

TIME DOMAIN REFLECTOMETRY

PROBLEMA

MISURA IMPEDENZA DI UNA LINEA.

Metodo tradizionale $\rightarrow \Gamma(\omega) \Rightarrow Z$

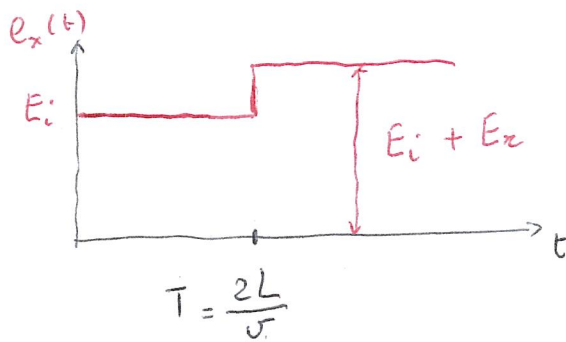
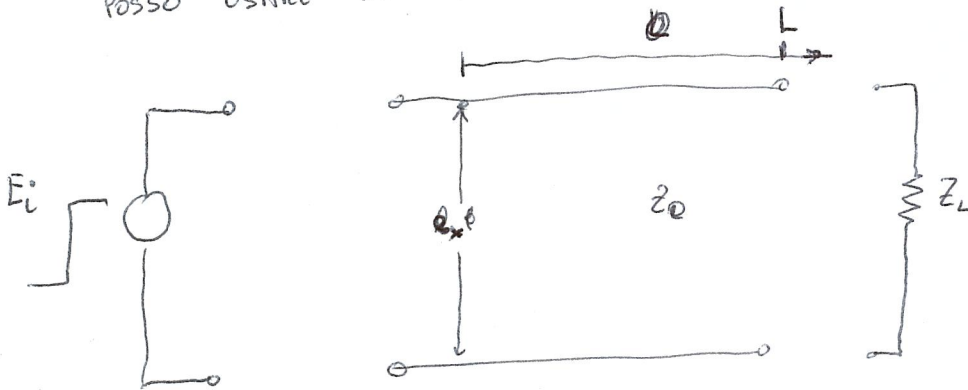
CHE SUCCIEDE SE HO DISCONTINUITA' O TRATTI DI IMPEDENZA DIVERSA?

LE MISURE IN FREQUENZA NON POSSONO RISOLVERE LE ~~POSIZIONI~~ POSIZIONI

L'INFORMAZIONE E' COMUNQUE CONTENUTA NELLE RISPOSTE IN FREQUENZA.

SOLUZIONE! MISURE DI ECO (COME RADAR)

POSSO USARE LE MISURE IN TEMPO (\neq Istanti $\Rightarrow \neq$ POSIZIONI)



$$\frac{E_r}{E_i} = \Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$$

I APPLICAZIONE

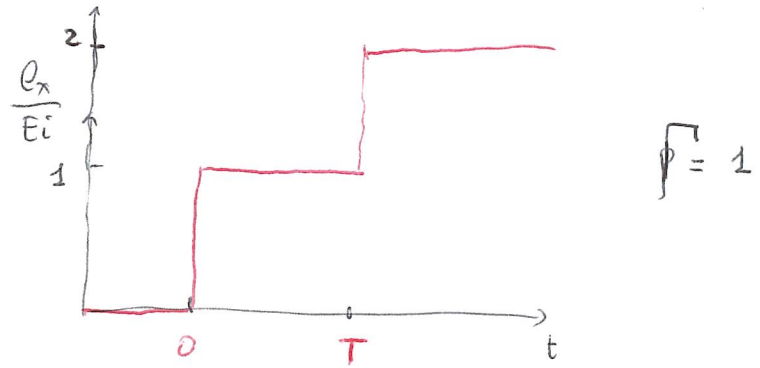
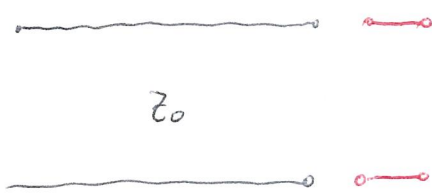
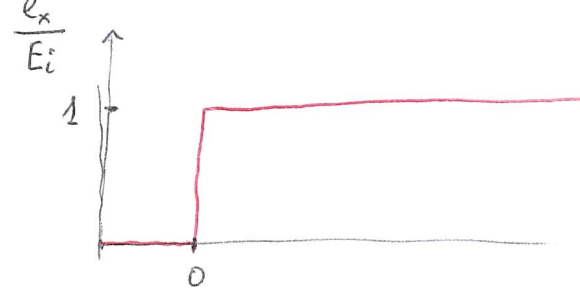
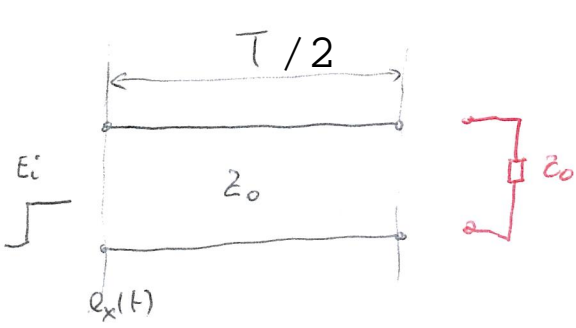
\leadsto POSSO LOCALIZZARE DISACCOPPIAMENTI
~~DISACCOPPIAMENTI~~

$$L = \frac{vT}{2}$$

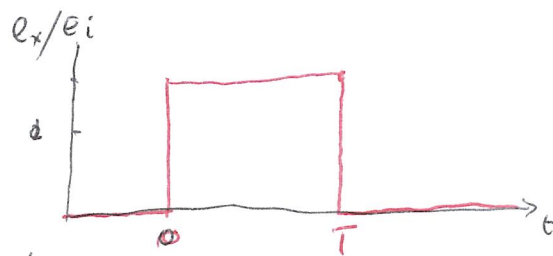
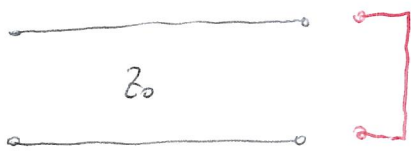
II APPLICAZIONE

\leadsto POSSO CAPIRE LA NATURA E LA QUANTITA'
DEL DISACCOPPIAMENTO

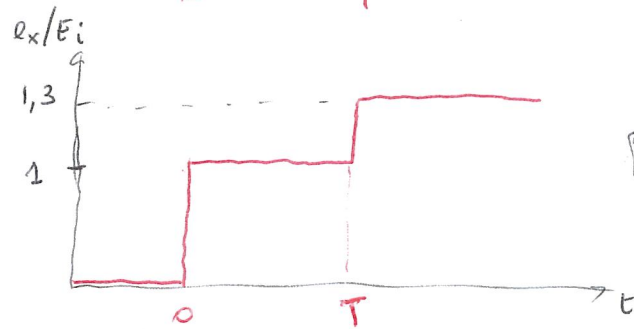
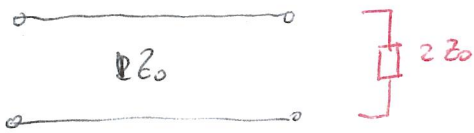
\rightarrow A RIGORE USO LA TRASFORMATA DI LAPLACE
MA NOI POSSIAMO FARE INTUITIVAMENTE - (CASI SEMPLICI)



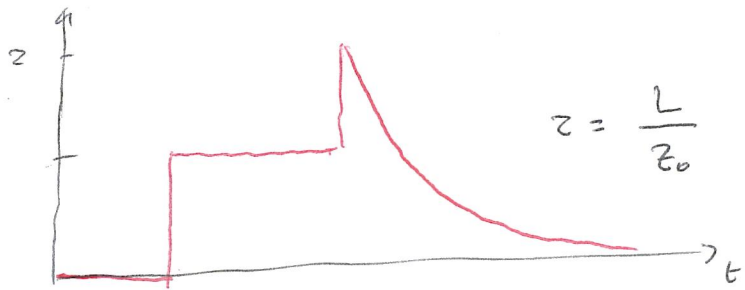
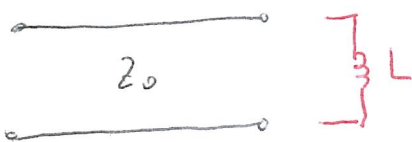
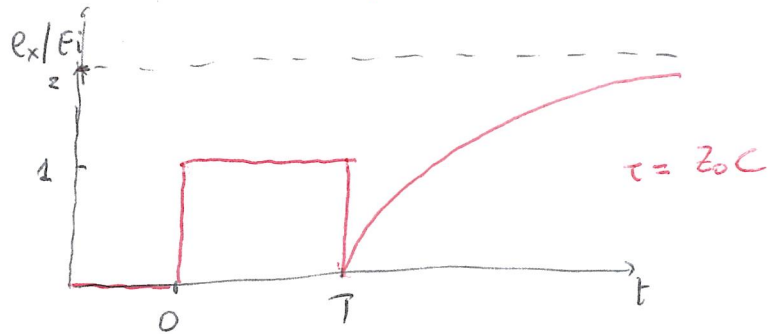
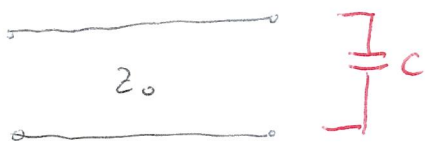
$$\Gamma = 1$$



$$\Gamma = -1$$



$$\Gamma = \frac{1}{3}$$



$$z = \frac{L}{Z_0}$$

IMPULSO SINTETICO COM VNA (TIME DOMAIN)

VANTAGGIO RISPETTO ALLA TOR TRADIZIONALE:

VNA HA UN ELEVATO
RANGE DINAMICO

SISTEMI LINEARI:

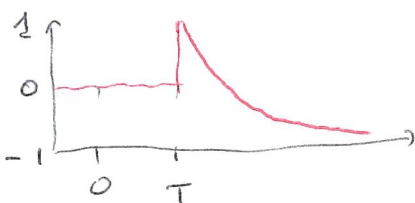
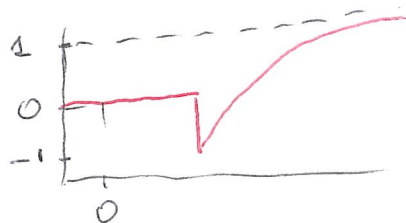
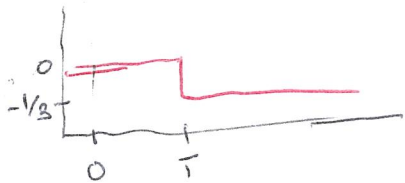
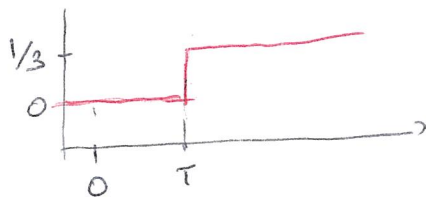
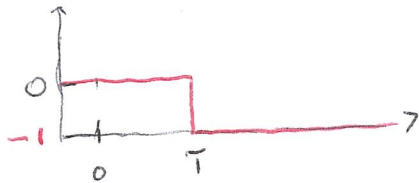
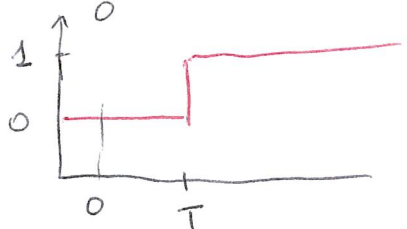
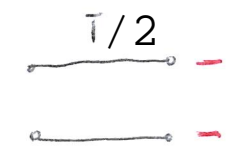
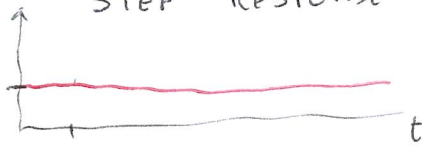
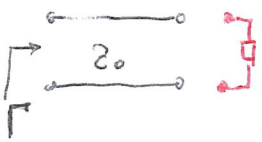
RISPOSTA IN TEMPO

FOURIER

← FUNZIONE DI
TRASFERIMENTO

IL VNA FA LA FFT DELLA ~~RISPOSTA~~ RISPOSTA

STEP RESPONSE



IV CONSEGUEENZA

TIME DOMAIN

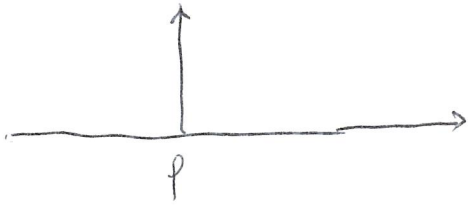
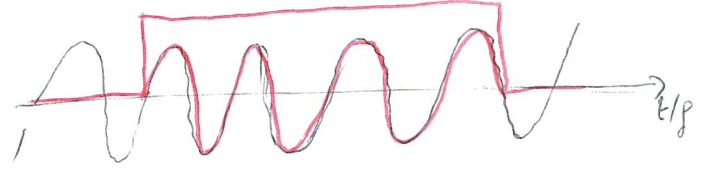
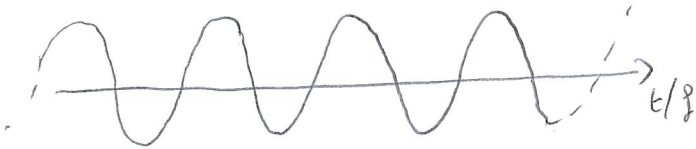
(sintetico)

← FFT

FREQUENCY DOMAIN

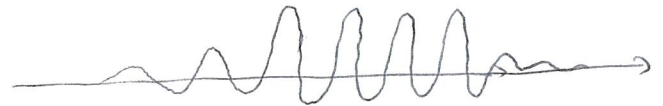
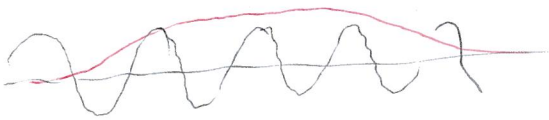
(minore)

DALLA TEORIA DELLA FFT SI SA CHE IL NUMERO LIMITATO DI CAMPIONI HA DEGLI EFFETTI



FINESTRA RETTANGOLARE $\Delta = -13\text{dB}$, $BW = \dots$

LA FINESTRA RETTANGOLARE NON E' L'UNICA POSSIBILE, MA SI PUO' FARE UN "PROFILO" DIVERSO



LE VARIE FINESTRE RIDUCONO Δ MA AUMENTANO BW

WINDOW

MINIMUM

$\Delta = -13\text{dB}$

FINESTRA RETTANGOLARE

NORMAL

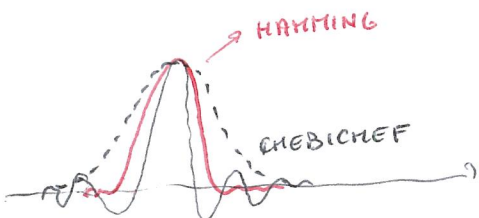
$\Delta = -44\text{dB}$

FINESTRA HANNING

MAXIMUM

$\Delta = -95\text{dB}$

FINESTRA TCHEBICHEF
COSENO RIALZATO



~~...~~ PULSE RESPONSE

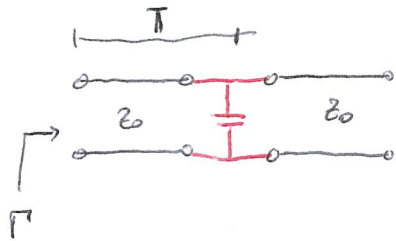
→ ESERCIZIO

APERTO

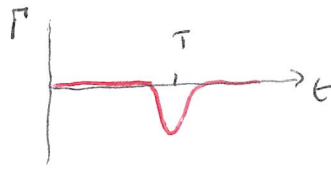
SI VEDONO LE FINESTRE

FAULT LOCATION

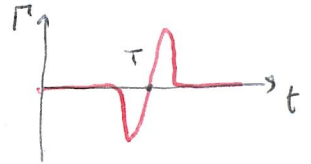
VARIATIONE C
(CAVO PIEGATO)



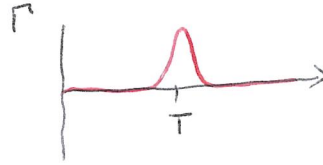
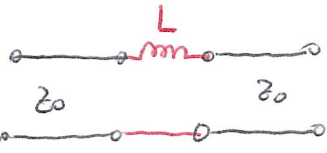
STEP RESPONSE



LOW PASS PULSE



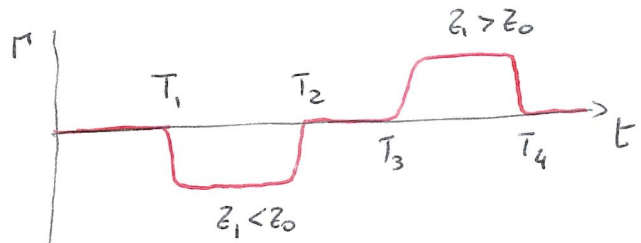
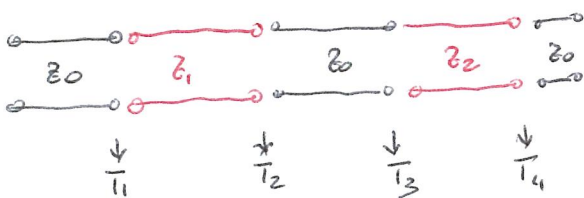
VARIATIONE DI L
(CAVO SFILACCIATO)



OCCHIO ALL'INIZIO GUIDA

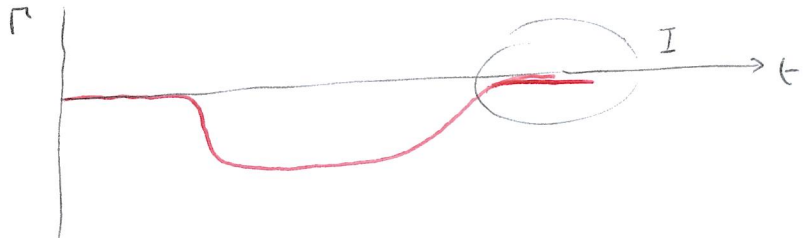
MISURA DI IMPEDENZA IN FUNZIONE DI Z

MICROSTRISCE



$$Z(x) = Z(x) = Z_0 \frac{1 + \Gamma}{1 - \Gamma}$$

ESEMPIO



NON IDEALITA'

- Ⓘ NON TORNA A ZERO \rightsquigarrow (ATTENUAZIONE, PERDITA ENERGIA) & RIFLESSIONI
- Ⓜ IL SECONDO TEMPO DI SALITA E' PIU' LENTO \rightsquigarrow DISPERSIONE

PER FARE $Z(x)$ BISOGNA CALCOLARSI Γ !!

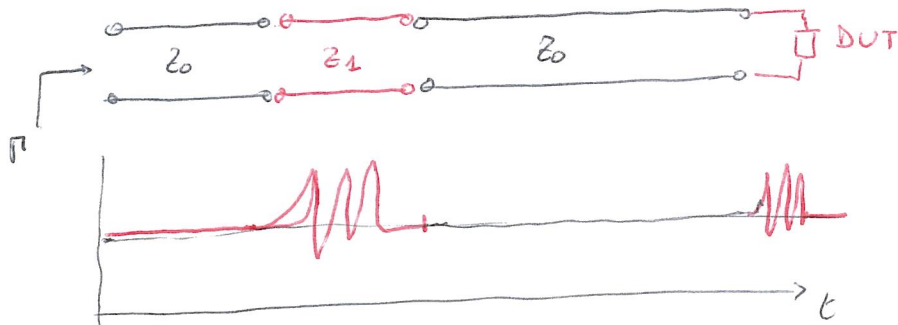
V CONSEQUENZA:

POSSO DISCRIMINARE IN TEMPO
LA PARTE DI RISPOSTA
CHE MI INTERESSA



GATING

ESEMPIO



TIME DOMAIN
(PULSE RESPONSE)



GATING
(ovvero problemi
di "finestra")



FREQUENCY DOMAIN

PROBLEMA IL GATING TOGLIE POTENZA AL SEGNALE
⇒ SNR + ~~meno~~ BASSO
⇒ ATTENUATORE ATTENUA DI PIU' ---

LOW PASS STEP

LOW PASS ~~RECEIVE~~ PULSE

BAND PASS

→ USATO PER DISPOSITIVI PASSA BANDA

→ SEGNO E AMPIEZZA DI f NON SEMPRE
DI FACILE INTERPRETAZIONE

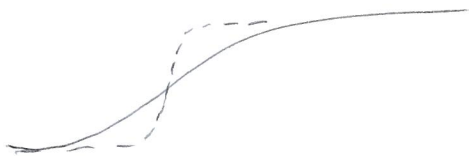
→ USATO PER IL GATING

CATING



- MISURA Γ CAVO già misurato

- ~~IL~~ EFFETTO DELLE FINESTRE E DI FOCA



Γ di un aperto con
+ finestre (LOW PASS)
PULSE

Ten Steps for Performing TDR (Low Pass Step)

1. Set up desired frequency range (need wide span for good spatial resolution)
2. Under SYSTEM, transform menu, press "set freq low pass"
3. Perform one- or two-port calibration
4. Select S11 measurement *
5. Turn on transform (low pass step) *
6. Set format to real *
7. Adjust transform window to trade off rise time with ringing and overshoot *
8. Adjust start and stop times if desired
9. For gating:
 - set start and stop frequencies for gate
 - turn gating on *
 - adjust gate shape to trade off resolution with ripple *
10. To display gated response in frequency domain
 - turn transform off (leave gating on) *
 - change format to log-magnitude *

* If using two channels (even if coupled), these parameters must be set independently for second channel

