IMPEDANCE TESTS OF SINGLE OR COUPLED RESONATORS

by Harold A. Wheeler

A line is terminated in a single resonator or a coupled pair of resonators. The terminal impedance locus is measured by SWR in the line and is plotted on a reflection chart. Certain points on the plot are identified and are used to compute the power factors of the resonators and of the line loading, and the coefficient of coupling. Any one of these may be found directly by observing certain frequencies on the locus.

p_1 = (unloaded) power factor of primary resonator

p_1' = loading power factor of primary resonator

p_1'' = $p_1' + p_1$ = loaded power factor of primary resonator

p_2 = power factor of secondary resonator

k = coefficient of coupling between primary and secondary resonators

k_x = apparent coefficient of coupling at crossover of loop in locus

g = normalized conductance (scale on axis of chart)

Each pair of points marked on a locus corresponds to a pair of frequencies (f_+, f_-) such that

$$\text{the indicated } p \text{ or } k = \frac{f_+ - f_-}{f_o} \tag{1}$$

Relations for coupled circuits: (Fig. 3)

$$k^2 = k_x^2 + p_2^2 ; \tag{2}$$

$$(p_2 / k)^2 = \frac{g_x - g_1}{g_o - g_1} \quad ; \quad (k_x / k)^2 = \frac{g_o - g_x}{g_o - g_1} \qquad (3) \quad (4)$$

Determine p_2 directly by upper dotted circle.

Determine k directly by lower dotted circle, if there is a loop and crossover: $p_2^2 < k^2$.

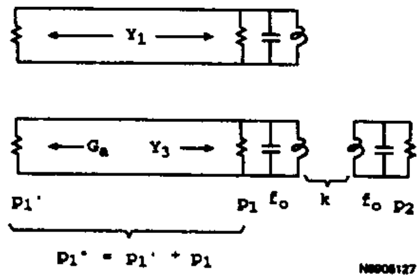

Fig. 1 - The circuit of a line and single or coupled resonators.

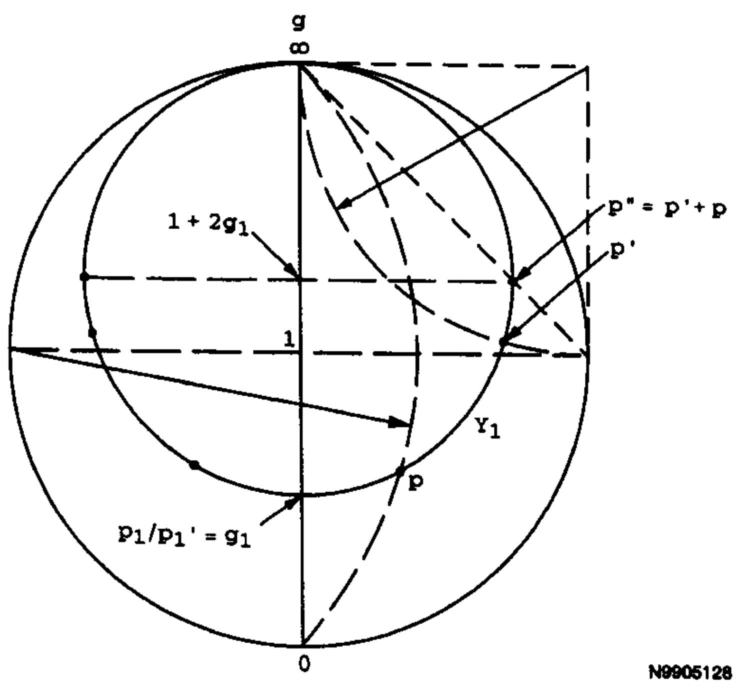

Fig. 2 - The reflection chart of single resonator.

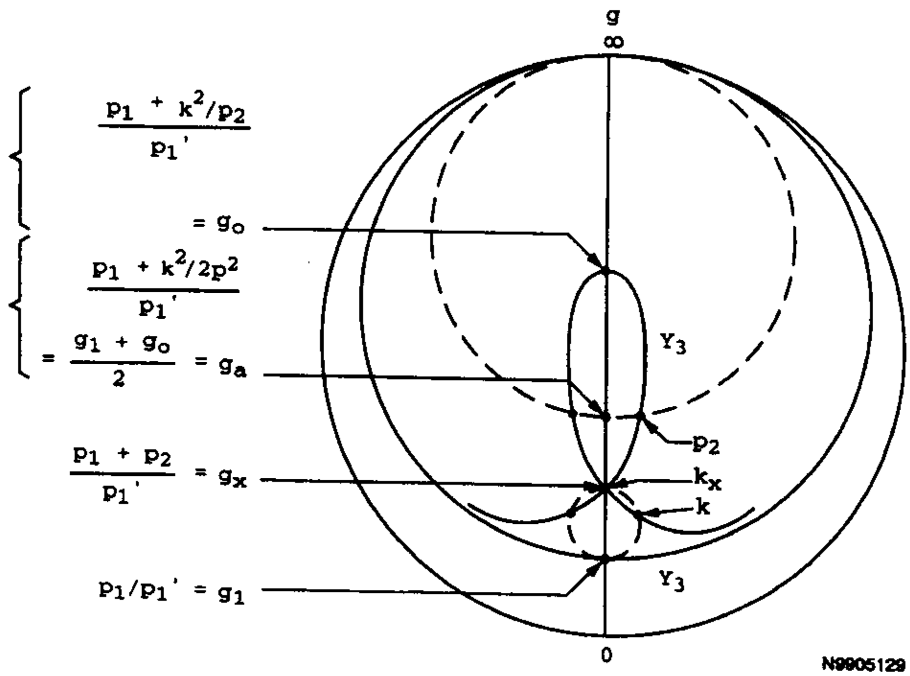

Fig. 3 - The reflection chart of coupled resonators.

Preferred procedures are as follows.

Weak coupling (no loop): $k^2 < p_2^2$.
Compute p_1' for primary.
Note g_1 and g_o ; draw dotted circle through g_a ; compute p_2 by (1);

$$k = \sqrt{p_1' p_2 (g_o - g_1)} \qquad (5)$$

Moderate coupling (small loop): $p_2^2 < k^2 < 2p_2^2$
Evaluate p_2 as above.
Draw dotted circle through g_1 and g_x; compute k by (1).

Strong coupling (large loop): $2p_2^2 < k^2$
Compute p_1' for primary. Note g_1 and g_x ;

$$p_2 = p_1'(g_x - g_1) \qquad (6)$$

At crossover, compute k_x by (1);

$$k = \sqrt{k_x^2 + p_2^2} = k_x \sqrt{\frac{g_o - g_1}{g_o - g_x}} \qquad (7)$$

The latter formula for k does not require p_1' but does require g_o.

Instead of computing p_2 before k, the following procedure gives p_2 after k ; it is most useful if p_2 is so small it is difficult to measure directly: After determining k by lower dotted circle,

$$p_2 = \frac{k^2}{p_1'(g_o - g_1)} \qquad (8)$$

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NB 68, p. 27-34. Also see J-323.
J-102
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