射頻系統戰力驗證
網路分析儀實務應用

賴正恆

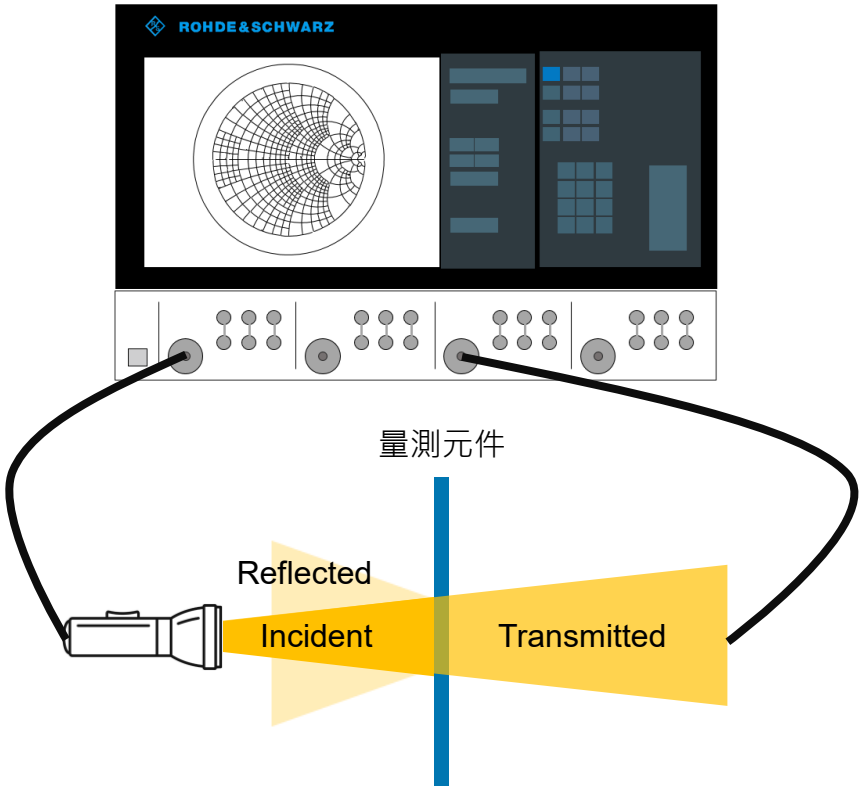
ROHDE&SCHWARZ

Make ideas real

前言



網路分析儀基本架構



射頻/微波元件分類

- 1 Port Devices
  - Antennas
  - Loads / Terminations





- 2 Port Devices
  - Cables
  - Amplifiers
  - Filters





- 3 Port Devices
  - Couplers
  - Mixers
  - Power Splitters





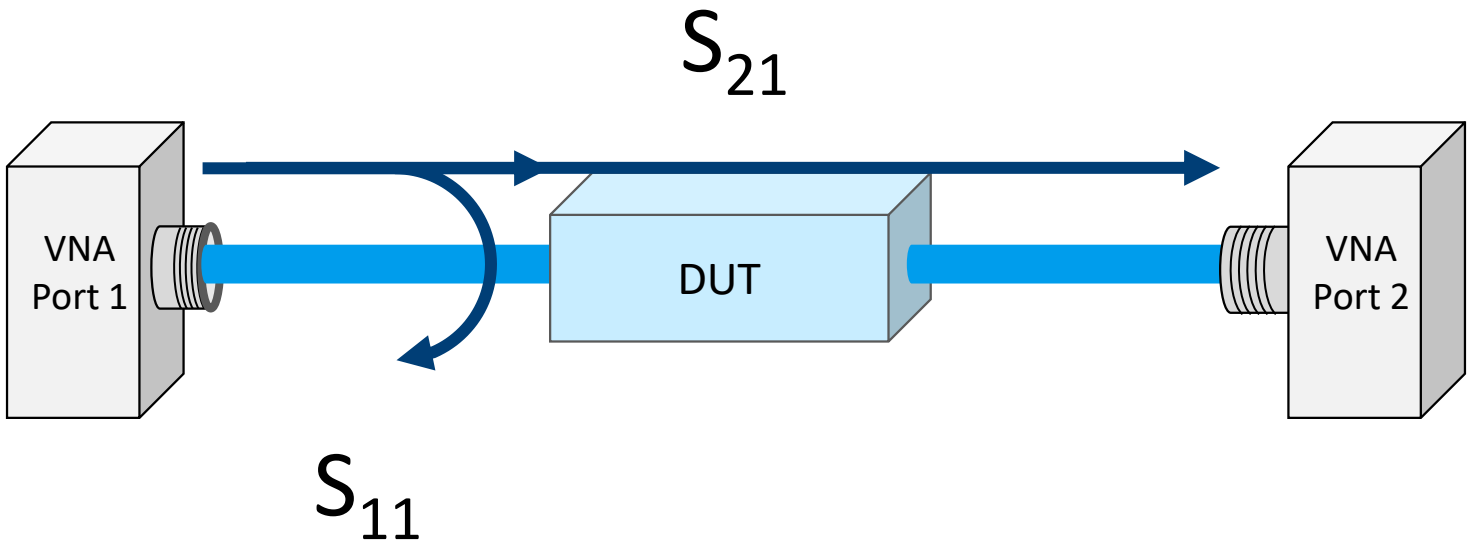
- 4+ Port Devices
  - Circulator
  - Switches





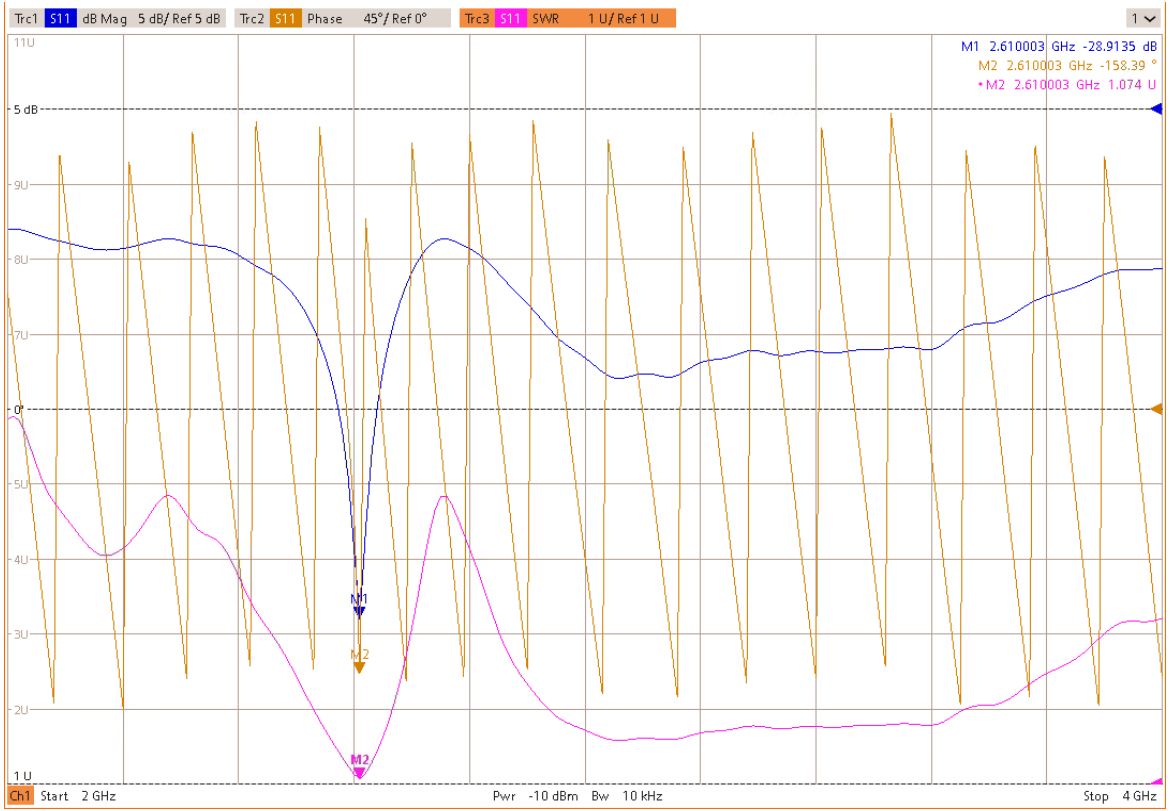
網路分析儀描述元件參數

- S參數(S-Parameter)
  - 含振幅和相位

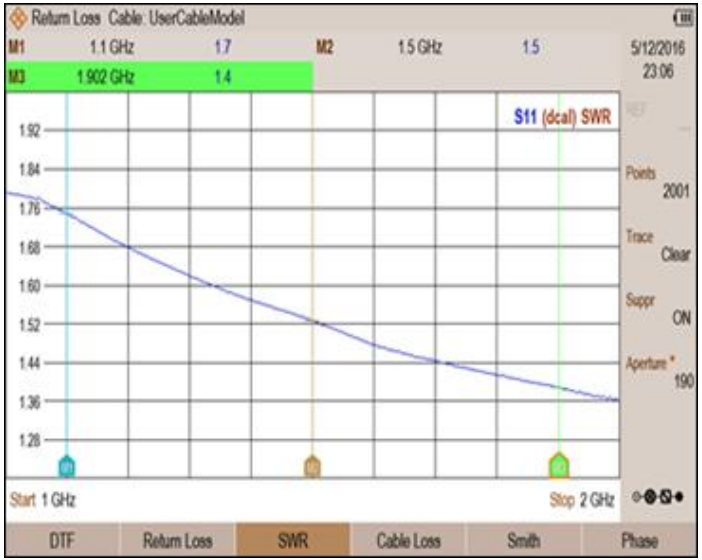


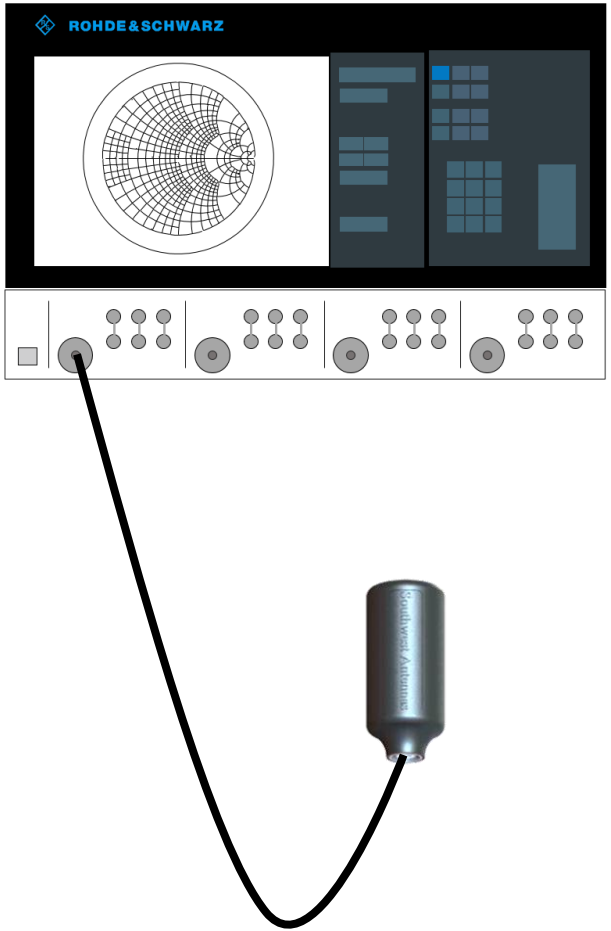
網路分析儀 — 單埠量測參數

- 反射系數 S_{11}
  - 振幅 (Return Loss)
  - 相位
  - 反射駐波比 (SWR)

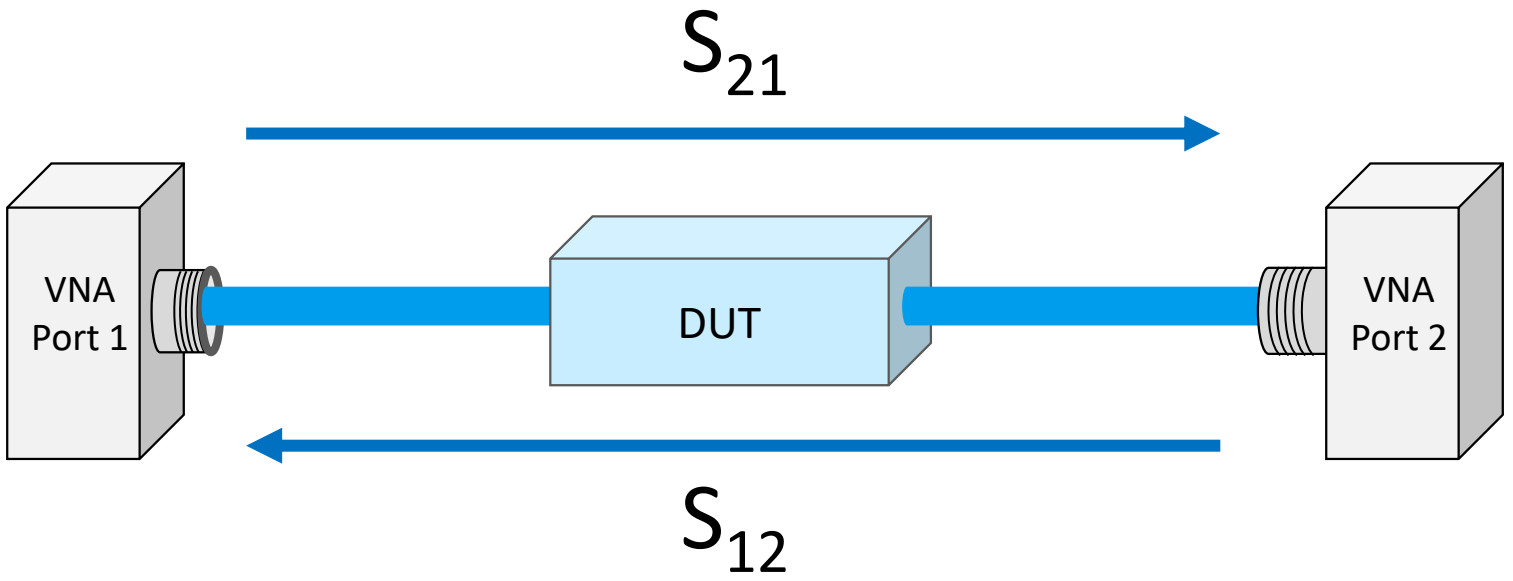


網路分析儀 — 單埠量測參數
天線反射駐波比



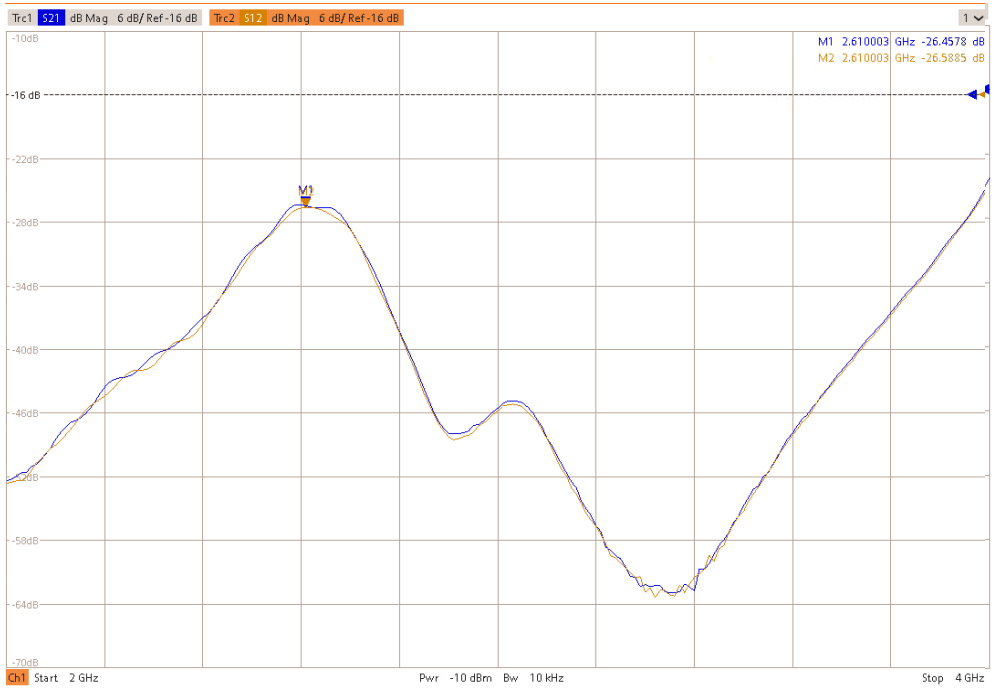


網路分析儀 — 雙埠量測參數

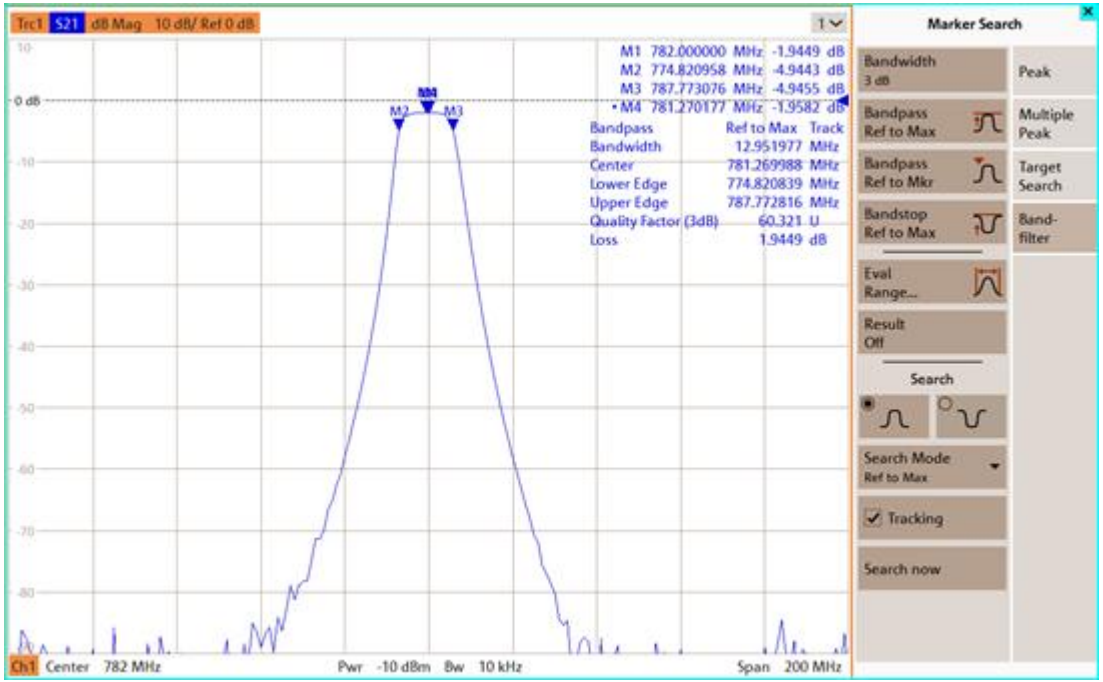


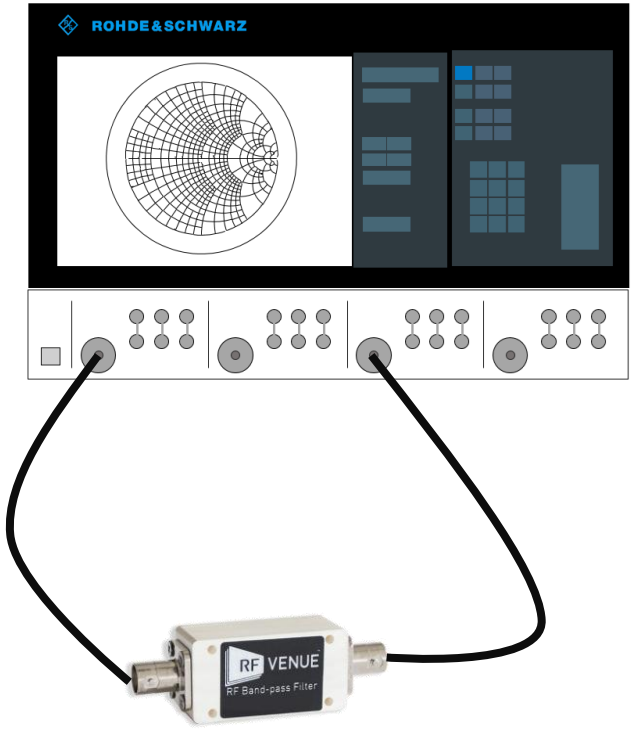
網路分析儀 — 雙埠量測參數

- 傳輸係數 (Transmission Coefficient) S_{21}
  - 被動元件 Insertion Loss
  - 主動元件 Gain



網路分析儀 — 雙埠量測參數濾波器

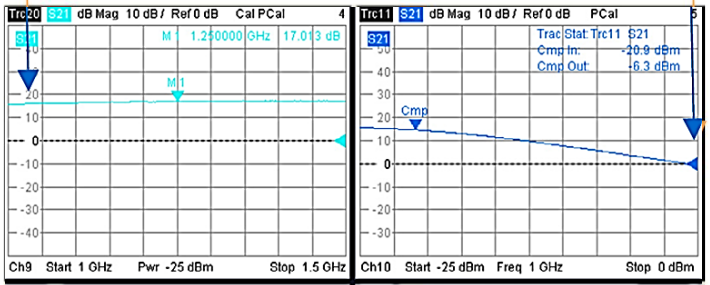




網路分析儀 — 雙埠量測參數
功率放大器

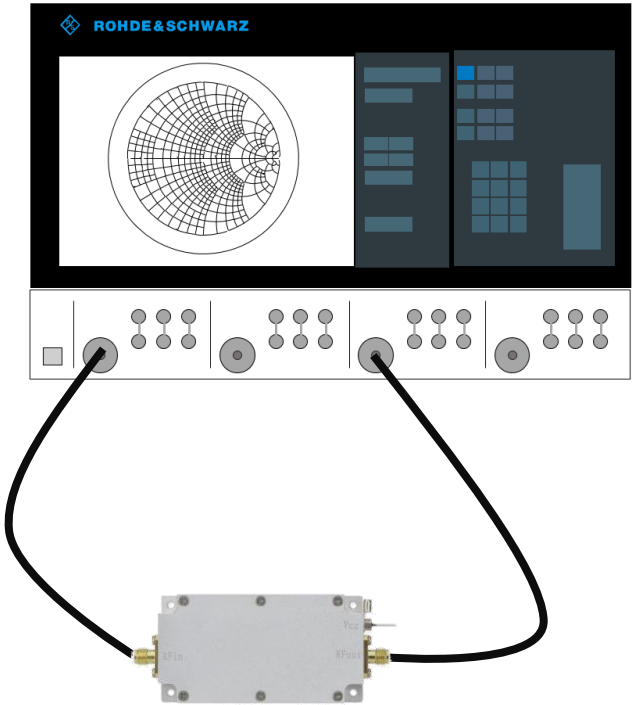
Gain

1dB Compression

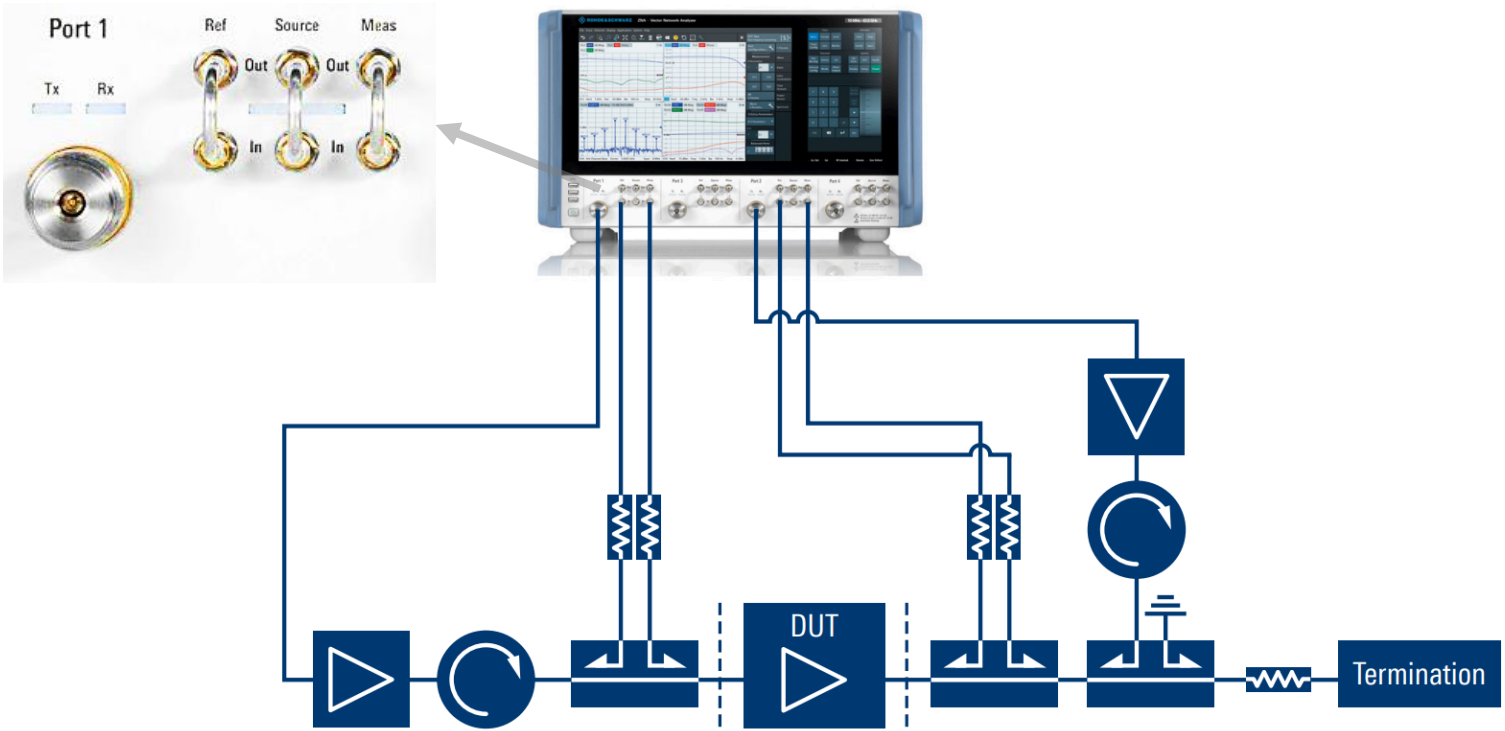


Harmonics

Reflection



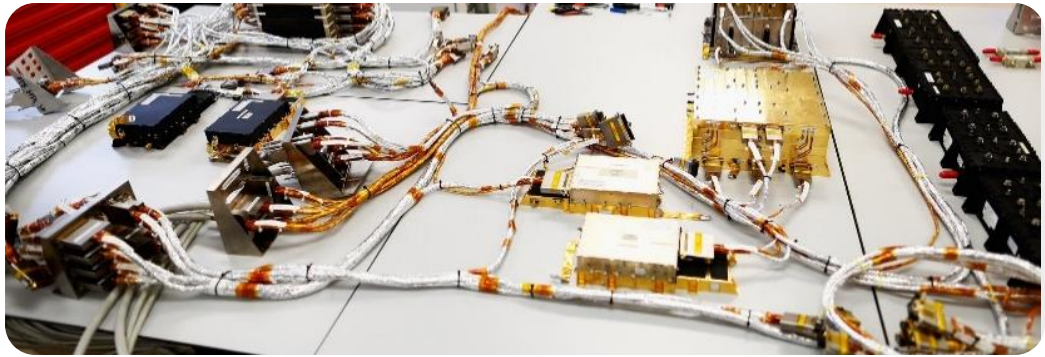
網路分析儀功能
高功率放大器



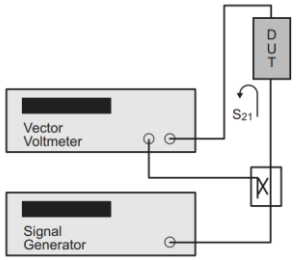
網路分析儀功能
高功率放大器



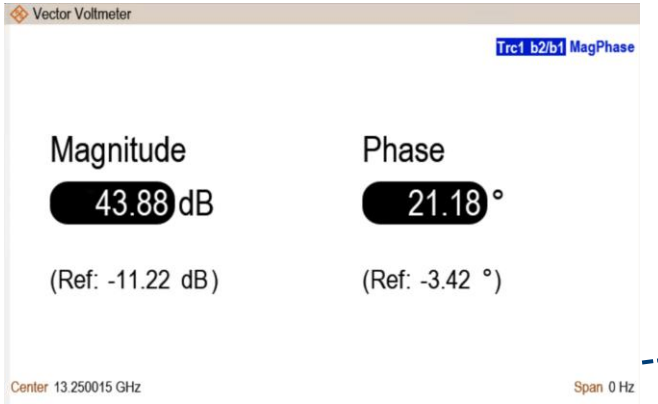
向量電壓計VECTOR VOLTMETER



網路分析儀功能
向量電壓計VECTOR VOLTMETER



Legacy VVM Solution

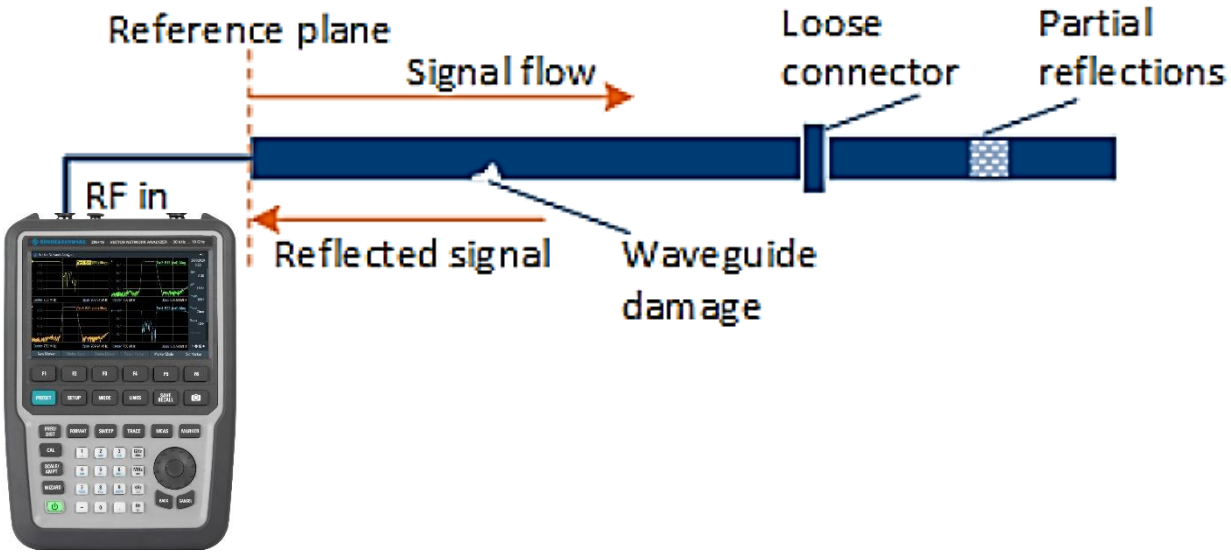




導波管量測



網路分析儀功能
導波管


Reference plane
Signal flow
Loose connector
Partial reflections
RF in
Reflected signal
Waveguide damage

網路分析儀功能
導波管校正程序

轉接頭



校正器



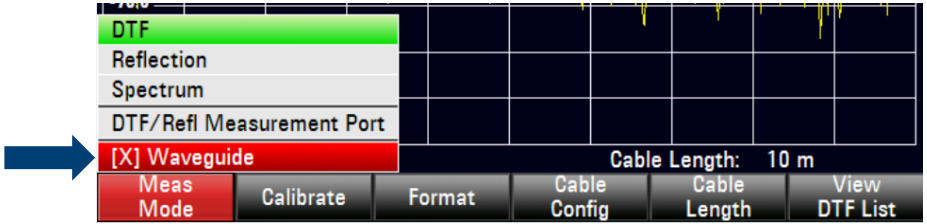
校正器文件

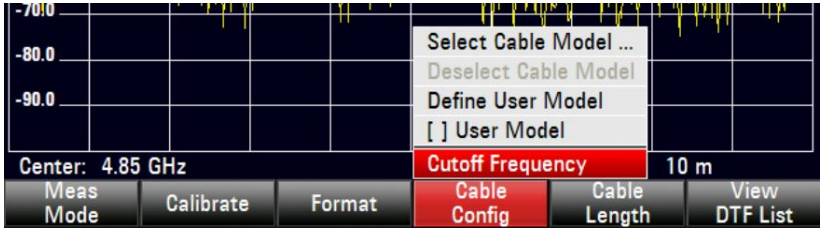
Rhode & Schwarz Network Analyzers

Table 9. Standard Definitions for Rohde & Schwarz

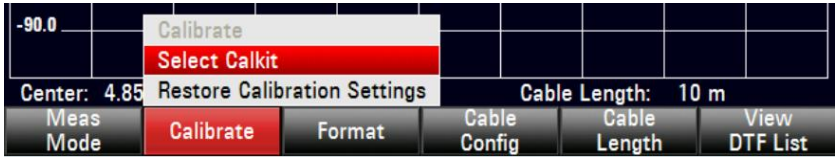
Short		Reflect	
Label	= G344A	Label	= G344A
Min Freq	= 3.151 GHz	Min Freq	= 3.151 GHz
Max Freq	= 5.85 GHz	Max Freq	= 5.85 GHz
Length	= 0.0 mm	Length	= 0.0 mm
Offset Short		Through	
Label	= SHIM + G344A	Label	= Thru (0 cm)
Min Freq	= 3.151 GHz	Min Freq	= 3.151 GHz
Max Freq	= 5.85 GHz	Max Freq	= 5.85 GHz
Length	= 20.504 mm	Length	= 0.0 mm
Match		Line 1	
Label	= Fixed	Label	= G322B0.807
Min Freq	= 3.151 GHz	Min Freq	= 3.151 GHz
Max Freq	= 5.85 GHz	Max Freq	= 5.85 GHz
		Length	= 20.504 mm

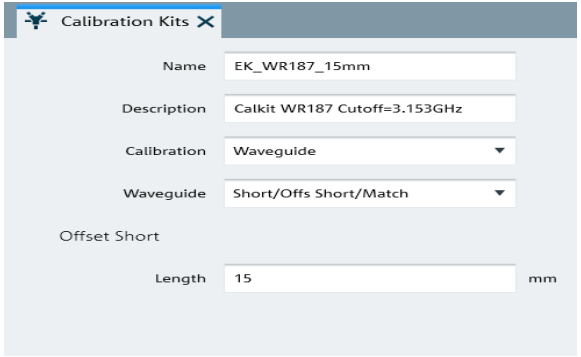
網路分析儀功能
導波管校正程序

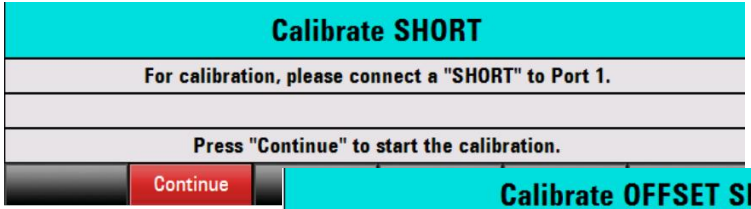


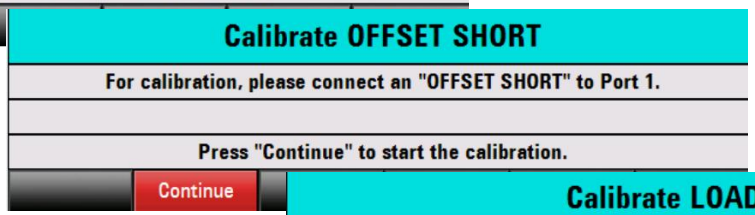


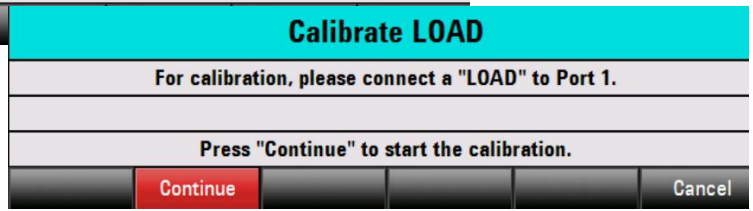
網路分析儀功能
導波管校正程序



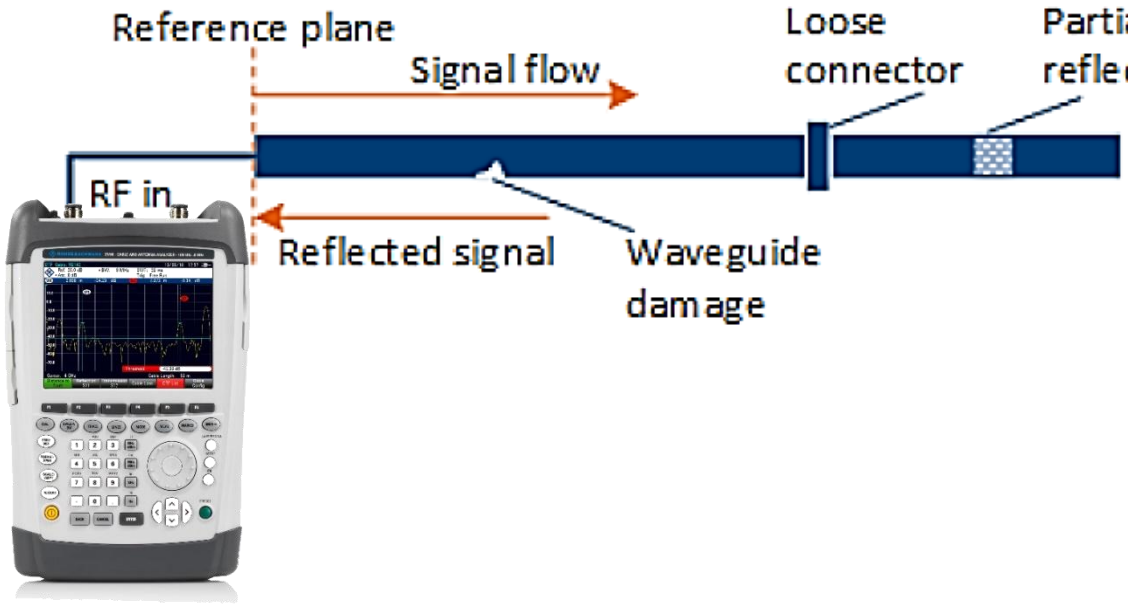


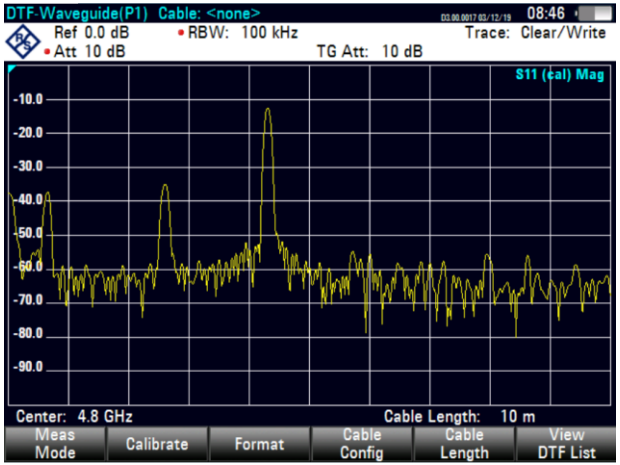






網路分析儀功能
導波管量測





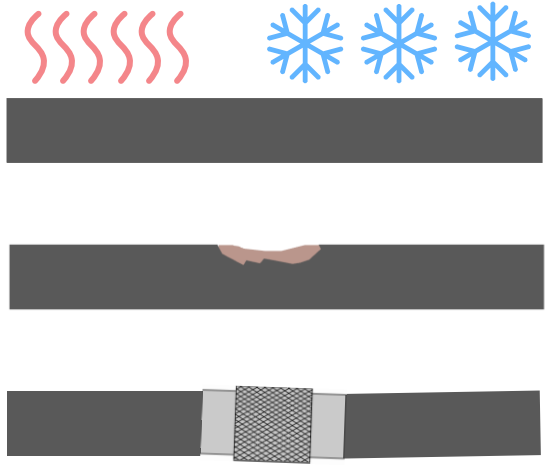
電纜線斷點

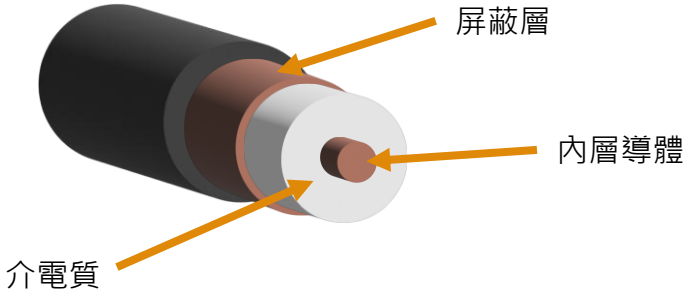


網路分析儀功能
射頻電纜線常見問題

- 電纜線的斷點
  - 可能突然發生或隨時間逐漸累積
  - 導致系統完全失效或降低效能
- 電纜線中存在許多潛在的問題
  - 環境因素 – 水氣、日曬、高溫/寒冷、雷擊
  - 損傷 – 折痕、割傷、過度彎曲
  - 品質不良或安裝不當的接頭與轉接頭
- 有問題的電纜造成阻抗改變
  - 改變了中心導體與屏蔽層之間的間距
  - 改變了兩者之間的介電質(Dielectric)特性

- 阻抗改變導致訊號反射





網路分析儀功能
斷點距離量測

- 利用網路分析儀反射系數，讀出纜線斷點



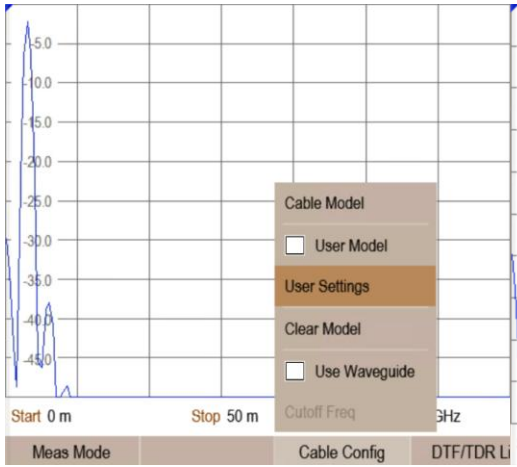
網路分析儀功能
時域反射技術 — 斷點距離量測

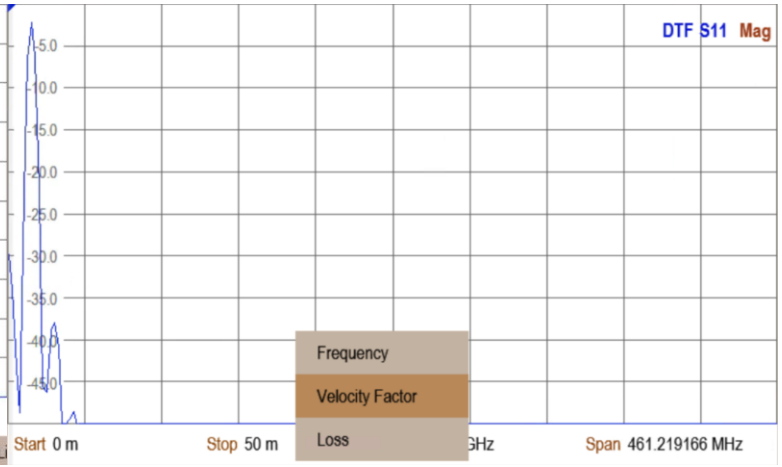
- 送出脈衝至電纜中
- 該脈衝產生反射，若電纜有短路、開路或阻抗不匹配的情況
- 多處斷點則會導致多次反射



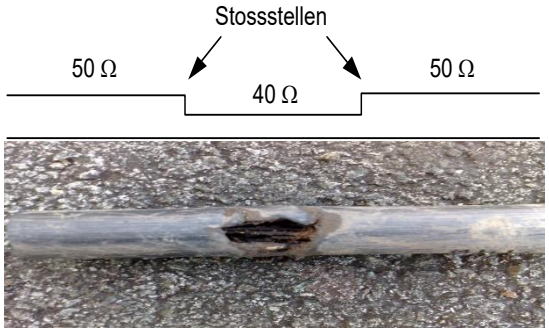
網路分析儀功能
時域反射技術 — 斷點距離量測

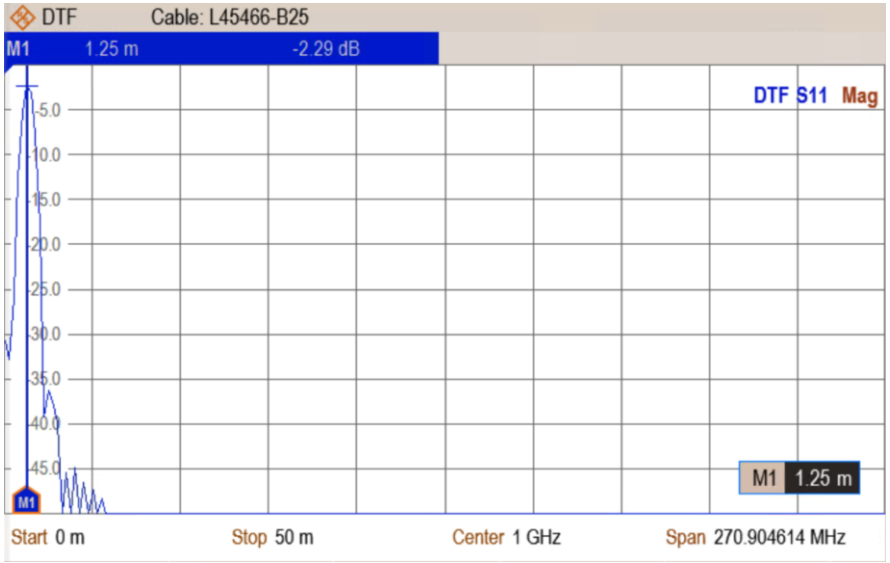






網路分析儀功能
時域反射技術 — 斷點距離量測







THANK YOU!