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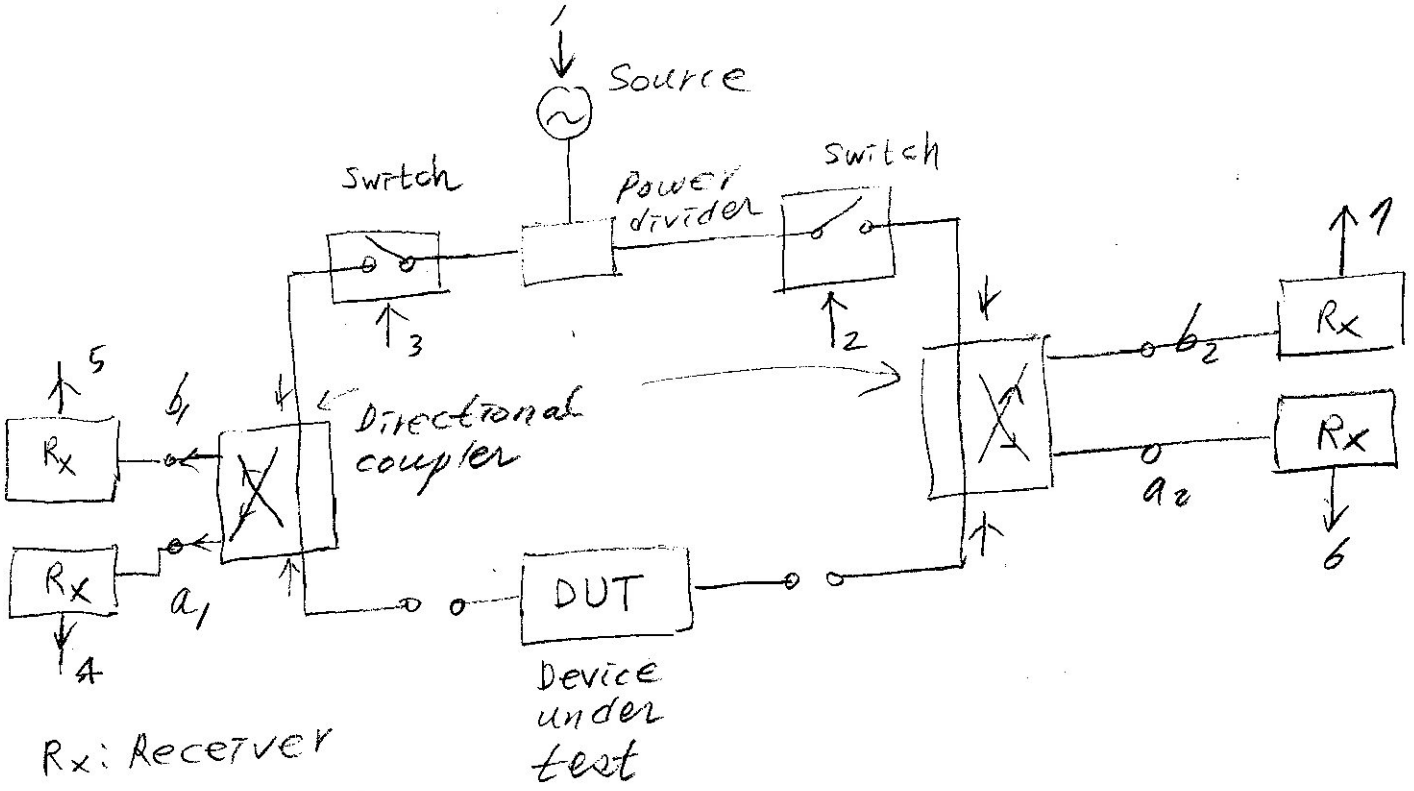
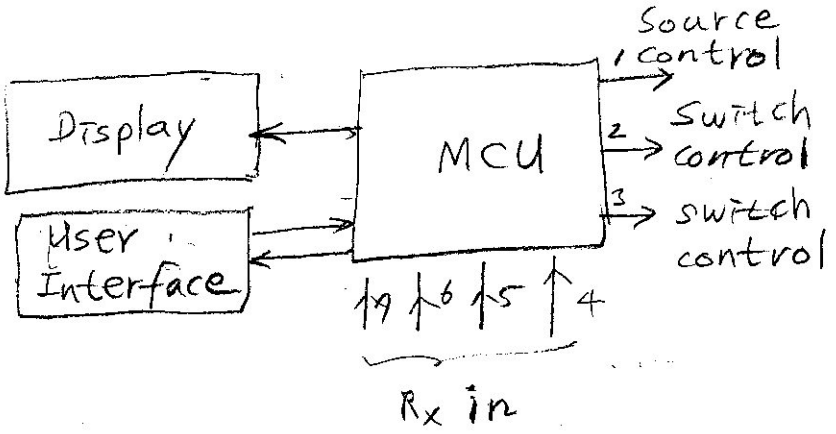
(Radio Engineering Lab.)

1. Network analyzer block diagram





Source + power divider : supply RF signals to port 1 and port 2

Switch : select the port for RF signal injection

Directional coupler : sample incident and reflected signals

Receiver: measure magnitude and phase of RF signal

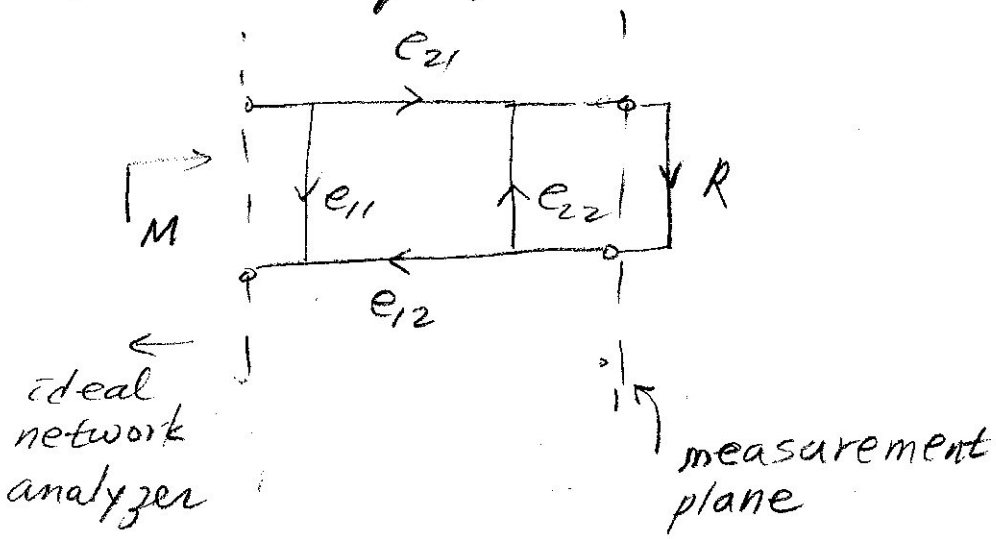
MCU : operate the instrument

Display : display the results

Interface : instrument control and operation

2. One-port calibration

- Network analyzer's imperfection can be represented by the following figure



$e_{11}, e_{12}, e_{21}, e_{22}$: one-port error parameters

R : reflection coefficient of a DUT

M : reflection coefficient measured by a network analyzer

$$M = e_{11} + \frac{e_{12}e_{21}R}{1 - e_{22}R}$$

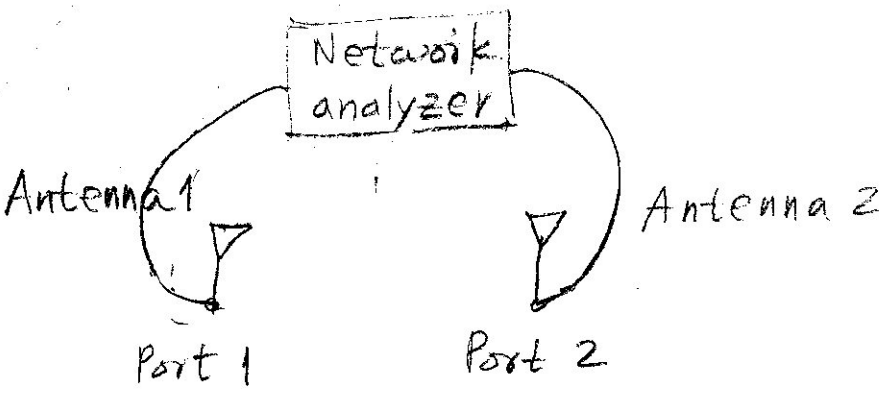
$e_{11}, e_{12}e_{21}, e_{22}$: three unknowns

R_1, R_2, R_3 : three calibration loads with known reflection coefficient

M_1, M_2, M_3 : measured reflection coefficient corresponding to R_1, R_2, and R_3.

→ obtain 3 equations to solve for $e_{11}, e_{12}e_{21}$ and e_{22}.

3. Antenna mutual coupling measurement.

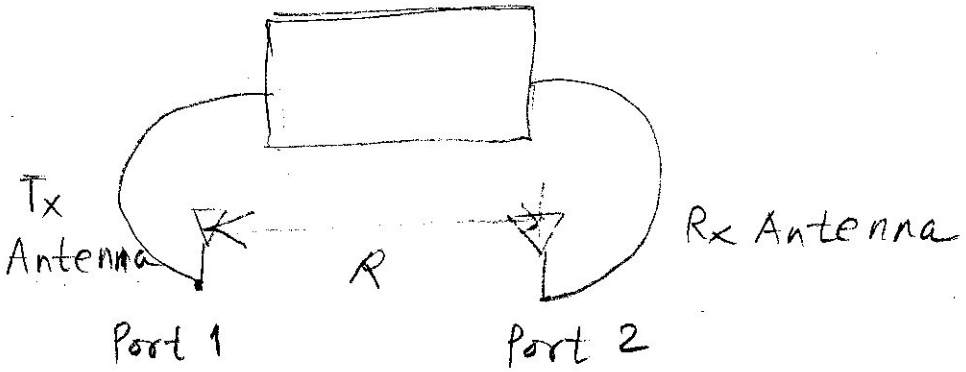


Measure $[S] = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$

Mutual coupling : S_{12}, S_{21}

If necessary, convert [S] into [Z] or [Y] to obtain Z_{12}, Z_{21} or Y_{12}, Y_{21}.

4. Antenna gain measurement using a network analyzer.



Measurement 1 : Rx Antenna = standard gain antenna with gain G_{REF}
Tx Antenna = horn, dipole

(1) $S_{21,REF}(dB) = 10 \log_{10} \frac{P_2}{P_1} = 10 \log_{10} \left[\left(\frac{\lambda}{4\pi R} \right)^2 P_T G_T \right] + G_{REF}(dB)$

Measurement 2: Replace Rx antenna with an antenna under test (AUT) and measure S_{21}.

(2) $$S_{21,AUT}(dB) = 10\log_{10}\left[\left(\frac{\lambda}{4\pi R}\right)^2 P_T G_T\right] + G_{AUT}(dB)$$

From (1) and (2), obtain

$$G_{AUT}(dB) = S_{21,AUT}(dB) - S_{21,REF}(dB) + G_{REF}(dB)$$