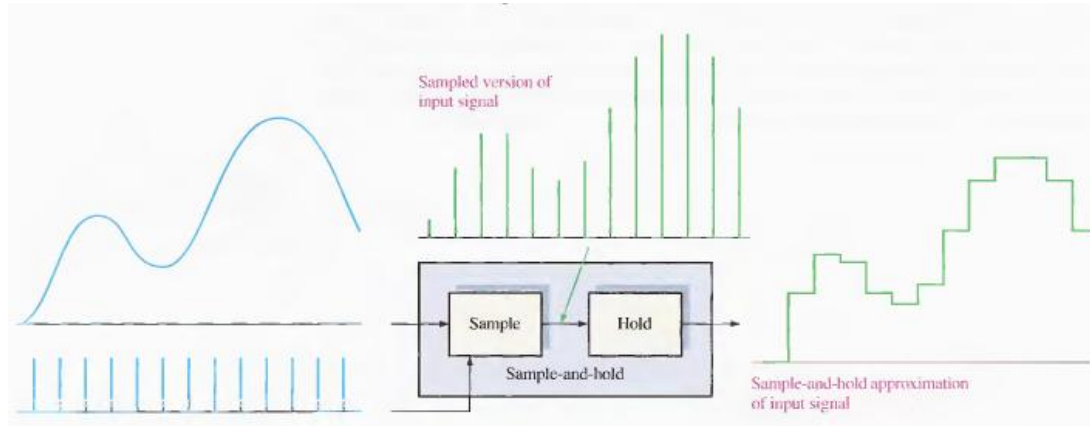


Representação em um determinado número de níveis

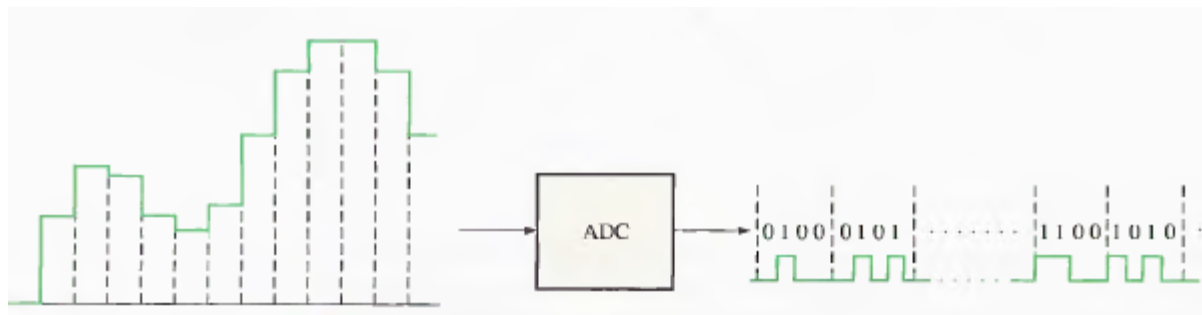
Amostrar e reter



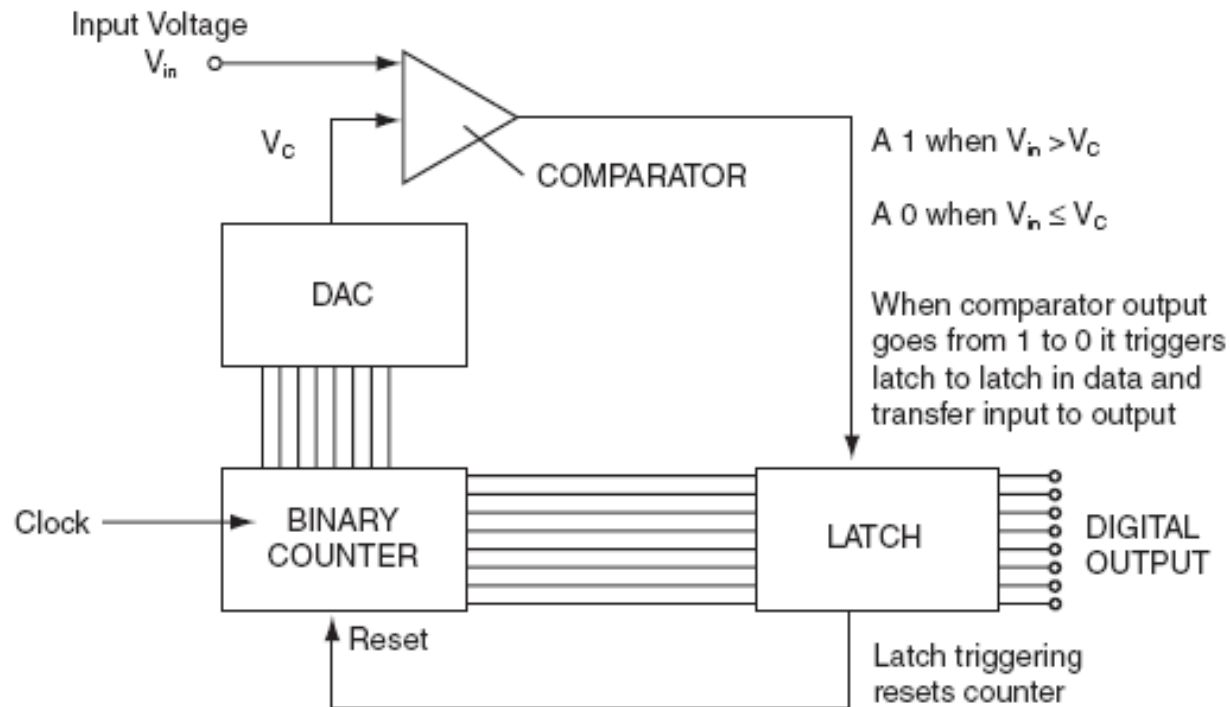
Amostrar e reter



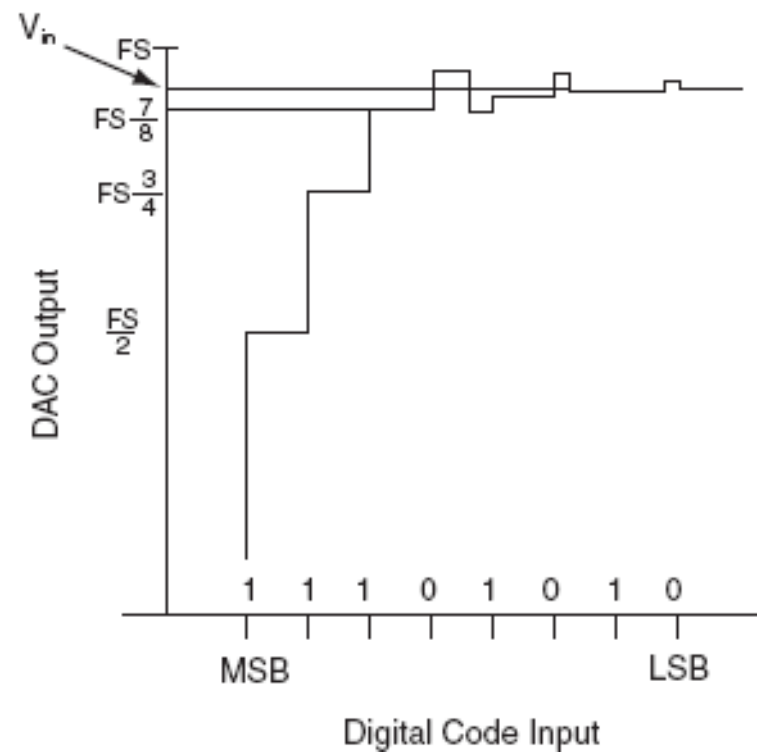
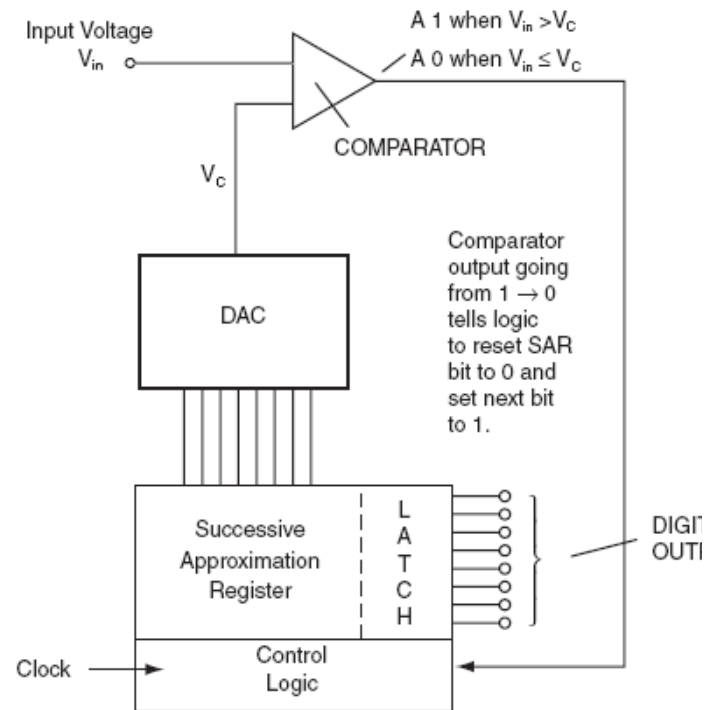
Amostras retidas → Números binários



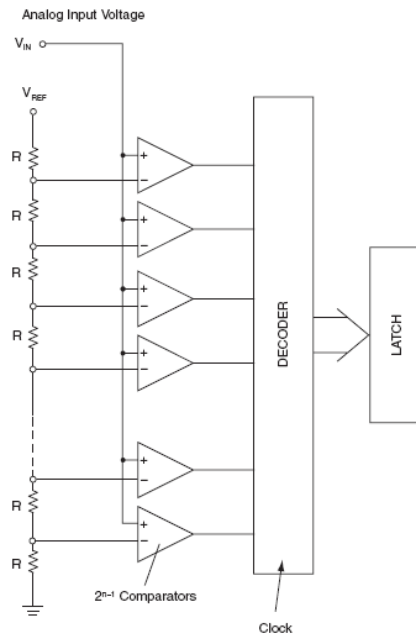
Conversor AD com contador binário



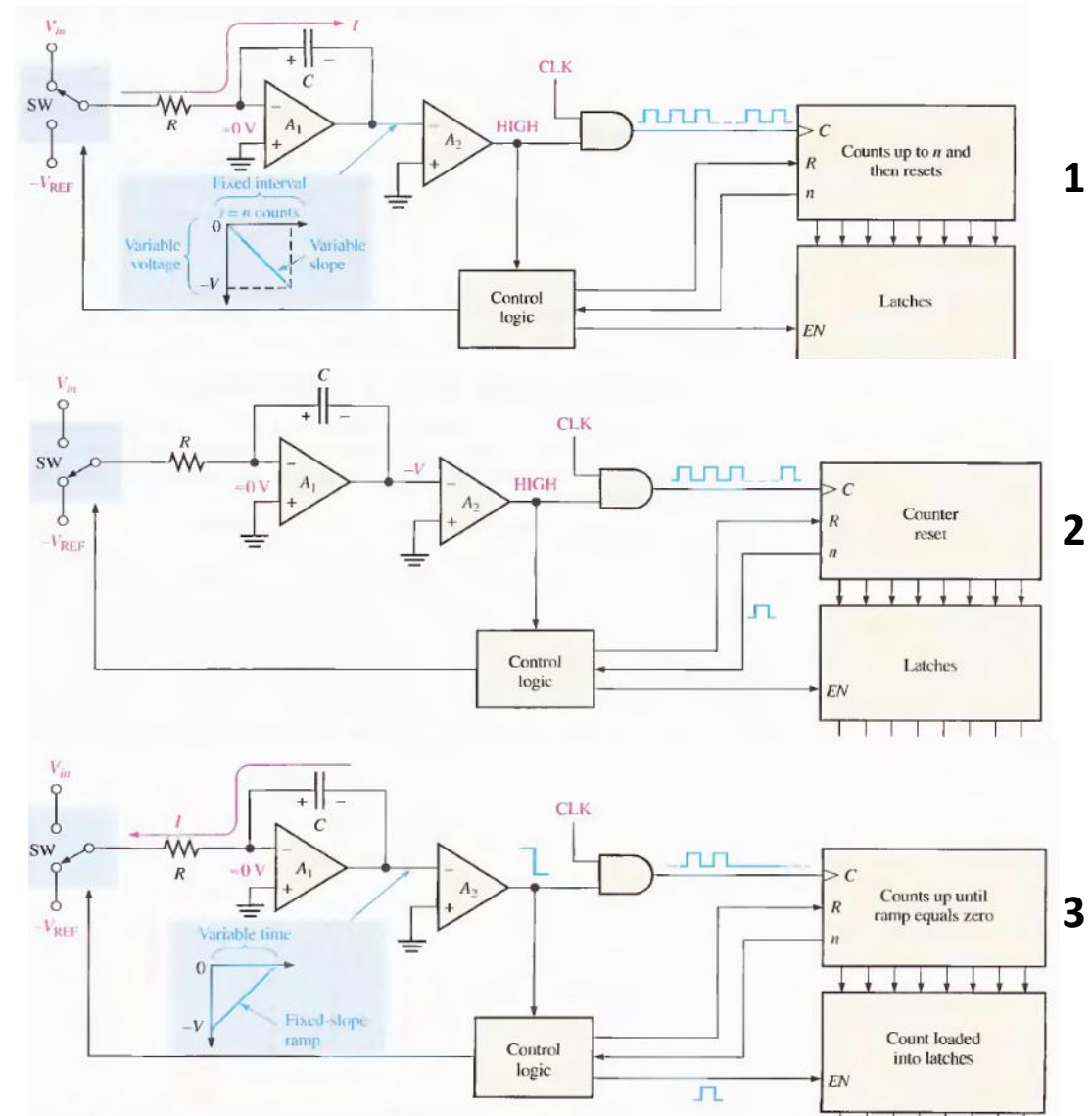
Conversor AD com Aproximação Sucessiva



Conversor AD tipo Flash



Conversor AD Dual-Slope



Características de conversores AD e DA

Número de bits

Taxa de amostragem

Faixa de tensão de entrada

Resolução $Q = \frac{\Delta V}{2^n}$

Erro de quantização $e_q = \pm \frac{Q}{2}$

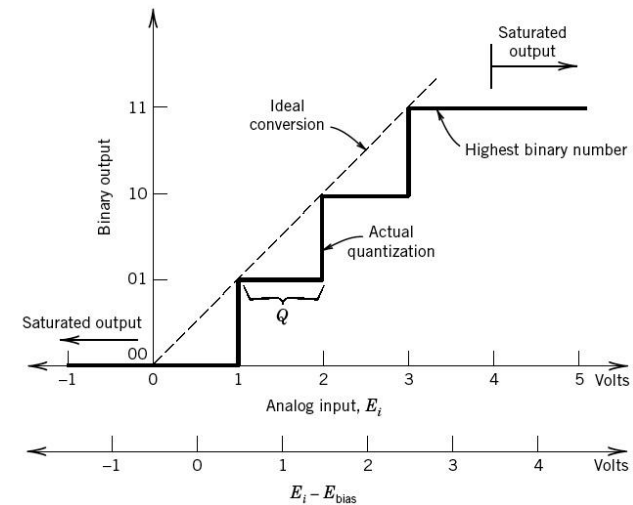
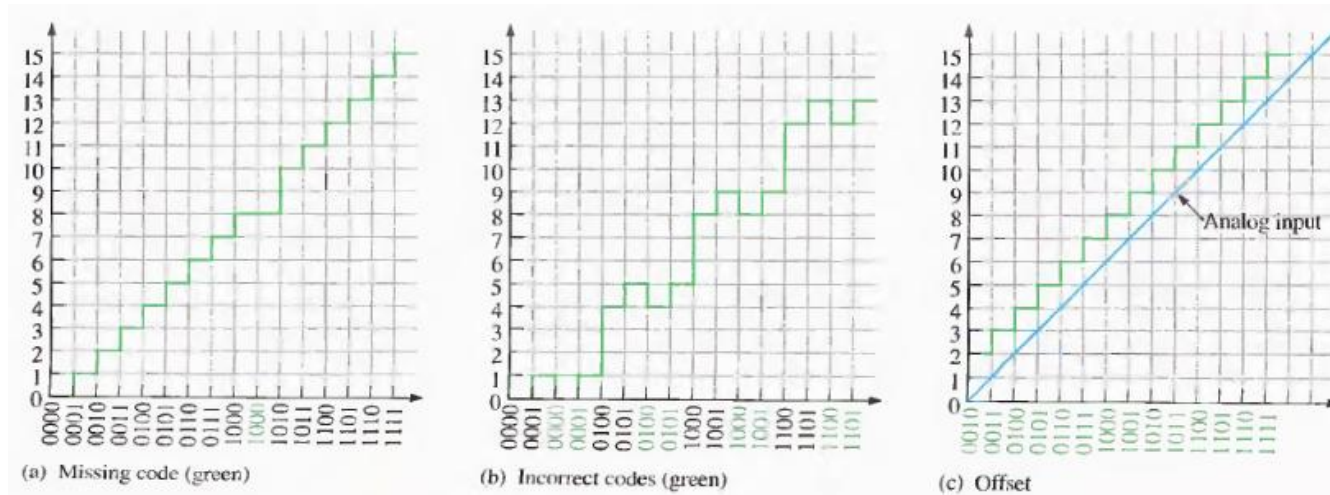
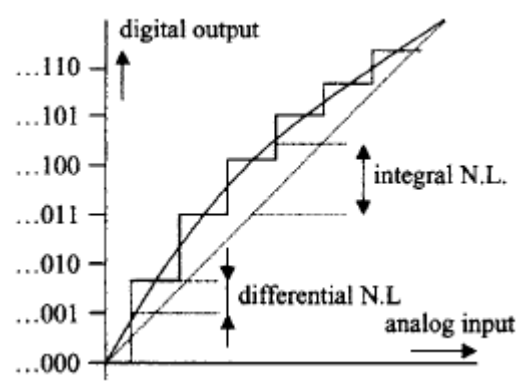


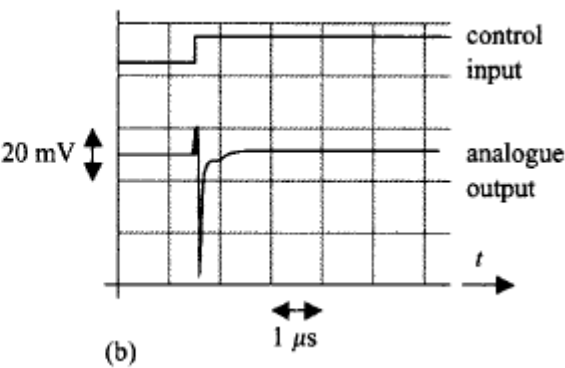
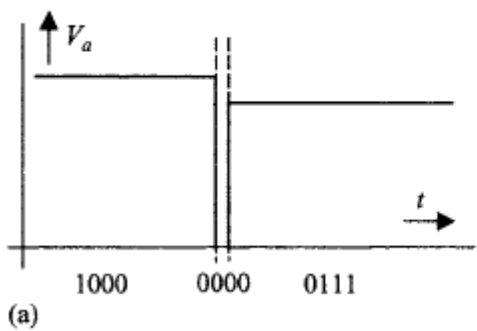
Figure 7.7 Binary quantization and saturation.



Características de conversores AD e DA

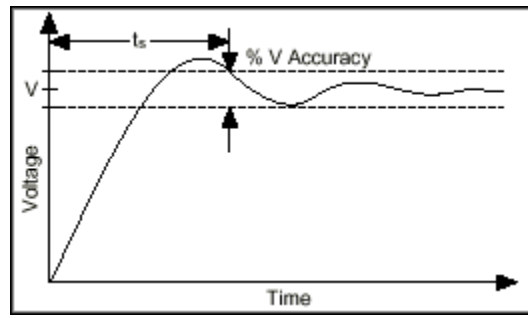
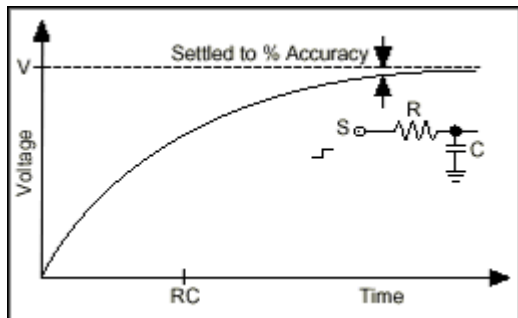
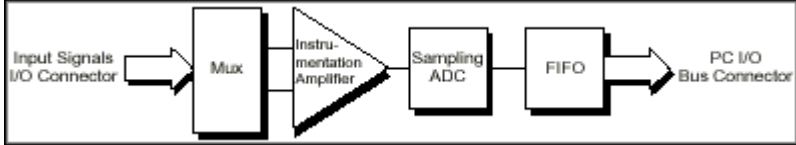


Não-linearidade diferencial e integral



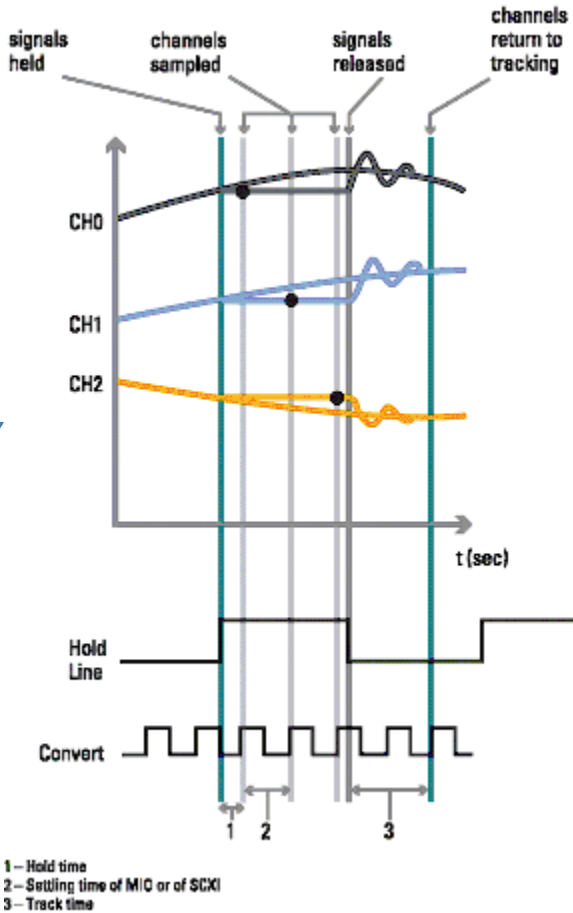
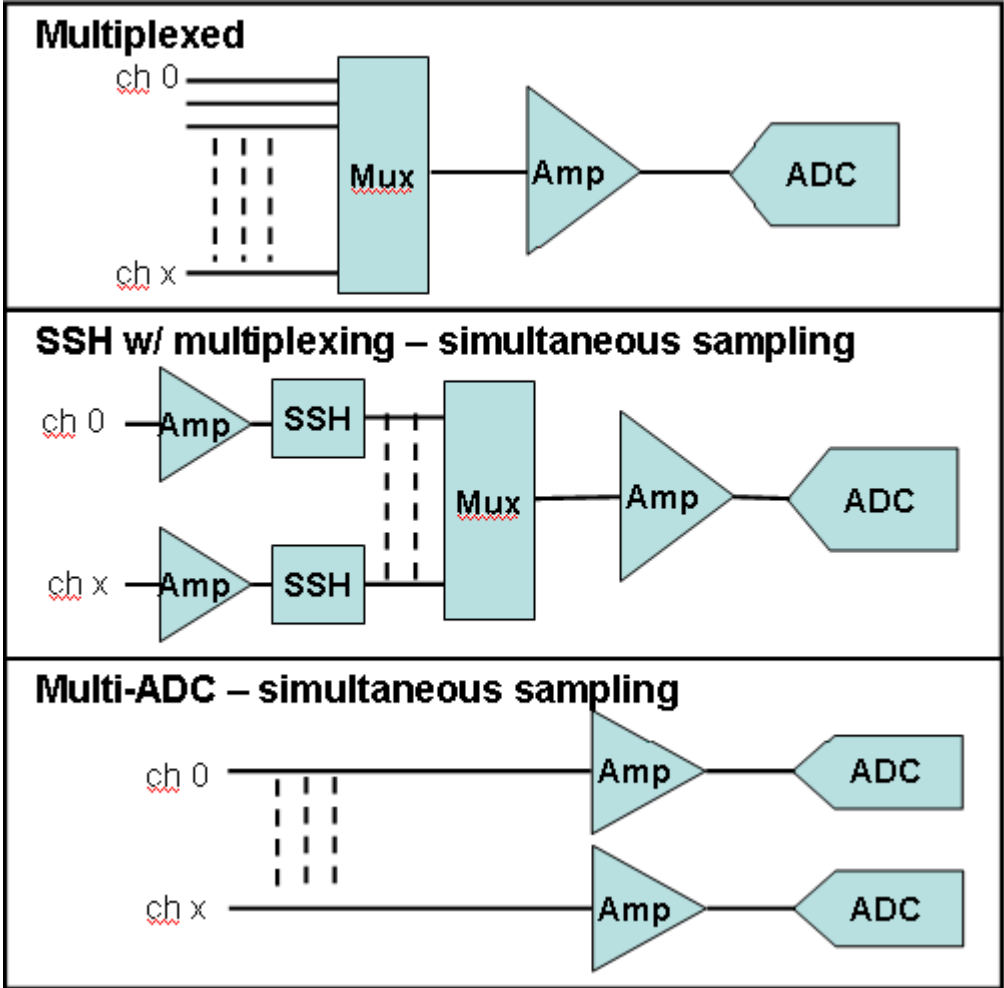
Glitching

Tempo de ajuste – settling time

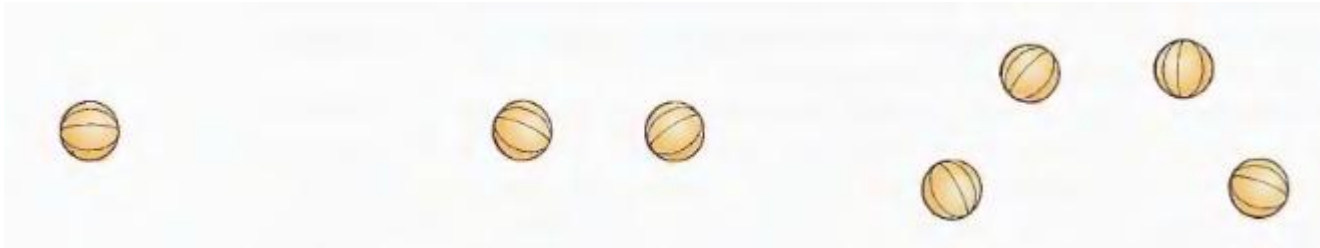


Características de conversores AD e DA

Múltiplos canais



Aliasing



Diferentes tempos de amostragem

Aliasing

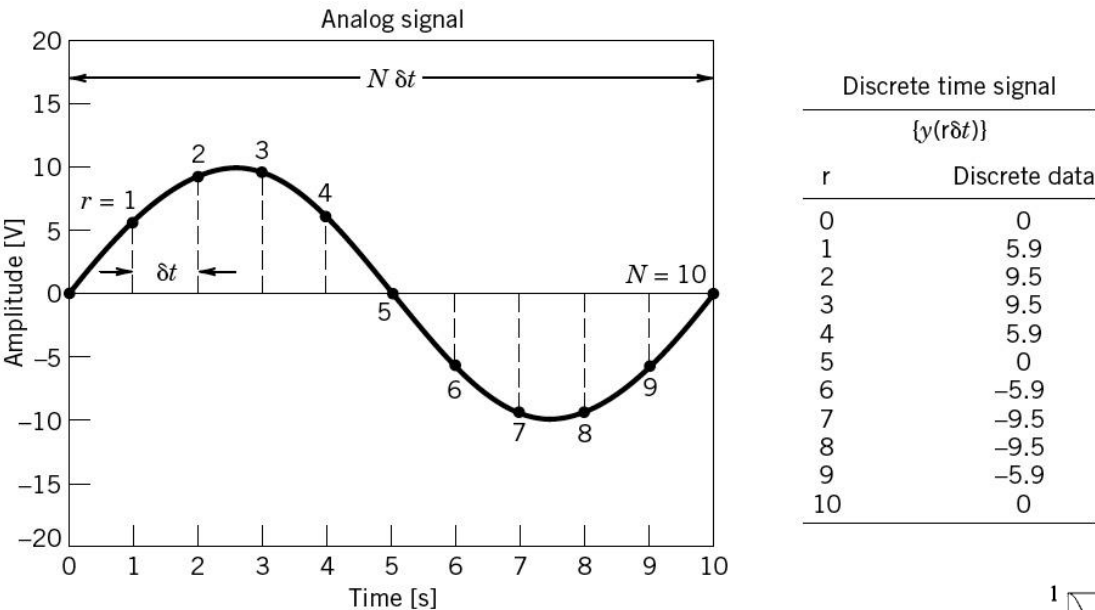
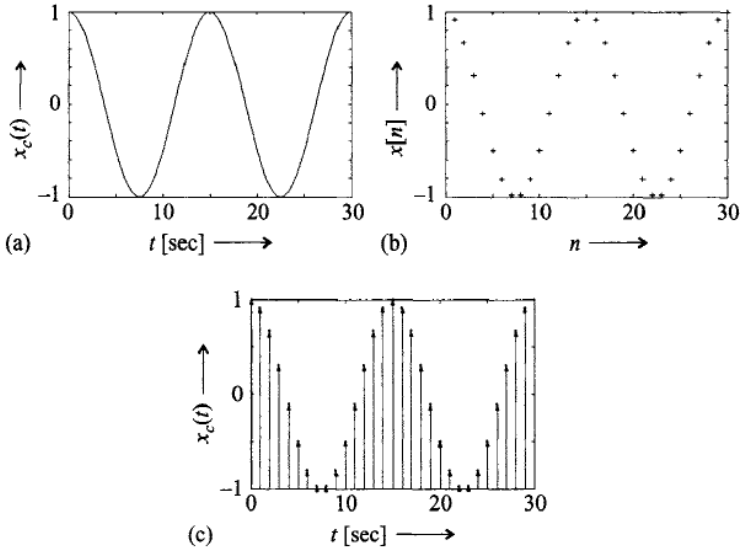


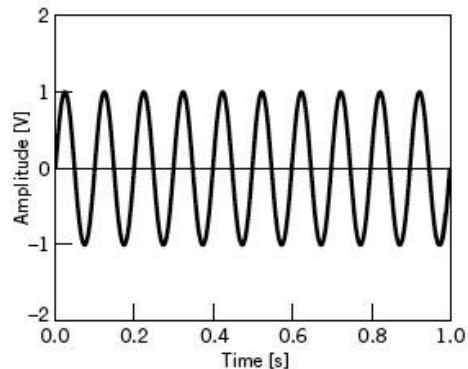
Figure 7.1 Analog and discrete representations of a time-varying signal.



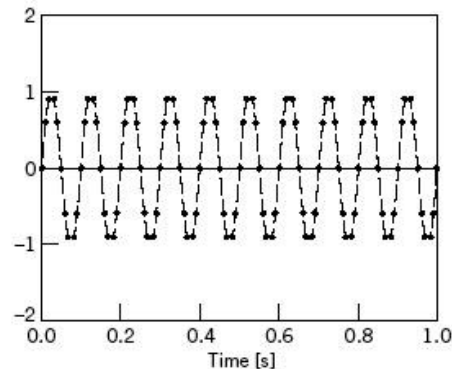
Aliasing

Frequência de Nyquist

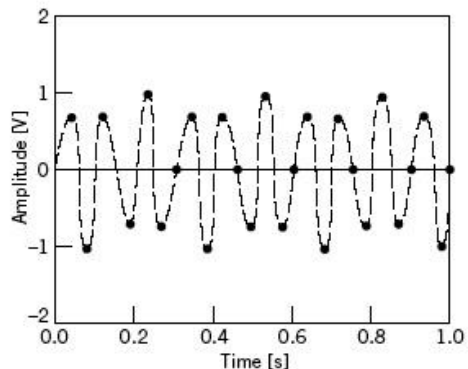
$$f_{\text{sampl}} \geq 2 f_{\text{cut}}$$



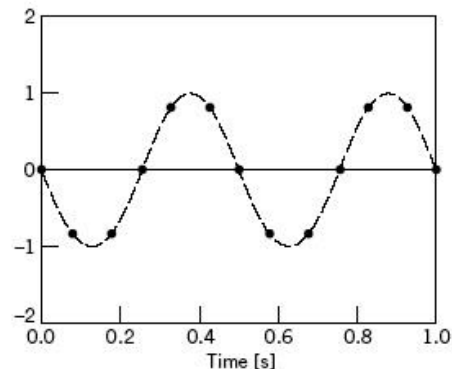
(a) Original 10-Hz sine wave analog signal



(b) $f_s = 100$ Hz



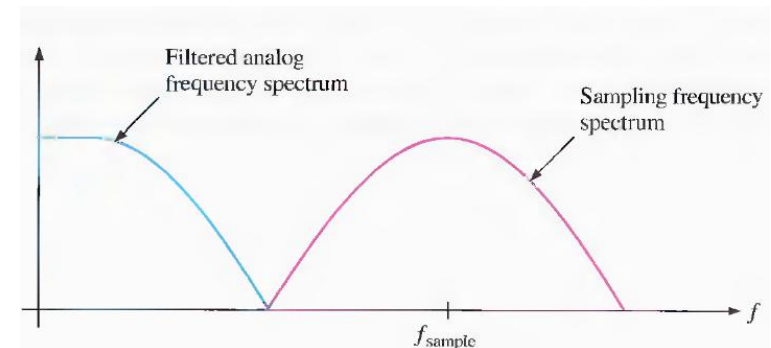
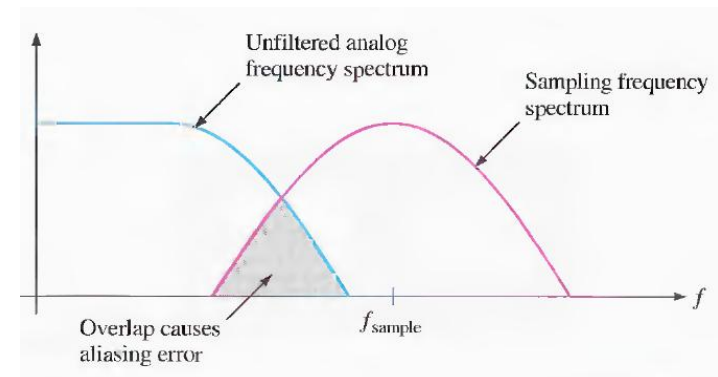
(c) $f_s = 27$ Hz



(d) $f_s = 12$ Hz

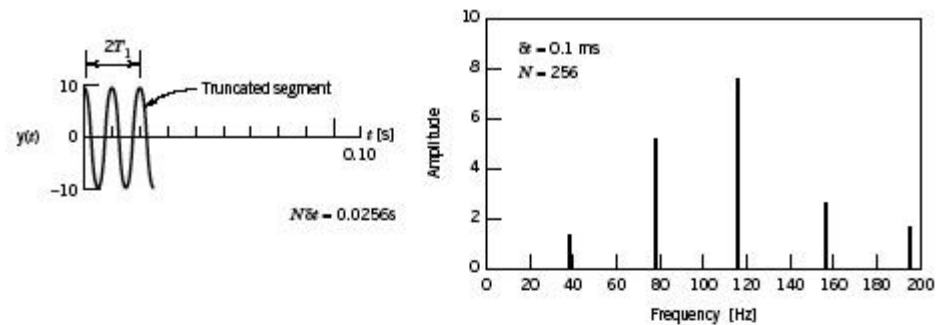
Figure 7.2 The effect of sample rate on signal frequency and amplitude interpretation.

Filtragem

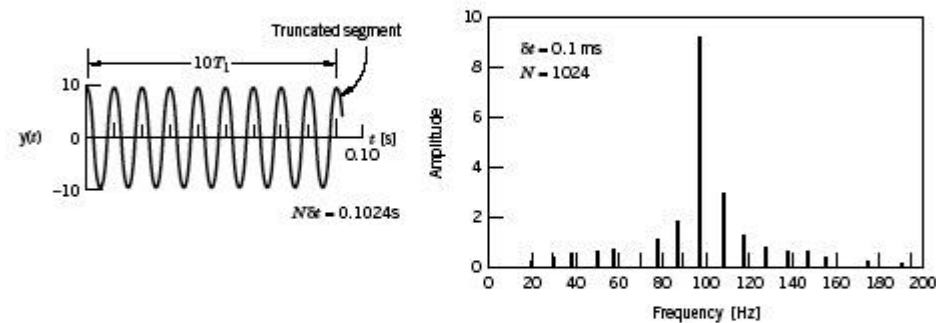


Na prática utilizam-se filtros de amostragem de freq. de corte pelo menos 5x menor que a freq. de amostragem

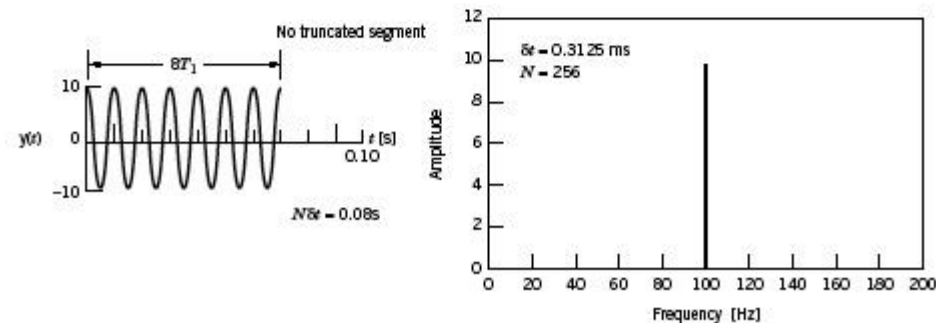
Ambiguidade de amplitude - Leakage



(a) $N = 256$, $\delta f = 39$ Hz



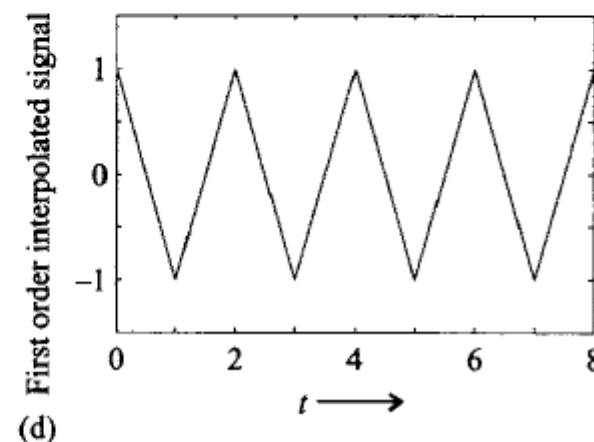
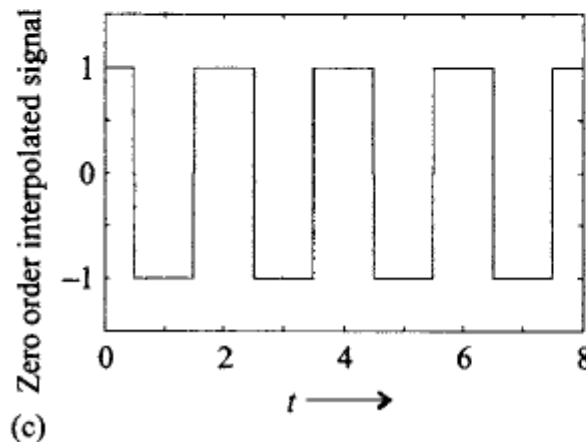
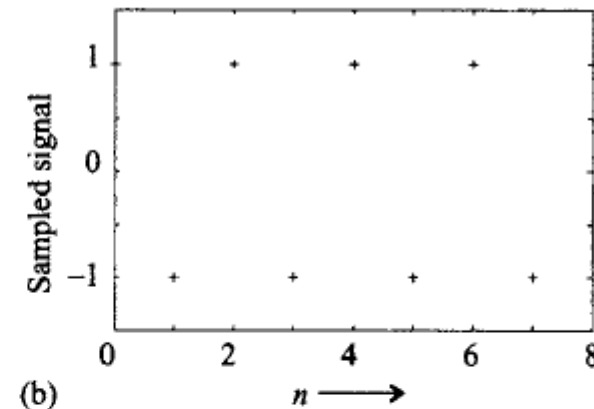
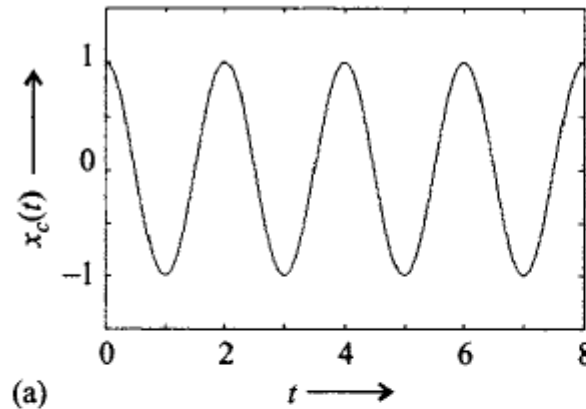
(b) $N = 1024$, $\delta f = 9.8$ Hz



(c) $N = 256$, $\delta f = 12.5$ Hz

Figure 7.4 Amplitude spectra for $y(t)$. (a) $\delta f = 39$ Hz. (b) $\delta f = 9.8$ Hz. (c) $\delta f = 12.5$ Hz.

Filtro de reconstrução

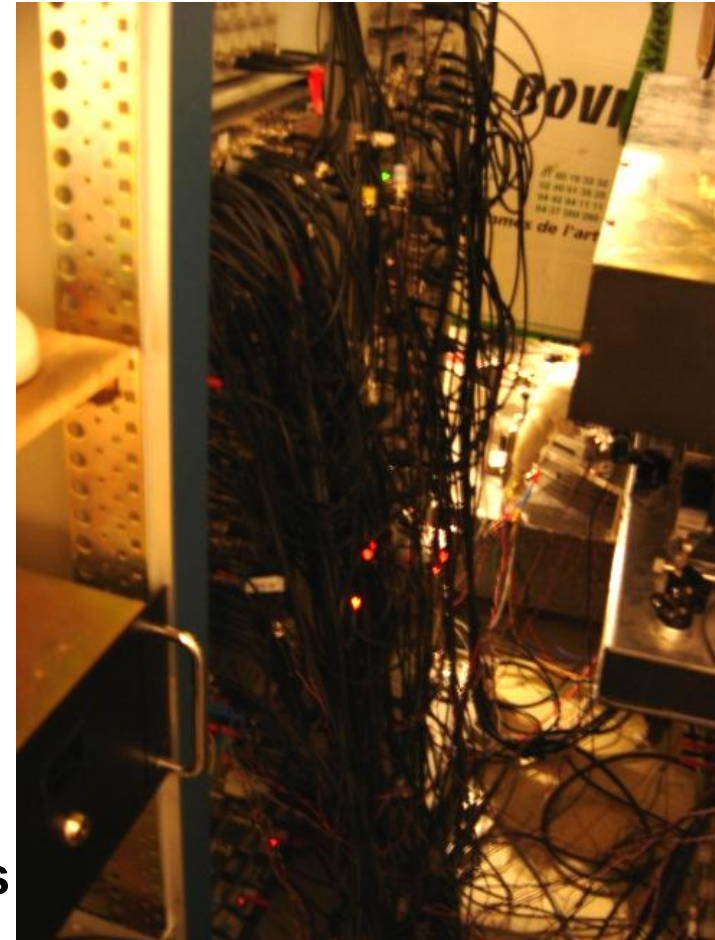


Resposta ideal para um filtro de reconstrução

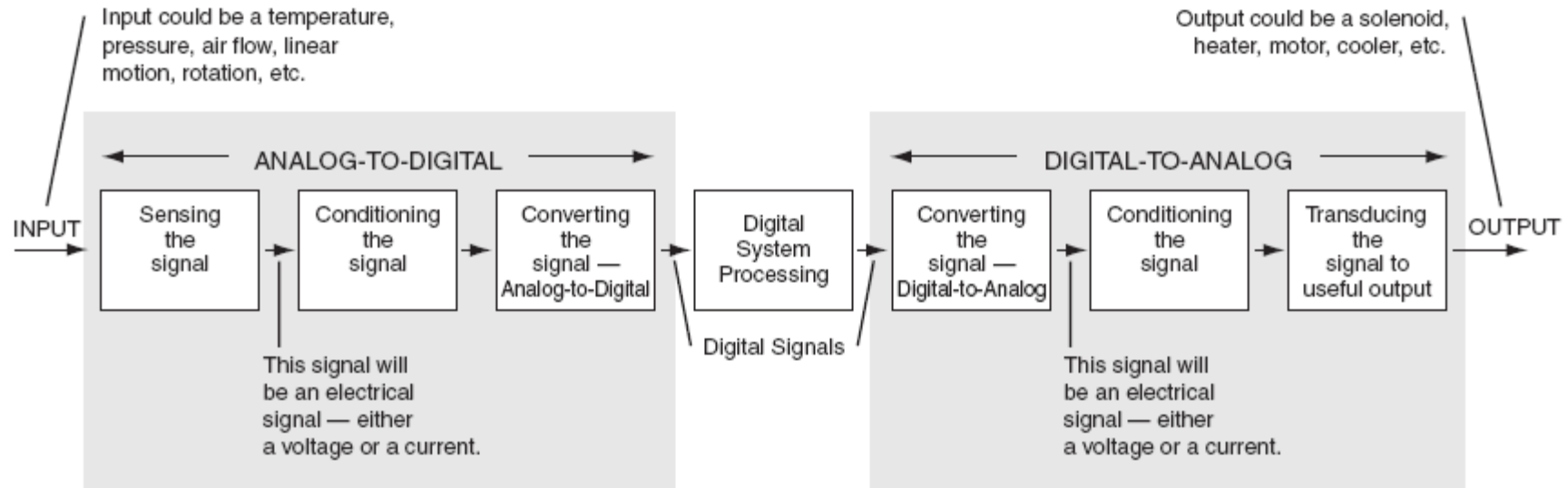
$$x_r(t) = \sum_{n=-\infty}^{\infty} x[n] \operatorname{sinc} \frac{\pi(t - n\Delta t)}{\Delta t}$$

Interligações

- Cabeamento
- Conexões
- Interfaces com instrumentos de medidas



Interligações



- *Conectar fisicamente diversas partes em um sistema de medida*
- *Conexões adequadas a cada parte do sistema (Custo/Benefício)*
- *Imunidade a ruído do sistema de medição*
- *Minimização de erros de medição*

Fios e cabos

Conexões rígidas, resistência a torção, facilidades de conexão, resistência elétrica

Cabo metálico e óptico

Transmissão de informação, imunidade a ruído, perda de transmissão

Cabos simples, trançados, coaxiais

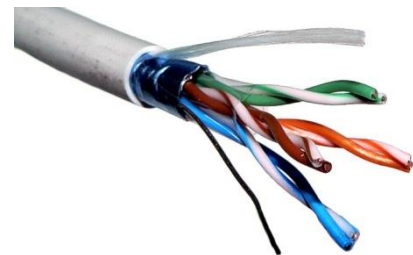
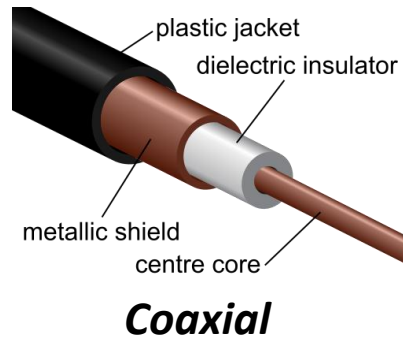
Faixas de frequência, imunidade a ruído

Cabos com múltiplos pares

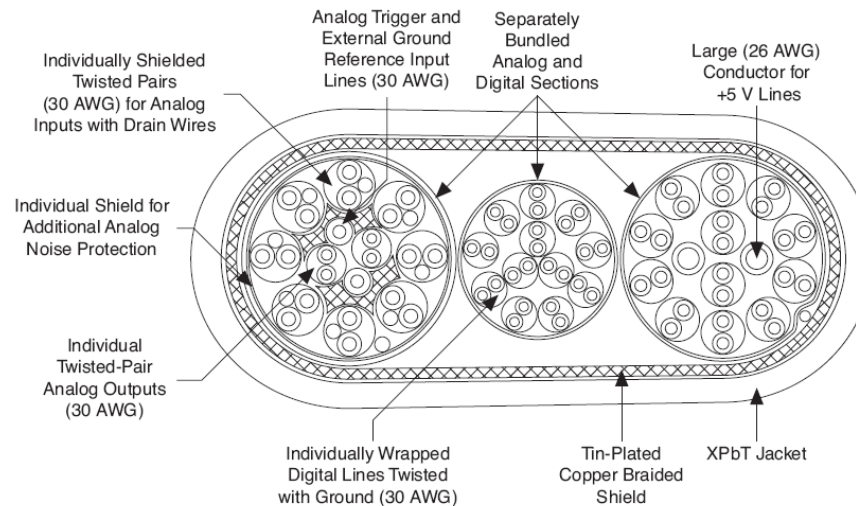
Imunidade a ruído



Ribbon, Flat cable



UTP – Par Trançado



Cabo DAQ - NI



Cabos Coaxiais

Type (/U)	MIL-W-17	Z0(Ω)	Dielectric Type	Capacitance (pF/ft)	O.D. (in.)	dB/100 ft @400 MHz	Vmax (rms)	Shield
RG-58	/28-RG58	53.5	PE	28.8	0.195	11.7	1,900	Braid
RG-58A	/28-RG58	52.0	PE	29.6	0.195	13.2	1,900	Braid
RG-58B		53.5	PE	28.8	0.195	14.0	1,900	Braid
RG-58C	/28-RG58	50.0	PE	30.8	0.195	14.0	1,900	Braid
RG-59/A	/29-RG59	73.0	PE	21.1	0.242	10.5	2,300	Braid
RG-59B	/29-RG59	75.0	PE	20.6	0.242	9.0	2,300	Braid
RG-62/A/B	/30-RG62	93.0	ASP	13.5	0.242	8.0	750	Braid
RG-63/A/B	/31-RG63	125.0	ASP	10.0	0.405	5.5	1,000	Braid
RG-65/A	/34-RG65	950.0	ASP	44.0	0.405	16 @5MHz	1,000	Braid
RG-71/A/B	/90-RG71	93.0	ASP	13.5	0.245	8.0	750	Braid
RG-79/A/B	/31-RG79	125.0	ASP	10.0	0.436	5.5	1,000	Braid
RG-83		35.0	PE	44.0	0.405	9.0	2,000	Braid
RG-88		48.0		50.0	0.515	0.7 @1MHz	10,000	Braid
RG-108/A	/45-RG108	78.0	PE	19.7	0.235	2.8 @10MHz	1,000	Braid
RG-111/A	/15-RG111	95.0	PE	16.3	0.478	10.5	1,000	Braid
RG-114/A	/47-RG114	185.0	ASP	6.5	0.405	8.5	1,000	Braid
RG-119	/52-RG119	50.0	ST	29.4	0.465	3.8	6,000	Braid
RG-120	/52-RG120	50.0	ST	29.4	0.523	3.8	6,000	Braid
RG-122	/54-RG122	50.0	PE	30.8	0.160	18.0	1,900	Braid
RG-130	/56-RG130	95.0	PE	17.0	0.625	8.8	3,000	Braid
RG-131	/56-RG131	95.0	PE	17.0	0.683	8.8	3,000	Braid
RG-133/A	/100-RG133	95.0	PE	16.3	0.405	5.7	4,000	Braid
RG-141/A		50.0	ST	29.4	0.190	9.0	1,900	Braid
RG-142/A/B	/60-RG142	50.0	ST	29.4	0.195	9.0	1,900	Braid
RG-144	/62-RG144	75.0	ST	19.5	0.410	4.5	5,000	Braid
RG-164	/64-RG164	75.0	PE	20.6	0.870	2.8	10,000	Braid
RG-165	/65-RG165	50.0	ST	29.4	0.410	5.0	5,000	Braid
RG-166	/65-RG166	50.0	ST	29.4	0.460	5.0	5,000	Braid
RG-174		50.0		30.5	0.110	14.7		Braid

Alimentação, Sinal Digital, Sinal Analógico

Faixa de frequência

Robustez

Número de vias (pinos)



BANANA

Conexões simples, BF

Conexões de alimentação

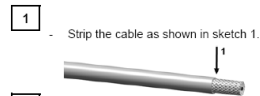
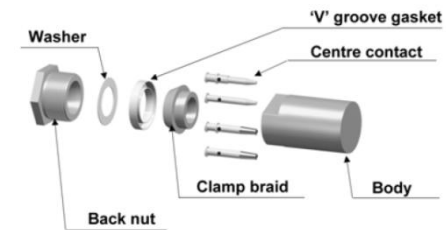
Adaptações para outros tipos de conexão



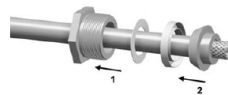
BNC

BF e imunidade a ruído

	Standard BNC		Commercial BNC	
Applications	♦ Military Telecommunications ♦ Civil Telecommunications ♦ Measurement and instrumentation ♦ General electronics		♦ Civil Telecommunications ♦ Datacommunications ♦ Measurement and instrumentation ♦ Broadcast application ♦ Security & video systems ♦ Antennas ♦ Automotive industry ♦ General electronics	
Impedance	50 Ω	75 Ω	50 Ω	75 Ω
Codification	R141 XXX XXX	R142 XXX XXX	R141 XXX 161	R142 XXX 161
Frequency range	DC - 4 GHz	DC - 1 GHz	DC - 1.5 GHz	
Temperature range	- 85°C / + 165°C		-35°C / + 70°C	
Durability	500 matings		100 matings	
Coupling nut	Cross knurl		Straight knurl	
Material	Brass		Die cast zinc	
Coupling nut	PTFE		Polypropylen	
Insulator	Beryllium copper		Brass	
Female center contact				



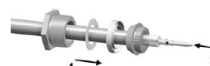
- 1 - Strip the cable as shown in sketch 1.
- 2 - Slide the back nut, the washer and the "V" groove gasket onto the cable.
- 3 - Slide the clamp braid sleeve over the braid.



- 3 - Fold the braid back and trim off the extra braid.
- 4 - Trim dielectric back as shown in sketch 2.



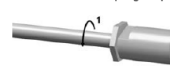
- 4 - Slide the back nut over the cable assembly.
- 5 - Slide the centre contact onto the inner conductor.



- 5 - Solder the centre contact onto the inner conductor.



- 6 - Screw sub-assembly into the connector body with the adapted wrench.
- 7 - Recommended coupling torque (see table).



SMA

50 Ω	DC - 18 GHz
-------------	-------------

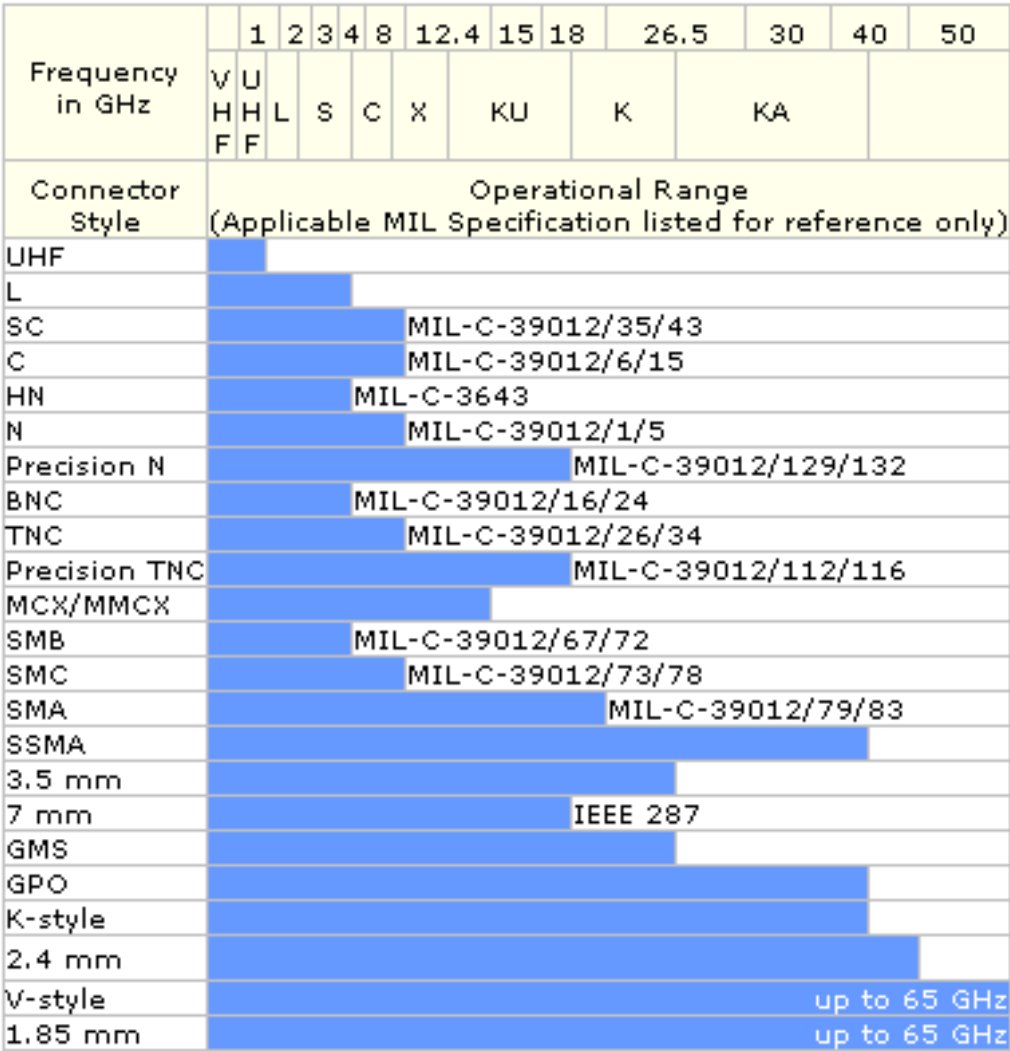


N

50 Ω	DC - 11 GHz
75 Ω	DC - 1.5 GHz



Coaxiais (BNC, SMA, N, ...)



Multipinos

*Comunicação entre circuitos
Sinais de natureza diferente*



- *Comunicação com instrumentos*
- *Leitura de dados*
- *Automação de medidas*
- *Múltiplos instrumentos*



Serial

GPIO

...

NI Automotive Diagnostic Command Set



```
long ndReadStatusOfDTC(  
    TD1 *diagRef,  
    unsigned s  
    TD3 *DTCID  
    TD4 DTCs[  
    long *len,  
    LVBoolean *success,
```



Interfaces

Serial

RS-232C

Data Terminal Equipment (DTE)

Data Communication Equipment (DCE)

Conectores DB-25 ou DB-9

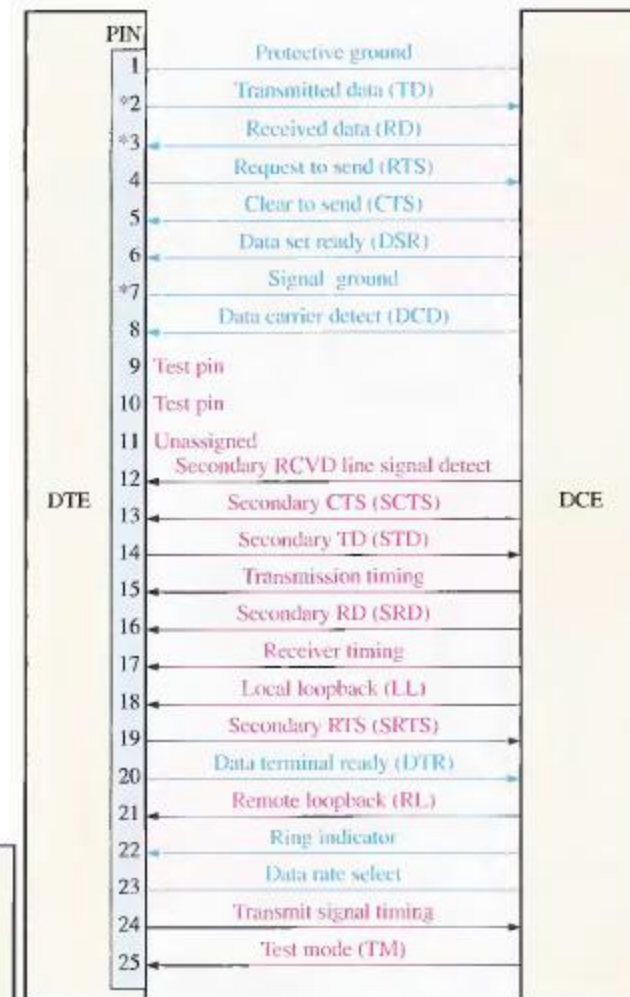
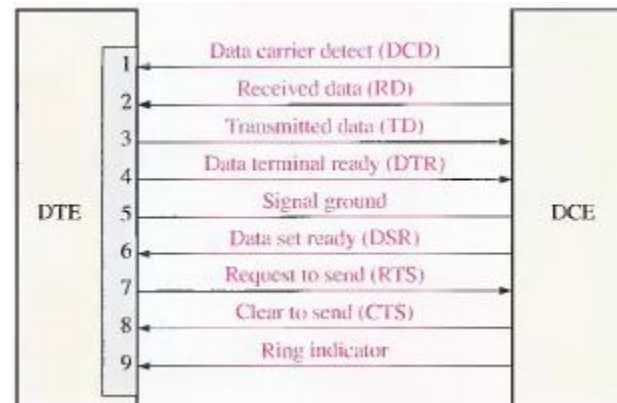
Comunicação de mestre/escravo

Níveis de tensão maiores para dar imunidade a ruídos

Protocolos de hardware e de software

Número variável de pinos (>3)

Equipamentos podem ter interface já preparada para terminal ou cabo de comunicação precisa ter Tx e Rx cruzados



GPIB

HP-IB, GPIB

General Purpose Interface Bus

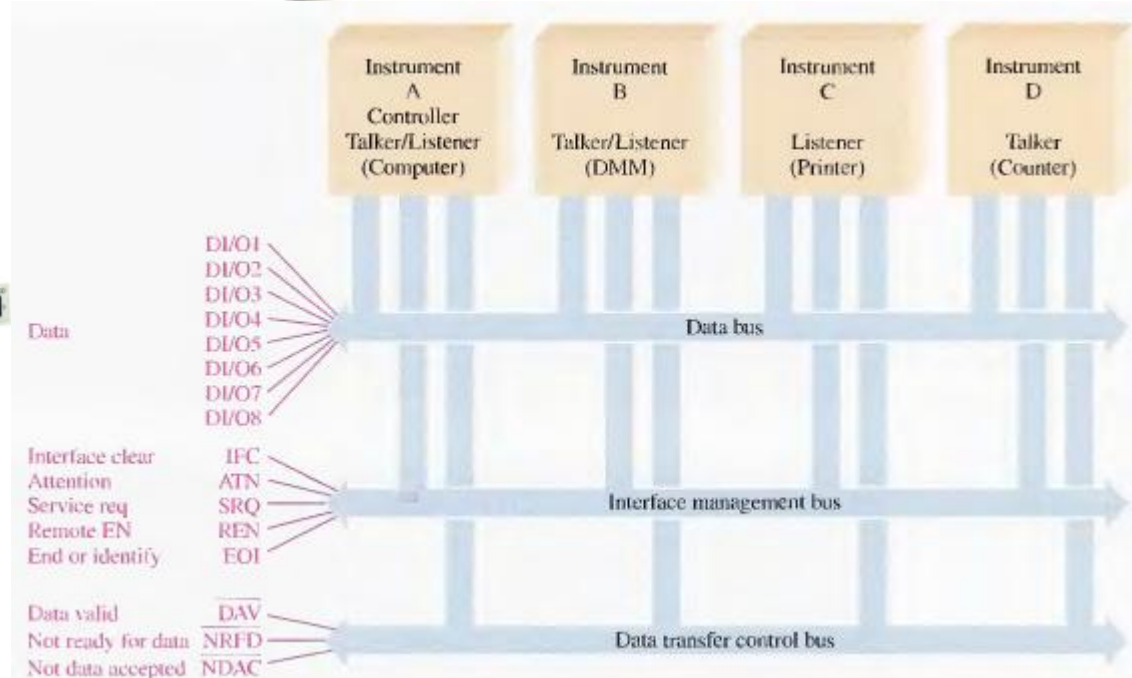
Maior imunidade a ruídos

Conexão de vários equipamentos numa interface

488 – 16 equipamentos

488.2 – 256 equipamentos

Seleção de equipamento por endereço



Interfaces

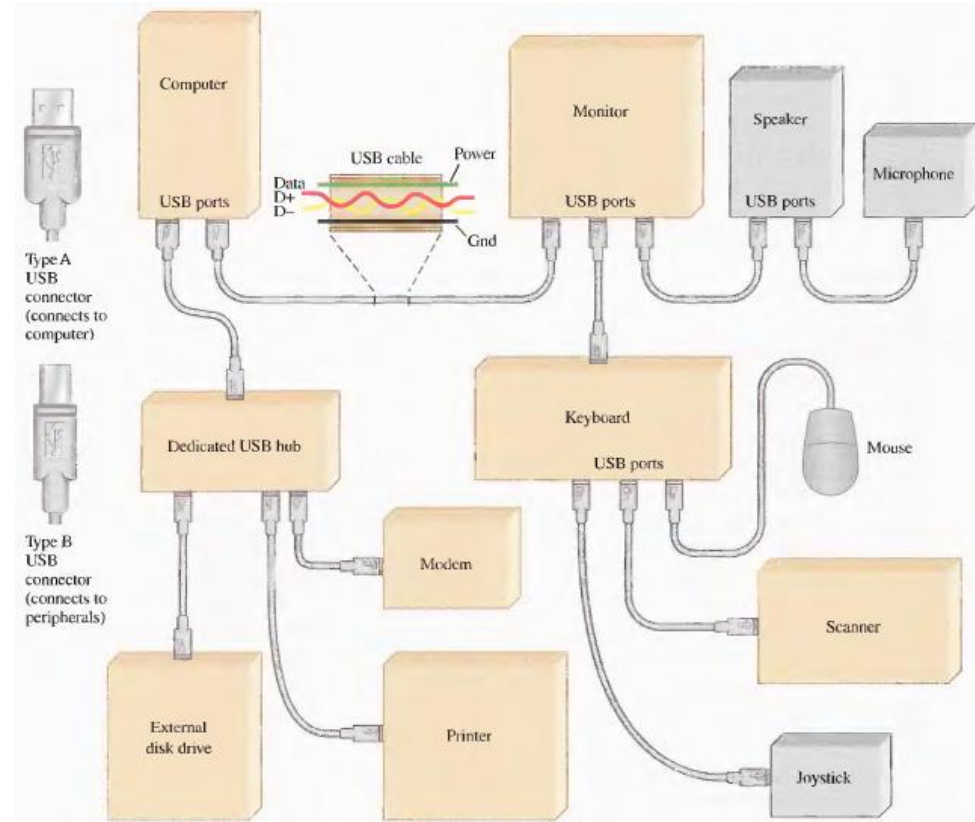
USB

Interface serial mais rápida

Possibilidade de vários equipamentos

Diferentes versões (taxas de comunicação)

USB 1.1, 2.0 (3.0!!!)



IEEE 1394

Firewire

Comunicação de vídeo, câmeras digitais

Ethernet, ...