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Q Meter Techniques

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The Q Meter has frequently been described as one of the most flexible instruments available with applications limited largely by the ingenuity of the person using it. It is our desire here to delineate some of those techniques, not normally encountered in everyday work, in the hope that wider dissemination of information gathered through many channels, will prove of some value.

In order to approach our specific problems in a general way, it might be well to review some basic facts relative to the operation of the Q Meter.

The Q Meter is always operated with a coil connected to its coil terminals. If we are interested in measuring the Q of a coil, this coil will be connected to these terminals and it will be measured in one operation. If we are interested in making other measurements; (i.e., the Q of a capacitor, the impedance of a circuit, the parameters of a tuned circuit; etc.), we still need a coil, even though we are interested in that particular coil only as a reference. This so-called "work coil" would probably be a shielded unit to prevent stray coupling, hand-capacitance effects, etc.; and might be selected for its inductance, Q; etc., as needed for the particular application involved.

In making measurements (other than the Q of a coil) of circuit parameters there will be two steps involved. The first will be with the work coil mounted on the Q meter, where the resonating capacitance (C_1), circuit Q (Q_1), and frequency will be recorded. The second will be with the unknown connected in addition to the work coil and once again the above reading will be noted, this time as C_2 and Q_2.

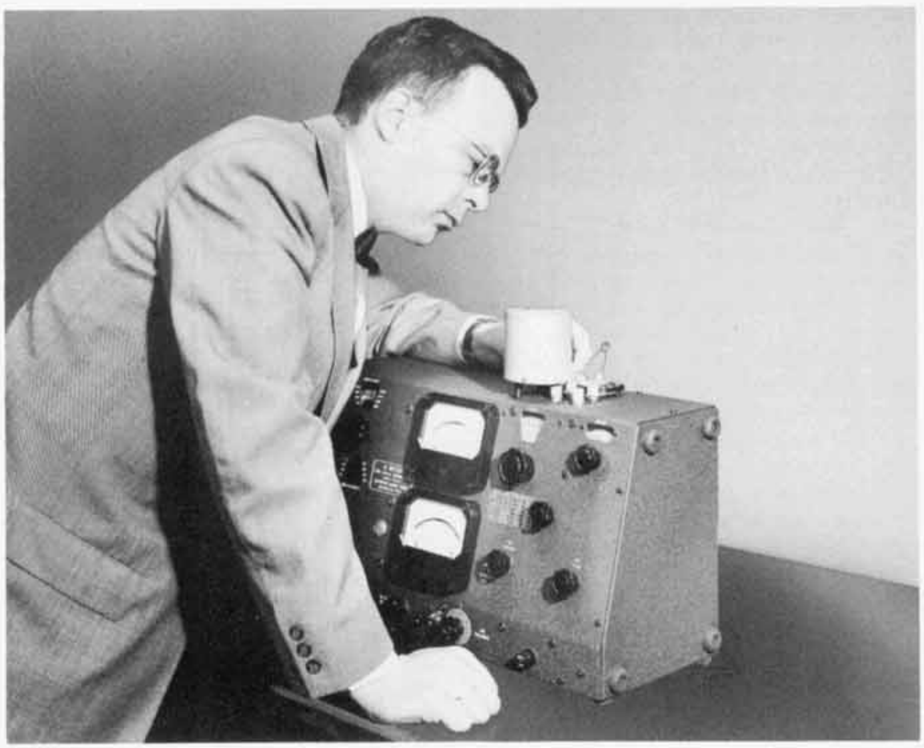

Figure 1. The author connects a fixed capacitor to the terminals of a series jig prior to measuring the capacitance on a Type 260-A Q Meter.

YOU WILL FIND . . .

From this data the desired parameters can be determined using the appropriate formula selected from those shown in figure 2. High impedance circuits are measured by connecting them in *parallel* with the *Q Capacitor;* i.e., across the "Capacitor" terminals, and using the formulas shown under the heading "Parallel Connection to Q Circuit". If the unknown consists of more than one parameter, it should be noted that the *equivalent parallel* parameters are obtained in this manner. Low impedance circuits are measured by connecting them in *series* with the "Low" side of the coil. In like manner the "Series Connection to Q Circuit" formulas are used to yield the *equivalent series parameters* of the circuit involved.

With the above in mind, it might be well to resolve some specific problems.

1. Measurement of Coils.

a. *Coil inductance too great to resonate with minimum capacitance of Q Meter at desired frequency.* Since this can be considered a high impedance measurement, the unknown coil can be connected to the capacitor terminals and readings of C_1, C_2, Q_1, and Q_2 made in two steps. There will actually be two coils involved in this measurement. C_1 and Q_1 will be the values read with the

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work coil only mounted on the coil terminals. C_2 Q_2 are made after the *unknown* coil has been added across the capacitor terminals and the measurement is made with *both* coils connected. Formula 3b will yield the inductive reactance and 2b will give the equivalent parallel resistance. Combining these two parameters, formula 1b will give the Q directly.

b. *Maximum resonating capacitance on Q Meter insufficient at chosen frequency.* If it is desired to measure a coil having so low an inductance that it cannot be resonated with the capacitance available on the Q Meter, additional capacitance can be added across the Q Meter capacitor terminals and the coil measured in a normal manner. The additional capacitance must be known, if it is desired to compute the reactance of the coil.

c. *Measurement of extremely high Q coils.* If the Q of a coil is beyond the range of the Q meter with its highest XQ multiplier, it can be measured using the same procedure described under (a) above.

d. *Measurements at frequencies below 50 kc.* Measurements can be made on both the 160-A and 260-A Q Meters at frequencies down to 1000 cps by disconnecting the Q Meter oscillator and supplying the instrument signal from an external source through a Coupling Unit Type 564-A. A jack has been provided in the top of the 160-A Q Meter for this purpose. The 260-A has also been provided with a removable panel in the rear of the instrument where disconnection of the 50-ohm cable from the thermocouple block by means of a BNC connector allows easy adaption to low frequency measurements. Any audio oscillator having good waveshape and capable of developing a variable voltage up to 22 volts across 500 ohms can be used.

For coil measurements at these lower frequencies, it will probably be found necessary to provide additional capacitance across the capacitor terminals to resonate the inductors frequently encountered in this frequency range. In using an external oscillator, care must be exercised that the output attenuator is turned all the way down before connecting to the Q Meter in order to pre-

SERIES CONNECTION TO Q CIRCUIT

$$Q_x = \frac{(C_1 - C_2)\,Q_1 Q_2}{C_1 Q_1 - C_2 Q_2} \qquad (1a)$$

$$R_s = \frac{1.59 \times 10^8 \left(\frac{C_1}{C_2} Q_1 - Q_2\right)}{f C_1 Q_1 Q_2} \qquad (2a)$$

$$X_s = \frac{1.59 \times 10^8 \,(C_1 - C_2)}{f C_1 C_2} \qquad (3a)$$

$$L_s = \frac{2.53 \times 10^{10}\,(C_1 - C_2)}{f^2 C_1 C_2} \qquad (4a)$$

$$C_s = \frac{C_1 C_2}{(C_2 - C_1)} \qquad (5a)$$

When C_1 is:
Greater than C_2, X_s is inductive (+).
Less than C_2, X_s is capacitive (−).

PARALLEL CONNECTION TO Q CIRCUIT

$$Q_x = \frac{(C_2 - C_1)\,Q_1 Q_2}{C_1 (Q_1 - Q_2)} \qquad (1b)$$

$$R_p = \frac{1.59 \times 10^8\, Q_1 Q_2}{f C_1 (Q_1 - Q_2)} \qquad (2b)$$

$$X_p = \frac{1.59 \times 10^8}{f\,(C_2 - C_1)} \qquad (3b)$$

$$L_p = \frac{2.53 \times 10^{10}}{f^2\,(C_2 - C_1)} \qquad (4b)$$

$$C_p = C_1 - C_2 \qquad (5b)$$

When C_1 is:
Greater than C_2, X_p is capacitive (−).
Less than C_2, X_p is inductive (+).

In the formulas for Q, the quantities $(C_1 - C_2)$ and $(C_2 - C_1)$ are always considered positive.

The following symbols refer to values of the unknown impedance, Z:

Q_x = Q of the unknown impedance
R_s = Effective series resistance.
X_s = Effective series reactance.
L_s = Effective series inductance.
C_s = Effective series capacitance.
R_p = Effective parallel resistance.
X_p = Effective parallel reactance.
L_p = Effective parallel inductance.
C_p = Effective parallel capacitance.

The units used are:

R = Resistance in ohms.
X = Reactance in ohms.
L = Inductance in microhenries.
C = Capacitance in micro-microfarads.
f = Frequency in kilocycles per second.

Figure 2. General formulas for series and parallel connections.

SERIES CONNECTION TO Q-METER

$$R_p = \frac{1.59 \times 10^8\,(C_1 - C_2)^2\, Q_1 Q_2}{f C_1 C_2 (C_1 Q_1 - C_2 Q_2)} \qquad (6a)$$

$$X_s = X_p = \frac{1.59 \times 10^8\,(C_1 - C_2)}{f C_1 C_2} \qquad (7a)$$

$$L_s = L_p = \frac{2.53 \times 10^{10}\,(C_1 - C_2)}{f_2 C_1 C_2} \qquad (8a)$$

$$C_s = C_p = \frac{C_1 C_2}{(C_2 - C_1)} \qquad (9a)$$

PARALLEL CONNECTION TO Q-METER

$$R_s = \frac{1.59 \times 10^8\, C_1\,(Q_1 - Q_2)}{f\,(C_2 - C_1)^2\, Q_1 Q_2} \qquad (6b)$$

$$X_s = X_p = \frac{1.59 \times 10^8}{f\,(C_2 - C_1)} \qquad (7b)$$

$$L_s = L_p = \frac{2.53 \times 10^{10}}{f^2\,(C_2 - C_1)} \qquad (8b)$$

$$C_s = C_p = C_1 - C_2 \qquad (9b)$$

In the above formulas the same units, symbols and conditions stated in figure 2 apply except that these formulas are accurate only for impedances having a Q greater than 10. The formulas in figure 2 are accurate for any impedance.

Figure 3. Series and parallel connection formulas for impedances having a Q greater than 10.

$$Q_x = \frac{X_s}{R_s} = \frac{6.28 \times 10^{-3} f L_s}{R_s} = \frac{1.59 \times 10^8}{f R_s C_s} = \frac{R_p}{X_p} = \frac{159\, R_p}{f L_p} = 6.28 \times 10^{-9} f R_p C_p \qquad (10)$$

$$R_s = \frac{R_p}{1 + Q_x^2} \qquad (11a) \qquad\qquad R_p = R_s\,(1 + Q_x^2) \qquad (11b)$$

$$X_s = X_p \frac{Q_x^2}{1 + Q_x^2} \qquad (12a) \qquad\qquad X_p = X_s \frac{1 + Q_x^2}{Q_x^2} \qquad (12b)$$

$$L_s = L_p \frac{Q_x^2}{1 + Q_x^2} \qquad (13a) \qquad\qquad L_p = L_s \frac{1 + Q_x^2}{Q_x^2} \qquad (13b)$$

$$C_s = C_p \frac{1 + Q_x^2}{Q_x^2} \qquad (14a) \qquad\qquad C_p = C_s \frac{Q_x^2}{1 + Q_x^2} \qquad (14b)$$

Figure 4. Series to parallel transfer formulas.

clude possible thermocouple damage. Reasonably good waveshape is required of the supply, since the thermocouple responds to the rms voltage and the Q Voltmeter is a peak-reading device. The presence of harmonics will therefore affect the Q reading.

e. *Dielectric measurements at low frequencies.* We have had many inquiries from customers relative to the use of a Q Meter for low frequency dielectric measurements. On information received from the field, a typical installation for 1 kc operation would include, in addition to a Q Meter and a 564-A Coupling Unit, a Hewlett-Packard audio oscillator Type 200 AB (20 cycles to 40 kc), a UTC Type MQ B-11 inductor and a good variable or decade capacitor having up to approximately 1500 MMFD, or equivalent equipment. Operation at other frequencies would have other inductance or capacitance requirements.

f. *Inductance measurements.* It might be worth noting that in using the L/C dial for direct inductance measurement, the *effective* inductance is given. If it is desired to read the true inductance and the distributed capacitance, C_d, is known, it can be done by *increasing* the capacitance dial setting, after resonance has been established, by an amount equal to the C_d and reading off the corresponding value of inductance as the true inductance.

2. Measurements of Capacitors.

This is a fairly common operation and there is no point in elaborating on it. Briefly, the Q of a capacitor is evaluated by first selecting a suitable coil and measuring its Q and resonating capacitance on the Q Meter. After noting these as Q_1 C_1, the unknown capacitor is connected across the capacitor terminals and the circuit is once again resonated using the internal Q capacitor. Values of Q_2 C_2 are recorded, and from Q_1, Q_2, C_1, and C_2, the Q of the unknown can be computed using the appropriate equation in figure 2. It might be noted that the accuracy of measuring capacitance can be improved by using an external variable precision capacitor. Since this measurement is essentially one of substitution, the range of measurable capacitance can also be extended by using a coil with less inductance, thereby requiring the addition of more external capacitance.

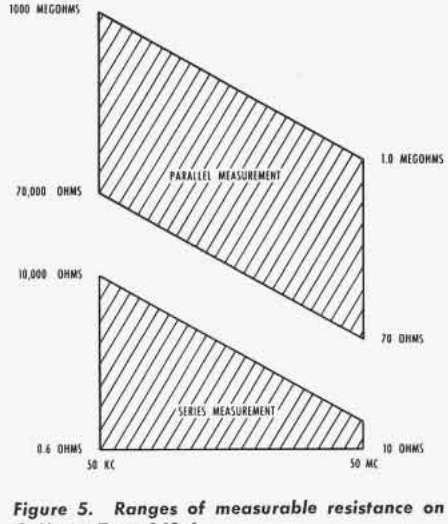


Figure 5. Ranges of measurable resistance on Q Meter, Type 260-A.

Large capacitors may be measured by connecting them in series with the low side of the coil. For this measurement, however, a coil is used whose inductance will resonate to the desired test frequency with the Q capacitor set to the high capacitance end, so that the addition of the test capacitor will cause a measurable change. It is also necessary to shunt the capacitor under test with a 3 to 10 megohm resistor to provide a dc return path for the voltmeter.

With large capacitors it is particularly important to minimize lead length. Shorting the capacitor out, rather than removing it entirely, during the first measurement is desirable.

Figure 6. Grid electrode holder for measuring mica in a plane parallel to the cleavage plane.
(Courtesy of Bell Telephone Laboratories and American Society for Testing Materials. From ASTM Designation: D748-54T. Reprinted with permission.)

3. Measurements of Resistors at Radio Frequencies.

Resistors are handled either in series with the low end of the coil or in parallel with the capacitor terminals, depending upon whether the resistance value is low or high respectively. There are values of resistance for each frequency, however, that cannot be measured. Some idea of this can be had from figure 5. The use of the low Q scale tends to shrink this area which cannot be measured and there have been articles[1] in the literature describing other techniques that can be employed to surmount this problem.

4. Measurement of Mica.

Q Meters have found wide application in the sorting of mica based on its dielectric properties. The measurement can be accomplished in the perpendicular plane, using a clamp type holder with suitable test electrodes, or in a plane parallel to the cleavage plane using a holder with grid electrodes. The latter is illustrated in figure 6. The actual test methods employed have been adequately covered elsewhere[2].

5. Application of Biasing Potentials.

It is sometimes desirable to investigate circuits with biasing potentials or currents applied during the measurement. Figure 7 illustrates how this can be accomplished using a blocking capacitor and a high impedance power source. Capacitor C must be large enough to present negligible reactance at the operating frequency, and R must be high enough to prevent loading of the circuit by the power supply. The applied voltage will be determined by the resistance, R, and the biasing current. Polarity of the battery and magnitude of the biasing current are inconsequential to the operation of the Q Meter.

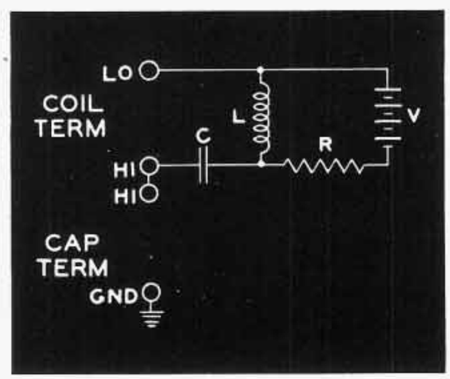


Figure 7. Circuit for applying Q Meter bias.

OWNERS OF SIGNAL GENERATORS, TYPE 202-F FM-AM AND UNIVERTERS, TYPE 207-F PLEASE NOTE

Final Operating Instruction Manuals for these instruments are now available. If you have not received your copy, please let us know and it will be forwarded immediately.

Figure 8. Q Meter, Type 260-A connected to RF Voltage Standard, Type 245-B.

6. Use of 260-A as a Signal Generator.

The 260-A Q Meter can be improvised as a CW signal source up to approximately 20 mcs, by removing the small rear cover plate, disconnecting the coaxial cable going into the thermocouple block, and connecting it to the input of the 245-B RF Voltage Standard through a 20 db pad. The output of the 245-B then is ½, 1.0, or 2 microvolts depending upon which level is selected on the meter. The X Q control varies the oscillator output for the signal level desired. See figure 8.

7. Use of Q Meter as a Wave Meter.

If the oscillator range switch is set between ranges to turn the oscillator off, a coil can then be connected across the coil terminals and coupled to an active circuit whose frequency is not known. After the Q capacitor has been tuned for a maximum deflection and the active circuit removed, the Q Meter oscillator can then be turned on and its frequency varied for another indication of resonance. The frequency thus indicated, is the frequency of the unknown signal under test.

8. Miscellaneous.

a. *Use of 260-A with frequency counter.* Where greater than 1% frequency accuracy is desired, the Q Meter oscillator can be monitored with a counter. This is accomplished by removing the rear panel, disconnecting the transmission line going to the thermocouple block, and inserting a "tee" fitting to allow the parallel connection of the counter input. Operating the Q Meter with its multiplier set at "X 1" will afford approximately 0.5 volts to a high input impedance counter.

b. *Use of Scale Magnifier.* Where it is desired to read the main capacitor dial more closely than ordinarily allowed, a hemicylindrical magnifier made from plastic, as shown in figure 9, can be used. Constructional details are shown in figure 10.

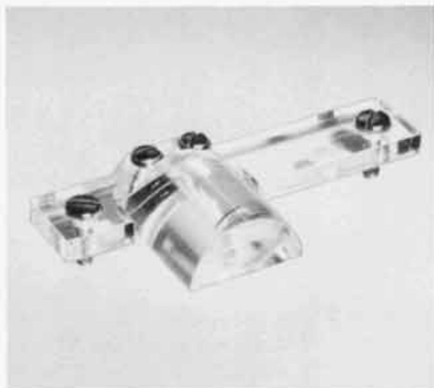
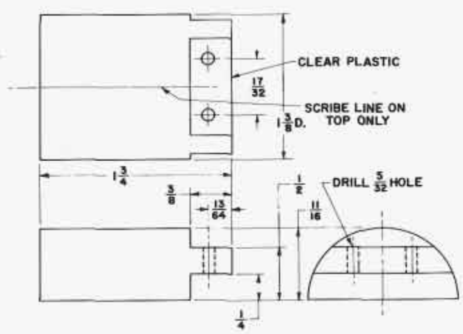


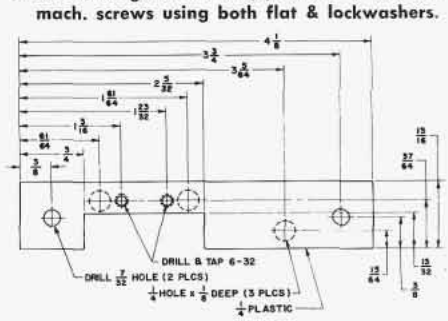
Figure 9. Main capacitor dial magnifier.



MAGNIFIER

ASSEMBLY INSTRUCTIONS

1. **Remove (2) #10-32 x 3/8 BH mach. screws on 260-A panel which line up with 7/32 dia. holes.**
2. **Attach strip with (2) #10-32 x 5/8 BH mach. screws thru 7/32 dia. holes, using flat washers & lock washers. (1/4 dia. spot-face at 3-5/64 will clear fiducial screw on recent 260-A's. Other (2) 1/4 dia. spot-faces will clear fiducial screws on early 260-A's).**
3. **Mount magnifier with (2) #6-32 x 1/2 BH mach. screws using both flat & lockwashers.**



ATTACHMENT STRIP

Figure 10. Construction and assembly details of the main capacitor dial magnifier.

c. *Use of "delta Q" scale to refine resonance.* The "delta Q" scale can be used to obtain a very precise resonance by taking advantage of its greater sensitivity. After carefully resonating the Q Circuit in a normal manner, set the "delta Q" dial to the Q indicated on the Q Meter, and depress the key. By adjusting the "delta Q" potentiometers to center the needle on the red scale, very fine adjustments can be made to the internal resonating capacitor for resonance.

d. *Use of "delta Q" scale as a "go—no-go" test.* Using the technique shown above under (c), once resonance is established, limits within the confines of the red scale can be established. Centering the needle in the red scale for the nominal value, tolerances can be set up for components in terms of deviation from the center point in either direction.

e. *Use of "Lo Q" scale for zeroing voltmeter.* Since both the "Q" scale and "Lo Q" scale have the same zero point, the voltmeter can be adjusted by making the adjustment on the "Q" scale and depressing the "Lo Q" key to make sure there is no change on the needle. When the instrument is properly adjusted for zero, "pumping" the "Lo Q" key should not move the needle at all.

Conclusion

The foregoing discussion is by no means intended to define the limits of the Q Meter, but instead indicate some of its potentialities. As new problems arise, we hope new techniques will be developed. Our field staff stands ready to assist in these problems.

Bibliography

1. Lafferty, R. E., "Extended Q Measurements", Electronics, November 1951.
2. ASTM Designation: D748 — 54T.
3. Cook, L. O. "A Versatile Instrument — The Q Meter", BRC Notebook No. 4, Winter 1955.
4. Riemenschneider, N. L., "Measurement of Dielectric Materials and Hi Q Capacitors with the Q Meter", BRC Notebook No. 8, Winter 1956.
5. Wangsgard, A. P. and Hazen, T., "The Q Meter for Dielectric Measurements on Polyethylene and other Plastics at Frequencies up to 50MC", Electrochemical Preprint, 90-11.
6. "Tentative Methods of Test for Power Factor and Dielectric onstant of Electrical Insulating Materials", ASTM Designation: D150 - 47T.
7. Instruction Manual for the Q Meter Type 260-A, Boonton Radio Corp., Boonton, N. J.

Glide Slope Generator Tone Signal

Phase Relationships of the 90-150 cps Tones

When the weather gets soupy airliners and military aircraft rely on electronic guidance systems for safe landings[1]. One component of this common navigational system is the glide path established by a transmitter located near the end of a runway and the associated receiving and indicating equipment in the aircraft.

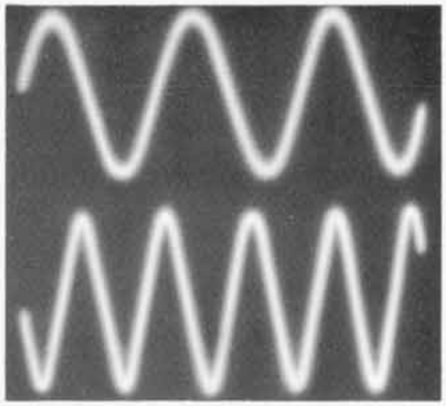
Operation of the system is based upon the ratio of a 90 cps signal to a 150 cps signal appearing at the output of the receiver. The desired course is that inclined plane in which the two modulation tones are of equal intensity and the receiver circuits must be adjusted to produce the corresponding on-course indication.

To insure proper operation of the receivers and indicators it is necessary to check them at frequent intervals with signals corresponding to those received aboard the aircraft in various positions with respect to the desired glide slope. This is usually done with the Glide Slope Signal Generator Type 232-A or its military equivalent, Signal Generator SG-2. This instrument contains a synchronous alternator which supplies 90 cps and 150 cps tones and has provisions for mixing the ratio of the two by predetermined amounts to correspond to different positions of the aircraft with respect to the on-course signal.

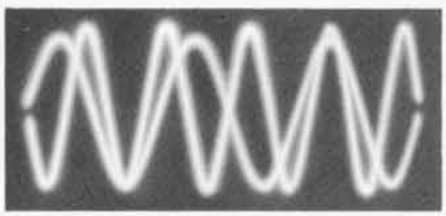
Standard Conditions

In the ground transmitter the relative phase of the 90 cps and 150 cps modulation signals is set so that at no time do peak voltages of both signals occur simultaneously. Otherwise the maximum percentage modulation which could be assigned to either signal would be one-half the maximum total modulation level since each would contribute equally at the in-phase instant as shown in Figure 1.

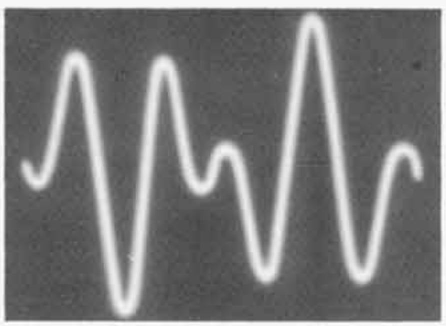
If, however, the relative phase between the alternators is correct, at no time will peaks add in either polarity but will be spaced by a minimum separation of approximately 12° of the 30 cycle repetition rate of the composite pattern. This condition is shown in Figure 2. For a given total peak-to-peak swing of the modulation, it is now possible to deliver a larger percentage



a. Incorrectly-phased 90 cps and 150 cps tones. Leads from 150 cps alternator have been reversed.



b. Incorrectly-phased tones superimposed.

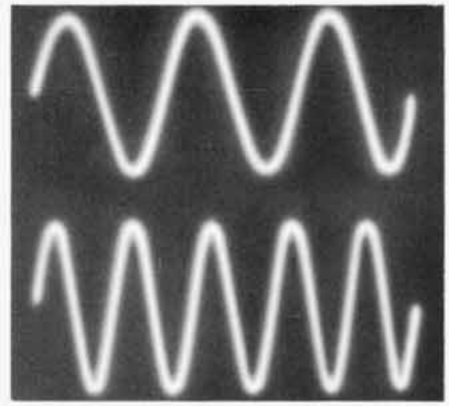


c. Sum of incorrectly-phased tones for "on course" signal as applied to modulator of Glide Slope Signal Generator Type 232-A.

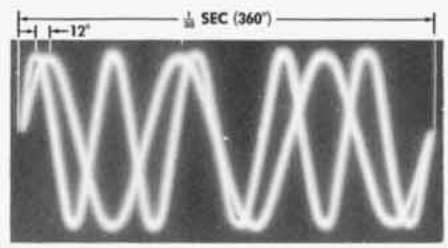
Figure 1. Waveforms for incorrectly phased 90 cps and 150 cps modulation signals.

modulation of each of the two component signals comprising the composite waveform.

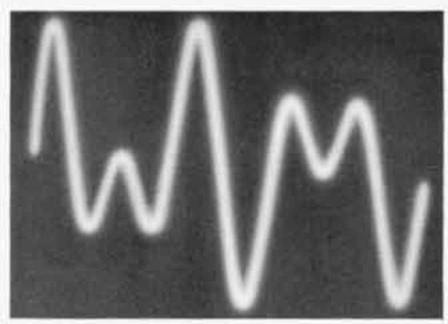
The condition pictured in Figure 2 has been selected as standard and is defined on page 41 of reference number 2. This specification defines a certain phase relationship for the signals. There are, however, at least four ways in which the phase relationship can be tested *provided* an initial overall test is made



a. Correctly-phased 90 cps and 150 cps tones displayed separately.



b. Correctly-phased tones superimposed.



c. Sum of correctly-phased tones for "on course" signal as applied to modulator of Glide Slope Signal Generator Type 232-A.

Figure 2. Waveforms for correctly phased 90 cps and 150 cps modulation signals.

to be certain that the output windings from the 90 cps and 150 cps alternator have been properly interconnected and that the two voltages are approximately equal.

Testing Methods

The definition, which may be used as one basis for a method of measurement, states that the 90 cps and 150 cps signals shall be in phase on the *zero-axis-*

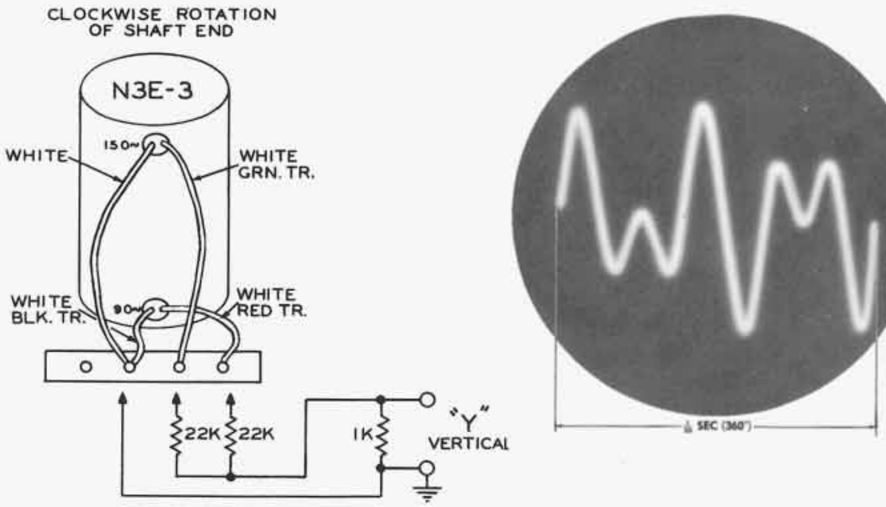


Figure 3. Test connections and correct oscilloscope pattern for the 90-150 cps alternator (Eastern Air Devices Co., Type N3E-3) in the Type 232-A Glide Slope Signal Generator.

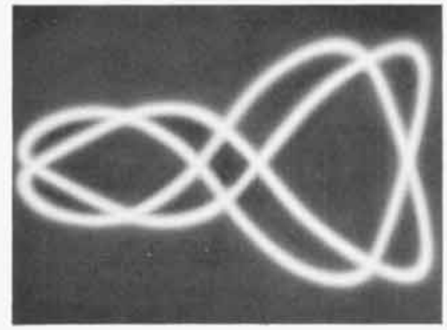


Figure 4. Pattern, obtained from a 30 cps sinusoidal sweep, for testing phase relationships.

crossing on the *positive-going* wave slope. If a dual-channel electronic switch is available for the oscilloscope, it is possible to superimpose the 90 cps and 150 cps signals and obtain the pattern shown in Figure 2b. By the use of suitable techniques and equipment, the region in the vicinity of the zero-axis-crossing can be investigated and the relative phase of the two signals at this point determined.

The second method, which also is based on a definition but requires a somewhat more difficult oscilloscope technique, consists of measuring the separation of the peaks of the two signals to insure that they are not closer than a minimum separation of 12° for either positive or negative pairs as shown in Figure 2b.

In the third method, the two tones are added to give a composite signal as shown in Figure 3. With proper phasing there are pairs of peaks which have the same amplitude. A slight shift in the relative phase will increase the amplitude of one of the peaks while decreasing the amplitude of the other on both the positive and negative pairs. In order to increase the sensitivity of this measurement it is common practice to blow up the image and depress the zero axis by means of the centering control so that a magnified portion of the tips of a pair of peaks appears on the screen. This is a very sensitive test and will yield good accuracy in testing for correct phase angle provided the two signals are of approximately equal magnitude.

A glance at the display will show that it consists of a "W" connected with an "M" in which pairs of legs on both letters are equal. A display in which an "M" is followed by a "W", is equally valid depending on the phase of the synchronizing voltage used for the oscilloscope. Improper connection of the alternator windings gives the waveform of Figure 1c.

A fourth method is based upon forming a Lissajous pattern by using a properly-phased 30 cps sine wave to drive the horizontal oscilloscope amplifier. This has the practical effect of taking the pattern of Figure 3 and wrapping it around a transparent cylinder so that the two ends connect as shown in Figure 4 which strongly resembles a large pair of ice tongs. Since the amplitude of the two peaks depends on the relative phasing of the 90 cps and 150 cps signals, the adjustment for which points of the ice tongs just meet is a very sensitive measure of the phase relationship of the two signals.

Summary

Of the four methods described above two are based on measuring relative phase of two signals in a superimposed display and two are based upon relaive amplitude measurements of a composite signal.

When using expanded displays of either of the methods in which amplitude is used as a measure of phase relationship, care must be exercised to insure that the magnitudes of the 90 cps and the 150 cps signals are approximately equal and that the interconnections from the generator are correct as indicated by the "W-M" display shown in Figure 3.

Bibliography

1. "Bad Weather Flying" Beatty E.W., BRC Notebook No. 4, Winter 1955.

2. "Calibration Procedures for Signal Generators Used in the Testing of VOR and ILS Receivers", RTCA report 208-35-DO-52.

The Need for Special Instruments

It has always been our policy to develop and design instruments which can be applied under a wide variety of conditions. This flexibility tends to broaden the market thus lowering the price. It also makes it possible for a given laboratory to sustain its work with a smaller number of instruments. For instance the Q Meter Type 260-A covers a frequency range of 50 kc to 50 mc and can be extended down to 1 kc with standard, readily available, external equipment. The range of Q measurements is 10 to 625 and the capacitance range is 30 to 460 micromicro farads. A single-frequency Q meter to measure one level of Q at a given capacitance could be built to very high accuracy but since few would be needed, the price would be high and the owner would soon find many problems not covered by the instrument.

Our policy has also always provided for a standard cabinet and cabinet finish. In addition we have not provided any means for furnishing instruments with performance characteristics or specifications different from those standardly advertised. These policies, also, are based on our strong desire to hold the price to all at a minimum. Our time and money has been concentrated on providing the highest average usefulness to the greatest number of our customers. We have always felt that providing more service to the few would result in less service for the many.

Recent changes in the electronic field have indicated the need for some additions to this policy. Electronic instruments are being used as parts of large assemblies of test equipment instead of as individual laboratory equipments. Since each company's instruments are a different color these assemblies are by no means uniform in appearance. Customers who assemble these instruments quite naturally want them finished in a uniform manner. Commercial equipment in some cases does not exactly fit the performance requirements in other ways. As long as substantial redesign is not required these changes can be made. The importance of the application very frequently justifies the added charges for making minor changes and special arrangements.

To better serve the special requirements discussed above Boonton Radio Corporation has recently set up a Special Devices group. This group will handle finishing and small changes such as relocation of connectors, special cables, and other minor changes to accommodate special requirements. Our internal methods for handling these orders have been simplified so as to give rapid service. Arrangements have been made to assure that none of the charges for this special work appear in the price of our standard instruments. We would be happy to hear your special needs for our equipment with the type of slight modification discussed here.

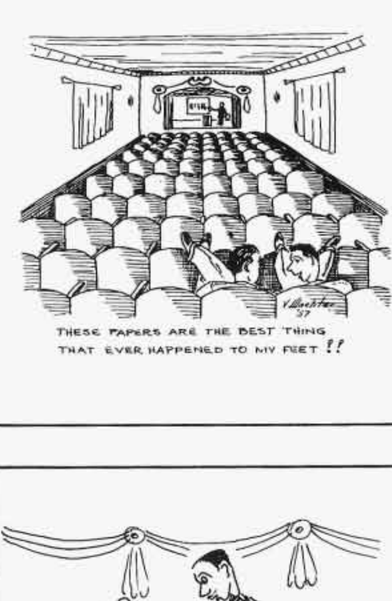
Conventioneering with Cartoons

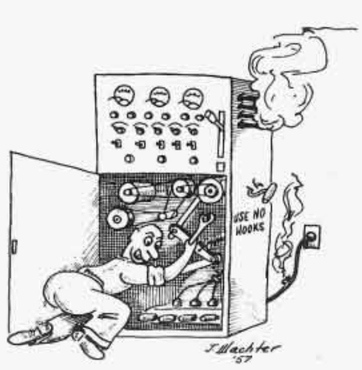
JAMES E. WACHTER, *Project Engineer*

EDITOR'S NOTE

Anyone who has ever attended an IRE show doubtless knows that Jim Wachter, Project Engineer and amateur cartoonist extraordinary at BRC, has covered the field with his "Conventioneering with Cartoons" series illustrated here. Jim saw the convention from "both sides of the fence" so to speak. He served his time in the BRC booth and joined the throngs to view other exhibits. We think the cartoons are an authoritative sampling of what one might expect to encounter at a typical IRE show.

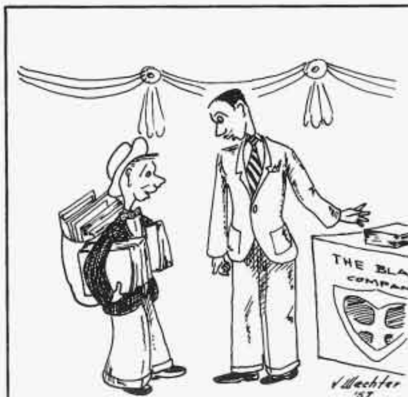
YOU FELLA'S GOT TO LEAVE. THE SHOW'S OVER !!


THESE PAPERS ARE THE BEST THING THAT EVER HAPPENED TO MY FEET !!



TEN MINUTES BEFORE THE SHOW OPENS ?

WHAT'S WRONG WITH OUR DISPLAY ?



JUST LITERATURE PLEASE !!

Q METER CONTEST AWARD

Q of the coil displayed at the IRE show is 336.7. The winning estimate (338) was submitted by Mr. George S. Scholl, Research Engineer with the American Machine and Foundry Co. of Alexandria, Va.

The coil in question was displayed in the BRC booth at the IRE show in New York during March 18 - 21. Anyone visiting the booth was invited to estimate the Q of the coil in competition for a Q Meter which was also on display. Entries were submitted on specially prepared forms. These entries have been tabulated and set up in graph form below to give an indication of the distribution of estimates.

Measurement of the coil was made at BRC by our Quality Control Engineer, on March 25, under the following conditions:

1. The coil was conditioned for 2 hours in the Standard Room with the atmosphere maintained at 73 ±2°F, relative humidity 50 ±5%.

2. Measurement was made on a BRC Type 260-A Q Meter which was checked by Q Standards 513-A and 518-A.

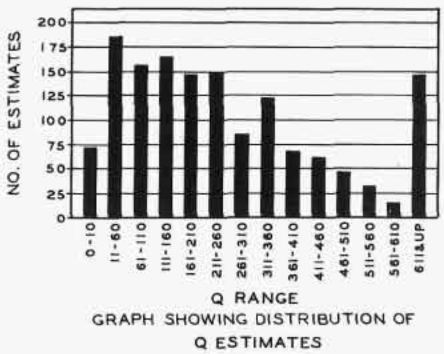
3. The coil was dismounted from the display case and connected to the Q Meter with the coil axis vertical. The winding ends were clamped by the Q Meter coil binding posts; spacing between the winding ends being the same as it was while the coil was on display.

4. The coil measurement frequency of 12.5 mc was checked against a crystal calibrator.

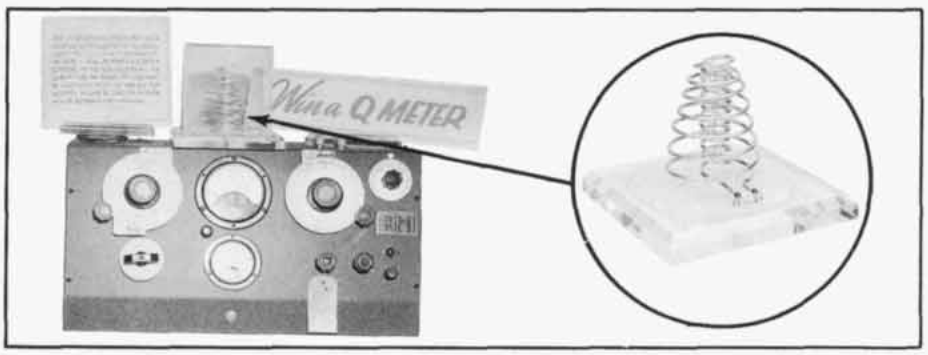
Following measurement, the coil was disconnected from the Q Meter, then reconnected and measured again in the same manner. Readings obtained for both measurements are shown in the table below.

Readings	1st Meas.	2nd Meas.	Average
Frequency (mc)	12.5	12.5	12.5
Q Meter Multiplier	1.4	1.4	1.4
Q Voltmeter	241.0	240.0	240.5
Q Indication	337.4	336.0	336.7
Q Meter Capacitance (μμf)	74.2	74.0	74.1

Other Q estimates worthy of honorable mention were submitted by J. C. Clements, Raytheon Mfg. Co. Ltd. (334) and J. F. Sterner, RCA, Isidore Bady, U.S.A.S.E.L., and S. Krevsky, Evans Sig. Lab., (all with 333).



Graph showing distribution of estimates in the Q Meter contest.



Shown above are the Type 260-A Q Meter and the controversial coil as they were displayed in the BRC booth at the IRE convention. An enlargement of the coil is shown in the insert.

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