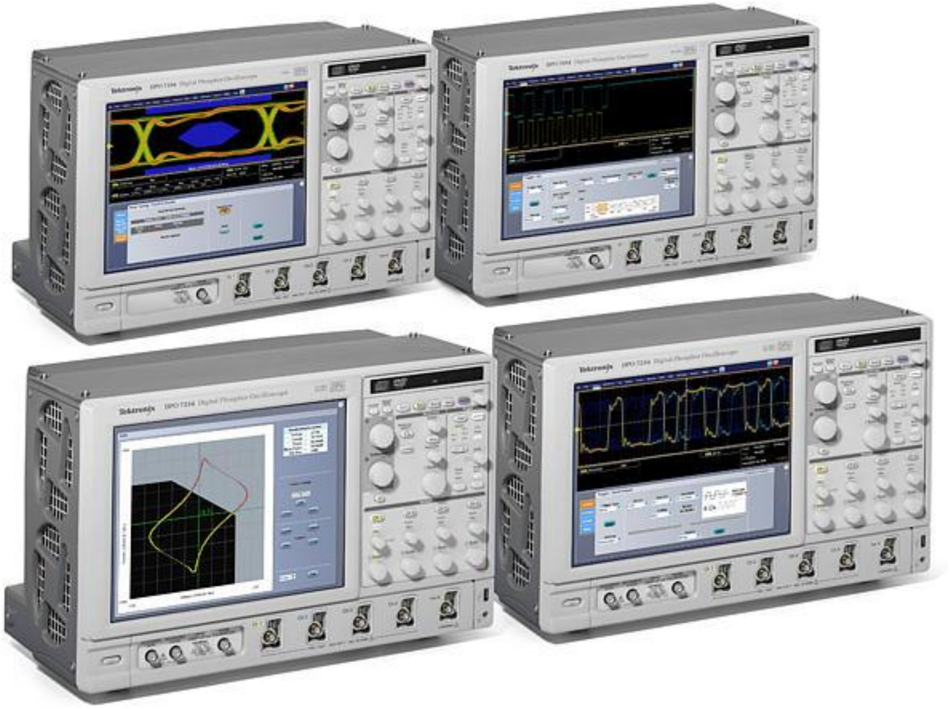
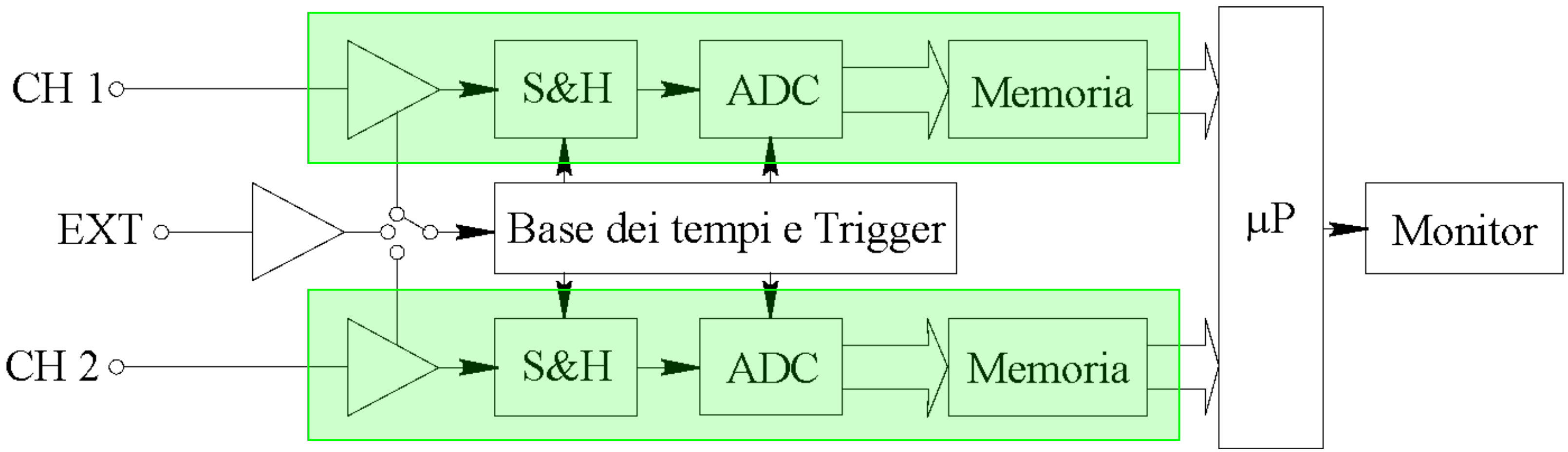
Oscilloscopio digitale

DSO Digital Storage Oscilloscope



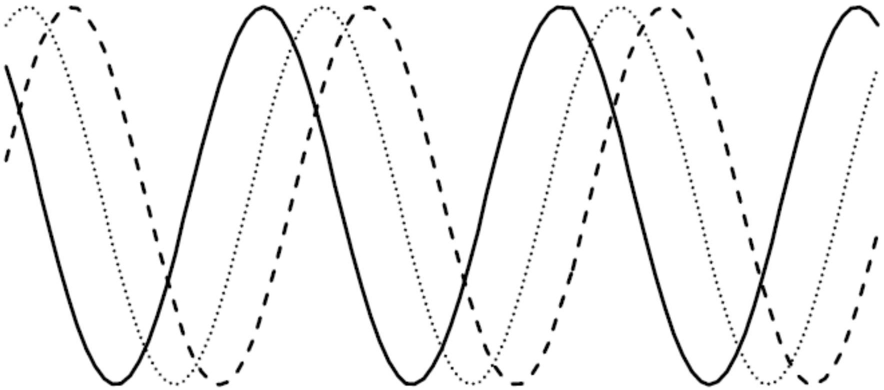
Oscilloscopio digitale

DSO Digital Storage Oscilloscope



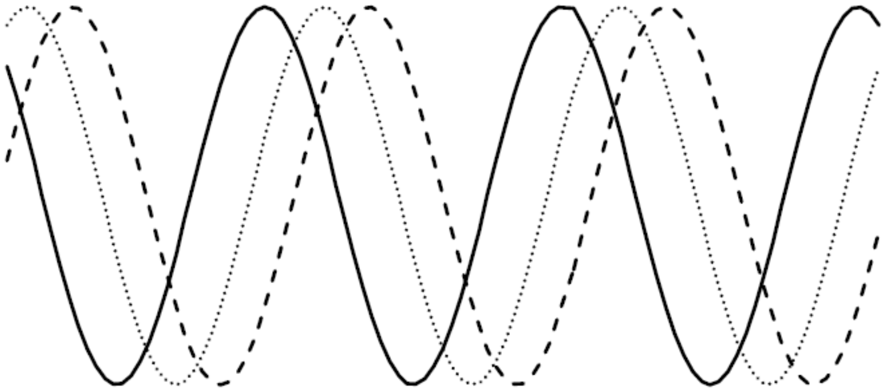
Il trigger

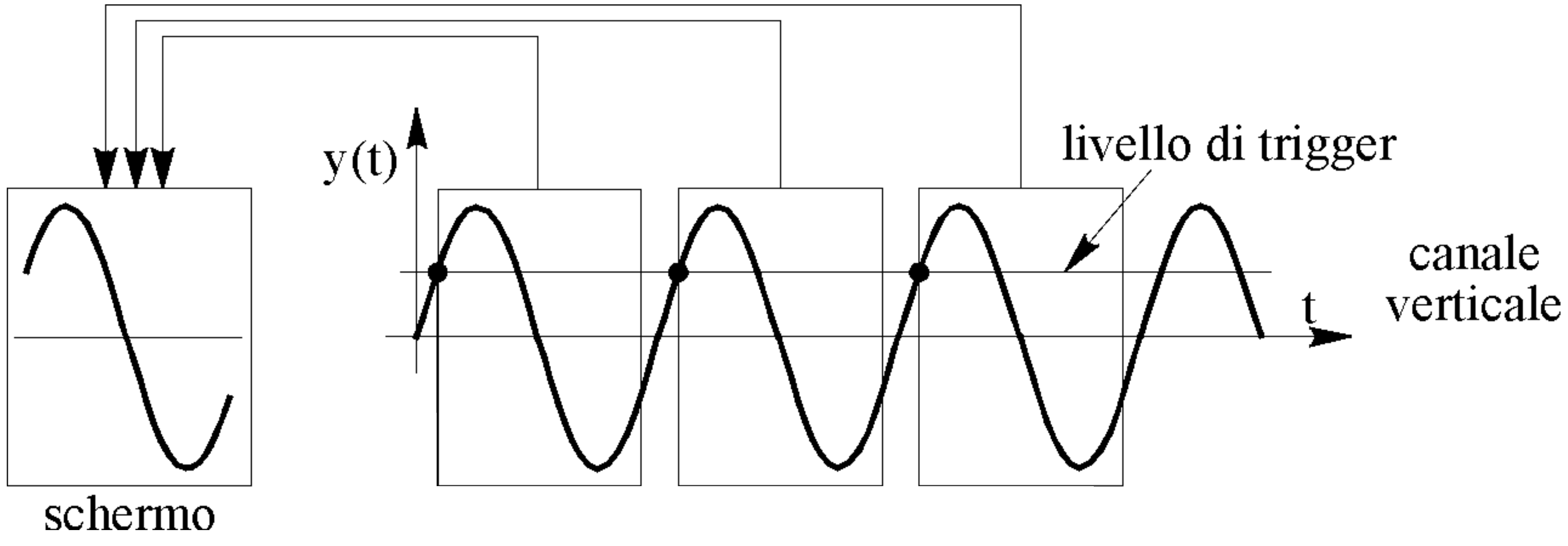
Base dei tempi non sincronizzata



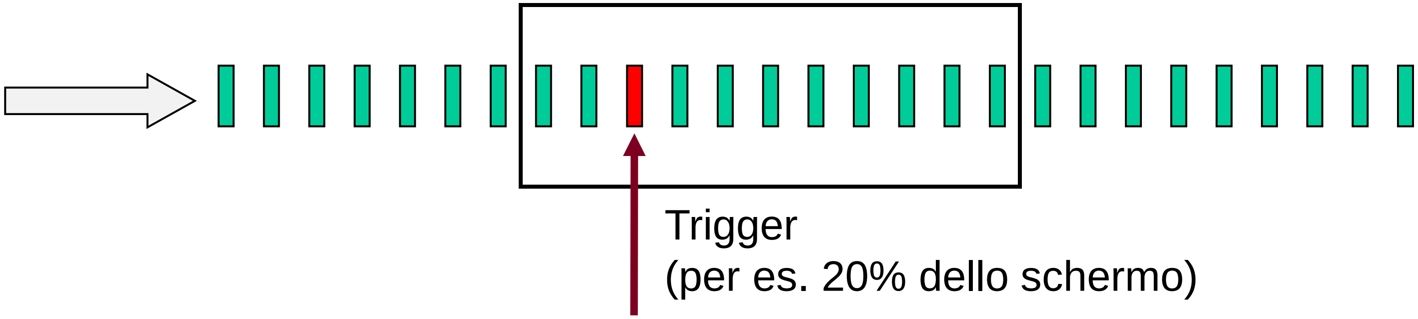
Il trigger

Base dei tempi non sincronizzata





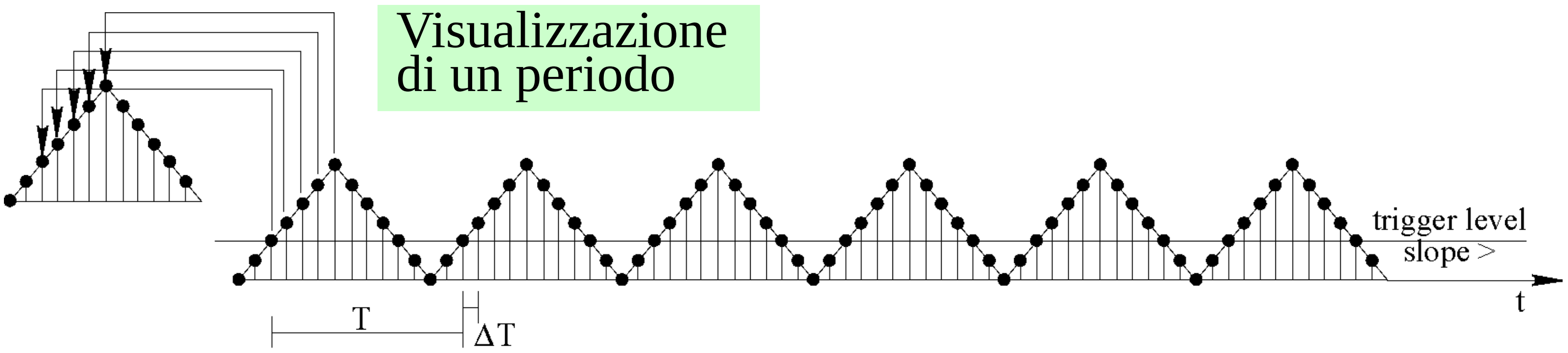
Il *buffer* circolare



Trigger
(per es. 20% dello schermo)

Campionamento in tempo reale

(*real-time sampling*)



Oscilloscopio digitale

Principali specifiche

Numero di canali

Frequenza di campionamento

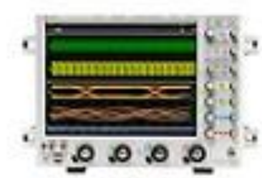
Banda passante

Memoria

Numero di bit

Oscilloscopio digitale

Principali specifiche: esempi

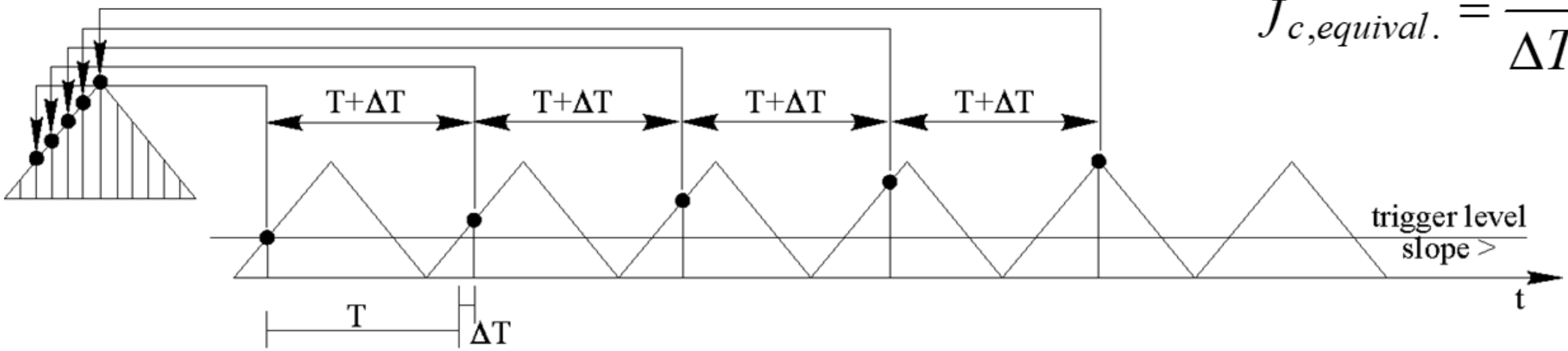


	Entry level	Intermedio	Top
Bandwidth	50 MHz	2 GHz	63 GHz
Sample rate	1 GSa/s	20 GSa/s	160 GSa/s
Channels	2	4	4
Memory depth	16 kpts	50 Mpts	2 Gpts

Campionamento in tempo equivalente
(sequenziale)

Bandwidth	50 GHz
Sample rate	300 kSa/s

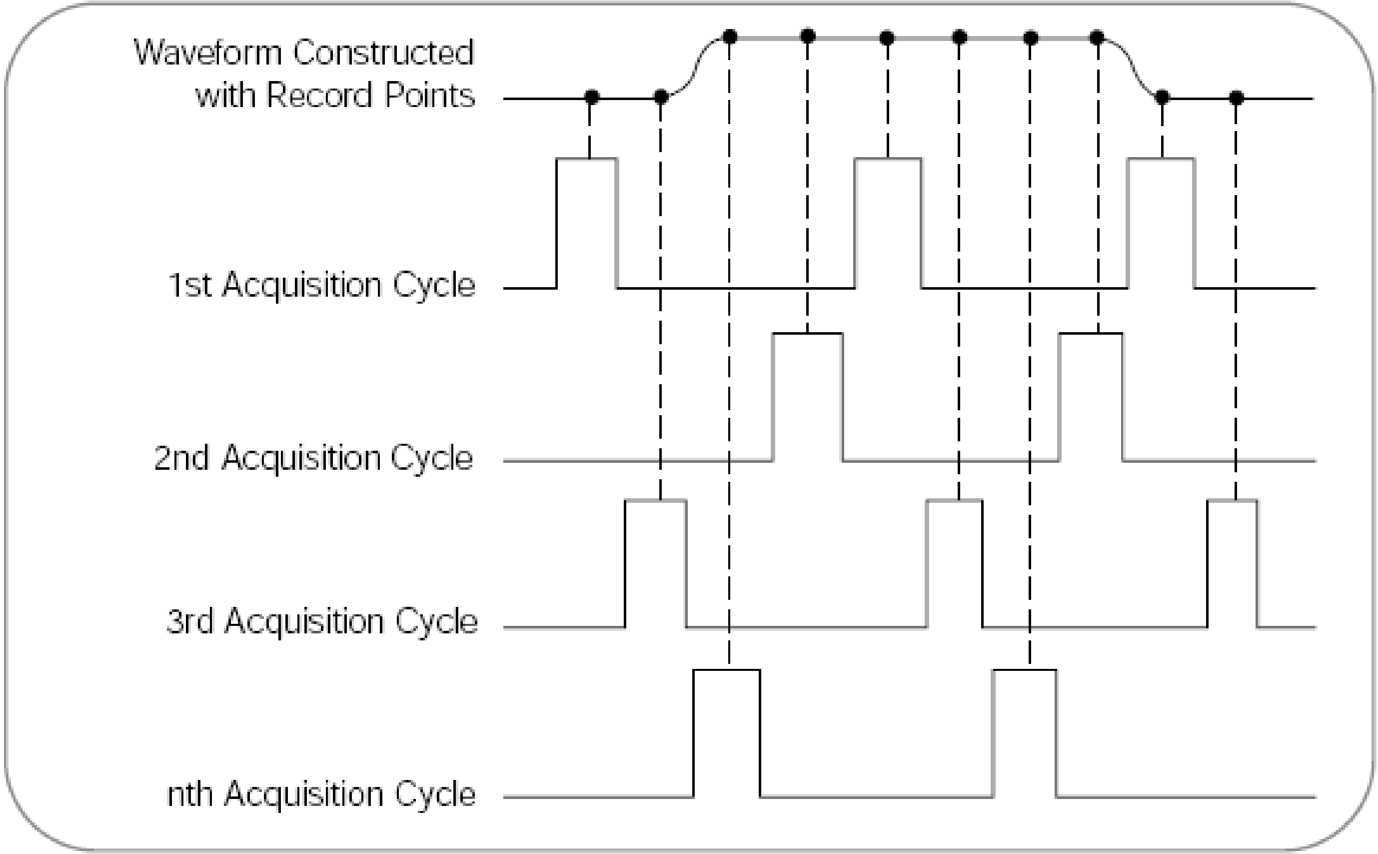
$$f_{c,equival.} = \frac{1}{\Delta T}$$



Campionamento in tempo equivalente

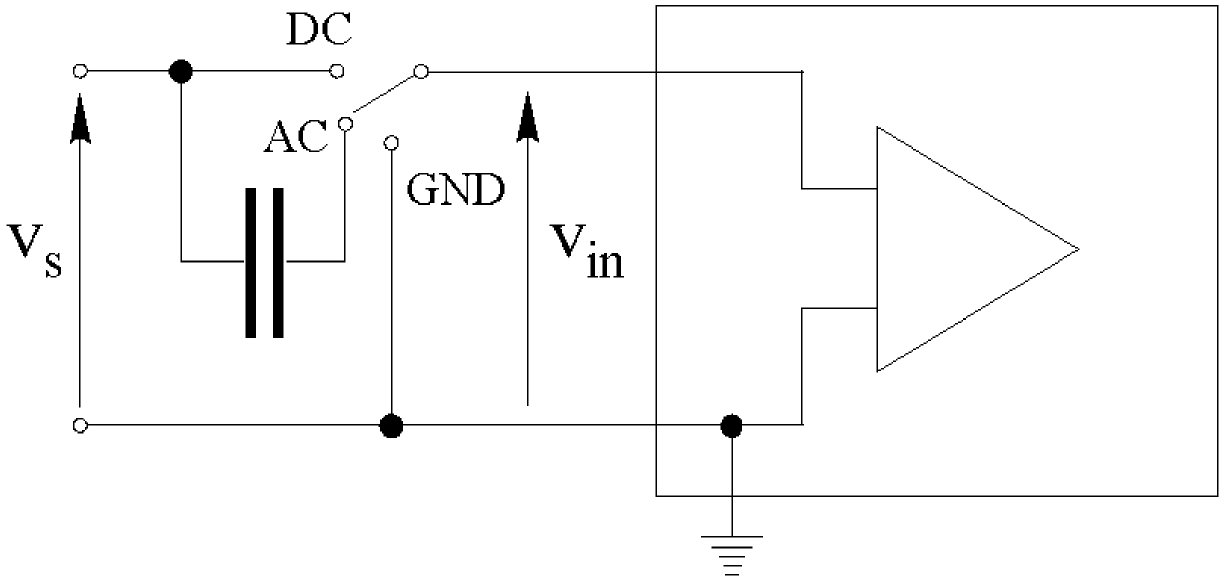
(casuale, per segnale ripetitivo)

Esempio



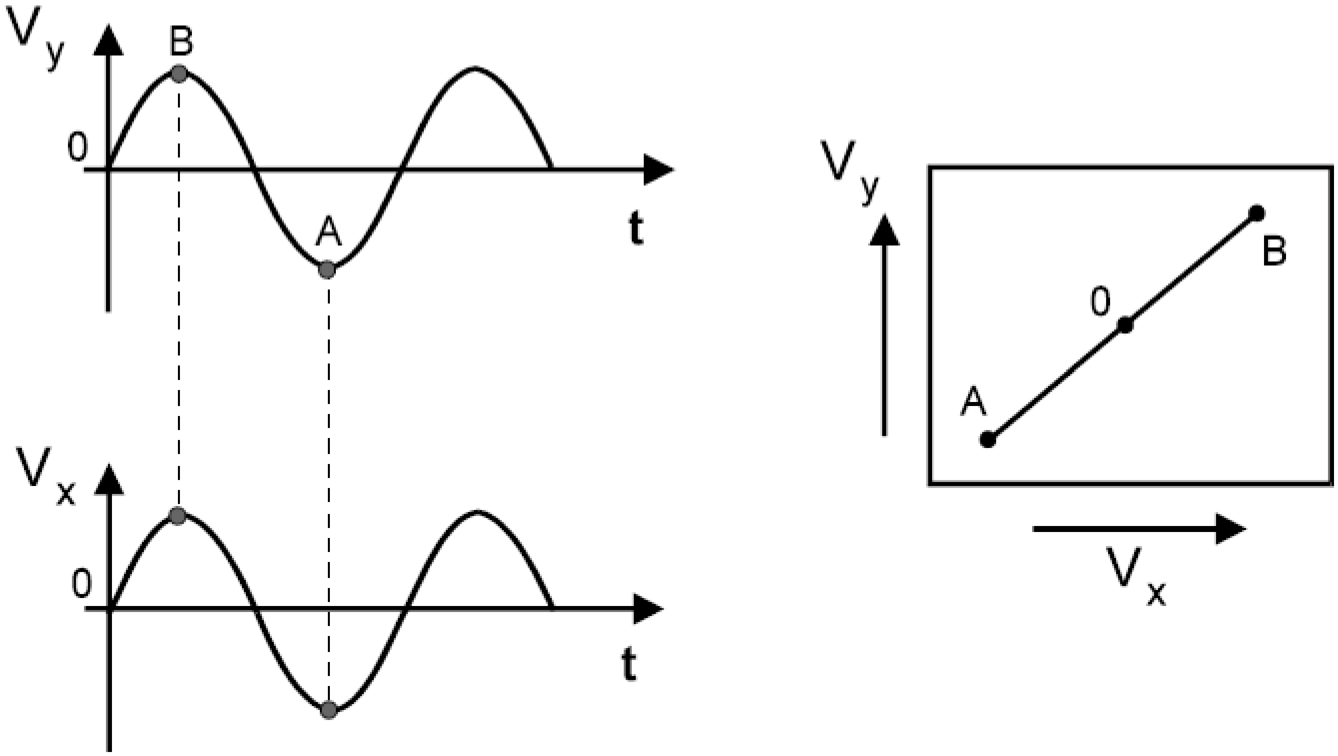
Oscilloscopio digitale

Il canale verticale

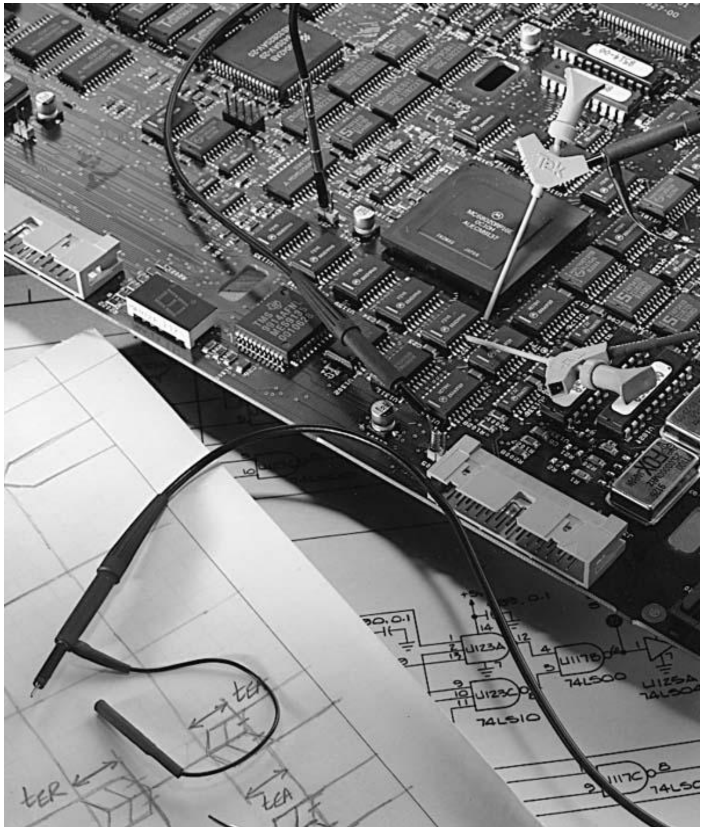


Oscilloscopio digitale

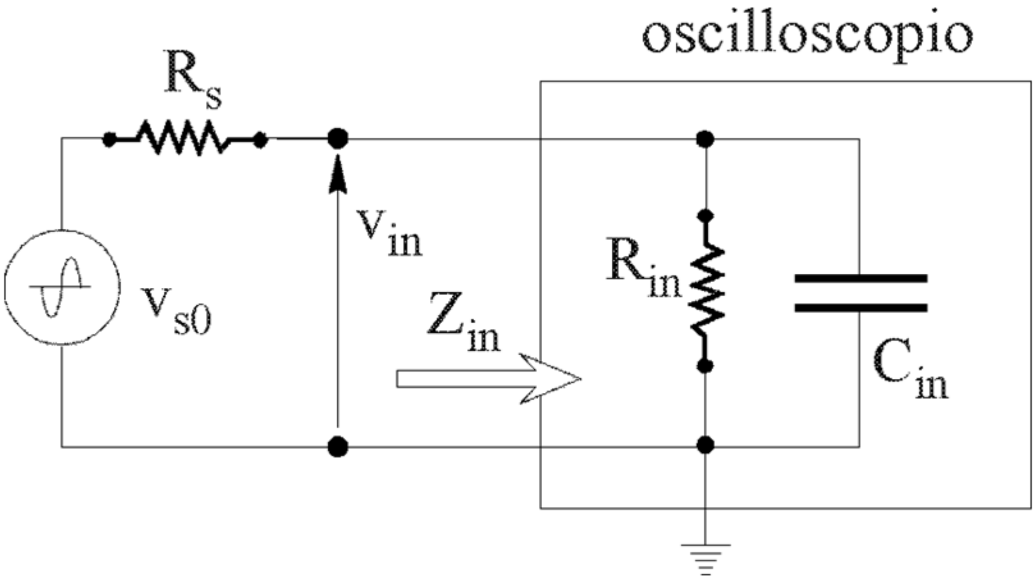
Modalità XY



Le sonde di tensione



L'impedenza d'ingresso dell'oscilloscopio



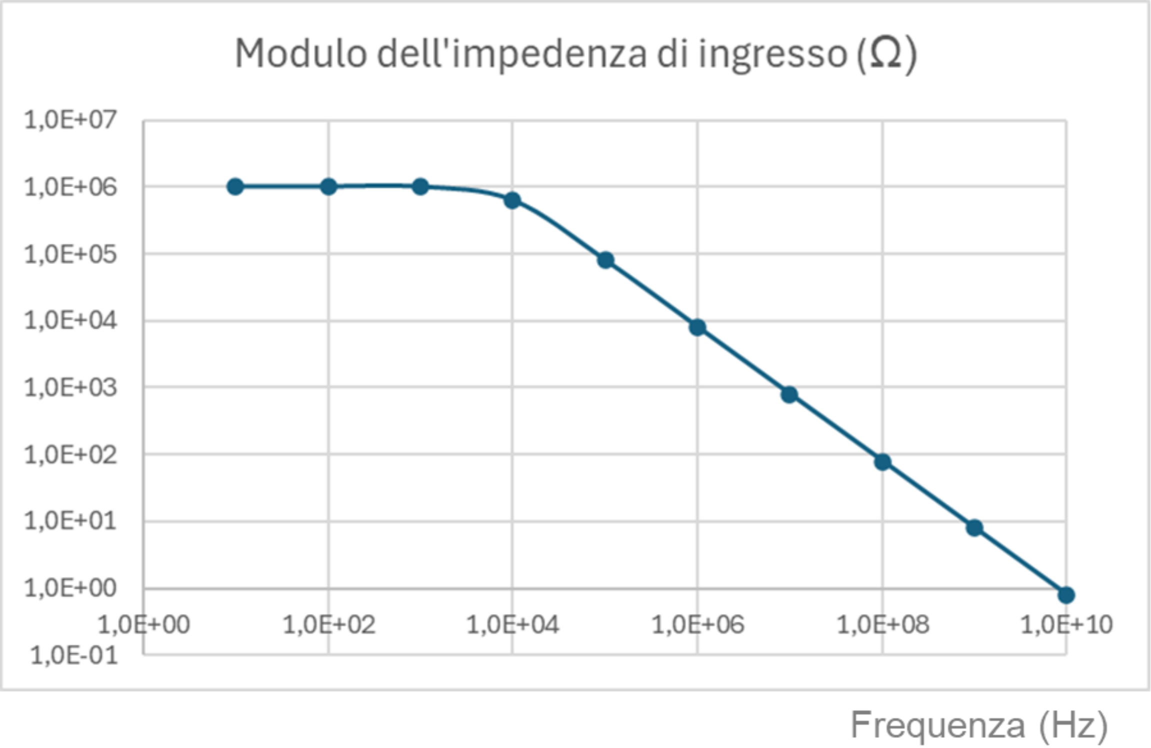
R_{in} = 1 MΩ
C_{in} = 10 ÷ 30 pF

$$\mathbf{Z}_{Cin} = \frac{1}{j\omega \cdot C_{in}}$$

$$\mathbf{Z}_{in} = \frac{R_{in} \cdot \mathbf{Z}_{Cin}}{R_{in} + \mathbf{Z}_{Cin}} = \frac{R_{in}}{1 + j\omega \cdot R_{in} C_{in}} = \frac{R_{in}}{1 + j\omega\tau_{in}} \qquad \left(\tau_{in} = R_{in} C_{in}\right)$$

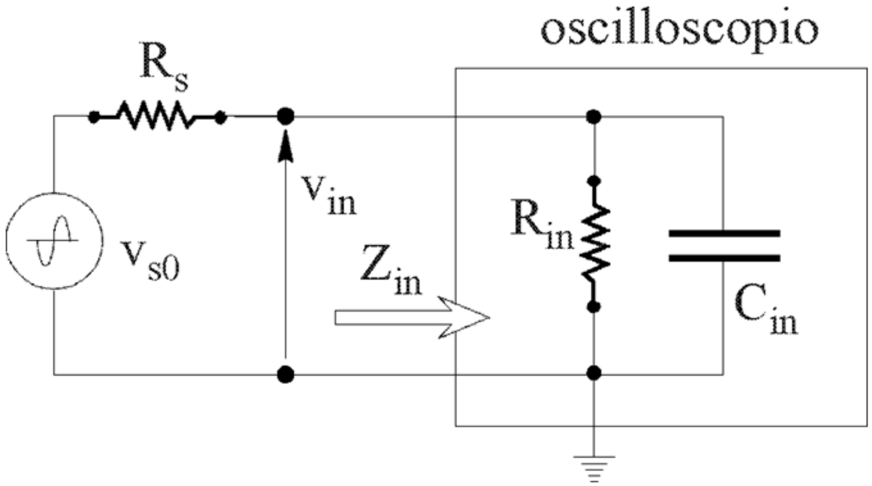
L'impedenza d'ingresso dell'oscilloscopio

$$\mathbf{Z}_{in} = \frac{R_{in} \cdot \mathbf{Z}_{Cin}}{R_{in} + \mathbf{Z}_{Cin}} = \frac{R_{in}}{1 + j\omega \cdot R_{in} C_{in}} = \frac{R_{in}}{1 + j\omega\tau_{in}} \qquad (\tau_{in} = R_{in} C_{in})$$



R_{in} = 1 MΩ
C_{in} = 20 pF

L'impedenza d'ingresso dell'oscilloscopio



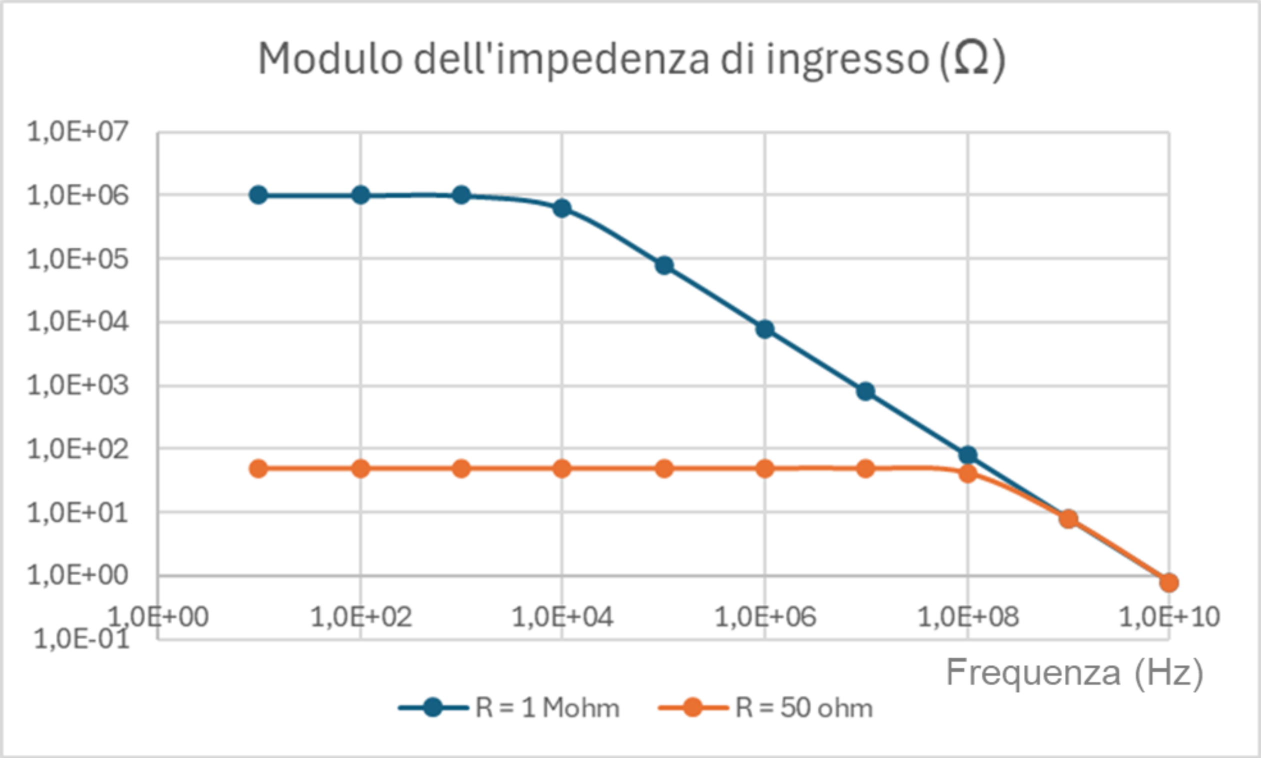
$$W' = \frac{V_{in}}{V_{s0}} = \frac{Z_{in}}{R_s + Z_{in}} = \frac{\dfrac{R_{in}}{1 + j\omega\tau_{in}}}{R_s + \dfrac{R_{in}}{1 + j\omega\tau_{in}}} = \frac{R_{in}}{R_s + R_s j\omega\tau_{in} + R_{in}}$$

$R_s << R_{in}$

$$W' = \frac{V_{in}}{V_{s0}} \cong \frac{1}{1 + j\omega\tau \dfrac{R_s}{R_{in}}} = \frac{1}{1 + j\omega\tau'}$$

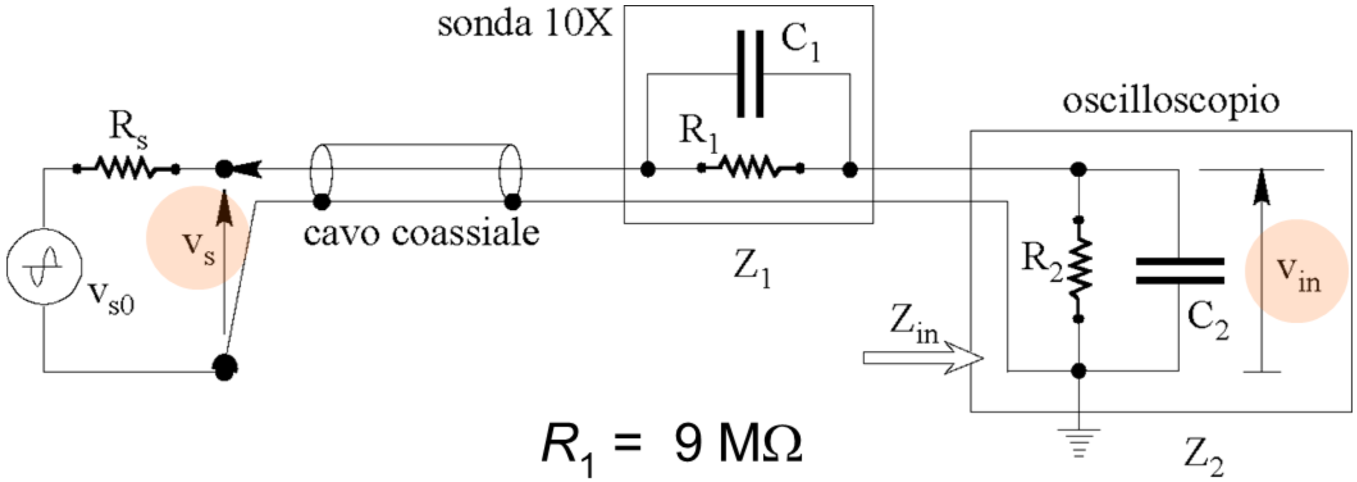
$$\tau' = \tau \cdot R_s / (R_{in})$$

Impedenza d'ingresso 50 Ω



C_{in} = 20 pF

Le sonde di tensione 10X

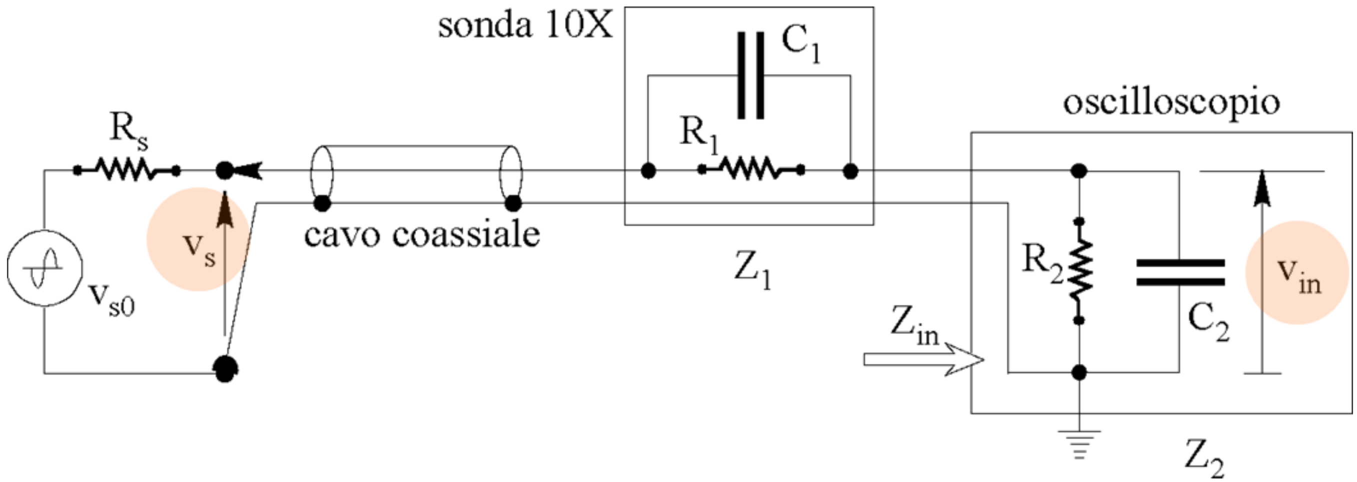


R_1 = 9 MΩ
R_2 = 1 MΩ

$$W = \frac{V_{in}}{V_s} = \frac{\mathbf{Z}_2}{\mathbf{Z}_1 + \mathbf{Z}_2} = \frac{\mathbf{Y}_1}{\mathbf{Y}_1 + \mathbf{Y}_2}$$

$$W_0 = \left.\frac{V_{in}}{V_s}\right|_{DC} = \frac{R_2}{R_1 + R_2} = \frac{1}{10}$$

Le sonde di tensione 10X



$$\begin{cases} k_1 = \dfrac{1}{R_1} \quad \text{e} \quad \tau_1 = R_1 C_1 \\ k_2 = \dfrac{1}{R_2} \quad \text{e} \quad \tau_2 = R_2 C_2 \end{cases}$$

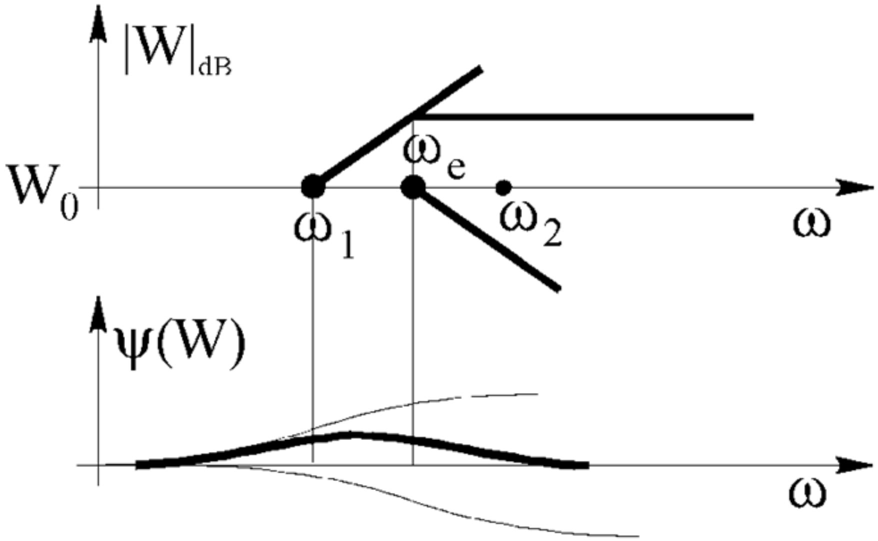
$$W(\omega) = \frac{V_{in}}{V_s} = \frac{k_1(1 + j\omega\tau_1)}{k_1(1 + j\omega\tau_1) + k_2(1 + j\omega\tau_2)}$$

Le sonde di tensione 10X

Diagrammi di Bode

$$W(\omega) = \frac{V_{in}}{V_s} = W_0 \frac{1 + j\omega\tau_1}{1 + j\omega\tau_e} \quad \text{essendo} \quad \tau_e = \frac{k_1\tau_1 + k_2\tau_2}{k_1 + k_2}$$

Caso A) $\tau_1 > \tau_2 \quad \Rightarrow \tau_1 > \tau_e > \tau_2 \qquad \omega_1 < \omega_e < \omega_2$



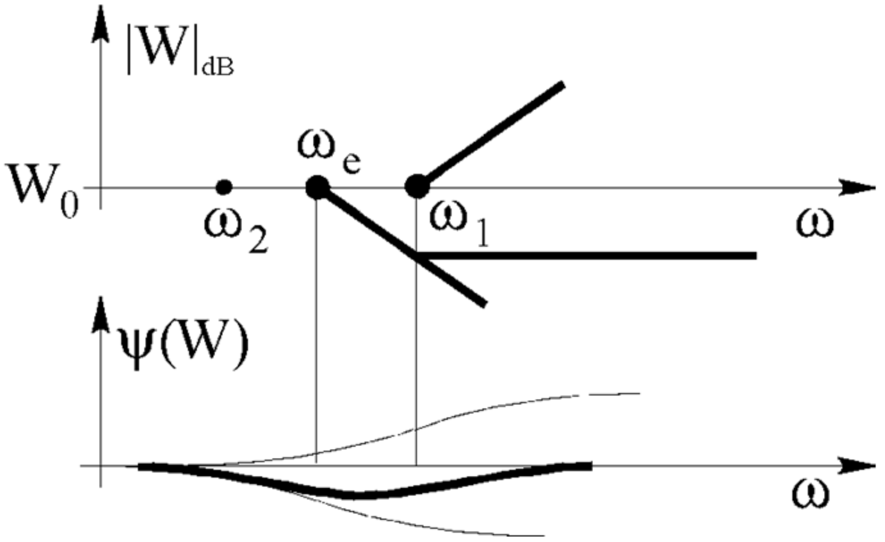
Sovracompensazione

Le sonde di tensione 10X

Diagrammi di Bode

$$W(\omega) = \frac{V_{in}}{V_s} = W_0 \frac{1 + j\omega\tau_1}{1 + j\omega\tau_e} \quad \text{essendo} \quad \tau_e = \frac{k_1\tau_1 + k_2\tau_2}{k_1 + k_2}$$

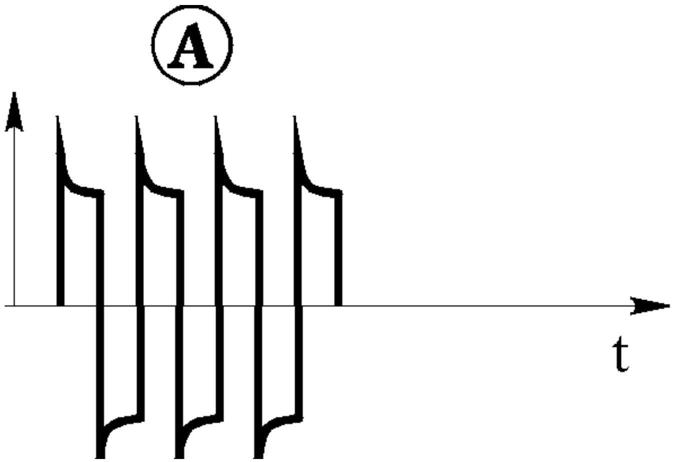
Caso B) $\tau_1 < \tau_2 \quad \Rightarrow \tau_1 < \tau_e < \tau_2 \qquad \omega_1 > \omega_e > \omega_2$



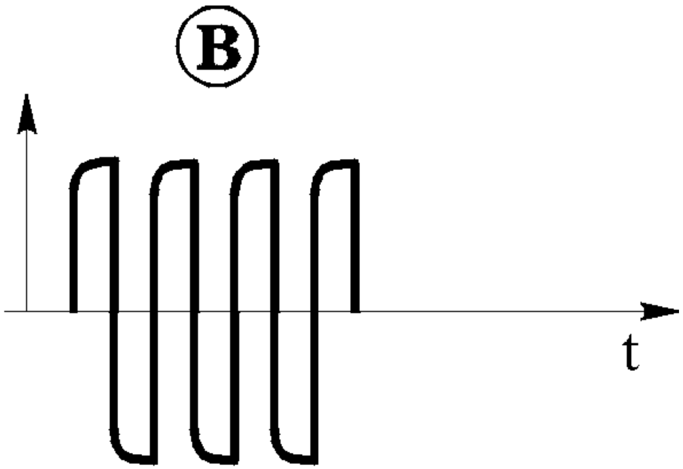
Sottocompensazione

Le sonde di tensione 10X

A) Sovracompensazione



B) Sottocompensazione

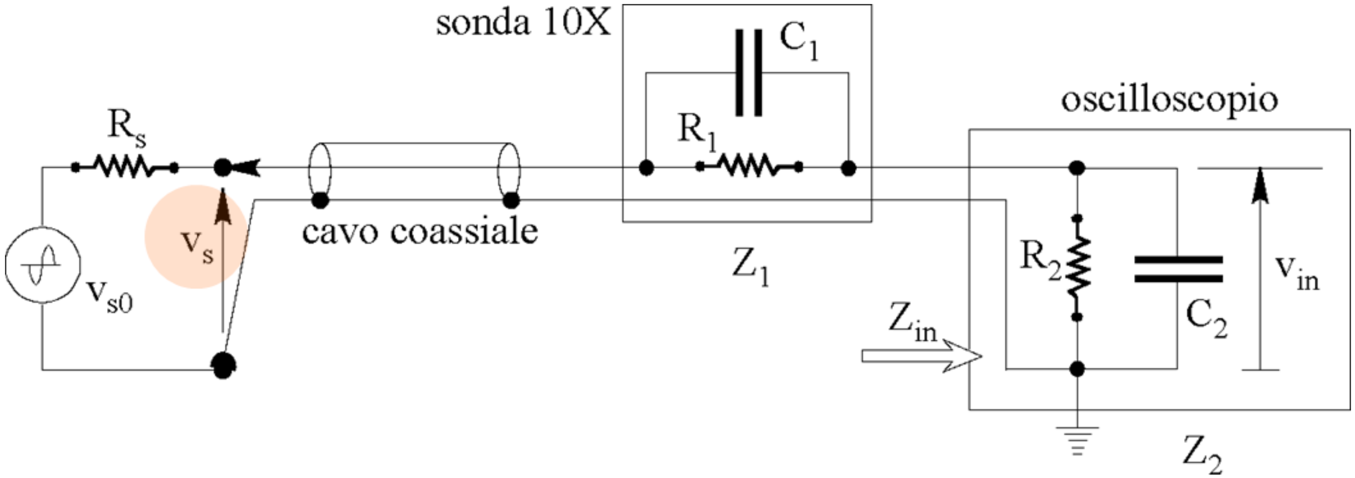


Compensazione

$$\tau_1 = R_1 C_1 = \tau_2 = R_2 C_2$$

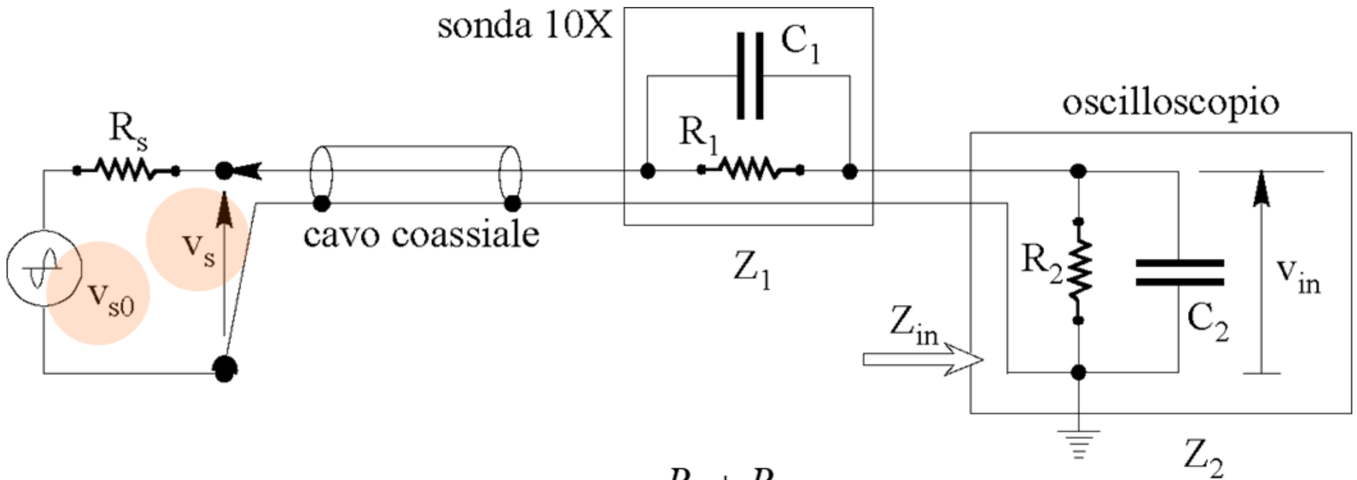
Le sonde di tensione 10X

Impedenza d'ingresso della sonda compensata



$$\mathbf{Z}_{osc+sonda} = \mathbf{Z}_1 + \mathbf{Z}_2 = \frac{R_1}{1+j\omega\tau_1} + \frac{R_2}{1+j\omega\tau_2} = \frac{R_1+R_2}{1+j\omega\tau}$$

Le sonde di tensione 10X



$$W'' = \frac{V_s}{V_{s0}} = \frac{Z_{osc+sonda}}{R_s + Z_{osc+sonda}} = \frac{\dfrac{R_1+R_2}{1+j\omega\tau}}{R_s + \dfrac{R_1+R_2}{1+j\omega\tau}} = \frac{R_1+R_2}{R_s + R_s j\omega\tau + R_1 + R_2}$$

$$R_s << R_1 + R_2$$

$$W'' = \frac{V_s}{V_{s0}} \cong \frac{1}{1+j\omega\tau\dfrac{R_s}{R_1+R_2}} = \frac{1}{1+j\omega\tau''}$$

$$\tau'' = \tau \cdot R_s/(R_1+R_2)$$