

CHECK YOUR Q READINGS By the Delta C Method

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There are instances not covered by the Q Standard Type 513-A in which the Q Meter user may question the Q values indicated by his instrument and, lacking a quick cross-check, believes he must content himself with questionable information. This is not necessarily so, since in many cases the "Delta C" method is both convenient and reassuring. Convenient in that the check can be conducted relatively quickly and at any frequency within the Q accuracy specification of the instrument; reassuring when it substantiates the Q Meter.

The check is based upon the equation:

$$Q_c = \frac{2C_r}{\Delta C} \sqrt{\left(\frac{V_r}{V_1}\right)^2 - 1} \quad (1)$$

the derivation of which is too lengthy to include here.* The quantities involved in the equation are from the following Q Meter equivalent circuit including the external inductor and its associated voltage-capacitance curve:

C_r = capacitance to resonate the circuit.

V_r = voltage across the Q Meter capacitor at resonance.

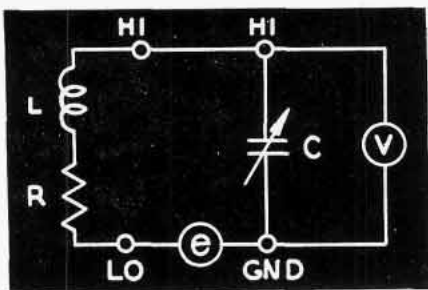


Figure 1. Equivalent Circuit of Q Meter.

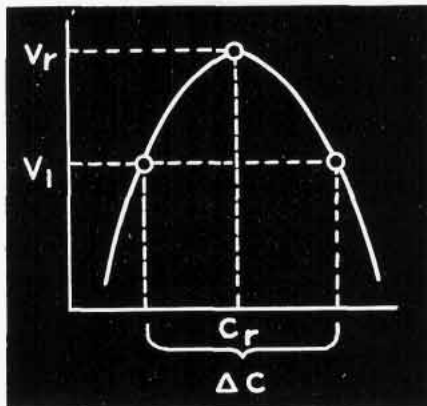


Figure 2. Capacitance Curve of the Q Meter Circuit.

V_1 = voltage across the Q Meter capacitor at a point other than resonance.

ΔC = capacitance between two points of equal voltage (V_1), one on either side of resonance.

Q_c = circuit Q = $\omega L/R$ where R includes all losses in the coil and the Q Meter circuit.

It is worthwhile to note here that since the Q-voltmeters of all BRC Q Meters are linear with respect to voltage and Q, equivalent values of indicated Q may be substituted in the ratio V_r/V_1 . Equation 1 contains an approximation which is negligible when Q is greater than 100.

An easy level at which to make the ΔC measurement is at the half-voltage or half-Q points ($V_r/V_1 = 2.0$), in which case the preceding equation becomes

$$Q_c = 3.4641 \frac{C_r}{\Delta C} \quad (2)$$

Another frequently used level is at the 0.707 voltage or Q points where:

$$Q_c = \frac{2 C_r}{\Delta C} \quad (3)$$

An outline of the procedure using equation (2) and applicable to all Q Meters manufactured by Boonton Radio Corporation is:

1. Set the Q Meter oscillator to the desired frequency.
2. Adjust the XQ control for unity.
3. Connect a shielded inductor requiring a capacitance setting near the maximum available reading for a Q Reading near full scale.
4. If Q Meters Type 160-A or 260-A are being checked, set the vernier scale to zero.
5. Resonate the circuit with the internal resonating capacitor.
 - a. Record the resonating capacitance indicated on the Q capacitor dial as C_r .
 - b. Record the Q at resonance as indicated on the Q voltmeter as Q_r .
6. With the internal resonating capacitor (vernier capacitor on Q Meters Type 160-A and 260-A) detune the circuit on either side of resonance to the point where the Q indicated by the Q voltmeter is equal to $Q_r/2$. Record the capacity between these two points as ΔC .
7. To avoid errors due to mechanical and electrical backlash all settings of the Q condenser should be approached with the same direction of rotation. To minimize errors in reading all settings and readings should

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be made several times and then averaged.

8. Insert the values of C_R and ΔC in equation (2) and calculate Q_C .

Now, if the value of Q_C calculated in step 8 agrees with the value of Q_R recorded in step 5.b. within ± 15 percent all is well and good and the Q Meter can be assumed to be performing satisfactorily.

The method of Q Meter checking discussed here does not take into account variations in Q indication resulting from changes in loading across the measuring terminals (see " Q Meter Comparison ", Notebook 2, Summer 1954.) Difficulties (if indicated) lie elsewhere. For methods of isolating the problem see the Maintenance Section of the applicable Instruction Book.

* Hartshorn, L., and Ward, W.H., Institute of Electrical Engineers, (London, 1936), equation 6. - pp. 79, 597, 609.